MP 30 GANDHI SAGAR OFF-STREAM PUMPED STORAGE PROJECT (1440 MW)

FEASIBILITY REPORT

GREENKO ENERGIES PRIVATE LIMITED

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CHAPTER – 1

EXECUTIVE SUMMARY

This Pre-Feasibility Report (PFR) is for the Off-stream Pumped Storage Project of 1440 MW / 10411.2 MWH storage capacity, located at Neemach District, Madhya Pradesh. The MP 30 Gandhi Sagar Off-stream PSP Project will comprise of two reservoirs i.e. Gandhi Sagar lower reservoir (already existing) and MP 30 Gandhi Sagar Upper Reservoir (to be constructed newly). This scheme envisages non-consumptive re-utilization of 1.22 TMC of water of Gandhi Sagar reservoir by recirculation. The water in Gandhi Sagar reservoir (existing lower reservoir) will be pumped up and stored in the proposed Off-stream Pumped Storage Project of MP 30 Gandhi Sagar Upper reservoir and will be utilized for power generation. The gross storage capacity of Gandhi Sagar reservoir is 258.47 TMC. The Geographical Co - ordinates of the proposed MP 30 Gandhi Sagar Off-stream Pumped Storage Project component of upper reservoir is at latitude 24° 31' 6.89" North and Longitude is 75° 30' 56.12" East and that of Gandhi Sagar lower reservoir (existing) are 24° 31' 5.40" North and 75° 32' 5.28" East. Proposed rating of Off-stream Pumped Storage Project is 1440 MW.

The cycle efficiency of the project is expected to be around 80%. It is proposed to use One 400KV Double Circuit Transmission Lines with Moose conductor of length 81 Km. This line will be connected to 400/220 kV PGCIL substation at Kota of Rajasthan State for evacuation of generated Power and for Supply of power during pumping mode.

The total land required for construction of various components including land required for infra item like road, job facilities, muck disposal area etc. are tentatively estimated to about 402.50 Ha. It is proposed to construct the project within a period of 3.5 years including infrastructure development which is proposed to be completed within 6 months. The total cost of the project is estimated to **6991.25** Crores.

CHAPTER – 2

INTRODUCTION OF THE PROJECT/BACKGROUND INFORMATION

2.1 Introduction

India is leading the world's renewable energy revolution and is on track to achieve 175 GW of RE capacity by 2022. Today, Wind & Solar, are the lowest cost source of new energy, however their inherent infirm nature & non-schedulability presents a huge challenge for integrating large RE capacities, while maintaining grid stability. Today, increasing RE capacities coupled with ever changing dynamic demand curves of the States/DISCOMs/STUs are leading to sub-optimal utilization of the existing base-load assets resulting in high fixed cost pass through per kWh and additional burden to the consumers.

In this scenario, Off-stream Pumped Storage Projects present a unique and viable solution to the needs of National Grid by being able to provide lowest cost proven energy storage, grid management, frequency regulation and renewable energy integration solutions

Greenko Group is India's leading clean energy company, with **~6.4 GW** operational portfolio across 15 states in India. Greenko Group has an existing asset base of over **USD 8.5 Billion** with an equity investment of **USD 2.2 Billion**. Greenko enjoys strong shareholder support of the world's largest sovereign wealth funds of Singapore (GIC) and Abu Dhabi (ADIA). Greenko Group has an experienced & diverse management team to develop, execute and operate challenging projects with expertise across large-scale Wind, Solar PV and Hydro projects. The team has recently commissioned one of the **World's largest single 816 MW_{DC} Solar PV Plant in Kurnool**, Andhra Pradesh within a record time of **6 months**.

Greenko Group has over the past 10 years, developed capabilities not just in RE project execution, but also **state of the art digital capabilities** for **efficiently forecasting renewable generation trends** in Solar & Wind domains giving it a **unique capability to integrate diverse generation** streams of energy to lead the creation of a Decarbonized, Digitized future on the Energy sector in India.

Greenko has conceptualized two worlds first and largest GW scale Integrated Renewable Energy storage projects located in Andhra Pradesh and Karnataka. **IREP Pinnapuram** is in Andhra Pradesh which configurates **3000MW Solar, 500MW Wind and 1200MW PSP** with 9hrs of storage Similarly, other project is **IREP Saundatti** which configurates **2900MW Solar, 500MW Wind and 1260MW PSP** with 10.5hrs of storage. Both these projects are in advanced stage of obtaining statutory clearances and ground breaking as site is expected shortly.

Greenko Group has been in the process of evaluating suitable locations for such Off-stream Hydro Storage for over 1 year and has identified Rampura Taluk, Neemach District, Madhya Pradesh for the proposed MP 30 Gandhi Sagar Off-stream Pumped Storage Project. We will be requiring 1.22 TMC of water for establishing the 1440 MW Pumped Storage project with 7.23 hours storage capacity.

This PFR is for the Off-stream Pumped Storage Project of 1440 MW / 10411.2 MWH storage capacity, located at Neemach District, Madhya Pradesh. The MP 30 Gandhi Sagar Off-stream PSP Project will comprise of two reservoirs i.e. Gandhi Sagar lower reservoir (already existing) and MP 30 Gandhi Sagar Upper Reservoir (to be constructed newly). This scheme envisages non-consumptive re-utilization of 1.22 TMC of water of the Gandhi Sagar reservoir by recirculation. The water in the Gandhi Sagar reservoir (existing lower reservoir) will be pumped up and stored in the proposed Off-stream Pumped Storage Project of MP 30 Gandhi Sagar Upper reservoir and will be utilized for power generation. The Geographical Co-ordinates of the proposed MP 30 Gandhi Sagar Off-stream Pumped Storage Project component of upper reservoir is at latitude 24° 31' 6.89" North and Longitude is 75° 30' 56.12" East and that of Gandhi Sagar lower reservoir (existing) are 24° 31' 5.40" North and 75° 32' 5.28" East. Proposed rating of Off-stream Pumped Storage Project is 1440 MW.

2.2 Scope of Report

The proposed MP 30 Gandhi Sagar Off-stream PSP is a self-identified project and this Pre-feasibility Study Report has been prepared to study, evaluate and establish the technical feasibility and economic viability of the proposed MP 30 Gandhi Sagar Off-stream PSP.

2.3 Scope of Works

The MP30 Gandhi Sagar Off-stream PSP Project envisages construction of MP 30 Gandhi Sagar upper reservoir (proposed) located in Khemla Block village, Rampura Taluk of Neemach district and Gandhi Sagar reservoir (existing) located near Gandhi Sagar village of Mandsaur district. The Gandhi Sagar reservoir (Existing) is under operation with a gross storage capacity of 258.47 TMC and MP30 Gandhi Sagar Off-stream PSP upper reservoir is proposed for the live storage capacity of 1.22 TMC.

Two alternative layouts for this scheme were studied.

Alternative – 1: Layout with Surface Power House and other components of this scheme are Upper reservoir, Intake structure, Penstock / Pressure Shaft, Tail Race Outlet and Tail Race Channel.

Alternative -2: Layout with underground Power House and other components of this

scheme are Upper reservoir, Intake structure, Pressure Shaft, Tail Race Tunnel, Tail Race Outlet and Tail Race Channel.

Alternative -1

The Alternative – 1 layout is proposed with surface power house. The surface power house involves little deeper excavation since the Off-stream Pumped Storage Project is placed much below the Minimum Draw Down Level of lower reservoir because of technical requirement during pumping operations. However, necessary slope protection measures are proposed to be provided for the cut slopes as it involves deeper excavation. Construction time for completion of this Alternative is estimated to 36 months excluding Pre-construction activities.

Alternative - 2

The Alternative – 2 layout is proposed with underground power house. The underground power house requires Adit tunnels viz., Main Access Tunnel to Power house Service bay and Transformer hall, Adit to Power house cavern top, Adit to Transformer cavern top, Bus duct tunnels etc. The total length of all adits are worked out to about more than 2000m. Though construction work can be carried out for underground structures all through the season, the time required to complete the activity is more and expensive also. Excavation of these tunnels will take longer duration to reach the power house and start works at power house.

The total construction time for the project is estimated to 54 months which is more compared to Alternative – 1 and total cost of the project is also more comparing to Alternative - 1. The construction duration of the scheme is very important which will impact the overall financial viability of the project adversely.

Due to the above reasons, Alternative -1 layout has been selected.

Proposed Scheme will involve construction of Rock fill embankment of maximum height 35m for creation of MP30 Gandhi Sagar Off-stream PSP upper reservoir with 1.80 TMC gross storage capacity. Six nos. of independent Penstock / Pressure Shafts will be taking off from Intake structure provided with Trash rack and Gates located in MP30 Gandhi Sagar Off-stream PSP upper reservoir. Surface Power House will be located on the downstream of the intake structure and shall be equipped with Five Vertical-axis Reversible Francis type units composed each of generator/motor and a pump/turbine having generated/pumping capacity of Five units of 240 MW / 251 MW and Two Vertical- axis Reversible Francis type units of 120 MW / 135 MW respectively.

400 KV Indoor Gas insulated switchgear (GIS) will be provided in a separate building located nearby area of the Main Power House. Step up transformers will be placed adjacent to the GIS building, which will be connected by bus duct galleries to machine hall.

One 400 KV Double Circuit Transmission Lines with Moose conductor of length **81 Kms (app)** from PSP will be connected to 400/220 kV PGCIL substation at Kota of Rajasthan State for evacuation of generated Power and for Supply of power during pumping mode.

The MP30 Gandhi Sagar Off-stream Pumped Storage Project envisages construction of

- 35m high rockfill embankment for creation of MP30 Gandhi Sagar Off-stream PSP upper reservoir of 1.80 TMC gross storage capacity
- Power Intake Structure
- 6 nos. each of 683.48m long and 7.5m dia. surface circular steel lined Penstock / Pressure Shaft (ie. consisting of 181.52m long surface penstock, 140.97m long vertical pressure shaft and 360.99m long Horizontal pressure shaft) in which 5 nos. will feed 5 units each of 240 MW and 1 no. will get bifurcated in to two of 5.3m dia. to feed 2 units each of 120 MW.
- A surface Power house having an installation of Five nos. Reversible Francis turbine each of 240MW capacity (All units are fixed speed turbines) operating under a rated head of 121.70m in generating mode and 127.90m in pumping mode and Two nos. Reversible Francis turbine each of 120 MW capacity (All are variable speed turbines) operating under a rated head of 121.00m in generating mode and 128.70m in pumping mode .
- 85m wide and FSD of 6.0m Tail race channel of about 860.00m long connecting to the Existing Gandhi Sagar reservoir.

2.4 Hydrology

The design flood discharge of the existing Gandhi Sagar reservoir is 12742 Cumec. The gross storage capacity of the Gandhi Sagar reservoir is 258.47 TMC. Operational pattern of MP30 Gandhi Sagar Off-stream PSP has been kept in such a way that 1.22 TMC of water will be utilized for the proposed MP30 Gandhi Sagar Off-stream Pumped storage Project and one-time filling of the proposed upper reservoir will be taken up from Gandhi Sagar reservoir. The project is a Off-stream pumped storage scheme and hence, no consumptive utilization of water is required for its operation.

2.5 Installed Capacity

The MP30 Gandhi Sagar Off-stream Pumped Storage Project is proposed with a Storage

Capacity of 10411.2 MWH with Rating of 1440 MW. This Project is comprising of 5 units of 240 MW each and 2 units of 120 MW each. The installed capacity of a pumped storage scheme is influenced by the requirements of daily peaking power requirements, flexibility in efficient operation of units, storage available in the reservoirs and the area capacity characteristics. The Project will generate 1440 MW by utilizing a design discharge of 220.91 & 111.10 Cumec with a rated head of 121.70m & 121.00m respectively for each unit of 240 MW & 120 MW respectively. The MP30 Gandhi Sagar Off-stream PSP will utilize 1525 MW to pump 1.22 TMC of water to the upper reservoir in 8.60 hours.

