

Caltrain / HSR Blended Service Plan Operations Considerations Analysis (Requested by Stakeholders)

Technical Appendix A: Detailed Simulation Results

Technical Appendix A – Detailed Simulation Results

This technical appendix presents the scenario-by-scenario detailed simulation results, including statistical tables as well as graphical time-distance (“string”) charts.

Table A1 shows the Caltrain simulation results for the AM peak hour (the peak 60 minutes within the AM peak) with trains departing terminals between 7 and 8am.

Table A1: Caltrain Simulation Results (AM Peak 60)
Speed: 79/79 (Caltrain/HSR) unless otherwise noted
AM Peak 60 – Trains Departing Terminals between 7 and 8 AM

Caltrain/ HSR Service Level	Average Trip Times (H:M:S)	Minimum Trip Time (H:M:S)	Maximum Trip Time (H:M:S)	Trip Time Standard Deviation (H:M:S)	Signal Delay (H:M:S)	Additional Caltrain Stops Required to Support Reliable Overtakes	Caltrain Peak Hour Service Intervals (at Palo Alto NB) (Minutes)	Infrastructure Assumed in Simulation
6/4	1:00:21	0:53:42	1:04:04	0:03:39	0:00:54	2	14/11/5/13/13/4	Long-Middle 4 Track Overtake
6/4	1:00:38	0:56:18	1:05:19	0:02:36	0:01:00	6	9/15/6/10/15/5	Short-Middle 4 Track Overtake
6/4	0:59:48	0:56:25	1:03:15	0:02:20	0:00:48	1	12/8/9/13/9/9	Middle 3 Track Overtake
6/4	1:01:29	0:55:58	1:04:07	0:02:52	0:18:40	9	11/13/5/11/15/5	North 4 Track Overtake
6/4	1:00:07	0:56:36	1:02:30	0:01:51	0:05:36	3	5/12/13/4/13/13	South 4 Track Overtake
6/4	1:00:34	0:57:02	1:05:48	0:03:10	0:07:32	5	4/12/13/5/12/14	HSR Redwood City Stop added to Long-Middle 4 Track Overtake
6/4	1:00:07	0:57:36	1:02:00	0:01:29	0:05:44	N.A.	12/13/5/14/9/7	Baby Bullet Caltrain service applied to Long-Middle 4 Track Overtake
(4/2)/4 ₁	1:05:57	1:04:02	1:08:06	0:02:11	0:02:44	3	14/9/5/13/13/6	Downtown Extension to Transbay Terminal applied to Long Middle 4 Track Overtake
	1:00:11	0:56:50	1:04:00	0:02:47				
6/4/1	1:00:06	0:55:49	1:05:29	0:02:52	0:04:02	2	3/14/12/3/16/12	Dumbarton Rail Corridor service added to Long Middle 4 Track Overtake

Note 1: First travel time data row is for travel to Transbay Terminal and second row is travel time data for 4th and King. The average travel to 4th and Townsend is 1:00:46. The average Caltrain travel time for all trips as measured at 4th & Townsend and 4th & King would be 1:00:23.

Table A2 shows the HSR simulation results for the AM peak hour with trains departing terminals between 7 and 8am.

Table A2: HSR Simulation Results (AM Peak 60)
Speed: 79/79 (Caltrain/HSR) unless otherwise noted
AM Peak 60 – Trains Departing Terminals between 7 and 8 AM

Caltrain/ HSR Service Level	Average Trip Times (H:M:S)	Minimum Trip Time (H:M:S)	Maximum Trip Time (H:M:S)	Trip Time Standard Deviation (H:M:S)	Signal Delay (H:M:S)	Infrastructure Assumed in Simulation
6/4	0:44:58	0:44:38	0:45:24	0:00:20	0:01:06	Long-Middle 4 Track Overtake
6/4	0:45:31	0:44:35	0:47:14	0:00:58	0:06:25	Short-Middle 4 Track Overtake
6/4	0:45:19	0:44:37	0:46:32	0:00:38	0:04:08	Middle 3 Track Overtake
6/4	0:47:42	0:45:20	0:50:31	0:01:54	0:35:59	North 4 Track Overtake
6/4	0:46:03	0:45:10	0:47:38	0:01:02	0:14:57	South 4 Track Overtake
6/4	0:48:39 ₁	0:47:53	0:49:28	0:00:28	0:05:41	HSR Redwood City Stop added to Long Middle 4-Track Overtake
(4/2)/4	0:46:38 ₂	0:46:20	0:47:13	0:00:17	0:02:49	Downtown Extension to Transbay Terminal added to Long-Middle 4-Track Overtake
6/4/1	0:45:01	0:44:37	0:45:52	0:00:26	0:03:18	Dumbarton Rail Corridor service added to Long-Middle 4 Track Overtake
6/4	0:45:33	0:44:38	0:47:20	0:00:58	0:05:01	Baby Bullet Caltrain service added to Long Middle 4-Track Overtake

Note 1: If the effects of the added Redwood City stop are removed, the average HSR travel time would be 45:28

Note 2: Travel Times measured at Transbay Terminal. Average DTX trip times to 4th and Townsend are 43:45 for HSR. Improvements in travel time to 4th and Townsend/4th and King versus the Long Middle 4 Track Overtake are due to elimination of delays and lower speeds associated with the low speed curve and low terminal area at 4th and King. In addition, HSR trains are able to pass Caltrain trips stopping at 4th and Townsend in route to Transbay Terminal because of three-track configuration.

Long Middle 4 Track Overtake

Table A3 shows the Long Middle 4 Track Overtake delay statistics for Caltrain and HSR trains for the AM peak period, PM peak period, the full day and the AM peak hour.

Table A3: Long Middle 4 Track Overtake Delay Statistics

	Delayed By	Caltrain			HSR			All Trains		
	Train Type	Stopped	Running	Total	Stopped	Running	Total	Stopped	Running	Total
AM Peak	Caltrain	0:00:10	0:00:48	0:00:58	0:00:00	0:00:25	0:00:25	0:00:10	0:01:13	0:01:23
	HSR	0:00:00	0:02:38	0:02:38	0:00:00	0:00:00	0:00:00	0:00:00	0:02:38	0:02:38
	Total	0:00:10	0:03:26	0:03:36	0:00:00	0:00:25	0:00:25	0:00:10	0:03:51	0:04:01
PM Peak	Caltrain	0:00:00	0:03:45	0:03:45	0:00:00	0:00:32	0:00:32	0:00:00	0:04:17	0:04:17
	HSR	0:00:28	0:05:12	0:05:40	0:00:00	0:00:00	0:00:00	0:00:28	0:05:12	0:05:40
	Total	0:00:28	0:08:57	0:09:25	0:00:00	0:00:32	0:00:32	0:00:28	0:09:29	0:09:57
Full Day	Caltrain	0:00:10	0:04:33	0:04:43	0:00:00	0:00:57	0:00:57	0:00:10	0:05:30	0:05:40
	HSR	0:00:28	0:08:45	0:09:13	0:00:00	0:00:00	0:00:00	0:00:28	0:08:45	0:09:13
	Total	0:00:38	0:13:18	0:13:56	0:00:00	0:00:57	0:00:57	0:00:38	0:14:15	0:14:53
AM 60	Caltrain	0:00:10	0:00:33	0:00:43	0:00:00	0:00:11	0:00:11	0:00:10	0:00:44	0:00:54
	HSR	0:00:00	0:01:06	0:01:06	0:00:00	0:00:00	0:00:00	0:00:00	0:01:06	0:01:06
	Total	0:00:10	0:01:39	0:01:49	0:00:00	0:00:11	0:00:11	0:00:10	0:01:50	0:02:00

Table A4 shows the Long Middle 4 Track Overtake travel time statistics for Caltrain and HSR trains for the AM peak period, PM peak period, the full day and the AM peak hour.

Table A4: Long Middle 4 Track Overtake Travel Time Statistics

		Average	Min	Max	Standard Deviation
AM Peak	Caltrain	1:00:38	0:53:42	1:05:38	0:03:36
	HSR	0:44:56	0:44:38	0:45:24	0:00:18
PM Peak	Caltrain	1:00:25	0:54:32	1:06:12	0:03:23
	HSR	0:45:05	0:44:38	0:46:16	0:00:25
Full Day	Caltrain	1:06:27	0:53:42	1:18:40	0:08:17
	HSR	0:44:59	0:44:37	0:46:26	0:00:22
AM 60	Caltrain	1:00:21	0:53:42	1:04:04	0:03:39
	HSR	0:44:58	0:44:38	0:45:24	0:00:20

Figure A1 shows the Long Middle 4 Track Overtake time-distance string chart for the morning peak period of 7 to 9am. **Figure A2** shows the Long Middle 4 Track Overtake time-distance string chart for the midday period of 11am to 1pm. **Figure A3** shows the Long Middle 4 Track time-distance string chart for the evening peak period of 5 to 7pm.

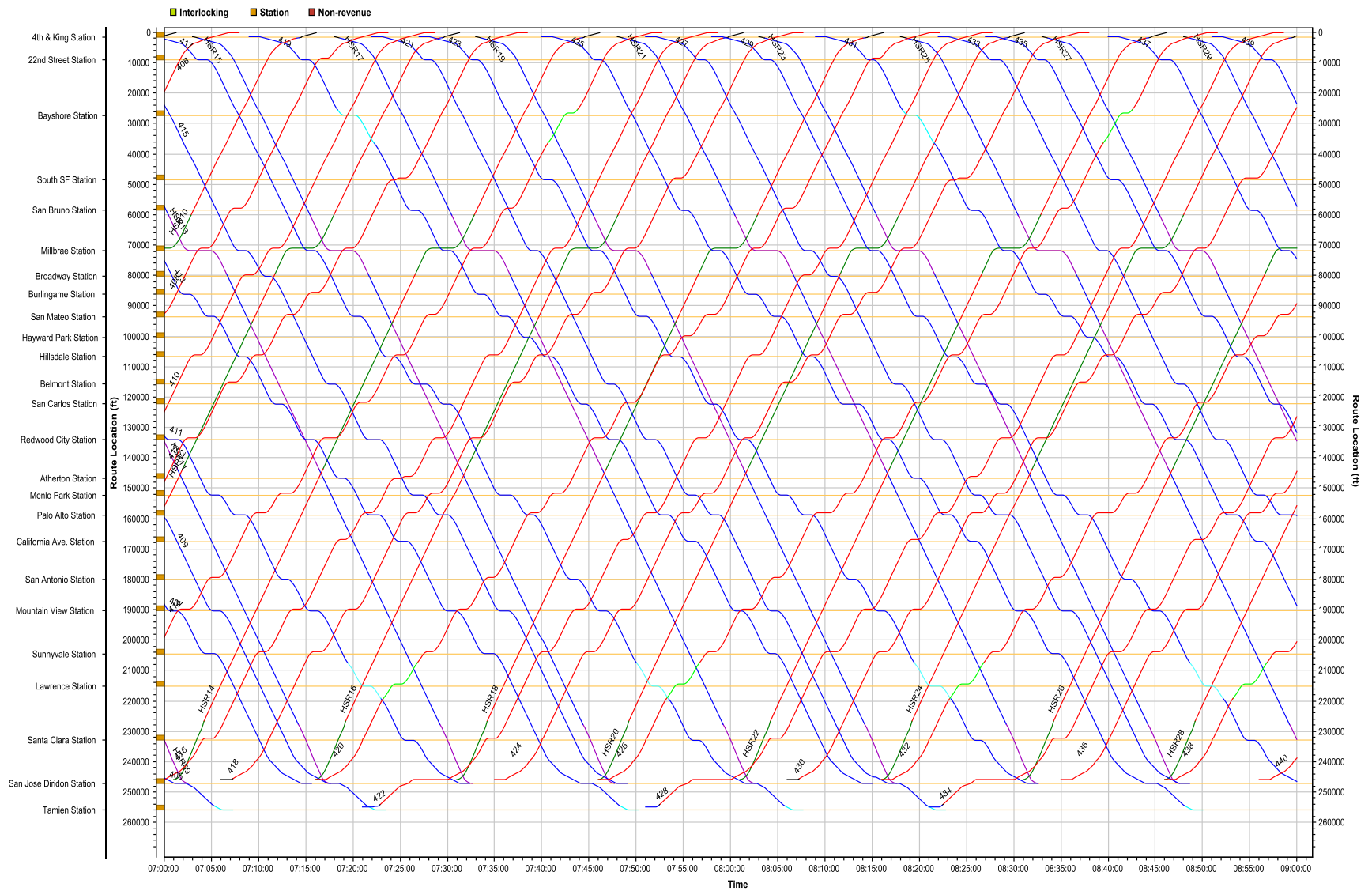


Figure A1: Long Middle 4 Track Overtake AM String Chart – 7 to 9 AM

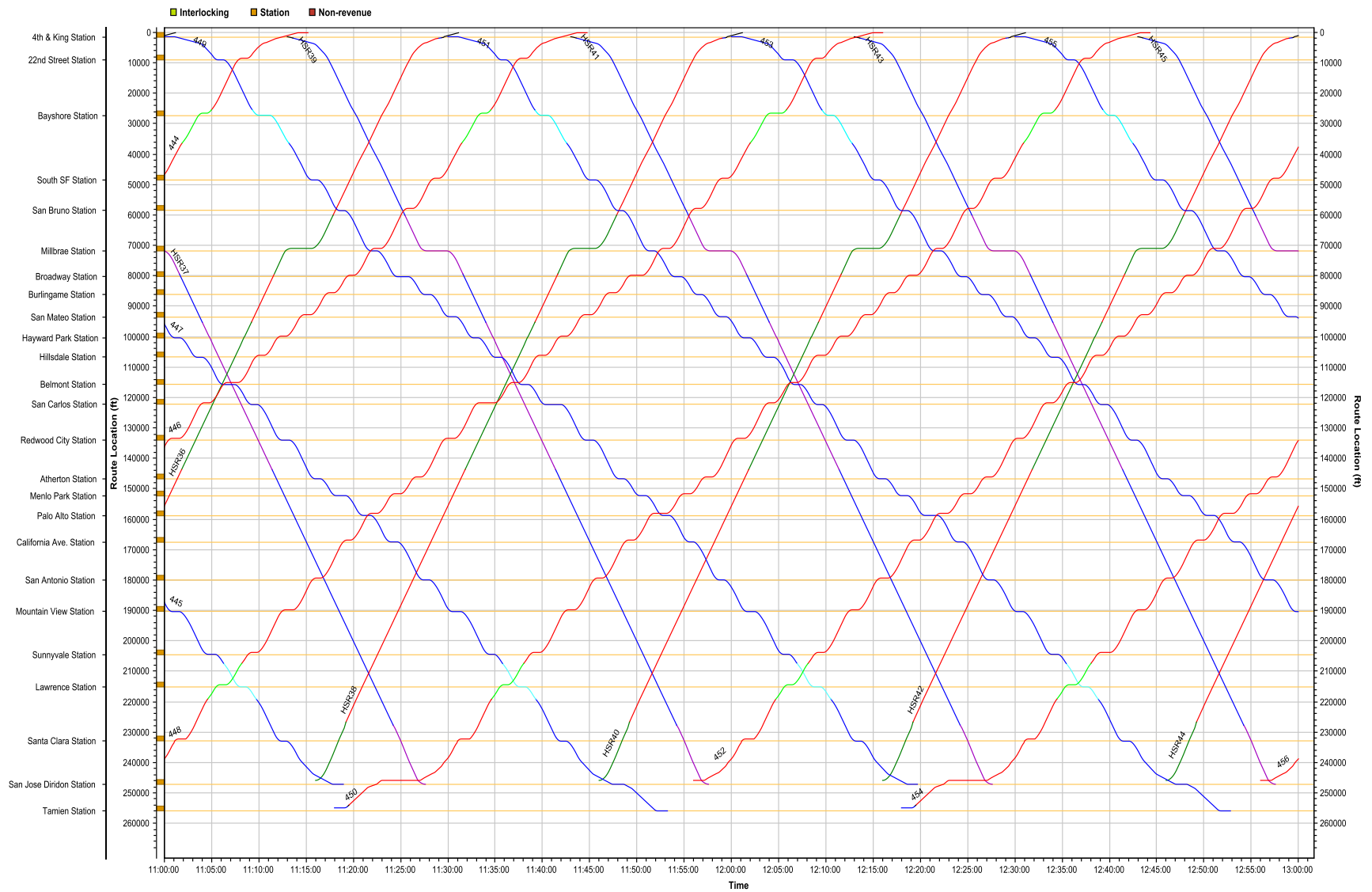


Figure A2: Long Middle 4 Track Overtake Midday String Chart 11 AM – 1 PM

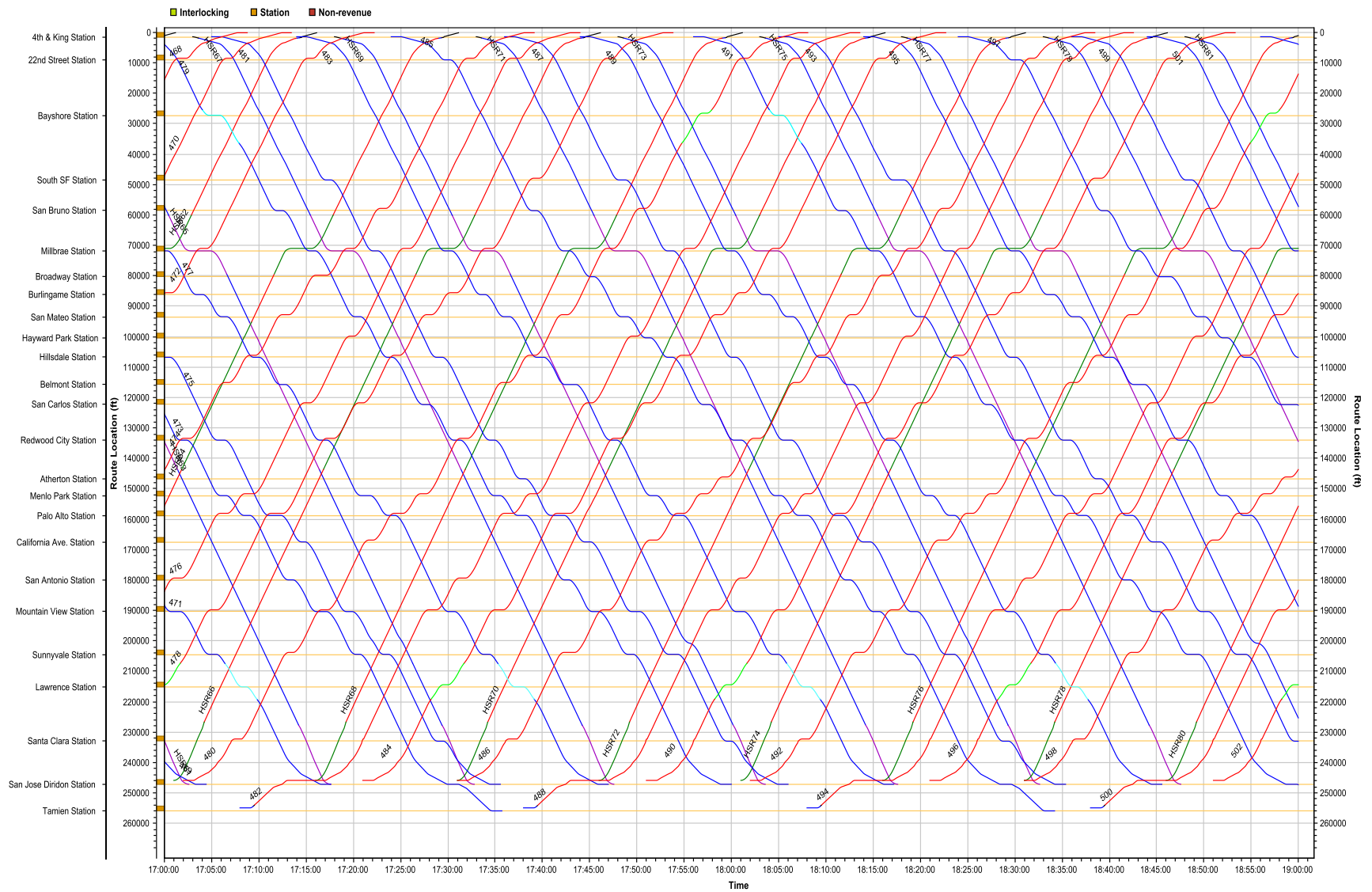


Figure A3: Long Middle 4 Track Overtake PM String Chart 5-7 PM

Short Middle 4 Track Overtake

Table A5 shows the Short Middle 4 Track Overtake delay statistics for Caltrain and HSR trains for the AM peak period, PM peak period, the full day and the AM peak hour.

