CHAPTER 1

INTRODUCTION

BWSSB intended to build 48ML capacity Ground Level reservoir at Kadugodi to cater the drinking water requirements of 9 villages of Mahadevapura zone. This Reservoir will receive an inflow of 85 MLD by gravity from Gottigere GLR. BWSSB has entrusted ONTB Consultant team for preparation of Detailed Project Report (DPR) for the proposed construction of 48 ML capacity Reservoir along with associated buildings at Kadugodi.

1.1 Basis of DPR Study

This DPR study is prepared based on the followings:

(i) Collection of data/information from BWSSB and discussion with BWSSB Engineers
(ii) Joint site visit by ONTB team and BWSSB team
(iii) Topographical survey carried out by ONTB.

1.2 Scope of Work

ONTB's scope of works for this consultancy is as indicated below:

(i) Site visits, data collection
(ii) Carry out Topographical Survey and Geotechnical Investigation
(iii) Preparation of Design, drawings and Cost Estimates for one no. of 48 ML Ground Level Reservoir (GLR) along with associated buildings.
(iv) Preparation of Detailed Project Report (DPR)

1.3 Approach

ONTB team has visited the proposed GLR location along with BWSSB team as well as survey & geotechnical investigation agencies to conduct the survey and soil investigation required for the design of GLR. The site is located to the North east of Bengaluru city and inside the forest area and adjacent to ITPL main road. The proposed land has 6.0 acres for construction of GLR and other utilities. The proposed land has big trees and vegetation. The topography of the proposed site is flat and has lot of plantation. Minimum and maximum elevations of the site are 892.00 m and 897.00 m respectively.

After carrying out topographical survey, ONTB has prepared general arrangement of the GLR and same has been discussed with BWSSB for further decisions. Since the GLR site had land issues, Geo-technical

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investigation was not carried out. The topographical survey was carried out as per the prevailing standards and code IS: 8009 (part 1).

Figure 1.1: Satellite Image of Proposed GLR Site @ Kadugodi.

1.4 Details of Command Area

The command area of the reservoir covers eastern side of the project area i.e. Mahadevapura Zone. Mahadevapura Zone consists of 23 Villages and out of which 9 villages comes under the command area of Kadugodi GLR. The villages under this reservoir command area are Khanekandya, Hagadur, Nagondhalli, Channasandra, Kadugodi Plantation, Belthur, Sorahunise, Varthur and Kumbena Agrahar. The demand for the zone is 85 MLD. This Reservoir will receive an inflow of 85 MLD by gravity MS Pipeline of 1000mm Diameter from Gottigere GLR. Table-1 provides the Village wise population and water demand for the base, intermediate and horizon year. Figure-1.2 shows the Command Area of Kadugodi GLR under Mahadevapura zone.

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Table-1: Details of Village Wise Population and Water Demand for the Base, Intermediate and Horizon years

Kadugodi GLR (Mahadevapura Zone):								
Sl.No	Village Covered	Population				Water Demand (MLD)		
		2011 Census	2019	2034	2049	2019	2034	2049
1	Khanekandya	470	662	1147	1817	0.12	0.20	0.32
2	Hagadur	21445	30218	52367	82982	5.33	9.24	14.64
3	Nagondhalli	2864	4036	6995	11084	0.71	1.23	1.96
4	Channasandra	23913	33695	58392	92530	5.95	10.30	16.33
5	Kadugodi Plantation	12555	17691	30658	48582	3.12	5.41	8.57
6	Belthur	26380	37171	64416	102076	6.56	11.37	18.01
7	Kumbena Agrahar	2416	3405	5900	9349	0.60	1.04	1.65
8	Sorahunise	8811	12416	21516	34095	2.19	3.80	6.02
9	Varthur	19063	26862	46550	73764	4.74	8.21	13.02
Total		**117917**	**166156**	**287941**	**456279**	**31**	**53**	**84.66**
							Say	**85.00**

