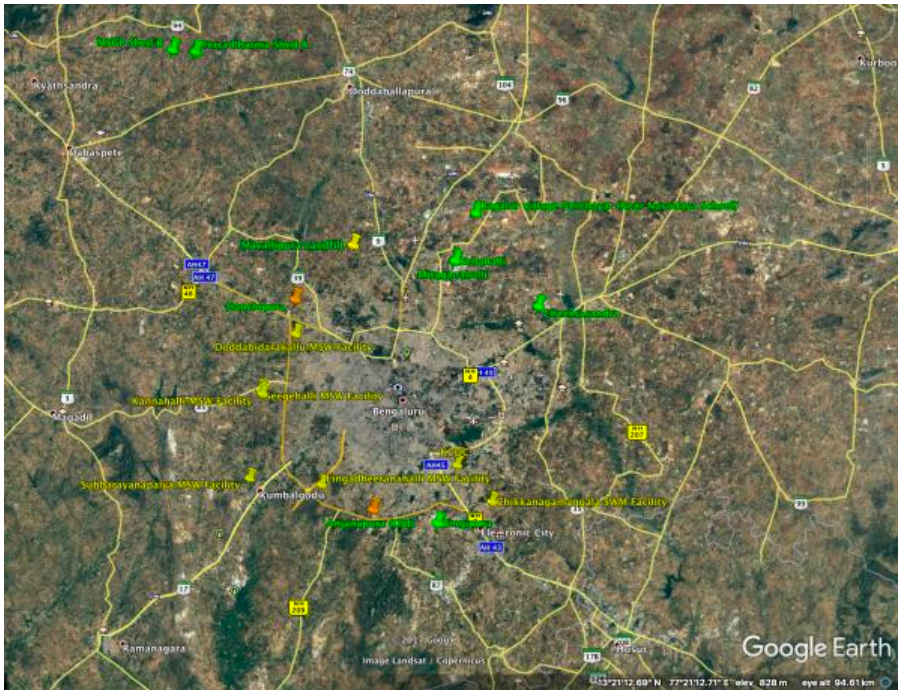
A Review of Health and Environmental Implications of Bengaluru's Solid Waste Landfills, Waste Processing Sites and Dumping grounds

With focus on the continuing toxic impacts of landfills in Mavallipura



A report submitted to the

Hon'ble High Cour of Karnataka in W. P. No. 46523/2012

by

Environment Support Group ®

[Environmental, Social Justice and Governance Initiatives]

Bangalore

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Contributions

This report is prepared by Environment Support Group Team in continuation with similar efforts earlier to document and establish the state of health and environmental impacts of solid waste management in Bengaluru.

In preparing this study, the Field Visits were conducted by Mallesh K.R., Dr. Apoorva Patil, Namrata Kabra, Harsh Vardhan Bhati, B. Srinivas, Anil, Dr. Swetha Rao Dhananka and Leo F. Saldanha.

The Primary Health Survey of villagers impacted by the Mavallipura landfills was undertaken by Dr. Girish Kumar and Dr. Subramanya Kumar of the Institute of Ayurveda and Integrative Medicine, Mavallipura, with assisatance from Dr. Apoorva Patil, a public health doctor from Environment Support Group, with advise from Dr. Shirdi Prasad Tekur, Community Health Specialist. Dr. Swetha Rao Dhananka, Mouna Nagaraju and Leo F. Saldanha contributed to the analysis of the health survey.

The legal analysis for this study was contributed by Harsh Vardhan Bhati, Namrata Kabra and Leo F. Saldanha with advise from Sunil Dutt Yadav, Counsel for Environment Support Group.

The overall presentation of the implications of these studies, with proposal for ways forward, is contributed by Dr. Swetha Rao Dhananka and Leo F. Saldanha.

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The research and field studies undertaken in the past by the ESG team forms the basis of this effort. The contributions are acknowledged of Bhargavi S. Rao, Sruthi Subbanna, Davis G. Thomas and Shashikala Iyer, who contributed to the preparation of the ESG's 2010 report entitled "*Bangalore's Toxic Legacy: Investigating Mavallipura's Illegal Landfills*" and 2013 report submitted to the High Court of Karnataka entitled "*Morbidity and Mortality due to chronic and infectious diseases in the villages impacted by landfills located in Mavallipura*".

Dedicated to Pourakarmikas who struggle every day to keep Bengaluru healthy for us and to those communities impacted by the dumping of our waste in their villages and commons

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1 Introduction

The aim of this report is to draw attention of key decision makers and the wider public to the continuous sources of pollution stemming from legal and illegal landfills, and also waste processing units in the Bengaluru metropolitan area. This report highlights and builds on environmental and public health impact evidence gathered over the past 15 years. It reveals that there is extensive environmental contamination everywhere solid waste is aggregated (commonly termed as dumping) in landfills, be they 'legal' or 'illegal' stations. Noxious gases that escape such landfills and toxic effluents that leach out of these dumping grounds are constantly contaminating soil, surface and ground water aquifers, and this is now manifesting in contamination of biological pathways. Needless to state, food grown in the contaminated areas, livestock which graze these regions, specially milk yielding cows and meat produced from such livestock, work as conduits for bioaccumulation of the pollutants and this has an indirect and extremely adverse impact on human health.

