BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

SOUTHERN ZONE, CHENNAI

ORIGINAL APPLICATION NO 514/2019

Applicant(s) : State Level Monitoring Committee

Versus

Respondent(s) : The State of Kerala & others

REPORT FILED BY THE CHIEF ENVIRONMENTAL ENGINEER, REGIONAL OFFICE, ERNAKULAM FOR AND ON BEHALF OF THE KERALA STATE POLLUTION CONTROL BOARD AS PER THE ORDER DATED 05.08.2019 IN THE ABOVE APPLICATION

I, M.A Baiju, 53 years, S/o M.K Aravindakshan, now working as Chief Environmental Engineer, Regional Office, Kerala State Pollution Control Board, Ernakulum. I am competent to and duly authorized to represent the Board. I know the facts and circumstances of the case. The factual submissions made here under are true and correct to the best of my knowledge, information and belief. The legal submissions made therein are made on advice received from the Standing Counsel. In these circumstances, it is just and necessary that this Hon'ble Tribunal may be pleased to accept the accompanying report on file and it is so humbly prayed in the interests of justice in this case.

1. This application is filed primarily against the environmental degradation occurred due to outbreak of fire happened on 22.02.2019 at the solid waste dump site owned and operated by Kochi Corporation at Brahmapuram situated in Vadavucode-Puthencruz Grama Panchayath in Ernakulam District. Application is specifically emphasized the need of scientific management of solid waste transferred to this facility. The letter from Hon'ble Justice A.V Ramakrishna Pillai, Chairman, State Level Monitoring Committee is the prime cause of this application and it is a speaking one which explains that the solid waste including non bio degradable wastes were seen dumped at Brahmapuram solid waste management facility and was personally inspected on 23.02.2019 along with this deponent. The letter further explains that the recurrent disposal of mixed waste create huge legacy waste heap at this facility which is the main reason for the fire out break happened on 22.08.2019. It is with due

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seriousness I may also humbly submit that some more fire outbreaks were occurred in that summer season. Since the fire outbreak occurred on 22.02.2019 was very severe and was sensitized in the media in a far-reaching manner, the Board had immediately engaged Environment Technology Division of CSIR-National Institute of Inter disciplinary science and Technology (CSIR-NIIST) to conduct studies on emission possibilities of Dioxins & Dioxin like PCB's occurred there due to the fire outbreak. The detailed report submitted by the NIIST is self explanatory which illustrate that there were dioxins at higher levels. Copy of the report submitted by the NIIST is produced herewith and marked as **Annexure-A.**

2. It is respectfully submitted that dumping of solid waste has been started by Kochi Corporation in the year 2008 and continuing till date. It is important to note that the waste contains biodegradable as well as plastic and other wastes. It is suspected that no proper segregation is being practiced from the beginning itself which is the main cause of this huge legacy waste dump. Though the claim of the corporation is that they are practising windrow composting for the biodegradable fractions of waste, no satisfactory facilities are seen provided there for windrow processing during inspections conducted on various occasions by the Board officials. Also it can be seen that there are areas where the authorities had already made some capping of waste using soil.

3. I may humbly submit that this facility is being continuously watched and very recently inspected on 17.08.2019. During inspection all the records related to waste collection and transfer were verified and the observations made are illustrated as follows. The facility was once again visited by surveillance team of Regional Office, Ernakulam on 03.09.2019 as a follow up action.

a. They have provided 9 Nos of cameras along different locations but display facility has been provided for 4 cameras only. To verify the situation along tromel shed where manure production is being taken place, one more camera need be installed inside that shed also. It is highly required that all the cameras shall be connected to SPCB so that our surveillance team will be able to close watch all day to day operations of this solid waste management facility.

b. They have not provided scientific facilities for windrow composting as not more than 20-22 waste heaps were seen there where as minimum 40 windrows are required for the satisfactory operation of a good windrow composting facility. It can also be seen that no periodical shuffling for aeration is being practiced there. Some of the sheds provided for

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composting is seen collapsed or in a dilapidated condition due to uneven settlement of its foundation.

c. It may be pertinent to note that State Level Monitoring Committee was constituted by Hon'ble National Green Tribunal as per the order dated 16.01.2019 in O.A No. 606 of 2018. Meetings of SLMC (NGT) were held on several occasions and lot of decisions were taken and directions were given to Corporation authorities to rectify the defects noticed. But still they are not able to undertake any satisfactory rectification measures to provide scientific facilities and to avoid dumping of waste which is being continued there.

d. Since no proper segregation is being practiced there, more plastic wastes are usually seen in the waste dumping area. It can be seen that disposal of bio degradable wastes are still continued where no additional rectification measures are seen made to properly treat these wastes except dumping.

e. Vehicles carrying wastes are seen there and identified that the same are transported from other municipalities. The health staff informed that wastes are still being transferred from Kalamassery, Thripunithura, Thrikkakara, Angamaly and Aluva Municipalities and Vadavucode – Puthencruz & Cheranalloor Grama Panchayaths and it is revealed from the records also.

f. It is respectfully submitted that they are maintaining log books for collected wastes from the Corporation as well as from other local bodies. On verifying records available the collected quantity of Bio degradable fraction of waste in the month of May, June and July 2019 are assessed as follows.

Sl No	Month	Kochi Corporation	5 Municipalities	2 Panchayaths	Total(tonnes)
1	May 2019	5786.617	1401.188	124.479	7312.284
2	June 2019	5579.435	1351.088	104.605	7035.128
3	July 2019	5716.85	1430.949	116.905	7264.704

g. The shredder installed for plastic waste was not seen operational and bundled plastic wastes are seen there. Responsible official of the Corporation informed that some parts of these plastic wastes were transferred to some recycling facilities.

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h. Though they are collecting mixed waste including plastic from Corporation area to this facility, the plastic wastes alone are transferred to outside agency by manual segregation done by rag pickers at the site. Hence it is evident that the balance quantity of collected non bio degradable wastes is deposited along with heaped legacy waste. As per the logbook details of mixed waste including plastic waste managed in May, June and July 2019 are as illustrated below

Sl No	Month	Qty of Collected waste(MT)	Qty of waste transferred to outside agencies(MT)	Balance(MT)
1	May 2019	3889.184	39.535	3850.305
2	June 2019	3827.8	17.56	3810.24
3	July 2019	4268.407	44.080	4224.327

i. Quantity of manure named "City compost" production is seems to be marginal compared to the daily waste collected at the plant. Though they are transferring an average of 365.19 T/day of wastes out of which 234.91 T/day is biodegradable fraction, the manure production is negligible. No records were seen provided for assessing the quantity of manure production in the facility.

j. Hence to find out the quantity of waste dumped every day following calculations are made

Sl No	Month	Qty of Bio Degradable waste	Qty of Mixed waste	Qty of Plastic waste transferred to outside agency	Qty of manure(City compost)production
1	May	7312.284	3889.184	39.535	No Records available
2	June	7035.128	3827.8	17.56	No Records available
3	July	7264.704	4268.407	44.080	No Records available

k. It may kindly be noted that the solid waste management facility at Brahmapuram is started in the year 2008 and still continuing, the total waste quantity been dumped there will be huge which can be actually ascertained through a total station survey/drone mapping only as illustrated in the CPCB guidelines.

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l. It may be pertinent to note that they are allowing other 5 municipalities and 2 Grama panchayaths to dispose their wastes (claiming that only biodegradable fraction is being transferred by other municipalities) from 2012 onwards as reported by the Corporation. It is important to note that these local bodies also are bound to comply with the provisions of the Solid Waste Management Rules 2016 and at least five Municipalities should have been obtained authorization since all of them generating more than 5 MT/Day of wastes.

m. Actually the corporation was issued with a notice dated 14.01.2019 for submitting action plan for proper management of waste but no satisfactory reply is seen submitted till date other than proposals for a waste to energy plant and bio mining of a portion of legacy waste accumulated there. Also they are producing "manure" (City compost) in small quantities.

n. An interesting fact is that the manure called city compost they produced was analysed for its fertiliser value and found that the same is not meeting the standards stipulated in Solid waste management rules 2016. Apart from this there is presence of heavy metals in the manure. Copy of the Analysis report is produced here with and marked as **Annexure-B.**

o. It is important to note that the Corporation had submitted a proposal for Bio Mining of the entire Legacy waste deposited there for technical advice and necessary guidance was given noting the discrepancies observed. Copy of the reply attached as **Annexure-C.** Another proposal for land disposal of rejects was made by the Corporation for necessary guidance from the Board for which an inspection was conducted along with the Environmental Engineer, Kochi Corporation on 17.08.2019. Copy of the requests along with Google map of the proposed site are attached as **Annexure-D(1&2)** and Copy of the reply given to Secretary, Kochi Corporation is produced herewith and marked as **Annexure-E.**

p. It is respectfully submitted that a compliance report is already filed dated 23.07.2019 as per the order dated 23.10.2018 of the Hon'ble National Green Tribunal in Applications No. 533-535 of 2018 which was in connection with pollution problems of Brahmapuram dumping yard and as a follow up action, the Dumping yard was inspected on 26.07.2019 from this office. This was exclusively done to kindly inform the Hon'ble National Green Tribunal the updated status of the solid waste management plant at Brahmapuram operated by the Kochi Corporation before the hearing in Application 533-535 of 2018 which was fixed on 05.08.2019. The date of hearing was postponed by the Hon'ble NGT to 1.09.2019.

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q. No actions were taken to install proper Effluent Treatment facilities as suggested during last SLMC meeting and the leachate was seen collected in a tank/pit which was seen kept open.

I may humbly submit that there is no satisfactory progress of works observed on the implementation of any of the proposals except a waste to energy plant.

Dated this the 4th day of September 2019

CHIEF ENVIRONMENTAL ENGINEER

M. A. BAIJU
Chief Environmental Engineer

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REGIONAL OFFICE

Study Report on the emission of dioxins and dioxin – like PCBs during the dumpyard fire at Brahmapuram, Feb 2019

Environmental Technology Division
CSIR- National Institute for Interdisciplinary Science & Technology (CSIR- NIIST)
Thiruvananthapuram, Kerala – 695 019

April 2019

Acknowledgements

This study was urgently taken up at the initiative of CSIR- NIIST as soon as the incident of fire breakout at Brahmapuram was reported in media. Open burning of municipal solid wastes is a major source of dioxin emission in developing countries and dumpyard fires are very common in the country. No study report is available in India on the emission of dioxins during a dumpyard firebreak out.

We thank Dr. A.Ajayaghosh, Director, CSIR- NIIST for directing us immediately to take up the study and facilitating the administrative and logistic support in executing the work at short notice. We gratefully acknowledge Dr. Ajit Haridas, former Chief Scientist, CSIR-NIIST & Chairman, KSPCB for suggesting the study and for his significant contributions in establishing and further upgrading the Dioxin Research Laboratory at CSIR-NIIST.