The Key parameters of MP30 Gandhi Sagar Off-stream PSP are as follows:

Sl. No.	Parameter	Unit	Value
1	Energy Storage Capacity	MWH	10411.2
2	Rating	MW	1440
3	No. of Units	Nos.	7
4	Rated Head in Turbine mode for larger unit	M	121.70
5	Rated Head in Turbine mode for smaller unit	M	121.00
6	Total Design Discharge	Cumec	1326.75
7	Design Discharge per unit of 240 MW	Cumec	220.91
8	Design Discharge per unit of 120 MW	Cumec	111.10
9	Water Requirement	TMC / MCum	1.22 / 34.55
10	Generation Duration	Hrs	7.23
11	Turbine Capacity – 5 Units	MW	240
12	Turbine Capacity – 2 Units	MW	120
13	Annual Energy Generation	MU	3612
14	Pump Capacity – 5 Units	MW	251
15	Pump Capacity – 2 Units	MW	135
16	Rated Head in Pump mode for larger unit	M	127.90
17	Rated Head in Pump mode for smaller unit	M	128.70
18	Pumping Duration	Hrs.	8.60
19	Expected Cycle Efficiency	%	80

The volume of water required for turbine mode of operation is equated to the pumped mode. Annual energy generation by MP30 Gandhi Sagar Off-stream PSP in Turbine mode is 3612 MU with 95% machine availability.

2.6 Power Evacuation

One 400 KV Double Circuit Transmission Lines with Moose conductor of length **81 Kms (app)** from PSP will be connected to 400/220 kV PGCIL substation at Kota of Rajasthan

State for evacuation of generated Power and for Supply of power during pumping mode.

2.7 Environmental Aspects

Upper and lower reservoir for MP30 Gandhi Sagar Off-stream PSP will consist of proposed MP30 Gandhi Sagar Off-stream PSP upper reservoir (to be constructed newly) and the existing Gandhi Sagar reservoir. There will be submergence of land in the proposed MP30 Gandhi Sagar Off-stream PSP upper reservoir for the Off-stream Pumped Storage Project. Also, land will be required for the construction of power house complex and its appurtenant works Viz., Intake structure, Penstocks / Pressure Shafts, powerhouse, Tail Race Pool and Tail Race Channel etc. Total land required for construction of various components including submergence by formation of MP30 Gandhi Sagar upper reservoir and Land required for other infra item like road, job facilities, muck disposal area etc., are estimated to about 402.50 Ha. The same will be analysed once again after finalization of layout during DPR stage. Based on assessment of environmental impacts, management plans will be formulated for compensatory afforestation and other environmental issues. These issues would be addressed during the investigations for DPR.

2.8 Construction Planning & Schedule

It is proposed to construct the project within a period of 3.5 years including infrastructure development which is proposed to be completed within 6 months.

2.9 Employment generation due to the project

As project is planned to complete in 36 months, at the time of peak construction work in the project, around 4800 persons may be engaged. Out of 4800 nos. the majority of about 1800 nos. will be from the local population/surrounding Villages and balance persons of about 3000 nos. will be skilled /semiskilled from other area. All the local persons will come from their homes only. Only the migrated manpower will stay at site camp.

Then after commissioning of the project, about 150 to 200 persons will be required for operations, which might be from local areas or migrated from another area.

2.10 Project Cost Estimate

The estimate of the project cost has been prepared as per the "Guidelines for formulation of Detailed Project Reports for Hydro- Electric Schemes" issued by Central Electricity Authority in January 2018 (Revision 5.0) to arrive at hard cost of the project at April 2019 price level. Quantities have been worked out on the basis of preliminary designs and drawings of different component works. Unit rate analysis was done as per the Guidelines for the preparation of Detailed Project Report of Irrigation and Multipurpose Projects and

Guidelines for the preparation of Estimates for River valley projects. The quantities and ratings of various Hydro Mechanical and Electro-mechanical equipment's have been worked out on the basis of system design and equipment sizing calculations.

The total project cost works out as given below:

S.NO.	Description of Item	Cost in Crores
1	Cost of Civil Works	2797.67
2	Cost of Power Plant Electro-Mechanical Equipment including Transmission line	1930.50
3	Total Hard Cost	4728.17
4	IDC & Others	2263.08
5	**Total cost of the Project**	**6991.25**

2.11 Economic Financial Analysis

The economical evaluation of MP30 Gandhi Sagar Off-stream PSP will be arrived at as per the prevailing guidelines of PSP.

2.12 Conclusions

The MP30 Gandhi Sagar Off-stream PSP is envisaged to be completed in a period of 3.5 years. The project would generate designed energy of 3612 MU at 95% plant availability. Other benefit of this storage project can be in the form of spinning reserve with almost instantaneous start-up from zero to full power supply, supply of reactive energy, primary frequency regulation, voltage regulation, etc.

CHAPTER – 3

PROJECT DESCRIPTION

3.1 SALIENT FEATURES OF THE PROJECT

1		**NAME OF THE PROJECT**	**MP 30 GANDHI SAGAR Off-stream Pumped Storage Project**
2		**Location**	
	a	Country	India
	b	State	Madhya Pradesh
	c	District	Neemach
	d	Village near Power House	Khemla Block, Rampura Taluk
3		**Geographical Co-Ordinates**	
	a	**MP 30 GANDHI SAGAR OFF-STREAM PSP Upper Reservoir - (Now Proposed)**	
		Latitude	24° 31' 6.89" N
		Longitude	75° 30' 56.12" E
	b	**Gandhi Sagar reservoir Reservoir – Lower (Existing)**	
		Latitude	24° 31' 5.4" N
		Longitude	75° 32' 5.28" E
4		**Access To Project Site**	
	a	Airport	Neemach, 85Km from project site
	b	Rail head	Neemach, 67 Km from project site
	c	Road	SH 31A
	d	Port	Navlakhi
5		**Project**	
	a	Type	Off-stream Pumped Storage Project
	b	Storage Capacity	10411.20 MWH
	c	Rating	1440 MW
	d	Peak operation duration	7.23 Hours daily
6		**MP 30 GANDHI SAGAR OFF-STREAM PSP – Upper Reservoir**	
	a	Live Storage	1.22 TMC

	b	Dead Storage	0.58 TMC
	c	Gross Storage	1.80 TMC
	d	Full Reservoir level (FRL)	EL +523.00 m
	e	Minimum Draw Down Level (MDDL)	EL +508.00m
	f	Top Bund Level (TBL)	EL +526.00m
	g	Foundation Level	EL +491.00 m
	h	Max Height of Embankment	35.00 m
	i	Length of Embankment	5561.131 m
7		**Gandhi Sagar reservoir - Lower Reservoir – (Existing)**	
	a	Type of Dam	Masonry Gravity Dam
	b	Full Reservoir Level (FRL)	EL 400.00 m
	c	Minimum Draw Down Level (MDDL)	EL 381.00 m
	d	Height of Dam above deepest bed level	63.70 m
	e	Length of Dam	514.00m
	f	Gross Storage Capacity	258.47 TMC
8		**RCC intake Structure**	
	a	Type	Diffuser Type
	b	Elevation of Intake centre line	EL +495.50 m
	c	Elevation of bell mouth bottom	EL +491.05 m
9		**Penstock /Pressure Shafts**	
	a	Type	Finished steel lined - circular
	b	Number of Penstocks	6 Nos. wherein 1 No. Independent Pressure shaft bifurcated in to 2 for Smaller units
	c	Diameter of Penstock	7.5 m - Main Penstock 5.3 m – Branch Penstock
	d	Length of penstock/Pressure Shaft	For 5 nos. – 683.48 m each (Main Penstock) for 5 larger units For 1 no. – 607.23m long (Main Penstock) and 76.25m each Branch Penstock for 2 smaller units

10		**Powerhouse**	
	a	Type	Surface Powerhouse
	b	Dimensions (Excluding Service Bay)	181.20m (L) x 25.50m (W) x 56.10m (H)
11		**Tail Race Channel**	
	a	Type & Shape	Concrete lined & Trapezoidal
	b	Length of the channel	860.00 m
	c	Bed Width	85.00 m
	d	Full supply depth	6.0 m
	e	Bed slope	1 in 7000
12		**Tailrace Outlet Structure**	
	a	Type	Diffuser Type
	b	Elevation of outlet Centre line	EL +370.71 m
13		**Hydro-Mechanical Equipment**	
	a	**RCC Intake Structure**	
	i	Trash Rack	Vertical with inclination of 15°
	ii	No. of Trash racks	6 nos.
	iii	No. of bays in each trash rack	2 nos. of 7.75m(W) x 10.97m(H) & 1 no. of 8.5m(W) x 10.97m(H) for each unit
	iv	Intake Service Gate	Size – 6.20m (W) x 7.50 m (H) – 6 Nos. With Rope Drum Hoist
	v	Intake Stop log Gate	Size – 6.20m (W) x 7.50 m (H) – 1 No. with Moving Gantry
	b	**Draft Tube Gates**	High pressure steel type slide gates
	i	No. of Service gates per unit	5 Nos. - 7.0 m (W) x 8.5 m (H) for Larger Units & 2 Nos. - 5.1 m (W) x 6.2 m (H) for Smaller Units with Independent Hydraulic Hoist
	ii	No. of Stoplog gates per unit	1 No. – 7.0 m (W) x 8.5 m (H) for Larger Units & 1 No. - 5.1 m (W) x 6.2 m (H) for Smaller Units with Moving Gantry Crane
	c	**Tailrace Outlet Structure**	
	i	No. of Trash racks	7 nos.

	ii	No. of bays in each trash rack	2 nos. of 6.65m(W) x 10.87m(H) & 1 no. of 6.70m(W) x 10.87m(H) for each larger unit & 2 nos. of 5.20m(W) x 6.73m(H) + 1 no. of 6.60m(W) x 6.73m(H) for each smaller unit
14		**Electro Mechanical Equipment**	
	i	Pump Turbine	Francis type, vertical shaft reversible pumpturbine
	ii	Total No of units	7 no's (5 X 240MW & 2 X 120 MW)
	iii	Total Design Discharge (Turbine Mode)	1326.75 Cumec
	iv	Rated Head in Turbine mode	121.70 m for larger unit & 121.00m for smaller unit
	A	**240 MW Turbines**	
	i	Total No of units	5 Units (Fixed speed)
	ii	Turbine Design Discharge	220.91 Cumec
	iii	Rated Head in Turbine Mode	121.70m
	iv	Pump Capacity	251 MW
	v	Rated Pumping Head	127.90 m
	Vi	Rated Pump Discharge	183.86 Cumec
	vii	Synchronous speed	136.36 rpm
	I	**Generator-Motor**	
	a	Type	Three (3) phase, alternating current synchronous generator motor semi umbrella type with vertical shaft
	b	Number of units	5 Units
	c	Rated Capacity	Generator – 240 MW; Pump Input – 251 MW
	d	Rated Voltage	18.00 KV
	II	**Main Power Transformer**	
	a	Type	Three Single Phase Power transformers with Off-Circuit tap changer (OCTC)
	b	Number of units	15 Numbers (ie. 3 Nos./Unit)

	c	Rated Capacity of each unit	Single Phase, 18KV/400 KV, 100 MVA
	d	Rated Voltage	Primary – 18 kV; Secondary - 400 kV adjustable range of the secondary voltage: - 10% to +10%(3kV/tap)
	B	**120 MW Turbines**	
	i	Total No of units	2 Units (Variable speed)
	ii	Turbine Design Discharge	111.10 Cumec
	iii	Rated Head in Turbine Mode	121.00 m
	iv	Pump Capacity	135 MW
	v	Rated Pumping Head	128.70 m
	vi	Rated Pump Discharge	98.16 Cumec
	vii	Synchronous speed	187.50 rpm
	I	**Generator-Motor**	
	a	Type	Three(3)phase, alternating current asynchronous generator motor semi umbrella type with vertical shaft
	b	Number of units	2 Units
	c	Rated Capacity	Generator – 120 MW Pump Input – 135 MW
	d	Rated Voltage	18 KV
	II	**Main Power Transformer**	
	a	Type	Indoor, 3-Ph transformers with Off-Circuit tap changer (OCTC)
	b	Number of units	2 Units
	c	Rated Capacity of each unit	Each 160 MVA, 18KV/400 KV rating power transformers.
	d	Rated Voltage	Primary – 18 KV ; Secondary - 400 kV adjustable range of the secondary voltage: -10% to +10%(3kV/tap)
15		**400 KV Gas Insulated Switchgear**	
	a	Type of GIS	Indoor Type
	b	No. of GIS units	One No.

