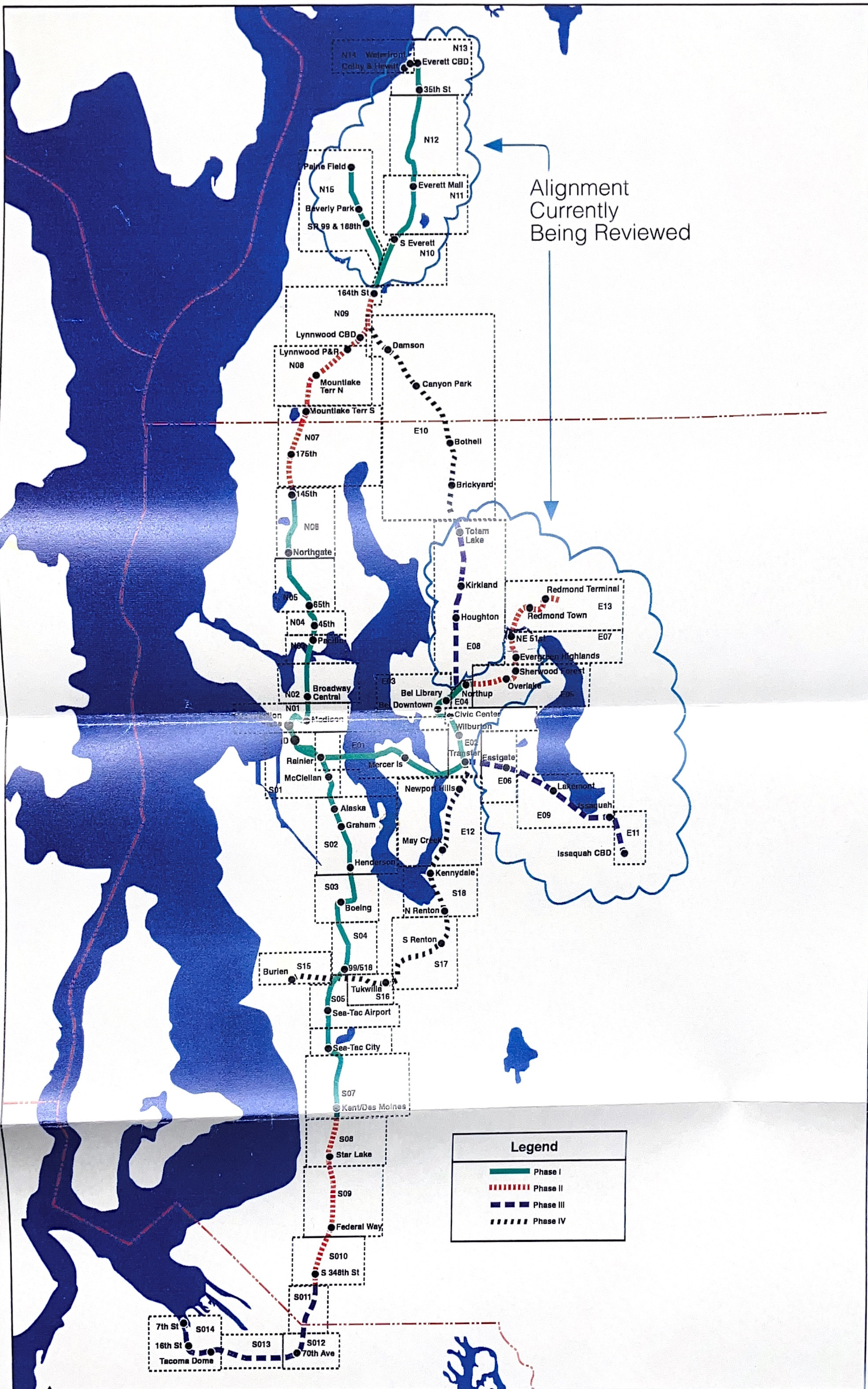

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Rail
Construction Segments and Phasing
System Plan
FIGURE 7-1

service, can be reinvested in more local service. Existing bus service can also be restructured to serve neighborhoods and communities better than it does today.

Growth Management

The Rail/TSM Alternative is the most consistent with growth management objectives. The system would be implemented incrementally to serve both immediate and long-term needs.

The Rail/TSM Alternative capacity and service quality afford the best opportunity to accommodate housing and employment growth without severe economic and environmental consequences. The system can help local land use authorities preserve people-oriented communities and open space by being able to move larger numbers of people conveniently among and within the region's urban centers where street capacity is already fully used.

Environmental Quality

The Rail/TSM Alternative is the only alternative that significantly increases the current share of regional trips using transit. It is also the only alternative that provides enough added capacity to accommodate the expected increase in riders as a result of efforts guided by growth management and air quality legislation.

The Rail/TSM Alternative presents the greatest potential benefits for air quality and energy conservation among the alternatives. Because of its higher capacity, it also presents the best environmental insurance policy for the future. In the event of energy shortages or other severe environmental conditions, this transit system has the capacity and reliability to accommodate significantly higher service demands compared to other alternatives.

7.0 Phasing and Implementation Strategies

Chapter 6.0 summarized the JRPC rationale for the selection of the 2020 Rail/TSM Alternative to serve as the basis for the development of the recommended System Plan for the region. Chapter 7.0 provides an overview of the implementation strategies discussed and reviewed by the JRPC. The topics discussed in this chapter include: the phasing and refinement of the system; growth management and land use integration; and, the RTP institutional responsibilities.

7.1 System Refinement and Phasing

During the phasing analysis process the goal was to optimize a balance between an aggressive and technically supportable implementation schedule, an equitable deployment of the system in the three corridors and the region's fiscal resources. This overview of the phasing process includes an overview of the methodology, the models and process, and the results of the analysis.

7.1.1 Alternative Refinement and Phasing Methodology

The primary purpose of the *Alternative Refinement and Phasing Methodology Report*, PB/KE Team, October 1992, was to define the process and tools to be used in refining the scope and implementation schedule for the RTP Draft System Plan. System refinement and phasing involves three primary elements: 1) the reduction of the potential components of the selected alternative to a specific and quantifiable scope and budget; 2) the formulation of the scope into discrete elements that can be scheduled individually and integrated collectively into a summary project schedule; and 3) the generation of cash flows and other presentation data in a format supportive of the financial analysis and decision-making process. In addition, the methods report served the following purposes:

- Established a method for refining and comparing the alternatives and segments of the alternatives that is consistent with RTP goals and performance criteria and state and federal guidelines and procedures.

- Developed a systematic process for organizing the alternatives into implementation segments and a consistent method for organizing information on potential benefits, impacts and cost.

- Provided decisionmakers with a process for illuminating key differences among alternative segments and phasing scenarios and key tradeoffs involved in the selection process.

The methodology report contains three primary elements:

- Presentation of the refinement and phasing framework that is consistent with the current process for the development and adoption of the Regional Transit System Plan;

- A set of general evaluation categories;

- A framework and set of models for use in subdividing the alternatives into implementation segments; and

- A prototypical set of phasing scenarios for arranging the results of the analysis.

7.1.1.1 General Considerations

The alternative refinement and phasing process represents a critical element in System Plan development. A stringent refinement and phasing analysis is required to develop the data necessary to analyze the financial and operational considerations of the System Plan. The more critical phasing considerations discussed to date, and which may be expanded during the analysis are discussed below.

Operational Considerations

This category is intended to include all aspects of the operational impacts as the system is deployed. It includes analysis of the system components required for reliable and efficient operation of trains. It also includes considerations that range from reconfiguring the bus service network to support the rail element to acquisition of bus equipment (new and replacement) to developing the bus maintenance facility program required to support bus fleet expansion. From the initial deployment of the high capacity elements of the system through the development of the final elements, the bus support system, HOV and other TSM components must be carefully coordinated. This

analysis must be conducted at a level of detail appropriate to assure a reasonable and efficient operations plan.

As an example, key assumptions for the rail component would include:

- Each initial corridor segment should be capable of sustaining operations when complete and would be a "Minimum Operable Segment (MOS)" for the corridor or corridors.

- An MOS should have logical operational termini connecting a set of two or more significant origin/destinations.

- The rail termini need to be accessible, have the physical capability of functioning as an interim terminus, support the turnback and storage of trains, and be located at logical automobile and bus intercept locations.

- As each segment of the rail system is placed in service the bus operating plans must be coordinated to provide effective and efficient service.

- The segments must include access to a rail maintenance shop and storage yard for the receipt and static testing of cars and to sustain the dynamic testing and revenue operations.

- Each maintenance shop and storage yard must have access to a tangent (or near tangent) section of track approximately two miles long for the dynamic testing and burn-in of cars necessary for commissioning prior to the start of revenue service.

- The capacity of the Seattle CBD street system and the Downtown Seattle Transit Tunnel (DSTT) bus capacity is a critical issue in the successful operation of the regional system. Construction of the DSTT prolonged the ability to provide regional bus service until the initial portions of the rail system can be completed. Construction of the rail system must be phased in a manner that assures that surface street and DSTT bus and rail operations will be able to provide adequate transit capacity. The rail system must provide more corridor capacity than the b it displaces.

Existing Facility Transition

This category would address the utilization of existing facilities such as the DSTT, the Ryerson Maintenance Facility, and the I-90 floating bridge. The analysis will include determining how to transition the facilities necessary to support the rail and bus requirements at various phases through full system development.

Implementation Capacity (Financial, Engineering and Construction)

Based on several implementation scenarios, cash flow analysis of the capital and O&M cost for the system will be developed. Metro will test the expenditure plans through use of a model to determine the financial capacity needed to support the different scenarios. The financial models will be used to analyze various revenues (including federal, private and state funds) and provide capital reserve and debt service projections. Sensitivity tests will be performed to evaluate levels and types of financial risks. Adjustments will then be made in the implementation schedule until cash flow and revenues balance.

Detailed schedules will be prepared which analyze the number of design and construction contracts required for each phase of the project. A cash flow plan that is resource-loaded by work category will be developed from these schedules. In addition to a conceptual labor and income impact analysis for the project, a general idea of the optimum contracting parameters for the program will be established.

The output of these efforts will be analyzed with a view to the labor market, availability of materials and historic information. This analysis will provide for the identification of potential constraints and risks associated with the various phasing scenarios.

Ridership and Economics

One critical criterion for assessing the phasing scenarios will be return on investment in terms of ridership and farebox recovery rates. This particular criterion will be important in identifying the initial priority corridor and choosing between future investments following deployment of the initial phase of the system.

Ridership projections by segment would also allow for the calculation of a formal cost-effectiveness index.

Compatibility with Other Regional Programs

Compatibility with other regional programs would include a fairly broad range of items such as the WSDOT schedule for completion of the HOV program, major local arterial improvements; resource allocation strategy; level of service requirements of the Growth Management Act and its concurrency requirements; facility useful life; and other regional projects such as the Sea-Tac airport expansion and the High Speed Rail Project.

Ease of Implementation

An assessment of the speed at which a program element could be implemented - based on right-of-way availability, coordination with and approval by other agencies, construction impacts, complexity of the work, and projects of other agencies - would be provided to determine its ease of implementation.

Compounded Construction Impacts

Construction projects should be coordinated, to the extent possible, to avoid multiple disruptions to a community. Projects of others such as WSDOT and local jurisdictions will play a critical role. A listing of all elements of the program will be prepared and analyzed to assess whether an implementation scenario causes unacceptable regional impacts.

Regional Equity

Regional equity focuses on not only the total capital and service investment in a geographic area but also the rate and schedule of investment. All geographic areas should have some "early action" capital projects identified to be built in conjunction with the initial phase of the RTP program. The equity relationship between generated revenues, capital invested, and service provided on a county, corridor and sub-corridor basis for the selected alternative must be assessed.

As an example of the phasing program, the initial elements for the rail system in all three corridors would be identified. These three MOS's would connect to the tunnel and an interim terminus on each line. The segments must be served by a maintenance facility, storage yard, and terminate at a location that makes sense as a destination and has the physical capacity to accommodate the necessary mode transfer. At least one of the MOS's will be open to revenue service by 2001. Application of the above criteria would locate the initial and subsequent terminals until the rail lines are built-out in 2020 or some shorter timeframe.

Based on each interim terminal for each line, the resource allocation and TSM program would be identified and scheduled. In conjunction with this effort, the HOV and park-and-ride program would be scheduled emphasizing service in the outlying areas. Park-and-ride or transit centers could be developed at future rail station sites to emphasize or simulate rail operations with express buses to the nearest rail terminal in the interim.

The regional equity analysis will include an assessment of the socioeconomic equity in the program and its impacts on the transit-dependent population. Assessment of this area may require the use of travel time and performance factors such as passenger miles and service for selected geographic areas.

Growth Management

Subsequent to the generation of the Alternative Refinement and Phasing Methodology Report, the JRPC expanded the general evaluation criteria to include support of the growth management strategy for the region.

7.1.1.2 Phasing Model Development

The purpose of the phasing model is to provide a mechanism to define the physical extent of, and, the relationship between the system segments; develop the time frame for the design and construction of each of the segments; and determine cash flow needs from the combined design and construction activities for minimum operable segments (MOS). Thus, the three main parameters for development of the phasing model were segments, time and cost. To evaluate different phasing scenarios the model needed to simulate and display these three parameters for analysis and discussion and include the ability to produce several scenarios in a short time.

The model was developed in a two-step process. The first step was to develop a relatively detailed model - the "Micro Phasing Model" - and then use the micro model to create larger building blocks which can be manipulated in a "Macro Phasing Model". When a reasonable scenario has been identified at the macro level, the scenario is returned to the more exhaustive micro model for verification and more detailed analysis. The following sections describe the methodology which guided the phasing model development; a detailed description of the model development process can be found in the *Alternative Refinement and Phasing Methodology Report*, PB/KE Team, October 1992.

Micro Phasing Model

The rail alternative alignments were broken into phases/MOS's which can be independently designed, constructed and placed in operation. A typical phase consists of six segment or civil construction contracts and five phasewide contracts. The contracts were then scheduled over time using the critical path method, adjusted for available float to even the resource curve, and cost loaded using standard contract cash flows. A composite cash flow curve was then produced for each phase which was then integrated into a total cost curve for the system.

The rail alternative was broken into construction segments (CS) such that each segment represented a potential civil construction contract. The CS limits generally coincide with the facility boundaries of the capital cost estimate to assure compatibility with the capital cost estimate at the detailed facility level. **Figure 7-1** depicts the forty-six construction segments for the three corridors for the 2020 Rail/TSM Alternative as well as the segments related to each time phase. **Table 7.1** shows a cost and quantity matrix, indicating incremental and cumulative values for dollar amount, lengths in route miles, and number of stations for the particular set of time phases displayed in **Figure 7-1**.

Figure 7-2 shows an example of the Scope and Cost Data Sheet used in the analysis to summarize the scope and costs from the Capital Cost Estimate by CS. There are forty-six sheets, one for each CS. In the top part of the data sheet a table displays route feet for each type of guideway (aerial, at-grade, tunnel cut-and-cover, etc.). Stations and major structures such as parking lots and access ramps are called out in a separate section. In the lower part of the sheet, dollar amounts from the Capital Cost Estimate appear along with stationing and route

TABLE 7.1

REGIONAL TRANSIT PROJECT
RAIL PHASING: COST AND QUANTITY MATRIX – MILE FOR 3C-1 BASED SCENARIOS

(7/17/92-AOT)

Corridor	Cost and Quantity	Phase I (2005)	Phase II (2010)	Phase III (2015)	Phase IV (>2015)
North Corridor	Cost ($x1,000,000) – Incremental	1,368	469	615	316
	–Cumulative	1,368	1,837	2,452	2,768
	Lenght (Route Miles) – Incremental	9	9	10 (1)	5
	– Cumulative	9	19	28	34
	Number of Stations – Incremental	7	6	5 (2)	3
	– Cumulative	7	13	18	21
	Unit Costs ($Million/Mile) – Incremental	146	51	62	62
	– Cumulative	146	99	86	82
East Corridor	Cost ($x1,000,000) – Incremental	802	381	400	1,004
	–Cumulative	802	1,183	1,583	2,587
	Lenght (Route Miles) – Incremental	12	5	9 (1)	22
	– Cumulative	12	17	26	48
	Number of Stations – Incremental	8	5	4 (2)	10
	– Cumulative	8	13	17	27
	Unit Costs ($Million/Mile) – Incremental	66	73	45	45
	– Cumulative	66	68	61	54
South Corridor	Cost ($x1,000,000) – Incremental	1,353	280	352	403
	–Cumulative	1,353	1,633	1,985	2,388
	Lenght (Route Miles) – Incremental	17	6	10	10
	– Cumulative	17	23	33	43
	Number of Stations – Incremental	9	3	4	5
	– Cumulative	9	12	16	21
	Unit Costs ($Million/Mile) – Incremental	81	44	36	41
	– Cumulative	81	70	60	56
Total Rail (Excluding CR)	Cost ($x1,000,000) – Incremental	3,523	1,130	1,367	1,723
	–Cumulative	3,523	4,653	6,020	7,743
	Lenght (Route Miles) – Incremental	38	21	28	37
	– Cumulative	38	59	88	125
	Number of Stations – Incremental	24	14	13	18
	– Cumulative	24	38	51	69
	Unit Costs ($Million/Mile) – Incremental	92	54	48	46
	– Cumulative	92	79	69	62

1) The route length is calculated using assigned dollar amount diveded by average cost per route length for Phase III and IV.
2) The number of stations is calculated using phase route feet divided by average project route feet per station.

File: $&QUANT4

CONSTRUCTION SEGMENT - SCOPE AND COST

Construction Segment (CS): **N06**

CS# N06 Phase (MOS, 2010 or 2020) MOS

Description Northgate Station to 145th Street Station (Incl.)

Sta. 844+00 to 967+00; Route Length=12,300', (2.33 miles)

LINE - Length of Facilities in RF

Type of Guideway (incl. Stations)	#11415	#11416	#11417	#	#	#	#	#	Total
- Aerial	400	3,150							3,550
- At-Grade		2,000	400						2,400
- Retained Cut/Fill		3,900							3,900
- Tunnel, Cut & Cover		2,450							2,450
- Tunnel, Twin Bore									
- Segment Length (RF)	400	11,500	400						12,300

STATIONS

Station (Name/Type of Structure) #1 Northgate Station - Aerial, Center Platform with Canopy

#2 145th Street Station - At-Grade Center Platform with Canopy (Incl. 8 Elevators (2.1 million)

#3

#4

Major Structures (Greater than $1 Mil.) Parking Structure, 2+levels, 800 cars - $9.6 million at 145th Street Station

Access Aerial Ramp to Parking Structure - $5.3 million at 145th Street Station

COST by Facility

WBS	Description	Transit	Conting.	Total
11415	Northgate Station, 844+00 to 848+00, RL=400'	7,217	4,372	20,969
11416	Northgate Sta to 145th St. Sta, 848+00 to 963+00, RL+11,500'	42,472	9,829	52,300
11417	145th Street Station, 963+00 to 967+00, RL=400'	18,770	4,014	22,785

Total Segment Cost (Thousand Dollars) **96,054**

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System Plan
FIGURE 7-2

length for each facility. This information forms the basis for the next step in the construction scheduling process which is the preparation of a logic diagram for the CS activities.

For each CS a summary logic network diagram was prepared. Each activity is assigned a duration, and a "critical path" was calculated for the sequence of activities leading up to the end milestone, "Civil Construction Complete". Some of the activities were assigned standard durations common to all the construction segments, such as Preliminary Engineering - fourteen months, Final Design - twelve months, and Bid Evaluation and Award - eight months. Other activity durations and their lags are estimated or calculated separately for each construction segment taking into account their individual characteristics.

The group of civil construction segment logic networks comprising a phase are supplemented and tied together by phasewide networks. The phasewide network contains contracts for traction power; signal and communications; operation and maintenance facilities and storage yard; vehicles; and activities for testing and start-up. The end of the phasewide logic network constitutes the end of construction and the commencement of revenue service of that particular rail phase. The activity durations for the phasewide network are derived from experience on other projects and adjusted, as appropriate, for route length. In each case, the preliminary design of an MOS is preceded by the Alternatives Analysis/Draft Environmental Analysis phase; this effort is generally conducted for a corridor phase, or at a minimum, for an MOS.

The governing activities (those on the critical path) were analyzed for each phase and typically consisted of 1) a group of activities from one of the construction segments, and 2) some activities from the phasewide contracts such as traction power or signaling followed by integrated testing and start-up of the complete phase. In order to achieve a realistic schedule and resource allocation, the schedule float was utilized to stagger design starts allowing gradual application of resources and reasonable cushions between design and construction.

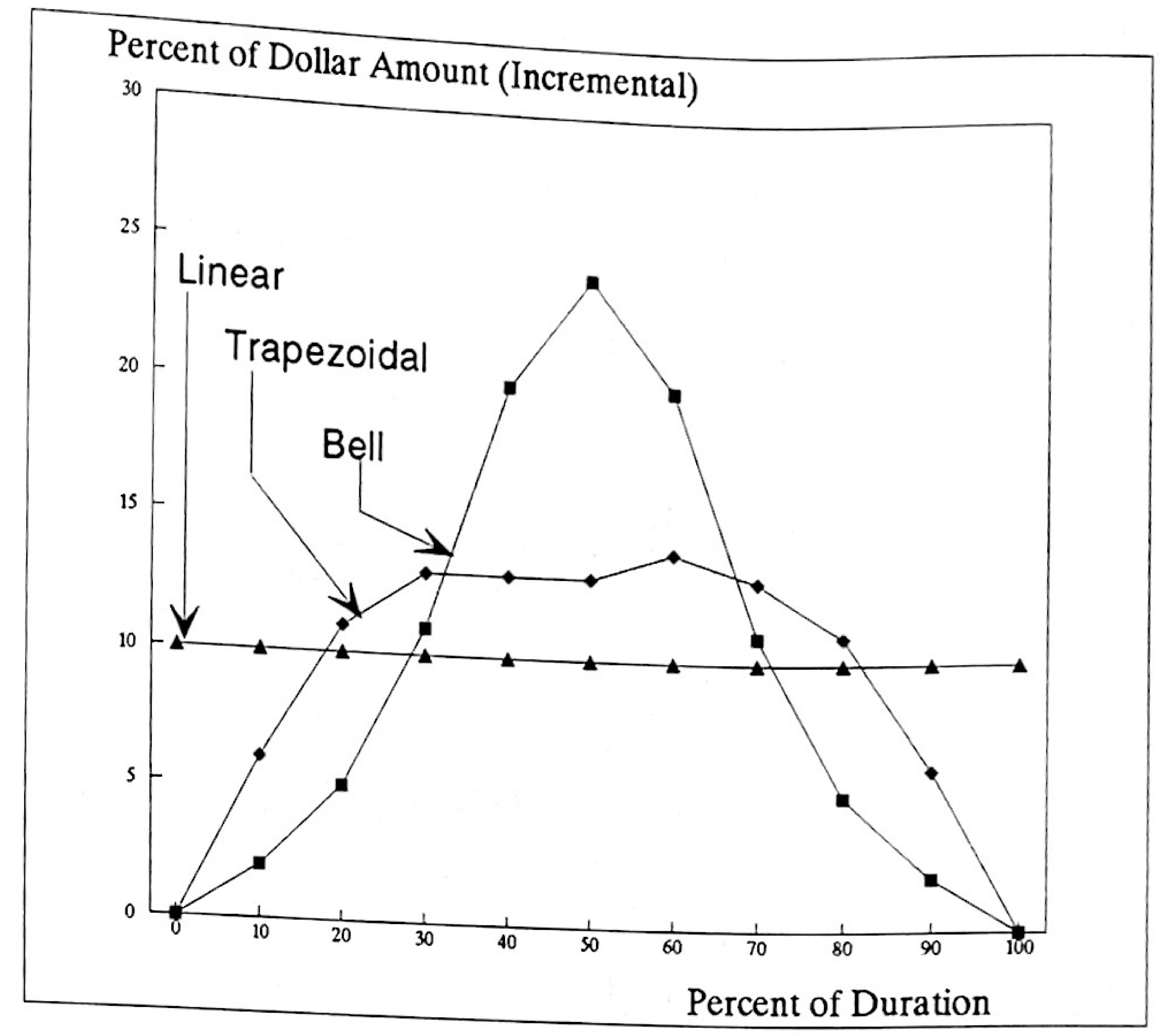
The next task is to cost load the developed network with costs from the capital cost estimate. Both the schedule and the capital costs needed to be structured to a common base for matching activities and costs. Each CS in the schedule was reduced to four activities - Design, Bid, Right-of-Way Acquisition, and Construction. These "hammock activities" were introduced to combine groups of activities in the network where the start of the hammock activity is identical to the start of the first activity in the group, and the end of the hammock activity coincides with the end of the last activity in the group. Similarly, the capital cost estimate needs to be structured to fit the phasing contract scope represented by the hammock activities as defined in the schedule network. The principal restructuring consists of breaking out some of the systemwide costs (traction power and signal, communication and fare vending) from the construction segment costs. A spreadsheet was designed to transform the Capital Cost Estimate to fit the hammock activities in the schedule network.

The final step in the cost loading process is to find a correct distribution of the costs along the duration of the activities. Due to the creation of hammock activities for each CS (one for design and one for construction), the cost profile cannot be assumed to be linear since that would tend to underestimate the cost peak per phase. Based on experience from transit contract cash flow distribution during design and construction, a trapezoidal distribution was selected to best represent the cost spreads for a CS, see **Figure 7-3**.

Utilizing the critical path method (CPM) network schedules and the hammock activity costs spreading, the network could be run and a cash flow produced for a test phasing scenario. **Figure 7-4** displays an example for all the nine phases by corridor assuming that the first phase in each corridor starts in the year 1993, the second phase in 2003, and the third phase in 2013. Note that this base scenario is used only as a test of the model. The combined result shows an unrealistically high peak of $1,013 million for the year 1998.

The Micro Phasing Model complies with the goal of accommodating variations in the three parameters: segment extension, time frame, and costs. Segment extension can be varied by adding or subtracting parts or whole construction segments and then re-tying systemwide activities and recalculating their durations. Time frame and sequence can be varied by changing the start date of each physical phase. Finally, changes in capital cost estimates can be accommodated by new entries in the Cost Input Spread Sheet and the corresponding reloading of costs in the CPM network.

REGIONAL TRANSIT PROJECT, PHASING ANALYSIS
CURVE SHAPE FOR CASH FLOW DISTRIBUTION



		Percent of Dollar Amount										
Bell	Accumulated	0	2	7	18	38	62	82	93	98	100	100
	Incremental	0	2	5	11	20	24	20	11	5	2	0
Trapezoidal	Accumulated	0	6	17	30	43	56	70	83	94	100	100
	Incremental	0	6	11	13	13	13	14	13	11	6	0
Linear	Incremental	10	10	10	10	10	10	10	10	10	10	10
Intervals (%)		0	10	20	30	40	50	60	70	80	90	100

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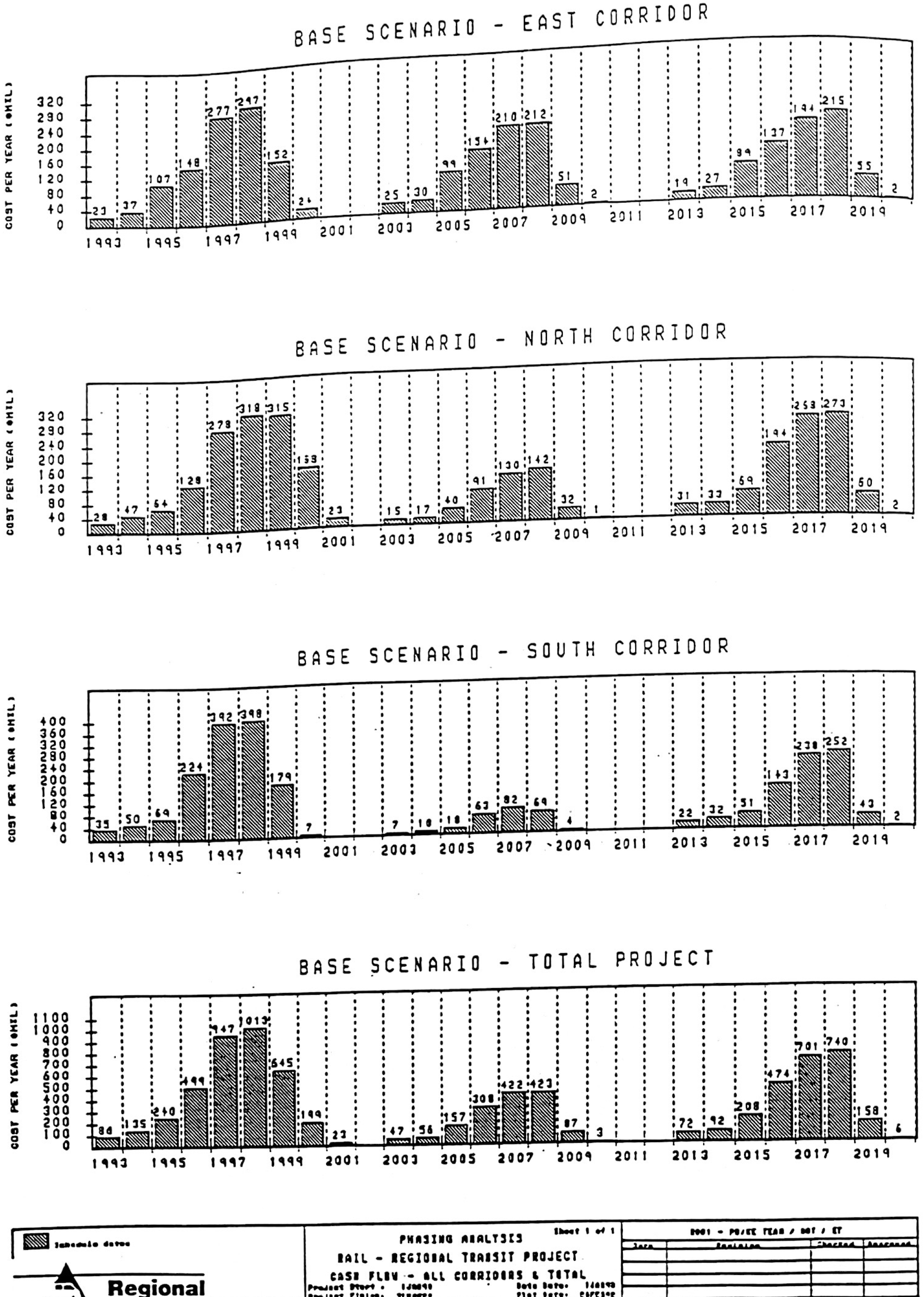
System Plan
FIGURE 7-3



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System Plan

FIGURE 7-4

Macro Phasing Model

The Micro Phasing Model, described above, is capable of creating new phasing scenarios accurately by changing segment size, time frame and cost. The analysis of a large number of phasing scenarios using the micro model would be prohibitively time consuming. The time to produce a new scenario by varying start dates of a phase is relatively fast, but to change physical limits or capital costs is complex and requires considerably more time. Development of a simpler Macro Phasing Model provided a faster turnaround time to support the analysis of a wide range of conceptual alternatives.

By using the information calculated through the Micro Phasing Model, a simpler macro model was developed, which functions at a summary level of activity but can create relatively accurate cash flow curves for a new scenario in minutes, to accommodate date changes, and in hours, if the scope and cost data are changed. The macro model uses physical phases as building blocks instead of construction segments and activities. Phases are here defined as complete rail sections including civil and systemwide activities. An example of a phase would be the North MOS from the DSTT to the 145th Street station, valued at 1,368 million 1991 dollars. The number of phases for the total project used in the macro model is ten to twenty versus the number of activities in the micro model which is approximately 1,200 including 250 cost-loaded hammock activities - a considerable simplification of the process.

Each activity (equal to a phase in the macro model) was cost loaded with a non-linear unit cost curve derived from the micro model. Selected unit curves from the micro model were used. When phase boundaries were changed in the macro model and no corresponding unit cost curve in the micro model was available, a unit cost curve was selected from an earlier calculated phase that was most similar to the new changed phase.

The Macro Phasing Model was developed using a spreadsheet approach (Lotus 1-2-3 Version. 3.1). The time unit in the micro model is a month, which is impractical at the macro model level of analysis. A yearly time unit was tried but found to cause too large of a swing in the cash flow peaks when phases were moved in time, therefore, half-year time units were chosen for the spreadsheet model which is adequate for gross level phasing analysis. When moving phases in time in minimum increments of half years, resulting cash flow totals and check sums could be produced and analyzed on the computer screen within minutes. Similarly, graphic charts could be produced concurrently on the computer screen.

Another macro model was developed through the scheduling software Primavera Version 5.0 using the same principle regarding unit cost curves from the micro model. The Primavera model is somewhat slower than the Lotus 1-2-3 model but produces smoother cash flow curves since the time unit is a month instead of half years and has the advantage of automatic leveling where desired maximum peaks and allowable windows for the start of revenue operations can be established for each run.

Use and Accuracy of the Models

The two macro models and the micro model are used as follows:

- The Lotus 1-2-3 Spreadsheet Macro Phasing Model is used to screen many conceptual scenarios to get a feeling for the viability of a concept in a short time. The use of estimated unit cost curves reduces the model's accuracy.

- The Primavera Macro Phasing Model is used to analyze the more promising scenarios and provides more accurate and smoother cash flow curves due to the use of a month as the time unit and the automatic resource leveling feature. Still, the model uses the unit cost curves approximated from the Micro Model which reduces the model's accuracy.

- For a very few promising scenarios, the Micro Phasing Model will be used. This model also uses Primavera but as a scheduling software in the traditional sense by including a larger number of cost-loaded activities. It takes more time to analyze and optimize a scenario using the micro model but the relative accuracy is higher and a more complete set of schedules and cash flow curves can be produced.

7.1.2 Phasing Scenarios

The three main parameters of the phasing task are segment extension, time frame, and design and construction costs or "where, when and how much". The phasing models described in Section 7.1.3 are capable

of providing the results of any combination of the three parameters in the form of segment schedules and cash flows by segment or total project.

The next step in the process is to evaluate the various scenarios against each other. This evaluation is partly technical and objective and partly responsive to the perceived social benefits of the various jurisdictions and hence subjective. The selection of the phasing scenarios to be modeled and evaluated evolved through a gradual process supported by results from earlier scenarios and supplemented by technical considerations and jurisdictional input.

The phasing model was used to process the various phasing scenarios while attempting to follow the general criteria listed below.

- Criteria Related to Operation of the System

  - Maintenance Facility and Storage Yard Access - Rolling stock must complete static testing, be maintained and stored and the phasing segments sized and timed to include access to a maintenance and storage facility.

  - Test Track - The rail vehicles need to be tested on a two- to four-mile long track with a reasonably straight and level alignment. The test track section of the system (including a repair and assembly shop) must be powered-up in advance of the other parts of the system to allow time (9 to 15 months) for vehicle assembly and acceptance testing.

- Criteria Related to Sequence and Date of Operation

  - Sequential Build-out - Rail lines typically are built sequentially in progressive segments; vehicles operating on the line are part of, and need access to, the entire system. (Some scenarios with non-sequential build-out were developed, on request.)

  - Equity by Corridor and County - From an equity perspective, it is necessary that revenues collected in a geographic area approximate the capital and service investment in the geographic area. This requirement is particularly complex when equity is sought not only at buildout but at incremental levels. These conditions are in conflict with several other criteria and compromises must be made..

- Criteria Related to Yearly Construction Costs

  - Regional Construction Capacity - There is an optimal size to the construction project that the resources available in the region can absorb effectively and efficiently; too large a project will increase cost and results in the import of construction resources from outside the region. The exact maximum limit is not rigidly quantifiable, but range is in the 400 to 600 million dollars per year.

    The cash flow curve reflects the capital implications of a given implementation schedule. The schedule for the alternative implementation scenarios will be developed to minimize the capital cost of design and construction. The schedule and corresponding cash flow should reflect a level of expenditure that maximizes the rate of implementation while remaining within the fiscal constraints of the financial plan.

  - Federal Funding - Federal funds need to pay for at least 33 percent of the cost of the rail system. Based on an assessment of the Section 3 funding estimated to be available over the life of the project and the competitiveness of the various segments of the project for those funds at a national level, it is possible to schedule the implementation of the program in a sequence and duration that maximizes federal funding. The maximization of federal funds will probably result in a slower implementation schedule than one that results in the minimization of total project cost; the best balance or compromise will be sought.

7.1.2.1 Generation of the Baseline Scenario

The following is a brief summary of the assumptions and logic used to develop the baseline scenario and refine the RTP implementation scenarios currently being discussed as part of the phasing analysis. For scheduling purposes, the rail system was divided into sub-phases or

minimum operable segments. Each MOS connects a logical set of origins and destinations at its termini and includes access to a maintenance shop and storage yard. The MOS can be designed, constructed and operated relatively independent of the balance of the rail system and still facilitate the turnback of trains. The termini should accommodate, at least on an interim basis, a logical interface with the bus system. Accepting the logic of the MOS concept, there are basically two methods to alter the rate of implementation:

