DRAFT

100 Percent Report

Crater Lake Transportation Study

August 1989

Sno-engineering, Inc.

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Prepared For:

National Park Service

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I. INTRODUCTION

Sno-engineering, Inc. of Bellevue, Washington and TDA, Inc. of Seattle, Washington have been retained by the National Park Service - Denver Service Center (NPS) to study alternative transportation systems for implementation at Crater Lake National Park. The desire to remove vehicular traffic from the Rim Village, in conjunction with a new Activity Center/Hotel and other planned improvements, is the major catalyst for this study. Through the removal of automobiles with their attendant traffic, noise, and pollution, the Village Rim area will be restored to a more natural, leisurely, pedestrian environment.

Crater Lake National Park has witnessed diminished visitation over the last decade. According to NPS visitor data (1976-1988), Crater Lake experienced peak use during 1977 when 617,000 people visited the park. Since reaching this crest, use has gradually tapered off. While the National Park system has seen an average annual growth rate of 3.8 percent from 1980 to 1987, Crater Lake has received a nominal increase of 0.025 percent per annum during this period. When comparing historical visitation at Crater Lake with all parks in the Pacific Northwest Region, it is evident that the average annual growth rates between 1981 and 1987 were -1.4 percent and 1.5 percent respectively. The recent closure of the Crater Lake Lodge, due to structural problems, will undoubtably also have ramifications on visitor use. It is anticipated that the development of year-round overnight lodging accommodations, enhanced visitor facilities, and restoration of the Rim Village will sponsor renewed interest in visiting the park, thereby reversing the past declines in visitation. Accordingly, a transportation system must be capable of accommodating existing visitation levels and future growth.

Crater Lake National Park currently receives approximately 5,000 visitors per day during peak summer periods and about 600 visitors per day at peak occasions in the winter. This and other information, such as traffic counts, user surveys, and general observations, have been provided by the NPS. However, no data has been provided on actual parking accumulation counts during peak summer and winter periods. Accordingly, parking estimates have been derived from park management observations as well as analysis of traffic count data.

In March of 1989, Sno-engineering, Inc. and TDA, Inc. submitted a Technical Memorandum representing the fifty percent completion stage of the Crater Lake Transportation Study (Contract No. CX-2000-4-0025, Work Directive 12, Modification No. 10). Eight alternative transportation systems were studied in the first phase, including shuttle bus, covered walkway, covered moving sidewalk, covered walkway to tunnel with moving sidewalk and elevator, funicular railway (elevated or in tunnel), aerial gondola, people mover/monorail (elevated or in tunnel), and aerial tramway (Appendix A). Based upon the recommendations contained in the fifty percent report, the

National Park Service formulated six alternatives for consideration in this hundred percent phase report. These alternatives included the aerial gondola, elevated funicular railway, and three shuttle bus options, in addition to an option whereby all parking would be provided at the Crater Rim through the construction of a parking structure, and no additional transportation system would be required.

This is a draft 100 percent report. It has the same limitations of parking and visitation data that existed in the 50 percent technical memorandum. Upcoming field counts (planned for August 1989) will provide new information on peak parking requirements and vehicle mix.

II. GOALS AND OBJECTIVES

The goal of providing a transportation system linking a remote parking area and the Rim Village is to reduce the amount of vehicular traffic near the Crater Rim and to provide a more natural, leisurely, pedestrian environment for site visitors. A number of surveys have identified visitor priorities at Crater Lake National Park. Visitors have ranked two NPS development goals consistently higher than others. The most frequently identified objective is that of minimizing environmental impacts to the Crater Lake ecosystem, followed by efforts to reduce visual intrusions and congestion in the vicinity of the Rim Village. These visitor choices generally support NPS plans to return the Rim Village area to a more natural, less cluttered state. The selection and design of a transportation system between the proposed lower parking lot and the new Activity Center/Hotel must take these public concerns into account, along with other environmental and operational issues identified by the NPS.

III. PLANNING CONSIDERATIONS AND DESIGN GUIDELINES

In recognition of the aforementioned goals and objectives, the following planning considerations have been identified. In addition, these considerations have led to the development of recommended design guidelines for the proposed transportation system.

A. Site Characteristics

The slope which separates the remote parking lot from the new Activity Center/Hotel (Scheme C) covers a vertical rise of 75 feet over a distance of 750 lineal feet, as shown in Figure 1. Slope gradients range from almost flat to between 35 and 40 percent, with an average overall gradient of ten percent. Below the 7,050 foot elevation the slope is nearly flat. Above this elevation, average slopes increase to approximately eighteen percent.

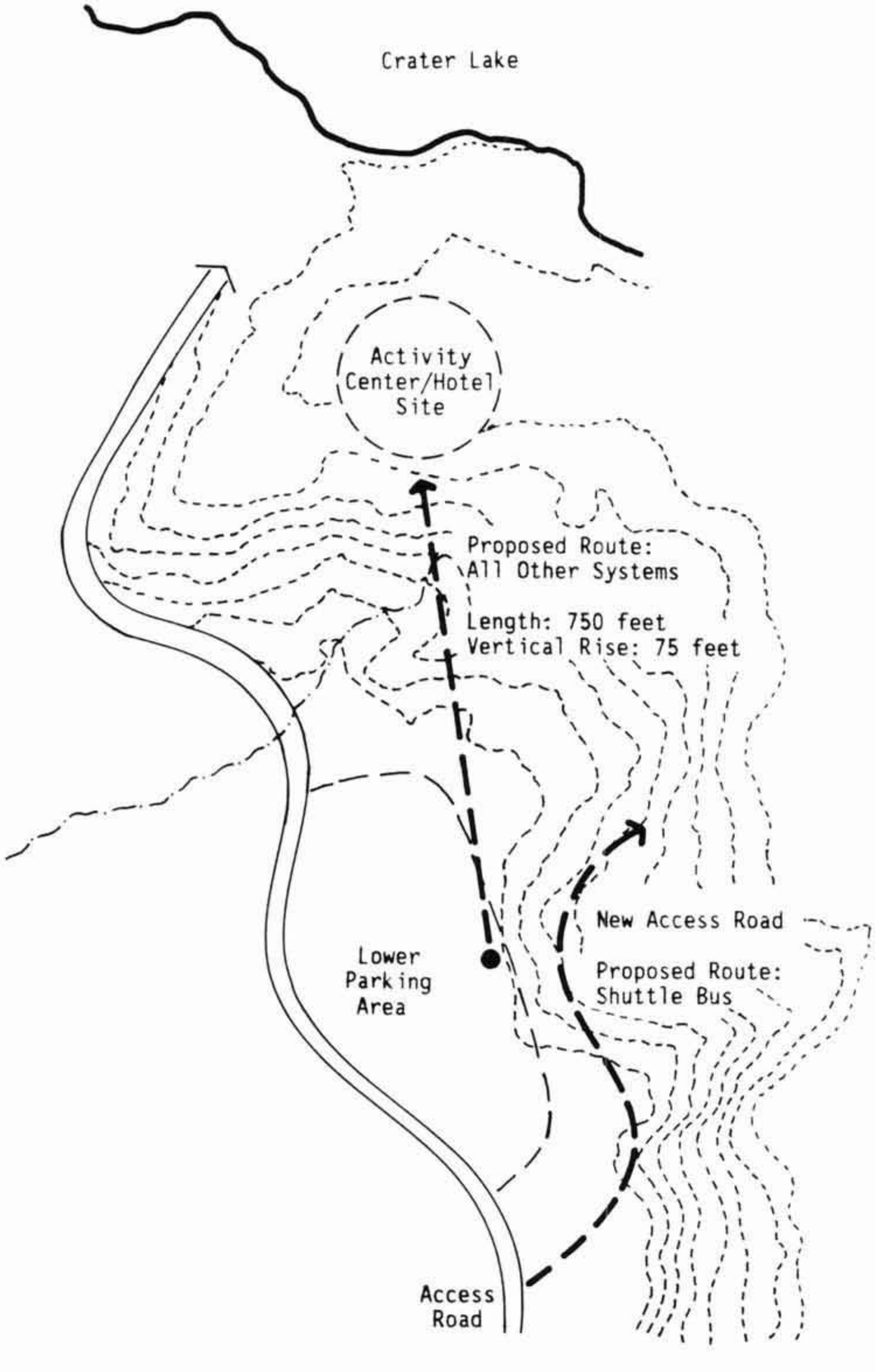

Figure 1. Location of alternative transportation systems linking the lower parking lot and Activity Center/Hotel.

The hill is primarily covered with stands of coniferous trees, consisting mainly of Mountain Hemlock. Several natural openings also occur in this area, which are largely devoid of vegetation. Severe climatic conditions coupled with volcanic soil types result in a short growing season. For this reason, disturbed areas are slow to regenerate, and care should be taken to preserve existing site vegetation. Maximum snow depths of up to fifteen feet have been recorded in this area, with severe drifting on the lee side of tree clusters and existing structures.

A small drainage with its source at the 7,080 foot elevation supports intermittent flows. This drainage runs in a southwesterly direction, crossing the existing road at the 7,050 foot elevation. A minor ridgeline, located southeast of the small drainage, causes an undulation in the terrain between the lower parking area and the Activity Center/Hotel site. This topographic feature is illustrated in Figure 2, a slope profile of the alignment between the lower parking area and the Activity Center/Hotel. This profile is a useful tool in determining impacts associated with different transportation systems. The south facing slope is fully exposed to the prevailing winter winds.

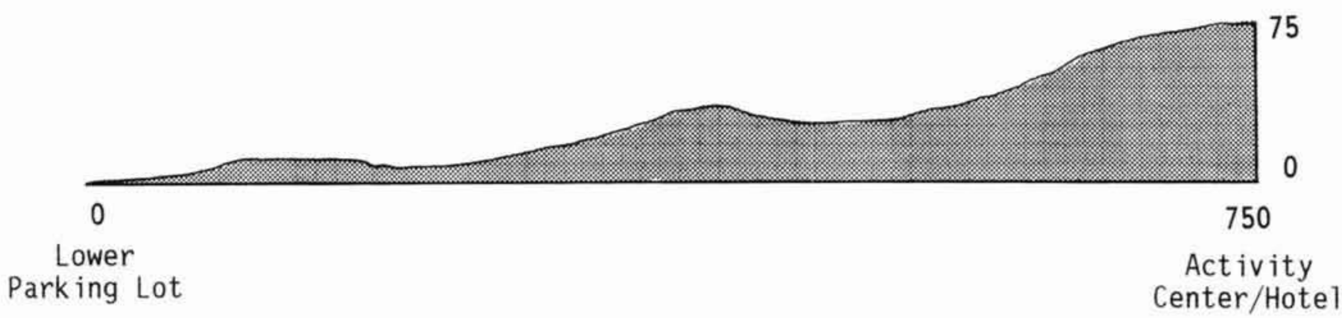

Figure 2. Representative slope profile between lower parking area and Activity Center/Hotel.

B. Sense of Arrival and Park Service Presence

The siting and relationships of the parking, transportation system, and Activity Center/Hotel should combine to create a clear entry sequence and sense of arrival. This consideration will be important in the design of both the upper and lower terminals of the transportation system and/or the placement of parking areas. If alternative transportation routes are available (i.e., walking and riding), the choice between the two routes should be clear both in the lower parking area and at the Rim Village, with both transportation choices designed to provide a sense of arrival. In addition, the transportation system should not conflict with park operations or visitor activities on a year-round basis.

C. Cohesive Architectural Character

The architectural style chosen for the new Activity Center/Hotel is described as Mountain Cascade. The design and sizing of terminal buildings and selection of materials for use in the transportation system must be compatible with this architectural theme.

D. Views

Views both to and from the transportation system must be considered. The system should not contribute to a sense of visual "clutter" from the access road, parking area, Activity Center/Hotel, or Rim Village open spaces. As an example, the lower parking lot was relocated in order to prevent negative visual impacts from Garfield Peak. Conversely, opportunities to view the Lake and surrounding environment while moving between the parking and Rim Village should be considered in the siting and selection of a transportation system.

E. User Appeal

In order to function successfully, the parking and transportation system must be appealing to visitors. The relative attractiveness of the system is a function of location, novelty, convenience, speed (trip length and frequency), comfort, station design, and cost to the user. Unpleasant odors, loud noises, and other system characteristics may have a strong negative influence on visitor perceptions of any alternative transportation mode.

F. Ease of Access

The siting and design of the transportation system must provide for handicapped access. This consideration will influence the location of dedicated parking spaces both in the lower parking area and at the Activity Center/Hotel, depending on seasonal operating characteristics of the transportation system. Additionally, the system should be designed for easy access for all users, both to facilitate rapid loading during the high-volume summer season, and so that visitors can save their energy for enjoyment of the Rim Village. Surveys have shown that the average age of visitors is 45 years, with roughly a third of all visitors being between the ages of 26 and 40. While this is a typically mobile population, three quarters of all visitors arrive in family groups which may include young children or older adults. Children under ten and adults over the age of 65 each represent approximately thirteen percent of all visitors to Crater Lake, and may have special needs. In addition, almost half of all visitors arrive in groups of two, with over a third travelling in groups of three or four. The ease with which a system can accommodate groups of this size should also be a consideration.

G. System Capacity and Operational Considerations

The transportation system, including waiting areas, terminals, and conveyances, must be able to handle high volumes and high turnover rates during the busy summer months. In addition, consideration should be given to operation of the system during the winter season when lower visitation is experienced at Crater Lake. Coordination between the provision of covered parking at the Activity Center/Hotel and winter operation of the transportation system will be necessary. In addition, the system should be designed to accommodate future capacity upgrades if visitation increases. Reliability of the system, ease of maintenance, energy consumption, impact on air quality, and staffing requirements are all long-term operational considerations in the selection and design of the transportation system. Relative operational and maintenance life-cycle costs are also important elements in the selection process.

H. Implementation Considerations

Capital costs for implementation should be taken into account, including any special considerations which may lead to increased difficulty in construction or initial operation of the system.

IV. VISITATION ANALYSIS

Recently authorized additional work will provide current summer counts of parking accumulations and vehicle mix (cars, trucks, RV's, trailers). These counts will be done in August of 1989. The results may modify the visitation estimates provided in this section. For this draft report, this section contains the same information as that in the 50 percent technical memorandum.

A. Existing Conditions

Visitation patterns described below are based upon total visits to Crater Lake, including both recreational and non-recreational visitors.

1. Seasonal Patterns

As would be expected, the visitation patterns for Crater Lake National Park are highly seasonal. Nearly half of the year's visitation occurs in the peak months of July and August, as illustrated in Figure 3 below.

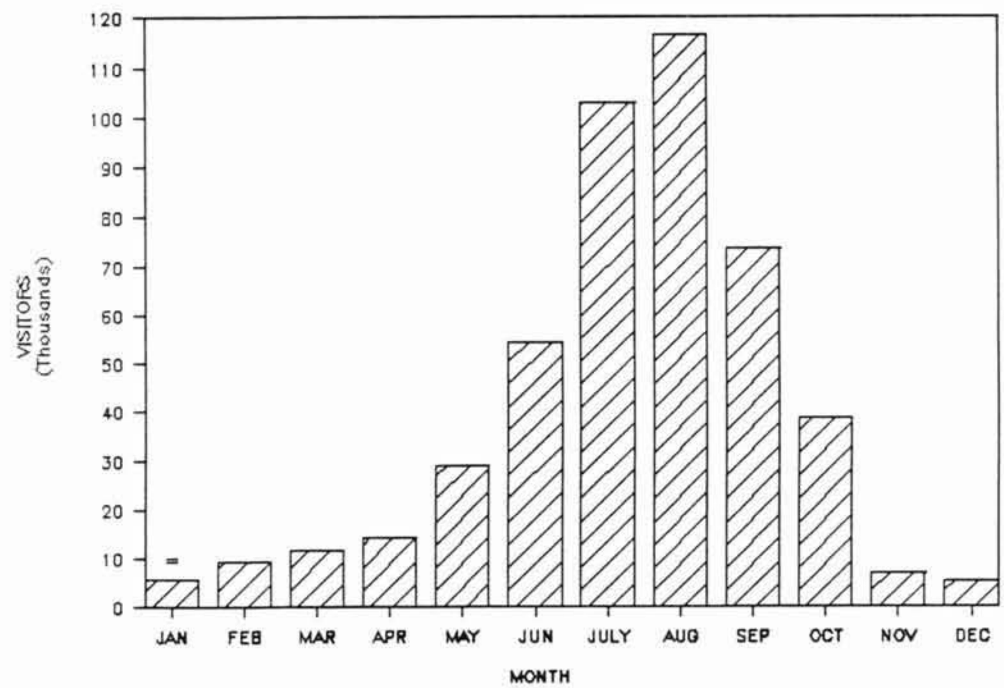

Figure 3. 1988 visitation figures for Crater Lake National Park by month.

2. Daily Patterns

Figure 4, illustrates visitation patterns for a typical week in August. During this peak month, visitation is high every day of the week, with slightly higher peaks on weekends. As shown in Figure 5 (a typical week in February), weekend peaks are more pronounced during the winter than during the summer peak period.