Table A5: Short Middle 4 Track Overtake Delay Statistics

	Delayed By	Caltrain			HSR			All Trains		
	Train Type	Stopped	Running	Total	Stopped	Running	Total	Stopped	Running	Total
AM Peak	Caltrain	0:00:01	0:03:44	0:03:45	0:00:00	0:00:12	0:00:12	0:00:01	0:03:56	0:03:57
	HSR	0:07:27	0:17:03	0:24:30	0:00:00	0:00:00	0:00:00	0:07:27	0:17:03	0:24:30
	Total	0:07:28	0:20:47	0:28:15	0:00:00	0:00:12	0:00:12	0:07:28	0:20:59	0:28:27
PM Peak	Caltrain	0:00:46	0:03:39	0:04:25	0:00:00	0:02:21	0:02:21	0:00:46	0:06:00	0:06:46
	HSR	0:05:06	0:21:04	0:26:10	0:00:00	0:00:00	0:00:00	0:05:06	0:21:04	0:26:10
	Total	0:05:52	0:24:43	0:30:35	0:00:00	0:02:21	0:02:21	0:05:52	0:27:04	0:32:56
Full Day	Caltrain	0:00:47	0:07:23	0:08:10	0:00:00	0:02:43	0:02:43	0:00:47	0:10:06	0:10:53
	HSR	0:13:26	0:39:40	0:53:06	0:00:00	0:00:00	0:00:00	0:13:26	0:39:40	0:53:06
	Total	0:14:13	0:47:03	1:01:16	0:00:00	0:02:43	0:02:43	0:14:13	0:49:46	1:03:59
AM 60	Caltrain	0:00:01	0:00:59	0:01:00	0:00:00	0:00:00	0:00:00	0:00:01	0:00:59	0:01:00
	HSR	0:01:50	0:04:35	0:06:25	0:00:00	0:00:00	0:00:00	0:01:50	0:04:35	0:06:25
	Total	0:02:15	0:08:09	0:10:24	0:00:00	0:00:00	0:00:00	0:02:15	0:08:09	0:10:24

Table A6 shows the Short Middle 4 Track Overtake travel time statistics for Caltrain and HSR trains for the AM peak period, PM peak period, the full day and the AM peak hour.

Table A6: Short Middle 4 Track Overtake Travel Time Statistics

		Average	Min	Max	Standard Deviation
AM Peak	Caltrain	1:01:01	0:55:50	1:05:19	0:02:41
	HSR	0:45:36	0:44:35	0:48:22	0:01:05
PM Peak	Caltrain	1:00:58	0:56:52	1:04:49	0:02:20
	HSR	0:45:51	0:44:35	0:47:59	0:01:03
Full Day	Caltrain	1:06:44	0:55:50	1:18:35	0:07:49
	HSR	0:45:19	0:44:35	0:48:22	0:00:53
AM 60	Caltrain	1:00:38	0:56:18	1:05:19	0:02:36
	HSR	0:45:31	0:44:35	0:47:14	0:00:58

Figure A4 shows the Short Middle 4 Track Overtake time-distance string chart for the morning peak period of 7 to 9am. **Figure A5** shows the Short Middle 4 Track Overtake time-distance string chart for the midday period of 11am to 1pm. **Figure A6** shows the Short Middle 4 Track Overtake time-distance string chart for the evening peak period of 5 to 7pm.

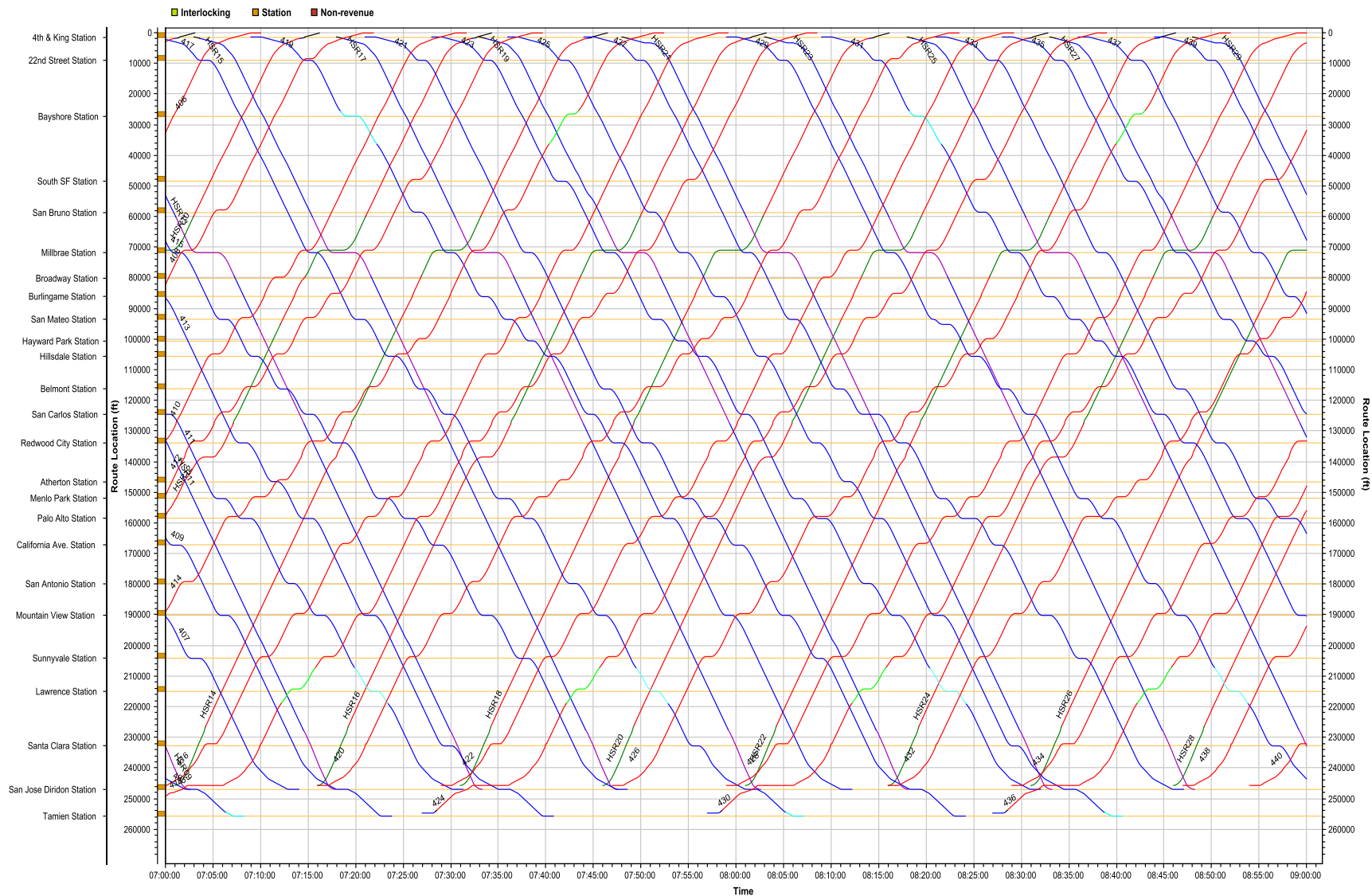
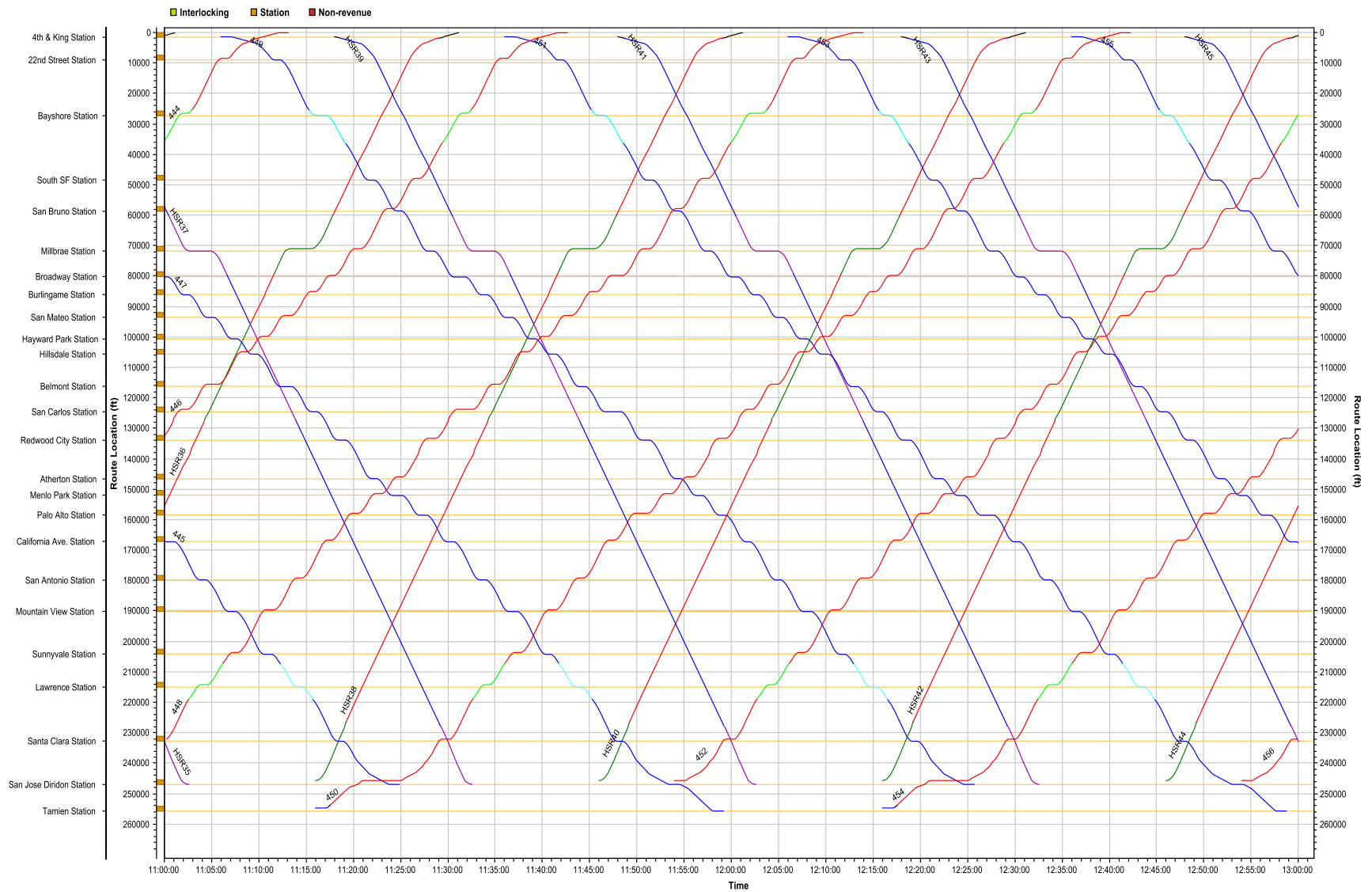


Figure A4: Short Middle 4 Track Overtake AM String Chart 7-9 AM



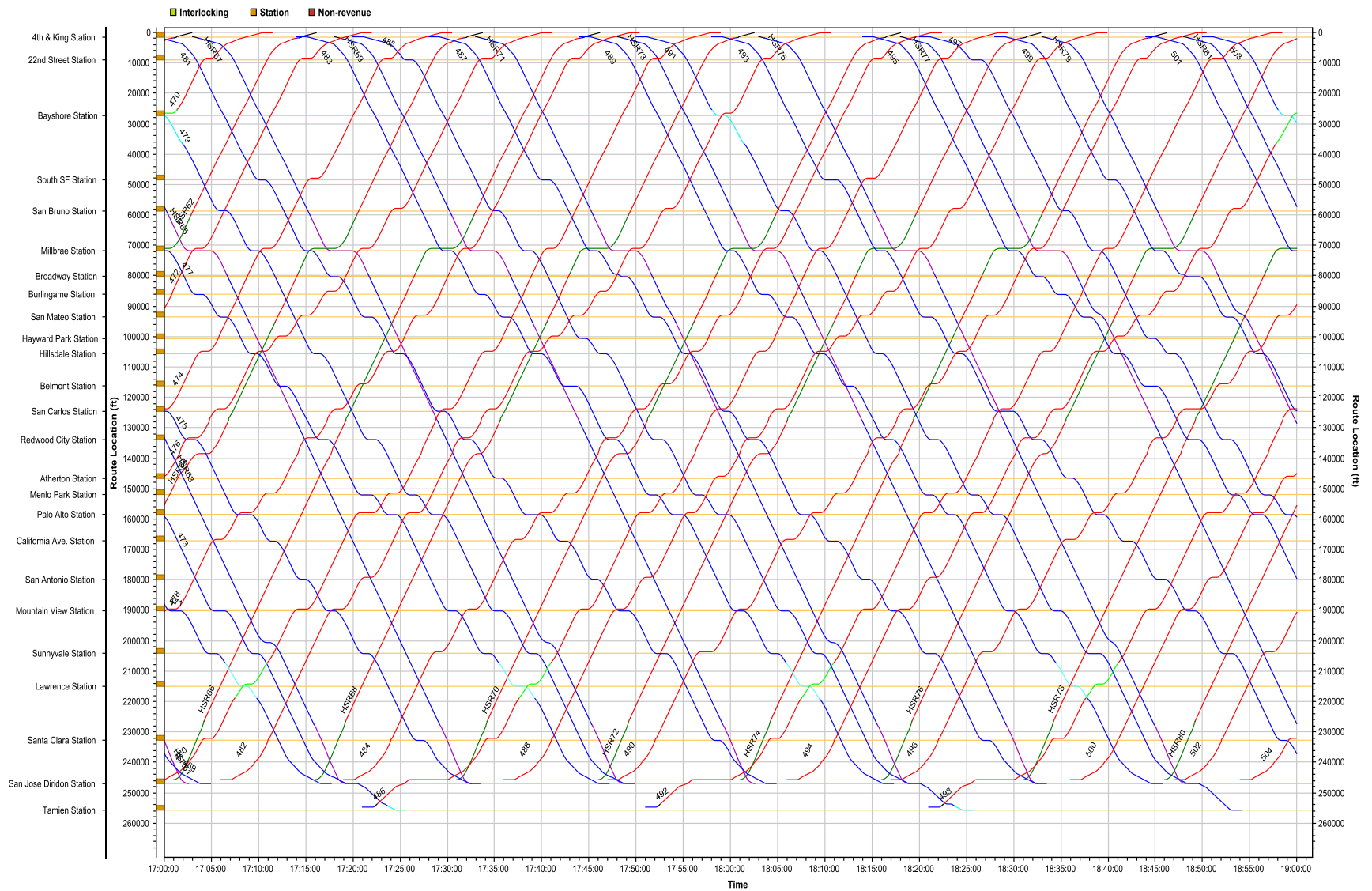


Figure A6: Short Middle 4 Track Overtake PM String Chart 5-7 PM

Middle 3 Track Overtake

Table A7 shows the Middle 3 Track Overtake delay statistics for Caltrain and HSR trains for the AM peak period, PM peak period and the full day.

Table A7: Middle 3 Track Overtake Delay Statistics

	Delayed By	Caltrain			HSR			All Trains		
	Train Type	Stopped	Running	Total	Stopped	Running	Total	Stopped	Running	Total
AM Peak	Caltrain	0:01:30	0:00:28	0:01:58	0:00:00	0:00:00	0:00:00	0:01:30	0:00:28	0:01:58
	HSR	0:01:04	0:11:43	0:12:47	0:00:00	0:00:00	0:00:00	0:01:04	0:11:43	0:12:47
	Total	0:02:34	0:12:11	0:14:45	0:00:00	0:00:00	0:00:00	0:02:34	0:12:11	0:14:45
PM Peak	Caltrain	0:00:00	0:01:57	0:01:57	0:00:00	0:00:21	0:00:21	0:00:00	0:02:18	0:02:18
	HSR	0:00:50	0:14:43	0:15:33	0:00:00	0:00:00	0:00:00	0:00:50	0:14:43	0:15:33
	Total	0:00:50	0:16:40	0:17:30	0:00:00	0:00:21	0:00:21	0:00:50	0:17:01	0:17:51
Full Day	Caltrain	0:01:30	0:02:25	0:03:55	0:00:00	0:00:21	0:00:21	0:01:30	0:02:46	0:04:16
	HSR	0:01:54	0:28:11	0:30:05	0:00:00	0:00:00	0:00:00	0:01:54	0:28:11	0:30:05
	Total	0:03:24	0:30:36	0:34:00	0:00:00	0:00:21	0:00:21	0:03:24	0:30:57	0:34:21

Table A8 shows the Middle 3 Track Overtake travel time statistics for Caltrain and HSR trains for the AM peak period, PM peak period and the full day.

Table A8: Middle 3 Track Overtake Travel Time Statistics

		Average	Min	Max	σ
AM Peak	Caltrain	1:00:13	0:56:25	1:04:12	0:02:28
	HSR	0:45:20	0:44:37	0:47:12	0:00:44
PM Peak	Caltrain	1:00:15	0:55:21	1:04:16	0:02:39
	HSR	0:45:28	0:44:38	0:47:13	0:00:40
Full Day	Caltrain	1:06:11	0:55:21	1:18:40	0:08:06
	HSR	0:45:12	0:44:37	0:47:13	0:00:35

Figure A7 shows the Middle 3 Track Overtake time-distance string chart for the morning peak period of 7 to 9am. **Figure A8** shows the Middle 3 Track Overtake time-distance string chart for the midday period of 11am to 1pm. **Figure A9** shows the Middle 3 Track Overtake time-distance string chart for the evening peak period of 5 to 7pm.