We gratefully acknowledge the significant contributions of Late Dr. Anbu Munusamy in establishing the facility at CSIR-NIIST. Since June 2014, Dr. K. P. Prathish is in charge of the facility. CSIR-NIIST is the first institute in the country to carry out dioxin analysis and the facilities at NIIST has been upgraded under DSIR-NIIST- CRTDH project in 2016. We gratefully acknowledge the support of Department of Scientific & Industrial Research (DSIR) for funding the upgradation of the facility under CRTDH project.

CSIR-NIIST recently submitted the first study report in India on the "Determination of emission factors of dioxins from open burning of municipal solid wastes in Kerala" to Kerala State Pollution Control Board and other stakeholders such as MoEFCC, MoHUA and CPCB. We gratefully acknowledge the support of KSPCB in funding the project.

The present project was carried out by the following team:

1. Dr. K. P. Prathish, Scientist, CSIR- NIIST
2. Mr. Shaji Kumar. V.K, Senior Technical Officer, CSIR- NIIST
3. Mr. Ajay. S.V, Research Scholar, CSIR- NIIST
4. Mr. Rajendra Prasad & Mr. Ratheesh S, Casual Labourers

For further information, contact Dr. Prathish K P, 94477 98707 prathishkp@niist.res.in.

Executive Summary

Open burning of municipal solid wastes is one of the major sources of dioxin emission in developing countries. Dioxins are a class of persistent organic pollutants (POPs) unintentionally produced during various combustion processes such as waste incineration, open burning of MSW, chemical and metallurgical manufacturing processes etc. CSIR- NIIST established the first dioxin research laboratory in India and is a participant institute in India's National Implementation Plan (NIP) submitted in April 2011 for meeting the country's obligations towards Stockholm Convention. The lack of dioxin emission data from open burning of MSW was one of the major shortcomings identified by UNIDO's independent evaluators in India's NIP. A study funded by Kerala State Pollution Control Board (KSPCB) was carried out by NIIST on the "Determination of emission factors of dioxins from open burning of municipal solid wastes in Kerala" and the report was submitted in December 2018.

An incident of massive fire breakout was reported on 23rd February 2019 at Brahmapuram waste dumpyard in Kochi. The total area of the site is approximately 106 acres and about 60 acres is covered with dumped wastes. The smoke from the fire spread to the city and some of the residents required medical attention for respiratory ailments. The fire was brought under control after three days on 25th February evening. Subsequently, there have been smaller fires at least 6 times till April 2019. Dumpyard fires are common during dry season.

CSIR-NIIST was sensitized by the news of fire breakout in media on 23/02/2019 and immediately realized the need to carry out onsite ambient air and residual ash sampling during the incident. Dr. A. Ajayaghosh, Director, CSIR- NIIST deputed a team led by Dr. K. P. Prathish, Scientist, CSIR-NIIST to the site and the ambient air sampling was initiated in the afternoon of 24th February 2019. Ambient air sampling was carried out using high volume sampler at the dumpyard, powered by portable generator. The ambient air, residual ash and sediment samples were collected and transported to Dioxin Research Laboratory on 26th February 2019. The sample preparation, analysis and quantification of dioxins and PCBs were carried out at the NABL accredited (ISO/IEC 17025:2005) laboratory at CSIR-NIIST.

The following are the major findings of the present study.

- Dioxins were detected and quantified in ambient air, residual ash and sediment samples collected from the premises of waste dumpyard during fire break out.

- The average dioxin levels observed in **ambient air** was found to be **10.3 pg TEQ/m^3**. The observed levels are **50 and 10 times higher than reference and field blank data**.

- The average dioxin concentration observed in **residual ash samples** collected from different locations in the fire covered area is **158.5 ng TEQ/kg of ash**.

- The observed dioxin levels in **sediment samples** collected from nearby marsh fields is **6.8 ng TEQ/kg**.

- The dioxin generated by the fire is given by Emission Factor x Activity Rate.

    - The Activity Rate = total quantity of MSW burned = Area burned (from satellite photo of 23/2/2019) x burn depth (20 cm as given by Dr.Ajit Haridas), and bulk density (350 kg/m^3) = **1800 tonnes (appr.)**
    - The **Emission Factor for dioxins** as determined in "Burn-hut" at CSIR-NIIST is **39.81 µg PCDD-F TEQWHO/ ton of waste burned**.

    - Hence, estimated dioxin emitted **= 72 milligram Toxicity equivalence (TEQ).**

    - The WHO /FAO maximum tolerable monthly intake of dioxins for humans is **70 picogram TEQ/kg body weight** (tolerable annual intake for a 65 kg person is 54.6 nanogram TEQ). **<u>While only a very small fraction of the dioxins generated reaches humans via the food chain,</u>** the total dioxin generated is sufficient to exceed tolerable annual intake of 72 x 10^{-3} / 54.6 x 10^{-9} = 1.3 million persons

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1. Introduction

Municipal Solid Waste management is an important problem faced by developing countries like India. The major cities in India faces the threats of increasing municipal solid waste generation and it has become a big burden on both the local bodies as well as public. Kerala is one among the most densely populated states in India. Kerala is facing a crisis situation in MSW management due to unscientific practices, shortage of wasteland and huge protest from citizen on acquisition of land for treatment plants learning from the past unsuccessful and bitter experiences. The increasing population, urbanization and improvement in quality of life are the main reasons for the rapid expansion of quantity of MSW. Kochi is the commercial and Industrial capital of the state of Kerala. The total solid waste generation rate is 180 -250 metric tonnes per day [1]. Unlike other cities like Thiruvananthapuram and Kollam, Kochi city has a waste treatment plant operated by corporation. The waste treatment plant of the city is located at Brahmapuram, which is in the vicinity of smart city project. The plant is on the shores of Kadambrayar with an approximate area of 106 acres. The plant treats only biodegradable waste and all the other waste is being dumped outside the plant in an unscientific manner. Open dumping of the waste is an unhygienic process and it can cause severe health issues. However, the most common type of waste management practice followed in Indian cities is open dumping of waste [2]. Unlike other Indian cities the more congested and populated cities like Kochi is extremely vulnerable to the consequences of open dumping of MSW. The estimated waste in the waste dump is approx. 800,000 tonnes, spread over 60 acres of land [1]. The wastes from nearby municipalities such as Ankamaly, Aluva, Kalamassery, Thrikkakkara, Tripunithura are also taken to Brahmapuram and more than half of the plant area is now completely immersed in wastes. A major share of everyday wastes including plastics, non-biodegradables and hazardous wastes are open dumped outside without any proper attention.

An important consequence of such open dumping of wastes is the break out of spontaneous fires. A major fire break out occurred on 22nd February 2019 at Brahmapuram waste treatment plant, where about 8 lakh tonnes of wastes are accumulated. The city was engulfed by thick smoke on the early hours of 23rd February 2019. The intense smoke created much health effects and

breathing problems to the residents of the area and many were relocated from the vicinity of the treatment plant. The incident raised lot of concern to the residents of Kochi and invited sharp criticism to the stakeholders. The district collector coordinated the efforts of government machinery such as fire and rescue force, health department etc. to extinguish the fire and smoke. Finally the situation was brought under control and smoke was completely shut down after three days on 25th February evening.

Uncontrolled open burning of MSW has been recognized as the major source for un-intentionally produced persistent organic pollutants (U-POPs) called "Dioxins" into the environment. Dioxins (polychlorinated dibenzo p-dioxins - PCDDs) and furans (Polychlorinated dibenzofurans - PCDFs) are the prominent groups which comes under the U-POP category. Tetra chlorinated dibenzodioxin (TCDD) is the most toxic congener of dioxins and certain polychlorinated biphenyls (PCBs) which exhibits TCDD like property are known as dioxin-like PCBs (dl-PCBs). Dioxin is the general term used to represent these three groups of compounds viz. PCDDs, PCDFs and dl-PCBs and a total of 29 compounds from these groups are in the watch list. These compounds have very high persistency in the environment and can cause bio-accumulation. The major health effects associated with dioxins are immunotoxicity, carcinogenesis, reproductive ailments, kidney and liver malfunctions etc. These compounds are highly toxic to humans and animals at picogram levels. As per WHO/FAO, the maximum tolerable monthly intake of these highly toxic compounds is 70 pg TEQ/Kg body weight, above which human beings are vulnerable to its consequences. The POP phase out got an international recognition with Stockholm Convention in 2001. India, being a member nation of the convention in April 2006 developed a National Implementation Plan (NIP) on POPs. The NIP was focused to develop annual emission inventories of POPs and the country's road map to its reduction, elimination and exploring the Best Environmental Practices (BEP) and Best Available Technologies (BAT). India's NIP project was funded by United Nations Industrial Development Organisation (UNIDO) and the final report was submitted in April 2011[3]. The lack of adequate data on emission of dioxins during open burning of MSW was identified as a major shortcoming in India's NIP by UNIDO's expert evaluation team [4].

CSIR-NIIST is one of the participant institutes in the NIP preparation and has the state of the art analytical facilities and technical expertise to carry out dioxin analysis in environmental and food matrices. CSIR-NIIST has recently conducted simulated waste combustion studies in a laboratory scale "Burn Hut" and generated the emission factors of dioxins from open burning of MSW in Kerala. It is the first report in India. The study was funded by Kerala State Pollution Control Board and the final report has been submitted in December 2018. The study found that high levels of dioxins are emitted during open burning of untreated wastes and it is a serious problem to be addressed.

The present study was undertaken by CSIR-NIIST when fire at Brahmapuram was reported by news media. Director, CSIR- NIIST was appraised about the requirement to carry out onsite ambient air sampling and residual ash sample collection, and with his support, a pickup van, generator and two High volume ambient air PUF sampler were rushed to the site on the early morning (4 am) of 24th February 2019. The team led by Dr. K. P. Prathish, Scientist, Mr. Shaji Kumar V. K., Senior Technical Officer, Mr. Ajay S V , Research Scholar and Mr. Rajendra Prasad, Skilled worker, reached the site at around 11.30 am on 24th February 2019. The ambient air, residual ash and sediment samples were collected and transported to Dioxin Research Laboratory on 26th February 2019. The sample preparation, analysis and quantification of dioxins and PCBs were carried out at the NABL accredited (ISO/IEC 17025:2005) laboratory at CSIR-NIIST. The fire report supplements our previous report on "Emission factors of dioxins from open burning of municipal solid wastes in Kerala" submitted to Kerala State Pollution Control Board in December 2018. We hope that these studies will help Government to take important policy decisions on scientific solid waste management.

