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Damage Assessment report for molasses tank burst accident occurred at

M/S. SAHAKAR MAHARSHI SHIVAJIRAO NARAYANRAO NAGAWADE
Sahakari Sakhar Karkhana Ltd.,
Village Limpangaon, Tal. Shrigonda,
Dist. Ahmednagar- 413726

● Prepared by ●

VSI
संशोधनेन संवृद्धिः

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AUGUST - 2023

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DECLARATION

I hereby declare that Vasantdada Sugar Institute (VSI), Pune has prepared the damage assessment report for M/s. Sahakar Maharshi Shivajirao Narayanrao Nagawade Sahakari Sakhar Karkhana Limited (SMSNNSSKL), Tal. Shrigonda, District Ahmednagar due to an accident of molasses tank burst on Feb. 10, 2022. This report is based on the ground water and soil samples collected from the accident affected area, a representative sample/s from non-affected areas and the field observations of the visiting team. Other information and data/photographs pertaining to the accident has been provided by the SMSNNSSKL. VSI has used all skills, knowledge, care and diligence within the terms, conditions & scope of the work order.

(Dr. Deepali Nimbalkar)
Sr. Scientist and Head
Department of Environmental Sciences

Date: August 10, 2023

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Executive Summary

This final report comprised of first and the second phase data of the study. The first phase report of the study was submitted to the factory in February 2023. The second phase of the study encompasses ground water and soil monitoring data, its results and interpretation, geo-profile studies and geology, hydro-geology related observations, preventive measures recommendations, damage assessment and its monetization. For easier understanding and continuity of the subject, the first phase work is also included in this report. This is mainly to give background of the study and readily provide monitoring locations related data to the reader.

On the request of the factory, additional sampling was done at five dug well (ground water samples) and seven locations for soil. Those locations were not included in the first phase of the report. Hence, all monitored locations were re-described in the second phase along with images showing its location on Google-earth. Sampling locations were grouped into different zones. This zonation is mainly based on the proximity of the location to the accident site. Hence, ground water and soil sampling locations of zone and zone 2 are very important and they were located within 1km distance from the accident site.

Initially, molasses analysis was done to understand its pollution strength/potential. It was observed that the molasses has an acidic nature. Its pH is observed in the range of 4.7 to 5.7. Usually, molasses is observed rich in organic as well as inorganic material. Therefore, it showed relatively high chemical oxygen demand (COD average 63,000 mg/L) and biological oxygen demand (BOD – average – 23,000 mg/L). In addition, nitrogen, phosphorous and potassium (N, P, K) content along with chloride, sulphate and silica are observed/ reported to considerable extent.

In order to assess the environmental damage due to the accident,

- Ground water samples were collected and analysed from 18 locations during first phase and five more samples were added at later stages of the study. Thus, total 23 water samples were analysed
- Similarly, soil samples were collected and analysed initially from 18 locations and seven more samples were added at later stages of the study. Thus, total 25 soil samples were analysed
- Geo-profile study carried out at 30 locations

For ground water quality, in order to understand the contamination due to molasses and its percolation in the dug well near to the accident site – COD, BOD characteristics of water was considered a key parameter. In addition, pH, electrical conductivity (EC) of ground water, its hardness, TDS and concentration of major cations, anions are also considered while assessing the present status of the waterbody with respect to the accidental contamination of the same.

Results of ground water quality study showed pH in the range of 7.0 to 7.9 which is neutral to mild alkaline nature, except one sampling location - W 11 -where pH of 6.8 reported. Ground water samples from non-affected areas showed pH value ≥7.5. All collected samples were colourless. Its electrical conductivity ranged from 876 micro mho/cm to 6389 micro mho/cm. Highest conductivity reported for samples collected near river Ghod.

Usually, COD of unpolluted water is observed <20 mg/L. In the present study, out of 23 ground water samples, eight samples (all from affected areas) showed COD of <20 mg/L. But, in contrast the ground water sample from uncontaminated areas particularly sample W 16 and W 18 reported COD values of 48 mg/L and 176 mg/L respectively. COD value reported for W 18 is the highest for the study area. Since COD and BOD are interlinked parameters, a similar trend was observed for BOD parameter for the ground water samples of the study area. Considering an average COD value of analysed C-molasses samples of 63,000 mg/L, the COD values reported for the sampled ground water are considerably low as far as comparison is concerned. Analysis results of COD, BOD parameters clearly indicate that, the status of ground water of the study area is more or less clean to mildly polluted. It showed very minor or traces of pollution at few locations. This very mild pollution characteristics may be due to local contamination.

Hardness and TDS parameters of samples ground water considered important in order to assess its potable characteristics. Amongst these two parameters, TDS of sampled ground water observed in the ranges of 502 mg/L to 3742 mg/L. According to the IS 10500:2012 standard for drinking water, acceptable limit of TDS is 500 mg/L. Reports for the hardness characteristics show that its value ranged from 130 mg/L to 1270 mg/L. Acceptable limit of total hardness (as CaCO3) as per IS 10500:2012 is 200 mg/L. Only four samples out of 23, reported hardness $\leq$ 200 mg/L. Thus, ground water characteristics of the study area for TDS parameter observed exceeding the standard at all monitored locations but hardness observed within the standard only at four locations.

Overall, the ground water characteristics of the samples collected from accident contaminated/affected areas were observed to be similar to the non-affected/contaminated areas.

In case of soil analysis, pH characteristic is observed to be neutral (pH 7.25) to highly alkaline (pH 9.12). Available nitrogen and phosphorous levels for most of the samples of study area are observed in low to very low ranges. Whereas, the potassium level at many places is observed in high to very high levels. Soil organic carbon was also reported as moderately high to high values.

Overall, the soil analysis results show a similar trend as ground water analysis. It means, the impact due to accidental contamination of the resources (water and soil) is probably remediated naturally. The soil samples collected from accident contaminated/affected areas and non- affected areas show more or less similar characteristics. Therefore, the present status of soils of the study area show no traces of molasses

contamination as such. It may be due to the effective scrapping action taken by the factory management immediately after the accident. In this action, molasses from contaminated soil and other surfaces was scrapped with bagasse, removed mechanically and transferred to the compost yard of the distillery unit.

- **Geo-physical studies**

From the resistivity surveys, it is inferred that throughout the area from surface downwards up to depth of 25 meters the strata are highly weathered and conducive for water infiltration and therefore the infiltration of the molasses released during the accident may have contaminated the groundwater present in the area. This contamination might have occurred immediately after the accident. However, the samples of ground water collected during the study reveals almost negligible traces of pollutants in the collected samples. These pollutants may be due to local contamination.

- **Preventive measures**

This type of accident occurred a second time in the past nine years in the distillery unit. Therefore, a major preventive measure is to strictly adhere and follow Indian standard 5521: 2022 Steel tanks for storage of molasses- specification (second revision). This standard covers the requirements of materials, recommended volumes and dimensions, method of construction, and testing of mild steel tanks for storage of molasses in sugar factories. It is advised to appoint a Competent Auditor for this purpose and confirm the compliance of standard.

- **Damage Assessment and Monetization**

In the present study, a shadow pricing mechanism was used to determine the damage cost. In this method, the estimation of the distance function enables us to obtain the shadow price of the undesirable outputs. This method is originally described in a research paper published by F. Hernández-Sancho et al. (2010). In their study, researchers considered nitrogen, phosphorous, suspended solids, BOD and COD as undesired output of sewage treatment plants. This is mainly because the cost involved in removing these undesirable components is considerable in order to reuse the sewage. Hence, they considered the cost as an environmental benefit cost and interpreted the results.

However, in the present case, ground water and soil is affected due to accidental release of the molasses. Strength of liquid pollutants is usually measured in BOD and COD. While estimating COD, the demand of oxygen for oxidation of inorganics gets covered. Therefore, in the present study estimating cost for the inorganic may lead to duplication of the cost for the same pollution. In other words, the damage cost due to inorganic also gets covered through COD value. Therefore, COD and BOD are considered as important parameters for damage cost estimation.

The damage assessment and preventive/mitigation measures cost is as follows.

Table 1: Cost of damage and its preventive measures

Particular	Details	Cost/provision (Rs)
Damage Cost	Cost of damage due to accidental discharge of molasses into the ground water of nearby areas	36,97,624.00
	Cost of damage due to accidental discharge of molasses into the soils of nearby areas	36,97,624.00
	Cost of damage to flora/trees due to accidental discharge of molasses	2,08,750.00
Preventive measures provision	Provision for implementation of preventive and mitigation measures	75,00,000.00
Remedial or Mitigation measures (additional) through CER	Provision for implementation of CER activities	51,00,000.00
	TOTAL	**2,02,03,998.00**
	Rupees two crores two lakhs three thousand nine hundred ninety eight	

Damage Assessment Report: Phase I

1.0 Introduction

M/s. Sahakar Maharshi Shivajirao Narayanrao Nagawade Sahakari Sakhar Karkhana Limited (SMSNNSSKL), Tal. Shrigonda, Dist. Ahmednagar is a one of the progressive and leading sugar factories of Ahmednagar district of Maharashtra. It was established in the year 1965 and has registration No.: ANR/PRG (A)/1-dated 03.08.1965. The factory achieved significant development under the leadership of Late Mr. Shivajirao Nagawade. Now, it is growing under the leadership of Chairman Mr. Rajendra S. Nagawade. Gradually, the sugar unit expanded and the factory established a 30 KLPD distillery unit in 1986. In the year 2021 the factory started a 26 MW cogeneration unit. Presently the cane crushing capacity of the sugar unit is 4,800 TCD, Cogeneration unit is 26 MW and distillery unit is operated at 30 Kilo litre per day (KLPD) capacity.

1.1 Geographical location of the factory

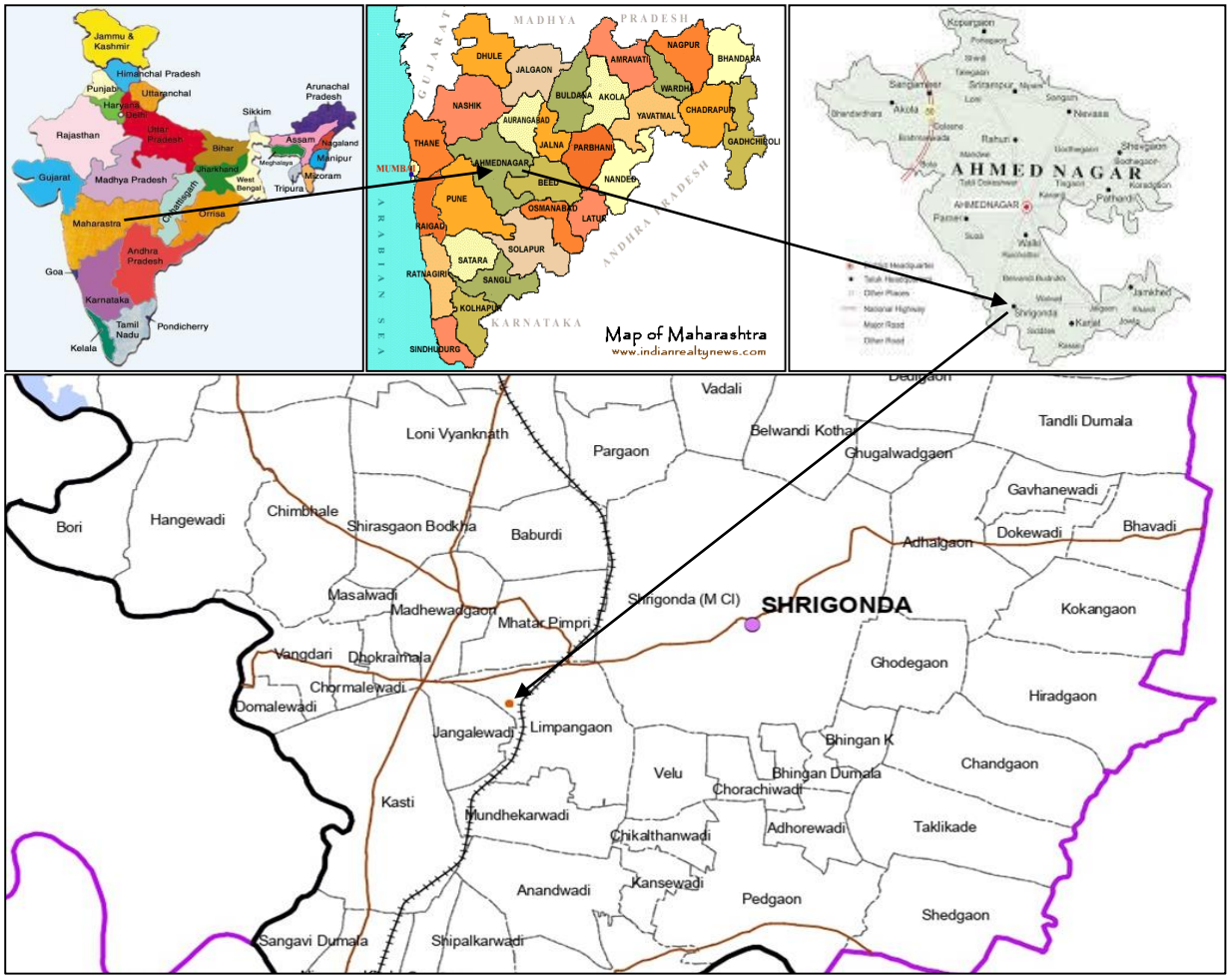


Figure 1.1: Site location map

The site is located at Plot number 52/2 village Limpangaon of Shrigonda taluka of Ahmednagar district, Maharashtra.

Geographical coordinates of the industrial unit are –

1. 18°35'31.71"N, 74°37'0.86"E
2. 18°35'20.94"N, 74°37'28.02"E
3. 18°35'2.82"N, 74°37'19.10"E
4. 18°35'18.38"N, 74°36'56.07"E

1.2 Access

Taluka headquarter and town Shrigonda is approx. 8.5 km from the factory site. The unit is approx. 0.5 km from Shrigonda- Nhavare State highway and approx. 2.3 km from NH 160 i.e. Kurkumbh-Ahmednagar road. Nearest railway station is Shrigonda which is approx. 2.5 km from the project site. It is on the Daund-Manmad route. Pune and Shirdi airport are near to the site. They are at approx. 75 and 120 km aerial distance from the site.

1.3 Raw material and finished product storage details

Table 1.1: Raw material and finished product storage details

Storage details	Capacity
Molasses storage tank M1	4500 MT (02 Nos.)
Molasses storage tank M2	4500 MT (01 Nos.)
Rectified Spirit Storage Tank - 1	6,77,934 BL
Rectified Spirit Storage Tank - 2	6,83,944 BL
Rectified Spirit Storage Tank - 3	6,53,777 BL
Rectified Spirit Storage Tank - 4	95,807 BL
ENA Storage Tank-1	96,000 BL
ENA Storage Tank- 2	96,000 BL

*All tanks are provided with Recirculation and water cooling system.

1.4 Environmental Conditions

M/s. Sahakar Maharshi Shivajirao Narayanrao Nagawade Sahakari Sakhar Karkhana Limited (SMSNNSKL) is located in village Limpangaon, taluka Shrigonda, district Ahmednagar.

The distillery unit of the factory is located towards the south of the industrial plot. Satellite image shows that there are spent wash storage lagoons and compost yard is located towards east of the unit. Towards south, there are agricultural plots located in the immediate surrounding and a tiny settlement at approx. 100 m from the site. In the west, there is a small natural drainage (nalla) and a fallow land plot with scrub vegetation. Few agricultural plots observed after the fallow land. Towards north, sugar unit of the factory is observed in the immediate surrounding area.

The plots in the immediate surrounding of the site are presently under agricultural land use. There is a residential area at an approx. 500 m towards NW of the site. An artificial small-scale reservoir is located

towards the West direction within the project boundary. Nearest Village Jangalewadi is located towards SW of the site at approx 1.5 km. Ghod Left Canal is adjacent to the factory in the West direction. River Ghod ~6.2 km from the site flows from West of village Jangalewadi. In addition to these few Wells are within 1 km radius of the site.

1.5 Climatic conditions

Gradual increase in maximum temperature of the taluka observed from the month of February of 2022. Max temperature of +40°C was recorded in the months of April and May. Sharp decrease in the maximum temperature observed after onset of monsoon.

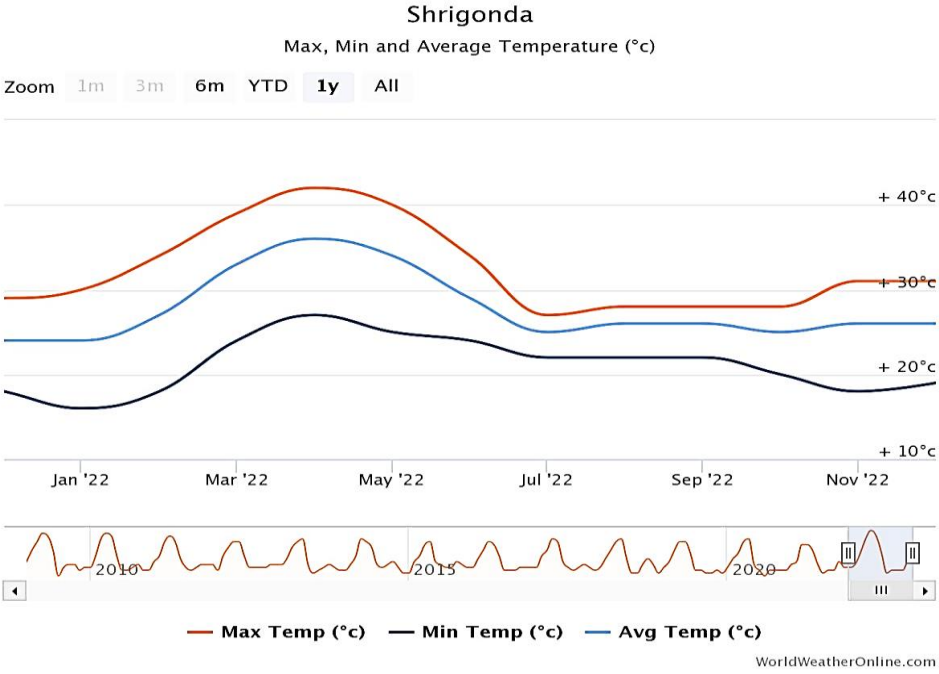


Fig. 1.2: Maximum, Minimum and Average temperature of Shrigonda taluka (year 2022)

The maximum humidity of taluka ranges between 70-80% in the month of June to September. Humidity ranges around 40 % in the month of January. It decreases further upto April, observed around 20-25%.

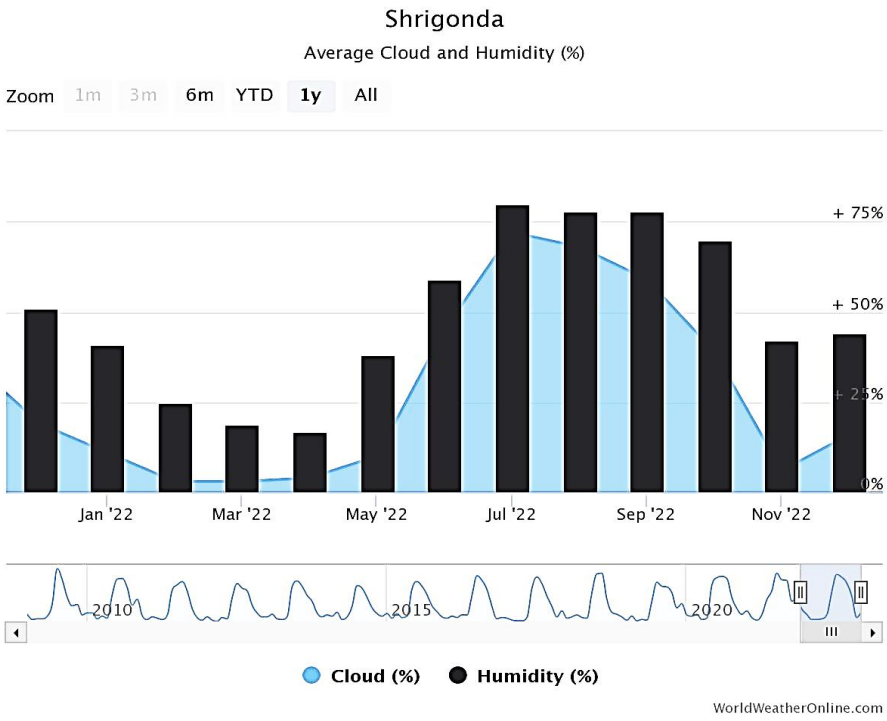


Fig. 1.3: Average humidity of Shrigonda taluka

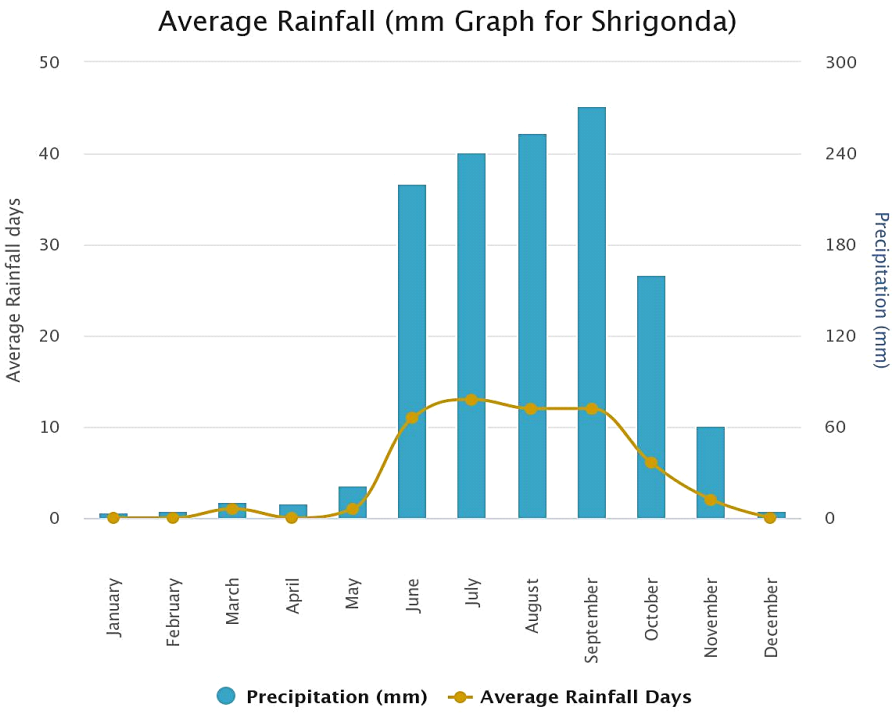


Fig. 1.4: Average rainfall of Shrigonda taluka (year 2022)

Source: worldweatheronline.com

2.0 Background of damage assessment work

On 10th Feb 2022, one of the molasses tanks of 4500 MT capacity located in the distillery unit burst at 06.45 am. Due to this, the stored molasses flowed out of the factory premises and found its way through nearby natural drainage. The factory management took immediate action to control and remove the molasses from outside premises. In the control action, the management took the following steps.

- Stopped the flow of molasses in the natural drainage (*nalla*) by constructing temporary bunds
- Deployed tankers to collect the molasses from the *nalla*
- Used vehicle mount diesel engine pumps to collect the molasses in tankers
- Brought the tankers to the factory premises and stored the molasses from tankers into spent wash storage constructed lagoons of distillery unit
- Used scrapping material such as bagasse to prevent spread of molasses in the surrounding field
- Collected the scrapped bagasse and brought it to the compost yard of the distillery unit
- Used the scrapped material for composting activity
- The management could able to control and restrict the flow of molasses within 800 m (aerial distance) from the distillery premises
- Prevented the spread molasses in the surrounding agricultural and/or open land to maximum extent
- Closed the distillery operations till the action of molasses removal from the natural environment gets completed.

Figure 2.1: The place (tank location) of accident

Figure 2.2: Photographs of the damaged area

- **Immediate control measures implemented by the factory management after the incident:**

Figure 2.3: Removal of contaminated soil

Figure 2.4: Construction of temporary bunds on natural drain to restrict the flow of molasses

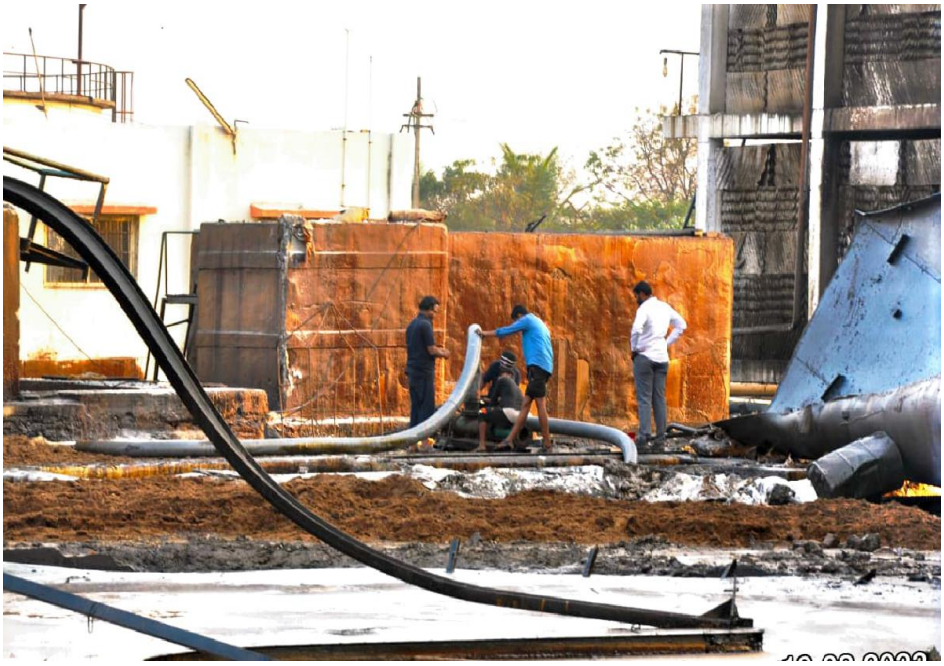


Figure 2.5: Used vehicle mount diesel engine pumps to collect the left over molasses in tankers

Immediately, the factory management reported the accident to regulatory authorities such as Maharashtra State Pollution Control Board. The board officials visited the site on the same day i.e. Feb 10, 2022 and prepared the onsite observation report. Copy of the same is enclosed as annexure I.

2.1 Summary of the MPCB-FO visit report

As per instruction SRO, Ahmednagar visit paid to industry regarding blast of molasses tank incident happened in industry premises. During visit following observations are made as below

- During the visit it is observed that, blast of molasses tank (No.-1) M-1 incident happened in the molasses storage area.
- Industry representative informed that, said incident happened at 6.45 AM on 10/02/2022
- Due to said incident molasses has spread in premises (i.e. near ETP area, CPU area) & it has also flowed into the nearby *nalla* and it has flown till approx. 1.0 Km in the said *nalla*. Same *nalla* blocked using black cotton soil.
- Due to said incident molasses flown into nalla, due to which It has also spread in nearby farmlands
- Industry representatives informed that they have stored approx. 4102.800 MT molasses in molasses storage tank no.-1 (M-1) same is spread in premises and nearby *nalla*
- Industry representatives informed that they have stored approx. 3034.710 MT in molasses tank No. 2 (M-II) & approx. 4072.380 MT molasses in tank No. 3 (M-III)
- Due to this incident the wall near ETP was damaged

Remarks (By MPCB):

- Instructed industry to submit action taken report on top priority
- Industry shall remove all molasses from nearby *nalla* on top priority
- Instructed industry to submit the molasses storage arrangement details on top priority in MPCB office
- Industry shall carry out safety audit of molasses storage tank No. 2 & 3
- Industry representative informed that this accident happened due to spontaneous combustion in tank No.-1 (M-I)

Later, due to NGT Application No. 85/2022 (WZ) and Caveat No. 12/2022, the state pollution control board gave directives to the factory to prepare a damage assessment report. Hence, the factory management approached Vasantdada Sugar Institute (VSI), Pune to prepare damage assessment work. VSI is NABET accredited Environment Impact Assessment (EIA) consultant providing its services to the sugar industry for more than two decades.

Scope of phase 1

1) Detailed survey of the accident affected/damaged site and identification of locations for collection of water and soil samples
2) Geo-referencing of locations identified for water/soil sample collection

This was mainly to identify the core and buffer area of the accident. It should get clearly demarcated on the map/satellite image. On the basis of this data, a number of samples for water, soil and geological/hydrogeological investigations would get finalized.

On Dec. 02, 2022 a project team comprised of following members visited the site and collected site specific information and data.

Table 2.1: Details of experts involved in damage assessment work

#	Name	Expertise
1)	Dr. Nitin Karmalkar	Geology and geophysical surveys
2)	Dr. Amol Deshmane	Ecology and Biodiversity, Impact assessment
3)	Dr. R.A. Duraiswami	Hydrogeology and water quality assessment, Remote sensing and GIS applications
4)	Dr. Vivek Patil	Environment Sciences, Impact assessment
5)	Ms. Priyanka Kad	Land Use Land cover studies using remote sensing, GIS

3.0 Findings of First phase study

Based on the visit and collected data, an area affected due to molasses spread was demarcated on satellite image.

Figure 3.1: Image showing spillage of molasses inside factory premises

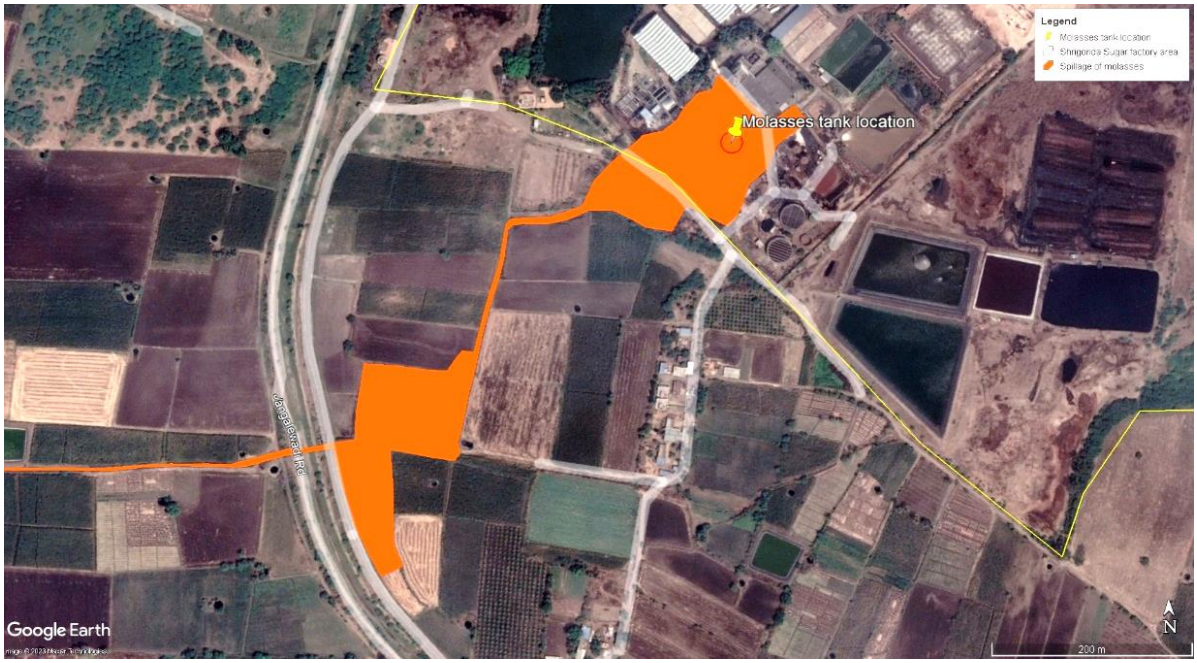


Figure 3.2: Image showing spillage of molasses outside factory premises

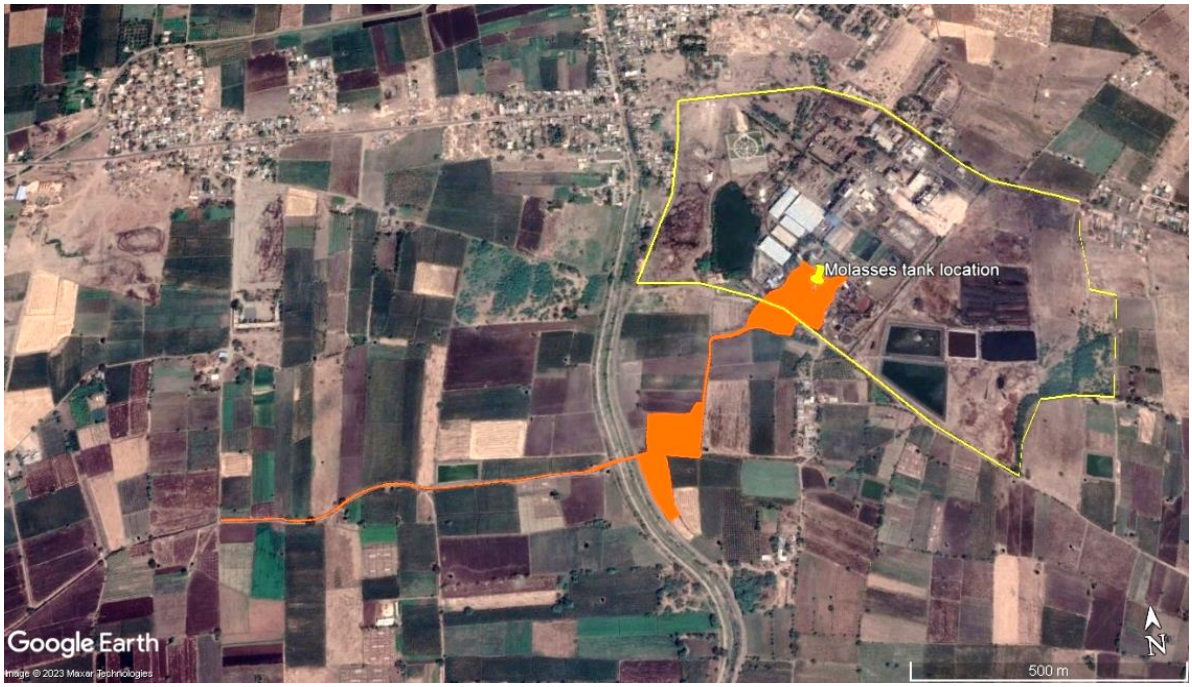


Figure 3.3: Google earth image showing spillage of molasses in the nearby area

(In these images orange colour used to show the spread of molasses and its flow in the natural drainage)

Also, soil and water sample collection locations were determined. These locations are covered in figure 3.5 and 3.6. While selecting the locations, highly, moderately and low affected areas as well as non-affected areas were considered to get the broader picture. Water and soil samples for the mentioned location was collected on Feb 06 and 07, 2023.

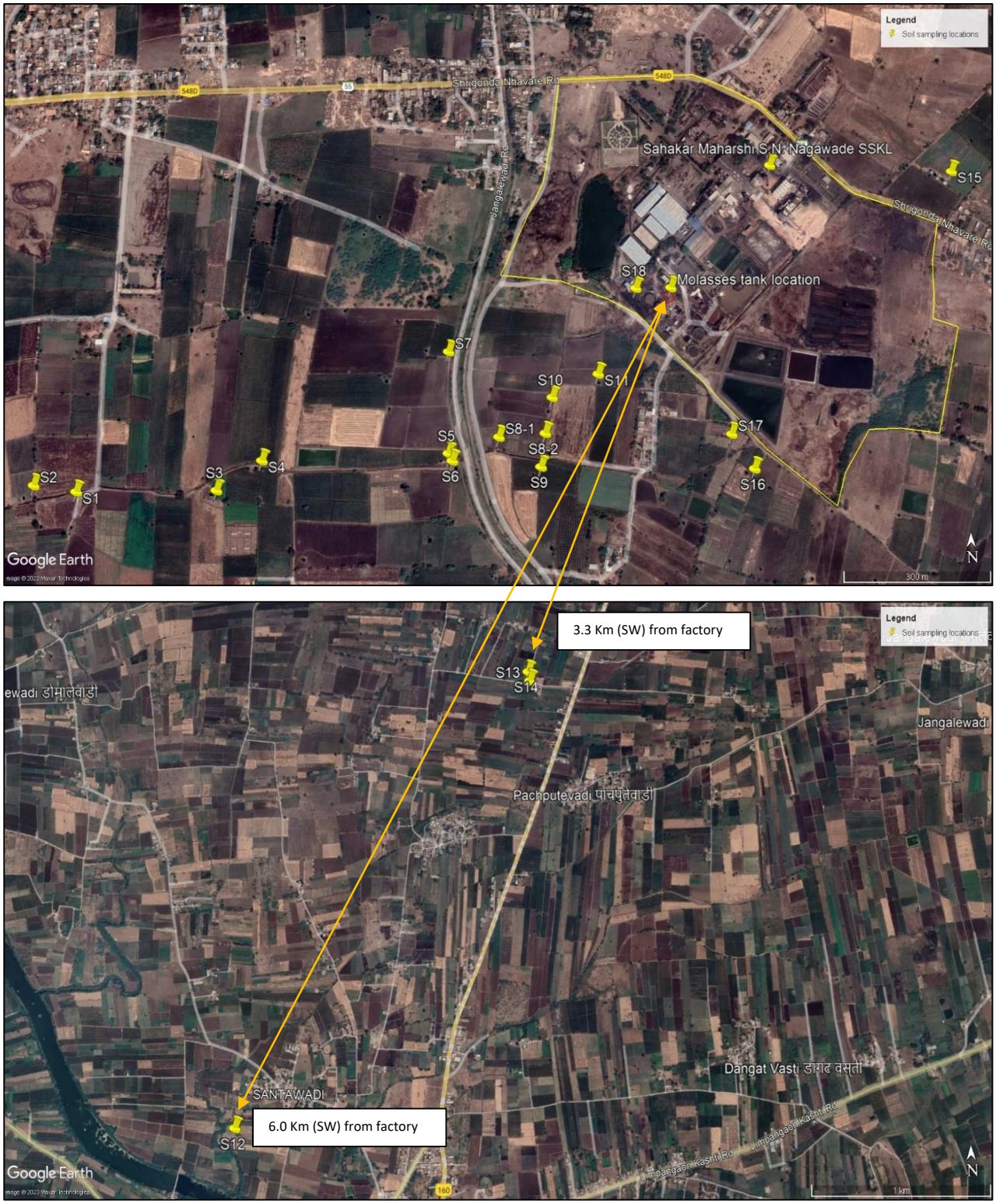


Figure 3.4: Soil sampling location map

Table 3.1: Soil Sampling locations with geographical coordinates

#	Sample	Geographical location	Location specification	Remark
1.	**Soil Sample 1**	18°35'4.61"N, 74°36'25.67"E	Farm of Mr. Pappu Jangale	low affected area
2.	**Soil Sample 2**	18°35'5.10"N, 74°36'22.67"E	Farm of Mr. Bhaskar Jangale	low affected area
3.	**Soil Sample 3**	18°35'4.41"N, 74°36'35.47"E	Farm of Mr. Ganesh Gund	moderately affected
4.	**Soil Sample 4**	18°35'6.19"N, 74°36'38.63"E	Farm of Mr. Dyaneshwar Gund	moderately affected
5.	**Soil Sample 5**	18°35'6.26"N, 74°36'51.75"E	Farm of Mr. Tukaram Gund	moderately affected
6.	**Soil Sample 6**	18°35'5.78"N, 74°36'52.01"E	Farm of Mr. Tukaram Gund	moderately affected
7.	**Soil Sample 7**	18°35'12.77"N, 74°36'51.93"E	Farm of Mr. Parshuram Gund	moderately affected
8.	**Soil Sample 8-1**	18°35'7.19"N, 74°36'55.34"E	Farm of Mr. Lokesh Rode	highly affected area
9.	**Soil Sample 8-2**	18°35'7.33"N, 74°36'58.62"E	Farm of Mr. Lokesh Rode	highly affected area
10.	**Soil Sample 9**	18°35'5.22"N, 74°36'58.23"E	Farm of Mr. Dyaneshwar Rode	highly affected area
11.	**Soil Sample 10**	18°35'9.61"N, 74°36'59.21"E	Farm of Mr. Madhukar Gund	highly affected area
12.	**Soil Sample 11**	18°35'11.01"N, 74°37'2.54"E	Farm of Mr. Rangnath Gund	highly affected area
13.	**Soil Sample 12**	18°33'20.37"N, 74°34'22.64"E	Farm of Mr. Kokate	non affected area
14.	**Soil Sample 13**	18°34'34.88"N, 74°35'21.32"E	Farm of Mr. Kondiba Rahinj	non affected area
15.	**Soil Sample 14**	18°34'36.46"N, 74°35'21.02"E	Farm of Mrs. Anjana Gawade	non affected area
16.	**Soil Sample 15**	18°35'23.76"N, 74°37'29.17"E	Farm of Mr. Madhukar Kalane	non affected area
17.	**Soil Sample 16**	18°35'4.66"N, 74°37'13.22"E	Farm of Mr. Baban Dhage	non affected area
18.	**Soil Sample 17**	18°35'6.89"N, 74°37'11.77"E	Farm of Mrs. Rukhmini Dhage	non affected area
19.	**Soil Sample 18**	18°35'16.56"N, 74°37'5.53"E	Near molasses storage tank	highly affected area

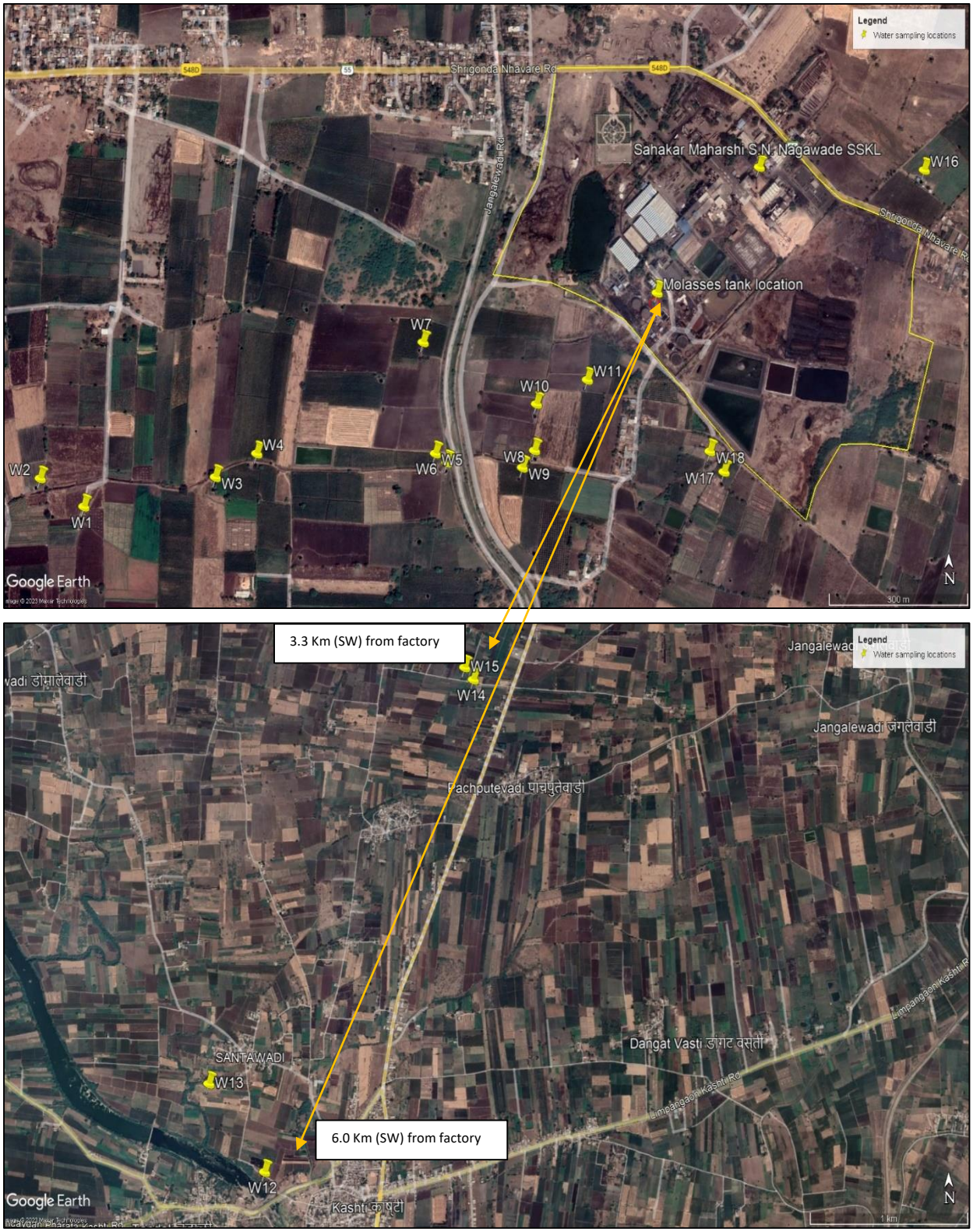


Figure 3.5: Water sampling location map

Table 3.2: Water Sampling locations with geographical coordinates

#	Sample	Geographical location	Location specification	Remark
1.	**Well water 1**	18°35'3.14"N, 74°36'25.58"E	Well of Mr. Pappu Jangale	Low to moderately affected area
2.	**Well water 2**	18°35'4.91"N, 74°36'22.31"E	Well of Mr. Bhaskar Jangale	Low to moderately affected area
3.	**Well water 3**	18°35'4.96"N, 74°36'35.29"E	Well of Mr. Ganesh Gund	moderately affected
4.	**Well water 4**	18°35'6.43"N, 74°36'38.30"E	Well of Mr. Dyaneshwar Gund	moderately affected
5.	**Well water 5**	18°35'6.40"N, 74°36'51.53"E	Well of Mr. Tukaram Gund	moderately affected
6.	**Well water 6**	18°35'5.83"N, 74°36'52.37"E	Well of Mr. Tukaram Gund	moderately affected
7.	**Well water 7**	18°35'13.42"N, 74°36'50.61"E	Well of Mr. Parshuram Gund	moderately affected
8.	**Well water 8**	18°35'6.57"N, 74°36'58.86"E	Well of Mr. Lokesh Rode	highly affected area
9.	**Well water 9**	18°35'5.50"N, 74°36'57.96"E	Well of Mr. Dyaneshwar Rode	highly affected area
10.	**Well water 10**	18°35'9.49"N, 74°36'59.02"E	Well of Mr. Madhukar Gund	highly affected area
11.	**Well water 11**	18°35'11.01"N, 74°37'2.81"E	Well of Mr. Rangnath Gund	highly affected area
12.	**Well water 12**	18°33'4.49"N, 74°34'35.83"E	Well Near Ghod River - Kashti	non affected area
13.	**Well water 13**	18°33'20.80"N, 74°34'23.99"E	Well Near Natural drain (Mr. Kokate)	non affected area
14.	**Well water 14**	18°34'34.68"N, 74°35'21.90"E	Well of Mr. Kondiba Rahinj	non affected area
15.	**Well water 15**	18°34'36.97"N, 74°35'20.05"E	Well of Mrs. Anjana Gawade	non affected area
16.	**Well water 16**	18°35'24.36"N, 74°37'28.24"E	Well of Mr. Madhukar Kalane	non affected area
17.	**Well water 17**	18°35'5.19"N, 74°37'12.86"E	Well of Mr. Baban Dhage	non affected by molasses/but low laying to spent wash storage tanks area
18.	**Well water 18**	18°35'6.48"N, 74°37'11.84"E	Well of Mrs. Rukhmini Dhage	

Damage Assessment (Phase 2 i.e. final report)

- **Brief about the study of phase two of damage assessment**

As discussed in the introductory part of the report (Phase 1, page 5) that damage was caused due to accidental release of molasses (C-heavy type) outside the factory premises of M/s. Sahakar Maharshi Shivajirao Narayanrao Nagawade Sahakari Sakhar Karkhana Limited, Shrigonda assessed in this study. **According to the letter from Maharashtra Pollution Control Board (MPCB – letter ref. MPCB/RONK/ID/221017001/2022 dated Oct. 17th 2022 – enclosed as annexure 2), it directed the factory to –**

1) carryout assessment of contamination and

2) Estimate cost of remediation and damage assessment

- **The Study Process**

In this context, ground water and soil samples were collected to assess contamination of pollutant. Results and interpretation of the same are covered in detail in this part of the report. Estimation of remediation cost is also dependent on this study. Damage assessment part of the report is based on 'Framework for Environmental Damages Cost Assessment' – Special report on monetizing damages - published by National Environmental Engineering Research Institute (NEERI – Year 2019). This report by NEERI used as a basic guideline to describe the damages due to the accident, understanding its impact and monetizing the damage. Schematic of the process is given in figure 1.1.

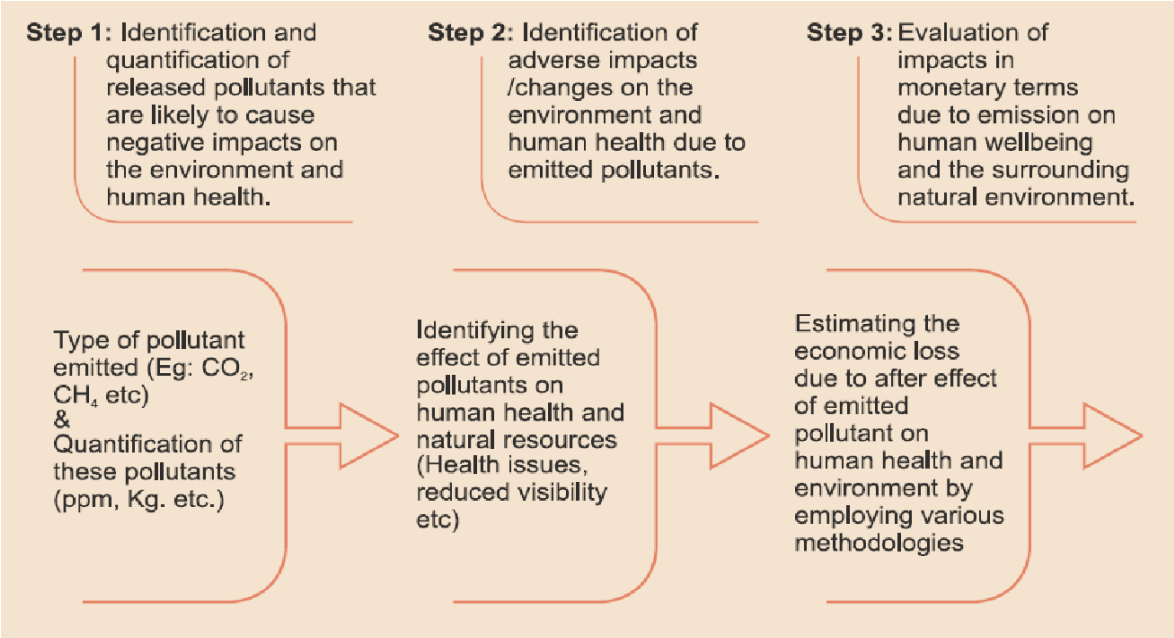


Figure 1.1: Schematic of damage assessment process used for this study

Source: 'Framework for Environmental Damages Cost Assessment' – Special report on monetizing damages - published by National Environmental Engineering Research Institute (NEERI – Year 2019)

1.0 Identification of pollutant/s type, its source, quantity and characteristics

Therefore, while assessing the damage, the nature of the pollutant is described in the first part. It includes pollutant type, its source, quantity and characteristics.

Type of pollutant	C-heavy type molasses
Source	It is generated from sugar manufacturing process - from sugar cane
Quantity	Approx. 4,000 tons of molasses (C heavy type)

Further, molasses characteristics were determined by analyzing the samples in the lab and through available research papers. The findings of the same are as follows.

Table 1.1: General characteristics of C-heavy molasses as a raw material for fermentation unit

Particulars	Test values
pH of molasses	4.20-4.50
Brix	86.00-90.00
Moisture content (%)	15.00-21.50
Total suspended solids (%)	3.50-7.00
Total dissolved solids (%)	72.00-82.00
Total reducing sugars (%) by mass	42.00-52.00
Total fermentable sugars (%) by mass	40.00-48.00
Fermentable/Non fermentable ratio (F/N)	1.50-2.00
Calcium content (gms/1000 brix)	1.80-2.75
Ash (Molasses) in %	**7 to 10**
Carbonated ash (%)	8.00-12.00
Sulphated ash (%)	11.00-15.00
Nitrogen (% of molasses)	0.700-1.200
Potassium (% of ash)	15.00-16.50
Sodium (% of ash)	0.90-0.95
Chlorides (% of ash)	13.00-14.00
Phosphates (% of ash)	0.25-0.35
Total organic volatile acids (mg/lit.)	2500-7000
Non-sugar organic compounds*	20 to 25

*includes nitrogenous substances, cane wax, vitamins, etc.

Reference: NATIONAL SUGAR INSTITUTE, KANPUR (Presentation by Dr. Seema Paroha of NSI)

Table 1.2: Characteristics of C-heavy molasses - Analysed considering water pollutant/contaminant)

#	Parameter	Test value*	Unit
1	pH at 25°C	4.7 to 5.7	---
2.	Colour	Dark brown	
2	Electrical Conductivity@25°C	359 -1586	µmhos/cm
3	Chemical oxygen demand	54,000-69,000	mg/l
4	BOD at 27° C for 3 days	14,998 -24,998	mg/l
5	Total Suspended Solids	2,896 -3,968	mg/l
6	Sulphate as SO4	20,875 - 41,250	mg/l
7	Chlorides as cl	13,995.6 – 18,994	mg/l
8	Acidity	60,000-75,000	mg/l
9	Silica (Colloidal)	4,901.1 – 5,882	mg/l
10	Phosphorous (P)	230.39 to 235.29	mg/l
11	Potassium (K)	27,843 -30,539	mg/l
12	Sodium (Na)	7,389.16–20,295.57	mg/l
13	Total Dissolved Solids	65,940 – 72,426	mg/l
14	Nitrogen (TKN)	7,560 – 8,960	mg/l
15	Nitrate	BDL	
16	Calcium as Ca	8,016 -16,032	mg/l
17	Magnesium as Mg	4,609.22- 4,613.11	mg/l
18	Copper as Cu	BDL	mg/l
19	Iron as Fe	4.639 – 5.360	mg/l
20	Chromium (Cr) Total	BDL	mg/l
21	Nickel (Ni)	BDL	mg/l
22	Zinc (Zn)	BDL	mg/l
23	Manganese as Mn	BDL	mg/l
24	Lead as Pb	BDL	mg/l
25	Cadmium as Cd	BDL	mg/l
26	Volatile Acids	491.4 – 510.3	mg/l
***average of three samples**			

BDL = Below detection limit;

BDL value of Pb, Cd Cr, Mn, Zn, Ni and Cu = 1 mg/L

1.1 Characterization of pollutant i.e. molasses

pH of molasses: Molasses (C-Heavy type) analysis report presented in table 1.2, indicates that it is acidic in nature (ranging between 4.7 to 5.7). Similar type of observation was reported by Kassa (2019) - who reported pH of 5.05 of molasses. In present study, molasses got discharged in a large volume and its entrainment was observed in nearby dug wells. This might have caused a change in the pH of water from neutral to acidic. Acidic pH might have caused damage to aquatic life. **Because, baseline data i.e. test reports of accident affected dug wells (after the accident) is not available, specific comment related to impact is assumptive.**

After pH, the second important pollution parameter is colour. Molasses has a very dark brown colour. Therefore, when molasses entered nearby dug wells, the colour of the receiving waterbody might have become brown or dark in colour. In such a situation light penetration into the waterbody gets drastically reduced. It also affects the exchange of oxygen between water bodies and the atmosphere. Thus, depletion of dissolved oxygen (DO) of water observed in such circumstances.