In fact, the adverse impact of such contamination on communities living by such large dumping grounds is increasing constantly. As this report demonstrates on the basis of in-depth analysis, all waters used and consumed in villages impacted by two landfills in Mavallipura, Yelahanka, North Bengaluru is highly contaminated. This is now manifesting in a range of chronic ailments in the affected population which is far in excess of the normative morbidity expected in such populations. In addition, these populations appear to be highly vulnerable to epidemics specially those are vector borne or water borne. It may be surmised, thereby, that similar could be the condition of populations living by such landfills all around Bengaluru.

It may be recalled that in 2010 Environment Support Group (ESG) released a report entitled "*Bangalore's Toxic Legacy: Investigating Mavallipura's illegal landfills*"[1]. This report similarly analysed the impacts of the Mavallipura landfills on human health and environment and found the condition to be extremely distressing. As a consequence of this report, the Karnataka State Pollution Control Board was compelled to take cognizance of the serious nature of the pollution. After the due process of its own investigations, the board confirmed that Bruhat Bengaluru Mahanagara Palike (BBMP) and its contractors, namely, M/s Bailappa and M/s Ramky Infrastructure Private Ltd had extensively contaminated the area by recklessly dumping lakhs of tons of waste in large swathes of land that included forest land and village grazing pastures (gomala). While the Board had already initiated criminal proceedings under the Water Act, 1974 against Mr. Bailappa[2], it proceeded to issue a closure notice of the M/s Ramky run facility on 11 July 2012[3].

[1] Rao, B.S. et al., Bangalore's Toxic Legacy: Investigating Mavallipura's Illegal Landfills, Environment Support Group, July 2010, accessible at: http://www.esgindia.org/sites/default/files/campaigns/mavallipura/resources/bangalore-toxic-landfills-mavallipura-es.pdf.

[2] CC No. 261/2006 *KSPCB vs. Bailappa H. and Anr.* (2006).

[3] KSPCB Order dated 11th July 2012, No. KSPCB/CEO-2/EO/MSW/Mavallipura/2012-13/1721, directing 1st Respondent BBMP and 10th Respondent Ramky to stop receiving waste at landfill at Mavallipura.

As a consequence of the closure of the Mavallipura landfill, waste had to be diverted to the landfill at Mandur, Bangalore East. Here too, years of dumping waste without any appropriate treatment has resulted in extensive contamination of the region. The increasing waste burden accentuated the prevailing stench and contamination. Local impacted communities rose in protest against the facility by blockading hundreds of garbage trucks every time living in the vicinity of the landfills became unbearable. These blockades coincided with the festive Dasara season when waste generated increases substantially, and the protests reached a height through 2012. The consequent impact on the city was that putrefying waste accumulated for days on end in almost every street corner of the city; there was nowhere to dump the waste anymore. In desperation, people resorted to burning waste, which in term created a massive problem of air pollution all over the metropolitan area.

At about this time, several Public Interest Litigations[4] were filed drawing the attention of the High Court of Karnataka to the collapse of the solid waste management systems of Bengaluru. These PILs which were initiated in July 2012, and thereafter, continue to be heard by the Court. The outcome has been an extraordinary effort on the part of several Judges of the High Court of Karnataka to invest substantial amounts of time in appreciating the nuances of the problem and moulding relief and directions in a manner that can be considered amongst the most progressive efforts in environmental jurisprudence in recent years. Justice Mr. N. Kumar (now retired) and Justice Ms. B. V. Nagarathna, in particular, even took the extraordinary step of visiting each and every aspect of waste generation and management system prevalent, so that it would help them shape their directions. Broadly, the outcome can be described as considering the messy state of affairs of Bangalore's waste management as one of governance failure. In response to the submissions made by the Petitioners, in particular ESG, the Court directed the Karnataka Government and Bruhat Bengaluru Mahanagara Palike, amongst others, to ensure that decentralisation and devolution of power to the local communities became the method of building civic responsibility for effective waste management. In addition, the Courts helped shaped a path-breaking policy of ensuring segregation of waste at source became the main plank on which the rest of the waste stream would be handled, not only providing relief to thousands of workers exposed to high risks, but also to ensure the waste did not get dumped in villages around Bangalore.

In the process, the Court substantially interrogated the messy mechanisms of private contractors, who were now in control of the waste management systems, and resolved to bring them under judicial scrutiny, and also subject their functioning to oversight by citizens. This was proposed by forcing the State Government to pass necessary legislations to establish Ward Committees, and ensure that the information and accountability systems would be transparent and accountable at all times and to everyone.

