UWR Rainwater Offset Unit Standard (UWR RoU Standard)

Concept & Design: Universal Water Registry

www.uwaterregistry.io

Project Concept Note & Monitoring Report (PCNMR)

Project Name: Water Credit Project by NSL Aland Unit, Karnataka, India

UWR RoU Scope: 2 & 5

Monitoring Period: 01/01/2014 - 31/12/2025

Crediting Period[1]: 2014-2025

UNDP Human Development Indicator[2]: 0.644

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[1] Not applicable. RoUs can be claimed for the "Lifetime of the Project Activity as per UWR RoU standard version 8.1

[2] Value is applicable for India according to latest HDI 2023-24 https://hdr.undp.org/sites/default/files/2023-24_HDR/HDR23-24_Statistical_Annex_HDI_Table.xlsx.

This is below 0.9 as per requirement mentioned in methodology rainwater offset methodology standard version 8.1.

A.1 Location of Project Activity

State	Karnataka
District	Kalaburagi District
Block Basin/Sub Basin/Watershed	Please refer to http://cgwb.gov.in/watershed/basinsindia.html
Lat. & Longitude	17.456198°N - 17.466185°N 76.559959°E - 76.574790°E
Area Extent	213.20 acres (86.27 Ha)
No. of Villages/Towns	Bhusnoor village

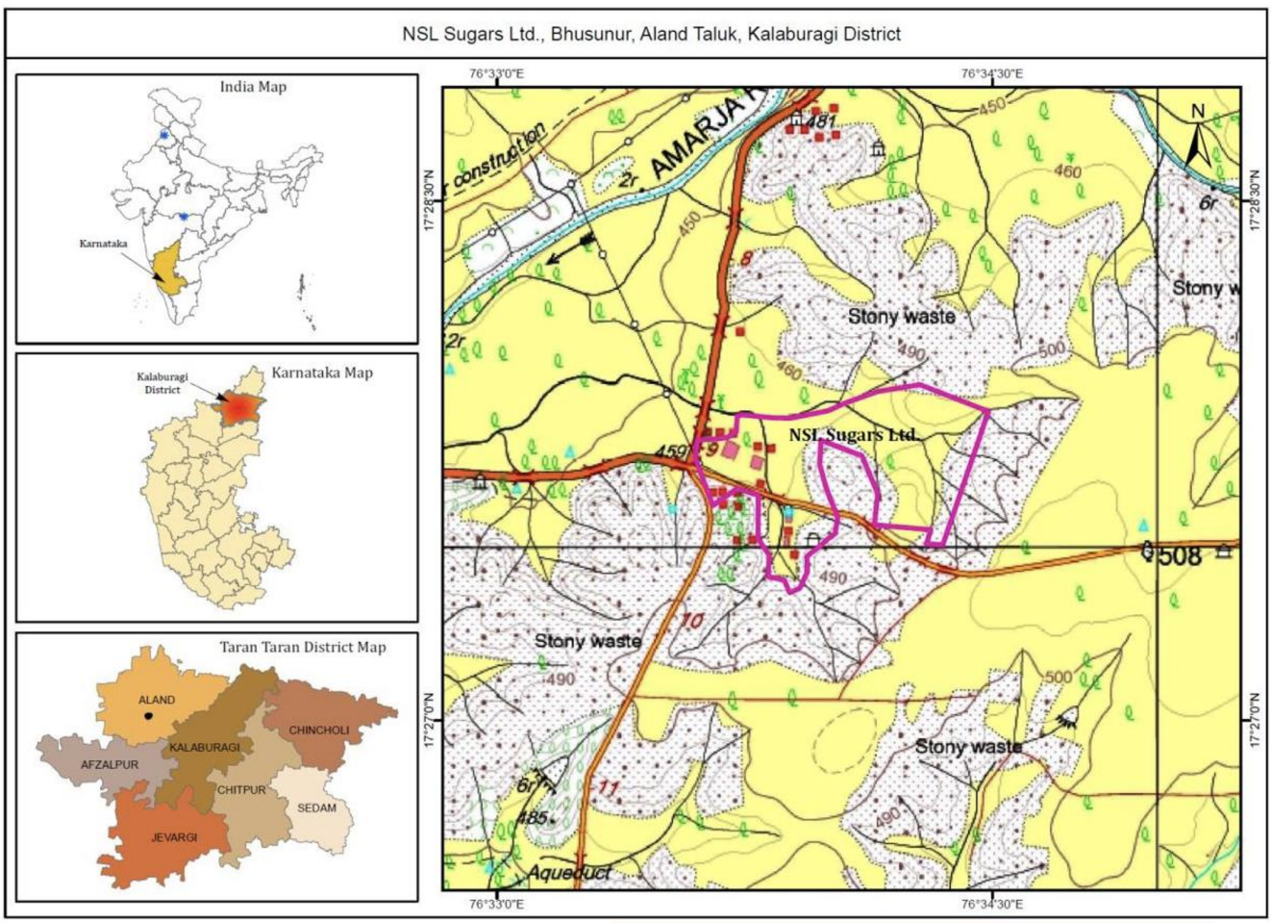


Figure 01: Location of NSL Sugars, Bhusnoor, Aland Taluk, Kalaburagi District, Karnataka, India

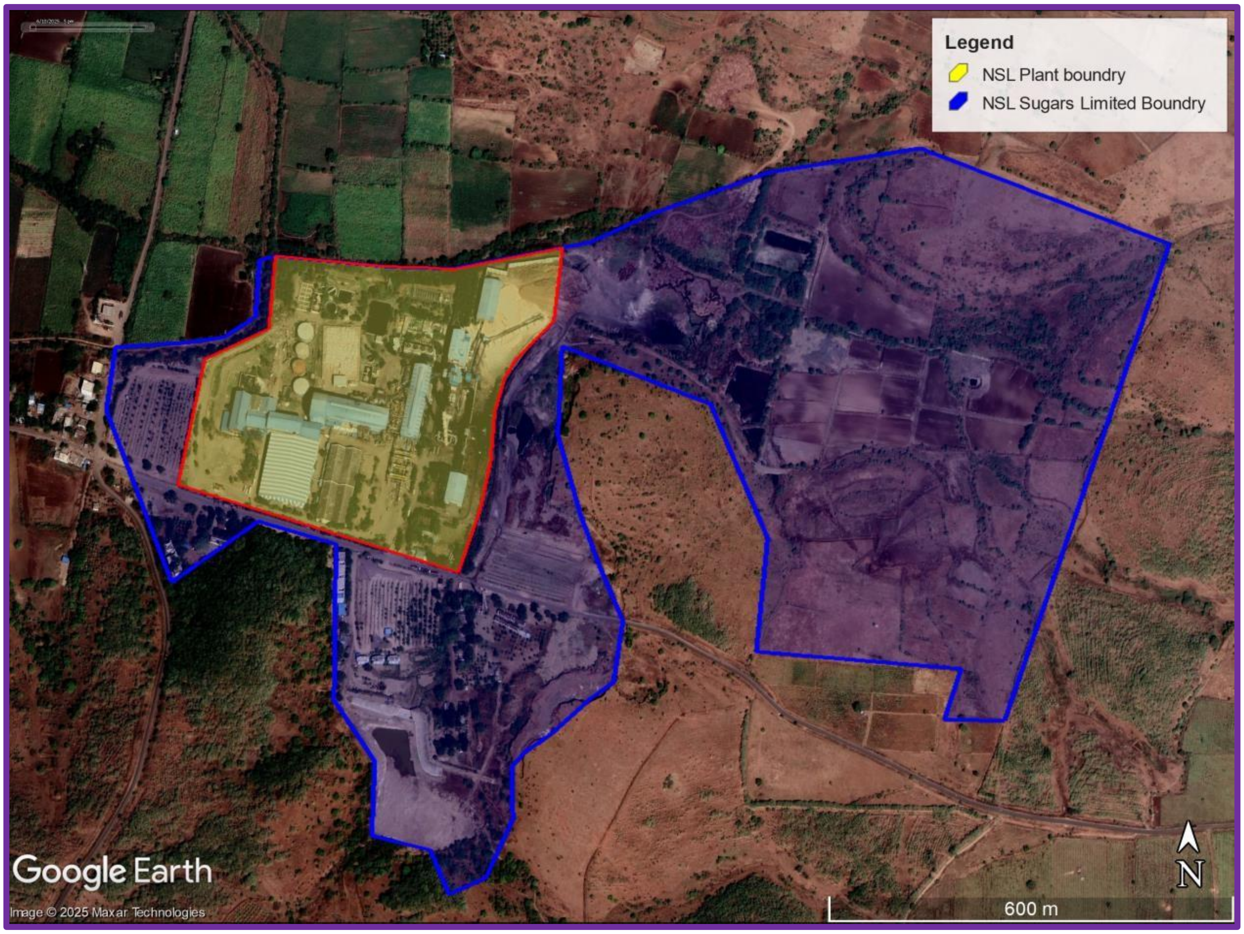


Figure 02: Aerial view of NSL Sugars ltd, Aland Unit

A.2. Project owner information, key roles and responsibilities

The NSL Sugars Limited, is a Public Limited Company incorporated in the Companies Act 1956. It is an integrated Sugar, Distillery and Co-generation Plant. Initially, a sugar manufacturing and Co-gen Unit was established and commenced its production in 2004 and a molasses-based Distillery unit in 2007. The NSL is one of the most efficient sugar companies and the sugar arm of the NSL Group. NSL (Nuziveedu Seeds Limited) group foundation was led by Sri Venkata Ramaiah in 1973, and built upon by his son Sri M Prabhakar Rao, who has been leading the company since 1982. The company has evolved over the years with core expertise in research, marketing and supply chain to emerge as the largest seed company in India.

Name	Designation
Shri. M. Prabhakar Rao	Chairman of NSL Group
Shri Bhaskar Naidu	Sr. General Manager & Unit Head of NSL Sugars Limited, Aland

Roles and responsibilities are clearly documented here within the management plan including clear lines of accountability and reporting:-

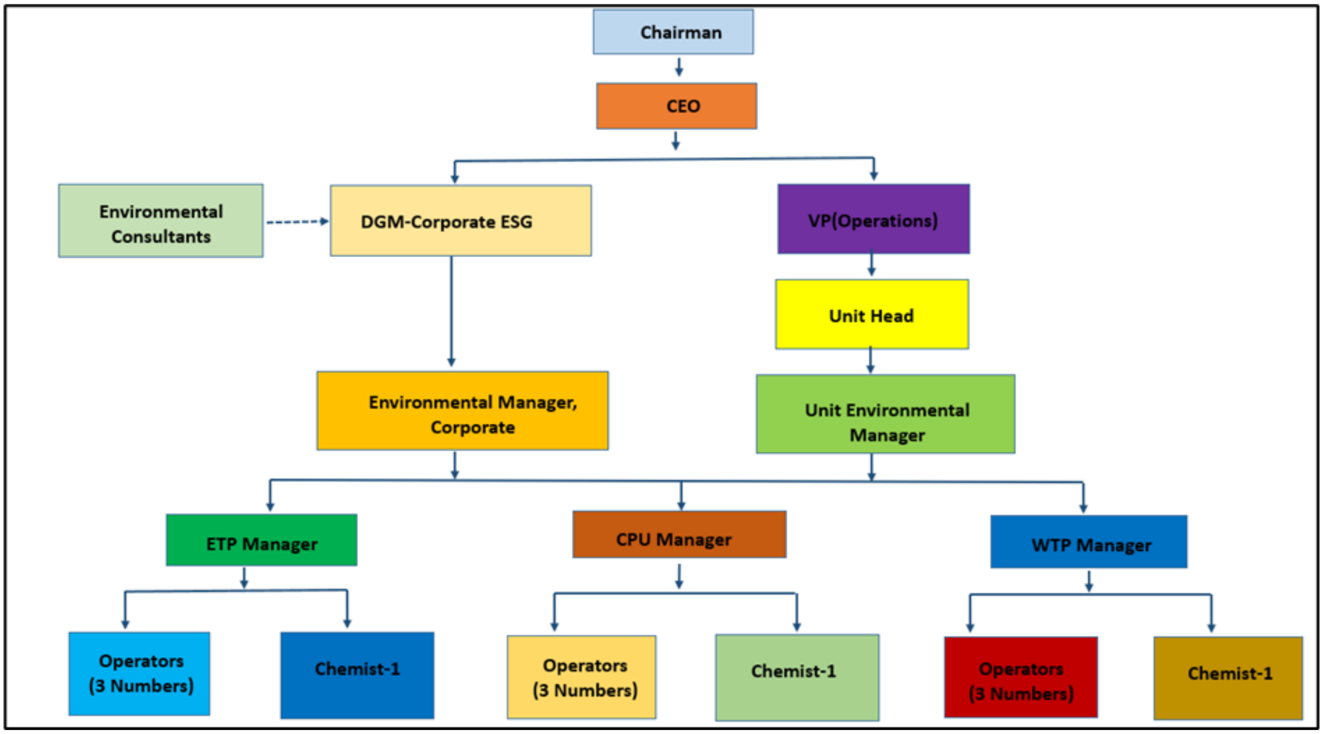


Figure 03: Environment Management Cell

S. No.	Designation	Responsibility
1	Chairman	• Strategic Oversight • Board Leadership • Compliance and risk management
2	CEO	• Allocate adequate resources, including budgets and personnel, to implement and maintain environmental initiatives. • Invest in technologies and infrastructure that support sustainable practices
3	DGM- Corporate ESG	Interact with regulatory authorities, local communities, and other stakeholders to address environmental concerns and promote sustainability initiatives.
4	VP (Operation)	Ensuring the alignment of environmental goals with operational objectives
5	Environmental Manager, Corporate	• Compliance Management • Environmental Monitoring and Reporting • Sustainability Initiatives • Training and Awareness • Incident management • Documentation and record keeping

6	Unit head	• Strategic Leadership • Compliance Oversight • Team management • Resource allocation • Policy Advocacy and Representation
7	Unit Environmental Manager	• Environmental Compliance • Develop strategies to mitigate adverse environmental impacts • Pollution Control • Resource management • Environmental Monitoring • Training and education
8	ETP Manager	• Resource management • Pollution Control • Effluent quality Monitoring • Training and education • To verify the data entered in log book regarding treated and untreated effluent quality
9	ETP chemist	• Effluent Analysis and Monitoring • Treatment Process Optimization
10	ETP Operators	Operation and Maintenance of ETP
11	CPU manager	• Pollution Control • To verify the data entered in log book regarding treated and untreated effluent quality • To verify the working efficiency of CPU
12	CPU Chemist	• Treated Effluent Analysis and Monitoring • Treatment Process Optimization
13	CPU operator	Operation and Maintenance of CPU
14	WTP Manager	Water quality analysis
15	WTP operator	Operation and Maintenance of WTP
16	WTP Chemist	• Water quality Analysis and Monitoring • Treatment Process Optimization
17	APC operator	Operation and Maintenance ESP
18	Supervisors	Development and Maintenance of Greenbelt and other general EMP of the industry

Table 01: Roles & responsibilities of Environment Management Cell at NSL Plant

The Project owner of NSL-Aland attest to the following:

(a) NSL Aland Unit owns the water user rights for the area within the project's boundary,

GOVERNMENT OF KARNATAKA

No:KGWA/GW/NOC/40/2022-23/775

Karnataka Groundwater Authority,
No.1/1, KSFC Bhavan,
Thimmaiah Road, Bangalore.
Dated: 15.04.2024
E-mail: gwdkar@gmail.com
Ph No. 080-22268732

Form 3A
(Rule-6)

Permission for digging/drilling a well/ Bore well/ Extraction of Groundwater for Industrial/ Commercial/ Entertainment or other use

M/s. NSL Sugars Limited, Bhusnoor village, Aland Taluk, Kalburgi District is permitted for extraction of groundwater at **Bhusnoor village, Aland Taluk, Kalburgi District** from **04 Borewells** for **Industrial and Domestic use.**

1) **M/s. NSL Sugars Limited** is permitted to abstract **300 m^3/day** (not exceeding **57000 m^3/year)** of groundwater through **four (04) Borewells** for industrial and Domestic purpose only. No additional groundwater abstraction structures to be constructed for this purpose without prior approval of the KGWA.
2) This NOC is valid for **three years** from **15.04.2024** to **14.04.2027** for Industrial and Domestic use.
3) As per the categorization of taluks, Aland taluk in Kalaburgi district fall under Safe taluk category. Hence, the **Groundwater Abstraction Charges** to be paid is **Rs.600 per day** at the rate of Rs-**2.00** per KLD.
4) The Firm at its own cost shall install one piezometer, at suitable locations and execute groundwater regime monitoring programme in and around the project area on regular basis in consultation with the Senior Geologist, District Groundwater Office, Groundwater Directorate, Kalaburgi District.

No. of Piezometers	Monitoring Mechanism		
	Manual	DWLR	DWLR with Telemetry
1	0	1	0

5) The firm shall submit the water audit report through certified auditors within one year of completion of the same to KGWA.

<u>State Government NOC for ground water withdrawal for NSL Aland Unit</u>

(b) NSL AlandUnit holds an uncontested legal land title for the project area within the project's boundary

Consent For Operation (CFO-Air,Water)

Consent No. AW-327912
Valid upto: 30/06/2026

Industry Colour: RED   Industry Scale: LARGE

Karnataka State Pollution Control Board
Parisara Bhavana,No.49, Church Street,Bengaluru-560001
Tele : 080-25589112/3, 25581383
Fax:080-25586321
email id: ho@kspcb.gov.in

(This document contains 5 pages including annexure & excluding additional conditions)

Combined Consent Order No. AW-327912   **PCB ID:** 10477   **Date:** 11/11/2021

Combined consent for discharge of effluents under the Water (Prevention and Control of Pollution) Act , 1974 and emission under the Air (Prevention and Control of Pollution)Act , 1981

Ref: 1. Application filed by the applicant/organization on 03/07/2021

2.Inspection of the Industry/organization/by RO, on 02/07/2021

3.Proceedings of the ECM dated 17/09/2021 ,held on 07/09/2021

Consent is hereby granted to the Occupier under Section 25(4) of the Water (Prevention & Control of Pollution) Act, 1974 (herein referred to as the Water Act) & Section 21 of Air (Prevention & Control of Pollution) Act, 1981, (herein referred to as the Air Act) and the Rules and Orders made there under and authorized the Occupier to operate /carryout industry/activity & to make discharge of the effluents & emissions confirming to the stipulated standards from the premises mentioned below and subject to the terms and conditions as detailed in the Schedule Annexed to this order.

Location:

Name of the Industry:	N S L Sugars Ltd.UnitII (Lesse of SSKN Bhusnoor village,Aland Tq,KLB Dist		
Address:	-, Bhusnoor		
Industrial Area:	Not In I.A,	Bhusnoor,	
Taluk:	Aland,	District:	Gulbarga

CONDITIONS:

a) Discharge of effluents under the Water Act:

Sr	Water Code	WC(KLD)	WWG(KLD)	Remark
1	Boiler Feed	450.000	120.000	
2	Cooling Water	3225.000	593.000	
3	D.M Water Plant	125.000	125.000	
4	Domestic Purpose	100.000	80.000	
5	Processing whereby water gets polluted and the pollutants are easily bio-degradable	875.000	574.000	

b) Discharge of Air emissions under the Air Act from the following stacks etc.