2. Experimental Section

2.1 Materials and Methods

2.1.1 High Volume Polyurethane Foam Sampler for Ambient Air Sampling

Ambient air sampling of Dioxins and PCBs were carried out by passing large volume of air through glass micro-fibre filter and Polyurethane foam cartridge in a high volume sampler. The high

molecular weight long chain dioxins and PCBs associated with particulates are trapped on the filter. Due to the volatilization, the lower chlorinated dioxins and PCBs are not entirely associated with particulates and hence are not trapped on the glass micro fibre filter. They are predominantly adsorbed on to the polyurethane foam cartridge kept at the downstream of glass microfiber filter. Upon completion of sampling, filter paper as well as the PUF cartridge is extracted in Soxhlet apparatus by following standard procedures as given in sec.2.3. The final extract contains the total dioxins and PCBs sampled from the particulate and gaseous phase in the ambient air.

APM 460 PUF sampler from M/s. EnviroTech Instruments Pvt. Ltd. (Fig 1) was employed for the ambient air sampling from open burning sites in the study. The equipment consists of following parts.

1) Particle Fractionator: A cyclone device designed for flow range of 200 – 250 LPM for fractionating dust into two fractions. PM 10 dust is accumulated on the filter paper (8" x 10" size) while coarse dust is collected in a cup laced under the cyclone.

2. PUF Cartridge: Polyurethane foam for trapping the low molecular weight dioxins and PCBs

3. PUF Housing: Housing of APM 460 PUF is compatible with standard borosilicate glass cartridges available from SKC or other international vendors. It is lined with Teflon and fitted at the bottom of the filter adapter casting.

4: Recommended Filter: Any standard 8 "x10 "filter such as Whatman GD/A for sampling of PM 10 dust where high molecular weight dioxins and PCBs are collected with particulates

Sampling time: upto 48 hours depending on the expected levels and analytical capabilities

Sampling Time record: Electromechanical Time Totalizer accurate up to 0.6 minutes record actual time of the sampling.

Fig 1: PUF sampler

2.1.2 Extraction and Cleanup apparatus/equipment

The HVS air, ash and sediment samples obtained from the Brahmapuram waste dump yard were extracted with organic solvents. Soxhlet extraction apparatus was used for the manual extraction of samples (Fig 2).

- The source material containing the compound to be extracted is placed inside the thimble. The thimble is then loaded into the main chamber of the Soxhlet extractor.
- A condenser is fitted above the main chamber
- The extraction solvent to be used is placed in a distillation flask and is placed on the heating element
- Upon heating the solvent in distillation flask will be evaporated and will be condensed down to the main chamber. The hot solvent will dissolve off the organic content in the

sample. The solvent will flush out to the flask by siphoning action. The process is repeated for several cycles so as to ensure maximum extraction of contaminants.

Fig 2: Soxhlet Extraction System

2.1.3 Automated sample cleanup system

The removal of unwanted matrix components such as lipids, fats and other organic impurities prior to GC- MS/MS quantification is essential to avoid interferences. Also the Non-dioxin like PCBs (NDL), Non-ortho PCBs (NO) and Mono- ortho PCBs (MO) has to be separated from the dioxin fraction. Manual cleanup methods are available. However, it is tedious and time consuming. To ensure fast and better cleanup efficiencies, we have employed DEXTech Automated Dioxin clean up system (Make: LCTech) (Fig 3). The system consisted of 3 columns connected in series – Universal silica column, alumina column and carbon column. MO-PCBs & NDL-PCBs are collected as first fraction and PCDD/F & NO-PCBs fraction is collected as second fraction from the system.

Fig 3: Automated Dioxin clean up system

2.1.4 Nitrogen Evaporator

The fractions obtained after cleanup is evaporated to dryness and finally reconstituted to 200 uL using nonane before injecting to GC-MS/MS. The fraction is concentrated to 200 uL by using Nitrogen Evaporator (FMS make, Fig 4). Nitrogen evaporator consists of nitrogen purging as well as heating facilities inside a closed chamber. Specially made concentrating tubes are used to perform the concentrating steps. Continuous vacuum will be applied inside the container withdrawing the evaporated solvent from the system. Purge flow and temperature shall be controlled throughout the process. The instrument minimizes the losses due to the volatility of the compounds and nullifies the chances of cross contamination. Ultra high purity (UHP) nitrogen is used for the purging process.

Fig 4: Nitrogen Evaporator

2.1.5 GC-MS/MS

A triple quadruple mass spectrometer (GC-MS/MS) is used for the quantification of dioxins, furans and PCBs. Agilent Technologies Make 7890 Series gas chromatrograph coupled to 7000C Triple Quadrupole MS/MS is used for the analysis (Fig 5).

Fig 5: Gas Chromatography – Triple Quadruple Mass Spectrometer

2.1.6 Standards, Chemicals and Solvents

All native dioxins, furans, PCB standards were procured from Cambridge Isotope Laboratories, UK. C^{13} labelled mixture of dioxins (DF-LCS-C200), non-ortho PCBs (MBP-CP), mono - ortho PCBs (MBP-MO) and cleanup standard spiking solution ($^{37}Cl_4$ - 2,3,7,8-TCDD) (Cat No: S13CSSA) were procured from Wellington Laboratories, England. Unlabelled and C^{13} labelled non-dioxin-like PCBs were procured from CIL. All high purity solvents such as toluene, hexane, dichloro methane were procured from Spectrochem, India. Keeper solvents such as nonane and isooctane were obtained from E-Merck, Germany.

2.2 Sampling of ambient air, residual ash and sediment

The ambient air sampling was initiated at 2.0 pm on 24th February 2019 and was operated till the fire was extinguished at around 4.00 pm on 25th February 2019. As the KSEB power supply was disconnected in the area, the samplers were operated on generator power. The sampling team tirelessly refueled the generator overnight to ensure its uninterrupted operation. There were difficulties in accessing a sampling location closer to the dump yard due to (1) It was unethical to interrupt selflessly hardworking firemen to extinguish the fire by installing the samplers in their pathway and (2) It was not safe to keep the generator near the fire range, where any uncontrolled fire would harm our equipments. Hence the ambient air sampler was kept about 50- 100 meters away from the epicenter of fire and was not in the predominant wind direction. With reference to the wind rose diagram obtained from the India Meteorological Department the predominant wind movement in the Cochin area was in the north-east direction. The dumpyard area in the north- east direction was fully covered with huge waste piles and leachates and hence installing samplers and generator was extremely difficult in the north east direction. Hence active sampling in the pathway of smoke movement was not possible and the sampling done south-west direction can be considered as a passive ambient air sampling at the site.

Pre-weighed filter papers and pre-cleaned polyurethane foam plugs were set onto the sampler and started the sampling at around 2.00 pm. The sampling was conducted with periodic refueling of generator at regular intervals to ensure uninterrupted operation. The samplers were switched off for 1-2 hrs for relocating the position, and to avoid overheating of the system. Considering

the dilution factor that may affect the sample concentration the sampling was stopped at 22 hours upon extinguishing of fire on 25th February 2019 at 4.00 pm. The air suction rate ranged from 0.15 m^3/min to 0.17 m^3/min for one sampler and it ranged from 0.10 m^3/min to 0.12 m^3/min for the second sampler. Hence average suction rate was taken as 0.16 m^3/min and 0.11 m^3/min respectively. Total volume of air sampled was 213.8 m^3 and 141.8 m^3 respectively.

Apart from ambient air samples, we have collected residual ash from various locations in the waste pile and sediment samples from the marshy field about 150 meters away from the dumpyard. Coning and quartering method was followed for residual ash sampling. Upon completion of sampling on 25th February 2019, the samples were carefully packed and transported to Dioxin Research Laboratory, CSIR-NIIST for analysis and quantification.

Fig 6: Brahmapuram waste dumpyard

Fig 7 & 8: Air samplers positioned at the site

Fig:: 10

Fig 9 & 10: Collection of Ash and residue from the site

2.3 Sample analysis & Quantification

2.3.1 Sample preparation

All the samples were extracted using Soxhlet apparatus with toluene as the extraction solvent. 100 pg of C^{13} isotope labelled congener mixture was spiked as internal standard on to the samples before extraction. The internal standard recovery percentages will be calculated along with quantification of native compounds to evaluate the efficacy of the end to end analytical workflow. In addition, the internal standard spike recovery rates will compensate for the loss of native congeners in its quantification procedure. 16 hour Soxhlet extraction with 5 siphons per hour was followed as per the method (Refer US-EPA 8290) was carried out.

The sample cleanup and fractionation was done using DEXTech Automated Dioxin Cleanup System. Two fractions PCDD/F & NO-PCB combined and NDL & MO-PCBs are collected separately in two concentrator tubes and concentrated to near dryness using nitrogen evaporator.

2.3.2 Quantification of Dioxins and Dioxin- like PCBs

Agilent 7890B GC system coupled to an Agilent 7000C series triple quadrupole GC/MS system was used for quantification of dioxins and furans. The sample upon evaporation to near dryness was mixed with 20 pg labelled syringe/recovery standard before making it upto 200 µL. The syringe standard is used to gauge the performance of the instrument. Thus the internal standard recovery studies will monitor the analyte loss during extraction & cleanup steps, while the syringe standard will monitor the instrumental losses. The GC-MS run conditions are as given in table 1.

Table 1: GC/MS run conditions

GC Conditions	
Column	Agilent DB-5 MS UL, 60 m*250 um*0.25um Fused silica capillary column
Inlet	Programmed temperature vaporization inlet (PTV)
Outlet	Vacuum
Injection volume	4 uL
Injection port	Multi-Mode Inlet (MMI)
Injection port liner	Multi-baffle, deactivated PTV liner
Injection mode	Solvent vent
Vent flow	100 mL/min; pressure 5 psi
Purge flow	60 mL/min
Carrier gas	Helium
Carrier gas mode	Constant flow
Column flow	1.02 mL/min
Retention time locking	15.192 for TCDD
Oven program	60 ^{0}C (1 minutes) 30 ^{0}C/min to 270^{0}C (9 minutes) 2 ^{0}C /min to 310 ^{0}C (29 minutes) 10 ^{0}C/min to 325 ^{0}C (35.5 minutes)
Total run time	35.5 minutes
MS conditions	
Operation mode	Electron ionization (EI), Multiple reaction monitoring (MRM)
Transfer line temperature	280 ^{0}C
Source temperature	330 ^{0}C
Quadrupole temperature	150 ^{0}C

2.4 Toxicity Equivalence factor and Quantification and Recovery calculation

2.4.1 Toxicity Equivalence Factor calculation

The toxicity of a mixture is stated as TEQ (TCDD equivalents) and is equal to the sum of the concentration of individual congeners multiplied by their toxicity equivalent factors (TEF).

$$\text{TEQ} = \sum \left[PCDDi \times TEFi\right] + \sum \left[PCDFi \times TEFi\right] + \sum \left[PCBi \times TEFi\right]$$

The 2005 World Health Organization re-evaluated the human toxicity equivalency factors for dioxins and is given in Table 2.