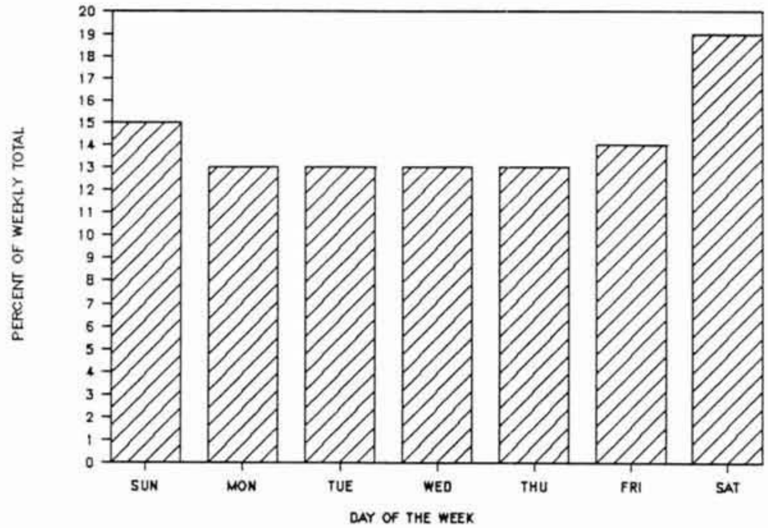

Figure 4. Typical summer season daily visitation patterns at Crater Lake.

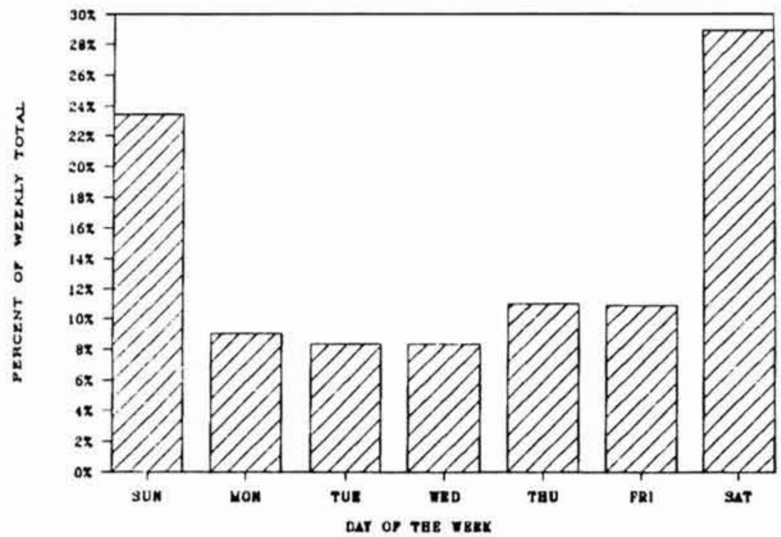

Figure 5. Typical winter season daily visitation patterns at Crater Lake.

3. Hourly Patterns

Figure 6 illustrates the hourly patterns of visitation for a weekend day in August. About two-thirds of site visitors arrive within the five hour period between 10 a.m. and 3 p.m. Figure 7 illustrates hourly patterns for a weekend day in February. As in the summer season, most winter visitors arrive during a five hour peak period.

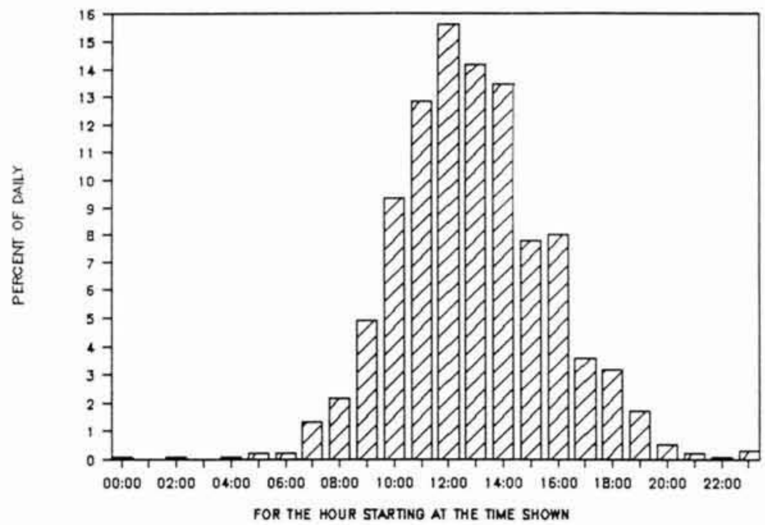

Figure 6. Typical summer season hourly visitation patterns at Crater Lake.

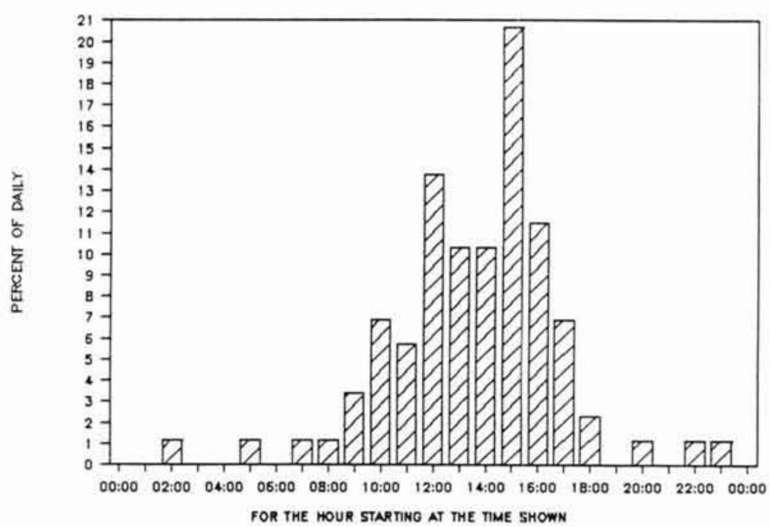

Figure 7. Typical winter season hourly visitation patterns at Crater Lake.

B. Historical Trends in Visitation Levels

Annual visitation to Crater Lake National Park has been dropping. Since 1976, it has declined at an average annual rate of almost two percent per year. This trend is contrary to other National Park visitation patterns, as shown in Figure 8. For example, overall visitation to the National Park system has been up nearly four percent per year in the 1980-1987 period. In the Pacific Northwest region, visitation has increased by 1.5 percent per year during the same period.

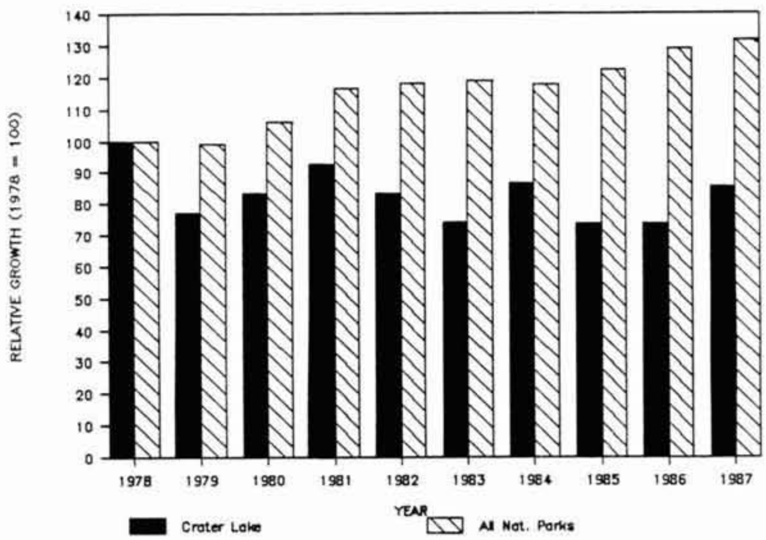

Figure 8. Comparison of visitation at Crater Lake National Park and all National Parks between 1978 and 1987.

C. Projected Visitation Conditions

For purposes of this analysis, it is assumed that the improvements to the facilities at Crater Lake National Park will allow the park to regain the visitation it has lost over the last decade and to experience a net increase due to construction of the Activity Center/Hotel. Specifically, it is assumed that visitation from 1988 levels will increase at almost two percent per year through 1999. The result of these assumptions is that peak day visitation in summer will increase by 24 percent between now and 1999 and winter visitation will increase by 42 percent, due to the greater increase in winter services associated with the new Activity Center/Hotel.

V. OPERATIONAL REQUIREMENTS

This section provides information on the performance requirements for the proposed transportation systems.

A. Frequency of Service

The required hours of operation for the transportation system will depend upon the amount of parking provided at the Crater Rim on a seasonal basis. In general, regular scheduled service should provide for about 95 percent of visitors. This will require a ten to twelve hour service day. Some on-demand service may be needed outside these hours, to meet the needs of hotel and lodge guests under alternatives which provide no Rim parking. Section VI will describe specific hours of operation for each of the five alternatives.

During peak use periods, the frequency of scheduled service will be determined by the capacity requirements. During the remaining hours of the year, "on-demand" service will be sufficient to meet visitors needs. Less frequent scheduled service would be perceived as unacceptable to visitors for this short distance.

B. System Capacity

Table 1 shows the total parking and transportation system requirements, based upon 1988 conditions. This information was derived from the available hourly traffic counts which indicated time patterns of arrivals and departures, and from an estimated total parking capacity in the summer of 450 public spaces in addition to 54 employee spaces. This information will be updated as a result of August 1989 field counts. The winter figures were derived from known winter park attendance, and daily and hourly patterns from the available traffic counts.

For 1988, a capacity of about 900 persons per hour in each direction would be required during the summer months. In the winter, the requirement for system capacity drops to about 150 passengers per hour, one direction on a peak day.

Table 2 provides a summary of travel and parking demand information projected to the year 1999. Under these conditions, the capacity of the transportation system would increase to about 1,100 passengers per hour one-way in the summer, and 200 passengers one-way in the winter. These projected demands were forced to meet a limit of about 500 parked cars and 30 recreational vehicles.

TABLE 1. SUMMARY OF EXISTING RIM VILLAGE TRAVEL AND PARKING DEMANDS

	SUMMER	WINTER
DAILY VISITATION, PEAK		
Persons	4850	600
Mean Duration, hrs.	2.25	2.0
ARRIVALS, PEAK HOUR		
Persons	757	94
Vehicles	242	30
Avg. Veh. Occup.	3.1	3.1
DEPARTURES, PEAK HOUR		
Persons	686	120
Vehicles	219	39
Avg. Veh. Occup.	3.1	3.1
PARKED VEH., MAX. ACCUM.		
Visitor Automobiles	382	46
Visitor Large Vehicles	68	8
Employee Vehicles	50	8
Total	500	62
TRANSP. SYSTEM DEMAND, PERSONS/HR		
% of Arriv.	80%	80%
Arrivals	606	75
% of Depart.	70%	80%
Departures	480	96
TRANSP. SYSTEM CAPACITY, PERSONS/HR		
Percent of demand	150%	150%
Capacity	908	144

Source: TDA Inc.

Note: Employee traffic volumes are small and are not included in these calculations.

TABLE 2. SUMMARY OF PROJECTED 1999 RIM VILLAGE TRAVEL AND PARKING DEMANDS

SUMMARY OF PROJECTED TRAVEL and PARKING DEMANDS -- 1999 (rev)
(FORCED TO A MAX. PARKING OF 500 AUTOS, 30 RV's)

	SUMMER	WINTER
DAILY VISITATION, PEAK		
Persons	5400	850
Mean Duration, hrs.	2.25	2.0
ARRIVALS, PEAK HOUR		
Persons	843	132
Vehicles	269	42
Avg. Veh. Occup.	3.1	3.1
DEPARTURES, PEAK HOUR		
Persons	764	171
Vehicles	245	55
Avg. Veh. Occup.	3.1	3.1
PARKED VEH., MAX. ACCUM.		
Visitor Automobiles	425	66
Visitor Large Vehicles	30	5
Employee Vehicles	74	41
Total	529	112
TRANSP. SYSTEM DEMAND, PERSONS/HR		
% of Arrivals	80%	100%
Arrivals	674	132
% of Departures	70%	100%
Departures	535	171
TRANSP. SYSTEM CAPACITY, PERSONS/HR		
Percent of demand	150%	150%
Capacity	1012	257

Source: TDA Inc.

Note: Employee traffic volumes are small and are not included in these calculations.

VI. TRANSPORTATION AND PARKING ALTERNATIVES

A. Description of Alternatives

Six alternatives have been selected for final consideration. The following matrix outlines the basic components of each transportation and parking alternative.

TABLE 3. OUTLINE OF PARKING AND TRANSPORTATION ALTERNATIVES

	Lower Parking Area		Activity Center/Hotel		Crater Lake Lodge	Transportation
Alt.	Structure	Surface	Structure	Surface	Surface	System
1.	120	380	0	0	0	year-round shuttle bus
2a.	120	280	0	0	100	elevated funicular railway
2b.	120	280	0	0	100	aerial gondola
3.	0	280	60	60	100	summer/shoulder shuttle bus
4.	0	280	120	0	100	summer/shoulder shuttle bus
5.	0	0	400	0	100	none

All alternatives will also include a pedestrian pathway from the lower parking lot to the Activity Center/Hotel. It is expected that during the summer months, many visitors will use this as a preferred means of accessing the Crater Rim, as only a short walk is required.

1. Alternative 1: Shuttle Bus With No Rim Parking

The first alternative prohibits all parking on the Crater Rim. No parking would be provided at either Crater Lake Lodge or the new Activity Center/Hotel. All parking would be located in the lower lot, with year-round shuttle bus access to both the Activity Center/Hotel and the Lodge. Regularly scheduled service would be provided to the Activity Center/Hotel, with a separate on-call van serving Lodge guests. Surface parking for 380 cars would be provided, along with a 120 space parking structure for use during the winter months. In addition, thirty recreational vehicle spaces will be provided in the lower parking lot.

Bus vehicles could range from small twelve to twenty passenger vans to larger transit coaches. For their advantage of reliability and long-term maintainability, transit quality coaches should be used in this application. A single thirty passenger coach would provide adequate capacity for most of the year, with additional buses required during the summer months. Typically, the coaches would be diesel powered. However, because of odor problems, and the desire to maintain high air quality standards, alternative fuels such as methanol, propane, or liquified natural gas could be considered. Limited fixed facilities for bus service would be required . The upper terminal for buses would be incorporated in the porte-cochere of the hotel. One or more small terminals would be required in the lower parking lot. Maintenance can be handled elsewhere at a location to be determined. Covered winter storage for the buses would probably be required. For purposes of the comparison of alternatives, these facilities were assumed to be located in the vicinity of Mazama campground.

Figure 9. Typical shuttle bus system.

2a. Elevated Funicular Railway

Unlike Alternative 1, this alternative provides some parking on the Crater Rim. Rim parking would be limited to 100 spaces for overnight guests at Crater Lake Lodge. No parking would be provided at the new Activity Center/Hotel. In the lower parking lot, 280 surface spaces would be provided, along with a 120 space parking structure for use during the winter months. In addition, thirty recreational vehicle spaces will be provided in the lower lot. Year-round transportation to the Activity Center/Hotel would be provided exclusively by an elevated funicular railway from the lower parking lot.

A funicular railway consists of two trains running in a "jig-back" configuration on a single pair of rails, guided by a single cable or haul rope. At the halfway point, a double track is provided to allow the trains to pass. The trains are typically divided into several cars, and can accommodate wheelchairs and either seated or standing passengers. Capacity is a function of the number and size of cars in each train and the speed of the haul rope. Since the funicular runs on an inclined plane, the floors are designed to maintain a horizontal position. The funicular can be run on an at grade, elevated or underground rail system. A straight route is preferred, and abrupt or extreme changes in gradient must be avoided. For this reason, an elevated funicular does not typically follow the natural contours of the site. In fact, a convex curvature of the track is required to keep the haul rope in the proper position. Use of an elevated track would necessitate making an allowance for maximum snow pack and clearance. Accordingly, the track would be elevated twenty to twenty-five feet above the ground. As in any elevated structure, the supports must be designed to accommodate snow creep. A funicular system could be designed to accommodate future increases in capacity through the use of larger cars.

There would be no major technical problems associated with implementation of a funicular system. Funiculars have been in continuous operation in many alpine settings throughout Europe since the turn of the century. No known systems are currently operating in North America. However, a number of lift manufacturers with offices in the United States have the expertise to design and install funiculars. These fully automated systems have been found to be extremely reliable and are able to operate in all weather conditions.

Based upon the volume and patterns of site visitation at Crater Lake, a design capacity of 1,000 people per hour will be required to accommodate peak conditions in the summer months. This will be accomplished through the use of two thirty-passenger cars, operating at a speed of 1,000 feet per minute. As one car leaves the lower terminal, the other car will leave the upper terminal (double reversible technology), with a by-pass section at mid-point for passing of the two cars. As with any of the systems, there could be occasional, short-term peaks exceeding capacity. This system will be fully automated for maximum operating efficiency.