Sl. No.	Description of chimney/outlet	Limits specified refer schedule
The details of Sources, control equipments and its specification, type of fuel,constituents to be controlled in emissions etc. are detailed in Annexure-II.		

The consent for operation is granted considering the following activities/Products;

Sr	Product Name	Applied Qty/Month	Unit
1	Co-Gen	24480.0000	MWH
2	White Crystal Sugar	25860.0000	M.T

This consent is valid for the period from 01/07/2021 **to** 30/06/2026

To,

N S L Sugars Ltd.UnitII (Lesse of SSKN Bhusnoor village,Aland Tq,KLB Dist

CFO dated 11/11/2021 shows the amount of water and air discharge permission from Government by NSL Aland Unit

Malli Karjun, Dy. M. (Env)
for master file.
30/3/12

35(b)

F. No. J-11011/375/2010- IA II (I)
Government of India
Ministry of Environment and Forests
(I.A. Division)

Paryavaran Bhawan
CGO Complex, Lodhi Road
New Delhi – 110 003

E-mail : lk.bokolia@nic.in
Telefax : 011: 2436 6017
Dated March, 2012
20

To,

Shri Ram Mohan Rao,
General Manager
M/s NSL Sugar Ltd (Unit-II) (Lessee of SSKN).
Village Bhusanoor, Taluka Aland.
District Gulbarga – 585302, Karnataka

E-mail: alland.nslsl@nslsugars.com ; pelcpl@gmail.com ;
Fax No.: 08477 294888

Subject: Expansion of Sugar Plant (1,250 TCD to 7,500 TCD), Molasses/Grain based Distillery Plant (Rectified Spirit, ENA & Ethanol, 60 KLD), Cogeneration Power Plant (34 MW) and Captive Power Plant (3 MW) at Village Bhuanoor, Tehsil Aland, District Gulbarga, Karnataka by M/s NSL Sugars Ltd. (Unit-II)– Environmental Clearance reg.

Ref. : Your letter no. NSLSL II/VP/MoEF/2011-12 dated 5th August, 2011.

Sir,

Kindly refer your letter dated 5th August, 2011 alongwith project documents including Form I, Terms of References, Pre-feasibility Report, EIA/EMP Report alongwith Public Hearing Report regarding above mentioned project.

2.0 The Ministry of Environment and Forests has examined the application. It is noted that proposal is for expansion of sugar plant (1,250 TCD to 7,500 TCD), molasses and grain based distillery plant (Rectified Spirit, ENA & Ethanol, 60 KLD), Cogeneration Power Plant (34 MW) and CPP (3 MW) at Sy. No. 179, 180,181,182, 183 & 202, Village Bhuanoor, Tehsil Aland, District Gulbarga, Karnataka by M/s NSL Sugars Ltd (Unit-II). No national parks/sanctuaries/ reserve forests are located within 10 Km. Total plot area is 133 acres and proposed expansion will be carried out within the existing sugar plant premises. Total project cost is Rs. 362.13 Crores. Amarja River is flowing at 1.6 km. No. of working days of distillery unit will be 300 days. Details of the existing and proposed plants are as given below:

S.N.	Plants	Existing	After Expansion
1	Sugar	1,250 TCD	7,500 TCD
2	Distillery (Molasses/grains based)	--	60 KLPD
3	Co-generation Power Plant	--	34 MW
4	CPP	--	3 MW

3.0 ESP alongwith adequate stack height will be provided to bagasse/coal fired boilers (1 No. x 135 TPH and 1 No. x 25 TPH) to control particulate emissions within 100 mg/Nm^3. Total fresh water requirement from Amarja River will be 4775 m^3/day. Wastewater (750 m3/day) from the sugar unit will be treated in the biological effluent treatment plant (ETP). Spent wash (600 m^3/day) from molasses based distillery will be concentrated in multiple effect evaporator (MEE) to 60 % solids and sent to a incinerator boiler (25 TPH) for

1/7

incineration to achieve zero discharge. Spentwash (360 m^3/day) from the grain based distillery will be separated in decanter and then concentrated in MEE followed by drying in a dryer to form Distiller's Dry Grains with Soluble (DDGS). Treated effluent will be recycled/reused within factory premises. No effluent will be discharged outside the premises. Storage capacity for spent wash lagoon will not be more than 30 days. Baggase from sugar plant will be used as fuel in cogen boiler. Yeast sludge will be mixed with press mud to prepare compost. DDGS will be sold as cattle feed. Boiler ash will be sent to brick manufacturers/cement plant.

4.0 Public Hearing / Public Consultation meeting was conducted on 20th April, 2011.

5.0 All molasses based distilleries are listed at S.N. 5 (g) (i) under category 'A' and appraised at Central level.

6.0 The proposal was considered by the Expert Appraisal Committee (Industry-2) in its 15th and 29th meeting held during 22nd-23rd October, 2010 and 17th–18th November, 2011 respectively. The Committee recommended the proposal for environmental clearance.

7.0 Based on the information submitted by the project proponent, the Ministry of Environment and Forests hereby accords environmental clearance to above project under the provisions of EIA Notification dated 14th September 2006, subject to the compliance of the following Specific and General Conditions:

<u>Above Photographs shows the Environmental clearance which clearly declares the land occupied and details of project implementation and capacity by the Aland unit</u>

(c) NSL Aland Unit holds all necessary permits to implement the project or has applied for the same.- Yes, Unit possess all necessary documents like Environmental Clearance from MoEF&CC and **CFO** from State Pollution Control Board as attached above.

(d) Project implementation Cost- The estimated project cost was referred as INR 17,58,69,743 /-

A.2.1 Project RoU Scope

PROJECT NAME	Water Credit Project by NSL Aland Unit, Karnataka, India
UWR Scope:	Scope-2 & 5
Date PCNMR Prepared	Current Version: 12/06/2026 Final Version: NA (will be considering during Verification)

A.3. Land use and Drainage Pattern

For Scope-5

Not Applicable, since this scope of project activity involves treating and reusing wastewater from distillery and sugar plant.

It doesn't include or harm any land-use practices and Drainage system as it is an industrial process designed with technical requirements and following the specified norms of local pollution control board.

For Scope-2

Land-use refers to the way in which the land has been used by humans and their habitat, usually with accent on the functional role of land for economic activities. It is the intended employment of management strategy placed on the land-cover type by human agents, and/or managers. Land-cover refers to the physical characteristics of earth's surface, captured in the distribution of vegetation, water, soil and other physical features of the land, including those created solely by human activities; for example - settlements. The land use and land cover are complex and largely continuous pattern and in order to understand its complexity, it is necessary to characterize them.

Land use land cover of the study area is derived through interpretation of satellite remote sensing image in digital environment using remote and GIS software Erdas Imagine (version 8.5). Satellite Image of the study area downloaded from U.S. Geological Survey web site USGS Earth Explorer (www.earthexplorer.usgs.gov) and a land use map was prepared. The following are the steps involved in preparation of Land use Land cover map.

The optimal season and latest cloud free data chosen for better discrimination of various land use types in the study are during the month of December. Accordingly, satellite scene was selected on the USGS website by giving the geographic coordinates of the project site and acquired the satellite image. The satellite image selected is from Landsat 9 with Operational Land Imager (OLI) sensor comprising of 9 spectral bands. The bands from 1 to 7 have the spatial resolution of 30 m and the band 8 is having the spatial resolution of 15 m (panchromatic). We have used bands 1 – 7 for classification.

Ortho-rectified satellite image obtained from USGS website were cross-checked by overlaying on the geo-referenced Survey of India toposheet for corrections. Geo-referencing was done using UTM projection system with WGS 84 spheroid & datum and zone 43. Subset of the correctly geo-referenced satellite image was taken using circular vector layer of 10 km radius from the project site (developed using buffer function taking project site location as centre point). The subset of the satellite image was subjected to image enhancement including band combinations before subject to classification for better understand of the land use / land cover classes. Histogram stretching which is one of the image enhancement techniques applied to a 12-bit multispectral data. The digital classification technique has been used for the extraction of the land use / land cover information from the imagery.

Unsupervised classification method with nearest neighbourhood algorithm was used to classify the satellite image. After the completion of the initial classification, the classified image was subject to post classification improvements. Here, the misclassified pixels were re-classified considering small areas of interest (AOI) or through interactive editing (onscreen visual interpretation) for improved accuracy. For onscreen interpretation, the satellite data was displayed in standard false colour composite (FCC) format by assigning blue, green and red colour of the monitor to the green, red and near infra-red bands of satellite data respectively, in ordered to discriminate the land use features clearly. Other band combination was also used in discriminating the different land use / land cover classes. Satellite image also subjected to pan sharpening to enhance the resolution by keeping the multispectral feature. For this the band 8 of the satellite data with 15 m resolution is merged with the multispectral image having bands 1 to 7 with 30 m resolution to get the enhanced image and displayed in standard false colour composite (FCC) (Fig. 1). This enhanced FCC was used to identify the misclassified pixels and re-classify them into correct classes. Misclassified pixels were also identified through thorough ground truthing. Ground truth has been done in the study area using handheld Garmin eTrex GPS for recording the coordinates of the different land use / land cover classes. These were used to improve the classified map.

Further, other ancillary data such as drainage pattern derived from Survey of India toposheets and Digital Elevation Model obtained from SRTM data downloaded with USGS Earth Explorer website (www.earthexplorer.usgs.gov) were used to improve the land use / land cover classification of the study area.

The classified output has a 'salt and pepper' appearance, because of the difference in reflectance value of each pixel. A low pass filter (5 x 5) was applied for smoothening of the output data and to minimize the 'salt and pepper' effect. The satellite remote sensing, with its synoptic view and repetitively, is very helpful in order to cover large areas within a short time to characterize land use & land cover qualitatively and quantitatively.

Results and Discussion

The date of acquisition of the satellite image for the study area is 20th November 2024 with the path and row of 145 and 48, respectively.

Drainage pattern of the study area was developed using Survey of India (SOI) toposheet of the numbers E43Q06, E43Q0, E43Q10 & E43Q11. Toposheets were downloaded from Online maps Portal of Survey of India website (https://onlinemaps.surveyofindia.gov.in/). The drainage pattern thus developed clearly showed that most of the drainage flowing **towards south** with Amarja, a major river flows in the study area which is 1.68 m away from the centre point of the project site (**Figure-4**).

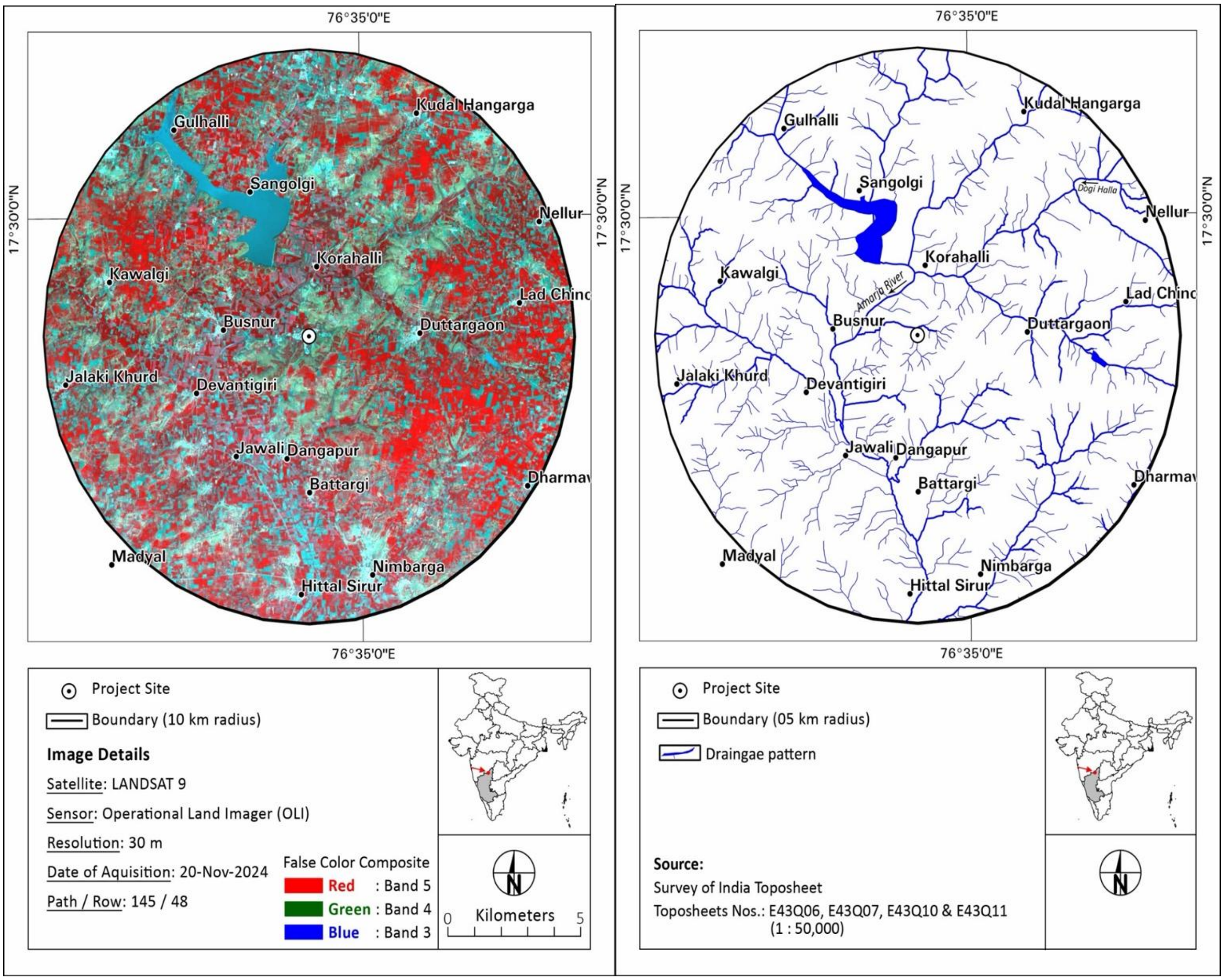


Figure 04: Satellite Image and Drainage pattern of the project site in 10 km radius

The Digital Elevation Model (DEM) for the study area indicates that, the difference in the elevation of the study area is 124 m above Mean Sea Level (from 420 - 544 m, **Figure 4 & 5**), indicating comparatively flat terrain with little undulation in the centre of the study area.

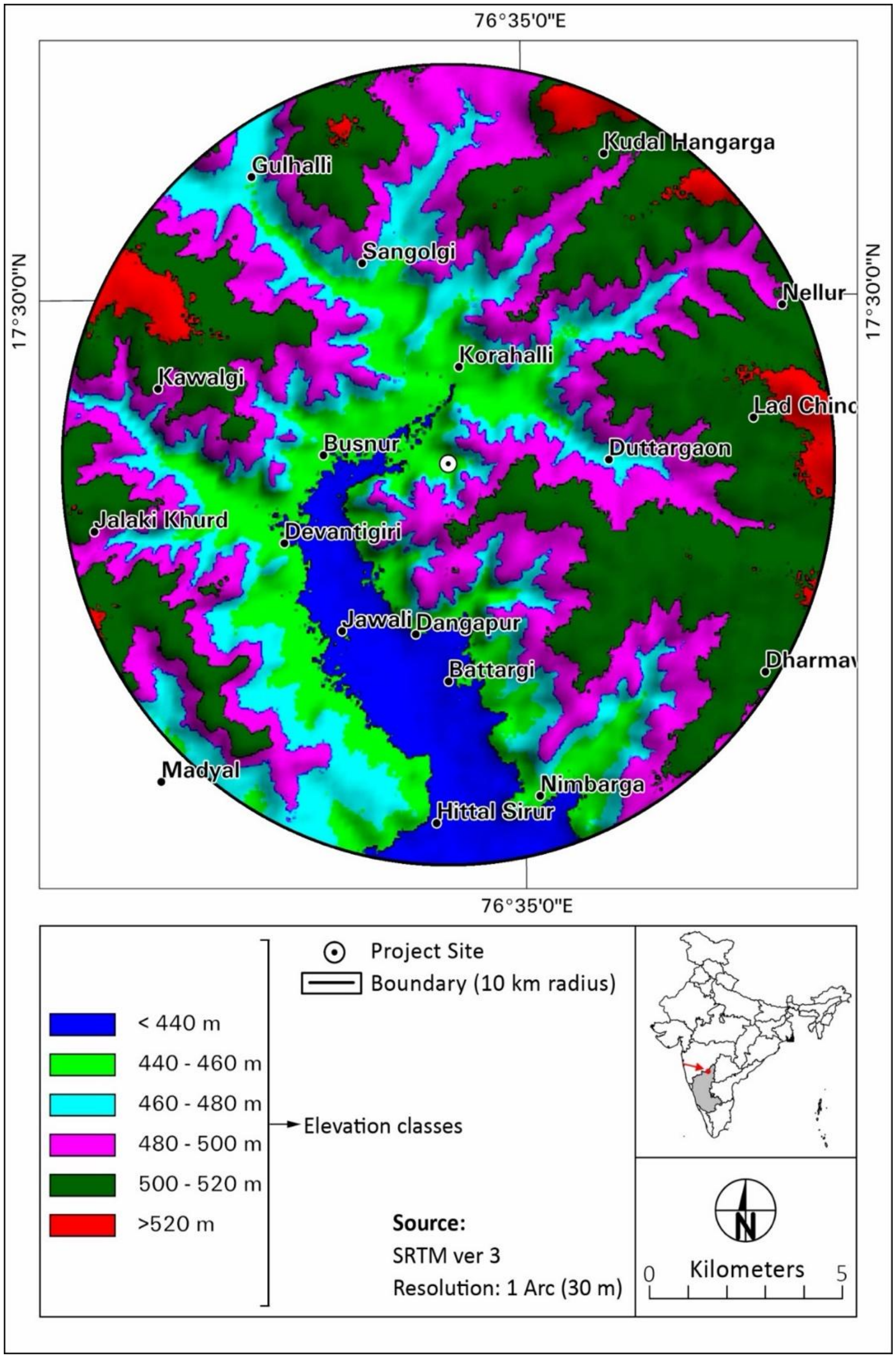


Figure 05: Digital Elevation Model of the project site in 10 km radius

Seven different land use / land cover classes have been identified in the study area and the image was classified accordingly. **Table 02** shows the information about the extent of identified land use / land cover classes thus derived from the satellite image in the study area and represented below in **Figure 06**.

