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GOVERNMENT OF PAKISTAN
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
IRRIGATION SYSTEMS MANAGEMENT PROJECT

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PRC Engineering / CHECCHI

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FULL FUNDING BUDGET FOR IRRIGATION, DRAINAGE SYSTEMS AND FLOOD BUNDS IN N.W.F. PROVINCE

PRC Engineering / CHECCHI

APRIL, 1987

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DEFINITION OF TERMS AND ABBREVIATIONS

Sf, Ft^2, Sq.ft, Sqft	Square feet
Cf, Ft^3, Cu.ft	Cubic feet
Ft	Feet
Cfs, Ft^3/s, Cu.ft/s, Cusec	Cubic feet per second
Cy, Yd^3	Cubic yard (27 cf)
Hft^3	Hundred square feet
Tcf, Tft^3	Thousand of cubic feet
Msf, Mft^3	Millions of square feet
Hr	Hour
Hp	Horsepower
Mi	Canal mile (5,000 feet)
Km	Kilometer (1,000 meters)
Rs.M	Rupees million
PID	NWFP Irrigation and Power Department
PRC/C, PRC	PRC/Checchi, Consultants
GOP	Government of Pakistan
O&M	Operation and Maintenance
OM&R	Operation, Maintenance and Replacement
ISRP	Irrigation Systems Rehabilitation Project
CSR	Composite Schedule of Rates
Killa-bushing	An indigenous method of constructing velocity dissipators along and perpendicular to canal banks, used to form berms to protect inside toe of embankment
Lead	A combined distance and lift measurement for hauling earth
Pitching	A particular method of lining the inner slope of canal prism
Work Charged Establishment	Temporary labor employed for execution of a work
PB	Patrol Bank
NPB	Non Patrol Bank
T & P	Tools and Plant
T&T Charges	Telephone and Telegraph Charges

FULL FUNDED BUDGET
FOR
N.W.F.PROVINCE

A. CANAL YARDSTICK

I. INTRODUCTION

1. Work Plan

Task No. III of the October 1986 PRC/Checchi Work Plan includes the following tasks:

a) Estimation of full funding level required for each PID, assuming system completely rehabilitated.
b) Evaluation of adequacy and accuracy of yardsticks/other budgetary procedures currently in use, and with PID, undertake preparation of necessary revisions.
c) Development of efficient management system for budgeting.
d) Identification of means with which funding requirements can be reduced.

This report concerns Tasks III.a and III.b. The evaluation of yardsticks is taken up first and the other tasks shall be undertaken subsequently.

2. General

At present the PID does not use yardsticks as a basis for requesting funds for annual operation and maintenance of the Irrigation System in the Province. The funds are demanded on the basis of actual requirement of work but allocations are made by the Government on adhoc basis by enhancing slightly the allocation of the previous year to cover price escalation. Obviously, establishment of yardsticks to arrive at correct budget requirements for O&M is quite necessary, in order to ensure that funds allocated meet the O&M requirements during the year.

It was recommended in Chapter III of our report entitled "Recommendations for Improved Operation and Maintenance of Rehabilitated Canal Systems" to:

- Establish a three-man Technical Committee in the Province for developing maintenance yardsticks similar to that recommended for other Provinces.
- Adopt a formal procedure for updating annually the yardsticks quantities and unit costs.
- Apply computer based techniques such as spread sheet analysis to facilitate budget preparation.

3. Three-man Committee

The three-man committee of Irrigation Department of NWFP was formed in June 1986 with the following members:

Mr. Abdul Rauf Khan, Superintending Engineer, Northern Circle,	Chairman
Mr. Abdul Qayyum Khan, Executive Engineer, Warsak Canals,	Member
Mr. Aman Gul Khattak, Executive Engineer, Mardan,	Member

The first meeting of the Committee was held with representatives of PRC/C in the office of Provincial Coordinator, Peshawar on 14th July, 1986. Later Mr. Abdul Jalil Khan, S.E Central Circle replaced Mr. Abdul Rauf Khan as Chairman of the Committee. Six meetings of the Committee were held in which the PRC representatives participated to fix the parameters on which the yardsticks and full funded budget for O&M of the Canal System of NWFP Province were to be based.

The decisions taken in these meetings were recorded in the minutes copies of which are on the file. A summary thereof is given below:

II. SUMMARY OF DECISIONS

1. Categories of Canals

It was agreed that for estimation of O&M cost, the NWFP canals shall be classified in the following six categories on the basis of their discharge capacities:

(a) Upto 15 Cusecs
(b) 15-50 Cusecs
(c) 50-200 Cusecs
(d) 200-500 Cusecs
(e) 500-1000 Cusecs
(f) Over 1000 Cusecs

(Minutes of meeting of 15th October, 1986)

2. Typical Cross-section

a) **Fill and Cut**

When developing typical cross-sections for the various catagories of canals, the earthwork quantities shall be computed taking the channel section 2/3 in cut and 1/3 in fill. (Minutes of meeting of 15th October, 1986)

b) **Bank width and side slopes**

Following bank widths and side slopes will be used in typical cross-sections of channels of various catagories.

Channel Category (Cusecs)	Patrol Bank Top Width (Ft)	Non-Patrol Bank Top Width (Ft)	Outer Slopes of Banks
i) Upto 15	12.0	5.0	1.5:1
ii) 15-50	12.0	6.0	1.5:1
iii) 50-200	12.0 Kachha] Road]	8.0	1.5:1
	20.0 Gravel] Road]		
iv) 200-500	20.0	8.0	1.5:1
v) 500-1000	20.0	9.0	1.5:1
iv) Over 1000	20.0	12.0	2:1

(Minutes of meeting of 15th October, 1986)

3. Earthwork Excavation

Earthwork for canal, with capacity less than 1000 cusecs, will be done manually. For channels, having over 1000 cusecs discharge capacity, the work will be done by machines using small dozers and draglines or backhoes. (Minutes of meeting of 15th October, 1986)

4. Sediment Deposition in Canals

The rate of sediment deposition in canals, with less than 200 cusecs discharge, will be taken as 2-3 inches and for bigger canals about 1 inch per year. (Minutes of meeting of 15th October, 1986)

5. Haul Distances for Earthwork

The following haul distances (leads) will be assumed while working out cost of earthwork done on different categories of canals.

(a)	Upto 15 cusecs	200 ft	
(b)	15 - 50 cusecs	200 ft	Minutes of Oct 15,1986.
(c)	50 - 200 cusecs	250 ft	
(d)	200 - 500 cusecs	300 ft	
(e)	500 - 1000 cusecs	500 ft	
(f)	Over 1000 cusecs	500 ft	Minutes of Feb 7,1987.

6. Drains

a) Categories of Drains

For determining yardsticks, the drains will be classified in following five catagories. (Minutes of meeting of 15th October, 1986)

Bed width (Ft)	Classification
Upto 10	Sub Drains
10 to 15	Branch Drains
15 to 25	Main Drains
25 to 50	Main Drains
Above 50	Outfall Drains

b) Siltation Rate

Rate of siltation shall be taken as 12 inches per year in all categories of drains.

The bed clearance of drains shall be done twice a year. The silt deposit in sub and branch drains shall be removed manually, while in the main and outfall drains, bed clearance will be done with machines.

The natural drains for outfalls some of the main drains get choked with silt and gravel. Sediment removal below outfalls drains streams will be done every five years.

c) Inner Slopes

The inner side slopes of the drains in NWFP will be kept at 1:1

d) Weed Clearance

The weed growth will be removed twice a year. As a large number of drains do not have service roads, the desilting shall be done manually or with the help of backhoe or dragline which shall be paid additional cost of track making for their crawling. In this connection the report of Mr. Rauf Khan, Ex-Secretary, Irrigation, NWFP which he

complied after his visit to Egypt will be consulted for guidance. (Minutes of meeting of 15th October, 1986)

7. Applicable Rates

Earthwork rates based on basic analyses with existing wage rates shall be used. (Minutes of meeting of 12th November, 1986).

8. Multiplier for Non-Rehabilitated Canals

A majority of channels have not so far been rehabilitated, it was agreed that a suitable multiplier of the rate of Rs 250/- per acre, fixed as O&M ceiling for rehabilitated canals, shall be determined for determining the yardstick rates for non-rehabilitated canals. (Minutes of meeting of 12th November, 1986)

9. Deterioration of Top and Slopes

For estimating quantities of earthwork required for repairing top of the bank and side slopes, the erosion shall be taken as 1 inch per year. (Minutes of meeting of 10th December, 1986)

10. Maintenance Cost of the Structures

Maintenance cost of structures shall be taken as 1.5% of their current value. Director Design and Planning will work out the present day costs of following catagories of structures. (Minutes of meeting of 10th December, 1986)

a) For Headworks and Canals Regulators
b) Falls
c) Bridges
d) Aqueducts
e) Super-Passages
f) Syphons (under passages)

g) Water Course Crossings

h) Water Mills

i) Culverts

j) Outfalls

k) Inlet Works

11. **Berm Replacement**

For determining yardsticks, the following lengths shall be taken for annual berm replacement for the various catagories of channels:

Category (Cusecs)	Length of Berm Replacement on each bank. (Ft)
Upto 50	Nil
50 - 200	25
200-1000	50
Above 1000	75

(Minutes of meeting od 10th December, 1986)

12. **Turfing on Outer Slopes of the Canals**

Turfing of 5% of the area of outer slopes of the banks shall be done annually to protect them from erosion. This percentage is fixed arbitrarily and will be revised in subsequent years on the basis of experience gained.

