Project. Physical contingencies of 10% have been added to all estimated costs. Price increases were estimated by applying the annual rates of price escalation of 10% for local costs and 6% for foreign costs. Expected price increases amount to Rs. 1,232 million, or 74% of base cost plus physical contingencies.

## 2.2. Procurement

Construction works would be carried out by international competitive bidding, and equipment would be procured through international competitive bidding. CDA would retain consulting firms, composed of foreign specialist in association with local consultants to assist in the detail design of project features, preparation of design and contract documents, supervision of construction, and the establishment of operation and maintenance programs.

## 2.3. Operation and Maintenance Costs

Operation and maintenance costs (O & M cost) of the project include electric power costs, chemical costs, repairing costs and replacement costs. O & M cost at full development stage is summarized below. (Breakdown of electric power costs, chemical costs and replacement costs are given in Table C.II-20):

| Annual running expenses | (Rs. 1,000) |
|---|---|
| 1. Electric power cost | 10,971 |
| 2. Chemical cost | 12,813 |
| 3. Personnel expense | 2,288 |
| 4. Repair | 3,318 |
| Total | 29,390 |

Total replacement cost for 50 years 1985 to 2034:

| | (Rs. 1,000) |
|---|---|
| 1. Water treatment plant | 92,140 |
| 2. Pumping plant | 68,519 |
| 3. Electric plant | 152,058 |
| Total | 312,717 |

TABLE C.II-1 COST SUMMARY (1)

| | Item | Local | Foreign | Total | Foreign (%) |
|---|---|---|---|---|---|
| | | ----- Rs. Million ------ | | | |
| 1. | Conduction main | 249.7 | 177.8 | 427.5 | 42 |
| 2. | Water treatment plant | 190.3 | 184.9 | 375.2 | 49 |
| 3. | Pumping station | 51.6 | 54.1 | 105.7 | 51 |
| 4. | Distribution main | 70.5 | 70.5 | 141.0 | 50 |
| 5. | Service reservoir | 112.8 | 77.8 | 190.6 | 41 |
| 6. | Electric works | 13.8 | 23.3 | 37.1 | 63 |
| | Sub-total (1∿6) | 688.7 | 588.4 | 1,277.1 | 46 |
| 7. | Project office | 12.0 | - | 12.0 | - |
| 8. | Land acquisition | 35.6 | - | 35.6 | - |
| 9. | Office equipment | 2.2 | 6.3 | 8.5 | 74 |
| 10. | Engineering | 31.2 | 116.4 | 147.6 | 79 |
| 11. | Administration | 35.6 | - | 35.6 | - |
| | Sub-total (7∿11) | 116.6 | 122.7 | 239.3 | 51 |
| | Base Cost (1∿11) | 805.3 | 711.1 | 1,516.4 | 47 |
| 12. | Physical contingency | 80.5 | 71.1 | 151.6 | |
| 13. | Price escalation | 842.7 | 389.3 | 1,232.0 | |
| | Total Cost | 1,728.5 | 1,171.5 | 2,900.0 | 40 |

TABLE C.II-2 COST SUMMARY (2)

(Unit: Rs. Million)

| | Item | Phase I | Phase II | Phase III | Total |
|---|---|---|---|---|---|
| 1. | Conduction main | 427.5 | - | - | 427.5 |
| 2. | Water treatment plant | 196.1 | 101.2 | 77.9 | 375.2 |
| 3. | Pumping station | 89.4 | 10.4 | 5.9 | 105.7 |
| 4. | Distribution main | 76.0 | 65.0 | - | 141.0 |
| 5. | Service reservoir | 124.6 | 43.0 | 23.0 | 190.6 |
| 6. | Electric works | 32.2 | 3.4 | 1.5 | 37.1 |
| | Sub-total (1∿6) | 945.8 | 223.0 | 108.3 | 1,277.1 |
| 7. | Project office | 12.0 | - | - | 12.0 |
| 8. | Land acquisition | 35.6 | - | - | 35.6 |
| 9. | Office equipment | 8.5 | - | - | 8.5 |
| 10. | Engineering | 121.1 | 17.8 | 8.7 | 147.6 |
| 11. | Administration | 27.8 | 4.5 | 3.3 | 35.6 |
| | Sub-total (7∿11) | 205.0 | 22.3 | 12.0 | 239.3 |
| | Base Cost (1∿11) | 1,150.8 | 245.3 | 120.3 | 1,516.4 |
| 12. | Physical contingency | 115.1 | 24.5 | 12.0 | 151.6 |
| 13. | Price escalation | 659.1 | 288.2 | 284.7 | 1,232.0 |
| | Total Cost | 1,925.0 | 558.0 | 417.0 | 2,900.0 |

TABLE C.II-3 COST SUMMARY - LOCAL COST

(Unit: Rs. Million)

| Item | Phase I | Phase II | Phase III | Total |
|---|---|---|---|---|
| 1. Conduction main | 249.7 | - | - | 249.7 |
| 2. Water treatment plant | 99.6 | 51.4 | 39.3 | 190.3 |
| 3. Pumping station | 44.2 | 4.6 | 2.8 | 51.6 |
| 4. Distribution main | 38.2 | 32.3 | - | 70.5 |
| 5. Service reservoir | 72.1 | 26.4 | 14.3 | 112.8 |
| 6. Electric works | 11.9 | 1.3 | 0.6 | 13.8 |
| Sub-total (1∿6) | 515.7 | 116.0 | 57.0 | 688.7 |
| 7. Project office | 12.0 | - | - | 12.0 |
| 8. Land acquisition | 35.6 | - | - | 35.6 |
| 9. Office equipment | 2.2 | - | - | 2.2 |
| 10. Engineering | 25.8 | 3.6 | 1.8 | 31.2 |
| 11. Administration | 27.8 | 4.5 | 3.3 | 35.6 |
| Sub-total (7∿11) | 103.4 | 8.1 | 5.1 | 116.6 |
| Base Cost (1∿11) | 619.1 | 124.1 | 62.1 | 805.3 |
| 12. Physical contingency | 61.9 | 12.4 | 6.2 | 80.5 |
| 13. Price escalation | 448.4 | 193.4 | 200.9 | 842.7 |
| Total Cost | 1,129.4 | 329.9 | 269.2 | 1,728.5 |

TABLE C.II-4 COST SUMMARY - FOREIGN COST

(Unit: Rs. Million)

| | Item | Phase I | Phase II | Phase III | Total |
|---|---|---|---|---|---|
| 1. | Conduction main | 177.8 | - | - | 177.8 |
| 2. | Water treatment plant | 96.5 | 49.8 | 38.6 | 184.9 |
| 3. | Pumping station | 45.2 | 5.8 | 3.1 | 54.1 |
| 4. | Distribution main | 37.8 | 32.7 | - | 70.5 |
| 5. | Service reservoir | 52.5 | 16.6 | 8.7 | 77.8 |
| 6. | Electric works | 20.3 | 2.1 | 0.9 | 23.3 |
| | Sub-total (1∿6) | 430.1 | 107.0 | 51.3 | 588.4 |
| 7. | Project office | - | - | - | - |
| 8. | Land acquisition | - | - | - | - |
| 9. | Office equipment | 6.3 | - | - | 6.3 |
| 10. | Engineering | 95.3 | 14.2 | 6.9 | 116.4 |
| 11. | Administration | - | - | - | - |
| | Sub-total (7∿11) | 101.6 | 14.2 | 6.9 | 122.7 |
| | Base Cost (1∿11) | 531.7 | 121.2 | 58.2 | 711.1 |
| 12. | Physical contingency | 53.2 | 12.1 | 5.8 | 71.1 |
| 13. | Price escalation | 210.7 | 94.8 | 83.8 | 389.3 |
| | Total Cost | 795.6 | 228.1 | 147.8 | 1,171.5 |

TABLE C.II-5 COST SUMMARY - PHASE I

(Unit: Rs. Million)

| | Item | Local | Foreign | Total |
|---|---|---|---|---|
| 1. | Conduction main | 249.7 | 177.8 | 427.5 |
| 2. | Water treatment plant | 99.6 | 96.5 | 196.1 |
| 3. | Pumping station | 44.2 | 45.2 | 89.4 |
| 4. | Distribution main | 38.2 | 37.8 | 76.0 |
| 5. | Service reservoir | 72.1 | 52.5 | 124.6 |
| 6. | Electric works | 11.9 | 20.3 | 32.2 |
| | Sub-total (1∿6) | 515.7 | 430.1 | 945.8 |
| 7. | Project office | 12.0 | - | 12.0 |
| 8. | Land acquisition | 35.6 | - | 35.6 |
| 9. | Office equipment | 2.2 | 6.3 | 8.5 |
| 10. | Engineering | 25.8 | 95.3 | 121.1 |
| 11. | Administration | 27.8 | - | 27.8 |
| | Sub-total (7∿11) | 103.4 | 101.6 | 205.0 |
| | Base Cost (1∿11) | 619.1 | 531.7 | 1,150.8 |
| 12. | Physical contingency | 61.9 | 53.2 | 115.1 |
| 13. | Price escalation | 448.4 | 210.7 | 659.1 |
| | Total Cost | 1,129.4 | 795.6 | 1,925.0 |

TABLE C.II-6 COST SUMMARY - PHASE II

(Unit: Rs. Million)

| | Item | Local | Foreign | Total |
|---|---|---|---|---|
| 1. | Conduction main | - | - | - |
| 2. | Water treatment plant | 51.4 | 49.8 | 101.2 |
| 3. | Pumping station | 4.6 | 5.8 | 10.4 |
| 4. | Distribution main | 32.3 | 32.7 | 65.0 |
| 5. | Service reservoir | 26.4 | 16.6 | 43.0 |
| 6. | Electric works | 1.3 | 2.1 | 3.4 |
| | Sub-total (1∿6) | 116.0 | 107.0 | 223.0 |
| 7. | Project office | - | - | - |
| 8. | Land acquisition | - | - | - |
| 9. | Office equipment | - | - | - |
| 10. | Engineering | 3.6 | 14.2 | 17.8 |
| 11. | Administration | 4.5 | - | 4.5 |
| | Sub-total (7∿11) | 8.1 | 14.2 | 22.3 |
| | Base Cost (1∿11) | 124.1 | 121.2 | 245.3 |
| 12. | Physical contingency | 12.4 | 12.1 | 24.5 |
| 13. | Price escalation | 193.4 | 94.8 | 288.2 |
| | Total Cost | 329.9 | 228.1 | 558.0 |

TABLE C.II-7 COST SUMMARY - PHASE III

(Unit: Rs. Million)

| | Item | Local | Foreign | Total |
|---|---|---|---|---|
| 1. | Conduction main | - | - | - |
| 2. | Water treatment plant | 39.3 | 38.6 | 77.9 |
| 3. | Pumping station | 2.8 | 3.1 | 5.9 |
| 4. | Distribution main | - | - | - |
| 5. | Service reservoir | 14.3 | 8.7 | 23.0 |
| 6. | Electric works | 0.6 | 0.9 | 1.5 |
| | Sub-total (1∿6) | 57.0 | 51.3 | 108.3 |
| 7. | Project office | - | - | - |
| 8. | Land acquisition | - | - | - |
| 9. | Office equipment | - | - | - |
| 10. | Engineering | 1.8 | 6.9 | 8.7 |
| 11. | Administration | 3.3 | - | 3.3 |
| | Sub-total (7∿11) | 5.1 | 6.9 | 12.0 |
| | Base Cost (1∿11) | 62.1 | 58.2 | 120.3 |
| 12. | Physical contingency | 6.2 | 5.8 | 12.0 |
| 13. | Price escalation | 200.9 | 83.8 | 284.7 |
| | Total Cost | 269.2 | 147.8 | 417.0 |

TABLE C.II-8 SCHEDULE OF EXPENDITURE - PHASE I

(Unit: Rs. Million)

| | | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Conduction main | - | - | 26.2 | 78.8 | 90.0 | 91.9 | 96.6 | 44.0 | 427.5 |
| 2. | Water treatment plant | - | - | - | - | 43.2 | 104.6 | 47.5 | 0.8 | 196.1 |
| 3. | Pumping station | - | - | - | - | 1.9 | 35.5 | 36.5 | 15.5 | 89.4 |
| 4. | Distribution main | - | - | - | 17.0 | 21.5 | 27.1 | 8.2 | 2.2 | 76.0 |
| 5. | Service reservoir | - | - | - | - | - | 49.7 | 49.7 | 25.2 | 124.6 |
| 6. | Electric works | - | - | - | - | - | 1.5 | 18.7 | 12.0 | 32.2 |
| | Sub-total (1∿6) | - | - | 26.2 | 95.8 | 156.6 | 310.3 | 257.2 | 99.7 | 945.8 |
| 7. | Project office | - | - | 12.0 | - | - | - | - | - | 12.0 |
| 8. | Land acquisition | - | - | 6.0 | 29.6 | - | - | - | - | 35.6 |
| 9. | Office equipment | - | - | 8.5 | - | - | - | - | - | 8.5 |
| 10. | Engineering | 24.9 | 16.6 | 8.1 | 7.8 | 11.9 | 23.9 | 19.9 | 8.0 | 121.1 |
| 11. | Administration | 5.5 | 3.4 | 0.6 | 1.9 | 3.1 | 6.2 | 5.1 | 2.0 | 27.8 |
| | Sub-total (7∿11) | 30.4 | 20.0 | 35.2 | 39.3 | 15.0 | 30.1 | 25.0 | 10.0 | 205.0 |
| | Base Cost (1∿11) | 30.4 | 20.0 | 61.4 | 135.1 | 171.6 | 340.4 | 282.2 | 109.7 | 1,150.8 |
| 11. | Physical contingency | 3.0 | 2.0 | 6.1 | 13.5 | 17.2 | 34.1 | 28.2 | 11.0 | 115.1 |
| 12. | Price escalation | 1.2 | 2.5 | 15.5 | 50.1 | 80.6 | 203.6 | 206.0 | 99.6 | 659.1 |
| | Total Cost | 34.6 | 24.5 | 83.0 | 198.7 | 269.4 | 578.1 | 516.4 | 220.3 | 1,925.0 |

TABLE C.II-9 SCHEDULE OF EXPENDITURE - PHASE I/LOCAL COST

(Unit: Rs. Million)

| | | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Conduction main | - | - | 16.3 | 45.4 | 52.1 | 53.5 | 53.3 | 29.1 | 249.7 |
| 2. | Water treatment plant | - | - | - | - | 22.1 | 55.0 | 22.0 | 0.5 | 99.6 |
| 3. | Pumping station | - | - | - | - | 1.3 | 17.7 | 17.9 | 7.3 | 44.2 |
| 4. | Distribution main | - | - | - | 8.4 | 10.7 | 13.6 | 4.3 | 1.2 | 38.2 |
| 5. | Service reservoir | - | - | - | - | - | 28.7 | 28.7 | 14.7 | 72.1 |
| 6. | Electric works | - | - | - | - | - | 0.6 | 7.0 | 4.3 | 11.9 |
| | Sub-total (1~6) | - | - | 16.3 | 53.8 | 86.2 | 169.1 | 133.2 | 57.1 | 515.7 |
| 7. | Project office | - | - | 12.0 | - | - | - | - | - | 12.0 |
| 8. | Land acquisition | - | - | 6.0 | 29.6 | - | - | - | - | 35.6 |
| 9. | Office equipment | - | - | 2.2 | - | - | - | - | - | 2.2 |
| 10. | Engineering | 4.5 | 3.0 | 1.9 | 1.7 | 2.7 | 5.5 | 4.6 | 1.9 | 25.8 |
| 11. | Administration | 5.5 | 3.4 | 0.6 | 1.9 | 3.1 | 6.2 | 5.1 | 2.0 | 27.8 |
| | Sub-total (7~11) | 10.0 | 6.4 | 22.7 | 33.2 | 5.8 | 11.7 | 9.7 | 3.9 | 103.4 |
| | Base Cost (1~11) | 10.0 | 6.4 | 39.0 | 87.0 | 92.0 | 180.8 | 142.9 | 61.0 | 619.1 |
| 12. | Physical contingency | 1.0 | 0.6 | 3.9 | 8.7 | 9.2 | 18.1 | 14.3 | 6.1 | 61.9 |
| 13. | Price escalation | 0.5 | 1.1 | 11.6 | 38.1 | 54.3 | 137.3 | 135.3 | 70.1 | 448.3 |
| | Total Cost | 11.5 | 8.1 | 54.5 | 133.8 | 155.5 | 336.2 | 292.5 | 137.2 | 1,129.3 |

TABLE C.II-10 SCHEDULE OF EXPENDITURE - PHASE I/FOREIGN COST

(Unit: Rs. Million)

| | | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Conduction main | - | - | 9.9 | 33.4 | 37.9 | 38.4 | 43.3 | 14.9 | 177.8 |
| 2. | Water treatment plant | - | - | - | - | 21.1 | 49.6 | 25.5 | 0.3 | 96.5 |
| 3. | Pumping station | - | - | - | - | 0.6 | 17.8 | 18.6 | 8.2 | 45.2 |
| 4. | Distribution main | - | - | - | 8.6 | 10.8 | 13.5 | 3.9 | 1.0 | 37.8 |
| 5. | Service reservoir | - | - | - | - | - | 21.0 | 21.0 | 10.5 | 52.5 |
| 6. | Electric works | - | - | - | - | - | 0.9 | 11.7 | 7.7 | 20.3 |
| | Sub-total (1∿6) | - | - | 9.9 | 42.0 | 70.4 | 141.2 | 124.0 | 42.6 | 430.1 |
| 7. | Project office | - | - | - | - | - | - | - | - | - |
| 8. | Land acquisition | - | - | - | - | - | - | - | - | - |
| 9. | Office equipment | - | - | 6.3 | - | - | - | - | - | 6.3 |
| 10. | Engineering | 20.4 | 13.6 | 6.2 | 6.1 | 9.2 | 18.4 | 15.3 | 6.1 | 95.3 |
| 11. | Administration | - | - | - | - | - | - | - | - | - |
| | Sub-total (7∿11) | 20.4 | 13.6 | 12.5 | 6.1 | 9.2 | 18.4 | 15.3 | 6.1 | 101.6 |
| | Base Cost (1∿11) | 20.4 | 13.6 | 22.4 | 48.1 | 79.6 | 159.6 | 139.3 | 48.7 | 531.7 |
| 12. | Physical contingency | 2.0 | 1.4 | 2.2 | 4.8 | 8.0 | 16.0 | 13.9 | 4.9 | 53.2 |
| 13. | Price escalation | 0.7 | 1.4 | 3.9 | 12.0 | 26.3 | 66.3 | 70.7 | 29.4 | 210.7 |
| | Total Cost | 23.1 | 16.4 | 28.5 | 64.9 | 113.9 | 241.9 | 223.9 | 83.0 | 795.6 |

TABLE C.II-11 SCHEDULE OF EXPENDITURE - PHASE II

(Unit: Rs. Million)

| | | 1992 | 1993 | 1994 | 1995 | Total |
|---|---|---|---|---|---|---|
| 1. | Conduction main | - | - | - | - | - |
| 2. | Water treatment plant | - | 37.7 | 43.9 | 19.6 | 101.2 |
| 3. | Pumping station | - | 4.0 | 4.3 | 2.1 | 10.4 |
| 4. | Distribution main | 19.5 | 19.5 | 19.5 | 6.5 | 65.0 |
| 5. | Service reservoir | - | 8.6 | 21.5 | 12.9 | 43.0 |
| 6. | Electric works | - | - | 2.4 | 1.0 | 3.4 |
| | Sub-total (1∿6) | 19.5 | 69.8 | 91.6 | 42.1 | 223.0 |
| 7. | Project office | - | - | - | - | - |
| 8. | Land acquisition | - | - | - | - | - |
| 9. | Office equipment | - | - | - | - | - |
| 10. | Engineering | 1.6 | 5.6 | 7.3 | 3.3 | 17.8 |
| 11. | Administration | 0.4 | 1.4 | 1.8 | 0.9 | 4.5 |
| | Sub-total (7∿11) | 2.0 | 7.0 | 9.1 | 4.2 | 22.3 |
| | Base Cost (1∿11) | 21.5 | 76.8 | 100.7 | 46.3 | 245.3 |
| 12. | Physical contingency | 2.1 | 7.7 | 10.1 | 4.6 | 24.5 |
| 13. | Price escalation | 18.7 | 79.9 | 123.7 | 65.9 | 288.2 |
| | Total Cost | 42.3 | 164.4 | 234.5 | 116.8 | 558.0 |

TABLE C.II-12 SCHEDULE OF EXPENDITURE - PHASE II/LOCAL COST

(Unit: Rs. Million)

| | | 1992 | 1993 | 1994 | 1995 | Total |
|---|---|---|---|---|---|---|
| 1. | Conduction main | - | - | - | - | - |
| 2. | Water treatment plant | - | 18.9 | 22.6 | 9.9 | 51.4 |
| 3. | Pumping station | - | 1.8 | 1.9 | 0.9 | 4.6 |
| 4. | Distribution main | 9.7 | 9.7 | 9.7 | 3.2 | 32.3 |
| 5. | Service reservoir | - | 5.3 | 13.2 | 7.9 | 26.4 |
| 6. | Electric works | - | - | 0.9 | 0.4 | 1.3 |
| | Sub-total (1∿6) | 9.7 | 35.7 | 48.3 | 22.3 | 116.0 |
| 7. | Project office | - | - | - | - | - |
| 8. | Land acquisition | - | - | - | - | - |
| 9. | Office equipment | - | - | - | - | - |
| 10. | Engineering | 0.3 | 1.1 | 1.5 | 0.7 | 3.6 |
| 11. | Administration | 0.4 | 1.4 | 1.8 | 0.9 | 4.5 |
| | Sub-total (7∿11) | 0.7 | 2.5 | 3.3 | 1.6 | 8.1 |
| | Base Cost (1∿11) | 10.4 | 38.2 | 51.6 | 23.9 | 124.1 |
| 12. | Physical contingency | 1.0 | 3.8 | 5.2 | 2.4 | 12.4 |
| 13. | Price escalation | 12.0 | 52.6 | 83.7 | 45.3 | 193.6 |
| | Total Cost | 23.4 | 94.6 | 140.5 | 71.6 | 330.1 |

TABLE C.II-13 SCHEDULE OF EXPENDITURE - PHASE II/FOREIGN COST

(Unit: Rs. Million)

| | | 1992 | 1993 | 1994 | 1995 | Total |
|---|---|---|---|---|---|---|
| 1. | Conduction main | - | - | - | - | - |
| 2. | Water treatment plant | - | 18.8 | 21.3 | 9.7 | 49.8 |
| 3. | Pumping station | - | 2.2 | 2.4 | 1.2 | 5.8 |
| 4. | Distribution main | 9.8 | 9.8 | 9.8 | 3.3 | 32.7 |
| 5. | Service reservoir | - | 3.3 | 8.3 | 5.0 | 16.6 |
| 6. | Electric works | - | - | 1.5 | 0.6 | 2.1 |
| | Sub-total (1∿6) | 9.8 | 34.1 | 43.3 | 19.8 | 107.0 |
| 7. | Project office | - | - | - | - | - |
| 8. | Land acquisition | - | - | - | - | - |
| 9. | Office equipment | - | - | - | - | - |
| 10. | Engineering | 1.3 | 4.5 | 5.8 | 2.6 | 14.2 |
| 11. | Administration | - | - | - | - | - |
| | Sub-total (7∿11) | 1.3 | 4.5 | 5.8 | 2.6 | 14.2 |
| | Base Cost (1∿11) | 11.1 | 38.6 | 49.1 | 22.4 | 121.2 |
| 12. | Physical contingency | 1.1 | 3.9 | 4.9 | 2.2 | 12.1 |
| 13. | Price escalation | 6.7 | 27.3 | 40.0 | 20.8 | 94.8 |
| | Total Cost | 18.9 | 69.8 | 94.0 | 45.4 | 228.1 |

TABLE C.II-14 SCHEDULE OF EXPENDITURE - PHASE III

(Unit: Rs. Million)

| | | 1998 | 1999 | 2000 | Total |
|---|---|---|---|---|---|
| 1. | Conduction main | - | - | - | - |
| 2. | Water treatment plant | 29.0 | 43.4 | 5.5 | 77.9 |
| 3. | Pumping station | 2.3 | 2.4 | 1.2 | 5.9 |
| 4. | Distribution main | - | - | - | - |
| 5. | Service reservoir | - | 16.1 | 6.9 | 23.0 |
| 6. | Electric works | - | 1.0 | 0.5 | 1.5 |
| | Sub-total (1∿6) | 31.3 | 62.9 | 14.1 | 108.3 |
| 7. | Project office | - | - | - | - |
| 8. | Land acquisition | - | - | - | - |
| 9. | Office equipment | - | - | - | - |
| 10. | Engineering | 2.5 | 5.1 | 1.1 | 8.7 |
| 11. | Administration | 0.9 | 1.9 | 0.5 | 3.3 |
| | Sub-total (7∿11) | 3.4 | 7.0 | 1.6 | 12.0 |
| | Base Cost (1∿11) | 34.7 | 69.9 | 15.7 | 120.3 |
| 12. | Physical contingency | 3.4 | 7.0 | 1.6 | 12.0 |
| 13. | Price escalation | 72.2 | 170.4 | 42.1 | 284.7 |
| | Total Cost | 110.3 | 247.3 | 59.4 | 417.0 |

TABLE C.II-15 SCHEDULE OF EXPENDITURE - PHASE III/LOCAL COST

(Unit: Rs. Million)

| | | 1998 | 1999 | 2000 | Total |
|---|---|---|---|---|---|
| 1. | Conduction main | - | - | - | - |
| 2. | Water treatment plant | 14.4 | 22.8 | 2.1 | 39.3 |
| 3. | Pumping station | 1.1 | 1.1 | 0.6 | 2.8 |
| 4. | Distribution main | - | - | - | - |
| 5. | Service reservoir | - | 10.0 | 4.3 | 14.3 |
| 6. | Electric works | - | 0.4 | 0.2 | 0.6 |
| | Sub-total (1~6) | 15.5 | 34.3 | 7.2 | 57.0 |
| 7. | Project office | - | - | - | - |
| 8. | Land acquisition | - | - | - | - |
| 9. | Office equipment | - | - | - | - |
| 10. | Engineering | 0.5 | 1.1 | 0.2 | 1.8 |
| 11. | Administration | 0.9 | 1.9 | 0.5 | 3.3 |
| | Sub-total (7~11) | 1.4 | 3.0 | 0.7 | 5.1 |
| | Base Cost (1~11) | 16.9 | 37.3 | 7.9 | 62.1 |
| 12. | Physical contingency | 1.7 | 3.7 | 0.8 | 6.2 |
| 13. | Price escalation | 48.8 | 122.6 | 29.8 | 201.2 |
| | Total Cost | 67.4 | 163.6 | 38.5 | 269.5 |

TABLE C.II-16 SCHEDULE OF EXPENDITURE - PHASE III/FOREIGN COST

(Unit: Rs. Million)

| | | 1998 | 1999 | 2000 | Total |
|---|---|---|---|---|---|
| 1. | Conduction main | - | - | - | - |
| 2. | Water treatment plant | 14.6 | 20.6 | 3.4 | 38.6 |
| 3. | Pumping station | 1.2 | 1.3 | 0.6 | 3.1 |
| 4. | Distribution main | - | - | - | - |
| 5. | Service reservoir | - | 6.1 | 2.6 | 8.7 |
| 6. | Electric works | - | 0.6 | 0.3 | 0.9 |
| | Sub-total (1~6) | 15.8 | 28.6 | 6.9 | 51.3 |
| 7. | Project office | - | - | - | - |
| 8. | Land acquisition | - | - | - | - |
| 9. | Office equipment | - | - | - | - |
| 10. | Engineering | 2.0 | 4.0 | 0.9 | 6.9 |
| 11. | Administration | - | - | - | - |
| | Sub-total (7~11) | 2.0 | 4.0 | 0.9 | 6.9 |
| | Base Cost (1~11) | 17.8 | 32.6 | 7.8 | 58.2 |
| 12. | Physical contingency | 1.7 | 3.3 | 0.8 | 5.8 |
| 13. | Price escalation | 23.4 | 47.8 | 12.6 | 83.8 |
| | Total Cost | 42.9 | 83.7 | 21.2 | 147.8 |

TABLE C.II-17 COST ESTIMATE SUMMARY

(Unit: Rs. Million)

| Item | Local | Foreign | Total |
|---|---|---|---|
| 1. Conduction main | | | |
| - Intake tower | 10.6 | 7.9 | 18.5 |
| - No.1 tunnel, D = 2.4m, L = 770m | 16.8 | 11.4 | 28.2 |
| - Pressure break basin | 10.3 | 12.4 | 22.7 |
| - Conduit, L = 106m | 1.0 | 0.7 | 1.7 |
| - No.2 tunnel, D = 2.4m, L = 11,480m | 209.0 | 144.1 | 353.1 |
| - Pipe line, PRCC, ø 1,650mm, L = 2 x 650m | 2.0 | 1.3 | 3.3 |
| Total | 249.7 | 177.8 | 427.5 |
| 2. Water treatment plant | | | |
| - Civil works | 107.5 | 80.0 | 187.5 |
| - Buildings | 17.9 | 12.0 | 29.9 |
| - Pipe | 11.5 | 12.0 | 23.5 |
| - Mechanical plant | 36.5 | 57.1 | 93.6 |
| - Chemical system | 14.2 | 13.7 | 27.9 |
| - Instruments | 2.7 | 10.1 | 12.8 |
| Total | 190.3 | 184.9 | 375.2 |
| 3. Pumping station | | | |
| - Civil works | 3.2 | 1.5 | 4.7 |
| - Building | 4.3 | 2.9 | 7.2 |
| - Pump and motor | 44.1 | 49.7 | 93.8 |
| Total | 51.6 | 54.1 | 105.7 |

(Cont'd)

COST ESTIMATE SUMMARY (CONT.)

(Unit: Rs. Million)

| Item | Local | Foreign | Total |
|---|---|---|---|
| 4. Distribution main | | | |
| 4.1 Low zone, L = 1,550m | | | |
| - Earth works | 0.8 | 0.6 | 1.4 |
| - Pipe, DIP, ø800mm | 5.0 | 4.7 | 9.7 |
| Sub-total (1) | 5.8 | 5.3 | 11.1 |
| 4.2 High zone, L = 2 x 1,530m | | | |
| - Earth works | 1.1 | 0.9 | 2.0 |
| - Pipe, DIP, ø700m | 7.6 | 7.1 | 14.7 |
| Sub-total (2) | 8.7 | 8.0 | 16.7 |
| 4.3 Rawalpindi, L = 2 x 6,420m | | | |
| - Earth works | 13.2 | 7.2 | 20.4 |
| - Pipe, PRCC, ø1,500mm | 42.8 | 50.0 | 92.8 |
| Sub-total (3) | 56.0 | 57.2 | 113.2 |
| Total | 70.5 | 70.5 | 141.0 |
| 5. Service reservoir | | | |
| 5.1 H-11 reservoir, V = 104,000m$^3$ | | | |
| - Earth works | 1.6 | 1.6 | 3.2 |
| - Concrete works | 38.4 | 15.0 | 53.4 |
| - Pipe | 23.1 | 24.7 | 47.8 |
| Sub-total (1) | 63.1 | 41.3 | 104.4 |
| 5.2 Gorla-2 reservoir 16,610m$^3$ | | | |
| - Earth works | 2.6 | 2.6 | 5.2 |
| - Concrete works | 5.8 | 4.6 | 10.4 |
| - Prestressing works | 6.3 | 2.3 | 8.6 |
| - Pipe works | 0.7 | 0.5 | 1.2 |
| - Appurtenant works | 1.2 | 1.6 | 2.8 |
| Sub-total (2) | 16.6 | 11.6 | 28.2 |

(Cont'd)

COST ESTIMATE SUMMARY (CONT.)

