Analysis of the status of groundwater quality which was contaminated with waste oil in the Chunnakam area, Jaffna

November 2013 - September, 2014

Regional Laboratory,
National Water Supply & Drainage Board,
Jaffna.

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Abstract

The Jaffna peninsula covers an area of 1,012.01 sq m including inland waters with a population of 607,158. In Jaffna Mainly four groundwater aquifers are available for water consumption depends on the water capacity and quality of the water.

Those four aquifers are Vadamarachchi-east aquifer, Chavakachcheri aquifers, Chunnakam aquifers, and Kayts aquifers.

Chunnakam aquifer is the high capacity and acceptable quality water for drinking and other usage. This is the thick lens float over the sea water. Due to these high capacity and good quality water supplies are generated from this area. This water is supplying to many water scarcity areas such as Watharawaththai, Atchuvely, Navaly, Kantharodai, Sandilipay, Karainagar, Jaffna municipal council areas etc. Population vise also Valikamam takes place second rank in Jaffna, because population is also based on the potable water availability.

Continuously we have observed fuel smell in our Chunnakam water intake site, the intake site is located very close to the Chunnakam fossil fuel power station. and we analyzed the oil and grease content of the intake well and the adjacent wells and found the oil contamination. Due to this we have stopped the pumping from Chunnakam Intake site and continue our supply from Pokkanai Intake.

For the project Waste oil contamination data were collected through questionnaire and from those data, 100 wells were selected for analysis. These wells water quality were analyzed for pH, EC, Total hardness, COD, Oil & Grease, Nitrate, Nitrite, and heavy metals for some sample.

under the project 150 wells were analyzed, 109 (73%) wells have shown the higher oil level than the standard, 07 (4%) wells were under the limit and 34 wells (23%) were not contaminated with oil and grease. from the analysis the oil and grease contamination was observed within 1.5 km surrounding of the power station.

As per the predicted maps, the high oil and grease concentration layers were observed in the surrounding of the Chunnakam power station area.

And the oil spreading pattern showed towards north, up to 1.50 to 2.0 km oil contaminants were spread up in the north direction and less than 1.5 km in the other direction.

Form the questioner, health problems were not reported by the area public and no any significant crop pattern changes or unknown diseases were not observed in the Agricultural practices.

Higher Nitrate concentration also was observed in this area, because high agricultural practices are going on this area. COD showed the unexpected results and other quality parameters were mostly complying with the SLS 614(1983).

Acknowledgement.

First and foremost let me place on record my sincere gratitude to the Research Appraisal Committee, Assistant General Manager (R&D) and the Research and Development section for entrusting this research project and giving me the time extension to complete this project.

The assistance given to me by the Deputy General Manager (N), Regional Manager (J) and the supporting staff of Regional Office to complete my project on time, they have been good enough to give the guidelines from time to time to proceed with the research.

It is the Chief of laboratory services, who have been giving me the relevant advice as and when required without any hesitation and made all the necessary arrangements to provide the chemicals and the glassware, when our supplies got depleted. I am really thankful to him for all his continuous assistance.

In this connection the timely assistance given by the Manager, Palmyrah Research Institute by providing an important chemical on loan at the appropriate time helped us to overcome our shortage.

My Research Assistant Ms. P. Sutharshini, and the staff attached to the Regional Laboratory, Jaffna has given me their whole hearted support to complete the research work smoothly.

Last but not least in importance is the moral support and encouragement given to me by my parents and the circle of friends.

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CHAPTER -01

INTRODUCTION

1.1 General Introduction

Location

The Jaffna peninsula covers an area of 1,012.01 sq m including inland waters with a population of 607,158 and is located in the northern tip of Srilanka. (Statistical Hand book, Jaffna 2013)

The **topography** is low and flat, the highest elevation is only +10 m MSL

The peninsula is split in to 3 parts by lagoons which are connected to the sea.

The Elephant pass Lagoon separates the peninsula from the mainland, the Vadamarachchi Lagoon separates the peninsula in western and eastern part and the Upparu Lagoon separates the northern from the western and eastern parts.

Climate

The climate of the Jaffna peninsula is determined by the monsoon that forms a distinct wet and dry seasons. The major rainy season occurs during the North-East monsoon from October to December which is the Maha season and the minor rainy season occurs during the south- west monsoon in April and May which is the Yala season. Received rain fall was 913mm in 2012 and average temperature in this year was 28.46^{o} C. (Statistical Hand book, Jaffna 2013).

Geology

Jaffna peninsula is underlain by three formations: the pre-Paleozoic basement rocks, Mannar sandstone and the Jaffna limestone. The pre-Paleozoic basement rocks are described as massive, crystalline, igneous and metamorphic. they can be found at a depth of 240 m. the basement rock are overlain by the quartzitic sedimentary deposits, the Mannar sandstone formation of early tertiary up to Miocene age.

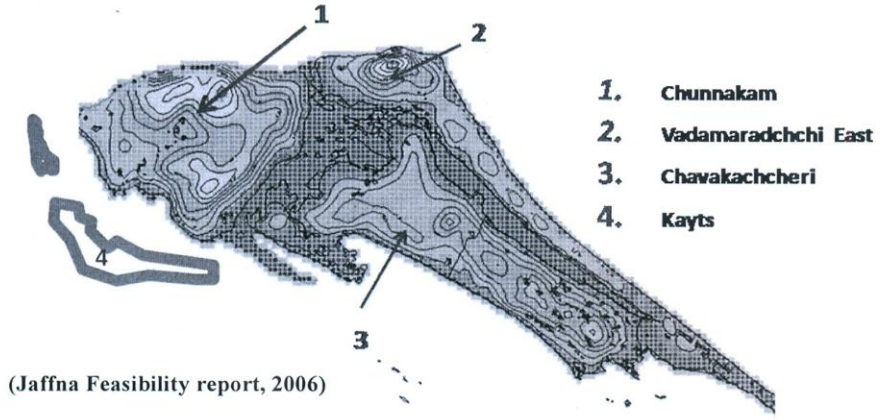
The Jaffna limestone is the main aquifer of the peninsula, the entire groundwater is generated almost entirely from percolated rainfall and it forms a fresh water lens beneath the peninsula. It has been found, that the fresh water lenses do not extend below the base of the limestone

Surface water and groundwater are the main water resources of Srilanka. Groundwater is an important source of water for human consumption in many parts of the world and is water occurring in a large quantity in the rock formation in the earth's crusty (Cooray, 1984). The need for clean water as one of the most essential commodities for mankind can never be over emphasized. The quality and quantity of groundwater monitoring is one of the most important aspects of groundwater resource management and prevention of groundwater pollution.

In the case of Jaffna, people mainly depend on groundwater for their drinking, irrigation, and domestic purpose. Hence the attention has to be paid to protect and conserve the existing good quality water. Groundwater has been mainly confined to the sedimentary Miocene formation in the Jaffna peninsula and the North West area in Sri Lanka (Palitha Manchanayake and Madduma Bandara, 1999)

1.2 Groundwater resource in Jaffna peninsula

In Jaffna Mainly four groundwater aquifers are available for water consumption depends on the water capacity and quality of the water.



(Jaffna Feasibility report, 2006)

Figure: 1.1 four types of aquifers in Jaffna

Those four aquifers are Vadamarachchi-east aquifer, Chavakachcheri aquifers, Chunnakam aquifers, and Kayts aquifers. Of these four aquifers Chunnakam aquifer contains the highest capacity of water.

In Jaffna peninsula, the occurrence of the fresh water is typical of that of any small island with the groundwater lenses floating over the sea water, the thickness and the uniformity of these freshwater lenses would be greatly affected by the cavernous limestone found in the area. However there have been over 100,000 dug wells constructed found in the Jaffna peninsula, with depths ranging from 5 m to 10 m, which are used for small scale agriculture and domestic purposes. (Arumugam, 1968). For the agriculture purposes 25,256 agro wells, 2,433 ditches, 1,084 Ponds are used in Jaffna in 2012 (By the estimate of Department of Agrarian development, Jaffna).

The Jaffna peninsula is underlain by Jaffna limestone of early Miocene age. The limestone is typically a compact, hard, partly crystalline rock. It is massive in places but some layers are fossiliferous and weathered into a honeycombed mass (Coorey, 1984). The formation is almost flat bedded, but may have a slight regional dip to the west, and consequently it thickens to the west. It has the vertical thickness of at least several hundred feet, and at one drilling site in the southeastern part of the peninsula at Palai it was found to be (270 ft) 90 m thick, and underlain by a thick sandstone formation overlaying the Precambrian basement.

Aquifer Type

1. **Sand dune aquifer**

A zone of coastal sand dunes extends southeast from Pointpedro for some 50 km to Chundikkulam. At its widest, near Kudathanai, the dune system is just over 4 km wide. It gradually becomes narrower towards the southeast and at Chundikulam it is barely 1 km wide. The dunes are mostly quite low. Commonly less than 4 m or so above sea level, but there is a discontinuous higher zone close to the coast that appears from visual observation to be about 15 m high. The sand rest is on the upper surface of the Jaffna limestone, which in this area shelves gently to the south and east. The maximum currently known thickness is about 17 m, near Manatkadu, but it may be thicker further southeast.

2. Yellow and Brown sand aquifer of the Palai area

The area referenced here is the long area of land between Vadamarachchi lagoon and Jaffna lagoon, extending more or less to Uppu aaru and towards Point Pedro. As with the dune sand aquifer, the sand here rests on the upper surface of the Jaffna Limestone that shelves gently to the southeast. The thickness of the sand deposits consequently increase towards the southeast and decrease towards Uppu aaru lagoon. It thins to zero in a discontinuous area to the west of point Pedro where there are outcrops of limestone. The area is flat and low, with a maximum land elevation of less than 10 m (feasibility study, 2006)

3. Limestone Aquifer

There is very little data available about the lithology, and about distribution of solution cavities, despite the numbers of wells and drill holes constructed in the area. Few of the recorded drill logs provide detail on their lithology or on solution cavities beyond a comment that they are present. It is assumed that solution cavities are present throughout the full thickness of the limestone and they are generally interconnected. There are some areas, where the upper few meters of limestone appear to be relatively massive, and perhaps not karstic. Water heads in the sand and the limestone, however, where penetrated by adjacent drill holes are usually the same within a few millimeters suggesting that, the sand and limestone aquifer are usually well connected.

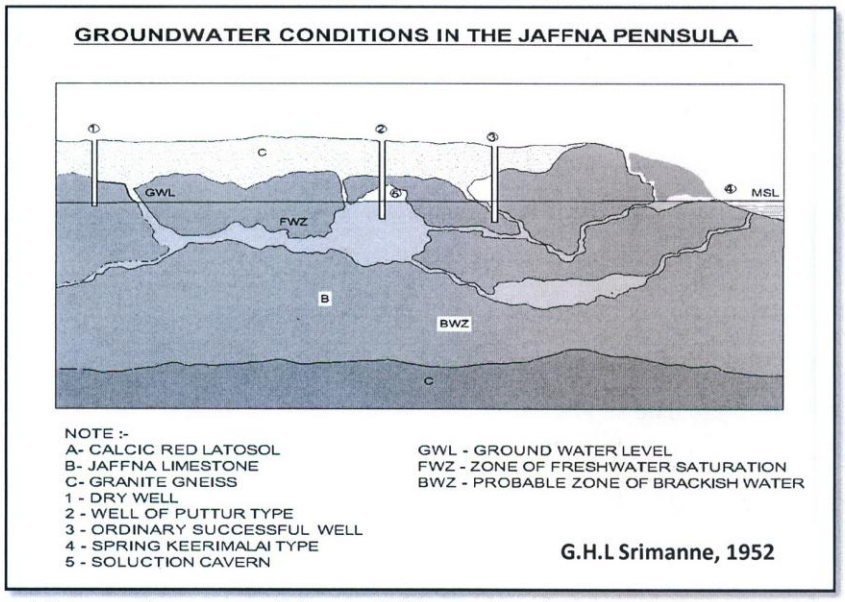


Figure: 1.2 groundwater condition in Jaffna peninsula

As per the figure 1.2, Jaffna underground water store in the lime stone cavities and the cavities are open to the sea. So the lime stone aquifer is having limited capacity and the contaminants are easily reaching to the aquifer due to thin soil beds.

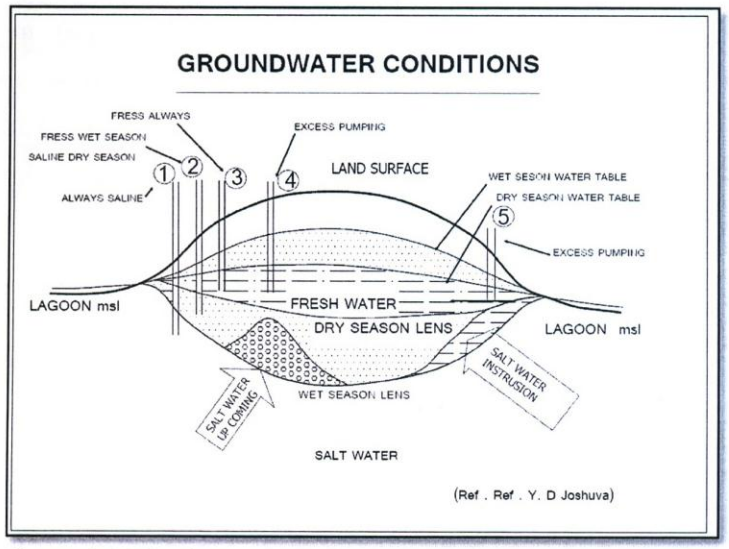


Figure 1:3 Floating pattern of fresh water lens in Jaffna

As per the figure 1.3, the Jaffna peninsula fresh water lenses are floating in the salt water and surrounded by the sea water. As such it is facing high risk of sea water intrusion and up corning into the fresh water lenses.