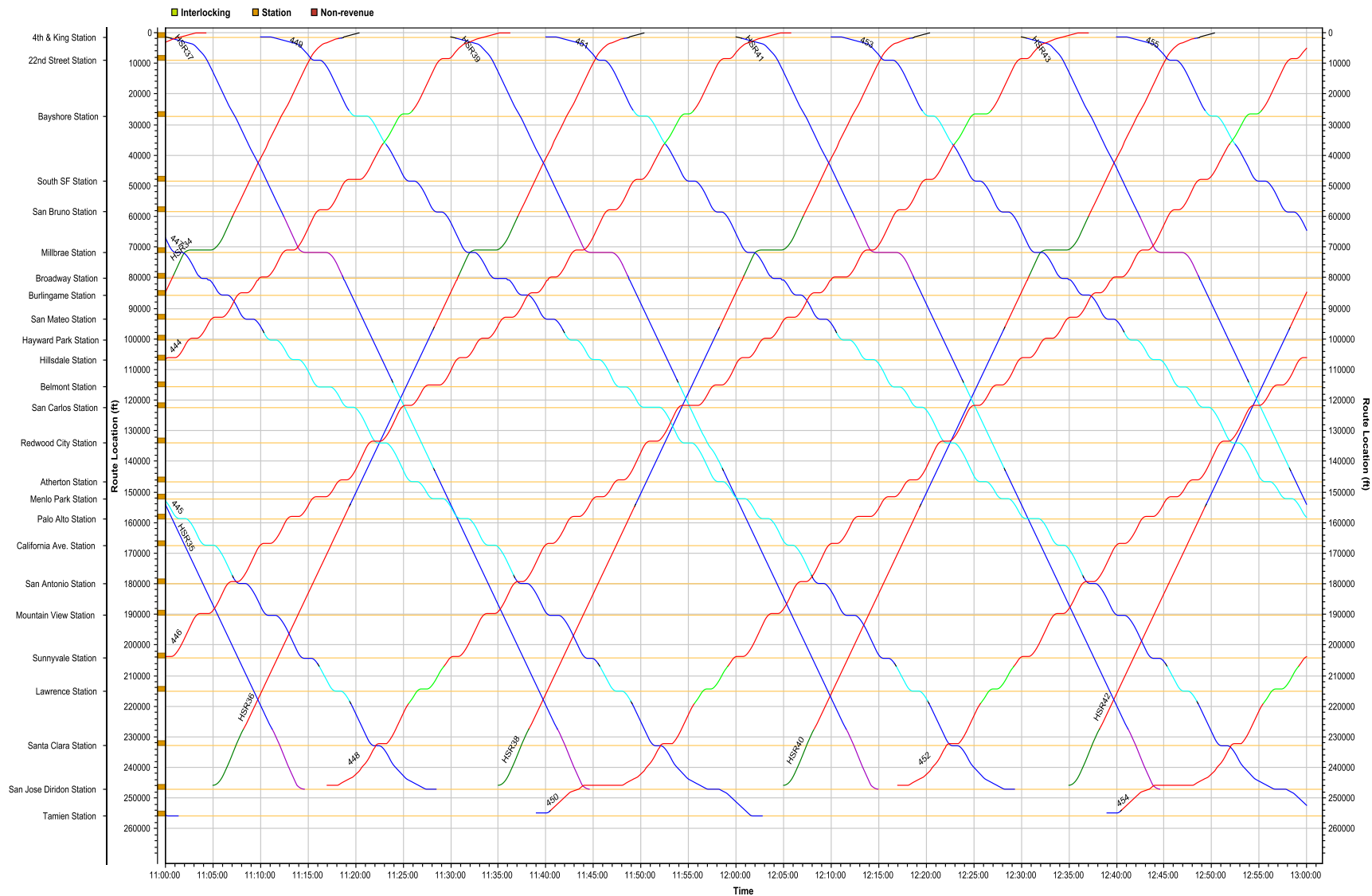


Figure A8: Middle 3 Track Overtake String Chart 11 AM - 1 PM

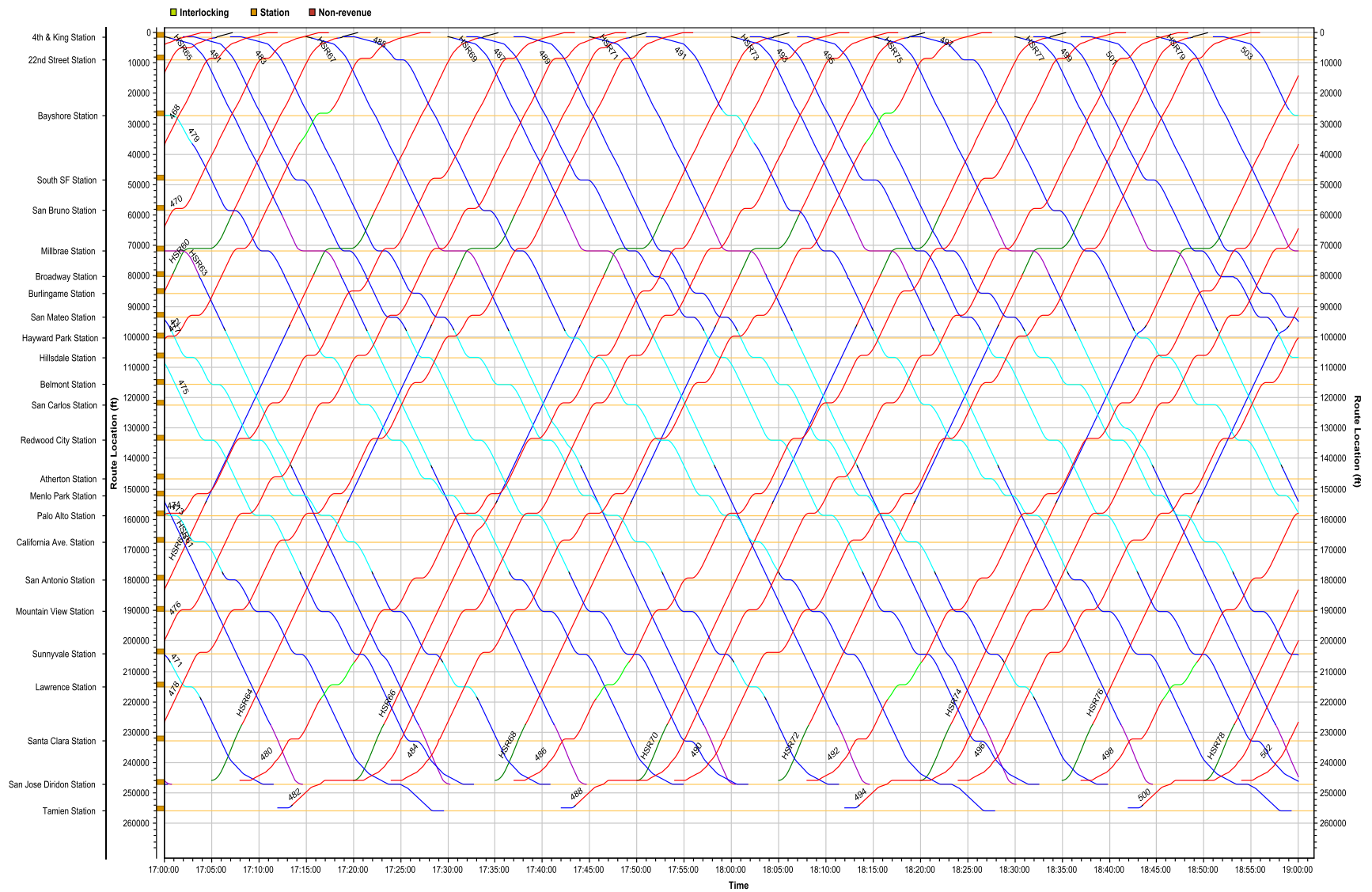


Figure A9: Middle 3 Track Overtake PM String Chart 5-7 PM

North 4 Track Overtake

Table A9 shows the North 4 Track Overtake delay statistics for Caltrain and HSR trains for the AM peak period, PM peak period and the full day.

Table A9 : North 4 Track Overtake Delay Statistics

	Delayed By Train Type	Caltrain			HSR			All Trains		
		Stopped	Running	Total	Stopped	Running	Total	Stopped	Running	Total
AM Peak	Caltrain	0:00:00	0:01:29	0:01:29	0:17:41	0:34:54	0:52:35	0:17:41	0:36:23	0:54:04
	HSR	0:15:27	1:33:50	1:49:17	0:00:00	0:00:00	0:00:00	0:15:27	1:33:50	1:49:17
	Total	0:15:27	1:35:19	1:50:46	0:17:41	0:34:54	0:52:35	0:33:08	2:10:13	2:43:21
PM Peak	Caltrain	0:00:00	0:00:00	0:00:00	0:25:05	0:34:01	0:59:06	0:25:05	0:34:01	0:59:06
	HSR	0:28:21	1:30:24	1:58:45	0:00:00	0:00:00	0:00:00	0:28:21	1:30:24	1:58:45
	Total	0:28:21	1:30:24	1:58:45	0:25:05	0:34:01	0:59:06	0:53:26	2:04:25	2:57:51
Full Day	Caltrain	0:01:32	0:01:59	0:03:31	1:01:27	2:04:59	3:06:26	1:02:59	2:06:58	3:09:57
	HSR	0:43:48	3:17:54	4:01:42	0:00:00	0:00:00	0:00:00	0:43:48	3:17:54	4:01:42
	Total	0:45:20	3:19:53	4:05:13	1:01:27	2:04:59	3:06:26	1:46:47	5:24:52	7:11:39

Table A10 shows the North 4 Track Overtake travel time statistics for Caltrain and HSR trains for the AM peak period, PM peak period and the full day.

Table A10: North 4 Track Overtake Travel Time Statistics

		Average	Min	Max
AM Peak	Caltrain	1:01:50	0:55:58	1:05:29
	HSR	0:47:45	0:43:51	0:52:22
PM Peak	Caltrain	1:01:53	0:57:53	1:05:21
	HSR	0:48:51	0:44:25	0:54:38
Full Day	Caltrain	1:07:09	0:55:58	1:17:37
	HSR	0:46:15	0:43:51	0:54:38

Figure A10 shows the North 4 Track Overtake time-distance string chart for the morning peak period of 7 to 9am. **Figure A11** shows the North 4 Track Overtake time-distance string chart for the midday period of 11am to 1pm. **Figure A12** shows the North 4 Track Overtake time-distance string chart for the evening peak period of 5 to 7pm.

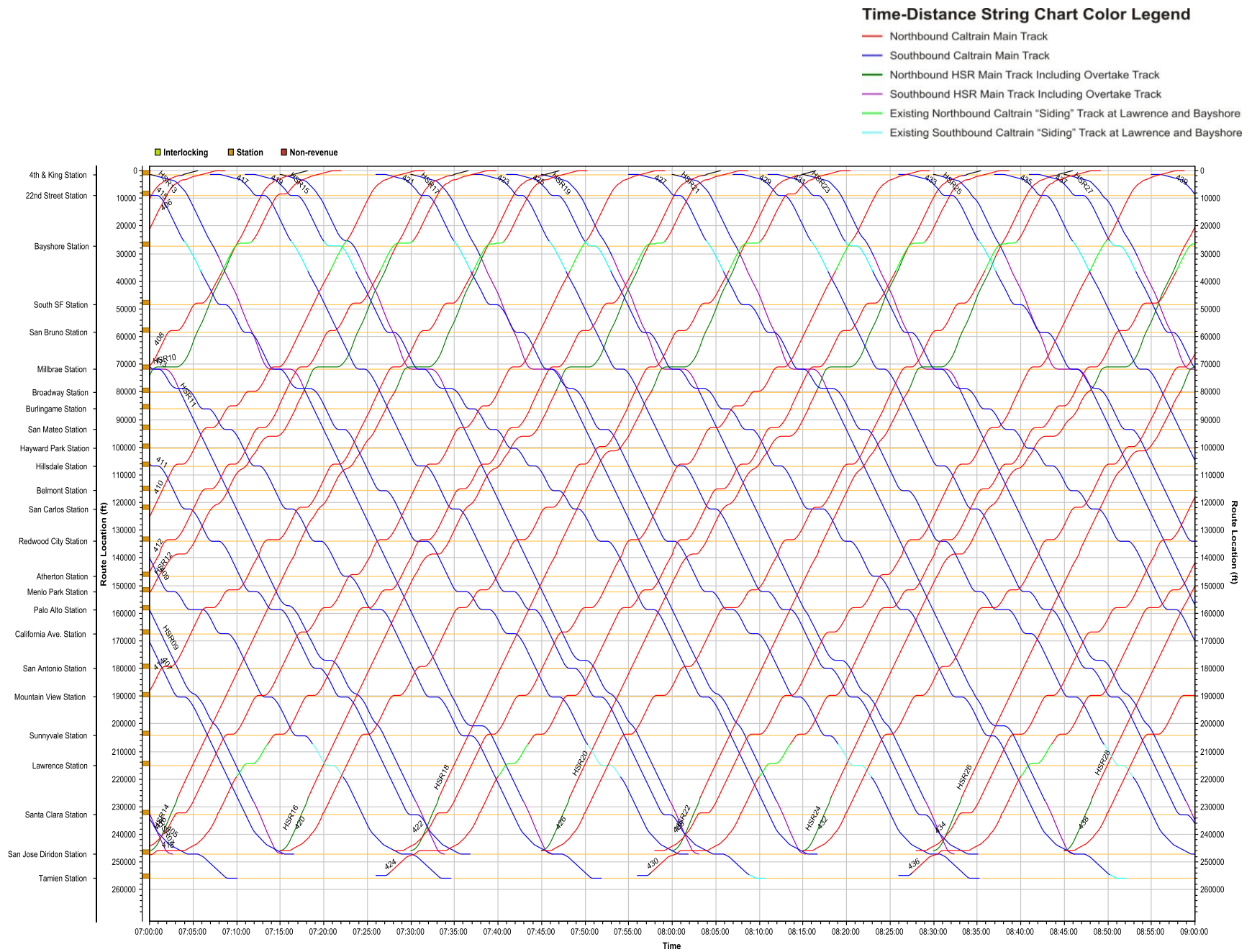


Figure A10: North 4 Track Overtake AM String Chart 7-9 AM

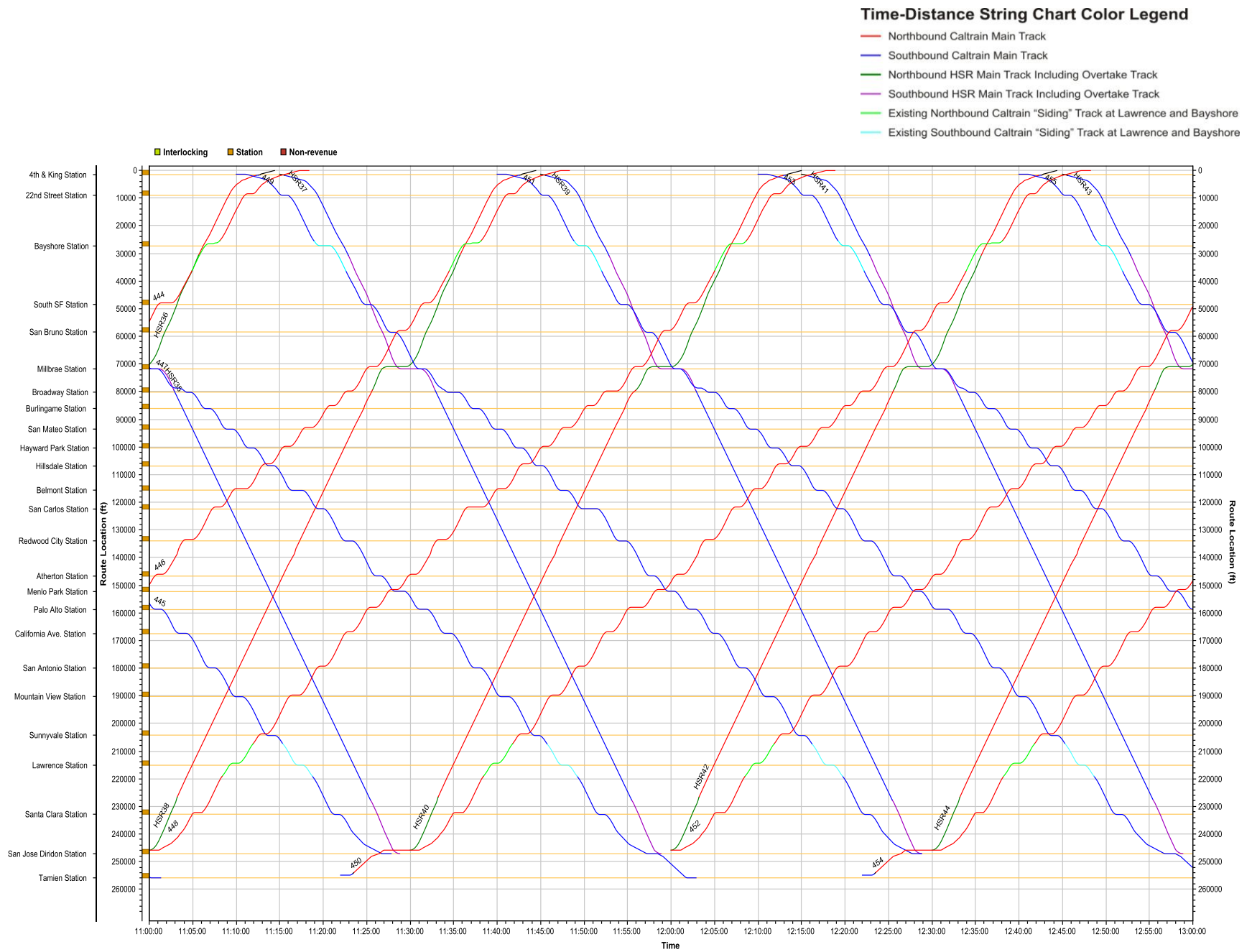
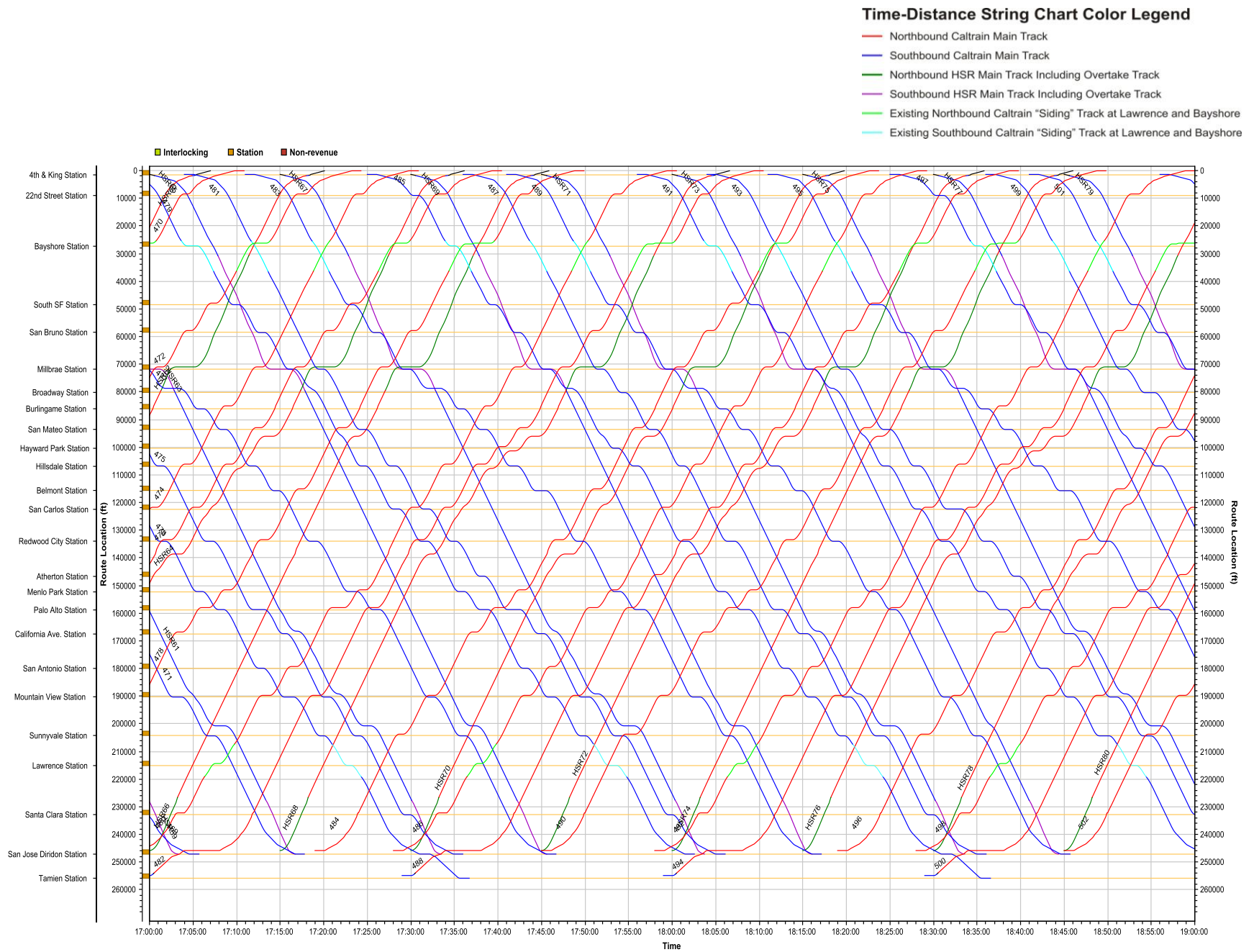