(Unit: Rs. Million)

| Item | Local | Foreign | Total |
|---|---|---|---|
| 5.3 Gorla-1 reservoir, $V = 26,000m^3$ | | | |
| - Earth works | 6.3 | 6.5 | 12.8 |
| - Concrete works | 9.5 | 7.6 | 17.1 |
| - Prestressing works | 10.0 | 3.6 | 13.6 |
| - Pipe works | 5.0 | 4.5 | 9.5 |
| - Appurtenant works | 2.3 | 2.7 | 5.0 |
| Sub-total (3) | 33.1 | 24.9 | 58.0 |
| Total | 112.8 | 77.8 | 190.6 |
| 6. Electric works | | | |
| - Transmission line, 11kV, 25km | 2.9 | 4.7 | 7.6 |
| - Sub-station and distribution | 10.9 | 18.6 | 29.5 |
| Total | 13.8 | 23.3 | 37.1 |
| Base Cost (1∿6) | 688.7 | 588.4 | 1,277.1 |

TABLE C.II-18 OPERATION AND MAINTENANCE

| | | |
|---|---|---|
| 1. | Electric power cost (Tariff B-3) | |
| | a. Pumping station | |
| | - Installed capacity | 2,750 Kw |
| | - Annual operation | 7,008 hr |
| | - Annual power consumption | 19.27 MwH |
| | - Annual power charge | |
| | Fixed charge | 2,541 $Rs.x10^3$ |
| | Energy charge | 6,746 -do- |
| | Sub-total | 9,287 -do- |
| | b. Water treatment plant | |
| | - Installed capacity | 800 Kw |
| | - Daily water treatment | 442.5 $m^3x10^3$ |
| | - Daily power consumption | 7,369 KwH |
| | - Annual water treatment | 161.5 $m^3x10^6$ |
| | - Annual power charge | |
| | Fixed charge | 739 $Rs.x10^3$ |
| | Energy charge | 945 -do- |
| | Sub-total | 1,684 -do- |
| | c. Total electric power cost | 10,971 $Rs.x10^3$ |
| 2. | Chemical cost | |
| | a. Alum | |
| | - Daily consumption | 8.85 ton |
| | - Annual cost: Rs. 3,400x8.85x365 | 10,982 $Rs.x10^3$ |
| | b. Chlorine | |
| | - Daily consumption | 1,328 kg |
| | - Annual cost (Rs. 3,400/900 kg)x1,328x365 | 1,831 $Rs.x10^3$ |
| | c. Total chemical cost | 12,813 $Rs.x10^3$ |

TABLE C.II-19 REPLACEMENT COST

| | (Rs. 1,000) |
|---|---|
| 1. Water treatment plant | |
| a. Phase I | |
| - Mechanical equipment: life span of 20 years | 15,234 |
| - Chemical equipment: life span of 15 years | 14,546 |
| b. Phase II | |
| - Mechanical equipment: life span of 20 years | 8,203 |
| - Chemical equipment: life span of 15 years | 9,015 |
| c. Phase III | |
| - Mechanical equipment: life span of 20 years | 6,347 |
| 2. Pumping equipment (life span of 20 years) | |
| a. Phase I | 27,086 |
| b. Phase II | 8,993 |
| c. Phase III | 5,354 |
| 3. Electric equipment (life span of 15 years) | |
| a. Phase I | 48,953 |
| b. Phase II | 19,713 |
| c. Phase III | 7,363 |

4. Yearly replacement cost ($Rs.10^3$)

| Year | Phase I | Phase II | Phase III | Total |
|---|---|---|---|---|
| 2006 | 63,499 | - | - | 63,499 |
| 10 | - | 28,728 | - | 28,728 |
| 11 | 42,320 | - | - | 42,320 |
| 15 | - | 17,196 | 7,363 | 24,559 |
| 20 | - | - | 11,701 | 11,701 |
| 21 | 63,499 | - | - | 63,499 |
| 25 | - | 28,728 | - | 28,728 |
| 30 | - | - | 7,363 | 7,363 |
| 31 | 42,320 | - | - | 42,320 |

TABLE C.II-20 SUMMARY OF COST ALLOCATION

(Unit: Rs. Million)

| Item | Phase I | | | Phase II | | | Phase III | | |
|---|---|---|---|---|---|---|---|---|---|
| | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total |
| 1. Islamabad | 325.8 | 453.9 | 779.7 | 70.4 | 102.6 | 173.0 | 45.4 | 79.7 | 125.1 |
| 2. Rawalpindi | 468.2 | 677.2 | 1,145.4 | 157.7 | 227.3 | 385.0 | 102.4 | 189.5 | 291.9 |
| 2.1. RMC | 223.4 | 323.2 | 546.6 | 75.4 | 108.7 | 184.1 | 48.7 | 90.2 | 138.9 |
| 2.2. CB | 244.8 | 354.0 | 598.7 | 82.3 | 118.6 | 200.9 | 53.7 | 99.3 | 153.0 |
| Whole Project (1 + 2) | | | | | | | | | |
| Total | 794.0 | 1,131.1 | 1,925.0 | 228.1 | 329.9 | 558.0 | 147.8 | 269.2 | 417.0 |

TABLE C.II-21 COST ALLOCATION OF PHASE I PROJECT

(Unit: Rs. Million)

| Item | Islamabad (32.24%) | | Rawalpindi (67.76%) | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | RMC (47.70%) | | CB (52.30%) | | Total | | | | |
| | FC | LC | FC | LC | FC | LC | FC | LC | FC | LC | Total |
| 1. Conduction Main | 57.3 | 80.5 | 57.5 | 80.7 | 63.0 | 88.5 | 120.5 | 169.2 | 177.8 | 249.7 | 427.5 |
| 2. W. Treatt. Plant | 31.1 | 32.1 | 31.2 | 32.2 | 34.2 | 35.3 | 65.4 | 67.5 | 96.5 | 99.6 | 196.1 |
| 3. Pumping Station | 37.2 | 36.3 | 3.8 | 3.8 | 4.2 | 4.1 | 8.0 | 7.9 | 45.2 | 44.2 | 89.4 |
| 4. Distribution Main | 9.3 | 10.2 | 13.6 | 13.4 | 15.0 | 14.6 | 28.6 | 28.0 | 37.9 | 38.2 | 76.1 |
| 5. Service Reservoir | 26.1 | 36.4 | 11.8 | 17.8 | 12.9 | 19.6 | 24.7 | 37.4 | 50.8 | 73.8 | 124.6 |
| 6. Electric Works | 16.7 | 9.8 | 1.7 | 1.0 | 1.9 | 1.1 | 3.6 | 2.1 | 20.3 | 11.9 | 32.2 |
| Sub-total | 177.7 | 205.3 | 119.6 | 148.9 | 131.2 | 163.2 | 250.8 | 312.1 | 428.5 | 517.4 | 945.9 |
| (Ratio) | (40.5%) | | (28.4%) | | (31.1%) | | (59.5%) | | | | |
| 7. Project Office | - | 4.9 | - | 3.4 | - | 3.7 | - | 7.1 | - | 12.0 | 12.0 |
| 8. Land Acquisition | - | 14.4 | - | 10.1 | - | 11.1 | - | 21.2 | - | 35.6 | 35.6 |
| 9. Office Equipment | 2.6 | 0.9 | 1.8 | 0.6 | 1.9 | 0.7 | 3.7 | 1.3 | 6.3 | 2.2 | 8.5 |
| 10. Engineering | 38.6 | 10.4 | 27.1 | 7.4 | 29.6 | 8.0 | 56.7 | 15.4 | 95.3 | 25.8 | 121.1 |
| 11. Administration | - | 11.3 | - | 7.9 | - | 8.6 | - | 16.5 | - | 27.8 | 27.8 |
| Sub-total | 41.2 | 41.9 | 28.9 | 29.4 | 31.5 | 32.1 | 60.4 | 61.5 | 101.6 | 103.4 | 205.0 |
| 12. Contingencies | 106.9 | 206.7 | 74.9 | 144.9 | 82.1 | 158.7 | 157.0 | 303.6 | 263.9 | 510.3 | 774.2 |
| Total | 325.8 | 453.9 | 223.4 | 323.2 | 244.8 | 354.0 | 468.2 | 677.2 | 794.0 | 1,131.1 | 1,925.1 |

Note: Allocation ratio: Islamabad = 33.00/102.37 ≒ 0.3224
Rawalpindi = 69.37/102.37 ≒ 0.6774

FC; Foreign Cost, LC; Local Cost

TABLE C.II-22 COST ALLOCATION OF PHASE II PROJECT

(Unit: Rs. Million)

| Item | Islamabad (32.24%) | | Rawalpindi (67.76%) | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | RMS(47.70%) | | CB(52.30%) | | Total | | | | |
| | FC | LC | FC | LC | FC | LC | FC | LC | FC | LC | Total |
| 1. Conduction Main | - | - | - | - | - | - | - | - | - | - | - |
| 2. W. Treatt. Plant | 16.1 | 16.6 | 16.1 | 16.6 | 17.6 | 18.2 | 33.7 | 34.8 | 49.8 | 51.4 | 101.2 |
| 3. Pumping Station | 4.2 | 3.3 | 0.8 | 0.6 | 0.8 | 0.7 | 1.6 | 1.3 | 5.8 | 4.6 | 10.4 |
| 4. Distribution Main | 4.1 | 4.3 | 13.6 | 13.4 | 15.0 | 14.6 | 28.6 | 28.0 | 32.7 | 32.3 | 65.0 |
| 5. Service Reservoir | 7.0 | 11.2 | 4.6 | 7.3 | 5.0 | 7.9 | 9.6 | 15.2 | 16.6 | 26.4 | 43.0 |
| 6. Electric Works | 1.5 | 0.9 | 0.3 | 0.2 | 0.3 | 0.2 | 0.6 | 0.4 | 2.1 | 1.3 | 3.4 |
| Sub-total | 32.9 | 36.3 | 35.4 | 38.1 | 38.7 | 41.6 | 74.1 | 79.7 | 107.0 | 116.0 | 223.0 |
| (Ratio) | (31.0%) | | (33.0%) | | (36.0%) | | (69.0) | | | | |
| 7. Project Office | - | - | - | - | - | - | - | - | - | - | - |
| 8. Land Acquisition | - | - | - | - | - | - | - | - | - | - | - |
| 9. Office Equipment | - | - | - | - | - | - | - | - | - | - | - |
| 10. Engineering | 4.4 | 1.1 | 4.7 | 1.2 | 5.1 | 1.3 | 9.8 | 2.5 | 14.2 | 3.6 | 17.8 |
| 11. Administration | - | 1.4 | - | 1.5 | - | 1.6 | - | 3.1 | - | 4.5 | 4.5 |
| Sub-total | 4.4 | 2.5 | 4.7 | 2.7 | 5.1 | 2.9 | 9.8 | 5.6 | 14.2 | 8.1 | 22.3 |
| 12. Contingencies | 33.1 | 63.8 | 35.3 | 67.9 | 38.5 | 74.1 | 73.8 | 142.0 | 106.9 | 205.8 | 312.7 |
| Total | 70.4 | 102.6 | 75.4 | 108.7 | 82.3 | 118.6 | 157.7 | 227.3 | 228.1 | 329.9 | 558.0 |

Note: FC; Foreign Cost
LC; Local Cost

TABLE C.II-23 COST ALLOCATION OF PHASE III PROJECT

(Unit: Rs. Million)

| Item | Islamabad (32.24%) | | Rawalpindi (67.76%) | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | RMC(47.70%) | | CB(52.30%) | | Total | | | | |
| | FC | LC | FC | LC | FC | LC | FC | LC | FC | LC | Total |
| 1. Conduction Main | - | - | - | - | - | - | - | - | - | - | - |
| 2. W. Treatt. Plant | 12.4 | 12.7 | 12.5 | 12.7 | 13.7 | 13.9 | 26.2 | 26.6 | 38.6 | 39.3 | 77.9 |
| 3. Pumping Station | 3.1 | 2.8 | - | - | - | - | - | - | 3.1 | 2.8 | 5.9 |
| 4. Distribution Main | - | - | - | - | - | - | - | - | - | - | - |
| 5. Service Reservoir | - | - | 4.1 | 6.8 | 4.6 | 7.5 | 8.7 | 14.3 | 8.7 | 14.3 | 23.0 |
| 6. Electric Works | 0.9 | 0.6 | - | - | - | - | - | - | 0.9 | 0.6 | 1.5 |
| Sub-total | 16.4 | 16.1 | 16.6 | 19.5 | 18.3 | 21.4 | 34.9 | 40.9 | 51.3 | 57.0 | 108.3 |
| (Ratio) | (30.0%) | | (33.3%) | | (36.7%) | | (70.0%) | | | | |
| 7. Project Office | - | - | - | - | - | - | - | - | - | - | - |
| 8. Land Acquisition | - | - | - | - | - | - | - | - | - | - | - |
| 9. Office Equipment | - | - | - | - | - | - | - | - | - | - | - |
| 10. Engineering | 2.1 | 0.5 | 2.3 | 0.6 | 2.5 | 0.7 | 4.8 | 1.3 | 6.9 | 1.8 | 8.7 |
| 11. Administration | - | 1.0 | - | 1.1 | - | 1.2 | - | 2.3 | - | 3.3 | 3.3 |
| Sub-total | 2.1 | 1.5 | 2.3 | 1.7 | 2.5 | 1.9 | 4.8 | 3.6 | 6.9 | 5.1 | 12.0 |
| 12. Contingencies | 26.9 | 62.1 | 29.8 | 69.0 | 32.9 | 76.0 | 62.7 | 145.0 | 89.6 | 207.1 | 296.7 |
| Total | 45.4 | 79.7 | 48.7 | 90.2 | 53.7 | 99.3 | 102.4 | 189.5 | 147.8 | 269.2 | 417.0 |

Note: FC; Foreign Cost
LC; Local Cost

# CHAPTER III. OPERATION AND MAINTENANCE

# CHAPTER III. OPERATION AND MAINTENANCE

## 3.1. Proposed Organization

The organizations of respective levels concerning Khanpur water supply are indicated in Figure C.III-1, C.III-2, C.III-3 and C.III-4 respectively.

## 3.2. Functions and Responsibilities

### 3.2.1. Boards

The Water Management Board on the Khanpur water will be organized consisting of the representatives of Ministry of Water and Power, Ministry of Agriculture, Ministry of Industry, Ministry of Defence, Capital Development Authority, Water and Power Development Authority, Government of Punjab and Government of NWFP. The major purpose of the board are to decide on water allocation of Khanpur water for respective consumers, to direct revision for seasonal fluctuation of water requirement and priority of water release from Khanpur reservoir during drought period, to decide on water charge revision if required and other political matters concerning Khanpur water.

Under the supervision of the water management board, Regional Water Supply System Operation and Maintenance Board (RWSSB), which will be consisted of Capital Development Authority (CDA), Public Health Engineering Department (PHED) of Punjab Government, Rawalpindi Municipal Corporation (MES), Cantonment Board (CB) and Military Engineering Services (MES), will be organized.

Major functions of RWSSB are to decide on treated water allocation and adjustment for common use water supply system between Islamabad and Rawalpindi, to decide on water charges and tariff system for respective consumers, to deliverate and evaluate annual operation and maintenance budget, to evaluate operation and maintenance activities on the water supply systems.

3.2.2. Committees

The Water Supply System Coordinating Committee on the Khanpur Water (CCKW) is established to undertake the following activities. Members of the CCKW consist of WAPDA, CDA, PHED, MRC, RCB, MES, Irrigation Department of Punjab and NWFP Government, POF and PIDC of Industry.

- To prepare annual operation and maintenance programmes on the Khanpur water
- To prepare annual water supply programmes including seasonal requirements
- To decide on and arrange detailed water release plan for each consumers based on the direction of Water Management Board on Khanpur water on the revision of water allocation and release schedules
- To evaluate annual operation and maintenance cost of raw water and treated water including repairing works for common use facilities
- To prepare annual and periodical assessment reports which will be directed by the Boards
- To function as working group for the Boards

Another committee concerned is Water Supply System Coordinating Committee on other water sources such as Simly and Rawal dams, groundwater developed in the twin cities and surface water in Islamabad area. The functions of this committee will be similar to those of CCKW.

### 3.2.3. Operation and Maintenance Offices

Under the control of regional water supply system operation and maintenance board and water supply system coordinating committee on Khanpur water, following three offices are proposed such as WAPDA Khanpur Dam O.M. Office, Islamabad Water Supply O.M. Office and Rawalpindi Water Supply O.M Office. Major function and responsibility of divisions in respective offices are described in this Appendix C.

#### A. WAPDA Khanpur Dam Operation/Maintenance Office

Under the WAPDA Superintendent, three divisions are organized such as Administration and Finance, Khanpur dam and Canal Control Division.

The Office, headed by the Superintendent of WAPDA will take care of overall operation and maintenance work on the Khanpur dam and left and Right Bank Main Canal as well as related appurtenant facilities including operation of intake tower, diversion facilities and head regulators along the main canals.

#### a. Administration and Finance Division

Under the division director, six sections are established such as Administration and Personal Services, Budget Formulation and Control, Revenue and Cost Control and Accounting, Bill and Collection, Procurement of Material, Education and Training.

1) Administration and Personal Services

- General affairs of the office
- Personal control and labour recruitment
- Other related activities of the office

2) Budget Formulation and Control

- Responsible for the formulation and control of yearly and monthly budgets related to the operation/maintenance of water supply systems
- To formulate revenue and expenditure budgets
- To check revenue and expenditure budgets against actual achievements
- To revise and restructure water tariff systems in collaboration with Revenue and Cost Control and Accounting Section

3) Revenue and Cost Control and Accounting

- To calculate the amount of revenue from water charges and other sources on monthly and yearly basis
- To check and analyse revenue achievements in comparison with budget
- To calculate the amount of costs incurred on operation/maintenance and labor/personnel on monthly and yearly basis
- To check and analyse actual expenditure in comparison with budget
- To regularly compile financial statements including profit and loss statement, cashflow statement and balance sheet
- To make recommendation on the revision and restructuring of water tariff systems

4) Bill and Collection

- Responsible for the issuance of bills and collection of charges related to water supply and relevant services
- To take charge of meter fixing for users

5) Procurement of Materials

- Responsible for the control of procurement and storing of materials and spares
- To perform quality control of material and equipment

6) Education and Training

- In charge of education and training of personnel so that they may acquire up-to-date knowledge and technology on engineering, machines, electricity, finance, accounting and management in connection with water supply

b. Khanpur Dam Division

Under the Division Director, four units sector are organized, such as Operation, Monitoring and Recording, Maintenance and Repairing, and Mechanics and Workshop

- To prepare seasonal water release schedule based on respective consumers' requirement and operation rule curve on the Khanpur reservoir
- To operate intake tower, head regulators at division work and main gate of spillway
- To monitor and record hydro-meteorological data and storage water in the reservoir
- To inspect and patrol dam and its appurtenant structures
- To survey and design required repairing and improving work on the dam and related appurtenants structures

- To maintain not only dam body and facilities but also overall the equipments and instruments related to the O & M works

c. Canal Control Division

Under the Division Director, three units sector are set up such as Operation and Recording, Maintenance and Repairing, and Terminal Control for Industry and Irrigation

- To prepare, evaluate and report water distribution schedule for the Irrigation and Industry water supply
- To operate the head regulator and check gate at distribution points
- To partol and maintain the Left Bank Main Canal up to end point of the canal
- To plan maintenance, repairing and rehabilitation works within their territory systems
- To patrol both Left and Right Main Canal as well as branch and tertial canal system and to educate terminal consumers of irrigation and industry
- To record water distribution to respective consumers.

B. Islamabad Water Supply Operation/Maintenance Office

Under the CDA Superintendent, five divisions are organized such as Administration and Finance, Khanpur dam, Simly dam, Headwork and Tubewell, and Distribution Division.

The Office, headed by the Superintendent of CDA, will take care of overall operation and maintenance work on the water supply systems within Islamabad Capital area for the time being.

a. Administration and Finance Division

Under the division director six sections are established instead of existing CDA maintenance directorate, such as Administration and Personal Service, Budget Formation and Control, Revenue and Cost & Accounting, Bill and Collection, Procurement of Materials, and Education & Training.

Major functions and responsibilities are similar to those of WAPDA Khanpur Dam O & M Office Organization (Please refer to Item 3.1.).

b. Khanpur Dam Division

Under the division director, five sections are proposed such as Golra Water Treatment Plant, Pumping Station, Discharge and Conduction Main, Mechanics & Repairing, and Workshop.

- To coordinate water release plan from Khanpur dam and supply/production plan with concerned divisions and offices such as WAPDA Khanpur Dam O & M Office and Rawalpindi Water Supply System O & M Office
- To test and analyze raw water and to control water quality
- To operate and maintain the water treatment and pumping plants
- To monitor and record production and consumed materials and chemicals
- To patrol, maintain and operate pipeline main and valves
- To maintain and control the equipment, instrument and workshop

c. Simly Dam Division

Under the division director three sections such as Dam Operation and Monitoring, Simly Water Treatment Plant, and Conduction Main Maintenance are organized.

- To prepare seasonal water release schedule and reservoir operation rules
- To monitor and record hydro-mateorological data and storage water in the reservoir
- To inspect and patrol dam and its appurtenant structures
- To survey and design required repairing and improving work on the dam and related structures
- To test and analyze raw water and to control water quality
- To operate and maintain water treatment plant
- To monitor and record production and consumed materials and chemicals
- To patrol, maintain conduction main and service reservoirs

d. Head Work, Tubewell Division

Under the division director four sections such as Head Work and Water Treatment Tubewell and Sump Pump, Conduction Main Maintenance, and Mechanics & Workshop are organized.

- To operate and maintain head works, tubewell and sump pumps and water treatment plants
- To monitor and record production of water
- To analyze raw water and to control water quality
- To patrol, maintain conduction main and to operate values along pipeline systems

e. Distribution Division

Under the division director, three sections are proposed such as Distribution Control, Service Reservoir Control and Patrolling & Maintenance.

- To control water distribution to each sectors and Rawalpindi area

- To maintain and patrol distribution main and distribution networks
- To instruct and promote saving water leakage and wastage

C. Rawalpindi Water Supply Operation/Maintenance Office

Under the PHED Superintendent four division such as Administration & Finance, Khanpur Dam, Rawal Dam, and Distribution Divisions are organized.

The office, headed by PHED superintendent, will take care of overall operation and maintenance works on the water supply systems upto main distribution points and instruct operation and maintenance manners for respective terminal consumer agencies concerned.

FIGURE C.III-1 PROPOSED ORGANIZATION CHART OF WATER SUPPLY SYSTEM OPERATION AND MAINTENANCE (1)

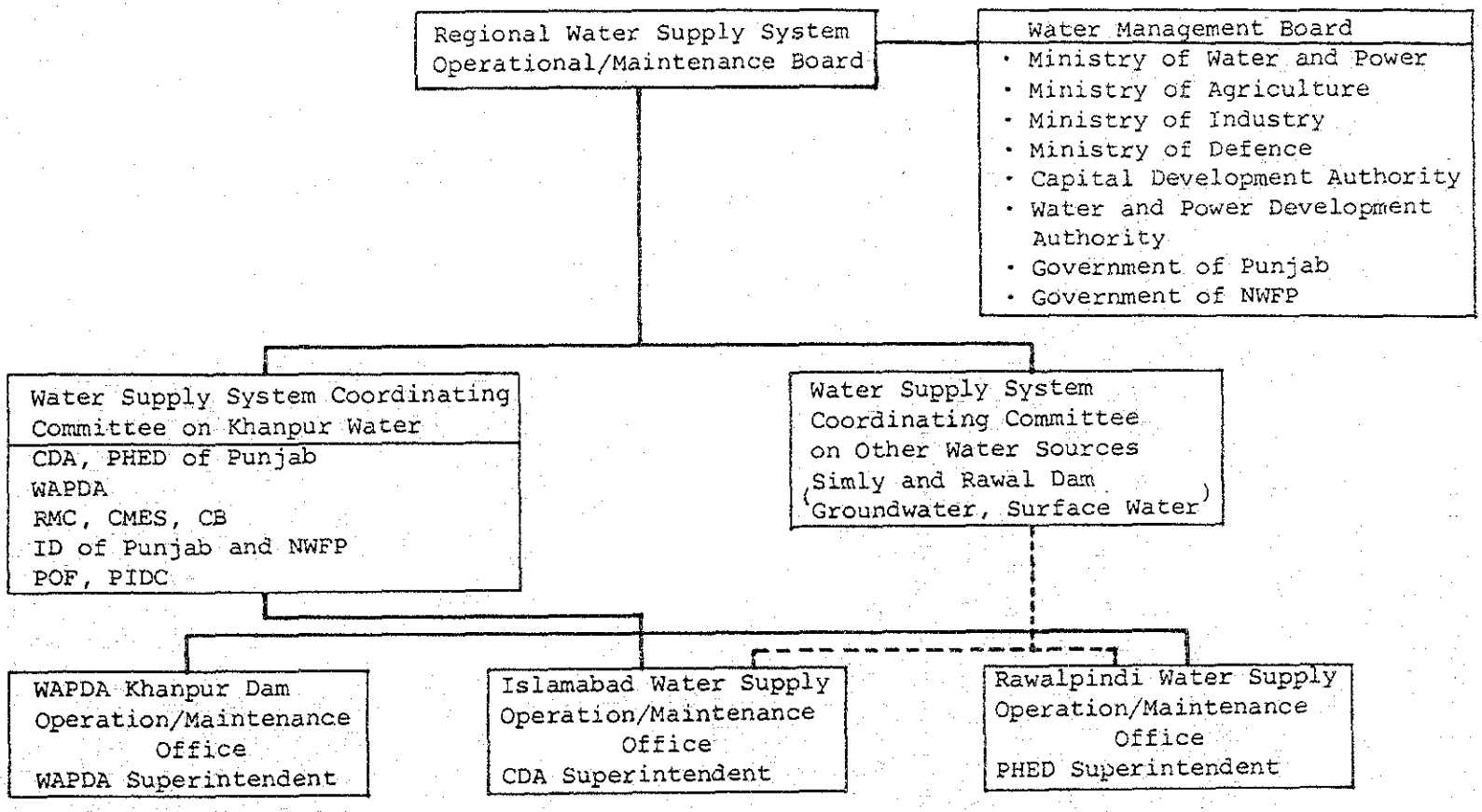


FIGURE C.III-2 PROPOSED ORGANIZATION CHART OF WATER SUPPLY SYSTEM OPERATION AND MAINTENANCE (2)

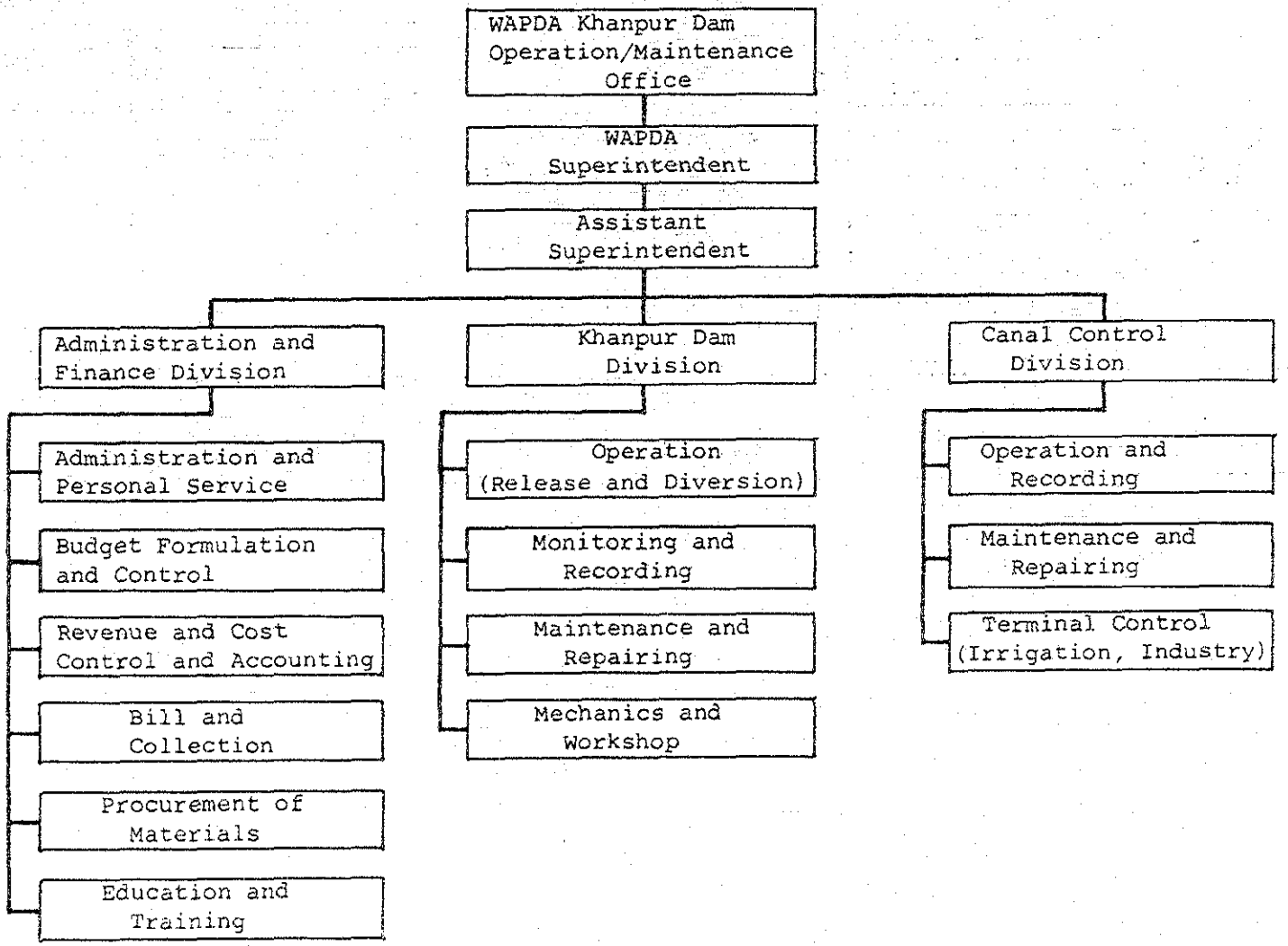


FIGURE C.III-3 PROPOSED ORGANIZATION CHART OF WATER SUPPLY SYSTEM OPERATION AND MAINTENANCE (3)