S. No.	Land use / Land cover classes	Area (ha)	Area (%)
1	Forest / Trees Outside Forest	6,538.95	20.89
2	Open grasses	4,253.06	13.59

3	Agriculture / Agriculture Plantation	11,669.31	37.28
4	Agriculture Harvest	5,876.51	18.78
5	Open / Agriculture Fallow	1,978.34	6.32
6	Built up	311.99	1.00
7	Water	670.82	2.14
Total		**31,298.96**	**100.00**

Table 02: Land use / land cover classes in 10 km area around the project site

There are **no reserved forests** in the study area with 10 km radius from the project boundary. In order to understand the impact on each of the land use land cover classes in the study area, the entire study area is divided into two different impact zones such as up to 2 km radius from the project site as immediate impact zone 2 – 10 km zone. The land use land cover classes falling in these zones have calculated separately and given in the **Table 03**.

The immediate impact zones are dominated by the land cover classes such as forest and grassy patches (27.64% & 30.51%, respectively) as compared to 20.61% and 12.88% in the 2 – 10 km zone from the project site, respectively. These land cover classes are the preferred habitat for the fauna of the area and these land cover classes to be avoided from the exposure of dust from the sugar & distillery industry. A proper green belt with about 2500 trees per ha to be planted all along the boundary of the project so as to reduce the spread of dust from the industry to the surrounding land cover classes. These land cover classes acts as profound carbon sink for the carbon emission from the industry.

S. No.	Land Use Land Cover classes	Up to 2 km from project site		2 - 10 km from project site	
		Area (Ha)	Area (%)	Area (Ha)	Area (%)
1	Forest / Trees Outside Forest	347.92	27.64	6,191.03	20.61
2	Open grasses	384.05	30.51	3,869.01	12.88
3	Agriculture / Agriculture Plantation	285.95	22.71	11,383.36	37.89
4	Agriculture Harvest	139.52	11.08	5,736.98	19.10
5	Open / Agriculture Fallow	83.32	6.62	1,895.02	6.31
6	Built up	17.33	1.38	294.66	0.98
7	Water	0.81	0.06	670.01	2.23
Total		**1,258.90**	**100.00**	**30,040.07**	**100.00**

Table 03: Land use land cover classes in immediate impact zone of 2 km from the project site and 2 – 10 km area from the project site

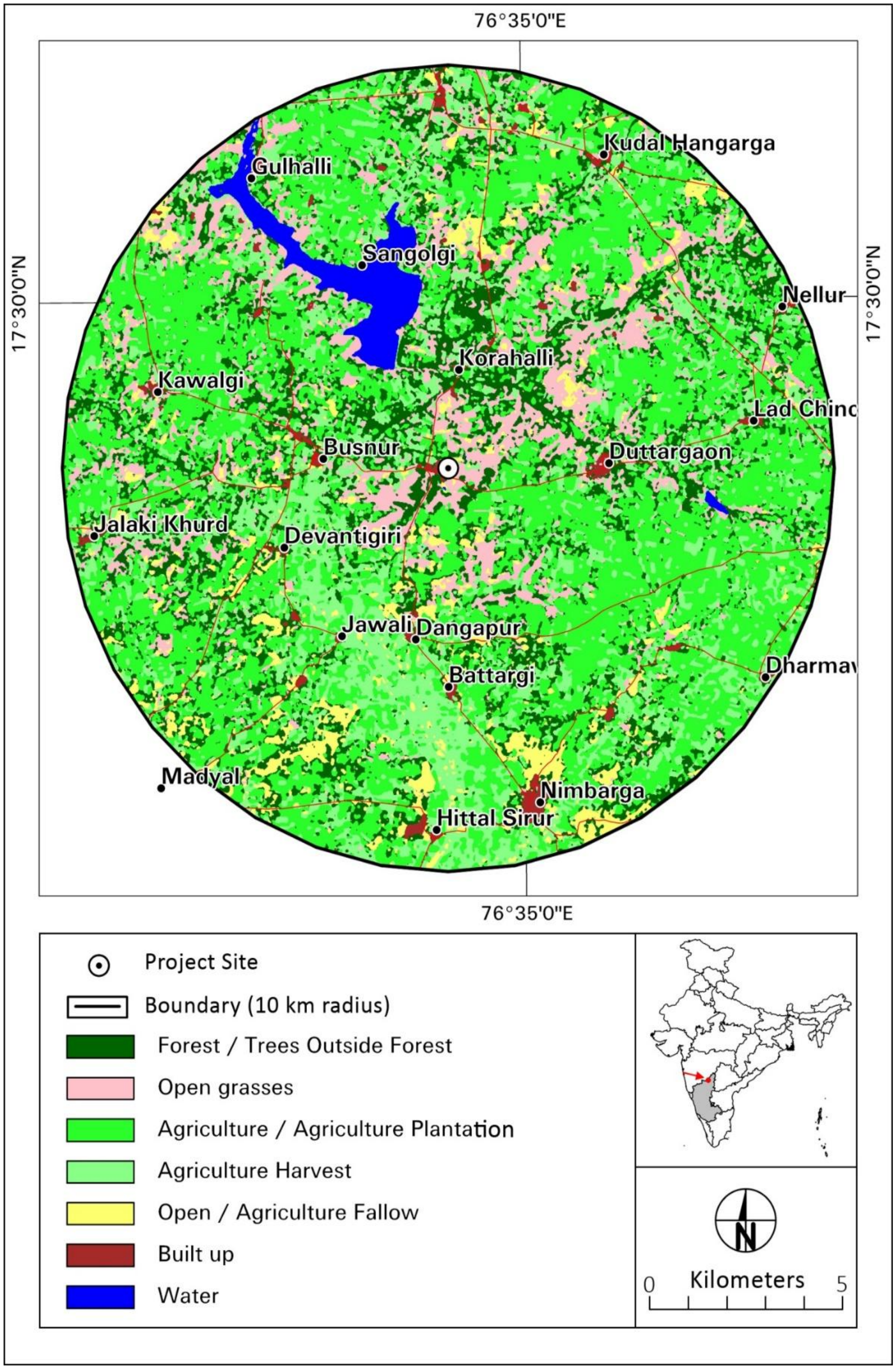


Figure 06: Land use / Land cover map of the project site in 10 km radius

A.4. Climate

For Scope-5

Not Applicable, since this project does not include any activity that is influenced by the climatic conditions of the area as it treats and reuses only the wastewater from the distillery and sugar plant without letting the water exposed to any climatic condition.

For Scope-2

Climate

The climate is a dominant factor in determining the relative abundance or scarcity of water in an area. The available secondary sources of information have been utilized for analyzing the climate characters of the study area. Climatologically the area experiences a **semi-arid type of climate.** Dryness and hot weather prevail in major part of the year. The area falls under Northern Dry Agro-climatic zone of Karnataka state and is categorized as drought prone. The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons: summer from March to May; rainy season or south-west monsoon season from June to September; post-monsoon season covering the months of October and November and dry or winter Season from December to February.

The Climate has an important role in the build-up of pollution levels. Winter is critical for air pollution build up because of frequent calm conditions with temperature inversions resulting in poor atmospheric mixing and pollutants. The climate of Kalburgi district in wet season is warm, oppressive, and overcast and the dry season is hot and partly cloudy. The maximum temperature varies between 41.9^{o}C to 30.3^{o}C and the minimum temperature varies from 17.4^{o}C to 26.5^{o}C. The monthly average temperatures of the area are presented in **Table 05** and **Figure 07**.

Period	Max	Mean	Min
January	35	24	13
February	38	26	15
March	41	30	18
April	43	33	22
May	44	34	24
June	40	29	23
July	35	27	22
August	35	27	21
September	33	26	20
October	33	25	17
November	33	24	14
December	33	23	12

Table 05: Average Monthly Temperatures of NSL Sugars Aland Unit

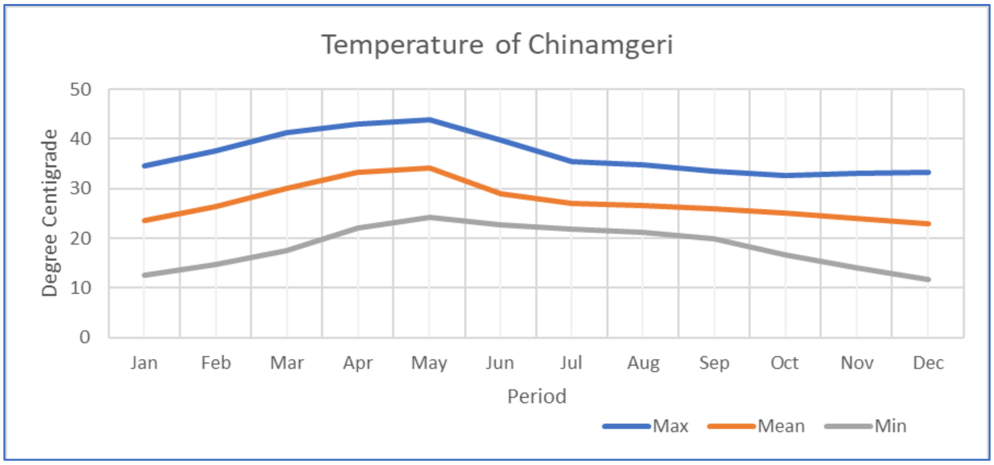


Figure 07: Variation of Temperatures of an area in and around NSL Sugars Aland Unit

Relative humidity, in general, is moderate to high throughout the year in the area. The average humidity is found to be lowest from March to April, ranging from 29% to 37%. The average humidity of the area starts rising from June to September ranging from 63% to 79%. From October onwards the humidity gradually records from 66% up to March up to 29%. Thereafter it starts rising with the commencement of Summer. In general, the humidity varies from a minimum of 29% during March to a maximum of 79% during September. Variation of relative humidity is presented is given in **Table 06** and **Figure 08**.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
2014	49.38	34.62	25.31	27.69	37.12	62.00	77.12	81.31	83.88	80.75	80.25	63.81	**59**
2015	44.94	39.38	26.00	33.44	36.12	62.31	70.06	75.31	72.44	69.31	49.31	40.31	**52**
2016	37.25	29.75	19.38	35.62	29.50	54.75	70.38	71.50	76.19	69.56	61.88	46.44	**50**
2017	40.81	40.62	28.06	33.25	37.62	68.88	76.19	75.88	81.12	81.19	71.88	54.00	**57**
2018	51.75	37.06	44.38	33.12	46.19	51.69	67.31	72.06	80.19	71.88	63.44	51.56	**56**
2019	41.94	33.69	40.44	44.38	37.19	57.31	58.69	67.88	76.69	66.19	53.62	43.81	**52**
2020	39.38	34.69	27.75	26.44	38.06	70.00	77.31	76.38	80.56	76.06	58.81	42.62	**54**
2021	36.25	26.69	27.94	20.75	32.94	68.38	71.19	72.81	79.62	79.69	69.06	49.75	**53**
2022	32.88	28.69	25.06	30.31	38.12	67.12	68.31	70.00	69.06	57.31	44.06	48.75	**48**
2023	38.81	34.31	24.50	25.44	25.00	58.12	69.56	74.44	79.19	82.94	70.62	60.50	**54**
2024	50.94	37.44	33.81	30.69	37.81	69.12	81.12	84.12	85.75	84.44	81.38	71.94	**62**
2025	58.94	38.50	24.81	35.50	51.38	68.81	78.94	79.25	82.88	82.81	82.50	71.06	**63**
Average	**44**	**35**	**29**	**31**	**37**	**63**	**72**	**75**	**79**	**75**	**66**	**54**	

Table 06: Average Monthly Relative Humidity (%) of NSL Sugars Aland Unit

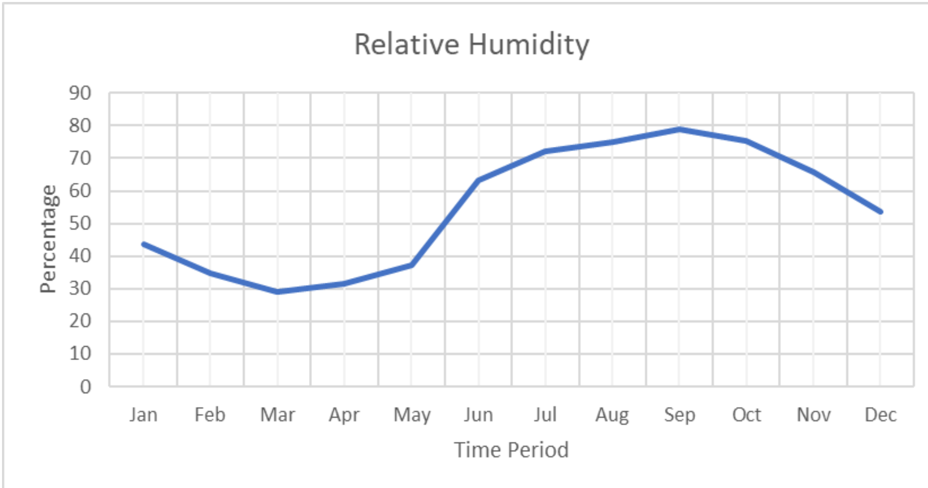


Figure 08: Variation of Monthly Humidity of area in and around NSL Sugars Aland Unit

A.5. Rainfall

For Scope-5

Not Applicable, since this project does not involve any usage of rainfall data.

For Scope-2

The Aland taluk in which the present study area falling enjoys semi-arid climate. Dryness and hot weather prevail in major part of the year. The area falls under Northern Dry Agro-climatic zone of Karnataka state and is categorized as drought prone. The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons: summer from March to May; rainy season or south-west monsoon season from June to September; post-monsoon season covering the months of October and November and dry or winter Season from December to February. The NSL Plant is collecting the daily rainfall data from a **rain gauge station** established in their Plant premises in 2013 and continuing to monitor. The average rainfall data from 2014 to 2025 (12 Years) of the station is 717.72 mm. The maximum rainfall of 1026.7 mm was received in 2022 and a minimum of 359.2 mm during the year 2017.

The monthly rainfall data of NSL Sugars from 2014 to 2025 is presented in **Table 07** below:

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Rainfall (mm)
2014	0	0	0	55.8	11.4	65	110.8	194.2	101.2	67	14.3	0	**619.7**
2015	0	0	0	44	3.3	80.2	238.1	70.6	240	35.2	6.4	0	**717.8**
2016	0	18.6	54.6	48.8	97.4	36.4	150.8	172.6	97.3	60.9	11	12.2	**760.6**
2017	6.2	0	13.6	47.6	26.8	47.8	8.6	67.8	61.5	59.6	3.5	16.2	**359.2**
2018	0	0	8.6	22.2	10.2	144.6	158.8	36	284.3	6.2	0	0	**670.9**
2019	0	0	34.2	0	5.6	282.4	28	208.4	178.6	118.2	0	0	**855.4**
2020	0	0	0	39.6	27.6	212	32.2	117.4	43.2	35	5.6	0	**512.6**
2021	0	0	0	0	0	116.3	53	83.1	197.2	176.4	0	0	**626**
2022	0	0	35.2	14.6	27.1	155.5	328.4	85.3	174.3	206.3	0	0	**1026.7**
2023	0	0	0	28.6	99.2	104.6	183.8	90.7	376.5	86.8	16	1.2	**987.4**

2024	0	0	0	0	64.1	50.4	288.7	149.9	202.4	95.3	0	0	**850.8**
2025	0	0	11.6	54.2	82.9	30.3	231.9	15	182.3	12.3	5	0	**625.5**
Average Rainfall (mm)	**0.52**	**1.55**	**13.15**	**29.62**	**37.97**	**110.46**	**151.09**	**107.58**	**178.23**	**79.93**	**5.15**	**2.47**	**717.72**

Table 07: Monthly Rainfall Data of NSL Sugars Aland Unit (2014 to 2025)

In general, the rainfall for 12 years from 2014 to 2025 is showing a rising trend. The year 2018 and successive three years followed by 2021 being good rainfall years, general rainfall is showing a rising trend.

A.6. Ground Water

For Scope-5

Not Applicable, since this scope of project does not include any activity that uses the ground water.

For Scope-2

As per the groundwater estimation-2022, the Total Annual Ground Water Recharge in the Kalaburgi District is 69992.08 Ham; however, Extractable Ground Water is 63667.13 Ham only. The Current Annual Extraction for all purposes is 26478.31 Ham, and Net Ground Water Available for Future use in the district is 37036.50 Ham. The Ground Water Resource Estimation for Kalaburgi District and Aland Taluk is presented in Table 08.

Similarly, in Aland Taluk, in which the study area is falling has the Total Ground Water Recharge from all sources is 12449.53 Ham, however, Extractable Ground Water is 11204.58 Ham. The Current Ground Water Extraction for all purposes is 6121.03 Ham and the Annual Ground Water Availability for Future Use is computed to be around 5034.56 Ham. The Stage of Ground Water Extraction of the entire Aland Taluk has the Stage of Ground Water Extraction of 53.63% classified as Safe Category indicating that there is a scope for further ground water extraction in the area. However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority need to be strictly implemented in the area, so that ground water sustainability is maintained.

Details	Kalaburgi District	Aland Taluk
Total Annual Ground Water Recharge (Ham)	69992.08	12449.53
Annual Extractable Ground Water Availability (Ham)	63667.13	11204.58
Current Annual Ground Water Extraction (Ham)	26478.31	6121.03
Net Annual Ground water availability for future use (Ham)	37036.50	5034.56
Stage of Ground Water Extraction (%)	-	**54.63**
Category		**Safe**

Table 08: Ground Water Resources of Kalaburgi District and Aland Taluk

Hydrogeology

Hydrogeological conditions of the area are also among important factors in planning rainwater harvesting aquifer recharge schemes. The recharged water moves below the soil zone in moisture fronts through the zone of aeration. The unsaturated flow is governed by the permeability of the zone of aeration, which in turn varies with the moisture content of the front. Usually, in the case of consolidated rock formations, the subsoil zone passes into weathered strata, which, in turn, passes into un-weathered but fractured rock. The hydrogeological properties of the weathered strata are generally much better as compared to the parent rock due to higher porosity and permeability imparted by weathering. The nature of the soil, subsoil, weathered mantle and presence of hard pans or impermeable layers govern the process of recharge into the unconfined aquifer.

The saturation and movement of ground water within unconfined and all deeper semi- confined and confined aquifers are governed by the Storativity and Hydraulic Conductivity of the aquifer material. Aquifers best suited for artificial recharge are those, which absorb large quantities of water and release them whenever required. Detailed geology and hydrogeological study besides the regional picture of hydrogeological set up available from previous studies is therefore imperative to know precisely the promising hydrogeological units for recharge and correctly decide on the location and type of structures to be constructed either for storage of rainwater harvested or for recharge to the ground water.

Regional Hydrogeology

Ground water occurs in all the formations. However, nature and occurrence depend on various factors like rainfall, topography, land forms and geology of the area. From the ground water point of view, the geological formations occurring in the area may be classified into two categories as **Hard Rock** (crystalline Rocks) and unconsolidated sediments or **soft rocks.**

Crystalline rocks consisting of granite gneisses, schists and Charnockites are grouped into hard rocks, while **unconsolidated formations** especially the alluvium along the rivers and stream courses are the soft rocks.

The hard crystalline rocks lack primary porosity. The occurrence and movement of ground water are usually limited to secondary porosity developed through weathering and fracturing of the rock formation. As a result, groundwater prospects in hard rocks are limited and depends upon the degree of the intensity and depth of fracturing and weathering. The intensity and depth of weathering and fracturing vary widely from place to place. The hard rock aquifers are anisotropic, and non-homogenous, as such occurrence and movement of ground water vary widely within a short distance. Ground water occurs under water table conditions in weathered residuum and semiconfined to confined conditions in deeper fractured zones. Generally, most of the area is underlain by hard rock aquifers.

The massive Deccan Trap basalts are more compact and have negligible primary and secondary porosity. When massive traps are jointed, fractured, and weathered and the interconnected vesicles are present or exposures of red bole may influence the groundwater movement laterally and downward direction and form reasonably the good aquifer. The major part of the district is occupied by basalt aquifers. The soft rock aquifers consisting of alluvium are restricted to a small patch in the NE corner of the district along the river courses. Generally, the groundwater in the area is extracted through the open wells in the shallow zones of the weathered part of the hard rock aquifers. The groundwater from the deeper aquifers is drawn from the bore wells drilled 80 to 150 m bgl in the district.

The Deccan Trap Basalts are generally grouped under Hard Rock aquifers from the point of occurrence and movement of groundwater. Within the Plant premises, there are two Deccan Trap flow systems with alternate layers of massive and vesicular units that play an important role in their disposition to possess the groundwater-bearing horizons and to form the aquifers. In the north eastern part of where the altitude of the area is relatively high the separation of two basalt flows by a red bole bed of sedimentary origin. Each Basalt lava flow is generally comprised of a lower massive unit and upper vesicular units. The disposition of each flow shows a marked variation in vertical and horizontal permeabilities. The degree of weathering, the intensity of fractures, density and disposition of vesicles are deciding factors for their water-bearing capabilities. The massive rock is hard and compacts their water being capabilities generally enhanced by the presence of fractures and joints, while vesicular basalt possesses fairly high porosity and imparts permeability when the vesicles are interconnected and uniformly distributed throughout the rock. Weathering renders secondary porosity thereby increasing the water-bearing capacity in the basalt rocks.

There are as many as seven bore wells were observed in and around the plant area including three bore wells located in the plant premises drilled to a depth of 300 m bgl. The reported information of these wells shows that the weathering of the basalts is very shallow from 5 to 7 m bgl with groundwater levels of 3 to 5 m bgl. The shallow groundwater during the post-monsoon period is due to the shallow thickness of weathered followed by the massive basalt rock, since recharged water does not go into the deeper levels due to the massiveness of the rock, the groundwater levels become very shallow during the rainy season, and almost the aquifer goes dry during the summer. Since the Plant located relatively in low-lying area is one among the reasons for shallow water levels in and around the area.

The Plant and its surrounding areas area are underlain by geological formations ranging in age from Archaean to Recent period mostly consisting of Archaean Granitic Gneiss, Dharwar Schists, Pre Cambrian-Meta sediments mostly consisting of Conglomerates, Shales and Sand Sandstones, Deccan Trap Basalts of Pliostocene period and Recent Alluvium along the river courses. The Peninsular gneisses are pink and grey granites that have intruded into the gneisses in the extreme NE corner of the district which are the oldest rocks in the area. The rock formations are followed by Metasediments comprised of sandstones, shales, limestones and dolomites belonging to the Bhima Series of Pre Cambrian-Age in the SE part of the District Chitapur, Jawargi and Sedam Taluks. The Bhima Series of the rocks are overlain by the Deccan Trap Basalt Formation with three distinct flows with thicknesses ranging from 20 to 30 m. In some places, laterites are common over the Deccan Trap Basalts covering Aland, Afjalpur and parts of Chicholi Talukas. Around 70% of the district area is underlain by the basalt formation of the district.

Groundwater occurs under unconfined to semi-confined conditions within these formations. Typically, groundwater is found under phreatic conditions in the moderately weathered basalt and under unconfined conditions within the fissured and fractured zones at greater depths. The area is underlain by both porous and fissured formations, which constitute the primary aquifer systems, comprising unconsolidated to semi-consolidated rock masses.

In the plant area Geological section delineated from Geophysical data, the lithological distribution is approximately as follows: topsoil (about 5%) consisting of black cotton soil to sandy clay, highly weathered basalt (around 10%), red bole as a thin clayey horizon, weathered vesicular basalt (approximately 10%), moderate weathered vesicular basalt (about 10%), and basement massive basalt occupying roughly 65% of the subsurface. Among these formations, the weathered basalt and fractured/jointed zones are identified as the most promising aquifers within and surrounding the plant area. These zones exhibit adequate porosity and permeability to yield groundwater, making them suitable targets for groundwater extraction. Based on the geophysical investigations and the interpreted resistivity data from eight VES locations, it is inferred that the study area predominantly consists of basaltic formations with variable weathering intensity. The subsurface lithology is characterized by multiple distinct layers up to a maximum depth of approximately 220 meters below ground level. The lithological sequence identified from the VES data includes the following layers in order of superposition: Topsoil, highly weathered vesicular basalt, red bole (lateritic clay layer), Weathered vesicular basalt, Vesicular basalt, massive basalt (basement rock). The topsoil and highly weathered basalt layers form the shallow surface zone with low to moderate resistivity values, indicative of porous, weathered material. Below this, the red bole acts as a thin, low-resistivity layer signifying iron-rich clay deposit. **Two primary aquifer zones** are inferred within the weathered and vesicular basalt horizons.

- The first aquifer zone is identified approximately between 6 to 15 meters' depth, corresponding to weathered vesicular basalt with moderate resistivity, indicating fractured and porous conditions favourable for groundwater storage.

- The second aquifer zone lies between approximately 14 to 20 meters' depth within the vesicular basalt layer, showing higher resistivity values consistent with less weathered but fractured basalt, capable of yielding moderate groundwater.

The massive basalt underlying these zones represents the basement rock, with very high resistivity values and limited permeability, acting as a hydrogeological barrier. Considering the geophysical evidence, the aquifer potential in the area ranges from poor to moderate. Groundwater extraction is feasible primarily from the weathered and vesicular basalt zones up to depths of 15 to 25 meters, but for the shallow water levels is feasible for ground water recharge. It is recommended to recharge this zone which will in turn recharge the fracture zones and such saturate the entire aquifer zone

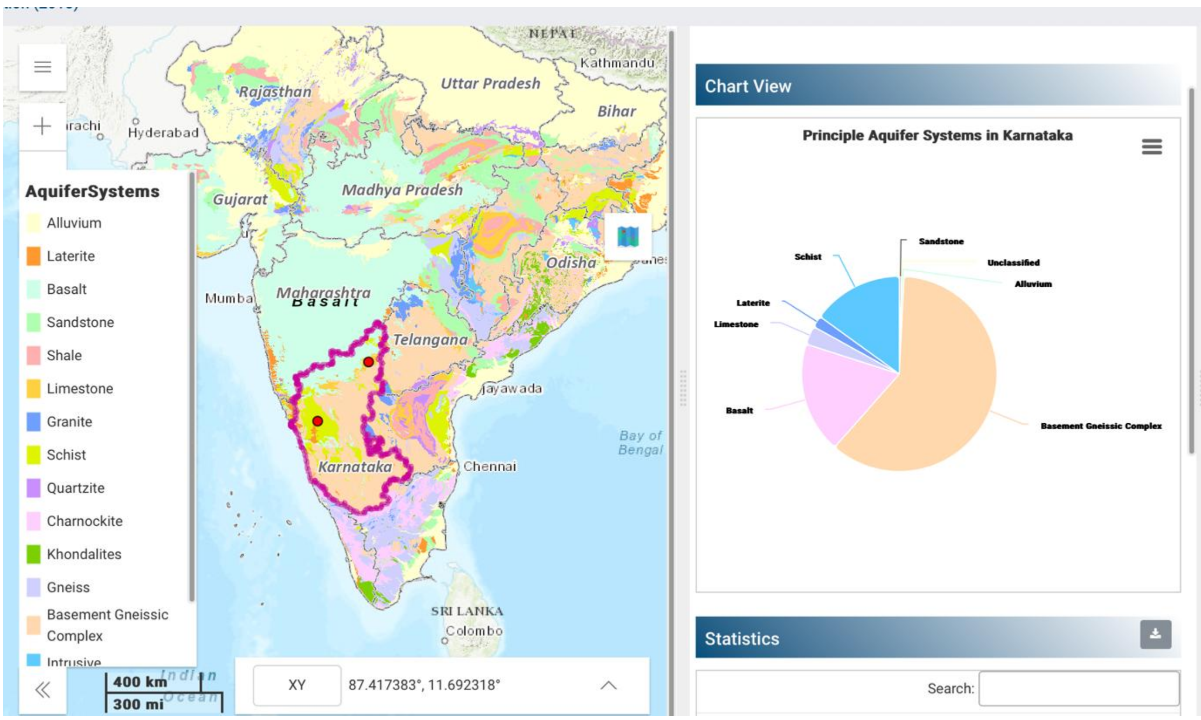


Figure 09: The Aquifer system available according to the India Water Resources Information System[3] in the plant site state- Karnataka

[3] https://indiawris.gov.in/wris/#/Aquifer

Statistics

Search:

Principle Aquifer	Aquifer System	Aquifer Type	Thickness (m)	DTW (Decadal Avg.) (mgbl)
Alluvium	704.44	Unconfined	20-60	20-60
Basalt	34899.50	Unconfined	10-45	10-45
Basement Gneissic Complex	114967.88	Unconfined Semi-confined to Confine	Up to 60	Up to 60
Laterite	3627.27	Unconfined	5 -15	5 -15
Limestone	5873.49	Unconfined, Semi Confined to Confin	40-150	40-150
Sandstone	721.04	Unconfined	60-80	60-80
Schist	28464.07	Unconfined-Semi-confined	35	35
Unclassified	38.29			

Showing 6 to 8 of 8 entries Previous 1 2 Next

Figure 10: Showing the types of Aquifer system and their technical specification available according to the India Water Resources Information System in the plant site state- Karnataka

A.7. Alternate methods

W.r.t Scope-5

a) Common Practices for Wastewater Treatment in Sugar and Distillery Industries:
- Anaerobic Digestion: Used to treat high-strength effluent like spent wash, reducing COD/BOD and generating biogas.
- Multiple Effect Evaporation (MEE): Concentrates spent wash to reduce volume, preparing it for further treatment.
- Bio-composting: Combines treated spent wash with press mud to produce organic fertilizer.
- Zero Liquid Discharge (ZLD): Integrates MEE, crystallization, and reverse osmosis to recover water and prevent discharge.
- Irrigation Use: Treated effluent is diluted and applied in agriculture under controlled conditions.

- Incineration: Concentrated spent wash is burned for energy recovery in distillery operations.

b) Common Practices for Condensate water in Sugar and Distillery Industries:
   - It is generally used in the process back after treatment.
   - In some distilleries especially molasses-based units, condensate can be reused for diluting molasses in the fermentation section.

These methods align with regulatory norms and support resource recovery and sustainability.

Industries face challenges such as high capital and operational costs, land scarcity for methods like bio-composting, and skilled workforce shortages. Managing spent wash with high COD/BOD, odor control, seasonal effluent variations, and strict regulatory compliance adds complexity. Additionally, handling byproducts and ensuring sustainable water reuse remain significant concerns. Hence implementing these methods in industry improves the water security.

W.r.t Scope-2

As per the study and data available of the NSL project it is clear that the project owner is trying to collect and conserve the rainwater for reuse in the plant activity to avoid any runoff and wastage of water. The hydrological structures and conservation measures are developed in such a way that the runoff generated within the plant will be collected and stored to meet a part of the water requirement of the Plant.
As it was determined from each zone and land use hydrological characteristics, the runoff is the major component which is being affected by various factors. The following are the factors which are affecting different hydrological characteristics:

Storm Characteristics	Nature of Storm
	Seasonal Storms
	Intensity
	Duration
	Areal extent (Distribution)
	Antecedent Precipitation
	The direction of Storm Movement
Meteorological Characteristics	Temperature
	Humidity
	Wind velocity
	Pressure Variation
	Size
	Shape
	Slope (Average land slope & Stream slope)
	Altitude (Elevation)
Catchment Characteristics	Topography
	Geology
	Land use/vegetation
	Orientation
	Type of drainage network
	Proximity to Ocean and mountains
	Ranges
	Depressions

	Pits and Ponds
Storage Characteristics	Steams and channels
	Upstream tanks/ponds
	Flood plains and swamps
	Ground water storage in pervious deposits

Based on the above characteristics it is found that in general, low-intensity storms over longer spells contribute to the ground water storage and produces relative less runoff. On the other hand, high-intensity storm or smaller catchment areas increases the runoff since the losses like infiltration and evaporation are less. However, if there is a succession of storms the runoff will increase due to the initial wetness of the soil, and antecedent rainfall and most of the area is well developed into buildings for Plant activities and paved ones. As usual, the rain during the summer will produce less runoff and during the winter will produce more runoff.

The development of these catchment areas and measures to prevent run-off will save water and result is less runoff in the area.

A.8. Design Specifications

W.r.t Scope-5

A) Sugar Effluent Treatment Plant (ETP) is designed to treat wastewater generated from leakages and spillage of juice and syrup and molasses in different sections of the industry. Leakage occurs at pipe joints and pump glands. The periodical washing of floor also contributes pollution load in the wastewater. Wastewater is also generated due to the cleaning of equipment such as mills, evaporators, pans, juice heaters, etc. The effluent thus generated is having COD and BOD that needs to be treated before using it for agricultural purposes.

ETP is having following 9 steps of treatment processes:

1. Screen Chamber, Oil & grease trap
2. Equalization Tank
3. Neutralization tank
4. Feed tank
5. Anaerobic Digester
6. Extended Aeration Tank
7. Clarifier
8. Treated Effluent Storage tank
9. Dual Medial Filter

Details of treatment unit:

S. No.	Name of the unit	Dimensions	Volume, m^3
1	Bar Screen chamber	2.5 m X 1.8 m X 2.3 m	10.10
2	Oil & grease removal	8 m X 2 m X 2m	32
3	Equalization Tank	20 m X 20 m X 3 m	1200
4	Neutralization tank	2.0 X 2.0 X 1.85	7.2
5	Feed Tank(Buffer tank)	12.67dia X 3.3	410
6	UASB Tank	17.2 Dia X 6.5	1500

7	Extended Aeration tank	27.4 X 13.7 X 3	1125
8	Secondary Clarifier	12.65 m Dia X 3 m	375
9	Treated effluent storage tank	6 m X 5 m X 2.25 m	75
10	Sludge Drying Beds	38.25mX7.90mX1.4m	425
11	Bar Screen chamber	2.5 m X 1.8 m X 2.3 m	10.10
12	Oil & grease removal	8 m X 2 m X 2m	32

Table 09: Major ETP tank list of NSL Sugars Aland Unit

Physio-Chemical process:

1) Screen Chamber, Oil and grease trap:

Screen chamber has been provided to accommodate the screen. The screen will remove the suspended particles like bagasse, cotton waste, etc. coming from the sugar unit.

BAR SCREEN CHAMBER:

Type	:	Rectangular
Volume	:	10.10 M^3
Size	:	2.4 x 1.8 x 2.3 m
MOC of Tank	:	R.C.C.
Screen	:	Manual Removable type
MOC of Screen	:	SS
Quantity	:	1 No.

Bar Screen Chamber

Oil & Grease trap is provided for removal of free & floating oil and grease, which otherwise would affect the performance of anaerobic biological treatment. The trap is provided with oil removal mechanism. A screen chamber is provided ahead of oil & grease trap for removal of coarse material.

Type	:	Rectangular
Volume	:	32 M^3
Size	:	8 x 2.1 x 2 m
MOC of Tank	:	R.C.C.
Mechanism	:	Belt Type
Quantity	:	1 No.

2) Equalization Tank:

Equalization Tank

An Equalization Tank is provided for dampening the fluctuations in wastewater characteristics and quantity. From this tank the effluent will be pumped to neutralization tank.

Type	:	Square
Volume	:	1200 M^3
Size	:	20.1 x 20 x 2.9 m
MOC of Tank	:	R.C.C.
Quantity	:	1 No.
Pump Capacity	:	40 M^3/Hr
Type of Pump	:	Self-priming, non-clog, semi open impeller
Quantity	:	2 Nos (1W+1Sb)
Mixing	:	By Air

Operating parameters- Feed pH should be maintained between 6.8 to 7.2 by adding Lime

3) Neutralization tank:

Neutralization Tank

In this tank lime will be added to the effluent to increase the pH of the effluent.

Type	:	Square
Volume	:	50 M^3
Size	:	3.7 x 3.7 x 3 m
MOC of Tank	:	R.C.C.
Quantity	:	1 No.

4) Feed tank:

Feed Tank

Operation:

The bottom sludge should be drained on daily basis

The neutralized effluent from the feed tank will be fed to anaerobic digester through pumping.

Type	:	Square
Surface Area	:	375 M^3
Size	:	12.67 Dia x 3.3 m
MOC of Tank	:	R.C.C.
Quantity	:	1 No.

5) Anaerobic Digester:

UASB Tank

In this type of treatment effluent is treated anaerobically in air tight RCC tank. The reactor consists of three zones viz. Influent distribution zone, Reaction zone, Gas solid liquid separation zone.

Influent Distribution zone: The raw wastewater enters into the digester at the bottom through influent distribution zone. A sophisticatedly designed piping network is provided for uniform distribution of the effluent in the tank. The effluent then travels upward in the reactor.

Reaction zone: In the reaction zone the anaerobic bacteria are maintained on the surface of the PVC media. The organic matter in the wastewater comes in contact with the bacterial population and is degraded anaerobically to methane rich biogas, the end product of anaerobic digestion. The process of conversion of organic matter into the biogas is a two-stage process. In the first stage the organic matter in the raw effluent is converted in to the volatile acids by acid forming bacteria. In the second stage the acid produced in the first stage are converted in to methane by another group of bacteria i.e. methane formers. In anaerobic digester process both the stages are completed in single reactor. The biogas so produced is bubbled through the effluent and is separated out in the third section i.e. Gas collection zone. The suspended solids are also separated to prevent escape of solids from the reactor.

Gas collection zone: In gas collection zone the biogas generated will be collected and the same will be conveyed to flare stack where it is flared continuously. The treated effluent overflows through a launder and will take to a secondary treatment.

Size of the tank	:	17.2 mm dia. x 6.5 mm ht.
Tank Vol	:	1500 M^3
Gas generated per Kg	:	0.45 NM^3
COD Reduction	:	65 %
Gas Generated	:	0.5 to 0.53 kg per kg of COD reduction
MOC of Tank	:	R.C.C. M 20
Quantity	:	1 No.