Figure A11: North 4 Track Overtake Midday String Chart 11 AM - 1 PM



South 4 Track Overtake

Table A11 shows the South 4 Track Overtake delay statistics for Caltrain and HSR trains for the AM peak period, PM peak period and the full day.

Table A11: South 4 Track Overtake Delay Statistics

	Delayed By	Caltrain			HSR			All Trains		
	Train Type	Stopped	Running	Total	Stopped	Running	Total	Stopped	Running	Total
AM Peak	Caltrain	0:01:51	0:04:33	0:06:24	0:00:45	0:05:55	0:06:40	0:02:36	0:10:28	0:13:04
	HSR	0:02:08	0:39:45	0:41:53	0:00:00	0:00:00	0:00:00	0:02:08	0:39:45	0:41:53
	Total	0:03:59	0:44:18	0:48:17	0:00:45	0:05:55	0:06:40	0:04:44	0:50:13	0:54:57
PM Peak	Caltrain	0:00:07	0:12:53	0:13:00	0:00:00	0:07:37	0:07:37	0:00:07	0:20:30	0:20:37
	HSR	0:03:00	0:43:58	0:46:58	0:00:00	0:00:00	0:00:00	0:03:00	0:43:58	0:46:58
	Total	0:03:07	0:56:51	0:59:58	0:00:00	0:07:37	0:07:37	0:03:07	1:04:28	1:07:35
Full Day	Caltrain	0:01:58	0:17:26	0:19:24	0:00:45	0:14:01	0:14:46	0:02:43	0:31:27	0:34:10
	HSR	0:05:48	1:31:31	1:37:19	0:00:00	0:00:00	0:00:00	0:05:48	1:31:31	1:37:19
	Total	0:07:46	1:48:57	1:56:43	0:00:45	0:14:01	0:14:46	0:08:31	2:02:58	2:11:29

Table A12 shows the South 4 Track Overtake travel time statistics for Caltrain and HSR trains for the AM peak period, PM peak period and the full day.

Table A12: South 4 Track Overtake Travel Time Statistics

		Average	Min	Max
AM Peak	Caltrain	1:00:36	0:56:36	1:03:36
	HSR	0:46:06	0:44:40	0:48:27
PM Peak	Caltrain	1:00:18	0:57:05	1:03:05
	HSR	0:46:15	0:44:37	0:48:47
Full Day	Caltrain	1:06:12	0:56:36	1:18:04
	HSR	0:45:34	0:44:37	0:48:47

Figure A13 shows the South 4 Track Overtake time-distance string chart for the morning peak period of 7 to 9am. **Figure A14** shows the South 4 Track Overtake time-distance string chart for the midday period of 11am to 1pm. **Figure A21** shows the South 4 Track Overtake time-distance string chart for the evening peak period of 5 to 7pm.

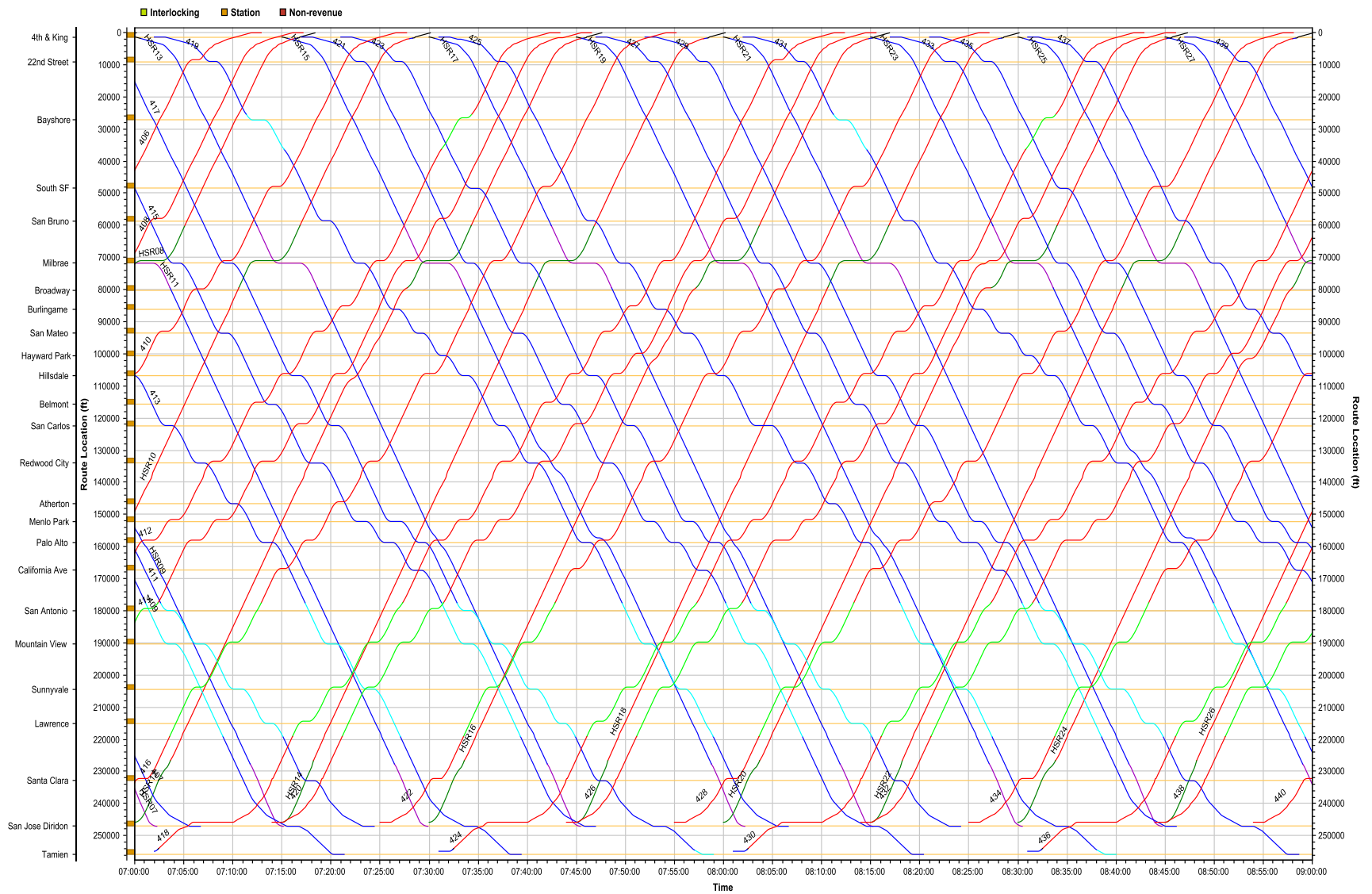


Figure A13: South 4 Track Overtake AM String Chart 7-9 AM

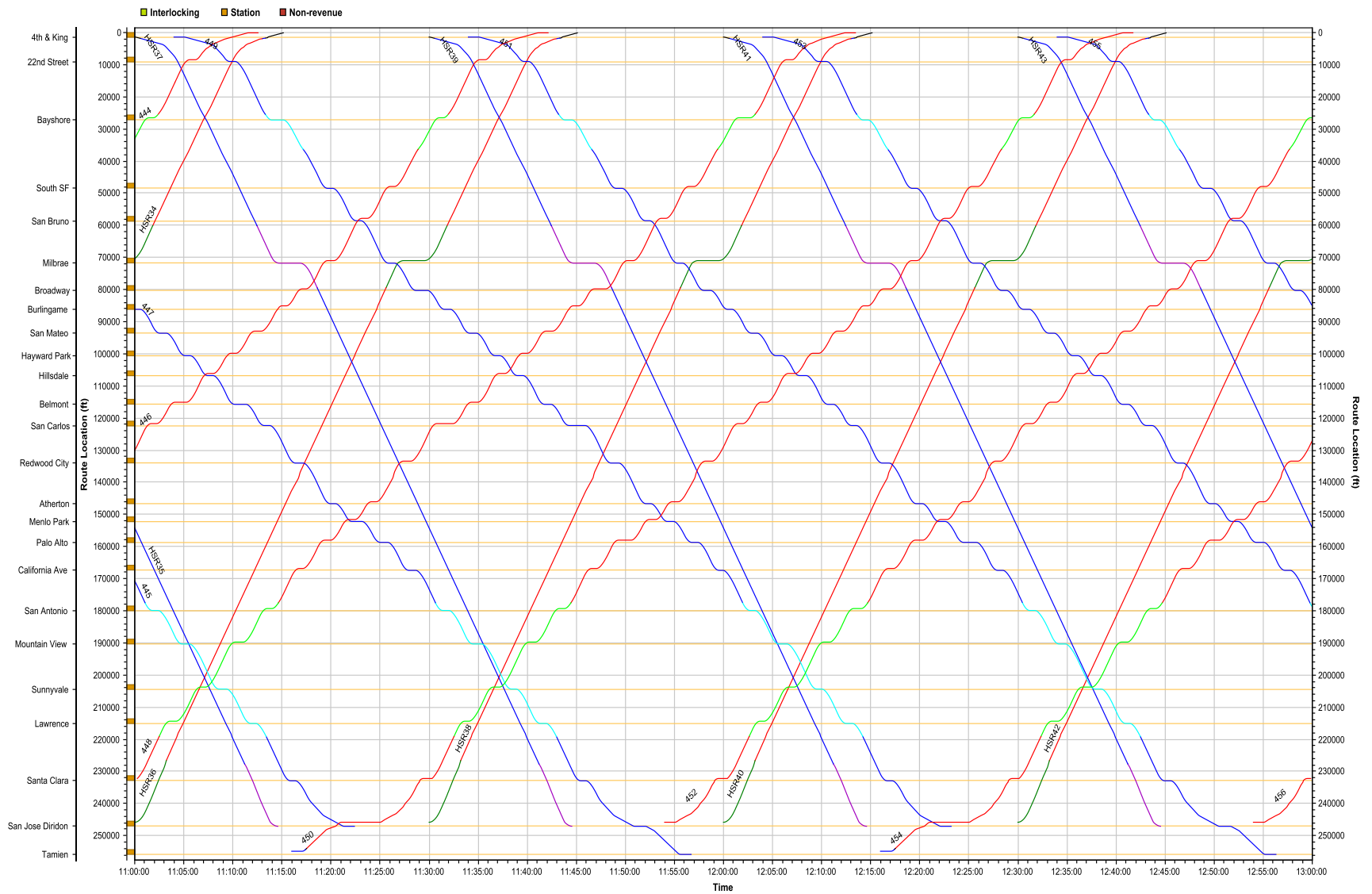


Figure A14: South 4 Track Overtake Midday String Chart 11 AM - 1 PM

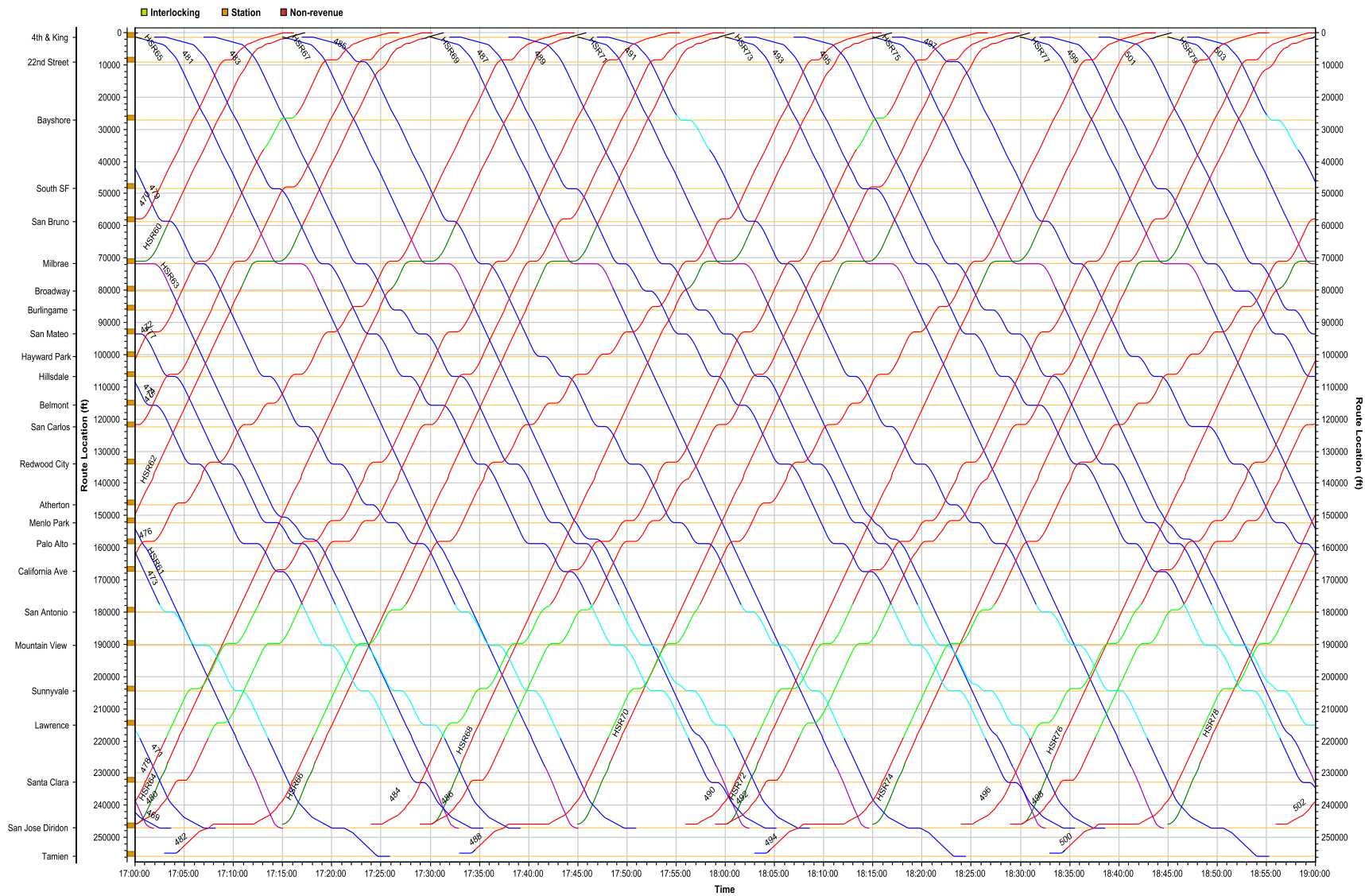


Figure A15: South Overtake PM String Chart 5-7 PM

Additional Infrastructure and Service Pattern Configurations

HSR Redwood City Station

Table A13 shows the HSR Redwood City stops with Long Middle 4 Track Overtake delay statistics for Caltrain and HSR trains for the AM peak period, PM peak period and the full day.

Table A13: Long Middle 4 Track (RWC) Delay Statistics

	Delayed By Train Type	Caltrain			HSR			All Trains		
		Stopped	Running	Total	Stopped	Running	Total	Stopped	Running	Total
AM Peak	Caltrain	0:00:33	0:06:54	0:07:27	0:00:00	0:03:52	0:03:52	0:00:33	0:10:46	0:11:19
	HSR	0:00:00	0:20:02	0:20:02	0:00:00	0:00:00	0:00:00	0:00:00	0:20:02	0:20:02
	Total	0:00:33	0:26:56	0:27:29	0:00:00	0:03:52	0:03:52	0:00:33	0:30:48	0:31:21
PM Peak	Caltrain	0:00:16	0:09:47	0:10:03	0:00:00	0:03:46	0:03:46	0:00:16	0:13:33	0:13:49
	HSR	0:00:10	0:13:20	0:13:30	0:00:00	0:00:00	0:00:00	0:00:10	0:13:20	0:13:30
	Total	0:00:26	0:23:07	0:23:33	0:00:00	0:03:46	0:03:46	0:00:26	0:26:53	0:27:19
Full Day	Caltrain	0:00:49	0:16:41	0:17:30	0:00:00	0:09:55	0:09:55	0:00:49	0:26:36	0:27:25
	HSR	0:00:33	0:44:05	0:44:38	0:00:00	0:00:00	0:00:00	0:00:33	0:44:05	0:44:38
	Total	0:01:22	1:00:46	1:02:08	0:00:00	0:09:55	0:09:55	0:01:22	1:10:41	1:12:03

Table A14 shows the Long Middle 4 Track Overtake with HSR Redwood City stops travel time statistics for Caltrain and HSR trains for the AM peak period, PM peak period and the full day.