	c	Location	Inside GIS Building above ground
	d	Scheme	Double Busbar Arrangement with bus coupler
16		**Power Evacuation**	
	a	Voltage Level (KV)	400 KV
	b	No. of Transmission lines	One 400 KV transmission line with double circuit.
	c	Total Length	400 KV Double Circuit Transmission Lines with Moose conductor of length 81 Kms (app) from PSP will be connected to **400 / 220 KV PGCIL substation** at **Kota of Rajasthan State** for evacuation of generated Power and for Supply of power during pumping mode
17		**ESTIMATED COST**	
	a	Civil Works	2797.67 Cr.
	b	E&M Works incl. Transmission line	1930.50 Cr.
	c	IDC & Others	2263.08 Cr.
		Total Project Cost with IDC	**6991.25 Cr.**

3.2 HYDROLOGY & POWER POTENTIAL STUDIES

Determination of Power Potential is the primary step in planning a Hydro Power Plant. The power potential of the project shall be dependent on the project layout, operating water levels, data on long term flow availability, selected turbo generating equipment type and its parameters etc.

This storage project is being planned on the allocated water of 1.22 TMC for non-consumptive utilization by recirculation from existing Gandhi Sagar reservoir. Secondly the proposed upper MP30 Gandhi Sagar Off-stream PSP reservoir is not located across any stream and the existing Gandhi Sagar reservoir is located across river Chambal. Therefore, no Specific hydrological studies are required to be carried out and similarly power potential studies are also required to be carried out for the power potential possibility to be generated by recirculation of inflows in between these reservoirs.

The MP30 Gandhi Sagar Off-stream PSP is proposed to utilize the water available in the existing Gandhi Sagar reservoir reservoir located near Rampura Taluk in Neemach district.

For forming the new upper reservoir to store the pumped water from lower reservoir, it is proposed to construct a rockfill embankment for the maximum height of about 35m from the foundation level. Six penstocks of 7.5m dia. each starts from the power intake structure which is located on upper reservoir in which 1 no. of Penstock will get bifurcated in to two near power house and conveys the water to the powerhouse. The water from power house out fall is let back to the existing Gandhi Sagar reservoir through Tail Race Channel.

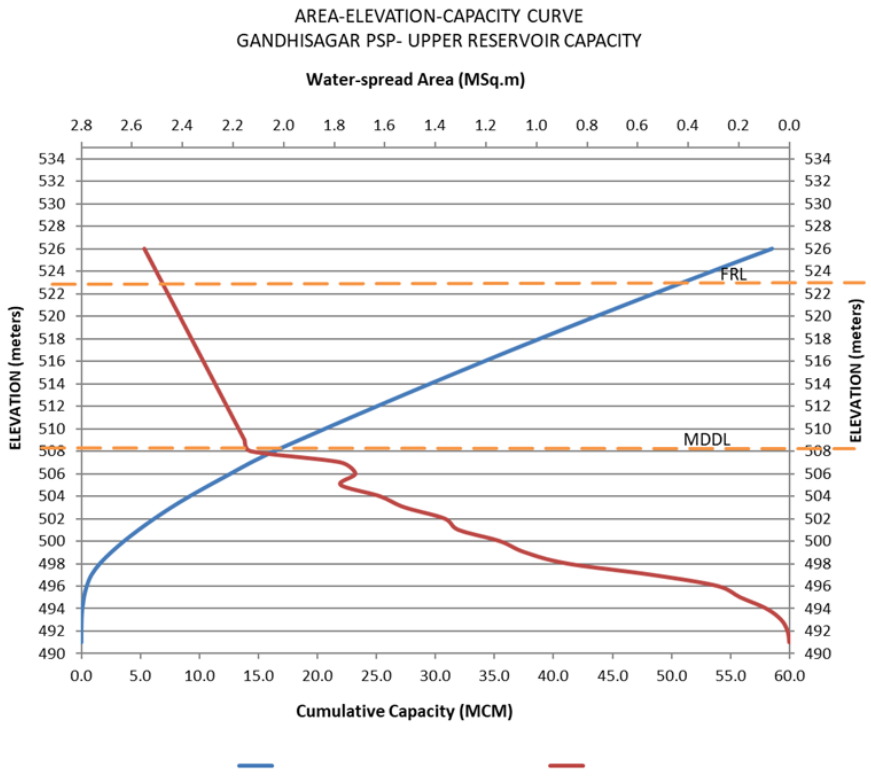
The Key parameters of proposed MP30 Gandhi Sagar Off-stream PSP Upper Reservoir are as follows:

Sl. No.	Parameter	Unit	Value
1	Full Reservoir Level (FRL)	M	EL 523.00
2	Minimum Draw Down Level (MDDL)	M	EL 508.00
3	Live Storage	TMC	1.22
4	Dead Storage	TMC	0.58
5	Gross Storage	TMC	1.80
6	Height of RCC Intake Structure	M	40.00
7	Maximum Height of Rock Fill Embankment	M	35

The area capacity table for the proposed upper reservoir is given in the table

MP30 GANDHI SAGAR OFF-STREAM PSP - UPPER RESERVOIR CAPACITY							
Sl.No	Elevation (m)	Water-spread Area (Sqm)	Water-spread Area (MSqm)	Capacity (Cum)	Capacity (Mcum)	Cumulative Capacity (Mcum)	Cumulative Capacity (TMC)
1	491	0	0.000	0	0.000	0.000	0.00
2	492	6988.68	0.007	2330	0.002	0.002	0.00
3	493	32091.97	0.032	18019	0.018	0.020	0.00
4	494	90844.45	0.091	58977	0.059	0.079	0.00
5	495	194417.80	0.194	139387	0.139	0.219	0.01
6	496	283051.08	0.283	237351	0.237	0.456	0.02
7	497	544503.75	0.545	406713	0.407	0.863	0.03
8	498	878172.98	0.878	704725	0.705	1.568	0.06
9	499	1046055.64	1.046	960891	0.961	2.528	0.09
10	500	1146110.20	1.146	1095702	1.096	3.624	0.13
11	501	1309112.46	1.309	1226709	1.227	4.851	0.17
12	502	1363291.76	1.363	1336111	1.336	6.187	0.22
13	503	1522066.69	1.522	1441951	1.442	7.629	0.27
14	504	1621336.59	1.621	1571440	1.571	9.200	0.32
15	505	1774727.55	1.775	1697454	1.697	10.898	0.38
16	506	1716392.73	1.716	1745479	1.745	12.643	0.45
17	507	1775679.77	1.776	1745952	1.746	14.389	0.51

18	508	2131850.26	2.132	1951054	1.951	16.340	0.58
19	509	2155140.1	2.155	2143485	2.143	18.484	0.65
20	510	2178430.0	2.178	2166775	2.167	20.651	0.73
21	511	2201719.9	2.202	2190065	2.190	22.841	0.81
22	512	2225009.8	2.225	2213355	2.213	25.054	0.88
23	513	2248299.6	2.248	2236645	2.237	27.291	0.96
24	514	2271589.5	2.272	2259935	2.260	29.551	1.04
25	515	2294879.4	2.295	2283225	2.283	31.834	1.12
26	516	2318169.3	2.318	2306515	2.307	34.140	1.21
27	517	2341459.1	2.341	2329805	2.330	36.470	1.29
28	518	2364749.0	2.365	2353094	2.353	38.823	1.37
29	519	2388038.9	2.388	2376384	2.376	41.200	1.45
30	520	2411328.8	2.411	2399674	2.400	43.599	1.54
31	521	2434618.6	2.435	2422964	2.423	46.022	1.63
32	522	2457908.5	2.458	2446254	2.446	48.468	1.71
33	523	2481198.4	2.481	2469544	2.470	50.938	1.80
34	524	2504488.3	2.504	2492834	2.493	53.431	1.89
35	525	2527778.1	2.528	2516124	2.516	55.947	1.98
36	526	2551068.02	2.551	2539414	2.539	58.486	2.07



The Key parameters of the existing Gandhi Sagar reservoir are as follows:

Sl. No.	Parameter	Unit	Value
1	Full Reservoir Level (FRL)	M	EL 400.00
2	Minimum Draw Down Level (MDDL)	M	EL 381.00
3	Gross Storage	TMC	258.47
4	Height of Dam above deepest bed level	M	63.70

3.2.1 Discharge Series

Based on the inflow data and the storage capacity of the existing reservoir, power potential study was carried out to assess the installed capacity. The MP30 Gandhi Sagar Off-stream PSP is envisaged to utilize 1.22 TMC of water to be pumped from the existing Gandhi Sagar reservoir to the proposed upper MP30 Gandhi Sagar Off-stream PSP reservoir in 8.60 hours. The project is a pumped storage scheme and hence, no consumptive utilization of water is required for its operation.

3.2.2 Gandhi Sagar Reservoir (Existing)

The existing Gandhi Sagar reservoir will be utilised as a lower reservoir to enable MP30 Gandhi Sagar Off-stream PSP to operate as a peak station. The FRL & MDDL of existing Gandhi Sagar reservoir is at EL 400.00m & EL 381.00 m respectively. The Gross storage capacity of existing reservoir is 258.47 TMC. Water will be pumped to the proposed upper reservoir through TRC.

The proposed MP30 Gandhi Sagar Off-stream PSP upper reservoir is located at EL 491m and the FRL and MDDL of this reservoir is at EL 523.00m & EL 508.00m respectively. The live storage of the proposed reservoir is kept for 1.22 TMC. A tail race channel of approx. 860m will discharge the flow into existing Gandhi Sagar reservoir after power generation.

3.2.3 Operation of MP 30 Gandhi Sagar Off-stream Pumped Storage Project

The MP30 Gandhi Sagar Off-stream PSP is proposed with a Storage Capacity of 10411.2 MWH with Rating of 1440 MW. This project is comprising of 5 units of 240 MW each and 2 units of 120 MW each. The Project will generate 1440 MW by utilizing a design discharge of 220.91 & 111.10 Cumec with a rated head of 121.70m & 121.00m respectively for each unit of 240 MW & 120 MW respectively. The MP30 Gandhi Sagar Off-stream PSP will utilize 1525 MW to pump 1.22 TMC of water to the upper reservoir in 8.60 hours.

