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Rainwater Harvesting & Artificial Recharging in Vedanta Alumina Refinery Township, Lanjigarh, Odisha

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Abstract: This report presents a detailed study of rainwater harvesting and artificial groundwater recharge techniques tailored for Lanjigarh Block, Kalahandi District. The area faces seasonal water scarcity due to erratic rainfall and over-dependence on groundwater. By analyzing rainfall patterns, topography, and hydrogeological features, this plan aims to provide a sustainable solution to water scarcity through rooftop rainwater harvesting and various artificial recharge structures such as percolation pits, recharge trenches, and check dams.

I. INTRODUCTION

A. Introduction

The Alumina Refinery of M/s. Vedanta Limited is located at Lanjigarh in Kalahandi district of Odisha State. The plant is in operation since 2008. The plant is engaged in producing 5mtpa alumina and has 220MW Captive Power Plant. It is one of the world's premier alumina refining complex. The alumina feeds its smelter plant in Jharsuguda district and BALCO, Chhattisgarh.

The plant is located at Lanjigarh village in a gentle sloping basin well drained by River Vansadhara and is having an average elevation of 440m alms. It is surrounded by high hills on all sides and lies north of Niyamgiri Hill Ranges containing large deposit of bauxite. It is around 10km west of State Highway connecting Muniguda and Bhawanipatna, the district headquarters. The geographic co-ordinate of the township is as below:

Longitude: 83022'51.4" E Latitude : 19042'09.84" N

The site falls on the Survey of India topo-sheet 65M/06. The location of the township is shown in fig.no.1.

The plant requires large amounts of water for alumina processing and power plants and township. At present the plant gets its water supply from Tel River.

The plant has set up a township to accommodate its staff. The township is located in the south of the plant at the foothills of Niyamgiri Hill Range and is spread over an area of 132 acres.

The plant intends to implement rainwater harvesting practices in its township area. The report covers the details of the rainwater harvesting methods suitable for the area.

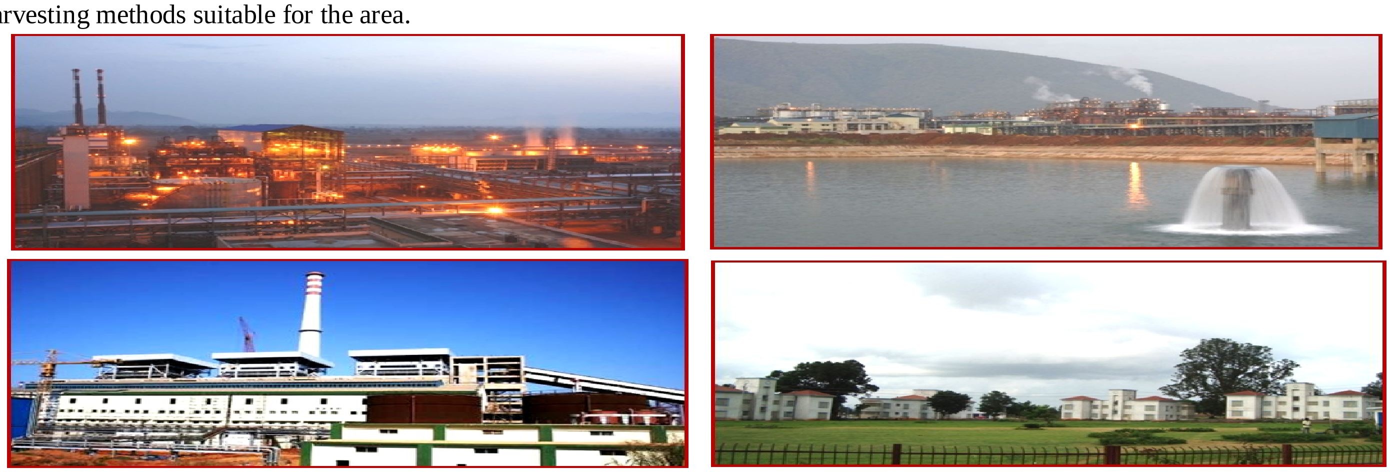

Fig 1: Location of Vedanta in Kalahandi district

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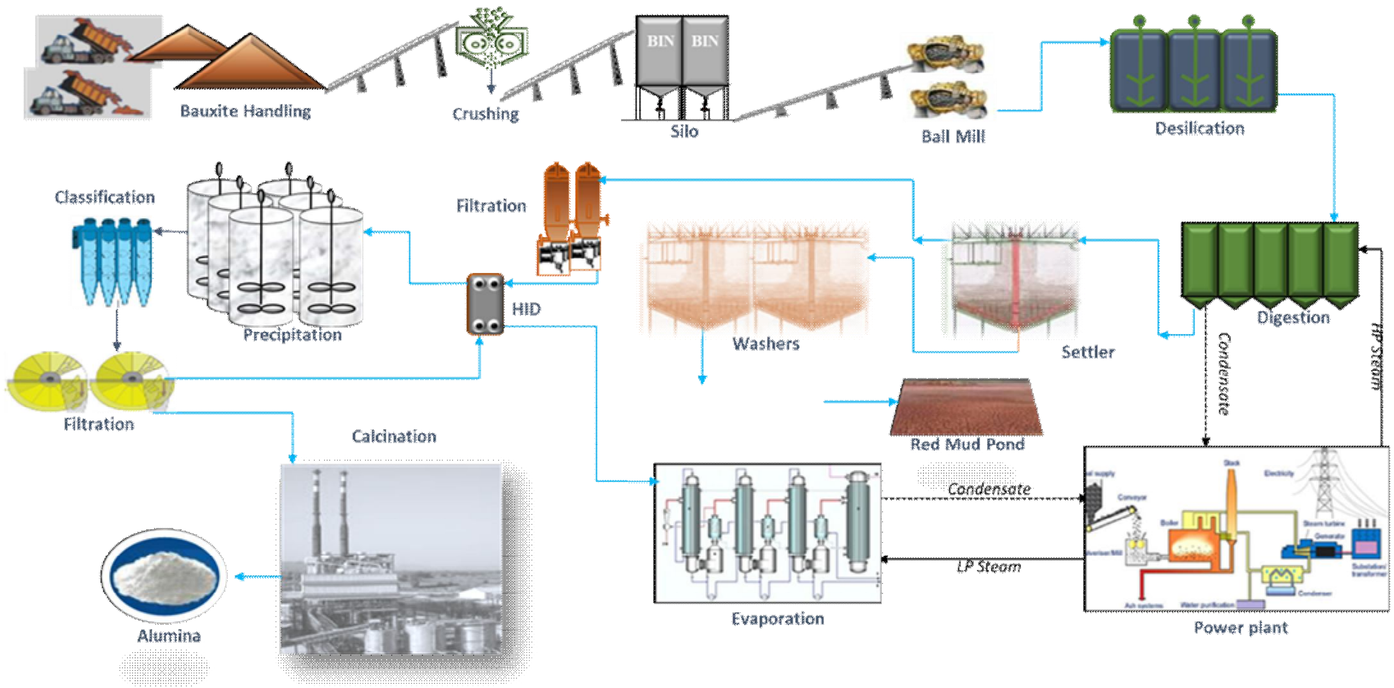