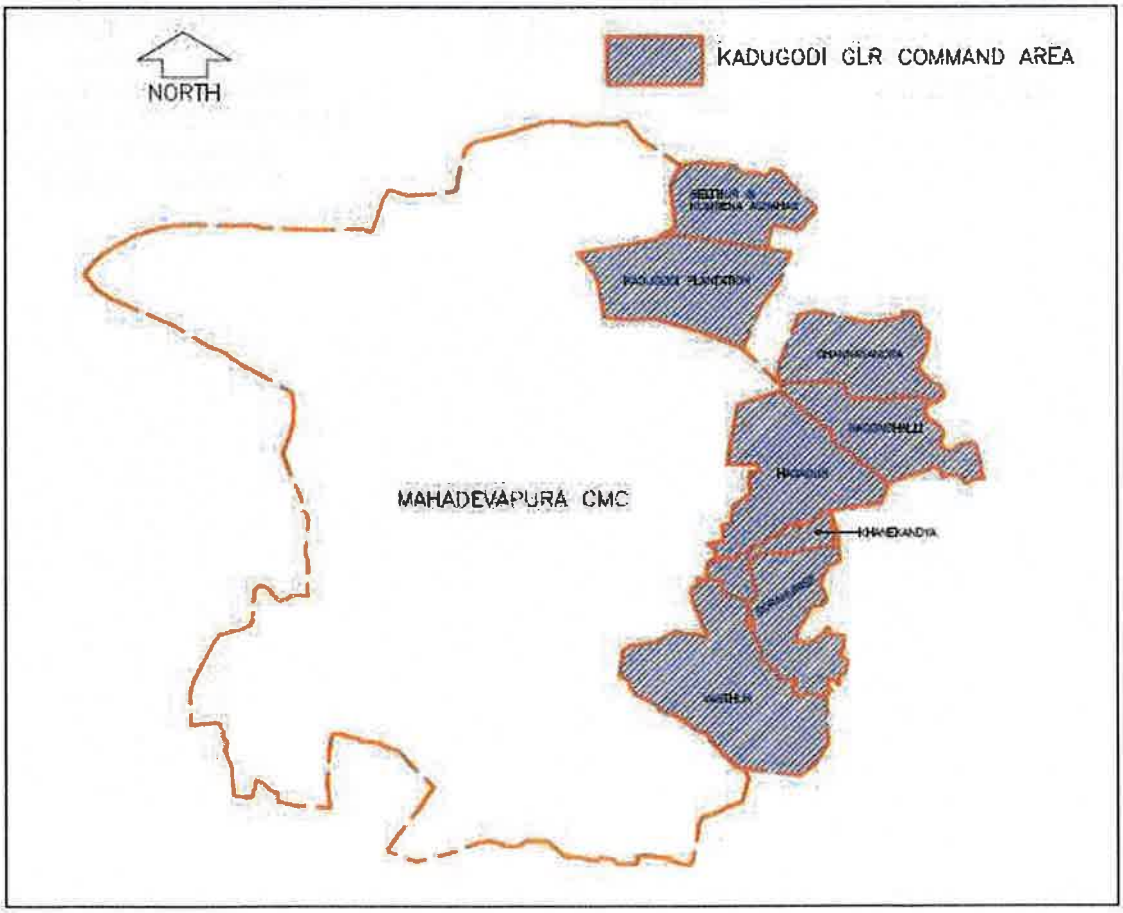

Figure – 1.2: Command Area of Kadugodi GLR under Mahadevapura zone.

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1.5 Methodology

The size of proposed reservoir is 120 m x 70 m x 6.0 m. GLR consists of two equal compartments of clear size 60m x 70m with service water depth of 6m with 0.6m of freeboard. GLR is covered with RCC cover slab. This will accommodate to store minimum 48.0ML volume of clear water. In the tank baffle walls are provided to guide the flow of the water. The walls of the tank are designed as free cantilever for tank full case for strength design and for crack width calculations. Each Compartment has one internal staircase which is situated at middle of the tank. Also, one more external staircase is provided for roof access.

The reservoir is covered to reduced thermal strain due to daily temperature change is one of the major factors affecting natural deterioration of the reservoir. The effective measure against this is a soil mat or a gravel mat / clay tile to cover the entire reservoir structure and thereby reduce solar gain. Full cover of the reservoir will prevent sunshine to radiate to the stored water.

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CHAPTER-2

STRUCTURAL DESIGN CONCEPT

2.1 Design Criteria for Civil Structures

This Chapter is intended to lay down the brief outlines for Design basis, and other related required aspects of Civil & Structural works for various structures proposed at the reservoir location.

2.1.1 Design Loadings

All Structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions; these include Dead load, Live load, Wind load, Seismic load, Dynamic load, Vehicular load, Monorail / EOT Crane load, and Stresses due to temperature changes, shrinkage & creep in materials, etc.

2.1.1.1 Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment's and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping, etc., shall be considered. Dead loads shall be in general as per IS 875 Part (1)-1987. However, the following minimum loads shall be considered in design of structures:

(i)	Weight of Water	:	10 KN/m^3
(ii)	Weight of Soil (irrespective of strata available at site and type of soil used for filling etc.). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered	:	20.00 KN/m^3
(iii)	Weight of Concrete	:	24.00 KN/m^3
(iv)	Weight of Reinforced Concrete	:	25.00 KN/m^3
(v)	Weight of Brickwork (exclusive of plaster)	:	22.00 N/m^2 per mm thickness of brickwork
(vi)	Weight of Solid Concrete Block work (exclusive of plaster)	:	24 N/m^2 per mm thickness of Block work
(vii)	Weight of Plaster to masonry surface	:	18.00 N/m^2 per mm thickness
(viii)	Weight of Sand	:	20.00 KN/m^3
(ix)	Weight of Granolithic, Terrazzo finish or Rendering screed, etc.	:	24.00 N/m^2 per mm thickness

(x)	Weight of MS Chequered plates	:	78.5 N/m^2 per mm thickness of plates.

2.1.1.2 Live Load

Live Load will include the superimposed loads due to the use/occupancy of the structure/building not including dead, wind or earthquake load.

Live Loads will be in general as per IS 875 Part (2)-1987. However, the following minimum live loads shall be considered in the design of structures.

(i)	Live Load on roofs	:	1.50 kN/m^2
(ii)	Live Load on floors supporting Equipment such as pumps, valves, Blowers, Compressors and Equipment etc. (Subject to verification of vendor's requirement):		10.00 KN/m^2
(iii)	Live Load on all other floors Walkways, stairways and Platforms	:	5.00 KN/m^2
(v)	Live Load Surcharge for Structures	:	1.2m x Density of soil (Equivalent load as per IRC 6)

Apart from the specified live loads or any other load due to material stored, any other equipment loads or possible overloading during maintenance or erection/construction will be considered and shall be partial or full whichever causes the most critical condition.

2.1.1.3 Wind Load

Wind loads shall be as per IS 875 Part (3)-2015.

Design Wind Speed at any height $V_z = (V_b \times k_1 \times k_2 \times k_3 \times k_4)$ m/sec	
Basic wind speed (V_b)	33 m/sec
k_1 - Probability factor or Risk Coefficient	Table -1
k_2 - Terrain height & structure size factor	Table - 2
k_3-Topography factor	Clause 6.3.3
k_4-Importance factor for cyclonic zone	Clause 6.3.4
Wind Pressure at any height: $P_z = (0.6 \times V_z^2)$ N/m^2	Clause 7.2
Design wind pressure $P_d = (P_z \times k_a \times k_d \times k_c)$ N/m^2	
k_a - Area averaging factor	Clause 7.2.2
k_d -Wind directionality factor	Clause 7.2.1
k_c - Combination factor	Clause 7.3.3.13

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2.1.1.4 Earthquake Load

This shall be computed as per IS 1893 (Part 1) - 2016 for Buildings and IS 1893 (Part 2) - 2014 for Liquid Retaining structures. An importance factor appropriate to the type of structure will be considered for design of all the structures.

