Lessons Learned from New LRT Start-Ups

The Portland Experience

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The first light rail line in Portland, Oregon, began revenue service on September 5, 1986, after more than a decade of planning, engineering, and construction. The project was known as the Banfield Light Rail Project, recognizing the combined scope of Banfield Freeway (I-84) improvements and light rail construction. The combined $319-million project, jointly managed by the Oregon Department of Transportation and the Tri-County Metropolitan Transportation District of Oregon (Tri-Met), was the largest single public works project in the state's history. The overall project was delivered on schedule and within budget. The successful start-up of the 15.1-mi Portland-to-Gresham line was accomplished by stressing teamwork throughout all phases of the project. The transition from engineering staff to operating personnel was structured to maximize coordination. The establishment of an operations core start-up team provided the organizational framework necessary to develop a rail operations plan and complementary start-up activities schedule. First-year ridership exceeded prerevenue service estimates, and operating costs were below budget. This success reflects the importance Tri-Met assigned to learning as much as possible from properties with experience in light rail operations, and to including all areas of Tri-Met's organization in the development and activation of the start-up plan.

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THE TRI-COUNTY METROPOLITAN TRANSPORTATION District of Oregon (Tri-Met) is the public transportation agency in the Portland region. Tri-Met serves a 725-mi^2 service area in three Oregon counties (Multnomah, Washington, and Clackamas). The service area population is slightly less than 1 million. Tri-Met has a fleet of 550 buses, of which 87 are articulated, and 26 articulated light rail vehicles (LRVs). The LRVs operate on a 15.1-mi rail line between downtown Portland and the City of Gresham, located in east Multnomah County.

Tri-Met was created by the Oregon legislature in 1969 to acquire the assets of the privately owned systems then providing transit service in Portland and its suburbs. It has a seven-member board of directors appointed by the governor. In addition to farebox revenues, Tri-Met is financially supported by a payroll tax levied at the rate of 0.6 percent on all employers' payrolls and self-employed persons in its service area. (There is no sales tax in Oregon.)

The Tri-Met system transports approximately 120,000 originating ("revenue" or "linked") passengers each weekday. About 60 percent of these trips are generated in the more densely populated area of the City of Portland; the remainder is almost all suburban ridership. During the peak hour 411 buses and 22 LRVs (11 two-car trains) are in service. More than 40 percent of the peak hour work trips to the Portland central business district (CBD) are made on Tri-Met.

Portland's light rail transit (LRT) system is the result of a freeway construction controversy that occurred in the mid-1970s. As part of the federal Interstate highway network, the Oregon Department of Transportation (ODOT) had proposed construction of the Mt. Hood Freeway. The name of the proposed freeway was somewhat misleading in that this was actually to be an urban freeway through southeast Portland. The political debate triggered by the freeway proposal resulted in a regional decision to withdraw the freeway proposal and to transfer the funding to a transit-oriented transportation solution. Eventually this produced a $105-million upgrading of a segment of the existing Banfield Freeway (I-84), and the $214-million 15.1-mi LRT system. The LRT system opened on September 5, 1986. It was named MAX, short for Metropolitan Area Express.

MAX has been recognized as a major success from opening day, with average weekday ridership at 20,000 boarding rides (versus a first-year projection of 17,000) and operating and maintenance costs 22 percent below budget for fiscal year 1986–1987. Much of the immediate success of MAX can be attributed to the positive momentum generated by delivering the largest public works project in Oregon's history (the $319-million combined light rail and Banfield freeway widening project) on time and on budget, and by holding an opening weekend celebration, featuring free rides on MAX, that attracted over 150,000 people.

The successful start-up of MAX was really the culmination of more than a decade of planning and coordination. In retracing the history of the project, it becomes obvious that significant lessons were learned in all functional areas of the project (financing, preliminary engineering, construction, etc.). The primary focus of this paper is on the last 2 years before the start of revenue service in September 1986. This 2-year time frame provides an opportunity to critique the most intensive period of rail start-up activity.

PHYSICAL DESCRIPTION AND OPERATING CHARACTERISTICS

MAX extends 15.1 mi in a generally east-west direction between downtown Portland and Gresham. In the Portland city center the line terminates in a three-track offstreet loop just west of 11th Avenue between Morrison and Yamhill streets. Downtown operation on restricted lanes of city streets is on Morrison (westbound) and Yamhill (eastbound) between the 11th Avenue terminus and First Avenue, and on First Avenue between Yamhill and the approach to the Steel Bridge (*1*).