Fig 2: Alumina Refining Process

II. STUDY AREA: LANJIGARH BLOCK (VEDANTA TOWNSHIP)

Lanjigarh is in the southern part of Odisha and is characterized by undulating terrain, lateritic soil, and seasonal rivers. The region receives average annual rainfall of about 1100-1200 mm, mainly during the monsoon season. Groundwater levels have shown a declining trend, particularly in post-monsoon months.

III.OBJECTIVES

1) To assess rainfall and surface runoff in Vedanta Township
2) To identify feasible locations for rainwater harvesting and recharge structures.
3) To design suitable rainwater harvesting and recharge techniques based on hydrogeological conditions.
4) o develop an implementation plan for sustainable water resource management.

IV.LITERATURE REVIEW

Su et al. (2009): Rainwater harvesting system is an effective choice to conserve water resource, but its capability in effected by demand of water and temporary distribution of rainwater. It has been obvious that the natural rainfall is a continuous process and having its own characteristics and hence it can be explained the probabilistic features of rainfall and its relationship with the supply lacking and design storage capacity of water conservation system.This technical paper discusses with the methods and process of design capacity assessment and its storage capacity. Consequently, a model has been developed to evaluate intensity of rainfall and results obtained were used in futuristic calculation of design storage capacity and the deficit in water supply. The city of Taipei adopted such model as a study are for the purpose of analysis and demonstration for water demand and deficit with design storage capacity relationship.

Farreny et al. (2011) For urban area rainwater harvesting systems, building roofs plays an important role in collecting the rainfall. This technical paper elaborates about the quantitative and qualitative data of roof top storm water collected within the premises of building roofs in an urban area weather environment.

This technical paper aims at roof selection criteria to enhance the quality and availability of rainwater. Roofs were selected and monitored for certain period of time for the estimation of runoff volume collected at the rooftop. Collection of roof top runoff volume were different for different kind of roofs depending upon its slope's roughness and flatness.Results so found have significant impact on local governments and urban planners for the redesign of building and subsequently, for sustainable rainwater conservation management.

Ward et al. (2012) Sustainable water management tool kit proves water conservation system as an integral part with the feasibility of potential water conservation scenario. This technical paper aims at the results of longitudinal empirical performance assessment of rain water harvesting system which is located in an office building in the United Kingdom. Moreover, it compares the real time performance with the calculated performances recommended by the British Standards Institute between the Intermediate (Simple calculations) and Detailed (Simulation based) approaches. However, for full life cost data analysis, extra cost details on maintenance and operation is required to perform potential and significant cost saving.

Welderufael et al. (2013) Natural stream flow which occurs from substantial amount of rainfall are intercepted by many water concerned human activities, Rain water harvesting techniques is one of them which involves collection of runoff for the different purpose of the community. Due to increased consumption of water resources in the country, an issue of concern arises for water availability to preserve the ecosystem. To resolve the problem of water scarcity due to excessive use of water runoff, many techniques was adopted in Central South Africa. In this process, small scale formers have adopted the objectives of collecting and preserving the rain water for crop production.

Thomas et al. (2014) United States had adopted a fairly different system for water conservation of runoff. The country adopted the electronic survey system to facilitate the community towards good practices of collecting rain water runoff developed by American Rainwater Catchment System (ARCSA). All the members of ARCSA responded to the survey and about 2700 Rain Water Harvesting Systems across the country have observed in surrounding area. All the exercises was setup regarding the harvesting rain water, its treatment techniques and quality of water testing methods. All the respondents reported about the harvesting water uses which implies the rainwater for irrigation as well as potable use purpose. As a whole, the survey renders the data about non-potable rain water harvesting techniques in the United States and this practice also used for future water conservation techniques research.

Yosef & Asmamaw D. K. (2015) Ethiopia region is largely dependent on rainfall and rain-based agriculture has been widely adopted for many centuries. Therefore, rainfall constitute an important component of the weather for improvement in agricultural productivity. Acute weather conditions and seasonal variation of functional weather elements imparts adverse impact on productivity because crop productivity is controlled mainly by rainfall. With the growing weather circumstances, rainfall is a must factor for agricultural schemes and its management. In order to counter such a problem, efforts by capable Ethiopia government and local communicating have adopted various water conservation techniques.

Various rain water harvesting techniques has been done up to a remarkable effect on soil moisture enhancement, surface runoff and groundwater recharge. Consequently, improvement in cultivation of crops which helps in reduction of risks and possesses positive benefits towards ecosystem. As a whole, water conservation techniques helps in management of water scarcity, agricultural progress and water resource management.