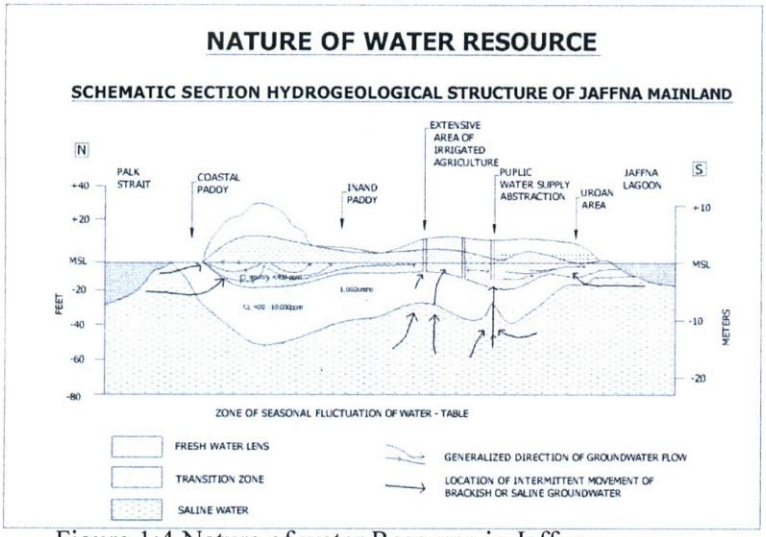


Figure 1:4 Nature of water Resource in Jaffna

As per the figure 1.4, improper construction of wells is increasing the above risk.

1.3 Study Area

Chunnakam (Tamil-சுன்னாகம், Sinhala- චුන්නාකම් CHUNNANAKAM) is a big town, located in the 9°45′0″N 80°01′0″E .and this area takes important part in commercial activities in Jaffna. **Chunnam+Gramam**, **Chunnam** means **Limestone** *and* **Gramam** means **village,** Limestone are widely found in the nearby areas. Chunnakam is about 5 miles^2 in area and it has Punnalaikadduvan on its East, Uduvil on its South, Sandilipay on its West and Mallakam on its North as bordering villages.

Population

Table 1:1 As 2012 Dec 31st the Total population in Jaffna District is 607,158

Divisional Secretariats	Population
Delft	4,527
Islands south	18,260
Islands North	10,802
Karainagar	10,897
Jaffna	59,367
Nallur	66,884
Valikamam south west	52,276
Valikamam west	47,460
Valikamam South	50,812
Valikamam North	34,394
Valikamam East	73,074
Thenmaradchi	71,387
Vadamaradchy Southwest	45,793
Vadamaradchy North	45,937
Vadamaradchy East	15,288
Total population	**607,158**

(Source: Divisional secretariats, 2013, Statistical hand book)

Figure 1:3 Schematic section hydro geological structure of Jaffna mainland

In which Valikamam south consist 50,812 no of population and Valikamam east consist 73,074, totally these two areas consisting around 123,886 . it is around 20% of total population in Jaffna..

G.N Division	Population (no)
J/196	3249
J/197	1238
J/267	3179

Table 1:2 Selected GN Divisions for sample collection

Chunnakam aquifer is the high capacity and acceptable quality water for drinking and other usage. This is the thick lens float over the sea water. Due to these high capacity and good quality, water supplies are generated from this area. This water is supplying to many water scarcity areas such as Watharawaththai, Atchuvely, Navaly, Kantharodai, Sandilipay, Karainagar, and Jaffna municipal council areas. Population of Valikamam also takes second rank in Jaffna, because population is also based on the water availability.

Not only the water is used for domestic purpose, but also for Agricultural purposes. Agriculture is practiced in larger extents. Therefore the aquifer is exposed to several vulnerabilities such as over extraction of groundwater, higher fertilizer usage, and other forms of pollution by anthropogenic activities.

Major part of lands are used for Agricultural purposes. In this area mainly vegetable crops such as mixed crop cultivation, leafy vegetable, chilli, Red onion cultivation, some cereals, fruit crops such as banana, grapes, papaw, pomegranate and other vegetable crops are practiced. These yield more income and thus increase the GDP of these people.

1.4 Fossil fuel power stations

In a fossil fuel power plant the chemical energy stored in fossil fuels such as coal, fuel oil, natural gas or oil shale and oxygen of the air is converted successively into thermal energy, mechanical energy and, finally, electrical energy.

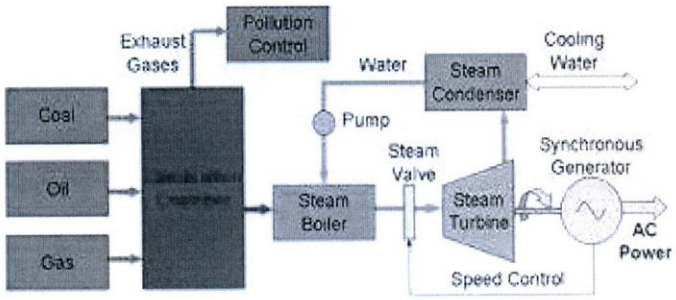


Figure 1:5: Fossil Fuel Powered steam Turbine Electricity Generation

A fossil fuel power plant is a system of devices for the conversion of fossil fuel energy to mechanical work or electric energy. The main systems are the steam cycle and the gas turbine cycle. The steam cycle relies on the Rankine cycle in which high pressure and high temperature steam raised in a boiler is expanded through a steam turbine that drives an electric generator. The steam gives up its heat of condensation in a condenser to a heat sink such as water from a river or a lake, and the condensate can then be pumped back into the boiler to repeat the cycle. The heat taken up by the cooling water in the condenser is dissipated mostly through cooling towers into the atmosphere.

Combustion-generated pollutants, such as oxides of nitrogen (NOx), sulfur (SOx), and particulates, if uncontrolled and emitted into the atmosphere represent environmental and health hazards, such as acid rain. Environmental regulations supported by intensive research and developments have reduced pollutant emissions significantly. Improvements in efficiency and emissions come by increasing steam pressure and temperature in the steam cycle, and by increased turbine inlet temperature in the gas turbine cycle. Coal gasification produces a fuel gas that is capable of being used in the gas turbine

In addition to that, the fuel is also affecting the soil and water directly or indirectly, and the fossil fuel is having high hazardous heavy metal and aromatic carbons in the composition.

Element	Weigh %		Hydrocarbon	Weigh %
Carbon	83 – 87		Paraffins	30
Hydrogen	10 - 14		Naphthenes	49
Nitrogen	0.1 – 2		Aromatics	15
Oxygen	0.1 - 1.5		Asphaltics	6
Sulfur	0.5 - 6			
Metals	< 0.1			
The hydrocarbon weight % values are averages.				

Table 1:3 Elements in the fossil fuels

Mainly the ground water contamination is very riskful and very difficult to remove. U.S.EPA also recommends water quality criteria for many of the constituents in oil and grease and many state and federal water quality standards prohibit oil in quantities that produce a film or sheen on the water. And several health effects also may be caused due to the contamination. This affects the aquatic life. Low levels of oil pollution can reduce aquatic organism's ability to reproduce and survive. Studies indicate that 0.3 – 0.6 mg/L of certain aromatic hydrocarbons can be lethal to aquatic organisms. While chronic concentrations over 50 µg/L may be harmful to estuarine species. Oils can also increase chemical oxygen demand.

1.5 Chunnakam Power station

Chunnakam power station is located in this area which is operated by Ceylon Electricity Board, It was started in 1958 for the supply of the electricity to Jaffna.

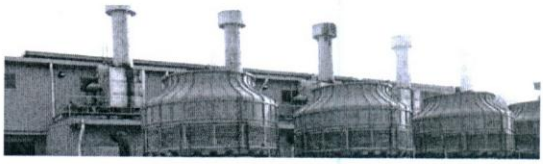


Figure 1:6 Chunnakam Power station

CEB is getting electricity from some sub contractors, and they are also operating their fossil power plant in the same premises. During the war time Jaffna got their whole electricity demand from these power plants and that time they were unable to comply with the Environmental regulation and they were given priority for the security of the plants. Time to time contractors were changed but all were operated the fossil power plant.

From this power station waste water was dumped into the adjacent bare lands without any proper treatments, due to this the waste oil has reached the underground aquifer. .

Figure 1:7 waste oil stagnated near the C surrounding

Figure 1:8 Chunnakam New Power Plant

Recently the CEB opened a new fossil fuel power plant named "Uthuru janani" in 2013 Feb, by which it can generate 24 MW of electricity.

1.6 Health related problems due to Oil Contamination

The oil and grease contamination affect the community in different ways, aromatic carbons and heavy metals cause high health risk for people.

1. **Cancer Incidence**

   One health problem that is commonly associated with long-term exposure to petroleum products is cancer. Several fragmented studies have been conducted to examine possible correlations between increased cancer incidence and long-term oil exposure; however, this is a topic that has not been thoroughly researched.

2. **Pulmonary Health problems**

   Many people who are exposed to air pollution created by drilling operations and waste gas flaring suffer from pulmonary health issues. Most of these pulmonary

problems are caused by inhalation of oil fumes from burning oil fires, gas flaring, and pure crude oil.

3. **Pregnancy and Early Childhood Development**

Exposure to crude oil in everyday life can lead to birth defects, miscarriages, and problems in early childhood to children. In the scientific data we gathered on health effects in Northeast Ecuador, there was one study devoted to pregnancy.

4. **Dermatological Heath problems**

The direct exposure with oil contaminants causes dermatological health problems.

5. **Psychological Health problems**

The majority of oil spills fall under the category of a technological disaster, because they are caused by careless, irresponsible, or reckless human behavior (Picou, 2009). Technological disasters such as the Exxon-Valdez oil spill can lead to social problems and psychological health issues. Economic collapse, social problems, change in subsistence lifestyle of natives, loss of life, contaminated water supplies and crops, and stress of the environmental cleanup can all also lead to psychological health problems. These are all topics that are addressed in the compilation of research on psychological health issues resulting from oil exposure that have collected.

6. **Health effect by Lead**

Potential health effects from ingestion of water constipation, vomiting, hyperactivity, unsteady(vertigo), gout, arthritis, birth defects, coordination inabilities, muscle weakness, muscles aches, anorexia, fits, cirrhosis, metallic taste Thyroid disfunction , sleeplessness, diarrhea, fatigue, pituitary damage, sterility, tremors, degeneration of motor neurons, growth problems in long bones, cataracts, headaches , anemia, leads lined gums.

7. **Health effects of Aromatic carbons**

- Presence of **Benzene** causes anemia, blood platelets, increasing risk of cancers

- Presence of **Ethylbenzene** causes liver, kidney problems these may exist in the discharge of petroleum refineries.

- Presence of **Ethylene dibromide** causes liver, stomach, reproductive system, kidney disorders, increase the cancer risk may exist in the discharge of petroleum refineries.

- **Tolune** also exist in the discharge of petroleum refineries which also cause health problems

8. **Adverse human impacts:**

   Toxicity varies among different type of oil & grease. Refined oils are generally more toxic than crude oil. Various hydrocarbons founds in fuels can pose a wide range of human health problems, from affecting the kidney s, and blood to increasing the risk of cancer.

1.7 Statement of problems

Pollution can come from two types of sources; point and non-point. Point sources are identifiable and localized sources of pollution. Point sources that can contaminate groundwater include landfills, buried gasoline or oil storage tanks, septic systems, industrial sources and accidental spills. Non-point sources tend to be in the form of pesticides and nutrients that enter the soil as a result of intense agricultural operations or the widespread use of road salts and chemicals.

Improper disposal of oil directly on the ground, down a storm drain, or in the trash threatens the quality of our water and environment. Used oil may be containing toxic chemicals which are harmful to the environment and public health. Waste oil disposed of in landfills or dumped on the ground can seep into the groundwater, which may contaminate wells or surface waters.

Water recharge to karsts aquifers occurs directly, either through swallow holes and sinkholes, or indirectly through the pores in the soil overlying the limestone bedrock.

Chunnakam power station dump the waste oil directly to the land which was mixed up with surrounding groundwater wells and the well water odour was changed unfavorably. Therefore several wells were not used for domestic and agricultural purposes in nearby areas.

1.8 Identification of problems:

Kerosene oil type odour was observed in Bowsering water from Chunnakam WSS Intake. Odour was observed in pipe born supply water too from Chunnakam intake. Chunnakam intake and the surrounding wells were checked for oil & grease and identified oil & grease residues in all wells. And several public complaints received through MOH Chunnakam regarding the oil & grease odour. Chunnakam Pradesh Saba Chairman called the meeting with all relevant institutions and site visit also was arranged.

Ministry Of Health (MOH), Central Environment Authority (CEA), Board Of Investment (BOI), Predesha Sabah (PS) and National Water Supply & Drainage Board (NWSDB) jointly visited the site and MOH collected the samples from the Power station oil dumping point. All those oil & grease samples results were exceeding the CEA standard .CEB power station surrounding wells were also checked by NWSDB and found that wells also have oil & grease residue. **Chunnakam Intake site was given up due to this contamination.**

Based on these problems National water supply & Drainage Board, Jaffna started a project to analysis the problems.