Critically, all these efforts helped shaped national policy outcomes on municipal waste management as

[4] W.P. 24739/2012 *Kavit Shankar v. State of Karnataka and Ors.*
W.P. 46523/2012 *Environment Support Group and Ors. v. Bruhat Bengaluru Mahanagara Palike and Ors.*
W.P. 30450/2012 *G R Mohan v. The Chief Secretary and Ors.*
W.P. 46601/2012 *Nityananda V Nayak v. Bruhat Bengaluru Mahanagara Palike and Ors.*

the Court agreed with the submission of ESG that the 2013 proposal Union Ministry of Environment, Forest and Climate Change to modify the Municipal Solid Waste Management Rules, 2000. These were fraught with promotion of highly regressive methods that further deteriorated the environmental status across the country, Hence, it directed the Ministry to come up with Rules based on active public debate and consultations, and considerations of all points of view. The result is the Municipal Solid Waste Management Rules, 2016. A thematic summary of the key directions of the Karnataka High Court is provided in the next chapter.

The current report builds on past reports and submissions made to the High Court of Karnataka by ESG.

This report is structured into five parts:

Part 1: Introduction and thematic representation of the directions of the Hon'ble High Court of Karnataka in the PILs on solid waste management.

Part 2: Analysis of the results of Health Survey and Water analysis conducted in villages impacted by Mavallipura Landfills

Part 3 Environmental status of seven approved and unapproved landfills in and around Bengaluru.

Part 4 Environmental status of seven waste processing plants established by BBMP

Part 5 Conclusion

1.1 Summary of Karnataka HC directions in matters of SWM PILs

In response to a batch of Public Interest Litigations filed by ESG, Kavith Shankar and various other organisations and individuals, the High Court of Karnataka began to interrogate systematically the solid waste management (SWM) systems in Bangalore, a process which commenced in mid – 2012 and is ongoing. The following presents the thematic summary of the major observations/directions of the High Court based on these PILs:

Civic Responsibility

- "those who create waste or pollution are primarily responsible for its disposal and/or for the establishment of Units for this purpose."[5]
- Every citizen must be reminded of the fundamental duty to segregate waste at source in order to maintain a clean and healthy environment overall.[6]
- All aspects of solid waste management, including insistence on segregation of waste at source, its collection, processing, and transport of refuse to landfills, constituting fundamental elements of "how to keep the city clean is the total responsibility of the Corporation".[7]
- Observed that "solid waste generation and its improper management is a key environment, social and growing economic problem not only at local levels, but also at National and global levels…..
  Effective Solid Waste Management systems are necessary to ensure protection of environment and human health. Inefficient solid waste management has the direct bearing on the standard of living of the citizens and public health as well as on environment. The best way of managing waste is not create waste in the first place…… The cooperation of the citizens will generate this waste is of paramount important also, the Pourakarmikas who collect waste from door to door are to be properly educated and trained. Responsibilities have to be fixed on the Corporator of the Wards and members of the Ward Committee, who are equally responsible for Municipal Solid Waste Management. Similarly, the role of Palike officials at the ground level cannot be underestimated. On the contrary, greater responsibility should be foisted on them and they should be made accountable for any improper Municipal Solid Waste Management. In other words, it should be coordinated and collective effort on the part of each one stakeholder. It is only then, this problem could be tackled effectively". [8]

Solid Waste Management Strategy

- Bulk-generators to process and manage waste that they generate locally and without mixing it in a municipal waste stream.[9] 2696 bulk-generators identified to confirm with this requirement.[10] Subsequently, upto 3500 bulk-generators identified and "directed to do in situ processing/

[5] Order of Principal Bench of Chief Justice Mr. Vikramjit Sen and Justice Ms. B. V. Nagarathna dated 27/Aug/2012. These batch of PILs were subsequently heard by Division Bench of Justice Mr. N. Kumar and Justice Ms. B. V. Nagarathna during 06/Dec/2012 to 23/Jun/2016, by Justice Mr. Ashok B. Hinchigeri and Justice Ms. K. S. Mudagal during 12/Apr/2017 to 28/Apr/2017, by Justice Mr. Jayant Patel and Justice Mr. N. K. Sudhindra Rao on 05/Jun/2017 and thereafter by Justice Mr. Jayant Patel and Justice Ms. S. Sujatha.
[6] Ibid, order dated 10/Sept/2012
[7] Ibid, order dated 06/Dec/2012.
[8] Ibid, order dated 17/Dec/2015
[9] Ibid, order dated 13/Dec/2012
[10] Ibid, order dated 13/Feb/2015

linkage with service providers" including by way of bio-methanation.[11]

