

The traffic control room is divided into three separate areas; a control room, a machine room and a power room. The control room is where the operation of the system is performed by operators and is the focal point of the traffic control and management system. Because of this, the room must be separated from noise and heat sources and its color and lighting must be well coordinated in order to ensure efficient operation. Various equipment such as the computer and transmission devices are to be placed in the machine room. The power room accommodates power supply equipment like the uninterruptible power supply, rectifier and battery.

e Environmental Conditions

- Air conditioning

Control room and machine room must be air-conditioned to provide suitable environmental condition for the operators and equipment. Although some equipment operate within the broad temperature range, the reliability of the equipment will be enhanced at the constant temperature.

- Lighting

Lighting plays an important role in the operation of the system and must be designed to create efficient and comfortable working condition for the operator.

Light sources must be placed in such a way that light reflected by the graphic display panel or CRT screen will not be directly seen by the operator. Illumination of the control console must be bright enough for operator to operate switches or to record the operation.

(11) Uninterruptible Power Supply

As the traffic management and operation system relies on a computer system that operates on a 24-hour basis, a continuous and stable power supply is essential for operation of the traffic control room and the traffic operation room. Uninterruptible power supply system consists of a generator, a constant voltage and constant frequency power supply, a changeover switch, batteries and rectifier.

Under normal condition, the power supply system receives commercial power and supplies power to the equipment through a stabilizing circuit. Should an interruption occur, power is supplied from the batteries until the generator has started and reached a steady state. The changeover switch is provided to switch over automatically between commercial power and the generator.

Capacity of the power supply system is determined by the power requirements of all surveillance and control equipment at the traffic control room, power for air conditioning system and emergency light, and allowance for future expansion. A smaller backup system is provided for carrier terminal stations to maintain the transmission system when commercial power is interrupted.

Power for roadside facilities is directly supplied by commercial power and no backup power is provided for economic reason.

(12) Measurement facilities

In order to maintain the good conditions of the motorways and prevent traffic hazards, the height and axle weight of vehicles must be checked according to the law.

a. Vehicle height checkers

Vehicle height checkers are installed to enforce vehicle height regulations for all vehicles at entrance ramps prior to the tollgates.

b. Axle weight scales

Axle weight scales are installed at each entrance to tollgates to check the maximum allowable axle weight of vehicle.

## 6.2.2 Road Maintenance and Operations

### 1) General

The purpose of this section is to describe the road maintenance and operations portion of the "Immediate Implementation Plan", covering the 324.8 km of motorway from Kinali to Sakarya (Kazanci) in Divisions 17 and 1 in the Istanbul and Izmit areas. Provided will be a breakdown of the inspection work, maintenance and repair work (including repairs to pavement, cleaning of the roadway and drainage channels, roadside earth, repainting traffic control facilities, bridges, tunnels, etc.), snow and ice control, and the required vehicles and equipment necessary to provide maintenance and operations. Regarding inspections, maintenance work to pavement, cleaning work, repair work to bridges, slope protection work and grass cutting work, etc. the following assumptions have been created, considering the present motorway maintenance and operations and the experience in the foreign countries.

### 2) Inspection Works

Each maintenance office operate inspection works of routine (every other day), periodic (yearly) and special activities by road maintenance patrol crew with three (3) patrol cars.

The following are the office name and jurisdictional road locations and length;

#### Division 17

Main Maintenance Center (MMC)	Maintenance Office (MO)	Road Length
Istanbul	Selimpasa	58 km (from sta. 23 km to sta. 81 km)
	Mahmutbay	47 km (from sta. 0 km to sta. 23 km + 3-access)
	Kavacik	64.5 km (1st & 2nd ring Roads + 1-access)
	Bridges (3 -Main bridges)	2.5 km
Total		172.0 km

## Division 1

<u>Main Maintenance Center (MMC)</u>	<u>Maintenance Office (MO)</u>	<u>Road Length</u>
Tutunciftlik	Kurikoy	58.2 km (from sta. 0 to sta. 50.7 + 1 - Access)
	Tutunciftlik	48.2 km (from sta. 50.7 to sta. 98.9)
	Sapanca	46.4 km (from sta. 98.0 to sta. 145.3)
	Total	152.8 km

Normal inspections shall be done by KGM staff, such as inspections of pavement, drainage, slopes, bridges, etc. But the periodic inspection of long span bridges is assumed to be done by contract.