Seismic Parameters:

Seismic zone	Annex E
Zone factor (Z)	Table 3
Importance Factor (I)	Table 8
Response Reduction Factor (R)	Table 9

Damping ratio: 5% for RCC structures & 2% for Steel Structures

Hydrodynamic Impulsive pressure will be considered for the analysis of Liquid Retaining Structures as per the provisions of IS: 1893 (Part 2) - 2014.

2.1.1.5 Dynamic Load

Dynamic loads due to working of plant items such as Pumps, Blowers, Compressors, Switch Gears, Travelling Cranes, etc. shall be considered in the design of structures. Dynamic Loads due to the working of Machines / Equipment- Foundation weight will be sized to 3 times the dynamic weight of rotating equipment.

2.1.1.6 Monorail / EOT Crane Load

(i)	For Hoists and Monorails	-	For manually operated - Lifted load, Impact factor 10%, Lateral surge 10%, and Longitudinal surge 5 % of Crab.
(ii)	For EOT Cranes	-	Lifted load, Impact factor 25%, Lateral surge 10% and Longitudinal surge 5 % of Crab.

2.1.1.7 Vehicular Load

For any structure surcharge load or pipeline below the roads, Class A (Standard Live Load) loading of IRC 6 shall be considered.

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2.1.2 Analysis /Assumptions

2.1.2.1 Liquid Retaining Structures

All Liquid Retaining Structures will be analysed & designed with respect to their aspect ratios and respective boundary conditions as per the provisions of relevant codes and standard specialist literature.

The design of all structural members of all Liquid Retaining Structural members will conform to 'Controlled cracked design criteria' as per the provisions of IS 3370-2009 (Part-1&2) specifications by adopting the 'Limit State Design approach' with serviceability crack width of 0.1 mm and other limit state requirements also to ensure an adequate degree of safety and serviceability.

2.1.2.2 Non-Liquid Retaining Structures & Buildings

All Building Structures will be idealized & analysed as RC structural framing system. The design of all structural members of all buildings will confirm to 'Limit State Design' as per the provisions of IS: 456-2000 for strength, serviceability and durability criteria requirements.

2.1.3 Design Criteria for Underground or Partly Underground Liquid Retaining Structures

All Underground or Partly Underground Liquid Retaining Structures will be designed for the following conditions:

(i) Liquid depth up to full height of wall; no relief due to soil pressure from outside will be considered.

(ii) Structure empty (i.e., empty of liquid, any material, etc.) full earth pressure and surcharge pressure (1.2m of soil fill) wherever applicable will be considered.

(iii) Partition wall between dry sump and wet sump will be designed for full liquid depth up to full height of wall.

(iv) Partition wall between two compartments will be designed as one compartment empty and other full.

(v) Walls will be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads (Hydrodynamic Impulsive Pressure).

(vi) If water table exists, underground or partially underground structures will be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures beneath the base slab with reference to geotechnical report recommendations. The Structures will be designed for uplift in empty conditions and ensure a minimum factor of safety of 1.2 against uplift with appropriate safety factor to the characteristic dead load.

a) The equilibrium and safety of structure and parts of it against sliding and overturning, especially when the structure is founded on a side of long or sloping ground shall be checked.

b) For General retaining walls both overturning and sliding checks will be performed with appropriate safety factors for Characteristic Dead Loads as per codal provisions.

c) For Large sized tanks where the walls are designed as retaining walls, overturning check will be performed with appropriate safety factors for Characteristic Dead Loads as per codal provisions.

(vii) All the Liquid Retaining Structures will be designed for maximum design crack widths of 0.1mm for direct tension and flexure.

(viii) In case of large and deep underground tanks such as Wet Wells, the analysis can be carried by Finite Element Method using latest version of STAAD Pro or any other equivalent software predominantly used and accepted in the industry.

(ix) Overturning: The Stability of a structure as a whole against overturning will be ensured so that the restoring moment will be not less than the sum of 1.2 times the maximum overturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In cases where dead load provides the restoring moment, only 0.9 times the characteristic dead load will be considered. Restoring moment due to imposed loads shall be ignored.

(x) Sliding: The Structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load will be taken into account.

2.1.4 Foundations

(i) The minimum depth of foundations for all structures, equipment's, buildings and frame foundations and load bearing walls will be as per IS 1904 but in any case, this will not be less than 1.0 meter in the original soil.

(ii) All related parameters of design and Safe Bearing Capacity of the soil strata will be considered as per Geotechnical report recommendations.

(iii) Care will be taken to avoid the foundations of adjacent buildings or structure foundations without destabilizing them. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions.

(iv) Special attention is drawn to danger of uplift being caused by the ground water table. If water table exists, all related underground structural slabs will be designed for uplift forces due to ground water pressure with reference to the Geotechnical report recommendations.

(v) EGL (Existing ground level) and FGL (Finished ground level) will be marked on all drawings showing foundation/sub-structure details and related design documents.

(vi) Foundations and structures for machines subject to vibrations shall be so proportioned that the amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).

(vii) Machine foundations shall be designed and detailed as per IS: 2974. All appendages to such foundations will be reinforced suitably to ensure integral action.

(viii) Machine/static equipment foundations will be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs will be suitably sealed.

2.1.5 Design Life Period

The design depreciation period of all structures and buildings will be 60 years as minimum, anticipating that no major repair will be required in the depreciation period.