Figure : 1.9 Site inspection with CEA, MOH, PS, and BOI

Figure .1.10 Stagnated oil in the dumping site

Figures 1:11 Oil Contaminated wells

1.9 Objective of study

- Surveying of waste oil affected area.
- To identify the waste oil contaminated wells through the survey study
- Analyze the water quality of the waste oil contaminated wells
- To map the waste oil affected area
- Study the extent of waste oil penetration in the Chunnakam aquifer
- Identify the level of water quality deterioration in the study area

CHAPTER 02

METHOD AND MATERIAL

2.1 Data collection

Affected area wells were surveyed through the Questionnaire. Data were recorded and summarized in Excel. (The Format of questionnaire annexed)

2.2 Selection of wells

CPH –Chunnakam Power House

a) 0- 200 m circumference from the CPH
b) **200-500 m** circumference from the CPH
c) > **500 m** circumference from the CPH

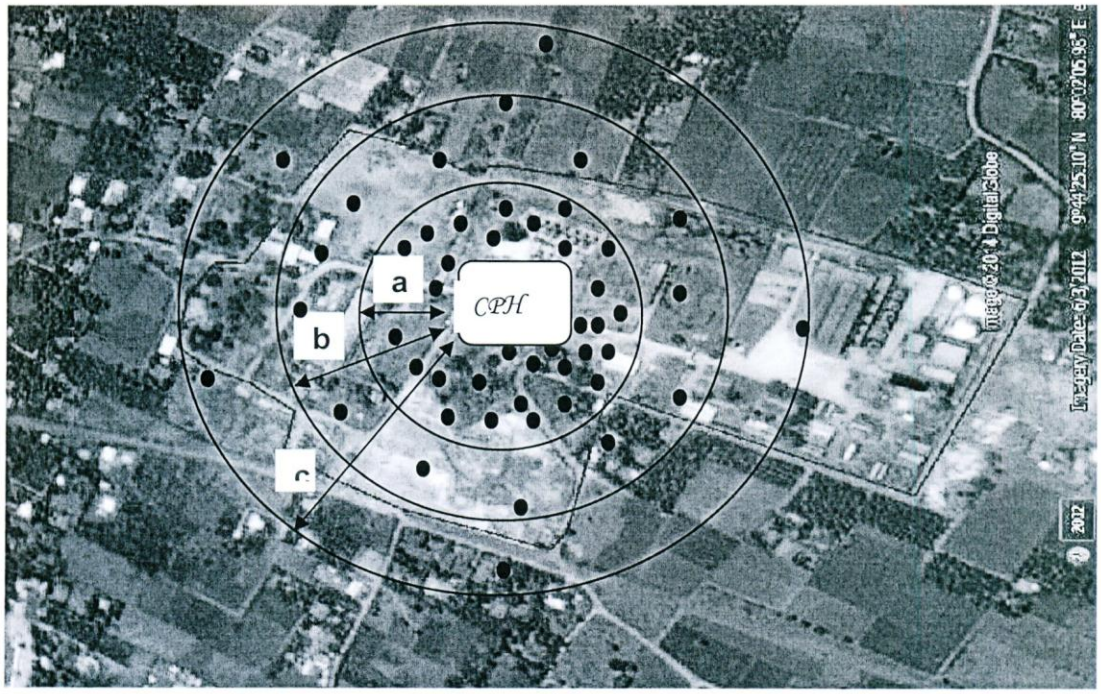


Figure 2:1: Diagrammatic figure of the well selection from the study area

281 wells were selected from the surrounding area of the Chunnakam power house.

From Zone a (0 to 200 m) - all well locations were collected,

From Zone b (200- 500 m) - problem reported location wells details were collected and

From Zone C (more than 500 m) - locations were randomly selected

2.3 Measurement of Distance of wells from the centre of the CPS

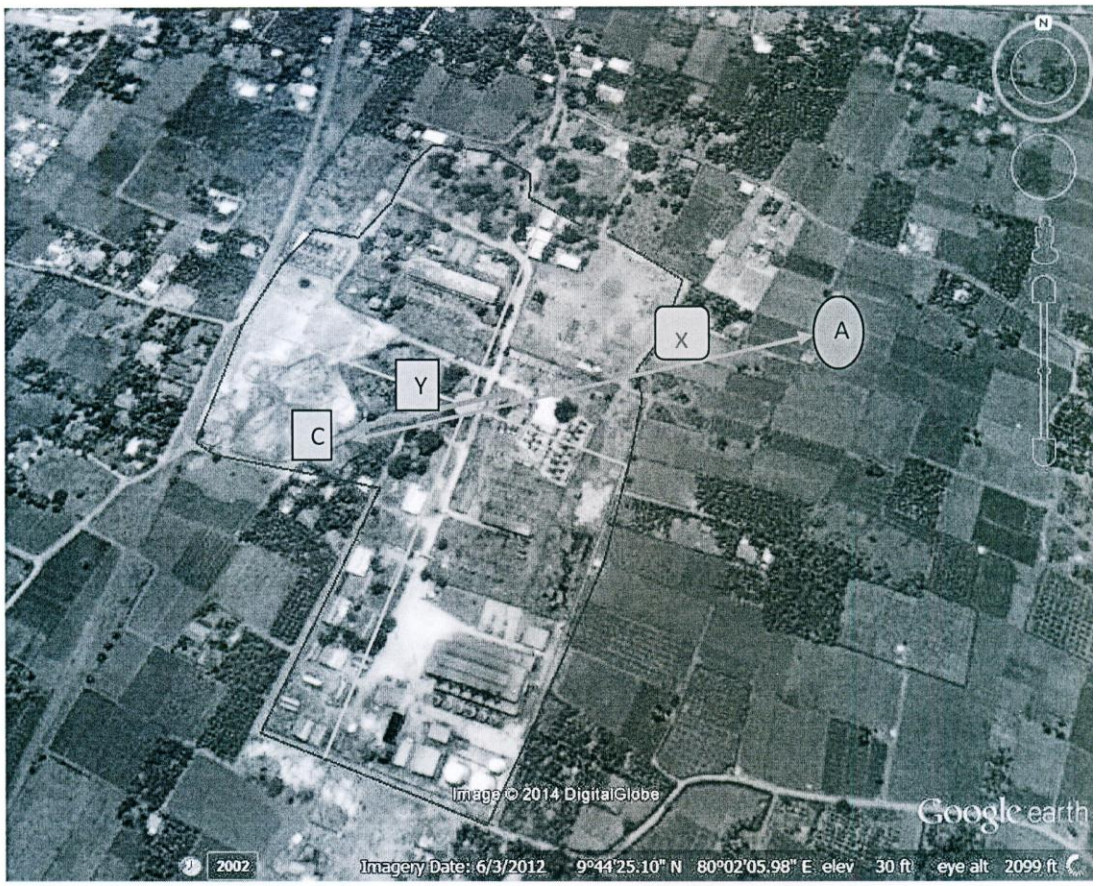


Figure2.2 Method for Distance Measurement of wells

A- A well location

X- Distance of well from Centre of CPS

Y- Distance from Centre of CPS to boarder of CPS

C – Centre of CPS (Chunnakam Power Station)

Distance of well = (X-Y) m

2.4 Collection of water samples

Groundwater samples were drawn from the 100 wells from November 2013 to August 2014 .The samples were collected from surface and the bottom of the Dug wells by using a specific water sampler. Samples were collected by direct pumping in tube well, because most of the tube wells are installed with electric driven pumps and hand pumps.

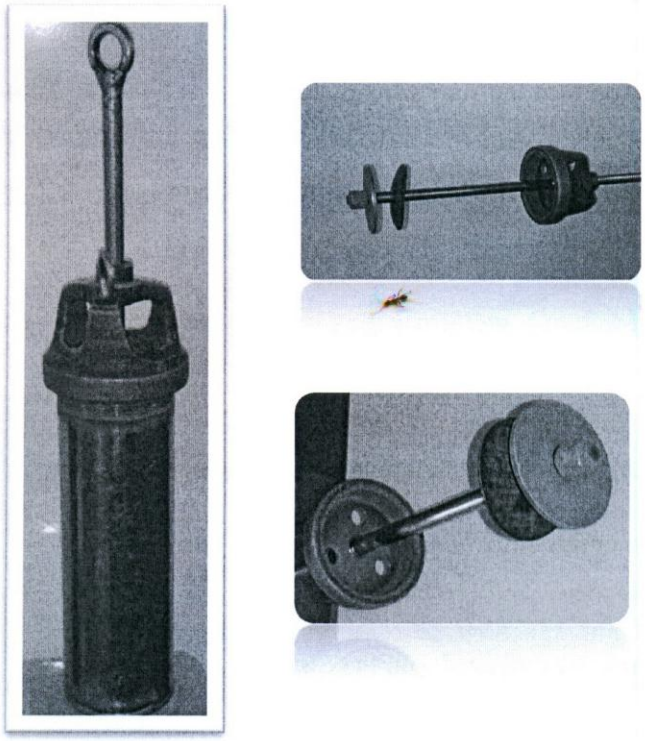


Figure 2:3 Diagram of the water sampler

2.5 Analysis of samples

Water samples were analyzed for pH, EC, Total Hardness, Heavy metal (Pb, As, and Cr), Oil & Grease, Chemical oxygen demand (COD), NO_3^-, and NO_2^--N.

2.5.1 pH - Method of Analysis

Required equipment: pH Meter

Method:

1. Calibrated the pH meter initially
2. Washed the probe by distilled water
3. Placed the probe into the sample
4. Switched on the meter
5. Then pressed the start or ready button
6. Recorded the value

Figure: 2.4 pH meter

pH meter was frequently calibrated with pH 4, pH 7, pH 10 standard solutions

2.5.2 EC- Method of Analysis

Required equipment: Conductivity Meter

Units: µS/cm or mS/cm

Same as the pH Meter.

Meter was frequently calibrated with 143 µS/cm,

1413 µS/cm standard solutions

Figure .2.5 EC Meter

2.5.3 COD Analysis

CELL NO.1 (BLANK)	CELL NO.2 (SAMPLE 1)	CELL NO.3 (SAMPLE 2)
Dist water – 10 ml	Sample – 10 ml	Sample – 10 ml
$K_2Cr_2O_7$ – 6.0 ml	$K_2Cr_2O_7$ – 6.0 ml	$K_2Cr_2O_7$ – 6.0 ml
Ag_2SO_4/H_2SO_4 – 14 ml	Ag_2SO_4/H_2SO_4 – 14 ml	Ag_2SO_4/H_2SO_4 – 14 ml

After the addition of these chemicals, the set up was allowed to digest for 2 hours at 150^0 C

Then digestion completed it was allowed to cool to room temperature

Then that digested samples was titrated with FAS

The indicator is ferrion indicator

The known value of COD solution was prepared with 425 mg Potassium hydrogen phthalate dissolved in 1000 ml of distilled water and technique and quality of the results were checked with this solution

CALCULATION: COD (mg/l) = $\frac{(a-b)*M*8000}{\text{ml of sample}}$

a- ml of FAS for Blank b-ml of FAS for sample M-Molarity of FAS

Calculation of Molarity: 10.0 ml of $K_2Cr_2O_7$ is acidified by using 10 ml of Ag_2SO_4/H_2SO_4 and titrate with FAS

$$M = \frac{\text{Volume of } K_2Cr_2O_7}{\text{Volume of FAS}} \times 0.1$$

Colour change from digestion to end of the titration

Colour Change: ORANGE ⟶ BLUE –GREEN ⟶ REDDISH BROWN

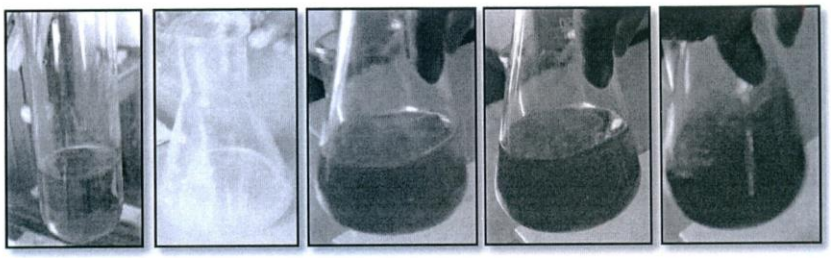


Figure : 2.6 Colour changes during the COD Analysis titration with FAS

2.5.4 Hardness

Method of Analysis: EDTA Titration

Equipment Required: Burettes, Pipettes, Titration flasks

Chemical Required: EDTA, Eriochrome Black T (indicator) and Ammonium buffer

Method:

1. 25ml sample was added into the titration flask
2. 2 ml of buffer and some of indicator were added in to the flask
3. Titrated against EDTA solution, swirling the flask continuously until a blue colour formation (End point)
4. The burette reading was recorded

Calculation

Total Hardness (mg/l) = Required volume of EDTA x [EDTA] X Molecular weight of $CaCO_3$

ml of Sample

EDTA was standardized with 0.01M $CaCO_3$ solution.

2.5.5 Nitrate and Nitrite

Nitrate: Cadmium Reduction method

Equipment Required: Direct reading spectrophotometer, sample cells

Chemical Required: NitraVer 5 Nitrate powder pillows,

Nitrite: Diazotization method

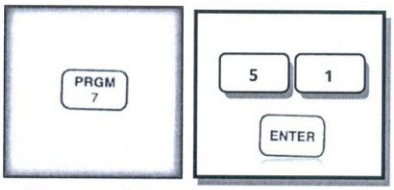
Equipment Required: Direct reading spectrophotometer, sample cells

Chemical Required: NitriVer 3 Nitrite powder pillows

Figure 2.7 Colorimeter (DR/890)

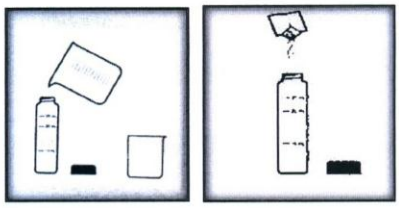
Method of analysis

1. the programme number 51 for Nitrate (DR/850) and 63 for Nitrite were Entered
2. pressed: **ENTER**



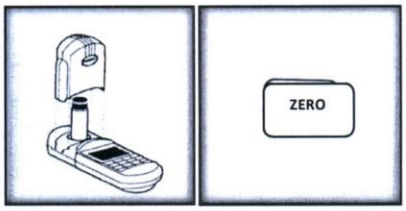
3. 25 ml sample was Measured into a dry sample cell

4. 25 ml demineralized water was Measured into a dry sample cell
5. One NitraVer 5 Nitrate powder pillow was added into each cell, Shake Vigorously. and for nitrite one NitriVer 3 Nitrite powder pillow was Added into each cell, swirl to mix

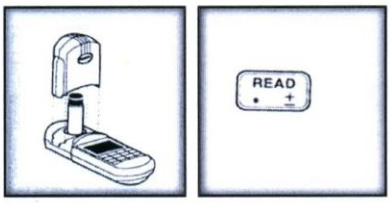


6. It was Allowed 1 minutes reaction period (Amber colour) for nitrate and for nitrite Allowed 15 minutes reaction period (Pink colour)
7. The blank was placed into the cell holder, closed the shield

8. Pressed: **ZERO**



7. The sample was placed into the cell holder, closed the shield.
8. Pressed: **READ**



9. the result was recorded

2.5.6 Oil and Grease Analysis (USEPA method)

Method of Analysis: Hexane extractable gravimetric method for water and waste water

Apparatus and equipment

a) Separatory funnel, 2L with PTFE (Teflon) stopcock
b) Distilling flask, 125ml
c) Water bath
d) Filter paper, (WhatMan No. 40 or equivalent).
e) Weighing balance
f) large glass type funnel,

Reagents and standards

a) Hydrochloric acid: HCl (1+1)
b) Petroleum ether (BP 40°C-60°C) or n- Hexane
c) Acetone
d) Anhydrous sodium sulphate-Na_2SO_4

Before starting the testing:

- The sample must be at room temperature before analyzing.
- Do not use plastic tubing to transfer the solvent between containers.
- Do not pre-rinse the collecting vessel with sample.