The provision and maintenance of turfing on non-rehabilitated canals shall be funded through a multiplier to be determined later. (Minutes of meeting of 19th November, 1986).

13. **Haul Distance for Machines**

The haul distance for earthwork to be done by machines for channels above 1000 cusecs shall be taken as 5000 Ft. (Minutes of meeting of 7th February, 1987)

14. **Crop Compensation**

Crop compensation shall be provided for 10% of the total channel length. (Minutes of meeting of 7th February, 1987)

15. **Maintenance of Bridges**

The rates for the maintenance cost of bridges of various catagories of channels shall be taken as below: (Minutes of meeting of 7th February, 1987)

Main Canals	Rs.2000	per structure
Distributaries	Rs.1500	per structure
Minors	Rs.1000	per structure

16. **Maintenance of Kachha Roads**

Out of the total length of canal roads, 80% shall be maintained mechanically and the remaining 20% through manual labor. (Minutes of meeting of 7th February, 1987)

17. **Pitching and Lining Repairs**

Canal pitching length at 10% and lining at 50% shall be taken for repairs annually. (Minutes of meeting of 7th February, 1987)

18. **Length of Canals**

Length of canals 1845 miles in NWFP Province as determined by NESPAK shall be taken for computing yardstick. (Minutes of meeting of 7th February, 1987)

19. **Sediment Removal**

The Committee agreed to revise the percentage of canal lengths for sediment removal annually as below: (Minutes of meeting of 5th March, 1987)

Upto 15 cusecs	25%
15 - 50 cusecs	20%
50 - 200 cusecs	10%
200 - 500 cusecs	5%

III. PREVIOUS STUDIES

As mentioned earlier, no regular O&M yardsticks have ever been used in the PID. Sometime back, an attempt was made by PID to develop an O&M yardstick based on an adhoc percentage of capital cost of the irrigation installations. This warranted updating the capital cost of the works on the present day rates. The fixing of an arbitrary percentage of updated cost of installation to serve as a yardstick was controversial as it could not conform to objective conditions. Besides it was time consuming and involved difficulties of maintaining updated capital cost for the entire irrigation system. Preparation of new yardsticks, on the pattern followed by other Provinces for improved maintenance of irrigation works, was decided by the Committee.

IV. GENERAL PROCEDURES

The scheme employed to assess the yardsticks required physical inspection of representative irrigation facilities to determine their present condition. In cases where maintenance was not considered adequate, maintenance standards were upgraded, unit costs determined and new yardsticks developed as detailed in this report.

V. INSPECTION OF FACILITIES

In consultation with officers of PID of NWFP Province, the following facilities were inspected:

1. **Headworks and Associated Structures**

   Munda Head Works

   Amandara Head Works

   Baran Dam

2. **Canals**

   Doaba Canal and some of its distribution systems.

   Lower Swat Canal and part of its distribution systems.

   Upper Swat Canal and part of its distribution systems.

   Marwat Canal and part of its distribution system.

3. **Drains**

   Drains around Peshawar and Bannu

4. **Flood Bunds**

   Flood bunds and spurs along river Indus close to D.I.Khan

Maintenance yardsticks have been developed for canals, drains and flood embankments. It is not considered necessary to develop yardsticks for barrages (which are very few in the Province) as every barrage has its own peculiar operation and maintenance characteristics requiring an individual O&M budget.

The new yardsticks values are given in the unit of Rupees per mile of canal, drain or flood bund and are categorized according to the types of the facilities.

The lengths of each category are given in Table 1. The full funded budget is the sum of the products of the respective yardsticks and the length of

each facility. For comparison purpose the budget figures of 1986-87 have been adopted.

VI. CANAL MAINTENANCE STANDARDS

The components of canal systems requiring annual maintenance are the channel embankments and bed levels (see Figure I Sheets 1 and 2).

The items of jobs involved are repairs of the inside and outside slopes of the embankment and the inspection roads; the maintenance of channel beds to design levels requires periodical removal of sediment deposits; maintenance of structures involve repair to masonry, painting of metal surfaces and repairs to downstream silting basins of regulators and falls.

The maintenance standards adopted for these work items are given below:

FACILITY	MAINTENANCE STANDARD
a) Canal embankment	1. Replace 5 inches of material on patrol and non petrol roads along 20% of total length of canals each year.
	2. 80% kachha roads shall be maintained mechanically and 20% by manual labor.
b) Embankment outside slopes	1. Replace 5 inches of material on slopes of 20% of all channels.
	2. Repair 20 raincuts per mile on main canals and branches and 10 per mile on distributaries and minors.
	3. Remove all trees and bushes on the slopes and shoulders and control weed

		growth to facilitate inspection of any seepage or drainage.
c)	Embankment Inner slope and berms	1. Maintain turf on inner and outer slopes and berms above water level.
		2. Cut weeds and trees from inner slopes and berms to allow visual inspection of canal bank prism.
		3. Provide 25 to 75 ft of berm replacement along various categories of canals above 50 cusecs.
d)	Sediment Removal	1. Remove annually about 6000 cft of sediment from 25% of minors upto 15 cfs; 9000 cft from 20% of channels of 15-50 cfs; 12000 cft from 10% of channels upto 200 cfs and 9000 cft from 5% of channels from 200-500 cfs.
		2. Establish monitoring stations at suitable locations to ensure that cross sections and sediment concentrations remain within design limits.
		3. Sediment removed from the channel will be placed directly along the toes of the outer slopes. It may have some market value to off-set some cost of removal.
e)	Canal Structures	Inspect annually all gates, gears, gate-hoists and steel accessories and repaint, repair or replace as needed during canal

closures. The costs is to be included for this work as per mile cost of the canals.

VII. CANAL SIZE AND CATEGORIES - LENGTH AND QUANTITIES

The maintenance standard fixed for each canal is dependent upon an annual unit cost allowed for their various categories. The canals are divided in following six classes according to individual discharge capacity:

1. Categories

Canal Size (Cusecs)		Length (miles)
Upto 15		444
15 - 50	Minors and sub minors	616
50 - 200	Bigger minors and distributaries	390
200 - 500	Branch canals	257
500 - 1000	Main and branch canals	79
above 1000	Main canals	59
		1845

2. Canal Maintenance Quantities

Earthwork quantities were worked out by taking average depth for various ranges of discharge and varying widths of the Patrol Bank and Non-Patrol Banks as tabulated below:

Canal Category Cusecs	Average Depth(Ft)	Bank Top Width(Ft)		Freeboard (Ft)	Side slopes	
		P.B.	N.P.B.		Inner	Outer
Upto 15	1.5	12	5	1.5	1:1	1.5:1
15 - 50	2.4	12	6	1.5	1:1	1.5:1
50 - 200	3.6	12	8	2.0	1:1	1.5:1
200 - 500	4.8	20	8	2.5	1:1	1.5:1
500 -1000	6.0	20	9	2.5	1:1	1.5:1
above1000	7.5	20	12	3.0	1:1	2:1

While working out quantities of earthwork required for O&M of the channels it was assumed that one-third are in filling, two-third are in cutting and there are no berms along channels having capacities upto 200 cusecs.

Typical sections for distributaries and minors (upto 200 cusecs), main canals and branches (200-1000 cusecs) are shown in Figure 1 Sheets 1 and 2. The quantities are shown in Figure 1, Sheet 3.

Sediment removal quantities have been worked out based on the following assumptions:

i) Due to limited time available during annual closure of a canal system, sediment removal would be confined to about 25% length of the channels upto 15 cfs, 20% of length for 15 - 50 cfs, 10% of length for 50 - 200 cfs and 5% of length for 200-500 cfs.

ii) The average width of channels for sediment removal has been taken as follows:

Category (Cusecs)	Bed Width (ft)
Upto 15	5
15 - 50	9
50 - 200	24
200 - 500	36

iii) The depth of sediment removal has been taken as 1.0 ft for channels upto 500 cfs.

VIII. MAINTENANCE METHODS

To achieve efficiency, it is desireable to allow the maintenance needs to accumulate for 4 to 5 years and carry out work on 20 to 25% of the channel length every year. However, some components of works on canal system such as rainfall damage, erosion, structure repairs and road grading would require regular annual maintenance/operation.

In view of the good labor availability in the Province, it is proposed to carry out works by intensive use of labor, and use machines only for channels above 1000 cusecs. Road grading of dirt roads should be done mechanically for eighty percent of their length.

1. Excavation, Load and Haul of Earthwork

This work shall be done by basket labor. Nowadays, extensive use is being made of farm tractors fitted with dozing blades. This arrangement works very well for leads upto 1000 ft and is more economical as compared to manual labor. Some donkey labor is also available although this force is becoming scarce.

Borrowing of earth from the fields close to the canals is becoming a problem. There is reluctance on the part of the farmers of the adjacent agricultural land to permit borrowing of earth from their fields due to standing crops or to prevent robbing of the rich top soil. According to Canal and Drainage Act of NWFP, earth can be borrowed from the farmers fields on payment of crop compensation. Therefore, crop compensation has been provided for 10% of the length of channels in the yardstick.

In view of their experience, the members of the Technical Committee indicated the following leads (haul distances) in earthmoving for various categories of channels.