- alter the duration of each MOS, or,

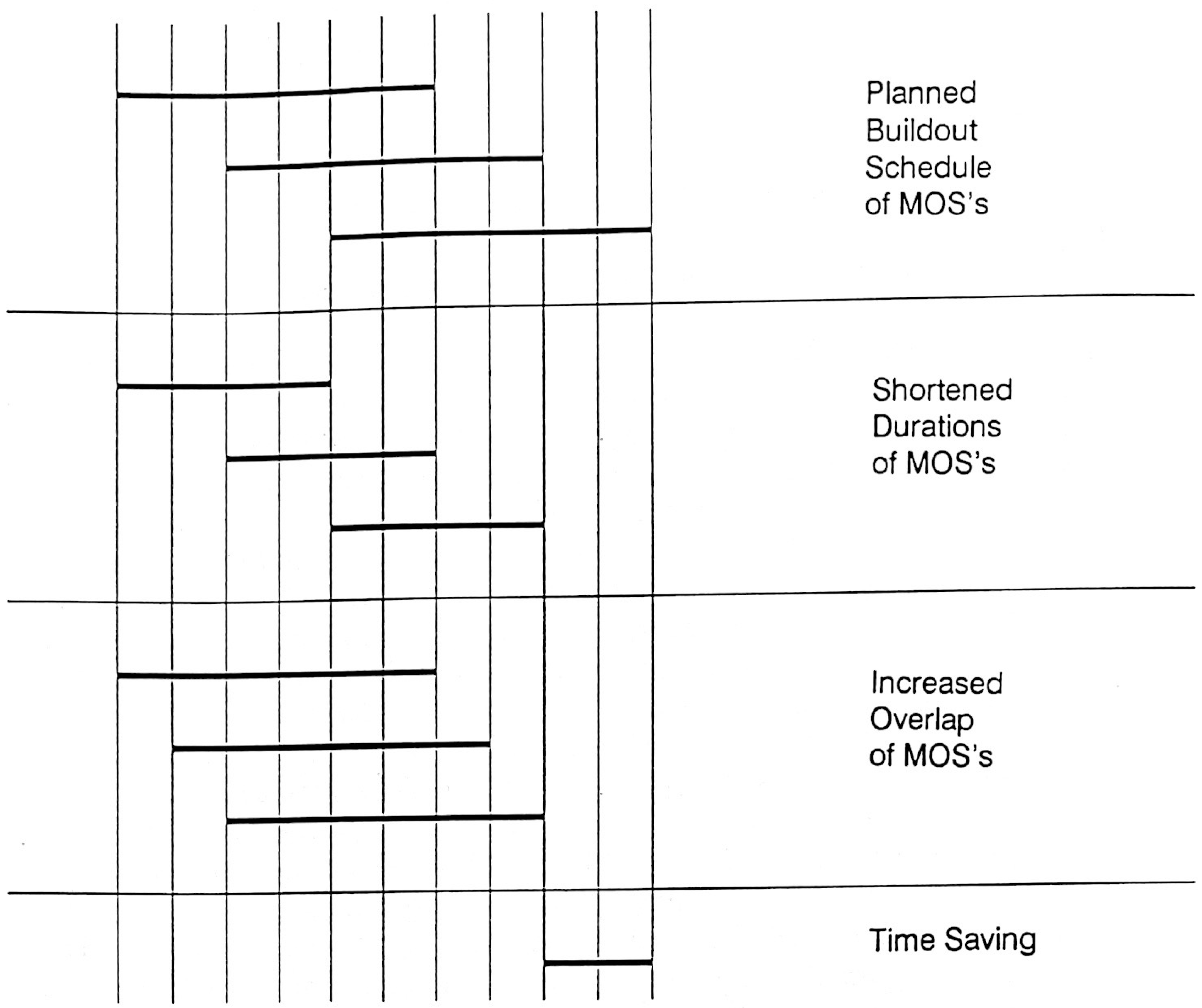
- change the degree of overlap between MOS's

The two methods are shown schematically in **Figure 7-5**.

During the phasing process the goal was to optimize the balance between tight implementation schedule and the region's fiscal resources by using aggressive, but realistic MOS durations and maximizing the degree of overlap between phases. **Figure 7-6** reflects a typical construction segment schedule for a civil engineering contract. An MOS is comprised of a number of construction segments and systemwide activities as reflected in **Figure 7-7**. For a typical civil engineering contract, the duration of preliminary engineering and final design phases are approximately 14 and 12 months, respectively. The advertising, evaluation and award phase is scheduled for eight months. The pre-construction phases, from the start of design to the start of construction, for a typical civil contract take approximately 34 months; almost three years exclusive of the AA/DEIS process. While the right-of-way acquisition typically can start about half way into the preliminary engineering phase, most right-of-ways will be acquired during final design when the boundary lines are well enough defined to support the acquisition process. The construction duration varies depending on the size and type of the contract; in this example the civil portion of the construction is projected at 42 months.

Figure 7-8 reflects an integrated MOS schedule for the construction segments and systemwide contracts. On average, the typical schedule for an MOS is approximately seven to eight years. The following is a summary discussion of the impacts of changing the MOS duration or overlap (the NE 145th Street to 164th Street MOS was used for this example).

IMPLEMENTATION SCENARIOS



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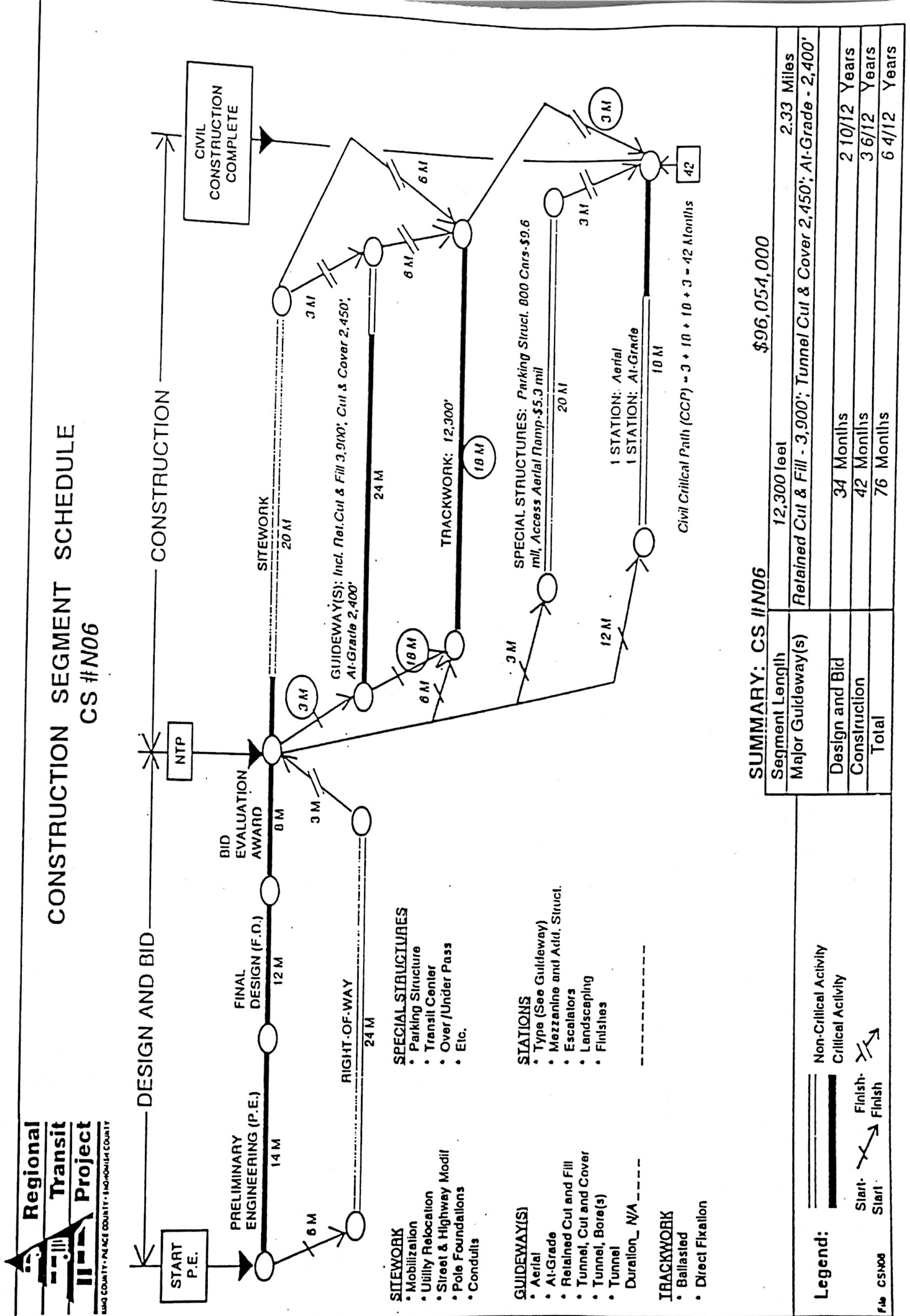
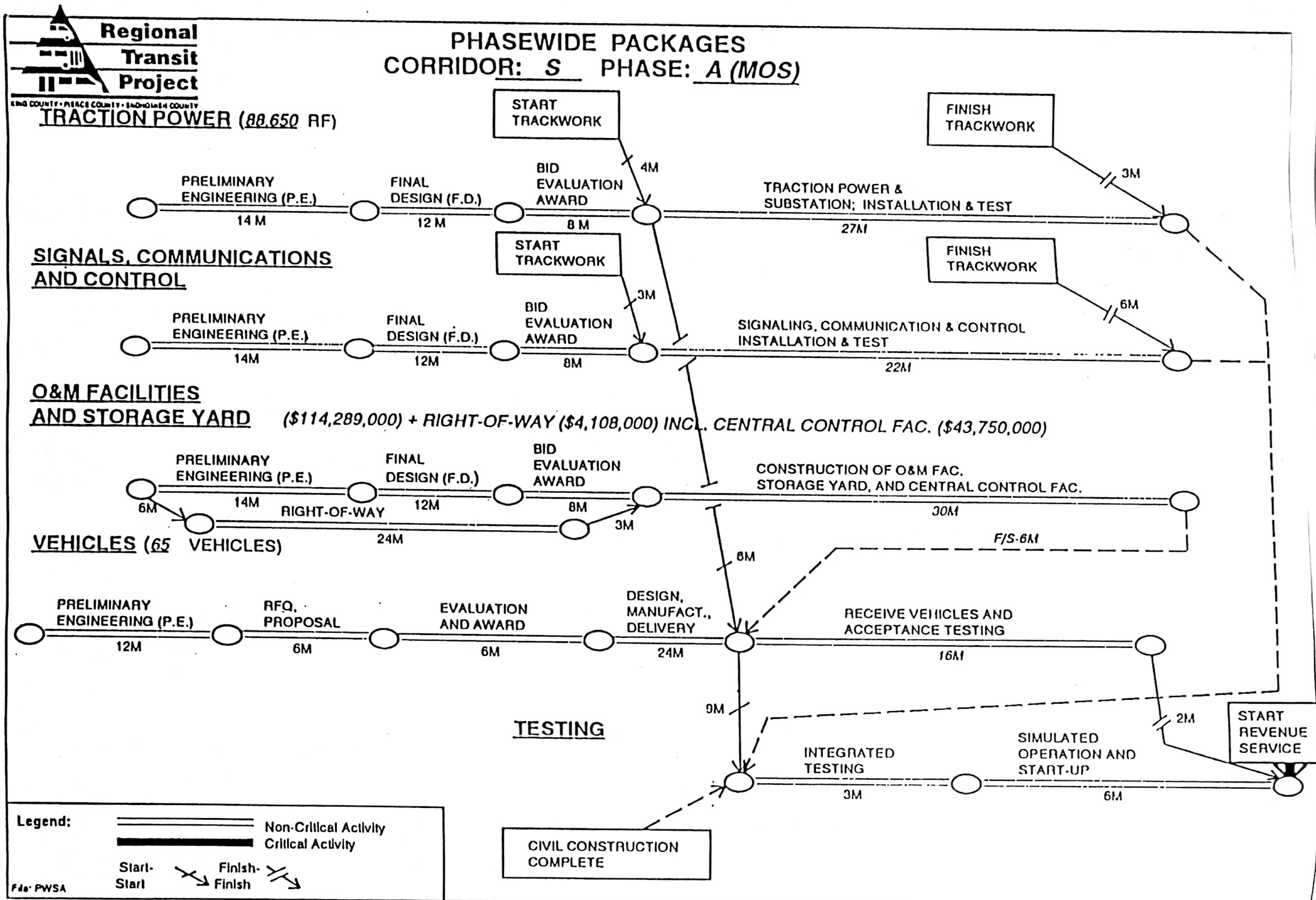
SYSTEM PLAN
FIGURE 7-5



SYSTEM PLAN
FIGURE 7-6



SYSTEM PLAN
FIGURE 7-7

ACTIVITY ID	ORIG DUR	TOTL FLT	EARLY START	EARLY FINISH	Activity (2002–2015)
					GENERAL, NORTH, 2010
NB000	0	0	1JAN03		START NORTH, 2010
					CS#N07 - 145TH ST TO MOUNTLAKE TERRACE S STN
N0701	0	2	1APR03	31MAR03	START PRELIMINARY ENGINEERING
N0702	18	2	1APR03	30SEP04	PRELIMINARY ENGINEERING
N0704	12	2	1OCT04	30SEP05	FINAL DESIGN
N0706	8	2	1OCT05	31MAY06	BID, EVALUATION, AWARD AND PERMITS
N0708	24	7	1OCT03	30SEP05	RIGHT-OF-WAY
N0710	0	2	1JUN06	31MAY06	NOTICE TO PROCEED
N0712	18	2	1JUN06	30NOV07	SITEWORK
N0714	20	2	1SEP06	30APR08	GUIDEWAY: AT-GR 9,370', RET C/F 6,130', AER 4,450'
N0716	18	2	1MAY07	31OCT08	TRACKWORK: 19,950'
N0718	20	11	1SEP06	30APR08	SPEC STRUCT: PARK 2: LEV 1,200 CARS (14 4 M)
N0720	18	5	1AUG07	31JAN09	2 STATIONS: ONE AERIAL, ONE AT-GRADE
N0730	0	5	1FEB09	31JAN09	CIVIL CONSTRUCTION COMPLETE
					CS#N08 - MOUNTLAKE S TO LYNNWOOD P&R STN
N0801	0	0	1JAN03	31DEC02	START PRELIMINARY ENGINEERING
N0802	18	0	1JAN03	30JUN04	PRELIMINARY ENGINEERING
N0804	12	0	1JUL04	30JUN05	FINAL DESIGN
N0806	8	0	1JUL05	28FEB06	BID, EVALUATION, AWARD AND PERMITS
N0808	24	5	1JUL03	30JUN05	RIGHT-OF-WAY
N0810	0	0	1MAR06	28FEB06	NOTICE TO PROCEED
N0812	18	0	1MAR06	31AUG07	SITEWORK
N0814	24	0	1JUN06	31MAY08	GDWAY: C/F 8,290', AER 3,000', C&C 1200', AT-GR 400'
N0816	24	0	1DEC06	30NOV08	TRACKWORK: 12,890'
N0818	24	10	1JUN06	31MAY08	SPEC STRUCT: PARK 500 CAR, AT-GR 500, BRIDGE WIDE
N0820	18	4	1SEP07	28FEB09	2 STATIONS: ONE AT-GRADE, ONE AERIAL
N0830	0	4	1MAR09	28FEB09	CIVIL CONSTRUCTION COMPLETE
					CS#N09 - LYNNWOOD P&R (NOT INCL) TO 164TH ST SW
N0901	0	1	1JAN03	31DEC02	START PRELIMINARY ENGINEERING
N0902	18	1	1JAN03	30JUN04	PRELIMINARY ENGINEERING
N0904	12	1	1JUL04	30JUN05	FINAL DESIGN
N0906	8	1	1JUL05	28FEB06	BID, EVALUATION, AWARD AND PERMITS
N0908	24	6	1JUL03	30JUN05	RIGHT-OF-WAY
N0910	0	1	1MAR06	28FEB06	NOTICE TO PROCEED
N0912	20	1	1MAR06	31OCT07	SITEWORK
N0914	24	1	1JUN06	31MAY08	GDWAY: AT-GR 7,110', C/F 4660', AER 2290', C&C 1700'
N0916	24	1	1DEC06	30NOV08	TRACKWORK: 15,760'
N0918	24	10	1JUN06	31MAY08	SPEC STR.: 2 PARK AT-GR 500, 2,00 CARS, ACCESS RAMP
N0920	12	4	1MAR08	28FEB09	2 STATIONS: AT-GRADE CENTER PLATFORM W/ CANOPY
N0930	0	4	1MAR09	28FEB09	CIVIL CONSTRUCTION COMPLETE

Activity Bar/Early Dates
Critical Activity
Primavera Systems, Inc 1984-1990

Planning Unit : Month
Project Start : 1JAN93
Project Finish: 31DEC20

PHASING ANALYSIS
RAIL - REGIONAL TRANSIT PROJECT
NORTH CORRIDOR / 2010 / BAR CHART

Sheet 1 of 2
Data Date: 1JAN93
Plot Date: 24FEB92

Date	Revision	Checked	Approved

SYSTEM PLAN
FIGURE 7-8

- The construction market tends to "over-heat" resulting in fewer bidders per contract, higher contract contingencies and higher bids.

- Higher utilization of construction labor resources and equipment will press less productive units into service resulting in higher cost.

- It is difficult to maximize the federal funding contribution since more funds are required during a shorter span of years.

- Service is provided at a higher rate than demand warrants; the system will be utilized less in earlier years than in a slower build-out scenario because of the demand inherent in population growth.

Figure 7-10 shows an example of a set of sub-phases (Scenario PS10) with total duration spanning the years 1994 to 2010 (17 years), where the capital cost expenditures for the rail system are within $400 - 600 million per year. (Note that on this figure the TSM portion, marked in black on the graph, brings the peak over $600 million per year.) While the application of this approach produces a technically sound scenario, it is necessary to apply a wider range of criteria and political considerations to arrive at the optimal implementation scenario for the region. The next sections describe the development of the baseline scenarios and its subsequent modification and analysis.

Utilizing the process described in general above and more completely in the Alternative Refinement and Phasing Methodology Report, a baseline scenario was generated for the $7.9 billion dollar, 164-mile system (inclusive of commuter rail) at the micro-level of development. The baseline scenario schedule is reflected in **Figure 7-11** and the corresponding cash flow in **Figure 7-4**.

The generation of the baseline scenario provided the database for the micro model and the subsequent set of 2020 Alternative phasing scenarios and cash flows necessary to assess the financial implications of constructing the entire 2020 Alternative. Review of the baseline scenario against the general phasing criteria served as the basis for the

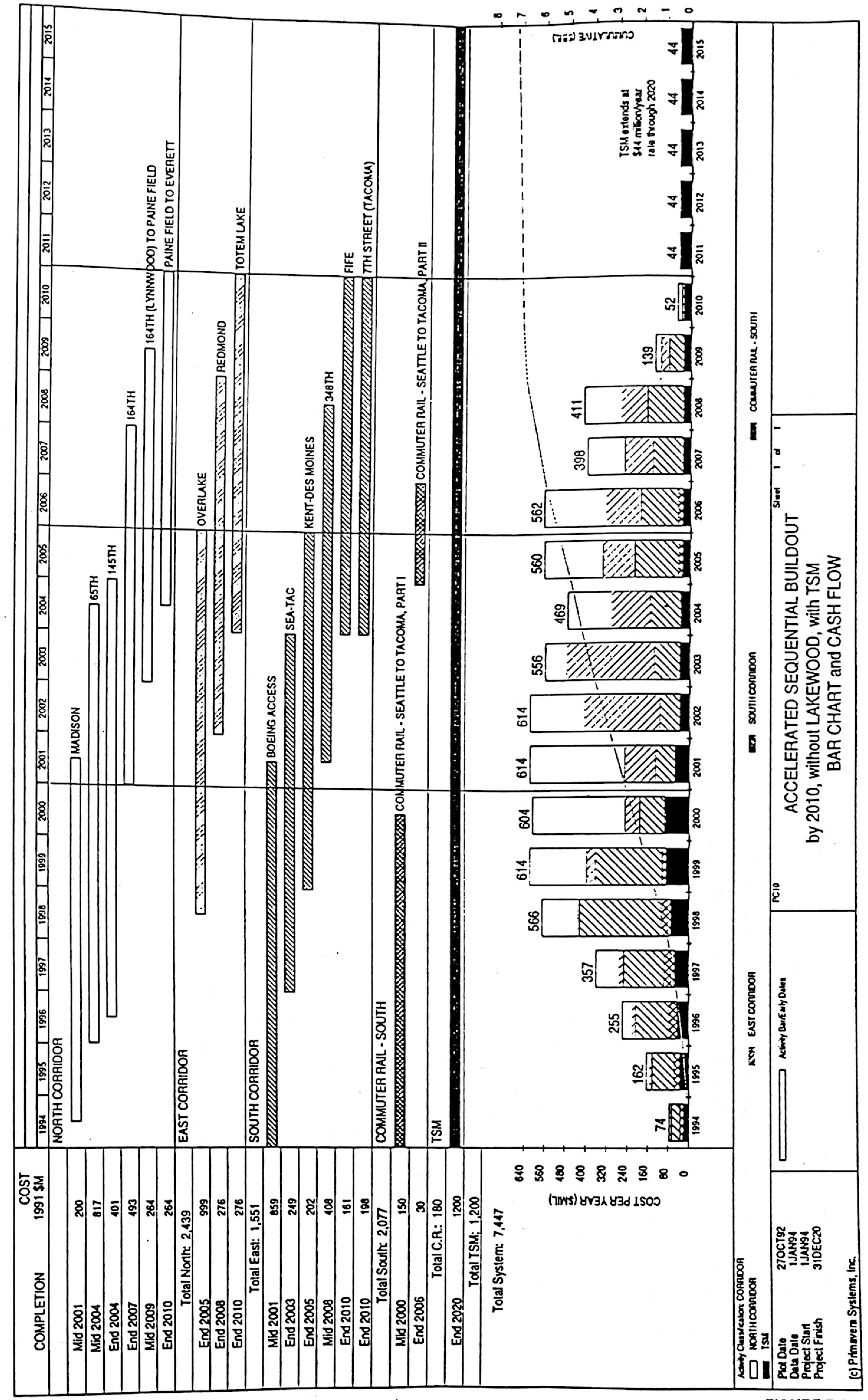
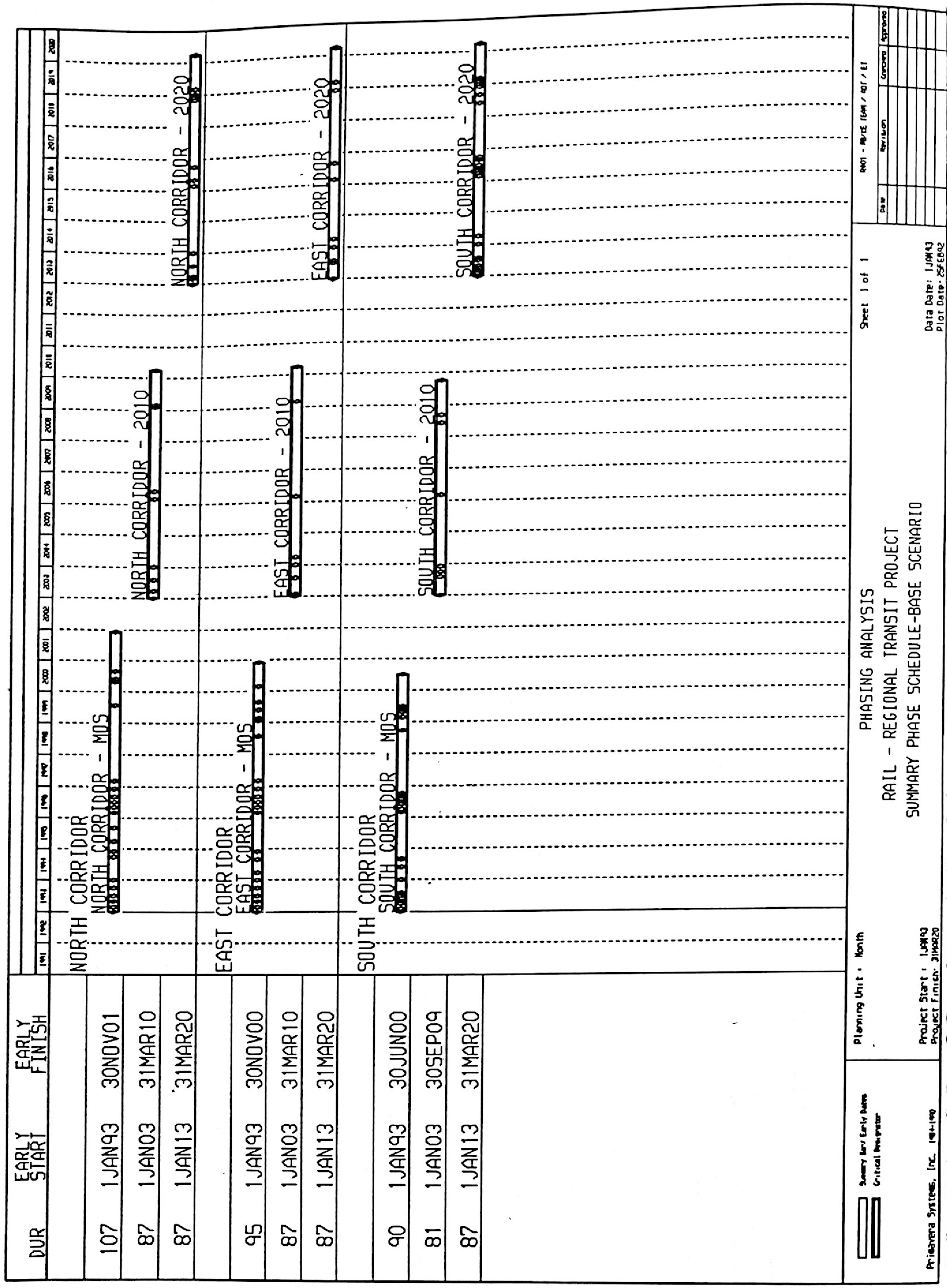


FIGURE 7-10
SYSTEM PLAN



SYSTEM PLAN

FIGURE 7-11

JRPC's initial reduction of the system to a more efficient and effective system and the generation of a subsequent set of phasing scenarios that addressed a broad enough range of probable phasing concepts to establish a prototypical set of possibilities.

Based largely on the analysis of the productivity of the system segments, the JRPC recommended that the Draft System Plan scope be reduced by postponing the following segments: Totem Lake to I-5 north; I-90/I-405 to Issaquah; I-90/I-405 to Kennydale; and Burien to Kennydale. These segments will be considered in a future phase. **Table 7.2** reflects recommended (Phases I-III) and deferred (Phase IV) portions of the system. The resulting reduction in the capital cost of the system to $6.2 billion reduced the potential buildout date from 2020 to 2015.