Adham et al. (2016) Water conservation techniques has been widely applied in dry and semi-dry zones to minimize the danger from drought. Due to scarcity of water resources with increasing demand of water, an assessment and waking parttern of rain water harvesting system becomes of utmost importance.This technical paper aims at developing a simple and effective water conservation system at a catchment area to calculate and customize the overall effectiveness of rain water harvesting within design and management criteria. This model was adopted to analyze rainfall data for 1980-2004 within 25 sub-catchment of watershed area of Wadi Oum Zessar (South Eastern Tunisia). This study stresses on the performance of rain water harvesting system for all seasons of the year (i.e., Summer, Wet, and Winter). This study also shows impact on advantages of long-term water harvesting system and improvement on understanding of hydrological processes within rain water harvesting system and also renders the solutions for water conservation techniques performances.

Roman et al. (2017) Many cities having combined sewer overflow has to counter the urban storm water with the priority. Many of the advanced approaches are now being proposed to resolve the problem. Current research in information technology are now providing cost-effective techniques to receive the best performance of traditional rainfall water infrastructure through the regular monitoring approach. This technical paper elaborates the regular monitoring and evaluation approach which may be applied for traditional rainwater harvesting system in New York City to enhance performance by least discharge to the combined sewer during rainfall water, reducing water use for irrigation of local vegetation and optimization of health.

To achieve this objective, a hydrologic and hydraulic model was developed for a planned and designed rainwater harvesting system to explore multiple potential scenarios prior to the systems actual construction.

Lopes et al. (2017) Urban water system across the world is having increasing and variable water scarcity, increase in demand, basic infrastructure deficit, uncertainly being produced by climate change. Rainwater harvesting systems presents the hopeful alternative for water supply system flexibility and capacity increase of water demand. This technical paper aims all the purpose of demand of non potable water and the size of tank in which the rainfall water is received which are helpful for assessment of performance. The efficiency of Rainwater harvesting systems highlights the usefulness of the water supply and demand mechanism towards the economic assessment.

Traboulsi & Traboulsi (2017) The problem of water scarcity and domestic water demand increase becomes more severe over last decades in lebnan and various countries in the middle east region. This issue rises due to population and other economic growth. Rainwater harvesting system proves cost effective, safe and reliable alternative source for docetic source, but uncomfortable and impractical aspects which rates high cost and space requirement for its construction makes this concept not currently adopted in rural and urban areas. This technical paper emphasizes of a purely new water conservation method which may be conveniently adopted in both village and city area. In this method, Rainwater is collected and stored directly into the taken installed in the roof area of the building and it is not necessary to collect such storm water in ground and underground tanks. This method is popularly adopted in Lebanon by which very helpful in recharging the rainwater and eventually saving a lot of amounts of electrical energy which are required for pumping of water from the ground water. It is quite evident that the runoff received from rainwater is not holded on coastal area and thereby reducing the rate of infiltration in the underground surface which may ultimately lead to the ocean.

Kisakye & Van der Bruggen (2018) Climate alternation possesses acute uncertainties toward water accessibility within the rural communities which are facing the scarcity of water already. The rainwater harvesting technique becomes a major strategy for safe drinking water availability in Uganda. However, water conservation capacity has unknown effects of climate changes. Thus, this technical paper evaluates the water-saving and impact of climate changes on water security using water conservation technique for Kabrole district, Uganda. This process also assesses the effects of rainfall during rainy season for saving of water and its security and also calculate the scarcity of water.

Braga et al. (2018). All the cities along with the district of Columbia (DC) facing the problem of combined sewer overflows to manage stormwater flow through the combined sewerage system. Rainwater harvesting system with advancement technique is a modern logistic approach to balance the stormwater and having the feasibility to reduce the issue of combined overflow and to enhance the conservation of water. The rainwater harvesting system adopts regular monitoring and controlling techniques to save or release the water from a rain water harvesting structure. This implies the efficiency of RWH system to get the benefits of wet weather flow from two firehouses installed in DC. Monitoring data's were collected on regular basis for the period of three years for RHW system which were installed systems were emphatic for net weather flow as well as average discharge and harvesting rates are more than 95% . The results propound that if executed to a large scale, Rainwater harvesting system would be a significant tool in impressive management of stormwater flow.

Freni & Liuzzo (2019) Water conservation systems have several advantages being an improved optional water supply remedial solution, within dry and semi-dry areas. Urban areas having risk of flood can be benefited by this system. This technical paper summarises the potential of rainwater harvesting system with reduction of water consumption and in addition to this, efficiency of retention of rainfall water in flood-prone residential communities. The aim of the technical paper was to evaluate the reliability of water conservation system keeping in view of surface runoff retention. Eventually, the performance of rainwater harvesting system to supply stored water for cleaning of water closets in more than stored 400 single family homes in a residential area of Sicily (Southern Italy) was evaluated. For this study, area with high susceptibility of flooding was selected. Results so obtained shows that potential rainwater harvesting system installation was made within the flood risk areas which is highly concerned to rainfall amount.

Santos et al. (2020). In order to improve the capacity and efficiency of water consumption, the use of non-potable water for pavement washing, toilet clearing, cultivation and others is the effective strategy which is being adopted. For such situation, the design and analysis of rainwater harvesting system may be made by applying recent or historical records for the future projections of the rain water harvesting systems to be developed. The technical paper includes the study of the rainwater harvesting system in the area of Portugal Southern Europe. The main objective was to evaluate the impact of climate change on these water conservation systems and for this purpose daily simulation using the projected rainfall data was taken into account. It has been observed that there were no appreciable changes in water conservation system performance in the concerned areas.

Storm water in ground and underground tanks. This method is popularly adopted in Lebanon by which very helpful in recharging the rainwater and eventually saving a lot of amounts of electrical energy which are required for pumping of water from the ground water. It is quite evident that the runoff received from rainwater is not holded on coastal area and thereby reducing the rate of infiltration in the underground surface which may ultimately lead to the ocean.

Zhang et al. (2021). Rainwater harvesting systems along with the drip irrigation system are frequently adopted water conservation techniques as curtaining farming and husbandry sustainability in dryland areas of northwest china, however, above mentioned techniques are having benefits as well as drawbacks of their own. According to a meta-analysis conducted on various study cases of four regions of northwest China, it has been evaluated for fruits yield, soil water storages and efficiency of water stored. It is shown that 38.5% of fruits yield (by weight) are currently produced in northwest china. In addition to this also drip irrigation helps in improving yield of fruits which increase by 53.3% or even more so the rainwater harvesting system helps by 19.1% improvement. Further later studies shows that rainwater harvesting system increases o-2 m soil water retention by 13.7 also, the method of drip irrigation system, increase the water use efficiency by 17.2%.