SL. No	Target Analytes (PCDD/ PCDF/PCB)	WHO-Toxic Equivalent Factor (WHO-TEF_{05})
PCDDs		
1	2,3,7,8- TCDD	1
2	1,2,3,7,8- PeCDD	1
3	1,2,3,4,7,8- HxCDD	0.1
4	1,2,3,6,7,8 – HxCDD	0.1
5	1,2,3,7.8.9 – HxCDD	0.1
6	1,2,3,4,6,7,8-HpXDD	0.01
7	OCDD	0.0003
PCDFs		
8	2,3,7,8 –TCDF	0.1
9	1,2,3,7,8-PeCDF	0.03
10	2,3,4,7,8-PeCDF	0.3
11	1,2,3,4,7,8-HxCDF	0.1
12	1,2,3,6,7,8- HxCDF	0.1
13	1,2,3,7,8,9- HxCDF	0.1
14	2,3,4,6,7,8-HxCDF	0.1
15	1,2,3,4,6,7,8- HpCDF	0.01
16	1,2,3,4,7,8,9- HpCDF	0.01
17	OCDF	0.0003
MO PCBs (Dioxin like-PCBs)		
18	PCB 105	0.00003
19	PCB 114	0.00003
20	PCB 118	0.00003
21	PCB 123	0.00003
22	PCB 156	0.00003

23	PCB 157	0.00003
24	PCB 167	0.00003
25	PCB 189	0.00003

Table 2: Toxicity equivalency factors for dioxins and dioxin like PCBs as per WHO_{2005}

2.4.2 Calculation of RF & RRF of native and labelled compounds

Response factor (RF) is the ratio of area of the peak of a particular compound to its concentration or quantity. Relative response factor of native compound ($RRF_{(n)}$) is the ratio of response factor of native congener with respect to that of labelled congener (also called internal standard).

The relative response factor of labelled compound is the ratio of response factor of internal standards with respect to that of recovery or syringe standard. The recovery or syringe standard is used to quantify the instrument efficiency.

(a) $$RRF_{(n)} = \frac{A_x}{Q_x}\frac{Q_{is}}{A_{is}}$$

(b) $$RRF_{(l)} = \frac{A_{is}}{Q_{is}}\frac{Q_{rs}}{A_{rs}}$$

Where

Ax is the response (sum of two m/z's) of native compounds;

Ais is the response (sum of two m/z's) of corresponding internal standard

Ars is the response (sum of two m/z's) of recovery standard;

Qis is the amount of internal standard pg/mL;

Qrs is the amount of recovery standard pg/mL;

Qx is the amount of native component pg/mL.

The average relative response factor is calculated as

$$\overline{RRF} = \frac{1}{m}x\sum_{i=1}^{m} RRF_{(n)}$$

Where

m is the number of standards (concentration levels);

n is the native component;

i is the calibration level.

The average relative response factor for labelled compounds is calculated as

$$\overline{RRF} = \frac{1}{m} x \sum_{i=1}^{m} RRF_{(l)}$$

Where

m is the number of standards (concentration levels);

l is the labelled compound;

i is the calibration level.

2.4.3 Calculation concentration component of interest

The content component of interest is calculated by = $C_x = \frac{A_x}{A_{is}} \frac{Q_{is}}{DIV} \frac{}{\overline{RRF_{(n)}}}$ where

Cx is the content of the component of interest in ng/kg;

Ax is the response (sum of two m/z values) of native compounds in sample extracts

Ais is the response (sum of two m/z values) of corresponding labelled internal standard in sample extracts;

Qis is the amount of injected labelled internal standard pg/mL;

DIV is the calculation factor from concentration (pg/mL) to content on sample basis (ng/kg) = M/V, where

V is final volume in µl;

M = sample intake in g.

RRF(n) is the relative response factor of native congeners

2.4.4 Internal Standard Recovery

The recovery for the internal standards used is calculated by:

Percentage recovery (%) $= \frac{A_{is}}{Q_{is}} \frac{Q_{rs}}{A_{rs}} x \frac{100}{RRF_{(l)}}$ where

Ais is the response (sum of two m/z's) of the internal standard in the sample;

Ars is the response (sum of two m/z's) of the recovery standard in the sample,

Qis is the Amount of internal standard pg/mL;

Qrs is the Amount of recovery standard pg/mL;

RRF(l) is the relative response factor of labelled congeners

3. Results and Discussion

3.1. Levels of dioxin and dioxin-like PCBs in ambient air, residual ash and sediment samples

3.1.1 Dioxin levels in Ambient Air samples

We carried out the sampling, sample preparation and quantification of dioxins in ambient air, residual ash and sediment samples following the procedures as given in section 2. Table 3 shows the concentration of dioxins present in two ambient air samples, two residual ash samples and one sediment sample collected during the fire break out at Brahmapuram.

Table 3: Concentration of dioxins in ambient air, residue and sediment samples in Brahmapuram, Kochi

Sl No	Matrix		Concentration	Average Concentration
1	**Ambient Air**	S1	9.5 pg TEQ/m^3	10.3 pg TEQ/m^3
2		S2	11.1 pg TEQ/m^3	
3	**Residual Ash**	Res -1	153.2 ng TEQ/kg	158.5 ng TEQ/ kg
4		Res- 2	163.8 ng TEQ/kg	
5	**Sediment**	Sed- 1	6.8 ng TEQ/kg	6.8 ng TEQ/kg

Hitherto this study, CSIR- NIIST conducted the ambient air sampling and analysis from some of the open burn sites in Thiruvananthapuram city. A comparative evaluation of the ambient air dioxins levels in various open burn sites and that of the levels observed at Brahmapuram is given in Table 4. We have also assessed the background ambient air dioxin levels in two neutral locations to get deeper insight into the effect of open burning activity in the state.

These two sites are

(1) **Reference Blank:** 24 hr ambient air sampling inside NIIST campus representing a location devoid of any open burning activities and is considered as reference blank.

(2) **Field Blank:** A field blank has been taken near an open burning site at Thakaraparampu at Thiruvananthapuram city. The field blank sampling was carried out on a day devoid of any open burning activity for 24hrs. Previously we carried out sampling from the same location under open burning condition.

Table 4 show the comparison of concentration of dioxins observed in ambient air at Brahmapuram waste treatment plant during accident fire vis-à-vis that observed at other open burning sites in Thiruvananthapuram city.

Table 4: Concentration of dioxins in ambient air at Brahmapuram vis-à-vis Other open burning sites

SL. No	Sampling location	Distance of sampler from the epicenter of open burn (metre)	Date of Sampling	Observed Concentration (pg TEQ/m^3)
1	**Brahmapuram S1**	50 -100	25/02/2019	9.5
2	**Brahmapuram S2**	50 -100	25/02/2019	11.1
3	**Open burn site, Pettah**	10	14/11/2018	13.04
4	**Open burn site, Thakaraparampu**	2-3	05/12/2018	41.36
5	**Control Site (NIIST Campus)**	Reference Blank	22/10/2018	0.2
6	**Open burn site, Thakaraparampu (Same site as in 3)**	Field Blank (Devoid of open burning activity)	08/01/2019	1.35
7	**European Cities**	NA	NA	0.3

It can be observed from Table 3 and 4 that the levels of dioxins observed in ambient air during the fire breakout at Brahmapuram is about 50 & 10 times higher than the reference blank and field blank concentration respectively. In addition, the sampler was placed about 50 -100 meter away from the waste pile. It may also be noted that passive sampling was conducted at Brahmapuram due to difficulties in accessing the active wind direction and for maintaining a safe

distance from the fire spots to operate the generator and sampling equipments. The concentration of dioxins observed at open burn sites at Pettah and Thakaraparambu indicates that the distance of the sampler and wind direction influence the sampling. The samplers at Thakaraparambu and Pettah were kept at 2 meters and 10 meters distance respectively and the concentrations were decreasing with increasing distance. It is quite obvious due to dilution occurring with distance and possible quick condensation of semi-volatile dioxins.

3.1.2. Dioxin levels in Residual Ash samples

The dioxin levels observed in the residual ash samples collected from different points on the burned waste heap at Brahmapuram was analyzed as per the procedures mentioned in section 2.3. The obtained results are shown in Table 5. It can be understood the concentration of dioxins measured in two residual ash are very similar ie 153.2 and 163.8 ng TEQ/kg respectively. Hence an average concentration of 158.5 ng TEQ/kg can be considered for the comparative evaluation of the observed levels at Brahmapuram vis-à-vis other dumpsites in various countries.

Table 5: Concentration of dioxins in residual Ash and sediment samples in Brahmapuram, Kochi

Sl No	Matrix		Concentration	Average Concentration
1	**Residual Ash**	Res -1	153.2 ng TEQ/kg	158.5 ng TEQ/ kg
2		Res- 2	163.8 ng TEQ/kg	
3	**Sediment**	Sed- 1	6.8 ng TEQ/kg	6.8 ng TEQ/kg

Table 6 shows the PCDD/Fs concentrations (ng/kg dry wt) in soils from dumping and control sites in Asian developing countries with those in general and contaminated soils from other locations in the world. It was the first comprehensive data of PCDD/Fs and related compounds in dumping soils from Asian developing countries, which were comparable or greater than those in soils from dioxin-contaminated sites reported in developed nations. It highlighted the role of dumping sites as a significant source of PCDD/Fs.

The average concentration of 158.5 ng TEQ/kg observed in residual ash samples at Brahmapuram is in the range of dioxin levels observed in various infamous dumping site of the world such as Vietnam, Philippines, Cambodia, The Netherlands, Greece and USA. The dioxin levels reported at an infamous dumpyard soil in India at Perungudi, Chennai is 52 ng TEQ/kg[7]. The level observed at Brahmapuram is about 3 times higher than that at Perungudi. The variation in the levels may be due to difference in sampling sites, composition of wastes and combustion conditions and the sensitivities of the analytical instruments used in the previous study.

The table shows that data is not available in many developed countries on dump yard samples, because there are no such sites in most of those countries.

3.1.3 Dioxin levels in Sediment samples

We observed that there is a marshy field near the Brahmapuram waste dumpsite which is about 150 metres away from the epicentre of fire breakout. Also the marshy field lies in the predominant wind direction. Hence, we were interested to examine the dioxin levels in the sediment samples collected from the field. The dioxin levels present in the sediment samples is not related to the present fire break out. However, it could give an idea of the dispersion of such pollutants over the years from similar fires occurred at the dumpyard. The dioxin levels observed in sediment sample is 6.8 ng TEQ/kg. Since it cannot be compared with dioxin levels in river sediments, no comparative evaluation has been carried out for the sediment data. We need to carry out further investigation to understand the long term effect of such fire break out incidents and the present data will be useful for future comparative evaluation.

