Ministry of Public Works
The Palestinian Interim Self-Government Authority

NO. 1

STUDY REPORT
ON
THE PROJECT FOR
IMPROVEMENT AND MAINTENANCE OF MAIN ROAD
IN
THE WEST BANK

FEBRUARY 1999

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

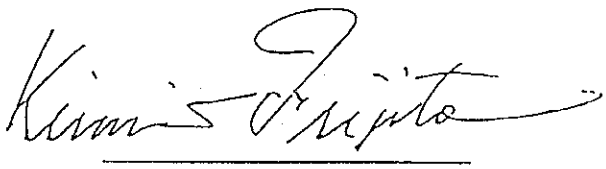
In response to a request from the Palestinian Interim Self- Government Authority (PA), the Government of Japan decided to conduct a study on the Project for Improvement and Maintenance of Main Roads in the West Bank and entrusted the Japan International Cooperation Agency (JICA) to conduct the study with the assistance of the Japan International Cooperation System (JICS).

JICA sent to PA a study team from October 4 to November 7, 1998, January 29 to February 14, 1999.

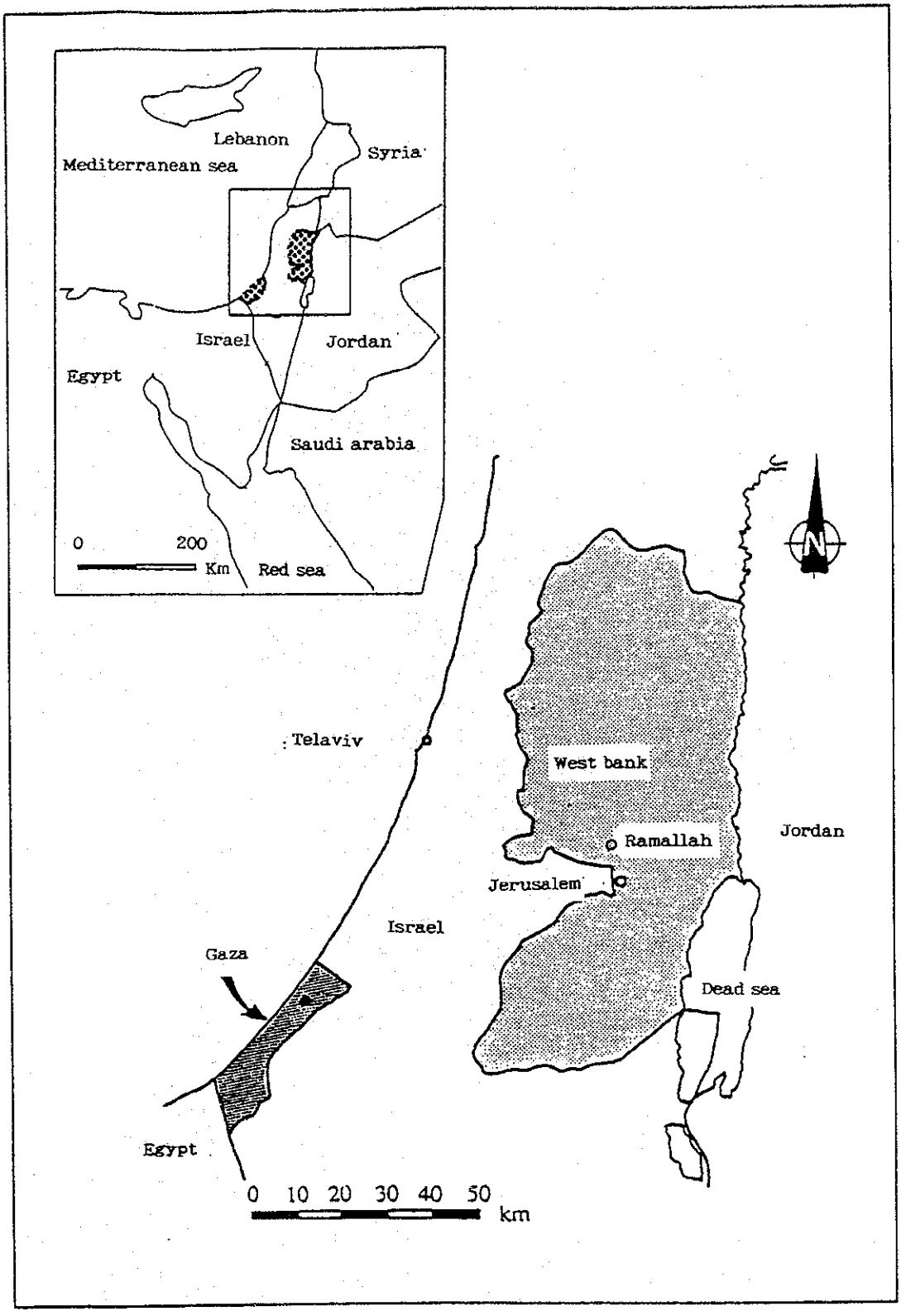
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Palestinian Interim Self- Government Authority for their close cooperation extended to the team.