The line crosses the Willamette River on the Steel Bridge, a double-deck lift span, sharing roadway space with vehicular traffic. On the east side of the river the route stretches about 0.7 mi on a restricted portion of Holladay Street to the start of a completely grade-separated 4.9-mi section between the rights-of-way of the Banfield Freeway (I-84) and the Union Pacific Railroad. This section is between Lloyd Center and Gateway stations.

At Gateway the route crosses over the Banfield Freeway, running then in a north-south direction, adjacent to the I-205 connector freeway, for 0.6 mi between Gateway and Burnside Street. The line then resumes its generally east-west alignment in the median strip of East Burnside Street for 5.3 mi between I-205 and 199th Avenue. From this point to the eastern terminus at Cleveland and Eighth in Gresham, the line runs a distance of 2.1 mi on the former right-of-way of the Portland Traction Company.

Traction power at nominal 750 volts dc is transmitted to cars through simple trolley wire (in the downtown area) or catenary (in the outlying sections). Power is supplied by 14 mainline substations plus one at the Ruby Junction Operations Facility. These unmanned substations use transformer-rectifier units to convert 12,000-volt ac power, provided by Pacific Power and Light Company and Portland General Electric Company, to the 750 volts dc required for operation.

On most of the route the line is double-tracked, providing for one-way travel on each track under normal operating conditions. There are two major exceptions. The easternmost segment of the line, the 2.1 mi between Ruby Junction and Gresham Terminal, is a single-track section with a passing track at Gresham City Hall and a second track at the Gresham Terminus. The line also operates on a single track in the downtown area in a loop, using Morrison Street (westbound) and Yamhill Street (eastbound) between First and 11th avenues.

Track gauge is railroad standard, 4 ft 8½ in. (1435 mm). Between the Gresham Terminal and Lloyd Center, 115-lb heat-treated RE rail is laid on wood ties. Between Lloyd Center and the downtown terminus, girder rail is installed in a latex plastic material that holds rails in position, dampens vibration, and mitigates electrical current leakage.

Crossovers between inbound and outbound tracks are provided at intervals to permit operation in both directions on a single track during trackway repairs or service disruptions. Extra track space is available for emergency or special storage of cars at both terminals and at Coliseum, Hollywood, and Gateway stations.

Rail operation is protected by automatic block signal (ABS) systems in two high-speed sections, one between Lloyd Center and Gateway Station, alongside the Banfield Freeway, and the other between Ruby Junction and the Gresham terminus, the single-track section on the former Portland Traction Company right-of-way. In these sections trains are kept separated by operators' visual observations of wayside signals. Trains are stopped in the event of failure to observe signals, employing automatic train stop (ATS) protection. There is also a short signalized section governing the operation over the Steel Bridge with ATS protection.

In the sections of the route along East Burnside Street and Holladay Street, the line is not signalized per se, but operators are governed by street traffic signal indicators at the numerous intersections. LRVs preempt these signals as they approach, which halts cross traffic and permits the LRVs to proceed through the intersections without stopping. Special bar-type signals, located both in advance of and at each intersection, indicate to the operator whether street traffic signals have been preempted, providing sufficient time for stopping in the event of failure to preempt.

In the downtown area, LRVs are governed by traffic signal indicators, and there are no arrangements for preemptions. The only special rail signal is located at the entrance to the 11th Avenue loop; that signal indicates the status of the switches governing access to the three tracks within the terminus loop.

In downtown Portland, LRVs are scheduled to operate at low speeds (15 mph maximum), controlled by street traffic signals. The traffic signals compose the only crossing protection. On Holladay Street and on East Burnside Street, traffic signals control LRV, pedestrian, and automobile traffic flow at crossings. As noted previously, signals are preempted by approaching trains. In the section along the Banfield Freeway, there are no at-grade crossings. At

199th Avenue and at intersections east of it, grade crossings are protected by gates activated by the arrival and passage of trains. There are 10 locations at which gates are installed.

There are 22 station stops in each direction on the line, requiring 38 station platforms or sidewalk loading locations. (There are several island-style platforms that serve both directions of travel.) Stations are of simple design, generally consisting of concrete slab (or sidewalk in the city), a row of shelters, ticket vending and validating machines, information displays, and a hydraulic lift to raise wheelchair passengers from the platform to the level of the LRV floor. Four stations have park-and-ride facilities, providing a total capacity of about 1,600 parking spaces.