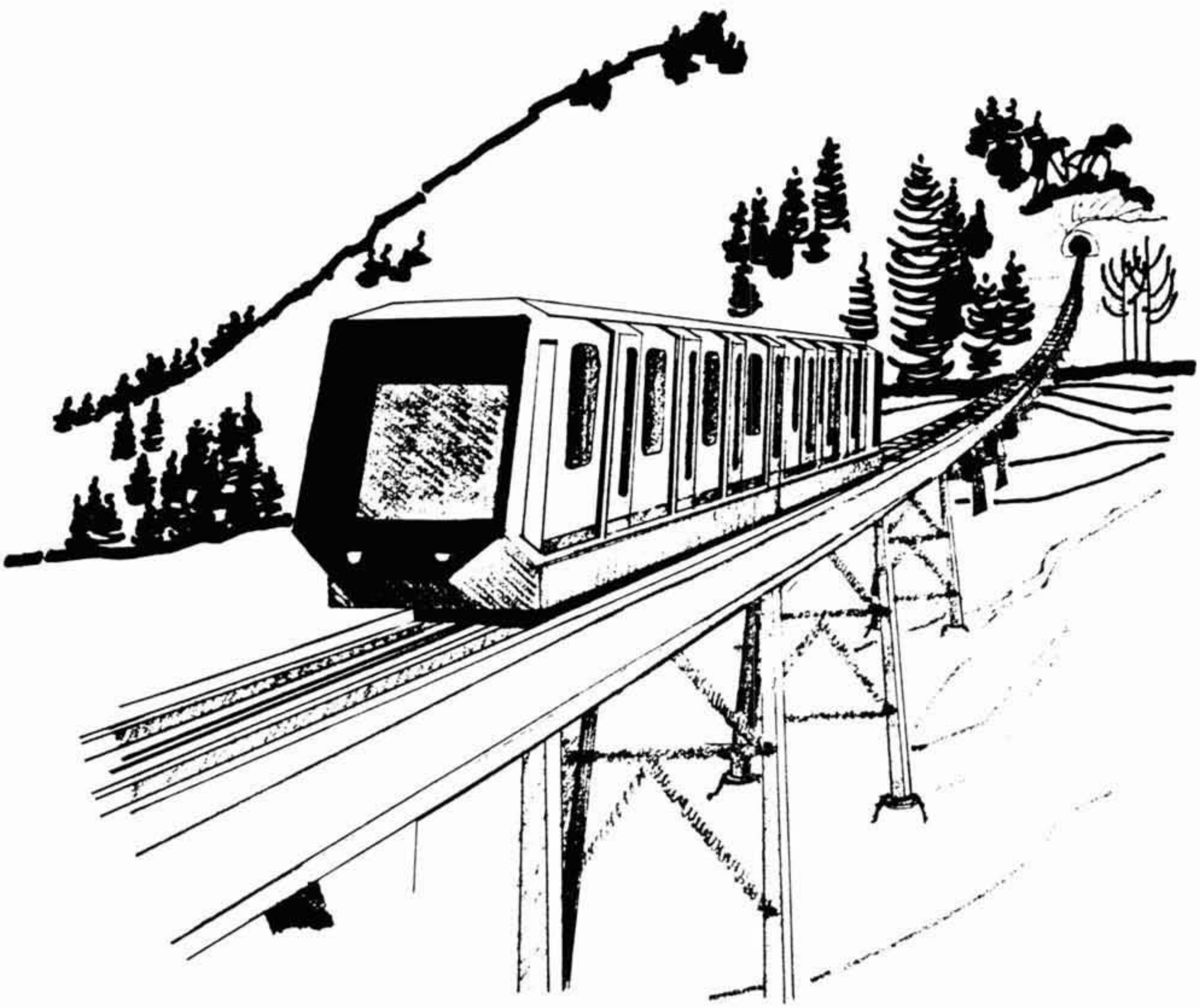

Figure 10. Typical elevated funicular system.

2b. Aerial Gondola

The parking configuration in Alternative 2b is identical that in 2a. However, transportation between the lower parking lot and Activity Center/Hotel would be provided by an aerial gondola.

A gondola typically consists of a series of enclosed cabins, each holding from 2 to 12 passengers. Recent innovations in gondola technology have allowed for larger cabin designs which can accommodate wheelchair access. Gondola cabins are suspended from an overhead cable and can be designed as a "jig-back" or in a continuous loop arrangement. Different types of gondolas can be developed to meet unique operating needs, as this is one of the most versatile of all aerial transportation systems. Gondolas are not able to span great distances between towers, however, this is not an issue with the application of an aerial gondola at Crater Lake. Gondolas are easily adaptable to terrain undulations based upon the placement of towers. To allow for fifteen foot snow depths and cabin clearance, tower heights would be approximately forty to fifty feet. Snow creep is also an important design consideration for placement of gondola towers. Gondolas must be designed along a straight alignment and trees will have to be cleared along the gondola route. The greatest advantage of a gondola is that the number of cabins can be varied to provide operating flexibility as capacity demands change. In addition, due to the relatively small size of gondola terminals, this type of system is adaptable for integration with smaller scale architecture.

There would be no major technical barriers to implementation of a gondola system at Crater Lake. Gondolas have been installed in many mountain settings throughout North America and at numerous World's Fairs, amusement parks, and tourist attractions, such as Expo '87, Vancouver, B.C,; New Orleans World's Fair 1988; Walt Disney World; and Opryland, U.S.A. During 1988, three new gondolas were installed out of 103 aerial lifts constructed in North America. Accordingly, there are several manufacturers in the United States with considerable design, installation and operational experience. These systems have a proven track record of reliability and are able to operate in all types of climatic conditions, however extreme wind may sometimes cause lift closures or require operation at reduced line speed for safety reasons.

The gondola system proposed for installation at Crater Lake, like the funicular, has a design capacity of 1,000 people per hour in order to handle peak summer visitation. The gondola would be designed as a "jig-back" system, using three ten-passenger cabins grouped together at each terminal. As one cluster of gondola cabins leaves the lower terminal, the other group of cabins will leave the upper terminal. This system will operate at 1,000 feet per minute. As with any of the systems, there could be occasional, short-term peaks exceeding capacity. Like funiculars, jig-back gondolas can also be fully automated and operated on an on-demand basis.

Figure 11. Typical "jig-back" aerial gondola system.

3. Shuttle Bus with Surface and Structured Rim Parking

Alternative 3 provides for parking at Crater Lake Lodge (100 spaces) and the Activity Center/Hotel. Both surface and structured parking would be built at the new Activity Center/Hotel, providing 60 spaces each, and five spaces for winter parking of recreational vehicles. The lower parking lot would consist of spaces for 280 autos and 30 recreational vehicles. A shuttle bus system would transport visitors from the lower parking lot to the Activity Center/Hotel during the peak summer months. During the winter, all visitors would park at the Crater Rim (120 spaces).

4. Shuttle Bus with Structured Rim Parking

Alternative 4 also provides for summer-only use of the lower parking lot. However, all 120 spaces at the Activity Center/Hotel would be in a parking structure, with the exception of five surface spaces for recreational vehicles. The 100 spaces at Crater Lake Lodge would remain.

5. All Parking on Rim

This alternative provides parking on the Crater Rim for all Park visitors except those arriving in recreational vehicles. A parking structure on the west side of the new Activity Center/Hotel would provide 400 spaces, with an additional 100 spaces at Crater Lake Lodge. A reduced lower parking lot would accommodate 30 recreational vehicles with on-call shuttle service to the Activity Center/Hotel.

B. Hours of Operation by Alternative

The required hours of operation for each alternative are shown in Table 4.

TABLE 4. PROPOSED HOURS OF OPERATION BY SEASON FOR EACH ALTERNATIVE

```
        OPTION:  1     **** = scheduled;  .... = on-demand only

                                HOUR  BEGINNING
SEASON (MONTHS)     0   1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18  19  20  21  22  23  24
--------------------|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|
                    |                                                  12 hr.
SUMMER (J,A)        |................................************************************************................
                    |                                                   10
WINTER (N-A)        |....................................****************************************....................
                    |                                                   10
SHOULDER (M-J,S-O)  |....................................****************************************....................
                    |
```

```
        OPTION:  2a,b  **** = scheduled;  .... = on-demand only

                                HOUR  BEGINNING
SEASON (MONTHS)     0   1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18  19  20  21  22  23  24
--------------------|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===
                    |                                                  12 hr.
SUMMER (J,A)        |................................************************************************................
                    |                                                   10
WINTER (N-A)        |....................................****************************************....................
                    |                                                   10
SHOULDER (M-J,S-O)  |....................................****************************************....................
                    |
```

```
        OPTION:  3     **** = scheduled;  .... = on-demand only

                                HOUR  BEGINNING
SEASON (MONTHS)     0   1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18  19  20  21  22  23  24
--------------------|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===
                    |                                                  12 hr.
SUMMER (J,A)        |                        ........************************************************............
                    |
WINTER (N-A)        |(none)
                    |                                                   10
SHOULDER (M-J,S-O)  |                            ........****************************************................
                    |
```

```
          OPTION:  4      **** =  scheduled;  .... =  on-demand only

                                    H O U R   B E G I N N I N G
SEASON (MONTHS)     0   1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18  19  20  21  22  23  24
--------------------|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===
                    |                                               12 hr.
SUMMER (J,A)        |                       ........************************************************................
                    |
WINTER (N-A)        |(none)
                    |                                                10
SHOULDER (M-J,S-O)  |                           ........****************************************....................
                    |
```

```
          OPTION:  5      **** =  scheduled;  .... =  on-demand only

                                    H O U R   B E G I N N I N G
SEASON (MONTHS)     0   1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18  19  20  21  22  23  24
--------------------|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===
                    |                   (for RV's only)
SUMMER (J,A)        |...............................................................................................
                    |
WINTER (N-A)        |(none)
                    |                   (for RV's only)
SHOULDER (M-J,S-O)  |...............................................................................................
                    |
```

```
          OPTION:  x      **** =  scheduled;  .... =  on-demand only

                                    H O U R   B E G I N N I N G
SEASON (MONTHS)     0   1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18  19  20  21  22  23  24
--------------------|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===|===
                    |                                               12 hr.
SUMMER (J,A)        |                       ........************************************************................
                    |
WINTER (N-A)        |(none)
                    |                                                10
SHOULDER (M-J,S-O)  |                           ........****************************************....................
                    |
```

C. Comparison of Alternatives

In order to make an objective comparison of the six alternatives, various evaluation criteria have been identified. These criteria represent various project requirements, design objectives, and management goals. Through the application of these criteria, positive and negative attributes of each alternative have been determined. The criteria have been grouped into three categories relating to user, environmental, and operational concerns. To facilitate comparison of the alternatives, each evaluative criterion has been separately addressed in the following section. Unless otherwise noted, the alternatives have been evaluated in the context of peak summer season use.

1. Vehicular Impact on the Crater Rim

The primary objective of this transportation study is to investigate means of reducing vehicular impacts on the Crater Rim. There are three interrelated components which result in vehicular impacts: the amount of surface parking on the Rim, the design of the access roads to Crater Lake Lodge and the Activity Center/Hotel, and the number of car and bus trips generated during the peak summer season.

While Alternative 1 does not include any Rim parking, a shuttle bus system will provide access to Crater Lake Lodge and the new Activity Center/Hotel. This will necessitate the presence of roads and shuttle buses between the two facilities on the Rim. Alternative 2 will have parking at Crater Lake Lodge, but will not have parking or shuttle service at the Activity Center/Hotel, as the funicular or gondola will provide access for visitors. Limited traffic impacts will result from a summer only service and emergency access road on the west side of the Activity Center/Hotel. Alternatives 3 and 4 will each result in vehicular traffic at the Rim, as some parking is provided at both the Activity Center/Hotel and Crater Lake Lodge. Alternative 4 will result in slightly less impact than Alternative 3, as all spaces at the Activity Center/Hotel will be in an underground parking structure. Alternative 5 will have maximum vehicular impact on the Crater Rim, with no lower parking lot. A large parking structure will be located to the west of the Activity Center/Hotel and surface parking will be provided at Crater Lake Lodge.

Bus and auto trips generated during peak season for each alternative are presented below. During the winter months, the number of trips will be reduced.

TABLE 5. NUMBER OF DAILY PEAK SEASON TRIPS

Alternative	Activity Center/Hotel			Crater Lake Lodge		
	Buses	Cars	Vans	Buses	Cars	Vans
1	592	0	106	0	0	70
2	0	0	0	0	100	0
3/4	368	646	275	0	100	0
5	0	2856	128	0	100	0

In summary, the option which has the least vehicular impact to the Crater Rim is Alternative 2. This alternative results in the least amount of vehicular traffic to and from the Rim, with Rim parking restricted to Crater Lake Lodge. In addition, the road design in this alternative is the least intrusive upon the Rim Village area, as it does not access the Activity Center/Hotel from the east.

2. User Criteria

Sense of Arrival

The design of the new parking and transportation system for Crater Lake should be easily understood by Park visitors. Several factors contribute to the clarity and directness of the entry sequence. First, visitors can be more easily oriented or directed if all visitors arrive at the same location. In addition, the more access roads and parking lot options that are available, the more confusing it will be for visitors. A sense of arrival for all the alternatives is somewhat lacking due to the fact that most visitors' first experience will be of a large parking lot. This is compounded by the fact that in most of the alternatives, visitors will be asked to park before they have reached their destination at the Crater Rim.

Taking these factors into consideration, it appears that Alternative 5 presents the clearest entry sequence, as all visitors will go to the same area to the west of the Activity Center/Hotel near the Crater Rim. From this point, overnight lodge guests can continue on to Crater Lake Lodge, while all other day visitors and hotel guests will park in the garage. Alternative 1 also offers a fairly clear entry sequence, as all Park visitors will proceed to the lower parking lot upon arrival. Because there is a single destination, confusion is limited. However, visitors must stop and park before reaching the Crater Rim and proceed to a bus terminal to take a bus to the Activity Center/Hotel or a van to Crater Lake Lodge. Alternative 2 begins to create somewhat more confusion in the entry sequence, as Crater Lake Lodge guests can drive to their final destination, while all other visitors must park in the lower lot. However, upon arriving in the parking lot, it will be very clear how to access the Crater Rim via the gondola or funicular, and the terminal will be prominently located. The most confusing alternatives are 3 and 4, which both include three separate parking areas for visitors. During the summer and shoulder seasons, active management of the parking supply will be required. It will be necessary to communicate very clearly who can park at the Crater Rim lots and who must take a bus from the lower parking area. As with all bus options, location of the various bus stops must be clearly designated, so that visitors know where to wait and how often a bus will depart for the Rim.

View Potential

This consideration addresses the opportunity for views of the landscape as visitors approach the Crater Rim. Alternative 2 provides the best opportunity for viewing the Park landscape as visitors approach the Crater Rim. These elevated transportation systems offer expansive views and allow visitors to passively enjoy these views as they are transported to and from the Activity Center/Hotel. The bus ride in Alternatives 1, 3, and 4 will provide some opportunity for views. Alternative 5, while allowing visitors to drive nearest the Crater Rim, probably does not allow full enjoyment of the views as visitors will be engaged in negotiating the access road and looking for a place to park.

User Appeal

The transportation system with the greatest user appeal will be most effective at counteracting any negative implications associated with the use of remote parking lots. Because of the widely recognized appeal of the private vehicle, Alternative 5 will clearly be the most appealing, since visitors will be able to drive their cars directly to their destination. Alternative 2 will represent a relatively high level of user appeal, due to the uniqueness and speed of the funicular and gondola systems. The shuttle bus alternatives (1, 3, and 4) have the least visitor appeal, due to their familiarity, and operating characteristics such as frequency of departure, length of trip, comfort, etc.

Ease of Access

Access for handicapped and elderly visitors and families with small children is an important consideration in the design of a parking and transportation system. Alternative 5 allows the most ease of access, with a drop-off zone in front of the Activity Center/Hotel and adjacent to the entrance to the parking structure. Alternative 3 and 4, with some parking on the Rim, can set aside handicapped parking at the Activity Center/Hotel. Alternative 2 provides relatively good accommodation for mobility impaired visitors, with parking directly next to the terminal and easy access onto gondola cabins or funicular cars. Accessible buses will be required for Alternative 1, an alternative somewhat less accessible than Alternative 2.

Comfort

The general comfort level of the transportation alternatives will affect how visitors respond to the remote parking configuration at Crater Lake. Clearly, Alternative 5 presents the most comfortable option, as visitors can stay in their cars until they arrive at their final destination. The funicular is probably the next most satisfactory system, as it runs on a fixed track and offers a smooth ride in comfortable conditions. The buses and gondola did not receive as high a rating, as they are more susceptible to motion due to environmental factors such as wind, weather, and road conditions.

Trip Time

The calculation of total trip time consists of two primary components: actual transport time and waiting and/or loading/unloading. For the funicular and gondola systems, the total perceived trip time, including waiting, loading/unloading and travel between terminals, will be three minutes. At 1,000 feet per minute, the time to travel the distance of 750 feet, including acceleration and deceleration, will be approximately one minute. During peak times, departures would take place at two minute intervals. At off-peak times, departure would be activated by the visitor (i.e., by pushing a button), and would be immediate. Except under adverse weather conditions, the trip time for bus alternatives would be about two minutes from the lower parking area to the Activity Center/Hotel. During peak times, buses would depart as frequently as every 1.5 minutes. Adding half of this as the average peak wait time makes the perceived trip time about two to five minutes. During most of the year, the policy headway (maximum time between buses) of 7.5 minutes would prevail, resulting in a perceived trip time of five to six minutes. For alternatives with some parking at the Rim, auto access times from the lower entrance road will be slightly under two minutes. Clearly, Alternative 5 represents the "shortest" trip time, as visitors will not perceive the drive to the Rim parking as a separate trip.

Effect on Overnight Guests

Overnight guests have two needs that differ from those of typical visitors. First, hotel and lodge guests must transport luggage and other belongings from their cars to their rooms. Second, overnight guests may be arriving in the late evening, after most Park operations have ended for the day. Clearly, Alternatives 3, 4, and 5, which provide for vehicular access and parking at the lodge and hotel will be most convenient for overnight guests. Alternatives 1 and 2 require that overnight guests load their luggage onto and off of a bus, van, gondola, or funicular. These transportation systems would also necessitate a 24-hour per day operating schedule in order to accommodate late arriving and early departing guests. In Alternative 1, late and early service would be provided on-demand by hotel/lodge vans. Both the funicular and the gondola systems would employ a security person/operator during off-peak times. This person can assist late-arriving guests. In addition, the automated funicular can be programmed to respond to a visitor activated signal similar to the button inside an elevator. A similar radio-controlled system is possible with a gondola, however, it would probably be simpler for the operator to activate the system, rather than the visitors.

