**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,**
**SOUTHERN ZONE, CHENNAI**
**Original Application No.16 of 2019**

K. Gemini (Died),
S/o. Kannupaiyan,
No.5/1-34, Rettaipulliyamaram Raman Nagar Post,
Mettur Dam Salem District – 636 403 and Ors.

...Applicants

-Vs-

The Union of India
Rep. by the Secretary to Government,
Ministry of Environment, Forests & Climate Change,
New Delhi – 110 003 and Ors.

...Respondents

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**Filed by**
**Thiru.S. Sai Sathya Jith,**
**Advocate, Chennai.**

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III Floor, Pritvi Wing,
India Paryavaran Bhavan Jor Bagh,
New Delhi – 110 003 and Ors.

...Respondents

**COMPLIANCE REPORT FILED ON BEHALF OF THE THIRD RESPONDENT – TAMIL NADU POLLUTION CONTROL BOARD.**

I, S.Palanisamy, S/o. Thiru.S.Santhappan, aged 58 years, having office at No.76, Mount Salai, Guindy, Chennai-600 032, do hereby solemnly affirm and sincerely stated as follows:-

1. I submit that I am the Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board, Chennai – 600 032 and I am authorized to file this report on behalf of the Third respondent (TNPCB) and as such I am well acquainted with the facts of the case as per the records available in our office.
2. It is respectfully submitted that the applicant has filed the application before the Hon'ble Tribunal against the MOEF&CC and M/s.ChemplastSanmar Ltd., Salem District and others with following prayer:

   ***"to direct the respondents 1 to 3 to issue necessary directions stopping all further work and dismantling and demolishing the unit No.IV of the 4 th respondent located in S.No.58/8(part) etc., of Verrakkalpudur Village, Mettur Taluk, Salem District".***

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No.76, MOUNT SALAI, GUINDY,
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3. It is respectfully submitted that on 25.9.2019, the Hon'ble NGT, (SZ), Chennai has constituted a Joint Committee consisting of passed an order among other things inter alia as follows:-

    1. Senior Officer from the SEIAA; Tamil Nadu;
    2. Senior Scientist from the CPCB
    3. Senior Scientist from the SPCB

    to go into the allegation contained in this application and submit a factual report and if there is any violation the action if any taken in this regard. They also mention in the report whether any environmental clearance is required for starting the Unit-IV of the respondent no-4 project for manufacturing of Hydrogen Peroxide in that location.The Joint Committee complete the exercise within a period of two months and submit a report to this Tribunal by E-mail.

4. It is respectfully submitted that the third respondent (TNPCB) has filed its report along with Joint Committee Report during the month of 21st November, 2019 before the Hon'ble NGT,(SZ).

5. It is respectfully submitted that on 25.11.2019, the Hon'ble Tribunal had passed an order inter alia as follows:-

    ***"consider the observations made by the Joint Committee we feel it appropriate to appoint a Joint Committee consisting of a member from NEERI, IIT Engineering Department, Chennai, the Director of Safety and Occupational Health from Govt. of Tamil Nadu, a Senior Official from CPCB, Senior Official from Tamil Nadu Pollution Control Board and a member from National Geophysical Research Institute to consider the question whether the safety measures taken by the Respondent no. 04 in the Secured Land Fill (SLF) are sufficient. A member from National Geophysical Research Institute, Hyderabad and also regarding the ground water contamination caused on account of the activities of the Respondent no. 04 industrial group and also the land fill measures taken by the industry to dispose of the hazardous substance, scientifically dumped in the land fill as per rules and whether it is likely to cause any further degradation of the soil for ground water and if there is any possibility and then further remedial measures which are to be taken and also suggest the same and the expenses incurred for the purpose has to be met by the Respondent no. 04 industry.***

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*7. The Pollution Control Board will act as the nodal agency for this purpose. The committee is directed to complete the study and submit its report within a period of three month".*

6. It is respectfully submitted that the Hon'ble NGT, (SZ) has passed order dt.06.10.2020 and directed as follows:-

*"So under these circumstances, since it is a general study to be conducted to assess the water quality in that area for the benefit of the local people, we direct the Pollution Control Board to appropriate this amount from the environmental compensation lying with them and thereafter when they are assessing the environmental compensation from the persons to be recovered in proportion to the level of pollution contributed by the units, including the fourth respondent, if any and recover this portion of the amount also from those persons, as part of the environmental compensation fixed or assessed, so that the necessary study to be conducted for the benefit of the people can be proceeded with. The committee is also directed to consider the reply/objection filed by the fourth respondent and compliance of the recommendations made by the committee which the fourth respondent is expected to carry out and if there is any deficiency, they are directed to mention the same also in the further report to be filed.*

*The committee is directed to complete the study and submit the report on or before 6.1.2021 to this Tribunal by e-filing at ngtszfiling@gmail.com.*

7. It is respectfully submitted that to comply the above orders passed by the Hon'ble Tribunal on 6.10.2020, the Joint Committee Report has been filed during the month of November 2021.

8. It is further submitted that on 26.05.2022, the Hon'ble Tribunal was disposed the OA, with certain directions and the operative portion of the order is as follows:

*"72.In the result, this Original Application is disposed of with the following directions:-*

*vi. The Joint Committee, after getting the report from NGRI, is directed to assess the Environmental Compensation against the industries which are responsible for excess TDS and other metals found in the water quality and if it is found that 4th respondent is also contributing to the same, then they are at liberty to assess the Environmental Compensation and realise the amount*

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*from the 4th respondent or other erring units which are found to be responsible for such pollution after giving proper opportunity in accordance with law.*

*vii The 4th respondent is directed to comply with the recommendations given by the Joint Committee for improvement of their unit against possible pollution noted by them to avoid complaints from the public.*

*(viii) The Pollution Control Board is directed to monitor the compliance of the directions given by the Joint Committee to the 4th respondent periodically and if there is any violation of non-compliance of the recommendation, then the Pollution Control Board is directed to initiate appropriate action against the 4th respondent including imposing of Environmental Compensation for the violation after giving them proper opportunity of hearing in accordance with law.*

*(ix) The Joint Committee is directed to complete the study within a period of six months and file the report to this Tribunal and on the basis of the Study the Pollution Control Board is directed to take further action to be taken against the erring units and submit the periodical report to this Tribunal regarding the action taken once in three months from the date of completion of study by the Joint Committee.*

*(x) In the meantime, Pollution Control Board is also directed to submit the periodical report of inspection and compliance of recommendations of the Joint Committee by the 4th respondent and if there is any violation of found, nature of action taken once in three months.*

*(xi) If the Pollution Control Board wants to change the agency from NGRI to any other agency for conducting the study as directed by the Joint Committee, they are at liberty to approach the Joint Committee for the change and if any change has been made by the Committee, then the study will have to be conducted by that agency which will have to be evaluated by the Joint Committee for assessing the further aspects including compensation and source of contamination of industries which are responsible for the same and fix a responsibility of payment of compensation applying „Polluter Pays" principle against such units and the amount incurred for conducting study as directed by this Tribunal also to be included in the compensation amount to be recovered from the persons/units responsible and also suggest any*

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***remedial measures to be taken by the erring industries to restore the damage caused to the environment to its original position.***

***(xii) Considering the fact that Hydrogen peroxide is highly reactive and a dangerous explosive hazard, if it is not properly handled, we direct the MoEF&CC to reconsider the question as to whether Item 6 (b) has to be reintroduced and the hazardous substances mentioned therein has to be included in category of obtaining prior Environmental Clearance with specific reference to the inclusion of Hydrogen peroxide also in such category requiring prior Environmental Clearance (EC) and on the basis of the study, if it is required, they are directed to take steps to amend the EIA Notification accordingly and this aspect will have to be considered by the MoEF&CC applying the —Precautionary Principle‖ and also the probable danger that is likely to be caused in the course of manufacturing of Hydrogen peroxide, considering that it is highly reactive and a dangerous explosive hazard besides it being mutagenic and there is a need to handle Hydrogen Peroxide (H2O2) with extreme caution to protect the people and environment.***

***Xv. As and when the report is received, the Registry is directed to place the same before the Bench for consideration and for issuing further direction, if any, required in this regard.***

***73. With the above observations and directions, this Original Application is disposed of.***

9. It is submitted that to comply the order passed on 26.05.2022, by the Hon'ble NGT(SZ), Chennai after concurrence of the Joint Committee to carry out the ground water study through IIT Madras, a work order was issued to Dr.S.Mathava Kumar, Associate Professor, IIT Madras for "Assessment of Ground water contamination in and around M/s.Chemplast Sanmar Plant at Mettur, Salem" at a total cost of Rs.24,95,818/- and submit the final report by June 2023. Further, Dr.S.Mathava kumar vide email dated 27.06.2023 has stated that due to unexpected instrument down time, the metal analysis were delayed and requested to provide a two weeks no cost extension of project and ensured to submit the report on (or) before 15.07.2023.

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10. It is submitted that Dr.S.Mathava Kumar, Associate Professor, IIT Madras has presented the draft report on "Assessment of Ground water contamination in and around M/s.Chemplast Sanmar Plant at Mettur, Salem" before the Joint Committee & TNPCB officials on 01.09.2023. During the presentation, the Joint committee members insisted Dr.S.Mathava kumar, IIT Madras to re-sample in some of the locations from already sampled locations and also to present a final presentation incorporating re-sample values & comments of the Joint Committee members and identify the source of polluting industries.

11. It is submitted that on 15.05.2024, Dr.Mathav Kumar, IIT Madras has presented the draft final report on "Assessment of Ground water contamination in and around M/s.Chemplast Sanmar Plant at Mettur, Salem" before the Joint Committee & TNPCB officials and expressed the following major observation and conclusion and also submitted the final report on "Assessment of Ground Water Contamination in and around M/s.Chemplast Sanmar Plants at Mettur, Salem".

12. It is submitted that the study conducted by the IIT Madras has submitted its specific conclusion in its final report which is as follows:

    a. The investigations of physicochemical and biological parameters show that the Chemplast Sanmar Industries was not the source of any pollution to groundwater in the surrounding localities.

    b. Although, most bore wells and open wells are polluted in the locality, there is no traceable source linking to the Chemplast Sanmar Industries. The upstream and downstream piezometric well's water quality assessments within the M/s.Chemplast Sanmar Industries indicate that SLFs had not contributed to any organic or inorganic water contamination within the plant as well as outside of the plant area.

    c. The soil samples collected from the new bore holes inside the Chemplast Sanmar Industries does not show any contamination of metal ions (i.e. lead, mercury, cadmium and nickel), which indicate that the SLFs inside the Chemplast Sanmar Industries are properly functioning over the years.

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d. It is recommended to carry out frequent water quality monitoring around the localities of P.N.Patti, Khuduridi and Kaptoruti. Frequent monitoring of wells for specific chemicals used in all industries located at Mettur would provide detailed information about the role of each industry in ground water pollution, if any.

13. It is submitted that the final report on "Assessment of Ground water contamination in and around M/s.Chemplast Sanmar Plant at Mettur, Salem is enclosed as an **Annexure-1.**

Under the above circumstances, it is humbly prayed that this Hon'ble National Green tribunal may be pleased to pass such further or other orders as this Hon'ble Tribunal may deem fit and proper in the facts and circumstances of this case and thus render justice.

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## VERIFICATION

I, S.Palanisamy, S/o. Thiru.S.Santhappan, working as Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board having office at No. 76, Anna Salai, Guindy, Chennai – 32, do hereby submit that the above contents are true to the best of my knowledge and belief.

9/9/24

JOINT CHIEF ENVIRONMENTAL ENGINEER
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A Project Report on

# The Assessment of Groundwater Contamination in and around The M/s Chemplast Sanmar Plants at Mettur

IITM Project No: IC22231283CETNPC008671
Client: TNPCB, Chennai
Duration of the Project: March to November, 2023

**Prepared by:**

**Dr. S. Mathava Kumar**

**Environmental Engineering Division**
**Department of Civil Engineering**
**Indian Institute of Technology Madras**

A Project Report on

# The Assessment of Groundwater Contamination in and around The M/s Chemplast Sanmar Plants at Mettur

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Client: TNPCB, Chennai
Duration of the Project: March to November, 2023

**Project Report Prepared by : Dr. S. Mathava Kumar, Associate Professor,**
**Environmental Engineering Division,**
**Dept. of Civil Engg., IIT Madras Chennai - 36**

**Name and Signature of the PI:**

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# Executive Summary

The localities in and around the M/s Chemplast Sanmar Industries in Mettur, Salem were monitored for various physicochemical and biological parameters. This study was performed to investigate whether the M/s Chemplast Sanmar Industries were acting as a source of ground water contamination in the surrounding locality. The localities around the M/s Chemplast Sanmar Extensive sampling were carried out in openwells and borewells around the M/s Chemplast Sanmar Industries by categorising the localities into 4 zones and 8 quadrants. The sampling wells were selected such that almost all the zones and quadrants were covered. Sampling was also performed in piezometric wells inside the M/s Chemplast Sanmar Industries covering monitoring wells upstream and downstream to the M/s Chemplast Sanmar Plants. Sampling was carried out twice, during pre-monsoon and post-monsoon seasons to understand the distribution of contaminants in the wells before and after rainfall. The physicochemical parameters analysed were pH, Temperature, DO, TDS, EC, alkalinity, hardness, anions, metals, phenolics, COD and TOC. Total coliforms were also analysed for all the samples. Therefore, a total of 21 physicochemical parameters and 1 biological parameter were analysed for 11 openwell, 16 borewell and 18 SLF well samples. During the postmonsoon season, two new borewells were installed in the M/s Chemplast Sanmar Plants I and II. The soil samples were collected at various depths during the installation and were characterised. The water samples from the newly installed borewells were also analysed for physicochemical and biological characteristics. To further assess water quality in areas with a higher potential for contamination, a third round of sampling was conducted in October 2023.

The distribution of contaminants in the localities were studied with the help of an opensource Geographical Information System application (QGIS). The compliance of each well sample collected was checked according to the IS-10500:2012 drinking water standards and the potential polluted localities were identified with the help of contour mapping of the contaminated zones. The information obtained in this investigation was utilised to rationally identify whether the M/s Chemplast Sanmar Industries contributed to any pollution of groundwater in the surrounding locality.

# Chapter 1. Introduction

## 1.1. Background

Ground water is a principal resource for various agricultural, industrial and potable requirements of a locality. The quality and enrichment of ground water is affected by natural and anthropogenic activities. The condition of ground water in a locality is a direct indicator that reflects the natural and anthropogenic activities in that locality. The flow of groundwater is through the cracks, crevices and pores available under the ground. Traditionally, ground water is collected and stored in common households using wells. A more modern practice is to dig deep borewells. These wells are monitored regularly to determine the quality of groundwater and to understand the sources that are responsible in case of groundwater pollution. Various physicochemical and biological parameters of water such as dissolved oxygen (DO), pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), total solids (TS), turbidity, alkalinity, hardness, $Fl^-$, $Cl^-$, $SO_4^{2-}$, $NO_3^-$-N , $NH_3^+$-N, $PO_4^{3-}$, total coliforms (TC), total organic carbon (TOC), chemical oxygen demand (COD) and heavy metals ($Pb^{2+}$, $Cd^{2+}$, $Ni^{3+}$, $Hg^{2+}$, etc.) are estimated to determine the quality of ground water. This study is aimed at monitoring the quality of ground water in and around a 4km radius from the M/s Chemplast Sanmar Industries, Mettur. The ground water quality was monitored by collecting water samples from openwells (OW), borewells (BW) and secured landfill (SLF) piezometric wells located inside the industry to identify potential polluting hazards.

## 1.2. The current status of the M/s Chemplast Sanmar Industrial Cluster in Mettur

The M/s Chemplast Sanmar Industries are located at a distance of 0.9-2.5 km, Tamilnadu. The location, area and year of establishment of M/s Chemplast Industries are provided in Table 1.1. The entire product line of M/s Chemplast Sanmar Industries is provided in Fig. 1.1

**Table 1.1.** Location details of M/s Chemplast Sanmar plants

| M/s Chemplast Sanmar Plants | Latitude | Longitude | Area (acres) | Establishment Year |
|---|---|---|---|---|
| Plant 1 | 11.80578 | 77.82266 | 70-80 | 1988 |
| Plant 2 | 11.81972 | 77.84256 | 80-90 | 1967 |
| Plant 3 | 11.82259 | 77.85027 | 80-90 | 1965 |
| Plant 4 | 11.81675 | 77.84185 | 60-70 | 2019 |

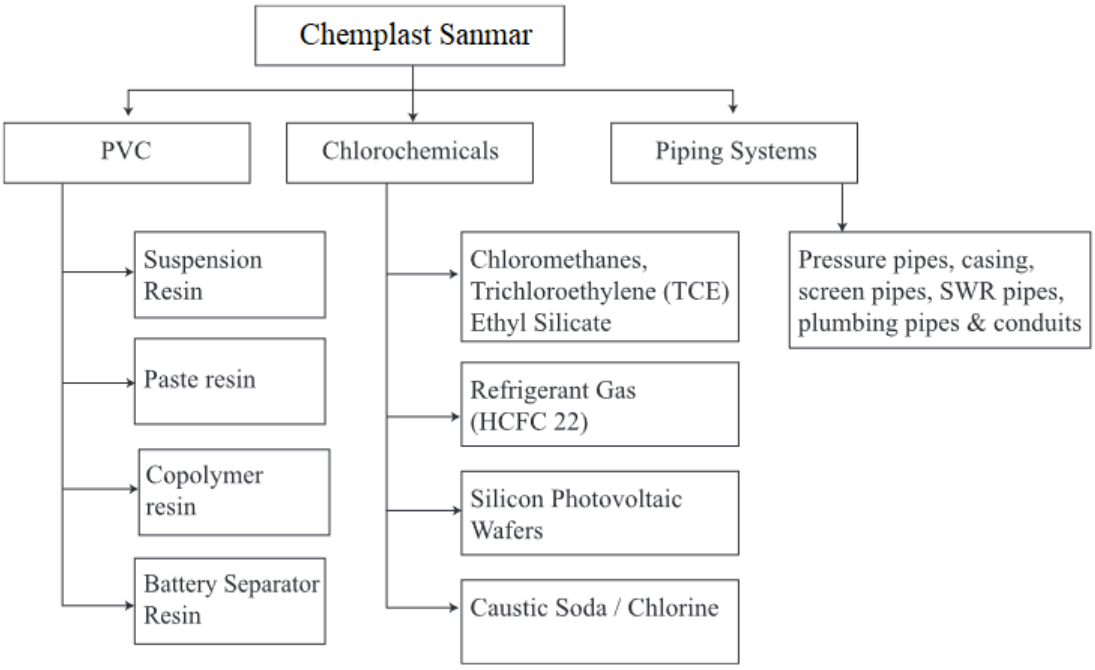


**Figure 1.1.** Product line of M/s Chemplast Sanmar group of industries

The M/s Chemplast Sanmar manufacturing complex at Mettur is composed of four units (Plant I, II, III and IV). Plant I is spread over an area of 71 acres and manufactures 2500 tpa of refrigerant gas HCFC 22. HFC-23 is an inevitable biproduct during the process of HCFC-22. It has a high global warming potential and therefore it is destroyed in the plant by thermal oxidation in the presence of oxygen and hydrogen. This process produces HF and HCl as biproducts.

Plant II is spread over an area of 137 acres. It produces four grades of polyvinyl chloride (PVC) resins at a capacity of 66000 tpa. Plant II began its operations in May 1967, with technology from B. F. Goodrich, USA. The raw materials for PVC production are ethylene and chlorine. Ethylene is imported and the chlorine is produced in Plant III and another plant in Karaikal. Chlorination of ethylene produces ethylene dichloride (EDC). The EDC from Karaikal is transported by road to Mettur. The company has a captive salt field in Vedaranyam to produce the chlorine required for the process. This is a specialty paste based PVC resin manufacturing facility. M/s Chemplast also operates a 300000 tpa suspension PVC resin facility in Cuddalore. Both the PVC resin manufacturing facilities are one of the largest of their types in the country.

Plant III is spread over an area of 129 acres and manufactures 80000 tpa caustic soda and 35000 tpa chloromethanes. Plant III produces chlorine, which is used in the production of EDC. The ethylene

precursor is completely imported for this process. The company has also installed a gas-based powerplant of 12 MW at this location. Plant IV is spread over an area of 10 acres and manufactures 34000 tpa (50% basis) hydrogen peroxide, polysilicon and silicon wafers (1).

### 1.2.1. Environmental status of M/s Chemplast Mettur Industrial Cluster

The caustic soda plant (Plant III) shifted its technology from mercury-based cells to membrane-based cells in 2007. This was well ahead of the deadline (2012) proposed by Ministry of Environment, Forest and Climate change (MoEF_CC) for the compulsory change. The know-how of the membrane-based cells is provided by Asahi Kohatsu Corporation (AKC), Japan. In 2016-2017, the zero-gap electrolyser technology was introduced in the plant to improve the electrolysis efficiency resulting in a reduced carbon footprint. As per the compliance report (Proposal No. IA/TN/IND/21367/1910), the company has complied 13 of the 29 compliance conditions and the remaining 16 conditions are being complied. One such condition for compliance that is 'being complied' states "*Regular monitoring of ground water by installing at least 4 piezometric wells around the plant area shall be periodically carried out and reports submitted to Ministry's Regional Office at Bangalore, CPCB and SPCB*" (2).

The PVC plant (Plant II) and chloromethane plant (Plant III) generates an effluent of 383 KLD and 75 KLD, respectively. The effluent generated from the plants are treated in the wastewater treatment plants and then by reverse osmosis (RO) to recover water. The reject from RO is then evaporated to recover an additional amount of water. The salts precipitated during the evaporating process is used for the preparation of brine at Plant III. The sludge from the effluent treatment plants and the brine water sludge in Plant III are categorised as hazardous and were disposed in the captive SLF till 2020. The operation of the SLFs were then stopped and they were closed. Piezoelectric pumps were installed around the SLFs to monitor the groundwater quality post closure. From 2021, the hazardous wastes are disposed in the common Treatment, Storage and Disposal Facility (TSDF).

The industrial complex is also supported by a 48.5 MW thermal power plant and a 0.3 MLD RO plant. The Mettur complex has consumed 1578378 kL of water from the Stanley reservoir in the year 2021-2022 of which 56% was recycled. The company also has installed rain water collection schemes spanning 24230

$m^2$ with storage tanks with an overall capacity of 79160 kL. The rainwater is collected and stored. During the days of very heavy rainfall, the excess stormwater is sent to the effluent storage tank.

### 1.3. Other industrial players in Mettur

Apart from the infrastructures of the M/s Chemplast Sanmar Mettur complex, the locality also houses major industrial players like Madras aluminium company Ltd. (M/s MALCO) and Mettur thermal plant. M/s MALCO houses an 80000 TPA aluminium refinery, a 40000 TPA aluminium smelter and a 75 MW captive power plant. The surrounding area houses the Mettur Thermal Power Plant (MTP), a 1440 MW coal-based power plant. Therefore, the locality of the M/s Chemplast Sanmar plant is considered sensitive as there were reports of groundwater, soil and air contamination in the past (3). It was reported that the localities P.N. Patti, Veerakkalpudhur and Gonur panchayats had severe soil and water pollution in the year 2007 – 2008. The location of the M/s Chemplast Sanmar Industries, M/s MALCO and MTP plants are provided in Fig. 1.2. Other industries around the region are provided in Annexure I.

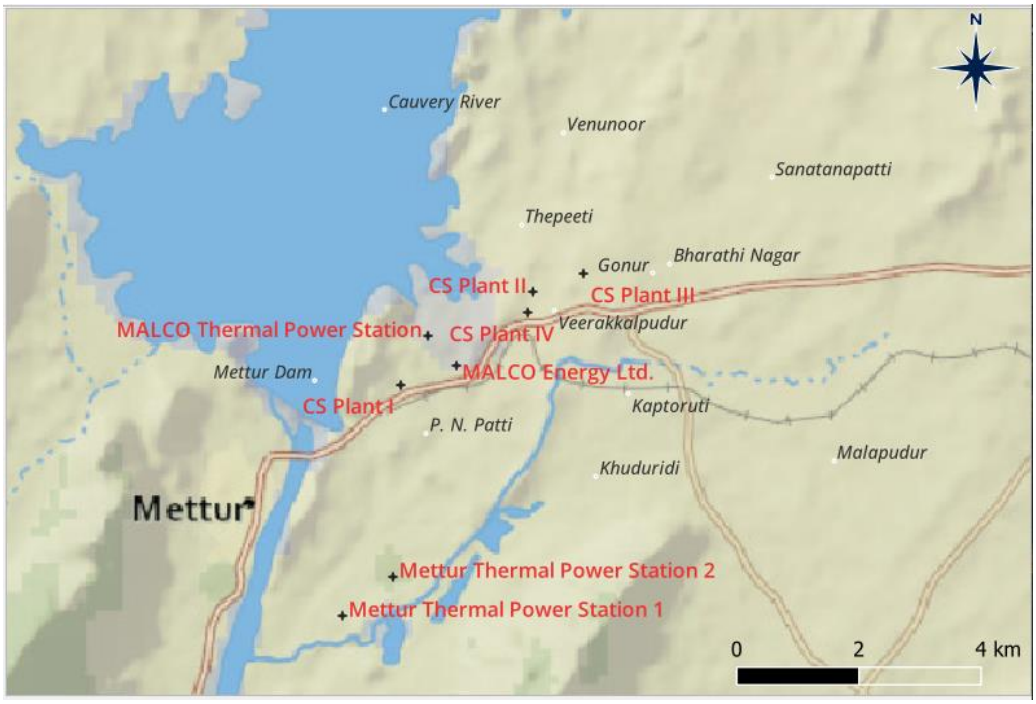


**Figure 1.2**. Location of M/s Chemplast Sanmar (Plants I-IV), M/s MALCO and MTP in Mettur

In 2017, the Central pollution control board (CPCB) of India rated the Mettur industrial cluster as a critically polluted area (CPA). The comprehensive environmental pollution index (CEPI) score was 71.82 (Air: 41.25, Water: 19.38, Land: 69.38). However, installation of zero liquid discharge and strict

restrictions by TNPCB reduced the CEPI score to 20.77 in 2019. There are a total of 92 industries in the cluster out of which 6 are from the 17-category industries of CPCB. There are also 4 large-scale, 1 medium scale and 81 small scale industries (4). 67 of 92 industries fall into the red category of polluting the environment and 25 industries fall into the orange category.

### 1.4. The need for this study

The CPA status of the Mettur industrial cluster in 2017 mandates bi-annual reporting of compliance by the M/s Chemplast Sanmar group of Industries. Moreover, although the captive SLFs of the Plants have stopped their operations since 2021, it is necessary to monitor the quality of ground water in the area to identify any potential leakage of contaminants from the SLFs. Consistent TNPCB compliance mandates and environmental management efforts from M/s Chemplast Sanmar industries have resulted in improved quality of groundwater in the industrial cluster and in the surroundings according to the compliance reports of 2020 and 2021 (4). However, it is necessary to monitor the surroundings of the industry frequently to identify any mismanagement in the cluster. Therefore, this study focuses on the quality of ground water within the M/s Chemplast Sanmar Mettur Industrial cluster and its surroundings.

# Chapter 2. Objective and scope of the study

The major objective of this study is *to 'determine whether the M/s Chemplast Sanmar Industries in the Mettur complex contribute to any deterioration in water quality in the locality'*. The objectives can be delineated as follows:

- To determine the quality of groundwater in and around the M/s Chemplast Sanmar plants at Mettur for about 4 km radius.
- To check the performance of the SLFs by analysing water quality in the piezometric wells
- To identify locations for installing new piezometric wells near SLF to monitor the functioning of the SLFs
- Preparation of a detailed report based on the results of groundwater contamination study for estimating the extent and nature of groundwater contamination.

To achieve the objectives provided, the scope of the study is designed as follows:

- Data collection about groundwater quality in and around the M/s Chemplast Sanmar plants at Mettur.
- Identification of borewells and openwells in and around 4 km radius from the plants for water sample collection.
- Preparation of questionnaire to collect background information from the users of the identified wells for groundwater quality determination.
- Collection of water samples (pre-monsoon and post-monsoon) and their water quality analysis for physicochemical and biological parameters as per The Standard Methods.
- Examination of the water quality in the existing piezometeric wells around the SLFs within the industrial premises.
- Identification of two locations within the premises of the plant for installing new piezometeric borewells based on water quality
- Collection of soil and water samples during the installation of the new piezometric wells and their analysis to identify the soil and water contamination

# Chapter 3. Methodology

An overview of the methodology followed for this study is provided in Fig. 3.1. The methodology is designed as to first identify potential places of sampling and the positions of borewells and open wells through a site recognition survey. After identifying the sites, water samples are collected from borewells and open wells, and are analysed for various physicochemical and biological parameters to determine the level of water pollution. To understand the level of water pollution, the contaminant levels in the open wells and borewells are compared to a reference sample from Cauvery River. Sampling was carried out twice, during pre-monsoon and post-monsoon seasons, and the water quality analysis was carried out immediately at IIT Madras.

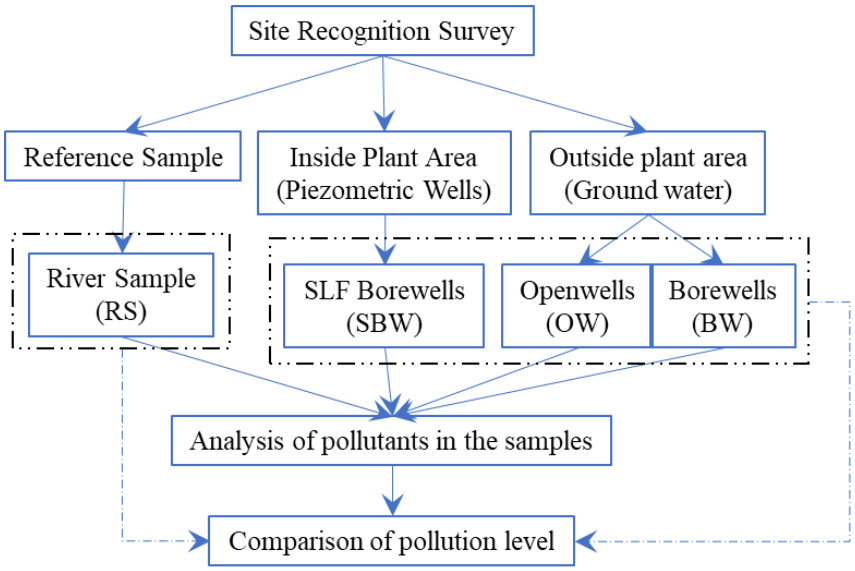


**Figure 3.1.** Overview of the methodology followed for this study

## 3.1. Site recognition survey

The locality in and around the M/s Chemplast Sanmar plants were surveyed for potential sampling wells. The sampling locations were divided into core zones (within 1 km from reference point), impact zones (1-3 km from the reference point) and buffer zone (3-4 km from from the reference point). The location Veerakkalpudhur, nearest locality to the Plants was considered as the centre for zonation. The zoning of areas upto 4 km radium from the centre point is shown in Fig. 3.2. The zones are then divided into 8 equal quadrants and the sampling wells were decided in such a manner that they are distributed evenly throughout all the zones and quadrants. The region of Mettur usually has its onset of South-West monsoon during the months of June and North-East monsoon during the months of October. However, it also

experiences a heavy summer rainfall during the month of May-June. The sampling was planned in such a way that one cycle was carried out during the dry period of March and the other cycle was carried during the heavy summer rainfall in the month of May which will be during the onset of South-West monsoon.

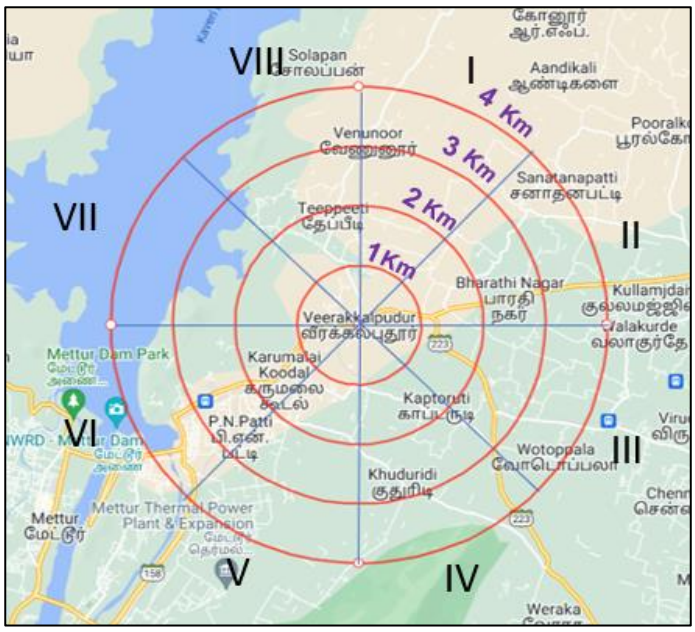


**Figure 3.2.** Zones and quadrants in the sampling area according to the site recognition survey

The openwells and borewells selected for sampling are shown in Fig. 3.3 and Fig. 3.4, respectively. Fig. 7 shows the location of piezometric wells selected for sampling inside the M/s Chemplast plants. A total of 11 openwells,16 borewells and 18 piezometric wells were sampled in this study.

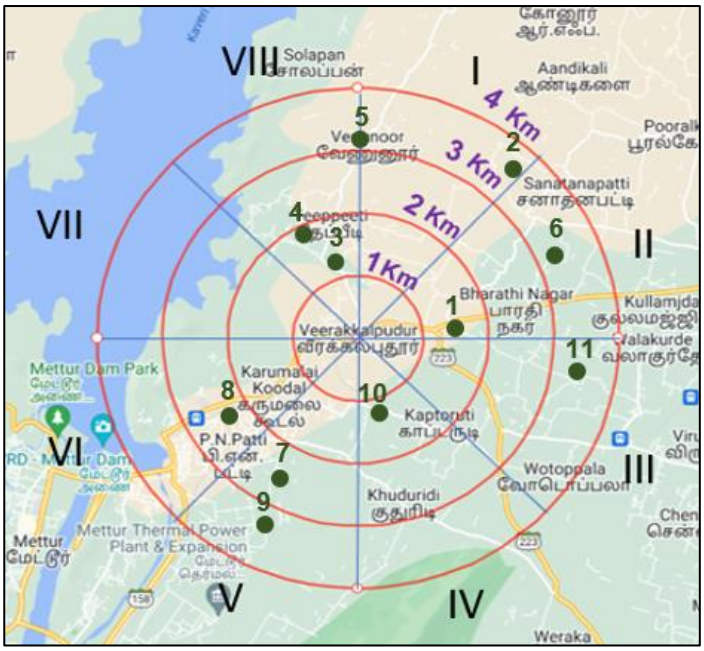


**Figure 3.3.** Open well locations selected for sampling around the plant

**Table 3.1.** Location data of openwells sampled at various locations around the M/s Chemplast plants

| Openwell | Lattitude | Longitude | Sample Code for | |
|---|---|---|---|---|
| | | | Pre-monsoon* | Post-monsoon* |
| OW 1 | 11.816 | 77.862 | S1-OW 1 | S2-OW 1 |
| OW 2 | 11.838 | 77.873 | S1-OW 2 | S2-OW 2 |
| OW 3 | 11.827 | 77.845 | S1-OW 3 | S2-OW 3 |
| OW 4 | 11.831 | 77.836 | S1-OW 4 | S2-OW 4 |
| OW 5 | 11.846 | 77.848 | S1-OW 5 | S2-OW 5 |
| OW 6 | 11.826 | 77.87 | S1-OW 6 | S2-OW 6 |
| OW 7 | 11.797 | 77.831 | S1-OW 7 | S2-OW 7 |
| OW 8 | 11.803 | 77.826 | S1-OW 8 | S2-OW 8 |
| OW 9 | 11.792 | 77.832 | S1-OW 9 | S2-OW 9 |
| OW 10 | 11.805 | 77.851 | S1-OW 10 | S2-OW 10 |
| OW 11 | 11.807 | 77.883 | S1-OW 11 | S2-OW 11 |

* Monsoon indicates South-West monsoon during the sampling period

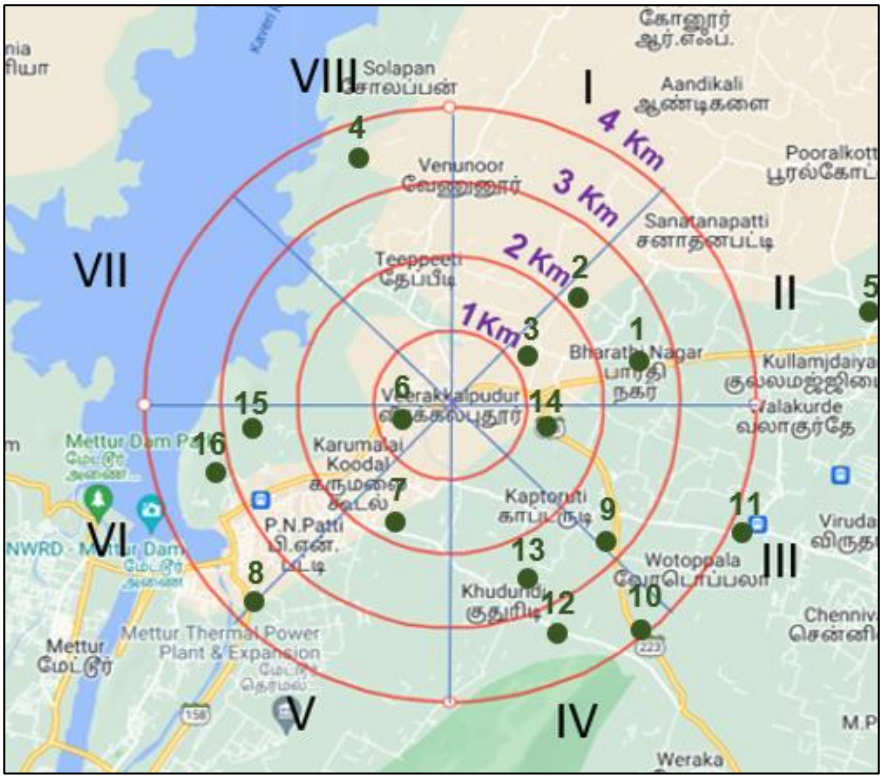


**Figure 3.4.** Borewell locations selected for sampling around the plant

**Table 3.2.** Location data of borewells sampled at various locations around the M/s Chemplast plants

| Borewell | Lattitude | Longitude | Sample Code for | |
|---|---|---|---|---|
| | | | Pre-monsoon* | Post-monsoon* |
| BW 1 | 11.821 | 77.87 | S1-BW 1 | S2-BW 1 |
| BW 2 | 11.827 | 77.858 | S1-BW 2 | S2-BW 2 |
| BW 3 | 11.826 | 77.854 | S1-BW 3 | S2-BW 3 |
| BW 4 | 11.855 | 77.845 | S1-BW 4 | S2-BW 4 |
| BW 5 | 11.824 | 77.892 | S1-BW 5 | S2-BW 5 |
| BW 6 | 11.812 | 77.844 | S1-BW 6 | S2-BW 6 |
| BW 7 | 11.802 | 77.831 | S1-BW 7 | S2-BW 7 |
| BW 8 | 11.79 | 77.821 | S1-BW 8 | S2-BW 8 |
| BW 9 | 11.798 | 77.863 | S1-BW 9 | S2-BW 9 |
| BW 10 | 11.786 | 77.869 | S1-BW 10 | S2-BW 10 |
| BW 11 | 11.8 | 77.881 | S1-BW 11 | S2-BW 11 |
| BW 12 | 11.787 | 77.855 | S1-BW 12 | S2-BW 12 |
| BW 13 | 11.793 | 77.849 | S1-BW 13 | S2-BW 13 |
| BW 14 | 11.805 | 77.865 | S1-BW 14 | S2-BW 14 |
| BW 15 | 11.813 | 77.824 | S1-BW 15 | S2-BW 15 |
| BW 16 | 11.806 | 77.817 | S1-BW 16 | S2-BW 16 |

* Monsoon indicates South-West monsoon during the sampling period

The piezometric borewells sampled inside the M/s Chemplast plants are shown in Fig. 3.5 and Fig. 3.6. The latitude and longitude data of the sampled piezometric wells are shown in Table 3.3. A total of 18 piezometric borewells were sampled in the pre-monsoon season. To effectively monitor the ground water quality, 2 more bore wells DBW-1 and DBW-2 were constructed and their location is also provided in Table 3.3. An extra piezometric borewell (PBW-19) was sampled during the post-monsoon season to understand the upstream characteristics. The consolidated location of all the sampled wells (openwells, borewells, piezometric wells) are shown in Fig. 3.7. A total of 46 wells were sampled during pre-monsoon season and 49 wells were sampled during the post-monsoon season.

