PROJECT REPORT

TECHNICAL ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

Date: November, 2021

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and Development

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Funded by: The Federal Ministry of Economic Cooperation and Development (BMZ)

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C O N T E N T S

INTRODUCTION:

TIDE is implementing a project titled Integrated Water Management in partnership with BORDA, in the two cities of Chikkaballapur and Chintamani in Karnataka. The project aims to provide technical support to municipality in assessing ground water scenario, particularly focusing on borewells. The specific objective is to recommend plan for reviving defunct borewells in Chintamani taluk (city) through suitable ground recharge technique(s). To achieve the objective, M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS – GESTS had been selected to provide the technical service with the assignment title **"Providing technical assessment of groundwater scenario at Chintamani City, Karnataka leading to plan for revival of defunct borewells with suitable recharge technology options"** for both functioning and defunct borewells and to plan suitable technological options.

This taluk is located between north latitude 13^0 16 15" and 13^0 40' 32.5" & east longitude 77^0 57' 26" and 78^0 12' 27". It is is bounded by Bagepalli taluk on north, Kolar taluk of Kolar district on south, Srinivasapura taluk of Kolar district on east and Sidlaghatta taluk on western side.

To carry out the assignment the detailed scope of the work is defined as follows:

Stage I: Assessment of ground scenario to implement bore well recharge

a) Assessment of the groundwater scenario including borewell camera inspections and bore well performances in general in the city, highlighting areas of concern, any O&M measures required

b) Assessment of the project area to assess the type of catchment areas, drainage/stream conditions viz., fan or fern type for the estimate of runoff flow based on the available rainfall data

c) Assessment of the present water retention structures viz., type of storage structures, ponds and tanks, diversion streams, etc

d) Identification and sample selection of the bore wells/ tube wells or the intensive pilot study based on the Geography, Geological, Hydrological, Hydro-geological, Type of Catchment Conditions – Paved and Nonpaved areas, Catchment Inflow &quality, Outflow Conditions, Water Demand – for different usages, etc.,

e) Carrying out the Geological and Hydrological Interpretation of the areas in order to know the surface and sub –surface profiles

f) Based on the available rainfall data & type of catchment, define the runoff flow statistics, its characteristics, its quantities for the planning of regional regression recharge (RRR) measures

Stage II: Preparation for implementation of identified technique for bore well recharge (numbers can be decided later)

g) Planning and Preparation of design of the recharge structures for the RRR of selected bore wells and tube Wells considering its catchment and sub catchment characteristics

h) Development of implementation plan for RRR selected bore wells and tube wells

i) Development of the related maps and drawings for the development of spatial data base.

j) Preparation of Detailed Designs, Hydraulic and Structural Components and its details, Conceptual and Good For Construction Drawings, Detailed Specifications and Standards, BoQs, Cost Estimation of planned activities for RRR selected bore wells and tube wells

k) Development of framework to monitor extent of recharge through suggested technology option.– In different seasonal periods

l) Way forward to improve overall performance of the bore wells in the city in relation to groundwater/borewell recharging.

Overall study and implementation activities should attempt for the recharge of the tube wells and bore wells and also in the lines of Zero Liquid discharge concept from the catchment areas. The approach of the study should be in the form of scientific and engineering point of view considering the real time data.

PLANNING & METHODOLOGY OF INVESTIGATION:

Overall field level planning and methodology is made to augment the ground water aquifer with natural conditions by transforming the natural movement of surface (runoff) water by utilizing the suitable Scientific and Civil Engineering Techniques. In addition to the above scope of work, the following important points are also focused.

- ✓ To increase the underground aquifer water levels in a sustainable way with good yield where over exploitation of aquifer is under process
- ✓ Proposal of Conservation, renovation and rehabilitation of the storage structures to hold the excess runoff water for future requirements – As these requirements changes based on the seasonal conditions and developmental aspects.

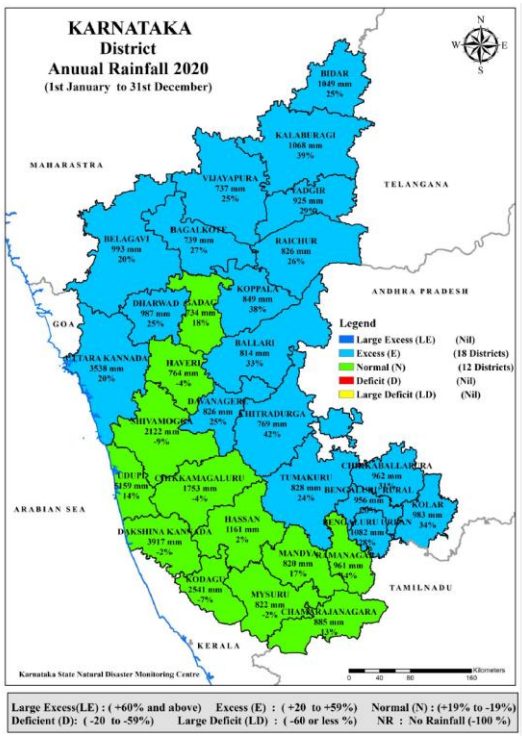
As the recharge projects basically depends on the site specific, Hydrological and Hydrogeological characteristics of the area the scientific and engineering investigation is carried out in a systematically by covering the entire Chintamani Municipal Council (CMC) area and its peripheral boundary. The first step considering in this planning is

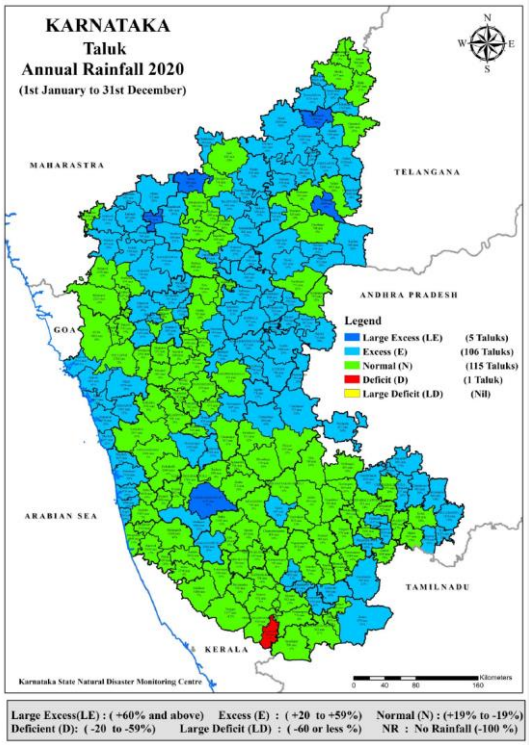
the entire CMC boundary is demarcated i.e., the municipal limits and following factors were considered in selection of the Borewells and Open Wells.

- ✓ The council area where the ground water is over exploiting i.e., running the bore and open well submersible and mono block pumps running continuously for more than 10 hours a day.
- ✓ The council area where the ground water levels are depleted substantially and desaturated i.e., where the borewells are drilled more than 1000 ft.
- ✓ The council area where the ground water is in adequate during the lean periods
- ✓ The council area where the ground water is ingress with the different chemicals like fluoride, nitrate, iron, magnesium etc. In the council area fluoride content is found more in most of the places.

The Methodology adopted in the assessment of the above areas is in the following manner with respect to scientific and engineering analysis.

<u>Hydrometeorological Study</u> – In this, the rainfall pattern, evaporation losses and climatological features of the project area was studied following the secondary data source (KSNDMC). This source has given the detailed information with respect to the climatological features wherein it has helped to plan for the different recharge measures. The Annual rainfall (Year 2020) of the Chikkaballapura district is about 962mm which is considered as excess compare to normal rainfall and the project area (Chintamani Taluk – From 1st January to 31st January 2020) is 992mm which is 26% more than the normal rainfall.





The Mean rainfall* and other statistics of Chintamani Taluk considered in the design analysis are as follows:

S.No	Parameters	Unit	Value	Remarks
1	Mean Rainfall	mm	760.00	
2	Standard Deviation	mm	180.00	
3	Coefficient of Variation	%	24.00	
4	Average Rainy days	No's	46.00	
5	Maximum Rainfall	mm	1145.00	

*Reference –IWM & Rainfall Atlas of Karnataka 2019

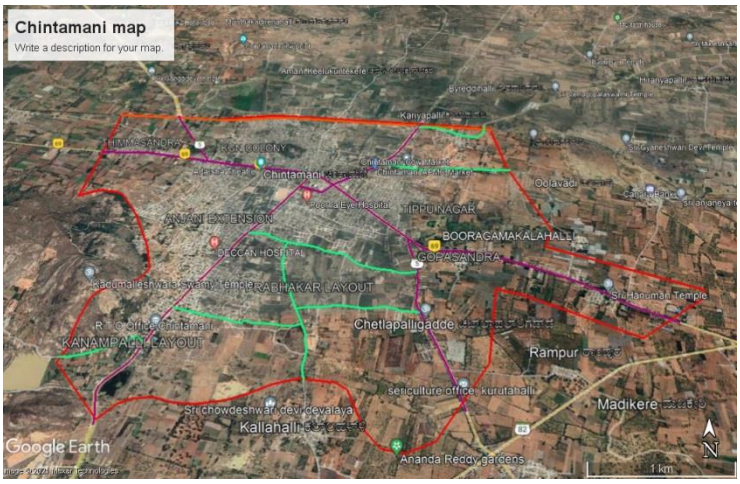
And, the recorded annual potential evaporation is around 1950 mm with May registering over 220 mm and December around 120mm. In most of the farming places and other horticultural lands mulching is commonly practiced for high value crops like tomato, capsicum, cauliflower, cabbage and other vegetables and thus controls and reduces the growth of the weeds and also to prevent the water evaporation from the soil and sub-surface soils.

This is indicating the precise application of water through drip irrigation and thus making the irrigation more efficient than flow method of irrigation because of lack of water sources and in turn reducing the evaporation and runoff from the agricultural fields. As there are few tanks within the CMC area and peripheral area there is also high evaporation rate from the large water bodies and in turn losing the quite an amount of surface water. Therefore, the main factors observed for this Evaporation loss are large water surface areas, Temperature, Vapour pressure difference, Wind effect, Atmospheric pressure and Quality of water.

In some of the household level, Rooftop rain water harvesting was systematically carried out and this in turn reducing the large quantities of runoff water is being harvesting and reducing the percolation and evaporation losses.

Hydrological Study – In this study the availability of source of water for the purpose of recharging the ground water aquifer was carried out. During the field investigation the catchment areas where assessed such that the type of catchment, drainage pattern and its slopping pattern is visualized. The same has been related with the Topographical Sheet (Reference Survey of India - D44M3 – 1:50,000 Scale). The catchment areas of the Bore wells and open wells were assessed such that the maximum runoff water is envisaged to percolate and to sustain the underground aquifer for this continuation of pumping. As there are different types of source of water available for the recharge purpose – for borewell and open wells Insitu precipitation is the one which is found feasible.

Since the project is focused within the Municipal Council Limits, this In-situ precipitation may or may not be adequate to cause artificial recharge but the runoff going unutilized outside the areas planned by transmitting thru simple recharge structures adjacent to the road footpaths, road junctions, road speed beakers and at the low laying areas i.e., at the flooding areas.



On the other hand, this assessment was also carried out for the present water retention structures in order to assess the type of catchment areas, drainage/stream conditions, rate of water enters the stream viz., fan or fern type for the estimate of runoff flow. It is found that most of the catchment areas are in fan shaped and contributing the greater runoff due to the fact that stream/tributaries of smaller sizes.

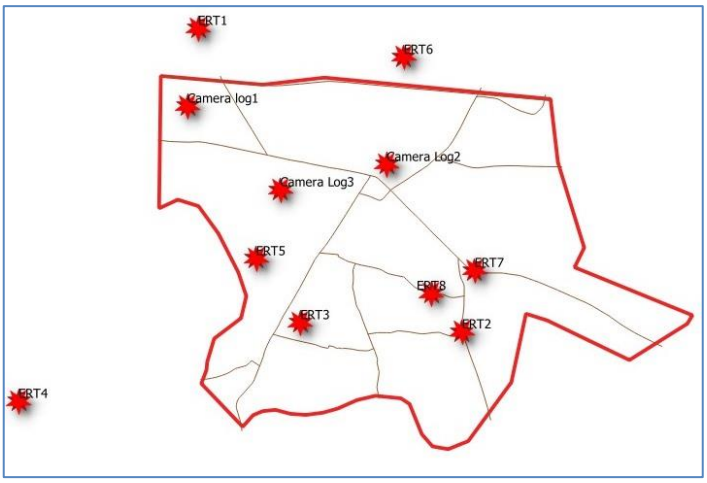
In addition, the assessment was also made considering the following information.

- The recharge structural location based on the available area
- The quantity of water that may be diverted to the proposed structure
- The period of time for which the source of water available
- The quality of source of water and the pretreatment required – if any
- Conveyance system required to bring the water to the recharge site.

In some of the areas, in north-eastern part of the city the percolation and evaporation are observed to be high due to surface water availability and poor drainage system. Overall this Hydrological study was undertaken to harvest the surplus monsoon runoff water which can be harnessed as a source of water for the recharge structures.

Hydrogeological & Geophysical Study – In order to understand the precise hydrogeology of the area, the available secondary data has been verified along with the site investigation thru Geophysical Study (i.e., Electrical Resistivity Test). This investigation was carried out for the selected borewells and open wells within the

project area. This has helped to understand the different geological strata, their geological age sequence, boundaries/contacts of individual formations and the structural expressions like Strike, Dip, Faults, Folds, Flexures, Intrusive bodies etc.



This has also helped us to understand the regional hydrogeological rock units, geomorphic units, lineaments, their ground water potential and general pattern and movement of ground water flow of aquifer. This movement of most of the ground water flow has been observed from the North-West to North-East Side of the city as similar to the Surface Water flow.

Thus the data pertaining to the characteristics of sub-surface lithological formation, unknown sub-surface hydrogeological conditions and the type of recharge mechanism suitable for a particular area is assessed. Hence, attempt was made to gather the following information to plan the recharge measures.

- Stratification of aquifer systems and spatial variability of hydraulic conductivity of different zones.
- Negative or non-productive zones of low hydraulic conductivity in unsaturated and saturated zones
- Vertical hydraulic conductivity discontinuities such as dykes, faults etc
- Moisture movement and infiltration
- Direction of ground water flow under natural/artificial recharge processes

As there are two popular surface electrical methods in Geophysical investigations namely Schlumberger and Werner configurations. The Schlumberger method of Electrical Resistivity Test (ERT) has been used in the present study with the help of a DC resistivity meter.

DC Resistivity Meter Model DDR-3

The DC Resistivity Meter Model DDR-3 of IGIS make is used in the present geophysical investigations. It is having features with high quality data acquisition capability as well as for its field worthiness. The meter consists of two units, a current unit and a potential unit. While the current unit serves the purpose of sending the required output of constant current, the potential unit provides an accurate measurement and display of potential/resistance values directly over a liquid crystal display.

The field measurements for DC resistivity investigations basically involves sending a known strength of current into the ground through the current electrodes and observing the resulting voltage across the potential electrodes, to get the resistance values. The instrument has the facility to provide direct readout of these resistance values on liquid crystal display to the operator. The picture of Resistivity Meter used in the present study is given below.

Methodology of Testing – Resistivity sounding is a process, in which depth investigation is made. In this, the center of the configuration (o) is kept fixed and measurements are made by successively increasing electrode spacing. The apparent resistivity values obtained with increasing values of electrode separations are used to estimate the thickness and resistivity of the subsurface formations. The plot between apparent resistivity and the distance between any two successive electrodes separation is used for analysis of thickness and true resistivity of the subsurface formations.

The resistivity data is to be interpreted (analyzed) in terms of physical parameters viz., resistivity and thickness of the formations and these parameters in-turn, along with hydro-geological information are to be used to infer the nature of subsurface formations. In the present study Inverse Slope method of interpretation is used to interpret the data acquired from the field.

In Geo-electrical methods, current is sent into the ground through a pair of electrodes called current electrodes and resulting potential difference across the ground is measured with the help of another pair of electrodes called potential electrodes. The ratio between the potential difference (ΔV) and the current (I) gives the resistance (R), which depends on the electrode arrangement and on the resistivity of the subsurface formations.

In Schlumberger configuration, all the four electrodes are kept in a line. The outer electrode spacing is kept large, compared to the inner electrode spacing, usually more than 5 times. Field resistance values will be obtained at every change of electrode spacing for calculating apparent resistivity values. The disposition of electrodes for Schlumberger configuration is shown in below picture and the apparent resistivity ρa for a specified configuration is computed with below mentioned formula.

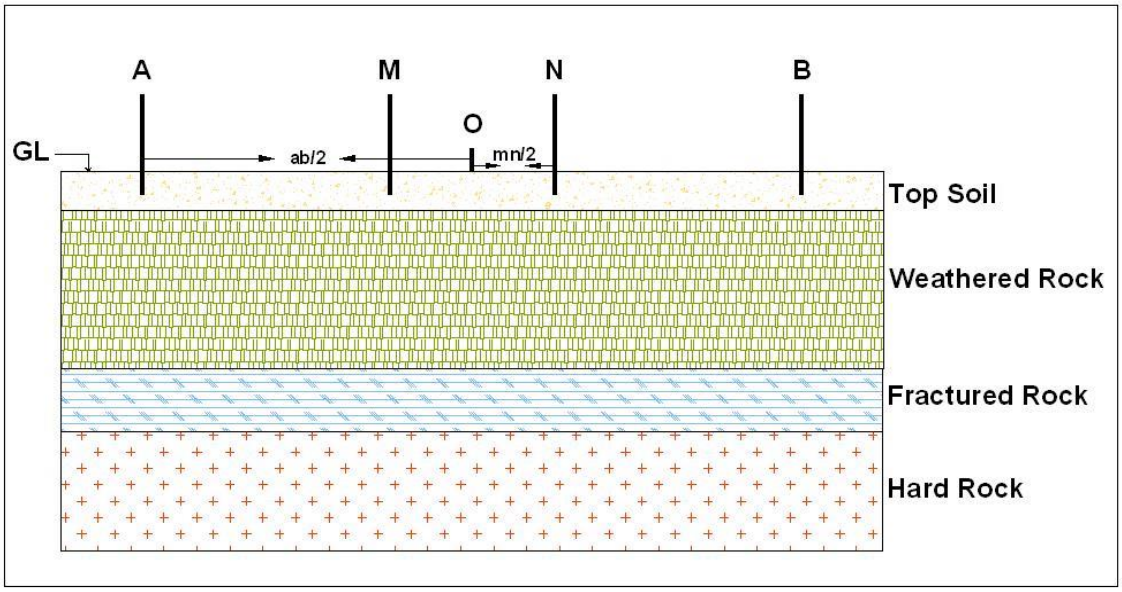
$$\rho_a = \Pi\, k\, R$$

Where ‘k’ is the constant = $[(AB/2)^2 - (MN/2)^2]/MN$

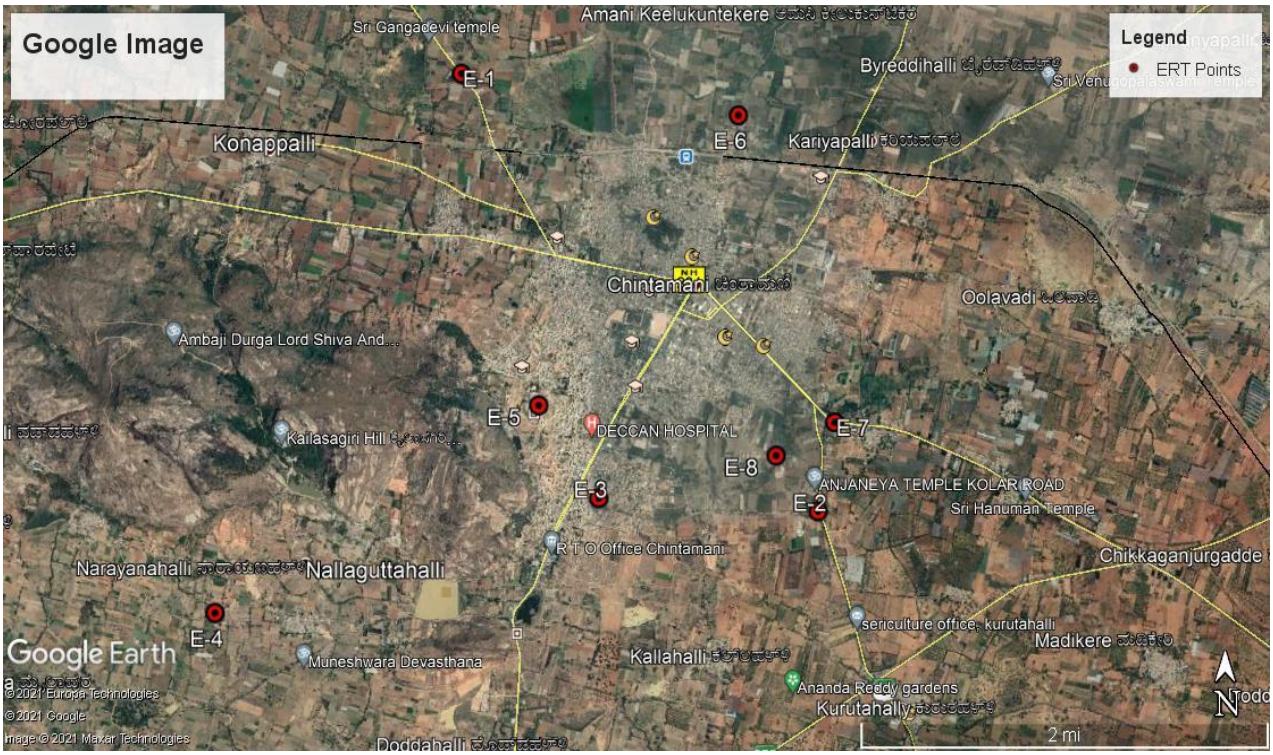
‘AB’ is current electrode spacing and

‘MN’ is potential electrode spacing

$$R = \Delta V / I$$

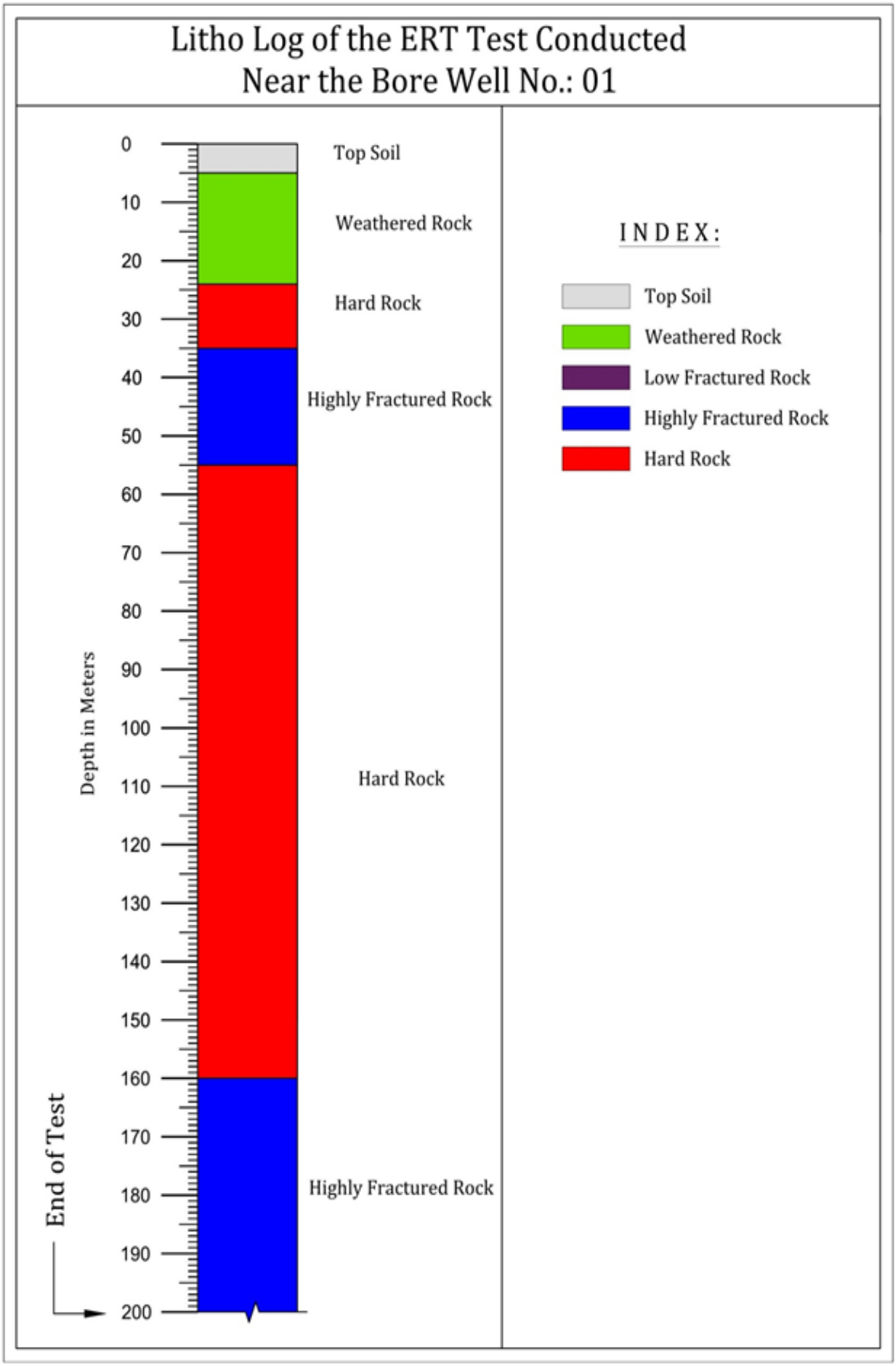


Schlumberger configuration DC Resistivity

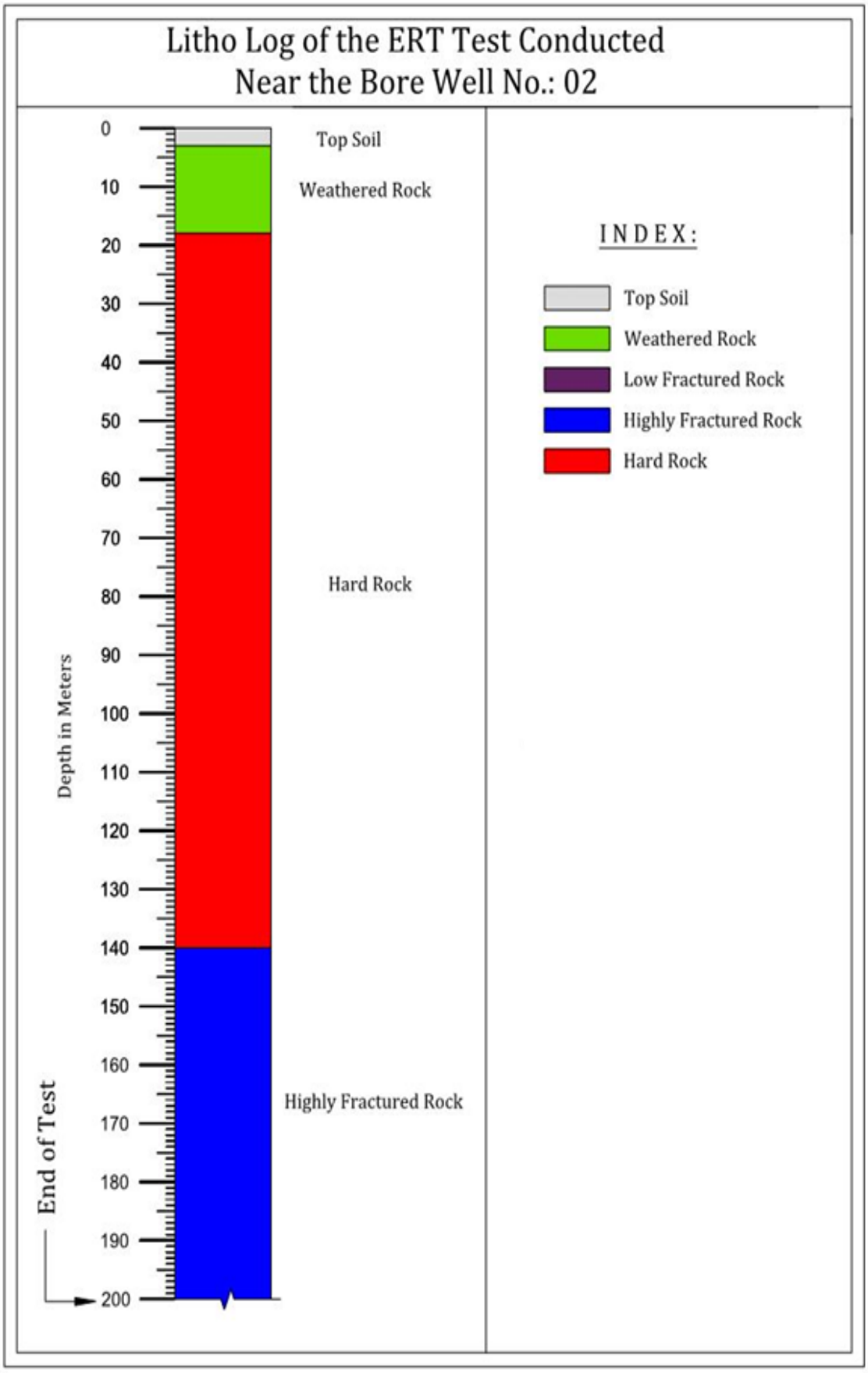


In order to understand the subsurface geological formations including their Thickness, Vertical and Horizontal disposition within the entire Proposed area, total 8 electrical resistivity tests were conducted up to 200 meters depth from the existing ground level. All the ERT field data have been analyzed and interpreted for assessment of existing sub-surface geological units.

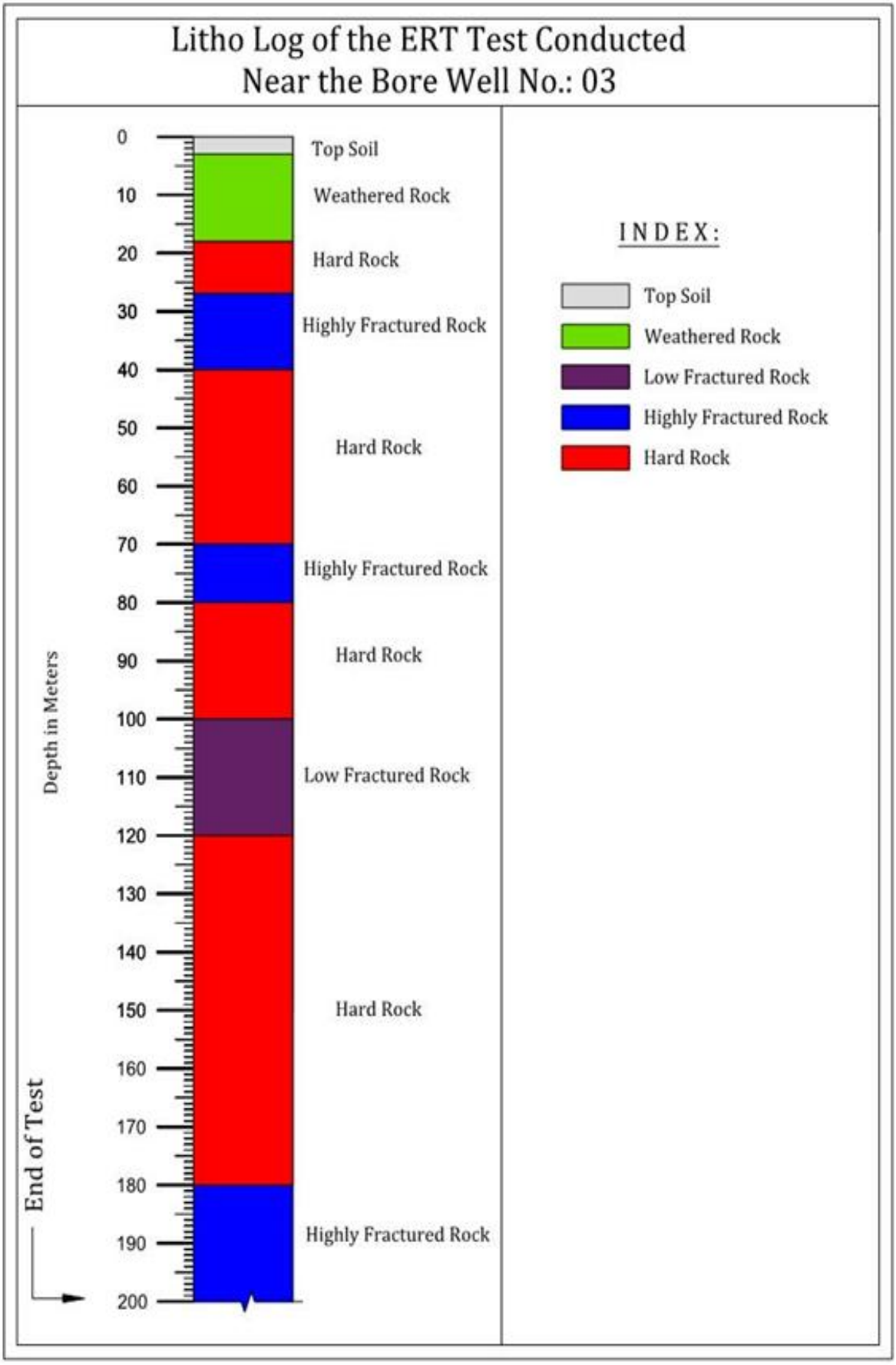
Well No. 01			
1	Well Location		
a	Village	:	Nayanapalli
b	Taluk	:	Chintamani
c	District	:	Chikkaballapura
d	State	:	Karnataka
e	GPS Co-ordinates	:	13°24'59.90"N, 78° 2'16.60"E
2	Total Depth of the Well	:	1280 ft
3	Water Encountered Depth During Drilling	:	1250 ft
4	Depth of Casing	:	90 -110 f
5	Well Utilization	:	Drinking
6	Drill Time Yield	:	2 inch
7	Yield during well pumping	:	2 inch
8	Natural Recharge Conditions	:	
a	Type of recharge structure located near the well (like natural streams/surface tanks etc.)	:	Near Surface Tank
9	Well Location with reference to the surrounding topographical conditions (located in recharge zone/runoff zone)	:	located in recharge zone
10	ERT Information		
a	ERT No.	:	1
b	Total depth of information acquired	:	200 m
c	Number of aquifers present within investigated depth (weathered zone/fractured zone etc.)	:	One Weathered Layer Two Fractured Layers
d	Depth of aquifers layers	:	Weathered Layer depth 5-24m Fractured Layers depth 35-55 & 160-200m
11	Recommendations for well sustainability	:	Recommended to develop a Recharge well up to a depth of 55m from the existing ground level at a distance of about 30m from the Well No 01


Litho Log of the ERT Test Conducted
Near the Bore Well No.: 01
Depth in Meters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Top Soil
Weathered Rock
Hard Rock
Highly Fractured Rock
Hard Rock
Highly Fractured Rock
End of Test
INDEX:
Top Soil
Weathered Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock

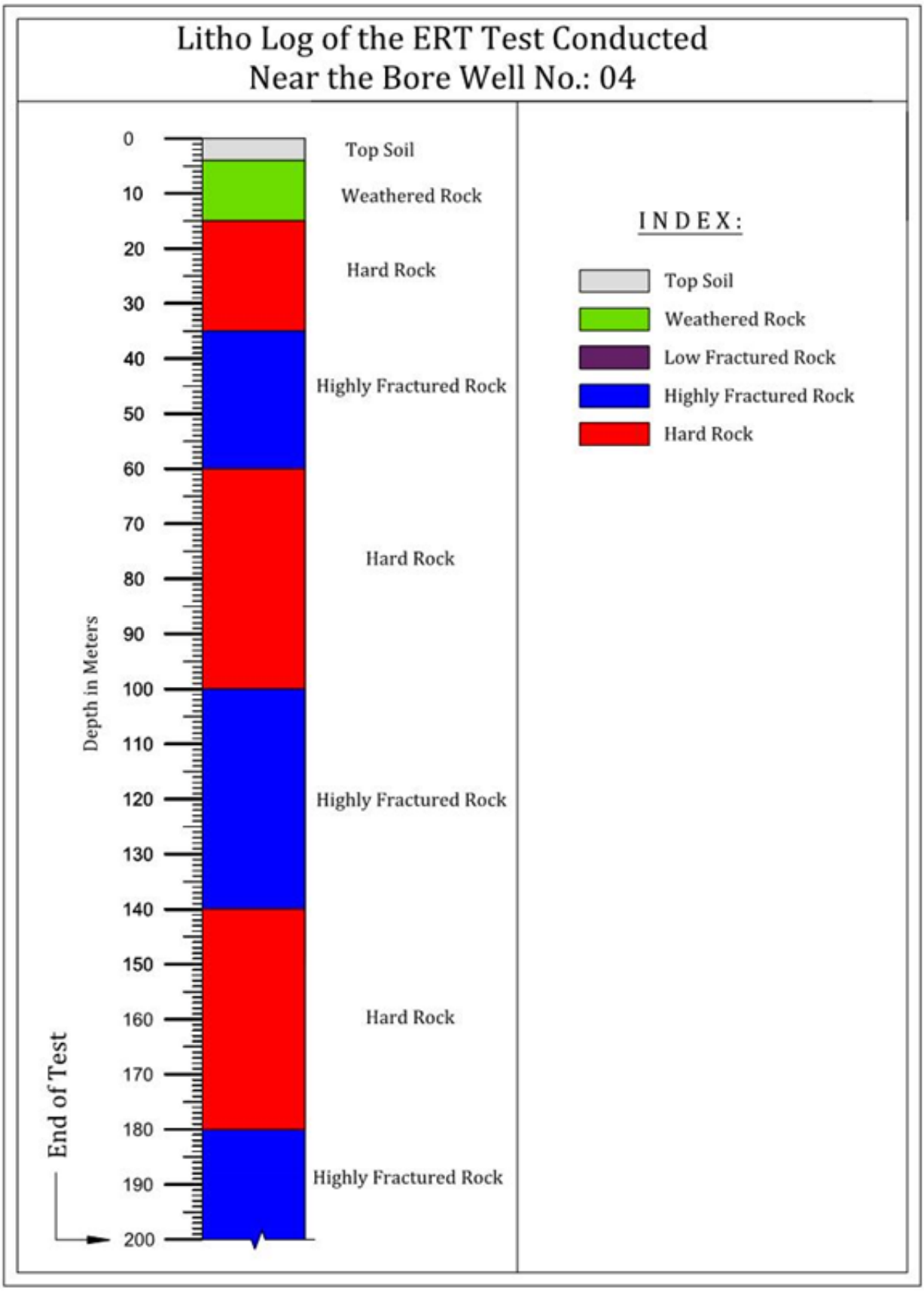
Well No. 02			
1	Well Location		
a	Village	:	Kollar X main Road
b	Taluk	:	Chintamani
c	District	:	Chikkaballapura
d	State	:	Karnataka
e	GPS Co-ordinates	:	13°23'11.60"N, 78° 3'50.80"E
2	Total Depth of the Well	:	1520 f
3	Water Encountered Depth During Drilling	:	1500 f
4	Depth of Casing	:	100 f
5	Well Utilization	:	Drinking
6	Drill Time Yield	:	2 inch
7	Yield during well pumping	:	1 inch
8	Natural Recharge Conditions	:	
a	Type of recharge structure located near the well (like natural streams/surface tanks etc.)	:	-NO-
9	Well Location with reference to the surrounding topographical conditions (located in recharge zone/runoff zone)	:	located in recharge zone
10	ERT Information		
a	ERT No.	:	2
b	Total depth of information acquired	:	200 m
c	Number of aquifers present within investigated depth (weathered zone/fractured zone etc.)	:	One Weathered Layer One Fractured Layers
d	Depth of aquifers layers	:	Weathered Layer depth 3-18m Fractured Layers depth 140-200m
11	Recommendations for well sustainability		Recommended to develop a Recharge well up to a depth of 30m or 150m whichever is feasible from the existing ground level at a distance of about 30m from the Well No 02


Litho Log of the ERT Test Conducted
Near the Bore Well No.: 02
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Depth in Meters
End of Test
Top Soil
Weathered Rock
Hard Rock
Highly Fractured Rock
INDEX:
Top Soil
Weathered Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock

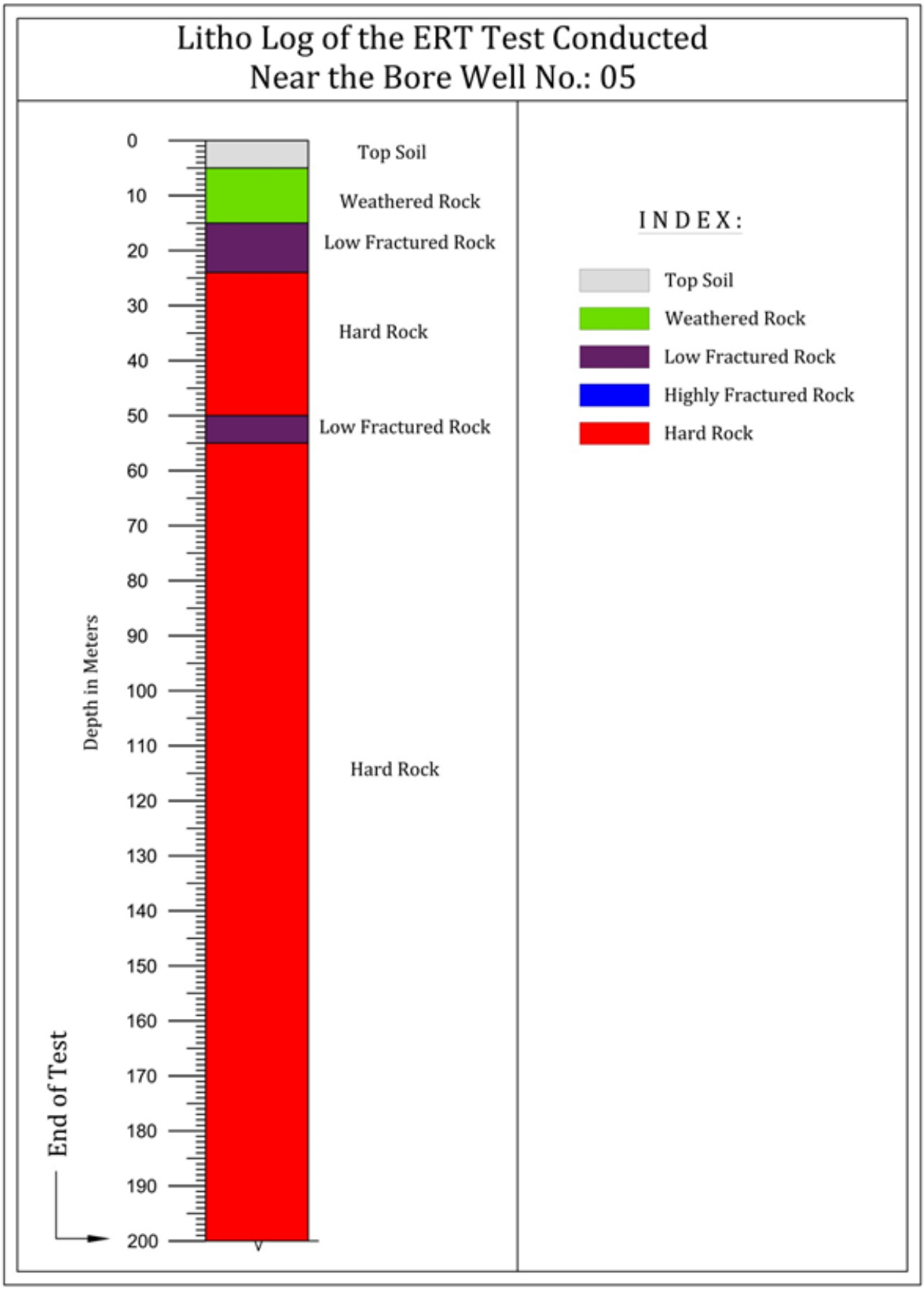
	Well No. 03		
1	Well Location		
a	Village	:	Prabhakar layout
b	Taluk	:	Chintamani
c	District	:	Chikkaballapura
d	State	:	Karnataka
e	GPS Co-ordinates	:	13°23'14.90"N, 78° 2'53.10"E
2	Total Depth of the Well	:	1450 f
3	Water Encountered Depth During Drilling	:	1380 f
4	Depth of Casing	:	80-100f
5	Well Utilization	:	Drinking
6	Drill Time Yield	:	2 inch
7	Yield during well pumping	:	1.5 inch
8	Natural Recharge Conditions	:	
a	Type of recharge structure located near the well (like natural streams/surface tanks etc.)	:	-NO-
9	Well Location with reference to the surrounding topographical conditions (located in recharge zone/runoff zone)	:	located in runoff zone
10	ERT Information		
a	ERT No.	:	3
b	Total depth of information acquired	:	200 m
c	Number of aquifers present within investigated depth (weathered zone/fractured zone etc.)	:	One Weathered Layer Four Fractured Layers
d	Depth of aquifers layers	:	Weathered Layer depth 3-18m Fractured Layers depth 27-40, 70-80, 100-120 & 180-200m
11	Recommendations for well sustainability		Recommended to develop a Recharge well up to a depth of 120m from the existing ground level at a distance of about 30m from the Well No 03


Litho Log of the ERT Test Conducted
Near the Bore Well No.: 03
Depth in Meters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
End of Test
Top Soil
Weathered Rock
Hard Rock
Highly Fractured Rock
Hard Rock
Highly Fractured Rock
Hard Rock
Low Fractured Rock
Hard Rock
Highly Fractured Rock
INDEX:
Top Soil
Weathered Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock

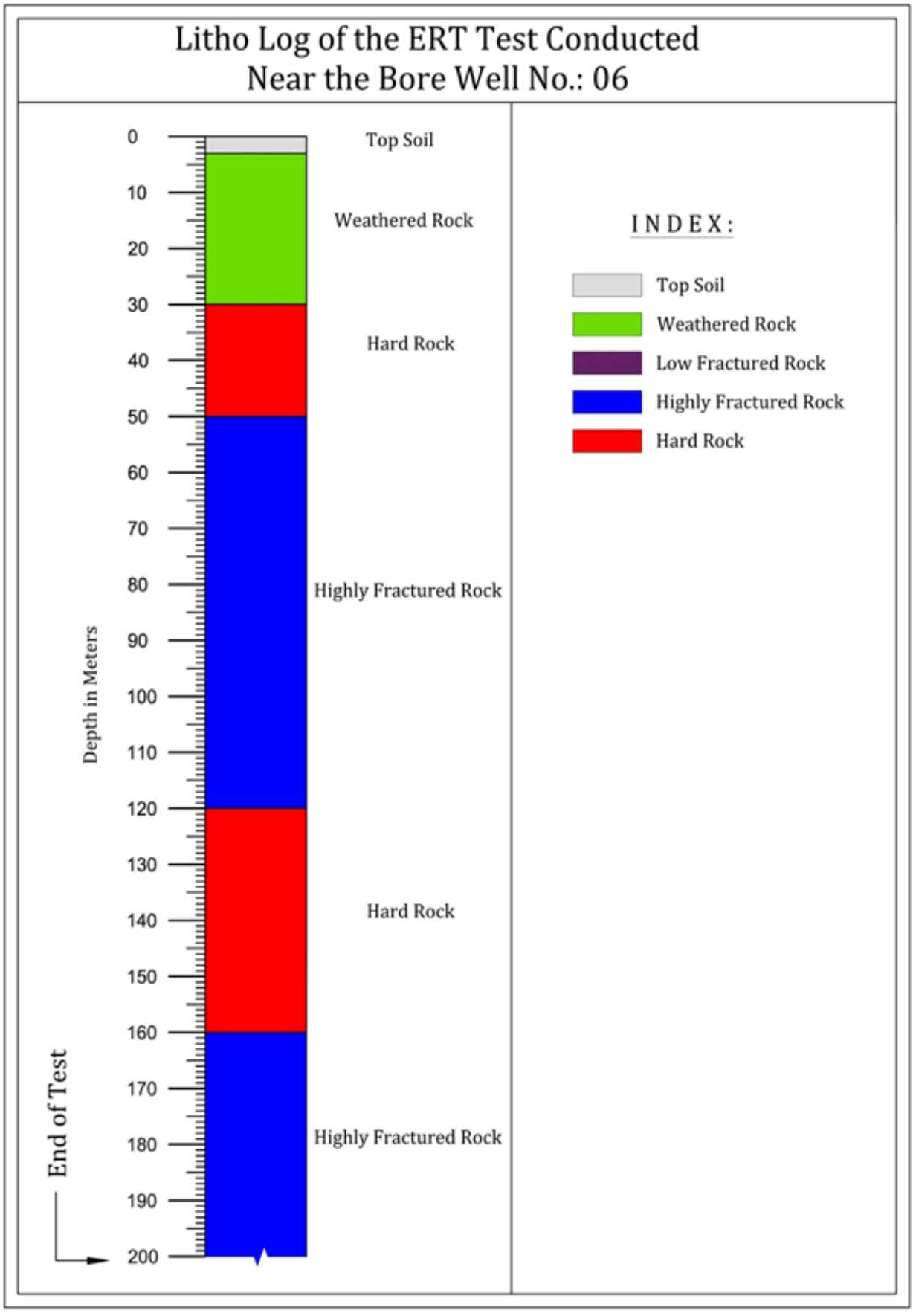
Well No. 04			
1	Well Location		
a	Village	:	Narayan halli
b	Taluk	:	Chintamani
c	District	:	Chikkaballapura
d	State	:	Karnataka
e	GPS Co-ordinates	:	13°22'46.80"N, 78° 1'12.50"E
2	Total Depth of the Well	:	500 f
3	Water Encountered Depth During Drilling	:	450 f
4	Depth of Casing	:	100 f
5	Well Utilization	:	Drinking
6	Drill Time Yield	:	2 inch
7	Yield during well pumping	:	Dry condition
8	Natural Recharge Conditions	:	
a	Type of recharge structure located near the well (like natural streams/surface tanks etc.)	:	-NO-
9	Well Location with reference to the surrounding topographical conditions (located in recharge zone/runoff zone)	:	located in runoff zone
10	ERT Information		
a	ERT No.	:	4
b	Total depth of information acquired	:	200 m
c	Number of aquifers present within investigated depth (weathered zone/fractured zone etc.)	:	One Weathered Layer Three Fractured Layers
d	Depth of aquifers layers	:	Weathered Layer depth 4-15m Fractured Layers depth 35-60, 100-140 &180-200
11	Recommendations for well sustainability		Recommended to develop a Recharge well up to a depth of 140m from the existing ground level at a distance of about 30m from the Well No 04


Litho Log of the ERT Test Conducted
Near the Bore Well No.: 04
Depth in Meters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
End of Test
Top Soil
Weathered Rock
Hard Rock
Highly Fractured Rock
Hard Rock
Highly Fractured Rock
Hard Rock
Highly Fractured Rock
INDEX:
Top Soil
Weathered Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock

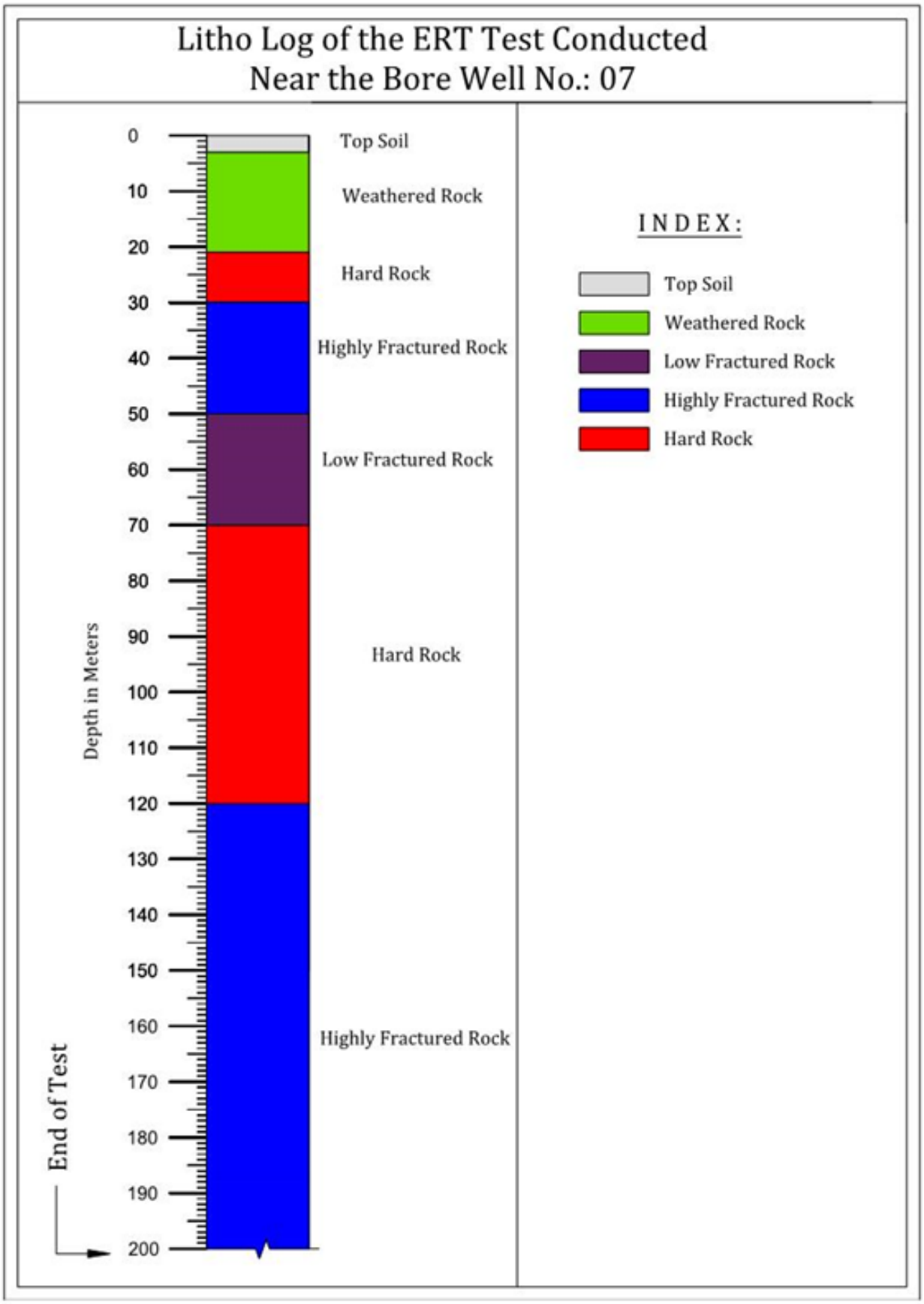
Well No. 05			
1	Well Location		
a	Village	:	Filter bed
b	Taluk	:	Chintamani
c	District	:	Chikkaballapura
d	State	:	Karnataka
e	GPS Co-ordinates	:	13°23'37.70"N, 78° 2'37.30"E
2	Total Depth of the Well	:	1550 f
3	Water Encountered Depth During Drilling	:	1480 f
4	Depth of Casing	:	100 f
5	Well Utilization	:	Drinking
6	Drill Time Yield	:	2 inch
7	Yield during well pumping	:	2 inch
8	Natural Recharge Conditions	:	
a	Type of recharge structure located near the well (like natural streams/surface tanks etc.)	:	-NO-
9	Well Location with reference to the surrounding topographical conditions (located in recharge zone/runoff zone)	:	located in recharge zone
10	ERT Information		
a	ERT No.	:	5
b	Total depth of information acquired	:	200 m
c	Number of aquifers present within investigated depth (weathered zone/fractured zone etc.)	:	One Weathered Layer Two Fractured Layers
d	Depth of aquifers layers	:	Weathered Layer depth 5-15m Fractured Layers depth 15-24 & 50-55m
11	Recommendations for well sustainability		Recommended to develop a Recharge well up to a depth of 55m from the existing ground level at a distance of about 30m from the Well No 05


Litho Log of the ERT Test Conducted
Near the Bore Well No.: 05
Depth in Meters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
End of Test
Top Soil
Weathered Rock
Low Fractured Rock
Hard Rock
Low Fractured Rock
Hard Rock
INDEX:
Top Soil
Weathered Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock

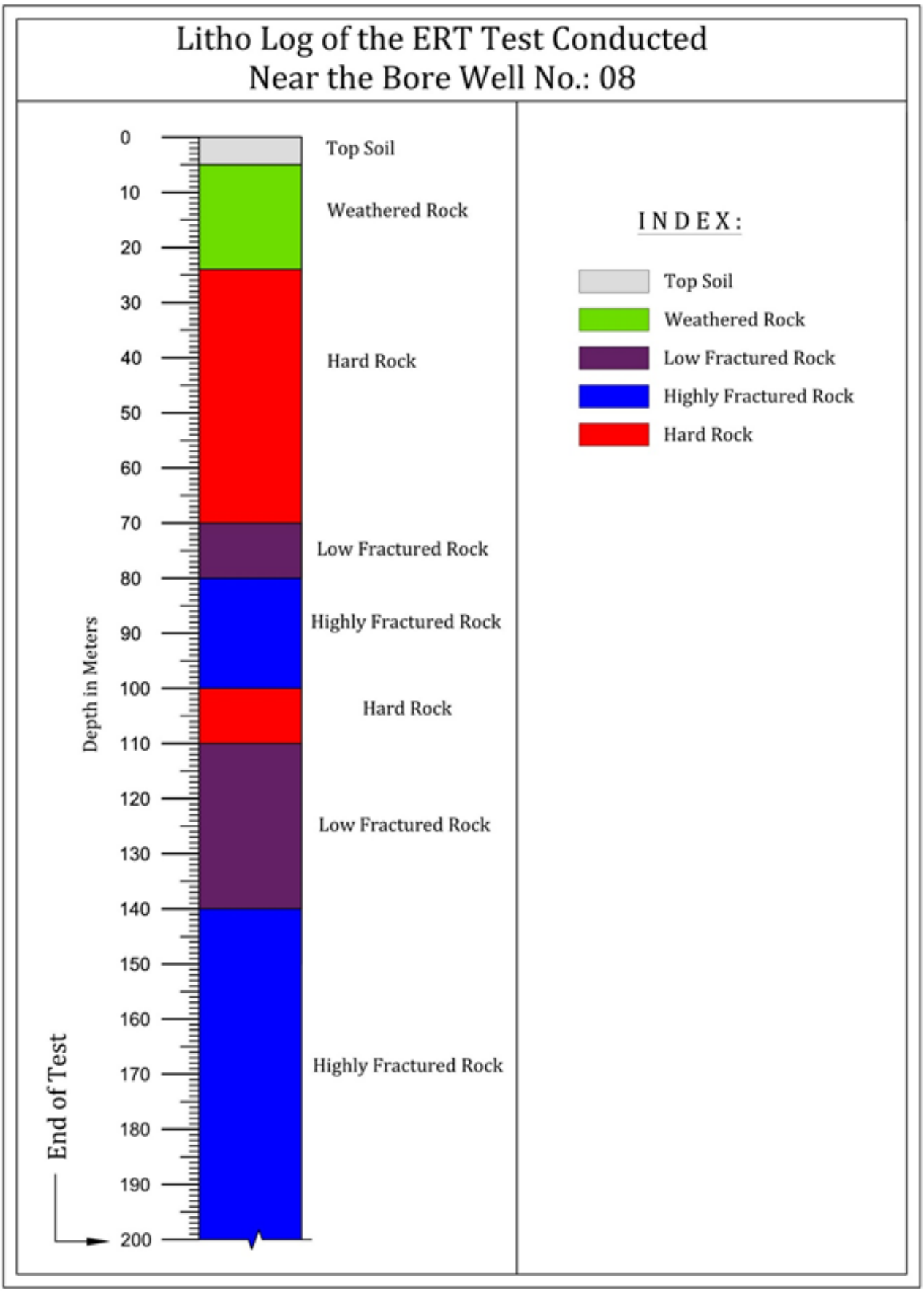
Well No. 06			
1	Well Location		
a	Village	:	Mukralli
b	Taluk	:	Chintamani
c	District	:	Chikkaballapura
d	State	:	Karnataka
e	GPS Co-ordinates	:	13°24'49.60"N, 78° 3'30.00"E
2	Total Depth of the Well	:	1400 f
3	Water Encountered Depth During Drilling	:	1315 f
4	Depth of Casing	:	80-100 f
5	Well Utilization	:	Drinking
6	Drill Time Yield	:	2 inch
7	Yield during well pumping	:	2 inch
8	Natural Recharge Conditions	:	
a	Type of recharge structure located near the well (like natural streams/surface tanks etc.)	:	Near Surface Tank
9	Well Location with reference to the surrounding topographical conditions (located in recharge zone/runoff zone)	:	located in recharge zone
10	ERT Information		
a	ERT No.	:	6
b	Total depth of information acquired	:	200 m
c	Number of aquifers present within investigated depth (weathered zone/fractured zone etc.)	:	One Weathered Layer Two Fractured Layers
d	Depth of aquifers layers	:	Weathered Layer depth 3-30 m Fractured Layers depth 50-120 & 160-200
11	Recommendations for well sustainability		Recommended to develop a Recharge well up to a depth of 120m from the existing ground level at a distance of about 30m from the Well No 06


Litho Log of the ERT Test Conducted
Near the Bore Well No.: 06
Depth in Meters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
End of Test
Top Soil
Weathered Rock
Hard Rock
Highly Fractured Rock
Hard Rock
Highly Fractured Rock
INDEX:
Top Soil
Weathered Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock

Well No. 07			
1	Well Location		
a	Village	:	Kollar X road
b	Taluk	:	Chintamani
c	District	:	Chikkaballapura
d	State	:	Karnataka
e	GPS Co-ordinates	:	13°23'33.50"N, 78° 3'55.30"E
2	Total Depth of the Well	:	1500 f
3	Water Encountered Depth During Drilling	:	1420 f
4	Depth of Casing	:	110 f
5	Well Utilization	:	Drinking
6	Drill Time Yield	:	2 inch
7	Yield during well pumping	:	2 inch
8	Natural Recharge Conditions	:	
a	Type of recharge structure located near the well (like natural streams/surface tanks etc.)	:	Surface Tank
9	Well Location with reference to the surrounding topographical conditions (located in recharge zone/runoff zone)	:	located in recharge zone
10	ERT Information		
a	ERT No.	:	7
b	Total depth of information acquired	:	200 m
c	Number of aquifers present within investigated depth (weathered zone/fractured zone etc.)	:	One Weathered Layer Two Fractured Layers
d	Depth of aquifers layers	:	Weathered Layer depth 3-21 Fractured Layers depth 30-70 & 120-160
11	Recommendations for well sustainability		Recommended to develop a Recharge well up to a depth of 70m from the existing ground level at a distance of about 30m from the Well No 07


Litho Log of the ERT Test Conducted
Near the Bore Well No.: 07
Depth in Meters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
End of Test
Top Soil
Weathered Rock
Hard Rock
Highly Fractured Rock
Low Fractured Rock
Hard Rock
Highly Fractured Rock
INDEX:
Top Soil
Weathered Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock

Well No. 08			
1	Well Location		
a	Village	:	Prabhakar layout
b	Taluk	:	Chintamani
c	District	:	Chikkaballapura
d	State	:	Karnataka
e	GPS Co-ordinates	:	13°23'25.30"N, 78° 3'39.80"E
2	Total Depth of the Well	:	1000 f
3	Water Encountered Depth During Drilling	:	850 f
4	Depth of Casing	:	80 f
5	Well Utilization	:	Drinking
6	Drill Time Yield	:	2 inch
7	Yield during well pumping	:	Dry condition
8	Natural Recharge Conditions	:	
a	Type of recharge structure located near the well (like natural streams/surface tanks etc.)	:	-NO-
9	Well Location with reference to the surrounding topographical conditions (located in recharge zone/runoff zone)	:	located in recharge zone
10	ERT Information		
a	ERT No.	:	8
b	Total depth of information acquired	:	200 m
c	Number of aquifers present within investigated depth (weathered zone/fractured zone etc.)	:	One Weathered Layer Two Fractured Layers
d	Depth of aquifers layers	:	Weathered Layer depth 5-24 Fractured Layers depth 70-100 & 110-200
11	Recommendations for well sustainability		Recommended to develop a Recharge well up to a depth of 100m from the existing ground level at a distance of about 30m from the Well No 08

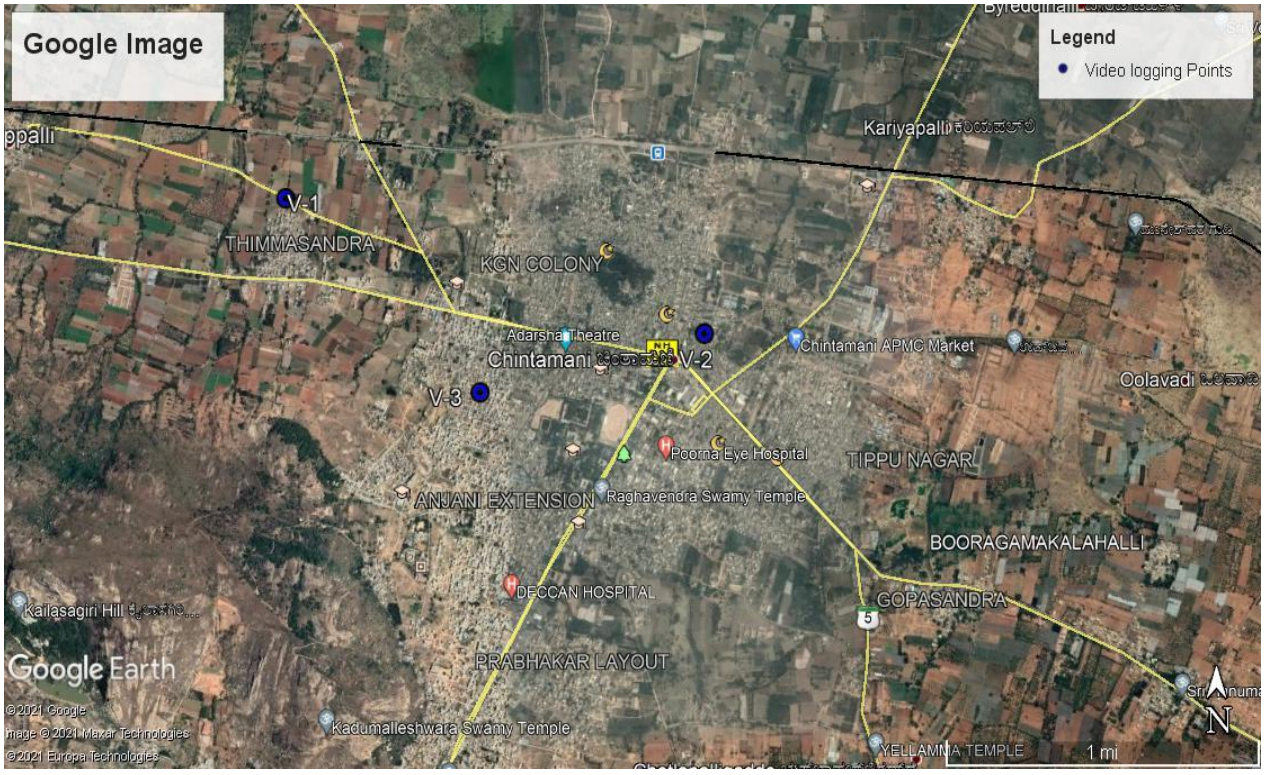

Litho Log of the ERT Test Conducted
Near the Bore Well No.: 08
Depth in Meters
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
End of Test
Top Soil
Weathered Rock
Hard Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock
Low Fractured Rock
Highly Fractured Rock
INDEX:
Top Soil
Weathered Rock
Low Fractured Rock
Highly Fractured Rock
Hard Rock


MYK LATICRETE
MYK LATICRETE
93X2+6Q3, Chintamani, Karnataka 563125, India
Latitude
13° 23' 51.95746" N
Longitude
78° 3' 7.36788" E
Local 12:27:21 PM
GMT 06:57:21 AM
Altitude 801 meters
Thursday, 16-09-2021

On the other hand, Borehole camera mapping was also done in order to understand the existing profile of the geology within the area. This has revealed the following observations.

- Whether the borewell is dry or yield the water source
- If yielding, depth of yielding the water source
- Type of profile, formation with strata
- Depth of casing installed
- Any suspended material
- Study the feasibility for rejuvenation and rehabilitation
- Video & Camera clipping of the profiles

Based on the site conditions, three important borewells video logging had been carried out and the below figure shows the location of the video logging points..



Video Logging

Video Logging -1

Location	:	Chintamani
Co-ordinates	:	13°24'32.15"N, 78° 2'12.81"E
District	:	Chikkballapur
Date	:	17-09-2021
Total depth	:	198m

Video Logging -1	
Depth Range (m)	Observations
0 – 6	Dry Bore well completely closed with casing
6	Struck the cable at 6.10 meters depth
20	Casing slightly damaged at 20.30m depth
32	Casing closed,
32-82	Dry bore well
82-140	Slightly yielding zone at 82m depth, some Suspended Material visible at 83m depth
145-158	yielding zone at 145 & 158m depths
184	Water column start (water level)
190	Collapsed the bore well at 190m depth
190	Suspended Material is Struck and visible at depth of 190m
@190	Due to some suspended materials we could not go further depth.
** The slots are not visible.	

BORE WELL

WATER COLUMN

END OF DEPTH

VIDEO LOGGING – BORE WELL No. 1

Video Logging -2

Location	:	Bangu Bazar, Chintamani
Co-ordinates	:	13°24'11.33"N, 78° 3'23.93"E
District	:	Chikkballapur
Date	:	17-09-2021
Total depth	:	24m
Bore well Conditions	:	Running well

Video Logging -2	
Depth Range (m)	Observations
0 – 12	Dry Bore well completely closed with GI casing High Fluoride & calcite water
12	Water column Start and visible Iron rod
12-20	Due to High turbid water the visibility is not clear
21	we observed some Suspended Material, may be one or two bore well motors
@22	End of bore well
** The slots are not visible.	

WATER COLUMN WITH IRON ROD

VIDEO LOGGING – BORE WELL No. 2

Video Logging -3

Location : Chintamani
Co-ordinates : 13°24'2.29"N, 78° 2'45.87"E
District : Chikkballapur
Date : 17-09-2021
Total depth : 183m
Bore well Conditions : Running well but at present at the time of video logging motor is problem

Video Logging -3	
Depth Range (m)	Observations
0 – 3	Dry Bore well completely closed with GI casing
3.5	Casing Damage
3.5-25	Closed casing, we observed high fluoride & calcium
25	End of the casing a the depth of 25m
38	Water yielding zone
38-52.5	Dry Bore well, observed slightly water flowing
52.5	High water yielding zone
53	Suspended Material, yield zone at 52.5m
@53	Could not go further video logging at depth of 53m, because of Suspended Material struck.
** The slots are not visible. We recommend having flushing of bore well.	

CASING IS IN DAMAGE CONDITION

HIGH YIELDING ZONE

SUSPENDED MATERIAL IN BORE HOLE

Overall, the above methodology has drawn the different inferences of ground water resources that have made to select and plan the different recharge structures for the replenish/augment the underground aquifer system along with the improvement and management aspects.

Hence, planning and methodology of the assignment was made in addition to the above scope of work and to achieve the set out objectives along with the following advantages of the recharge measures.

- Attempt to develop the sustainable ground water supplies for the growing population and city limits
- Development of aquifer levels in a tangible manner
- Increase in the sub surface storage space
- Reduction in the evaporation losses
- Improvement in the quality of water thru filtration process

CLIMATOLOGICAL SCENARIO IN CHINTAMANI:

Underground water assessment was made in Chintamani taluk, Chikkaballapura district of Karnataka State. As this taluk possess the semi-arid to arid climate, the dryness and hot weather prevails in major part of the year. This entire area falls under the Eastern dry agro-climatic zone of Karnataka state and is categorized as drought prone area.

The normal annual rainfall in Chintamani taluk for the period 1981 to 2010 is 726 mm. Seasonal rainfall pattern indicates that, major amount of (389 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 54% of the annual normal rainfall, followed by North-East Monsoon season (232 mm) constituting 32% and remaining (105 mm) 14% in Pre-Monsoon season.

Computations were carried out for the 30 year blocks of 1981- 2010, the mean monthly Rainfall at Chintamani taluk is ranging between 2 mm during January to 151 mm during October. The coefficient of variation percent for pre-monsoon, monsoon and post monsoon season is 55, 31 & 61 percent respectively. Annual CV at this station works out to be 31 percent as shown in below table.