Operating parameters:

Feed pH	:	6.8 to 7.5
Digester over flow	:	6.9 to 7.6
VFA to Alkalinity ratio	:	0.3 to 0.6
COD	:	Inlet and Outlet

6) Extended Aeration tank:

Aeration Tank

The partially treated effluent from anaerobic digester shall then be subject to activated sludge process for further reduction of organic matter. Aeration tanks are provided for degradation of organic matter through biological process. Microorganism in the controlled environment carries out the biodegradation process. The container i.e. aeration tank of requisite capacity is provided for this purpose. The tank shall be provided with an diffused aeration mechanism to transfer the oxygen from air to tank content for survival of microorganisms. Constant Mixed Liquor Suspended Solids (MLSS) shall be maintained in definite proportions at aeration tank by recycling the bio-sludge trapped by the secondary clarifier. The content in the aeration tank is kept under constant aeration and mixing. 25.00 HP diffused type of aerators shall be provided for transferring the oxygen for metabolism.

Type	:	Rectangular
BOD % Reduction	:	96%
MLSS	:	4200 ppm
Volume	:	1126 M^3
Size	:	27.4 x 13.7 x 3 m
Air Required	:	900 M^3/Hr.*
Energy Required	:	20 KWhr

Operating parameters:

Feed pH	:	7.6 to 8.2
Settling	:	300 to 500 ml/Litre
MLSS	:	3000 to 4500 mg/l
Colour	:	Brownish
SVI	:	50 to 100

7) Secondary Clarifier:

Secondary Clarifier Tank

A secondary Clarifier in the form of circular tank shall be provided for settlement of fully aerated effluent from the extended aeration tank. The tank shall be provided with centrally driven fixed bridge type clarifier mechanism. Part of the settled sludge at the bottom of the settling tank will be pumped to the EAT and part of it will be discharged on sludge drying beds as per operational requirement. This sludge being fully mineralized is suitable for sun drying on sand drying beds.

Type	:	Circular
Total Size	:	12.65 dia. x 3 m ht
Tank Vol.	:	376 M^3
Qty.	:	1 No.

Operating parameters:

pH	:	7.6 to 8.2
Total Suspended Solids:	:	<100 mg/l
COD	:	<250 mg/l
Oil & Grease	:	<10mg/l
Colour & Odor	:	No colour and Odor

Sludge Drying Beds:

Sludge Drying Beds

In the activated sludge process system the sludge is sufficiently mineralized and does not need any further treatment before dewatering and disposal. Sand filtration drying beds will be provided, where sludge will be dewatered by filtration through sand bed and sun drying of the dewatered sludge is scraped & may be used as manure.

Sludge from Primary Treatment	:	423 Kg dry basis
Area Provided	:	38.25 m X 7.90 m X 1.4 m
Drying Cycle	:	2 to 3 days

8) Treated Effluent Storage Tank:

Treated Water Tank

This tank is provided to store the treated effluent before pumping to the green belt development area or sugar cane irrigation

List of Equipment:

S. No.	Name of the equipment	Capacity, m^3/hr
1.	Raw effluent transfer pump • Make:-KBL • Type:-DB 80/20 • Total head:-30m • Size: 80X100 mm • Disch:- Speed:-1440 rpm • Qty:-02 Nos	Cap: 1200 m^3/hr
2.	UASB feed pump • Make:- K.B.L • Type:-DB 100/20 • Head:-30 Mts • Size:-100X125mm • Disch:- 100m^3/hr • Speed:-1440 • Kw-7.5 • Qty:- 02 Nos	Cap: 367.9 m^3/hr
3.	Bio-sludge recirculation pump • Pump 02 Nos • Make:-K.B.L • Type:- SP-3L+ • Impeller Dia:-224mm • Size:-80X80mm • Disch:-12.5lps • Motor speed:-1440rpm • Kw-3	Cap: 248 m^3/hr

4.	Treated effluent transfer pump • Pump make:-KBL • Type:-KDS/-1030± • Size:-100X100mm • Head:- 25mtrs • Disch:-28-0-15 lps • KW:-7.5. • Speed:- 2980rpm • Qty:- 02 Nos	Cap: 82.8 m3/hr
5.	Air Blower-I (Aeration tank) • Make:-Kay International ltd, M/C. • S.No:-59AC1203893STB • Blower speed:- 1150 rpm • Motor Hp:-10 • Qty:- 01 Nos	Cap: 500 m^3/hr Delivery pressure:0.25 Kg/cm^2
6.	Air Blower-I (Equalization tank) • Make:-Kay International ltd, M/C. • S.No:-59AC1203893STB • Blower speed:- 1150 rpm • Motor Hp:-10 • Qty:- 01 Nos	Cap: 500 m^3/hr Delivery pressure:0.25 Kg/cm^2
7.	Aeration tank and Gear boxes • Make:-Transmital BONFIGLOL1 • Type:-307L-228-0-HCP160T • Ratio:-28-0 • Motor speed:-1450 rpm • Kw:-15 • Qty:-02 Nos	Cap: 1548.44 m^3

Table 10: Major List of Equipment used in ETP of NSL Sugars Aland Unit

Final Effluent Quality & Compliance

The treated water from the polishing pond meets environmental discharge norms and can be safely released or reused for agricultural and gardening purposes.

Parameters	UOM	Before Treatment	After Treatment
Quantity	m^3/day	750	750
pH		4.5-5.5	6.5-8.2
Chemical Oxygen Demand	mg/l	5000	<250
Bio-Chemical Oxygen Demand	mg/l	2000	<100
Suspended solids	mg/l	600-800	<100
Oil Grease	mg/l	70	<10

Table 11: Parameters values before and after testing of ETP process at NSL Sugars Aland Unit

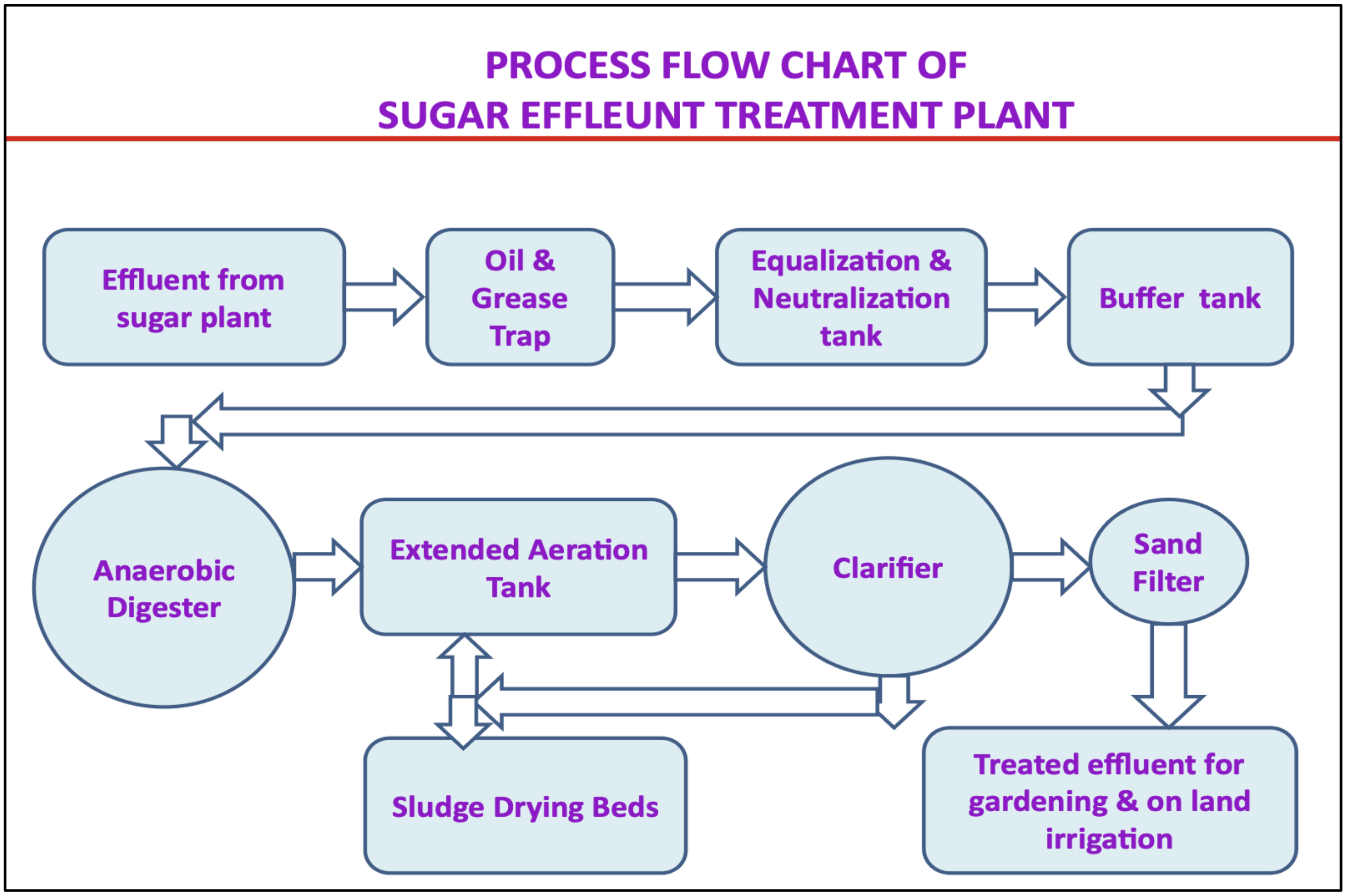


Figure 11: Showing the process flow of STP plant in NSL Sugars Aland Unit

B) Sugar Condensate Plant: is designed to captures process vapours from evaporators and pans, converting them into purified, reusable water. This drastically reduces fresh water consumption and helps achieve Zero Liquid Discharge (ZLD) when integrated with the distillery.

The major impurity contents of sugar factory condensate are trace organics and more particularly the Ammonical Nitrogen which can prove detrimental for reuse applications.

The treatment scheme for condensate polishing unit involves the utilization of biological mode, specially developed to treat not only trace organics, but basically the Ammonical nitrogen. The treatment scheme therefore comprises of an Aerobic – Anaerobic approach.

Although, the characteristics of condensate are fairly uniform with reference to period, it is desirable to provide some cushion for minor variations in the form of equalization tank. This also serves as a part of composite and complex biological system specially developed as the treatment scheme. The condensate is subjected to aerobic and anaerobic biological modes selectively to cater for and treat the two main impurities. Care is taken to optimize the treatment structures as well as the energy inputs, thereby minimizing the capital as well as working expenditures

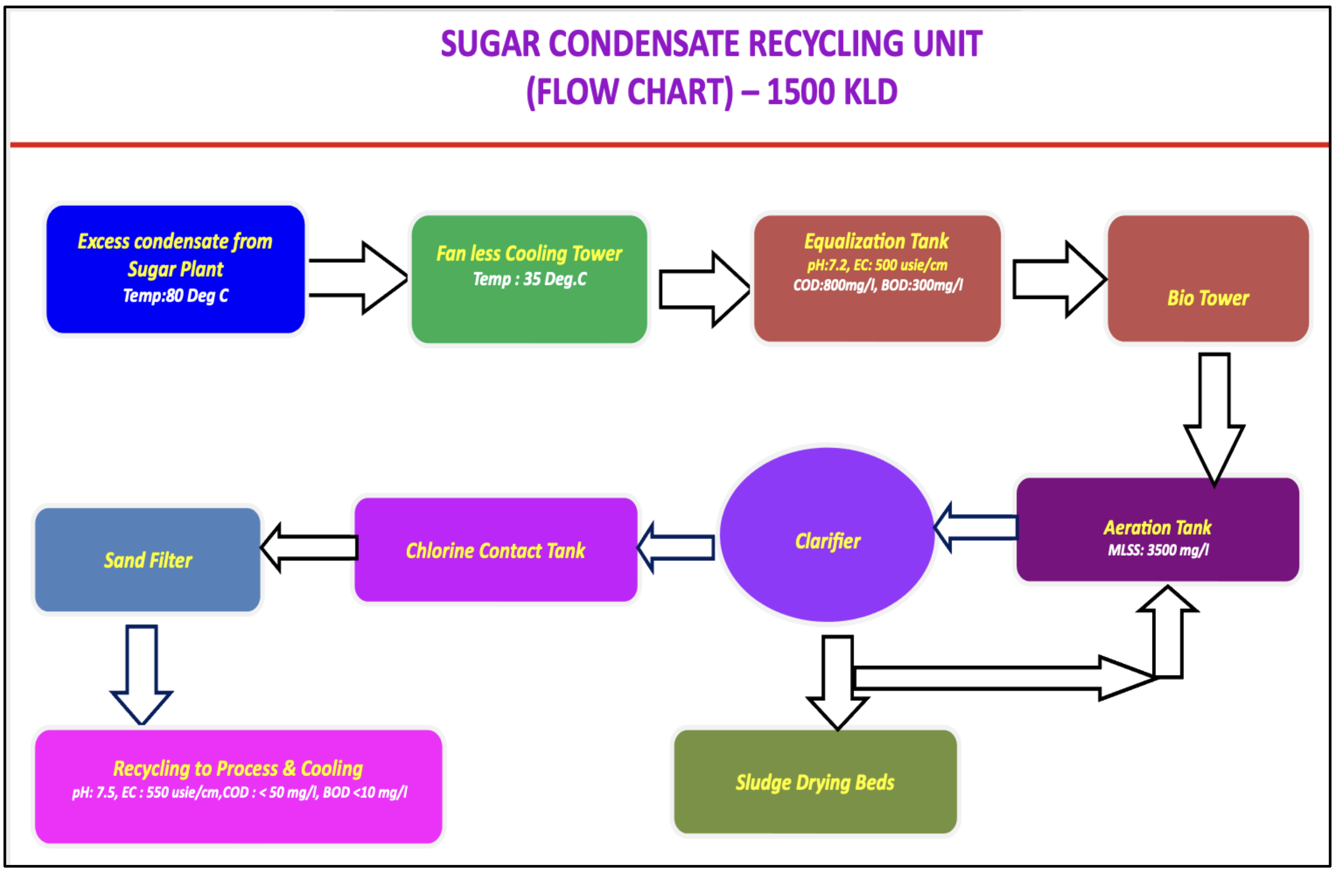
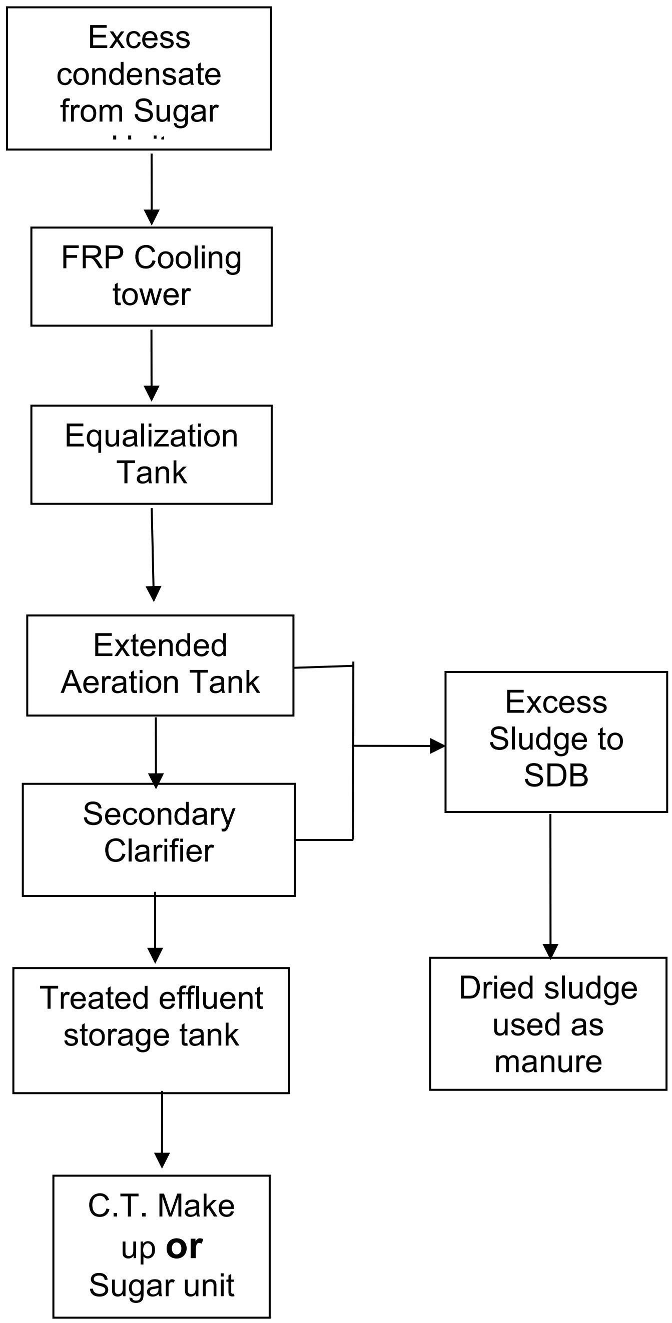


Figure 12: Showing the process flow of Sugar Condensate Recycling plant in NSL Sugars Aland Unit

SCHEMATIC DIAGRAM OF CONDENSATE POLISHING UNIT



a) Excess Condensate from Sugar Unit:

Condensate generated from various stages of sugar manufacturing, particularly from evaporators and pans, is collected as excess condensate. Although relatively clean, this condensate contains traces of sugars, dissolved organic matter, and volatile compounds, making it unsuitable for direct reuse. Therefore, it is routed to the condensate polishing unit for treatment and recovery.

b) FRP Cooling Tower:

The hot condensate is first passed through an FRP (Fibre Reinforced Plastic) cooling tower to reduce its temperature. Cooling is essential to create favourable conditions for subsequent biological treatment processes and to prevent thermal shock to microorganisms responsible for degrading organic contaminants.

c) Equalization Tank:

The cooled condensate is then transferred to the equalization tank, which acts as a buffer to balance fluctuations in flow rate and pollutant concentration. Continuous mixing in the tank ensures a homogeneous wastewater stream, thereby providing a steady and uniform feed to the downstream treatment units.

d) Extended Aeration Tank:

From the equalization tank, the condensate enters the extended aeration tank where air is supplied continuously through diffusers or aerators. Under aerobic conditions, microorganisms metabolize the dissolved and suspended organic matter present in the condensate, resulting in a significant reduction in BOD and COD. The extended retention time enhances the treatment efficiency and ensures stabilization of the wastewater.

e) Secondary Clarifier:

The mixed liquor from the aeration tank is conveyed to the secondary clarifier, where biological solids settle under gravity. The clarified water overflows from the top and is collected for reuse, while the settled sludge is concentrated at the bottom. A portion of the sludge is recirculated to maintain an adequate microbial population in the aeration tank, and the excess sludge is withdrawn for further handling.

f) Excess Sludge to Sludge Drying Bed:

The excess sludge generated during the biological treatment process is directed to sludge drying beds. In these beds, moisture is removed through evaporation and drainage, resulting in a reduction in sludge volume and facilitating its handling and disposal.

g) Dried Sludge Used as Manure:

After sufficient drying, the stabilized sludge contains organic matter and nutrients that make it suitable for use as manure or soil conditioner. Its beneficial reuse contributes to resource recovery and supports sustainable waste management practices.

h) Treated Effluent Tank:

The clarified water obtained from the secondary clarifier is collected in the treated effluent tank, which serves as a storage and balancing reservoir. This tank ensures a continuous supply of treated water and allows for monitoring of water quality parameters before reuse.

i) Cooling Tower Makeup for Sugar Unit:

Finally, the treated condensate is reused as cooling tower makeup water within the sugar plant. Recycling the treated condensate reduces freshwater consumption, minimizes wastewater discharge, and promotes efficient water management, thereby contributing to the sustainability and resource conservation goals of the sugar mill.

For Scope-2

Plant Area Assessment for Rainwater Harvesting

The topography, climate, soil, land use and hydrogeological conditions are important factors controlling the suitability of an area for ground water recharge. The prevalent topography, soil and land use conditions determine the extent of infiltration, whereas the hydrogeological conditions govern the occurrence of potential aquifer systems and their suitability for artificial recharge. The Layout Plan of NSL Sugars Aland Unit Is presented in **Figure 13**.

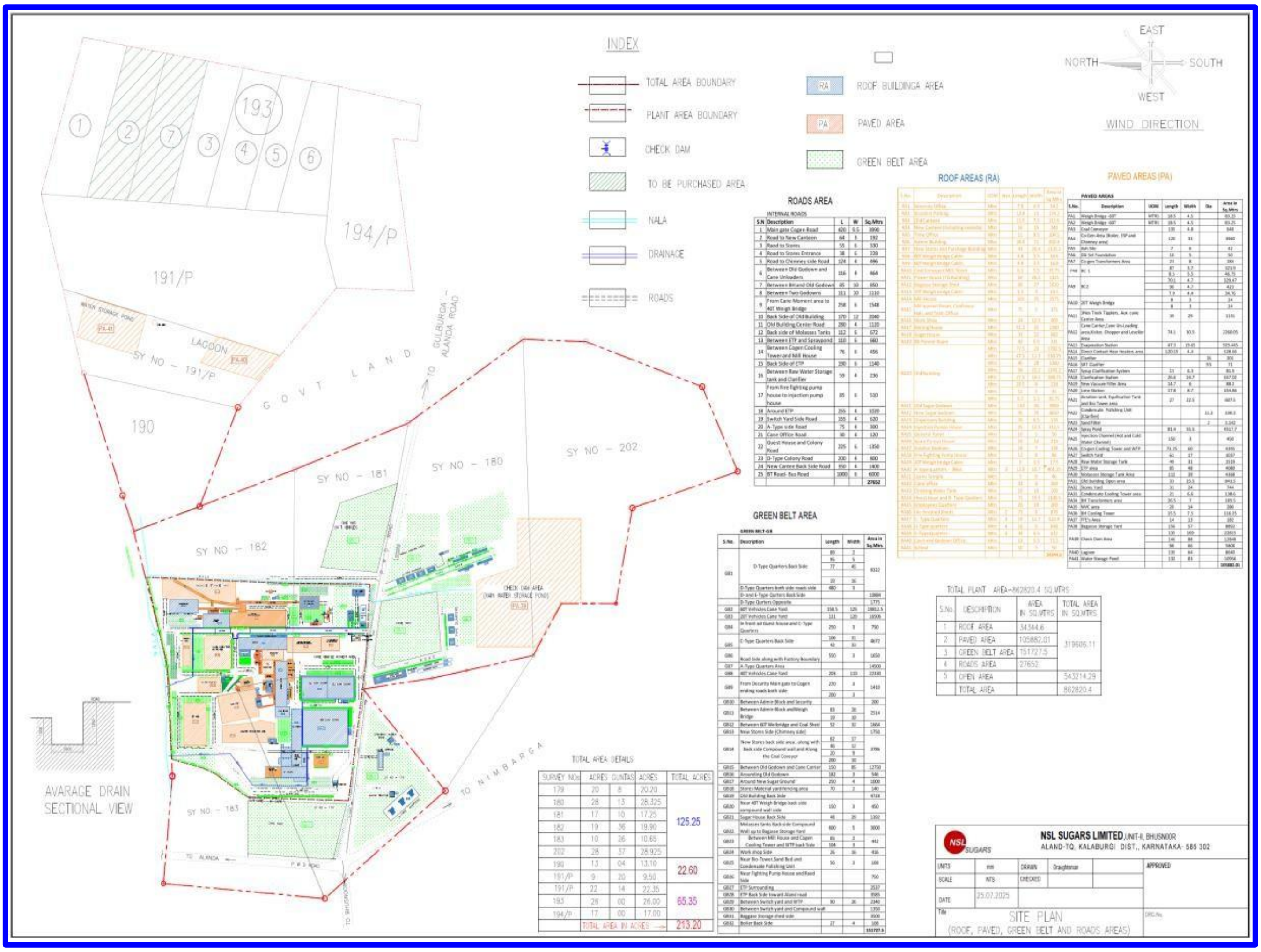


Figure 13: Layout plan of NSL Sugars Aland Unit

1.1 Topography of Plant Layout

The topography of the plant area is assessed based on the topographic contour map. From the data provided, it is found that the topography is varying from a higher altitude of **485 m** in **the east side** to a lower altitude of **458 m** in the **west side**. However, the general **master slope** of the plant is towards the **West to East direction** of the plant. Based on the altitude, slope, and topography and to avoid the potential contamination areas, the Plant has been divided into 4 catchments. The contour map of the plant is given in **Figure 14**. The existing drains are shown in **Figure 15.**

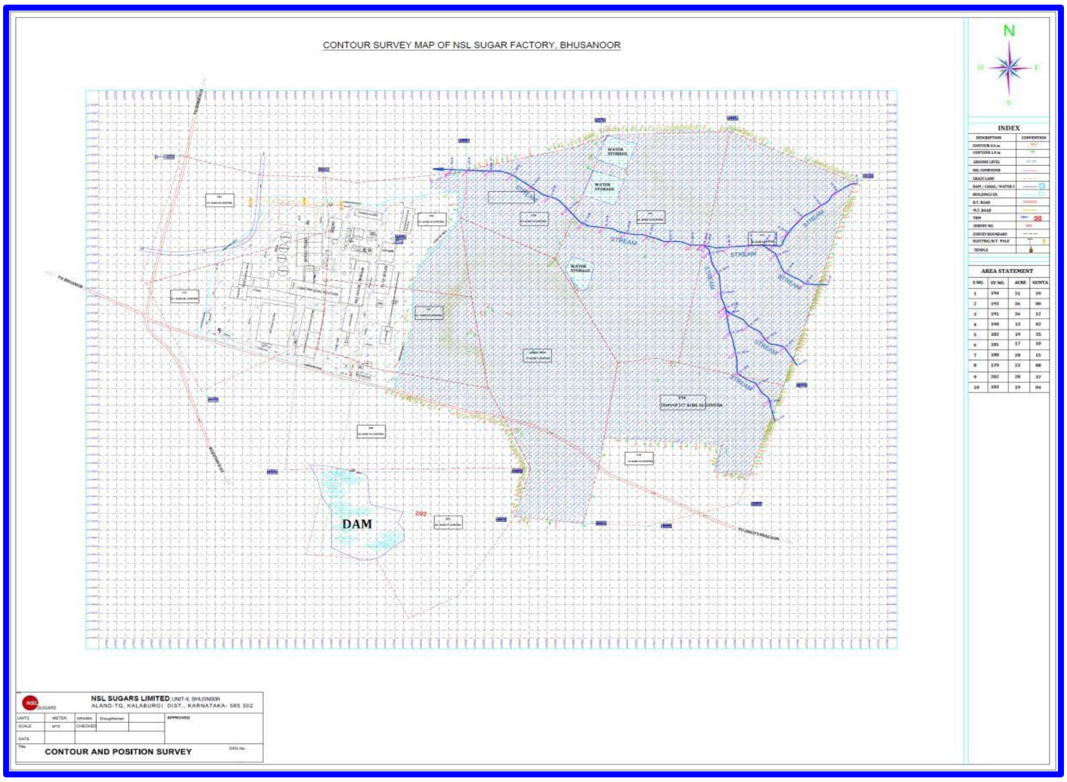


Figure 14: Contour Map of NSL Sugars Aland Unit

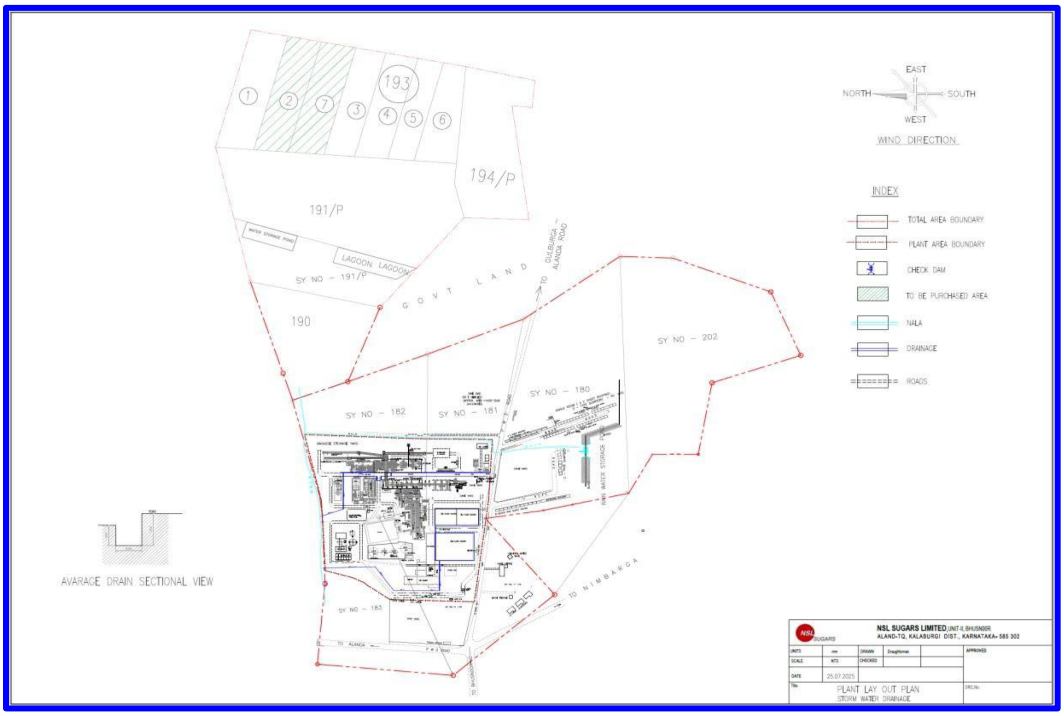


Figure 15: Plant Layout with Drains of NSL Sugars Aland Unit

1.2 The Catchment Characteristics

The catchment characteristics of the area have been analysed concerning its land use, topography, physiography, precipitation and climatic factors. Based on these factors it has been analysed that whenever the storm occurs, a portion of rainfall infiltrates into the ground, some portion evaporates and the rest flows as runoff through drains. Since the catchments possess a variable slope the flow over the land surface flows as a sheet of water (Overland flow) and joins to the drain. Thus, the rainwater, over the land surface and under the land surface will create the hydraulic gradient towards the drain. On the other hand, because of this overland flow through different puddles, pits and potholes and joins in the low-lying areas forms as depression areas. Such depression areas have been selected and utilized for water harvesting structures and recharge measures. **Catchment-1 to Catchment-4** as demarcated and mentioned are shown in Google Map in **Figure 16**.

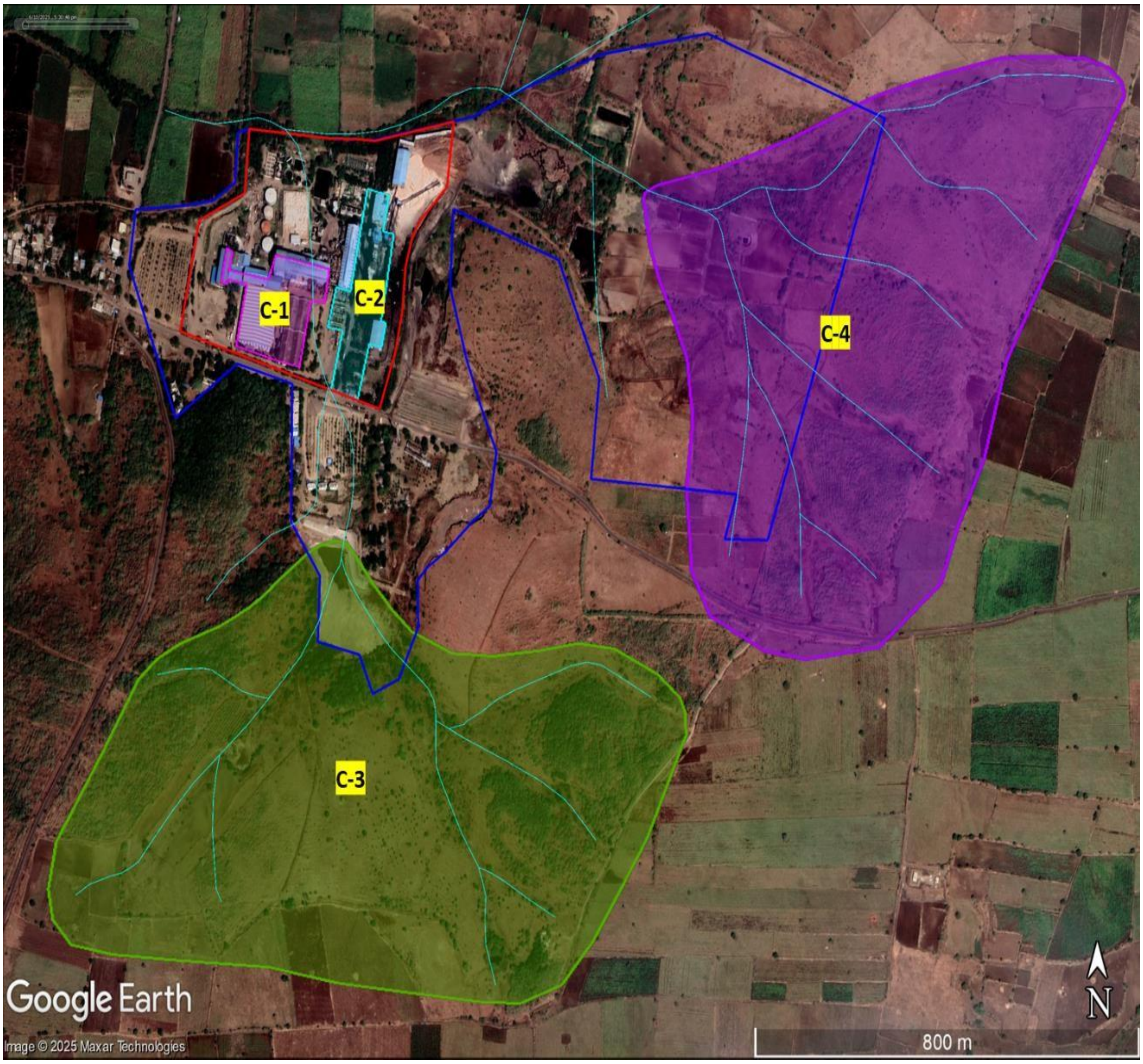


Figure 16: Catchments on google earth, NSL Sugars Aland Unit

1.3 Assessment of Existing Structural Units

On-site investigations were conducted in an entire plant to know and assess the different types of catchments, existing within the plant and structural units to manage the rainwater harvesting potential from each catchment area i.e., Hard surface (Paved Area) and soft surface (Non-Paved Area). It is observed that the entire plant area (213.20 acres) had been divided with different catchments depending upon the slope of the Plant area viz., Cement Concrete (CC) roads, buildings with RCC roofs and asbestos/iron (GI) sheets, open area/greenbelt etc. However, as there is a tremendous scope to harvest the rainwater/runoff from both hard surfaces and soft surfaces, it can appropriately be collected for utilisation or can be recharged to an underground aquifer. The catchments identified and existing structural components like roofs, buildings, roads, greenbelt and open areas have been computed catchment-wise and are given in **Figure 16 and Table 12**

Catchment-1 (C1)		
S. No.	**Description**	**Area in m^2**
Built-Up Area		
1	Boiler House	1140
2	Sugar House	341
3	Old Building	2714.87
4	Old Sugar Godown	4950
5	New Sugar Godown	6650
Sub Total		15795.87
Road & paved Area		
6	Paved area	4,355
Sub Total		4,355
Green Belt / Open Area		
7	Open / Green	4,355
Sub Total		4,355
Total		**24,506**
Catchment-2 (C2)		
Sl No	**Description**	**Area in m^2**
Built-Up		

1	Security Office	34.2
2	Scooter Parking	174.2
3	Old Canteen	111.6
4	New Canteen	240
5	Time Office	104.5
6	Admin Building	202.4
7	New Stores and Purchase Building	1135.2
8	60T Weigh Bridge Cabin	16.8
9	60T Weigh Bridge Cabin	16.8
10	Coal Conveyor MCC Room	35.75
11	Power House (TG Building)	1325
12	Bagasse Storage Shed	1620
Sub Total		5016.45
Road		
13	Paved area	9,933
Sub Total		9,933
Green Belt / Open		
14	Open / Green	9,933
Sub Total		9,933
Total		**24,883**
Catchment-3 (C3)		
S.No	**Description**	**Area in m^2**
1	Open & Greenbelt	686054
Total		**686,054**
Catchment-4		
S.No	**Description**	**Area in m^2**
1	Open & Greenbelt	630338

Total	630,338

Table 12: Details of the Catchment -1 to 4 land use Surfaces in NSL Sugars Aland Unit

Each structural component in the catchment is subdivided into different types of roofs like RCC, Asbestos/GI sheet, and Cement concrete (CC) surfaces i.e. pavement area, green belt and open areas.

The consolidated figures of each catchment are presented in **Table 13.**

Land Use		Roofs	Paved area	Open Area	Catchment Wise	
		RCC, Asbestos / G.I Sheet in m^2	CC / BT in m^2	Green Belt / Open /Parkin m^2	Total Area in m^2	Remarks
Catchment	C1	15796	4355	4355	24506	Factory area within the compound
	C2	5016	9933	9933	24882	
	C3	-	-	686054	686054	Factory area, outside the compound
	C4	-	-	630338	630338	
Total Area		**20,812**	**14,288**	**1,330,680**	**1,365,780**	

Table 13: Consolidated Details of the catchment-wise land use Surfaces in NSL Sugars Aland Unit

1.4 Assessment of the Existing Strom water Structures

The storm water drains are well laid as per the requirement following the slope the plant area. The existing drains are shown in **Figure 17** and the existing recharge and storage structures are presented in **Figure 19.**

Storm Water Drains: Stormwater drain systems are existing covering major plant area to make way for the runoff created due to rainfall, especially in the Plant area. All the drains have been assessed based on the topography data available for the plant and from the existing stormwater drains, for which the carrying capacity of stormwater generated in the plant premises is also analysed. In general, found that all the existing stormwater drains have appropriate slopes for carrying runoff generated to the average rainfall of the area. The existing layout of the stormwater drains in the premises is clearly shown in **Figure 17** with the direction of flow. Based on the observations majority of stormwater drains are well laid, however, these drains are filled with sand and waste materials and the top level of the drain is much below the road level as the vehicle movement and road area hight is increased. Due to the reason of soil, dust and organic waste is entering in to the drains along with the storm water and entering in to the drains. As such the drains are very poorly maintained. It is observed that 80% 0f the existing drains levels need to be raised to maintain them properly.

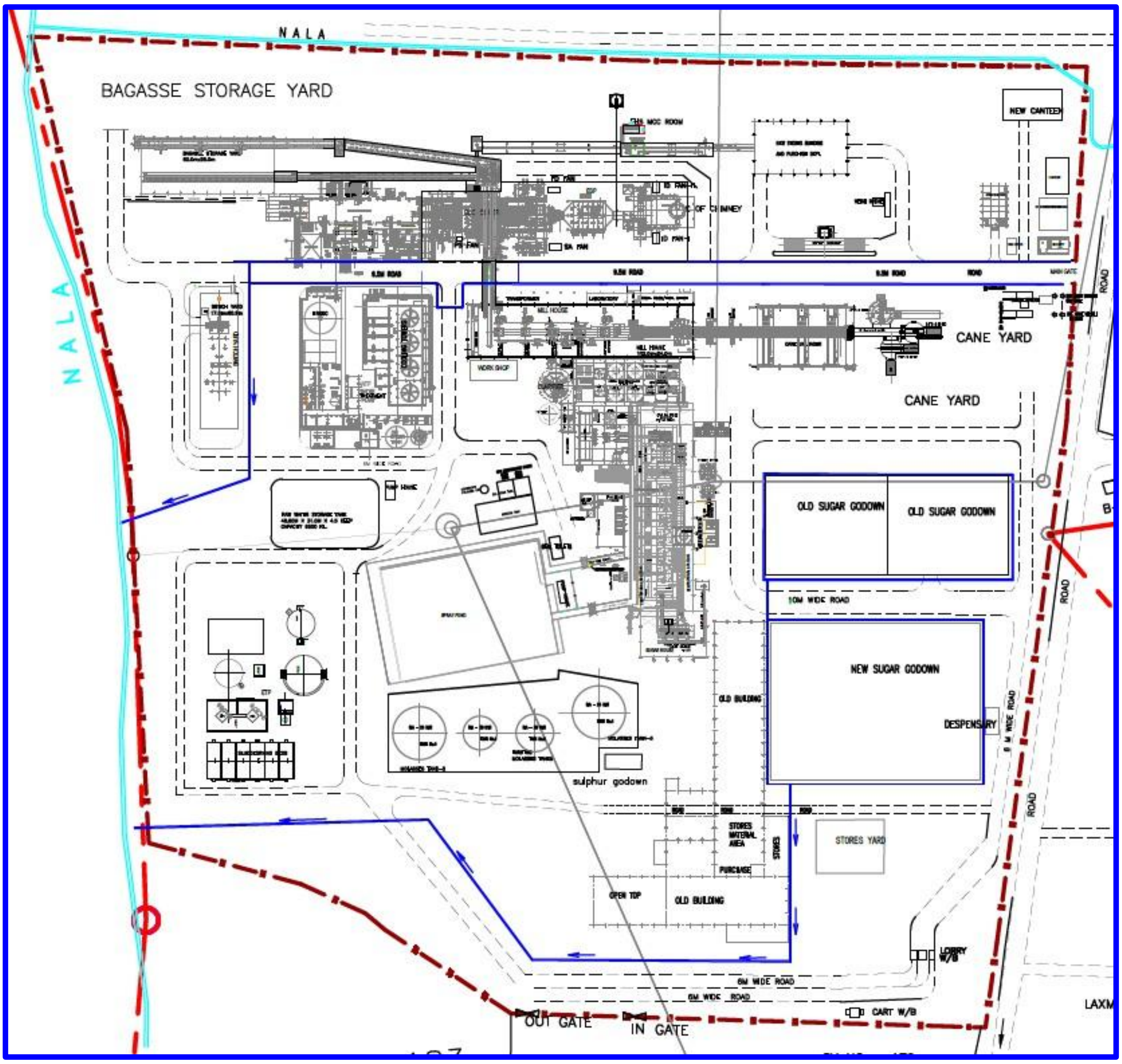


Figure 17: Existing Stormwater Drains in NSL Sugars Aland Unit

Existing Pond with Check Dam: It is located in the Southern part of the plant area outside the plant premises. This structure is constructed by the plant in their own premises for storing and recharging the water simply wasting through the natural drain. Major portion of this catchment is from outside the plant area belongs to forest and agriculture land, it is completely an open area with green belt. The Existing Pond with Check Dam capable storing to an extent of 200000m^3 of water as in **Figure 18** below.

Figure 18: Site image of check dam, which is located at Aland unit premises

Existing Pond-1: The existing pond is located in north central part of the northern boundary of the Plant area. Rainwater Pond 1 covering an area of about 5843m^2 with 3.0 m depth, to store rainwater of about 18000m^3. Without having the proper consideration of generation of runoff from the catchment this pond has been constructed to store the water and reuse and recharge the same. During rainy season, the water is being diverted from the water from natural stream passing adjacent to this pond by constructing temporary bund and allowing it to enter in to recharge pond to recharge.

Existing Pond-2: The existing pond-2 is located just north of the existing pond-1. Rainwater pond 2 is also covering an area of about 7169m^2 with 4.0m depth, to store rainwater of about 30000m^3. Since it is located in the higher elevation and don't have any catchment runoff into this pond. During rainy season plant has tried to divert the water from natural stream passing adjacent to the pond -1 by constructing temporary channel but it was not successful and rain water was unable enter in to the Pond-2, as the pond is located relatively in higher elevation to the stream.

Pond Proposed of treated ETP water: This pond is constructed to store and reuse the treated wastewater since it is unlined, and if the water is not treated properly will become problem so KSPCB has raised the concern and suggested to close the pond if it is not maintaining properly. Now it is suggested to maintain its shape properly and go for HDPE lining system to avoid the seepage of water into subsurface. Properly treated wastewater as per the PCB norms shall be stored in the HDPE lined pond and reuse the same into the greenbelt maintenance cleaning and other purposes.

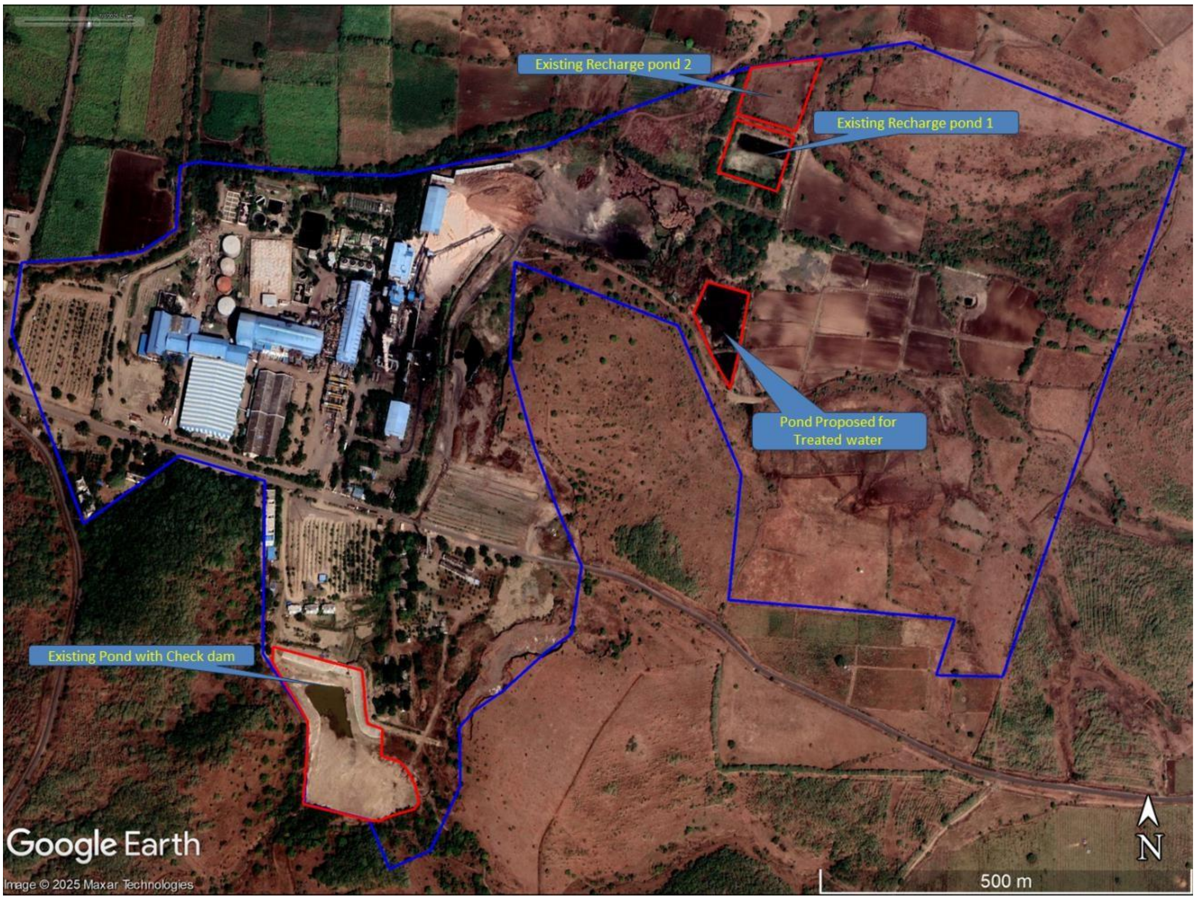


Figure 19: Location of Existing Rain Water Harvesting Structures in The Plant Area

There is one Check Dam constructed with the storage capacity 150000 m^3 and two storage ponds of 29000 m^3 and 18000 m^3 within their land for the purpose of recharge. The rainfall runoff generated in the plant as well as outside area also comes into the plant area is also captured and stored in these ponds. If we consider one time storage of these structures is recharged to the groundwater in a year, the quantity of the minimum rainwater that gets recharged in a year would be around 1,97,000 m^3 per year. However, it is also possible to recharge more than one time storage capacity in a year due to good rainfall (Generally these ponds are filled 2 to 2.5 times in a year to the normal rain fall), then the recharge quantity would be much more than 2,07,000 m^3 in a year with these three recharge structures. These structures not only augment the plant bore well, but also surrounding agriculture and drinking water bore wells.

Similarly, the rooftop rain water is collected through down pipes, channels and stored in a RCC tank to the tune of 40,821 m^3/year and being utilized for cooling towers as long as harvested water is available as shown in **Figure 20**. There after these waters again reused for green belt cleaning purposes etc.

Figure 20: Pipeline arrangement for Rooftop harvesting in Aland unit

Figure 21: A RCC water tank arranged to collect rooftop rainwater during the rainy season

On the whole minimum rain water harvested and recharged due to 3 recharge ponds and rooftop harvesting is 2,31,821 m^3/year. The fresh water requirement to the plant after expansion is around 2940 KLD. Thus, the total water harvested is equivalent to 82 days fresh water requirement of the plant that reduces the cost on water and saves the precious water resource.

A.9. Implementation Benefits to Water Security

For Scope-5- Key Benefits:

a) Ensures regulatory compliance by effectively reducing Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), and other pollutants in wastewater before discharge or reuse.
b) Protects water resources and ecosystems by preventing contamination of surface water, groundwater, and surrounding soil through effective wastewater treatment and management.
c) Promotes circular economy practices through resource recovery, including treated water reuse, hot condensate recovery, biogas generation, and bio-compost production.
d) Reduces freshwater consumption by maximizing the reuse of treated effluent and recovered condensate water, thereby minimizing dependence on groundwater and external water sources.
e) Enhances water security and climate resilience by ensuring sustainable water availability and reducing operational risks associated with water scarcity.
f) Optimizes water and energy efficiency through water recycling, process optimization, and recovery of thermal energy from hot condensate, resulting in reduced energy consumption and operating costs.
g) Minimizes the overall environmental footprint by reducing wastewater generation, pollutant discharge, freshwater abstraction, and associated greenhouse gas emissions.
h) Improves operational efficiency and cost savings by lowering water procurement costs, reducing wastewater treatment and disposal expenses, and enhancing resource utilization.
i) Strengthens Environmental, Social, and Governance performance by demonstrating responsible water stewardship, sustainable resource management, and alignment with corporate sustainability objectives.
j) Supports long-term sustainable industrial growth by integrating efficient water management practices, ensuring regulatory compliance, conserving natural resources, and contributing to the achievement of sustainability goals and relevant Sustainable Development Goals (SDGs).

For Scope-2 Key Benefits:

a) Maximizes rainwater utilization by harvesting and storing rainfall within the plant premises, reducing the loss of a valuable natural resource.
b) Reduces surface runoff and minimizes the loss of rainwater while preventing waterlogging and localized flooding during heavy rainfall events.
c) Enhances groundwater recharge, contributing to improved groundwater availability and long-term water security.
d) Reduces dependence on external water sources and minimizes stress on groundwater aquifers through sustainable water resource management.
e) Strengthens resilience to water scarcity and climate variability by ensuring reliable water availability during lean seasons and drought conditions.
f) Improves groundwater and nearby surface water quality through natural filtration, recharge, and reduced pollutant transport.
g) Prevents soil erosion and enhances soil moisture, supporting greenbelt development, vegetation growth, and improved land productivity.

h) Promotes biodiversity conservation by maintaining ecological balance and supporting healthy terrestrial and aquatic ecosystems within the project area.
i) Improves catchment and stormwater management by facilitating efficient collection, storage, and utilization of rainwater resources.
j) Supports long-term environmental sustainability by promoting integrated water resource management, climate resilience, regulatory compliance, and responsible water stewardship

A9.1 Objectives vs Outcomes

For Scope-5

Objective: The project aims to promote sustainable water resource management by treating and reusing wastewater generated from sugar and distillery operations, along with recovering and utilizing hot condensate water. The objective is to minimize freshwater withdrawal, reduce pollutant discharge, improve energy efficiency, enhance compliance with environmental regulations, and mitigate adverse impacts on surrounding ecosystems and communities through efficient water and waste management practices.

Outcome: The project has successfully established a circular water management approach wherein high-strength effluents are effectively treated and reused, resulting in substantial reductions in COD, BOD, and other contaminants before discharge. Reuse of treated wastewater and hot condensate has significantly reduced freshwater consumption and overall effluent generation while improving energy efficiency by utilizing the thermal energy available in condensate streams. The project has enhanced environmental performance, minimized odour and nuisance in the surrounding areas, reduced risks of soil and water contamination, and ensured compliance with applicable environmental standards. Collectively, these interventions have contributed to improved ecosystem health, sustainable water use, and a lower environmental footprint of the sugar and distillery operations.

For Scope-2

Objective: The project aims to conserve and sustainably utilize rainwater through the implementation of a scientifically designed rainwater harvesting system comprising multiple catchment areas. The objective is to augment groundwater resources, reduce stormwater runoff, improve water quality, strengthen water security, and enhance ecological balance by promoting efficient capture, storage, and recharge of rainwater.

Outcome: The project has effectively captured and utilized monsoon runoff, thereby enhancing groundwater recharge and improving the availability of water during lean periods. Reduced surface runoff has minimized soil erosion, waterlogging, and the risk of inundation in nearby areas, while also preventing pollutants from entering surrounding water bodies. The recharge process has contributed to improved groundwater quality through natural filtration and dilution mechanisms, supporting sustainable water availability and reducing dependence on external water sources. Increased soil moisture and improved catchment management have strengthened vegetation cover and ecological health, thereby supporting biodiversity and maintaining the overall environmental balance of the project area.

A9.2 Interventions by Project Owner / Proponent / Seller

For Scope-5

Interventions by Project Owner for ETP plant:

1. **Regular Monitoring and Maintenance:** Ensuring continuous monitoring of wastewater quality, system performance, and compliance with environmental standards through automated systems and regular inspections.
2. **Resource Recovery:** Implementing systems to recover biogas, treated water, or compost from the effluent treatment process, which adds value and reduces overall operational costs.
3. **Training and Skill Development**: Conducting regular training sessions for staff to ensure efficient operation and maintenance of the ETP, improving both performance and compliance with regulations.
4. **Compliance with Regulatory Standards**: Regularly updating the ETP to comply with evolving environmental regulations and local pollution control board requirements, ensuring sustainable operations.
5. **Public Awareness and Engagement:** Collaborating with local communities to raise awareness about the importance of ETP and its benefits for environmental protection and public health.
6. **Optimization of Chemical Usage:** Implementing strategies to optimize the use of chemicals in the treatment process, reducing operational costs and minimizing chemical waste.
7. **Zero Liquid Discharge (ZLD) Implementation:** Working towards a ZLD approach to ensure that no wastewater is discharged into the environment, promoting water reuse and reducing environmental impact.

Interventions by Project Owner for Use of Condensate water in plant:

1. **Infrastructure Upgrade:** Installed piping and storage systems to collect and transport hot condensate from process areas.
2. **Heat Recovery Systems:** Integrated heat exchangers to utilize thermal energy from hot condensate in preheating operations.
3. **Water Reuse Integration:** Modified existing processes to allow direct reuse of hot condensate as boiler feed water or for cleaning.
4. **Monitoring Systems:** Implemented flow meters and temperature sensors to monitor condensate recovery and reuse efficiency.
5. **Training & SOPs:** Conducted staff training and developed standard operating procedures for effective condensate management.
6. **Sustainability Alignment:** Ensured alignment of interventions with corporate water conservation and sustainability goals

For Scope-2

NSL Group identified huge potential and decided to take up the rainwater harvesting in project as discussed in above sections to conserve and store the rainwater and avoid the storm runoff.

1. **Installation of RWH Structures:** Project owners establish dedicated rainwater harvesting systems, such as recharge wells, ponds, and surface collection tanks, to capture and store rainwater during the monsoon season.
2. **Catchment Area Development:** They improve and maintain catchment areas, including roofs, paved surfaces, and surrounding land, to maximize rainwater collection potential.
3. **Filtration and Pre-treatment Systems:** Installing filtration units and first flush diverters to ensure clean and safe water storage, preventing contamination from debris or pollutants.
4. **Groundwater Recharge:** Implementing systems like recharge wells or pits to direct harvested rainwater into the ground, replenishing local aquifers and improving groundwater levels.
5. **Water Quality Monitoring:** Regular testing of stored rainwater to ensure its quality is suitable for reuse in plant operations or irrigation, meeting health and environmental standards.
6. **Reuse of Harvested Rainwater:** The harvested water is utilized for various plant needs, such as cooling systems, irrigation, cleaning, or non-potable uses, reducing dependence on external water sources.
7. **Monitoring and Optimization:** Using digital tools and sensors to monitor rainfall patterns, water levels, and system efficiency, enabling timely interventions and optimization of water collection.
8. **Sustainability Initiatives:** Aligning the rainwater harvesting strategy with broader sustainability goals, such as reducing the plant's water footprint, conserving local water resources, and supporting the community's water needs.

These interventions help to conserve water, reduce dependency on external sources, and promote sustainable water management within the sugar and distillery industry.

A.10. Feasibility Evaluation

For Scope-5

The installed ETP and condensate water recovery system by the project owner are robust and effectively handle variations in wastewater effluent. Prior to project implementation, a feasibility study was conducted in accordance with Karnataka State Pollution Control Board guidelines.

For Scope-2

The rainwater harvesting system installed by the project owner is robust and capable of managing heavy rainfall events. The catchment areas are well-graded to ensure efficient runoff collection, and the storage infrastructure is of high quality.

A.11. Ecological Aspects & Sustainable Development Goals (SDGs):

For Scope-5

This project demonstrates sustainable management and efficient utilization of water resources by treating and reusing ETP effluent and condensate water, thereby reducing dependence on groundwater extraction and conserving millions of litres of freshwater for distillery operations. The project also minimizes ecological impacts by preventing inundation of inhabited areas, reducing the risk of waterlogging and associated vector-borne diseases, and safeguarding groundwater quality through effective effluent treatment and the use of impervious infrastructure that prevents seepage and soil contamination. The initiative serves as a model for sustainable captive water management across water-intensive industries.

The ETP effectively treats the distillery effluent, and the use of impervious machinery within the ETP area further safeguards against potential leakage and contamination of surrounding soil.

For Scope-2

Rainwater harvesting is an environmentally sustainable practice that conserves water, enhances groundwater recharge, and supports ecosystem preservation. Its key ecological benefits include:

- Replenishes aquifers and reduces dependence on borewells and other groundwater sources, promoting sustainable water availability.
- Reduces surface runoff, thereby preventing soil erosion, inundation of inhabited areas, and waterlogging that can lead to vector-borne diseases.
- Improves groundwater and surface water quality by minimizing the entry of pollutants into water bodies.
- Supports aquatic ecosystems, biodiversity conservation, and the development of water-sensitive urban environments with minimal ecological disturbance.

SDGs Impacted- Linkage of the project activities with SDGs:

SDG 6	Clean Water and Sanitation – Enhances water availability, quality, and accessibility through harvesting, recharge, or conservation.
SDG 8	Decent Work and Economic Growth – Generates local employment during project implementation and maintenance.
SDG 12	Responsible Consumption and Production – Promotes sustainable use and management of natural resources.
SDG 13-	Climate Action – Contributes to climate resilience and adaptation by reducing water stress and improving local hydrological balance.
SDG 15	Life on Land – Supports ecosystem restoration, soil moisture retention, and biodiversity through improved water balance.

A.12. Recharge Aspects:

For Scope-5

Not Applicable, since this aspect does not lead to any recharging and storing facility for a long time for the water recycled.

For Scope-2

For the rainwater harvesting systems (RWH) indirectly contribute to recharging the bore wells within the project area and reduce the storm water flow in the area. First flushing device and sand filters and storm water conveyance system is implemented to prevent any contamination and maintain the quality of water before it enters the recharge areas. Consequently, the bore wells in the region are filled with water during the non-monsoon season, indicating successful groundwater recharge.

A.12.1 Solving for Recharge

For Scope-5

Water Budget Component	Typical Estimated Uncertainty (%)	Description
Surface Inflow	NA	NA
Precipitation	NA	NA
Surface Outflow	NA	NA
Evapotranspiration	NA	NA
Change in Storage	NA	NA
Deep Percolation	NA	NA

For Scope-2

Recharge = Rainfall + Surface Inflow – Evapotranspiration – Surface Outflow – Change in Storage

Evapotranspiration & Other Data: https://datameet-pune.github.io/open-water-data/docs/open-water-data-paper.pdf (or available under Documents Section- Water Data Guide)

Water Budget Component	Typical Estimated Uncertainty (%)	Description
Surface Inflow	1%	Typical range of accuracy from meters to minimum delivery accuracy requirements of delivery and diversion measurement devices.
Precipitation	2%	Typical range of accuracy from field-level rain gauges to extrapolation of local weather station data

Surface Outflow	1%	Typical range of accuracy from meters to estimated outflow relationships
Evapotranspiration	10%[4]	Clemmens and Burt, 1997; typical accuracy based on free water surface evaporation coefficient.
Change in Storage	5%	Estimated accuracy of change in storage calculation based on field scale water budget calibration to observed water levels.
Deep Percolation	5%	Typical range of calculated accuracy from field-scale water budget results (fields ranging from 56 to 125 acres)
Total	25%	

A.13. Quantification Tools

The following tools are recommended to be used to estimate the quantity of RoUs in the absence of tamperproof flow meters or systems that accurately quantify the volume in litres or m^3 of water being harvested or conserved by the project activity.

For Scope-5

The baseline scenario is the situation where, unutilized water is not conserved/treated/recycled and water is extracted from multiple bore wells within the project boundary which would have depleted the local groundwater resources (aquifers), in the absence of the project activity, the water for distillery process, gardening and other plant facilities usage would have been extracted from the ground water which have been avoided with the ETP implementation and reuse of condensate water installed within the project boundary.

Hence, the quantity of RoUs estimated as: *"the net quantity of treated wastewater that is gainfully used post treatment."*

Option -2 as per Rainwater Offset Standard version 8.1 is used and stated as:

Harvested/Recycled unutilized water or Volume of sea water utilized (m3) = Quantity of treated or recycled water in liters treated or harvested or volume of the artificial holding tank (1m^3 = 1000 liters).

The net quantity of treated water used is measured via flow meters installed at the site.

Further, as per *Rainwater Offset Standard version 8.1* a Conservative Approach: *The UWR RoU Verifier is recommended to apply a **10-50%** uncertainty factor related to degree of uncertainty to the final quantity*

[4] Since the harvested rainwater is utilized immediately and not stored for extended periods, and the flow distance within the project area is minimal, the potential for evaporation losses is significantly reduced. Therefore, a lower evaporation factor has been considered for the calculation than recommended.

of RoUs calculated for vintage years 2014-2021. However, a more conservative approach to uncertainty may be selected by the RoU Verifier as per its discretion.

An uncertainty factor of 0.5% has been considered for the entire monitoring period from 01/01/2014 to 31/12/2025 for Scope 5 project. This factor reflects the high accuracy of the water flow measurements, which are obtained through calibrated flow meters with a standard accuracy of 0.5%. As these meters operate with minimal scope for manual intervention, the measurement process is free from human error and ensures consistent reliability throughout the monitoring period. Accordingly, the uncertainty factor has been derived based on this, representing a realistic and technically justified estimation.

The sugar ETP and CPU Unit data for the treated water and ROUs generated[5] is represented in the Table-14 below:

Year	Water treated in CPU Unit (m3)	Water treated in STP Unit (m3)
2014	92562	33330
2015	199082	63770
2016	207922	90485
2017	76177	32399
2018	45225	19660
2019	121941	46884
2020	90266	33614
2021	84771	30350
2022	129534	49819
2023	187470	87020
2024	196793	58080
2025	193254	84157
ROUs	**1624996**	**629568**
Total ROUs	**2254564**	
Final ROUs after uncertainty factor of 0.5%	**2243291**	

Table 14: Total RoUs for Scope-5 of NSL Sugars Aland Unit

[5] For the calculations, please refer ER Sheet

For Scope-2

The baseline scenario is the situation where, unutilized water is not harvested into a well/aquifer/sub-surface structure/above-ground storage tank/collection chamber, in the absence of the project activity, the water for gardening and other plant facilities usage would have been extracted from the ground water which have been avoided with the rainwater harvesting method installed within the project boundary.

Hence, the quantity of RoUs is estimated as: *"the net quantity of rainwater harvested that is gainfully used in some other plant activity"*

Option -1 as per Rainwater Offset Standard is stated as:

Harvested/Recycled unutilized water or Volume of water utilized (m3) = Area of Catchment/Roof/Collection Zone (m2) X Amount of rainfall (mm) X Runoff coefficient*Uncertainty Factor (1-0.25 = 0.75)

Further, as per *Rainwater Offset Standard version 8.1* a Conservative Approach: *The UWR RoU Verifier is recommended to apply a* ***10-50%*** *uncertainty factor related to degree of uncertainty to the final quantity of RoUs calculated for vintage years 2014-2021. However, a more conservative approach to uncertainty may be selected by the RoU Verifier as per its discretion.*

An uncertainty factor of 25% (0.75) has been considered for the entire monitoring period from 01/01/2014 to 31/12/2025 for Scope 2 project as per recharge aspect discussed in above section.

Water Harvesting Potential

Water harvesting potential of any catchment area is to be calculated under this methodology for each given year that the RoU is being claimed. The total amount of water that is received from rainfall over an area is called the rainwater legacy of that area. The amount that can be effectively harvested is called the water harvesting potential.

Assessment of Annual Rainwater Harvesting Potential (ARHP)

- Availability of source water is one of the basic prerequisites for taking up any rainwater harvesting and aquifer recharge scheme.
- The source of water available for aquifer recharge in the present case is only the rainfall-runoff which otherwise goes waste into local drains.
- A realistic assessment and quantification of the source water will help in designing the storage and recharge capacity of the RWH structures.
- The estimation of rainfall-runoff is made to quantify the water available for recharge, after all, losses.
- This estimated runoff will be used for the assessment of the size of the recharge structures.
- Though there are various methods to estimate the runoff, rational method is generally used as it is one of the most common and popularly used for small areas.
- The rational method is the sensible approach to determining the yield of a catchment by assuming the runoff coefficient.

- The **runoff coefficient** for various surfaces as per CGWB.
- Hence, based on each land use, its areas have been determined along with the corresponding runoff coefficient.
- The runoff coefficients established by CGWB[6], based on the field experiments are being used for the computation of rain water harvesting potential as listed in **Table No. 15**.
- Knowing the areas, runoff coefficient and average annual rainfall, the runoff from each land use has been determined. In this manner, all the land use, and open areas have been considered and cumulative runoff has been determined.
- The run-off coefficients for a different surface type are given in Table No. 15.

Different Surfaces	Runoff Coefficient (K)	Runoff Coefficient (K) used
Roof conventional (Flat)	0.7 to 0.8	0.7
Roof inclined (Sloping)	0.85 to 0.95	0.85
Concrete/Kota Paving	0.6 to 0.7	0.6
Gravel	0.5 to 0.7	0.5
Brick Paving	0.7	0.7
Parks and Farms	0.05- 0.3	0.3

Table No. 15: Details of Runoff Coefficient (CGWB) and in line with the recommended Runoff Coefficient (K) by UWR ROU latest Standard

The following is the rational formula adopted to determine the yield of the catchment byconsidering the above runoff coefficient:

Annual rainwater harvesting potential is given by V = K × I× A

Where, V=Volume of water that can be harvested annually in litres.

K = Runoff coefficient

I = Annual rainfall in (mm)

A = Catchment area in (m²

Based on the above method and using the land use pattern, estimated the Annual Rain Water Harvesting Potential (ARHP) for different areas. In this calculation of ARHP, the Average Annual Rainfall considered is **717.72 mm**[7]**.** The table indicates that there is a tremendous scope to harvest the rain water to the tune of **292,668,205.64 (l) liters** within plant premises as indicated in **Table 16.**

[6] http://cgwa-noc.gov.in/LandingPage/index.htm

[7] Please refer ER Sheet for calculation

Total Catchment	Type of Surface	Area Type	Gross Available Area in m2	Quantity of Runoff = V = K × I× A
	Landuse		A	V (l)
Rooftop Area	Roofs	Flat-RCC, Asbestos	20,812	10455983.49
Paved Area	Paved area	Concrete	14,288	6152841.44
Surface	Open Area	Green Belt/Park	13,30,680	286515364.20
			13,65,780	**292668205.64**

Table No. 16: Details of Annual Rain Water Harvesting Potential for Aland Unit

Quantification

The formula for calculation for harvesting potential or volume of water received or runoff produced or harvesting capacity is given as:-

Harvesting potential or Volume of water utilized (m^3) = Area of Catchment/Roof/Collection Zone (m^2) X Amount of rainfall (m) X Runoff coefficient

Year	Runoff Generated in Catchment 1			Total Harvested water-m3 (RoUs) in Catchment 1
	Roofs	Paved Area	Open Area	
2014	6852.15	1619.28	809.64	9281.06
2015	7936.86	1875.61	937.81	10750.28
2016	8410.11	1987.45	993.72	11391.28
2017	3971.75	938.59	469.29	5379.63
2018	7418.28	1753.06	876.53	10047.87
2019	9458.33	2235.16	1117.58	12811.07
2020	5667.92	1339.42	669.71	7677.06
2021	6921.81	1635.74	817.87	9375.41
2022	11352.43	2682.77	1341.38	15376.58
2023	10917.88	2580.08	1290.04	14787.99
2024	9407.47	2223.14	1111.57	12742.18
2025	6916.28	1634.43	817.22	9367.93
				128988.33

Table 17-1: RoUs generated from Catchment-1

Year	Runoff Generated in Catchment 2			Total Harvested water- m3 (RoUs) in Catchment 2
	Roofs	Paved Area	Open Area	
2014	2175.89	3693.29	1846.64	7715.82
2015	2520.34	4277.94	2138.97	8937.26
2016	2670.62	4533.02	2266.51	9470.15
2017	1261.22	2140.76	1070.38	4472.36
2018	2355.66	3998.43	1999.21	8353.31
2019	3003.48	5098.01	2549.01	10650.50
2020	1799.84	3054.99	1527.50	6382.33
2021	2198.01	3730.83	1865.42	7794.26
2022	3604.95	6118.93	3059.46	12783.34
2023	3466.96	5884.71	2942.35	12294.02
2024	2987.33	5070.60	2535.30	10593.23
2025	2196.26	3727.85	1863.93	7788.04
				107234.62

Table 17-2: RoUs generated from Catchment-2

Year	Runoff Generated in Catchment 3			Total Harvested water- m3 (RoUs) in Catchment 3
	Roofs	Paved Area	Open Area	
2014	0.00	0.00	127544.30	127544.30
2015	0.00	0.00	147734.87	147734.87
2016	0.00	0.00	156543.80	156543.80
2017	0.00	0.00	73929.18	73929.18
2018	0.00	0.00	138082.09	138082.09
2019	0.00	0.00	176055.18	176055.18
2020	0.00	0.00	105501.38	105501.38
2021	0.00	0.00	128840.94	128840.94
2022	0.00	0.00	211311.49	211311.49
2023	0.00	0.00	203222.92	203222.92
2024	0.00	0.00	175108.42	175108.42
2025	0.00	0.00	128738.03	128738.03

1772612.60

Table 17-3: RoUs generated from Catchment-3

Year	Runoff Generated in Catchment 4			Total Harvested water- m3 (RoUs) in Catchment 4
	Roofs	Paved Area	Open Area	
2014	0.00	0.00	117186.14	117186.14
2015	0.00	0.00	135736.98	135736.98
2016	0.00	0.00	143830.52	143830.52
2017	0.00	0.00	67925.22	67925.22
2018	0.00	0.00	126868.13	126868.13
2019	0.00	0.00	161757.34	161757.34
2020	0.00	0.00	96933.38	96933.38
2021	0.00	0.00	118377.48	118377.48
2022	0.00	0.00	194150.41	194150.41
2023	0.00	0.00	186718.72	186718.72
2024	0.00	0.00	160887.47	160887.47
2025	0.00	0.00	118282.93	118282.93

1628654.72

Table 17-4: RoUs generated from Catchment-4

Year	Runoff Generated in all Catchments				Total Harvested water- m^3 (RoUs)	Total ROUs after applying Uncertainty factor of 0.75 (RoUs)
	Catchment-1	Catchment-2	Catchment-3	Catchment-4		
2014	9281	7716	127544	117186	261727	196295
2015	10750	8937	147735	135737	303159	227370
2016	11391	9470	156544	143831	321236	240927
2017	5380	4472	73929	67925	151706	113780
2018	10048	8353	138082	126868	283351	212514
2019	12811	10650	176055	161757	361274	270956
2020	7677	6382	105501	96933	216494	162371
2021	9375	7794	128841	118377	264388	198291
2022	15377	12783	211311	194150	433622	325216
2023	14788	12294	203223	186719	417024	312768

2024	12742	10593	175108	160887	359331	269498
2025	9368	7788	128738	118283	264177	198133
Total	**128988**	**107235**	**1772613**	**1628655**	**3637490**	**2728118**

Table 18: Total RoUs generated for Scope-2 of NSL Sugars Aland Unit

Final ROUs from Both Scopes (Scope 2 & Scope 5) are as follows:

Final Vintage wise RoUs Calculation				
Year	**Water treated in CPU Unit (m3)**	**Water treated in ETP Unit (m3)**	**Total Harvested water- m3 (RoUs)**	**Vintage wise ROU achieved**
	Scope-5		**Scope 2**	
2014	92099	33163	196295	321558
2015	198087	63451	227370	488907
2016	206882	90033	240927	537841
2017	75796	32237	113780	221813
2018	44999	19562	212514	277074
2019	121331	46650	270956	438936
2020	89815	33446	162371	285631
2021	84347	30198	198291	312836
2022	128886	49570	325216	503673
2023	186533	86585	312768	585885
2024	195809	57790	269498	523097
2025	192288	83736	198133	474157
Total	**1616871**	**626420**	**2728118**	**4971409**
Final ROU achieved in current period	**4971409**			

Table 19: Vintage wise Total RoUs from Scope 2 and Scope-5 of NSL Sugars Aland Unit

	Total RoUs generated with Uncertainty factor	Total RoUs generated without Uncertainty factor
Total RoUs Generated from Aland Unit	**4,971,409**	**5,892,054**
Annual RoUs Generated from Aland Unit	**414,284**	**491,005**

A.14. UWR Rainwater Offset Do No Net Harm Principles

W.r.t Scope-5

The project activity accomplishes the following:

- Implementation of project activity prevents the release of wastewater directly into nearby river Amarja which is the crucial step towards greener economy.
- The project activity does not harm any person or environment and it helps in improving the water quality of the area.
- The by-products are also used as fertilizers by the farmers in nearby areas.
- This creates awareness among the employees and local people to practice such things on their level.

W.r.t Scope-2

The project activity accomplishes the following:

- Increases the sustainable water yield in areas where over development has depleted the aquifer and water level in surrounding areas.
- The catchments areas are built to collect the rainwater from going into storm drains or sewers and utilise in the facility for different purposes in future.
- This creates awareness among the employees and local people to practice such things on their level

A.15. Scaling Projects-Lessons Learned-Restarting Projects

W.r.t Scope-5

No Scope of extension observed as of now, by Project owner.

W.r.t Scope-2

No Major Scope of extension observed as of now. Although as per the RWH report submitted by project owner, there is a proposal to construct one check dam in the upstream portion and divert the runoff water from the catchment to the existing Rainwater Ponds-1 and Pond-2 through the pipeline system to store and recharge the maximum water which is generating in that catchment 4 a new catchment area is proposed.