Fares are not collected on trains. Ticket vending machines at each station provide tickets for passengers without transfers or monthly passes. Discounted multiple-ride tickets are available in lots of 10; these tickets are individually validated by passengers on the platform before they board the train.

The fare structure is the same for both Tri-Met buses and MAX; fares are transferable between bus and MAX. Fare inspectors check payment receipts or passes to enforce correct fare payment, and issue citations with court authority to anyone without valid proof of fare payment.

The center of operations for MAX is the operations facility located in a four-story building close to the mainline at Ruby Junction (199th Avenue). The building houses the rail operating staff, the control center for rail, and the report facility for train operators. The facility is also the center of maintenance activities for right-of-way track, signals, and electrical systems, as well as for the LRVs.

Yard tracks surround the operating facility, providing storage space for cars not in service and permitting movement of LRVs to and from the mainline and through the shop and carwasher. The facility also has a storeroom for the spare parts and units required for the maintenance of facilities and equipment.

The LRV passenger fleet consists of 26 double-ended, six-axle articulated cars, with four double doors per side. The manufacturer is Bombardier, Inc., employing a design by BN of Belgium. Car specifications are as follows:

Length, 88 ft;
Width, 8 ft 8 in.;
Height, 12 ft 5 in.;
Floor height, 3 ft 2 in.;
Empty weight, 45 tons;
Seats, 76;
Capacity (seated plus standing passengers), 166 (design load);
Wheelchair spaces, 2;

Maximum speed, 55 mi/hr;
Minimum radius curve, 82 ft;
Brakes, dynamic, disc, and magnetic.

MAX is operated as a regional urban and suburban trunk route. Service is provided between approximately 5 a.m. and 1 a.m. 7 days a week. Service frequencies and train lengths (one- or two-car consists) are designed to provide seats for all passengers in any normal 30-min period in the off-peak period on weekdays and all day on Saturdays, Sundays, and holidays. During weekday peak periods, 7 a.m. to 9 a.m. and 4 p.m. to 6 p.m., service is designed for 30-min car loadings not to exceed 166 passengers per car.

On the basis of the above design standards, weekday MAX trains are scheduled every 7 min during peak periods, every 15 min during off-peak periods and until 10:30 p.m., and then every 30 min until 1 a.m. The peak vehicle requirement is 22 LRVs, deployed as 11 two-car consists. (Consists are limited to a maximum of two LRVs because downtown Portland city blocks are only 200 ft long.) On Saturdays, MAX trains run every 15 min until 10:30 p.m., and then half-hourly until 1 a.m. For Sunday or holiday service, MAX trains are scheduled every 15 min until 7:30 p.m., and then half-hourly until 1 a.m. Single-car trains are typically deployed during weekends, but second sections are added if warranted by passenger loads.

The opening of light rail service was accompanied by revised connecting bus services. Changes to the bus network were essential to provide access and connectivity to the rail service to fully realize the benefits of an integrated bus/rail service. Bus routes have been restructured so that buses connect with trains at 17 of the 25 light rail stations. Exclusive multimodal transit facilities (transit centers) have been constructed at Coliseum, Hollywood, Gateway, and Gresham Central stations. Bus/rail connections at other stations are made on the street.

Gateway Station is the most critical point of connection between buses and MAX. Timed-transfer operations occur there, with trains and buses pulsing every 15, 30, or 60 min. Inbound and outbound trains pass at Gateway during the timed-transfer "window" in order to make complete bus/rail meets. Timed-transfer operations are also scheduled at Gresham Central, 188th Avenue, 122nd Avenue, and Hollywood stations, particularly during periods of long headway operation. Trains are also scheduled for night and Sunday/holiday downtown meets.

RAIL OPERATIONS PLAN

One of Tri-Met's goals is to operate MAX safely, reliably, and efficiently and to integrate the rail line's operation with bus services for the greatest convenience to the public. The rail operations plan is designed to further this goal by providing information and by documenting procedures and policies necessary to activate and operate the light rail line in the safest, most reliable manner.

Formal development of the rail operations plan began in fall 1985, approximately 1 year prior to start-up. However, the first efforts directed towards conceptualization of the plan date back to 1980, when estimates for staffing plans, operating plans, and operating budgets were developed by a joint venture team of Parsons Brinckerhoff Quade & Douglas, Inc., and Louis T. Klauder & Associates (PB/LTK). Tri-Met began recruiting key rail operations staff then as well.