Statistical Analysis of Rainfall Data of Chintamani Station, (1981 to 2010)

Description	JAN	FEB	MAR	APR	MAY	PRE	JUN	JLY	AUG	SEP	SW	OCT	NOV	DEC	NE	ANNUAL
NRF (mm)	2	4	12	22	64	105	65	79	97	148	389	151	65	16	232	726
CV (%)	271	260	162	121	70	55	81	86	70	45	31	90	81	108	61	31
% of ARF	0.3	0.6	1.7	3.0	8.8	14.5	8.9	10.9	100	20.4	53.6	20.8	8.9	2.2	32.0	100

In the Sub-urban and rural areas of taluk, the Gneisses and Granites are found more and agriculture is the basic source of livelihoods. The soils observed are mostly four classes

of soils viz., clayey, clayey mixed, loamy skeletal and rock land. The physiography of the entire area is in southern maidan region, characterized by undulating landscape with broad valleys, where the elevation ranges from 700 to 1338 m amsl with good degree of slope. The eastern part of the taluk is covered by prominent hill ranges which are continuation of Nandidurga hill ranges running almost N-S direction and is the provenance for the sediment and drainage of Pennar. The remaining portion is having rolling topography undulating and gently sloping lands and valleys. The prominent hill ranges in the area is Devarbetta hill range with 1014 m amsl.

During the field investigation it is observed that, due to over exploitation of underground water (Continuously pumping for more than 10 hours each bore well) there is a threat to underground aquifer and also to the irrigation water for agriculture. It is also predicted that due to lack of underground water there are no development of industrial sector. It is also revealed during the investigation that the due to higher depth of drilling of bore wells i.e., more than 1000 – 1500 ft (300 – 450m) the zone of saturation (Weathered/phreatic zone) has got dried up and the area is depended on the Pre-monsoon and Post-monsoon rainfall where thru fractured zones the ground water is yielding.

On the other hand, it is also observed that the ground water quality is good for drinking purpose except in some areas as affected by the fluorides and nitrates which are found more than the permissible limits. Ground water samples were also taken from the 12 locations (6 Bore Wells & 6 Open Wells) to know the other predominating parameters of the quality aspects.

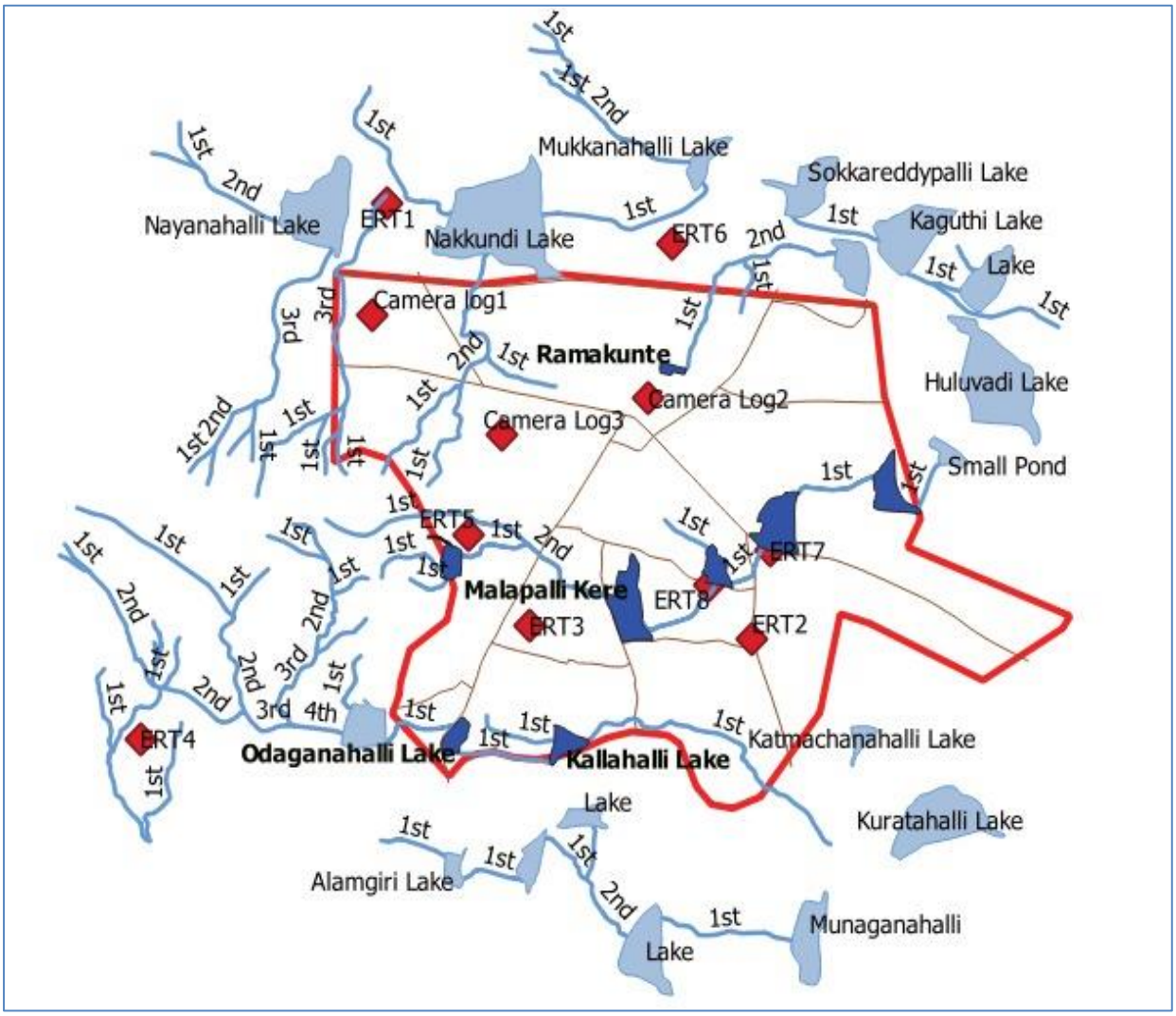
DRAINAGE & CATCHMENT AREAS:

As it is observed that, there are no perennial streams/rivers within the district and also in the taluk areas. The entire district has three river basins namely, Palar, Ponnaiyar and Pennnar and all these rivers are rainfed and carries water only during the rainy seasons. Palar originates at Ambajidurga hillocks in Chintamani taluk and flows NW-SE directions. The drainage is highly dendritic in nature.

The Pennar river originates in Doddapallapura taluk of Bangalore district and flows towards north covering parts of Sidlaghatta, Gowribidinur, Bagepalley and Gudibanda taluks and river Papagni enters in Sidlaghatta taluk and flows towards NE covering parts of Chintamani, Bagepalley, and Sidlaghatta, taluks.

North Pinakani originates from nandihills in Chikkaballapura taluk and flows in Chikkaballapura and Gowribidanur taluks for about 55 kms and enters Anathapura district in Andra.Pradesh state. South Pinakani originates from Nandi hills and flows in Chickballapur and Sidlaghatta taluks for about 110 kms and enters Tamilnadu state. Apart from these rivers Arkavathi a tributary of Cauvery also originates in Nandi hills and flows only 2.8 kms in the district and enters Bangalore district.

In the case of Municipal Council area there are 7 major tanks were observed along with other peripheral tanks which has a good impact on the underground aquifer. These tanks are found to be the chain of tanks with good drainage system with first and second order streams. These are found to be using for the irrigation purpose but due to increase of urban areas some of the tank bed areas are being encroaching and some of the tank inlet drainage system is being closed or objecting the flow of water by the house dwellers by throwing the litter and other unwanted waste. On the other hand in these drainage systems the vegetation and bushes are grown up which need to be immediately cleaned up.



The above figure shows the Drainage Network Map within and around the CMC area.

The above figure depicts that within the CMC and peripheral of CMC area there is a good network of drainage system with chain of tanks. And it is the immense and utmost important to rehabilitate and renovate the drainage system and tank areas in order to overcome the water crisis as it is the need of the hour.

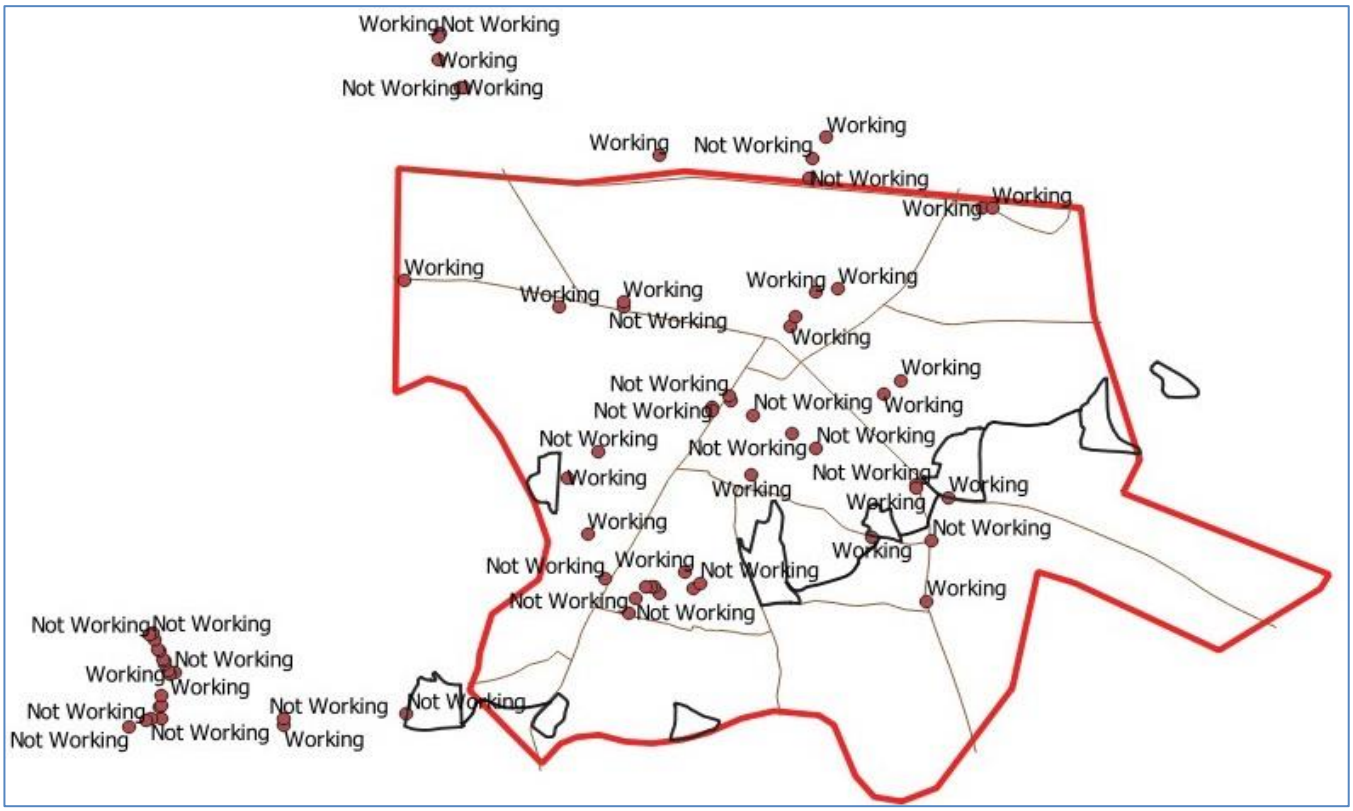
CRICITAL ISSUES & POINT OF PROBLEMS:

During the study and investigation the Critical Issues and Point of Problems were concentrated in order to plan the Regional Regression Recharge Measures (RRR) within the Municipal Council Area and Peripheral areas (Way Forward – For Future Course of action on phase wise).

CRICITAL ISSUES: The following are the Critical Issues that were observed.

- Drilling of borewells to the deeper aquifers i.e., depth of borewells ranging from 600 ft to 1850 ft.
- Installation of the submersible pumps of higher capacities viz., 20 hp, 25 hp
- Continuously exploitation of water for more than 10 hours and in some cases 24 hours which resulted in the declining of ground water levels and depletion of ground water resources
- This extraction of bore water is being stopped only during the power failures
- Disappearance of the zone of saturation (Weathered/phreatic zone) and exploiting the fractured zones for the ground water.
- Tremendous reduction in the yield of the water
- Increase in the paved areas thru developmental activities like Cement Concrete Roads/BT roads, footpaths etc along with other urbanization structures

The below figure gives the glance of the Working and Non-Working of the Borewells that are investigated on priority basis.



POINT OF PROBLEMS: The following are the Point of Problems that were observed.

- Municipal Council water supply system is depended on the underground aquifer for the supply of water due to absence of major rivers, reservoirs and Comprehensive Water Supply System.
- Lack of water security for users through ground water management, rapid urbanization of the town and increase in the population.
- Indiscriminate exploitation of ground water resulted into the unsustainability of the aquifer zone and deterioration of ground water quality.
- Over application of the pesticides and fertilizers is another factor where the ground water quality is being affected.
- Since, there is no other source community is dependent on the filter water (supplying by the private tankers) for the drinking purpose and some are on municipal water.
- Negligence of the defunct and abundant bore wells.
- Negligence of the percolation and irrigation tanks.
- Siltation and non-maintenance of the tank bed areas and tank bund.
- Non-maintenance of the Surplus weirs and sluices of the tanks.
- Siltation, non-maintenance and obstructing of the tank inlets i.e., drainages which are connected to the chain of tanks thru vegetation, litter and garbage.

The above issues and point of problems has affected the both the piezometric effect and volumetric effect which in turn reduction in the underground aquifer levels in both zone of saturation and fractured zones. Therefore, it is immense need to provide the regulated and augmented through suitable measures to provide sustainability and protection of aquifer system.

PLANNING OF REGIONAL REGRESSION RECHARGE (RRR) MEASURES:

Based on the field investigation and considering the critical issues and point of problems, Regional Regression Measures have been planned such that natural pattern of recharge is modified to some extent to increase the recharge affect. At the same time, the future requirement (Way forward) is suggested with some measures to accelerate the natural process of recharging the aquifer by improving the drainage system and through regulation procedures.

This planning has been done considering the following factors of field investigation.

- Available surface runoff
- Rainfall pattern
- Land use and vegetation
- Topography and terrain profile
- Soil type and soil depth

- Thickness of weathered / granular zones
- Hydrological and Hydrogeological characteristics
- Infrastructure facilities that are available

However, within the CMC area artificial recharge measures / structures are proposed so that the ground water is augmented at a rate exceeding under natural conditions of replenishment. Overall, these recharge measures aims to augment the natural replenishment of ground water storage by implementing the structural works with spreading of water and by artificially changing the aquifer conditions to some extent. And also, the recharge measures aims to reduce the overdraft, conserving the surface runoff and increasing the ground water supplies. In this entire planning attempt is made to have the impact in piezometric surface i.e., weather zone in a sustainable manner so that there will not be any break down of water supply system during the critical periods.

As the occurrence of rainfall is limited and is about 3 – 4 months in a year, these recharge measures and techniques aim to extend the recharge period in the post-monsoon for about 3 or more months and resulting in enhanced sustainability of ground water sources within the city during the lean periods.

Also, as this taluk possess the semi-arid to arid climate, the dryness and hot weather prevails in major part of the year the rates of potential evapotranspiration (PET – varies from 300 to 1300mm) are exceptionally high and this is the another factor which is considered in the selection and design of the recharge structures. Attempt is made to divert most of the surface runoff to the storage to the underground aquifer within the shortest possible time.

Therefore, considering the above scientific and engineering characteristics of Hydrology, Hydrogeology and Geophysical Studies along with the field/site conditions with respect to the critical issues and point of problems, the following are the Regional Regression Recharge Measures (RRR) are proposed into two levels. Though these falls under the standard methods of recharge techniques but considering the local satiation the two levels has been categorized.

- At Chintamani Municipal Council (CMC) Level
- Way Forward – For Future Aspect Level

CMC Level – Regional Regression Recharge Measures (RRR)

1. Individual Recharge structures open well measures
2. Individual Recharge structures Bore Well Measures
3. Road Junction Recharge Structures
4. Water Stagnation Recharge Structure at Stagnation points
5. Round about recharge structures
6. Footpath recharge structures

7. Intermittent Storm Water recharge structures
8. Construction of Check dams/Gabion Structures within the drainage
9. Impoundment of local storm runoff which is collected in the paved and non-paved areas at the ditches and low laying areas.
10. In the Open and government building all bore wells need to be provide with recharge measures
11. Dugout ponds in the open areas – where accessible to the public is limited/restricted
12. Desiltation of the tank bed areas and Strengthening of the Tank bunds
13. Renovation and Rehabilitation of the Surplus weirs and Sluices
14. Removal of the vegetation and litter from the drainages which are connecting to the chain of tanks within the municipal council
15. Desiltation of the drainages which are connecting to the chain of tanks within the municipal council

WAY FORWARD – Future Aspect Level:

1. Planning and implementation of the Comprehensive Water Supply System through permanent source
2. Shifting of ground water pumpage from the center of the city to the sustainable yield tube wells
3. Desiltation of the peripheral tanks bed areas
4. Desiltation of the tank bed areas and Strengthening of the Tank bunds
5. Renovation and Rehabilitation of the Surplus weirs and Sluices
6. Desiltation of the drainages which are connecting to the chain of tanks within the municipal council
7. Construction of Check dams/Gabion Structures for the peripheral drainages
8. Recycling and reuse of water
9. Roof Top Rainwater harvesting for each and every household as mandatory during the building permission
10. Regulatory measures thru pricing of water supply system
11. Metering of piped water supply system

DESIGN DETAILS – CMC – RRR STRUCTURES:

Regional Regression Recharge Measures are designed at the CMC level in order to address the following issues based on the critical issues and point of problem that has been observed with respect to the ground water scenario.

- To enhance the sustainable yield in the areas where the aquifer levels are depleted
- To utilize the maximum rainfall runoff which is going unutilized
- Conservation and storage of excess water

- Maximum infiltration of rain water into the sub soils and recharge the underground aquifer
- To reduce the chemicals that are prone to human nature due to over exploitation and deeper drawing of water
- To control and reduce the flood hazard and improve the vegetation cover
- To raise the water levels in the other water bodies like wells, open wells, kalyanis, lakes, tanks, dugout ponds etc
- To improve the quality of existing ground water through dilution
- To arrest the suspended solids thru filtration systems

The following are the RRR structures proposed in this pilot project (From Sr. No. 2 – 10) and Sr. No. 1 can be taken up by in consultation with Government.

Sr. No	Type of Structure	No. of Structures proposed	Structural Code	Remarks
1	Renovation & Rehabilitation of Percolation Tanks (1 – 8)*	8	Mandatory to take up this activity by either by Government or by some big funding agency	Tanks inside CMC Area
		9 – 27		Tanks outside CMC Area
2	Open Wells – Recharge Structure	5	CBT-001	*Initially, for pilot projects no. of structures are proposed and shown in respective maps – The final no. of structures can be decide by the CMC, BORDA & TIDE*
3	Tube Wells – Roof top Rain Water Harvesting Recharge Structure	5	CBT-002	
4	Tube Wells – Surface Water Harvesting Recharge Structure	5	CBT – 002S	
5	Road Junction - Recharge Structure	5	CBT-003	
6	Water Stagnation/Flooding area – Recharge Structure	5	CBT-004	
7	Footpath – Recharge Structure	5	CBT-005	
8	Intermittent Storm Water – Recharge Structure (Soakway)	5	CBT-006	
9	Dugout ponds/Kalyanis	6	CBT-007	
10	Gabion Check Dam Structures	5	CBT-008	In First Order Streams
11	Check Dams	7	CBT-009	In Second & Third Order Streams

*Note: * For location of the structures – Refer to the Tanks & Its Catchment Map & it is the budgetary issue along with the concern of the Irrigation department. Hence renovation and rehabilitation is the utmost important as these are going to the future source of water sources in a sustainable manner.*

Open Wells – Recharge Structure (CBT-001): The recharge structure is proposed for the open wells with following considerations.

- A dry/unused open well is selected as a recharge structure
- The recharge water is guided through a pipe to the bottom of the well or below the water level to avoid scouring bottom and entrapment of air bubbles in the aquifer
- Before using the well as recharge structure its bottom should be cleaned and all the fine deposits should be removed
- Attempt is made such that the recharge water is free for silt and other turbidity as far as possible
- The structure should be replaced with filter media and cleaned once in a year

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/011 & 012 - A & B), its design (Annexure No. 1) and its Bill of Quantities are shown in the Annexure No. 9.

Tube Wells – Roof top Rain Water Harvesting Recharge Structure (CBT-002): The recharge structure is proposed for the tube wells with the following considerations. In this type of structure only the roof rain water is filter thru the filtration process and allowed to flow into the tube wells.

- Where land availability is limited
- Where aquifer is deep and over laid by impermeable strata
- If the roof top rain water is available the same can be channelized to the bore well and recharges under gravity flow conditions
- Recharge water should be silt free as far as possible
- The well can also be used for pumping
- Most suitable for the areas where ground water levels are deep
- The runoff of 1st rain should not be allowed to go percolate to the rain water harvesting structure and allowed it to go to the drain by making suitable by-pass arrangement in water carrying pipe system.

Tube Wells – Surface Water Harvesting Recharge Structure (CBT-002S): In case the open surface catchment area is available, the surface water can be harvested into the tube wells thru filtration systems. But for this purpose, the in and around area should be graded i.e., slope should be given (at least 1 in 2) for a length of approximately 300 – 500m based on the availability so that the surface rain water can be recharged.

Note: This Tube Well – Surface Water Harvesting Recharge Structure (CBT – 002S) is NOT RECOMMENDED as the surface water sometimes may contain such impurities/chemicals/microbiological particles which many not be possible to remove/filter from this artificial filtration system and there will be a major threat of shallow / deep aquifer pollution.

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/013 & 014 – A, B & C), its design (Annexure No. 1) and its Bill of Quantities are shown in the Annexure No. 10.

Road Junction – Recharge Structure (CBT-003): The recharge structure is proposed at the junction of the roads or at the right angle crossing of the road with the following considerations.

- It is proposed in the gated community or colony road junctions
- The road surface water is allowed to flow into the recharge pit
- Structure is proposed at the junction where four roads intersection and also two roads crosses the right angle triangle
- The structure can also propose where the three roads intersect
- Proposed where the traffic is limited and confined and where heavy loads impact is limited
- Storm water drains at the road junctions can be used as this structure

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/015), its design (Annexure No. 2) and its Bill of Quantities are shown in the Annexure No. 11.

Water Stagnation/Flooding Areas - Recharge Structure (CBT-004): The recharge structure is proposed in the areas where the water stagnation and flooding area is prone with the following considerations.

- Where land is available either at the road side or at the open areas
- It is proposed where the areas are prone to flooding and impounding with rain water
- Proposed in the areas which are not threat to the humans and animals
- Suitable for the areas where movement of humans and animals are limited
- Catchment and roof top rain water can be allowed to recharge the aquifer with filtration process
- Proposed where the traffic is limited and confined and where heavy loads impact is limited

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/016), its design (Annexure No. 3) and its Bill of Quantities are shown in the Annexure No. 12.

Footpath - Recharge Structure (CBT-005): The recharge structure is proposed under the footpaths prone with the following considerations.

- The structure can be constructed under the footpaths
- The structure is embedded under the footpaths

- A channel or entrance provision with screens/mesh need to be provided
- Structure can be constructed adjacent to the main roads, colony roads and within the gated communities.
- Since it is the small and simple structure, no. of structures can be increased based on the constraints.
- Most of the runoffs from the roads can be diverted to these structures
- Catchment and roof top rain water can be allowed to recharge the aquifer with filtration process

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/017), its design (Annexure No. 4) and its Bill of Quantities are shown in the Annexure No.13.

Intermittent Storm Water – Recharge Structure (Soakway) (CBT-006): The recharge structure is proposed within the storm water drain with the following considerations.

- The structure is proposed where only storm water is ensured without mixing of sewage or other polluted water
- Within the storm water a soakway is prepared at every junction of the road and a bore hole of 10m depth
- It is proposed were the area is limited but prone to more runoff
- In case the storm water length (Continuous stretch of 1 km) is more at every 300m interval the structure can be proposed.
- Since it is the small and simple structure, no. of structures can be increased based on the constraints.
- Most of the runoffs from the roads can be diverted to these structures
- As the drilling of bore hole of 10m depth is the cost factor because of which cost of the structure increases.

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/018), its design (Annexure No. 5) and its Bill of Quantities are shown in the Annexure No.14.

Dugout Pond/Kalyanis (CBT-007): The recharge structure is proposed in the open areas with the following considerations.

- These are similar to the Kalyanis which are existing
- These structures are proposed in the open areas where land is available
- Proposed at the larger water stagnation / flooding areas
- From the feasibility and threat point of view, the structure is proposed below the ground so that embankment can be avoided
- Since it is simple structure, but the cost of the revetment increases and also larger area occupies because of which the no. of structures can be limited

- Evaporation losses will takes place due to larger area of water surface

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/019), its design (Annexure No. 8) and its Bill of Quantities are shown in the Annexure No.15.

Gabion Check Dam Structure (CBT-008): These structures are proposed in the streams with the following considerations.

- It is proposed in the first order stream preferably as the flow intensity and velocity will be less
- Proposed in the confirmed banks on either side of the stream
- Local stones (size varies from 200mm to 300mm) can be used in the construction
- These structures over a period of time can act as solid and similar to the check dams
- There will be minimum maintenance of these structure – preferably during the first year to protect the circumferential mesh
- Stylo hamate grass seeds can be poured within the voids of the structure so that over a period of a good grass barrier can create
- Though the structural cost is average, the no. of structures can be increased and also the labour employment can be created.

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/020), its design (Annexure No. 6) and its Bill of Quantities are shown in the Annexure No. 16.

Check Dam (CBT-009): These structures are proposed in the streams with the following considerations.

- It is proposed in the 2^{nd}, 3^{rd} or 4^{th} order streams preferably as the flow intensity and velocity will be high
- Proposed in the confirmed banks on either side of the stream
- Course Rubble Stones (CRS) to be used in the construction
- A skilled labour / mason is required for construction
- Once the structure is completed in full shape, there will be no maintenance
- The structure will act as permanent barrier across the stream
- The cost of the structure is high due to
- These structures over a period of time can act as solid and similar to the check dams

The detailed drawing (Drawing No. BT/GESTS/RRR-RC/021-25), its design (Annexure No. 7) and its Bill of Quantities are shown in the Annexure No. 17.

Type of Structure	Drawing No.	Design Annexure No.	BOQ Annexure No.	Structural Code
Open Wells – Recharge Structure	BT/GESTS/RRR-RC/011 & 012 - A & B	1	9	CBT-001
Tube Wells – Recharge Structure	BT/GESTS/RRR-RC/013 & 014 - A & B	1	10	CBT-002
Road Junction - Recharge Structure	BT/GESTS/RRR-RC/015	2	11	CBT-003
Water Stagnation/Flooding area – Recharge Structure	BT/GESTS/RRR-RC/016	3	12	CBT-004
Footpath – Recharge Structure	BT/GESTS/RRR-RC/017	4	13	CBT-005
Intermittent Storm Water – Recharge Structure (Soakway)	BT/GESTS/RRR-RC/018	5	14	CBT-006
Dugout ponds/Kalyanis	BT/GESTS/RRR-RC/018	8	15	CBT-007
Gabion Check Dam Structures	BT/GESTS/RRR-RC/019	6	16	CBT-008
Check Dams	BT/GESTS/RRR-RC/020	7	17	CBT-009

Percolation tanks which are existing within the CMC area are focused to renovate as these are the most prevalent structures to recharge the ground water reservoir in both alluvial as well as hard rock formation. It is also observed through the resistivity test that the CMC area has the more hard rock formations along with highly fractured and weathered zones. The following are the points considered for the renovation and rehabilitation of the percolation tanks.

- As these existing percolation tanks are located within the heart of the city, the renovation and rehabilitation will helps to allow the water to percolate to ground water reservoir before onset of summer and also reduces the evaporation losses during the summer season
- As the tanks are clearly demarked with the submergence area/boundary and having good catchment areas
- As most of the percolation tank areas are having the fractured and weathered rock formation, the recharge affect will be more
- As most of the tanks are observed that the permeable zone is high to accommodate the recharge water.
- It is observed that there will be impact on the wells and tube/bore wells which are located around the tanks

- Tanks are having surplus weir and sluices which need to be repaired so that chain of tank linkages can be created to maintain the water balance.

The following are the tanks details within and outside the CMC areas along with the stream courses, submergence areas and catchment areas.

TANKS WITHIN CMC AREA					
S.No	**Name of the Tank**	**Bed Area (Sq.mt)**	**Catchment area (Sq.mt)**	**Stream length (m)**	**Remarks**
1	Lake Below Mt. Kadumalleshwara	35108	431410	s1 = 331, 624	
2	Malapalli Kere	123967	2743491	s1 = 1707, 578 s2 = 796	
3	Malapalli Chikka Kere	43534	3432504	s1 = 402, 744	
4	Gopasandra Kere	117538	5288038	s1 = 403	
5	Burugamakahalli Kere	77382	6357254	s1 = 628	
6	Odaganahalli Lake	37101	4758464	s1 = 639	
7	Kallahalli Lake	44774	5439876	s1 = 720, 629	
8	Ramakunte	12553	12553	Not Identified	

TANKS ADJACENT TO CMC AREA					
S.No	**Name of the Tank**	**Bed Area (Sq.mt)**	**Catchment area (Sq.mt)**	**Stream length (m)**	**Remarks**
9	Nayanahalli Lake	246734	4077062	s1 = 257, 277, 290, 273, 384, 403, 1035, 191, 219, 861 s2 = 543, 499, 193, 776, 668 s3 = 1546	
10	Nakkundi Lake	486515	12019927	s1 = 990, 963, 612, 1483, 912, 305, 389, 359 s2 = 1390, 156, 190 s3 = 1857	
11	Mukkanahalli Lake	51603	15353716	s1 = 1459, 247, 314, 194, 412 s2 = 244, 202, 1005	
12	Sokkareddypalli Lake	122126	705355	Not Identified	
13	Karepalli Lake	89963	1769403	s1 = 1040, 454 s2 = 766	
14	Kaguthi Lake	187872	3308460	s1 = 704	
15	Huluvadi Lake	336946	1290230	Not Identified	

16	Small Pond	34352	1290230	s1 = 383	
17	Lake above Munugahalli	44657	1508839	s1 =	
18	Alamgiri Lake	32810	616291	s1 = 530	
19	Munugahalli Lake	51830	1218693	s1 = 486	
20	Kannampalli Kere	97140	3718182	s1 = 261, 281, 115, 426, 1492, 458, 484, 312, 502, 421, 504, 287 s2 = 1057, 251, 847, 572, 264, 729 s3 = 77, 464, 791 s4 = 384	
21	Kuratahalli Lake	242586	11526531	s1 = 2462	Stream not connected
22	Munaganahalli Lake	123714	1218693	s1 = 1070	
23	Lake before Munganahalli	152919	4841738	s1 = 422, 487, 591	
24	Lake above Huluvadi Lake	108361	3692343	S1 = 438, 241	
25	Lake East of Huluvadi Lake	21460	4138178	s1 = 1103	
26	Lake before to Alamgiri Lake	17709	290049	s1 = 35, 68, 151 s2 = 139	
27	Chinnasandra Kere	320856	6837971	s1 = 708, 1070, 695 s2 = 816, 728	

*Note: * In addition to the above recharge structures another additional drawings are given so that based on the requirement and applicability the same can be used.*

OPERATIONS & MAINTENANCE MEASURES:

Operation and Maintenance measures are utmost important for any type of structure in order to increase the sustenance and life of the structure. This is important because infiltration capacity reduces with increasing the formation of silt, chemical precipitation and accumulation of organic matter, litter, etc with the flow of water.

Several issues are to be considered in the operation and maintenance of artificial recharge structures. These have been categorized as issues of high value concern and moderate value concern. High value concern is basically with respect to Safety, optimization techniques and programs, value of wet-dry cycles, frequency of pond cleaning and conditions of filters attached to the structures. Whereas, security issues and rising ground water levels are among those of moderate value concerns.

As this water levels and water quality is of prime importance and this data speaks about the efficiency of the structures that are constructed and about the pollution of the sources.

In addition to the above, the operation and maintenance should also include the following.

- ✓ Flow rate, duration and quality of source of water
- ✓ Inflow and outflow rates, duration and quality of inflow and outflow into and out of each unit of the recharge system
- ✓ Recharge rates versus time for each unit and for the system as a whole
- ✓ Depth of water level along with the quality in the area being recharged and adjacent areas
- ✓ No. of hours of pumping of the bore wells and power usage
- ✓ Depth of water in the recharge structures versus time (in case of surface structures)
- ✓ Time, rate and volume of pumping of each structure and for the system as a whole
- ✓ Periodic action and forestall major repair or replacement of the structural components along with the filter media's.
- ✓ Removal of the litter, unwanted & suspended material, organic matter, mud cake and scarifying of recharge ponds on period basis is one of the major activity to be carried out
- ✓ Regular application of the lubricants, oils, grease and protective substance to the mechanical parts or replacement of minor parts that are subject to the deterioration or repeated failures.
- ✓ Regular observation and recording of the behavior of the both static and dynamic components of the system to detect changes in their inherent conditions and indicates the need for unscheduled maintenance.

MAINTENANCE OF ROOF TOP RAIN WATER HARVESTING SYSTEM:

Maintenance of roof top rainwater harvesting system (RRHS) is simple and costs little. As the entire system is household-based, it becomes one of the assets of the household and hence could be maintained best by the users themselves. It requires continuous care and maintenance just as any other asset in the household. In fact, maintenance of RRHS should get priority over other household assets, as it ensures the good health of all people in the household. Cleanliness of surroundings as well as the system including its various components such as roof, gutters, filtration unit and the storage tank, will ensure supply of water of potable quality throughout the water scarcity period for the drinking and cooking purposes of the household. The following are the tips to be followed in the maintenance of the RRWHS.

- Always keep the surroundings of the tank clean and hygienic
- Remove algae from the roof tiles and asbestos sheets before the monsoon
- Drain the tank completely and clean the inside of the tank thoroughly before the monsoon
- Clean the water channels (gutters) often during rainy season and definitely before the first monsoon rain
- Avoid first 15 or 20 minutes of rainfall depending on the intensity of rain. Use the first flush arrangement to drain off this first rainwater.
- Change the filter media every rainy season
- Cover all inlet and outlet pipes with closely knit nylon net or fine cloth or cap during non-rainy season to avoid entry of insects, worms and mosquitoes
- Withdraw water from the system at the rate of 5 litres/head/day. This will ensure availability of water throughout the water scarcity period.
- Leakage or cracks in the storage tank should be immediately attended to. This will obviate the need for major repairs caused by propagation of cracks.
- Heavy loads should not be applied on the lid.
- Water should not be allowed to stagnate in the collection pit
- The tap should have lock system to prevent pilferage or wastage of water
- The filter material should be washed thoroughly before replacing in the filter Bucket

People may be educated by providing the above tips for maintenance of the system through pictures, handouts and wall posters. The implementing agency should visit the structures as follow-up to monitor and motivate the users in proper maintenance of the systems. There could be informal group discussions among the users on the Maintenance aspects of the Roof Top Rainwater Harvesting Systems.

As a precautionary and preventive measure, the water from the storage tank may also be tested for the presence of disease causing microorganisms. This task may be taken up by the implementing agency as an immediate follow up of the construction of the systems. This helps the agency to find out the users attention to the maintenance of the system as well as necessary awareness to be given on various maintenance aspects.

ANNEXURES:

The detailed designs followed by the detailed structural drawings, Bill of Quantities and maps have been enclosed for the implementation of the pilot project. However, the number of structure to be implemented can be decided by the CMC, Borda and TIDE based on the budgetary constraints.

ACKNOWLEGMENTS:

We the team M/s. GREENFEILDS ENGINEERS TECHNOLOGICAL SOULTIONS – GESTS, Hyderabad wish to place our sincere thanks to the Chintamani Municipal Council (CMC), & TIDE, Bangalore, Karnataka for giving the opportunity, guidance and support to carry out this technical study in Chintamani taluk.

Also we would like to convey our sincere and special thanks to Shri. S. Vishwanth garu, Water Conservation Expert who accompany us during our field visit and given us an immense support and guidance to carry out the investigation and also suggested the characteristics and parameters which need to be consider for the Chintamani taluk as it is one of the most drought prone and over exploited area which need to give special attention in this assignment.

Based on the site investigation and its conditions and following the standard references, books, reports, manuals, electronic documents and individual contributions from different scientists the proposed measures where planned for the implement on the pilot basis for revival of the defunct borewells with suitable recharge technological options.