Table 6: Comparison of PCDD/Fs Concentrations (ng/kg dry wt) in soils from Dumping and Control Sites in Asian Developing countries with those in General and Contaminated Soils from Other Locations in the World [7]								
Country	**Year**	**Soils from contaminated sites**			**General soils**			**Remark**
		Mean concentration	**ng/kg WHO TEQ**	**Concentration range**	**Mean concentration**	**ng/kg WHO TEQ**	**Concentration range**	
Philippines	1999	6100	546	44000-75000	57	na	14 - 100	Dumping sites, uncontrolled burning
Cambodia	1999	30000	402	330-20000	130	1.9	40 - 370	Dumping sites, uncontrolled burning
India	2000	7400	52	22000-34000	32	0.22	18 - 79	Dumping sites, uncontrolled burning
Hanoi, Vietnam	2000	6100	102	125-50500	370	1.1	na	Dumping sites, uncontrolled burning
Hochiminh, Vietnam	2002	370	2.7	21-880	190	1.27	130 - 260	Dumping sites, uncontrolled burning
Rio de Janeiro, Brazil	1999	na	13900	na	na	na	na	HCH plant waste site
Crete, Greece	1996	37000	410	2900-105000	na	na	na	Open landfill dump sites, uncontrolled burning
Barcelona, Spain	1999	700	11.85	na	na	na	na	Municipal waste incinerator
The Netherlands	1989 /90	na	3-252	na	na	na	na	Municipal waste incinerator
Ohio, USA	1995 /96	15700	458	na	na	na	na	Municipal waste incinerator
Thailand	1997	na	na	na	15	na	na	na

Australia	1998	na	na	na	37	na	31 - 42	na
Lake Baikal, Russia	1997	na	na	na	73	na	na	na
Japan	1997 /98	na	na	na	3700	42.8	na	na
Hong Kong	1996	na	na	na	6100	na	2500 - 8650	na
Brazil	1997	na	na	na	20	na	na	na
British Columbia, Canada	1997	na	na	na	460	na	49 -1900	na
Michigan, USA	1998	na	na	na	230	na	94 - 490	na
Indiana, USA	1996	na	na	na	2000	na	1600 - 2400	na
Norway	1997	na	na	na	130	na	na	na
Spain	1996	na	na	na	315	na	130 - 500	na
United Kingdom	1997	na	na	na	290	na	286-600	na
United Kingdom	1990	na	na	na	4660/324	21 /19	na	na
Germany	1996 /97	na	na	na	649	na	647-650	na

3.2 Evaluation of the analytical data

3.2.1 Internal standard recovery rate

The sample preparation procedures are the most critical aspect determining the quality of analytical data obtained in dioxin analysis. The ultratrace levels of dioxins in environmental samples (in picogram levels) and presence of high levels of interfering compounds (in micro to milli gram) are the critical factors. The isotope dilution method is followed in dioxin analysis to monitor the performance of analytical methodology as well as to compensate for the native analyte losses during the sample processing. It is carried out by spiking known concentration of isotope labelled internal standards of all the congeners in each sample prior to extraction and the recovery of internal standards are assessed at the end of each analysis. As per regulations and standard methods, the recovery of internal standards should be in the range of 60 -120 %. The equation for calculating internal standard recovery is given in section 2.4. In case the recovery rate is less than 60%, the results are still acceptable if the particular congener's contribution to total toxicity equivalence (TEQ) is less than 10 %. Table 7 and 8 shows the internal standard recovery rate observed in a representative ambient air and residual ash sample in the present study. It can be observed that the recovery rates for all dioxins are in the range of 60 – 120 % and hence the sample preparation and analytical methods followed in the present study is acceptable.

Table 7: Recovery rate and TEQ calculation of ambient air sample											
Spiked IS concentration (except OCDD & OCDF) Qis				500 ppt		OCDD and OCDF concentration			1000 ppt		
Spiked Syringe standard concentration						100 ppt					
Compounds	**Avg resp IS**	**Obt resp of IS**	**Syr std avg resp**	**Syr std obt resp**	**RF of IS**	**RF of Syr std**	**RRF of IS to Syr std**	**% recovery**	**conc /gm**	**TEF**	**TEQ**
PCB 81	98927.3	89463.3	15711.6	21143.0	197.9	157.1	1.3	67.2	14.1	0.0003	0.004
PCB 77	109098.9	63398.0	15711.6	21143.0	218.2	157.1	1.4	43.2	12.0	0.0001	0.001
2378-TCDF	95361.3	89455.1	15711.6	21143.0	190.7	157.1	1.2	69.7	10.4	0.10	1.04
2378-TCDD	27414.2	27326.9	15711.6	21143.0	54.8	157.1	0.3	74.1	1.0	1.00	0.96
PCB 126	43680.2	68241.5	15711.6	21143.0	87.4	157.1	0.6	116.1	3.1	0.10	0.31
12378-PeCDF	32754.7	34283.9	15711.6	21143.0	65.5	157.1	0.4	77.8	7.5	0.03	0.22
23478-PeCDF	35962.1	37888.7	15711.6	21143.0	71.9	157.1	0.5	78.3	1.2	0.30	0.36
PCB 169	30714.4	30076.6	15711.6	21143.0	61.4	157.1	0.4	72.8	1.7	0.03	0.05
12378-PeCDD	19652.7	20403.9	15711.6	21143.0	39.3	157.1	0.3	77.2	2.9	1.00	2.89
123478-HxCDF	38985.0	53388.9	7547.9	10616.0	78.0	75.5	1.0	97.4	4.0	0.10	0.40
123678-HxCDF	43075.8	11159.5	7547.9	10616.0	86.2	75.5	1.1	18.4	2.8	0.10	0.28
234678-HxCDF	41109.6	47569.5	7547.9	10616.0	82.2	75.5	1.1	82.3	8.3	0.10	0.83
123478-HxCDD	13302.7	17786.1	7547.9	10616.0	26.6	75.5	0.4	95.1	4.4	0.10	0.44
123678-HxCDD	16547.1	17786.1	7547.9	10616.0	33.1	75.5	0.4	76.4	2.9	0.10	0.29
123789-HxCDD	14205.4	16860.9	7547.9	10616.0	28.4	75.5	0.4	84.4	3.2	0.10	0.32
123789-HxCDF	34250.5	39974.9	7547.9	10616.0	68.5	75.5	0.9	83.0	1.7	0.10	0.17
1234678-HpCDF	33704.3	38183.7	4880.9	8368.0	67.4	48.8	1.4	66.1	3.9	0.01	0.04
1234678-HpCDD	11068.4	13168.4	4880.9	8368.0	22.1	48.8	0.5	69.4	122.4	0.01	1.22
1234789-HpCDF	28531.6	35358.8	4880.9	8368.0	57.1	48.8	1.2	72.3	1.8	0.01	0.02
OCDD	12181.8	14452.5	4880.9	8368.0	12.2	48.8	0.2	69.2	25.8	0.0003	0.01
OCDF	18730.2	21539.8	4880.9	8368.0	18.7	48.8	0.4	67.1	5.4	0.0001	0.001

Table 8: Recovery rate and TEQ calculation of residue ash sample

Spiked IS concentration (except OCDD & OCDF) Qis	500 ppt	OCDD and OCDF concentration	1000 ppt
Spiked Syringe standard concentration		100 ppt	

Sample intake – 5.036 gm

Compounds	Avg resp of IS	Obt resp of IS	Syr std avg resp	Syr std obt resp	RF of IS	RF of Syr std	RRF of IS to Syr std	% recovery	conc/ gm	TEF	TEQ
PCB 81	73670.9	86487.2	11435	15728	147.3	114.4	1.3	85.4	73.3	0.0003	0.02
PCB 77	76123.5	54868.2	11435	15728	152.2	114.4	1.3	52.4	457.1	0.0001	0.05
2378-TCDF	72627.2	66146.2	11435	15728	145.3	114.4	1.3	66.2	97.1	0.1	9.71
2378-TCDD	21220.4	23923.9	11435	15728	42.4	114.4	0.4	82.0	19.8	1	19.8
PCB 126	34247.3	37904.4	11435	15728	68.5	114.4	0.6	80.5	108.3	0.1	10.8
12378-PeCDF	39283.6	43893.0	11435	15728	78.6	114.4	0.7	81.2	90.6	0.03	2.72
23478-PeCDF	48297.4	54433.6	11435	15728	96.6	114.4	0.8	81.9	209.5	0.3	62.8
PCB 169	42258.8	49136.5	11435	15728	84.5	114.4	0.7	84.5	17.5	0.03	0.52
12378-PeCDD	27361.1	31412.3	11435	15728	54.7	114.4	0.5	83.5	33.9	1	34.0
123478-HxCDF	71268.2	78332.4	13939	19327	142.5	139.4	1.0	79.3	62.3	0.1	6.23
123678-HxCDF	73096.7	82381.1	13939	19327	146.2	139.4	1.0	81.3	56.4	0.1	5.64
234678-HxCDF	80781.5	87606.2	13939	19327	161.6	139.4	1.2	78.2	67.2	0.1	6.72
123478-HxCDD	26547.7	32404.3	13939	19327	53.1	139.4	0.4	88.0	13.8	0.1	1.38
123678-HxCDD	31005.1	32649.4	13939	19327	62.0	139.4	0.4	75.9	27.7	0.1	2.77
123789-HxCDD	29371.2	28975.5	13939	19327	58.7	139.4	0.4	71.2	21.0	0.1	2.10
123789-HxCDF	78891.9	86444.8	13939	19327	157.8	139.4	1.1	79.0	14.9	0.1	1.49
1234678-HpCDF	82630.8	83056.2	13453	19327	165.3	134.5	1.2	70.0	26.4	0.01	0.26
1234678-HpCDD	27435.4	31528.5	13453	18891	54.9	134.5	0.4	81.8	786.7	0.01	7.87
1234789-HpCDF	82305.5	81092.9	13453	18891	164.6	134.5	1.2	70.2	16.0	0.01	0.16
OCDD	37607.2	44864.2	13453	18891	37.6	134.5	0.3	85.0	303.2	0.0003	0.09
OCDF	60444.6	65672.2	13453	18891	60.4	134.5	0.4	77.4	35.0	0.0001	0.004

Fig: 11

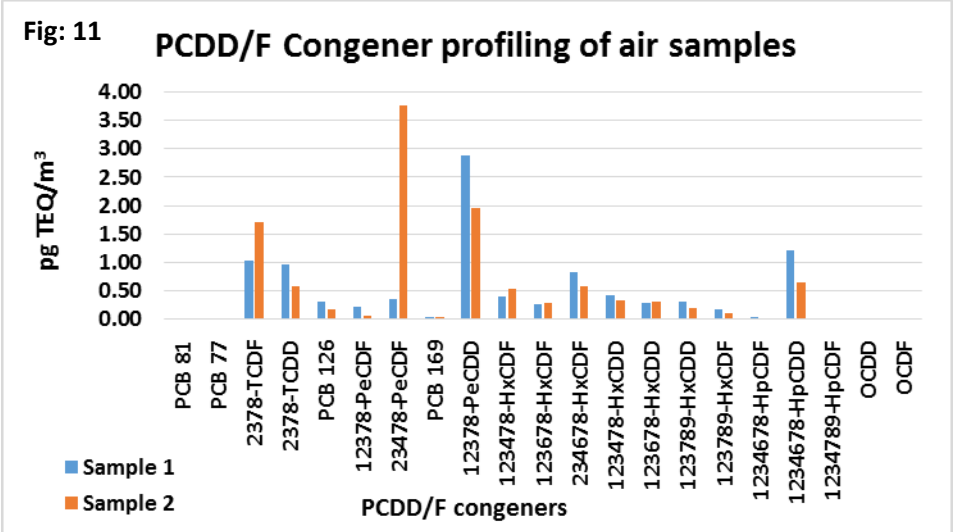


Fig: 12

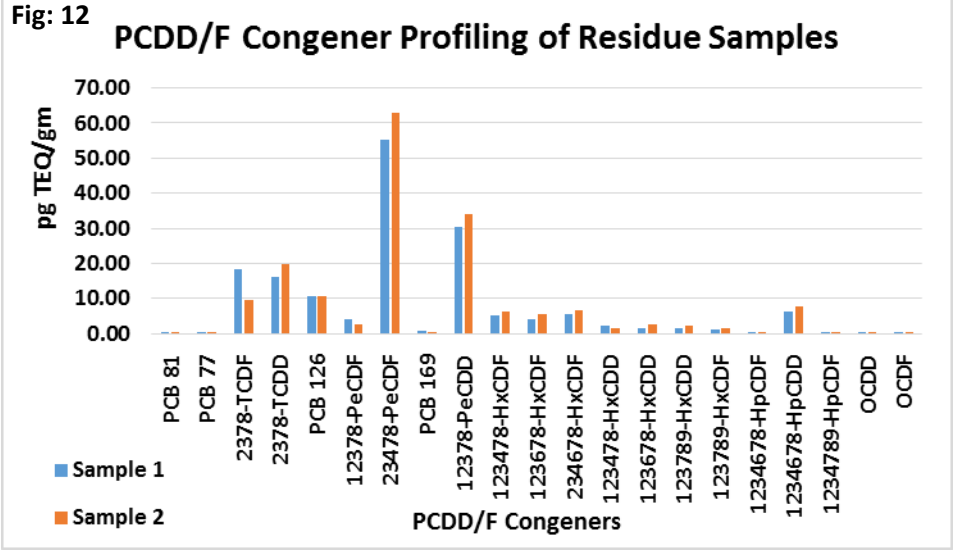


Fig: 13

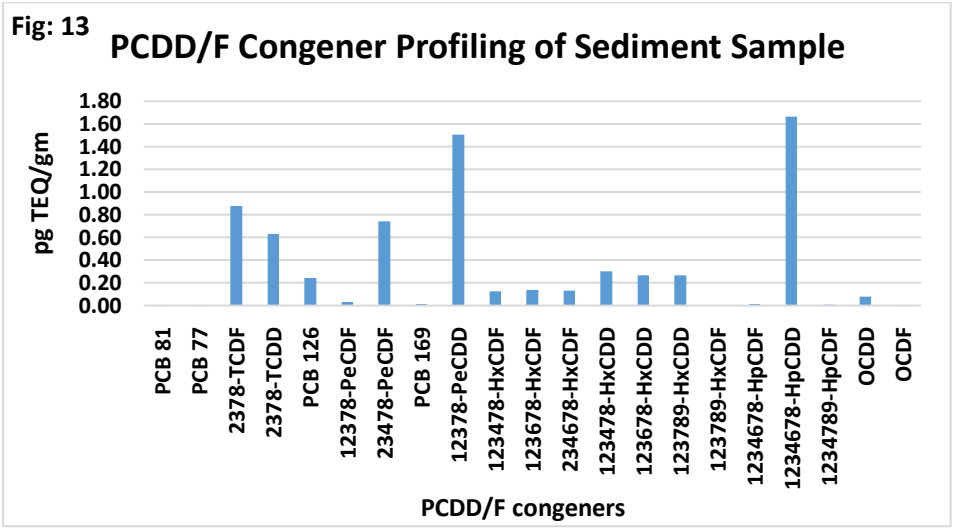


Fig 11, 12 & 13: PCDD/F congener profiling with respect to TEQ for air, residue and sediment samples

3.2.2 Congener Profile

A comparative study on the observed levels of each congener on the basis of its contribution to total toxicity equivalence (TEQ) was also conducted. Fig 11, 12 and 13 shows the congener distribution profile in ambient air, residual ash and sediment samples. All the samples showed predominance of lower chlorinated dioxins and furans in terms of toxicity equivalence. TCDD (the known human carcinogen) the most toxic congener with WHO TEF value 1 has been detected in all the samples. 'Penta' chlorinated species were found to be particularly higher in all the samples. The formation tendencies are not clear as the critical parameters influencing the predominance of particular congeners such as the waste composition, temperature, oxygen levels etc. are still under study.

3.3 Comparative evaluation vis-à-vis simulated waste combustion experiments

CSIR- NIIST had submitted the study report on "Determination of emission factors of dioxins from open burning of municipal solid wastes in Kerala" to Kerala State Pollution Control Board in December 2018. We reported the emission factors of dioxins in air and residual ash by carrying out simulated waste combustion studies in a laboratory scale "Burn Hut". It is the first study report in India on emission factors of dioxins from open burning of MSW.

A comparative evaluation of the reported concentrations of dioxins from simulated waste combustion studies and the data observed in air and residual ash samples at Brahmapuram fire break out was carried out.

The concentrations of dioxins in two experiments conducted at the laboratory studies at NIIST using simulated waste composition (10 Kg) and combustion conditions is 9.7 pg TEQ/Nm^3 & 23.85 pg TEQ/Nm^3. Whereas the average dioxin levels observed at ambient air sampled from Brahmapuram during fire break out is 10.3 pg TEQ/m^3. The observed dioxin levels in air at Brhampuram is comparable with respect to the concentrations observed in simulated waste combustion studies conducted in burn hut.

Table 9: Concentration of dioxins in air & residual ash in Brahmapuram and Burnhut samples			
Sl No	**Matrix**	**Sampling site**	**Concentration**
1	**Air sample**	**Brahmapuram**	**10.3 pg TEQ/Nm^3**
2	Air sample	Burnhut expt 1	9.7 pg TEQ/Nm^3
3	Air sample	Burnhut expt 2	23.85 pg TEW/Nm^3
4	**Residual ash sample**	**Brahmapuram**	**158.5 ng TEQ/ kg**
5	Residual ash sample	Burnhut expt 1	136.9 ng TEQ/ kg
6	Residual ash sample	Burnhut expt 2	101.9 ng TEQ/ kg

Similarly the average dioxin emission levels in residual ash was found to be slightly higher at Brahmapuram (158.5 ng TEQ/kg) compared to that from the two simulated burn hut studies ie 136.9 and 101.9 ng TEQ/kg. The slight variation observed in field data and in the laboratory studies is negligible considering the possible diversity of waste composition and combustion conditions. The stark similarity of the observed concentration in simulated combustion studies and field emission data indicates the effectiveness of the "Burnhut" study data for the estimation of emission factor. Most importantly, it can be considered as the default emission factor from open burning of MSW in India and can be used for total emission calculations and annual emission inventorisation.

3.4 Estimate of total dioxin generated during the fire breakout incident

An estimate of the total quantity of dioxin emitted during the fire breakout at Brahmapuram on 22 – 25th February 2019 was calculated based on the present monitoring study as well as the dioxin emission factor study report submitted by CSIR-NIIST in December 2018 [8]. The present study clearly indicates that the concentration of dioxins present in the ambient air and in residual ash were closely matching with the dioxin levels observed in the simulated open burning study conducted in a "Burn Hut " using known quantities and typical composition of original municipal solid wastes in Kerala. Hence, the emission factor of dioxins calculated using the simulated open

burning studies can be applied for calculating the total quantity of dioxins emitted during the fire breakout.

Emission factor (EF) is the total quantity of dioxins emitted per ton open burning of MSW.
As per CSIR-NIIST study report, the average emission factor of dioxins to air and land is **5.1 & 34.71 µg PCDD-F TEQ_{WHO}/ ton of original waste** burned respectively and the total emission factor (**EF_{total}**) is **39.81 µg PCDD-F TEQ_{WHO}/ ton of original waste [8].**
An estimate of total emission of dioxins during the incident can be calculated by multiplying the emission factor obtained from simulated waste combustion studies and the activity rate.

Total dioxin emission = 'Emission Factor' X 'Activity rate'

Activity rate is the estimated total quantity of waste burned during the incident. The estimate of MSW burned was calculated based on the preliminary site investigation and satellite data on 23/02/2019. Fig 14 shows the site status as per satellite data as on 23/02/2019 and the boundary marked in red is the dumpyard area where fire breakout occurred. The flat surface area covered with fire in the demarked boundary region is 17,000 square meters. It was assumed that the fire surface area of waste piles is 1.5 times the plane area and the depth of burn is about 20 cm (0.2 m). The volume of waste burned is 5100 m^3. The typical bulk density of municipal solid wastes is 350 kg/m^3 as per literature [9]. Hence the total quantity of waste burned or the **'activity rate'** is estimated to be **1800 tonnes**.

Total estimated dioxin emission obtained by multiplying the emission factor (**EF_{total}**) of **39.81 µg PCDD-F TEQ_{WHO}/ ton of original waste** and the activity rate of **1800 tonnes** is ~ **72 milligram Toxicity equivalence (TEQ).** It is a significant quantity considering the fact that the maximum tolerable monthly intake of dioxins for humans as per WHO/FAO is only **70 picogram TEQ/kg body weight.** For a person with body weight of 65 Kg, 54.6 nanogram TEQ (70*65*12) will be the annual tolerable intake. **While only a very small fraction of the dioxins generated reaches humans via the food chain,** the 72 mg TEQ of dioxins generated during the fire is sufficient to exceed the tolerable annual intake of 1.3 million people**.**

Fig 14: Brahmapuram waste treatment plant (Google Inc.) as on 23/02/2019 and the boundary demarked in red is the fire covered area

It may also be noted that several such fire breakouts incidents had occurred in the past and is still occurring intermittently at Brahmapuram as well as at several small, medium and large scale MSW open dumpyards across the state and in the country. The findings of the studies conducted by CSIR-NIIST clearly indicate that alarmingly high levels of dioxins are getting emitted from such anthropogenic activities across the country. The possible health consequences of human exposure to these highly toxic POPs are a matter of great concern.

4. Summary and Recommendation

The waste dump at Brahmapuram caught fire during early hours of 23/2/2019 and the fire was brought under control on 25/2/2109. CSIR-NIIST conducted the dioxin emission monitoring during 24- 25th February 2019.