2.1.6 Design Requirements

The following are the design requirements for all reinforced or plain concrete structures:

(i) All Blinding and levelling concrete will be a minimum 100 mm thick in concrete grade M10.

(ii) All Liquid Retaining Reinforced Concrete Structures, concrete will be of a minimum M30 grade with a maximum 20 mm aggregate size for all structural members and for Buildings, Reinforced Concrete shall be of a minimum M25 grade (Footings, Plinth Beams, Columns, Slab and beams, etc., i.e. which are other than Liquid Retaining Structures) with a maximum 20 mm aggregate size for all structural members. Further, if there is any Liquid Retaining RCC tank coming up with in the Buildings, concrete will be of minimum M30 grade for such RCC tanks also.

(iii) The Reinforced Concrete for water retaining Structures will have a minimum cement content of 400 kg/m^3 with a maximum 20 mm size aggregate. Reinforced concrete for building structures will have maximum cement content of 360 kg/m^3 with a maximum 20 mm size aggregate. Reinforced concrete shall have minimum slump of 100mm with maximum water cement ratio of 0.48. Unless otherwise noted, cement shall be ordinary Portland cement conforming to IS 8112.

(iv) The minimum cover to the main reinforcing bars for different members is:

Non–Liquid Retaining Structures will be as follows unless stated otherwise.

Slab (Floor, Roof, Canopy, Chajjas and Staircase)	30 mm
Beams (Sides, Bottom & Top)	40 mm
Lintels (all around)	30 mm
Columns	
i) For Column width 200	40 mm
ii) For Column width 230 & above	50 mm
Pedestals (in contact with earth)	50 mm
Basement wall, retaining walls	
i) Face in contact with Earth	50 mm

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ii) Interior face	50 mm
Foundations (Top, Bottom and sides)	50 mm

Liquid Retaining Structures will be as follows unless stated otherwise.

Walls - Face in contact with Earth	60 mm
Walls - Face in contact with Water	60 mm
Base Slab in contact with Water	60 mm
Base Slab in contact with Soil	60 mm
Launders/Gutter Slabs	45 mm

(v) Reinforcement for Water retaining structures & those connected with these systems and Buildings will be TMT-CRS (Corrosion Resistant Steel) of Grade Fe 500D. All physical and chemical properties of this Fe 500D grade steel shall conform to IS: 1786-2008. Welded wire fabric shall conform to IS: 1566.

(vi) All Buildings will have a minimum 1 meter wide, 100 mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles. All plinth protection will be supported on well compacted strata.

(vii) All pipes and ducts laid below the structural plinth and road works will be surrounded with concrete of grade M15 having minimum 150 mm thick concrete or D/4 (D = outer dia. of pipe) thickness whichever is more.

(viii) Use of pressure relief valves to reduce uplift pressure due to ground water table will not be allowed.

(ix) Detailing of the reinforcement will be considered as per latest Indian code of practices and special publications as applicable.

(x) Sliding layer or slip layer will be provided between subbase and structural slab (Raft). Polythene sheets of 1000 microns will be provided as sliding layer as per IS specification.

(xi) Water tightness testing of Liquid Retaining structures will be done as per IS 3370 (Part 1)-2009.

(xii) The following minimum thicknesses will be used for different reinforced concrete members, irrespective of design requirements:

a)	Walls for Liquid Retaining Structures	:	250 mm
b)	Foundations for Walls of Liquid Retaining Structures	:	300 mm
c)	Roof slabs for Liquid Retaining Structures (Other than flat slabs)	:	150 mm
d)	Bottom slabs for Liquid Retaining Structures	:	250 mm

	(Other than wall foundations)		
e)	Floor slabs, Roof slabs, Walkways & Canopy slabs, etc.	:	125 mm
f)	Walls of cables / Pipe trenches, Underground pits, etc.	:	200 mm
g)	Column Footings	:	300 mm
h)	Parapets, Chajja and all fascia's	:	100 mm
i)	Precast trench cover	:	75 mm
j)	Column Dimensions		
	a) To match with Block Masonry wall width	:	200mm
	b) To match with Brick Masonry wall width	:	230mm
	c) In general case	:	300 mm
k)	Beam Dimensions		
	a) To match with Block masonry wall width	:	200mm
	b) To match with Brick masonry wall width	:	230mm
	c) In general case	:	300 mm
l)	Launder Base Slab	:	200 mm
m)	Launder Vertical Wall, Baffle Wall, Gutter Slab, etc.	:	175 mm
n)	Grade Slabs	:	150 mm

2.1.7 Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints will be designed to suit the structure. However, contraction joints will be provided at specified locations spaced not more than 7.5 m in both right-angle directions for walls and rafts.

Expansion joints of suitable gap at suitable intervals not more than 30 m will be provided in walls, floors and roof slabs of liquid retaining structures.

Construction joints will be provided at right angles to the general direction of the member. The locations of construction joints will be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints will be provided at every 2 m height. PVC water stops of 150 mm width will be used for walls and 230 mm width for base slabs.

2.1.8 Buildings and Structures

All the Building and Structure works will generally comply with the following requirements unless otherwise specified elsewhere.

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(i) All Building structures will be of RC structural framing system with structural Concrete Grade of M25 (minimum).

(ii) All external walls will be in Solid Cement Concrete blocks of concrete grade M15 and will be provided as per IS: 2185 (Latest Revision) and will be 200 mm thick.

(iii) All Internal partition walls will be in solid cement concrete blocks of concrete grade M15 and will be provided as per IS: 2185 (Latest Revision). All internal walls will be 200mm thick except for toilets. Toilet partition walls will be in 100 mm thick solid concrete block.