7.1.2.2 The Four Remaining Phasing Alternatives

Following the review of approximately 70 phasing scenarios and modifications at the macro level of analysis, the RTP staff was able to group the phasing approaches into four prototypical classifications:

- A sequential segmental buildout starting from the Downtown Seattle Transit Tunnel and working outward in the three corridors more or less simultaneously (2015 Buildout).
- The acceleration of one or two corridors with a corresponding delay in the other corridor(s) (2015 Buildout).
- A non-sequential buildout, or "Golden Spike", building the center and ends of the system as rapidly as possible and then constructing the center sections (2015 Buildout).
- An accelerated buildout by 2010; this alternative includes the potential for both a Sequential and Golden Spike Option.

The four remaining phasing alternatives that will be carried forward for further discussion are outlined below.

TABLE 7.2

CAPITAL COST PER NEW RIDER BY MAJOR SEGMENTS OF THE 2020 RAIL SYSTEM

Segment	Number of Rail System New Riders in Forecast Year (Daily)	Number of Rail System New Riders in Forecast Year (Annually)	Capital Cost of Segment (1991 dollars, in thousands)	Annual Capital Cost per New Rider in Forecast Year
North Corridor				
University St. Station to NE 65th St.	26,500	7,445,000	959,000	$4.77
NE 65th St. to NE 145th St.	8,000	2,250,000	409,000	$6.73
NE 145th St. to SW 164th St.	4,500	1,265,000	469,000	$13.73
SW 164th St. to Everett	4,000	1,125,000	615,000	$20.25
SW 164th to Paine Field	1,000	280,000	168,000	$22.22
East Corridor				
University St. Station to Northup	4,500	1,265,000	854,000	$25.00
Northup to Redmond	4,250	2,000,000	429,000	$7.94
Northup to Totem Lake	2,500	700,000	300,000	$15.87
Totem Lake to I-5 North	750	210,000	421,000	$74.25
I-90/I-405 to Issaquah	1,000	280,000	301,000	$39.81
I-90/I-405 to Kennydale	750	210,000	274,000	$48.32
South Corridor				
University St. Station to Boeing Access Rd.	15,000	4,215,000	723,000	$6.35
Boeing Access Rd. to Kent-Des Moines Rd.	5,250	1,475,000	630,000	$15.82
Kent-Des Moines Rd. to S. 348th St.	4,500	1,265,000	280,000	$8.20
S. 348th St. to Tacoma	2,300	645,000	352,000	$20.21
Burien to Kennydale	500	140,000	430,000	$113.76
Commuter Rail Seattle to Tacoma	1,200	315,000	195,000	$22.93
	86,500	25,085,000	7,809,000	$11.53

Alternative 1: Sequential Build-out in All Three Corridors - System Completed by Year 2015 (Figure 7-12)

This phasing alternative is designed to bring the system on-line by advancing the project in sequential increments which generally are simultaneous in three corridors, with a slight delay in the East Corridor.

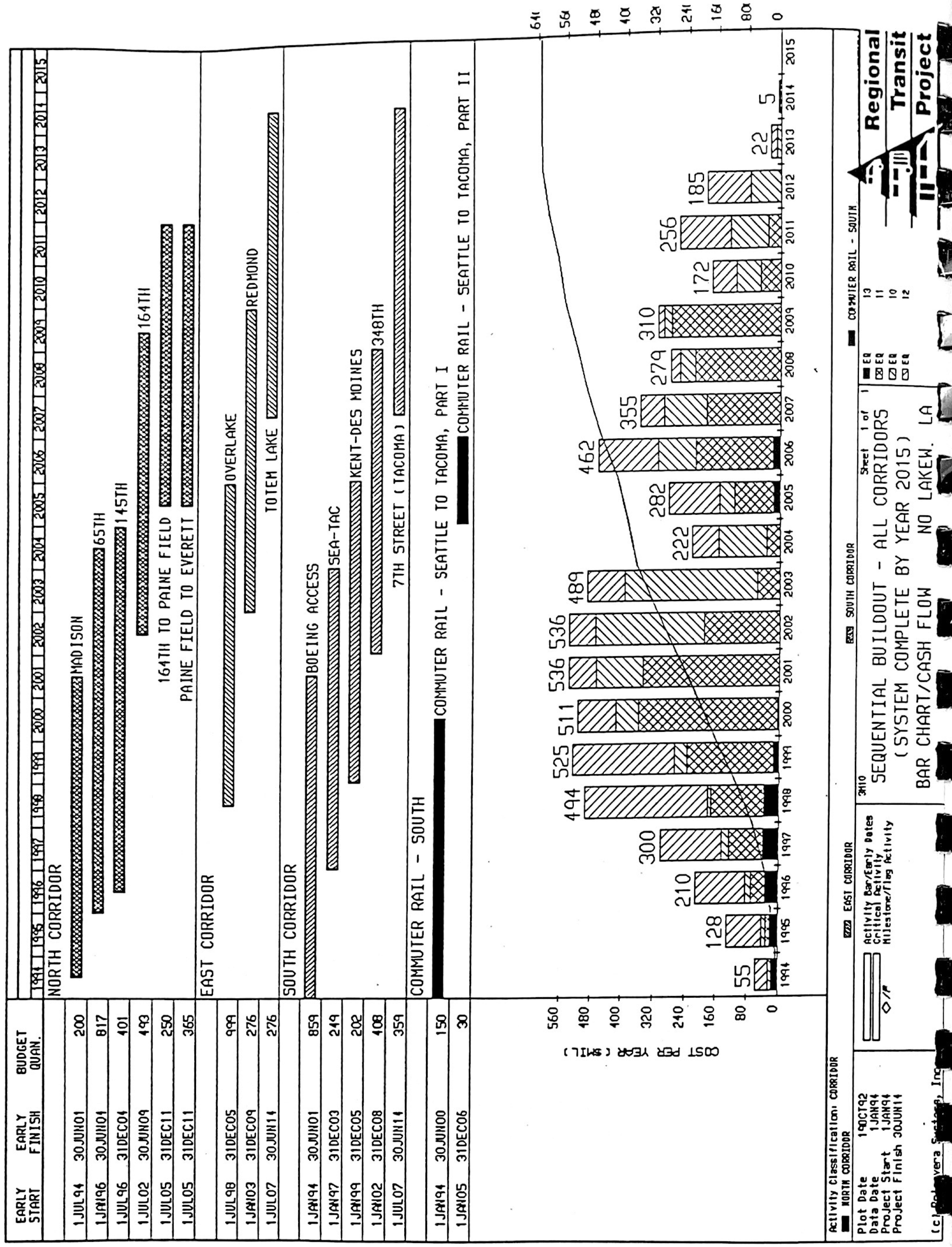
Service and physical facilities would include the following:

- Immediate and significant systemwide expansion of bus fleets and services.
- Local transportation system improvements in all jurisdictions (e.g., signal improvements, arterial HOVs, bus bases, etc.).
- Approximately 88 miles of guideway and 52 stations by 2015 with rail to major activity centers in each corridor by 2005 (Bellevue, Northgate, Sea-Tac).
- Commuter rail service in the South Corridor initiated by 1996 and built-out by 2006.
- Right-of-way preservation, access improvements, park-and-ride lots and transit centers for areas not served by 2015 rail system.
- Allowances for right-of-way purchase and access improvements and partial funding of park-and-ride lots in areas (preferably future station sites) not served by the 2005 system but served in subsequent phases by 2015.
- Development and implementation of higher capacity feeders, circulators and distributors such as LRT, Automated Guided Transit (AGT) and Personal Rapid Transit (PRT).

The advantages of this phasing scheme are:

- Maximizes regional benefits for employment and income with relatively level expenditures of $450 to $650 million annually for approximately 15 years.

PA #1



SYSTEM PLAN
FIGURE 7-12

- Allows implementation flexibility by designing and constructing the system in three corridors simultaneously; thus, an issue at one site or in one corridor does not stop all RTP progress.

- Maximizes ease of DSTT operational transition by phasing in initial segments of three corridors simultaneously with minimal or no joint operation with buses.

- Provides the additional corridor and CBD capacity required by 2005.

- Maximizes ridership return on investments and sequentially implements next most productive system segment(s).

- Provides the opportunity to maximize federal funding early in the program, to the extent funding availability is consistent with schedule requirements, by implementing the most nationally competitive segments first and the opportunity to front-load the financial plan with the maximum amount of federal dollars available.

- From a corridor perspective, provides a relatively equitable level of investment.

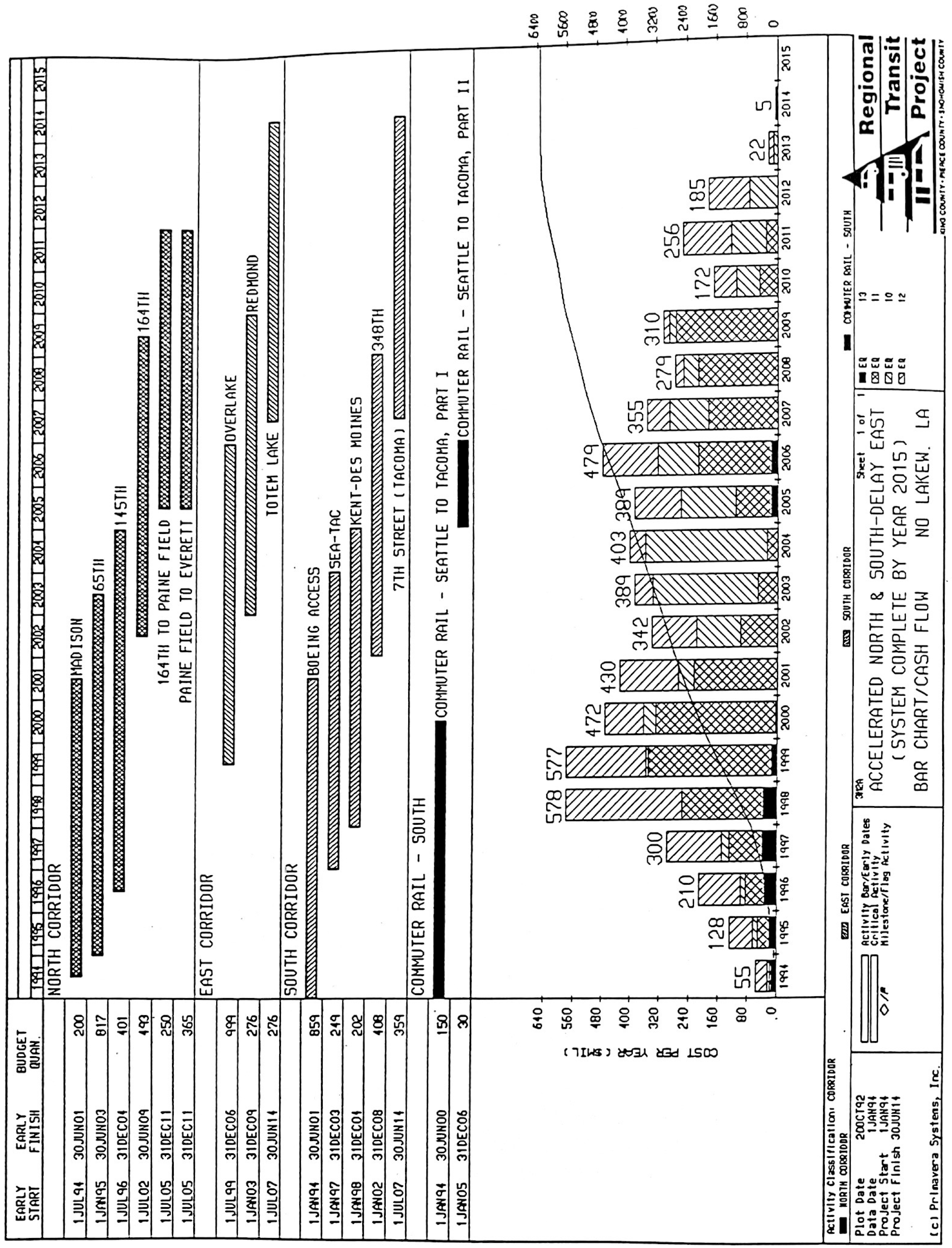
- Maximizes operational efficiency and effectiveness while minimizing the dollars spent on duplicative or reconfigured facilities.

The primary disadvantage of this approach is that because the rail system progresses sequentially out from the DSTT, Snohomish and Pierce Counties (with the exception of commuter rail in the South Corridor) are not reached until Phase II (about 2008) and Phase III (about 2012), respectively.

Alternative 2: Accelerated Sequential Build-out of Two Corridors; Delay of Third Corridor (Figure 7-13)

This phasing alternative is designed to extend two of three corridors to 2015 limits as rapidly as possible (about five years earlier than Alternative 1) while delaying Phase I and II of the third corridor for approximately five years.

PA #2b



SYSTEM PLAN
FIGURE 7-13

Service and physical facilities would include the following:

- Immediate and significant systemwide expansion of bus fleets and services.
- Local transportation system improvements in all jurisdictions (e.g., signal improvements, arterial HOVs, bus bases, etc.).
- Approximately 88 miles of guideway and 52 stations by 2015 with rail to major activity centers in two corridors by 2005 (Bellevue, Northgate, Sea-Tac - two of the three).
- Commuter rail service in the South Corridor initiated by 1996 and built-out by 2005.
- Right-of-way preservation, access improvements, park-and-ride lots and transit centers for areas not served by 2015 rail system.
- Allowances for right-of-way purchase and access improvements and partial funding of park-and-ride lots in areas (preferably future station sites) not served by the 2005 system but that will be served in subsequent phases by 2015.
- Development and implementation of higher capacity feeders, circulators and distributors such as LRT, AGTs and PRTs.

The advantages of this phasing scheme are discussed below:

- Maximizes regional benefits from employment and income with relatively level expenditure of $450 to $650 million annually for approximately 15 years.
- While less implementation flexibility exists than in Alternative 1, it allows implementation flexibility by designing and constructing a system in two corridors and an issue at one site or in one corridor does not stop all RTP progress.
- Provides additional capacity in two corridors required by 2005 earlier than Alternative 1.
- With North Corridor delay, maximizes return on investment for South Corridor; with South Corridor delay, maximizes return

on investment for North Corridor; and with East Corridor delay, maximizes return on investment for North and South Corridors.

- May increase total federal investment by spreading competitive segments over a longer period of time.

- From a corridor perspective, accelerates equity accomplishment for the two corridors that are accelerated for build-out.

Disadvantages of this phasing alternative include:

- North Corridor Delay

  - Would delay capacity relief required in the highest demand and most congested corridor as well as delaying the regional link to the North Corridor.

  - Would probably require continued joint use of the DSTT until the North Corridor rail service is initiated and CBD capacity constraints would continue.

  - Would have some of the less competitive parts of the system competing for FTA funding during the initial phases of implementation and might result in delay of FTA approval for the AA/DEIS process.

  - Acceleration of any two corridors results in "spikey" cash flows and would increase bonding and debt service requirements and tax regional engineering and construction resources.

  - Would result in operational inefficiency and ineffectiveness and result in "throw-away" modifications for interim bus service improvements.

- South Corridor Delay

  - Delay capacity relief required in the second highest demand corridor as well as delaying the regional link to the South Corridor.

  - Would have some of the less competitive parts of the system competing for FTA funding during the initial phases of implementation and might result in delay of FTA approval for the AA/DEIS process.

  - Would lose access to the maintenance shops and storage yards at Boeing Access Road and overload Northup maintenance shops until the 145th Street shops could be put on line.

  - Would result in operational inefficiency and ineffectiveness and result in "throw-away" modifications for interim bus service improvements.

- East Corridor Delay

  - Would delay regional link to the East Corridor.

  - Would result in operational inefficiency and ineffectiveness and result in "throw-away" modifications for interim bus service improvements.

Alternative 3: Non-Sequential Build-Out - Golden Spike (Figure 7-14)

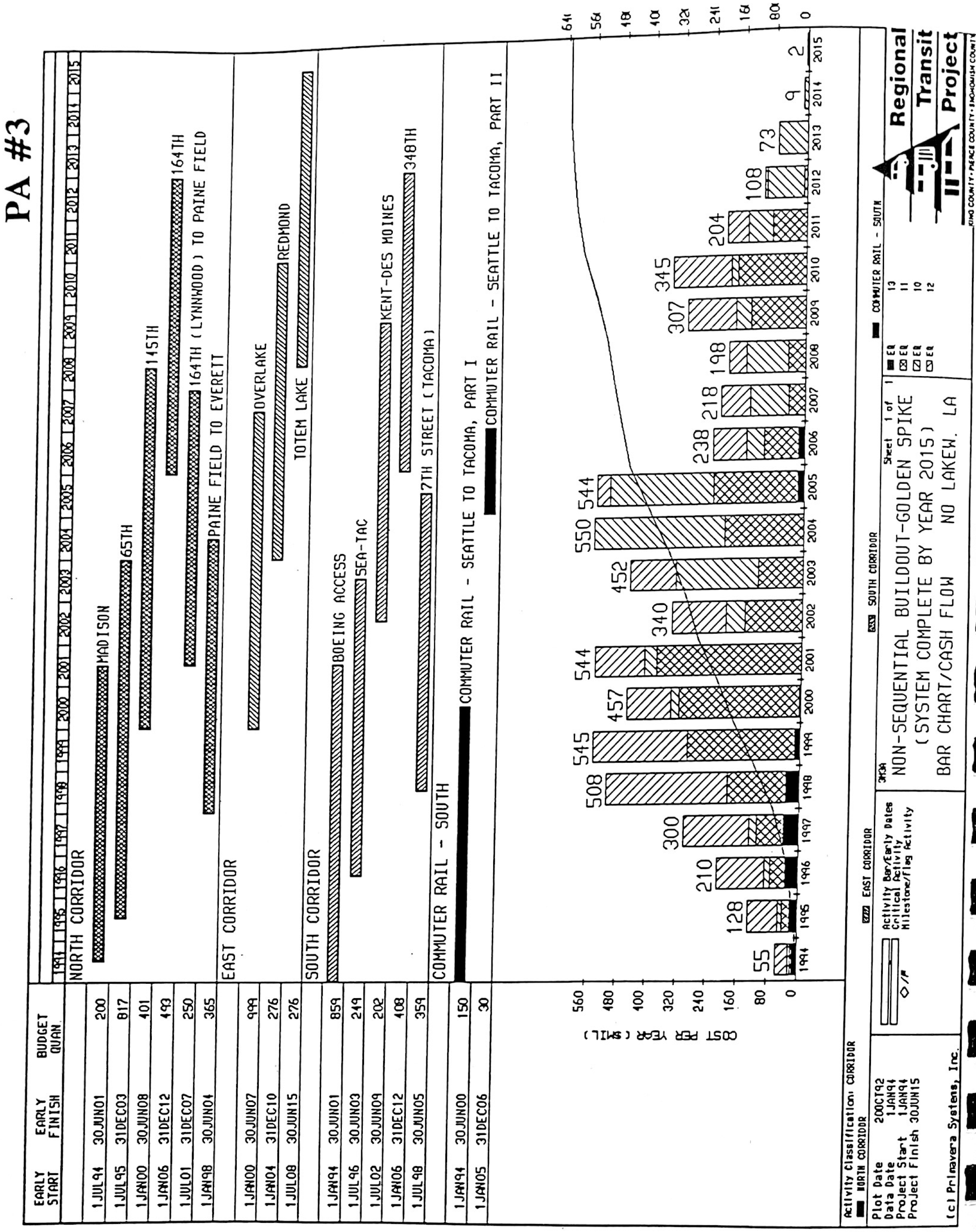
The Non-sequential Build-out Alternative represents a scenario where Phase I of the system, like the sequential build-out, is pursued simultaneously in all three corridors. Emphasis then shifts to the ends of the 2015 system with construction of the Everett/Paine Field and/or Tacoma extension components of Phase III. Phase II, the central part of the system, is then completed and ties Phase I and Phase III together.

Service and physical facilities are similar to the other two alternatives and would include the following:

- Immediate and significant systemwide expansion of bus fleets and services.

- Local transportation system improvements in all jurisdictions (e.g., signal improvements, arterial HOVs, bus bases, etc.).

PA #3



SYSTEM PLAN
FIGURE 7-14

- Approximately 88 miles of guideway and 52 stations by 2015 with rail to major activity centers in each corridor by 2005 (Bellevue, Northgate, Sea-Tac, Everett/Paine Field and/or Tacoma Extension).

- Commuter rail service in the South Corridor initiated by 1996 and built-out by 2005.

- Right-of-way preservation, access improvements, park-and-ride lots and transit centers for areas not served by 2015 rail system.

- Allowances for right-of-way purchase and access improvements and partial funding of park-and-ride lots in areas (preferably future station sites) not served by the 2005 system but that will be served in subsequent phases by 2015.

- Development and implementation of higher capacity feeders, circulators and distributors such as LRT, AGTs and PRTs.

The advantages of this phasing scheme are:

- Provides additional flexibility by designing and constructing Phase I and parts of Phase III simultaneously.

- Maximizes ease of DSTT operational transition by phasing in initial segments of three corridors simultaneously with minimal or no joint operation with buses assuming Everett/Paine Field or Tacoma Extension do not delay Phase I segments.

- Provides the additional corridor and CBD capacity required by 2005.

- Allows implementation flexibility by designing and constructing the system in three corridors at four or five locations simultaneously with Everett/Paine Field and/or Tacoma Extension segments on line by 2005.

- Maximizes ridership return on investments and sequentially implements next most productive system segment for Phase I only (the Phase III segments deviate from this criteria).

- Phase I provides reasonable equity from a corridor perspective; Everett/Paine Field and/or Tacoma Extension acceleration increases Snohomish and Pierce Counties' initial equity

The primary disadvantages of Alternative 3 include the following:

- As a result of the acceleration of Phase I and the Everett/Paine Field and/or Tacoma Extension simultaneously, the cash flow is "spikey" with expenditures in the $650 to $850 million range; moreover, it would increase bonding requirements and debt service expenditures

- Would require placing the three operational segments of Phase I and the Everett/Paine Field and/or Tacoma Extension segments of the system in place simultaneously taxing regional design, construction and operational resources resulting in marginally higher cost and the need to import resources from other states.

- With a limited level of Section 3 FTA funds available in the 1993 through 2005 timeframe, accelerated portions of Phase III would be in competition with Phase I for FTA funds which may result in a net loss in FTA dollars for the total project.

- From a ridership perspective, more productive segments in Phase II are deferred until after construction of less productive segments in Phase III, thus deferring the addition of corridor capacity in critical areas.

- From 2004 to 2012, Snohomish County riders bound for points south of 145th Street and/or north of 7th Street would have to transfer from bus to rail in addition to making other trip transfers.

- Snohomish County and/or Pierce County would not be effectively tied to the regional rail system until 2012 requiring the maintenance of two or three separate rail fleets and operations.

Alternatives 4a and 4b: Acceleration Buildout - System Completed by Year 2010 (Figures 7-15 and 7-16)

Alternative 4a *Sequential Buildout*

This alternative (**Figure 7-15**) is an accelerated version of Alternative 1, i.e., it is designed to bring the system on-line by 2010, advancing the project in increments which generally are simultaneous in the three corridors, with a slight delay in the East Corridor.

The advantages of this alternative are the same as for Alternative 1. In addition, the following can be noted:

- Completion of the program by 2010 including the Everett, Totem Lake and Tacoma extensions.

- Continuous high investment between the years 1999 and 2008 utilizing the region's trained resources to the maximum extent.

The disadvantages are:

- The cumulative funding requirements are higher in a shorter timeframe making it more difficult to maximize federal funding.

- Some operational difficulties may occur, e.g., the three-year time difference between the extensions to NE 65th Street and NE 145th Street is too long.

Alternative 4b *Non-Sequential Buildout - Golden Spike*

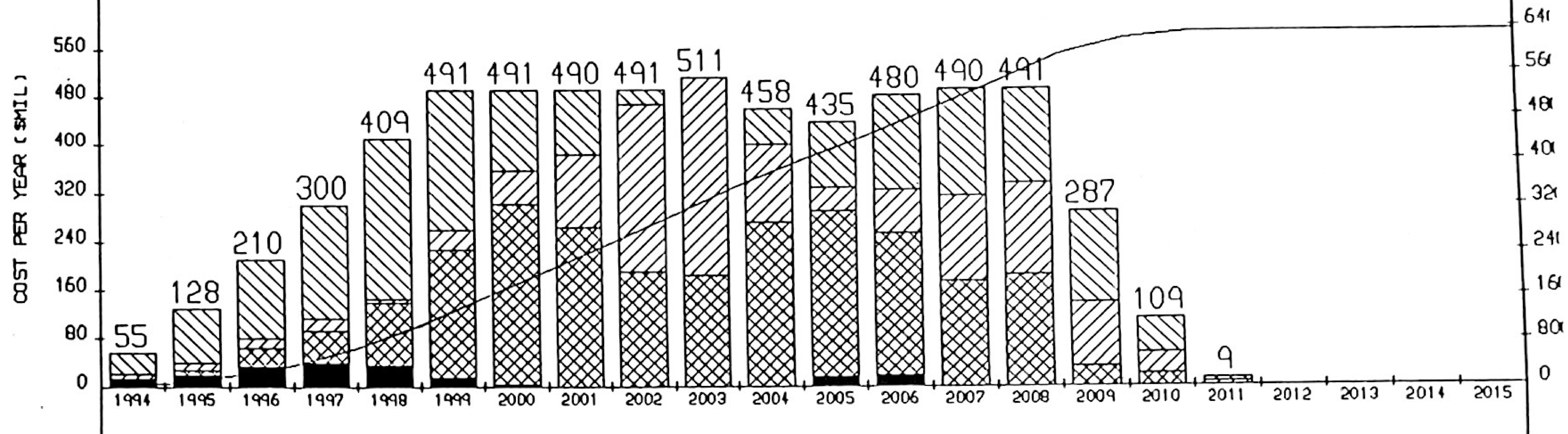
This alternative (**Figure 7-16**) is an accelerated version of Alternative 3, i.e., it represents a scenario where the ends of the system - Everett and Tacoma - will be built in Phase II (Year 2010) instead of Phase III (Year 2015).