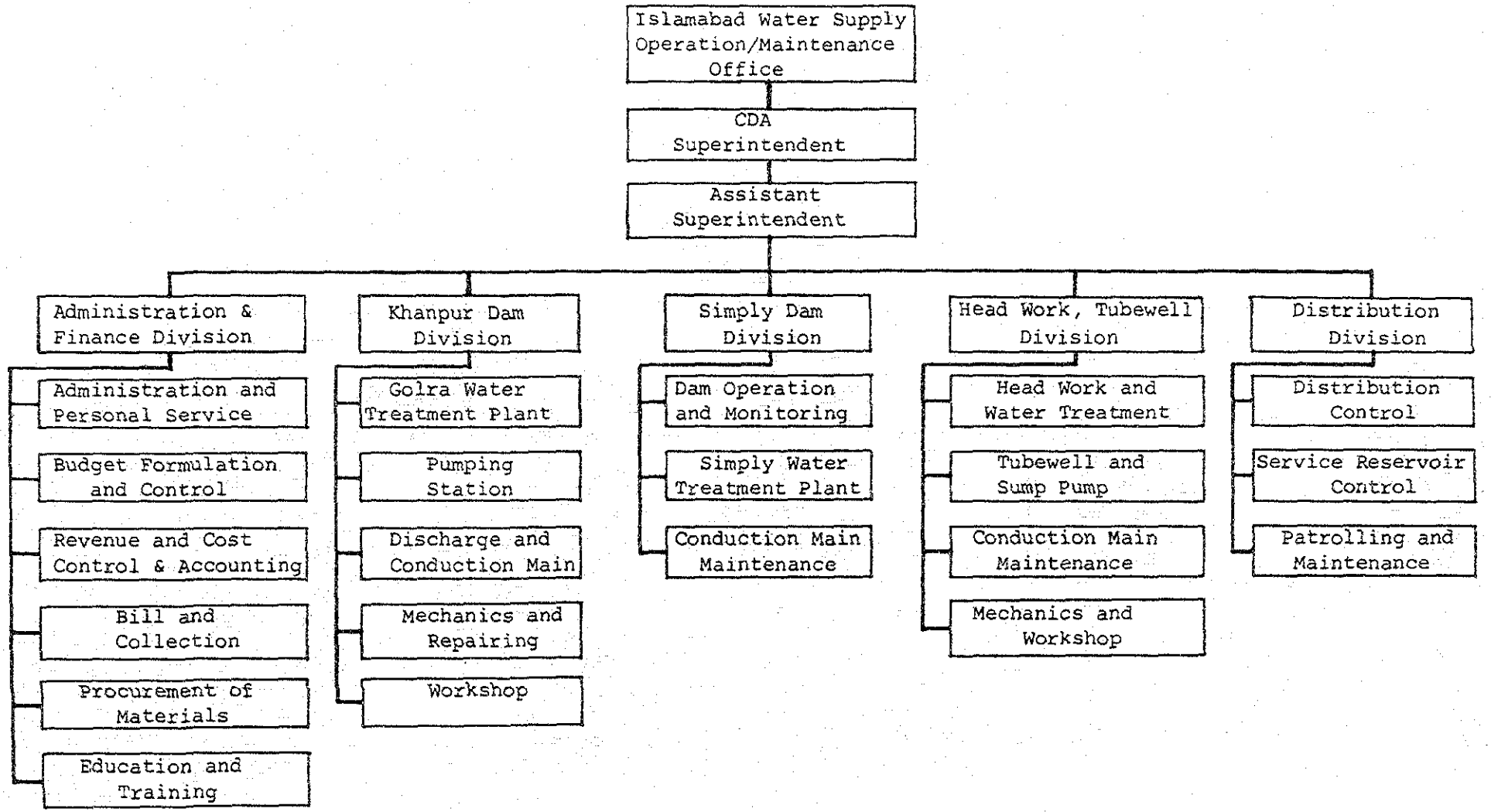
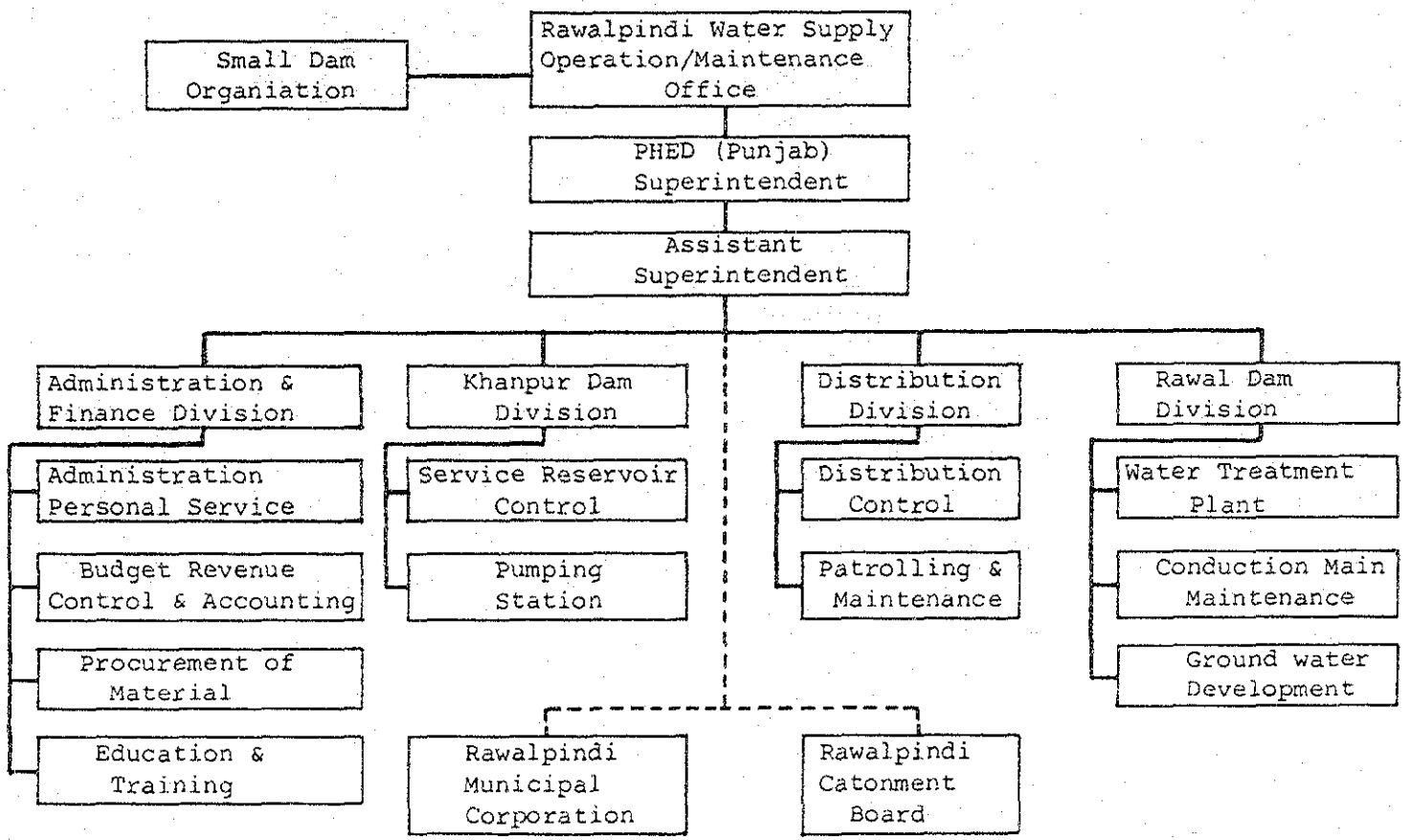


FIGURE C.III-4 PROPOSED ORGANIZATION CHART OF WATER SUPPLY SYSTEM OPERATION AND MAINTENANCE (4)



# CHAPTER IV. PROJECT JUSTIFICATION

# CHAPTER IV. PROJECT JUSTIFICATION

## 4.1. Evaluation of Socio-Economic Survey

The Study Team has conducted extensive house visit sampling investigations to determine the economic value per unitary consumption of water. They covered all project areas, namely, Islamabad, Rawalpindi City and Cantonment, and the number of samples reached approximately 3,000. Investigators visited domestic houses, public institutions and commercial/industrial establishments. An outcome of this on-the-spot inquiry survey is that the domestic and commercial/industrial users are willing to pay Rs. 6.21 and Rs. 3.01 per thousand gallons of water respectively. This, further, boils down to the weighted average figure of Rs. 5.37 per thousand gallons of water.

When analysis is confined to those consumers who voiced their satisfaction with the present water charges, the willingness to pay per thousand gallons of water works out to Rs. 6.80 and Rs. 5.62 for domestic and commercial/industrial users respectively, ultimately being rendered to Rs. 6.49 as the total average value.

Since those who are dissatisfied with the existing status of water supply, be it water charges or otherwise, will not express the true and real level of their willingness, the latter figures have been ultimately adopted as representing the unitary economic values of urban water. Those who are satisfied with the present water charges comprise 73.9% of the total consumers.

To calculate the total yearly economic value of the Khanpur water, the volume of the water to be consumed in a certain future year is mutiplied by this unitary economic value of water.

However, the benefit of water will increase as years go by, even on the assumption that the volume of water to be supplied remain the same. This is because people attach more economic value per unitary consumption of water as their income grows. In economists' jargons, it is called the income elasticity of economic value of water. As a result of the surveys, it has been found that the elasticity is 50%, which means that when income increases by 10% the economic value of water will increase by 5%. This income elasticity factor has been integrated in the computer programs to determine the economic benefit of the supply of the Khanpur Dam urban water.

As one of other findings of house-visit investigations, monthly income per household is Rs. 2,937, Rs. 1,495 and Rs. 1,977 for Islamabad, Rawalpindi City and Rawalpindi Cantonment respectively. The total weighted average works out at Rs. 1,890. The number of household members is 6.18, 7.65 and 5.75 for the above areas in the same order, respectively. The total average is calculated at 6.61.

Table C.IV-1 summarizes the outcome of sampling surveys.

TABLE C.IV-1 OUTCOME OF HOUSE VISIT INVESTIGATIONS ON WILLINGNESS TO PAY FOR WATER CONSUMPTION

1. General

| Items | Islamabad | Rawalpindi | |
|---|---|---|---|
| | | City | Cantonment |
| 1. Domestic Users | | | |
| 1) Willingness to Pay | Rs. 1.41/000 ℓ (Rs. 6.43/000 gal.) | Rs. 0.63/000 ℓ (Rs. 2.87/000 gal.) | Rs. 1.89/000 ℓ (Rs. 8.59/000 gal.) |
| 2) Monthly Wages per Household | Rs. 2,937 | Rs. 1,495 | Rs. 1,977 |
| 3) Ratio of Willingness to Pay to Wages | 1.005 % | 0.912 % | 1.577 % |
| 4) No. of Members per House-hold | 6.18 | 7.65 | 5.75 |
| 2. Commercial/Industrial Users | | | |
| 1) Willingness to Pay | Rs. 0.49/000 ℓ (Rs. 2.21/000 gal.) | Rs. 0.44/000 ℓ (Rs. 1.98/000 gal.) | Rs. 0.98/000 ℓ (Rs. 4.47/000 gal.) |
| 2) No. of Workers per Estab-lishment | 11.5 | 4.1 | 7.9 |
| No. of Samples (Effective) | | | |
| a. Domestic Users | 557 | 1,017 | 328 |
| b. Commercial/Industrial Users | 210 | 430 | 165 |

The investigations were conducted in Jul. to Aug., 1984.

- Cont'd -

2. Weighted Average of Willingness to Pay

| Items | Weighted Average of Willingness to Pay |
|---|---|
| 1. Domestic Water | Rs. 1.37/000 ℓ (Rs. 6.21 / 000 gal. ) |
| 2. Com./Ind. Water | Rs. 0.66/000 ℓ (Rs. 3.01 / 000 gal. ) |
| 3. Total Weighted Average | Rs. 1.18/000 ℓ (Rs. 5.37 / 000 gal. ) |

| Items | Islamabad | Rawalpindi | |
|---|---|---|---|
| | | City | Cantonment |
| Willingness to Pay, Domestic Water | Rs.1.41/000 ℓ (Rs.6.43/000gal. | Rs.0.63/000 ℓ (Rs.2.87/000gal) | Rs.1.89/000 ℓ (Rs.8.59/000gal.) |
| Willingness to Pay, Com./Ind. Water | Rs.0.49/000 ℓ (Rs.2.21/000gal. ) | Rs.0.44/000 ℓ (Rs.1.98/000gal) | Rs.0.98/000 ℓ (Rs. 4.47/000gal.) |
| Share on Khanpur Water | 0.324 | 0.294 | 0.382 |
| Share of Dom./Pub. Water | 0.75 | 0.73 | 0.73 |
| Share of Com./Ind. Water | 0.25 | 0.27 | 0.27 |
| Process for Calculation of Total Weighted Average | Rs.6.43 x 0.324 x 0.75 + Rs. 2.21x0.324x0.25+ Rs.2.87 x 0.294 x 0.73 + Rs. 1.98x0.294x0.27+ Rs.8.59 x 0.382 x 0.73 + Rs. 4.47x0.382x0.27= Rs. 5.37/000 gal. = Rs. 1.18/000 ℓ | | |

- Cont'd -

3. Weighted Average of Willingness to Pay for the Satisfied 1/

| Items | Weighted Average of Willingness to Pay |
|---|---|
| 1. Domestic Water | Rs. 1.50 / 000 ℓ ( Rs. 6.80 / 000 gal. ) |
| 2. Com./Ind. Water | Rs. 1.24 / 000 ℓ ( Rs. 5.62 / 000 gal. ) |
| 3 Total Weighted Average | Rs. 1.43 / 000 ℓ ( Rs. 6.49 / 000 gal. ) |

| Items | Islamabad | Rawalpindi | |
|---|---|---|---|
| | | City | Cantonment |
| Willingness to Pay, Domestic Water | Rs. 1.54/000 ℓ (Rs. 7.01/000 gal.) | Rs. 0.68/000 ℓ (Rs. 3.07/000 gal ) | Rs. 2.09/000 ℓ (Rs. 9.49/000 gal.) |
| Willingness to Pay, Com./Ind. Water | Rs. 1.29/000 ℓ (Rs. 5.87/000 gal.) | Rs. 1.04/000 ℓ (Rs. 4.71/000 gal ) | Rs. 1.34/000 ℓ (Rs. 6.11/000 gal.) |
| Share on Khanpur Water | 0.324 | 0.294 | 0.382 |
| Share of Dom./Pub. Water | 0.75 | 0.73 | 0.73 |
| Share of Com./Ind. Water | 0.25 | 0.23 | 0.23 |
| Process for Calculation of Total Weighted Average | Rs. 7.01 x 0.324 x 0.75 + Rs. 5.87 x 0.324 x 0.25 + Rs. 3.07 x 0.294 x 0.73 + Rs. 4.71 x 0.294 x 0.27 + Rs. 9.49 x 0.382 x 0.73 + Rs. 6.11 x 0.382 x 0.27 = Rs. 6.49/000 gal. = Rs. 1.43/000 ℓ | | |

1/ the Satisfied : the Customers Who Are Satisfied with the Present Water Charges

- Cont'd -

4. Income Elasticity of Willingness to Pay per Thousand Gallons

Unit : Rs.

| Items | Islamabad | | Rawalpindi City | | Rawalpindi Cantonment | | Weighted Average 1/ | |
|---|---|---|---|---|---|---|---|---|
| | Wages/M | Willingness to to Pay/000 gal. | Wages/M | Willingness to to Pay/000 gal. | Wages/M | Willingness to to Pay/000 gal. | Wages/M | Willingness to to Pay/000 gal. |
| No.1 | - | - | - | - | 300 | 4.5 | | |
| 2 | - | - | 750 | 2.7 | 750 | 7.1 | | |
| 3 | 1,500 | 3.4 | 1,500 | 2.8 | 1,500 | 8.4 | | |
| 4 | 2,500 | 5.4 | 2,500 | 2.9 | 2,500 | 9.8 | | |
| 5 | 3,500 | 4.9 | 3,500 | 3.3 | 3,500 | 8.6 | | |
| 6 | 4,500 | 6.8 | 4,500 | 3.6 | 4,500 | 7.2 | | |
| 7 | 6,800 | 9.7 | - | - | 5,000 | 11.2 | | |
| Regression Equation | Y=1.7789+0.00113X 2/ | | Y=2.4373+0.000244X | | Y=6.0867+0.000786X | | Y=3.6181+0.000739X | |
| Corr. Coeff. | 0.969 | | 0.971 | | 0.671 | | | |
| Elasticity 3/ | 0.652 (X=Rs. 2,937)<br>0.832 (X=Rs. 7,769) 4/ | | 0.130 (X=Rs. 1,495)<br>0.384 (X=Rs. 3,955) 4/ | | 0.203 (X=Rs. 1,977)<br>0.403 (X=Rs. 5,230) 4/ | | 0.279 (X=Rs. 1,890)<br>0.505 (X=Rs. 5,000) 4/ | |

1/ Weighted : Shares on population in 1981, namely, 15%, 48% and 37% for Islamabad, Rawalpindi City and Rawalpindi Cantonment respectively.

2/ X: Wages/M
Y: Willingness to Pay/000 gal.

3/ $\frac{X}{Y} \cdot \frac{dY}{dX}$

4/ Forecasted Monthly Wages in the Year 2000

## 4.2. Economic Analysis

The economic internal rate of return (EIRR) is a comprehensive index expressing the economic feasibility of a project. It integrates both capital investments and operation/maintenance costs aspects as well as time aspects of a project. Also, it is an assessment from the standpoint of national economy.

Annual benefits are computed by multiplying the volume of water to be sold in a given year by the unitary economic value of water (= Rs. 6.49/000 gal.). They are added together over the entire period of project life.

Project costs are composed of construction, operations/maintenance and replacement costs of Khanpur water storage, conduction, treatment and distribution facilities.

The construction costs, allocable to urban water, of Khanpur Dam including Left Bank Canals are incorporated in the costs. They amount to Rs. 876.106 million at 1984 prices. (Refer to Table C.IV-2)

Costs are estimated on a yearly basis and ultimately aggregated over the entire period of project life.

In totalizing yearly benefits and costs a discount rate that equalizes the present worths of both of them is sought and found. The value of EIRR for the Project has been computed at 6.2% as shown in Table C.IV-4. If the costs of distribution facilities including mains and networks are excluded from project costs because of uncertain elements involved in their estimation, then it works out at 5.5% as shown in Table C.IV-5. It is to be remembered that the unitary economic value of water is cut to Rs. 3.75 in calculating the second value of EIRR.

The costs over the entire period of project life amount to Rs. 6,410 million. When distribution costs are excluded they come to Rs. 3,705 million. The coefficient of 0.578 deriving from the cost ratio (3,705/6,410) is applied to Rs. 6.49, resulting in Rs. 3.75.

The EIRR value of 6.2% is low compared with standard levels of the rate of the opportunity cost of capital which fall between 8% and 15%. It is to be stressed, however, that 5% to 6% is a standard level as an EIRR value for a project in water supply sector.

The value is based upon the project benefits calculated from consumers' willingness to pay for water supply service. It is, as has been seen, Rs. 6.49 per thousand gallons. It is to be reminded that it expresses the very minimum of the unitary value of water, because such major benefits as health and time saving benefits may not be included in it, and also because indirect benefits in the form of far-reaching socio-economic impacts are excluded from it.

Supposing all the benefits deriving from water supply are quantitatively expressed, the unitary economic value of water will be pushed up to a much higher level, which in turn will bring up the value of EIRR to a proper and reasonable height.

It is not uncommon in a project for the construction of a social infrastructure and whose primary objective is the provision of public service to have an EIRR value in the range of 3 to 5%, and in spite of it to be judged feasible because of the magnitude of expected intangible benefits.

TABLE C.IV-2 ECONOMIC COST OF KHANPUR DAM CONSTRUCTION

Unit: Rs. million

| Five Year Plan Period | Total 1/ Financial Costs | Economic 2/ Costs | Representative Year | Conversion Factor to 1984 Prices | Economic Costs at 1984 Prices |
|---|---|---|---|---|---|
| 2 | 17.060 | 5.389 | 1963-64 | 5.447 | 29.354 |
| 3 | 71.351 | 22.538 | 1967-68 | 4.557 | 102.706 |
| 4 | 362.428 | 114.480 | 1972-73 | 3.387 | 387.744 |
| 5 | 750.913 | 237.192 | 1980-81 | 1.258 | 298.388 |
| 6 | 183.348 | 57.914 | 1984 | 1 | 57.914 |
| | 1,385.100 | 437.513 | | | 876.106 |

1/ Financial costs on the construction of the Khanpur Dam reservoir and the irrigation facilities (RBC + LBC), including direct, overhead and interest costs

2/ Economic costs on the construction of the Khanpur Dam reservoir and LBC, allocable to urban water supply

| | |
|---|---|
| the Dam | : 379.472 |
| LBC | : 58.041 |
| | 437.513 |

(Interest and taxes have been deducted.)

Sources: Khanpur Dam P.C. 1 proforma,
Pakistan Economic Survey 1983-84
and the study by JICA

TABLE C.IV-3 ABBREVIATION TABLE

- ECONOMIC EVALUATION -

1) Input

| | | |
|---|---|---|
| CC | : | Construction Costs (Rs. million) |
| Mm | : | Number of Replacement Years |
| RY | : | Replacement Year |
| RC | : | Replacement Costs (Rs. million) |
| OMC | : | Operation & Maintenance Costs (Rs. million) |

2) IRR Computation

| | | |
|---|---|---|
| DC.RT | : | Discount Rate (= Discount Factor) |
| PW.BF | : | Present Worth (= Present Value) of Benefit (Rs. million) |
| RW.CS | : | Present Worth (= Present Value) of Cost (Rs. million) |
| NPW | : | Net Present Worth (= Net Present Value) (Rs. million) |
| BC.RT | : | Benefit Cost Ratio (%) |

3) Cash Flow Analysis

| | | |
|---|---|---|
| YR | : | Year |
| BNFT | : | Benefit (Rs. million) |
| COST | : | Cost (Rs. million) |
| CSFL | : | Cash Flow (Rs. million) |
| AC.BF | : | Accumulated Benefit (Rs. million) |
| AC.CS | : | Accumulated Cost (RS. million) |
| AC.CF | : | Accumulated Cash Flow (Rs. million) |

TABLE C.IV-4 ECONOMIC EVALUATION

## < ECONOMIC EVALUATION >

< INPUT >

CC 1= 33.418
CC 2= 39.578
CC 3= 65.631
CC 4= 151.861
CC 5= 303.69
CC 6= 509.935
CC 7= 396.121
CC 8= 179.079
CC 9= 107.904
CC 10= 189.796
CC 11= 173.673
CC 12= 60.2
CC 13= 0
CC 14= 34.231
CC 15= 108.468
CC 16= 71.349
CC 17= 25.5

OM 8= 32.81
OM 9= 37.371
OM 10= 42.001
OM 11= 46.301
OM 12= 55.796
OM 13= 57.239
OM 14= 57.239
OM 15= 59.339
OM 16= 61.439
OM 17= 67.425
OM 18= 68.19
OM 19= 68.296

NM= 9

| | | | |
|---|---|---|---|
| RV 1= 22 | RC 1= 63.499 |
| RV 2= 26 | RC 2= 28.728 |
| RV 3= 27 | RC 3= 42.32 |
| RV 4= 31 | RC 4= 24.559 |
| RV 5= 36 | RC 5= 11.701 |
| RV 6= 37 | RC 6= 63.499 |
| RV 7= 41 | RC 7= 28.728 |
| RV 8= 46 | RC 8= 7.363 |
| RV 9= 47 | RC 9= 42.32 |

X= 0.06

< CASH FLOW ANALYSIS >

| YR | BNFT | COST | CSFL | AC.BF | AC.CS | AC.CF |
|---|---|---|---|---|---|---|
| 1 | 0 | 908 | -908 | 0 | 908 | -908 |
| 2 | 0 | 35 | -35 | 0 | 943 | -943 |
| 3 | 0 | 55 | -55 | 0 | 998 | -998 |
| 4 | 0 | 120 | -120 | 0 | 1118 | -1118 |
| 5 | 0 | 227 | -227 | 0 | 1345 | -1345 |
| 6 | 0 | 359 | -359 | 0 | 1705 | -1705 |
| 7 | 0 | 263 | -263 | 0 | 1968 | -1968 |
| 8 | 58 | 133 | -75 | 58 | 2101 | -2043 |
| 9 | 60 | 86 | -26 | 119 | 2187 | -2068 |
| 10 | 62 | 129 | -67 | 181 | 2316 | -2136 |
| 11 | 64 | 116 | -52 | 244 | 2432 | -2188 |
| 12 | 84 | 58 | 26 | 328 | 2490 | -2162 |
| 13 | 86 | 27 | 59 | 415 | 2517 | -2102 |
| 14 | 88 | 40 | 48 | 503 | 2557 | -2055 |
| 15 | 90 | 70 | 20 | 592 | 2627 | -2035 |
| 16 | 92 | 52 | 40 | 684 | 2680 | -1995 |
| 17 | 107 | 35 | 73 | 792 | 2714 | -1922 |
| 18 | 108 | 24 | 84 | 900 | 2738 | -1838 |
| 19 | 106 | 23 | 84 | 1006 | 2761 | -1754 |
| 20 | 103 | 21 | 82 | 1110 | 2782 | -1672 |
| 21 | 101 | 20 | 81 | 1210 | 2802 | -1592 |
| 22 | 98 | 37 | 62 | 1309 | 2839 | -1530 |
| 23 | 96 | 18 | 78 | 1404 | 2856 | -1452 |
| 24 | 93 | 17 | 76 | 1497 | 2873 | -1376 |
| 25 | 91 | 16 | 75 | 1588 | 2889 | -1301 |
| 26 | 88 | 21 | 67 | 1676 | 2911 | -1234 |
| 27 | 86 | 23 | 63 | 1763 | 2933 | -1171 |
| 28 | 84 | 13 | 70 | 1846 | 2947 | -1100 |
| 29 | 82 | 13 | 69 | 1928 | 2959 | -1031 |
| 30 | 80 | 12 | 68 | 2008 | 2971 | -964 |
| 31 | 77 | 15 | 62 | 2085 | 2987 | -901 |
| 32 | 75 | 11 | 65 | 2161 | 2997 | -836 |
| 33 | 74 | 10 | 64 | 2234 | 3007 | -773 |
| 34 | 72 | 9 | 62 | 2306 | 3017 | -711 |
| 35 | 70 | 9 | 61 | 2376 | 3025 | -650 |
| 36 | 68 | 10 | 58 | 2444 | 3035 | -592 |
| 37 | 66 | 15 | 51 | 2510 | 3051 | -541 |
| 38 | 64 | 7 | 57 | 2574 | 3058 | -484 |
| 39 | 63 | 7 | 56 | 2637 | 3065 | -428 |
| 40 | 61 | 7 | 55 | 2698 | 3072 | -373 |
| 41 | 60 | 9 | 51 | 2758 | 3081 | -323 |
| 42 | 58 | 6 | 52 | 2816 | 3086 | -271 |
| 43 | 57 | 6 | 51 | 2872 | 3092 | -220 |
| 44 | 55 | 5 | 50 | 2927 | 3097 | -170 |
| 45 | 54 | 5 | 49 | 2981 | 3102 | -121 |
| 46 | 52 | 5 | 47 | 3033 | 3107 | -74 |
| 47 | 51 | 7 | 44 | 3084 | 3115 | -30 |
| 48 | 50 | 4 | 45 | 3134 | 3119 | 15 |
| 49 | 48 | 4 | 44 | 3182 | 3123 | 59 |
| 50 | 47 | 4 | 43 | 3229 | 3126 | 103 |

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.050 | 4199 | 3401 | 798 | 123 |
| 0.060 | 3229 | 3126 | 103 | 103 |
| 0.070 | 2518 | 2900 | -382 | 87 |

BC.RT= 103.2833508047

- Cont'd -

X= 0

< CASH FLOW ANALYSIS >

| YR | BNFT | COST | CSFL | AC.BF | AC.CS | AC.CF |
|---|---|---|---|---|---|---|
| 1 | 0 | 910 | -910 | 0 | 910 | -910 |
| 2 | 0 | 40 | -40 | 0 | 949 | -949 |
| 3 | 0 | 66 | -66 | 0 | 1015 | -1015 |
| 4 | 0 | 152 | -152 | 0 | 1167 | -1167 |
| 5 | 0 | 304 | -304 | 0 | 1470 | -1470 |
| 6 | 0 | 510 | -510 | 0 | 1980 | -1980 |
| 7 | 0 | 396 | -396 | 0 | 2376 | -2376 |
| 8 | 93 | 212 | -119 | 93 | 2588 | -2495 |
| 9 | 102 | 145 | -44 | 195 | 2734 | -2539 |
| 10 | 111 | 232 | -121 | 306 | 2965 | -2659 |
| 11 | 121 | 220 | -99 | 427 | 3185 | -2758 |
| 12 | 169 | 116 | 53 | 596 | 3301 | -2705 |
| 13 | 184 | 57 | 127 | 780 | 3359 | -2579 |
| 14 | 199 | 91 | 108 | 979 | 3450 | -2471 |
| 15 | 215 | 168 | 48 | 1194 | 3618 | -2424 |
| 16 | 233 | 133 | 100 | 1427 | 3751 | -2323 |
| 17 | 289 | 93 | 196 | 1717 | 3844 | -2127 |
| 18 | 309 | 68 | 241 | 2025 | 3912 | -1886 |
| 19 | 321 | 68 | 253 | 2347 | 3980 | -1633 |
| 20 | 332 | 68 | 264 | 2679 | 4048 | -1370 |
| 21 | 343 | 68 | 274 | 3021 | 4117 | -1095 |
| 22 | 354 | 132 | 222 | 3375 | 4248 | -873 |
| 23 | 365 | 68 | 297 | 3740 | 4317 | -576 |
| 24 | 377 | 68 | 309 | 4118 | 4385 | -267 |
| 25 | 389 | 68 | 321 | 4507 | 4453 | 54 |
| 26 | 402 | 97 | 305 | 4909 | 4550 | 359 |
| 27 | 415 | 111 | 305 | 5324 | 4661 | 663 |
| 28 | 429 | 68 | 360 | 5753 | 4729 | 1024 |
| 29 | 443 | 68 | 374 | 6196 | 4797 | 1398 |
| 30 | 457 | 68 | 389 | 6653 | 4866 | 1787 |
| 31 | 472 | 93 | 379 | 7124 | 4959 | 2166 |
| 32 | 487 | 68 | 419 | 7612 | 5027 | 2585 |
| 33 | 503 | 68 | 435 | 8114 | 5095 | 3019 |
| 34 | 519 | 68 | 451 | 8634 | 5164 | 3470 |
| 35 | 536 | 68 | 468 | 9170 | 5232 | 3938 |
| 36 | 554 | 80 | 474 | 9724 | 5312 | 4412 |
| 37 | 572 | 132 | 440 | 10295 | 5444 | 4852 |
| 38 | 590 | 68 | 522 | 10886 | 5512 | 5374 |
| 39 | 609 | 68 | 541 | 11495 | 5580 | 5915 |
| 40 | 629 | 68 | 561 | 12124 | 5649 | 6476 |
| 41 | 650 | 97 | 553 | 12774 | 5746 | 7028 |
| 42 | 671 | 68 | 602 | 13444 | 5814 | 7631 |
| 43 | 693 | 68 | 624 | 14137 | 5882 | 8255 |
| 44 | 715 | 68 | 647 | 14852 | 5950 | 8902 |
| 45 | 738 | 68 | 670 | 15590 | 6019 | 9572 |
| 46 | 762 | 76 | 687 | 16353 | 6094 | 10258 |
| 47 | 787 | 111 | 676 | 17140 | 6205 | 10935 |
| 48 | 813 | 68 | 744 | 17952 | 6273 | 11679 |
| 49 | 839 | 68 | 771 | 18791 | 6342 | 12450 |
| 50 | 866 | 68 | 798 | 19658 | 6410 | 13248 |

BC.RT= 306.6802480636

TABLE C.IV-5 ECONOMIC EVALUATION
- EXCL. DISTRIBUTION -

< ECONOMIC EVALUATION >

< INPUT >

CC 1= 33.418
CC 2= 21.978
CC 3= 58.131
CC 4= 126.761
CC 5= 160.09
CC 6= 300.832
CC 7= 242.721
CC 8= 94.9
CC 9= 65.604
CC 10= 87.096
CC 11= 39.573
CC 12= 0
CC 13= 0
CC 14= 34.231
CC 15= 68.368
CC 16= 15.349
CC 17= 0

OM 8= 10.71
OM 9= 13.771
OM 10= 15.301
OM 11= 15.301
OM 12= 21.996
OM 13= 22.739
OM 14= 22.739
OM 15= 22.739
OM 16= 22.739
OM 17= 28.725
OM 18= 29.39
OM 19= 29.39

