No. BBMB/DRIP-II/BHAKRA/01/2020

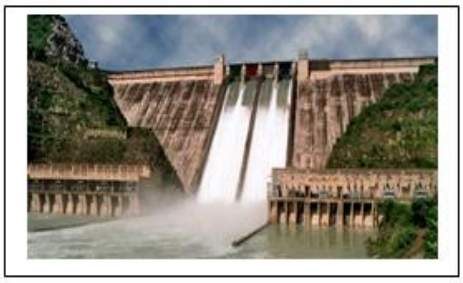
GOVERNMENT OF INDIA

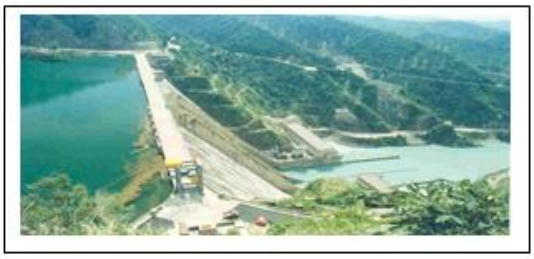
BHAKRA BEAS MANAGENEMT BOARD

DAM REHABILITATION AND IMPROVEMENT PROJECT PHASE- II & III

BHAKRA DAM

PROJECT SCREENING TEMPLATE



February/ 2020

Office of Chief Engineer
Bhakra Dam
Nangal-140124
Tel: 01887-223001, e-mail: cebhd@bbmb.nic.in

Table of Contents

FORM-I: PROJECT DETAILS

1. Project Description:

a. Project Identification Code (PIC): HP27VH0001

(As given in National Register of Large Dams, if applicable)

b. Project Name: Bhakra Dam

c. River Basin: Indus

d. Sub River Basin: Satluj

e. River/Stream: Satluj

2. Project Location:

a. State: Himachal Pradesh

b. District: Bilaspur

c. Earthquake Zone: IV

d. Survey of India Topo Sheet No. Not Available

e. Nearest City: Nangal Township

f. Nearest Airport: Chandigarh

g. Nearest Railhead: Nangal Dam

h. Name of Immediate u/s Project: Kol Dam Project

i. Name of Immediate d/s Project: Nangal Dam

j. Latitude/Longitude (in degrees, minutes, seconds):

Lat:	31^0	24'	40"	N
Long:	76^0	26'	10"	E

3. Project Benefits:

a. Type of Project: Multi-Purpose Project

b. Irrigation Benefits, in hectares (ha):

(i) Gross Command Area (GCA): 26,80,000

(ii) Cultivable Command Area (CCA): 23,70,000

(iii) Annual Irrigation Potential (AIP): 16,00,000

c. Hydropower Benefits:

(i) Installed Capacity (MW): 1379 (ii) Firm Power (MW): 1379

(iii) Average Annual Energy Generation (MU): 5500

d. Domestic/Municipal/Industrial Water Supply: Benefits transmitted to Partner States

(i) Annual Water Supply (MCM): NA

(ii) Nos. of Population Benefitted (In Lakh): NA

e. Flood Protection: Area of Punjab along River Satluj

(i) Flood Protected Area (ha): Area of Punjab

(ii) Details of Area Benefitted (ha): Area of partner States

f. Details of Tourism/Recreational Facilities: NA

4. Project Ownership Details:

a. Dam Owning Agency: Chief Engineer, Bhakra Dam

b. Implementing Agency: BBMB

c. Details of Dam Incharge:

(i) Name: Er.A.K.Aggarwal (ii) Designation: Chief Engineer

(iii) Phone No. (With STD Code): 01887-223001

(iv) Fax No. 01887-223801

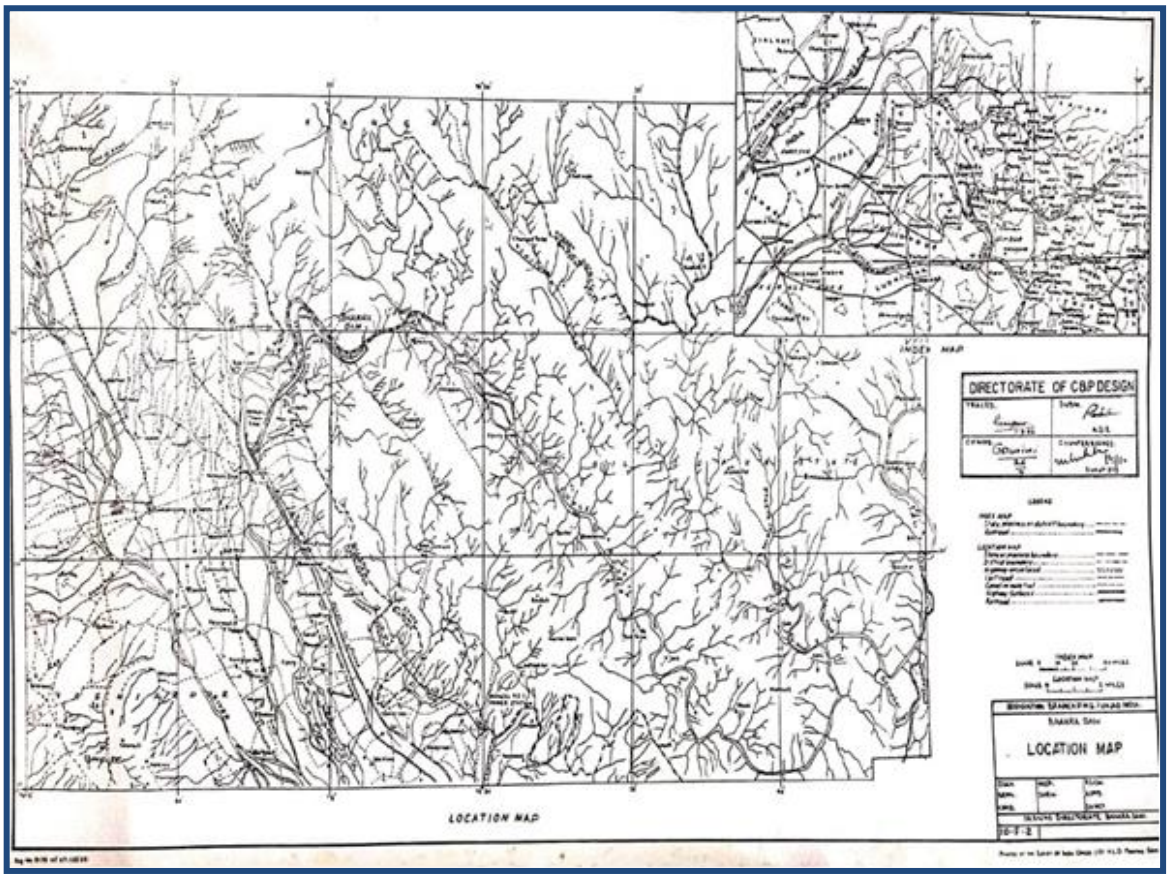
(v) E-mail: cebhd@bbmb.nic.in

(vi) Contact Address: o/o Chief Engineer, Bhakra Dam, BBMB,
Nangal Township-140124, Distt. Ropar (Punjab)

Appendix-I A

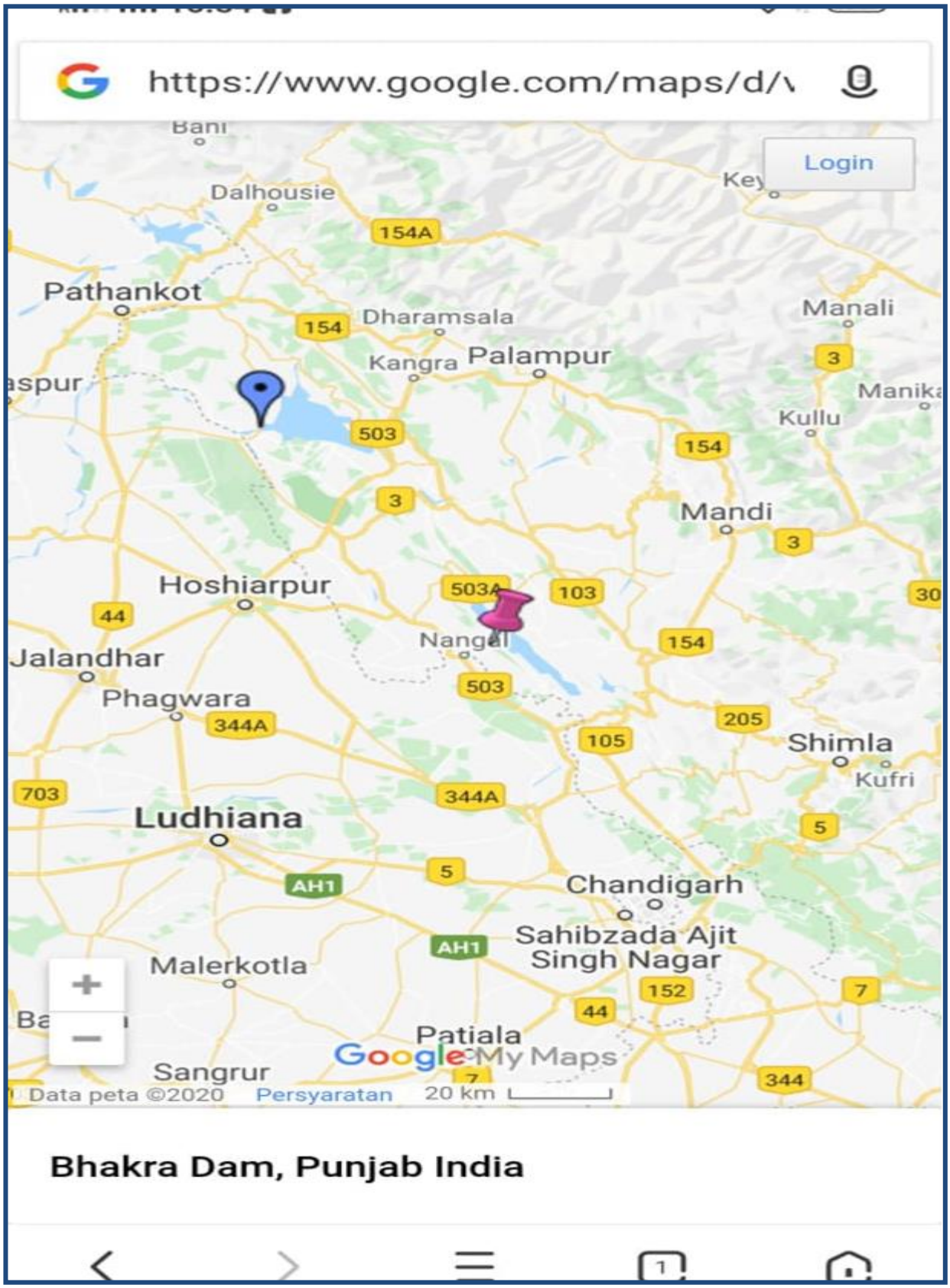
LOCATION /INDEX MAP OF PROJECT

The Bhakra Dam, located near village Bhakra in District Bilaspur of Himachal Pradesh, is a 225.55 m (740 ft) high straight gravity concrete dam, built across river Satluj in a deep and narrow gorge of the lower Shiwalik hills. The dam has been founded on the rock formations comprising largely of calcareous sandstone. The length and width of the dam at the top is 518.16m (1700 ft) and 9.14 m (30 ft) respectively, with the width of dam at base being kept as 190.50 m (625 ft). The width including apron and heel claystone plug is 402.34 m (1320 ft). A net-work of galleries with a total length of about 5 km (3 miles) for the purpose of drainage, inspection, checking of structural behaviour of dam and operation & maintenance of gates and other equipment, has also been provided in the body of the dam. The dam was designed as a gravity structure by gravity analysis. Nevertheless the joints of the blocks were grouted and the dam had been rechecked by the Trial Load Analysis also. The lake created by the dam at maximum reservoir level of El. 515.11 m (El.1690 ft) is 168.35 sq. km. (65 sq. miles) in area with gross storage capacity of 9868 x 106 m³ (8.0 x DSRP REPORT of BHAKRA DAM Page 9 of 194 106 acre ft). At the time of completion of the project, the reservoir had a live storage of 7436 x 106 m 3 (6.03 x 106 acre ft)



Appendix-I B

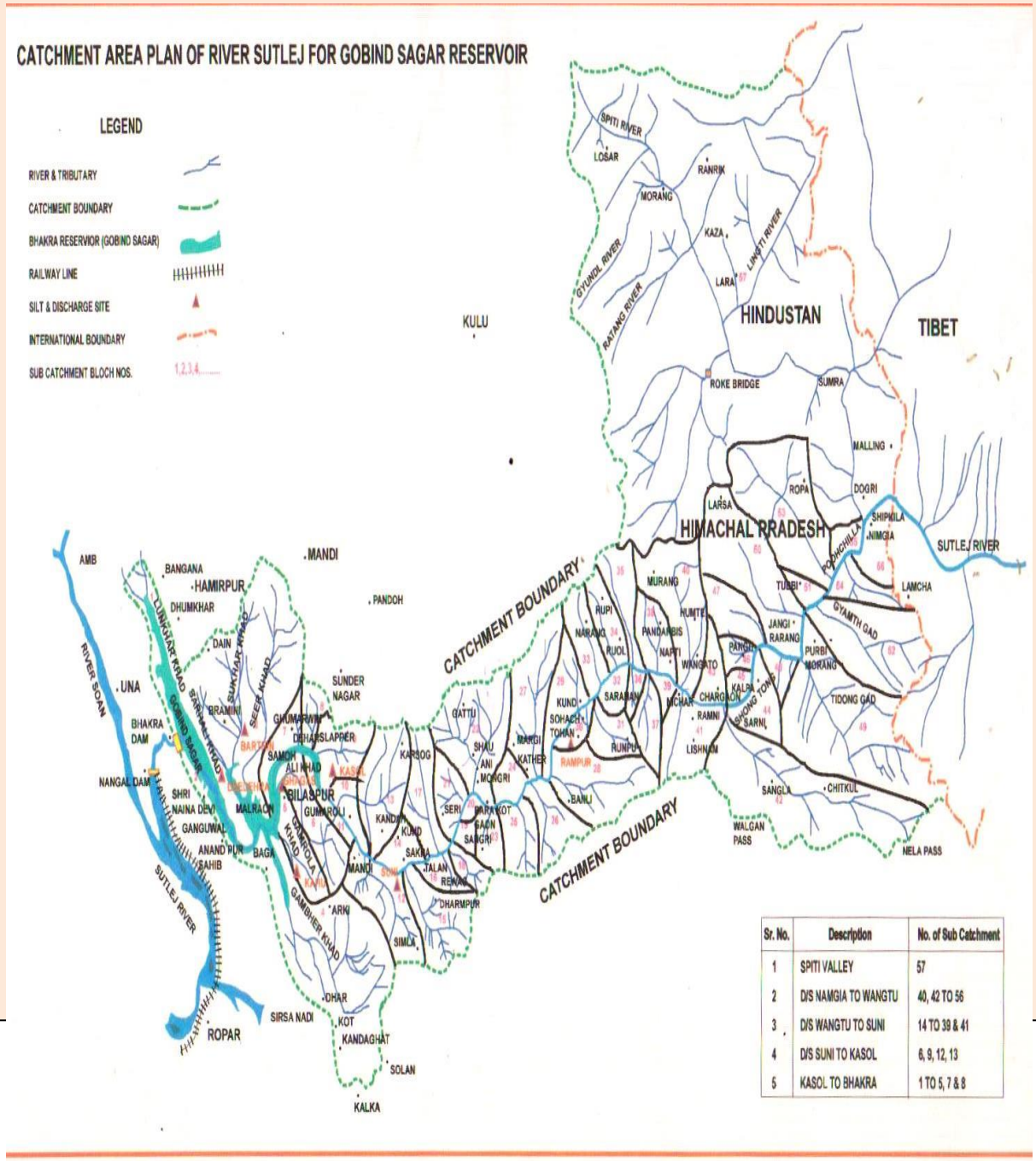
GOOGLE MAP OF DAM ATTACHED



Appendix-I C

CATCHMENT AREA MAP OF PROJECT

The Immediate upstream Project is Kol Dam Project. G&D sites at Bhakra, Berthin, Kahu, Rampur etc are existing sites. Dam is constructed on Satluj River and Seer, Sukhar, Sarhali, Gambhar, Baspa, Spiti etc are its Major tributaries. Rampur and Reckonpeo are important places. Weather Station is installed at Berthin, Kaza, Kalpa, Namgia, Rakchham under HP-II.

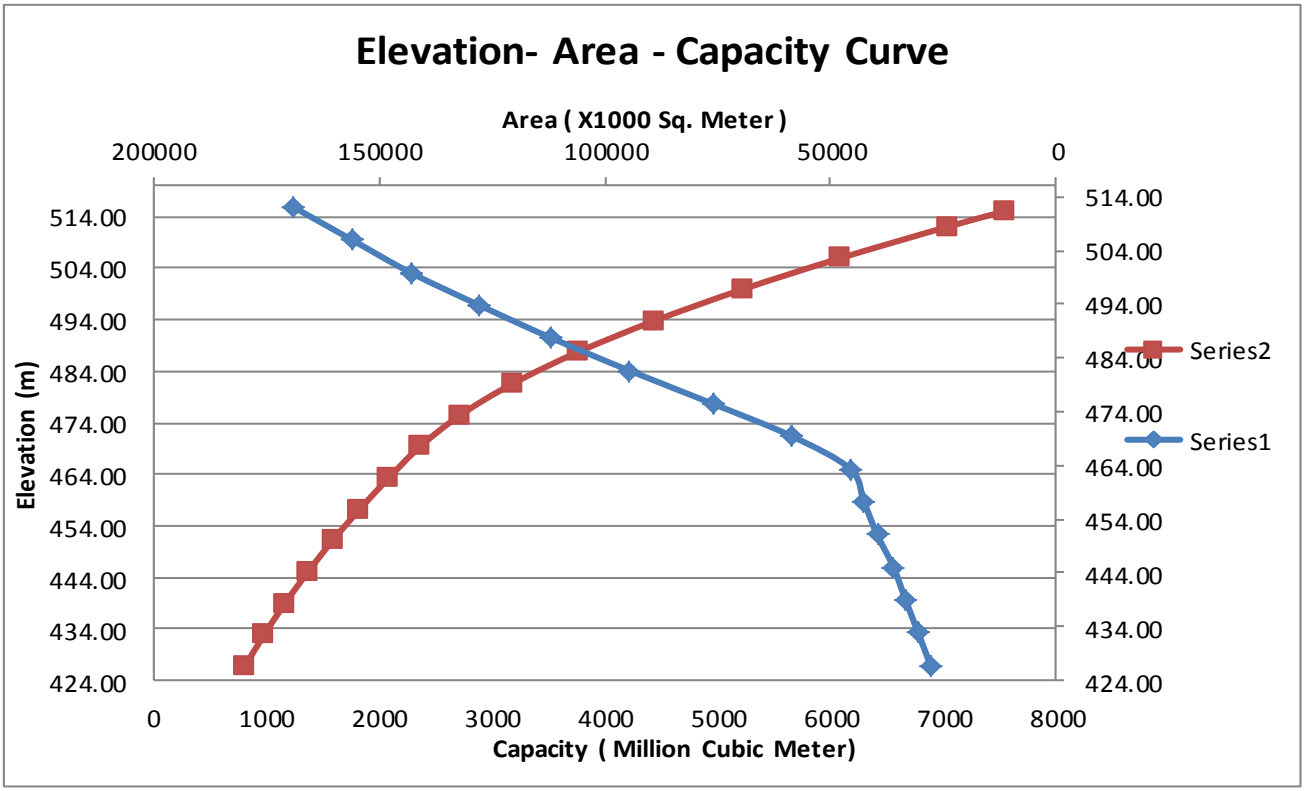


Appendix-I D

ELEVATION -AREA-CAPACITY CURVE

Tabular Form

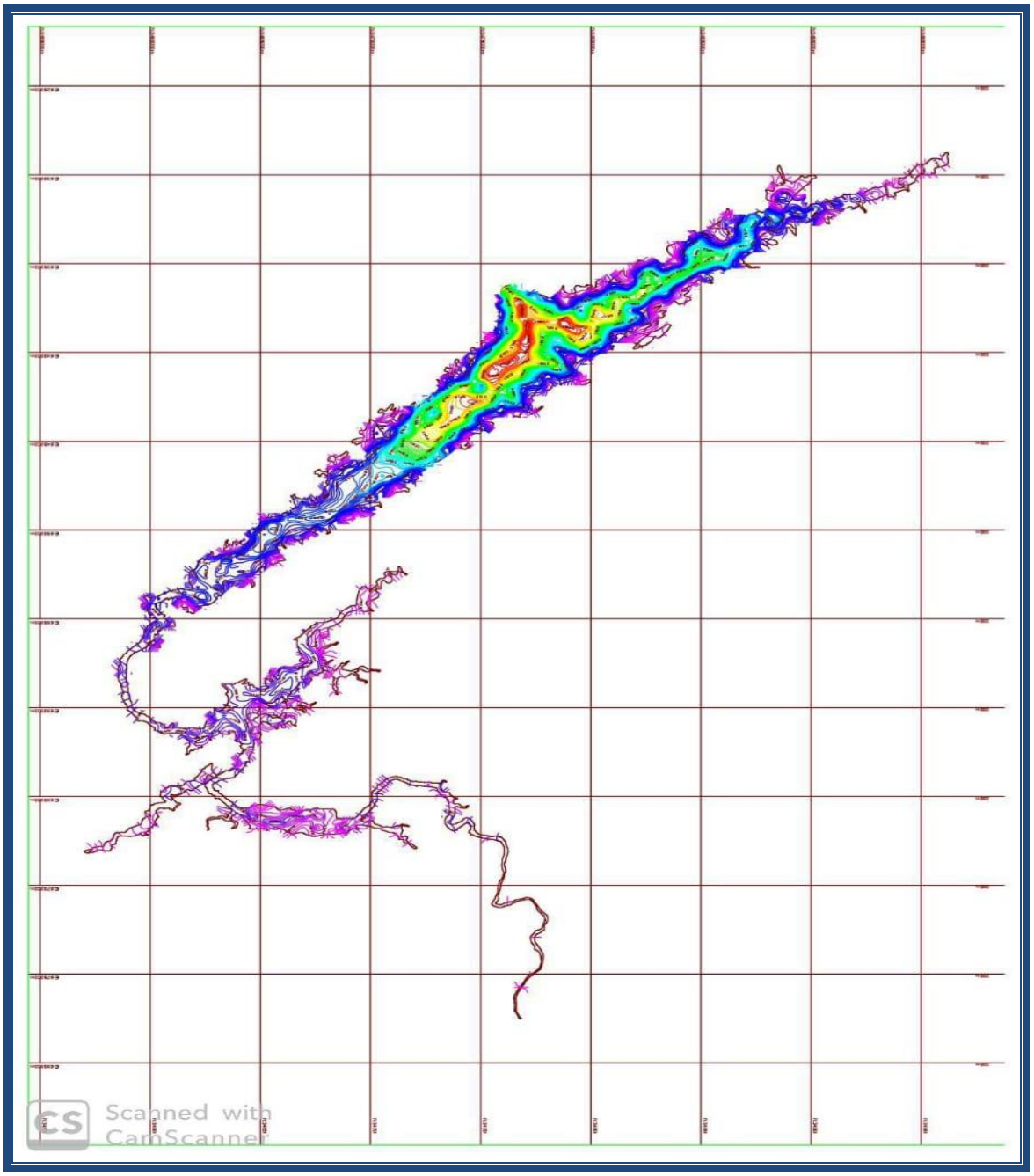
Elevation (m)	Water Spread Area (X1000 Sq. Meter)	Cumulative Capacity (Million cubic meter)
426.72	27709	808
432.82	30464	977
438.91	33249	1163
445.01	35932	1366
451.10	39572	1585
457.20	42512	1826
463.30	45503	2085
469.39	58435	2363
475.49	76093	2719
481.58	94403	3183
487.68	111783	3758
493.78	127781	4439
499.87	143093	5218
505.97	156091	6091
512.06	169055	7042
515.11	169055	7558


Elevation- Area - Capacity Curve
Area (X1000 Sq. Meter)
200000
150000
100000
50000
0
514.00
504.00
494.00
484.00
474.00
464.00
454.00
444.00
434.00
424.00
Elevation (m)
0
1000
2000
3000
4000
5000
6000
7000
8000
Capacity (Million Cubic Meter)
Series2
Series1

Appendix-I E

RESERVOIR SUBMERGENCE MAP OF PROJECT

(SHOWING FRL & MWL CONTOURS FOR FREEBOARD STUDY)



FORM-II: DAM SPECIFIC DETAILS

1. Dam Features:

I. Main Dam

a. Type: Straight Concrete Gravity Dam

b.. Total length of the Main dam (m): 518.16 m

c.. Length of Embankment dam (m): NA

d. Length of Masonry/Concrete dam (m): 518.16 m

e. Top width of Embankment Dam (m): NA

f. Top width of Masonry/Concrete Dam (m): 9.14 m

g. Elevation of top of Embankment Dam (m): NA

h. Elevation of top of Masonry/Concrete Dam (m): 518.16

i. Elevation of top of Upstream Solid Parapet Wall (m): 519.54 m

j. Height of Embankment Dam above Lowest River Bed Level (m): NA

k. Height of Masonry/Concrete Dam above deepest foundation level (m): 225.55

l. Lowest River Bed Elevation (m): 350.52 m

m. Deepest Foundation Elevation (m): 292.61 m

II. Saddle Dam : Not Applicable

a. Type: -

b. Length of the Saddle dam (m): -

c. Top width of Saddle Dam (m): -

d. Elevation of top of Saddle Dam (m): -

e. Elevation of top of Upstream Solid Parapet Wall (m): -

f. Height of Saddle Dam above Lowest Bed Level in case of embankment dam or above deepest foundation level in case of concrete / masonry dam (m): -

III Main Spillway:

(a) Type of Spillway: Central Spillway

(b) Length of Spillway (m): 79.25

(c) Location of Spillway: Central

(**Central Spillway**/Left Flank/Right Flank/Saddle, in addition Chainage may also be mentioned)

(d) Spillway Crest Level (m): 501.46

(e) Number of Bays: 04

(f) Number and thickness of Piers (m): 05 & thickness 18.29 m

(g) Total Discharging Capacity at MWL (m^3/s): 5589

(h) Design head used for working out spillway crest profile (m): 13.65 m

(i) Type of Energy Dissipation Arrangement: Stilling basin

(j) Type of Spillway Gate: Radial

(k) Size of Spillway Gate: Width (m) 15.24 Height (m) 14.50

(l) Type of Hoist for Spillway Gates: (Rope Drum/ Hydraulic) Rope Drum / Electrical

(m) Hoist Capacity of Spillway Gates (MT): 100,000 LBS at 1.3FPM

(n): Hoist Operation: Electrical

(Manual / Electrical / Remote Control)

(o) Number of Sets of Stop-logs: 01

(p) Number of Stop Log Units per Set & Size: 01

(q) Number of Gantry Crane(s) for 150 01

(r) Gantry Crane Capacity (MT):

IV Auxiliary Spillway: Not Applicable

(a) Type of Spillway: -

(b) Length of Spillway (m): -

(c) Location of Spillway: -

(Central Spillway/Left Flank/Right Flank/Saddle, in addition Chainage may also be mentioned)

(d) Spillway Crest Level (m) -

(e) Number of Bays: -

(f) Number and Thickness of Piers: ----, --- m

(g) Total Discharging Capacity at MWL (m^3/s): -

(h) Design head used for working out spillway crest profile (m): -

(i) Type of Energy Dissipation Arrangement: -

(j) Type of Spillway Gate: -

(k) Size of Spillway Gate: Width (m) - Height (m) -

(l) Type of Hoist for Spillway Gates: -

(m) Hoist Capacity of Spillway Gates (MT): -

(n): Hoist Operation: -
(Manual/Electrical/Remote Control)

(o) Number of sets of Stop-logs: -

(p) Number of Stop Log Units per set & size: -

(q) Number of Gantry Crane(s) for Stop Log Gates: -

(r) Gantry Crane Capacity (MT): -

V Fuse Plug: Not Applicable

(a) Location: -

(b) Length (m): -

(c) Crest Level (m): -

(d) Top Width (m): -

-

(e) Discharging Capacity at MWL (m^3/s):