The major findings of the study are:

1. The average dioxin levels observed in ambient air was found to be 10.3 pg TEQ/ m^3 at a distance of 50m to 100m from the fire. The observed levels are 50 and 10 times higher than reference and field blank data.
2. The dioxins generated are predominantly captured in residual ash. This was observed also in our previous laboratory studies. The Brahmapuram residue ash has dioxin content 159 ng TEQ/kg of ash. It is comparable with the results obtained from the Burnhut studies (101.9 and 136.9 ngTEQ/kg of waste) conducted at CSIR-NIIST.
3. The quantity of dioxins emitted during the fire at Brahmapuram **is 72 milligram Toxicity equivalence,** using emission factors determined in burn-hut studies.

<u>Recommendations</u>

- It is essential to establish modern solid waste treatment plants and clear the dumpyards of wastes by 'bio-mining' to separate combustible and inert material. The contaminated ash separated during bio-mining should be removed to sanitary landfill.
- Given the widespread burning of waste and dumpyard fires, analysis of dioxins in animal origin food samples such as milk, egg, meat and in human milk is recommended.

5. References

1. Hridya K K, Princy Lukose, R Rajesh., 2019,Solid Waste Management in Cochin, India; Practices, Challenges and Solutions, Journal of Basic and Applied Engineering Research 9 (3), 746-751.

2. Das, D., Srinivasu, M., Bandyopadhyay, M., 1998. Solid state acidification of vegetable waste. Indian Journal of Environmental Health 40 (4), 333–342.

3. Development of a National Implementation Plan in India as a first step to Stockholm convention on persistent organic pollutants (UNIDO project GF/IND/07/004), Government of India, April, 2011

4. Development of a National Implementation Plan in India as a first step to Stockholm convention on persistent organic pollutants (UNIDO project GF/IND/07/004),Final Independent Evaluation, United Nations Industrial Development Organisation, Vienna, November, 2011

5. USEPA Method 8290: Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) by high-resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS)

6. Compendium Method – TO -9A Determination of Polychlorinated, polybrominated and brominated / chlorinated dibenzodioxins and dibenzofurans in Ambient Air.

7. Open Dumping Site in Asian Developing Countries: A Potential Source of Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans, Environmental Science & Technology, 2013 (1=37) 1493- 1503.

8. Determination of Emission factors of Dioxins from open burning of municipal solid waste in Kerala, KSPCB project, submitted in December 2018.

9. ME, S. T. M., & ME, A. H. B. (2011). Characterisation of municipal solid waste at landfill, India. Proceedings of the Institution of Civil Engineers, 164(4), 247.

Annexure - 2

KERALA STATE POLLUTION CONTROL BOARD
CENTRAL LABORATORY, GANDHI NAGAR, KOCHI- 682020

682020
Phones- CES 0484-2207781, EPABX 0484-2207783 Fax-2207781
Email: kspcbcl@asianetindia.com Website: www.keralapcb.nic.in

ANALYSIS REPORT

Analysis Report No.		Date-25.June 2019	Format No: PCB/CL/CH/F 7
Ref. No.	Nil Dated 22.05.2019	Date Of Collection	22 May 19
Received From	R O Ernakulam	Date of Receipt	25 June 19
No. Of Sample	1	Period Of Analysis	25 June 2019
Source	Brahmapuram Plant(Fertilizer Value)	Scientist-in-charge	Josemin
Sample Condition	Fit for analysis	Sample Type	Sludge sample
Sample Collected by	CEE, R O Ernakulam	Sample Volume & Container Type	1L Glass Bottle
Sample Preservation	As per APHA/IS :3025(Part-1)		

Sample ID : LB 9 Packed manure - 2

Sl.No	Parameters	Unit	Value	Test Method
1	Cadmium	mg/Kg	11.6	APHA, 3111-B
2	Total Chromium	mg/Kg	26.2	APHA, 3111-B
3	Copper	mg/Kg	205.0	APHA, 3111-B
4	Iron	mg/Kg	4980.0	APHA, 3111-B
5	Manganese	mg/Kg	150.2	APHA, 3111-B
6	Lead	mg/Kg	44.8	APHA, 3111-B
7	Zinc	mg/Kg	281.4	APHA, 3111-B
8	Nickel	mg/Kg	49.8	APHA, 3111-B
9	Total Nitrogen	mg/Kg	2338.0	APHA,4500-N Org-B,22nd Ed.,2012
10	Phosphorus	mg/Kg	140.0	APHA,45000 P/D,E,-E,22nd Ed.,2012
11	Potassium	mg/Kg	2345.0	APHA,3500-K B.

End of Report

Checked By : Ajila V.A
Assistant Scientist

Authorised By :
V.T. SAJIMON
Chief Environmental Scientist (I/C)

KERALA STATE POLLUTION CONTROL BOARD * REGIONAL OFFICE * GANDHI NAGAR COCHIN 682 020

M. A. BAIJU
Chief Environmental Engineer

KERALA STATE POLLUTION CONTROL BOARD
CENTRAL LABORATORY, GANDHI NAGAR, KOCHI- 682020

- 682020
Phones- CES 0484-2207781 EPABX 0484-2207783 Fax-2207781
Email: kspcbcl@asianetindia.com Website: www.keralapcb.nic.in

ANALYSIS REPORT

Analysis Report No.		Date-25.June 2019	Format No. PCB/CL/CH/F 7
Ref. No.	Nil Dated 22.05.2019	Date Of Collection	22 May 19
Received From	R O Ernakulam	Date of Receipt	25 June-19
No. Of Sample	1	Period Of Analysis	25-June 2019
Source	Brahmapuram Plant(Fertilizer Value)	Scientist-In-charge	Josemin
Sample Condition	Fit for analysis	Sample Type	Sludge sample
Sample Collected by	CEE, R O Ernakulam	Sample Volume & Container Type	1L Glass Bottle
Sample Preservation	As per APHA/IS :3025(Part-1)		

Sample ID : LB 30 Packed manure - 1

Sl.No	Parameters	Unit	Value	Test Method
1	Cadmium	mg/Kg	10.4	APHA, 3111-B
2	Total Chromium	mg/Kg	30.8	APHA, 3111-B
3	Copper	mg/Kg	167.4	APHA, 3111-B
4	Iron	mg/Kg	5880.0	APHA, 3111-B
5	Manganese	mg/Kg	160.6	APHA, 3111-B
6	Lead	mg/Kg	32.0	APHA, 3111-B
7	Zinc	mg/Kg	278.4	APHA, 3111-B
8	Nickel	mg/Kg	56.4	APHA, 3111-B
9	Total Nitrogen	mg/Kg	2268.0	APHA,4500-N-Org-B,22nd Ed.,2012
10	Phosphorus	mg/Kg	118.0	APHA,45000 P/D,E, E,22nd Ed.,2012
11	Potassium	mg/Kg	1780.0	APHA,3500-K B.

End of Report

Checked By : Ajila V.A
Assistant Scientist

Authorised By : V.T. SAJIMON
Chief Environmental Scientist (I/C)

Note : The test result relate only to the sample submitted for analysis and it shouldn't be reproduced/Advertised in full without the written permission of the authorised signatory of the lab.

KERALA STATE POLLUTION CONTROL BOARD * REGIONAL OFFICE * GANDHI NAGAR COCHIN 682 020

M. A. BAIJU
Chief Environmental Engineer

KERALA STATE POLLUTION CONTROL BOARD
CENTRAL LABORATORY, GANDHI NAGAR, KOCHI- 682020

- 682020
Phones- CES 0484-2207781 EPABX 0484-2207783 Fax-2207781
Email: kspcbcl@asianetindia.com Website: www.keralapcb.nic.in

ANALYSIS REPORT

Analysis Report No.		Date-25.June 2019	Format No: PCB/CL/CH/F-7
Ref. No.	Nil Dated 22.05.2019	Date Of Collection	22 May 19
Received From	R O Ernakulam	Date of Receipt	25 June 19
No. Of Sample	1	Period Of Analysis	25 June 2019
Source	Brahmapuram Plant(Fertilizer Value)	Scientist-in-charge	Josemin
Sample Condition	Fit for analysis	Sample Type	Sludge sample
Sample Collected by	CEE, R O Ernakulam	Sample Volume & Container Type	1L Glass Bottle
Sample Preservation	As per APHA/IS :3025(Part-1)		

Sample ID : LB 12 Unpacked - 2

Sl.No	Parameters	Unit	Value	Test Method
1	Cadmium	mg/Kg	10.6	APHA, 3111-B
2	Total Chromium	mg/Kg	29.0	APHA, 3111-B
3	Copper	mg/Kg	147.8	APHA, 3111-B
4	Iron	mg/Kg	5300.0	APHA, 3111-B
5	Manganese	mg/Kg	150.8	APHA, 3111-B
6	Lead	mg/Kg	50.6	APHA, 3111-B
7	Zinc	mg/Kg	295.0	APHA, 3111-B
8	Nickel	mg/Kg	54.6	APHA, 3111-B
9	Total Nitrogen	mg/Kg	2166.0	APHA,4500-N Org-B,22nd Ed.,2012
10	Phosphorus	mg/Kg	186.0	APHA,4500-P/D,E,-E,22nd Ed.,2012
11	Potassium	mg/Kg	2915.0	APHA,3500-K B

End of Report

Checked By : Ajila V.A
Assistant Scientist

Authorised By

V.T. SAJIMON
Scientist (I/C)
Chief Environmental Engineer

Note : The test result relate only to the sample submitted for analysis and it shouldn't be reproduced, except in full without the written permission of the authorised signatory of the lab.

KERALA STATE POLLUTION CONTROL BOARD
GANDHI NAGAR
COCHIN 682 020
REGIONAL OFFICE

M. A. BAIJU
Chief Environmental Engineer

KERALA STATE POLLUTION CONTROL BOARD
CENTRAL LABORATORY, GANDHI NAGAR, KOCHI- 682020

- 682020
Phones- CES 0484-2207781, EPABX 0484-2207783, Fax-2207781
Email: - kspcbcl@asianetindia.com Website: www.keralapcb.nic.in

ANALYSIS REPORT

Analysis Report No.		Date-25.June 2019	Format No. PCB/CL/CH/F-7
Ref. No.	Nil Dated 22.05.2019	Date Of Collection	22-May-19
Received From	R O Ernakulam	Date of Receipt	25-June 19
No. Of Sample	1	Period Of Analysis	25 June 2019
Source	Brahmapuram Plant(Fertilizer Value)	Scientist-in-charge	Josemin
Sample Condition	Fit for analysis	Sample Type	Sludge sample
Sample Collected by	CFE, R O Ernakulam	Sample Volume & Container Type	1L Glass Bottle
Sample Preservation	As per APHA/IS :3025(Part-1)		

Sample ID : UB 80 Unpacked - 1

Sl.No	Parameters	Unit	Value	Test Method
1	Cadmium	mg/Kg	11.6	APHA, 3111-B
2	Total Chromium	mg/Kg	31.6	APHA, 3111 B
3	Copper	mg/Kg	185.0	APHA, 3111 B
4	Iron	mg/Kg	3960.0	APHA, 3111-B
5	Manganese	mg/Kg	163.8	APHA, 3111-B
6	Lead	mg/Kg	45.8	APHA, 3111 B
7	Zinc	mg/Kg	283.8	APHA, 3111-B
8	Nickel	mg/Kg	60.8	APHA, 3111 B
9	Total Nitrogen	mg/Kg	2570.0	APHA,4500-N Org B,22nd Ed.,2012
10	Phosphorus	mg/Kg	110.0	APHA,4500 P/D,E, E,22nd Ed.,2012
11	Potassium	mg/Kg	2360.0	APHA,3500-K B.