There was a transitional component to staffing and recruiting for the various phases of the overall light rail project. As the project shifted from planning to preliminary engineering, continuity was maintained by including some of the planners on the newly formed in-house engineering team. Specific technical expertise needs were addressed either by hiring outside talent or through consulting contracts. This strategy built a strongly qualified engineering team, yet maintained the needed links to both the history of the project and Tri-Met in general. Likewise, the same type of transitional staffing efforts followed as the project enlarged in scope to include final design, construction, and operational readiness elements.

In developing the rail start-up organization, Tri-Met's executive management placed top priority on defining the rail operations organizational structure. After various organizational structures from other transit systems with bus and rail modes had been reviewed and analyzed, separate departments for rail transportation and rail maintenance were created in Tri-Met's operations division. With this decision in place, executive management recruited the two key rail operations directors (one promoted internally and one hired from the outside, reflecting a balanced strategy) almost 5 years before actual start-up. Thus, the rail transportation and rail maintenance directors participated in the engineering team's planning and design efforts.

With the engineering project staff working closely with rail operations management, executive management addressed the issue of how to coordinate and prepare the entire agency for start-up. Again, various rail start-up organizational alternatives were reviewed and analyzed; ultimately it was decided to create an interdisciplinary rail operations start-up team. The core of this team was a small group of Tri-Met staff from planning and operations, plus two on-site consultants provided through a rail operations readiness contract with the firm of ATE, Inc. This start-up core team had three key aspects. First, the team members were fully reassigned to lead the start-up effort. Second, the two rail directors were not on the core team in recognition of the greater need for them to continue working closely with engineering.

Third, the core-team leader was formally recognized and authorized by executive management by creation of a director of rail start-up position.

The rail start-up core team was charged with developing the rail operations plan and a complementary start-up activities schedule. Addressing the need for thorough coordination throughout the entire agency, the core team identified 14 different functional areas related to start-up as shown below:

- Rail transportation;
- Rail maintenance;
- Safety;
- Security;
- Fare collection and structure;
- Hiring and staffing;
- Information systems;
- Financial forecasting;
- Rail budget development and cost control;
- Marketing and customer services;
- Press, political affairs, and community relations;
- Bus operations;
- Service design; and
- Handicapped access.

Each functional task area was assigned an appropriate task manager, who was responsible for developing the plan and schedule for that particular function. Through a series of weekly coordinating sessions, with all task managers present, the operations plan was refined and revised as necessary, until all task plans were consistent and coordinated.

The formation of a start-up team and the requirement to develop a detailed start-up plan not only provided a working structure for the large coordinating task, but also aided the transition of rail transportation and rail maintenance functions into operating departments. Staffing plans, operating plans, and operating budgets were all reviewed and updated from the preliminary estimates prepared in 1980 by PB/LTK (2). Tables 1 and 2 include PB/LTK's 1980 estimates of light rail operating statistics and costs.

Many of the important elements of the staffing and operating plans, such as the operator's rule book, maintenance rule book, standard operating procedures, training programs, and supplemental agreement to the existing labor contract, were being developed before the start-up plan was commissioned. However, with the additional resources dedicated in the form of a start-up team, it was possible to expedite individual efforts and place them into a cohesive framework. It was particularly advantageous to assign the experienced rail start-up professionals (the two ATE consultants) specifically to the rail transportation and rail maintenance directors.

TABLE 1 MAX LIGHT RAIL OPERATING STATISTICS COMPARISON

Operating Statistic	PB/LTK Estimate 1980	Tri-Met Estimate 1986	Tri-Met Actual 1987[a]
Annual boarding rides (millions)	9.2	4.1–4.9	7.2
Park-and-ride spaces	2,043	1,602	1,602
LRVs	26	26	26
Speed (mph)	19.6	17.1	15.5
Annual car miles (millions)	1.415	1.038	1.286
Annual car hours	72,000	60,000	89,000
Car hours/train hours	1.48	1.32	1.72
Staff			
LRV operators	32	34	34
Other transp/fare inspection	26	20.5	20.5
Vehicle maint/stores	28	26	26
ROW maintenance	23	25.5	25.5
Total staff	109	106	106

[a]September 1986 to August 1987.