Effect on RV Users

Thirty special parking spaces will be provided for recreational vehicles (RV's) in all five alternatives. In alternatives 1 and 2, all visitors, including those in RV's, will park in the lower lot in both summer and winter. Alternatives 3 and 4 both call for RV parking in the lower parking lot during the summer months and also provide five winter season spaces at the Activity Center/Hotel. In Alternative 5, most visitors will park in the parking structure on the Crater Rim. However, RV's will park in a separate lower parking lot during the summer which will be served by an on-demand shuttle bus. Visitors who wish to walk from this parking lot to the Activity Center/Hotel must cross the main access road to do so. During the winter, five RV spaces will be provided on top of the main parking garage. In alternatives 3, 4, and 5, RV winter parking is limited to five spaces. During the summer, these spaces will be used for additional handicapped or employee parking.

3. Environmental Criteria

Visual Impacts

Visual impacts of the various parking and transportation alternatives are similar to those described in the section outlining vehicular impacts at the Crater Rim. While features of the lower parking lot will not be visible from the Rim due to topography and vegetation, they are important in that they form a first impression for the visitor. In this respect, Alternatives 1 and 2 both call for large parking lots and structures in the lower area. However, Alternative 2 has somewhat more significant visual impact, due to the presence of an elevated funicular or aerial gondola in the landscape and the fact that these structures will remain on site year round. Three support towers will be required for the gondola which would reach a height of 40 to 50 feet, in order to accommodate maximum snow deposition. The funicular would be elevated to about 25 feet above ground level, supported by three concrete columns. In addition, the funicular would have a passing station in the center of the track, measuring approximately 60 feet long and 12 feet in width. In comparing the visual impact of these two systems, it is also important to recognize that the gondola employs a sequence of spaced towers linked by cable, while the funicular has the appearance of an elevated railway. The visual impact of either system is clearly a matter of opinion.

Architectural Character

All the parking and transportation alternatives will require the use of traditional architectural treatments for bus stops, terminals, and/or parking structures. Alternative 5 will present the most difficult architectural challenge, with a very large parking structure in close proximity to the

Activity Center/Hotel and Crater Rim. The lower parking structures in Alternatives 1 and 2 will be quite large and may compete visually with the Activity Center/Hotel. In addition, the gondola or funicular in Alternative 2 will be modern components which must interface directly with the Activity Center/Hotel structure. Alternatives 3 and 4 require the smallest parking structures, under the Activity Center/Hotel building.

Air Quality/Odor
Crater Lake's atmospheric conditions are some of the cleanest in the world. Accordingly, odor and air quality are important considerations. The funicular and gondola options will not result in any air quality or odor problems at Crater Lake since these systems utilize electric motors. Alternatives which depend upon auto access or shuttle buses to the Crater Rim will contribute to decreased air quality. Alternative 5 will have the most impact on air quality in the vicinity of Rim Village, as all cars will be funneled to the parking structure adjacent to the Activity Center/Hotel. Alternatives 3 and 4 each contribute both auto and bus emissions at Rim Village, while Alternative 1 represents the least amount of vehicular traffic of all the bus alternatives, as no private autos will be allowed access to the Crater Rim, on a year-round basis. In addition, this issue will be influenced by the type of fuel used for the shuttle buses.

From an operational standpoint, diesel powered buses are a logical choice for long-term maintainability. However, the odor may be undesirable. Several other choices may be available, including gasoline, propane, methanol, or liquified natural gas, and are described below. While gasoline powered buses are somewhat less durable, they are currently available and will minimize odor. Engines modified to run on propane are also available. However, there can be unpleasant odors in the exhaust and special fueling systems are required. While methanol powered buses are operating, and doing so with minimum odor, the technology is still in the demonstration phase. With upcoming Federal and Los Angeles basin air quality requirements, methanol or some other alternative to diesel engines will probably be perfected in the next few years. Liquified natural gas is an abundant fuel with minimum exhaust odors. However, practical application at Crater Lake would depend on a nearby source of natural gas and a special fueling system would be required.

Noise/Vibration
Noise and vibration are an issue both for riders and for visitors near the transportation route. Due to their use of electric power, funiculars and gondolas are somewhat quieter than buses. In addition, some vibration is experienced by gondola and bus riders, while the fixed funicular track eliminates most vibrations for this system. The level of noise for the bus alternatives will be higher than for Alternative 2. For these reasons, the funicular system is the least disruptive system, followed by the gondola.

Energy Use/Power Requirements
When comparing energy and power requirements for the transportation alternatives, it is evident that the bus systems all require the use of fossil fuels, while the funicular and gondola rely on electricity. Additionally, with the exception of Alternative 1, all other options consume fossil fuels through the provision of various parking schemes for private vehicles at the Activity Center/Hotel and/or Crater Lake Lodge. Total fuel consumption for each alternative will reflect a balance between buses and private vehicles traveling to the Crater Rim. Fuel consumption for each alternative is outlined below.

TABLE 6. PROJECTED ANNUAL FUEL REQUIREMENTS BY ALTERNATIVE

Alternative	Type of Fuel	Annual Requirement
1 - buses[1]	fossil	12,000 gallons
- on-demand shuttle	fossil	1,300 gallons
- autos[2]	fossil	0 gallons
2 - funicular/gondola	electricity	44,000 KWH
- autos[2]	fossil	300 gallons
3 - buses[1]	fossil	3,700 gallons
- on-demand shuttle	fossil	650 gallons
- autos[2]	fossil	5100 gallons
4 - buses[1]	fossil	3,700 gallons
- on-demand shuttle	fossil	650 gallons
- autos[2]	fossil	5100 gallons
5 - on-demand shuttle	fossil	1,100 gallons
- autos[2]	fossil	9100 gallons

1) See discussion of alternate fuels.
2) Only the portion from the entrance at the lower parking lot to the Crater Rim was considered.

Tree Removal
Most of the proposed parking lots, road alignments, and the gondola/funicular route are in areas of sparse tree cover, where tree minimal removal will be necessary. The greatest number of trees will be removed during construction of the central access road included in Alternatives 1, 3, and 4. Somewhat fewer trees will be impacted in Alternative 2 due to the shorter access road and the limited clearing required for installation of the gondola or funicular. Alternative 5 will result in the least amount of tree removal, due to the fact that the parking structure and access road to the Lodge are planned for sites which have already been disturbed.

Conflict With Pedestrian Pathway
A pedestrian path will be provided in all alternatives between the lower parking area and the Activity Center/Hotel. In alternatives 1, 3, and 4, the pedestrian path must cross the central road once, near the Activity Center/Hotel. In Alternative 2, the pedestrian path crosses under the funicular or gondola alignment several times, but does not require any road crossings. Alternative 5 provides a pedestrian path for RV users who must park in the lower parking lot. Because the main access road to the Crater Rim is not realigned in this alternative, visitors parking in the lower lot must cross the main road in order to walk to the Activity Center/Hotel.

4. Operations Criteria

System Capacity
All the proposed systems meet the peak capacity of 1,000 people per hour in each direction. However, the parking configurations and transportation requirements outlined in the various alternatives may not fully reflect the need for higher capacity than is currently provided.

Frequency of Service
During peak conditions, the funicular and gondola both have the capacity to maintain a two minute departure schedule. At other times, the fully automated funicular and gondola systems can provide on-demand service. For the bus alternatives, the time between departures will vary from 1.5 minutes at the peak to a maximum of 7.5 minutes. The operating schedules for each alternative were shown in Table 4. For the bus alternatives, a mix of scheduled and on-demand service will be provided. In Alternative 2, the funicular or gondola will operate 24 hours per day, as needed. Alternative 5 represents the most "frequent" service, as Park visitors proceed directly to the Activity Center/Hotel in their own vehicles.

Staffing Requirements
The staff requirements for the funicular and gondola are virtually the same, and amount to five full time staff positions. While the funicular can be more fully automated than the gondola, it is still desirable to have attendants present at peak times to be certain that visitors and their belongings are safely inside the cars before departure. Gondola attendants will also perform this function, as well as activating the system to depart. At non-peak times, both systems would require a single security person/operator to assist late-arriving guests and to ensure the security of the terminals, etc. This person would be stationed at one terminal and would use a video camera system to monitor activities at the other terminal. Either system will require a full-time resident system supervisor/technician. This person would be fully responsible for maintenance, staffing, system programming, and trouble-shooting.

For Alternative 1, the peak staff is comprised of 12 drivers (for two shifts), one dispatcher, one manager, and a half-time maintenance mechanic. The reduced off-peak staff sizes and the staff needed for other alternatives corresponds to the reduced demand for bus service. It was assumed that the late and early hour on-demand van service would be provided by available hotel and Lodge staff.

TABLE 7. STAFFING REQUIREMENTS BY ALTERNATIVE

Alternative	Peak Staff	Average (off-peak) Staff
1	14.5	4.5
2	5.0	5.0
3	9.5	4.5 (none in winter)
4	9.5	4.5 (none in winter)
5	none	none

Emergency/Service Access
Alternatives 1, 3, 4, and 5 all allow full vehicular access to the Activity Center/Hotel on a year-round basis. In these options, a road will be plowed for either buses or cars during the winter months. Alternative 2 does not provide plowed access to the facility. All winter access is assumed to be provided by the funicular or gondola. While service and emergency access can be accommodated by these systems, it would require the cumbersome and time-consuming task of transferring goods from a truck to the transportation system, and then into the Activity Center/Hotel. Neither the gondola nor the funicular are suited to transport fire fighting equipment. In addition, use of the systems for service and emergency access is likely to disrupt the operating schedule and delay service for Park visitors.

Snow Removal
All of the bus alternatives will require plowing of the access road to the Activity Center/Hotel and the winter parking structure, whether located at the lower lot, or adjacent to the Activity Center/Hotel. Alternative 3 will require somewhat more plowing of parking areas, due to the reduced number of covered parking spaces provided. Alternative 2 will require the least amount of plowing, as no access road will be cleared to the Activity Center/Hotel.

Storm Weather Operation
This discussion presumes that Park visitors will be able to access the site during poor weather conditions. Given this assumption, visitors will be capable of driving to the parking structure at the Crater Rim (Alternative 5). Visitors who park in the lower parking area will be most easily served by the funicular, which is virtually unaffected by weather conditions. Gondola and

bus service are more susceptible to the influence of weather. Extreme wind conditions may prevent the gondola from operating, while heavy snows may cause delays or suspension of bus service. However, it is expected that the gondola and buses would be affected for brief periods, under most circumstances.

System Expandability

Clearly, the shuttle bus systems (1, 3, and 4) provide the most flexibility in addressing increased capacity needs, as additional parking areas could be constructed and more buses could be added to the fleet. The funicular capacity could be increased, if additional parking is provided near the lower terminal. First, the present cars could be converted, reducing the number of seats and increasing standing room for passengers. This modification would result in a capacity nearly double the original design. Additionally, another car could be added to the funicular railway. However, this approach would require modifications to the upper and lower terminals. The gondola is more limited in its ability to accommodate expansion. While another cabin could be added, this would necessitate a complete upgrade of cables, gear boxes, and line machinery. Alternative 5 is not well-suited to capacity expansions. In essence, if the parking structure is too small, a remote parking area will have to be built, necessitating the addition of a transportation system.

Management Considerations

While it is important to provide parking for hotel guests and handicapped visitors at the Activity Center/Hotel, all other parking should be limited to the lower lot. If any parking for the general public is provided at the Crater Rim, many visitors will not park in the lower lot until they are certain parking at the rim is full. Accordingly, this typical pattern of use by visitors will generate increased traffic on the new access road and in the Rim Village. This unnecessary traffic will also contribute to a reduction in air quality in the park. When considering "winter only" parking for the general public at the Crater Rim, it must be understood that at some point in the future, demand will exceed parking capacity. At that time, winter use of the lower lot and transportation system will be necessary. In addition, the same problems associated with providing limited Rim parking in the summertime will also become apparent during the winter season. In this respect, alternatives which concentrate parking in one particular area present fewer long-term management problems than alternatives with dispersed parking facilities. In this respect, Alternatives 1 and 5 provide the most suitable parking configuration, followed by Alternative 2.

Response to System Failure

In the event of system failure, such as bus breakdown or malfunction of the funicular or gondola, alternative means of accessing the Crater Rim must be provided. Alternatives 1, 3, and 4 which rely on buses respond fairly well to system failure. If a bus breaks down, it can be replaced. In the interim, delays may be caused if buses are forced to make less frequent runs due to reduced fleet size. Alternative 2 does not respond well to system failure. In the event of a breakdown of the funicular or gondola, buses would have to be obtained, and visitors would have to be shuttled to either the Lodge or the service entrance of the Activity Center/Hotel, since no central road is provided in this alternative. Alternative 5 does not depend on any transportation system, therefore it is not subject to system failures.

5. System Costs

Capital Cost

Capital costs are summarized in Table 8. These costs do not include the Activity Center/Hotel or landscaping. Alternatives 1 and 3 are the least expensive, followed by 4, 2b, and 2a, respectively. The most expensive is Alternative 5, the large parking structure at the Activity Center/Hotel.

TABLE 8. CAPITAL COSTS BY ALTERNATIVE (in millions)

Alternative	Transportation	Parking, Roads and Structures*	Total
1	$ 0.51	$ 3.77	$ 4.28
2a	$ 2.85	$ 5.07	$ 7.92
2b	$ 1.50	$ 5.07	$ 6.57
3	$ 0.34	$ 3.82	$ 4.16
4	$ 0.34	$ 4.98	$ 5.32
5	$ 0.00	$ 8.34	$ 8.34

* Structures include bus or gondola/funicular terminals, maintenance buildings, and parking garages.

Operating and Maintenance Costs

The direct annual operating and maintenance costs associated with the various transportation alternatives are shown in Table 9.

TABLE 9. OPERATING AND MAINTENANCE COSTS BY ALTERNATIVE (in millions)

Alternative	Transportation	Parking, Roads and Structures*	Total
1	$ 0.223	$ 0.065	$ 0.288
2	$ 0.158	$ 0.042	$ 0.200
3	$ 0.100	$ 0.077	$ 0.177
4	$ 0.100	$ 0.066	$ 0.166
5	$ 0.019	$ 0.093	$ 0.112

The least expensive alternative from the standpoint of operating and maintenance is Alternative 5. Alternatives 3 and 4 are in the intermediate range, and Alternatives 1 and 2, providing the most transportation service and the least Rim parking, are the most expensive.

Life-Cycle Costs

Project life-cycle costs for all alternatives are represented in Table 10. These costs include all capital, operating and maintenance costs for each alternative over a 25 year period, discounted at seven percent. Elements which have been included in these calculations are: Activity Center/Hotel, roadways, parking lots and garages, terminal buildings, maintenance facilities, landscaping, and the actual transportation systems. These costs range from $25.56 million for Alternative 3 to $31.42 million for Alternative 2a.

	Alternative 1		Alternative 2a		Alternative 2b		Alternative 3		Alternative 4		Alternative 5	
	CAPITAL COST	ANNUAL M&O	CAPITAL COST	ANNUAL M&O	CAPITAL COST	ANNUAL M&O	CAPITAL COST	ANNUAL M&O	CAPITAL COST	ANNUAL M&O	CAPITAL COST	ANNUAL M&O
VISITOR BUILDINGS:												
Lodge (note 1)	$14.93	$0.199	$16.93	$0.231	$16.93	$0.231	$14.93	$0.199	$14.93	$0.199	$14.93	$0.199
LANDSCAPING (note 3)												
Upper	$1.33	$0.019	$0.82	$0.018	$0.82	$0.018	$1.37	$0.018	$1.28	$0.018	$1.16	$0.022
Lower	$0.47	$0.009	$0.45	$0.006	$0.45	$0.006	$0.42	$0.008	$0.42	$0.008	$0.32	$0.006
TRANSPORTATION SYSTEM:												
Hardware (note 2)	$0.51	$0.199	$2.85	$0.158	$1.50	$0.158	$0.34	$0.089	$0.34	$0.089	$0.00	$0.000
Terminals/Garage	$2.22	$0.016	$3.75	$0.026	$3.75	$0.026	$0.23	$0.002	$0.23	$0.002	$0.10	$0.000
Parking Garage - upper							$1.94	$0.008	$3.29	$0.014	$7.56	$0.050
Maint/Storage Facility	$0.17	$0.006					$0.17	$0.006	$0.17	$0.006		
Lodge Shuttle (note 4)		$0.008		$0.000		0		$0.000		$0.000		$0.000
On-demand Shuttle		$0.016		$0.000		0		$0.011		$0.011		$0.019
ROADWAY SYSTEM												
Roads	$1.38	$0.008	$1.32	$0.007	$1.32	$0.007	$1.48	$0.007	$1.29	$0.007	$0.68	$0.004
Snow Removal		$0.035		$0.009		$0.009		$0.054		$0.037		$0.039
TOTALS	$21.01	$0.515	$26.12	$0.455	$24.77	$0.455	$20.88	$0.402	$21.95	$0.390	$24.74	$0.340
LIFE CYCLE COST (note 5)		$27.01		$31.42		$30.07		$25.56		$26.49		$28.70

NOTES:

1. For Site Plan 2, lodge costs include the costs for the upper gondola or funicular terminal.
2. Vehicle replacement costs are included for the bus alternatives.
3. Landscaping includes surface parking costs.
4. Capital costs of the Hotel and Lodge vans used for this service included in the hourly charge of $22 for this "on-demand" service.
5. Life cycle costs were based on (per Karl von Rosenberg 7/27/89):
   - o all capital costs incurred in the first year, plus
   - o net present value of annual operating and maintenance costs for 25 years discounted at 7%.

   Energy costs are included but will be discussed in more detail elsewhere.

TABLE 11. COMPARATIVE MATRIX SHOWING ABILITY OF PARKING AND TRANSPORTATION ALTERNATIVES TO MEET PROJECT CRITERIA

Project Objective	1	2a	2b	3	4	5
Reduction of Vehicular Impact	Moderately Successful	Highly Successful	Highly Successful			

User Criteria	1	2a	2b	3	4	5
Sense of Arrival	Highly Successful					Moderately Successful
View Potential	Moderately Successful	Highly Successful	Highly Successful	Moderately Successful	Moderately Successful	
User Appeal		Moderately Successful	Moderately Successful			Highly Successful
Ease of Access				Moderately Successful	Moderately Successful	Highly Successful
Comfort		Moderately Successful				Highly Successful
Trip Time		Moderately Successful	Moderately Successful			Highly Successful
Effect on Hotel Guests		Moderately Successful	Moderately Successful	Highly Successful	Highly Successful	Highly Successful
Effect on RV Users	Highly Successful	Highly Successful	Highly Successful	Moderately Successful	Moderately Successful	

Environmental Criteria	1	2a	2b	3	4	5
Visual Impacts	Highly Successful	Moderately Successful	Moderately Successful			
Architectural Character	Moderately Successful			Highly Successful	Highly Successful	
Air Quality/Odor	Moderately Successful	Highly Successful	Highly Successful			
Noise/Vibration		Highly Successful	Moderately Successful			
Energy Use/Power Requirements	Moderately Successful	Highly Successful	Highly Successful			
Tree Removal		Moderately Successful	Moderately Successful			Highly Successful
Conflict With Pedestrian Path	Moderately Successful	Highly Successful	Highly Successful	Moderately Successful	Moderately Successful	

Ability to Satisfy Evaluation Criteria

Highly Successful (dark shading) — Moderately Successful (light shading)

Operations Criteria

Operations Criteria	1	2a	2b	3	4	5
System Capacity	Highly Successful	Highly Successful	Highly Successful	Highly Successful	Highly Successful	Highly Successful
Frequency of Service		Moderately Successful	Moderately Successful			Highly Successful
Staffing Requirements		Moderately Successful	Moderately Successful			Highly Successful
Emergency/Service Access	Highly Successful	Moderately Successful	Moderately Successful	Highly Successful	Highly Successful	Highly Successful
Snow Removal	Moderately Successful	Highly Successful	Highly Successful		Moderately Successful	Moderately Successful
Storm Weather Operation		Moderately Successful				Highly Successful
System Expandability	Highly Successful			Highly Successful	Highly Successful	
Management Considerations	Highly Successful	Moderately Successful	Moderately Successful			Highly Successful
Response to System Failure				Moderately Successful	Moderately Successful	Highly Successful

System Costs

System Costs	1	2a	2b	3	4	5
Capital Costs	Highly Successful		Moderately Successful	Highly Successful		
Operating & Maintenance Costs				Moderately Successful	Moderately Successful	Highly Successful
Life-Cycle Costs				Highly Successful	Moderately Successful	

Ability to Satisfy Evaluation Criteria

Highly Successful (dark shading)   Moderately Successful (light shading)

VII. SUMMARY

Based upon the description and analysis of the various parking and transportation alternatives, certain strengths and weaknesses of each option become apparent.

Alternative 1 has several positive aspects, the most important of which is its effectiveness in removing parking and traffic from the Crater Rim. Several drawbacks associated with this alternative are inconvenience for overnight guests to the Lodge and Hotel, reliance on bus service during the winter months, the general lack of appeal of a shuttle system. In addition, issues relating to air quality and the consumption of fossil fuels are also important.

Alternatives 2a and 2b rank high on many of the evaluative criteria, with the funicular showing some advantage over the gondola. These systems generally offer more benefits to the user than a shuttle bus system, without as many negative environmental impacts. From an operational perspective, the systems provide a high level of service and are reliable under nearly all conditions. However, Alternative 2 is impractical in its assumption that no road access will be provided during the winter for service and emergency vehicles or hotel guests and employees. Alternatives 2a and 2b have the highest life-cycle costs.

Alternatives 3 and 4 result in nearly identical ratings in our evaluation, as the only difference between them is the ratio of surface to structured parking at the Activity Center/Hotel. The difference between these alternatives and Alternative 1 is that buses are only used during the summer months, with road access to the Activity Center/Hotel for winter visitors.

Alterative 5 is clearly superior to all other options from the perspective of the various user criteria. However, this alternative does not accomplish the basic objective of removing the majority of vehicular traffic from the Crater Rim. In addition, the presence of a large parking structure and many vehicles associated with this alternative will have an overall adverse impact on the Crater Lake environment.

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Please see the original document for clarification.

IX. LIST OF REFERENCES

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Potential Applications of Aerial Tramway and Gondola Systems for Urban Passenger Transportation, Harley O. Staggers National Transportation Center, West Virginia University, 1985.

Visitor Services Project, Crater Lake National Park, Report 6, NPS, 1985.

Program Development and Design Criteria for Activity Center/Hotel Facility at Rim Village, Crater Lake National Park, NPS, (no date).

APPENDIX A

EXCERPT FROM 50 PERCENT PHASE

TECHNICAL MEMORANDUM

NOTE: The following sections of the 50 percent report have been presented here as a reference. The remainder of the 50 percent report has been integrated into the 100 percent report.

VI. SYSTEM ALTERNATIVES

A. Overview of Alternative Transportation Systems

1. Shuttle Bus

Bus vehicles could range from small twelve to twenty passenger vans to larger transit coaches. For their advantage of reliability and long-term maintainability, transit quality coaches should be used in this application. A single thirty passenger coach would provide adequate capacity for most of the year, with additional buses required during the summer months. Typically, the coaches would be diesel powered. However, because of odor problems, alternative fuels such as methanol or propane could be considered. Limited fixed facilities for bus service would be required . The upper terminal for buses would be incorporated in the porte-cochere of the hotel. One or more small terminals would be required in the lower parking lot. Maintenance can be handled elsewhere at a location to be determined. Covered winter storage for the buses would probably be required.

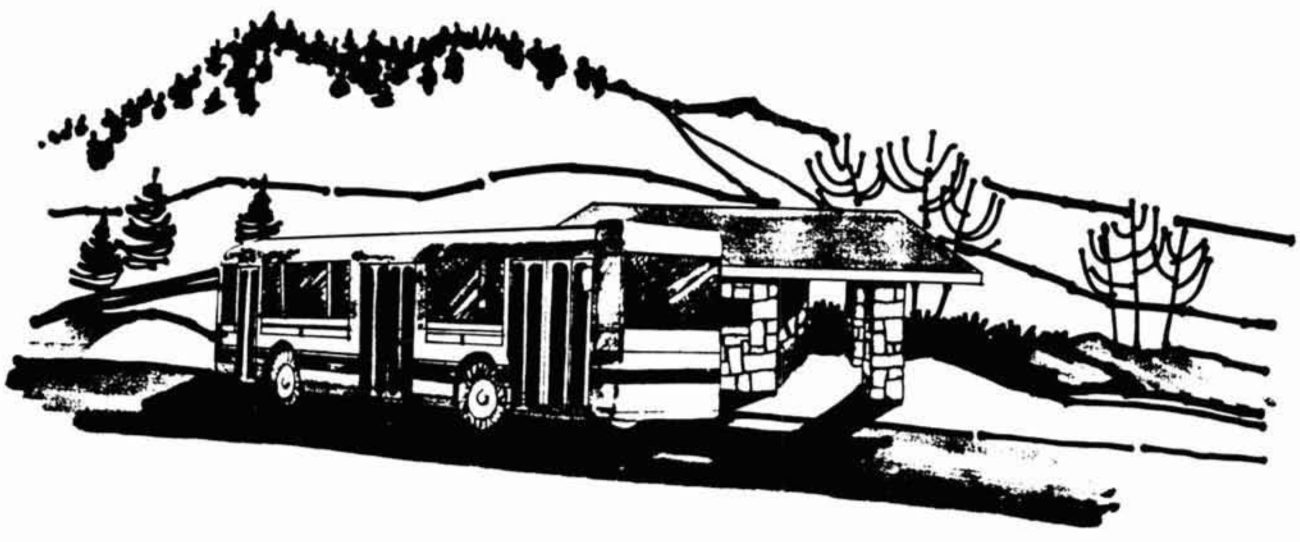

Figure 9. Typical shuttle bus system.

2. Covered Walkway

A covered walkway, fifteen to seventeen feet in width, would provide an adequate pedestrian level of service, even at peak times. The average grade of this walkway would be about ten percent. However, depending upon the details of layout, there may be portions requiring short reaches of steps. Handicapped access and parking should be provided at the Activity Center/Hotel. Because of heavy winter snow loads, the cover for this walkway may present a major structural requirement. In order to maintain a gradient of approximately ten percent, the walkway would have to follow a serpentine route to the Activity Center/Hotel.

Figure 10. Typical covered walkway.

3. Covered Moving Sidewalk

This is similar to the covered walkway alternative except there is a mechanical assist, both uphill and downhill, for pedestrians. Most, or all of the distance would be covered with moving sidewalks. However, depending upon location of the route, there may be short portions of grades requiring an escalator (moving steps) instead. The moving sidewalk has the advantage of reducing effort required of pedestrians. However, the speeds of these conveyance systems are only about half of typical walking speed. Through the use of escalators, the vertical rise can be achieved using a more direct route than with a covered walkway or moving sidewalk system.

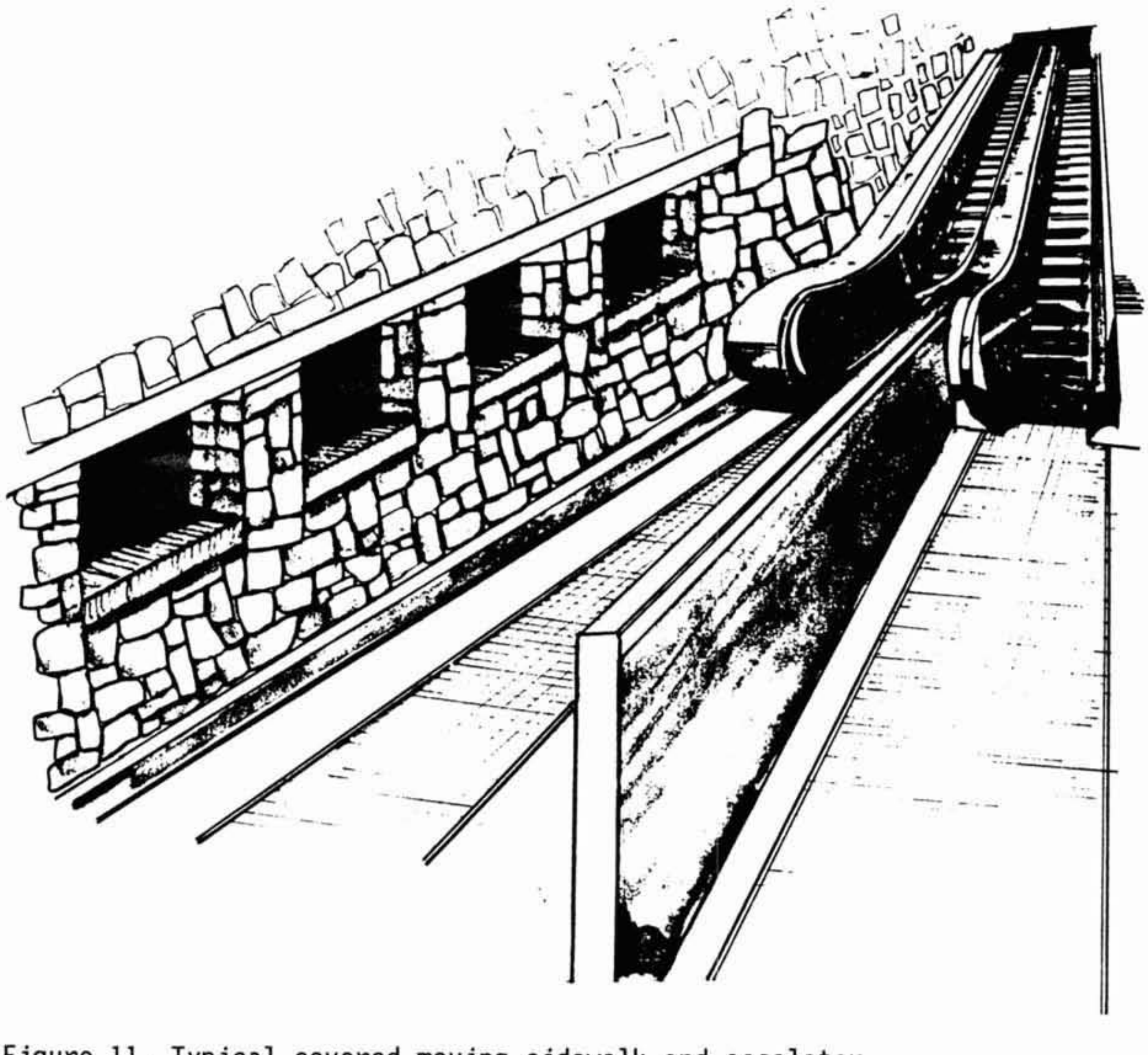

Figure 11. Typical covered moving sidewalk and escalator.

4. Covered Walkway to Tunnel with Moving Sidewalk and Elevator

For this alternative, a pedestrian tunnel would be bored on a nearly level grade from the lower parking lot to a point under the Activity Center/Hotel. Moving sidewalks in both directions would be provided through this approximately 600 foot tunnel and 150 foot covered walkway. From the end of the tunnel, two elevators would provide vertical transportation for the 70 foot rise to the hotel's interior.

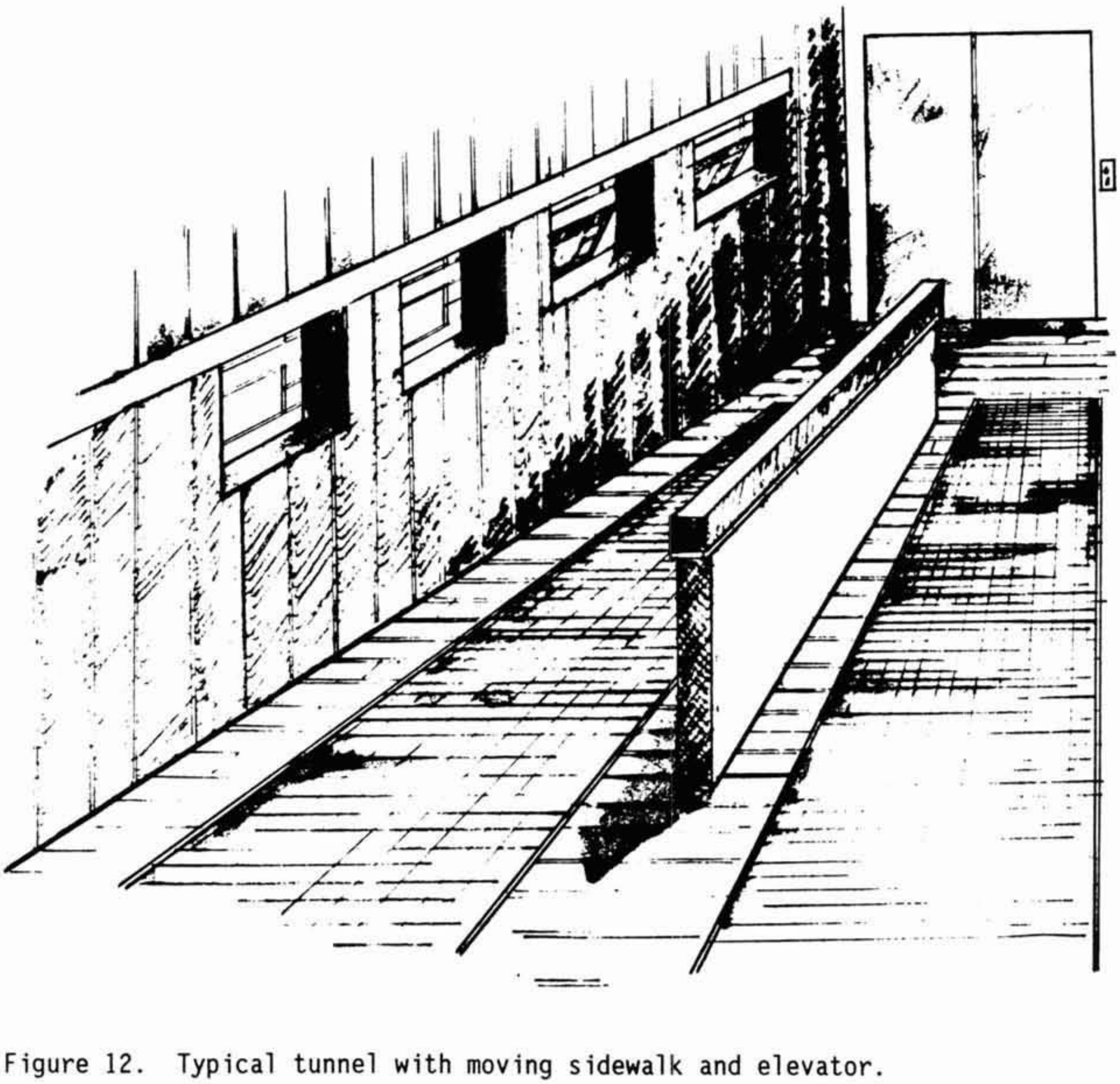

Figure 12. Typical tunnel with moving sidewalk and elevator.