Temperature is also one of the important parameters for molasses. Usually the temperature of the molasses storage tank is maintained between 30 ^{o}C to 34 ^{o}C i.e. below 35 ^{o}C. But, a temperature of even 34^{o}C is warmer for well water which is usually observed around 27^{o}C. This is another reason for DO depletion. Organic as well as inorganic content of molasses is another major factor for DO depletion

Chemical oxygen demand (COD) and Bio-chemical Oxygen Demand (BOD):

The COD value of C-heavy molasses is in the range of 54,000 to 69,000 mg/L. BOD value of the analysed molasses sample was observed in the range of 14,998 mg/L to 24,998 mg/L. This COD/BOD value is considerably high and thus has the potential to cause damage to receiving water bodies. Considering the same the molasses (pollutant) entered into the water bodies (dug wells) had a very high pollution potential. According to the standards set by the Central Pollution Control Board (CPCB) for discharge of effluent/wastewater into any of the water body, BOD should be < 30 mg/L (Reference https://cpcb.nic.in).

Reference: Kassa, Y. Application of cane molasses as concrete retarder admixture. *SN Appl. Sci.* **1**, 1547 (2019). https://doi.org/10.1007/s42452-019-1608-8

2.0 Identification of adverse impacts or change in the environment or impact on human health due to emitted pollutants

This part presumably overlapped with assessment of contamination. Because, the data required for both is same - that is groundwater and soil analysis report. Hence, this part of the report will discuss monitoring and analysis of ground water and soil. Changes in the environment due to the pollutant is discussed in the later half.

2.1 Water and Soil sample collection, analysis results and data interpretation

For this study, a laboratory team of Department of Environmental Sciences of Vasantdada Sugar Institute (VSI) was involved in the sample collection and analysis. The laboratory of the Department of Environmental Sciences is accredited for many parameters of water, wastewater, soil, sludge, solid waste, ambient air, stack gas analysis by National Accreditation Board for Calibration and Testing Laboratories (NABL – accreditation certificate and approved scope is enclosed as annexure VI). This team visited the site on Feb 05 and 06, 2023 and March 16, 2023 to collect the ground water and soil samples from the study area. These samples were collected as per the sample collection procedures of the laboratory. Procedure for water sample collection is prepared based on the guidelines by the Central Pollution Control Board (CPCB). Procedure for soil sampling is developed based on the best practices followed at national and international levels. These samples were brought to the laboratory and analysed by experienced staff. For the analysis of collected groundwater samples, standard methods prescribed by American Public Health Association (APHA) and Bureau of Indian Standard (BIS) were mainly followed. Most of the parameters are under the NABL accreditation scope of the laboratory. In case of soil samples, BIS and Fertilizer Control Order (FCO) methods were used.
(Guidelines for water quality monitoring by Central Pollution Control Board MINARS/27/2007-08)

2.2 Molasses analysis results and its interpretation

In case of any water pollutant or wastewater its pollution strength is mainly assessed based on its chemical oxygen demand (COD)/biological oxygen demand (BOD) values. COD is often used as a measurement of pollutants in water, wastewater and aqueous hazardous wastes. COD is a measure of the oxygen equivalent of the organic matter in a water sample that is susceptible to oxidation by a strong chemical oxidant. COD is widely used as a measure of the susceptibility to oxidation of the organic and inorganic materials present in water bodies. The COD test of natural water yields the total quantity of oxygen that is required for oxidation of a waste to carbon dioxide and water (McCutcheon et al. 1993). In a BOD test, only biologically reactive carbon is oxidized while in a COD test, all organic matter is converted to carbon dioxide. The COD concentrations observed in surface water resources typically range from 20 mg/L or less in unpolluted

waters to greater than 200 mg/L in waters receiving effluents. Industrial wastewaters may have COD ranging from 100 mg/L to 60,000 mg/L (Chapman 1992).

In addition, other parameters such as pH, electrical conductivity, total dissolved solids are also important in determining the pollution strength of a liquid waste. These parameters were checked and results of the same are discussed here sequentially.

Hardness and Total Dissolved Solids (TDS): Hardness of water indicates the amount of calcium and magnesium dissolved in it. Water hardness is the total calcium and magnesium ion concentration in a water sample and is expressed or reported as mg/l as CaCO3 equivalent (i.e. concentration of calcium carbonate). Dissolved calcium (Ca++) and magnesium (Mg++) are the only two divalent cations found at appreciable levels in most waters. In natural water, both calcium and magnesium primarily exist bound to bicarbonate, sulfate or chloride. Total dissolved solids or TDS is the amount of dissolved ions, including salts, minerals and metals, in a water source.

These two parameters are broadly indicating the characteristics of ground water particularly for drinking and domestic purposes. IS 10500; 2012 prescribes acceptable limit of hardness as 200 mg/L and total dissolved solids this limit is at 500 mg/L.

Reference: McCutcheon, S.C., Martin, J.L, and Bamwell, T.O. (1993). Water Quality. In Handbook of Hydrology, Edited by D.R. Maidment. McGraw-Hill Inc., New York.
Chapman, D. (Editor) (1992). Water Quality Assessments. Published E & FN Spon on behalf of UNESCO, WHO and UNEP. London.

2.3 Physiographic setting

The Sugar Factory is to the northeast of village Janglewadi and is included in Survey of India Toposheet 47J/10 and extends in quadrants A3, B2, and B3 (Fig. 2.1). The sugar Factory is located at an elevation 543 m AMSL on the water divide separating the Pimpri Nala and the Gade Odha. The sugar factory is drained by 1st order streams, NE of Janglewadi. The stream between the Pimpri Nala and the Gade Odha is unnamed on Survey of India Toposheet 47J/10 and is herein considered and called as “Janglewadi Odha”.

The Janglewadi Odha is a 4th order ephemeral stream, that drains into the Ghod River. The Janglewadi Odha flows in the NE-SW direction upto the west of village Rahinjwadi where it is joined by the 3rd order N-S trending stream. After the confluence the stream is perineal.

Overall, the drainage pattern of Janglewadi Odha is dendritic and reflects the homogeneous substrate. For easier understanding, an area around the Janglewadi Odha is termed and referred as Janglewadi Odha micro-watershed. It is covered by soil and underlain by vesicular basalts belonging to the Cretaceous-

Palaeogene Deccan Traps. In the SW the microwatershed is covered by a thin veneer of Quaternary alluvium between Pimpalchamala and Kashti along the Ghod River.

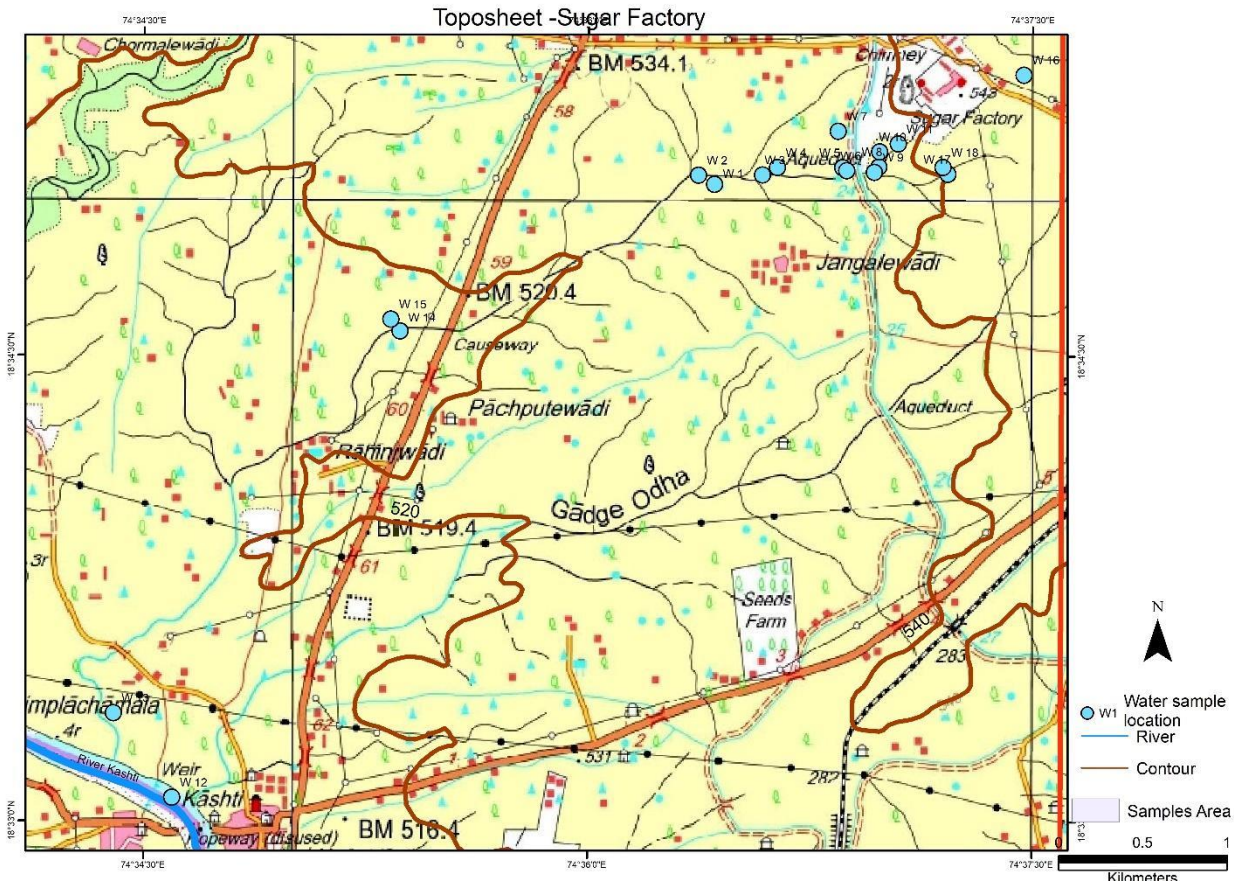


Fig. 2.1: Part of Survey of India toposheet for the Janglewadi Odha mini watershed showing the Sugar Factory and water sample locations (in blue circled spots)

The NE of the Janglewadi Odha is drained by the Ghod left bank canal and its subordinate branches. One such branch from the Ghod left bank canal runs in the NE-SW direction south of Pachputewadi-Rahinjwadi and Pimplachamala. Another major branch of Ghod Left Bank Canal is present to the north of the study area and irrigates the region south of Thokriwadi. The Ghod Left Bank Canal and its subordinate branches constitute the command area where canal water is used for irrigation and groundwater from dug wells and borewells are used for protective irrigation or seasonal crops. The return flow (recharge) from the command area tends to flow towards the lower part of the micro watershed where the major cation and anions tend to concentrate giving a poor water quality in the Pimplachamala-Kashti areas.

The test results of ground water samples collected mostly of the affected wells are presented here in the graph form as well as tabulated. Test reports of the same are enclosed as annexure to this report (Annexure VII). For easier understanding the test values of important parameters are given in graphical form. These graphs are prepared for a group of samples collected from a specific area/zone. Details of the same are as follows.

Table 2.1: Categorization of zones and details of sample collected form each zone

Sampling Zone	Sample Location/identification Code	Location/Identification Details*
Zone 1	W01 to W07	Samples from molasses spread area; distance in the range of 490 m to 1350 m from accident site
Zone 2	W08 to W11	Samples from molasses spread area; located within 400 m from accident site
Zone 3	W12 and W13	Samples collected from dug well near river Ghod; located at a distance of 5960 m and 5,920 m respectively from accident site
Zone 4	W14, W15 and W19 to W23	Samples from affected area beyond 3,000 m from accident site
Zone 5	W16, W17 and W18	Samples from area where molasses spread not observed

* distances given in the table are aerial distances measured using Google Earth Image. It is from the molasses storage tank of the distillery unit.

The distance of each location from the accident site/factory site estimated through Google earth image is as follows.

Table 2.2: Geographical location and distance from factory of collected samples

#	Location/Identification code	Distance (aerial distance in m)	Latitude & longitude
1	W 01	1270	18°35'3.14"N, 74°36'25.58"E
2	W 02	1350	18°35'4.91"N, 74°36'22.31"E
3	W 03	980	18°35'4.96"N, 74°36'35.29"E
4	W 04	880	18°35'6.43"N, 74°36'38.30"E
5	W 05	520	18°35'6.40"N, 74°36'51.53"E
6	W 06	500	18°35'5.83"N, 74°36'52.37"E
7	W 07	490	18°35'13.42"N, 74°36'50.61"E
8	W 08	320	18°35'6.57"N, 74°36'58.86"E
9	W 09	380	18°35'5.50"N, 74°36'57.96"E
10	W 10	280	18°35'9.49"N, 74°36'59.02"E
11	W 11	150	18°35'11.01"N, 74°37'2.81"E
12	W 12	5960	18°33'4.49"N, 74°34'35.83"E
13	W 13	5920	18°33'20.80"N, 74°34'23.99"E
14	W 14	3320	18°34'34.68"N, 74°35'21.90"E
15	W 15	3340	18°34'36.97"N, 74°35'20.05"E
16	W 16	690	18°35'24.36"N, 74°37'28.24"E

17	W 17	300	18°35'5.19"N, 74°37'12.86"E
18	W 18	260	18°35'6.48"N, 74°37'11.84"E
19	W 19	2474	18°34'55.21"N; 74°35'45.08"E
20	W 20	2603	18°34'53.54"N; 74°35'41.01"E
21	W 21	2442	18°34'55.23"N; 74°35'46.18"E
22	W 22	2984	18°34'40.11"N; 74°35'31.78"E
23	W 23	2600	18°34'49.71"N, 74°35'41.47"E

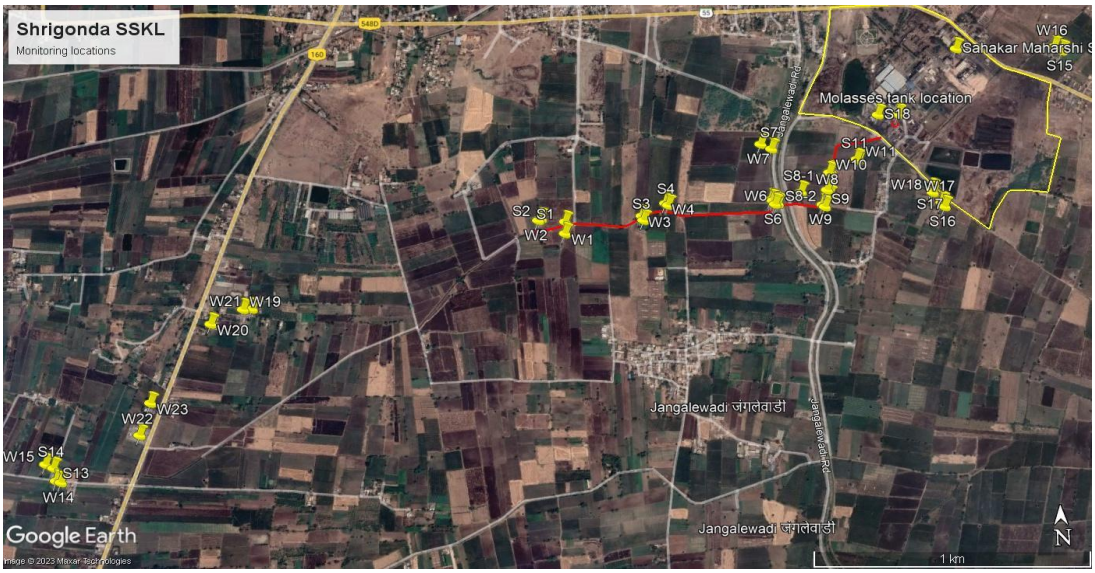


Figure 2.2: The sugar factory premises and the location of the tank is shown; The red line indicates the flow of molasses in the natural drainage.

Figure 2.3: Ground water monitoring locations from zone 1- sample W01 to W07 and the sugar factory premises (Yellow polygon) showing the molasses tank location where accident occurred





Figure 2.4: Photographs of water sampling conducted for damage assessment study

Sampling Zone 1: Locations W 01 to W 07 - Samples from molasses spread area; distance in the range of 490 m to 1350 m from accident site

In the entire sampling zone, dug wells are the only groundwater sampling source. There is a canal passing between the sugar factory and this sampling zone. This zone observed moderate spread of the molasses after the accident. Molasses flowed in the natural drainage passing close to the sampled dug wells. It was spread partially in the agricultural fields along the natural drainage. Dug well water contamination was observed to minor extent. W 05 and W 06 sample locations are very close to the natural drainage that carried molasses after the accident. These locations are observed very close to the canal. Similarly, location W04, W 03 and W 02 were other sampling locations close to and in downstream directions of the natural drainage.

Sampling Zone 2: Locations W8 to W11 - Samples from molasses spread area; located within 400 m from accident site. This is the high affected zone, located in the immediate surroundings of the accident site. In this, sampling locations W10 and W08 are observed very close to the natural drainages. Local persons communicated that these two wells were majorly affected by the accident. Molasses entered into these wells and contaminated the water. Therefore, the analysis results of ground water samples collected from these locations are of high importance for the study.

Figure 2.5: Groundwater monitoring locations from sampling zone 2- sample W08 to W11

Sampling Zone 3: Samples collected from dug wells near river Ghod; located at a distance of 5,960 m and 5,920 m respectively from the accident site. These two locations were at distant places from the accidental site. The objective of sampling here was to check the status of ground water near the river, any influence of accident through the discharges from nala on ground water before it meets the river (Ghod). In addition, any capillary action from river water was also able to check.

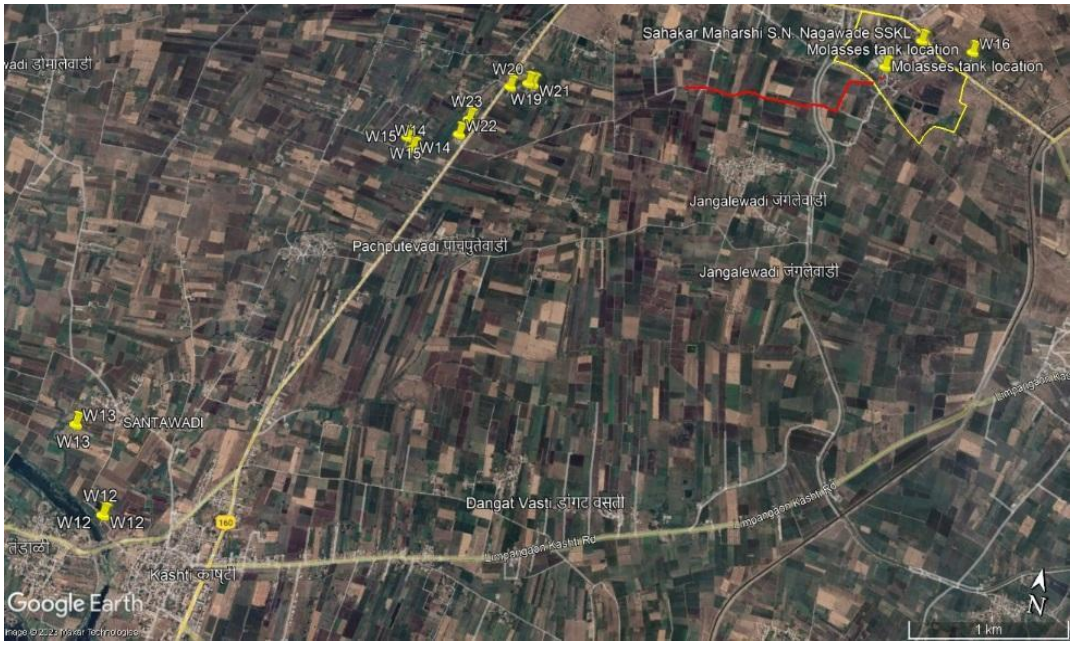


Figure 2.6A and 2.6B: The first image shows the site and sampling location W 12 and W13 and second image shows the close-up of location W12 and W13.

Sample zone 4: Samples from affected area beyond 3000 m from accident site (Sample W14, W15, W19 to W23)

After the accident, molasses which flowed through the natural drainage was stopped near location W02 and W01 (locations marked at figure 2.3) by constructing a temporary bund. The factory lifted the molasses from this point, carried it into the tankers to the spent wash storage tanks of the factory. Therefore, the samples W14, W15 and W 19 to W23 considered as low or low to moderately affected.

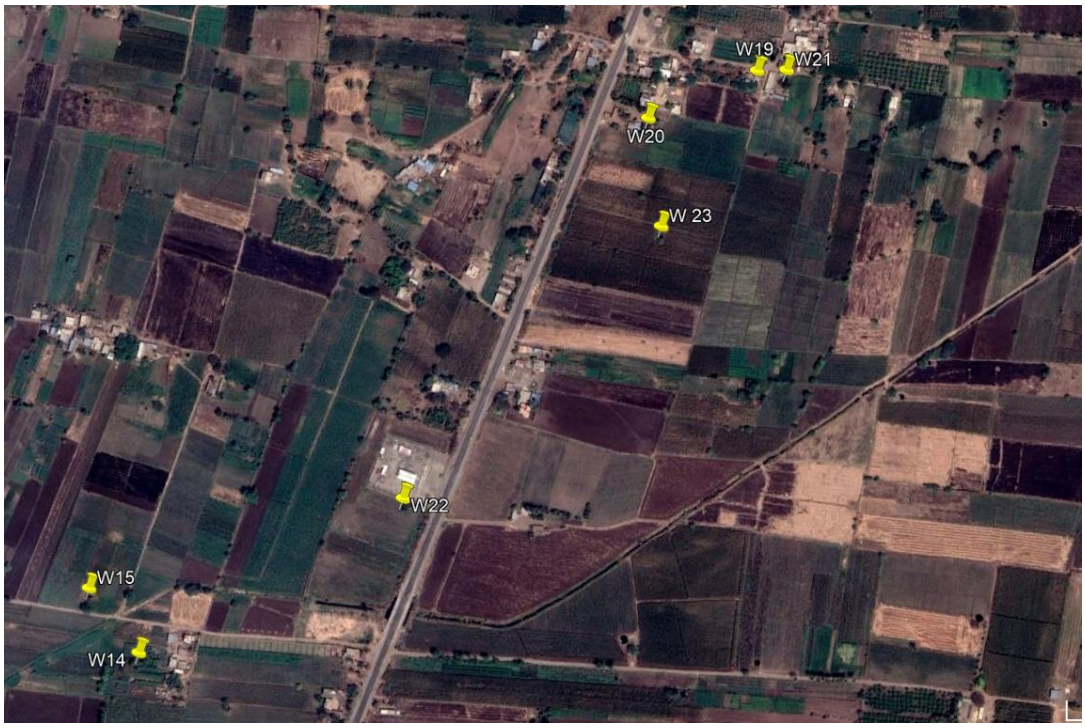


Figure 2.7: Groundwater monitoring locations from sampling zone 4- sample W14, W 15 and W19 to W 23

Sample zone 5: Samples from area where molasses spread not observed (W 16 to W 18)

Sample locations of this zone were situated on the upper side of the natural drainage (W17 and W18) and one sample location W16, on the other side of the factory/opposite side of the accident affected area. The test results of the same indicate the baseline values of various parameters for the rest of the non-affected area. By comparing the results of samples from the affected areas with these sample results, it will able to get some conclusion about the impact due to accidental intrusion of pollutants.

Figure 2.8: Groundwater monitoring locations from zone 5- sample W16 to W18

Table 2.3: Analysis results of Ground water samples collected from the study area

Parameters	Unit	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11
pH at 25°C	---	7.7	7.5	7.5	7.6	7.7	7.5	7.5	7.4	7.4	7	6.8
Electrical Conductivity@25°C	µmhos/cm	1275	1230	1056	0980	0979	0876	0846	4076	1983	1884	2771
Colour unit	CU	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total Dissolved Solid	mg/l	760	732	628	568	568	536	502	2438	1182	1122	1658
Chemical oxygen demand	mg/l	64	48	16	16	32	16	32	64	32	48	96
Biochemical Oxygen Demand 27° C for 3 days	mg/l	26	19	5	5	10	5	13	26	13	19	35
Total Suspended Solids	mg/l	8	10	6	8	8	6	12	16	6	8	8
Hardness(Total)	mg/l	206	296	208	202	200	190	182	1040	640	640	680
Dissolved Oxygen	mg/l	4	4.1	3.8	3.9	3.8	3.9	3.6	3.8	3.3	3.8	3
Total Solids	mg/l	1124	1128	848	724	726	608	592	372.8	1242	1168	1694
Chlorides as cl	mg/l	99.97	139.96	119.96	89.97	99.97	59.98	39.99	499.85	439.8	269.9	389.8
Calcium as Ca	mg/l	72.14	88.17	77.14	76.15	108.21	96.19	60.12	284.56	148.29	156.31	228.45
Fluoride as F	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Magnesium as Mg	mg/l	6.31	18.46	6.318	2.916	22.30	22.79	29.61	183.57	116.56	117.53	109.72
Residual Chlorine	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sulphate as SO4	mg/l	140	163	125	103	112	80	78	567	435	351	412
Phosphorous (P)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Potassium (K)	mg/l	2	1	1	2	2	2	BDL	1	1	1	5
Sodium (Na)	mg/l	48.66	38.22	48.96	29.06	29.06	29.06	27.68	218.7	213.7	167.4	206.8
N as Nitrate (NO3) nitrogen	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total alkalinity as CaCO3	mg/l	257.5	402.5	300	197.5	210	212.5	225	360	372.5	387.5	695
Silica (SiO2)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2.467	4.54
Copper (Cu)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Manganese (Mn)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Iron (Fe)	mg/l	2.595	0.321	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead (Pb)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nickel (Ni)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chromium (Cr) Total	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium (Cd)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc (Zn)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Parameters	Unit	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23
pH at 25°C	---	7.8	7.4	7.2	7.2	7.9	7.5	7.7	7.14	7.37	7.39	7.78	7.2
Electrical Conductivity@25°C	µmhos/cm	5848	6389	3071	1898	1245	1001	5035	1780	2480	3560	1610	3130
Colour	CU	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Total Dissolved Solid	mg/l	3320	3742	1762	1134	736	596	3002	1098	1500	2140	968	1897
Chemical oxygen demand	mg/l	16	16	16	BDL	48	16	176	16	24	20	20	46
Biochemical Oxygen Demand (@27°C for 3 d)	mg/l	6	6	6	BDL	19	6	67	06	11	09	09	18
Total Suspended Solids	mg/l	4	16	10	8	6	6	20	14	16	14	12	72
Hardness(Total)	mg/l	780	900	620	680	440	260	840	330	510	330	130	1270
Dissolved Oxygen	mg/l	2.9	3.2	3	4.1	4	3.2	3	4.1	3.5	3.3	3.5	4.8
Total Solids	mg/l	4106	3776	1842	1152	796	612	3116	2012	1802	2168	1020	1942
Chlorides as cl	mg/l	479.8	659.8	379.8	429.8	269.9	219.9	529.8	899.72	1199.63	1499.54	799.75	374.88
Calcium as Ca	mg/l	224.44	436.87	108.21	112.22	116.23	100.2	172.34	80.16	120.24	112.24	40.08	245.28
Fluoride as F	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Magnesium as Mg	mg/l	135	112.54	122.41	137.97	80.62	38.83	162.24	31.59	51.03	12.15	7.29	159.89
Residual Chlorine	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sulphate as SO4	mg/l	824	828	694	693	362	301	594	111.88	113.88	114.75	112.50	96.50

Parameters	Unit	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23
Phosphorous (P)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Potasium (K)	mg/l	2	1	1	2.63	0	1	51.1	BDL	BDL	BDL	BDL	BDL
Sodium (Na)	mg/l	333.9	419.7	247.2	242.3	210.8	219.7	241.3	364	475.5	212.81	111.33	71
N as Nitrate (NO3) nitrogen	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.7619	1.719	1.785	1.327	BDL
Total alkalinity (as CaCO3)	mg/l	330	335	295	260	245	345	467.5	125	135	150	145	302.5
Silica (SiO2)	mg/l	2.85	3.24	1.68	1.298	2.467	2.33	4.15	19.93	17.97	15.29	13.88	21.47
Copper (Cu)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Manganese (Mn)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Iron (Fe)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.00	2.30
Lead (Pb)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nickel (Ni)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chromium (Cr) Total	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium (Cd)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc (Zn)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.12

BDL = Below Detection Limit

BDL value of respective parameter is given in the final test report enclosed as annexure VII to this document.

Water Quality Test Results

a) pH

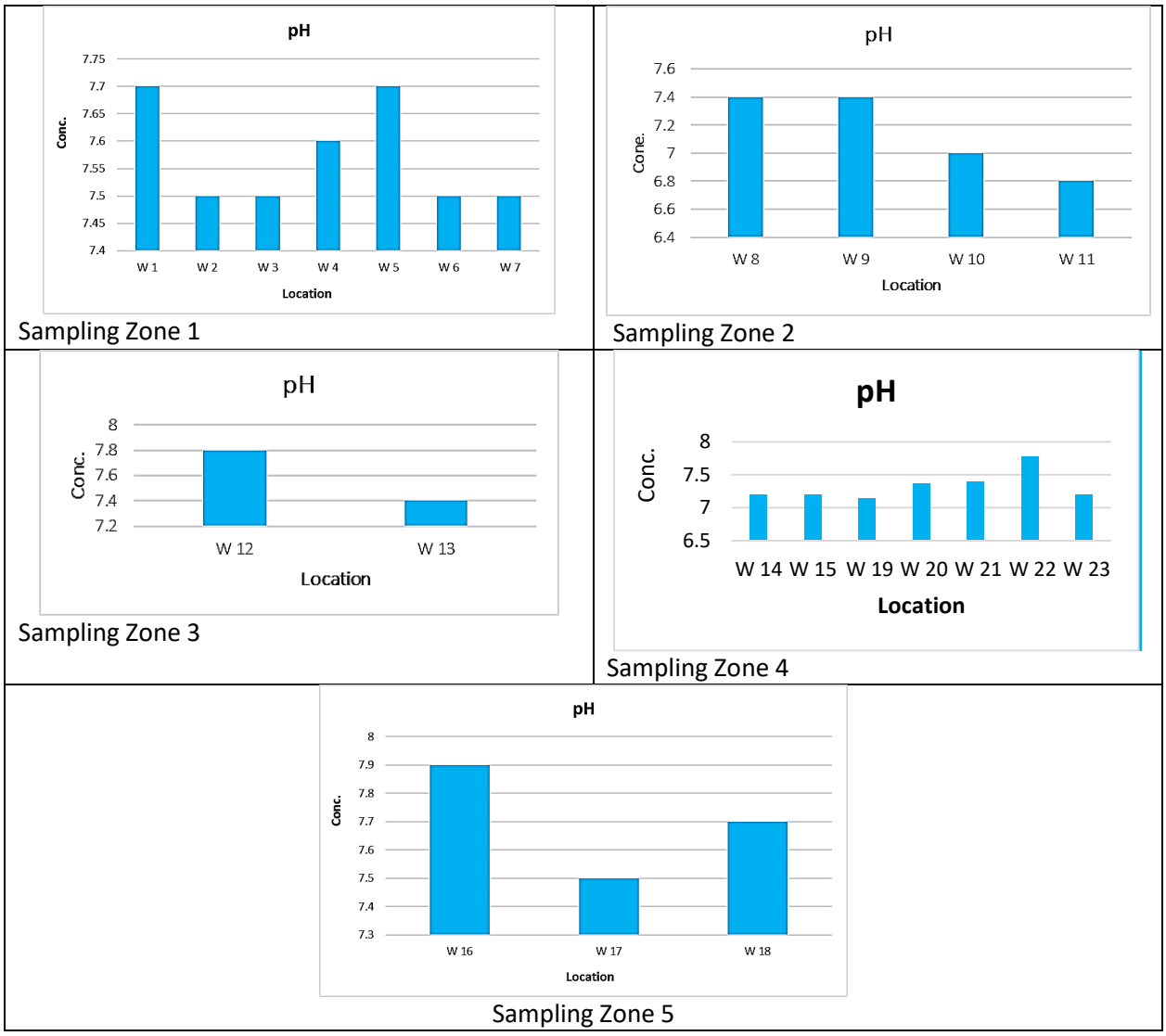


Figure 2.9: Graphical presentation of pH value of all groundwater samples of the study area

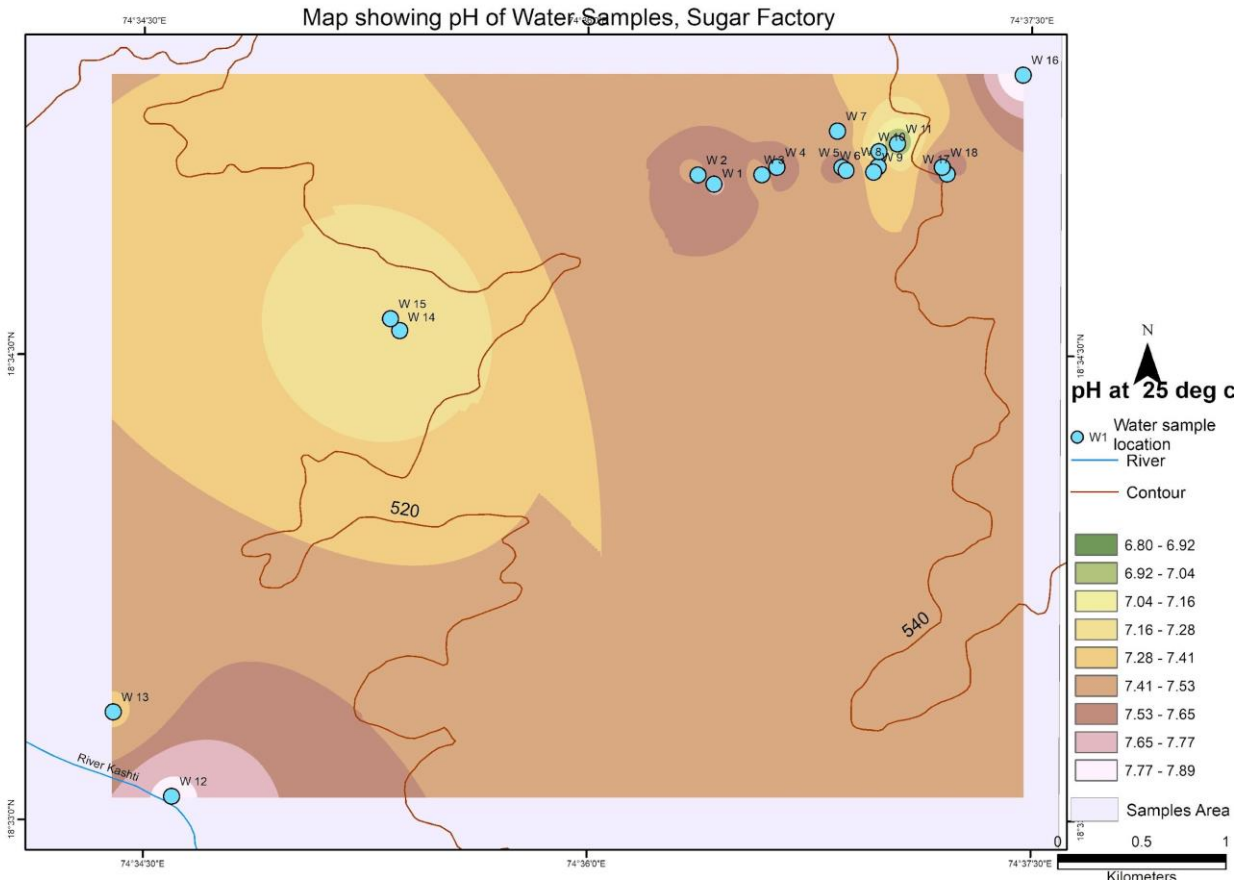


Fig. 2.10: Spatial distribution of pH in the study area

Observations: Test values observed for Zone 5 – which is a non-affected area – are important indicators and comparison of results from affected area will give easy understanding of overall test results. Sampling zone 01 and 02 were the moderate to high affected areas. Therefore, results of samples from this zone anticipated to give a true picture of the current situation.

To begin with, pH is the foremost important parameter. It was observed from table 1.1 that molasses is having acidic pH. Therefore, if it is present in the waterbody it would indicate acidic character of water. The groundwater from the study area was observed near neutral to slightly alkaline (pH: 6.8 to 7.9; avg. 7.5). The spatial variations of pH in the groundwater regime from the Janglewadi Odha micro watershed show interesting variations (Fig. 2.10). Highest pH is seen in dug-wells to the northeast of the Sugar Factory (W16 – non affected area) and close to the Ghod River near Kashti (W12). Lower pH (<7.2) is seen along the Ghod LBC and NW of Pachputewadi (W14, W15). The lower pH zone NW of Pachputewadi may be due to agricultural return flow from canal water irrigation. The area north of Janglewadi (W2 to W8) shows moderate to high pH. It was observed that, pH of 6.8 for sample W11 is the only sample from Sampling zone 2 having trace of acidic nature. All other ground water samples from Sampling zone 1 to 4 are having pH of 7.2 to 7.8. From the monitoring results, it was observed that the acidic effect due to molasses did not persisted for sampled locations. Probable reason for neutralization of pH of sampled ground water is rain water as well as natural dilution of ground water.

b) Electrical conductivity

Electrical conductivity of ground water samples from the study area show wide variations and range from 846 to 6389 µmhos/cm (Table 2.3). Based on the electrical conductivity the samples from the present study fall within 3 categories viz. 8 samples represent low (C1 < 2.68 µmhos/cm), 8 samples representing medium (C2 – 2.69 to 5.75 µmhos/cm), 2 samples representing high (C3 >5.56 µmhos/cm) electric conductivity. Lower EC is seen in dug wells (Fig. 2.11) to the northeast of the Sugar Factory (W16) and NW of Pachputewadi (W14, W15). High electrical conductivity (W12, W13) is seen in the south-western part of the Janglewadi Odha micro watershed in the Pimplachamala-Kashti areas.

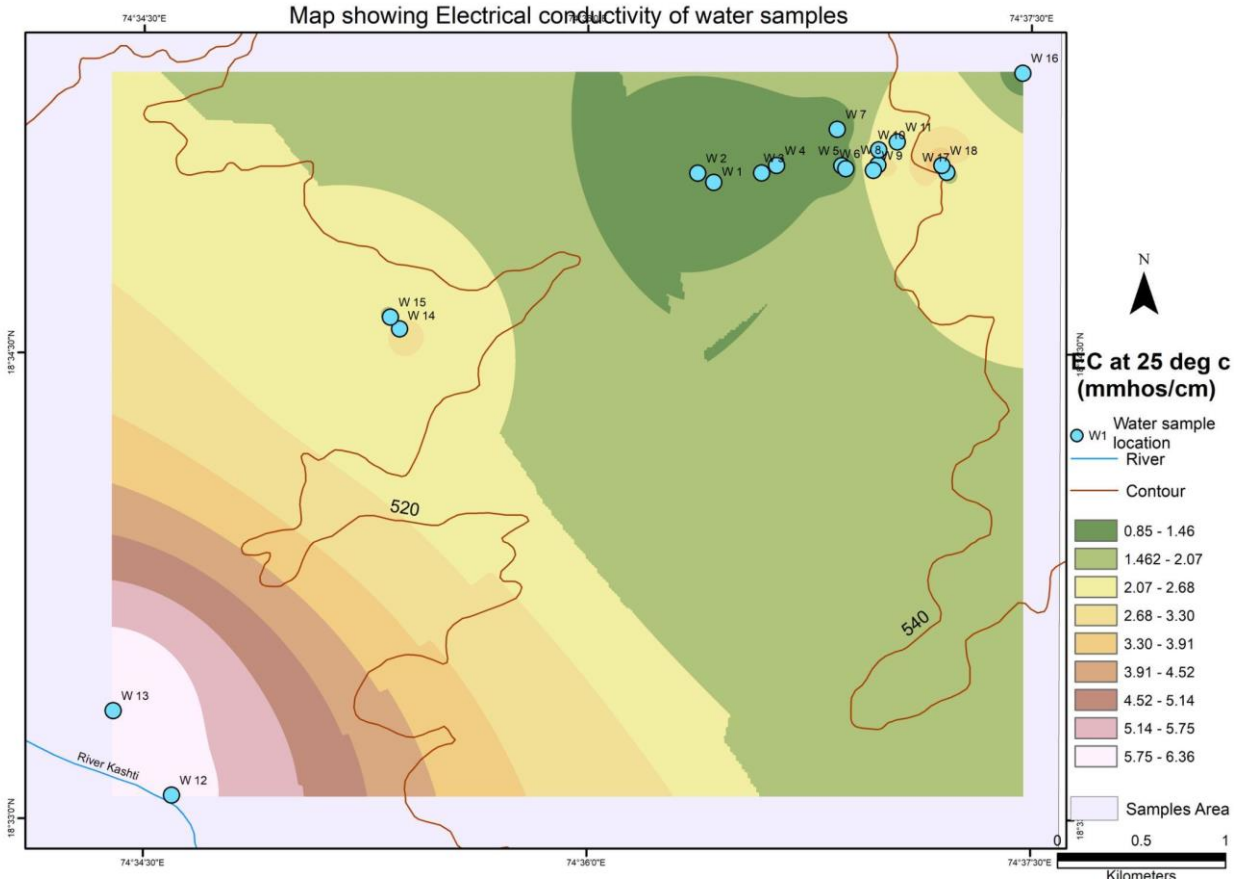


Fig. 2.11: Spatial distribution of electrical conductivity of ground water in the study area

c) Dissolved Oxygen (DO)

Dissolved Oxygen (DO) is vital for the survival of aquatic life forms in water. Dissolved oxygen also affects oxidation-reduction reactions involving iron, manganese, nitrogen and sulphur. It is desirable to maintain dissolved oxygen level as near saturation as possible.

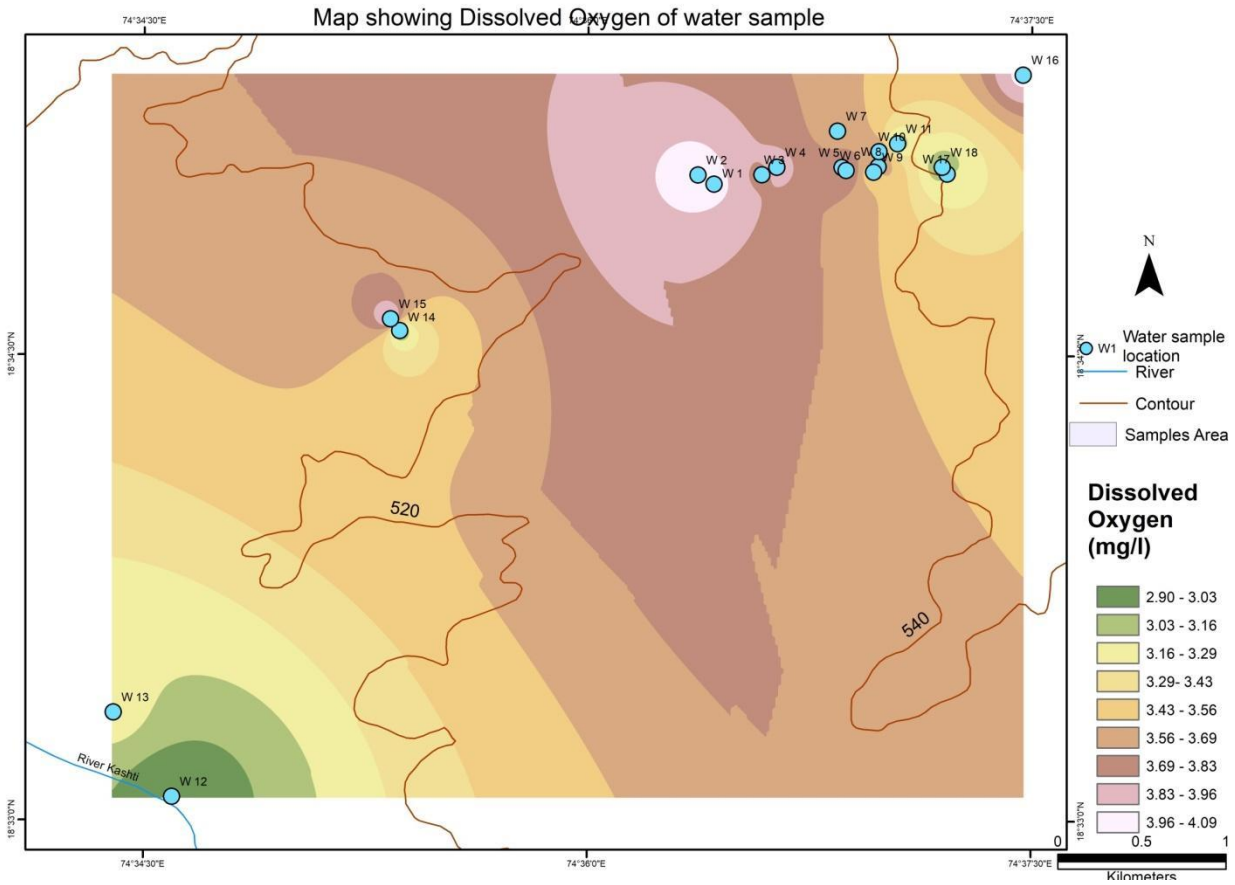
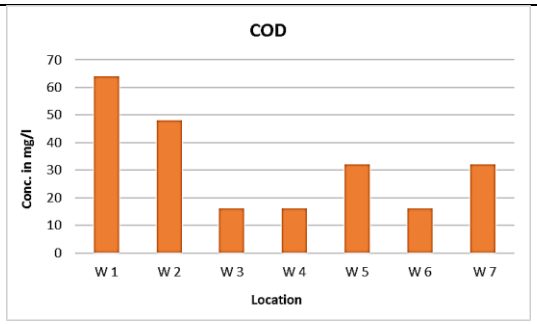


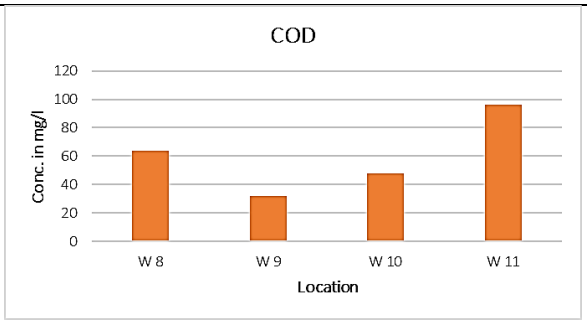
Fig. 2.12: Spatial distribution of DO in the study area

DO is a principle measurement in pollution surveys. Low levels of DO indicate that the water is contaminated with reducing substances. In the groundwater samples from the Janglewadi Odha micro watershed, DO range observed from 2.9 to 4.8 mg/l. The DO shows spatial variations in the Janglewadi Odha micro watershed as two high zones (Fig. 2.12), one to the northeast of the Sugar factory (W16 – DO 4.0 mg/L), and the other along a stream section north of the Janglewadi (W1, W2) and northwest of Pachputewadi (W15). Moderate DO has been recorded northwest of Pachputewadi and for location W 01 to W10 with DO levels in the range of 3.3 mg/L to 4.1 mg/L. Lowest DO value in the study area has been recorded at W12 near Kasthi (DO = 2.8 mg/L) near the confluence with Ghod River.

d) COD



Sampling Zone 1



Sampling Zone 2

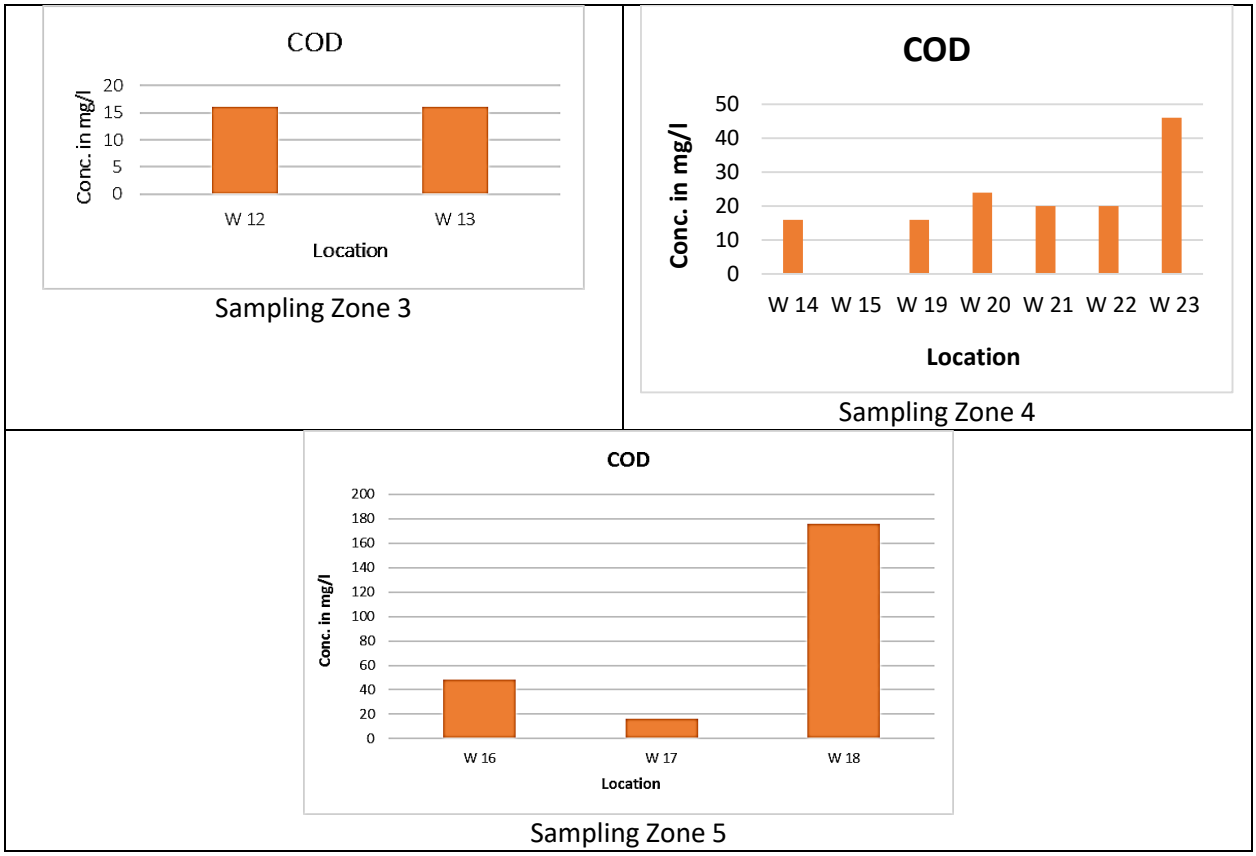


Figure 2.13: Graphical presentation of COD values observed for all groundwater samples of the study area

One of the most important parameter of the study was Chemical oxygen demand (COD). COD was considered as a prime parameter to understand the characteristics of water (ground water) in terms of pollution concentration. Chemical Oxygen Demand (COD) is used for measuring the pollution strength of domestic as well as industrial wastes. All organic compounds can be oxidized; therefore, COD values are generally greater than BOD. However, with COD, it is not possible to distinguish biologically degradable and non-degradable organic matter. COD values from 16 mg/L to 96 mg/l are recorded in the groundwater samples from affected area. Significant variations of COD are seen in the study area. Low COD is seen in the region west of micro watershed (W12 to W15). Low COD (≤ 20 mg/L) isolated pockets are seen around W3, W4, W6, W17 to W19 and W21 and W22 (Fig. 2.13). Of these, sampling location W3, W4 and W6 are very close to the natural drainage that carried the molasses after accident. **According to the Champman (1992), COD of unpolluted water is observed <20 mg/L.** COD value more than 20 mg/L but less than 50 mg/L was reported at W1, W 2, W 5, W7, W 10, W 16, W 20 an W 23. Whereas location W8 and W11 reported COD of 64 mg/L and 96 mg/L respectively. W16 and W 18. Location W 16 and W 18 are from sampling zone 5, which was not affected by the molasses spread. But here, COD value observed 48 mg/L (W 16) and 176 mg/L (W18). This may be due to local contamination of groundwater. Considering the COD of molasses, which was maximum upto 69,000 mg/L (refer table 1.2), traces or fractional COD levels

observed for the sample collected from the study area and particularly from the molasses spread area. It indicates that the impact of molasses as a contaminant of groundwater is totally mitigated.

