APPENDIX D: RIDERSHIP AND COST METHODOLGY

The following sections describe the methodologies applied during the Alternatives Analysis to estimate ridership, capital costs and operating and maintenance costs for the various alternatives under consideration.

Travel Demand Estimation Methodology

Travel demand estimates were generated by the project team utilizing the Delaware Valley Regional Planning Commission's (DVRPC) regional travel demand model with assistance from DVRPC. DVRPC is the designated Metropolitan Planning Organization (MPO) for the region and covers the majority of the study area. The remainder of the study area is covered by the Southern New Jersey Transportation Planning Organization (SJTPO). The DVRPC model is Tranplan software based and has been developed and enhanced over many years. It is calibrated to household survey and other data obtained and updated regularly by DVRPC. The model consists of multiple modules comprising the standard four-step process of trip generation, trip distribution, mode split, and assignment. The technical details of the model can be found in the DVRPC technical report "2005 Travel Simulation for the Delaware Valley Region, January 2000".

The DVRPC model covers a region of 10 counties in Pennsylvania and New Jersey, which is subdivided into about 2000 traffic analysis zones. Basic demographic data, such as population and employment data, are specified for each individual traffic zone for travel demand analysis. The model simulates the travel pattern in the region in the form of trip tables, and "assigns" these trip tables on the transportation network to predict traffic volumes on the highway and transit networks.

The model is a multi-modal model, considering both highway and transit systems. These networks are used to estimate the travel services (e.g., travel time, waiting time, etc.) and travel costs of various transportation modes. The highway network and the transit network are coded separately in the DVRPC model. The highway network includes all freeways, parkways, principal arterials, secondary arterials, and many collectors within the study area. The transit network covers the scheduled transit services in the region. These include the PATCO line, commuter rail lines, subway/elevated rail lines, and the bus routes operated by SEPTA, New Jersey Transit, and local jurisdictions.

The model requires individual transit lines to be encoded in the transit network, together with detailed operation data, such as line alignment, stop locations, frequencies, operation run times of line segments. The model defines three major transit modes: commuter rail mode, subway/elevated transit mode, and surface transit mode, with specified operating characteristics. It also defines various transit operating companies, with specific transit fare structures. Based on the transit sub-mode and operation company definitions, the model is able to generate detailed transit operation data, such as travel time spent in vehicles, average walk time and wait time, average transit fare, etc., for individual traffic zone pairs. These service data are used for analyzing ridership for different transit improvement alternatives in the study.

The model was recently validated by DVRPC against the observed 2005 highway traffic and transit ridership data. The 2005 model is served as the base year model for this study. Also, DVRPC developed the 2030 model based on the long-range population and employment forecasts, and the transportation networks considered in DVRPC constrained long-range plan. The 2005 and 2030 models were provided by DVRPC for this study.

For this project, the various model components were obtained from DVRPC along with base year (2005) and forecast year (2030) demographics and transportation (highway and transit) networks. A 2030 no-build scenario was established and modeled for comparison to each of the proposed alternatives. The No-Build scenario reflects base year transportation networks and the programmed projects included in the fiscally constrained 2030 Long Range Transportation Plan. Subsequently, each of the alternatives was coded into the transportation network based on the specific alignment, station locations, operating characteristics (frequency, run time, fare assumptions), and mode of access assumptions including walk access and park and ride opportunities, as appropriate.

Separate model runs were then prepared for each alternative and compared against the No-Build to isolate their potential benefits. Only the mode choice and assignment components of the four step procedure were modeled in order to be consistent with the FTA requirement that the trip table remain constant among the various build and the no-build scenarios. Essentially, the ridership results prepared during the AA reflect only the direct transportation benefits of the project and do not capture the secondary benefit that would result from a redistribution of trips over time as a reaction to the new transportation investment.

The operating assumptions and ridership results specific to each alternative are described in Chapter 6.

Capital Cost Estimation Methodology

The following section describes the approach used to estimate conceptual level capital costs during the Alternatives Analysis. Capital costs include the one-time expenditures to design and construct the proposed project and acquire the vehicles and equipment necessary to operate it.