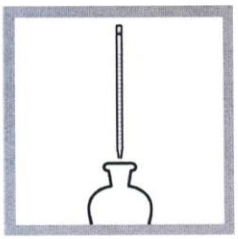
Cleaning

Bottles–Detergent water wash, tap water rinse, cap with aluminum foil, and bake at 200–250 °C for 1 h minimum prior to use. Solvent rinse may be used in place of baking.

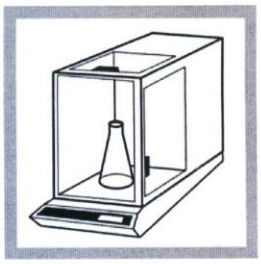
Methods:

1. 300 ml of Sample was collected in a clean 500-ml separatory funnel.

2. Using a pipette and pipette filler, 4 ml of 1:1 Hydrochloric Acid solution was added to the separatory funnel. Mix well. The pH must be ≤ 2 to hydrolyze oils and grease and prevent sodium sulfate interference.

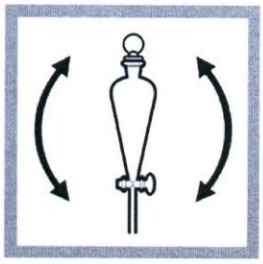


3. Using an analytical balance, weighed a previously dried and cleaned 125-mL distillation flask containing 3–5 boiling chips to the nearest 0.1 mg. Recorded the weight of the flask.

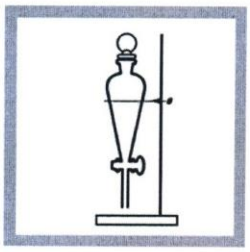


4. 20 ml of n-hexane was added to the separatory funnel. If the sample was collected in a separate container if repeating this step, rinsed the collecting vessel

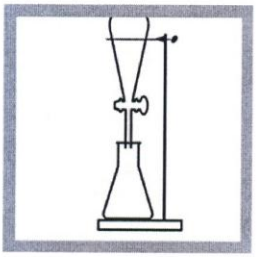
5. Stoppered the funnel. Inverted the funnel and released the gases through the stopcock. Then, vigorously shake the funnel for two minutes.



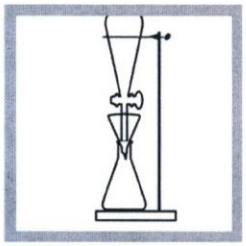
6. Allowed the funnel stand undisturbed for at least 10 minutes to ensure separation of the lower water layer and the upper solvent layer.



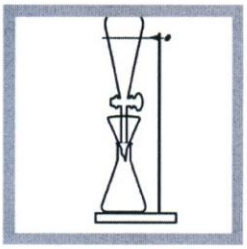
7. Slowly drained the lower water layer from the separatory flask into the original sample container or 500-mL volumetric flask.



8. The filtering funnel Set up was prepared. Put the glass funnel in the neck of the distillation flask. A folded 12.5 cm filter paper was placed in the funnel. 10 g of anhydrous sodium sulfate was added to the filter paper. Rinsed the sulfate with a small amount of the hexane. Discarded the hexane properly. Used the same filter, funnel and sodium sulfate when repeating this step for the second and third extractions.



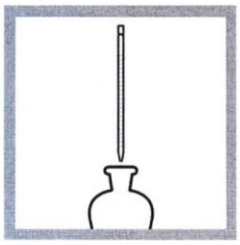
9. Drip-drained the solvent layer into the pre-weighed boiling flask through a funnel containing filter paper and 10 g anhydrous sodium sulfate.



10. Returned the water layer to the separatory funnel, used the same glass funnel for the second and third extraction.

11. Repeated the steps 4- 10 for two more times. After the third extraction, the water layer was discarded

12. The separatory funnel was rinsed with three separate 5-mL aliquots of fresh n-hexane to remove any oil film left on the funnel walls.

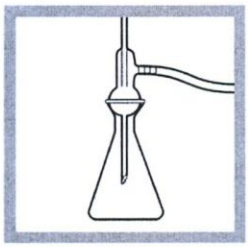


13. Rinsed the tip of the glass funnel with 5 ml of n-hexane while removing it from the distillation flask. Checked for sodium sulfate contamination.

14. distilled off the n-hexane, using the distillation assembly,

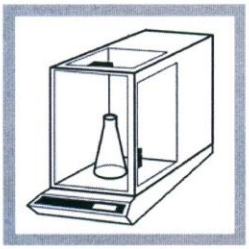
15. Disconnected the condenser/connector portion of the distillation assembly at the pinch clamp and removed the distillation flask from the heat source with an anti-lint cloth or tongs.

16. Removed the remaining solvent vapors from the distillation flask



17. Placed the flask in a desiccators for 30 minutes (or longer if necessary) until it cools to room temperature.

18. The flask was weighed, using an analytical balance,



20. The test results were calculated

(A – B) x1000= mg/l

A= Weight (mg) of residue

+ flask

B= Weight (mg) of flask

2.6 Heavy Metal Analysis

The heavy metals were analysed in Central Laboratory, National Water Supply and Drainage Board, at Ratmalana with Atomic Absorption Spectrometer (AAS)

2.7 Data Analysis

MS Excel 2007, SAS, Ms Word 2007 and Arc Map 10 were used for data analysis

CHAPTER 03

RESULTS AND DISCUSSION

3.1 Research Time frame

No	Work description	2013		2014								
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	Data collection											
2	Mapping											
3	Analysis											
4	Reporting											

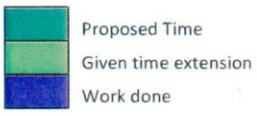


Table 3.1 Research work plan

3.2 Well survey map

Figure 3:1 CPS surrounding wells collected by Questionnaire

Number of wells selected for analysis -281 wells

- **200** m circumference from the CPH (**80**wells)-28.5%
- **200-500 m** circumference from the CPH (**122**wells)- 43.4%
- **500 m** circumference from the CPH (79wells)- 28.1%

3.3 Affected GN division.

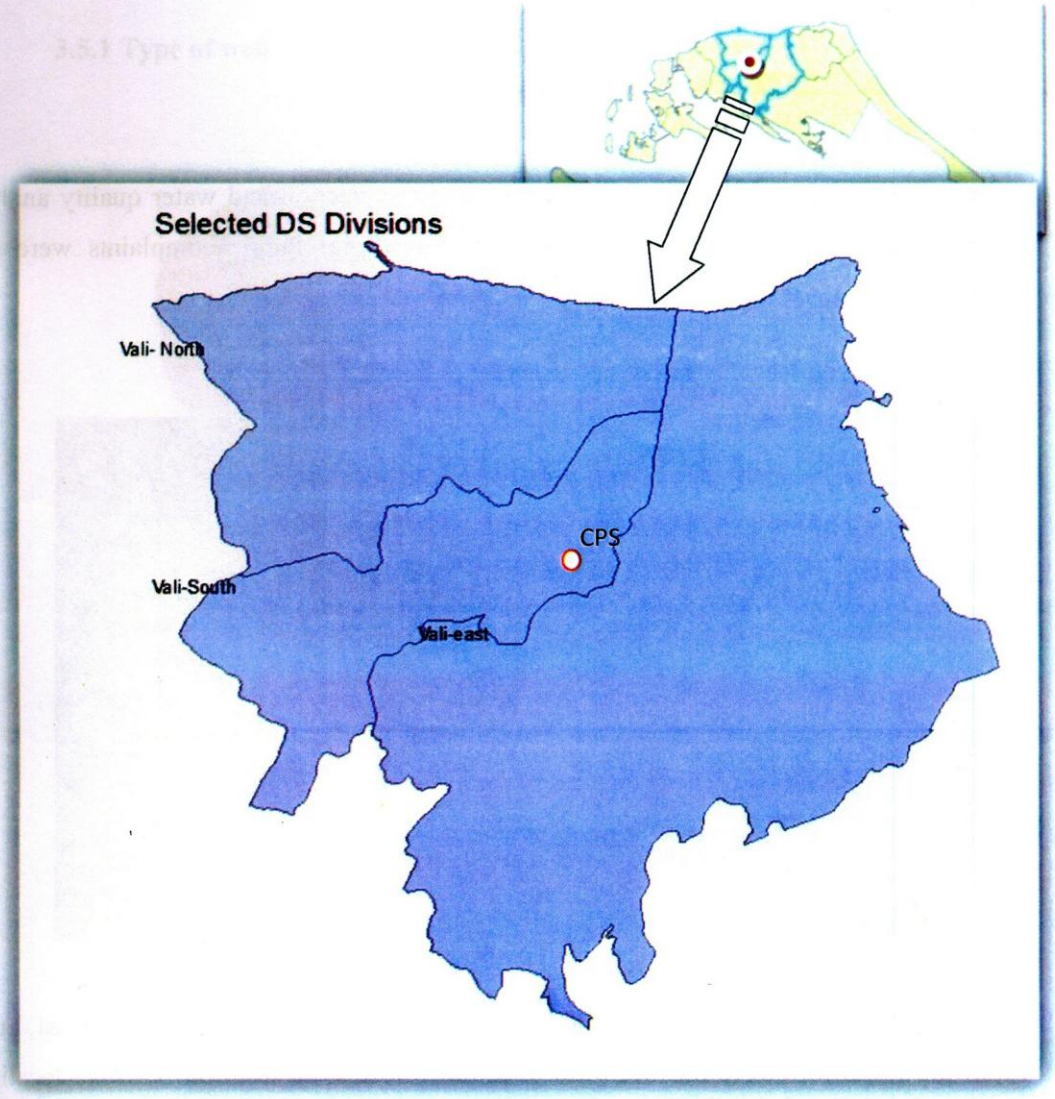


Figure 3:2 Collection point map

Chunnakam power station is located in the centre of the Valikamam- south Divisional secretary Division, Three DS divisions were selected for the well survey, such as Vali North, Vali South and Vali East.

In this survey the CPS is considered as the centre, from which point well survey was done. As per the survey two DS divisions were affected by the problem namely Vali

South and Vali East. Of these DS divisions the following GN divisions were highly affected.

- J/196 - Chunnakam Town East
- J/197 - Chunnakam Town East
- J/267 - Urelu

Above GN divisions were covered for the sample collection and water quality analysis because these areas are closer to the CPS and several Public complaints were also received from these areas.

3.4 Selected well Locations.

Figure 3:3 Analyzed wells location

Through the well survey, we have selected 100 well locations as per the proposal, but to find the extent of contamination area, we have done the analysis in 50 other locations, additionally. East and South of the Chunnakam power station are mostly agricultural lands and well density is comparably less than in other sides.

Complaints and visual observation of the oil layer were observed in the wells mostly in the Northern part of the project area.

Number of wells selected for analysis -150 wells

- **200** m circumference from the CPH (**67**wells)
- **200-500 m** circumference from the CPH (**42**wells)
- **500 - 2000 m** circumference from the CPH (**41**wells)

3.5 Analysis of the data survey

3.5.1 Type of well

No of Dug wells	189
No of Tube wells	92

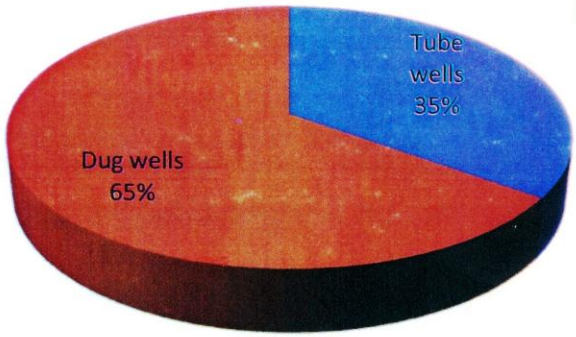


Figure 3:4 Types of well among surveyed wells

In our Study area, most of the wells are shallow dug wells (65%) and others are shallow tube wells (35%). All tube wells are connected with the electric driven pump or hand pump.

3.5.2 Usage pattern

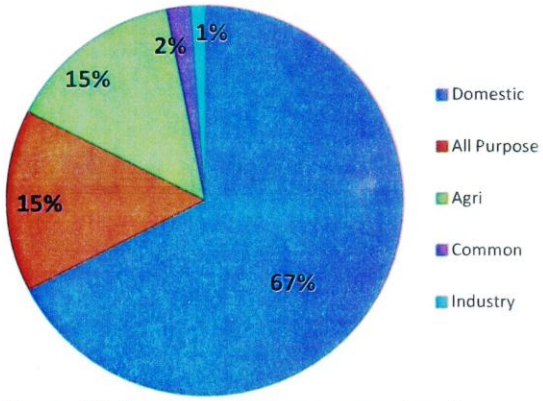


Figure 3.5 Usage patterns of surveyed wells

The 67% of the wells were used for domestic purposes including home gardening. And the all purpose includes agricultural and domestic usage. 15% of the wells were categorized like this.

In the agricultural wells, a single well is feeding several plots, and very long and continuous pumping was observed. Totally 30 % of the wells were included under Agricultural usage.