TABLE 2 MAX LIGHT RAIL COST ESTIMATE COMPARISON

Annual Operating Costs	PB/LTK Estimate 1980	Tri-Met Estimate 1986	Tri-Met Actual 1987[a]
Rail transportation	3.002	2.085	1.894
Rail maintenance	3.626	3.144	2.558
Electrical power	1.331	0.840	0.567
Insurance & claims	0.167	0.168	0.092
General & administrative	0[b]	0.987	0.889
Estimated annual cost	8.126	7.224	–
Actual annual cost	–	–	6.000
Cost/car mile ($)	5.74	6.96	4.67

NOTE: All operating costs are in millions of 1987 dollars.
[a]September 1986 to August 1987.
[b]G&A costs included in rail transportation and maintenance figures.

In recognition of the importance of the peer review process, the rail operations plan called for continuing and intensifying the process initiated with the first peer review held in September 1984. Thus, additional peer reviews were held in February and August 1986 (1 month before start-up). Also, at Tri-Met's request, a system safety review was conducted by the American Public Transit Association's Rail Safety Review Board. All of the peer reviews provided excellent recommendations to improve Tri-Met's LRT system.

As it was being developed, the rail operations plan represented a vision of what the end product should be, namely a safe, reliable, efficient, and integrated light rail line. The companion volume to the rail operations plan, the start-up activities schedule, represented the process for achieving the goals enumerated in the plan.

START-UP ACTIVITIES SCHEDULE

The purpose of the start-up activities schedule was to summarize the sequence and timing of all activities required to establish revenue service on the target date, September 5, 1986. The schedule was actually a series of separate schedules that described the event sequence and deadline dates for each of the 14 task areas identified in the rail operations plan.

The first set of activity schedules was issued in December 1985, concurrent with the production of the second monthly progress report on the start-up effort. Each subsequent month, a new set of schedules, updated and reflecting progress made, was issued together with the monthly progress report up until the September 1986 start-up date.

In selecting a format and methodology for the activities schedule, various computerized and manual systems were analyzed. Ultimately, the start-up core team chose to use a simple manual tracking chart of a simple matrix design, with rows identifying tasks and subtasks, and columns denoting time in monthly gradations. This approach was selected because it maintained continuity and familiarity by replicating the engineering activities scheduling system, and maximized the simplicity and comprehensibility of the project scheduling system, particularly for nontechnical team members.

The core team was also concerned that team members might think that a detailed automated project scheduling system would obviate the need for oral project communication. Thus, the strategy was to foster open, face-to-face communication, in part, through the weekly coordinating meetings, and to position the easy-to-use activities schedules as supporting documents, useful for task monitoring and accountability purposes.

In many functional task areas the individual activities schedules were fairly straightforward and almost perfunctory in nature. However, there was one critically important start-up task that benefited from the development of activities schedules: the rail operations recruitment and training program. By graphically identifying subtask time requirements for recruiting, testing, training, and appointing different classifications of operating personnel, it was possible to develop a comprehensive, incremental schedule for staffing rail operations. The incremental schedule was then adjusted periodically to match the engineering staff's updated construction and equipment testing schedules, so that operating staff appointments coincided with the availability of equipment and facilities for training purposes.

Based upon the results of the supplemental working and wage agreement relating to light rail operation negotiated with union representatives, preference was given to qualified Tri-Met employees when filling positions for LRT operations and maintenance. The agreement also stipulated that all normal work would be performed by Tri-Met employees. Outside contractors could only be used for emergency repairs, unanticipated work overloads, and specialized heavy-duty maintenance for which Tri-Met does not have the necessary equipment.

For the rail transportation department, this meant that the rail controller and supervisor positions would be appointed according to seniority from the ranks of qualified bus supervisors. Similarly, light rail operators would be appointed according to seniority from the ranks of qualified bus operators.

The process for appointing rail controller/supervisors and operators was very thorough. It included personnel file reviews (with acceptable performance levels identified), written examinations of the rail operator's rulebook, medical examinations, and, after acceptance into the training program, daily written examinations and quizzes. Even with this relatively straightforward approach to staffing and training, various complexities surfaced, including coordinating replacement supervisors and operators for bus operations, separating total staffing complements into subgroups for effectively sized training classes, and rescheduling tasks based on replacement candidates' availability.

The rail maintenance department was organized into two sections: vehicle maintenance and right-of-way maintenance. For the vehicle maintenance section, foreman, LRV mechanic, and fare/lift equipment maintainer positions were appointed according to seniority from the ranks of qualified bus maintenance employees. The same agreement was in place for staffing the right-of-way section, which led to the appointment of rail right-of-way maintainers and cleaners from the bus maintenance building and grounds section. However, for the various skilled right-of-way labor positions (power maintainers, signal maintainers, etc.), in-house, qualified candidates were few. Thus external recruitment was required. Also, in some cases, qualified applicants were transferred from the Banfield Light Rail Project engineering department to the rail right-of-way maintenance section. The development and use of a simple, flexible activity schedule for coordinating and tracking the complexities of staffing the rail transportation and rail maintenance departments were quite helpful.