MM= 9
RV 1= 22 RC 1= 63.499
RV 2= 26 RC 2= 28.728
RV 3= 27 RC 3= 42.32
RV 4= 31 RC 4= 24.559
RV 5= 36 RC 5= 11.701
RV 6= 37 RC 6= 63.499
RV 7= 41 RC 7= 28.728
RV 8= 46 RC 8= 7.363
RV 9= 47 RC 9= 42.32

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.050 | 2426 | 2222 | 204 | 109 |
| 0.060 | 1866 | 2086 | -220 | 89 |

X= 0.05

< CASH FLOW ANALYSIS >

| YR | BNFT | COST | CSFL | AC.BF | AC.CS | AC.CF |
|---|---|---|---|---|---|---|
| 1 | 0 | 908 | -908 | 0 | 908 | -908 |
| 2 | 0 | 20 | -20 | 0 | 928 | -928 |
| 3 | 0 | 50 | -50 | 0 | 978 | -978 |
| 4 | 0 | 104 | -104 | 0 | 1082 | -1082 |
| 5 | 0 | 125 | -125 | 0 | 1208 | -1208 |
| 6 | 0 | 224 | -224 | 0 | 1432 | -1432 |
| 7 | 0 | 172 | -172 | 0 | 1605 | -1605 |
| 8 | 36 | 71 | -35 | 36 | 1676 | -1640 |
| 9 | 38 | 51 | -13 | 74 | 1727 | -1653 |
| 10 | 39 | 63 | -23 | 114 | 1790 | -1677 |
| 11 | 41 | 32 | 9 | 155 | 1822 | -1668 |
| 12 | 54 | 12 | 42 | 209 | 1835 | -1626 |
| 13 | 56 | 12 | 44 | 265 | 1847 | -1581 |
| 14 | 58 | 29 | 29 | 323 | 1875 | -1552 |
| 15 | 60 | 44 | 16 | 383 | 1919 | -1536 |
| 16 | 62 | 17 | 44 | 445 | 1937 | -1492 |
| 17 | 73 | 13 | 60 | 518 | 1949 | -1431 |
| 18 | 74 | 12 | 62 | 592 | 1961 | -1369 |
| 19 | 73 | 12 | 62 | 666 | 1973 | -1308 |
| 20 | 72 | 11 | 61 | 739 | 1984 | -1246 |
| 21 | 71 | 11 | 61 | 809 | 1995 | -1186 |
| 22 | 70 | 32 | 38 | 879 | 2026 | -1148 |
| 23 | 69 | 10 | 59 | 947 | 2036 | -1089 |
| 24 | 68 | 9 | 58 | 1015 | 2045 | -1030 |
| 25 | 66 | 9 | 58 | 1081 | 2054 | -972 |
| 26 | 65 | 16 | 49 | 1147 | 2070 | -923 |
| 27 | 64 | 19 | 45 | 1211 | 2089 | -878 |
| 28 | 63 | 7 | 56 | 1274 | 2097 | -823 |
| 29 | 62 | 7 | 55 | 1336 | 2104 | -768 |
| 30 | 61 | 7 | 54 | 1397 | 2111 | -713 |
| 31 | 60 | 12 | 48 | 1458 | 2123 | -665 |
| 32 | 59 | 6 | 53 | 1517 | 2129 | -612 |
| 33 | 58 | 6 | 52 | 1575 | 2135 | -560 |
| 34 | 57 | 6 | 52 | 1632 | 2140 | -509 |
| 35 | 56 | 5 | 51 | 1688 | 2146 | -458 |
| 36 | 55 | 7 | 48 | 1743 | 2153 | -410 |
| 37 | 54 | 15 | 39 | 1798 | 2168 | -371 |
| 38 | 53 | 5 | 49 | 1851 | 2173 | -322 |
| 39 | 53 | 4 | 48 | 1903 | 2177 | -274 |
| 40 | 52 | 4 | 47 | 1955 | 2181 | -226 |
| 41 | 51 | 3 | 48 | 2006 | 2189 | -183 |
| 42 | 50 | 4 | 46 | 2056 | 2193 | -137 |
| 43 | 49 | 4 | 45 | 2105 | 2196 | -92 |
| 44 | 48 | 3 | 45 | 2153 | 2200 | -47 |
| 45 | 47 | 3 | 44 | 2201 | 2203 | -2 |
| 46 | 47 | 4 | 43 | 2247 | 2207 | 40 |
| 47 | 46 | 7 | 39 | 2293 | 2214 | 79 |
| 48 | 45 | 3 | 42 | 2338 | 2217 | 121 |
| 49 | 44 | 3 | 42 | 2383 | 2220 | 163 |
| 50 | 44 | 3 | 41 | 2426 | 2232 | 204 |

BC.RT= 109.1833214319

- Cont'd -

X= 0

< CASH FLOW ANALYSIS >

| YR | BNFT | COST | CSFL | AC.BF | AC.CS | AC.CF |
|---|---|---|---|---|---|---|
| 1 | 0 | 910 | -910 | 0 | 910 | -910 |
| 2 | 0 | 22 | -22 | 0 | 932 | -932 |
| 3 | 0 | 58 | -58 | 0 | 990 | -990 |
| 4 | 0 | 127 | -127 | 0 | 1116 | -1116 |
| 5 | 0 | 160 | -160 | 0 | 1276 | -1276 |
| 6 | 0 | 301 | -301 | 0 | 1577 | -1577 |
| 7 | 0 | 243 | -243 | 0 | 1820 | -1820 |
| 8 | 54 | 106 | -52 | 54 | 1926 | -1872 |
| 9 | 59 | 79 | -21 | 113 | 2005 | -1893 |
| 10 | 64 | 102 | -38 | 177 | 2107 | -1931 |
| 11 | 70 | 55 | 15 | 247 | 2162 | -1916 |
| 12 | 98 | 22 | 76 | 344 | 2184 | -1840 |
| 13 | 106 | 23 | 83 | 450 | 2207 | -1757 |
| 14 | 115 | 57 | 58 | 566 | 2264 | -1698 |
| 15 | 125 | 91 | 33 | 690 | 2355 | -1665 |
| 16 | 135 | 38 | 97 | 825 | 2393 | -1568 |
| 17 | 167 | 29 | 138 | 992 | 2422 | -1430 |
| 18 | 178 | 29 | 149 | 1170 | 2451 | -1281 |
| 19 | 186 | 29 | 156 | 1356 | 2481 | -1125 |
| 20 | 192 | 29 | 162 | 1548 | 2510 | -962 |
| 21 | 198 | 29 | 169 | 1746 | 2539 | -794 |
| 22 | 204 | 93 | 112 | 1950 | 2632 | -682 |
| 23 | 211 | 29 | 182 | 2161 | 2662 | -500 |
| 24 | 218 | 29 | 189 | 2379 | 2691 | -312 |
| 25 | 225 | 29 | 196 | 2604 | 2721 | -116 |
| 26 | 232 | 58 | 174 | 2837 | 2779 | 58 |
| 27 | 240 | 72 | 168 | 3076 | 2850 | 226 |
| 28 | 248 | 29 | 218 | 3324 | 2880 | 444 |
| 29 | 256 | 29 | 226 | 3580 | 2909 | 671 |
| 30 | 264 | 29 | 235 | 3844 | 2939 | 905 |
| 31 | 273 | 54 | 219 | 4117 | 2992 | 1124 |
| 32 | 281 | 29 | 252 | 4398 | 3022 | 1376 |
| 33 | 291 | 29 | 261 | 4689 | 3051 | 1637 |
| 34 | 300 | 29 | 271 | 4989 | 3081 | 1908 |
| 35 | 310 | 29 | 280 | 5299 | 3110 | 2189 |
| 36 | 320 | 41 | 279 | 5618 | 3151 | 2467 |
| 37 | 330 | 93 | 237 | 5949 | 3244 | 2705 |
| 38 | 341 | 29 | 312 | 6290 | 3273 | 3016 |
| 39 | 352 | 29 | 323 | 6642 | 3303 | 3339 |
| 40 | 364 | 29 | 334 | 7005 | 3332 | 3673 |
| 41 | 375 | 58 | 317 | 7381 | 3390 | 3991 |
| 42 | 388 | 29 | 358 | 7768 | 3420 | 4349 |
| 43 | 400 | 29 | 371 | 8169 | 3449 | 4719 |
| 44 | 413 | 29 | 384 | 8582 | 3478 | 5103 |
| 45 | 427 | 29 | 397 | 9008 | 3508 | 5500 |
| 46 | 440 | 37 | 404 | 9449 | 3545 | 5904 |
| 47 | 455 | 72 | 383 | 9904 | 3616 | 6287 |
| 48 | 470 | 29 | 440 | 10373 | 3646 | 6727 |
| 49 | 485 | 29 | 455 | 10858 | 3675 | 7183 |
| 50 | 501 | 29 | 471 | 11359 | 3705 | 7654 |

BC.RT= 306.6140296644

## 4.3. Water Tariff

Under the average water rate of Rs. 9.0 per thousand gallons a household pays the water bill corresponding to 2% of its monthly income. It is known that a household has the ability to pay for water 4% to 5% of its income. In this regard the rate is not an unduly hard one for the beneficiaries.

The water tariff proposed here is based on this average water rate and is so structured that up to a certain volume of water to be consumed unitary charge is low, and from there on unitary charge progressively goes up in parallel with the rise of water consumption.

As shown in Table C.IV-6, water charge per thousand gallons is Rs. 2 up to two thousand gallons of water to be consumed per month. If monthly water consumption exceeds two thousand gallons, for the third one thousand gallons Rs. 4 are charged. Likewise, for the fourth, fifth and sixth one thousand gallons Rs. 20, Rs. 36 and Rs. 46 are charged. For instance, when a household consumes five thousand gallons of water a month, it shall pay Rs. 64 (= 2 + 2 + 4 + 20 + 36).

This volume-related progressive water tariff is so intended that the notion of water as a basic human need will be met, and at the same time the costs of water supply service will be borne according to the size of income as is clearly evinced in the latter half of Table C.IV-6.

It is to be remembered that the water tariff will be applied only to domestic users.

It is true that the beneficiaries are able to pay the bill under the proposed average water rate of Rs. 9.0/000 gal. in terms of international standard. But, it is also true that the rate is

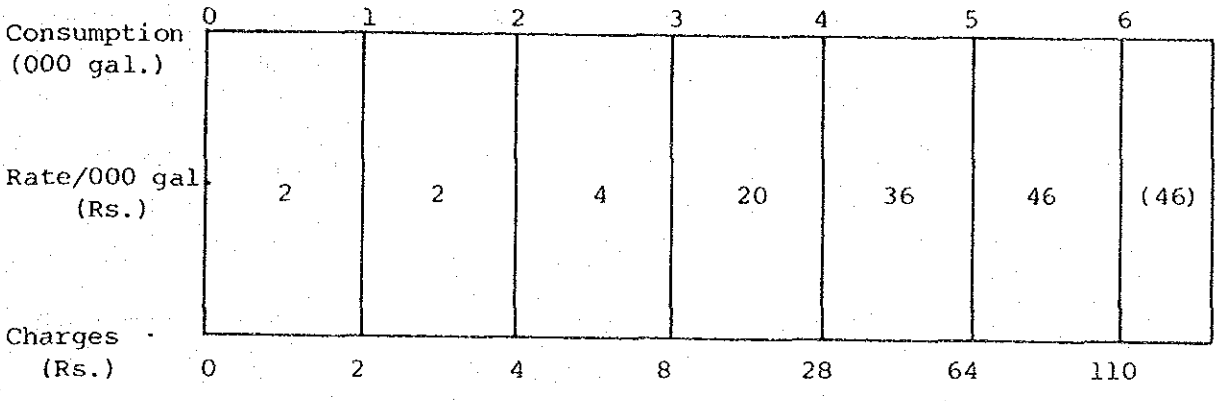
unusually high compared with the prevailing domestic standards. You can bring a horse to a pond, but you cannot force it to drink. However a water rate is theoretically justified, it is of little use if the beneficiaries are opposed to it. In that case, the average water rate will be Rs. 6.49 per thousand gallons since this is the rate they are willing to pay. And the difference of Rs. 2.51 per thousand gallons will be subsidized by the Government. The subsidy will amount to Rs. 67.7 million (= 102.37 mgd x 1,000 x 0.95 x 0.95 x 0.80 x Rs. 2.51 x 365/days/1,000,000) per annum.

The water tariff under the average rate of Rs. 6.49/000 gal. will be structured as shown in Table C.IV-7.

TABLE C.IV-6 PROPOSED WATER TARIFF STRUCTURE

- AVERAGE RATE: Rs. 9.0/000 gal. -

1. Water Tariff Structure



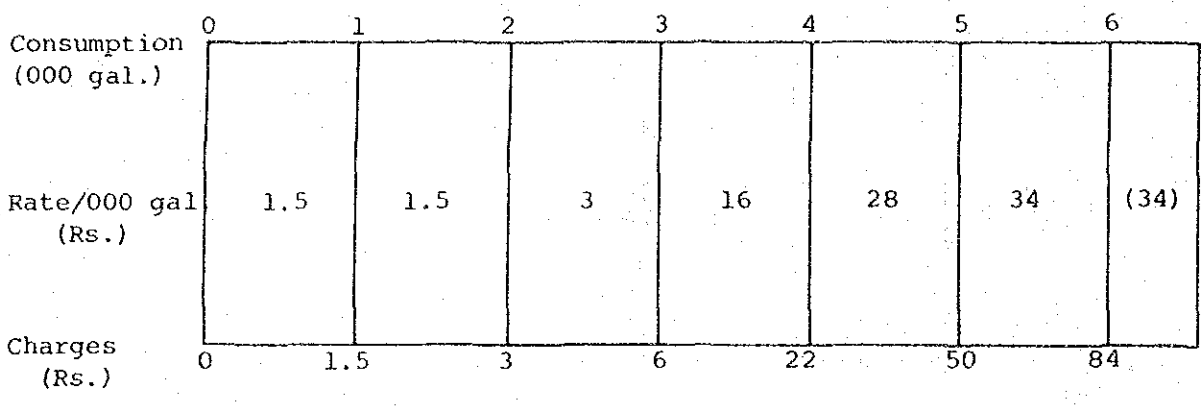

2. Water Charges by Income

| No. | Income (Rs./M) | Share of Household | Water Cons. /M(000 gal.) | Water Charges /M (Rs.) | Water Charge /000 gal.(Rs.) |
|---|---|---|---|---|---|
| 1 | 300 | 4.4 | 2.9 | 7.6 | 2.6 |
| 2 | 750 | 22.3 | 3.6 | 20.0 | 5.6 |
| 3 | 1,500 | 38.0 | 4.1 | 31.6 | 7.7 |
| 4 | 2,500 | 17.9 | 4.3 | 38.8 | 9.0 |
| 5 | 3,500 | 9.8 | 4.8 | 56.8 | 11.8 |
| 6 | 4,500 | 3.5 | 5.1 | 68.6 | 13.5 |
| 7 | 5,270 | 4.1 | 7.1 | 160.1 | 22.5 |
| Ave. | 1,890 | - | 4.2 | 37.6 | 9.0 |

TABLE C.IV-7 PROPOSED WATER TARIFF STRUCTURE

- AVERAGE RATE: Rs. 6.49/000 gal.-

1. Water Tariff Structure




2. Water Charges by Income

| No. | Income (Rs./M) | Share of Household | Water Cons. /M(000 gal.) | Water Charges /M (Rs.) | Water Charges /000 gal.(Rs.) |
|---|---|---|---|---|---|
| 1 | 300 | 4.4 | 2.9 | 5.7 | 2.0 |
| 2 | 750 | 22.3 | 3.6 | 15.6 | 4.3 |
| 3 | 1,500 | 38.0 | 4.1 | 24.8 | 6.0 |
| 4 | 2,500 | 17.9 | 4.3 | 30.4 | 7.1 |
| 5 | 3,500 | 9.8 | 4.8 | 44.4 | 9.3 |
| 6 | 4,500 | 3.5 | 5.1 | 53.4 | 10.5 |
| 7 | 5,270 | 4.1 | 7.1 | 121.4 | 17.1 |
| Ave. | 1,890 | - | 4.2 | 27.3 | 6.5 |

## 4.4. Financial Analysis

Financial analysis is an assessment of the financial situation of an organization directly involved in a project.

Project costs are composed of the costs of raw water, construction, operation/maintenance and replacement, whereas project benefits are water charges receipts. Incremental benefits result by subtracting the former from the latter.

### 4.4.1. Cash Flow Analysis

#### A. Costs

Raw water will be purchased from WAPDA at the rate of Rs. 2.77 per thousand gallons. This rate is necessary to cover the financial costs for the construction and operation maintenance of the Khanpur Dam. (Refer to Table C.IV-8) The volume of water to be supplied will be 51.185 MGD from 1992 to 1995, 76.778 MGD from 1996 to 2000 and 102.370 MGD from 2001 on.

The capital for the construction of Khanpur water conduction facilities will be invested during the construction period of 1985 to 2000. It will be borrowed from external and domestic sources. Lending terms for foreign exchange component will be 5% annual rate of interest and the payback period of thirty 30 years with 10 year grace period. Terms for local currency component will be 11% annual rate of interest and the payback period of 25 years with 5 year grace period.

The proposed lending terms on foreign loans are one of the standard cases for a project in the public sector. The terms on local loans are somewhat soft in that the annual rate of interest is by three points lower than the prevailing rate. They are supposed to be borne by the central government. Financial costs arise in the form of principal and interest to be repaid to the lenders.

The costs for the maintenance and operation of the facilities concerned will arise from 1992 when water will start to be supplied, recurring over the whole period of project life.

Lastly, the capital for the replacement of some equipment in pumping stations and treatment plant will be required during 50 years of project life.

B. Benefits

Benefits are calculated by multiplying the volume of water to be consumed by water rate. The average rate will be Rs. 9.0 per thousand gallons. From 1992 to 1995, 30.4 to 35.9 MGD, from 1996 to 2000, 48.6 to 59.0 MGD and from 2001 on, 70.9 to 73.9 MGD will be consumed. It is assumed that the rates of conveyance, treatment and distribution losses are 5%, 5% and 27 to 20% respectively.

The water rate of Rs. 9.0 per thousand gallons is theoretically appropriate and reasonable since it means that a household will pay water charges corresponding to 2% of its income. But, it cannot be denied that the proposed rate is very high compared with the existing water tariffs and charges. If the rate is difficult to be implemented, and the willingness to pay of Rs. 6.49 is adopted in its stead, the difference of Rs. 2.51 must be covered by subsidies.

C. Cash Flow

The third page of Table C.IV-10 shows the cash flow of the Project over 50 years of project life. It can be observed in the table that for 28 years since the commencement of the Project incremental benefits are negative, but from the 29th year on they are positive and increase as years progress. So far as accumulated incremental benefits are concerned, they continue to be negative until the 37th year. That is to say, the capital recovery period is 36 years.

Further, it is to be observed that at the end of the project life accumulated costs and benefits come to Rs. 17,040 million and Rs. 27,260 million respectively. It means that accumulated incremental benefits are Rs. 10,219 million, and the benefits/costs ratio is 160%.

4.4.2. Financial Analysis

A. Computation of FIRR

The primary objective of this study is to find out the optimum water conduction route from Khanpur to a service reservoir around Tomar. In this sense it is basically different from the ordinary water supply feasibility study, in which the costs of water distribution mains and networks are calculated based on the construction plan and time schedule, along with the costs of water transmission and treatment.

However, if the costs of distribution are not taken into account, discrepancy and imbalance arise between benefits and costs since the former is derived from the water price for end users. Thus, they have ultimately been incorporated in the project costs to calculate FIRR, although they may not be as firmly based as the costs of conduction and treatment. Preliminary estimates of the costs for the construction of distribution facilities are as shown in Table C.IV-12.

At the same time, the water price covering the costs up to service reservoir has been calculated in order to put benefits in a balanced position vis-a-vis "without distribution" costs, and from this approach FIRR has been computed.

FIRR( = financial internal rate of return) is a discount rate (= discount factor) at which the present worth ( = present value) of financial costs equals that of financial benefits. That is to say, when the FIRR value is applied as the discount rate the accumulated incremental benefits in the cash flow table are rendered zero.

As shown in the first page of Table C.IV-10, the value of FIRR for the Khanpur water conduction facilities construction project works out to 6.6%.[1/]

If distribution costs are excluded, and along with it water rate is proportionately cut from Rs. 9.0 to Rs. 6.0 per thousand gallons, the resultant FIRR value is put at 6.9% as shown in the first page of Table C.IV-11.

Generally speaking, a project can be said to be financially viable if the value of FIRR is beyond the annual rate of the opportunity cost of capital. It varies from one country to another, and from one period to another. It can be known from the prevailing annual rate of interest in bank loans. In Pakistan it is now around 14%.

What is to be stressed here is that the ultimate objective of the Project is to supply urban water to the public and industry, and in this sense it is basically different from an undertaking in the private sector.

If "no loss, no profit" principle is to be followed as a public project, theoretically the value of FIRR for the Project should be zero. However, to meet unexpected expenditure in the unforeseen future and to alleviate financial losses in the first half of project life, that is to say, to maintain financial safety and security a certain level of FIRR will be necessitated. It is to be determined side by side with water rate and lending terms on investment capital so as to keep a balance among them. Ultimately it settled down to about half the value of the prevailing bank rate in Pakistan.

Note: 1/ If the payment of interest is not incorporated in the project costs, the value of FIRR works out to 8.2%.

B. B/C Ratio and NPW

FIRR is a discount rate at which benefits to costs ratio is one, and the net present worth is zero as described above. At 0% discount rate B/C ratio is 160% and NPW Rs. 10,219 million as already observed. (The net present worth (= net present value) or NPW (= NPV) is another expression of accumulated incremental benefits).

B/C ratios and NPW at different discount rates falling between 5% and the FIRR value are as shown in the first page of Table C.IV-10.

TABLE C.IV-8 UNITARY CHARGE OF KHANPUR DAM WATER (URBAN)

1. Data & Information Concerned

1) Financial costs for the construction of
the Dam (allocable to urban water supply): Rs.622.332 million
the LBC (allocable to urban water supply): Rs. 95.188 million

| | |
|---|---|
| Total | Rs.717.520 million |
| 2) Interest rate (annual) | : 14% |
| 3) Economic life of the Dam & LBC | : 55 Years |
| 4) Annual O/M costs as percentage of capital costs | :0.5% |

2. Capital Recovery Costs (Annual)

$$\text{Rs. } 717.520 \text{ million} \times \frac{0.14\ (1+0.14)^{55}}{(1+0.14)^{55}-1} = \text{Rs.}100.527 \text{ million}$$

3. Annual O/M Costs

Rs. 622.332 million x 0.005 = 3.112 million

4. Annual Supply of Raw Water

Rs.102.37 MGD x 1000 x 365 = 37,365,050
thousand gal./year

5. Unitary Rate

$$\frac{\text{Rs. } 100,527 \text{ million} + \text{Rs. } 3.112 \text{ million}}{37,365,050 \text{ thousand gal.}}$$

= Rs. 2.77/000 gal. = Rs. 0.61/000 ℓ

Source :based on the study by JICA

TABLE C.IV-9 ABBREVIATION TABLE

- FINANCIAL EVALUATION -

| Abbreviation | Meaning |
|---|---|
| WP | Water Price per Thousand Gal. (Rs.) |
| CCF | Construction Cost, Foreign Exchange Component |
| (Rs.mln) | |
| CCL | Construction Cost, Local Currency Component (Rs.mln) |
| OM | Operations and Maintenance Cost (Rs.mln) |
| MM | Number of Replacement Years |
| RY | Replacement Year |
| RCF | Replacement Cost, Foreign Exchange Component (Rs.mln) |
| RCL | Replacement Cost, Local Currency Component (Rs.mln) |
| I1 | Annual Interest Rate, Foreign Exchange Component |
| PB1 | Payback Period, Foreign Exchange Component (Years) |
| G1 | Grace Period, Foreign Exchange Component (Years) |
| I2 | Annual Interest Rate, Local Currency Component |
| PB2 | Payback Period, Local Currency Component (Years) |
| G2 | Grace Period, Local Currency Component (Years) |
| DC.RT | Discount Rate |
| PW.BF | Present Worth, Benefit (Rs.mln) |
| PW.CW | Present Worth, Raw Water Cost (Rs.mln) |
| PW.CC1 | Present Worth, Construction Cost-Foreign Exchange Component (Rs.mln) |
| PW.CC2 | Present Worth, Construction Cost-Local Currency Component (Rs.mln) |
| PW.CC | Present Worth, Construction Cost (Rs.mln) |
| PW.RC | Present Worth, Replacement Cost (Rs.mln) |
| PW.OM | Present Worth, Operations and Maintenance Cost (Rs.mln) |
| PW.CS | Present Worth, Cost (Rs.mln) |
| PW.NPW | Net Present Worth (Rs.mln) |
| BC.RT | Benefit Cost Ratio (%) |
| X | Discount Rate |
| YR | Year |
| BNFT | Benefit (Rs.mln) |



- Cont'd -

| Abbreviation | Meaning |
|---|---|
| CW | Raw Water Cost (Rs.mln) |
| CC | Construction Cost (Rs.mln) |
| RC | Replacement Cost (Rs.mln) |
| OM | Operations and Maintenance Cost (Rs.mln) |
| COST | Cost (Rs.mln) |
| CSFL | Incremental Benefit (Rs.mln) |
| AC.BF | Accumulated Benefit (Rs.mln) |
| AC.CW | Accumulated Raw Water Cost (Rs.mln) |
| AC.CC | Accumulated Construction Cost (Rs.mln) |
| AC.RC | Accumulated Replacement Cost (Rs.mln) |
| AC.OM | Accumulated Operations and Maintenance Cost (Rs.mln) |
| AC.CS | Accumulated Cost (Rs.mln) |
| AC.CF | Accumulated Incremental Benefit(Rs.mln) |

TABLE C.IV-10 FINANCIAL EVALUATION

[ FINANCIAL EVALUATION ]

< INPUT >

WP= 9

| | | |
|---|---|---|
| CCF 1 = 22.44 | CCL 1 = 10.978 | |
| CCF 2 = 27.26 | CCL 2 = 12.318 | |
| CCF 3 = 29.961 | CCL 3 = 45.109 | |
| CCF 4 = 67.373 | CCL 4 = 110.853 | |
| CCF 5 = 170.672 | CCL 5 = 187.499 | |
| CCF 6 = 305.324 | CCL 6 = 312.866 | |
| CCF 7 = 237.137 | CCL 7 = 264.068 | |
| CCF 8 = 103.059 | CCL 8 = 116.825 | |
| CCF 9 = 67.234 | CCL 9 = 67.206 | |
| CCF 10 = 113.595 | CCL 10 = 118.334 | |
| CCF 11 = 102.449 | CCL 11 = 106.671 | |
| CCF 12 = 35 | CCL 12 = 36 | |
| CCF 13 = 0 | CCL 13 = 0 | |
| CCF 14 = 19.524 | CCL 14 = 18.615 | |
| CCF 15 = 59.351 | CCL 15 = 64.935 | |
| CCF 16 = 40.98 | CCL 16 = 42.171 | |
| CCF 17 = 14.9 | CCL 17 = 15.2 | |

OM 8 = 32.81
OM 9 = 37.371
OM 10 = 42.001
OM 11 = 46.301
OM 12 = 55.796
OM 13 = 57.239
OM 14 = 57.239
OM 15 = 59.339
OM 16 = 61.439
OM 17 = 67.425
OM 18 = 68.19
OM 19 = 68.296

MM= 9

| | | |
|---|---|---|
| RY 1 = 22 | RCF 1 = 0 | RCL 1 = 63.499 |
| RY 2 = 26 | RCF 2 = 0 | RCL 2 = 28.728 |
| RY 3 = 27 | RCF 3 = 0 | RCL 3 = 42.32 |
| RY 4 = 31 | RCF 4 = 0 | RCL 4 = 24.559 |
| RY 5 = 36 | RCF 5 = 0 | RCL 5 = 11.701 |
| RY 6 = 37 | RCF 6 = 0 | RCL 6 = 63.499 |
| RY 7 = 41 | RCF 7 = 0 | RCL 7 = 28.727 |
| RY 8 = 46 | RCF 8 = 0 | RCL 8 = 7.363 |
| RY 9 = 47 | RCF 9 = 0 | RCL 9 = 42.32 |

| | | |
|---|---|---|
| I1= 0.05 | PB1= 30 | G1= 10 |
| I2= 0.11 | PB2= 25 | G2= 5 |

< FIRR COMPUTATION >

| DC.RT | PW.BF | PW.CW | PW.CC1 | PW.CC2 | PW.CC | PW.RC | PW.OM | PW.CS | NPW | BC.RT |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.050 | 5823 | 1094 | 1032 | 2308 | 3340 | 116 | 752 | 5304 | +519 | 109 |
| 0.060 | 4477 | 876 | 863 | 1911 | 2774 | 81 | 605 | 4337 | +139 | 103 |
| 0.070 | 3492 | 711 | 727 | 1590 | 2318 | 56 | 492 | 3579 | -87 | 97 |