Table A14: Long Middle 4 Track (RWC) Travel Time Statistics

		Average	Min	Max
AM Peak	Caltrain	1:01:03	0:56:12	1:07:41
	HSR	0:48:47	0:47:48	0:50:11
PM Peak	Caltrain	1:00:59	0:56:53	1:06:17
	HSR	0:48:31	0:47:48	0:50:24
Full Day	Caltrain	1:06:48	0:56:12	1:18:49
	HSR	0:48:30	0:47:48	0:50:31

Figure A16 shows the Long Middle 4 Track Overtake with HSR Redwood City stops time-distance string chart for the morning peak period of 7 to 9am. **Figure A17** shows the Long Middle 4 Track Overtake with HSR Redwood City stops time-distance string chart for the midday period of 11am to 1pm. **Figure A18** shows the Long Middle 4 Track Overtake with HSR Redwood City stops time-distance string chart for the evening peak period of 5 to 7pm.

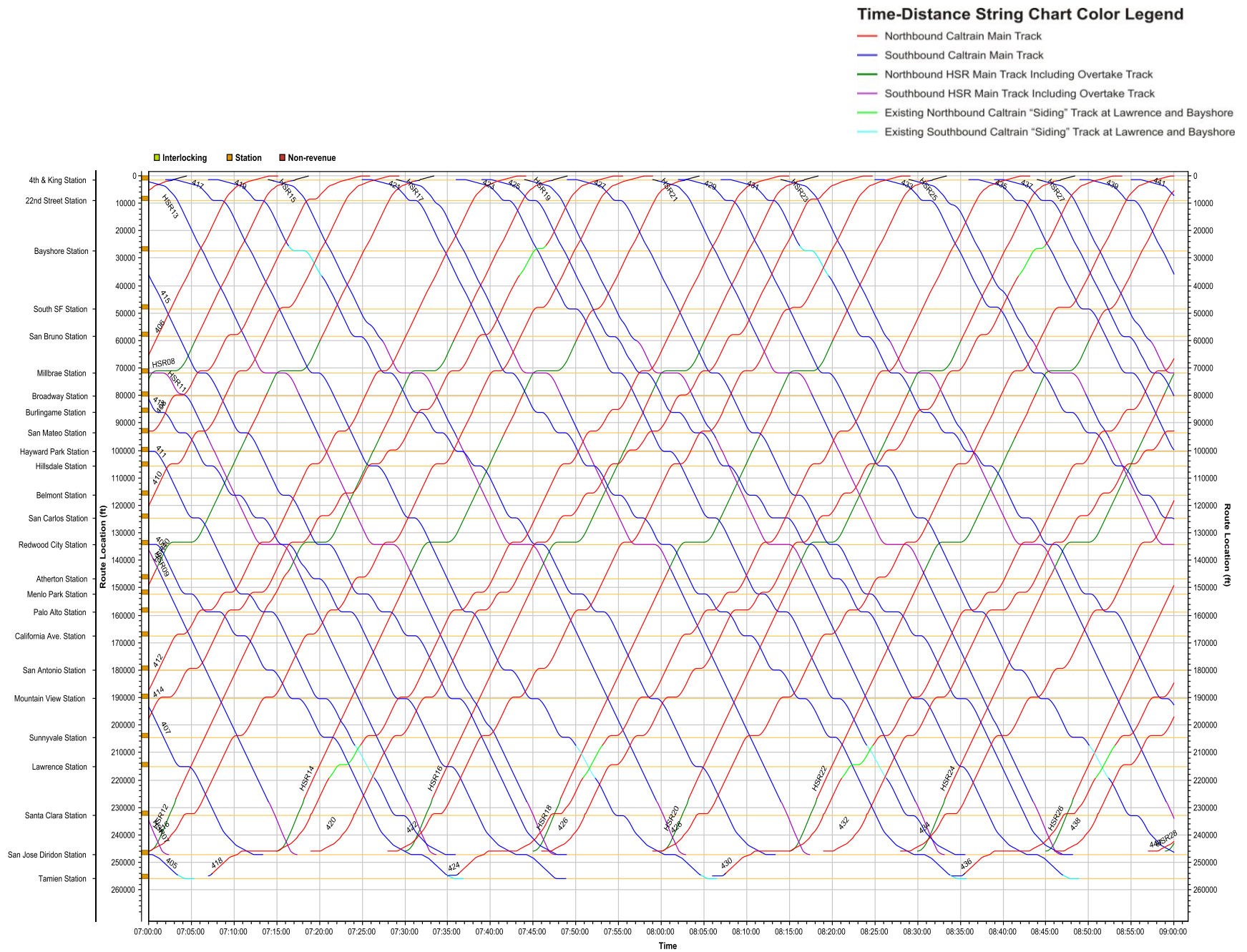
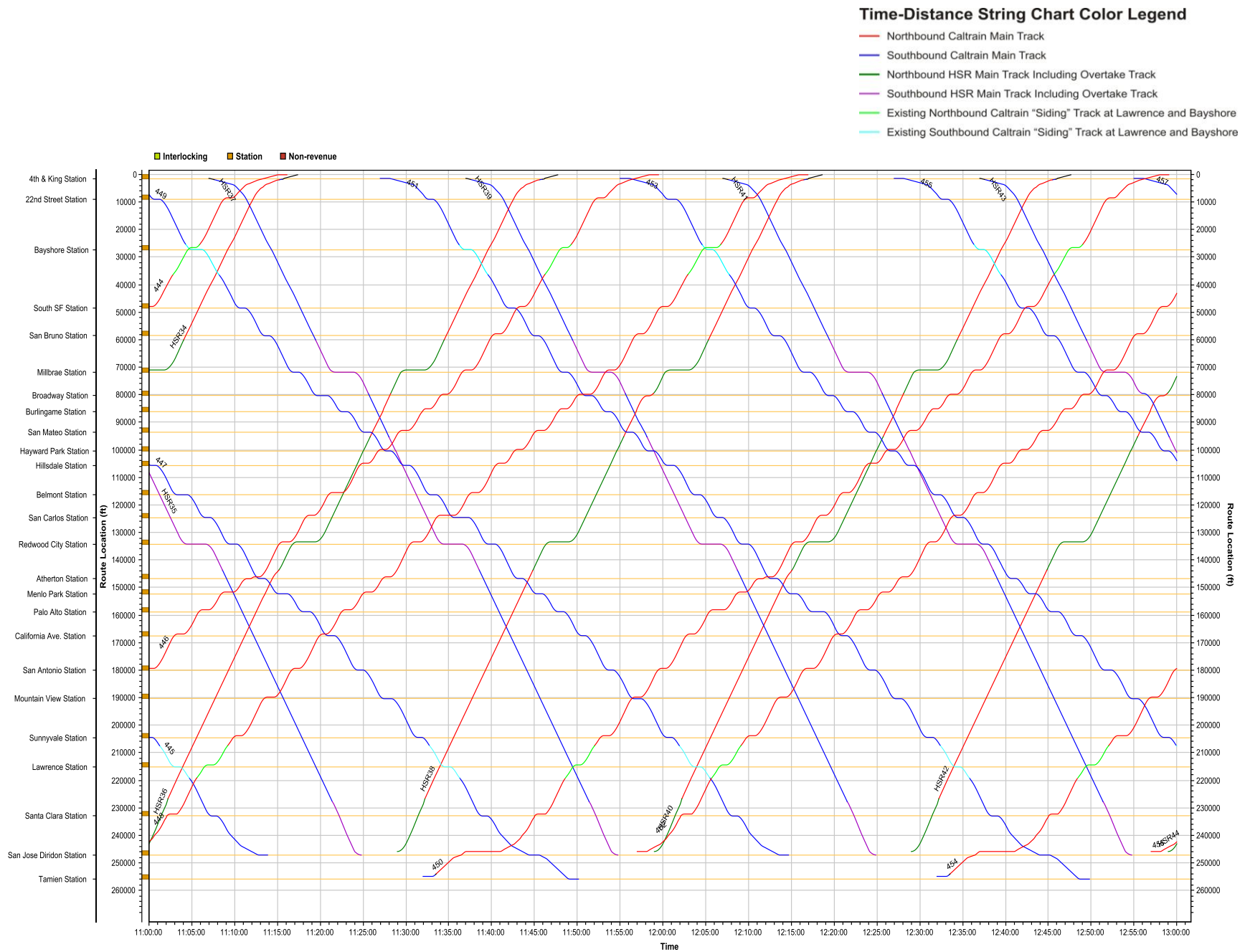
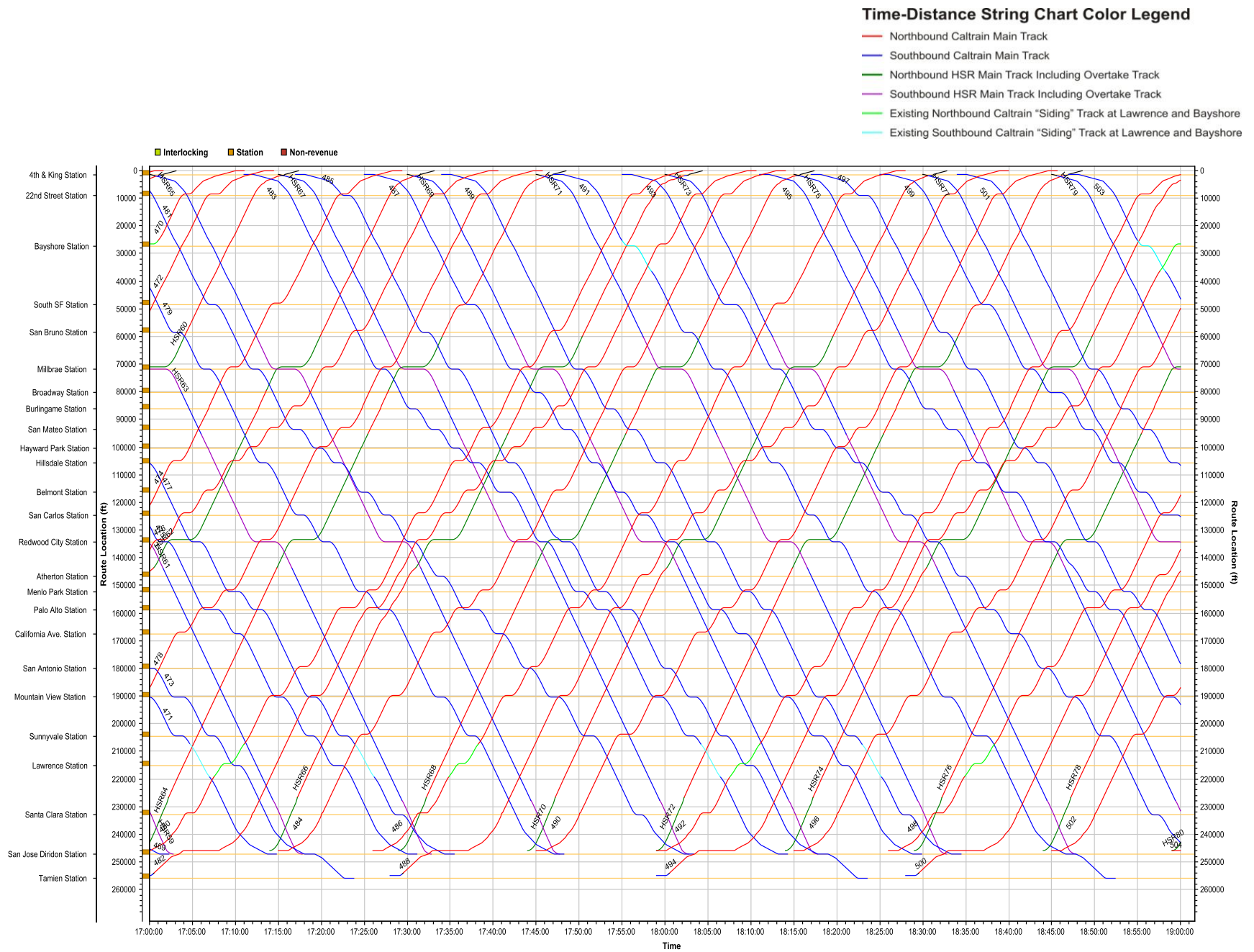


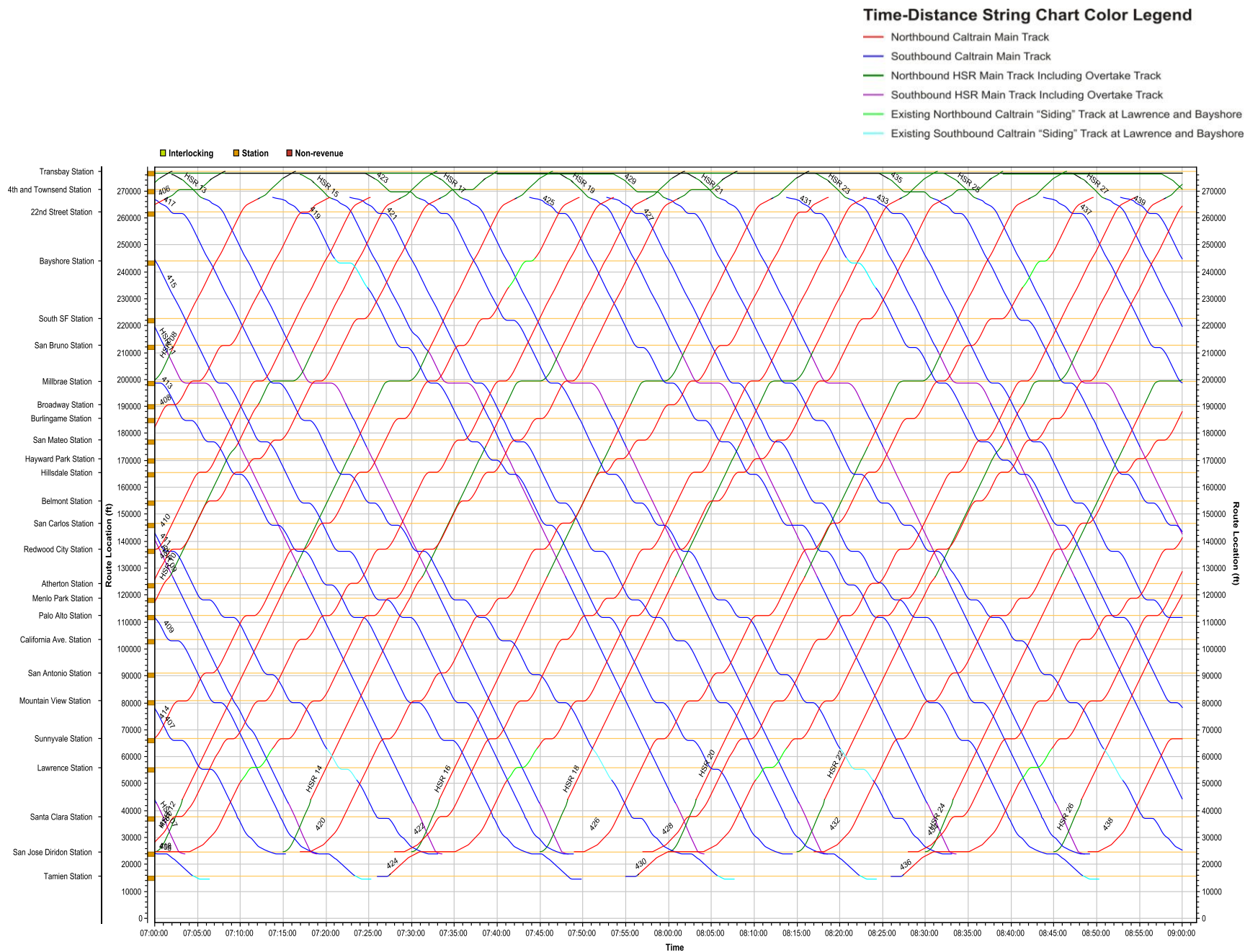
Figure A16: Long Middle 4 Track Overtake with HSR RWC Stop AM String Chart 7-9 AM





DTX Extension

Figure A19 shows the Downtown Extension with Long Middle 4 Track (79/79) time-distance string chart for the morning peak period of 7 to 9am. **Figure A20** shows the Downtown Extension with the Long Middle 4 Track Overtake (79/79) time-distance string chart for the midday period of 11am to 1pm. **Figure A21** shows the Downtown Extension with the Long Middle 4 Track Overtake (79/79) time-distance string chart for the evening peak period of 5 to 7pm.