VI. Sluice Arrangement (In Concrete and Masonry Dams): PENSTOCK HEAD GATE

(a) No. of Sluices & Sill Level (m): 16 Nos. at 402.33 m & 432.80 m

(b) Size of Sluice: Width (m): 2.64 Height (m): 2.64 Dia. (m): -

(c) Discharging Capacity of Sluice at FRL (m^3/s): 187.97 & 160.10

(d) Type of Service Gate: Jet flow gate

(e) Size of Service Gate: Width (m) 2.64 m Height (m) 2.64 m

(f) Type of Hoist for Service Gates: Traveling crane

(g) Hoist Capacity of Service Gates (M.T.): 15

(h): Hoist Operation: Manual

(Manual/Electrical/Remote Control)

(i) Type of Emergency Gate: Jet flow fixed wheel gate

(j) Size of Emergency Gate: Width (m) 3.34 m Height (m) 3.34 m

(k) Type of Hoist for Emergency Gates: Gantry crane

(l) Hoist Capacity of Emergency Gates (M.T): 150

(m): Hoist Operation: Manual

(Manual / Electrical)

VII. Outlet works (In Embankment, Concrete & Masonry Dams): RIVER OUTLET

(a) Location: 402.33 m & 432.80 m

(b) Number: 8 No + 8 No =16

(c) Sill level (m)

(d) Size: Width (m) Height (m) Dia (m)

(e) Discharging Capacity (m^3/s 115.56

(f) Type of Service Gate: Jet flow fixed wheel gate

2.56 3.108

(g) Size of Service Gate: Width (m) Height (m)

(h) Type of Hoist for Service Gates: Hydraulic

(i) Hoist Capacity of Service Gates (M.T):

(j) Hoist Operation :(Manual/Electrical/Both) Hydraulic hoist

(k) Type of Emergency Gate: Emergency bulk head gate (fixed

(l) Size of Emergency Gate: Width (m) 3.34 Height (m) 3.34

(m) Type of Hoist for Emergency Gates: Through 150 ton Gantry crane

(n) Hoist Capacity of Emergency Gates (M.T): 150

(o) Hoist Operation: Electro mechanical

(Manual / Electrical)

2. Reservoir Features:

a. Catchment Area at Dam site (km^2): 5698 b. Maximum Water Level (m): 515.24

c. Full Reservoir Level (m): 515.24

d. Minimum Draw Down Level (m): 445.73 e. Dead Storage Level (m): 445.73

f. Live Storage Capacity (Mm^3): 7197

g. Gross Storage Capacity (Mm^3) at FRL: 9621

h. Reservoir Spread Area (km^2) at FRL: 168.35

3. Construction Aspects:

a. Date of Starting the Construction (DD/MM/YYYY): 17/11/1955

b. Date of Completion (DD/MM/YYYY): 22/10/1963

c. Designing Agency: Irrigation Department Punjab

d. Construction Agency: Bhakra Management Board

e. Construction Cost (Rupees in Lakh): 24.528

4. Operational Aspects:

1965

a. Date of first full impoundment (MM/YYYY): Yes

b. Whether Pre & Post monsoon inspection being carried out:

c. Major recommendations of dam safety inspection, along with brief status on compliance:

Para 5.2 to 5.4 of DSRP report

d. Any operational failure in the past: No

e. Any other past dam incident: Yes

f. Operation and Maintenance Manual: Yes

Year of publication: 1967

g. Emergency Action Plan: Yes

Year of Publication: 2007

5. Instrumentation Aspects:

(Data Records and other information including pictures can be included in Appendix II-D)

a. List of Instruments installed in the Dam:

Sl. No.	Name of Instrument	Working Status	Year of Installation	Nos of Year data available
1.	Water Level Sensor	Y	1961	59
2.	Plumb Bob	Y	1961	59 years
3.	Inclinometer	N		
4.	Stress meters	Y	1955-1963	Since installation

5.	Strain meters	Y	1955-1963	Since installation
6.	Toe Drain	N		
7.	Drain Wells	Y	1955-1963	Since installation
8.	V-Notches	N		
9.	Pressure Gauges	Y	1955-1963	Since installation
10.	Accelerograph	Y	1993	26 years
11.	SCADA	N		
12.	Surveillance	Y	2017	2
13.	Rain Gauge ORG	Y	1962	58
14.	Rain Gauge SRRG	Y/N	1962	58
15.	……..			

d. Most of the instrumentation in the dam was installed during its construction about 50 years ago. With the age, some of the embedded instruments have become unserviceable and are not amenable to reinstallation. Also, the needs for monitoring have also changed and the emphasis is now on the deformation, seepage, uplift and other transient behavior of the dam. A large database has been created out of systematic observations from beginning and is very valuable.

In view of improved technologies, it is necessary that the required modernization of the selected observation programme may be carried out along with establishment of a computerized database for the historical observations and covering the current and future observations. Please refer Chapter 11 of DSRP Inspection Report.

.

6. List of Past Rehabilitation Works: Various Rehabilitation Works

a. Name of Scheme (If any):

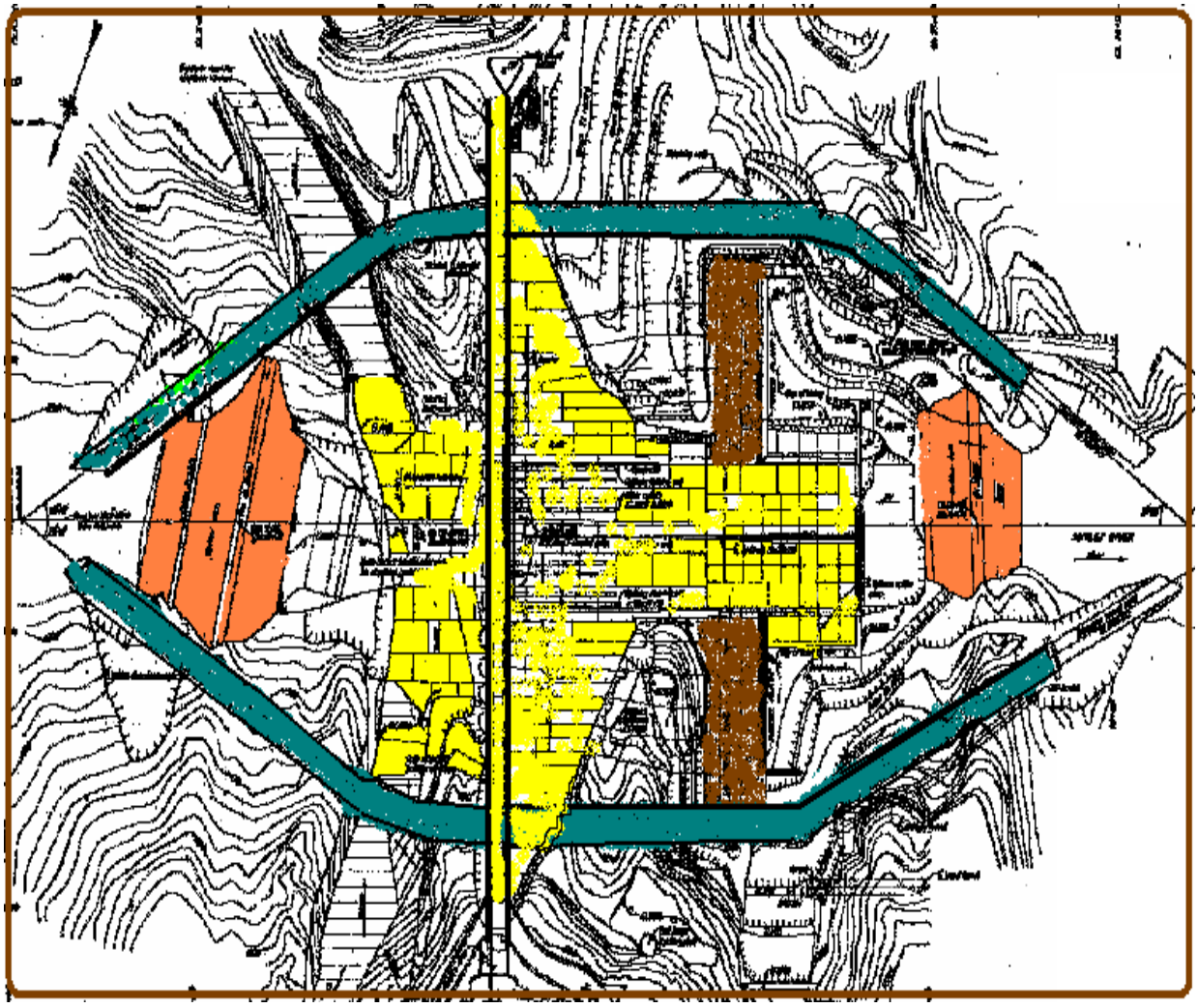
b. Period of Scheme: From to

c. Detail of Important Rehabilitation Works Carried Out (including by state funds):

Please refer Chapter 6 & Chapter 7 of DSRP Inspection Report.

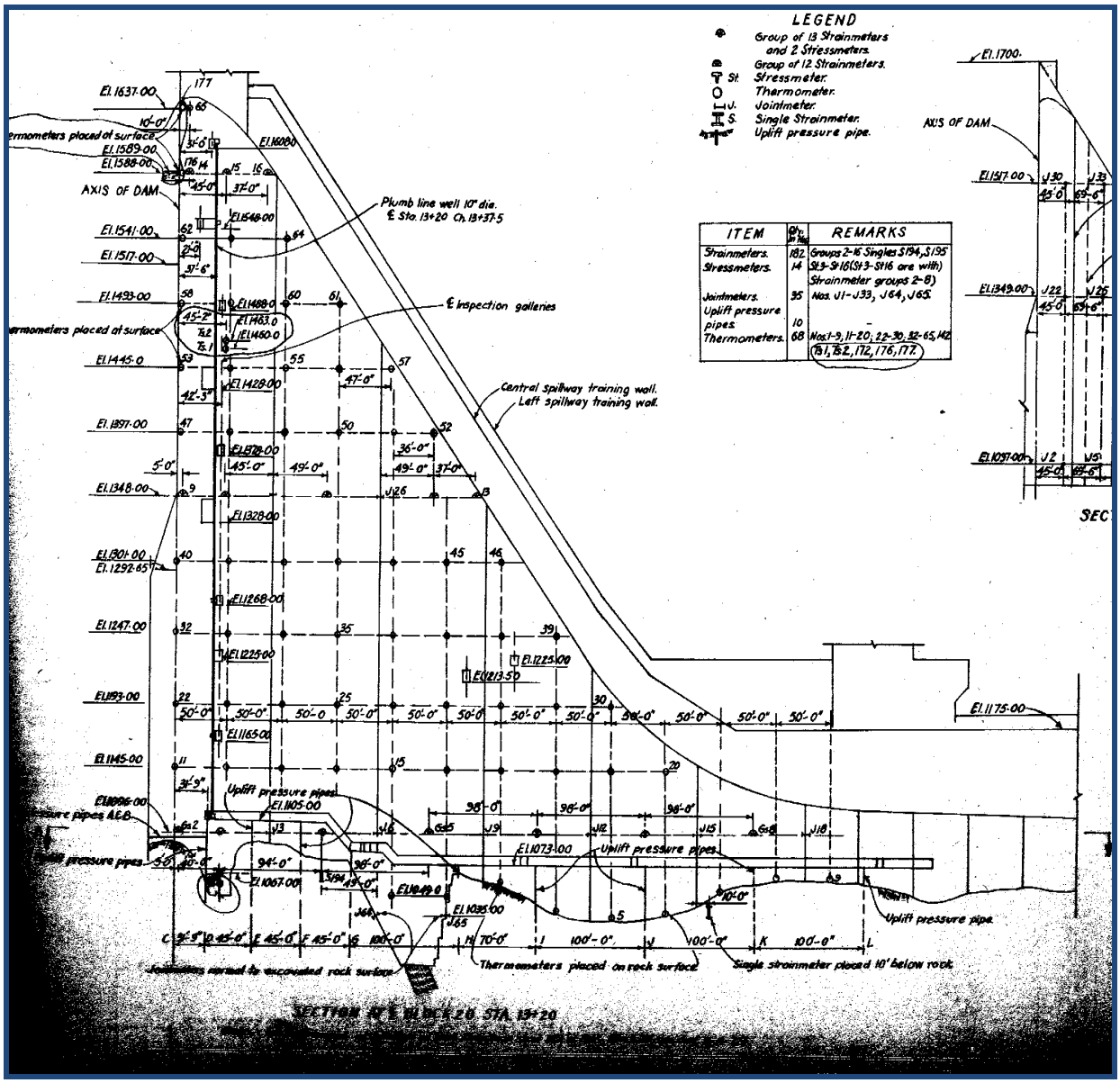
Appendix-II A

LAYOUT PLAN OF DAM



Appendix-II B

LONGITUDINAL SECTION OF THE DAM

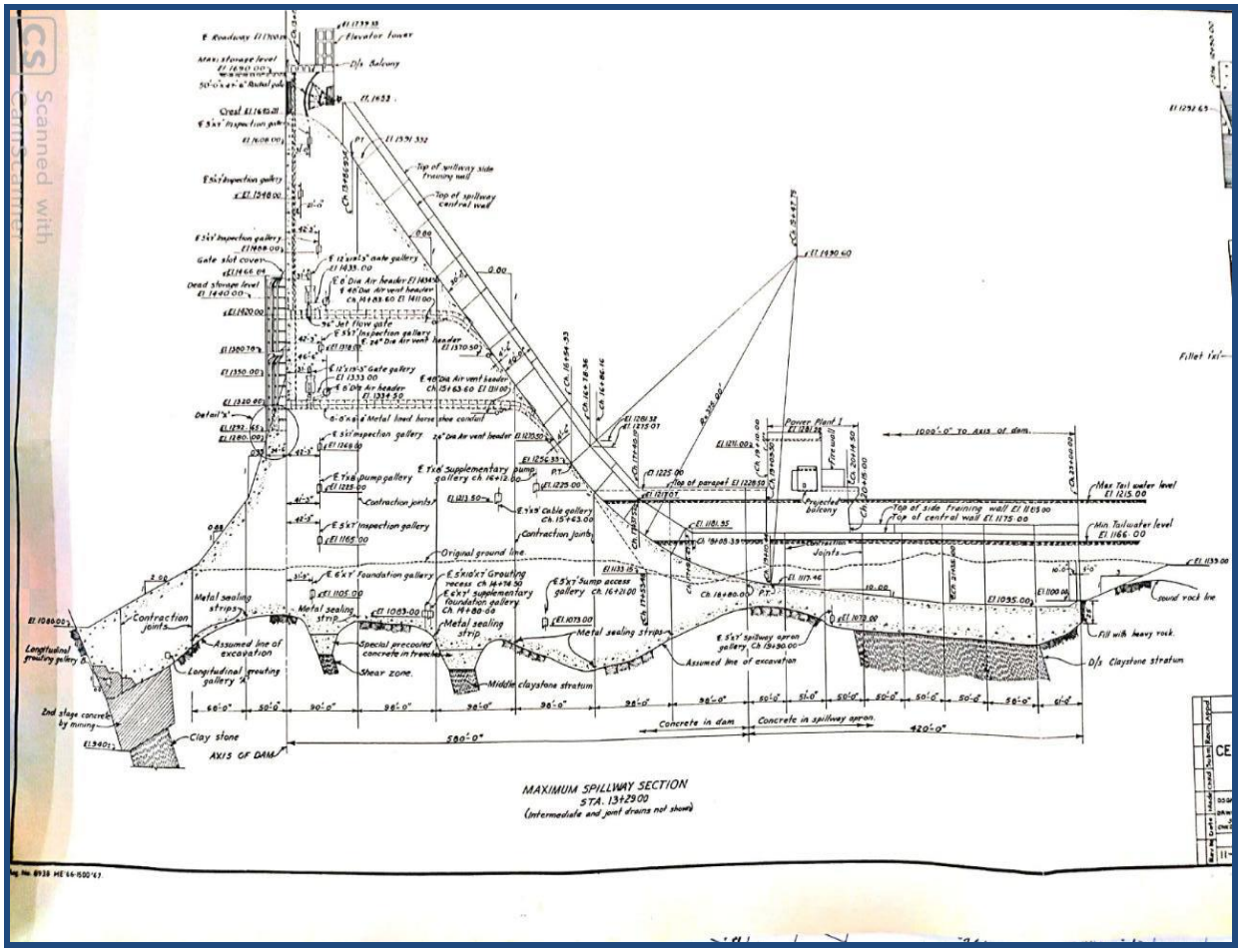


Appendix-II C

Brief description of the dam

The Bhakra Dam, located near village Bhakra in District Bilaspur of Himachal Pradesh, is a 225.55 m (740 ft) high straight gravity concrete dam, built across river Satluj in a deep and narrow gorge of the lower Shiwalik hills. The dam has been founded on the rock formations comprising largely of calcareous sandstone. The length and width of the dam at the top is 518.16m (1700 ft) and 9.14 m (30 ft) respectively, with the width of dam at base being kept as 190.50 m (625 ft). The width including apron and heel claystone plug is 402.34 m (1320 ft). A net-work of galleries with a total length of about 5 km (3 miles) for the purpose of drainage, inspection, checking of structural behaviour of dam and operation & maintenance of gates and other equipment, has also been provided in the body of the dam.

TYPICAL CROSS SECTIONS OF THE DAM



Appendix-II D

REPORT ON DAM INSTRUMENTATION

Enclosed: Yes

Sr No.	Name of dam	Name of Instruments	Number of Instruments	Performance (Instruments in working order)
1.	**BHAKRA DAM**	**Dam Instruments** Stress meter	25	13
	(Dam Instruments)	Strain meter	418	368
		Joint meter	80	57
		Resistance Thermometer	179	164
		M.S. Tiltmeter	2	-
		Structural Response Recorder	2	-
		Strong Motion Accelerograph (A – 800)	4	4
		Plumb line Well	3 lines	3 lines
		Uplift Pressure Pipes and U.P.P. cum D.Hs Dam Portion	(53+14)=67	60
		Ground Water Holes	(24+15)=39	(24+14)=38
		Drain Holes	724	724
		Water Tube Tiltmeter	1	1
		Uplift pressure pipes PP-1	(34+6)=40	40
		Piezometer Pipes PP-II	7	7
		Man Holes PP-II(EWS)	11	11
		Piezometer in river outlets Outlet No. 5 Outlet No. 12	 72 72	 64 66

Please Refer Chapter 11 and Annexure 23 of DSRP Inspection Report for various instruments installed.

FORM-III: HEALTH STATUS OF DAMS

1. Design Flood Review (In case of PMF/SPF, as approved by CWC):

a. Original Inflow Design Peak Flood (m^3/s): 11331.44

a.1. Original MWL (m): 515.12 a.2. Original Routed Outflow (m^3/s): 9207

a.3. Maximum observed flood peak (m^3/s) and date: 17234. 06.08.1971

b. Date of Latest Review (DD/MM/YYYY): January 2000

c. Revised Inflow Design Peak Flood (m^3/s): 22487
(PMF / SPF / 100 Year Flood)

c.1. Revised MWL (m): Under consideration with Management c.2.Revised Routed Outflow (m 9207

Report of Design Flood Review is enclosed as Appendix III-A (along with copy of CWC approval, if applicable) : Enclosed

d. Flood Routing Conducted? Yes If Yes, Attach Flood Routing Report with Calculations in Appendix III-B

e. Attach Free Board Calculations in Appendix-III C

f. Proposed measures to accommodate increase in design flood, attached in Appendix-III D

g. If design flood review & flood routing is not yet done, tentative time frame for carrying out the same: Has been done.

From: DD/MM/YYYY To: DD/MM/YYYY

2. Dam Safety Review Panel (DSRP) Review:

a. Date of Latest DSRP Inspection / 17 / 12 2019

b. Attach DSRP Report as in Appendix III E : Yes Attached

c. Key Actionable Points for Rehabilitation: as per DSRP Inspection Report and are given as under:

SN	Observations/Significant Deficiencies Noticed	Remedial Measures Suggested
1.	A number of landslides have been observed within the Bhakra Dam complex. Most of them are on the right bank	Remedial measures for treatment of landslides may be taken up as suggested in Para 9.5.2 and para 18.1.1

SN	Observations/Significant Deficiencies Noticed	Remedial Measures Suggested
	near the downstream abutment of Bhakra Dam and above the right bank power house and a few on the left bank on power house- dam road. Joints have opened out indicating distress in the rock mass. Another vulnerable active landslide is present on the left bank just above the road bench and reservoir rim	
2.	The Dinky tunnel is the access to the abutment drainage gallery of Bhakra dam and the Highway tunnel is alternate access to Dinky tunnel. Over the period of time since their construction, there have been collapses of the small rocks blocks from the ground and sides. Considerable seepage along the joints in both the tunnels has been noticed.	Remedial measures for treatment of Dinky Tunnel and Highway Tunnel may be taken up as suggested in para 18.1.2.
3.	Satluj River and their tributaries are contributing huge quantity of silts, deposited mainly between FRL and minimum draw down level (MDDL) resulting formation of delta and affecting live storage of the Bhakra reservoir.	Curative measures and Preventive measures as suggested in para 18.1.3 may be taken up.
4	Development and Implementation of Silt Management Strategy is desirable. The silt management plan will have to have long term as well as short term measures. The catchment area treatment will	Looking at the large size of Bhakra reservoir and also the large steeply sloping catchment of the project, it is not likely that a single measure will be possible and a basket of measures as per the techno economic feasibility in the affected portions of the reservoir and catchment will be necessary. Since preliminary measures like treatment of

SN	Observations/Significant Deficiencies Noticed	Remedial Measures Suggested
	provide long term effects, there are requirements of short term measures like providing sediment trap measures in the areas contributing relatively larger amount of the silt to the reservoir.	directly draining catchment and general improvement of the catchment area have already been identified by the project authorities, the same may be taken up under DRIP. Please refer details under Para 9.3 and para 9.5.1.
5.	In view of Revision of Inflow Design Flood, it is imperative to keep radial gates at overflow spillway and River outlets gates in the dam body in healthy operational conditions through regular maintenance and periodic operation.	SCADA system along with Hydro-metrological inputs may be installed for gates in dam body. The system as detailed under para 9.5.3 and para 18.2.1 may be included for automation of gates.
6	Back-up Power supply for gate operating equipments	A dedicated Diesel generating set of adequate capacity or separate DG sets to cater for operational needs of spillway and river outlet gates simultaneously need to be provided as back-up supply for gate operating equipments and also to the computerized control system in case of power failure. Please refer para 18.2.1.
7	Operation of River Outlet gates	Further it is observed that each set of 8 River outlet gates provided in dam body is operated through a single power pack unit with hydraulic piping connected to Hydraulic cylinder of each gate. With this arrangement it is not clear whether all gates can be operated simultaneously if required under flood conditions. If not so, it would be preferable to provide facility for simultaneous operation of each gate to negotiate design flood without any time delay in availability of any gate. Project Authorities may consider making appropriate arrangements in view of site constraints. Please refer para 18.2.1.

SN	Observations/Significant Deficiencies Noticed	Remedial Measures Suggested
8	Finding causative factors for deformation behaviour of the Dam and monitoring the behavior of the Bhakra dam, the deflection of the dam under loading and unloading conditions due to filling and depletion of the reservoir is required to ensure continued safety.	The additional FEM Study for static deformation behaviour including elasto-plastic analysis (Creep Study) of Bhakra Dam including risk assessment studies may be considered under DRIP-II. Please refer details under Para 9.1, Para 9.5.4 and para 18.3.1.
9	Examining Seismic safety of the dam under revised seismic parameter inputs	Seismic Analysis of Bhakra Dam as proposed at para 9.4 and para 18.3.2 may be carried out.
10	**Reservoir Management in View of Revision of Inflow Design Flood** The reservoir operation simulation for finding non-structural alternatives is required for routing the revised inflow flood of PMF levels.	If indicated after the flood management analysis for revised PMF, Hydro Dynamic two dimensional Model Studies of Bhakra Reservoir as recommended by 5th DSC may also be carried out. This may also include reservoir operation simulation for finding non-structural alternatives for routing the revised inflow flood of PMF levels. Please refer para 9.2 and para 18.3.3 and 5th DSC Report for details.
11	Modernization, upgradation and automation of Instrumentation with Real Time Monitoring System	Most of the instrumentation in the dam was installed during its construction about 50 years ago. With the age, some of the embedded instruments have become unserviceable and are not amenable to reinstallation. Also, the needs for monitoring have also changed and the emphasis is now on the deformation, seepage, uplift and other transient behavior of the dam. A large database has been created out of systematic observations from beginning and is very valuable. In view of improved technologies, it is necessary that the required modernization of the selected observation programmes may be carried out along with

SN	Observations/Significant Deficiencies Noticed	Remedial Measures Suggested
		establishment of a computerized database for the historical observations and covering the current and future observations. Please refer details under para 11.1.
12	Geological / Geotechnical Investigations	Mapping the slide area on the left abutment for joint patterns and geotechnical properties for designing the support systems. Mapping of the left abutment area overlooking powerhouse where the old guniting and anchors are to be replaced by the rockbolts and shotcrete. The foundation and other abutment areas are performing satisfactorily and additional investigations are not required at this stage. Please refer details under Chapter 12
13	Special testing and investigation needs for safety problems	Dynamic shear wave propagation properties for dam concrete need be tested for assessing the performance during earthquakes. Please refer details under Chapter 12
14	Geophysical Investigations .	At this point of time, no additional geophysical testing is found necessary
15	Other Investigative Studies	a) Bathymetry Surveying of the delta area formed at the upstream tail of reservoir may be carried out and compared with the original area for assessing the silt deposition. Also, the bathymetry survey for finding the current profile of the bed for finding encroachment of the dead storage area is also needed. b) Under Water Scanning (through ROVs / Drivers) Under water scanning of upstream face has been recommended through ROV. c) Material Testing (destructive / non-destructive) Material testing has been carried out recently and except that mentioned at ii above, no other tests are contemplated. However, depending upon the outcome of

SN	Observations/Significant Deficiencies Noticed	Remedial Measures Suggested
		the studies for structural behavior, tests as and where required will be considered. Please refer details under Chapter 12
16	Recommendations made by the 5th Dam Safety Committee given at para 5.3 above.	A number of recommendations for safety assurance and other general improvement have been made by the previous exercises of the Dam Safety Committee. Pending Recommendations made by the 5th Dam Safety Committee given at para 5.3 above may be undertaken for carrying out minor works. Please refer details under Para 5.3

3. Seismic Review:

a. Seismic Zone at the time of Design: IV

b. Revised Seismic Zone: IV

c. Historical significant earthquake events in the near vicinity: **NIL**

Event 1: Date: Epicenter:

Magnitude:

Event 2: Date: Epicenter:

Magnitude:

d. Details of nearest project whose site specific seismic parameter study has been approved by National Committee on Seismic Design Parameter (NCSDP): **Not Available**

(i) Name of Project:

(ii) Date of Approval:

(iii) Approved Parameters:

(a). Peak Ground Acceleration (PGA)

(b). Maximum Credible Earthquake (MCE):

(c). Design Basis Earthquake (DBE):

(d). Seismic Design Coefficient (Horizontal):

e. Whether need for seismic design review: Y/N , If yes, attach in Appendix III-F

4. Summary of Present Distress Condition:

Sl No.	Description	Concrete
1.	Leakage through dam body	Negligible
2.	Excessive seepage through dam body	No
3.	Excessive seepage through foundation	No
4.	Leakage through contraction joints	No
5.	Excessive settlement of dam body?	
6.	Clogging of Porous / Formed and foundation drains holes?	No
7.	Are Porous / Formed Drains Counter - sunk plug in place on top of dam?	Yes
8.	Are Water Seals in Place on Porous / Formed Drains in gallery?	NA
9.	Undesirable vegetation?	Yes on D/S face of Dam
10.	Deteriorated Concrete-Facing, Outlet, Spillway	No
11.	Erosion of surfaces, slides & signs of differential movement	
12.	Are there any surface cracks?	Yes
13.	Adequate slope protection?	
14.	Erosion of the upstream/downstream face?	
15.	Animal Burrows?	
16.	Any evidence of piping through dam body?	
17.	Any evidence of piping through foundation	No
18.	Are there wet spots or areas on the downstream face, at the toe, or beyond the dam?	Yes
19.	Spillway glacis erosion?	
20.	Can water flow into the principal spillway without difficulty, as intended when constructed?	Yes
21.	Is the primary spillway/waste weir structure in good condition?	Yes
22.	If there are drainage outlets, are they clear and flowing?	Yes
23.	Is the seepage water clear or muddy?	Clear
24.	Is there any unusual movement or cracking at or beyond the toe?	No

Sl No.	Description	Concrete
25.	Is there any evidence of instability on the slopes around the reservoir?	No
26.	Is a lot of sediment entering the reservoir, or has this happened in the past?	Gradual sedimentation
27.	Are gates/stop logs/valves and other operating equipment in working condition?	Yes
28.	Is the drainage gallery easily accessible and does it have adequate lighting facilities and safety handrails on steps?	Yes
29.	Gate corrosion	No
30.	Are Gate Seals showing signs of weathering, cracking or tearing?	No
31.	Is the surface of gates and paint deteriorated?	No
32.	Is the alternative power system for gate operation working properly?	N A
33.	Are the hydraulic hoists working satisfactorily?	Yes
34.	Are the decking, girders and structural supports of spillway bridge, hoist bridge and catwalks structurally sound?	Yes
35.	Is the floor of the bridge structurally sound and safe?	Yes
36.	Is there catwalk access to gate trunions?	No
37.	Is the concrete surface of the Energy Dissipation Arrangement (EDA) and d/s apron in good condition?	Yes
38.	Is access road to dam site well maintained?	Yes
39.	Are communication facilities available at dam site?	Yes
40.	Whether there is a standby power supply?	Yes
41.	Is fencing of project area required or needs to be strengthened?	No
42.	Is sufficient stock of spare which needs frequent replacement maintained at the site?	Yes
43.	Are the instruments installed properly accessible?	Yes
44.	Are all the instruments in proper working condition?	Mostly working
45.	Need for repair of instrument	Yes
46.	Need for replacing instruments	No
47.	Need for additional instruments	No
48.	Need for Stability Analysis	No
49.	Need for E/Q design review	Yes
50.	Need for operational review	No

Sl No.	Description	Concrete
51.	Need for sump/pumping arrangement to dewater Drainage Gallery	No
52.	Inspection of Sluice / Outlets conducted?	Yes
53.	Seepage through outlets / interfaces?	
54.	Is there evidence of Sluice / outlet scour?	No
55.	Settlement of outlet head works?	
56.	Is there differential settlement in outlets?	
57.	Is there siltation at sluice / outlet intake?	No
58.	Is there impact of siltation on discharge capacity of sluice / outlet?	No
59.	Is there seepage in outlet gate wells?	