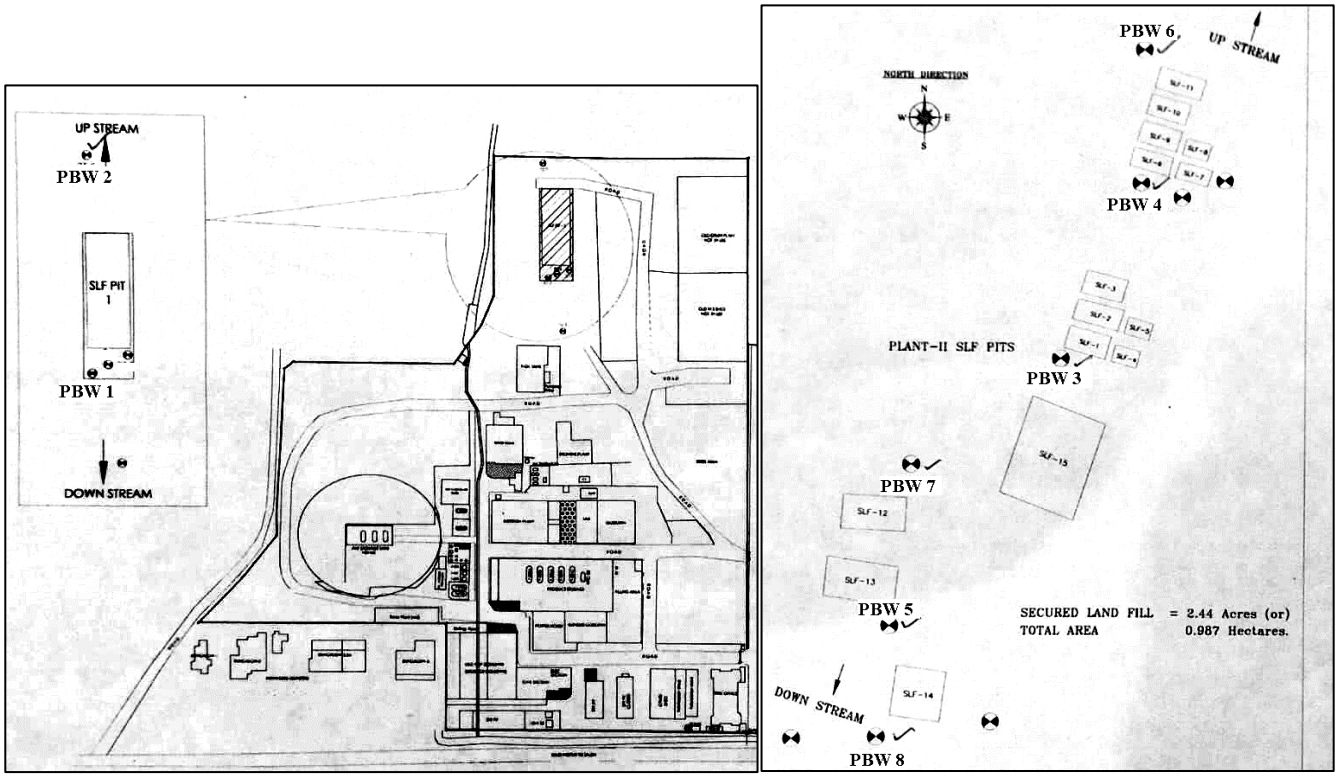


**Figure 3.5.** Location of the sampled piezometric wells in the M/s Chemplast Sanmar Plants I and II.

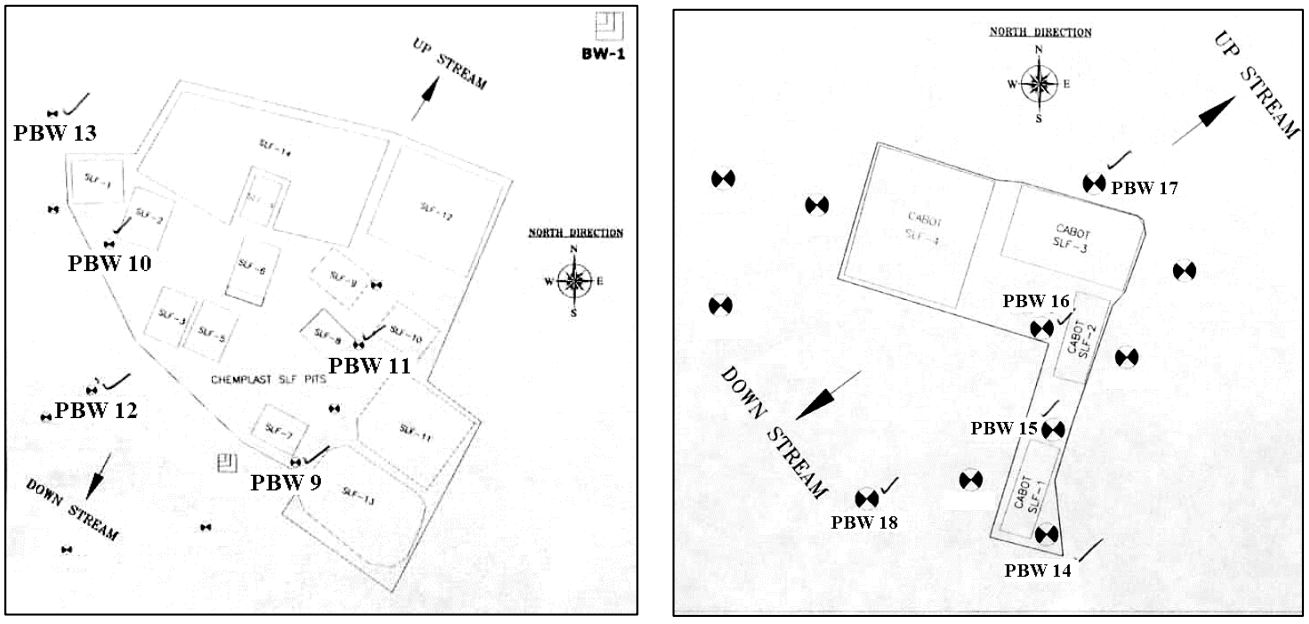


**Figure 3.6.** Location of the sampled piezometric wells in the M/s Chemplast Sanmar Plants III and V.

**Table 3.3.** Piezometric well samples collected within M/s Chemplast Sanmar plants

| Piezometric Wells | Lattitude | Longitude | Location | Pre-monsoon* Sampling | Post-monsoon* Sampling |
|---|---|---|---|---|---|
| PBW1 | 11.806947 | 77.820653 | Plant 1 (Downstream) | S1-PBW1 | S2-PBW1 |
| PBW2 | 11.806937 | 77.820057 | Plant 1 (Upstream) | S1-PBW2 | S2-PBW2 |
| PBW3 | 11.819713 | 77.84461 | Plant 2 | S1-PBW3 | S2-PBW3 |
| PBW4 | 11.820642 | 77.84461 | Plant 2 | S1-PBW4 | S2-PBW4 |
| PBW5 | 11.818856 | 77.843558 | Plant 2 | S1-PBW5 | S2-PBW5 |
| PBW6 | 11.820903 | 77.844666 | Plant 2 (Upstream) | S1-PBW6 | S2-PBW6 |
| PBW7 | 11.819323 | 77.843772 | Plant 2 | S1-PBW7 | S2-PBW7 |
| PBW8 | 11.819064 | 77.843499 | Plant 2 (Downstream) | S1-PBW8 | S2-PBW8 |
| PBW9 | 11.819824 | 77.84714 | Plant 3 | S1-PBW9 | S2-PBW9 |
| PBW10 | 11.821579 | 77.845813 | Plant 3 | S1-PBW10 | S2-PBW10 |
| PBW11 | 11.820317 | 77.84745 | Plant 3 | S1-PBW11 | S2-PBW11 |
| PBW12 | 11.82007 | 77.84619 | Plant 3 (Downstream) | S1-PBW12 | S2-PBW12 |
| PBW13 | 11.82304 | 77.845305 | Plant 3 (Upstream) | S1-PBW13 | S2-PBW13 |
| PBW14 | 11.820995 | 77.84778 | Plant 4 | S1-PBW14 | S2-PBW14 |
| PBW15 | 11.821119 | 77.847422 | Plant 4 | S1-PBW15 | S2-PBW15 |
| PBW16 | 11.821648 | 77.847384 | Plant 4 | S1-PBW16 | S2-PBW16 |
| PBW17 | 11.821843 | 77.84765 | Plant 4 (Upstream) | S1-PBW17 | S2-PBW17 |
| PBW18 | 11.8204939 | 77.8472142 | Plant 4 (Downstream) | S1-PBW18 | S2-PBW18 |
| PBW19 | 11.821545 | 77.847588 | Plant 4 | S1-PBW19 | S2-PBW19 |
| DBW1 | 11.806474 | 77.820291 | Plant 1 | S1-DBW1 | S2-DBW1 |
| DBW2 | 11.82102 | 77.846277 | Plant 3 | S1-DBW2 | S2-DBW2 |

* Monsoon indicates South-West monsoon during the sampling period

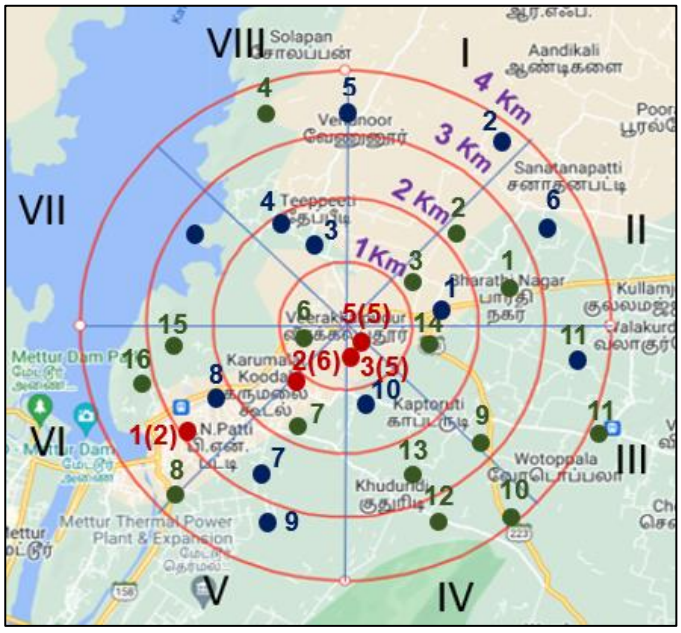


**Figure 3.7.** Consolidated locations of all the sampling wells in this study

(● open well, ● borewell, ● piezometric borewells)

## 3.2. Sample collection and analysis

### 3.2.1. Sample collection from open wells and bore wells

The sampling of open wells was carried out with the help of a rope and a bucket. The bucket was rinsed twice with the well water before collecting the samples in the 1 L HDPE container. The bigger size suspended solids were filtered with the help of a screening filter. The collected samples were then stored at 4 °C inside an icebox. The sampling of borewells was done by pumping out the borewell for atleast 2-5 min and then collecting the samples in the 1 L HDPE container. The collected samples were stored in the icebox at 4 °C. While collecting the samples from the piezometric borewells inside the M/s Chemplast Sanmar plants, the borewells were bailed out by pumping for 2 min. The samples were then collected in 1 L HDPE containers and stored in an ice box at 4 °C. 100 mL of the collected sample from was stabilised with $HNO_3$ for analysis of metals. Another 100 mL of sample was stabilised with $H_2SO_4$ for analysis of organic contaminants. The collected samples are shown in Fig. 3.8.


**Figure. 3.8.** Picture of the sample containers and the ice box used for sampling.

### 3.2.2. Sample nomenclature

The nomenclature of the samples was provided as <Sampling identifier>-<Well type>-<Sample number>. A sample identifier 'S1' denotes that the sample was collected before South-West monsoon (i.e., pre-monsoon) and a sample identifier 'S2' denotes that the sample was collected during the South-West monsoon (i.e., post-monsoon). The well type identifier denotes whether the samples were collected from an openwell (OW), borewell (BW) or a piezometric borewell in the SLF (PBW). For example, a sample

nomenclature of S1-OW-5 indicates the 5$^{th}$ open well sample collected during the pre-monsoon sampling period. The soil samples are named as <S>-<Sampled Borewell>-<Sampled depth>. For examples, a sample identifier S-DBW1-50 means the soil sample was collected from a newly drilled borewell No. 1 at a depth of 50 ft.

### 3.2.3. On-line analysis of physicochemical parameters

After collecting the samples, parameters like pH, turbidity, EC, DO, $NO_3^-$-N, $NH_4^+$-N, ORP and turbidity were measured instantly using portable meters. pH was measured using a Eutech Cyberscan pH 510 meter with a ECFC7252 pH Probe. The temperature corrections were made using a pH5TEM01 ATC temperature probe. 3-Point calibration of the pH meter was performed using Eutech EU-4BT (pH= 4.01), EU-7BT (pH 7.00) and EO-10BT (pH 10.01) buffers before measuring the pH of the samples. EC was measured using a Hanna Edge meter with a HI763100 ATC corrected conductivity Probe. The conductivity meter was calibrated with a Eutech ECCON1413BT (1413 μS/cm) conductivity standard. DO, $NO_3$-N, $NH_3$-N and ORP were measured using a Vernier Labquest 2 Multiparameter datalogger. DO probe (Labquest DO-BTA) was calibrated with the help of 2 M $Na_2SO_3$ solution (DO = 0) and by oxygen saturation in air. The $NO_3^-$-N probe (Labquest NO3-BTA) and $NH_4^+$-N probe (Labquest NH4-BTA) were calibrated using the provided 1 mg/L and 100 mg/L standard solutions. The ORP probe (Labquest ORP-BTA) was calibrated using Hanna HI7021 standard ORP (240 mV) solution. During the online measurement, the probes were rinsed thoroughly with deionised water before and after each sample measurement to reduce cross contamination. Turbidity was measured by Eutech TN 100 turbidity meter.

### 3.2.4. Summary Sheet

During the sampling of borewells and openwells, a summary sheet was created that contained the feedback from people using the respective wells along with the online measured parameters (Fig. 3.9). The summary sheet contained general information like the location of the well (Latitude and Longitude data), well type, purpose of usage, qualitative assessment of the water quality by the users, waste and wastewater disposal in the locality, water level at the time of sampling and the measured online parameters.

**Sampling Point Identification Number:** OOW 5

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.846 | Type of Sample | Bore Well | | |
| | Longitude | : | 77.848 | | Open Well | ✓ | |
| Date of installation | 1980 | | Depth of Well | | 40 ft (80 ft initially) | | |
| Distance from Chemplast | 3 – 4 Km | | Quadrant as per MAP | | VIII | | |
| Name of the Owner | Ponnuswamy | | | | | | |
| Address | Veeranoor, konnur post, Mettur | | | | | | |
| No. of people living | Agricultural and drinking | | | | | | |
| Purpose of Water usage | Daily 4 hrs per day | | | | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 3-4 hrs per day (based on requirement) | | | | | | |
| User Rating for water | Very Good | | Good ✓ | | Poor | | Average |
| Type of Sewage disposal in the location | Nothing | | | | | | |
| Method of Solid waste disposal in the location | Open (collection→ door to door) | | | | | | |
| Parameters Measured at site and their value | pH | : | 7.49 | | Temp (°C) | : | 29.5 |
| | ORP (mV) | : | 154.5 | | Conductivity (µS/cm) | : | 1098 |
| | Turbidity (NTU) | : | 0.26 | | | | |
| | Ammonia (mg/l) | : | 0.3 | | Nitrate (mg/l) | : | 26.3 |
| Photographs Taken | Yes ✓ No | | | | | | |

**Remarks (if any):**

Water level: 5.2 m; pump: 5 Hp; Algal growth is seen.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 11:50 AM

**Figure 3.9.** A model summary sheet used for recording the user feedback and online parameters measured during the sampling.

### 3.2.5. Offline analysis of physicochemical parameters and biological parameters

The parameters analysed after transporting the samples to the laboratory were TSS, TDS, alkalinity, hardness, $Cl^-$, $SO_4^{2-}$, $PO_4^{3-}$, $F^-$, COD, TOC, TN, Total coliforms and heavy metals ($Ni^{2+}$, $Cd^{2+}$, $Pb^{2+}$, $Hg^{2+}$). The samples were analysed according to the procedures of American public health association (APHA) and US Environmental protection agency (US-EPA). The standard procedures for analysis of various parameters are shown in Table 3.4.

**Table 3.4.** List of parameters and their method of analysis with their acceptable and permissible limits

| Sl. No | Parameter | Code | IS-10500:2012 | |
|---|---|---|---|---|
| | | | Acceptable Limit | Permissible Limit |
| 1. | pH | APHA 4500- $H^+$ | 6.5-8.5 | NA |
| 2. | Electrical Conductivity (EC) | APHA 2510 B | NA | NA |
| 3. | Temperature | APHA 2550 | NA | NA |
| 4. | Alkalinity | APHA 2320 B | 200 mg/L | 600 |
| 5. | Hardness | APHA 2340 C | 200 mg/L | 600 |
| 6. | Dissolved oxygen (DO) | APHA 4500-O | 5 mg/L | 4 mg/L |
| 7. | Turbidity | APHA 2130 B | 1 NTU | 5 NTU |
| 8. | Chemical oxygen demand (COD) | APHA 5220 C | NA | NA |
| 9. | TOC | APHA 5310 | NA | NA |
| 10. | Total dissolved solids (TDS) | APHA 2540 C | 500 mg/L | 2000 mg/L |
| 11. | Sulphates | APHA 4500-$SO_4^{2-}$ E | 200 mg/L | 400 mg/L |
| 12. | Nitrates-N | APHA 4500-$NO_3^-$ | 10.2 mg/L | NA |
| 13. | Phosphates | APHA 4500-$PO_4^{3-}$ | 0.3 mg/L (US-EPA) | 3 mg/L (US-EPA) |
| 14. | Chlorides | APHA 4500-$Cl^-$ B | 250 mg/L | 1000 mg/L |
| 15. | Fluorides | APHA 4500-$F^-$ D | 1 mg/L | 1.5 mg/L |
| 16. | Ammonia-N | APHA 4500-$NH_4^+$ | 0.5 mg/L | NA |
| 17. | Total Coliforms (TC) | Part 9215 C | 0 | NA |
| 18. | Nickel | APHA 3120-B | 20 µg/L | NA |
| 19. | Cadmium | APHA 3120-B | 3 µg/L | NA |
| 20. | Lead | APHA 3120-B | 10 µg/L | NA |
| 21. | Mercury | APHA 3120-B | 1 µg/L | NA |

### 3.2.6. Spatial distribution of pollutants in the sampled area

The spatial distribution of pollutants in the sampled location was visualised using tools provided in an open-source graphic information system software QGIS (software information and ref). The sampling location data was saved as a comma separated value (csv) file and was loaded into a new QGIS project as a delimited text layer encoded with UTF-8. The longitude data was provided as x-axis and the latitude

was provided as y-axis data. EPSG:4326-WGS 84 was used as the coordinate reference system (CRS). The spatial distribution of pollutants is represented as a contour map. The contour is generated with IDW interpolation with the sampling location data as the vector layer and the pollutant concentration as the attribute. The interpolation generated was used as the input layer for the contour polygon. The contour polygon is generated from the interpolation by providing the intervals and the respective colour ramps. The QGIS project was then exported to a new print layout and the respective frames, legends and scales were provided in each figure.

### 3.2.7. Construction of new borewells in the SLF

The location of new borewells were selected based on the outcome of pre-monsoon water quality analysis data corresponding to SLF wells. Two borewells (DBW1 and DBW2) were installed upto a depth of 50 ft to monitor the ground water quality more effectively. DBW1 was installed in Plant-1 at the location 11.806474°,77,820291°. DBW2 was installed in Plant-3 at the location 11.8202°,77.846277°. The images of the borewells are provided in Fig. 3.10. During the process of borewell installation, soil samples were collected from the depths of 25 ft and 50 ft (S-PBW-25, S-PBW-50, respectively). The proximate analysis was carried out by measuring the C, H, N and S composition with the help of a Elementer Unicube CHNS analyser. For analysis of heavy metals ($Cd^{2+}$, $Pb^{2+}$, $Hg^{2+}$ and $Ni^{2+}$), 0.5 g of soil sample was digested in 10 mL of 10% $HNO_3$ for 2 hours and filtered. The filtrate was analysed for metals by ICP-OES as described by APHA 3120-B. The composition of metals in the soil was then compared with the Hazardous waste levels, Schedule II, HW Rules 2008 from Ministry of Environment, Forest and Climate Change, Govt. of India.


**Figure 3.10.** Geotagged photographs of the new borewells constructed in Plant 1 and Plant 3

# Chapter 4. Results and Discussion

The samples collected from the openwells, borewells and SLF piezometric wells were analysed for various physicochemical and biological parameters (pH, DO, Turbidity, TDS, EC, TOC, COD, $SO_4^{2-}$, $PO_4^{3-}$, $NO_3^-$, $NH_4^+$, $Cl^-$, $F^-$, hardness, alkalinity, $Pb^{2+}$, $Cd^{2+}$, $Hg^{2+}$, $Ni^{2+}$ and Total coliforms). The results of each parameter for post and pre-monsoon sampling from openwells, borewells and SLF wells were separately presented and discussed. The spatial distribution of pollutants is represented with the help of GIS in Annexure II.

## 4.1. Total Dissolved Solids and Electrical Conductivity

The total dissolved solids (TDS) is a measure of all components in an aqueous matrix that can pass through a filter paper of pore size less than 1 μm. Usually, it is the water without its particulate matter. It is composed of inorganic and organic compounds that are dissolved in water. Surface water and aquifers usually contain very high inorganic solids compared to that of organic solids, therefore, TDS is dominantly conferred by inorganic salts. Electrical conductivity (EC) is an indirect measure of TDS under such conditions. The inorganic salts are usually ionised in water which allows the water to conduct electricity. This conducting nature of water is measured through EC and has a direct relation to TDS. US-EPA and BIS standards recommend a TDS of 500 mg/L as an acceptable limit and BIS recommends a permissible limit of 2000 mg/L. A high TDS in water can lead to corrosion of pipelines and formation of scales in the water storage containers. Moreover, a high TDS can result in an osmotic imbalance within the cells of phytoplanktons and zooplanktons that grow in water. Even in the case of humans, high TDS in drinking water results in the decrease of aesthetic qualities of water and also can result in renal failure at extreme cases.

The electrical conductivity varies from 487 μS/cm to 2725 μS/cm for the borewells during the pre-monsoon sampling with corresponding TDS of 366 mg/L to 2576 mg/L, respectively. The dissolved solids content was highest in borewells S1-BW9 and S1-BW13 (2520 and 2750 μS/cm, with TDS 2576 mg/L and 2270 mg/L, respectively). The borewell **S1-BW9 is close to a Poultry farm** near Wotopalla on the Nangavalli-Mettur road. The borewell S1-BW13 is just 1.5 km near S1-BW9. Another borewell in the

vicinity, S1-BW12 also has a very high dissolved solids content (1838 µS/cm, 1356 mg/L). It can be hypothesised that **the source of high TDS can be located in between the wells S1-BW9 and S1-BW13**. The average value for EC in borewells was 1428 µS/cm with a corresponding TDS of 1323 mg/L. The locations of Khuduridi and P. N. Patti (1500 – 2200 µS/cm) had EC higher than the average and those at a distance of atleast 3 km had an EC lower than the average (around 1100-1400 µS/cm). The areas close to the M/s Chemplast Sanmar Plant-I had a conductivity of 1100-1400 µS/cm, whereas, the conductivity was lower (<800 µS/cm) towards the Cauvery River. The borewells close to the Mettur reservoir had a very low conductivity (<400 µS/cm) making it convincingly understandable that ***M/s Chemplast Sanmar Plant-I does not contribute to any significant ionic pollution to the surrounding places*.** The M/s Chemplast plants II, III and V are located at a distance of >2 km from P.N. Patti and Khuduridi. Therefore, the plants fall under the region where the conductivity is around 1100 to 1400 µS/cm. The M/s Chemplast Plant-IV is located at a distance within 2 km from this region, and has a higher EC 1500-1800 µS/cm (TDS of 1300-1500 mg/L).

During the post-monsoon sampling, there was a decrease in the EC of the borewells S2-BW 3,7,9 and 13. The EC of borewells S2-BW 5, 11, 12, 13 and 14 were high (> 1800 µS/cm, 1400 mg/L TDS). The conductivity of the wells S2-BW9 and S2-BW7 decreased significantly after the monsoon. Also, the EC of borewells 12, 13 and 14 were still high as seen during post-monsoon confirming the presence of an ionic pollutant source in this region (Fig. AII. 1b). Another important observation is this study is the steep increase in conductivity of S2-BW8 (3820 µS/cm, 3396 mg/L). ***The BW8 is located towards the Mettur Thermal Power Station 2*** and downstream to a heavily populated locality of Thangampuri pattinam near Chinnakavuur bus stop. The water quality in the wells close to M/s Chemplast Sanmar plants did not change significantly after the monsoon with respect to EC (Fig. AII. 1b). The average EC in the borewells after monsoon was 1431 µS/cm which was very similar to that during pre-monsoon sampling.

The EC in openwells in the pre-monsoon ranged from 961 µS/cm to 2350 µS/cm with an average of 1456 µS/cm. The EC was highest in S1-OW6 (2350 µS/cm). The well is located in a sparsely occupied area used mostly for agriculture. There are not many anthropogenic contributors except for agricultural activity. The locality around all the four plants of M/s Chemplast Sanmar had an EC in the range of 1400-1800

µS/cm (Fig. AII. 1a). The openwells had lower conductivity (<1100 µS/cm) downstream of the localities P.N. Patti and Khuduradi (Monitored by S1-OW7 and S1-OW9).

During the post-monsoon season, the conductivity of OW6 reduced to 1529 µS/cm. However, the conductivity of OW11 and OW 2 increased to 2018 µS/cm and 1810 µS/cm, respectively. OW11 is located close to a private farm land in a sparsely populated area. OW2 is located close to a well populated locality Sanatanapatti. Other than this locality, the land area around OW2 is used only for agricultural purposes. EC in the locality reduced gradually on moving towards the Cauvery River (Fig. AII. 1d).

The conductivity of the water in the piezometric wells inside the M/s Chemplast Sanmar plants ranged from 372 µS/cm to 1001 µS/cm during the pre-monsoon sampling. The average of EC in all piezometric samples inside the plant was 522 µS/cm which was very less compared to the borewells and openwells outside the plant. The EC in the plants II, III and IV were less than 450 µS/cm, whereas the EC was high around Plant I (>850 µS/cm). During post-monsoon sampling, the conductivity ranged from 451 µS/cm to 1450 µS/cm. The average conductivity was 692 µS/cm which was higher than that of pre-monsoon samples (Fig. AII. 1d). Therefore, the ionic content had increased in the borewells inside M/s Chemplast after the rainfall.

The IS-10500 (2012) standards for TDS specify an acceptable limit of 500 mg/L and a permissible limit of 2000 mg/L. Only 2 borewells out of 16 were in compliance for the acceptable limit and 14 borewells were in compliance for permissible limit during the pre-monsoon sample. Similarly, during the pre-monsoon sampling also, only 2 borewells out of 16 were in compliance for acceptable limits and 15 borewells were in compliance for permissible limits. In the openwell samples, no wells were within the acceptable limit, however all the openwells were within the permissible limits in the pre-monsoon and post-monsoon samplings. ***In the piezometric wells within M/s Chemplast Sanmar Plants (SLF wells), 16 out of 18 samples had a TDS within acceptable limits*** and all samples were within the permissible limits during the pre-monsoon sampling. 12 out of 21 wells had TDS within acceptable limits during the post monsoon sampling. All the wells had TDS within the permissible limits.

### 4.2. Alkalinity

Alkalinity is the capability of water to neutralise a $H^+$ ion. It is an important parameter as the level of alkalinity determines the corrosivity of water. An alkalinity of atleast 40 mg/L as $CaCO_3$ is required so that the water will not be corrosive. However, an alkalinity higher than 200 mg/L will impart a bitter taste to the water and clog the pipe lines due to formation of excess scaling. The IS-10500:2012 standard recommends a total alkalinity of 200 mg/L as $CaCO_3$ as the acceptable limit and 600 mg/L as $CaCO_3$ as the permissible limit for surface and drinking water.

The borewells sampled during the pre-monsoon season had alkalinity in the range of 130 mg/L to 425 mg/L with an average of 287 mg/L. The alkalinity was highest in the sample S1-BW6. BW6 is located 780 m from M/s Chemplast plant III and 1 km from M/s Chemplast Sanmar Plant II. It is located very close (~100 m) downstream of a densely populated Raman Nagar. 3 of the 16 borewell samples during the pre-monsoon were within the acceptable limits. The wells near M/s Chemplast Plant I were having alkalinity within the acceptable limits. The wells around M/s Chemplast Plant II, III and V had alkalinity exceeding the acceptable limits. Especially, in places like Veerakkalpudur, Gonur, Bharatinagar and Malapudur (Fig. AII. 4b).

In the openwell samples alkalinity ranged from 170 mg/L to 400 mg/L with an average of 314 mg/L during pre-monsoon sampling. Only 1 sample was within the acceptable limit and all samples were within the permissible limit for alkalinity. The openwells close to M/s Chemplast Sanmar Plant I, II and III all had alkalinity above the acceptable limits (Fig. AII. 4a). The places Thepeeti, Gonur, Veerakkalpudur and Sanathanapatti had alkalinity well above acceptable limits but within the permissible limits. The wells OW1, OW2, OW3, OW4 and OW6 formed a polluted cluster. The alkalinity is high in the borewells and openwells around Veerakkalpudur, Gonur and Bharatinagar.

The alkalinity in SLF wells ranged from 95 mg/L to 330 mg/L with an average of 184 mg/L as $CaCO_3$ during the pre-monsoon sampling**.** ***12 of the 18 wells had the alkalinity within the acceptable limit and all the 18 wells had the alkalinity within permissible limit***.

The borewells sampled during the post-monsoon season had alkalinity in the range of 160 mg/L to 540 mg/L with an average of 313 mg/L. The alkalinity was highest in the sample S1-BW10. BW10 is located 300 m from to the Nagavalli-Mecheri combined water treatment in Veerakkal. 2 of the 16 borewell

samples during the post-monsoon were within the acceptable limits. The alkalinity was exceeding the acceptable limits around the localities Khudiridi, Veerakkalpudur and P.N. Patti.

In the openwell samples alkalinity ranged from 270 mg/L to 400 mg/L with an average of 319 mg/L. No sample was within the acceptable limit and all samples were within the permissible limit for alkalinity. The alkalinity became higher towards the south of the sampling extent near BW12, BW8 and BW10 in the post-monsoon sampling close to Khuduridi.

The alkalinity in SLF piezometric wells ranged from 140 mg/L to 340 mg/L with an average of 191 mg/L as $CaCO_3$ during the post-monsoon sampling. ***12 of the 18 wells had the alkalinity within the acceptable limit and all the 18 wells had the alkalinity within permissible limit***. The wells in M/s Chemplast Sanmar Plant I had alkalinity above the acceptable limits (Fig. AII. 4f). There was an increase in alkalinity after the monsoon which must be due to the geology of the locality.

### 4.3. Hardness

Hardness represents the amount of calcium, magnesium and other multivalent cations in water. Hardness results in the formation of scales in the transport pipelines. Moreover, hardwater will lead to dryness and irritation of the skin. Hard water is also not good for daily activities like washing and cleaning. Hard water leaves deposits when it comes in contact with surfaces. Cleaning utensils with a hard water will leave a thin layer of scales on them which are aesthetically not desired. Moreover, hard water can decrease the effectiveness of detergents and can reduce lather formation. The IS-10500:2012 specifies a standard of 200 mg/L as $CaCO_3$ for an acceptable limit and 600 mg/L as $CaCO_3$ for a permissible limit.

During the pre-monsoon sampling the borewell hardness ranged from 110-640 mg/L as $CaCO_3$ with an average of 327 mg/L as $CaCO_3$. The hardness was highest in the sample collected from BW9 (S1-BW9 with 640 mg/L). The samples collected from borewells close to M/s Chemplast Sanmar plants I, II, III, IV and V had hardness in the range of 200 – 300 mg/L as $CaCO_3$. The hardness was high (>400 mg/L as $CaCO_3$) around the localities of Khuduriri, Kaptoruti and Malapudur (Fig. AII.3b). This is a sparsely populated area with agriculture and vegetation spread generously. Therefore, the introduced hardness might be due to the geology in this area.

The openwells during pre-monsoon sampling had hardness ranging from 290 mg/L as $CaCO_3$ to 500 mg/L as $CaCO_3$ with an average of 325 mg/L as $CaCO_3$. The openwells close to all the M/s Chemplast Sanmar plants had a hardness of 300 – 400 mg/L as $CaCO_3$. The sample from the well OW-6 (S1-OW6) had the highest hardness (500 mg/L). OW6 is also located in a sparsely populated vegetation dominated land area. The piezometric borewells inside The M/s Chemplast Sanmar plants had hardness in the range of 120-290 mg/L as $CaCO_3$ with an average of 190 mg/L as $CaCO_3$. ***The hardness was lower near M/s Chemplast Sanmar Plant 1 ranging from 100-200 mg/L and it was higher 200-300 mg/L near the Plants II, III and IV*** (Fig. AII. 3c). The hardness in the M/s Chemplast Sanmar SLF piezometric wells was very low compared to that of the openwells and borewells outside the industry.

During the post-monsoon sampling, hardness ranged of 160-1700 mg/L with an average of 567 mg/L as $CaCO_3$. The hardness was very high (1700 mg/L as $CaCO_3$) in the sample collected from BW8 (Fig. AII. 3e). Hardness was also very high in the sample S2-BW11 (920 mg/L as $CaCO_3$) and the surrounding borewells of the locations Walakurde, Chinnakoothanur, Palangottai, Perundhurai and Wottoppala. ***The hardness of the samples from borewells around M/s Chemplast Plants were very less compared to that of these localities***.

The hardness ranged from 300-800 mg/L as $CaCO_3$ with an average of 516 mg/L as $CaCO_3$ in the openwells sampled in the post-monsoon season. The hardness was highest in OW11 (800 mg/L as $CaCO_3$). The wells around the M/s Chemplast Sanmar plants had a hardness of 300-400 mg/L as $CaCO_3$. An isolated openwell near Theepampatti (OW4) had a hardness of 540 mg/L as $CaCO_3$ (Fig. AII. 3d). Overall, the hardness of openwells and borewells increased drastically post-monsoon. This might be an indication of a geological leaching of metals from the rocks. Isolated increase in hardness in OW2 and OW11 might hint at anthropogenic sources of hardness post-monsoon. The hardness was moderately high (500-600 mg/L) around the localities of Khudurudi, Kaptoruti and P.N. Patti.

The hardness in the post-monsoon samples of SLF piezometric wells ranged between 150-420 mg/L as $CaCO_3$ with an average of 252 mg/L as $CaCO_3$. The hardness of the wells in Plant I were higher than that of the other plants (Fig. AII. 3f). The post-monsoon samples from SLF piezometric wells had low hardness compared to the samples from the openwells and borewells collected from around the M/s Chemplast Sanmar plants.

## 4.4. Inorganic Ions

### 4.4.1. Chloride

The IS-10500:2012 standard recommends a Chloride of 250 mg/L (as Cl) as acceptable limit and 1000 mg/L (as Cl) as permissible limit for drinking water.

The borewells sampled during the pre-monsoon season had chlorides ranging from 64 mg/L (at S1-BW1) to 404 mg/L (at S1-BW13), with an average of 142 mg/L. It shall be noted that the borewell sample from BW-13 had a chloride content beyond the acceptable limit of 250 mg/L. BW-13 is also the only borewell sample that had a value exceeding the acceptable limit of 250 mg/L, and is almost equidistant (3.2 km) from M/s Chemplast plant I and M/s Chemplast Plant II. It is located within 1 km radius from a nearby MTPS Fly ash lake-2 maintained by Mettur Thermal Power station and has agricultural fields starting in a proximity of ~70 m. 15 of the 16 borewell samples during the pre-monsoon were within the acceptable limits and all samples were within permissible limit as per IS-10500:2012. It is also evident from the contour plot (Fig. AII.5) that the chloride levels showed a declining trend moving outwards BW-13, with the values approximately <250 mg/L at a distance more than 3 km from BW-13. Also, M/s Chemplast plant I, II, III and IV are in the contour levels ranging from 0 – 250 mg/L.

The borewells sampled during the post monsoon season had chlorides ranging from 78 mg/L (at S2-BW1) to 355 mg/L (at S2-BW13), with a comparatively slightly higher average of 160 mg/L. It is interesting to note that in the case of post monsoon sampling, the two borewell locations with the maximum and minimum chloride levels were observed in the corresponding same borewells, with S1-BW13 showing the highest chloride content (355 mg/L). BW-13 is also the only borewell sample that had a value exceeding the acceptable limit of 250 mg/L. Also, from the contour plot (Fig. AII.5e) there are two hotspots at BW-13 and BW-11. As mentioned before, BW13 is almost equidistant (3.2 km) from M/s Chemplast plant I and M/s Chemplast Sanmar Plant II and is located within 1 km radius from a nearby MTPS Fly ash lake-2 maintained by Mettur Thermal Power station. It has agricultural fields starting in a distance of ~70 m. BW-11 is located in a sparsely populated area, with the closest cultivation at a distance of 150-250 m and is ~4 km away from the nearby major industries in the study area. It is pertinent to note that M/s Chemplast plant I, II, and III had chloride levels ranging from 0 – 190 mg/L, except M/s

Chemplast plant IV with a chloride level falling in the next range 190- 230 mg/L (Fig. AII. 5e). 15 of the 16 borewell samples during the post-monsoon were within the acceptable limits and all samples were within permissible limit as per IS-10500:2012. The two hotspots (BW13 and BW11) and the wells around it (BW6, BW8, BW12 and BW14) had high chloride levels.