The Key parameters of Off-stream Pumped Storage Project Operation are as follows:

Sl. No.	Parameter	Unit	Value
1	Energy Storage Capacity	MWH	10411.2
2	Rating	MW	1440
3	No. of Units	Nos.	7
4	Rated Head in Turbine mode for larger unit	M	121.70
5	Rated Head in Turbine mode for smaller unit	M	121.00
6	Total Design Discharge	Cumec	1326.75
7	Design Discharge per unit of 240 MW	Cumec	220.91
8	Design Discharge per unit of 120 MW	Cumec	111.10
9	Water Requirement	TMC / MCum	1.22 / 34.55
10	Generation Duration	Hrs	7.23
11	Turbine Capacity – 5 Units	MW	240
12	Turbine Capacity – 2 Units	MW	120
13	Annual Energy Generation	MU	3612
14	Pump Capacity – 5 Units	MW	251
15	Pump Capacity – 2 Units	MW	135
16	Rated Head in Pump mode for larger unit	M	127.90
17	Rated Head in Pump mode for smaller unit	M	128.70
18	Pumping Duration	Hrs.	8.60
19	Expected Cycle Efficiency	%	80

The volume of water required for turbine mode of operation is equated to the pumped mode. Annual energy generation by MP30 Gandhi Sagar Off-stream PSP in Turbine mode is 3612 MU with 95% machine availability.

3.2.4 Operating Head

The energy computations have been carried out based on headwater/full reservoir level (HWL/FRL), tail race water level conditions, efficiency of the turbo-generator and the minimum and maximum load. Full reservoir level at MP30 Gandhi Sagar upper reservoir is at EL+523.00m and MDDL is at EL+508.00m. Full reservoir level at Gandhi Sagar lower reservoir is at EL 400.00m and MDDL is at EL+381.00m. The total head loss in the system is arrived as 3.30m & 4.0m for larger and smaller units respectively. Thus, the rated head of 121.70m and 121.00m are considered for larger and smaller units respectively for the proposed project. The normal tail water level is the level at the tail race outlet corresponds to design discharge flow of 1326.75 Cumec passing through the turbine considering all

machines running at full plant load. Normal tail water level corresponding to above design discharge is EL +381.00m. The bed level of the tail race Channel is kept at EL +374.88m.

3.3 DESIGN FEATURES OF MAJOR COMPONENTS

3.3.1 Introduction

The MP30 Gandhi Sagar Off-stream Pumped Storage Project envisages construction of upper reservoir near village Khemla Block in Rampura taluk of Neemach District whereas the existing Gandhi Sagar reservoir is located near Gandhi Sagar village in Mandsaur District will be the lower reservoir.

The scheme will involve construction of rock fill embankment of maximum height of 35m for creation of MP30 Gandhi Sagar Off-stream PSP upper reservoir of 1.80 TMC gross capacity. The MP30 Gandhi Sagar Off-stream PSP is proposed in between two reservoirs i.e. MP30 Gandhi Sagar Off-stream PSP Upper (to be constructed newly) & Gandhi Sagar reservoir Lower Reservoirs (Existing) and one-time water will be pumped from existing Gandhi Sagar reservoir to fill up the proposed Upper reservoir. Water will be let out from the MP30 Gandhi Sagar Off-stream PSP upper reservoir through Power Intake and Penstock/Pressure shaft of 683.48m long to feed the MP30 Gandhi Sagar Off-stream PSP, having a Storage Capacity of 10411.2 MWH with Rating of 1440 MW. This project is comprising 5 units of 240 MW each and 2 units of 120 MW each. The water after power generation will be conveyed through a 860m long Tail Race Channel to discharge water in to Lower reservoir of existing Gandhi Sagar reservoir. The total design discharge for the proposed scheme is 1326.75 Cumec with the rated head of 121.70m for larger unit and 121.00m for smaller unit. General Layout of the proposed scheme is enclosed in the drawing no. MP30 – PSP - 002.

3.3.2 Alternate Studies

Two alternative layouts for this scheme were studied.

Alternative – 1: Layout with Surface Power House and other components of this scheme are Upper reservoir, Intake structure, Penstock / Pressure Shaft, Tail Race Outlet and Tail Race Channel.

Alternative -2: Layout with underground Power House and other components of this scheme are Upper reservoir, Intake structure, Pressure Shaft, Tail Race Tunnel, Tail Race Outlet and Tail Race Channel.

Alternative -1

The Alternative – 1 layout is proposed with surface power house. The surface power house

involves little deeper excavation since the Off-stream Pumped Storage Project is placed much below the Minimum Draw Down Level of lower reservoir because of technical requirement during pumping operations. However, necessary slope protection measures are proposed to be provided for the cut slopes as it involves deeper excavation. Construction time for completion of this Alternative is estimated to 36 months excluding Pre-construction activities.

Alternative - 2

The Alternative – 2 layout is proposed with underground power house. The underground powerhouse requires Adit tunnels viz., Main Access Tunnel to Powerhouse Service bay and Transformer hall, Adit to Powerhouse cavern top, Adit to Transformer cavern top, Bus duct tunnels etc. The total length of all adits are worked out to about more than 2000m. Though construction work can be carried out for underground structures all through the season, the time required to complete the activity is more and expensive also. Excavation of these tunnels will take longer duration to reach the powerhouse and start works at powerhouse.

The total construction time for the project is estimated to 54 months which is more compared to Alternative – 1 and total cost of the project is also more comparing to Alternative - 1. The construction duration of the scheme is very important which will impact the overall financial viability of the project adversely.

Due to the above reasons, Alternative -1 layout has been selected.

3.3.3 Key Parameters of Upper and Lower Reservoirs

The Key parameters of the proposed Upper MP30 Gandhi Sagar Off-stream PSP Reservoir are as follows:

Sl. No.	Parameter	Unit	Value
1	Top of Bund	M	EL +526.00
2	Full Reservoir Level (FRL)	M	EL +523.00
3	Minimum Draw Down Level (MDDL)	M	EL +508.00
4	Live Storage	TMC	1.22
5	Dead Storage	TMC	0.58
6	Gross Storage	TMC	1.80
7	Deepest Foundation Level (m)	M	EL +491.00
8	Maximum Height of Rockfill Embankment	M	35

The Key parameters of the Existing Gandhi Sagar reservoir Lower Reservoir are as follows:

Sl. No.	Parameter	Unit	Value
1	Design Flood Discharge	Cumec	12742
2	Full Reservoir Level (FRL)	m	EL 400.00
3	Minimum Draw Down Level (MDDL)	m	EL 381.00
4	Gross Storage	TMC	258.47
5	Length of Dam	m	514.00
6	Height of Dam above deepest bed level	m	63.70

3.3.4 RCC Intake Structure

The intake structure of MP30 Gandhi Sagar Off-stream PSP is proposed with Diffuser type and will be constructed in the Upper reservoir. Generally, for normal hydroelectric projects, the bell mouth entrance is ideal for generation (turbine) mode when water enters. In this case there is a minimal loss as water accelerates through the bell-mouth and into the penstock. But in pumped storage project, this design may not be suitable for pumped storage operation as when in pumping mode water flows in the opposite direction through the bell-mouth transition. Water discharging from the penstock will not follow the bell-mouth and will continue as a column of water with minimum divergence.

Therefore, it is proposed to have long and gradual diffuser section at a shallow angle so that the discharging pump mode flow can be maintained with an even velocity distribution and decelerate with minimal losses prior to reaching the Intake Penstock / Pressure Shaft.

Six separate intakes are provided to feed the steel lined Penstock/ pressure shaft independently. It is proposed to have independent trash rack in front of each intake structure which will be installed in slanting position with the slope of 15° with vertical. The hydraulic design of trash rack opening is done considering the velocity of flow through the trash rack which will be limited to 1.0 m/sec without clogging.

Submergence of Intake shall be checked for a discharge corresponding to design discharge to prevent vortex formation and entry of air into the system as per IS: 9761 and accordingly the MDDL and center line of intake is kept at EL+508.00m and EL+495.50 m respectively.

3.3.5 Penstock / Pressure Shaft

Six independent Penstock / Pressure shaft of 7.5 m diameter in which five nos. will feed 5 units of 240 MW each and 1 no. will get bifurcated in to two to feed 2 units of 120 MW each. The length of the penstock up to powerhouse location shall be 683.48m. The pressure shaft is designed to withstand the internal pressure from water and external

pressure from rock. Rock participation factor is considered in the design of pressure shaft. The length of penstock consisting of 181.52m long surface penstock, 140.97m long vertical pressure shaft and 360.99m long Horizontal pressure shaft respectively to feed the water for each unit of turbine. The steel lined pressure shaft will be backfilled with concrete. Flow from each of these penstocks to turbines shall be controlled by a butterfly valve (MIV) in the powerhouse. Economical dia. of the pressure shaft has been worked out by cost optimization studies for various diameters. Accordingly, a main pressure shaft of diameter 7.5m has been adopted to carry the design discharge of 220.91 Cumec for each unit of 240 MW and branch pressure shaft of diameter 5.3m has been adopted to carry the design discharge of 111.10 Cumec for each unit of 120 MW.

3.3.6 Power House

It has been proposed to have power house and all associated components on the surface. As the proposed power house involves little deeper excavation, intricate supporting arrangements for the cut slopes involving anchors etc., are provided. The control room is proposed on the downstream of machine hall above the Draft tubes.

The project envisages the utilization of the Rated head of 121.70m for larger units and 121.00m for smaller units. The Pumped storage plant comprises of 7 units ie. 5 units each of 240 MW and 2 units each of 120 MW .

The Key parameters of Storage Operation are as follows:

Sl. No.	Parameter	Unit	Value
1	Energy Storage Capacity	MWH	10411.2
2	Rating	MW	1440
3	No. of Units	Nos.	7
4	Rated Head in Turbine mode for larger unit	M	121.70
5	Rated Head in Turbine mode for smaller unit	M	121.00
6	Total Design Discharge	Cumec	1326.75
7	Design Discharge per unit of 240 MW	Cumec	220.91
8	Design Discharge per unit of 120 MW	Cumec	111.10
9	Water Requirement	TMC / MCum	1.22 / 34.55
10	Generation Duration	Hrs	7.23
11	Turbine Capacity – 5 Units	MW	240
12	Turbine Capacity – 2 Units	MW	120
13	Annual Energy Generation	MU	3612
14	Pump Capacity – 5 Units	MW	251
15	Pump Capacity – 2 Units	MW	135

Sl. No.	Parameter	Unit	Value
16	Rated Head in Pump mode for larger unit	M	127.90
17	Rated Head in Pump mode for smaller unit	M	128.70
18	Pumping Duration	Hrs.	8.60
19	Expected Cycle Efficiency	%	80

Pumping operation is proposed at 8.60 hours/day. Each day turbine volume is equal to the Pumped volume. Turbine operation is proposed at 7.23 hours/day during morning peaking and evening peaking hours.

3.3.7 Machine Hall

The internal dimensions of powerhouse have been proposed with length 181.20m and width 25.50m including control room. The units have been kept at about 26.00m spacing between larger units and 23.00m spacing between smaller units while the erection bay have been proposed as 30m long. For housing control room and various auxiliaries/offices, 4 nos. floor have been proposed on the D/s side of Powerhouse over the draft tube. The main inlet valve is proposed to be housed in powerhouse just u/s of turbine. 2 Nos. of EOT crane of suitable capacity shall be installed in erection bay and unit bay to facilitate erection and repair of heavy equipment including main inlet valves.

The machine floor is designed to carry load of machines, live load and thrust transferred through turbines, generators and other machinery. The machine floor is designed as a RCC raft with adequate openings as required for equipment foundations and cable trenches etc.

3.3.8 Tailrace Outlet

The outlet structure of MP 30 Gandhi Sagar PSP is proposed with Diffuser type and will be constructed at the end of Tail Race Tunnel. Generally, the bell mouth entrance is ideal for pumping mode when water enters. In this case there is a relatively even velocity distribution over the trash rack and minimal losses as water accelerates through the bell-mouth and into the Tail race tunnel. But when operating in generation (turbine) mode water will be discharged to the lower reservoir through this structure. Water discharging from the Tail race tunnel will not follow the bell-mouth and will continue as a column of water with minimal divergence. This column of discharging water will continue to the trash rack and result in very high localized water velocities through the trash rack center, resulting in excessive localized load and flow induced vibration and in the longer term resulting in trash rack failure. The localized water velocity through the central portion of

the trash rack could be multiple times the average velocity estimated for the trash rack.

In case of pumped storage project, this bell-mouth arrangement shall be replaced by a long and gradual diffuser section at a shallow angle so that the discharging turbine mode flow can be maintained with an even velocity distribution and decelerate prior to reaching the trash rack and therefore, finally the flow will discharge through a flat trash rack at the end of the diffuser with a uniform low velocity.

Seven separate outlets are provided to discharge the water from the Tail race tunnel. It is proposed to have independent trash rack in front of each outlet structure which will be installed in slanting position with the slope of 15° with vertical. The hydraulic design of trash rack opening is done considering the velocity of flow through the trash rack which will be limited to 1.0 m/sec without clogging.

Submergence of Outlet has been checked for a discharge corresponding to design discharge and to prevent vortex formation and entry of air into the system as per IS: 9761 and accordingly the MDDL and center line of outlet is kept at EL 381.00m and EL 370.71m respectively.

3.3.9 Tail Pool and Tail Race Channel

The tail water from the machines, is led back to the lower reservoir through a tail race tunnel / tailrace channel. Water from the draft tube of each of the machines will enter through tail race tunnel into a tail pool constructed with RCC walls on three sides. The tail pool is connected to a tail race channel that conveys the water into the Lower Reservoir.

3.4 ELECTRO - MECHANICAL EQUIPMENTS

3.4.1 ELECTRO-MECHANICAL EQUIPMENTS:

The Electro-Mechanical equipment required for the proposed **pumping scheme** comprises of the following:

(1) Butterfly Valve for each Turbine.

(2) Reversible Pump Turbine and it's auxiliaries like HP/LP air compressor system, water depression system, lubricating oil system, Governor and it's oil pressure unit and Cooling water system etc.

(3) Generator/Motor (DFIM) and its auxiliaries like AC Excitation (VSI) for **variable speed** machines, DC excitation with SFC (Static Frequency Converter) for **fixed speed** machines & Automatic Voltage Regulation system, Cooling system, Brakes, PLC and Automation arrangement etc.,

(4) Generator circuit breakers for variable speed machines with Phase reversal device and it's accessories.

(5) Control, Protection, metering, measurement and annunciation panels for Turbine, synchronous generators, asynchronous generator-motor and 400KV feeders.

(6) Bus duct (IPBD) shall be provided for connecting generator to the generating transformer, SAT, LAVT (for variable speed machines this is part of Generator circuit breaker), NGT etc., for trouble free reliable operation.

(7) Single phase 18KV/400 KV Generator Transformers with OFF Load tap changer along with control and protective gear and breakers etc.

(8) 400 KV Gas Insulated switch-gear (GIS) for secondary side of the transformers.

(9) Auxiliary Power supply system consisting of unit auxiliary transformers, station auxiliary transformer, D.G Set for alternative emergency supply and station/ unit auxiliary boards for station auxiliaries, unit auxiliaries.

(10) Control supply system consisting of station battery, charger and its distribution system.

(11) The station auxiliaries like EOT crane, D.T crane, Air Compressor system, Dewatering and Drainage system, firefighting equipment, Air conditioning, Ventilation system and illumination system.

(12) Power evacuation system consists of transmission line, protection/ metering equipment, CT's, PT's, LA's along with its supporting structures and Receiving end equipment including bay extension at the other end.

(13) SCADA and Instrumentation system with necessary panels and workstations for GIS and for power plant operation from Local and Remote.

3.4.2 MECHANICAL EQUIPMENT:

The Mechanical equipment consists of Turbine, Main Inlet Valve, Governor, instrumentation & control system, HP/LP Air Compressor system, oil pumping system, cooling water system, Drainage, Dewatering system, crane etc.

3.4.2.1 BUTTER FLY VALVE:

Each Turbine is provided with a Butterfly valve to act as a main inlet valve to achieve quick closing to cut off the water supply for the Turbine in the event of any machine tripping on a lock out fault. The Butter fly valve shall be normally opened and closed by hydraulic system and also have backup closing system with counter weight for closing during emergency. Hydraulic operated Bypass valve is provided across the Butterfly valve for smooth operation

with pressure balance condition.

3.4.2.2 TURBINE/PUMP:

The type of turbine will be reversible vertical shaft Francis type directly coupled to the vertical synchronous generator/asynchronous generator-motor. The turbine will have adjustable guide vanes for control of the flow. In hours of low demand electricity gets consumed and water gets pumped into the higher reservoir. When the peak hours arrive, and the demand is high, water gets turbine and generates therefore Electricity. The final design of the Turbine components would be carried out by means of Model Test results of Turbine.

3.4.2.3 GOVERNING SYSTEM:

The turbine will be controlled by an electronic governor. The Governor in general shall be designed in accordance to IEC 61362.The guide vanes will be actuated by guide vane servomotor through the governor. The system will be so designed that the main functions of speed control, power control are handled as a separate program parts and shall be programmed to suit Francis turbine having adjustable guide vanes. Governor shall also support RGMO/FGMO mode of operation, Electrical Inertia as per the Indian Electricity Grid Code.

3.4.2.4 AUXILIARY SYSTEMS:

i) Air Conditioning System:

Chiller units of adequate capacity shall be provided for air-conditioning of the important areas of the plant. Chiller units are to be placed in transformer cavern. Detailed design of same shall be done at DPR stage.

ii) Ventilation System:

Adequate ventilation tunnels have been proposed in this project, consists of Transformer cavern, Power house and other areas. Air Handling units are to be placed in transformer cavern. Detailed design of same shall be done at DPR stage.

iii) Crane and Hoists:

Two nos. EOT cranes of suitable capacity each will be installed in the power house building for handling equipment during erection and maintenance. For handling of intake and draft tube gates suitable electrically operated hoisting mechanism will be provided individually. Tandem operation of two EOT cranes shall be provided.

iv) Dewatering and Drainage System:

For Dewatering of turbine casing water up to the Tail race gate, required number of submersible pumps with suitable capacity will be provided. The Dewatering sump will be located in the station floor and a pipe from the Tail race will be embedded and connected to the Dewatering sump. An isolation valve will be provided in this pipe which will be opened during Dewatering. The discharge from the pumps will be taken above the maximum flood level. The discharge line will be provided with necessary isolation valves and piping. Necessary level switches will be provided in the Dewatering sump to facilitate auto start / stop of the pumps. Sizing of pumps will be done during preparation of DPR.

To remove drain water collected in the drainage sump located in the BF valve pit / Station floor, required number of pumps of suitable capacity will be installed with necessary piping and valves. The discharge from the pumps will be taken above the maximum flood level. The discharge line will be provided with necessary isolation valves and piping. Necessary level switches will be provided in the drainage sump to facilitate auto start/stop of the pumps. Sizing of pumps will be done during preparation of DPR.

v) Fire Protection System:

The proposed fire protection system shall be designed to provide adequate safety measures in the area susceptible to fire in the power station. TAC classifies hydel power generating stations as "Light hazard Occupancy" and hence the system shall be designed accordingly. This system is designed as per applicable requirements of NFPA 70.

vi) Air Compressor System

Suitable Tank mounted HP and LP air compressor system to meet the station requirements such as for brakes, cleaning, Blowdown system etc. are considered.

3.4.3 ELECTRICAL EQUIPMENT:

The Electrical scheme showing the major system, such as the Generator and its connections to 400 KV Switch Yard for Power evacuation, 11KV Switchgear and 415V Auxiliary Power distribution.

3.4.3.1 Synchronous/Asynchronous Motor:

The Synchronous/Asynchronous generator/Motor will be 3 phase with 0.9 PF (lag), 50 Hz with Static type excitation system/AC Excitation (VSI) for variable speed machines, suitable for parallel operation with the grid. The generator neutral (star point) will be grounded through suitably rated grounding/ distribution Transformer with loading resistor connected

to secondary side to restrict earth fault current to a safe limit. Six terminals of the generator, 3 on the phase side and 3 on the neutral side will be brought out for external connection. The short circuit ratio of the generator shall be greater than 1 (for Fixed Speed machine) for better stability on faults.

and for asynchronous generator motor short circuit ration shall be in line with DFIM technology.

3.4.3.2 STATIC EXCITATION SYSTEM (FOR FIXED SPEED MACHINES):

For fixed speed machines the excitation system will be of static type system. The excitation voltage is controlled by (silicon Controlled Rectifier - SCR). The voltage is supplied by a pair of brushes and slip rings. The ceiling voltage of the excitation system will be at least 200% of the normal field voltage and response ratio will be about 2.0.

3.4.3.3 VOLTAGE SOURCE CONVERTER AND CONTROL SYSTEM (FOR VARIBALE SPEED MACHINES):

The excitation system shall enable the operation of the generator motor units in frequency regulation, voltage regulation modes within the capability diagram of the units. The excitation system shall manage the DFIM operating point parameters such as active power, reactive power or stator voltage, shaft or runner speed according to desired P, Q set points (given by operator through SCADA system) and optimizing rules.

The excitation system shall include two types of controls:

- A guide vane regulation controlling the guide vane opening and thus the mechanical torque on shaft.
- A rotor current regulation controlling the electromagnetic torque in air gap and the magnetizing current of the DFIM.

The excitation system shall be designed to perform the following functions:

- Ensure the rotation of shaft line and voltage ramp up of DFIM stator.
- Bring the DFIM to synchronizing conditions
- Keep the unit at a desired set point within the capability curve of the primary mover and the DFIM.
- Contribute to grid support through primary and secondary frequency control and primary voltage control.
- Keep the unit within stability limits whether hydraulic, or electrical and within thermal limits
- Ensure safe state return in case of unit shut down whether normal shut down or trip whatever the cause.

- Ensure that all requirements arising from grid connection specification are met Perform the specific tasks required by generator/turbine mode, motor/pump mode, condenser mode (in Motor rotation direction), STATCOM mode, electric braking, black start, line charging and islanded network operation.

  The excitation system shall be connected to SCADA system.

  The harmonic content injected into the neighboring power grids must comply with IEC 61000-2-4 class 3 and IEC 61000- 3-6 standard.

  The excitation system shall include two control strategies which can switched from one to the other

  (a) Active and reactive loads are controlled by the voltage source inverter (VSI) while the speed of shaft line is controlled by turbine governor.

  (b) Speed and reactive load are controlled by the VSI while the active load is controlled by turbine governor.

3.4.3.4 STEP-UP TRANSFORMERS:

Power generated will be stepped up to 400 KV by means of Three Single Phase, 18KV/400KV, 100 MVA oil filled power transformers/Unit i.e. total 15 Numbers of Single Phase 18KV/400 KV Power transformers for 5 units of 240 MW units and Three Phase 18KV/400 KV, 160 MVA power transformer – 2 Nos. for 2 Units of 120 MW units.

3.4.3.5 400 KV GIS:

Indoor metal-enclosed phase segregated type SF6 gas insulated switchgear system rated for 400 kV, 3 phases, 50 Hz SF6 gas insulated metal enclosed bus bars complete with Generator transformer, Line, Bus coupler, SAT bays.

LOCAL CONTROL CUBICLE

The Local control cubicle shall contain all the equipment required for controlling and monitoring the bay.