Common purpose means more than one family or a community uses the well for their day to day needs and mostly these wells are located at public places. Very small scale industries were also observed in this area.

Agricultural wells and all purpose wells show higher water usage than the others.

3.5.3 Extraction Pattern

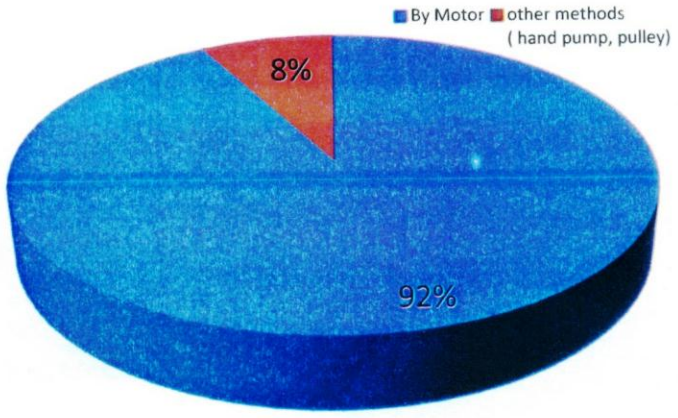


Figure 3.6 Extraction patterns of surveyed wells

All the people are using Electric driven pump or Kerosene pump for the water extraction (92%), but very few people (8%) are using hand pumps for tube wells and pulleys for normal wells. Usage frequency is very much less in these hand pump or pulley fixed wells. Pump users are not maintaining any control measure for the extraction but they are considering only the electricity cost.

So that, the quantity of extraction cannot be quantified.

3.6 Analysis of Water quality parameters

3.6.1 Analysis of Oil and Grease contamination results

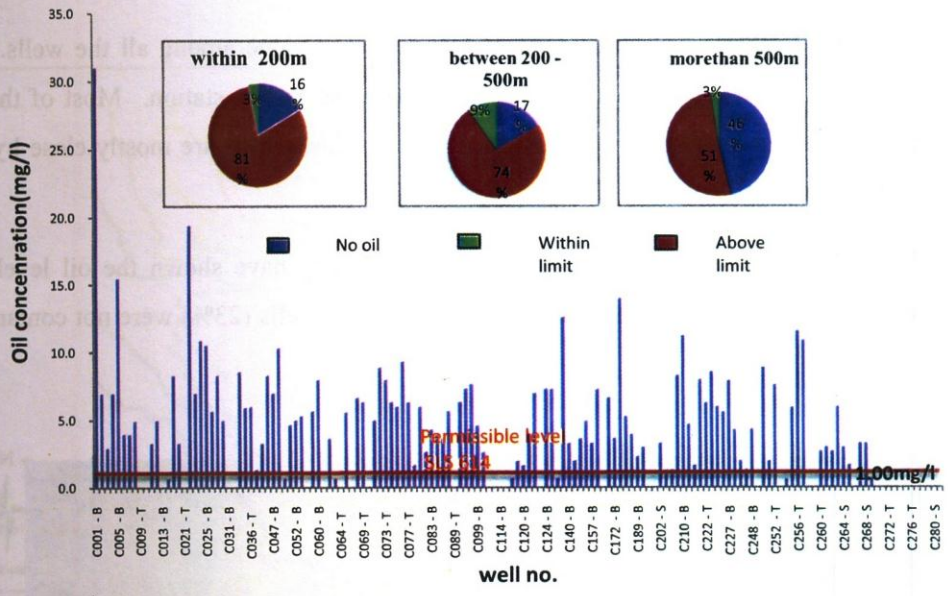


Figure 3.7 oil concentration of Analyzed wells

Oil & grease concentration was analyzed in 150 locations, dug wells were analyzed in bottom and top of the water layer, and tube wells water were analyzed in a single point. The total analysis is 226. 116 out of 150 wells were having oil and grease contaminations.

Distance	% of the wells exceeding 1mg/l
Within 200 m from CPS	81
200 m - 500 m from CPS	74
> 500 m from CPS	51

Table 3.2Contamination level vs. distance

81% of the wells were having more than 1.00 mg/l oil & grease concentration within 200m distance from the power station. And 74 % of wells were exceeding the 1.00 mg/l, which wells are located 200 – 500 m distance from the power station. And only 51 % of the wells have more than 1.00 mg/l oil concentration in more than 500 m distance.

1.00 mg/l is the maximum permissible limit of the SLS 614, 1983 publication.

31.020 mg/l oil concentration was observed as high value among all the wells. It was observed in the MOH office, located in front of the Power station. Most of the wells showed thin oil film layer in the surface of the wells, which are mostly close by to the power station.

150 wells were analyzed, in which 109 (73%) wells have shown the oil level above standard, 07 (4%) wells were under the limit and 34 wells (23%) were not contaminated with oil and grease.

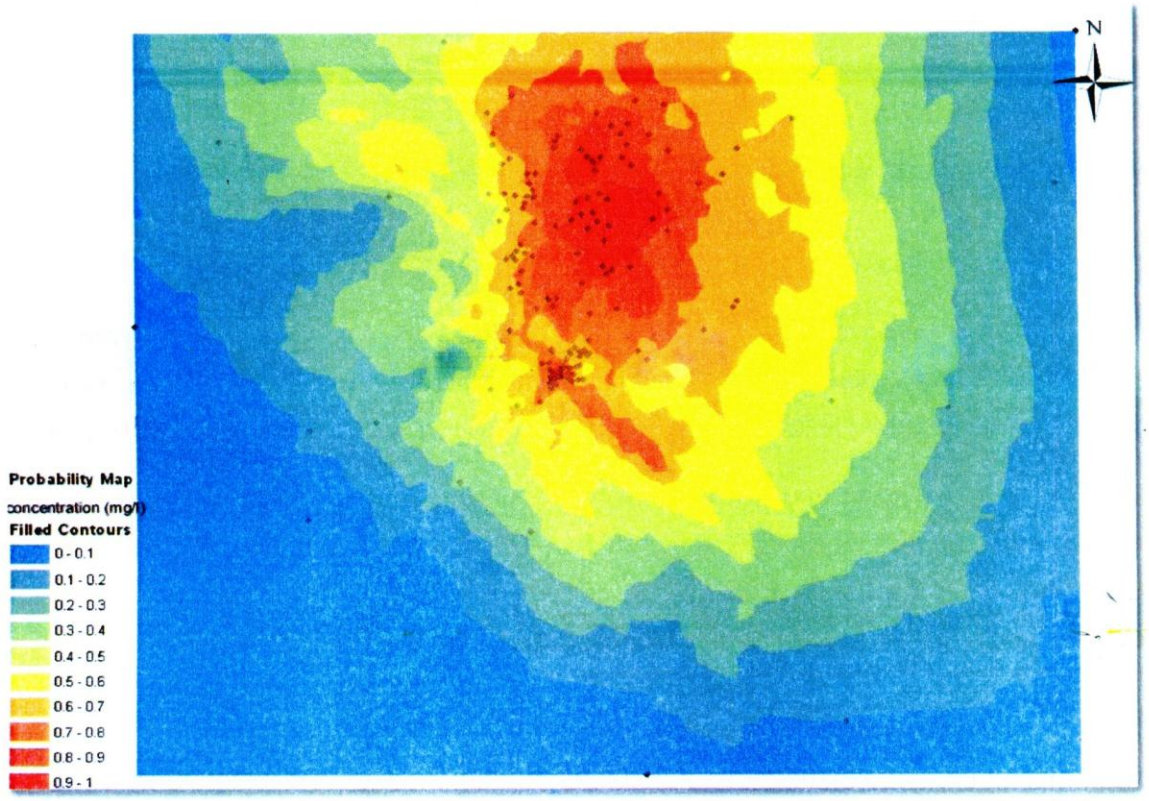


Figure 3. 8 spatial distributions of oil concentration of Analyzed wells

The above predicted maps showed, oil and grease concentration layers and the high concentration layers were observed in the surrounding of the Chunnakam power station area.

Pattern of the oil spreading showed towards north, up to 2.0 km. Oil contaminants were spread more in the northern direction and less in the other direction up to1.5 km.

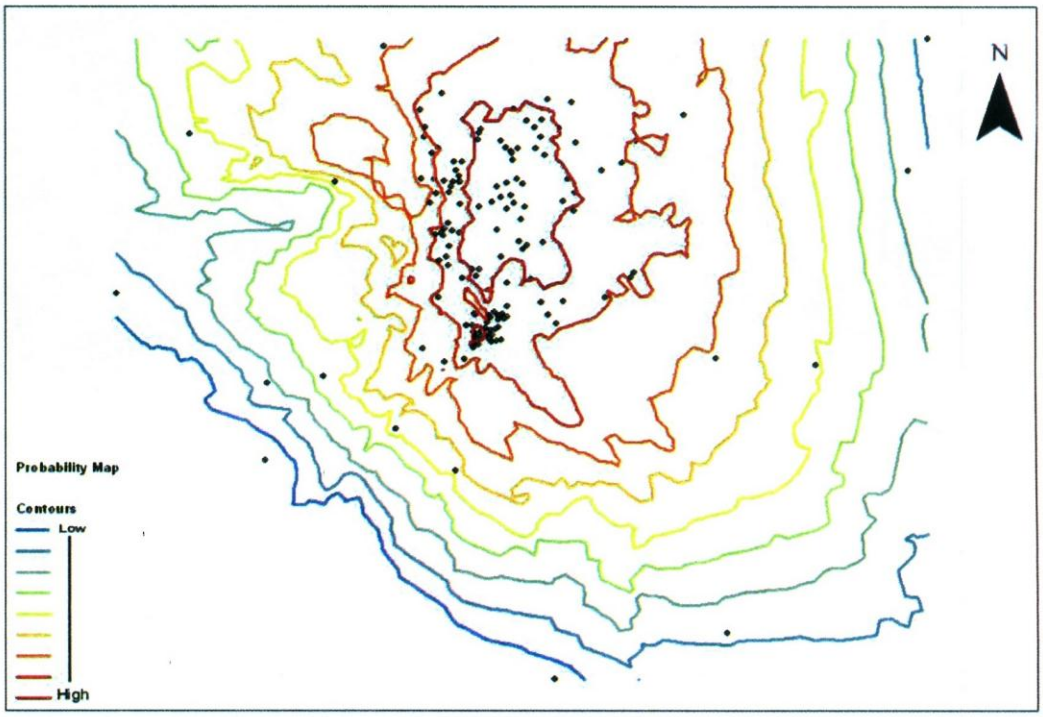


Figure 3.9 Contour Map for oil concentrations of Analyzed wells

Figure 3.9 is also showing same pattern as figure 3.8. The contours defined the contaminated level zones; 500 m surrounding area from CPS was having high risk of oil contamination.

The oil spreading area is limited to within the 1.5 km but in the north direction it has moved to up to 1.8 km. We can safely say the risk may be up to 2 km.

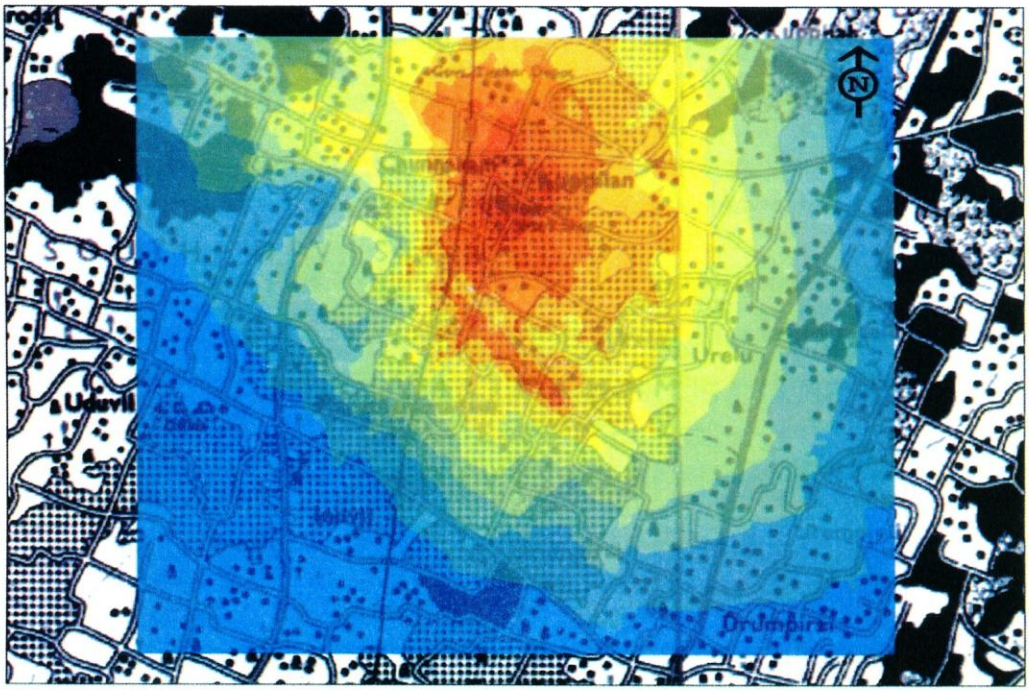


Figure 3.10 Map of oil and grease contaminated area.

Figure 3.10 showed the over lapping of the oil spreading map into the Survey department map. It clearly showed the oil contamination area and the high concentrations were observed in the Chunnakam power station surroundings.