5. Any Other Distress Conditions, if any, noted other than above:

NIL

Appendix-III-A

REPORT OF DESIGN FLOOD REVIEW

Design Flood Review Report is attached as Appendix-III-A

Appendix III-B

FLOOD ROUTING STUDIES INCLUDING SPILLWAY OUTFLOW CALCULATIONS

As per Central Water Commission (CWC) report, January 2000 (finalised in 2014), the value of PMF worked out for Bhakra Dam is 22592 Cumec (797800 Cusec) by Hydro-meteorological approach.

New maximum level after flood routing as per revised PMF value of 22,592 Cumec (7,97,800 Cusec) worked out by CWC is yet to decided. The agenda note to revise the rule curve in this regard stands submitted to BBMB Board office by Water Regulation Directorate of BBMB for discussions in Irrigation sub-committee of BBMB consisting of Members from partner States.

Please refer Chapter 4 and Chapter 9 (para 9.2) of DSRP Inspection Report.

Appendix III-C

FREE BOARD CALCULATIONS

Revised free board calculations are not required as already freeboard of 10 feet exists and provided between MWL at elevation 1690 ft. and top of the dam at elevation 1700 ft.

APPENDIX III-D

PROPOSED MEASURES TO ACCOMMODATE REVISED DESIGN FLOOD

a. Original design flood (m^3/s): 11331

b. Revised design flood (m^3/s): 22487

c. Percentage increase (%): 98

Proposed Rehabilitation Measures:

(a) Structural Measures: NIL

(b) Non-structural Measures: Under consideration with Management

- Lowering of FRL:
- Modification in Operation Rule Curve
- Provision for Early Flood Warning System; RTDSS already installed

APPENDIX III-E

LATEST INSPECTION REPORT OF DAM SAFETY REVIEW PANEL (DSRP)

DSRP Report is attached as Appendix III E

Brief description of proposed Rehabilitation And Improvement Works

S. No.	Description	Estimated Cost in Crores	Remarks
A	**Rehabilitation and Improvement Proposals for Bhakra Dam**		
1	Strengthening of slopes surrounding Bhakra Dam Abutments, upstream & downstream areas	33.10	Work is proposed to be undertaken in Phase-II. If there is any change in items and quantities after the inspection visit of Director, GSI, Chandigarh.
2	Treatment of Highway and Dinky Tunnels: .(Item No. 18.1.2 of Dam Safety Review Panel	1.20	Work is proposed to be undertaken in Phase-II. If there is any change in items and quantities after the inspection visit of Director, GSI, Chandigarh.
3	Modernization, upgradation and automation of Instrumentation with Real Time Monitoring System	4.58	Work is proposed to be undertaken in Phase-II.
4	SCADA Enabled Automation of Spillway radial gates and Outlet gates of Bhakra Dam	2.62	Work is proposed to be undertaken in Phase-II.
5	**Purpose Driven Study:** Additional FEM Study for	1.00	Work is proposed to be undertaken in

S. No.	Description	Estimated Cost in Crores	Remarks
	static deformation behaviour including elasto-plastic analysis (Creep Study) of Bhakra Dam including risk assessment studies.		Phase-II after finalization of TOR by experts of DSRP.
6	**Purpose Driven Study:** Seismic Analysis of Bhakra Dam to examine seismic safety under revised seismic parameter inputs	1.00	Work is proposed to be undertaken in Phase-II after finalization of TOR by experts of DSRP.
7	Treatment of hot spots and landslides around Bhakra reservoir by taking suitable measures	118.00	Applicability of Environmental, Forest and Himachal State Government Clearances and proposed to be undertaken in Phase-III.
	Total	**161.50**	

Important Note: It is worthwhile and pertinent to mention here that the provisions in the proposals at Sr. No. 1 & 2 are the preliminary one and the revised PST may have to be submitted after the inspection visit of Director, GSI, Chandigarh, as desired by Chairman BBMB during his field visit on 05.02.2020

Appendix III-F

SEISMIC DESIGN REVIEW

Refer Chapter 8 para 8.2 of DSRP inspection Report of Bhakra Dam.

Appendix-III-G

PHOTOGRAPHS SHOWING DISTRESS CONDITION

No distress reported in the dam body.

FORM-IV: REHABILITATION PROPOSALS

1. Structural Rehabilitation Works:

S. No.	Description	Estimated Cost in Crores	Remarks
	Rehabilitation and Improvement Proposals for Bhakra Dam		
1	Strengthening of slopes surrounding Bhakra Dam Abutments, upstream & downstream areas	33.10	Work is proposed to be undertaken in Phase-II. If there is any change in items and quantities after the inspection visit of Director, GSI, Chandigarh.
2	Treatment of Highway and Dinky Tunnels: .(Item No. 18.1.2 of Dam Safety Review Panel	1.20	Work is proposed to be undertaken in Phase-II. If there is any change in items and quantities after the inspection visit of Director, GSI, Chandigarh.
3	Treatment of hot spots and landslides around Bhakra reservoir by taking suitable measures	118.00	Applicability of Environmental, Forest and Himachal State Government Clearances and proposed to be undertaken in Phase-III.

2. Structural Measures for Ensuring Hydrological Safety: NIL

3. Non-structural Measures:

Non-structural Measures: **Under consideration with BBMB Management**

- Lowering of FRL:
- Modification in Operation Rule Curve
- Provision for Early Flood Warning System; RTDSS already installed

4. Basic Facilities Enhancement: NIL

5. Instrumentation, SCADA, Surveillance system, etc.:

S. No.	Description	Estimated Cost in Crores	Remarks
A	**Rehabilitation and Improvement Proposals for Bhakra Dam**		
1	Modernization, upgradation and automation of Instrumentation with Real Time Monitoring System	4.58	Work is proposed to be undertaken in Phase-II.
2	SCADA Enabled Automation of Spillway radial gates and Outlet gates of Bhakra Dam	2.62	Work is proposed to be undertaken in Phase-II.

6. Tourism/Fisheries/Hydropower Development: NIL

7. Others (Investigation, Design Studies, Consultancy)

S. No.	Description	Estimated Cost in Crores	Remarks
	Rehabilitation and Improvement Proposals for Bhakra Dam		
1	**Purpose Driven Study:** Additional FEM Study for static deformation behaviour including elasto-plastic analysis (Creep Study) of Bhakra Dam including risk assessment studies.	1.00	Work is proposed to be undertaken in Phase-II after finalization of TOR by experts of DSRP.
2	**Purpose Driven Study:** Seismic Analysis of Bhakra Dam to examine seismic safety under revised seismic parameter inputs	1.00	Work is proposed to be undertaken in Phase-II after finalization of TOR by experts of DSRP.

6. ITEM WISE DETAIL OF COST

APPENDIX IV-A

Cost Estimates of Rehabilitation Proposal

REHABILITATION AND IMPROVEMENT WORKS OF BHAKRA DAM		
	GENERAL ABSTRACT	
SL NO	**DESCRIPTION OF WORK**	**AMOUNT in Cr**
1.	**Structural Rehabilitation Works**	
i	Strengthening of slopes surrounding Bhakra Dam Abutments, upstream & downstream areas	33.10
ii	Treatment of Highway and Dinky Tunnels: .(Item No. 18.1.2 of Dam Safety Review Panel	1.20
iii	Treatment of hot spots and landslides around Bhakra reservoir by taking suitable measures	118.00
	Sub Total	**152.3**
2.	**Structural Measures for Ensuring Hydrological Safety**	---
i		--
3.	**Non-structural Measures**	
i		---
4.	**Basic Facilities Improvement**	
i		
5.	**Instrumentation, SCADA, Surveillance system, etc.**	
i	Modernization, upgradation and automation of Instrumentation with Real Time Monitoring System	4.58
ii	SCADA Enabled Automation of Spillway radial gates and Outlet gates of Bhakra Dam	2.62
	SUB TOTAL	**7.20**
6.	**Tourism/Fisheries/Hydropower Development**	
i		
7.	**Others (Investigation, Design Studies, Consultancy)**	
i	**Purpose Driven Study:** Additional FEM Study for static deformation behaviour including elasto-plastic analysis (Creep Study) of Bhakra Dam including risk assessment studies.	**1.00**
ii	**Purpose Driven Study:** Seismic Analysis of Bhakra Dam to examine seismic safety under revised seismic parameter inputs	**1.00**
	GRAND AMOUNT	
	Say	**161.50 Cr.**

APPENDIX IV-B

Work No. 1

Strengthening of slopes surrounding Bhakra Dam Abutments, upstream & downstream areas.(Item No. 9.5.2 of Dam Safety Review Panel (DSRP) Inspection Report of Bhakra Dam).

REPORT

This estimate amounting to Rs. 38.88 Crore has been framed to cover the probable cost of above noted work.

Necessity & Provision :-

Bhakra Dam is a straight concrete gravity dam constructed across the river Sutlej. The following items are being taken under DRIP-II proposals in respect of Bhakra Dam Division.

The construction of Bhakra Dam was started by drilling and blasting the hard rocks so as to construct dam to its designed depth & width. The approach roads &rail network at EL-1225ft on both sides of River Sutlej downstream of Bhakra dam and up to EL-1700ft was constructed before starting construction of the dam. The area around Bhakra dam was gunited and shotcreted at many places during and after the construction of dam to control the hill slides so as not to cause any damage to dam body and its appurtenant structures. But with the passage of time and weathering actions &effects, these rocks have started fracturing / sliding at many places. As it has been experienced during the rainy season of 2018, big chunks of rock fell down near Shri Naina Devi Ji Barrier on left side upstream of Bhakra Dam and damaged security check post, boom barrier, fixed camera and barbed wire fencing etc. and also blocked the road. Now during this rainy season i.e.2019, hill slides have occurred at various locations, upstream & downstream of Bhakra Dam both on left & right side and caused road blockages. Recently a report has also been received through geological department and detected various locations which are vulnerable and requires their immediate treatment. Some locations on left side beyond Sh. Naina Devi Ji Barrier has been pointed out which needs their immediate treatment and has also been proposed to be shotcreted. As such, keeping in view the un-stability of rock masses surrounding the dam area and to provide the counter measures, the treatment with Shotcreting100 mm thickness with 50 x 50mm wire mesh & Rock bolting in 30% of the total area to be shotcreted is being proposed.

In this regard, the detailed proposal was presented to DSRP during inspection visit and it is recommended by DSRP that the rehabilitation proposal in Project Screening Template (PST) format be undertaken accordingly.

Geological Recommendations: (Para 18.1 of Dam Safety Review Panel (DSRP) Inspection Report of Bhakra Dam)

Treatment of Landslides: (Para 18.1.1 of Dam Safety Review Panel (DSRP) Inspection Report of Bhakra Dam)

A number of landslides have been observed within the Bhakra Dam complex. Most of them are on the right bank near the downstream abutment of Bhakra Dam and

above the right bank power house and a few on the left bank on power house- dam road. Joints have opened out indicating distress in the rock mass. Another vulnerable active landslide is present on the left bank just above the road bench and reservoir rim. All these slides are either resulted due to wedge failure by intersection of joints or weathering along joint planes and steep disposition of rock mass from where rock falls have occurred. Overhangs have also been observed at places within the rock fall / rock slide scars. Since the slides are active and moving headwords due to retrogression, these are required to be stabilized to prevent further aggravation. The following remedial measured are suggested:

a) Provide chain link shotcrete to prevent weathering and further degradation of rock mass.

b) Rock bolts to stitch the joints. It appears that end anchorage of the rock bolt may not be effective in many cases owing to weathering of rock mass /along joints therefore, grouted rock bolts / grouted anchors are recommended. Efforts should be made to provide the rock bolts / grouted anchors in such a fashion, so that they should intersect most of the joints for effective stitching.

c) Drainage holes by inserting pipes perforated on the upper half to be installed at 10º to 15º towards downslope to drain out the subsurface water. Contour/catch water drains with chute drains at the crown of the slides/ rock fall zones may also be provided.

d) The major vulnerable landslide occurred upstream of the Bhakra Dam on the left bank just above the road bench and reservoir rim has reached about 100m above the road bench due to headword / retrogressive movement. Some open joints (more than 20cm) have also been observed within the rock mass (sandstone). Further aggravation of this slide may result in dumping of huge debris within the reservoir and washing out of road bench present just above the reservoir rim. Therefore, the landslide

May be treated on priority basis. One or two berms/benches should be made within this rock slide and be treated by chain link shotcrete, grouted rock bolts/anchors; contour/catch water drains at each berm and above the crown with chute drains, drainage holes as mentioned earlier etc. In addition, two rows of cable anchors from the created bench and road bench are suggested.

e) It is suggested to prepare large scale contour plan and geological map including discontinuity/joint data analysis to identify suitable stretch for berms, direction of rock bolts/anchors etc before implementation of the suggested treatments.

f) It is also observed that some of the slides are being treated by guniting, where drainage holes as mentioned earlier should be provided in these zones also.

Provisions: -

As per above, the following provisions have been made to treat the hill slopes.

i. Removal of grass roots / trees, shrubs etc. With the passage of time and due to weathering effect, growth of vegetation & trees, have occurred at many places on these. As such their removal is necessarily before treatment by shotcreting
ii. Shotcreting 100 mm thickness with 50x50 mm wire mesh of 4 mm size on the entire areas around Bhakra Dam as per drawings attached
iii. Grouted rock bolting at 30% of entire area.
iv. Weep holes @ 1 No. per10 sqm. area.

v. Allied equipment and accessories required for the shotcreting work (As per AOR)
vi. Plan showing main Geological features in foundation and abutment of Dam
vii. General layout / contour plan

ABSTRACT OF COST

Sr. No.	Description	Unit	Qty.	Rate	Amount	Total Amount in Rs
1.	**Strengthening of slopes surrounding Bhakra Dam Abutments, upstream & downstream areas**					
I	Clearing & Uprooting Vegetation	Sqm.	97351	83.32	81,11,285.00	
Ii	Shotcreting 100 mm thick with Wire Mesh 50mm x 50 mm	Sqm	97351	2501.02	24,34,76,798.00	
iii	Rock Bolting 3 Mtr. Long	Mtr	87615	661.00	5,79,13,515.00	
Iv	Weep Holes for Shotcreted area	Mtr	29205	736.81	2,15,18,536.00	33,10,20,134.00

(DETAIL OF QUANTITES)

Work No. 1 : **Strengthening of slopes surrounding Bhakra Dam Abutments, upstream & downstream areas.**

S. No	Description	Length	Height	Area	Rate	Amount (Rs)
i. ii a) b)	Clearing & uprooting vegetation pass bushes shrubs saplings and trees growth up to 300 mm removing stems of trees cut earlier and disposal of unserviceable material and stacking serviceable material to used and actioned up to lead of 1000 mtr including removal and disposal of top organic sail not exceeding 150 mm in thickness			97351 sqm	83.32 @ per sqm (Annexure-I(i))	**8111285**
	Shotcreting 100 mm Thick With Wire Mesh 50x50 mm					
c)	PP-I Tunnel Portion	220.00	(40.00+122.00+55.00)/3	15840.00 sft		
	Tunnel to security barrack					
	Left side	320.00	(45.00+8500+140.00)/3	28800.00 sft		
	Right side	140.00	(30.00+85.00+45.00)/3	7420.00 sft		
	Front of Shahedi samarak	230.00	(70.00+100.00+58.00)/3	1748.00 sft		
d)	Near bit shop	300.00	(60.00+80.00+35.00)/3	17400.00 sft		
e)	PP-II area tunnel upper side	800.00	(85.00+152.00+285.00+240.00)/4	152000 sft		
f)	Top of Dam Tunnel to gate service area.	765.00	(45.00+140.00+220.00+285.00+185.00)/5	133875 sft		
g)	Timber Ropeway portion	215.00	(62.00+135.00+80.00)/3	19780.00 sft		
h)						
i)	Shri Naina Devi Barrier to Top of Dam (Nehru centre	810.00	95.00+249.00+226.00+199.00+90.00+130.00+44.00+42.00/8	108844.00 sft		

			Total = or =	493546.00 sft 45869.00 Sqm		
j)	Behind PP-I (100mm thick shotcreting) EL 1225' to EL 1310'	116.00	27	3132 sqm		
k)	EL 1225' to 1360'	20.00	43	860 sqm		
l)	EL 1310' to 1410'	215.00	32	6880 sqm		
m)	EL1410' to 1470'	215.00	19	4085 sqm		
n)	EL 1470' to 1530'	178.00	19	3382 sqm		
o)	EL1530' ti 1600'	180.00	28	5040 sqm		
p)	EL 1600' to 1700'	61.00	32	1952 sqm		
q)	EL.1600' to 1625'	12.00	8	96 sqm		
r)	Behind PP-II (100mm thick shotcreting) EL 1225' to EL 1298'	132.00	23	3036 sqm		
s)	EL 1298' to 1362'	122.00	20.50	2501 sqm		
T	El-1362' to 1420'	61.00	18.00	1098 sqm		
U	El-1420' to 1500'	61.00	24.00	1464 sqm		
V	El-1500' to 1600'	61.00	30.00	1813 sqm		
W	El-1600' to 1700'	204.00	43.00+39.00+32.00 +29.00/4	7293 sqm		
			Total =	42632.00sqm		
	Total =(45869.00+42632.00) =			88501.00 sqm		
	Add 10% for undulation/uneven area : 88501.00x10% =			8850.00		

	Grand Total =	97351.00		
	Shotcreting @ Rs.2501.02/ Sqm. AOR (Annexure-I(ii))	**97351.00**	**2501.02**	**243476798.00**
Iii	Rock bolting 1 No. rock bolt 3 mtr long / sqm. Assuming 30% of total area for rock bolting: 97351 x30% = 29205.00 29205.00 x 3 = 87615.00 mtr (AOR Annexure-I iii)	**87615.00**	**661.00**	**57913515.00**
Iv	Providing and fixing beep hole A.O.R One no beep hole 3 m long per 10 sqm = 3x 97351/10 = 29205.00 (AOR Annexure-I iv)	**29205.00**	**736.81**	**21518536.00**
	Total Amount =			**331020134.00**

Important Note:

It is worthwhile and pertinent to mention here that the provisions in the proposal at Sr. No. 1 & 2 are the preliminary one and the revised PST may have to be submitted after the inspection visit of Director, GSI, Chandigarh, as desired by Chairman BBMB during his field visit on 05.02.2020

Annexure 1-(i)

AOR FOR REMOVING GRASS ROOTS, TREES, SHRUBS etc.

For 100 sqm

Clearing & uprooting vegetation, grass, bushes ,shrubs, saplings and trees growth up to 300 mm removing stems of trees cut earlier and disposal of unserviceable material and stacking serviceable material to used and actioned up to lead of 1000 mtr including removal and disposal of top organic sail not exceeding 150 mm in thickness.		
Sr. No.	Description	Rate
1	Skilled Mazdoor 7 Nos @ 338.02	2366.00
2	Un skilled Mazdoor 5 Nos @ 282.12	1411.00
3	Mate (Supervisor) 1 No @ 349.07	349.00
4	Scaffolding charges (As per previous analysis AOR)	3377.00
A	Total	7499.00
B	Add 10 % contractor ‘s profit	750.00
	(A+B)	8249.00
	Add labour cess @ 1%	82.50
	Gross Total	8331.50
	For 1 sqm 8331.50/100= 83.32	83.32 per sqm

Annexure 1-(ii)

ANALYSES OF RATES FOR SHOTCRETING 100mm THICK

S.NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT in Rs
1.	**1) Material**				
	i)Cement 443.5 kg / cum =1.00x0.101x443.50=44.79 kg say= 0.90 bags	Kg	0.90	260.00	234.00
	ii)Sand @ 0.924 cum / cum =1.00x0.0101x0.924 = 0.093 cum	Cum	0.093	519.26	48.29
	iii)Coarse aggregate @ 0.308 / cum 1.00x0.101x0308 = 0.031 /cum	Cum	0.031	762.19	23.63
	iv)Wire mesh 50mm x 50 mm size of 4 mm wire	kg	2.50	90.00	225.00
	v)Admixture for shotcreting@ 4% of weight of cement 44.79 x 4% =	Kg	1.79	75.00	134.25
				Total=	665.17
	Add 10% contractor profit			=	631.69
	Scaffolding				
	Dowels,steel bars 32mmx32mmx6' long. (As per Annexure ii) = 30 NOS				
	30x6'=180' or 54.86 mtr @ 7.86/mtr =431.20 kg @4300/M.T =18542.00				
	Contractor's profit @ 10% = 1854.20				
2	Total = 20396.20				
	Add labour cess @1% = 203.96				
	vii) Deodar wood = 288 planks				
	288x10.00x0.83x0.13=310.75 cft or 8.80 cum				

	@88519.57+45%ZP = 128353.37x8.80=112909.66 (CSR Item No. 17.01) Total = 112909.66+2096.20+203.20 =1150109.82 Less credit @50% =575054.91 Rate for sft = 574054.91/3347.50 = 171.79 Total material cost =			Total=	171.79

Machinery Charge (For four Sqm)

S.NO	Description	Unit	Qty	Rate	Amount in Rs
1.)	i) Air compressor 365 cfm	Hour.	1.00	671.00	671.00
	ii) Shotcreting equipment 4-6 cum	Hour.	1.00	1683.00	1683.00
	iii)D.G Set. (20.00+823.23+2399.60+33.00)= 3275.83	Hour.	1.00	3275.83	3275.83
	Total =				5629.83
	Over head charge / contractor profit @ 10% =				562.98
	Total =				6192.81
	Rate per Sqm (6192.81/4) = 1548.20				1548.20
2.)	Material Charge /Sqm (731.69 +171.79) =				903.48
	Total rate / sqm =				2451.98
	Misc. provisions / sundries etc @ 2% on [2451.98]=				49.04
	Grand Total / Sqm =				2501.02

1. DIESEL GENERATING SET 100 KVA

	Annual scheduled production hours= (10mx25dx3cx4hrs)						3000
	Cost of equipment				=		800,000
	Scheduled life in year				=		15
	Scheduled life in hrs.				=		30,000
	Repair provision in %				=		120
I	OWNERSHIP COST						
	Salvage value in %				=		10
a	With ref.to life in yrs.= 0.9xcost of eqp./life in yrs.				=		48000
b	With ref.to life in hrs.= 0.9xcost of eqp.xAnnu. life/life in hrs.						72000
	Average yearly depriciation.				=		60000
	Average hourly depriciation.				=	Rs.	20.00
II	OPERATIONAL COST						
1)	Hourly repair charges.				Rs.	32.00	
2)	Operation &maintenance crew.						

S.No.	Category	Nos.	Rate	Total
Regular Labour				
1	Operator	3.00	9982.50	29947.50
2	Mechanic	0.75	9982.50	7486.88
3	Foreman	0.75	13241.25	9930.94
4	Electrician	3.00	11962.50	35887.50
5	Supervisor	0.00	9982.50	0.00
6	Driver	0.00	10518.75	0.00
	SUB-TOTAL			**83252.81**
Casual Labour				
1	Helper	3.00	8250.00	24750.00
2	Chowkidar	0.75	8250.00	6187.50
3	Beldar	0.00	8250.00	0.00
4	Cableman	0.00	8250.00	0.00
	SUB-TOTAL			**30937.50**
Total direct crew/month				**114190.31**
Add for indirect crew cost @ 80% for Regular				66602.25
Add for indirect crew cost @ 55% for Casual				17015.625
Total crew charges/month.				197808.19
Total crew charges/year.				2373698.25
Hourly crew charges				791.23275
Total operational cost				

Rs. 823.23

III	P.O.L & ENERGY CHARGES						
	Fuel consumption inLtr/hr.=0.22 x B.H.P.xC1xC2					29.48	
	Factor C1 i.e.Type factor =			1.00			
	Factor C2 i.e.Duty factor =			1.00			
	B.H.P./Kwh of Engine =			180			
	Rate of diesel/ltr.or Elect./Kwh =				68.00		
	Cost of fuel					=	2004.64
	Lubricants @	25%	of fuel charges			=	394.96
					TOTAL	= Rs.	**2399.60**
IV	MISCELLANEOUS CHARGES						
	Misc. charges @ 10% of repair charges					= Rs.	3.20
	Total hourly operational cost					= Rs.	2821.22
	Hourly use rate of equipment					= Rs.	2821.22
	Rate per unit (kwh) =Hrly.use rate/output in Kwh(=KVAxP.F.)						**Rs. 33.19**
							Say Rs. 33.00

Total rate (i+ii+iii+iv) = (20.00+823.23+2399.60+33.00) = 3275.83

2. AIR COMPRESSOR 365 CFM (DIESEL)

	Annual scheduled production hours=(10mx25dx3cx4hrs)=					3000
	Cost of equipment				=	900,000
	Scheduled life in year				=	10
	Scheduled life in hrs.				=	15,000
	Repair provision in %				=	100
I	OWNERSHIP COST					
	Salvage value in %				=	10
a	With ref.to life in yrs.= 0.9xcost of eqp./life in yrs.				=	81000
b	With ref.to life in hrs.= 0.9xcost of eqp.xAnnu. life/life in hrs.					162000
	Average yearly depriciation.				=	121500
	Average hourly depriciation.				=	Rs. 40.50
II	OPERATIONAL COST					
1)	Hourly repair charges.				Rs. 60.00	
2)	Operation &maintenance crew.					