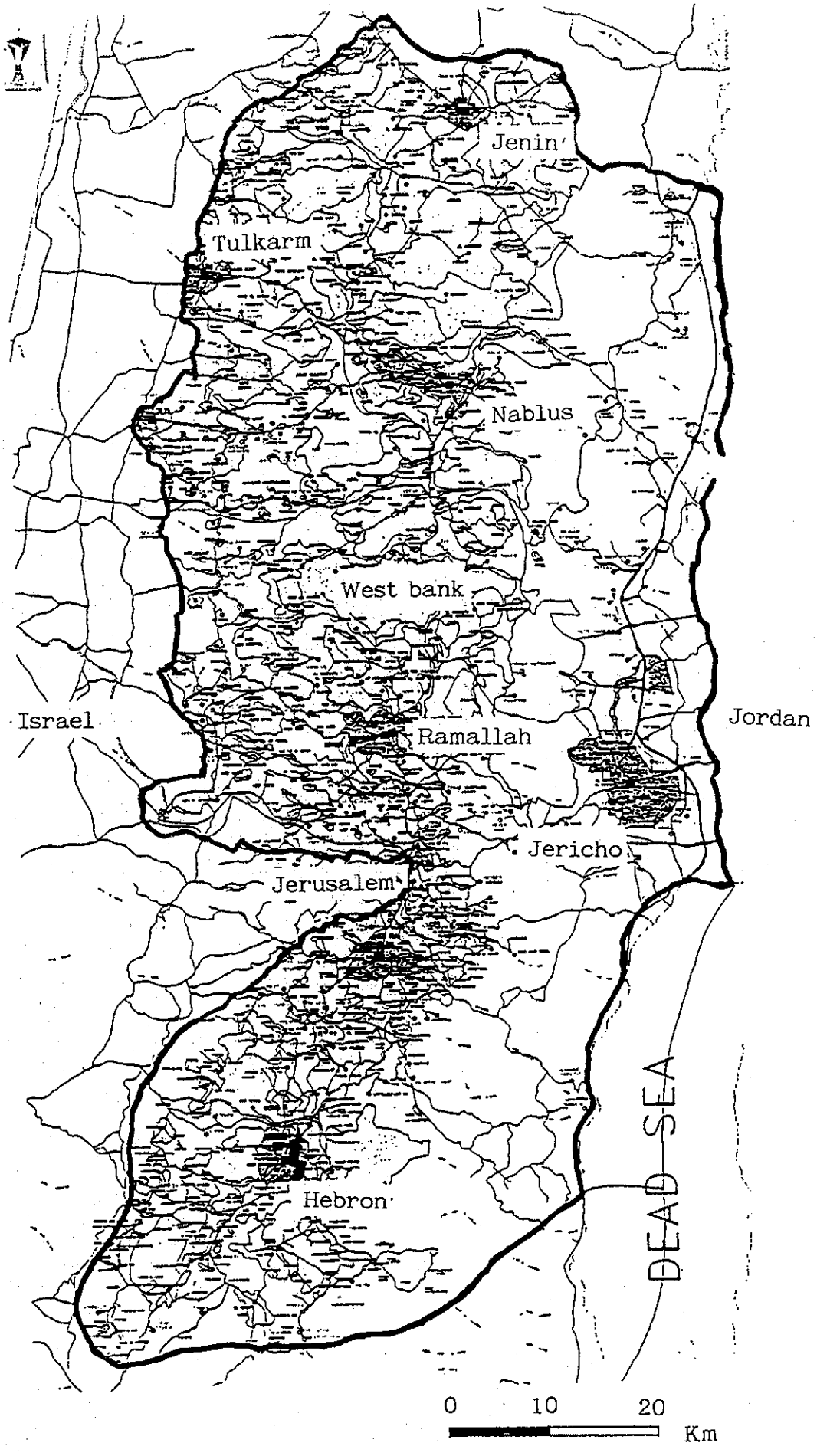
February 1999



Kimio Fujita
President
Japan International Cooperation Agency



Location Map



Perspective

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Chapter 1 Background of the Project

Roads are the only means of transport in the West Bank and Gaza, but despite their extreme importance, they were not properly maintained for close on 30 years under the Israeli occupation, with the result that they are in a conspicuous state of disrepair. As shown in Table 1, roads in the West Bank and Gaza total 2,500km (paved roads only), of which no more than 15%, such as those around Jewish settlements, are in good condition. Most of the other roads linking residential areas in the West Bank and Gaza need to be repaired or rebuilt.

On the other hand, with the growing number of people returning from abroad, the number of vehicles has also risen dramatically (a rise of 50% in 1997 compared with the previous year). Narrow roads approximately 3m wide are no longer able to cope with the increased traffic, and it is necessary to widen the roads, reduce the curves, etc.

Table-1 Total road length and condition

Unit : Km

Road Category	Main		Regional		Access		Total	
Road Condition	Total length	Rate	Total length	Rate	Total length	Rate	Total length	Rate
Good	79	13%	122	17%	183	15%	384	15%
Normal	185	31%	280	40%	249	21%	714	29%
Bad	336	56%	298	43%	768	64%	1402	56%
Total	600	100%	700	100%	1,200	100%	2,500	100%

Source: MPW

At the present time, paved roads in the West Bank total 2,206km and account for approx. 90% of all roads in the whole of Palestine, but only 14% of these roads are in good condition. The others urgently need to be repaired or rebuilt. Tables 2 and 3 show the total length and category of roads in the West Bank.

Table-2 Total road length and condition in the West Bank

Unit : Km

Road Category	Main		Regional		Access		Total	
Road Condition	Total length	Rate	Total length	Rate	Total length	Rate	Total length	Rate
Good	56	11%	98	15%	150	14%	304	14%
Normal	165	33%	262	41%	217	20%	644	30%
Bad	280	56%	275	44%	703	66%	1258	56%
Total	501	100%	635	100%	1,070	100%	2,206	100%

Source: MPW

Table-3 Road category in the West Bank

	Road Category	Length (Km)	Width (m)	Supervising Organization
Local	Main road	441	7	MPW (Ministry of Public Works)
	Regional road	615	3~6	〃
	Access road	1,070	3	〃
	Agriculture	5,000	3	〃
Urban	Main road	60	7~14	MPW and Municipality
	Regional road	20	6	〃

Source: MPW

Temporary autonomy in the West Bank began in accordance with the Oslo Accords of September 1995, with the area under self-government divided into three areas: Area A where wide-ranging autonomy has been granted to the Palestinians excluding foreign affairs and defense, Area B where security is maintained jointly with Israel, and Area C where the Palestinians have no rights regarding the land. In 1996 the Ministry of Public Works (MPW) transferred the authority to execute public works from the Public Works Division of the Israeli Civil Administration Bureau, and although discussion with Israel is still required in Area C, maintenance and repair work is being undertaken in the autonomous regions.

However, the MPW lacks construction machinery, equipment and vehicles, and at the present time such work is entrusted to the private sector or the machinery is leased and urgent roadworks are carried out by direct management. The high cost of commissioning the private sector to carry out roadworks and the cost of hiring equipment is putting pressure on the budget for purchasing equipment and carrying out roadworks, extremely limiting the ability of the MPW to carry out roadworks. For this reason, the MPW wishes to acquire the minimum equipment needed for roadworks and to carry out such roadworks urgently, and at the same time to increase the roadworks by reducing the cost of hiring equipment, and promote plans for the improvement of roads in the West Bank.