The advantages of Alternative 4b are the same as for Alternative 3. In addition, the following should be considered:

- Completion of the system including the outer parts to 164th Street and 348th Street by 2010.

PA #4-1

EARLY START	EARLY FINISH	BUDGET QUAN.	ACTIVITY
			NORTH CORRIDOR
1JAN95	31DEC01	200	MADISON
1JAN96	30JUN04	817	65TH
1JAN99	30JUN07	401	145TH
1JAN01	31DEC07	493	164TH
1JAN03	30JUN09	250	164TH (LYNNWOOD) TO PAINE FIELD
1JUL04	31DEC10	365	PAINE FIELD TO EVERETT
			EAST CORRIDOR
1JUL98	31DEC05	999	OVERLAKE
1JUL03	30JUN10	276	REDMOND
1JAN05	31DEC11	276	TOTEM LAKE
			SOUTH CORRIDOR
1JUL94	31DEC01	859	BOEING ACCESS
1JUL97	30JUN04	249	SEA-TAC
1JUL01	30JUN08	202	KENT-DES MOINES
1JUL03	30JUN10	408	348TH
1JAN05	31DEC11	359	7TH STREET (TACOMA)
			COMMUTER RAIL - SOUTH
1JAN94	30JUN00	150	COMMUTER RAIL - SEATTLE TO TACOMA, PART I
1JAN05	31DEC06	30	COMMUTER RAIL - SEATTLE TO TACOMA, PART II



Activity Classification: CORRIDOR
■ NORTH CORRIDOR ▨ EAST CORRIDOR ▧ SOUTH CORRIDOR ■ COMMUTER RAIL - SOUTH

Plot Date 21OCT92
Data Date 1JAN94
Project Start 1JAN94
Project Finish 30JUN14

Activity Bar/Early Dates
Critical Activity
Milestone/Flag Activity

3M11 Sheet 1 of 1

ACCELERATED BUILDOUT - SEQUENTIAL
(SYSTEM COMPLETE BY YEAR 2010
BAR CHART/CASH FLOW - NO LAKEW. LA

EQ 13
EQ 11
EQ 10
EQ 12

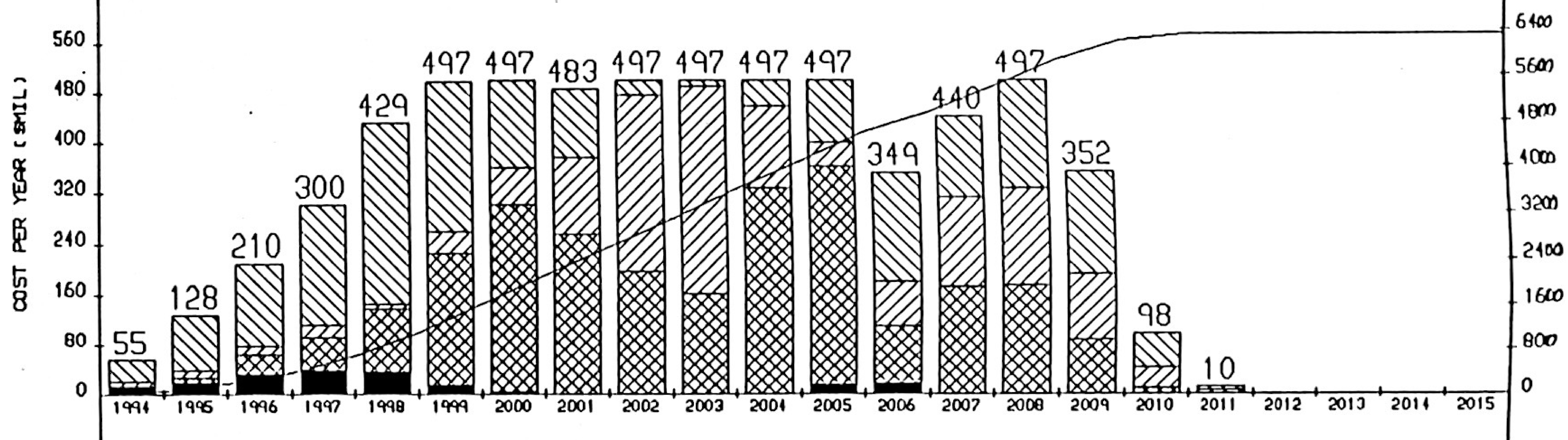
Regional Transit Project
KING COUNTY • PIERCE COUNTY • SNOHOMISH COUNTY

(c) Primavera Systems, Inc.

SYSTEM PLAN
FIGURE 7-15

PA #4

EARLY START	EARLY FINISH	BUDGET QUAN.	ACTIVITY
			NORTH CORRIDOR
1JAN95	31DEC01	200	MADISON
1JAN96	30JUN04	817	65TH
1JAN99	30JUN07	401	145TH
1JAN04	31DEC10	493	164TH
1JUL01	31DEC07	250	164TH (LYNNWOOD) TO PAINE FIELD
1JUL01	31DEC07	365	PAINE FIELD TO EVERETT
			EAST CORRIDOR
1JUL98	31DEC05	999	OVERLAKE
1JUL03	30JUN10	276	REDMOND
1JAN05	31DEC11	276	TOTEM LAKE
			SOUTH CORRIDOR
1JUL94	31DEC01	859	BOEING ACCESS
1JUL97	30JUN04	249	SEA-TAC
1JUL03	30JUN10	202	KENT-DES MOINES
1JAN05	31DEC11	408	348TH
1JUL01	30JUN08	359	7TH STREET (TACOMA)
			COMMUTER RAIL - SOUTH
1JAN94	30JUN00	150	COMMUTER RAIL - SEATTLE TO TACOMA, PART I
1JAN05	31DEC06	30	COMMUTER RAIL - SEATTLE TO TACOMA, PART II



Activity Classification: CORRIDOR
■ NORTH CORRIDOR ▨ EAST CORRIDOR ▧ SOUTH CORRIDOR ■ COMMUTER RAIL - SOUTH

Plot Date 20OCT92
Data Date 1JAN94
Project Start 1JAN94
Project Finish 30JUN14

Activity Bar/Early Dates
Critical Activity
Milestone/Flag Activity

3M10 Sheet 1 of 1

ACCELERATED BUILDOUT - GOLDEN SPIKE
(SYSTEM COMPLETE BY YEAR 2010
BAR CHART/CASH FLOW - NO LAKEW. LA

EQ 13
EQ 11
EQ 10
EQ 12

Regional Transit Project
KING COUNTY • PIERCE COUNTY • SNOHOMISH COUNTY

(c) Primavera Systems, Inc.

SYSTEM PLAN
FIGURE 7-16

- Continuous high investment during the years 1999 to 2008 utilizing the region's trained construction resources to the maximum extent.

The disadvantages are:

- The cumulative funding requirements are higher in a shorter timeframe making it more difficult to maximize federal funding.

- In order to achieve a reasonably smooth cash flow curve, the advanced sections of the ends of the system - Lynnwood-Everett and Tacoma - would be delayed by two or three years.

It should be noted that Alternatives 1 through 4 are only a few versions of the many tried options analyzed. The search for an optimum solution will continue during the System Plan review phase.

7.1.3 Analysis of General Phasing Considerations

The following provides an overview of the analysis of the general phasing considerations completed to date.

7.1.3.1 Existing Facility Transition

In order to implement the RTP Rail Alternative, two major existing facilities will require some level of modifications and/or improvements. These facilities are the DSTT and the HOV/transit sections of I-90 from downtown Seattle to I-405. The modifications needed to transition these facilities to rail operations have the potential to cause significant disruptions to transit operations using them. The guiding strategy in developing the transition plans for the DSTT and I-90 is to maintain peak period transit operations to the maximum extent possible while minimizing the number and duration of any necessary interruption of peak transit service.

In addition to these major facility modifications, implementation of the South Corridor Commuter Rail service will require modifications to the existing rail terminal facilities in downtown Tacoma and downtown Seattle. Other existing facilities will also require modifications or replacement. However, these efforts are not expected to involve significant disruptions to ongoing transit operations.

At an early stage of the RTP system planning, the use of the Ryerson Maintenance Facility as an interim facility for maintaining rail vehicles appeared to be a desirable and useful possibility. However, due to the rapid bus service expansion programmed by 2005 and the corresponding maintenance facility capacity requirement, the Ryerson facility would not be adequate and has been dropped from further consideration; therefore, no modifications are required to the Ryerson facility.

Downtown Seattle Transit Tunnel

The conversion of the DSTT from its existing all-bus operations to a joint bus/rail or all rail operation will involve the conversion or modification of a number of its elements. The following elements are considered to require the most extensive work and/or present the greatest probability of impacting the existing transit service: modification of the height of station platforms, installation of train control and signal systems, modification of the overhead contact system, addition of power capacity, and installation of a fare collection system. The tunnel was built with rails already installed; except for minor work involved with the train control and traction power systems, no major modification to the installed tracks is foreseen at this time.

Station platform height modifications may be required in order to transition the DSTT to a rail facility. Level boarding onto trains is needed to speed service and to comply with the Americans with Disabilities Act. The existing platform height may need to be raised approximately 30 inches to match the floor height of a typical light-rail vehicle.

Train control and signal systems need to be added to the DSTT to support an all rail operation as the existing tunnel signaling system is not adequate for the operation of trains running on short headways. Train control systems will require the installation of major amounts of electrical circuits and wiring along the tracks, with either direct connections to the rails or installation of continuous loop detectors "saw-cut" into the pavement between the rails. In addition, to the work along the tracks, major wiring and equipment installation will be required within each of the stations. The nature of this work is such that it can be carried out during evening hours and, in general, allow operable conditions during the day. Where work is required on the trackbed, the transit roadbed can be made usable by laying down metal planks or similar provisions. Bus operations should experience only minor temporary impacts.

The overhead contact system (OCS), under a joint use scenario, will need to be revised to permit use by rail cars using pantographs for power pickup. The modification will consist of lowering the positive wire, of the two existing wires, by approximately six inches. This adjustment will allow the pantograph to collect power without a danger of contacting the negative wire and causing a short-circuit. Making this modification will require nearly all of the present OCS to be rebuilt, although most of the existing materials and assemblies can probably be reused. This work can be staged, tunnel segment by tunnel segment, with the majority of the work for the change-over of each segment being done at night. The final relocation of the trolley wire, in a segment, may require a brief disruption of service within that segment. Under an all rail scenario, the traction power system may be converted to third rail distribution.

Traction power modifications will either be done inside existing equipment rooms or can be done along with the installation of the train control system. No permanent service disruptions should result from this work.

Fare collection machines are expected to be installed in the mezzanine areas of the stations. The installation work can be carried out during evening hours without disrupting the normal operation of the tunnel.

I-90 Bridge and Roadway

The rail alignment on the I-90 bridge and roadway will place the tracks in the transit/HOV lanes. When rail service is introduced onto I-90 HOV traffic may be eliminated for the transit/HOV lanes for reasons of operational safety. Once construction of the rail line begins, transit/HOV traffic would operate in the peak direction of travel during the construction period.

7.1.3.2 Operational Considerations

Some operational factors that need to be considered as part of the RTP Rail System are 1) reconfiguration of the bus network, 2) rail-bus interfaces, 3) the rail operation network, 4) the rail support system and 5) operation and maintenance costs. A brief discussion of these elements is provided below.

Reconfiguration of Bus Network

As rail service is activated, the existing bus network will be modified 1) to provide connection to rail stations and 2) to terminate those routes that parallel the rail line and offer little or no travel time savings at the nearest rail station. Local service routes will typically be revised to include rail stations as bus stops. Express routes will be routed to the terminal station requiring passengers to transfer to the rail system to continue their trip.

The express routes that currently operate along I-5 will be modified each time the rail line is extended outward along the I-5 corridor, shortening the bus portion and lengthening the rail portion of the trip. Express bus service currently operating on I-90 will be terminated at the Mercer Island Station. Express buses currently operating over the SR 520 bridge will be routed into the Northup or other Bellevue area station(s) for transfer to the rail system. As the rail line is extended toward Redmond and Totem Lake, the termination points for these buses will be adjusted.

Rail-Bus Interface

Rail-bus interfaces occur in two areas: the bus-to-rail transfer at rail stations and potential joint bus/rail operation in the DSTT. The interface at rail stations requires road access into the station which, at some stations, will include special bus-only access to/from freeways. At the station, the buses would be provided with close-in transfer points that would minimize the transfer inconvenience and provide fast access/egress by the buses.

Until the rail system provides sufficient service and can replace enough of the existing buses that need to enter downtown Seattle, the limited street capacity for buses in the downtown may require joint bus/rail operation in the DSTT. Joint operation is possible with a north-south rail line up to the time when the headway between trains is reduced to approximately four minutes. When the headway reaches four minutes, there is insufficient time between trains to permit safe and effective operation of buses. Current projections of demand indicate that once rail service is extended to the University District on the north and to Kent-Des Moines in the south, that four minute or shorter headways would be required.