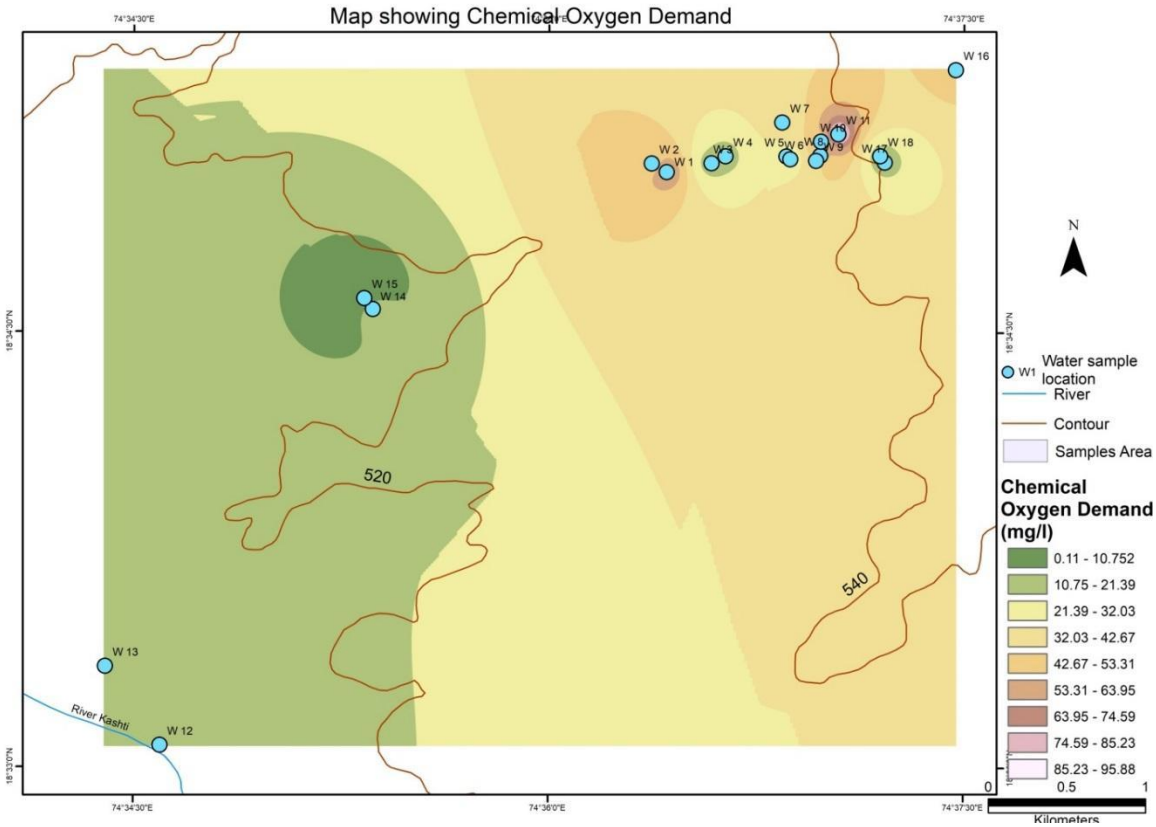
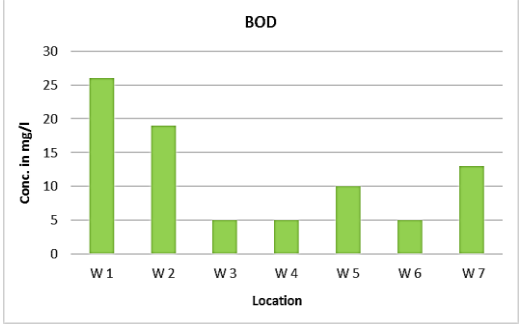
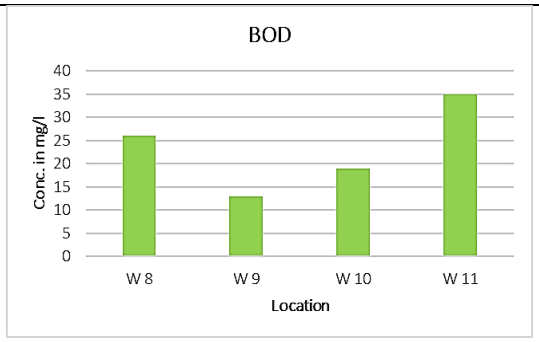


Fig. 2.14: Spatial distribution of COD in the study area

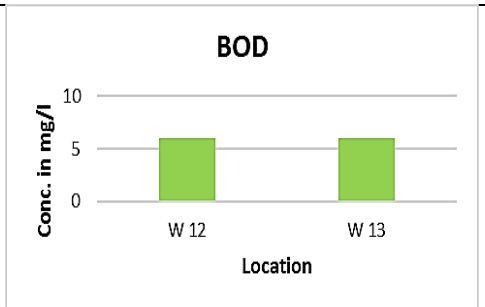
e) Bio-chemical Oxygen Demand (BOD)



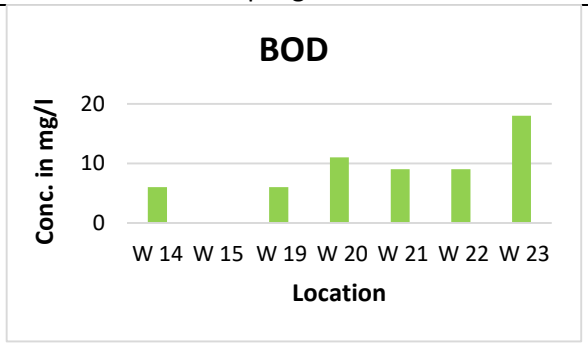
Sampling Zone 1



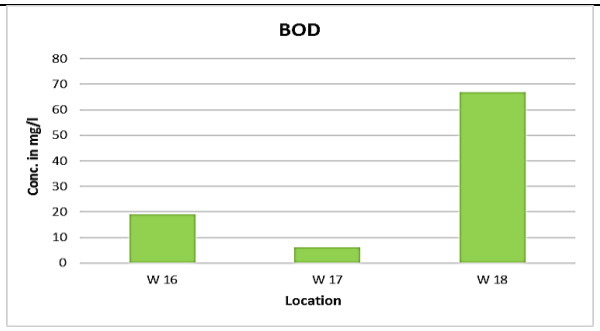
Sampling Zone 2



Sampling Zone 3



Sampling Zone 4



Sampling Zone 5

Figure 2.15: Graphical presentation of BOD values observed for all ground water samples of the study area

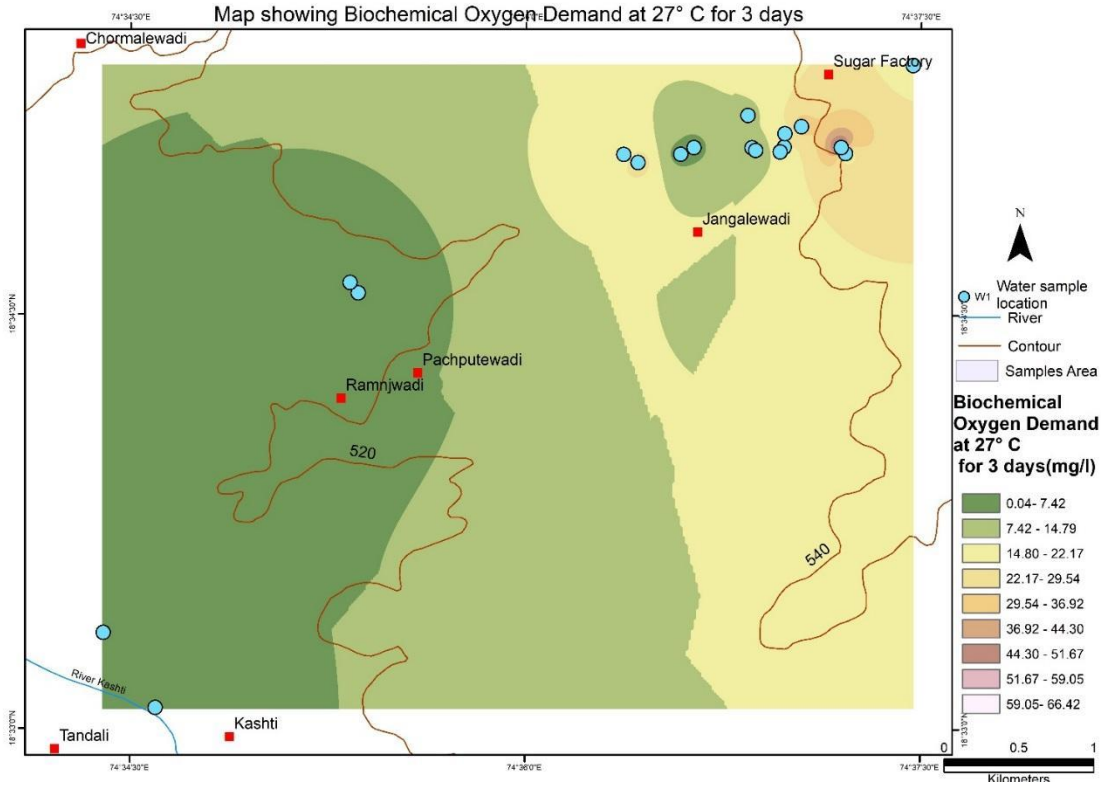


Fig. 2.16: Spatial distribution of BOD in the study area

Biochemical Oxygen Demand (BOD) test measures the oxygen required or consumed by microbes/bacteria, during the process of oxidizing organic matter under aerobic conditions. Greater the organic matter in the water, higher the BOD. The test is therefore used to measure the purification capacity of streams and other water bodies and thus serves the Regulatory Authorities as means of checking on the quality of effluents discharged into such water bodies. In the present study, BOD of 5 to 67 mg/l observed for groundwater samples from the affected area of the study. Out of 23 samples, 12 samples reported to have value of less than 10 mg/L. BOD levels of W 1 to W7 samples observed <30 mg/L. BOD values for samples collected from W3, W4 and W6 observed 5 mg/L. Whereas, BOD value for location W5, W7 and W2 recorded as 10 mg/L, 13 mg/L and 19 mg/L respectively. For location W1, BOD value was 26 mg/L. BOD test values for

monitored locations of sampling zone 2 observed below 30 mg/L except for location W 11. At this location BOD was recorded as 35 mg/L. Highest BOD value of 67 mg/L was recorded for sample W 18 which is from non-affected area.

Therefore, two key pollution indicator parameters i.e. COD and BOD – test values reported for the ground water samples of the study area show low values at most of the monitored locations. COD values more than 50 mg/L reported only at three locations. Similar trend observed for BOD values. Therefore, impact of molasses spread on ground water quality of the study area was not observed from the test results.

f) Total Hardness

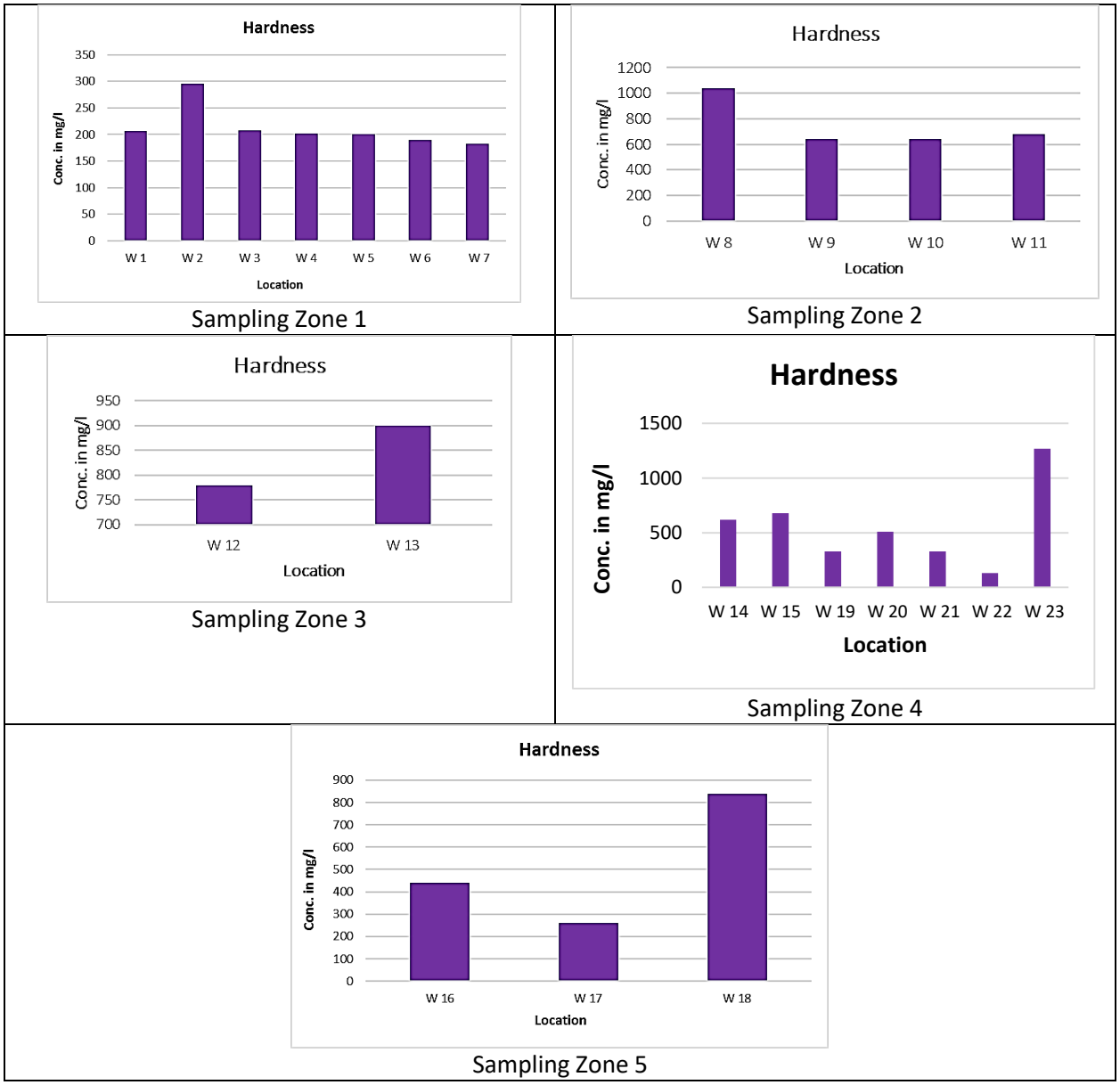


Figure 2.17: Graphical presentation of parameter Hardness observed for all ground water samples of the study area

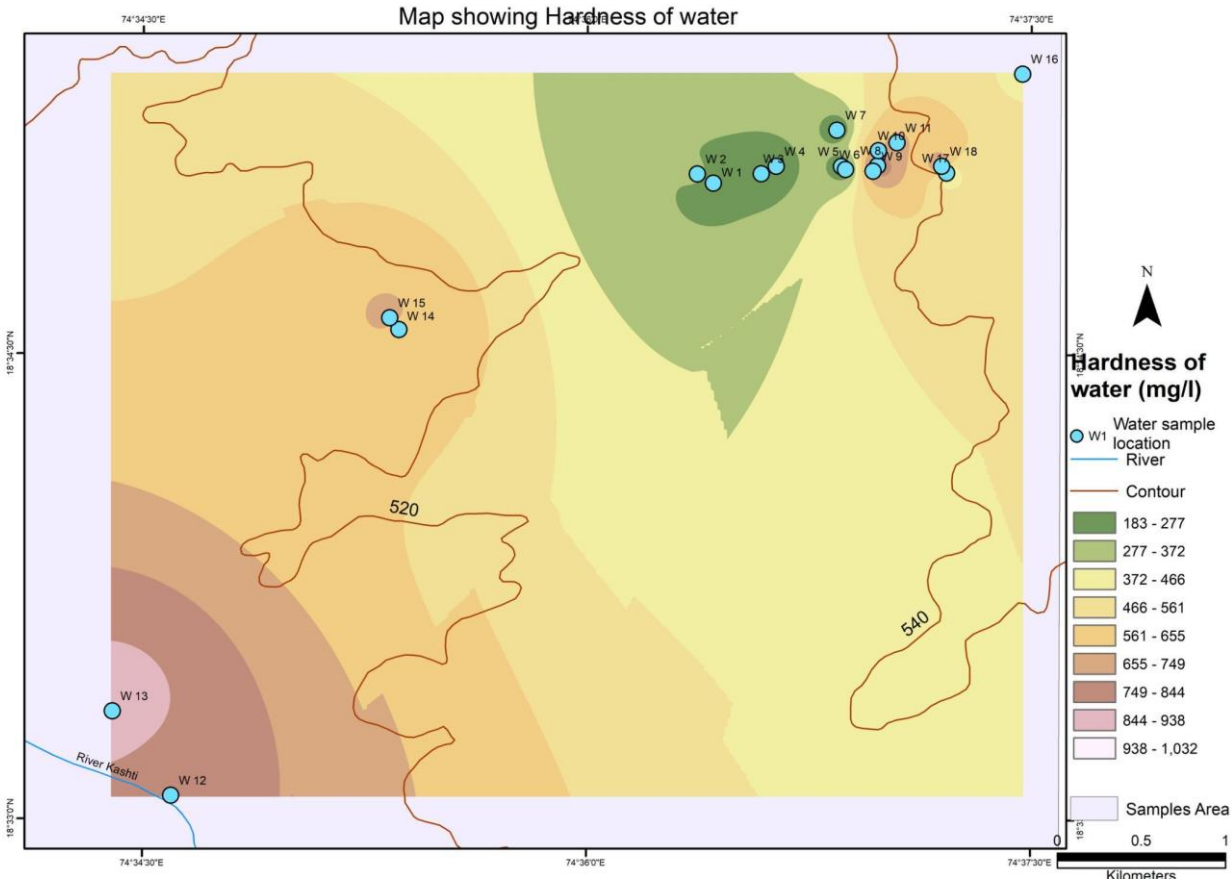


Figure 2.18: Spatial distribution of Hardness in the study area

Total Hardness is an important parameter of groundwater quality, especially when the water is to be used for domestic purposes. Hardness of water indicates the amount of calcium and magnesium dissolved in it. Therefore, water hardness is the total calcium and magnesium ion concentration in a water sample. It is expressed or reported as mg/l as CaCO3 equivalent (i.e. concentration of calcium carbonate). Dissolved calcium (Ca++) and magnesium (Mg++) are the only two divalent cations found at appreciable levels in most waters. In natural water, both calcium and magnesium primarily exist bound to bicarbonate, sulfate or chloride.

The Total hardness is mainly due to Ca and Mg and originates in areas where topsoil is thick and lime rich formations are present. In basalts, the weathering of plagioclase releases abundant Ca along with Mg, which is also additionally released by weathering of augite and olivine.

The Total Hardness for groundwater samples from the study area shows wide variation from 130 to 1270 mg/L. A total of 10 groundwater samples from the micro watershed have total hardness above the prescribed drinking water limit of 600 mg/l. The excess of total hardness in the groundwater may cause scale deposition in the distribution system, excessive soap consumption, scum formation and lead to health hazards such as urolithiasis, nervous system defects, etc. Interestingly, the total Hardness of groundwater varies spatially along the natural nala (Janglewadi Odha) (Fig. 2.18). Moderate to high total hardness was

reported from ground water samples along the Ghod left bank canal and NW of Pachputewadi (W14, W15 and W 09, W 10, W 11). High total hardness was reported for ground water samples from Pimplachamala-Kashti areas (W12, W13), in sampling zone 2 at location W 08 (1040 mg/L)and in sampling zone 05 at location W18 (840 mg/L), W23 (1270 mg/L). Hardness of sample W1 and W3 to W 7 was observed around 200 mg/L. Only for sample W 2 it was observed 296 mg/L. These hardness values of sample W 01 to W 07 was observed expressively less when compared to samples W 16, W 17 and W 18 which represents non-affected areas. For many of the samples, the limit prescribed by IS 10500; 2012 for hardness observed exceeded. Its prescribed acceptable limit is 200 mg/L.

g) Total Dissolved Solids (TDS)

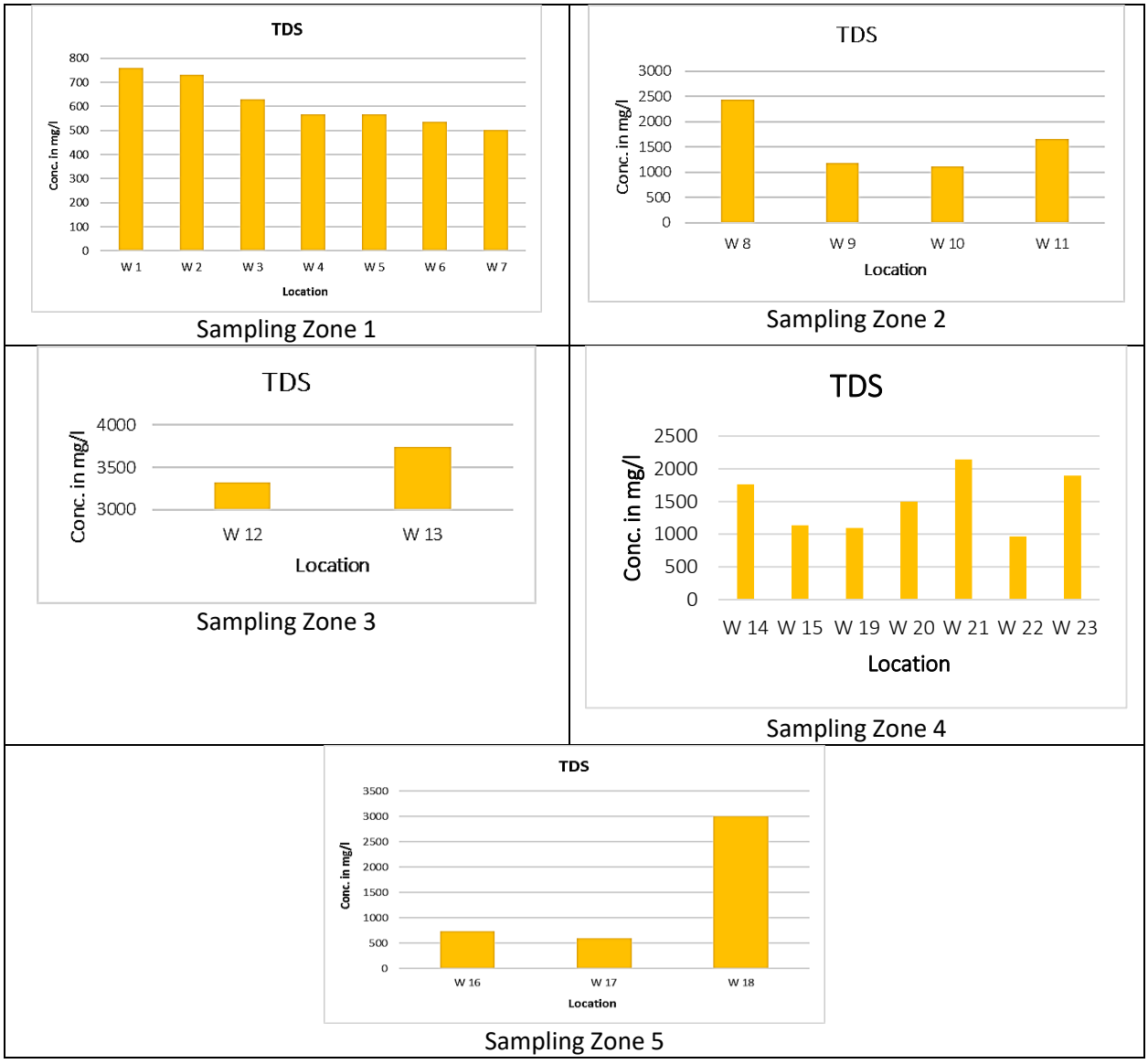


Figure 2.19: Graphical presentation of parameter TDS observed for all groundwater samples of the study area

Total dissolved solids or TDS is the amount of dissolved ions, including salts, minerals and metals, in water source. Hardness and TDS, these two parameters are broadly indicating the characteristics of ground water particularly for drinking and domestic purposes. IS 10500; 2012 prescribes acceptable limit of hardness as 200 mg/L and total dissolved solids this limit is at 500 mg/L.

TDS of samples observed above 500 mg/L at all locations. For locations W 4 to W 7 TDS was observed in the range of 502 mg/L to 568 mg/L. TDS of samples collected at W1 and W2 observed 760 mg/L and 732 mg/L respectively. TDS value exceeding 3000 mg/L reported for locations W 12 and W13 which are near rive Ghod. These locations are almost 6 km from the site. Similarly, for location W 18 which is from a non-affected area, TDS value reported here of 3002 mg/L. In short, this area is a drought prone area. Due to high abstraction of ground water TDS values may be observed high in this area. An impact due to the accident on TDS values of ground water samples of study area, not observed from the results of the tested samples.

h) Other major cations and anions

Calcium is one of the most abundant cations in the groundwater from the area. The calcium concentration in the study area ranges from 60.12 to 436.87 mg/l. The abundance of calcium can be related to weathering of plagioclase and augite in the basalts and precipitation of calcrete or calci from surface water or groundwater. The Magnesium (Mg) concentration in the groundwater from the study area is subordinate to Calcium and has a limited range from 2.91 to 183.57 mg/l. Third major cation studied for groundwater from the study area was Sodium (Na). Its concentrations ranged from 29.06 to 475.5 mg/L. The concentration of potassium (K) in the groundwater of study area observed below detection level for most of the samples. But, highest potassium level of to 51.1 mg/l reported for location W 18.

The chloride (Cl) content in the well water samples of study area observed vary in the range of 39.99 to 1499.54 mg/l. High chloride of > 200 mg/l is associated with 16 from the study area and can be attributed to several factors such as domestic sewage, effluents and excessive irrigation with poor drainage and water logging. Thus, in the micro watershed the high EC-Cl water appears to be associated with the highly saline waters from Pimpalchamala and Kashti along the Ghod River. Lowest Chloride content reported in dugwells along the stream north of Janglewadi.

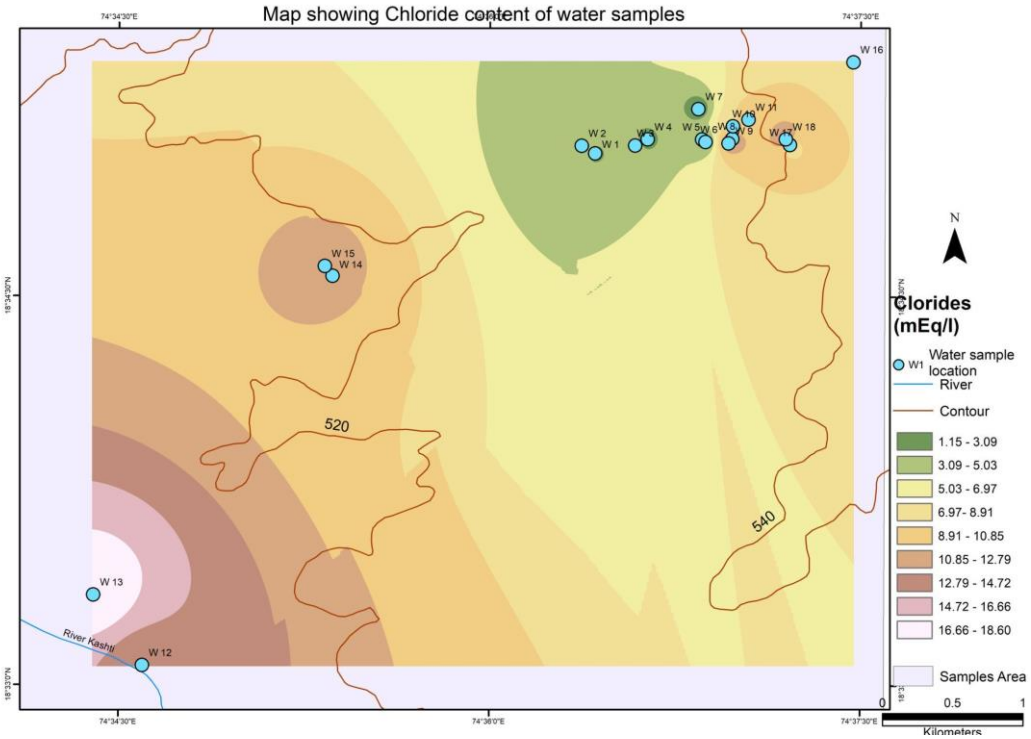


Figure 2.20: Spatial distribution of Chloride in the study area

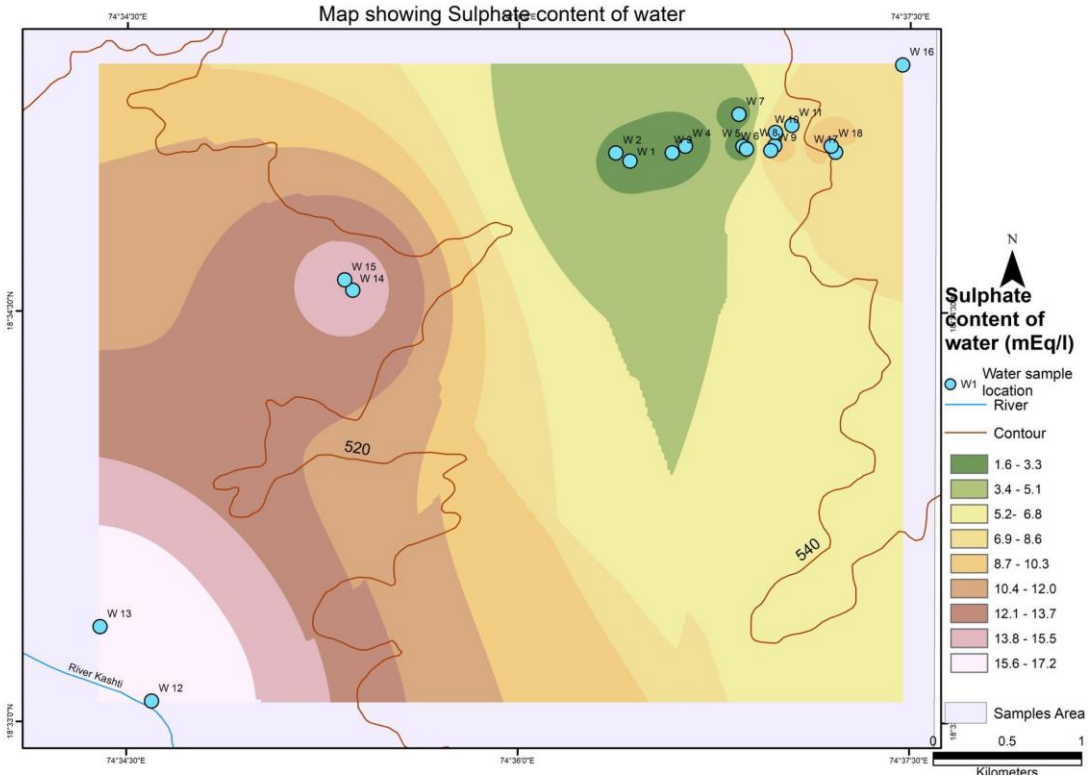


Fig. 2.21: Spatial distribution of Sulphate in the study area

In case of sulphate (SO_4) content of groundwater from the study area, it varied from 78 to 824 mg/l. High sulphate is spatially distributed towards the lower reaches of the Janglewadi Odha micro watershed (W12, W13, W14, and W15). A higher sulphate content zone is seen around W12 and W13. The lowest spatial distribution of sulphate concentrations are seen in the waterlogged areas in and around Pachputewadi and

especially along the dugwells north of Junglewadi (Fig. 2.21). Nitrogen as Nitrate (NO_3), Residual chlorine, and phosphorous (P) are not detected in the groundwater samples from the present study.

The total alkalinity in the ground water from the study area varied from 125 to 695 mg/l. In general, the spatial distribution of the total alkalinity of groundwater from the study area show low to moderate values (Fig. 2.22), except along the Ghod left bank canal where the total alkalinity is considerably high (W18 and W9 to W11).

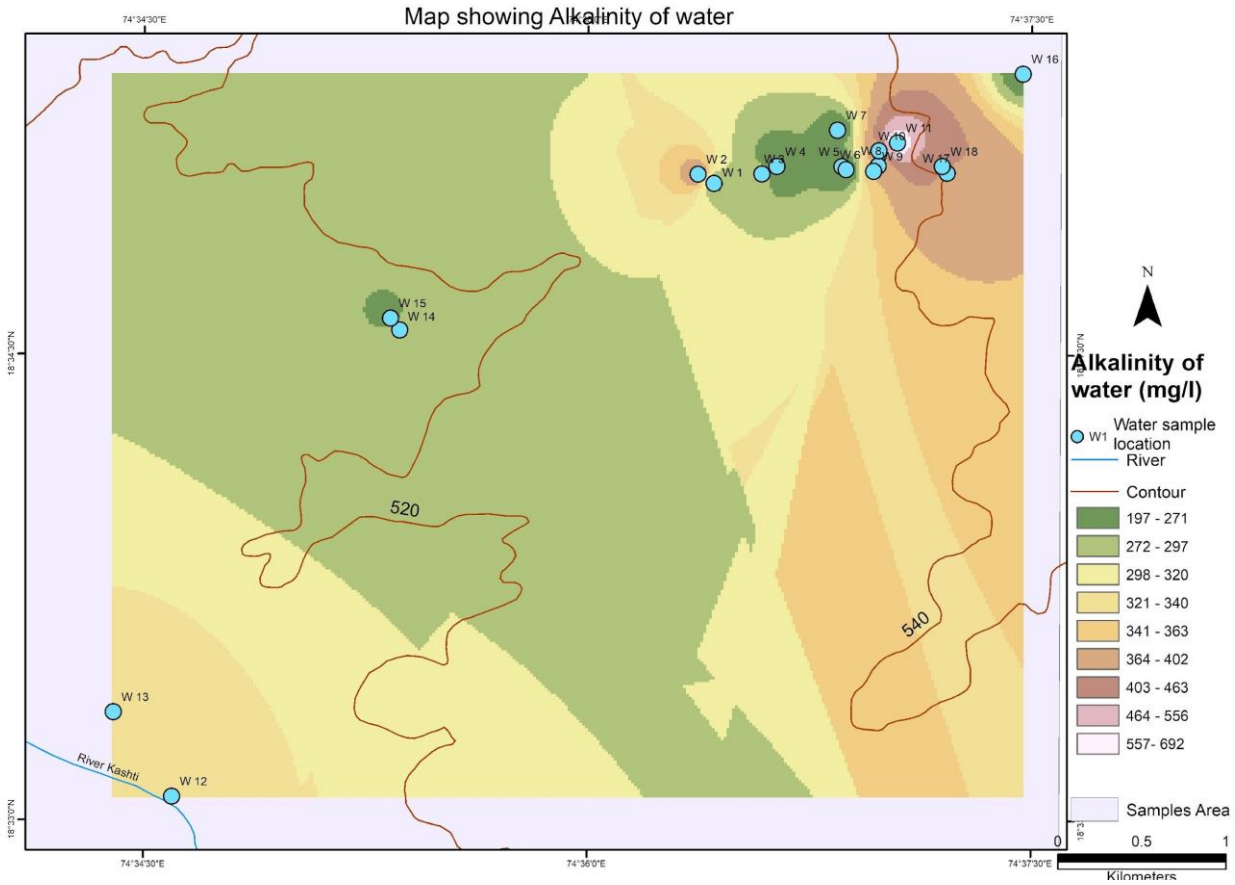


Fig. 2.22: Spatial distribution of Alkanity in the study area

Colour: This test parameter is discussed specifically because the molasses which spread accidentally having dark brown colour. Therefore, parameter color considered important for the study. It was observed that, all collected samples were transparent and having no traces of any colour.

The ground water sample analysis results of the study area indicate that the impact of accidental contamination of molasses on the ground water characteristics of the area could have attenuated naturally. Test parameters of samples from the accident affected area as well as from non-affected places were varied in more or less a same range.

3.0 Soil sampling, analysis and interpretation

In this study, soil sampling was carried out initially at 18 locations. Later, another seven samples were collected and thus total 25 locations/samples. Soil samples were collected on the same day/date as water samples. These samples were collected, handled, stored and transported as per the standard procedures developed by the laboratory. Soil samples were collected and analysed with an objective of assessing the damage due to spread of molasses mainly in the agricultural fields of affected area. Samples were collected from the affected as well as non-affected areas for the purpose of comparison and interpretation. Results of the same are as follows.

Table 3.1: Categorization of zones and details of sample collected form each zone

Sampling Zone	Sample identification /location code	Location/Identification Details
Zone 1	S01 to S07	Samples from molasses spread area; distance in the range of 450 m to 1450 m from accident site
Zone 2	S08 to S12 and S17 to S19	Samples from molasses spread area; located within 400 m from accident site S17 and S18 – locations not affected by the molasses spread but located in the downstream of tanks were molasses was stored after collection from the field S19 is within factory premises – closer to outlet of natural drainage, near molasses tanks.
Zone 3	S13	Samples collected near river Ghod;
Zone 4	S14, S15 and S20 to S25	Samples from affected area beyond 3000 m from accident site
Zone 5	S16	Samples from area where molasses spread not observed

Table 3.2: Geographical location and distance from factory of collected samples

Sample identification/ location code	Distance (aerial distance in m)	Latitude and Longitude
S 01	1247	18°35'4.61"N, 74°36'25.67"E
S 02	1328	18°35'5.10"N, 74°36'22.67"E
S 03	971	18°35'4.41"N, 74°36'35.47"E
S 04	866	18°35'6.19"N, 74°36'38.63"E
S 05	502	18°35'6.68"N, 74°36'51.79"E
S 06	531	18°35'5.63"N, 74°36'51.30"E
S 07	442	18°35'12.77"N, 74°36'51.93"E
S 08	404	18°35'7.19"N, 74°36'55.34"E

S 09	325	18°35'7.33"N, 74°36'58.62"E
S 10	378	18°35'5.22"N, 74°36'58.23"E
S 11	271	18°35'10.01"N, 74°36'58.90"E
S 12	161	18°35'11.01"N, 74°37'2.54"E
S 13	5953	18°33'20.37"N, 74°34'22.64"E
S 14	3325	18°34'35.17"N, 74°35'21.26"E
S 15	3308	18°34'37.71"N, 74°35'20.85"E
S 16	737	18°35'25.25"N, 74°37'29.29"E
S 17	341	18°35'4.66"N, 74°37'13.22"E
S 18	268	18°35'6.89"N, 74°37'11.77"E
S 19	81	18°35'16.56"N, 74°37'5.53"E
S 20	2488	18°34'54.57"N, 74°35'44.65"E
S 21	2608	18°34'53.25"N, 74°35'40.77"E
S 22	2427	18°34'55.72"N, 74°35'46.50"E
S 23	2990	18°34'40.32"N, 74°35'31.41"E
S 24	2928	18°34'42.88"N, 74°35'32.70"E
S 25	2570	18°34'52.36"N, 74°35'41.86"E

Figure 3.1: Soil sampling in the study area and its packing/handling

Sampling zones are more or less same as water sampling zone. Hence, the description of the sampling zone is similar. But, for easy understanding and ready reference it is described here.

Sampling zone 1: Sample identification/Location code S1 to S7

In this area, moderate spread of molasses was observed. This spread was observed mainly in those field/soils, which located along the natural drainages (Junglewadi Odha) carrying molasses. Thus, the soil sampling locations were near to the ground water sampled locations.

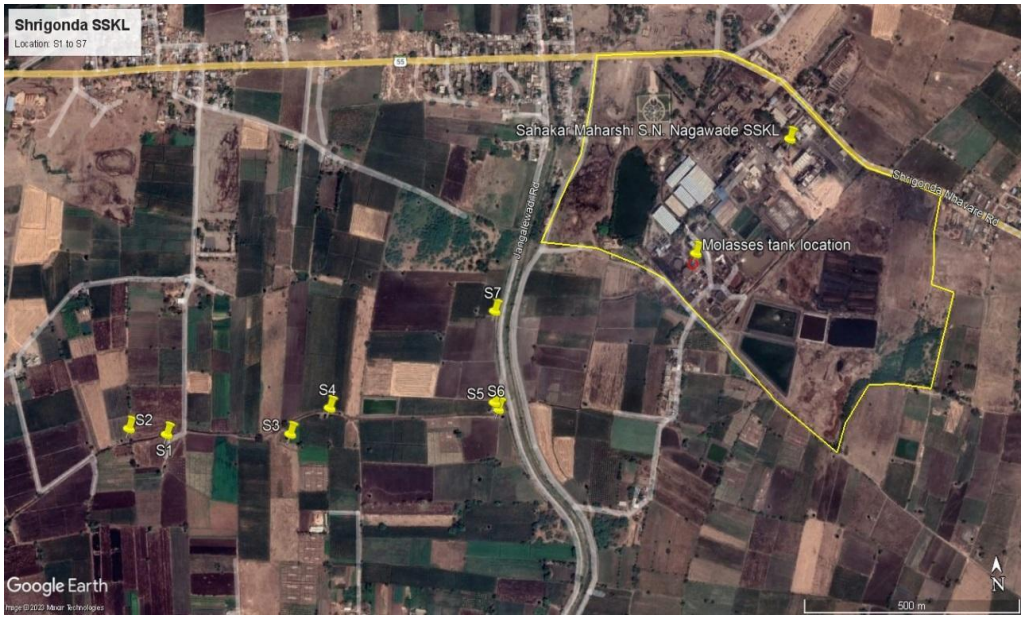


Figure 3.2: Soil sampling zone 1: Sample identification/location code S01 to S07

Figure 3.3A & 3.3B: Soil sampling locations from Zone 2 – sample identification/location code S8 to S12 & S17 to S19

Sampling Zone 2: Locations S08 to S12 and S17 to S19

Soils of this zone were highly affected due to the molasses spread. According to the locals, molasses spread over the soil was observed for a few days after the accident. Later, it was removed by the factory team. On this background, the results of soil sample testing of this zone were considered a very important part of the study.

Sample S 19 was collected from the factory premises. This sample was collected from the accident affected open land inside the factory premises. Samples S17 and S18 were collected outside the premises. Spots were located in the upward side of Junglewadi odha (nala carried molasses after the accident) and thus considered as a non-affected area. But it is in the close vicinity of the factory. Hence, these samples were grouped together under sampling zone 02.

Figure 3.4: Soil sampling zone 3 - Sample identification/location S13

Sampling Zone 03: It represents, only one sample collected near to the river Ghod. It is close to the confluence zone of the Junglewadi odha and the river. The sampling spot was approx. 6 km away from the accident spot. Thus, more or less represents the background characteristics of the soil. In addition, the influence of the river was anticipated on its characteristics. Hence, the sample was collected from this area.

Figure 3.5: Soil sampling locations from Zone 4: Sample identification/location code S14, S15 & S20 to S25

Sampling zone 04: Considering soil contamination due to the accident, soils in this zone was relatively low or very minor affected. In general, the samples are collected at an approx. distance of 3.0 km from the accident site.

Figure 3.6: Soil sampling zone 5 - locations S16

Sampling zone 5: This sample was collected outside the factory premises but from other end – i.e. where no molasses discharge observed at all.

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Table 3.3: Analysis results of Soil samples collected from study area

Parameters	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
pH at 25°C	---	8.75	8.69	8.90	8.28	8.25	8.60	8.80	7.25	8.39	8.54	8.53	8.59
Electrical Conductivity@25°C	µmhos/cm	752.4	562.4	606.4	593.3	541	393	325.2	2757	1240	492.2	468.2	519.9
Moisture	%	23.85	11.12	16.21	6.6	10.17	6.29	14.35	16.77	31.05	13.92	9.47	11.74
Available Nitrogen	Kg/Ha	119	129	151	176	113	110	107	114	310	132	160	125
Available Phosphorus	Kg/Ha	7.52	7.61	10.07	1.5	9.74	16.34	14.3	12.75	24.41	22.57	0.167	2.25
Available Potassium	Kg/Ha	560	870	234	936	730	127	160	510	540	580	590	500
Organic carbon	%	0.361	0.418	0.932	0.741	0.532	0.437	0.837	0.95	1.0	0.989	0.342	0.818
Organic matter	%	0.623	0.721	1.607	1.279	0.918	0.754	1.443	1.63	1.73	1.705	0.59	1.41
Copper (Cu)	mg/kg	0.975	1.31	1.12	1.08	1.335	1.315	0.59	1	1.8	0.87	1.245	1.26
Manganese (Mn)	mg/kg	11.72	16.6	10.84	9.895	9.495	9.62	7.48	9.9	9.62	12.62	10.31	15.86
Iron (Fe)	mg/kg	492.5	626.05	546	497.5	497.85	542.51	280.1	487	427.3	465.5	367.45	606.2
Zinc (Zn)	mg/kg	0.835	0.94	0.79	0.785	0.91	1.105	0.67	0.71	1.04	0.68	0.805	0.815

Parameters	Unit	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25
pH at 25°C	---	9.12	8.55	8.23	8.4	9.24	8.31	6.46	8.04	7.91	8.07	8.27	8.22	8.24
Electrical Conductivity@25°C	µmhos/cm	525.4	954.1	1466	914.1	313.2	555.8	9574	1678	394.5	272.2	148.2	152	655.7
Moisture	%	10.5	28.5	12.07	9.97	11.86	13.1	12.7	9.3	11.12	23.69	10.35	12	8.86
Available Nitrogen	Kg/Ha	103	163	147	157	141	116	169	248	229	144	154	156	235
Available Phosphorus	Kg/Ha	19.82	23.83	24.23	0.37	3.13	7.81	14.09	0.45	0.083	0.2	0.29	0.32	2.75
Available Potassium	Kg/Ha	520	165	690	540	210	510	580	32	226	239	32.4	38	320
Organic carbon	%	0.627	1.027	0.703	0.799	0.627	0.342	0.97	0.93	0.98	0.85	0.589	0.62	0.65
Organic matter	%	1.082	1.771	1.213	1.377	1.082	0.59	1.67	1.6	1.70	1.47	1.01	0.99	0.84
Copper (Cu)	mg/kg	1.02	0.945	1.525	1.1	1.42	1.02	2.39	0.96	0.98	0.98	1.2	1.21	BDL
Manganese (Mn)	mg/kg	13.54	19.47	14.91	11.33	12.92	13.03	6.065	9.0	8.0	12.0	10.0	11.0	6.0
Iron (Fe)	mg/kg	505	491.3	712.25	600.9	619.5	497.2	461.9	530	620	483	620	560	450
Zinc (Zn)	mg/kg	0.72	0.82	0.985	1.14	0.845	0.75	1.1	0.91	1.12	0.78	0.96	0.98	BDL

3.1 Soil Quality Test Results

1) pH

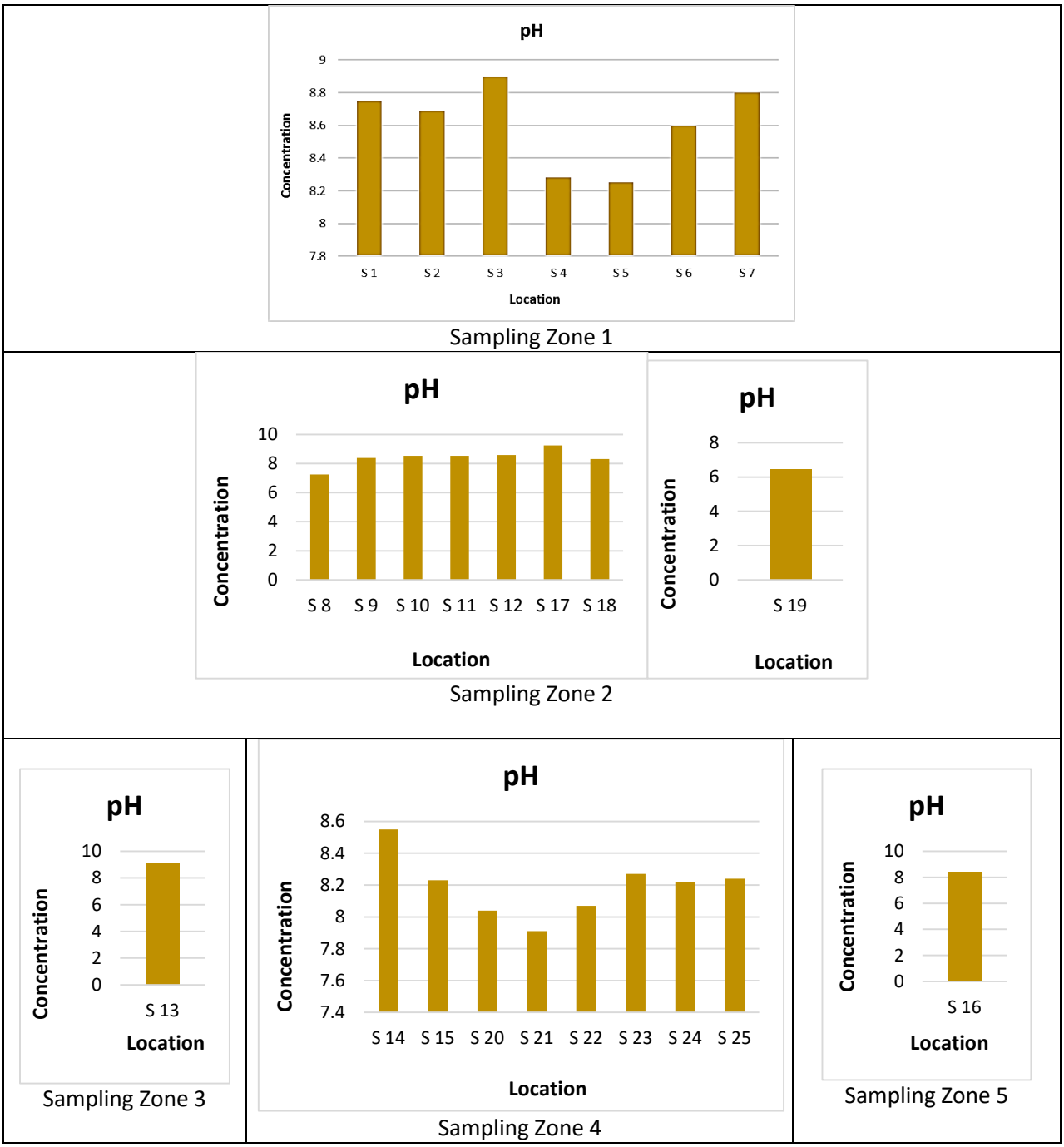


Figure 3.7: Graphical presentation of pH observed for all soil samples of the study area

Soil pH Rating

Sr.No.	Category	Soil pH
1	Very acidic	< 4.5
2	Acidic	4.6- 5.2
3	Moderately acidic	5.3- 6.0
4	Slightly acidic	6.1- 6.5
5	Neutral	6.6- 7.0
6	Slightly alkaline	7.1- 7.5
7	Moderately alkaline	7.6-8.3
8	Alkaline	8.4-9.0
9	Very alkaline	> 9.0

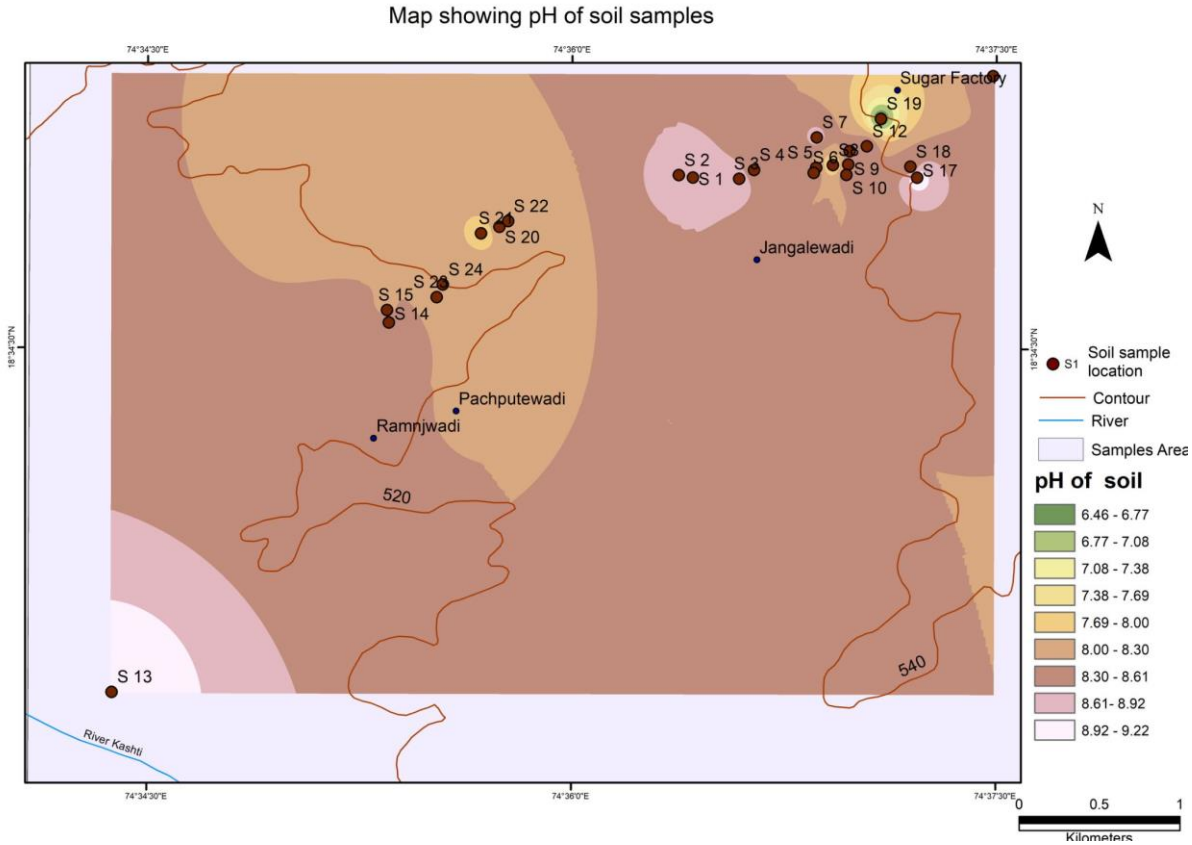


Fig. 3.8: Spatial distribution of pH in the study area

Observation/Interpretation

Results obtained for soil pH were compared to the above chart to understand its categorization. According to the pH values of soil samples from sampling zone 1 and Zone 2 –which was moderate to highly affected due to molasses spread – showed mostly moderately alkaline to alkaline characteristics. Samples from location S4 and S5 had pH of 8.2 and Sample S8 had pH of 7.2 are observed on the lower side. Whereas pH of 8.9 for sample from location S3 and pH of 9.2 (indicating very alkaline nature) for sample S17 observed on the higher side in this zone. Soil characteristic of very alkaline was observed for sample S13 – which collected near river Ghod. Soil sample collected from location S16 – which was from a non-affected area – showed alkaline characteristics with pH value of 8.4. Test values for pH of soil samples from the study area outside the premises show no influence of acidic pH of molasses.

2) Electrical conductivity of soil

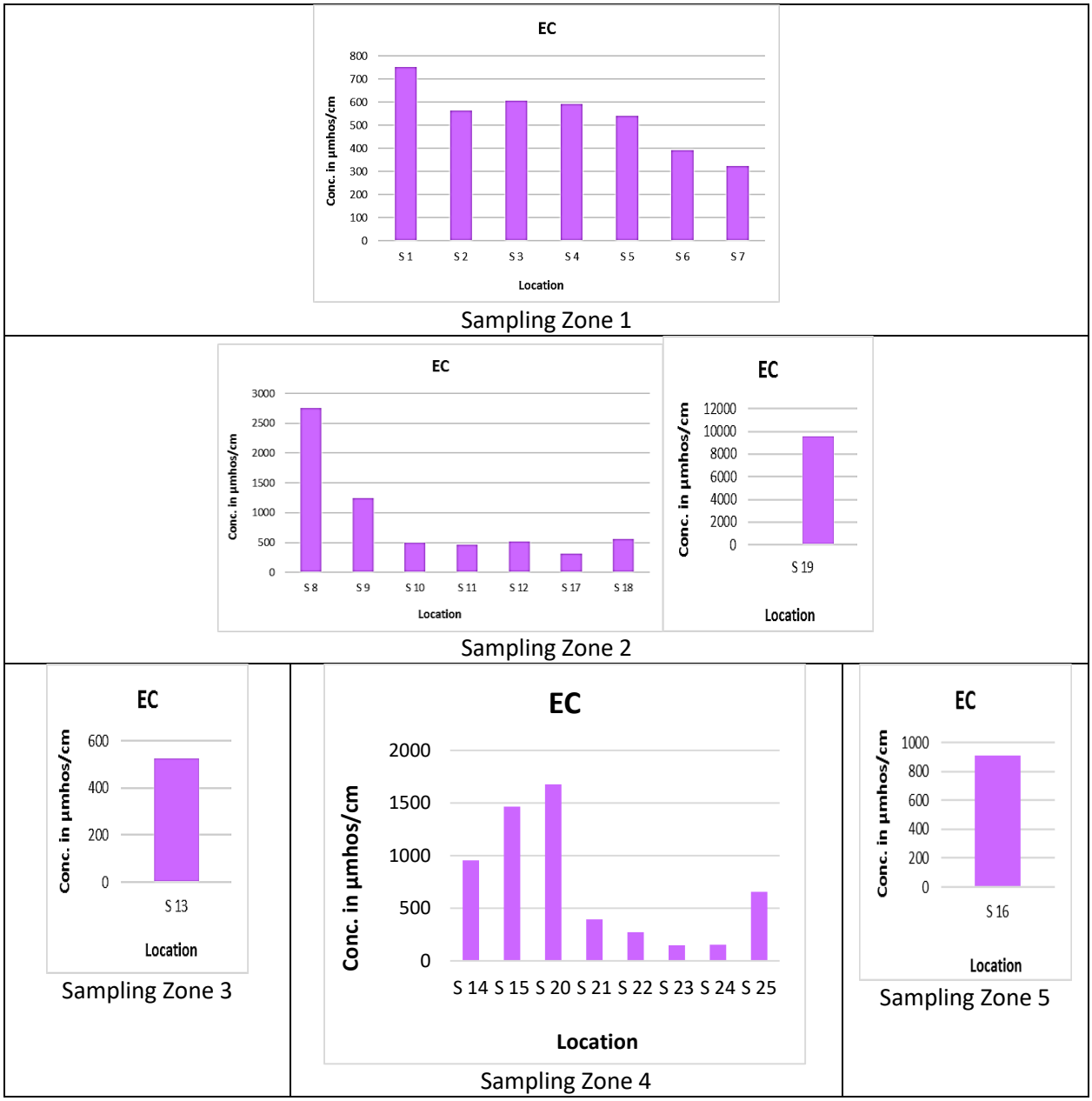


Figure 3.9: Graphical presentation of EC observed for all soil samples of the study area

1000 micro mho/cm = 1 mili mho/cm

Electrical Conductivity of Soil:-

Sr.No.	Category	EC of soil mili ohm/ dSm^{-1}
1	Good soil	Below 1
2	Poor seed emergence	1 - 2
3	Harmful for some crops like pulses	2 - 3
4	Harmful for most of crops	Above 3

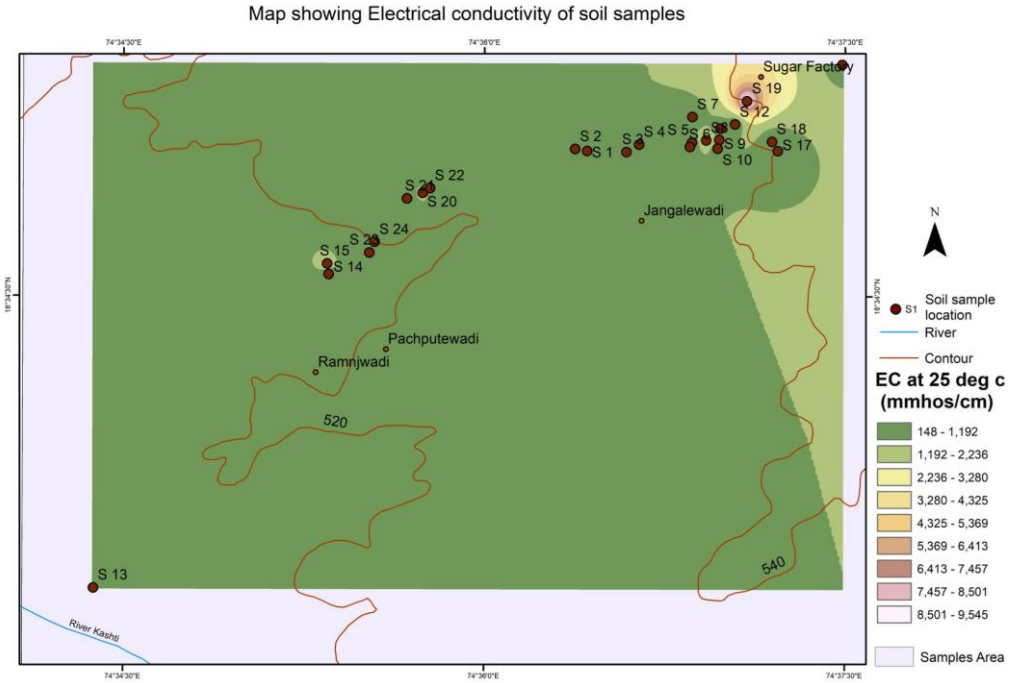
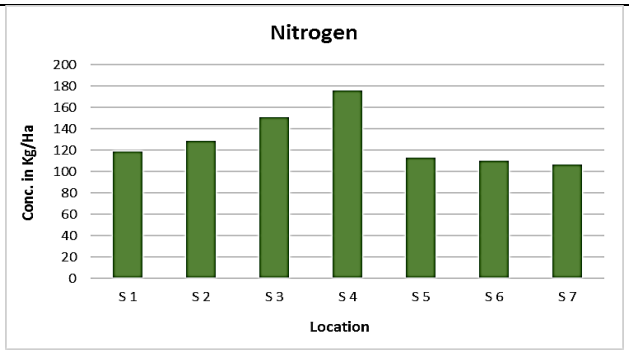


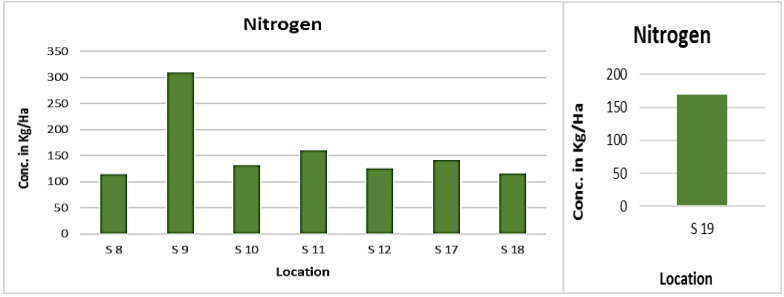
Fig. 3.10: Spatial distribution of EC in the study area

The test results of zone 1 and zone 2 samples show mostly good soil characteristics for electrical conductivity parameter, except for location S-8. Here, the EC was reported 2.7 mili mho/cm which is harmful for some crops like pulses. In zone 4, EC more than 1.4 mili mho/cm and 1.6 mili mho/cm was reported for location S15 and S20. It can be observed from the test results of EC of soils that there is no impact of accidental release of molasses.