- Cont'd -

X= 0.07

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 2 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 3 | 0 | 0 | 3 | -3 |
| 3 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 6 | 0 | 0 | 6 | -6 |
| 4 | 0 | 0 | 5 | 0 | 0 | 5 | -5 | 0 | 0 | 12 | 0 | 0 | 12 | -12 |
| 5 | 0 | 0 | 11 | 0 | 0 | 11 | -11 | 0 | 0 | 23 | 0 | 0 | 23 | -23 |
| 6 | 0 | 0 | 22 | 0 | 0 | 22 | -22 | 0 | 0 | 45 | 0 | 0 | 45 | -45 |
| 7 | 0 | 0 | 29 | 0 | 0 | 29 | -29 | 0 | 0 | 75 | 0 | 0 | 75 | -75 |
| 8 | 75 | 30 | 36 | 0 | 19 | 85 | -10 | 75 | 30 | 112 | 0 | 19 | 161 | -86 |
| 9 | 76 | 28 | 48 | 0 | 20 | 97 | -20 | 151 | 58 | 160 | 0 | 39 | 258 | -106 |
| 10 | 78 | 26 | 68 | 0 | 21 | 116 | -37 | 230 | 84 | 229 | 0 | 60 | 374 | -144 |
| 11 | 79 | 24 | 98 | 0 | 21 | 145 | -65 | 309 | 109 | 327 | 0 | 82 | 519 | -209 |
| 12 | 104 | 34 | 118 | 0 | 24 | 177 | -73 | 413 | 143 | 445 | 0 | 107 | 697 | -283 |
| 13 | 105 | 32 | 121 | 0 | 23 | 177 | -71 | 519 | 175 | 567 | 0 | 131 | 874 | -354 |
| 14 | 107 | 30 | 120 | 0 | 22 | 172 | -65 | 626 | 205 | 687 | 0 | 153 | 1047 | -420 |
| 15 | 108 | 28 | 125 | 0 | 21 | 175 | -67 | 735 | 234 | 813 | 0 | 175 | 1222 | -487 |
| 16 | 109 | 26 | 130 | 0 | 20 | 177 | -68 | 844 | 260 | 944 | 0 | 195 | 1400 | -555 |
| 17 | 126 | 32 | 128 | 0 | 21 | 182 | -55 | 971 | 293 | 1072 | 0 | 217 | 1582 | -610 |
| 18 | 126 | 30 | 120 | 0 | 20 | 171 | -44 | 1098 | 323 | 1192 | 0 | 237 | 1753 | -655 |
| 19 | 123 | 28 | 114 | 0 | 18 | 161 | -38 | 1221 | 352 | 1306 | 0 | 256 | 1915 | -693 |
| 20 | 118 | 26 | 110 | 0 | 17 | 155 | -36 | 1340 | 379 | 1417 | 0 | 273 | 2070 | -730 |
| 21 | 114 | 24 | 106 | 0 | 16 | 147 | -33 | 1455 | 404 | 1524 | 0 | 290 | 2218 | -763 |
| 22 | 110 | 23 | 99 | 0 | 15 | 138 | -27 | 1565 | 427 | 1623 | 0 | 305 | 2357 | -791 |
| 23 | 106 | 21 | 92 | 0 | 14 | 128 | -22 | 1672 | 449 | 1716 | 0 | 320 | 2486 | -813 |
| 24 | 103 | 20 | 86 | 0 | 13 | 120 | -16 | 1775 | 469 | 1802 | 0 | 333 | 2606 | -830 |
| 25 | 99 | 19 | 80 | 0 | 12 | 112 | -12 | 1875 | 488 | 1883 | 0 | 346 | 2718 | -842 |
| 26 | 96 | 17 | 74 | 0 | 11 | 104 | -8 | 1971 | 506 | 1957 | 0 | 357 | 2822 | -850 |
| 27 | 92 | 16 | 68 | 2 | 10 | 98 | -5 | 2064 | 523 | 2026 | 2 | 368 | 2920 | -856 |
| 28 | 89 | 15 | 62 | 2 | 10 | 90 | +0 | 2153 | 538 | 2088 | 4 | 379 | 3011 | -857 |
| 29 | 86 | 14 | 54 | 1 | 9 | 80 | +5 | 2239 | 553 | 2143 | 6 | 388 | 3091 | -851 |
| 30 | 83 | 13 | 45 | 1 | 8 | 69 | +13 | 2323 | 566 | 2188 | 7 | 397 | 3161 | -838 |
| 31 | 80 | 12 | 33 | 2 | 8 | 57 | +23 | 2403 | 579 | 2222 | 10 | 406 | 3218 | -814 |
| 32 | 77 | 11 | 24 | 3 | 7 | 47 | +30 | 2480 | 591 | 2246 | 13 | 414 | 3265 | -784 |
| 33 | 74 | 11 | 19 | 3 | 7 | 41 | +33 | 2555 | 602 | 2266 | 16 | 421 | 3306 | -751 |
| 34 | 72 | 10 | 16 | 2 | 6 | 36 | +35 | 2627 | 613 | 2282 | 19 | 428 | 3343 | -715 |
| 35 | 69 | 9 | 11 | 2 | 6 | 30 | +39 | 2697 | 622 | 2294 | 22 | 434 | 3373 | -676 |
| 36 | 67 | 9 | 7 | 2 | 5 | 25 | +41 | 2764 | 631 | 2301 | 25 | 440 | 3399 | -634 |
| 37 | 64 | 8 | 5 | 2 | 5 | 21 | +42 | 2829 | 640 | 2306 | 27 | 446 | 3421 | -591 |
| 38 | 62 | 7 | 4 | 2 | 5 | 20 | +42 | 2892 | 648 | 2311 | 30 | 451 | 3441 | -548 |
| 39 | 60 | 7 | 3 | 2 | 4 | 18 | +42 | 2952 | 655 | 2314 | 32 | 456 | 3459 | -506 |
| 40 | 58 | 6 | 1 | 2 | 4 | 15 | +42 | 3010 | 662 | 2316 | 35 | 460 | 3474 | -464 |
| 41 | 56 | 6 | 0 | 2 | 4 | 13 | +42 | 3066 | 668 | 2317 | 37 | 465 | 3488 | -421 |
| 42 | 54 | 6 | 0 | 2 | 3 | 13 | +40 | 3121 | 674 | 2317 | 40 | 469 | 3501 | -380 |
| 43 | 52 | 5 | 0 | 2 | 3 | 12 | +39 | 3173 | 680 | 2318 | 42 | 472 | 3514 | -340 |
| 44 | 50 | 5 | 0 | 2 | 3 | 11 | +38 | 3224 | 685 | 2318 | 45 | 476 | 3526 | -301 |
| 45 | 48 | 4 | 0 | 2 | 3 | 10 | +38 | 3272 | 690 | 2318 | 47 | 479 | 3536 | -263 |
| 46 | 47 | 4 | 0 | 2 | 3 | 10 | +36 | 3319 | 695 | 2318 | 50 | 482 | 3546 | -226 |
| 47 | 45 | 4 | 0 | 1 | 2 | 8 | +36 | 3365 | 699 | 2318 | 51 | 485 | 3555 | -190 |
| 48 | 43 | 4 | 0 | 1 | 2 | 8 | +35 | 3409 | 703 | 2318 | 53 | 488 | 3564 | -155 |
| 49 | 42 | 3 | 0 | 1 | 2 | 7 | +34 | 3451 | 707 | 2318 | 55 | 490 | 3571 | -120 |
| 50 | 40 | 3 | 0 | 1 | 2 | 7 | +33 | 3492 | 711 | 2318 | 56 | 492 | 3579 | -87 |

BC.RT= 97.5691116904

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X= 0

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 2 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 3 | 0 | 0 | 3 | -3 |
| 3 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 7 | 0 | 0 | 7 | -7 |
| 4 | 0 | 0 | 7 | 0 | 0 | 7 | -7 | 0 | 0 | 14 | 0 | 0 | 14 | -14 |
| 5 | 0 | 0 | 15 | 0 | 0 | 15 | -15 | 0 | 0 | 30 | 0 | 0 | 30 | -30 |
| 6 | 0 | 0 | 33 | 0 | 0 | 33 | -33 | 0 | 0 | 64 | 0 | 0 | 64 | -64 |
| 7 | 0 | 0 | 47 | 0 | 0 | 47 | -47 | 0 | 0 | 112 | 0 | 0 | 112 | -112 |
| 8 | 128 | 51 | 62 | 0 | 32 | 147 | -18 | 128 | 51 | 174 | 0 | 32 | 259 | -130 |
| 9 | 141 | 51 | 89 | 0 | 37 | 178 | -37 | 270 | 103 | 264 | 0 | 70 | 438 | -167 |
| 10 | 154 | 51 | 134 | 0 | 42 | 228 | -74 | 424 | 155 | 399 | 0 | 112 | 666 | -242 |
| 11 | 167 | 51 | 207 | 0 | 46 | 305 | -137 | 591 | 207 | 606 | 0 | 158 | 971 | -379 |
| 12 | 234 | 77 | 266 | 0 | 55 | 399 | -165 | 826 | 284 | 872 | 0 | 214 | 1371 | -545 |
| 13 | 254 | 77 | 292 | 0 | 57 | 427 | -172 | 1081 | 362 | 1164 | 0 | 271 | 1798 | -717 |
| 14 | 276 | 77 | 310 | 0 | 57 | 445 | -169 | 1357 | 439 | 1475 | 0 | 328 | 2244 | -886 |
| 15 | 298 | 77 | 346 | 0 | 59 | 483 | -184 | 1656 | 517 | 1822 | 0 | 388 | 2727 | -1071 |
| 16 | 323 | 77 | 385 | 0 | 61 | 524 | -201 | 1979 | 595 | 2208 | 0 | 449 | 3252 | -1273 |
| 17 | 401 | 103 | 404 | 0 | 67 | 575 | -174 | 2380 | 698 | 2612 | 0 | 516 | 3828 | -1447 |
| 18 | 428 | 103 | 407 | 0 | 68 | 579 | -151 | 2808 | 802 | 3020 | 0 | 585 | 4407 | -1598 |
| 19 | 445 | 103 | 412 | 0 | 68 | 584 | -138 | 3254 | 905 | 3432 | 0 | 653 | 4991 | -1737 |
| 20 | 460 | 103 | 429 | 0 | 68 | 601 | -140 | 3714 | 1009 | 3862 | 0 | 721 | 5593 | -1878 |
| 21 | 475 | 103 | 440 | 0 | 68 | 612 | -137 | 4189 | 1112 | 4302 | 0 | 790 | 6205 | -2015 |
| 22 | 490 | 103 | 442 | 0 | 68 | 614 | -123 | 4680 | 1216 | 4745 | 0 | 858 | 6819 | -2139 |
| 23 | 506 | 103 | 439 | 0 | 68 | 610 | -104 | 5187 | 1319 | 5184 | 0 | 926 | 7430 | -2243 |
| 24 | 523 | 103 | 436 | 0 | 68 | 608 | -85 | 5710 | 1423 | 5621 | 0 | 994 | 8039 | -2329 |
| 25 | 540 | 103 | 436 | 0 | 68 | 608 | -68 | 6250 | 1526 | 6057 | 0 | 1063 | 8647 | -2397 |
| 26 | 557 | 103 | 432 | 0 | 68 | 604 | -47 | 6807 | 1630 | 6490 | 0 | 1131 | 9252 | -2444 |
| 27 | 575 | 103 | 427 | 13 | 68 | 612 | -37 | 7383 | 1733 | 6918 | 13 | 1199 | 9865 | -2481 |
| 28 | 594 | 103 | 414 | 13 | 68 | 599 | -5 | 7977 | 1837 | 7332 | 26 | 1268 | 10465 | -2487 |
| 29 | 613 | 103 | 387 | 13 | 68 | 572 | +41 | 8591 | 1940 | 7720 | 40 | 1336 | 11037 | -2446 |
| 30 | 633 | 103 | 344 | 13 | 68 | 529 | +104 | 9225 | 2044 | 8064 | 53 | 1404 | 11567 | -2341 |
| 31 | 654 | 103 | 273 | 19 | 68 | 464 | +189 | 9879 | 2147 | 8338 | 73 | 1472 | 12032 | -2152 |
| 32 | 675 | 103 | 212 | 28 | 68 | 412 | +262 | 10555 | 2251 | 8550 | 101 | 1541 | 12445 | -1889 |
| 33 | 697 | 103 | 183 | 28 | 68 | 383 | +314 | 11252 | 2354 | 8733 | 130 | 1609 | 12828 | -1575 |
| 34 | 720 | 103 | 162 | 28 | 68 | 362 | +357 | 11972 | 2458 | 8896 | 158 | 1677 | 13190 | -1217 |
| 35 | 743 | 103 | 125 | 28 | 68 | 325 | +417 | 12716 | 2561 | 9021 | 187 | 1746 | 13516 | -799 |
| 36 | 767 | 103 | 84 | 33 | 68 | 290 | +477 | 13484 | 2665 | 9106 | 220 | 1814 | 13806 | -322 |
| 37 | 792 | 103 | 63 | 33 | 68 | 268 | +523 | 14276 | 2768 | 9169 | 254 | 1882 | 14075 | +201 |
| 38 | 818 | 103 | 56 | 33 | 68 | 262 | +556 | 15095 | 2872 | 9226 | 288 | 1951 | 14337 | +757 |
| 39 | 845 | 103 | 48 | 33 | 68 | 253 | +591 | 15940 | 2975 | 9274 | 321 | 2019 | 14591 | +1348 |
| 40 | 872 | 103 | 27 | 33 | 68 | 233 | +639 | 16813 | 3079 | 9302 | 355 | 2087 | 14825 | +1987 |
| 41 | 900 | 103 | 13 | 36 | 68 | 221 | +679 | 17713 | 3182 | 9316 | 391 | 2155 | 15046 | +2667 |
| 42 | 930 | 103 | 7 | 49 | 68 | 229 | +700 | 18644 | 3286 | 9323 | 441 | 2224 | 15275 | +3368 |
| 43 | 960 | 103 | 7 | 49 | 68 | 228 | +731 | 19604 | 3389 | 9331 | 490 | 2292 | 15504 | +4100 |
| 44 | 991 | 103 | 6 | 49 | 68 | 227 | +764 | 20596 | 3493 | 9337 | 540 | 2360 | 15732 | +4864 |
| 45 | 1023 | 103 | 2 | 49 | 68 | 224 | +799 | 21619 | 3596 | 9340 | 589 | 2429 | 15956 | +5663 |
| 46 | 1057 | 103 | 0 | 55 | 68 | 228 | +828 | 22677 | 3700 | 9341 | 645 | 2497 | 16184 | +6492 |
| 47 | 1091 | 103 | 0 | 42 | 68 | 214 | +877 | 23768 | 3803 | 9341 | 687 | 2565 | 16398 | +7369 |
| 48 | 1126 | 103 | 0 | 42 | 68 | 214 | +912 | 24895 | 3907 | 9341 | 730 | 2634 | 16612 | +8282 |
| 49 | 1163 | 103 | 0 | 42 | 68 | 214 | +949 | 26059 | 4010 | 9341 | 772 | 2702 | 16826 | +9232 |
| 50 | 1201 | 103 | 0 | 42 | 68 | 214 | +987 | 27260 | 4114 | 9341 | 814 | 2770 | 17040 | +10219 |

BC.RT= 159.972332403

TABLE C.IV-11 FINANCIAL EVALUATION
- EXCL. DISTRIBUTION -

[ FINANCIAL EVALUATION ]

< INPUT >

WP= 6

| | | |
|---|---|---|
| CCF 1 = 22.44 | CCL 1 = 10.978 | |
| CCF 2 = 14.96 | CCL 2 = 7.018 | |
| CCF 3 = 24.661 | CCL 3 = 42.909 | |
| CCF 4 = 52.873 | CCL 4 = 95.653 | |
| CCF 5 = 87.572 | CCL 5 = 101.199 | |
| CCF 6 = 175.524 | CCL 6 = 198.766 | |
| CCF 7 = 153.337 | CCL 7 = 157.268 | |
| CCF 8 = 65.659 | CCL 8 = 78.425 | |
| CCF 9 = 42.534 | CCL 9 = 42.009 | |
| CCF 10 = 53.995 | CCL 10 = 56.734 | |
| CCF 11 = 24.649 | CCL 11 = 26.271 | |
| CCF 12 = 0 | CCL 12 = 0 | |
| CCF 13 = 0 | CCL 13 = 0 | |
| CCF 14 = 19.524 | CCL 14 = 18.615 | |
| CCF 15 = 35.951 | CCL 15 = 41.035 | |
| CCF 16 = 8.58 | CCL 16 = 8.571 | |
| CCF 17 = 0 | CCL 17 = 0 | |

OM 8 = 10.71
OM 9 = 13.771
OM 10 = 15.301
OM 11 = 15.301
OM 12 = 21.996
OM 13 = 22.739
OM 14 = 22.739
OM 15 = 22.739
OM 16 = 22.739
OM 17 = 28.725
OM 18 = 29.39
OM 19 = 29.39

MM= 9

| | | |
|---|---|---|
| RY 1 = 22 | RCF 1 = 0 | RCL 1 = 63.499 |
| RY 2 = 26 | RCF 2 = 0 | RCL 2 = 28.728 |
| RY 3 = 27 | RCF 3 = 0 | RCL 3 = 42.32 |
| RY 4 = 31 | RCF 4 = 0 | RCL 4 = 24.559 |
| RY 5 = 36 | RCF 5 = 0 | RCL 5 = 11.701 |
| RY 6 = 37 | RCF 6 = 0 | RCL 6 = 63.499 |
| RY 7 = 41 | RCF 7 = 0 | RCL 7 = 28.727 |
| RY 8 = 46 | RCF 8 = 0 | RCL 8 = 7.363 |
| RY 9 = 47 | RCF 9 = 0 | RCL 9 = 42.32 |

| | | |
|---|---|---|
| I1= 0.05 | PB1= 30 | G1= 10 |
| I2= 0.11 | PB2= 25 | G2= 5 |

< FIRR COMPUTATION >

| DC.RT | PW.BF | PW.CW | PW.CC1 | PW.CC2 | PW.CC | PW.RC | PW.OM | PW.CS | NPW | BC.RT |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.050 | 3882 | 1094 | 586 | 1378 | 1965 | 116 | 309 | 3486 | +396 | 111 |
| 0.060 | 2985 | 876 | 493 | 1147 | 1641 | 81 | 247 | 2846 | +138 | 104 |
| 0.070 | 2328 | 711 | 417 | 960 | 1378 | 56 | 200 | 2346 | -18 | 99 |

- Cont'd -

X= 0.07

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 2 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 2 | 0 | 0 | 2 | -2 |
| 3 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 5 | 0 | 0 | 5 | -5 |
| 4 | 0 | 0 | 4 | 0 | 0 | 4 | -4 | 0 | 0 | 9 | 0 | 0 | 9 | -9 |
| 5 | 0 | 0 | 7 | 0 | 0 | 7 | -7 | 0 | 0 | 16 | 0 | 0 | 16 | -16 |
| 6 | 0 | 0 | 14 | 0 | 0 | 14 | -14 | 0 | 0 | 30 | 0 | 0 | 30 | -30 |
| 7 | 0 | 0 | 18 | 0 | 0 | 18 | -18 | 0 | 0 | 49 | 0 | 0 | 49 | -49 |
| 8 | 50 | 30 | 24 | 0 | 6 | 61 | -11 | 50 | 30 | 74 | 0 | 6 | 111 | -61 |
| 9 | 51 | 28 | 35 | 0 | 7 | 71 | -19 | 101 | 58 | 110 | 0 | 13 | 182 | -80 |
| 10 | 52 | 26 | 45 | 0 | 7 | 79 | -27 | 153 | 84 | 155 | 0 | 21 | 261 | -108 |
| 11 | 53 | 24 | 63 | 0 | 7 | 95 | -42 | 206 | 109 | 219 | 0 | 28 | 356 | -150 |
| 12 | 69 | 34 | 74 | 0 | 9 | 118 | -49 | 275 | 143 | 293 | 0 | 38 | 475 | -199 |
| 13 | 70 | 32 | 76 | 0 | 9 | 118 | -48 | 346 | 175 | 370 | 0 | 47 | 594 | -247 |
| 14 | 71 | 30 | 76 | 0 | 8 | 115 | -44 | 417 | 205 | 447 | 0 | 56 | 709 | -291 |
| 15 | 72 | 28 | 78 | 0 | 8 | 114 | -42 | 490 | 234 | 525 | 0 | 65 | 824 | -334 |
| 16 | 73 | 26 | 77 | 0 | 7 | 111 | -38 | 563 | 260 | 602 | 0 | 72 | 936 | -373 |
| 17 | 84 | 32 | 74 | 0 | 9 | 116 | -32 | 647 | 293 | 677 | 0 | 81 | 1052 | -405 |
| 18 | 84 | 30 | 70 | 0 | 8 | 109 | -25 | 732 | 323 | 748 | 0 | 90 | 1162 | -430 |
| 19 | 82 | 28 | 67 | 0 | 8 | 103 | -21 | 814 | 352 | 815 | 0 | 98 | 1266 | -452 |
| 20 | 79 | 26 | 65 | 0 | 7 | 99 | -20 | 893 | 379 | 881 | 0 | 106 | 1366 | -472 |
| 21 | 76 | 24 | 61 | 0 | 7 | 93 | -16 | 970 | 404 | 942 | 0 | 113 | 1459 | -489 |
| 22 | 73 | 23 | 56 | 0 | 6 | 86 | -13 | 1043 | 427 | 999 | 0 | 119 | 1546 | -502 |
| 23 | 71 | 21 | 52 | 0 | 6 | 80 | -9 | 1115 | 449 | 1052 | 0 | 126 | 1627 | -512 |
| 24 | 68 | 20 | 49 | 0 | 5 | 75 | -6 | 1183 | 469 | 1101 | 0 | 131 | 1703 | -519 |
| 25 | 66 | 19 | 46 | 0 | 5 | 70 | -4 | 1250 | 488 | 1147 | 0 | 137 | 1773 | -523 |
| 26 | 64 | 17 | 42 | 0 | 5 | 65 | -1 | 1314 | 506 | 1189 | 0 | 142 | 1838 | -524 |
| 27 | 61 | 16 | 39 | 2 | 4 | 62 | +0 | 1376 | 523 | 1228 | 2 | 147 | 1901 | -525 |
| 28 | 59 | 15 | 34 | 2 | 4 | 56 | +2 | 1435 | 538 | 1263 | 4 | 151 | 1958 | -522 |
| 29 | 57 | 14 | 29 | 1 | 4 | 49 | +7 | 1493 | 553 | 1293 | 6 | 155 | 2008 | -515 |
| 30 | 55 | 13 | 24 | 1 | 3 | 43 | +11 | 1548 | 566 | 1317 | 7 | 159 | 2051 | -503 |
| 31 | 53 | 12 | 17 | 2 | 3 | 35 | +17 | 1602 | 579 | 1334 | 10 | 163 | 2087 | -485 |
| 32 | 51 | 11 | 12 | 3 | 3 | 30 | +21 | 1653 | 591 | 1346 | 13 | 166 | 2118 | -464 |
| 33 | 49 | 11 | 9 | 3 | 3 | 26 | +23 | 1703 | 602 | 1355 | 16 | 169 | 2144 | -441 |
| 34 | 48 | 10 | 7 | 2 | 2 | 23 | +24 | 1751 | 613 | 1363 | 19 | 172 | 2168 | -416 |
| 35 | 46 | 9 | 5 | 2 | 2 | 20 | +26 | 1798 | 622 | 1368 | 22 | 175 | 2188 | -390 |
| 36 | 44 | 9 | 3 | 2 | 2 | 17 | +26 | 1843 | 631 | 1371 | 25 | 177 | 2206 | -363 |
| 37 | 43 | 8 | 2 | 2 | 2 | 16 | +27 | 1886 | 640 | 1373 | 27 | 180 | 2222 | -335 |
| 38 | 41 | 7 | 1 | 2 | 2 | 14 | +27 | 1928 | 648 | 1375 | 30 | 182 | 2236 | -308 |
| 39 | 40 | 7 | 1 | 2 | 2 | 13 | +27 | 1968 | 655 | 1377 | 32 | 184 | 2250 | -281 |
| 40 | 38 | 6 | 0 | 2 | 1 | 11 | +27 | 2007 | 662 | 1377 | 35 | 186 | 2261 | -254 |
| 41 | 37 | 6 | 0 | 2 | 1 | 10 | +26 | 2044 | 668 | 1377 | 37 | 188 | 2272 | -227 |
| 42 | 36 | 6 | 0 | 2 | 1 | 10 | +25 | 2080 | 674 | 1378 | 40 | 190 | 2283 | -202 |
| 43 | 34 | 5 | 0 | 2 | 1 | 10 | +24 | 2115 | 680 | 1378 | 42 | 191 | 2293 | -177 |
| 44 | 33 | 5 | 0 | 2 | 1 | 9 | +24 | 2149 | 685 | 1378 | 45 | 193 | 2303 | -153 |
| 45 | 32 | 4 | 0 | 2 | 1 | 8 | +23 | 2181 | 690 | 1378 | 47 | 194 | 2311 | -129 |
| 46 | 31 | 4 | 0 | 2 | 1 | 8 | +22 | 2213 | 695 | 1378 | 50 | 196 | 2320 | -106 |
| 47 | 30 | 4 | 0 | 1 | 1 | 7 | +22 | 2243 | 699 | 1378 | 51 | 197 | 2327 | -83 |
| 48 | 29 | 4 | 0 | 1 | 1 | 6 | +22 | 2272 | 703 | 1378 | 53 | 198 | 2334 | -61 |
| 49 | 28 | 3 | 0 | 1 | 1 | 6 | +21 | 2300 | 707 | 1378 | 55 | 199 | 2340 | -39 |
| 50 | 27 | 3 | 0 | 1 | 0 | 5 | +21 | 2328 | 711 | 1378 | 56 | 200 | 2346 | -18 |

BC.RT= 99.2153295487

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X= 0

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 2 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 2 | 0 | 0 | 2 | -2 |
| 3 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 6 | 0 | 0 | 6 | -6 |
| 4 | 0 | 0 | 5 | 0 | 0 | 5 | -5 | 0 | 0 | 11 | 0 | 0 | 11 | -11 |
| 5 | 0 | 0 | 10 | 0 | 0 | 10 | -10 | 0 | 0 | 21 | 0 | 0 | 21 | -21 |
| 6 | 0 | 0 | 21 | 0 | 0 | 21 | -21 | 0 | 0 | 43 | 0 | 0 | 43 | -43 |
| 7 | 0 | 0 | 30 | 0 | 0 | 30 | -30 | 0 | 0 | 73 | 0 | 0 | 73 | -73 |
| 8 | 85 | 51 | 42 | 0 | 10 | 105 | -19 | 85 | 51 | 116 | 0 | 10 | 178 | -92 |
| 9 | 94 | 51 | 65 | 0 | 13 | 130 | -36 | 180 | 103 | 181 | 0 | 24 | 309 | -129 |
| 10 | 102 | 51 | 89 | 0 | 15 | 156 | -53 | 282 | 155 | 270 | 0 | 39 | 465 | -182 |
| 11 | 111 | 51 | 133 | 0 | 15 | 200 | -88 | 394 | 207 | 404 | 0 | 55 | 666 | -271 |
| 12 | 156 | 77 | 167 | 0 | 21 | 267 | -110 | 550 | 284 | 571 | 0 | 77 | 933 | -382 |
| 13 | 169 | 77 | 185 | 0 | 22 | 285 | -115 | 720 | 362 | 757 | 0 | 99 | 1219 | -498 |
| 14 | 184 | 77 | 197 | 0 | 22 | 298 | -114 | 904 | 439 | 954 | 0 | 122 | 1517 | -612 |
| 15 | 199 | 77 | 215 | 0 | 22 | 315 | -116 | 1104 | 517 | 1170 | 0 | 145 | 1833 | -729 |
| 16 | 215 | 77 | 229 | 0 | 22 | 330 | -114 | 1319 | 595 | 1400 | 0 | 168 | 2163 | -843 |
| 17 | 267 | 103 | 236 | 0 | 28 | 368 | -101 | 1587 | 698 | 1636 | 0 | 196 | 2532 | -945 |
| 18 | 285 | 103 | 238 | 0 | 29 | 371 | -85 | 1872 | 802 | 1875 | 0 | 226 | 2903 | -1031 |
| 19 | 297 | 103 | 243 | 0 | 29 | 375 | -78 | 2169 | 905 | 2118 | 0 | 255 | 3279 | -1110 |
| 20 | 306 | 103 | 252 | 0 | 29 | 385 | -78 | 2476 | 1009 | 2371 | 0 | 284 | 3665 | -1188 |
| 21 | 316 | 103 | 254 | 0 | 29 | 387 | -70 | 2793 | 1112 | 2625 | 0 | 314 | 4052 | -1259 |
| 22 | 327 | 103 | 252 | 0 | 29 | 385 | -58 | 3120 | 1216 | 2877 | 0 | 343 | 4437 | -1317 |
| 23 | 337 | 103 | 250 | 0 | 29 | 383 | -45 | 3458 | 1319 | 3128 | 0 | 373 | 4821 | -1363 |
| 24 | 348 | 103 | 249 | 0 | 29 | 382 | -33 | 3806 | 1423 | 3378 | 0 | 402 | 5203 | -1397 |
| 25 | 360 | 103 | 249 | 0 | 29 | 382 | -22 | 4166 | 1526 | 3628 | 0 | 431 | 5586 | -1419 |
| 26 | 371 | 103 | 245 | 0 | 29 | 378 | -7 | 4538 | 1630 | 3873 | 0 | 461 | 5965 | -1426 |
| 27 | 383 | 103 | 242 | 13 | 29 | 388 | -4 | 4922 | 1733 | 4116 | 13 | 490 | 6354 | -1431 |
| 28 | 396 | 103 | 231 | 13 | 29 | 377 | +18 | 5318 | 1837 | 4347 | 26 | 520 | 6731 | -1413 |
| 29 | 409 | 103 | 209 | 13 | 29 | 355 | +53 | 5727 | 1940 | 4557 | 40 | 549 | 7087 | -1359 |
| 30 | 422 | 103 | 185 | 13 | 29 | 332 | +90 | 6150 | 2044 | 4742 | 53 | 578 | 7419 | -1269 |
| 31 | 436 | 103 | 140 | 19 | 29 | 293 | +143 | 6586 | 2147 | 4883 | 73 | 608 | 7712 | -1126 |
| 32 | 450 | 103 | 104 | 28 | 29 | 266 | +184 | 7036 | 2251 | 4988 | 101 | 637 | 7978 | -942 |
| 33 | 465 | 103 | 85 | 28 | 29 | 246 | +218 | 7501 | 2354 | 5073 | 130 | 667 | 8225 | -723 |
| 34 | 480 | 103 | 71 | 28 | 29 | 233 | +246 | 7981 | 2458 | 5145 | 158 | 696 | 8458 | -476 |
| 35 | 495 | 103 | 53 | 28 | 29 | 215 | +280 | 8477 | 2561 | 5199 | 187 | 725 | 8673 | -195 |
| 36 | 511 | 103 | 37 | 33 | 29 | 204 | +307 | 8989 | 2665 | 5237 | 220 | 755 | 8878 | +111 |
| 37 | 528 | 103 | 29 | 33 | 29 | 195 | +332 | 9517 | 2768 | 5266 | 254 | 784 | 9074 | +443 |
| 38 | 545 | 103 | 25 | 33 | 29 | 191 | +353 | 10063 | 2872 | 5291 | 288 | 813 | 9265 | +797 |
| 39 | 563 | 103 | 18 | 33 | 29 | 185 | +377 | 10627 | 2975 | 5310 | 321 | 843 | 9451 | +1175 |
| 40 | 581 | 103 | 7 | 33 | 29 | 173 | +408 | 11208 | 3079 | 5317 | 355 | 872 | 9624 | +1583 |
| 41 | 600 | 103 | 3 | 36 | 29 | 172 | +427 | 11809 | 3182 | 5321 | 391 | 902 | 9797 | +2011 |
| 42 | 620 | 103 | 3 | 49 | 29 | 186 | +433 | 12429 | 3286 | 5325 | 441 | 931 | 9983 | +2445 |
| 43 | 640 | 103 | 3 | 49 | 29 | 185 | +454 | 13069 | 3389 | 5328 | 490 | 960 | 10169 | +2899 |
| 44 | 661 | 103 | 2 | 49 | 29 | 184 | +476 | 13730 | 3493 | 5330 | 540 | 990 | 10354 | +3376 |
| 45 | 682 | 103 | 0 | 49 | 29 | 182 | +499 | 14413 | 3596 | 5331 | 589 | 1019 | 10537 | +3875 |
| 46 | 704 | 103 | 0 | 55 | 29 | 188 | +516 | 15118 | 3700 | 5331 | 645 | 1049 | 10726 | +4391 |
| 47 | 727 | 103 | 0 | 42 | 29 | 175 | +552 | 15845 | 3803 | 5331 | 687 | 1078 | 10901 | +4944 |
| 48 | 751 | 103 | 0 | 42 | 29 | 175 | +576 | 16597 | 3907 | 5331 | 730 | 1107 | 11076 | +5520 |
| 49 | 775 | 103 | 0 | 42 | 29 | 175 | +600 | 17372 | 4010 | 5331 | 772 | 1137 | 11251 | +6121 |
| 50 | 800 | 103 | 0 | 42 | 29 | 175 | +625 | 18173 | 4114 | 5331 | 814 | 1166 | 11426 | +6747 |

BC.RT= 159.04643745

## 4.5. Sensitivity Analysis

### 4.5.1. Sensitivity Analysis in Economic Evaluation

Sensitivity analysis has been conducted to see how the value of EIRR is affected if conditions and premises under which it is computed are changed. This is necessary because a project is a future undertaking and there are inevitably a lot of uncertainties in the future.

Firstly, an analysis has been made to observed the effect to EIRR if the completion of the first phase of construction works is delayed. As a result of the analysis it has been found that one year delay lowers EIRR by 0.1% to 6.1%, and 2 year delay brings down the index by 0.2% to 6.0%. This comparatively light negative impact of the delays in tunnel construction will be mainly accounted for by the fact that only 50% of Khanpur urban water will be supplied at the end of Phase I.

The second analysis is to find how it will affect EIRR if an overrun of construction costs occurs. The result reveals that the overrun by 10% reduces EIRR by 0.3% to 5.9%. If it is by 20%, the index goes down by 0.5% to 5.7%. It shows a considerable extent to which EIRR is affected if estimate of construction costs is not proper and exact. But the Study Team is confident that its estimate is correct and firm, and any overrunning will not happen.

