Chapter - 10

Construction Program, Manpower Deployment and Plant Planning

10.0 General

This chapter describes the construction methodology and equipment planning for construction of the main components under Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link project. The construction methodology for major components has been described under the relevant sub sections of this chapter. The type and sizes of the equipment to be used have also been indicated while describing the construction methodology. The number of machines required for construction of each major component of the project has been worked out and total requirement for each type and size of the major equipment has been arrived at after preparing the construction/ deployment schedule for main components of the project. In case, the work is executed through award of contract, the contractors in all probability may suggest their own construction techniques and equipment for execution of the job based on equipment actually available with them. The tentative requirement of machines as worked out herein will help in the analysis of rates of works, cost estimation and in evaluating the reasonableness of the participating bidders' construction techniques and equipment, within overall construction schedule and cost estimate.

10.1 Objective of the Project

The "Wainganga (Gosikhurd) – Nalganga (Purna Tapi)" link project is an intrastate river link project envisaging to divert water from Gosikhurd on Wainganga river to serve the areas in Wainganga and Wardha sub-basins of Godavari basin and Purna Tapi sub-basin of Tapi basin of Vidarbha region.

The link project envisages diversion of 1772 Mcum from the existing Gosikhurd (Indira Sagar) project (first National Project in the country) on Wainganga river in Pranhita sub-basin of Godavari basin for extending irrigation, domestic and industrial water supply benefits in six districts of Vidarbha region of Maharashtra State viz. Nagpur, Wardha, Amravati, Yeotmal, Akola & Buldhana before outfalling into Nalganga project on Nalganga river in Tapi basin.

The link canal will bring additional areas to an extent of 371277 ha under irrigation besides providing drinking and industrial water supply in Vidarbha region. The link canal envisages to serve the command areas lying in upper reaches through pumping and feeding proposed storages/tanks enroute, which could not possibly be served through conventional projects. The scheme will help in removing the backlog in irrigation development in Vidarbha region by meeting the demands of one of the most water short areas in the country lying in Akola, Buldhana and Amravati districts apart from other three districts of Nagpur, Wardha and Yeotmal. This link project is thus likely to bring economic prosperity to the acute water short, drought-prone command area lying in the vicinity of the link project in the Vidarbha region.

10.2 Main Project Components

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project envisages construction of the following main components at the DPR preparation stage:

i) Head works at existing Gosikhurd reservoir (FRL 245.5 m) across Wainganga river for a peak discharge of 347.2 cumec.
ii) 426.54 km long canal off taking from existing Gosikhurd reservoir to Nalganga reservoir, comprising of open canal, pipe lines & tunnels
iii) Lifting arrangements through 6 stages of lifting 23.25 m (RD 2.4 to 2.9 km), 23.5 m (RD 20 to 20.9 km), 29.25 m (RD 39.9 to 42.7 km), 28 m (RD 169.6 to 170.4 km), 30 m (RD 176.9 to 178.1 km) and 21.25 m (RD 292.85 to 293.7 km) totaling to 155 m of static lift
iv) Canal falls at two locations at RD 302.925 km (7 m) and RD 426.425 km (6 m) to dissipate the available excess head and reduce quantum of filling
v) Pipelines for total 25.978 km length in 11reaches viz., RD 27.40 km (1210 m), RD 44 km (553 m), RD 49.65 km (1937 m), RD 60.05 km (9783 m), RD 83.6 km (3485 m), RD 87.7 km (1819 m), RD 93.4 km (3551 m), RD 112.45 (1111 m), RD 257.1 km (500 m), RD 363.88 km (1698 m) and RD 370.48 km (331 m)
vi) Seven tunnels for a cumulative length of 13.826 km located at RD 73.50 km (3317 m), RD 141.45 km (776 m), RD 150.25 km