In the open well samples collected before monsoon, chlorides varied from 89 mg/L (at OW-11) to 284 mg/L (at OW-6) with an average of 178 mg/L. The highest value was obtained at OW-6, which exceeded the acceptable limit. OW-6 is located in an agricultural land nearby Bharathi Nagar, with extensive cultivation within a radius of 500 – 600 m. Also, two locations, OW-2 and OW-8 had chloride values almost equal to the acceptable limit. However, it is to be noted that all samples had a chloride level within the permissible limit of 1000 mg/L as per IS-10500:2012. OW-8 is very close to the industrial cluster in the S-E side of our study area, with a huge number of large scale and small-scale industries. There is a densely populated residential area in the nearby locality. From the contour (Fig. AII. 5a) plotted from the values observed in 11 open wells in the study area, ~ 70% of the study area had chloride values > 150 mg/L, with hotspots at OW-2, OW-6 and OW-8 as mentioned above. All the major industries lie in the contour of 150 - 190 mg/L. 10 of the 11 borewell samples during the pre-monsoon were within the acceptable limits and all samples were within permissible limit as per IS-10500:2012.

For the post monsoon sampling of openwells, chloride level ranged from 96 mg/L (at OW-11) to 277 mg/L (at OW-10), with the average (188 mg/L) slightly higher than the pre-monsoon sampling average. Unlike OW-11, OW-10 is farther from the industrial cluster, located in an agricultural land in an area with comparatively low population density. Similar to the pre-monsoon sampling, ~ 70% of the study area had chloride values > 150 mg/L. OW-7 is located at 300 m radius from the industrial cluster with the major industries and the small-scale industries at the S-E portion of our study area. Also, all the major industries lie in the contour of 150 - 190 mg/L. 8 of the 11 borewell samples during the pre-monsoon were within the acceptable limits and all samples were within permissible limit as per IS-10500:2012.

For the pre monsoon sampling of SLF piezometric wells in the M/s Chemplast Sanmar plants, chloride level ranged from 60 mg/L to 106 mg/L with the average (86 mg/L). The wells in Plant I and Plant II had chlorides in the range of 90-100 mg/L (Fig. AII. 5c). The wells in Plants III and V had chlorides in the range of 60-90 mg/L. The concentration of chlorides in the SLF piezometric wells were lesser than that

of samples from openwells and borewells. During the post monsoon sampling, there was a significant increase in the chloride concentrations in the SLF wells. The chloride levels ranged from 70 – 230 mg/L with an average of 112 mg/L. Although marginally within the acceptable limits, the wells in Plant III (S2-PBW10 and S2-PBW 9) were with a chloride concentration significantly higher than the other SLF wells (Fig. AII. 5e).

### 4.4.2. Sulphate

Sulphates are naturally occurring in the soil formed by the leaching of sulphur compounds from mineral rocks. Sulphates are usually not considered a major health hazard, however, at very high concentrations (> 500 mg/L) they will cause a laxative effect to infants. High sulfate concentrations will cause scaling on pipelines and can result in formation of taste and odour in water. Therefore, EPA limits sulphate concentration to 250 mg/L to improve the aesthetics of drinking water. The drinking water standard IS-10500:2012 recommends a sulphate of 200 mg/L (as $SO_4^{2-}$) as acceptable limit and 400 mg/L (as $SO_4^{2-}$) as permissible limit for drinking water.

The borewells sampled during the pre-monsoon season had sulphates ranging from 29 mg/L (at S1-BW15) to 770 mg/L (at S1-BW9), with an average of 142 mg/L. It shall be noted that, out of 16 samples, 7 samples (BW- 5, 8,9,11,12,13,14) had sulphates more than both acceptable and permissible limit, which indicates that the same are not recommended for drinking purpose, as far as the sulphate levels are concerned. BW-9 is located farther from the industrial cluster and closer to huge areas of farm lands, in a comparatively scarcely populated area. BW-5 is located in front of Rangagounder Thirumana Mandapam, which is surrounded by residential and commercial area at a distance of ~170 m, and is proximal to SH158-state highway, at the downstream end of Mettur dam, in the vicinity of the major industrial cluster of the area, which is in a densely populated area. It shall be noted that large agricultural fields are also located in near proximity (~25 m). BW-12 & 13 are located within 100 m to each other at the Southern end of the study area, located near to the huge stretch of Vanavasi Reserve Forest and Pakkanadu Reserve Forest, with farm lands nearby. BW-14 is located close to Nangavalli Metur Road SH223 in a mildly populated area with residential and significant stretches of agricultural fields nearby. It is also evident from the contour plot (Fig. AII. 6b) that the sulphates levels show a declining trend moving towards the industrial cluster,

with hotspots at the above mentioned borewell locations (BW- 5, 8,9,11,12,13,14). 7 of the 16 borewell samples during the pre-monsoon were exceeding the acceptable limits, while the same samples exceeded the permissible limit also as per IS-10500:2012

The borewells sampled during the post-monsoon season had sulphates ranging from 31 mg/L (at S2-BW3) to 1568 mg/L (at S2-BW13), with a slightly higher average (314 mg/L) than that from pre monsoon sampling. The well BW8 with high sulphate also had the highest TDS (3596 mg/L) compared to all the wells. It shall be noted out of 16 samples, 6 samples (BW- 5, 8, 11, 12, 13, 14) had sulphates more than both acceptable and permissible limits.

In the open well samples collected before monsoon, sulphates varied from 72 mg/L (at OW-9) to 573 mg/L (at OW-6) with an average of 203 mg/L. It is pertinent to note that the open well OW-6 that showed the highest level of sulphate, had the maximum level of chloride also (284 mg/L exceeding the acceptable limit of chlorides which is 250 mg/L). Also, four locations, OW-6, OW-8, OW-10 and OW-11 had sulphate values higher than the acceptable limit of 200 mg/L, with two (OW-6 and OW-11) out of the four locations exceeded the permissible limit as per IS-10500:2012. This implies that the groundwater sourced from these two locations- OW-6 and OW-11 are not recommended for drinking purpose (Fig. AII. 6a). OW-6 is located in an agricultural land nearby Bharathi Nagar, with extensive cultivation within a radius of 500 – 600 m. OW-8 is very close to the industrial cluster at the S-E side of our study area, with a huge number of large scale and small-scale industries. There is a densely populated residential area in the nearby locality. OW-10 is ~2 km away from the major industrial cluster and has large areas of agricultural land in proximity, with the nearest settlement on the S-E side (~200m). OW-11 is in a densely cultivated farmland at the eastern end of the study area, far from the industrial cluster in a sparsely populated area. From the contour (Fig. AII. 6a) plotted from the values observed in 11 open wells in the study area, the major industrial cluster lie in the contour of 50 - 150 mg/L, well within the acceptable limit. The open well with the highest level of sulphate, OW-6 was the hotspot as observed from the contour. 7 of the 11 open well samples during the pre-monsoon were within the acceptable limits and in the remaining four samples, two samples exceeded permissible limit as per IS-10500:2012.

For the post monsoon sampling in openwells, sulphate level ranged from 77 mg/L (at S2-OW-3) to 647 mg/L (at S2-OW-11), with the average (161 mg/L) lower than the pre-monsoon sampling average. OW-

11 had the highest level of sulphate content for both pre monsoon and post-monsoon periods. Also, OW-11 is the only open well that showed sulphate level beyond the permissible limit of 400 mg/L), with the remaining 10 open well falling within the acceptable limit of 200 mg/L. It shall be noted that sulphates at OW-11 during pre-monsoon had also exceeded permissible limit. It is an isolated polluted well. OW-11 is in a densely cultivated farmland at the eastern end of the study area, far from the industrial cluster in a sparsely populated area. From the contour plot (Fig. AII. 6d), it shall be noted that the major industries lie in the contour of 0 - 150 mg/L contour range, well within the acceptable limit. The open well with the highest level of sulphate, OW-11 was the hotspot as observed from the contour, with the values declining towards the industrial cluster. 10 of the 11 open well samples during the post monsoon were within the acceptable limits and one sample exceeded permissible limit as per IS-10500:2012.

During the pre-monsoon sampling in SLF piezometric wells, sulphate level ranged from 14 mg/L (at S1-PBW1) to 77 mg/L (at S1-PBW13), with the average of 28 mg/L. The sulphate concentration in SLF wells was way lower compared to that of open and borewells outside the M/s Chemplast Sanmar Plants. Among the M/s Chemplast Plants, Plant I had the highest sulphate concentration (50-150 mg/L) while the SLF wells in other plants had only a concentration of 0-50 mg/L (Fig. AII. 6c). All the pre-monsoon samples from SLF wells were complaint to the acceptable limit recommended by IS-10500:2012.

During the post-monsoon sampling in SLF piezometric wells, sulphate level ranged from 10 mg/L (at S2-DBW2) to 87 mg/L (at S2-PBW7), with the average of 26 mg/L which was slightly lower than that of pre-monsoon sampling. The highest sulphate concentration among the SLF wells was found in the newly drilled borewell (DBW2) close to M/s Chemplast Plant 3 (Fig. AII. 6f).

### 4.4.3. Nitrate

Nitrates ($NO_3^-$) are inorganic ions found in the nature and also due to anthropogenic sources. They are usually formed in soil and subsoil surfaces due to the activity of nitrifying bacteria (Rhizobia) especially in the vicinity of leguminous plants. Anthropogenic activities like combustion of biomass, illegal and uncontrolled discharge of sewage into land or water, use of fertilisers and irregular crop rotation can cause nitrate contamination of soil, surface and ground water. High nitrate concentration in water can cause diseases like methemoglobinemia, anaemia, increased heart rate, abdominal cramps, nausea, etc. Therefore, it is necessary to monitor nitrates in drinking water sources. The IS10500:2012 standards specify an acceptable limit of 45 mg/L $NO_3^-$ (10.2 mg/L as $NO_3^-N$) without any relaxation.

The borewell samples collected during the pre-monsoon season contained $NO_3^-N$ in the range of 2.8 (S1-BW5) mg/L to 26.9 (S1-BW7) mg/L with an average of 12.5 mg/L (as $NO_3^-N$). ***From the contour diagram (Fig. AII. 7), it was observed that around 50% of the area monitored for nitrates were extensively polluted with $NO_3^-$-N above 10 mg/L.*** The wells BW7 and BW6 indicated that the localities of P.N. Patti and Veerakkalpudur were highly polluted with nitrates. The localities of Gonur, Thepeeti, Bharati Nagar and Venunoor also had considerable nitrate pollution. The localities are very densely populated. Agriculture in this area must be minor due to the presence of densely packed residential buildings. ***Therefore, the possibility of seepage of untreated municipal water should not be overlooked***. Moreover, this locality encompasses major industries like M/s MALCO Energy Ltd. and Chemplast Sanmar Plants II and IV. The cluster is flanked by M/s MALCO Thermal Power Station, M/s Chemplast Sanmar Plant I, Cabot Sanmar Plant V and M/s Chemplast Sanmar Plant III. ***Only 6 wells out of 16 were within the acceptable limit of $NO_3^-$-N pollution according to IS-10500:2012.***

The borewell samples collected during the post-monsoon season contained $NO_3^-$-N in the range of 0.6 (S2-BW5) mg/L to 16 (S2-BW10) mg/L at an average of 6.9 mg/L. The concentration of $NO_3^-$-N decreased drastically after the monsoon. This must be due to the dilution or washout of nitrogen from the aquifer during the monsoon. The pollution level of $NO_3^-$-N was alleviated to a great extent that 10 samples out of 16 were within the acceptable limit specified according to IS-10500:2012. The localities of P. N. Patti and Kaptoruti (BW6 and BW7) were polluted similar to that of pre-monsoon sampling, but with a reduced $NO_3^-$-N concentration of 8-12 mg/L (Fig. AII. 7d). Surprisingly, there was an increase in the

nitrate concentration of BW10 and BW9 after the monsoon (Fig. AII. 7e). The locality is a sparsely populated land area covered majorly by vegetation. The wells BW7, BW6 and BW15 around the industrial localities of M/s MALCO Thermal power station, M/s MALCO Energy ltd. and M/s Chemplast Sanmar Plant IV also had $NO_3^-$ concentration exceeding the limits.

The concentration of $NO_3^-$-N during the pre-monsoon sampling in openwells ranged from 7.3 mg/L (S1-OW2) to 30.1 mg/L (OW11) with an average of 19.2 mg/L. The average value shows that almost all of the areas are exceeding the acceptable range for $NO_3^-$-N. The wells OW2 and OW6 in the N-E region of sampling area had high $NO_3^-$N concentration. Contribution to the pollution by well OW5 led to the plume extending all the way to N-W upto OW-4. This whole area is a moderately populated arable land with moderate to low vegetation (Fig. AII. 7a). The $NO_3^-$-N concentration in this region was very high (20-27 mg/L), therefore it formed a secondary pollution of 16-20 mg/L $NO_3^-$-N which encompassed The M/s Chemplast II, III, IV plants, M/s MALCO Thermal Power Station and M/s MALCO Energy Ltd. industries. Openwell in the vicinity of M/s Chemplast Plant I also had very high $NO_3^-$-N concentration (27 mg/L). Only 4 wells out of 11 were within the acceptable limit for $NO_3^-$-N according to IS-10500:2012.

Similar to borewells, the openwells also had reduced $NO_3^-$-N pollution after the monsoon. The openwell samples collected during the post-monsoon season contained $NO_3^-$N in the range of 2.6 (S2-OW10) mg/L to 20.3 (S2-OW2) mg/L with an average of 9 mg/L. The contour maps represent a trend of alleviation of the pollution of pre-monsoon sampling due to the monsoon. Although the polluted wells OW1, OW2, OW4 and OW5 had higher $NO_3^-$-N concentration similar to that of pre-monsoon sampling, their concentrations were less (12-16 mg/L) compared to that of pre-monsoon (26-30 mg/L). Moreover, the localities of the M/s Chemplast Sanmar and M/s MALCO industries within the study area had a $NO_3^-$N concentration of only 3-8 mg/L (Fig. AII. 7d). 7 wells out of 11 were in compliance with the acceptable limits of IS-10500:2012.

The SLF piezometric well samples collected during the pre-monsoon season contained $NO_3^-$N in the range of 3.1 (S1-PBW17) mg/L to 24.5 (S1-PBW2) mg/L with an average of 7.3 mg/L (as $NO_3^-$N). All the wells in M/s Chemplast Sanmar Plant I (PBW1, PBW2) had very high $NO_3^-$N concentrations (20-25 mg/L) (Fig. AII. 7c). In the other plants, except for S1-PBW10, all other wells were within the acceptable limit

for $NO_3^-$N pollution. ***A total of 15 out of 18 wells were in compliance with the acceptable limits according to IS-10500:2012.***

The $NO_3^-$N concentration in the post-monsoon SLF well samples varied from 0.2 (S2-PBW4) -13 mg/L (S2-PBW1) with an average of 2.8 mg/L. The $NO_3^-$N concentration decreased generously after the monsoon. The $NO_3^-$N concentration was very high in the SLF wells of M/s Chemplast Sanmar Plant I. Both the wells (PBW1, PBW2) alongside the newly constructed borewell (DBW1) had $NO_3^-$N concentrations above 10 mg/L (Fig. AII. 7f). ***Except these three wells, other 18 wells were in compliance to the acceptable limits of IS-10500:2012 standards.***

### 4.4.4. Ammonium

Ammonium nitrogen ($NH_4^+$-N) is the most reduced form of nitrogen in the ecosystem. It is usually formed during dissimilatory mechanism of organisms. The organic nitrogen is reduced during the process releasing $NH_4^+$-N into the ecosystem. The presence of $NH_4^+$-N brings forth various problems in the habitat. $NH_4^+$-N is a nutrient source for planktons and microalgae, therefore, the increase in $NH_4^+$-N in any aquifer would result in eutrophication and depletion of dissolved oxygen. The accepted limit for $NH_4^+$-N in drinking water samples is 0.5 mg/L as per IS-10500:2012. There is no relaxed permissible limit for $NH_4^+$-N.

The borewell samples collected during the pre-monsoon season contained $NH_4^+$-N in the range of 0.3 (S1-BW7) mg/L to 2.3 (S1-BW10) mg/L with an average of 1.06 mg/L. The M/s Chemplast Sanmar Plants II, III, IV and V are located in the region with a marginally higher $NH_4^+$-N concentration (0.5-0.8 mg/L) than that of the acceptable limit of IS-10500:2012. The industries like M/s Chemplast Sanmar Plant I, M/s MALCO Energy Ltd. and M/s MALCO Thermal Power Station are located within the region of acceptable $NH_4^+$-N limit. A cluster of wells around BW10 comprising the borewells BW12, BW9, BW11 and BW10 had $NH_4^+$-N exceeding the limits (Fig. AII. 8b). This comprises the localities of Khudiridi and Malapudur. BW9 and BW10 are located in sparsely populated vegetative area. BW9 is closely located to a Poultry farm. These are some of the probable contributors to the high $NH_4^+$-N content of the borewell. BW12 is located in a sparsely populated location with lots of vegetation. BW11 is located on a moderately populated arable land with little or no vegetation. The localities of Kaptoruti and Sanathanapatti monitored

by BW 14 and BW 5, respectively, had $NH_4^+$-N in the range of 1.3-1.5 mg/L (Fig. AII. 8b). 4 wells out of 16 had $NH_4^+$-N concentrations within the acceptable limit according to IS-10500:2012.

The borewell samples collected during the post-monsoon season contained $NH_4^+$-N in the range of 0.2 (S2-BW4) mg/L to 5.9 (S2-BW10) mg/L with an average of 0.92mg/L. The average $NH_4^+$-N concentration has decreased compared to that of pre-monsoon sampling. It is also noted that BW10 was the only well where the $NH_4^+$-N concentration has drastically increased. It is located close to a region of very high vegetative cover. Therefore, agricultural runoff after rainfall might have been a reason for this increase in $NH_4^+$-N. In the other regions, the $NH_4^+$-N concentration has decreased significantly. Even the polluted borewells BW12, BW11, BW 10 and BW9 had lower $NH_4^+$-N concentrations that that of pre-monsoon sampling (Fig. AII. 8d). Other regions, including the localities that comprise of M/s Chemplast Sanmar and M/s MALCO industries have $NH_4^+$-N within the acceptable limits as per IS-10500:2012. ***9 wells out of 16 had $NH_4^+$-N concentrations within the acceptable limit according to IS-10500:2012.***

The openwell samples collected during the pre-monsoon season contained $NH_4^+$-N in the range of 0.3 (S1-OW4) mg/L to 1.2 mg/L (S1-OW11) with an average of 0.6mg/L. The wells OW11, OW1 and OW3 had high $NH_4^+$-N above the acceptable limit according to IS-10500:2012 (Fig. AII. 8a). The M/s Chemplast Sanmar Plants II, III and IV are located in the 0.5-0.8 mg/L contour. The other industries (M/s MALCO Energy Ltd., M/s MALCO Thermal Power Station and M/s Chemplast Sanmar Plants I) are in the contour region with 0.3-0.5 mg/L $NH_4^+$-N. A total of 8 openwells out of 11 had $NH_4^+$-N within the acceptable limits as per IS-10500:2012.

During the post-monsoon season, the $NH_4^+$-N ranged from 0.2 mg/L (S2-OW4) to 1.1 mg/L (S2-OW11) with an average of 0.45 mg/L. The average $NH_4^+$-N value decreased during the post-monsoon season. Moreover, OW11 persisted to be the openwell with the highest $NH_4^+$-N concentration (4.23b). The localities of M/s Chemplast Sanmar Plants and M/s MALCO Industries had $NH_4^+$-N within acceptable limit according to IS-10500:2012. A total of 9 out of 11 openwells had their $NH_4^+$-N concentration within the acceptable limit according to IS10500:2012.

The pre-monsoon samples from SLF wells had $NH_4^+$-N ranging from 0.2 mg/L to 0.5 mg/L with an average of 0.3 mg/L. It was observed that all the wells were within the acceptable limit for $NH_4^+$-N according to IS-10500:2012. During the post-monsoon sampling, the newly drilled borewells both had

$NH_4^+$-N slightly above the acceptable limit. However, 18 wells of the sampled 21 had $NH_4^+$-N lower than the acceptable limit as per IS10500:2012. ***The wells in Plant I (PBW 1) and the newly drilled borewells (DBW 1 and 2) had the higher $NH_4^+$-N during the post-monsoon sampling*** *(Fig.* AII. 8b*).*

The $NH_4^+$-N concentration in SLF wells were much lower than that of borewells and openwells. Moreover, openwells had a lower $NH_4^+$-N than borewells.

### 4.4.5. Phosphates

Phosphates ($PO_4^{3-}$) are a common constituent in commercial fertilisers, sewage, organic manure and industrial effluent. They are highly water soluble and therefore find their way into surface water and aquifers due to seepage and diffusion. The presence of $PO_4^{3-}$ in water is undesirable as it might cause algal blooms in surface water. The intensity and speed of algal bloom formation depends on the concentration of $PO_4^{3-}$. Algal blooms can form when the $PO_4^{3-}$ is as low as 0.3 mg/L. Although IS-10500 doesn't specify a standard for $PO_4^{3-}$, EPA specifies an acceptable limit of 0.3 mg/L and a permissible limit of 3 mg/L $PO_4^{3-}$ ions in water.

The borewells sampled during the pre-monsoon season had $PO_4^{3-}$ in the range of 0.9 (S1-BW4) -2.2 mg/L (S1-BW10) at an average of 1.34 mg/L. Almost 80% of the region covered by the borewells fall under 1-1.5 mg/L of $PO_4^{3-}$ in the contour plot. BW10 was an isolated polluted borewell. BW8 and BW13 form a polluted borewell cluster had $PO_4^{3-}$ concentration ranging from 1.5-2 mg/L (Fig. AII. 9b). All the wells had $PO_4^{3-}$ concentration exceeding the acceptable limit and were within the permissible limit as per US-EPA standards. All the industries including M/s MALCO Energy Ltd., M/s MALCO Thermal Power Station, M/s Chemplast Sanmar Plants I, II, III, IV and V were in the region with $PO_4^{3-}$ concentrations between 1-1.5 mg/L. None of the borewell samples was in compliance to the acceptable limits and all of the borewell samples were in compliance to the permissible limits as per US-EPA standards. The borewells sampled during the post-monsoon season had $PO_4^{3-}$ in the range of 1.5 (S2-BW16) - 3.2 mg/L (S2-BW10) at an average of 2.1 mg/L. There was a significant increase in $PO_4^{3-}$ concentration after the monsoon. The borewells BW2 (Gonur), BW4 (Venunoor) and BW10 (Khuduridi) form isolated polluted borewells with concentrations ranging from 2.5-3.5 mg/L (Fig. AII. 9d). BW2 is located upstream to a densely populated locality in Gonur. BW4 is located in a sparsely populated locality with agricultural lands near Venunoor

and BW10 is located in a sparsely populated locality near Khuduridi close to a vegetative area. The concentration of $PO_4^{3-}$ is around 2-2.5 mg/L in 80% of the area which was 1-1.5 mg/L during the pre-monsoon season. Except for one borewell sample (S1-BW10), other samples were within the permissible limit according to the drinking water standards by US-EPA.

The openwells sampled during the pre-monsoon season had $PO_4^{3-}$ in the range of 1.2 (S1-OW2) - 4 mg/L (S1-OW11) at an average of 1.9 mg/L. According to the contour extrapolation, the localities of Khuduridi, Kaptoruti and Malapudur were in the region of $PO_4^{3-}$ >2 mg/L. The wells S1-OW3 and S1-OW5 with $PO_4^{3-}$ concentration in the range of 2-2.5 mg/L (Fig. AII. 9a) was observed comprising the localities of Veerakkalpudur, Thepeeti and Venunoor. This locality also encompasses the M/s Chemplast Sanmar Plants II, III, IV and the M/s MALCO Thermal Power Station. 10 out of 11 openwell samples were in compliance for the permissible limit according to US-EPA standards. None of the wells were in compliance for the acceptable limit.

The openwells sampled during the post-monsoon season had $PO_4^{3-}$ in the range of 1.9 (S1-OW1) - 3 mg/L (S1-OW2) at an average of 2.3 mg/L. The $PO_4^{3-}$ concentration in the openwells increased after the monsoon. Three openwells S2-OW7, S2-OW3 and S2-OW2 were the most polluted with concentrations between 2.5-3 mg/L $PO_4^{3-}$. OW2 is located in a sparsely populated locality in Sanathanapatti. OW3 is located in a sparsely populated vegetative area near Thepeeti and OW10 is located in a farmland surrounded by vegetation near Kaptoruti. The industries M/s Chemplast Sanmar Plants I and IV, M/s MALCO Energy, and M/s MALCO Thermal Power Station were located in the contours of 2-2.5 mg/L (Fig. AII. 9d). The M/s Chemplast Sanmar Plants II and III were located in the contour regions of 2.5-3 mg/L. ***None of the openwell samples were in compliance for the acceptable limit of US-EPA and all of them were in compliance for the permissible limits of US-EPA standards.***

The SLF wells sampled during the pre-monsoon season had $PO_4^{3-}$ in the range of 1.13 (PBW7) – 2.31 mg/L (PBW1) at an average of 1.65 mg/L. The $PO_4^{3-}$ concentration was around 2-2.5 mg/L in the Champlast Plant 1 and was around 1-2 mg/L in the M/s Chemplast Plants III and IV. M/s Chemplast Plant II had a $PO_4^{3-}$ concentration around 1-1.5 mg/L (Fig. AII. 9c). Almost all the wells were not in compliance to US-EPA acceptable standards for drinking water. However, all the wells were in compliance to the permissible limit. The SLF wells sampled during the post-monsoon season had $PO_4^{3-}$ in the range of 1.6

(S1-PBW3) -5.36 mg/L (S1-DBW2) with an average of 2.35 mg/L. The $PO_4^{3-}$ concentration had increased significantly after the monsoon. The Plants I and IV were located in the 2-2.5 mg/L contour and the Plants II and III were located in the 3-4 mg/L contours (Fig. AII. 9f). The highest $PO_4^{3-}$ concentration was found in DBW2. ***19 of the 21 SLF samples were within the permissible limits of US-EPA.***

### 4.4.6. Fluoride

The presence of fluoride in surface water and aquifers is primarily due to the leaching from soil, plants and anthropogenic reasons like degradation of polyfluorinated compounds. Excess fluoride in drinking water can cause dental fluorosis, skeletal fluorosis, arthritis, osteoporosis, fatigue and muscular damage. At low concentrations, fluorides can strengthen the enamel and prevents cavities. However, at concentrations higher than 4 mg/L, they are hazardous.

The IS-10500:2012 specifies a standard of 1 mg/L fluorides as acceptable limit and 1.5 mg/L fluorides as permissible limits. The pre-monsoon samples of the borewells had fluoride concentration in the range of 0.09-0.2 mg/L with an average of 0.14 mg/L. Therefore, the fluoride concentration in borewells were well within the acceptable standards according to IS-10500:2012. Although all the wells had fluoride content comfortably within the acceptable limits, some wells had a fluoride content significantly higher compared to other wells. The concentration of fluorides was in the range of 0.17-0.2 mg/L in the region around Khuduridi, P.N. Patti, Veerakkalpudur and Kaptoruti (Fig. AII. 10b). In other localities, the fluoride concentration was less than 0.1 mg/L. In post-monsoon samples, the fluoride concentration ranged from 0.04 mg/L to 0.21 mg/L with an average concentration of 0.13 mg/L which was very similar to that of pre-monsoon samples. After the monsoon, the contour with fluoride concentration > 0.2 mg/L moved towards Malapudur (Fig. AII. 10d).

The fluoride concentration in openwell samples ranged from 0.1 mg/L to 0.22 mg/L before monsoon with an average of 0.15 mg/L. The concentration of fluoride was above 0.17 mg/L in the localities around M/s Chemplast Sanmar and M/s MALCO industries (Fig. AII. 10a). In the other regions, fluoride concentration was less than 0.13 mg/L. The fluoride concentration during the post-monsoon season in openwells ranged from 0.09 mg/L to 0.2 mg/L with an average of 0.14 mg/L. The average concentration was similar to that of pre-monsoon samples.

The fluoride concentration in the M/s Chemplast SLF wells ranged from 0.05 mg/L to 0.13 mg/L with an average of 0.08 mg/L. The concentration of fluoride was around 0.09-0.13 mg/L in Plant I and it was less than 0.07 mg/L in Plant II, III and IV (Fig. AII. 10). The fluoride concentrations were very similar between post and pre-monsoon samples and there was no significant change.

### 4.4.7. Metals

Mercury, Nickel, Cadmium and lead were the toxic heavy metals analysed during this study. Almost all heavy metals are a constituent of mineral rocks and can be found in water through natural processes. However, anthropogenic sources also exist and majority of surface water pollution is through anthropogenic sources.

Mercury can be released into the soil and gradually into surface water and aquifers through burning of wood containing mercury, illegal disposal and burning of industrial wastes, especially that of Portland cement, improper dumping and disposal of electronic wastes, and so on. The presence of mercury in drinking water can lead to a myriad of health effects like mood swings, insomnia, muscle weakness, muscle atrophy, irregular sensations, etc. Higher exposure can cause kidney failure, respiratory failure and death.

Nickel is naturally found in the environment at very low concentrations (~0.1-1 μg/L). However, exposure to higher concentrations of nickel (> 30 μg/L) will lead to itching and rashes on fingers, respiratory illness, decreased lung function, asthma and bronchitis. Prolonged exposure can cause nasal and lung cancers.

Lead is found as Lead sulfide in geological formations worldwide and can enter surface water through leaching from soil and rocks. Anthropogenic routes include improper disposal of electronic waste, corrosive leaching of lead from metallic water pipes, industrial dumping, etc. Exposure to lead can cause learning problems, hyperactivity, hearing problems and anaemia in children. In adults, exposure of lead can cause increased hypertension, increase in blood pressure, decreased kidney functionality and reproductive abnormalities. EPA has recommended that the drinking water should not contain any trace of lead as it has high accumulating capability in the bones of infants and children. However, it is safe to bath in water containing trace amounts of lead as skin is impervious to lead.

Cadmium is a natural mineral found in leafy vegetable and rock deposits with copper, lead and zinc ores. They are used in batteries for energy storage. The most ubiquitous distribution of cadmium in batteries and their improper disposal can introduce cadmium in surface water and soil. It is classified as a probable carcinogen and can affect kidney and bone on exposure.

IS-10500:2012 recommends an acceptable limit of 1 µg/L for mercury, 20 µg/L for nickel, 3 µg/L for cadmium and 10 µg/L for lead.

***The surveyed localities did not contain any quantifiable amount of cadmium in any of the wells***. Moreover, before monsoon, the sampled wells did not contain any quantifiable amounts of nickel, mercury or cadmium. Only trace amounts of lead (< 2 µg/L) were found in SLF wells inside the M/s Chemplast Sanmar Industries. PBW7 in M/s Chemplast Plant 2 had 2 µg/L of lead and PBW12 inside M/s Chemplast Plant III had 1 µg/L lead. The concentration of lead was well within the acceptable limit as per IS-10500:2012.

However, ***during the post-monsoon sampling, the presence of lead and nickel was widely observed in almost all types of wells, however, it was within the acceptable limits in almost all the cases***. Cadmium and mercury were below detectable limit (<1 µg/L) in all the wells of post-monsoon sampling.

Lead was absent in openwells during the post-monsoon sampling. BW2 (4 µg/L) and BW11 (6 µg/L) contained lead at concentrations within the acceptable limit (Fig. AII. 16d). BW2 is present in the locality of Gonur and Bharatinagar. BW11, in the locality of Malapudur is an isolated borewell and it should be noted that it had high hardness and sulphate concentration during the post-monsoon season. It is located 226 m from SSR Pipes, a pipe manufacturing company.

***Several SLF wells (PBW6, PBW7, PBW12 and PBW13) had lead concentrations above the acceptable limit of 10 µg/L (Fig. 4.32)*** The extent of metal pollution in the soil was checked by taking cored sampled at 25 and 50 ft during the drilling process. It was seen that the soil contained 5.2 mg/kg lead at a depth of 25 ft and 16.6 mg/kg lead at a depth of 50 ft (Table 4.2). PBW1, PBW2, PBW8, PBW10, DBW2 and PBW18 had lead at concentrations below acceptable limit. The lead concentrations were higher in Plant II and Plant III compared to Plant I.

Nickel was widely distributed in the borewells (Fig. AII. 16b). The concentration was exceeding acceptable limit marginally in BW12 (26 µg/L), located close to Khuduridi, below the Vanavasi reserved

forest which is a hill of 800 m elevation. There is no industrial presence around this well and it is located amidst a sparsely populated vegetative land area. Acceptable amount of nickel (1-2 µg/L) was present in the areas flanking the Industrial cluster of M/s Chemplast Sanmar and M/s MALCO industries towards the S-W and S-E directions.

Nickel was also widely present in openwells during post-monsoon sampling. OW11 had the highest nickel concentration (12 µ/L) which is within the acceptable limits according to IS-10500:2012. OW11 is located in Malapudur very close to BW11 which had traces of lead, although within acceptable limits. OW11 is present in a locality with thick vegetation. There is no relatable industrial pollution around this locality that can contribute to Nickel presence. Similar to the borewells, openwells in the localities flanking the M/s Chemplast Sanmar and M/s MALCO cluster had acceptable amounts of nickel (1-2 µg/L) towards the S-E direction (Fig. AII. 16a). Nickel was present widely in SLF wells within the M/s Chemplast Sanmar Plant. All the borewells in Plant I had the presence of Nickel in them (Fig. AII. 16b). Although it was within the acceptable limit in PBW1 (6 µg/L), ***it was marginally close to the acceptable limit in PBW2 (22 µg/L) and DBW1 (19 µg/L).***

The Nickel composition of the soil was 25.8 mg/kg at 25 ft and 30.6 mg/kg at 50 ft. However, the water sampled from DBW1 after 20 days had a Nickel concentration of only 2 µg/L showing that the high Nickel content found in S2-DBW1 was due to leaching from the soil during the construction of borewell. The wells in Plant II did not have detectable concentration of Nickel except PBW6 which had 1 µg/L, which is well within the acceptable limit. ***Plant III however, had a prominent distribution of Nickel with the highest concentrations in PBW11 (19 µg/L) which was close to the acceptable limit.***

## 4.5. Organic contaminants

### 4.5.1. COD

The Chemical oxygen demand (COD) is the amount of oxygen required to chemically oxidise all the organic content present in water. There is no particular standard for COD in drinking water, however, effluent discharge standards of TNPCB specifies a COD limit of 50 mg/L to metropolitans and 100 mg/L to class I cities. Drinking waters are not expected to contain much COD and there is a BOD (biochemical oxygen demand) limit of 3 mg/L for drinking water. A COD of <25 mg/L in wells can be considered acceptable and a COD of <10 mg/L can be considered drinkable water quality (5). The wells with a COD of 50 and above are considered to be polluted wells and require treatment with activated carbon filters before using it for drinking (6).

The COD of the borewells in pre-monsoon sampling ranges from 6 mg/L (OBW 11,12,16) to 163 mg/L with an average of 43 mg/L. The COD was highest (163 mg/L) in BW8. The borewell is located downstream to P.N. Patti and is surrounded by densely packed localities with moderate vegetation. It is located very close (160 m) from the Cauvery River on SH-158 and is located 1.2-1.4 km to the north of Mettur Thermal Power Station 1 and 2. It is also located 1.6 km from M/s Chemplast Plant I. The contour diagram of COD during the pre-monsoon sampling shows that BW8 was an isolated polluted borewell with a very high COD. The surrounding borewells (BW12, BW13, BW15 and BW16) all had COD in the range of 10-40 mg/L (Fig. AII. 11b). However, the wells BW7 and BW8 had a COD of 60-70 mg/L. The wells BW2 and BW1 also had a COD of 70-80 mg/L in the locality of Bharati Nagar and Gonur. This is a moderately populated area with moderate vegetation. Industrial zones surrounding M/s Chemplast Sanmar Plants II, III, IV and V had a COD of 60-70 mg/L. ***Almost 50% of the surveyed region of borewells were predicted to have a COD of 60-70 mg/L***. 6 borewells were within a COD of 25 mg/L and 11 borewells were within a COD of 50 mg/L.

The COD of the borewells in post-monsoon samples ranges from 19 mg/L (S2-BW4) to 137 mg/L (S2-BW8) with an average of 44 mg/L. The average post-monsoon COD in the borewells was similar to that of the average during pre-monsoon sampling. BW8 had the highest COD similar to the pre-monsoon sampling. The nearby borewells had COD in the range of 30-40 mg/L. The COD of BW8 was slightly

lesser that that during the pre-monsoon season. The Industrial zone containing M/s Chemplast Sanmar Plants II, III, IV and V was in the zone of 70-80 mg/L COD (Fig. AII. 11e). Another observation was that the COD increased in borewells BW14 and BW11. Only 2 borewells had a COD less than 25 mg/L and 11 borewells had a COD less than 50 mg/L during the post-monsoon sampling.

The COD of the openwells in pre-monsoon sampling ranged from 16 (S1-OW4) -51 mg/L (S1- OW8) with an average of 29 mg/L. S1-OW8 is located 400 m from M/s Chemplast Sanmar Plant 1. It is also located to the South West location around 1.5 km from BW8 which was the most polluted borewell. OW8 is located in a densely populated locality with low to moderate green cover. Other than this, almost 50% of the openwells surveyed in this area had a COD around 20-30 mg/L and 40% wells had a COD around 30-40 mg/L. ***The openwells were comparably less polluted than borewells with respect to COD*** (Fig. AII. 11). Only 1 openwell was within the COD limit of 25 mg/L and 10 openwells had a COD within 50 mg/L.

The COD of the openwells in post-monsoon sampling ranges from 32 (S1-OW1, S1-OW9, S1-OW10) - 80 mg/L (S1- OW8) with an average of 45 mg/L. The average COD during the post-monsoon season increased drastically in the openwells compared to that of pre-monsoon season. Similar to pre-monsoon sampling, OW8 had the highest COD in post-monsoon sampling too. The wells OW8, OW4 and OW3 surrounding the industries M/s Chemplast Sanmar Plant I, M/s MALCO Energy ltd., M/s MALCO Thermal Power Station had high COD. No well had a COD within 25 mg/L and 8 wells had a COD within 50 mg/L.

***The piezometric borewells in the M/s Chemplast SLFs have lesser COD compared to that of borewells and openwells outside the plants.*** The COD values ranged from 13 (S1-PBW13) to 90 mg/L (S1-PBW15) with an average of 33 mg/L. The wells in M/s Chemplast Sanmar Plant I had a COD of 40-50 mg/L. The wells of Plants II and IV had a COD of less than 40 mg/L. The wells in Plant III had a higher COD (70-90 mg/L) compared to the wells of other plants (Fig. AII. 11c).