3.6.1.a. Oil contamination at different distance ranges from CPS surrounding

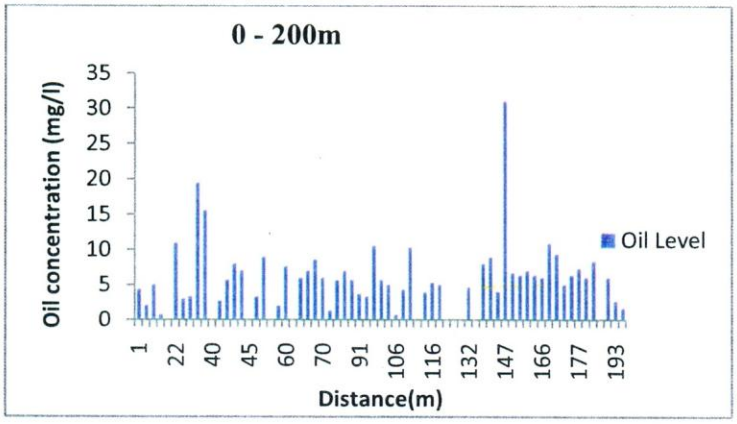


Figure 3.11 Oil contaminations at different distance ranges from CPS - 200 m

Figure 3.11 shows that the oil contaminations within 200 m from Chunnakam power station, where 80.59 % of the wells contaminated by waste oil which contain above 1.00mg/l oil and Grease contamination. 19.41% of the wells were not contaminated. Within 200 m distance 67 wells were analyzed.

In this 200 m surrounding, majority of the wells were affected.

Description	*0 - 200 m*
High	31.020 mg/l
Low	0.000 mg/l
mean	5.080 mg/l
No of contaminated wells	54 (80.59 %)

Table 3.3 Oil concentration within 200 m

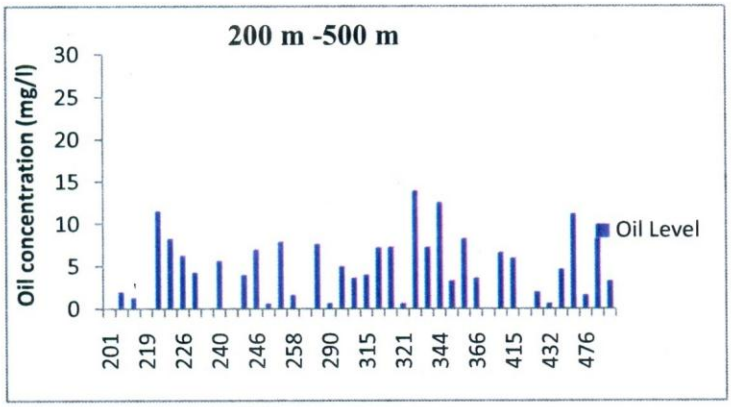


Figure 3.12 Oil contaminations at different distance ranges from CPS –**200** -500 m

Figure 3:12 shows that the oil concentration with distance from 200 m to 500 m from CPS. Here also the oil contamination level was high, nearly 78.04 % of the wells were affected and 17 % of the wells have no oil contamination. In this 200 m to 500 m surrounding 42 wells were analyzed.

Description	*200 - 500 m*
High	13.980 mg/l
Low	0.000 mg/l
mean	4.541 mg/l
% of contaminated wells	32 (78.04%)

Table 3.4 Oil concentration within 200 - 500 m

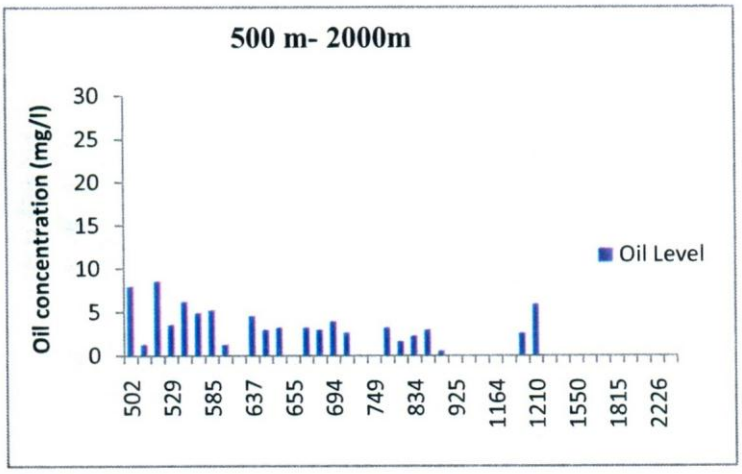


Figure 3.13 Oil contaminations at different distance ranges from CPS – **500**-2000 m

Figure 3:13 shows more than 500 m distance from CPS. 51% of the wells showed the oil concentration of more than 1.00 mg/l and 46 % of the wells were not contaminated with oil & Grease. In this circumference the oil & Grease contamination is comparably less. At 2000 m distance it does not show oil contamination in our selected locations. 41 wells were analyzed in more than 500 m surrounding.

Description	500 - 1000 m	1000 - 1500 m	>1500 m
High	8.580	5.940	0.000
Low	0.000	0.000	0.000
mean	2.851	1.226	0.000
% of contaminated wells	73.07	28.57	0.00

Table 3.5 Oil concentration within 500 - 2000 m

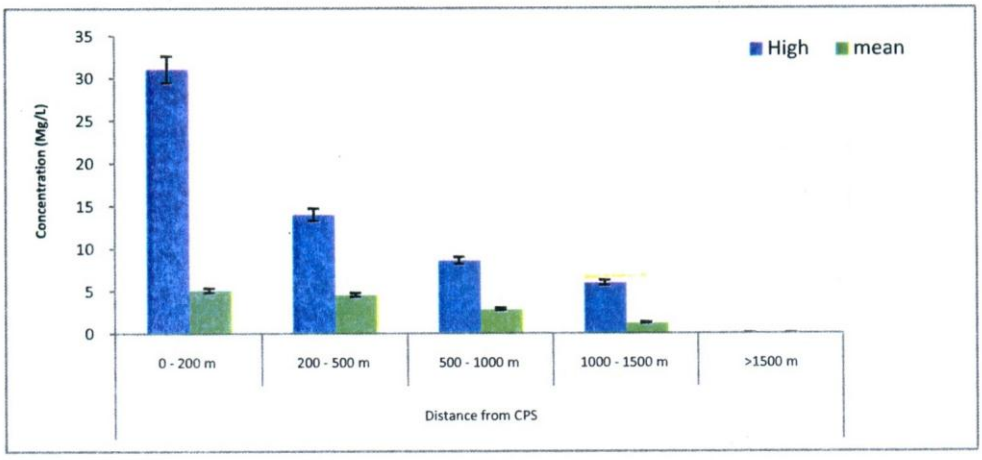


Figure 3.14 Oil contamination level with distance ranges

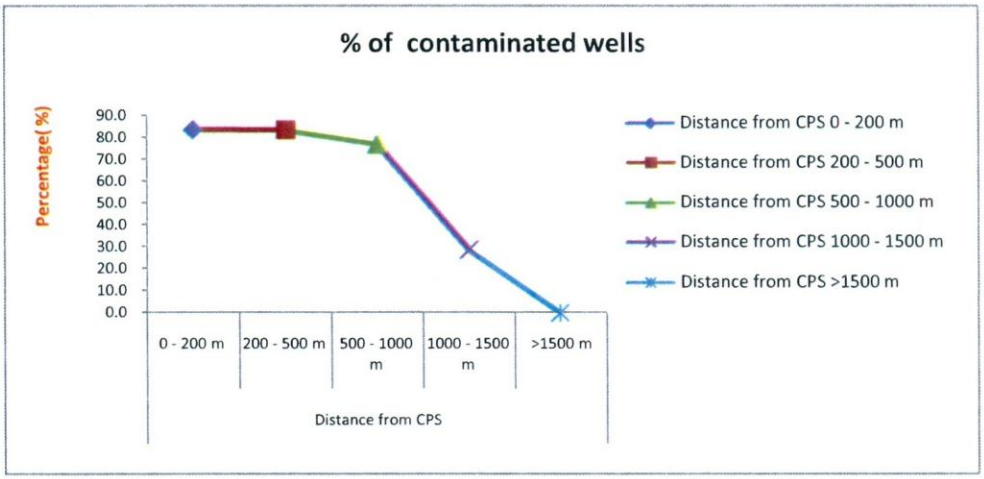


Figure 3.15 Number of contaminated wells with distance ranges

As per the figure 3.14 and 3.15, the oil contamination level has decreased according to the distance. After the 1500 m distance from the CPS, no oil contamination was observed.

3.6.1. b. Oil Concentration Vs type of Usage

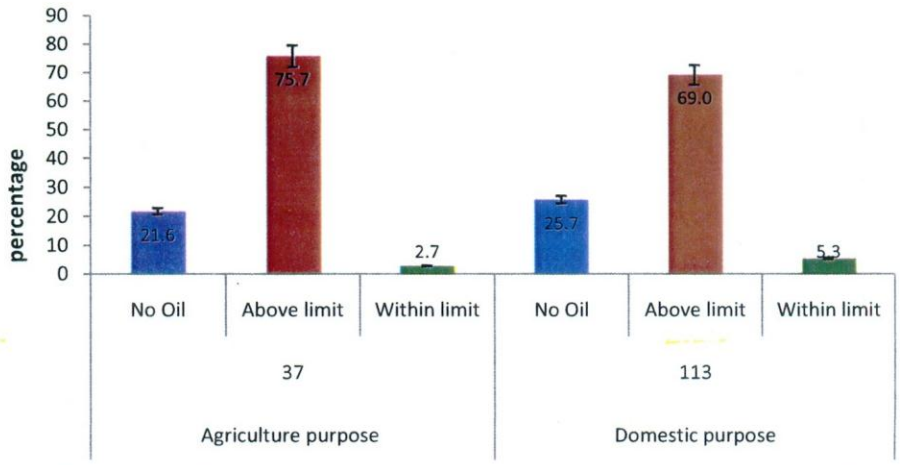


Figure 3.16 Oil and Grease concentration level in Agro and Domestic wells

Figure 3:16 shows the Oil concentration with the type of usage of the wells. There were not any differences in oil contamination between the types of usage.

Since Agricultural wells and Domestic wells, both were showing the same pattern in the oil contamination, we may be concluding that the extraction pattern does not affect the oil and Grease spreading. .

3.6.1. c. Oil concentration Vs well type

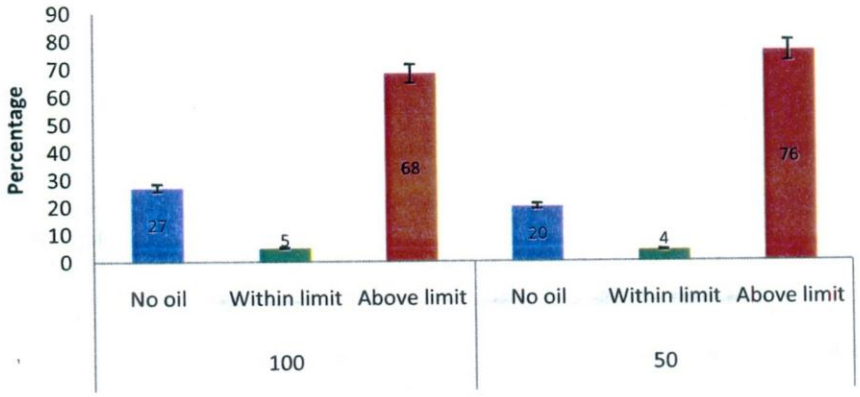


Figure 3.17 Oil and Grease concentration in Different well types

Figure 3:17 shows the Oil concentration with the type of wells. There were not any significant differences in oil contamination with the type of wells. In Dug wells and Tube wells, both were showing the same pattern in the oil contamination.

The tube wells and Dug wells are shallow, around 10 m depth; the well profile was also mostly same.

Figure 3:18. Highly Contaminated well Locations

Figure 3:19. Contaminated well Locations with Concentration within SLS limit

Figure 3:20. Well Locations with No Oil Concentration

The Figure 3:18 shows the oil & Grease contaminated wells in the surrounding of CPS. In these locations the oil result exceeded the SLS 614 1983 standard of 1.00 mg/l. Compared with other direction; North part of the study area showed high contamination.

Figure 3:19 shows the oil concentrations of analyzed wells, which were within the limit. Only a few numbers of wells come under this category.

Figure 3:20 shows the locations of wells, which were not contaminated with oil & grease. Here most of the wells are in the border of 2km distance.

3.6.2 Analysis of Nitrate Concentration

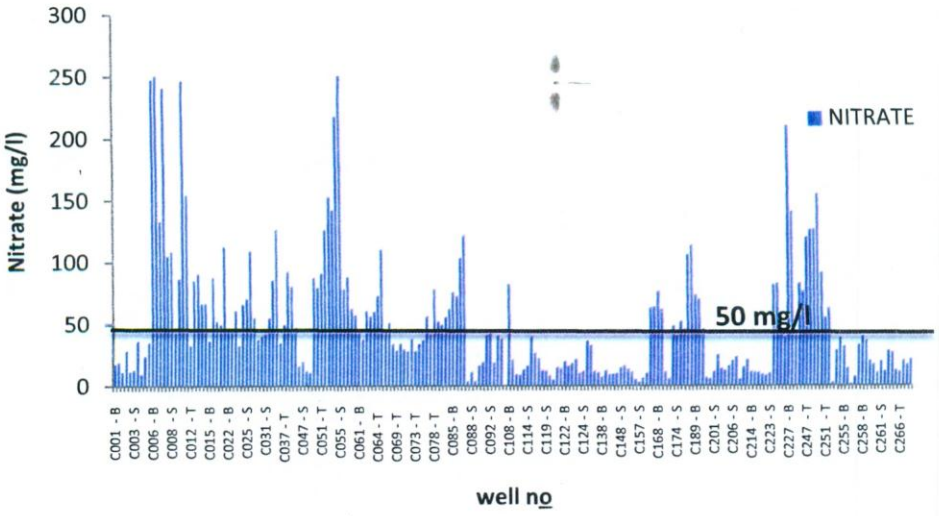


Figure 3:21 Nitrate concentration in Analyzed wells

Figure 3.21 shows the Nitrate contamination of analyzed wells.138 wells were analyzed for Nitrate of which 51 wells were showed the above the standard of 50 mg/l and others were below that level

Maximum Nitrate reading among these wells was 251.0 mg/l and minimum was 1.0 mg/l. WHO and SLS 614 (2013) are recommending 50.0 mg/l as a maximum permissible level in the drinking water sources.