This technical paper enlightens the prouder ability of integrating rainwater harvesting and drip irrigation system for enhancement of water conservation, its productivity, preserving land degradation and desertification as well as reducing poverty in drought prone area.

V. METHODOLOGY

1) Collection of rainfall data (2008-2024) from IMD/local sources.
2) Site visits and hydrogeological survey.
3) Use of GIS for mapping runoff and recharge potential.
4) Design and estimation of appropriate structures using BIS guidelines.

VI. RAINFALL & RUNOFF ANALYSIS

The analysis shows uneven distribution of rainfall with high runoff losses. Peak rainfall months are June to September. Rational method and SCS Curve Number techniques were used to estimate runoff potential from catchment areas in the block.

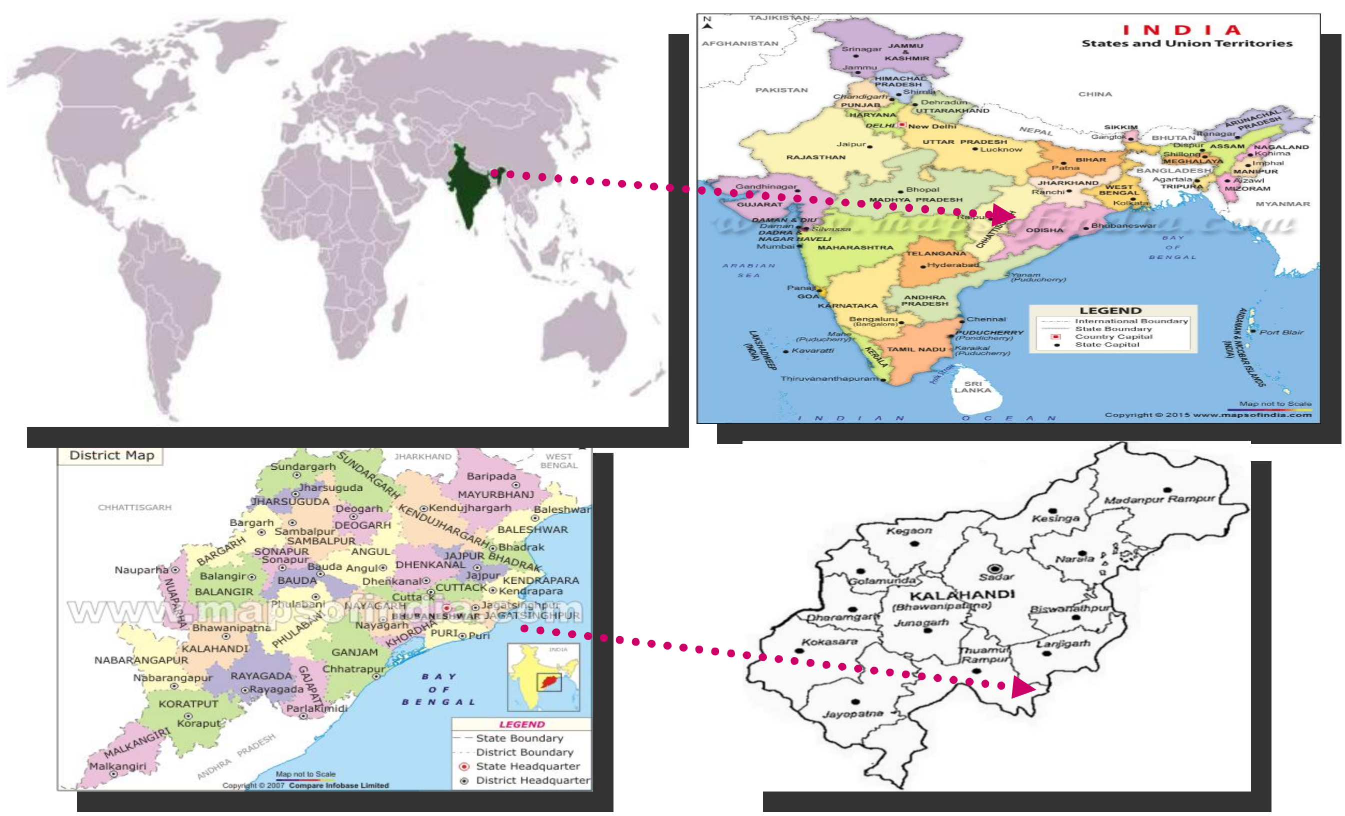

Fig 3: Location of Vedanta Township in Kalahandi district

A. Vedanta Township Area

The Vedanta Township spreads over an area of 132 acers and lies south of the foothills of the Niyamgiri Hill Range. The surface elevation varies between 510m (south) and 470m amsl(north) and slopes south-west to north-west with gradient of 4m/100m. The township comprises Guest house, bachelors; hostel, quarters, greenbelt, road, school, hospital, security barrack and open vacant land. A well drainage network has been developed to channelize the surface runoff which flows under gravity. The township gets its water supply from river Tel. One STP is set up to treat sewage water. The treated sewage water is used for greenbelt development and dust suppression.