### 3) Cleaning Work

The breakdown of cleaning work is provided as follows;

- Road cleaning including interchanges and parking lots will be done by KGM staff, or force account.
- Cleaning of bridge rail, guardrail, and tunnel wall will be done by KGM staff, or force account.
- Cleaning interchanges green area, toilets, parking areas will be done on a contract basis.
- Rest areas, service areas; The cleaning of the parking lots and facilities, grass cutting, etc., will be done on a contract basis.
- Drainage cleaning. Cleaning of drainage culverts and channels will be done on a contract basis.
- Grass cutting will be done on a contract basis with unimog or other equipment.

#### 4) Maintenance Work

Normal maintenance work will be done by KGM, or force account. The resultant is that contractors are bidding on the provision of services, and not any variations in equipment costs. A description of maintenance work related to pavement, vegetation slope, and repair of bridges is as follows:

##### (1) Pavement rehabilitation

Pavement works such as pothole and crack repair will be done by force account by KGM staff. Significantly large overlay works will be done on a contract basis with the contractor furnishing all the heavy equipment, including the paving machines, bituminous distributors, and compaction equipment (steel wheel roller, pneumatic rollers), etc.

##### (2) Repair of bridges

Will be done by KGM staff, or force account except for major repairs, such as repair of joints, slabs, slope protection around the abutment, painting of the bridge structure, etc. However, long span bridges will be inspected periodically and planned for repair works on a contract basis.

##### (3) Slope protection works

Ordinary repair works will be done by KGM staff, or force account. Large slope protection works requiring civil engineering expertise will be done on a contract basis.

#### 5) Snow and Ice Control

According to the snowfall records (see Table 5.6.17, "Meteorological Data For Cities Adjacent to the Motorway Routes"), Istanbul has an annual rainfall of 677 cm, 123 days of rain, and 27 frost days between November and April. It also has an average temperature of 14.0 °C, a maximum temperature of 40.5 °C, and a low temperature of -16.1 °C. The maximum depth of snow is 75 cm. The maximum depth of snow in Izmit, on the eastern end of this section of motorway, is 90 cm. According to KGM records, roadways near this segment of motorway were closed to traffic four times due to significant snowfall from 1989 to 1991.

As snowfall is an expected phenomenon each winter, and snow and ice removal are already part of the maintenance responsibility of KGM, KGM should be expected to be equipped to respond to the snowfall when it occurs. According to Table 5.6.16, for a maximum snowfall of 0.3 - 1.0 m, the following typical snow removal equipment should be provided at each maintenance office:

<u>Equipment Type</u>	<u>No. required</u>
10 ton truck	2
Unimog Truck with Attachment snow blade, covered salt storage, etc.	4
7 ton truck	2
Chemical sprayer	1
Sprinkler truck	1

These maintenance vehicles should be provided at each maintenance office in Divisions 17 and 1 that can expect appreciable snowfall during the winter season;

Table 6.2.6 Maintenance office

<u>Division 17</u>	<u>Division 1</u>
Selimpasa	Tutunciftlik
Muhmutbay	Kurtkoy
Kavacik	Sapanca

#### 6) Vehicles and Equipment

Based on the above discussion the following required number of vehicles and equipment (see Table 6.2.7) is estimated for the force account works of the road maintenance and operations including the traffic management and operations;