- The statement of BBMP Commissioner is taken on record that "it has identified of suitable site in all the 198 wards of the city of Bengaluru for segregation and storage of waste", and to "allow Non-Governmental agencies to take over the responsibility of disposal of the dry waste on experimental basis for the period of six months without expecting any return from them"; that "BBMP has appointed to all the 198 wards and environmental engineers for the purpose of keeping the wards clean. In addition to the environmental engineers, the Senior and Junior Health Inspectors are also working in tandem with these engineers" and that "these officials would be primarily responsible for keeping these wards clean"; and that bulk waste-generators have come forward to handle between 1000-1500 MT of waste/day, thus reducing the burden on BBMP.[12]
- The Corporation and Expert Committee members were directed to find suitable mechanism for removal of garbage in slums and keep them clean and hygienic.[13]
- The court reiterated that "dumping of garbage on the outskirts of Bangalore is not a solution" and observed that there seems to be a vested interest of the authorities in transporting the garbage to outskirts, so that the contractors prosper. The Court further directed that garbage processing centers be establish in each MLA Constituency, so that the waste is processed and recycled locally as it is a resource and not "waste". Only medical and hazardous waste to be disposed after appropriate treatment.[14]
- BDA, BMRDA and Other such local planning authorities required to ensure that in every neighbourhood waste processing sites are identified as part of civic amenity area before plan is sanctioned.[15]
- Specific plans develop in addressing waste processing for wet waste, construction and demolition waste, sanitary waste, and animal waste. Networks of food waste from hotels, kalyanamantap (functions/wedding halls), etc. to be channelized into piggeries. Large building construction plans to be approved only after builders produce viable plan for dealing with construction and demolition debris.[16]
- All heads of Government departments held accountable in ensuring waste generated is segregated and managed locally.[17]
- All 198 wards of BBMP provided with at least one dry waste collection center.[18] "BBMP to give details of the various Dry Waste Collection Centers with addresses on the website, so that the public would become better aware about these centers".[19]
- All bulk-waste generators, such as residential and commercial establishment, Indian Railways, Public Institutions, Government, Semi-Government, Defence Cantonments, etc. to manage waste generated in situ by ensuring waste is segregated into bio-degradable (wet waste), non-biodegradable (dry waste), and domestic hazardous waste (sanitary waste). In areas outside of such institutional areas, BBMP to ensure waste is collected from door-to-door in these segregated forms, handled appropriately, processed, recycled and only refuse landfill without causing any public health or environmental hazard. Any violation to be dealt with as a criminal

[11] Ibid, order dated 10/Apr/2015
[12] Ibid, order dated 02/Apr/2013
[13] Ibid, order dated 20/Dec/2013
[14] Ibid, order dated 18/Jun/2014
[15] Ibid, order dated 07/Jul/2014
[16] Ibid, order dated 01/Sept/2014
[17] Ibid, order dated 23/Sept/2014
[18] Ibid, order dated 09/Jan/2015
[19] Ibid, order dated 13/Feb/2015

offence and publishable under provisions of MSW Rules and Section 431(A) of Karnataka Municipal Corporation Act, 1976.[20]

Enforcement Mechanism

- Impose fines on those not segregating waste at source into dry and wet waste.[21]
- Waste should be collected in segregated forms and processed in at least three places in every ward.[22]
- BBMP responsible in ensuring all plastic waste manufactures are held accountable for the plastic waste as per Extended Producers Responsibility under Plastic Waste Management Rules, 2016. [23]

Legal Reforms

- Central Government effort to amend the existing MSW Rules, 2000 and replace it with MSW Rules, 2013 "shall be kept on hold" as it fails to acknowledge the progressive methods relating to "segregation of solid waste at source" not incorporated and thus Central Government directed to review its policy.[24] Subsequently, given that the "Central Government has withdrawn the draft rules which they have published", Court took on record statement of Central Government Counsel that a new set of rules would be legislated only "after taking into consideration the orders passed by this Court".[25] Compliance with this decision continue to be monitor by the Court with the intent of ensuring that the new Rules would only be framed after ensuring that all concerned across the Country would be heard particularly State Pollution Control Board and Committees and key functionaries overseeing SWM operations in Urban areas.[26]

Building Transparency and Accountability

- All details pertaining to waste collection, processing and transportation should be shared online on ward basis.[27] Citizens should be able to address their problems directly by contacting officials in charge in every ward/zone. BBMP to institute a regular procedure to interact with citizens at zonal levels to remedy grievances.[28]
- Report and recommendations of BBMP Expert Committee of Municipal Solid Waste Management and Technical Committee Reviewing Expression of Interest of bid documents are to be placed in public domain for public comments, criticisms and objections and only after due consideration of such responses is a final decision to be taken on the recommendation of the Expert Committees.[29]

[20] Ibid, order dated 17/Dec/2015
[21] Ibid, order dated 10/Sept/2012
[22] Ibid, order dated 10/Sept/2012
[23] Ibid, order dated 13/Dec/2012
[24] Ibid, order dated 11/Oct/2013 and order dated 24/Oct/2013.
[25] Ibid, order dated 13/Nov/2013. The Court in the subsequent hearing held on 20/12/2013 took on record the submission made to Union Ministry of Environment and Forest with regard to draft MSW Rules 2013 by 2nd petitioner in WP 46523/2012.
[26] Ibid, order dated 25/Apr/2014
[27] Ibid, order dated 09/Oct/2012
[28] Ibid, order dated 01/Sept/2014
[29] Ibid, order dated 27/May/2013