3) Nitrogen



Sampling Zone 1



Sampling Zone 2

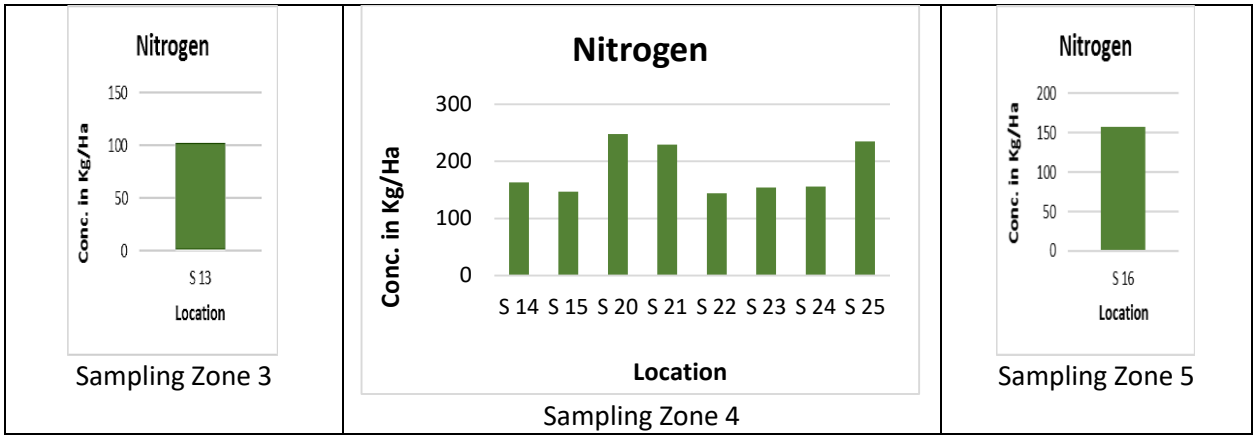


Figure 3.11: Graphical presentation of Nitrogen observed for all soil samples of the study area

Soil available Nitrogen (kg/ha)

Sr. No.	Category	Soil available Nitrogen(kg/ha)
1	Very low	< 140
2	Low	141 - 280
3	Moderate	281 - 420
4	Moderately high	421 - 560
5	High	561 - 700
6	Very high	> 700

Map showing Nitrogen content of soil samples

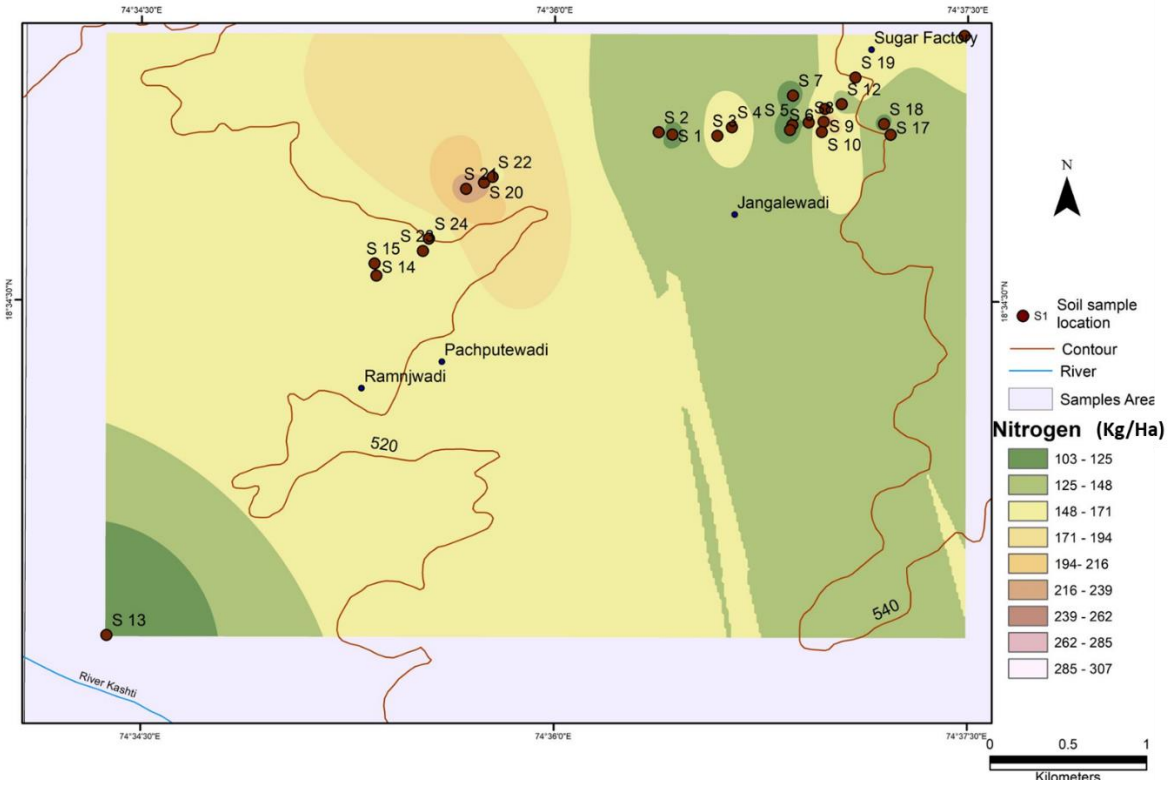


Fig. 3.12: Spatial distribution of Nitrogen in the study area

Observations

In general, the soil samples of study area show very low to low nitrogen content. Particularly, soils from sampling zone 1 and zone 2 which is affected by the accidental release of molasses show typically the above stated characteristics. Sample from location S-09, the only sample reported moderate nature of nitrogen content. From molasses analysis (table 1.1), the amount of nitrogen released due to accident was about 7.5 to 9.0 kg/ton of molasses. Considering average 8.25 kg/ton, approx. 31 to 32 tons of nitrogen was released through molasses. Therefore, a positive impact i.e. soil nitrogen content on higher side for accident affected areas was anticipated. However, all soil samples from the study area show nitrogen deficiency. It can be inferred that presently, there is no impact of accident on inorganic content of soil.

4) Phosphorous

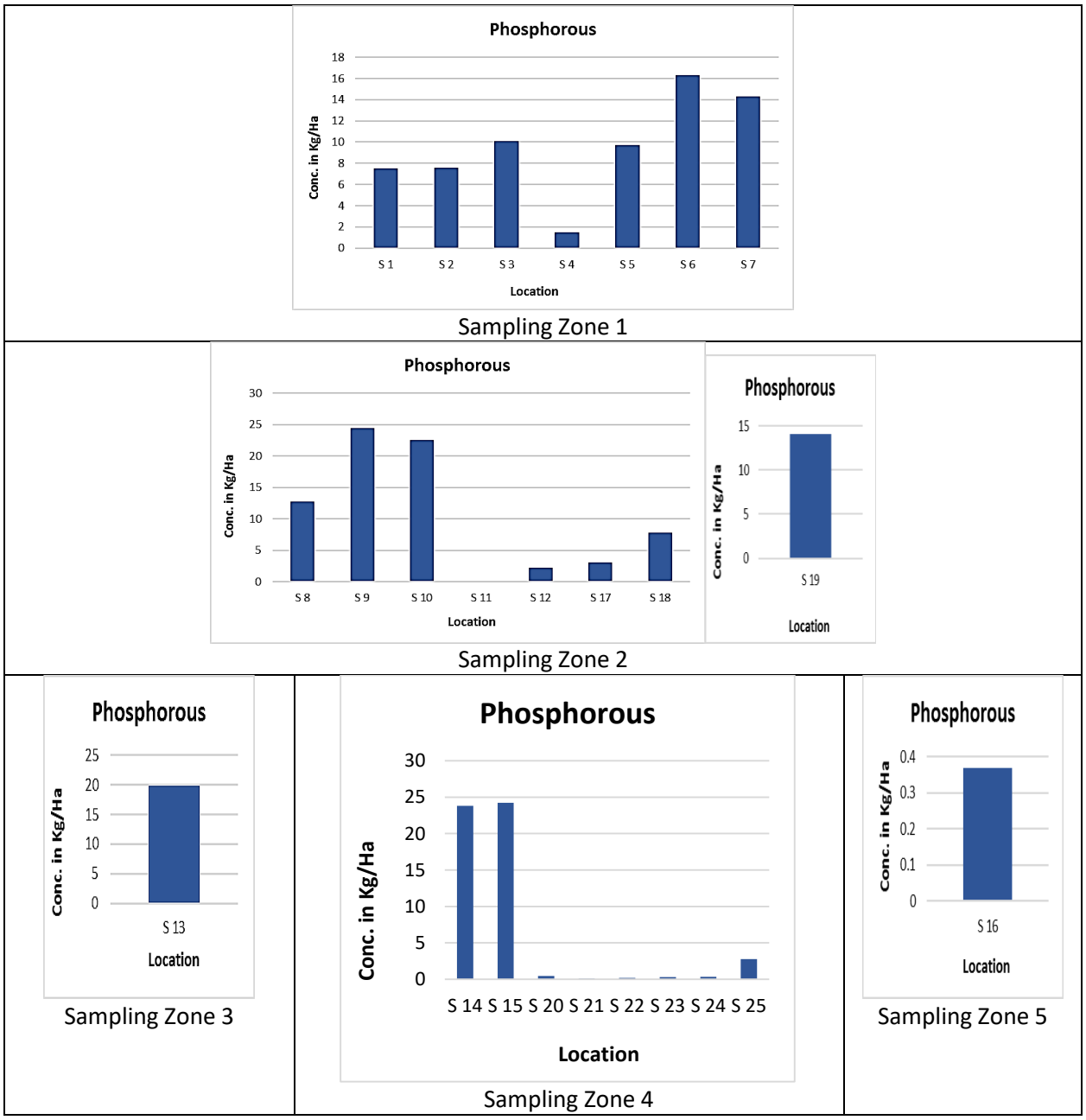


Figure 3.13: Graphical presentation of Phosphorous observed for all soil samples of the study area

Soil available Phosphorous(P) kg / ha

Sr.No.	Category	Soil available Phosphorous (kg / ha)
1	Very low	0 -7
2	Low	7 –14
3	Moderate	14 –21
4	Moderately high	21 –28
5	High	26 –35
6	Very High	More than 35

Observations

In case of phosphorous (P) it was observed that, out of 24 samples, 11 samples showed very low P content. Samples collected from location S06 and S07, show moderate levels of phosphorous. Sample collected from locations S09, S10, S14 and S15 reported moderately high levels of phosphorous.

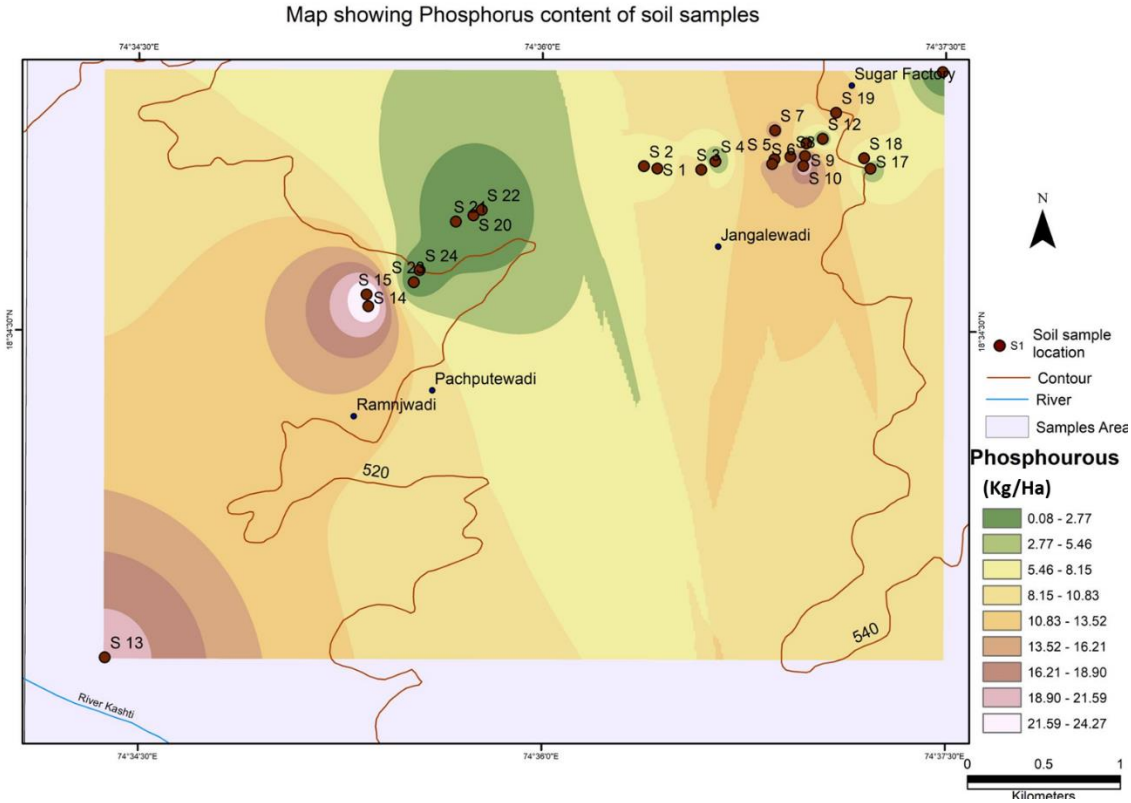


Fig. 3.14: Spatial distribution of Phosphorous in the study area

5) Potassium

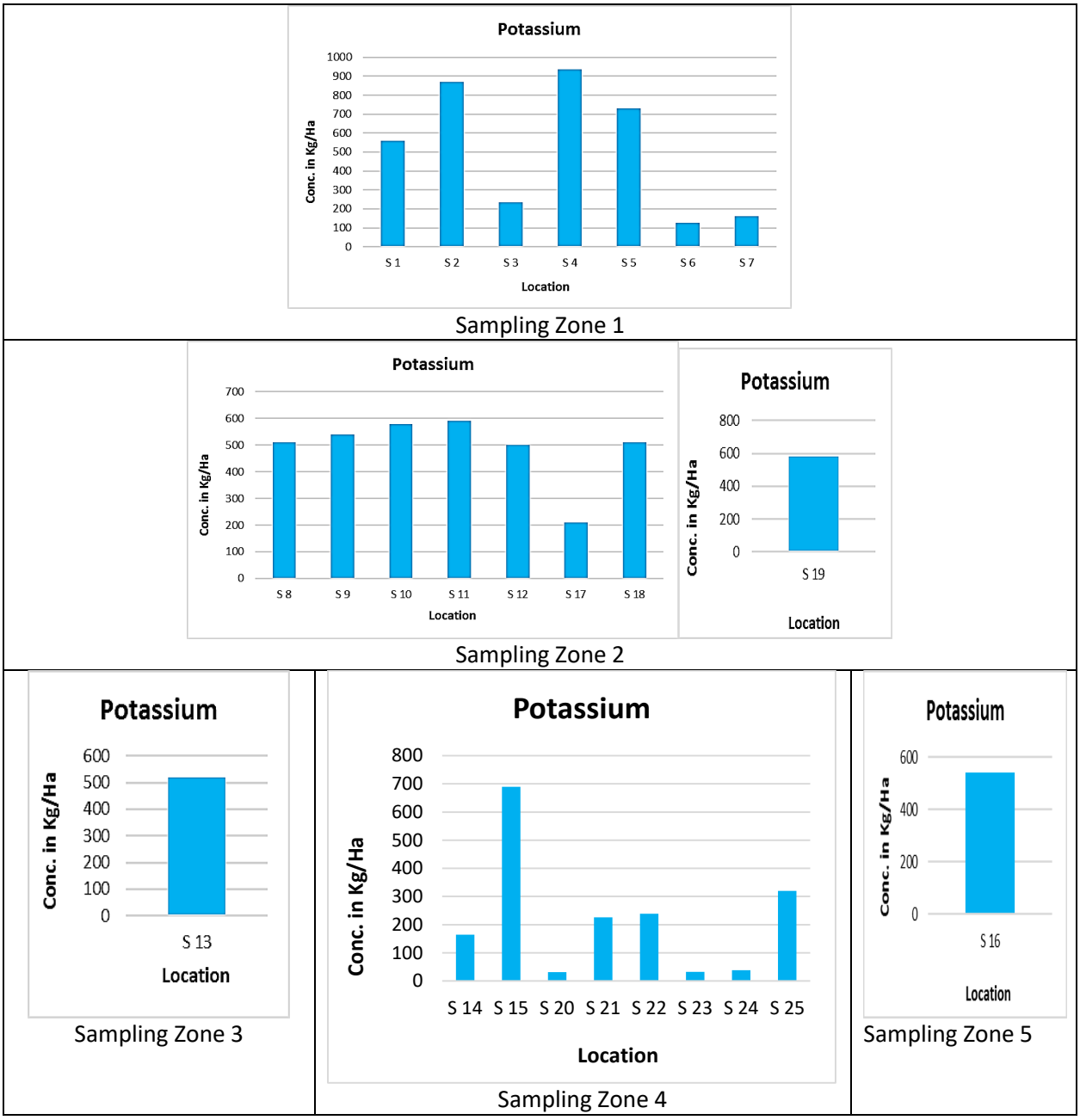


Figure 3.15: Graphical presentation of Potassium observed for all soil samples of the study area

Soil available (K) Potash, Kg/ha.

Sr.No.	Category	Available K Kg/ha.
1	Very Low	< 100
2	Low	101 - 150
3	Medium	151 - 200
4	Moderately High	201 – 250
5	High	251 - 300
6	Very high	> 300

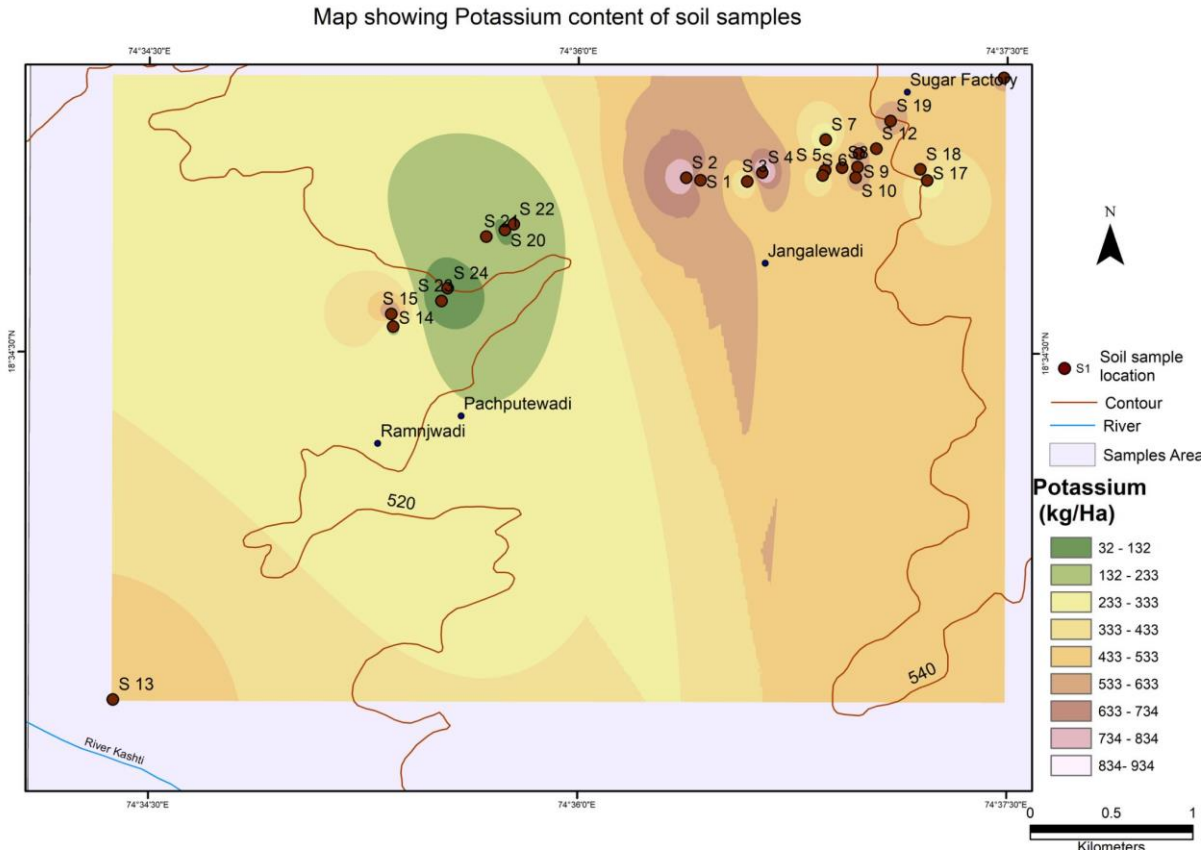
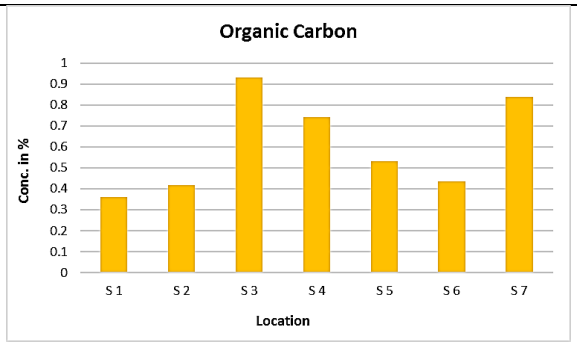


Fig. 3.16: Spatial distribution of Potassium in the study area

Observations

From sampling zone 1 and zone 2, out of 15 samples 11 samples reported to have very high levels of potassium content. Similar tend observed for sample collected from non-affected areas (S16) and for sample collected near the river (S13).

5) Organic carbon



Sampling Zone 1

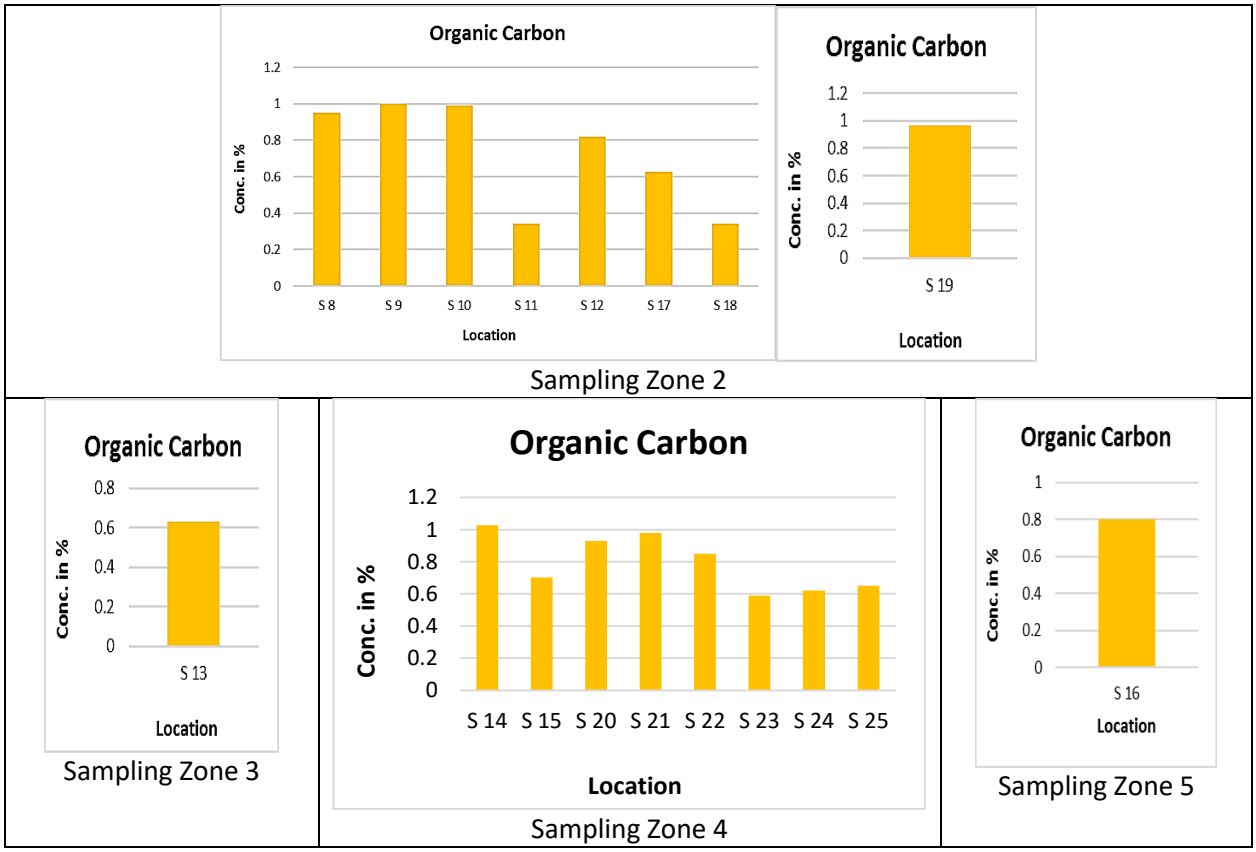
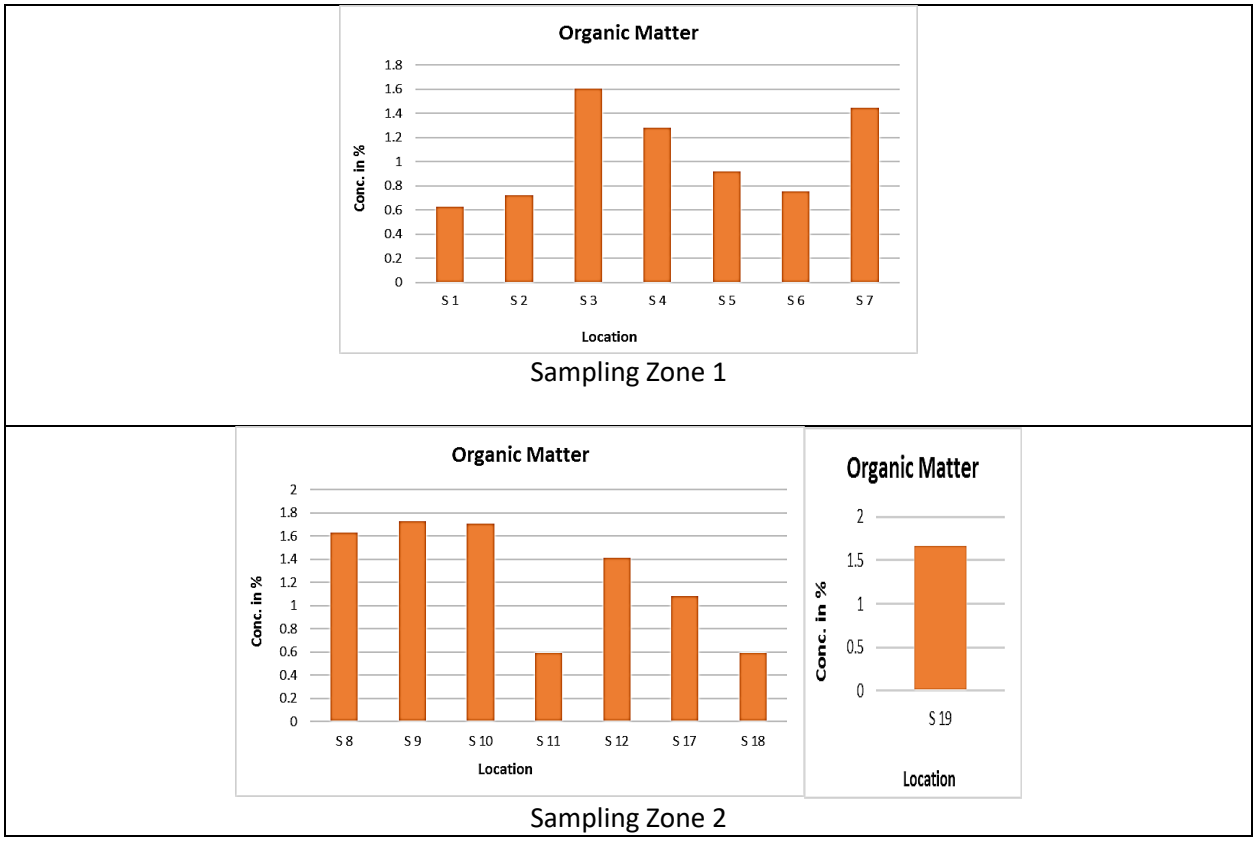


Figure 3.17: Graphical presentation of Organic carbon observed for all soil samples of the study area

5) Organic matter



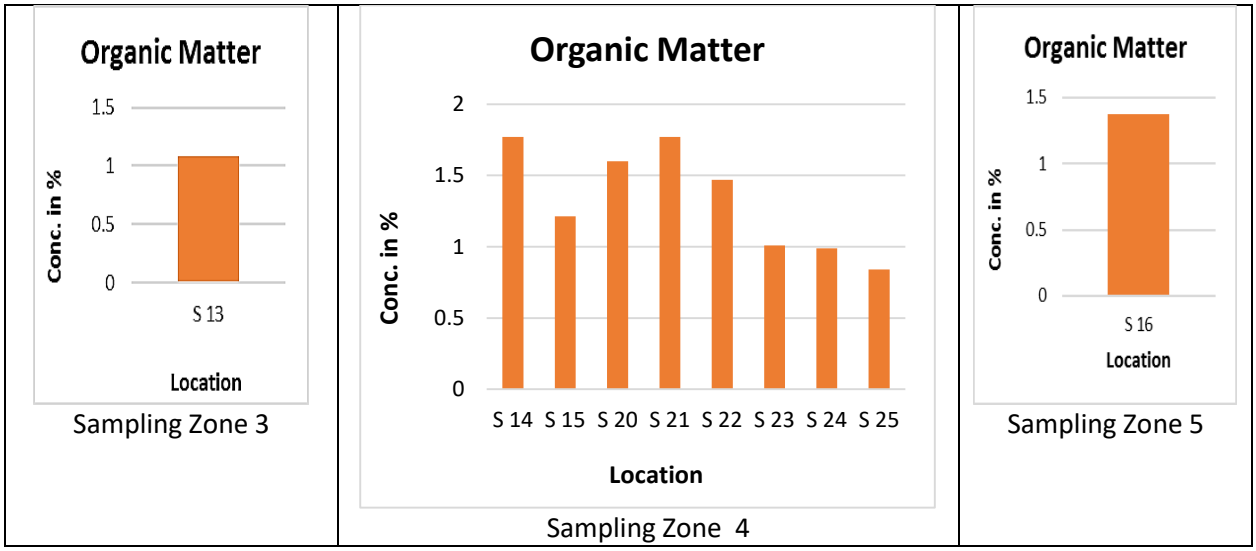


Figure 3.18: Graphical presentation of Organic matter observed for all soil samples of the study area

% Organic carbon :

Sr. No.	Category	% Organic carbon
1	Very low	Less than 0.20
2	Low	0.21 - 0.40
3	Moderate	0.41 - 0.60
4	Moderately high	0.61 - 0.80
5	High	0.81 - 1.00
6	Very high	Greater than 1.00

Map showing Organic carbon content of soil samples

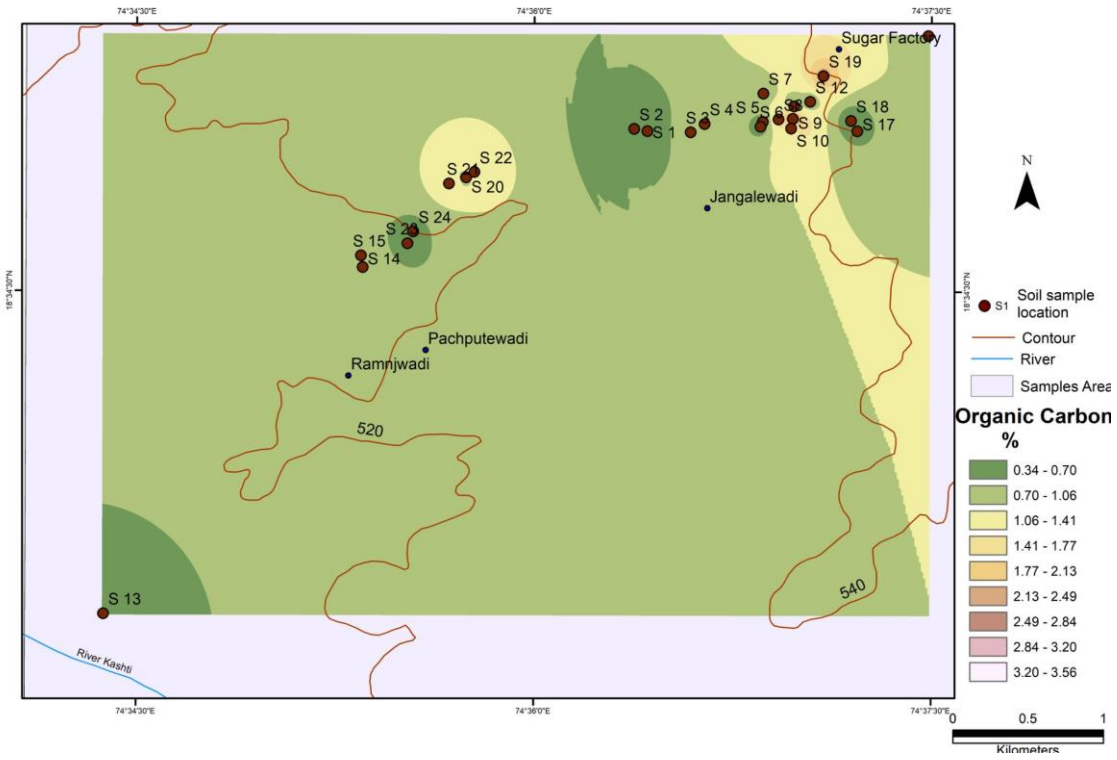


Fig. 3.19: Spatial distribution of Organic carbon in the study area

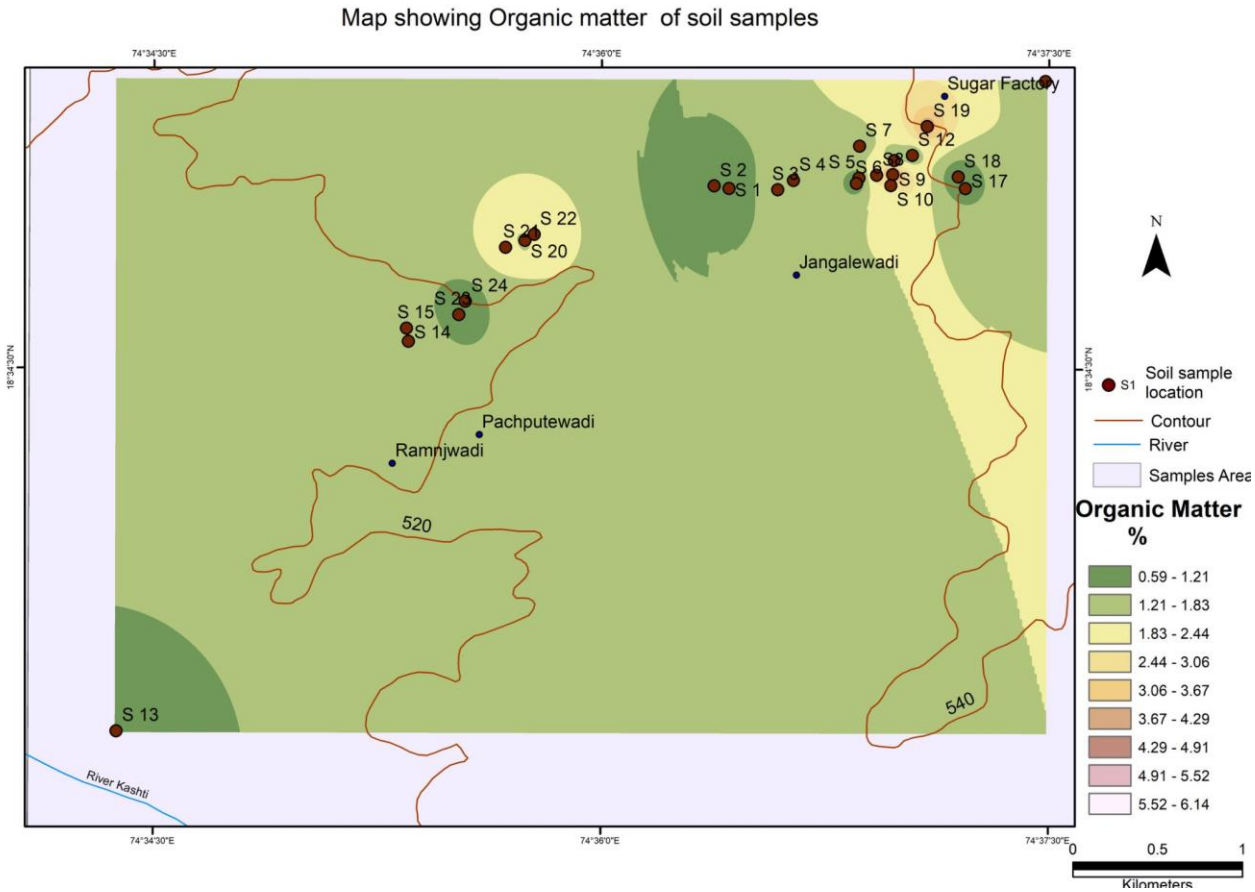


Fig. 3.20: Spatial distribution of Organic matter in the study area

Observations

Soil organic carbon greater than 0.61% upto 1% is considered as moderately high and high. In case of zone 1 and 2, out of 15 samples, 09 samples reported moderately high and high levels. Similar tend observed for sample collected from non-affected areas (S16) and for sample collected near the river (S13).

Soil organic matter (OM) is determined by equation: OM = organic carbon x 1.724

Since, OM value is totally dependent on soil organic carbon. separate comment on the OM is not considered here.

Overall, the soil analysis results show similar trend as ground water analysis. It means, the impact due to accidental contamination of the resources (water and soil) is probably 27remediated naturally. The soil samples collected from accident contaminated/affected areas and non- affected areas show more or less similar characteristics. Therefore, present status of soils of the study area show no traces of molasses contamination as such. It may be due to effective scrapping action taken by the factory management immediately after the accident. In this action, molasses from contaminated soil and other surfaces was scrapped with bagasse, removed mechanically and transferred to the compost yard of the distillery unit.

4.0 Geological and Geo-Hydrological Investigations

The following was the scope of work:

- Entire stretch of the proposed area and small sections exposed were observed to understand geological conditions.
- Observations were made in the entire area to infer the role of local geological, geomorphological and climatological factors leading to weathering of the rock.
- Electrical Resistivity Surveys were conducted to infer subsurface geological conditions in general and thickness / depth of different layers in particular besides geotechnical strata classification for estimating the extent and thickness of different layers.

4.1 Scope of the work:

The Hydrogeological investigations were undertaken by adopting Electrical Resistivity Method. The main objectives of these investigations were to:

1. Attempt geo-technical strata classification by using resistivity method
2. To delineate the areas suitable for rainwater harvesting
3. locating the site for bore hole
4. delineate the groundwater table

   The results of the electrical resistivity surveys along with the strata classification and aquifer conditions are included in this report.

   In order to understand the hydrogeological the investigations were conducted in two parts, viz. (A) Hydrogeological and (b) Geophysical (Electrical Resistivity). The outcome of the investigations is discussed in the present report.

(A) HYDROGEOLOGICAL

(i) Climate and Rainfall:

The climate of the district is characterised by a hot summer and general dryness throughout the year except during the southwest monsoon season, i.e, June to September. The mean minimum temperature is 12.3°C and mean maximum temperature is 39.1°C. 4 The normal rainfall over the district varies from 484 mm to about 879 mm. Rainfall is minimum in the northern parts of the district around Kopargaon and Sangamner and it gradually increases towards southeast and reaches the maximum around Jamkhed. The district being situated in “Rain Shadow” zone of Western Ghats, it often suffers the drought conditions. Almost entire district covering Ahmadnagar, Rahuri , Nevasa, Shevgaon, Jamkhed, Karjat, Srigonda, Pathardi and Parner talukas comes under “Drought Area”. The average rainfall for the period 1995-2004 ranges from 484 mm (Kopargaon) to 879.43 mm (Akola) and the same is presented in Table-3. It is noticed that the average annual rainfall has decreased during the last 10 years period as compared to the normal annual rainfall.

(ii) Geomorphology:

Physiographically the district forms part of Deccan Plateau. Part of Sahayadri hill ranges fall in the district. Western Ghat section in Akole taluka is hilly which extends to relatively flat areas in Shevgaon and Jamkhed talukas in the east. From the main Sahayadri range three spurs namely Kalsubai, Baleshwar and Harishchandgad strech eastwards. Physiographically the district can be broadly divided in four major characteristic landforms viz., hill and ghat section (7.6% area); foothill zone (19.4% area); plateau (3.71% area) and plains (occupy 69.30% area). The district lies partly in Godavari basin and partly in Bhima basin. The northern part of the district is drained by Godavari River and its tributaries viz., Pravara, Mula, Adula and Mahalungi whereas the southern part is drained by Bhima River and its tributaries viz., Ghod and Sina. All the rivers have sub parallel to semi-dendritic drainage pattern and the drainage density is quite high. Based on geomorphological setting and drainage pattern, the district is divided into 80 watersheds

(iii) Hydrogeology

The major part of the district is underlain by the basaltic lava flows, which were formed by the intermittent fissure type eruptions during of upper Cretaceous to lower Eocene age. The Deccan Trap has succession of 19 major flows in the elevation range of 420 to 730 m above mean sea level (amsl). These flows are characterised by the prominent units of vesicular and massive Basalt. The Alluvium of Recent age also occurs as narrow stretch along the course of major rivers deposited over the Traps. A map depicting the hydrogeological features is shown in Figure 4.1.

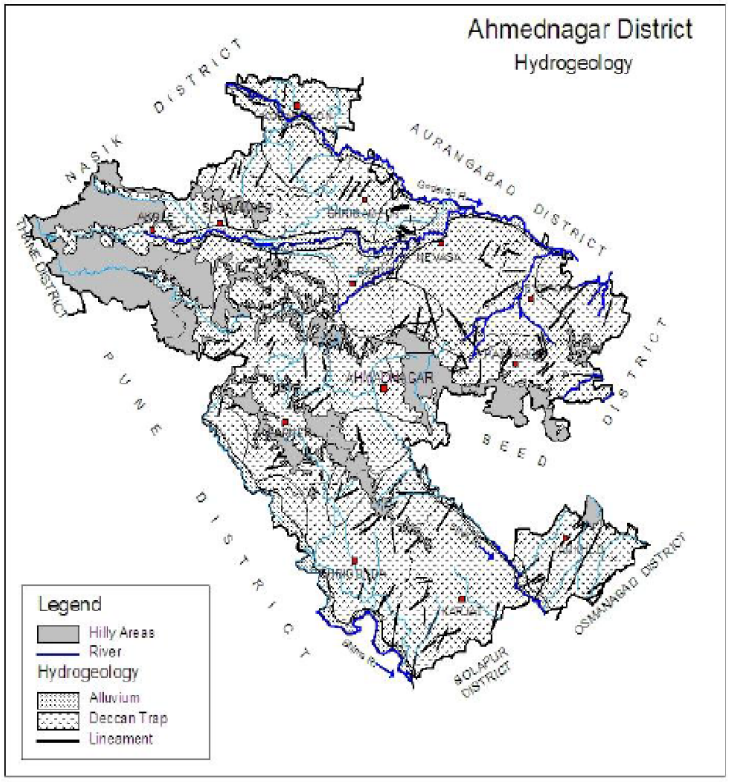


Fig. 4.1: Hydrogeological features of Ahmednagar district

(iv) Geology

Deccan Traps

Deccan Traps occupy about 95% area of the district and it occurs as basaltic lava flows which are normally horizontally disposed over a wide stretch and give rise to table-land type of topography also known as plateau. These flows occur in layered sequence ranging in thickness from 15 to 50 m. Flows are represented by massive portion at bottom and vesicular portion at top and are separated from each other by marker bed known as bole bed. The thickness of weathering varies widely in the district form 5 to 25 m bgl. The weathered and fractured trap occurring in topographic lows form the main aquifer in the district. The ground water occurs under phreatic, semi-confined and confined conditions. Generally the shallower zones down to the depth of 20 m bgl form phreatic aquifer. The water bearing zones occurring between the depths of 20 and 40 m are weathered interflow or shear zones and yield water under semiconfined conditions. Deeper semi-confined to confined aquifers occur below the depth of 40 m as the borewells drilled have shown presence of fractured zones at deeper depths at places. The vesicular portion of different lava flows varies in thickness from 8 to 10 m and forms the potential aquifer zones. However the nature and density of vesicles, their distribution, inter-connection, depth of weathering and topography of the area are the decisive factors for occurrence and movement of ground water in vesicular units. The massive portion of basaltic flows are devoid of water, but when it is weathered, fractured, jointed or contain weaker zones ground water occurs in it. The yield of the dugwells ranges from 2 to 3655 lpm, whereas that of borewells ranges from 500 lph to about 20000 lph when favourably located.

Alluvium

Alluvium occurs in small areas along banks and flood plains of major rivers like Godavari, Pravara, Mula rivers and their tributaries. In the Alluvium the coarse grained detrital material like sand and gravel usually occurring as lenses forms good aquifer. The ground water occurs in phreatic aquifer under water table conditions in flood plain Alluvium deposits near the river banks. Confined conditions are also found wherever the thick clay deposits confine the ground water below it. From CGWB exploration in Godavari-Pravara Alluvium it is observed that the thickness of Alluvium is less than 30 m and the aquifer thickness is limited to 3m. The yield of the dugwells ranges from about 1 to 53 6 lps, whereas in shallow tubewells it ranges form 0.08 to 7.14 lps

(B) GEOPHYSICAL STUDY

In order to study the overall sub-surface geological conditions of the area, Geophysical investigations (Electrical Resistivity Surveys) were carried out. This was to understand the overall spread of sub-surface geological formations in the entire area. From the Electrical Resistivity Surveys, Electrical Resistivity Method (IS: 1892-1979 Appendix B clause 3.3 B-2):

4.2 Methodology

4.2.1 Electrical Resistivity Method (IS: 1892-1979 Appendix B clause 3.3 B-2)

By applying this method, the resistance to the flow of an electric current through the subsurface materials is measured at intervals on the ground surface. The resistivity is usually defined as the resistance between opposite phases of a unit cube of the material. Each material has its own resistivity depending upon the water content, compaction and composition. The test is conducted by driving four metal spikes to serve as electrodes in to the ground along a straight line at equal distances. A direct voltage is imposed between the two outer potentiometer electrodes and the potential drop is measured between the inner electrodes. To interpret the resistivity data for knowing the nature and distribution of the subsurface formations, it is necessary to make preliminary trial on known formations. The potential 'V' thus obtained divided by the current 'I' applied gives the resistance 'R' of the ground. The product of the resistance and the spacing factor, which is depending upon the disposition of the electrodes, is the resistivity of the ground. This method is routinely used for:

1. Determining the sub-surface strata classification
2. Determination of hard rock foundation
3. Estimation of overburden thickness and hard rock quantities and
4. Determination of the suitability of the area for quarrying and excavation

A great variety of electrode arrangements have been used to measure the earth resistivity but essentially they may be grouped into three classes.

Arrangements in which -

- the potential differences between two widely spaced measuring electrodes are recorded.
- The potential gradient or electric field intensity is measured using closely spaced pair of measuring electrodes.
- the curvature of the potential function is measured using a closely spaced current electrode pair as well as a closely spaced measuring electrode pair.

Any one of these arrays may be used to study variations in resistivity with depth or in lateral condition. In studying the variation of resistivity with depth, as in the case of a layered medium the spacing between the various electrodes is gradually increased. With larger spacing, the effect of material at depth on the measurements becomes more pronounced.

In studying the lateral as well as vertical variations, various electrode configurations are adopted and the array is moved as a whole along a traverse line. The first type of measurement is called as 'Vertical Electrical Sounding' (VES) and the second one is 'Horizontal Profiling' (HP). In the present work both VES and HP were conducted at 6 different locations at the site. The L sections generated on the basis of values of

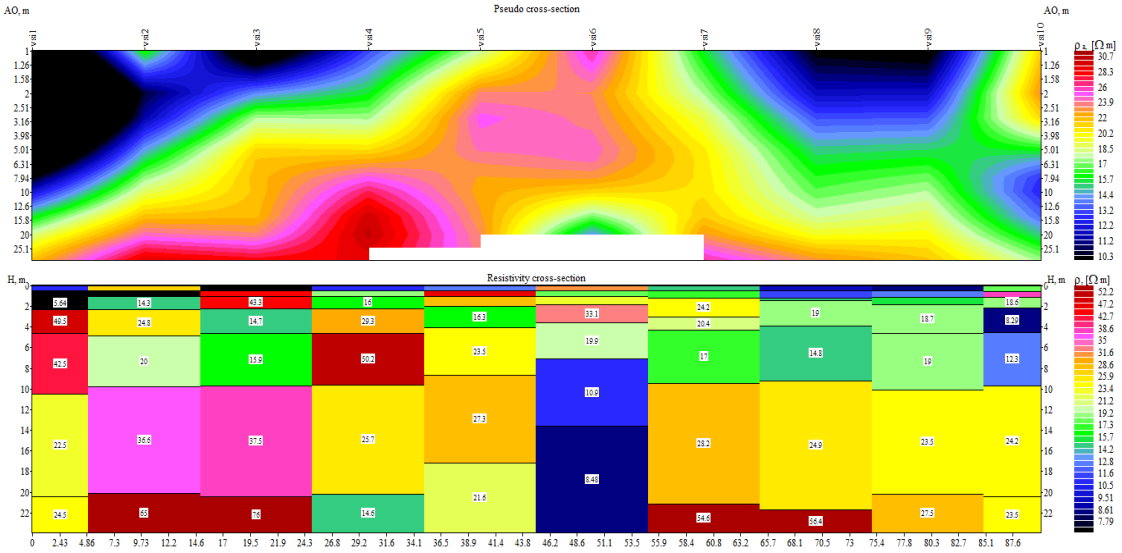
electrical resistivity for the site have been used to depict 2-D subsurface images of the strata that are also included in this report.

4.3 Results and data processing

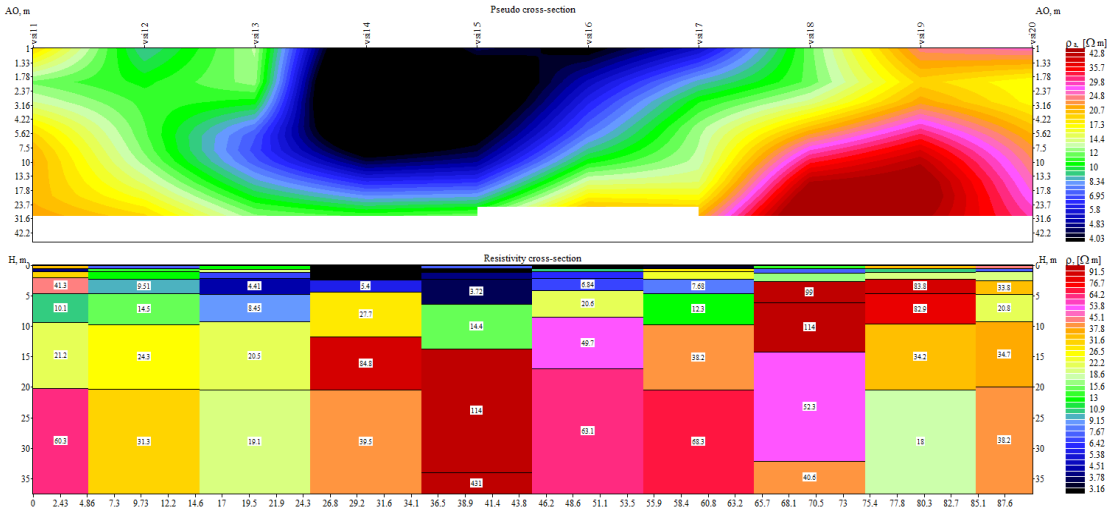
In the area to understand the shallow subsurface geological and aquifer conditions extending up to 70-90 meters depth, vertical electrical soundings were conducted at 30 different locations. Using IPI2 WINDOW based software the data obtained from field was processed. This software helps in interactive semi-automated interpretation of the field data. All the sounding data were modeled for the existing sections. The VES data on apparent resistivity values was modeled by using IPI2 WINDOW based software to get different layers depicting their thickness, depth and true resistivity (see appendix I). In nutshell, the above interpretation gives generalized geological situation with depth-wise variations. As discussed above the sounding points with typical curves at selected sites give point information, which was further utilized to build comprehensive picture of subsurface geological situation depth-wise by preparing 2-D geoelectrical sections.

4.3.1 Profiles

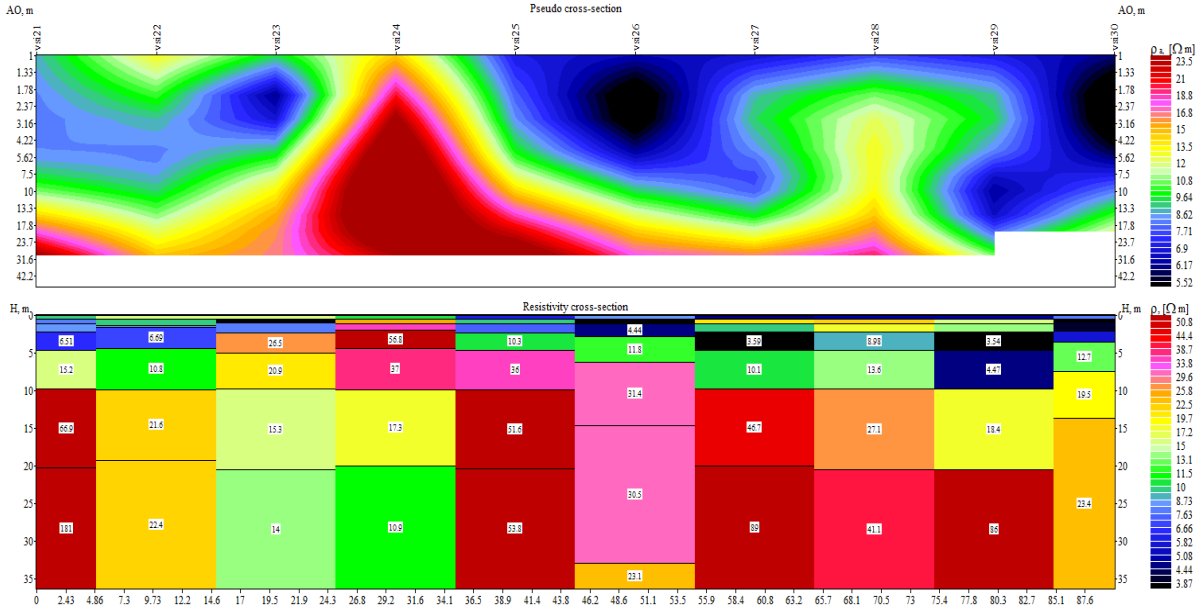
1-10



11-20



21-30



The geoelectrical cross-sections passing through various points have been presented in the above figures. It is to be noted that these are apparent resistivity L sections, which broadly match the true resistivity of formations. The values of true resistivity have been computed and thickness, depth and true resistivity have been presented in appendix. Using IPI2 software, the values of true resistivity of strata (ρ), its thickness (h) and depth (d) have been obtained after modeling of data and are depicted in table form besides each curve.

Based on the resistivity modeled values it can be seen that the area shows presence of shallow to deep aquifer beyond 5 meters at VES locations of 1,to 4 upto 20 meters depth. VES locations 5, 6, 7 shows increasing resistivity values up to 5 meters and then drop which continues up to 20 meters. VES 7, 8, 9, 10 show low resistivity upto 25 meters. The VES location from 11 to 18 shows low resistivity values up to a

depth of 30 meters while VES 19 and 20 shows slightly higher values beyond the depth of 7.5 meters. The VES profile between VES 21 and 30 barring VES 24 shows consistently lower values up to the depth of 30 meters.

Some salient characteristics of occurrence of ground water in hard rock are listed below:

Features of Occurrence of Ground Water in Hard Rocks are:

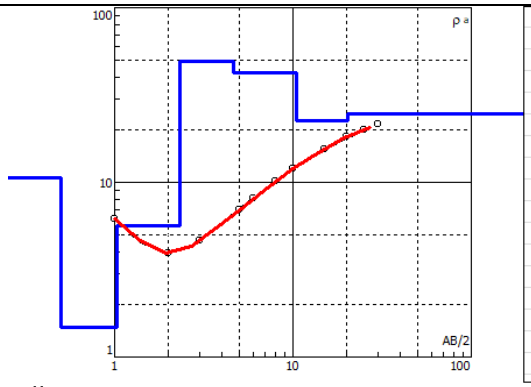
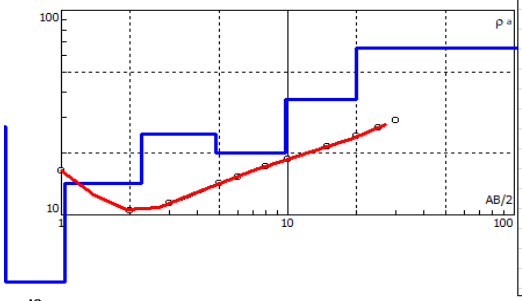
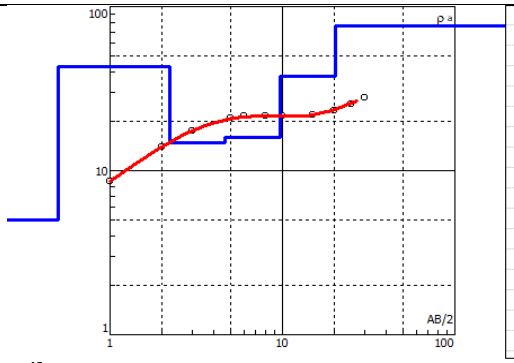
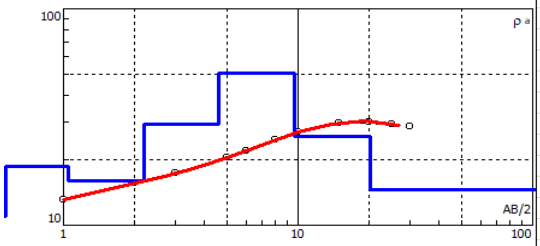
1. Ground water reservoir (aquifer) in hard rocks is dominantly shallow
2. The bulk of the ground water is stored in the zone of weathering (Vadose zone)
3. Fractures and joints in hard rock occur as conduits for rapid transport of water as they do not provide large space for storage of ground water
4. The width of fractures & lineaments and weak planes narrows as depth increases
5. Fairly limited aquifer water yield by wells and bore wells in comparison to alluvial and sedimentary rock aquifer wells
6. Unpredictable ground water occurrence over short distances

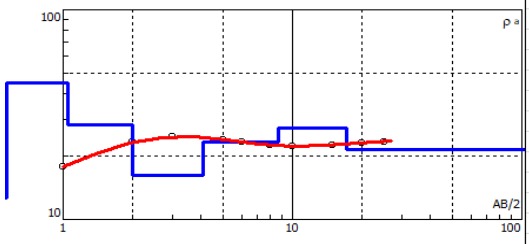
The principle ground water reservoir in hard rocks therefore consists of two parts viz.

1. “Vadose zone” or unsaturated zone that lie between ground surface and water table; and
2. The phreatic or unconfined zone that lie below the water table

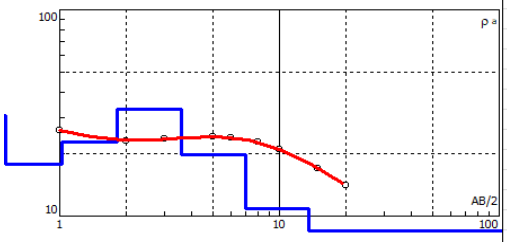
The deeper ground water below water table in zone of fractures lack substantial storage unless it is connected with thick vadose zone above or else is connected to a surface water source. Exclusively from the issue of ground water storage, the “vadose zone” in hard rocks is extremely important, because the pore spaces in this domain undergo re-saturation during infiltration and recharge and undergo de-saturation under conditions of evaporation and drainage. The volume of saturation involved in the process of change in saturation in vadose zone (zone of weathering) is far large than the changes in volume of water involved in the elastic storage of water below the water table. It therefore may be noted, that the dynamic resource in ground water reservoir in the hard rock areas is governed by the “vadose zone” through which water levels fluctuate. It may also be mentioned that available storage in weathered zone in hard rocks is very much linked to base flow fluctuations in local streams.

4.3.2 Modeled electrical resistivity data output

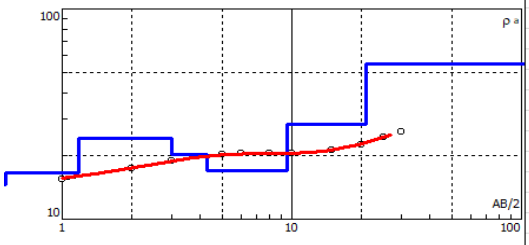
#	Graph with Values
1	 vsi1 N ρ h d Alt 1 10.6 0.5 0.5 -0.5 2 1.49 0.538 1.04 -1.038 3 5.64 1.27 2.31 -2.311 4 49.5 2.32 4.63 -4.628 5 42.5 5.85 10.5 -10.48 6 22.5 9.92 20.4 -20.4 7 24.5
2	 vsi2 N ρ h d Alt 1 26.9 0.5 0.5 -0.5 2 4.72 0.54 1.04 -1.04 3 14.3 1.23 2.27 -2.271 4 24.8 2.56 4.83 -4.827 5 20 4.92 9.75 -9.751 6 36.6 10.3 20.1 -20.07 7 65
3	 vsi3 N ρ h d Alt 1 5.03 0.5 0.5 -0.5 2 43.2 0.55 1.05 -1.05 3 43.3 1.16 2.21 -2.211 4 14.7 2.42 4.63 -4.628 5 15.9 5.07 9.7 -9.702 6 37.5 10.7 20.4 -20.41 7 76
4	 vsi4 N ρ h d Alt 1 11 0.502 0.502 -0.5025 2 18.6 0.549 1.05 -1.051 3 16 1.16 2.21 -2.211 4 29.3 2.39 4.61 -4.606 5 50.2 5 9.6 -9.603 6 25.7 10.6 20.2 -20.2 7 14.6

5	 vsi5	

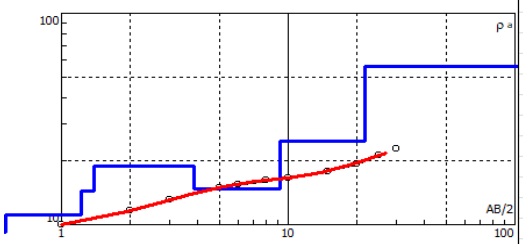
N	ρ	h	d	Alt
1	12.7	0.507	0.507	-0.5067
2	45	0.544	1.05	-1.051
3	28.4	0.953	2	-2.004
4	16.3	2.07	4.07	-4.074
5	23.5	4.62	8.69	-8.694
6	27.3	8.51	17.2	-17.2
7	21.6			

6	 vsi6	

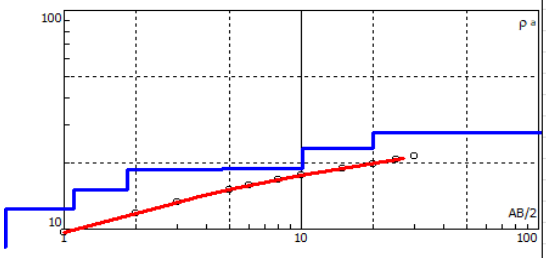
N	ρ	h	d	Alt
1	30.7	0.514	0.514	-0.5139
2	17.8	0.516	1.03	-1.03
3	22.9	0.795	1.82	-1.825
4	33.1	1.77	3.6	-3.596
5	19.9	3.45	7.05	-7.046
6	10.9	6.55	13.6	-13.59
7	8.48			

7	 vsi7	

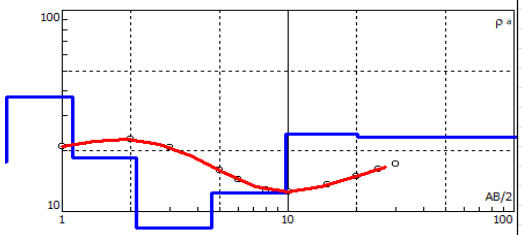
N	ρ	h	d	Alt
1	14.5	0.5	0.5	-0.5
2	16.7	0.676	1.18	-1.176
3	24.2	1.84	3.02	-3.016
4	20.4	1.25	4.27	-4.271
5	17	5.22	9.49	-9.49
6	28.2	11.7	21.1	-21.15
7	54.6			

8	 vsi8	

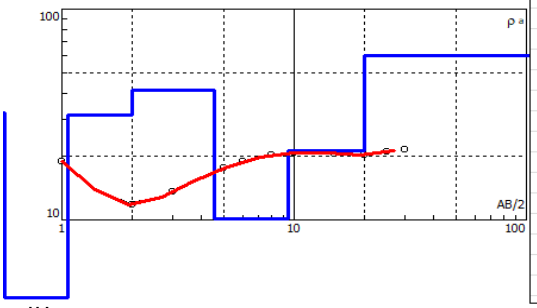
N	ρ	h	d	Alt
1	9.16	0.5	0.5	-0.5
2	11.1	0.718	1.22	-1.218
3	14.4	0.182	1.4	-1.4
4	19	2.46	3.86	-3.858
5	14.8	5.33	9.19	-9.188
6	24.9	12.5	21.7	-21.68
7	56.4			

9	 vsi9	

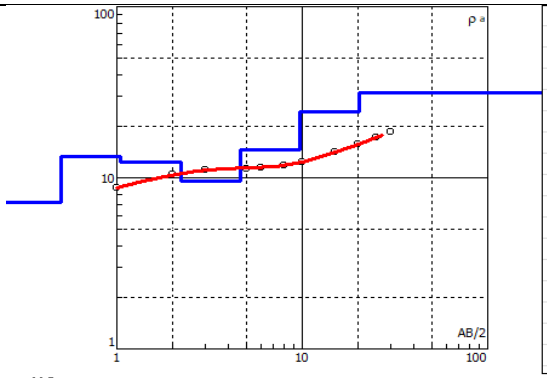
N	ρ	h	d	Alt
1	8.29	0.5	0.5	-0.5
2	12.4	0.601	1.1	-1.101
3	15.1	0.745	1.85	-1.846
4	18.7	2.78	4.63	-4.628
5	19	5.46	10.1	-10.08
6	23.5	10.1	20.2	-20.17
7	27.5			

10	 vsi10	

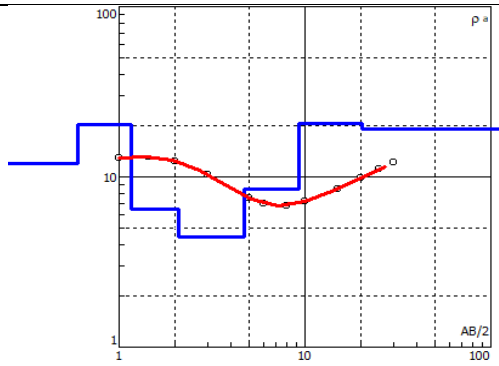
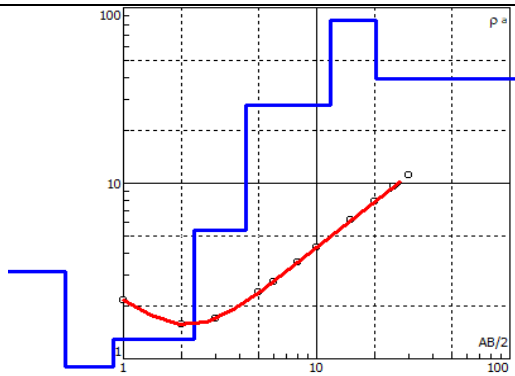
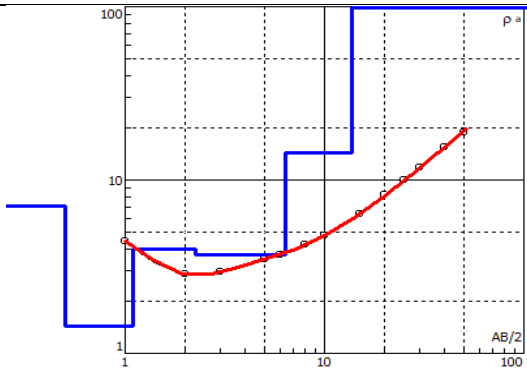
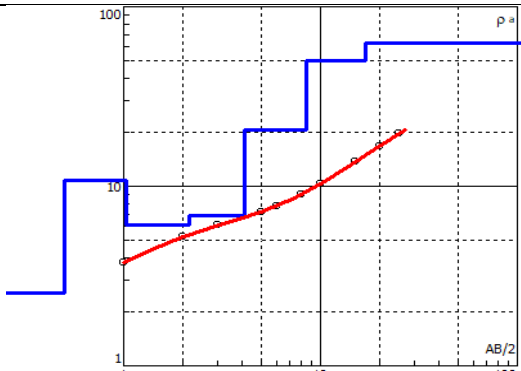
N	ρ	h	d	Alt
1	17.6	0.531	0.531	-0.5309
2	37	0.588	1.12	-1.118
3	18.6	1.02	2.14	-2.14
4	8.29	2.42	4.56	-4.564
5	12.3	5.16	9.73	-9.729
6	24.2	10.7	20.4	-20.4
7	23.5			

11	 vsi11	

N	ρ	h	d	Alt
1	32.3	0.504	0.504	-0.5045
2	4.11	0.552	1.06	-1.056
3	31.4	0.949	2.01	-2.005
4	41.3	2.55	4.55	-4.554
5	10.1	4.83	9.39	-9.387
6	21.2	10.8	20.2	-20.18
7	60.3			

12	 vsi12	

N	ρ	h	d	Alt
1	7.23	0.5	0.5	-0.5
2	13.3	0.542	1.04	-1.042
3	12.3	1.17	2.21	-2.213
4	9.51	2.42	4.63	-4.634
5	14.5	5.07	9.71	-9.707
6	24.3	10.7	20.4	-20.37
7	31.3			

13	 vsi13				
	N	ρ	h	d	Alt
	1	12.1	0.601	0.601	-0.6015
	2	20.2	0.567	1.17	-1.169
	3	6.5	0.928	2.1	-2.097
	4	4.41	2.59	4.68	-4.682
	5	8.45	4.57	9.25	-9.252
	6	20.5	11.1	20.4	-20.4
	7	19.1			
14	 vsi14				
	N	ρ	h	d	Alt
	1	3.14	0.5	0.5	-0.5
	2	0.905	0.386	0.886	-0.8861
	3	1.29	1.45	2.33	-2.332
	4	5.4	2	4.33	-4.331
	5	27.7	7.44	11.8	-11.78
	6	84.8	8.62	20.4	-20.4
	7	39.5			
15	 vsi15				
	N	ρ	h	d	Alt
	1	7.08	0.5	0.5	-0.5
	2	1.44	0.59	1.09	-1.09
	3	4.01	1.17	2.26	-2.258
	4	3.72	4.16	6.41	-6.414
	5	14.4	7.32	13.7	-13.74
	6	114	20.3	34	-34
	7	431			
16	 vsi16				
	N	ρ	h	d	Alt
	1	2.55	0.503	0.503	-0.5029
	2	10.8	0.531	1.03	-1.034
	3	6.07	1.11	2.14	-2.142
	4	6.84	2	4.14	-4.137
	5	20.6	4.29	8.43	-8.427
	6	49.7	8.57	17	-17
	7	63.1			

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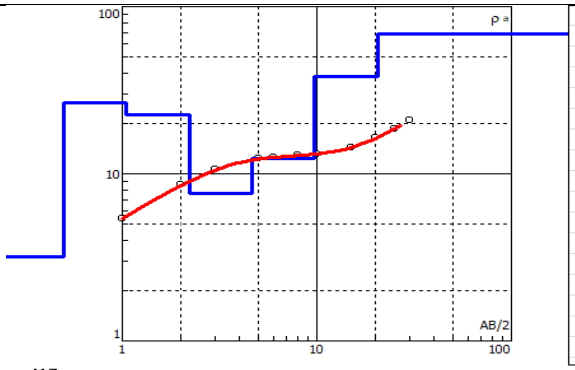
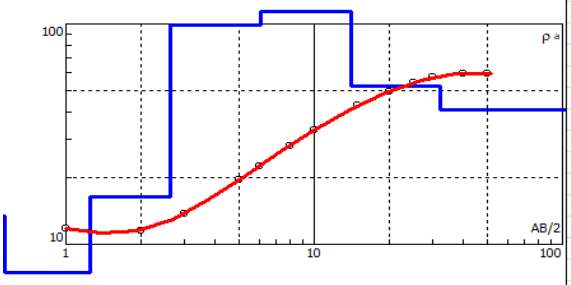
17



vsi17

N	ρ	h	d	Alt
1	3.17	0.5	0.5	-0.5
2	26.6	0.541	1.04	-1.041
3	22.5	1.17	2.21	-2.206
4	7.68	2.4	4.61	-4.61
5	12.3	5.12	9.73	-9.734
6	38.2	10.7	20.5	-20.47
7	68.3			

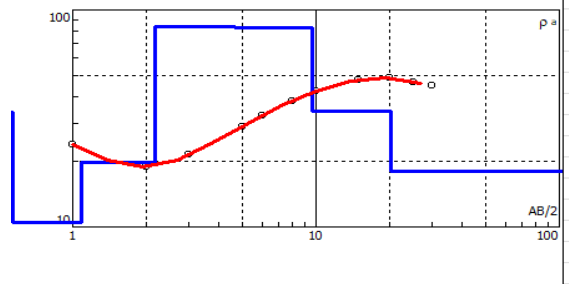
18



vsi18

N	ρ	h	d	Alt
1	13.4	0.551	0.551	-0.5513
2	7.47	0.7	1.25	-1.252
3	16.4	1.39	2.64	-2.639
4	99	3.43	6.07	-6.074
5	114	8.08	14.1	-14.15
6	52.3	18	32.2	-32.16
7	40.6			

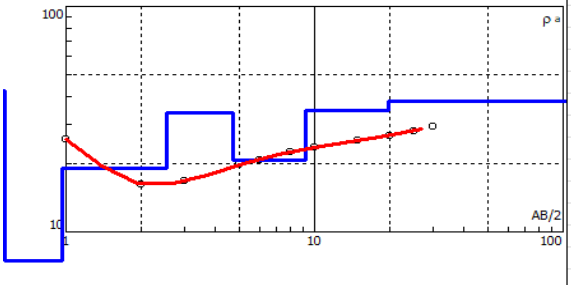
19



vsi19

N	ρ	h	d	Alt
1	33.9	0.51	0.51	-0.5095
2	10.5	0.571	1.08	-1.081
3	19.8	1.11	2.19	-2.186
4	83.8	2.44	4.63	-4.628
5	82.9	5	9.62	-9.623
6	34.2	10.8	20.4	-20.39
7	18			

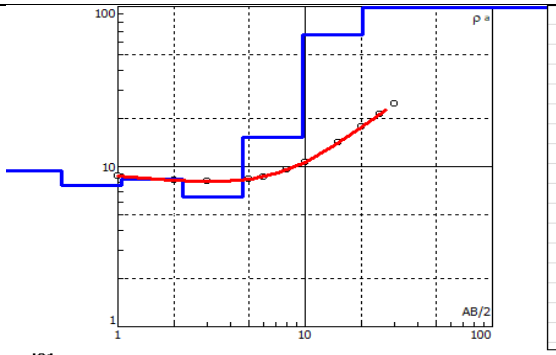
20



vsi20

N	ρ	h	d	Alt
1	42.3	0.5	0.5	-0.5
2	7.43	0.462	0.962	-0.9624
3	19.1	1.57	2.53	-2.529
4	33.8	2.16	4.69	-4.689
5	20.8	4.52	9.21	-9.207
6	34.7	10.7	19.9	-19.91
7	38.2			

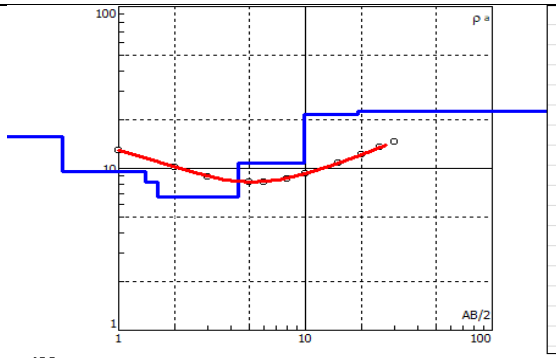
21



vsi21

N	ρ	h	d	Alt
1	9.43	0.503	0.503	-0.5028
2	7.64	0.541	1.04	-1.043
3	8.31	1.16	2.21	-2.206
4	6.51	2.42	4.62	-4.624
5	15.2	5.1	9.73	-9.725
6	66.9	10.5	20.2	-20.19
7	181			

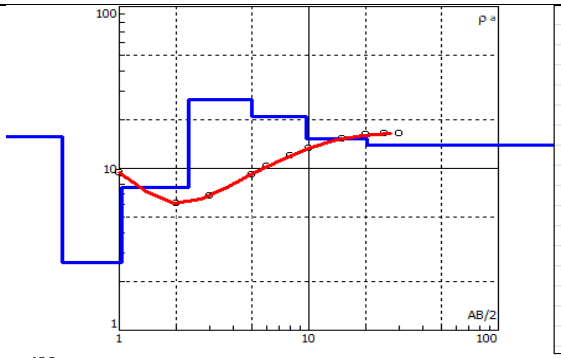
22



vsi22

N	ρ	h	d	Alt
1	15.7	0.5	0.5	-0.5
2	9.5	0.893	1.39	-1.393
3	8.28	0.215	1.61	-1.608
4	6.69	2.74	4.35	-4.351
5	10.8	5.48	9.83	-9.827
6	21.6	9.37	19.2	-19.19
7	22.4			

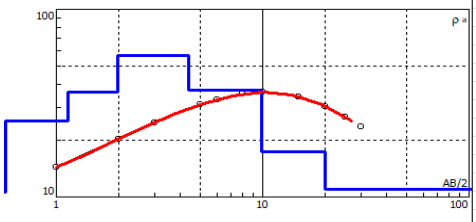
23



vsi23

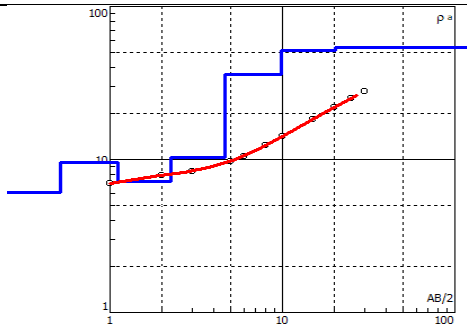
N	ρ	h	d	Alt
1	15.7	0.5	0.5	-0.5
2	2.64	0.531	1.03	-1.031
3	7.65	1.28	2.31	-2.312
4	26.5	2.68	5	-4.995
5	20.9	4.69	9.69	-9.689
6	15.3	10.7	20.4	-20.4
7	14			

24

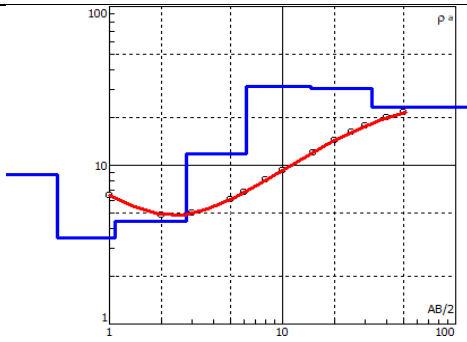


vsi24

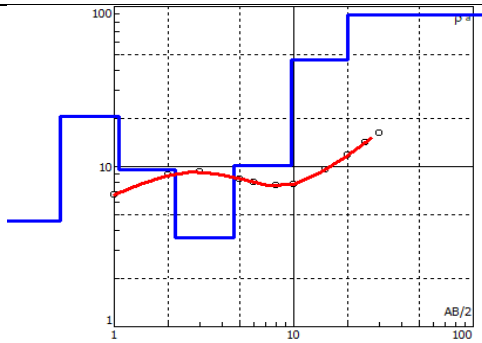
N	ρ	h	d	Alt
1	10.6	0.5	0.5	-0.5
2	25.4	0.639	1.14	-1.139
3	36.1	0.845	1.98	-1.984
4	56.8	2.39	4.37	-4.371
5	37	5.47	9.84	-9.839
6	17.3	10.1	20	-19.97
7	10.9			

25	 vsi25	

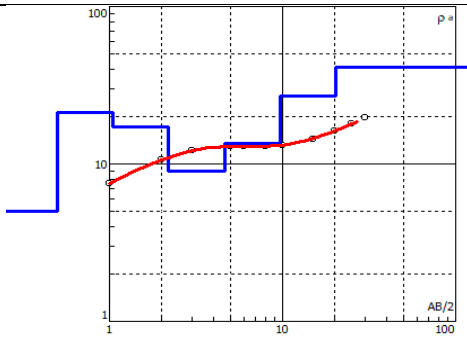
N	ρ	h	d	Alt
1	6.05	0.513	0.513	-0.5131
2	9.54	0.59	1.1	-1.104
3	7.2	1.15	2.26	-2.258
4	10.3	2.35	4.61	-4.608
5	36	5.29	9.9	-9.896
6	51.6	10.5	20.4	-20.4
7	53.8			

26	 vsi26	

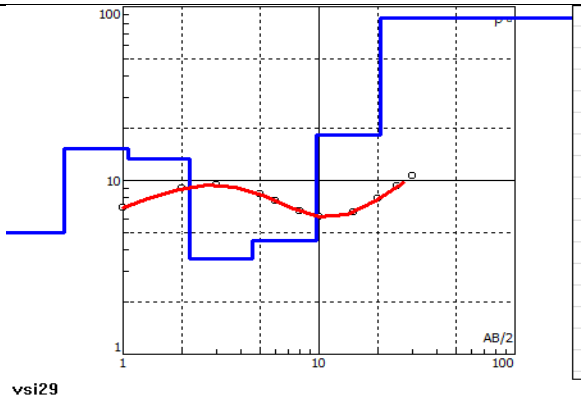
N	ρ	h	d	Alt
1	8.67	0.5	0.5	-0.5
2	3.46	0.583	1.08	-1.083
3	4.44	1.68	2.76	-2.764
4	11.8	3.46	6.22	-6.219
5	31.4	8.4	14.6	-14.62
6	30.5	18.3	32.9	-32.88
7	23.1			

27	 vsi27	

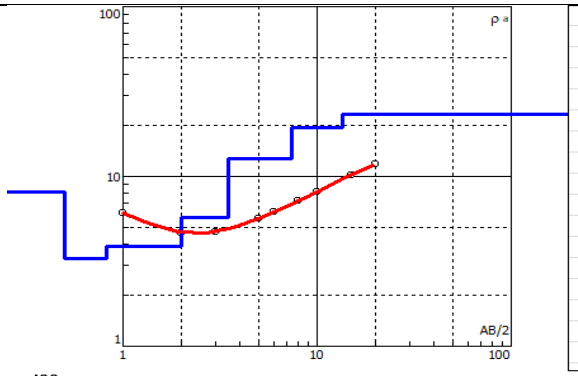
N	ρ	h	d	Alt
1	4.55	0.503	0.503	-0.503
2	20.6	0.56	1.06	-1.063
3	9.56	1.13	2.19	-2.195
4	3.59	2.41	4.61	-4.608
5	10.1	5.17	9.78	-9.776
6	46.7	10.2	20	-19.97
7	89			

28	 vsi28	

N	ρ	h	d	Alt
1	5.03	0.5	0.5	-0.5
2	21.4	0.549	1.05	-1.049
3	17.2	1.15	2.2	-2.202
4	8.98	2.41	4.62	-4.615
5	13.6	5.11	9.73	-9.728
6	27.1	10.7	20.4	-20.41
7	41.1			

29	 vsi29	

N	ρ	h	d	Alt
1	5.03	0.5	0.5	-0.5
2	15.3	0.555	1.05	-1.055
3	13.4	1.15	2.2	-2.201
4	3.54	2.37	4.57	-4.571
5	4.47	5.16	9.73	-9.735
6	18.4	10.7	20.4	-20.44
7	86			

30	 vsi30	

N	ρ	h	d	Alt
1	8.06	0.5	0.5	-0.5
2	3.28	0.321	0.821	-0.8208
3	3.88	1.19	2.01	-2.01
4	5.72	1.5	3.51	-3.506
5	12.7	3.88	7.39	-7.39
6	19.5	6.21	13.6	-13.6
7	23.4			

5.0 Preventive and mitigation measures

5.1 Storage of Molasses

Such type of accident occurred second time in the past nine years in the distillery unit. Therefore, it is advised to the factory management to strictly adhere and follow Indian standard 5521: 2022 Steel tanks for storage of molasses- specification (second revision). This standard covers the requirements of materials, recommended volumes and dimensions, method of construction, and testing of mild steel tanks for storage of molasses in sugar factories. It is advised to appoint competent auditor for this purpose and confirm the compliance of standard.

Volume & Dimensions: The diameter and height of the molasses storage tanks usually depends upon the size of the ground area available and the volume of molasses required to be stored. Table 5.1 gives the recommended volumes and dimensions of tanks for storage of molasses.

Table 5.1: Recommended Volumes and Dimensions for Steel Tanks for Storage of Molasses

Volume	Effective volume	Height	Diameter	Bottom plate	1st Course	2nd Course	3rd Course	4th Course	5th Course	6th Course	Last 2 Course	Roof
(m^3)	(m^3)	(m)	(m)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1250	1125	8	14.11	12	8	6	4	6	6	6	6	5
1500	1350	8.5	14.99	12	8	8	6	6	6	6	6	5
2000	1800	9.6	16.29	12	10	8	6	6	6	6	6	5
2500	2250	9.8	18.03	12	12	10	8	6	6	6	6	5
3000	2700	9.6	19.95	12	12	10	8	6	6	6	6	5
3500	3150	9.8	21.33	12	14	12	10	8	6	6	6	5
4000	3600	9.6	23.04	12	14	12	10	8	6	6	6	5
4500	4050	9.8	24.19	12	16	12	10	8	6	6	6	5
5000	4500	9.6	25.76	12	16	14	12	10	8	6	6	5
5500	4950	9.6	27.02	12	16	14	12	10	8	6	6	5
6000	5400	9.8	27.93	12	18	14	12	10	8	6	6	5
6500	5850	10	28.78	12	18	16	14	12	10	8	6	5
7000	6300	10	29.86	12	20	16	14	12	10	8	6	5
7500	6750	10	30.91	12	20	16	14	12	10	8	6	5
8000	7200	10	31.92	12	20	16	14	12	10	8	6	5

Note: The height of the tank shall be determine taking into consideration the soil bearing capacity and the cost of making foundation suitable for the recommended height.

5.2 Material used to build storage tank-

1. The tank for storage of molasses shall be built from mild steel plant with Grade A (IS 2062)
2. Thickness of the steel plates used in the bottom, shell and roof shall be as given in Table 1. (IS 1730)
3. Fabrication procedure shall be as per IS 803

4. Tank shall be designed with due consideration of seismic loading as per IS 1893 (part 2).

5. The welding details of shell should be as per the IS 803.

6. The welding of top curb angle with shell and roof should be as per IS 803.

5.3 FABRICATION

1. All joints shall be seam or butt welded. The welded joints shall be sound and finished smooth inside and shall be water-tight. The bottom plates shall be V-grooved and welded with butt welding. Mild steel strip 60 mm wide and 6 mm thick shall be provided (over lapped welded) over the welds. After welding of bottom plate, Weldment should be checked with Die pentrant /magnetic particle inspection method.

2. The permissible stresses for welds and welded connections shall conform to values given in IS 816.

3. Suitable radial trusses shall also be employed for support of the roof of the tank (see fig.1), which may directly be supported on the shell plates with a curb angle at the roof level all around.

4. **Centre Column-** Two channels MC 300 or MC 225 at right angles to each other with suitable saddle at the base shall be provided (see IS 803).

5. The permissible stresses for the bottom, shell and roof of the tank shall be in accordance with IS 800.

6. The tank shall be designed with due consideration to the wind loads, which shall be in accordance with IS 875 (Part 3).

7. To ensure proper welding of bottom plate with the first shell course, minimum outside projection of bottom plate from shell should be 25 mm.

8. Minimum spacing or unsupported length of the roof plate should not be more than 2100 mm.

5.4 Fittings and accessories-

1. Outlet- The outlet shall be of steel with a minimum diameter of 15 cm and shall be located on the first course of the tank 15 cm above the bottom. The suction for pumping molasses should be from the side of the tank.

2. Outlet Discharge Valve- A sluice valve, of stainless steel, Class 150, followed by another similar valve, in series shall be fitted to the outlet opening.

3. Drainage or Washout Valve- A stainless steel sluice valve, Class 150, followed by another similar valve, in series shall be fitted at the bottom of the tank and also connected to the outlet (fig. 1).

4. Inlet- The inlet of molasses shall preferably be at the bottom (see Fig. 1) unless the molasses is discharged through an overhead pipeline in which case the molasses should not be allowed to fall from a height as in doing so a lot of air gets occluded, which is not desirable. Instead, the pipe may be held tangential to the inside of the wall about a meter from the top. The inlet shall be fitted with a non-return valve followed by a sluice valve.

5. Indicator Thermometer- The tank shall be provided with at least three RTDs or 15 cm dial thermometers, one about 0.15 m from the bottom, other at one-third height and the third at two-thirds height of the tank.

6. Manhole- Two manholes having diameter of 45 to 60 cm shall be located one on the top and other on the side bottom of the tank (see fig. 1). A suitable attachment shall be provided to securely hold the man-way door in position through a suitable bracket. A bolt without attachment shall be fitted to hold the bracket in position, alternatively, a loose cover with lifting handle may be provided. The manhole covers shall be watertight.

7. Safety Railing- A safety railing, with toe plate, all around the roof of the tank shall be provided. The railing shall be of the height of 1 m. The maximum distance between two railing posts shall be 2.4 m (see fig. 1). A walkway on the top of the roof sheet is to be marked with weather proof paint near the trusses for safety purpose.

8. Vent Pipe or Chimney- A vent pipe or chimney shall be provided at the center of the roof for venting out of the gas (see fig. 1). For large size tank over 16 m diameter, more than one vent pipe may be provided. The mouth of the vent pipe shall be suitably protected with wire netting.

9. A 25 mm drip cock shall be provided at the outlet for sampling purposes

10. Water Spraying Coil- Provision of a perforated water spraying coil 25/40 mm in diameter shall be made all round outside the tank with water inlet connections at Four peripheral Points. The direction of the perforations shall be such that the water flows along the sides of the tank (see fig. 1).

11. Painting- The tank shall be suitably painted on the outside and with anti-corrosive paint on the inside. The roof, and the supporting trusses and the top strake may be painted inside also.

12. Staircase- The tank shall be provided with a staircase of sturdy construction and design and made of mild steel, duly painted. The staircase shall be provided with suitable hand railing and adequate landings.

13. The tank may be provided with a suitable level indicator.

14. All openings in the tank shall be so made that there is no possibility of accumulation of liquid or other foreign matter and the entrances are protected against dust, insects, and other extraneous materials. All component parts shall be capable of being cleaned and inspected in position or by dismantling, if necessary.

15. To include following accessories as a part of molasses tank:

a) Suitably designed molasses cooling system; and

b) Re-circulation pumping system.

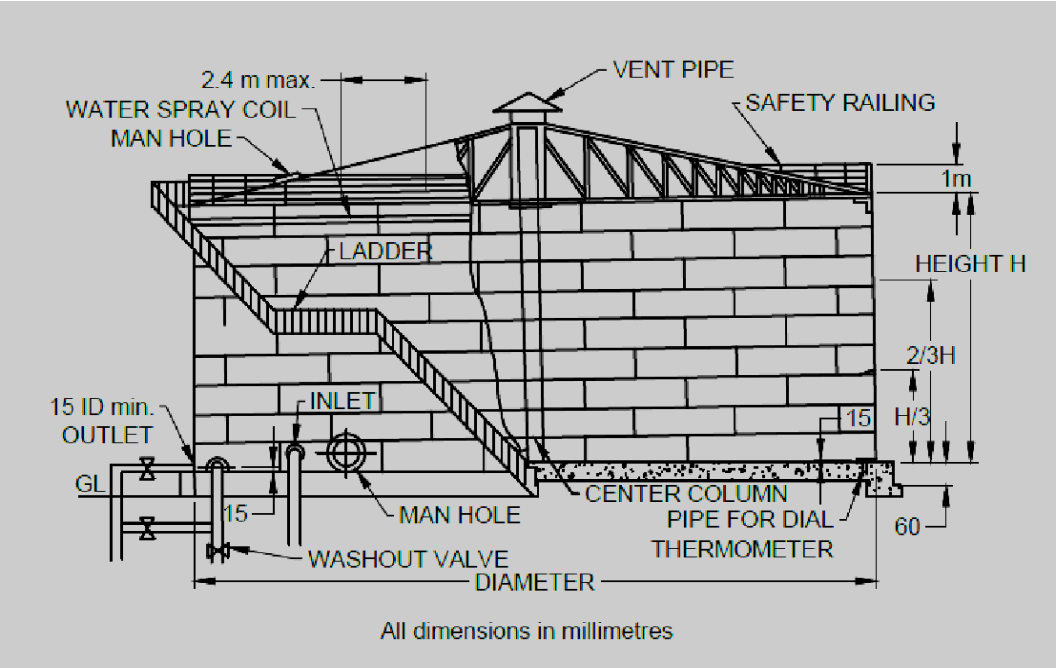


Figure 5.1: Details of the Steel Tank for Storage of Molasses

Above guideline are taken from IS 5521: 2022 of 'Steel Tanks for Storage of Molasses – Specification (Second Revision)'. This guideline covered for only safety aspect that related to accident happens in factory. For other detail aspects related to construction of molasses storage tank please, refer following standards.

Table 5.2: Detail aspects related to construction of molasses storage tank

#	IS	Title
1.	800 : 2007	General construction in steel-Code of practice (*third revision*)
2.	803 : 1976	Code of practice for design fabrication and erection of vertical mild steel cylindrical welded oil storage tanks (*first revision*)
3.	816 : 1969	Code of practice for use of metal arc welding for general construction in mild steel (*first revision*)
4.	875 (Part 3) : 2015	Design loads (other than earthquake) for buildings and structures- Code of practice: Part 3 Wind loads (*third revision*)
5.	1162 : 2021	Cane Molasses- Specification (*first revision*)
6.	1730 : 1989	Dimensions for steel plates, sheets strips and flats for general engineering purposes (*second revision*)
7.	1893 (Part 2) : 2014	Criteria for earthquake resistant design of structures: Part 2 Liquid retaining tanks (*fifth revision*)
8.	2062 : 2011	Hot rolled medium and high tensile structural steel- Specification (*seventh revision*)

5.5 Additional measures

- From the past accident history, it is recommended to consult the expert and explore feasibility of an auto system to control the temperature and pressure (of gasses) inside the molasses storage tanks.
- Consult safety expert for feasibility of installation of early warning/detection system
- Molasses storage tank yard should be fenced properly and work entry permit system should be practiced even for the workers and factory staff. This should be immediately and strictly followed to prevent fatalities in such accidents.
- Consult an expert civil engineer and make suitable arrangement to prevent the spread/spilled material to maximum extent within the premises. Consult him for making garland drainages/dykes all around the molasses storage tank area. The management should also explore the feasibility of making any additional measures outside its premises in consultation with an expert civil engineer and local village panchayat
- Make a permanent impervious storage tank arrangement within the factory premises. This tank will be used to store the collected spilled material. During off-season it can be used as a rain water harvesting storage. It should be provided with suitable capacity pumps and suitable length and dimeter pipelines
- Measures suggested by Civil engineer, safety expert or structural engineers etc need to be implemented in a time bound manner. Environment and safety management teams must be empowered for smooth, time bound and responsible implementation of the suggestions.

Table 5.3: Estimated provisions for preventive measures

#	Preventive measure/activity	Estimated cost/provision (Rs in lakhs)
1.	Consultation of safety expert, safety audit and safety measures	15.00
2.	Consultation of civil engineering expert	05.00
3.	Fencing and garland drains to collect the spilled material	20.00
4.	Provisions of storage tank	15.00
5.	Provision for measures recommended by expert civil engineer	20.00
	TOTAL	**75.00**

5.6 Remediation/Mitigation measures

- It was observed from ground water and soil analysis results that the contamination of ground water as well as soil from accident affected area is remediated naturally.

- Even though, the pollutants got mitigated naturally, but it is advised to the factory to undertake following measures as corporate environmental responsibility (CER)

Table 5.4: Estimated provisions for preventive measures

#	Preventive measure/activity	Estimated cost (Rs in lakhs)			
		1st year	2nd year	3rd year	Total
1.	Development of a greenbelt along the fencing near molasses storage area and thickening of greenbelt in other areas Tree plantation outside the factory premises (neighboring villages)	03.00	03.00	03.00	**09.00**
2.	Provision of safe drinking water to the affected families and all locals of Jungle wadi (per year – for next three years)	07.00	07.00	07.00	**21.00**
3.	Provisions of organic fertilizers and/or liquid/similar fertilizers for enhancing N and P availability to the crops – On subsidized rate for farmers affected due to the accident (for next three years)	05.00	05.00	05.00	**15.00**
4.	Skill development/training to local youth for employment/job opportunities (per year for next three years)	02.00	02.00	02.00	**06.00**
	TOTAL	17.00	17.00	17.00	**51.00**

6.0 Damage assessment and monetization

6.1. Water environment

The test reports of ground water samples collected from an area where molasses spread occurred compared with representative samples where spread doesn't occur or at a far distance. From these results it was observed that, at present the impact of molasses on ground water environment got mitigated. Important pollution parameters such as pH, COD, BOD indicate the ranges in normal or very mildly polluted. The pollutants might have diluted and partially carried away due to rains. Further, dilution might have also occurred by subsoil (Below surface) streams of respective dug wells.

Therefore, monetizing the damage of water environment, carried out using **shadow pricing mechanism. In this method, the estimation of the distance function enables us to obtain the shadow price of the undesirable outputs. In this case the undesirable output considered as BOD and COD values that are the major indicator of pollution. This method is originally described in a research paper published by F. Hernández-Sancho et al. (2010). In their study, these researchers considered nitrogen, phosphorous, suspended solids, BOD and COD as undesired output of sewage treatment plants in their studies. This is mainly because the cost involved in removing these undesirable components is considerable in order to reuse the sewage. Hence, the considered the cost as environment benefit cost and interpreted the results.**

However, in the present case, ground water and soil is affected due to accidental release of the molasses. Strength of liquid pollutant is usually measured in BOD and COD. While estimating COD, the demand of oxygen for oxidation of inorganics is get covered. Therefore, in the present study estimating cost for the inorganic may lead to duplication of the cost for same pollution. In other words, the damage cost due to inorganic also gets covered through COD value. Therefore, COD and BOD considered as important parameter for damage cost estimation.

Reference F. Hernández-Sancho et al. / Science of the Total Environment 408 (2010) 953–957 (Enclosed as annexure to the report for ready reference) (described on page 40 of Framework for Environmental Damages Cost Assessment by NEERI).

Table 6.1: Monetization calculations as per the said method

Important parameter considered	Test Value (kg/ton - rounded average basis)	Total discharge value
Chemical oxygen demand (COD)	63	63 kg/T x 4000 tons = 252,000 kg
Bio-chemical oxygen demand (BOD)	23	23 kg/T x 4000 tons = 92,000 kg

as per the abovementioned guideline publication, pollutant cost of the above parameters are

Table 6.2: Pollutant cost of COD and BOD

	Damage cost in €/kg (2010)	Total discharge value of pollutant	€/Rs rate for April 2023 (max)	Damage cost In Rs – (rounded to nearest number)
Chemical oxygen demand (COD)	0.140	252,000 kg	91.0386	**32,11,842.00**
Bio-chemical oxygen demand (BOD)	0.058	92,000 kg	91.0386	**4,85,782.00**
TOTAL				**36,97,624.00**

6.2 Soil environment

While estimating damage cost for soil environment of the accident affected area, following points were considered.

- Duration of spread of the pollutant in the soil
- Nature of the pollutant for soil environment
- Percolation of the pollutant and its present status in subsoil layers or levels
- Long term impact associated with the pollutant released

There is no evidences or record available to ascertain the period of accumulation of pollutant in the soil. According to the factory officials, they scrapped the molasses from field using available bagasse and removed it to maximum extent in 10-12 days after the accident. Hence, it is presumed that molasses spread was observed for two weeks. Considering the organic nature of molasses and its high content of potash, makes it difficult to distinguish undesirable components. Even, the acidic nature of the molasses might have helped in reducing soil alkalinity which is reported in the samples collected from non-affected area.

Therefore, the accidental spread of molasses on soil perceived as an impact due to high COD, BOD of molasses. The same amount i.e. Rs. 36,97,624.00 (Rupees thirty-six lakhs ninety-seven thousand six hundred twenty-four) is suggested as a damage cost.

6.3 Geo-physical report

From the resistivity surveys it is inferred that throughout the area from surface downwards up to depth of 25 meters the strata are highly weathered and conducive for water infiltration and therefore the infiltration of the molasses released during the disaster and may have contaminated the groundwater present in the area. This contamination might have occurred immediately after the accident. However, the samples of

ground water collected during the study reveals almost traces of pollutant in the collected samples. These pollutants may be due to local contamination.

As far as the damage assessment concerned, the damage due to discharge of molasses having very high COD, BOD into the ground water and soil is already monetized (Refer table 6.2). It covers the contamination of ground water which is monitored and geo and hydro-geo studies. Therefore, no additional damage cost from geological and hydro-geological perspective is proposed here.

6.4 Crop and agriculture

In this case, there is no specific data available for quantification of crop damage. It was observed from the data provided by the factory officials, MPCB site visit record covered site specific conditions observed at that time. However, there is no any mention of how many dug wells were affected due to the accident? How much soil observed damaged due to molasses spread? How many crops suffered the impact of accident? **Through this report we request the concerned authorities to prepare a standard operating procedure/s (SOPs) and develop related format/s to record the damage in all future cases (applicable to even other industrial accident cases).**

6.5 Wild Flora and Fauna

During the initial preliminary visit to site in Dec. 2022, there were five eucalyptus trees found dried and dead, just outside the boundary-wall of the accident site. Acidic pH of the molasses and its temperature might be the reason for the death of those trees. These trees were not observed during actual damage assessment survey. Therefore, its diameter and related parameters for estimation of its volume were not available. This data serves as an input to estimate the cost of the tree.

Therefore, this damage assessment is carried out based on the reference where cost was recovered for damaging trees. The said reference is enclosed as Annexure IV. The cost charged per tree is Rs. 41,750/-. Considering the same, cost for damaging five trees is Rs. 2,08,750/-

7.0 Conclusion

Table 7.1: The damage assessment and preventive/mitigation measures cost

	Particular	Cost/provision (Rs)
Damage Cost	Cost of damage due to accidental discharge of molasses into the ground water of nearby areas	36,97,624.00
	Cost of damage due to accidental discharge of molasses into the soils of nearby areas	36,97,624.00
	Cost of damage to flora/trees due to accidental discharge of molasses	2,08,750.00
Preventive measures provision	Provision for implementation of preventive and mitigation measures	75,00,000.00
Mitigation measures (additional) through CER	Provision for implementation of CER activities	51,00,000.00
	TOTAL	**2,02,03,998.00**
	Rupees two crores two lakhs three thousand nine hundred ninety eight	

8.0 Project Team

The Institute has received accreditation from Quality Council of India (QCI)/National Accreditation Board for Education and Training (NABET) for EIA consultancy services. It is also a recognized Research and Development center of Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology, Government of India.

Table 8.1: Project team of Damage assessment study

Name	Designation	Role / Expertise
Dr. Deepali Nimbalkar	Senior Scientist & Head Dept. of Environmental Sciences, VSI	**Environment Expert**
Dr. Nitin Karmalkar	Ex-Vice Chancellor, Retired head of Department of Environmental Sciences of Savitribai Phule Pune University	**Geology and Hydro-geology**
Dr. Duraiswami Raymond	Associate Professor, Dept. of Geology, Savitribai Phule Pune University	**Geology and Hydro-geology**
Dr. Amol Deshmane	Scientist Dept. of Environmental Sciences, VSI	**Project coordinator** **Ecology, Biodiversity and Environment Expert**
Dr. Vivek Patil	Scientific Officer Dept. of Environmental Sciences, VSI	**Environment Expert**
Mr. Vikram Deshmukh	Scientific Officer Dept. of Environmental Sciences, VSI	**Environment Expert**
Ms. Priyanka Kad	Research Assistant, Dept. of Environmental Sciences, VSI	**GIS Expert**

Team for sampling and laboratory analysis of collected samples

1. Dr. Hemlata Hingane (Scientific officer, VSI)
2. Mr. Aftab Momin (Research assistant, VSI)
3. Mr. Parshuram Chalwadi (Research assistant, VSI)
4. Ms. Pooja Kerle (Research assistant, VSI)

LIST OF ANNEXURES

Annexure I

Visit report of MPCB official on accident site dated 10/02/2022

MAHARASHTRA POLLUTION CONTROL BOARD

Sub Regional Office, Ahmednagar. Savitribai Fula Vyapari Sankul, 1st floor, Hall No. 2 & 3, Near T.V. Centre, Savedi, Ahmednagar-414003.		**Office Contact No.**: 0241 - 2470852 **E-mail ID** :-sroahmednagar@mpcb.gov .in Visit us At-mpcb.gov.in

VISIT REPORT

Date of Visit	10/02/2022.
Name & Address of the Industry	Sahakar Maharshi Shivajirao Narayanrao Nagawade SSK Ltd Plot No. 5212, Limpangaonvitthal, Tal. Shrigonda. Dist. Ahmednagar.
Person Contacted	R.S. Naik
Contact details (Industry representative)	9130009200
Contact Number and E mail ID	Shrigondasugar@yahoo.co.in.
Validity of Consent Status	Valid upto - 31/07/2022.

Production Details (consented products):-

Sr. No.	Product Name	Quantity (As per Consent)	Quantity Actual Jan. 2022
1)	Sugar	1584 0 MT/M	16196 MT/M
2)	Molasses	5760 MT/M	5380 MT/M
3)	Press Mud	5760 MT/M	4590 MT/M
4)	Bagasse	40320 MT/M	40440 MT/M
5)	Co. Generation	26 MW	16 MW.

Maharashtra Pollution Control Board

Water Pollution aspect:-	Industrial		Domestic
Effluent Generation in M3/d	Process	Cooling	Domestic
As per Consent	398.0	-	45.0
Actual	390.0	-	30.0
Treatment System Provided Details (Capacity):-	Primary, secondary & tertiary.		Soak Pit/ STP
Disposal as per Consent	Yes / No		Yes / No.
Quantity of Disposal	Stored in kaccha lagoon & irrigation		gardening
Online Monitoring System Applicable Water	Yes/No	If Yes Connected to 1. CPCB Server 2. MPCB Server	
	Remote calibration applicable	Yes/No	
	Sensor Properly Placed	Yes/No	
Separate Electric Meter Provided	Yes/No		
Meter Readings	0		

Operation& Maintenance: Industrial: Poor Average Good **Domestic:** Poor Average Good

Last JVS Details : - Date of Collection Payment: - Yes / No

Amount details:

Water Sample collected: Yes/No

If Yes details of source-

Parameters-

Air Pollution Aspects:

Source	Fuel	Quantity/ Unit	Pollutants	Stack Height	Control Equipment Installed
Boiler 1 & 2	Biogas	27000 kg/hr	TPM/ SO2	30.0	wet scrubber
Boiler III	~~	15000 kg/hr	~~	30.0	~~
Boiler V	~~	~~	~~	60.0	~~
Boiler VI	~~	1272 MT/Day	~~	73.0	ESP.

Online Monitoring System Air (Stack)	Yes/No	If Yes Connected to 1. CPCB Server 2. MPCB Server	NO.
	Remote calibration applicable	Yes/No	
	Sensor Properly Placed	Yes/No	

	Whether proper stack monitoring facility exists	Yes/No
	Whether calibration facility exist	Yes/No

Online Monitoring System Air (Ambient)	Yes/No	If Yes Connected to 1. CPCB Server 2. MPCB Server
	Remote calibration applicable	Yes/No
	Sensor Properly Placed	Yes/No

Air Sample collected: Yes/No

if Yes details of source- —

Parameters- —

Hazardous Waste Management (Last consent Details):

Category No. & Type	Quantity as per consent/UOM	Method of disposal as per consent	Actual Disposal/UOM	Total quantity disposed as per FORM-IV	Last Disposal quantity/UOM	Last Disposal date
5.1	25 (TS)/M	Burning in Boiler				

Non Hazardous Waste Management:

Name of Waste	Quantity as per consent	Method of disposal as per consent	Last disposal date	Last disposal quantity	Actual Disposal
1) Fly/Boiler Ash	2749 MT/Day	Bio composting.			

Tree Plantation:

Total plot area sq. mtr.	BUA in sq. mtr.	Green Belt area sq. mtr.	Plantation Done in Nos.	Proposed Plantation
331800	96683	78301	15000	1000

Statutory Submission:

Hazardous waste Annual Returns: - Submitted up to 13/06/2021.

Environment Statement Report : - Submitted up to 27/09/2021.

Previous Legal Action	Bank Guarantee Details:
Action Initiated Date:- Specific Compliance :-	BG Imposed : Yes/No BG Imposed against : Consent / Directions Number (Only for Directions) :

Maharashtra Pollution Control Board

Bank Guarantee details:-

Bank Guarantee Imposed for	Amount as per consent / direction	Bank Guarantee number	BG issued date	Bank Guarantee Validity
O & M of PCS &	Rs. 25.0 lacks	Not Submitted		
Compliance of				
Consent Condition				

Additional observations:

As per instruction SRO Ahmednagar visit paid to industry regarding blast of molasses tank incident happened in industry premises, during visit following observation are made as below.

(1) During visit it is observed that blast of molasses tank (No-1) M-1 incident happened in molasses storage area.

(2) Industry representative informed that said incident happened at 6.45 AM on 10/02/2022.

(3) Due to said incident molasses sp has been spread in premises (i.e. near ETP area, CPU area & same ETP tank) & it has also went into the nearby by nalla & same it has flown till approx 1.0km in the said nalla same nalla blocked through soil.

(4) Due to said incident molasses flown into nalla due to which it has also spread

in nearby farmlands.

(5) Industry representative informed that they have stored approx - 4102.800 MT molasses in (old molasses) storage tank No-1 (M-I) Same is spread in premises & nearby by nalla.

(6) Industry representative informed that they have stored approx - 3036.710 MT in molasses in tank No-2 (M-II) & approx - 4072.380 MT molasses in tank No-3 (M-III).

(7) Due the this incident the wall nearby Z-top has damaged.

Remark=> 1) Instructed to industry submit action taken report on top priority.

2) Industry shall removed all molasses from nearby by nalla. on top Priority.

3) Instructed to industry submit the molasses storage arrangement details on top Priority in MPCB office

4) Industry shall carried out Safety Audit of molasses storage tank No-2 & No-3.

* industry representative informed that this incident happened due to spontaneous combustion in tank No-1 (M-I)

Naik R.S.
M.M.

Maharashtra Pollution Control Board

Ravidas Patil (Sr.)
M.P.C.B. Ahmednagar.

Annexure II

Letter/order issued by MPCB to the Factory regarding damage assessment study – letter dated 17/10/2022

MAHARASHTRA POLLUTION CONTROL BOARD

Tel.No.(0253) 2362820

E-mail: ronashik@mpcb.gov.in

"Your Service is our Duty"

Regional Office- Nashik,
Udyog Bhavan, 1st floor,
Trimbak Road, MIDC Comp.
Near ITI., Satpur, Nashik-422007.

BY R.P.A.D./FAX/HAND DELIVERY
No: MPCB/RONK/ID/2210/7000 /2022 Date: - 17/10/2022

To,
M/s. Sahakar maharshi Shivajirao Narayanrao Nagawade SSK Ltd, (Distillery Unit)
Plot No. 52/1, A/p. Limpangaon, Tq. Shrigonda,
Dist. Ahmednagar.

Sub: Interim Directions under Section 33 A of Water (P & CP) Act, 1974 & under Section 31A of Air (P & CP) Act.1981.

Ref: 1. Proposed Directions issued on 9.2.2022.
2. Personal hearing extended on 28.7.2022 at HQ.

This refers to the proposed directions issued by the Board vide above referred letter (1) and personal hearing extended to factory representative on 28.7.2022. During the personal hearing as agreed by your representative, it is directed to comply the following directions in time bound manner.

1. Industry shall carryout the assessment of contamination, cost of remediation and damage assessment through NEERI/IIT/VSI within two months.
2. Industry shall comply with recommendations of report submitted by the institute at Sr. No. 1 above before six months and report the remedial action taken as per suggestion of expert agency before next crushing season.
3. Industry shall ensure OCEMS connectivity to MPCB server within 7 days.
4. Industry should not dispose spent wash sludge to any party.

If you fails to comply these directions in time bound manner, the Board will have no any other option than to issue final directions such as disconnection of electricity and water supply of your industry, which may be noted.

(Ravindra B. Andhale)
Regional Officer, Nashik.

Copy Submitted for information to: -
The Principal Scientific Officer, M.P.C. Board, Mumbai.

Copy forwarded to: -
Sub. Regional Officer MPCB, Ahmednagar – He is directed to serve the copy of these directions to the industry & submit timely compliance report along with photographs and monitoring reports of the said directions scrupulously.

Annexures III - Joint Committee report as per order dated 29/09/2022 of Honorable National Green Tribunal (NGT)

REPORT OF THE JOINT COMMITTEE IN COMPLANCE WITH ORDER DATED 29/09/2022 OF THE HON'BLE NATIONAL GREEN TRIBUNAL (NGT) IN THE MATTER OF OA NO. 85/2022 (WZ), SACHIN SUDAMRAO PACHPUTEVS SHAHAKAR MAHARSHI SHIVAJIRAO NARAYANRAO NAGAWADE SSK LTD (SUGAR UNIT) AND OTHERS

1.0 Background

Grievance in the Original Application No. 85 of 2022 (WZ), titled Sachin Sudamrao Pachpute vs Shahakar Maharshi Shivajirao Narayanrao Nagawade SSK Ltd., (Sugar Unit) and Others, as per order dated 29/09/2022 of the Hon'ble NGT is about discharging effluent in Ghod River without treating at Effluent Treatment Plant (ETP), non-compliances of consent to operate conditions issued by Maharashtra Pollution Control Board (MPCB). Also, the applicant alleged that due to molasses tank blast took place in the storage area, resulted in spreading of molasses in nearby natural nalla and agricultural lands. As a result, caused damage to standing crops of various farmers. Further, alleged that the respondent industry has non-complied with the directions issued dated 10/02/2022 by MPCB and the same is reproduced below:

"(i) The industry shall stop the feeding of sugarcane for crushing immediately and stop the operation of sugar factory within 48 Hrs. in a safe manner;

(ii) The Industry shall collect, transport, store and dispose the molasses spread/flown and contaminated soil due to the said incident in a scientific manner so as to avoid further contamination of groundwater, surface water and soil within 48 Hrs. The Industry shall submit concrete action plan immediately.

(iii) The Industry shall not restart crushing operation till further order/directions of the Board & Competent Authorities."

Hon'ble NGT directed vide order dated 29/09/2022 (copy of Hon'ble NGT order, dated 29/09/2022 is given at **Annexure-1**) and relevant order is reproduced as below:

"7. We, therefore, constitute a Committee comprising one member each of Central Pollution Control Board (CPCB), Maharashtra Pollution Control Board (MPCB) and the District Collector of the concerned district, of which MPCB

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shall be nodal agency, with the direction that a report shall be submitted by the Committee after visit to respondent No.1's Unit in respect of as to whether the order dated 10.02.2022 issued by respondent No.2/MPCB has been carried out or not and any relevant factual aspect may also be brought to our notice.

8. The Committee shall submit its report within one month by e-mail at ngt-pune@gov.in preferably in the form of searchable PDF/OCR Support PDF and not in the form of Image PDF."

2.0 Approach

In order to comply with the aforesaid Hon'ble NGT order, dated 29/09/2022 the joint committee carried-out inspection of respondent No.1 industry i.e. M/s Shahakar Maharshi Shivajirao Narayanrao Nagawade SSK Ltd (Sugar Unit), Tal: Shrigonda, Dist: Ahmednagar (hereinafter referred as the industry) on 21/10/2022. The following committee members were present during the inspection:

i. Shri Nishchal C., Scientist 'D', CPCB, Regional Directorate, Pune
ii. Shri Chandrakant Shinde, Sub-Regional Officer, MPCB, Ahmednagar
iii. Shri Sudhakar Bhosle, SDM, Ahmednagar as representative of District Collector, Ahmednagar

Also, Shri Rajendra Patil, Field Officer-MPCB, Ahmednagar was present during the joint committee inspection. Shri R. S. Naik, Managing Director of the industry was accompanied the joint committee during the inspection and provided background information about the industry, environmental management system, alleged issued and area under reference.

3.0 Observations and findings

This report is outcome containing factual aspect of the said joint committee based on the preliminary information gathered from MPCB, followed by inspection of the industry & alleged areas, analysis results of water/effluent samples, information submitted the industry through MPCB and subsequent discussions of the joint committee. The observations & findings of the joint committee are given as below:

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3.1 About the industry

M/s Shahakar Maharshi Shivajirao Narayanrao Nagawade SSK Ltd., is an integrated Sugar & Distillery industry, located at Plot no. 52/2, A/p-Limpangaon, Tal: Shrigonda, Dist: Ahmednagar. Both sugar & distillery is located within the same premises and having separate consent to operate (CTO) issued by MPCB. The CTO of sugar industry was expired on 31/07/2022 (Copy of CTO dated 23/11/2021 is given at **Annexure-2** for kind reference). As per the records of MPCB, the industry has applied for renewal of CTO vide dated 15/06/2022, which is pending before MPCB. CTO issued for cane crushing capacity of 3,500 TCD with manufacturing of following products, depicted in the below Table.

S. no.	Product/by-product	Consented quantity, MT/month
1.	Sugar	15,840
2.	Molasses	5,760
3.	Press mud	5,760
4.	Bagasse	40,320
5.	Co-generation	26 MW

Similarly, CTO of distillery was expired on 31/08/2022 (Copy of CTO dated 03/02/2021 is given at **Annexure-3** for kind reference). As per the records of MPCB, the industry has applied for renewal of CTO vide dated 17/06/2022, which is pending before MPCB. CTO issued for 30 KLPD molasses based distillery with manufacturing of following products, depicted in the below Table.

S. no.	Product/by-product	Consented quantity, KL/month
1.	Rectified spirit or Extra Neutral Alcohol or Ethanol	900
2.	Fusel oil	01

3.2 Water and effluent management – sugar industry

Main source of water is Ghod Left Bank Canal and the industry has obtained permission from Irrigation Dept., Pune for withdrawal of water. As per the records, the average daily consumption of fresh water is 800 m^3/day and mainly used for process (cooling water & machinery cleaning water) @ 240 m^3/day, utilities i.e. sugar industry boiler feed @ 600 m^3/day, cooling tower make-up & ancillary activities @ 220 m^3/day and domestic purpose @ 25 m^3/day respectively.

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The main sources of effluent generation from process are; mill house section, boiling house section (multiple effect evaporators), vacuum pans, centrifugal section, process condensate contaminated with concentrated juice, ancillary activities (rotary vacuum filter cleaning & gland leakages from pumps, pipelines etc.) and fresh water RO reject & boiler blowdown streams. The management of process effluent & condensate and condensate/blowdown streams from utilities are briefed as follows:

- **Process effluent management:** Effluent generating from mill house section, centrifugal section & boiling house section is collected separately and channelized into ETP for treatment. The industry has provided ETP of reported designed capacity of 1,000 m^3/day and the reported effluent generation from the process is about 850 m^3/day (at full cane crushing capacity), out of which fresh water RO reject & utility boiler blowdown @ 250 m^3/day is recycled in the process. Hence, the actual effluent generation from the process is 600 m^3/day.

  The various unit operations & processes of ETP are; Process effluent → V-Notch chamber → Bar screen chamber → Grit chamber → O&G skimmer → Surge tank → Equalization tank with sparge aeration (lime addition) → Primary clarifier → Anaerobic holding tank-1 & 2 → Anaerobic filter → Bio-tower → Tube settler → Activated sludge process → Secondary clarifier (with RAS recycling) → Supernatant collection tank → Pressure sand filter → Activated Sand filter → Treated effluent collection tank → Treated effluent discharge to unlined lagoon (15 day storage capacity) for irrigation as per CTO conditions.

  Primary & secondary sludge from tube settler & clarifiers → Sludge holding tank → Sludge drying beds (02 nos., 20x5x2 m each) → Soil conditioner.

- **Process condensate management:** As informed, excess condensate from multiple effect evaporators & pan evaporators are collected separately and treated in newly commissioned ETP – condensate polishing unit (CPU). The industry has provided separate ETP (CPU) of reported designed capacity of 1,200 m^3/day.

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The various unit operations & processes of ETP (CPU) are; Excess condensate → Two stage cooling tower → Equalization tank with diffused aeration → Anaerobic filter → Activated sludge process → Secondary clarifier → Flash mixer (with addition of alum & poly electrolyte) → Filter feed tank → Chlorination → Multi grade filter → Activated Sand filter → Treated condensate collection tank → Treated condensate is reused in recirculation pump cooling & its accessories and spray pond make-up. Also, treated condensate is reused in utilities (cooling tower make-up) after treatment through softner. Excess treated condensate is channelized to fresh water reservoir for reuse in process (sugar & distillery unit).

Secondary sludge from clarifiers of CPU of sugar & distillery industry is handled in a common sludge drying bed of ETP of sugar industry.

3.3 Water and effluent management – distillery industry

Main source of water is Ghod Canal and treated condensate from sugar & distillery industry. As per the records, the average daily consumption of fresh water is 70 m^3/day and mainly used for utilities i.e. distillery industry boiler feed @ 24 m^3/day, cooling tower make-up & ancillary activities @ 42 m^3/day. Similarly, the average daily consumption of treated condensate is 270 m^3/day and mainly used for manufacturing process (molasses dilution & fermenter make-up) @ 260 m^3/day, DM plant @ 05 m^3/day and ancillary activities @ 05 m^3/day respectively.

The main sources of effluent generation from process are; wash water used to clean the fermenters, spent wash & spent leese from distillation of fermented mash, ancillary activities and condensate from boiler & blowdown streams. The management of distillery effluent and condensate/blowdown streams from utilities are briefed as follows:

- **Distillery effluent management:** Effluent generating from various process is collected separately and channelized into ETP for treatment. The industry has provided ETP comprising of UASB followed by MEE and the reported effluent generation from process is about 360 m^3/day.

The various unit operations & processes of ETP are; Process effluent → 5 day storage lined lagoon → Buffer tank (with lime addition) UASB reactor, 02 nos. (5,200 m^3) → Treated effluent storage tank → MEE feed tank → MEE (5 stage) MEE concentrate @ 270 m^3/day → Spent wash lined lagoon (8,380 m^3 i.e. 30 days capacity) at bio-compost yard → Concentrated spent wash → Bio-composting on 05 acre lined platform as per CTO conditions.

Biogas generation from UASB is about 350 – 450 m^3/hr, which is either used in captive co-gen boiler as a supplementary fuel and the excess biogas is flared in the flaring system. Sludge from primary storage lagoon (5 day capacity) & yeast sludge from fermenters → Used in bio-composting.

- **MEE condensate management:** MEE condensate from multiple effect evaporator is collected and treated in newly commissioned ETP – condensate polishing unit (CPU). The industry has provided separate ETP (CPU) of reported designed capacity of 360 m^3/day.

  The various unit operations & processes of ETP (CPU) are; MEE condensate → Two stage cooling tower → Equalization tank with diffused aeration → Anaerobic filter → Activated sludge process → Secondary clarifier → Flash mixer (with addition of alum & poly electrolyte) → Filter feed tank → Pressure sand filter → Activated Sand filter → Treated condensate collection tank → Treated condensate is reused in molasses dilution & fermenter make-up, recirculation pump cooling & its accessories and utilities (cooling tower make-up) after treatment through softner.

- As informed, domestic wastewater generation from the sugar & distillery unit is in the tune of 45 & 03 m^3/day and as per CTO conditions, it is treated through septic tank followed soak pit. The treated domestic wastewater is being used for gardening as per CTO conditions.

Photographs of various treatment units of ETP of sugar & distillery unit is given below for kind reference.

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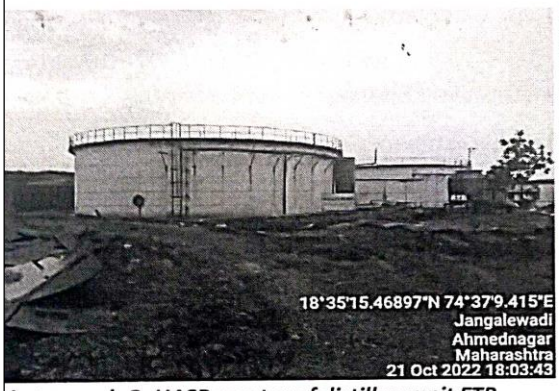
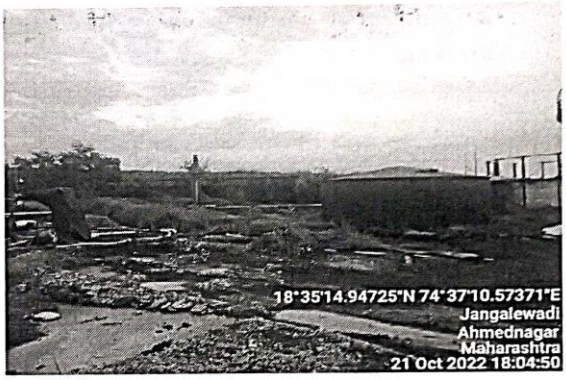
Photograph-1: Grit chamber and oil & grease skimmer installed at ETP.

Photograph-2: ASP of sugar unit ETP under stabilization process.



Photograph-3: UASB reactor of distillery unit ETP.



Photograph-4: Biogas holder and flaring system.

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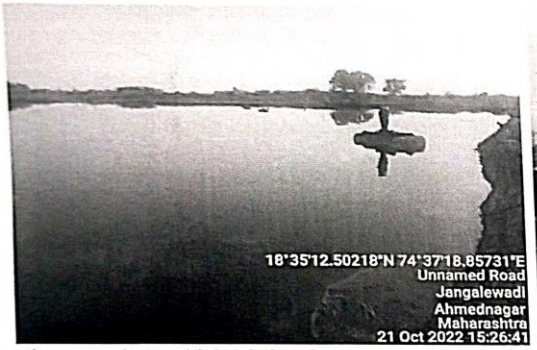
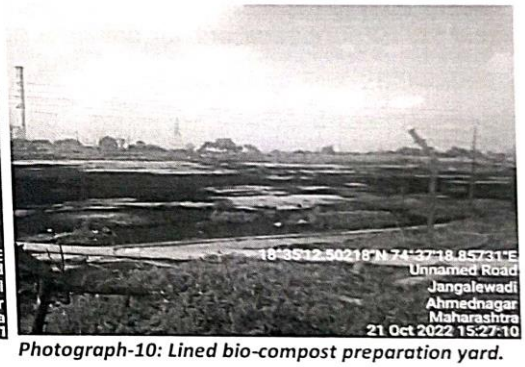
Photograph-7: CPU of sugar unit ETP.

Photograph-8: 30 days lined spent wash storage lagoon.



Photograph-9: Old brick lined spent wash storage lagoon.



Photograph-10: Lined bio-compost preparation yard.

Photograph-11: PTZ camera installed at bio-composy yard of distilley unit.

Photograph-12: OCEMS installed at final treated effluent conveyance pipline of sugar unit ETP.

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3.3 Compliance verification as per Hon'ble NGT order dated 29/09/2022

The Hon'ble NGT vide its order dated 29/09/2022 has directed the joint committee to submit a report in respect of as to whether the order dated 10/02/2022 issued by respondent No.2/MPCB has been carried out or not and also relevant factual aspect. Point-wise compliance verification to the directions as on date of joint committee inspection is depicted below.

- ***Direction no. 1 u/s 33A of the Water (Prevention & Control of Pollution) Act, 1974 and u/s 31A of the Air (Prevention & Control of Pollution) Act, 1981, dated 10/02/2022: "The industry shall stop the feeding of sugarcane for crushing immediately and stop the operation of sugar factory within 48 Hrs. in a safe manner."***

- As per the Form R.T. 8 (C) i.e. the final manufacturing report for the crushing season 2021-22 (Central Excise Rule 83) submitted to the Commissioner of Sugar, Pune it is observed that cane crushing for the season 2021-22 was started w.e.f. 27/10/2021 and end date of cane crushing was 28/04/2022. Total cane crushed and production details during the aforesaid cane crushing season is depicted in the below Table.

S. no.	Particulars	Quantity, MT
1.	Cane crushed	8,94,631.36
2.	Sugar	95,189
3.	Molasses	39,091.47
4.	Bagasse	2,58,210.4

- From the aforesaid report submitted to Commissioner of Sugar, Pune it is observed that the industry didn't stopped cane crushing on or before 12/02/2022 i.e. within 48 hrs from the date of issue of directions from MPCB.

- In response to the aforesaid directions of MPCB dated, 10/02/2022; the industry vide letter no. Central/Dist/57/1851/2021-22, dated 25/02/2022 submitted reply to MPCB. Wherein, it is observed that the industry didn't stopped cane crushing during the season 2021-22 by citing reasons about the excess sugar cane cultivation in the area, agreement made with shareholder farmers for buying sugar cane and also referring to the circular of Commissioner of Sugar, Maharashtra vide letter dated 08/02/2022 regarding not to stop the cane crushing until all the sugar cane is crushed (quantity

registered by various shareholder farmers). Relevant extract from the aforesaid letter dated 25/02/2022 is reproduced as below:

"..In season 2021-22, sugarcane production is increased in Maharashtra as compare to last two year due to the satisfactory rainfall and hence in our work-space, there is lot 'off sugarcane production for this crushing season. Now, we had crushed the 6.45 Lac MT of sugarcane in this crushing season and balance 2.75 Lac MT sugarcane is remaining & it is factory responsibility to crush the all sugarcane which is registered to our factory by our shareholder farmers.

Also, Hon'ble Commissioner of Sugar, Maharashtra state giving order that, do not stopped the crushing season until to crush all sugarcane, which is registered to sugar factory.."

However, it is observed from the aforesaid reply submitted dated 25/02/2022 to MPCB that the industry has stopped their distillery production activities during February, 2022 and later continued the operation of distillery. Copy of the aforesaid reply submitted by the industry vide dated 25/02/2022 to MPCB is given at **Annexure-4** for kind information.

- ***Direction no. 2 u/s 33A of the Water (Prevention & Control of Pollution) Act, 1974 and u/s 31A of the Air (Prevention & Control of Pollution) Act, 1981, dated 10/02/2022: "The Industry shall collect, transport, store and dispose the molasses spread/flown and contaminated soil due to the said incident in a scientific manner so as to avoid further contamination of groundwater, surface water and soil within 48 Hrs. The Industry shall submit concrete action plan immediately."***

- During joint committee inspection it was gathered and also based on the filed inspection report carried-out by MPCB vide dated 10/02/2022 that the incidence of blast at one of the molasses storage tank was occurred at 06.45 hrs on 10/02/2022. The industry has provided following tanks for storage and handling of molasses:

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S. no.	Storage tank identity (based on license issued by the Excise Dept., Govt. of Maharashtra)	Capacity, MT	Remarks
1.	M-1	4,500	For production & sale
2.	M-1		For production & sale
3.	M-2		For production & captive use in distillery

- Based on the information submitted and discussion with Excise Sub-inspector, Excise Dept., it is observed that erstwhile M-2 tank (meant for production & captive use in distillery) was collapsed during December, 2018 due to structural failure. Subsequently, the industry has obtained permission from Excise Dept., to store the molasses in M-1 tank (meant for production & sale). All the molasses storage tank was commissioned during 1984 and last structural audit was conducted on 05/03/2021. On 10/02/2022, the M-1 tank consisting of molasses of about 4,100 MT was resulted in blast. It is gathered from the internal investigation report of industry that the molasses generated & stored during the last crushing season was having high brix (up to 60) and purity. It was concluded from the internal investigation report that due to absence of proper online cooling and stirring mechanism, an exothermic reaction took place with generation of unstable gases like SO_2, SO_3 and CO_2 and due to very high static pressure of dissolved gases, resulted in explosion of molasses storage tank.

- On account of explosion, the molasses was spread in the ETP area and also flown to the area i.e. barren land towards south-west direction (outside the compound wall, within the purview of industry) and ultimately to the malicha nalah.

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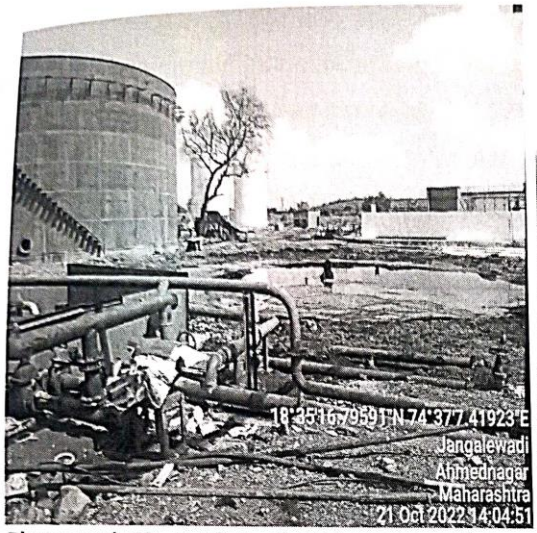

Photograph-13: A view of area where molasses storage tank blast occurred.

Photograph-14: Area showing molasses spread near the ETP of sugar unit.

Photograph-15: Area showing molasses spread outside the compound wall (within industry land) and soil scrapped & levelled.

Photograph-16: A view of malicha nalah (natural drain) conatimanted with leachate from the molasses spilled area and also overflow from lined lagoons.

- The industry vide letter dated 10/02/2022 submitted action plan to MPCB for collection and management of spilled molasses i.e. water and soil contaminated with molasses. Wherein, the industry mentioned that in order to contain the spread of molasses and further contamination of water at downstream location; corrective measures were taken immediately after the incidence by creation of artificial earthen bund to the natural drain at Village:

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Janglewadi (located app. 1 Km from the industry premises). Also, mentioned that molasses contaminated water and soil shall be removed with the help of tankers for further processing of molasses contaminated water in the ETP of distillery unit comprising of UASB (bio-digester) followed by MEE and molasses contaminated soil in the bio-compost preparation. Copy of action plan dated 10/02/2022 submitted by the industry to MPCB is given at **Annexure-5** for kind reference.

- It is gathered from the industry and also from the field inspection report of MPCB dated 10/02/2022 that on the day of incidence about 4,100 MT of molasses was spread within the industry premises and also flown to malicha nalah/natural drain. Also, it is observed from the subsequent field inspections carried-out by MPCB that the industry has initiated collection of molasses contaminated water & soil from the affected areas and nalah. It has been reported that the industry has re-collected ~54 MT (18 trips x 3 KL tanker capacity) of molasses (not contaminated with soil & water) in tankers through pumps during 11/02/2022 to 12/02/2022 and transferred to existing molasses storage tank for distillation. Further, the industry has created artificial earthen bund to the natural drain and collected ~ 2,340 MT (195 trips x 12 MT/trip) of molasses contaminated water in tankers through pumps during 15/02/2022 to 26/02/2022 and stored in 05 days spent wash impervious (concrete) lagoon. Similarly, the industry has collected ~9,915 MT (661 trips x 15 MT/trip) of molasses contaminated soil by scrapping top layer of soil (~10 cm) from 01 acre of own land and also scrapping the bottom layer of soil (~ 10 cm) from natural drain during 12/02/2022 to 02/03/2022 and transferred to the existing bio-compost yard. Further, the affected areas i.e. ETP area & outside compound wall (within the purview of industry) was topped with overburden soil, lime & bagasse etc. The industry has supplemented the details of no. of vehicles utilized, date and no. of trips covered regarding quantification for collection of molasses contaminated water & soil. The details of the same is provided at **Annexure-6** for kind reference.

- The molasses contaminated water was treated in the existing ETP of distillery comprising of UASB followed by concentration through MEE. The resultant concentrated stream from MEE was utilized in the bio-compost preparation by proportionating with concentrated spent wash. Similarly, the molasses contaminated soil was utilized by proportionating with the press mud & other additivities for preparation of bio-compost. Details about ratio/quantity of proportionating of concentrated stream of molasses contaminated water & soil with the press mud, spent wash & other additives and also final analysis results of prepared bio-compost was not made available to the joint committee.

- During joint committee inspection it was observed that the industry had re-collected molasses contaminated water & soil from affected areas and utilized in the bio-compost preparation during last cane crushing season only i.e. utilized till April, 2022. However, affected area especially near the ETP area of sugar unit i.e. compound wall of the industry, seepage of leachate was observed, leading to the natural drain. Also, it was observed that overflow of spent wash contaminated water from 30 days concrete lined spent wash storage lagoon was observed which is confluencing with the natural drain near the upstream location of natural drain.

- MPCB has issued show-cause notice to the industry vide dated 29/09/2022 for non-compliances of various environmental enactments and also forfeited bank guarantee of Rs. 25 Lakhs for the non-compliances of CTO conditions. Further, MPCB has issued interim directions to the industry u/s 33A of the Water (Prevention & Control of Pollution) Act, 1974 and u/s 31A of the Air (Prevention & Control of Pollution) Act, 1981, dated 17/10/2022 to:
  a. Carry-out assessment on contamination of soil, cost of remediation and damage assessment through NEERI/IIT/VSI within two months and comply with recommendations of such report before six months.
  b. OCEMS connectivity to MPCB server within 7 days.
  c. Not to dispose spent wash sludge.

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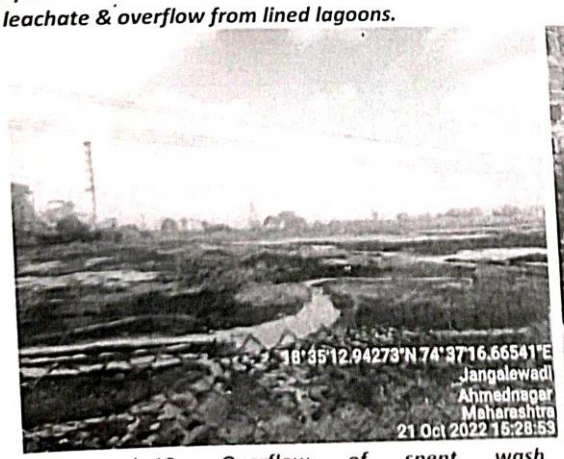
Copy of interim directions issued by MPCB dated 17/10/2022 is given at **Annexure-7** for kind reference.

- Joint committee collected grab water/leachate contaminated water samples along the stretch of natural drain i.e. upstream & downstream locations from the molasses spread/affected areas and submitted to laboratory of MPCB at Nashik for analysis of various physico-chemical parameters viz. pH, EC, SS, TDS, Chloride, Sulphates, Phosphate, Potassium, COD, BOD & TKN. Analysis results of the same is yet to be received from MPCB. Details of sampling locations along the stretch of natural drain is depicted in the below photographs for kind reference.

Photograph-17: Water sample colelcted from upstream location of natural drain, prior mixing of leachate & overflow from lined lagoons.

Photograph-18: Overflow of spent wash containmnated water from the 30 days lined lagoon.



Photograph-19: Overflow of spent wash containmnated water from the bio-compost yard.

Photograph-20: Spent wash contaminated water sample colelcted from overflow stream, near compound wall of industry before joining the natural drain.

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Photograph-21: Spent wash contaminated water sample colelcted from natural drain, near compound wall of industry.

Photograph-22: Water sample colelcted from downstream location of natural drain (about 700 m from the industry where overflow streams confluenced with the natural drain).

Photograph-23: Water sample colelcted from downstream location of natural drain (about 1 Km from the industry where overflow streams confluenced with the natural drain).

- ***Direction no. 3 u/s 33A of the Water (Prevention & Control of Pollution) Act, 1974 and u/s 31A of the Air (Prevention & Control of Pollution) Act, 1981, dated 10/02/2022: "The Industry shall not restart crushing operation till further order/directions of the Board & Competent Authorities."***

- The industry has not complied with the aforesaid direction, as the industry didn't stopped cane crushing activities during last season nor applied for restart permission.

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4.0 Conclusions

i. The industry is an integrated sugar & distillery unit, located within the same premises and having separate CTO issued by MPCB. The CTO of industry (Sugar unit & Distillery unit) was expired on 31/07/2022 and 31/08/2022. As per the records of MPCB, the industry has applied for renewal of CTO of Sugar & Distillery unit, which are pending before MPCB.

ii. The industry (Sugar unit) in compliance to the Schedule-I of CTO dated 23/11/2021 i.e. Terms & conditions for compliance of Water Pollution Control has provided ETP of reported design capacity of 1,000 m^3/day comprising of primary, secondary & tertiary treatment system for treatment of process effluent. Also, CPU of reported design capacity of 1,200 m^3/day for treatment of excess condensate. The treated effluent from ETP is discharged for irrigation on 150 acre agricultural land (own & also pvt. land, as per bi-lateral agreement with farmers). Similarly, treated condensate from CPU is reused in utilities (cooling tower make-up) after treatment through softner. Excess treated condensate is channelized to fresh water reservoir for reuse in process (sugar & distillery unit). Also, the industry (Sugar unit) in compliance to Schedule-I of CTO dated 03/02/2021 i.e. G) CREP conditions for sugar factory; has initiated stabilization of ASP of ETP as well as ASP of CPU to achieve the desired MLSS concentration prior to starting of cane crushing activities of sugar unit.

iii. The industry (Distillery unit) in compliance to the Schedule-I of CTO dated 03/02/2021 i.e. Terms & conditions for compliance of Water Pollution Control has provided comprehensive treatment for volume reduction of spent wash consisting of bio-digester (UASB) of reported design capacity of 360 m^3/day followed by MEE followed by bio-composting on 05 acre concrete lined bio-compost yard. Biogas generated @ 350 – 450 m^3/hr from UASB is used as a supplementary fuel in co-gen boiler of sugar unit and excess biogas is flared in the flaring system. The concentrated spent wash (up to 45%) is utilized in preparation of bio-compost. Also, installed CPU of reported design capacity of 360 m^3/day for treatment of MEE condensate. Treated MEE condensate is reused in molasses dilution & fermenter make-up, recirculation pump cooling

& its accessories and utilities (cooling tower make-up) after treatment through softner.

iv. The industry (Sugar unit) has installed online continuous effluent monitoring system (OCEMS) at the final treated effluent conveyance pipeline of sugar unit for monitoring of parameters viz. pH, TSS, COD, BOD & Flow in compliance to the CPCB directions vide dated B-29016/04/06/PCI-I, dated 05/02/2014 and as per 1st Revised Guidelines for Online Continuous Effluent Monitoring Systems, July, 2018 of CPCB. Also, OCEMS is connected to CPCB & MPCB servers.

v. The industry (Sugar unit) has installed online continuous emission monitoring system (OCEMS) at the stack of co-gen boiler of sugar unit for monitoring of parameter i.e. PM in compliance to the CPCB directions vide dated B-29016/04/06/PCI-I, dated 05/02/2014 and as per 1st Revised Guidelines for Online Continuous Emission Monitoring Systems, August, 2018 of CPCB. Also, OCEMS is connected to CPCB & MPCB servers and status of its connectivity to servers have been communicated to MPCB vide email dated 23/08/2022.

vi. Further, the industry (distillery unit) has installed online flow meter at the spent wash conveyance pipeline to the 30 days lined spent wash storage lagoon and also installed PTZ camera at the 05 care bio-compost preparation yard. The aforesaid monitoring system is installed in compliance to the1st Revised Guidelines for Online Continuous Effluent Monitoring Systems, July, 2018 of CPCB. Wherein, it is mentioned that the industries claiming Zero discharge and not discharging effluent outside the premises shall to install Camera and flow meter at the discharge point from the channel / drain provided for carrying the effluent within the industry. Also, OCEMS is connected to CPCB & MPCB servers.

vii. It is observed from the Form R.T. 8 (C) i.e. the final manufacturing report for the crushing season 2021-22 (Central Excise Rule 83) submitted to the Commissioner of Sugar, Pune that cane crushing for the season 2021-22 was

started w.e.f. 27/10/2021 and end date of cane crushing was 28/04/2022. The industry has not complied to the directions issued by MPCB i.e. didn't stopped cane crushing on or before 12/02/2022 i.e. within 48 hrs from the date of issue of directions from MPCB by referring to the circular issued by the Commissioner of Sugar, Maharashtra vide letter dated 08/02/2022.

viii. Based on the aforesaid Form R.T. 8 (C) that total cane crushed during last crushing season is exceeding the consented capacity of 3,500 TCD (4,858 > 3,500 TCD). It was gathered that the industry has communicated to MPCB vide letter dated 28/01/2022 with a request for amendment in their CTO i.e. to grant cane crushing capacity of 4,800 TCD, instead of making an CTE application for expansion in the cane crushing capacity. Later, the industry made a CTE application to MPCB vide dated 20/04/2022 for expansion of cane crushing capacity from the existing 3,500 to 7,500 TCD. Accordingly, MPCB during the CAC meeting vide dated 24/06/2022 had considered the CTE expansion application of the industry and also noted the various violations done by the industry. After due deliberation, CAC of MPCB decided to grant CTE expansion for cane crushing from existing 3,500 to 7,500 TCD with a condition to submit a bank guarantee of Rs. 25 Lakhs for compliance towards consent conditions.

MPCB has issued show-cause notice to the industry vide dated 29/09/2022 for non-compliances of various environmental enactments and also forfeited bank guarantee of Rs. 25 Lakhs for the non-compliances of CTO conditions.

ix. MPCB has issued interim directions to the industry u/s 33A of the Water (Prevention & Control of Pollution) Act, 1974 and u/s 31A of the Air (Prevention & Control of Pollution) Act, 1981, dated 17/10/2022 to carry-out assessment on contamination of soil, cost of remediation and damage assessment through NEERI/IIT/VSI. The industry vide letter dated 22/10/2022 issued the work order to M/s VSI, Pune for carrying out soil contamination assessment study including damages to recipient environment and remedial measures thereto.

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x. Prima-facie the explosion of molasses storage tank occurred due to the end of life of storage tank, as the storage tanks were commissioned during 1984 followed by inadequate operation & maintenance of storage tanks. Also, as reported by the industry's internal investigation team that due to absence of proper online cooling and stirring mechanism, an exothermic reaction took place with generation of unstable gases like SO_2, SO_3 and CO_2 and due to very high static pressure of dissolved gases, resulted in explosion of molasses storage tank.

xi. On account of explosion, the molasses was spread in the ETP area and also flown to the area i.e. barren land towards south-west direction (outside the compound wall, within the purview of industry) and ultimately to the malicha nalah/natural drain. The industry immediately contained the spread of molasses by creating artificial earthen bund at the natural drain and re-collected ~ 2,340 MT of molasses contaminated water and transferred to 05 days lined spent wash storage lagoon. Also, collected ~9,915 MT of molasses contaminated soil by scrapping top layer of soil (~10 cm) from 01 acre of own land and also scrapping the bottom layer of soil (~ 10 cm) from natural drain and transferred to the existing bio-compost yard. Collected molasses contaminated water is treated in existing ETP of distillery unit and utilized in bio-compost preparation. Similarly, collected molasses contaminated soil is utilized by proportionating with the press mud & other additivities for preparation of bio-compost.

xii. During joint committee inspection, old brick lined (13,500 m^3 capacity) spent wash storage lagoons was found filled with sludge & spent wash contaminated water. Also, the new concrete lined 30 days spent wash storage lagoon was found filled with spent wash contaminated water. Apparently, the industry has not completely utilized the spent wash generated during the last operational season of distillery. Also, not de-suldged the old brick lined lagoon. The unutilized concentrated spent wash of last season was about 3,230 MT. Further, on an account of heavy rain (about 735.33 mm) occurred during June, 2022 till 17th, October, 2022 in the area; had resulted in overflow of spent wash contaminated water from the lagoons into adjoining low lying

area and also into the natural drain. The industry has recollected overflowed spent wash contaminated water through pumps from low lying areas and channelized into exiting 30 days lined storage lagoon. As per the information submitted, about 6,286 MT of spent wash contaminated water is stored in the 30 days lined spent wash storage lagoon. Apparently, the stored quantity is even more; as the capacity of 30 days storage lagoon is 8,380 m^3 and it was evident that during joint committee inspection lagoon water overflow was observed.

xiii. Joint committee collected grab water/leachate contaminated water samples along the stretch of natural drain i.e. upstream & downstream locations from the molasses spread/affected areas and submitted to laboratory of MPCB at Nashik for analysis of various physico-chemical parameters viz. pH, EC, SS, TDS, Chloride, Sulphates, Phosphate, Potassium, COD, BOD & TKN. Analysis results of the same is yet to be received from MPCB. Upon receipt of analysis results, the agency engaged i.e. M/s VSI, Pune may consider the same to assess the extent of contamination and also while preparing remedial measures thereto.

5.0 Recommendations

Based on the joint committee inspection, observations & findings w.r.t environmental management system installed for treatment of effluent and present compliance status w.r.t. collection & management of molasses contaminated water & soil; the industry may be directed through MPCB to:

i. Immediately expedite the execution of work w.r.t. carrying out soil contamination assessment study including damages to recipient environment and remedial measures thereto. Further, to ensure the implementation of recommendations if any; of aforesaid study report in a time bound manner and be verified by MPCB.

ii. Distillery operations shall not be permitted during the present season until the remaining spent wash contaminated water stored in the 30 days lined spent wash storage lagoon; old brick lined spent wash storage lagoon and leachate

collection pit of bio-compost yard, are completely treated in the existing ETP of distillery i.e. through UASB (bio-digester) followed by concentration in MEE. Resultant concentred effluent shall be utilized in preparation of bio-compost along with press mud.

iii. Expedite to make an application to the Competent Authority i.e. SEIAA, Maharashtra for obtaining Environmental Clearance (EC) for expansion of cane crushing capacity from existing 3,500 to 7,500 TCD. Further, till expansion EC is obtained from SEIAA, Maharashtra the cane crushing capacity may be restricted to the consented capacity of 3,500 TCD as per CTO of MPCB.

iv. De-sludge the accumulated sludge from the old brick lined spent wash storage lagoon and the sludge shall be managed in existing sludge drying beds of ETP. The dried sludge may be proportionated with press mud for preparation of bio-compost, upon examining the feasibility through the aforesaid engaged agency i.e. M/s VSI, Pune. Also, to dismantle the old brick lined spent wash storage lagoon before starting distillery operation.

v. Provide adequate free board to the 30 days lined spent wash storage lagoon. Also, to always keep the level of spent wash in the 30 days lined spent wash storage lagoons well below the upper ridge of the lagoon so as to ensure no possibility of run-off/overflow.

vi. Ensure that concentrated spent wash generated shall be completely utilized in preparation of bio-compost during non-monsoon season i.e. within 270 days of total operational period. Further, at the end of each season accumulated sludge shall be removed and managed in existing sludge drying beds of ETP. Upon start of distillery season, the dried sludge may be may be proportionated with press mud for preparation of bio-compost.

vii. Obtain valid registration/certification for the production and ensure the quality of bio-compost (bio-enriched organic manure) as per Gazette Notification SO. 2776 (E), dated 10/10/2015 under the Fertilizer (Control) Fourth Amendment

Order, 2015 issued by Ministry of Agriculture and Farmers Welfare (Dept. of Agriculture, Cooperation and Farmers Welfare.

viii. Ensure compliance of show-cause notice dated 29/09/2022 issued by MPCB w.r.t. dismantling of 04 no. of old boilers.

ix. In order to prevent the re-occurrence of explosion/blast of molasses storage tanks; necessary safety audits especially w.r.t. structural stability shall be conducted through the competent person before staring of cane crushing/distillery operations. Also, adequate online water cooling & stirring mechanism may be provided to ensure the optimum temperature inside the molasses storage tank.

x. Dyke area of sound construction should be provided to the storage tanks, wherever possible, so that all contents of the tank, in case of partial or full rupture accident, can be enclosed in the dyke. Each dyke should have roads all around for access during emergency scenarios. In case such dykes are not possible, necessary arrangement shall be in place to contain spillages from such tanks and channelizing the same to a safe impervious storage facility within the plant premises.

(Nishchal C.)
Scientist 'D'
CPCB, RD-Pune

(Chandrakant Shinde)
Sub-Regional Officer
MPCB, Ahmednagar

(Sudhakar Bhosle)
SDM, Ahmednagar as
representative of District
Collector, Ahmednagar

.....

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Annexure IV - Reference for Tree damage compensation

Printed from
THE TIMES OF INDIA

PWD to pay Rs 33 lakh fine, plant saplings for damaging trees

TNN | Mar 14, 2022, 09.03 AM IST

NEW DELHI: The forest department has slapped a fine of Rs 33.4 lakh on the Public Works Department (PWD) for damaging nearly 80 trees and removing others.

In an order by the deputy conservatory of forest, Central forest division, the PWD has been asked to plant 820 saplings. The forest department noted that PWD damaged 79 trees by exposing their roots and three others by removal at Vikas Marg. The department, in an order dated March 8, asked PWD to pay the penalty within 15 days. The order came following an investigation after a resident complained about the damage.

The forest department also issued a warning that no more trees should be felled or pruned without permission.

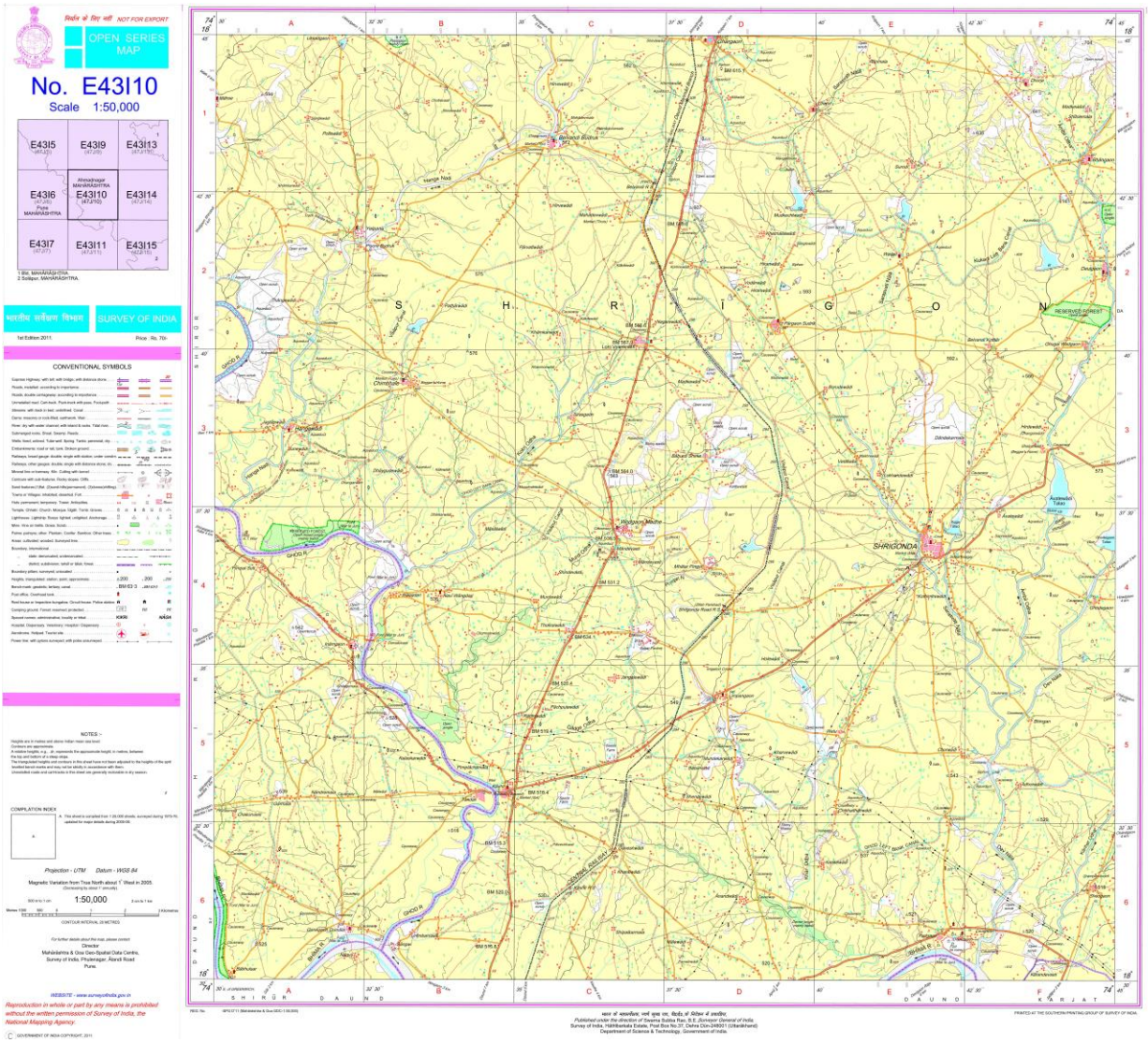
"Also 820 trees should be planted within six months of this order and be successfully maintained for seven years. The 820 saplings shall be 6-7 feet tall of native species, such as Arjun, Jamun, Gular, Pilkha, Neem, Amaltash, etc (sic)," the order added.

Meanwhile, tree activists pointed out that similar offences had taken place in the past too.

"Recently, PWD was asked to pay a fine of over Rs 38 lakh for damaging 380 trees in Vasant Vihar through concretisation. Officials are seldom booked or punished in such matters even as the department pays up with public money. When such matters are heard in courts, the officers concerned are often absent with their department's lawyers requesting them not to be called. We feel that unless officers are held accountable, such offences will continue," said Bhavereen Kandhari, a tree activist and member of Delhi Tree SOS.

Annexure V

Toposheet of study area



Annexure VI

Accreditation certificate and approved scope by NABL

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

VASANTDADA SUGAR INSTITUTE, MANJARI (BK), TAL. HAVELI, PUNE, MAHARASHTRA, INDIA

in the field of

TESTING

Certificate Number: TC-9821

Issue Date: 03/09/2021 Valid Until: 02/09/2023

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Identity : Vasantdada Sugar Institute

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

National Accreditation Board for Testing and Calibration Laboratories

SCOPE OF ACCREDITATION

Laboratory Name :	VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES, VASANTDADA SUGAR INSTITUTE, MANJARI (BK), TAL. HAVELI, PUNE, MAHARASHTRA, INDIA		
Accreditation Standard	ISO/IEC 17025:2017		
Certificate Number	TC-9821	**Page No**	1 of 17
Validity	03/09/2021 to 02/09/2023	**Last Amended on**	-

S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
Permanent Facility				
1	CHEMICAL- ATMOSPHERIC POLLUTION	Air	Particulate Matter less than 10 µm (PM10)	USEPA Appendix J to Part 50 (40 CFR)
2	CHEMICAL- ATMOSPHERIC POLLUTION	Air	Particulate Matter less than 2.5 µm (PM2.5)	USEPA Appendix L to Part 50 (40 CFR) / CPCB Manual
3	CHEMICAL- ATMOSPHERIC POLLUTION	Air	Sulfur Dioxide (SO2)	IS: 5182 (Part 2)
4	CHEMICAL- ATMOSPHERIC POLLUTION	Ambient air	Nitrogen Dioxide (NO2)	IS: 5182 (Part 6)
5	CHEMICAL- ATMOSPHERIC POLLUTION	Ambient Noise	Noise Level (Leq) (Ambient)	IS : 9989
6	CHEMICAL- ATMOSPHERIC POLLUTION	Stack Gases	Sulfur Dioxide(SO2)	IS :11255 (Part-2)
7	CHEMICAL- ATMOSPHERIC POLLUTION	Suspended particulate matter	Suspended particulate matter (SPM)	EPA Method 5
8	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Beer	Alcohol Content (at 20 degree C)	ASBC (Volume 64/4, pp.242)
9	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Ethanol Anhydrous	Alcohol Content (at 20 degree C)	AOAC Official method, 21th Edition, 982.10, Volume-II
10	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Ethanol Anhydrous	Aldehyde as acetaldehyde	IS 6613 (ANNEX A)
11	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Ethanol Anhydrous	Methanol content (By GC)	IS 15464 (ANNEX J)
12	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Ethanol Anhydrous	Residue on evaporation	IS 15464 (ANNEX E)
13	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Ethanol Anhydrous	Specific Gravity (at 20 degree C)	AOAC Official method, 21th Edition, 982.10, Volume-II
14	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Ethanol Anhydrous	Total Acidity	IS 15464 (ANNEX D)
15	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Extra Neutral Alcohol	Alcohol Content (at 20 degree C)	AOAC Official method, 21th Edition, 982.10, Volume-II

This is annexure to 'Certificate of Accreditation' and does not require any signature.

National Accreditation Board for Testing and Calibration Laboratories

SCOPE OF ACCREDITATION

Laboratory Name :	VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES, VASANTDADA SUGAR INSTITUTE, MANJARI (BK), TAL. HAVELI, PUNE, MAHARASHTRA, INDIA		
Accreditation Standard	ISO/IEC 17025:2017		
Certificate Number	TC-9821	**Page No**	2 of 17
Validity	03/09/2021 to 02/09/2023	**Last Amended on**	-

S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
16	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Extra Neutral Alcohol	Aldehyde as acetaldehyde	IS 6613 (ANNEX A)
17	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Extra Neutral Alcohol	Ester as ethyl acetate	IS 323 (ANNEX G)
18	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Extra Neutral Alcohol	Methanol content (By GC)	IS 6613/3752 (16.2)
19	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Extra Neutral Alcohol	Residue on evaporation	IS 323 (ANNEX E)
20	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Extra Neutral Alcohol	Specific Gravity (at 20 degree C)	AOAC Official method, 21th Edition, 982.10, Volume-II
21	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Extra Neutral Alcohol	Total Acidity	IS 323 (ANNEX D)
22	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Fortified Wines	Alcohol Content (at 20 degree C)	ASBC (Volume 64/4, pp.242)
23	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Fortified Wines	Volatile Acidity	IS 7585 (Clause 5.3)
24	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL- Vodka	Residue on evaporation	IS 3752 (Clause 5)
25	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Brandy	Alcohol Content (at 20 degree C)	ASBC (Volume 64/4, pp.242)
26	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Brandy	Aldehyde as acetaldehyde	IS 3752 (Clause 12)
27	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Brandy	Ester as ethyl acetate	IS 3752 (Clause 10)
28	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Brandy	Methanol Content (By GC)	VSITL/04/SOP/04(f): 2015
29	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Brandy	Residue on evaporation	IS 3752 (Clause 5)

This is annexure to 'Certificate of Accreditation' and does not require any signature.

National Accreditation Board for Testing and Calibration Laboratories

SCOPE OF ACCREDITATION

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Accreditation Standard	ISO/IEC 17025:2017		
Certificate Number	TC-9821	**Page No**	3 of 17
Validity	03/09/2021 to 02/09/2023	**Last Amended on**	-

S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
30	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Brandy	Volatile Acidity	IS 3752 (Clause 8)
31	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Gin	Alcohol Content (at 20 degree C)	ASBC (Volume 64/4, pp.242)
32	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Gin	Aldehyde as acetaldehyde	IS 3752 (Clause 12)
33	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Gin	Ester as ethyl acetate	IS 3752 (Clause 10)
34	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Gin	Methanol content (By GC)	VSITL/04/SOP/04(f): 2015
35	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Gin	Residue on evaporation	IS 3752 (Clause 5)
36	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Gin	Volatile Acidity	IS 3752 (Clause 8)
37	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Rum	Alcohol Content (at 20 degree C)	ASBC (Volume 64/4, pp.242)
38	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Rum	Aldehyde as acetaldehyde	IS 3752 (Clause 12)
39	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Rum	Ester as ethyl acetate	IS 3752 (Clause 10)
40	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Rum	Methanol content (By GC)	VSITL/04/SOP/04(f): 2015
41	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Rum	Residue on evaporation	IS 3752 (Clause 5)
42	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Rum	Volatile Acidity	IS 3752 (Clause 8)
43	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Vodka	Alcohol Content (at 20 degree C)	ASBC (Volume 64/4, pp.242)

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SCOPE OF ACCREDITATION

Laboratory Name :	VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES, VASANTDADA SUGAR INSTITUTE, MANJARI (BK), TAL. HAVELI, PUNE, MAHARASHTRA, INDIA		
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44	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Vodka	Aldehyde as acetaldehyde	IS 3752 (Clause 12)
45	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Vodka	Ester as ethyl acetate	IS 3752 (Clause 10)
46	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Vodka	Methanol content (By GC)	VSITL/04/SOP/04(f): 2015
47	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Vodka	Volatile Acidity	IS 3752 (Clause 8)
48	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Whisky	Alcohol Content (at 20 degree C)	ASBC (Volume 64/4, pp.242)
49	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Whisky	Aldehyde as acetaldehyde	IS 3752 (Clause 12)
50	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Whisky	Ester as ethyl acetate	IS 3752 (Clause 10)
51	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Whisky	Methanol content (By GC)	VSITL/04/SOP/04(f): 2015
52	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Whisky	Residue on evaporation	IS 3752 (Clause 5)
53	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	IMFL-Whisky	Volatile Acidity	IS 3752 (Clause 8)
54	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	Conductivity Ash	ICUMSA method GS2/3/9-17
55	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	ICUMSA Colour	ICUMSA method GS2/3-10
56	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	ICUMSA Colour	ICUMSA method GS2/3-9
57	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	ICUMSA Colour	ICUMSA method GS9/1/2/3-8

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58	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	Insoluble Matter	ICUMSA method GS2/3/9-19
59	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	Polarization	ICUMSA method GS2/3-1
60	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	Reducing Sugar %	ICUMSA method GS2/9-6
61	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	Sugar Moisture by Loss on drying	ICUMSA method GS2/1/3/9-15
62	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Plantation white sugar	Sulphite (SO2 Content)	ICUMSA method GS2/1/7/9-33
63	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Raw Sugar	Conductivity Ash %	ICUMSA method GS1/1/3/9-1
64	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Raw Sugar	ICUMSA Colour	ICUMSA method GS1/3-7
65	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Raw Sugar	Polarization	ICUMSA method GS1/1/3/9-1
66	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Rectified Spirit	Alcohol Content @ 20 Degree C	AOAC official method, 21th edition, 982.10, Volume-II
67	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Rectified Spirit	Aldehyde as acetaldehyde	IS 6613 (ANNEX A)
68	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Rectified Spirit	Ester as ethyl acetate	IS 323 (ANNEX G)
69	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Rectified Spirit	Methanol content (By GC)	IS 323 (ANNEX H 2)
70	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Rectified Spirit	Residue on Evaporation	IS 323 (ANNEX E)
71	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Rectified Spirit	Specific Gravity (at 20 C)	AOAC Official method, 21th Edition, 982.10, Volume-II

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72	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Rectified Spirit	Total Acidity	IS 323 (ANNEX D)
73	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Table Wines	Alcohol Content (at 20 degree C)	ASBC (Volume 64/4, pp.242)
74	CHEMICAL- FOOD & AGRICULTURAL PRODUCTS	Table Wines	Volatile Acidity	IS 7585 (Clause 5.3)
75	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Carbonate Alkalinity	APHA 23rd Ed. (2320B)
76	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Dissolved Oxygen	APHA 23rd Ed.(4500 – O, B)
77	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Fluoride as F	APHA 23rd Ed. (4500- F – B, D)
78	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Sulphate as SO4	APHA 23rd Ed. (4500- SO4 2- C, E)
79	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Total Alkalinity (as CaCO3)	IS 3025(Part 23)
80	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Total Dissolved Solid	IS 3025 (Part 16)
81	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Total Dissolved Solid	APHA 23rd Ed. (2540C)
82	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Total Fixed Solids	APHA 23rd Ed. (2540-E)
83	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Total Solids	APHA 23rd Ed. (2540 B)
84	CHEMICAL- POLLUTION & ENVIRONMENT	Effluent and Sewage	Total Volatile Solids	APHA 23rd Ed. (2540-E)
85	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Acidity as CaCO3	IS 3025 (Part 22)
86	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Ammonia as NH3	APHA 23rd Ed. (4500 - NH3, F)
87	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Bicarbonate Alkalinity	APHA 23rd Ed. (2320B)
88	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Bio Chemical Oxygen Demand at 27°C for 3days	IS :3025(Part 44): 1993(RA:2019)
89	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Cadmium as Cd	APHA 23rd Ed. (3111B)

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90	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Calcium as Ca	APHA 23rd Ed. (3500, Ca, B)
91	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Chemical Oxygen Demand (COD)	IS :3025 (Part 58)
92	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Chloride as Cl	APHA 23rd Ed. (4500 Cl– B, D)
93	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Chromium as Cr	APHA 23rd Ed.(3111B)
94	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Colour	APHA 23rd Ed (2120 B Page 2-6)
95	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Conductivity @ 25°C	APHA 23rd Ed. (2510 B)
96	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Copper as Cu	APHA 23rd Ed. (3111B)
97	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Iron as Fe	APHA 23nd Ed. (3111B)
98	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Kjeldahl Nitrogen as N	APHA 23rd Ed. (4500 –Norg, B)
99	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Lead (Pb)	APHA 23rd Ed. (3111B)
100	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Magnesium as Mg	APHA 23rd Ed. (3500, Mg, B)
101	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Manganese (Mn)	APHA 23rd Ed. (3111B)
102	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Nickel (Ni)	APHA 23rd Ed. (3111B)
103	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Oil & Grease (Gravimetric method)	IS :3025 (Part 39)
104	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	pH@25oC	APHA 23rd Ed. (4500-H +B)
105	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Phosphate as P	APHA 23rd Ed. (4500 –P, D)
106	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Potassium (K)	APHA 23rd Ed. (3500 – K -B)
107	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Residual chlorine	APHA 23rd Ed. (4500 Cl-B)
108	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Sodium (Na)	APHA 23rd Ed. (3500- Na, B)

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109	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Temperature	IS: 3025 (Part 9)
110	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Total Suspended Solids	APHA 23rd Ed. (2540D)
111	CHEMICAL- POLLUTION & ENVIRONMENT	Effluents and Sewage	Zinc as Zn	APHA 23rd Ed. (3111B)
112	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Ammonia as NH3	APHA 23rd Ed. (4500 - NH3, F)
113	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Bio Chemical Oxygen Demand at 27°C for 3days	IS :3025 (Part 44)
114	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, semi solid	Cadmium as Cd	APHA 23rd Ed. (3111B)
115	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Chemical Oxygen Demand (COD)	IS :3025 (Part 58)
116	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, semi solid	Chromium as Cr	APHA 23rd Ed. (3111B)
117	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Colour	APHA 23rd Ed. (2120 Page 2-6)
118	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, semi solid	Copper as Cu	APHA 23rd Ed. (3111B)
119	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, semi solid	Iron as Fe	APHA 23rd Ed. (3111B)
120	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Kjeldahl Nitrogen as N	APHA 23rd Ed. (4500 –Norg, B)
121	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, semi solid	Lead (Pb)	APHA 23rd Ed. (3111B)
122	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Manganese (Mn)	APHA 23rd Ed. (3111B)
123	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Nickel (Ni)	APHA 23rd Ed. (3111B)
124	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Oil & Grease (Gravimetric method)	IS :3025 (Part 39):1991(RA: 2019)
125	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	pH@25oC	APHA 23rd Ed.(4500-H +B)
126	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Potassium (K)	APHA 23rd Ed. (3500 – K -B)
127	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Sodium (Na)	APHA 23rd Ed. (3500- Na, B)

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128	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Sulphate as SO4	APHA 23rd Ed. (4500- SO4 2- C, E)
129	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Temperature	IS: 3025 (Part 9)
130	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Total Alkalinity (as CaCO3)	IS 3025 (Part 23)
131	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Sludge, Solid, Semi solid	Zinc as Zn	APHA 23rd Ed. (3111B)
132	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid, Slurry, Solid, Semi solid	Conductivity @ 25°C	APHA 23rd Ed. (2510 B)
133	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Acidity as CaCO3	IS 3025 (Part 22)
134	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Bicarbonate Alkalinity	APHA 23rd Ed. (2320B)
135	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Calcium as Ca	APHA 23rd Ed. (3500, Ca, B)
136	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Carbonate Alkalinity	APHA 23rd Ed. (2320B)
137	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Chloride as Cl	APHA 23rd Ed. 4500 Cl– B, D
138	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Dissolved Oxygen	APHA 23rd Ed.(4500 – O, B)
139	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Fluoride as F	APHA 23rd Ed. (4500- F – B, D)
140	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Magnesium as Mg	APHA 23rd Ed.(3500, Mg, B)
141	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Phosphate as P	APHA 23rd Ed. (4500 –P, D)
142	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Residual chlorine	APHA 23rd Ed.(4500 Cl-B)
143	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Sulphate as SO4	APHA 23rd Ed. (4500- SO4 2- C, E)
144	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Total Alkalinity (as CaCO3)	IS 3025(Part 23)
145	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Total Dissolved Solid	APHA 23rd Ed.2540C
146	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Total Dissolved Solid	IS 3025 (Part 16)

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147	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Total Fixed Solids	APHA 23rd Ed. (2540-E)
148	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Total Solids	APHA 23rd Ed. (2540 B)
149	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Total Suspended Solids	APHA 23rd Ed. (2540D)
150	CHEMICAL- POLLUTION & ENVIRONMENT	Liquid/Slurry/Sludge/Solid/Semi-Solid	Total Volatile Solids	APHA 23rd Ed. (2540-E)
151	CHEMICAL- POLLUTION & ENVIRONMENT	Sludge and Solid	Moisture	IS:9235
152	CHEMICAL- POLLUTION & ENVIRONMENT	Sludge and Solid	Nitrogen (Kjeldahl)	IS:10158
153	CHEMICAL- POLLUTION & ENVIRONMENT	Sludge and Solid	pH	IS:10158
154	CHEMICAL- POLLUTION & ENVIRONMENT	Sludge and Solid	Phosphorus	IS:10158
155	CHEMICAL- POLLUTION & ENVIRONMENT	Sludge and Solid	Potassium	IS:10158
156	CHEMICAL- POLLUTION & ENVIRONMENT	Sludge and Solid	Volatile substance	IS:10158- Part 3
157	CHEMICAL- POLLUTION & ENVIRONMENT	Sludge and Solid	Zinc	USEPA SW 846 3050 B, 7000 B
158	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Available Nitrogen	IS 14684
159	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Available Nitrogen	VSITL/ES/SOP/03/02: 2021
160	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Available Phosphorous	Method manual, Soil Testing in India (Dept. of Agriculture Man and Cooperation, Ministry of Agri. Government of India),4.6.3.13 ,page no.96-99
161	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Available Phosphorous	Olsen's method, Watanabe and olesen's
162	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Available Potassium	Methods Manual, Soil Testing in India (Dept. of Agriculture and Cooperation, Ministry of Agri. Government of India) 4.6.3.14, page no-99
163	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Cation exchange capacity	IS:2720 (Part II)

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164	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Copper	USEPA SW 846 3050 B, 7000 B
165	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Electrical Conductivity	Methods Manual, Soil Testing in India (Dept. of Agriculture and Cooperation, Ministry of Agri. Government of India),4.6.3.8a, page no.81
166	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Iron	USEPA SW 846- 3050 B / 7000 B
167	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Manganese	USEPA SW 846 3050 B, 7000 B
168	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Moisture	IS:2720 (Part II)
169	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	Organic Matter	Methods Manual, Soil Testing in India (Dept. of Agriculture and Cooperation, Ministry of Agri. Government of India), 4.6.3.9, page no.84
170	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	pH@25oC	IS:2720 (Part 26)
171	CHEMICAL- POLLUTION & ENVIRONMENT	Soil	ZInc	USEPA SW 846 3050 B, 7000 B
172	CHEMICAL- WATER	Ground Water	Acidity as CaCO3	IS: 3025 (Part 22)
173	CHEMICAL- WATER	Ground Water	Ammonia (NH3)	APHA 23rd Ed. (4500 - NH3, F)
174	CHEMICAL- WATER	Ground Water	Bicarbonate Alkalinity	APHA 23rd Ed. (2320B)
175	CHEMICAL- WATER	Ground Water	Bio Chemical Oxygen Demand at 27°C for 3days	IS 3025 (Part 44)
176	CHEMICAL- WATER	Ground Water	Cadmium (Cd)	APHA 23rd Ed. (3111B)
177	CHEMICAL- WATER	Ground Water	Calcium as Ca	APHA 23rd Ed. (3500Ca, B)
178	CHEMICAL- WATER	Ground Water	Carbonate Alkalinity	APHA 23rd Ed. (2320B)
179	CHEMICAL- WATER	Ground Water	Chemical Oxygen Demand (COD)	APHA 23rd Ed. (5220-B)
180	CHEMICAL- WATER	Ground Water	Chloride as Cl	APHA 23rd Ed. (4500 Cl- B, D)
181	CHEMICAL- WATER	Ground Water	Chromium (Cr) Total	APHA 23rd Ed. (3111B)
182	CHEMICAL- WATER	Ground Water	Colour	APHA 23rd Ed. (2120)
183	CHEMICAL- WATER	Ground Water	Conductivity @ 25°C	APHA 23rd Ed. (2510 B)
184	CHEMICAL- WATER	Ground Water	Copper (Cu)	APHA 23rd Ed. (3111B)

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National Accreditation Board for Testing and Calibration Laboratories

SCOPE OF ACCREDITATION

Laboratory Name :	VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES, VASANTDADA SUGAR INSTITUTE, MANJARI (BK), TAL. HAVELI, PUNE, MAHARASHTRA, INDIA		
Accreditation Standard	ISO/IEC 17025:2017		
Certificate Number	TC-9821	**Page No**	12 of 17
Validity	03/09/2021 to 02/09/2023	**Last Amended on**	-

S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
185	CHEMICAL- WATER	Ground Water	Dissolved Oxygen	APHA 23rd Ed. (4500 – O, C)
186	CHEMICAL- WATER	Ground Water	Dissolved Oxygen	IS: 3025 (part 38)
187	CHEMICAL- WATER	Ground Water	Fluoride as F	APHA 23rd Ed. (4500- F – D)
188	CHEMICAL- WATER	Ground Water	Hardness (Total)	APHA 23rd Ed.(2340 – C)
189	CHEMICAL- WATER	Ground Water	Iron (Fe)	APHA 23rd Ed. (3111 B)
190	CHEMICAL- WATER	Ground Water	Lead (Pb)	APHA 23rd Ed. (3111B)
191	CHEMICAL- WATER	Ground Water	Magnesium as Mg	APHA 23rd Ed. (3500Mg, B)
192	CHEMICAL- WATER	Ground Water	Manganese (Mn)	APHA 23rd Ed. (3111B)
193	CHEMICAL- WATER	Ground Water	N as Kjeldahl Nitrogen	APHA 23rd Ed.(4500 –N org, B)
194	CHEMICAL- WATER	Ground Water	N as Nitrate (NO3) nitrogen	APHA 23rd Ed. (4500 – NO3-B)
195	CHEMICAL- WATER	Ground Water	N as Nitrite (NO2) nitrogen	APHA 23rd Ed. (4500 – NO2 -B)
196	CHEMICAL- WATER	Ground Water	Nickel (Ni)	APHA 23rd Ed. (3111 B)
197	CHEMICAL- WATER	Ground Water	pH@25oC	APHA 23rd Ed. (4500-H+ B)
198	CHEMICAL- WATER	Ground Water	Phosphorous (P)	APHA 23rd Ed. (4500 –P, D)
199	CHEMICAL- WATER	Ground Water	Potassium (K)	APHA 23rd Ed. (3500 – K -B)
200	CHEMICAL- WATER	Ground Water	Residual chlorine	APHA 23rd Ed. (4500 Cl-B)
201	CHEMICAL- WATER	Ground Water	Silica (Colloidal)	APHA 23rd Ed. (4500 – SiO2 - C)
202	CHEMICAL- WATER	Ground Water	Sodium (Na)	APHA 23rd Ed. (3500- Na, B)
203	CHEMICAL- WATER	Ground Water	Sulphate as SO4	APHA 23rd Ed. (4500- SO4 2- C, E)
204	CHEMICAL- WATER	Ground Water	Sulphate as SO4	IS: 3025 (Part 24)
205	CHEMICAL- WATER	Ground Water	Temperature	IS: 3025 (Part 9)
206	CHEMICAL- WATER	Ground Water	Total alkalinity as CaCO3	IS: 3025 (Part 23)
207	CHEMICAL- WATER	Ground Water	Total Dissolved Solid	APHA 23rd Ed. (2540 C)
208	CHEMICAL- WATER	Ground Water	Total Dissolved Solid	IS: 3025 (Part 16)
209	CHEMICAL- WATER	Ground Water	Total Fixed Solids	APHA 23rd Ed. (2540-E)
210	CHEMICAL- WATER	Ground Water	Total Solids	APHA 23rd Ed. (2540 B)
211	CHEMICAL- WATER	Ground Water	Total Suspended Solids	APHA 23rd Ed. (2540 D)
212	CHEMICAL- WATER	Ground Water	Total Volatile Solids	APHA 23rd Ed.(2540-E)
213	CHEMICAL- WATER	Ground Water	Zinc (Zn)	APHA 23rd Ed. (3111B)

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S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
214	CHEMICAL- WATER	Industrial Water	Conductivity @ 25°C	APHA 23rd Ed. (2510 B)
215	CHEMICAL- WATER	Industrial Water	pH@25oC	APHA 23rd Ed. (4500-H +B)
216	CHEMICAL- WATER	Irrigation Water	Ammonia (NH3)	APHA 23rd Ed - (4500 - NH3, F)
217	CHEMICAL- WATER	Irrigation Water	Bio Chemical Oxygen Demand at 27°C for 3days	IS 3025 (Part 44)
218	CHEMICAL- WATER	Irrigation Water	Conductivity @ 25°C	APHA 23rd Ed. (2510 B)
219	CHEMICAL- WATER	Irrigation Water	Dissolved Oxygen	APHA 23rd Ed. (2540 C)
220	CHEMICAL- WATER	Irrigation Water	Dissolved Oxygen	IS 3025 (Part 16)
221	CHEMICAL- WATER	Irrigation Water	pH@25oC	APHA 23rd Ed. (4500-H +B)
222	CHEMICAL- WATER	Potable Water	Cadmium (Cd)	APHA 23rd Ed. (3111B)
223	CHEMICAL- WATER	Potable water	Calcium as Ca	APHA 23rd Ed. (3500Ca, B)
224	CHEMICAL- WATER	Potable Water	Chloride as Cl	APHA 23rd Ed. (4500 Cl– B, D)
225	CHEMICAL- WATER	Potable Water	Chromium (Cr) Total	APHA 23rd Ed.(3111B)
226	CHEMICAL- WATER	Potable Water	Colour	APHA 23rd Ed. (2120 B)
227	CHEMICAL- WATER	Potable Water	Copper (Cu)	APHA 23rd Ed. (3111B)
228	CHEMICAL- WATER	Potable Water	Dissolved Oxygen	APHA 23rd Ed.(4500 – O, C)
229	CHEMICAL- WATER	Potable Water	Dissolved Oxygen	IS 3025 (part 38)
230	CHEMICAL- WATER	Potable Water	Fluoride as F	APHA 23rd Ed. (4500- F – D)
231	CHEMICAL- WATER	Potable Water	Hardness (Total)	APHA 23rd Ed. (2340 – C)
232	CHEMICAL- WATER	Potable Water	Iron (Fe)	APHA 23rd Ed.(3111 B)
233	CHEMICAL- WATER	Potable Water	Lead (Pb)	APHA 23rd Ed.(3111B)
234	CHEMICAL- WATER	Potable Water	Magnesium as Mg	APHA 23rd Ed. (3500Mg, B)
235	CHEMICAL- WATER	Potable Water	Manganese (Mn)	APHA 23rd Ed. (3111B)
236	CHEMICAL- WATER	Potable Water	N as Nitrate (NO3) nitrogen	APHA 23rd Ed. (4500 – NO3-B)
237	CHEMICAL- WATER	Potable Water	pH@25oC	APHA 23rd Ed. (4500-H +B)
238	CHEMICAL- WATER	Potable Water	Residual chlorine	APHA 23rd Ed.-(4500 Cl-B)
239	CHEMICAL- WATER	Potable Water	Sulphate as SO4	APHA 23rd Ed.(4500- SO4 2- C, E)
240	CHEMICAL- WATER	Potable Water	Sulphate as SO4	IS 3025 (Part 24)
241	CHEMICAL- WATER	Potable Water	Total alkalinity as CaCO3	IS :3025 (Part 23)
242	CHEMICAL- WATER	Potable Water	Total Dissolved Solid	APHA 23rd Ed.(2540 C)

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S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
243	CHEMICAL- WATER	Potable Water	Total Dissolved Solid	IS 3025 (Part 16)
244	CHEMICAL- WATER	Potable Water	Zinc (Zn)	APHA 23rd Ed.(3111B)
245	CHEMICAL- WATER	Surface Water	Acidity as CaCO3	IS: 3025 (Part 22)
246	CHEMICAL- WATER	Surface Water	Ammonia (NH3)	APHA 23rd Ed, (4500 - NH3, F)
247	CHEMICAL- WATER	Surface Water	Bicarbonate Alkalinity	APHA 23rd Ed. (2320 B)
248	CHEMICAL- WATER	Surface Water	Bio Chemical Oxygen Demand at 27°C for 3days	IS: 3025 (Part 44)
249	CHEMICAL- WATER	Surface Water	Cadmium (Cd)	APHA 23rd Ed. (3111B)
250	CHEMICAL- WATER	Surface Water	Calcium as Ca	APHA 23rd Ed. (3500Ca, B)
251	CHEMICAL- WATER	Surface Water	Carbonate Alkalinity	APHA 23rd Ed. (2320 B)
252	CHEMICAL- WATER	Surface Water	Chemical Oxygen Demand (COD)	APHA 23rd Ed. (5220-B)
253	CHEMICAL- WATER	Surface Water	Chloride as Cl	APHA 23rd Ed. (4500 Cl– B, D)
254	CHEMICAL- WATER	Surface Water	Chromium (Cr) Total	APHA 23rd Ed. (3111B)
255	CHEMICAL- WATER	Surface Water	Colour	APHA 23rd Ed (2120)
256	CHEMICAL- WATER	Surface Water	Conductivity @ 25°C	APHA 23rd Ed. (2510 B)
257	CHEMICAL- WATER	Surface Water	Copper (Cu)	APHA 23rd Ed. (3111B)
258	CHEMICAL- WATER	Surface Water	Dissolved oxygen	IS: 3025 (part 38)
259	CHEMICAL- WATER	Surface Water	Dissolved Oxygen	APHA 23rd Ed. (4500 – O, C)
260	CHEMICAL- WATER	Surface Water	Fluoride as F	APHA 23rd Ed. (4500- F – D)
261	CHEMICAL- WATER	Surface Water	Hardness (Total)	APHA 23rd Ed. (2340 – C)
262	CHEMICAL- WATER	Surface Water	Iron (Fe)	APHA 23rd Ed. (3111. B)
263	CHEMICAL- WATER	Surface Water	Lead (Pb)	APHA 23rd Ed. (3111B)
264	CHEMICAL- WATER	Surface Water	Magnesium as Mg	APHA 23rd Ed. (3500 Mg, B)
265	CHEMICAL- WATER	Surface Water	Manganese (Mn)	APHA 23rd Ed. (3111B)
266	CHEMICAL- WATER	Surface Water	N as Kjeldahl Nitrogen	APHA 23rd Ed. (4500 –Norg, B)
267	CHEMICAL- WATER	Surface Water	N as Nitrate (NO3) nitrogen	APHA 23rd Ed. (4500 – NO3-B)
268	CHEMICAL- WATER	Surface Water	N as Nitrite (NO2) nitrogen	APHA 23rd Ed. (4500 – NO2 -B)
269	CHEMICAL- WATER	Surface Water	Nickel (Ni)	APHA 23rd Ed. (3111 B)
270	CHEMICAL- WATER	Surface Water	pH	APHA 23rd Ed (4500 H+ B)
271	CHEMICAL- WATER	Surface Water	Phosphorous (P)	APHA 23rd Ed. (4500 –P, D)

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S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
272	CHEMICAL- WATER	Surface Water	Potassium (K)	APHA 23rd Ed. (3500 – K -B)
273	CHEMICAL- WATER	Surface Water	Residual chlorine	APHA 23rd Ed. (4500 Cl-B)
274	CHEMICAL- WATER	Surface Water	Silica (Colloidal)	APHA 23rd Ed. (4500 – SiO2- C)
275	CHEMICAL- WATER	Surface Water	Sodium (Na)	APHA 23rd Ed. (3500- Na, B)
276	CHEMICAL- WATER	Surface Water	Sulphate as SO4	APHA 23rd Ed. (4500- SO4 2- C, E)
277	CHEMICAL- WATER	Surface Water	Sulphate as SO4	IS: 3025 (Part 24)
278	CHEMICAL- WATER	Surface Water	Temperature	IS: 3025 (Part 9)
279	CHEMICAL- WATER	Surface Water	Total alkalinity as CaCO3	IS: 3025 (Part 23)
280	CHEMICAL- WATER	Surface Water	Total Dissolved Solid	APHA 23rd Ed. (2540 C)
281	CHEMICAL- WATER	Surface Water	Total Dissolved Solid	IS: 3025 (Part 16)
282	CHEMICAL- WATER	Surface Water	Total Fixed Solids	APHA 23rd Ed. (2540-E)
283	CHEMICAL- WATER	Surface Water	Total Solids	APHA 23rd Ed. (2540 B)
284	CHEMICAL- WATER	Surface Water	Total Suspended Solids	APHA 23rd Ed. (2540 D)
285	CHEMICAL- WATER	Surface Water	Total Volatile Solids	APHA 23rd Ed. (2540-E)
286	CHEMICAL- WATER	Surface Water	Zinc (Zn)	APHA 23rd Ed. (3111B)
287	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitter	construction and workmanship	IS 13487
288	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitter	Emission rate as a function of inlet pressure	IS 13487
289	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitter	Emitter Exponent	IS 13487
290	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitter	Emitter Pull Out	IS 13487
291	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitter	Flow path	IS 13487
292	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitter	Resistance to Hydrostatic Pressure at ambient and elevated temperature	IS 13487
293	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitter	Uniformity of emission rate (Cv) & Deviation of mean emission rate from nominal emission rate	IS 13487
294	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Carbon black content	IS 13488

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S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
295	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	E.S.C.R test	IS 13488
296	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Emission Rate of inlet pressure	IS 13488
297	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting Pipe	Emitting Unit Exponent	IS 13488
298	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Flow path	IS 13488
299	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Inside Diameter	IS 13488
300	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Resistance to hydrostatic pressure at Ambient and elevated temperature	IS 13488
301	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Resistance to pull out of joints between fitting and emitting pipe	IS 13488
302	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Resistance to tension at elevated temperature	IS 13488
303	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Spacing of emitting unit	IS 13488
304	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Uniformity of emission rate (Cv) & Deviation of mean emission rate from nominal emission rate	IS 13488
305	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Visual appearance	IS 13488
306	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Emitting pipe	Wall thickness	IS 13488
307	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	Carbon black content	Is 12786
308	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	E.S.C.R test	IS 12786
309	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	Elongation at break	IS 12786
310	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	Hydraulic characteristics Acceptance and quality test	IS 12786
311	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	Outside diameter	IS 12786

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S.No	Discipline / Group	Materials or Products tested	Component, parameter or characteristic tested / Specific Test Performed / Tests or type of tests performed	Test Method Specification against which tests are performed and / or the techniques / equipment used
312	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	Reversion test	IS 12786
313	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	Tensile strength	IS 12786
314	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	Visual Appearance	IS 12786
315	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Irrigation lateral	Wall Thickness	IS 12786
316	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Carbon black content	IS 14151 (Part 2)
317	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Density	IS 14151 (part 2)
318	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Elongation at break	IS 14151
319	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Hydraulic characteristics Acceptance and quality test	IS 14151 (Part 2)
320	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Melt flow rate	IS 14151 (Part 2)
321	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Outside diameter	IS 14151 (Part 2)
322	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Ovality	IS 14151 (Part 2)
323	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Reversion test	IS 14151 (Part 2)
324	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Tensile strength	IS 14151 (Part 2)
325	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Visual Appearance	IS 14151 (Part 2)
326	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	Sprinkler pipe	Wall thickness	IS 14151 (Part 2)
327	MECHANICAL- PLASTICS AND PLASTIC PRODUCTS	sprinkler pipe	Workmanship appearance	IS 14151 (Part 2)

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Annexure VII

Analysis reports of ground water samples collected for damage assessment

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VASANTDADA SUGAR INSTITUTE
Manjari (Bk.), Tal. : Haveli,
Dist. : Pune - 412 307, Maharashtra, India

TC - 9821

VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-261 (Page 1 of 2)**
ULR	: TC982123300000261F
Sample UIN	: 03-230208-001 to 002
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well of Mr. Pappu Jangale– code W01(18º35'3.14''N; 74º36'25.58''E)& Mr. Bhaskar Jangale - code W 02 (18º35'4.91''N; 74º36'22.31''E) Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	:08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W 01	W 02		
1	pH at 25oC	7.7	7.5	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	1275	1230	µmhos/cm	APHA23rd Ed.(2510 B):2017
4	Total Dissolved Solid	760	732	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	64	48	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	26	19	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	08	10	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	206	296	mg/L	APHA23rdEd.(2340â€"C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	2.595	0.321	mg/L	APHA23rdEd.(3111 B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	4.0	4.1	mg/L	APHA23rdEd.(4500"O,C):2017

Reply to be sent on the name of Institute and not on individual's name.

VASANTDADA SUGAR INSTITUTE — CONTINUATION SHEET

संशोधनेन संवृद्धिः ISO 9001:2015

VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

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18	Chlorides as Cl	99.97	139.96	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	1124	1128	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	72.14	88.17	mg/L	APHA 23rdEd.(3500Ca,B):2017
21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	6.31	18.46	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	140.00	163.00	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	257.5	402.5	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	2.00	1.00	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	48.66	38.22	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	BDL	BDL	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous≤ 0.1 mg/L, BDL for Nitrate & Silica ≤ 1 mg/L

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

The test report shall not reproduce in full without approval of the Laboratory
--------End of Test Report----------

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pp.shinde@vsisugar.org.in
Web site : www.vsisugar.com

संशोधनेन संवृद्धिः
ISO 9001:2015

VASANTDADA SUGAR INSTITUTE

Manjari (Bk.), Tal. : Haveli,
Dist. : Pune - 412 307, Maharashtra, India

TC - 9821

VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-262 (Page 1 of 2)**
ULR	: TC982123300000262F
Sample UIN	:03-230208-003 to 004
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well of Mr. Ganesh Gund – code W03 (18°35'4.96''N; 74°36'35.29''E) and Mr. Dnyaneshwar Gund – code W04 (18°35'6.43''N; 74°36'38.30''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W03	W04		
1	pH at 25°C	7.5	7.6	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	1056	980	µmhos/cm	APHA23rd Ed.(2510 B):2017
4	Total Dissolved Solid	628.00	568.00	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	16.00	16.00	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	5.00	5.00	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	06.00	08.00	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	208.00	202.00	mg/L	APHA23rdEd.(2340 "C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

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17	Dissolved Oxygen	3.8	3.9	mg/L	APHA23rdEd.(4500"O,C):2017
18	Chlorides as Cl	119.96	89.97	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	848	724	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	72.14	76.15	mg/L	APHA 23rdEd.(3500Ca,B):2017
21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	6.318	2.916	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	125.00	103.00	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	300.00	197.5	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	1.0	2.0	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	48.96	29.06	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	BDL	BDL	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous≤ 0.1 mg/L, BDL for Nitrate & Silica ≤ 1 mg/L

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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ISO 9001:2015

VASANTDADA SUGAR INSTITUTE

Manjari (Bk.), Tal. : Haveli,
Dist. : Pune - 412 307, Maharashtra, India

TC - 9821

VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-263 (Page 1 of 2)**
ULR	:TC982123300000263F
Sample UIN	:03-230208-005 to 006
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well of Mr. Tukaram Gund – Code W 05 (18°35'6.40''N; 74°36'51.53''E); Code W06 (18°35'5.83''N; 74°36'32.37''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W05	W06		
1	pH at 25°C	7.7	7.5	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	979	876	µmhos/cm	APHA23rd Ed.(2510 B):2017
4	Total Dissolved Solid	568.00	536.00	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	32.00	16.00	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	10.00	5.00	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	08	06	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	200	190	mg/L	APHA23rdEd.(2340â€“C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017

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Page 2 of 2

15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	3.8	3.9	mg/L	APHA23rdEd.(4500"O,C):2017
18	Chlorides as Cl	99.97	59.98	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	726.00	608.00	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	108.21	96.19	mg/L	APHA 23rdEd.(3500Ca,B):2017
21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	22.30	22.79	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	112.00	80.00	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	210.0	212.5	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	2.0	2.0	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	29.06	29.06	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	BDL	BDL	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous≤ 0.1 mg/L, BDL for Nitrate & Silica ≤ 1 mg/L

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-264 (Page 1 of 2)**
ULR	:TC982123300000264F
Sample UIN	:03-230208-007 to 008
Name of Laboratory (VSI) & Location where tests performed	:Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well of Mr. Parshuram Gund – Code W07 (18°35'13.42''N; 74°36'50.61''E) & : Mr. Lokesh Rode – code W08 (18°35'06.57''N; 74°36'58.86''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	:08/02/2023
Date/s of Analysis	:08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W07	W08		
1	pH at 25°C	7.5	7.4	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	846	4076	µmhos/cm	APHA23rd Ed.(2510 B):2017
4	Total Dissolved Solid	502	2438	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	32	64	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	13	26	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	12	16	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	182	1040	mg/L	APHA23rdEd.(2340â€“C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017

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15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	3.6	3.8	mg/L	APHA23rdEd.(4500"O,C):2017
18	Chlorides as Cl	39.99	499.85	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	592.00	3728.00	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	60.12	284.56	mg/L	APHA 23rdEd.(3500Ca,B):2017
21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	29.61	183.57	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	78.00	567.00	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	225	360	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	BDL	1	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	27.68	218.7	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	BDL	BDL	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any):): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous & Potassium ≤ 0.1 mg/L, BDL for Nitrate & Silica ≤ 1 mg/L,

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-265 (Page 1 of 2)**
ULR	:TC982123300000265F
Sample UIN	:03-230208-009 to 010
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well water of Mr. Dnyanesh Rode – Code W09 (18º35'5.50''N;74⁰36'57.96''E)& : Mr. Madhukar Gund – Code W 10(18º35'9.49''N; 74⁰36'59.02''E) Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	:08/02/2023
Date/s of Analysis	:08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W09	W10		
1	pH at 25°C	7.4	7.0	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	1983	1884	µmhos/cm	APHA23rd Ed.(2510B):2017
4	Total Dissolved Solid	1182	1122	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	32	48	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	13	19	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	06	08	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	640.00	640.00	mg/L	APHA23rdEd.(2340â€"C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017

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Page 2 of 2

17	Dissolved Oxygen	3.3	3.8	mg/L	APHA23rdEd.(4500"O,C):2017
18	Chlorides as Cl	439.8	269.9	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	1242	1168	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	148.29	156.31	mg/L	APHA 23rdEd.(3500Ca,B):2017
21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium às Mg	116.56	117.53	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	435	351	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	372.5	387.5	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	1.00	1.00	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	213.7	167.4	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	BDL	2.467	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous≤ 0.1 mg/L, BDL for Nitrate & Silica ≤ 1 mg/L

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-266 (Page 1 of 2)**
ULR	:TC982123300000266F
Sample UIN	:03-230208-011 to 012
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable).	: Well of Mr. Rangnath Gund Code W11 (18°35'11.01''N; 74°37'2.81''E) Well Near Ghod River, Kashti Code W12 (18°33'4.49''N; 74°34'35.83''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: W11- 06/02/2023, W12-07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W11	W12		
1	pH at 25°C	6.8	7.8	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	2771	5848	µmhos/cm	APHA23rd Ed.(2510 B):2017
4	Total Dissolved Solid	1658	3320	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	96.00	16.00	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	35.00	6.00	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	8	4	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	680	780	mg/L	APHA23rdEd.(2340â€"C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	3.0	2.9	mg/L	APHA23rdEd.(4500"O,C):2017
18	Chlorides as Cl	389.8	479.8	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	1694	4106	mg/l	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	228.45	224.44	mg/l	APHA 23rdEd.(3500Ca,B):2017

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21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	109.72	135.00	mg/l	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/l	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	412.00	824.00	mg/l	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	695.00	330.00	mg/l	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/l	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	5.00	2.00	mg/l	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/l	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	206.8	333.9	mg/l	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	4.54	2.85	mg/l	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous≤ 0.1 mg/L, BDL for Nitrate ca ≤ 1 mg/L

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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ISO 9001:2015

VASANTDADA SUGAR INSTITUTE

Manjari (Bk.), Tal. : Haveli,
Dist. : Pune - 412 307, Maharashtra, India

TC - 9821

VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-267 (Page 1 of 2)**
ULR	:TC982123300000267F
Sample UIN	:03-230208-013 to 014
Name of Laboratory (VSI) & Location where tests performed	:Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well Mr. Kokate Code W13 (18°33'20.80''N; 74°34'23.99''E) : Well of Mr. Kondiba Rahinj Code – W14 (18°34'34.68''N; 74°35'21.90''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	:08/02/2023
Date/s of Analysis	:08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W13	W14		
1	pH at 25°C	7.4	7.2	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	6389	3071	µmhos/cm	APHA23rd Ed .(2510B):2017
4	Total Dissolved Solid	3742	1762	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	16.00	16.00	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	6.00	6.00	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	16.00	10.00	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	900.00	620.00	mg/L	APHA23rdEd.(2340â€“C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	3.2	3.0	mg/L	APHA23rdEd.(4500-O,C):2017
18	Chlorides as Cl	659.8	379.8	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	3776	1842	mg/L	APHA 23rdEd. (2540B):2017

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

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20	Calcium as Ca	436.87	108.21	mg/L	APHA 23rdEd.(3500Ca,B):2017
21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	112.54	122.41	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	828	694	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	335	295	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	1.00	1.00	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	419.7	247.2	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	3.24	1.68	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous≤ 0.1 mg/L, BDL for Nitrate ≤ 1 mg/L

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-268 (Page 1 of 2)**
ULR	:TC982123300000268F
Sample UIN	:03-230208-015 to 016
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well of Mrs. Anjana Gawade, Code W15 (18°34'36.97''N; 74°35'20.05''E) : Well of Mr. Madhukar Kalane Code W16 (18°35'24.36''N; 74°37'28.24''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W15	W16		
1	pH at 25°C	7.2	7.9	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	1898	1245	µmhos/cm	APHA23rd Ed.(2510 B):2017
4	Total Dissolved Solid	1134	736	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	BDL	48	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	BDL	19	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	08	06	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	680	440	mg/L	APHA23rdEd.(2340â€“C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	4.1	4.0	mg/L	APHA23rdEd.(4500"O,C):2017

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

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18	Chlorides as Cl	429.8	269.9	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	1152	796	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	112.22	116.23	mg/L	APHA 23rdEd.(3500Ca,B):2017
21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	137.97	80.62	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	693	362	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	260	245	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	2.63	BDL	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	242.3	210.8	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	1.298	2.467	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous & Potassium ≤ 0.1 mg/L, BDL for Nitrate ≤ 1 mg/L, BDL for COD & BOD ≤ 5 mg/L.

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-269 (Page 1 of 2)**
ULR	: TC982123300000269F
Sample UIN	: 03-230208-017 to 018
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well of Mr. Baban Dhage Code W17 (18°35'5.19''N; 74°37'12.86''E) : Well of Mrs. Rukhmini Dhage Code W18 (18°35'6.48''N; 74°37'11.84''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W17	W18		
1	pH at 25°C	7.5	7.7	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	1001	5035	µmhos/cm	APHA23rd Ed.(2510B):2017
4	Total Dissolved Solid	596.00	3002.00	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	16	176	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	06	67	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	06	20	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	260	840	mg/L	APHA23rdEd.(2340â€"C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	3.2	3.0	mg/L	APHA23rdEd.(4500"O,C):2017
18	Chlorides as Cl	219.9	529.8	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	612.00	3116.00	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	100.2	172.34	mg/L	APHA 23rdEd.(3500Ca,B):2017

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21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	38.83	162.24	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	301.00	594.00	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	345.00	467.5	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	1	51	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	BDL	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	219.7	241.3	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	2.33	4.15	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous ≤ 0.1 mg/L, BDL for Nitrate ≤ 1 mg/L.

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-280 (Page 1 of 2)**
ULR	:TC982123300000280F
Sample UIN	:03-230317-001 to 002
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well of Mr. Dattatray Gawade W19 (18º34'55.21''N; 74º35'45.08''E) : Well of Mr. Sudam Pachpute W 20(18º34'53.54''N;74º35'41.01''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 15/03/2023
Date of Receipt of sample	: 17/03/2023
Date/s of Analysis	: 17/03/2023 to 23/03/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W19	W20		
1	pH at 25ºC	7.14	7.37	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	1780	2480	µmhos/cm	APHA23rd Ed.(2510 B):2017
4	Total Dissolved Solid	1098	1500	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27ºC	16	24	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27ºC	06	11	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	14.00	16.00	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	330	510	mg/L	APHA23rdEd.(2340â€"C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	4.1	3.5	mg/L	APHA23rdEd.(4500"O,C):2017
18	Chlorides as Cl	899.72	1199.63	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
19	Total Solids	2012.00	1802.00	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	80.16	120.24	mg/L	APHA 23rdEd.(3500Ca,B):2017

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

Page 2 of 2

21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	31.59	51.03	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	111.88	113.88	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	125.00	135.00	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	BDL	BDL	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	1.76	1.71	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	364.00	475.5	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	19.93	17.97	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous & Potassium ≤ 0.1 mg/L.

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-281 (Page 1 of 2)**
ULR	:TC982123300000281F
Sample UIN	:03-230317-003 to 004
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	: Well of Mr. Harbhau Rahinj W21 (18º34'55.23''N; 74⁰33'46.18''E) : Well of Mr. Shivaji Jaybhay W22 (18º34'40.11''N; 74⁰35'31.78''E) : Sampling Plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 15/03/2023
Date of Receipt of sample	: 17/03/2023
Date/s of Analysis	: 17/03/2023 to 23/03/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		W21	W22		
1	pH at 25°C	7.39	7.78	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	3560	1610	µmhos/cm	APHA23rd Ed.(2510B):2017
4	Total Dissolved Solid	2140.00	968.00	mg/L	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	20.00	20.00	mg/L	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	09.00	09.00	mg/L	IS 3025 (Part 44):2019
7	Total Suspended Solids	14.00	12.00	mg/L	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	330	130.00	mg/L	APHA23rdEd.(2340â€“C):2017
9	Copper as Cu	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	BDL	1.00	mg/L	APHA23rdEd.(3111 B):2017
11	Nickel as Ni	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
12	Zinc as Zn	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
14	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111 B):2017
15	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111 B):2017
16	Total Chromium as Cr	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	3.3	3.5	mg/L	APHA23rdEd.(4500"O,C):2017
18	Chlorides as Cl	1499.72	799.75	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017

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19	Total Solids	2168.00	1020.00	mg/L	APHA 23rdEd. (2540B):2017
20	Calcium as Ca	112.24	40.08	mg/L	APHA 23rdEd.(3500Ca,B):2017
21	Fluoride as F	BDL	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
22	Magnesium as Mg	12.15	7.29	mg/L	APHA23rdEd.(3500Mg,B):2017
23	Residual Chlorine	BDL	BDL	mg/L	APHA 23rdEd. (4500Cl-B):2017
24	Sulphate as SO4	114.75	112.50	mg/L	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	150	145.00	mg/L	IS:3025(Part23):2019
26	Phosphorous as P	BDL	BDL	mg/L	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	BDL	BDL	mg/L	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	1.785	1.327	mg/L	APHA23rdEd.(4500NO3B):2017
29	Sodium as Na	212.81	111.33	mg/L	APHA23rdEd.(3500-Na, B):2017
30	Silica as SiO_2	15.29	13.88	mg/L	APHA23rdEd.(4500SiO2B):2017

Remark (If any): BDL for Color ≤ 1CU, BDL for Copper ≤ 0.2 mg/L, BDL for Nickel & Iron ≤ 0.3 mg/L, BDL for Zn ≤ 0.05 mg/L, BDL for Mn≤ 0.1 mg/L, BDL for Pb ≤ 1 mg/L, BDL for Cd ≤ 0.05 mg/L, BDL for Cr ≤ 0.2 mg/L, BDL for F ≤ 0.1 mg/L, BDL for Residual Chlorine ≤ 1 mg/L, BDL for Phosphorous & Potassium ≤ 0.1 mg/L.

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

Note: The above test values are related only to the item tested
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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-272 (Page 1 of 2)**
ULR	**:TC982123300000272F**
Sample UIN	**:03-230530-003**
Name of Laboratory (VSI) & Location where tests performed	**:** Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Water (Ground Water)
Sampling location and sampling plan (if applicable)	Well of Sachin Pachpute (623/3) – Code W-23 : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 30/05/2023
Date of Receipt of sample	: 30/05/2023
Date/s of Analysis	: 30/05/2023 to 06/06/2023

Sr. No.	Test Parameter	Test Value Ground Water (W-23)	Unit	Test Method
1	pH at 25oC	7.22	---	APHA 23rd Ed.(4500-H +B): 2017
2	Colour	BDL	CU	APHA 23 rd Ed. (2120)
3	Electrical Conductivity@25°C	3132	µmhos/cm	APHA23rd Ed.(2510B):2017
4	Total Dissolved Solid	1897	mg/l	APHA23rdEd.2540C:2017
5	Chemical oxygen demand at 27°C	46.00	mg/l	IS :3025 (Part 58):2017
6	Biochemical Oxygen Demand at 27°C	18.00	mg/l	IS 3025 (Part 44):2019
7	Total Suspended Solids	72.00	mg/l	APHA 23rdEd.(2540D):2017
8	Hardness(Total) as $CaCO_3$	1270.00	mg/l	APHA23rdEd.(2340 "C"):2017
9	Copper as Cu	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron as Fe	2.30	mg/L	APHA23rdEd.(3111 B):2017
11	Nickel as Ni	BDL	mg/L	APHA23rd Ed.(3111 B):2017
12	Zinc as Zn	0.122	mg/L	APHA 23rd Ed.(3111B):2017
13	Manganese as Mn	BDL	mg/L	APHA23rdEd.(3111B):2017
14	Lead as Pb	BDL	mg/L	APHA23rd Ed.(3111 B):2017
15	Cadmium as Cd	BDL	mg/L	APHA23rd Ed.(3111 B):2017
16	Total Chromium as Cr	BDL	mg/L	APHA 23rd Ed.(3111B):2017
17	Dissolved Oxygen	4.8	mg/l	APHA23rd Ed.(4500"O,C):2017
19	Chlorides as Cl	374.88	mg/l	APHA 23rd Ed. (4500 Cl-B, D): 2017
20	Total Solids	1942	mg/l	APHA 23rdEd. (2540B):2017

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21	Calcium as Ca	245.28	mg/l	APHA 23rdEd.(3500Ca,B):2017
22	Fluoride as F	BDL	mg/L	APHA 23rd Ed.(4500-F"D):2017
23	Magnesium as Mg	159.89	mg/l	APHA23rdEd.(3500Mg,B):2017
24	Sulphate as SO4	96.50	mg/l	APHA 23rdEd. (4500- SO4 2-C, E): 2017
25	Total Alkalinity as $CaCO_3$	302.5	mg/l	IS:3025(Part23):2019
26	Phosphorous as P	BDL	mg/l	APHA23rdEd.(4500 P, D):2017
27	Potassium as K	BDL	mg/l	APHA 23rdEd. (3500"K-B):2017
28	Nitrate	BDL	mg/l	APHA23rdEd.(4500 NO_3 B):2017
29	N as Kjeldahl Nitrogen	17.4	mg/l	APHA23rdEd.(4500 NOrg, B):2017
30	Sodium as Na	71.00	mg/l	APHA23rdEd.(3500-Na, B):2017
31	Silica as SiO_2 (Colloidal)	21.47	mg/l	APHA23rdEd.(4500SiO2B):2017
32	Residual Chlorine	BDL	mg/l	APHA 23rdEd. (4500Cl-B):2017

Remark (If any): BDL for Colour ≤ 1 CU, BDL for Phosphorous, Cd, Nitrate & Cr ≤ 4mg/L, BDL for Residual Chlorine BDL for Pb ≤ 1mg/L, BDL for Copper ≤ 6mg/L, BDL for Ni ≤ 0.3mg/L, BDL for Mn≤ 8 mg/L, BDL for F ≤ 3 mg/L, BDL for K ≤ 5 mg/L

Report Date: 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	: VSITL-2023-03-270
ULR	: TC982123300000270F
Sample UIN	: 03-230208-019 to 020
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Pappu Jangale S01 (18°35'4.61" N; 74°36'25.67"E) : Farm of Mr. Bhaskar Jangale S02 (18°35'5.10"N; 74°36'22.67"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		S01	S02		
1	pH@25oC	8.75	8.69		IS:2720(Part26):2011
2	Electrical Conductivity	752.4	562.4	µmhos/cm	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	23.85	11.12	%	IS:2720(PartII):2010
4	Organic Matter	0.623	0.721	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	560.00	870.00	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	492.5	626.05	mg/kg	USEPA SW 846-3050B/7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-019 to 020
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Pappu Jangale S01 (18°35'4.61" N; 74°36'25.67"E) : Farm of Mr. Bhaskar Jangale S02 (18°35'5.10"N; 74°36'22.67"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		S01	S02		
1	Organic Carbon	0.361	0.418	%	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	119.00	129.00	Kg/ha	IS: 14684:2008
3	Available Phosphorous	7.52	7.61	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	0.975	1.31	mg/kg	USEPASW8463050 B,7000B:1996
4	Zinc	0.835	0.94	mg/kg	USEPASW8463050 B,7000B:1996
6	Manganese (Mn)	11.72	16.6	mg/kg	USEPASW8463050 B,7000B:1996

Remark if any: -

Report Date: -

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VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-271**
ULR	: TC982123300000271F
Sample UIN	: 03-230208-021 to 022
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Ganesh Gund S3 (18º35'4.41" N; 74º36'35.47"E) : Farm of Mr. Dnyaneshwar Gund S4 (18º35'6.19" N; 74º36'38.63"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S3)	(S4)		
1	pH@25oC	8.90	8.28	--	IS:2720(Part26):2011
2	Electrical Conductivity	606.4	593.3	µmhos/cm	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation ,Ministry of Agri. Government of India), 4.6.3.8a, pageno.81:2011
3	Moisture	16.21	6.60	%	IS:2720(Part II):2010 1%to100%
4	Organic Matter	1.607	1.279	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	234.00	936.00	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	546.00	497.5	mg/kg	USEPA SW 8463050B/7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-021 to 022
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Ganesh Gund S3 (18°35'4.41" N; 74°36'35.47"E) : Farm of Mr. Dnyaneshwar Gund S4 (18°35'6.19" N; 74°36'38.63"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S3)	(S4)		
1	Organic Carbon	0.932	0.741	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	151	176	Kg/ha	IS: 14684:2008
3	Available Phosphorous	10.07	1.50	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	1.12	1.08	mg/kg	USEPASW8463050 B,7000B:1996
5	Zinc	0.79	0.785	mg/kg	USEPASW8463050 B,7000B:1996
6	Manganese (Mn)	10.84	9.895	mg/kg	USEPASW8463050 B,7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-284**
ULR	: TC982123300000284F
Sample UIN	: 03-230208-023 to 024
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Tukaram Gund S5 (18º35'6.68" N; 74º36'51.79"E) : Farm of Tukaram Gund S6 (18º35'5.63" N; 74º36'51.30"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value (S5)	Test Value (S6)	Unit	Test Method
1	pH@25oC	8.25	8.60	--	IS:2720(Part26):2011
2	Electrical Conductivity	541.00	393.00	µmhos/cm	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	10.17	6.29	%	IS:2720(Part II):2010 1%to100%
4	Organic Matter	0.918	0.754	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	730.00	127.00	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	497.85	542.51	mg/kg	USEPA SW 8463050B/7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-023 to 024
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Tukaram Gund S5 (18°35'6.68" N; 74°36'51.79"E) : Farm of Tukaram Gund S6 (18°35'5.63" N; 74°36'51.30"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value (S5)	Test Value (S6)	Unit	Test Method
1	Organic Carbon	0.532	0.437	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	113	110	Kg/ha	IS: 14684:2008
3	Available Phosphorous	9.74	16.34	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	1.335	1.315	mg/kg	USEPASW8463050B,7000B:1996
5	Zinc	0.91	1.105	mg/kg	USEPASW8463050B,7000B:1996
6	Manganese (Mn)	9.495	9.62	mg/kg	USEPASW8463050B,7000B:1996

Remark if any : -

Report Date : - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	: VSITL-2023-03-273
ULR	: TC982123300000273F
Sample UIN	: 03-230208-025 to 026
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Parshuram Gund S07 (18°35'12.77" N; 74°36'51.93"E) : Farm of Mr. Lokesh Rode S08 (18°35'7.19" N; 74°36'55.34"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value (S07)	Test Value (S08)	Unit	Test Method
1	pH@25°C	8.80	7.25		IS:2720(Part26):2011
2	Electrical Conductivity	325.2	2757	µmhos/cm	Methods Manual, Soil Testing in India (Dept .of Agriculture and Co-operation, Ministry of Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	14.35	16.77	%	IS:2720(Part II):20101%to100%
4	Organic Matter	1.443	1.63	%	Methods Manual, Soil Testing in India (Dept. of Agriculture' and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	160	510	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	28.01	487	mg/kg	USEPA SW 846-3050B/7000B:1996

Remark if any: -
Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-025 to 026
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Parshuram Gund S07 (18°35'12.77" N; 74°36'51.93"E) : Farm of Mr. Lokesh Rode S08 (18°35'7.19" N; 74°36'55.34"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value (S07)	Test Value (S08)	Unit	Test Method
1	Organic Carbon	0.837	0.95	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	107	144	Kg/ha	IS: 14684:2008
3	Available Phosphorous	14.30	12.75	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	0.59	1.0	mg/kg	USEPASW8463050 B,7000B:1996
5	Zinc	0.67	0.71	mg/kg	USEPASW8463050 B,7000B:1996
6	Manganese (Mn)	7.48	9.9	mg/kg	USEPASW8463050 B,7000B:1996

Remark if any: -
Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-274**
ULR	: TC982123300000274F
Sample UIN	: 03-230208-027 to 028
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Lokesh Rode S09 (18º35'7.33" N; 74º 36'58.52"E) : Farm of Mr. Dnyaneshwar Rode S10 (18º35'5.22" N; 74º 36'58.23"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value (S09)	Test Value (S10)	Unit	Test Method
1	pH@25oC	8.39	8.54		IS:2720(Part26):2011
2	Electrical Conductivity	1240	492.2	µmhos/cm	Methods Manual, Soil Testing in India (Dept .of Agriculture and Co-operation, Ministry of Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	31.05	13.92	%	IS:2720(Part II):2010 1%to100%
4	Organic Matter	1.73	1.705	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	540.00	580.00	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	427.3	465.5	mg/kg	USEPA SW 846-3050B/7000B:1996

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Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-027 to 028
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Lokesh Rode S09 (18º35'7.33" N; 74º 36'58.52"E) : Farm of Mr. Dnyaneshwar Rode S10 (18º35'5.22" N; 74º 36'58.23"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 06/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S09)	(S10)		
1	Organic Carbon	1.00	0.989	%	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	310.00	132.00	Kg/ha	IS: 14684:2008
3	Available Phosphorous	24.41	22.57	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	1.8	0.87	mg/kg	USEPASW8463050 B,7000B:1996
5	Zinc	1.04	0.68	mg/kg	USEPASW8463050 B,7000B:1996
6	Manganese (Mn)	9.62	12.62	mg/kg	USEPASW8463050 B,7000B:1996

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Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-275 (Page 1 of 2)**
ULR	: TC982123300000275F
Sample UIN	: 03-230208-029 to 030
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Madhukar Gund S11 (18º35'7.33" N; 74º 36'58.52"E) : Farm of Mr. Rangnath Gund S12 (18º35'7.33" N; 74º 36'58.52"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: S11-06/02/2023, S12- 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S11)	(S12)		
1	pH@25oC	8.53	8.59	--	IS:2720(Part26):2011
2	Electrical Conductivity	468.2	519.9	µmhos/cm	Methods Manual, Soil Testing in India (Dept. of Agriculture and C o-operation, Ministry of Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	9.47	11.74	%	IS:2720(Part II):2010 1%to100%
4	Organic Matter	0.590	1.410	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	590.00	500.00	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation ,Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	367.45	606.2	mg/kg	USEPA SW 846-3050B/7000B:1996

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Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-029 to 030
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Madhukar Gund S11 (18º35'7.33" N; 74º 36'58.52"E) : Farm of Mr. Rangnath Gund S12 (18º35'7.33" N; 74º 36'58.52"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: S11-06/02/2023, S12- 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S11)	(S12)		
1	Organic Carbon	0.342	0.818	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	160.00	125.00	Kg/ha	IS: 14684:2008
3	Available Phosphorous	0.167	2.25	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	1.245	1.26	mg/kg	USEPASW8463050 B,7000B:1996
5	Zinc	0.805	0.815	mg/kg	USEPASW8463050 B,7000B:1996
6	Manganese (Mn)	10.31	15.86	mg/kg	USEPASW8463050 B,7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-276**
ULR	: TC982123300000276F
Sample UIN	: 03-230208-031 to 032
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Kokate S13 (18º33'20.37"N; 74º34'22.64"E) : Farm of Mr. Kondiba Rahinj S14 (18º34'35.17" N; 74º 35'21.26"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value (S13)	Test Value (S14)	Unit	Test Method
1	pH@25oC	9.12	8.55		IS:2720(Part26):2011
2	Electrical Conductivity	525.4	954.1	µmhos/cm	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	10.50	28.50	%	IS:2720(Part II):2010
4	Organic Matter	1.082	1.771	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	520.00	165.00	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	505.00	491.3	mg/kg	USEPA SW 846-3050B/7000B:1996

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Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-031 to 032
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Kokate S13 (18°33'20.37"N; 74°34'22.64"E) : Farm of Mr. Kondiba Rahinj S14 (18°34'35.17" N; 74° 35'21.26"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S13)	(S14)		
1	Organic Carbon	0.627	1.027	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	103.00	163.00	Kg/ha	IS: 14684:2008
3	Available Phosphorous	19.82	23.83	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	1.02	0.945	mg/kg	USEPASW8463050 B,7000B:1996
5	Zinc	0.72	0.82	mg/kg	USEPASW8463050 B,7000B:1996
6	Manganese (Mn)	13.54	19.47	mg/kg	USEPASW8463050 B,7000B:1996

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Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VSITL/COMN/FM32C

TEST REPORT

Report Identification number	: VSITL-2023-03-277
ULR	: TC982123300000277F
Sample UIN	: 03-230208-033 to 034
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mrs. Anjana Gawade S15 (18°34'37.71"N; 74°35'20.85"E) : Farm of Mr. Madhular Kalane S16 (18°35'25.25"N; 74°37'29.29"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S15)	(S16)		
1	pH@25°C	8.23	8.4		IS:2720(Part26):2011
2	Electrical Conductivity	1466.00	914.1	µmhos/cm	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	12.07	9.97	%	IS:2720(Part II):2010
4	Organic Matter	1.213	1.377	%	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
8	Available Potassium	690.00	540.00	Kg/ha	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri Government of India) 4.6.3.14, page no-99:2011
9	Iron	712.25	600.9	mg/kg	USEPA SW 846-3050B/7000B:1996

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Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-033 to 034
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mrs. Anjana Gawade S15 (18°34'37.71" N; 74°35'20.85" E) : Farm of Mr. Madhular Kalane S16 (18°35'25.25"N; 74°37'29.29"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value (S15)	Test Value (S16)	Unit	Test Method
1	Organic Carbon	0.703	0.799	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	147.00	157.00	Kg/ha	IS: 14684:2008
3	Available Phosphorous	24.23	0.37	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	1.525	1.1	mg/kg	USEPASW8463050 B,7000B:1996
5	Zinc	0.985	1.14	mg/kg	USEPASW8463050 B,7000B:1996
6	Manganese (Mn)	14.91	11.33	mg/kg	USEPASW8463050 B,7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-278**
ULR	: TC982123300000278F
Sample UIN	: 03-230208-035 to 036
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Baban Dhage S17 (18°35'4.65"N; 74°37'12.73"E) : Farm of Mrs. Rukmini Dhage S18 (18°35'6.89"N; 74°37'11.77"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S17)	(S18)		
1	pH@25oC	9.24	8.31		IS:2720(Part26):2011
2	Electrical Conductivity	313.2	555.8	µmhos/cm	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	11.86	13.1	%	IS:2720(Part II):2010
4	Organic Matter	1.082	0.59	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9, page no.84:2011
8	Available Potassium	210	510	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation ,Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
9	Iron	619.5	497.2	mg/kg	USEPA SW 846-3050B/7000B:1996

Remark if any: -

Report Date: - 25/02/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-035 to 036
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Baban Dhage S17 (18°35'4.65"N; 74°37'12.73"E) : Farm of Mrs. Rukmini Dhage S18 (18°35'6.89"N; 74°37'11.77"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/02/2023

Sr. No.	Test Parameter	Test Value (S17)	Test Value (S18)	Unit	Test Method
1	Organic Carbon	0.627	0.342	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation ,Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	141.00	116.00	Kg/ha	IS: 14684:2008
3	Available Phosphorous	3.13	7.81	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	1.42	1.02	mg/kg	USEPASW8463050-B,7000B:1996
5	Zinc	0.845	0.75	mg/kg	USEPASW8463050-B,7000B:1996
6	Manganese (Mn)	12.92	13.03	mg/kg	USEPASW8463050-B,7000B:1996

Remark if any: -

Report Date: -

Authorized Signatory: Dr. A. B. Deshmane
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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-279**
ULR	: TC982123300000279F
Sample UIN	: 03-230208-037
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Near molasses storage tank S19 (18°35'16.56"N; 74°37'5.53"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/07/2023

Sr. No.	Test Parameter	Test Value	Unit	Test Method
		Near molasses storage tank (S19)		
1	pH@25°C	6.46		IS:2720(Part26):2011
2	Electrical Conductivity	9574	µmhos/cm	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	12.7	%	IS:2720(Part II):2010
4	Organic Matter	1.67	%	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	580	Kg/ha	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	461.9	mg/kg	USEPA SW 846-3050B/7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230208-037
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: **Near molasses storage tank S19** (18°35'16.56"N; 74°37'5.53"E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 07/02/2023
Date of Receipt of sample	: 08/02/2023
Date/s of Analysis	: 08/02/2023 to 16/07/2023

Sr. No.	Test Parameter	Test Value	Unit	Test Method
		Near molasses storage tank (S19)		
1	Organic Carbon	0.97	%	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	169.00	Kg/ha	IS: 14684:2008
3	Available Phosphorous	14.09	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	2.39	mg/kg	USEPASW8463050-B,7000B:1996
5	Zinc	1.1	mg/kg	USEPASW8463050-B,7000B:1996
6	Manganese (Mn)	6.065	mg/kg	USEPASW8463050-B,7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-282**
ULR	: TC982123300000282F
Sample UIN	: 03-230317-006 to 008
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Dattatray Gawade S20 (18°34'54.57" N; 74°35'44.65" E) : Farm of Mr. Sudam Pachpute S21 (18°34'53.25" N; 74°35'40.77" E) : Farm of Mr. Haribhau Rahinj S22 (18°34'55.72" N; 74°35'46.50" E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 15/03/2023
Date of Receipt of sample	: 17/03/2023
Date/s of Analysis	: 17/03/2023 to 23/03/2023

Sr. No.	Test Parameter	(S20)	(S21)	(S22)	Unit	Test Method
1	pH@25°C	8.04	7.91	8.07		IS:2720(Part26):2011
2	Electrical Conductivity	1678	394.5	272.2	µmhos/cm	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation ,Ministr yof Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	9.3	11.12	23.69	%	IS:2720(Part II):2010
4	Organic Matter	1.60	1.70	1.47	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
8	Available Potassium	32.00	226.00	239.00	Kg/ha	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri Government of India) 4.6.3.14, page no-99:2011
9	Iron	530	620	483	mg/kg	USEPA SW 846 -3050B/7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230317-006 to 008
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Dattatray Gawade S20 (18º34'54.57" N; 74º35'44.65" E) : Farm of Mr. Sudam Pachpute S21 (18º34'53.25" N; 74º35'40.77" E) : Farm of Mr. Haribhau Rahinj S22 (18º34'55.72" N; 74º35'46.50" E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 15/03/2023
Date of Receipt of sample	: 17/03/2023
Date/s of Analysis	: 17/03/2023 to 23/03/2023

Sr. No.	Test Parameter	(S20)	(S21)	(S22)	Unit	Test Method
1	Organic Carbon	0.93	0.98	0.85	%	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	248.00	229.00	144.00	Kg/ha	IS: 14684:2008
3	Available Phosphorous	0.45	0.083	0.20	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	0.96	0.98	0.980	mg/kg	USEPASW8463050-B,7000B:1996
5	Zinc	0.91	0.91	0.78	mg/kg	USEPASW8463050-B,7000B:1996
6	Manganese (Mn)	9.00	8.00	12.00	mg/kg	USEPASW8463050-B,7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	: VSITL-2023-03-283
ULR	: TC982123300000283F
Sample UIN	: 03-230317-009 to 010
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Form of Mr. Shivaji Jaybhay S23 (18°34'40.32" N; 74°35'31.41" E) : Form of Mr. Manish Jaybhay S24 (18°34'42.88" N; 74°35'32.70" E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 15/03/2023
Date of Receipt of sample	: 17/03/2023
Date/s of Analysis	: 17/03/2023 to 23/03/2023

Sr. No.	Test Parameter	Test Value (S23)	Test Value (S24)	Unit	Test Method
1	pH@25oC	8.27	8.22		IS:2720(Part26):2011
2	Electrical Conductivity	148.2	152.00	µmhos/cm	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India),4.6.3.8a, pageno.81:2011
3	Moisture	10.35	12.00	%	IS:2720(Part II):2010 1%to100%
4	Organic Matter	1.01	0.99	%	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
5	Available Potassium	32.4	38.00	Kg/ha	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri Government of India) 4.6.3.14, page no-99:2011
6	Iron	620.00	560.00	mg/kg	USEPA SW 846-3050B/7000B:1996

Remark if any: -

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230317-009 to 010
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Form of Mr. Shivaji Jaybhay S23 (18°34'40.32" N; 74°35'31.41" E) : Form of Mr. Manish Jaybhay S24 (18°34'42.88" N; 74°35'32.70" E) : Sampling plan as per VSITL/ES/FM/10
Date of sampling (If applicable)	: 15/03/2023
Date of Receipt of sample	: 17/03/2023
Date/s of Analysis	: 17/03/2023 to 23/03/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		(S23)	(S24)		
1	Organic Carbon	0.589	0.62	%	Methods Manual,SoilTesting in India (Dept.of Agriculture and Co-operation,Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
2	Available Nitrogen	154	156	Kg/ha	IS: 14684:2008
3	Available Phosphorous	0.29	0.32	Kg/ha	Olsen's method, Watanabe and Olsen's:2011
4	Copper	1.2	1.21	mg/kg	USEPASW8463050-B,7000B:1996
5	Zinc	0.96	0.98	mg/kg	USEPASW8463050-B,7000B:1996
6	Manganese (Mn)	10.00	11.00	mg/kg	USEPASW8463050-B,7000B:1996

Remark if any: -
Report Date: -

Authorized Signatory: Dr. A. B. Deshmane
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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**: VSITL-2023-03-285 (Page 1 of 1)**
ULR	: TC982123300000285F
Sample UIN	: 03-230530-002
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Sachin Pachpute (Gat 623/3) (18º34'52.36"N, 74º35'41.86"E,) (sample Code- S25)
Date of sampling (If applicable)	: 30/05/2023
Date of Receipt of sample	: 30/05/2023
Date/s of Analysis	: 30/05/2023 to 06/06/2023

Sr. No.	Test Parameter	Test Value Soil (S-25)	Unit	Test Method
1	pH@25oC	8.24		IS:2720(Part26):2011
2	Moisture	8.86	%	IS:2720(Part II):2010
3	Available Potassium	320.00	Kg/ha	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministry of Agri Government of India) 4.6.3.14, page no-99:2011
4	Organic Matter	0.84	%	Methods Manual, Soil Testing in India (Dept.of Agriculture and Co-operation, Ministry of Agri. Government of India), 4.6.3.9,page no.84:2011
5	Iron	450.00	mg/kg	USEPA SW 846-3050B/7000B:1996
6	Copper	BDL	mg/kg	USEPASW846-3050 B,7000B:1996
7	Zinc	BDL	mg/kg	USEPASW8463050 B,7000B:1996
8	Manganese (Mn)	6.00	mg/kg	USEPASW8463050 B,7000B:1996

Remark if any: - BDL for Cu ≤ 6 mg/kg, For Zn ≤ 4 mg/kg

Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230530-002
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Soil
Sampling location and sampling plan (if applicable)	: Farm of Mr. Sachin Pachpute (Gat 623/3) (18º34'52.36"N, 74º35'41.86"E,) (sample Code- S25)
Date of sampling (If applicable)	: 30/05/2023
Date of Receipt of sample	: 30/05/2023
Date/s of Analysis	: 30/05/2023 to 06/06/2023

Sr. No.	Test Parameter	Test Value Soil (S 25)	Unit	Test Method
1	Electrical Conductivity	655.07	µmhos/cm	Methods Manual, Soil Testing in India (Dept.of Agriculture and Co-operation, Ministry of Agri. Government of India),4.6.3.8a, pageno.81:2011
2	Organic Carbon	0.65	%	Methods Manual, Soil Testing in India (Dept. of Agriculture and Co-operation, Ministryof Agri. Government of India), 4.6.3.9,page no.84:2011
3	Available Nitrogen	235.00	Kg/ha	IS: 14684:2008
4	Available Phosphorous	2.75	Kg/ha	Olsen's method, Watanabe and Olsen's:2011

Remark if any: -
Report Date: - 25/07/2023

Authorized Signatory: Dr. A. B. Deshmane
Scientist

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Analysis reports of molasses sample collected for damage assessment

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VASANTDADA SUGAR INSTITUTE'S TESTING LABORATORIES

VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-295 (Page 1 of 1)**
ULR	:TC982123300000295F
Sample UIN	: 03-230418-001 to 002
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Liquid Slurry/Sludge/Solid/Semi Solid (Molasses-001 to 002)
Sampling location and plan (if applicable)	: NA
Date of sampling (If applicable)	: NA
Date of Receipt of sample	: 18/04/2023
Date/s of Analysis	: 18/04/2023 to 26/04/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		M-001	M-002		
1	pH at 25°C	4.68	5.15	---	APHA 23rd Ed.(4500-H +B): 2017
2	Electrical Conductivity@25°C	359	1586	µmhos/cm	APHA23rd Ed.(2510B):2017
3	Total Suspended Solids	3960	3364	mg/L	APHA 23rdEd. (2540D): 2017
4	Chemical oxygen demand	64000	54000	mg/L	IS :3025 (Part 58):2017
5	Biochemical Oxygen Demand at 27°C	24998	14998	mg/L	IS 3025 (Part 44):2019
6	Chlorides	-	5998.14	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
7	Phosphorous(P)	235.29	230.39	mg/L	APHA23rdEd.(4500"P,D):2017
8	Calcium as Ca	8016	-	mg/L	APHA 23rd Ed.(3500Ca,B):2017
9	Magnesium as Mg	4613.11	4609.22	mg/L	APHA23rdEd.(3500Mg,B):2017
10	Copper(Cu)	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
11	Iron(Fe)	5.360	4.639	mg/L	APHA23rdEd.(3111B):2017
12	Chromium(Cr) Total	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
13	Nickel(Ni)	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
14	Zinc (Zn)	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
15	Manganese (Mn)	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017
16	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed.(3111B):2017
17	Cadmium as Cd	BDL	BDL	mg/L	APHA23rdEd.(3111B):2017

Remark (If any): BDL for Copper ≤ 0.2 mg/l, BDL for Cadmium & Zinc ≤ 0.05 mg/l, BDL for Chromium ≤ 0.2 mg/l, BDL for Nickel ≤ 0.3 mg/l, BDL for Manganese ≤ 0.1 mg/l, BDL for Lead ≤ 1 mg/l,

Report Date: 31/07/2023

Authorized Signatory: Dr. A.B. Deshmane
Scientist

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VSITL/COMN/FM32D

TEST REPORT

Sample UIN	: 03-230418-001 to 002
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Liquid Slurry/Sludge/Solid/Semi Solid (Molasses-001 to 002)
Sampling location and sampling plan (if applicable)	: NA
Date of sampling (If applicable)	: NA
Date of Receipt of sample	: 18/04/2023
Date/s of Analysis	: 18/04/2023 to 26/04/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		M-001	M-002		
1	Total Dissolved Solid	70162	65940	mg/l	APHA 23rdEd. (2540C): 2017
2	N as Kjeldahl Nitrogen	8960	7560	mg/L	APHA23rdEd. (4500 Norg,B):2017
3	Acidity as $CaCO_3$	60000	50000	mg/l	IS:3025(Part22):2019
4	Volatile Fatty Acid	491.4	510.3	mg/l	APHA 23rdEd. (5560 C):2017
5	Chlorides	13995.6	-	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
6	N as Nitrate(NO_3)	BDL	BDL	mg/L	APHA23rdEd.(4500 "NO_3-B):2017
7	Sulphate as SO_4	41250	20875	mg/l	APHA 23rdEd. (4500- SO_4 2-C, E): 2017
8	Silica(Colloidal)	4901.9	5555.5	mg/L	APHA23rdEd.(4500"SiO_2-C):2017
9	Calcium as Ca	-	16032	mg/L	APHA 23rd Ed.(3500Ca,B):2017
10	Sodium(Na)	19704.4	20295.57	mg/l	APHA 23rd Ed.(3500-Na, B):2017
11	Potassium as K	30539	27843	mg/L	APHA23rd Ed.(3500K-B):2017

Remark (If any):

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VSITL/COMN/FM32C

TEST REPORT

Report Identification number	**:VSITL-2023-03-296 (Page 1 of 1)**
ULR	:TC982123300000296F
Sample UIN	: 03-230421-003 to 004
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Liquid Slurry/Sludge/Solid/Semi Solid (Molasses-003 to 004)
Sampling location and plan (if applicable)	: NA
Date of sampling (If applicable)	: NA
Date of Receipt of sample	: 21/04/2023
Date/s of Analysis	: 21/04/2023 to 28/04/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		M-003	M-004		
1	pH at 25°C	5.19	4.96	---	APHA 23rd Ed.(4500-H +B): 2017
2	Electrical Conductivity@25°C	680.2	1969	µmhos/cm	APHA23rd Ed.(2510B):2017
3	Total Suspended Solids	2896	3020	mg/L	APHA 23rdEd. (2540D): 2017
4	Chemical oxygen demand	69000	64000	mg/L	IS :3025 (Part 58):2017
5	Biochemical Oxygen Demand at 27 °C	24750	24975	mg/L	IS 3025 (Part 44):2019
6	Phosphorous(P)	220.58	235.2	mg/L	APHA23rd Ed.(4500"P, D):2017
7	Calcium as Ca	9619.2	5611.2	mg/L	APHA 23rd Ed.(3500Ca,B):2017
8	Magnesium as Mg	3402	486.00	mg/L	APHA23rdEd.(3500Mg,B):2017
9	Copper(Cu)	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
10	Iron(Fe)	4.838	5.216	mg/L	APHA23rd Ed. (3111B):2017
11	Chromium(Cr) Total	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
12	Nickel(Ni)	BDL	BDL	mg/L	APHA23rd Ed. (3111B):2017
13	Zinc (Zn)	BDL	BDL	mg/L	APHA 23rd Ed.(3111B):2017
14	Manganese (Mn)	BDL	BDL	mg/L	APHA23rdEd. (3111B):2017
15	Lead as Pb	BDL	BDL	mg/L	APHA23rd Ed. (3111B):2017
16	Cadmium as Cd	BDL	BDL	mg/L	APHA23rd Ed .(3111B):2017

Remark (If any): BDL for Copper ≤ 0.2 mg/l, BDL for Cadmium & Zinc ≤ 0.05 mg/l, BDL for Chromium ≤ 0.2 mg/l, BDL for Nickel ≤ 0.3 mg/l, BDL for Manganese ≤ 0.1 mg/l, BDL for Lead ≤ 1 mg/l,

Report Date: 31/07/2023

Authorized Signatory: Dr. A.B. Deshmane
Scientist

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TEST REPORT

Sample UIN	: 03-230423-003 to 004
Name of Laboratory (VSI) & Location where tests performed	: Department of Environmental Science Testing Laboratory VSITL, Pune
Name of customer and Address	: Sahakar Maharshi Shivajirao Narayanrao Nagawade SSKL : A/P Shrigonda Factory, Tal Shrigonda , Dist Ahmednagar 413726
Sample type/description	: Liquid Slurry/Sludge/Solid/Semi Solid (Molasses-003 to 004)
Sampling location and sampling plan (if applicable)	: NA
Date of sampling (If applicable)	: NA
Date of Receipt of sample	: 21/04/2023
Date/s of Analysis	: 21/04/2023 to 28/04/2023

Sr. No.	Test Parameter	Test Value		Unit	Test Method
		M-003	M-004		
1	Total Dissolved Solid	72426	94268	mg/L	APHA 23rd Ed. (2540C): 2017
2	N as Kjeldahl Nitrogen	9240.0	8960	mg/L	APHA23rdEd. (4500 Norg.B):2017
3	Acidity as $CaCO_3$	32000	30750	mg/L	IS:3025(Part22):2019
4	Volatile Fatty Acid	517.86	396.9	mg/L	APHA 23rd Ed. (5560 C):2017
5	Chlorides	14995.35	24,492	mg/L	APHA 23rd Ed. (4500 Cl-B, D): 2017
6	N as Nitrate(NO_3)	BDL	BDL	mg/L	APHA23rd Ed.(4500 $^{-}NO_3$-B):2017
7	Sulphate as SO_4	40750	16900	mg/L	APHA 23rd Ed. (4500- SO_4 2-C, E): 2017
8	Silica(Colloidal)	5882.35	588.23	mg/L	APHA23rd Ed.(4500$^{-}SiO_2$-C):2017
9	Sodium(Na)	7389.16	23047.6	mg/L	APHA 23rd Ed.(3500-Na. B):2017
10	Potassium as K	25147	32548	mg/L	APHA23rd Ed.(3500K-B):2017

Remark (If any):

Report Date: 31/07/2023

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Scientist

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Annexure VIII

Research papers referred for the study

1. McCutcheon, S.C., Martin, J.L, and Bamwell, T.O. (1993). Water Quality

HANDBOOK OF HYDROLOGY

David R. Maidment
Editor in Chief

Professor of Civil Engineering
University of Texas at Austin

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CHAPTER 11
WATER QUALITY

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U.S. Environmental Protection Agency
Athens, Georgia

In the early years of hydrology, water quality was relatively unimportant except in arid lands where salinization occurred. In arid regions, recognition of the problems of water quantity and quality dates back to the ancient civilizations in Egypt, Mesopotamia, and India. Since the beginning of the f

11.2.6 Sodium Adsorption Ratio

The hydraulic conductivity of soils containing clays is affected by the cations present in waters applied to the soil in irrigation. Of particular concern is the relationship between monovalent sodium and divalent calcium and magnesium. The relationship is usually represented by the sodium adsorption ratio (SAR) expressed as

$$SAR = \frac{\{Na^+\}}{\sqrt{\frac{\{Ca^{2+}\} + \{Mg^{2+}\}}{2}}} \qquad (11.2.7)$$

where the brackets indicate that concentrations are expressed as meq L^{-1}. Hydraulic conductivity generally decreases with increasing sodium adsorption ratios. Values of SAR greater than 6 to 9 in a water used for irrigation indicate that a reduction of the hydraulic conductivity of the soil, and consequently the water infiltration rate, is to be expected if swelling, high-exchange-capacity clays are present. SAR values less than 6 are generally considered not to be a problem, while values greater than 9 may cause severe problems.[8] The reduction in infiltration capacity is also impacted by carbonate and bicarbonate concentrations. Carbonate deposition may remove Ca^{2+} and Mg^{2+} from the soil water, increasing the hazard due to sodium.

11.2.7 Dissolved Oxygen

Dissolved oxygen content is a measure of the ability of surface waters to support aquatic life. Oxygen is poorly soluble in water, and the *oxygen saturation concentration* is dependent on three primary parameters—temperature, atmospheric pressure, and dissolved solids. At 1 atm of pressure, the solubility of oxygen in fresh water ranges from 14.6 mg L^{-1} at 0°C to 6.4 mg L^{-1} at 40°C. See Table 14.4.5 and Eq. (14.4.12). Dissolved solids concentrations of 36.1 ‰ salinity reduce oxygen saturation concentration to 11.4 mg L^{-1} at 0°C and to 5.3 mg L^{-1} at 40°C.

The low solubility of oxygen in water is the primary factor that requires treatment of liquid wastes before discharge to a receiving water. The presence of dissolved oxygen determines whether waste material is degraded by aerobic (with oxygen) or anaerobic (without oxygen) processes. Aerobic processes use oxygen for the oxidation of organic matter in wastes and produce relatively innocuous end products. Anaerobic processes degrade wastes without oxygen in a slower process and the degradation products, such as hydrogen sulfide and methane, are often obnoxious. The critical conditions for dissolved oxygen deficiency typically occur during the late summer months when temperatures are high, saturation concentrations are low, biological processes are enhanced, and stream flow is low.

11.2.8 Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

BOD is the amount of oxygen consumed by microorganisms while stabilizing or degrading carbonaceous and nitrogenous compounds under aerobic conditions. The BOD test is widely used as an indicator of the strength of municipal and industrial wastes and is an important test used in protecting aquatic life from oxygen deficiency. It is the primary regulatory tool used in limiting discharge of these wastes to water; and the BOD test is a key in defining the technology-based waste treatment require-

ments (e.g., secondary treatment or equivalent) required under the U.S. Clean Water Act. BOD modeling is reviewed in Chap. 14.

The COD test measures the total quantity of oxygen required for oxidation of a waste to carbon dioxide and water. It is sometimes used as an approximate substitute for BOD as the COD test can be performed in 3 h instead of the 5-day period required for the BOD test. During the COD test, all organic matter is converted to CO_2 and water in contrast to the BOD test, in which only biologically reactive carbon is oxidized. As a result, COD values are greater than BOD values. The primary limitation of the COD test is the inability to distinguish between biologically degradable and biologically refractory material (nonbiodegradable material).

11.2.9 Nitrogen

Occurrence in Natural Waters. The nitrogen cycle (Fig. 11.2.3) is important to water quality for several reasons. *Nitrification* (oxidation of ammonia and nitrite to

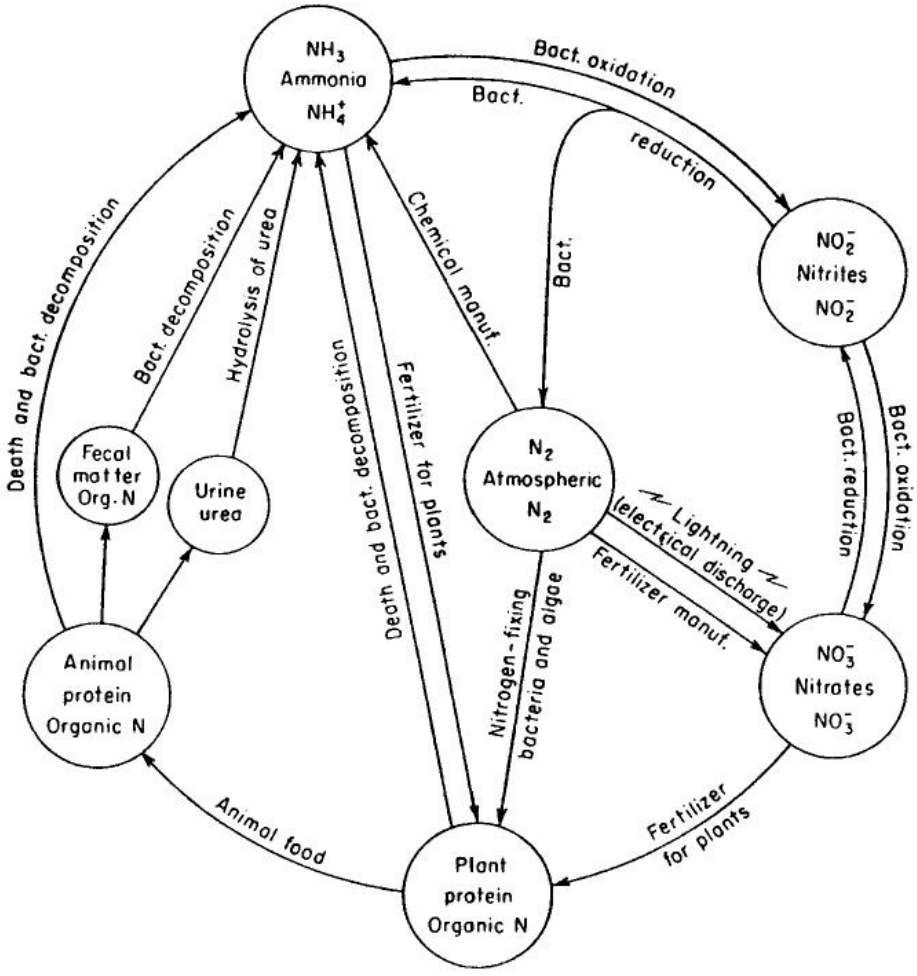

FIGURE 11.2.3 The nitrogen cycle. *(Reproduced from Ref. 60 with permission.)*

2. Chapman, D. (Editor) (1992). Water Quality Assessments

Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring - Second Edition

Edited by
Deborah Chapman

PUBLISHED ON BEHALF OF

UNITED NATIONSEDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

WORLD HEALTHORGANIZATION

UNITED NATIONS ENVIRONMENT PROGRAMME

Published by E&FN Spon, an imprint of Chapman & Hall,

First edition 1992
Second edition 1996

Printed in Great Britain at the University Press, Cambridge

ISBN 0 419 21590 5 (HB) 0 419 21600 6 (PB)

A catalogue record for this book is available from the British Library

3.5.1. Total organic carbon

Organic carbon in freshwaters arises from living material (directly from plant photosynthesis or indirectly from terrestrial organic matter) and also as a constituent of many waste materials and effluents. Consequently, the total organic matter in the water can be a useful indication of the degree of pollution, particularly when concentrations can be compared upstream and downstream of potential sources of pollution, such as sewage or industrial discharges or urban areas. In surface waters, TOC concentrations are generally less than 10 mg l^{-1}, and in groundwater less than 2 mg l^{-1}, unless the water receives municipal or industrial wastes, or is highly coloured due to natural organic material, as in swamps. In such situations, TOC concentrations may exceed 100 mg l^{-1} (TOC concentrations in municipal wastewaters range from 10 to > 100 mg l^{-1}, depending on the level of wastewater treatment). Total organic carbon consists of dissolved and particulate material and is, therefore, affected by fluctuations in suspended solids, which can be quite pronounced in rivers. The dissolved and particulate organic carbon (DOC and POC respectively) can be determined separately after filtering the sample through a glass fibre filter (approximately 0.7 µm pore diameter), and this is recommended for river studies. In most surface waters, DOC levels exceed POC levels and are in the range 1-20 mg l^{-1}. During river floods, and throughout the year in many turbid rivers, POC is the most abundant form (see Table 6.3).

Total organic carbon is determined without filtration of the sample. Samples for TOC determination should be stored in dark glass bottles, with minimum exposure to light or air, at 3-4° C for no more than seven days prior to analysis. Alternatively, samples can be acidified with sulphuric acid to pH 2 or less.

There are various methods available for determining organic carbon depending on the type of sample to be analysed. Methods are based on the principle of oxidation of the carbon in the sample to carbon dioxide (e.g. by combustion, chemical reaction or ultra violet irradiation) which is then determined by one of several methods (e.g. volumetric determination, thermal conductivity or specific CO_2 electrode).

3.5.2. Chemical oxygen demand

The chemical oxygen demand (COD) is a measure of the oxygen equivalent of the organic matter in a water sample that is susceptible to oxidation by a strong chemical oxidant, such as dichromate. The COD is widely used as a measure of the susceptibility to oxidation of the organic and inorganic materials present in water bodies and in the effluents from sewage and industrial plants. The test for COD is non-specific, in that it does not identify the oxidisable material or differentiate between the organic and inorganic material present. Similarly, it does not indicate the total organic carbon present since some organic compounds are not oxidised by the dichromate method whereas some inorganic compounds are oxidised. Nevertheless, COD is a useful, rapidly measured, variable for many industrial wastes and has been in use for several decades.

The concentrations of COD observed in surface waters range from 20 mg l^{-1} O_2 or less in unpolluted waters to greater than 200 mg l^{-1} O_2 in waters receiving effluents. Industrial wastewaters may have COD values ranging from 100 mg l^{-1} O_2 to 60,000 mg l^{-1} O_2.

Samples for COD analysis should be collected in bottles which do not release organic substances into the water, such as glass-stoppered glass bottles. Ideally samples should be analysed immediately, or if unpolluted, within 24 hours provided they are stored cold. If analysis cannot be carried out immediately, the samples should be preserved with sulphuric acid. For prolonged storage samples should be deep frozen. If appropriate, samples can be filtered prior to analysis using glass fibre filters. Unfiltered samples containing settleable solids should be homogenised prior to sub-sampling. The standard method for measurement of COD is oxidation of the sample with potassium dichromate in a sulphuric acid solution (although other oxidants can be used which may have different oxidation characteristics) followed by a titration. It is extremely important that the same method is followed each time during a series of measurements so that the results are comparable.

3.5.3. Biochemical oxygen demand

The biochemical oxygen demand (BOD) is an approximate measure of the amount of biochemically degradable organic matter present in a water sample. It is defined by the amount of oxygen required for the aerobic micro-organisms present in the sample to oxidise the organic matter to a stable inorganic form. The method is subject to various complicating factors such as the oxygen demand resulting from the respiration of algae in the sample and the possible oxidation of ammonia (if nitrifying bacteria are also present). The presence of toxic substances in a sample may affect microbial activity leading to a reduction in the measured BOD. The conditions in a BOD bottle usually differ from those in a river or lake. Therefore, interpretation of BOD results and their implications must be done with great care and by experienced personnel. Further discussion of the BOD test, together with case history results, is given in Velz (1984).

Standardised laboratory procedures are used to determine BOD by measuring the amount of oxygen consumed after incubating the sample in the dark at a specified temperature, which is usually 20° C, for a specific period of time, usually five days. This gives rise to the commonly used term "BOD_5". The oxygen consumption is determined from the difference between the dissolved oxygen concentrations in the sample before and after the incubation period. If the concentration of organic material in the samples is very high, samples may require dilution with distilled water prior to incubation so that the oxygen is not totally depleted.

As noted above, BOD measurements are usually lower than COD measurements. Unpolluted waters typically have BOD values of 2 mg l^{-1} O_3 or less, whereas those receiving wastewaters may have values up to 10 mg l^{-1} O_2 or more, particularly near to the point of wastewater discharge. Raw sewage has a BOD of about 600 mg l^{-1} O_2, whereas treated sewage effluents have BOD values ranging from 20 to 100 mg l^{-1} O_2 depending on the level of treatment applied. Industrial wastes may have BOD values up to 25,000 mg l^{-1} O_2.

Water samples collected for BOD measurement must not contain any added preservatives and must be stored in glass bottles. Ideally the sample should be tested immediately since any form of storage at room temperature can cause changes in the BOD (increase or decrease depending on the character of the sample) by as much as 40 per cent. Storage should be at 5° C and only when absolutely necessary.

3. Kassa, Y. Application of cane molasses as concrete retarder admixture

Research Article

Application of cane molasses as concrete retarder admixture

Yohannes Kassa[1]

Received: 9 August 2019 / Accepted: 31 October 2019 / Published online: 5 November 2019

Abstract
Cane molasses a local material, one of the four types of sugar by-product coming out of the factory among with bagasse, pressed mud, and discharging water containing mud. It contains sugar, non-sugar, and water. Despite the objective of sugar factories, which intended to produce molasses whose purity is as low as possible, most of the time it contains some amount of sugar which can be capable of acting as a retarder admixture. In Ethiopia, a considerable amount of molasses is being discharged as a by-product from sugar factories every year. Thus, this study aims to explore the potentiality of molasses material for concrete works. This study tried to establish a different mix ratio of molasses as a retarder for the concrete mix, while at the same time, the properties of C-25 Concrete were determined. It was found out that the presence of molasses in concrete had significantly extended the setting time and reduce the rate of strength development at early ages but enhance the compressive strength at the later ages. During the study, it became evident that the addition of molasses into cement paste has the capability to delay the setting time of cement paste with a minimum of 380 min and a maximum of 990 min and at the same time it increases the concrete compressive strength at the 28th days with a range of 4.5–16.52%. Therefore, molasses could be used as a conventional retarder admixture for concrete.

Keywords Molasses · Retarder · Cement concrete · Workability · Compressive strengths

1 Introduction

Due to the sensitive nature of chemical admixture dosages and the scarcity of expertise which could control the optimum amount of the chemical admixtures to be added in concrete products that make the applications of concrete admixture difficult in construction projects which take place in a country like Ethiopia. The challenge becomes worse when the cost to obtain chemical admixtures is taken into consideration. Thus, it is required to develop a way that aimed to utilize concrete admixture from local organic materials or industrial by-products to achieve a comparable product with a smaller cost and lesser complex procedure than chemical admixture.

Among organic chemicals, sugar is a moderate retarder. Nevil in 2006 [1] in his book suggests that the presence of retarder in concrete could produce a denser C–S–H (calcium–silicate–hydrate) product in the later age of concrete (beyond 28 days) when it is compared with concrete without retarder admixture. Alternatively, the retarded concrete obtains a reduced compressive strength during its early ages (up to 7 days). Similarly, sugar possesses the retarding effect by inhibiting the formation of hydration product, which possibly contributes to strength development [2–5].

However, contrasting views have been observed from different researchers; the retarding action of sugar mainly depends on its amount in the concrete and the chemical composition of cement [6, 7].

Khan and Baradan [8] study has found out that sugar has a retarding capability on the setting time of concrete. The study was conducted by comparing the effect of sugar on three different cement type with varying curing conditions, and in all cases, the setting times

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SN Applied Sciences (2019) 1:1547 | https://doi.org/10.1007/s42452-019-1608-8

Research Article SN Applied Sciences (2019) 1:1547 | https://doi.org/10.1007/s42452-019-1608-8

were extended, 0.04% (of the weight of cement) quantity of sugar has been extended the final setting time of cement past by 255 min that could be qualified as a common retarder.

Oyekan [9] worked on the utilization of admixture to enhance the compressive strength of sandcrete blocks by the addition of sugar. The study revealed that 0.1% sugar content (by weight of cement) increased the compressive strength of the blocks by nearly 17% at 28 days. At 0.2% sugar content (by weight of cement), the 28 days strength of the blocks was increased by only 9%, but the 14 days strength of the blocks was increased by 56.6%. Such quantities of sugar can, therefore, be used as a quick solution during an unexpected stoppage of mixers to avoid hardness of concrete [10].

Given the fact that Ethiopia has made a substantial investment to increase the sugar production capacity and its vision to become the world 8th largest sugar producer by 2023 with production estimate of 4.2 million metric ton (MMT), following Australia (4.8 MMT) and preceding the USA (3. 3MMT) indicates that the production of molasses will grow proportionally [11]. In 2001–2010, the Ethiopian sugar cooperation had a production trend of 16,386 ton of molasses per annual from three sugar factories, namely Fincha, Methara, and Wenji [12]. A portion of the molasses produced in Ethiopia is used to prepare cattle feed, ethanol production, and local asphalt pavement materials. However, the amount of molasses disposed of by the sugar factories sooner or later will become an environmental threat to the country unless recycled or reused for other purposes [13].

Regardless of the goal of the sugar manufacturing unit to withdraw molasses whose purity is as little as viable, however, most of the time it incorporates sugar [14]; hence, molasses can behave as retarder as sugar did. Molasses composed of reducing and non-reducing sugars [15]. Sucrose and raffinose are the type of non-reducing sugar that exists in molasses, which has an excellent retarding capability [4]. Therefore, it is a reasonable move to put it forward the idea of using molasses as a retarder admixture as far as the amount of sugar required to get the retarding effect present in higher proportion in molasses material [16].

Neville [1] states the use of molasses as a retarder historically rooted from the early 1990s in the construction of England–France channel to prevent the setting of residual concrete.

High-performance concrete was prepared with molasses of different dosages and also found that the addition of molasses causes a considerable increase in the setting time [17].

In another experiment [18], it was found that the usage of molasses as a retarder admixture satisfies the ASTM standard and by reducing the dosage, and it could be used as a "type A" admixture as per ASTM C494 [19] standard.

Molasses has shown a proportional result on the setting behavior of cement, slump, and compressive strength of concrete compared to VZ4 (retarder with high plasticizing effect), a commercial admixture [20].

Akar [21] promotes the application of organic admixture (molasses) in concrete by asserting the benefit with respect to cost and environmental conservation by examining its effect on concrete durability, and the use of molasses as retarder admixture could contribute to environmental preservation by converting sugar industry waste into a usable element and by reducing the demand for chemical admixture and its related by-product waste.

It is difficult to predict the properties of cane molasses collectively since properties of molasses are highly influenced by the type of the soil on which the source cane has grown, the type, and condition of the cane, climatic condition, and processing of the cane [22]. Therefore, a proper investigation of the effect of typical molasses material is necessary.

2 Materials

2.1 Molasses

The end by-product of the processing in the sugar factories, Type C [23] molasses with the high solid content sample was collected from Wenji shewa sugar factory, located in Ethiopia at 110 kilometers distance from the capital city. The total molasses produced per day is approximately 189.65 tonne. Samples were extracted from the blackstrap molasses storage container. To avoid spoil and contamination due to atmospheric air and water, the molasses transported by covering with plastic containers. The physicochemical property of the molasses used throughout the experiment is reported in Table 1.

Table 1 Physicochemical characterization of molasses

Parameters	Values
PH	5.05
Ash content (%)	10.8
Brix	79.5
Color	Dark brown
Viscosity	3042 cP @20 °C
Total sugar (%)	46.8 ± 0.37
Free reducing sugar (%)	15.9 ± 1.07
Nitrogen (%)	0.33 ± 0.04

SN Applied Sciences (2019) 1:1547 | https://doi.org/10.1007/s42452-019-1608-8 Research Article

2.2 Cement

Commercially available ordinary Portland cement with 42.5 R Strength Class was used. The chemical composition of the cement used in this study is given in Table 2.

2.3 Aggregate

Locally available natural sand with absorption of 1% and moisture content of 2% as fine aggregate was used in the overall study. Crushed aggregate available from a local source has been used with a nominal maximum size of 38 mm with 1.5% absorption capacity and moisture content of 1% used as coarse aggregate.

2.4 Water

Potable water was used to mix the concrete and start the hydration reaction.

3 Methods

An experimental approach was implemented in order to study the suitability of molasses as concrete retarder admixture. Various concrete tests were used to investigate the retarding capability of molasses and its effect on the performance of the concrete in its fresh and hardened phase, such as consistency, workability, and strength. The tests were conducted on concrete by adding molasses at a different dosage.

3.1 Tests on fresh concrete properties

Under this phase, experiment was done on the consistency and setting time of cement paste and workability of concrete. Eight cement samples for consistency and setting time test and four cement samples for workability test were prepared with and without molasses. The number of replicates for each test was three.

The Vicat method, specified by ASTM C187-16 [24], was used to determine the quantity of water needed to produce a cement paste of standard consistency and also for the setting times of the cement samples.

The Vicat method also used for the determination of the initial and final setting time of the cement by Vicat apparatus which comply with the ASTM C 191-13 [25] specification. Here, the cement pastes were prepared by using a uniform quantity of water recorded for the standard consistence. Cement paste with varying dosage of molasses; 0.0%, 0.025%, 0.05%, 0.075%, 0.1%, 0.15%, 0.2%, and 0.3%, by weight of cement was prepared. The result of the setting time is presented as a percentage change between the various molasses dosages and the control mix by using the following equation:

$$\text{Percentage Increase of time setting} = \frac{ST_M - ST_C}{ST_C} \quad (1)$$

where: ST_M = Setting time of cement paste with different molasses range. ST_C = Setting time of control cement paste.

Slump test prescribed by ASTM C 143-10 [26] was used to determine the workability of four concrete samples prepared with molasses dosage of 0.0%, 0.05%, 0.075%, and 0.1% of the weight of cement. The concrete sample was taken from fresh concrete, batched and mixed to test the compressive strength of the same molasses dosage.

Table 2 National cement chemical composition

Constituent	Percentage by weight (%)
SiO_2	22.76
Al_2O_3	6.12
Fe_2O_3	3.12
CaO	61.99
MgO	1.57
SO_3	3.2

3.2 Test on harden concrete properties

After identifying the properties of the constituent materials for concrete, a theoretical mix design with targeted slump value of 25–50 mm and compressive strength 25 MPa was arranged according to the EBCS [27] mix design method. Based on the theoretical mix design, a trial mix was prepared to extrapolate with the actual result, and the result was conforming to the theoretical one. Therefore, the mix design was applied for the entire concrete samples with and without molasses. The mixes were proportioned for a cement content of 352.2 kg/m^3, fine aggregate content of 606.2 kg/m^3, coarse aggregate content of 1204.66 kg/m^3, and water–cement ratio of 0.46. Four concrete cube samples with the dimensions of 15 × 15 × 15 cm were prepared to determine the effect of varying dosage of molasses ranging from 0 to 1% by weight of cement. The mixtures were labeled as MC-0, MC-0.05, MC-0.075, and MC-1 with different molasses dosage as percentages of the weight of cement represented by the numerical. Table 3 shows the final mix proportions for 1 m^3 of concrete with a varying dosage of molasses.

The strength development of the concrete mix with respect to the age of mix was determined by comparing

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Table 3 Mix proportion for the concrete work

Mix code	Cement type	Cement quantity (kg/m^3)	W/B	Water (kg/m^3)	FA (kg/m^3)	CA (kg/m^3)	Molasses (g/m^3)
MC-0	OPC	352.2	0.46	162	606.2	1204.66	0
MC-0.05	OPC	352.2	0.46	162	606.2	1204.66	176.1
MC-0.075	OPC	352.2	0.46	162	606.2	1204.66	264.15
MC-0.1	OPC	352.2	0.46	162	606.2	1204.66	352.2

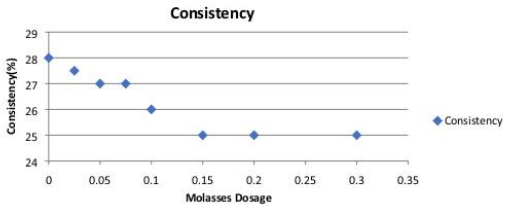

Fig. 1 Consistency result

Table 4 Setting time record

Samples (%)	Initial setting time (mins)	Final setting time (mins)
0.000	180	290
0.025	255	380
0.050	300	575
0.075	525	930
0.100	600	990
0.150	496	690
0.200	160	240
0.300	75	150

the percentage of strength gain at 7, 14, and 28 days. Three samples were used for each age mix, and the average result adopted as the compressive strength. The test was performed according to IS 516-59 [28].

4 Result and discussion

The control paste (without molasses) had a normal consistency of 28%. All of the pastes containing molasses showed normal consistency less than the control paste (see Fig. 1). Further increment of molasses dosage shows a continuous reduction in the water demand. The cement pastes with molasses up to 0.15% showed consistency within this range; however, beyond 0.15% addition, the results showed slightly lower values. Based on the finding, the minimum consistency was recorded for 0.3%. It is evident from the result that the addition of molasses to a cement paste increases its flowability. This effect can be exploited to reduce the amount of water in a mix to increase the strength of cement paste.

The observed values of the initial and final setting time of the cement pastes for the varying dosages of molasses are given against time in Table 4.

Figure 2 shows the percentage change in the initial and final setting time of cement samples with varying degree of molasses. The highest percentage increase in setting time from the control mix was recorded for molasses range of [0.075–0.1%], while the smallest percentage change recorded for 0.3% molasses dosage, indeed the fastest setting time attainment. According to the percentage change result (by Eq. 1), minimum addition of molasses says 0.025% by weight of dry cement into concrete can increase the initial setting time with 42%. The percentage increment of the final setting time is proportional to the percentage increment of the initial setting time. Maximum percentage increment is obtained with 0.1%, while 0.025% was recorded for the minimum. Higher result of initial and final setting time can be achieved with the addition of a smaller amount of molasses, and this explained by the fact that the molasses used for this research contain a higher amount of sugar (48%). Referring to the above results, it can be concluded that smaller dosages of the molasses are more effective in retardation of the setting times; however, with subsequent increase in dosage, less retardation is detected; indeed, a reverse effect, i.e., acceleration, is obtained. Increasing the amount of molasses alternatively increases the amount of minor chemicals and chemical compounds such as chlorides and hydroxides, which are most known as accelerator admixtures. It is due to this phenomenon that a reverse effect was observed with respect to the increment of molasses dosage.

The research finding is conformed to other researches despite the dosage. The deviation was caused by the amount of sugar in the molasses. According to Juneja et al. [16], the maximum percentage increment of initial and final setting time was recorded as 94% and 43%, respectively, by introducing a molasses having 20–25% sugar with dosage of 0.25% by weight of dry cement. Correspondingly, an approximately higher value of setting time

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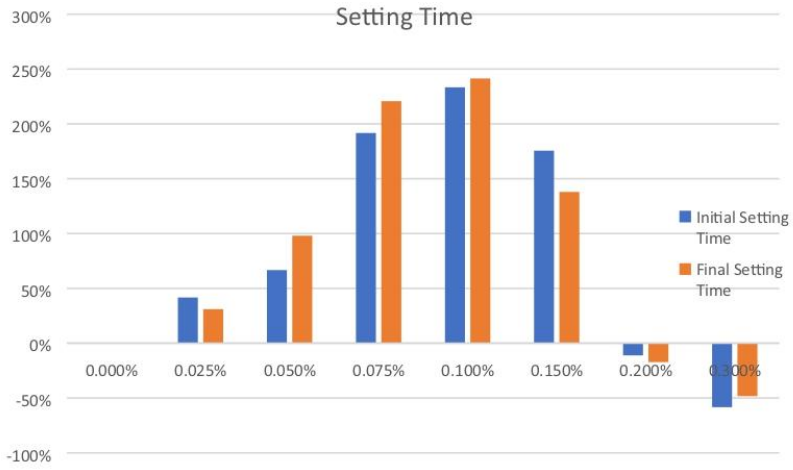

Fig. 2 Percentage difference for setting time

was observed in this research with 0.05% molasses dosage. Also, the observed negative effect due to the higher dosage is conformed to other researches.

Concrete specimens with molasses as admixture exhibited better workability than concrete without molasses. Based on the experimental results, as the percentage of molasses increased, consequently slump also increased. A true slump of 50 mm is observed with molasses percentage of 0.1% (see Fig. 3). Addition of molasses to the concrete greatly influenced its workability as witnessed during the experimentation, and this is due to the fact that molasses retardation mechanism is similar to common retarder admixture. According to the adsorption mechanism of retarder admixture, an impermeable layer will be developed on the cement particles. Due to the layer, water molecules are blocked to enter into the surface of anhydrate cement grains. As a result, slow hydration of cement occurs, which entails slowdown of the rate of strength development; in other words, the concrete mix remains plastic for certain time. This effect accounts for the record of higher slump value with respect to increment in the dosage of molasses.

Figure 4 shows the compressive strength development of the concrete samples together with the control sample for the 7, 14, and 28 days. The highest strength development throughout all its age was observed for concrete sample with molasses percentage of 0.1 by weight of cement; 25.4 MPa, 30.12 MPa, and 33.92 MPa were recorded for 7, 14, and 28 days, respectively. The molasses percentage of 0.05 and 0.075 by weight of cement shows an early compressive strength (7 days) below the reference; however, the 28 days strength shows a greater value than the reference. The relationship between the increase in 14 days compressive strength and dosage of molasses is almost linear. Also, the result was manifested until 28 days.

According to the finding of this study, it is evident that molasses can slow down the hydration reaction; in other words, it inhibits the chemical reaction, which contributes to strength development. Therefore, it is common to notice smaller strength development within 7 days.

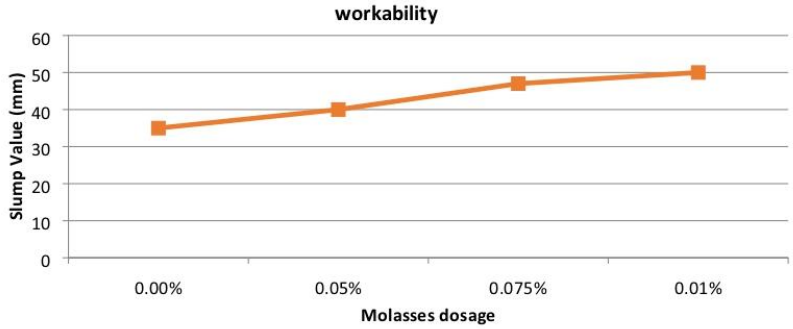

Fig. 3 Concrete workability

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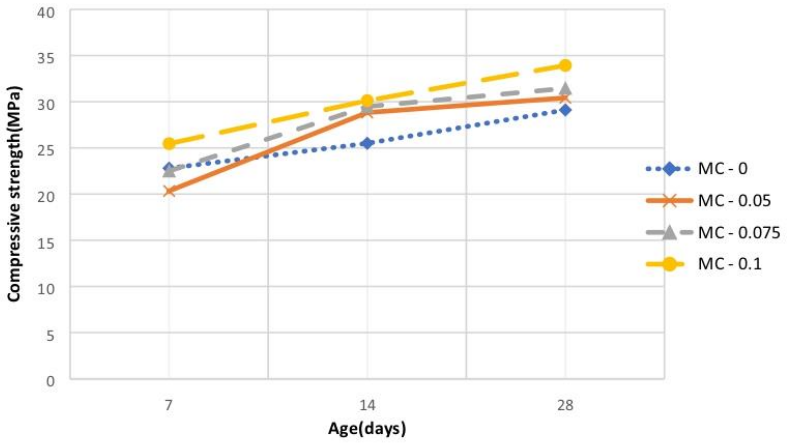

Fig. 4 Compressive strength test result

The positive effect on the development of compressive strength that observed on this study agrees with other research finding [21]. Also, it is conclusive to say that molasses enhance the compressive strength of concrete. However, further investigation is necessary to explain the nature of the hydration products, and the mechanism of interaction between cement and molasses contributes to strength increment.

5 Conclusion

The following conclusions are drawn based on the results of the present investigation:

(1) The presence of molasses into concrete has significantly improved the compressive strengths and setting time.
(2) The molasses dosage ranging from 0.05 to 0.075% gives a favorable maximum delay of initial setting time that complies with ASTM C494 specification. On the other hand, the molasses dosage ranging from 0.025 to 0.05% gives the appropriate final setting time.
(3) The workability of concrete containing molasses increases proportionally as the molasses percentage increases, which are due to the prolonged period of the stiffing process of concrete by molasses as a retarder admixture; thus, this could be exploited to reduce the amount of water to increase the compressive strength of concrete.
(4) Molasses-based cement paste with the dosage greater than 0.05% satisfies the ASTM C 494 specification for minimum compressive strength attainment of retarder admixture in 7 and 28 days, i.e., 90%.
(5) The results of the experiment revealed that molasses has a capability to retard the setting time of cement paste, increase the workability, and reduce the strength development at the early ages. Therefore, molasses can be qualified as conventional retarder admixtures and can be used in hot weather concreting.
(6) However, some inconsistent result was observed due with increasing dosage, i.e., the opposite effect, accelerating the setting time. The finding of this research suggests that the dosage of 0.05% of molasses represents an optimum dosage.
(7) This research is limited to study the setting time of cement paste at room temperature; however, further studies are required to study at a different temperature as far as a varying degree of temperature produces a different effect of retardation.

Acknowledgements I want to express my sincere gratitude to Mr. Tewodros Kassa who was instrumental in providing me with the chance to complete this study, for his guidance and support at all times and his constructive criticism and advice during the preparation of this journal.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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