5. Funicular Railway

This method of conveyance consists of two trains running in a "jig-back" configuration on a single pair of rails, guided by a single cable or haul rope. At the halfway point, a double track is provided to allow the trains to pass. The trains are typically divided into several cars, and can accommodate wheelchairs and either seated or standing passengers. Capacity is a function of the number and size of cars in each train and the speed of the haul rope. Since the funicular runs on an inclined plane, the floors are designed to maintain a horizontal position. The funicular can be run on an at grade, elevated or underground rail system. With either type of system, a straight route is preferred, but moderate curvatures can be accommodated if necessary. However, abrupt or extreme changes in gradient must be avoided. For this reason, an elevated funicular does not typically follow the natural contours of the site. In fact, a convex curvature of the track is required to keep the haul rope in the proper position. Use of an elevated track would necessitate making an allowance for maximum snow pack and clearance. Accordingly, the track would be elevated twenty to twenty-five feet above the ground. As in any elevated structure, the supports must be designed to accommodate snow creep. A funicular system could be designed to accommodate future increases in capacity.

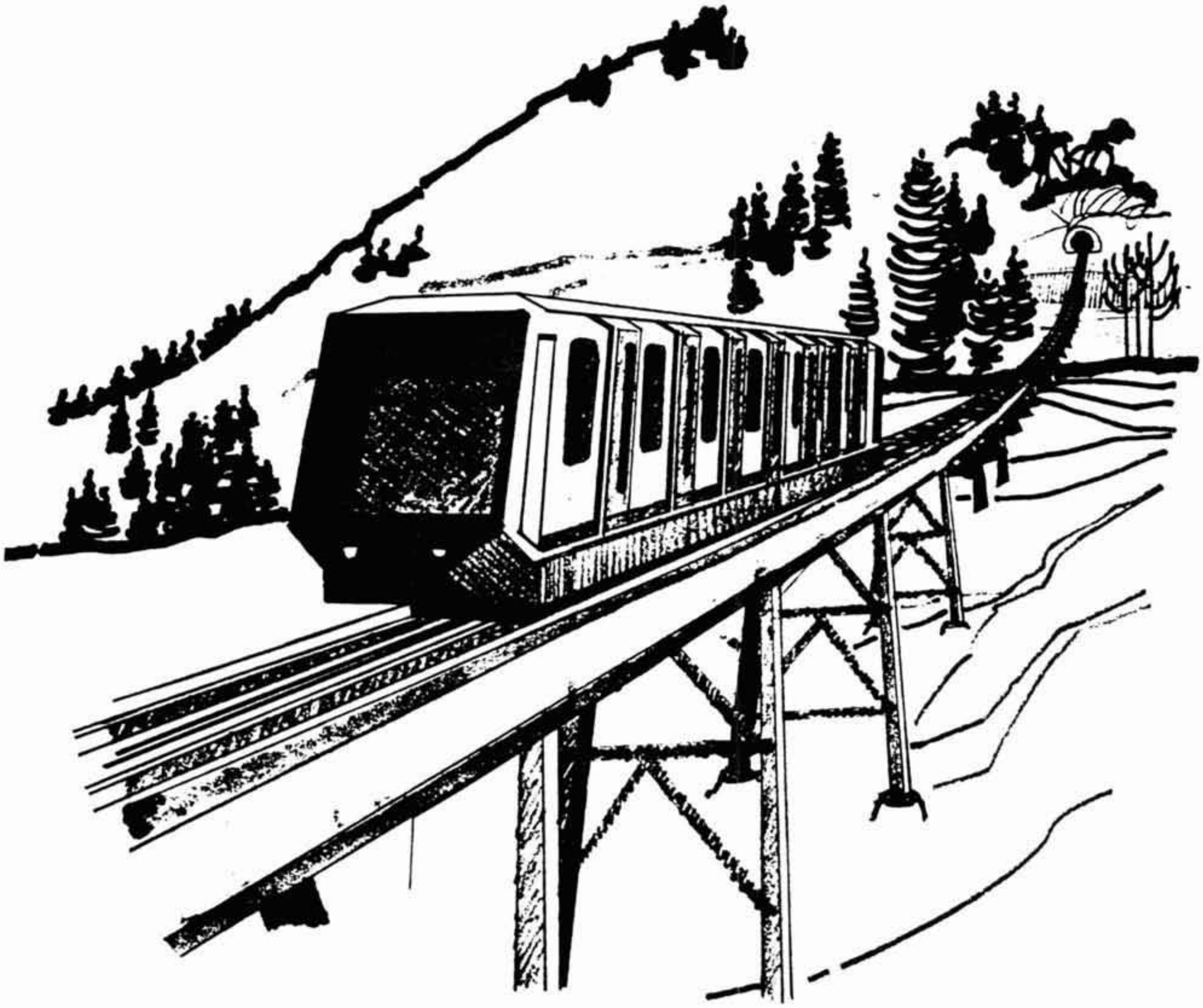

Figure 13. Typical elevated funicular system.

Figure 14. Typical funicular system in tunnel.

6. Aerial Gondola

A gondola typically consists of a series of enclosed cabins, each holding from 2 to 12 passengers. Recent innovations in gondola technology have allowed for larger cabin designs which can accommodate wheelchair access. Gondola cabins are suspended from an overhead cable and can be designed as a "jig-back" or in a continuous loop arrangement. Different types of gondolas can be developed to meet unique operating needs, as this is one of the most versatile of all aerial transportation systems. Unlike aerial trams, gondolas are not able to span great distances between towers. However, the need to span great distances is not an issue with the application of any aerial lift at Crater Lake. Gondolas are easily adaptable to terrain undulations based upon the placement of towers. Terminals and towers are significantly smaller than those required for a tram system. However, to allow for fifteen foot snow depths and cabin clearance, tower heights would be approximately forty to fifty feet. Snow creep is also an important design consideration for placement of gondola towers. Gondolas, like trams, must be designed along a straight alignment and trees will have to be cleared along the gondola route. The greatest advantage of a gondola is that the number of cabins can be varied to provide operating flexibility as capacity demands change. In addition, due to the smaller size of gondola terminals, this type of system is more adaptable for integration with smaller scale architecture. Gondolas have been installed at many of the World's Fairs, at amusement parks, and tourist attractions, including Expo '87, Vancouver, B.C,; New Orleans World's Fair 1988; Walt Disney World; and Opryland, U.S.A.

Figure 15. Typical "jig-back" aerial gondola system.

7. People Mover/Monorail

These systems can be provided in a variety of forms. However, they generally share the characteristics of being automated, electrically powered systems, operating on a dedicated guideway, either supported from below or suspended from above. Examples of these systems include shuttles that exist at several airports, including Seattle, Tampa and Atlanta and those in theme parks, such as Disney World. In addition, suspended monorails have been used in theme parks. Cable-drawn people movers will not be considered here, in order to maintain a distinction between them and funiculars. For this reason, this analysis will only address people movers or monorails with on-board electrical propulsion.

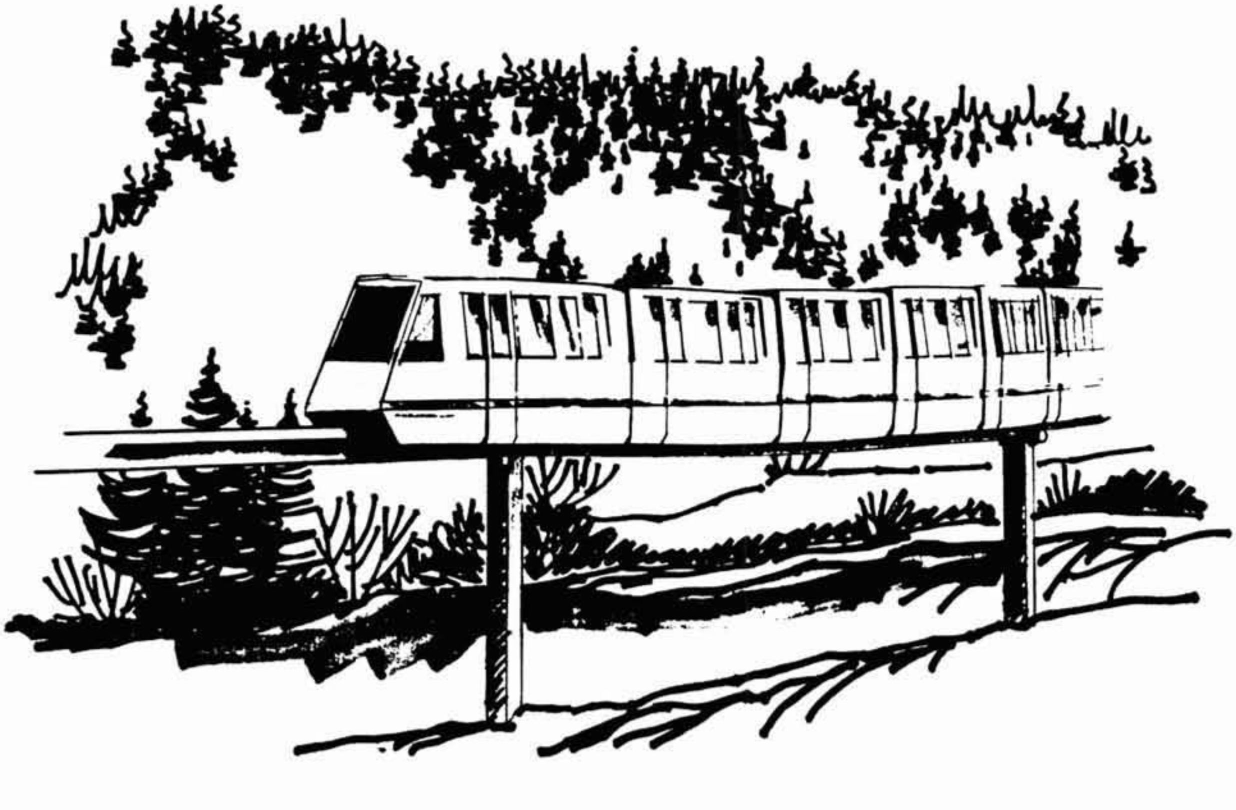

Figure 16. Typical people mover/monorail system.

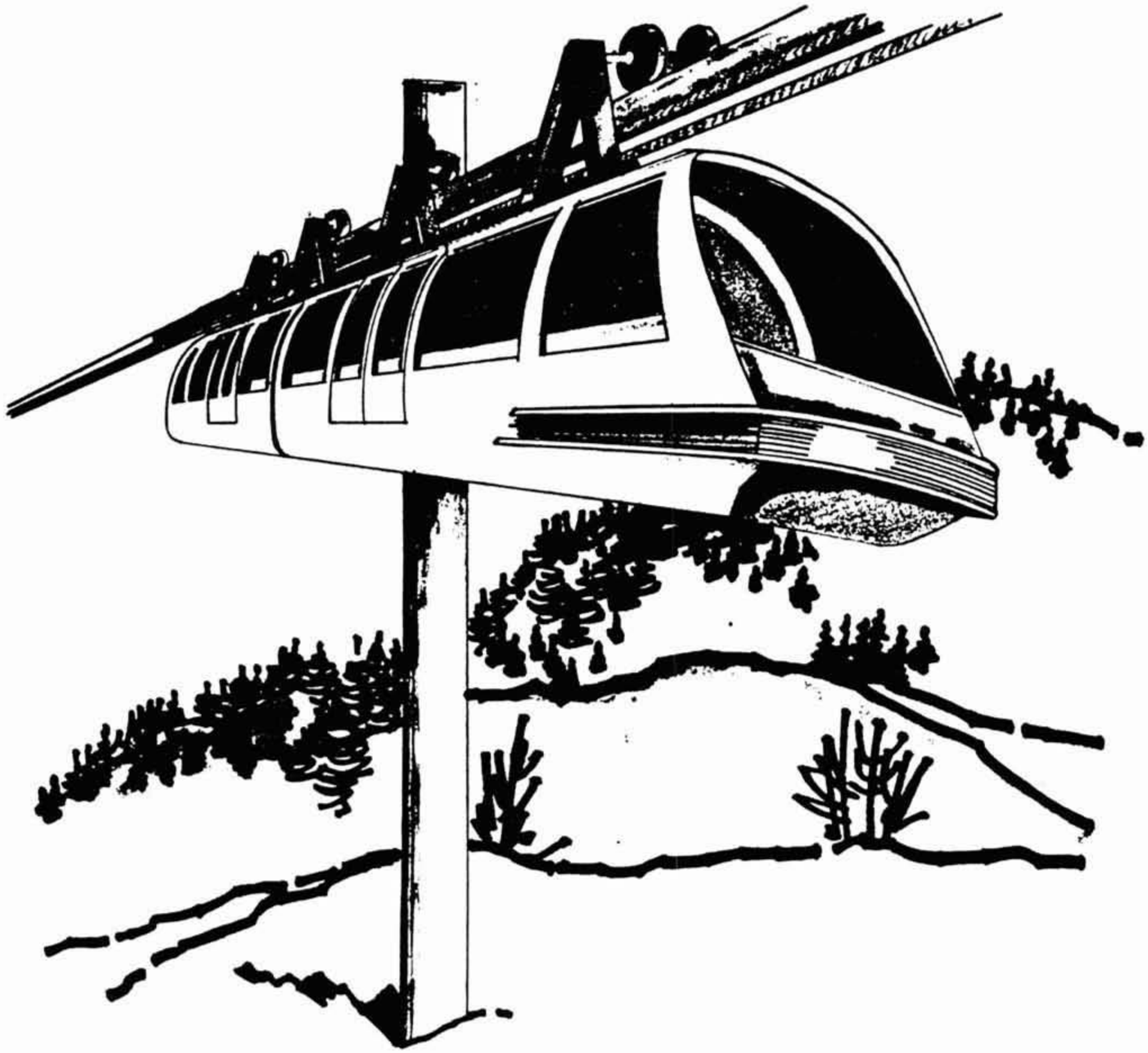

Figure 17. Suspended people mover/monorail system.

8. Aerial Tramway

This type of aerial conveyance consists of two large cars suspended from overhead cables and moving alternately in opposite directions. In such a "jig-back" system, one car moves uphill while the other car moves down. The capacity of each car range from 35 to 200 passengers. Large terminals and towers are required to support the cars, although towers can be placed relatively far apart. Trams are typically utilized to span long distances with potential lengths in excess of two miles. Trams are most often utilized in situations where extremely steep and undulating terrain is encountered. The shortest North American tramway of which we are aware is located at Royal Gorge, Colorado, spanning a vertical rise of 119 feet over a slope length of 2,200 feet. The route must be in a straight line, with towers and terminals built high enough off the ground to accommodate the large cars. Clearing of forest cover will probably be necessary along the tram alignment. The towers would have to be designed to withstand snow creep as a result of the considerable snow deposition at the site. Future expansion of capacity is not possible with this system. Due to the large size and extremely high capital costs of tramway systems, this alternative has been eliminated from further consideration. This system is also considered to have significant negative environmental and visual impacts to the site. In addition, the same type of service is provided by a gondola at a significantly lower capital cost. In summary, installation of an aerial tram at Crater Lake is not appropriate.

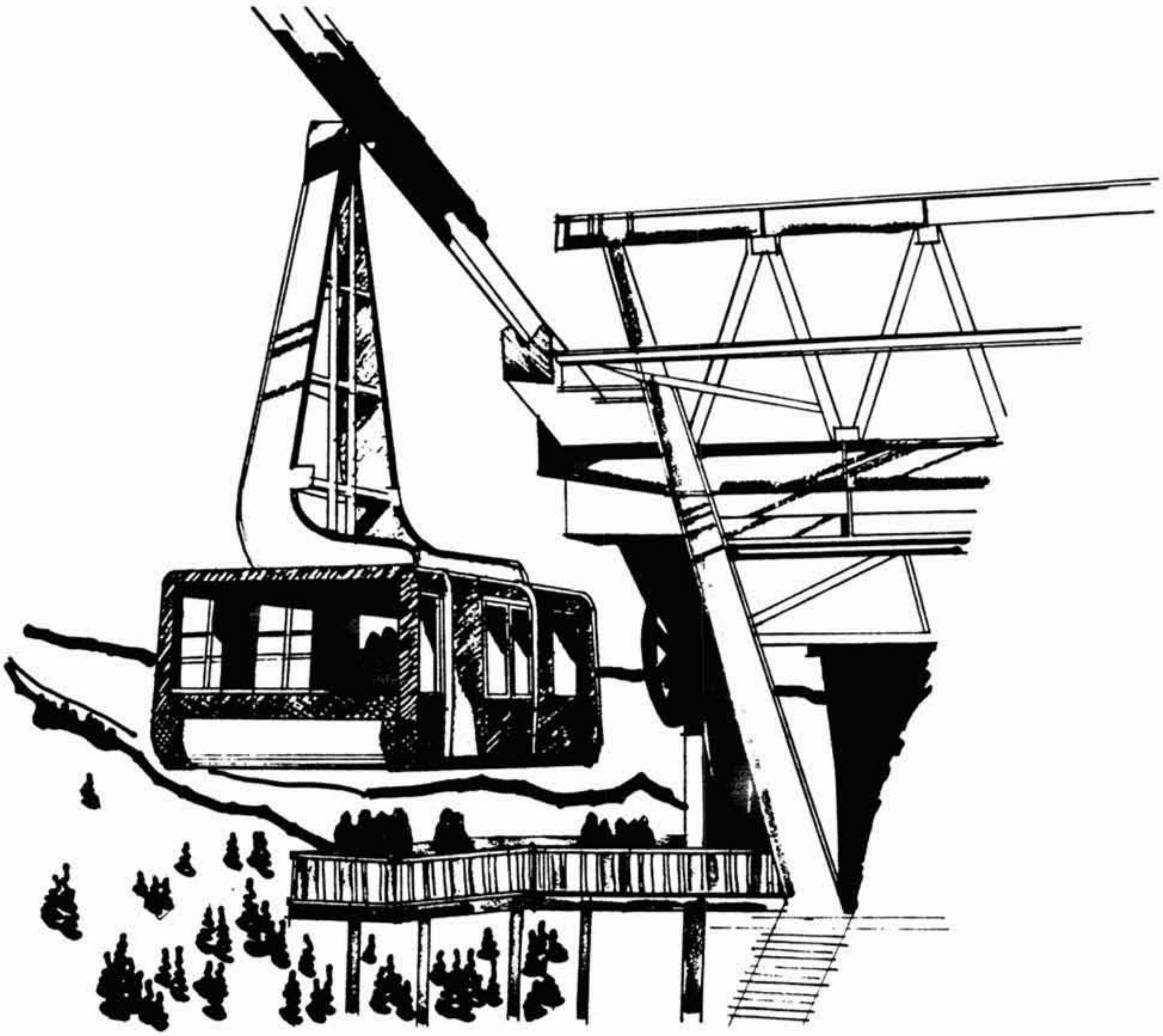

Figure 18. Typical aerial tramway system.