Table 6.2.7 Required Vehicles and Equipment

Vehicles and Equipment	Number of Unit		
	Standard Maintenance Office covering 50 km	Div.1 Kurfkoy Tutunciflik Sapanca	Div. 17 Selimpasa Muhmutbay Kavacik Bridges
1. Sedan Car	3	9	11
2. Sedan Car (Road Maintenance)	3	9	9
3. Sedan Car (Traffic Management)	4	12	12
4. Pick up (Machine/Electric)	2	6	7
5. Dump or Maintenance Truck	5	15	17
6. Unimog Truck Attachment: 18 Snow blade -4, covered salt strage -4, curb stone washer -1, Dril -1, glass cutter -1, tunnel washer -1, excavating arm - 1, breaker -1, front sweeper-1, mud pump 1, others -2	4	12  attachment 54	12  attachment 54
7. Maintenance platform	1	3	3
8. Road cleaner with Vacuum	1	3	5
9. Splinkler Truck	1	3	3
10. Compressor	1	3	6
11. Cutting Machine	1	3	3
12. Roller	1	3	3
13. Portable Welding Machine	1	3	4
14. Rekker	3	9	9
15. Pneumatic Excavator	1	3	3
16. Traffic signal truck	2	6	6
17. Mini Bus	5	15	17
18. Winch/Truck erantl	1	3	3
19. Small Tractor	-	0	5
20. Asphalt Plant	(1)	1	1
21. Loader	1	3	3
22. Maintenance gantry	-	0	1
Total	40 + (18)	124+(54)	144+(54)

### 6.2.3 Architectural Facilities

The actual size of each architectural facility referred to section 5.7 is not uniform and depends on the extent of the service and size of the subject area. The actual facilities to be introduced at a main maintenance centre or maintenance office also vary depending on the local requirements. In the case of high snowfall mountainous areas in the north and east for example, measures to combat snow and ice are the most important while such measures are not required in the south and west. The prospective sizes and configuration of the architectural facilities are examined next in view of estimating the project cost on a reliable basis.

#### 1) Main Maintenance Centers

The construction of 8 main maintenance centers across Turkey is currently planned. Using the main maintenance center planned at the Adana East Interchange within the jurisdiction of the No. 5 Regional Office as an example, the possible size and configuration of the main maintenance center is estimated here based on its drawings.

The traffic control building at the center will be constructed as an independent building from the administration building to function as a central traffic control center which will conduct high level traffic control work consisting of not only the collection, analysis and study of traffic information but also the examination of desirable traffic control methods and measures.

#### 2) Maintenance Office

Using the Kavacik Maintenance Office near Istanbul under the jurisdiction of the No. 17 Regional Office, the construction of which is near completion as of August, 1992, as an example, the possible size and configuration of the maintenance office is estimated. The construction of some 30 maintenance centers across Turkey is currently planned. At each maintenance center, the traffic operation building will be separately constructed from the administration building and will act as the command center for traffic control.



3) Maintenance Units

The maintenance units will be seasonal facilities, operating only in winter. Consequently, the facilities should be kept to a minimum to limit the initial construction cost as well as maintenance cost. The construction of some 35 maintenance units across Turkey is planned.

4) Toll Collection Stations

The number of toll booths and the size of the monitoring station and office at each toll collection station will depend on the passing traffic volume forecast. The toll collection station near Adana under the jurisdiction of the No. 5 Regional Office will be used to determine the general size of the stations. The construction of some 70 toll collection stations across Turkey is planned.

5) Barriers

The size of the barriers on motorways will also depend on the passing traffic volume forecast. The barrier on Route Urla near Istanbul will be used to determine the general size of the barriers. Some 20 barriers across Turkey are planned.

6) Parking Areas

A public toilet will be constructed at each parking area. The ratio of Turkish style bowls and Western style bowls will be 6:4. Some 100 parking areas across Turkey are planned.

7) Service Areas

As the service areas will generate profits, the use of the BOT method is planned for their construction and management. Accordingly, determination of the standard size is rather difficult unless the accurate traffic volume and composition of travelling vehicles for each service area are known. It will be the responsibility of the private enterprises which will construct and manage the service areas to decide the size and configuration of each service area. Some 15 services areas across Turkey are planned.