Gaza procured equipment for road improvement and maintenance with Japanese grant aid in 1966, but maintenance of the remaining roads in the West Bank is one of the most important issues facing the Palestinians. It was under such conditions that the Palestinian Interim Self-Government Authority requested aid from the Japanese government to procure equipment for the improvement and maintenance of roads.

Chapter 2 Contents of the Project

2-1 Objectives of the Project

This Project covers the West Bank of Palestine, where it will improve the roads of approximately 400 km long including main roads, regional roads, and access roads by procuring the equipment for road improvement and maintenance necessary for implementing a plan formulated by the MPW. This Project has an objective to improve the living of the residents by improving the traffic convenience, as well as making the access of local residents to social services such as medical services and education easy.

2-2 Basic Concept of the Project

Based on the Project for Improvement and Maintenance of Main Roads in the West Bank formulated by the MPW, this Project covers the roads that can be improved individually by the MPW and that need urgent improvement. The length of the roads to be covered by the Project and the annual road improvement plan are shown in Tables-4 and 5. Roads of approximately 400 km long will be improved in five years.

This Project will procure the equipment necessary for improving the roads in the below mentioned areas.

Table-4 Road classification and road length for each Project area

Unit : Km

Project area	Main	Regional	Access	Total
North Nablus	5.0	70.1	91.7	166.8
(Jenin)	(0)	(20.0)	(22.0)	(42.0)
(Tulkarm)	(5.0)	(28.1)	(7.3)	(40.4)
(Nablus)	(0)	(22.0)	(62.4)	(84.4)
Central Ramallah	11.0	5.0	107.3	123.3
South Hebron	39.5	29.7	66.5	135.7
Total length	55.5	104.8	265.5	425.8

Source: MPW

Table-5 Annual road improvement plan of each Project area

Unit : Km

Project area	1999	2000	2001	2002	2003	Total
North Nablus	51.6	26	32.5	19.8	36.9	166.8
(Jenin)	(6.0)	(17.0)	(10.0)	(4.5)	(4.5)	(42.0)
(Tulkarm)	(23.6)	(7.0)	(4.5)	(3.3)	(2.0)	(40.4)
(Nablus)	(22.0)	(2.0)	(18.0)	(12.0)	(30.4)	(84.4)
Central Ramallah	20	43	18.4	27.9	14	123.3
South Hebron	59.9	26.5	23.7	25.6	0	135.7
Total length	131.5	95.5	74.6	73.3	50.9	425.8

Source: MPW

The Project area can be broadly classified into three areas: the northern area (jurisdiction of Nablus, branches of Jenin and Tulkarm, the central area (jurisdiction of Ramallah, and the southern area (jurisdiction of Hebron). All areas include lots of highlands and hilly areas and the Project roads mainly consist of narrow regional and access roads of approximately 3 m wide.

The configuration and the specifications of necessary equipment will be examined by considering the natural conditions, present state of the roads, work contents, existing equipment, delivery achievements of the main manufacturers in Palestine, and the standard of civil engineering calculation by the Ministry of Construction of Japan.

<Details of necessary equipment>

The necessary equipment is classified into the one for road improvement and the one for road maintenance and the one for auxiliary in accordance with the purpose to use. The work schedule and the necessary equipment for each purpose to use are shown in Tables-6 to 8 and Figures-1 to 3.

(1) Equipment for road improvement

This equipment mainly consists of the civil engineering equipment to be used for improving road shoulders, widening roads, and repairing base courses. Road pavement will be entrusted to private companies and the equipment for pavement will not be included in this Project.

Work schedule and necessary equipment of road improvement											
(1) Schedule	Digging, excavatin	→	Loading	→	Delivery crushed ston	→	Compaction	→	Improvement of drain ditches		
(2) Necessary Equipment	Bulldozer		Wheel Loader		Stone Crusher		Vibratory Roller		Concrete Mixer		
	Excavator		Truck Loader		Motor Grader		Water Tanker				
			Dump Truck		Dump Truck						
	Aux. Truck Trailer		Aux. Truck Trailer						Aux. Cargo Truck		
Figure											

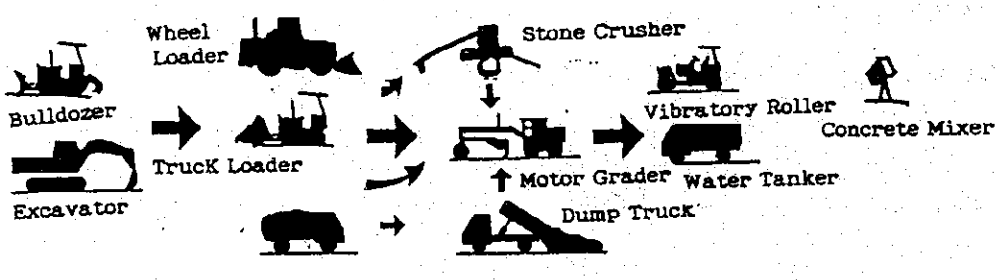


Figure-1 Work schedule and necessary equipment for road improvement

Table-6 Specifications and purpose of equipment necessary for road improvement

No.	Name of Equipment	Specifications	Purpose
1	Bulldozer	220-240HP, Ripper, ROPS cab	Digging of base and surface course
2	Excavator A	Ap.20ton, STD Bucket, with Breaker	Digging and loading of base and surface course
3	Excavator B	Ap.30ton, STD Bucket, with Breaker	Digging and loading of base and surface course
4	Wheel Loader A	Ap.13ton, STD.Bucket, ROPS cab	Loading of rocks, gravel, etc.
5	Wheel Loader B	Ap.16ton, STD.Bucket, ROPS cab	Loading of rocks, gravel, etc.
6	Truck Loader	Ap.200HP, ROPS cab	Loading (quarry site, steep slope)
7	Dump Truck	Payload min.10ton, 6×4	Transportation of rocks, gravel, etc.
8	Stone Crusher	Ap.7-10ton /Hr, Engine type	Production of crushed stones
9	Motor Grader	Ap.135HP, Ripper, ROPS cab	Molding of road surface
10	Vibratory Roller	Ap.10ton, Cab, Tandem type	Compacting of base and surface course
11	Water Tanker	Ap.8,000liter, Supply bar	Adjustment of moisture content and water sprinkling
12	Concrete Mixer	0.5m^3, Engine type	Improvement of Shoulder such as drain ditches and curbstone