400 KV POTHEAD YARD:

The 400 KV pothead yard will consist of two Outgoing line bays with isolator, CT, CVT, WT & LA and take off tower. The isolators will be of Horizontal double break type with motor operated mechanism.

3.4.4 CONTROL, INSTRUMENTATION & PROTECTION SYSTEMS:

There shall be one control panel each for the Turbine governing, unit & its auxiliaries,

station and its auxiliaries, GIS & its auxiliaries. It should be able to synchronize the units either manually through these control boards or through SCADA system located in control room. Protection panel for turbine, units, generator transformer, GIS, auxiliary transformers, line protections etc. The protection system adopted should be state of art type with latest practices in compliance with CEA requirements.

3.4.5 COMMUNICATION SYSTEM:

To communicate inside power house and pothead yard internally, to HO and LDC following communication systems are considered.

a) Internal Telephone System
b) External Communication.
c) Power Line Carrier Communication/OPGW.

3.4.6 POWER EVACUATION

It is proposed to have One Double Circuit Transmission Line to connect the project to existing substation for evacuation of stored power during Generating mode and for supply of power during Pumping mode. Various existing substation details have been collected and the same are given below:

1. One 400 KV Double Circuit Transmission Lines with Moose conductor of length **81 Kms (app)** from PSP will be connected to 400/220 kV PGCIL substation at Kota of Rajasthan State for evacuation of generated Power and for Supply of power during pumping mode.
2. One 400 KV Double Circuit Transmission Line with Moose conductor of length 121 **KMs (app)** from PSP will be connected to 400 / 220 kV PGCIL substation at Dabri, Nagda in Madhya Pradesh State for evacuation of generated power and for supply of power during pumping mode.
3. One 400 KV Double Circuit Transmission Line with Moose conductor of length 133 **KMs (app)** from PSP will be connected to 765 / 400 kV PGCIL substation at Chittorgarh district, Rajasthan State for evacuation of generated power and for Supply of power during pumping mode.
4. One 400 KV Double Circuit Transmission Line with Moose conductor of length 183 **KMs (app)** from PSP will be connected to 765 / 400 kV PGCIL substation at Indore, Madhya Pradesh State for evacuation of generated power and for Supply of power during pumping mode.

However, final connecting point for evacuation of generated/consumption of pumping

power will be finalized considering bay availability, existing transformer capacity and transmission line route feasibility up to receiving end during DPR Stage.

3.4.7 SALIENT FEATURES OF E & M EQUIPMENT

1		**Electro-Mechanical Equipment**	
		Pump Turbine	Francis type, vertical shaft reversible pump-turbine
		Total No of units	7 nos. (5 X 240 MW + 2 X 120 MW)
		Total Design Discharge (Turbine Mode)	1326.75 Cumec
	a	**240 MW Turbines**	
		Total No. of units	5 Units with Fixed speed
		Turbine Design Discharge	220.91 Cumec
		Rated Head in Turbine Mode	121.70 m
		Pump Capacity	251 MW
		Rated Pumping Head	127.90 M
		Rated Pump Discharge	183.86 Cumec
		Synchronous speed	136.36 rpm
	b	**120 MW Turbines**	
		Total No. of units	2 Units with Variable speed
		Turbine Design Discharge	111.10 Cumec
		Rated Head in Turbine Mode	121.00 m
		Pump Capacity	135 MW
		Rated Pumping Head	128.70 M
		Rated Pump Discharge	98.16 Cumecs
		Synchronous speed	187.5 rpm
	i	**Generator-Motor (240 MW unit)**	
		Type	Three (3) phase, alternating current synchronous generator motor semi umbrella type with vertical shaft
		Number of units	5 Units
		Rated Capacity	Generator – **240 MW**; Pump Input – **251 MW**
		Rated Voltage	18 KV

	ii	**Main Power Transformer**	
		Type	Three Single Phase Power transformers with Off-Circuit tap changer (OCTC)
		Number of units	15 Numbers (3 Numbers/Unit) i.e. Three Single Phase, 18KV/400KV, each 100 MVA rating power transformers.
		Rated Capacity of each unit	Single Phase, 18KV/400 KV, 100 MVA
		Rated Voltage	Primary – 18 kV; Secondary - 400 kV adjustable range of the secondary voltage: -10% to +10%(3kV/tap)
	i	**Generator-Motor (120 MW unit)**	
		Type	Three (3) phase, alternating current asynchronous generator motor semi umbrella type with vertical shaft (Variable Speed machine)
		Number of units	2 Units
		Rated Capacity	Generator – **120 MW**; Pump Input – **135 MW**
		Rated Voltage	18 KV
	ii	**Main Power Transformer**	
		Type	Three Phase Power transformers with Off-Circuit tap changer (OCTC)
		Number of Transformers	2 Nos.
		Rated Capacity of each unit	Each 160 MVA, 18KV/400 KV rating power transformers.
		Rated Voltage	Primary – 18 kV; Secondary - 400 kV adjustable range of the secondary voltage: -10% to +10%(3kV/tap)
2		**400 KV Gas Insulated Switchgear**	
	1	Type of GIS	Indoor Type
	2	No. of GIS units	One No.
	3	Location	Inside GIS Building above ground
	4	Scheme	Double Bus bar Arrangement with coupler
3		**POWER EVACUATION**	
	a	Voltage Level (KV)	400 KV
	b	No. of Circuits	Two Nos.
	c	Conductor	Moose

	d	No. of Transmission Lines	One 400 KV transmission line with double circuit.
	e	Total Length	One 400 KV Double Circuit Transmission Lines with Moose conductor of length **81 Kms (app)** from PSP will be connected to 400/220 kV PGCIL substation at Kota of Rajasthan State for evacuation of generated Power and for Supply of power during pumping mode.

CHAPTER – 4

SITE ANALYSIS

4.1 General

MP 30 Gandhi Sagar Off-stream PSP is located in Neemach district of Madhya Pradesh. It envisages utilization of Gandhi Sagar reservoir as lower Reservoir (Existing) & creation of upper reservoir near Rampura Taluk Neemach district. The project is about 67 km from Neemach Railway station and the nearest Airport is at Neemach. The nearest Village to project is Khemla Block, which comes under Rampura Taluk. The Installed capacity of the Project is proposed as 1440 MW.

The Gandhi Sagar reservoir created by the dam is the third largest in India (after the Indirasagar Reservoir and Hirakud Reservoir), with a total area of 723 km2 (279 sq mi). The catchment area of the Chambal River from the Vindhyachal ranges to the south and Aravalli to the northeast, covering a drainage area of 22,584 km2 (8,720 sq mi); important tributaries that discharge into the Chambal upstream of this reservoir include the Shipra, Chhoti, Kalisindh, Ansar, and Rupniya on the eastern side, and the Tilsoi, Edar, Retum and Shivna in the west. The maximum length and width of the reservoir are 68 kilometres (42 mi) and 26 kilometres (16 mi), respectively. The Gandhi Sagar Wildlife Sanctuary, which has an area of 36,892 hectares (91,162 acres), is shared by the Mandsaur and Neemach districts, in the catchment area of the Gandhi Sagar reservoir. The sanctuary's forested area was once a hunting area of the Holkar royal family of Indore. The reservoir is under the control of the irrigation and fisheries departments of the Government of Madhya Pradesh, and is mostly used for fisheries development also.

The mean depth of the reservoir is 11.73 metres (38.5 ft), with a shore development index of 4.78, and a volume development index of 0.601 at the Full Reservoir Level. Scientific studies indicate that the reservoir is productive as regards fisheries, with the reservoir water indicating a moderate-to-high rate of primary productivity. Commercial Fisheries was initiated in 1959–60 in Gandhi Sagar, and has been credited as the best-managed reservoir in the state. Fish capture in the reservoir is prohibited between 16 June and 15 August. The reservoir attracts a large number of migratory and non-migratory birds throughout the year, has been qualified under "A4iii criteria" by the IBA, as the bird congregation is of more than 20,000 waterbirds.

The Gandhi Sagar Dam is one of the four major dams built on India's Chambal River. The dam is located in the Mandsaur, Neemach districts of the state of Madhya Pradesh. It is a masonry gravity dam, standing 63.70 metres (209.0 ft) high, with a gross storage capacity

of 7.322 billion cubic metres from a catchment area of 22,584 km2 (8,720 sq mi).

Madhya Pradesh is a state in central India. Its capital is Bhopal, and the largest city is Indore, with Jabalpur, Gwalior, Ujjain and Sagar being the other major cities. Nicknamed the "Heart of India" due to its geographical location, Madhya Pradesh is the second largest Indian state by area and the fifth largest state by population with over 75 million residents. It borders the states of Uttar Pradesh to the northeast, Chhattisgarh to the southeast, Maharashtra to the south, Gujarat to the west, and Rajasthan to the northwest. Its total area is 308,252 km2. Before 2000, when Chhattisgarh was a part of Madhya Pradesh, Madhya Pradesh was the largest state in India and the distance between the two furthest points inside the state, Singoli and Konta, was 1500 km. Konta is presently in Sukma district of Chhattisgarh state.

4.2 General Features of the Project

MP30 Gandhi Sagar Off-stream PSP is in Neemach district of Madhya Pradesh. MP30 Gandhi Sagar Off-stream PSP Project envisages construction of MP30 Gandhi Sagar upper reservoir (proposed) and Gandhi Sagar reservoir (existing lower reservor) and one-time water will be pumped from existing Gandhi Sagar reservoir to fill up the proposed upper reservoir. Installed capacity of the Project is proposed as 1440 MW (5 x 240 MW & 2 x 120 MW). There are no monuments of archeological or national importance which would be affected by project activities directly or indirectly.

The project envisages construction of rock fill embankment with the maximum height of 35m for creation of MP30 Gandhi Sagar Off-stream PSP upper reservoir of 1.80 TMC gross capacity. The total design discharge for the proposed scheme is 1326.75 Cumec with the rated head of 121.70 m for larger units and 121.00m for smaller units. Six intake structures are provided with trash rack and gated arrangements. Six independent pressure shaft / penstock of 7.5 m diameter will take off from intake structure in which 5 nos. independent Penstock / Pressure Shaft will feed 5 units of 240 MW each and 1 no. of independent Penstock / Pressure Shaft will get bifurcated in to two near power house to feed 2 units of 120 MW each. The length of the penstock / Pressure shaft up to powerhouse location shall be 683.48m consisting of 181.52m long surface penstock, 140.97m long vertical pressure shaft and 360.99m long Horizontal pressure shaft. Water from the draft tube of each of the machines after power generation will enter into a tail pool through Tail race tunnel. The tail pool is connected to a tail race channel that conveys the water into the Lower Reservoir.

CHAPTER – 5

PLANNING BRIEF

5.1 General

The MP30 Gandhi Sagar Off-stream Pumped Storage Project envisages construction of upper reservoir near village Bhimpura in Rampura taluk of Neemach District whereas the existing Gandhi Sagar reservoir is located near Gandhi Sagar village in Mandsaur District will be the lower reservoir.

The scheme will involve construction of rock fill embankment of maximum height of 35m for creation of MP30 Gandhi Sagar Off-stream PSP upper reservoir of 1.80 TMC gross capacity. The MP30 Gandhi Sagar Off-stream PSP is proposed in between two reservoirs i.e. MP30 Gandhi Sagar Off-stream PSP Upper (to be constructed newly) & Gandhi Sagar reservoir Lower Reservoirs (Existing) and one-time water will be pumped from existing Gandhi Sagar reservoir to fill up the proposed Upper reservoir. Water will be let out from the MP30 Gandhi Sagar Off-stream PSP upper reservoir through Power Intake and Penstock/Pressure shaft of 683.48m long to feed the MP30 Gandhi Sagar Off-stream PSP, having a Storage Capacity of 10411.2 MWH with Rating of 1440 MW. This project is comprising 5 units of 240 MW each and 2 units of 120 MW each. The water after power generation will be conveyed through 860m long Tail Race Channel to discharge water in to Lower reservoir of existing Gandhi Sagar reservoir. The total design discharge for the proposed scheme is 1326.75 Cumec with the rated head of 121.70m for larger units and 121.00m for smaller units.