B. Detailed System Descriptions

For each of the alternative systems, this section summarizes the key characteristics of the application. The costs shown are for the hardware, guideways, and direct operating and maintenance only. Building costs for terminals and other fixed facilities (bus stops) are not included, as they can vary widely depending upon architectural treatment. The cost figures are planning level estimates based on schematic layouts and typical unit costs. The values are in 1989 dollars, with no provision for inflation.

The "base case" parking scenario assumed parking at the Rim sufficient to meet winter demands. However, for each option, the added cost of providing winter operating and maintenance functions are also provided.

1. Shuttle Bus

Hours of Operation: The hours of operation by season are summarized in Table 4 below. The daily service hours match those previously outlined in Table 1.

TABLE 4. PROPOSED SEASONAL SHUTTLE BUS OPERATING SCHEDULE AND FLEET SIZE

Season	Number of Buses Required to Meet Demand and Total Numbers of Hours/Day/Bus				Total
	1 Bus	2 Buses	3 Buses	5 Buses	Bus Hours
Summer:					
Peak (17 days)	4 hrs		3 hrs	5 hrs	646
Off Peak (45 days)	4 hrs	3 hrs	5 hrs		1,125
Winter:					
Peak (52 days)					0
Off Peak (130 days)					0
Shoulder:					
Peak (34 days)	5 hrs	5 hrs			510
Off Peak (88 days)	10 hrs				880
				TOTAL	3,161

Frequency of Service: During times of operation, the frequency is never less than the policy requirement of service every 7.5 minutes. During summer peaks, this frequency increases to as often as a bus every 1.5 minutes.

Trip Time: Except under adverse weather conditions, the trip time would be about two minutes from the parking lot to the new Activity Center/Hotel. Adding one-half of the policy headway (time between buses) of 7.5 minutes, makes the perceived trip time about five to six minutes.

Capacity: The fleet is sized to provide sufficient capacity for all seasons. As with any of the systems, there could be occasional, short-term peaks exceeding capacity.

Capital Cost: The cost estimates assume that the buses are either leased or provided by a private operator. Under these conditions, capital costs for the buses are included in the hourly or monthly charges. This does not include provision for a maintenance, for any storage facilities, or for the passenger terminal needed at the lower parking lot (approximately 900 square feet).

Operating and Maintenance Costs: The preliminary estimate of annual operating and maintenance cost is $160,000. If winter operations were provided, this figure would increase to $250,000.

Implementation Considerations: The shuttle system is most flexible of all the options, and the easiest to implement.

Environmental Impacts: Unpleasant noises and odors may be associated with a shuttle bus system.

2. Covered Walkway

Hours of Operation: A covered walkway could be available at all hours, but would probably be closed at the end of the service day for maintenance and reasons of security.

Frequency of Service: Service is continuous when the covered walkway is open.

Trip Time: The walk would require between six and seven minutes. Because of the uphill grade and the altitude, only half the normal walking speed was used in this estimate.

Capacity: The width was sized to provide sufficient capacity for all seasons. As with any of the systems, there could be occasional, short-term peaks exceeding capacity.

Capital Cost: Structural requirements to meet the heavy winter snow loads are a major component of the costs for this alternative. The planning level cost estimate for 750 lineal feet of covered sidewalk is $1.8 million. This assumes less expensive construction than that for the covered walk at Park Headquarters that cost about $250 per square foot. A figure of $150 per square foot was used in arriving at this estimate. Without a structural cover, the capital cost for a walkway would be reduced to about $250,000.

Operating and Maintenance Costs: The estimated annual operating and maintenance cost is $20,000. If all winter parking were to be provided at the Rim, this figure would be reduced.

Implementation Considerations: This presents no technical problems except for the design of the cover structure to withstand snow loading conditions.

Environmental Impacts: The visual impact of a lineal shed-like structure could be significant.

3. Covered Moving Sidewalk

Hours of Operation: As a continuously moving system, a moving sidewalk could be available at all hours, but would probably be closed at the end of the service day for maintenance and for reasons of security.

Frequency of Service: Service is continuous when the moving sidewalk is open.

Trip Time: The trip would require between six and seven minutes. This is based upon a typical moving sidewalk speed of about two feet per second, half that of normal walking.

Capacity: Capacity would be sufficient to serve all anticipated design demands. As with any of the systems, there could be occasional, short-term peaks exceeding capacity.

Capital Cost: The estimated cost for a covered moving sidewalk is $3.1 million. Approximately seventy percent of the cost is for the cover structure.

Operating and Maintenance Costs: The estimated annual operating and maintenance cost would be $70,000. If service were to be provided through the winter, this figure would increase to $125,000.

Implementation Considerations: There would be no major technical barriers to implementation, except for design of the structural cover.

Environmental Impacts: As with the covered walkway, the visual impact of a lineal shed-like structure could be significant.

4. Covered Walkway to Tunnel with Moving Sidewalk and Elevator

Hours of Operation: The covered walkway and moving sidewalk would provide continuous service, while the two elevators would provide on-demand service. As with the other walkway systems, it is likely that the tunnel and elevators would be closed at the end of the service day to allow for maintenance and for security purposes.

Frequency of Service: At peak times, elevator service could be provided at almost two departures per minute. Service on the moving sidewalk would be continuous during operating hours.

Trip Time: The mean trip time from the entrance of the covered walkway/tunnel to the Activity Center/Hotel would be seven to eight minutes.

Capacity: Capacity would be sufficient to serve all anticipated design demands. As with any of the systems, there could be occasional, short-term peaks exceeding capacity.

Capital Cost: The estimated capital cost for the combined system would be $4.4 million. Three quarters of this would be for the tunneling. However, tunneling costs are particularly sensitive to local site conditions and the cost estimate is therefore subject to wide variation.

Operating and Maintenance Costs: The estimated annual cost for operations and maintenance would be $90,000. If service were to be provided through the winter, this would increase to $145,000.

Implementation Considerations: There is considerable technical and cost risk in the tunneling.

Environmental Impacts: After site restoration is completed, a tunnel system would have minimal environmental impact.

5. Funicular Railway

Hours of Operation: The funicular system can be designed to be fully automated. Therefore, the hours of operation can be extended beyond those outlined in Table 1, as deemed appropriate by park management.

Frequency of Service: During peak conditions, the funicular has the capacity to maintain a two minute departure schedule.

Trip Time: The actual trip time, including loading/unloading and travel time, will be two minutes. At 1,000 feet per minute, the time to travel the distance of 750 feet, including acceleration and deceleration, will be approximately one minute.

Capacity: The system is designed to accommodate peak conditions during the summer months, requiring a capacity of approximately 1,000 people per hour, in either direction. This will be accomplished through the use of two thirty-passenger cabins, operating at a speed of 1,000 feet per minute. As one cabin leaves the lower terminal, the other cabin will leave the upper terminal (double reversible technology), with a by-pass section at mid-point for passing of the two cabins. As with any of the systems, there could be occasional, short-term peaks exceeding capacity.

Capital Cost: The capital cost for the elevated system, including hardware, above-ground guideway, and all installation costs is $2.5 million. The construction of the funicular in an underground tunnel would add an estimated $1.6 million, for a total cost of $4.1 million.

Operating and Maintenance Costs: The preliminary estimate of annual operating and maintenance costs for the elevated and underground systems is $70,000. If the system is operated during the winter months, the annual costs are estimated to increase to $100,000.

Implementation Considerations: There would be no major technical problems associated with implementation of a funicular system. Funiculars have been in continuous operation in many alpine settings throughout Europe since the turn of the century. The systems have been found to be extremely reliable. No known systems are currently operating in North America. However, a number of lift manufacturers with offices in the United States have the expertise to design and install funiculars. The system can operate in all weather conditions.

Environmental Impacts: After site restoration is completed, a tunnel system would have negligible environmental impact. The elevated system would be visually prominent due to the trestle style of guideway needed to support the track and cabins. However, this system would have considerable user appeal due to its uniqueness.

6. Aerial Gondola

Hours of Operation: The gondola system would be operated based upon the schedule outlined in Table 1.

Frequency of Service: During peak conditions, the gondola has the ability to maintain a two minute departure schedule.

Trip Time: The total trip time, comprised of loading/unloading and travel between terminals, will be two minutes. At 1,000 feet per minute, the time to travel the distance of 750 feet, including acceleration and deceleration, will be approximately one minute.

Capacity: The system is designed to handle peak conditions during the summer months, requiring a capacity of approximately 1,000 people per hour in either direction. Accordingly, the proposed gondola has similar operating characteristics as the funicular. The gondola would be designed as a "jig-back" system, using three ten-passenger cabins grouped together at each terminal. As one cluster of gondola cabins leaves the lower terminal, the other group of cabins will leave the upper terminal. This system will operate at 1,000 feet per minute. As with any of the systems, there could be occasional, short-term peaks exceeding capacity.

Capital Cost: The capital cost for the "jig-back" gondola system is estimated to be $1.25 million, including all hardware and installation costs.

Operating and Maintenance Costs: The preliminary estimate of annual operating and maintenance cost for the gondola system is $85,000. If the system is operated during the winter months, the annual costs are estimated at $125,000.

Implementation Considerations: There would be no major technical barriers to implementation of a gondola system. There are numerous gondolas in operation throughout North America. During 1988, three new gondolas were installed out of 103 aerial lifts constructed in North America. These systems have a proven track record of reliability. Additionally, there are several manufacturers in the United States with considerable design, installation and operational experience. Existing systems operate in all types of climatic conditions, however extreme wind may sometimes cause lift closures or require operation at reduced line speed for safety reasons.

Environmental Impacts: The tower placement for a gondola generally follows the natural undulations of the terrain, somewhat reducing the visual impact of an aerial system. Some trees may be removed for tower placement and cabin clearance along the lift line, however trees can be cleared in such as way (scalloping, etc.) to mitigate visual impacts. The gondola is a very quiet operating system.

7. <u>People Mover/Monorail</u>

Hours of Operation: The people mover system can be designed to be fully automated. Therefore, the hours of operation can be extended beyond those outlined in Table 1, as deemed appropriate by park management.

Frequency of Service: At peak times, service could be provided every two minutes.

Trip Time: The mean trip time at the peak would be less than two minutes. At off-peak times, the longer wait would increase the trip time to about five minutes.

Capacity: With a typical thirty-passenger vehicle, a single vehicle would be sufficient to meet projected demands. As with any of the systems, there could be occasional, short-term peaks exceeding capacity.

Capital Cost: The estimated capital cost would be $5 to $10 million for an elevated system. Putting the system underground would add another $1 to $2 million. Less expensive, cable drawn systems could be used, however that would make this option similar to the funicular. The reason for including a people mover/monorail alternative is to provide a more sophisticated system that could be expanded in length and capacity.

Operating and Maintenance Costs: The estimated annual operating and maintenance cost would be about $85,000 per year. If operations were to continue through the winter, these costs would increase to about $150,000.

Implementation Considerations: Because of cost, this alternative should be considered only if there is reasonable expectation of the need to expand the length of the system.

Environmental Impacts: There may be some objection to the visual impact of an elevated system.

C. Life Cycle Costs for Alternative Systems

The present (1989) value of capital cost plus 25 years of operating and maintenance costs are summarized for each system in Table 5 below.

TABLE 5. ESTIMATED LIFE CYCLE COSTS

Transportation System	Life Cycle Cost (in millions)
Shuttle Bus	$ 1.7
Covered Walkway	$ 2.0
Covered Moving Sidewalk	$ 4.5
Covered Walkway/Tunnel/Elevator	$ 5.9
Funicular Railway	
Elevated	$ 3.3
Tunnel	$ 4.9
Aerial Gondola	$ 2.2
People Mover/Monorail	
Elevated	$ 6-8
Tunnel	$11-13

D. Evaluation of Alternative Transportation Systems

TABLE 6. COMPARATIVE MATRIX SHOWING TRANSPORTATION SYSTEM ABILITY TO MEET PROJECT REQUIREMENTS, DESIGN CRITERIA, AND MANAGEMENT GOALS

CATE-GORY	CRITERIA	BUS	COVERED WALKWAY	MOVING SDW/ESC	TUNNEL/M SDW/ELEV	FUNICULAR ELEV.	FUNICULAR TUNNEL	GONDOLA	PEOPLE MOVER ELEV.	PEOPLE MOVER TUNNEL
USER	Trip Time									
	User Appeal including View									
	Comfort									
	Handicapped Access									
	General Reliability/Maintenance									
ENVIRONMENTAL	Hotel/Architectural Interface									
	Visual Impact									
	Vibration/Noise									
	Energy/Power Requirements									
	Odor									
	Tree Removal									
	Conflict - Other Activities									
OPERATOR	System Capacity to meet demand									
	Expandability (lengthen system)									
	Staffing Requirements									
	Winter Operating Capability									
	Extreme Storm-Weather Operation									
	Capital Cost									
	Operating and Maintenance Cost									
	Implementation Considerations									

Relative Ability

\+ (white) → (black) −

The relative suitability of the various transportation systems is discussed in the following sections.

1. Shuttle Bus

Use of a shuttle bus system at Crater Lake is clearly the most flexible of all mechanized alternatives considered. The system is easily adjusted in capacity and length for expansion purposes. Additionally, a bus system could also be incorporated into a comprehensive tour and interpretive program for the park. The implementation of this system also has low capital cost requirements, since the bus fleet can be leased. No trees will have to be removed to accommodate a bus system, with the exception of those removed for the new road alignment from the lower parking area to the Activity Center/Hotel. Unpleasant odors and noise from buses should be a major factor in considering a bus shuttle system at Crater Lake. Concurrently, it is a widely recognized fact that buses are unappealing to a large segment of the population.

2. Covered Walkway

This alternative requires the most physical effort from visitors to Crater Lake. Accordingly, without parking at the Crater Rim, certain segments of the visitor population (other than handicapped) will find it very difficult to access the site. While operating and maintenance costs are very low, this alternative requires a considerable capital outlay due to the structural needs for accommodating the heavy snowload at Crater Lake. The covered walkway will have a major visual presence through the removal of trees and the need to have a meandering alignment in order to keep walkway gradients at an acceptable limit.

3. Covered Moving Sidewalk

This system is similar to the covered walkway in many respects. All handicapped access will have to be provided at the crater rim. Visual impact can be somewhat reduced if escalators are used in conjunction with moving sidewalks. In this situation the escalator can climb steep slopes, while the moving sidewalk is limited to a 10-15 percent gradient. Using a tunnel at the top, interface with the Activity Center/Hotel would not be visually evident. However, all visitors would enter the building at a subterranean level. The structure covering this system remains a significant factor when considering capital costs.

4. Covered Walkway to Tunnel with Moving Sidewalk and Elevator

The use of a tunnel/elevator system would eliminate the visual impacts associated with the covered sidewalk options. Additionally, the elevators could be designed to transport visitors directly to the interpretative center in the hotel. Counteracting this positive feature is the fact that a tunnel and elevator system will present an uninviting image to visitors. In addition, the capital cost of this system would be extremely high due to the horizontal and vertical tunneling requirements.

5. Funicular Railway

The uniqueness of an elevated funicular installation at Crater Lake would have considerable appeal to the public. Conversely, it is believed that an underground funicular would have minimal user appeal in a setting as magnificent as Crater Lake. An automated funicular system would be extremely convenient, providing a comfortable ride and full accessibility for handicapped riders. While a funicular operating in a tunnel costs substantially more than an elevated system, placement above grade may be inconsistent with the Crater Lake landscape, depending upon the final design.

6. Aerial Gondola

The gondola system shares many of the benefits of a funicular, with less visual impact and more potential for views of the surrounding landscape. However, gondolas are not presently automated and are somewhat susceptible to extreme wind conditions, depending upon the alignment and microclimatic wind patterns. Most importantly, a gondola system represents approximately one half the capital cost for an elevated funicular.

7. People Mover/Monorail

An elevated people mover system, like the funicular and the gondola, would have considerable user appeal and provide convenient handicapped access. This system also has the greatest potential for expandability (i.e. length, capacity, etc.), following the bus. When considering various user, environmental, and operational characteristics of a people mover system in comparison to those of the funicular and gondola, it appears the high capital cost is not warranted.