(2) Equipment for road maintenance

Equipment for cutting the asphalt surface and small repair

Work schedule and necessary equipment of road maintenance								
(1) Schedule	Cutting overlay of asphalt surface	→	Loading	→	Cleaning	→	Pavement	→	Compaction
(2) Necessary Equipment	Milling Machine		Milling Machine		Road Sweeper		Asphalt Finisher		Tire Roller
			Dump Truck				Dump Truck		
	Aux. Truck Trailer						Aux. Truck Trailer		Aux. Truck Trailer
Figure									

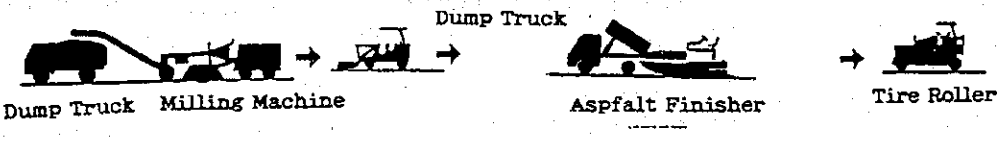


Figure-2 Work schedule and the equipment necessary for road maintenance

Work schedule and necessary equipment of road maintenance (periodical and small scale maintenance)									
(1) Schedule	Scrapping asphalt surface	→	Loading	→	Cleaning	→	Pavement	→	Compaction
(2) Necessary Equipment	Backhoe Loader		Backhoe Loader						Plate Compactor
	Pick Hammer		Dump Truck						Hand Guided Roller
	Air compressor								
	Asphalt Cutting Saw								
	Aux. Cargo Truck						Aux. Cargo Truck		Aux. Cargo Truck
Figure									

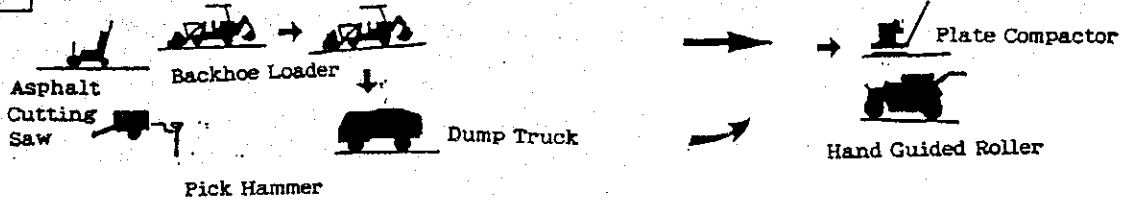


Figure-3 Work schedule and the equipment necessary for road maintenance (small repair)

Table-7 Specifications and purpose of equipment necessary for road maintenance

No.	Name of Equipment	Specifications	Purpose
1	Milling Machine	Ap.1.2m Cutting Width, Conveyor	Cutting overlay of asphalt surface course
2	Tire Roller	Ap.10ton, Front drum, rear tire	Compaction of surface course
3	Backhoe Loader	Ap.80HP, Breaker, ROPS cab	Small-scale digging, Loading, ditching
4	Pick Hammer	Air type, AP.7Kg	Asphalt excavation (small-scale)
5	Air Compressor	Ap. 7.5m^3/min	Air source for air tools
6	Asphalt Cutting Saw	Blade Width Ap.450mm, Manual type	Cutting of asphalt surface (small-scale)
7	Dump Truck	Payload min. 10ton, 6×4	Transportation of rocks, gravel, etc.
8	Hand Guided Roller	Ap. 0.6-0.7ton	Compaction (small-scale)

(3) Auxiliary equipment
Equipment for transporting the construction machine and materials.

Table-8 Specifications and purpose of auxiliary equipment

No.	Name of Equipment	Specifications	Purpose
1	Truck Trailer	Lowbed Type, Payload Ap. 30-35ton	Transportation of construction machines
2	Service Car	Double Cab, with Tool	Easy repair at site
3	Cargo Truck	3ton crane, Payload Ap.7ton	Transportation of material, fuel, etc.
4	Workshop Tools	for Heavy Vehicles and Construction Machine	For equipment repair

<Number of necessary items>

(1) Equipment for road improvement

The minimum necessary number and contents of equipment will be procured to three areas of northern area (Nablus), central area (Ramallah) and southern area (Hebron). The production of each equipment is shown in Table-9 in which the number of items in the cycle (digging, loading, transporting, molding, compacting) is calculated based on the production of the Vibratory Roller, which has the lowest productivity. One each Excavator (with breaker specifications) and Concrete Mixer will be procured to each area as the auxiliary equipment of each cycle. The Truck Loader, Stone Crusher, and Water Tanker will be shared by all areas.

Table-9: Calculation method of production for each unit of equipment

	Equipment	Hourly production	Summary of values	Vibratory Roller is 1	Necessary units
1	Bulldozer 220-240HP 30ton	60X4.55X1X 0.4/3.21 =34.0 m^3/h	4.55 : Production per cycle(m^3) 1 : Grade factor 0.4 : Job efficiency 3.21 : Cycle time (in minute)	0.94	1
2	Wheel Loader 150-180HP 13ton	3,600X1.73X 0.25/40 =38.9 m^3/h	1.73 : Production per cycle (m^3) 0.25 : Job efficiency 40 : Cycle time (sec)	0.82	1
3	Dump Truck 7m^3	60X7X0.9/39.2 =9.6m^3/h	7 : Body volume (m^3) 0.9: Job efficiency 39.2 : Cycle time (in minute)	3.33	4
4	Motor Grader 135HP	3.7X1800X0.1X 0.4/8 =33.3m^3/h	3.7 : Blade width (m) 1800 : Working speed (m/h) 0.1 : Grading depth (m) 0.4 : Job efficiency 8 : Average work frequency	0.96	1
5	Vibratory Roller 10ton	2000X2X0.1X 0.4/5 =32.0 m^3/h	2000 : Working speed(m/h) 2 : Effective pressing width(m) 0.1 : Pressing thickness(m) 0.4 : Job efficiency 5 : Average work frequency	1.00	1

1) Examination of entire work load

In this Project, roads of approximately 425km long will be improved in five years.
Entire soil amount of the work: 425,000m (total length) x 6m (road width) x 0.25 m (road thickness) = 637,500m^2
Annual soil amount of the work: 637,500 m^3/5 = 127,500m^3
Productivity of the equipment to be procured: 32m^3/h
Average annual working hours: 20days x 6 hours x 12 months = 1,440 hours
Annual Productivity of the equipment to be procured: 32 m^3/h x 1,440 h = 46,080 m^3
Necessary number of team equipment: 127,500 m^3/46,080 m^3 = 2.8

From the above-mentioned calculation, civil engineering equipment of three teams with the above mentioned specifications are necessary to implement this Project.