5.2 Planning Concept

The proper selection of construction methodology, projects scheduling followed by strict monitoring during construction are the major tools available in the hand of developers for ensuring completion of projects within scheduled time and cost. The project implementation schedule of the scheme is divided in to five stages as follows:

1. Preparation of DPR
2. Clearances & Permits
3. Pre-Construction Activities
4. Construction Activities
5. Testing & Commissioning

The preparation of Detailed Project Report including Topographic Survey & Geotechnical

Investigation will be completed within 6-month time. The Clearances & Permits includes Forest land clearance, Environmental clearances, DPR approval and other permits and licenses and all these activities will be completed within 1.5 to 2 years.

Pre-Construction activity involves construction infrastructure works like access road to project site and construction of building for accommodating men and materials, Award of tender for design works, Preparation of tender for Civil, H&M and E&M works, floating of tenders, Bid Evaluation, award of work and Mobilization to Site. This activity is proposed to be completed in 6 months.

The main Construction activities will be taken up once Pre-Construction activities are completed. The Construction work for Civil, H&M and E&M will be carried out either by EPC contract or based on item rate contract. Quality control of civil, H&M & E&M works will be taken care through internal / external agency. Based on the specific work of the project, equipment planning will be taken up and state of art equipment will be deployed at site during execution. It is proposed to get the Civil, Hydro-Mechanical and Electro-Mechanical works done through reputed contractors who have been doing similar kind of works.

The Testing & Commissioning including water filling in the system will be taken up once the construction works are completed. The total construction of the project including testing & commissioning are proposed to be completed within 3.0 years.

CHAPTER – 6

PROPOSED INFRASTRUCTURE

6.1 General

MP 30 Gandhi Sagar Off-stream PSP is located in Neemach district of Madhya Pradesh. It envisages utilization of Gandhi Sagar reservoir as lower Reservoir (Existing) & creation of upper reservoir near Rampura Taluk Neemach district. The project is about 67 km from Neemach Railway station and the nearest Airport is at Neemach. The nearest Village to project is Bhimpura, which comes under Rampura Taluk. The Installed capacity of the Project is proposed as 1440 MW.

6.2 Access Roads

6.2.1 Roads to Project

The project sites are accessible to motor vehicles from Bhimpura, SH 31 A.

6.2.2 Existing Road and Bridge Improvements

The conditions of Existing roads need to be improved.

6.2.3 Roads in the Project Area

The access road to project site is planned to take off from Bhimpura road. The specification of access road has been kept equivalent category.

The permanent colony, office and other temporary facilities are planned along the access road discussed above.

6.3 Construction Power Requirement

The requirement of construction power will be met from the existing transmission network in the area. In addition to use of power from local grid, it is planned to install stand by Diesel Generating sets for ensuring un-interrupted power supply during project construction.

6.4 Telecommunication

Adequate provision required for telecommunications including:

- Development of the existing telephone system to provide sufficient capacity for both voice and data transmission.
- Provision of radio and microwave facilities.
- Provision of VSAT connection at site for communication with head office.

6.5 Project Colonies / Buildings

- The contractors for Civil, Electro-Mechanical and Hydro-Mechanical works are planned to be hired for execution of this project. The skilled, semi-skilled and unskilled labor will be arranged by these contractors. Contractors shall themselves arrange for housing facilities for its work force in nearby villages.
- In addition, the developer will have his own staff or supervision of the works. Some of the existing houses in the nearby areas / villages will be hired on rent during construction period. It is proposed to construct residential as well as non-residential buildings for the project. Office buildings, guesthouse, security post, dispensary, etc. will also be constructed. These facilities shall be permanent in nature and shall also be used by O & M staff, once the construction is over.

6.6 Job Facilities

Workshop is proposed near all the components to facilitate the various preparatory works batching plants, Crushing plants, steel liner plates bending etc. The major fabrication and assembling of hydro- mechanical equipment can be done in this workshop and later can be transported to the desired sites. Labor colony, staff colonies will be provided nearer to the components.

6.7 Workshop

Workshop is proposed near diversion site to facilitate the various preparatory works like bending of reinforcements, steel liner plates bending etc. The major fabrication and assembling of hydro-mechanical equipment can be done in this workshop and later can be transported to the desired sites.

6.8 Water Supply

The provision of adequate water supplies for both the construction purposes and the use of personnel shall be done. In order to avoid any deterioration in water quality and subsequent changes in the aquatic biota, a proper sewage disposal system in and around various labour colonies shall be planned to check the discharge of waste.

6.9 Explosive Magazine

One explosive magazine store has been proposed in the project area. Portable magazines shall be kept at the sites of work for day-to-day requirements.

6.10 Medical Facilities

Medical facilities are provided at Neemach by State District Hospital and is equipped with almost all medical facilities.

CHAPTER – 7

REHABILITATION AND RESETTLEMENT

7.1 Introduction

Resettlement and Rehabilitation Plan (R & R) is an important aspect to be considered for project implementation. As non-forest land is envisaged to be acquired for development of upper reservoir and ancillary infrastructure facilities, it's important to provide fair and just compensation to the affected families whose land has been acquired and to make adequate provisions for such affected persons for their rehabilitation and resettlement in accordance with the RFCTLARR policy of 2013 including its amendments.

The Land requirement for the Project may be categorized as Forest, Non-Forest (Govt) and Private Land.

7.2 Land Requirement

The total land requirement for proposed project is about 402.50 Ha; out of which about 301.96 Ha is forest land and remaining about 100.54 Ha is non-forest area.

The forest land involved in the project shall be applied for diversion as per the guidelines issued under the Forest (Conservation) Act, 1980, Non-Forest (Government) land shall be applied from competent authority of the State Govt as per the laid-out process, whereas the private land involved in the project will be purchased directly from respective land owners through private negotiations on land price and completed on a mutual agreement.

7.2.1 Purchase of Private Land

The private land required for the project, if any is proposed to be purchased through a voluntary sale with a willing buyer and seller process. The process is undertaken through direct negotiations between land owners and Project Proponent with no obligation on the seller. The land owners are informed in advance, and each land owner negotiated on the price of land as part of land take.

The some of the steps in the land procurement process shall include the following:

- Identification of land required for the project and due diligence of land through verification of Revenue Records.
- Undertake consultation and negotiations with the land owners about the project and private land requirement.
- After negotiations on all aspects of purchase the voluntary sale of land is completed

through a registered sale agreement.

7.3 Rehabilitation and Resettlement

During the EIA/EMP Studies, Socio-economic survey for the Project Affected Families (PAFs) shall be carried out. Based on the findings of the socio-economic studies and survey, an appropriate R&R compensation package as per the provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement, 2013 (RFCTLARR, 2013) and respective State R&R Policy in vogue would be required to be formulated. If the total private land purchased exceeds the specified limits notified by the relevant rules of concerned State Government policy, the provisions of under RFCTLARR, 2013 shall be applicable to the proposed Project.

CHAPTER – 8

PROJECT SCHEDULE AND COST ESTIMATES

8.1 General

Construction of MP 30 Gandhi Sagar Off-stream PSP including erection of 7 generating units (ie. 5 units each of 240 MW and 2 units each of 120 MW) are planned to be completed in a period of 36 months excluding Pre-constructions works, creation of infrastructure facilities viz. additional investigations, improvement of road network and colonies.

Two shift working is considered economical for surface works. Opting 25 working days in a month, shift wise scheduled working hours annually are proposed to be adopted.

8.2 Target Schedule

The Total Construction period is scheduled as follows.

Preconstruction Period incl. Statutory Clearances	:	6 months
Construction Period (Main Works)	:	3.0 Years
Total Construction Period	:	3.5 Years

Tentative Construction scheduled for this project is prepared and enclosed as **Annexure- 8.1**.

8.3 Cost Estimates

The Civil Cost Estimates of the project has been prepared as per "Guidelines for preparation of estimates for the river valley projects" issued by CWC and Indian Standard IS: 4877 "Guide for Preparation of Estimate for River Valley Projects".

Rates of major items of works have been prepared based on SSR of Madhya Pradesh & local prevailing rates are adopted for the items not covered by the SSR wherever quantification has not been possible at the present stage of design, lumpsum provisions have been made based on judgement / experience of other projects.

8.4 Preparation Of Estimates

The capital cost of the project includes all costs associated with investigations, design, construction and maintenance during construction period of the project.

For preparation of cost estimates of civil works, the unit costs of labor, materials and equipment necessary to perform the work designated in the various pay-items for the proposed construction are determined based on Schedule of Rates for the year 2017-18 of Madhya Pradesh Irrigation and Water Resources Department and for items for which the rates are not available, the accepted schedule of rates of similar ongoing/recently executed

projects adopted. The rates of major items have been worked out by rate analysis.

The quantities of Civil Works are estimated based on designs and drawings prepared for various components of the project. The Daily wage rates have been taken as per Madhya Pradesh I&CAD Schedule of Rates for the year 2017 - 18.

Provision for contingencies are considered at 3% of the works cost and are provided in the detailed works estimates prepared on the heads of item rates and quantities of works to be executed. These percentage provisions are not considered on lump-sum items.

Description of Item	**Cost in Crores**
Cost of Civil Works	2797.67 Cr.
Cost of Power Plant - Electro Mechanical Equipment including Transmission line	1930.50 Cr.
Total Hard Cost	4728.17 Cr.
IDC & Others	2263.08 Cr.
Total cost of the Project	**6991.25 Cr.**

CHAPTER – 9

ANALYSIS OF PROPOSAL

This project is conceived as Integrated Renewable Energy Project along with solar and Wind. Therefore, financial analysis for the same will be carried out once Solar and Wind project proposals are finalized.