Environmental Education

- BBMP to intensively engage electronic and mass media in environmental education of the wide public with particular regard to solid waste management.[30]
- The State Government, BBMP and KSPCB are required to take appropriate steps in ensuring appropriate information on progressive solid waste management reaches every individual family as per MSW Rules 2000.[31]
- In compliance with 22/Nov/1991 directions of Supreme Court of India in *M. C. Mehta v. Union of India*, all theaters, TV channels, Doordarshan and All India Radio "to spare sometime for telecasting either a program or slides or short flims with regard to segregation of waste at source, transporting segregating waste from the houses to the collection points and from the collection point to the processing unit, so that people are educated……about the nuisance created by littering in public places, so that the future generation would understand the importance of solid waste management and all together a new culture would be developed in the society".[32]
- BBMP to ensure regular and effective education of public at large by developing and disseminating appropriate education material on segregation of waste at source and its management locally including by engaging electronic and print media. The exercise to be conducted by engaging Master Trainers, Suchimitras, Resident Welfare Association, Pourakarmikas, and civil society organizations. To ensure enforcement of norms and rules, Ex-Servicemen to be appointed by BBMP as Clean-Up Marshals. As has been done in Mumbai Municipal Corporation. [33]

Ward Committees

- Acknowledging garbage problem is an outcome of failure in civic governance, Ward Committees to be setup to ensure public oversight in civic matters as required under the Constitutional 74th Amendment (Nagarpalika Act, 1992).[34]
- Ward Committee members to be confirmed within 15 days, after due scrutiny of qualifying criteria as per applicable statutory requirements.[35] Considering that the order of the Court remained without compliance even three years later, BBMP was directed to setup Ward Committees within one month of 24/Apr/2017[36], a direction that was finally complied with in July 2017.[37] BBMP directed to display names and addresses of Ward Committee members in every ward office.[38]
- A comprehensive survey of waste generated, collected and transported in every ward to be undertaken everyday throughout the month of February 2013, and information so collected is collated and made available for public review.[39]
- The functioning of Ward Committees to be accessible to public and all details of the

[30] Ibid, order dated 01/Sept/2014
[31] Ibid, order dated 02/Apr/2013
[32] Ibid, order dated 10/Jul/2015
[33] Ibid, order dated 23/Jun/2016
[34] Ibid, order dated 08/Jan/2013
[35] Ibid, order dated 21/Jan/2013
[36] Ibid, order dated 24/Apr/2017. However, this order is not shown in the written recording of orders in the High Court of Karnataka.
[37] Ibid, order dated 19/Jul/2017.
[38] Ibid, order dated 08/Aug/2017.
[39] Ibid, order dated 21/Jan/2013

proceedings to be available in the public domain.[40]
- State directed to develop Ward Committee Rules with due dispatch to ensure these statutory citizen interface bodies could function.[41]

Pourakarmikas

- BBMP directed to ensure that Pourakarmikas (solid waste workers) are regularly paid their full salary.[42] Residents Welfare Associations and Suchimitra empowered with oversight responsibility to ensure contractors pay workers their salaries regularly.[43] Further payments to contractors made contingent upon issuance of No Objection Certificate/ Compliance Certificates by RWA/Suchimitra.[44]
- BBMP directed to verify list of Pourakarmikas, establish their identity and provide details of all Pourakarmikas and contact details of employer (Contractor/BBMP) is displayed in every ward and also on BBMP's website.[45]

Private Contractors

- BBMP to place in public record "the names of the contractors who have been employed in the last three years for the transportation of garbage and amounts paid to each one of them and on what basis and also the total amount paid the Corporation towards the transportation of garbage".[46]
- The work of contractors of BBMP to be scrutinized as per terms of contract and "if the Corporation finds there is any violation of any of the terms, they are at liberty to immediately take actions against such contractors to put an end to the contract, stop all further payment and initiate proceeding for recovery of the payments made".[47]

Landfills

- "Landfills are not a permanent solution", and thereby must be phased out.[48]
- The forcible reopening of Mavallipura landfill questioned in response to serious concerns raised by Indian Air Force, as dumping waste attracts birds thus risking flight movements in the abutting Yelahanka Air Force base with high rate of bird hits.[49] Consequently, in order to ensure safety of the aircraft and local population, no dumping to be allowed within 10kms. of airbase.[50]
- A minimum of one kilometer of no development zone to be maintained around existing landfill sites as per State Government policy.[51]
- Bio-mining of unprocessed legacy waste to be undertaken at Mavallipura.[52] Subsequently, this technique of cleaning up areas dumped with solid waste was reaffirmed in addressing problems of garbage accumulated over the years at Mandur and other landfills too.[53]

[40] Ibid, order dated 04/Feb/2013
[41] Ibid, order dated 23/Sept/2014
[42] Ibid, order dated 13/Feb/2015
[43] Ibid, order dated 03/Mar/2015
[44] Ibid, order dated 10/Apr/2015
[45] Ibid, order dated 08/Aug/2017
[46] Ibid, order dated 04/Mar/2013
[47] Ibid, order dated 04/Mar/2013
[48] Ibid, order dated 10/Sept/2012
[49] Ibid, order dated 06/Nov/2012
[50] Ibid, order dated 05/Dec/2014
[51] Ibid, order dated 22/Nov/2012
[52] Ibid, order dated 13/Dec/2012
[53] Ibid, order dated 18/Jun/2014