S.No.	Category	Nos.	Rate	Total
Regular Labour				
1	Operator	3.00	9982.50	29947.50
2	Mechanic	0.75	9982.50	7486.88
3	Foreman	0.40	13241.25	5296.50
4	Electrician	0.00	11962.50	0.00
5	Supervisor	0.00	9982.50	0.00
6	Driver	0.00	10518.75	0.00
	SUB-TOTAL			**42730.88**
Casual Labour				
1	Helper	3.00	8250.00	24750.00
2	Chowkidar	0.75	8250.00	6187.50
3	Beldar	0.00	8250.00	0.00
4	Cableman	0.00	8250.00	0.00
	SUB-TOTAL			**30937.50**
Total direct crew/month				**73668.38**
Add for indirect crew cost @ 80% for Regular				34184.7
Add for indirect crew cost @ 55% for Casual				17015.625
Total crew charges/month.				124868.70
Total crew charges/year.				1498424.4
Hourly crew charges				499.4748

	Total operational cost					Rs. 559.47
III	P.O.L.& ENERGY CHARGES					
	Fuel consumption in Ltr/hr.=0.22 x B.H.P.xC1xC2					27.5
	Factor C1 i.e.Type factor =		1.00			
	Factor C2 i.e.Duty factor =		1.00			
	B.H.P./Kwh of Engine =		125			
	Rate of diesel/ltr.or Elect./Kwh =			53.59		
	Cost of fuel				=	1473.73
	Lubricants @ 25%	of fuel charges			=	368.43
				TOTAL		**Rs. 1842.16**
IV	MISCELLANEOUS CHARGES					
	Misc. charges @ 10% of repair charges				=	Rs. 6.00
	Total hourly operational cost				=	Rs. 2448.13
	Hourly use rate of equipment				=	Rs. 2448.13
	Rate per 100 cfm of air				=	**Rs. 671.00**

3. SHOTCRETE MACHINE 4-6 Cum.

	Annual scheduled production hours= (10mx25dx1cx4hrs)					1000	
	Cost of equipment				=	900,000	
	Scheduled life in year				=	5	
	Scheduled life in hrs.				=	6,000	
	Repair provision in %				=	100	
I	OWNERSHIP COST						
	Salvage value in %				=	10	
a	With ref.to life in yrs.= 0.9xcost of eqp./life in yrs.				=	162000	
b	With ref.to life in hrs.= 0.9xcost of eqp.xAnnu. life/life in hrs.					135000	
	Average yearly depriciation.				=	148500	
	Average hourly depriciation.					Rs.	148.50
II	OPERATIONAL COST						
1)	Hourly repair charges.				Rs.	150.00	
2)	Operation &maintenance crew.						

S.No.	Category	Nos.	Rate	Total
Regular Labour				
1	Operator	1.00	9982.50	9982.50
2	Mechanic	0.50	9982.50	4991.25
3	Foreman	0.13	13241.25	1721.36
4	Electrician	0.00	11962.50	0.00
5	Supervisor	0.00	9982.50	0.00
6	Driver	0.00	10518.75	0.00
	SUB-TOTAL			**16695.11**
Casual Labour				
1	Helper	1.00	8250.00	8250.00
2	Chowkidar	0.25	8250.00	2062.50
3	Beldar	0.00	8250.00	0.00
4	Cableman	0.00	8250.00	0.00
	SUB-TOTAL			**10312.50**
Total direct crew/month				**27007.61**
Add for indirect crew cost @ 80% for Regular				13356.09
Add for indirect crew cost @ 55% for Casual				5671.875
Total crew charges/month.				46035.58
Total crew charges/year.				552426.93
Hourly crew charges				552.42693
Total operational cost				Rs. 702.43

III	P.O.L.& ENERGY CHARGES					
	Consumption of compressed air=200cfm					
	Rate of 100cfm compressed air=		327.00		654.00	
	Cost of compressed air			=	163.50	
	Lubricants @ 25%	of fuel charges		=	**Rs.**	**817.50**
		Sub total				
IV	MISCELLANEOUS CHARGES			=	Rs.	15.00
	Misc. charges @ 10% of repair charges			=	Rs.	1683.43
	Total hourly operational cost			=	**Rs.**	**1683.43**
	Hourly use rate of equipment			**Say**	**Rs.**	**1683.00**

Annexure (iii)

A.O.R FOR PROVIDING AND FIXING WEEP HOLES

1	Supply of perforated 2'' dia P.V.C pipe (Market Rate) = G.S.T @ 18 % = TOTAL =	169.00 31.00 200.00
2	Drilling 2" dia hole per mtr.	450.00
3	Fixing charges	10.00
4	1 % Sundries on (169.00+450.00+10.00) = 629.00x1% =6.29	6.29
5	10 % contractor profit on (169.00+450.00+10.00+6.29) = 635.29	63.53
6	1 % cess on 698.82	6.99
	TOTAL =	**736.81**

Annexure 1(iv)

AOR for Rock Bolting for 25 mm dia

Supply And Installation of 25mm Dia Rock Bolt (1mtr Long)

Sr No	Description	Qty	Rate	Amount	Remarks
Material Cost					
1	Rock Bolt 25mm dia @ 56.64 / Kg of 1.00 Mtr (Weight of 1.00 mtr 25mm Steel = 3.85 Kg)	3.85	56.64	218.06	For Rate Refer CP: 29 including GST
2	Wastage @ 2.5%			5.4515	
3	Cost of 15x15 cm 10 mm thick M S Plate	1.76	48	84.48	DSOR-2018 Code 1010
4	Cost of Nut 25mm Dia	0.25	48	12	DSOR-2018 Code 1034
	Total (A)			319.9915	
Manufacturing Charges :-					
Cutting and Making up & Threads		LS	30	30	As per Past Experiance
Installation Charges :-					
1	Placing of Rock Bolt	LS	50	50	As per Past Experiance
2	Grouting of Cement in Rock Bolt	LS	65	65	As per Past Experiance
3	Miscellaneous Charges for Scaffolding	LS	120	120	As per Past Experiance
	Total (B)			265	
	Total (A+B)			585	
	Add 13% CP & OH			76.048895	
	Hence Cost			661	

Work No. 2 : Treatment of Highway and Dinky Tunnels: .(Item No. 18.1.2 of Dam Safety Review Panel (DSRP) Inspection Report of Bhakra Dam)

The Dinky tunnel is the access to the abutment drainage gallery of Bhakra dam and the Highway tunnel is alternate access to Dinky tunnel. The Dinky tunnel in particular can also be used in case of future grouting of the right bank abutments if required. Accordingly it is necessary to maintain these tunnels in good shape. These tunnels had been constructed during construction of the project and are unlined till date, resulting weathering and deterioration of rock mass. Over the period of time since their construction, there have been collapses of the small rocks blocks from the crown and sides. Considerable seepage along the joints in both the tunnels has been noticed. A few wedge failures from the crown of Highway tunnel have also been observed. Suitable treatments are required to prevent the deterioration of the rock mass on stability consideration. Aggravation of wedge failure may lead to formation of cavities above the Highway tunnel and ultimately collapsing of the tunnel in long run and as such generation of landslides cannot be ruled out. This may endanger the stability of portion of abutment of Bhakra dam as tunnel is located near the dam foundation at the downslope. Similarly the stability of Dinky tunnel is to be restored to access the drainage gallery of Bhakra dam.

It is suggested to provide drainage holes at the first instant to handle the seepage. Thereafter, SFRS/wire mesh shotcrete is suggested as shotcrete may not be effective on wet and dripping surfaces. In addition, spot rock bolts should also be provided to prevent wedge failures. Concreting at the invert of the tunnels along with a wearing coat is also required.

It is also desirable to provide wiremesh shotcrete between crown & invert. It is accordingly recommended that wiremesh shotcreting may be provided along the selected lengths. Spot rock bolting may also be provided in reaches depending on the deposition of the rocks joints. Drainage holes shall also be provided in a regular pattern and the water channelized upto the sides drain. The invert of the tunnel shall be provided with concrete pavement.

Provision:-

Highway Tunnel :

- **i.** Concreting at the invert of the tunnel in whole length of 188 m with lean 1:5:10 , CC 1:2:4 alongwith side drains (as per drawing attached).
- **ii.** Shotcreting in selected / venerable portions (90 m length)
- **iii.** Grouted Rock bolting in 30% of the shotcreted area
- **iv.** Weep holes @ 1 No. per 10 sqm shotcreted area

Dinkey Tunnel:-

- **i.** Concreting at the invert of the tunnel in whole length of 124 m with lean 1:5:10 , CC 1:2:4 alongwith drain in the centre portion to be covered with precast RCC removable slabs (as per drawing attached).
- **ii.** Shotcreting in selected / venerable portions (55 m length)
- **iii.** Grouted Rock bolting in 30% of the shotcreted area
- **iv.** Weep holes @ 1 No. per 10 sqm shotcreted area

ABSTRACT OF COST

Sr. No.	Description	Unit	Qty.	Rate	Amount	Total Amount in Rs
	Dinkey Tunnel					
i	Shotcreting 100 mm thick with Wire Mesh 50mm x 50 mm	Sqm	1134.98	2501.02	2838608.00	
Ii	Weep Holes for Shotcreted area	Mtr	340.49	736.81	250876.00	
Iii	Rock Bolting 3 Mtr. Long	Mtr	1021.47	661.00	675192.00	
Iv	Earthwork excavation	Cum	184.09	52.74	9709.00	
V	Earthwork filling	Cum	46.20	98.77	4563.00	
vi	C.C 1:5:10	Cum	63.24	2192.60	138660.00	
vii	Shuttering	Sqm	148.00	174.14	25772.00	
viii	C.C 1:2:4	Cum	83.08	3524.21	292615.00	
Ix	R.C.C M20	Cum	8.86	4287.09	37985.00	
X	C.T.D Bars	Qtl	8.86	5821.91	51583.00	4325563.00
	Highway Tunnel					
I	Shotcreting 100 mm thick with Wire Mesh 50mm x 50 mm	Sqm	1857.24	2501.02	4644994.00	
Ii	Weep Holes for Shotcreted area	Mtr	557.17	736.81	410528.00	
Iii	Rock Bolting 3 Mtr. Long	Mtr	1671.51	661.00	1104868.00	
Iv	Earthwork excavation	Cum	575.16	52.74	303334.00	
V	C.C 1:5:10	Cum	165.44	2192.60	362744.00	
Vi	Shuttering	Sqm	150.40	174.14	26191.00	
Vii	C.C 1:2:4	Cum	315.84	3524.21	1113086.00	7692745.00
				Grand Total =		**12018308.00**
						Say 1.20 Cr

(DETAIL OF QUANTITES)

Treatment of Highway and Dinky Tunnels:(Item No. 18.1.2 of Dam Safety Review Panel Inspection Report)

S.N	Description	Length	Breadth	Height	Area	CSR+ZP	Amount in Rs
i	Concreting and shotcreting of Dinkey Tunnel						
a)	100 mm thick Shotcreting (rate as per A.O.R)	2 x 50.00	-	3.10	341.00		
		3.14x4.00x55.00			690.80		
				Total =	1031.80		
	Add 10% extra for unevenness				103.18		
	Total =				1134.98 sqm	2501.02	2838608.00
b)	Providing and fixing weep holes .A.O.R	One no beep hole 3 m long per 10 sqm = 3x1134.98/10 =340.49 m			340.49	736.81	250876.00
c	01 No. Rock bolting 3 m long / sqm assuming 30% of total area for rock bolting	1134.98 x 30 % = 340.49 x 3 = 1021.47 mtr.			1021.47	661.00	675192.00
d)	Excavation for roadwork in soil with hydraulic excavator of 0.9 cum bucket capacity including cutting and loading in tippers, trimming bottom and side slopes, in accordance with requirements of lines, grades and cross sections.(CSR item no 6.21)	184.09 cum as per x - section.			184.09	29.30+80%=52.74	9709.00
e)	Construction of embankment with earth obtained from roadway cutting or excavation including spreading, grading to required slope and compacting to meet requirement of table 300-2 as per technical clause 305 of MORT&H	46.20 cum as per x –section.			46.20	86.64+14%=98.77	4563.00

S.N	Description	Length	Breadth	Height	Area	CSR+ZP	Amount in Rs
	specifications (CSR item 24.5 b)						
f)	Cement concrete 1:5:10 with 40mm gauge stone ballast using concrete mixer volumetric type (As per CSR -2010 item No. 10.8 b ii)	Pavement 124x5.80x.100 =71.92 cum D/d 124x.70x.100 = 8.68 cum Total =71.92-8.68 =63.24			63.24 Cum	1712.97 +28% = 2192.60	138660.00
g)	Shuttering for faces of concrete foundations and foundation beam & plinth beam (vertical or battering) (CSR item no 9.1)	Drain sides = 2x124x.60 =148.00 sqm			148.00	128.99+ 35%= 174.14	25772.00
h)	Cement concrete 1:2:4 with stone ballast or shingle using concrete (As per CSR -2010 item No. 10.12 ii)	Pavement 124x5.80x0.100 = 71.92 Drain Sides 2x124x.10x0.80 =19.84 cum D/d 124x0.70x0.100= 8.68 cum Total = 91.76-8.68 = 83.08 cum			83.03 Cum	2753.29 +28%= 3524.21	292615.00
i)	Reinforced cement concrete M-20 with cement @375/kg per cum hand mixed but excluding steel reinforcement centering and shuttering in foundation and plinth (CSR item no 10.15)	124x0.70x0.100 =8.86 cum			8.86 cum	3349.29 +28%= 4287.09	37985.00
j)	Cold twisted deformed (Ribbed/ Tor Steel) Bars (Fe 415 grade as per IS 1786-1985) , for R.C.C works, where not including in the complete rate of RCC including biding & bending and placing in	8.86 x100 kg / cum =886 kg Or 8.86 Qtl			8.86 Qtl	5018.96 +16%= 5821.99	51583.00

S.N	Description	Length	Breadth	Height	Area	CSR+ZP	Amount in Rs
	position complete (CSR item no 18.17)						
					Total Rs=		**4325563.00**
ii. Concreting and shotcreting of Highway Tunnel							
a)	100 mm thick shotcreting	2 X90.00	-	3.10	558.00	2501.02	4644994.00
		3.14	4.00	90.00	1130.40		
				Total =	1688.40		
		10% extra for unevenness			168.84		
		Total =			1857.24		
b)	Providing and fixing weep holes A.O.R	One no beep hole 3 m long per sqm = 3x1857.24/10 =557.17 m			557.14 m	736.81	410528.00
C	01 No. Rock bolting 3 m long / sqm assuming 30% of total area for rock bolting	1857.24 x 30 % = 557.17 x 3 = 1671.51 mtr.			1671.51	661.00	1104868.00
d)	Excavation for roadwork in soil with hydraulic excavator of 0.9 cum bucket capacity including cutting and loading in tippers, trimming bottom and side slopes, in accordance with requirements of lines, grades and cross sections (CSR item no 6.21)	575.16 cum as per x – section			575.16	29.30+80 %=52.74	30334.00
e)	Cement concrete 1:5:10 with 40mm gauge stone ballast using concrete mixer volumetric type (As per CSR -2010 item No. 10.8 b ii)	Pavement 188x7.80x.100= 146.64 cum Drain 2x188x0.50x.100=18.80 cum Total = 165.44 cum			165.44 cum	1712.97+ 28%= 2192.60	362744.00
f)	Shuttering for faces of concrete foundations	Drain sides = 2x2x188x0.20 = 150.40 sqm,			150.40	128.99+35%=	26191.00

S.N	Description	Length	Breadth	Height	Area	CSR+ZP	Amount in Rs
	and foundation beam & plinth beam (vertical or					174.14	
g)	Cement concrete 1:2:4 with stone ballast or shingle using concrete (As per CSR -2010 item No. 10.12 ii)	Pavement 188x7.80x.100= 146.64 cum Drain bed 2x188x0.50x0.100 = 18.80 cum 2x2x188x0.20 = 150.40 cum			315.84 Cum	2753.29+ 28%= 3524.21	449689.00 1113086.00
							7692745.00
						Grand Total	**12018308.00**

Important Note: It is worthwhile and pertinent to mention here that the provisions in the proposal at Sr. No. 1 & 2 are the preliminary one and the revised PST may have to be submitted after the inspection visit of Director, GSI, Chandigarh, as desired by Chairman BBMB during his field visit on 05.02.2020

Work No. 3

Modernization, upgradation and automation of Instrumentation with Real Time Monitoring System.(Para No. 11.1 of Dam Safety Review Panel (DSRP) Inspection Report of Bhakra Dam).

Most of the instrumentation in the dam was installed during its construction about 50 years ago. With the age, some of the embedded instruments have become unserviceable and are not amenable to reinstallation. Also, the needs for monitoring have also changed and the emphasis is now on the deformation, seepage, uplift and other transient behavior of the dam. A large database has been created out of systematic observations from beginning and is very valuable. In view of improved technologies, it is necessary that the required modernization of the selected observation programmes may be carried out along with establishment of a computerized database for the historical observations and covering the current and future observations.

Provision:-

I There are following four type of instruments which are to be replaced or provided. Four No. strong motion Accelerographs installed in Dam body which have become absolute and needs replacement with new one with latest technology that will convert the data into real time. Provision of 5 Nos. SMAs (1 at EL 1083', 1 at EL 1378', 2 Nos. at EL 1608' and 1 at Top of Dam) has been made. Their real time data will be carried out to central control room at EL 1668' and SLDC complex at Chandigarh.

II Plumb line data from 03 Nos. Plumb lines provided in block 20 from El-1608 to 1105 (having 06 Nos. reading windows stations) , BK-15 from EL-1684 to 1288 feet (having 04 Nos. reading window stations) and BK-25 from EL-1684 to 1308 feet (having 03 Nos. reading window stations) being observed manually is also required to be converted into real time data observation and display at EL 1668 feet and SLDC complex at Chandigarh. Provision of real time display of plumb line data of block 20 EL1105' to central control room at EL 1668' and SLDC complex at Chandigarh has been made. As such 26 Nos. sensors are being proposed for 13 Nos. reading windows alongwith required hardware & software equipment and accessories.

III Total Stations are required to watch & monitor the development of any change all around the Dam and abutments. 02 Nos. Total Stations alongwith, 03 Nos. CORS station & 01 No. Reference station and allied accessories for data acquisition related to geodetic observation required as Dam monitoring solutions.

IV Some cracks were observed on the road along right abutment and it was proposed by the 5th Dam safety Committee to provide MPBX – extensometer at suitable interval to watch the behavior of settlement if any. Provision of 3 Nos. MPBX extensometer alongwith accessories have been made to monitor the behavior / settlement of right side road / abutment.

Keeping in view the position explained above a combined proposal under Dam Rehabilitation Improvement Project (DRIP) has been proposed. Hence the necessity of this estimate arises.

ABSTRACT OF COST

Work No. 3 : Modernization, upgradation and automation of Instrumentation with Real Time Monitoring System.			
i	Replacement of SMA's	**99,60,900.00**	
ii	Modernization of Plumb lines	**42,03,180.00**	
iii	Providing and installing of Total Stations with complete accessories. and cables etc., prism, GNSS Receiver., control room software and servers communication equipment power system and installation and commissioning etc.	**3,00,00,000.00**	
iv	Providing of MPBX Extensometers(3 Nos.)	**15,80,905.00**	**4,57,40,985.00**

DETAIL OF QUANTITY

Modernization, upgradation and automation of Instrumentation with Real Time Monitoring System

Sr. Nos.	Description	Single unit price (in swiss Frane) (A)	Quantity required (B)	Total cost (in swiss Frane) C=AxB	Extended price in Indian Rupees @ ICHF=Rs. 70/-
1.	Accelerometer sensor with cable (as per specifications attached)	4620/-	5	23100/-	1617000/-
2.	GPS receiver with cable (as per specifications attached)	770/-	5	3850/-	269500/-
3.	3 channel data acquisition system (as per specifications attached)	6039/-	2	12078/-	845460/-
4.	9 channel data acquisition system (as per specifications attached)	6039/-	1	6039/-	422730/-
5.	Batteries, chargers etc. For 5 stations	880/-	3	2640/-	184800/-
6.	Digital sensor cable and	4.50 per meter	For 1000 meters @ CHF 40.50	4500/-	315000/-

Sr. Nos.	Description	Single unit price (in swiss Frane) (A)	Quantity required (B)	Total cost (in swiss Frane) C=AxB	Extended price in Indian Rupees @ ICHF=Rs. 70/-
	accessories (1000 m)		per meter		
7.	Work station (as per specifications attached)	3300/-	2	6600/-	462000/-
8	Application software for strong motion data downloading and analysis of data (as per specifications attached)	165+660=825	1	825/-	57750/-
9	Note book computer (as per specifications attached)	3839/-	1	3839/-	268730/-
10	Spares (1 set DAS, one accelerometer, memory card, GPS antenna with cable, one power cable etc.) (as per specifications attached)	4620+6039+770 =11429/-	1	11429/-	800030/-
11.	Installation, commissioning & training to the staff for 5 working days by the staff of OEM at dam site for upkeep of equipments, processing of data etc.	16400/-	1	16400/-	1148000/-
1	On-site warranty for 24 months	4850/-	2	9700/-	679000/-
1	Export, packaging, freight insurance to Indian Airport (Chandigarh)	3900/-	1	3900/-	273000/-
			Total. Rs =	104900/	73,43,000/-
14.	On-line UPS-2KVA capacity 30 min back up at full load (as per specifications attached)	-	1	-	90,000/-
15.	Laser jet printer (B/W) (as per specifications attached)	-	1	-	80,000/-

Sr. Nos.	Description	Single unit price (in swiss Frane) (A)	Quantity required (B)	Total cost (in swiss Frane) C=AxB	Extended price in Indian Rupees @ ICHF=Rs. 70/-
			Total Rs. =		75,13000
			L/C charges on item no. 01 to 13 (as per quotation attached)3500 CHF x Rs.70 =		2,45,000/-
			Custom duty@ 30 % on item no. 01 to 13 i.e. on Rs. 73,43,000/- =		22,02,900/-
				Grand Total =	**99,60,900/-**

Work No. 4 : SCADA Enabled Automation of Spillway radial gates and Outlet gates of Bhakra Dam

ABSTRACT OF COST

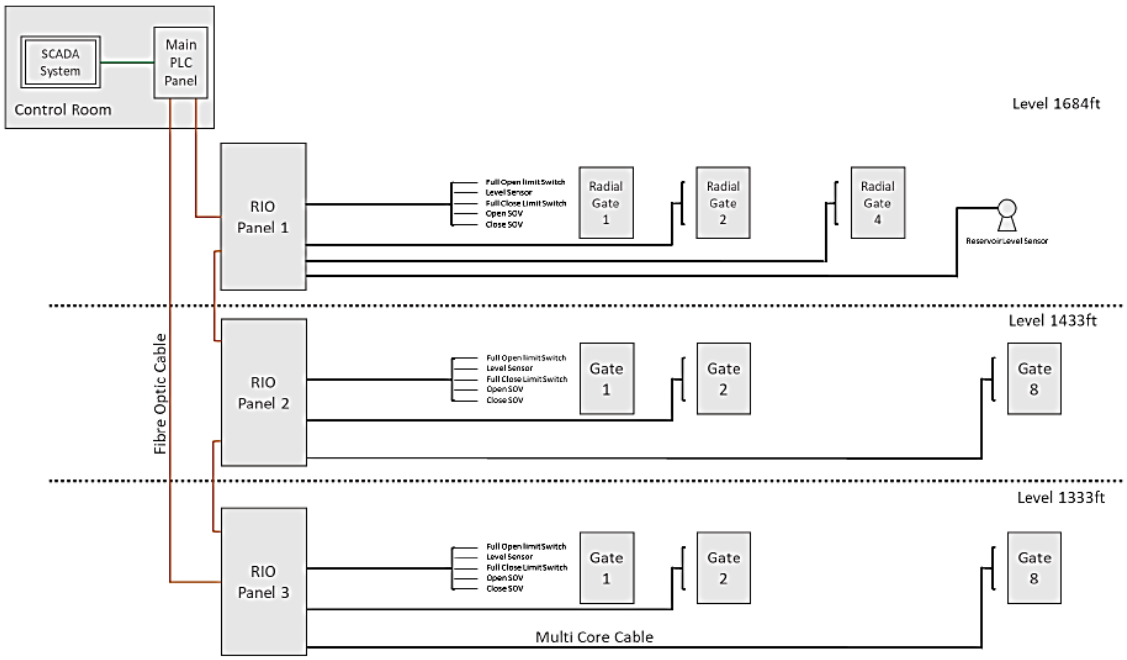
Sr no.	Nomenclature	Approx. Amount in Rs
1	Water Level Measuring Systems	
1.1	RADAR TYPE WATER LEVEL SENSOR (3 Nos) to measure the level of the water in the reservoir and Tail race. • The level sensors shall be suitable for flange or thread mounting as required. The installation shall avoid any degradation of instrument performance due to spurious reflections, absorption and condensation. Facilities shall be provided for rejection of spurious reflection. • The Radar type level instrument shall have the facility for dampening/ averaging the effect of waves, undulations on the water surface and discriminate the rate of change of levels and negate the effects of disturbances due to turbulence of water levels, strong air currents & electromagnetic waves etc. to provide steady readings. • All necessary instruments, interconnecting wiring, HDPE/GI pipe work, housing, cabling, panels etc. • Two type of Radar Level Transmitter need to install. At Upstream i.e. to measure the level of reservoir, two sensors of 120 Mtr will be installed. At downstream i.e. to measure the level of river outlet will be measure by a 30 Mtr range radar. Sensor Type Microwave non-contact sensor, Range 120 and 30 meters Resolution 3 mm or better Accuracy 0.025 % FSO Output Interface 4-20mA/HART Power Supply 24V DC Protection IP66 or better	12,45,000
2	Spillway gates/ radial gates	
2.1	Inclination Sensors for Flood Control Gates: Shaft Encoder based rotary position sensor (0-360 Deg), Range 0 ... 360 °Accuracy ≤ ± 0.5 °, Resolution ≤ 0.1 °, Output Interface 4-20mA, Power Supply 24V DC, Protection IP69 or better	4,75,200
2.2	RTU/PLC/IM BASED PANEL The Interface module/Remote Terminal Unit/PLC panel shall be used to collect the data from Dam. There shall be 1 RTU/PLC/IM on 4 Radial	6,58,500

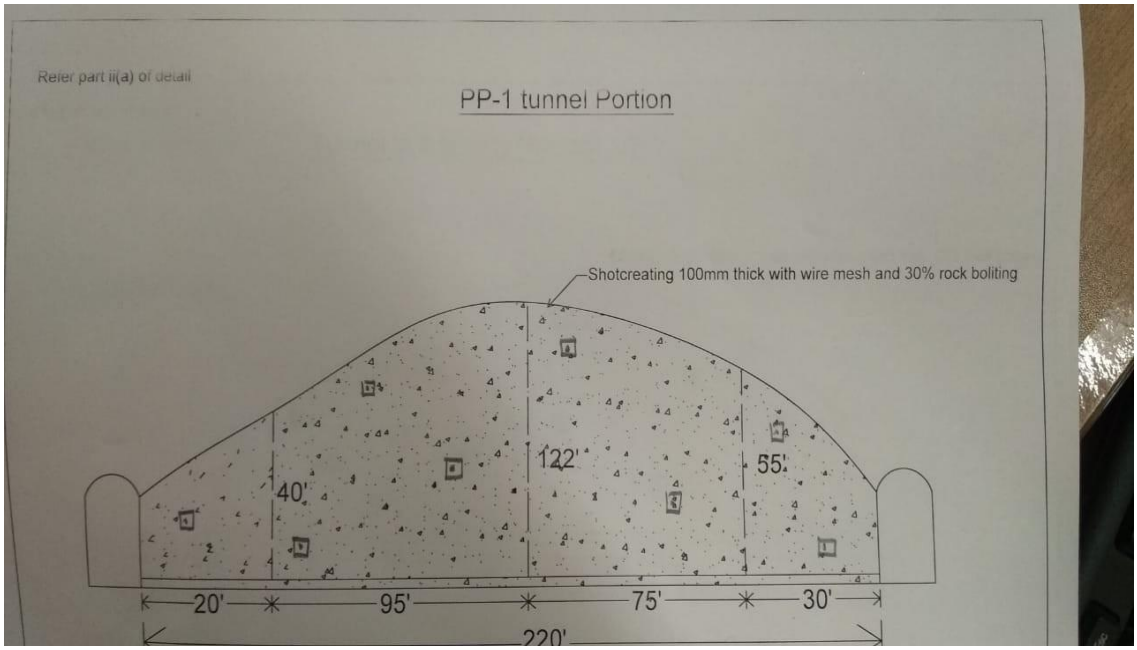
Sr no.	Nomenclature	Approx. Amount in Rs
	Gates (Flood Control Gates). These panels will have suitable equipment to collect the data of various level, position and surveillance instruments.	
2.3	INTERFACE PANEL FOR MOTOR DRIVE POWER PANELS (4 Nos): These Panels shall be used to Control & Monitor existing motor drive power panels in Auto/manual mode. By the help of these panels, SCADA based operation Control & monitoring of existing motor drive power panel shall be possible.	3,80,920
3	River Outlet Gates:	
3.1	LASER SENSOR FOR RIVER OUTLET GATES (16 Nos): LASER based distance sensors for real time position of River Outlet gate. Range 0.2-15 meters, Accuracy < 5 mm, Output Interface 4-20mA, Power Supply 10 ... 30 V DC / when operating in IO-Link mode: 18 ... 30 V, Protection IP65 or better Proximity Sensors for upper and lower limits. These sensors shall be equipped with suitable shaft couplings and electronic circuits to transmit the signals to the SCADA System via remote PLC/RTU for indication in Control Room& for further processing. All sensors will have to be mounted in the outdoor locations so that suitable protection class of the enclosures shall be ensured. Minimum IP65 protection class shall be provided.	19,00,800
3.2	Two RTU/PLC/IM shall be used for River Discharge Control gates. These panels will have suitable equipment to collect the data of various level, position and surveillance instruments.	13,17,000
3.3	INTERFACE PANEL FOR HYDRAULIC POWER PACK CONTROL PANEL (16 Nos): For smooth and reliable operation of river outlet gate. These Panels shall be used to Control & Monitor existing hydraulic power pack control panels in Auto/manual mode. By the help of this panel, SCADA based operation Control & monitoring of existing motor drive power panel shall be possible.	24,36,800
4	Monitoring & Control System: SCADA & PLC based central control and monitoring system with required I/O & software for design & engineering for acquisition of dam data like reservoir Level, Inflows, Discharge, Gate Opening Status etc. on HMI and 86" LED TV 4K Resolution with logging & A3 size color printer. Server & 56/86" LED TV shall be required as operator work station (OWS) and a computer with 24" TFT shall be required as an Engineer Work Station (EWS). It shall be able to communicate to external server of SLDC/NHP for display and recording of few important parameters like dam inflow etc from those sites. The Central processing unit (CPU) shall be able to set up in a modular configuration with distributed I/O for minimum cabling. There should be a wide range of modules used both for the centralized and the distributed configuration. There shall be two independent hot redundant industrial grade CPU & Engineering station. Processor shall be hot Redundant Hot Standby with communication	44,34,350