Category (cfs)	Haul Distance (Ft)	Remarks
Upto 15	200	Manual
15 - 50	200	Manual
50 - 200	250	Manual
200 - 500	300	Manual
500 - 1000	500	Manual
above 1000	5000	Mechanical

2. Compaction

Compaction shall be done by tamping-foot rollers drawn by farm tractors. This would easily give a dry density of 85%. A water tanker shall be employed for sprinkling water. The unit costs of compaction have been worked out on the basis of basic schedule of rates.

3. Sediment Removal

Annual sediment removal shall be done from 25% of channels upto 15 cfs discharges; from 20% with discharges from 15-50 cfs; from 10% with discharges from 50-200 cfs and from 5% with discharges 200-500 cfs. No sediment shall be removed from channels above 500 cfs. This work shall be done by manual labor.

4. Berm Repairs

Berm repairs shall be required for channels above 200 cusecs. For yardsticks purposes, 25 ft of berm replacement shall be taken for channels of 50-200 cfs; 50 ft from those of 200-500 cfs capacities and 75 ft for channels above 1000 cfs capacity.

5. Pitching Repair

Stone pitching has been provided to check side erosion of embankment. The existing length of pitching is as below for the various categories of channels:

Category (cfs)	Length (Tft) 1/ Left Side	Right Side	Total (Tft)
Upto 15	308.8	310.1	618.9
15 - 50	228.7	251.6	480.3
50 - 200	202.8	192.4	395.2
200 - 500	48.2	43.2	91.4
500 - 1000	19.1	29.3	48.4
above 1000	3.7	7.5	11.2
	811.3	834.1	1645.4

1/ Lengths taken from computerized report.

It is estimated that 10% of the pitching shall be repaired annually.

6. Lining Repairs

Cement concrete lining has been provided for the following lengths of various categories:

Category (Cusecs)	Length of lining (Ft) 1/
Upto 15	206.2
15 - 50	363.6
50 - 200	277.1
200 - 500	66.9
500 - 1000	-
above 1000	17.3
	1031.0

It is estimated that 5% lining length shall be repaired annually.

7. Structures Maintenance

The major canal structures are regulators, falls, bridges, culverts, aqueducts and syphons. From the computerized inventories, their numbers have been adopted for the main canals and branches, distributaries and minors as below:

Category Item	Number of Structures						
	Upto 15	15-50	50-200	200-500	500-1000	Above 1000	Total
Fall and Fall cum Bridges	405	561	675	227	71	52	1991
Bridges	59	81	139	192	60	44	575
Culverts /Syphons etc	64	88	154	320	99	73	798

1/ Lengths taken from computerized report.

8. **Dirt Road Maintenance**

It is intended to maintain 80% length of the kachha roads mechanically. The remaining 20% is proposed to be maintained by manual labor. The total length of dirt roads is 824 miles. 1/

9. **Shingle Road Repair**

Some distributaries and minors have shingle patrol roads. The length of such roads is 248 miles and these are maintained by the Irrigation Department. 1/

10. **Metalled Road Repair**

There are metalled roads along some channels. Their total length is 212 miles. These are also maintained by Irrigation Department. 1/

IX. UNIT AND YARDSTICK COSTS

1. **Earthwork**

The unit cost of earthwork has been worked out on the basis of the following wage rates:

(a)	Unskilled laborer	Rs 30/day
(b)	Dresser	Rs 37.5/day
(c)	Waterman	Rs 35/day
(d)	Bullock man with ½ pair of bullock	Rs 45/day

The unit costs for the various items of earthwork have been worked and are shown in Table 2. These rates are:

1.	Borrow pit excavation lead = 100 ft	Rs 254.10/Tft^3
2.	Compaction of earthwork	Rs 161.50/Tft^3

1/ Lengths given by Technical Officer

3. Sediment removal lead = 50 ft — Rs 299.50/Tft^3
4. Additional for every 50 ft increase in lead — Rs 10/Tft^3

On the basis of these rates, yardstick rates for earthwork for the various capacities of the canals involving different leads have been worked out and are shown in Table 3. These rates are much higher than the existing rate and, therefore, can cover the element of deferred maintenance. The new multiplier has been applied to cover funding requirements for non-rehabilitated canals.

2. Crop Compensation

The farmers do not allow earth to be borrowed from adjoining fields for repair work of canals particularly when there are standing crops. Therefore, crop compensation has to be paid. The Committee agreed that crop compensation should be provided for 10% of channels. Assuming a crop compensation rate of Rs 5000/acre, crop compensation for various categories is shown in Table 4.

3. Sediment Removal

Assumptions

1. Sediment will be removed from a channel when deposition of 1.0 ft has taken place.
2. The percentage of annual sediment removal of the channels shall be as below:

(a)	Upto 15 cfs	25%
(b)	15 to 50 cfs	20%
(c)	50 to 200 cfs	10%
(d)	200 to 500 cfs	5%
(e)	Above 500 cfs	nil

On the basis of these assumptions the yardstick for sediment removal is shown in Table 5.

4. Berm Replacement

Following lengths of berm replacement are assumed for various categories of channels:

(a)	Upto 15 cfs	nil
(b)	15 to 50 cfs	nil
(c)	50 to 200 cfs	25 ft each side
(d)	200 to 500 cfs	50 ft each side
(e)	500 to 1000 cfs	75 ft each side
(e)	Above 1000 cfs	75 ft each side

On the basis of CSR rates for killa-bushing, the following rates for berm replacement work out per mile for the various categories.

(i)	50 - 200 cfs	Rs 350
(ii)	200 - 500 cfs	Rs 1000
(iii)	500 - 1000 cfs	Rs 1950
(iv)	Above 1000 cfs	Rs 1950

5. Pitching Repair

On the basis of computerized report and assumed 10% of pitching repair, the length of annual pitching repair is as below:

Category (Cusecs)	Length of Repair (Ft)	Unit Cost per ft (Rs)	Yardstick Cost (Rs)
Upto 15	140	5	700
15 - 50	90	6	540
50 - 200	100	10	1000
200 - 500	35	12	420
500 - 1000	60	15	900
above 1000	17	20	340

The unit costs shown above have been worked out according to CSR.

6. Lining Repair

On the basis of computerized report and assumed 5% lining repair, the length of annual repair of lining per mile for various categories is as below:

Category (Cusecs)	Length of Lining (Ft)/mi	Unit Cost (Rs)	Yardstick Cost/mi(Rs)/mi
Upto 15	35	20	700
15 - 50	30	25	750
50 - 200	28	40	1120
200 - 500	18	50	900
500 - 1000	-	-	-
above 1000	17	75	1275

The unit costs shown above have been worked out according to CSR.

7. Structures Repair

The number of various types of structures for the different categories of channels have been taken from the computerized inventory report. Table 6 shows the number of structures per mile, the unit costs and the yardstick for the various categories of channels.

8. Road Grading

Grading of road six times a year will improve maintenance of dirt patrol roads. This operation is in addition to periodic grading done by beldars to control dust and effect minor repairs. It is recommended that cost of road grading be based on the use of a 125 hp motor grader fitted with a 12-foot blade. The average production rate is 100,000 sqft/hr and the hourly rate is Rs 350/hr. This gives a unit cost of Rs 3.5/1000 sqft.

9. Turfing

Turf cover would be provided over 5% of all slopes. Its unit cost is Rs 20 per hundred sqft as worked out below:

Operation	Laborer Required	Production Rate(Sqft/hr)	Hourly Cost	Unit Cost (Rs/sqft)
Grass Harvest	1	50	4.54 1/	0.10
Transplanting	1	50	4.54	0.10
Total				0.20

1/ Included 10% sundries and 10% contractor's profit.

The yardstick cost is in Table 7.

10. Shingle Road Maintenance

The total length of shingle roads is 248 miles. This has been spread over various categories of channels. Taking 10% length for repairs, yardstick per mile has been worked out as shown in Table 8.

11. Metalled Road Maintenance

The total length of metalled roads along the channels is 212 miles which is maintained by Irrigation Department. This length has been spread over various categories of channels. Taking 5% length of channels for annual repairs, yardstick per mile has been worked out as shown in Table 9.

12. Contract Administration

Adequate inspection has to be carried out by PID staff for maintaining the channels in proper state of repairs. It would require maintenance of adequate fleet of vehicles for inspection. This cost has been worked out in Table 10 and comes to Rs 380/mile for main canals and branches and Rs 190/mile for distributaries and minors. Cost of T & P at Rs 50/mile for

main canals and branches and Rs 45/mile for distributaries and minors has been added.

X. SUMMARY OF CANAL YARDSTICKS

A summary of maintenance yardstick using manual labor upto 1000 cfs capacity is given in Table 11 for the following items:

Work Items	Yardstick (TRs/mile)
Excavation and placement	3.9
Compaction	2.0
Crop compensation	0.1
Sediment removal	2.5
Berm replacement	0.4
Turfing slopes	0.5
Pitching repair	
Lining repair	
Structure repair	3.1
Road grading	1.4
Shingle road repair	0.1
Metalled road repair	0.1
Contract administration	0.2
Total canal yardstick	16.1

B. FLOOD BUND YARDSTICK

XI. INDUS RIVER - MAIN BUNDS AND SPURS

In NWFP a main bund close to D.I. Khan runs along river Indus for a length of about 24 miles with a large battery of stone armoured spurs to fight the onslaughts of mighty Indus river during flood season. This main bund provides protection to the city of D.I. Khan and Paharpur Canal System. Since river Indus carries large volumes of water as compared to other

rivers in NWFP, its flood protection problems are different. Therefore, it is proposed to develop a separate yardstick for the Indus river main bund and its appurtenant spurs. Typical section for main bund and spurs are shown in Figure 2.

The length of main bund and spurs is as below:

Main Bund	=	24 miles
Spurs	=	64 miles
Number of Spurs	=	30

XII. MAINTENANCE STANDARD

The following maintenance standard shall be adopted for main bund and spurs.

A. PREPAREDNESS FOR FLOOD SEASON

(i) Levelling of bund and spurs crest and their slopes to determine actual available free board above high flood marks and deterioration of slopes.

(ii) 10% of length of main bund and spurs shall be repaired annually.

(iii) About 5% of the designed quantity of stone used in armouring the spurs shall be replaced every year.

(iv) Visual inspection of river course will be carried out annually to determine any major changes in the river course. A detailed river survey may be required.

(v) Model testing will be done if there is any problem at critical points.

(vi) Consumable materials for flood fighting shall be procured and stored.

B. FLOOD PERIOD

(i) Special work charged establishment shall be employed during flood season for attending to leaks and minor repairs.

(ii) Consumable materials required during flood shall be kept in stock.

(iii) Heavy vehicles like trucks, tractors, dozers, pickups etc shall be hired for maintenance needs.

XIII. QUANTITIES

A. PREPAREDNESS OF FLOODS

1. Earth Work

Typical Sections of Main Bunds and spurs are shown in Fig. 2. Quantities required for maintenance standard are summarized in Table 12. The quantities have been worked out on the assumption that annual deterioration top of embankment is 1/2" and of slopes 1".

2. Stone

The total designed quantity of stone used in the spurs is about 36,700,000 cft. Five percent of this quantity is to be replaced every year. This gives an annual replacement quantity of stone as 1,835,000 cft. The quantity per mile of spurs comes to 28,700 cft.

3. Levelling Work

Levelling shall be carried out every year to find out available free-board and deterioration of slopes. The length of levelling would be about 88 miles and observation of X-section about 175 in number.

4. **Visual Inspection of River Course**

Soon after the flood season inspection of river course shall be done all along the main bund and spurs in large country boats. This would help in foreseeing any dangerous tendency of the river to attack any particular spur or the main bund between the spurs. This work would involve inspection about 40 miles of river course.

5. **Detailed Surveys and Model Studies**

As a result of visual inspection detailed surveys for any particular reach may be required for carrying out model studies. Lump sum provision would be made for this work.

6. **Repairs to Gauges and Huts**

Some repairs would be required to gauges and huts. A lump sum provision would be made for this item.

7. **Consumable Materials**

Some consumable materials such as torches, petromax lamps, old gunny bags, baskets, munj and coir rope etc shall be purchased before flood season for use during flood season. A lump sum provision would be made on the basis of actual expenditure.

B. **DURING FLOOD SEASON**

8. **Watching Establishment**

During flood season from 1st June to 30th September, additional work charged establishment shall be engaged for watching of main bunds and spurs. The strength of this establishment would be at the rate of two men per mile for the main bund and one man per mile for the spurs.

9. **Running Vehicles for Inspection**

It is assumed that during 4 months of flood season running of vehicles would be about 1000 miles per month and during the remaining period of the year 500 miles per month. This gives 90 miles running of vehicles per mile length of bunds.

10. **Using Machines**

During flood period tractors dozers, pick-up trucks etc shall be used for carriage of material and labor. A lump sum provision would be made.

11. **T and T Charges**

During flood season, telephones and wireless sets are installed at vulnerable points for flood warning. A lump sum provision would be made for it.

XIV. UNIT COST

1. **Earth Work**

Lead for earthwork for main bunds has been taken as 300 ft and for spurs 100 ft. From Table 3, the rates for main bund and spurs work out to Rs 455.5 and Rs 415.5 respectively for compacted earthwork.

2. **Stone Replacement**

According to the records of flood Sub-division D.I.Khan, the cost of stone delivered at the site of work is Rs 500 per hundred cft. The same rate has been used

3. **Levelling Work**

A lump sum provision of Rs 300 per mile has been made.

4. **Visual Inspection River Course**

A lump sum provision of Rs 300 per mile has been made.

5. **Repairs to Gauges and Huts**

A lump sum provision of Rs 300 per mile has been made.

6. **Model Studies**

Based on experience, a lump sum provision of Rs 1000/mile has been made for this item.

7. **Consumable Material**

Based on actual experience, a provision of Rs 300 per mile has been made.

8. **Watching Establishment**

The wages of a beldar has been taken as Rs 600 per month.

9. **Running Vehicles**

Rate per mile of running of vehicles has been taken as Rs 5.00.

10. **Using Machines during Flood Period**

On the basis of actual experience a rate of Rs 3000 per mile has been taken.

11. **T&T Charges**

A lump sum rate of Rs 500/mile has been taken for this item.

XV. OTHER RIVERS

On all other rivers there are flows and no floods. In the O&M yardstick these rivers have been taken as 8% of main Indus River.

XVI SUMMARY OF FLOOD BUND YARDSTICK

A summary of maintenance yardstick for main bund and spurs is given below:

Work Items	Yardstick T Rs/Mile	
	Main Bund	Spurs
Earthwork	13.2	9.1
Stone Replacement	-	203.7
Levelling	0.5	0.5
Inspection of River Course	0.3	0.3
River Survey	1500.0	1500.0
Repairs to Gauges & Huts	0.2	0.2
Model Studies	2.0	2.0
Consumable Materials	3.0	3.0
Watching Establishment	4.8	2.4
Running Vehicles	0.8	0.8
Use of Machines	3.0	3.0
T&T Charges	0.5	0.5
Running Generators	0.3	0.3
Total		227.3
Other Rivers (Spurs)	30.1	170.5

C. YARDSTICK FOR DRAINS

The field inspection of drainage system indicated that these are no maintenance roads along the drains. When the drains were initially constructed, the excavated material was heaped along the drains on the fields of farmers. The farmers gradually spread the dug earth spoils on

their lands, thus the excavated material was disposed off. The same treatment is meted out to the silt removed from the drains. In this way cultivation is done right upto the edges of drains. Absence of inspection roads causes difficulty in the movement of machines for sediment and weed removal from the drains and periodical inspection.

Weed growth in the drains is a serious problem. This causes obstruction in the flow of water and induces rapid siltation of drains.

XVI. SIZE CATAGORIES AND LENGTH

Surface drains are classified into following 5 catagories:

Bed width (ft)	Classification	Length (miles)
Upto 10 ft.	Sub-drains	1070
10 - 15	Branch drains	140
15 - 25	Main drains	89
25 - 50	Main drains	181
Above 50	Outfall drains	75
	Total	1555

According to NESPAK data, the total length of drains is 766 miles. This does not include data for drains located in Mardan, Swabi and Kohat Divisions. The total length of drains given by Irrigation Department is 1555 miles. There is no back up data for this mileage for splitting it into various catagories. Therefore NESPAK data has been used for splitting 1555 miles into above mentioned catagories on pro-rata basis.

XVII MAINTENANCE STANDARD

The following maintenance standard are proposed for drains:

FACILITY	MAINTENANCE STANDARD
Bed Control	i) Sediment shall be removed from drains upto 15 ft bed width in alternate years assuming that silt deposition is 6" per year. This gives as estimated sediment removal of 22 million cuft every year. ii) Sediment shall be removed from drains with bed width above 15 ft once in 4 years taking 6" deposition of silt every year. The estimated quantity of sediment removal per year for these categories of drains comes to 26 million cft. iii) Remove weeds manually twice a year from drains upto 15 ft bed width and by machines once a year from drains above 15 ft bed width.
Structures	i) Inspect and repair 25% of all structures and inlets annually. ii) Replace an average of 150 inlets each year.

XVIII MAINTENANCE METHODS

Suitable methods for drains maintenance are:

Sediment Removal	By manual labor upto 15 ft bed width and by machines above 15 ft be width.
Weed Removal	By manual labor upto 15 ft bed width and by machines above 15 ft bed width.

XIX. QUANTITIES

The quantities associated with maintenance standard are shown in Table 13.

XX. UNIT COSTS

1. Silt Removal

Silt removal is to be done manually in tributary and branch drains having bed width upto 15 ft. According to basic analysis of rates; the rate for earthwork excavation in drains within 50 ft lead comes to Rs 299.5 as shown in Table 2 page 2.

For main and outfall drains dragline shall be used for sediment removal. Unit rate for use of dragline is shown below.

Bed Width	Equipment	Production rate cft/hr	Hourly Cost/Rs	Unit Cost Rs/ft^3
15-25	D/L 200 HP1/	1800	550	.306
25-50	D/L 200 HP	1700	550	.324
Above 50	D/L 200 HP	1600	550	.344

1/ D/L = Dragline.

2. Weed Removal

Upto 10 ft bed width, weed removal shall be done manually. Taking wage of a coolie as Rs 30/day and his progress of weed removal as 2000 sqft per day, rate for manual weed removal works out as below:

No of Coolies	Wage/day Rs	Production Rate Sqft	Rate per 1000 sqft (Rs)
1	30	2,000	1.5

For weed removal by machines the same equipment as used for sediment removal can be used for weed removal. However, it should have 10 ft wide

rake-type bucket. The operational data and Unit Costs for backhoe and dragline is given below.

Bed Width Ft	Equipment	Production Rate Sft/Hr	Hourly Cost (Rs)	Unit Cost Rs/Ft^2
10-15 1/	B/H 135 HP	6000	470	7.8
15-25	D/L 200 HP	4500	550	12.2
25-50	D/L 200 HP	4200	550	13.1
Above	D/L 200 HP	4000	550	13.8

1/ B/H Backhoe

3. Structure Repairs

(a) Bridges

On the basis of experience, the following rates for maintenance have been assumed per structure.

Category (ft)	Rate (Rs)
Upto 10	1000
10 - 15'	1000
15 - 25'	1200
25 - 50'	1500
Above 50	1500

(b) Water Course Crossings

Following rates have been assumed for maintenance of each structure:

Category (ft)	Rate (Rs)
Upto 10'	300
10 - 15'	300
15 - 25'	500
25 - 50'	500
Above 50'	700

(c) **Aqueducts of Syphons**

The same rates as W.C.C have been taken.

(d) **Culverts**

The rates for water course crossing are applicable to culverts also.

4. **Contract Administration**

A rate of Rs 250/mile has been taken for all catagories of drains for use of vehicles for inspection and T&P.

XXI SUMMARY OF DRAIN YARDSTICK

Maintenance Yardstick for drains is given in Table 14 and is summarized as below:

	Item	Yardstick/Mile (Rs)
1.	Silt Removal	9907
2.	Weed Removal	6176
3.	Structure Repairs	369
4.	Contract Administration	250
	Total	16702

XXII. COMPARISON OF BUDGETS

The NWFP PID draws its budget from two items i.e., Demands Number 8 and 9. Revenue generating and unproductive canals, dams, tubewells, hydel schemes, establishment and special provisions for above items fall under Demand No. 8; civil canals, drains and bunds that do not generate revenues, are

charged to Demand No. 9. A summary of budgets items for Demands Number 8 and 9 for the year 1986-87 is shown in Table-15.

PID AND PRC UNIT COSTS COMPARISON

The unit cost of earthwork constitutes about 60% of the yardstick items. Therefore, it has the greatest influence on the magnitude of yardsticks. PID's existing unit costs are based on a certain percentages above CSR of 1967. It is considered that the rates obtaining in Swabi Division are representative of the entire Province. The existing premium for earthwork in the said division is 850% above CSR of 1967. This gives a rate of Rs. 312.50 for compacted earthwork for a lead of 1000 ft. According to the decision of the committee, PRC was required to workout a rate for earthwork from the basic analysis of rates using Rs. 30.00 per day as the wages of a laborer. This gives a rate of Rs. 415.61 for compacted earthwork for a 100 ft haul distance as shown in Table 2. In view of this difference of over Rs. 100, it is desireable that PID should revise their CSR to avoid underestimating of rehabilitation costs and to provide a firm basis for improved maintenance.

Full Funding Budget

The full funding budget presented in this report is only relevant and applicable for maintenance of the rehabilitated canals, flood bunds and surface drains. The PRC yardsticks do not include headworks, tubewells and other facilities.

The budget demand is the sum of the products of length and yardsticks for each category. This exercise has been done for canals, flood bunds and drains and is shown in Table-16.

For comparing those calculated budget figures with the corresponding actual budget figures for the year 1986-87 effort has been to separate the provisions for canals, flood and drains from the existing budget. For canals, the budget includes headworks also, although, the latter have not

been taken into account in developing the yardsticks. Similarly, the items for drains are mixed up and it is not possible to separate them, unless actual allocation are taken into account. Therefore, the comparison of calculated and actual budgets for canals, bunds and drains shown below should be considered as approximate.

Items	Budget (Rs m)		
	PID Actual 1986-87	Calculated PRC	Increase over PID Budget (%)
Canals	23.2	29.7	28
Flood Bunds	23.7	25.1	6
Drains	18.8	26.0	38

This comparison shows that for flood bunds the increase is very small i.e. 6%. This may increase if the actual length of spurs for other river is more than 54 miles as this figure is approximate. The allocation seems adequate. The increase in canals may be attributable to increased rates of earthwork and more items. The major increase is in drains. This is due to the following problems in working out the yardsticks:

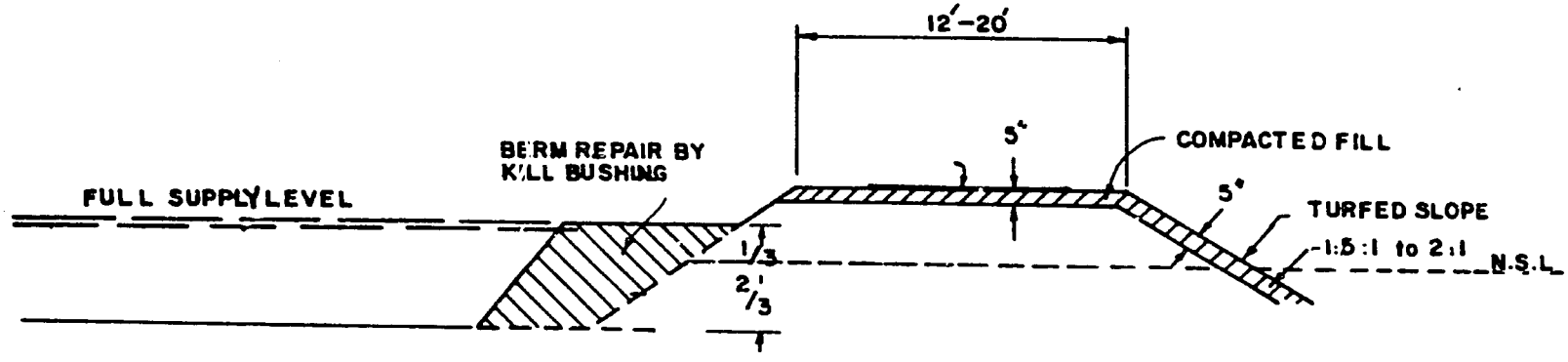
1. Estimates sediment removal quantities are on the higher side.

2. Weed removal would be done twice a year for drains upto 10 ft bed width which is about 70% of the total length of drains.

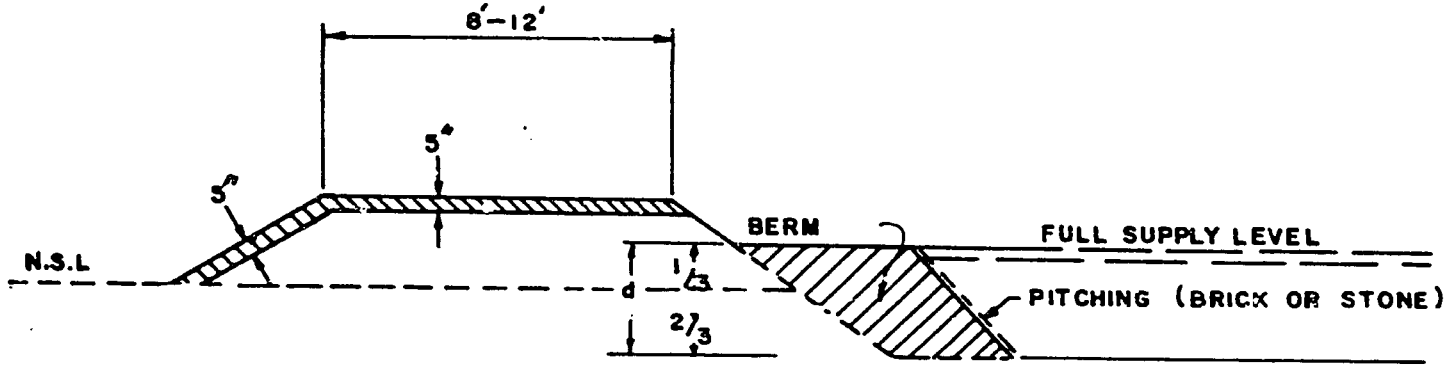
Full Funded Budget for 1986-87

On the basis of calculated budgets for canals, flood bunds and drains the full funded budget for demands Nos. 8 and 9 is as below: Comparison has also been made in this table with the actual budget for the year 1986-87:

Demand No.	Calculated Budget	PID Budgets 1986-87	%age Increase
8	265.6	259.1	2.5
9	69.0	60.6	14.0



PATROL BANK SIDE



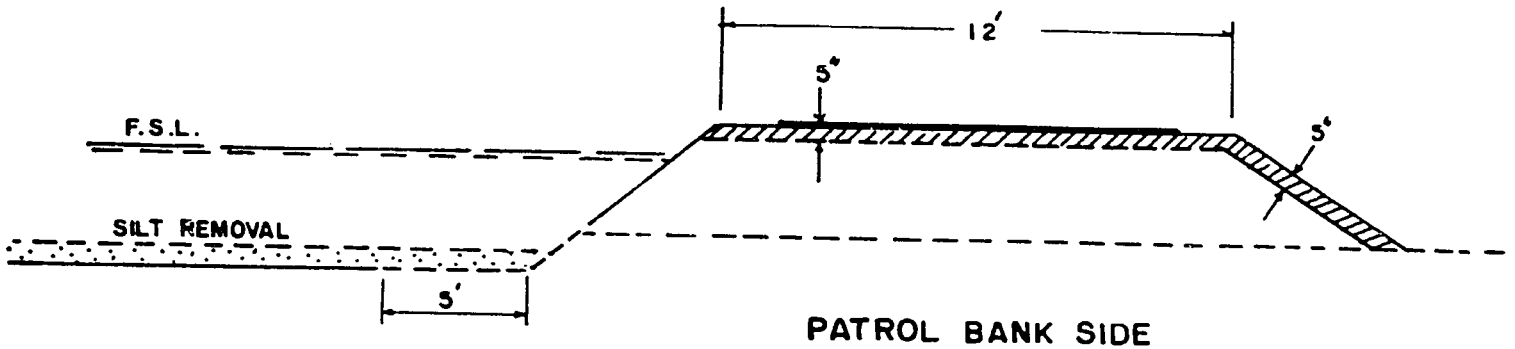
NON PATROL BANK SIDE

MAIN CANAL AND BRANCHES

(200 - ABOVE 1000 cfs.)

Maintenance Requirements
for
NWFP Canals

FIG. 1 SHEET 2



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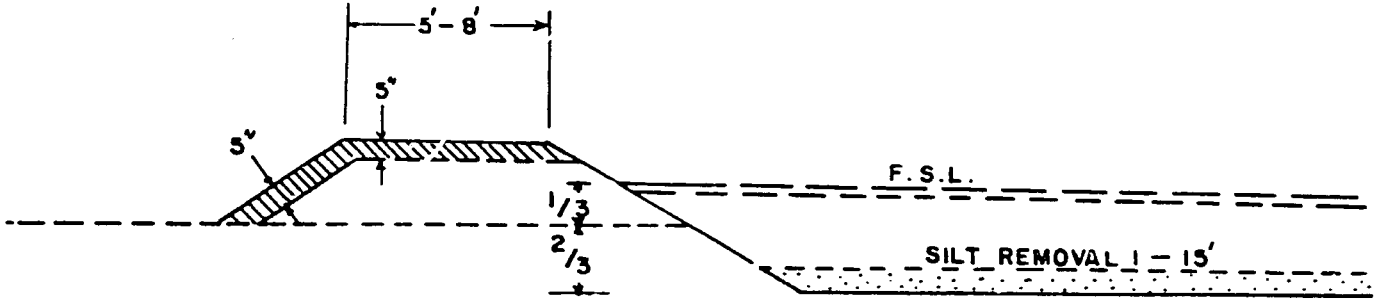


NON PATROL BANK SIDE

DISTRIBUTARY AND MINORS
(UPTO 200 cfs.)

Maintenance Requirements
for
NWFP Canals

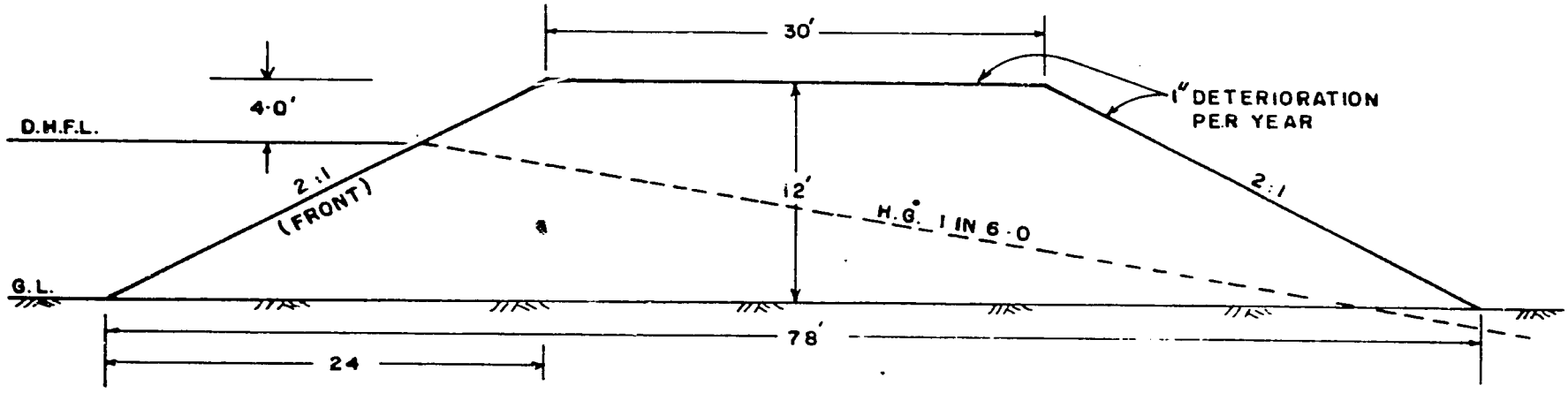
Figure I Sheet 3

Items	Units	Canal Categories (cusecs) Upto 15	15-50	50-200	200-500	500-1000	Above 1000	Total or Average
1. Canal Lengths								
a) Total	Miles	444	616	390	257	79	59	1845
b) Annual Maintenance	Miles	89	123	78	51	16	12	369
2. Crest Width								
a) Patrol Bank	Ft	12	12	12	20	20	20	
b) Non Patrol Bank	Ft	5	6	8	8	9	12	
3. Embankment Quantity 1/								
a) Crest	T cu ft/mi	7.8	8.3	9.2	12.8	13.3	14.7	9.4
b) Slope	T cu ft/mi	2.0	2.0	3.0	5.5	9.5	13.6	3.1
c) Total	T cu ft/mi	9.8	10.3	12.2	18.3	22.8	28.3	12.5
4. Equivalent Lead 2/	Ft	200	200	250	300	500	5000	
5. Silt Removal 3/	T cu ft/mi	6.3 4/	9.00 5/	12.0 6/	90.0 7/	0	0	
6. Erosion Control								
a) Berm Repair	Ft/m	-	-	50	100	150	150	
b) Pitching Repair 8/	Ft/m	140	90	100	35	60	17	
c) Lining Repair 9/	Ft/m	35	30	28	18	-	17	
7. Turfing 10/	TFt^2/m	2.0	2.0	3.0	37.5	4.0	6.0	

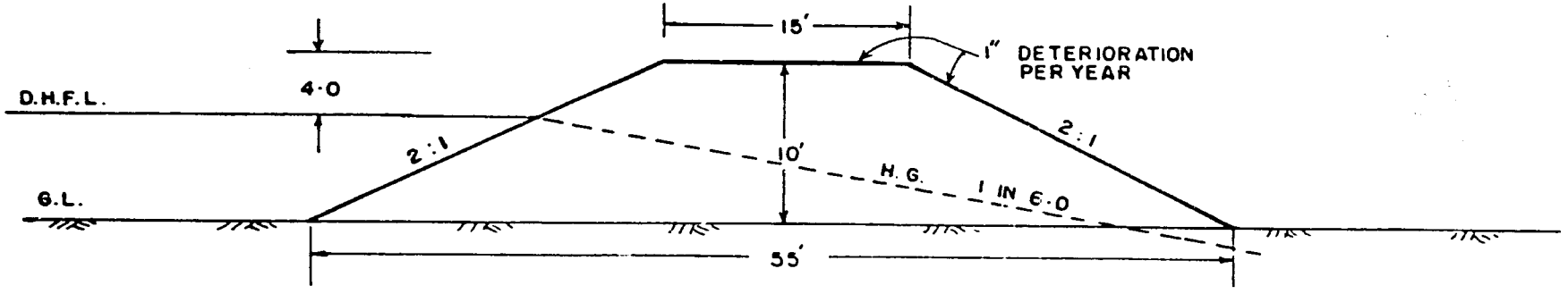
1/ All quantities are in place bank quantities
2/ Horizontal distance plus 8 times lift
3/ Quantities have been worked out with 1.0 depth of silt
4/ Quantity for 5.0 ft bed width and 25% channel silt clearned every year
5/ Quantity for 9.0 bed width and 28% channel silt clearned every year
6/ Quantity for 24 bed width and 10% channel silt clearned every year
7/ Quantity for 36 bed width and 5% channel silt cleared
8/ 10% of total length of pitching of both sides repaired annually
9/ Five of total length of lining requires repairs annually
10/ 5% turf cover on all slopes

N.W.F.P.
FIG. 2

FLOOD BUND SECTIONS



TYPICAL X-SECTION OF MAIN BUND



TYPICAL X-SECTION OF SPUR

Table 1

N.W.F.P.

LENGTHS OF CANALS, DRAINS AND FLOOD BUNDS
(UNIT CANAL MILES)

Lengths of Canals [1]/

Catagory cfs	Length
upto 15	444
15 to 50	616
50 to 200	390
200 to 500	257
500 to 1000	79
Above 1000	59
Total:	1845

Lengths of Drains

Catagory Bed Width	Length
Upto 10	1070
10 to 15	140
15 to 25	89
25 to 50	181
Above 50	75
Total:	1555 [2]/

Flood Bunds

A. Indus River	Length
Main Bund	24
Spurs	64
B. Other Rivers	
Spurs	54
Total:	142

[1]/ Data taken from NESPAK data collection exercise 1985.

[2]/ Total length given by Irrigation Department.