VII. SUMMARY AND RECOMMENDATIONS

Based upon the description and analysis of alternative transportation systems, a number of primary characteristics should be taken into consideration in the selection of the most appropriate system(s) for use at Crater Lake. In order for a system to be successful, visitors must find it an inviting and attractive alternative to close-in parking. This becomes especially important if there is a fee associated with use of the system. In general, an underground system of any kind lacks the necessary appeal and fails to take advantage of the spectacular nature of the site. As an example, tunnel funicular systems in Europe are popular tourist attractions, because they propel riders a long distance to an otherwise unreachable viewpoint in a dramatic mountain setting. Conversely, while elevated systems result in certain levels of visual impact, they also provide opportunity for viewing the Crater Lake environment and promote a sense of arrival at the Rim Village. In summary, an elevated gondola or funicular system would offer new tourism opportunities at Crater Lake.

Presently, three parking options are being considered in association with plans for the Activity Center/Hotel. These alternative parking schemes vary in the amount of parking they provide at the Crater rim and in a lower parking lot. While it is important to provide parking for hotel guest and handicapped visitors at the Activity Center/Hotel, all other parking should be limited to the lower lot. If any parking for the general public is provided at the Crater rim, many visitors will not park in the lower lot until they are certain parking at the rim is full. Accordingly, this typical pattern of use by visitors will generate increased traffic on the new access road and in the Rim Village. This unnecessary traffic will also contribute to a reduction in air quality in the park. When considering "winter only" parking for the general public at the Crater Rim, it must be understood that at some point in the future, demand will exceed parking capacity. At that time, winter use of the lower lot and transportation system will be necessary. In addition, the same problems associated with providing limited rim parking in the summertime will also become apparent during the winter season.

Based upon the preceding system descriptions and evaluation, it is our recommendation that the following systems be retained for more detailed study in the Stage 2 report: bus, covered walkway, elevated funicular, and aerial gondola.

APPENDIX B

RESPONSE TO NPS REVIEW COMMENTS

NPS REVIEW COMMENTS - TECHNICAL MEMORANDUM, TRANSPORTATION
CRATER LAKE NATIONAL PARK - PACKAGE 220

1. *p. 16. Covered walkway should provide for handicapped access (Max. grade 8.33%). Construction of a covered walkway will eliminate the cost of a trail from the lower parking area to the Activity Center/Hotel. With the other systems, a trail would be constructed for visitors that like to hike up. This should be reflected in the life cycle cost.*

   Cost of the pedestrian path was not included in life-cycle costs in the preliminary report, but will be in the 100% report.

2. *p. 29. Is the cost of the buses included in the operating and maintenance cost? What is the cost to lease the buses?*

   The cost of the buses is included in the leasing cost. That leasing cost includes maintenance, operations, operating personnel, and amortization of the capital cost. The amortization component of the lease price was based upon the use of thirty foot transit coaches costing about $150,000 each. With a twelve year life, amortizing the capital cost at twelve percent results in an annual capital cost of about $24,000. In the 100% report, the capital cost will be listed as a separate item and will not be included in the lease price.

3. *p. 36. What is the interest rate used for the life cycle cost analysis? Is the replacement cost included in the life cycle cost?*

   The discount rate used in the life-cycle cost analysis was eight percent. In the 100% report, this will be changed to seven percent to reflect NPS guidelines.

4. *How did the figure of 24% (2% year) project increase in visitation come about? (bottom of p. 10) Is analysis in referenced material? Similarly, what is the basis of the percentage of reduction in use if a fare is instituted? (pp. 11-14)*

   As was discussed on page 10, the projected growth was based solely on an assumption that the Park would regain the visitation levels it had lost over the last decade and gain visitation from the new hotel with year-round occupancy. That assumption resulted in an estimated 24 percent growth from 1988 levels for summer and 42 percent growth for winter. The ridership reduction on the basis of a fare was a very rough estimate to illustrate the direction of effect in the summer-winter differences. It was not based on any specific estimates of what the fare would be or of the fare elasticity for Park Visitors. In the 100% report, the alternative of a fare will be dropped because we have concluded that a specific fare would discourage use of the system and would not work to meet the project objectives. It would also be an undue burden on large families. In addition, the costs of fare collection are relatively high. If the Park Service chooses to pay for some or all of the system costs through user revenues, it would be more efficient to add an appropriate amount to the Park entrance fee.

5. *I think strong consideration of alternative fuels to diesel should be given for any bus or engine-driven system. Maintenance requirements (p. 15) must be considered as part of this study. Also, where would buses be parked when not in use?*

   The 100% report will discuss fuel alternatives to diesel for the bus systems. The newer cost estimates will consider both maintenance within the Park and maintenance outside of Park boundaries. It is proposed that buses will be parked in the vicinity of Mazama Campground. For those options requiring winter operations of the bus fleet, covered storage will be necessary.

6. *The cost estimate (pp. 28-36) will be critical for selection of the preferred alternative; therefore, every attempt should be made to put all alternatives on an equal basis. The costs for terminals, bus stops, etc. should therefore be included (p. 28) with assumptions made as to architectural treatment. Also, the impact of buses vs. no buses on the road to the rim should be factored in.*

   The life-cycle costs for the 100% report will include the capital and operating costs of all facilities in each alternative (the transportation system, terminals, maintenance facilities, road, other necessary structures, and staffing for terminal buildings).

7. *Comparative matrix is an excellent tool. Perhaps a numerical rating (1-5) could be used for each of the criteria, such that a total could be summed for each alternate. Weighing factors might also be used.*

   The matrix is a representation of subjective information which is not well-suited to the application of numeric values.

8. *Summary on p. 40 must indicate absolutely no rim parking as one end of the spectrum being considered.*

   This recommendation is reflected in the alternatives under consideration during the 100% phase of study.

9. *p. 36. LCC - Has the cost of cold weather operations and snow plowing been factored into these costs? Specifically, snow plowing. For the next phase, the funicular should be evaluated for the possibility of eliminating plowing to the new Activity Center/Hotel completely. Information on labor and equipment costs for snow plowing has been enclosed with these comments.*

   Snow plowing was not included in the costs in the preliminary report, but will be in the 100% report.

10. *It would be informative to include some discussion on the relative consumption of non-renewable energy fuels for each option. I.E. the buses will consume oil, as will snowplows, whereas hydro generated electric power will use less petroleum fuels.*

    This consideration will be included in the matrix comparing alternatives in the 100% phase report.

11. *The assumption here is visitation will increase. Again on p. 10, the increase is projected to be 24% by 1999. I question the rationale for this - it depends on why its been falling off. Crowding could be a major factor, but there could be others.*

    The rationale for the 24 percent growth was one of assuming that the park would recapture annual visitors that it had lost over the past decade. Neither the causes of the past loss of visitation, the steps necessary to regain it, nor the desirability of regaining visitation levels were part of the scope of work. The growth assumption was just that, an assumption.

12. *The operating cost effectiveness of these systems is critical. What comes to mind are the Colorado ski areas which close in April when the snow conditions are the best of the year. The rationale is that it is not cost effective to operate the systems when visitation drops to a certain level. What is the balance point?*

    The alternatives discussed in the 100% phase will illustrate the effect of various seasonal operating assumptions.

13. *Agree with the comments against diesel operations. At that altitude and grade it would be dismal. I'd suggest the A/E look at the types of coaches used at Muir Woods. They're built on a Ford chassis and can carry 25 people. They're used because of the tight radius and steep grades and are highly recommended by both operators and passengers.*

    We have not been able to obtain any information on these coaches.

14. *Do not suggest that the route terminate at the porte cochere of the lodge!! This is not the primary objective of the visitor nor should it be. During the winter months there may be some validity but not during the summer.*

    Our understanding is that the function of a porte cochere is to serve as the entry point for the building. Additionally, we expect that visitors will be oriented at the Activity Center/Hotel before proceeding to the rim or other destinations. Therefore, the porte cochere seems a logical terminus for the shuttle from the parking lot.

15. *Pp. 36-37. The gondola looks better than I'd ever expected it would.*

    Acknowledged.

16. *Must include parking plans and terminal plans with next submittal. Report is to look at overall transportation, including roads and parking. Since terminal designs and parking plans have only recently been submitted, additional comments are likely on these aspects. Completion and submittal of final transportation report may have to be delayed until these items can be reviewed.*

    The final report submitted by FFA will include all these elements.

17. *Life cycle cost analysis should use interest rates required by LCC standards. Life cycle costs should be broken down into fuel, power, operating personnel, maintenance, replacement equipment, and other cost categories as appropriate for the next stage of study. A copy of discount factors to be used with various types of fuels and information on electrical costs are included with these comments.*

    Procedures for generating life-cycle costs are described in the 100% report.

18. *Have standby power costs been included for funicular and gondola? Terminal buildings will have to be sized for generator. What KW generator will be required with each?*

Standby power is included in costs for the funicular and gondola in the 100% phase report.

19. *Basically, this study is thorough but difficult to fully evaluate without knowing the various parking options.*

This will be addressed in more detail in the 100% report.

20. *We are somewhat skeptical of the "General Reliability/Maint" in Table 6 on page 37. Surely mechanical conveyances are more complex and difficult to maintain than indicated.*

The systems all require similar levels of routine maintenance. If well-maintained, all the systems are considered to be highly reliable.

21. *p. 2 - last paragraph. Discussion of grades is somewhat confusing - should be clarified.*

This has been corrected.

22. *p. 4 - Figure 2. Horizontal and vertical scale would help the meaning of this figure.*

A scale has been added.

23. *p. 8 - Figure 5. Vertical legend in error?*

The vertical bars were at the correct relative height, but the vertical legend was in error. A corrected version is shown in the 100% report.

24. *p. 11 - Table 1. Why show three seasons when there are only two hours of operation scenarios?*

These illustrate the hours of operations that would be required if the parking scenario is one requiring operation in all seasons. The five new alternatives addressed in the 100% phase of study include several alternative seasonal operations.

25. *p. 37 - Table 6. Light grey does not show up well in the figure. Should be darkened.*

The copy quality in the 100% report will be better.

26. *p. 40. Recommendations - Report should note that funicular or gondola will have to be approved by the director (Reference NPS policies).*

If the funicular or gondola are selected as the preferred alternative, this issue will be addressed.

27. *p. 1 - paragraph 3. No specific parking accumulation data is available. However, the entire parking area at the rim fills on a peak visitor day. We concur with the recommendation of collecting parking use data this summer.*

Acknowledged.

28. *p. 6. Implementation Considerations - Timing of construction is an important implementation issue. In general, the system will probably have to be operational when the lower parking area is opened.*

We agree that this timing is appropriate.

29. *p. 8 - Figure 5. Scale of Y axis is incorrect.*

This has been corrected.

30. *p. 9. Hourly Patterns - Is this number of people at rim during that period, number arriving at that hour, or something else?*

Figures 6 and 7 show the arrivals by hour.

31. *p. 10. The comparison of Crater Lake vs. system-wide visitation is interesting but perhaps confusing. There has probably been an increase in the number of park service facilities since 1978. The change in visits per facility may not be quite as dramatic.*

Acknowledged.

32. *p. 10. It seems unusual that both summer and winter visitation would increase by the same amount. It seems that winter visitation will increase more since the increase in winter facilities is more dramatic.*

Acknowledged. This adjustment will be reflected in the 100% report.

33. *p. 11 - paragraph 2. First sentence doesn't read correctly.*

This has been corrected.

34. *p. 11 - last sentence. Believe "won't" should be changed to "will" in order to read properly.*

This has been corrected.

35. *pp. 12-14. Capacity and Summary of Parking Demands: This section does not address the need to define parking area requirements for the three parking options. Where does the 450 car number come from? Does this amount of parking adequately serve anticipated parking needs? How much parking is needed at the rim to provide for winter parking? Reference Article B.13.a of the modification.*

The five alternatives considered in the 100% phase of study address the various arrangements of parking. The 450 plus 54 spaces was based on an estimated current capacity of 500, and observations of those familiar with the Park that all spaces were occupied at peak times. No other data on parking accumulation were available. However, TDA is presently seeking authorization to conduct a field count in August of 1989 in order to obtain accurate information.

36. *Analysis of Systems: No estimate has been made of personnel requirements. This is an important factor in considering alternatives.*

This consideration will be included in the comparison of alternatives in the 100% phase report.

37. *Covered Walkway: Does not really address the issue of providing a means other than pedestrian to transport people.*

Acknowledged.

38. *Covered Moving Sidewalk: Would this system be handicap accessible?*

This would depend on the final design, but it is unlikely that it would be. It might be necessary to provide an alternative shuttle for the handicapped.

39. *Covered Walkway with Moving Sidewalk: Would this system be handicap accessible?*

This would depend on the final design, but it is unlikely that it would be. It might be necessary to provide an alternative shuttle for the handicapped.

40. *p. 28 - Line 5. Change "very" to "vary"*

This has been corrected.

41. *Building costs should be included in the final lift-cycle cost analysis. Buildings will have been designed to a preliminary level and should be included in the analysis.*

All costs will be included in the 100% report.

42. *Shuttle Bus: Bus operating schedule is difficult to follow. How many buses are needed total? Will spare buses be required?*

At the peak, five operating buses will be required. In addition, one spare bus will be needed.

43. *Shuttle Bus - trip time: Comment in regard to perceived trip time should apply to other systems such as gondola and funicular but only seems to be mentioned here.*

This has been included for all alternative in the 100% report.

44. *Shuttle Bus - capital cost: Ignoring maintenance, storage facilities, and passenger facilities makes an incomplete analysis. These items should be included in the detailed analysis.*

All costs will be included in the 100% report.

45. *Covered Walkway: 750 feet of walkway climbing 75 feet is 10 percent grade. It is probably unreasonable to plan such a walkway without intermediate landings. Has this been included? 10 percent grade does not meet handicap accessibility standards. This should be noted in the report. Walkway would either have to be lengthened significantly or handicap parking provided above.*

Landings would be required in any walkway design and have been considered. The walkway could be designed to be accessible, but this would result in a long and circuitous route. The covered walkway option has been eliminated from further consideration.

46. *Covered Walkway - costs: The walkway at Headquarters cost on the order of $300 per square foot on a much more accessible site. There should be some economies of scale with much more walkway to construct, but $150 per square foot is probably low. What will ventilation requirements be when the walkway is buried under fifteen feet of snow? How often will emergency exits be required? Seems as though walkway would almost need intermediate structures incorporating a landing, ventilation, and emergency exit. Does not sound like a great park experience.*

Acknowledged. The covered walkway option has been eliminated from further consideration.

47. *Covered Moving Sidewalk: May solve grade problems of option without moving sidewalk. Would it be handicap accessible?*

While a covered moving sidewalk could be made accessible, the escalators required in this option would not be accessible. It might be necessary to provide an alternative shuttle for the handicapped. The moving sidewalk option has been eliminated from further consideration.

48. *Covered Walkway and Tunnel, with Moving Sidewalk and Elevator: This solves grade and snow problems, but adds a tremendous expense of indefinite magnitude in tunneling. Recommend against any of these "covered walkway" options.*

Acknowledged. All covered walkway options have been eliminated from further consideration.

49. *Funicular Railway: The aerial funicular would appear to have a number of advantages including quiet, fast, and allowing riders to view the park resource while riding. It has its disadvantages also, including visibility, expense, and lack of future flexibility. While it may not end up preferred, it is probably worth giving more detailed analysis.*

Acknowledged. The funicular option will be further analyzed in the 100% phase of study.

50. *Aerial Gondola: Similar to the funicular, this system has enough advantages to warrant further analysis.*

Acknowledged. The gondola option will be further analyzed in the 100% phase of study.

51. *People Mover/Monorail: Recommend against further consideration of this option due to high expense.*

Acknowledged. The people mover option has been eliminated from further consideration.

52. *Evaluation Matrix: As may become obvious from more specific comments below, we feel the matrix tends to overly penalize the bus system in several areas.*

See discussion of comments 53-60.

53. *User Appeal: Covered walkway would have some user appeal, particularly if used only in summer since it could be open to the surrounding scenery.*

Acknowledged. All options will include a walkway for summer use.

54. *Visual Impact: Do not agree that bus will have more visual impact than gondola.*

Acknowledged. This is a matter of perspective in a subjective analysis.

55. *Odor: Odor problem with buses can be addressed with alternative fuels. Should be more in the middle range.*

Acknowledged. Alternative fuels will be discussed in the 100% report.

56. *Conflict: Tunnel should be same ability as tunnel funicular. Bus should move up one notch in ability.*

Acknowledged.

57. *Winter Operating Capability: Do not agree that bus system should be rated down quite as low as it is. Buses are operating regularly in a number of winter environments.*

Acknowledged. In most scenarios, plowing for emergency vehicles will be required anyway.

58. *Extreme Storm Weather Operation: For this short run, buses should be able to operate whenever people are able to make it up to the parking area.*

Acknowledged.

59. *Capital Cost: To compare on equal footing, buses should probably be addressed as being purchased at beginning of period.*

Capital costs for the buses are included in the lease costs.

60. *Shuttle Bus: Address fact that potential odor and pollution problems may be improved by use of alternative fuels.*

The effect of alternative fuels on odor and pollution will be discussed in the 100% report.

61. *Summary and Recommendations: Agree with the report's recommendations with exception of one system. Do not feel the covered walkway warrants further consideration. As an alternative, recommend the consideration of a multilevel parking structure near the Activity Center/Hotel which would eliminate the need for any mechanized transportation system.*

Acknowledged. These comments are reflected in the alternatives under consideration in the 100% phase of study.