8) Rest Areas

The difference between a rest area and a service area is whether or not overnight accommodation facilities, such as a hotel or motel, are provided. Apart from accommodation facilities, a rest area is exactly the same as a service area. The introduction of some 5 rest areas across Turkey is desirable.

9) Training Center

The establishment of 2 training centers, i.e. one at the halfway point between Ankara and Istanbul and one near Izmir or Adana, is desirable to enable the continuous education/training of KGM employees.

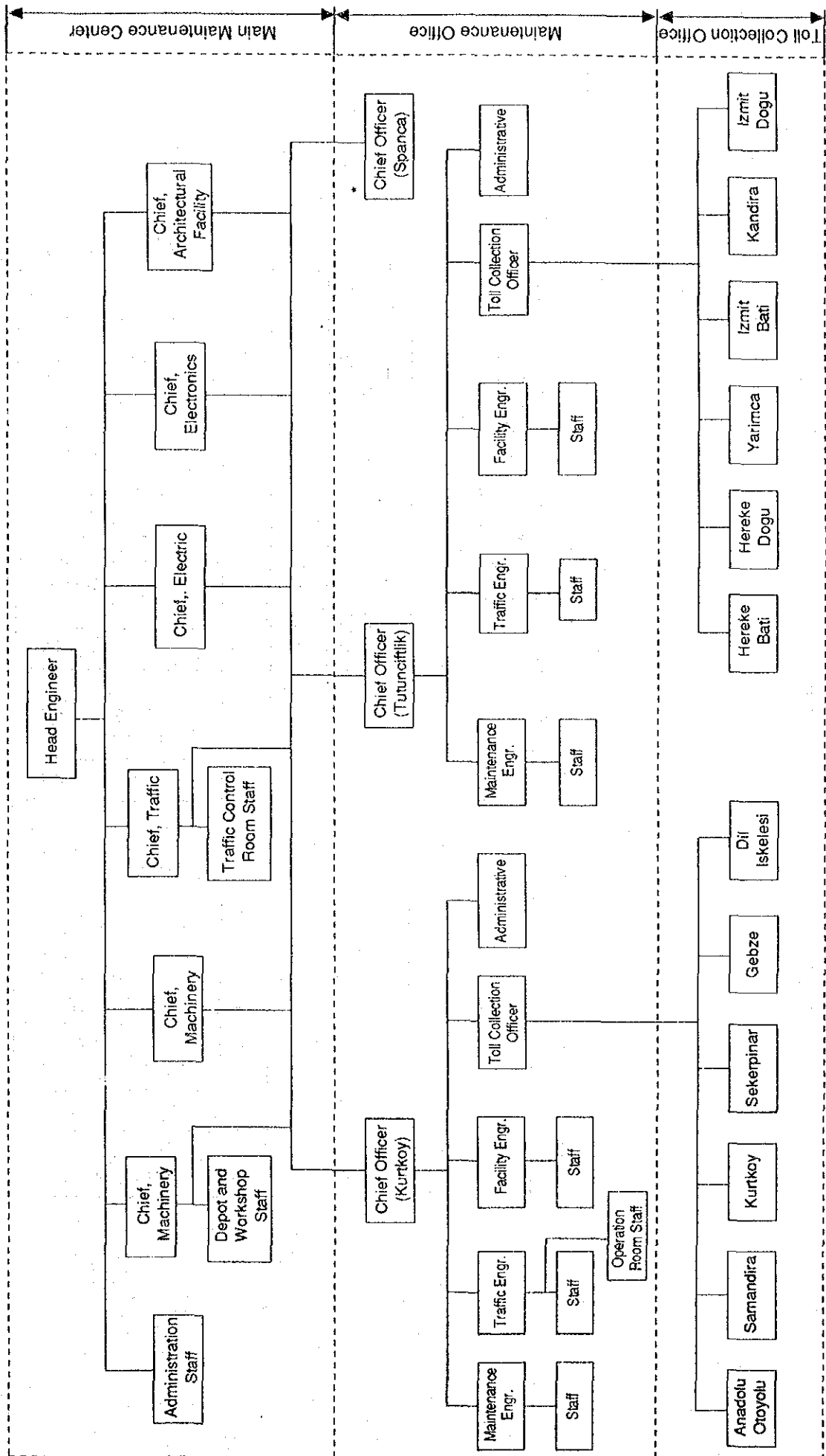
#### 6.2.4 Organization

The existing organization is shown in section 3.1, Institutional Organization. Section 5.3.1 provides a discussion and recommendations for an organization that would permit the efficient maintenance and management of the 3,000 km motorway. Included in those recommendations are suggestions for changes at both headquarters and the regional offices. The organization charts (Fig. 6.2.17, Fig. 6.2.18 and Fig. 6.2.19 are a recommendation for divisional offices, followed by a recommendation for each maintenance office (approx. 50 km intervals). The following indicates office name and the number of staff for the OMM system.

Division	Main Maintenance Center		Maintenance office with Toll Collection Office	
17 (766)	Istanbul	(115)	Bridges	(254)
			Selimpasa	(178)
			Mahmutbay	(149)
			Istanbul	(40)
			(Traffic Management•operation)	
			Kavacik	(53)
			(Road Maintenance•operation)	
1 (499)	Tutunciftlik	(95)	Kurtkoy	(158)
			Tutunciftlik	(164)
			Sapanca	(142)

Note: Figures in parenthesis indicate the number of personnel in each office.

Figure 6.2.17 1st Division of Organization chart of Main Maintenance Center, Maintenance Office and Toll Collection Office



\* Detailed organization is not shown.





## 6.3 Cost Estimation

### 1) General

The purpose of the cost estimate is to determine the cost of implementing a complete motorway maintenance & operations and traffic management system for the Republic of Turkey. This cost will be developed to include the cost to implement the system for the "immediate implementation plan" for approximately 320 km section of motorway from Kinali to Sakarya. Some sections of the motorway already have some of the facilities necessary for the maintenance and operations and traffic management system recommended by this study. These facilities, including buildings, equipment, and staff, will be accounted for in these estimates.