BASIC ANALYSIS OF RATES FOR COMPACTED EARTH WORK

Table-2

Assumptions

(i)	Wage of unskilled labourer	= Rs. 30.00/day
(ii)	Wage of skilled dressor	= Rs. 37.50/day
(iii)	Wage of water man (bahishti)	= Rs. 35.00/day
(iv)	Hire charges for roller	= Rs. 20.00/day
(v)	Bullock man with 1/2 pairs of bullock	= Rs. 45.00/day

1. Borrow pit excavation undressed lead upto 100 ft in ordinary or soft soil.

(i)	4 Nos. coolies for digging @Rs.30.00/day		= Rs.120.00
(ii)	3 Nos. coolies for carriage @Rs.30.00/day		= Rs. 90.00
		Total	= Rs.210.00
	Sundries @ 10%		= Rs. 21.00
		Total	= Rs.231.00
	Contractor's profit @ 10%		= Rs. 23.10
		Total	= Rs.254.10

Labour rate/1000 cft Rs.254.00

2. Compaction of Earth Work

(a) Laying earth in 6" layers levelling, dressing and watering

(i)	0.12 coolie @ Rs.30/day		= Rs. 3.60
(ii)	0.30 bahishti @ Rs.35/day		= Rs. 10.50
(iii)	0.75 dresser @ Rs.37.50/day		= Rs. 28.13
		Total	= Rs. 42.23
	Add sundries @ 10%		= Rs. 4.22
		Total	= Rs. 46.45
	Add contractor's profit @ 10%		= Rs. 4.64
		Total	= Rs. 51.09

(b) Compaction by rolling ordinary soil

(i)	0.50 coolie @ Rs.30/day		= Rs. 15.00
(ii)	1.25 bullock man with 1/2 pair of bullock @ Rs.45/day		= Rs. 56.25
			Rs. 71.25
(iii)	Hire charges for roller @ Rs.20/day		= Rs. 20.00
		Total	= Rs. 91.25
	Add sundries @ 10%		= Rs. 9.13
		Total	= Rs.100.38
	Add contractor's profit @ 10%		= Rs. 10.04
		Total	= Rs.110.42

Compacted 1000 cft earth work

(a)	Borrow pit excavation lead 100 ft		= Rs.254.10
(b)	Laying, dressing and watering		= Rs. 51.09
(c)	Compacting by roller		= Rs.110.42
		Total	= Rs.415.61

Say: Rs.415.60

ANALYSIS OF RATES FOR SEDIMENT REMOVAL FROM CANALS AND DRAINS LEAD 50.

(a)	4 Coolies for digging @ Rs 30/day	=	120.00
(b)	3 Coolies for carrying @ Rs 30/day	=	90.00
(c)	1 Dresser for dressing @ Rs 37.5/day	=	37.05
	Total:		247.05
	Add 10% sundries		24.8
	Total:		272.3
	Add 10% Contractor's profit		27.2
	Total	Rs	299.5

Table 3

ANALYSIS OF RATES FOR EARTH WORK PER MILE FOR VARIOUS CATEGORIES AND LEADS.

Category cfs	Quantity of E/Work per mile (Tft^3)	Lead	Excavation and placing		Compaction		Total Amount per mile
			Rs./Tft^3	Amount	Rs./Tft^3	Amount	
Upto 15	7.8	200	274.00	2137	161.50	1259	3397
15 - 50	10.3	200	274.00	2823	161.50	1663	4486
50 - 200	12.2	250	284.00	3466	161.50	1970	5436
200 - 500	18.3	300	294.00	5382	161.50	2955	8337
500 - 1000	22.8	500	334.00	7617	161.50	3682	11299
Above 1000	28.3	5000	659.00	18649	161.50	4570	23219

Table 4

ANALYSIS OF CROP COMPENSATION PER MILE FOR VARIOUS CATEGORIES OF CANALS.

Assumptions:

(i) Percentage of channels for crop compensation = 10%

(ii) Rate of compensation = Rs.5,000/acre

(iii) Depth of borrow pits = 1.0 ft.

Item	Upto 15	15 - 50	50 - 200	200 - 500	500 - 1000	Above 1000
Earth work in cft/mile	9,800	10,300	12,200	18,300	22,800	28,300
Area in acres/ mile	0.23	0.24	0.28	0.42	0.52	0.65
Unit Cost Rs./Acre	5000	5000	5000	5000	5000	5000
Cost per mile (Rs.)	1,150	1,200	1,400	2,100	2,600	3,250
For 10% Channels (Rs.)	115	120	140	210	260	325

Table-5

YARDSTICK FOR SEDIMENT REMOVAL

Category/ Item	Upto 15 cft.	15-50 cft.	50-200 cft.	200-500 cft.
Length mile	444	616	390	257
Average bed width (ft)	5	9	24	36
Depth of Silt	1.0'	1.0'	1.0'	1.0'
Total sediment T.Cuft.	25	45	120	180
Percentage Remova	25	20	10	5
Quantity annualy removed $T.Ft^3$	6.25	9.00	12.00	9.00
Rate/$T.Ft^3$	299.5	299.5	299.5	299.5
Yardstick Rs./mile	1870	2850	3600	2700

Table-6

YARDSTICK FOR STRUCTURES

Item	Category of Canals					
	Upto 15	15-50	50-200	200-500	500-1000	Above 1000
Length	444	616	390	257	79	59
Fall & Fall Bridge	405	561	675	227	71	52
Per Mile	0.91	0.91	1.73	0.88	0.89	0.88
Unit Cost	1500	1500	2000	3000	3500	4000
Yardstick/mile	1365	1365	3460	2640	3080	3520
V/Bridge	59	81	139	192	60	40
Per Mile	0.13	0.13	0.35	0.75	0.76	0.75
Unit Cost	1000	1000	1500	1500	2000	2000
Yardstick/mile	130	130	525	1140	1520	1500
Culverts, syphon acqueduct & Supper/passage etc.	64	88	154	320	99	73
Per Mile	0.14	0.14	0.39	1.24	1.25	1.24
Unit Cost	1000	1000	1500	1500	2000	2000
Yardstick/mile	140	140	585	1860	2500	2480
Total Structure Yardstick Rs./Mile	1635	1635	4570	3001	7100	7500

Table 7

TURFING YARDSTICK

Category	Length of Slopes	Area per mile	Turfing 5% Area	Cost @ Rs 20 /Hft^2
Cfs	Ft	Ft^2	Ft^2	
Upto 15	2 x 4= 8	40000	2000	400
15 - 38	2 x 4= 8	40000	2000	400
50 - 200	2 x 6=12	60000	3000	600
200 - 500	2 x 7.5=15	75000	3750	750
500 - 1000	2 x 8=16	80000	4000	800
Above 1000	2 x 12=24	120000	6000	1200

Table 8

YARDSTICK FOR MAINTENANCE OF SHINGLE ROADS

Category/ Item	Upto 15 Cft	15-50 Cft	50-200 Cft	200-500 Cft	500-1000 Cft	Above 1000 Cft
Length of canals (mile)	444	616	390	257	79	59
Length of Road (mile)	74	57	51	48	14	4
Road Width	12	12	12	12	12	12
Repair Lengths 10% (mile)	7.4	5.7	5.1	4.8	1.4	0.4
Area for Repairs Ft^2/mile	83	46	65	93	89	34
Unit cost for repairs Rs/Hft^2	200	200	200	200	200	200
Yardstick per mile (Rs)	166	92	130	186	178	68

Table 9

YARDSTICK FOR MAINTENANCE OF METALLED ROAD

Category/ Item	Upto 15 Cft	15-50 Cft	50-200 Cft	200-500 Cft	500-1000 Cft	Above 1000 Cft
Length of Canals	444	616	390	257	79	59
Length of Road (mile)	63	49	43	41	12	4
Road Width	12'	12'	12'	12'	12'	12'
Repairing length 5%	3.2	2.5	2.2	2.1	0.6	0.2
Area of Repair/Ft^2/mile	36	20	28	41	38	17
Unit Rate Rs/Hft^2	400	400	400	400	400	400
Yardstick per mile (Rs)	144	80	112	164	152	68

RATE PER MILE FOR O&M OF VEHICLES

Table-10

DESCRIPTION	NO TRIPS PER YEAR	TOTAL TRIPS	RATE PER MILE RS.	COST PER MILE RS.	ADD FOR T&P MILE RS.	TOTAL PER MILES RS.
Main Canals and Branches	SDO, XEN, SE, CE 24, 24, 12, 6	66	5/-	330	50	380
Distributaries Minors	12, 9, 6, 2	29	5/-	145	45	190

Table 10

TABLE 11

SUMMARY OF CANAL YARDSTICKS

S.No.	Maintenance Operations	Units	Upto 15 cfs	15 - 50 cfs	50 - 200 cfs	200 - 500 cfs	500 - 1000 cfs	Above 1000 cfs	Total/ Average*	Remarks
	Total Length	Miles	444	616	390	257	79	59	1845	
1.	Excavation & Placement									
	Quantity	Tft^3/mile	7.8	10.3	12.2	18.3	22.8	28.3	12.3	
	Unit Cost	Rs/Tft^3	274.1	274.1	284.1	294.1	334.1	659		
	Yardstick	Rs/mile	2137	2823	3466	5382	7617	18649	3862	
2.	Compaction									
	Quantity	Tft^3/mile	7.8	10.3	12.2	18.3	22.8	28.3	12.3	
	Unit Cost	Rs/Tft^3	161.51	161.51	161.51	161.51	161.51	161.51	161.51	
	Yardstick	Rs/mile	1259	1663	1970	2955	3682	4570	1990	
3.	Crop Compensation									
	Quantity	Acre/mile	0.23	0.24	0.28	0.42	0.52	0.62	3.4	
	Unit Cost	T Rs/acre	5.0	5.0	5.0	5.0	5.0	5.0		
	Yardstick	Rs/mile	115	120	140	210	260	125	149	
4.	Sediment Removal									
	Quantity	Tft^3/mile	6.25	9.0	18.0	18.0	-	-		
	Unit Cost	Rs/Tft^3	299.5	299.5	299.5	299.5	-	-		
	Yardstick	Rs/mile	1872	2845	3594	2696	-	-	2535	
5.	Berm Replacement									
	Quantity	Ft/mile	-	-	50	100	150	150		
	Unit Cost	Rs/ft	-	-	7	10	13	13		
	Yardstick	Rs/mile	-	-	350	1000	1950	1950	359	
6.	Turfing Slope									
	Quantity	Tft^2/mile	2.0	2.0	3.0	3.75	4.0	6.0		
	Unit Cost	Rs/Hft^2	20.0	20.0	20.0	20.0	20.0	20.0		
	Yardstick	Rs/mile	400	400	600	750	800	1200	534	
7.	Pitching Repair									
	Quantity	Ft/mile	140	90	100	35	60	17		
	Unit Cost	Rs/ft	5	6	10	12	15	20		
	Yardstick	Rs/mile	700	540	1000	420	900	340	690	
8.	Lining									
	Quantity	Ft/mile	35	30	28	18	-	17		
	Unit Cost	Rs/ft	20	25	40	50	-	75		
	Yardstick	Rs/mile	700	750	1120	900	-	1275	821	
9.	Structures									
(a)	Fall & Regulators									
	Quantity	No/mile	0.91	0.91	1.73	0.88	0.89	0.88		
	Unit Cost	Rs/No	1500	1500	2000	3000	3500	4000		
	Yardstick	Rs/mile	1365	1365	3460	2640	3080	3520	2127	
(b)	V/R Bridges									
	Quantity	No/mile	0.13	0.13	0.35	0.75	0.75	0.75		
	Unit Cost	Rs/No	1000	1000	1500	1500	2000	2000		
	Yardstick	Rs/mile	130	130	525	1125	1500	1500	455	
(c)	Culvert, Syphons									
	Quantity	No/mile	0.14	0.14	0.39	1.24	1.24	1.24		
	Unit Cost	Rs/No	1000	1000	1500	1500	2000	2000		
	Yardstick	Rs/mile	140	140	585	1860	2480	2480	486	
10.	Road Grading									
	Quantity	Tft^2/mile	360	360	360	600	600	600		
	Unit Cost	Rs/ft^2	3.5	3.5	3.5	3.5	3.5	3.5		
	Yardstick	Rs/mile	1260	1260	1260	2100	2100	2100	1440	
11.	Shingle Road									
	Quantity	Ft^2/mile	83	46	65	73	89	17		
	Unit Cost	Rs/Hft^2	200	200	200	200	200	200		
	Yardstick	Rs/mile	166	92	130	186	178	68	134	
12.	Metalled Road									
	Quantity	Ft^2/mile	36	20	28	41	38	17		
	Unit Cost	Rs/ft^2	400	400	400	400	400	400		
	Yardstick	Rs/mile	144	80	112	164	152	68	117	
13.	Administration	Rs/mile	190	190	190	380	380	380	231	
Total Canal Yardstick			10578	12398	18502	22768	25079	39085	16091	

Table 12

FLOOD BUND YARDSTICK

Item	Unit	Type of Bund		Total Average
		Main Bund	Spurs	
A. Indus River				
1. Length	Mile	24	64	68
2. Preparedness for Floods:				
(a) Earthwork:				
- Quantity	Tcft/mi	29	22	
- Unit Cost	Rs/Tcft	455.5	415.5	
- Yardstick	Rs/mile	13,210	9,141	
(b) Stone Replacement:				
- Loose Stone				
° Quantity	Tcft/mi	-	20.1	
° Unit Cost	Rs/Tcft	-	5000	
° Yardstick	Rs/mi	-	100,500	
- Stone in Gabions				
° Quantity	Tcft/mi	-	8.6	
° Unit Cost	Rs/Tcft	-	12000	
° Yardstick	Rs/mi	-	103,200	
(c) Levelling work for Bund and Spurs - L.S.	Rs/mi	500	500	
(d) Visual inspection of River course - L.S.	Rs/mi	300	300	
(e) River survey - L.S.	Rs/mi	1,500	1,500	
(f) Repairs to Gauges & Huts - L.S.	Rs/mi	200	200	
(g) Model studies - L.S.	Rs/mi	2,000	2,000	
(h) Consumable materials - L.S.	Rs/mi	3,000	3,000	
B. Flood Period				
(a) Watching Establishment				
- Quantity	mm/mi	8	4	
- Unit Cost	Rs/mm	600	600	
- Yardstick	Rs/mi	4,800	2,400	
(b) Running Vehicles				
- Quantity	miles/mi	165	165	
- Unit Cost	Rs/mile	5	5	
- Yardstick	Rs/mi	825	825	
(c) Using tractors, dozers - L.S.	Rs/mi	3,000	3,000	
(d) T&T charges - L.S.	Rs/mi	500	500	
(e) Running generators - L.S.	Rs/mi	300	300	
Total T.Rs		30.14	227.37	

Table 13

Item	Unit	Drain Bed Width - Ft				
		Upto 10'	10'-15'	15-25'	25-50'	Above 50
Drain Length	Mile	1070	140	89	181	75
Silt Removal	Tft^3/mi	12.5	31.3	50.0	93.8	125.0
Weed Removal	Tft^2/mi	50 1/	62.5 1/	100.0 2/	187.5 2/	250.0 2/
Structure Repairs						
a) Bridges	No/mi	0.12	0.12	0.12	0.12	0.12/194
b) W.C. Crossings	No/mi	0.14	0.14	0.14	0.14	0.14/222
c) Acquducts & Syphons	No/mi	0.28	0.28	0.28	0.28	0.28/440
d) Culvers (Inlets)	No/mi	0.25	0.25	0.25	0.25	0.25/376

1/ Weed removal twice a year.

2/ Weed removal once a year.

Table 14

Drain Yardstick

Item	Units	Bed Width Catagory (ft)					
		Upto 10'	10-15'	15-25'	25-50'	Above 50'	Total or Average
Total Length	Miles	1070	140	89	18.1	75	1555
Silt Removal							
Quantity	Tft /□	12.5	31.3	50	93.8	125	31.2
Unit Cost	Rs/Tft	299.5	299.5	306	324	34.4	304.87
Yardstick	Rs/mi	3744	9374	15300	30391	43000	9907
Weed Removal							
Quantity	Tft /mi	50	62.5	100	187.5	250	79.64
Unit Cost	Rs/Tft	15	78	122	131	138	46.20
Yardstick	Rs/mi	750	4875	12200	24563	34500	6176
Contract Admins	Rs/mi	250	250	250	250	250	250
Structure Repairs							
a) Bridges							
Quantity	No/mi	0.12	0.12	0.12	0.12	0.12	0.12
Unit Cost	Rs/No	1000	1000	1200	1500	1500	1094
Yardstick	Rs/mi	120	120	144	180	180	131
b) W.C.Crossings							
Quantity	No/mi	0.14	0.14	0.14	0.14	0.14	0.14
Unit Cost	Rs/No	300	300	500	500	700	354
Yardstick	Rs/mi	42	42	70	70	98	50
c) Acqueducts & Syphons							
Quantity	No/mi	0.28	0.28	0.28	0.28	0.28	0.28
Unit Cost	Rs/No	300	300	500	500	700	354
Yardstick	Rs/mi	84	84	140	140	196	99
d) Culverts							
Quantity	No/mi	0.25	0.25	0.25	0.25	0.25	0.25
Unit Cost	Rs/No	300	300	500	500	700	354
Yardstick	Rs/mi	75	75	125	125	175	89
Total		5065	14820	28299	55719	39699	16702

TABLE 15

DEMAND NOS. 8 AND 9 FOR FISCAL YEAR 1986-87

	Items	Amount (Rs M)
DEMAND NO. 8		
1.	Extension and Improvement [1]	23.1
2.	M & R of Canal (Production) [2]	23.2
3.	M & R of Canals (Unproductive)	44.1
4.	M & R of Dams	1.4
5.	M & R of Lift Schemes	10.9
6.	M & R of Chitral Schemes	1.5
7.	M & R of Tubewells	44.1
8.	Hydel Schemes	2.2
9.	Special Provisions [3]	37.0
10.	Administration	71.6
	Total	259.1
Demand No. 9		
1.	M & R of Civil Canals	4.1
2.	M & R of Drains	18.8
3.	M & R of Bunds	23.7
4.	T & P and other	1.0
5.	Special Provisions	13.0
	Total	60.6

1/ Includes Productive and unproductive

2/ Includes Rs. 0.56 of T & P

3/ Includes M & R of Colonies, Electricity charges etc.

Table 16

BUDGET FOR CANALS DRAINS AND FLOOD BUNDS

Canals				Drains				Flood Bunds			
Catagory cfs	Length miles	Yardstick Rs/mile	Amount Rs &M	Catagory B in feet	Length miles	Yardstick Rs/mile	Amount Rs & M	Catagory cfs	Length miles	Yardstick Rs/mile	Amount Rs & M
Upto 13	444	10578	4.70	Upto 10	1070	5065	5.42	Indus River			
15-50	616	12398	7.64	10-15	140	14820	2.07	Bunds	24	30140	0.72
50-200	390	18502	7.21	15-25	89	28299	2.52	Spurs	64	227370	14.55
200-500	257	22768	5.85	25-50	181	55719	10.09	Other Rivers			
500-1000	79	25079	1.98	Above 50	75	78399	5.88	Spurs	54	181900	9.82
Above 1000	59	39085	2.81								
Budget for Canals =			29.69	Budget for drains =			25.98	Budget for Flood Bunds =			25.09