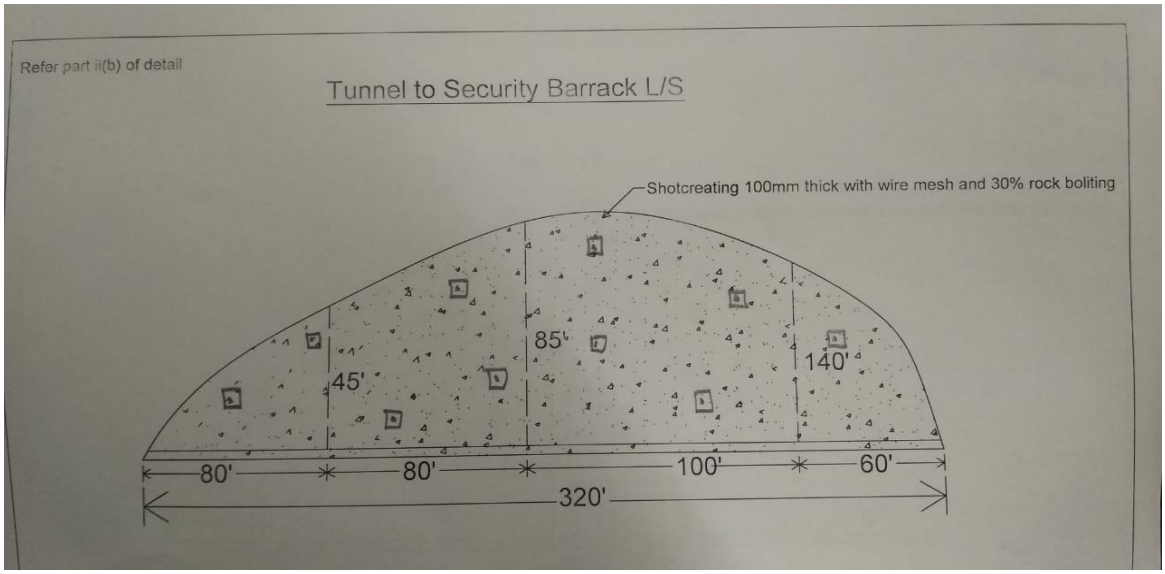
Sr no.	Nomenclature	Approx. Amount in Rs
	redundancy with RTU/Interfacing Modules (IM). All the subsystems & field devices such as RTU/IM, Radar, rotary, angular, linear encoders, level instruments, display meters etc. shall be interconnected through Profinet/Profibus communication bus and industrial Ethernet via optical fiber to provide highest level of availability. The system shall have redundancy link between main CPU & RTU/IM. The system shall have a Large video screens (LVS/LED) for status display, control & data logging, reports generation etc. The systems shall have GPRS modem & Ethernet communication. PLC CPU shall have enough in-built memory for data and program memory & shall be capable to expend memory to GBs, a backup battery superfluous with it. Apart from runtime software the development software, it shall also be provided for engineering/ development station. The system shall also enable simple program or firmware updates. The inbuilt Memory can be used during operation for storing and accessing data, e.g. for measured value archiving or recipe processing. In addition to standard automation, safety technology and motion control shall also be integrated in the processor. These should be controlled through genuine supervisory control & data acquisition software having suitable tags requirement. The licenses shall be runtime with development with lifetime validity. Nomenclature of Software solution will depend upon the OEM selected for supplying the hardware and software system technology. Security: SCADA server shall provide adequate security features. It shall be able to define operators' scope of responsibility along with passwords. Security feature of SCADA can be integrated with operating system or can be standalone. For Cyber Security, shall install appropriate Firewall. The SCADA software should have OPC UA connectivity & inbuilt historian.	
5	UPS: 2 no. 5 kVA UPS with suitable battery banks to provide redundant supply backup to Control & Monitoring System. Pure sine wave UPS of 5KVA with 2 hours backup. Power Supply- Dual Redundant Power Supply Electrical Supply- 220V AC and supply from AC distribution	3,47,600
6	SURVEILANCE SYSTEM: 25 Nos (Camera with 32 CH NVR & Accessories): There will be two types of camera will be used in surveillance system. • PTZ (Pan tilt zoom) Camera (2 Nos.): These cameras will monitor the dam area. Which is capable of remote directional and zoom control? The camera will have latest specifications prevailing in the market at the time of finalization. However, few technical specs of PTZ camera are as follows- IP Based Outdoor type Day / Night 6"PTZ , 2 megapixel or more (1920 x 1080) resolution, viewing range- 350 Mtr, Day & Night (ICR), WDR (150dB), DIS & Shock detection with built-in gyro sensor, intelligent Video / Audio Analytics, Defog, Multiple streaming, Wise Stream II	3,50,000

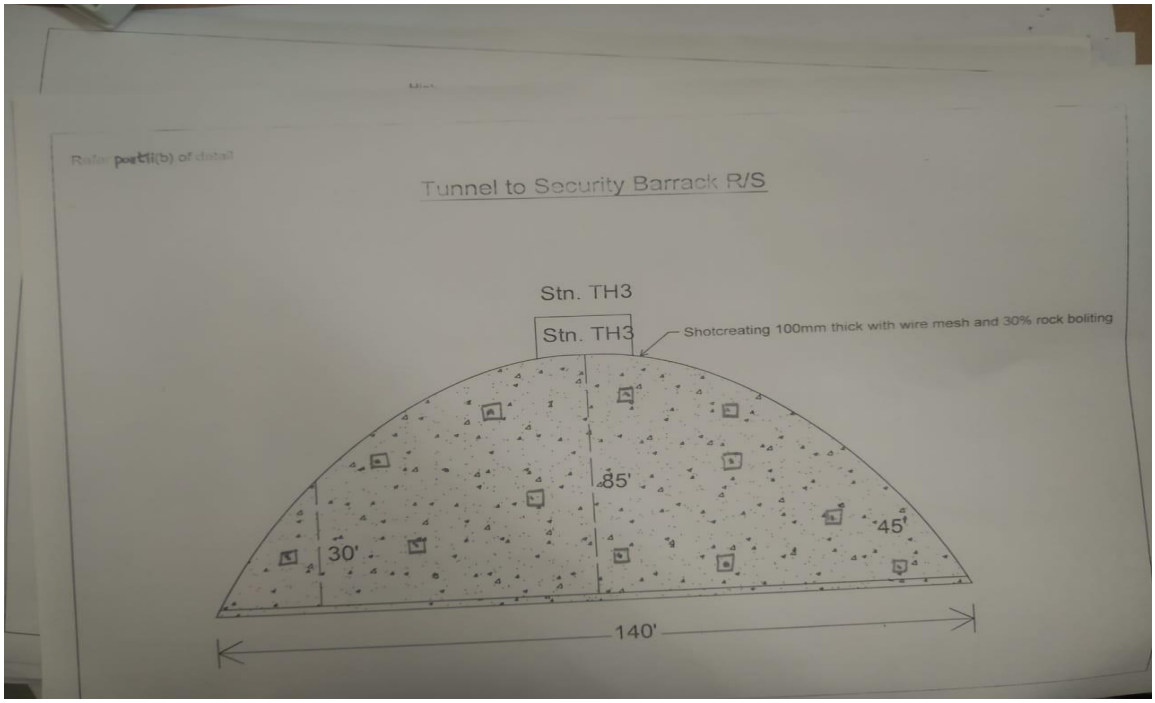
Sr no.	Nomenclature	Approx. Amount in Rs
	support, BLC, WDR, SSDR, Degree of Protection- IP66, IK10, Power Supply, brackets & all required accessories to complete the installation. • Varifocal Camera (23 Nos.): These cameras will be installed at gates, cabin & at entry of Dam. The camera will have latest specifications prevailing in the market at the time of finalization. However, few technical specs are as follows. 2 megapixel (1920 x 1080 effective pixels) or more, (B/W, IR LED on), Focal Length (Zoom Ratio)- 3.2 ~ 10mm (3.1x) varifocal lens, Day/Night-Auto, MJPEG codec supported, Multiple streaming, IR viewable length-30m, Other Feature- Motion detection, Tampering, Defocus detection, BLC, WDR, SSDR, view (90˚/270˚), LDC support, Storage-Micro SD/SDHC/SDXC memory slot (Max. 128GB), Degree of Protection-IP66, IK10, PoE/12VDC & Power Supply, brackets & all required accessories to complete the installation. • IP based 4K network video recorder that supports up to 32 channels, H.265/H.264/MJPEG, ARB & failover (N+1), 8 front hot swappable SATA HDDs (with a maximum internal storage capacity of 48TB), e-SATA/iSCSI storage, RAID-5, Wise Stream compression technology, dual monitor video out. Supports camera resolution up 12MP. H.265, H.264 compression, MPEG codec support, pression simultaneous playback of multiple channels, HDMI/VGA Local Monitor, 32 PoE/PoE Port, TCP/IP, 256Mbps network camera recording, ARB supported with Recording with keyboard, joystick, control software & all required accessories to complete the installation. • 86” LED Display- It shall be provided for Surveillance system. Resolution-4K • Cable & Accessories	9,60,500 2,97,650 4,98,900
7	CONTROL CABIN (1 Nos): The SCADA and Central Control System will be installed and access from Control Room.	8,75,750
8	ELECTRONIC SIREN SYSTEM (4 Nos): Warning system before gate opening to protect local people from flood. The operation of these sirens shall be wirelessly by GSM or by radio modem.	7,88,000
9	GSM BASED REMOTE MONITORING (5 Nos): • To access the data from web page. Also, for the remote location data retrieving wirelessly. The systems shall have GPRS modem & Ethernet communication. • Server shall be required as operator work station (OWS) and a computer with 24” TFT shall be required as an Engineer Work Station (EWS). It shall be able to communicate to external server of SLDC/NHP for display and recording of few important parameters from those sites. • It shall be capable to retrieve data from external server for further display and recording in system historian.	19,25,000
10	Cable for communication, wireless module, armoured fiber optic cable with GI conduit	11,12,560
11	Detailed Engineering, Drawings, Documentation including making flow charts for application software development in PLC/SCADA and making operation and maintenance manuals for the entire packing.	7,50,000
12	Supervision of Erection, commissioning, trials, training for up to 180-man days	5,00,000

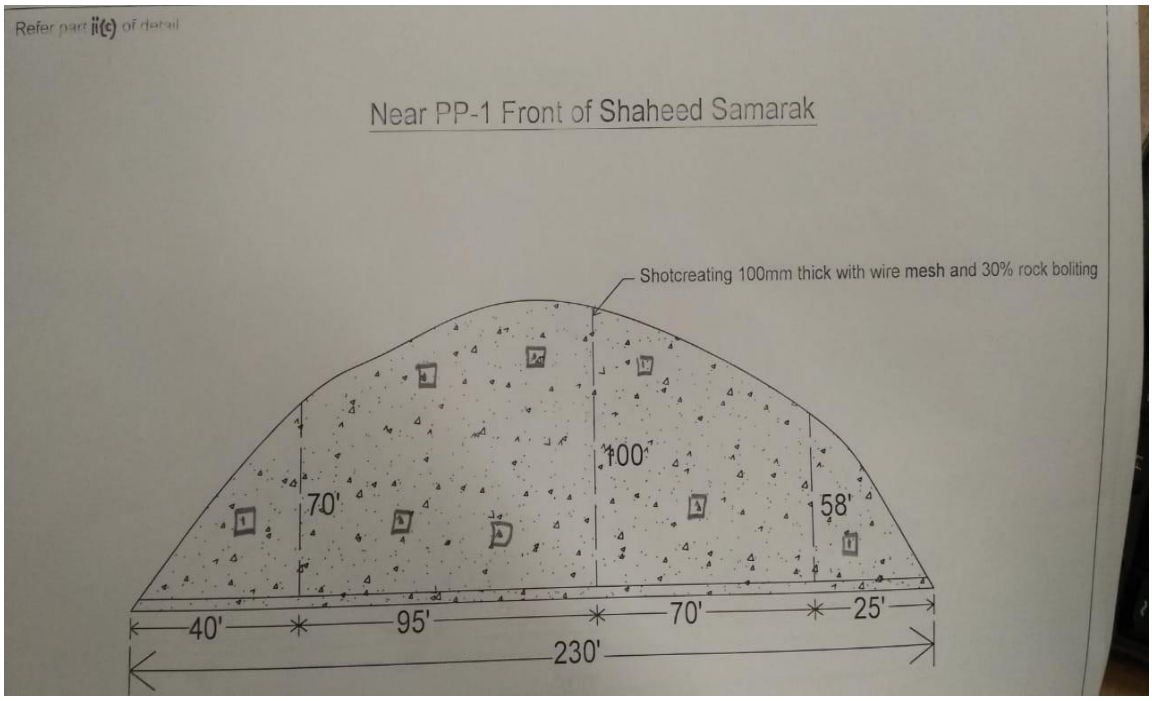
Sr no.	Nomenclature	Approx. Amount in Rs
13	Annual Maintenance contract (AMC) for 5 years @6,00,000 per year after warranty period of 1 year.	30,00,000
14	Lumpsum (L.S.) amount for unforeseen expenditure/items at the time of execution of work.	20,00,000
	Total: **(GST @ different rates item wise is extra to this cost)**	**2,62,54,530**

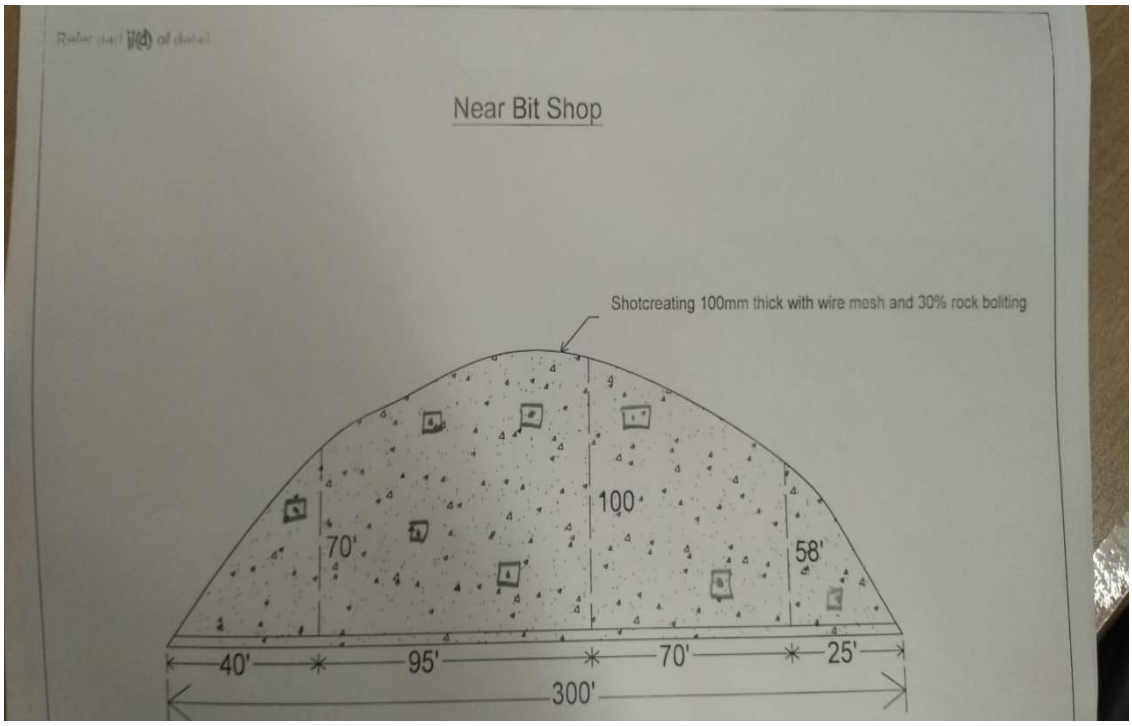


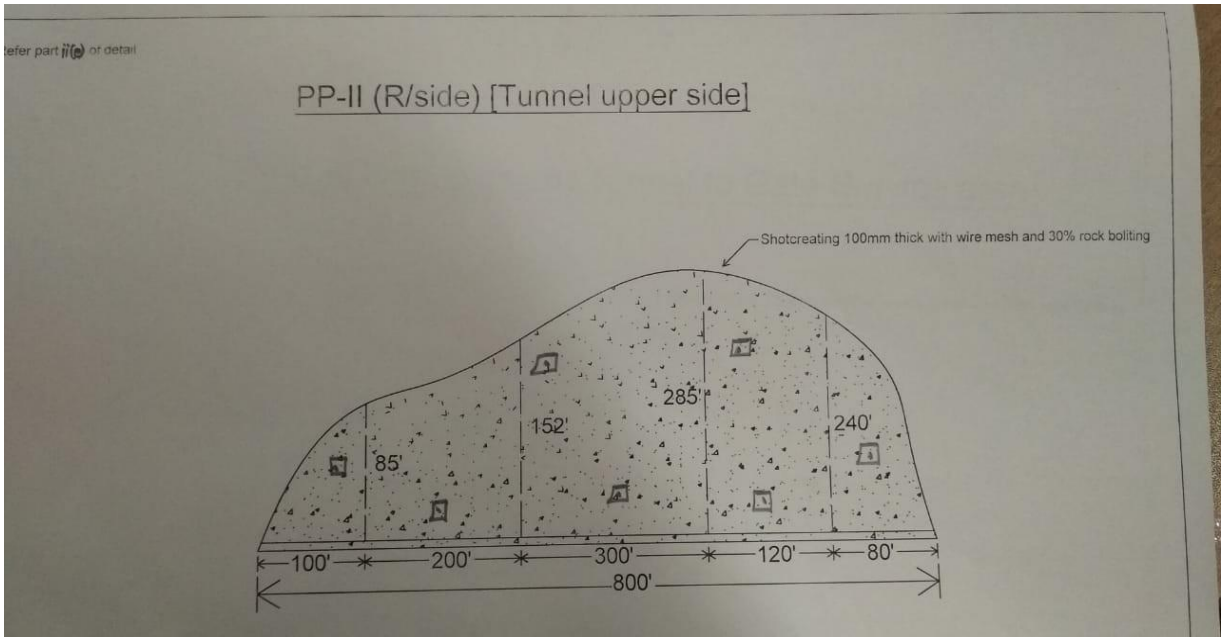

Refer part ii(a) of detail
PP-1 tunnel Portion
Shotcreating 100mm thick with wire mesh and 30% rock boliting
40'
122'
55'
20'
95'
75'
30'
220'

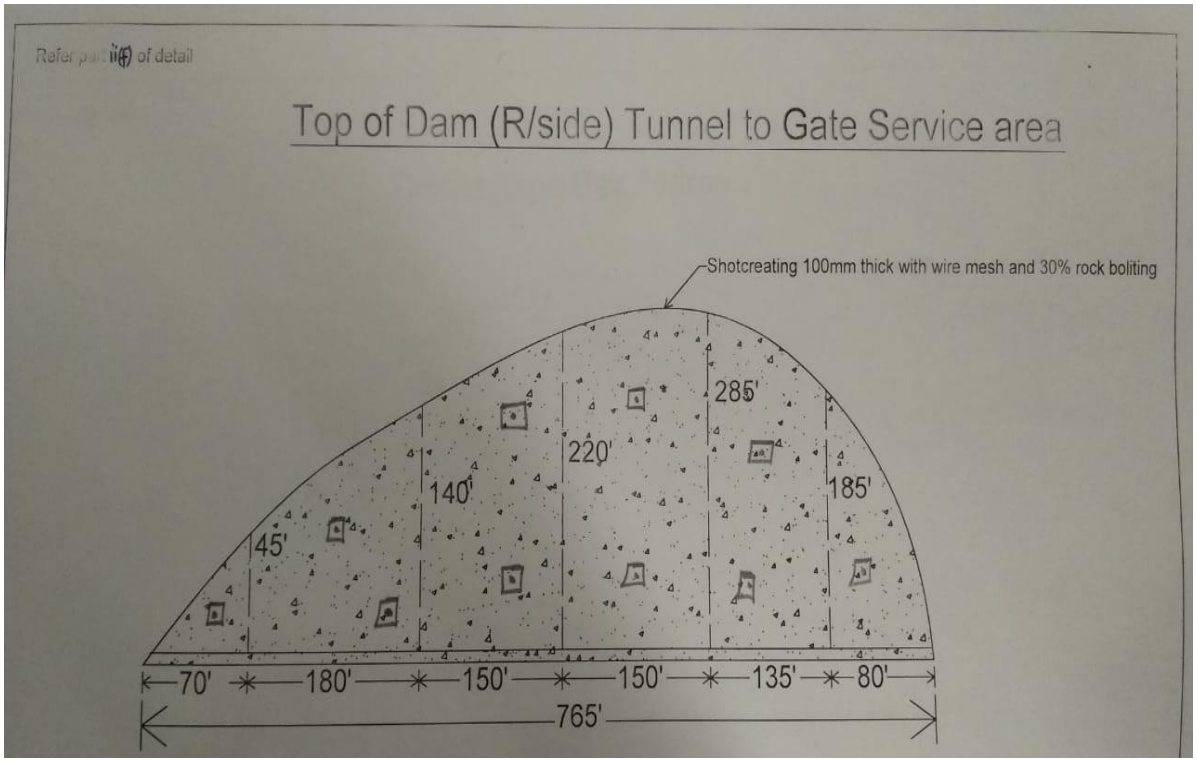

Refer part ii(b) of detail
Tunnel to Security Barrack L/S
Shotcreating 100mm thick with wire mesh and 30% rock boliting
45'
85'
140'
80'
80'
100'
60'
320'

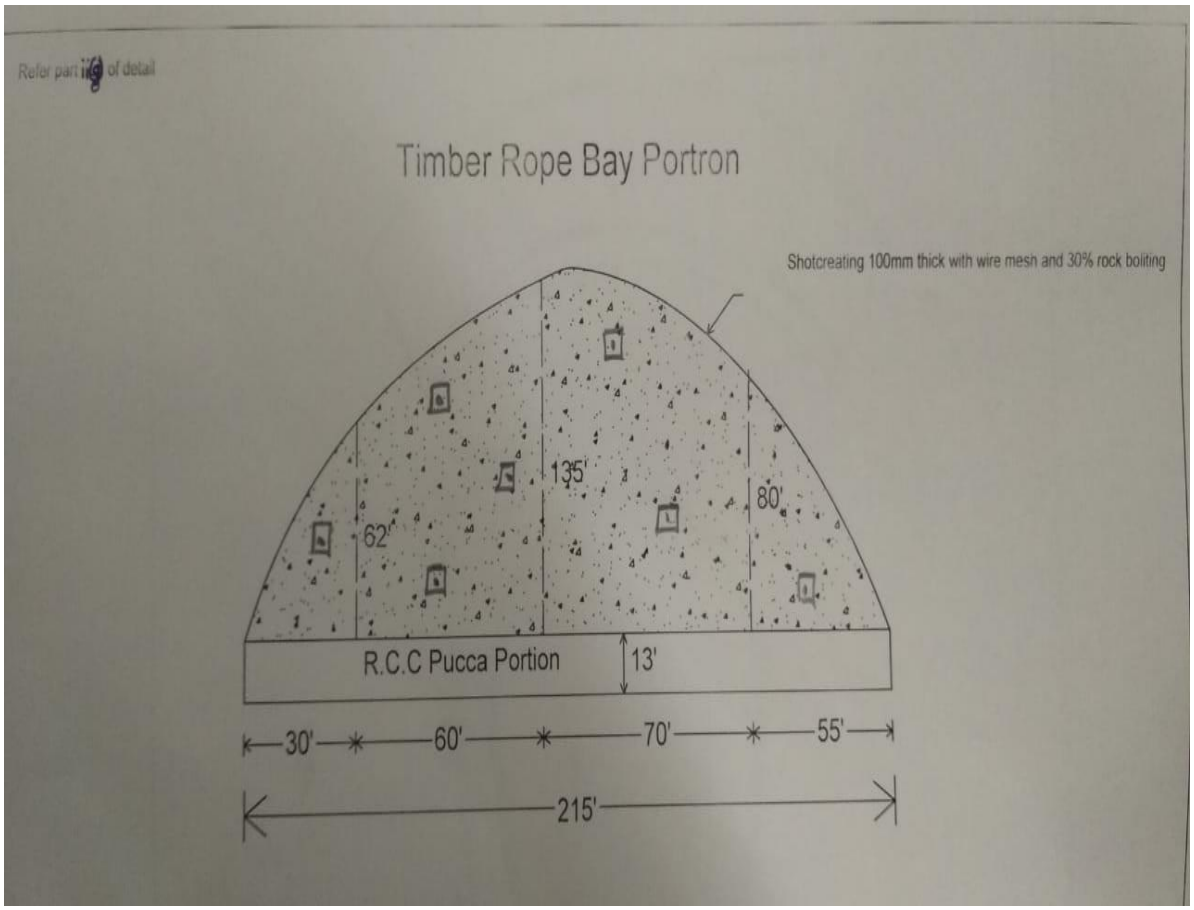

Refer part ii(b) of detail
Tunnel to Security Barrack R/S
Stn. TH3
Stn. TH3
Shotcreating 100mm thick with wire mesh and 30% rock boliting
85'
45'
30'
140'