(iv) Finishes to concrete liquid retaining structures will be,

F1 - External surfaces, buried

F2 - External surfaces exposed and up to 300 mm below ground level

F2 - Internal surfaces

Finishes to other concrete structures will be:

F1 - Buried

F1 - Exposed, where plastering is specified

F2 - Exposed

(v) All Internal masonry, concrete and ceiling surfaces finish shall have 12 mm thick plain faced cement plaster in cement mortar (1:4) with neat cement finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.

(vi) All External masonry and concrete with rough board finish shall have 20 mm thick sand faced cement plaster in two coats, base coat 12 mm thick in cement mortar 1:4 and finishing coat 8 mm thick in cement mortar 1:4. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.

(vii) All External surfaces above ground level will have one coat of primer and two coats of waterproof cement-based paint of approved quality and shade. A coat of silicone water repellent paint will also be applied thereon.

(viii) Toilet areas, walls and ceilings, will have one coat of primer and two coats of plastic emulsion paint.

(ix) Toilet floor slab will be filled with Brick Bat Coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.

(x) The Finished floor level in toilet areas will be 25 mm below general finished floor level elsewhere in the building.

(xi) The Flooring in the Office rooms, Control rooms, Security cabin areas except Toilets, Staircases will be in Granite flooring of approved make.

(xii) The Flooring in the Chlorination Building and Loading/Unloading Bays shall be 60mm thick cement flooring with Metallic concrete hardener topping, under layer of 40mm thick cement concrete 1:1:2

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granolithic (1 cement : 1 coarse : 2 graded stone aggregate 16mm thick nominal size) and top layer of 20mm thick metallic concrete hardener consisting of mix 1:2 (1 cement : 2 stone aggregate 6mm nominal size) by volume & mixed with metallic hardening compound of approved quality @ 3 kg/m2. Including cement slurry and rounding off edges.

(xiii) Toilet areas shall have Ceramic tiles flooring of approved make, shade and size, placed in cement mortar 1:3 laid on 12mm thick bed. 2100 mm high Glazed tiles dado of approved make, shade, size and pattern, placed in cement mortar 1:3 shall also be provided in these areas.

(xiv) All staircases will have 25 mm thick chequered Concrete tiles for treads and 25 mm thick plain concrete tiles for risers of approved make and shade and half tile skirting set in cement mortar in 1:4 to give an overall thickness of 50 mm. All concrete stairs will have aluminium nosing over 2 mm thick rubber strip of width same as nosing for the full length of the tread. Nosing will be fixed with countersunk screws.

(xv) Stairways shall be provided to permit access between different levels within buildings. Staircase will be minimum 1200mm wide, width of Landing = 1200 mm, minimum Tread = 300 mm, maximum Riser = 150 mm and maximum 15 number of steps per flight unless specified otherwise. Staircases in general will not be steeper than 40°. The maximum vertical run for a single flight of stairs will be 2.5 m.

(xvi) Main Entrance Steps/Ramps shall be provided to access the Building/Sheds for pedestrians/ Vehicular Equipment entry. Minimum 1000mm wide platform shall be provided between Entrance Doors and Steps/Ramps. Steps shall be Minimum width of Tread = 300mm & Maximum Rise = 150 mm. Ramps will be provided with maximum slope of 1 in 10 unless specified otherwise.

(xvii) All Roofs tops will be made accessible with ladder provision. Vertical step ladders fitted with landing point extensions will be permitted to access areas not frequently visited.

(xviii) Steel staircases will be constructed of standard channel stringers with MS Grating treads 25mm thick with non-skid nosing. Steel Ladders shall be minimum 600mm wide and will not exceed 6m of straight run. The ladders will be painted with epoxy paint.

(xix) All hand Railing will be provided with stainless steel staircase railing with handrail 50mm dia. 16 gauge hollow pipe welded to vertical hollow 50mm dia. pipe of 16 gauge stainless steel vertical pipe spaced at 1.20m regular intervals and 5 Nos. of 25 mm dia. stainless steel horizontal hollow pipe. The entire assembly is fixed to staircase concrete by using expansion bolts by drilling concrete. The minimum height of hand railing will be 1m

(xx) The Reinforced Concrete roofs will be made waterproof by application of an approved Roof Polythene / Bitumen Membrane / Felt as per specifications. The finished roof surface shall have adequate slope of 1 in 150 to drain quickly the rainwater to R.W down take inlet points.

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(xxi) All Roof floors will have minimum 750 mm height solid concrete block parapet wall where accessible is provided and will have minimum 300 mm height solid concrete block parapet wall where accessible is not provided.

(xxii) For roofing drainage, cast iron or uPVC rainwater down takes with CI bell mouth or uPVC bend and CI or uPVC grating at top will be provided. For roof areas up to 40 sq. m minimum two nos. 100 mm diameter down take pipes will be provided. For every additional area of 40 sq. m or part thereof, at least one no. 100 mm dia. down take pipe will be provided.

(xxiii) Top surfaces of Chajjas and canopies will be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rainwater.

(xxiv) Building plinth will be minimum 450 mm above average finished ground level around building or high flood level whichever is more.

(xxv) All Doors, Windows, Ventilators and Rolling shutters will have lintels above. Chajja projection to lintels on external walls shall be such as to prevent the rainwater splashing into the building. Chajja projection of minimum 750 mm for Rolling shutters, Collapsible doors & Wide double doors and 600 mm for Doors, Windows & Ventilators shall be provided. Chajja shall be projected 150 mm on either sides from size of Doors/Windows/Ventilators/Rolling shutters/ Collapsible Doors/ Wide double doors.

(xxvi) All Windows and Ventilators will have 25 mm thick Kota stone sills bedded in cement mortar (1:3).

(xxvii) All Wooden/Steel material type joinery components such as Doors, Windows, Ventilators, Rolling Shutters, Collapsible gates and Grill works, etc., shall be painted with two coats of synthetic enamel paint over a priming coat (ready mixed Zinc Chromate Yellow primer of approved brand and manufacturer confirming to IS: 127-106, 341 and 340).