The third analysis is based on the supposition that Khanpur water is not sold 100%. Supposing it is demanded by 90%, EIRR is reduced by 0.6% to 5.6%. If only 80% is sold, the feasibility index is further reduced by 1.3% to 4.9%. It testifies to the importance of the study of water demand and supply.

Lastly, an analysis has been performed, supposing the situation where all the negative aspects in the preceding three cases are combined together. One instance is the combination of one year completion delay of Phase I, 10% overrun of construction costs and water sale ratio of 90%. In the next one, two year delay, 20% overrun and water sale of 80% are put together.

Computation resulted in the EIRR value of 5.3% for the first instance, and 4.3% in the second.

If things go bad as in the two instances, the feasibility of the Project will be strongly affected, though not to the extent that it is rendered nil. Besides, it is improbable that things will turn out altogether adverse and negative.

4.5.2. Sensitivity Analysis in Financial Evaluation

Sensitivity analysis from financial standpoint has been made by changing the conditions upon which the value of FIRR is computed.

In the first place, the annual rate of interest on local currency component is presupposed to be a full 14%. As regard other factors in the lending terms and the average water rate, they are unchanged.

As a result of the analysis it has been discovered that under the lending terms of 14% annual rate of interest and the repayment period of 25 years with the grace period of 5 years for local component, and 5% annual rate of interest and the repayment period of 30 years with the grace period of 10 years for FEC, and the average water rate of Rs. 9.0 per thousand gallons, the value of FIRR is calculated at 4.1%.

This value itself is not to be argued about. The problem is the cashflow. As shown in the third page of Table C.IV-13 negative

incremental benefits exceeding Rs. 200 million appear consecutively for 13 years. It cannot but put financial strains on the water supply organization.

The objective of the second analysis is to find out the water rate that will produce the FIRR value of 6% to 7% under the same lending terms as in the first case. The result is that water rate of Rs. 10.5 per thousand gallons produces the FIRR of 6.5%. In other words, if the terms on local component is not attenuated, the beneficiaries will have to pay Rs. 1.5 more to make up for it.

In the third case, under the given water rate of Rs. 8.0, the interest rates on both components that will produce the FIRR of 6% to 7% have been sought. It has been found that under the water rate of Rs. 8.0 per thousand gallons, and the lending terms of 4% annual rate of interest and the payback period of 30 years with the grace period of 10 years for foreign exchange component, and 9% annual rate of interest and the payback period of 25 years with the grace period of 5 years for the local currency component, the value of EIRR is calculated at 6.8%. That is to say, if the water rate is cut by Rs. 1, interest rates on foreign exchange and local currency portions shall be cut by 1% and 2% respectively to retain the value of FIRR.

Lastly, it is clarified that if the water rate is further cut down to Rs. 6.5, interest rates on FC and LC must be lowered to 1% and 7% respectively to have the FIRR value of 6.6%.

TABLE C.IV-12 DISBURSEMENT SCHEDULE FOR DISTRIBUTION SYSTEM

(Unit: Rs.Million)

| | TOTAL | | | 1986 | | | 1987 | | | 1988 | | | 1989 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total |
| Pump | 28.2 | 28.4 | 56.6 | - | - | - | - | - | - | - | - | - | - | - | - |
| Trunk Main | 134.5 | 140.2 | 274.7 | - | - | - | - | - | - | 14.5 | 15.2 | 29.7 | 29.0 | 30.3 | 59.3 |
| Primary Main | 100.1 | 105.1 | 205.2 | - | - | - | - | - | - | - | - | - | 16.7 | 17.6 | 34.3 |
| Second/Tertiary Pipes | 353.6 | 363.0 | 716.6 | - | - | - | - | - | - | - | - | - | 37.4 | 38.4 | 75.8 |
| Total | 634.0 | 644.2 | 1,278.2 | 12.3 | 5.3 | 17.6 | 5.3 | 2.2 | 7.5 | 14.5 | 15.2 | 29.7 | 83.1 | 86.3 | 169.4 |

| | 1990 | | | 1991 | | | 1992 | | | 1993 | | | 1994 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total |
| Pump | 22.6 | 2.8 | 25.4 | 5.6 | 25.6 | 31.2 | - | - | - | - | - | - | - | - | - |
| Trunk Main | 29.0 | 30.3 | 59.3 | 24.1 | 25.2 | 49.3 | - | - | - | 5.7 | 5.9 | 11.6 | 11.5 | 11.9 | 23.4 |
| Primary Main | 22.0 | 23.3 | 45.3 | 16.7 | 17.6 | 34.3 | - | - | - | - | - | - | 13.1 | 13.7 | 26.8 |
| Second/Tertiary Pipes | 56.2 | 57.7 | 113.9 | 37.4 | 38.4 | 75.8 | 37.4 | 38.4 | 75.8 | 19.0 | 19.3 | 38.3 | 35.0 | 36.0 | 71.0 |
| Total | 129.8 | 114.1 | 243.9 | 83.8 | 106.8 | 190.6 | 37.4 | 38.4 | 75.8 | 24.7 | 25.2 | 49.9 | 59.6 | 61.6 | 121.2 |

| | 1995 | | | 1996 | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total | F.C. | L.C. | Total |
| Pump | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Trunk Main | 11.5 | 11.8 | 23.3 | - | - | - | 3.7 | 3.8 | 7.5 | 5.5 | 5.8 | 11.3 | - | - | - |
| Primary Main | 19.6 | 20.6 | 40.2 | - | - | - | 4.8 | 4.9 | 9.7 | 7.2 | 7.4 | 14.6 | - | - | - |
| Second/Tertiary Pipes | 46.7 | 48.0 | 94.7 | 35.0 | 36.0 | 71.0 | 14.9 | 15.2 | 30.1 | 19.7 | 20.4 | 40.1 | 14.9 | 15.2 | 30.1 |
| Total | 77.8 | 80.4 | 158.2 | 35.0 | 36.0 | 71.0 | 23.4 | 23.9 | 47.3 | 32.4 | 33.6 | 66.0 | 14.9 | 13.2 | 30.1 |

TABLE C.IV-13 SENSITIVITY ANALYSIS - ECONOMIC EVALUATION

1. Completion Delay of Phase I

A. One Year Delay

121 KW(1)=0

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.010 | 13903 | 5441 | 8462 | 256 |
| 0.020 | 10034 | 4719 | 5315 | 213 |
| 0.030 | 7355 | 4169 | 3186 | 176 |
| 0.040 | 5475 | 3741 | 1734 | 146 |
| 0.050 | 4136 | 3401 | 735 | 122 |
| 0.060 | 3171 | 3126 | 44 | 101 |
| 0.070 | 2464 | 2900 | -436 | 85 |

B. Two Year Delay

121 KW(1)=0:KW(2)=0

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.010 | 13810 | 5441 | 8369 | 254 |
| 0.020 | 9949 | 4719 | 5230 | 211 |
| 0.030 | 7277 | 4169 | 3108 | 175 |
| 0.040 | 5403 | 3741 | 1662 | 144 |
| 0.050 | 4071 | 3401 | 670 | 120 |
| 0.060 | 3110 | 3126 | -16 | 99 |

2. Overrun of Construction Costs

A. Ten Percent

1260 COST=K+1.1*SC+SR+OM

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.010 | 13989 | 5668 | 8321 | 247 |
| 0.020 | 10114 | 4930 | 5184 | 205 |
| 0.030 | 7429 | 4365 | 3064 | 170 |
| 0.040 | 5543 | 3924 | 1619 | 141 |
| 0.050 | 4199 | 3572 | 628 | 118 |
| 0.060 | 3229 | 3286 | -57 | 98 |

B. Twenty Percent

1260 COST=K+1.2*SC+SR+OM

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.010 | 13989 | 5895 | 8094 | 237 |
| 0.020 | 10114 | 5141 | 4973 | 197 |
| 0.030 | 7429 | 4561 | 2868 | 163 |
| 0.040 | 5543 | 4107 | 1436 | 135 |
| 0.050 | 4199 | 3742 | 457 | 112 |
| 0.060 | 3229 | 3445 | -216 | 94 |

- Cont'd -

3. Demand Shortage

A. Ten Percent

```
1030 BENEFIT=(SBR1+SBR2)*0.9
```

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.010 | 12590 | 5441 | 7149 | 231 |
| 0.020 | 9102 | 4719 | 4383 | 193 |
| 0.030 | 6686 | 4169 | 2517 | 160 |
| 0.040 | 4989 | 3741 | 1247 | 133 |
| 0.050 | 3779 | 3401 | 378 | 111 |
| 0.060 | 2906 | 3126 | -220 | 93 |

B. Twenty Percent

```
1030 BENEFIT=(SBR1+SBR2)*0.8
```

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.010 | 11191 | 5441 | 5750 | 206 |
| 0.020 | 8091 | 4719 | 3372 | 171 |
| 0.030 | 5943 | 4169 | 1774 | 143 |
| 0.040 | 4434 | 3741 | 693 | 119 |
| 0.050 | 3360 | 3401 | -42 | 99 |

4. Combination of 1., 2. and 3.

A, 1.A., 2.A. and 3.A.

```
 121 KW(1)=0
1260 COST=K+1.1*SC+SR+OM
1030 BENEFIT=(SBR1+SBR2)*0.9
```

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.010 | 12513 | 5668 | 6844 | 221 |
| 0.020 | 9031 | 4930 | 4101 | 183 |
| 0.030 | 6620 | 4365 | 2255 | 152 |
| 0.040 | 4927 | 3924 | 1004 | 126 |
| 0.050 | 3723 | 3572 | 151 | 104 |
| 0.060 | 2854 | 3286 | -432 | 87 |

B. 1.B., 2.B. and 3.B.

```
 121 KW(1)=0:KW(2)=0
1260 COST=K+1.2*SC+SR+OM
1030 BENEFIT=(SBR1+SBR2)*0.8
```

< IRR COMPUTATION >

| DC.RT | PW.BF | PW.CS | NPW | BC.RT |
|---|---|---|---|---|
| 0.010 | 11048 | 5895 | 5153 | 187 |
| 0.020 | 7959 | 5141 | 2819 | 155 |
| 0.030 | 5822 | 4561 | 1261 | 128 |
| 0.040 | 4323 | 4107 | 216 | 105 |
| 0.050 | 3257 | 3742 | -486 | 87 |

TABLE C.IV-14 SENSITIVITY ANALYSIS-FINANCIAL EVALUATION

1. WP = Rs.9.0, I1 = 5%, I2 = 14%

[ FINANCIAL EVALUATION ]

< INPUT >

WP= 9

| | | | | | |
|---|---|---|---|---|---|
| CCF | 1 = 22.44 | CCL | 1 = 10.978 | | |
| CCF | 2 = 27.26 | CCL | 2 = 12.318 | | |
| CCF | 3 = 29.961 | CCL | 3 = 45.109 | | |
| CCF | 4 = 67.373 | CCL | 4 = 110.853 | | |
| CCF | 5 = 170.672 | CCL | 5 = 187.499 | | |
| CCF | 6 = 305.324 | CCL | 6 = 312.866 | | |
| CCF | 7 = 237.137 | CCL | 7 = 264.068 | | |
| CCF | 8 = 103.059 | CCL | 8 = 116.825 | | |
| CCF | 9 = 67.234 | CCL | 9 = 67.206 | | |
| CCF | 10 = 113.595 | CCL | 10 = 118.334 | | |
| CCF | 11 = 102.449 | CCL | 11 = 106.671 | | |
| CCF | 12 = 35 | CCL | 12 = 36 | | |
| CCF | 13 = 0 | CCL | 13 = 0 | | |
| CCF | 14 = 19.524 | CCL | 14 = 18.615 | | |
| CCF | 15 = 59.351 | CCL | 15 = 64.935 | | |
| CCF | 16 = 40.98 | CCL | 16 = 42.171 | | |
| CCF | 17 = 14.9 | CCL | 17 = 15.2 | | |

OM 8 = 32.81
OM 9 = 37.371
OM 10 = 42.001
OM 11 = 46.301
OM 12 = 55.796
OM 13 = 57.239
OM 14 = 57.239
OM 15 = 59.339
OM 16 = 61.439
OM 17 = 67.425
OM 18 = 68.19
OM 19 = 68.296

MM= 9

| | | | | | |
|---|---|---|---|---|---|
| RY | 1 = 22 | RCF | 1 = 0 | RCL | 1 = 63.499 |
| RY | 2 = 26 | RCF | 2 = 0 | RCL | 2 = 28.728 |
| RY | 3 = 27 | RCF | 3 = 0 | RCL | 3 = 42.32 |
| RY | 4 = 31 | RCF | 4 = 0 | RCL | 4 = 24.559 |
| RY | 5 = 36 | RCF | 5 = 0 | RCL | 5 = 11.701 |
| RY | 6 = 37 | RCF | 6 = 0 | RCL | 6 = 63.499 |
| RY | 7 = 41 | RCF | 7 = 0 | RCL | 7 = 28.727 |
| RY | 8 = 46 | RCF | 8 = 0 | RCL | 8 = 7.363 |
| RY | 9 = 47 | RCF | 9 = 0 | RCL | 9 = 42.32 |

| | | |
|---|---|---|
| I1= 0.05 | PB1= 30 | G1= 10 |
| I2= 0.14 | PB2= 25 | G2= 5 |

< FIRR COMPUTATION >

| DC.RT | PW.BF | PW.CW | PW.CC1 | PW.CC2 | PW.CC | PW.RC | PW.OM | PW.CS | NPW | BC.RT |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.030 | 10301 | 1776 | 1513 | 4703 | 6216 | 341 | 1210 | 9544 | +757 | 107 |
| 0.040 | 7686 | 1384 | 1244 | 3850 | 5095 | 233 | 947 | 7660 | +25 | 100 |
| 0.050 | 5823 | 1094 | 1032 | 3170 | 4203 | 160 | 752 | 6211 | -387 | 93 |



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X= 0.04

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC. BF | AC. CW | AC. CC | AC. RC | AC. OM | AC. CS | AC. CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 2 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 3 | 0 | 0 | 3 | -3 |
| 3 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 6 | 0 | 0 | 6 | -6 |
| 4 | 0 | 0 | 6 | 0 | 0 | 6 | -6 | 0 | 0 | 13 | 0 | 0 | 13 | -13 |
| 5 | 0 | 0 | 13 | 0 | 0 | 13 | -13 | 0 | 0 | 26 | 0 | 0 | 26 | -26 |
| 6 | 0 | 0 | 27 | 0 | 0 | 27 | -27 | 0 | 0 | 53 | 0 | 0 | 53 | -53 |
| 7 | 0 | 0 | 37 | 0 | 0 | 37 | -37 | 0 | 0 | 91 | 0 | 0 | 91 | -91 |
| 8 | 94 | 37 | 49 | 0 | 23 | 111 | -17 | 94 | 37 | 140 | 0 | 23 | 202 | -108 |
| 9 | 99 | 36 | 72 | 0 | 26 | 135 | -36 | 193 | 74 | 213 | 0 | 50 | 338 | -144 |
| 10 | 104 | 34 | 110 | 0 | 28 | 174 | -69 | 297 | 109 | 324 | 0 | 78 | 512 | -214 |
| 11 | 108 | 33 | 169 | 0 | 30 | 233 | -124 | 406 | 142 | 493 | 0 | 108 | 745 | -338 |
| 12 | 146 | 48 | 212 | 0 | 34 | 296 | -149 | 552 | 191 | 706 | 0 | 143 | 1041 | -488 |
| 13 | 153 | 46 | 225 | 0 | 34 | 306 | -153 | 705 | 237 | 932 | 0 | 177 | 1348 | -642 |
| 14 | 159 | 44 | 230 | 0 | 33 | 308 | -149 | 865 | 282 | 1163 | 0 | 210 | 1657 | -792 |
| 15 | 165 | 43 | 247 | 0 | 32 | 323 | -157 | 1031 | 325 | 1411 | 0 | 243 | 1980 | -949 |
| 16 | 172 | 41 | 263 | 0 | 32 | 337 | -164 | 1203 | 367 | 1674 | 0 | 276 | 2318 | -1114 |
| 17 | 205 | 53 | 264 | 0 | 34 | 351 | -145 | 1409 | 420 | 1938 | 0 | 311 | 2670 | -1260 |
| 18 | 211 | 51 | 255 | 0 | 33 | 340 | -128 | 1621 | 471 | 2193 | 0 | 344 | 3010 | -1388 |
| 19 | 211 | 49 | 248 | 0 | 32 | 330 | -118 | 1832 | 520 | 2442 | 0 | 377 | 3340 | -1507 |
| 20 | 210 | 47 | 249 | 0 | 31 | 327 | -117 | 2042 | 567 | 2691 | 0 | 408 | 3667 | -1625 |
| 21 | 208 | 45 | 245 | 0 | 29 | 321 | -112 | 2251 | 613 | 2937 | 0 | 438 | 3989 | -1737 |
| 22 | 207 | 43 | 237 | 0 | 28 | 310 | -103 | 2458 | 656 | 3175 | 0 | 467 | 4299 | -1840 |
| 23 | 205 | 41 | 227 | 0 | 27 | 296 | -91 | 2663 | 698 | 3402 | 0 | 495 | 4596 | -1932 |
| 24 | 204 | 40 | 217 | 0 | 26 | 284 | -80 | 2867 | 739 | 3619 | 0 | 521 | 4880 | -2013 |
| 25 | 202 | 38 | 209 | 0 | 25 | 273 | -71 | 3070 | 778 | 3829 | 0 | 547 | 5154 | -2084 |
| 26 | 201 | 37 | 199 | 0 | 24 | 261 | -60 | 3271 | 815 | 4028 | 0 | 571 | 5416 | -2144 |
| 27 | 199 | 35 | 189 | 6 | 23 | 255 | -55 | 3471 | 851 | 4218 | 6 | 595 | 5671 | -2200 |
| 28 | 198 | 34 | 176 | 6 | 22 | 240 | -41 | 3669 | 885 | 4395 | 12 | 618 | 5911 | -2242 |
| 29 | 196 | 33 | 158 | 5 | 21 | 219 | -22 | 3866 | 919 | 4553 | 18 | 640 | 6131 | -2265 |
| 30 | 195 | 31 | 134 | 5 | 21 | 193 | +2 | 4061 | 950 | 4688 | 24 | 661 | 6324 | -2262 |
| 31 | 193 | 30 | 100 | 7 | 20 | 159 | +34 | 4255 | 981 | 4789 | 32 | 681 | 6484 | -2228 |
| 32 | 192 | 29 | 73 | 11 | 19 | 133 | +58 | 4448 | 1011 | 4862 | 43 | 701 | 6618 | -2170 |
| 33 | 191 | 28 | 60 | 10 | 18 | 118 | +73 | 4639 | 1039 | 4923 | 53 | 719 | 6736 | -2097 |
| 34 | 189 | 27 | 51 | 10 | 17 | 106 | +83 | 4829 | 1066 | 4974 | 64 | 737 | 6843 | -2014 |
| 35 | 188 | 26 | 37 | 9 | 17 | 90 | +97 | 5017 | 1093 | 5011 | 74 | 755 | 6934 | -1916 |
| 36 | 187 | 25 | 24 | 11 | 16 | 77 | +109 | 5204 | 1118 | 5035 | 85 | 771 | 7011 | -1806 |
| 37 | 185 | 24 | 17 | 10 | 16 | 68 | +117 | 5390 | 1142 | 5053 | 96 | 787 | 7079 | -1689 |
| 38 | 184 | 23 | 15 | 10 | 15 | 64 | +119 | 5574 | 1165 | 5068 | 106 | 803 | 7144 | -1569 |
| 39 | 183 | 22 | 12 | 10 | 14 | 59 | +123 | 5757 | 1188 | 5081 | 116 | 817 | 7204 | -1446 |
| 40 | 181 | 21 | 6 | 9 | 14 | 52 | +129 | 5939 | 1209 | 5088 | 126 | 832 | 7256 | -1316 |
| 41 | 180 | 20 | 2 | 9 | 13 | 47 | +133 | 6120 | 1230 | 5090 | 136 | 845 | 7303 | -1183 |
| 42 | 179 | 19 | 1 | 13 | 13 | 47 | +131 | 6299 | 1250 | 5092 | 149 | 859 | 7351 | -1052 |
| 43 | 177 | 19 | 1 | 12 | 12 | 45 | +132 | 6477 | 1269 | 5093 | 162 | 871 | 7397 | -920 |
| 44 | 176 | 18 | 1 | 12 | 12 | 43 | +132 | 6653 | 1288 | 5094 | 174 | 883 | 7441 | -787 |
| 45 | 175 | 17 | 0 | 11 | 11 | 41 | +133 | 6828 | 1305 | 5095 | 185 | 895 | 7482 | -653 |
| 46 | 174 | 17 | 0 | 12 | 11 | 40 | +133 | 7002 | 1322 | 5095 | 198 | 906 | 7523 | -520 |
| 47 | 172 | 16 | 0 | 9 | 10 | 36 | +136 | 7175 | 1339 | 5095 | 207 | 917 | 7559 | -384 |
| 48 | 171 | 15 | 0 | 8 | 10 | 34 | +136 | 7347 | 1354 | 5095 | 216 | 927 | 7594 | -247 |
| 49 | 170 | 15 | 0 | 8 | 9 | 33 | +136 | 7517 | 1370 | 5095 | 224 | 937 | 7628 | -111 |
| 50 | 169 | 14 | 0 | 8 | 9 | 32 | +136 | 7686 | 1384 | 5095 | 233 | 947 | 7660 | +25 |

BC.RT= 100.334421859

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X= 0

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 2 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 3 | 0 | 0 | 3 | -3 |
| 3 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 7 | 0 | 0 | 7 | -7 |
| 4 | 0 | 0 | 7 | 0 | 0 | 7 | -7 | 0 | 0 | 14 | 0 | 0 | 14 | -14 |
| 5 | 0 | 0 | 15 | 0 | 0 | 15 | -15 | 0 | 0 | 30 | 0 | 0 | 30 | -30 |
| 6 | 0 | 0 | 34 | 0 | 0 | 34 | -34 | 0 | 0 | 65 | 0 | 0 | 65 | -65 |
| 7 | 0 | 0 | 49 | 0 | 0 | 49 | -49 | 0 | 0 | 114 | 0 | 0 | 114 | -114 |
| 8 | 128 | 51 | 68 | 0 | 32 | 152 | -23 | 128 | 51 | 182 | 0 | 32 | 267 | -138 |
| 9 | 141 | 51 | 103 | 0 | 37 | 192 | -51 | 270 | 103 | 286 | 0 | 70 | 460 | -190 |
| 10 | 154 | 51 | 163 | 0 | 42 | 257 | -103 | 424 | 155 | 450 | 0 | 112 | 717 | -293 |
| 11 | 167 | 51 | 261 | 0 | 46 | 359 | -191 | 591 | 207 | 711 | 0 | 158 | 1076 | -485 |
| 12 | 234 | 77 | 340 | 0 | 55 | 474 | -239 | 826 | 284 | 1052 | 0 | 214 | 1551 | -724 |
| 13 | 254 | 77 | 376 | 0 | 57 | 511 | -256 | 1081 | 362 | 1428 | 0 | 271 | 2062 | -981 |
| 14 | 276 | 77 | 399 | 0 | 57 | 534 | -258 | 1357 | 439 | 1828 | 0 | 328 | 2597 | -1239 |
| 15 | 298 | 77 | 445 | 0 | 59 | 582 | -283 | 1656 | 517 | 2273 | 0 | 388 | 3179 | -1523 |
| 16 | 323 | 77 | 492 | 0 | 61 | 631 | -308 | 1979 | 595 | 2766 | 0 | 449 | 3811 | -1832 |
| 17 | 401 | 103 | 514 | 0 | 67 | 685 | -284 | 2380 | 698 | 3281 | 0 | 516 | 4496 | -2116 |
| 18 | 428 | 103 | 517 | 0 | 68 | 689 | -260 | 2808 | 802 | 3798 | 0 | 585 | 5185 | -2377 |
| 19 | 445 | 103 | 523 | 0 | 68 | 695 | -249 | 3254 | 905 | 4322 | 0 | 653 | 5881 | -2627 |
| 20 | 460 | 103 | 545 | 0 | 68 | 717 | -257 | 3714 | 1009 | 4868 | 0 | 721 | 6599 | -2884 |
| 21 | 475 | 103 | 560 | 0 | 68 | 732 | -256 | 4189 | 1112 | 5428 | 0 | 790 | 7331 | -3141 |
| 22 | 490 | 103 | 563 | 0 | 68 | 735 | -244 | 4680 | 1216 | 5991 | 0 | 858 | 8066 | -3385 |
| 23 | 506 | 103 | 560 | 0 | 68 | 731 | -225 | 5187 | 1319 | 6552 | 0 | 926 | 8798 | -3611 |
| 24 | 523 | 103 | 557 | 0 | 68 | 729 | -206 | 5710 | 1423 | 7109 | 0 | 994 | 9528 | -3817 |
| 25 | 540 | 103 | 557 | 0 | 68 | 729 | -189 | 6250 | 1526 | 7667 | 0 | 1063 | 10257 | -4007 |
| 26 | 557 | 103 | 553 | 0 | 68 | 724 | -167 | 6807 | 1630 | 8220 | 0 | 1131 | 10982 | -4174 |
| 27 | 575 | 103 | 546 | 18 | 68 | 737 | -161 | 7383 | 1733 | 8767 | 18 | 1199 | 11719 | -4335 |
| 28 | 594 | 103 | 530 | 18 | 68 | 720 | -125 | 7977 | 1837 | 9297 | 36 | 1268 | 12439 | -4461 |
| 29 | 613 | 103 | 494 | 18 | 68 | 684 | -70 | 8591 | 1940 | 9791 | 55 | 1336 | 13124 | -4532 |
| 30 | 633 | 103 | 436 | 18 | 68 | 626 | +7 | 9225 | 2044 | 10228 | 73 | 1404 | 13750 | -4525 |
| 31 | 654 | 103 | 340 | 26 | 68 | 539 | +115 | 9879 | 2147 | 10568 | 100 | 1472 | 14290 | -4410 |
| 32 | 675 | 103 | 259 | 39 | 68 | 469 | +205 | 10555 | 2251 | 10827 | 139 | 1541 | 14760 | -4204 |
| 33 | 697 | 103 | 220 | 39 | 68 | 431 | +266 | 11252 | 2354 | 11048 | 178 | 1609 | 15191 | -3938 |
| 34 | 720 | 103 | 193 | 39 | 68 | 404 | +315 | 11972 | 2458 | 11242 | 217 | 1677 | 15596 | -3623 |
| 35 | 743 | 103 | 147 | 39 | 68 | 358 | +384 | 12716 | 2561 | 11389 | 257 | 1746 | 15954 | -3238 |
| 36 | 767 | 103 | 98 | 46 | 68 | 316 | +450 | 13484 | 2665 | 11488 | 303 | 1814 | 16271 | -2787 |
| 37 | 792 | 103 | 74 | 46 | 68 | 292 | +500 | 14276 | 2768 | 11563 | 349 | 1882 | 16564 | -2287 |
| 38 | 818 | 103 | 67 | 46 | 68 | 286 | +532 | 15095 | 2872 | 11631 | 395 | 1951 | 16850 | -1754 |
| 39 | 845 | 103 | 58 | 46 | 68 | 276 | +568 | 15940 | 2975 | 11689 | 442 | 2019 | 17126 | -1185 |
| 40 | 872 | 103 | 32 | 46 | 68 | 250 | +621 | 16813 | 3079 | 11721 | 488 | 2087 | 17376 | -563 |
| 41 | 900 | 103 | 14 | 49 | 68 | 235 | +664 | 17713 | 3182 | 11736 | 538 | 2155 | 17612 | +101 |
| 42 | 930 | 103 | 7 | 68 | 68 | 247 | +682 | 18644 | 3286 | 11744 | 606 | 2224 | 17860 | +783 |
| 43 | 960 | 103 | 7 | 68 | 68 | 247 | +712 | 19604 | 3389 | 11751 | 674 | 2292 | 18108 | +1496 |
| 44 | 991 | 103 | 6 | 68 | 68 | 246 | +745 | 20596 | 3493 | 11757 | 742 | 2360 | 18354 | +2241 |
| 45 | 1023 | 103 | 2 | 68 | 68 | 242 | +780 | 21619 | 3596 | 11760 | 810 | 2429 | 18597 | +3022 |
| 46 | 1057 | 103 | 0 | 76 | 68 | 249 | +808 | 22677 | 3700 | 11761 | 886 | 2497 | 18846 | +3830 |
| 47 | 1091 | 103 | 0 | 58 | 68 | 229 | +861 | 23768 | 3803 | 11761 | 944 | 2565 | 19075 | +4692 |
| 48 | 1126 | 103 | 0 | 58 | 68 | 229 | +897 | 24895 | 3907 | 11761 | 1002 | 2634 | 19305 | +5589 |
| 49 | 1163 | 103 | 0 | 58 | 68 | 229 | +933 | 26059 | 4010 | 11761 | 1060 | 2702 | 19535 | +6523 |
| 50 | 1201 | 103 | 0 | 58 | 68 | 229 | +971 | 27260 | 4114 | 11761 | 1118 | 2770 | 19765 | +7495 |

BC.RT= 137.920158817

- Cont'd -

2. WP = Rs.10.5, I1 = 5%, I2 = 14%

[ FINANCIAL EVALUATION ]

< INPUT >

WP= 10.5

| | | | |
|---|---|---|---|
| CCF | 1 = 22.44 | CCL | 1 = 10.978 |
| CCF | 2 = 27.26 | CCL | 2 = 12.318 |
| CCF | 3 = 29.961 | CCL | 3 = 45.109 |
| CCF | 4 = 67.373 | CCL | 4 = 110.853 |
| CCF | 5 = 170.672 | CCL | 5 = 187.499 |
| CCF | 6 = 305.324 | CCL | 6 = 312.866 |
| CCF | 7 = 237.137 | CCL | 7 = 264.068 |
| CCF | 8 = 103.059 | CCL | 8 = 116.825 |
| CCF | 9 = 67.234 | CCL | 9 = 67.206 |
| CCF | 10 = 113.595 | CCL | 10 = 118.334 |
| CCF | 11 = 102.449 | CCL | 11 = 106.671 |
| CCF | 12 = 35 | CCL | 12 = 36 |
| CCF | 13 = 0 | CCL | 13 = 0 |
| CCF | 14 = 19.524 | CCL | 14 = 18.615 |
| CCF | 15 = 59.351 | CCL | 15 = 64.935 |
| CCF | 16 = 40.98 | CCL | 16 = 42.171 |
| CCF | 17 = 14.9 | CCL | 17 = 15.2 |

OM 8 = 32.81
OM 9 = 37.371
OM 10 = 42.001
OM 11 = 46.301
OM 12 = 55.796
OM 13 = 57.239
OM 14 = 57.239
OM 15 = 59.339
OM 16 = 61.439
OM 17 = 67.425
OM 18 = 68.19
OM 19 = 68.296