(6489 m), RD 298.975 km (667 m), RD 371.525 km (781 m), RD 406.075 km (948 m) and RD 411.775 km (848 m)

vii) Out fall structures and Head regulators for integration of existing reservoirs of Lower Wardha and Katepurna

viii) Raising of six existing storages to accommodate additional waters through link canal

ix) Construction of 31 new storages along the link alignment to receive diverted waters

x) 22 nos. of Feeder canals/Direct sluices for integration of 38 existing/ proposed intermittent storages along the alignment

xi) Subsidiary lift arrangements from main link canal to feeder canals at RD 115.45 km (7 m), RD 147.55 km (5 m), RD 150.00 km (10 m), RD 246.30 km (10 m) and RD 377.13 km (8 m)

xii) Cross drainage/cross masonry and regulating works across the link canal (582 nos.)

xiii) Command area development of about 371277 ha in Nagpur, Wardha, Yeotmal, Amravati, Akola and Buldhana districts

xiv) Canal top solar power generation arrangement (Estimated potential -1884 MW) at appropriate reaches along the link canal alignment.

xv) Outfall structure at existing Nalganga reservoir on Nalganga river, a tributary of Purna Tapi with FRL 294.44 m

10.3 Basis for Study

10.3.1 General

Methodology adopted for construction of "Wainganga (Gosikhurd) – Nalganga (Purna Tapi)" link Project takes into consideration the construction schedule, the compatibility of the construction equipment to site conditions and the quantities as well as the utilization factor of the equipment within the scheduled construction period. Number of machines required for construction of major components of the project has been worked out and the total requirement for each type and size of machine for the project as a whole has been arrived at after drawing up the construction/deployment schedule for the main components of the project.

Mechanized construction has been planned for almost all types of construction jobs so as to achieve consistent quality at a faster rate and also to

minimize the requirement of skilled manpower. Moreover, very high degree of quality standards are required to be maintained as underground works are normally not available for regular maintenance after the completion.

Sequencing of construction activities, wherever possible, has been attempted in such a way that equipment from one activity, on its completion can be shifted to the other. This way, the total requirement of equipment at a time would be reduced and also, sufficient utilization of equipment on the project would be ensured.

10.3.2 Construction Material Sources

Locations of different borrow areas and quarries for construction material with respect to the location of the main canal have been described in the Chapter - 4 on "Surveys and Investigations".

Suitable fill material would be adequately available for the main link canal, feeder canals, CD/CM structures, enroute storages, lifting arrangements etc. in the borrow areas/quarries identified along the link canal. Construction material for concrete, viz. sand/fine aggregate, rock/coarse aggregate, for both non-wearing and wearing surfaces are also located in the vicinity of project site.

Locations of all rock/sand quarry sites visited by CSMRS, New Delhi corresponding to different locations along the link alignment with respective lead distance have been shown in **Table-10.1**.

Table-10.1
Locations of Rock /Sand Quarry Sites along the Link Alignment

Sl. No.	Name of the Project	Location of Rock/Sand Quarry Site	Distance from Link Canal
I	**Gosikhurd to Lower Wardha (Phase-I) Nagpur & Wardha districts**		
A	**Rock Quarry**		
1	Surgaon	Adjacent to the link (22 km from Nagpur)	Adjacent.
2	Sawangi -Deoli	Right of the link canal.	5 km.

3	Haladgaon	Just right side of the Nagpur-Wardha road and left of the link canal	4 km
4	Keljhar	1km away from the Nagpur-Wardha road and left of the link canal	5 km
5	Yelakeli	7 km from the Wardha district and left of the link canal	20 km.
6	Sorta	Left side of the Arvi – Pulgaon road and left of the link canal	25 km.
B	**Sand Quarry**		
1	Binaghat	Confluence point of Kanhan and Pench rivers	57 km
2	Wadhona	Near Wadhona village on the left bank of the Kanhan river	17 km
3	Saikheda	On left bank of Wardha river about 3.5 km d/s of Lower Wardha dam	6 km
II	**Lower Wardha to Nalganga (Phase-II) Amravati, Akola and Buldhana districts**		
A	**Rock Quarry**		
1	Sonegaon	1.5 km from Chandur railway	4 km
2	Palskhed	2 km from Chandur railway	5 km
3	Masood	16 km from the link canal	16 km
4	Borgaon Manju	20 km from the link canal	20 km
5	Mathni	2 km from the link canal	2 km
6	Tembhurna	Adjacent to the link	Adjacent
7	Yeota	Akola-Malkapur	16 km
B	**Sand Quarry**		
1	Bhatkuli	Near Bhatkuli village on the bank of Pedhi river and right side of link canal	16 km

2	Hivra Korde	Near Hivra Korde village on the bank of Pedhi river and right side of link canal	12 km
3	Bhastan	On the bank of Purna river and right side of the link canal	30 km
4	Yerli	Near Yerli village on the bank of Purna river	30 km

However, during the construction, appropriate decision may have to be taken to select the borrow areas in the vicinity of the link project which meet the requisite specifications. The area for disposal of excavated material has been considered at an average distance of 1.0 km from the proposed canal & other structures for equipment planning purpose. Also, an average lead of 2.0 km has been considered in fetching fill material to the link canal from the borrow areas.

10.3.3 Basic Considerations

Based on past experience, about 8 working months in a year are available in the area where the project is situated. Other projects in the region have also been planned with this consideration. All the surface works are proposed to be executed in two shifts.

10.3.3.1 Scheduled Working Hours

Equipment planning for calculating requirement of equipment is carried out based on the number of working days available, which further depends upon climatic conditions of the project area. In the present scenario, the monsoon sets in during June and continues till October in the project area. Therefore, for equipment planning purpose the monsoon season has been considered from 15th June to 15th October. Thus, for over ground works i.e. construction of link canal, proposed storages and appurtenant works a working season of eight months would be available. The scheduled working hours considering 25 working days per month as per the ‘Guidelines for preparation of DPR of Irrigation and Multi-purpose Projects-2010’ work out as under:

Type of Work/ Type of shift	**Over ground works (hour)**
Single shift work/day	8x25x6 =1,200 Hrs
Two shift work/day	8x25x10 =2,000 Hrs

Two shifts working of equipment is normally considered the most economical in view of the high cost of three shift working on account of low availability of equipment and higher stand-by equipment requirement. Thus planning for all over ground works has been carried out based on two shifts per day working.

Provision of stand by equipment has been considered as follows:

1. Single shift working 10%
2. Two shift working 20%

10.3.3.2 Construction Program

A construction period of 5 years has been planned to complete all the works beginning with preliminary works. The infrastructural development, pre-construction surveys and investigations, preparation of design specifications and tender documents are proposed to be completed during first year. Detail design & drawing work are also expected to be completed in last two quarters of first year. In case the works are to be executed through award of contract, it is planned to award contracts for all major works in the last two quarters of 1st year. Establishment of infrastructure facilities including widening of access roads, construction of project roads as well as office and residential complex can be completed in first one and half year. Land acquisition for the canal and proposed storages is planned to be completed during second to fourth quarters of the first year. Construction of the main canal which involves stripping/site clearance, foundation excavation, construction of embankments of canal, lining, construction of cross drainage/cross masonry structures and feeder canals/sluices are proposed to be commenced from fourth quarter of the first year and completed by second quarter of fifth year. Construction of proposed 31 storage tanks and raising of six existing storages which includes river diversion works, excavation, consolidation, grouting, construction of embankment, spillways and erection of gates are expected to be carried out from fourth quarter of the first

year to second quarter of fifth year. These works pertaining to the storage tanks are proposed to be undertaken by the WRD, Govt. of Maharashtra. The various works pertaining to proposed lifts in the main canal viz. excavation, construction of sump, delivery cistern and pump house, laying of raising mains, erection of electro mechanical equipment are proposed to be completed during the period from the first quarter of second year to second quarter of fifth year. The excavation and muck disposal, shotcreting and grouting, tunnel lining, portal formation & slope stabilization in respect of the seven tunnels proposed along the link alignment shall be undertaken from the first quarter of the 2nd year and could be completed by the end of third quarter of fifth year. The earth work excavation, construction of inlet and outlet bays and laying of pipe lines in respect of the eleven pipe line reaches proposed in the canal alignment are also proposed to be commenced in the first quarter of second year and is planned to be completed by second quarter of fifth year. It is proposed to divide the entire length of the link canal into number of segments and take up the work in all the segments simultaneously so that the total work can be completed within the planned time period.

The detailed construction schedule for the project in the form of a bar chart is attached as **Annexure-10.1**.

10.4 Construction Methodology and Equipment Planning

The construction methodology and equipment planning in line with the planned construction programme for different components of the project have been described in the succeeding sub-sections.

10.4.1 Wainganga – Nalganga Link Canal

Main activities to be undertaken for construction of the canal system are main canal, cross drainage/cross masonry works, pipe lines, lifts, tunnels, canal/tunnel lining etc. The construction of the canal system involves excavation, placement of fill materials, spreading and wetting and compaction of the fill materials.

10.4.1.1 Main Canal Excavation

Total quantity of main canal excavation is about 7,82,91,311 m^3, out of which soft soil is 3,87,46,363 m^3, 1,55,815 m^3 is murum / weathered rock and the remaining 3,93,89,133 m^3 is hard rock. The dumping site for disposal of excavated material is proposed at an average distance of 1.0 km. On the other hand, the fill placement is estimated to be about 6,72,45,861 m^3, out of which about 28,28,251 m^3 can be met from spoil banks and the net requirement from borrow area shall be 6,44,17,610 m^3. The quantities of different activities for the construction of main canal are shown in **Table -10.2**.

Table – 10.2

Quantities of Different Activities for Construction of Main Canal

Description of Work	**Type / Material**	**Quantity, in-situ**	**Unit**
Excavation	Total quantity	7,82,91,311	m^3
	Soft soil	3,87,46,363	m^3
	Murum and weathered rock	1,55,815	m^3
	Dense medium rock	0	m^3
	Hard rock	3,93,89,133	m^3
Fill placement	Total quantity	6,72,45,861	m^3
	Met from spoils	28,28,251	m^3
	Net required from borrow area	6,44,17,610	m^3

The earth work involves both common excavation in overburden and rock. Three working seasons have been earmarked for undertaking excavation. The estimation of hourly quantities of soil/rock involved in surface excavation for main canal which provision of equipment is to be made is given in **Table –10.3**

Table – 10.3

Estimation of Hourly Quantity for Canal Excavation

Description of work	**Soft Soil**	**Murum/Weathered/Dense medium rock and Hard Rock**
Total Volume (cum)	3,87,46,363	3,95,44,948
Time period (months)	36	36
No. of years/ seasons	3	3
Shifts proposed /day	2	2

Total Operational hours per one season	2,000	2,000
Work load / season (m^3)	1,29,15,454	1,31,81,649
Peak work load / season (m^3)	1,61,44,318	1,64,77,062
Peak work load / hr (m^3)	8,072	8,239

Total quantity of soft soil and murum/hard rock - 16311m^3/hr.

10.4.1.2 Pipe Lines

The pipe lines are proposed to be laid on the concrete bed just about one metre below the ground. Therefore, the earth work involves excavation mainly in overburden and only to some extent in rock. Total quantity of excavation involved is about 15,95,579 m^3 out of which soft soil is 14,14,050 m^3 while the hard rock is 1,81,529 m^3. The fill placement is mainly involved in the construction of transition phases from canal to pipe lines and vice versa i.e. inlet and outlet bays, which is estimated to be 3,61,204 m^3. The quantities of different activities for the construction of pipe lines are shown in **Table -10.4**.

Table – 10.4
Quantities of Different Activities for Construction of Pipe lines

Description of Work	**Type / Material**	**Quantity, in-situ**	**Unit**
Excavation	Total quantity	15,95,579	
	Soft soil	14,14,050	m^3
	Murum and weathered rock	0	m^3
	Dense medium rock	0	m^3
	Hard rock (requiring blast)	1,81,529	m^3
Fill placement	Total quantity	3,61,204	m^3
	Met from spoils	0	m^3
	Net required from borrow area	3,61,204	m^3

One and a half working seasons have been earmarked for undertaking excavation of pipe lines. The estimation of hourly quantities of soil/rock involved in excavation of pipe lines for which provision of equipment is to be made is given in **Table –10.5**.

Table – 10.5
Estimation of Hourly Quantity of Pipe Lines Excavation

Description	Soft Soil	Murum/Weathered/ Dense Medium Rock & Hard Rock
Total volume (m^3)	14,14,050	1,81,529
Time period (months)	18	18
No. of years/seasons	1.5	1.5
Shift proposed	2	2
Total operational hours (hour) for one season	2,000	2,000
Work load / season (m^3)	9,42,700	1,21,019
Peak work load / season (m^3)	11,78,375	1,51,274
Peak work load / hr (m^3)	589	76

Total peak work load for soft soil and hard rock – 665 m^3/hr.

10.4.1.3 Tunnels

The tunnels are mainly proposed where deep cut reaches are encountered in the canal alignment. Therefore, the construction of tunnels involves excavation mainly in rock for the main tunnel. The estimated muck from the construction of main tunnels is estimated to be about 15,31,211 m^3. In addition, in the transition reaches from canal to tunnel and vice versa i.e. near the entry and exit of the tunnels, the excavation comprises of mostly overburden and to some extent weathered/hard rock. The quantity of excavation involved in transition reaches is about 5,59,090 m^3 out of which soft soil is 4,01,668 m^3, murum/weathered rock is 31,484 m^3 and hard rock is 1,25,938 m^3. The quantities of different activities for the construction of tunnels are shown in **Table -10.6**.

Table – 10.6
Quantities of Different Activities for Construction of Tunnels Excavation

Description of Work	Type / Material	Quantity, in-situ	Unit
Excavation	Total quantity	5,59,090	
(Transition reaches)	Soft soil	4,01,668	m^3
	Murum and weathered rock	31,484	m^3
	Dense medium rock	0	m^3

	Hard rock	1,25,938	m^3
Muck (Main tunnels)	Total quantity (Hard rock)	15,31,211	m^3

The equipment planning for the construction of main tunnels has not been carried out in the present DPR. Tunnel boring machines can be considered for this purpose which will be arranged by the firm/company to which the contract is awarded. Three working seasons have been earmarked for undertaking excavation in the tunnels. The estimation of hourly quantities of soil/rock involved in excavation of transition reaches (excluding main tunnels) for which provision of equipment is made is given in **Table –10.7**.

Table – 10.7
Estimation of Hourly Quantity of Excavation in Transition Reaches of Tunnels

Description	**Soft soil**	**Murum/Weathered/Dense Medium Rock & Hard Rock**
Total volume (cum)	4,01,668	1,57,422
Time period (months)	36	36
No. of years/ seasons	3	3
Shift proposed	2	2
Total operational hours (hour) for one season	2,000	2,000
Work load / Season (m^3)	1,33,889	52,474
Peak work load / Season(m^3)	1,67,362	65,593
Peak work load / hr (m^3)	84	33

Total peak work load for soft soil and murum/hard rock – 117 m^3/hr.

10.4.1.4 Lifts

Total quantity of excavation involved in the proposed lifts at six locations in the main link canal is about 40,65,014 m^3, out of which soft soil is 11,38,903 m^3. The major part of excavation is hard rock to an extent of 29,26,111 m^3. The minor fill placement is required for construction of Delivery cisterns/chambers which is estimated to be 10,832 m^3. The quantities of different activities for the construction of lifts in the main canal are shown in **Table -10.8**.

Table – 10.8

Quantities of Different Activities for Construction of Lifts in Main Canal

Description of Work	**Type / Material**	**Quantity, in-situ**	**Unit**
Excavation	Total quantity	40,65,014	
	Soft soil	11,38,903	m^3
	Murum and weathered rock	0	m^3
	Dense medium rock	0	m^3
	Hard Rock requiring blasting	29,26,111	m^3
Fill placement (For Delivery Cisterns/Chambers)	Total quantity	10,832	
	Met from spoils	0	m^3
	Net required from borrow area	10,832	m^3

Two and a half working seasons have been earmarked for undertaking excavation in the lifts in main canal. The estimation of hourly quantities of soil/rock involved in excavation of the lifts for which provision of equipment is made is given in **Table –10.9**.

Table – 10.9

Estimation of Hourly Quantity of Lifts Excavation

Description	**Soft soil**	**Murum/Weathered/ dense medium rock& hard rock**
Total volume (cum)	11,38,903	29,26,111
Time period (months)	30	30
No. of years/seasons	2.5	2.5
Shift proposed	2	2
Total operational hours (hour) for one season	2,000	2,000
Work load / season (m^3)	4,55,561	11,70,444
Peak work load / season (m^3)	5,69,452	14,63,056
Peak work load / hr (m^3)	285	732

Total peak work load for soft soil and hard rock – 1017 m^3/hr.

10.4.1.5 Enroute Storages

The enroute storages will be finalised by Govt. of Maharashtra after detailed surveys & investigations. Therefore, the information on the programme of excavation / remodeling of the proposed intermediate storages and its feeder branch canals shall be provided by the Govt. of Maharashtra. Hence, no equipment planning for the present has been considered towards construction of the storages. Also, no formal river diversion arrangement has been provided on this account. The diversion arrangement during project construction will be evolved depending upon the requirement.

10.4.1.6 Head Works and Outfall Points

Total quantity of excavation involved in the proposed head regulators at Gosikhurd, Lower Wardha and Katepurna reservoirs is about 1,25,751 m^3, out of which soft soil is 27,261 m^3. The major part of excavation is hard rock to an extent of 98,490 m^3. The minor fill placement required for construction of head regulators is proposed to be obtained from the spoil banks. The quantities of different activities for the construction of head regulators are shown in **Table - 10.10**.

Table – 10.10
Quantities of Different Activities for Construction of Head Regulators

Description of Work	**Type / Material**	**Quantity, in-situ**	**Unit**
Excavation	Total quantity	1,25,751	
	Soft soil	27,261	m^3
	Murum and weathered rock	0	m^3
	Dense medium rock	0	m^3
	Hard Rock requiring blasting	98,490	m^3
Fill placement (For Delivery Cisterns/Chambers)	Total quantity	The minor fill placement will be made from spoil banks	
	Met from spoils		m^3
	Net required from borrow area		m^3

No separate planning for the equipment for head works at off take point and out fall point and at the two balancing reservoirs has been made as it is

presumed that the number of equipment kept as standby in other major activities would be adequate for the purpose .

10.4.2 Fill Placement

The fill placement as indicated in Tables 10.2, 10.4 & 10.8 in respect of canal, pipe lines and lifts respectively will require excavation and loading of material at the borrow areas/quarries, transportation of the material to the placement site, unloading, spreading, wetting and compaction. The average distance of borrow area from the construction sites is taken as about 2 km.

10.4.3 Concreting in the project

The concreting works involved in various major components of the link project are as under:

Sl. No.	Component	Quantity (m^3)
1	Canal (lining)	14,94,154
2	Pipe lines	19,20,637
3	Tunnels	2,28,821
4	Lifts	5,78,190
5	Head Regulators	9,044
	Total	42,30,846

The total quantum of concreting involved in the project is 42,30,846 m^3.

10.4.4 Proposed Construction Methods

(i) Surface Excavation: Following construction methods are proposed for surface excavations in connection with the major construction activities viz. canal, pipe lines, tunnels and lifts:

- Excavation and loading of soil by 3.0 m^3 capacity Hydraulic Excavators assisted by front end loader (shovel).
- Transportation of the excavated material to the disposal area by 18.12 m^3 (31.75 Tonnes) capacity Dumper
- Spreading the excavated quantity using Dozers of 275 H.P capacity
- Compaction using Double Drum Sheep foot Rollers of 1.5 m dia of 1.2 m width with 900-100 crawler tractors.

(ii) Hard Rock Excavation: Following construction methods are proposed for excavation in hard rock in connection with the major construction activities viz. canal, pipe lines, tunnels and lifts:

- Drilling by 120 cfm capacity Heavy Duty Jack Hammers
- Providing the air requirements by Air Compressors of 250 cfm / 500 cfm capacity
- Loading and transportation of excavated rock material through Tippers of 4.5 m^3 (6.5 T capacity)

(iii) Placement of Fill Material: Following construction methods are proposed for obtaining and placing the fill material in connection with the major construction activities viz. canal, pipe lines and lifts:

- Excavation and transportation of soil from borrow area using scrapers of 11.50 m^3 and pushers of 250-275 HP
- Spreading the fill material using Dozers of 180 H.P capacity and taking the spread area of 30.48 m (100 ft)
- Wetting the fill by using water tankers of 10,000 litres capacity and water pump of 2,275 litres per minute capacity
- Compaction of the fill by using Self propelled Vibrators Tampering foot Compactors

(iv) Concreting

- Mixing and preparation of concrete using 46.2 m^3/hr mixers
- Concrete transportation by 4.5 m^3 transit mixers
- For concrete lining and concreting works, placing of concrete by 25 m^3/hr concrete pumps
- Preparation of coarse and fine aggregates using aggregate crushing and screening plant of 180 tph

Based on the above methodology, major construction plant and equipment required for construction of link canal, pipe lines, lifts and tunnel transition reaches have been worked out and are given in **Table-10.11**.

Table 10.11
Major Construction Plant and Equipment

Sl. No.	Description	Size/ Capacity	Nos. of Equipment									
			For Canal Excavation		For Excavation of			Embankment of				Total
			Soil	Murum/ Hard Rock	Tunnel	Lift	Pipe lines	Canal	Lift	Pipe lines		
1	Hydraulic Excavator	3.0 m^3	40		1	2	3					**46**
2	Dumper	18.12 m^3 (31.75 Tonne)	158		5	5	10					**178**
3	Dozer	275 HP	46		1	2	4					**53**
4	Double drum sheep foot roller with 900-100 crawler tractors	1.5 m dia., 1.2 m width	92		1	3	7					**103**
5	Jack hammer	120 cfm		1648	7	146	16					**1817**
6(a)	Air compressor	250 cfm		412	4	37	4					**457**
6(b)	Air compressor	500 cfm		206		18	2					**226**
7	Trucks/Tipper	4.5 m 6.5 Tonne		1163	5	103	11					**1282**
8	Scraper	11.5 m^3						408	0	3		**411**
9	Pusher	250-275 HP						82		1		**83**
10	Water tankers/ sprinklers	10000 litres						94	0	1		**95**
11	Dozer 180HP capacity	180 HP						104	0	1		**105**
12	Compactor (self propelled vibrators tampering foot)							56	0	1		**57**
13	Mixer (46.2 m^3/hr)										23	**23**
14	Transit mixer 4.5 m^3										80	**80**
15	Concrete pump 25 m3/hr										38	**38**
16	Aggregate crushing & screening plant of 180 TPH										11	**11**

Note: Each Air compressor of 250 cfm/500 cfm capacity can cater for 2/4 Jack hammers.

10.5 Deployment Schedule

Based on equipment planning and construction programme described in preceding sections, a construction schedule for whole of the project has been prepared in the form of a Bar Chart and is placed at **Annexure-10.1**. Keeping this construction schedule as one of the major criteria, a deployment schedule of major construction equipment required for the project is placed at **Annexure-10.2**. The number of equipment shown in the list has been arrived at after scheduling the equipment in such a way that minimum number of equipment, in general, would be needed. The basis for planning, indicating the type of equipment to be used, has already been dealt with in the respective sections and sub-sections corresponding to different items of the structures. As the deployment schedule may differ depending upon the number of executing agencies, the total number of equipment required will have to be reviewed at the time of project execution.

10.6 Manpower Planning

10.6.1 Organisation Setup

The project will be implemented under an organisation set-up headed by an officer of the rank of General Manager. The works will be executed under the overall supervision of six Officers of the rank of Chief Engineers who will report to the General Manager. In addition, there will be six officers of the rank of Superintending Engineer to assist the GM: Director (Administration), Director (Finance), Director (Technical Coordination) and Director (EMP and R&R), Public Relations Officer and Labour Welfare Officer. Each will be assisted by appropriate subordinate officers and staff. The organisation chart for the project is appended as **Annexure -10.3** in Volume - II. The six Chief Engineers for the Project to look after the works are Chief Engineer (Designs), Chief Engineer (Reach-I), Chief Engineer (Reach-II), Chief Engineer (Reach-III), Chief Engineer (Storages-I) and Chief Engineer (Storages-II). Chief Engineer (Designs) will be supported by 4 officers of the rank of Superintending Engineer, three for design units and one for Quality control; Chief Engineer (Reach-I) will take care the first reach of the link alignment from Gosikhurd to Lower Wardha. He will be supported by 3 officers of the rank of Superintending Engineer; One Superintending Engineer will be responsible for Earth work and construction of canal in Nagpur district; Second Superintending Engineer will be responsible for

Earth work and construction of canal in Wardha district and the third Superintending Engineer will look after the construction of CD/CM structures and Colony and Stores in the reach. Chief Engineer (Reach-II) will take care the second reach of the link alignment from Lower Wardha to Katepurna. He too will be supported by 3 officers of the rank of Superintending Engineer. One Superintending Engineer will be responsible for Earth work and construction of canal in Amravati and Washim districts; Second Superintending Engineer will be responsible for Earth work and construction of canal in Akola district upto Katepurna and the third Superintending Engineer will look after the construction of CD/CM structures and Colony and Stores in the reach. Chief Engineer (Reach-III) will take care the third reach of the link alignment from Katepurna to Nalganga. He too will be supported by 3 officers of the rank of Superintending Engineer. One Superintending Engineer will be responsible for Earth work and construction of canal in Akola district beyond Katepurna; Second Superintending Engineer will be responsible for Earth work and construction of canal in Buldhana district and the third Superintending Engineer will look after the construction of CD/CM structures and Colony and Stores in the reach. Chief Engineer (Storages-I) shall look after the works pertaining to the proposed storages in Nagpur and Wardha districts including R&R and command area development while Chief Engineer (Storages-II) shall look after similar works pertaining to the proposed storages in Amravati, Yeotmal, Akola and Buldhana districts. Each of these two Chief Engineers will be supported by 3 officers of the rank of Superintending Engineers. Under Chief Engineer (Storages-I), one Superintending Engineer will be responsible for construction of storages in Nagpur district while the second Superintending Engineer will be responsible for construction of storages in Wardha district and the third Superintending Engineer will be responsible for feeder canals, pipe distribution networks and command area development; Similarly, under Chief Engineer (Storages-II), one Superintending Engineer will be responsible for construction of storages in Amravati and Yeotmal districts while the second Superintending Engineer will be responsible for construction of storages in Akola and Buldhana districts and the third Superintending Engineer will be responsible for feeder canals, pipe distribution networks and command area development. Each circle will have two division offices which will be headed by the officers of the rank of Executive Engineers. Executive Engineers in turn will have Deputy Executive Engineers as their subordinate officers who will manage Sub-Divisional offices. Detailed manpower requirement has been indicated in **Annexures-10.4 & 10.5 in Volume - II**.

10.7 Year Wise Allocation of Cost

The year wise allocation of cost for the project (as per 2017-18 price level) is given below.

Yearly phasing of Expenditure

Year	**Allocation of cost (in lakh)**	**%age**
1st Year	537520	10
2nd Year	1075040	20
3rd Year	1612558	30
4th Year	1343800	25
5th Year	806280	15
Total cost	**5375198**	**100**
say	**53752 crore**	