(2) Equipment for road maintenance

Equipment necessary for the regular road maintenance will be procured to the five areas including the three main areas of northern (Nablus), central (Ramallah), and southern areas (Hebron) plus Jenin and Tulkarm of northern areas with the minimum necessary number of items and contents. One each Dump Truck, Back hoe Loader, Asphalt Cutting Saw, and Hand Guided Roller will be procured to each area and the Milling Machine, Tire Roller, Pick Hammer, and Air Compressor will be shared by all areas

(3) Auxiliary equipment

One each of Cargo Truck and Trailer Truck will be procured for the transportation of equipment and materials, and the Workshop Tools and Service Car will be procured for the maintenance of equipment.

The places to deliver each equipment and the number of items are shown in Table-10. The necessary number has been examined by considering the existing equipment of the MPW.

Table-10 Places to deliver the equipment and the number of items

Name of equipment/area	Ramallah	Nablus	Hebron	Jenin	Tulkarm	Necessary Q'ty	Existing Q'ty	Q'ty
Equipment for road improvement								
Bulldozer	○	○	○			3	1	2
* Excavator	○	○	○			3	0	3
* Wheel Loader	○	○	○			3	1	2
Truck Loader						2	1	1
Dump Truck	○4	○4	○4			12	7	5
Stone Crusher						1	0	1
Motor Grader	○	○	○			3	1	2
Vibratory Roller	○	○	○			3	2	1
Water Tanker						1	0	1
Concrete Mixer	○	○	○			3	0	3
Equipment for road maintenance								
Milling Machine						1	0	1
Dump Truck	○	○	○	○	○	5	0	5
Tire Roller						1	0	1
Backhoe Loader	○	○	○	○	○	5	1	4
Pick Hammer						2	0	2
Air Compressor						1	0	1
Asphalt Cutting Saw	○	○	○	○	○	5	0	5
Hand Guided Roller	○	○	○	○	○	5	1	4
Auxiliary equipment								
Cargo Truck						1	0	1
Truck Trailer						1	0	1
Service Car	○	○	○			3	0	3
Workshop tool								1set

One each Excavator and Wheel Loader will be used especially for the hard base rocks.

2-3 Basic Design

2-3-1 Design Concept

1) Concept on natural conditions

Since the West Bank of Palestine is dry with small precipitation, the design policy shall include the measures for dust (cab, double air cleaner, etc.). In addition, many sites have hard bed rocks and hilly areas, the heavy construction machine for earthmoving is necessary to reinforce a traveling frame and

attachment, etc. for rock sites.

2) Concept on social conditions

Palestine does not have its own harbor and Israel proceeds the custom clearance. Therefore, the equipment to be procured must have the specifications that can be imported without problem to Israel. Because the West Bank includes the roads under Israeli jurisdiction, the vehicles to run on general roads must have the equipment conforming to the latest homologation of Israel.

3) Concept on the use of the equipment and materials to be procured at site and those from the third country

With the advancement of Japanese companies to Palestine in the recent several years, the number of the equipment manufactured in Japan is increasing. However under the relationship between Israel and Arabian countries before the agreement of temporary autonomy, Japanese companies had placed importance on Arabian countries. Therefore in the present Israeli market, products of Europe and America constitute the main stream and the local agencies of these countries have been fulfilled. Especially, the vehicles must have the European specifications from the standpoint of the Israeli homologation, which the Japanese manufactures cannot correspond at present. Thus the products must be procured from the third country.

4) Concept on the maintenance ability of the implementation agency

The equipment must be selected from those widely used in general and can be easily maintained by the MPW engineers. In addition, the manufactures' agents must provide sufficient explanation on the operation and maintenance methods of the equipment when they deliver the equipment.

5) Concept on determining the type and grade of the equipment

By referencing to the present state of roads (including the width), structure of planned roads, existing equipment in West Bank, the delivery results of main manufacturers in Palestine, and the standards of Israel, the equipment must be selected for road improvement and road maintenance with the purpose of road improvement in the Project for improvement and maintenance of main road in the West Bank formulated by the MPW.

6) Concept on the term of works

The term of works must be a single year because this Project is the procurement of standard equipment. However the equipment must go through the Israeli procedure at the custom clearance and carried by inland transportation from the main harbor in Israel to the West Bank of Palestine, implementation of smooth unloading and custom clearance are required.

2-3-2 Basic Design

The main specifications, the number of items, and the purpose to use the equipment to be procured in this Project are shown in Table-11.

Table-11 Contents of the equipment

No.	Name of Equipment	Specifications	Purpose	Q'ty
1	Motor Grader	Ap.135HP, Ripper, ROPS cab	Molding of road surface	2
2	Bulldozer	220-240HP, Ripper, ROPS cab	Digging of base and surface course	2
3	Excavator A	Ap.20ton, STD Bucket, with Breaker	Digging and loading of base and surface course	2
4	Excavator B	Ap.30ton, STD Bucket, with Breaker	Digging and loading of base and surface course	1
5	Backhoe Loader	Ap.80HP, Breaker, ROPS cab	Small-scale digging, Loading, ditching	4
6	Wheel Loader A	Ap.13ton, STD.Bucket, ROPS cab	Loading of rocks, gravel, etc.	1
7	Wheel Loader B	Ap.16ton, STD.Bucket, ROPS cab	Loading of rocks, gravel, etc.	1
8	Truck Loader	Ap.200HP, ROPS cab	Loading (quarry site, steep slope)	1
9	Dump Truck	Payload min.10ton, 6×4	Transportation of rocks, gravel, etc.	10
10	Truck Trailer	Lowbed Type, Payload Ap. 30-35ton	Transportation of construction machines	1
11	Service Car	Double Cab, with Tool	Easy repair at site	3
12	Vibratory Roller	Ap.10ton, Cab, Tandem type	Compacting of base and surface course	1
13	Tire Roller	Ap.10ton, Front drum, rear tire	Compaction of surface course	1
14	Hand Guided Roller	Ap. 0.6-0.7ton	Compaction (small-scale)	4
15	Cargo Truck	3ton crane, Payload Ap.7ton	Transportation of material, fuel, etc.	1
16	Water Tanker	Ap.8,000liter, Supply bar	Adjustment of moisture content and water sprinkling	1
17	Milling Machine	Ap.1.2m Cutting Width, Conveyor	Cutting overlay of asphalt surface course	1
18	Air Compressor	Ap. 7.5m³/min	Air source for air tools	1
19	Concrete Mixer	0.5m³, Engine type	Improvement of Shoulder such as drain ditches and curbstone	3
20	Asphalt Cutting Saw	Blade Width Ap.450mm, Manual type	Cutting of asphalt surface (small-scale)	5
21	Pick Hammer	Air type, AP.7Kg	Asphalt excavation (small-scale)	2
22	Stone Crusher	Ap.7-10ton /Hr, Engine type	Production of crushed stones	1
23	Workshop Tools	for Heavy Vehicles and Construction Machine	For equipment repair	1

Table-12 Possible country of origin of the equipment

No.	Equipment	Japan	Germany	Italy	Sweden	Holland	U.K.	France
1	Motor Grader	○						
2	Bulldozer	○						
3	Excavator A	○						
4	Excavator B	○						
5	Backhoe Loader			○			○	
6	Wheel Loader A	○						
7	Wheel Loader B	○						
8	Truck Loader	○						○
9	Dump Truck		○	○	○	○		
10	Truck Trailer		○	○	○	○		
11	Service Car	○						
12	Vibratory Roller	○	○					
13	Tyre Roller	○						
14	Hand Guided Roller	○						
15	Cargo Truck		○	○	○	○		
16	Water Tanker		○	○	○	○		
17	Milling Machine	○	○					
18	Air Compressor	○						
19	Concrete Mixer	○						
20	Asphalt Cutting Saw	○						
21	Pick Hammer	○						
22	Stone Crusher	○						
23	Workshop Tools	○						

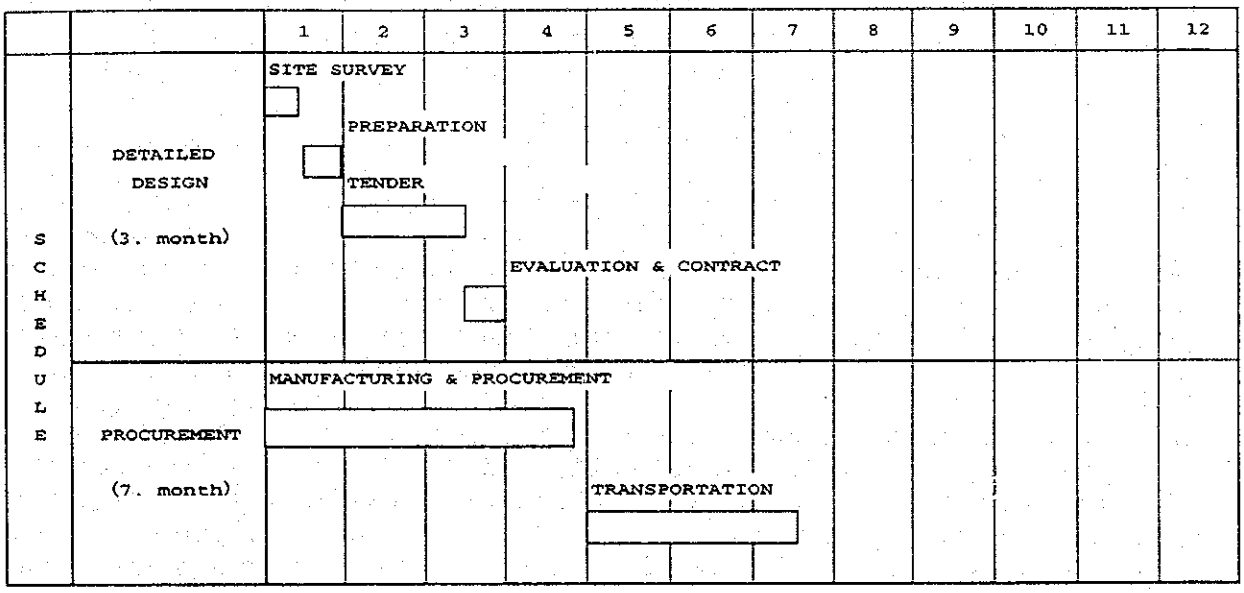
Chapter 3 Implementation Plan

3-1 Implementation Plan

3-1-1 Implementation Schedule

The project will be implemented in a period of 10 months as detailed in table-13

Table-13: Project implementation schedule



3-1-2. Obligations of Recipient Country

The recipient country must open a bank account in the bank in Japan and issue an authorization to pay (A/P). In addition, the recipient country must pay the charges related to the above mentioned.

The recipient country must proceed the exemption procedure on the custom duties, domestic tax, and other financial surcharges to be applied to the Japanese national on the equipment and duties to be procured based on the approved agreement.

The recipient country must provide necessary conveniences on the entrance and staying of the Japanese nation for implementing their work among the duties to be provided by them based on the approved agreement.

The equipment to be purchased based on the grant aid must be properly and effectively maintained and used for the implementation of the said Project, and the necessary staffs must be secured for the above mentioned purpose. In addition, the recipient country must bear all the maintenance expenses necessary for implementing the Project except for the expenses borne by the grant aid.

3-2 Operation and Maintenance Plan

(1) Maintenance after procurement of the examined equipment
The maintenance of the procured equipment is determined to be sufficiently handled by the following items.

1) Preparation of equipment history
Histories of procured equipment will be prepared, a plan for operation, maintenance, and repair will be formulated, and the maintenance will be implemented in accordance with the plan. The contents to be recorded in the history include (a) type, standard, serial number, and year procured, (b) deliverer, delivery date, price, (c) contents of accessories, attached tools, history of movement, (d) outline of remodeling, (e) details of work, maintenance, and repair, and (f) photograph.

2) Daily inspection
The daily inspection will be implemented in accordance with the daily inspection table instructed by the manufacturer. The amounts of cooling water and oil consumed and added must be recorded on the daily inspection record before the work and every operating hour, and the daily inspection system will be introduced to report the inspected results to the machine engineers.

3) Regular maintenance
The regular maintenance will be implemented in accordance with the above mentioned daily inspection table and the time unit recommended by the manufacturer. In addition, service agreement will be concluded with the local agent as necessary to receive advice and instruction.

4) Repair schedule
- Work request form

If any problem is recognized in the inspection of mechanical engineer, a work request form must be issued as necessary to implement the inspection.

- Repair table

The repair table must be made by recording on the above-mentioned history. If any part is needed, a part request table must be prepared and the delivery must be requested to the part administrator by reporting the fact to the engineer from the worker. After the repair is implemented, the repair result must be confirmed and inspected under the witnesses of the engineer and the operator.

5) Administration of spare parts
With regard to the parts administration, the amount, items, the inventory amount (parts value), and the parts necessary for regular inspection (first moving parts) must be accurately understood and the inventory must be properly managed. The parts generally required are as follows.

- Regular replacement parts
  Elements, filters, fan belts, and so on

- Replacement parts necessary for wear and tear
  Blades, cutting edges, end bits, sprockets, segments, brake linings, bolts and nuts.

- Repair kits for water and/or oil leak
  Sealings, gaskets, grease fittings, oil seals, and dust seals must be selected. The spare parts for engine do not necessary to be stored regularly, but must be procured by considering the operating time of the equipment.

(2) Equipment maintenance and management costs

With the increase of the equipment owned by the MPW by this Project, the measures to increase the annual budget for the increased equipment maintenance and management expenses and the increase of forty-five maintenance staffs (equipment maintenance and operation) are necessary. Then necessary equipment maintenance and management cost based on the "construction machine depreciation manual" of Japan and considering the state of Palestine is calculated to be approximately 90 million-yen a year as shown in Table-14, this expenses is necessary to implement this Project. And, The material expenses including the asphalt for the road improvement of annual 80km need approximately 160 million-yen. It increases 40 million- yen compare with fiscal year 1997. However, the increase of these expenses can be appropriated by the decrease of approximately 90 million-yen of equipment rent and the expenses of 90-million yen entrusted to private sectors shown in the results of fiscal year 1997. Thus this amount is considered not to affect the project operation. In addition, the MPW plans to establish a Maintenance Road Fund starting from the next fiscal year. This Fund will be contributed under a certain ratio from the taxes on fuel, vehicle registration, and road use, and used for the entire road improvement. Appropriation from this Fund to the operation cost (equipment maintenance costs) can be expected also.

Table-14: Expenses for Maintenance and Management of Equipment

Expense Item	Amount (JP¥)
Management	4,374,000
Maintenance and repair	26,464,000
Personnel	33,480,000
Fuel	24,553,000
Oil	1,518,000
Total	90,389,000

1) Management costs

The management costs are the general terms for the entire expenses including taxes and other public charges, insurance expenses, expenses storage facilities, storage operating expenses and so on that become necessary in accordance with the owning of machines and are calculated by multiplying the annual management ratio (1%) to the basic price of each equipment. Table 15-1 shows the details of management costs for each equipment.

Table 15-1: Breakdown of Management Expenses by Type of Equipment

(Unit : thousand Yen)

Equipment	Basic Price	Annual maintenance cost factor	No. of units	Total
Motor Grader	14,100	1%	2	282.00
Bulldozer	26,900	1%	2	538.00
Excavator A	18,200	1%	2	364.00
Excavator B	27,700	1%	1	277.00
Backhoe Loader	8,000	1%	4	320.00
Wheel Loader A	16,300	1%	1	163.00
Wheel Loader B	18,500	1%	1	185.00
Truck Loader	24,000	1%	1	240.00
Dump Truck	9,180	1%	10	918.00
Truck Trailer	16,000	1%	1	160.00
Service Car	2,500	1%	3	75.00
Vibratory Roller	13,400	1%	1	134.00
Tire Roller	8,200	1%	1	82.00
Hand Guided Roller	1,220	1%	4	48.80
Cargo Truck	5,260	1%	1	52.60
Water Tanker	7,270	1%	1	72.70
Milling Machine	25,000	1%	1	250.00
Air Compressor	2,800	1%	1	28.00
Concrete Mixer	4,000	1%	3	120.00
Asphalt Cutting Saw	220	1%	5	11.00
Pick Hammer	39	1%	2	0.78
Stone Crusher	5,300	1%	1	53.00
Grand Total	-	-	49	4,374.88

2) Maintenance and repair costs

The maintenance and repair costs mean the costs necessary for the maintenance and repair in order to keep the effective use of equipment and include the costs other than the operating expenses. The amount is calculated from the following expression:
{(Basic price x maintenance repair ratio) - (basic price x ratio of procured parts)} ÷ service life x number of items

Table 15-2: Breakdown of Maintenance and Repair Expenses

(Unit : thousand Yen)

Equipment	Basic Price	Maintenance and repair cost factor (%)	No. of units	Expenses For parts provided (%)	Service life (Years)	Total
Motor Grader	14,100	35	2	7	7	1,128
Bulldozer	26,900	45	2	7	6	3,408
Excavator A	18,200	30	2	7	5	1,674
Excavator B	27,700	30	1	7	5	1,274
Backhoe Loader	8,000	30	4	7	5	1,472
Wheel Loader A	16,300	40	1	7	6	896
Wheel Loader B	18,500	40	1	7	6	1,017
Truck Loader	24,000	45	1	7	6	1,520
Dump Truck	9,180	50	10	5	5	8,262
Truck Trailer	16,000	25	1	5	5	960
Service Car	2,500	50	3	5	5	675
Vibratory Roller	13,400	35	1	7	6	626
Tire Roller	8,200	35	1	7	8	287
Hand Guided Roller	1,220	35	4	7	6	227
Cargo Truck	5,260	50	1	5	5	474
Water Tanker	7,270	40	1	5	6	424
Milling Machine	25,000	30	1	7	6	959
Air Compressor	2,800	30	1	5	5	140
Concrete Mixer	4,000	30	3	5	5	600
Asphalt Cutting Saw	220	40	5	3	3	136
Pick Hammer	39	35	2	3	3	8
Stone Crusher	5,300	35	1	7	5	297
Grand Total	-	-	49	-	-	26,464

3) Personnel expenses

With the introduction of the equipment in this Project, increases of fifteen equipment maintenance staffs and thirty operating staffs are planned The personnel expenses related to these staffs are calculated according to the following expression.

- 30 operating staffs x 550 US$/month = US$16,550
- 15 equipment maintenance staffs x 450 US$/month = US$6,750
- US$23,250 x 12(month) x 120 (¥/US$) = ¥33,480,000

4) Fuel expenses

The fuel expenses are calculated according to the following expression.

- Amount of fuel consumed by each equipment for each hour (liter/PS.h) x approximate horsepower (PS) x annual hours to use (1,440 hours) x number of items x fuel cost at site (liter/US$)

Table-15-3: Breakdown of Fuel Consumption

Equipment	Fuel consumption (liter/PS.h)	House Power (PS)	Annual run hours	No. of units	Annual fuel consumption (liters)
Motor Grader	0.105	135	1,440	2	40,824
Bulldozer	0.138	220	1,440	2	87,437
Excavator A	0.138	170	1,440	2	67,565
Excavator B	0.138	208	1,440	1	41,334
Backhoe Loader	0.100	85	1,440	4	48,960
Wheel Loader A	0.115	160	1,440	1	26,496
Wheel Loader B	0.115	175	1,440	1	28,980
Truck Loader	0.138	200	1,440	1	39,774
Dump Truck	0.040	260	1,440	10	149,760
Truck Trailer	0.080	382	1,440	1	44,006
Service Car	0.030	120	1,440	3	15,552
Vibratory Roller	0.144	100	1,440	1	20,736
Tire Roller	0.075	100	1,440	1	10,800
Hand Guided Roller	0.002	5	1,440	4	58
Cargo Truck	0.030	200	1,440	1	8,640
Water Tanker	0.037	220	1,440	1	11,722
Milling Machine	0.040	280	1,440	1	16,128
Air Compressor	0.155	70	1,440	1	15,624
Concrete Mixer	0.010	15	1,440	3	648
Asphalt Cutting Saw	0.170	3	1,440	5	3,672
Pick Hammer	-	-	-	-	-
Stone Crusher	0.115	20	1,440	1	3,312
Grand Total	-	-	-	49	682,028
Calculation formula and expense amount	682,028liters×0.3($/liters)×120(Yen/$)= 24,553,000(Yen)				

5) Oil costs

As for the oil costs, each equipment generally replaces the oil for each part at every regular checkup (every year). The engine oil will be replaced at an average of four times a year. The calculation of oil costs uses the following expression.

- Annual amount of oil used (liter or kg) x oil price (US$) x 120 (¥/US$)

Table-15-4: Breakdown of Oil Expenses

Equipment	No. of units	Engine oil capacity (liter)		Hydraulic Oil capacity		Gear oil (liter)		Grease (Kg)	
		unit	total	unit	total	unit	total	unit	Total
Motor Grader	2	100	200	60	120	100	200	10	20.0
Bulldozer	2	120	240	200	400	40	80	20	40.0
Excavator A	2	50	100	160	320	10	20	10	20.0
Excavator B	1	80	80	200	200	20	20	10	10.0
Backhoe Loader	4	30	120	50	200	8	32	7	28.0
Wheel Loader A	1	45	45	105	105	35	35	10	10.0
Wheel Loader B	1	60	60	120	120	40	40	10	10.0
Truck Loader	1	120	120	200	200	40	40	20	20.0
Dump Truck	10	120	1,200	10	100	40	400	15	150.0
Truck Trailer	1	40	40	10	10	40	40	20	20.0
Service Car	3	20	60	-	-	8	24	7	21.0
Vibratory Roller	1	50	50	60	60	25	25	10	10.0
Tire Roller	1	50	50	60	60	25	25	10	10.0
Hand Guided Roller	4	10	40	5	20	-	-	1	4.0
Cargo Truck	1	80	80	10	10	15	15	10	10.0
Water Tanker	1	80	80	10	10	15	15	10	10.0
Milling Machine	1	100	100	60	60	100	100	10	10.0
Air Compressor	1	100	100	-	-	-	-	0.5	0.5
Concrete Mixer	3	8	24	-	-	-	-	1	3.0
Asphalt Cutting Saw	5	-	-	-	-	-	-	-	-
Pick Hammer	-	-	-	-	-	-	-	-	-
Stone Crusher	1	15	15	-	-	-	-	10	10.0
Grand Total	49	-	2,804	-	1,995	-	1,111	-	416.5

Engine oil : 2,804×2×120=673,000
Hydraulic oil : 1,995×2×120=479,000
Gear oil : 1,111×2×120=266,000
Grease : 416.5×2×120=100,000
Total: 1,518,000yen

Chapter 4 Project Evaluation and Recommendation

4-1 Project Effect

The objective of this project is to procure equipment for the improvement and maintenance of 425km (approx. 20%) of roads in urgent need of repair out of a total 2,200km of paved roads in the West Bank. The direct beneficial effects to be achieved from this project are a reduction in the cost of roadworks currently consigned to private companies and the cost of hiring equipment, and the allocation of the amount thus saved to the improvement of additional roads, promoting the early accomplishment of the road improvement plan. By improving road shoulders and pavements, roads will be made safer for both vehicles and pedestrians, and by owning its own equipment, the MPW will be able to respond faster to disasters and other emergencies.

As an indirect effect, the improvement of a road network will facilitate movement by residents and revitalize the movement of goods as well as boosting economic activity. Local residents will gain easier access to social services such as medical care and education and the lives of the region's 1.7 million inhabitants will be greatly improved.

Judging from the above, the approval of aid for the execution of this project is deemed appropriate.

4-2 Recommendation

The executive agency is considered to be technically capable of executing the project, but the following items need to be taken into consideration.

1) The MPW will be in charge of the management and maintenance of the procured equipment, but the necessary maintenance personnel and budget must be ensured.

2) The MPW must instruct MPW engineers in correct use of the equipment and provide technical instruction in maintenance of the equipment, either independently or with the cooperation of the manufacturers.

3) After the procured equipment has been unloaded at a port in Israel, it will be transported overland to the West Bank. As the customs clearance at the port comes under the jurisdiction of Israel, the MPW must liaise closely with the agencies concerned.