The capital costs estimates for each alternative are commensurate with the level of planning and alternative development of the AA phase and are based on a conceptual level of design. As such, they rely on a number of assumptions related to the physical scope, design standards, local costs, inflation rates, and other factors. Project contingencies and allowances were applied to capture the costs of unknown or unquantifiable items based on the current level of design detail so that the estimates reflect complete project costs. The level of estimating detail will increase as the project advances to future stages of design resulting in more refined and more detailed estimates of capital costs.

General Assumptions

Capital costs were developed according to current unit costs during the time frame of the AA, and thus reflect a present value for the year 2008. The year of expenditure (YOE) values reflect a 3.75% percent escalation rate compounded annually to the midpoint of construction of 2014. Equivalent annualized costs were developed for each alternative based on FTA guidelines for the typical life for different project components in combination with an annual discount rate of 7%.

Sources of unit costs

Capital cost estimates at this stage of design require the application of unit costs for typical cross-sections and typical elements. Unit costs for typical cross-sections or elements were developed from the costs of the various subcomponents of the typical section, or from parametric cost information from similar projects with adjustments for location and escalation. Several cost items had to be estimated as a percentage of raw construction costs based on industry experience. Unit costs were developed using various local and national sources. To the extent available, local source data from recent projects was utilized. This was supplemented with information from other similar projects across the country and federal cost databases. Key sources of capital cost information include:

- RS Means Heavy Construction Cost Data
- FTA Fixed Guideway Heavy and Light Rail Capital Cost Studies
- CATS LYNX South Corridor Blue Line
- RTD Denver West Corridor Light Rail
- Dulles Corridor Metrorail Extension
- PATCO Capital Projects for infrastructure improvements and vehicle procurements

Unit costs from prior projects and or different geographic locations were adjusted to account for inflation and for geographic cost differences.

Cost Estimate Approach and Organization

Capital costs for each alternative were developed and organized in conformance with FTA guidelines. The estimates are organized using a segmented and tiered approach by dividing each alternative into logical geographic segments, within which the costs are categorized according to FTA's Standard Cost Categories (SCC).

The FTA SCC format organizes capital costs by major cost categories as shown in Table D-1. Within these, smaller sub-categories further standardize project costs for comparison to FTA's database of unit costs. The sub-categories are also used to apply a typical life-time to an element which provides the basis for annualizing the present value capital cost estimates to an equivalent annual value for recapitalization.

In the AA estimate, each SCC category consists of multiple cost line items, as appropriate, with corresponding unit costs and quantities derived from the conceptual design and alternatives definition.

Corridor-wide construction elements (support facilities), vehicles, and project "soft costs" (related to professional services and unallocated contingencies) were applied to the overall alternative costs, rather than by geographic segment.

Table D-1: FTA Standard Cost Category Organization

10 Guideway & Track	Guideway and track costs including costs for grading, excavation, drainage, retaining walls, bridges and structures and trackwork including special trackwork.
20 Stations	Station costs including rough grading, excavation, station structures, finishes, vertical circulation elements (ramps, stairs, elevators, escalators), lighting, safety and security systems and multi-story parking structures.
30 Support Facilities	Light and heavy maintenance facilities and vehicle storage yards including all necessary site prepartion work and storage tracks.
40 Sitework & Special Conditions	Demolition, clearing, earthwork, utilities and utility relocation, hazardous material remediation, other environmental mitigation; sound walls, roadway and intersection modifcations, surface parking at stations, pedestrian and bicycle access, landscaping, fencing, site lighting, and any temporary facilities/construction.
50 Systems	Train control and signals, traffic signals, grade crossing protection, traction power supply and distribution, communications and supervisory control systems, passenger information system and fare collection system.
60 ROW	Purchase or lease of real estate and costs associated with household and business relocations.
70 Vehicles	Rail vehicles, buses, non-revenue vehicles, and spare parts.
80 Professional Services	Preliminary engineering, final design, project management for design and construction, construction administration and management, professional liability insurance, permits and review fees, testing, inspection, and costs for start-up and training.
90 Unallocated Contingency	Overall project contingency and reserves

The capital cost estimates include contingencies reflective of the planning level of project development and to account for the lack of design detail, unknown conditions, and the potential for scope changes resulting from design refinement. Two-types of contingencies are applied in the estimate: allocated contingencies and unallocated contingencies. Allocated contingencies are applied to the individual cost estimate categories outlined in Table D-1. They are reflective of the current level of design detail and the potential for unknown conditions to increase the directly estimated cost as the design is refined. In certain instances, the applied values also reflect potential variances in unit costs. Table D-2 lists the allocated contingencies applied to each cost category during the AA.