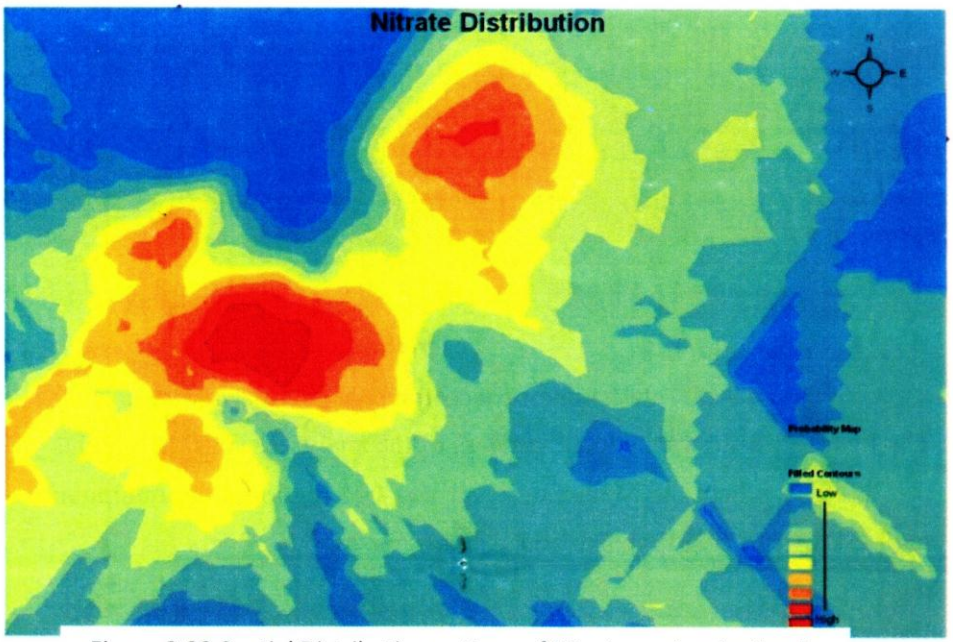


Figure 3:22 Spatial Distribution pattern of Nitrate contamination in the project area

The surroundings of Chunnakam power station is mainly agricultural area, due to the high capacity of water and red soil series, So the Nitrate concentration was very high in majority of the wells.

Figure 3.22 shows the predicted Map of the Nitrate concentration spatial distribution pattern. Areas which are closer to CPS were having high concentration of Nitrate. These wells are mainly used for the agricultural purposes, where most of the cash crops, vegetable crops, leafy vegetables, and fruit crops are cultivated.

Not only the Agro wells but also domestic wells have high Nitrate concentration in this red soil area, in which domestic wells are located near the agro lands.

3.6.3 Analysis the Total Hardness concentration

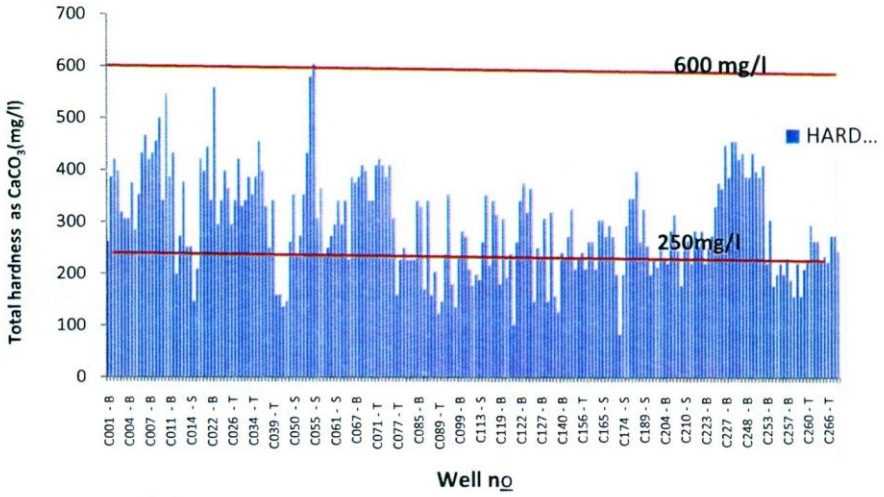


Figure 3:23: Total hardness concentration of the analyzed wells

The figure 3:23 shows the total hardness of the analyzed wells. 216 points were analyzed in 138 wells, where the Maximum level was 604 mg/l and the minimum level was 103 mg/l. SLS 614 (1983) recommended limits for total Hardness (as $CaCO_3$) is 250 – 600 mg/l.

The average total hardness of the area is 298 mg/l in our study area, and the bottom is showing higher concentration than surface of the water columns.

3.6.4 Analysis of Nitrite as Nitrogen concentration

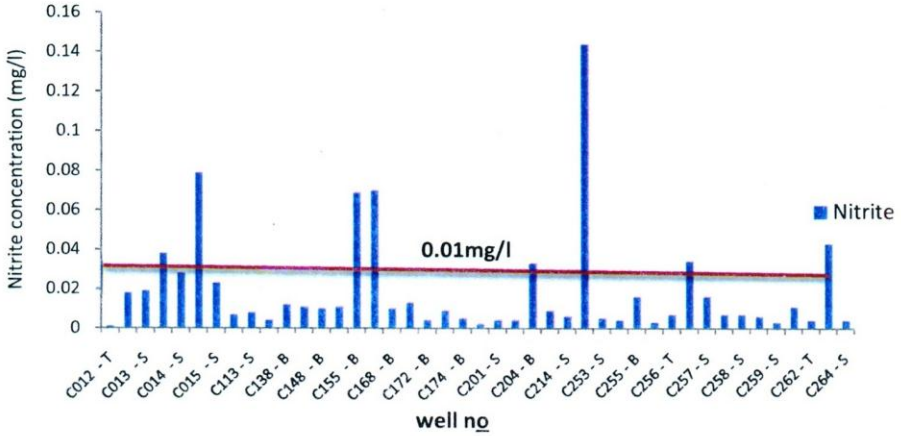


Figure 3:24 concentration of Nitrite as N in analyzed wells

The figure 3:24 shows the Nitrite as N concentration of the analyzed wells. 43 points were analyzed in 27 wells, where the Maximum level was 0.144 mg/l and the minimum level was 0.001 mg/l. SLS 614 (1983) recommendation for Nitrite as Nitrogen is 0.010 mg/l

19 points were exceeding the maximum permissible levels out of 43 points.

3.6.5 Analysis of Chemical Oxygen Demand concentration

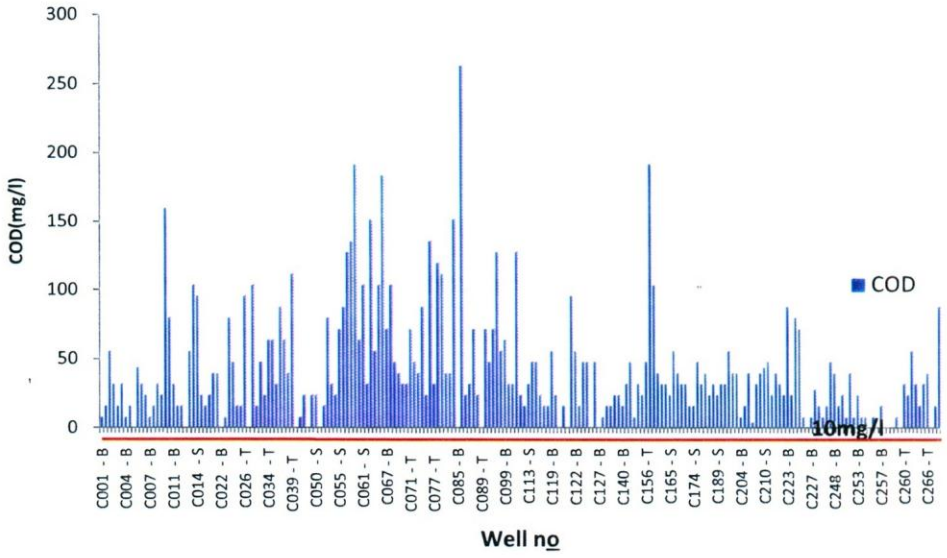


Figure 3:25 Concentration of COD in the analyzed area

The figure 3:25 shows the COD concentration of the analyzed wells. 214 points were analyzed in 150 wells, where the Maximum level was 264 mg/l and the minimum level was 0.00 mg/l. SLS 614 (1983) recommendation for the COD limit is 10.0 mg/l

Not any direct correlation was observed between oil and Grease concentration and COD, Nitrate concentration and COD.

3.6.6 Analysis of Electrical conductivity

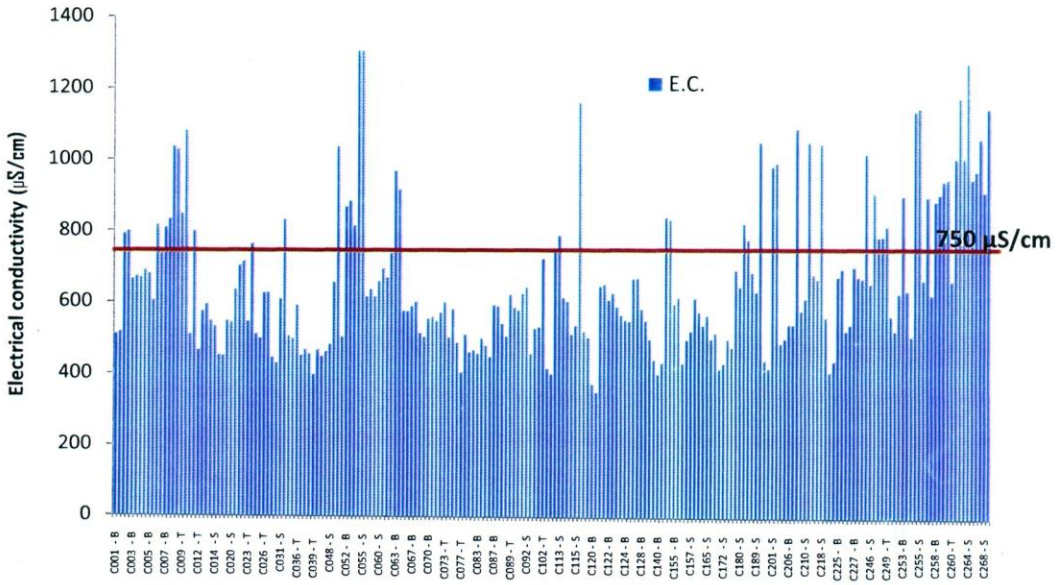


Figure 3:26 Value of Electrical conductivity in analyzed wells

The figure 3:26 shows the EC of the analyzed wells. 214 points were analyzed in 150 wells; where the Maximum level was 1310 µS/cm and the minimum level was 355 µS/cm. SLS 614 (1983) recommended upper and lower limits are 750 µS/cm and 3500 µS/cm. And SLS 614 (2013) recommendation is 750 µS/cm (TDS - 500mg/l). Average conductivity of this area was 664 µS/cm.

As per this, the area is having a good ground water potential. And comparably with the available data, the better ground water conductivity was observed in this area.

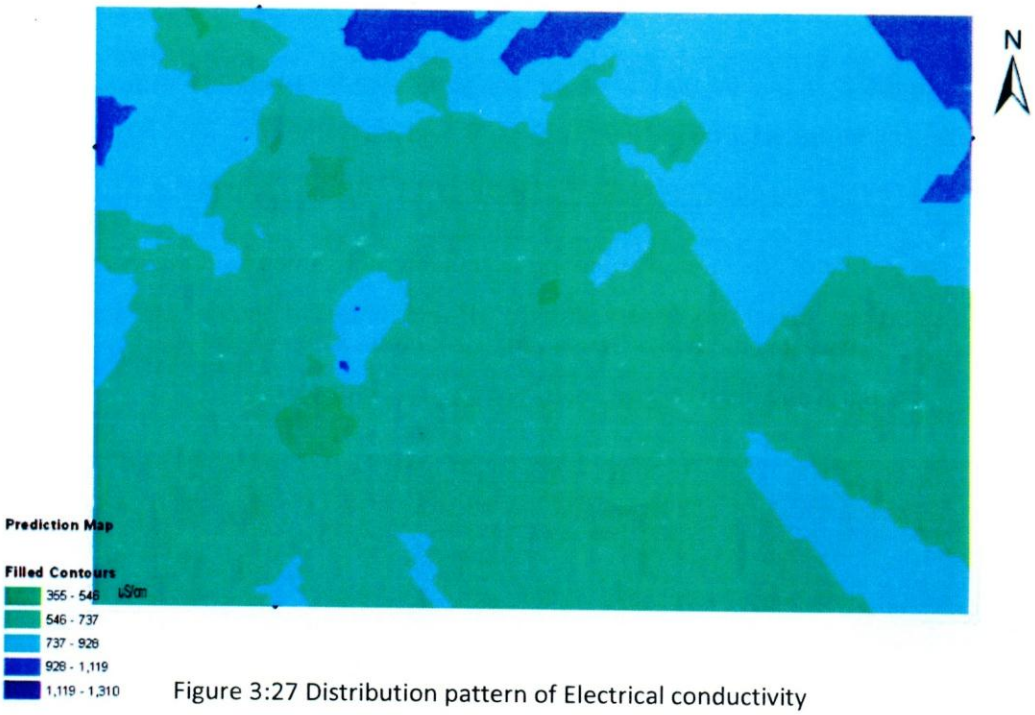


Figure 3:27 Distribution pattern of Electrical conductivity

As per the Figure 3.27, the whole study area was having good conductivity values.

Whole data were analyzed in the 10 months period and each point was analyzed at a single time. So the seasonal variation interpretation was not possible for this data, but in comparison with the adjacent wells quality the EC variation was less.