MP30 Gandhi Sagar Off-Stream PSP (1440 MW) - Tentative Construction Schedule																																		Annexure - 8.1					
Project Details	Year 1												Year 2												Year 3												Year 4					
	Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2		
Project Timeline																																							
Pre-Construction Activities																																							
Main Construction Activities																																							
Rockfill Dam																																							
Intake Structure & Tunnel																																							
Pressure Shaft																																							
Power House																																							
Tail Race Tunnel/ Tail Race Channel																																							
Transmission Line																																							
Filling of Upper Reservoir																																							
Filling in Water Conductor System																																							
Testing and Commissioning of Units																																							

DRAWINGS

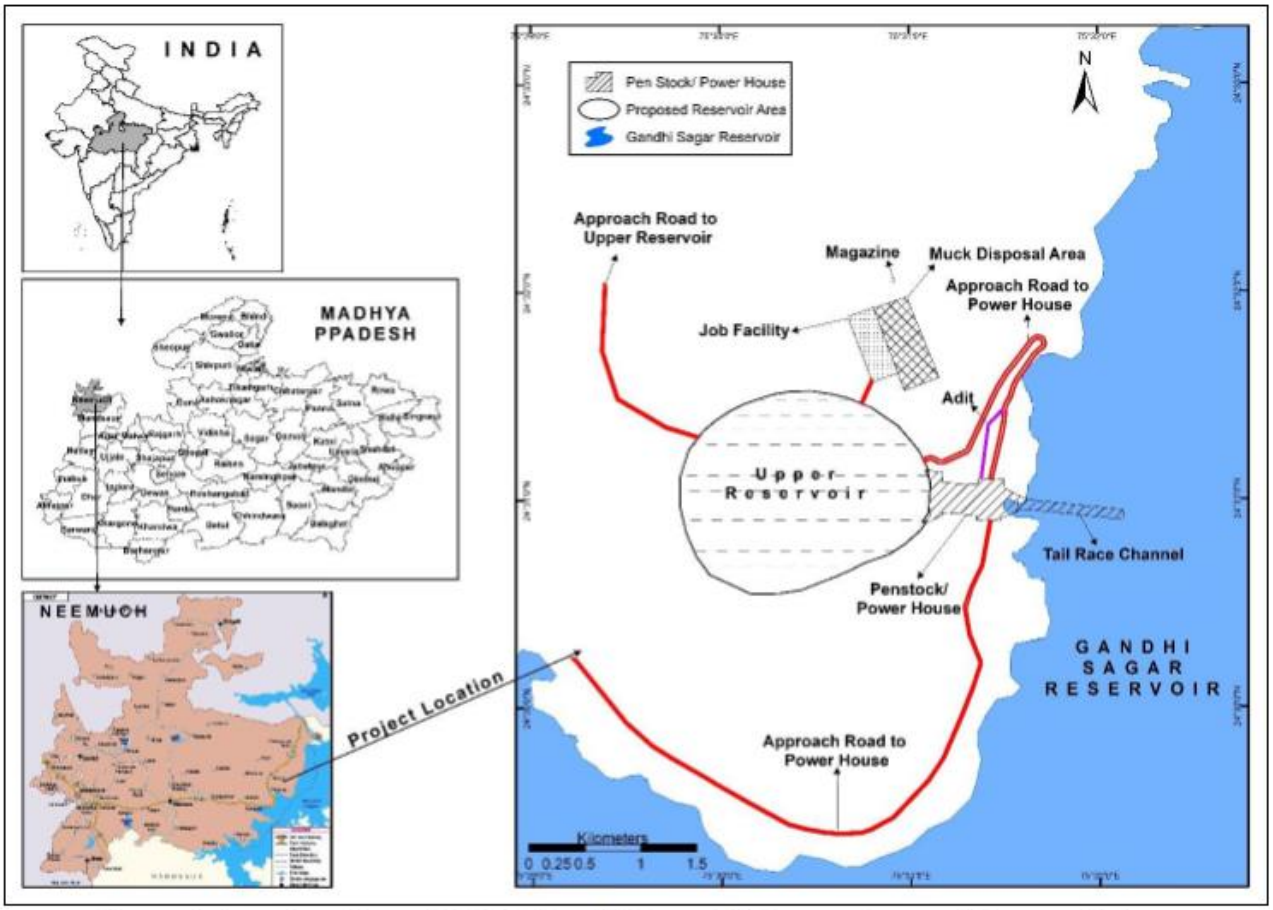
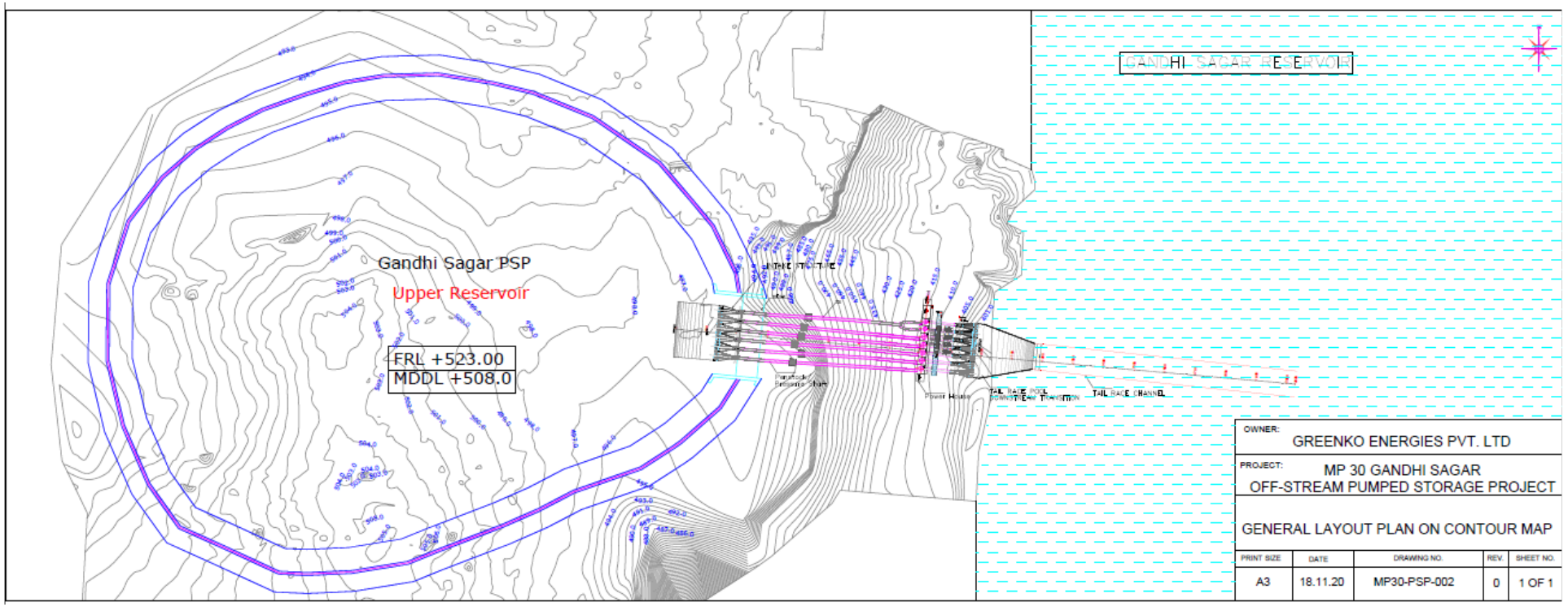


Figure 1: Location Map of MP 30 Gandhi Sagar Off-Stream Pumped Storage Project



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PROJECT:	MP 30 GANDHI SAGAR OFF-STREAM PUMPED STORAGE PROJECT
	GENERAL LAYOUT PLAN ON CONTOUR MAP

PRINT SIZE	DATE	DRAWING NO.	REV.	SHEET NO.
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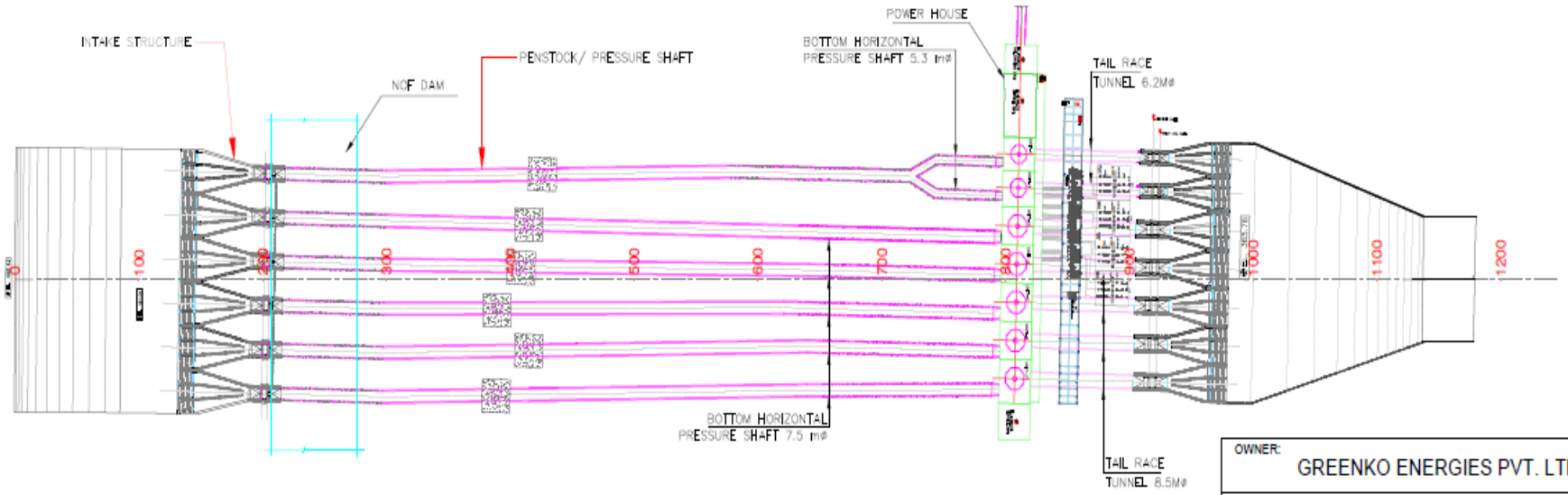

GENERAL ARRANGEMENT–PLAN

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PROJECT: MP 30 GANDHI SAGAR OFF-STREAM PUMPED STORAGE PROJECT				
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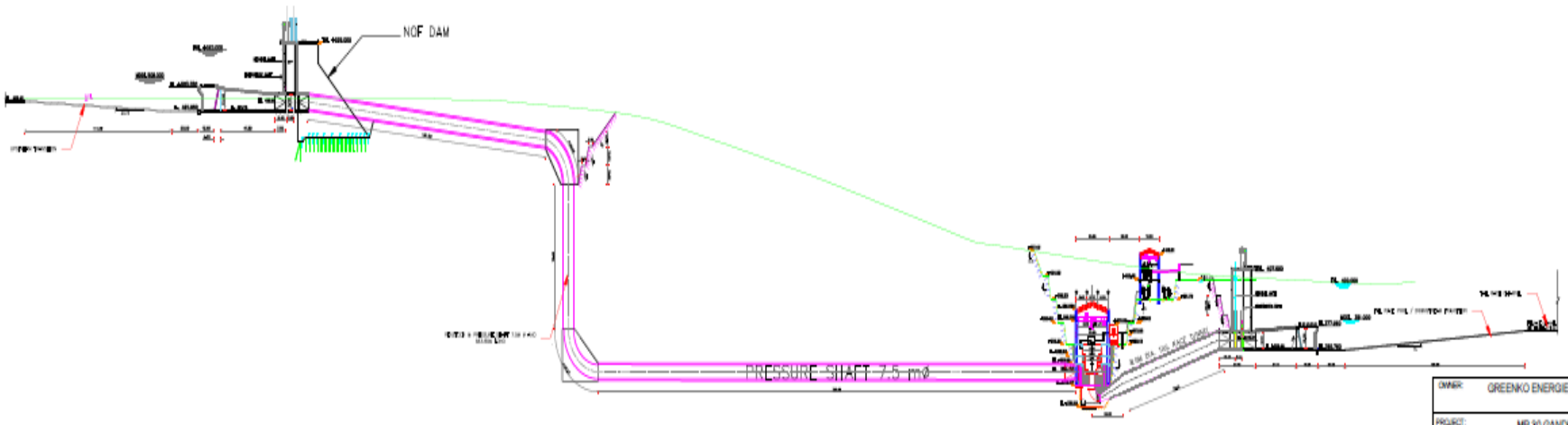

GENERAL ARRANGEMENT–LONGITUDINAL SECTION

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PROJECT:	MP 30 GANDHI SAGAR OFF-STREAM PUMPED STORAGE PROJECT
DRAWING TITLE:	GENERAL ARRANGEMENT LONGITUDINAL SECTION

PRINT SIZE	DATE	DRAWING NO.	REV.	SHEET NO.
A3	18.11.20	MP30-PSP-004	0	1 OF 1

MP 30 GANDHI SAGAR OFF-STREAM PUMPED STORAGE PROJECT