Table D-2 Allocated Contingencies

SCC Category	Allocated Contingency
10 Guideway & Track	30%
20 Stations	25%
30 Support Facilities	25%
40 Sitework & Special Conditions	35%
50 Systems	20%
60 ROW	40%
70 Vehicles	15%

Unallocated contingencies (Category 90) are applied to the overall total capital cost to account for potential changes to the project scope (e.g.: additional betterments that may be required) and other unforeseeable project cost increases that are not directly associated with any particular cost category. An overall unallocated project contingency of 10% was applied to each alternative during the Alternatives Analysis cost estimation.

Operating and Maintenance Costs

The following section describes the approach applied to estimating operating and maintenance costs (O&M) during the Alternatives Analysis study. Operating and maintenance cost estimates capture annual expenditures for the direct operation and maintenance of a proposed alternative. These estimates include both the cost of the new service as well as the cost increases or savings due to any changes in existing transit service. The alternatives for which O&M costs were developed include transit services similar to PATCO's existing system as well as light rail operations similar to the NJ Transit River LINE. O&M cost models were developed for each type of operation based on current operating expenditures and service quantities for the PATCO Speedline and NJTransit and other light rail operations. .

As required by FTA, all O&M expenditures were treated as variable—dependent on the size and scope of the operation and having no fixed costs. All types of O&M expenditures were assigned to one of four variables, as shown in Table D-3.

Table D-3: O&M Cost Variables

Variable	Definition	Costs Captured
Train hours	Total number of hours spent by each train in service	Operating costs (including labor costs)
Vehicle miles	Total number of miles traveled by each vehicle in service	Vehicle maintenance costs
Peak vehicles	Maximum number of vehicles in service during the peak hour	General administration costs
Route miles	Total length of the route	Non-vehicle maintenance costs

Unit costs associated with each variable were then developed from data collected from systems similar to the proposed alternatives. The calculated unit costs are summarized in Table D-4.

For the PATCO-type O&M model, expenditure and service data was obtained directly from PATCO consistent with what the agency reports to the National Transit Database (NTD) for 2008. The appropriate expenditures were assigned to the above variables and unit costs were calculated.. The proposed PATCO expansion options would operate in a nearly identical fashion to the existing PATCO line and are expected to generate an equivalent amount of O&M expenditure per quantity of service as the existing service.

For the diesel light rail model, use of NTD data was not appropriate as the detailed reporting for NJTransit light rail systems provides data only for directly operated services. The existing RiverLINE best reflects the type of operation for the Light Rail operation proposed in this study so that unit costs were based on this operation. However, because the River LINE is operated under contract for NJTransit, detailed expenditures for the O&M variables are not available.

The project team obtained the total O&M expenditures for the RiverLINE from NJTransit and estimated the share of the total associated with each variable based on information from other light rail systems with similar operating characteristics. Using known service quantities for the RiverLine, these values were then used to estimate unit variable costs for estimating diesel light rail O&M costs.

Table D-4: O&M Model Unit Costs (2008$)

	PATCO NTD Unit Costs	Diesel LRT Unit Costs
Per Train Hour	$ 470.08	$ 281.23
Per Vehicle Mile	$ 1.59	$ 4.38
Per Peak Vehicle	$ 70,279.23	$ 360,355.70
Per Route Mile	$ 727,173.18	$ 144,071.12

O&M service quantities for each variable were calculated for each alternative based on the proposed service levels described in Section 5 - Definition of Alternatives. Annual service quantities assume peak period durations and weekend service levels similar to those on PATCO's existing system. Service quantities calculations for each alternative reflect changes to the existing PATCO line, specifically a reduction in service with the implementation of a new PATCO line, and a modest increase in service with the implementation of a Diesel Light Rail service associated with the need for additional capacity across the Ben Franklin Bridge. The O&M quantities for each alternative were then applied to the O&M unit costs to produce total O&M costs for each service and net O&M costs for each alternative.