Fig. 4: Vedanta Township

B. Sub-Surface Geology

The township is underlain by hard rock comprising Khondalite & Charnockite of the Eastern Ghat series in the southern part and by Porphyritic granite in the north. Major part is covered under granite. Moderately thick weathered zone is developed over granite which serves as a good shallow aquifer and is commonly exploited by dug wells, handpumps and shallow tubewells. Occurrence of deep fractures in granite is uncertain. In township area, thick colluviums of varying depth also developed over the weathered zone. The average depth of water level in the dug wells varies from 5 to 8.5m below ground level during post-monsoon. The groundwater quality is good with electrical conductivity remains within 300 micromhos/cm at 250C

C. Climate

The area experiences tropical monsoon climate with three distinct seasons in a year viz. Winter, Summer and Rainy seasons. The Summer season starts from March & extends up to May, Rainy season from June to September and Winter season from November to February. The summer is hot with temperature remaining high above 400C. The winter is dry and pleasant with temperature remaining around 10 to 12 0C during night times

D. Rainfall

South-West Monsoon brings the maximum rainfall in the area. The monsoon seasons starts from end of May and prevails up to mid-October. July and August are the wettest months in the year. The average annual rainfall (2008 to 2017) of Lanjigarh block is 1451 mm. The table 1 and fig. 3 show the annual and av.monthly rainfall in the block. More than 82 % of the rainfall occurs during the months of June to September.

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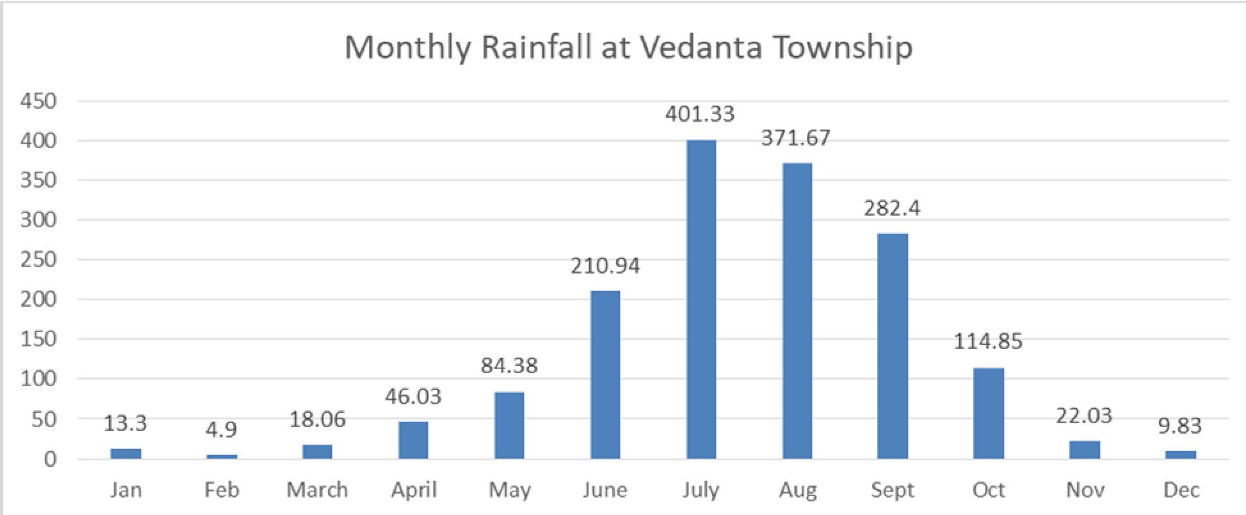

Fig.5: Av. Monthly Rainfall at Vedanta Township

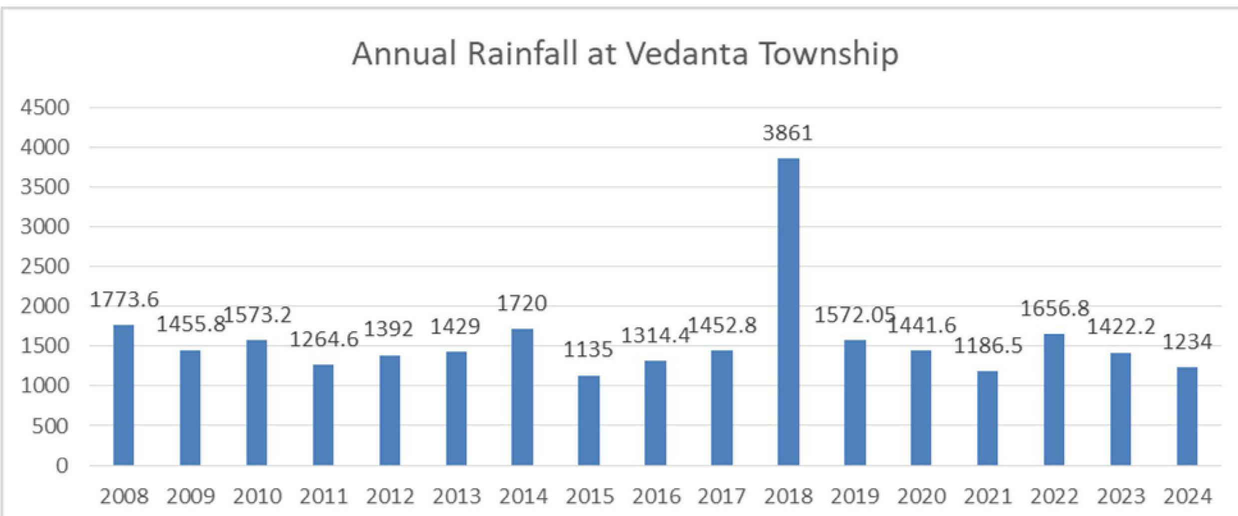

Fig.4: Annual Rainfall of Lanjigarh block

Table 1: Monthly Rainfall in Lanjigarh Block.

Year/ Month	Jan	Feb	Ma rch	Apri l	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
2008	36	6	25	20	0	270.4	132.2	716.8	545.2	22	0	0	1773.6
2009	0	0	0	0	0	133.2	786.5	286.1	158.4	71.6	20	0	1455.8
2010	0	0	0	0	120.2	224	431.8	237	309	185	26.8	39.4	1573.2
2011	0	7	0	120. 4	34	189.6	184	414.6	289	26	0	0	1264.6
2012	34	0	0	109	30	153	403	325	228	14	96	0	1392
2013	0	0	0	62	90	379	407	150	87	254	0	0	1429
2014	0	13	18	4	259	12	638	377	301	87	11	0	1720

2015	19	0	19	65	94	213	160	262	271	3	14	15	1135
2016	0	9	18	0	48	101	402.6	313.4	204.2	218.2	0	0	1314.4
2017	0	0	47	0	69.4	219.6	459.6	264.8	220.2	166.2	6	0	1452.8
2018	39.3	34.9	38.8	85.1	296.3	594.2	1010.8	819.8	494.8	305.8	104.1	37.4	3861
2019	1.82	6.2	8.63	10.54	23.48	156.98	454.07	657.01	253.3	0	0	0	1572.05
2020	0	0	0	174.1	56.5	345.9	183.7	200.6	218.8	261.6	0.4	0	1441.6
2021	0	0	0	10	133.9	167.5	164.4	209.5	239.3	137.7	95.1	29.1	1186.5
2022	83.3	0	0	56.3	83.7	194.7	419.6	568.7	126	124.5	0	0	1656.8
2023	3	3.8	94.8	55.2	55.9	61.2	334.1	282.2	435.4	60.1	0	36.5	1422.2
2024	9.7	3.8	37.8	10.9	40.2	170.8	251.4	233.9	420.3	15.8	1.2	38.2	1234
Avg.	13.3	4.9	18.06	46.03	84.38	210.94	401.33	371.67	282.4	114.85	22.03	9.83	1581.44

VII. DESIGN OF RAINWATER HARVESTING STRUCTURES

A. Proposed Systems

- Rooftop rainwater harvesting (Executive Hostels, DAV School and hospital, residential quarters
- Design is based on roof size, rainfall intensity, and water demand.

B. Rainwater Harvesting

Rainwater harvesting is the technique of collection and storage of rainwater at surface or in sub-surfaces water bearing zones before it is lost as surface runoff.

Artificial recharge to ground water is a process by which ground water reservoir is augmented at a rate exceeding that under natural conditions through human interference. Above measures are the need of the hour as the demand for water specifically ground water has increased and will be increased many times in future. The demand for water may result to various problems such as depletion in ground water resources, long term decline in water table and other related problems. So the above measures should be taken up right now to solve the problems which may occur in future. The present report gives a picture of rainwater harvesting practices to be implemented by the township.

C. Rainwater Harvesting Concept for the township

The main aim of rainwater harvesting will be to harvest, store & recharge the sub- surface aquifer system through suitable structures. The area comprises sheds, building, road, greenbelt and open area. Roof-top of sheds and building, road and paved area generate huge rainwater. The table below shows the land utilization of the township. Good amount of surface runoff is being generated from the greenbelt and open area due to moderate slope of the ground because of its location on the foot-hills. Surface runoff flow under gravity.

The mode of recharging rainwater is as below.

1) Rainwater being generated from large roofs of buildings and sheds will be recharged to groundwater system directly through suitable recharge structures (roof-top rainwater harvesting & recharging)
2) Rainwater (surface runoff) from all other area will be channelized, stored in harvesting reservoirs and will be recharged through injection wells inside the reservoirs.

The township has already developed a well network of drainage system to channelize the surface runoff which flow under gravity on moderate to high sloping surface. The surface runoff flow uni-directionally from south-east to north-west and exit the township near 2nd Gate and ultimately join in natural stream. It is proposed to construct rainwater harvesting reservoirs in the north-west corner of the township area.

Table2: Land Utilization of the township

Sl. No	Land Utilization	Area (sq.m)
1	Roof-top of sheds & buildings	39583
2	Roads	24750
3	Greenbelt	100000
4	Open Area	302267
	Total	466600

D. Volume of Rainwater available for Harvesting

The volume of rainwater to be available for harvesting depends upon the rainfall and the runoff co-efficient. The table 1 shows that the area has good average annual rainfall which is 1581mm (last 17 yrs average) and 82 % (1186mm) of the annual rainfall occurs during June to September. The rainfall during non-monsoon is being lost due to absorption on surface and evaporation and does not generate much runoff and is not be available for harvesting. Rainfall during only monsoon is available for harvesting. For calculation of total volume of water available for harvesting the figure of 1186mm is being taken in to account. Again 100% of 1186mm rainfall will not be available for harvesting as some portion of it will be lost in the process of collection. This percentage will vary from areas to areas depending upon the nature of surface receiving rainfall. On the basis of past experience on similar projects, 80% of it will be taken for roof-top area, 40%, 20% & 30% for road, greenbelt and open area respectively. This percentage of rainfall will be multiplied with the area which will give net water available for harvesting annually.

Rainwater Available for harvesting = area (sq.m) x annual rainfall (m) x runoff co- efficient

Volume Generated from the entire Township area

The total area of the township area is 466600 sq.m. By multiplying this area with annual rainfall and runoff co-efficient 1,83,500 m3 of surface runoff is being generated annually. The table below shows the volume of rainwater available from respective area annually.

Table 3: Annual availability of rainwater

Sl. No	**Nature of Surface**	**Area (sq.m)**	**Runoff-Coefficient**	**Annual Volume of rainwater available(cub.m)**
1	Roof-top of sheds & buildings	39583	0.8	37556.35
2	Roads	24750	0.5	14676.75
3	Greenbelt	100000	0.2	23720
4	Open Area	302267	0.3	107546.6
Total:			**466600**	**183500**

E. Methods of Rainwater Harvesting

On the basis of quality of rainwater available and the sub-surface hydrogeology, it is decided to recharge the roof-top rainwater directly to the groundwater system and surface runoff from open, road/paved and greenbelt area will be stored first and then will be recharged to aquifer system

1) Roof-top Rainwater Harvesting

In the township area there are buildings with large roofs i.e. Executive Hostels, School and hospital. These buildings generate good amount of clean rainwater which will be put into the aquifer system through suitable recharging structures. The area is underlain by hard rock. Weathered/fissured rock constitute the potential phreatic aquifers. Presence of fractures in compact/hard granite below weathered zone is uncertain. So it is decided to recharge the phreatic aquifers. The designs of recharging structures for individual building are given below.

A1: Executive Hostels

Executive Hostel comprises three buildings/building complex i.e. Boy's hostel, Girl's hostel and Store, Entrance block & Canteen. Roof top area of the individual building is given in the table.

Table 4: Roof Area of buildings

Sl. No	Building	Roof Area(sq.m)
1	Boy's Hostel	4582
2	Girl's Hostel	2442
3	Store, Entrance block& canteen	2206
	Total	9230

On the basis of the prevailing Hydrogeological conditions, it is proposed to recharge the roof-top rainwater through recharge borewell. The recharge structure will be a recharge borewell inside a storage-cum-filtration chamber. It is proposed to construct one structure for each building.


VIII. ARTIFICIAL RECHARGE STRUCTURES

A. Recommended Structures

- Injection wells in overdrawn areas
- Location-specific designs ensure maximum infiltration and minimum siltation.
- Design of Recharging Structure

On analyzing the data available and disposition of aquifer system it is proposed that injection well would be the most suitable recharging structure for this area. An artificially gravel packed injection (Recharge) well will be constructed within a storage cum filtration chamber. First injection well will be constructed and then chamber will be constructed. The structure will be constructed near to building or available place suitable.

1) Injection (Recharge) well

The depth of injection well will be around 50m bgl or will be decided during drilling depending upon the availability of aquifer. 4" (102mm) dia. PVC pipe will be lowered in a 6 1/2" dia. drilled borehole. All aquifer zones will be tapped by placing 4" dia. PVC slotted pipe. The area around the pipe will be filled up with gravel. After construction of the injection well, it will be developed with air compressor to clear the well of all suspended matter.

Drilling of Borewell

Drilling will be carried out through DTH Rig with hammer bit. 4" dia. PVC Pipe will be lowered in a borehole. Slotted pipe will be placed against weathered and fractured rock.

Filtration/Storage Chamber

A storage/filtration chamber will be constructed around the injection well. The dimension of the chamber is shown in the table taking average maximum rainfall intensity of 25mm/hr and intake capacity of injection well to 1.0 lps. Incase more rainfall, excess water will be allowed to overflow the chamber. An out let will be provided on the top of the chamber for overflow excess water. The wall of the trench is made of RBC structure as per the design shown in fig. 6. The chamber is filled with filtering material i.e. gravel and medium to fine sand. The chamber is connected to the roof-tops through PVC Pipe. The approximate design of the recharge structure is shown in fig.6.

Table 5: Dimension of Storage Chamber

Sl. No	Source	Roof Area(sq. m)	Dimension of Storage Chamber (LXWXD)	No. of Recharge well
1	Boy's Hostel	4582	6X4X3	2
2	Girl's Hostel	2442	5X3X3	1
3	Store, Entrance block & canteen	2206	5X3X3	1
	T otal	9230		

Fig.6: Exucative Hostel

Channelization of roof top water

Rainwater to be generated from the roof-tops will be brought down through 4" PVC pipe which will be connected to filtration cum storage chamber as shown in the fig.11 or as per the suitability of the site. The water will flow under gravity.

Volume of water Available.

The annual volume of water available for harvesting and recharging depends upon the roof area, annual rainfall and runoff coefficient. The av. annual monsoon rainfall for the block is around 1186mm. The volume is calculated by the following formula.

Volume available for harvesting (annual)= Rainfall (m) x Area (m2) X Runoff co-efficient

The table no. below shows the volume of rainwater to be recharged annually.

Table 6: Volume of Rainwater available for recharging

Sl. No	Source	Roof Area (sq.m)	Rainwater to be generated (m^3) annually	Remarks
1	Boy's Hostel	4582	4891	Recharged to weathered /fissured/fracturedaquifer through recharging well
2	Girl's Hostel	2442	2607	
3	Store, Entrance block & canteen	2206	2355	
	Total	9230	9853	

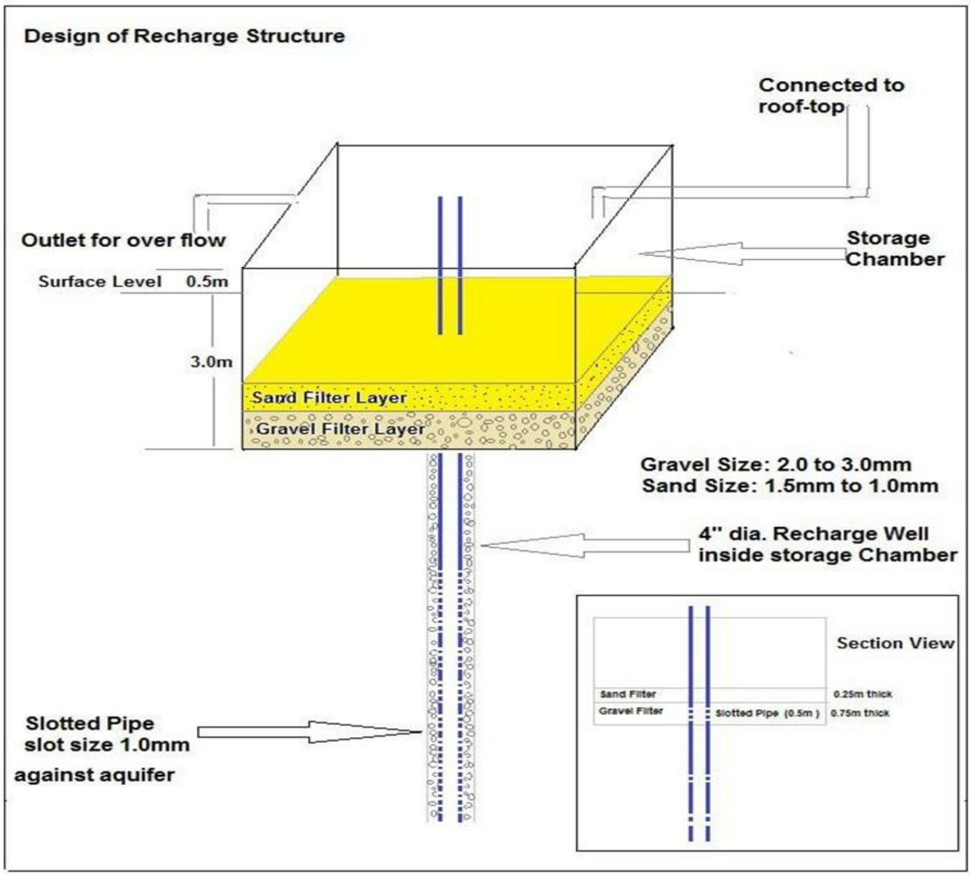

Fig.6: Design of Recharging Structure

2) Buildings of DAV School & Hospital

Roof-top of buildings of DAV School & Hospital generate clean water. With the existing channelization of roof water, it is proposed to recharge the roof water to shallow aquifer through recharge shaft. A recharge shaft is a conventional dugwell pierced through the aquifer and touch groundwater level. The bottom of the dug well will be filled up with one-meter-thick gravel filter material. The dug well will be lined against the collapsible formation and bottom will be naked. The depth will be around 10m and diameter will be 1.5 to 2.0m. The size of the gravel will around 3mm to 5mm. DAV School has three buildings. It is proposed to have one dug well for each building. The dug wells should be constructed at suitable sites for easy channelization of roof water.

Roof-top rainwater of the hospital building will be recharged to shallow aquifer through similar type of recharge shaft.

Table 7: Volume of rainwater from buildings

Sl. No	Source	Roof Area (sq.m)	Rainwater to be generated (m^3) annually	Remarks
1	DAC School building	1500	1423	Recharged to weathered /fissured/fracturedaquifer through recharging well
2	Hospital Building	2000	1897	
	Total		3320	

Fig.7: DAV School

Fig. 8: Hospital Building

3) Recharge Structure for Surface Runoff.

Surface runoff being generated from all sources except the roofs of the above buildings will be stored in harvesting reservoirs and subsequently to be recharged through borewells. The recharge borewells will be constructed within the harvesting reservoirs. The entire surface runoff from the township flows from south-east to north-west and exits at the 2nd gate and ultimately joins in natural stream outside the township. Drainage network has been developed. There are 2 main drains joined with small drains. Each main drain carry runoff from almost half of the township. It is proposed to construct two(2nos.) of rainwater harvesting reservoirs each for the drains.

FIG.9: WELL DEVELOPED DRAINAGE NETWORK

Volume of Runoff Available for Storage in the Reservoirs

Dimension of the reservoirs depend upon the volume of runoff available for storge, intake capacity of the injection wells and seepage through the bottom of reservoirs. The monsoon rainfall (1186mm) spreads over a period of 4months (120 days). On the basis of the daily rainfall pattern over the years, assuming intake capacity of borewell to be 1lps and seepage through the bottom, the dimension of the reservoirs is calculated taking rainfall of 100mm.The required storage volume is found to be around 14500.

Fig.10: Rainwater Harvesting pond

Table 8: Dimensions of the reservoirs

Sl. No	Reservoir	Length x Width(m)	Depth(m)	Storage Capacity (cub.m)	No. of Recharge borewell
1	Reservoir-1`	50x40	3	6000	4
2	Reservoir-2	70x40	3	8400	4
	Total			14400	

Rainwater Harvesting Reservoir No.1

Reservoir No.1 will be constructed in the vacant land in between the security barrack and the hospital. The dimension of the reservoir will be 50 long, 40 wide and 3m deep. The depth will be below the bottom of the drain. The existing drain will be connected to the reservoir. At the entry of runoff into the reservoir a small de-silting chamber will be constructed to allow load in runoff to settle down. Out let provision will be kept in case of overflow. The outlet should be connected to the reservoir no.2.The bottom of the reservoir will be kept naked to allow downward seepage.

Rainwater Harvesting Reservoir No.2

Reservoir No.1 will be constructed in the vacant land near the gate no.2 all along the boundary. The dimension of the reservoir will be 70m long, 40m wide and 3m deep. The depth will be below the bottom of the drain. The existing drain will be connected to the reservoir. At the entry of runoff into the reservoir a small de-silting chamber will be constructed to allow load in runoff to settle down. Out let provision will be kept in case of overflow. The bottom of the reservoir will be kept naked to allow downward seepage.

Injection (Recharge Well)

Recharge well will be constructed inside the reservoir. 4 no. of wells will be constructed in each reservoir. The depth of injection well will be around 50m bgl or will be decided during drilling depending upon the availability of aquifer. 4" (102mm) dia. PVC pipe will be lowered in a 6 1/2" dia. drilled borehole. All aquifer zones will be tapped by placing 4" dia. PVC slotted pipe. The area around the pipe will be filled up with gravel. After construction of the injection well, it will be developed with air compressor to clear the well all suspended matter

Fig.11: Recharge Well inside Reservoir

IX. IMPLEMENTATION PLAN

A. Phase-wise plan

- Phase I: Awareness, community training, and pilot structures
- Phase II: Budget, design drwainings, Full-scale construction at Vedanta township
- Phase III: Monitoring and maintenance

X. BENEFITS

1) Recharge of groundwater aquifers
2) Reduction in soil erosion and flooding
3) Water availability during dry months
4) Reduction of water consumption.

XI. CHALLENGES

1) Township Community participation
2) Land availability

XII. RECOMMENDATIONS

1) Make rainwater harvesting mandatory in government buildings
2) Train local masons and youth in rainwater harvesting construction
3) Integrate rainwater harvesting in watershed and MGNREGA works
4) Adopt low-cost, replicable designs

XIII. CONCLUSION

1) The township of M/s. Vedanta Ltd is located in Lanjigarh village in Kalahandi district, Odisha State. The township spreads over an area of 466600 sq.m area on the foothills of Niyamagiri Hill Range.
2) The township meets its water requirement from surface water from Tel River.
3) Water consumption of township is 600000 cubic meter per annum.
4) The township implement rainwater harvesting and artificial recharging to groundwater practices in which we collect 150000 cubic meters of rain water per annum
5) Rainwater being generated from roof of some building will be recharged to groundwater through injection well.
6) Surface runoff will be stored in rainwater harvesting reservoirs and subsequently will be recharged to groundwater system through borewells.
7) The water positivity of Vedanta township is about 40% of consumption. The total consumption reduced to 60%

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