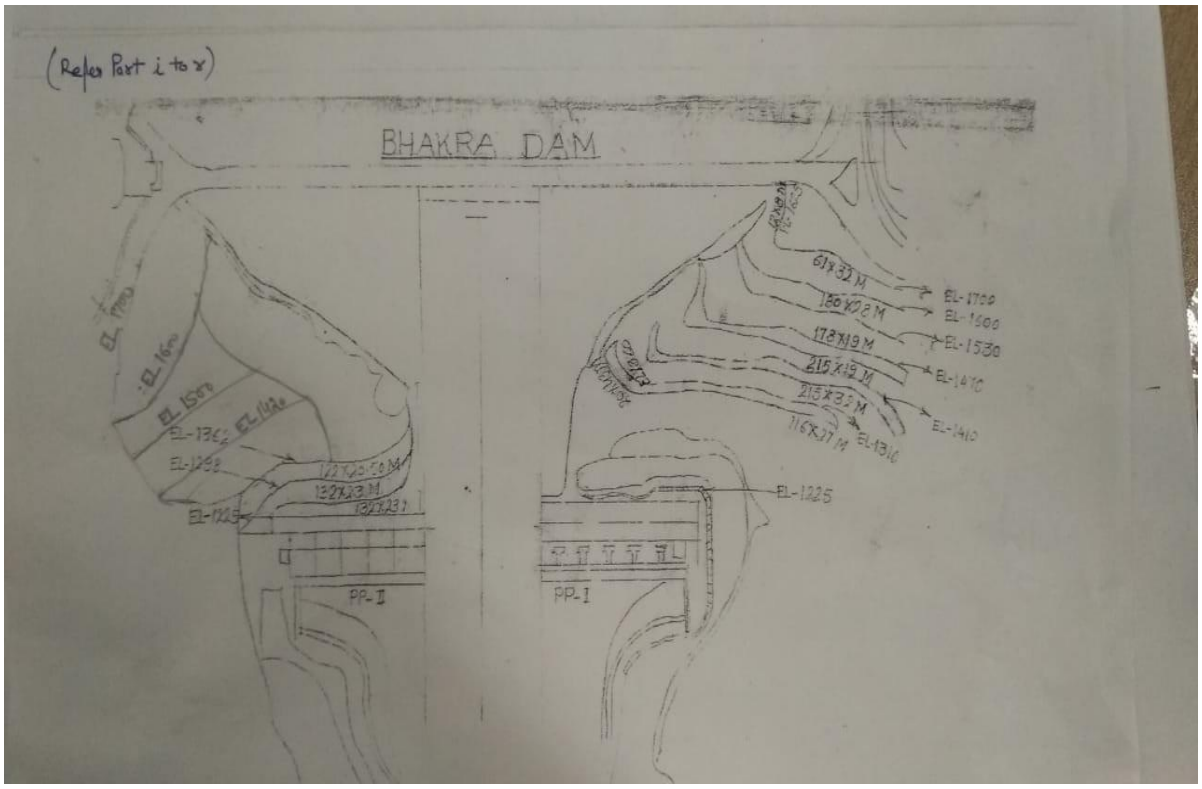

Refer part ii(c) of detail
Near PP-1 Front of Shaheed Samarak
Shotcreating 100mm thick with wire mesh and 30% rock boliting
100'
70'
58'
40'
95'
70'
25'
230'

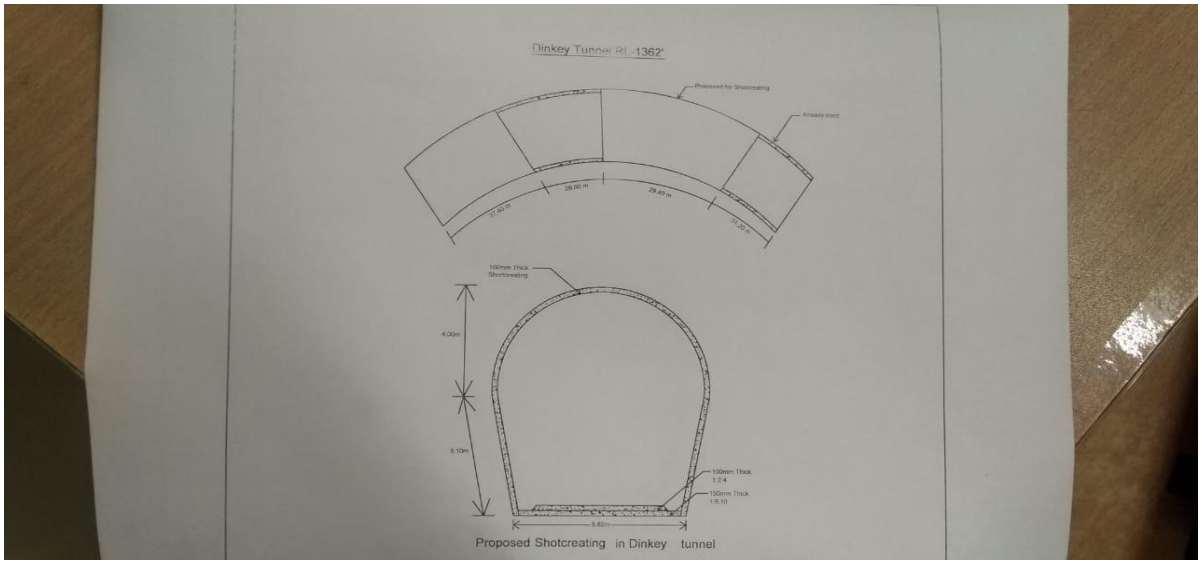

Near Bit Shop
Shotcreating 100mm thick with wire mesh and 30% rock boliting
100'
70'
58'
40'
95'
70'
25'
300'

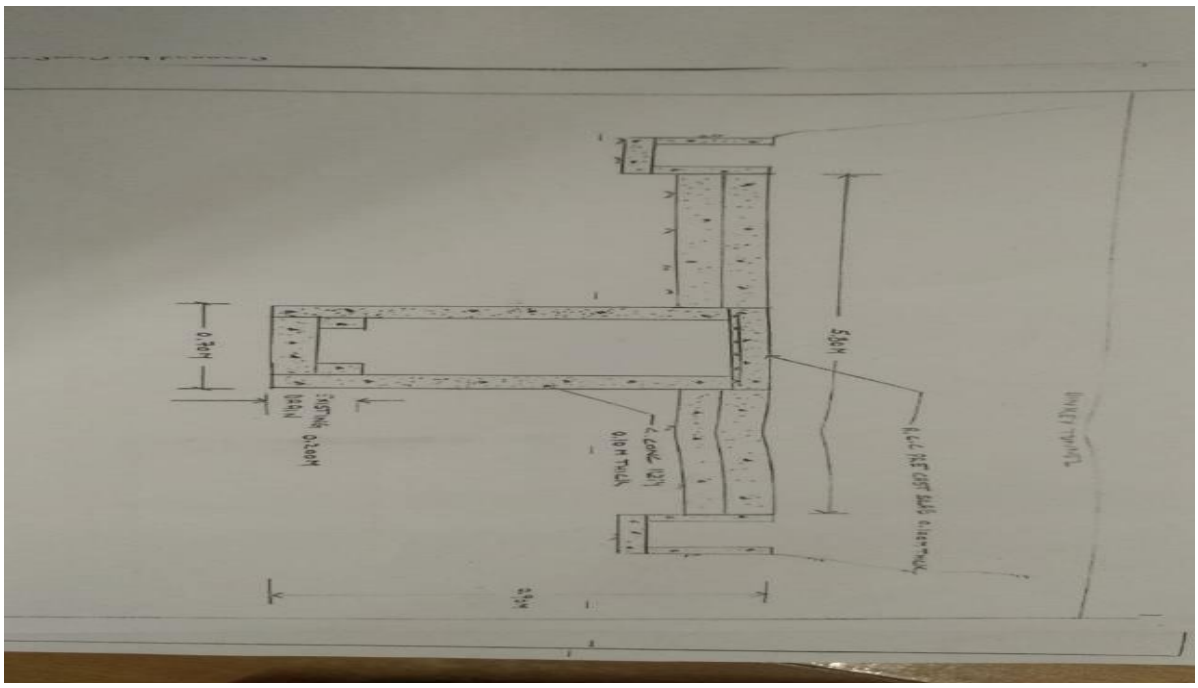

PP-II (R/side) [Tunnel upper side]
Shotcreating 100mm thick with wire mesh and 30% rock boliting
285'
152'
240'
85'
100'
200'
300'
120'
80'
800'

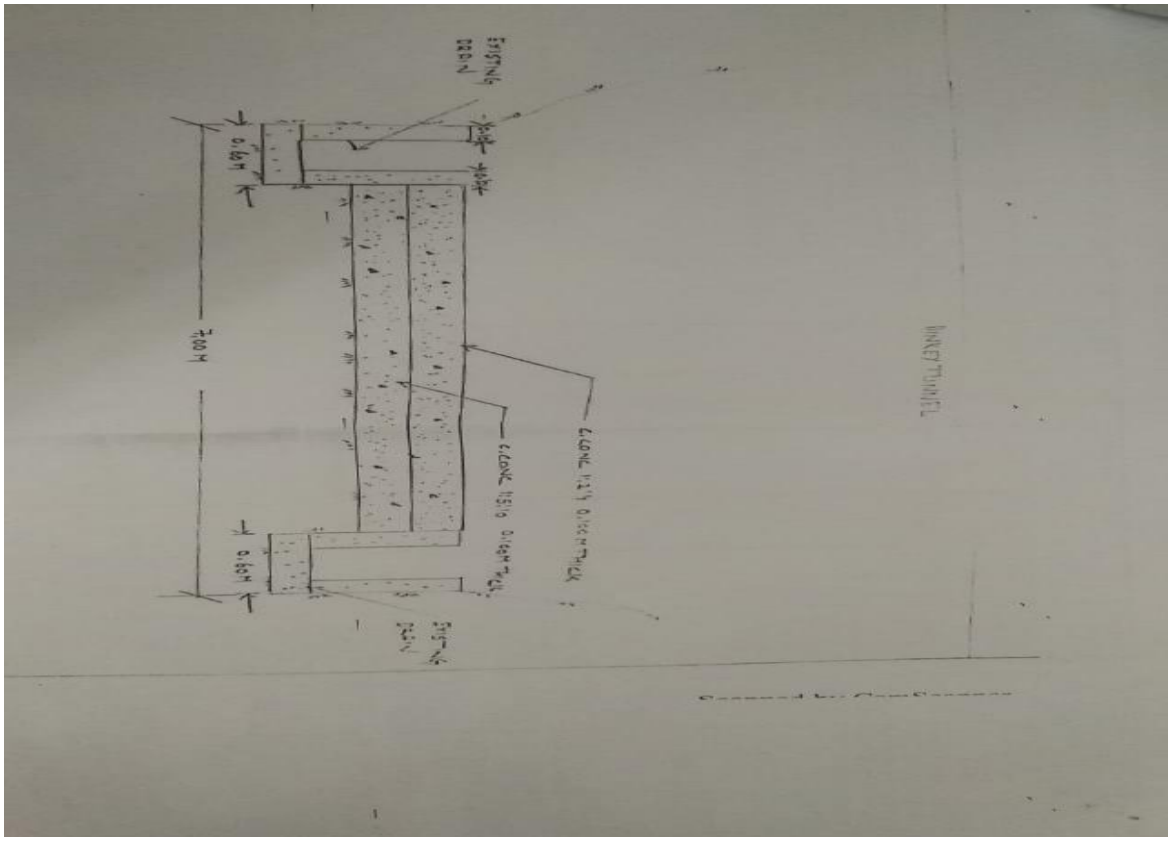

Refer part (F) of detail
Top of Dam (R/side) Tunnel to Gate Service area
Shotcreating 100mm thick with wire mesh and 30% rock boliting
285'
220'
140'
185'
45'
70'
180'
150'
150'
135'
80'
765'

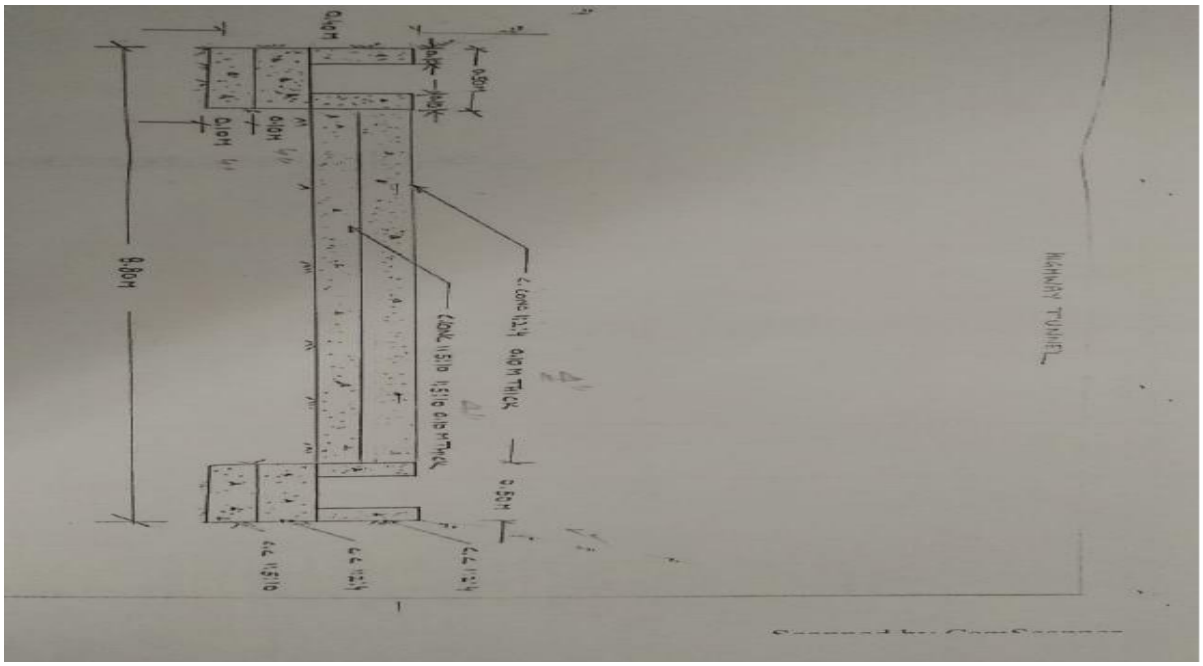

Refer part (G) of detail
Timber Rope Bay Portron
Shotcreating 100mm thick with wire mesh and 30% rock boliting
135'
80'
62'
R.C.C Pucca Portion
13'
30'
60'
70'
55'
215'

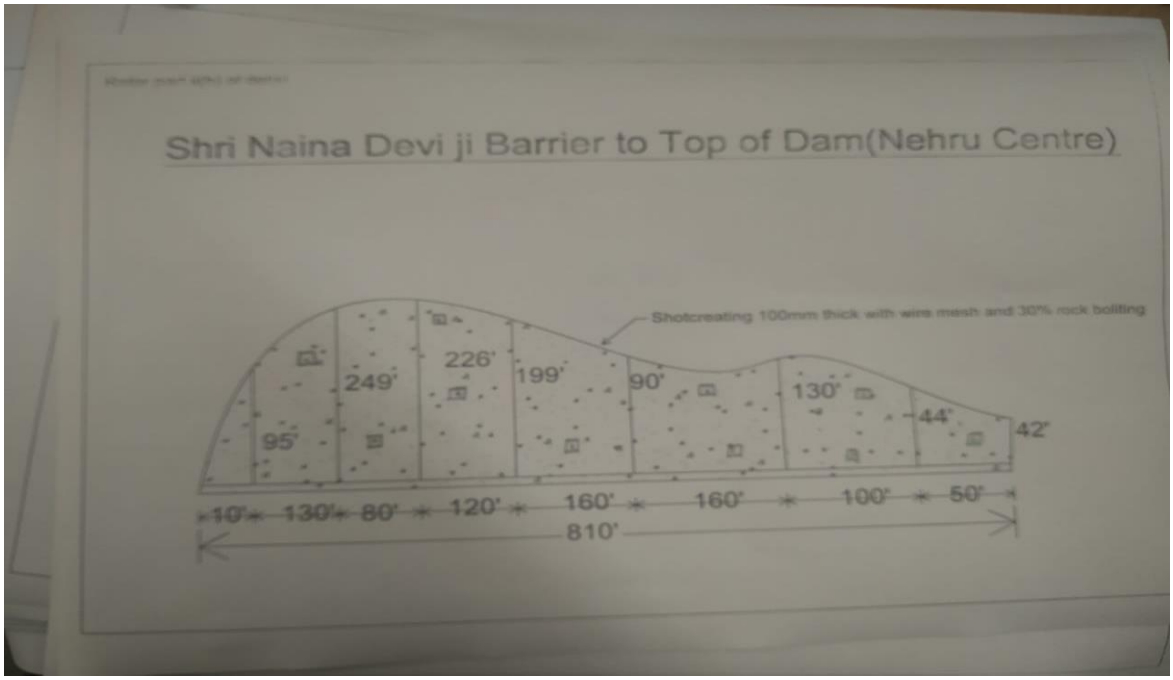

(Refer Part i to x)
BHAKRA DAM
EL-1709
EL-1600
EL-1530
EL-1470
EL-1410
EL-1316
EL-1225
PP-I
PP-I


Dinkey Tunnel RL-1362'
Proposed Shotcreating in Dinkey tunnel








Shri Naina Devi ji Barrier to Top of Dam(Nehru Centre)
Shotcreating 100mm thick with wire mesh and 30% rock bolting
95'
249'
226'
199'
90'
130'
44'
42'
10'
130'
80'
120'
160'
160'
100'
50'
810'

Annexure -3(i)

"Replacement of SMA's

DETAIL OF QUANTITIES & SPECIFICATIONS

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
1.	Accelerometer sensor with cable	Type	Tri-axial, force balance accelerometer in a single module with output for one vertical (Z) and two horizontal components (N-S and E-W) orthogonal to each other	EL 1083 EL 1378 EL 1608	1 No. 1 No. 3 Nos	5 Nos.
		Full scale range	± 1g, ± 2g, ± 4g, Peak-to Peak user selectable			
		Frequency response	Flat response (within ± 3dB) to ground acceleration in the range of DC to 200 Hz/or better			
		Damping	0.7 critical			
		Output impedance and interface	Matching to the recorder unit			
		Dynamic range	>130 dB			
		Clip level	Greater than full scale range			
		Output	Matching to the multi-channel-recorder unit			
		Offset drift	<0.001g/deg.C			
		Non-linearity	<0.1 % full scale range selected			
		Cross-axis sensitivity	<0.5 % full scale range selected			
		Hysteresis	Less than 0.05 % of full scale range selected			
		Self Noise Level	Less than 0.001% of full scale for entire frequency band			
		Calibration coil	Standard, digitally enabled			
		Levelling & Mounting	Should have an indicator for levelling the sensor Should have levelling feet Should have an indicator mark on each component of the sensor to indicate its direction of relative orientation All nuts and bolts should be provided for installation/anchoring the sensor on the dam body			
		Supply Voltage	10-16 V DC			
		Power requirement	<1.2 watt at 12V DC			
		Enclosure	The tri-axial sensors should be mounted in a single water-			

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
			proof, vacuum-tight enclosure and strong enough to work under hot and high humid weather conditions			
		Operating temperature and humidity range	Operating temperature 0 deg to 60 deg C Humidity 100% RH			
		ESD, RF, EMI Protection	Protected against the transients			
		Spare connector	One spare connector, each for multi-channel-recorder end and sensor end			
2.	GPS receiver with cable	GPS time synchronization from external GPS receiver	Sufficient thick high quality cable is required to be supplied for GPS antenna on the dam to the recorder unit	EL 1083 EL 1378 EL 1608	1 No. 1 No. 3 Nos	5 Nos.
3.	3 channel data acquisition system	Number of channels	Three channel	EL 1083 EL 1378	1 No. 1 No.	2 Nos.
		Dynamic range	135 dB or more measured at 100 sps			
		ADC resolution	24 bit independent digitizer for each channel			
		Input range	Should match to the sensor outputs			
		Common mode rejection	Greater than 70 dB			
		Channel to channel skew	Zero-simultaneous sampling of all channels Immune to electro magnetic interference			
		System noise	Not more than 2-3 counts of 24 bit system			
		Sampling rate	User-selectable 1, 10, 20, 50,100,200,500 sps per channel in different streams both in continuous and trigger modes simultaneously as per user requirements Option to select different sampling rates for weak and strong motion channels			
		Filter	Linear phase digital FIR filter			
		RAM	At least 4 MB RAM			
		Storage type	Hard disk or compact flash memory card of 16 GB or more, removable without loss of data Two sets of spare memory cards (16 GB, as detailed above) should be provided			

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
		Recording format	Standard seismological format compatible to Windows/UNIX with proven compression technique. It should be easily convertible to SEED format			
		GPS Timing System	UTC timed with digitally controlled precision VCXO clock phase locked to GPS Timing accuracy less than 0.1mSec when GPS is locked Free running TCXO accuracy of 1 ppm over wide temperature range GPS receiver electronic circuit should be inside the DAS with Antenna exposed outside Antenna cable length should be 15 mts or more Antenna should be enclosed in water tight and can work effectively in extreme climatic condition Antenna mounting rod and its accessories Antenna cable should be laid through thick plastic conduit pipe from roof-terrace to the digitizer			
		Sensor control	Sensor calibration facility for both BB seismometer and accelerometer Sensor mass position monitoring for BB seismometer Sensor mass centering on command for BB seismometer			
		State of health of each channel	Provision for checking state of health information like sensor mass position, temperature voltage, condition of GPS time lock etc. Locally and remotely			
		Status display	Status display indicators for power, data acquisition, SOH, GPS etc. Should be provided			
		Gain	User selectable multiple gain through software			
		Data acquisition mode	Continuous and triggered mode as per user configuration Restoration of automatic data acquisition in DAS on assumption			
		Trigger	User selectable, independently for each channel at different sampling rates based on triggering criteria as STA/LTA, Level etc.			

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
		Communication	In built communication interface circuitry for provision of remote data acquisition and state-of-health in near real time mode through GSM-modem and VSAT Suitable interface and cable connectivity with the DAS unit to computer /laptop for parameter setting and data downloading			
		Transmission setting	Should have facility to select transmission of data to remote location in the following options: Continuous mode transmission for BB data Continuous or trigger mode transmission of SMA data as per user configuration			
		GSM modem/VSAT connectivity	Ethernet port (10/100 Base-T) supporting TCP/IP and UDP/IP Compression of data before transferring to mobile GSM-modem Continuous and trigger both (6 channels) Duplex communication between field and both hubs Extensive error correction Support for off-the-shelf communication equipment Appropriate cable to connect the DAS with the GSM-modem/VSAT (RJ-45 port or single port)			
		Power supply	Supply voltage 10-15 volts through battery-charger activated maintenance free batteries Power consumption of DAS less than 6W at 12 V DC recording 6 channels at 100 SPS Low battery voltage protection and DAS shall resume data acquisition and transmission automatically when the power is restored			
		Operating temperature and humidity range	Operating temperature 0 deg to 50 deg C Humidity : upto 100% RH			
		Environment	All the indoor units should work in typical tropical environment conditions and should work without air			

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
			conditioning			
		Housing	GPS and DAS modules should be enclosed in a weather- and shock-proof sealed enclosures			
		Grounding	DAS earth cable should properly be grounded at the time of installation			
4.	9 channel data acquisition system	Sensor	Each sensor to be connected to a multi-channel recorder (9 or more channel recorder) preferably in a star-topology for signal as well as DC power. Each sensor is required to be connected to a multi-channel recorder to be installed in	EL 1608	1 No.	1 No.
		Multi-channel recorder	The multi-channel recorder should continuously monitors the real-time data generated by each of the sensors attached to the system and compares the measured data to at least five independent trigger criteria selected by the user The multi-channel recorder should display the status and health of the reporting accelerometers through LED/LCD display, alarm relays, etc. The multi-channel recorder should have data storage capacity at least 64 GB capacity or more. Two sets of spare memory disks are required to be supplied with multi-channel recorder The recorder should support simultaneous recording of data from 9 channels (3 channel per accelerometer x 3) at different sampling rates-50,100,200,500 sps The multi-channel recorder should work from 12V battery and power consumption should be less than 30 watts for 9 channels The multi-channel recorder should be equipped with battery-bank to sustain the operation of the equipment for about 48 hrs in case of AC main failure. Battery -bank of the recorder should be equipped with a charger connected to 230 V AC main supply			

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
			The multi-channel recorder should support connectivity to GPRS/GSM modem /VSAT for transfer of recorded data to central computer, if required in future The recorder should support to download the recorded data from the memory disk into a Note Book computer. All such application software, interface units and connectivity cables for downloading data to Note Book computer are required to be supplied in 2 sets Each channel should have independent digitizer of 24 bit resolution for recording data from each of tri-axial accelerometer			
		Multi-core cable	The multi-core cable is of industry with heavy cable jacketing in order to protect the cable from damage and negate the effects of electromagnetic interference between various signals and power signal cables All the multi-core cables should be strong enough and high standard to sustain hot and humid conditions			
		GPS time synchronization	GPS time synchronization from external GPS receiver. sufficient thick high quality cable is required to be supplied for GPS antenna on the dam to the recorder unit			
		Spares	Suitable number of interface units, interconnection sets, routers, repeaters, junction boxes, multicore cable cables required for installation and commissioning of the accelerometers and multi-channel recorder should be supplied			
5.	Batteries, chargers etc. For 5 stations	-	-	EL 1083 EL 1378 EL1608	1 No. 1 No. 1 No.	3 Nos
6.	Digital sensor cable and accessories (1000 m)	-	-	-	-	1000 mters
7.	Work station	-	a) Intel core i5 processor 4 cores @ 3.0 GHz or more	-	-	2 Nos.

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
			with 8 MB cache; or equivalent b) Minimum RAM of 32 GB c) Internal hard disk with minimum storage capacity of 1 TB d) DVD-RW drive e) 24 inch graphics LED Monitor with display resolution should be 1920x1080 f) At least 2 GB VRAM g) Graphic card compatible to NVIDIA Quadro K620, 2 GB, DP/DL-DVI-I h) 2 numbers of 10/100/1000 Mbps Ethernet ports, USB 2.x-4 ports i) Latest operating system and related software compatible to application software with recovery kit j) Restoration software in case of disaster or crash of the system K) Keyboard and Optical Mouse l) Latest antivirus with valid license for warranty period m) One number of 2 TB capacity external USB hard disk is to be supplied with each work station			
8.	On-line UPS-2KVA capacity 30 min/one hour back up at full load		Input from main AC supply (230 V, 50 Hz) with range 180V-300V, Freq 50Hz +/- 5% Output voltage 230V +/- 2% AC, Freq 50Hz =/- 0.5%, sine waveform Indicators for the mains presence, battery charging/discharging, battery low, AC input/output voltage, /nverter failure, etc. High voltage AC surge protection circuit Inverter efficiency: 90 % minimum Protection circuit for overload, short circuit, and under voltage at battery terminals Required number of SMF batteries to support one hour backup at full load	-	1 No.	1 No.

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
9.	Laser jet printer (B/W)		A4 size, black and white printer At least 1200 dpi resolution 128 MB RAM Post-script LAN support Printing speed:12 ppm or better; and printing on both sides of the paper The printer must work from 230V/Hz AC supply One set of printer cartridge is to be provided	-	1 No.	1 No.
10.	Application software for strong motion data downloading and analysis of data	Application software for Strong Motion Data Analysis	Application software utilities foe parameter setting, on-site control panel, calibration signal, functional test, data acquisition; local data retrieval, processing and analysis purposes. Media and license to be provided Appropriate communication software to download the event data and log, into Note Book computer Appropriate utility software for faster downloading of large amounts of data from the ring-buffer disk/PC-card of the multi-channel-recorder unit, through fast-communication port into the Note Book computer Data plotting and display software Provision to convert the data into mSEED, SAC, SEISAN and ASCII formats Provision to display the trigger information on different streams, state of health of the sensor, GPS, triggered streams etc. Complete software analysis package for Strong Motion data to assess the dynamic response of the dam during strong ground shaking Continuous waveform display of the recorded data	-	1 No.	1 No.
		Application software for seismic data analysis	Application software utilities for parameter setting, on-site control panel, calibration signal, State of Health (SOH) monitoring, data acquisition; local data retrieval, processing and analysis purposes. Media and license to	-	1 No.	1 No.

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
			be provided Data retrieval package to download the data as per user criteria in the user required output format such as mSEED, SEISAN, SAC etc. For the purpose of analysis of the data Display of continuous in-coming data into the archive or ring buffers 24 Hrs data plotting and display software Installation and configuration of SEISAN software foe event analysis with instrument response files			
11.	Note book computer	-	Intel core i7 processor at 3.3 GHz or more with on board 4 MB cache memory Memory 16 GB RAM 1 TB HDD Graphic card with VRAM 2 GB 17” colour monitor Enhanced key board, optical mouse DVD R/W combo drive (latest) USB ports minimum two Integrated 10/100/1000 Mbps Ethernet port OS with license compatible to application software Latest antivirus Additional PCI slots-2 Nos Suitable port required for parameter setting and downloading of data from DAS	-	1 No.	1 No.
12.	Spares (1 set DAS, one accelerometer, memory card, GPS antenna with cable, one power cable etc.)	1 set DAS	Specifications as per Sr. No. 4 above	-	1 No.	1 No.
		1 No. Accelerometer sensor with cable	Specifications as per Sr. No. 1 above	-	1 No.	1 No.
		1 No. GPS receiver and cable	Specifications as per Sr. No. 2 above	-	1 No.	1 No.

Sr. No.	Description	Parameter	Specifications	Location	Quantity	Total Quantity
	Additional units (spares)	Four numbers of battery chargers with LVD	3 Nos. covered in Sr. No. 5 above	-	-	-
		Four numbers of internal battery (if used in DAS)		-	-	-
		One unit of GPS antenna with cable (10m)	Covered in Sr. No. 12	-	-	-
		One number of connecting cable from DAS to Note Book computer	Covered in Sr. No. 6 above	-	-	-
		2 Nos. 24 port 10/100/1000 Mbps Ethernet switch		-	-	-
13	Installation, commissioning & training to the staff for 5 working days by the staff of OEM at dam site for upkeep of equipments, processing of data etc.	-	-	-	One Job	One job
14.	On-site warranty for 24 months	-	-	-	One Job	One Job
15.	Export, packaging, freight insurance to Indian Airport (Chandigarh)	-	-	-	One Job	One Job

ii) **Modernization of Plumb line**

Sr. No.	Description	Price Per Unit	Qty.	Total Cost In Rs	Remarks
1	Type and cost of Sensor to be installed	95,000/ Unit	26 Nos.	2,47,00,00.00	Proximity sensor
2	Type and cost of cable about 225 m long	170/ mtr	2300 mtr	3,91,000.00	Screened cable. So that no interference will be get from outer
3	Design, manufacturing & supply of continuous online monitoring system complete with signal processing units , monitoring , modules, hardware software allied accessories along with computer etc. for plumb wire 0.3 inch thick movement	740000.00	01 No	7,40,000.00	Including cards processors
4	Lump sum, erection, testing and commissioning charges for above continues online monitoring cost of installation.	3,00,000	01 No	3,00,000-00	
				Total = 39,01,000.00	
				Add GST @ 18% =7,02,180.00	
				Gross Total = 42,03,180.00	

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iv) **Providing of MPBX Extensometer**

ABSTRACT OF COST

Sr. Nos.	Description of items	Units	Qty.	Rate	Amount in Rs.
1	Supply of Multi Point Boreholes Extensometer	No	03	70,000/-	2,10,000.00
2	Supply of 8/10 core jelly filled cable	Mtr.	200	150/-	30,000.00
3	Supply of data logger for day to day monitoring	No	01	4,50,000/-	4,50,000.00
4	PVC conduit	Mtr.	50	35/-	1,750.00
5	Installation charges for above instruments	Job	01	90,000/-	90,000.00
6	Drilling charges for 65 mm Borehole	Mtr.	60	9,300/-	5,58,000.00
				Total =	**13,39,750.00**
				GST @ 18% =	**2,41,155.00**
				Total =	**15,80,905.00**

Providing of MPBX Extensometer

DETAIL

Sr.No.	Description of items	Units	Qty.
1	Supply of Multi Point Boreholes Extensometer	No	03
2	Supply of 8/10 core jelly filled cable	Mtr.	200
3	Supply of data logger for day to day monitoring	No	01
4	PVC conduit	Mtr.	50
5	Installation charges for above instruments	Job	01
6	Drilling charges for 65 mm Borehole	Mtr.	60

Detail of excavation in Dinkey Tunnel									
S.NO	**R.D**	**DISTANCE**	**CUTTING (Sqm)**	**FILLING (Sqm)**	**MEAN AREA CUTTING (Sqm)**	**MEAN AREA FILLING (Sqm)**	**VOLUME CUTTING (Cum)**	**VOLUME FILLING (Cum)**	
A									
1	**0**	**0**	**0.54**	_	_	_	_	_	
2	**30**	**30**	**2.27**	_	**1.41**	_	**42.30**	_	
3	**60**	**30**	**1.65**	_	**1.96**	_	**58.80**	_	
4	**90**	**30**	**2.36**	_	**4.01**	_	**120.30**	_	
5	**120**	**30**	**--**	**0.72**	_	**1.54**	_	**46.20**	
³	**124**	**4**	**0.21**	_	**0.47**	_	**1.88**	_	
						Total =	**223.28 cum**	**46.20 cum**	

B	**Earth work for drain, sump to existing drain** **(1.64+1.36)x0.60x9.14 =8.23 cum** **2**		**8.23 cum**	
C (-)	**Existing Drain earth work** **(1.36+0.16)x0.60x104 = 47.42 cum** **2**		**47.42 cum**	
	Total earth work in excavation(A+B-C)= (223.28 + 8.23-47.42) = 184.09 cum		**184.09 cum**	

Detail of excavation in Highway Tunnel

S.NO	R.D	LENGTH	AREA(SQM)	MEAN AREA(SQM)	VOLUME (Cum)
1	0	0	1.73	-	-
2	30	30	2.49	2.11	63.30
3	60	30	2.82	2.66	79.80
4	90	30	1.06	1.94	58.20
5	120	30	1.29	1.18	35.40
6	150	30	4.90	3.10	93.00
7	159	9	5.07	4.99	44.91
8	168	9	9.86	7.47	67.23
9	177	9	7.09	8.48	76.32
10	187	10	4.31	5.70	57.00
				TOTAL =	**575.16 cum**

Work No. 5 : Treatment of hot spots and landslides around Bhakra Reservoir By taking suitable measures

INTRODUCTION : Bhakra Reservoir, named as Gobind Sagar has an enormous spread area of water extending over 168.53 Sq.Km (65 sq.mile) at full reservoir elevation of 515.11M (1690 feet). The river Sutluj originating from Mansrover lake along with its tributaries has catchment area of $5687.6x10^3$ hectares or 56876 Sq.Km meter (21960 sq. miles). While negotiating through vivid terrains, it is transports lot of silt into the reservoir affecting it is life. The silt contribution is largely due to unprecedented deforestation, over grazing in the pasture land, unscientific agriculture practice, in-different attitude of people residing in catchment area in adopting contour terrace farming, absence of effective afforestation programme and other un planned development activities under take in catchment area including mining activities road / railway construction etc. The silt transported by the river, its tributaries is deposited behind the dam in the reservoir, reducing its capacity and thus affecting its useful life. With commencement of Beas Sutlej link project, its water being diverted for generation of power at Dehar power house, also contributes of certain amount of silt in to Bhakra reservoir. The sedimentation survey are being connected regarding, sedimentation of silting of reservoir from the year 1959, up to the year 1977 it was done or annual basis whereas afterword once in two year, so that the rate of siltation be calculated for finding out the capacity of Bhakra Reservoir.

The latest results of sedimentation survey for the year 2016-2018

CAPACITY	ORIGINAL DESIGNED CAPACITY		CAPACITY OF RESRVOIR ENDING 2016		SILT DEPOSITED DURING 2016-18		BALANCE CAPACITY OF RESRVOIR ENDING 2018(Actual/Designed)	
	M m^3	maf.	M m^3	maf.	M m^3	maf.	M m^3	maf.
DEAD STORAGE	2431.806	1.9706	1406.966	1.1406	19.0	0.0154	1387.966	1.1252
LIVE STORAGE	7436.034	6.0285	6242.154	5.0606	35.01	0.0284	6207.144	5.0322
GROSS STORAGE	9867.84	8.0000	7649.12	6.2018	54.01	0.0438	7595.11/ 7884.71	6.1574/6.3922

The loss of the storage capacity of the Reservoir is the higher concern for the project authority and it attracts very obvious attention to the same to prolong the life of the Reservoir it can be done in the by talking in consideration following 2 type of measures

(a) By taking suitable protective measure

(b) By taking corrective measure

Protective measures:

1. Afforestation.
2. To monitor Illegal mining.
3. To control the Illegal construction activities.
4. Construction of gully plugs/rock fill dam / Check Dam.

In addition to the above measures IIT, Ropar has been given the work for study of Hot Spots of Silt in the Bhakra Reservoir, the number and location of the check Dams, Rock Fill Dams can be changed after receiving the report.

(b) **Corrective measure**

The work for productive use of silt in the Bhakra Reservoir has been given to IIT, Roorkee. The work of Desalting of Reservoir will be taken in hand after the receiving the report from IIT, Roorkee.

Thus percentage loss of live / dead storage of capacity up to the year 2018 has worked to be 16.51.percent and 42.93 percent respectively. Thus over all capacity of Gobing sagar reservoir from the year of 1959 to 2018 has reduced up to 23.02%. In order to prolong the life of Bhakra Reservoir, some preventive and corrective measures has to be taken by BBMB. As if BBMB takes effective efforts in preventive / corrective measures, if will increase the life of reservoir by which there will be heavy financial benefits to the nation. However consent of HP Govt. is urgently required before taking in hand such type of construction works as the entire area falls in the Himachal state. The detail of two type of measures have been given below

1. Afforestation.
2. To monitor Illegal mining.
3. To control the Illegal construction activities.
4. Construction of gully plugs/rock fill dam / Check Dam.

The detail of each activity is as under:-

1. Afforestation:- In this regards, BBMB, has started activities since 1985-88. From that time, plantation is being done in BBMB land falling in elevation of 1680’ up to 1700’. But from this year 2019-20, it has been decided to distribute plants to people residing in the catchment area of Bhakra Reservoir.in this plan a target of distribution 3 lac plants has been fixed by the humble chairman BBMB. In the coming time such target will be fixed and

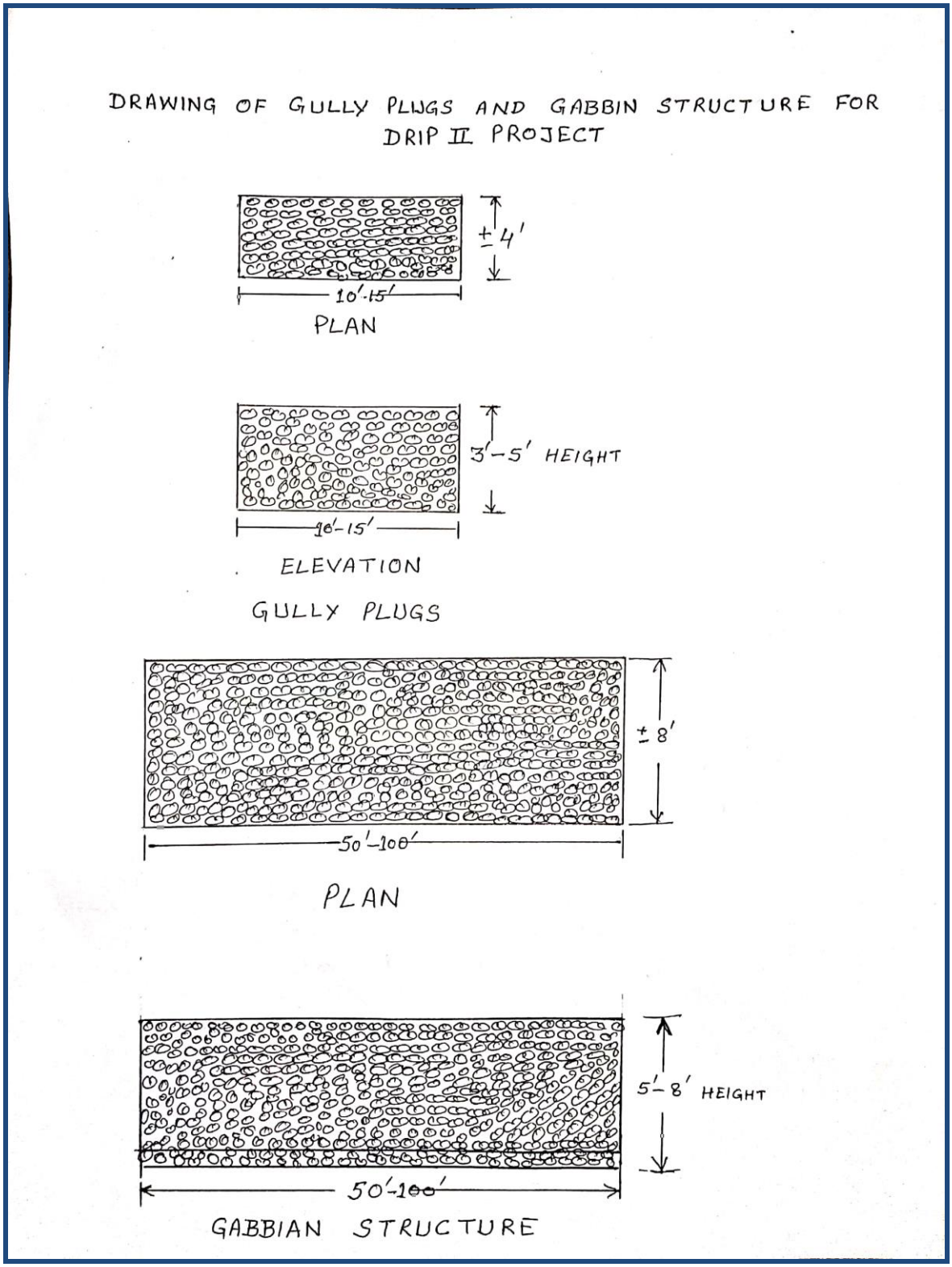
achieved to control the siltation in the reservoir. In this plan rupees 2.26 crore has been kept for plantation / distribution of plants in catchment / fringe area of reservoir.

Monitor of Illegal mining :- one mining officer along with staff should always tour in catchment area to keep close watch on Illegal mining in the Bhakra Catchment area. This will also help to minimize the formation of silt in Bhakra catchment area. So for this purpose 20 nos seminars will be conducted in catchment area. The cost for 1 seminar has been kept as Rs. 1 lacs.

Constriction of Gully plugs /rock fill dams/check Dams:-

(i) **Gully plugs**:-These are the small structures which will be constructed across first order / second order of stream by arranging local material to arrest the velocity of surface water and to reduce the soil erosion and will also help in growth of vegetation in the area. The Bhakra reservoir is 96 Km long, by doubling its length of both banks it will be about 200 Km. about 40 gully plugs will be constructed in each Km. so nos. of gully plugs will be 192x40=7680 Nos. This activity will involve only labour charges. So this will also enhance the employment opportunity to the local people of catchment area. The approximate width of each gully plug will be ±4 feet and width will be varying from 10-15 feet

(ii) **Gabion structure**: -the Gabion structures are somewhat bigger structures than the gully plugs. It will arrest velocity of water and will also reduce the sedimentation into the reservoir. The average 10 numbers gabion structures are proposed to be constructed per km of Reservoir. So total number of gabion structure will be about 2000. The size of gabion structure will be 50 feet up to 100 feet length & width will be ±8th feet. The material will be arranged locally. This activity will involve labour charges only and bigger size near to Reservoir will help the development opportunity to the local people of catchment area.

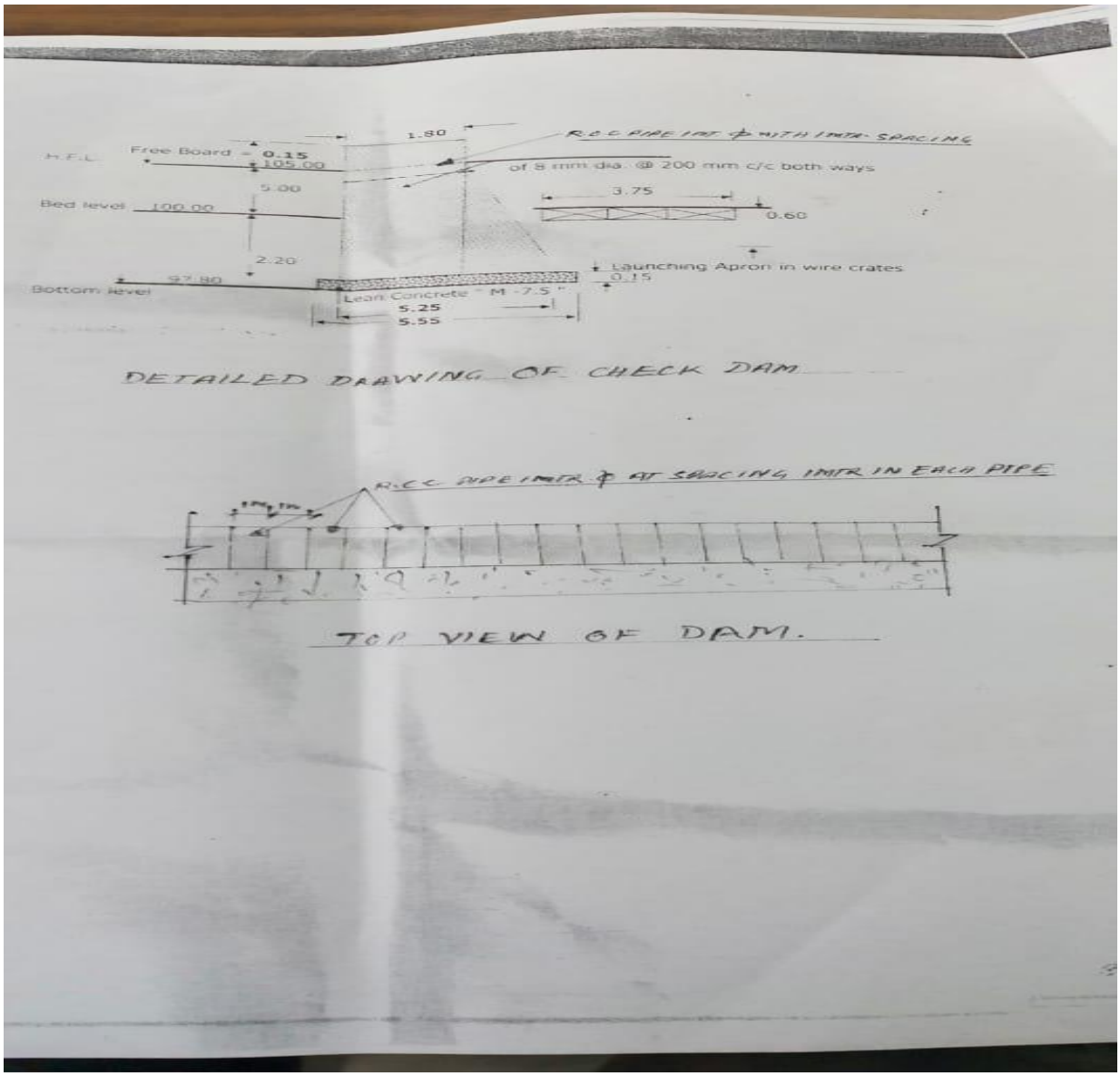


(iii) **Check Dams**:- There are eight number of Khad/ Tributaries namely Lunkhar khad, seer khad, Gambrola khad, Malta Khad, Sarhali Khad, Ali Khad and sukhar khad coming into the Bhakra reservoir. Total length of above khads is about 200 Kms and about 30 number of check dams are being proposed @ Rs.167013 per meter length of dam.it is big structure

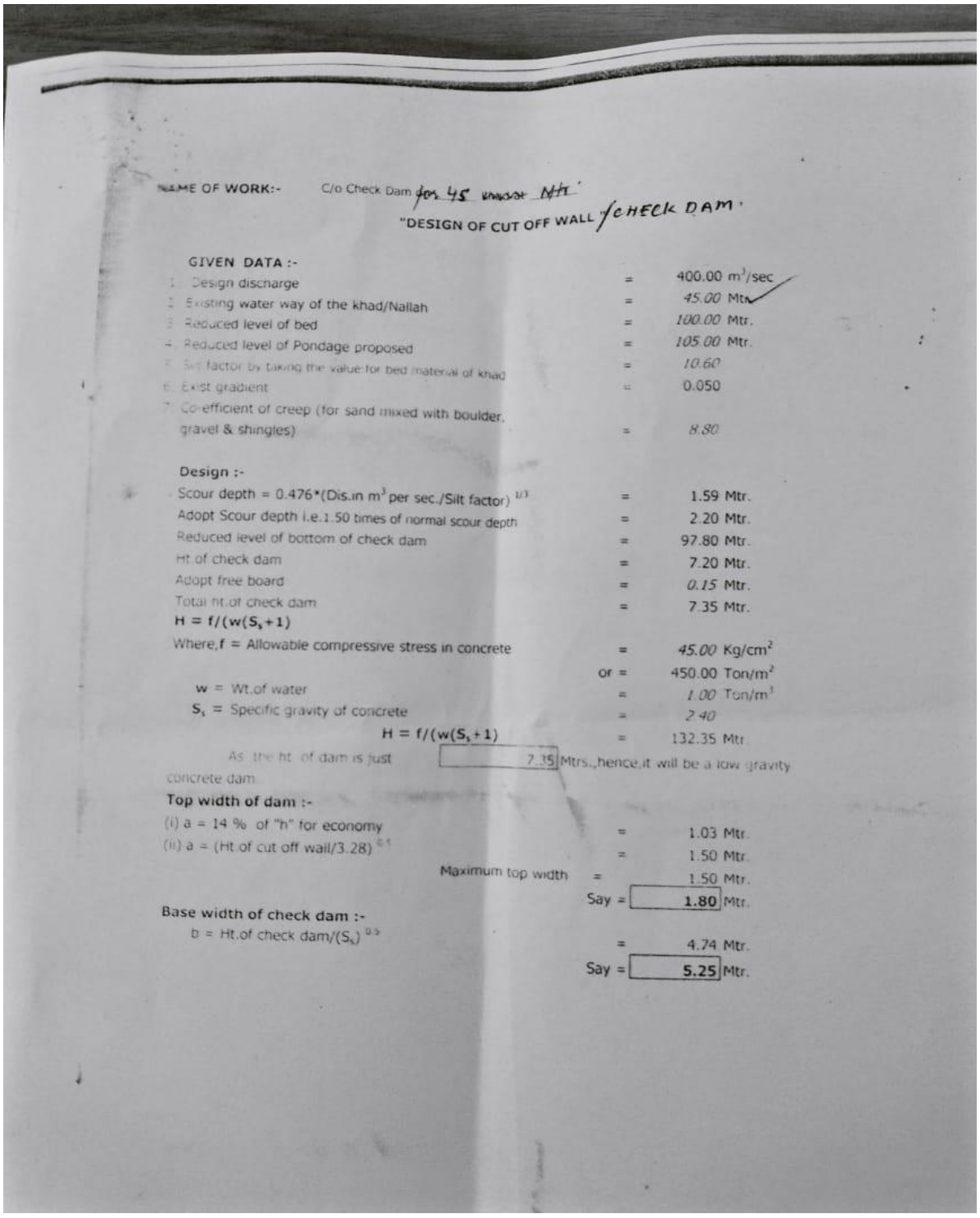
made of concrete and will control and will control the silt entry into the reservoir up to 90%. These check Dams will also help to provide temporary crossway for the people of the area.

Note:- The number of Gully Plugs, Gabion structures and Check Dam may be increased or decreased after receiving the study for hot spots of Silt in Bhakra Reservoir from IIT Ropar. Moreover before taking in hand the construction of these structures, the consent of Himachal Pradesh Govt. is urgently required and acquisition of land have also to be done before taking up this work. In view of the position explained as above it is proposed that this work may be taken in DRIP-III. Further Para No. 9.3, & 9.5.1 & 18.1.3 of DSRP report have also been referred in this regard. In view of the whole position explained, this proposal is being proposed for taken up subsequently add not under DRIP-II as of now.

Annexure-I



Annexure-II



NAME OF WORK:- C/o Check Dam for 45 mcusec Nth

"DESIGN OF CUT OFF WALL "/CHECK DAM.

GIVEN DATA :-

1	Design discharge	=	400.00 m^3/sec
2	Existing water way of the khad/Nallah	=	45.00 Mtr.
3	Reduced level of bed	=	100.00 Mtr.
4	Reduced level of Pondage proposed	=	105.00 Mtr.
5	Silt factor by taking the value for bed material of khad	=	10.60
6	Exist gradient	=	0.050
7	Co-efficient of creep (for sand mixed with boulder, gravel & shingles)	=	8.80

Design :-

Scour depth = 0.476*(Dis.in m^3 per sec./Silt factor) $^{1/3}$		=	1.59 Mtr.
Adopt Scour depth i.e.1.50 times of normal scour depth		=	2.20 Mtr.
Reduced level of bottom of check dam		=	97.80 Mtr.
Ht of check dam		=	7.20 Mtr.
Adopt free board		=	0.15 Mtr.
Total ht.of check dam		=	7.35 Mtr.
$H = f/(w(S_s+1)$			
Where,f = Allowable compressive stress in concrete		=	45.00 Kg/cm^2
		or =	450.00 Ton/m^2
w = Wt.of water		=	1.00 Ton/m^3
S_s = Specific gravity of concrete		=	2.40
$H = f/(w(S_s+1)$		=	132.35 Mtr.

As the ht. of dam is just 7.35 Mtrs.,hence,it will be a low gravity concrete dam

Top width of dam :-

(i) a = 14 % of "h" for economy		=	1.03 Mtr.
(ii) a = (Ht.of cut off wall/3.28) $^{0.5}$		=	1.50 Mtr.
	Maximum top width	=	1.50 Mtr.
		Say =	1.80 Mtr.

Base width of check dam :-

b = Ht.of check dam/(S_s) $^{0.5}$

=	4.74 Mtr.	
Say =	5.25 Mtr.	

Retaining structure in the fringe area of reservoir for slope stabilization:

The reservoir has some critical slides in the fringe area and requires some retaining Structures for slope stabilization. It is proposed to provide about 14 nos retaining structures in the fringe area of length 74325.

A study to find out Hot spots of silt into reservoir has been assigned to IIT, Ropar. After Their report, the actual no of check dams / rock fill dams will be ascertained and will be increased / decreased accordingly.

Memo for DRIP-II works to be executed in Bhakra Reservoir

Abstract of cost

1.		Afforestation 5 Lakh Plants	=	2,2600000.00
2.		20 Nos seminars to monitor illegal mining 020,00000.00 Activities in the catchment area:@Rs 1 lakh/ seminar	=	
3.	(i)	construction of 8000 gully plugs at different locations in catchment Area@ Rs.15000/each	=	12,0000000.00
	(ii)	Construction of 2000 Nos Gabbian structure at Different location in catchment area @50,000/each	=	10, 00,00000.00
	(iii)	Construction of 30 nos check Dams@167013 Per/running mtr. Length of dam	=	43,85,772,18.00
4.		Construction of 14 nos 74325 ft. long Retaining structures for slope Stabilization 495732077.00	=	
		Total	=	1178909295.00

SayRs.117.89Crore

(One hundred seventeen crore, eighty nine lakhs nine thousand two hundred ninety five)

DETAIL ITEMS OF WORK & COST FOR DRIP-II PROJECT

1.		**Afforestation:-**		
	(i)	20,000 mandays for collection, distribution Plantation of plants @ Rs.300/each	=	60 lac
	(ii)	Arrangement of 4 nos mini trucks for supply of plants in different area along Reservoir @Rs.3000/per truck/per day for 300 days =4x3000x300	=	36 lac

(iii) Arrangement of 2.5 lac fruit plants grafted = 1 crore
@ average rate Rs 40/per plants on
(1,0000000)
Govt. approved rate=2.5 lac x 40

(iv) Arrangement 0f 2.5 lac medicinal plants for self-plantation = 25 lac
Fringe / catchment area on Govt. approved rate
@ Rs.10/each=2.5 x 10

(v) Arrangement of seeds of kikar and other = 5 lac
non-eatable plants by animals
For growing in catchment/ fringe area

Total = 2.26 crore

2. **To monitor illegal mining the catchment area**

Expenditure for arrangement of 20 nos seminars at different place to educate the
people to minimize the illegal mining and regarding method of mining if urgently required. so that contract to entry of silt in the reservoir including refreshment/ Tea party to gathering tent expenditure etc. @ 1 lac/seminar

20x1 =20 lac

3. (i) Gully Plug labour cost=15000 as stone may have to be collected from distance places up
to 1 Km or more collection & construction including pitting up to 8" to 10" depth
40 nos gully plus in 1000 mtr. the creek having height may have to provide more plugs
8000 nos @ Rs.15000/- (labour charges)
8000x15000 = 12 crore

(ii) Gabbian structure
2000 nos at different location in catchment area L.S. =10 crore
@ 50,000/each(labour charges)

Total 22.20 crore

GENERAL ABSTRACT OF COST FOR CHECK DAMS TO BE CONSTRUCTED ALONG TRIBUTARIES OF RIVER SATLUJ

Sr. No	Description of items	Unit	Length in meter	Rate per meter length	Amount in Rs
1.	Check dam on seer khad (Ghumarwin)	Meter	95	167013/-	15866595.00
2.	Check dam on seer khad (Karangohra)	-Do-	85	-Do-	14196105.00
3.	Check dam on seer khad (Kosohal)	-Do-	90	-Do-	15031170.00
4.	Check dam on seer khad (Matial)	-Do-	130	-Do-	21711690.00
5.	Check dam on seer khad (Talwara)	-Do-	90	-Do-	15031170.00
6.	Check dam on Ghamber khad(Bridge)	-Do-	125	-Do-	20876625.00
7.	Check dam on Ghamber khad	-Do-	105	-Do-	17536365.00

Sr. No	Description of items	Unit	Length in meter	Rate per meter length	Amount in Rs
	(Neri)				
8.	Check dam on Ali khad (bridge)	-Do-	108	-Do-	18037404.00
9	Check dam on Ali khad (kuddi)	-Do-	92	-Do-	15365196.00
10	Check dam on Ali khad (Thoru)	-Do-	112	-Do-	18705456.00
11	Check dam on Ali khad (Jakhala)	-Do-	76	-Do-	12692988.00
12.	Check dam on Ali khad (Ashamajri)	-Do-	45	-Do-	7515585.00
13	Check dam on Sukher khad (Sukhar village)	-Do-	72	-Do-	12024936.00
14	Check dam on matla Khad (matla village)	-Do-	66	-Do-	11022858.00
15	Check dam on matla Khad (tail)	-Do-	86	-Do-	14363118.00
16	Check dam on Ghamrola khad (Tail)	-Do-	115	-Do-	19206495.00
17.	Check dam on Ghamrola khad (Village)	-Do-	95	-Do-	15866235.00
18	Check dam on Lunkhar khad (dhanet)	-Do-	106	-Do-	17703378.00
19	Check dam on Lunkhar khad (Maishali)	-Do-	77	-Do-	12860001.00
20	Check dam on Sarhali khad v.Daslehra	-Do-	89	-Do-	14864157
21	Check dam on Sarhali khad v.Jhabola	-Do-	95	-Do-	15866595.00
22	Check dam on Sarhali khad v.Naghiar		90	-Do-	15031170.00
23	Check dam on Sarhali khad v.Kosarian		85	-Do-	14196105.00
24	Check dam at Gamber Khad v.Kahu		102	-Do-	17035326.00
25	Check dam at Gamber Khad v.Patta		104	-Do-	17369352.00
26	Check dam at Gamber Khad v.kothi pura		95	-Do-	15866595.00
27	Check dam at Gamber Khad v.Kollar		90	-Do-	15031170.00
28	Check dam at Gamber Khad v.Tanu		106	-Do-	17703378.00
			Total		438577218.00
			2626 Mtr. @ 167013/Mtr.= 438577218.00		

Detail of items works and cost of DRIP-II project:-

*Note 10% extra has been taken for extra head load & extra lead in each AOR where as in CSR 20% extra has been provide for un-metaled Road.