(xxviii) All Aluminium Doors, Windows and Ventilators will confirm to latest version of IS: 1948. All fixtures for doors, windows and ventilators will also be of aluminium. Aluminium grills shall be provided in all the windows. Doors will be in two panel and both panels shall be glazed/unglazed.

(xxix) The Doors/Windows/Ventilator will be fire proof material for MCC, DG and other Electrical Rooms/ Buildings.

(xxx) Openings of the windows & ventilators will be minimum 25% of the external wall area.

(xxxi) Ventilator will be provided where height of floor is more than 3m.

(xxxii) All Windows and Ventilators shall have Aluminium wire mesh. Frame of Doors, Windows and Ventilators will be of aluminium of standard rolled section. The minimum size will be as per below:

Door of opening size 1.2m x 2.1m

Door of opening size 0.75m x 2.1m for toilets

Glazed windows of minimum size 1.2m x 1.2m

Ventilators of minimum size 0.6m x 0.6m

(xxxiii) Rolling shutters shall be made of MS laths. Rolling shutter will be of minimum size 3.0m wide x 3.0m high. Rolling shutters will be provided in MCC cum panel room, chlorine tonner shed, at entry and exit of the pump house for access to pumps, motors, valves, panels and wherever required.

(xxxiv) All the walkways will have minimum 1 m width and will be covered with mosaic tiles.

(xxxv) For structures containing water or process liquid, the top of the wall will be at least 0.5m higher than the maximum water surface level calculated at high flood level and peak plant flow. The top level of internal plant roads and approaches will be at least 0.5m above the site High Flood Level.

(xxxvi) If the High flood level is more than Ground Level, then the road will be constructed on the Earthen Embankments/Engineered Embankment. Earthen Embankments/ Engineered Embankment will be constructed with side slope of at least 2 horizontals to 1 vertical. Stone pitching will be provided at both sides of the embankment as per IS: 8237. Top width of embankment will be taken as 6.0m. Top level of embankment will be 0.5m above high flood level. Good quality of filling materials can be used for embankment construction as approved by Engineer and will be as per standard practices.

(xxxvii) If any Engineered Embankments and all other associated works connected to this system (Such as, all controlled filling requirements, Type & suitability of materials, Methodologies, Testing, Protective systems, Aprons, Proper slopes, Stability, Specifications, Quality control, and all other requirements pertaining to this system of works, etc.,) will be considered. Also, to enlist the services of an experienced & specialized agency for all related design aspects considerations, equipment specifications, and implementation methodology, etc., as an advice for the same.

2.1.9 Roadways, Pathways & Hard Standings

A comprehensive network of roadways will be provided around the GLRs other layouts to link in with the existing road network and permit access to the plant for necessary maintenance, delivery of consumables and personnel access. All roads will be of wet mix macadam having minimum width of 5.0 meters. Vehicular access will be provided for all Plant structures and buildings. All roads will be provided with drainage on either side of road and will be constructed to prevent standing water.

Paved pedestrian access ways will be constructed to provide a network of logical routes interlinking plant areas.

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Hard standing areas with shading facility shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading. The Road system will be designed such that vehicles involved in the delivery of consumables can follow a continuous route through the works and out again.

2.1.10 Site Drainage

The Site drainage systems shall comprise with the Storm Water Drainage and Sewage Drainage (Sewer System).

2.1.10.1 Storm Water Drainage

Storm water drains adjacent to the roads shall be sized for a rainfall intensity of 50 mm/hr, allowing for 100% runoff. Drains adjacent to roads will be in stone masonry in CM (1:4) of appropriate thickness, topped with 75 mm thick M10 concrete and internally flush pointed in cement mortar (1:4), 20 mm thick. The minimum width of drain shall be 450mm.

The storm water drainage system will also be designed to cater the run-off from the existing plot areas and structures, if necessary, depending upon the site topography.

2.1.10.2 Sewage Drainage (Sewer System)

The foul drainage system will accept discharge from toilets, washrooms, offices and the laboratory. The foul drainage system will be conveyed to proposed nearest public sewer wherever exist.

2.1.11 Cable and Pipe Work Trenches

Cable and pipework trenches will generally be constructed in reinforced concrete. All floor cut-outs and cable ducts, etc. will be covered with M25 precast concrete covers (Heavy Duty) or MS grating as per direction of Engineer in outdoor areas and M.S. chequered plates, suitably painted of adequate thickness in indoor areas. All uncovered openings will be protected with hand railing. The pipe, cable trenches will be suitably sloped to drain off rainwater to a suitable location.

Layout of trenches outside the buildings will allow space for construction of future trenches where necessary with due consideration for planning for future developments. This aspect shall be brought to the notice of the Engineer while planning the works.

2.1.12 Pipes and Ducts

RCC Ducts for Drainage will have minimum 1-meter diameter pre-cast cover (M20 concrete, Heavy duty) where laid under roads. Access shafts of size not less than 600 mm x 1000 mm will be provided.
All Drains (except storm water drains adjacent to roads) will be covered and designed structurally for appropriate loads.

2.1.13 Boundary walls

Compound wall shall consist of RC precast slab panels (M25), RC post at regular intervals including plinth beam as supports for the panels and necessary RC foundation system for the same along with barbed wire stretched between MS angles fixing at the top of the precast panels with necessary fixtures. All Structural designs and Specifications will confirm to relevant codal provisions.

2.2 Design and Detailing Standards

All Designs will be based on the latest Indian Standard Specifications or Codes of Practice. The design standards adopted will follow the best modern engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the Engineer

All Reinforced Concrete Structural Design will generally conform to the following publications of the Indian Standards Institution:

IS:875 1987/2015	-	Code of practice for Design loads (other than earthquake) for building structures (Parts 1 to 5).
IS:456 2000	-	Code of practice for plain and reinforced concrete.
IS:3370 2009	-	Code of practice for Concrete Structures for the Storage of Liquids (Parts 1 to 4).
IS:1893 2016	-	Criteria for Earthquake Resistant Design of Structures (Part 1)
IS:1893 2014		Criteria for Earthquake Resistant Design of Structures (Part 2)
IS:2974 1982	-	Code of Practice for Design and Construction of Machine Foundations (Parts 1 to 4).
IS:1904 2005	-	Code of Practice for Design and Construction of Foundation in Soils: General
IS:2185 2005		Requirements. Code of practice for Concrete masonry units (Parts 1 to 4).
IS:4995 1974	-	Criteria for Design of Reinforced Concrete Bins for Storage Structures. (Part

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I & II)

IS:2911 2010	-	Code of Practice for Design and Construction of Pile Foundations.
IS:3414 2005	-	Code of practice for Design and Installation of Joints in Buildings.
IS:4326 1993	-	Code of practice for earthquake resistant design and construction of buildings
IRC:6 2014	-	Standard Specification and code of practice for roads and bridges: Loads and Stresses.
SP:16 1980	-	Design Aids for Reinforced Concrete to IS 456.
SP:34 1987	-	Handbook on Concrete Reinforcement and Detailing.

All Structural Steel Design will generally conform to the following publications of the Indian Standards Institution:

IS: 800	-	Code of Practice for General Construction in Steel.
IS: 806	-	Code of Practice for use of Steel Tubes in General Building Construction.
SP:38	-	Handbook of Typified Design of Structures with Steel Roof Trusses.

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CHAPTER 3

MECHANICAL AND INSTRUMENTATION SYSTEM

3.1 Valves

Resilient seated Butterfly valve with extended spindle arrangement for ease access from finished ground level (Size: 1000 mm Dia, MOC: Ductile Iron, PR: PN1.6) with Metallic Expansion Bellows of same size (MOC: AISI 304, PR: PN1.6) for dismantling purpose along with Bypass valve (Size:100 mm Dia, Type: Resilient seated Sluice valve, MOC: Ductile Iron, PR: PN1.6) arrangement to be used in GLR, Totally Seven Butterfly valve are required for GLR out of which one manually operated Butterfly valve 1000 mm Dia. will be installed at upstream of Flow meter and two nos. of motorised Butterfly valve of 1000 mm Dia. will be installed at inlet of GLR. Two nos. of motorised Butterfly valve of 1000 mm Dia. will be installed at two outlet pipes and one manually operated Butterfly valve 1000 mm Dia. and 600 mm Dia. distribution header of GLR. All valves will be located within the GLR campus.

All BFVs would be motor operated with manual override facility. Local valve position indicators and open / closed limit switches for control panel indication shall be provided for all valves.

GLR will be constructed as two compartment system for better maintenance for the same, each compartment of GLR shall be provided with manually operated drain valve (Size: 300 mm dia, Type: Resilient seated Sluice valve, MOC: Ductile Iron, PR: PN1.6) at the Bed level of GLR for complete draining during maintenance.

3.2 Miscellaneous Equipment's

Two nos. of Domestic water pump set 2.0 HP with all HDPE pipe work, valves, and fittings with 1000 Litres. and necessary Electrical Starter Panel shall be provided for local application within the GLR campus.

3.3 Instrumentation

The ICP (Instrumentation Control Panel) system proposed at GLR location monitors the level of the reservoir & also the flow at the inlet and outlet of the GLR. The instruments for Measuring the flow, Pressure & level are part of the scheme. The level measurement would be done using an ultrasonic level transmitter (0-10 m) range and the flow measurement is proposed using an Electromagnetic Flow meter at inlet and outlet of the reservoir and the pressure measurement by using pressure gauge at the Inlet. The panel will display the level reading on a Digital panel meter and the flow reading on an FIT and field mounted Pressure gauge. The ICP also monitors the open/close status of the butterfly valves of the Inlet/outlet pipe. GSM/GPRS Modules at GLR Location to transmit the signal to Central SCADA System.

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CHAPTER 4

ELECTRICAL SYSTEM

4.1 Background

This section provides brief description of the power supply arrangement and electrical works for the proposed 48ML GLR at Kadugodi. At GLR campus major electrical loads are motorized valves, indoor and outdoor lighting.

4.2 Power Supply Arrangement:

Power supply for the proposed GLR campus shall be derived at 415V from the nearest overhead line (Incomer-1). Provision for connecting second incomer (Incomer-2) shall also be provided for the GLR campus with 1 No. of 100A manual Change over switch (CoS). Under normal conditions power supply to the GLR campus shall be made available from the Changeover switch with switch connected to incomer-1. In case of power not available from incomer-1, provision for receiving the power shall be made available through incomer-2 using the manual change over switch from alternative source.

All works upto the metering shall be done by BESCOM. The contractor scope starts from the outgoing side of metering and include all the works as mentioned below & single line diagram.

The Contractor's scope also includes liasoning with BESCOM for getting construction power supply, making new power supply arrangement for the plant and getting final clearance from CEIG for complete Electrical system.

Contractor shall take responsibility and coordinate with concerned authorities for carrying out the above works. However necessary assistance wherever required shall be provided by the employer in executing these works.

4.3 General Design Criteria

(i) The Ambient temperature for the equipment design shall be considered as 45 ^{0}C.

(ii) The design parameters considered for electrical system are as per the below table.

Sr. No.	Parameter	415 V System	AC Control, Lighting and Space Heating
1	Nominal voltage	415 V	240 V
2	Number of phases	3	1

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3	Frequency	50 Hz	50 Hz
4	Connection	4 Wire	2 wire (Phase & Neutral)

(iii)Voltage and frequency variations shall be as follows at all distribution voltage levels:

Voltage: ± 10%;

Frequency : ± 5%;

Combined voltage and frequency variation: +10%.

4.4 System Protection

415 V Incomer Feeders

- Over load, Earth fault and Short circuit protection;
- Under voltage relay.

Motorized Valves

Motor Protection Circuit Breaker with Overload protection + Short circuit protection + Single phasing preventor and Thermal protection.

4.5 Switchgear Instruments

415V Main LT Panel Incomer

- MFM- with the facility to measure A, V, KW, KWh, KVAr, PF, KVARh, Hz and Hormonic (%THD) contents with communication port.

4.6 Pumping Station Equipment & Design Considerations

415V LT Panels

415V LT Panel shall be floor standing with a channel base frame, sheet steel enclosed with IP 54 Degree of Protection, Form – IV enclosure as per IS 8623 complete with MCCB's/MPCBs, Control & Protection. The PMCC shall be rated for a fault current not less than 25KA (rms) for 1 sec.

Indoor Lighting DB:

Indoor lighting DB shall be 4 Way, TPN, min. IP43 Protection as per IS: 13032 and suitable for 12 Nos. Single Pole out goings and for 1 No 4 pole Incomer. The DB shall be rated for a fault current not less than 10KA (rms) for 1 sec.

LV Power Cables

LV power cables shall be 1.1 kV, XLPE insulated, GI steel wire/strip armoured with

Al conductor - for sizes greater than 6 sq.mm
Cu conductor - for sizes up to 6 sq.mm

No. of cores shall be as per requirement.

Control Cables

Control cables shall be 650/1100V, stranded copper conductors and GI armouring. No. of cores shall be as per requirement. Minimum size of core shall be 1.5 Sq.mm.

Cable Rating

All power cables shall be sized for continuous current carrying capacity and permissible voltage drop at an ambient temperature of 45℃. Due consideration shall be taken of cable grouping, method of installation and local variations in ambient conditions. Further, for cables controlled by circuit breakers, due consideration shall be given to the fault level.

LV cables shall be sized for a minimum fault clearance time of 1 second for incoming feeders and 0.5 seconds for outgoing feeders.

For all LT Cables, the total Voltage drop from mail LT panel to motor terminal or equipment terminal shall be limited to 3%.

Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motor controls or the ability of the motor to start and run effectively and in any event shall not exceed 15%.

Cable Installations

Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. These shall be used to route cables along walls, below beams and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made while sizing the cables.

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Cables of different categories shall be installed so as to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The distances in mm that shall be maintained between the different categories of cables are provided in the below table

Separation Distances between different Categories of Cable

Cable Category	HV Power	LV Power	C&I/Protection	Telecom
HV Power	N/A	300	600	600
LV Power	300	N/A	300	300
C&I Protection	600	300	N/A	100
Telecomm	600	300	100	N/A

Cable Numbering

All cables shall be allocated a unique number which will be fixed to each end of the cable using a corrosion resistant label. Cables of different categories will be tagged with the following subscripts and a three digit number.

LV power	P___
Control	C___
Instrumentation	I___
Protection	PR___
Telecommunication	T___

Lighting

All internal and external areas shall be provided with LED lighting. The illumination levels to be achieved shall be as follows:

Area	**Illumination Level (Lux)**
Switchgear/Electrical room	250 Lux
Building entrance	100 Lux
Outdoor	20 Lux

Luminaries for internal & external lighting shall of LED type. The outdoor lighting fittings shall be weatherproof, dustproof and corrosion resistant with IP65 protection class.

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The lighting installations will be designed using a maintenance factor of 0.7 for indoor and 0.6 for outdoor. Outdoor/ street lighting shall be provided with photocell & timer controls, with manual override facilities.

Octagonal poles of minimum 7/8 m shall be used for road lighting.

Wiring:

Lighting in external areas shall be provided using multicore armoured cable.

Lighting in other internal areas shall be provided with 2.5/4 sq.mm PVC insulated 1100V grade, copper conductor single core cable.

Small Power Outlets

Switched single phase three pin 5 A and 15A receptacles will be provided throughout. In offices and control rooms they will be the decorative type and industrial type in all other areas.

Ventilation

Exhaust fans will be provided in switchgear rooms as per requirement & Ceiling fans will be provided in offices, control rooms. The supply to these fitted ceiling fans shall be provided from the local lighting circuit.

Earthing System

a) An earthing system comprising earth electrodes and conductors will be established and shall be designed to give a combined earth resistance value of not greater than 1 ohm. In order to be sure of obtaining suitable final values, soil resistivity will be measured at the various sites during the detail design phase of the work.

b) Materials used for earth electrodes will be designed to suit the ground conditions and could either be plain mild steel or copper coated steel.

c) The maximum temperature allowed for steel welded joints will be taken as 500 ^{0}C with an ambient of 45 ^{0}C. Main equipotential bonding conductors will be galvanized steel.

d) Circuit protective conductors will comprise either the armouring of the supply cable or, for major loads such as main switchboards and large drives the supply cabling plus an additional suitably sized single core copper cable.

Lightning Protection System

a) The need of lightning protection will be established by calculating the overall risk factor as per IS/IEC 62305.

b) Air termination system comprising of rods/mesh or combination of both will be provided and the methods used to determine the positioning of Air termination system will be as per IS/IEC 62305.

c) Air termination system will be connected to the earthing system by down conductors fixed along the outer surface of building. Number & layout of the down conductors will be as per IS/IEC 62305.

d) Each down comer will be terminated to a separate treated test earth electrode which in turn will be connected to station earthing system.

e) Test link will be provided in the run of each down conductor at approximately 1000 mm above ground level.

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