COST ESTIMATES AND RESULTS

Tri-Met's light rail operating cost estimates originated with the work performed in 1980 by the joint venture of Parsons Brinckerhoff Quade & Douglas, Inc., and Louis T. Klauder & Associates (PB/LTK). These cost estimates were documented in their Phase II report (2). The report was one of 11 technical reports that dealt with specific elements of the project.

Tables 1 and 2 compare 1980 estimates of operating statistics and costs with Tri-Met's 1986 estimates and actual results for 1987. PB/LTK's cost figures were originally calculated using 1978 dollars, then factored up to 1980 dollars using an 8 percent annual rate. For comparative purposes, these costs have been factored back to 1978 dollars and then multiplied by the actual annual change in the U.S. Consumer Price Index to determine equivalent costs in 1987 dollars.

PB/LTK's cost estimates were developed from an operating scenario that estimated first-year ridership of 9.2 million boarding rides. (This represented a level of service about one-third higher than the revised May 1986 Tri-Met estimate.) Based upon this service level, PB/LTK determined staffing and materials requirements.

Staffing estimates were based upon the organizational structures of other transit properties and Tri-Met's labor practices and productivity rates. Staffing assumptions were considered adequate for regular maintenance activities, with some contracting for specialized, heavy maintenance activities (track rebuilding, rail grinding, etc.). Power costs were based upon private utility company rate structures. PB/LTK estimated annual light rail operating and maintenance costs of approximately $8.2 million and assumed no increase in bus operations or administrative costs. A rail operations staff of 109 was estimated to be required to provide 1.415 million annual car miles of service.

Beginning in autumn 1985, Tri-Met tried to refine PB/LTK's original estimates and assumptions. Numerous iterations resulted in May 1986 estimates that included a staff of 106 providing 1.038 million car miles of service. The first-year ridership estimate was substantially reduced to a range of 4.1 million to 4.9 million boarding rides. The 1986 Tri-Met annual operating and maintenance cost estimate was 11 percent lower than the 1980 PB/LTK estimate. The estimated operations and maintenance cost per car mile is $6.96, compared with PB/LTK's estimate of $5.74, because Tri-Met reduced PB/LTK estimated operating speed by 2.5 mph (to 17.1 mph). The fairly sharp changes between the PB/LTK estimates and the Tri-Met figures are due primarily to the 6 years that elapsed between the two sets of assumptions underlying the estimates. Prior to 1986, Tri-Met developed several updates to PB/LTK's 1980 cost estimates; however, until the start-up coordination team was in place, in-house efforts to update operating assumptions and cost estimates were difficult.

First-year actual results (September 1986 to August 1987) reflect the higher-than-anticipated ridership level, as well as the additional car hours of service required to support this ridership level. The car-hour/train-hour ratio is higher than previous estimates, reflecting the need to operate more two-car consists as ridership levels warrant. The operating speed is considerably less than expected, due to slower-than-planned operating speeds along Holladay Street and the downtown Portland alignment.

First-year costs are $1.2 million below the Tri-Met 1986 estimate, because actual power and maintenance costs were significantly under budget. Power costs are expected to remain relatively stable at this favorable rate over the next few years. However, rail maintenance costs are expected to increase gradually in the next 2 years as the system ages and as warranty agreements expire, necessitating additional in-house labor resources. Beyond the 2-year mark, rail maintenance costs should remain stable.

SUMMARY

A successful light rail start-up project requires a strong commitment from executive management to create a start-up core team by contracting with experienced start-up consultants and fully reassigning key staff, and to support the leader of the team by conferring both the authority and resources required by the project.

A comprehensive rail operations plan and a complementary start-up activities schedule are essential project control documents. The primary purpose of producing and regularly revising these documents is to provide start-up team members with reference materials during weekly and daily communication and coordination meetings.

The large scope of a rail start-up project requires that considerable energies be focused towards resolving a myriad of detailed issues. To keep the overall project priorities in place and continuously synchronized, it may be useful to develop a start-up summary checklist. This checklist, or set of guidelines, can be drawn from lessons learned and experience gained by other properties' rail start-ups. An excellent method to assist in developing a property-specific set of guidelines is to conduct peer reviews at regular intervals.

REFERENCES

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