We the GESTS team worked as various levels with the bottom of our hearts and to the extent possible for the justification in all aspects during the site investigation and report preparation in order to bring out planned measures for pilot implementation so that the efforts made by the CMC, & TIDE for revival of underground aquifer levels under the project Integrated Water Management project not go waste.

Concluding this report, as the surface conditions encountered during the field visit and may vary from the other parts of the areas, it is notified that that recommendations/suggestions are specific and in light of these surface and existing conditions. This report is purely technical report and is prepared based on the investigation carried out at the particular points. The reported results are for information and for interpretation and it is presumed that the tests performed on the specimen belongs to that point of investigation. Results of tests may vary from point to point and also in some parameter from time to time for the same sample.

The Consultants are responsible up to this report only and client need to take a final decision on this report before conclusions and execution of the project and its allied activities. Only such professionals who understand the reporting standards/units/reference ranges and limitations of standards should interpret the results (if required and in consent with consultant). As the results of investigations are influenced by various factors such as sensitivity, temperature, climatic conditions, etc and specific of test procedures, chemical actions and reactions and its interactions and quality of the sample, neither GESTS or its employees / representatives assume any

liability, responsibility for and loss or damage that may be incurred by any person as a result of presuming the meaning or its respective contents of the report. This Investigation reports provides general awareness, strength, profile of the area and design details. This report cannot be used as legal document.

By GESTS TEAM

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DESIGN OF THE RECHARGE STRUCTURE (For Both Open & Tube Wells)						
S.No	**Description**	**Symbol**		**Value**	**Units**	**Remarks**
1	Mean Annual Rainfall of the Chintamani Taluk	R	=	726.00	mm	
2	Area of Catchment	C	=	100.00	Sq.mt	
3	Height of Rainfall	R'	=	0.73	m	
4	Volume of Water falls over the area	V	=	72.60	Cum	
			=	72600.00	lits	
5	Catchment Coefficient	c	=	0.85		
6	Evaporation Coefficient	Ec	=	0.80		
7	Effective Water that can be recharge - annually	Wr	=	49368.00	lits	
			=	49.37	Cum	
8	Available Area of Recharge Structure					
	Area	A	=	2.00	Sq.mt	
	Assuming depth of water to be impound with one rain as average annual depth	d	=	0.73	m	
	Factor of Safety	f	=	1.50		
	Total depth of Water to be impounded	d	=	1.82	m	
	Volume of Water holding	V	=	3.63	Cum	
9	Filtration unit depth					
	Sand depth		=	0.50	m	As per IS 15797 - 2008
	Gravel depth		=	0.50	m	
	Charcoal depth		=	0.50	m	
10	Total depth of recharge pit	D	=	3.32	m	
11	Size of the Recharge Pit - Inner Dimensions					
	Length of the Pit	L	=	1.40	m	
	Width of the Pit	B	=	1.43	m	
	Depth of the Pit	D	=	3.32	m	
12	Thickness of Wall assumed	t	=	0.23	m	
13	Size of the Recharge Pit - Outer Dimensions					
	Length of the Pit	L	=	1.90	m	Round off to 2m
	Width of the Pit	B	=	1.90	m	Round off to 2m
	Depth of the Pit	D	=	3.32	m	

DESIGN OF THE ROAD RECHARGE STRUCTURE						
S.No	**Description**	**Symbol**		**Value**	**Units**	**Remarks**
1	Mean Annual Rainfall of the Chintamani Taluk	R	=	726.00	mm	
2	Length of the Road	Lr	=	500.00	m	
	Width of the Road	Wr	=	7.50	m	
	Area of Catchment	C	=	3750.00	Sq.mt	
3	Height of Rainfall	R'	=	0.73	m	
4	Volume of Water falls over the area	V	=	2722.50	Cum	
			=	2722500.00	lits	
5	Catchment Coefficient	c	=	0.85		
6	Evaporation Coefficient	Ec	=	0.80		
7	Effective Water that can be recharge - annually	Wr	=	1851300.00	lits	
			=	1851.30	Cum	
8	Available Area of Recharge Structure					
	Length of the Road trench	Lt	=	7.50	m	
	Width of the Trench	Wt	=	1.00	m	
	Area	A	=	7.50	Sq.mt	
	Assuming depth of water to be impound with one rain as average annual depth	d	=	0.73	m	
	Factor of Safety	f	=	1.50		
	Total depth of Water to be impounded	d	=	1.82	m	
	Volume of Water holding	V	=	13.61	Cum	
9	Filtration unit depth					
	Sand depth		=	0.50	m	As per IS 15797 - 2008
	Gravel depth		=	0.50	m	
	Charcoal depth		=	0.50	m	
10	Total depth of recharge pit	D	=	3.32	m	
11	Size of the Recharge Pit - Inner Dimensions					
	Length of the Pit	L	=	7.50	m	
	Width of the Pit	B	=	1.00	m	
	Depth of the Pit	D	=	3.32	m	
12	Thickness of Wall assumed	t	=	0.23	m	
13	Size of the Recharge Pit - Outer Dimensions					
	Length of the Pit	L	=	8.00	m	
	Width of the Pit	B	=	1.50	m	
	Depth of the Pit	D	=	3.32	m	

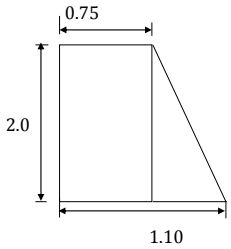
DESIGN OF THE WATER STAGNATION/FLOODING RECHARGE STRUCTURE						
S.No	**Description**	**Symbol**		**Value**	**Units**	**Remarks**
1	Mean Annual Rainfall of the Chintamani Taluk	R	=	726.00	mm	
2	Length of the Road	Lr	=	500.00	m	
	Width of the Road	Wr	=	7.50	m	
	Area of Catchment	C	=	3750.00	Sq.mt	
3	Height of Rainfall	R'	=	0.73	m	
4	Volume of Water falls over the area	V	=	2722.50	Cum	
			=	2722500.00	lits	
5	Catchment Coefficient	c	=	0.85		
6	Evaporation Coefficient	Ec	=	0.80		
7	Effective Water that can be recharge - annually	Wr	=	1851300.00	lits	
			=	1851.30	Cum	
8	Available Area of Recharge Structure					
	Area	A	=	10.00	Sq.mt	
	Assuming depth of water to be impound with one rain as average annual depth	d	=	0.73	m	
	Factor of Safety	f	=	1.50		
	Total depth of Water to be impounded	d	=	1.82	m	
	Volume of Water holding	V	=	18.15	Cum	
9	Filtration unit depth					
	Sand depth		=	0.50	m	As per IS 15797 - 2008
	Gravel depth		=	0.50	m	
	Charcoal depth		=	0.50	m	
10	Total depth of recharge pit	D	=	3.32	m	
11	Size of the Recharge Pit - Inner Dimensions					
	Length of the Pit	L	=	3.20	m	
	Width of the Pit	B	=	3.13	m	
	Depth of the Pit	D	=	3.32	m	
12	Thickness of Wall assumed	t	=	0.23	m	
13	Size of the Recharge Pit - Outer Dimensions					
	Length of the Pit	L	=	3.70	m	
	Width of the Pit	B	=	3.60	m	
	Depth of the Pit	D	=	3.32	m	

DESIGN OF THE FOOTPATH RECHARGE STRUCTURE						
S.No	**Description**	**Symbol**		**Value**	**Units**	**Remarks**
1	Mean Annual Rainfall of the Chintamani Taluk	R	=	726.00	mm	
2	Length of the Road	Lr	=	500.00	m	
	Width of the Road	Wr	=	7.50	m	
	Area of Catchment	C	=	3750.00	Sq.mt	
3	Height of Rainfall	R'	=	0.73	m	
4	Volume of Water falls over the area	V	=	2722.50	Cum	
			=	2722500.00	lits	
5	Catchment Coefficient	c	=	0.85		
6	Evaporation Coefficient	Ec	=	0.80		
7	Effective Water that can be recharge - annually	Wr	=	1851300.00	lits	
			=	1851.30	Cum	
8	Available Area of Recharge Structure					
	Length of the trench	Lt	=	3.00	m	
	Width of the Trench	Wt	=	1.00	m	
	Area	A	=	3.00	Sq.mt	
	Assuming depth of water to be impound with one rain as average annual depth	d	=	0.73	m	
	Factor of Safety	f	=	1.50		
	Total depth of Water to be impounded	d	=	1.82	m	
	Volume of Water holding	V	=	5.45	Cum	
9	Filtration unit depth					
	Sand depth		=	0.50	m	As per IS 15797 - 2008
	Gravel depth		=	0.50	m	
	Charcoal depth		=	0.50	m	
10	Total depth of recharge pit	D	=	3.32	m	
11	Size of the Recharge Pit - Inner Dimensions					
	Length of the Pit	L	=	1.70	m	
	Width of the Pit	B	=	1.76	m	
	Depth of the Pit	D	=	3.32	m	
12	Thickness of Wall assumed	t	=	0.23	m	
13	Size of the Recharge Pit - Outer Dimensions					
	Length of the Pit	L	=	2.20	m	
	Width of the Pit	B	=	2.20	m	
	Depth of the Pit	D	=	3.32	m	

DESIGN OF THE INTERMITTENT STORM WATER RECHARGE STRUCTURE (SOAKWAY)

S.No	Description	Symbol		Value	Units	Remarks
1	Mean Annual Rainfall of the Chintamani Taluk	R	=	726.00	mm	
2	Length of the Road	Lr	=	500.00	m	
	Width of the Road	Wr	=	7.50	m	
	Area of Catchment	C	=	3750.00	Sq.mt	
3	Height of Rainfall	R'	=	0.73	m	
4	Volume of Water falls over the area	V	=	2722.50	Cum	
			=	2722500.00	lits	
5	Catchment Coefficient	c	=	0.85		
6	Evaporation Coefficient	Ec	=	0.80		
7	Effective Water that can be recharge - annually	Wr	=	1851300.00	lits	
			=	1851.30	Cum	
8	Available Area of Recharge Structure					
	Length of the Road trench	Lt	=	100.00	m	
	Width of the Trench	Wt	=	0.60	m	
	Area	A	=	60.00	Sq.mt	
	Assuming depth of water to be impound with one rain as average annual depth	d	=	0.73	m	
	Factor of Safety	f	=	1.50		
	Total depth of Water to be impounded	d	=	1.82	m	
	Volume of Water holding	V	=	108.90	Cum	
9	Depth of Borehole proposed	D	=	10.00	m	
10	Filtration unit with Broken bricks or Charcoal					
11	Soakway interval within the drain	s	=	100.00	m	
	or at the road junction					

DESIGN OF GABION CHECK DAM STRUCTURE
TIDE PROJECT



Existing Stream Dimensions

Bottom Width of the Stream		=		3.00	m
Top Width of the Stream		=		15.00	m
Average height of the Stream		=		3.20	m
Assuming Velocity of flow		=		1.50	m/Sec
Discharge		=		43.2	Cumecs
	Say	=		35.00	Cumecs

Discharge (Q)	Q	=		=	35.000	Cumecs
Length of the Linear Water way (m)	L	=	L	=	15.00	m
High Flood depth (m) (From Rainfall Intensity curves)	H_f	=	$\left(\frac{Q}{1.8 \times L}\right)^{(2/3)}$	=	1.19	m
Depth of the George Portion (m)	x	=	x	=	3.20	m
Height of the body wall H (m)	H	=	$h = X - H_f$	=	2.01	m
Free board (m)	f	=	f = 0.5h	=	1.01	m
Height of the Abutment (m)	H'	=	$(H+H_f)$	=	3.20	m

Considering the values as:

Sp. Wt of water (KN/Cu.m)	w	=	10.00	=	10.00
Gravitational constant	g	=	9.81	=	9.81
Unit wt. Of Basalt Stone Masonary (KN/Cu.m)	c	=	28.50	=	28.50
Top width of the body wall	a	=	0.75	=	0.75
Batter on the downstream side (H:V)	s	=	1 in 3	=	1 in 3
Coefficient of friction between the wall and soil	μ	=	0.60	=	0.6

Calculation Details - Considering 1 m length of the dam
Condition:
<u>When the Gabion Check Dam is full of Water:</u>

Bottom width (m)	b	=	b	=	1.42
			Say	=	1.10
Horizontal Water thrust (KN)	P	=	$P = \frac{WH^2}{2}$	=	20.22
This Horizontal thrust acts at (from the base of the dam)	t1	=	$t_1 = \frac{H}{3}$	=	0.67

Self Weight of the dam (KN) $W = \left(\frac{W = c(a+b) \times 1x H}{2} \right) = 53.0183$

This Self wt. acts through Center of Gravity of the dam section from vertical side of the dam $X = \left(\frac{X = a^2+b^2+ab}{3(a+b)} \right) = 0.47$

Let the resultant force (R) cuts the base at F at a distance Z from the heel (D) $Z = \left(\frac{Z = X + \frac{P}{W} \times \frac{H}{3}}{} \right) = 0.72372$

Ecentricity $e = \left(Z - \frac{b}{2} \right) = 0.17$

Check for Ecentricity $= b/6 = 0.18333$

Ecentricity is Less than B/6, Hence the Design is Safe

Negative Sign (e) indicates that the resultant cuts the base within the centre of the base and is towards Heel

Maximum compressive Stress at toe- KN/Sq.m. $C = \left(\frac{W}{b} \frac{(1+6e)}{b} \right) = 2.53$

Minimum comptressive stress at Heel- KN/Sq.m $D = \left(\frac{W}{b} \frac{(1-6e)}{b} \right) = 93.8705$

Condition:
When the Gabion Check Dam is without Water:

In this case, since there is no water, the total force will the total weight of the dam only and it acts through the centre of gravity.ie.,. Z = X

$Z = X = 0.47$

Ecentricity $e = \left(Z - \frac{b}{2} \right) = -0.08$

Check for Ecentricity $= \left(\frac{b}{6} \right) = 0.18333$

Ecentricity is less than b/6, Hence the Design is safe

Negative Sign (e) indicates that the resultant cuts the base within the centre of the base and is towards Heel

Maximum compressive Stress at toe- KN/Sq.m $C = \left(\frac{W}{b} \frac{(1+6e)}{b} \right) = 26.6453$

Minimum comptressive stress at Heel- KN/Sq.m $D = \left(\frac{W}{b} \frac{(1-6e)}{b} \right) = 69.7515$

Check for Stability of the Structure:

Check against Tension

When the Gabion Check Dam is full of Water: **Ecentricity is Less than B/6, Hence the Design is Safe**

When the Gabion Check Dam is without Water: **Ecentricity is less than b/6, Hence the Design is safe**

Check against Sliding $= \mu W > P$

$\mu W = 31.811$

$P = 20.22$

Hence the structure is safe against Sliding

Check against Overturning $Z < b$

Hence the structure is safe against Overturning

$Z = 0.72372$

$b = 1.1$

Hence the structure is safe against Overturning

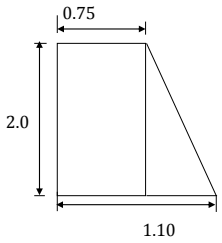
Check against Max. Comp stresses $= 300 - 400$ KN/M2 300

When Gabion Check dam is full of water
At Heel $= 93.87$
At Toe $= 2.5$
Hence the structure is safe against Max. Comp stress at Heel
Hence the structure is safe against Max. Comp stress at toe

When Gabion Check dam is without water
At Heel $= 26.65$
At Toe $= 69.75$
Hence the structure is safe against Max. Comp stress at Heel
Hence the structure is safe against Max. Comp stress at toe

All the conditions have been satisfied - Hence the structure is safe.

DESIGN OF CHECK DAM STRUCTURE
TIDE PROJECT



Existing Stream Dimensions

Bottom Width of the Stream		=		3.00	m
Top Width of the Stream		=		15.00	m
Average height of the Stream		=		3.20	m
Assuming Velocity of flow		=		1.50	m/Sec
Discharge		=		43.2	Cumecs
	Say	=		35.00	Cumecs

Discharge (Q)	Q	=		=	35.000	Cumecs
Length of the Linear Water way (m)	L	=	L	=	15.00	m
High Flood depth (m) (From Rainfall Intensity curves)	H_f	=	$\left(\frac{Q}{1.8 \times L}\right)^{(2/3)}$	=	1.19	m
Depth of the George Portion (m)	x	=	x	=	3.20	m
Height of the body wall H (m)	H	=	$h = X - H_f$	=	2.01	m
Free board (m)	f	=	f = 0.5h	=	1.01	m
Height of the Abutment (m)	H'	=	$(H+H_f)$	=	3.20	m

Considering the values as:

Sp. Wt of water (KN/Cu.m)	w	=	10.00	=	10.00
Gravitational constant	g	=	9.81	=	9.81
Unit wt. Of Concrete (KN/Cu.m)	c	=	24.00	=	24.00
Top width of the body wall	a	=	0.75	=	0.75
Batter on the downstream side (H:V)	s	=	1 in 3	=	1 in 3
Coefficient of friction between the wall and soil	μ	=	0.60	=	0.6

Calculation Details - Considering 1 m length of the dam
Condition:
<u>When the Gabion Check Dam is full of Water:</u>

Bottom width (m)	b	=	b	=	1.42
			Say	=	1.10
Horizontal Water thrust (KN)	P	=	$P = \frac{WH^2}{2}$	=	20.22
This Horizontal thrust acts at (from the base of the dam)	t1	=	$t_1 = \frac{H}{3}$	=	0.67

Self Weight of the dam (KN) $W = \left(\frac{W = c\frac{(a+b)}{2} \times 1 \times H}{} \right) = 44.647$

This Self wt. acts through Center of Gravity of the dam section from vertical side of the dam $X = \left(X = \frac{a^2+b^2+ab}{3(a+b)} \right) = 0.47$

Let the resultant force (R) cuts the base at F at a distance Z from the heel (D) $Z = \left(Z = X + \frac{P}{W} \times \frac{H}{3} \right) = 0.77167$

Ecentricity $e = \left(Z - \frac{b}{2} \right) = 0.22$

Check for Ecentricity $= b/6 = 0.18333$

Design is not safe

Negative Sign (e) indicates that the resultant cuts the base within the centre of the base and is towards Heel

Maximum compressive Stress at toe- KN/Sq.m. $C = \left(\frac{W}{b} \frac{(1+6e)}{b} \right) = -8.49$

Minimum comptressive stress at Heel- KN/Sq.m $D = \left(\frac{W}{b} \frac{(1-6e)}{b} \right) = 89.6633$

Condition:
When the Gabion Check Dam is without Water:

In this case, since there is no water, the total force will the total weight of the dam only and it acts through the centre of gravity.ie.,. Z = X

$Z = X = 0.47$

Ecentricity $e = \left(Z - \frac{b}{2} \right) = -0.08$

Check for Ecentricity $= \left(\frac{b}{6} \right) = 0.18333$

Ecentricity is less than b/6, Hence the Design is safe

Negative Sign (e) indicates that the resultant cuts the base within the centre of the base and is towards Heel

Maximum compressive Stress at toe- KN/Sq.m $C = \left(\frac{W}{b} \frac{(1+6e)}{b} \right) = 22.4382$

Minimum comptressive stress at Heel- KN/Sq.m $D = \left(\frac{W}{b} \frac{(1-6e)}{b} \right) = 58.7381$

Check for Stability of the Structure:

Check against Tension

When the Gabion Check Dam is full of Water: **Design is not safe**

When the Gabion Check Dam is without Water: **Ecentricity is less than b/6, Hence the Design is safe**

Check against Sliding $= \mu W > P$

$\mu W = 26.7882$

$P = 20.22$

Hence the structure is safe against Sliding

Check against Overturning $Z < b$

Hence the structure is safe against Overturning

$Z = 0.77167$

$b = 1.1$

Hence the structure is safe against Overturning

Check against Max. Comp stresses $=$ 300 - 400 KN/M2 300

When Gabion Check dam is full of water
At Heel = 89.66
At Toe = -8.5
Hence the structure is safe against Max. Comp stress at Heel
Hence the structure is safe against Max. Comp stress at toe

When Gabion Check dam is without water
At Heel = 22.44
At Toe = 58.74
Hence the structure is safe against Max. Comp stress at Heel
Hence the structure is safe against Max. Comp stress at toe

All the conditions have been satisfied - Hence the structure is safe.

DESIGN OF DUGOUT POND

	Irrigation		Remarks
1	**Type of Crop**	Paddy	
2	**Area of Aycut/Catchment**	10.00	Acres
3	**Area of Catchment in Hac**	4.05	Hac
4	**Water Requirement per acre**	0.57	m
	Livestock		
5	**No. of Cows**	100.00	No.
6	**No. of Buffaloas**	300.00	No.
7	**No. of Goats**	1000.00	No.
8	**No. of Sheeps**	3000.00	No.
9	**No. of Chickens**	50.00	No.
10	**No. of Dogs**	50.00	No.
	Domestic Details		
11	**No. of families**	0	No.
12	**Male**	0	No.
13	**Female**	0	No.
14	**Childrens**	0	No.
15	**Total Population**	0	No.
	Site Area of Dugout Pond		
	Above the G.L		
16	**Length**	20.00	m
17	**Breadth**	20.00	m
18	**Approximate Depth**	2.50	m
19	**Side slopes**	1:2	

Calculations Of Water requirements

1	Irrigation		
	Type of Crop	Paddy	
	Area (acres)	10	Acres
	Water Req (m)	0.57	m

2	Livestock	Per day	for 365 days
	No. of Cows	100	2491125
	No. of Buffaloas	300	7473375
	No. of Goats	1000	4964000
	No. of Sheeps	3000	14892000
	No. of Chickens	50	1643
	No. of Dogs	50	332150

3	Domestic Details		
	No. of families	0	
	Male	0	
	Female	0	
	Childrens	0	
	Total Population	0	0

4	20% for Evaporation and other losses	0.20	

5	Site Area		
	Above the G.L		
	Length (m)	20	
	Bredth (m)	20	
	Below the G.L		
	Approximate Depth (m)	2.5	
	Side slopes	1:2	

Conversion Units			
1 Hac	=	2.471	acres
1 Hac	=	10000	Sq.mt
1 Cu.m	=	1000	Litres
1 Cu.m	=	35.32	Cu.ft
1 Kilo Lit	=	1000	Litres

Water requirement in liters				
68.25	Lit Per day	For 365 Days	=	24911
68.25	Lit Per day	For 365 Days	=	24911
13.60	Lit Per day	For 365 Days	=	4964
13.60	Lit Per day	For 365 Days	=	4964
0.09	Lit Per day	For 365 Days	=	33
18.20	Lit Per day	For 365 Days	=	6643

Per capita demand per day				
75		For 365 days	=	27375

Considering	5	
members in each familily		

Anticipated rainfall Consideration:			
In Medium rainfall regions			
1 Hac =	200	Cu.m of water	
In Low rainfall regions			
1 Hac =	100	Cu.m of water	

DESIGN OF THE DUGOUT POND

Water requirement Calculations

I. Design Consideration as per existing requirements:

1	Irrigation		Units
	Type of Crop	Paddy	
	Area	10.00	Acres
	Area	4	Hac
	Area	40469	Sq.mt
	Water Req	0.57	m
	Quantity	23068	Cu.m
	Quantity	23067584	Lit
2	Livestock		
	No. of Cows	2491125	Lit
	No. of Buffaloas	7473375	Lit
	No. of Goats	4964000	Lit
	No. of Sheeps	14892000.0	Lit
	No. of Chickens	1642.5	Lit
	No. of Dogs	332150.0	Lit
	Quantity	30154293	Lit
3	Domestic Details		
	No. of families	0	Lit
	Male	0	LIt
	Female	0	Lit
	Childrens	0	Lit
	Quantity	0	Lit
	Total Quantity of Water required	53221876	Lit
	20% for Evaporation and other losses	10644375	Lit
	Total Quantity of Water required	63866252	Lit
	Total Quantity of Water required	**63866.25**	**K Lit**

Calculation of Dimensions:

Dimensions of Dugout Pond		
Above the Ground Level		
Length	20.00	m
Breadth	20.00	m
Below the Ground Level		
Approximate Depth	2.50	m
Side slopes	1.00	
Length	15.00	m
Breadth	15.00	m
Center Line		
Depth to the Center (m)	1.25	m
Length	17.5	m
Breadth	17.5	m
Quantity of Earthwork to be excavate	656.25	Cu.m
Quantity of Water can be Store	656.25	Cu.m
Quantity of Water can be Store	656250	Lit
Stone Requirement		
Length	17.50	m
Breadth	17.50	m
Slope Length (m)	3.54	m
No. of Sides	4.00	
A 500mm thick dry rubble pitching is to be provided on the sides of the dugout pond - below the G.L	0.50	m
Quantity of Stone requirement (Cu.m)	123.74	Cu.m

II. Design Consideration from Anticipated runoff:			
Considering the Meidum rainfall regions			
Area of Catchment	=	4.05	Hac
Total Quanity of water yeid from Catchment	=	809.39	Cu.m
Total Quanity of water yeid from Catchment	=	809388.91	Lit
Quantity of water stored in the Proposed Dugout pond	=	656.25	Cu.m
Quantity of water stored in the Proposed Dugout pond	=	656250	Lit
Quantity of water stored in the Proposed Dugout pond	=	656.25	K Lit
No. of Fillings	=	1	No.s

BILL OF QUANTITIES FOR THE OPEN WELL - RECHARGE STRUCTURE										
							Strl Code:		CBT - 001 (B)	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	Upto a depth of 3m	Cum	1.00	3.86	1.00	3.00	11.59			
	More than 3m depth	Cum	1.00	3.86	1.00	0.32	1.24			
	Sub Total						**12.82**			
2	Supplying, laying and fixing of the Perforated PVC pipe (IS 13592-2000) of 160mm dia of 6 kg/Sq.cm along with all bends, elbows, Tee and other accessories etc in complete asepcts as directed by the Engineer-in-charge	m	1.00	50.00	1.00	1.00	50.00			
3	Supplying, laying and fixing of the charcoal of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	kg	1.00	3.86	1.00	0.50	598.64			
4	Supplying, laying and fixing of the Gravel of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	Cum	1.00	3.86	1.00	0.50	1.93			
5	Supplying, laying and fixing of the Fine Sand for the filter media	Cum	1.00	3.86	1.00	0.50	1.93			
6	Supplying, laying and fixing of the 110mm dia of PVC pipe (IS 13592-2000) with of 6 kg/Sq.cm along with all accessories, washers, nuts and bolts, nails, etc for complete item of work for fixing the down pipe and connecting to the well	m	1.00	20.00	1.00	1.00	20.00			
	SUB TOTAL - I									
7	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
8	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: **ONLY)**

BILL OF QUANTITIES FOR THE TUBE WELL - ROOF TOP RAIN WATER HARVESTING RECHARGE STRUCTURE										
							Strl Code:		CBT - 002 (A)	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	Upto a depth of 3m	Cum	1.00	2.46	2.46	3.00	18.15			
	For Connecting Pipe line	Cum	1.00	1.50	1.50	3.00	6.75			
	More than 3m depth	Cum	1.00	2.46	2.46	0.55	3.33			
	For Connecting Pipe line	Cum	1.00	1.50	1.50	0.32	0.72			
	For the PVC Pipe Line alignment	Cum	1.00	100.00	0.60	0.60	36.00			
	Sub Total						**64.95**			
2	Supplying, laying and fixing of the Perforated PVC pipe (IS 13592-2000) of 160mm dia of 6 kg/Sq.cm along with all bends, elbows, Tee and other accessories etc in complete asepcts as directed by the Engineer-in-charge	m	1.00	15.00	1.00	1.00	15.00			
2.a)	Supplying, laying and fixing of the PVC pipe (IS 13592-2000) of 160mm dia of 6 kg/Sq.cm along with all bends, elbows, Tee and other accessories etc in complete asepcts as directed by the Engineer-in-charge - For Horizontal Alignment of the Building	m	1.00	100.00	1.00	1.00	100.00			
2.b)	Supplying, laying and fixing of the PVC pipe (IS 13592-2000) of 160mm dia of 6 kg/Sq.cm along with all bends, elbows, Tee and other accessories etc in complete asepcts as directed by the Engineer-in-charge - For Vertical Alignment of the Building	m	1.00	35.00	1.00	1.00	35.00			
3	Supplying, laying and fixing of the charcoal of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	kg	1.00	2.00	2.00	0.50	620.00			
4	Supplying, laying and fixing of the Gravel of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	Cum	1.00	2.00	2.00	0.50	2.00			

BILL OF QUANTITIES FOR THE TUBE WELL - ROOF TOP RAIN WATER HARVESTING RECHARGE STRUCTURE										
							Strl Code:	CBT - 002 (A)		
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
5	Supplying, laying and fixing of the Fine Sand for the filter media	Cum	1.00	2.00	2.00	0.50	2.00			
6	Supplying, laying and fixing of the Coconut coil for the filter media	kg	1.00	2.00	2.00	0.50	704.00			
7	Supplying, laying and fixing of the 110mm dia of PVC pipe (IS 13592-2000) with of 6 kg/Sq.cm along with all accessories, washers, nuts and bolts, nails, etc for complete item of work for fixing the down pipe and connecting to the well	m	1.50	20.00	1.00	1.00	30.00			
8	Reinforced Brick Masonry for partition walls (23.0 cm thick) in CM (1:4) prop. (Cement : Screened sand) using common burnt clay bricks of class as per Table- I of IS:1077-1992, Non- Modular or traditional size 23 x 11 x 7 cms from approved source having minimum crushing strength of 40 Kg/Sq.cm and placing 2 Nos. of 6mm M.S plain rods in every third layer with free ends of the reinforcement pegged into mortar joints of main brick walls where applicable including cost and conveyance of all materials like cement, steel, sand, bricks, water etc., to site, including sales & other taxes on all materials, all operational, incidental charges such as labour charges for mixing cement mortar, scaffolding charges, constructing masonry, lift charges, curing, etc., and overheads & contractors profit but excluding cost of steel and its fabrication charges for complete for finished item of work.	Cum	1.00	8.92	0.23	3.32	6.81			
	SUB TOTAL - I									
9	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
10	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: ONLY)

BILL OF QUANTITIES FOR THE TUBE WELL - SURFACE WATER HARVESTING RECHARGE STRUCTURE										
							Strl Code:		CBT - 002 (C)	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	Upto a depth of 3m	Cum	1.00	3.30	3.30	2.65	28.86			
	Sub Total						**28.86**			
2	PCC (1:3:6) mix using 40mm size HBG Machine crushed stone aggregate and fine aggregate conforming to table 1000-2 of MoRT&H including cost and conveyance of all materials to site and labour charges for centering, machine mixing, laying, Vibrating, curing etc., including all other incidental and operational charges of all T&P (excluding Seignorage charges) etc., complete for finished item of work as per MoRT&H specification 1500,1700, 2100 (4th Revision) and as directed by the Engineer-in-Charge for foundations for levelling course.	Cum	1.00	3.30	3.30	0.15	1.63			
3	Reinforced Brick Masonry for partition walls (23.0 cm thick) in CM (1:4) prop. (Cement : Screened sand) using common burnt clay bricks of class as per Table- I of IS:1077-1992, Non- Modular or traditional size 23 x 11 x 7 cms from approved source having minimum crushing strength of 40 Kg/Sq.cm and placing 2 Nos. of 6mm M.S plain rods in every third layer with free ends of the reinforcement pegged into mortar joints of main brick walls where applicable including cost and conveyance of all materials like cement, steel, sand, bricks, water etc., to site, including sales & other taxes on all materials, all operational, incidental charges such as labour charges for mixing cement mortar, scaffolding charges, constructing masonry, lift charges, curing, etc., and overheads & contractors profit but excluding cost of steel and its fabrication charges for complete for finished item of work.	Cum	1.00	11.08	0.23	3.95	10.07			

BILL OF QUANTITIES FOR THE TUBE WELL - SURFACE WATER HARVESTING RECHARGE STRUCTURE										
							Strl Code:		CBT - 002 (C)	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
4	Plastering 12mm thick in two coats using screened sand with base coat of 8mm thick in CM (1:6) and top coat of 4mm thick in CM (1:4) with dubara sponge finishing including cost and conveyance of all materials like cement, sand, water etc., to site, including sales & other taxes on all materials, and all operational, incidental charges on materials and including cost of all labour charges for mixing mortar, finishing, scaffolding, lift charges, curing, including cutting grooves as directed by Engineer-in-charge etc., and overheads & contractors profit complete for finished item of work. (SS 901,903 & 904).	Sq.mt	1.00	10.16	1.00	8.36	84.94			
5	Supplying, laying and fixing of the charcoal of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	kg	1.00	2.54	2.54	1.00	2000.00			
6	Supplying, laying and fixing of the Gravel of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	Cum	1.00	2.54	2.54	0.50	3.23			
7	Supplying, laying and fixing of the Fine Sand for the filter media	Cum	1.00	2.54	2.54	0.50	3.23			
8	Supplying, laying and fixing of the Coconut coil for the filter media	kg	1.00	2.54	2.54	0.50	1135.48			
	SUB TOTAL - I									
9	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
10	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: **ONLY)**

BILL OF QUANTITIES FOR THE ROAD JUNCTION - RECHARGE STRUCTURE										
							Strl Code:		CBT - 003	
S.No	**Description of Item of Work**	**Unit**	**No's**	**Length**	**Width**	**Depth**	**Quantity**	**Rate Rs. Ps.**	**Amount**	**Remarks**
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	Upto a depth of 3m	Cum	1.00	8.00	1.50	3.00	36.00			
	Upto a depth of 3m	Cum	2.00	8.60	0.45	0.45	3.48			
	Upto a depth of 3m	Cum	2.00	1.50	0.30	0.45	0.41			
		Cum					**39.89**			
	More than 3m depth	Cum	1.00	8.00	1.50	0.32	3.84			
2	Supplying, laying and fixing of the I Sectional beam of size 100 x 100mm x 19.3 kg/m thick in both axis with butt weilding of minimum 10mm size	m	1.00	15.00	1.00	1.00	15.00			
	Horizontal Direction	kgs	16.00	8.60	1.00	19.30	2655.68			
	Vertical Direction	kgs	80.00	2.40	1.00	19.30	3705.60			
		kgs					**6376.28**			
3	Supplying, laying and fixing of the charcoal of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	kg	1.00	8.00	1.50	0.50	1860.00			
4	Supplying, laying and fixing of the Gravel of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	Cum	1.00	8.00	1.50	0.50	6.00			

BILL OF QUANTITIES FOR THE ROAD JUNCTION - RECHARGE STRUCTURE										
							Strl Code:		CBT - 003	
S.No	**Description of Item of Work**	**Unit**	**No's**	**Length**	**Width**	**Depth**	**Quantity**	**Rate Rs. Ps.**	**Amount**	**Remarks**
5	Supplying, laying and fixing of the Fine Sand for the filter media	Cum	1.00	8.00	1.50	0.50	6.00			
6	Supplying, laying and fixing of the Coconut coil for the filter media	kg	1.00	8.00	1.50	0.50	2112.00			
	SUB TOTAL - I									
7	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
8	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: **ONLY)**

BILL OF QUANTITIES FOR THE WATER STAGNATION/FLOODING - RECHARGE STRUCTURE										
							Strl Code:		CBT - 004	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	Upto a depth of 3m	Cum	1.00	3.00	3.00	3.00	27.00			
	Upto a depth of 3m	Cum	1.00	4.16	4.06	0.73	12.33			
	Upto a depth of 3m	Cum	1.00	4.16	4.06	1.07	18.07			
		Cum					**57.40**			
2	Reinforced Brick Masonry for partition walls (23.0 cm thick) in CM (1:4) prop. (Cement : Screened sand) using common burnt clay bricks of class as per Table- I of IS:1077-1992, Non- Modular or traditional size 23 x 11 x 7 cms from approved source having minimum crushing strength of 40 Kg/Sq.cm and placing 2 Nos. of 6mm M.S plain rods in every third layer with free ends of the reinforcement pegged into mortar joints of main brick walls where applicable including cost and conveyance of all materials like cement, steel, sand, bricks, water etc., to site, including sales & other taxes on all materials, all operational, incidental charges such as labour charges for mixing cement mortar, scaffolding charges, constructing masonry, lift charges, curing, etc., and overheads & contractors profit but excluding cost of steel and its fabrication charges for complete for finished item of work.	Cum	1.00	15.52	0.23	1.73	6.18			
3	PCC (1:3:6) mix using 40mm size HBG Machine crushed stone aggregate and fine aggregate conforming to table 1000-2 of MoRT&H including cost and conveyance of all materials to site and labour charges for centering, machine mixing, laying, Vibrating, curing etc., including all other incidental and operational charges of all T&P (excluding Seignorage charges) etc., complete for finished item of work as per MoRT&H specification 1500,1700, 2100 (4th Revision) and as directed by the Engineer-in-Charge for foundations for levelling course.	Cum	1.00	15.52	0.23	0.30	1.07			
4	Supplying, laying and fixing of the Fine Sand for the filter media									
	Upto a depth of 3m	Cum	1.00	3.00	3.00	3.00	27.00			
	Upto a depth of 3m	Cum	1.00	4.16	4.06	0.73	12.33			
	Upto a depth of 3m	Cum	1.00	4.16	4.06	1.07	18.07			
		Cum					**57.40**			

BILL OF QUANTITIES FOR THE WATER STAGNATION/FLOODING - RECHARGE STRUCTURE										
							Strl Code:		CBT - 004	
S.No	**Description of Item of Work**	**Unit**	**No's**	**Length**	**Width**	**Depth**	**Quantity**	**Rate Rs. Ps.**	**Amount**	**Remarks**
6	Supplying, laying and fixing of 300mm x 300mm x 60 mm thick factory made cement concrete interlocking perforated paver block of M-35 grade (confirming to IS: 15658: 2006)/Cement Concrete blocks made by block making machine with strong vibratory compaction, using PU/rubber mould of approved size, design & shape, laid in required colour and pattern over and including 20 mm thick bed of cement mortar of 1:4 (1 Cement: 4 coarse sand) including grouting of joints with cement slurry of matching colour. All complete as per the direction of engineer in charge. Make Hindustan Tiles/NIMCO Tiles/ NITCO/NTC.	Cum	1.00	3.70	3.60	0.30	4.00			
	SUB TOTAL - I									
7	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
8	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: **ONLY)**

BILL OF QUANTITIES FOR THE FOOTPATH - RECHARGE STRUCTURE										
							Strl Code:		CBT - 005	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	Upto a depth of 3m	Cum	1.00	2.80	2.20	3.00	18.48			
	More than 3m dpeth	Cum	1.00	2.80	2.20	1.10	6.78			
	Sub Total						**25.26**			
2	Reinforced Brick Masonry for partition walls (23.0 cm thick) in CM (1:4) prop. (Cement : Screened sand) using common burnt clay bricks of class as per Table-I of IS:1077-1992, Non- Modular or traditional size 23 x 11 x 7 cms from approved source having minimum crushing strength of 40 Kg/Sq.cm and placing 2 Nos. of 6mm M.S plain rods in every third layer with free ends of the reinforcement pegged into mortar joints of main brick walls where applicable including cost and conveyance of all materials like cement, steel, sand, bricks, water etc., to site, including sales & other taxes on all materials, all operational, incidental charges such as labour charges for mixing cement mortar, scaffolding charges, constructing masonry, lift charges, curing, etc., and overheads & contractors profit but excluding cost of steel and its fabrication charges for complete for finished item of work.	Cum	1.00	10.00	0.30	4.10	12.30			
3	Supplying, laying and fixing of the charcoal of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	kg	1.00	2.20	2.20	0.50	750.20			
4	Supplying, laying and fixing of the Gravel of size 20mm to 40mm from smallest size on top to bigger size at the bottom for the filter media	Cum	1.00	2.20	2.20	0.50	2.42			
5	Supplying, laying and fixing of the Fine Sand for the filter media	Cum	1.00	2.20	2.20	0.50	2.42			
6	Supplying, laying and fixing of the coconut fibre for the filter media	Cum	1.00	2.20	2.20	0.50	851.84			

BILL OF QUANTITIES FOR THE FOOTPATH - RECHARGE STRUCTURE										
							Strl Code:		CBT - 005	
S.No	**Description of Item of Work**	**Unit**	**No's**	**Length**	**Width**	**Depth**	**Quantity**	**Rate Rs. Ps.**	**Amount**	**Remarks**
7	Supplying, laying and fixing of 300mm x 300mm x 60 mm thick factory made cement concrete interlocking perforated paver block of M-35 grade (confirming to IS: 15658: 2006)/Cement Concrete blocks made by block making machine with strong vibratory compaction, using PU/rubber mould of approved size, design & shape, laid in required colour and pattern over and including 20 mm thick bed of cement mortar of 1:4 (1 Cement: 4 coarse sand) including grouting of joints with cement slurry of matching colour. All complete as per the direction of engineer in charge. Make Hindustan Tiles/NIMCO Tiles/ NITCO/NTC.	Cum	1.00	3.50	3.50	0.30	3.68			
8	Supplying, laying and fixing of the MS Square Bars of size 25mm x 25mm of spacing 50mm x 50mm in both axis with butt weilding complete in all aspects as per the standard specifications									
	Horizontal Direction	kgs	12.00	2.80	1.00	4.90	164.64			
	Vertical Direction	kgs	56.00	0.60	1.00	4.90	164.64			
		kgs					**329.28**			
	SUB TOTAL - I									
8	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
9	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: **ONLY)**

BILL OF QUANTITIES FOR THE STORM WATER SOAKWAY - RECHARGE STRUCTURE										
							Strl Code:		CBT - 005	
S.No	**Description of Item of Work**	**Unit**	**No's**	**Length**	**Width**	**Depth**	**Quantity**	**Rate Rs. Ps.**	**Amount**	**Remarks**
1	Drilling of bore holes of 150mm dia upto a depth of 10m within the existing storm water drain for the percolation of the storm water									
	Upto a depth of 10m	m	1.00	-	-	10.00	10.00			
2	Supplying, laying and fixing/Inserting of the Perforated PVC pipe (IS 13592-2000) of 150mm dia of 6 kg/Sq.cm along with all bends, elbows, Tee and other accessories etc in complete asepcts as directed by the Engineer-in-charge	m	1.00	10.00	1.00	1.00	10.00			
3	Filling of the broken brick bats within the bore hole pipe and also around the bore hole on the surface of drain	cum	1.00	0.75	0.75	0.75	0.44			
4	Supplying, laying and fixing of RCC perforated (1 x 0.75 x 0.1m) cover along with the inverted earthen pot cover for the bore hole and fixing within the brick bats firmly in all aspects	LS	1.00	1.00	1.00	1.00	1.00			
5	Resortation of the damaged storm water drain walls as per the original existing sectional detials at the selected drains locations and bringing back to the orignal sectional drain conditons	LS	1.00	1.00	1.00	1.00	1.00			
	SUB TOTAL - I									
6	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
7	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: ONLY)

BILL OF QUANTITIES FOR THE DUGOUT POND - RECHARGE STRUCTURE										
							Strl Code:		CBT - 007	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	As per design calculations sheet	Cum	1.00	1.00	1.00	1.00	656.25			
2	Supplying, Laying and fixing of the stone revetment of 500mm thick random rubble stone masonary on all four sides of the dugout pond as per the drawing and specifications upto the total depth as directed by the Engineering in charge									
	As per design calculations sheet	Cum	1.00	1.00	1.00	1.00	123.74			
	SUB TOTAL - I									
3	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
4	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: **ONLY)**

BILL OF QUANTITIES FOR THE GABION CHECK DAM - RECHARGE STRUCTURE										
							Strl Code:		CBT - 008	
S.No	**Description of Item of Work**	**Unit**	**No's**	**Length**	**Width**	**Depth**	**Quantity**	**Rate Rs. Ps.**	**Amount**	**Remarks**
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	Upstream Cutoff Wall - Upto 3m depth	Cum	1.00	15.00	0.45	3.00	20.25			
	Downstream Cutoff Wall - Upto 3m depth	Cum	1.00	15.00	0.45	3.00	20.25			
	Upstream launching apron	Cum	1.00	15.00	2.18	0.90	29.43			
	launching apron below the body wall of gabion check dam	Cum	1.00	15.00	2.18	0.70	22.89			
	Downstream launching apron	Cum	1.00	15.00	3.45	0.60	31.05			
	Retaining wall	Cum	2.00	9.01	1.30	0.60	14.06			
		Cum					**137.93**			
	Upstream Cutoff Wall - More than 3m depth	Cum	1.00	15.00	0.45	0.53	3.58			
	Downstream Cutoff Wall - More than 3m depth	Cum	1.00	15.00	0.45	0.74	5.00			
		Cum					**8.57**			
2	Supplying, Laying and fixing of the stones of 300mm size random rubble stone masonary for the Gabion Check Dam as per the drawing and specifications upto the total depth as directed by the Engineering in charge									
	Upstream Cutoff Wall - Upto 3m depth	Cum	1.00	15.00	0.45	3.00	20.25			
	Downstream Cutoff Wall - Upto 3m depth	Cum	1.00	15.00	0.45	3.00	20.25			
	Upstream launching apron	Cum	1.00	15.00	2.18	0.90	29.43			
	launching apron below the body wall of gabion check dam	Cum	1.00	15.00	2.18	0.70	22.89			
	Downstream launching apron	Cum	1.00	15.00	3.45	0.60	31.05			
	Retaining wall	Cum	2.00	9.01	1.30	0.60	14.06			
	Upstream Cutoff Wall - More than 3m depth	Cum	1.00	15.00	0.45	0.53	3.58			
	Downstream Cutoff Wall - More than 3m depth	Cum	1.00	15.00	0.45	0.74	5.00			
	Gabion Check Dam - Body Wall	Cum	1.00	15.00	0.93	2.00	27.75			
	Retaining wall - Body Wall	Cum	2.00	9.01	0.65	3.00	35.14			
		Cum					**209.39**			

BILL OF QUANTITIES FOR THE GABION CHECK DAM - RECHARGE STRUCTURE										
							Strl Code:		CBT - 008	
S.No	**Description of Item of Work**	**Unit**	**No's**	**Length**	**Width**	**Depth**	**Quantity**	**Rate Rs. Ps.**	**Amount**	**Remarks**
3	Supplying, Laying and fixing G.I Chiecken Wire mesh of diamond shape Should be of weave type of Hexagonal with thickness of 2.5mm in a 50ft roll of corrosion resistant (preferably used for the defence) of size 50 x 50mm size or as per the manufacturer standard for the entire peheriperal of the Gabion Check Dam as per the drawing and specifications as directed by the Engineering in charge									
	Top Surface of the Gabion check dam	Sq.mt	1.00	15.00	9.91	1.00	148.65			
	Gabion Check dam body wall	Sq.mt	1.00	15.00	5.00	1.00	75.00			
	Retaining wall - Body Wall	Sq.mt	2.00	9.01	7.00	1.00	126.14			
		Sq.mt					**349.79**			
	SUB TOTAL - I									
8	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
9	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

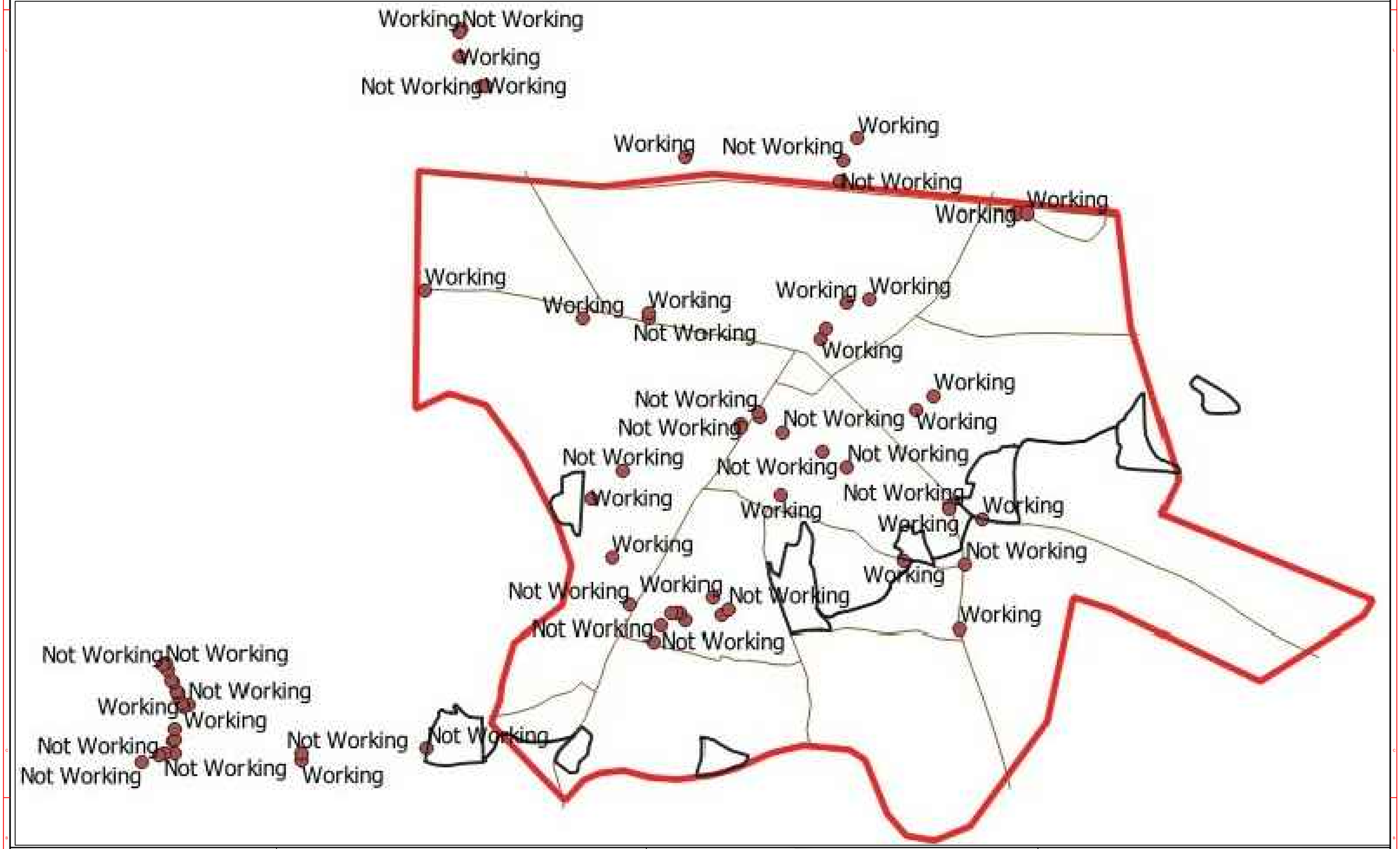
(IN WORDS: **ONLY)**

BILL OF QUANTITIES FOR THE CHECK DAM - RECHARGE STRUCTURE										
							Strl Code:		CBT - 009	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
1	Earth work in excavation of foundation of structures as per drawing and technical specification, including setting out, construction of shoring and bracing, removal of stumps and other deleterious matter, dressing of sides and bottom and back filling with approved material as per MORT&H specification no.304 in ordinary soils upto SDR soils using Machinery.									
	Upstream toe/return walls	Cum	1.00	26.67	0.80	1.80	38.40			
	Downstream toe/return walls	Cum	1.00	24.41	0.80	1.80	35.15			
	Upstream loose stone apron	Cum	1.00	18.77	5.00	0.45	42.23			
	Downstream loose stone apron	Cum	1.00	17.27	4.70	0.45	36.52			
	Upstream solid apron	Cum	1.00	15.94	3.00	0.45	21.51			
	Downstream solid apron	Cum	1.00	15.56	3.00	0.45	21.01			
	Upstream cutoff wall	Cum	1.00	15.94	0.50	1.35	10.76			
	Downstream cutoff wall	Cum	1.00	15.56	0.50	1.35	10.50			
	Upstream wing walls	Cum	2.00	8.15	1.30	1.80	38.14			
	Downstream wing walls	Cum	2.00	7.86	1.30	1.80	36.78			
	Abutment walls	Cum	2.00	1.75	1.30	1.80	8.19			
		Cum					**299.20**			
2	PCC (1:3:6) mix using 40mm size HBG Machine crushed stone aggregate and fine aggregate conforming to table 1000-2 of MoRT&H including cost and conveyance of all materials to site and labour charges for centering, machine mixing, laying, Vibrating, curing etc., including all other incidental and operational charges of all T&P (excluding Seignorage charges) etc., complete for finished item of work as per MoRT&H specification 1500,1700, 2100 (4th Revision) and as directed by the Engineer-in-Charge for foundations for levelling course.									
	Upstream toe/return walls	Cum	1.00	26.67	0.80	0.30	6.40			
	Downstream toe/return walls	Cum	1.00	24.41	0.80	0.30	5.86			
	Upstream solid apron	Cum	1.00	15.94	3.00	0.45	21.51			
	Downstream solid apron	Cum	1.00	15.56	3.00	0.45	21.01			
	Upstream cutoff wall	Cum	1.00	15.94	0.50	0.50	3.98			
	Downstream cutoff wall	Cum	1.00	15.56	0.50	0.50	3.89			
	Upstream wing walls	Cum	2.00	8.15	1.30	0.30	6.36			
	Downstream wing walls	Cum	2.00	7.86	1.30	0.30	6.13			
	Abutment walls	Cum	2.00	1.75	1.30	0.30	1.37			
		Cum					**76.50**			

BILL OF QUANTITIES FOR THE CHECK DAM - RECHARGE STRUCTURE										
							Strl Code:		CBT - 009	
S.No	**Description of Item of Work**	**Unit**	**No's**	**Length**	**Width**	**Depth**	**Quantity**	**Rate Rs. Ps.**	**Amount**	**Remarks**
3	Providing and laying Boulders apron on river bed for protection against scour with stone boulders not less than 40 Kgs each etc., complete as per drawing and technical specifications as per MoRTH Specification No: 2507.20									
	Upstream loose stone apron	Cum	1.00	18.77	5.00	0.45	42.23			
	Downstream loose stone apron	Cum	1.00	17.27	4.70	0.45	36.52			
		Cum					**78.75**			
4	Providing and constructing stone masonary work in Cement mortar in 1:4 in foundation complete as per drawings and technical specifications including cost of all materials, labor, HOM curing form works, scaffolding and centering as per spcificaitons, A. Random Rubble masonary (Coursed/uncoursed) Morth specificaitons 1405.4									
	Below Ground Level									
	Upstream toe/return walls	Cum	1.00	26.67	0.80	1.50	32.00			
	Downstream toe/return walls	Cum	1.00	24.41	0.80	1.50	29.29			
	Upstream wing walls	Cum	2.00	8.15	1.30	1.50	31.79			
	Downstream wing walls	Cum	2.00	7.86	1.30	1.50	30.65			
	Abutment walls	Cum	2.00	1.75	1.30	1.50	6.83			
	Above Ground Level									
	Upstream toe/return walls	Cum	1.00	26.67	0.50	1.00	13.34			
	Downstream toe/return walls	Cum	1.00	24.41	0.50	1.00	12.21			
	Upstream wing walls	Cum	2.00	8.15	0.65	2.00	21.19			
	Downstream wing walls	Cum	2.00	7.86	0.65	2.00	20.44			
	Abutment walls	Cum	2.00	1.75	0.65	3.00	6.83			
		Cum					**204.55**			
5	Providing and laying Design Mix M25 with OPC @ 340 kgs with 40mm and down size graded granite metal coarse aggregates @ 0.7 cum and fine aggregates @ 0.47 cum with superplastisier @ 3lts confirming to IS 9103 - 1999 reaffirmed - 2008 Including cost of materials, labour, HOM Curing, forms works, scaffolding, and centering complete as per specifications - for height upto 5m									
	Check Dam Body wall - Below the Ground Level	Cum	1.00	15.00	1.75	1.50	39.38			
	Check Dam Body wall - Above the Ground Level	Cum	1.00	15.00	0.93	2.00	27.75			
		Cum					**67.13**			

BILL OF QUANTITIES FOR THE CHECK DAM - RECHARGE STRUCTURE										
							Strl Code:		CBT - 009	
S.No	Description of Item of Work	Unit	No's	Length	Width	Depth	Quantity	Rate Rs. Ps.	Amount	Remarks
6	Providing HYSD bars (Fe-500) of 10mm diameter, wrought and put up bars including cost and conveyance of steel to site and all labour charges for fabrication of reinforcement including cutting, bending, binding rods, tying grills, placing them in position etc., complete including cost and conveyance of binding wire and all handling charges and operational charges etc., and including over lapping welding if required etc., complete for all for skin reinforcement @ 5 kg/Sq.mt on the surface of solid apron and check dam body wall for finished item of work as per standard drawings, as per the directions of the Engineer-in-Charge.									
	Upstream surface solid apron	Sq.mt	1.00	15.94	3.55	-	56.57			
	Downstream surface solid apron	Sq.mt	1.00	15.56	3.85	-	59.91			
	Check Dam body wall	Sq.mt	1.00	15.00	4.78	-	71.70			
	5 kgs/Sq.mt	**kgs**	**5.00**				**188.18**			
	SUB TOTAL - I									
8	Add 10% for contingencies and for Unforeseen & Miscellaneous items	LS					0.10			
	SUB TOTAL - II									
9	**Total No. of Structures Proposed**	**No's**	**1.00**							
	GRAND TOTAL									

(IN WORDS: **ONLY)**



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QUALITY ASSURANCE

Verification of accuracy, correctness and completeness in respect of design analysis and drawings are assured by respective design consultant.

By Designer			
Sig.			
Date			
Name			
	Drawn By	Checked By	Approved By

CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

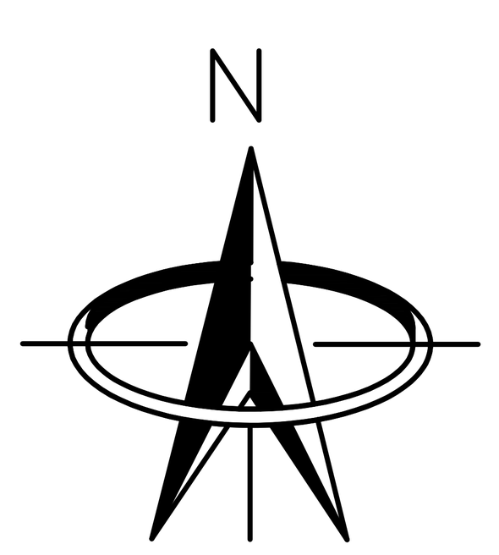
DRAWING TITLE: INVESTIGATED WORKING & NON-WORKING OPEN & TUBE WELLS MAPS

REV 0

Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/MAPS/001

SCALE :- NTS



QUALITY ASSURANCE			
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By Designer			
Sig.			
Date			
Name			
	Drawn By	Checked By	Approved By

CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: GESTS
Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

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DRAWING TITLE: LOCATION OF PROPOSED OPEN WELL - RECHARGE STRUCTURES

REV 0

Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/MAPS/002

SCALE :- NTS

N

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CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

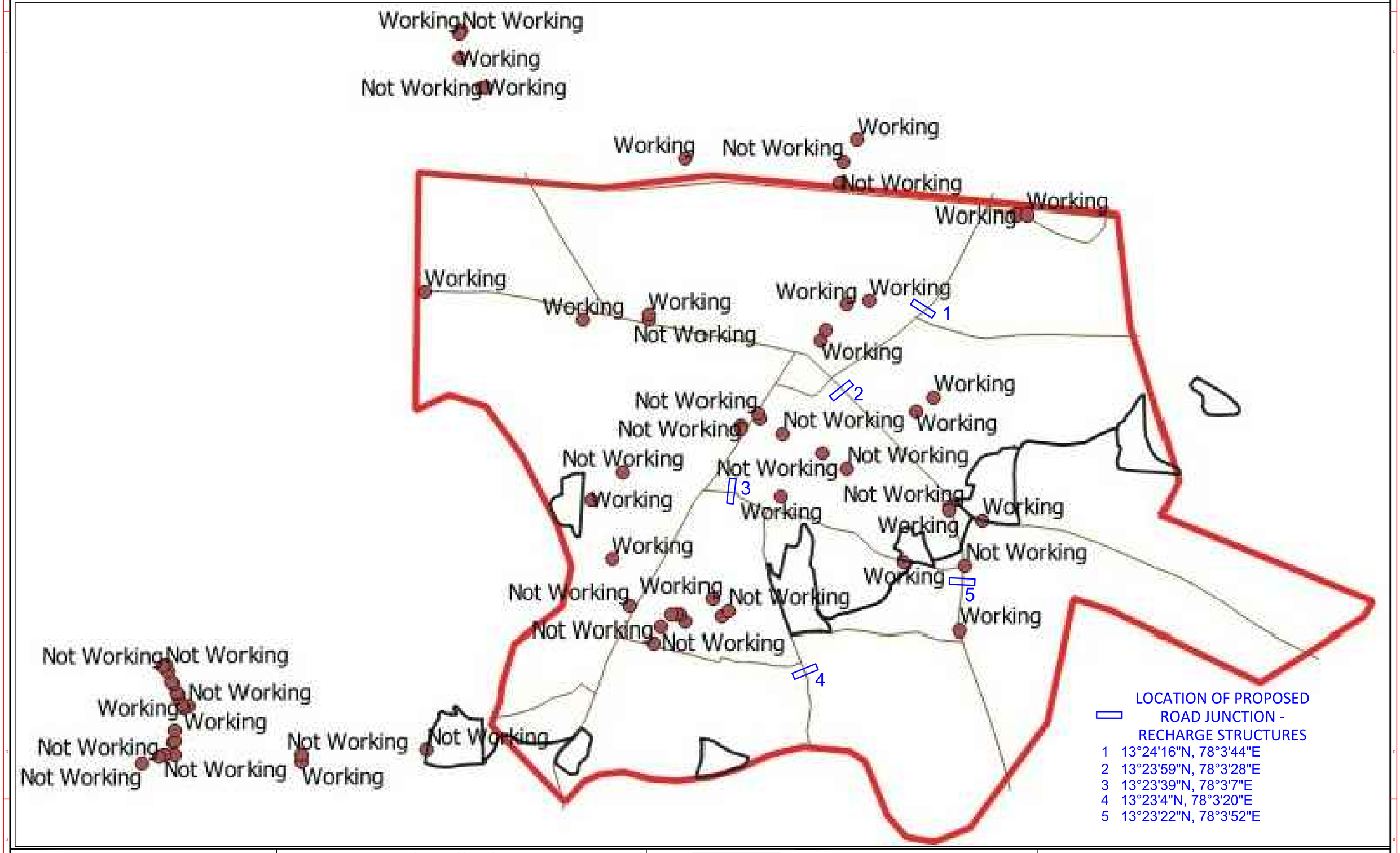
DRAWING TITLE: LOCATION OF PROPOSED TUBE WELL - RECHARGE STRUCTURES

REV 0

Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/MAPS/003

SCALE :- NTS



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Date			
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CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

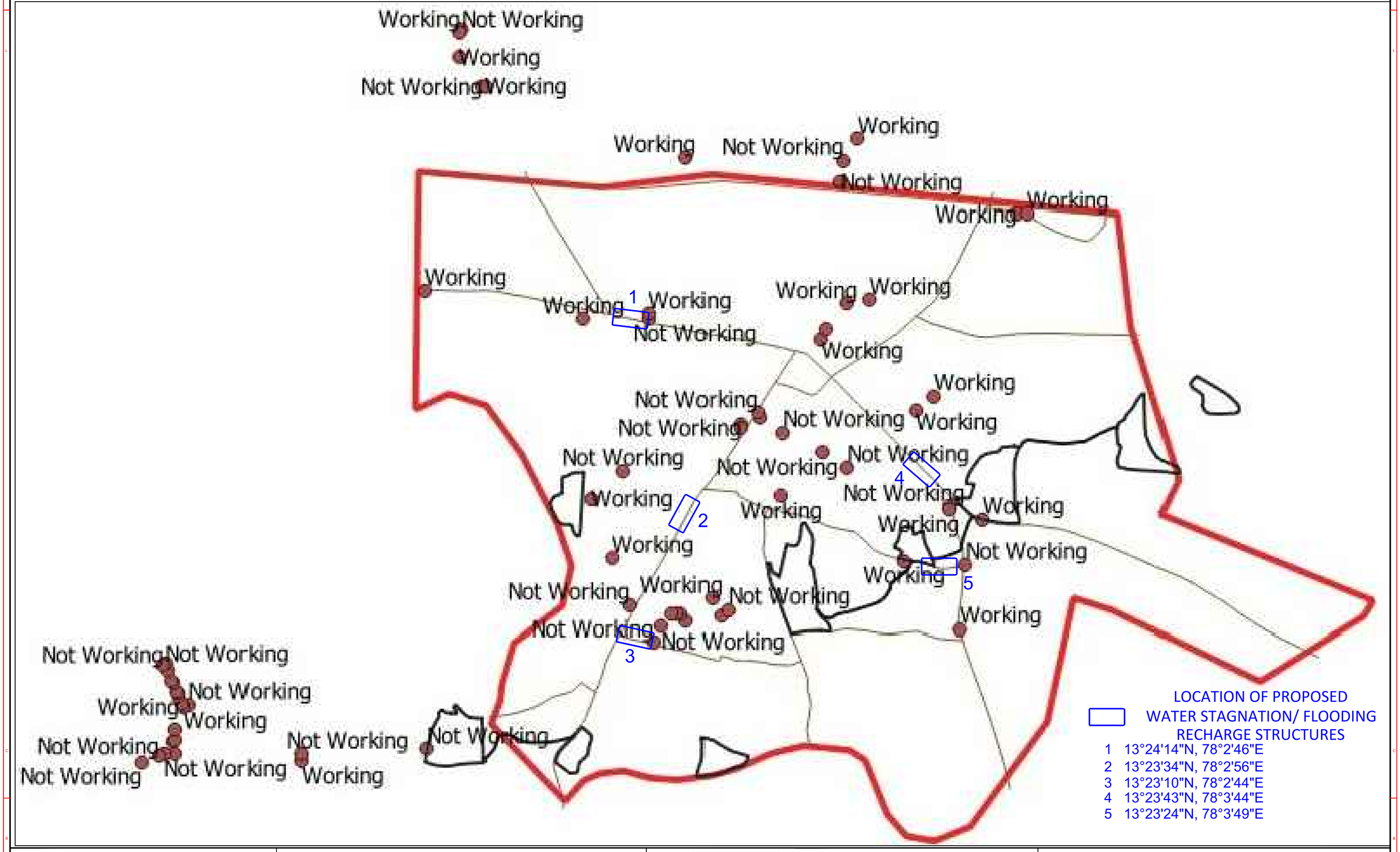
DRAWING TITLE: LOCATION OF PROPOSED ROAD JUNCTION - RECHARGE STRUCTURES

REV 0

	Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/MAPS/004

SCALE :- NTS



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CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: LOCATION OF PROPOSED WATER STAGNATION/FLOODING RECHARGE STRUCTURES

REV 0

Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/MAPS/005

SCALE :- NTS

N

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Date			
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CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS:

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: LOCATION OF PROPOSED FOOTPATH - RECHARGE STRUCTURES

REV 0

Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/MAPS/006

SCALE :- NTS

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QUALITY ASSURANCE

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CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in
GESTS

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

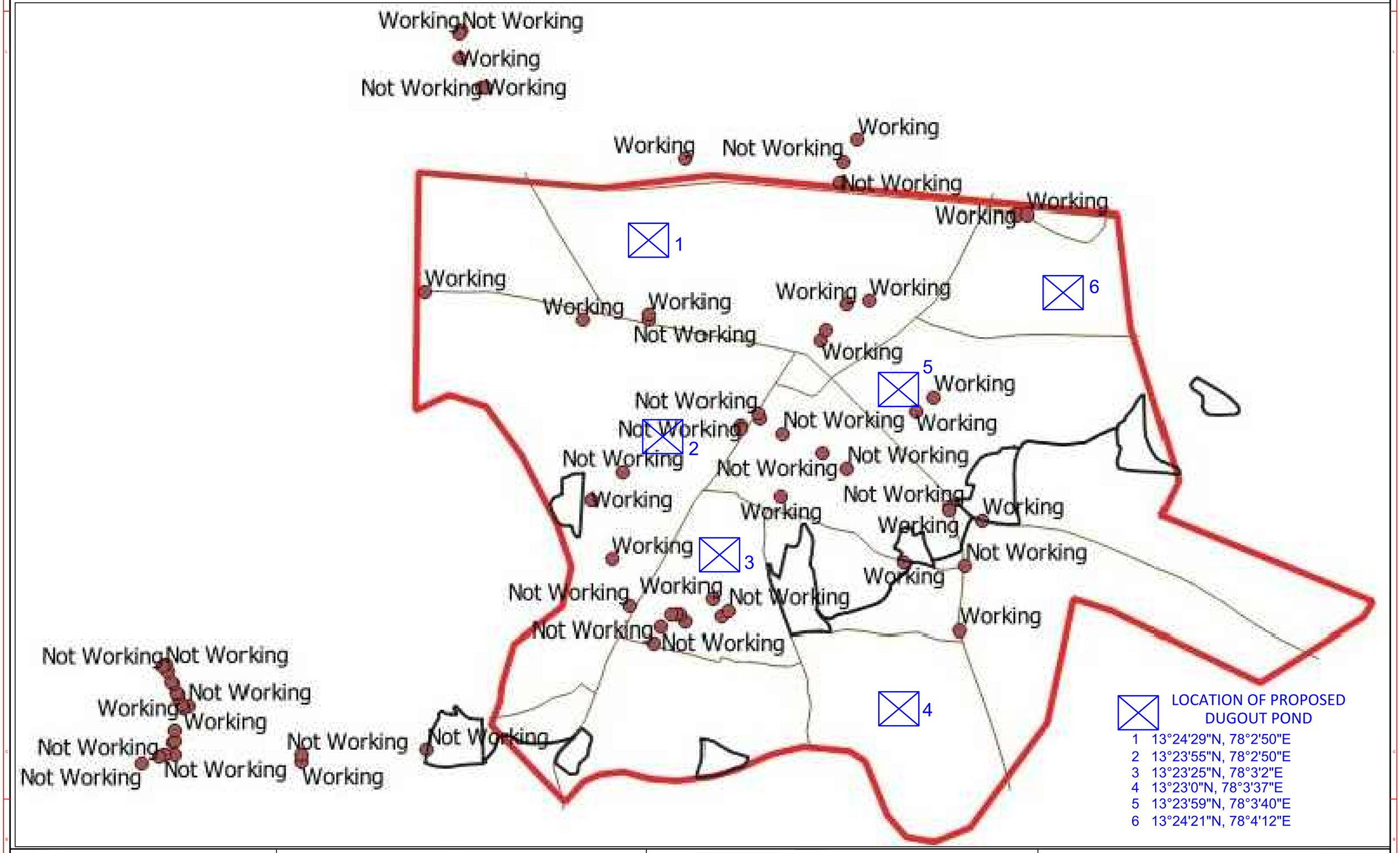
DRAWING TITLE: LOCATION OF PROPOSED INTERMITTENT STORM WATER - RECHARGE STRUCTURE (SOAKWAY)

REV 0

Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/MAPS/007

SCALE :- NTS



N

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TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

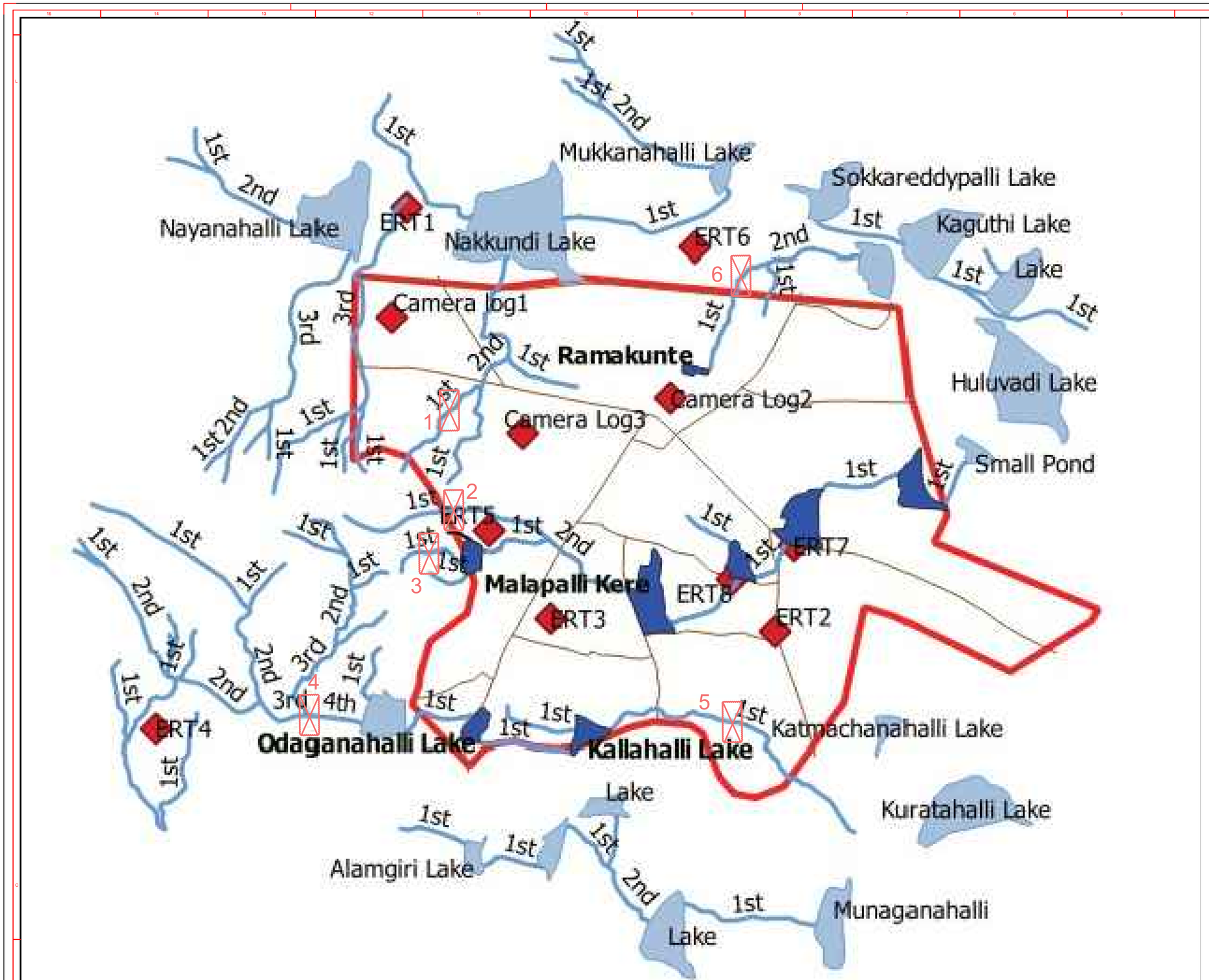
DRAWING TITLE: LOCATION OF PROPOSED DUGOUT POND

REV 0

	Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/MAPS/008

SCALE :- NTS



LOCATION OF PROPOSED GABION STRUCTURE

1 13°24'8"N, 78°2'28"E
2 13°23'43"N, 78°2'28"E
3 13°23'32"N, 78°2'22"E
4 13°22'50"N, 78°1'53"E
5 13°22'48"N, 78°3'40"E
6 13°24'44"N, 78°3'43"E

N

QUALITY ASSURANCE

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By Designer			
Sig.			
Date			
Name			
	Drawn By	Checked By	Approved By

CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

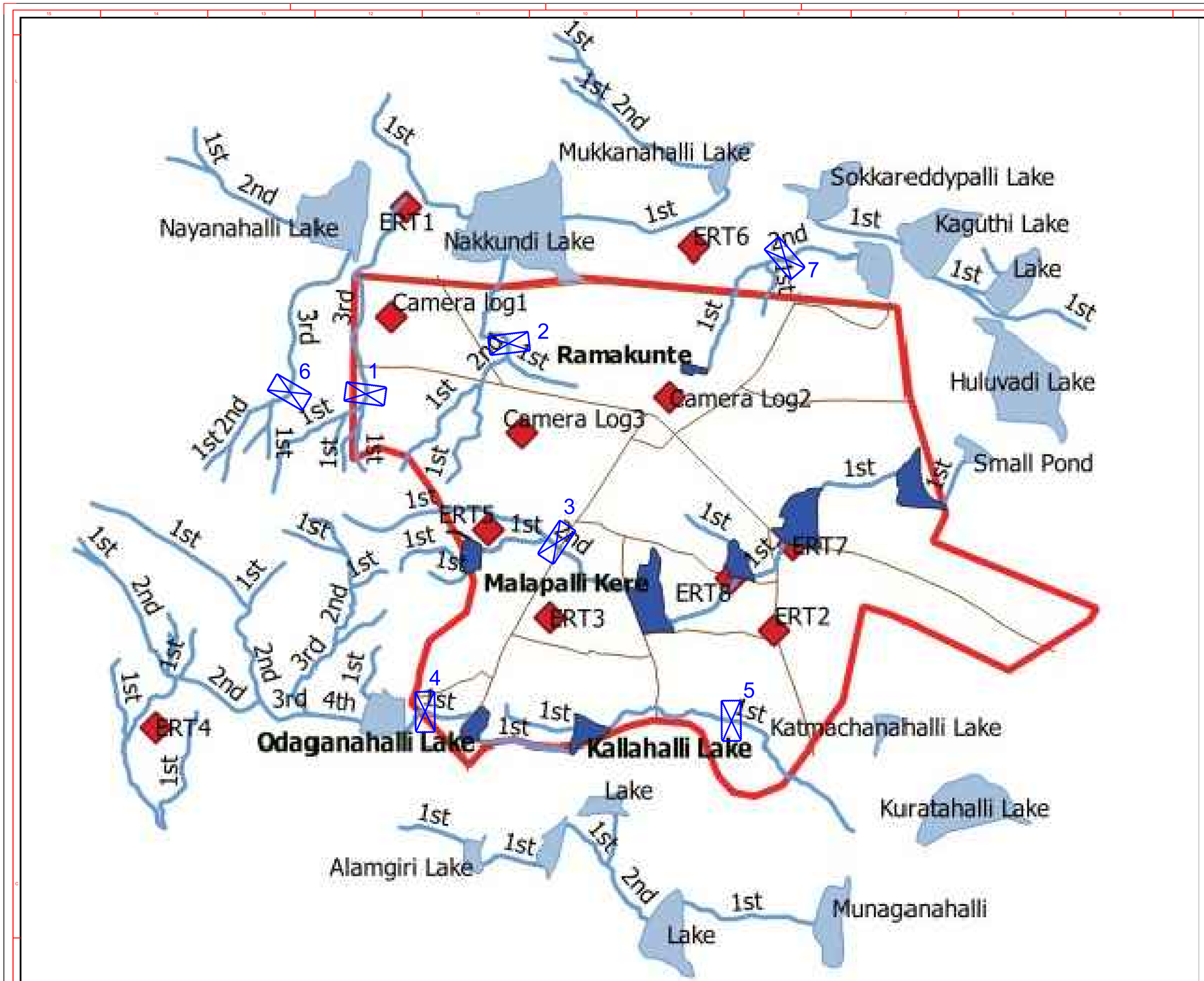
DRAWING TITLE: LOCATION OF PROPOSED GABION STRUCTURE

DRAWING NUNBER: BT/GESTS/MAPS/009

REV 0

Date	Approved for Issue

SCALE :- NTS



LOCATION OF PROPOSED CHECK DAM

1	13°24'12"N, 78°2'6"E
2	13°24'24"N, 78°2'43"E
3	13°23'34"N, 78°2'54"E
4	13°22'51"N, 78°2'21"E
5	13°22'48"N, 78°3'42"E
6	13°24'13"N, 78°1'47"E
7	13°24'47"N, 78°3'51"E

N

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Date			
Name			
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CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

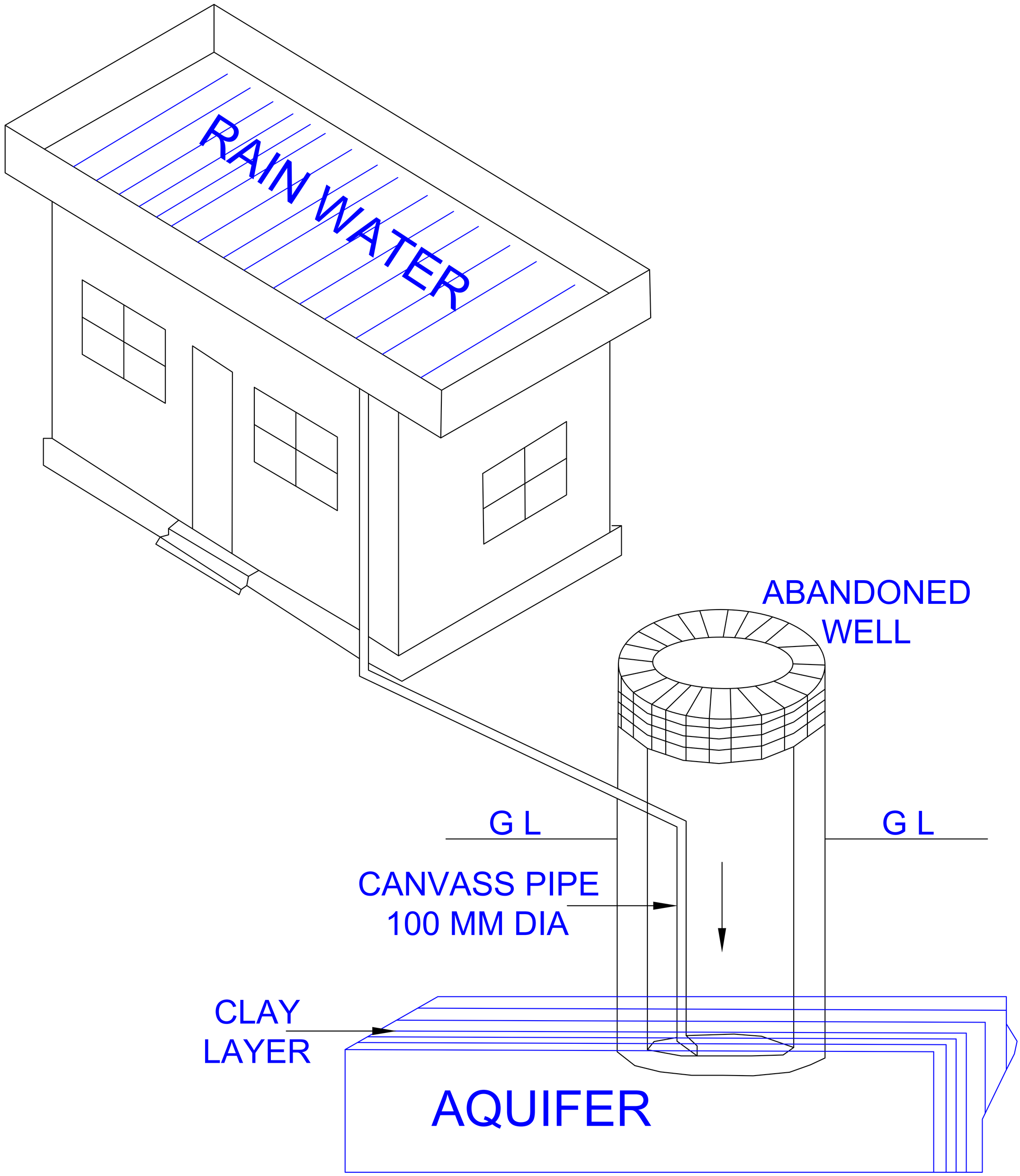
DRAWING TITLE: LOCATION OF PROPOSED CHECK DAM STRUCTURE

DRAWING NUNBER: BT/GESTS/MAPS/010

REV 0

Date	Approved for Issue

SCALE :- NTS



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CLIENT:

BORDA SOUTH ASIA

TIDE 25 @ 2018

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Sig.			
Date			
Name			
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TECHNICAL CONSULTANTS:

GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: OPEN WELL - RECHARGE STRUCTURE
CBT 001 (A)

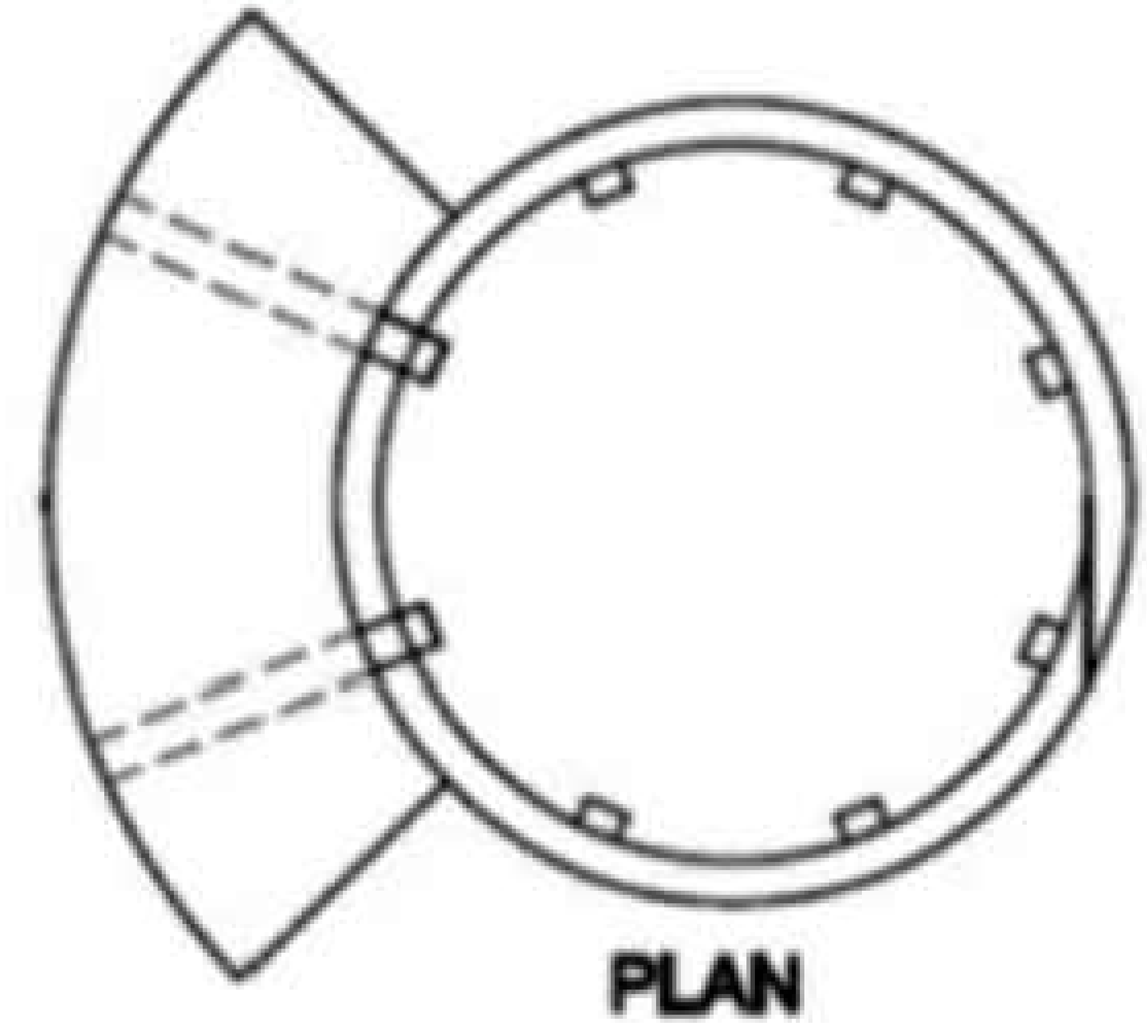
Date	Approved for Issue

DRAWING NUMBER: BT/GESTS/RRR-RC/011

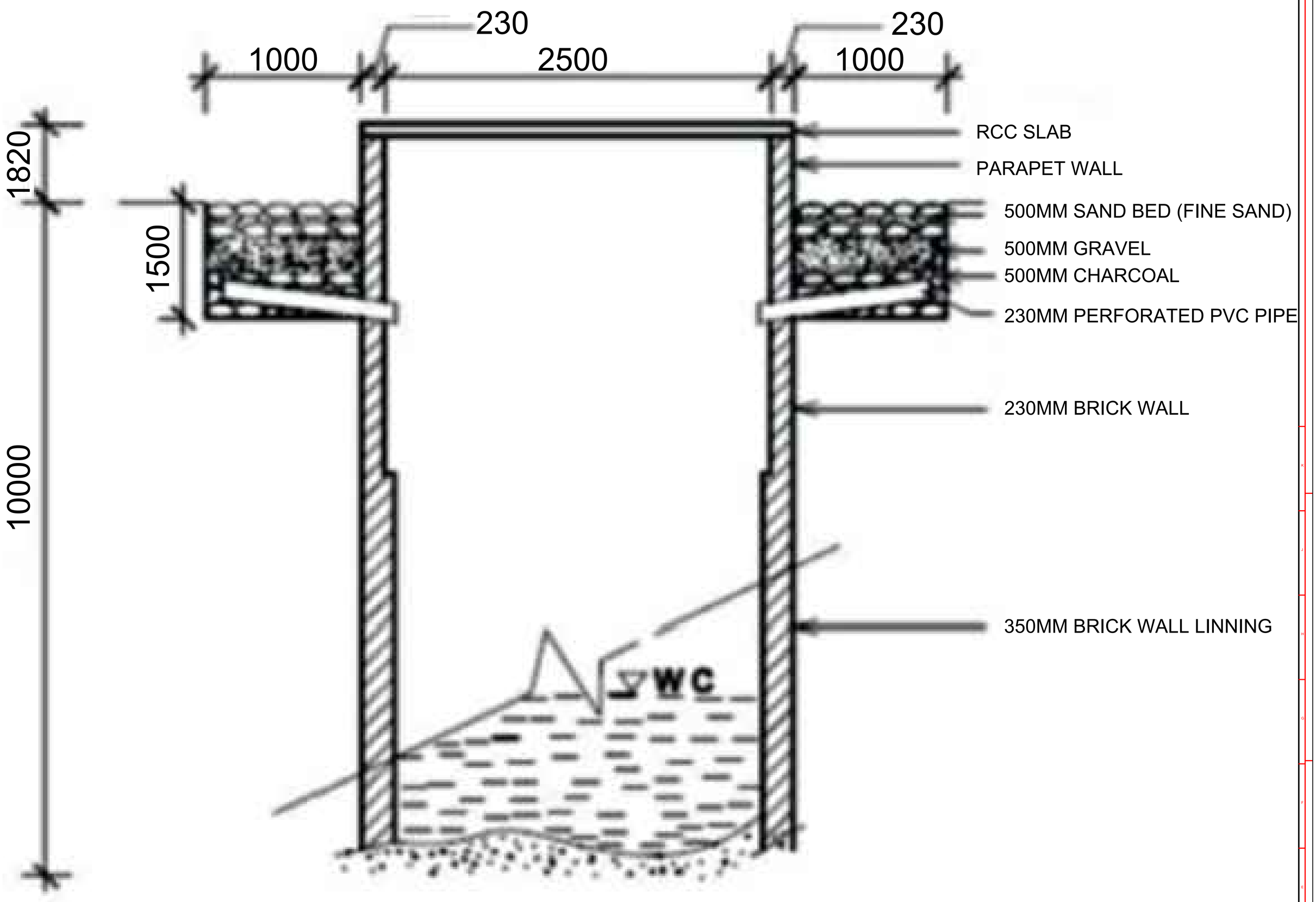
REV 0

SCALE :- NTS

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED



PLAN



SECTION

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CLIENT: BORDA SOUTH ASIA, TIDE 25 @ 2018

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Sig.			
Date			
Name			
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TECHNICAL CONSULTANTS:

GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: OPEN WELL - RECHARGE STRUCTURE CBT 001 (B)

Date	Approved for Issue

DRAWING NUMBER: BT/GESTS/RRR-RC/012

REV 0

SCALE :- NTS

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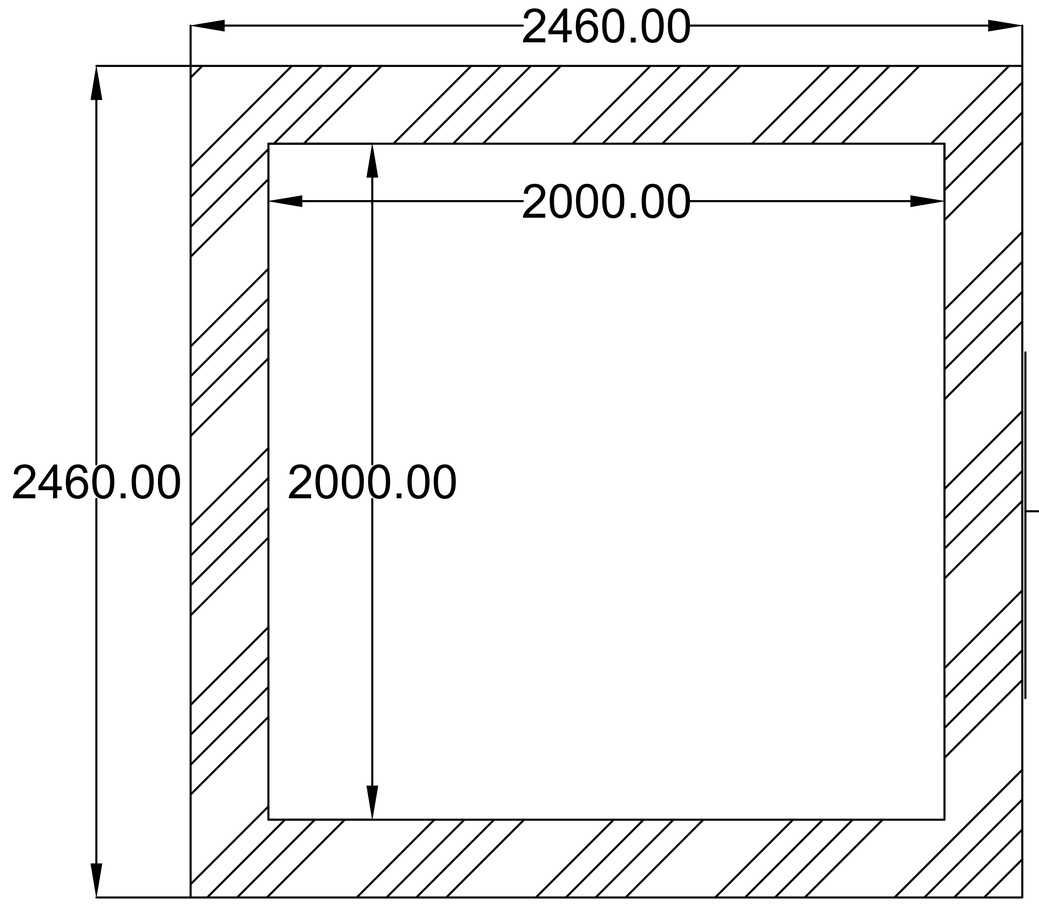
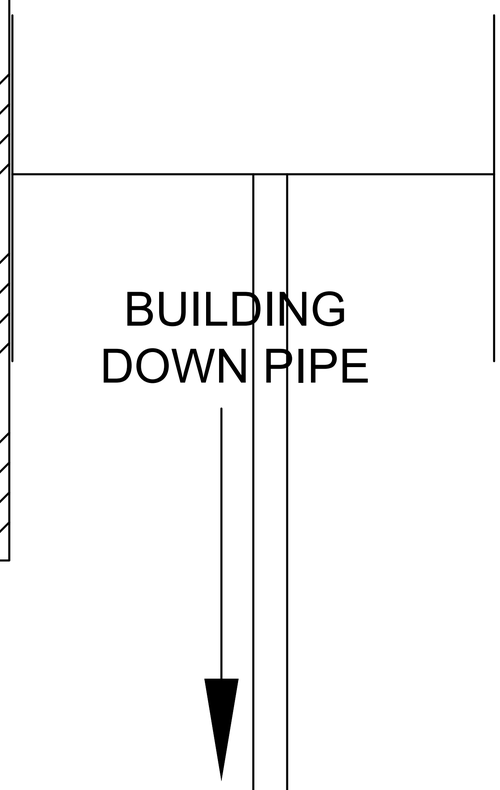
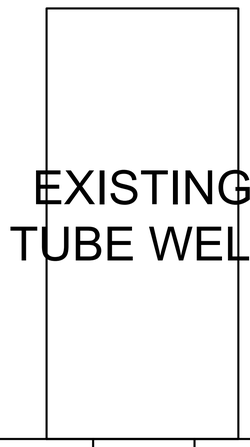
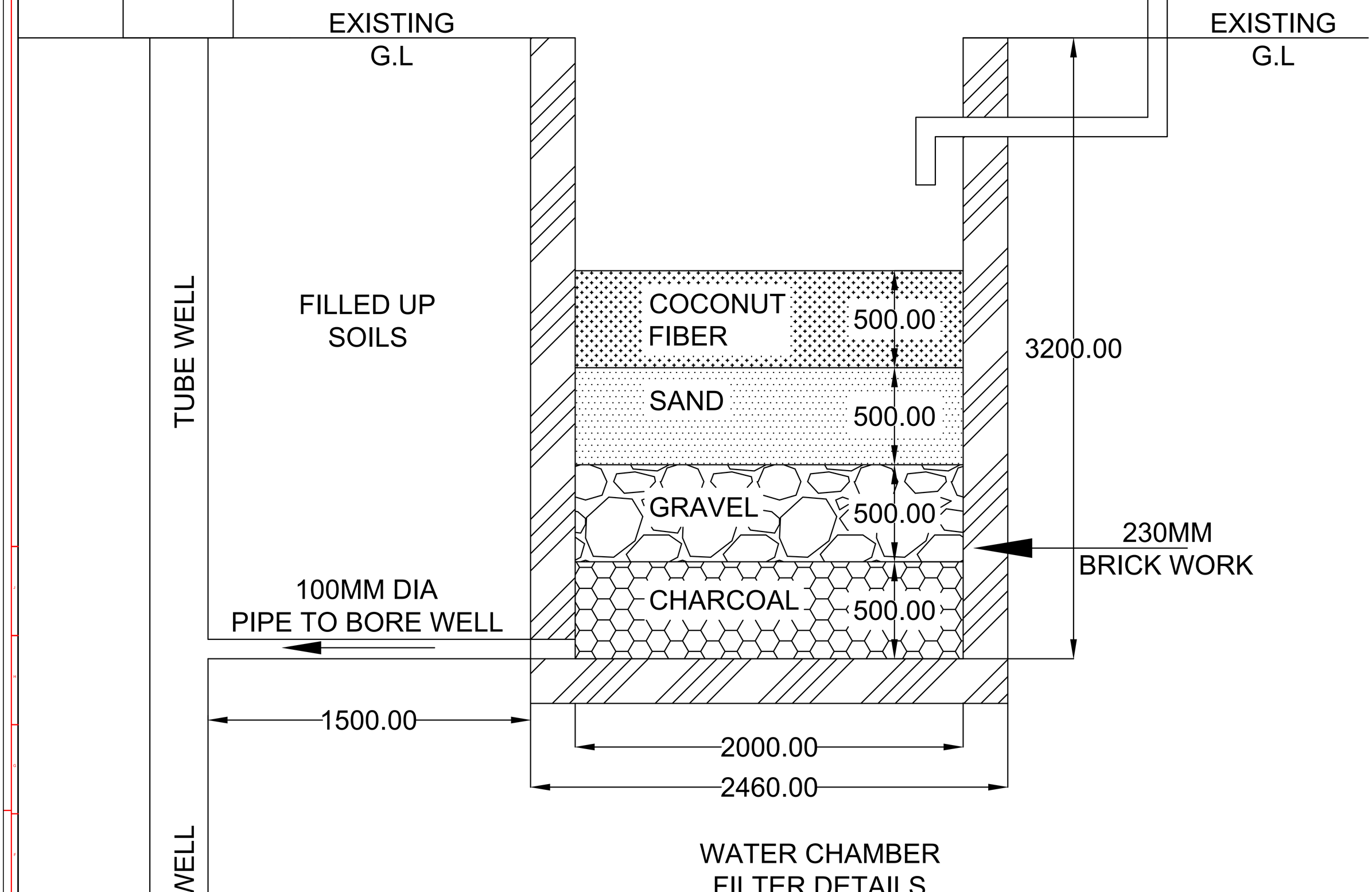


WATER CHAMBER
FILTER DETAILS
PLAN







WATER CHAMBER
FILTER DETAILS
SECTIONAL DETAILS

N

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CLIENT: BORDA SOUTH ASIA, TIDE 25 @ 2018

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Date			
Name			
Drawn By	Checked By		Approved By

TECHNICAL CONSULTANTS:

GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: TUBE WELL - RECHARGE STRUCTURE
CBT 002 (A)

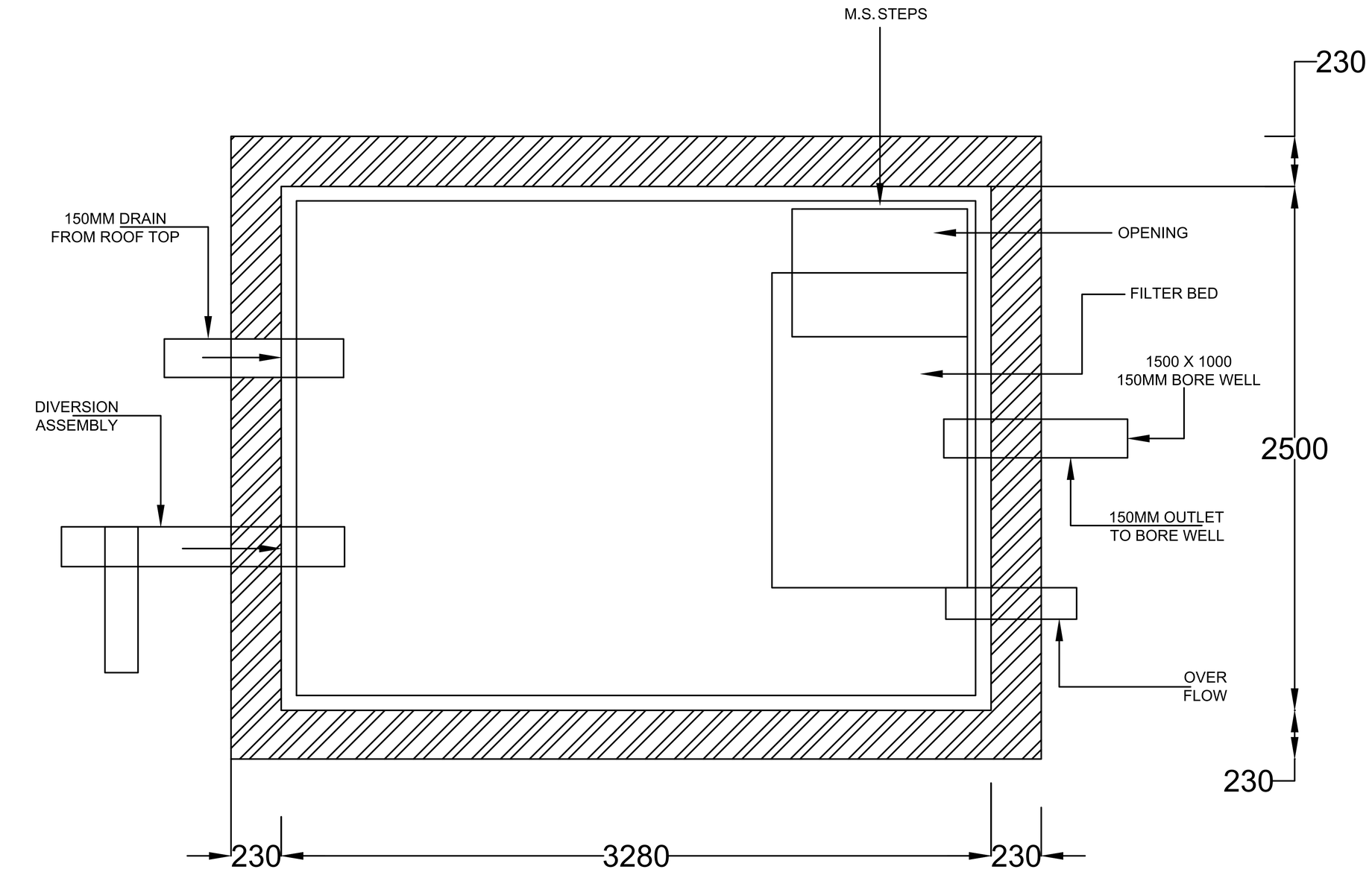
Date	Approved for Issue

DRAWING NUMBER: BT/GESTS/RRR-RC/013

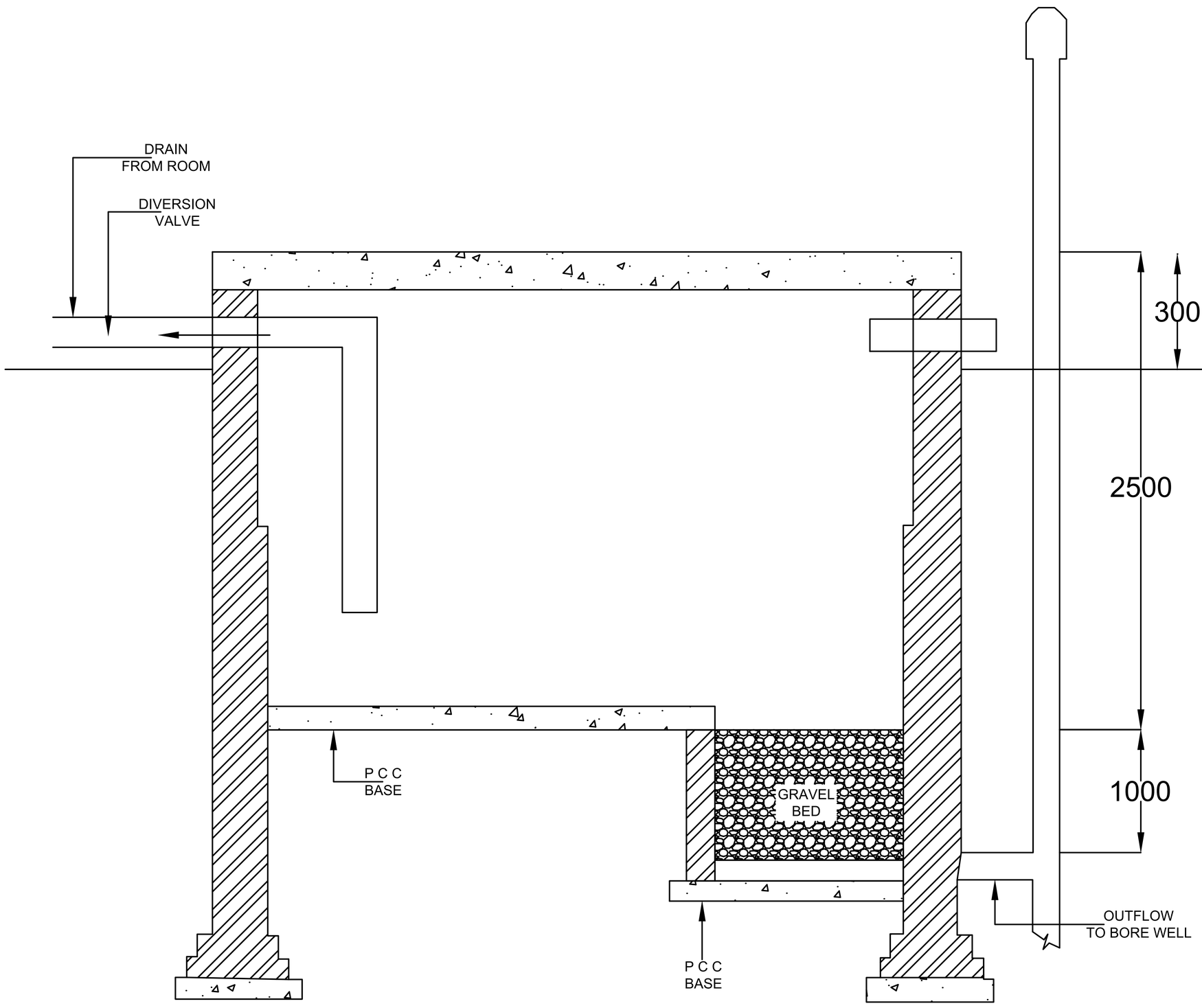
REV 0

SCALE :- NTS

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED



PLAN



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CLIENT: BORDA SOUTH ASIA

TIDE 25 @ 2018

By Designer			
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Name			
Drawn By	Checked By		Approved By

TECHNICAL CONSULTANTS:

GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
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DRAWING TITLE: TUBE WELL - RECHARGE STRUCTURE
CBT 002 (B)

Date	Approved for Issue

DRAWING NUMBER: BT/GESTS/RRR-RC/014

REV 0

SCALE :- NTS

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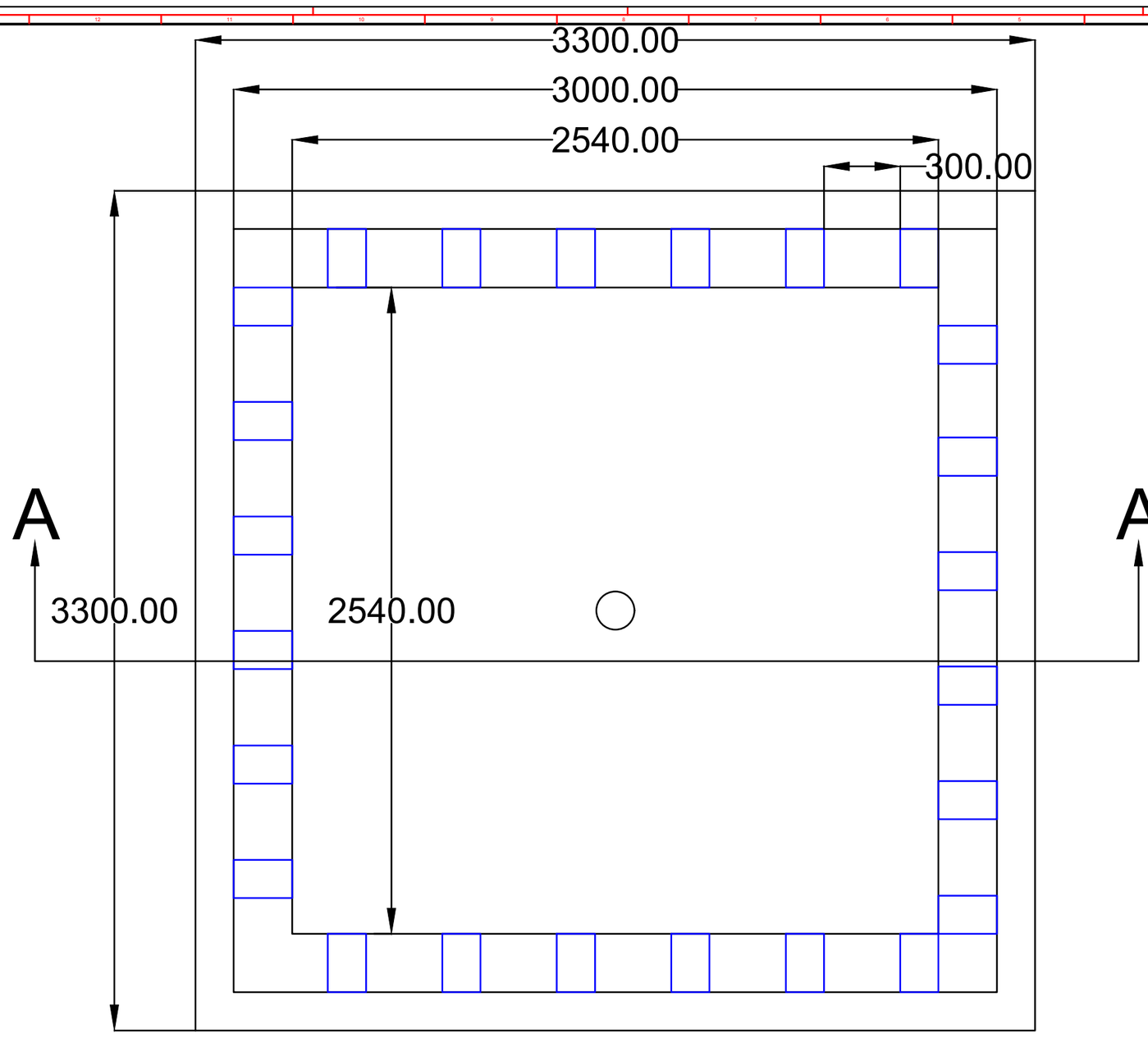

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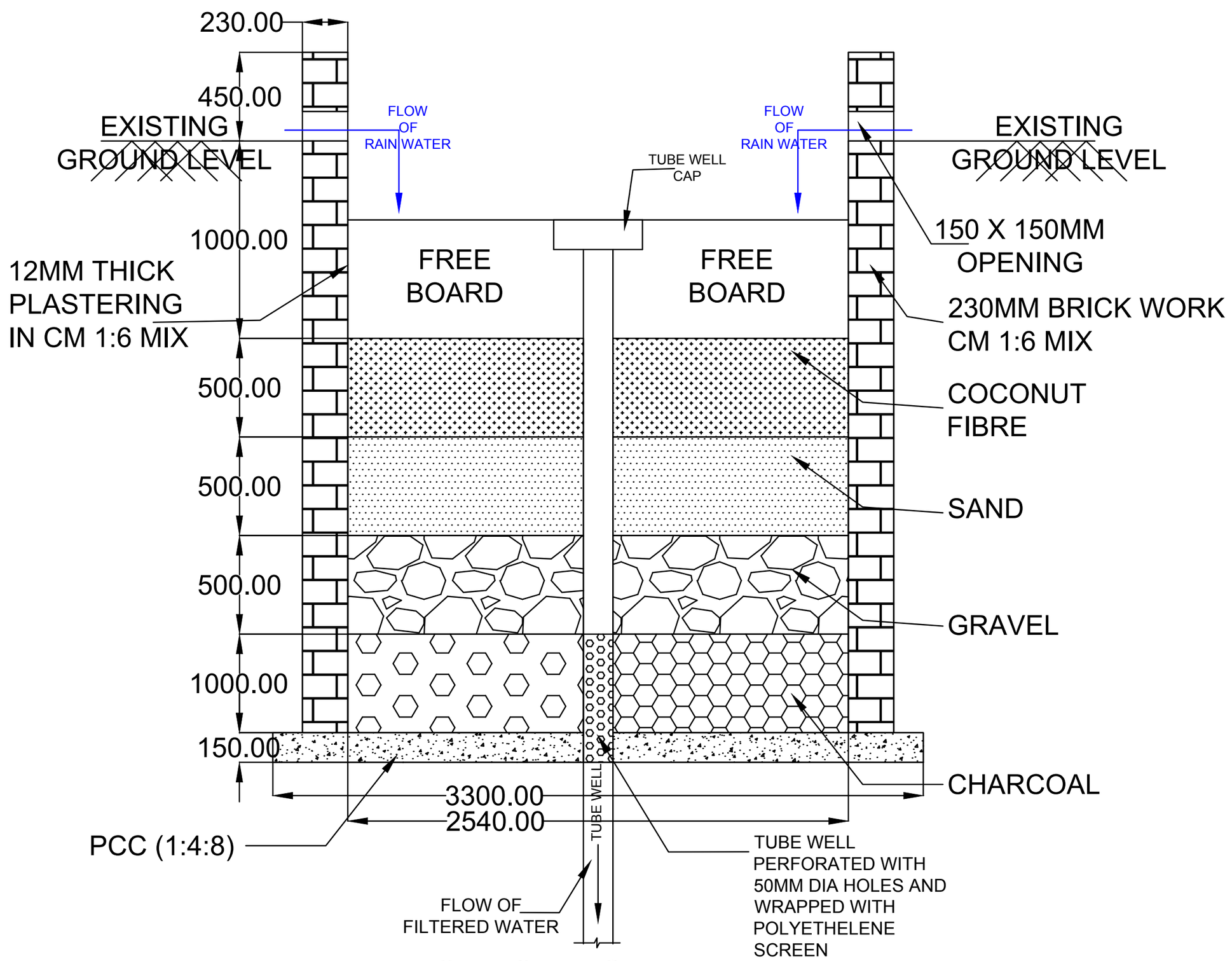


SECTION - 'AA'

N

QUALITY ASSURANCE

Verification of accuracy, correctness and completeness in respect of design analysis and drawings are assured by respective design consultant.

CLIENT: BORDA SOUTH ASIA

TIDE 25 @ 2018

By Designer			
Sig.			
Date			
Name			
Drawn By	Checked By		Approved By

TECHNICAL CONSULTANTS:

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: TUBE WELL - SURFACE WATER HARVESTING RECHARGE STRUCTURE - 002 S (C)

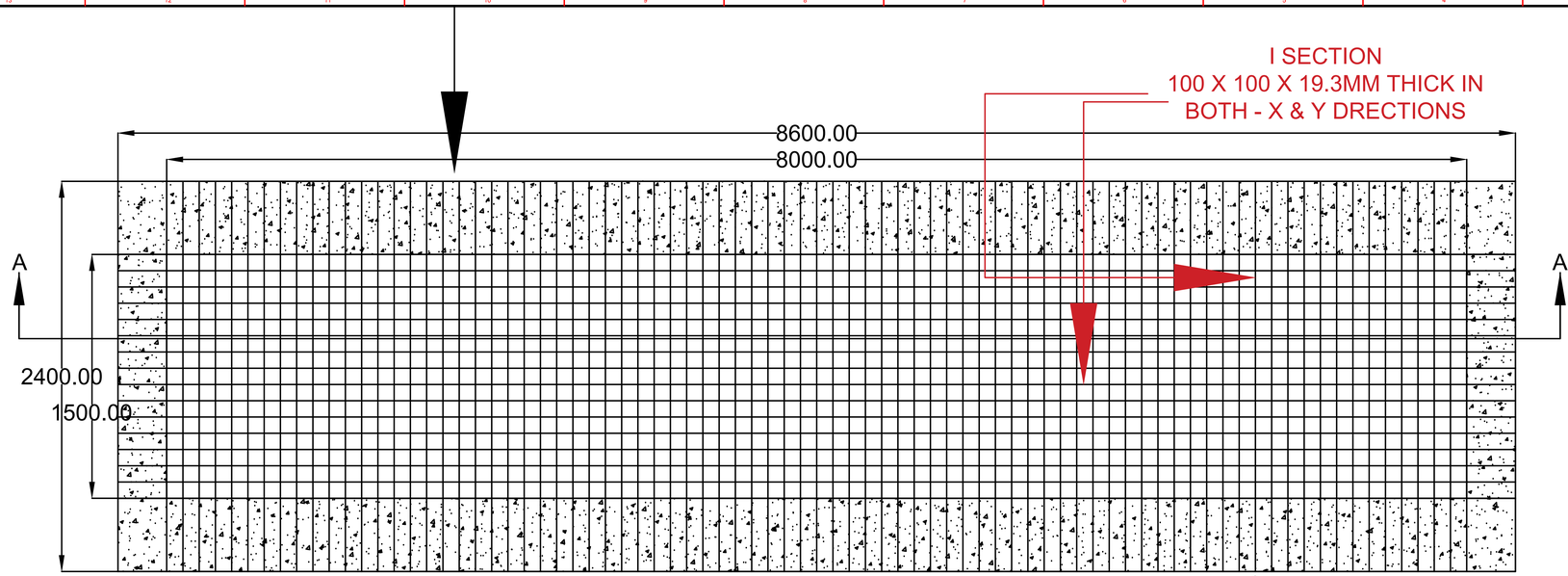
Date	Approved for Issue

DRAWING NUMBER: BT/GESTS/RRR-RC/014

REV 0

SCALE :- NTS

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED



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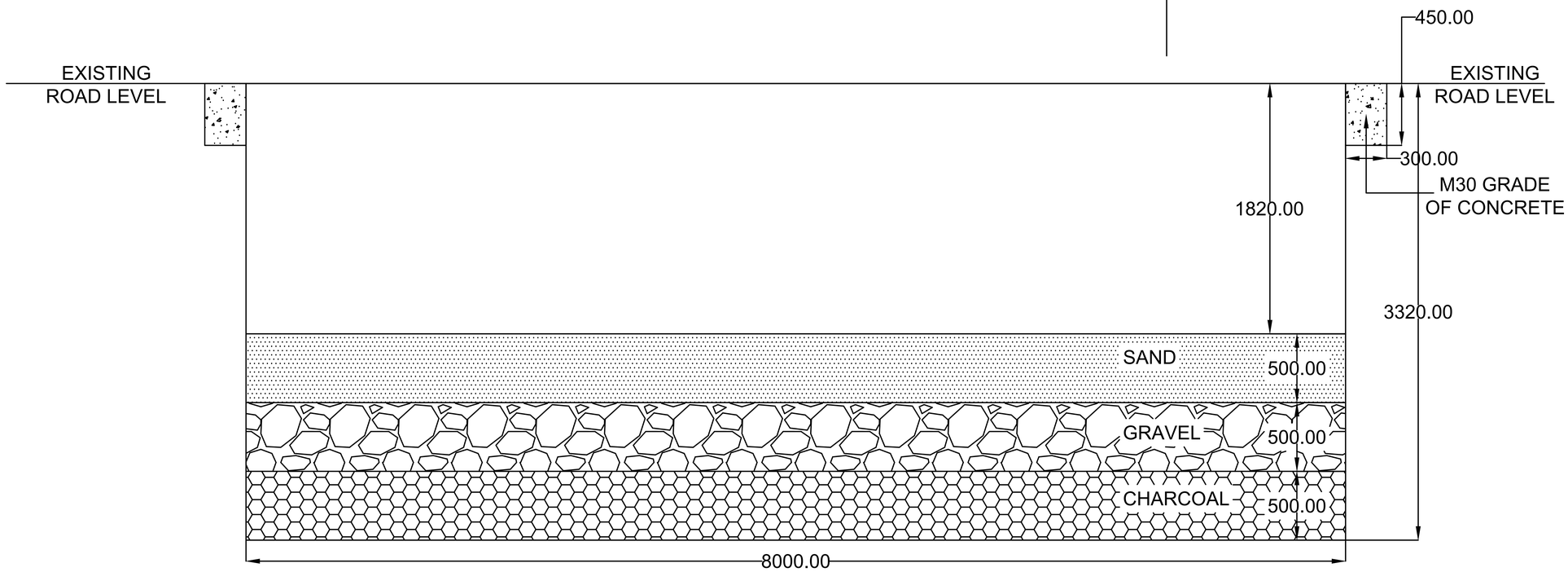

SECTION - AA

ROAD JUNCTION - RECHARGE STRUCTURE

N

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By Designer			
Sig.			
Date			
Name			
	Drawn By	Checked By	Approved By

CLIENT: BORDA SOUTH ASIA

TIDE 25 @ 2018

TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: ROAD JUNCTION - RECHARGE STRUCTURE
CBT 003

REV 0

DRAWING NUNBER: BT/GESTS/RRR-RC/015

Date	Approved for Issue

SCALE :- NTS

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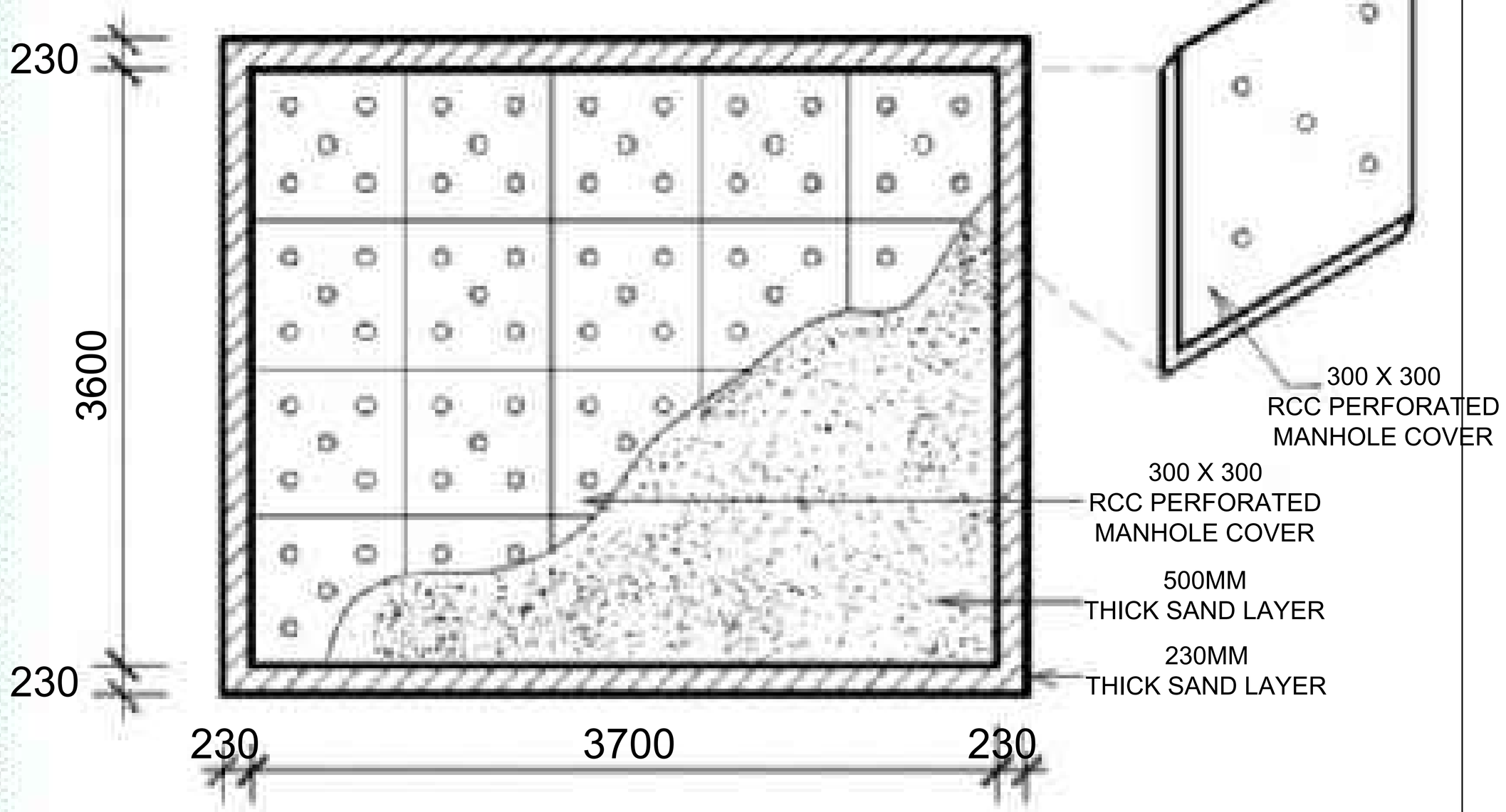

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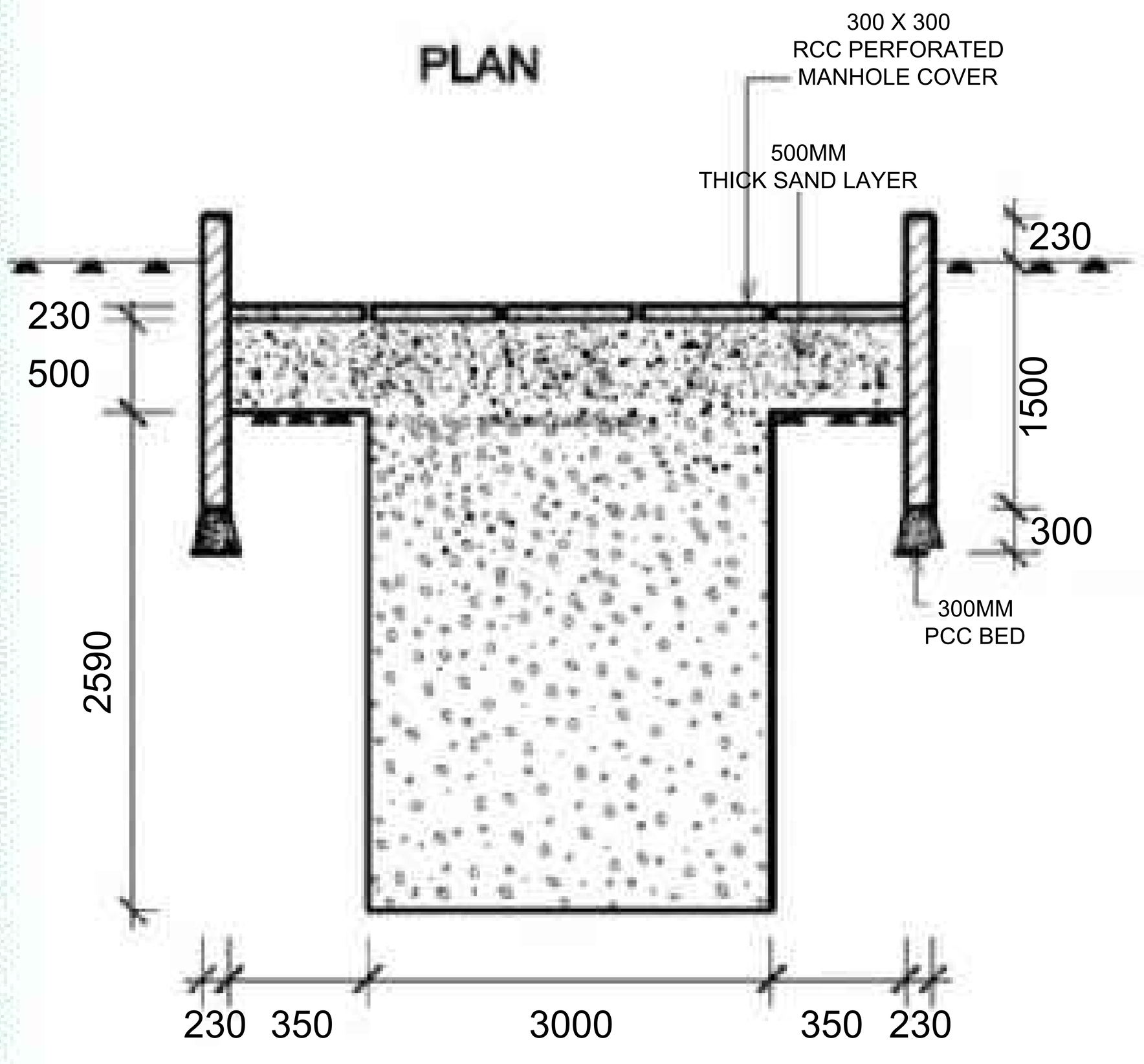

SECTION

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CLIENT: BORDA SOUTH ASIA, TIDE 25 @ 2018

By Designer			
Sig.			
Date			
Name			
Drawn By	Checked By		Approved By

TECHNICAL CONSULTANTS:

GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: WATER STAGANATION / FLOOTING RECHARGE STRUCTURE - CBT 004

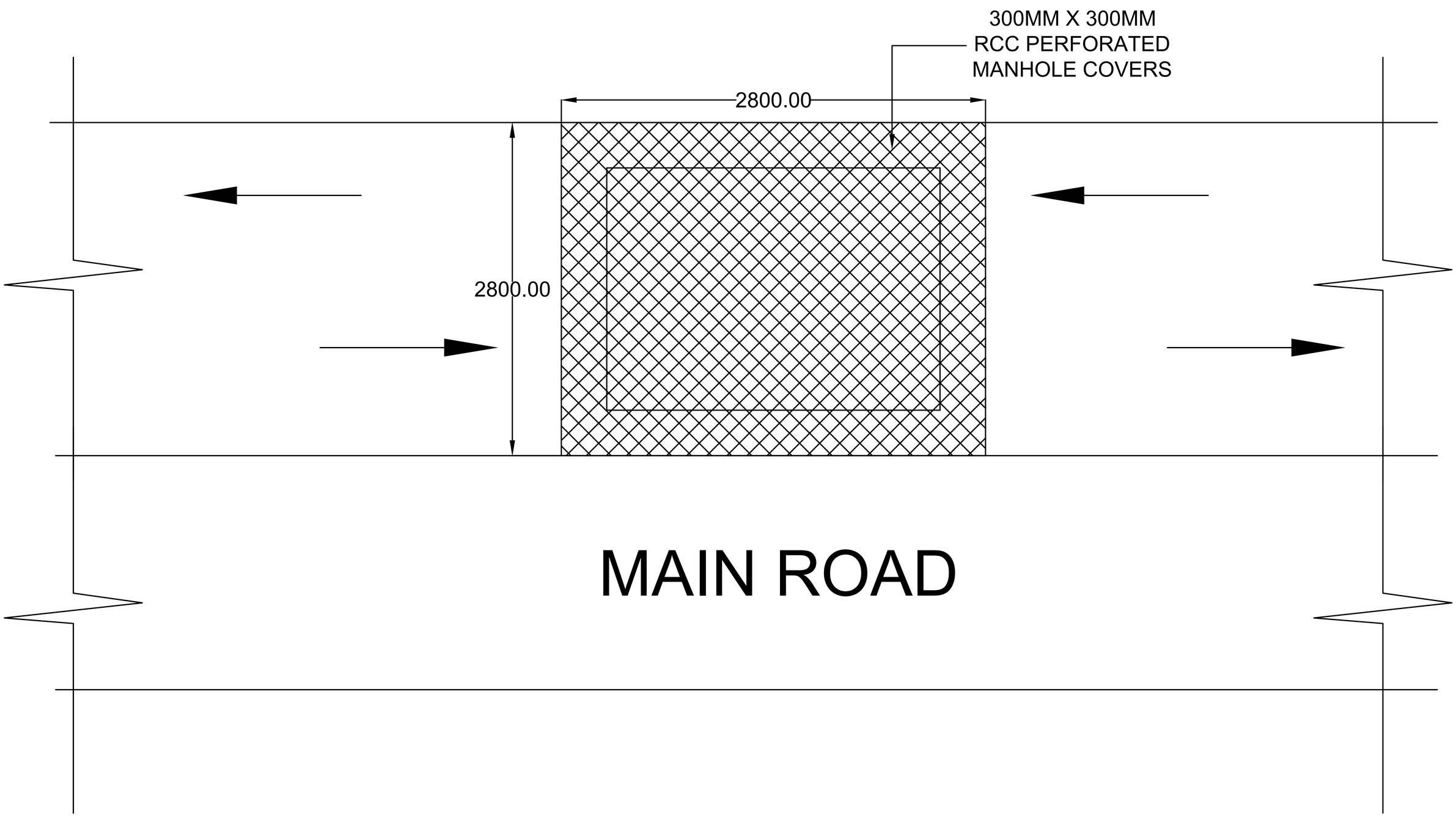
Date	Approved for Issue

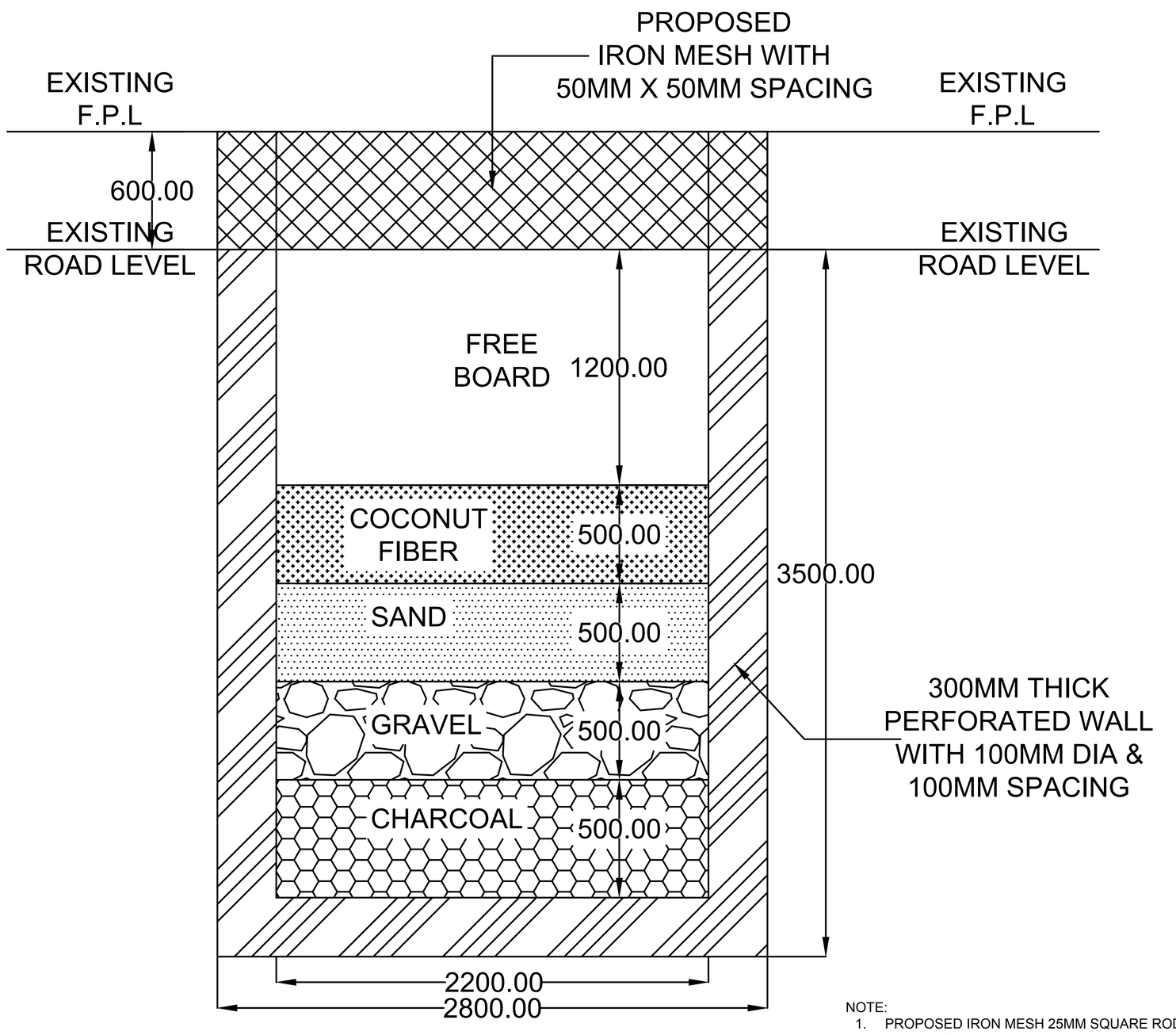
DRAWING NUMBER: BT/GESTS/RRR-RC/016

REV 0

SCALE :- NTS

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED





FOOTPATH
RECHARGE STRUCTURE

NOTE:
1. PROPOSED IRON MESH 25MM SQUARE RODS
2. HEAVY LOADS SHOULD NOT APPLY
3. WEILDING OF RODS SHOULD BE DONE FIRMLY
4. PROVISION SHOULD BE MADE WITH LOCK & KEY ARRANGMENTS
5. REGULAR REMOVAL OF LITTER AND GRIT SHOULD BE DONE TO IMPROVE THE PERFORMANCE OF THE STRUCTURE ALONG WITH THE REPLACEMENT OF FILTER MEDIA

N

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CLIENT: BORDA SOUTH ASIA, TIDE 25 @ 2018

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Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: FOOTPATH RECHARGE STRUCTURE - CBT 005

Date | Approved for Issue

DRAWING NUMBER: BT/GESTS/RRR-RC/017

REV 0

SCALE :- NTS

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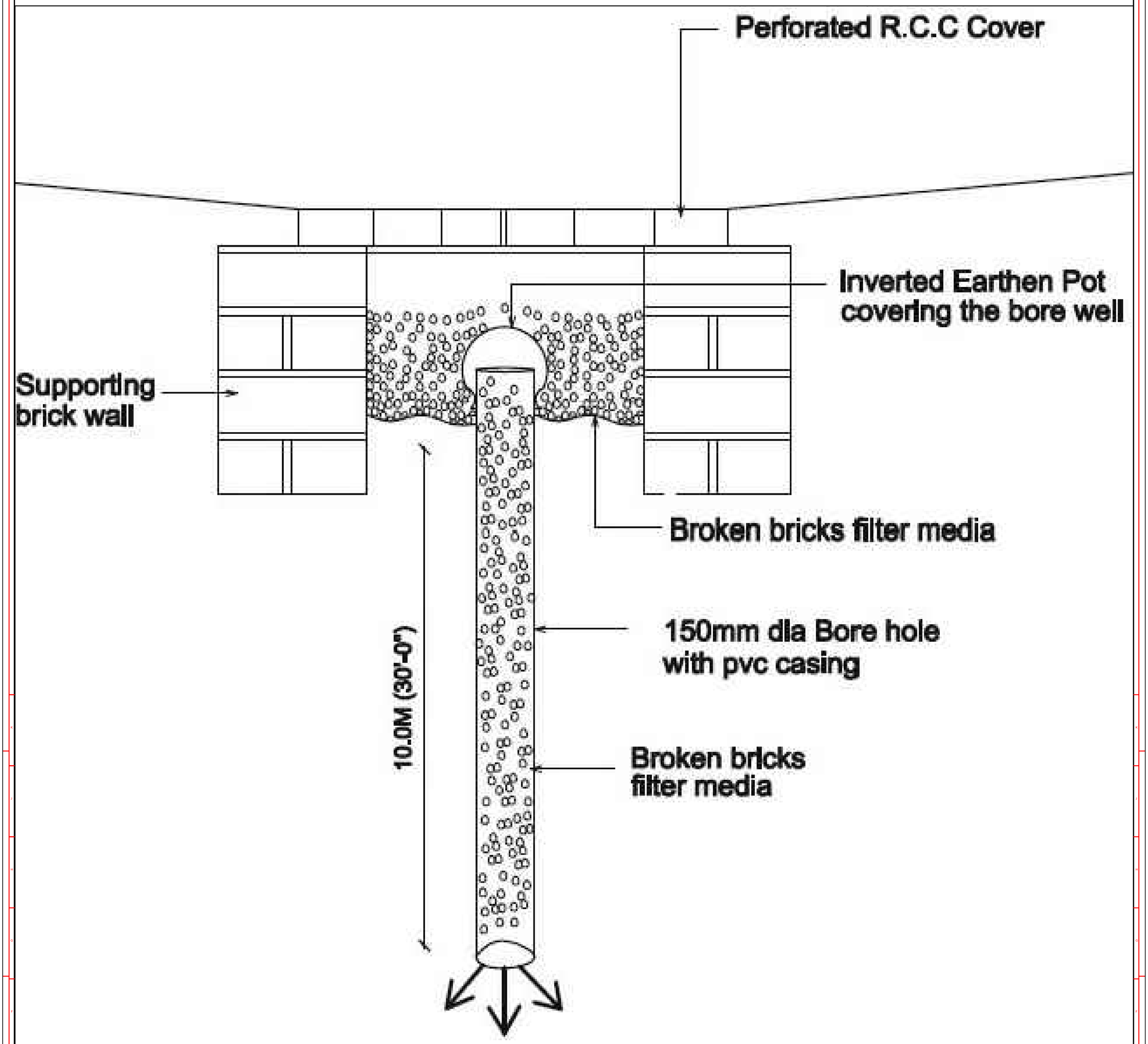

NOTE:

1. THESE SOAKWAY SHOULD BE CONSTRUCTED AT EVERY 100M INTERVAL OR AT THE ROAD JUNCTIONS WITHIN THE STORM WATER DRAINS
2. STORM WATER DRAINS SHOULD ENSURE ONLY STORM WATER SHOULD ENTER
3. REGULAR MAINTENANCE IS REQUIRED.

N

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CLIENT: BORDA SOUTH ASIA, TIDE 25 @ 2018

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Date			
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TECHNICAL CONSULTANTS:

GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

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DRAWING TITLE: INTERMITTENT STORM WATER - RECHARGE STRUCTURE (SOAKWAY) - CBT 006

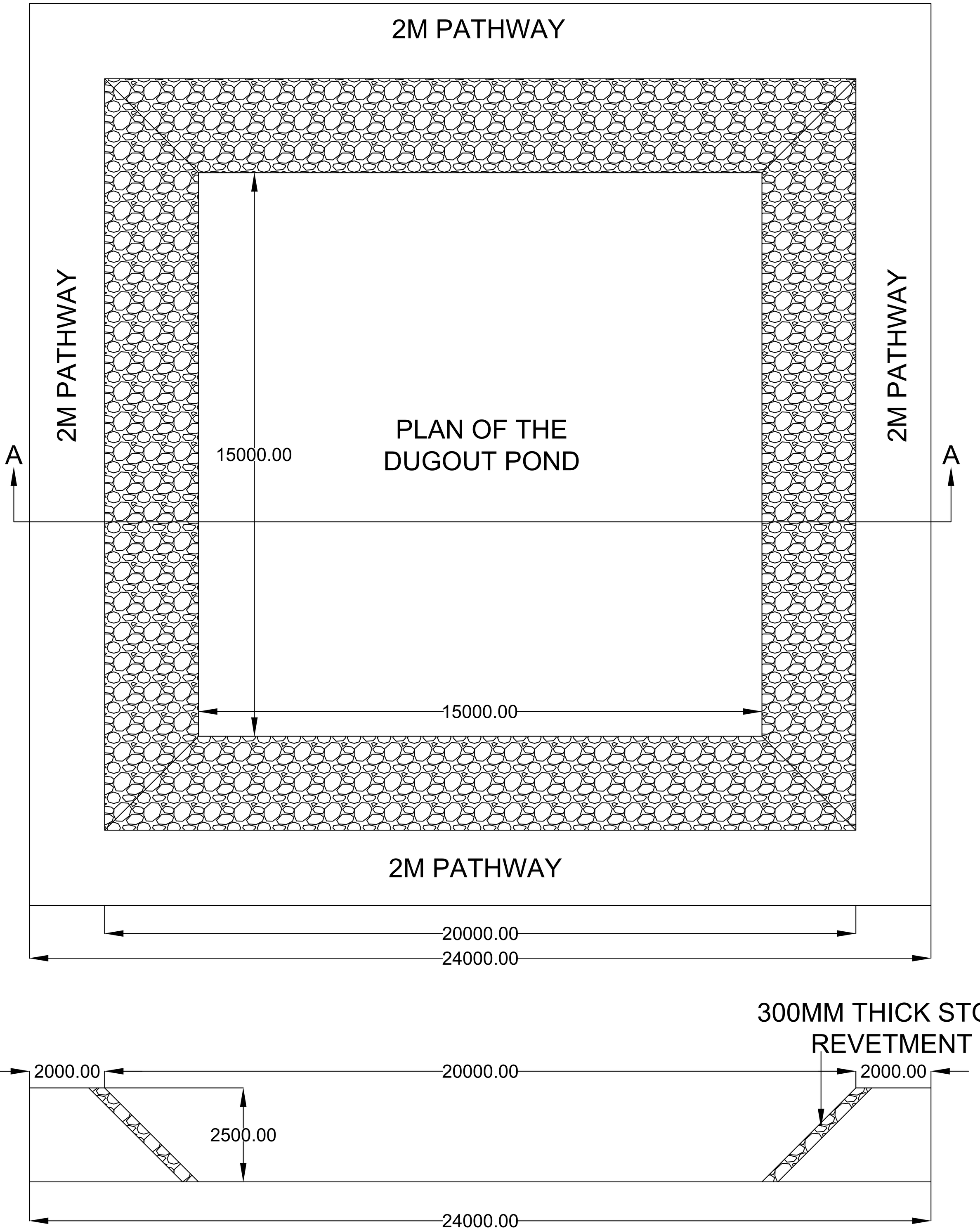
Date	Approved for Issue

DRAWING NUMBER: BT/GESTS/RRR-RC/018

REV 0

SCALE :- NTS

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED



SECTION - 'AA'

N

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CLIENT: BORDA SOUTH ASIA, TIDE 25 @ 2018

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Date			
Name			
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TECHNICAL CONSULTANTS:

GESTS

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER

M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Medchal - Malkajgiri District,
Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: DUGOUT POND
RECHARGE STRUCTURE - CBT 007

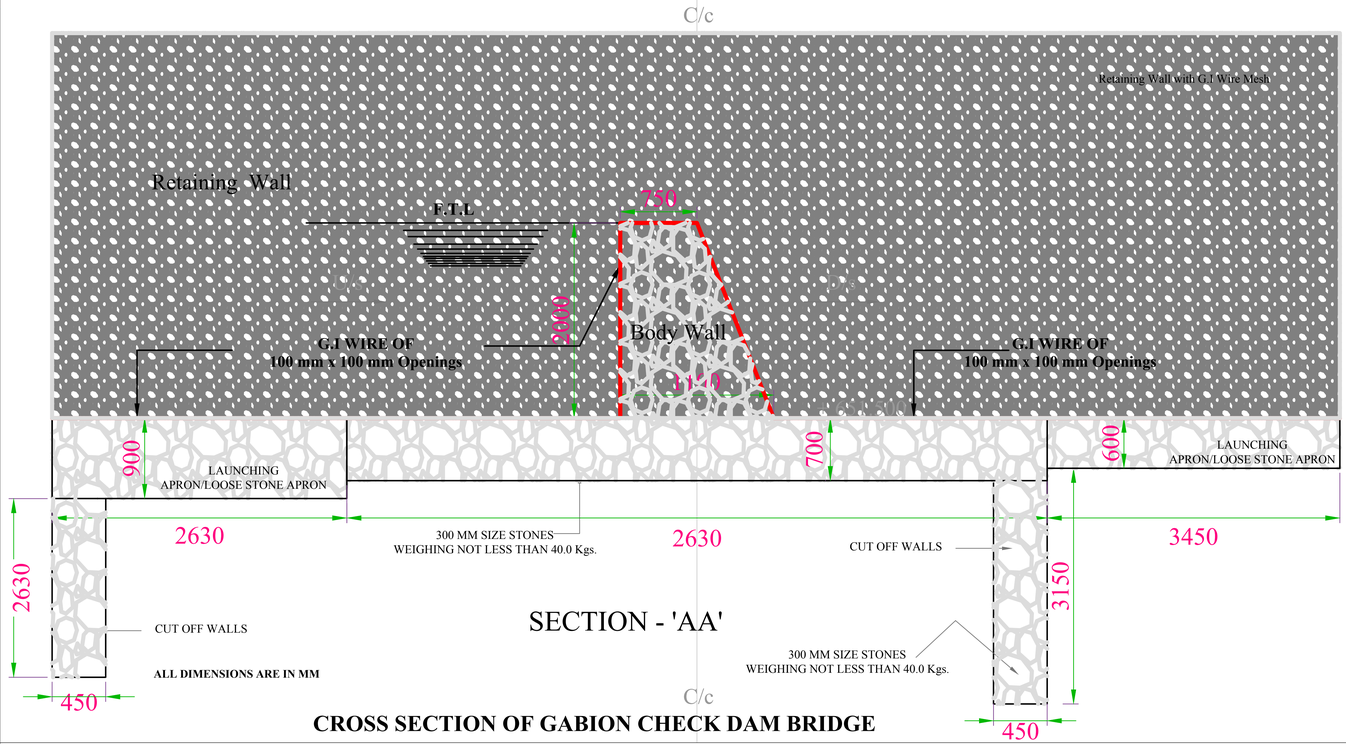
Date	Approved for Issue

DRAWING NUMBER: BT/GESTS/RRR-RC/019

REV 0

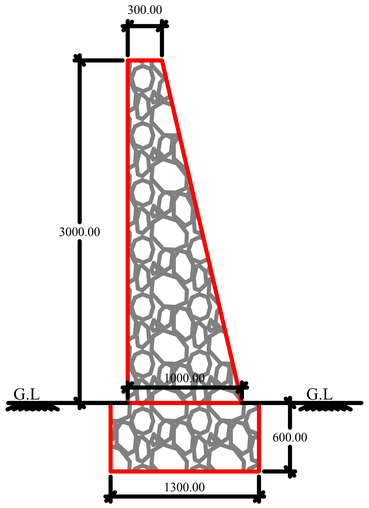
SCALE :- NTS

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED



SECTION - 'AA'

CROSS SECTION OF GABION CHECK DAM BRIDGE



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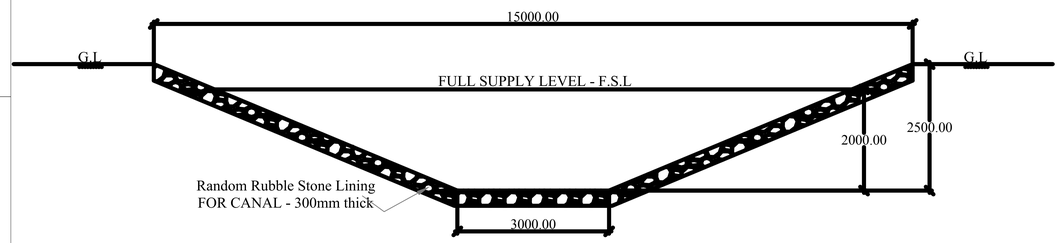
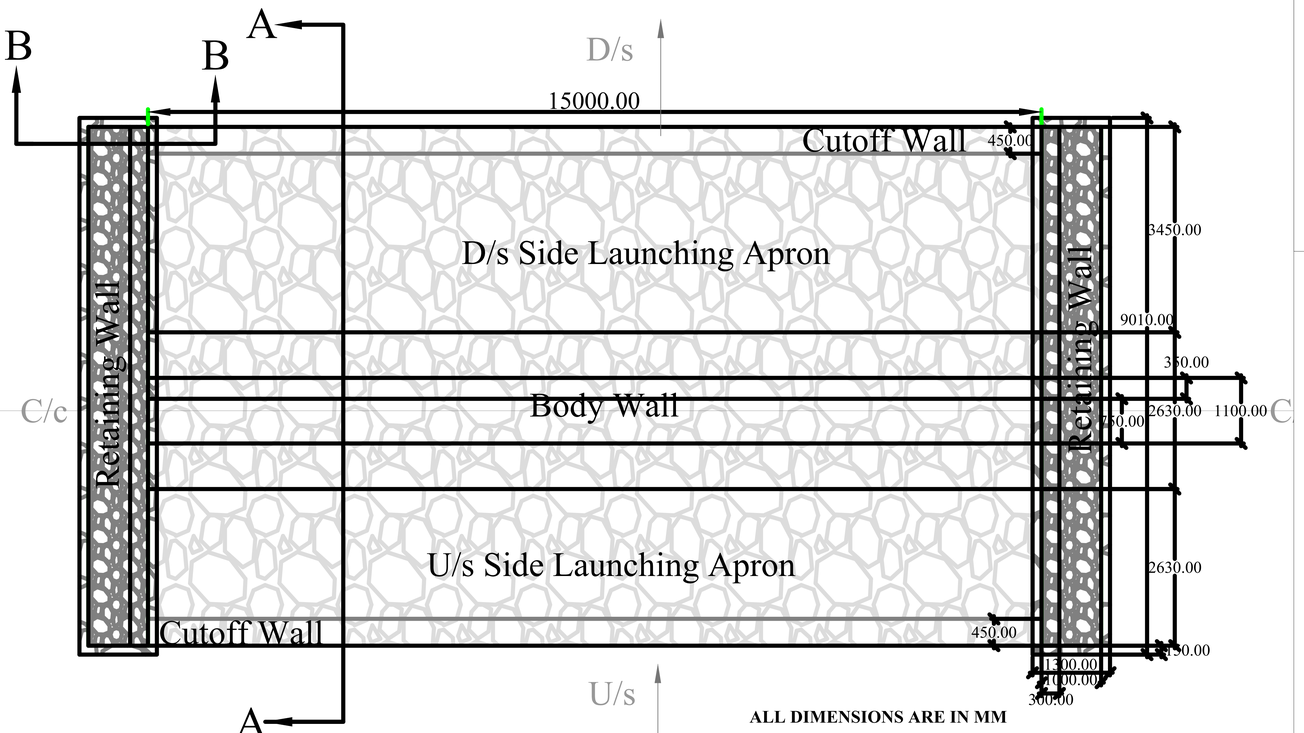


REHABILITATION OF EXISTING STREAM



ALL DIMENSIONS ARE IN MM

NOTES:

1. **All Dimensions are in Millimeters unless otherwise specified & for execution dimensions to be followed**
2. **The Designs are made for 15 m Length Linear Water Way for Gabion Check Dam**
3. **G.I Wire Mesh of 100mm x 100mm openings should be provided for the circumference of the Gabion Check Dam with anchor rods of 0.6m length (if required)**
4. **The above drawings are prepared for the site specific conditions and no part of the drawing should be reproduced/copied.**
5. **If any ambiguity is found in the designs/drawings/report - it shall brought to the notice of the Consultant - BEFORE TAKING ANY DECISION**
6. **All the Execution work should be made as per the given drawings, Specifications and following the relevant standards wherever applicable along with Quantity & Quality Check**
7. **If any decision taken on the site with respect to the change in the drawings / dimensions / specifications etc it shall brought to the notice of the Consultant before execution.**
8. **If any execution takes place due to change in the site conditions and without prior information to the consultant , consultant will not be responsible in any manner and all responsibilities lies on the Contractor and Client.**
9. **In the case of estimations - A variation of 3 - 5% may occur based on the site conditions for which an authentic/valid reason may be noted and approved before execution**
10. **Execution should be made following the relevant IS standard code of practice with all precautionary and safety measures as laid from time to time.**

N

QUALITY ASSURANCE

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By Designer			
Sig.			
Date			
Name			
	Drawn By	Checked By	Approved By

CLIENT: BORDA SOUTH ASIA — TIDE 25 @ 2018

TECHNICAL CONSULTANTS:
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062,
Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in
GESTS (ISO:9001-2008)

PROJECT TITLE : ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE : GABION CHECK DAM - CBT 008

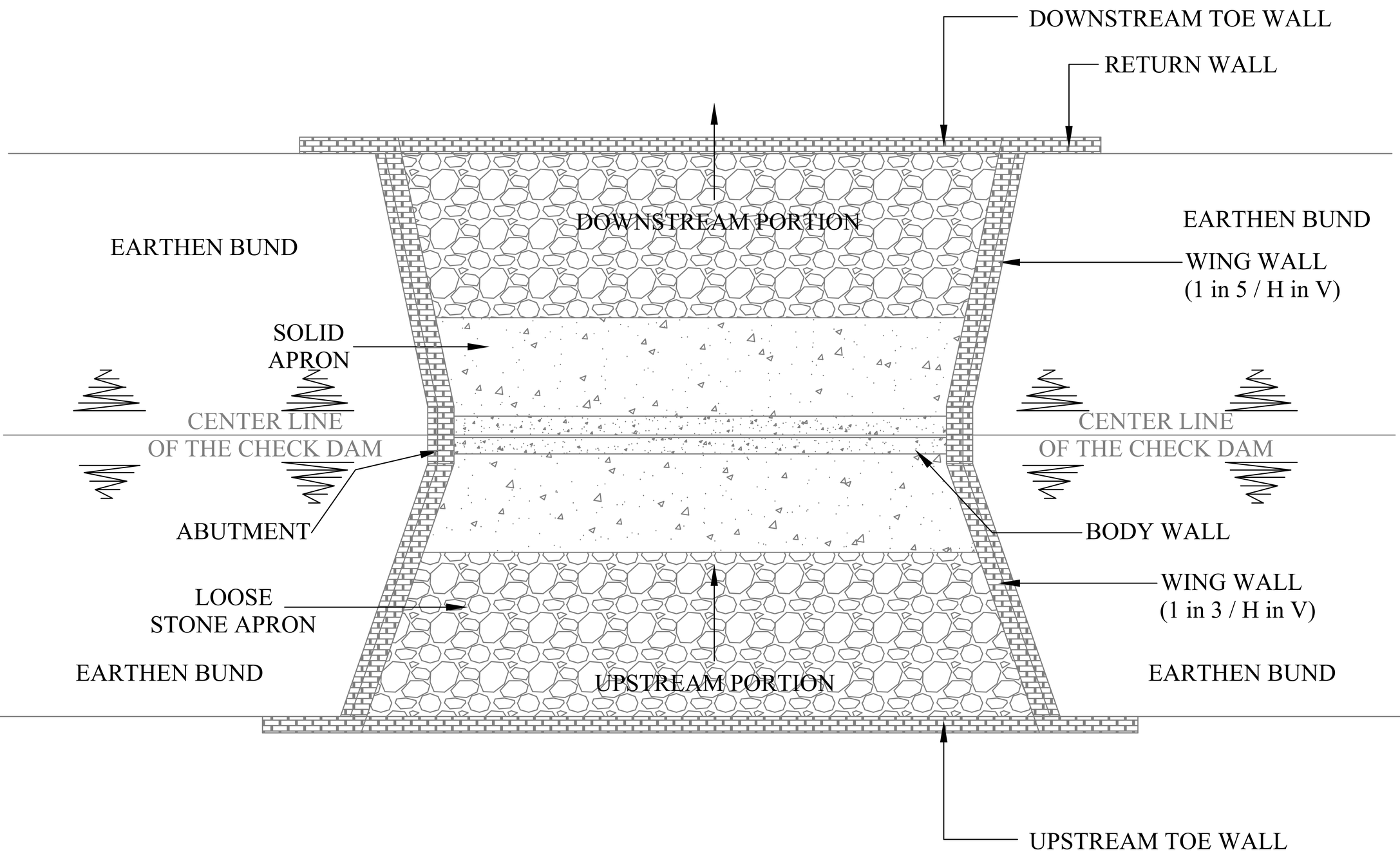
DRAWING NUMBER : BT/GESTS/RRR-RC/020

REV : 0

CAD FILE :

SCALE :- NTS & ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED

Date	Approved for Issue



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CLIENT: BORDA SOUTH ASIA; TIDE 25 @ 2018

TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

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DRAWING TITLE: CHECK DAM - CBT 009
COMPONENTS OF CHECK DAM

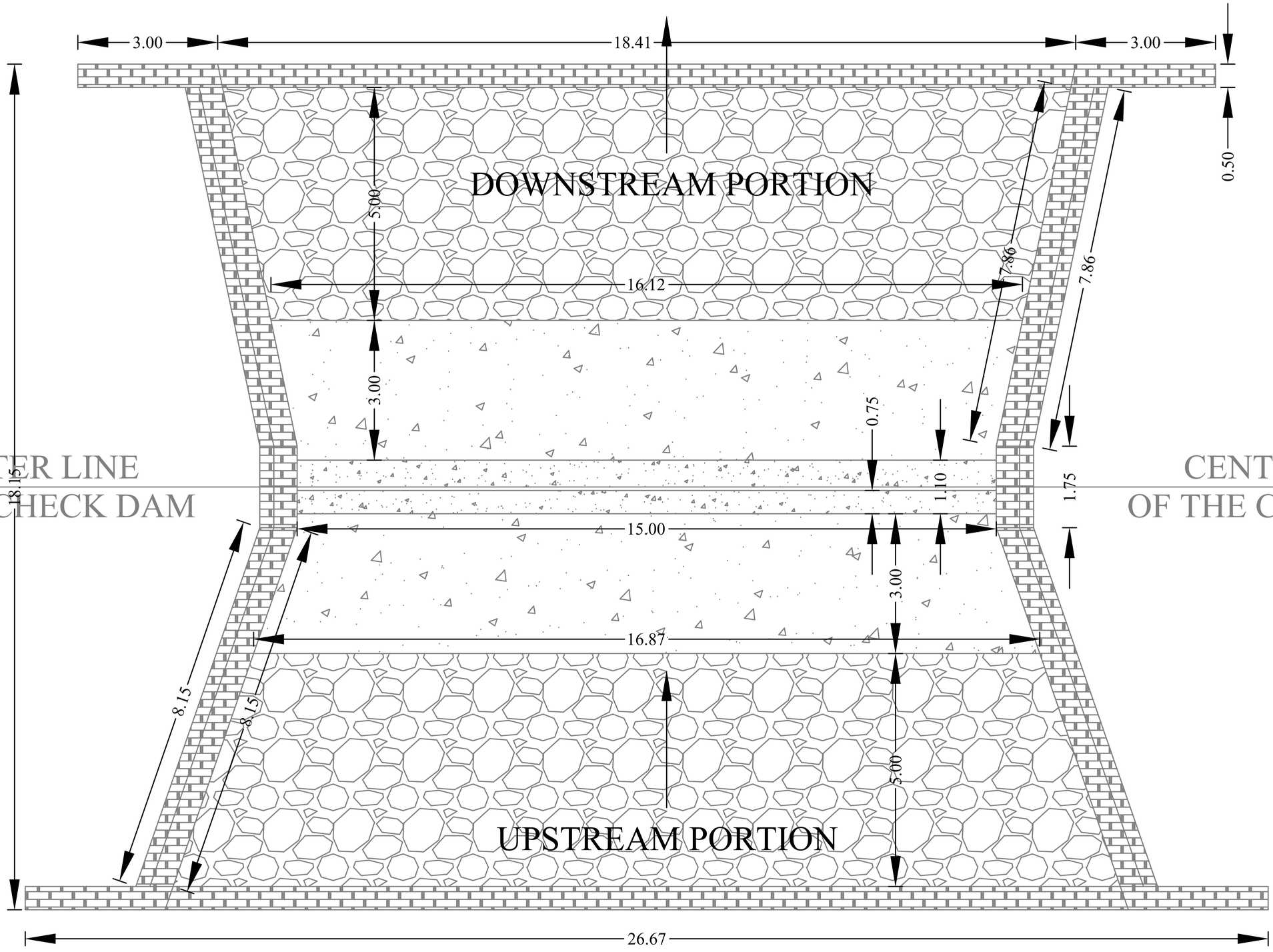
REV 0

	Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/RRR-RC/021

SCALE :- NTS

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED



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TECHNICAL CONSULTANTS:

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

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DRAWING TITLE: CHECK DAM - CBT 009
DIMENSIONAL DETAILS OF CHECK DAM

REV 0

Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/RRR-RC/022

SCALE :- NTS

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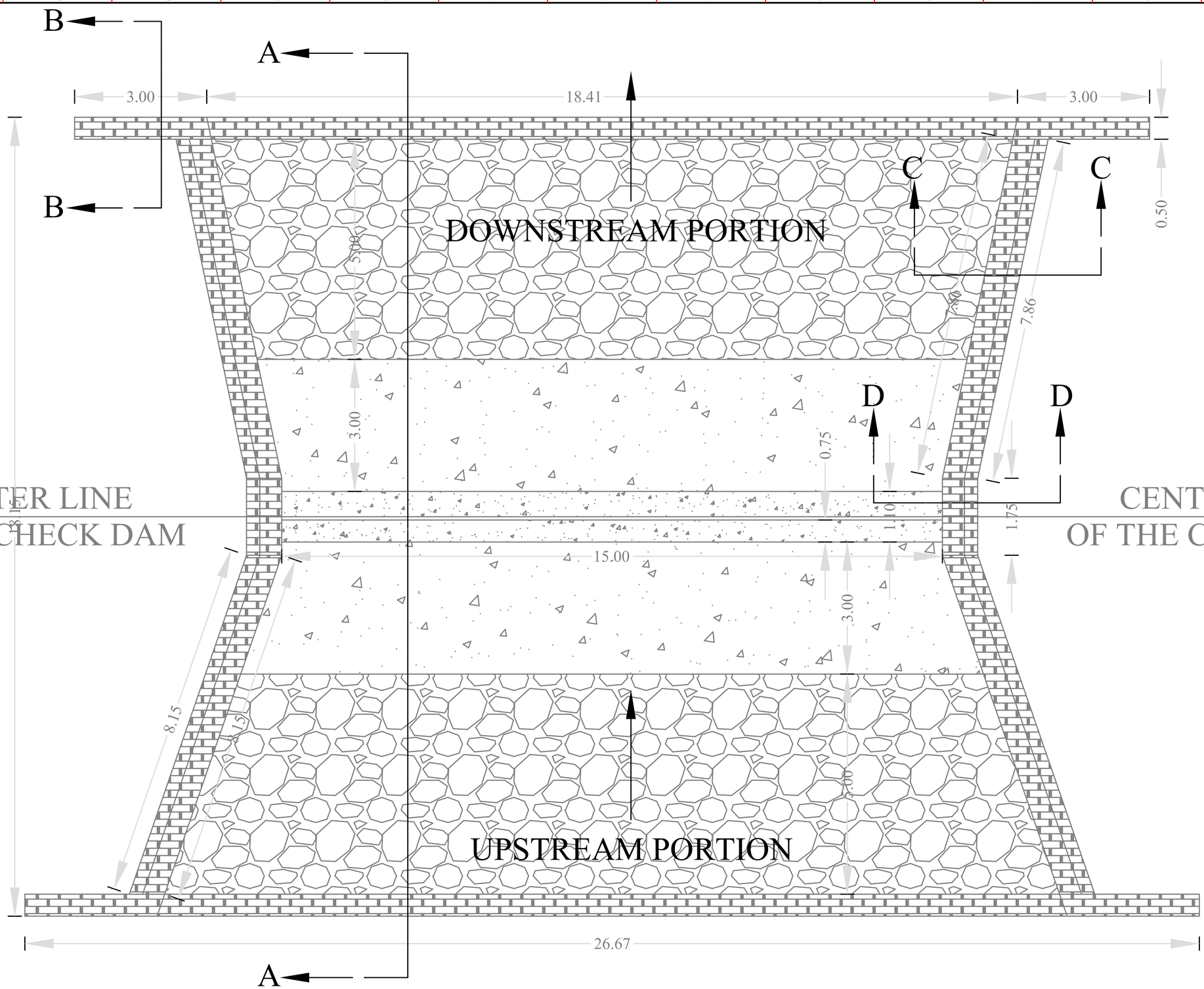

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TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

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DRAWING TITLE: CHECK DAM - CBT 009
SECTIONAL DETAILS OF CHECK DAM

DRAWING NUNBER: BT/GESTS/RRR-RC/023

REV 0

Date	Approved for Issue

SCALE :- NTS

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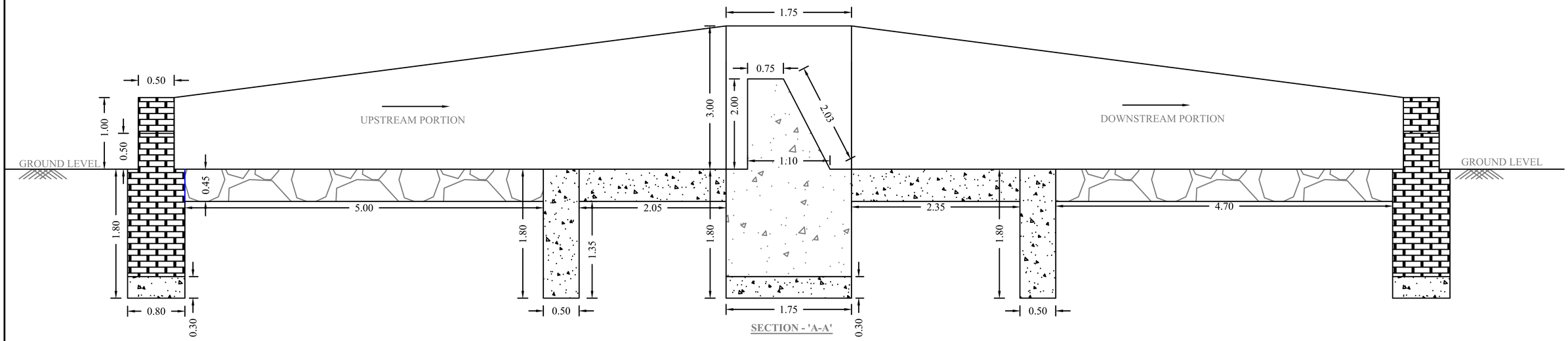
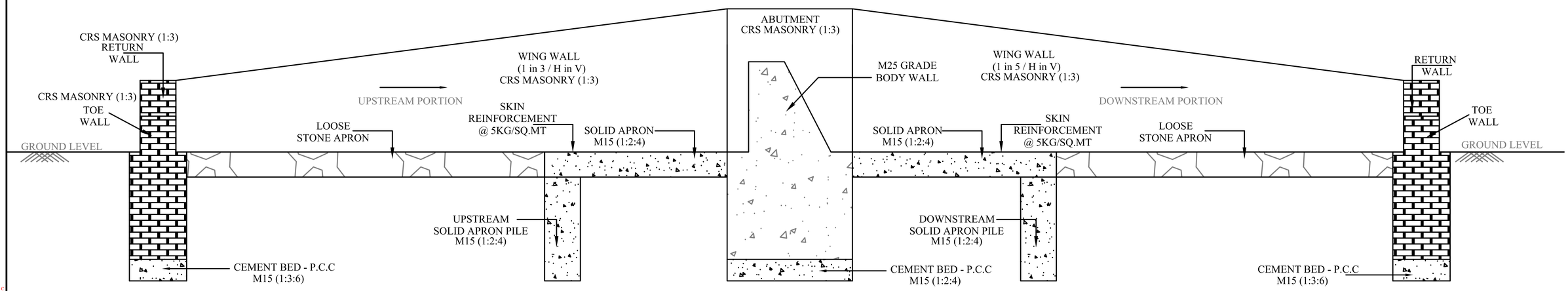


SECTION - 'A-A'



SECTION - 'A-A'

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TECHNICAL CONSULTANTS: Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

GESTS

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: CHECK DAM - CBT 009
SECTIONAL DETAILS OF CHECK DAM

REV 0

Date	Approved for Issue

DRAWING NUNBER: BT/GESTS/RRR-RC/024

SCALE :- NTS

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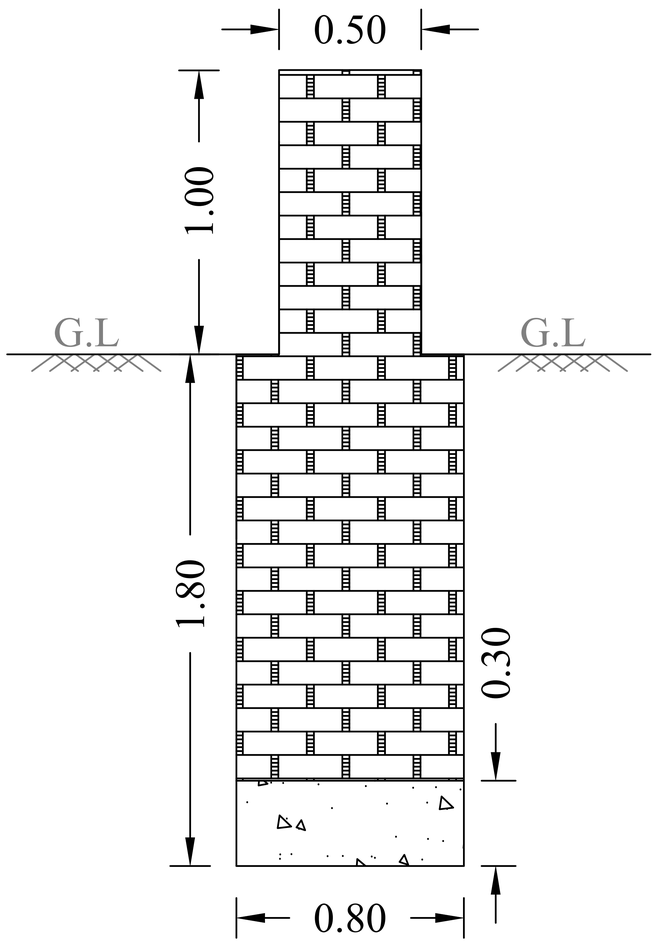
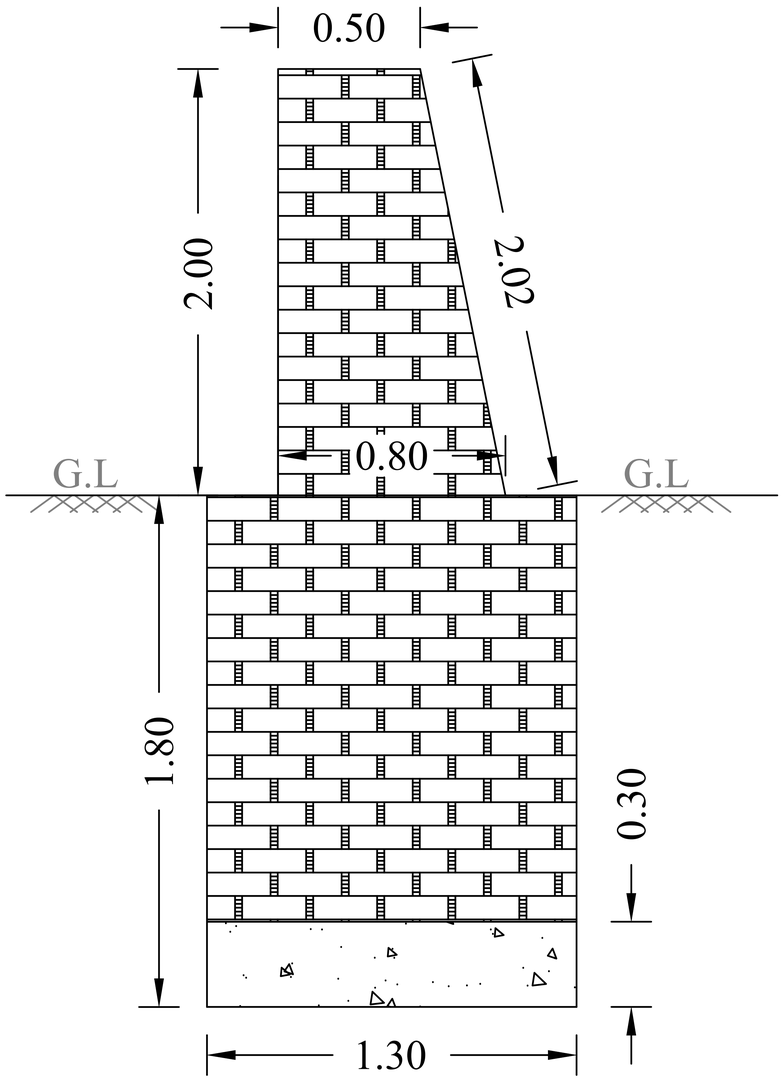
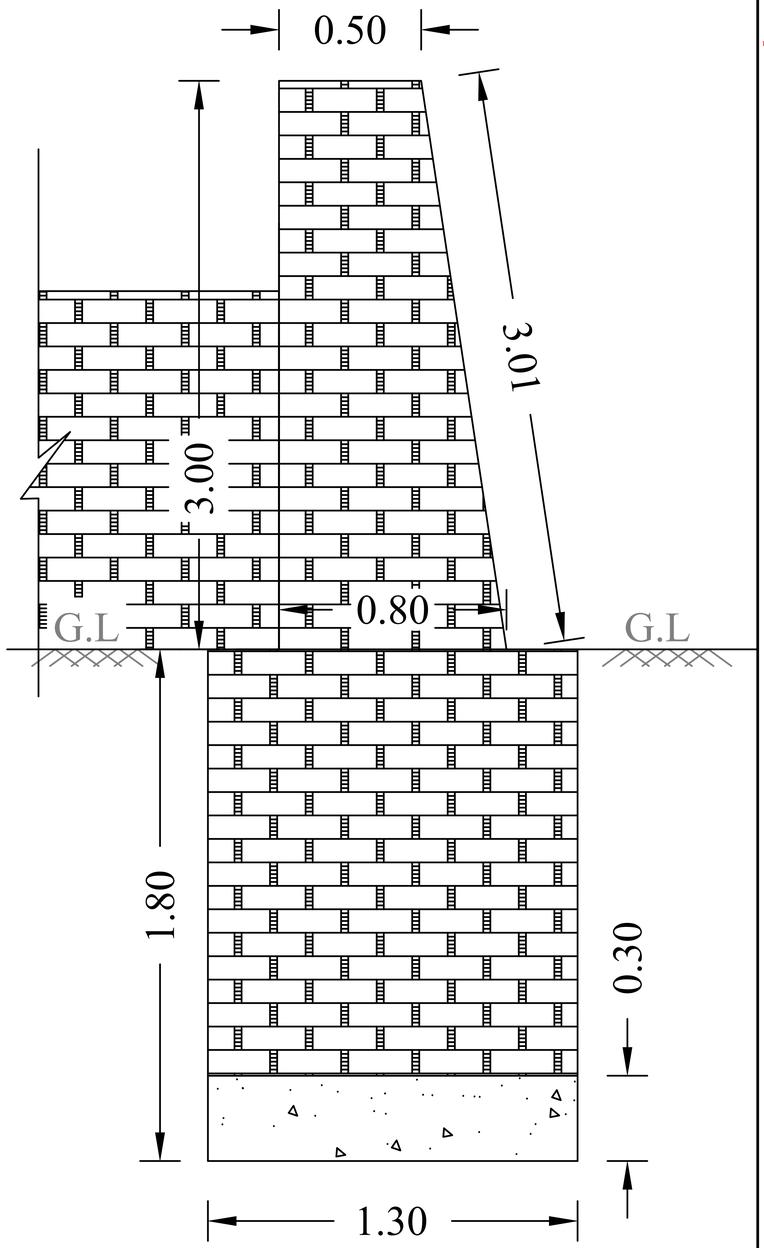


SECTION - 'B - B'
RETURN WALL



SECTION - 'C - C'
WING WALL



SECTION - 'D - D'
ABUTMENT

N

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Date			
Name			
	Drawn By	Checked By	Approved By

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TECHNICAL CONSULTANTS:

Rudra Amarnath Babu, B.Tech, M.Tech, MICE, MIE, (Ph.D)
CHARTERED ENGINEER
MANAGING PARTNER
M/s. GREENFIELDS ENGINEERS TECHNOLOGICAL SOLUTIONS - GESTS
Plot N0. 20A, H.No. 1-1-307/20A, Sri Ramnagar Colony,
Nr. CAL Public School, KAPRA, ECIL Post, Hyderabad - 500 062, Telangana State, INDIA
Mobile No. +91-09676060154, 09866086165, 09866939148
E-mail: gests2007@yahoo.com, www.gests.in

PROJECT TITLE: ASSESSMENT OF GROUNDWATER SCENARIO AT CHINTAMANI CITY, KARNATAKA LEADING TO PLAN FOR REVIVAL OF DEFUNCT BOREWELLS WITH SUITABLE RECHARGE TECHNOLOGY OPTIONS

DRAWING TITLE: CHECK DAM - CBT 009
SECTIONAL DETAILS OF CHECK DAM

REV 0

Date	Approved for Issue

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ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED