SCRTD METRO RAIL PROJECT
Preliminary Engineering

OPERATING AND MAINTENANCE COST ESTIMATE

WBS 17 BAB

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SUMMARY

This report presents the estimated annual operating and maintenance cost (O/M) for the Metro Rail System. Costs are given for both the full 18-mile system and the 8.8-mile minimum operable segment (MOS).

Operating and maintenance costs are incurred in the day to day operation of the transit system. These costs include labor, material, and other expenses required to operate, maintain and manage the system.

Costs were organized according to major groups of functional activities. These include:

- Operations
- Vehicle Maintenance
- Ways and Structure Maintenance
- Subsystems Maintenance
- General Administration

An item by item description is given for each of these areas including labor and material requirements and specific procedures for cost estimation. Cost estimates are summarized in tabular form and show wages, benefits and materials expenses for each cost item.

Total O/M costs are $45.5 million for the full system and $30.6 for the MOS.

Appendices provide detailed derivations of labor and material expenses.

CHAPTER I
COST ESTIMATING METHODOLOGY

Operating and maintenance (O&M) costs are incurred in the day to day operation of the transit system. These costs include labor, material, and other expenses required to operate, maintain, and manage the system. Various operating and maintenance activities are required to insure that Metro Rail provides a high level of service and operates in a safe and reliable manner. Examples include train operation, vehicle inspection, station cleaning, police supervision, and track maintenance. These activities became the framework for derivation of the O/M costs.

Three major steps in determining these costs were undertaken:

- Activities were identified and grouped under headings that are compatible with the existing RTD organization and those of other modern rail transit systems.

- Staffing requirements for each functional activity were estimated by skill or managerial levels. The number of positions needed to meet service demands multiplied by the applicable rate of pay produced direct labor costs. The cost of benefits was added as a percent of direct labor.

- Material, electrical power and other non-labor expenses were estimated and added to the labor cost to arrive at total cost.

Each of these steps is discussed in detail.

1.1 ACTIVITY ORGANIZATION

The first step in the cost estimation process was to identify the complete list of O/M activities to be performed by Metro Rail and organize these into a consistent and logical framework. The adopted organization is displayed in Table 1-1. Major headings and their contents are:

- Operations - Including the operation of trains, yards, central control, stations and the provision of security.

- Vehicle Maintenance - Including service, inspection and cleaning of vehicles, heavy and component repair and maintenance support.

- Ways and Structures - Including track and structures maintenance and building and station cleaning.

- Subsystems Maintenance - Including maintenance of power systems, train control equipment, communications equipment and fare collection equipment.

- General Administration - Including general management, finance, customer relations, planning and marketing.

Estimating O&M cost for each of these activity groups involved two major cost components, namely:

- Labor - The costs associated with Metro Rail personnel including salaries, wages, and fringe benefits.

- Materials and Other Expenses - The cost of replacement parts, supplies, electrical power, subcontracted activities, and miscellaneous expenses.

For some activities, such as train operation, the labor component predominated. In others such as power systems operations and maintenance, the non-labor expenses were more substantial than the cost of labor. Detailed discussions pertaining to each of these areas will be highlighted in Chapter 3.

TABLE 1-1

ORGANIZATION OF OPERATIONS AND MAINTENANCE ACTIVITIES

I. OPERATIONS

- Management
- Train Operations
- Central Control
- Stations
- Security

II. VEHICLE MAINTENANCE

- Management
- Service, Inspection and Cleaning
- Heavy and Component Repair
- Maintenance Support

III. WAYS AND STRUCTURES MAINTENANCE

- Management
- Track and Structure Maintenance
- Facilities Maintenance

IV. SUBSYSTEMS MAINTENANCE

- Management
- Train Control
- Fare Collection
- Communication
- Power

V. GENERAL ADMINISTRATION

- Management
- Finance
- Planning and Marketing
- Customer Relations
- Operations Training and Safety

1.2 LABOR COSTS AND STAFFING LEVELS

Labor cost estimation requires the following sequence of steps:

- Estimation of personnel requirements by skill level
- Establishment of pay scales for each skill level
- Estimation of fringe benefits based on total salaries and wages.

To estimate personnel requirements for each of the identified O&M activities, an assessment was made of the expected workload including shift coverage, complexity of the activity, duration of the activity and required skill levels. These were assessed given a variety of sources including detailed operating and maintenance procedures and annual budgets from PATCO (Philadelphia), BARTD (San Francisco), WMATA (Washington) and MARTA (Atlanta).

The next step was to translate the expected workload into equivalent person years of effort. This was accomplished in a variety of ways depending on the activity. For vehicle service, inspection, and cleaning, as an example, person hours per work task was available from PATCO maintenance procedures.

These, multiplied by number of expected tasks per year modified to reflect known differences in the Metro Rail System, yielded person-hours per year which was reduced to person-years. For other activities, specific shift assignments were made in terms of number of persons per shift by time of day and day of week. These were in

turn translated into person years. The number of personnel required to perform the expected tasks was determined by factoring the person years of effort upward to provide for vacations, sick leave and other absences of regularly assigned individuals.

A few exceptions to the general approach are worthy of mention. In the case of train operators, an RTD scheduling model was used to generate personnel requirements. For general administration, encompassing such activities as payroll, customer relations and management, Metro Rail personnel levels were determined by factoring current RTD employment levels by expected average growth in system riders and employees. General security forces were bolstered to reflect the need expressed by RTD for a significant incremental increase in existing security forces. Personnel requirements associated with the automatic fare collection system and with closed circuit TV monitoring were adapted from special studies of each activity. (1) (2)

1.2.1 Pay Scales

Positions were classified on the basis of managerial or skill level. These are generic in nature and do not necessarily correspond to the titles that will be assigned to Metro Rail personnel.

An annual or hourly rate was assigned to each position or skill level to derive the costs of direct labor. Wage scales are those adopted by RTD for similar duties or skills required in bus operations.

Table A-3 in Appendix A lists the position categories and pay rates that were used in the O&M estimate.

1.2.2 Fringe Benefits

The employee benefit package is a significant portion of total labor cost. It includes items such as FICA, pension, hospitalization, dentistry, workers compensation, life insurance, sick leave, holiday and vacation. Percentages of current RTD benefits to total wage and salaries were obtained from the accounting department for salaried and hourly personnel and applied to estimated Metro Rail direct wages and salaries to calculate benefit costs.

For RTD operators and mechanics the current benefit rate is 45.5 percent. This was applied to hourly rated employees to estimate Metro Rail benefits. For management employees the current RTD experience of 30 percent was used.

1.3 MATERIAL AND OTHER EXPENSES

Materials and other expenses include the cost of electrical power, parts, supplies, subcontracted activities and miscellaneous expenses.

Electrical power costs were estimated from engineering estimates of power consumption for trains, stations, yards, shops and other facilities multipled by the adopted unit cost of electricity. Expenses for major vehicle parts such as wheels and brakes were estimated given part replacement intervals and part unit costs from BARTD (San Francisco), WMATA (Washington D.C.), part manufacturers, and other sources. For other expenses such as supplies and miscellaneous parts, costs were based on current experience of representative rail rapid transit systems.

Some activities such as elevator and escalator maintenance and traction motor repair were assumed to be subcontracted and are included in the "materials and other expenses" category. These costs were estimated from experience at WMATA.

Liability expenses incurred as a result of casualty losses, personal injuries or property damage in combination with insurance coverage also represent a significant annual cost included in the estimate.

Not included are expenditures for depreciation, interest.

These vary considerably over the lifetime of the system and would be more appropriate in a discussion of capital cost.

CHAPTER II
BASIS FOR THE ESTIMATES

Operating and Maintenance (O/M) costs were developed and summarized for both the full system and the minimum operable segment (MOS). The cost estimates are based on the preliminary operating plan together with operating and maintenance practices that are typical for newer rail rapid transit systems. All costs are given on an annual basis.

2.1 SYSTEM DESCRIPTION

The cost estimate was based on an understanding of the Metro Rail system including the following elements:

- Ways and Structures
- Stations
- Subsystems
- Yards and Shops

A brief description follows for the full system and the minimum operable segment.

2.1.1 Metro Rail System

The Metro Rail system is conceived as a modern steel wheel, steel rail system similar in many respects to newer systems such as those in Washington, D.C., Atlanta, Baltimore, and San Francisco.

The initial line will be 18 miles long in a subway configuration. Sixteen stations are presently planned with two others under consideration. The distance between stations ranges from 0.5 miles in downtown area to 2.7 miles through the Santa Monica mountains.

Stations will be cut and cover construction with either one or two mezzanines and fare collection areas and with one or multiple entry/exit points to street level. Additional exits will be provided for use in emergencies. Escalators, stairs and elevators will provide vertical circulation between surface, mezzanine and platform levels, with one elevator per station. Plans call for equipping the station for both attended and unattended operation. Some stations will have adjacent parking facilities, pick-up/drop-off areas and/or bus pull-in areas to accommodate patrons arriving by automobile or by bus.

The passenger vehicle for the Metro Rail system will be a 75-ft-long, standard gauge, steel wheel vehicle capable of operating at speeds up to 70 mph. The vehicles will run on 750v DC power and they will be capable of regenerative braking. The basic unit will be a married pair (two cars, coupled together, which share some equipment). Each vehicle will hold about 75 seated passengers, and up to about 100 standees at adequate passenger comfort levels.

The interior will include seating for able-bodied and handicapped patrons and include handholds and stanchions for standing patrons. Vehicles will be equipped with lighting, heating, ventilating, and air conditioning apparatus to maintain a comfortable environment for passengers.

Vehicles will operate in trains of as many as six cars. Trains will be automatically controlled from central control with an on-board operator performing some functions.

The main storage yard and the shop facility for the starter line will be located in the vicinity of the southeastern terminus. Two tail tracks will be located near the North Hollywood terminal and will provide some temporary storage space. Crossover tracks, and pocket tracks will be situated at suitable locations to enable trains to turn back at both ends of the corridor and at selected midline locations. These tracks will also provide temporary storage for malfunctioning trains, and permit reverse running during emergency situations.

2.1.2 Minimum Operable Segment

The minimum operable segment is the shortest portion of the entire Metro Rail line which is capable of operating as a stand alone system. The segment is 8.8 miles long and extends between Union Station and the Beverly/ Fairfax station. It contains eleven stations with another station at Crenshaw/ Wilshire under consideration. The storage and maintenance facility for the minimum operable segment remains at the downtown location with the option to reduce its initial size to match the demands of the shortened system.

The alignment of the minimum operable segment is shown in Figure 2-1 in the context of the full 18-mile system.

Southern California Rapid Transit District
Metro Rail Project

ROUTE ALIGNMENT FOR MINIMUM OPERABLE SEGMENT

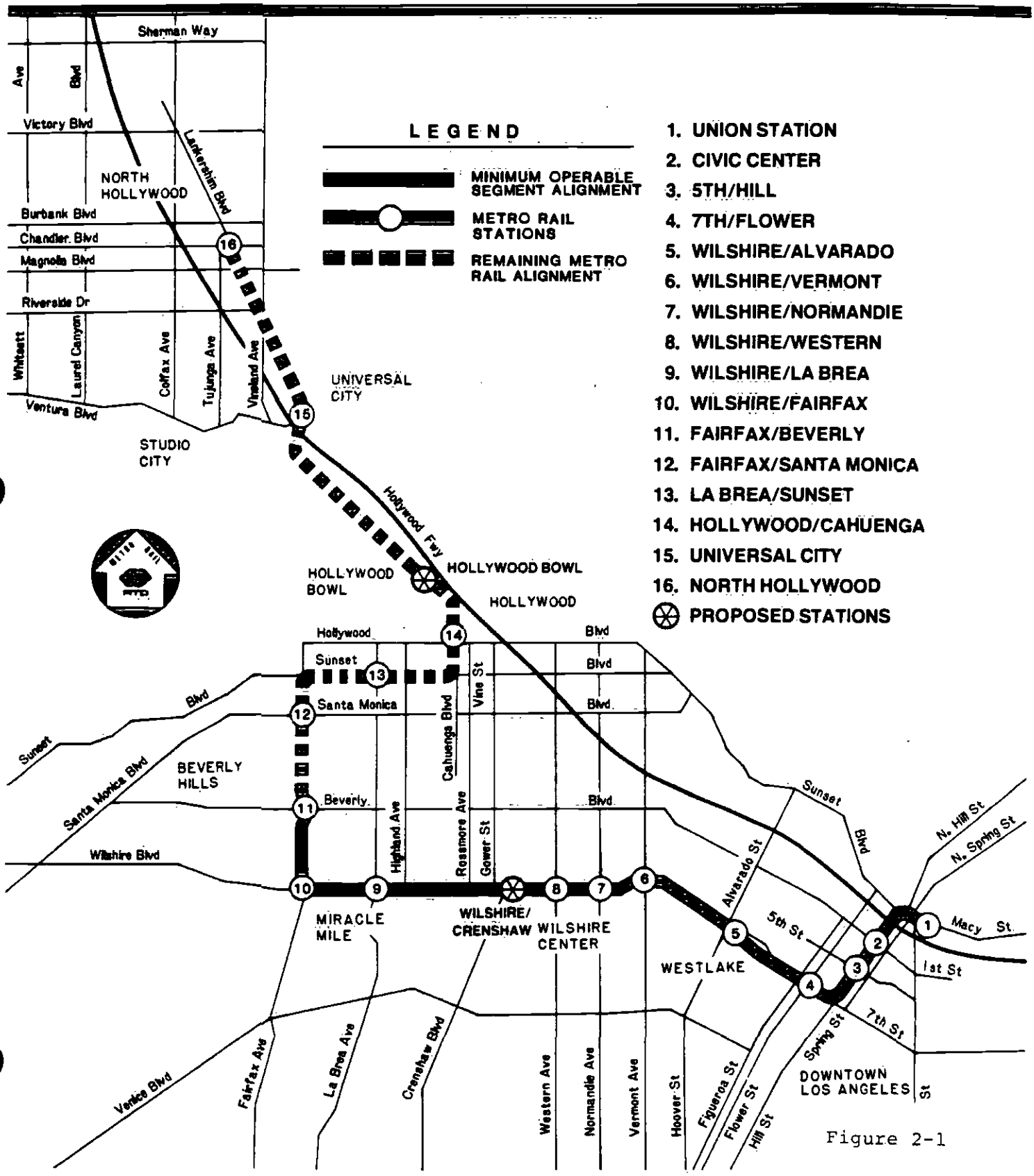

Figure 2-1

2.2 THE OPERATING PLAN

The O/M cost estimate is based on the projected operating plan for the year 2000.(3) Several important aspects of the plan, including hours of operating, train frequency, and train length by time of day are summarized in Table 2-1.

Generated in the plan are a set of key operating statistics that were used as input for several elements of labor and materials cost.

These statistics include:

- Hourly train requirements
- Vehicle fleet size
- Annual vehicle miles and train hours

These statistics are used in prorating materials cost from representative systems and deriving estimated work loads for labor activities.

TABLE 2-1

Projected Frequency of Service
and Train Size in the Year 2000

HOURS OF OPERATION	NUMBER OF CARS PER TRAIN	TIME BETWEEN TRAINS (MINUTES)
Weekdays		
Early Morning		
5:30 A.M. - 6:00 A.M.	6	15.0
6:00 A.M. - 6:30 A.M.		7.5
Peak Periods		
6:30 A.M. - 9:00 A.M.	6	3.5-6.0
3:30 A.M. - 6:30 A.M.		3.5-6.0
Midday		
9:00 A.M. - 3:30 P.M.	6	7.5
Evening		
6:30 P.M. - 7:30 P.M.	6	7.5
Night		
7:30 P.M. - 1:30 A.M.	4	15.0
Saturday		
Morning		
5:30 A.M. - 7:30 A.M.	4	15.0
Day		
7:30 A.M. - 7:30 P.M.	6	10.0
Evening		
7:30 A.M. - 1:30 A.M.	4	15.0
Sundays and Holidays		
All Day		
5:30 A.M. - 1:30 A.M.	4	15.0

2.2.1 Hourly Train Requirements

Hourly train requirements were derived from patronage estimates, vehicle capacity, specified policy headways, and vehicle load standards. The details of the derivation are presented in the preliminary operating plan.

2.2.2 Vehicle Fleet Size

The train length and schedules form the basis of the vehicle fleet size.

A total fleet size of 140 cars will be required for year 2000 service:

- 114 cars for revenue service (peak-hour service of 19 6-car trains);
- 12 cars for terminal spares (two gap trains) to replace in-service failures or to fill gaps resulting from significant service delays;
- 14 cars for maintenance spares, assuming 90-percent availability.

2.2.3 Annual Statistics

Table 2-2, available in the operating plan, provides a summary of data used for several elements of vehicle maintenance costs and for traction power requirements. Table 2-3 presents the statistics for the minimum operable segment.

TABLE 2-2

Summary of Operating Statistics

Period	Days Per Year	No. of Train/ Trips	No. of Car Trips	Train Hours	Car Hours	Car Miles
Weekdays	255	167	954	190.5	1,088	35,680
Saturdays	52	104	560	117.0	630	20,994
Sundays and Holidays	58	80	320	90.0	360	11,968
Annual	365	52,633	290,950	59,830	331,080	10,884,232
Annualization Factor (Annual/Weekday)		315	305	314	304	305

Route Miles: 18-6
Track Miles: 37.2
Stations: 16
Round-trip Time: 1 hour, 9 minutes

TABLE 2-3

MINIMUM OPERABLE SEGMENT

Preliminary Operating Statistics

Total Fleet Size	74 Cars
Revenue Trains	10 Trains
Stations	11 Stations
Route Miles	8.82 Miles
Track Miles	17.64 Miles
Round-trip Time	43 Minutes
Annual Train Trips	44,700 Train Trips (round trip)
Annual Car Trips	247,000 Car Trips (round trip)
Annual Car Miles	4,360,000 Car Miles
Annual Car Hours	175,000 Car Hours
Annual Train Hours	31,700 Train Hours

2.3 KEY SYSTEM ELEMENTS

The O&M cost estimate relied on an understanding of certain key system elements and the results of various special studies. The following system specifications were used:

- An 18.6 mile full system with 16 stations.
- An 8.8 mile minimum operable segment with 11 stations.
- Seven day, twenty hour per day operation.
- Attended stations and trains.
- Use of an automatic train control system that includes train supervision, train operation and train protection components.
- Use of a barrier type, distance based automatic fare collection system.
- Use of vehicles of a type that already will have been proven in service on one or more other systems.
- Totally underground system with the exception of the yard facility near Union Station.
- Patronage levels as specified in the preliminary operating plan.
- End to end operation, no midline turnbacks.

2.4 ADDITIONAL DATA SOURCES

Numerous and varied sources were used to estimate and validate the staffing levels, material consumption and miscellaneous expenses. Among the sources are:

- Special studies conducted for Metro Rail
- Direct input from RTD
- Detailed 1982 budgets for MARTA and WMATA
- Recent performance statistics of MARTA, WMATA, BARTD and PATCO
- Organizational charts for MARTA, WMATA, BARTD and PATCO
- Plans formulated for the Baltimore and Miami systems

Specific reference will be made to these sources in the derivation of the cost estimates presented in Chapter 3.

CHAPTER III
DESCRIPTION OF THE COST ELEMENTS

This chapter contains an item by item description of the cost elements including labor and material requirements and specific procedures for cost estimation.

Operations and maintenance costs have been organized into five major groups including:

- Operations
- Vehicle Maintenance
- Ways and Structures Maintenance
- Subsystems Operation and Maintenance
- General Administration

A discussion of each element and its subgroups follows.

3.1 OPERATIONS

The operations category includes the operation of Metro Rail trains, stations and yards and the provision of security for property and passengers. Five functions are included in the operations group.

- Management
- Train and Yard Operations
- Control Center
- Stations
- Security

Materials expenses for operations are also included.

3.1.1 Management

Management of the operations function will be under the direction of a manager who will report directly to the RTD executive in charge of Metro Rail. The Operations Manager will be responsible for operational activities, policy formulation, budget administration and coordination with maintenance and administrative functions.

The manager will be assisted by a secretary.

3.1.2 Train and Yard Operations

Daily operations of Metro Rail trains will be the responsibility of a manager and one assistant. Field supervision of trains as well as stations and other activities will be provided by a staff of sixteen supervisors assigned to 24 hour coverage of the system. This coverage will be distributed as outlined below.

- Line Supervisors
  - Weekdays: 4 Morning, 4 Afternoon, 1 Evening
  - Weekends: 2 Morning, 2 Afternoon, 1 Evening

- Yard Supervisors
  - All days: 1 Morning, 1 Afternoon, 1 Evening

One additional line supervisor is included to supplement the basic weekday coverage.

The requirement for train operators was determined by applying an RTD operator scheduling model to the train schedule outlined in the Preliminary Operating Plan. To operate the 167 daily, 104 Saturday and 80 Sunday-Holiday

train trips, 43 train operators are required. Ten percent was added to this number to provide for gap train operation and stand by protection.

A total of six yard operators will be required to assist in make up and break up of train consists in the yard, and to relay trains between the storage yard servicing facilities, and Union Station. Train operators will handle most trainsets to and from the yard. However, yard operators will handle unscheduled movements and also certain regular moves, particularly in the peak period.

Three crew dispatchers will work a total of two shifts daily, seven days per week. They are responsible for the scheduling and assignment of operators to trains.

One clerk is assigned to assist train and yard operations management.

3.1.3 Control Center

Daily train operation will be directed from the control center. A total of 11 Dispatchers (4 Lead Dispatchers, 7 other Dispatchers) are assigned on a three shift seven day basis to insure trains operate on schedule, operating rules are followed and system safety is maintained. The control center will be the hub for system operating and communications including train control, interlockings, radios, public address systems, and closed circuit television monitors.

The control center will be under the overall supervision of a manager and an assistant who will supervise the dispatching function and direct the several other functions in the control center (e.g. security, train control, and other subsystem operations).

Hour to hour train dispatching will be under the supervision of a lead dispatcher 24 hours per day with one additional dispatcher (control operator) employed mornings and afternoons six days per week. At all times one control operator will run the Union Station yard interlocking.

One clerk will assist control center management and maintain necessary records.

3.1.4 Stations

Cost estimates for station operations were prepared on the basis that each of the system's sixteen stations will be attended on a three shift basis by a single attendant. The resulting number of attendants, 67, has then been projected as an upper limit to station staffing costs. If due to physical configuration and/or service requirements, two attendants are needed, it has been assumed that this additional coverage could be provided within the projected cost through reassignment of personnel.

The stations function will be supervised by a manager and two assistants who will be responsible for station personnel, policy, procedures and activities.

One clerk will assist station management.

3.1.5 Security

The security function associated with Metro Rail operation has been included in the operations group. It is recognized that in actual practice bus and rail security may well be integrated as a single RTD department. The number of positions estimated for rail security forces are

incremental additions to forces already in place for bus operations and will provide coverage for patrons, stations, trains, fare collection, yard and shops.

The personnel needs were estimated by projecting system needs for general security on a shift basis and for specific needs as outlined in special studies on fare collection and closed circuit television. (1)(2)

The security function will be managed by a police captain with four sergeants, one in command of each shift. Two investigators are also included for the special needs of the rail operation.

Two special functions are included with staffing levels projected by studies on each subject. Six security guards will assist in the collection of revenues from fare machines as detailed in the alternative analysis for the fare collection system. Fourteen personnel are included to monitor closed circuit TV transmissions from key station areas to the control center as outlined in the analysis of CCTV alternatives.

The number of police officers was developed on the assumption that stations will be attended and that coverage will be provided during all hours of operation. Both general and specialized police activities have been included and result in a total of 56 police officers with activity assignments as outlined below.

- Yard and Shop Facility: 5 officers providing 24 hour coverage.
- On Train In Station: 16 officers providing 24 hour coverage.

- Mobile Patrol: 12 officers providing 24 hour coverage.
- Parking Lot Enforcement: 6 officers providing 24 hour protection.
- Fare Compliance: 4 officers (two teams of two each).

Two clerical personnel are included to assist rail police management in recordkeeping.

3.1.6 Materials

Non-labor expenses for rail security were estimated from experience at WMATA.(4) Supplies and miscellaneous expenses for other operations functions are primarily clerical in nature and were therefore aggregated with general administration non-labor expenses.

3.2 VEHICLE MAINTENANCE

Vehicle maintenance costs are comprised of labor, material and other expenses associated with daily and periodic service and maintenance of both revenue and non-revenue Metro Rail vehicles exclusive of the train control and communications subsystems. Four functions comprise the vehicle maintenance group.

- Management
- Service, Inspection and Cleaning
- Heavy and Component Repair
- Maintenance Support

3.2.1 Management

Vehicle maintenance functions will be directed by a manager and an assistant. The manager will report directly to the RTD executive in charge of Metro Rail. They will be responsible for establishment, administration, and monitoring of vehicle maintenance policies, procedures, programs and budgets. Responsibilities will include close coordinaion with the operations and subsystems functions to assume an adequate number of vehicles are available to safely operate a quality public service.

Two secretaries will assist the two managers.

3.2.2 Service, Inspection and Cleaning

Included in this activity group are scheduled vehicle service, inspection and cleaning. A plan was devised for each of these activities specifying mileage or time intervals between inspections and cleanings and the necessary personnel requirements. This plan was patterned after the vehicle maintenance program at PATCO. (5)

A supervisor is responsible for the service and inspection function including passenger vehicle preventative maintenance, corrective repair and cleaning. Duties include monitoring personnel performance, enforcing procedures and coordinating with maintenance support. Four foremen are assigned on a shift basis and have responsibility for direct supervision of repairmen and cleaners. Maintenance crews consisting of a total of 12 mechanics, 12 electricians, and 7 technicians were assigned to perform projected workloads. Eighteen vehicle cleaners were assigned on a shift basis to perform daily light cleaning and periodic thorough cleaning. A clerk is required to perform administrative duties.

3.2.3 Heavy and Component Repair

A supervisor is responsible for the heavy and component repair functions including vehicle overhaul, major corrective repair, maintenance and repair of vehicle components. Duties include monitoring performance, scheduling overhauls, enforcing procedures, and coordinating with maintenance support. Four heavy repair and component repair foremen are responsible for direct supervision of the maintenance crews consisting of a total of 20 mechanics, 24 electricians, 16 technicians, 3 machinists, a welder and 6 helpers. These are assigned on a two shift basis five days a week. A clerk is assigned administrative responsibilities.

Repair crew sizes were developed for Metro Rail by using personnel levels of other properties, primarily PATCO. Personnel requirements and time/mileage intervals were available from PATCO's vehicle overhaul program. This program was applied to the Metro Rail fleet. Additional personnel were included for unscheduled repair based on PATCO levels scaled upward by total vehicle miles per car. Total personnel levels were verified using the experience of BART and WMATA.

3.2.4 Maintenance Support

A manager will direct the complete maintenance support function and will be responsible to coordinate the support provided to ways and structures, subsystems, and vehicle maintenance. This support will primarily include quality assurance, reliability, warranty control, specification and procedures writing, document control, and program planning, scheduling and analysis.

The makeup of this group was synthesized from the personnel organizations of other properties adjusted for the fleet size, route miles and preliminary operating projections for Metro Rail. A staff 14 engineers and 11 technical assistants has been projected.

RTD incremental needs for rail transit inventory control will be assigned to a staff of two lead clerks and four clerks to operate the main stores facility and control satellite facilities.

Two clerical positions will be assigned to maintenance support.

3.2.5 Materials

Materials expenses for major vehicle components including wheels, brake shoes, brake discs and traction motors were estimated in detail given part replacement and overhaul intervals and part unit costs from part manufacturers and transit properties. Annual vehicle miles derived in the operating plan were used to estimate total component costs for Metro Rail. Other vehicle maintenance expenses including those for body parts, HVAC, other propulsion and electrical equipment, and vehicle cleaning supplies were estimated from unit cost per vehicle mile derived using WMATA data.

Details of the cost derivation are contained in Appendix B.

3.3 WAYS AND STRUCTURES MAINTENANCE

Ways and structures maintenance areas include the main line and yard tracks of Metro Rail, and its facili-

ties, specifically stations, shops, office buildings and tunnels.

The ways and structures category contains three activity groups:

- Management
- Track Maintenance
- Facilities Maintenance

Materials and subcontracted labor expenses are also included.

3.3.1 Management

Overall direction of ways and structures and facilities maintenance will be the responsibility of a manager who will report directly to the RTD executive in charge of Metro Rail. This manager will have overall responsibility for maintenance and cleaning of all rail transit facilities. He shall ensure that ways and structures are maintained so as to allow safe, timely and high quality operation of trains. Policy and procedures formulation, budget administration and coordination with operations and subsystems are among other key responsibilities.

The manager will be assisted by a secretary.

3.3.2 Track Maintenance

A manager will supervise track maintenance functions for all main line, and yard tracks, as well as for tunnels and other track structures. Maintenance crews will be assigned responsibility for specific portions of the rail line plus a mechanized crew will operate heavy machinery

such as rail grinding equipment, and track laying machinery over all portions of the line.

A supervisor will be in charge of the mechanized crew which will have three machinery operators and 12 repair and utility people. A foreman will be in charge of each of three maintenance crews which will be assigned to primary territories and/or functional responsibilities for routine maintenance. These crews are projected to have four repair or utility people each. Personnel requirements were estimated from experience of BART, WMATA and PATCO adjusting for track miles and vehicle miles.

One clerk will provide support and record keeping for the ways and structures function.

3.3.3 Facilities

Maintenance and custodial services for stations, offices, shops and other facilities are included in this group. A manager supported by one clerk is assigned overall responsibility for all facility maintenance and custodial services. Light cleaning crews consisting of five cleaners and a foreman perform daily sweeping and trash removal at each facility on a two shift daily basis. (Two cleaners per shift are provided on weekends). This provides an average of 2-1/2 to 3 hours of crew coverage per facility per day. Two heavy cleaning crews visit each facility twice monthly and do thorough cleaning, mopping and disinfecting. Each crew has a foreman and four cleaners. Maintenance crews perform routine facility maintenance including light fixture repair, lamp replacement, painting and miscellaneous activities in buildings, stations and parking lots. Crews spend approximately two weeks per year at each facility for

routine maintenance plus an additional component for trouble-shooting. Each crew consists of a foreman, and repairman/maintainers.

3.3.4 Materials and Subcontracted Labor Expenses

Materials expenses for track maintenance are based on the experience of MARTA. Facilities maintenance materials expenses for items such as janitorial supplies and light fixtures were based on WMATA expenses. Detailed estimates were made for elevator and escalator repair which is calculated as a subcontracted expense.

3.4 SUBSYSTEMS

For the maintenance of Metro Rail subsystems, five categories have been used. These are:

- Management
- Power
- Train Control
- Fare Collection
- Communications

3.4.1 Management

Subsystems maintenance have been placed under the direction of a manager who will report directly to the RTD executive in charge of Metro Rail. This person will supervise the technical managers in charge of each system, develop and approve policies and procedures, administer the budget and communicate with operations and maintenance personnel. This manager will be responsible for the overall safe and efficient operation of the Metro Rail subsystems including power, train control, fare collection and communications.

A technical staff assistant and a secretary will lend support.

3.4.2 Power

Maintenance of Metro Rail's traction power system and other power and distribution facilities are the responsibility of a manager. A total of four supervisors will be assigned on a three shift, 24 hour basis.

Full time coverage will be provided for power distribution and for emergency troubleshooting and repair with two positions each shift plus three extra positions working during peak hours. Two technicians and a clerk will support this area.

Three crews will be assigned for scheduled maintenance and heavy repair. Three foreman and a total of 24 craftsmen and repairmen are provided in this activity.

3.4.3 Train Control

A manager will have overall responsibility for the train control systems. Areas of responsibility include the train control computer, automatic train supervision equipment, automatic train operation equipment and automatic train protection equipment. These systems are found on the vehicle, at the wayside and in the central control facility. The manager will coordinate with operations, vehicle maintenance, and maintenance of way departments.

Cost estimates and staffing levels were derived from the experience of other systems. Route miles, number of vehicles and other operating statistics were considered in formulating the estimates.

A supervisor is planned for the control center for each shift. A total of four crews are assigned to perform scheduled maintenance. Two crews consisting of a foreman and five technicians and craftspeople are assigned to vehicle maintenance and work two shifts per day seven days per week each. One crew with a foreman and four workers is assigned to wayside systems maintenance. One crew of three technicians is assigned to the control center.

Provision has been made for 24 hour non-scheduled repair by technicians and repair people. This requires seven positions each weekday and three on weekends.

Four computer technicians and three engineers have also been included to support the train control system. Recordkeeping and other clerical duties will be performed by two clerks.

3.4.4 Automatic Fare Collection

A manager will direct the service and maintenance of the barrier-type AFC system. The staffing requirements to operate this system were detailed in an earlier report entitled "Analysis of Alternative Fare Collection Systems" WBS14 CAE11 dated January 1983. The personnel and costs cited in that report were used with the following modifications:

- Transit police have been included with the security functions.

- Revenue servicers, clerks and supervisors have been included within the finance portion of the General Administration grouping.

- Wage rates have been updated to current RTD levels.

- A clerical position has been added to aid in administration.

- Field technician positions were reduced given the availability of station agents. As is the experience of other systems, agents can perform routine repairs such as ticket jams.

Four supervisors and a total of 33 technicians, craftspeople and repairers will be responsible for keeping all Metro Rail AFC equipment operating at acceptable levels.

One clerk is assigned to maintain necessary records and support the manager.

3.4.5 Communications

Metro Rail will use several types of communications systems including telephones, public address systems, radios, closed circuit television and alarm systems. All systems will be the overall responsibility of a manager.

A control center supervisor will be assigned to each shift 24 hours a day. Six technicians and repairers will also be assigned around the clock for emergency trouble-shooting.

Two crews, each with a foreman and four technicians/ repairers, are included for scheduled facility and field communications work. Maintenance of communications systems on the vehicle will be performed on a two shift basis by crews having a foreman and seven technicians and repairers.

Two clerical positions are planned to support the manager and to complete necessary records and documentations.

3.4.6 Materials

A significant portion of non-labor expense is for electricity. A detailed estimate of power requirements was made including propulsion, stations, yards and shops and other power demands. Train power consumption estimates were generated from a train performance model. Station, yards and shops power was available from engineering estimates made specifically for the Metro Rail system. An assumed level of 7 cents per kilowatt hour was used to translate power demands into cost.(6) Other power costs were estimated as a percent of total station, yard and shops power as experienced at WMATA.

Material expenses for fare collection equipment were previously calculated in the fare collection alternatives analysis. These include ticket supplies, machine parts, and service materials. Train control and communication non-labor expenses were based on experience of MARTA.

3.5 GENERAL ADMINISTRATION

The existing SCRTD General Administration management and clerical levels were augmented to allow for the effective operation of Metro Rail service. Staffing levels were expanded in the following SCRTD departments:

- General Management (SCRTD 2,000)
- Controller - Treasurer - Auditor (SCRTD 7,000)
- Training and Safety (SCRTD 3,297 and 3,600)

- Planning and Marketing (SCRTD 4,000)
- Customer Relations (SCRTD 5,000)
- AGM for Management (SCRTD 9,000) Purchasing and Stores (SCRTD 9,400) was included within the maintenance support function of the vehicle maintenance group.

Metro Rail is projected to increase the overall size of SCRTD by 7% in terms of passengers carried and 8% in terms of employees. On this basis, a 7.5% growth factor was established for administrative functions which deal directly with system employees or patrons. Other functions were assumed to grow by one-half this amount.

The new positions required within each department have been allocated among skill levels based upon a review of the activities that Metro Rail service would bring to each department.

3.5.1 General Management

This category includes the RTD executive in charge of Metro Rail, an assistant and a secretary.

3.5.2 Controller - Treasurer - Auditor

This area provides for one manager, two staff assistants and four clerical positions to handle Metro Rail accounting, payroll, disbursements and management information needs.

For the unique requirements of the AFC system, three revenue supervisors, 8 servicers and a total of 29 clerical positions have been projected.

3.5.3 Training and Safety

Much of this function relates directly to the numbers of employees and therefore will increase in direct relationship to growth in overall RTD employment. A manager and six staff assistants have been included.

3.5.4 Planning and Marketing

A manager and eight staff positions have been included in the Planning and Marketing Department. Responsibilities include planning for an effective bus-rail interface plus several other activities unique to the rail system.

3.5.5 Customer Relations

Telephone information services are likely to increase in a direct relationship to total ridership. One manager and nine clerical positions are provided in this department.

3.5.6 AGM for Management

Nearly all other staff and support services are included in this heading, the largest of which is personnel and labor management. A manager, nine staff and six clerical positions have been added to this department.

3.5.7 Materials

Expenses for office supplies, duplicating, and other general administrative expenses are based on experience of WMATA, prorated by total system employees.

3.5.8 Liability

Annual expenses for personal injury, property damage, other liability expenses, and insurance coverage was based upon current RTD expenses increased in a direct relationship to growth in total RTD employees and passengers.

3.6 EXPECTED PERSONNEL LEVELS

In developing labor costs the basic building block was a person year of effort or a "position." A position is defined in terms of a five day work week 52 weeks per year (plus one additional day) or 2,088 hours per year. Some O/M activities require operation on a 7 day basis. A sufficient number of positions has been added to these activities to allow adequate coverage.

Many situations require that the position be filled at all times which implies that additional personnel are needed for vacation and other absences. To calculate the number of personnel required to fully staff the positions as outlined in this chapter, it was assumed that all individuals would have a basic vacation period of 10 days per year and that sickness, additional vacation, holidays and other absences would amount to an average of one and one-half days per month or 18 days per year. The average employee would occupy a position 1864 hours per year which requires 1.12 personnel per position (2,088 divided by 1864).

The 1.12 factor was used to calculate personnel requirements from position levels. Certain positions, usually management, will not be occupied when the regular employee is absent for short period of time. A one position, one person relationship was used in these cases and

the factor was not applied. Table 3-1 describes the relationship of personnel requirements to position levels for the five major activity groups.

3.7 FULL SYSTEM VERSUS MINIMUM OPERABLE SEGMENT

Identical procedures are employed in cost derivation for both the full system and the minimum operable segment. Each requires the same set of skill levels to perform each of the O&M activities, however as would be expected, the number of employees per level is often smaller for the MOS. In general, the labor costs for management in the MOS are similar to those for the full system since the same functional organization is preserved. For line positions such as operators, mechanics and craftsmen, greater opportunities exist to reduce personnel levels. Non labor expenses are generally smaller for the MOS due to lower levels of key operating statistics such as fleet requirements and vehicle miles.

Table 3-2 compares personnel levels for the full system versus the minimum operable segment. Note that the sharpest reduction in labor requirements tend to be for hourly workers.

TABLE 3-1

POSITION LEVELS AND PERSONNEL REQUIREMENTS

FULL SYSTEM

Grouping	Position Level	Personnel Required
Operations	248	274
Vehicles	169	185
Way and Structures	78	86
Sub Systems	178	196
Administrative	92	98
Total	765	839

MINIMUM OPERABLE SEGMENT

Operations	178	196
Vehicles	109	119
Way and Structures	63	70
Sub Systems	131	143
Administrative	67	70
Total	548	598

TABLE 3-2

PERSONNEL LEVELS

FULL SYSTEM VS. MOS

	FULL SYSTEM	MOS	RATIO MOS/FULL
I. Operations			
Salary	28	24	.86
Hourly	246	172	.70
II. Vehicle Maintenance			
Salary	40	28	.70
Hourly	145	91	.63
III. Ways and Structures			
Salary	10	9	.90
Hourly	76	61	.80
IV. Subsystems			
Salary	29	25	.86
Hourly	167	118	.71
V. General Administration			
Salary	46	34	.74
Hourly	52	36	.69
TOTAL			
Salary	153	120	.78
Hourly	686	478	.70

CHAPTER IV
OPERATING AND MAINTENANCE COST ESTIMATE

Based upon the projections of the year 2000 preliminary operating plan, annual operating and maintenance costs are presented for both the full system and the minimum operable segment. Components of the cost include wages, benefits and materials. Costs for electric power and liability expenses (casualty, property damage and insurance) are shown separately.

Two levels of detail underlying the cost summaries are included in this report as appendices. Appendix A displays a breakdown of each group into its subfunctions as outlined in Chapter 3. Appendix B details each subfunction by skill level, pay rate, number of positions, personnel requirements and costs.

4.1 FULL SYSTEM

Annual operating and maintenance costs for the full system total $45.5 million. Table 4-1 shows the personnel requirements, wage costs, benefits and other expenses for each major O/M function. These levels are for year 2000 operation.

4.2 MINIMUM OPERABLE SEGMENT

Annual operating and maintenance costs for the minimum operable segment are $30.6 million ($1983). Table 4-2 shows the personnel requirements, wage costs, benefits and other expenses for each function. These levels are for year 2000 operation.

TABLE 4-1

ANNUAL OPERATING AND MAINTENANCE COSTS

FULL SYSTEM

	PERSONNEL	WAGES	BENEFITS	MATERIAL	TOTAL
Operations	274	$ 6,374,130	$2,744,402	$ 40,000	$ 9,158,532
Vehicles	185	4,707,394	1,938,952	1,621,500	8,267,846
Way & Structures	86	2,021,604	866,150	1,844,000	4,731,754
Sub Systems	196	5,386,340	2,292,966	955,000	8,634,306
Electric Power				9,338,500	9,338,500
Administration	98	2,540,093	925,766	100,000	3,565,859
Liability				1,813,000	1,813,000
Total	839	$21,029,561	$8,768,236	$15,712,000	$45,509,797

Annual Costs in 1983 Dollars

TABLE 4-2

ANNUAL OPERATING AND MAINTENANCE COSTS

MINIMUM OPERABLE SEGMENT

	PERSONNEL	WAGES	BENEFITS	MATERIAL	TOTAL
Operations	196	$ 4,634,607	$1,974,975	$ 28,000	$ 6,637,582
Vehicles	119	3,057,416	1,248,094	658,200	4,963,710
Way & Structures	70	1,656,721	705,450	1,217,000	3,579,171
Sub Systems	143	3,991,795	1,679,951	660,000	6,331,746
Electric Power				5,282,100	5,282,100
Administration	70	1,868,181	678,208	75,000	2,621,389
Liability				1,190,000	1,190,000
Total	598	$15,208,720	$6,286,678	$9,110,300	$30,605,698

Annual Costs in 1983 Dollars

4.3 FUTURE REFINEMENTS OF THE ESTIMATE

As the operating plan or system specifications are modified, this estimate will be revised accordingly. There are some costs, primarily those associated with administration, that appear to be fixed with variations in service level. However, several cost elements are sensitive to changes in level of service or hours of operation. These include vehicle and subsystem maintenance, propulsion power and operator labor. Therefore, expected operating and maintenance costs must be refined and updated as operating plans are revised.

4.4 METRO RAIL O&M COST RELATIONSHIP TO OTHER SYSTEMS

As has been stated, the estimates for the several components for Year 2000 Operations and Maintenance Costs have been derived from numerous sources which often included the actual experience of other rail transit systems. Even when the initial basis for estimation was not a direct comparison to other systems, the results were validated by use of such comparisons with significant differences having to be justified. It is useful, therefore, to make at least one measurement of the overall cost estimate for Metro Rail along side the projected 1982 comparable figures for other systems. Table 4-3 discloses that the results in terms of cost per vehicle mile measure sensibly with those systems.

TABLE 4-3
UNIT COST COMPARISON
WITH OTHER SYSTEMS

($/Vehicle Mile)
1982

METRO RAIL (EST)	4.18
BARTD	4.15
WMATA	6.12
PATCO	3.40
MARTA	3.95

REFERENCES

(1) Booz, Allen, & Hamilton, Inc., Analysis of Alternate Fare Collection Systems, WBS 14 CAE 11, January 1983.

(2) Kaiser Engineers California, P.M. Burgess memo to W.J. Rhine, SCRTD, Re: Closed Circuit Television System (CCTV), January 28, 1983.

(3) Booz, Allen, & Hamilton, Inc., Preliminary Operating, Plan, WBS 13 DAA, May 1982.

(4) Washington Metropolitan Area Transit Administration (WMATA), Annual Operating Budget 1982-1983.

(5) PATCO, Director of Vehicle Maintenance, Letter to Michael Becher, SCRTD, RE; PATCO's Vehicle Maintenance Program, 1982.

(6) Metro Rail Procedural Memo A-26, Richard Gallagher, SCRTD, RE: Cost Analysis Procedures for WBS 14, May 27, 1982.

APPENDIX A
DETAILED BREAKDOWN OF THE OPERATING AND MAINTENANCE COST ESTIMATE

This appendix contains three tables that provide a detailed breakdown of the Operating and Maintenance cost estimates presented in Chapter IV.

Table A-1 lists personnel, wages, benefits, material and total expenses for the individual functions within each departmental group for the full system.

Table A-2 lists identical information for the minimum operable segment.

Table A-3 lists by job category or skill level, the rate of pay used in O&M calculations and the number of positions that have been included in the estimate for both the full system and MOS.

TABLE A-1

DEPARTMENTAL DETAIL - O&M COST ESTIMATE

FULL SYSTEM

		Personnel	Salaries/ Wages	Benefits	Material	Total
I.	OPERATIONS					
	Administration	2	$ 61,560	$ 18,468	$	$ 80,028
	Train Operators	83	2,033,128	824,718		2,857,846
	Control Center	15	420,098	179,385		599,438
	Stations	79	1,652,904	734,550		2,387,454
	Security	95	2,206,440	987,281	40,000	3,233,721
	Total	274	$6,374,130	$2,744,402	$ 40,000	$9,158,532
II.	VEHICLES					
	Administration	4	$ 119,956	$ 35,987	$	$ 155,943
	Service	61	1,423,987	620,866		2,044,853
	Heavy Repair	85	2,124,161	939,445		3,063,606
	MTCE Support	35	1,039,290	342,654	1,621,500	3,003,444
	Total	185	$4,707,394	$1,938,952	$1,621,500	$8,267,846
III.	WAY AND STRUCTURES					
	Administration	2	$ 61,560	$ 18,468	$	$ 80,028
	Track	36	917,499	389,963	256,000	1,563,462
	Facilities	48	1,042,545	457,719	1,588,000	3,088,264
	Total	86	$2,021,604	$ 866,150	$1,844,000	$4,371,754
IV.	SUB SYSTEMS					
	Administration	3	$ 91,728	$ 27,518	$	$ 119,246
	Power	52	1,365,747	577,305	92,000	2,035,052
	Train Control	53	1,495,530	636,404	50,000	2,181,934
	AFC	43	1,186,538	511,729	683,000	2,381,267
	Communications	45	1,246,797	540,010	130,000	1,916,807
	Total	196	$5,386,340	$2,292,966	$ 955,000	$8,634,306
V.	ADMINISTRATION					
	GM & Finance	54	$1,351,926	$ 524,729	$ 100,000	$1,976,655
	Support	24	662,531	219,808		882,339
	Marketing	20	525,636	181,229		706,865
	Total	98	$2,540,093	$ 925,766	$ 100,000	$3,565,859
	Electric Power				$9,338,500	$9,338,500
	Liability				1,813,000	1,813,000
	Grand Total	839	$21,029,561	$8,768,236	$15,712,000	$45,509,797

TABLE A-2

DEPARTMENTAL DETAIL - O&M COST ESTIMATE

MOS

		Personnel	Salaries/ Wages	Benefits	Material	Total
I.	OPERATIONS					
	Administration	2	$ 61,560	$ 18,468	$	$ 80,028
	Train Operators	55	1,398,611	552,625		1,951,236
	Control Center	13	362,690	153,265		515,955
	Stations	56	1,777,590	518,282		1,695,872
	Security	70	1,634,156	732,335	28,000	2,394,491
	Total	196	$4,634,607	$1,974,975	$ 28,000	$6,637,582
II.	VEHICLES					
	Administration	4	$ 119,956	$ 35,987	$	$ 155,943
	Service	30	692,673	298,761		991,434
	Heavy Repair	62	1,569,180	686,929		2,256,109
	MTCE Support	23	675,607	226,417	658,200	1,560,224
	Total	119	$3,057,416	$1,248,094	$ 658,200	$4,963,710
III.	WAY AND STRUCTURES					
	Administration	2	$ 61,560	$ 18,468	$	$ 80,028
	Track	29	728,154	309,133	125,000	1,162,287
	Facilities	39	867,007	377,849	1,092,000	2,336,856
	Total	70	$1,656,721	$ 705,450	$1,217,000	$3,579,171
IV.	SUB SYSTEMS					
	Administration	3	$ 91,728	$ 27,518	$	$ 119,246
	Power	37	999,464	415,967	60,000	1,475,431
	Train Control	37	1,072,184	449,104	40,000	1,561,288
	AFC	31	854,402	366,145	470,000	1,690,547
	Communications	35	974,017	421,217	90,000	1,485,234
	Total	143	$3,991,795	$1,679,951	$ 660,000	$6,331,746
V.	ADMINISTRATION					
	GM & Finance	41	$1,035,825	$ 401,017	$ 75,000	$1,511,842
	Support	16	462,607	152,815		615,422
	Marketing	13	369,749	124,376		494,125
	Total	70	$1,868,181	$ 678,208	$ 75,000	$2,621,389
	Electric Power				$5,282,100	$5,282,100
	Liability				1,190,000	1,190,000
	Grand Total	598	$15,208,720	$ 6,286,678	$9,110,300	$30,605,698

TABLE A-3

SUMMARY OF POSITIONS INCLUDED IN O&M COST ESTIMATE

Category/ Skill Level	Rate Year	Rate/ Hour	# Positions Full System	# Positions MOS
Manager VI	60540		1	1
Manager IV	41892		4	4
Manager III	38688		13	13
Manager II	37176		11	11
Supervisor I	35724		33	29
Staff Asst. III	33324		8	4
Staff Asst. II	30168		16	10
Staff Asst. I	27312		13	9
Engineer II	36084		7	6
Engineer I	33324		10	6
AFC Rev. Servicer	34000		8	6
AFC Rev Supervisor	31600		3	2
Secretary	19668		6	6
Lead Clerk	30168		4	4
Clerk III		11.20	49	37
Clerk II		10.84	92	67
Clerk I		10.39	10	7
Police Sgt/Inv.		16.82	6	4
Police Officer		12.36	56	42
Security Guard		11.30	6	4
Lead Dispatcher	30168		4	4
Dispatcher	28704		7	5
MTCE Foreperson	34332		24	18
Technician		15.01	48	33
MCHY Operator		14.14	3	3
Craftsperson		13.88	89	60
Repairperson II		13.20	83	55
Repairperson I		12.47	27	17
Utilityperson		11.79	28	20
Service Foreperson		12.85	4	4
Serviceperson		9.74	38	25
Train Operators		11.48	54	32
TOTAL POSITIONS			765	548
TOTAL PERSONNEL			839	598

APPENDIX B
DERIVATION OF LABOR AND MATERIAL EXPENSES

The following series of tables summarize the estimated personnel requirements by activity and skill level. The "position/skill level" are generic descriptions of the managerial or skill level. Each has an associated pay rate at either an annual or hourly basis.

Number of required positions (equivalent person years of effort) are listed for both the full system and the MOS. Total cost for each skill level and activity group are summarized.

The total number of salaried and hourly positions is indicated, the appropriate benefit rate is added and the total labor costs are derived. The number of personnel required is determined by using a factor of 1.12 on the hourly position subtotal.

Additional notes are provided for derivation of material expenses.

I. OPERATIONS

- Administration

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Supervision of all Metro Rail Operations	Manager IV	41,892	1	41,892	1	41,892
	Secretary	19,668	1	19,668	1	19,668
Sub Total Salaried Positions			2	61,560	2	61,560
Fringe @ .30				18,468		18,468
Sub Total Hourly Positions						
Fringe @ .455						
Total Labor (positions/labor cost)			2	80,028	2	80,028
Personnel			2		2	

I. OPERATIONS

- Train Operators

Activity Description	Position/Skill Level	Base Rate*	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Preliminary Operating Plan	Manager III	38,688	1	38,688	1	38,688
Peak Opr'n 19 Active, 2 Gap Trainsets	Manager II	37,176	1	37,176	1	37,176
6/4 Car Consists	Line & Yard Suprv'r	35,724	16	571,584	13	464,412
Full System to have 167 Trains Weekdays	Train Operators	11.48	48	1,150,571	27	647,196
104 Saturdays	Yard Operators	11.48	6	143,821	5	119,851
80 Sundays and Holidays	Clerk III	11.20	1	23,386	1	23,386
	Clerk II (Crew Dspr)	10.84	3	67,902	3	67,902
	Sub Total Salaried Positions		18	647,448	15	540,276
	Fringe @ .30			194,234		162,083
	Sub Total Hourly Positions		58	1,385,680	36	858,335
	Fringe @ .455			630,484		390,542
	Total Labor		76	2,857,846	51	1,951,236
	Personnel		83		55	

* Base rates are given on an annual basis for salaried positions and on an hourly basis for hourly positions

I. OPERATIONS

- Control Center

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Dispatch Trains and Coordinate Other Personnel and Functions at Control Center such as Communications, Security and Maintenance	Manager III	38,688	1	38,688	1	38,688
	Manager II	37,176	1	37,176	1	37,176
	Lead Dispatcher	30,168	4	120,672	4	120,672
	Dispatcher	28,704	7	200,928	5	143,520
	Clerk II	10.84	1	22,634	1	22,634
	Sub Total Salaried Positions		2	75,864	2	75,864
	Fringe @ .30			22,759		22,759
	Sub Total Hourly Positions		12(1)	344,234	10(1)	286,826
	Fringe @ .455			156,626		130,506
	Total Labor		14	599,483	12	515,955
	Personnel		15		13	

(1) Includes Dispatchers who will be replaced when absent for vacation, sickness, etc.

I. OPERATIONS

- Stations

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
One Attendant per Station Three Shifts Per Day	Manager III	38,688	1	38,688	1	38,688
	Manager II	37,176	2	74,352	2	74,352
	Clerk III	11.20	1	23,386	1	23,386
	Clerk II (Sta'n Attd't)	10.84	67	1,516,478	46	1,041,164
	Sub Total Salaried Positions		3	113,040	3	113,040
	Fringe @ .30			33,912		33,912
	Sub Total Hourly Positions		68	1,539,864	47	1,064,550
	Fringe @ .455			700,638		484,370
Total Labor			71	2,387,454	50	1,695,872
Personnel			79		56	

I. OPERATIONS

- Security

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Incremental Security for Metro Rail beyond forces already in place for RTD bus operations. Coverage for Stations - Yards - Parking Lots - Cash Collection - Fare Compliance, etc.	Captain (Mgr II)	37,176	1	37,176	1	37,176
	Sgt/Investigator	16.82	6	210,720	4	140,480
	Police Officer	12.35	56	1,445,248	42	1,083,936
	Security Guards (1)	11.30	6	141,564	4	94,376
	TV Monitor (Clk III)(2)	11.20	14	327,404	10	238,860
	Clerk II	10.84	1	22,634	1	22,634
	Clerk I	10.39	1	21,694	1	21,694
Sub Total	Salaried Positions		3(3)	107,416	2(3)	72,296
	Fringe @ .30			32,225		21,689
Sub Total	Hourly Positions		82	2,099,024	61	1,561,860
	Fringe @ .455			955,056		710,646
Total Labor			85	3,193,721	63	2,366,491
Personnel			95		70	

(1) Security Guards assist in AFC Collection as per AFC study findings
(2) Staffing level recommended by CCTV study
(3) Includes investigators (2 FS; 1 MOS)

II. VEHICLES

- Administration

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Supervision of Metro Rail Vehicle Service and Repair	Manager IV	41,892	1	41,892	1	41,892
	Manager III	38,688	1	38,688	1	38,688
	Secretary	19,668	2	39,376	2	39,376
	Sub Total Salaried Positions		4	119,956	4	119,956
	Fringe @ .30			35,987		35,987
	Sub Total Hourly Positions					
	Fringe @ .455					
Total Labor			4	155,943	4	155,943
Personnel			4		4	

II. VEHICLES

- Service, Inspection & Cleaning

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	NOS # Pos.	NOS Annual Cost
Periodic Inspection, Interior & Exterior Cleaning and Light Repairs for Metro Rail Vehicles	Manager II	37,176	1	37,176	1	37,176
	MTCE Foreperson	34,332	4	137,328	2	68,664
	Craftsperson	13.88	12	347,777	5	144,907
	Repairperson II	13.20	12	330,744	5	137,810
	Repairperson I	12.47	7	182,262	3	78,112
	Serviceperson	9.74	18	366,066	10	203,370
	Clerk II	10.84	1	22,634	1	22,634
	Sub Total Salaried Positions		5	174,504	3	105,840
	Fringe @ .30			52,351		31,752
	Sub Total Hourly Positions		50	1,249,483	24	586,833
	Fringe @ .455			568,515		267,009
Total Labor			55	2,044,853	27	991,434
Personnel			61		30	

II. VEHICLES

- Heavy Repair

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Heavy Repair as necessary, component repair and scheduled overhaul	Manager II	37,176	1	37,176	1	37,176
	MTCE Foreperson	34,332	4	137,328	4	137,328
	Craftsperson	13.88	28	811,480	20	579,620
	Repairperson II	13.20	20	551,240	13	358,306
	Repairperson I	12.47	16	416,598	11	286,411
	Utilityperson	11.79	6	147,705	6	147,705
	Clerk II	10.84	1	22,634	1	22,634
	Sub Total Salaried Positions		5	174,504	5	174,504
	Fringe @ .30			52,351		52,351
	Sub Total Hourly Positions		71	1,949,657	51	1,394,676
	Fringe @ .455			887,094		634,578
Total Labor			76	3,063,606	56	2,256,109
Personnel			85		62	

II. VEHICLES

- Maintenance Support

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Support Vehicle MTCE as well as Way & Structures and Sub Systems - Engineering, Planning, Scheduling, Documentation, Inventory Control, etc.	Manager III	38,688	1	38,688	1	38,688
	Engineer II	36,084	4	144,336	3	108,252
	Engineer I	33,324	10	333,240	6	199,944
	Staff Asst. III	33,324	2	66,648	1	33,324
	Staff Asst. II	30,168	4	120,672	2	60,336
	Staff Asst. I	27,312	5	136,560	3	81,936
	Clerk-Lead (Inv.)	30,168	2	60,336	2	60,336
	Clerk III (Inv.)	11.20	4	93,542	3	70,157
	Clerk II	10.84	2	45,268	1	22,634
	Sub Total Salaried Positions		26	840,144	16	522,480
	Fringe @ .30			252,043		156,744
	Sub Total Hourly Positions		8(1)	199,146	6(1)	153,127
	Fringe @ .455			90,611		69,673
	Total Labor		34	1,381,944	22	902,024
	Personnel		35		23	

(1) Includes Lead Clerks

III. WAY AND STRUCTURES

- Administration

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Supervision of Maintenance of Tracks and Facilities	Manager IV	41,892	1	41,892	1	41,892
	Secretary	19,668	1	19,668	1	19,668
Sub Total Salaried Positions			2	61,560	2	61,560
	Fringe @ .30			18,468		18,468
Sub Total Hourly Positions						
	Fringe @ .455					
Total Labor			2	80,028	2	80,028
Personnel			2		2	

III. WAY AND STRUCTURES

- Track

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Maintenance of Main, Yard & Auxiliary Tracks, Tunnels and Other Track Structures	Manager III	38,688	1	38,688	1	38,688
	Supervisor I	35,724	1	35,724	1	35,724
	MTCE Foreperson	34,332	3	102,996	2	68,664
	Machinery Operator	14.14	3	88,573	3	88,573
	Repairperson II	13.20	11	303,177	9	248,054
	Repairperson I	12.47	4	104,149	3	78,112
	Utilityperson	11.79	9	221,558	6	147,705
	Clerk II	10.84	1	22,634	1	22,634
Sub Total	Salaried Positions		5	177,408	4	143,076
	Fringe @ .30			53,222		42,923
Sub Total	Hourly Positions		28	740,091	22	585,078
	Fringe @ .455			336,741		266,210
Total Labor			33	1,307,462	26	1,037,287
Personnel			36		29	

III. WAY AND STRUCTURES

- Facilities

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Maintenance and Custodial Services for Stations, Offices, Shops and Other Facilities	Manager III	38,688	1	38,688	1	38,688
	MTCE Foreperson	34,332	2	68,664	2	68,664
	Craftsperson	13.88	4	115,926	4	115,926
	Repairperson II	13.20	4	110,246	4	110,246
	Utilityperson	11.79	7	172,322	4	98,470
	Service Foreperson	12.85	4	107,323	4	107,323
	Serviceperson	9.74	20	406,742	15	305,056
	Clerk II	10.84	1	22,634	1	22,634
Sub Total Salaried Positions			3	107,352	3	107,352
Fringe @ .30				32,206		32,206
Sub Total Hourly Positions			40	935,193	32	759,655
Fringe @ .455				425,513		345,643
Total Labor			43	1,500,264	35	1,244,856
Personnel			48		39	

IV. SUB SYSTEMS

- Administrative

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Supervision and Technical Direction for Sub Systems	Manager IV	41,892	1	41,892	1	41,892
	Staff Asst. II	30,168	1	30,168	1	30,168
	Secretary	19,668	1	19,668	1	19,668
Sub Total Salaried Positions			3	91,728	3	91,728
Fringe @ .30				27,518		27,518
Sub Total Hourly Positions						
Fringe @ .455						
Total Labor			3	119,246	3	119,246
Personnel			3		3	

IV. SUB SYSTEMS

- Power

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Operation and Maintenance of Wayside Traction Power and Other Major Source, Distribution and Consumption Facilities	Manager III	38,688	1	38,688	1	38,688
	Supervisor I	35,724	4	142,896	4	142,896
	MTCE Foreperson	34,332	3	102,996	2	68,664
	Technicians	15.01	2	62,682	2	62,682
	Craftsperson	13.88	15	434,722	10	289,814
	Repairperson II	13.20	15	413,424	10	275,616
	Utilityperson	11.79	6	147,705	4	98,470
	Clerk II	10.84	1	22,634	1	22,634
Sub Total	Salaried Positions		8	284,580	7	250,248
	Fringe @ .30			85,374		75,074
Sub Total	Hourly Positions		39	1,081,167	27	749,216
	Fringe @ .455			491,931		340,893
Total Labor			47	1,943,052	34	1,415,431
Personnel			52		37	

IV. SUB SYSTEMS

- Train Control

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Operate and maintain TC computer, ATS System and Central Control, Wayside and Vehicle Installations for ATO and ATP Systems	Manager III	38,688	1	38,688	1	38,688
	Supervisor I	35,724	4	142,896	4	142,896
	MTCE Foreperson	34,332	4	137,328	3	102,996
	Engineer II	36,084	3	108,252	3	108,252
	Technicians	15.01	20	626,817	13	407,432
	Craftsperson	13.88	8	231,851	5	144,907
	Repairperson II	13.20	6	165,370	3	82,685
	Clerk II	10.84	1	22,634	1	22,634
	Clerk I	10.39	1	21,694	1	21,694
	Sub Total Salaried Positions		8	284,268	7	249,936
	Fringe @ .30			85,280		74,981
	Sub Total Hourly Positions		40(1)	1,211,262	27(1)	822,248
	Fringe @ .455			551,124		374,123
	Total Labor Personnel		48 53	2,131,934	34 37	1,521,288

(1) Includes 4 Supervisor I Positions which will need to be filled for absences of regular employees

IV. SUB SYSTEMS

- AFC

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Operate and maintain barrier type automatic fare collection system	Manager III	38,688	1	38,688	1	38,688
	Supervisor I	35,724	4	142,896	3	107,172
	Technicians	15.01	14	438,772	10	313,409
	Craftsperson	13.88	14	405,740	10	289,814
	Repairperson II	13.20	5	137,808	3	82,685
	Clerk II	10.84	1	22,634	1	22,634
	Sub Total Salaried Positions		5	181,584	4	145,860
	Fringe @ .30			54,475		43,758
	Sub Total Hourly Positions		34	1,004,954	24	708,542
	Fringe @ .455			457,254		322,387
Total Labor			39	1,698,267	28	1,220,547
Personnel			43		31	

IV. SUB SYSTEMS

- Communications

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Maintain phone, public address, radio, CCTV and other communications systems	Manager III	38,688	1	38,688	1	38,688
	Supervisor I	35,724	4	142,896	4	142,896
	MTCE Foreperson	34,332	4	137,328	3	102,996
	Technicians	50.01	12	376,090	8	250,727
	Craftsperson	13.88	8	231,851	6	173,889
	Repairperson II	13.20	10	275,616	8	220,493
	Clerk II	10.84	1	22,634	1	22,634
	Clerk I	10.39	1	21,694	1	21,694
	Sub Total Salaried Positions		5	176,016	4	141,684
	Fringe @ .30			52,805		42,505
	Sub Total Hourly Positions		36(1)	1,070,781	28(1)	832,333
	Fringe @ .455			487,205		378,712
	Total Labor		41	1,786,807	32	1,395,234
	Personnel		45		35	

(1) Includes 4 Supervisor I Positions which will need to be filled during absences of regular employees

V. ADMINISTRATION

- General Management and Finance

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
General Management (RTD 2000's)	Manager VI	60,540	1	60,540	1	60,540
	Manager III	38,688	1	38,688	1	38,688
	Secretary	19,668	1	19,668	1	19,668
Controller-Treasurer-Auditor (RTD 2000's)	Manager II	37,176	1	37,176	1	37,176
	Staff Asst. II	30,168	2	60,336	1	30,168
	Clerk II	10.89	4	90,536	3	67,902
(AFC Related)	Servicer	34,000	8	272,000	6	204,000
	Revenue Supervisor	31,600	3	94,800	2	63,200
	Clerk III	11.20	29	678,182	22	514,484
Sub Total	Salaried Positions		17	583,208	13	453,440
	Fringe @ .30			174,962		136,032
Sub Total	Hourly Positions		33	768,718	25	582,385
	Fringe @ .455			349,767		264,985
Total Labor			50	1,876,655	38	1,436,842
Personnel			54		41	

V. ADMINISTRATION

- Support

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
AGM for Management (RTD 9000's except 9400)	Manager III	38,688	1	38,688	1	38,688
	Staff Asst. III	33,324	3	99,972	2	66,648
	Staff Asst. II	30,168	3	90,504	2	60,336
	Staff Asst. I	27,312	3	81,936	2	54,624
	Clerk II	10.84	6	135,803	4	90,535
Training - Safety (RTD 3297 & 3600)	Manager II	37,176	1	37,176	1	37,176
	Staff Asst. III	33,324	1	33,324		
	Staff Asst. II	30,168	3	90,504	2	60,336
	Staff Asst. I	27,312	2	54,624	2	54,624
	Sub Total Salaried Positions		17	526,728	12	372,072
	Fringe @ .30			158,018		111,622
	Sub Total Hourly Positions		6	135,803	4	90,535
	Fringe @ .455			61,790		41,193
	Total Labor		23	882,339	16	615,422
	Personnel		24		16	

V. ADMINISTRATION

- Marketing

Activity Description	Position/Skill Level	Base Rate	FULL SYSTEM # Pos.	FULL SYSTEM Annual Cost	MOS # Pos.	MOS Annual Cost
Planning and Marketing (RTD 4000's)	Manager II	37,176	1	37,176	1	37,176
	Staff Asst. III	33,324	2	66,648	1	33,324
	Staff Asst. II	30,168	3	90,504	2	60,336
	Staff Asst. I	27,312	3	81,936	2	54,624
Customer Relations (RTD 5000's)	Manager II	37,176	1	37,176	1	37,176
	Lead Clerk	30,168	2	60,336	2	60,336
	Clerk I	10.39	7	151,860	4	86,777
Sub Total Salaried Positions			12	373,776	9	282,972
Fringe @ .30				112,133		84,892
Sub Total Hourly Positions			7	151,860	4	86,777
Fringe @ .455				69,096		39,484
Total Labor			19	706,865	13	494,125
Personnel			20		13	

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POSITION AND SKILL LEVELS

MANAGEMENT AND ADMINISTRATIVE

Category	Rate	# Positions F.S.	MOS
Manager VI	60,540	1	1
Manager IV	41,892	4	4
Manager III	38,688	13	13
Manager II	37,176	11	11
Supervisor I	35,724	33	29
Staff Asst. III	33,324	8	4
Staff Asst. II	30,168	16	10
Staff Asst. I	27,312	13	9
Engineer II	36,084	7	6
Engineer I	33,324	10	6
AFC Rev Servicer	34,000	8	6
AFC Rev. Supv'r	31,600	3	2
Secretary	19,668	6	6
Lead Clerk	30,168	4	4
Clerk III	11.20	49	37
Clerk II	10.84	92	67
Clerk I	10.39	10	7
Police Sgt/Inv.	16.82	6	4
Police Officer	12.36	56	42
Security Guard	11.30	6	4

OPERATION AND MAINTENANCE

Category	Rate	# Positions F.S.	MOS
Lead Dispatcher	30,168	4	4
Dispatcher	28,704	7	5
MTCE Foreperson	34,332	24	18
Technician	15.01	48	33
Mchy. Operator	14.14	3	3
Craftsperson	13.88	89	60
Repairperson II	13.20	83	55
Repairperson I	12.47	27	17
Utilityperson	11.79	28	20
Service Foreperson	12.85	4	4
Serviceperson	9.74	38	25
Train Operators	11.48	54	32
TOTAL POSITIONS		765	548
TOTAL PERSONNEL		839	598

I. OPERATIONS

- Security

  $40,000, ($28,000 MOS) based on WMATA, prorated by number of police

- Other expenses included in general administration category

II. VEHICLE MAINTENANCE

Consist of detailed analysis for major components (traction motors, brakes and wheels) plus unit cost analysis for other expenses see attached sheets for derivation.

III. WAYS AND STRUCTURES

- Track

  $256,000 (57k track, 9k structures, 199k rail service vehicles) based on MARTA ($125,000 MOS)

- FACILITIES

$1,588,000	80,000	32 elevators @ 2500/year)	
($1,092,000 MOS)	468,000	78 escalators @ 6000/year)	WMATA Unit Costs
	1,040,000	16 stations @ 65k/year)	

IV. SUBSYSTEMS

- Power

  $92,000 ($46,000 service; $46,000 materials) based on MARTA ($60,000 MOS)

- Computer and Train Control

  $50,000 based on MARTA ($40,000 MOS)

- Fare Collection

  $683,000 from fare collection ALT analysis, WBS 14 CAE 11. ($470,000 MOS)

- Communications

  $130,000 Based on WMATA ($90,000 MOS)

V. GENERAL ADMINISTRATION

- Misc. materials and suppliers

  $100,000 based on WMATA, prorated by personnel. ($75,000 MOS)

- Liability

  $1,813,000 based on current RTD costs $25.9 million, prorated by expected system growth ($1,190,000 MOS)

RAIL CAR MAINTENANCE

- Traction Motor Overhall

  Veh miles = 10,884,000
  Motors/Veh = 4
  Motor Miles = 43,536,000

  Overhaul interval = 400,000 — GE phone interview
  Cost per overhaul = $1250 — WMATA Unit Cost
  $\frac{43,536,000}{400,000}$ = 108 overhauls X 1250 = $135,000 FULL ($54,000 MOS)

- Traction Motor Repair

  WMATA 60 failures/year
  Metro Rail $\frac{10,884,000}{18,200,000}$ x 60 = 36/yr; adjust for LA conditions = 30/yr

  Cost/repair = 8000 (WMATA); 30 X $8000 = $250,000 FULL ($96,000 MOS)

- Brake Discs

Veh miles	= 10,884,000	
Discs/Veh	= 8	
Disc miles	= 87,072,000	
Disc life	= 100,000 miles	interview Knor
Cost/Disc	= $395 (WMATA)	
87,072,000 / 100,000	= 870.7 X $395 =	343,934 FULL ($137,560 MOS)

- Brake Pads

Veh miles	= 10,884,000	
Pads/veh	= 16	
Pads miles	= 174,144,000	
Pad life	= 30,000 Miles	
Cost/pad	= $26	
174,144,000 / 30,000	X $26 =	150,925 FULL ($60,300 MOS)

- Transit Car Wheels

  Vehicle miles = 10,884,000
  Wheels/Veh = 8
  Wheel Miles = 87,072,000

  Wheel Life = 1,000,000 Miles
  Wheel Cost = $720

  $$\frac{87,072,000}{1,000,000} \times 720 = \$62,700 \quad \text{FULL}$$
  ($25,100 MOS)

- Other including Body parts, HVAC, equip repair parts, propulsion, truck parts other than wheels, electric parts

  = .567 $/veh mile (WMATA)
  = $617,000
  ($247,000 MOS)

- Cleaning & washing supplies = $72,000 (Based on WMATA)
  ($38,000 MOS)

ELECTRICAL POWER COST

	FULL SYSTEM	MOS
Propulsion	$4,352,000	$1,961,117
Station	3,920,000	2,695,000
Yards and Shops	613,200	324,120
Other	453,320	301,900
	$9,338,520	$5,282,137

Propulsion

	FULL	MOS	
Annual Train Trips	52,633		
Equiv Six car Trips	48,492	44,700	
kwh/Av Six car Train	12,822	6,268	(prorated by miles)
Annual kwh	62,176,442	28,015,968	
X.07	X.07	X.07	
$4,352,351	$4,352,351	1,961,117	

Stations

Station	16	11	
Kwh/station	3,500,000	3,500,000	
$/kwh	X.07	X.07	
	3,920,000	2,695,000	

- Yards and Shops

  From Prelim. EIS

  1000 kva, 24 hrs, 7¢/kwhr, 365 days/yr
  $613,200, Mos prorated vehicles, $324,120

- Other

  from WMATA, other power costs = .10 X (station power + yards & shops)
  = $453,320 full system
  = $301,900 MOS