MM= 9

| | | | | | |
|---|---|---|---|---|---|
| RY 1 = 22 | RCF | 1 = 0 | RCL | 1 = 63.499 |
| RY 2 = 26 | RCF | 2 = 0 | RCL | 2 = 28.728 |
| RY 3 = 27 | RCF | 3 = 0 | RCL | 3 = 42.32 |
| RY 4 = 31 | RCF | 4 = 0 | RCL | 4 = 24.559 |
| RY 5 = 36 | RCF | 5 = 0 | RCL | 5 = 11.701 |
| RY 6 = 37 | RCF | 6 = 0 | RCL | 6 = 63.499 |
| RY 7 = 41 | RCF | 7 = 0 | RCL | 7 = 28.727 |
| RY 8 = 46 | RCF | 8 = 0 | RCL | 8 = 7.363 |
| RY 9 = 47 | RCF | 9 = 0 | RCL | 9 = 42.32 |

| | | |
|---|---|---|
| I1= 0.05 | PB1= 30 | G1= 10 |
| I2= 0.14 | PB2= 25 | G2= 5 |

< FIRR COMPUTATION >

| DC.RT | PW.BF | PW.CW | PW.CC1 | PW.CC2 | PW.CC | PW.RC | PW.OM | PW.CS | NPW | BC.RT |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.050 | 6794 | 1094 | 1032 | 3170 | 4203 | 160 | 752 | 6211 | +583 | 109 |
| 0.060 | 5224 | 876 | 863 | 2625 | 3489 | 111 | 605 | 5082 | +141 | 102 |
| 0.070 | 4074 | 711 | 727 | 2185 | 2913 | 77 | 492 | 4195 | -120 | 97 |

- Cont'd -

X= 0.07

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 2 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 3 | 0 | 0 | 3 | -3 |
| 3 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 6 | 0 | 0 | 6 | -6 |
| 4 | 0 | 0 | 5 | 0 | 0 | 5 | -5 | 0 | 0 | 12 | 0 | 0 | 12 | -12 |
| 5 | 0 | 0 | 11 | 0 | 0 | 11 | -11 | 0 | 0 | 23 | 0 | 0 | 23 | -23 |
| 6 | 0 | 0 | 22 | 0 | 0 | 22 | -22 | 0 | 0 | 46 | 0 | 0 | 46 | -46 |
| 7 | 0 | 0 | 31 | 0 | 0 | 31 | -31 | 0 | 0 | 77 | 0 | 0 | 77 | -77 |
| 8 | 87 | 30 | 39 | 0 | 19 | 88 | -1 | 87 | 30 | 116 | 0 | 19 | 166 | -78 |
| 9 | 89 | 28 | 56 | 0 | 20 | 104 | -15 | 177 | 58 | 173 | 0 | 39 | 270 | -93 |
| 10 | 91 | 26 | 83 | 0 | 21 | 130 | -39 | 268 | 84 | 256 | 0 | 60 | 401 | -133 |
| 11 | 92 | 24 | 124 | 0 | 21 | 170 | -77 | 361 | 109 | 380 | 0 | 82 | 572 | -210 |
| 12 | 121 | 34 | 151 | 0 | 24 | 210 | -89 | 482 | 143 | 531 | 0 | 107 | 783 | -300 |
| 13 | 123 | 32 | 156 | 0 | 23 | 212 | -88 | 606 | 175 | 687 | 0 | 131 | 995 | -388 |
| 14 | 124 | 30 | 155 | 0 | 22 | 207 | -82 | 731 | 205 | 843 | 0 | 153 | 1202 | -471 |
| 15 | 126 | 28 | 161 | 0 | 21 | 211 | -84 | 857 | 234 | 1004 | 0 | 175 | 1413 | -556 |
| 16 | 127 | 26 | 166 | 0 | 20 | 214 | -86 | 985 | 260 | 1171 | 0 | 195 | 1627 | -642 |
| 17 | 148 | 32 | 162 | 0 | 21 | 216 | -68 | 1133 | 293 | 1334 | 0 | 217 | 1844 | -711 |
| 18 | 147 | 30 | 153 | 0 | 20 | 203 | -56 | 1281 | 323 | 1487 | 0 | 237 | 2048 | -767 |
| 19 | 143 | 28 | 144 | 0 | 18 | 192 | -48 | 1425 | 352 | 1632 | 0 | 256 | 2240 | -815 |
| 20 | 138 | 26 | 141 | 0 | 17 | 185 | -46 | 1563 | 379 | 1773 | 0 | 273 | 2426 | -862 |
| 21 | 133 | 24 | 135 | 0 | 16 | 176 | -42 | 1697 | 404 | 1908 | 0 | 290 | 2603 | -905 |
| 22 | 129 | 23 | 127 | 0 | 15 | 165 | -36 | 1826 | 427 | 2035 | 0 | 305 | 2769 | -942 |
| 23 | 124 | 21 | 118 | 0 | 14 | 154 | -29 | 1951 | 449 | 2153 | 0 | 320 | 2923 | -971 |
| 24 | 120 | 20 | 109 | 0 | 13 | 143 | -23 | 2071 | 469 | 2263 | 0 | 333 | 3067 | -995 |
| 25 | 116 | 19 | 102 | 0 | 12 | 134 | -18 | 2187 | 488 | 2366 | 0 | 346 | 3201 | -1013 |
| 26 | 112 | 17 | 95 | 0 | 11 | 124 | -12 | 2300 | 506 | 2461 | 0 | 357 | 3326 | -1026 |
| 27 | 108 | 16 | 87 | 2 | 10 | 118 | -10 | 2408 | 523 | 2549 | 2 | 368 | 3445 | -1037 |
| 28 | 104 | 15 | 79 | 2 | 10 | 108 | -4 | 2512 | 538 | 2629 | 5 | 379 | 3553 | -1041 |
| 29 | 100 | 14 | 69 | 2 | 9 | 96 | +4 | 2613 | 553 | 2699 | 8 | 388 | 3649 | -1036 |
| 30 | 97 | 13 | 57 | 2 | 8 | 82 | +14 | 2710 | 566 | 2756 | 10 | 397 | 3732 | -1021 |
| 31 | 93 | 12 | 41 | 3 | 8 | 66 | +27 | 2803 | 579 | 2798 | 14 | 406 | 3798 | -994 |
| 32 | 90 | 11 | 29 | 4 | 7 | 53 | +36 | 2894 | 591 | 2828 | 18 | 414 | 3852 | -957 |
| 33 | 87 | 11 | 23 | 4 | 7 | 46 | +41 | 2981 | 602 | 2851 | 22 | 421 | 3898 | -916 |
| 34 | 84 | 10 | 19 | 3 | 6 | 40 | +43 | 3065 | 613 | 2871 | 26 | 428 | 3938 | -873 |
| 35 | 81 | 9 | 13 | 3 | 6 | 33 | +47 | 3147 | 622 | 2884 | 30 | 434 | 3972 | -825 |
| 36 | 78 | 9 | 8 | 4 | 5 | 27 | +50 | 3225 | 631 | 2893 | 34 | 440 | 4000 | -774 |
| 37 | 75 | 8 | 6 | 3 | 5 | 23 | +51 | 3301 | 640 | 2899 | 38 | 446 | 4024 | -723 |
| 38 | 73 | 7 | 5 | 3 | 5 | 21 | +51 | 3374 | 648 | 2904 | 41 | 451 | 4046 | -671 |
| 39 | 70 | 7 | 4 | 3 | 4 | 19 | +50 | 3444 | 655 | 2908 | 44 | 456 | 4065 | -621 |
| 40 | 67 | 6 | 2 | 3 | 4 | 16 | +51 | 3512 | 662 | 2911 | 48 | 460 | 4082 | -570 |
| 41 | 65 | 6 | 0 | 3 | 4 | 14 | +50 | 3578 | 668 | 2912 | 51 | 465 | 4097 | -519 |
| 42 | 63 | 6 | 0 | 3 | 3 | 14 | +48 | 3641 | 674 | 2912 | 55 | 469 | 4111 | -470 |
| 43 | 61 | 5 | 0 | 3 | 3 | 13 | +47 | 3702 | 680 | 2912 | 58 | 472 | 4125 | -422 |
| 44 | 58 | 5 | 0 | 3 | 3 | 12 | +46 | 3761 | 685 | 2913 | 62 | 476 | 4137 | -376 |
| 45 | 56 | 4 | 0 | 3 | 3 | 11 | +45 | 3818 | 690 | 2913 | 65 | 479 | 4149 | -331 |
| 46 | 54 | 4 | 0 | 3 | 3 | 11 | +43 | 3873 | 695 | 2913 | 68 | 482 | 4160 | -287 |
| 47 | 52 | 4 | 0 | 2 | 2 | 9 | +43 | 3926 | 699 | 2913 | 71 | 485 | 4169 | -243 |
| 48 | 51 | 4 | 0 | 2 | 2 | 8 | +42 | 3977 | 703 | 2913 | 73 | 488 | 4178 | -201 |
| 49 | 49 | 3 | 0 | 2 | 2 | 8 | +40 | 4026 | 707 | 2913 | 75 | 490 | 4187 | -160 |
| 50 | 47 | 3 | 0 | 1 | 2 | 7 | +39 | 4074 | 711 | 2913 | 77 | 492 | 4195 | -120 |

BC.RT= 97.1182044491

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X= 0

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 2 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 3 | 0 | 0 | 3 | -3 |
| 3 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 7 | 0 | 0 | 7 | -7 |
| 4 | 0 | 0 | 7 | 0 | 0 | 7 | -7 | 0 | 0 | 14 | 0 | 0 | 14 | -14 |
| 5 | 0 | 0 | 15 | 0 | 0 | 15 | -15 | 0 | 0 | 30 | 0 | 0 | 30 | -30 |
| 6 | 0 | 0 | 34 | 0 | 0 | 34 | -34 | 0 | 0 | 65 | 0 | 0 | 65 | -65 |
| 7 | 0 | 0 | 49 | 0 | 0 | 49 | -49 | 0 | 0 | 114 | 0 | 0 | 114 | -114 |
| 8 | 150 | 51 | 68 | 0 | 32 | 152 | -2 | 150 | 51 | 182 | 0 | 32 | 267 | -117 |
| 9 | 164 | 51 | 103 | 0 | 37 | 192 | -28 | 315 | 103 | 286 | 0 | 70 | 460 | -145 |
| 10 | 179 | 51 | 163 | 0 | 42 | 257 | -77 | 494 | 155 | 450 | 0 | 112 | 717 | -222 |
| 11 | 195 | 51 | 261 | 0 | 46 | 359 | -163 | 690 | 207 | 711 | 0 | 158 | 1076 | -386 |
| 12 | 273 | 77 | 340 | 0 | 55 | 474 | -200 | 963 | 284 | 1052 | 0 | 214 | 1551 | -587 |
| 13 | 297 | 77 | 376 | 0 | 57 | 511 | -213 | 1261 | 362 | 1428 | 0 | 271 | 2062 | -800 |
| 14 | 322 | 77 | 399 | 0 | 57 | 534 | -212 | 1583 | 439 | 1828 | 0 | 328 | 2597 | -1013 |
| 15 | 348 | 77 | 445 | 0 | 59 | 582 | -233 | 1932 | 517 | 2273 | 0 | 388 | 3179 | -1247 |
| 16 | 377 | 77 | 492 | 0 | 61 | 631 | -254 | 2309 | 595 | 2766 | 0 | 449 | 3811 | -1502 |
| 17 | 468 | 103 | 514 | 0 | 67 | 685 | -217 | 2777 | 698 | 3281 | 0 | 516 | 4496 | -1719 |
| 18 | 499 | 103 | 517 | 0 | 68 | 689 | -189 | 3276 | 802 | 3798 | 0 | 585 | 5185 | -1909 |
| 19 | 520 | 103 | 523 | 0 | 68 | 695 | -175 | 3796 | 905 | 4322 | 0 | 653 | 5881 | -2084 |
| 20 | 536 | 103 | 545 | 0 | 68 | 717 | -180 | 4333 | 1009 | 4868 | 0 | 721 | 6599 | -2265 |
| 21 | 554 | 103 | 560 | 0 | 68 | 732 | -177 | 4888 | 1112 | 5428 | 0 | 790 | 7331 | -2442 |
| 22 | 572 | 103 | 563 | 0 | 68 | 735 | -162 | 5460 | 1216 | 5991 | 0 | 858 | 8066 | -2605 |
| 23 | 591 | 103 | 560 | 0 | 68 | 731 | -140 | 6051 | 1319 | 6552 | 0 | 926 | 8798 | -2746 |
| 24 | 610 | 103 | 557 | 0 | 68 | 729 | -119 | 6661 | 1423 | 7109 | 0 | 994 | 9528 | -2866 |
| 25 | 630 | 103 | 557 | 0 | 68 | 729 | -99 | 7291 | 1526 | 7667 | 0 | 1063 | 10257 | -2965 |
| 26 | 650 | 103 | 553 | 0 | 68 | 724 | -74 | 7942 | 1630 | 8220 | 0 | 1131 | 10982 | -3039 |
| 27 | 671 | 103 | 546 | 18 | 68 | 737 | -65 | 8614 | 1733 | 8767 | 18 | 1199 | 11719 | -3105 |
| 28 | 693 | 103 | 530 | 18 | 68 | 720 | -26 | 9307 | 1837 | 9297 | 36 | 1268 | 12439 | -3132 |
| 29 | 716 | 103 | 494 | 18 | 68 | 684 | +31 | 10023 | 1940 | 9791 | 55 | 1336 | 13124 | -3100 |
| 30 | 739 | 103 | 436 | 18 | 68 | 626 | +112 | 10762 | 2044 | 10228 | 73 | 1404 | 13750 | -2987 |
| 31 | 763 | 103 | 340 | 26 | 68 | 539 | +224 | 11526 | 2147 | 10568 | 100 | 1472 | 14290 | -2763 |
| 32 | 788 | 103 | 259 | 39 | 68 | 469 | +318 | 12314 | 2251 | 10827 | 139 | 1541 | 14760 | -2445 |
| 33 | 813 | 103 | 220 | 39 | 68 | 431 | +382 | 13128 | 2354 | 11048 | 178 | 1609 | 15191 | -2063 |
| 34 | 840 | 103 | 193 | 39 | 68 | 404 | +435 | 13968 | 2458 | 11242 | 217 | 1677 | 15596 | -1627 |
| 35 | 867 | 103 | 147 | 39 | 68 | 358 | +508 | 14835 | 2561 | 11389 | 257 | 1746 | 15954 | -1118 |
| 36 | 895 | 103 | 98 | 46 | 68 | 316 | +578 | 15731 | 2665 | 11488 | 303 | 1814 | 16271 | -540 |
| 37 | 924 | 103 | 74 | 46 | 68 | 292 | +632 | 16656 | 2768 | 11563 | 349 | 1882 | 16564 | +92 |
| 38 | 954 | 103 | 67 | 46 | 68 | 286 | +668 | 17611 | 2872 | 11631 | 395 | 1951 | 16850 | +761 |
| 39 | 985 | 103 | 58 | 46 | 68 | 276 | +709 | 18597 | 2975 | 11689 | 442 | 2019 | 17126 | +1470 |
| 40 | 1017 | 103 | 32 | 46 | 68 | 250 | +767 | 19615 | 3079 | 11721 | 488 | 2087 | 17376 | +2238 |
| 41 | 1051 | 103 | 14 | 49 | 68 | 235 | +815 | 20666 | 3182 | 11736 | 538 | 2155 | 17612 | +3053 |
| 42 | 1085 | 103 | 7 | 68 | 68 | 247 | +837 | 21751 | 3286 | 11744 | 606 | 2224 | 17860 | +3890 |
| 43 | 1120 | 103 | 7 | 68 | 68 | 247 | +873 | 22871 | 3389 | 11751 | 674 | 2292 | 18108 | +4763 |
| 44 | 1156 | 103 | 6 | 68 | 68 | 246 | +910 | 24028 | 3493 | 11757 | 742 | 2360 | 18354 | +5674 |
| 45 | 1194 | 103 | 2 | 68 | 68 | 242 | +951 | 25223 | 3596 | 11760 | 810 | 2429 | 18597 | +6626 |
| 46 | 1233 | 103 | 0 | 76 | 68 | 249 | +984 | 26456 | 3700 | 11761 | 886 | 2497 | 18846 | +7610 |
| 47 | 1273 | 103 | 0 | 58 | 68 | 229 | +1043 | 27730 | 3803 | 11761 | 944 | 2565 | 19075 | +8654 |
| 48 | 1314 | 103 | 0 | 58 | 68 | 229 | +1084 | 29044 | 3907 | 11761 | 1002 | 2634 | 19305 | +9738 |
| 49 | 1357 | 103 | 0 | 58 | 68 | 229 | +1127 | 30402 | 4010 | 11761 | 1060 | 2702 | 19535 | +10866 |
| 50 | 1401 | 103 | 0 | 58 | 68 | 229 | +1171 | 31803 | 4114 | 11761 | 1118 | 2770 | 19765 | +12038 |

BC.RT= 160.906851951

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3. WP = Rs.8, I1 = 4%, I2 = 9%

[ FINANCIAL EVALUATION ]

< INPUT >

WP= 8

| | | | | | |
|---|---|---|---|---|---|
| CCF | 1 | = 22.44 | CCL | 1 | = 10.978 |
| CCF | 2 | = 27.26 | CCL | 2 | = 12.318 |
| CCF | 3 | = 29.961 | CCL | 3 | = 45.109 |
| CCF | 4 | = 67.373 | CCL | 4 | = 110.853 |
| CCF | 5 | = 170.672 | CCL | 5 | = 187.499 |
| CCF | 6 | = 305.324 | CCL | 6 | = 312.866 |
| CCF | 7 | = 237.137 | CCL | 7 | = 264.068 |
| CCF | 8 | = 103.059 | CCL | 8 | = 116.825 |
| CCF | 9 | = 67.234 | CCL | 9 | = 67.206 |
| CCF | 10 | = 113.595 | CCL | 10 | = 118.334 |
| CCF | 11 | = 102.449 | CCL | 11 | = 106.671 |
| CCF | 12 | = 35 | CCL | 12 | = 36 |
| CCF | 13 | = 0 | CCL | 13 | = 0 |
| CCF | 14 | = 19.524 | CCL | 14 | = 18.615 |
| CCF | 15 | = 59.351 | CCL | 15 | = 64.935 |
| CCF | 16 | = 40.98 | CCL | 16 | = 42.171 |
| CCF | 17 | = 14.9 | CCL | 17 | = 15.2 |

OM 8 = 32.81
OM 9 = 37.371
OM 10 = 42.001
OM 11 = 46.301
OM 12 = 55.796
OM 13 = 57.239
OM 14 = 57.239
OM 15 = 59.339
OM 16 = 61.439
OM 17 = 67.425
OM 18 = 68.19
OM 19 = 68.296

MM= 9

| | | | | | |
|---|---|---|---|---|---|
| RY | 1 | = 22 | RCF | 1 | = 0 | RCL | 1 | = 63.499 |
| RY | 2 | = 26 | RCF | 2 | = 0 | RCL | 2 | = 28.728 |
| RY | 3 | = 27 | RCF | 3 | = 0 | RCL | 3 | = 42.32 |
| RY | 4 | = 31 | RCF | 4 | = 0 | RCL | 4 | = 24.559 |
| RY | 5 | = 36 | RCF | 5 | = 0 | RCL | 5 | = 11.701 |
| RY | 6 | = 37 | RCF | 6 | = 0 | RCL | 6 | = 63.499 |
| RY | 7 | = 41 | RCF | 7 | = 0 | RCL | 7 | = 28.727 |
| RY | 8 | = 46 | RCF | 8 | = 0 | RCL | 8 | = 7.363 |
| RY | 9 | = 47 | RCF | 9 | = 0 | RCL | 9 | = 42.32 |

I1= 0.04 PB1= 30 G1= 10
I2= 0.09 PB2= 25 G2= 5

< FIRR COMPUTATION >

| DC.RT | PW.BF | PW.CW | PW.CC1 | PW.CC2 | PW.CC | PW.RC | PW.OM | PW.CS | NPW | BC.RT |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.050 | 5176 | 1094 | 905 | 1838 | 2743 | 93 | 752 | 4683 | +492 | 110 |
| 0.060 | 3980 | 876 | 753 | 1522 | 2275 | 64 | 605 | 3822 | +158 | 104 |
| 0.070 | 3104 | 711 | 631 | 1267 | 1898 | 45 | 492 | 3147 | -43 | 98 |

- Cont'd -

X= 0.07

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | +0 | 0 | 0 | 0 | 0 | 0 | 0 | +0 |
| 2 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 2 | 0 | 0 | 2 | -2 |
| 3 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 5 | 0 | 0 | 5 | -5 |
| 4 | 0 | 0 | 4 | 0 | 0 | 4 | -4 | 0 | 0 | 9 | 0 | 0 | 9 | -9 |
| 5 | 0 | 0 | 9 | 0 | 0 | 9 | -9 | 0 | 0 | 18 | 0 | 0 | 18 | -18 |
| 6 | 0 | 0 | 17 | 0 | 0 | 17 | -17 | 0 | 0 | 36 | 0 | 0 | 36 | -36 |
| 7 | 0 | 0 | 23 | 0 | 0 | 23 | -23 | 0 | 0 | 60 | 0 | 0 | 60 | -60 |
| 8 | 66 | 30 | 29 | 0 | 19 | 78 | -11 | 66 | 30 | 89 | 0 | 19 | 138 | -72 |
| 9 | 68 | 28 | 38 | 0 | 20 | 87 | -19 | 134 | 58 | 128 | 0 | 39 | 226 | -91 |
| 10 | 69 | 26 | 54 | 0 | 21 | 102 | -32 | 204 | 84 | 183 | 0 | 60 | 328 | -123 |
| 11 | 70 | 24 | 78 | 0 | 21 | 125 | -54 | 275 | 109 | 261 | 0 | 82 | 453 | -178 |
| 12 | 92 | 34 | 94 | 0 | 24 | 153 | -61 | 367 | 143 | 356 | 0 | 107 | 607 | -239 |
| 13 | 94 | 32 | 97 | 0 | 23 | 153 | -58 | 461 | 175 | 453 | 0 | 131 | 760 | -298 |
| 14 | 95 | 30 | 96 | 0 | 22 | 148 | -53 | 557 | 205 | 549 | 0 | 153 | 909 | -352 |
| 15 | 96 | 28 | 101 | 0 | 21 | 151 | -54 | 653 | 234 | 651 | 0 | 175 | 1060 | -406 |
| 16 | 97 | 26 | 106 | 0 | 20 | 153 | -56 | 750 | 260 | 757 | 0 | 195 | 1213 | -463 |
| 17 | 112 | 32 | 104 | 0 | 21 | 158 | -46 | 863 | 293 | 862 | 0 | 217 | 1372 | -509 |
| 18 | 112 | 30 | 99 | 0 | 20 | 149 | -37 | 976 | 323 | 961 | 0 | 237 | 1522 | -546 |
| 19 | 109 | 28 | 93 | 0 | 18 | 141 | -31 | 1085 | 352 | 1055 | 0 | 256 | 1663 | -578 |
| 20 | 105 | 26 | 91 | 0 | 17 | 135 | -30 | 1191 | 379 | 1146 | 0 | 273 | 1799 | -608 |
| 21 | 102 | 24 | 87 | 0 | 16 | 129 | -27 | 1293 | 404 | 1234 | 0 | 290 | 1929 | -635 |
| 22 | 98 | 23 | 82 | 0 | 15 | 121 | -22 | 1391 | 427 | 1317 | 0 | 305 | 2050 | -658 |
| 23 | 94 | 21 | 76 | 0 | 14 | 112 | -17 | 1486 | 449 | 1393 | 0 | 320 | 2163 | -676 |
| 24 | 91 | 20 | 71 | 0 | 13 | 105 | -13 | 1578 | 469 | 1464 | 0 | 333 | 2268 | -689 |
| 25 | 88 | 19 | 66 | 0 | 12 | 98 | -9 | 1667 | 488 | 1531 | 0 | 346 | 2366 | -699 |
| 26 | 85 | 17 | 61 | 0 | 11 | 91 | -6 | 1752 | 506 | 1593 | 0 | 357 | 2458 | -705 |
| 27 | 82 | 16 | 57 | 1 | 10 | 86 | -4 | 1834 | 523 | 1650 | 1 | 368 | 2544 | -709 |
| 28 | 79 | 15 | 51 | 1 | 10 | 79 | +0 | 1914 | 538 | 1702 | 3 | 379 | 2623 | -709 |
| 29 | 76 | 14 | 45 | 1 | 9 | 71 | +5 | 1990 | 553 | 1747 | 4 | 388 | 2694 | -704 |
| 30 | 73 | 13 | 37 | 1 | 8 | 61 | +12 | 2064 | 566 | 1785 | 6 | 397 | 2756 | -692 |
| 31 | 71 | 12 | 28 | 1 | 8 | 51 | +19 | 2136 | 579 | 1814 | 8 | 406 | 2808 | -672 |
| 32 | 68 | 11 | 21 | 2 | 7 | 43 | +25 | 2205 | 591 | 1835 | 10 | 414 | 2851 | -646 |
| 33 | 66 | 11 | 17 | 2 | 7 | 37 | +28 | 2271 | 602 | 1852 | 13 | 421 | 2889 | -618 |
| 34 | 64 | 10 | 14 | 2 | 6 | 33 | +30 | 2335 | 613 | 1866 | 15 | 428 | 2923 | -587 |
| 35 | 61 | 9 | 10 | 2 | 6 | 28 | +33 | 2397 | 622 | 1877 | 17 | 434 | 2952 | -554 |
| 36 | 59 | 9 | 6 | 2 | 5 | 24 | +35 | 2457 | 631 | 1883 | 19 | 440 | 2976 | -518 |
| 37 | 57 | 8 | 4 | 2 | 5 | 20 | +36 | 2515 | 640 | 1888 | 22 | 446 | 2996 | -481 |
| 38 | 55 | 7 | 3 | 2 | 5 | 18 | +36 | 2570 | 648 | 1892 | 24 | 451 | 3015 | -445 |
| 39 | 53 | 7 | 3 | 1 | 4 | 17 | +36 | 2624 | 655 | 1895 | 26 | 456 | 3033 | -408 |
| 40 | 51 | 6 | 1 | 1 | 4 | 14 | +36 | 2676 | 662 | 1896 | 27 | 460 | 3048 | -371 |
| 41 | 49 | 6 | 0 | 1 | 4 | 13 | +36 | 2726 | 668 | 1897 | 29 | 465 | 3061 | -335 |
| 42 | 48 | 6 | 0 | 2 | 3 | 12 | +35 | 2774 | 674 | 1898 | 31 | 469 | 3074 | -299 |
| 43 | 46 | 5 | 0 | 2 | 3 | 11 | +34 | 2820 | 680 | 1898 | 34 | 472 | 3086 | -265 |
| 44 | 44 | 5 | 0 | 2 | 3 | 11 | +33 | 2865 | 685 | 1898 | 36 | 476 | 3097 | -231 |
| 45 | 43 | 4 | 0 | 1 | 3 | 10 | +33 | 2909 | 690 | 1898 | 38 | 479 | 3107 | -198 |
| 46 | 41 | 4 | 0 | 1 | 3 | 9 | +32 | 2951 | 695 | 1898 | 39 | 482 | 3116 | -165 |
| 47 | 40 | 4 | 0 | 1 | 2 | 8 | +31 | 2991 | 699 | 1898 | 41 | 485 | 3125 | -134 |
| 48 | 38 | 4 | 0 | 1 | 2 | 7 | +30 | 3030 | 703 | 1898 | 42 | 488 | 3133 | -103 |
| 49 | 37 | 3 | 0 | 1 | 2 | 7 | +30 | 3067 | 707 | 1898 | 43 | 490 | 3140 | -73 |
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X= 0

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | +0 | 0 | 0 | 0 | 0 | 0 | 0 | +0 |
| 2 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 2 | 0 | 0 | 2 | -2 |
| 3 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 6 | 0 | 0 | 6 | -6 |
| 4 | 0 | 0 | 5 | 0 | 0 | 5 | -5 | 0 | 0 | 11 | 0 | 0 | 11 | -11 |
| 5 | 0 | 0 | 12 | 0 | 0 | 12 | -12 | 0 | 0 | 24 | 0 | 0 | 24 | -24 |
| 6 | 0 | 0 | 26 | 0 | 0 | 26 | -26 | 0 | 0 | 51 | 0 | 0 | 51 | -51 |
| 7 | 0 | 0 | 38 | 0 | 0 | 38 | -38 | 0 | 0 | 89 | 0 | 0 | 89 | -89 |
| 8 | 114 | 51 | 50 | 0 | 32 | 134 | -19 | 114 | 51 | 139 | 0 | 32 | 224 | -109 |
| 9 | 125 | 51 | 71 | 0 | 37 | 160 | -35 | 240 | 103 | 211 | 0 | 70 | 384 | -144 |
| 10 | 137 | 51 | 107 | 0 | 42 | 201 | -64 | 377 | 155 | 318 | 0 | 112 | 586 | -209 |
| 11 | 149 | 51 | 165 | 0 | 46 | 263 | -114 | 526 | 207 | 484 | 0 | 158 | 849 | -323 |
| 12 | 208 | 77 | 212 | 0 | 55 | 346 | -137 | 734 | 284 | 697 | 0 | 214 | 1196 | -461 |
| 13 | 226 | 77 | 233 | 0 | 57 | 368 | -142 | 961 | 362 | 930 | 0 | 271 | 1564 | -603 |
| 14 | 245 | 77 | 249 | 0 | 57 | 384 | -138 | 1206 | 439 | 1180 | 0 | 328 | 1948 | -742 |
| 15 | 265 | 77 | 279 | 0 | 59 | 416 | -151 | 1472 | 517 | 1459 | 0 | 388 | 2365 | -893 |
| 16 | 287 | 77 | 313 | 0 | 61 | 453 | -165 | 1759 | 595 | 1773 | 0 | 449 | 2818 | -1059 |
| 17 | 356 | 103 | 331 | 0 | 67 | 502 | -145 | 2116 | 698 | 2105 | 0 | 516 | 3320 | -1204 |
| 18 | 380 | 103 | 334 | 0 | 68 | 506 | -125 | 2496 | 802 | 2439 | 0 | 585 | 3827 | -1330 |
| 19 | 396 | 103 | 339 | 0 | 68 | 511 | -114 | 2892 | 905 | 2779 | 0 | 653 | 4338 | -1445 |
| 20 | 409 | 103 | 353 | 0 | 68 | 525 | -116 | 3301 | 1009 | 3132 | 0 | 721 | 4863 | -1561 |
| 21 | 422 | 103 | 363 | 0 | 68 | 535 | -113 | 3724 | 1112 | 3496 | 0 | 790 | 5399 | -1674 |
| 22 | 436 | 103 | 365 | 0 | 68 | 537 | -101 | 4160 | 1216 | 3862 | 0 | 858 | 5936 | -1776 |
| 23 | 450 | 103 | 363 | 0 | 68 | 534 | -84 | 4610 | 1319 | 4225 | 0 | 926 | 6471 | -1860 |
| 24 | 464 | 103 | 361 | 0 | 68 | 533 | -68 | 5075 | 1423 | 4586 | 0 | 994 | 7004 | -1929 |
| 25 | 480 | 103 | 361 | 0 | 68 | 533 | -53 | 5555 | 1526 | 4948 | 0 | 1063 | 7538 | -1982 |
| 26 | 495 | 103 | 359 | 0 | 68 | 531 | -35 | 6051 | 1630 | 5307 | 0 | 1131 | 8069 | -2017 |
| 27 | 511 | 103 | 355 | 10 | 68 | 537 | -26 | 6563 | 1733 | 5662 | 10 | 1199 | 8607 | -2043 |
| 28 | 528 | 103 | 344 | 10 | 68 | 527 | +1 | 7091 | 1837 | 6007 | 21 | 1268 | 9134 | -2042 |
| 29 | 545 | 103 | 323 | 10 | 68 | 505 | +39 | 7637 | 1940 | 6330 | 32 | 1336 | 9639 | -2002 |
| 30 | 563 | 103 | 288 | 10 | 68 | 471 | +92 | 8200 | 2044 | 6619 | 42 | 1404 | 10111 | -1910 |
| 31 | 581 | 103 | 232 | 15 | 68 | 419 | +162 | 8781 | 2147 | 6851 | 58 | 1472 | 10530 | -1748 |
| 32 | 600 | 103 | 183 | 22 | 68 | 377 | +222 | 9382 | 2251 | 7034 | 81 | 1541 | 10908 | -1526 |
| 33 | 620 | 103 | 159 | 22 | 68 | 353 | +266 | 10002 | 2354 | 7194 | 103 | 1609 | 11262 | -1259 |
| 34 | 640 | 103 | 142 | 22 | 68 | 336 | +303 | 10642 | 2458 | 7336 | 126 | 1677 | 11599 | -956 |
| 35 | 660 | 103 | 111 | 22 | 68 | 305 | +355 | 11303 | 2561 | 7447 | 149 | 1746 | 11904 | -600 |
| 36 | 682 | 103 | 75 | 26 | 68 | 274 | +408 | 11986 | 2665 | 7523 | 175 | 1814 | 12178 | -192 |
| 37 | 704 | 103 | 56 | 26 | 68 | 254 | +449 | 12690 | 2768 | 7579 | 202 | 1882 | 12433 | +257 |
| 38 | 727 | 103 | 49 | 26 | 68 | 248 | +479 | 13418 | 2872 | 7629 | 229 | 1951 | 12682 | +736 |
| 39 | 751 | 103 | 42 | 26 | 68 | 241 | +510 | 14169 | 2975 | 7671 | 256 | 2019 | 12923 | +1246 |
| 40 | 775 | 103 | 25 | 26 | 68 | 223 | +551 | 14944 | 3079 | 7696 | 283 | 2087 | 13146 | +1798 |
| 41 | 800 | 103 | 12 | 28 | 68 | 212 | +587 | 15745 | 3182 | 7709 | 311 | 2155 | 13359 | +2385 |
| 42 | 826 | 103 | 7 | 39 | 68 | 218 | +607 | 16572 | 3286 | 7716 | 351 | 2224 | 13578 | +2993 |
| 43 | 853 | 103 | 7 | 39 | 68 | 218 | +635 | 17426 | 3389 | 7724 | 390 | 2292 | 13797 | +3628 |
| 44 | 881 | 103 | 6 | 39 | 68 | 217 | +664 | 18307 | 3493 | 7730 | 430 | 2360 | 14014 | +4292 |
| 45 | 910 | 103 | 2 | 39 | 68 | 214 | +695 | 19217 | 3596 | 7733 | 469 | 2429 | 14229 | +4988 |
| 46 | 939 | 103 | 0 | 44 | 68 | 216 | +722 | 20157 | 3700 | 7734 | 514 | 2497 | 14445 | +5711 |
| 47 | 970 | 103 | 0 | 33 | 68 | 205 | +764 | 21127 | 3803 | 7734 | 547 | 2565 | 14651 | +6476 |
| 48 | 1001 | 103 | 0 | 33 | 68 | 205 | +796 | 22129 | 3907 | 7734 | 581 | 2634 | 14856 | +7272 |
| 49 | 1034 | 103 | 0 | 33 | 68 | 205 | +828 | 23163 | 4010 | 7734 | 615 | 2702 | 15062 | +8101 |
| 50 | 1067 | 103 | 0 | 33 | 68 | 205 | +862 | 24231 | 4114 | 7734 | 648 | 2770 | 15267 | +8963 |