- BBMP and KSPCB to monitor and control fires in landfills and ensure noxious gases are captured so that they "do not affect the residents in nearby areas".[54]
- BBMP directed "not to make any payment" to landfill operator in Mavallipura, *viz.* M/s Ramky Infrastructure India Pvt. Ltd., "without any further orders from this Court" as it has "done nothing to remove the garbage, but they have received the tipping fee".[55] Activity of M/s Ramky limited to receiving only organic waste and process it into manure without any dumping. Similarly, Mandur facility to also be used for processing wet waste into manure, without any further dumping.[56] Subsequently, observing that M/s Ramky has not complied with the Court directions and run the facility as directed, their contract stands terminated. BBMP directed to approach the Bangalore City Civil Court and request vacation of Arbitration Application No. 195/2016 passed to maintain status quo is set aside so that High Court directions may be complied with.[57]
- BBMP to ensure that communities impacted by dumping of waste in Mavallipura and adjoining villages received free potable drinking water permanently and are also provided free mosquito nets preventing spread of diseases.[58] BBMP directed to hold health camps in all impacted villages to ascertain the extent of morbidity caused due to dumping of waste and attend to the needs of those who have been adversely impacted. Similarly camps to be undertaken to establish the extent to which livestock having impacted. BBMP to coordinate such actions in collaboration with Agricultural Department, Animal Husbandry Department, Health Department, Zilla Panchayat, etc.[59]
- As all local water found unpotable, villages under five Village Panchayat directly impacted by contamination of their water resources due to garbage dumping in Mavallipura provided with reverse osmosis plants to ensure drinking water is available to all affected residents.[60]
- KCDC to remove all inert waste and transport into a landfill and ensure that facility is available for receiving wet waste, especially from markets, and process it into manure.[61]

Waste Processing Facility

- KCDC facility to process organic wet waste and backlog cleared. Offered police protection to ensure the Unit functions in round the clock, in three shift and without any political interference.[62]
- Waste processing units in every neighbourhood/wards to be mandatorily made available as part of civic amenity infrastructure by planning authorities such as Bangalore Development Authority, and integrated into city master plans.[63]
- BBMP directed to setup waste processing facilities in Assembly Constituencies to reduce the transportation cost so that waste is processed in the area itself and the practice of transporting the waste outside the city and dumping in villages can be avoided. Similarly, dry waste collection centers should be setup in each ward.[64]

[54] Ibid, order dated 04/Feb/2013
[55] Ibid, order dated 30/Aug/2013
[56] Ibid, order dated 31/Oct/2014
[57] Ibid, order dated 23/Jun/2016
[58] Ibid, order dated 31/Oct/2014
[59] Ibid, order dated 13/Feb/2015
[60] Ibid, order dated 10/Apr/2015
[61] Ibid, order dated 13/Feb/2015
[62] Ibid, order dated 04/Feb/2013
[63] Ibid, order dated 04/Feb/2013
[64] Ibid, order dated 13/Nov/2013

Dumping in Lakes

- Waste dumping in Subramanyapura Lake to be stopped and the lake to be cleaned up. Poor who have encroached the lake to be rehabilitated by the Karnataka Slum Clearance Board. The entire lake and its Raja Kaluve to be surveyed and fenced within one month. The lake to be rehabilitated on a war-footing as per law and directions of the High Court.[65]
- Dispute relating to Subramanyapura Lake being a lake and not grazing pasture settled and order of Deputy Commissioner of Bengaluru District that it is a lake is taken on the record. That BBMP, BDA, BWSSB "have agreed to contribute to the cost of sewage being diverted" within two months is recorded.[66]
- BDA, KSPCB, BWSSB, LDA and BBMP "shall act in unison" to ensure that no polluted water flows into lakes and to prevent dumping of waste in lakes.[67]

[65] Ibid, order dated 21/Jan/2013
[66] Ibid, order dated 04/Mar/2013
[67] Ibid, order dated 10/Apr/2015

2 Environmental and Health Implications of Landfills in Mavallipura

2.1 Water and the life it gives or takes

According to a report by World Health Organisation entitled "Safer Water, Better Health", "almost one tenth of the global disease burden could be prevented by improving water supply, sanitation, hygiene and management of water resources".[68] Globally, water-related diseases remain a major public health concern. Contamination of drinking water by pathogenic microbes is the most common pathway enhancing health risks. If solid waste is not managed appropriately, waste ends up contributing enormously to contamination of surface and ground water aquifers and thus all life forms which depend on good clean water. While decomposing organic waste is a major site for incubation and spread of pathogenic microbes, and as a food source draw rodents and birds which further aid in the spread of infectious diseases, the fact that toxicity of waste is increasing is also a matter of great worry. Today's waste has a much higher burden of plastics and households toxic chemicals that easily find their way into landfills and just about anywhere waste is dumped. When this is burnt, which is a common practice, the toxicity escapes into the air, and when not burnt, it remains for long periods contaminating soil and water. Moreover, the ever increasing volume of plastic bottles and containers that are disposed due to weak recyling initiatives, end up in landfills where they act as a incubation zones for disease spreading vectors such as mosquitoes and flies. In Bengaluru, incidences of malaria, chikungunya and dengue is exceptionally high in communities living around landfills, and this is directly a consequence of the areas being infested by mosquitoes.

In achieving achieving Sustainable Development Goals, which lay great emphasis on ensuring Water, Sanitation and Health reaches all, ensuring solid waste management becomes a central activity to building health, water and ecological security.[69]

2.1.1 Water analysis villages impacted by Mavallipura landfills: Findings and discussion

The widespread contamination of water in and around Mavallipura, where two landfills were used for dumping Bengaluru's waste for over a dozen years, has been a matter of grave concern to communities living in the region. The first landfill was claimed to have been located in a private farm, that belonging to one Mr. Bailappa, and in which waste was essentially dumped into huge excavations till they resembled little hillocks. Soon it was discovered that this was forest land that the farmer had encroached

[68] (Prüss-Üstün A, Bos R, Gore F, Bartram J. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, Geneva, 2008. http://apps.who.int/iris/bitstream/10665/43840/1/9789241596435_eng.pdf)

[69] (Clean water and sanitation: Why it matters. Water and Sanitation- United Nations Sustainable Development, 2016. http://www.un.org/sustainabledevelopment/wp-content/uploads/2016/08/6_Why-it-Matters_Sanitation_2p.pdf)

and the landfill was closed in 2005. But no action was taken to attend to the waste that had accumulated. The second landfill was in Mavallipura's Gomala land (grazing pastures) in which M/s Ramky, a private company contracted to set up a 'scientific landfill', ended up dumping the waste over about 50 acres by employing, more or less, the same method Bailappa had: excavating deep pits to dump waste and then turning them into small hillocks of waste. There were several protests and demonstrations demanding the closure of this landfill too, and this action was finally initiated by KSPCB in July 2012.

The massive accumulated wastes that now were deposited in these landfills, produced large volumes of leachates which leaked out contaminating surface and ground water aquifers. As there were no leachate treatment systems in place, it was clearly evident that the leachates from the landfill were draining into all local water sources, one way or the other. Every time it rained, water percolated through these hillocks of waste, which now spread over 100 acres, and got contaminated and this water flowed out into local wells, ponds, borewells, lakes, etc. Several streams that fed the Arkavathy river downstream, which is a major drinking water source for Bengaluru, also got contaminated with this discharge from the landfills. Neither the operators of the landfills, or BBMP which employed them, have taken any action to address and remedy the situation.

Local villagers, meanwhile, began reporting wide ranging illnesses which they had said they never suffered from before the landfills were located in the region. Several reported chronic illnesses that had not seen manifest in local populations in their living memories. There were several deaths reported, which villagers asserted were due to the adverse impacts of the landfills. In addition, they reported high rates of morbidity and mortality in livestock which drank from these water sources directly.

When impacted communities approached ESG for assistance, the organisation responded in a variety of ways to draw the attention of regulatory authorities and BBMP to the dire situation of the villagers. But there was no effective response, and certainly not with due dispatch. One method of bringing the regulatory agencies and civic authorities to respond was to present evidence of the impacts of the landfills on local environment and health. This is normally achieved by testing the quality of water in the region. However, as both KSPCB and BBMP were not monitoring the quality of water, and there was weak or no compliance on the part of the landfill operators with standing environmental reporting norms that include reporting on the status of drinking water in the region, ESG decided to undertake the task of building a body of information on the quality of water in the impacted regions.

This was achieved by employing standard methods in assessing water quality in leachate tanks, in ponds, in wells, bore-wells, lakes, etc. of the impacted region. Water testing commenced in November 2005 and was continued periodically: June 2006, December 2009, March 2011, July 2012, March 2016 and September 2017. About 13 sampling locations were monitored, that included wells, borewells, ponds, lakes, and also leachate tanks.

By 2012, there was sufficient information available to suggest that the quality of water in Mavallipura and downstream villages was degraded rapidly. The details were analysed and published as a report: "Bangalore's Toxic Legacy: Investing Mavallipura's Illegal Landfills",[70] which formed a major basis for the shutting down of the landfill operated by M/s Ramky. In this report, extensive evidence was provided about how the landfills had operated in gross violation of environmental, planning, forest, revenue and social justice norms, and that its impacts on health and environment were extensive.

Subsequently, during the course of the hearings in WP 46523/2012 c/w WP 24739/2012 before the High Court of Karnataka, ESG made another updated submission. It focused on the status of health of the impacted communities before Hon'ble Justice Mr. N. Kumar (now retired) and Justice Ms. B. V. Nagarathna, during their visit to assess the condition of the landfills at Mavallipura. On the basis of these submissions and other reports, the High Court has issued a variety of directions to improve the situation of the impacted communities, which have not been conformed with rigorously. As a consequence, the landfills continue to contaminate human and livestock health, and with the heavy rains that have lashed the Bengaluru region this year, the volume of leachates has been unprecedented and this has further accentuated the adverse impact on every surface and ground water aquifer.