The service areas and rest areas will be developed by KGM using the BOT (build, operate and transfer) system, in which the private sector will provide the facilities initially, and then turn them over to KGM at a later agreed upon time. Construction cost for these facilities will be shouldered by the private sectors.

The cost to develop the system of maintenance & operations and traffic management & operations is comprised of three elements, as follows:

- The construction cost to develop the initial facilities;
- The cost to provide the original and new equipment; and
- The cost to operate and maintain the facilities and equipment on an annual basis.

The costs will be further broken down by function, as follows.

### 2) Traffic management and operations

#### (1) Construction Cost

The construction cost which includes the facilities and equipment cost and installation work cost is estimated in accordance with the recommended system configuration, which includes the following items:

##### a) Information gathering system

- Emergency telephones
- Traffic detectors
- Meteorological information facilities
- Closed circuit television (CCTV)

b) Information processing system

- Central processor
- Peripherals
- Graphic display panel
- Software

c) Motorist information system

- Variable message signs

d) Measurement system

- Vehicle height checkers
- Axle weight scales

e) Communications system

- Trenching, conduits and cables
- Trunk line systems
- Local line systems
- Exchanges

It should be noted that this construction cost does not include costs of office building, air-conditioning system and generator.

The unit costs of the equipment are estimated based on informations from available sources in foreign countries, as this equipment has a low availability in Turkey and has to be imported. The imported equipment costs includes customs and tax.

System construction cost is shown in Table 6.3.1 for each Division.