The COD of the SLF wells in post-monsoon samples ranges from 13 mg/L (S2-DBW2) to 48 mg/L (S2-PBW 18. S2- PBW 19) with an average of 33 mg/L. The average COD in the borewells in M/s Chemplast Sanmar Plants did not increase after the monsoon (Fig. AII. 11f). 6 wells had COD less than 25 mg/L and all the 21 wells had COD less than 50 mg/L.

***The average COD remained same in the borewells after monsoon, however it increased significantly in the openwells. This could mean that the agricultural runoffs and seepage of domestic sewage might be of concern in the surveyed region.***

### 4.5.2. TOC

The total organic carbon (TOC) is a measure of organic content in water similar to that of COD. However, TOC is a more accurate analysis than COD when the concentration of organics is very less as in surface water. The organic contents can be constituted by natural organic materials, emerging contaminants, agricultural dissolved organics like urea, disinfection biproducts, etc. There is no particular standard for TOC, however, a TOC of more than 2 mg/L in ground water would mean that there is some kind of seepage of anthropogenic carbon in it as TOC has direct correlation with biochemical oxygen demand (BOD) (7,8). Moreover, a TOC of greater than 10 mg/L is not advisable in water. When the TOC is high, it is advisable to use carbon-based absorbents to remove the organics from water before further treatment and consumption.

The TOC of the borewells during pre-monsoon sampling ranged from 0.5 (S1-BW11) – 11 mg/L (S1-BW8) with an average of 2.6 mg/L. The TOC of the borewells during post-monsoon sampling ranged from 2 (S2-BW10) – 11 mg/L (S2-BW8) with an average of 3.7 mg/L. Therefore, the TOC in the borewells increased considerably when compared to the pre-monsoon samples. It was observed that BW8 was the most polluted well with respect to TOC during both the pre-monsoon and post-monsoon samplings. The whole Industrial cluster of M/s Chemplast Sanmar Plants I, II, III, IV and V are located in the regions of 4-6 mg/L TOC (Fig. AII. 12b). The wells BW2, BW6 and BW14 surrounding the localities of Kaptoruti, Veerakkalpudur, Gonur, Thepeeti and Bharatinagar had TOC in the range of 3-6 mg/L.

The TOC of the openwells during pre-monsoon sampling ranged from 1.36 (S1-OW9) –3.92 mg/L (S1-OW8) with an average of 2.1 mg/L. OW8 is located very close (~400 m) to M/s Chemplast Plant I. The Industrial cluster of M/s Chemplast Sanmar Plants II, III and IV are located in the contours of 0-2 mg/L TOC. Other industries like M/s MALCO Energy Ltd. and M/s MALCO thermal power station are located in the contours 2-3 mg/L (Fig. AII. 12e). M/s Chemplast Sanmar Plant I is located in the contour of 4-6 mg/L.

The TOC of the openwells during post-monsoon sampling ranged from 3 (S2-OW4, S2-OW5) –7.7 mg/L (S2-OW8) with an average of 4mg/L (Fig. AII. 12d). The average of post monsoon samples was significantly higher than that of the pre-monsoon samples. OW8 was the most polluted well with respect to TOC in both pre-monsoon and post-monsoon samples. The contour regions of the M/s Chemplast Sanmar Plants II, III, IV shifted from 0-2 mg/L in pre-monsoon to 3-4 mg/L in post-monsoon season. Therefore, monsoon has had a significant effect on increasing the TOC of the openwells. Moreover, other industries like M/s MALCO Energy Pvt. Ltd. and M/s MALCO thermal power station also moved from 3-4 mg/L in pre-monsoon sampling to 4-6 mg/L TOC during the post monsoon sampling.

The TOC in the SLF wells ranged from 2.7 (S1 PBW13) – 5.3 mg/L (S1-PBW11) with an average of 4 mg/L during the pre-monsoon sampling. Almost all of the PBW wells had TOC in the range of 3-4 mg/L except for PBW11(5.3 mg/L), PBW 10 (5.0 mg/L) and PBW 5 (4.9 mg/L). During the post-monsoon sampling, the TOC of SLF wells ranged from 2.3(S2-PBW 2)-4.2 mg/L (S2-PBW 6) with an average of 3.5 mg/L. The average TOC during post-monsoon sampling was lesser than that of pre-monsoon sampling. Majority of the wells within the M/s Chemplast Sanmar Plants had their TOC between 3-4 mg/L except for Plant III and Plant II where the TOC ranged between 2-3 mg/L (Fig. AII. 12).

### 4.6. Dissolved Oxygen

Dissolved oxygen (DO) is the amount of oxygen in water that is available to aquatic organisms. It is an important indicator to overall biological activity of the water body. When the biological activity is high, the level of DO reduces significantly leading to asphyxiation in aquatic organisms. The oxygen concentration is usually maintained in the surface waters with little or no biological activity and with enough surface area to dissolve the oxygen from air. DO is also improved in the water bodies by aquatic plants and algae.

DO levels below 3 mg/L are of concern and waters with levels below 1 mg/L are considered hypoxic and usually devoid of life. WHO guidelines for drinking water doesn't recommend any health-based guideline for dissolved oxygen. However, as per EPA guidelines, DO levels < 3mg/L are of concern and that < 1 mg/L indicates to condition that does not support life. Also, very high values of DO may result in corrosion

of pipes. As per CPCB guidelines on designated best use for different classes of water source, a minimum of 4 mg/L of DO is recommended, and no less than 3.5 mg/L at any time for sustaining aquatic life.

The borewells sampled during the pre-monsoon season had DO ranging from 5.12 mg/L (at S1-BW8) to 7 mg/L (at S1-BW9), with an average of 5.8 mg/L. It shall be noted that all the 16 samples had DO more than the recommended limit of 4 mg/L. BW-8 is the most polluted borewell and it is located at the roadside proximal to SH158-State Highway, at the downstream end of Mettur dam, in the vicinity of the major industrial cluster of the area, which is in a densely populated area. It shall be noted that large agricultural fields are also located in near proximity (~25 m). BW-9 is located farther from the industrial cluster and closer to huge areas of farmlands, in a comparatively scarcely populated area. From the contour (Fig. AII. 13b) plotted from the various DO values observed in 11 open wells in the study area, the major industrial cluster lie in the contour of 5.5-6 mg/L, well above the minimum desired value of 4 mg/L. It is also observed that the open wells – OW- 9, OW-11, and OW-12 had DO levels at the higher range of 6.5 -7 mg/L. All 16 borewell samples during the pre-monsoon had DO more than recommended minimum limit of 4 mg/L, which makes them suitable for domestic consumption after conventional treatment and disinfection, outdoor bathing, and propagation of wildlife and fisheries.

The borewells sampled during the post-monsoon season had DO ranging from 5.85 mg/L (at S2-BW7) to 8.17 mg/L (at S2-BW1), with a higher average (7.4 mg/L) than that from pre monsoon sampling. It shall be noted similar to pre monsoon sampling, all the 16 samples had DO more than recommended minimum limit of 4 mg/L. From the contour (Fig. AII. 13e) plotted from the various DO values observed in 11 open wells in the study area, the major industrial cluster has DO levels > 7 mg/L, well above the minimum desired value of 4 mg/L. It is also observed that the open wells – OW- 1, OW-5, and OW-11 had DO levels had the richest DO levels with values >8 mg/L.

In the open well samples collected before monsoon, DO varied from 5.13 mg/L (at S1-OW-11) to 7.13 mg/L (at S1-OW-5) with an average of 5.71 mg/L. This implies that the groundwater sourced from these two locations- OW-6 and OW-11 are not recommended for drinking purpose. OW-11 is in a densely cultivated farmland at the eastern end of the study area, far from the industrial cluster in a sparsely populated area. OW-5 is located near Venunoor, with residential cluster at a distance of ~150 m, with Cauvery River running on the western side at a minimum distance of ~2 km, and Gonur Reserve Forest

at a distance of 650 m on the S-E side. From the contour (Fig. AII. 13a) plotted from the values observed in 11 open wells in the study area, the major industrial cluster lie in the contour of 5.5 - 6 mg/L, above the minim value of 4 mg/L. All of the 11 open well samples during the pre-monsoon had DO values well above the minimum limit of 4 mg/L. It is evident that the open well OW-5 had the richest OD level.

For the post monsoon sampling, DO level ranged from 4.07 mg/L (at S2-OW-10) to 7.49 mg/L (at S2-OW-5), with the average (6.52 mg/L) higher than the pre-monsoon sampling average. OW-5 had the highest DO level for both pre monsoon and post monsoon periods. OW-10 showed a DO level almost equal to the minimum value. OW-10 is farther from the industrial cluster, located with major land use as agriculture, with moderate population density. From the contour (Fig. AII. 13d) similar to the pre monsoon sampling, all the major industries lie in the contour of 6.5- 7.5 mg/L contour range, well above the minimum value of 4 mg/L. The point of concern may be OW-10, which marked the lowest level of DO (4-4.5 mg/L) up to a radius of ~ 1 km. Unlike pre monsoon sampling, 10 out of 11 samples had DO levels above the recommended minimum concentration of 4 mg/L.

The SLF wells sampled during pre-monsoon had DO in the range of 4.5 to 5.7 with an average of 4.5 mg/L. The DO was around 5-5.5 in M/s Chemplast Plant I and it was around 6.6-6.5 in M/s Champlast Plants II, III and V (Fig. AII. 13c). The DO in SLF wells increased after the monsoon. Post-monsoon samples had a DO in the range of 3 mg/L to 7.51 mg/L with an average of 6.48 mg/L which was way higher than the DO in pre-monsoon samples (Fig. AII. 13f). 15 of 18 pre-monsoon samples were in compliance for the acceptable limit of DO according to IS-10500:2012. 20 of 21 post-monsoon samples were in compliance for the acceptable limits.

### 4.7. pH

pH is the negative logarithm of $[H^+]$ concentration. Therefore, it represents the acidity or basicity of an aqueous system. pH controls many biological and mass transfer processes in water. The pH of fresh water sources is around 6.5-8.5. A slight change in pH will lead to changes in the biological structure of a habitat. Some organisms preferentially grow at a lower pH and some will require a higher pH. Therefore, it is required to maintain the pH of a habitat to preserve its natural biota. Moreover, change in pH can affect the organism by deterring its reproduction, growth and metabolism. In addition, pH also determines the

chemical states of elements like metals. The transport rate of metals increases at a lower pH resulting in increased bioaccumulation and biotoxicity. Therefore, it is important to regulate pH. US-EPA and BIS regulate pH to be between 6.5 - 8.5 without any relaxation in water. The pH in the borewells during the pre-monsoon sampling varied from 7.38 to 8.1 with an average of 7.7. It is well within the standard range recommended by IS-10500:2012. The borewells in the zone of industrial cluster of M/s Chemplast Sanmar and M/s MALCO were more alkaline (pH 8-8.5) compared to other borewells (pH 7.5-8) (Fig. AII. 14b). The pH in the borewells sampled after the monsoon varied from 7.25 to 8.21 with an average of 7.61. Therefore, the monsoon did not affect pH much in the borewells. However, it was observed that the borewells close to M/s Chemplast Sanmar Plant I and M/s MALCO Thermal power station (BW15 and BW16) had a decrease in their pH during the post-monsoon season (Fig. AII. 14e). In addition, the pH of the wells around the industrial zone also decreased to 7.5-8 from 8-8.5. The pH in openwell during pre-monsoon sampling ranged from 7.49 to 8.31 with an average of 7.78. Almost 90% of the surveyed region were predicted to be at a pH of 7.5-8 with only OW6 and OW8 in the 8-8.5 zone. The pH in openwells was slightly higher than that of the borewells. The pH of openwells during the post-monsoon season varied from 7.48-8.08 with an average of 7.72. Almost all of the wells were in the 7.5-8 range. The pH did not vary much after the monsoon in the openwells. The pH in SLF wells varied from 7.03 to 8.35 with an average of 7.78 during the pre-monsoon sampling. The pH was low (7-7.5) near M/s Chemplast Sanmar Plant I and was around 7.5-8.5 in the wells in other plants. After monsoon, the pH varied from 7.32-8.26 with an average of 8.0. The pH was observed to increase significantly after the monsoon in the SLF wells. More prominently, pH increased from 7-7.5 in to 7.5-8 in Plant I. Also, the pH of wells in Plant II and IV increased from 7.5-8 to 8-8.5.

### 4.8. Total Coliforms

Coliforms are organisms that are closely related to pathogenic disease-causing organisms, but are not known to cause diseases to humans. Therefore, they are used as indicator organisms to determine the presence of pathogenic organisms in water. The IS-10500:2012 does not allow the presence of any coliform in drinking water. IS-2296 recommends just disinfection for water with coliform levels below 50 CFU/100 mL. The water can be used for outdoor bathing if the coliforms is less than 500 CFU/100 mL

and can be used for drinking after conventional treatment and disinfection if the coliform level is within 5000 CFU/100 mL.

The total coliforms in the borewells in pre-monsoon samples ranged from 0 - 49 CFU/ mL with an average of 15 CFU/mL. The borewells were extensively polluted by coliforms. The regions near P.N. Patti, Khuduridi monitored by the wells BW7, BW9, BW12 and BW13 had coliforms above 20 CFU/mL (Fig. AII. 15). Except 6 wells, all the borewells were found to have coliforms in it.

The total coliforms in borewells during the post-monsoon season ranged from 0-45 CFU/mL with an average of 4.75 CFU/mL. Only 3 borewells contained coliforms after the monsoon. BE13 had the highest around 45 CFU/mL. The wells BW13, BW8 and BW16 comprising the localities of Khuduridiand P.N. Patti showed the presence of coliforms. The coliform level in the surveyed area reduced drastically after the monsoon. Majority of the wells to the east of the industrial cluster showed no presence of coliforms during the post-monsoon sampling, but had high amounts of coliforms before the monsoon (Fig. AII. 15).

The total coliforms in borewells during the post-monsoon season ranged from 0-31 CFU/mL with an average of 4 CFU/mL. 50% of the openwells did not have coliforms in it. OW9 had a high coliform among openwells. OW3 also had high coliform content and it was located very close to the M/s Chemplast II, III and IV plants. After the monsoon, almost all openwells were cleared of coliforms except OW2. OW2 had 40 CFU/mL coliforms. Therefore, it was observed that in both openwells and borewells, the coliform content decreased after monsoon.

The total coliforms in borewells during the post-monsoon season ranged from 0-40 CFU/mL with an average of 7 CFU/mL. Out of 18 wells, 7 wells had coliform contamination. PBW1 and PBW15 had highest coliform content. PBW1 is located in Plant I and PBW15 is located in Plant V. The coliforms in the SLF piezometric wells increased during the post-monsoon sampling. The total coliforms ranged from 0 to 40 CFU/mL with an average of 8 CFU/mL. 7 out of 21 wells had coliforms in it. Although coliforms reduced in borewells and openwells outside the M/s Chemplast plants, it did not reduce within the SLF piezometric wells.

### 4.9. Analysis of soil samples from Plant I and Plant III

New borewells (DBW-1 and DBW-2) were constructed in Plant I and III respectively, and soil samples were collected from both borewells at the depths of 25 ft and 50 ft. The bioavailability of cadmium, mercury, lead and nickel was analysed by digestion with $HNO_3$.

The CHNS of the soil samples were analysed and is provided in Table 4.1. It was observed that the soil from S-DBW-1 (0.5-0.6 %) contained more carbon content that the soil from S-DBW-2 (0.2 - 0.3%). Moreover, with increasing depth, the carbon content decreased. This must be due to the presence of humic substances close to the surface. The average nitrogen content was similar (~1.7-1.8 %) in both the soil samples. The hydrogen content was high in S-DBW-1 (0.1-0.36%) and was low in S-DBW-2 (0.02-0.06%). The sulphur content was high in S-DBW-2 compared to that of S-DBW-1.

**Table 4.1.** CHNS analysis of soil samples collected from Plant I and Plant III

| | **S1-DBW-1** | | **S2-DBW-2** | |
|---|---|---|---|---|
| | **25 ft** | **50 ft** | **25 ft** | **50 ft** |
| **C (%)** | 0.685 | 0.51 | 0.31 | 0.16 |
| **H (%)** | 0.358 | 0.0755 | 0.019 | 0.062 |
| **N (%)** | 1.76 | 1.83 | 1.96 | 1.51 |
| **S (%)** | 0.012 | 0.028 | 0.062 | 0.12 |

Moreover, the soil samples were also analysed for bioavailable metal ions by digesting the samples in $HNO_3$ and analysing in ICP-MS. The results are shown in Table 4.2.

**Table 4.2.** Concentration of selected metal ions in the soil samples from the constructed borewells

| **Sample Code with depth** | **Lead (mg/kg)** | **Cadmium (mg/kg)** | **Nickel (mg/kg)** | **Mercury (mg/kg)** |
|---|---|---|---|---|
| **HW Levels*** | **5000** | **50** | **5000** | **50** |
| **S-DBW-1 25 ft** | 5.2 | 0 | 25.8 | 0 |
| **S-DBW-1 50 ft** | 16.6 | 0 | 30.6 | 0 |
| **S-DBW-2 25 ft** | 1.0 | 0 | 27.4 | 1.2 |
| **S-DBW-2 50 ft** | 0.8 | 0 | 26.2 | 1.4 |

**Note:* HW – Hazardous waste acceptable levels, Schedule II, HW Rules 2008**

The soil samples did not have any cadmium, which must be the reason for the absence of this metal in any of the water sample analysed. It was also observed that the soil contained leachable nickel (25-31 mg/Kg) which would explain the presence of nickel in many of the water samples collected from the SLF piezometric wells. Trace amount of leachable mercury was observed in soil samples of S-DBW-2.

### 4.10. M/s Chemplast Plant Specific Contamination Analysis

The extensive water quality analysis of the samples collected in and around M/s Chemplast Sanmar Industries have not shown any contamination by the industry to its surroundings. However, it is necessary to understand whether there is any effect on ground water quality within the industry due to the presence of items within the SLFs. Therefore, it is important to monitor the upstream and downstream wells of the SLFs and track the significant changes in the quality of water. The upstream and downstream piezometric monitoring wells in plants I to IV of M/s Chemplast Sanmar Industries, which are selected for water quality assessment study within the plant is provided in Table 4.3.

**Table 4.3.** Location of upstream and downstream monitoring wells in M/s Chemplast Sanmar Industries

| Piezometric Wells | Latitude | Longitude | Location | Pre-monsoon* Sampling | Post-monsoon* Sampling |
|---|---|---|---|---|---|
| PBW1 | 11.806947 | 77.820653 | Plant I (Downstream) | S1-PBW1 | S2-PBW1 |
| PBW2 | 11.806937 | 77.820057 | Plant I (Upstream) | S1-PBW2 | S2-PBW2 |
| PBW6 | 11.820903 | 77.844666 | Plant II (Upstream) | S1-PBW6 | S2-PBW6 |
| PBW8 | 11.819064 | 77.843499 | Plant II (Downstream) | S1-PBW8 | S2-PBW8 |
| PBW12 | 11.82007 | 77.84619 | Plant III (Downstream) | S1-PBW12 | S2-PBW12 |
| PBW13 | 11.82304 | 77.845305 | Plant III (Upstream) | S1-PBW13 | S2-PBW13 |
| PBW17 | 11.821843 | 77.84765 | Plant IV (Upstream) | S1-PBW17 | S2-PBW17 |
| PBW18 | 11.8204939 | 77.847214 | Plant IV (Downstream) | S1-PBW18 | S2-PBW18 |

The water quality characteristics of upstream and downstream piezometric wells is provided in Annexure VI.

The upstream of Plant I is monitored by PBW 2 and the downstream is monitored by PBW 1. A total of 2 (PBW 1 and PBW 2) wells were sampled from Plant I in this study. It was observed that there was a slight decrease in pH and alkalinity in the downstream wells compared to that of upstream wells in Plant I. The other parameters had no significant change. Moreover, the presence of coliforms in both upstream and downstream wells, along with a slight increase in COD might indicate sewage contamination around the SLFs. However, there was no significant change in TOC in the upstream and downstream wells, which indicates that the SLFs did not contribute to any soluble organic contamination in ground water. During the post-monsoon sampling, the TDS and sulphates increased slightly along with a presence of metals like nickel and lead. The slight increase in concentration of nickel and lead was also found throughout the

openwells and borewells during the post-monsoon sampling. Therefore, it might be due to the geology of the area. It can be concluded that the SLFs in Plant I are operated properly and there is no change in water quality due to the operation of SLFs.

The upstream of Plant II is monitored by PBW 6 and the downstream is monitored by PBW 8. A total of 6 wells (PBW 3, 4, 5, 6, 7 and 8) were sampled from Plant II in this study. There was no significant difference in the water quality characteristics of upstream and downstream wells. However, it was observed that two SLF wells in Plant II (PBW 6 and PBW 7) have shown the presence of lead after the monsoon. In comparison, the upstream lead concentration was higher than the downstream lead concentration, which indicate that lead was not contributed by SLFs.

The upstream of Plant III is monitored by PBW 13 and the downstream is monitored by PBW 12. A total of 5 (PBW 9, 10, 11, 12 and 13) wells were sampled from Plant III in this study. There was no significant different in the water quality characteristics of upstream and downstream wells during the pre-monsoon sampling. However, similar to Plant II, Plant III showed a small increase in lead concentration in two SLF wells during the post-monsoon sampling. In the similar way, the upstream lead concentration was higher than the downstream lead concentration, which indicate that lead was not contributed by SLFs. Moreover, it also showed indications of sewage contamination. Therefore, the reason for the presence of lead in upstream of the piezometric wells of Plant III is unclear.

In Plant IV, the upstream was monitored by PBW 17 and the downstream was monitored by PBW 18. A total of 6 (PBW 14, 15, 16, 17, 18 and 19) wells were sampled during this study. The COD and coliforms of the downstream wells increased during the post-monsoon season indicating sewage contamination. The TOC did not change significantly indicating that the SLF did not contribute to any soluble organic contamination. There was no significant difference in other sample characteristics of upstream and downstream wells during the pre-monsoon and post-monsoon sampling. Therefore, it can be concluded that the SLFs in Plant IV are in proper operation and there is no change in ground water quality due to the operation of SLFs.

Overall, the water quality assessment considering the upstream and downstream piezometric wells of the SLFs with in the M/s Chemplast Sanmar Industries indicate that SLFs are not contributing to any water contamination within the plant as well as outside of the plant area.

### 4.11. Compliance status

The compliancy status of each well during the pre-monsoon and post-monsoon sampling to IS-10500:2012 is provided in Tables 4.4-4.9. During the pre-monsoon sampling in borewells, none of the samples were in compliance for phosphates. The other major not in compliance parameters were TDS, alkalinity, hardness and $NH_4^+$-N (with normalised average compliancy of 0.13, 0.19, 0.19 and 0.25, respectively out of a score of 1). Among the wells, BW16 had highest compliancy of 0.88 out of a score of 1. BW13 and BW9 were the ones with lowest compliancy scores (0.44, 0.50, respectively). The borewells during pre-monsoon sampling had an overall compliancy score of 0.63. All the wells were in compliance for the parameters pH, DO, fluoride, lead, cadmium, nickel and mercury. All the wells except BW13 were in compliance for chlorides.

During the post-monsoon sampling in borewells, all the wells were in compliance for pH. The parameters with worst compliancy were TDS, alkalinity and hardness (all with the score 0.13). Among the wells, BW13 had the worst score of 0.50 and BW3 had the best score of 0.94. The overall score increased to 0.67 compared to the pre-monsoon score of 0.63. BW13 had consistently worst compliancy during both the seasons.

In the openwells, during pre-monsoon sampling, none of the well were in compliance for TDS, hardness, and phosphate. Only 1 openwell (OW9) was in compliance for alkalinity. Only 1 open well (OW6) was not in compliance for chloride. All the wells were in compliance for pH, DO, fluoride, lead, cadmium, nickel and mercury. The well with worst compliance was OW6 with a compliance score of 0.50 and the best compliance score was 0.75 for the wells OW7 and OW9. The overall compliance score for openwells during the pre-monsoon sampling was 0.65.

During the post-monsoon sampling in the openwells, all the wells were not in compliance for TDS, alkalinity, hardness and phosphate. All the wells were in compliance for pH and fluoride and only 1 well was not in compliance for the parameters DO (OW10), sulphate (OW11) and total coliform (OW2).

Among the wells, the worst compliancy score was 0.56 (OW2) and the best compliancy score was 0.75 (OW8). The overall compliancy score for openwells post-monsoon was 0.68 which was higher compared to the pre-monsoon sampling.

In the SLF piezometric wells during pre-monsoon sampling, none of the wells were compliance for phosphate. All the wells were in compliance for the parameters pH, hardness, chloride, $NH_4^+$-N, sulphate, fluoride, lead, cadmium, nickel and mercury. Among the piezometric wells, the lowest score was 0.69 (PBW1 and PBW2) and the highest score was 0.94 (PBW 3, 4, 5, 7, 8, 9, 16, and 18). The overall compliancy score for SLF piezometric well during pre-monsoon sampling was 0.86.

During the post-monsoon sampling in piezometric wells, all the wells were in compliance for pH, chloride, sulphate, fluoride, cadmium and mercury. None of the wells were in compliance for phosphate. Only 1 well (DBW1) was not in compliance for DO. Among the wells, the newly constructed borewell DBW1, and the well PBW2 had the worst compliancy score (0.56) and the best compliancy score was 0.94 for the well PBW8. The average compliancy score was 0.79 which was significantly lower than that of pre-monsoon sampling.

Overall, it was observed that SLF wells had better compliance score compared to openwells and borewells.

**Table 4.4.** Compliance status of borewells during the pre-monsoon season

| Wells | pH | DO | TDS | Alkalinity | Hardness | $Cl^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $F^-$ | Total Coliform | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | Σ | Σ/n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1-BW1 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW2 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW3 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 9 | 0.56 |
| S1-BW4 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW5 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW6 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW7 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW8 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 9 | 0.56 |
| S1-BW9 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 8 | 0.50 |
| S1-BW10 | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S1-BW11 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 9 | 0.56 |
| S1-BW12 | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW13 | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 7 | 0.44 |
| S1-BW14 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW15 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S1-BW16 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| **Σ** | 16 | 16 | 2 | 3 | 3 | 15 | 6 | 4 | 9 | 0 | 16 | 6 | 16 | 16 | 16 | 16 | | |
| **Σ/n** | 1.00 | 1.00 | 0.13 | 0.19 | 0.19 | 0.94 | 0.38 | 0.25 | 0.56 | 0.00 | 1.00 | 0.38 | 1.00 | 1.00 | 1.00 | 1.00 | | **0.63** |

**Table 4.5.** Compliance status of borewells during the post-monsoon season

| Wells | pH | DO | TDS | Alkalinity | Hardness | $Cl^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $F^-$ | Total Coliform | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | Σ | Σ/n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1-BW1 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S1-BW2 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S1-BW3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S1-BW4 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW5 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW6 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S1-BW7 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S1-BW8 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW9 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW10 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW11 | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 9 | 0.56 |
| S1-BW12 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | 9 | 0.56 |
| S1-BW13 | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 8 | 0.50 |
| S1-BW14 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S1-BW15 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-BW16 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 13 | 0.81 |
| **Σ** | 16 | 16 | 2 | 2 | 2 | 14 | 10 | 9 | 10 | 0 | 16 | 11 | 16 | 16 | 15 | 16 | | |
| **Σ/n** | 1.00 | 1.00 | 0.13 | 0.13 | 0.13 | 0.88 | 0.63 | 0.56 | 0.63 | 0.00 | 1.00 | 0.69 | 1.00 | 1.00 | 0.94 | 1.00 | | **0.67** |

**Table 4.6.** Compliance status of openwells during the pre-monsoon season

| Wells | pH | DO | TDS | Alkalinity | Hardness | $Cl^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $F^-$ | Total Coliform | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | Σ | Σ/n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1-OW1 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-OW2 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S1-OW3 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 9 | 0.56 |
| S1-OW4 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S1-OW5 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S1-OW6 | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 8 | 0.50 |
| S1-OW7 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S1-OW8 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-OW9 | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S1-OW10 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S1-OW11 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| **Σ** | 11 | 11 | 0 | 1 | 0 | 10 | 4 | 8 | 7 | 0 | 11 | 7 | 11 | 11 | 11 | 11 | | |
| **Σ/n** | 1.00 | 1.00 | 0.00 | 0.09 | 0.00 | 0.91 | 0.36 | 0.73 | 0.64 | 0.00 | 1.00 | 0.64 | 1.00 | 1.00 | 1.00 | 1.00 | | **0.65** |

**Table 4.7.** Compliance status of openwells during the post-monsoon season

| Wells | pH | DO | TDS | Alkalinity | Hardness | $Cl^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $F^-$ | Total Coliform | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | Σ | Σ/n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S2-OW1 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S2-OW2 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 9 | 0.56 |
| S2-OW3 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S2-OW4 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S2-OW5 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S2-OW6 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S2-OW7 | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S2-OW8 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S2-OW9 | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S2-OW10 | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S2-OW11 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| **Σ** | 11 | 10 | 0 | 0 | 0 | 8 | 7 | 9 | 10 | 0 | 11 | 10 | 11 | 11 | 11 | 11 | | |
| **Σ/n** | 1.00 | 0.91 | 0.00 | 0.00 | 0.00 | 0.73 | 0.64 | 0.82 | 0.91 | 0.00 | 1.00 | 0.91 | 1.00 | 1.00 | 1.00 | 1.00 | | **0.68** |

**Table 4.8.** Compliance status of SLF piezometric wells during the pre-monsoon season

| Wells | pH | DO | TDS | Alkalinity | Hardness | $Cl^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $F^-$ | Total Coliform | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | Σ | Σ/n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1-PBW1 | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S1-PBW2 | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S1-PBW3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S1-PBW4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S1-PBW5 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S1-PBW6 | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 13 | 0.81 |
| S1-PBW7 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S1-PBW8 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S1-PBW9 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S1-PBW10 | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 13 | 0.81 |
| S1-PBW11 | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| S1-PBW12 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| S1-PBW13 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| S1-PBW14 | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S1-PBW15 | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 13 | 0.81 |
| S1-PBW16 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S1-PBW17 | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| S1-PBW18 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| **Σ** | 18 | 15 | 16 | 12 | 18 | 18 | 15 | 18 | 18 | 0 | 18 | 11 | 18 | 18 | 18 | 18 | | |
| **Σ/n** | 1.00 | 0.83 | 0.89 | 0.67 | 1.00 | 1.00 | 0.83 | 1.00 | 1.00 | 0.00 | 1.00 | 0.61 | 1.00 | 1.00 | 1.00 | 1.00 | | **0.86** |

**Table 4.9.** Compliance status of SLF piezometric wells during the post-monsoon season

| Wells | pH | DO | TDS | Alkalinity | Hardness | $Cl^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $F^-$ | Total Coliform | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | Σ | Σ/n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S2-PBW1 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 | 0.63 |
| S2-PBW2 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | 9 | 0.56 |
| S2-DBW1 | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 9 | 0.56 |
| S2-PBW3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| S2-PBW4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S2-PBW5 | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| S2-PBW6 | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | 13 | 0.81 |
| S2-PBW7 | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S2-PBW8 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 15 | 0.94 |
| S2-PBW9 | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S2-PBW10 | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 13 | 0.81 |
| S2-PBW11 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 11 | 0.69 |
| S2-PBW12 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | 13 | 0.81 |
| S2-PBW13 | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S2-DBW2 | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S2-PBW14 | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 12 | 0.75 |
| S2-PBW15 | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| S2-PBW16 | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 13 | 0.81 |
| S2-PBW17 | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| S2-PBW18 | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | 13 | 0.81 |
| S2-PBW19 | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 14 | 0.88 |
| **Σ** | 21 | 20 | 12 | 15 | 5 | 21 | 18 | 18 | 21 | 0 | 21 | 13 | 17 | 21 | 20 | 21 | | |
| **Σ/n** | 1.00 | 0.95 | 0.57 | 0.71 | 0.24 | 1.00 | 0.86 | 0.86 | 1.00 | 0.00 | 1.00 | 0.62 | 0.81 | 1.00 | 0.95 | 1.00 | | **0.79** |

# Chapter 5. Major Observations and Specific Conclusions

## 5.1. Major Observations

The investigation of physicochemical and biological parameters in borewells, openwells and SLF wells showed that almost all the wells were in compliance to the parameters pH, DO, fluorides and metals. The investigation also showed that the SLF piezometric wells had better compliance to water quality standards for the parameters TDS, alkalinity and hardness compared to that of open and borewells outside the SLF. Moreover, in certain openwells and borewells, the TDS and hardness were 1.5-3 times higher than that of SLF wells. It was evident that although the localities surrounding the M/s Chemplast Sanmar Plants have considerably high TDS, alkalinity and hardness, the SLF wells inside the plants did not contribute to any pollution with respect to dissolved solids, hardness and alkalinity. It was also a common observation that the polluted localities were atleast 2 km away from the location of the M/s Chemplast Sanmar Industries, except that, few locations (OW8 and BW8) were within 1-2 km from Plant I.

The concentration of $Cl^-$ and $SO_4^{2-}$ in the SLF wells were much lower compared to that of the borewells and openwells in the surrounding locality. The chloride concentration was within the acceptable limit in majority of openwells and borewells. However, many wells had very high sulphate concentrations exceeding the permissible limit by 2-3 times. These wells are located atleast 2 km from the M/s Chemplast Sanmar Industrial Plants. The SLF wells had very low $SO_4^{2-}$ during both pre-monsoon and post-monsoon samplings. Therefore, the plant is not responsible for the excessive sulphate contamination found in borewells and openwells.

The presence of $PO_4^{3-}$ in almost all the SLF wells, openwells and borewells were found to be higher than the acceptable limit; however, the concentration was within the permissible limit. It is necessary to control $PO_4^{3-}$ pollution by identifying the common practices in the household regions and agricultural lands that might have led to $PO_4^{3-}$ pollution.

The level of $NO_3^-$-N in openwells and borewells outside the M/s Chemplast Sanmar Industries exceeded the acceptable limit during pre- and post-monsoon seasons. Unlike $NO_3^-$-N, $NH_4^+$-N pollution was well within the acceptable limits in the SLF piezometric wells. However, a few openwells and borewells had very high $NH_4^+$-N contamination and they were located atleast 2 km away from the M/s Chemplast

Sanmar Industries. The prominent $NO_3^-$-N, $NH_4^+$-N and $PO_4^{3-}$ contamination might be due to release of nutrients from households (via sewage disposal) and agricultural lands (via fertiliser application). The investigation also revealed that there was significant organic contamination in the wells around the M/s Chemplast Industries. The contamination was higher in the wells outside the M/s Chemplast Plants. Therefore, the source of contamination is not the M/s Chemplast Industries. There was no significant increase in COD and TOC in the downstream wells of SLFs in the M/s Chemplast Plants. Moreover, the increase in nutrients, COD, TOC and coliforms in the wells of the surrounding locality might be indications of sewage contamination.

The localities with significant pollution and the possible sources of pollution are given in the table below

**Table 5.1.** Localities with significant pollution and possible sources of pollution

| Parameter | Compliance (%) | | Polluted Localities | Probable source(s) for pollution | | | Remarks |
|---|---|---|---|---|---|---|---|
| | Inside Chemplast | Outside Chemplast | | Domestic | Agricultural | Industrial | |
| **Alkalinity** | 69.0 | 10.1 | Veerakkalpudur | × | × | ✓ | Geology might be a possible reason |
| **TDS** | 73 | 6.3 | P.N. Patti | × | × | ✓ | Probable sources include small scale industries at The SIDCO Industrial complex; however, a long-term study is required for confirmation |
| **Hardness** | 61.9 | 7.8 | P. N. Patti, Kaptoruti, Kuduridi, Malapudur | × | × | ✓ | |
| **$Cl^-$** | 100 | 86.2 | Khudirudi, P. N. Patti | ✓ | ✓ | ✓ | |
| **$NO_3^-$-N** | 84.5 | 50 | P. N. Patti, Veerakkalpudur, Venunoor, Sanathanapatti, Thepeeti, Gonur | × | ✓ | × | Agricultural/Household discharges of used water |
| **$NH_3$-N** | 92.9 | 58.9 | Khudiridi, Malapudur | ✓ | ✓ | × | Sewage contamination |
| **$SO_4^{2-}$** | 100 | 68.3 | P. N. Patti, Kaptoruti, Kuduridi, Malapudur, Sanathanapatti | × | ✓ | ✓ | The probable sources include SIDCO and MTPS.<br>Agricultural practices might be a source |
| **$PO_4^{3-}$** | 0 | 0 | Multiple | ✓ | ✓ | × | House hold and agricultural practices |
| **Total Coliform** | 61.5 | 65.2 | Multiple | ✓ | × | × | Sewage contamination |
| **COD** | - | - | P. N. Patti, Thepeeti, Veerakkalpudur | ✓ | × | ✓ | Probable sources might include sewage contamination and agricultural practices |
| **TOC** | - | - | P. N. Patti | ✓ | × | ✓ | Probable sources include MTPS and sewage contamination |

## 5.2. Specific Conclusions

The investigation of physicochemical and biological parameters show that the M/s Chemplast Sanmar Industries was not the source of any pollution to groundwater in the surrounding localities. Although, most borewells and openwells are polluted in the locality, there is no traceable source linking them to the M/s Chemplast Sanmar Industries. The upstream and downstream piezometric well's water quality assessment with in the M/s Chemplast Sanmar Industries indicate that SLFs had not contributed to any organic or inorganic water contamination within the plant as well as outside of the plant area.

The soil samples collected from the new bore holes inside the M/s Chemplast Sanmar Industries does not show any contamination of metal ions (i.e. lead, mercury, cadmium and nickel), which indicate that the SLFs inside the M/s Chemplast Sanmar Industries are properly functioning over the years.

It is recommended to carry out frequent water quality monitoring around the localities of P. N. Patti, Khuduridi and Kaptoruti. Frequent monitoring of wells for specific chemicals used in all industries located at Mettur would provide a detailed information about the role of each industry in ground water pollution, if any.

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# ANNEXURE I

By RPAD

**TAMILNADU POLLUTION CONTROL BOARD**

| From | To |
|---|---|
| Er.K.Senthil Vinayagam, M.E.,<br>Tamil Nadu Pollution Control Board,<br>Siva Tower, Post Box No. 457,<br>1/276, Meyyanur Main road,<br>Salem District-636004<br>Contact: 0427 - 2448526<br>Email Id: deeslm@tnpcb.gov.in | Dr. S.Mathava Kumar,<br>Associate Professor,<br>Environment Engineering Division,<br>Department of Civil Engineering,<br>Indian Institute of Technology Madras,<br>Chennai - 600036.<br>Email Id: mathav@civil.iitm.ac.in |

**Lr.No.001/DEE/TNPCB/SLM/NGT/2023, dated: 17 /10/2023**

**Sir,**

Sub: TNPCB, O/o. DEE/Salem – NGT (SZ) – OA No.16 /2019 – Assessment of Ground water contamination in and around M/s. Chemplast Sanmar plants at Mettur, Salem District – Sample locations around the unit - Details called for - Sent – Reg.

Ref: Board's Memo No. T2/TNPCB/NGT OA 16 of 2019/2023 dated: 15.09.2023 received by this office through mail on 19.09.2023

******

With reference to the Board's memo cited, it is stated that the members of Joint Committee and TNPC Board on the report of "Assessment of Ground water contamination in and around M/s. Chemplast Sanmar plants at Mettur, Salem" presented on 01.09.2023, insisted to resample in some locations from already sampled location and present the final presentation on the same with re-sample values and identify the source of polluting industries.

Based on your request to the Board for providing the list of raw materials and final product produced in the major industries around 5km radius of M/s Chemplast Sanmar to match the source of ground water contamination at Mettur. The Board instructed the O/o. District Environmental Engineer, Tamil Nadu Pollution Control Board, Salem to provide necessary details to you with intimation to the Board.

In this regard, it is to inform that the above mentioned details are listed with topographic view of units located within 5 KM radius of M/s Chemplast Sanmar Industries and the same are enclosed herewith.

The receipt of this letter may be acknowledged.

Encl: As above

District Environmental Engineer,
Tamil Nadu Pollution Control Board
Salem

17/10/2023

Copy submitted to

1. The Member Secretary, Tamil Nadu Pollution Control Board, Chennai - for favour of kind information please.
2. The Joint Chief Environmental Engineer (M), Tamil Nadu Pollution Control Board. Salem Zone for favour of kind information please.

File Copy

O/o DEE. TNPC Board,
Salem

**LIST OF RAW MATERIALS AND FINAL PRODUCT PRODUCED IN THE MAJOR INDUSTRIES AROUND 5 KILOMETER RADIUS OF M/S CHEMPLAST SANMAR**

| Sl. No. | Name & address of the unit | Category Classification | List of raw materials used | List of final products | Remarks |
|---|---|---|---|---|---|
| 1. | M/s Chemplast Sanmar Limited, Plant I, Raman Nagar Post, Mettur Dam, Mettur Taluk Salem District | Red Large | Anhydrous Hydrogen Fluride | Monochlorodifluoro methane (R-22) | -- |
| | | | Chloroform | Hydrochloric Acid | |
| | | | Caustic Soda | Dilute Sulphuric Acid | |
| | | | Concentrated Sulphuric Acid | Dilute Hydrofluoric Acid | |
| | | | Sodium Sulphite | -- | |
| | | | Antimony | -- | |
| | | | | | |
| 2. | M/s Chemplast Sanmar Limited, Plant II PVC, Raman Nagar Post, Mettur Dam, Mettur Taluk Salem District | Red Large | Ethyle Di Chloride | PVC Resins | -- |
| | | | Sodium Bi Carbonate | Hydrochloric Acid | |
| | | | Sodium Hydroxide Flakes | -- | |
| | | | Sodium Carbonate | -- | |
| | | | Alum | -- | |
| | | | Ammonia | -- | |
| | | | | | |
| 3. | M/s Chemplast Sanmar Limited, Plant III Caustic Chlor Raman Nagar Post, Mettur Dam, Mettur Taluk Salem District | Red Large | Raw Salt | Caustic Soda | -- |
| | | | Sodium Carbonate (Soda Ash) | Chlorine | |
| | | | Floculating Agent | Hydrogen | |
| | | | Barium Chloride | Methyl Chloride | |
| | | | Con. Sulphuric Acid | Methylene Chloride | |

| | | | | | |
|---|---|---|---|---|---|
| | | | Methanol | Carbon Tetra Chloride | |
| | | | Burnt Lime | Chloroform | |
| | | | -- | Bleach Liquor | |
| | | | -- | Dilute Sulphuric Acid | |
| | | | -- | Hydrochloric Acid | |
| | | | | | |
| 4. | M/s Chemplast Sanmar Limited, Plant IV, Raman Nagar Post, Mettur Dam, Mettur Taluk Salem District | Red Large | Metallurgical Silicon | Silicon (Metal) Pure (Electronic Grade) (Semi Conductor Silicon) | -- |
| | | | Anhydrous HCl | Hydrogen Peroxide (50%) | |
| | | | Hydrogen | -- | |
| | | | Caustic Soda | -- | |
| | | | Hydrogen | -- | |
| | | | Tetra Butyl Urea | -- | |
| | | | Aromatic Solvent | -- | |
| | | | Palladium Catalyst | -- | |
| | | | Anthrquinone | -- | |
| | | | Oxiygen | -- | |
| | | | Nitric Acid | -- | |
| | | | 2-Methyl Cyclo hexylacetate | -- | |
| | | | Heavy Naptha | -- | |
| | | | Alumina | -- | |
| | | | | | |
| 5. | M/s Cabot Sanmar Limited, Raman Nagar Post, Mettur Dam, Mettur Taluk Salem District | Red Large | MG Silicon | Fumed Silica | -- |
| | | | Hydrogen gas | 30% HCl | |
| | | | Caustic Soda | Sodium Hypochlorite | |
| | | | Anhydrous hydrogen chloride | Hiboils as Hexachlorosilanes | |

| | | | | | |
|---|---|---|---|---|---|
| | | | -- | Chlorosilanes | |
| | | | | | |
| 6. | M/s Chemplast Sanmar Limited, Coal based power plant.<br>Raman Nagar Post,<br>Mettur Dam.<br>Mettur Taluk<br>Salem District | Red Large | Imported Coal<br>-- | Steam<br>Power | -- |
| | | | | | |
| 7. | M/s.Mettur Thermal Power Station-I, S.F.No. 387, 687-700, P.N.Patti Village , Mettur Taluk ,<br>Salem District . | Red Large | HCl<br>Caustic soda lye<br>Hydrated Lime<br>Tri sodium phosphate<br>Hydrazine Hydrate<br>Ammonia Liquor<br>Organo phosphate<br>Alum<br>Poly electrolite<br>Coal<br>HFD<br>HSD | Electricity | |
| | | | | | |
| 8. | M/s.Mettur Thermal Power Station II (1X600 MW), S.F.No. 387,687-700, P.N. Village , Mettur Taluk , Salem District . | Red Large | HCl<br>Caustic Soda Lye<br>Hydrated Lime<br>Tri Sodium Phosphate<br>Hydrazine hydrate | Electricity | |

| | | | | | |
|---|---|---|---|---|---|
| | | | Ammonia Liquor<br>Organo Phosphate<br>Alum<br>Poly Electrolyte<br>Sulphuric acid<br>Anti scalent<br>Corrosion Inhibitor<br>Biocide<br>Sodium hypo chloride<br>Coal<br>HSD<br>HFO | | |
| | | | | | |
| 9. | Magnesium Sulphate Manufacturing units, SIDCO industrial Estate, Mettur Taluk, Salem | Red Small | Sulphuric Acid<br>Raw Magnasite Dust<br>Light Calcined Magnesium | Magnesium Sulphate | |
| | | | | | |
| 10. | M/s . Esvee Chemical Industries S.F No. B18, SIDCO Industrial Estate, P.N,Patti Village, Mettur Taluk, Salem District. | Red- Small | Magnesite Powder<br>Sulphuric Acid | Magnesium Sulphate (Epsom Salt) | |
| | | | | | |
| 11. | M/s . Sreenivas Chemicals Unit-II S.F No. T S No-6,Block -68, Plot No-25D, SIDCO Industrial Estate, P.N.Patti Village, Mettur | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>Light Calcined Magnesite | Magnesium Sulphate | |

| | | | | | |
|---|---|---|---|---|---|
| | Taluk, Salem District. | | | | |
| | | | | | |
| 12. | M/s . T Chendur Chemical<br>S.F No. 34D SIDCO Industrial Estate, P.N.Patti Village, Mettur Taluk, Salem District. | Red- Small | Raw Magnesite Powder<br>Spent Sulphuric Acid<br>Lightly Calcinated Magnesite (LCM) | Magnesium Sulphate | - |
| | | | | | |
| 13. | M/s . Trisul Chemicals<br>S.F No. R.S. No. 514/1A, Konur Village, Mettur Taluk, Salem District. | Red- Small | Aluminium Hydrate<br>Sulphuric Acid<br>Magnesite<br>Sulphuric Acid<br>Sodium Sulphide solution 20% | Alum (non-ferric)<br>Magnesium Sulphate<br>Sodium Sulphide | - |
| | | | | | |
| 14. | M/s . B.K.S. Industries<br>S.F No. Block No :13, T.S No 4/5,SIDCO Industrial Estate, P.N.PATTI Village, Mettur Taluk, Salem District. | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>Light Calcined Magnesium | Magnesium Sulphate | - |
| | | | | | |
| 15. | M/s . Sri Venkateswara Chemicals<br>S.F No. T.S. No.4, Veerakal Pudur Village, Plot No.33B, SIDCO Industrial Estate, Mettur Dam, Veerakkal Village, Mettur Taluk, Salem District. | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>Light Calcined Magnesite | Magnesium Sulphate<br>Unreacted Ore and Fines | - |
| | | | | | |
| 16. | M/s . Visakan Enterprises<br>S.F No.Plot No: 21B, SIDCO Industrial Estate, P.N.PATTI Village, Mettur | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>Light Calcined Magnesium | Magnesium Sulphate | - |

| | | | | | |
|---|---|---|---|---|---|
| | Taluk, Salem District. | | Water | | |
| | | | | | |
| 17. | M/s . Shanmuga Chemicals<br>SF.NO.4/2.P.N.Patty village<br>plot No:33,<br>SIDCO industrial Estate,<br>Mettur Dam,<br>P.N.PATTI Village, Mettur<br>Taluk, Salem District. | Red- Small | Magnestite Powder<br>Sulphuric Acid | Magnesium Sulphate | - |
| | | | | | |
| 18. | M/s . Sri Lakshmi Industries<br>S.F No.Plot No.34C,<br>SIDCO Industrial Estate,<br>P.N.PATTI Village, Mettur<br>Taluk, Salem District. | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>Light Calcined Magnesium | Magnesium Sulphate | - |
| | | | | | |
| 19. | M/s . Sun Agro Chemicals<br>S.F No. T.S.No.4,5,6 & 7,<br>Plot No.32, SIDCO Industrial<br>Estate, P.N.PATTI Village,<br>Mettur Taluk, Salem District. | Red- Small | Spent Sulphuric Acid<br>Magnesite Powder<br>Magnesium Oxide | Magnesium sulphate | - |
| | | | | | |
| 20. | M/s . Alamelu Magnesia Pvt.<br>Ltd,<br>S.F No. B-20, SIDCO<br>Industrial Estate,<br>P.N.PATTI Village, Mettur<br>Taluk, Salem District | Red- Small | Magnesite Powder<br>Sulphuric Acid | Magnesium Sulphate | - |
| | | | | | |
| 21. | M/s . Calcimag Chemicals<br>India Pvt LTD<br>S.F No. Ward D/ Block<br>13/T.S.No.6, Plot No.17<br>SIDCO Industrial Estate,<br>.P.N.PATTI Village, Mettur | Red- Small | Raw Magnesite powder<br>Spent Sulphuric Acid | Magnesium Sulphate<br>Carbon Dioxide | - |

| | | | | | |
|---|---|---|---|---|---|
| | Taluk, Salem District. | | | | |
| | | | | | |
| 22. | M/s . Sumangali Chem Industries<br>S.F No. PlotNo -31,<br>SIDCO Industrial Estate,<br>P.N.PATTI Village, Mettur Taluk, Salem District. | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>Light Calcined Magnesite Powder | Magnesium Sulphate | - |
| | | | | | |
| 23. | M/s . Sri Sivasakthi Industry<br>S.F No. T.S.No:4pt, Plot No:12,SIDCO Industrial Estate,Mettur Dam,<br>Veerakkal Pudhur Village,<br>Mettur Taluk, Salem District. | Red- Small | Sulphuric Acid<br>Magnesite Powder<br>Light Calcined Magnesium | Magnesium Sulphate | - |
| | | | | | |
| 24. | M/s . Mani Agro Chem Private Limited<br>S.F No. T.S.No.4, Plot No.19 & T.S.No.6, Plot No.20-B,<br>P.N.Patti Village, Mettur Taluk, Salem District. | Red- Small | Magnesium Carbonate<br>Sulphuric Acid<br>Calcined Magnesite | Magnesium Sulphate<br>Magnesium Unreacted Ore Fines | - |
| | | | | | |
| 25. | M/s . Ram Lax Industries<br>S.F No. 4, Block No.68,<br>Plot No.7C, 7D, 7E,<br>SIDCO Industrial Estate,<br>P.N.Patti Village, Mettur Taluk, Salem District | Red- Small | Spent Sulphuric acid<br>Magnesite powder | Magnesium Sulphate | - |
| | | | | | |
| 26. | M/s.Kabaleeswar Chemicals,<br>S.F.No. T.S. No. 4/25,<br>Ward-D, Block No. 13,<br>Mico Farm Campus, | Red- Small | Lightly Calcined Magnesite (LCM) – 85% MgO Grade<br>Spent Sulphuric Acid ( 78% purity by mass ) | Magnesium Sulphate | - |

| | | | | | |
|---|---|---|---|---|---|
| | P.N.Patti Village , Mettur Taluk , Salem District . | | Weak Liquor | | |
| | | | | | |
| 27. | M/s . N.M.R.Industries<br>S.F No. 4/2 Karumalaikoodal Village, Plot No.7F<br>SIDCO industial Estate,<br>P.N.Patti Village,<br>Mettur Taluk, Salem District | Red- Small | Magnesite Powder<br>Spent Sulphuric Acid<br>Light Calcined Magnesite Powder | Magnesium Sulphate | - |
| | | | | | |
| 28. | M/s . Bavithra Industries<br>S.F No. Ward-D,<br>Block No-13,TS No 4/5 ,<br>P.N.Patti Village,<br>Mettur Taluk, Salem District. | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>Light Calcined Magnesite | Magnesium Sulphate | - |
| | | | | | |
| 29. | M/s . Bala Vinayaka Industries<br>S.F No. 184/1A1,<br>Veerakkalpudur Village,<br>Mettur Taluk,<br>Salem District. | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>LCM | Magnesium Sulphate | - |
| | | | | | |
| 30. | M/s . Universal Agro Chemical<br>S.F No. T S.No 4/5,<br>SIDCO Industrial Estate,<br>P.N.Patti Village, Mettur Taluk, Salem District | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>LCM | Magnesium Sulphate | - |
| | | | | | |
| 31. | M/s . Tripal International<br>S.F No. T.S.No.4pt,<br>Plot No-12A, SIDCO Industrial Estate,<br>P.N.Patti Village,<br>Mettur Taluk, Salem District. | Red- Small | Magnesite Powder<br>Sulphuric Acid<br>LCM | Magnesium Sulphate | - |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 32. | M/s . Nageswari Chemicals<br>S.F No. Ward D Block No.13,<br>T/S No.6/1 ,Plot No:14<br>SIDCO Industrial Estate,<br>P.N.Patti Village,<br>Mettur Taluk, Salem District | Red- Small | Sulphuric Acid<br>Raw MagnesiteDust<br>Light Calcined Magnesium | Magnesium Sulphate | - |
| 33. | M/s.Ramana Iyyanar Chemicals, S.F.No.<br>T.S.No.6/1, Ward-D,<br>Block No.13, Plot No.B 17,<br>SIDCO Industrial Estate,<br>P.N.Patti Village , Mettur Taluk , Salem District | Red- Small | Lightly Calcined Magnesite (LCM) – 85% MgO grade<br>Spent Sulphuric Acid ( 78% purity by mass )<br>Weak Liquor | Magnesium Sulphate | - |
| 34. | M/s . Thirumurugan Industries<br>S.F No.T.S.No. 6/1,<br>Block-13, Ward-D / Plot No.13/3 SIDCO Industrial Estate, P.N.Patti Village,<br>Mettur Taluk, Salem District. | Red- Small | Light Calcined Magnasite<br>MagnesitePowder<br>Sulphuric Acid<br>Weak Liquor | Magnesium Sulphate | - |
| 35. | M/s . Sabari Agro Chemicals<br>S.F No. T/S No 4/5, Ward No.D, Block No.13,<br>P.N.Patti Village, Mettur Taluk, Salem District | Red- Small | Magnesite Powder<br>Sulphurics Acid<br>Light Calclined Magnesite | Magnesium Sulphate | - |
| 36. | M/s . Sri Subramanian Chemicals<br>S.F No.T.S.No. 4/9, Ward-D, Block-13,<br>Mico Farm Complex,<br>P.N.Patti Village, Mettur Taluk, Salem District. | Red- Small | Lightly Calcined Magnesite (LCM) – 85% MgO grade<br>Spent Sulphuric Acid ( 78% purity by mass ) | Magnesium Sulphate | - |

| | | | | | |
|---|---|---|---|---|---|
| 37. | M/s . Mettur Organics<br>S.F No. T.S.6(Part), Plot No.8<br>P.N.Patti Village Mettur Taluk<br>Salem District | Green small | Vegetable oil | Liquid detergent | Formulation unit |
| | | | Sulphuric Acid | Turkey red oil | |
| | | | Linear Alkyl Benzene Sulphonic Acid (LABSA) | | |
| | | | Urea | | |
| | | | Caustic soda | | |

Apart for the above industries Light Engineering units, Stone crushers & Fly ash block manufacturing units are located within 5 KM radius of M/s Chemplast Sanmar Industries

District Environmental Engineer,
Tamil Nadu Pollution Control Board,
Salem.

17/10/2023

**ANNEXURE II**

**SPATIAL DISTRIBUTION OF POLLUTANTS IN THE SURVEYED AREA**

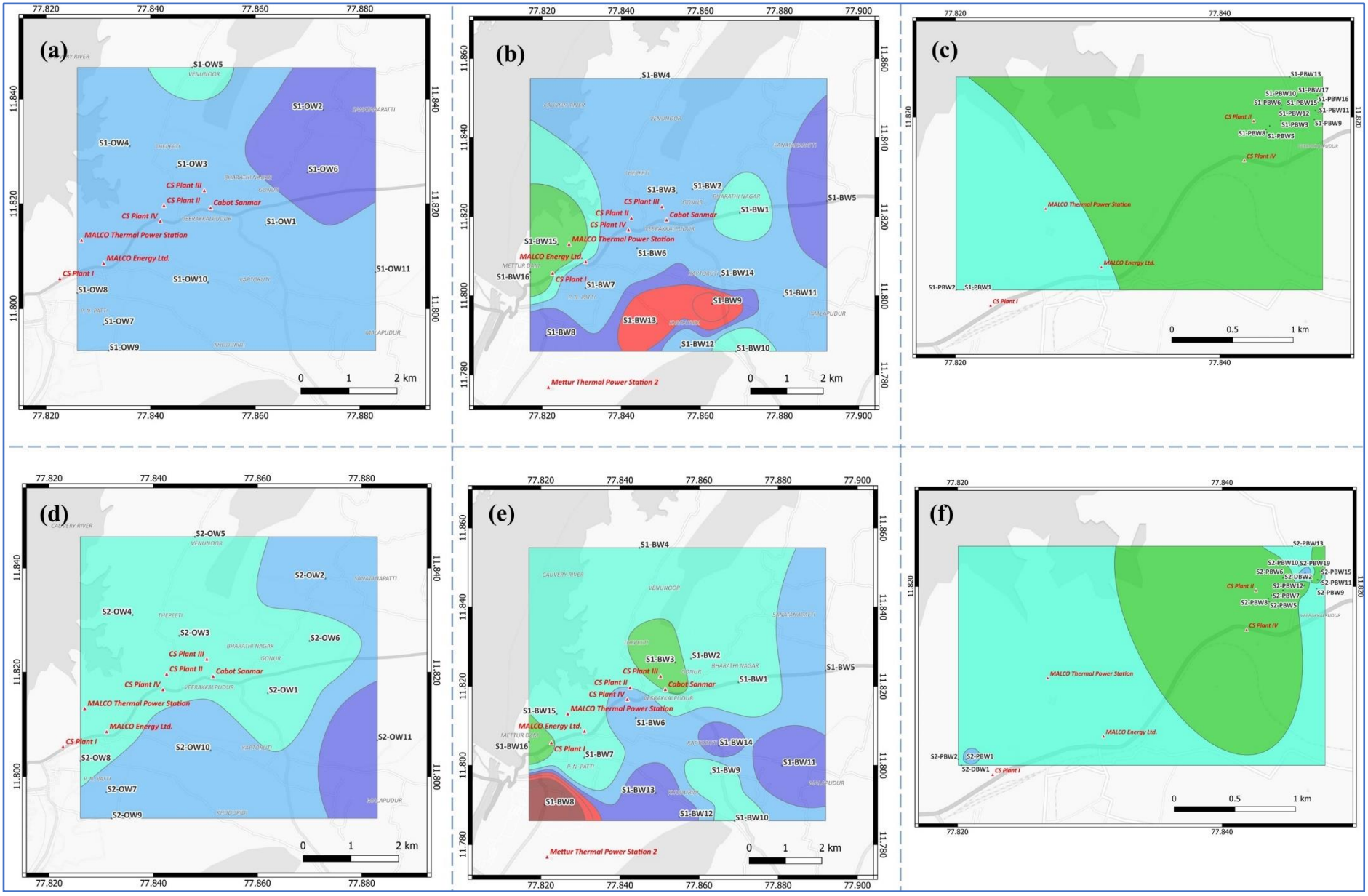



**Figure AII. 1.** Variation of total dissolved solids during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

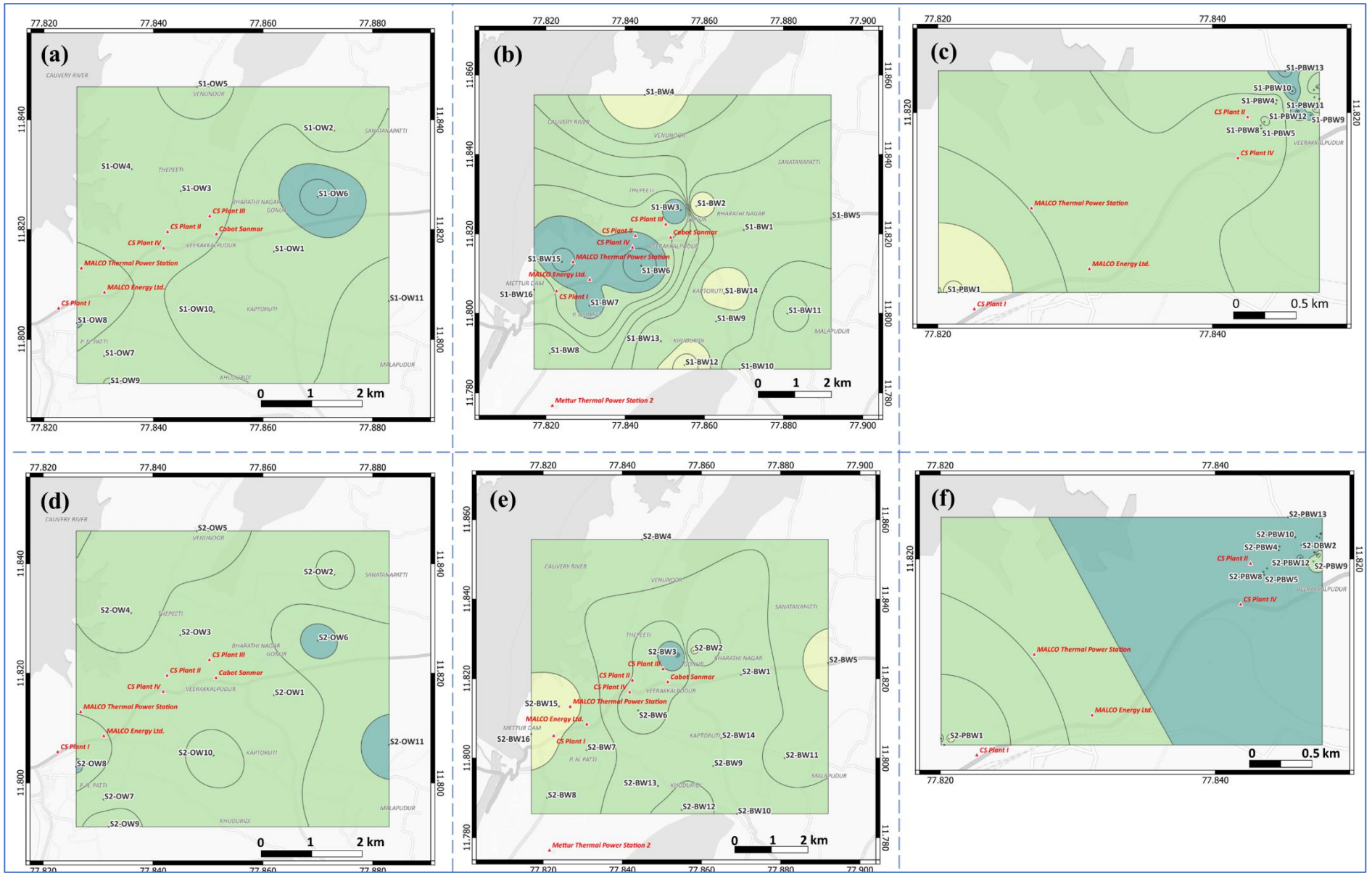



**Figure AII. 2.** Variation of electrical conductivity during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

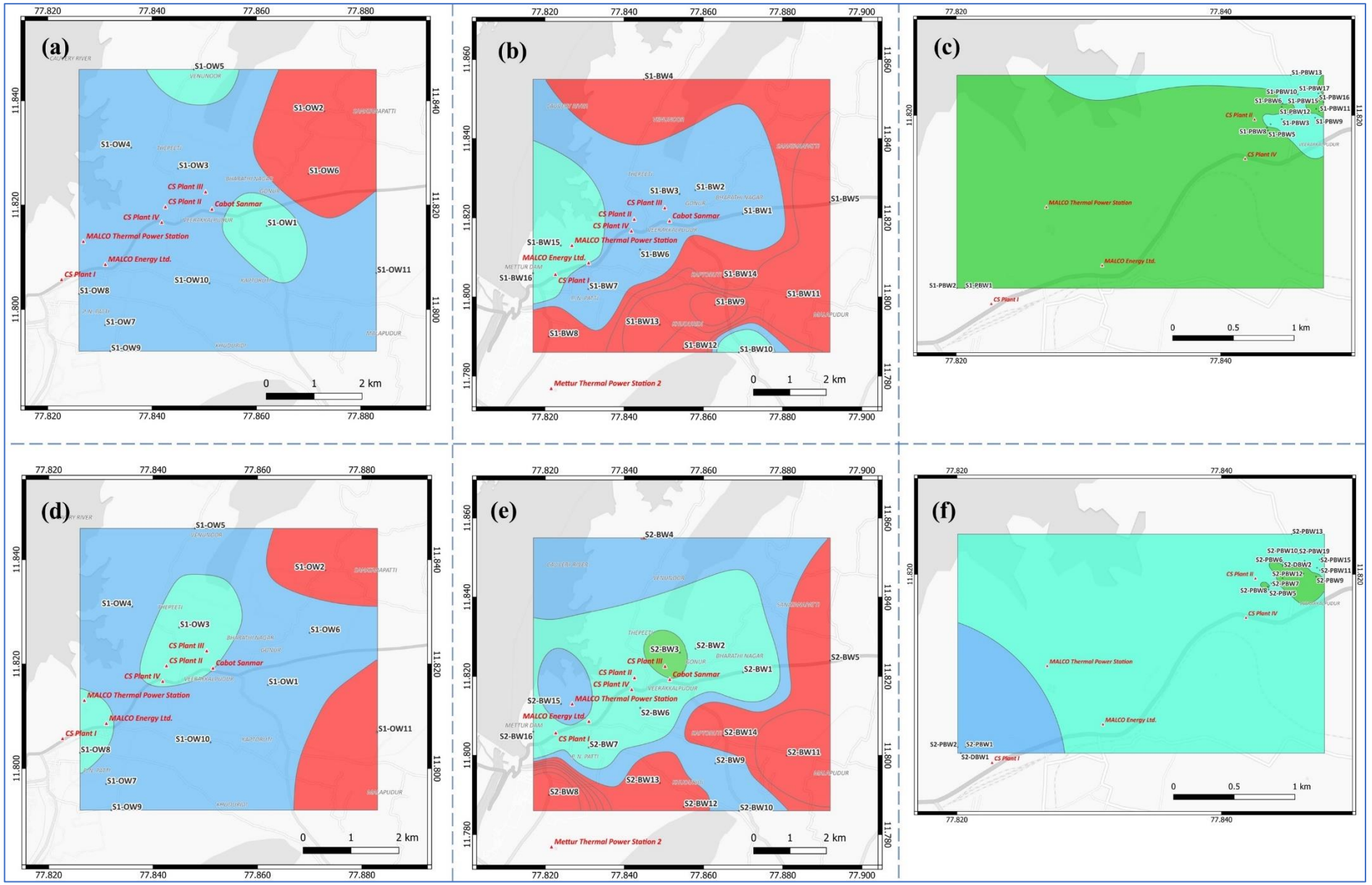



**Figure AII. 3.** Variation of groundwater hardness during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

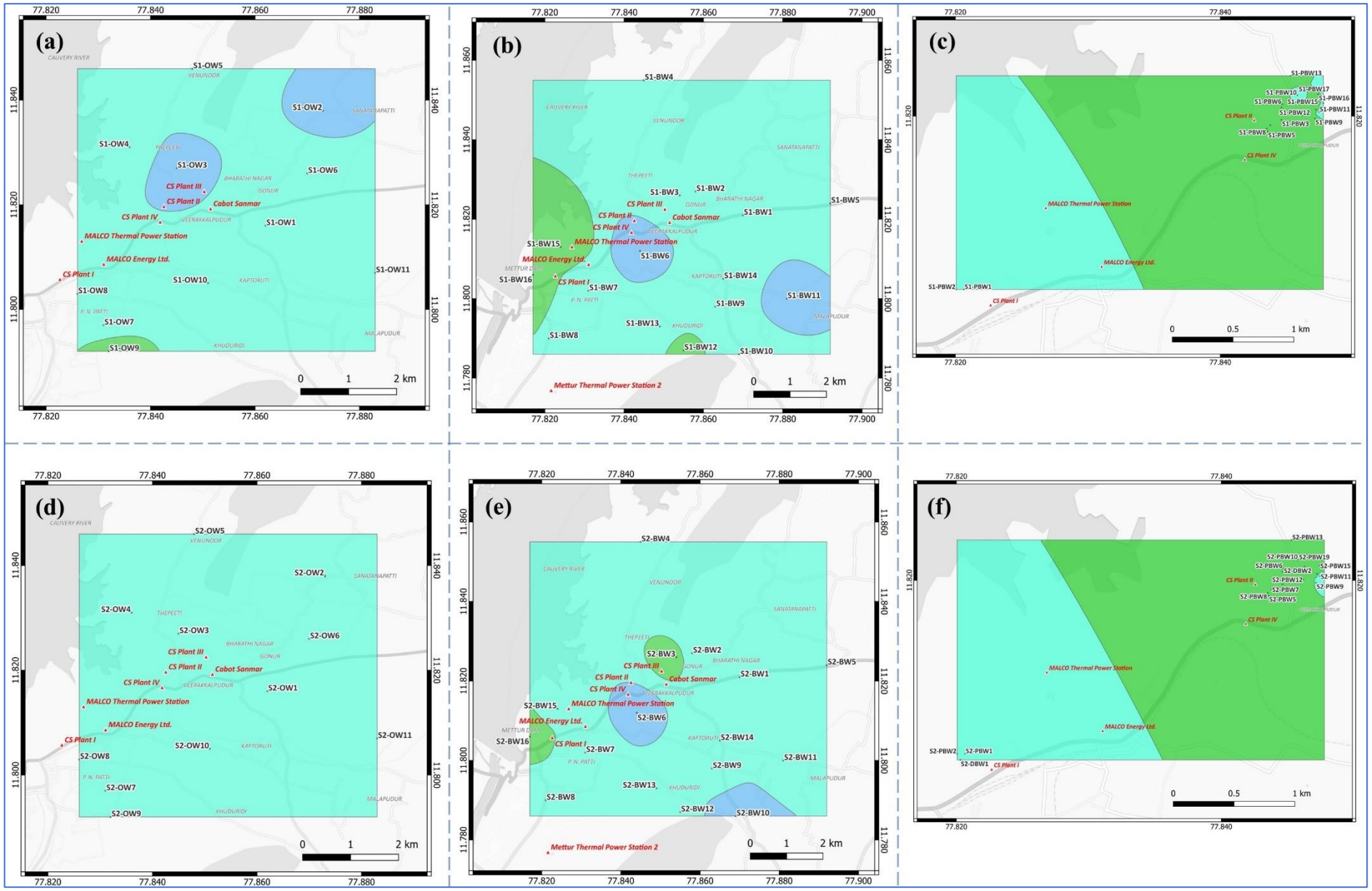



**Figure AII. 4.** Variation of groundwater alkalinity during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF) samplings