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4. WP = Rs.6.5, I1 = 1%, I2 = 7%

< INPUT >

WP= 6.5

| | | |
|---|---|---|
| CCF 1 = 22.44 | CCL 1 = 10.978 | |
| CCF 2 = 27.26 | CCL 2 = 12.318 | |
| CCF 3 = 29.961 | CCL 3 = 45.109 | |
| CCF 4 = 67.373 | CCL 4 = 110.853 | |
| CCF 5 = 170.672 | CCL 5 = 187.499 | |
| CCF 6 = 305.324 | CCL 6 = 312.866 | |
| CCF 7 = 237.137 | CCL 7 = 264.068 | |
| CCF 8 = 103.059 | CCL 8 = 116.825 | |
| CCF 9 = 67.234 | CCL 9 = 67.206 | |
| CCF 10 = 113.595 | CCL 10 = 118.334 | |
| CCF 11 = 102.449 | CCL 11 = 106.671 | |
| CCF 12 = 35 | CCL 12 = 36 | |
| CCF 13 = 0 | CCL 13 = 0 | |
| CCF 14 = 19.524 | CCL 14 = 18.615 | |
| CCF 15 = 59.351 | CCL 15 = 64.935 | |
| CCF 16 = 40.98 | CCL 16 = 42.171 | |
| CCF 17 = 14.9 | CCL 17 = 15.2 | |

OM 8 = 32.81
OM 9 = 37.371
OM 10 = 42.001
OM 11 = 46.301
OM 12 = 55.796
OM 13 = 57.239
OM 14 = 57.239
OM 15 = 59.339
OM 16 = 61.439
OM 17 = 67.425
OM 18 = 68.196
OM 19 = 68.29

MM= 9

| | | |
|---|---|---|
| RY 1 = 22 | RCF 1 = 0 | RCL 1 = 63.499 |
| RY 2 = 26 | RCF 2 = 0 | RCL 2 = 28.728 |
| RY 3 = 27 | RCF 3 = 0 | RCL 3 = 42.32 |
| RY 4 = 31 | RCF 4 = 0 | RCL 4 = 24.559 |
| RY 5 = 36 | RCF 5 = 0 | RCL 5 = 11.701 |
| RY 6 = 37 | RCF 6 = 0 | RCL 6 = 63.499 |
| RY 7 = 41 | RCF 7 = 0 | RCL 7 = 28.727 |
| RY 8 = 46 | RCF 8 = 0 | RCL 8 = 7.363 |
| RY 9 = 47 | RCF 9 = 0 | RCL 9 = 42.32 |

| | | |
|---|---|---|
| I1= 0.01 | PB1= 30 | G1= 10 |
| I2= 0.07 | PB2= 25 | G2= 5 |

< FIRR COMPUTATION >

| DC.RT | PW.BF | PW.CW | PW.CC1 | PW.CC2 | PW.CC | PW.RC | PW.OM | PW.CS | NPW | BC.RT |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.050 | 4205 | 1094 | 522 | 1444 | 1966 | 73 | 752 | 3886 | +319 | 108 |
| 0.060 | 3234 | 876 | 422 | 1195 | 1617 | 50 | 605 | 3150 | +83 | 102 |
| 0.070 | 2522 | 711 | 343 | 995 | 1339 | 35 | 492 | 2578 | -56 | 97 |

- Cont'd -

X= 0.06

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC.BF | AC.CW | AC.CC | AC.RC | AC.OM | AC.CS | AC.CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | +0 | 0 | 0 | 0 | 0 | 0 | 0 | +0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | +0 | 0 | 0 | 0 | 0 | 0 | 0 | +0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | +0 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 4 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 2 | 0 | 0 | 2 | -2 |
| 5 | 0 | 0 | 2 | 0 | 0 | 2 | -2 | 0 | 0 | 4 | 0 | 0 | 4 | -4 |
| 6 | 0 | 0 | 5 | 0 | 0 | 5 | -5 | 0 | 0 | 10 | 0 | 0 | 10 | -10 |
| 7 | 0 | 0 | 7 | 0 | 0 | 7 | -7 | 0 | 0 | 18 | 0 | 0 | 18 | -18 |
| 8 | 58 | 32 | 11 | 0 | 20 | 64 | -6 | 58 | 32 | 29 | 0 | 20 | 82 | -24 |
| 9 | 60 | 30 | 20 | 0 | 22 | 72 | -12 | 118 | 63 | 49 | 0 | 42 | 155 | -36 |
| 10 | 62 | 28 | 33 | 0 | 23 | 85 | -23 | 180 | 91 | 83 | 0 | 66 | 241 | -60 |
| 11 | 63 | 27 | 54 | 0 | 24 | 106 | -42 | 244 | 119 | 137 | 0 | 90 | 347 | -103 |
| 12 | 84 | 38 | 69 | 0 | 27 | 135 | -51 | 328 | 157 | 207 | 0 | 118 | 483 | -154 |
| 13 | 86 | 36 | 73 | 0 | 26 | 136 | -50 | 415 | 194 | 281 | 0 | 145 | 620 | -205 |
| 14 | 88 | 34 | 75 | 0 | 25 | 134 | -46 | 503 | 228 | 356 | 0 | 170 | 755 | -252 |
| 15 | 90 | 32 | 81 | 0 | 24 | 138 | -48 | 593 | 260 | 437 | 0 | 195 | 893 | -300 |
| 16 | 91 | 30 | 88 | 0 | 24 | 142 | -50 | 685 | 291 | 525 | 0 | 219 | 1036 | -351 |
| 17 | 107 | 38 | 89 | 0 | 25 | 152 | -45 | 792 | 329 | 614 | 0 | 244 | 1189 | -396 |
| 18 | 108 | 36 | 85 | 0 | 23 | 146 | -37 | 901 | 366 | 700 | 0 | 268 | 1335 | -434 |
| 19 | 106 | 34 | 82 | 0 | 22 | 139 | -33 | 1007 | 400 | 783 | 0 | 290 | 1474 | -467 |
| 20 | 103 | 32 | 82 | 0 | 21 | 135 | -32 | 1111 | 432 | 865 | 0 | 312 | 1610 | -499 |
| 21 | 100 | 30 | 80 | 0 | 20 | 131 | -30 | 1212 | 463 | 946 | 0 | 332 | 1742 | -529 |
| 22 | 98 | 28 | 77 | 0 | 18 | 124 | -26 | 1310 | 491 | 1023 | 0 | 351 | 1866 | -556 |
| 23 | 95 | 27 | 72 | 0 | 17 | 117 | -21 | 1406 | 518 | 1096 | 0 | 369 | 1984 | -577 |
| 24 | 93 | 25 | 68 | 0 | 16 | 110 | -17 | 1499 | 544 | 1164 | 0 | 385 | 2095 | -595 |
| 25 | 90 | 24 | 65 | 0 | 15 | 105 | -14 | 1590 | 568 | 1229 | 0 | 401 | 2200 | -609 |
| 26 | 88 | 22 | 61 | 0 | 15 | 99 | -10 | 1679 | 591 | 1291 | 0 | 416 | 2299 | -620 |
| 27 | 86 | 21 | 57 | 1 | 14 | 94 | -8 | 1765 | 612 | 1348 | 1 | 431 | 2394 | -629 |
| 28 | 83 | 20 | 53 | 1 | 13 | 88 | -4 | 1849 | 633 | 1401 | 3 | 444 | 2482 | -633 |
| 29 | 81 | 19 | 47 | 1 | 12 | 80 | +1 | 1931 | 652 | 1449 | 4 | 457 | 2563 | -632 |
| 30 | 79 | 18 | 40 | 1 | 11 | 71 | +8 | 2010 | 670 | 1489 | 6 | 468 | 2634 | -623 |
| 31 | 77 | 17 | 30 | 2 | 11 | 60 | +16 | 2088 | 687 | 1519 | 8 | 480 | 2695 | -607 |
| 32 | 75 | 16 | 23 | 2 | 10 | 52 | +22 | 2163 | 703 | 1543 | 11 | 490 | 2748 | -584 |
| 33 | 73 | 15 | 19 | 2 | 9 | 47 | +26 | 2237 | 718 | 1562 | 13 | 500 | 2795 | -557 |
| 34 | 71 | 14 | 16 | 2 | 9 | 42 | +29 | 2309 | 732 | 1578 | 16 | 510 | 2837 | -528 |
| 35 | 69 | 13 | 12 | 2 | 8 | 36 | +32 | 2379 | 746 | 1591 | 18 | 518 | 2874 | -495 |
| 36 | 68 | 12 | 7 | 2 | 8 | 31 | +36 | 2447 | 758 | 1599 | 21 | 527 | 2906 | -459 |
| 37 | 66 | 11 | 5 | 2 | 7 | 27 | +38 | 2513 | 770 | 1604 | 23 | 535 | 2934 | -420 |
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| 40 | 61 | 10 | 2 | 2 | 6 | 20 | +40 | 2702 | 802 | 1615 | 30 | 556 | 3004 | -302 |
| 41 | 59 | 9 | 0 | 2 | 6 | 18 | +40 | 2761 | 812 | 1616 | 32 | 562 | 3023 | -261 |
| 42 | 58 | 8 | 0 | 2 | 5 | 18 | +39 | 2820 | 821 | 1616 | 34 | 568 | 3041 | -221 |
| 43 | 56 | 8 | 0 | 2 | 5 | 17 | +39 | 2876 | 829 | 1617 | 37 | 574 | 3058 | -181 |
| 44 | 55 | 7 | 0 | 2 | 5 | 16 | +39 | 2931 | 837 | 1617 | 39 | 579 | 3074 | -142 |
| 45 | 53 | 7 | 0 | 2 | 4 | 14 | +38 | 2985 | 845 | 1617 | 42 | 584 | 3089 | -103 |
| 46 | 52 | 7 | 0 | 2 | 4 | 14 | +38 | 3037 | 852 | 1617 | 44 | 589 | 3103 | -65 |
| 47 | 50 | 6 | 0 | 1 | 4 | 12 | +38 | 3088 | 859 | 1617 | 46 | 593 | 3116 | -27 |
| 48 | 49 | 6 | 0 | 1 | 4 | 12 | +37 | 3138 | 865 | 1617 | 47 | 597 | 3128 | +9 |
| 49 | 48 | 5 | 0 | 1 | 3 | 11 | +36 | 3186 | 871 | 1617 | 49 | 601 | 3140 | +46 |
| 50 | 47 | 5 | 0 | 1 | 3 | 10 | +36 | 3234 | 876 | 1617 | 50 | 605 | 3150 | +83 |

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X= 0

< CASH FLOW ANALYSIS >

| YR | BNFT | CW | CC | RC | OM | COST | CSFL | AC. BF | AC. CW | AC. CC | AC. RC | AC. OM | AC. CS | AC. CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | +0 | 0 | 0 | 0 | 0 | 0 | 0 | +0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | +0 | 0 | 0 | 0 | 0 | 0 | 0 | +0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | +0 | 0 | 0 | 1 | 0 | 0 | 1 | -1 |
| 4 | 0 | 0 | 1 | 0 | 0 | 1 | -1 | 0 | 0 | 2 | 0 | 0 | 2 | -2 |
| 5 | 0 | 0 | 3 | 0 | 0 | 3 | -3 | 0 | 0 | 6 | 0 | 0 | 6 | -6 |
| 6 | 0 | 0 | 7 | 0 | 0 | 7 | -7 | 0 | 0 | 13 | 0 | 0 | 13 | -13 |
| 7 | 0 | 0 | 11 | 0 | 0 | 11 | -11 | 0 | 0 | 25 | 0 | 0 | 25 | -25 |
| 8 | 93 | 51 | 18 | 0 | 32 | 103 | -10 | 93 | 51 | 44 | 0 | 32 | 128 | -35 |
| 9 | 101 | 51 | 34 | 0 | 37 | 123 | -21 | 195 | 103 | 78 | 0 | 70 | 251 | -56 |
| 10 | 111 | 51 | 59 | 0 | 42 | 153 | -42 | 306 | 155 | 138 | 0 | 112 | 405 | -99 |
| 11 | 121 | 51 | 103 | 0 | 46 | 201 | -80 | 427 | 207 | 241 | 0 | 158 | 607 | -179 |
| 12 | 169 | 77 | 140 | 0 | 55 | 273 | -104 | 596 | 284 | 382 | 0 | 214 | 880 | -284 |
| 13 | 184 | 77 | 157 | 0 | 57 | 292 | -107 | 780 | 362 | 539 | 0 | 271 | 1172 | -392 |
| 14 | 199 | 77 | 169 | 0 | 57 | 304 | -105 | 980 | 439 | 708 | 0 | 328 | 1477 | -497 |
| 15 | 215 | 77 | 194 | 0 | 59 | 331 | -115 | 1196 | 517 | 903 | 0 | 388 | 1808 | -612 |
| 16 | 233 | 77 | 223 | 0 | 61 | 363 | -129 | 1429 | 595 | 1127 | 0 | 449 | 2171 | -742 |
| 17 | 289 | 103 | 240 | 0 | 67 | 411 | -121 | 1719 | 698 | 1367 | 0 | 516 | 2583 | -863 |
| 18 | 309 | 103 | 245 | 0 | 68 | 416 | -107 | 2028 | 802 | 1612 | 0 | 585 | 2999 | -971 |
| 19 | 321 | 103 | 250 | 0 | 68 | 422 | -100 | 2350 | 905 | 1863 | 0 | 653 | 3422 | -1071 |
| 20 | 332 | 103 | 264 | 0 | 68 | 436 | -103 | 2682 | 1009 | 2127 | 0 | 721 | 3858 | -1175 |
| 21 | 343 | 103 | 274 | 0 | 68 | 446 | -102 | 3026 | 1112 | 2401 | 0 | 790 | 4304 | -1278 |
| 22 | 354 | 103 | 277 | 0 | 68 | 449 | -94 | 3380 | 1216 | 2679 | 0 | 858 | 4753 | -1373 |
| 23 | 365 | 103 | 276 | 0 | 68 | 448 | -82 | 3746 | 1319 | 2956 | 0 | 926 | 5202 | -1456 |
| 24 | 377 | 103 | 277 | 0 | 68 | 448 | -71 | 4124 | 1423 | 3233 | 0 | 994 | 5651 | -1527 |
| 25 | 390 | 103 | 279 | 0 | 68 | 451 | -61 | 4514 | 1526 | 3512 | 0 | 1063 | 6102 | -1588 |
| 26 | 402 | 103 | 279 | 0 | 68 | 451 | -48 | 4916 | 1630 | 3792 | 0 | 1131 | 6553 | -1637 |
| 27 | 415 | 103 | 277 | 8 | 68 | 458 | -42 | 5332 | 1733 | 4070 | 8 | 1199 | 7011 | -1679 |
| 28 | 429 | 103 | 271 | 8 | 68 | 451 | -22 | 5761 | 1837 | 4341 | 16 | 1268 | 7463 | -1701 |
| 29 | 443 | 103 | 255 | 8 | 68 | 435 | +7 | 6205 | 1940 | 4596 | 25 | 1336 | 7899 | -1694 |
| 30 | 457 | 103 | 230 | 8 | 68 | 410 | +47 | 6662 | 2044 | 4827 | 33 | 1404 | 8309 | -1646 |
| 31 | 472 | 103 | 187 | 12 | 68 | 371 | +101 | 7135 | 2147 | 5014 | 45 | 1472 | 8680 | -1545 |
| 32 | 487 | 103 | 149 | 17 | 68 | 339 | +148 | 7623 | 2251 | 5164 | 63 | 1541 | 9020 | -1396 |
| 33 | 503 | 103 | 132 | 17 | 68 | 321 | +181 | 8127 | 2354 | 5296 | 81 | 1609 | 9342 | -1215 |
| 34 | 520 | 103 | 119 | 17 | 68 | 309 | +211 | 8647 | 2458 | 5415 | 99 | 1677 | 9651 | -1004 |
| 35 | 537 | 103 | 94 | 17 | 68 | 284 | +252 | 9184 | 2561 | 5510 | 117 | 1746 | 9935 | -751 |
| 36 | 554 | 103 | 64 | 21 | 68 | 257 | +297 | 9738 | 2665 | 5575 | 138 | 1814 | 10192 | -454 |
| 37 | 572 | 103 | 47 | 21 | 68 | 240 | +332 | 10311 | 2768 | 5622 | 159 | 1882 | 10433 | -122 |
| 38 | 591 | 103 | 42 | 21 | 68 | 235 | +356 | 10902 | 2872 | 5664 | 180 | 1950 | 10668 | +233 |
| 39 | 610 | 103 | 36 | 21 | 68 | 228 | +381 | 11512 | 2975 | 5701 | 201 | 2019 | 10897 | +615 |
| 40 | 630 | 103 | 21 | 21 | 68 | 214 | +415 | 12142 | 3079 | 5722 | 222 | 2087 | 11111 | +1030 |
| 41 | 650 | 103 | 10 | 22 | 68 | 205 | +445 | 12793 | 3182 | 5733 | 245 | 2155 | 11317 | +1476 |
| 42 | 671 | 103 | 6 | 31 | 68 | 209 | +462 | 13465 | 3286 | 5740 | 276 | 2224 | 11526 | +1938 |
| 43 | 693 | 103 | 6 | 31 | 68 | 209 | +483 | 14158 | 3389 | 5747 | 307 | 2292 | 11736 | +2422 |
| 44 | 716 | 103 | 5 | 31 | 68 | 208 | +507 | 14874 | 3493 | 5753 | 338 | 2360 | 11945 | +2929 |
| 45 | 739 | 103 | 2 | 31 | 68 | 205 | +533 | 15614 | 3596 | 5756 | 369 | 2428 | 12150 | +3463 |
| 46 | 763 | 103 | 0 | 34 | 68 | 207 | +556 | 16377 | 3700 | 5756 | 403 | 2497 | 12358 | +4019 |
| 47 | 788 | 103 | 0 | 26 | 68 | 198 | +590 | 17166 | 3803 | 5756 | 430 | 2565 | 12556 | +4609 |
| 48 | 813 | 103 | 0 | 26 | 68 | 198 | +615 | 17980 | 3907 | 5756 | 456 | 2633 | 12754 | +5225 |
| 49 | 840 | 103 | 0 | 26 | 68 | 198 | +642 | 18820 | 4010 | 5756 | 483 | 2702 | 12952 | +5867 |
| 50 | 867 | 103 | 0 | 26 | 68 | 198 | +669 | 19688 | 4114 | 5756 | 509 | 2770 | 13151 | +6537 |

BC.RT= 149.707911986

# CHAPTER V. RECOMMENDATIONS

# CHAPTER V. RECOMMENDATIONS

## 5.1. Survey and Investigation

### 5.1.1. Topographic Survey and Mapping

The following topographic survey and mapping shall be undertaken prior to and of during detailed design stage of the project implementation by the Government of Pakistan.

A. Topographic Map along Tunnel Route

The mapping of tunnel route shall be made based on the following specifications prior to commencement of detailed design works. The mapping works will be able to produce from aerophotograph which has been made by the Survey of Pakistan.

| | | |
|---|---|---|
| Mapping area | : | 3.0 km width along proposed tunnel route |
| Scale of mapping: | | 1:5,000 |
| Contour interval: | | 20 feet or 5 m |

B. Topographic Survey and Mapping at Major Facilities

Topo-map for major facilities such as water treatment plant, pumping station, service reservoir, intake tower, vertical shaft of tunnel as well as appurtenant structure along pipeline shall be made with scale 1:500 to 1:1,000 during detailed design stage.

### 5.1.2. Geological Investigation

Geological survey for No.1 and No.2 tunnel and major facilities shall be undertaken during detailed design stage by the execution agencies of Pakistan and consultants. Summary of the survey items and quantities, concepts and specifications are described as under.

A. Geological survey of tunnels

The following survey such as seismic survey, drilling, permeability test, geological and hydro-geological reconnaissance and rock test shall be executed to clarify conditions of rock mass and groundwater along the proposed tunnel routes.

Seismic survey and geological reconnaissance shall be made to picturize approximate conditions of rock mass along the tunnel routes. Seismic survey shall be made by refractive method. Drilling of proposed holes shall be made to examine the conditions of rock mass around tunnel portals, vertical shafts and faults. Drilling shall be carried out to take all cores as much as possible with appropriate tools such as double core tubes, and all cores shall be preserved. Permeability test at the drilling hole and hydrogeological reconnaissance shall be made to confirm the conditions and quantity of groundwater around mountain area of proposed tunnel routes. Method of permeability test shall be executed principally to the length of 20 - 30 m of drilling holes around the tunnel center to be excavated by means of pressure test. At the vertical shaft sites, however, it shall be made to the full length of its drilling holes. The interval of the tests shall be principally 5 m.

The rock tests shall be carried out to know engineering characteristic of rocks, and shall include uniaxial pressure test, supersonic velocity measurement and specific gravity measurement.

The geological maps shall be prepared to cover the area of 500 m on both side of the tunnel routes with scale 1:5,000.

Hydrogeological reconnaissance shall clarify conditions of groundwater in the mountain around the tunnel routes through observation of discharge on the streams and springs taking account of rainfall data.

Locations of the survey area shown in Figure VII-1 and approximately quantities of the respective survey are shown as below:

(1) Seismic Survey

| Line No. | Length of Line | Location |
|---|---|---|
| S-1 | 1,200 m | Along Tunnel-1 |
| S-2 | 4,560 | Along Tunnel-2-1 |
| S-3 | 7,920 | Along Tunnel-2-2 and 2-3 |
| S-4 | 720 | Depression North of Chhoi |
| S-5 | 720 | Depression South of Chhoi |
| S-6 | 960 | Across Vertical Shaft No.1 |
| S-7 | 960 | Across the fault near Sabra |
| S-8 | 720 | Alluvium Area near Chauntra |
| S-9 | 720 | Ditto |
| Total | 18,480 | |

(2) Drilling and Permeability Test

| Line No. | Depth | No. of Test | Location |
|---|---|---|---|
| B-1 | 15 m | 3 times | Intake Tower |
| B-2 | 20 | - | Tunnel-1 (Outlet) |
| B-3 | 70 | 6 | Depression North of Chhoi |
| B-4 | 60 | 6 | Depression South of Chhoi |
| B-5 | 120 | 24 | Vertical Shaft No.1 |
| B-6 | 75 | 14 | Vertical Shaft No.2 |
| B-7 | 60 | 6 | Alluvium Area near Chauntra |
| B-8 | 50 | 6 | Ditto |
| B-9 | 40 | 4 | Ditto |
| Total | 510 | 69 | |

Note: Standard penetration test shall be carried out to the unconsolidated layers of B-2, B-7, B-8 and B-9.

(3) Rock Tests

Rock tests shall be carried out to 18 samples in total for two samples from each holes.

B. Geological Survey of Major Facilities

The following geological survey of the major facilities shall be executed during detailed design stage.

(1) Drilling

| Facilities | No. of Hole and Length |
|---|---|
| 1. Water Treatment Plant | |
| - Flocculation and Sedimentation Basin | 8 holes x 20 m = 160 m |
| - Rapid Sand Filter Basin | 4 " x 20 m = 80 m |
| - Administration Building | 1 " x 20 m = 20 m |
| - Clear Water Reservoir | 2 " x 20 m = 40 m |
| 2. Pumping Station | 2 " x 25 m = 50 m |
| 3. Service Reservoir (H-11) | 4 " x 20 m = 80 m |
| Total | 21 holes 430 m |

(2) Standard Penetration Test

The standard penetration test shall be made at respective holes with interval of each two meters.

(3) Physical Soil Test

The following items on the soil test shall also be carried out to 12 samples in total from six sites of proposed facilities.

| Item | Test Samples |
|---|---|
| Water Content | 6 holes x 2 samples |
| Liquid & Plastic Limits | Ditto |
| Grain Size Analysis | Ditto |
| Specific Gravity | Ditto |
| Consolidation Test | Ditto |
| Uniaxial Compression Test | Ditto |

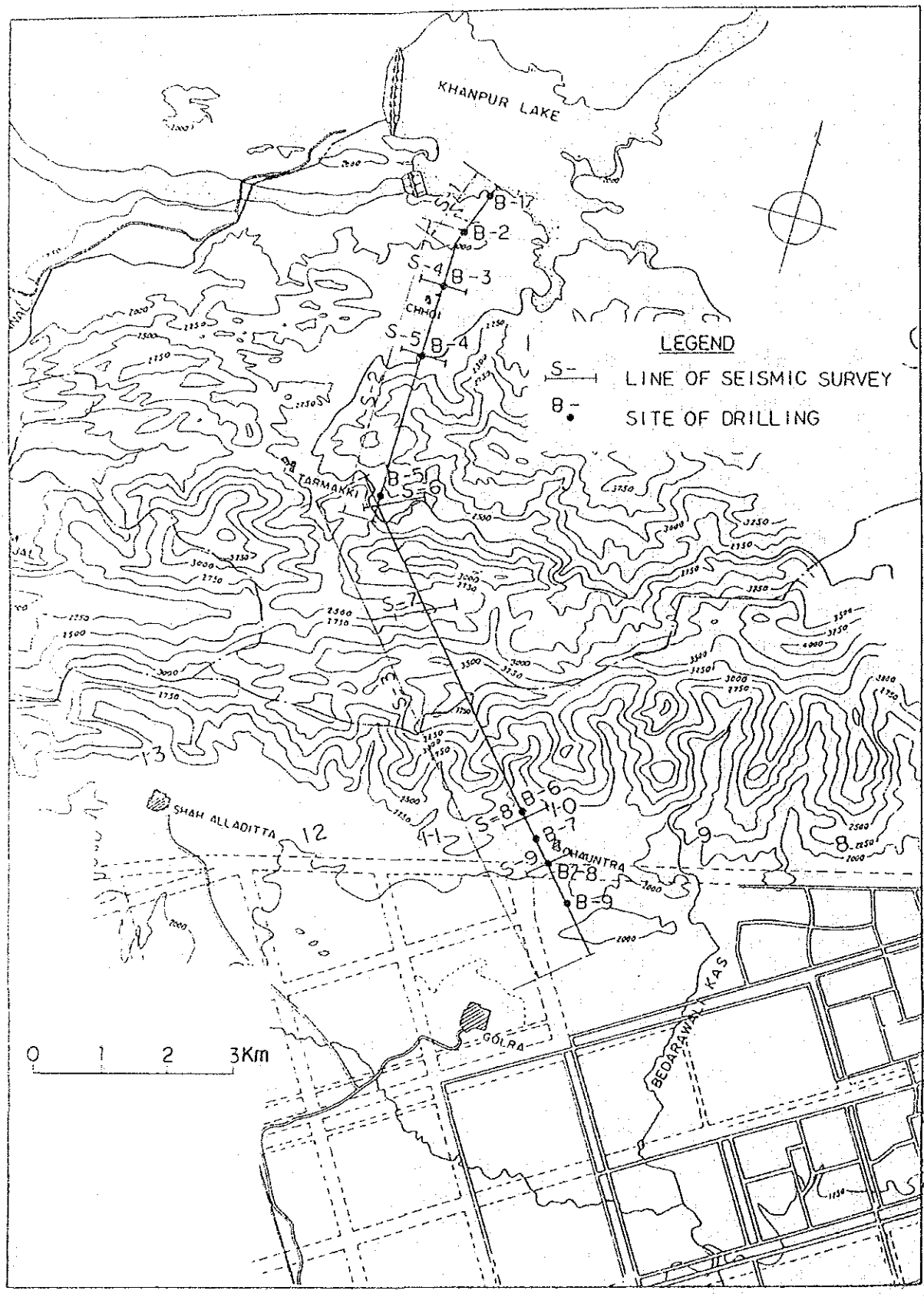


FIGURE C.V-1 LOCATION MAP OF GEOLOGICAL SURVEY OF PROPOSED TUNNEL ROUTE

# CHAPTER VI. MAJOR RECORDS OF MEETING AND CONFIRMATIONS

# CHAPTER VI. MAJOR RECORDS OF MEETING AND CONFIRMATIONS

## 6.1. General

Major records of discussion meeting and confirmations during course of field study in Pakistan are summarized in this chapter as a reference. The list of records and confirmations is shown as under.

| Reference No. | Description |
|---|---|
| RDC-01 | Construction schedule of Islamabad development |
| -02 | Beneficiary area in Rawalpindi district |
| -03 | Agreement of Khanpur water allocation in respective consumers |
| -04 | Minutes of meeting on the water balance of Khanpur water (1) |
| -05 | Ditto (2) |
| -06 | Confirmation on the minute of RDC-05 |
| -07 | Confirmation of study result on water balance of Khanpur water |
| -08 | Staged development plan of Khanpur water |
| -09 | CDA comments on comparative study of conduction main and appurtenant structures on Khanpur water supply system |
| -10 | Reply to CDA' comments on RDC-09 |