Table 6.3.1 Summary of Construction Cost Estimates  
by Traffic Management/Operations System

Unit: 1,000 US\$

No.	Description	Division	Estimated Amount	Per km
1.	Information Gathering System & Measurement System	17	5,821	43
		1	3,584	26
		total	9,405	35
2.	Information Processing System	17	8,585	6
		1	9,423	69
		total	18,008	67
3.	Motorist Information System	17	6,591	49
		1	8,025	59
		total	14,616	54
4.	Communication System	17	16,482	123
		1	16,625	123
		total	33,107	123
	Total	17	37,478	279
		1	37,658	278
		total	75,136	278

(2) Operation and Maintenance Cost

The operations and maintenance costs of the system includes the following items:

a System operations staff salary

This item is the total salary of staff engaged directly in the operation of traffic control room and traffic operation rooms. A 24-hour operation with three staff shifts is assumed.

b Electricity

Electricity is consumed by both the traffic control/operations rooms and the roadside equipment. Power consumption is calculated for each type of equipment is first determined and then the total power construction is determined for the entire system.

c Maintenance of the system

The system maintenance cost consists of labor, vehicles, spare parts and miscellaneous expenses. It is assumed that maintenance work is undertaken by a maintenance company on a contract basis.

d Patrol squad expenses

These expenses include staff salary, depreciation and operating cost of cars or trucks, and tools and devices carried by cars or trucks.

Estimated operations and maintenance cost is shown in Table 6.3.2.

Table 6.3.2 Summary of Annual Operations/Maintenance Cost

Unit: 1,000 US\$		
Division	Estimated Amount	Per km
17	1,874	14
1	1,883	14
total	3,757	14

3) Road maintenance and operations

The cost estimates for road maintenance and operations are made up of the following items:

(1) Personnel Cost

All staff for the OMM system of the motorway in Divisions 17 and 1 is counted for the cost estimates

Division 17----- 766 persons  
Division 1 ----- 499 persons

(2) Vehicle and Equipment

All vehicles and equipment required for the OMM system in Divisions 17 and 1 are counted. The following number includes the existing and newly purchased vehicles and equipment.

Division 17----- 144 units  
Division 1 ----- 124 units

For the purpose of cost estimation, annual depreciation cost of the vehicles and equipment are calculated instead of the new purchase cost.

(3) Pavement Maintenance Cost

As routine maintenance cost, repair costs for potholes, crack, rutting, etc. are prepared for Division 17 and 1.

Asphalt overlay cost for periodic maintenance is counted every 6 year.

(4) Long Span Bridges

Maintenance cost of 1st and 2nd Bosphorus and Golden Horn bridges is estimated considering inspection work, corrosion control, painting, joint replacement. The periodic inspection works will be done on a contract basis.

(5) Works on Contract Basis

The following works are estimated on contract basis with private firms.

- Asphalt overlay for periodic maintenance;
- Vegetation control, landscaping and watering;
- Repair of guardrail and wire fence;
- Cleaning and replacement of lighting post with lamp; and
- Inspection and Test of long span bridges.

(6) The costs of parts, fuel and lubricant, communication,, electricity, water, salt, traffic markings, etc. are also estimated.

(7) Road maintenance and operations costs are summarized in Table 6.3.3.

Table 6.3.3 Summary of Road Maintenance Operations Costs (1992 prices)

Unit: 1,000US\$

	Division 17 (172 km)	Division 1 (152.8 km)
1. Personnel cost	7,222	4,705
2. Equipment	8,008	7,208
3. Parts cost/repair	801	721
4. Fuel & lubricant	1,419	1,223
5. Communications	5	3
6. Electricity	133	92
7. Water cost (w/o vegetation water)	4	3
8. Salt	104	131
9. (1) Asphalt/routine maint. (annual cost)	507	405
(2) Asphalt/periodic maint. (every 6 year)	7,815	6,225
10. Long span br.	387	-
11. Traffic markings	179	143
12. Others (3+5+6+7+8+9(1)+10+11)x0.1	206	145
13. Works on contract basis with private firms	987	786

Note: Exchange Rate 1US\$ = TL6900 (June, 1992)

#### 4) Estimation of Building Construction Cost

The estimation of the construction cost of various buildings shall be based on the estimated total floor area of the building to be multiplied by the construction cost per m<sup>2</sup> (TL/m<sup>2</sup>) determined separately for each type of building.