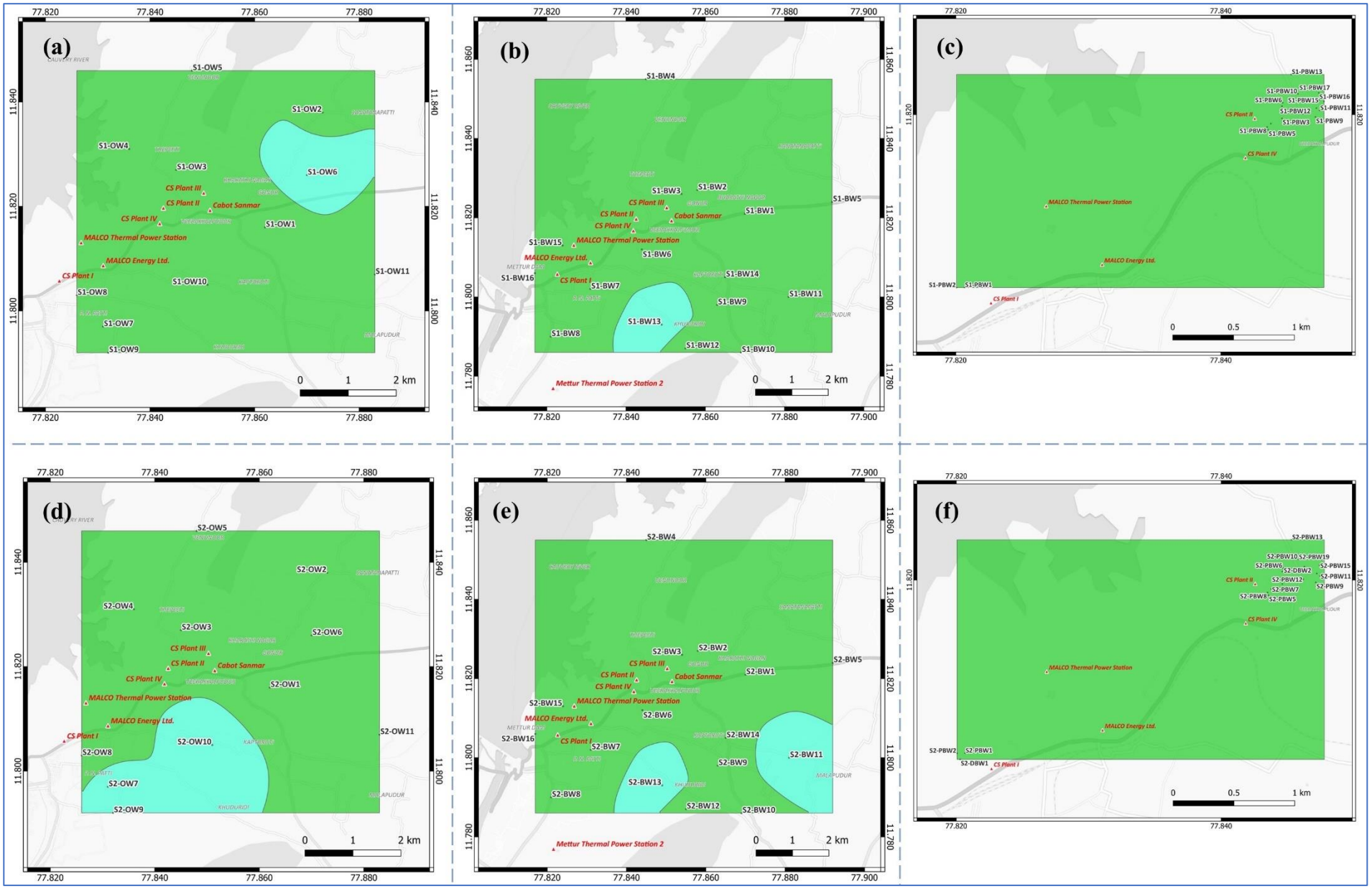



**Figure AII. 5.** Variation of $Cl^-$ in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

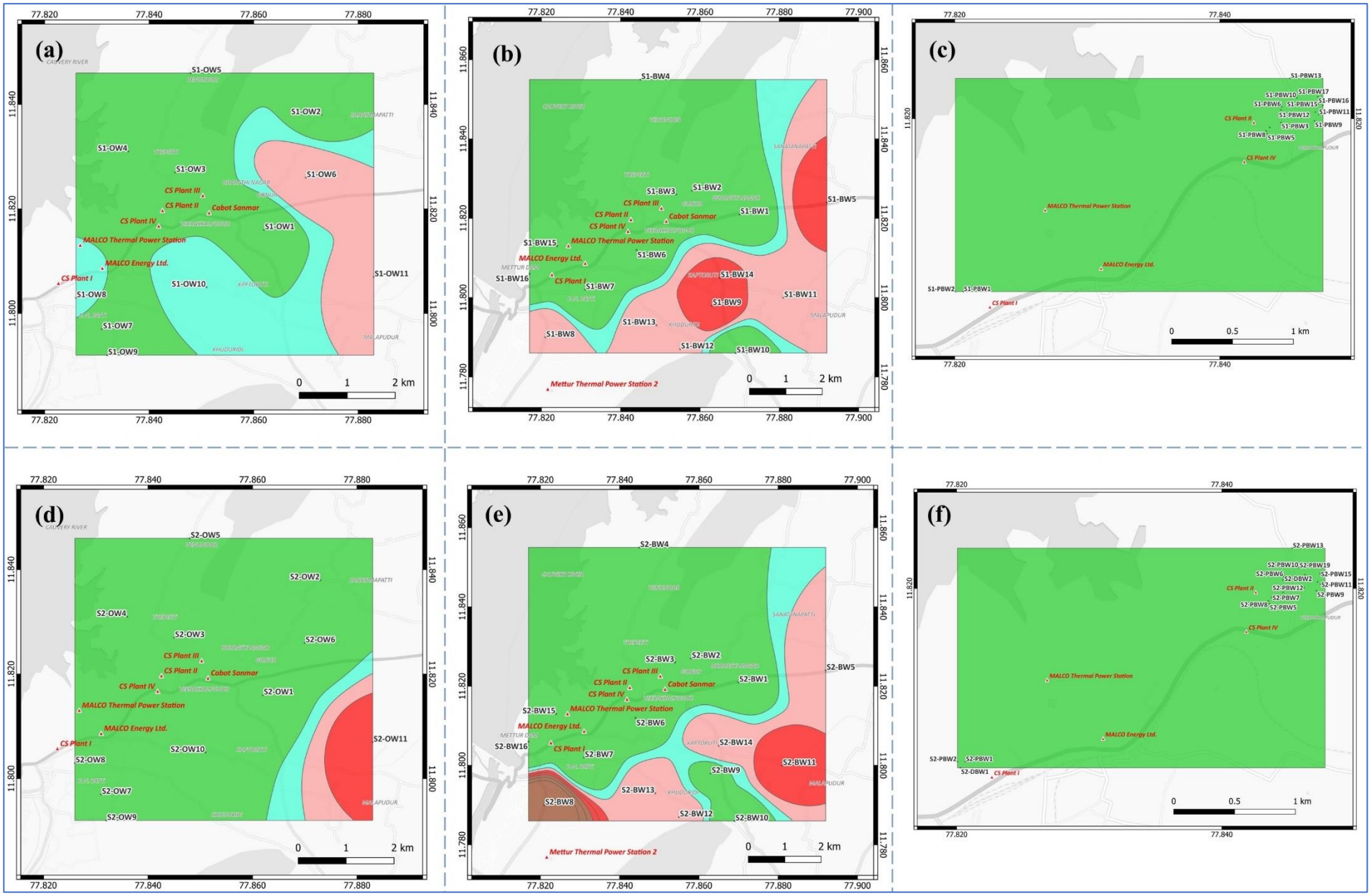



**Figure AII. 6.** Variation of $SO_4^{2-}$ in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

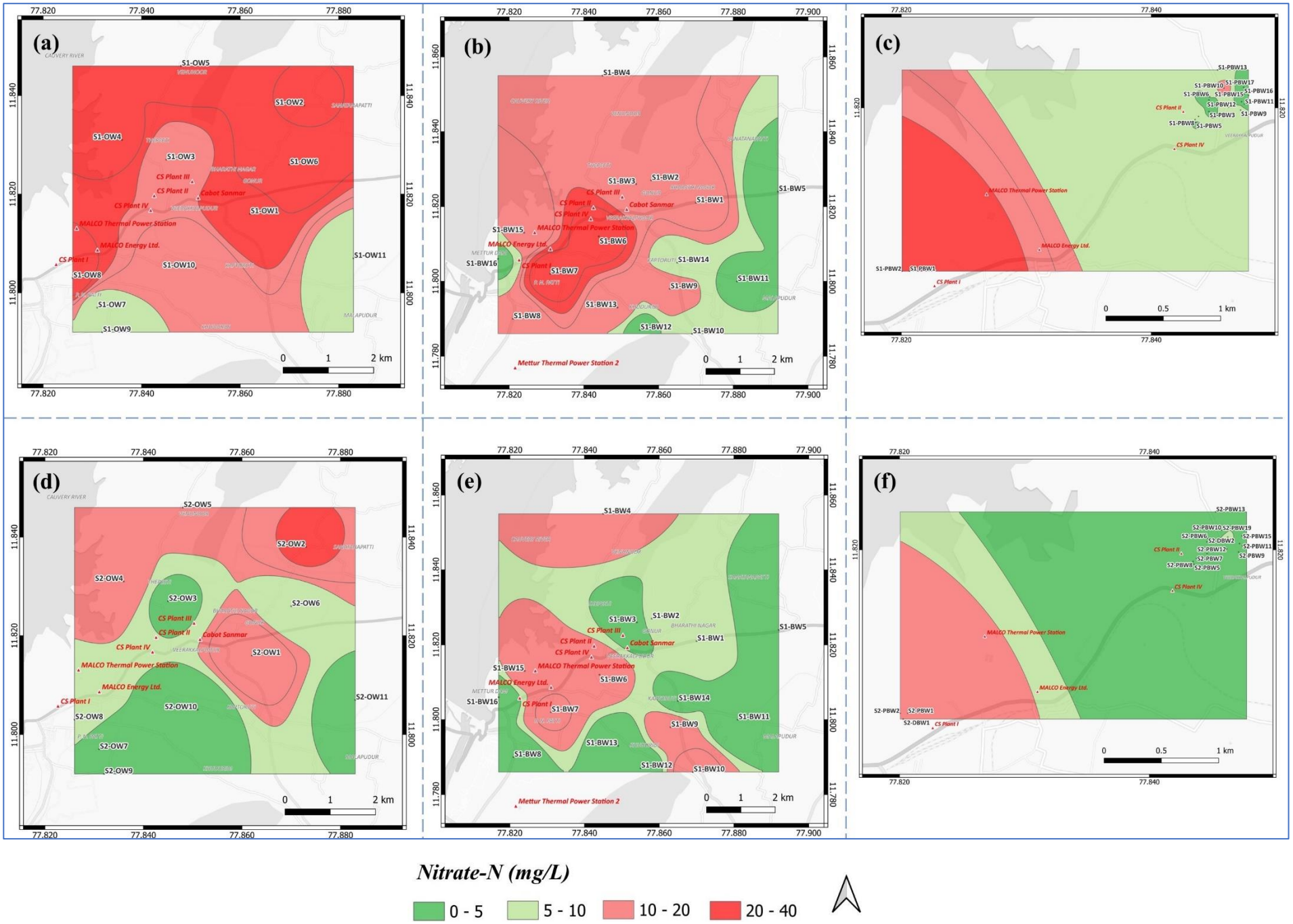



**Figure AII. 7.** Variation of $NO_3^-$-N in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

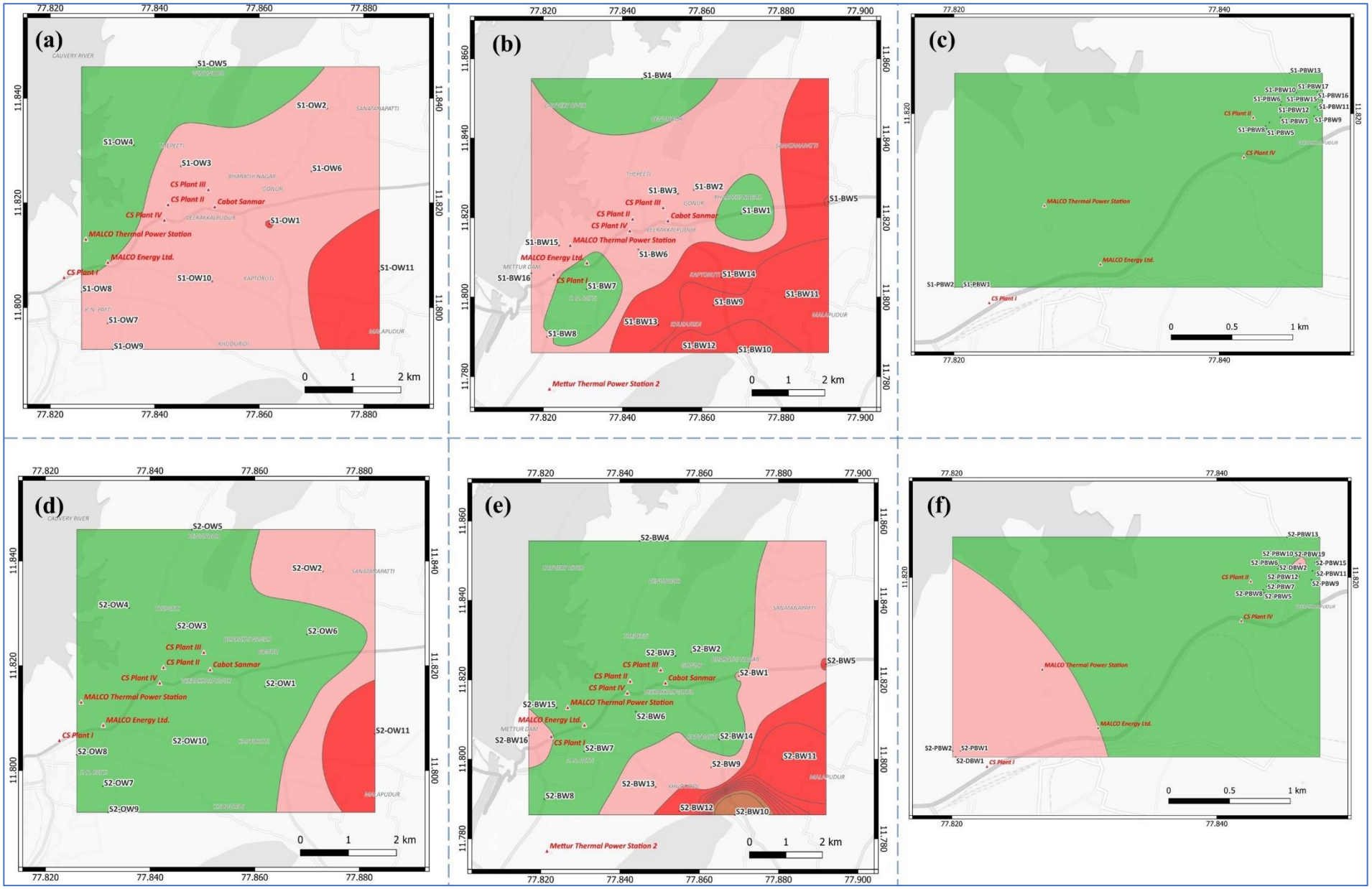



**Figure AII. 8.** Variation of $NH_3$-N in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

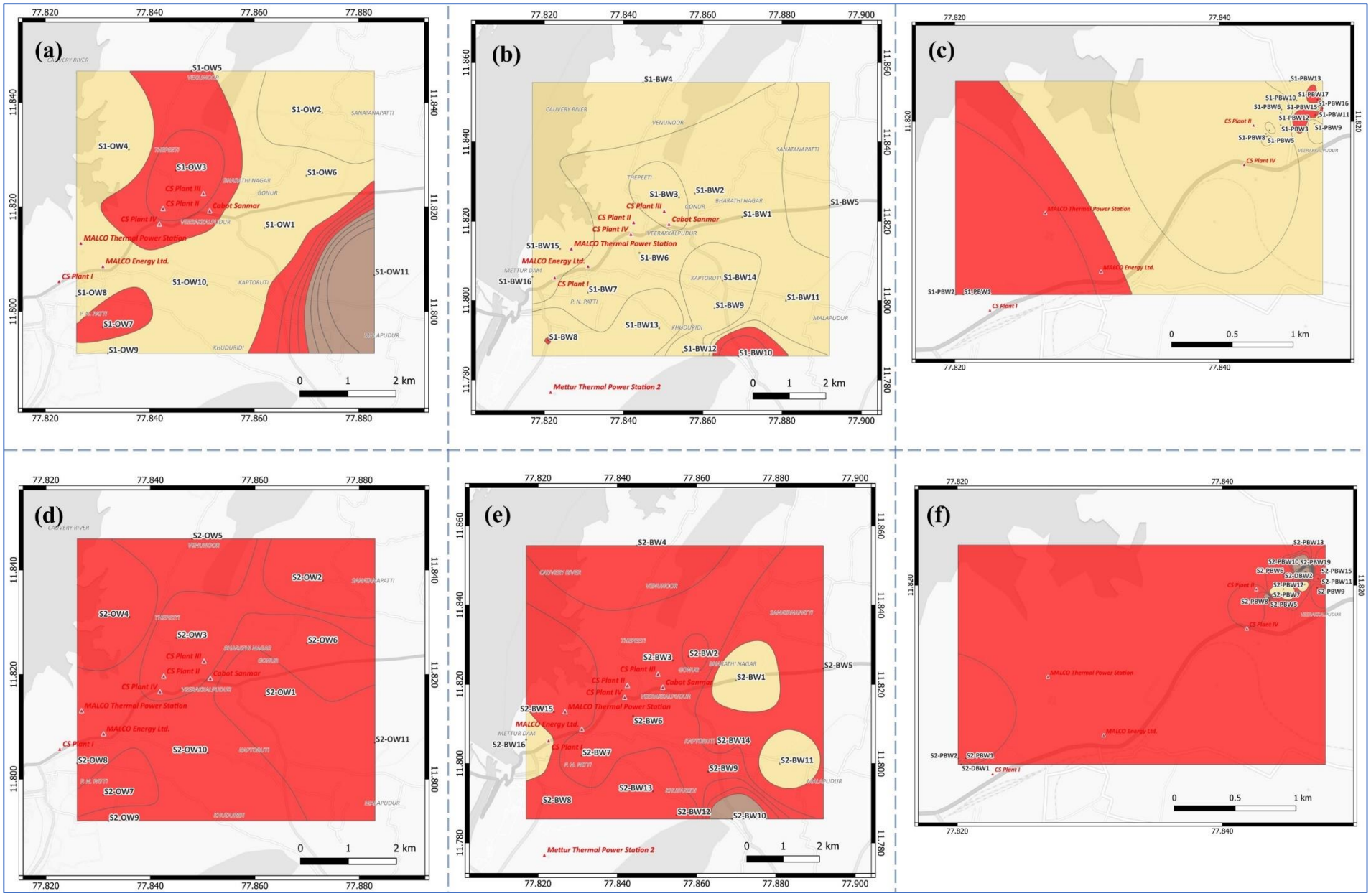



**Figure AII. 9.** Variation of $PO_4^{3-}$ in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

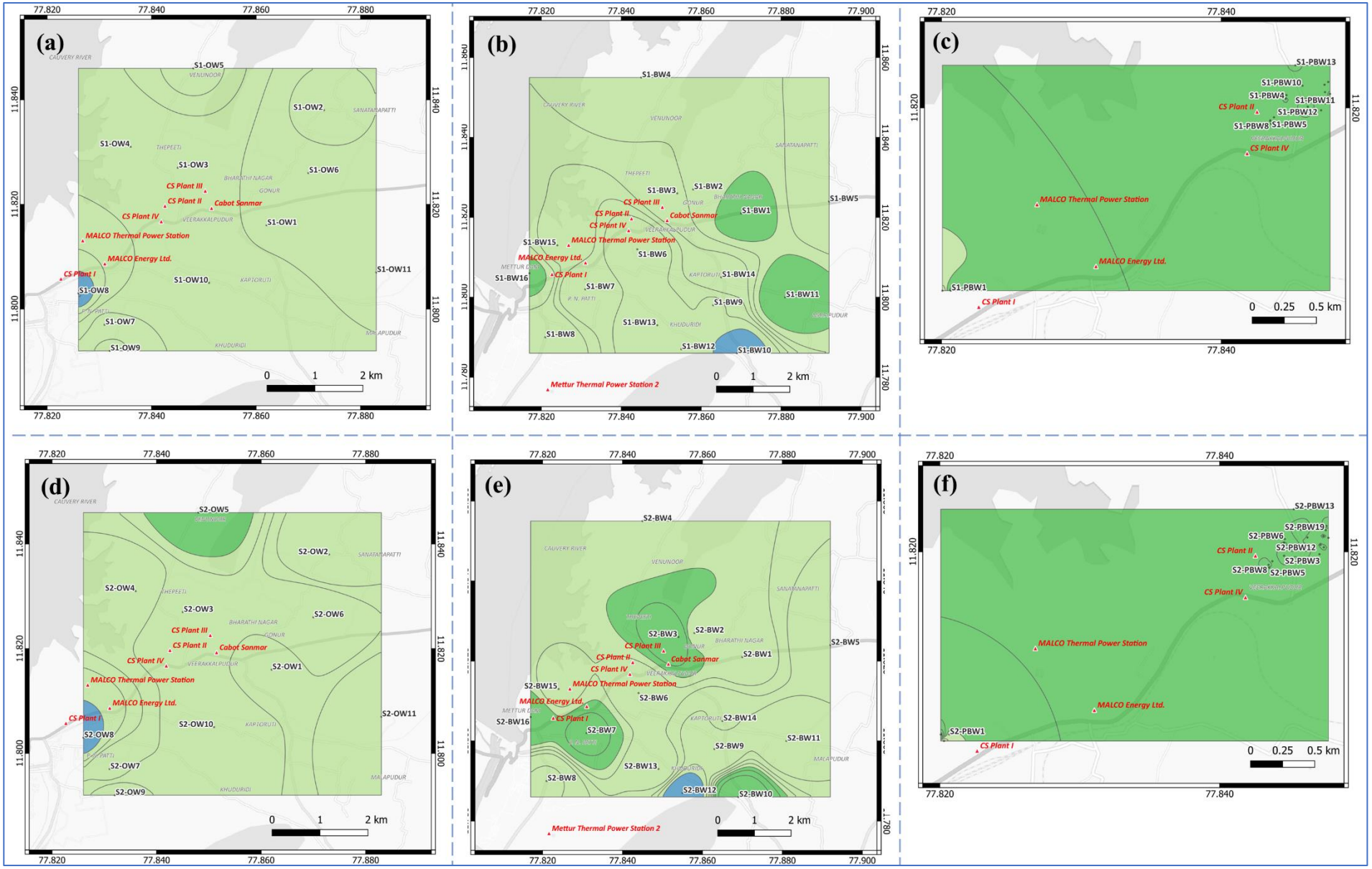



**Figure AII. 10.** Variation of fluoride in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

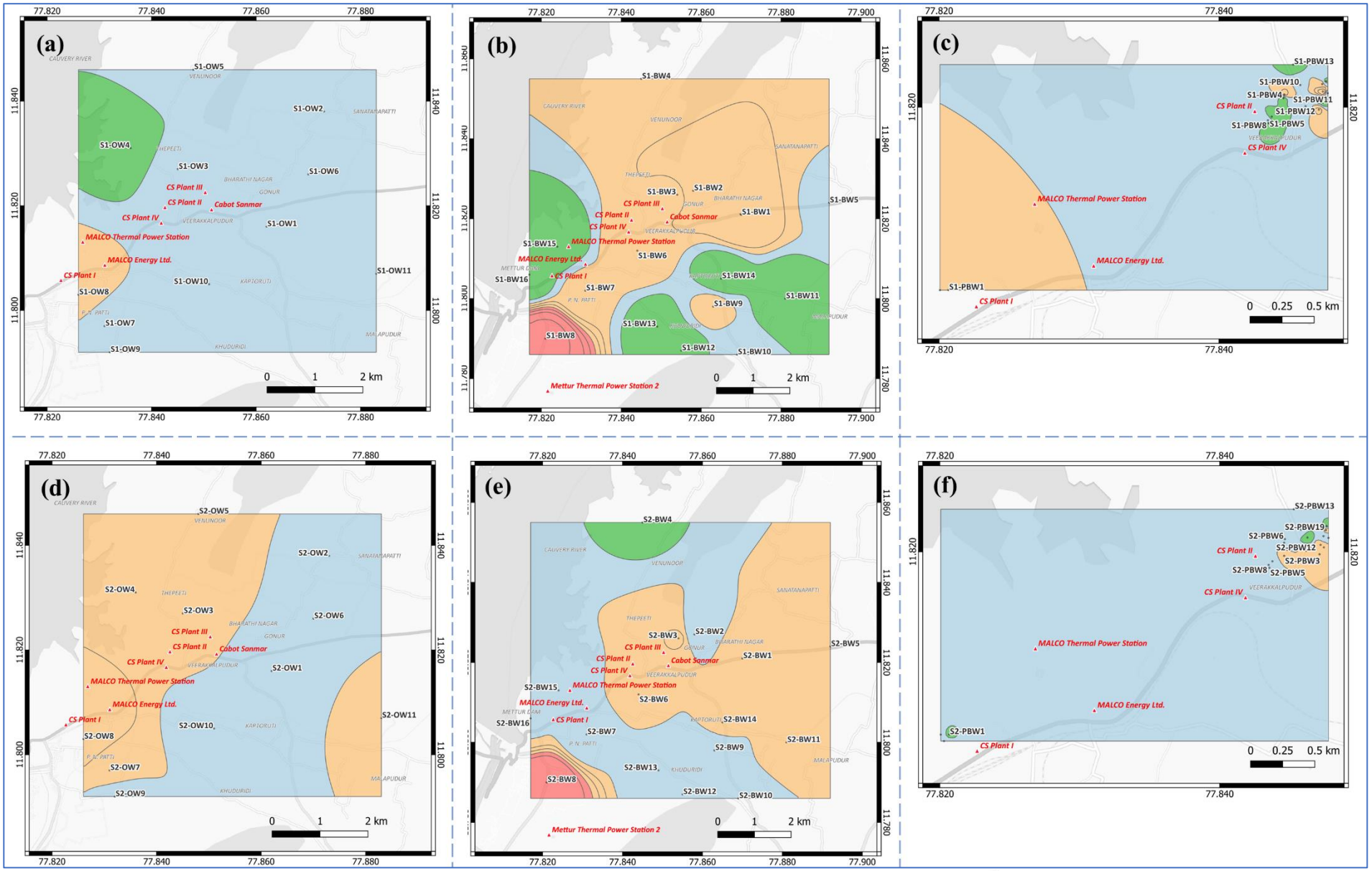



**Figure AII. 11.** Variation of chemical oxygen demand in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

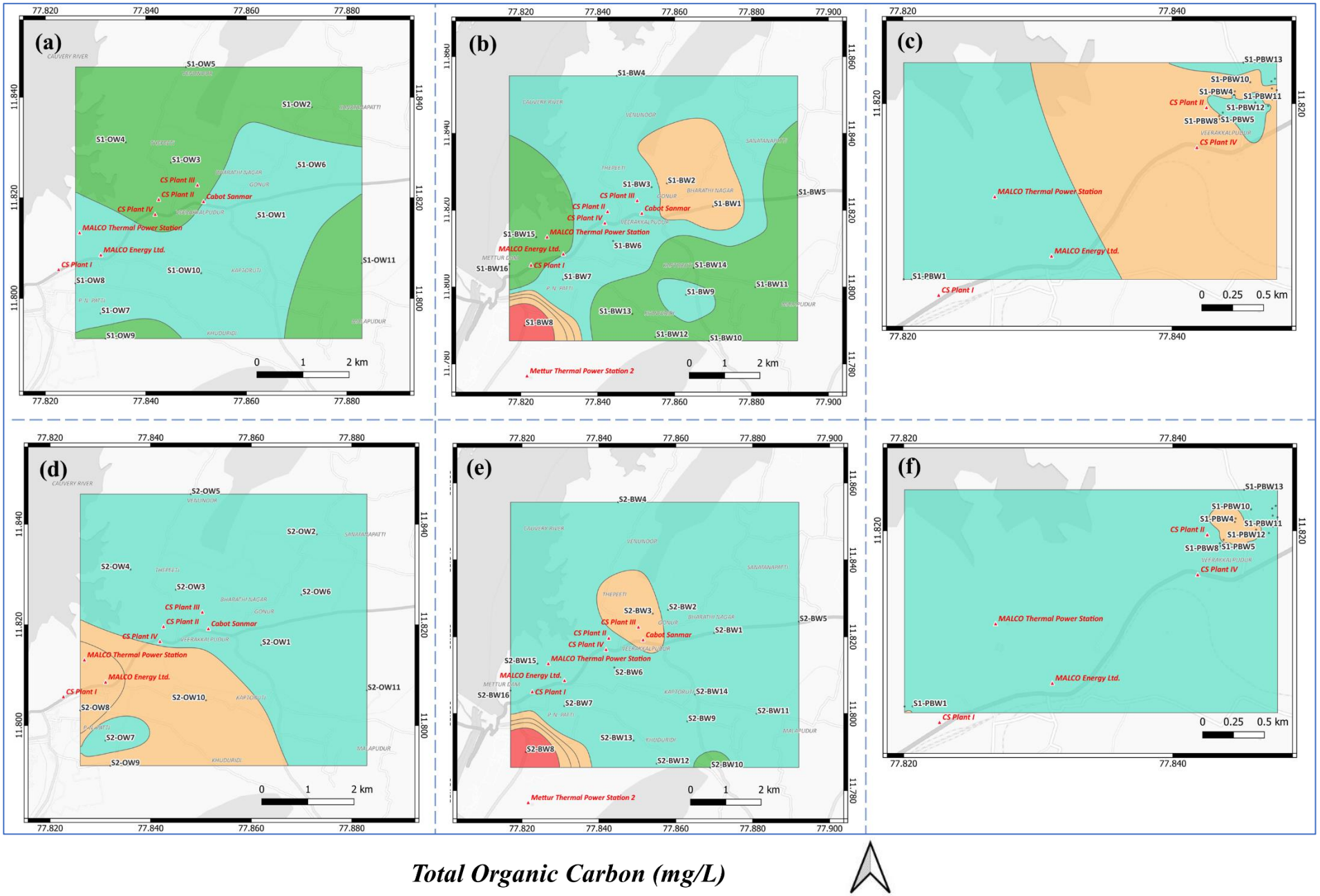



**Figure AII. 12.** Variation of total organic carbon in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

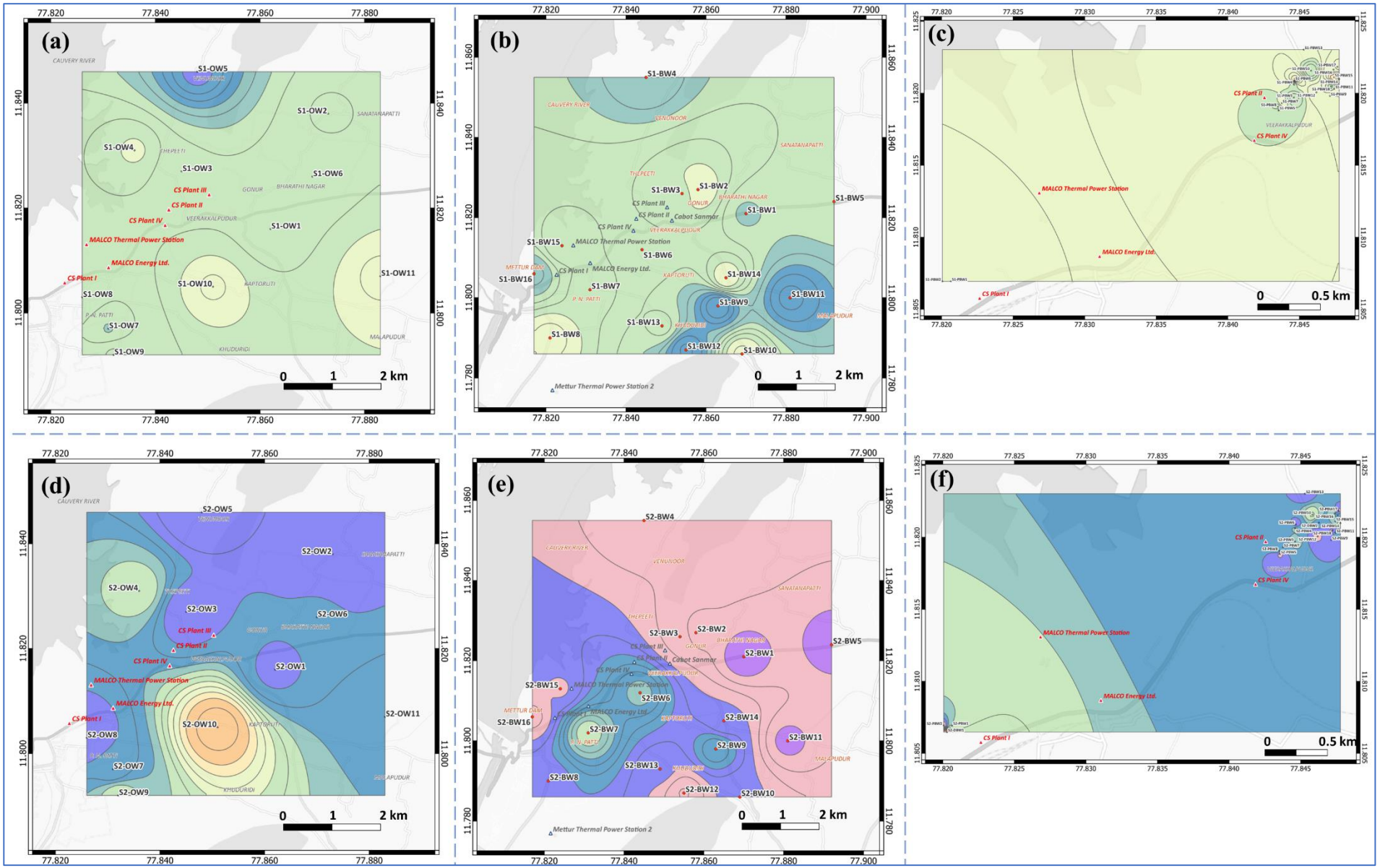



**Figure AII. 13.** Variation of dissolved oxygen in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

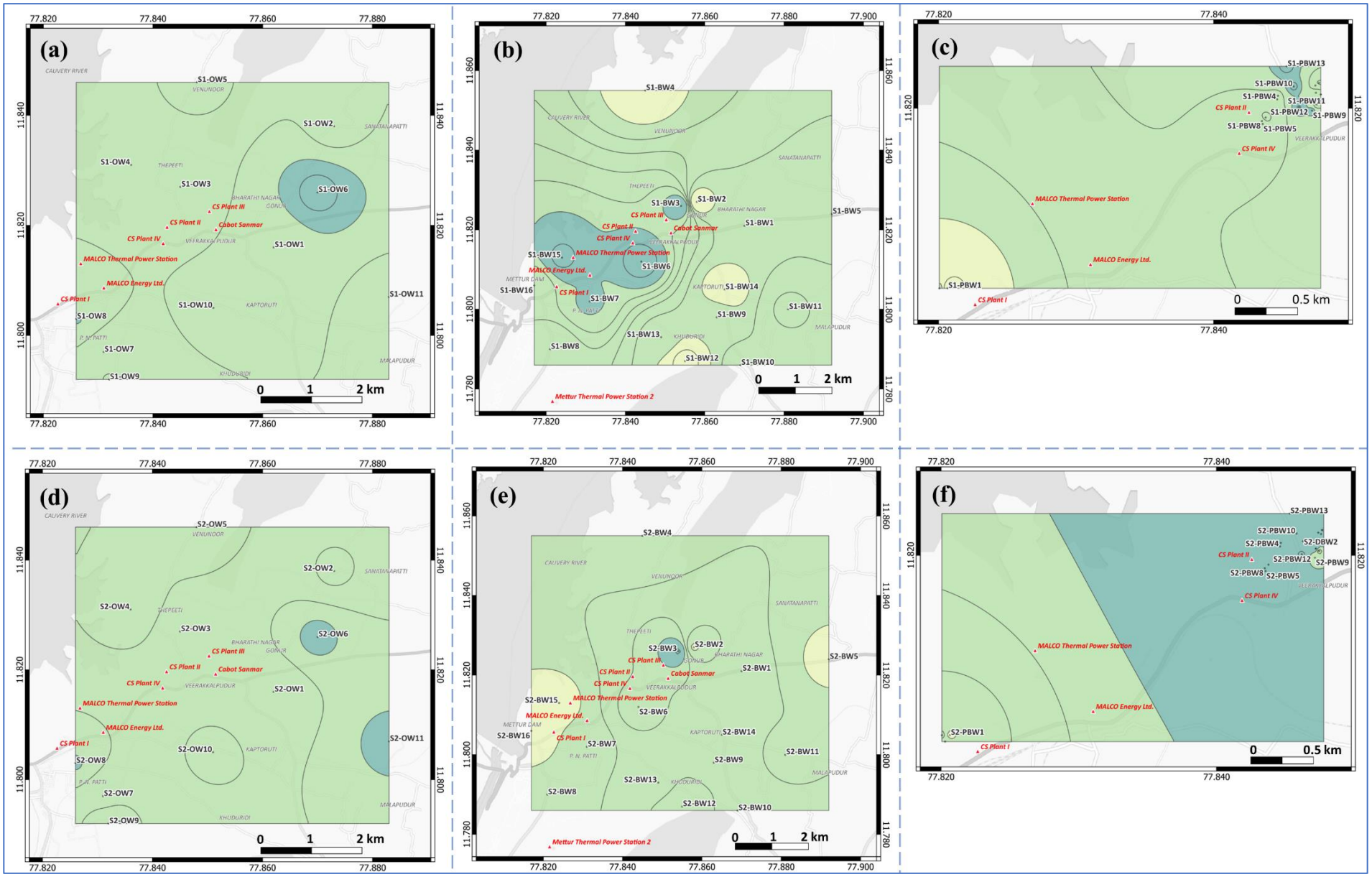



**Figure AII. 14.** Variation of pH in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

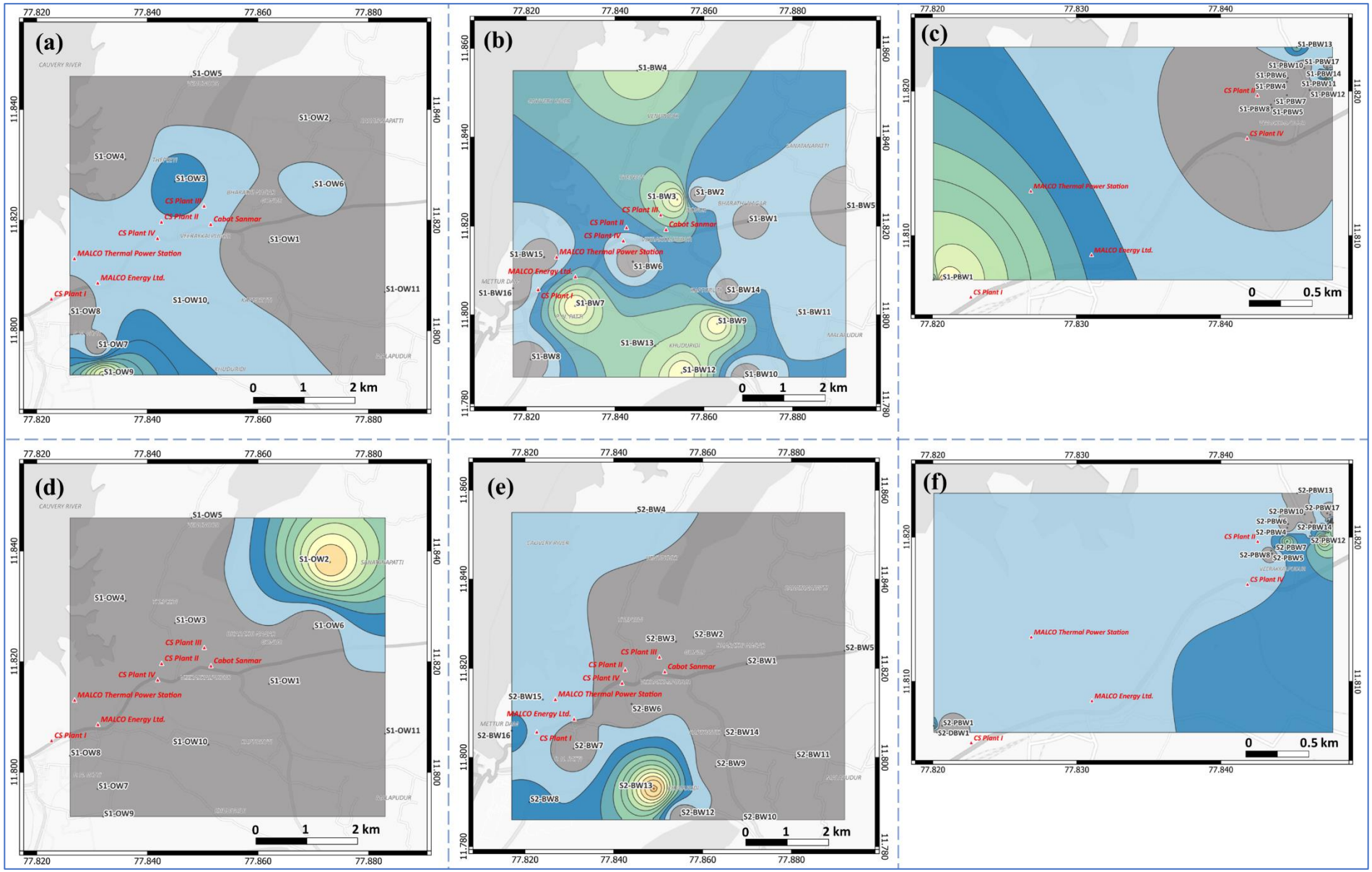



**Figure AII. 15.** Variation of coliforms in groundwater during pre-monsoon (a: OW, b: BW, c: SLF) and post-monsoon (d: OW, e: BW, f: SLF)

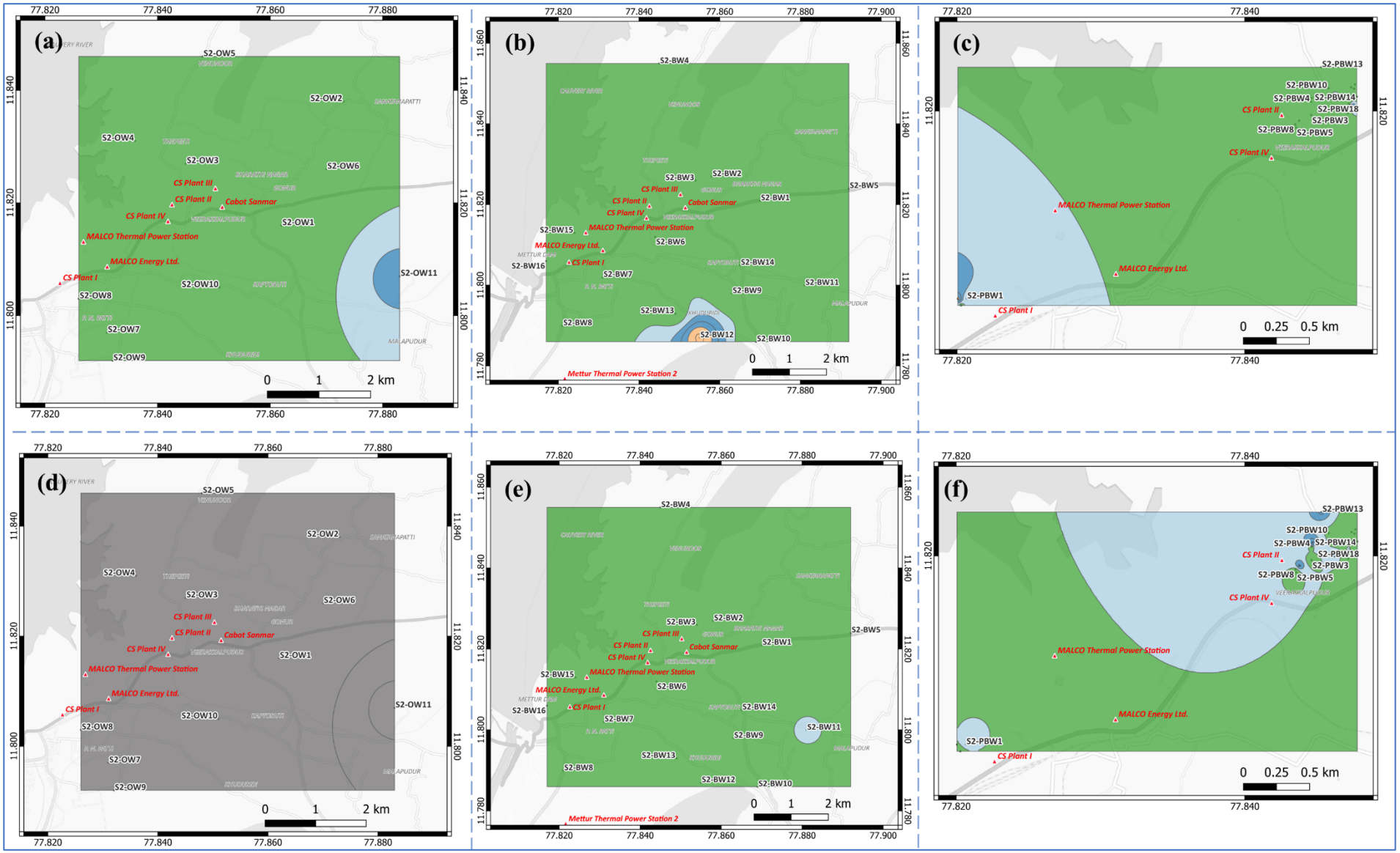



**Figure AII. 16.** Metal concentration in groundwater during post-monsoon for Nickel (a: OW, b: BW, c: SLF) and Lead (d: OW, e: BW, f: SLF)

## ANNEXURE III

**Procedures for analysis of physicochemical and biological parameters**

Total dissolved solids and total suspended solids were measured by APHA 2540 B and APHA 2540 D, respectively. Briefly, 100 mL of the sample was mixed thoroughly and was filtered through a pre-weighed Whatman GF/A 47 mm filter paper by vacuum filtration. The filter paper was evaporated to dryness and the particles retained on the filter paper was measured using a Wensar weighing balance. The difference between the weight of the filter paper before and after filtration will give TSS. TDS was measured by taking 40 mL of filtered sample in a pre-weighed crucible and evaporating it to dryness at 105 °C. The difference between the weight of the crucible before sample addition and after sample drying will give TDS.

Total alkalinity was measured by the APHA 2320 B titration method. Briefly, 25 mL of the unfiltered sample was taken in a conical flask and titrated against 0.02 N $H_2SO_4$ solution with methyl orange as the indicator. Appearance of a pink colour determines the end point of titration. The amount of acid consumed will determine the alkalinity and is expressed in mg/L as $CaCO_3$.

Hardness of the sample was determined by APHA 2340 C- EDTA titrimetric method. Briefly, 25 mL of sample was adjusted to a pH of 10 ±0.2 by using an ammonia buffer and titrated against 0.02 N EDTA solution. The appearance of a blue colour determines the end point of titration. The amount of EDTA consumed will determine the hardness and is expressed in mg/L as $CaCO_3$.

Chlorides ($Cl^-$) was measured using the APHA 4500-$Cl^-$ B, Argentometric titration method. Briefly, the 25 mL of the sample was titrated against 0.01 N $AgNO_3$ solution by using a 5% $K_2CrO_4$ as the indicator. The appearance of a pinkish white or yellow precipitate determines the end point of the titration.

Sulphates ($SO_4^{2-}$) were measured using APHA 4500 – $SO_4^{2-}$ E Turbidimetric method. Briefly, 20 mL of the sample was mixed with a pinch of $BaCl_2$ salt and the turbidity of the resultant colloidal suspension was measured using a Hach TN100 turbidity meter. A calibration curve plotted

between the turbidity and the concentration of samples with known sulphate was used to know the concentration of sulphate in the unknown sample.

Phosphates ($PO_4^{3-}$) were measured using APHA 4500-$PO_4^{3-}$ Stannous chloride method. 25 mL of sample was adjusted to a pH less than 8 with the help of a phenolphthalein indicator and strong acid (30% $H_2SO_4$, 0.4% $HNO_3$ in water) solution. 1 mL of acidified ammonium molybdate was added to this solution and mixed thoroughly. Then, a drop of stannous chloride solution (2.5% $SnCl_2$ in glycerol) was added for colour formation. The sample's optical density was measured at 690 nm. The concentration of $PO_4^{3-}$ was estimated with the help of a calibration curve plotted with known $PO_4^{3-}$ concentrations.

Fluorides ($F^-$) were measured by APHA 4500-$F^-$ D SPADNS method. To 10 mL of sample, 0.1 mL of 5% $NaAsO_2$ was added to remove interference due to oxidising substances. To this, 1 mL of zirconyl-SPADNS reagent was added and the absorbance was measured at 570 nm. The reduction in colour from the sample is compared to a reagent blank and is proportional to the $F^-$ concentration in the sample. The concentration was estimated with the help of a calibration graph plotted for samples with known $F^-$ concentration.

The Chemical oxygen demand (COD) was estimated by APHA 5220 C closed reflux $K_2Cr_2O_7$ oxidation method. 2.5 mL sample was taken in a digestion vial with 1.5 mL 0.1 N $K_2Cr_2O7$ and 3.5 mL con. $H_2SO_4$ solutions. The samples were digested at 150 °C for 2 h. The $K_2Cr_2O_7$ consumed is estimated by titrated against a standard 0.01 N ferrous ammonium sulphate solution and is reported as COD.

The TOC and TN were measured by Analytik Jena multi-N/C TOC/TN analyser. The instrument analyses TOC by combusting the sample at 700 °C and measuring the released $CO_2$ with a near-distant infrared (NDIR) sensor calibrated for $CO_2$. TN is measured similarly by oxidising the sample and measuring the released $NO_2$ with a chemiluminescent sensor.

The total coliforms were estimated by APHA 9215 C Heterotrophic plate count method but with a coliform selective MacConkey agar media. Briefly, 0.5 mL sample was spread plated on MacConkey agar plates and incubated at 37 °C for 1-2 days. The pink colonies with a precipitated

bile layer on their surrounding were confirmatory for total coliform bacteria. The positive colonies were counted using a colony counter.

For heavy metal analysis, the acid stabilised samples were filtered with a 0.22 μm nylon filter and then used for analysis by the ICP-MS instrument with commercial standards. For soil samples, 0.5 g of dried, crushed and sieved (2 μm) soil sample was digested in a closed reflux at 90 °C with 5 mL $HNO_3$ for 2 h and the final digested sample was made upto 100 mL with deionised water. The samples were taken for analysis by ICP-MS.

# ANNEXURE IV

## Summary Sheets

**Sampling Point Identification Number:** S1-OW 1

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.816 | Type of Sample | Bore Well | |
| | Longitude | : | 77.862 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 50 years back | Depth of Well | 30 ft – 40 ft |
| Distance from Chemplast | 1 – 2 Km | Quadrant as per MAP | II |
| Name of the Owner | Muthusamy | | |
| Address | 2/2/43, Kunjandiyur<br>Chittarrkadur | | |
| No. of people living | 4 | | |
| Purpose of Water usage | Agricultural (5 acres) | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Intermittent – weekly once or 3 days once | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Open disposal (gardening) | | | |
| Method of Solid waste disposal in the location | Open burning | | | |
| Parameters Measured at site and their value | pH | 6.53 | Temp (°C) | 30.1 |
| | ORP (mV) | 128.2 | Conductivity (µS/cm) | 1253 |
| | Turbidity (NTU) | 2.47 | | |
| | Ammonia (mg/l) | 1 | Nitrate (mg/l) | 26.6 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Motor Hp :7.5/5; Water level in the well (from GL): 5.5m

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 8:50 PM

**Sampling Point Identification Number:** S1-OW 2

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.838 | Type of Sample | Bore Well | |
| | Longitude | : | 77.873 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 1990 | Depth of Well | 60 ft |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | II |
| Name of the Owner | Meganathan (S/o chinnappan) | | |
| Address | Seathai thanempatti,<br>Aardikarai (past)<br>Mettur | | |
| No. of people living | Agricultural | | |
| Purpose of Water usage | Agricultural | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Daily 8 hrs | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |
| Type of Sewage disposal in the location | Open disposal | | | |
| Method of Solid waste disposal in the location | Agricultural | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.71 | Temp (°C) | 29.4 |
| | ORP (mV) | 112.5 | Conductivity (µS/cm) | 1790 |
| | Turbidity (NTU) | 1.3 | | |
| | Ammonia (mg/l) | 0.5 | Nitrate (mg/l) | 30.1 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water level – 4.90 m; Water pump – 5 Hp; 4 acres cultivated; water is available throughout the year.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 10:30 PM

**Sampling Point Identification Number:** S1-OW 3

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.827 | Type of Sample | Bore Well | |
| | Longitude | : | 77.845 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 1980 | Depth of Well | 60 ft |
| Distance from Chemplast | 1 – 2 Km | Quadrant as per MAP | I |
| Name of the Owner | Maanguppan | | |
| Address | Kozhi pannai,<br>Thippampatti, Konnur west | | |
| No. of people living | Agricultural and commercial supply | | |
| Purpose of Water usage | Agricultural | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 3-4 hrs per day (based on requirement) | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |
| Type of Sewage disposal in the location | Agriculture - Open disposal | | | |
| Method of Solid waste disposal in the location | Agricultural | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.69 | Temp (°C) | 30.1 |
| | ORP (mV) | 146.5 | Conductivity (µS/cm) | 1575 |
| | Turbidity (NTU) | 0.36 | | |
| | Ammonia (mg/l) | 0.6 | Nitrate (mg/l) | 17.9 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Agricultural land – 3 acres; water level – 6.4 m; pump – 5 Hp; paddy and groundnut cultivated; earlier smell was there but not in recent years.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 11:15 PM

**Sampling Point Identification Number:** S1-OW 4

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.831 | Type of Sample | Bore Well | |
| | Longitude | : | 77.836 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 2008 | Depth of Well | 80 ft |
| Distance from Chemplast | 1 – 2 Km | Quadrant as per MAP | VIII |
| Name of the Owner | Aruswamy | | |
| Address | Thippam patti, Mettur | | |
| No. of people living | Agricultural | | |
| Purpose of Water usage | Agricultural | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Daily pumping (4-8 hrs based on power) | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |
| Type of Sewage disposal in the location | Agriculture - Open disposal | | | |
| Method of Solid waste disposal in the location | Agricultural | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.75 | Temp (°C) | 29.5 |
| | ORP (mV) | 152.2 | Conductivity (µS/cm) | 1128 |
| | Turbidity (NTU) | 0.76 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 26 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Close to river; water level – 3.5m; water quality is not changed; Motor: 5 Hp; used for bathing and washing.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 11:35 AM

**Sampling Point Identification Number:** S1-OW 5

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.846 | Type of Sample | Bore Well | |
| | Longitude | : | 77.848 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 1980 | Depth of Well | 40 ft (80 ft initially) |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | VIII |
| Name of the Owner | Ponnuswamy | | |
| Address | Veeranoor, konnur post, Mettur | | |
| No. of people living | Agricultural and drinking | | |
| Purpose of Water usage | Daily 4 hrs per day | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 3-4 hrs per day (based on requirement) | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |
| Type of Sewage disposal in the location | Nothing | | | |
| Method of Solid waste disposal in the location | Open (collection→ door to door) | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.49 | Temp (°C) | 29.5 |
| | ORP (mV) | 154.5 | Conductivity (µS/cm) | 1098 |
| | Turbidity (NTU) | 0.26 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 26.3 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water level: 5.2 m; pump: 5 Hp; Algal growth is seen.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 11:50 AM

**Sampling Point Identification Number:** S1-OW 6

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.826 | Type of Sample | Bore Well | |
| | Longitude | : | 77.87 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 1970 | Depth of Well | 1.75 m |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | I |
| Name of the Owner | Govindaraj | | |
| Address | Madathappatti,<br>Konnur post,<br>Mettur | | |
| No. of people living | Agricultural | | |
| Purpose of Water usage | Agricultural | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 4-8 hrs per day in the morning | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 8.31 | Temp (°C) | 30.1 |
| | ORP (mV) | 149.9 | Conductivity (µS/cm) | 2350 |
| | Turbidity (NTU) | 2.23 | | |
| | Ammonia (mg/l) | 0.5 | Nitrate (mg/l) | 27.6 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water close to ground level; ground water level: 1.75 m; water colour- pale green; pump- 5Hp; acres: 8; drinking purpose usage.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 3:10 PM

**Sampling Point Identification Number:** S1-OW 7

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.797 | Type of Sample | Bore Well | |
| | Longitude | : | 77.831 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 1980 | Depth of Well | 60 ft |
| Distance from Chemplast | 2 – 3 Km | Quadrant as per MAP | V |
| Name of the Owner | Paramasivam | | |
| Address | Karumalai koodal | | |
| No. of people living | Nil | | |
| Purpose of Water usage | Agricultural | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 8 hrs/day daily; irrigation – 8 acres | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.68 | Temp (°C) | 30.1 |
| | ORP (mV) | 156.8 | Conductivity (µS/cm) | 1122 |
| | Turbidity (NTU) | 0.96 | | |
| | Ammonia (mg/l) | 0.5 | Nitrate (mg/l) | 9 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water table at12 m; washing, bathing and agricultural purpose.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 3:55 PM

**Sampling Point Identification Number:** S1-OW 8

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.803 | Type of Sample | Bore Well | |
| | Longitude | : | 77.826 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 2017 | Depth of Well | 30 ft |
| Distance from Chemplast | 2 – 3 Km | Quadrant as per MAP | VI |
| Name of the Owner | K.S.Paramasivam | | |
| Address | SIDCO, Karumalai koodal, Mettur | | |
| No. of people living | Commercial service center | | |
| Purpose of Water usage | Commercial water service center (earlier) | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Daily 2 hrs/day pumping | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |

| | | | | | |
|---|---|---|---|---|---|
| Type of Sewage disposal in the location | Nil | | | | |
| Method of Solid waste disposal in the location | Door to door (not applicable) | | | | |
| Parameters Measured at site and their value | pH | 8.01 | Temp (°C) | : | 29.6 |
| | ORP (mV) | 207.2 | Conductivity (µS/cm) | : | 1692 |
| | Turbidity (NTU) | 2.73 | | | |
| | Ammonia (mg/l) | 0.5 | Nitrate (mg/l) | : | 27.4 |
| Photographs Taken | Yes ✓ No | | | | |

**Remarks (if any):**

Dark green colour- algal growth seen; Water available at 2-2.5 m; Near by main road (branch); wetting curry leaves (correct purpose).

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 04:25 PM

**Sampling Point Identification Number:** S1-OW 9

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.792 | Type of Sample | Bore Well | |
| | Longitude | : | 77.832 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 1995 | Depth of Well | 50 ft |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | V |
| Name of the Owner | Senkottaiyan | | |
| Address | Siruthengal, Kattoor. | | |
| No. of people living | Agricultural purpose for 2.5 acres | | |
| Purpose of Water usage | Agricultural and drinking | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Daily pumping -3 hrs | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good ✓ | Good | Poor | Average |
| Type of Sewage disposal in the location | Agriculture | | | |
| Method of Solid waste disposal in the location | Nil | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.59 | Temp (°C) | 31 |
| | ORP (mV) | 164.1 | Conductivity (µS/cm) | 961 |
| | Turbidity (NTU) | 0.69 | | |
| | Ammonia (mg/l) | 0.5 | Nitrate (mg/l) | 8.4 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water level is deep (30-40 ft); No complaints with water.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 05:30 PM

**Sampling Point Identification Number:** S1-OW 10

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.805 | Type of Sample | Bore Well | |
| | Longitude | : | 77.851 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 1960 - 1965 | Depth of Well | 25 ft |
| Distance from Chemplast | 1 – 2 Km | Quadrant as per MAP | IV |
| Name of the Owner | Thangamani | | |
| Address | Sarala kaadu,<br>Karuppu reddiyoor. | | |
| No. of people living | Agricultural | | |
| Purpose of Water usage | Agricultural (not good for drinking) | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Daily pumping well – 4 hrs/day | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.85 | Temp (°C) | 30.5 |
| | ORP (mV) | 154.2 | Conductivity (µS/cm) | 1720 |
| | Turbidity (NTU) | 1.02 | | |
| | Ammonia (mg/l) | 0.5 | Nitrate (mg/l) | 10.1 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water quality is getting better; water level – 6m; well with lot of debris but water is clear in outlet; 3 acres for irrigation purpose.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 05:50 PM

**Sampling Point Identification Number:** S1-OW 11

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.807 | Type of Sample | Bore Well | |
| | Longitude | : | 77.883 | | Open Well | ✓ |

| | | | |
|---|---|---|---|
| Date of installation | 1970 | Depth of Well | 50 ft |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | III |
| Name of the Owner | Radha (S/o) kaliyappa gounder | | |
| Address | Uthandi vatheru<br>Viruthachalam patti. | | |
| No. of people living | Agricultural | | |
| Purpose of Water usage | Agricultural | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 5 hrs/day daily | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |
| Parameters Measured at site and their value | pH | 7.71 | Temp (°C) | 29.1 |
| | ORP (mV) | 174.5 | Conductivity (µS/cm) | 1288 |
| | Turbidity (NTU) | 0.89 | | |
| | Ammonia (mg/l) | 1.2 | Nitrate (mg/l) | 7.3 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water level – 5-6 m from surface; well in between agricultural land; water is clear; not used for drinking.

**Date of Sampling:** 26/3/2023 **Time of Sampling:** 09:05 AM

**Sampling Point Identification Number:** S1-BW 1

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.821 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.870 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2017-2018 | Depth of Well | 700 ft |
| Distance from Chemplast | 2 – 3 Km | Quadrant as per MAP | II |
| Name of the Owner | Senthil | | |
| Address | Sammathuvapuram, Konnur posts. | | |
| No. of people living | Commercial sales purpose | | |
| Purpose of Water usage | For household and sales outside | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Based on requirement | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good ✓ | Good | Poor | Average |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Soak pit | | | |
| Method of Solid waste disposal in the location | Public collection | | | |
| Parameters Measured at site and their value | pH | 7.52 | Temp (°C) | 29.1 |
| | ORP (mV) | 132.9 | Conductivity (µS/cm) | 1005 |
| | Turbidity (NTU) | 0.25 | | |
| | Ammonia (mg/l) | 0.4 | Nitrate (mg/l) | 16.6 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Sales purpose; buyer opinion (very good rating); last 6 years of same water quality.


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 09:25 AM

**Sampling Point Identification Number:** S1-BW 2

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.827 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.858 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 30 years back | Depth of Well | 400 ft |
| Distance from Chemplast | 2 – 3 Km | Quadrant as per MAP | II |
| Name of the Owner | Common borewell | | |
| Address | Mottur borewell | | |
| No. of people living | Common usage by nearby households | | |
| Purpose of Water usage | Not used/ agricultural purpose | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Hand pump- Based on requirement | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.4 | Temp (°C) | 29.3 |
| | ORP (mV) | 177.5 | Conductivity (µS/cm) | 795 |
| | Turbidity (NTU) | 67.3 | | |
| | Ammonia (mg/l) | 0.8 | Nitrate (mg/l) | 15.4 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Hand pump in agricultural land; water was initially turbid; not used for longtime (ontime observation).

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 09:50 AM

**Sampling Point Identification Number:** S1-BW 3

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.826 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.85 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 1986 | Depth of Well | 220 ft |
| Distance from Chemplast | 1 – 2 Km | Quadrant as per MAP | II (between I &II ) |
| Name of the Owner | Thangadurai | | |
| Address | 1/15 mottur,<br>Gonur post,<br>Mettur dam-4 | | |
| No. of people living | 5 acres | | |
| Purpose of Water usage | Agriculture | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Nil | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Agricultural usage | | | |
| Method of Solid waste disposal in the location | Nil | | | |
| Parameters Measured at site and their value | pH | 8.1 | Temp (°C) | 29.4 |
| | ORP (mV) | 153 | Conductivity (µS/cm) | 1377 |
| | Turbidity (NTU) | 0.22 | | |
| | Ammonia (mg/l) | 0.7 | Nitrate (mg/l) | 15.1 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

No change in water quality with time; pump- 5 Hp.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 10:10 AM

**Sampling Point Identification Number:** S1-BW 4

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.855 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.845 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 1980 | Depth of Well | 700 ft |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | VIII |
| Name of the Owner | Common panchayat | | |
| Address | Konnur west (panchayat)<br>Thottakaadu. | | |
| No. of people living | Common borewell | | |
| Purpose of Water usage | Drinking water | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Hand pump | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |
| Type of Sewage disposal in the location | Open drains/Gardening | | | |
| Method of Solid waste disposal in the location | Door to door collection | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.45 | Temp (°C) | 29.4 |
| | ORP (mV) | 190.3 | Conductivity (µS/cm) | 1100 |
| | Turbidity (NTU) | 3.96 | | |
| | Ammonia (mg/l) | 0.4 | Nitrate (mg/l) | 18.9 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Hand pump; common borewell (public use); water is clear but bit salty.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 12:25 PM

**Sampling Point Identification Number:** S1-BW 5

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.824 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.892 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2019 | Depth of Well | 630 ft |
| Distance from Chemplast | >4 Km | Quadrant as per MAP | II |
| Name of the Owner | Kuppuswamy | | |
| Address | Kullamadenayanoor post, 4 – road,<br>Pottaneri village,<br>Mettur. | | |
| No. of people living | 8 | | |
| Purpose of Water usage | Drinking and household | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 1 hr/day | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good ✓ | Good | Poor | Average |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Open disposal/Gardening. | | | |
| Method of Solid waste disposal in the location | Door to door collection | | | |
| Parameters Measured at site and their value | pH | 7.55 | Temp (°C) | 29.5 |
| | ORP (mV) | 86.7 | Conductivity (µS/cm) | 1737 |
| | Turbidity (NTU) | 2.12 | | |
| | Ammonia (mg/l) | 1.5 | Nitrate (mg/l) | 2.8 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water quality is good; new house – borewell inside house; no variation in water quality since its installation.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 12:55 PM

**Sampling Point Identification Number:** S1-BW 6

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.812 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.844 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2021 | Depth of Well | 110 ft |
| Distance from Chemplast | 0 – 1 Km | Quadrant as per MAP | VI |
| Name of the Owner | Anand | | |
| Address | Sakthi nagar,<br>Raman nagar post. | | |
| No. of people living | 4 | | |
| Purpose of Water usage | Household | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Pumped for household usage (not for drinking) | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Soak pit | | | |
| Method of Solid waste disposal in the location | Door to door collection | | | |
| Parameters Measured at site and their value | pH | 8.13 | Temp (°C) | 29.3 |
| | ORP (mV) | 153 | Conductivity (µS/cm) | 1464 |
| | Turbidity (NTU) | 0.11 | | |
| | Ammonia (mg/l) | 0.6 | Nitrate (mg/l) | 26.6 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Not used for drinking; bore water used for all needs except drinking; BW inside the house; location in the slope of the hill.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 03:30 PM

**Sampling Point Identification Number:** S1-BW 7

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.802 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.831 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2021 | Depth of Well | 160 ft |
| Distance from Chemplast | 1 – 2 Km | Quadrant as per MAP | V |
| Name of the Owner | P. Senthilkumar | | |
| Address | Karumalai koodal,<br>18 th ward,<br>P.N. Patti panchayat | | |
| No. of people living | 5 | | |
| Purpose of Water usage | Drinking | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 2000 lit/day | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good ✓ | Good | Poor | Average |
| Type of Sewage disposal in the location | Open ditch | | | |
| Method of Solid waste disposal in the location | Door to door collection | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 8.01 | Temp (°C) | 29.1 |
| | ORP (mV) | 172.7 | Conductivity (µS/cm) | 1005 |
| | Turbidity (NTU) | 2.73 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 26.9 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
Water at 90 ft; inside the house.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 04:10 PM

**Sampling Point Identification Number:** S1-BW 8

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.790 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.821 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2022 | Depth of Well | 200 ft |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | VI |
| Name of the Owner | Uma manikandan | | |
| Address | 13/3, motthiyen kaatu valavu,<br>Thangamapuri pattinam. | | |
| No. of people living | 4 | | |
| Purpose of Water usage | Washing and other use (not for drinking) | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Not often (used only for emergency purpose) | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |
| Type of Sewage disposal in the location | Open disposal/Soak pit | | | |
| Method of Solid waste disposal in the location | Door to door collection | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.71 | Temp (°C) | 30.3 |
| | ORP (mV) | 158.4 | Conductivity (µS/cm) | 1531 |
| | Turbidity (NTU) | 0.72 | | |
| | Ammonia (mg/l) | 0.5 | Nitrate (mg/l) | 10.5 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
Borewell found outside the house.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 05:05 PM

**Sampling Point Identification Number:** S1-BW 9

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.798 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.863 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2020 | Depth of Well | 500 ft |
| Distance from Chemplast | 2 – 3 Km | Quadrant as per MAP | III |
| Name of the Owner | Sakthivel | | |
| Address | AC Kandasamy street,<br>Karuppu reddiyaar post. | | |
| No. of people living | Nil | | |
| Purpose of Water usage | Agricultural usage mainly and it is drinkable | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 4 hrs/day | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good ✓ | Good | Poor | Average |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |
| Parameters Measured at site and their value | pH | 7.56 | Temp (°C) | 30.5 |
| | ORP (mV) | 169.8 | Conductivity (µS/cm) | 2520 |
| | Turbidity (NTU) | 2.47 | | |
| | Ammonia (mg/l) | 1.8 | Nitrate (mg/l) | 12.8 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water quality is very good; used for drinking; dam water connection at present is used for drinking.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 06:10 PM

**Sampling Point Identification Number:** S1-BW 10

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.786 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.869 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2013 | Depth of Well | 600 ft |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | IV |
| Name of the Owner | Muthu gounder | | |
| Address | 2/94, muniyappan kovil thottam, Veerakkal. | | |
| No. of people living | Agriculture | | |
| Purpose of Water usage | Agriculture and drinking after filteration | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Daily pumping | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good ✓ | Good | Poor | Average |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |
| Parameters Measured at site and their value | pH | 7.63 | Temp (°C) | 30.3 |
| | ORP (mV) | 166.3 | Conductivity (µS/cm) | 735 |
| | Turbidity (NTU) | 0.4 | | |
| | Ammonia (mg/l) | 2.3 | Nitrate (mg/l) | 8.8 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Irrigated for 7 acres (drip irrigation).

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 06:30 PM

**Sampling Point Identification Number:** S1-BW 11

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.800 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.881 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2015 | Depth of Well | 850 ft |
| Distance from Chemplast | 1 – 5 Km | Quadrant as per MAP | III |
| Name of the Owner | Common panchayat borewell | | |
| Address | Pazhankottai,<br>Viruthachalam patti (panchayat). | | |
| No. of people living | Common usage | | |
| Purpose of Water usage | Drinking water | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 6-7 hrs/day | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good ✓ | Good | Poor | Average |
| Type of Sewage disposal in the location | Soak pit | | | |
| Method of Solid waste disposal in the location | Door to door collection | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.71 | Temp (°C) | 30.6 |
| | ORP (mV) | 171.4 | Conductivity (µS/cm) | 1776 |
| | Turbidity (NTU) | 4.64 | | |
| | Ammonia (mg/l) | 1.9 | Nitrate (mg/l) | 4.7 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water from borewell is stored in small tank for distribution; quality is very good and used for drinking; solidwastes scattered in the road side.

**Date of Sampling:** 26/3/2023 **Time of Sampling:** 08:35 AM

**Sampling Point Identification Number:** S1-BW 12

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.787 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.855 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2021-2022 | Depth of Well | 560 ft |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | IV |
| Name of the Owner | Marimuthu | | |
| Address | Marikaatu vazhavu,<br>Veerakkal panchayat. | | |
| No. of people living | Nil | | |
| Purpose of Water usage | Agricultural | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Daily and stored in a concrete Groundlevel tank | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |
| Parameters Measured at site and their value | pH | 7.38 | Temp (°C) | 29.2 |
| | ORP (mV) | 146 | Conductivity (µS/cm) | 1838 |
| | Turbidity (NTU) | 0.2 | | |
| | Ammonia (mg/l) | 2.1 | Nitrate (mg/l) | 4.1 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
Stored in a GL concrete tank.

**Date of Sampling:** 26/3/2023 **Time of Sampling:** 10:05 AM

**Sampling Point Identification Number:** S1-BW 13

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.793 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.849 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 1989 | Depth of Well | 300 ft |
| Distance from Chemplast | 2 – 3 Km | Quadrant as per MAP | IV |
| Name of the Owner | Govindaraj .K.R. | | |
| Address | Kuthu reddiyoor | | |
| No. of people living | Agriculture | | |
| Purpose of Water usage | Agriculture | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 6-7 hrs/day (maximum) | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |
| Parameters Measured at site and their value | pH | 7.57 | Temp (°C) | 30.6 |
| | ORP (mV) | 176.9 | Conductivity (µS/cm) | 2725 |
| | Turbidity (NTU) | 0.25 | | |
| | Ammonia (mg/l) | 1.2 | Nitrate (mg/l) | 12.2 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Water quality is bad. (not useful for rice and other plants); last 2 years water quality is getting better and earlier it was bad; ash pond near thermal powerplant (6 to 7 Km).

**Date of Sampling:** 26/3/2023 **Time of Sampling:** 10:25 AM

**Sampling Point Identification Number:** S1-BW 14

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.805 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.865 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 1993 | Depth of Well | 670 ft |
| Distance from Chemplast | 1 – 2 Km | Quadrant as per MAP | III |
| Name of the Owner | Manickam | | |
| Address | Paattir theru,<br>Karikalan nagar,<br>Viruthasalam patti village | | |
| No. of people living | Nil | | |
| Purpose of Water usage | Agriculture only | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 2 hrs/day; 3.5 acres for irrigation is fixed. | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |
| Parameters Measured at site and their value | pH | 7.43 | Temp (°C) | 29.3 |
| | ORP (mV) | 124.2 | Conductivity (µS/cm) | 1561 |
| | Turbidity (NTU) | 0.55 | | |
| | Ammonia (mg/l) | 1.3 | Nitrate (mg/l) | 8.4 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

3.5 acres fixed for agriculture and 1.5 acres fixed for current cultivation; TDS level is decreasing in recent years; cowyard in the backside (borewell is located 100 m from cowyard); not used for any human activities.

**Date of Sampling:** 26/3/2023 **Time of Sampling:** 10:55 AM

**Sampling Point Identification Number:** S1-BW 15

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.813 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.824 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | 2016 | Depth of Well | 360 ft |
| Distance from Chemplast | 2 – 3 Km | Quadrant as per MAP | VI |
| Name of the Owner | Common panchayat borewell | | |
| Address | Ramamurthy nagar (backside of plant 1 and 2). | | |
| No. of people living | Common borewell | | |
| Purpose of Water usage | Drinking water supply | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Daily pumping (4 hrs). | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | Open drains | | | |
| Method of Solid waste disposal in the location | Door to door collection | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 8.11 | Temp (°C) | 30.6 |
| | ORP (mV) | 161 | Conductivity (µS/cm) | 514 |
| | Turbidity (NTU) | 0.99 | | |
| | Ammonia (mg/l) | 0.6 | Nitrate (mg/l) | 12.2 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Used for community drinking (all household use); water got at 150 ft.

**Date of Sampling:** 26/3/2023 **Time of Sampling:** 11:15 AM

**Sampling Point Identification Number:** S1-BW 16

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.806 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.817 | | Open Well | |

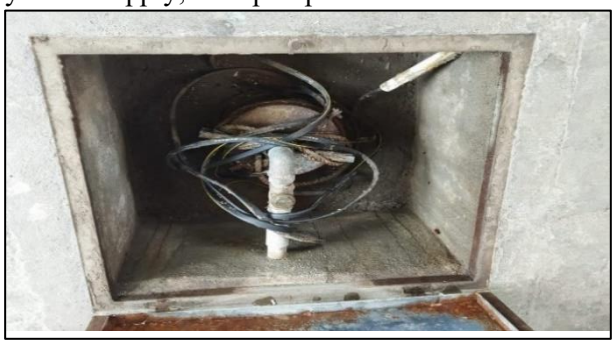
| | | | |
|---|---|---|---|
| Date of installation | 2008 | Depth of Well | 200 ft |
| Distance from Chemplast | 3 – 4 Km | Quadrant as per MAP | VI |
| Name of the Owner | Common borewell | | |
| Address | Kamalakshmi amman street, Kavipuram. | | |
| No. of people living | Nil | | |
| Purpose of Water usage | Community supply (all household needs) | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | 4 hrs daily. | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good ✓ | Poor | Average |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Open drains | | | |
| Method of Solid waste disposal in the location | Door to door collection | | | |
| Parameters Measured at site and their value | pH | 7.83 | Temp (°C) | 30.1 |
| | ORP (mV) | 153.2 | Conductivity (µS/cm) | 487 |
| | Turbidity (NTU) | 0.2 | | |
| | Ammonia (mg/l) | 0.6 | Nitrate (mg/l) | 4.5 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

Community water supply; bore pumped to tank.



**Date of Sampling:** 26/3/2023 **Time of Sampling:** 11:36 AM

**Sampling Point Identification Number: S1-RS**

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.786 | Type of Sample | Bore Well | |
| | Longitude | : | 77.802 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | >4 Km | Quadrant as per MAP | VI |
| Name of the Owner | River sample | | |
| Address | Cauvery river D/S | | |
| No. of people living | Nil | | |
| Purpose of Water usage | River water D/S side | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | Nil | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average ✓ |

| | | | | |
|---|---|---|---|---|
| Type of Sewage disposal in the location | Nil | | | |
| Method of Solid waste disposal in the location | Nil | | | |
| Parameters Measured at site and their value | pH | 8.28 | Temp (°C) | 30.5 |
| | ORP (mV) | 160 | Conductivity (µS/cm) | 557 |
| | Turbidity (NTU) | 1.58 | | |
| | Ammonia (mg/l) | 0.6 | Nitrate (mg/l) | 6.3 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
Lot of fish and aquatic plant

**Date of Sampling:** 26/3/2023 **Time of Sampling:** 12:40 AM

**Sampling Point Identification Number:** S1- PBW 1

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.806 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.820 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | 4000 m | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.03 | Temp (°C) | 31 |
| | ORP (mV) | 163.3 | Conductivity (µS/cm) | 1001 |
| | Turbidity (NTU) | 923 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 21.8 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
SLF-1 emptied and concreted.


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 11:16 AM

**Sampling Point Identification Number:** S1- PBW 2

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.806 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.820 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | 4000 m | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.52 | Temp (°C) | 29.7 |
| | ORP (mV) | 154.6 | Conductivity (µS/cm) | 866 |
| | Turbidity (NTU) | 37.8 | | |
| | Ammonia (mg/l) | 0.5 | Nitrate (mg/l) | 24.5 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

SLF-1 emptied and concreted.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 11:27 AM

**Sampling Point Identification Number:** S1- PBW 3

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.819 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.844 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | 4000 m | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.61 | Temp (°C) | 31 |
| | ORP (mV) | 155.6 | Conductivity (µS/cm) | 460 |
| | Turbidity (NTU) | 5.41 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 4.9 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

SLF-1 →Capacity- 275 $m^3$; quantity disposed- 272 MT; closed- 20/01/2023.
SLF-2 → Capacity- 275 $m^3$; quantity disposed- 275 MT; closed on- 21/03/2001.
SLF-4 → Capacity- 213 $m^3$; quantity disposed- 210 MT; closed on- 10/05/2001.


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 10:21 AM

**Sampling Point Identification Number:** S1- PBW 4

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.820 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.844 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | 1000 m | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.72 | Temp (°C) | 31 |
| | ORP (mV) | 168.9 | Conductivity (µS/cm) | 471 |
| | Turbidity (NTU) | 1.44 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 4.1 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

SLF-7 → Capacity- 160 $m^3$; quantity disposed- 156 MT; closed on- 30/10/2001.

SLF-6 → Capacity- 275 $m^3$; quantity disposed- 273 MT; closed on- 15/06/2001.


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 10:43 AM

**Sampling Point Identification Number:** S1- PBW 5

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.81 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.84 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | 1000 m | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.63 | Temp (°C) | 29.6 |
| | ORP (mV) | 156.4 | Conductivity (µS/cm) | 465 |
| | Turbidity (NTU) | 2.37 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 4.6 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
SLF-13
Capacity- 658 $m^3$; quantity disposed- 646 MT; closed on- 19/11/2007


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 10:04 AM

**Sampling Point Identification Number:** S1- PBW 6

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.820 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.844 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | 1000 m | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.75 | Temp (°C) | 31 |
| | ORP (mV) | 150.9 | Conductivity (µS/cm) | 464 |
| | Turbidity (NTU) | 5.93 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 5.3 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
Nil

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 10:58AM

**Sampling Point Identification Number:** S1- PBW 7

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.81 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.84 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | 1000 m | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.44 | Temp (°C) | 25 |
| | ORP (mV) | 148 | Conductivity (µS/cm) | 434 |
| | Turbidity (NTU) | 11.8 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 6.8 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
SLF- 12
Capacity- 252 $m^3$; quantity disposed- 248 MT; closed on- 20/08/2004.


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 9:16 AM

**Sampling Point Identification Number:** S1- PBW 8

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.81 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.84 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | 1000 m | Quadrant as per MAP | |
| Name of the Owner | Senthil | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.82 | Temp (°C) | 29.6 |
| | ORP (mV) | 146 | Conductivity (µS/cm) | 462 |
| | Turbidity (NTU) | 4.42 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 6.8 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

SLF-14

Capacity- 247 $m^3$; disposal quantity- 244 MT; closed on 04-07-2011


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 9:40 AM

**Sampling Point Identification Number:** S1- PBW 9

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.819 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.847 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 8.09 | Temp (°C) | 31.4 |
| | ORP (mV) | 164.4 | Conductivity (µS/cm) | 449 |
| | Turbidity (NTU) | 10.97 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 5.9 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

SLF-7 → Immobilized mercury; bearing brine sludge; 20m x 15m x 6m; 2473.96 T.


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 12:51 PM

**Sampling Point Identification Number:** S1- PBW 10

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.820 | Type of Sample | Bore Well | ✓ | |
| | Longitude | : | 77.846 | | Open Well | | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 8.31 | Temp (°C) | 31.4 |
| | ORP (mV) | 159.8 | Conductivity (µS/cm) | 1085 |
| | Turbidity (NTU) | 10.97 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 6.8 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
SLF-2
Immobilized mercury; quantity 2631.43 MT; dimension- 20m x 15m x 6m.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 12:28 PM

**Sampling Point Identification Number:** S1- PBW 11

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.820 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.847 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.51 | Temp (°C) | 30.5 |
| | ORP (mV) | 180.1 | Conductivity (µS/cm) | 646 |
| | Turbidity (NTU) | 4.3 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 4.2 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
SLF-8
Immobilized mercury; bearing brine sludge; 20m x 15m x 6.5m; quantity- 2917.29 MT.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 12:40 PM

**Sampling Point Identification Number:** S1- PBW 12

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.820 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.846 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 8.24 | Temp (°C) | 31.6 |
| | ORP (mV) | 162.6 | Conductivity (µS/cm) | 377 |
| | Turbidity (NTU) | 8.13 | | |
| | Ammonia (mg/l) | 0.2 | Nitrate (mg/l) | 5.4 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
SLF-7
Immobilized mercury; bearing brine sludge; 20m x 15m x 6m; 2473.96 T.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 12:10 PM

**Sampling Point Identification Number:** S1- PBW 13

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.820 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.845 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 8.35 | Temp (°C) | 30.3 |
| | ORP (mV) | 145.8 | Conductivity (µS/cm) | 372 |
| | Turbidity (NTU) | 10.78 | | |
| | Ammonia (mg/l) | 0.2 | Nitrate (mg/l) | 6.7 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
Nil.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 12:16 PM

**Sampling Point Identification Number:** S1- PBW 14

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.820 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.847 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.83 | Temp (°C) | 30.7 |
| | ORP (mV) | 178.4 | Conductivity (µS/cm) | 421 |
| | Turbidity (NTU) | 6.86 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 4 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**

SLF-1 → Hazardous waste category- 17.1; Hazardous waste quantity- 49 DMT; Status- capped.


**Date of Sampling:** 25/3/2023 **Time of Sampling:** 04:08 PM

**Sampling Point Identification Number:** S1- PBW 15

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.821 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.847 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.93 | Temp (°C) | 31.2 |
| | ORP (mV) | 160.9 | Conductivity (µS/cm) | 540 |
| | Turbidity (NTU) | 3.89 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 4.7 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
SLF-2
Hazardous waste category- 17.1;
Hazardous waste quantity- 95 DMT;
Status- capped

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 04:18 PM

**Sampling Point Identification Number:** S1- PBW 16

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.821 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.847 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.69 | Temp (°C) | 31.4 |
| | ORP (mV) | 179.5 | Conductivity (µS/cm) | 413 |
| | Turbidity (NTU) | 6.98 | | |
| | Ammonia (mg/l) | 0.2 | Nitrate (mg/l) | 3.4 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
Nil.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 04:25 PM

**Sampling Point Identification Number:** S1- PBW 17

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.821 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.847 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 7.54 | Temp (°C) | 30.6 |
| | ORP (mV) | 176 | Conductivity (µS/cm) | 622 |
| | Turbidity (NTU) | 14.88 | | |
| | Ammonia (mg/l) | 0.2 | Nitrate (mg/l) | 3.1 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
SLF-3
Hazardous waste category- 17.1;
Hazardous waste quantity- 76 DMT;
Status- capped.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 04:38 PM

**Sampling Point Identification Number:** S1- PBW 18

***Consultancy Project***

**Assessment of Groundwater Contamination in and around the M/s Chemplast Sanmar Plants at Mettur**

**Summary Sheet**

**Water Sample Collection Point and User Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| Location of the Sampling Point | Latitude | : | 11.821 | Type of Sample | Bore Well | ✓ |
| | Longitude | : | 77.844 | | Open Well | |

| | | | |
|---|---|---|---|
| Date of installation | | Depth of Well | |
| Distance from Chemplast | | Quadrant as per MAP | |
| Name of the Owner | | | |
| Address | | | |
| No. of people living | | | |
| Purpose of Water usage | | | |
| Average water pumping rate (L/d) & Type (per day or per week, etc.) | | | |

| | | | | |
|---|---|---|---|---|
| User Rating for water | Very Good | Good | Poor | Average |
| Type of Sewage disposal in the location | | | | |
| Method of Solid waste disposal in the location | | | | |

| | | | | |
|---|---|---|---|---|
| Parameters Measured at site and their value | pH | 8.14 | Temp (°C) | 29.9 |
| | ORP (mV) | 175.1 | Conductivity (µS/cm) | 497 |
| | Turbidity (NTU) | 10.7 | | |
| | Ammonia (mg/l) | 0.3 | Nitrate (mg/l) | 4.7 |
| Photographs Taken | Yes ✓ No | | | |

**Remarks (if any):**
Nil.

**Date of Sampling:** 25/3/2023 **Time of Sampling:** 04:48 PM

# ANNEXURE V

**Table V.1.** Characteristics of openwell samples collected during the pre-monsoon season

| Wells | Physicochemical Parameters | | | | | | | | Inorganic Ions | | | | | | | | | | Organic parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EC | DO | Temp. | Turbidity | pH | TDS | Alkalinity | Hardness | $Cl^-$ | $F^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | COD | TOC | Coliform |
| | µS/cm | mg/L | °C | NTU | | mg/L | mg/L as $CaCO_3$ | mg/L as $CaCO_3$ | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | mg/L | mg/L | CFU/mL |
| **S1-OW1** | 1294 | 5.8 | 30.1 | 1.7 | 7.8 | 1090 | 350 | 270 | 117 | 0.2 | 25 | 1.0 | 105 | 1.7 | BDL | BDL | BDL | BDL | 29 | 2.8 | BDL |
| **S1-OW2** | 1790 | 5.6 | 29.4 | 1.3 | 7.7 | 1510 | 405 | 340 | 248 | 0.2 | 30 | 0.5 | 158 | 1.2 | BDL | BDL | BDL | BDL | 26 | 1.6 | BDL |
| **S1-OW3** | 1575 | 5.8 | 30.1 | 0.4 | 7.7 | 1403 | 410 | 280 | 195 | 0.2 | 18 | 0.6 | 110 | 2.2 | BDL | BDL | BDL | BDL | 26 | 1.4 | 9 |
| **S1-OW4** | 1288 | 5.4 | 29.5 | 0.8 | 7.8 | 1113 | 380 | 340 | 103 | 0.2 | 26 | 0.3 | 120 | 1.7 | BDL | BDL | BDL | BDL | 16 | 1.6 | BDL |
| **S1-OW5** | 1098 | 7.1 | 29.5 | 0.3 | 7.5 | 987 | 250 | 260 | 99 | 0.1 | 26 | 0.3 | 109 | 1.8 | BDL | BDL | BDL | BDL | 27 | 1.7 | BDL |
| **S1-OW6** | 2350 | 5.7 | 30.9 | 2.2 | 8.3 | 1860 | 360 | 590 | 284 | 0.2 | 27 | 0.5 | 573 | 1.6 | BDL | BDL | BDL | BDL | 29 | 2.5 | 4 |
| **S1-OW7** | 1322 | 6.0 | 29.2 | 1 | 7.7 | 1130 | 245 | 285 | 142 | 0.1 | 9 | 0.5 | 84 | 2.0 | BDL | BDL | BDL | BDL | 29 | 2.6 | BDL |
| **S1-OW8** | 1692 | 5.7 | 29.6 | 2.7 | 8.0 | 1480 | 370 | 320 | 248 | 0.2 | 27 | 0.5 | 225 | 1.5 | BDL | BDL | BDL | BDL | 51 | 3.9 | BDL |
| **S1-OW9** | 1362 | 5.6 | 31 | 0.7 | 7.6 | 1207 | 170 | 200 | 213 | 0.1 | 8 | 0.5 | 72 | 1.5 | BDL | BDL | BDL | BDL | 26 | 1.4 | 31 |
| **S1-OW10** | 1720 | 5.2 | 30.5 | 1.0 | 7.9 | 1437 | 270 | 330 | 216 | 0.1 | 10 | 0.5 | 248 | 1.7 | BDL | BDL | BDL | BDL | 35 | 2.1 | 3 |
| **S1-OW11** | 1388 | 5.1 | 29.1 | 0.9 | 7.7 | 1263 | 245 | 370 | 89 | 0.2 | 7 | 1.2 | 435 | 4.1 | BDL | BDL | BDL | BDL | 30 | 1.5 | BDL |

**Table V.2.** Characteristics of openwell samples collected during the post-monsoon season

| Wells | Physicochemical Parameters | | | | | | | | Inorganic Ions | | | | | | | | | | Organic Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EC | DO | Temp. | Turbidity | pH | TDS | Alkalinity | Hardness | $Cl^-$ | $F^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | COD | TOC | Coliform |
| | µS/cm | mg/L | °C | NTU | | mg/L | mg/L as $CaCO_3$ | mg/L as $CaCO_3$ | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | mg/L | mg/L | CFU/mL |
| **S1-OW1** | 1364 | 7.0 | 29.3 | 5.0 | 7.6 | 922 | 350 | 480 | 163 | 0.1 | 19 | 0.4 | 115 | 1.9 | BDL | BDL | 1 | BDL | 32 | 4.0 | BDL |
| **S1-OW2** | 1810 | 7.2 | 28.2 | 0.5 | 7.6 | 1180 | 400 | 700 | 209 | 0.2 | 20.3 | 0.7 | 119 | 3.0 | BDL | BDL | BDL | BDL | 38 | 4.0 | 40 |
| **S1-OW3** | 1502 | 7.2 | 27.6 | 0.7 | 7.7 | 870 | 380 | 300 | 199 | 0.1 | 4.5 | 0.4 | 77 | 2.7 | BDL | BDL | BDL | BDL | 51 | 4.0 | BDL |
| **S1-OW4** | 1270 | 5.8 | 29.4 | 1.3 | 7.5 | 960 | 300 | 540 | 138 | 0.1 | 14.2 | 0.2 | 120 | 2.0 | BDL | BDL | BDL | BDL | 58 | 3.0 | BDL |
| **S1-OW5** | 1110 | 7.5 | 27.8 | 0.4 | 7.5 | 780 | 310 | 420 | 99 | 0.1 | 13 | 0.4 | 105 | 2.2 | BDL | BDL | BDL | BDL | 45 | 3.0 | BDL |
| **S1-OW6** | 1529 | 6.9 | 29.2 | 1.1 | 8.1 | 943 | 290 | 400 | 227 | 0.1 | 6.3 | 0.4 | 125 | 2.3 | BDL | BDL | 3 | BDL | 38 | 3.3 | BDL |
| **S1-OW7** | 1581 | 6.8 | 27.7 | 1.3 | 7.6 | 1270 | 300 | 540 | 269 | 0.1 | 2.9 | 0.4 | 119 | 2.6 | BDL | BDL | 1 | BDL | 48 | 3.3 | BDL |
| **S1-OW8** | 1139 | 7.2 | 28.9 | 2.1 | 8.0 | 700 | 290 | 360 | 135 | 0.2 | 7.7 | 0.3 | 99 | 2.2 | BDL | BDL | 1 | BDL | 80 | 7.7 | BDL |
| **S1-OW9** | 1361 | 5.8 | 29.1 | 0.5 | 7.5 | 1147 | 270 | 600 | 255 | 0.1 | 3.9 | 0.3 | 83 | 2.3 | BDL | BDL | 2 | BDL | 32 | 4.6 | BDL |
| **S1-OW10** | 1724 | 4.1 | 28.6 | 3.0 | 7.9 | 1060 | 280 | 540 | 277 | 0.1 | 2.6 | 0.4 | 167 | 2.2 | BDL | BDL | BDL | BDL | 32 | 4.0 | BDL |
| **S1-OW11** | 2018 | 6.4 | 28.3 | 0.3 | 8.1 | 1680 | 340 | 800 | 96 | 0.2 | 4.3 | 1.1 | 647 | 2.0 | BDL | BDL | 12 | BDL | 42 | 3.9 | BDL |

**Table V.3.** Characteristics of borewell samples collected during the pre-monsoon season

| Wells | Physicochemical Parameters | | | | | | | | Inorganic Ions | | | | | | | | | | Organic Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EC | DO | Temp. | Turbidity | pH | TDS | Alkalinity | Hardness | $Cl^-$ | $F^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | COD | TOC | Coliform |
| | µS/cm | mg/L | °C | NTU | | mg/L | mg/L as $CaCO_3$ | mg/L as $CaCO_3$ | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | mg/L | mg/L | CFU/mL |
| **S1-BW1** | 1105 | 6.0 | 29.1 | 0.3 | 7.5 | 940 | 380 | 210 | 64 | 0.1 | 17 | 0.4 | 64 | 1.3 | BDL | BDL | BDL | BDL | 80 | 4.2 | 2 |
| **S1-BW2** | 1195 | 5.2 | 29.3 | 67.3 | 7.4 | 1017 | 265 | 290 | 110 | 0.1 | 15 | 0.8 | 59 | 1.2 | BDL | BDL | BDL | BDL | 74 | 5.1 | BDL |
| **S1-BW3** | 1677 | 5.5 | 29.4 | 0.2 | 8.1 | 1490 | 345 | 300 | 238 | 0.1 | 15 | 0.7 | 90 | 1.7 | BDL | BDL | BDL | BDL | 58 | 3.5 | 45 |
| **S1-BW4** | 1500 | 6.4 | 29.4 | 4.0 | 7.5 | 1277 | 275 | 320 | 110 | 0.1 | 19 | 0.4 | 178 | 0.9 | BDL | BDL | BDL | BDL | 48 | 2.4 | 29 |
| **S1-BW5** | 1837 | 5.8 | 29.5 | 2.1 | 7.6 | 1687 | 330 | 500 | 89 | 0.1 | 3 | 1.5 | 654 | 1.1 | BDL | BDL | BDL | BDL | 38 | 1.7 | BDL |
| **S1-BW6** | 1564 | 5.6 | 29.3 | 0.1 | 8.1 | 1367 | 425 | 240 | 160 | 0.2 | 27 | 0.6 | 62 | 1.4 | BDL | BDL | BDL | BDL | 58 | 3.4 | BDL |
| **S1-BW7** | 1692 | 5.5 | 29.5 | 2.7 | 8 | 1247 | 355 | 230 | 144 | 0.2 | 27 | 0.3 | 40 | 1.4 | BDL | BDL | BDL | BDL | 45 | 2.2 | 47 |
| **S1-BW8** | 1831 | 5.1 | 30.3 | 0.7 | 7.7 | 1700 | 200 | 380 | 110 | 0.1 | 11 | 0.5 | 536 | 1.8 | BDL | BDL | BDL | BDL | 163 | 10.6 | 1 |
| **S1-BW9** | 2820 | 7.0 | 30.5 | 2.5 | 7.6 | 2577 | 350 | 640 | 234 | 0.2 | 13 | 1.8 | 770 | 1.0 | BDL | BDL | BDL | BDL | 45 | 2.7 | 40 |
| **S1-BW10** | 1035 | 5.2 | 30.3 | 0.4 | 7.6 | 827 | 250 | 135 | 71 | 0.2 | 9 | 2.3 | 31 | 2.2 | BDL | BDL | BDL | BDL | 30 | 1.7 | BDL |
| **S1-BW11** | 1776 | 6.9 | 30.6 | 4.6 | 7.7 | 1473 | 415 | 500 | 106 | 0.1 | 5 | 1.9 | 519 | 1.4 | BDL | BDL | BDL | BDL | 6 | 0.5 | 5 |
| **S1-BW12** | 1838 | 6.8 | 29.2 | 0.2 | 7.4 | 1357 | 190 | 490 | 135 | 0.2 | 4 | 2.1 | 436 | 1.1 | BDL | BDL | BDL | BDL | 6 | 0.6 | 49 |
| **S1-BW13** | 2725 | 5.7 | 30.6 | 0.3 | 7.6 | 2270 | 275 | 370 | 404 | 0.2 | 12 | 1.2 | 512 | 1.8 | BDL | BDL | BDL | BDL | 13 | 1.0 | 25 |
| **S1-BW14** | 1561 | 5.2 | 29.3 | 0.6 | 7.4 | 1193 | 270 | 380 | 149 | 0.1 | 8 | 1.3 | 608 | 1.0 | BDL | BDL | BDL | BDL | 10 | 0.7 | BDL |
| **S1-BW15** | 514 | 5.4 | 30.6 | 1.0 | 8.1 | 367 | 140 | 110 | 64 | 0.1 | 12 | 0.6 | 29 | 1.1 | BDL | BDL | BDL | BDL | 10 | 1.0 | 2 |
| **S1-BW16** | 487 | 6.3 | 30.1 | 0.2 | 7.8 | 393 | 130 | 140 | 82 | 0.1 | 5 | 0.6 | 41 | 1.1 | BDL | BDL | BDL | BDL | 6 | 0.8 | BDL |

**Table V.4.** Characteristics of borewell samples collected during the post-monsoon season

| Wells | Physicochemical parameters | | | | | | | | Inorganic ions | | | | | | | | | | Organic parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EC | DO | Temp. | Turbidity | pH | TDS | Alkalinity | Hardness | $Cl^-$ | $F^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | COD | TOC | Coliform |
| | µS/cm | mg/L | °C | NTU | | mg/L | mg/L as $CaCO_3$ | mg/L as $CaCO_3$ | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | mg/L | mg/L | CFU/mL |
| **S1-BW1** | 1036 | 8.2 | 27.7 | 0.8 | 7.7 | 690 | 330 | 320 | 92 | 0.1 | 8 | 0.5 | 50 | 1.7 | BDL | BDL | BDL | BDL | 51 | 3.5 | BDL |
| **S1-BW2** | 1029 | 7.9 | 27.4 | 38.0 | 7.4 | 690 | 330 | 360 | 138 | 0.1 | 6.8 | 0.3 | 47 | 2.4 | 4 | BDL | 3 | BDL | 26 | 3.3 | BDL |
| **S1-BW3** | 554 | 7.6 | 29.2 | 0.8 | 8.2 | 310 | 170 | 160 | 78 | 0.1 | 2 | 0.3 | 22 | 2.2 | BDL | BDL | 2 | BDL | 61 | 4.6 | BDL |
| **S1-BW4** | 1116 | 7.8 | 28 | 4.8 | 7.4 | 910 | 270 | 600 | 89 | 0.1 | 12 | 0.2 | 149 | 2.6 | BDL | BDL | BDL | BDL | 19 | 3.2 | 6 |
| **S1-BW5** | 1736 | 8.1 | 27.7 | 8.1 | 7.3 | 1380 | 290 | 760 | 113 | 0.2 | 0.6 | 1 | 539 | 1.9 | BDL | BDL | 2 | BDL | 58 | 2.8 | BDL |
| **S1-BW6** | 1642 | 6.3 | 29.3 | 0.1 | 7.9 | 1060 | 420 | 260 | 227 | 0.1 | 12.7 | 0.4 | 60 | 2.2 | BDL | BDL | BDL | BDL | 45 | 3.9 | BDL |
| **S1-BW7** | 1035 | 5.9 | 29.1 | 0.3 | 7.5 | 657 | 300 | 380 | 106 | 0.1 | 15.2 | 0.2 | 33 | 2.2 | BDL | BDL | BDL | BDL | 26 | 2.8 | BDL |
| **S1-BW8** | 3820 | 7.1 | 28 | 24.6 | 7.4 | 3397 | 370 | 1700 | 234 | 0.2 | 1.41 | 0.4 | 1568 | 1.8 | BDL | BDL | 3 | BDL | 138 | 10.9 | 9 |
| **S1-BW9** | 1189 | 6.6 | 29.1 | 1.3 | 7.8 | 793 | 260 | 460 | 128 | 0.2 | 13.2 | 0.6 | 153 | 2.4 | BDL | BDL | BDL | BDL | 22 | 2.8 | BDL |
| **S1-BW10** | 1520 | 7.4 | 28.4 | 0.3 | 7.8 | 957 | 540 | 420 | 99 | 0.0 | 16.1 | 5.9 | 83 | 3.2 | BDL | BDL | BDL | BDL | 26 | 2.0 | BDL |
| **S1-BW11** | 1753 | 8.1 | 27.5 | 11.6 | 7.5 | 1595 | 320 | 920 | 333 | 0.2 | 0.7 | 1.6 | 672 | 1.8 | 6 | BDL | 1 | BDL | 51 | 3.3 | BDL |
| **S1-BW12** | 1806 | 7.8 | 27.9 | 1.5 | 8.0 | 1533 | 360 | 700 | 152 | 0.2 | 2.5 | 1.3 | 502 | 2.0 | BDL | BDL | 26 | BDL | 38 | 2.4 | BDL |
| **S1-BW13** | 1915 | 7.3 | 27.9 | 0.8 | 7.7 | 1590 | 380 | 640 | 355 | 0.1 | 1.8 | 0.6 | 523 | 1.8 | BDL | BDL | 2 | BDL | 29 | 3.3 | 45 |
| **S1-BW14** | 1914 | 7.4 | 27.5 | 0.4 | 7.7 | 1557 | 300 | 780 | 234 | 0.2 | 3.7 | 0.4 | 571 | 2.1 | BDL | BDL | 3 | BDL | 45 | 3.9 | BDL |
| **S1-BW15** | 788 | 7.4 | 28 | 1.1 | 7.3 | 607 | 220 | 420 | 92 | 0.1 | 11.8 | 0.4 | 32 | 2.0 | BDL | BDL | 2 | BDL | 29 | 2.5 | 7 |
| **S1-BW16** | 553 | 7.7 | 27.9 | 0.5 | 7.3 | 357 | 160 | 200 | 92 | 0.1 | 1.7 | 0.6 | 36 | 1.5 | BDL | BDL | BDL | BDL | 38 | 3.5 | 9 |

**Table V.5.** Characteristics of SLF piezometric well samples collected during the pre-monsoon season

| Wells | Physicochemical parameters | | | | | | | | Inorganic Ions | | | | | | | | | | Organic parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EC | DO | Temp. | Turbidity | pH | TDS | Alkalinity | Hardness | $Cl^-$ | $F^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | COD | TOC | Coliform |
| | µS/cm | mg/L | °C | NTU | | mg/L | mg/L as $CaCO_3$ | mg/L as $CaCO_3$ | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | mg/L | mg/L | CFU/mL |
| **S1-PBW1** | 1001 | 5.1 | 31 | 923 | 7.0 | 629 | 270 | 200 | 101 | 0.1 | 21.8 | 0.3 | 77 | 2.3 | BDL | BDL | BDL | BDL | 42 | 3.1 | 40 |
| **S1-PBW2** | 866 | 5.1 | 29.7 | 38 | 7.5 | 663 | 330 | 185 | 99 | 0.1 | 24.5 | 0.5 | 67 | 2.2 | BDL | BDL | BDL | BDL | 45 | 3.8 | 18 |
| **S1-PBW3** | 460 | 5.7 | 31 | 5 | 7.6 | 390 | 130 | 225 | 99 | 0.1 | 4.9 | 0.3 | 30 | 1.3 | BDL | BDL | BDL | BDL | 19 | 3.5 | BDL |
| **S1-PBW4** | 471 | 5.5 | 30.7 | 1 | 7.7 | 330 | 105 | 120 | 101 | 0.1 | 4.1 | 0.3 | 20 | 1.3 | BDL | BDL | BDL | BDL | 13 | 4.0 | BDL |
| **S1-PBW5** | 465 | 5.4 | 30.1 | 2 | 7.6 | 363 | 160 | 160 | 89 | 0.1 | 4.6 | 0.3 | 26 | 1.6 | BDL | BDL | BDL | BDL | 16 | 4.9 | BDL |
| **S1-PBW6** | 464 | 4.8 | 30.1 | 6 | 7.8 | 317 | 150 | 220 | 60 | 0.1 | 5.3 | 0.3 | 19 | 1.3 | BDL | BDL | BDL | BDL | 32 | 4.7 | 1 |
| **S1-PBW7** | 434 | 5.3 | 30.8 | 12 | 7.4 | 302 | 150 | 210 | 71 | 0.1 | 6.8 | 0.3 | 21 | 1.1 | 2 | BDL | BDL | BDL | 16 | 3.4 | BDL |
| **S1-PBW8** | 462 | 5.6 | 29.6 | 4 | 7.8 | 283 | 165 | 200 | 82 | 0.1 | 6.8 | 0.3 | 26 | 1.3 | BDL | BDL | BDL | BDL | 29 | 4.1 | BDL |
| **S1-PBW9** | 449 | 5.2 | 31.4 | 11 | 8.1 | 323 | 190 | 220 | 78 | 0.1 | 5.9 | 0.3 | 25 | 1.3 | BDL | BDL | BDL | BDL | 61 | 4.0 | BDL |
| **S1-PBW10** | 436 | 5.7 | 30.5 | 7 | 8.3 | 277 | 216 | 240 | 67 | 0.1 | 10.8 | 0.4 | 25 | 1.7 | BDL | BDL | BDL | BDL | 38 | 5.2 | BDL |
| **S1-PBW11** | 646 | 5.4 | 30.5 | 4 | 7.5 | 440 | 220 | 190 | 96 | 0.1 | 4.2 | 0.3 | 30 | 1.7 | BDL | BDL | BDL | BDL | 16 | 5.3 | BDL |
| **S1-PBW12** | 377 | 5.2 | 31.6 | 8 | 8.2 | 300 | 110 | 210 | 89 | 0.1 | 5.4 | 0.2 | 15 | 2.0 | 1 | BDL | BDL | BDL | 26 | 3.0 | 1 |
| **S1-PBW13** | 392 | 5.3 | 30.3 | 11 | 8.4 | 357 | 95 | 290 | 106 | 0.1 | 6.7 | 0.2 | 14 | 1.6 | BDL | BDL | BDL | BDL | 13 | 2.7 | 14 |
| **S1-PBW14** | 421 | 4.5 | 30.7 | 7 | 7.8 | 383 | 240 | 160 | 71 | 0.1 | 4 | 0.3 | 25 | 2.0 | BDL | BDL | BDL | BDL | 26 | 4.1 | 15 |
| **S1-PBW15** | 540 | 4.7 | 31.2 | 4 | 7.9 | 437 | 175 | 180 | 89 | 0.1 | 4.7 | 0.3 | 21 | 1.4 | BDL | BDL | BDL | BDL | 90 | 4.7 | 37 |
| **S1-PBW16** | 413 | 5.1 | 31.4 | 7 | 7.7 | 347 | 180 | 250 | 89 | 0.1 | 3.4 | 0.2 | 29 | 2.1 | BDL | BDL | BDL | BDL | 45 | 3.1 | BDL |
| **S1-PBW17** | 622 | 5.2 | 30.6 | 15 | 7.5 | 410 | 235 | 180 | 85 | 0.1 | 3.1 | 0.2 | 20 | 1.7 | BDL | BDL | BDL | BDL | 19 | 3.9 | BDL |
| **S1-PBW18** | 497 | 5.6 | 29.9 | 11 | 8.1 | 313 | 180 | 170 | 85 | 0.1 | 4.7 | 0.3 | 27 | 1.9 | BDL | BDL | BDL | BDL | 16 | 4.5 | BDL |

**Table V.6.** Characteristics of SLF piezometric well samples collected during the post-monsoon season

| | Physicochemical parameters | | | | | | | | Inorganic Ions | | | | | | | | | | Organic parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Wells** | **EC** | **DO** | **Temp.** | **Turbidity** | **pH** | **TDS** | **Alkalinity** | **Hardness** | **$Cl^-$** | **$F^-$** | **$NO_3^-$-N** | **$NH_3$-N** | **$SO_4^{2-}$** | **$PO_4^{3-}$** | **$Pb^{2+}$** | **$Cd^{2+}$** | **$Ni^{2+}$** | **$Hg^{2+}$** | **COD** | **TOC** | **Coliform** |
| | **µS/cm** | **mg/L** | **°C** | **NTU** | | **mg/L** | **mg/L as $CaCO_3$** | **mg/L as $CaCO_3$** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **mg/L** | **µg/L** | **µg/L** | **µg/L** | **µg/L** | **mg/L** | **mg/L** | **CFU/mL** |
| **S2-PBW1** | 1272 | 6.0 | 29.2 | 8 | 7.3 | 1043 | 330 | 400 | 121 | 0.1 | 13 | 0.6 | 52 | 2.1 | 8 | BDL | 6 | BDL | 29 | 3.6 | BDL |
| **S2-PBW2** | 1104 | 7.5 | 28.4 | 34 | 7.7 | 837 | 340 | 420 | 121 | 0.0 | 11.9 | 0.5 | 17 | 2.0 | 5 | BDL | 22 | BDL | 22 | 2.3 | 15 |
| **S2-DBW1** | 971 | 3.2 | 27.8 | 557 | 7.5 | 823 | 290 | 400 | 188 | 0.1 | 12.6 | 0.6 | 60 | 2.3 | 45 | BDL | 19 | BDL | 32 | 4.2 | BDL |
| **S2-PBW3** | 462 | 6.3 | 29.1 | 1 | 8.1 | 403 | 150 | 180 | 78 | 0.1 | 0.8 | 0.3 | 20 | 1.6 | BDL | BDL | BDL | BDL | 45 | 4.1 | 25 |
| **S2-PBW4** | 451 | 6.3 | 28.9 | 1 | 8.1 | 397 | 140 | 180 | 82 | 0.1 | 0.2 | 0.3 | 22 | 2.0 | BDL | BDL | BDL | BDL | 29 | 4.2 | BDL |
| **S2-PBW5** | 462 | 7.4 | 28.2 | 1 | 8.1 | 400 | 140 | 240 | 85 | 0.1 | 0.8 | 0.4 | 19 | 2.1 | BDL | BDL | BDL | BDL | 38 | 3.9 | BDL |
| **S2-PBW6** | 465 | 7.0 | 28.3 | 1 | 8.1 | 397 | 150 | 220 | 103 | 0.1 | 0.6 | 0.3 | 17 | 2.1 | 23 | BDL | 1 | BDL | 32 | 4.2 | BDL |
| **S2-PBW7** | 460 | 6.5 | 29.3 | 1 | 8.1 | 420 | 150 | 240 | 71 | 0.1 | 0.4 | 0.3 | 10 | 1.6 | 17 | BDL | BDL | BDL | 32 | 4.0 | 13 |
| **S2-PBW8** | 470 | 6.5 | 28.9 | 1 | 8.1 | 400 | 160 | 180 | 74 | 0.1 | 0.7 | 0.4 | 20 | 3.3 | 4 | BDL | BDL | BDL | 32 | 3.9 | BDL |
| **S2-PBW9** | 986 | 7.0 | 27.7 | 6 | 7.9 | 847 | 200 | 180 | 181 | 0.1 | 1.6 | 0.4 | 34 | 2.6 | BDL | BDL | 1 | BDL | 45 | 3.1 | 40 |
| **S2-PBW10** | 1089 | 5.6 | 28.9 | 27 | 8.0 | 723 | 140 | 200 | 230 | 0.0 | 2.5 | 0.4 | 22 | 3.1 | 4 | BDL | 2 | BDL | 38 | 2.5 | BDL |
| **S2-PBW11** | 717 | 6.7 | 27.5 | 7 | 7.6 | 605 | 240 | 240 | 99 | 0.1 | 0.4 | 0.3 | 25 | 2.3 | BDL | BDL | 19 | BDL | 48 | 3.8 | 22 |
| **S2-PBW12** | 633 | 7.3 | 27.6 | 7 | 8.3 | 443 | 160 | 150 | 142 | 0.1 | 1 | 0.3 | 19 | 1.7 | 11 | BDL | 1 | BDL | 42 | 4.2 | 70 |
| **S2-PBW13** | 637 | 7.2 | 27.8 | 14 | 8.0 | 520 | 160 | 200 | 131 | 0.1 | 0.8 | 0.3 | 15 | 2.2 | 16 | BDL | 1 | BDL | 38 | 2.8 | BDL |
| **S2-DBW2** | 1525 | 6.7 | 27.9 | 614 | 8.1 | 1133 | 180 | 300 | 155 | 0.1 | 7.1 | 0.6 | 87 | 5.4 | 2 | BDL | 8 | BDL | 13 | 2.9 | BDL |
| **S2-PBW14** | 606 | 5.6 | 28.7 | 17 | 8.1 | 540 | 170 | 220 | 99 | 0.1 | 1 | 0.3 | 20 | 2.3 | BDL | BDL | 2 | BDL | 29 | 3.5 | 40 |
| **S2-PBW15** | 488 | 6.2 | 28.8 | 5 | 8.2 | 457 | 170 | 200 | 78 | 0.1 | 0.5 | 0.2 | 13 | 2.2 | BDL | BDL | BDL | BDL | 22 | 2.9 | BDL |
| **S2-PBW16** | 496 | 6.1 | 28.8 | 9 | 8.2 | 440 | 200 | 280 | 74 | 0.1 | 0.5 | 0.2 | 18 | 2.0 | BDL | BDL | 1 | BDL | 22 | 3.2 | BDL |
| **S2-PBW17** | 488 | 7.3 | 27.6 | 3 | 8.2 | 437 | 180 | 320 | 78 | 0.0 | 0.6 | 0.2 | 14 | 1.9 | BDL | BDL | BDL | BDL | 16 | 3.3 | BDL |
| **S2-PBW18** | 509 | 7.3 | 28.3 | 6 | 8.2 | 348 | 180 | 240 | 89 | 0.1 | 0.5 | 0.2 | 15 | 2.0 | 7 | BDL | BDL | BDL | 48 | 3.3 | 7 |
| **S2-PBW19** | 497 | 6.7 | 28.5 | 4 | 8.2 | 390 | 190 | 320 | 71 | 0.1 | 0.5 | 0.2 | 17 | 2.6 | BDL | BDL | BDL | BDL | 48 | 3.0 | BDL |

# ANNEXURE VI

Water quality comparison between the upstream and downstream piezometric wells

**Table VI. 1.** Water quality in the upstream and downstream piezometric wells during the pre-monsoon sampling

| Well* | Physicochemical parameters | | | | | | | | Inorganic ions | | | | | | | | | | Organic parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EC | DO | Temp. | Turbidity | pH | TDS | Alkalinity | Hardness | $Cl^-$ | $F^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | COD | TOC | Coliform |
| | µS/cm | mg/L | °C | NTU | | mg/L | mg/L as $CaCO_3$ | mg/L as $CaCO_3$ | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | mg/L | mg/L | CFU/mL |
| **P I US** | 866 | 5.1 | 29.7 | 38 | 7.5 | 663 | 330 | 185 | 99 | 0.14 | 24.5 | 0.5 | 67 | 2.2 | BDL | BDL | BDL | BDL | 45 | 3.8 | 18 |
| **P I DS** | 1001 | 5.1 | 31 | 923 | 7.0 | 629 | 270 | 200 | 101 | 0.08 | 21.8 | 0.3 | 77 | 2.3 | BDL | BDL | BDL | BDL | 42 | 3.1 | 40 |
| **P II US** | 464 | 4.8 | 30.1 | 6 | 7.8 | 317 | 150 | 220 | 60 | 0.07 | 5.3 | 0.3 | 19 | 1.3 | BDL | BDL | BDL | BDL | 32 | 4.7 | 1 |
| **P II DS** | 462 | 5.6 | 29.6 | 4 | 7.8 | 283 | 165 | 200 | 82 | 0.08 | 6.8 | 0.3 | 26 | 1.3 | BDL | BDL | BDL | BDL | 29 | 4.1 | BDL |
| **P III US** | 392 | 5.3 | 30.3 | 11 | 8.4 | 357 | 95 | 290 | 106 | 0.05 | 6.7 | 0.2 | 14 | 1.6 | BDL | BDL | BDL | BDL | 13 | 2.7 | 14 |
| **P III DS** | 377 | 5.2 | 31.6 | 8 | 8.2 | 300 | 110 | 210 | 89 | 0.10 | 5.4 | 0.2 | 15 | 2.0 | 1 | BDL | BDL | BDL | 26 | 3.0 | 1 |
| **P IV US** | 622 | 5.2 | 30.6 | 15 | 7.5 | 410 | 235 | 180 | 85 | 0.08 | 3.1 | 0.2 | 20 | 1.7 | BDL | BDL | BDL | BDL | 19 | 3.9 | BDL |
| **P IV DS** | 497 | 5.6 | 29.9 | 11 | 8.1 | 313 | 180 | 170 | 85 | 0.08 | 4.7 | 0.3 | 27 | 1.9 | BDL | BDL | BDL | BDL | 16 | 4.5 | BDL |

***Note:** P I - Plant I, P II - Plant II, P III - Plant III, P IV - Plant IV, US - Upstream, and DS- Downstream

**Table VI. 2.** Water quality in the upstream and downstream piezometric wells during the post-monsoon sampling

| Well* | Physicochemical parameters | | | | | | | | Inorganic ions | | | | | | | | | | Organic parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EC | DO | Temp. | Turbidity | pH | TDS | Alkalinity | Hardness | $Cl^-$ | $F^-$ | $NO_3^-$-N | $NH_3$-N | $SO_4^{2-}$ | $PO_4^{3-}$ | $Pb^{2+}$ | $Cd^{2+}$ | $Ni^{2+}$ | $Hg^{2+}$ | COD | TOC | Coliform |
| | µS/cm | mg/L | °C | NTU | | mg/L | mg/L as $CaCO_3$ | mg/L as $CaCO_3$ | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | mg/L | mg/L | CFU/mL |
| **P I US** | 1104 | 7.5 | 28.4 | 34 | 7.7 | 837 | 340 | 420 | 121 | 0.03 | 11.9 | 0.5 | 17 | 2.0 | 5 | BDL | 22 | BDL | 22 | 2.3 | 15 |
| **P I DS** | 1272 | 6.0 | 29.2 | 8 | 7.3 | 1043 | 330 | 400 | 121 | 0.11 | 13.0 | 0.6 | 52 | 2.1 | 8 | BDL | 6 | BDL | 29 | 3.6 | BDL |
| **P II US** | 465 | 7.0 | 28.3 | 1 | 8.1 | 397 | 150 | 220 | 103 | 0.07 | 0.6 | 0.3 | 17 | 2.1 | 23 | BDL | 1 | BDL | 32 | 4.2 | BDL |
| **P II DS** | 470 | 6.5 | 28.9 | 1 | 8.1 | 400 | 160 | 180 | 74 | 0.06 | 0.7 | 0.4 | 20 | 3.3 | 4 | BDL | BDL | BDL | 32 | 3.9 | BDL |
| **P III US** | 637 | 7.2 | 27.8 | 14 | 8.0 | 520 | 160 | 200 | 131 | 0.07 | 0.8 | 0.3 | 15 | 2.2 | 16 | BDL | 1 | BDL | 38 | 2.8 | BDL |
| **P III DS** | 633 | 7.3 | 27.6 | 7 | 8.3 | 443 | 160 | 150 | 142 | 0.05 | 1.0 | 0.3 | 19 | 1.7 | 11 | BDL | 1 | BDL | 42 | 4.2 | 7 |
| **P IV US** | 488 | 7.3 | 27.6 | 3 | 8.2 | 437 | 180 | 320 | 78 | 0.05 | 0.6 | 0.2 | 14 | 1.9 | BDL | BDL | BDL | BDL | 16 | 3.3 | BDL |
| **P IV DS** | 509 | 7.3 | 28.3 | 6 | 8.2 | 348 | 180 | 240 | 89 | 0.08 | 0.5 | 0.2 | 15 | 2.0 | 7 | BDL | BDL | BDL | 48 | 3.3 | 7 |

***Note:** P I - Plant I, P II - Plant II, P III - Plant III, P IV - Plant IV, US - Upstream, and DS- Downstream

**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL, SOUTHERN ZONE, CHENNAI.**

**Original Application No.16 of 2019**

K. Gemini (Died),
S/o. Kannupaiyan,
No.5/1-34, Rettaipulliyamaram Raman Nagar Post,
Mettur Dam Salem District – 636 403 and Ors.

...Applicants

-Vs-

The Union of India
Rep. by the Secretary to Government,
Ministry of Environment, Forests & Climate Change,
New Delhi – 110 003 and Ors.

...Respondents

**COMPLIANCE REPORT FILED ON BEHALF OF THE THIRD RESPONDENT – TAMIL NADU POLLUTION CONTROL BOARD.**

**Advocate for Respondent: TNPCB**
**Thiru.S. Sai Sathya Jith,**
**Advocate, Chennai.**

**Date:10.09.2024**

**Date of hearing on:15.10.2024.**