End of Report

Checked By : Ajila V.A Assistant Scientist

Authorised By : V. P. SAIMON Chief Environmental Scientist (I/C)

Note : The test results relate only to the sample submitted for analysis and it shouldn't be reproduced except in full without the written permission of the authorised signatory of the lab.

KERALA STATE POLLUTION CONTROL BOARD GANDHINAGAR COCHIN-682 020 REGIONAL OFFICE

M. A. BAIJU
Asst Environmental Engineer

ANNEXURE 8

Subject: Fwd: Re: Fwd: KMC-vetting of tender document prepared for bio-mining of legacy waste - reg.
Date: 07/12/19 02:08 PM
From: "CHAIRMAN KSPCB" <chn.kspcb@gov.in>
To: kochicorpsecretary@gmail.com
Cc: "DR. SHEELA A.M., RULES, HO" <rulespcb@gmail.com>, "BAIJU M.A., RO, ERNAKULAM" <pcbroekm@gmail.com>

Sir,

It is clarified that payment to contractor may be on volume of waste deposit cleared. But data on weight and volume of materials transported to be collected as given in item 2 of Page no 70.CPCB has issued guidelines for Bio mining. On vetting the RFP, we have the following remarks.

We note that the document does not give a preliminary quantification of the legacy waste. This is essential data to be provided in the RFP

Page no 8: - 2.3.1 Technical Capacity - Operation and maintenance of a MBT facility of at least 100 tpd

Page no 27:- may also be insisted that, Contractor must enter into Agreement with cement plant/thermal power plant for off take of RDF before commencement of mining. Agreement to be submitted to Engineer-in charge. It is to be included in scope of work

Page No :29:- Dust mitigation measures shall be displayed prominently at site for public viewing

Page no: 29:- Standards in Schedule II (i) of SWM rules, 2016 shall be met for Bio earth / Good earth (indicative flow diagram) before used for food crops.

Page No :63:- Appendix -1 Site location- Provide site map with clearly marked boundary

Page no: 83:– It may be appropriate to get rate per 100 m3 dump volume cleared.

CPCB issued guidelines for Bio mining and this shall also be considered.

Please take further action to the above

--
The Chairman
Kerala State Pollution Control Board
Head Office
Pattom P.O.
Thiruvananthapuram

M. A. BAIJU
Chief Environmental Engineer

KERALA STATE POLLUTION CONTROL BOARD * REGIONAL OFFICE * GANDHINAGAR COCHIN 682 020

KOCHI MUNICIPAL CORPORATION

Phone { 2369007, 2369196
2369143, 2369149
2369197, 2369069
Fax : 91-484-2369023

Corporation Office
P.B.No.1016
Ernakulam, Cochin 682 011

No. MOE2/3760/18

13/08/2019

From

Secretary

To

The Chief Environmental Engineer
Regional Office Kerala State Pollution Control Board
Gandhi Nagar, Ernakulam - 682 020
E.Mail: pcbroekm@gmail.com

Sir,

Sub: Construction of Scientific land fill at Brahmapuram - reg
Ref. Review meeting of State Level Monitoring Committee of NGT held at Thiruvananthapuram on 03/08/2019

When the committee was apprised of the 4 acres of land allocated for the construction of land fill in parallel to the windrow composting plant, the committee had directed to explore the possibility of finding other suitable site at elevated locations.

It is requested to kindly depute an environmental engineer to support us in finding an alternative location.

Yours faithfully,

13/8/19

Secretary

KOCHI MUNICIPAL CORPORATION

Phone { 2369007, 2369196
2369143, 2369149
2369197, 2369069

Fax : 91-484-2369023

Corporation Office
P.B.No.1016
Ernakulam, Cochin 682 011

No. MOE2/3760/18

19/08/2019

From

Secretary

To

The Chief Environmental Engineer
Regional Office Kerala State Pollution Control Board
Gandhi Nagar, Ernakulam - 682 020
E.Mail: pcbroekm@gmail.com

Sir,

Sub: Construction of Scientific land fill at Brahmapuram - reg

Ref. 1. Review meeting of State Level Monitoring Committee of NGT held at Thiruvananthapuram on 03/08/2019
2. Letter No.MOE2/3760/18 dated 13/08/2019
3. Site visit to Brahmapuram on 17/08/2019

As directed during the site visit to Brahmapuram on 17/08/2019 to submit the Google image marked with the land allocated for landfill at Brahmapuram the same is attached.

The link to the online google map/image is also given below. It may be copied and pasted in an internet explorer window to view the map.

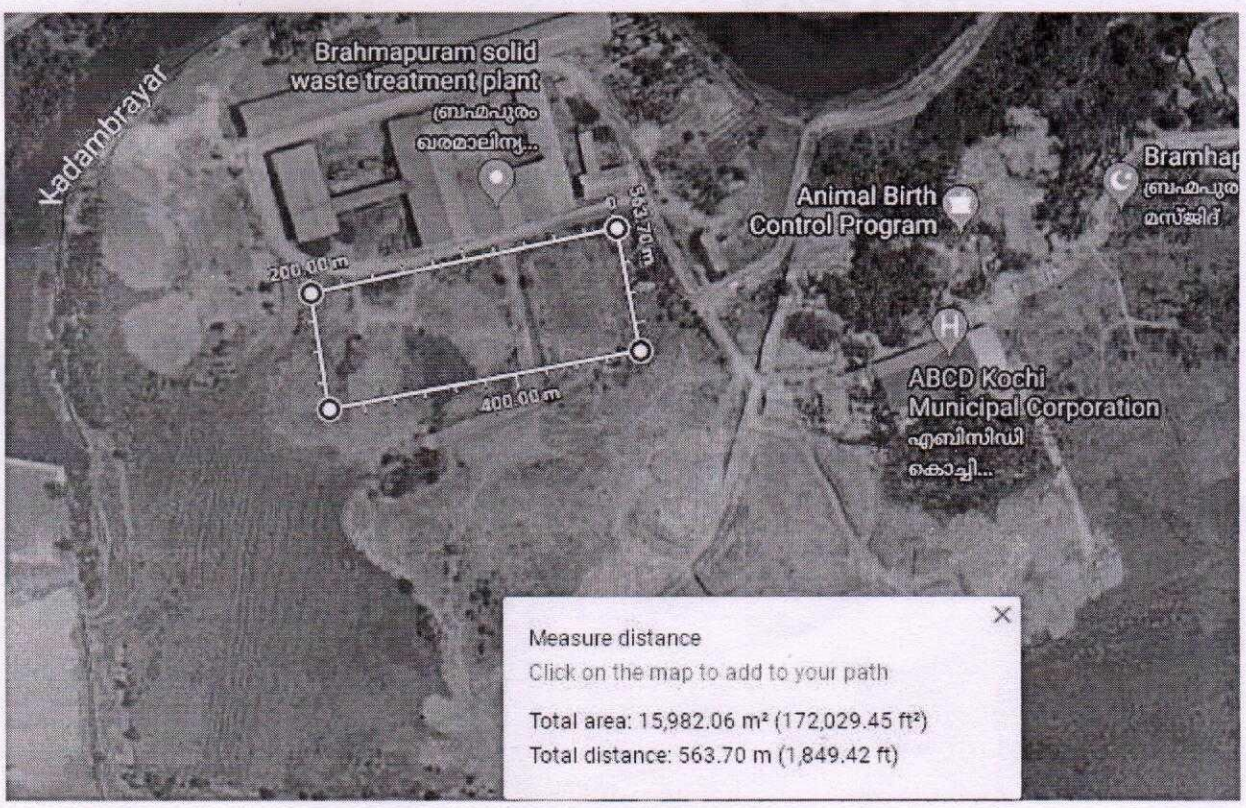
https://www.google.com/maps/place/Brahmapuram,+Kochi,+Kerala/@9.9918296,76.3650979,739m/data=!3m1!1e3!4m5!3m4!1s0x3b080b69b3e6fecb:0x6436d52fe572a489!8m2!3d10.000969!4d76.3787808

Kindly let us know whether we can proceed with this land for the construction of land fill.

Yours faithfully,

Secretary

Annexure - 1



Exe. Engg.

TITU
EXECUTIVE ENGINEER
LSGD
KOCHI MUNICIPAL CORPORATION

CEE : 0484 2207782
Phone : 0484 - 2207783 - 86
Fax : 0484 – 2207782
e-mail:pcbroekm@gmail.com

KERALA STATE POLLUTION CONTROL BOARD

REGIONAL OFFICE, GANDHI NAGAR, ERNAKULAM – 682 020

www.keralapcb.org

PCB/RO-EKM/GEN-97/12 Date: 22.08.2019

From

The Chief Environmental Engineer

To

The Secretary

Kochi Corporation

Sub:- Land fill option for waste at Brahmapuram-Reg.

Ref:- 1. Letter No. MOE2/3760/18 dated 13.08.2019 from Kochi Corporation

2. Discussion had with Environmental Engineer, Kochi Corporation during Inspection conducted at Brahmapuram plant by the Board Officials on 17.08.2019

Madam,

Pl recall the discussions under reference 2.

In reply to your request cited 1, following suggestions may be considered.

The land proposed behind the security cabin (About 4 Acres of land as shown in the Google map forwarded vide e-mail dated 17.08.2019) for waste filling seems to be not suitable as the guidelines by the Central Pollution Control Board specifically insisting 2m clear cover from ground water table. As you have mentioned in the letter, the SLMC is also suggesting alternate land as the proposed land is low-lying one. Copy of the guidelines by CPCB already forwarded to you may be perused for specific methodology and other procedures for legacy waste disposal.

You are also hereby advised as follows

a. Actual quantity of legacy waste dump shall be assessed as explained in the guidelines provided by CPCB (Item 4. Methodology & Subsequent illustrations) since the same procedure is not done so far.

b. Some other area, out of about 110 Acres of land available may be selected for the execution of your proposal of disposal of a part of legacy waste as per the request vide reference 1 following the guidelines of CPCB

Yours faithfully,

CHIEF ENVIRONMENTAL ENGINEER

Copy to : The Member Secretary, Thiruvananthapuram.