With regard to service areas and rest areas where operational earnings are expected, use of the BOT method utilizing private capital is planned for their construction and management, making it extremely difficult to predetermine the size and configuration of these facilities. The construction cost of these facilities shall be estimated for reference purposes only and this cost shall not be included in the total building construction cost. The estimated building construction cost shall not include the cost of building sites and taxes.

With regard to the power building where the substation and emergency power generation unit will be housed, the building cost shall be estimated separately from the electrical equipment cost. The building construction cost shall not include the cost of the fail-safe power supply unit for the traffic control equipment (CVCF, battery and rectifier).

The construction cost given in the previous section includes the cost of such building services as the electrical service and plumbing work in addition to the cost of the building proper.

It must be noted, however, that the estimated building construction cost does not include the cost of equipment and devices directly related to the traffic control system.

An amount equivalent to 3 % of the initial investment amount shall be listed to cover the annual maintenance cost of the buildings in question.

Table 6.3.4 Summary of Cost Estimation for Architectural Facilities

	(A)	(B)	(C)	(D)
	Name of Architectural Facilities	1 Division (US\$)	17 Division (US\$)	Total (US\$)
1.	Main Maintenance Center	1,467,969	1,475,143	2,943,112
2.	Maintenance Office	2,267,614	2,224,521	4,492,136
3.	Maintenance Unit	398,136	398,136	796,272
4.	Toll Collection Station	1,397,933	798,819	2,196,752
5.	Barrier	99,852	99,852	119,704
6.	Parking Area	302,511	259,295	561,806
7.	Service Area	517,619	517,619	1,035,238
8.	Rest Area	0	0	
9.	Training Center	0	0	
	Total	6,451,635	5,773,385	12,225,020

Note: Exchange Rate 1 US\$ = TL 6,900 (June, 1992)

#### 5) Summary of Cost Estimation

The summary of cost estimations is prepared as shown in Table 6.3.5, based on the previously discussed conditions. Reference shall be made to the notes of Table

Table 6.3.5 Summary of Cost Estimates

Unit: 1,000US\$

Items	Division 17		Division 1	
	Installation Cost	Annual Operation Cost	Installation Cost	Annual Operation Cost
1. Traffic Management & Operation	37,479	1,874	37,657	1,883
(1) Information Gathering System & Measurement System	5,821	} 1,874	3,584	} 1,883
(2) Information Processing System	8,585		9,423	
(3) Motorist Information System	6,591		8,025	
(4) Communication System	16,482		16,625	
2. Road Maintenance & Operations	8,008	11,746	7,208	9,156
(1)* Personnel Cost		(7,222)		(4,705)
(2) Vehicle & Equipment	8,008		7,208	
(3)* Parts/Repair of Equipment		(801)		(721)
(4) Fuel & Lubricant		1,419		1,223
(5) Pavement (Routine/1st yr, 1995)		507		405
(6) Pavement (Periodic/every 6 year)		7,815		6,225
(7) Long Span Bridges (2.5 km long)		387		-
(8)*** Works on Contract Basis		987		786
(9) Others		631		517
3.** Architectural Facilities	(5,773)		(6,452)	
Total	45,487	13,620	44,865	11,039

Notes \*: Personnel cost & parts repair cost are reference only and not counted for the total since 10 % of all toll revenue is not used for these costs.

\*\* : Architectural facilities cost is not accumulated to the total since the cost was counted for road construction works as the motorway facilities cost, or for BOT.

\*\*\* : Costs for asphalt overlay for periodic maintenance and inspection & test of long span bridges are not included in this item.







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