3.6.7 Analysis of pH

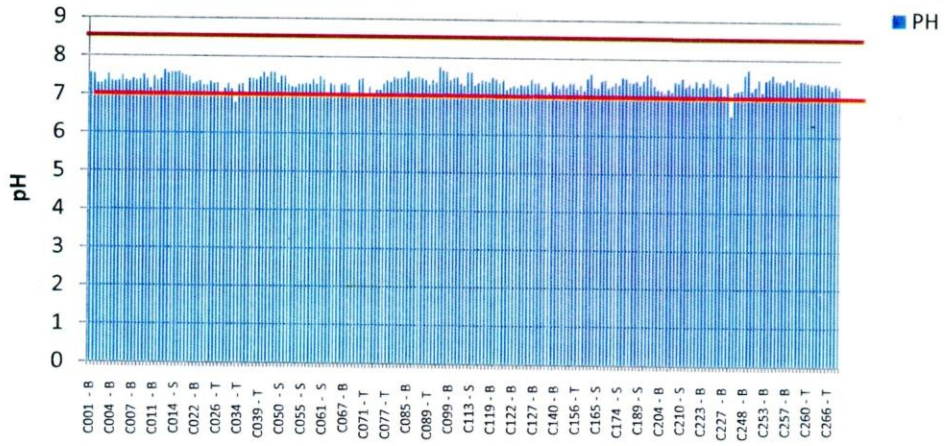


Figure 3:28 Value of pH in analyzed wells

The figure 3:26 shows the pH of the analyzed wells. 214 points were analyzed in 150 wells; where the Maximum level was 7.78 and the minimum level was 6.55. SLS 614 (1983) recommended upper and lower limits are (7.0 – 8.5) and (6.5 – 9.0).

As per this study, the area was having acceptable pH values, and the average pH is 7.37. No significant effect was observed in the pH due to the Oil and Grease contamination.

3.6.8 Analysis of Heavy metals – Pb, Cr, and As

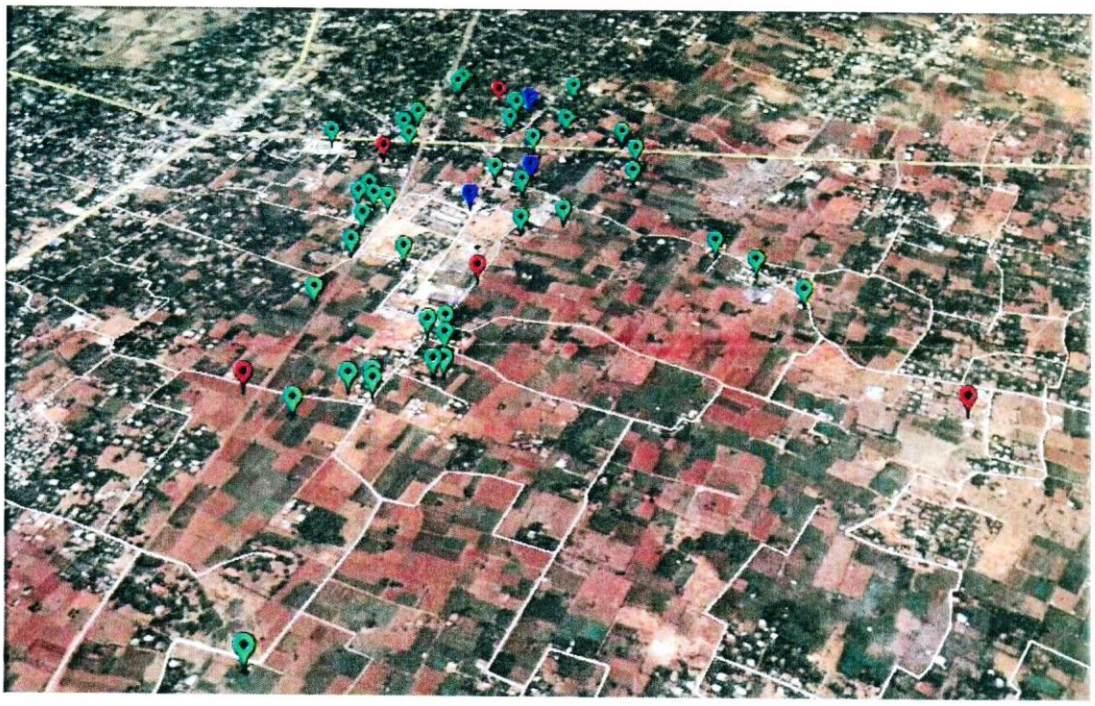


Figure 3:29 Heavy metals analyzed locations

The Heavy metals were analyzed in the selected 50 wells from the High oil content wells and nearby wells to the CPS. Concentration was analyzed up to 03 decimal in mg/l.

Lead (Pb) was analyzed in all 50 wells and 05 wells were showing lead contamination. Only 04 wells' lead concentration was exceeded the SLS 614(1983) recommended upper limit of 0.05mg/l.

Chromium (Cr) was analyzed in all 20 wells and 03 wells were showing Cr contamination. But all concentrations were within the SLS 614(1983) recommended upper limit of 0.05mg/l.

Arsenic (As) was analyzed in 10 wells and pollution was not observed

Type of Heavy metal	Maximum value	Minimum value	No of analyzed locations	Pollution %
Lead (Pb)	0.168	> 0.000	50	10
Chromium (Cr)	0.002	> 0.000	20	12
Arsenic (As)	> 0.000	> 0.000	10	0

Table 3.6 Heavy metal concentration

3.7. Seasonal variation in the Project period

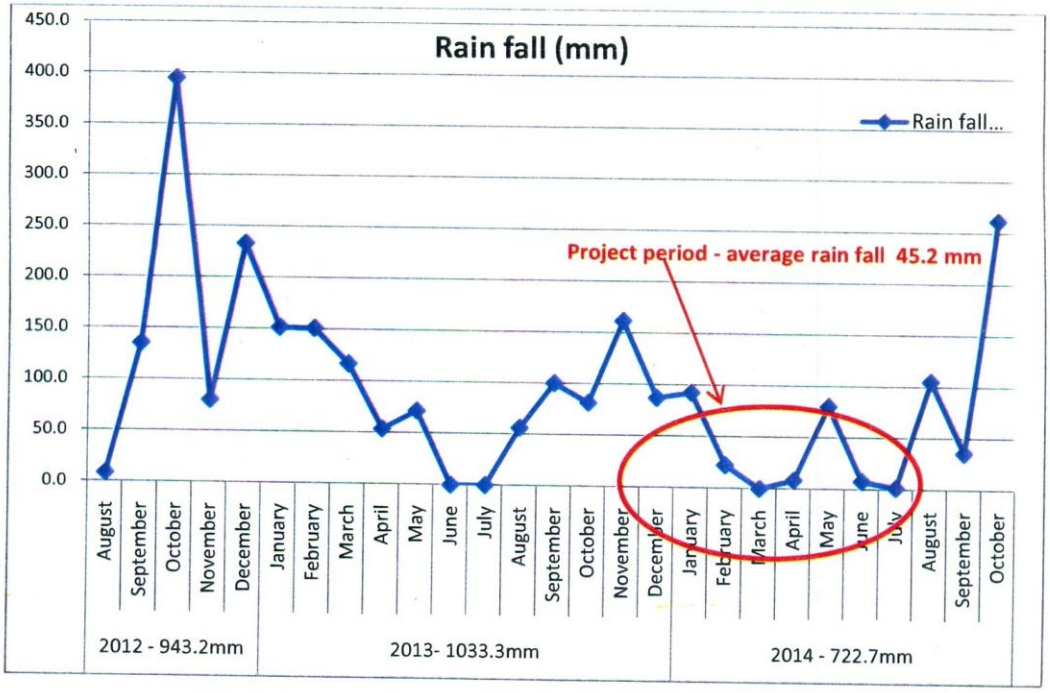


Figure 3:30 Rain fall data (From August 2012 to October 2014) –Metrological station, Thirunelveli

As per the Thirunelveli, Metrological station, the average annual rainfall in Jaffna is in the range of 1200 mm to 1400 mm, but it was received only 943.2mm and 1033.3 mm in 2012 and 2013 accordingly.

It was observed that, low rainfall was recorded during the entire project period. Only few months rainfall exceeded only 50 mm and showed a value below in other months. Assumption would be drawn that sampling and analysis was not affect during such time.

CHAPTER 04

Conclusion

Data were collected from 281 locations in the area surrounding the Chunnakam power station, of which all details of wells within 200m distance were collected (80 no). Between 200m to 500m distance from the power station, 122 well locations were identified. They were selected as these wells were said to have oil according to the complaints received. 79 well locations were located randomly in all directions in the region which is 500m away from the power station.

As per the survey two DS divisions were affected namely Vali South and Vali East. J/196, J/197 and J/267 GN divisions are highly affected in the above two DS divisions.

Around 82% of the sampled wells were used as main drinking water sources for domestic and other uses. Other wells are Agro wells but the farmers use the water for their drinking purpose from these as well. Most of them use mechanical pumps for the extraction of water (92%) while the rest use pulley and hand pumps.

Through the well survey, 100 well locations were selected as per the proposal, but to find the extent of contamination area, additional 50 other locations were selected. Dug wells were analyzed in bottom and top of the water layer, and tube wells water were analyzed in a single point. 226 no of samples were analyzed in total.

109 (73%) wells have shown the oil level above standard, 07 (4%) wells were under the limit and 34 wells (23%) were not contaminated with oil and grease. The results clearly showed the suspected oil contamination area and the high concentrations were observed in the Chunnakam power station and the surrounding.

Same pattern in the oil contamination was observed among dug wells and tube wells, and there is no difference in oil contamination level between the types of usage as well.

The oil contamination level has decreased with the distance. After 1500 m distance from the Chunnakam Power station, no oil contamination was observed. The predicted maps also showed, oil and grease concentration layers and the high concentration layers were

in the surrounding of the Chunnakam power station area. And the oil spreading pattern was observed towards north, up to 1.50 to 2.0 km with the height in the north direction and less than 1.5 km in the other directions.

138 wells were analyzed for Nitrate and 51 wells were shown the nitrate concentration above the standard of 50 mg/l and others were below the level. COD showed few unexpected results and other quality parameters were mostly complying with the SLS 614(1983).

From the above facts, we can conclude that the oil concentration of the water is high in the surrounding of Chunnakam power station and spread out from this point. It is already spread up to 1500 m surrounding and the contaminants moved towards the north. And high Nitrate pollution was also observed in the suburb Agricultural lands and some domestic wells.

From the questionnaire, health problems were not reported by any one and significant crop pattern changes or unknown diseases were not observed in the Agricultural practices. But as per the literatures the long term exposure of the contamination may cause bad Health effects to the community so that, further researches should be needed on this.

The entire conclusions are based on the research results obtained from the period of November 2013 to August 2014 and assumption would be drawn that sampling and analysis did not affect by rainfall during project period.

Recommendations

- ✓ In order to protect public health, establish systematic monitoring around all contaminated site to provide early warning of contaminant migration to Ground Water monitoring should be carried our on regular basis and reports made public.
- ✓ Mount a public awareness campaign to warn the individual who are consuming water from wells where oil content were detected that such activities are damaging their health.
- ✓ Provide adequate source of drinking water to those households whose drinking water supply is impacted.
- ✓ A proper remedial action to be taken at source level to control the spreading of oil residual further.
- ✓ The issue of oil contamination in wells needs to be addressed in a comprehension manner, but clear up actions must be site specific

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Annexure I

அலுவலகப் பாவனைக்கு மட்டும்

கிணற்று இல : கிடைக்கப் பெற்ற திகதி

பெற்றுக்கொண்ட அலுவலர் பெயர் கையொப்பம்

திகதி

Can No..

ஆழ்கூறு: X- ..... Y- .....

Select for Analysis : Yes/No

- ♥ பிரதேச செயலர் பிரிவு : .....
- ♥ கிராம சேவகர் பிரிவு : .....
- ♥ கிராமத்தின் பெயர் : .....
- ♥ கிணற்று உரிமையாளர் : .....
- ♥ விலாசம் : .....
  .....
  .....
- ♥ வசிக்கும் காலம் : .....
- ♥ கிணற்றின் வயது : .....
- ♥ கிணற்றின் வகை :
  - ○ பாதுகாப்பான கிணறு பாதுகாப்பற்ற கிணறு
  - ○ குழாய்க் கிணறு
- ♥ பாவனைமுறை :
  - ○ தனிநபர் பாவனை தோட்டப் பாவனை
  - ○ பொதுக்கிணறு
- ♥ பயன்பாடு :
  - ○ வீட்டுத்தேவை விவசாயத் தேவை

நீர் உறிஞ்சும் முறை :

- ○ மோட்டர்/ வாட்டப்பம கப்பி/ கைவாளி
- ○ கைப் பம்பி

Annexure I

- கிணற்றிலிருந்து மலசலகூடத்திற்கான தூரம் : ..... m
- மலசலகூடத்தின் வகை : .....
- மின் பிறப்பு நிலையத்திற்கான தூரம் அண்ணளவாக : .....
- நீண்டகால நோய்கள் ஏதாவது குடும்ப அங்கத்தவர்களிடம் உள்ளதா?: .....
- குறிப்பிடத்தக்க மாதிரியான நோய்கள்
  - ○ சுவாசத் தொகுதி சமிபாட்டுத்தொகுதி
  - ○ தோல் வியாதி புற்றுநோய்
- விவசாய விளைச்சலில் பாதிப்பு ஏதும் உள்ளதா: .....
- எந்த வகையான பயிர்கள் பயிரிடப்படுகின்றன : .....
- பயிர்களில் இனங்காணப்படாத தாக்கம் உள்ளதா: .....
- புறச்சுழலில் அவதானிக்கப்படக்கூடிய தாக்கங்கள் உள்ளதா: .....
- கிணற்றின் மேற்பரப்பில் அவதானிக்கப்படக்கூடிய படலங்கள்: .....
- நீரின் தன்மை
  - மணம்
    - ○ ஏதுமில்லை அடையாளப்படுத்தக்கூடியது
  - சுவை
    - ○ ஏதுமில்லை அடையாளப்படுத்தக்கூடியது
- மேலதிக குறிப்பு:

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உரிமையாளர் கையொப்பம் NIC No: .....

திகதி.....