A.O.R.'s for check Dams

(i) **A.O.R for lean concrete 1:4:8**

(a) CSR item no.10.10(b)= 1943.56+35% = 2623.80

(b) Add 10% extra head load 1.5 to 3 Km for + 263.38
Extra load average 10%

Rate per cum = 2886.18 per cum

(ii) **A.O.R for providing farm work/Shed Shuttering**

(a) CSR item no.9.3=234.13+35% = 316.07

(b) Add 10% extra for head load from 1.5 to 3 Km
For extra load @ 10% +31.61
Rate per sqm 347.68 per sqm

(iii) **A.O.R for providing c. cone 1:3:6**

(a) CSR item no 9.3=234+35% =3015.55

(b) Add 10% extra Head load from
1.5 Km to 3 Km for extra load from (+)301.55
@ Average 10%
Rate per cum 3317.55

(iv) **A.R.O for providing c. concrete (1:1$^{1/2}$:3)**

(a) CSR rate (3434.03+28%) =4395.55

(b) Add 10 % extra for head load
1.5 Km to 3 Km for extra load from (+)439.56
@ Average 10% rate per cum -4395.11

(v) **Tor Steel A.O.R**

(a) CSR Rate =4550/Qtl. =4550.00

(b) contractor profit @ 10% +455

(c) 10% extra on(a+b) for head load (+)500.50
5505.50/ Qtl.

(vi) AOR for RCC Pipe 2 mtr. long pipe @ for 1 Mtr.

(a) CSR item no 29.64(4) =7222.30

(b) Add 10% extra for Head Load =722.23
And extra load @10%
Rate per meter 7944.53
Distance between pipes is 1 meter
So one pipe of 2 meter
So rate per meter =7944.53

A.O.R for wire crate GI wire with bounders

Material		Detail of cost for 2 cum	
Stone = 2x380.79		= 761.58	
Carriage (stone/boundary)			
M.TPT.(Km)	8.00 for 2.00 @ 427.52/cum		=855.04
H/load(Km)	1.50 for 2.00 @ 923.21 / cum		=1846.42
		Total	=2701.46(B)

Labour Mason

2nd class	1x500	500(C)	
Total	A+B+C=761.58+2701.46+500	=	3963.04
Add 10% CP & 5 % OH Charges		=	(+)594.49
	Rate par 2 cum		4557.49
	Rate for 1 cum	=	2278.74 per cum

A.O.R

Wire crate made filled with bounders square cut face against the (boulders filling to be measured and paid separately) with GI wire 5mm thick corresponding to (SWG-6) of 15 cm x 15 cm mesh

Detail of cost for 9.375 sqm

(i) **Material**

GI wire 15 x15 mesh diagonal			
(9+9)x 1.25 x 2		=	31.82sqm
Add wastage twisting 10%		=	3.18 sqm
	Total		35sqm
For six side length of wire required			
	36x6	=	210
Weight @0.15 kg/mtr. = 35Kg@Rs 85/kg		=	2975(A)

(ii) Carriage

M.TPT (Km)	8.00 0.0035 @ 242.20/M.T	=	8.48
H/Load (Km)	1.50, 0.0035@674.10/MT	=	23.59
	Total	=	32.07(B)

(iii) Labour

Black smith (IInd class)	1@500/day	=	500.00(c)
Total A+B+C=2975+32.07+500		=	3507.07
Add 10% CP +5.0 OH Charges			+526.06
Cost for 9.375 sqm		=	4033.13sqm
Cost for 1 sqm	4033.13 / 9.375	=	430.20 sqm

Retaining structure in fringe area for slope stabilization

Area to be stabilization

Sr. no	Description	R.D ±	L/S or R/S	Area Identification	Length for stabilization
1.	Main stream	± 21	L/S	Near village khumi	4000’
2.	Main stream	± 27	L/S	Near village Makkri	4750’
3.	Main stream	± 35	L/S	Near village Saloa	5520’
4.	Main stream	± 121	L/S	Near village Juri Pattan	3250’
5.	Main stream	± 175	R/S	Near village Auhar	4375’
6.	Main stream	± 179	R/S	-Do-	6150’
7.	Lunkhar Khad	± 18	L/S	Near village Datun	6559’
8.	Lunkhar Khad	± 50	R/S	Near village Dohak	6250’
9.	Seer Khad	± 8	L/S	Near village Dibeu	4750’
10	Seer Khad	± 16	L/S	Near village Gahria	4375’
11.	Seer Khad	± 28	L/S	Near village Rohal	5600’
12	Gamber Khad	± 19	L/S	Near Dhaneshwari	6200’
13	Gamrola khad	± 3	R/S	Near Chandpur	6700’
14.	Ali Khad	± 7	R/S	Near Chandpur	5875’
				Total	74325’ feet

Detail of Quantizes of work for retaining structure

(1) E/W excavations in foundation in ordinary
Soil exclusive of compaction of earth
Total Qty. = 74325'x5'x5'= 1858125 cft = 52608.29 cum

(2) Lean concrete in foundation
C cone 1:3:6
Total Qty= 74325x5'x0.75=278718.25 cft= 7891.24 cum

(3) Boulder masonry in c. mortar 1:6 :-
Ist step=74325x5'x5' = 1858125 cft
IInd step=74325x4'x5' = 1486500 cft
IIInd step=74325x3'x5' = 1114875cft
Total = 4459500 cft =126259 cum

(4) CC topping 1:2:4, 6" thick
Qty= 74325'x3'x050=111487.50cft =3156.49 cum

Abstract of cost for retaining structures

1. 52608.29L cum: Earth work in execution in ordinary soil
(CSR No.6.2(i) @ 67.44 + 80% = Rs 121.39/cum = 6386120.00
2. 7891.24 cum: lean concrete 1:3:6
(as per A.O.R)@ 3317.10 / cum = 26176032.00
3. 126259.90 cum:- boulder masonry in cement mortar
1:6 (as per A.O.R) @ Rs.3570.23/ cum = 450776882.00
4. 3156.49 cum: cement topping 1:2:4
(As per A.O.R) @ Rs.3926.21/ cum = 12393043.00
Total = 495732077.00

(1) **AOR for providing lean concrete 1:3:6**
As per CSR item no (10.11)
Rate as per CSR item no 10.11
= 2233.74+35% = 3015.55
Add 10 % extra for lead
& Head load up to 3 Km +301.55
Un-metaled road
Rate per cum = 3317.10 per cum

(2) **AOR for boulder masonry in cement mortar**
1:6(as per CSR 12:33)
CSR rate =2269.52+35% = 3063.85
Add 10% extra for each load head load up to
Un-metaled road (+)306.38
Rate per cum = 3570.23 per cum

(3) **Cement concrete topping**
1:2:4 (CSR item no 10.22)
Rate as per CSR=2832.77+26% = 3569.29
Add 10% extra for Head load up to 3 Km = +356.92
Also Un-metaled road 3926.21 per cum

Detail of Measurement

Name of work: Construction of Check Dam for 45.00 Mtr.

Sr. No	Description of item	Nos.	Dimension			Qty.	Total Qty.	Rate	Amount in Rs
			Length	Breadth	Ht/D				
1.	Excavation in foundation & Trenches etc. in earth work in all kinds of soil within all leads & lift as per entire satisfaction of Engineer in charge. Rain water harvesting structure Launching apron	1.00 1.00	45.00 12.00	5.55 3.75	1.85 0.30	462.04 13.50 cum	475.54 cum	121.39	57726.00
2.	P/L cement concrete 1:4:8 (cement : 4 sand:8 graded aggregate 40 mm nominal size) & curing complete rain water harvesting structure	1.00	45.00	5.55	0.15	37.46 cum	37.46 cum	2886.18	108116.00
3.	Prov. form work with steel shuttering in all respect rain water harvesting structure toward water face portion between free board slanting height of wall on D/S side	1.00 1.00 1.00	45.00 45.00 45.00		7.75 0.15 7.98	348.75 6.75 359.28 Sqm	714.78 sqm	347.68	248515
4.	Providing and laying cement concrete 1:3:6 (1cement :3 : sand :6 graded stone 40 mm nominal)	1.00	45.00	5.7	0.15	38.48 sqm	38.48 sqm	3317.10	127642
5.	P/L cement concrete 1: 1.5:3 (1 cement :1.5 sand	1.00 1/2	45.00 45.00	1.80 3.45	7.75 7.20	672.75 558.90 cum	1186.65	4835.11	5737583.00

Sr. No	Description of item	Nos.	Dimension			Qty.	Total Qty.	Rate	Amount in Rs
	:3 graded stone aggregate 20 mm nominal size) & suring complete rain water harvesting structure Rectangular portion Triangular portion								
6.	Providing tor steel reinforcement for RCC work including bending & placing in position complete up to floor two level qty same as per item no.3 Side of dams								
	Free board portion	2.00	1.80	0.15	0.54				
	Rectangular portion	2.00	1.80	0.15	25.92				
	Triangular portion	2x1/2	3.45	7.20	24.84				
	Top portion	1.00	45.00	1.80	81.00 sqm				
	Bottom portion	2.00	45.00	5.25	472.50 sqm		1319.58 sqm		
	Skin reinforcement @ 5.00 Kg /sqm surface area						6597.88	5505.50	363198.00
7.	Wire crate of G.I. filled with boulder with square cut faces against the wire(wire crates ti be measured & paid for separately) for launching apron	1.00	45.00	3.75	0.60	1.1.25	101.25	5505.50	227874.00

Sr. No	Description of item	Nos.	Dimension			Qty.	Total Qty.	Rate	Amount in Rs
8.	Wire crates of G.I. wire filled with boulder with square cut faces against the wire (Boulder filled to be measured & paid for separately) for launching apron G.I. Wire 5.00 mm thick corresponding Size of one crate	1.25	1.25	0.60					
	Weaving area of one crate								
	Bottom & Top	=3.125 sqm							
	Sides	=1.500 sqm							
	Front & back	=1.500 sqm							
	Total	=6.125 sqm							
	Therefore nos. of crates in total length of nos of row Therefore total weaving area of wire crates Total	4500 Rmt.= 36.00 Nos. =3.00 nos.=108.00 =661.50 sqm 661.50@ Rs.430.20/sqm =284577.00							

Total =7158079.00

Rate per mtr. Length of Dam = $\frac{7158079}{45}$ = 159068.00

Add cost of 1 mtr. dia pipe for 1 mtr. length (as per CSR item No.29.64) =7944.53

Now rate per mtr. length of Dam =167012.53

Say Rs. 167013

(i) Item wise Detail of Costs

Cost Estimate of Rehabilitation proposals has been attached with the PST

(ii) Design and Drawings of Rehabilitation Works

Design and drawing of Rehabilitation proposals has been attached with the PST

FORM-V: ENVIRONMENTAL AND SOCIAL MANAGEMENT FRAMEWORK (ESMF) COMPLIANCE

1. Project Siting

A. Is the Project adjacent to or within any of the following environmentally sensitive areas?

Environmentally Sensitive Area	Yes	No	Name/ Identify	Distance from the project area
• Wildlife Sanctuary/ Bird Sanctuary National Parks/ Ecologically Protected Area/ Tiger Reserves		No		
• Reserved Forest Area		No		
• Buffer zone of protected area		No		
• Elephant movement Corridor		No		
• Designated Wildlife Migratory Route		No		
• Eco-sensitive zone		No		
• Cultural Heritage Site/ Archaeological sites		No		
• Others		No		

B. Details of Clearances required for proposed rehabilitation activities as per the table given in Appendix V-C:

S. No.	Proposed Activity	Clearance Required
1	All rehabilitation and improvement works proposed in this report.	No Clearance from any agency is required now, as necessary Clearance were accorded for construction of Bhakra Nangal Project at the start of construction during 1948 and before commissioning during 1963.

2. Identification of activities having potential environmental and social impact:

NIL

3. Whether Requirement for Specific Environment Management Plan (EMP) proposed:

No

(a) If yes, tentative time frame of ESMF Study:

From: MM/DD/YYYY To: MM/DD/YYYY

4. Whether mitigation measures have been identified as per Attachment 1:

No

, If yes Please attach as Appendix V-A

5. Whether mitigation measures are required to be implemented by Contractor:

Yes , If yes, Please attach as Appendix V-B

Attachment 1 – Abstract Screening for ESMF Activities and Categorization

S. N.	ESMF Activity/ Component	Diversion of Forest Land	Resettlement and Rehabilitation	Tree Felling	Borrow Area	Quarry Area	Blasting	Dredging/ Desilting of Reservoir	Labour Camps	Transportation of construction materials, manpower and Equipment through Protected areas/Reserve Forest	Heavy Machinery	Hot Mix Plant	Concrete Mixer and Heavy Pumps	Material Handling and Storage	Temporary Land Acquisition	Bush/ Vegetation Clearing	Haulage of Machinery	Debris Disposal	Transport of Materials	Small Tools and Pumps	Sheds to keep Machines and Tools	Others
1	Improving dam instrumentation and monitoring, SCADA and automation system of dams	D – Low risk. No action is required																				
2	Catchment Area Treatment (CAT) and Reservoir rim treatment	C – Moderate Risk. Generic mitigation measures will be applicable																				
3	Others a.Treatment of abutments with shotcreting. b. Treatment of Highway Tunnel and Dinky Tunnel in Right abutment of dam c. Modernization of Equipment	C – Moderate Risk. Generic mitigation measures will be applicable																				

- Fill with A/B/C/D (A-High Risk, B-Substantial Risk, C- Moderate Risk, D-Low Risk).
- For A & B – ESIA study including RAP & R&R shall be carried out by a third party. For C – Generic mitigation measures will be applicable. For D – No action is required beyond the above screening.

Appendix V-A

IDENTIFIED MITIGATION MEASURES

In case mitigation measures have not been identified, please leave the information blank.)

Enclosed : No

Summary on mitigation measures, if any:

NIL

Appendix V-B

MITIGATION MEASURES REQUIRED TO BE IMPLEMENTED BY THE CONTRACTOR

(In case Contractor mitigation measures have not been identified, please leave blank)

Enclosed : Yes

SPMU to provide a summary of mitigation measures to be implemented by contractor, if any:

Sl. No	Components	Potential Impacts	Mitigation Measures	Executing Responsibilities	Supervising Responsibilities	Monitoring Responsibilities
1.	Labour Camps	Worker/ Local people exposure	- Located handling sites away from populated areas - Proper operation and handling measures would be taken to minimize exposure - Would Provide sirens in vehicles to avoid any collision with human/animals - Child labour would be strictly prohibited - Would Provide signage near construction sites and approach roads	Contractor	Dam site in-charge	SPMU
2.	Heavy Machinery	Air / Noise Pollution	- Air pollution control measure like water sprinkling would be under taken - Use of barriers to reduce exposure - Plants, machinery and equipment would be handled so as to minimize generation of dust. - All crusher used in construction should confirm to relative	Contractor	Dam site in-charge	SPMU

Sl. No	Components	Potential Impacts	Mitigation Measures	Executing Responsibilities	Supervising Responsibilities	Monitoring Responsibilities
			dust emission devises - Low emission construction equipment, vehicles and generator sets would be used			
		Worker/ Local people exposure	- Handling sites would be located away from populated areas - Sirens in vehicles would be provided to avoid any collision with human/animals - Provide signage near construction sites and approach roads	Contractor	Dam site in-charge	SPMU
3.	Material Handling And Storage	Air / Noise Pollution	- Air pollution control measure like water sprinkling would be under taken - Limited hours of operation in populated areas would be considered - Use of barriers to reduce exposure - Low emission construction equipment, vehicles and generator sets may be used	Contractor	Dam site in-charge	SPMU
		Worker/ Local people exposure	- Handling sites would be located away from populated areas - Sirens in vehicles would be provided to avoid any collision with human/animals - Provide signage near construction sites and approach roads	Contractor	Dam site in-charge	SPMU

Sl. No	Components	Potential Impacts	Mitigation Measures	Executing Responsibilities	Supervising Responsibilities	Monitoring Responsibilities
4.	Haulage of Machinery	Air / Noise Pollution	- Air pollution control measure like water sprinkling would be under taken - Limited hours of operation in populated areas would be considered - Use of barriers to reduce exposure - Low emission construction equipment, vehicles and generator sets would be used	Contractor	Dam site in-charge	SPMU
		Soil Pollution	- Measures to prevent accidental Spills would be under taken	Contractor	Dam site in-charge	SPMU
		Worker/ Local people exposure	- Handling sites would be located away from populated areas - Sirens in vehicles would be provided to avoid any collision with human/animals - Provide signage near construction sites and approach roads	Contractor	Dam site in-charge	SPMU
5.	Debris Disposal	Air / Noise Pollution	- Air pollution control measure like water sprinkling would be under taken - Limited hours of operation in populated areas would be considered - Use of barriers to reduce exposure - Low emission construction equipment, vehicles and generator sets may be used	Contractor	Dam site in-charge	SPMU
		Water Pollution (Surface	- Solid waste would be dumped in specified place to minimize contamination of water	Contractor	Dam site in-charge	SPMU

Sl. No	Components	Potential Impacts	Mitigation Measures	Executing Responsibilities	Supervising Responsibilities	Monitoring Responsibilities
		Water)				
		Soil Pollution	- Measures to prevent accidental Spills would be under taken	Contractor	Dam site in-charge	SPMU
		Trucks Traffic increase	- Traffic in populated areas would be avoided as much as possible - Speed breaker and Signage would be installed near settlements - Roadside plantation would be taken	Contractor	Dam site in-charge	SPMU
6.	Transport of Materials	Air / Noise Pollution	- Air pollution control measure like water sprinkling would be under taken - Limited hours of operation in populated areas would be considered - Use of barriers to reduce exposure - Low emission construction equipment, vehicles and generator sets would be used emission devises	Contractor	Dam site in-charge	SPMU
		Soil Pollution	- Measures to prevent accidental Spills would be under taken	Contractor	Dam site in-charge	SPMU
		Trucks Traffic increase	- Traffic in populated areas would be avoided as much as possible - Speed breaker and Signage would be installed near settlements - Roadside plantation would be taken	Contractor	Dam site in-charge	SPMU
7.	Small Tools and Pumps	Air / Noise Pollution	- Air pollution control measure like water sprinkling would be under taken - Limited hours of operation in populated areas would be considered - Use of barriers to reduce exposure - Low emission construction	Contractor	Dam site in-charge	SPMU

Sl. No	Components	Potential Impacts	Mitigation Measures	Executing Responsibilities	Supervising Responsibilities	Monitoring Responsibilities
			equipment, vehicles and generator sets would be used emission devises			
8	Borrow Materials/ Area	Air / Noise Pollution	- Air pollution control measure like water sprinkling would be under taken - Limited hours of operation in populated areas would be considered - Use of barriers to reduce exposure - Low emission construction equipment, vehicles and generator sets would be used emission devises	Contractor	Dam site in-charge	SWRD
		Generation of Excavated material	- Remove dredged material as soon as possible from river side - Dumping of dredging material only in designated place by the engineers to minimize impact on environment	Contractor	Dam site in-charge	SPMU
		Landscape Degradation	- It is a direct, short term impact; Irreversible in nature; Severity is low; Insignificant Impact on	Dam Site In-charge	Dam Owner	SPMU
		Impact on Forest	▪ The hot mix plant will be installed and operated away from the forest area. ▪ The contractor will take all the precaution to avoid forest fire during operation of the hot mix plant	Contractor	Dam site in-charge	SPMU

Sl. No	Components	Potential Impacts	Mitigation Measures	Executing Responsibilities	Supervising Responsibilities	Monitoring Responsibilities
9.	Concrete Mixture and Heavy Pumps	Air / Noise Pollution	- Air pollution control measure like water sprinkling would be under taken - Limited hours of operation in populated areas would be considered - Use of barriers to reduce exposure - Low emission construction equipment, vehicles and generator sets may be used	Contractor	Dam site in-charge	SPMU
		Soil Pollution	- Measures to prevent accidental Spills would be under taken	Contractor	Dam site in-charge	SPMU
		Worker/Local people exposure	- Located handling sites away from populated areas - Proper operation and handling measureswould be taken to minimize exposure - Would Provide sirens in vehicles to avoid any collision with human/animals - Child labour would be strictly prohibited - Would Provide signage near construction sites and approach roads	Contractor	Dam site in-charge	SPMU

Appendix V-C

ACTIVITY-WISE CLEARANCES

Activity-wise Applicability of Environmental, Forest and Wildlife Clearances for Dam Rehabilitation and Improvement Works

S.N.	Types of Rehabilitation Works	Nature of Activities	Environmental Clearance	Forest Clearance	Wildlife Clearance	Remarks
1.	Improving dam instrumentation and monitoring, SCADA and automation system of dams	Involves carriage of the instruments, cables etc to project site and their installation in the project area.	No	No	No	
2.	Catchment Area Treatment (CAT) and Reservoir rim treatment	This activity is widespread within the dam catchment. Generally this activity is executed by Agriculture department/Forest department/ Watershed department of a given State. It involves transportation of materials and equipments for slope stabilization, check dams, sapling etc. Also this activity is very rare and exceptional in the rehabilitation Project as it is done at the time of construction of a new Project.	No	Yes		The proposed CAT works in forest area will be carried out by the forest department., whereas in the non forest area CAT works will be responsibility of the dam authority through State Government of Himachal Pradesh

S.N.	Types of Rehabilitation Works	Nature of Activities	Environmental Clearance	Forest Clearance	Wildlife Clearance	Remarks
3.	a. Treatment of abutments with shotcreting. b. Treatment of Highway Tunnel and Dinky Tunnel in Right abutment of dam	This activity is a localized activity limited to the dam area. It requires grouting materials, light drills/ hand tools only with few manpower. This does not require any major equipments/batching plant/Crusher. Materials for work (cement, sand, additives etc.) are to be brought to dam top for use.	No	No	No	
4.	Modernization of Equipment	Involves carriage of the instruments, cables etc to project site and their installation in the project area.	No	No	No	

FORM-VI: IMPLEMENTATION ARRANGEMENT

1. Civil Works-Main Package:

(a) Work Components

S. No.	Description	Estimated Cost in Crores	Remarks
A	**Rehabilitation and Improvement Proposals for Bhakra Dam**		
1	Strengthening of slopes surrounding Bhakra Dam Abutments, upstream & downstream areas	33.10	Work is proposed to be undertaken in Phase-II.
2	Treatment of Highway and Dinky Tunnels: .(Item No. 18.1.2 of Dam Safety Review Panel	1.20	Work is proposed to be undertaken in Phase-II.
3	Modernization, upgradation and automation of Instrumentation with Real Time Monitoring System	4.58	Work is proposed to be undertaken in Phase-II.
4	SCADA Enabled Automation of Spillway radial gates and Outlet gates of Bhakra Dam	2.62	Work is proposed to be undertaken in Phase-II.
5	**Purpose Driven Study:** Additional FEM Study for static deformation behaviour including elasto-plastic analysis (Creep Study) of Bhakra Dam including risk assessment studies.	1.00	Work is proposed to be undertaken in Phase-II after finalization of TOR by experts of DSRP.
6	**Purpose Driven Study:** Seismic Analysis of Bhakra Dam to examine seismic safety under revised seismic parameter inputs	1.00	Work is proposed to be undertaken in Phase-II after finalization of TOR by experts of DSRP.
	Total	**43.50**	

(b) Procurement Method: NCB

(C) Estimated Cost of Package (in Rupees): 43, 50, 000, 00.00

2. Other Packages

Sl. No.	Description	Procurement Method	Estimated Cost (Rs.in Lakhs)
1	NIL		

3. Procurement of Goods:

Sl No.	Description	Procurement Method	Estimated Cost(Rs.in Lakhs)
1	NIL		
2			

4. Consultancy Assignment(s):

Sl No.	Description	Procurement Method	Estimated Cost (Rs.)
1	NIL		

5. Implementation Timeline:

(a) Overall Phasing of Project Implementation: DRIP Phase II

Proposed Starting of implementation (MM/DD/YYYY): 01/04/2020

Proposed Ending of implementation (MM/DD/YYYY): 31/03/2026

Implementation Duration (months) (MM): 72

(b) Timeline phasing of implementation:

Sl. No.	Description	From (Month/Year)	To (Month/Year)	Status of Procurement Process
1	Civil Work – Main Package			
	Work No 1	04/2020	03/2023	NCB subject to

Sl. No.	Description	From (Month/Year)	To (Month/Year)	Status of Procurement Process
				approval of PST
	Work No 2	10/2020	03/2023	NCB subject to approval of PST
	Work No 3	04/2020	09/2021	NCB subject to approval of PST
	Work No.4	04/2020	09/2021	NCB subject to approval of PST
	Work No 5	04/2025	03/2029	DRIP Phase III
	Work No 6 & 7	10/2020	03/2023	After finalization TOR by DSRP
2	Other Packages	NIL		
3	Procurement of Goods (a) Provision for Instrumentation (b) Provision for the inspection vehicles	NIL		

FORM-VII: ADDITIONAL INFORMATION

This section contains information of all reports such as Emergency Action Plan (EAP), Dam Break Analysis (DBA), stability analyses, design drawings, geological report, geotechnical exploration logs, test results, geophysical results, underwater explorations, and other data that is pertinent and supports the PST work proposal.

1. Operation and Maintenance Manual

(a) Operation & Maintenance Manual: Y , if YES,

(b) Year of Publication: 1967

2. Emergency Action Plan

(a) Emergency Action Plan: Y , if YES,

(b) Year of Study: 2007

(c) Agency Conducting Study : BBMB

BBMB

3. Dam Break Analysis

(a) Dam Break Analysis: Under approval with CWC

(b) Year of Study: 2019

(c) Agency Conducting Study:

BBMB

5. Geotechnical Investigation

Please Refer Chapter 7 of DSRP Inspection Report of Bhakra Dam

(a) Year of Investigation:

(b) Agency Conducting Investigation:

6. Geophysical Investigation

Please Refer DSRP Report of Bhakra Dam

(a) Area of Study:

(b) Year of Investigation:

(b) Agency Conducting Investigation:

6. Stability Analysis of Dam and any other studies

Please Refer Chapter 8 of DSRP Inspection Report of Bhakra Dam

(a) Area of Study:

(b) Year of Study:

(c) Agency Conducting Study

7. Others **Nil**

(a) Area of Study:

(b) Year of Study:

(c) Agency conducting study: