RAIN WATER HARVESTING REPORT 2020-21

FOR

KRISHNA INSTITUTE OF MEDICAL SCIENCES "DEEMED TO BE UNIVERSITY", KARAD

SUBMITTED TO

Krishna Institute of
Medical Sciences
"Deemed to Be University"
Karad

PREPARED BY

EASE Technology, Kolhapur

DATE

20th January 2021

सं. IG29-93229
No.

अनुक्रमांक 146094962
Enrolment No.

इन्दिरा गांधी राष्ट्रीय मुक्त विश्वविद्यालय
INDIRA GANDHI NATIONAL OPEN UNIVERSITY

प्रमाणित किया जाता है कि *Murkute Pragatee Prakash*
This is to certify that

को निर्धारित पाठ्यक्रमों को पूरा करने और
after having passed the prescribed courses of study in the

June 2015 की परीक्षा उत्तीर्ण करने पर
examination is hereby awarded

Certificate in Water Harvesting and Management

प्रदान किया जाता है।

नई दिल्ली / New Delhi

दिनांक / Dated August 7, 2015

कुलसचिव
Registrar

इन्दिरा गांधी राष्ट्रीय मुक्त विश्वविद्यालय
INDIRA GANDHI NATIONAL OPEN UNIVERSITY

Rain Water Harvesting Completion Certificate

Name of the Institute	Krishna Institute of Medical Sciences "Deemed to Be University" Karad, Satara - 415539
Details of facility Audited	Campus of the Krishna Institute including all the faculties, Hostels, Hospital, Lab and all allied Utilities.
Report prepared by	Ms. Pragatee P. Murkute Mr. Milind M. Kumbhar Mr. Dhiraj A. Kekalekar
Company	EASE Technology 240 (1) (B) E-5, E Ward, Panchratna Apartment, Nagala Park, Kolhapur, MH - 416003

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CHAPTER - 1INTRODUCTION

Water is the most common or major substance onearth, covering more than 70% of the planet's surface. Alllivingthingsconsistmostlyofwater.Forexample,thehuman body is about 2/3rd water. Worldwide distributionof water is given in following table.

Table 1.1 Worldwide Distribution of Water

Sr. No.	Water Type	Volume (1000 Km^3)	% of Total Global volume
1	Ocean	1,370,323	94.200
2	Groundwater(fresh& saline)	60,000	4.100
3	Glaciers	24,000	1.650
4	Lakesandreservoirs	280	0.019
5	Soilmoisture	85	0.006
6	Atmosphericwater	14	0.001
7	Riverwater	1.2	0.001
	Total	**1,454,703.2**	**100.000**

Only 2 percent of the total volume of water (over 28,000,000 Km^3) is fresh water, whichcan be used for consumption and for agriculture as given intable 1.2.

Table 1.2 Worldwide Distribution of Fresh Water

Sr. No.	Water Type	Volume (1000 Km^3)	% of Total Global volume
1	Glaciers	24,000	85.000
2	Groundwater	4,000	14.000
3	Lakesandreservoirs	155	0.600
4	Soilmoisture	83	0.300
5	Atmosphericwater	14	0.050
6	Riverwater	1.2	0.004
	Total	**28,253.2**	**100.000**

The average runoff in the river system of India hasbeenassessedas1869km^3.Theutilizableportionof this conventional storage and diversion is estimated at about690km^3.Inaddition,thereissubstantialreplenishableground water potential in the country estimated at 432 km^3.For improving per capita water availabilityin the country, replenishment of ground water resources is anecessity which can bedone very effectively through rainwaterharvesting. Theharvestedrainwatercanalsobeuseddirectlyforvariouspurposes,whichwillimprovepercapitawateravailabilitysubstantially.

1.1 Hydrological cycle

Thenever-endingexchangeofwaterfromtheatmospheretotheoceansandbackisknownasthehydrologiccycle(Fig.1.1).Thiscycleisthesourceofallformsofprecipitation(hail,rain,sleet,andsnow),andthusof all the water. Precipitation stored in streams, lakes and soilevaporates while water stored in plants transpires to formcloudswhichstorethewaterintheatmosphere.

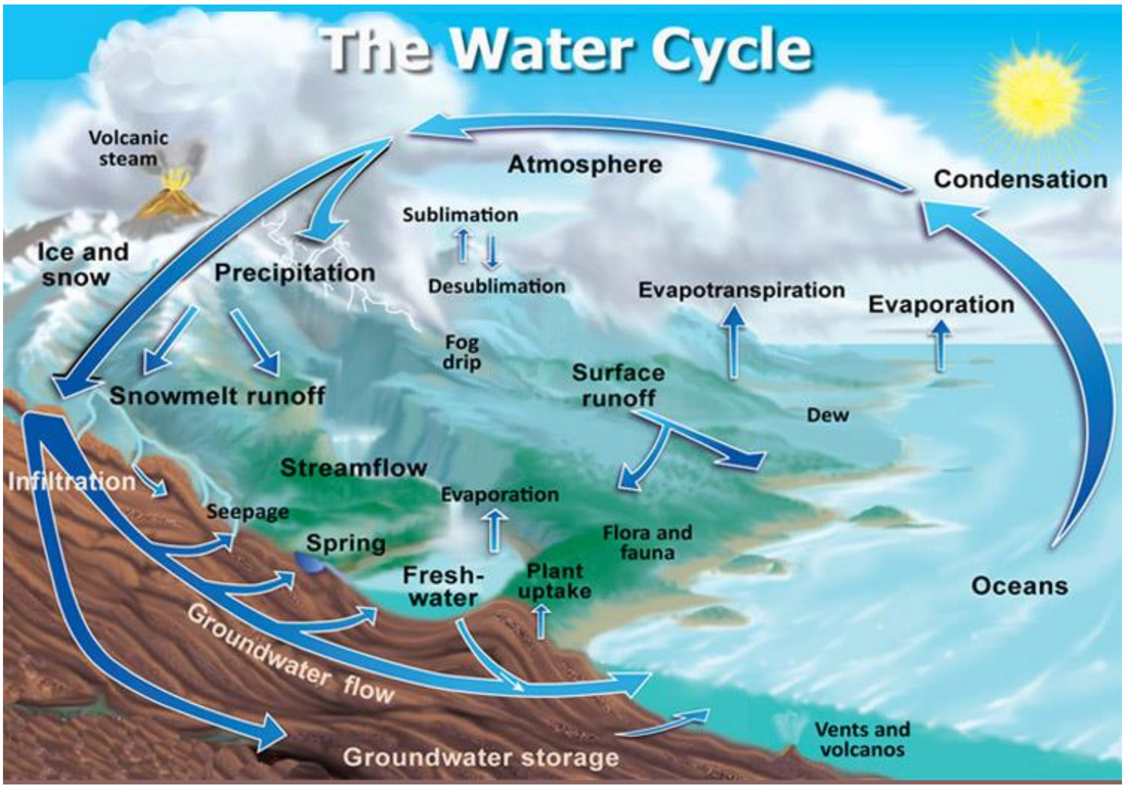


Fig. 1.1 Hydrological Cycle

Currently, about 75% to 80% of conventional watersupplyisfromlakes,riversandwells.Makingthemostefficientuseoftheselimitedandpreciousresourcesisessential. Otherwise, scarcity of water will be faced by ourfuturegenerations.Thisincludesusingappliancesandplumbing fixtures that conserve water, not wasting water, andtakingadvantageofalternativewatersourcessuchasgrey waterreuseandrainwaterharvesting.

1.2 Advantages of Rain Water

The rain water’s environmental advantage and purityoverotherwateroptionsmakesitthefirstchoice,eventhoughtheprecipitationcyclemayfluctuatefromyeartoyear.

Environmentaladvantage

Collecting the rain that falls on a building and usingthe same for various purposes is a simple concept. Sincetherainyouharvestisindependentofanycentralizedsystem,youarepromotingself-sufficiencyandhelpingtofosteranappreciationforthisessentialandpreciousresource.Thecollectionofrainwaternotonlyleadstoconservation of water but also energy since the energy inputrequired to operate a centralized water system designed totreat and pump water over a vast service area is bypassed.Rain water harvesting also lessens local erosion and floodingcaused by runoff fromimpervious cover such as pavementandroofs,assomerainisinsteadcapturedandstored.Thus,thestormwaterrun-off,thenormalconsequenceofrainfall,whichpicksupcontaminantsanddegradesourwater ways, becomes captured rainfall which can then fulfill anumberofproductiveuse.Policymakerswouldhavetoreconsider present assumptions regarding impervious coverand consequent run-off management strategies when rainwaterharvestingsystemsareinstalled.

Qualitativeadvantage

Acompellingadvantageofrainwateroverotherwatersourcesisthatitisoneofthepurestsourcesof wateravailable. Indeed, the quality of rain water is an overridingincentive for people to choose rain water as their primarywatersource,orforspecificusessuchaswateringhouseplants and gardens.Rain water quality almost alwaysexceeds that of ground or surface water as it does not comeinto contact with soil and rocks where it dissolves salts andminerals and it is not exposed to many of the pollutants thatoften are discharged into surface waters such as rivers, andwhich can contaminate groundwater.However, rain waterquality can be influenced by characteristics of area where itfalls,sincelocalizedindustrialemissionsaffectitspurity.Thus, rain water falling in non-industrialized areas can besuperior to that in cities dominated by heavy industry or inagriculturalregionswherecropdustingisprevalent.

Rain water is soft and can significantly reduce thequantity of detergents and soaps needed for cleaning, ascompared to typical municipal water.In addition, soap scumand hardness deposits disappear and the need for a watersoftener,oftenanexpensiverequirementforwellwatersystems, is eliminated.Water heaters and pipes will be freeof deposits caused by hard water and will last longer.Rainwater’s purity also makes it an attractive water source forcertainindustriesforwhichpurewaterisarequirement.Thus, industries such as computer microchip manufacturingand photographic processing would certainly benefit from thissourceofwater.

CHAPTER - 2PROJECT SUMMARY

Particulars	Details
Name of Institute	Krishna Institute of Medical Sciences “Deemed To Be University”, (KIMSDU)
Address	Near Dhebewadiphata, NH4, Pune - Bangalore Highway, Agashivnagar, MalkapurKarad, Maharashtra
Latitude	17°26'09.34"N,
Longitude	74°17’63.25"E
Nearest City	Karad: 3 Km (NE)
Nearest River /Water Body	Krishna River: 1.2 km
Nearest Highway	NH 4: 0.2 Km
Nearest Railway Station	Karad
Nearest Air Port	Pune international Airport - 170 Km
Water Resources	1. Malkapur Nagar parishad (M.N.P.) 2. Irrigation (Koyna river water) 3. Ground Water (Bore Well-for Emergency condition)
Water Permission	753.4 m3/day from Koyna river
Average Water Consumption per day by Institute	406 m3/day
Waste Water going to STP	345 m3/day
Total Water Recycle/Reuse	310 m3/day
Average annual rainfall	632 mm
Total rooftop and surface area	10670 Sq. Ft.
Proposed rooftop and surface area	9250 Sq. Ft.
Water Storage Tank	16 lac lit (Tanks with different capacities in various buildings of the campus)

BRIEF ABOUT RAIN WATER HARVESTING

Need for Rain Water Harvesting

For ourwater requirement we entirely depend uponrivers, lakes and ground water.However rain is the ultimatesource that feeds all these sources.Rain water harvestingmeanstomakeoptimumuseofrainwaterattheplacewhereitfallsi.e.conserveitanddon’ta llowit todrainaway andcausefloodelsewhere.A water audit is an on-site survey and assessment of water-using hardware, fixtures, equipment,landscaping, and management practices to determine the efficiency of water use and to developrecommendations for improving water-use efficiency. In simple words, a wateraudit is a systematic review of a site that identifies the quantities and characteristics of all the wateruses.

Need for Rain Water Harvesting

Water is one of the most essential forexistenceoflivingbeings.Surfacewaterandgroundwaterare two majorsourcesofwater.Duetooverpopulationandhigherusagelevelsofwaterinurbanareas,watersupplyagenciesare unable to cope up demand from surface sources like dams,reservoirs,riversetc.Thishasledtodiggingofindividualtubewells by house owners.Even water supply agencies haveresortedtogroundwatersourcesbydiggingtube-wellsinordertoaugmentthewatersupply.Replenishmentofgroundwaterisdrasticallyreduceddueto pavingofopenareas.Indiscriminateexploitation of ground water results in lowering of water tablerenderingmanybore-wellsdry.Toovercomethissituationborewellsaredrilledtogreaterdepths.Thisfurtherlowersthewatertable and in some areas this leads to higher concentration ofhazardouschemicalssuchasfluorides,nitratesandarsenic.Incoastal areas like Chennai, over exploitation of ground waterresulted in seawater intrusion thereby rendering ground waterbodies saline.In rural areas also, government policies onsubsidizedpowersupplyforagriculturalpumpsandpipedwatersupply through bore wells are resulting into decline in groundwater table.The solution to all these problems is to replenishgroundwaterbodieswithrainwaterbyman-mademeans.

Advantages of Rain Water Harvesting

(a) Promotesadequacyofundergroundwater

(b) Mitigatestheeffectofdrought

(c) Reducessoilerosionassurfacerun-offisreduced

(d) Decreases load on storm water disposal system

(e) Reduces flood hazards

(f) Improvesgroundwaterquality/decreasessalinity (by dilution)

(g) Prevents ingress of sea water in subsurface aquifers in coastal areas.

(h) Improvesgroundwatertable,thussavingenergy(toliftwater)

(i) Thecostofrechargingsubsurfaceaquiferislowerthansurfacereservoirs

(j) Thesubsurfaceaquiferalsoservesasstorageanddistributionsystem

(k) Nolandiswastedforstoragepurposeandnopopulationdisplacementisinvolved

(l) Storingwaterundergroundisenvironmentfriendly

Disadvantages of Rain Water Harvesting

(a) Supplies can be contaminated by bird/animal droppings on catchmentsurfacesand gutteringstructuresunlesstheyare cleaned/flushed beforeuse.

(b) Poorly constructed water jars/containers can suffer from algalgrowthandinvasionbyinsects,lizardsandrodents.Theycanactas a breeding ground for disease vectors if they are not properly maintained

Rain Water Harvesting potential

Thetotalamountofwaterthatisreceivedintheformofrainfalloveranareaiscalledtherainwaterendowmentofthatarea.Outofthis,theamountthatcanbeeffectivelyharvestediscalledrainwaterharvestingpotential.

Area of catchment X Amount of Rainfall = Rain Water Endowment

All the water which is falling over an area cannot beeffectively harvested, due to various losses on account ofevaporation,spillageetc.Becauseofthesefactorsthequantityofrainwaterwhichcaneffectivelybeharvestedisalwayslessthan the rain water endowment.The collection efficiency ismainlydependentonfactorslikerunoffcoefficientandfirstflush wastageetc.

Runoffisthetermappliedtothewaterthatflowsawayfrom catchments after falling on its surface in the form of rain.Runofffromaparticularareaisdependentonvariousfactorsi.e.rainfallpatternandquantity,catchmentareacharacteristicsetc.Fordeterminingrainfallquantity,therainfalldatapreferablyforaperiodofatleast10yearsisrequired.Thisdatacanbecollectedfrommeteorologicaldepartment.Fordeterminingthepatternofrainfall,theinformationmaybecollectedeitherfrommeteorologicaldepartmentorlocally.Thepatternofrainfallinaparticular catchment area influences the design of rain waterharvestingsystem.Inareaswhererainfallismorebutlimitedtoveryshortperiodinayear, bigstoragetankswouldberequiredto store rain water, if we are collecting rain water in storagetanks for direct use. In such areas, it is preferable to use rainwater for recharging of ground water aquifers, if feasible, toreducethecostofrainwaterharvestingsystem.

Runoff depends upon the area and type of catchmentover which it falls as well as surface features.Runoff can begenerated from both paved and unpaved catchment areas.Pavedsurfaceshaveagreatercapacityofretainingwateronthesurfaceandrunofffromunpavedsurfaceislessincomparisontopaved surface. In all calculations for runoff estimation, runoffcoefficientisusedtoaccountforlossesduetospillage,leakage,infiltrationscatchment surfacewettingandevaporation, which will ultimately result into reduced runoff.Runoffcoefficientforanycatchmentistheratioofthevolumeofwaterthatrunoffasurfacetothetotalvolumeofrainfallonthesurface. The runoff coefficient for various surfaces is given intable2.1.

Table No. 2.1 Runoff Coefficient for Various Surfaces

Sr. No.	Type of Catchment	Coefficients

Sr. No.	Type of Catchment	Coefficients
	Roof catchments	
1	Tiles	0.8-0.9
2	Corrugated Metal Sheets	0.7-0.9
	Ground Surface Coverings	
3	Concrete	0.6-0.8
4	Brick Pavement	0.5-0.6
	Untreated Ground Catchments	
5	Soil on Slopes Less than 10%	0.0-0.3
6	Rocky Natural Catchments	0.2-0.5

Source:*Pacey,AmoldandCullis,Adrian1989,RainwaterHarvesting:Thecollectionofrainfallandrunoffinruralareas,IntermediateTechnologyPublications,Londonp55*.

Based on the above factors, the water harvestingpotentialofsitecouldbeestimatedusingthefollowingequation:

Rain Water harvesting potential = Amount of RainfallxAreaofcatchmentxRunoffcoefficient

The calculation for runoff can be illustrated using thefollowingexample:

Consider a building with flat terrace area (A) of 100sqm. in KIMSDU. The average annual rainfall (R) in Karadis approximately 632 mm. (Ref - Gov. of Satara (Karad) District Average rainfall year -2002 to 2018).The runoff coefficient (C) for a flatterracemaybeconsideredas0.8.

Annual water harvesting potentialfrom100m^{2}roof= AxRxC

= 100x0.632x0.8

= 50.56cum

i.e.50, 560 liters.

CHAPTER - 3METHODS OF RAIN WATER HARVESTING

3.1 Ways of Harvesting Rain Water

- Surface Runoff Harvesting
- It is a method in which rainwater flowing as surface runoff is caught and used for recharging aquifers by adopting appropriate methods.
- Roof Top Rain Water Harvesting
- In rooftop harvesting,theroofbecomesthecatchment,and therainwater is collected from theroofofthehouse/building. It can either bestored in a tank or diverted toartificial rechargesystem.
- Techniques of Rain Water Harvesting (RWH)

a) Storing rain water for direct use

Inplacewheretherainsoccurthroughouttheyear,rainwater can be stored in tanks (Fig. 3.1). However, at placeswhererainsarefor2to3months,hugevolumeofstoragetankswould have to be provided. In such places, it will be moreappropriatetouserainwatertorechargegroundwateraquifersratherthantogoforstorage .Ifthestrataisimpermeable,thenstoringrainwaterinstoragetanksfordirectuseisabetter method.Similarly,ifthegroundwaterissaline/unfitforhuman consumption or ground water table is very deep, thismethodofrainwaterharvestingispreferable.

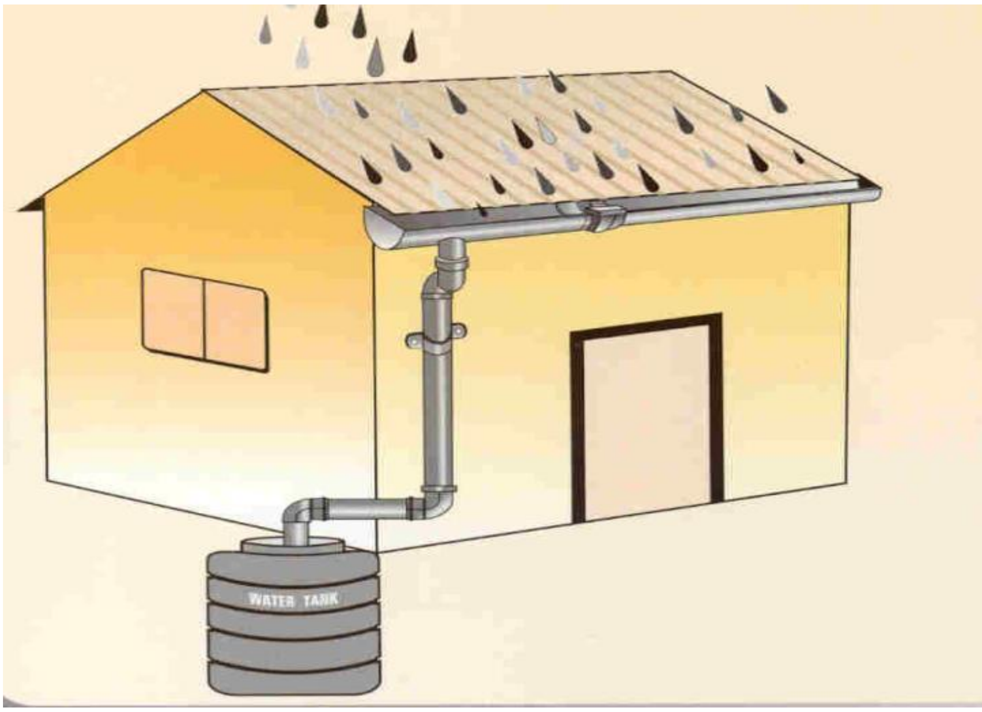


Fig. 3.1 Storing rain water for direct use

b) Recharging ground water aquifers, from Roof top runoff.

Rain water that is collected on the roof top of thebuilding may be diverted by drain pipes to a filtration tank (forborewell,throughsettlementtank)fromwhichitflowsintothe recharge well,as shown in Fig.3.2. The recharge wellshould preferably be shallower than the water table.Thismethod of rain water harvesting is preferable in the areaswhere the rainfall occurs only for a short period in a year andwater table is at a shallow depth.

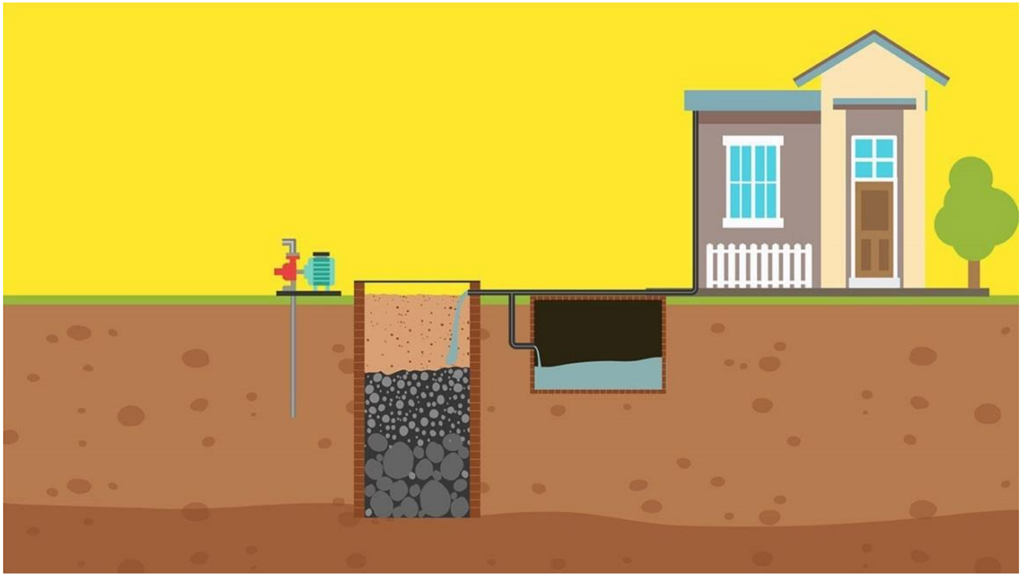


Fig. 3.2Recharging Ground water from Roof top runoff

c) Recharging ground water aquifers with runoff from ground area.

The rain water that is collected from the open areasmaybedivertedbydrainpipestoarechargedugwell/borewellthrough filter tanks as shown in Fig.3.3. The abandoned borewell/dugwellcanbeusedcosteffectivelyforthispurpose.

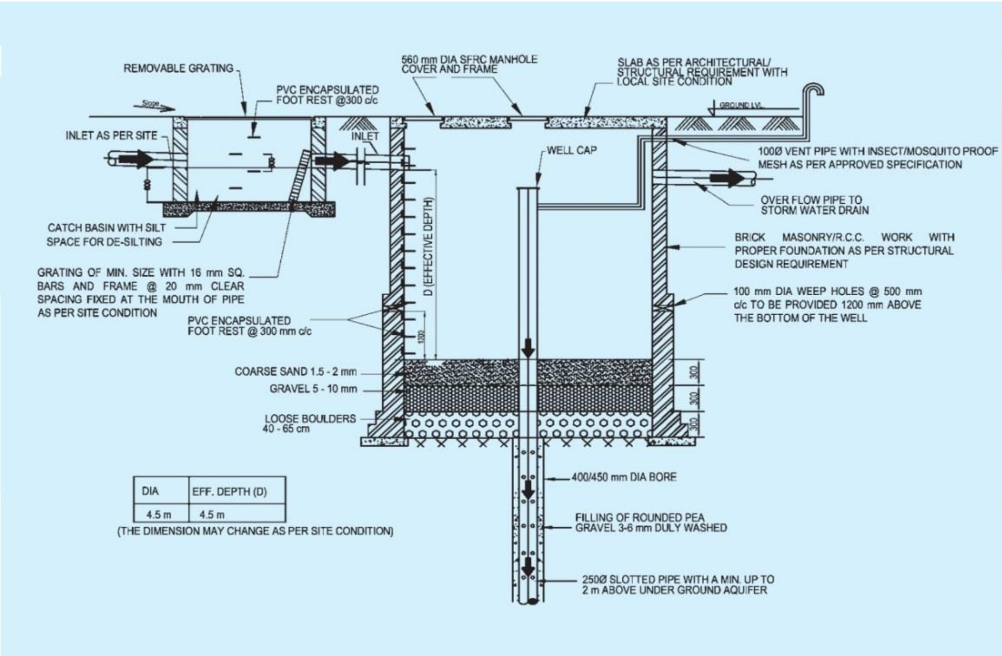


Fig. 3.3Recharging Ground water with runoff from Ground areas

3.2 Components of Rain Water Harvesting

Therainwaterharvestingsystemconsistsoffollowingbasiccomponents–

(a) Catchmentarea

The catchment area is the surface on which the rainwater falls.This may be a roof top or open area around thebuilding.Thequalityofwatercollectedfromrooftopiscomparatively much better than collection from the ground.Rainwaterharvestedfromcatchmentsurfacesalongthegroundshouldbeusedforlawnwatering,flushingetc.,because of increased risk of contamination.This water canalsobeusedforrecharginggroundaquifersafterproperfiltration.

Therainwateryieldvarieswiththesizeandtextureofthecatchmentarea.Asmooth,cleanerandmoreimprovised roofing material contributes to better water qualityand greater quantity with higher value of runoff coefficient.(Refertable2.1forrunoffcoefficient)

When roof of the building is used as the catchment forcollectingtherainwater,thetypeofroofandtheconstructionmaterialaffecttherunoffcoefficientandqualityofcollectedwater.RoofsmadeofRCC,GIsheets,corrugatedsheets,tilesetc.arepreferableforrooftopcollection.But thatched roofs are not preferred as these addcolour and dissolved impurities to water. Water to be usedfor drinking purpose should not be collected from roof withdamaged AC sheets or from roofs covered with asphalt andlead flashing or lead based paints as the lead contaminationmayoccurinthecollectedwater.

(b) Coarse mesh / leaf screen

To prevent the entry of leaves and other debris in thesystem, the coarse mesh should be provided at the mouth ofinflowpipeforflatroofsasshowninFig.3.4.

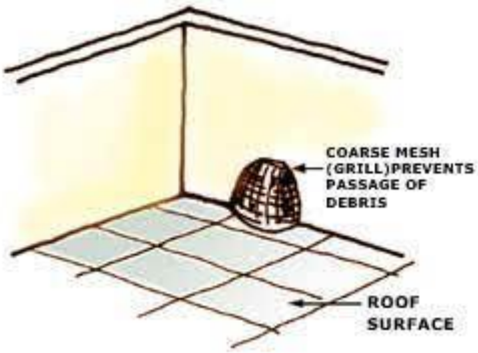


Fig.3.4. Coarse Mesh

For slope in roofs where gutters are provided to collectanddiverttherainwatertodownspoutorconduits,theguttersshouldhaveacontinuousleafscreen,madeof¼inchwiremeshinametalframe,installedalongtheirentirelength,andascreenorwirebasketattheheadofthedownspout.

Fig.3.5. Leaf Screen

(c) Gutter

Gutter is required to be used for collecting water fromslopingroofandtodivertittodownspout.Thesearethechannelsallaroundtheedgeofaslopingr ooftocollectandtransportrainwater to the storage tank.Gutters can be of semi-circular,rectangularortrapezoidalshape.Guttersmustbeproperlysized,slopedandinstalledinorder tomaximizethequantityofharvestedrain.Guttercanbemadeusinganyofthefollowingmaterials:

(a) Galvanizedironsheet

(b) Aluminum sheet

(c) Semi-circularguttersofPVCmaterialwhichcanbereadilypreparedbycuttingthesepipesintot woequalsemi-circularchannels

(d) Bambooorbeteltrunkscutverticallyinhalf(forlowcosthousingprojects)

The size of the gutter should be according to the flowduring the highest intensity rain.The capacity of the guttersshould be 10 to 15% higher. The gutters should be supportedproperly so that they do not sag or fall off when loaded withwater.The connection of gutters and down spouts should bedoneverycarefullytoavoidanyleakageofwaterandtomaximizetheyield.Forjointingofgutters,t heleadbasedmaterialsshouldnotbeused,asitwillaffectthequalityofwater.

(d) Down spout or conduit

Therainwatercollectedontherooftopistransporteddowntostoragefacilitythroughdownspouts/c onduits.Conduitscan be of any material like PVC, GI or cast iron. The conduitsshould be free of lead and any other treatment which couldcontaminatethewater.Table2.1givesanideaaboutthediameterof pipe required for draining out rain water based on rainfallintensityandroofarea.

(e) First flushing device

Roofwashingorthecollectionanddisposalofthefirstflushofwaterfromaroof,isveryimportantif thecollectedrainwateristobeuseddirectlyforhumanconsumption.Allthedebris, dirt and other contaminants especially bird dropping etc.accumulatedontheroofduringdryseasonarewashedbythefirstrainandifthiswaterwillenteri ntostoragetankorrechargesystemitwillcontaminatethewater.

Therefore,toavoidthiscontaminationafirstflushsys-temisincorporatedintherooftoprainwaterharvestingsystem.Thefirstflushingdevice,disposeofft hefirstspellofrainwatersothatitdoesnotenterthesystem.

If the roof is of sloping type, then the simplest systemconsistsofapipeandagutterdownspoutlocatedaheadofthedownspoutfromtheguttertothestoragetank.(Fig. 3.6)

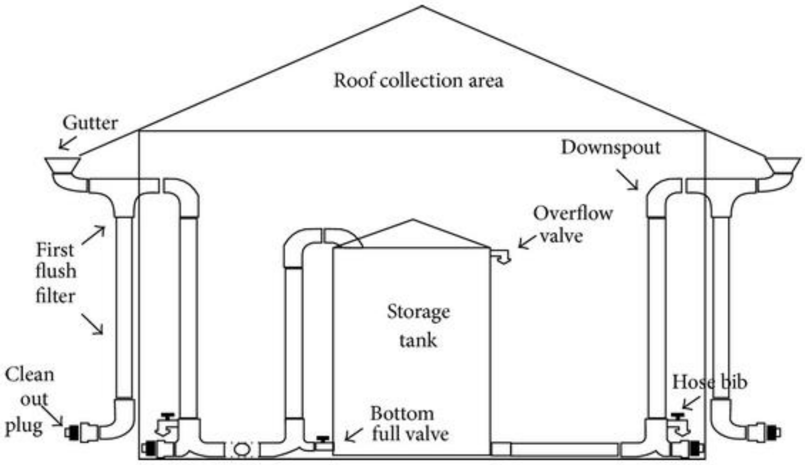


Fig. 3.6 Image of First flushing device

The pipe is usually 6 or 8 inch PVC pipe which has avalveandcleanoutatthebottom,mostofthesedevicesextendfrom the gutter to the ground where they are supported.Thegutter down spout and top of the pipe are fitted and sealed sothat water will not flow out of the top. Once the pipe has filled,therestofthewaterflowstothedownspoutconnectedtostoragetank.

Thealternateschemeforslopingroofinvolvesaverysimpledevicewhichisrequiredtobeoperated manually. In down take pipe at the bottom one plug/valveisprovided.Whentherainyseasonstart,thisplugshouldbe removed, and initial collection of roof top water should beallowedtodrain.After15–20minutes,plug/valveshouldbeclosed so that collected rain water can be diverted to storagetank.

(f) Filter

Ifthecollectedwaterfromrooftopistobeusedforhumanconsumptiondirectly,afilterunitisrequiredtobeinstalledinRWHsystembeforestoragetank.Thefilterisusedtoremovesuspendedpollutantsfromrainwatercollectedoverroof.The filter unit is basically a chamber filled with filteringmediasuchasfiber,coarsesandandgravellayerstoremovedebrisanddirtfromwaterbeforeitentersthestoragetank.Thefilterunitshouldbeplacedafterfirstflushdevicebutbeforestoragetank.Therearevarioustypeoffilterswhichhavebeendevelopedalloverthecountry.Thetypeandselectionoffiltersisgovernedbythefinaluseofharvestedrainwaterandeconomy.Dependinguponthefilteringmediausedanditsarrangements,varioustypesoffiltersavailablearedescribedbelow.

Sandfilter

Inthesandfilters,themainfilteringmediaiscommonlyavailablesandsandwitchedbetweentwolayersofgravels.Thefilter can be constructed in a galvanized iron or ferro cementtank. This is a simple type of filter which is easy to constructand maintain. The sand fillers are very effective in removingturbidity,colourandmicroorganism.Inasimplesandfilterthatcanbeconstructeddomestically,filtermediaareplacedasshowninFig.3.7.

Fig. 3.7 - Sand Filter

Charcoalfilter

Thisisalmostsimilartosandfilterexceptthata10-15cmthickcharcoallayerplacedabovethesandlayer.Charcoallayerinsidethefilterresultintobetterfiltrationandpurificationof water.The commonly used charcoal water filter is shown inFig.3.8.

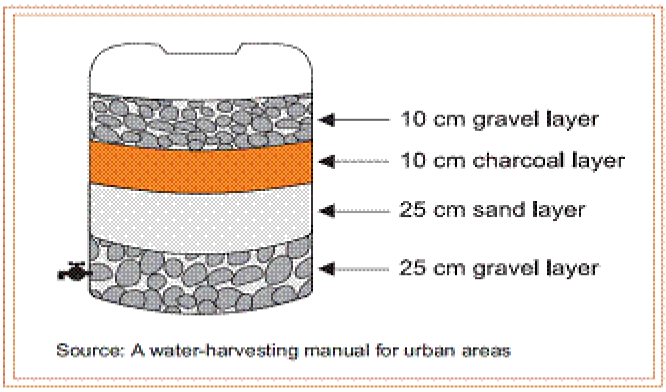


Fig. 3.8 Charcoal Filter

There are several other types of filters available for rain water filtration in the market.

(g) Storage tank

Whenevertherainwatercollectedfromrooftopisuseddirectlyforvariouspurposes,storagetankisre quired.Thestoragetank can be cylindrical, rectangular or square in shape.ThematerialofconstructioncanbeRCC,Ferro-cement,masonry,PVCormetalsheets.Dependingupontheavailabilityofspace,thestoragetankca nbeaboveground,partiallyundergroundorfullyunderground. Thedesignofstoragetankisdependentonmanyfactorswhicharelistedbelow:

(a) Numberofpersonsinthehousehold– Thegreaterthenumberofpersons,morewillberequirementofwater.

(b) Per capita requirement – varies from household tohousehold,basedonstandardofliving.Therequirementalsovarieswithseason.Insumm ertherequirementismoreincomparisontowinter.Similarly,thepercapitarequirement is more in urban areas in comparison toruralareas.

(c) Average annual rainfall

(d) Rainfall pattern – It has a significant impact on capacity of storage tank.If the rainfall is uniformly spread throughout the year, the requirement of storage capacity will be less. But if the rainfall is concentrated to a limited period in a year, the storage tanks of higher capacity will be required.

(e) Type and size of catchment – Depending upon the type of roofing material, the runoff coefficient varies which affect the effective yield from a catchment area. The size ofthe catchment also has a bearing on tank size.The more the catchment area, larger the size of storage tank.

CHAPTER - 4RECHARGING SUBSURFACE AQUIFERS

4.1 Methodsofrechargingsubsurfaceaquifers

Thevariousmethodsofrechargingsubsurfaceaquifersare:

1. Throughrechargepit.

This method is suitable where permeable strata isavailableatshallowdepth.Itisadoptedforbuildingshavingroofareaupto100Sqm.Rechargepitofanyshapeisconstructedgenerally1-2mwideand2-3mdeep.Thepitisfilledwithboulders,gravelandsandforfiltrationofrainwater.Wateringinto RWHstructureshouldbesiltfree.Toplayerofsandoffiltershouldbe cleaned periodically for better ingression of rain water in tothesubsoil.DetailsareshowninFig.4.1.

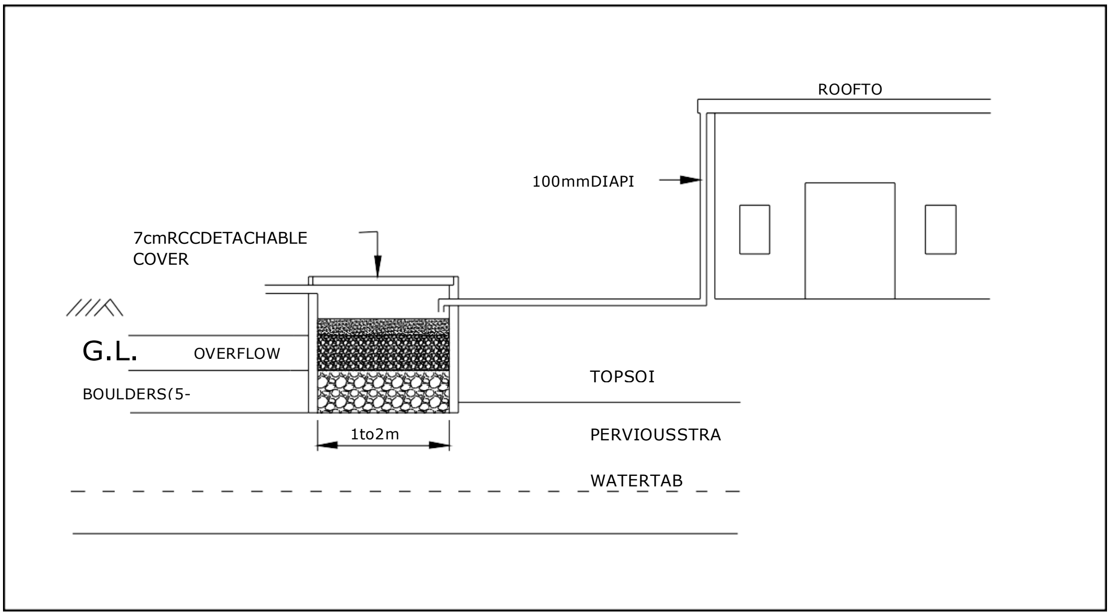


Fig 4.1 Through Recharge Pit

2. Recharge through abandoned hand pump.

In this method, an abandoned hand pump is used asrechargingstructure.Itissuitableforbuildinghavingrooftopareaupto150sqm.Rooftoprainwaterisfedtothehandpumpthrough100 mm dia. pipe as shown in Fig. 4.2. Water fed in the Rainwaterharvestingstructureshouldbesiltfree.Waterfromfirstrainshouldbedivertedtodrainthro ughsuitablearrangement.Ifwaterisnotclearthenfiltershouldbeprovided.

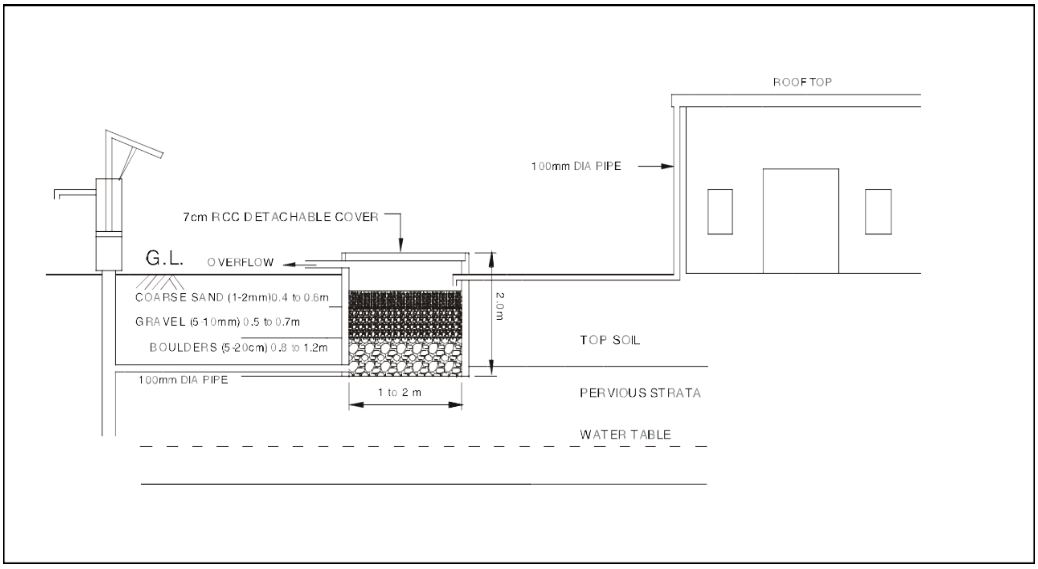


Fig. 4.2 Recharge Through Abandoned Hand Pump

3. Recharge through abandoned dug well/open well.

Inthismethod,adry/unuseddugwellcanbeusedasarechargestructure.Itissuitableforbuildingshavingarooftopareamorethan100sqm.Rechargewaterisguidedthroughapipeof100mmtothebottomofthewellasshowninFig.4.3.Wellcleaninganddesiltingisimperativebeforeusingit.Rechargewaterguidedshouldbesiltfree,otherwisefiltershouldbeprovidedas shown in Fig. 4.3. Well should be cleaned periodically andchlorinatedtocontrolbacteriologicalcontamination.

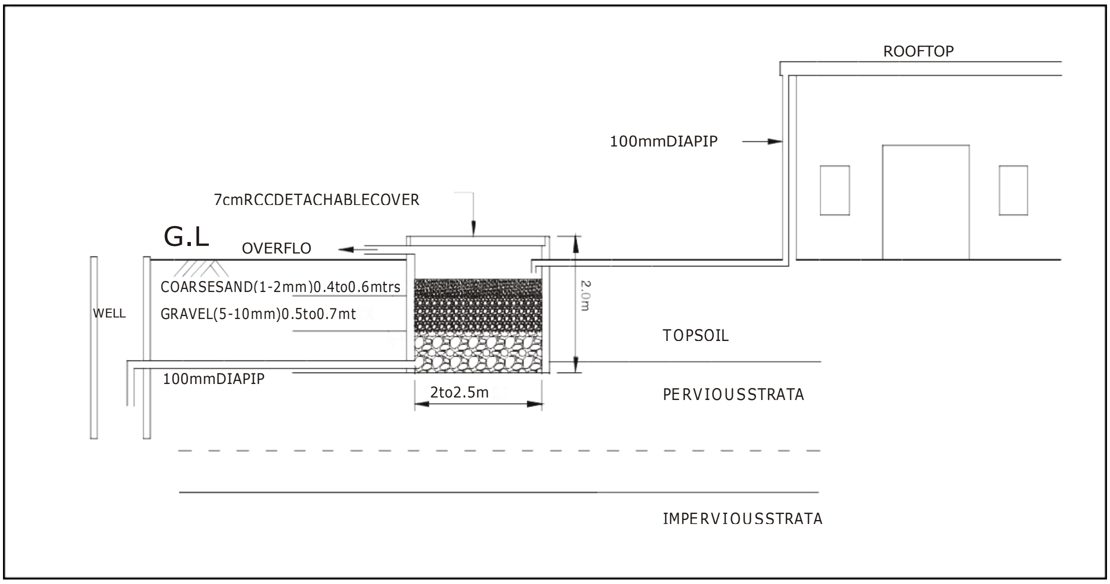


Fig 4.3 Recharge Through Abandoned Open Well

4. Through recharge trench.

Thismethodisusedwherepermeablestrataisavailableatshallowdepth.Itissuitableforbuildingshavingrooftopareabetween 200 & 300 sqm. In this method, trench of 0.5-1.0 mwide,1-1.5mdeepandofadequatelengthdependinguponrooftopareaandsoil/subsoilcharacteristicsshouldbeconstructedandfilledwithboulders,gravelandsandasshowninFig.4.4.Cleaningoffiltermediashouldbedoneperiodically.

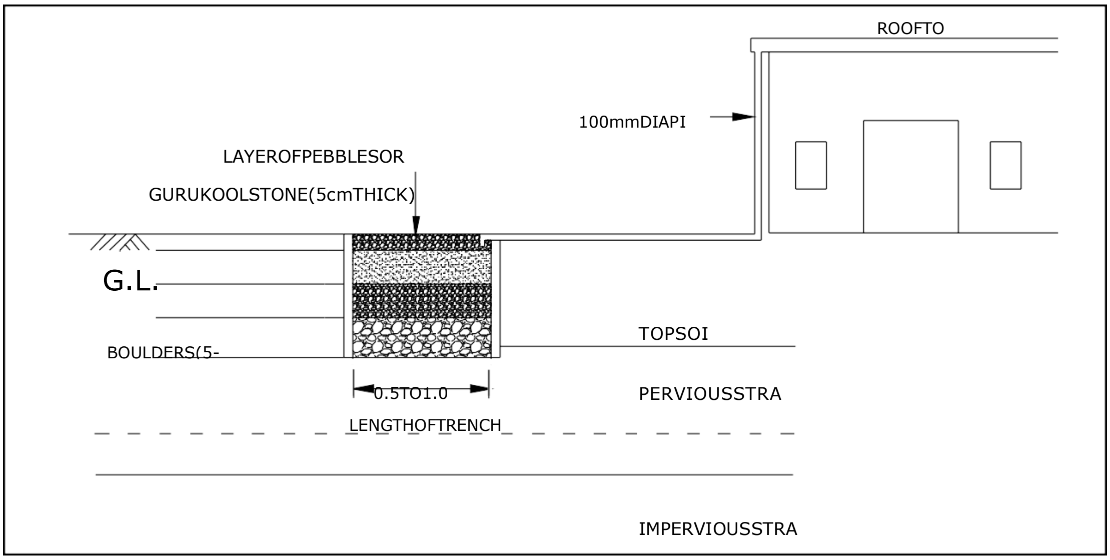


Fig. 4.4Through Recharge Trench

5. Rechargethroughshaft.

Thismethodissuitablewhereshallowaquiferislocatedbelowclayeysurface.Itisusedforbuildings havingrooftoparea between2000&5000sqm.Rechargeshaftofdiameter0.5-3mand10-15mdeepisexcavatedmechanically.Theshaftshouldendinimpermeablestrata.Theshaftshouldbe filledwithboulders,gravelandsandforfiltrationofrechargewater.Topsandlayershould be cleaned periodically. Recharge shaft should beconstructed 10-15 m away from the buildings for the safety ofthebuildings.ThedetailsaregiveninFig.4.5.

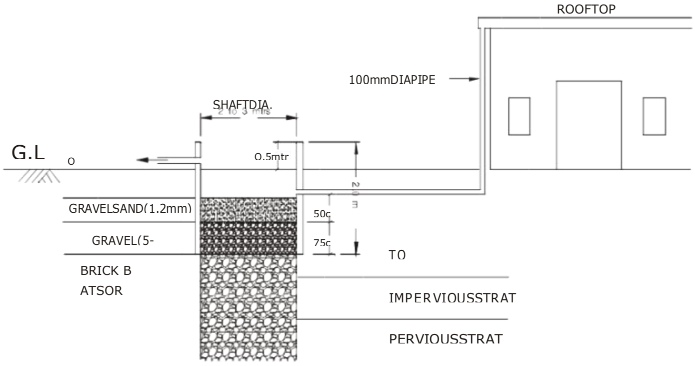


Fig. 4.5 Recharge Through Shaft

6. Recharge trench with bore

Thismethodisusedwheresub-soilisimperviousandlargequantityofroofwater/surfacerunoffisavailable.Inthis,trenchismade 1.5-3mwideand10-30mlengthdependinguponwater availability. Wells of 150-300 mm dia. and 3-5 m deep(belowperviouslayer)areconstructedinthetrench.Numbersofwellstobedugaredecidedinaccordancetowateravailabilityand rate of ingression. Trench is filled with filtration media asshown in Fig. 4.6. A suitable silt chamber is also inserted withgratingforwaterdivertingarrangementsasshowninthefigure.

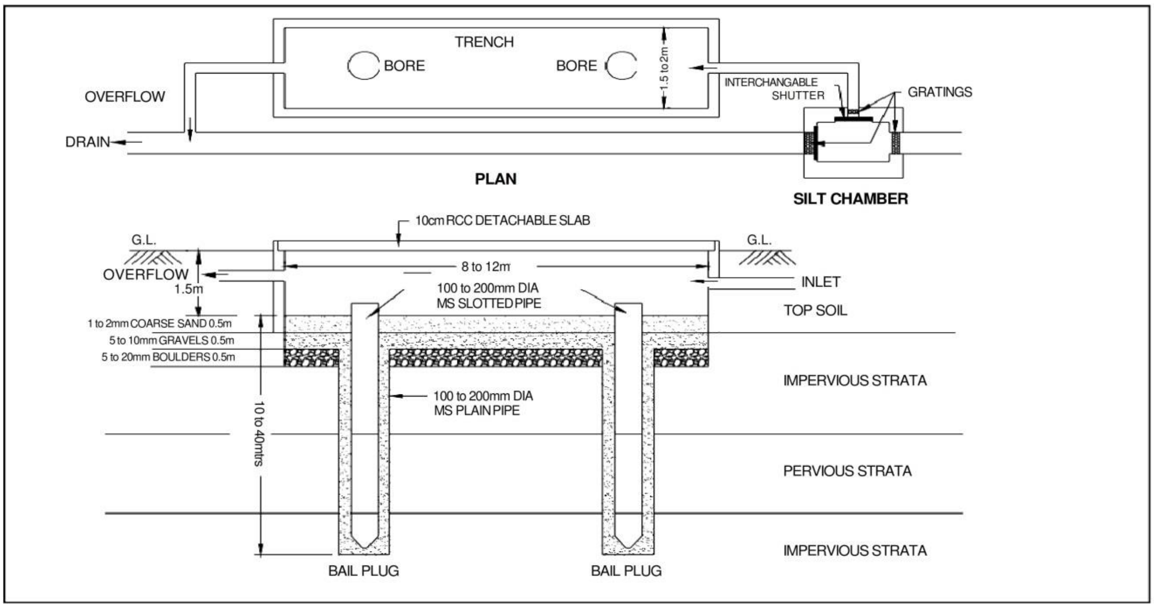


Fig. 4.6 Recharge Trench with Bore

CHAPTER - 5KIMSDU - CASE STUDY

5.1 Introduction

Krishna Institute of Medical Sciences “Deemed To Be University”, (Herein after referred to be KIMSDU) is located at Karad, Maharashtra. KIMSDU is accredited by NAAC 'A' grade and has been conferred with ISO 9001:2015 and ISO 14001:2015certification. The constituent faculties of the University include Medical, Dental, Physiotherapy, Nursing, Pharmacy and Allied Sciences offering undergraduate and postgraduate courses in the respective faculties. It also runs Ph.D. programs and Post-Doctoral Fellowships in various subjects.

The medical college is about 35 years old and is recognized by the Medical Council of India, Medical Council of Malaysia and is listed in the WHO's World Directory of Medical Schools. Medical Council of India recognizes MBBS and postgraduate degree/ diploma courses in clinical and basic sciences in 17 disciplines.

It has state-of-the-art museums with large collection of specimens and models. National Accreditation Board has accredited the KIMS diagnostic laboratory for Testing and Calibration Laboratories (NABL). The Lead Referral Laboratory is the first of its kind in Maharashtra state, which was ranked the first amongst 40 such centers in India. The well-equipped NABL accredited Department of Molecular Biology and Genetics is a feather in the cap.

Krishna Hospital and Medical Research Center and the hospital blood bank both have been separately accredited by NABH (National Accreditation Board for Hospitals and Healthcare).

The teaching hospital is 1125 bedded multispecialty tertiary care hospital with facilities for Critical Care, Endoscopic Surgeries, Dialysis, Cardiology, Cardio-vascular-thoracic-surgery, Oncology, Urology, Neurosurgery, Plastic surgery, Oral and Maxillofacial Surgery and a recognized Renal Transplant Unit. It has fully equipped major operation theaters, minor theaters, labour rooms, blood bank accredited by NABH, radio diagnosis and radiotherapy, computerized medical records, counseling services etc. There are separate intensive care units like Medical, Surgical, Coronary care, Pediatric, Neonatal (accredited by Neonatology Forum of India), Respiratory and Obstetrics. Neonatology Forum of India recognizes the neonatal ICU. The radio-diagnosis department has facilities for MRI, color Doppler, mammography, DSA etc. It also actively participates in national healthcare programs and various extensions and outreach community programs initiated by the institute.

The University has been ranked 5th amongst the cleanest higher Educational Institutions in the category of 'Technical Institutions - Universities (Residential)' in the year 2018. The University has also received certificate for 'Maintaining, Promoting and Encouraging the Culture of Swachhta in Higher Education Institutions in the country'.

The institute has also received recognitions as below:

1. Commendation Award (Green Institutional Mentor Award) – Letter dated 08th March 2020

2. Krishna Hospital and Medical Research Centre was ranked 1st as a Clean Hospital in “SwachhSarvekshan 2020” among the Hospitals in Malkapur Nagarparishad, Tal. Karad, Dist. Satara - Certificate dated 29th June 2019.

3. Recognized Social Entrepreneurship, Swachhata& Rural Engagement Cell - Certificate dated 30th August 2020.

Location of KIMSDU –

KIMSDU is located at NH4, Pune - Bangalore Highway, Agashivnagar, Malkapur, Karad, Maharashtra.

Figure – 5.1 Google Image of KIMSDU

Figure – 5.2 Photographs of KIMSDU Campus

5.2 Rain Water Harvesting in KIMSDU

As a primary data collected by survey, Sources of water for KIMSDU as follows;

Primary Source –

1. Koyana river (7,50,000 Lit/Day) Gov. of Maharashtra Sangli path-bandharevibhag, Sangli.
2. Malkapur Nagarparishad - 40000 Lit./day
3. There are seven submersible pumps of 750 Ipm capacity and Two spare for emergency.

Secondary / Alternate Source –

4. Bore wells act as an alternate source in the case of supply failure from river water. Presently the bore well water is being used for domestic use.

Rain water harvesting has been already installed in the campus area and used to recharge/increase ground water level. Following are the details of RWH system in KIMSDU.

Rain water harvesting in 2019

Sr. No.	Building Name	Terrace Area Sq. M.	Water Collection lac lit./year	Recharge pit near Bore
1	Krishna Institute of Medical Sciences - Annexure building	1600	8.08	Bore No. 2
2	Hostel No. 4 & 7	1740	8.79	Bore No. 5

Sr. No.	Building Name	Terrace Area Sq. M.	Water Collection lac lit./year	Recharge pit near Bore
3	Hostel No. 5 & 6	1700	8.59	Bore No. 6
4	Admin office, OPD Building & Cobalt Unit	1300	6.57	Bore No. 3
5	Ladies Hostel No. 1	1300	6.57	Bore No. 4
6	Ward No. 3 & 18	1000	5.05	-

Rain water harvesting in 2020 (In addition)

Sr. No.	Building Name	Terrace Area Sq. M.	Water Collection lac lit./year	Recharge pit near Bore
1	D type staff quarter	640	3.23	Bore No. 3 & 4
2	IHR Hostel (New)	450	2.27	Bore No. 3 & 4
3	IHR Hostel (Old)	440	2.22	Bore No. 3 & 4
4	NRI Hostel	500	2.52	Bore No. 3 & 4

Rain water harvesting proposed in 2021

Sr. No.	Building Name	Terrace Area Sq. M.	Water Collection lac lit./year	Recharge pit near Bore
1	Krishna Institute of Medical Sciences	2000	10.11	Bore No. 1
2	School of Dental Science	2250	11.37	Bore No. 7
3	Krishna Institute of Pharmacy	950	4.80	Bore No. 7
4	Krishna college of Physiotherapy	1050	5.30	Bore No. 7
5	Parking	3000	15.16	Bore No. 1

Monitoring of ground water level of Bore No. 2

March 2019	Water level (Ft.)
March	28

March 2019	Water level (Ft.)
April	30
May	32
June	30
July	29
August	25
September	16

Photographs of RWH Implementation -

CHAPTER - 6WATER QUALITY

Therainwaterisoneofpurestformofwateranddoesnot contain suspended / dissolved impurities.However whenthis water is collected through rain water harvesting, it gets contaminated becauseofcontactwithroofsurface/groundandsome of the impurities get mixed in it. These impurities are required to be removed before collecting the harvested rain water in storage tank or diverting it or recharging of ground water aquifers.

Followingprecautionsshouldbetakentoensurequalityofwater:

1. Roof,overwhichwaterfalls,shouldbecleanedbeforerainfall.
2. The suitable type of first flushing device to be installed and initial 10 to 15 minutes of runoff should be diverted.
3. The watercollected fromrooftop only,shouldbe stored in storage tank for direct use.
4. The runoff from surface/ground should be preferably be used for recharging ground water aquifers after proper filtration.
5. The rain water collected from roof top should pass through suitable type of filter and only then it should be stored in storage tank / used for recharging ground water aquifers.

The harvested rain water may contain some toxicsubstances which may affect our health. The water collectedfromrooftopafterfiltrationcanbeuseddirectlyforlawnwatering,washingetc.Butifthiswaterhastobeuseddirectlyfordrinkingpurpose,thenqualityofwatermustbeascertainedbeforeuse.Thewaterusedfordrinkingshouldcomplywiththeprovisionsof IS-10500:2012 i.e. Indian Standard “DRINKING WATER –SPECIFICATION”.Someimportanttestcharacteristics for drinking water as given in following table:.

Sr. No.	Substance orCharacteristics	DesirableLimit	Test Methods (Ref.toIS)	Remarks
EssentialCharacteristics				
i	Colour,Hazenunits,		3025 (Part-4): 1984	Extendedto25onlyif
ii)	Odour	Unobjectionable	3025(Part5):1983	a)Testcoldand whenheated b) Testatseveraldilutions
iii)	Taste	Agreeable	3025(Part7&8):1984	Testtobeconductedonlyaftersafetyhasbeenestablished
iv)	TurbidityNTU, Max	5	3025(Part10): 1984	-
v)	pHValue	6.5to8.5	3025(Part11): 1984	-
vi)	Total hardness(as CaCO3) mg/l, Max	300	3025 (Part 21): 1983	-
vii)	Chloride(asCl) mg/l, Max	250	3025(Part32): 1988	-
viii)	Dissolvedsolids mg/I, Max	500	3025(Part16): 1984	-
ix)	Calcium(asCa) mg/I, Max	75	3025(Part40): 1991	-

CHAPTER - 7OPERATION AND MAINTENANCE OF RWH

The initial start of a system involves testing whether or not the system works and if each component is performing to the manufacturer’s specifications. The operation and maintenance of a system is the continuous process of checking to see if individual system components are functioning properly, observing storage volume, and monitoring water usage. Routine maintenance and proper upkeep are directly related to water quality for potable water systems. Incorrect or deficient maintenance of equipment results in lower water quality and increased health risks. Regular testing for contaminants is a key determinant of system function. Each system is unique and has its own subtle variations in performance and functionality.

A system operator learns these nuances and keeps the system operating at an acceptable level. System Operator Responsibilities One person, the system operator, must be responsible for the upkeep of a RWH system. In a case where multiple individuals share in the responsibility of maintaining a system, eventually a breakdown will occur as a result of unattended maintenance. This lack of communication or miscommunication is often referred to as the “he said, she said” scenario. The burden of maintaining a system should rest with a sole individual who takes a keen interest in sustaining the highest quality of water and is capable of recognizing a declining level of performance.

- **Gutters**

Gutters are designed to catch all the runoff water from a roof. This clever but simple design also results in trapping debris and eventually blocking the flow of water. Monthly inspections of the gutter and removal of all materials, especially organic matter, is necessary to maximize water quality. Additionally, the gutters should be inspected after high intensity storms that include powerful wind gusts.

At least once a year, gutters should be flushed to remove sediment and debris lodged in corners, transitions, and internal hangers. New gutters may need to be washed with soap and water to remove oil residue deposited as a result of the manufacturing process; be sure to divert this water. When inspecting and cleaning gutters on ladders be cautious and have someone ensure that the bottom of the ladder is stable. Injuries as a result of falling off ladders are common and dangerous. Use the following list as a reminder when inspecting a gutter.

- Leaves
- Organic matter
- Twigs
- Feces
- Dead animals
- Sagging gutter sections
- Puddled water
- Loose hardware, connections

- Peeling paint
- Corrosion
- Leaks
- Sealer on transitions
- Ants • Sediment
- Asphalt particles
- Children's toys
- Algae, mold

➢ **Debris Screens**

Devices used to prevent leaves, twigs, carcasses, and other large debris from entering the storage tank are the first line of defense against contamination.

Leaf screens and gutter filters should be inspected on a monthly basis and after each major rainfall event, especially those that include high winds. The devices are designed to trap or stop debris; infrequent inspections and cleaning result in blockage, wasted water, and increased chances that decomposing debris will eventually enter the storage tank.

For example, a gutter clogged with leaves creates pooled water (Figure 17.2). The pressure from this pooled water is exerted on the decomposing debris and may force smaller debris particles into the downspout.

Debris screens should be inspected for the following items:

- Leaves
- Carcasses
- Decomposed organic matter
- Loose hardware
- Evidence of blockage
- Proper fitting components

➢ **Downspouts**

Downspouts should be regularly inspected for debris, loose hardware, and obstruction to flow. Unpainted PVC downspouts should be inspected for algae growth, leaks, and cracks. Over time, exposed PVC can become brittle and yellowish in color. Dented or crushed sections of downspouts hamper flow or may cause leakage.

Roof Washers and First Flush Diverters Roof washers, some box filters, and first flush diverters are considered a second line of defense against contamination after debris screens. Like a gutter, blockage in this device has negative consequences that result in less than optimal system performance and water quality.

These devices are natural traps for sediment and organic matter; weekly inspection is necessary. Monthly cleaning is suggested, depending on volume of debris encountered.

The drains should be kept clear to prevent puddling of water (Figure 17.3). Roof washers and first flush diverters should be inspected for the following:

- Clogged drain outlet
- Plugged screen
- Corrosion, leaks
- Animals
- Debris
- Mosquitoes
- Sediment
- Algae

- **Piping and Connections**

Piping and connections should be checked on a monthly basis. Plastic pipes should be checked for cracks and deformation. PVC plastic that is exposed to sunlight can degrade, turn yellowish in color, and become brittle. A visual inspection of outdoor components and piping should be conducted in the event of an abrupt change of temperature. Repairs that involve replacement and reconnecting of system components should be inspected more often until it is determined that there are no leaks.

- **Filters**

Filters are designed to stop particles of a specific size, preventing them from continuing on in the water stream. As the surface of the filter becomes clogged with particles, the flow is hampered and a drop in pressure results. A water pressure gauge installed on both the upstream and downstream sides of a filter or bank of filters can indicate a drop in pressure. This indicates required maintenance. Some filters can be cleaned while others, especially charcoal, must be replaced. Charcoal filters are replaced after a certain quantity of water has passed through them.

- **Pumps**

Most pumps are maintenance free, until they malfunction. Electric motors provide little warning prior to failure, and under most circumstances they last for years without need for replacement. Multiple starts within a short time period and lack of water in the pump housing contribute to premature failure. Contrary to popular belief, pumps are not damaged when flow is restricted or prevented, unless the water in the case becomes hot to the touch. The pressure switch that indirectly turns the pump on and off is the first to fail, because it contains moving parts and electrical contacts that become worn or dirty.

- **Water Testing**

Prior to consuming the water, an initial water quality assessment should be completed. The evaluation should be made by an individual with adequate knowledge and experience. Baseline test results provide a benchmark to compare subsequent results. At a minimum the water should be tested for bacteria, cryptosporidium, and giardia. The original analysis should be kept on file. The system should be retested after major repairs or replacement of sanitation equipment. If an unexpected or unexplained change in water quality occurs, testing for contamination may be appropriate. Yearly testing for total coliform (TC) and fecal coliform (FC) should be completed to serve as an indicator that the system is continuing to work properly. Testing may be viewed by a client as expensive and unnecessary, but it ensures that the water that is being delivered remains at an acceptable quality.

- **Maintenance Worksheet**

A good maintenance worksheet aids in collecting all the relevant information in one place for ease of evaluation. The worksheet ensures that every component of the systems is adequately evaluated. An example work sheet is provided as **Annexure I** in this report. All worksheets should be saved in a secure location with all other system information.

- **Inspection Accessibility**

Regular inspection and cleaning of RWH components is a key maintenance activity. Impediments that reduce the accessibility to serviceable components of a RWH system result in fewer inspections and cleanings. Devices such as filters, UV lights, leaf screens, and roof washers should be located to facilitate safe and easy inspection and cleaning.

- **Summary**

A RWH system that is properly operated and maintained will provide a higher quality of water with lower levels of risk than a comparable system that is neglected. Regular inspection and maintenance will aid the operator in fixing minor problems before they escalate. Operators should keep all records of operation and maintenance in case someone becomes ill after consuming the water. These records will aid in conveying the message that the system is performing at its designed level.

CHAPTER - 8RECOMMENDATIONSFOR EXISTING RWH

The campus of Krishna institute of Medical Sciences “Deemed to be University” is suitable for large scale Rain water harvesting system. The institute has already implemented the RWH system in the campus and also proposing new buildings/Departments for RWH (The layout of proposed building for RWH system enclosed as **Annexure II** in this report).

The existing RWH system is well executed in the campus. For proposed RWH plan we are suggesting some points that could be implemented for better results.

1. Existing RWH system is used for recharging Ground water. Existing storm water system should also be used for RWH/Ground water recharge.
2. RWH devices such as Coarse mesh; Leaf Screen, First flushing device etc. can be used for better results in proposed RWH system.
3. Piezometer should be installed for accuracy in Ground water level measurement.

Annexure I - Maintenance Worksheet Format

Annexure I

Maintenance Worksheet

Date - --/--/----

System Location: ______________________________

Operator: ______________________

Location of Records: ___________________________________

Filters: __________________________________

Pump: ______________________________________

Pressure Tank: ____________________________

UV System: __________________________________

Chlorine Application System: _______________

---

1) Catchment Surface: Free of Debris? □ Yes □ No

2) Gutters:

   a) Clean?: □ Yes □ No

   i) Leaf Screens: □ Yes □ No
   ii) Gutter Filters: □ Yes □ No
   iii) Inspection: □ Yes □ No
   iv) Confined space (O2 testing): □ Yes □ No

   b) Downspouts

   i) Intact: □ Yes □ No
   ii) First flush diverters- drained and clean: □ Yes □ No

3) Tanks

   a) Piping intact: □ Yes □ No

   i) Covers/lids/lock outs in place: □ Yes □ No
   ii) Overflow/vents properly screened: □ Yes □ No
   iii) Basket screens cleaned: □ Yes □ No

4) Pressure Tank

i) Leaks: □ Yes □ No

ii) Pump (cycle on)

(1) Leaks: □ Yes □ No

5) Filters: □ Yes □ No

(1) Rinse filters: □ Yes □ No

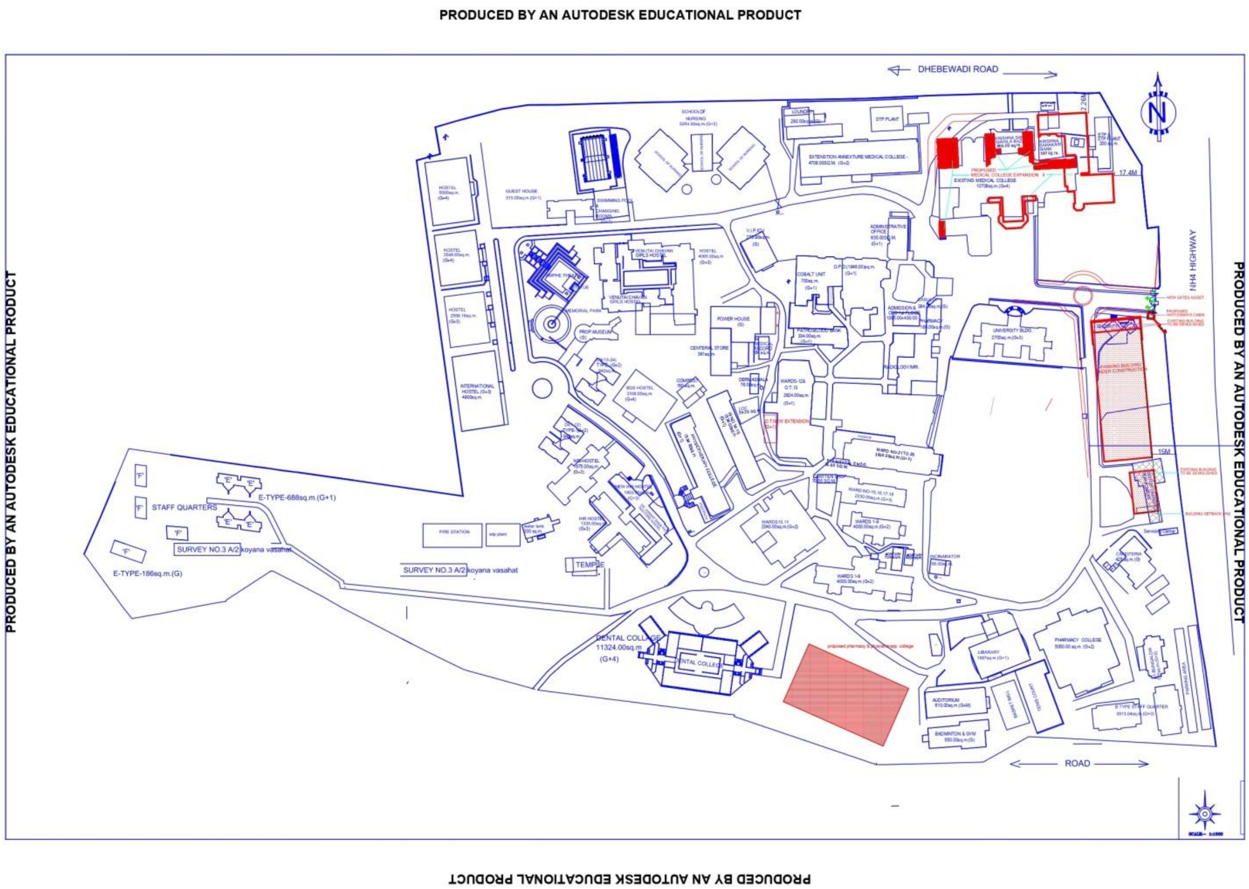
(2) Change filters: □ Yes □ No

6) Water Quality Testing

a) Sample taken: □ Yes □ No
b) Location from which sample was taken: ________________________
c) Testing Location: ____
d) Test to be run: ____

Annexure II - KIMSDU - Layout Plan With proposed Built up area

Annexure II


PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
DHEBEWADI ROAD
NH4 HIGHWAY
STAFF QUARTERS
E-TYPE-688sq.m.(G+1)
E-TYPE-186sq.m.(G)
SURVEY NO.3 A/2 koyana vasahat
SURVEY NO.3 A/2 koyana vasahat
TEMPLE
DENTAL COLLEGE
11324.00sq.m
(G+4)
ROAD
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT
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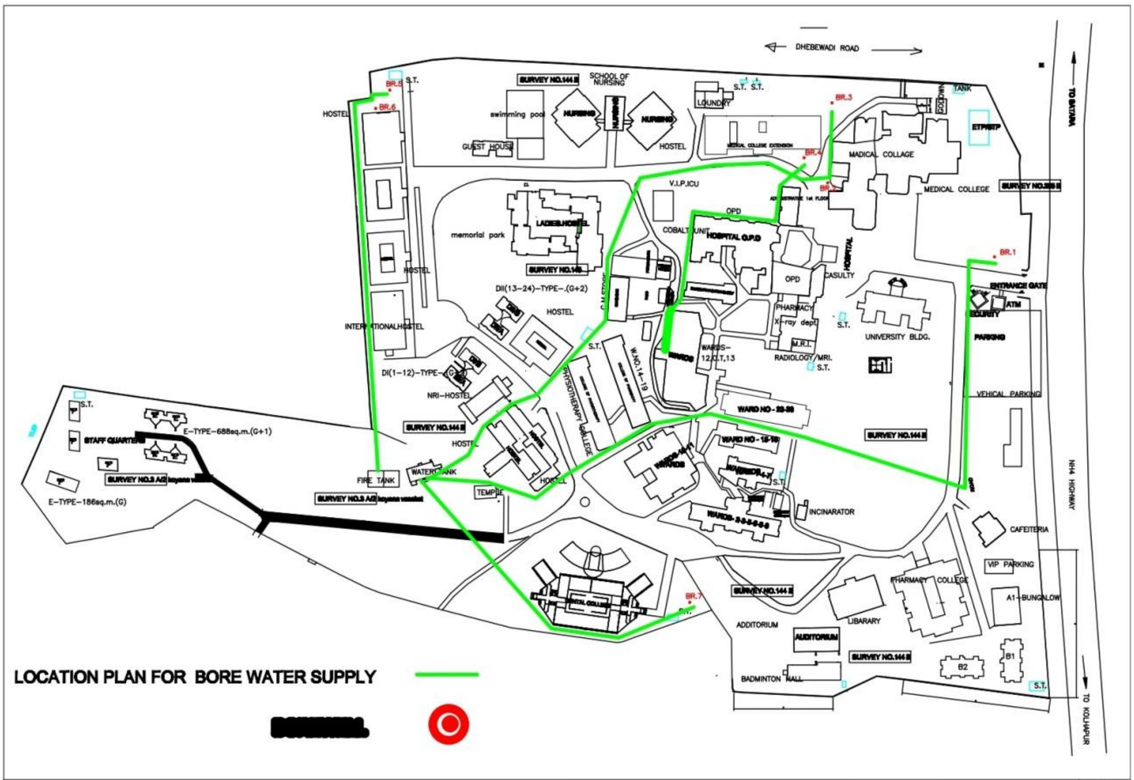
Annexure III - KIMSDU - Bore well Details

Annexure III



SITE PLAN AT GAT NO./S.NO 3A/2, KOYANA VASAHAT GRAMPANCHAYAT & S. NO. 144/B, 145, 266/B, 261/3C/B & 262

AT- MALKAPUR, TAL.- KARAD, DIST.- SATARA.(MAHARASHTRA) FOR KRISHNA INSTITUTE OF MEDICAL SCIENCE DEEMED UNIVERSITY , KARAD.

Ms. Pragatee Murkute	Mr. Milind Kumbhar	Mr. Dhiraj Kekalekar