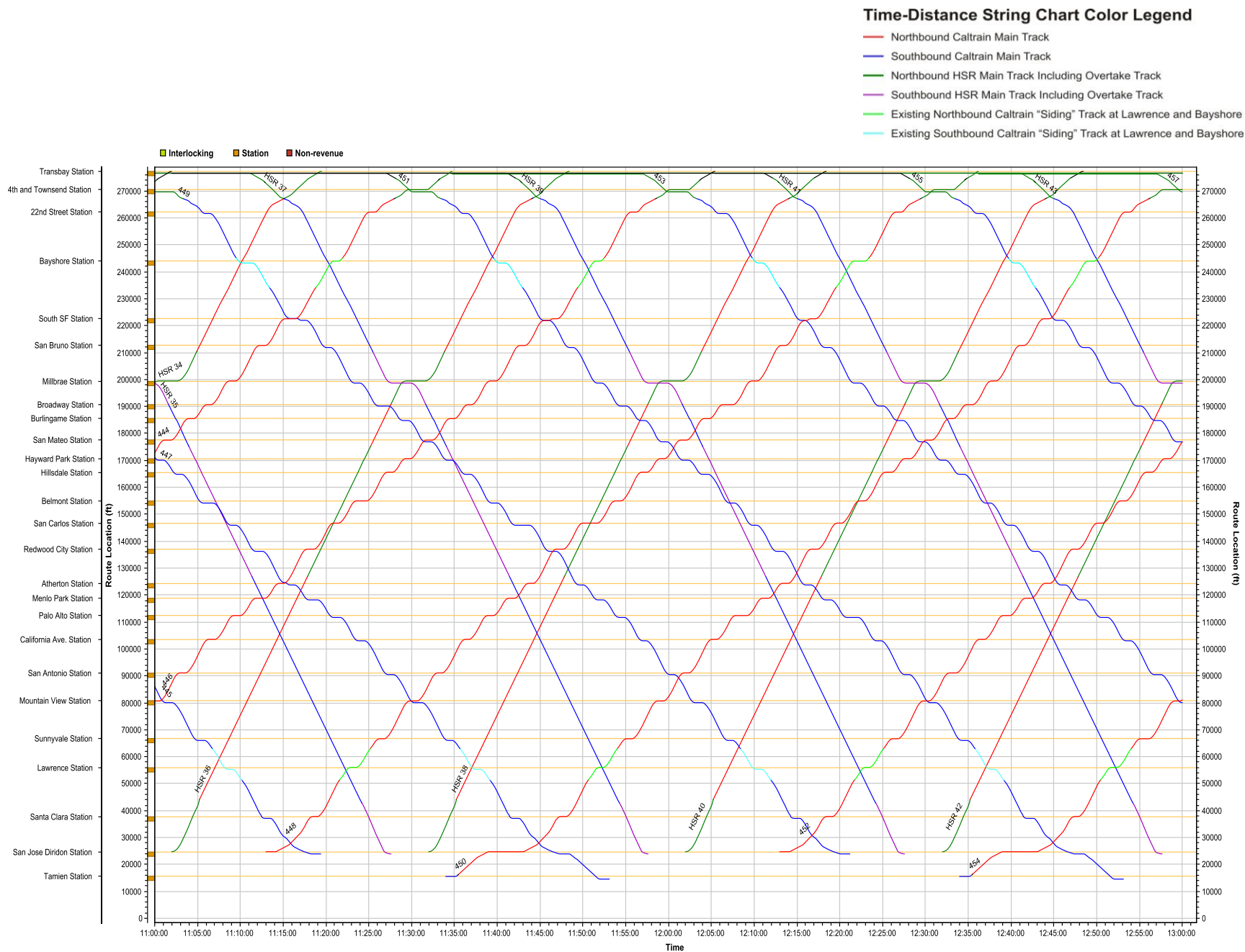


Figure A20: Downtown Extension with Long Middle 4 Track Overtake (79/79) String Chart 11 AM -1 PM

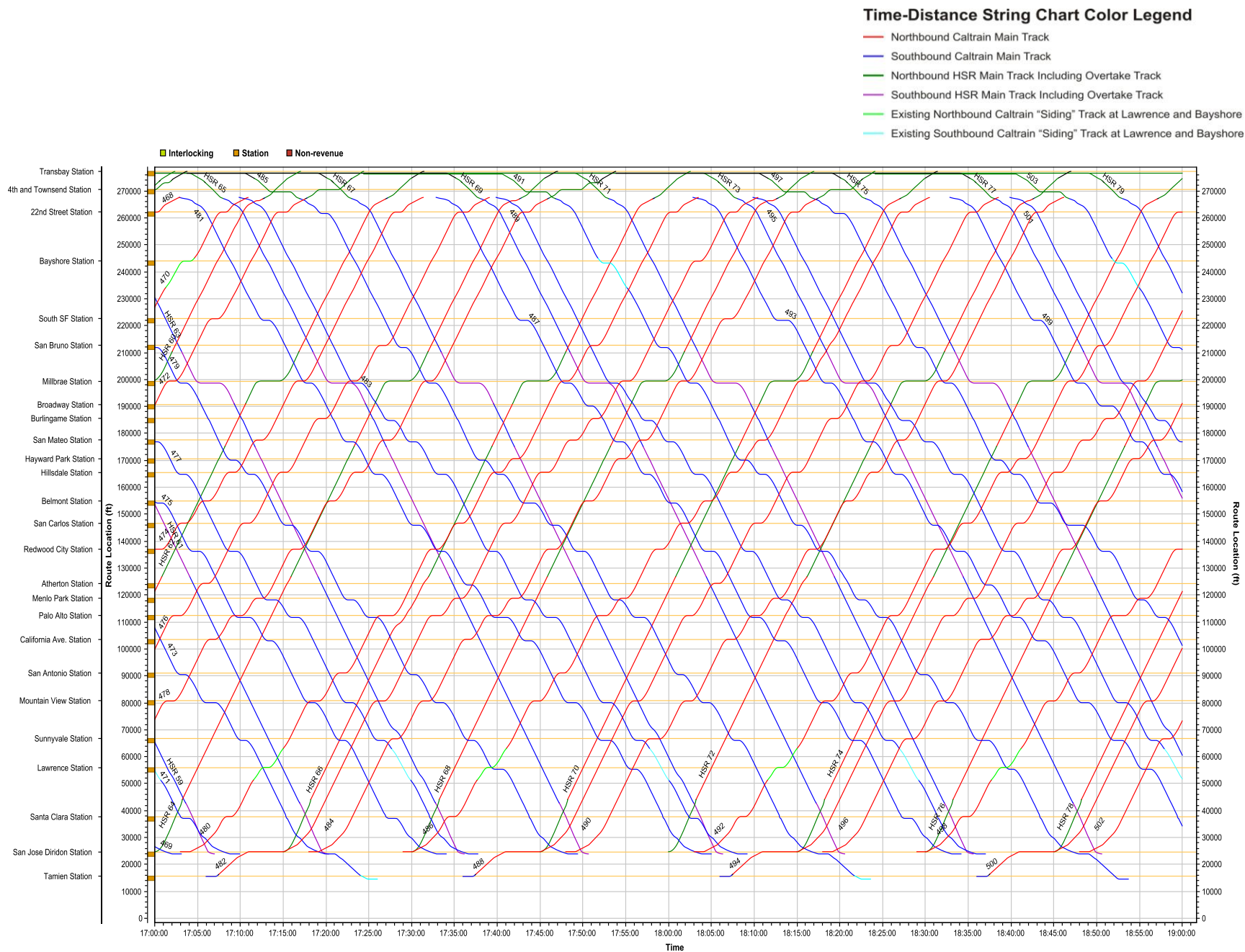


Figure A21: Downtown Extension with Long Middle 4 Track Overtake (79/79) PM String Chart 5-7 PM

Dumbarton Rail Corridor Service (79 MPH)

Figure A22 shows the Dumbarton Rail Corridor Service added to the Long Middle 4 Track Overtake (79 MPH) time-distance string chart for the morning peak period of 7 to 9am. **Figure A23** shows the Dumbarton Rail Corridor Service added to the Long Middle 4 Track Overtake (79 MPH) time-distance string chart for the midday period of 11am to 1pm. **Figure A24** shows the Dumbarton Rail Corridor Service added to the Long Middle 4 Track Overtake (79 MPH) time-distance string chart for the evening peak period of 5 to 7pm.

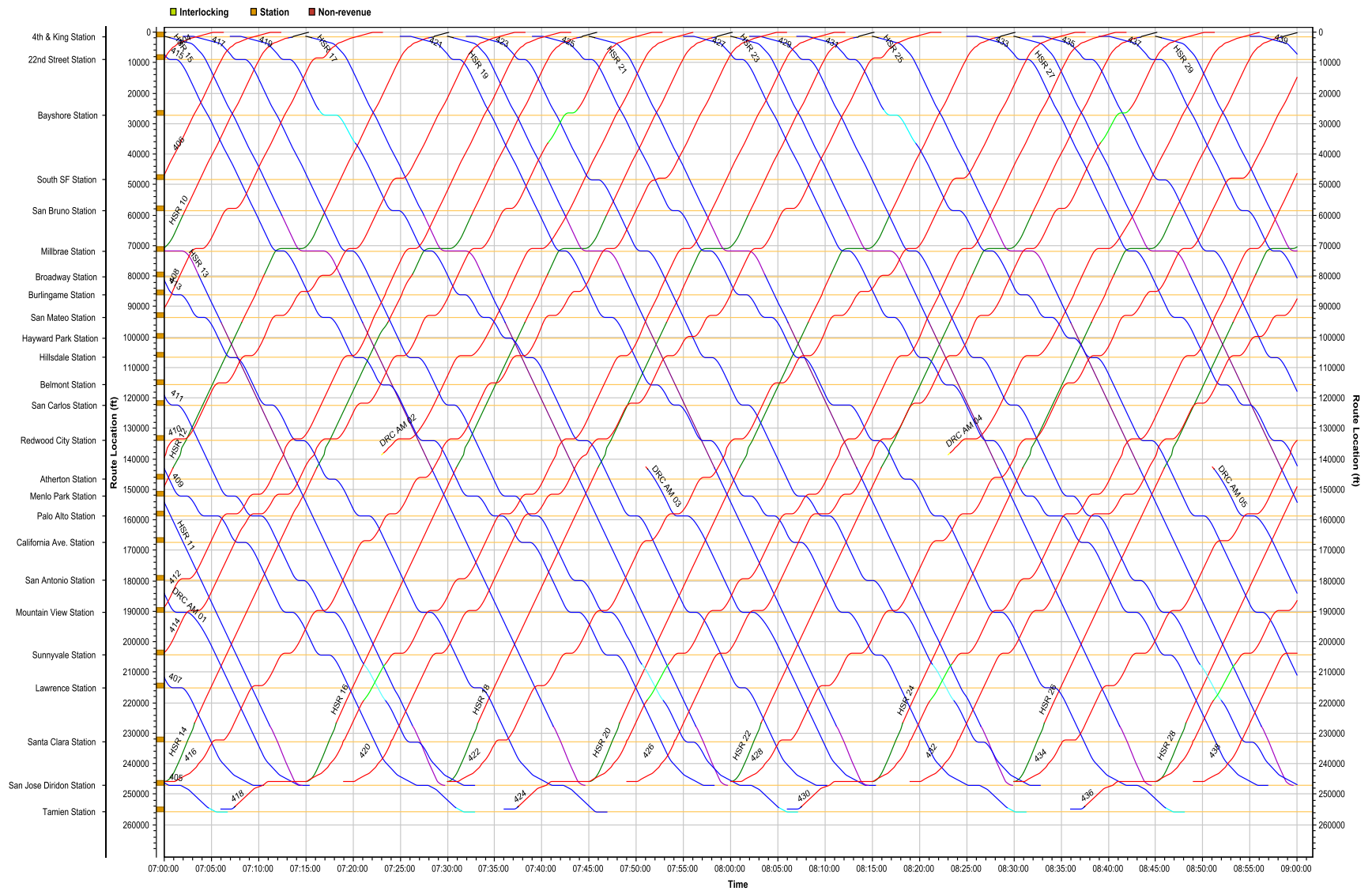


Figure A22: Dumbarton Rail Corridor Service added to Long Middle 4 Track Overtake (79 MPH) AM String Chart 7-9 AM

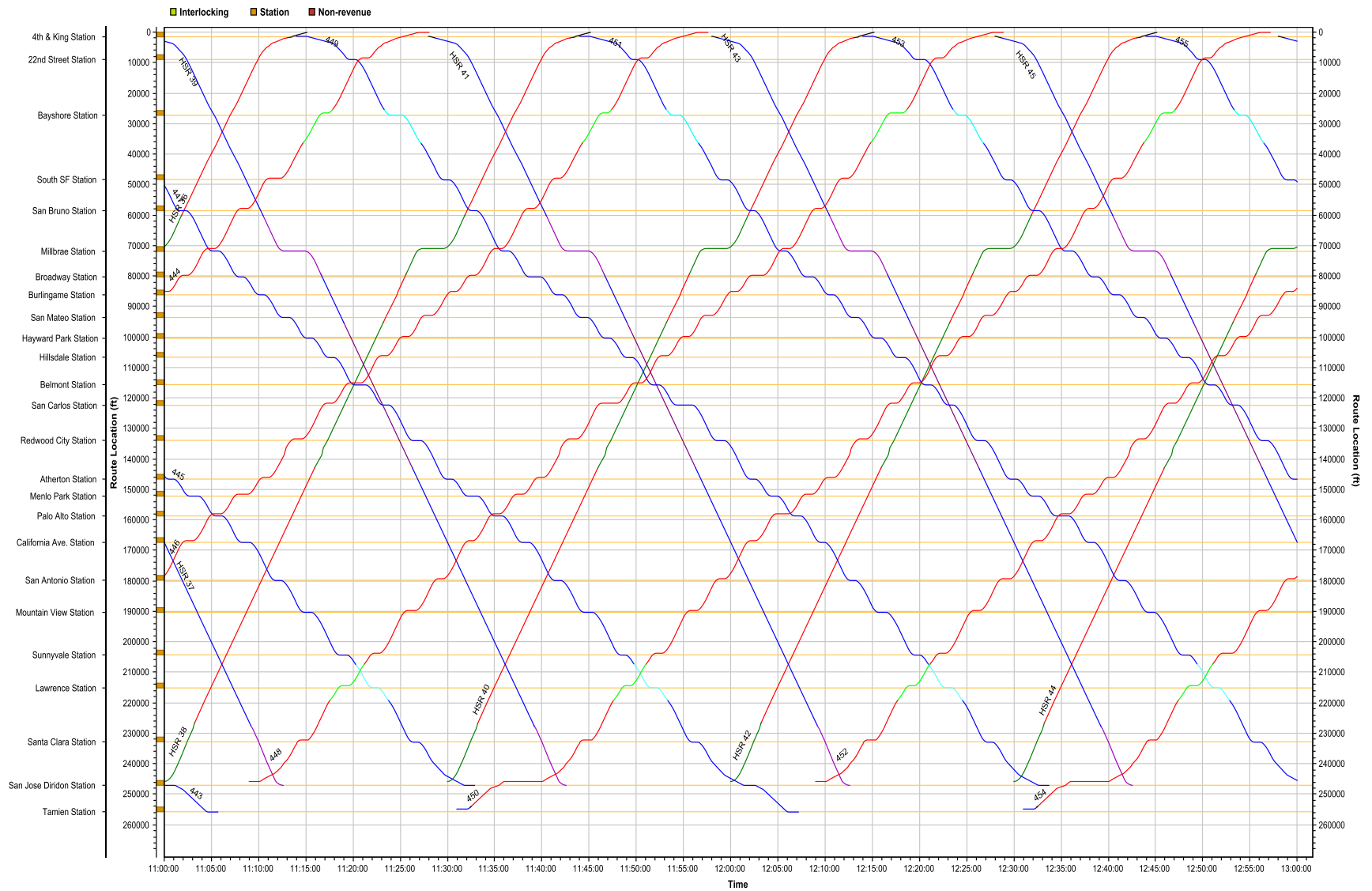


Figure A23: Dumbarton Rail Corridor Service Added to Long Middle 4 Track Overtake (79 MPH) Midday String Chart 11 AM - 1 PM

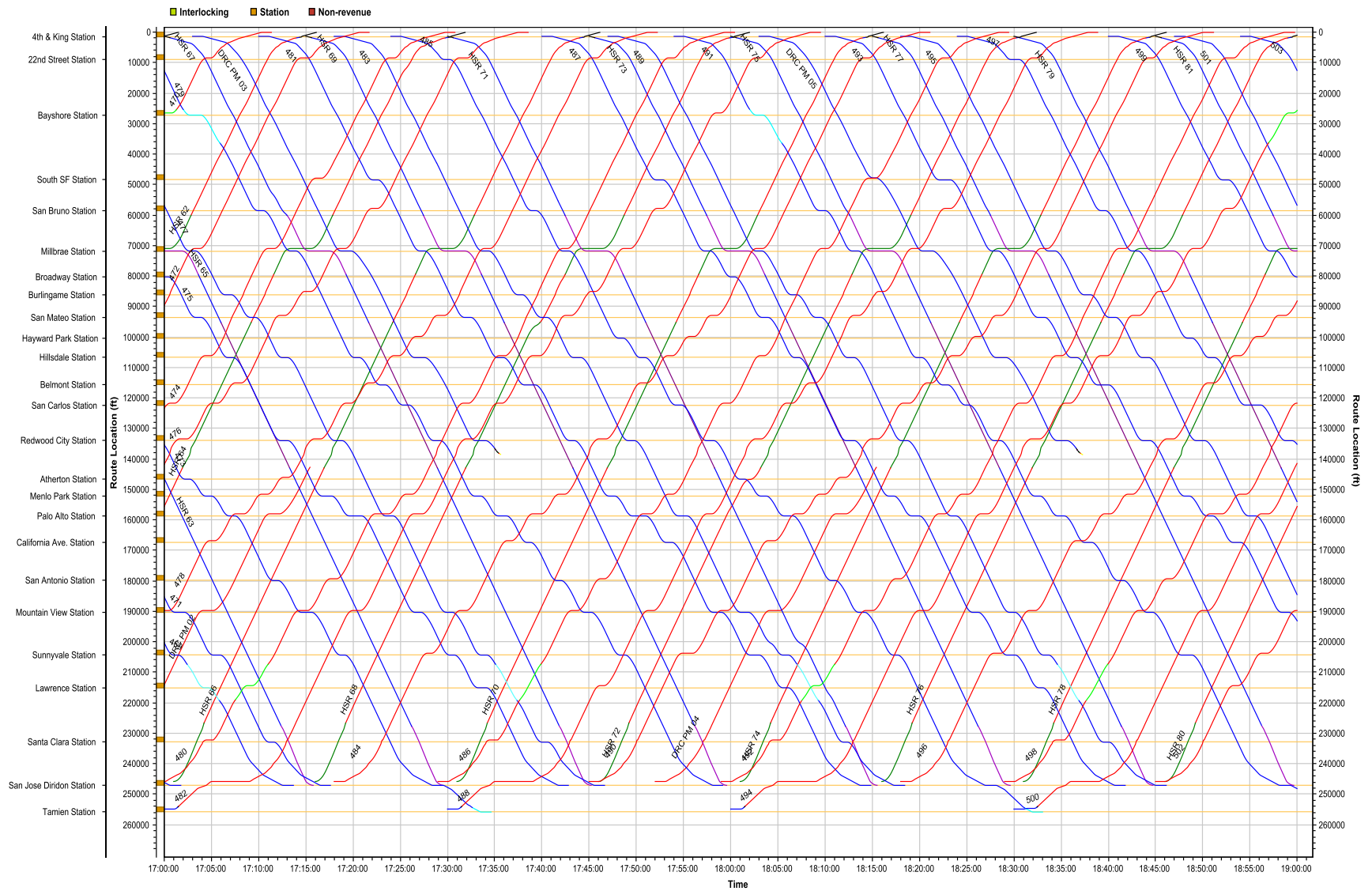


Figure A24: Dumbarton Rail Corridor Service Added to Long Middle 4 Track Overtake (79 MPH) PM String Chart 5-7 PM

Baby Bullet/Skip Stop Service (2/4)

Table A15 and **Table A16** display a sample of peak period service in the Baby Bullet service plan.

**Table A15: Peak 60 Minutes Northbound Baby Bullet Service -
AM Simulated Schedule**

	416B	418	420	422B	424	426
Tamien Station		6:57a			7:27a	
San Jose Diridon Station	7:00a	7:05a	7:12a	7:30a	7:35a	7:42a
College Park Station*						
Santa Clara Station			7:17a			7:48a
Lawrence Station		7:13a			7:43a	
Sunnyvale Station		7:16a	7:23a	7:40a	7:46a	7:54a
Mountain View Station	7:12a	7:21a	7:28a		7:51a	7:59a
San Antonio Station			7:31a			8:02a
California Avenue Station			7:34a			8:05a
Palo Alto Station	7:20a	7:28a	7:38a	7:50a	7:58a	8:09a
Menlo Park Station		7:30a	7:40a		8:00a	8:11a
Atherton Station		7:32a			8:02a	
Redwood City Station		7:36a	7:45a	7:57a	8:06a	8:16a
San Carlos Station			7:48a			8:19a
Belmont Station			7:50a			8:21a
Hillsdale Station	7:31a	7:41a	7:53a		8:11a	8:24a
Hayward Park Station		7:43a			8:13a	
San Mateo Station		7:45a	7:56a	8:06a	8:15a	8:27a
Burlingame Station		7:48a			8:18a	
Broadway Station		7:50a			8:20a	
Millbrae Station	7:39a	7:54a	8:02a	8:12a	8:24a	8:33a
San Bruno Station			8:06a			8:37a
So. San Francisco Station		8:01a	8:10a		8:31a	8:41a
Bayshore Station		8:06a			8:36a	
22nd Street Station		8:11a			8:41a	
4th & King Station	7:57a	8:15a	8:21a	8:29a	8:45a	8:52a

*Schedule to be determined

**Table A16: Peak 60 Minutes Southbound Baby Bullet Service –
AM Simulated Schedule**

	417B	419	421	423B	425	427
4th & King Station	7:00a	7:07a	7:15a	7:30a	7:37a	7:45a
22nd Street Station	7:06a	7:12a	7:20a	7:36a	7:42a	7:50a
Bayshore Station			7:24a			7:54a
South SF Station			7:29a			7:59a
San Bruno Station		7:22a			7:52a	
Millbrae Station	7:19a	7:25a	7:35a	7:49a	7:55a	8:05a
Broadway Station		7:28a			7:58a	
Burlingame Station		7:30a			8:00a	
San Mateo Station		7:33a	7:40a		8:03a	8:10a
Hayward Park Station			7:42a			8:12a
Hillsdale Station		7:37a	7:45a	7:57a	8:07a	8:15a
Belmont Station		7:39a			8:09a	
San Carlos Station		7:41a	7:48a		8:11a	8:18a
Redwood City Station	7:32a	7:47a	7:54a		8:17a	8:24a
Atherton Station			7:57a			8:27a
Menlo Park Station	7:37a	7:51a	7:59a		8:21a	8:29a
Palo Alto Station		7:54a	8:02a	8:08a	8:24a	8:32a
California Ave. Station		7:57a			8:27a	
San Antonio Station		8:00a			8:30a	
Mountain View Station	7:48a	8:04a	8:09a	8:15a	8:34a	8:39a
Sunnyvale Station			8:13a			8:43a
Lawrence Station			8:16a			8:46a
Santa Clara Station			8:21a			8:51a
College Park Station *						
San Jose Diridon Station	8:02a	8:16a	8:25a	8:30a	8:46a	8:55a
Tamien Station			8:33a			9:03a

*Schedule to be determined

Table A17 shows the Baby Bullet Caltrain with the Long Middle 4 Track Overtake delay statistics for Caltrain and HSR trains for the AM peak period, PM peak period, the full day and the AM peak hour.

Table A17: Baby Bullet Delay Statistics

	Delayed By Train Type	Caltrain			HSR			All Trains		
		Stopped	Running	Total	Stopped	Running	Total	Stopped	Running	Total
AM Peak	Caltrain	0:04:45	0:06:16	0:11:01	0:00:00	0:00:55	0:00:55	0:04:45	0:07:11	0:11:56
	HSR	0:02:57	0:11:18	0:14:15	0:00:00	0:00:00	0:00:00	0:02:57	0:11:18	0:14:15
	Total	0:07:42	0:17:34	0:25:16	0:00:00	0:00:55	0:00:55	0:07:42	0:18:29	0:26:11
PM Peak	Caltrain	0:00:09	0:01:05	0:01:14	0:00:00	0:01:47	0:01:47	0:00:09	0:02:52	0:03:01
	HSR	0:02:29	0:11:50	0:14:19	0:00:00	0:00:00	0:00:00	0:02:29	0:11:50	0:14:19
	Total	0:02:38	0:12:55	0:15:33	0:00:00	0:01:47	0:01:47	0:02:38	0:14:42	0:17:20
Full Day	Caltrain	0:04:54	0:07:21	0:12:15	0:00:00	0:02:42	0:02:42	0:04:54	0:10:03	0:14:57
	HSR	0:05:26	0:23:10	0:28:36	0:00:00	0:00:00	0:00:00	0:05:26	0:23:10	0:28:36
	Total	0:10:20	0:30:31	0:40:51	0:00:00	0:02:42	0:02:42	0:10:20	0:33:13	0:43:33
AM 60	Caltrain	0:03:46	0:01:32	0:05:18	0:00:00	0:00:26	0:00:26	0:03:46	0:01:58	0:05:44
	HSR	0:01:20	0:03:41	0:05:01	0:00:00	0:00:00	0:00:00	0:01:20	0:03:41	0:05:01
	Total	0:05:06	0:05:13	0:10:19	0:00:00	0:00:26	0:00:26	0:05:06	0:05:39	0:10:45

Table A18 shows the Baby Bullet Caltrain with the Long Middle 4 Track Overtake travel time statistics for Caltrain and HSR trains for the AM peak period, PM peak period, the full day and the AM peak hour.

Table A18: Baby Bullet Travel Time Statistics

		Average	Min	Max	Standard Deviation
AM Peak	Caltrain	1:00:34	0:57:04	1:06:02	0:02:01
	Baby Bullet	0:52:58	0:51:19	0:56:18	0:01:26
	HSR	0:45:17	0:44:37	0:47:20	0:00:41
PM Peak	Caltrain	1:00:10	0:56:49	1:02:43	0:01:24
	Baby Bullet	0:52:40	0:51:03	0:53:04	0:00:47
	HSR	0:45:23	0:44:37	0:47:45	0:00:49
Full Day	Caltrain	1:08:01	0:56:49	1:18:38	0:08:21
	Baby Bullet	0:52:44	0:51:03	0:56:18	0:01:08
	HSR	0:45:07	0:44:37	0:47:45	0:00:36
AM 60	Caltrain	1:00:07	0:57:36	1:02:00	0:01:29
	Baby Bullet	0:52:49	0:51:19	0:53:51	0:01:19
	HSR	0:45:33	0:44:38	0:47:20	0:00:58

Figure A25 shows the Baby Bullet Caltrain with the Long Middle 4 Track Overtake time-distance string chart for the morning peak period of 7 to 9am. **Figure A26** shows the Baby Bullet Caltrain with the Long Middle 4 Track Overtake stops time-distance string chart for the midday period of 11am to 1pm. **Figure A27** shows the Baby Bullet Caltrain with the Long Middle 4 Track Overtake time-distance string chart for the evening peak period of 5 to 7pm.

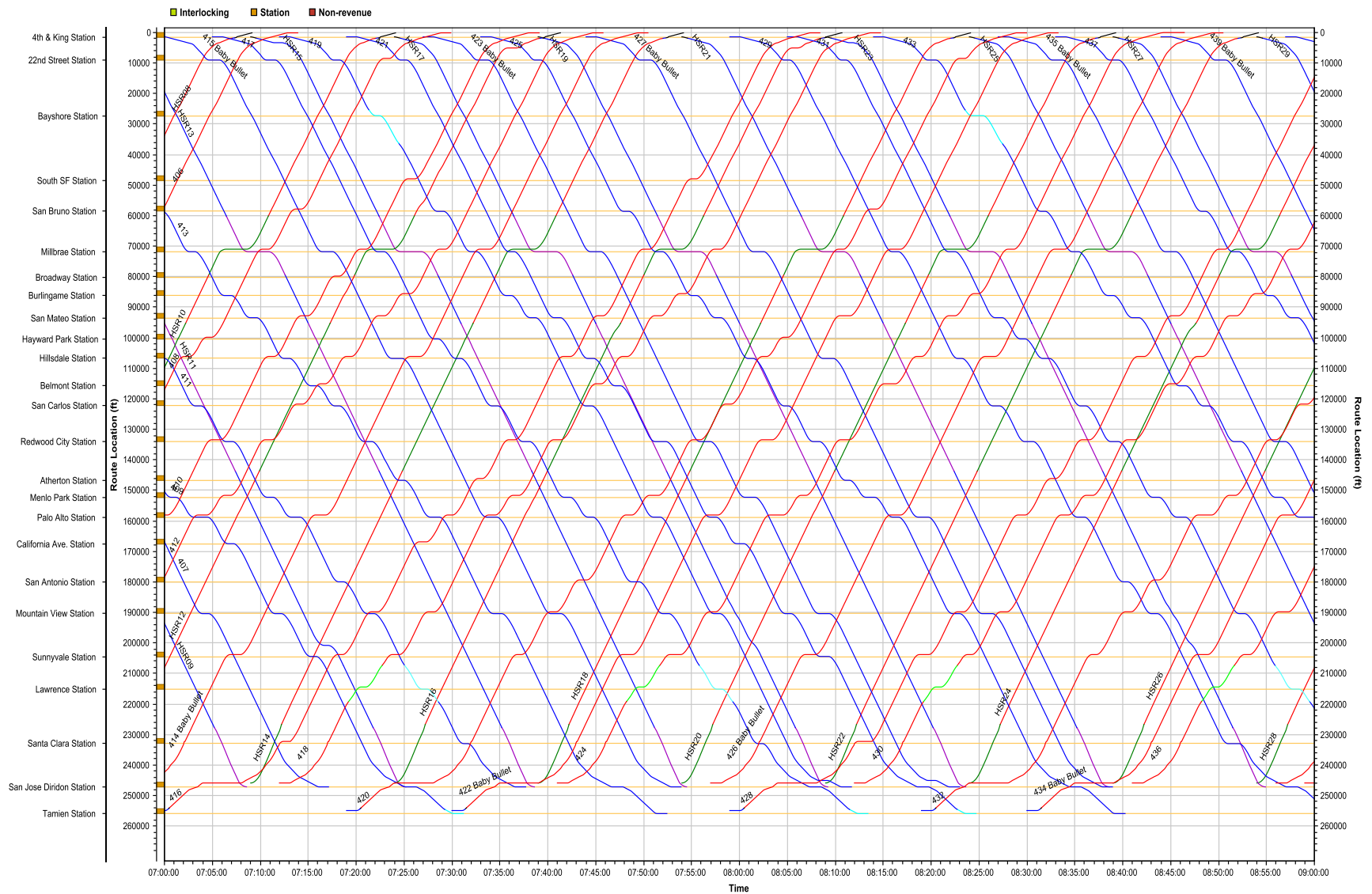


Figure A25: Baby Bullet Caltrain with Long Middle 4 Track Overtake AM String Chart 7-9 AM

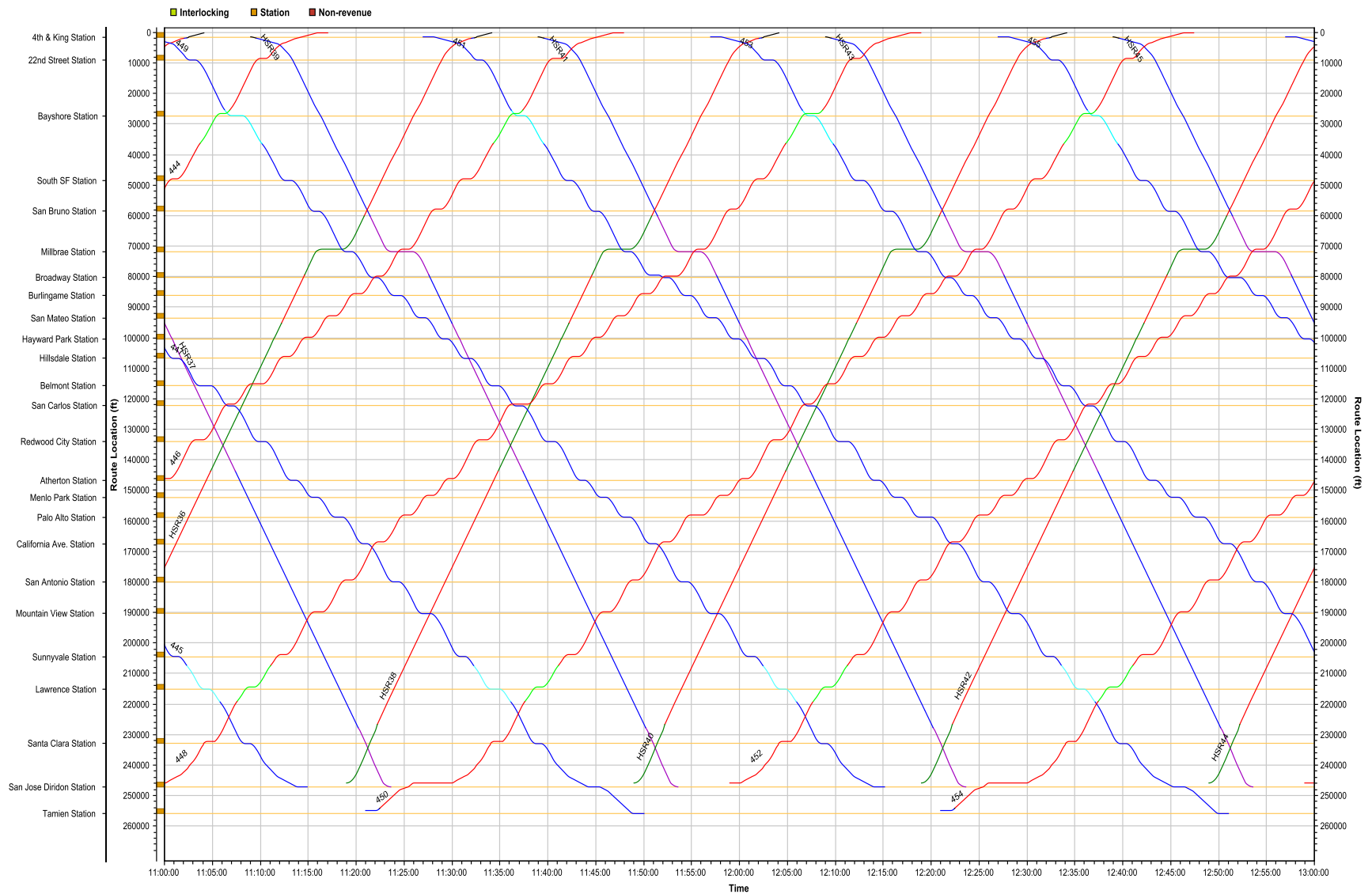


Figure A26: Baby Bullet Caltrain with Long Middle 4 Track Overtake String Chart 11 AM -1 PM

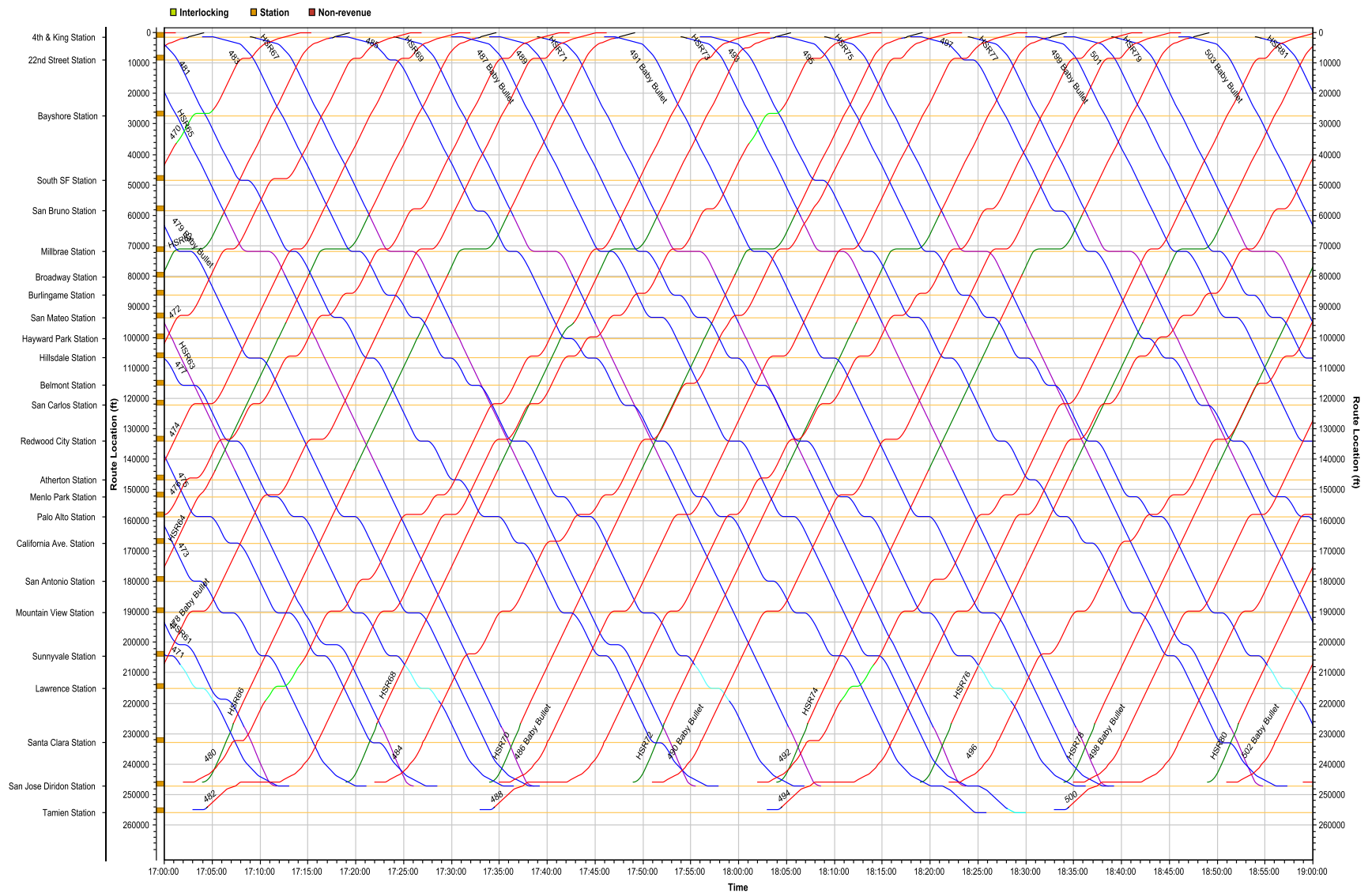


Figure A27: Baby Bullet Caltrain with Long Middle 4 Track Overtake PM String Chart 5-7 PM

Caltrain / HSR Blended Service Plan Operations Considerations Analysis (Requested by Stakeholders)

Technical Appendix B:

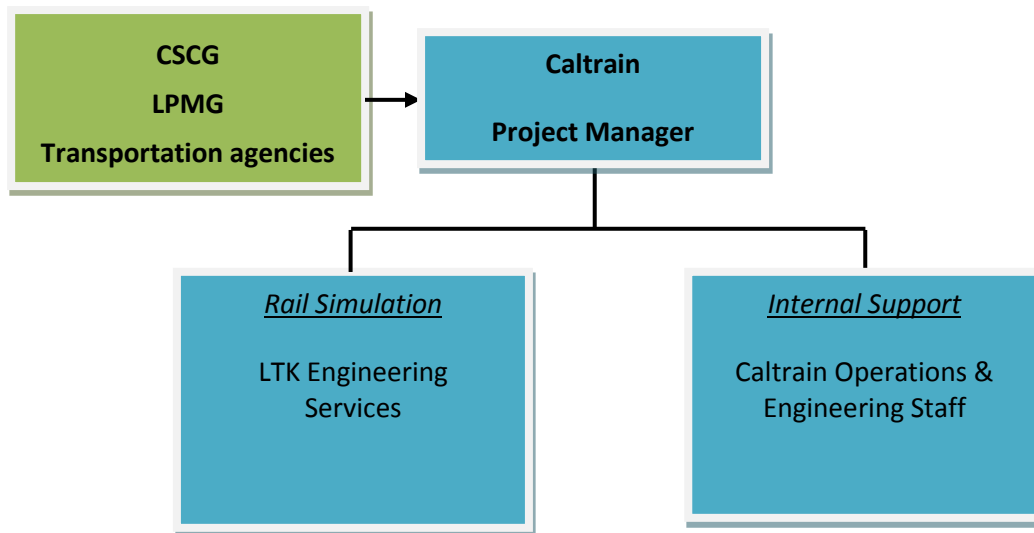
Process and Outreach

Technical Appendix B- Process and Outreach

This report was initiated in early 2012. The scope of the report was informed by stakeholders including city and county staff, elected officials, regional transportation agencies, and the California High Speed Rail Authority (CHSRA).

The project was managed by Caltrain staff with support from several consultants and in-house operations and engineering staff. The report was guided by input from the City/County Staff Coordination Group (CSCG) which is comprised of senior staff from the 17 cities and 3 counties that are directly impacted by the blended system; the Local Policy Maker Group (LPMG), which is made up of elected officials from the same 17 cities and 3 counties; and transportation agencies such as the California High-Speed Rail Authority and Santa Clara Valley Transportation Authority. **See Figure B1.**

Figure B1: Project Organization



Preliminary findings from the analysis were shared with the CSCG and LPMG in Fall of 2012. During January and February 2013, presentations on the preliminary findings were shared with the public, as requested.

Feedback from the preliminary findings presentations were incorporated into the draft report. Caltrain staff sought another round of comments from the CSCG and transportation agencies in May and the draft report was released to the public in early June. Presentations on the draft report were given to the CSCG, LPMG, and public entities such as Friends of Caltrain.

Comments on the draft report were due June 14, 2013. All comments received and the staff responses are noted in **attached Table B1**. The comments cover a range of topics and categorized by source. Based on these comments, appropriate modifications to the draft report were made and reflected in the final report.

**TABLE B1: DRAFT Caltrain / HSR Blended Service Plan / Operations Considerations Analysis
Comments and Responses - June 2013**

This table includes only those comments that are relevant to the scope of study. Other comments have been logged for future reference.
The comments included in the table have been abbreviated by staff.

*Note: See Attachment A – Additional studies are planned as part of the Caltrain / HSR Blended system planning process.

From	Comments	Caltrain Responses
Comments from Cities		
Town of Atherton	Simulated services and schedule spread skipped stops throughout the route, making intra-peninsula trips difficult and forcing transfers.	The prototypical schedule was developed as a modeling input only and is not a recommendation or endorsement of a particular schedule approach at this time. Additional analysis will be conducted.*
	More definitive studies are required before judgments about the preferred blended system alternative or about the impact of the blended system on any particular grade crossing can be determined.	Agreed. Additional analysis will be conducted.*
	At this point in the blended system planning process the CEQA process should be invoked and an initial study undertaken to determine if the CEQA process should be followed.	The JPB is the lead agency in the EIR process for the Peninsula Corridor Electrification project. The CHSRA will be the lead agency for environmentally clearing the blended system project.
City of Belmont	The City continues to express opposition to the HSR process and continues to not support any overtake option within Belmont's rail corridor segment.	This is the JPB's understanding. This study does not make policy recommendations regarding the selection or rejection of specific overtake options.

**TABLE B1: DRAFT Caltrain / HSR Blended Service Plan / Operations Considerations Analysis
Comments and Responses - June 2013**

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The comments included in the table have been abbreviated by staff.

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From	Comments	Caltrain Responses
City of Burlingame	The City requests additional language clarifying that the train schedules presented in the report do not represent actual planned future schedules.	Schedules shown are prototypical only. Additional clarifying language has been added in the final report.
City of Mountain View	Study demonstrates that the South 4 Track Overtake option does not perform as well as some other overtake options. City requests that this option be removed from consideration.	Selection or removal of overtake options will be a difficult policy decision and is not the purpose of this study. Decisions regarding overtake options will occur in subsequent stages of the Blended system planning process.*
	Study does not assess the VTA light rail station at Castro street as a potential impediment to the South 4 Track Overtake. Future efforts should address platform and other station-related improvements to ensure safety of pedestrians, bicyclists and motorists given the faster train speeds anticipated on the rail corridor.	Analyzing ROW impacts and station design is not part of this study scope. Such efforts will be addressed in subsequent stages of the Blended system planning process.*
City of Palo Alto	Comments made in the City of Palo Alto Caltrain Electrification NOP letter should also apply to this report	NOP comments will be addressed through the EIR process.

**TABLE B1: DRAFT Caltrain / HSR Blended Service Plan / Operations Considerations Analysis
Comments and Responses - June 2013**

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The comments included in the table have been abbreviated by staff.

*Note: See Attachment A – Additional studies are planned as part of the Caltrain / HSR Blended system planning process.

From	Comments	Caltrain Responses
City of San Carlos	<p>The City is not interested in hosting passing tracks. Future studies should include additional analysis of service levels assuming 8 trains per hour per direction using existing infrastructure.</p> <p>Additional testing and review beyond the model simulation used is necessary to refine ranking of overtake options.</p> <p>The City submitted a number of comments in its 2012 letter on the Caltrain / HSR Blended Operations Analysis. These comments still need to be addressed and should be part of any future review of service options and project designs.</p>	<p>Additional studies related to these issues will be conducted as part of the blended system planning process.*</p>
City and County of San Francisco	<p>Report assumes different platform heights for HSR and Caltrain. This requires separate tracks and platforms at Millbrae with potential ROW impacts.</p>	<p>EMU and HSR prototypical rolling stock specifications were assumed for the analysis. HSR vehicle specifications were based on data and assumptions provided by CHSRA. There will be further discussions about platform heights as we move forward with the blended system planning process.*</p>
	<p>Why is it assumed that the HSR train sets have fewer doors than the Caltrain trains, resulting in longer dwell times for HSR?</p>	<p>HSR vehicle specifications were based on information provided by CHSRA.</p>
	<p>Why does baseline schematic depict tracks and platform changes at 4th & King? Schematic overtake track configurations show HSR tracks staying in the middle and Caltrain going to the outside, creating a need for Caltrain to build additional platforms.</p>	<p>Schematics are for modeling purposes only. The schematics do not reflect conceptual engineering or design work.</p>

**TABLE B1: DRAFT Caltrain / HSR Blended Service Plan / Operations Considerations Analysis
Comments and Responses - June 2013**

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The comments included in the table have been abbreviated by staff.

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From	Comments	Caltrain Responses
City and County of San Francisco	The second paragraph under Figure 3 states that the 4 track overtake supports one-directional traffic. The four track configuration supports bi-directional traffic.	Correction. The text states that <i>each</i> track within the 4-track configuration supports dedicated (northbound or southbound) directional traffic.
	In analyzing the DTX, the study assumes that only a subset of Caltrain trips will continue from 4 th & King to the Transbay Terminal. All Caltrain trips, except maybe for special events, should originate/terminate there and also stop at 4th/Townsend.	Additional service plans and schedule options will be considered in subsequent stages of the planning process.*
	Why does the DTX yield higher levels of signal delay and more added Caltrain station stops to support the service extension to downtown San Francisco?	Within the simulation, additional station stops for Caltrain in the peak period are needed because of conflicts between inbound trains to TTC with outbound trains from 4th & King at CP Common. To increase the probability of delay-free operation at this at-grade conflict location, times for inbound Caltrain trips were modified by adding stops to some trips. Even with these added stops, signal delay to Caltrain increases under the DTX service scenario, when compared with the 6/4 Full Midline Overtake.
	How does the operations analysis assume that non-revenue train movements between Transbay and the surface 4th & King rail yard are accommodated?	Non-revenue movements were not modeled as part of this study and will be evaluated. Timing to be determined.

**TABLE B1: DRAFT Caltrain / HSR Blended Service Plan / Operations Considerations Analysis
Comments and Responses - June 2013**

This table includes only those comments that are relevant to the scope of study. Other comments have been logged for future reference.
The comments included in the table have been abbreviated by staff.

*Note: See Attachment A – Additional studies are planned as part of the Caltrain / HSR Blended system planning process.

From	Comments	Caltrain Responses
Comments from Transportation Agency / Corporation		
BART	Reference our Electrification Notice of Preparation letter that addressed issues related to infrastructure and station operation issues at Millbrae.	NOP comments will be addressed through the EIR process.
	BART prefers that connecting services arrive on regular headways, in order to even out load distribution and not overload specific trains or congested stations. Caltrain needs to consider potential impacts on BART's train operations and on station facilities.	This will be evaluated during development of the final train schedule.
VTA	The study shows that the Middle Track overtake options deliver better performance and should be used to remove North and South Overtake options from further consideration.	Selection or removal of options will be a difficult policy decision and is not the purpose of this study. Decisions regarding overtake options will occur in subsequent stages of the blended system planning process.*
	The South 4-track overtake option would require moving the existing VTA single track, disrupting light rail service and creating new barriers to adding a second LRT track.	Analyzing ROW impacts is not part of this study scope. Such efforts will be addressed in subsequent stages of the Blended system planning process.*
	The study does not include sufficient analysis for service planning purposes. Baseline schedule tested would add travel times to Mountain View or Palo Alto trips to San Francisco relative to current Baby Bullet schedule.	The prototypical schedule and Baby Bullet scenario were developed as modeling inputs only. Additional service plans and schedule options will be considered as part of the blended system planning process.*

**TABLE B1: DRAFT Caltrain / HSR Blended Service Plan / Operations Considerations Analysis
Comments and Responses - June 2013**

This table includes only those comments that are relevant to the scope of study. Other comments have been logged for future reference.
The comments included in the table have been abbreviated by staff.

*Note: See Attachment A – Additional studies are planned as part of the Caltrain / HSR Blended system planning process.

From	Comments	Caltrain Responses
Comments from Advocacy Groups		
Friends of Caltrain	The model assumed only two of the scheduled six Caltrain trains will continue on to the Transbay Terminal. Plan for all Caltrain trains to continue to Transbay.	Additional service plans and schedule options will be considered as part of the blended system planning process.*
	The studies assume the continuation of the holdout rule at Atherton, Broadway and South San Francisco. Blended system analysis should be redone with assumption that the holdout rule has been removed.	It can be deduced from the analysis that the blended system can work with removal of the holdout rule and operations will improve. Based on the status of hold out removal projects, impacts to schedule development and operations associated with electrification and the blended system will be analyzed.
	The studies compare and contrast the relative benefits of more frequent service and longer consists but do not analyze the benefits of both in combination.	The qualitative analysis of longer consists only included in the report was requested by the City of Palo Alto.
	It would be valuable to simulate the results of level-boarding related dwell time improvements on proposed schedules.	Caltrain is currently evaluating the challenges associated with level boarding. Based on technical and policy discussions, additional analysis will be conducted if appropriate.
	The prototypical baby bullet schedule does not clearly include the opportunity to coordinate transfers from baby bullet service to local trains.	The intent of the simulated Baby Bullet scenario was to establish the feasibility of operating a bullet service pattern within the blended system. The schedule used was prototypical and for modeling purposes only. Opportunities for transfers and coordination with local service will be considered in development of the final schedule.

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From	Comments	Caltrain Responses
Friends of Caltrain	It would be ideal for Caltrain and HSR to craft a "blended operations" plan that would allow local riders to use the HSR trains as a super-express, and for long-distance riders to use Caltrain trains as a connection, with a seamless fare experience and reasonable business outcome.	Issues and opportunities related to shared CHSR and Caltrain business practices and customer interface will be explored. Timing is to be determined.
	As Caltrain tests schedule concepts, staff could create a "dashboard" showing how well each schedule concept performs on these metrics for classes of stations. Even if the concepts are preliminary, riders would still be able to get a picture of how the concept being tested would affect them.	Yes. Additional service plans and schedule options will be considered as part of the blended system planning process.*
	The report indicates that "approximately half of the existing Caltrain stations do not have platform lengths sufficient to support an 8-car consist train." Which ones are not long enough?	Report text has been updated to include a list of stations with platform lengths under 680 feet.
Comments from Individuals		
Mark Duncan	A schedule optimized for EMUs making a skip stop pattern requires that diesel trains be operated as Baby Bullet or express trains. Thus Gilroy commuters would need to transfer in many cases to get to their destination.	Prototypical schedules for mixed diesel and electrification service do not assume forced transfers. Prototypical schedules for blended operations with all electric fleet assume forced transfers.

**TABLE B1: DRAFT Caltrain / HSR Blended Service Plan / Operations Considerations Analysis
Comments and Responses - June 2013**

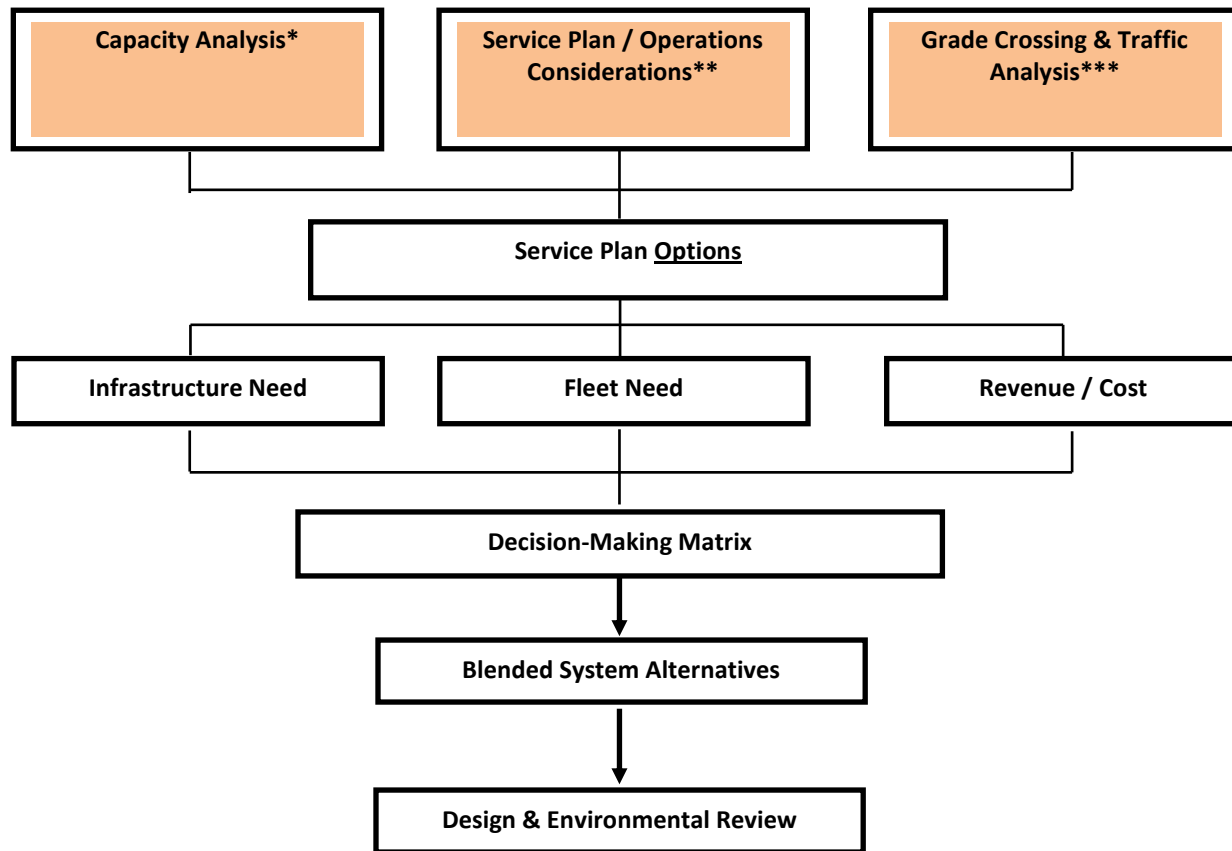
This table includes only those comments that are relevant to the scope of study. Other comments have been logged for future reference.
The comments included in the table have been abbreviated by staff.

*Note: See Attachment A – Additional studies are planned as part of the Caltrain / HSR Blended system planning process.

From	Comments	Caltrain Responses
Martin Sommer	In Figure 6: "Baseline Infrastructure with Middle 3 Track Overtake Infrastructure", Palo Alto Station is shown with the removal of a platform and addition of a new platform to accommodate a third track. This is inconsistent with the original station design, which created adequate room between the two existing tracks for a future third passing track.	Figure 6 has been corrected. In general, schematics are for modeling purposes only and do not reflect conceptual engineering or design work.
Kathy Hamilton	I am against the addition of any tracks. Community concerns should weigh just as heavily as operational performance in any decision regarding overtake tracks.	This study does not make policy recommendations regarding the selection or rejection of specific overtake options. Community concerns and impacts related to overtake track options will be considered in the blended system planning process.*
Scott Stanton	In considering alternatives for passing track locations, I would encourage you to consider the impact on residential neighborhoods along the right of way.	Noted.*
Michael Dury	The prototypical schedule shown perpetuates an endorsement of a skip-stop schedule, accepts current labor practices and extended turn-around times and creates the impression that nothing significant about the quality of Caltrain service will change before HSR comes to the Peninsula in 2029, when it will be degraded.	The prototypical schedule was developed as a modeling input only and is not a recommendation or endorsement of a particular schedule approach at this time. Additional service plans and schedule options will be considered as part of the blended system planning process.*

Attachment A: Caltrain / HSR Blended system Planning Process

The following is a visual depiction of the proposed planning process for conceptually defining the blended system.



The process is focused on:

1. Gathering technical information and education about priority operational issues
2. Using technical information to inform development of the blended service options
3. Identifying tradeoffs for each option related to infrastructure / fleet needs and revenue/cost assumptions
4. Developing a decision-making matrix and facilitating policy discussions
5. Selecting project alternatives for environmental evaluation

In 2012, Caltrain conducted the **Caltrain/ California HSR Blended Operations Analysis***, which showed that a blended system is operationally viable in the peninsula corridor. Following, in 2013, Caltrain prepared two studies called the **Caltrain / HSR Blended Service Plan/ Operations Considerations Analysis **** and the **Caltrain / HSR Blended Grade Crossing and Traffic Analysis *****. All three studies address step #1 in the process described above.

Tasks associated with the remaining boxes are to be conducted. Timing is to be developed allowing for prioritization of the peninsula corridor electrification program delivery and consistency with the CHSRA business plan.