In this section, we present the results of water analysis undertaken in the impacted villages since 2012, including as recently as September 2017, and also discuss the results of a rapid health survey undertaken amongst villages living near the landfills. The results reveal that the quality of water continues to deteriorate, and the manifestation of infectious and chronic illnesses in the impacted villagers is much higher than standard disease burden estimations applicable for India.[71]

Sampling Methodology-

During the 2017 episode of sampling water in the impacted zone of the Mavallipura landfills, thirteen grab samples of water were collected and tested for various parameters that included assessing physical, chemical and biological indicators of pollution. The samples were collected in 1.5 litres sterile bottles for physical, chemical and biological analysis. The samples were collected taking necessary precautions against external contamination and reached to the authorised laboratory for analysis within 3-4 hours of collection.

Sample sites for assessing quality of water in and around Mavallipura are indicated in the table, including details of years when sampling was undertaken and the geographical location and distance from the landfills. The same is also indicated in a Google Earth image.

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70 Rao, B.S. et al., Bangalore's Toxic Legacy: Investigating Mavallipura's Illegal Landfills, Environment Support Group, July 2010, accessible at: http://www.esgindia.org/sites/default/files/campaigns/mavallipura/resources/bangalore-toxic-landfills-mavallipura-es.pdf.

[71] See, for instance, *Burden of Disease in India*, Background paper issued by National Commission on Macroeconomics and Health, 2005, accessible at: http://www.who.int/macrohealth/action/NCMH_Burden%20of%20disease_(29%20Sep%202005).pdf

Table 1: Water sampling sites

Year → / Sampling Sites ↓	2005	2006	2009	2011	2012	2016	2017	Distance from the Ramky Landfill in Km.
FRLHT Bore well (Control sample)	ND	✔	✔	✔	✔	✔	✔	0.97
Hanumantharayappa Open well	ND	✔	ND	ND	ND	ND	ND	ND
Muniswappa Bore well	ND	✔	ND	ND	ND	ND	ND	ND
Dhanraj Field Bore well	✔	ND	✔	ND	ND	ND	ND	ND
Dumpyard Bore well	✔	ND	ND	ND	ND	ND	ND	0.53
Ramky Leachate Pond		ND	ND	ND	✔	✔	✔	0.25
Koranakunte well	✔	ND	✔	✔	✔	✔	✔	0.26
Koranakunte Lake	✔	ND	✔	✔	✔	✔	✔	0.26
Mavallipura Lake	ND	✔	✔	✔	✔	✔	✔	1.46
Bailappa Pond	ND	✔	✔	✔	✔	✔	✔	0.30
Anand Drinking Water Bore well	ND	✔	✔		✔	✔	✔	0.48
Nagaraj Drinking Water Bore well	✔	ND	✔	✔	✔	✔	✔	1.72
Over HeadTank(OHT) Mavallipura Bore well	ND	ND	ND	ND	ND	ND	ND	1.38
Temple Bore well Mavallipura	ND	ND	ND	ND	ND	ND	ND	1.79
New Nagaraj Bore well	ND	ND	ND	ND	ND	ND	✔	0.70
Dumpyard Drinking Water Bore well connected to RO no 21 Mavallipura	ND	ND	ND	ND	ND	ND	✔	0.51
AK Colony Bore well Connected to RO Plant Mavallipura	ND	ND	ND	ND	ND	ND	✔	1.32
Mavallipura Drinking water RO	ND	ND	ND	ND	ND	ND	✔	1.44
Mini Tank Bore well Water Mavallipura	ND	ND	ND	ND	ND	ND	✔	1.45
Prakash Bore well	ND	ND	ND	ND	ND	ND	✔	1.21
Subedhar Palya Upstream Drinking water Bore well	ND	ND	ND	ND	ND	ND	✔	0.89

ND: Not Done

Figure 1 Depicts the location from where the water samples were taken.

Figure 2 Representation of the elevation of the terrain: Environmental impacts untreated leachate flows from Ramky landfill.

Standards for water analysis

Water samples analysed have been compared with the drinking water quality standards per Indian Standards (IS) 10500/2012. The 2017 data is also compared with water quality data from 2005, 2006, 2009, 2011, 2012 and 2016.

The water analysis includes taking account of the:

- Physical Characteristics: Total hardness, Total Dissolved Solids (TDS), pH, Colour, Alkalinity .

- Biological characteristics: includes Coliform Bacterial.
- Chemical characteristics: includes Nitrates, Lead, Iron, Boron, Chloride, Residual free chlorine, Calcium, Copper, Manganese, Sulphate, Fluoride, Phenolic Compounds, Mercury, Cadmium, Arsenic, Cyanide, Zinc, Chromium, Aluminium, Magnesium, Biochemical Oxygen Demand and Chemical Oxygen Demand.

Each of these aspects qualify the purity of the water and help in guaging the health and environmental damage that can potentially result if no effort is invested in tackling sources polluting drinking water and other water bodies. Each sample is examined against the range of desired and maximum permissible limits for each standard. Where the values exceed permissible limits, these are shaded in grey and represented in bold.

Discussing Results of the Physical Parameters assessed for Drinking water

Total Hardness

Risks or effects of Total Hardness
Scale formation in utensils and hot water system, soap scums, Atopic dermatitis (or eczema), laxative effect, reproductive failure and stillbirth, calcification around bones.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit

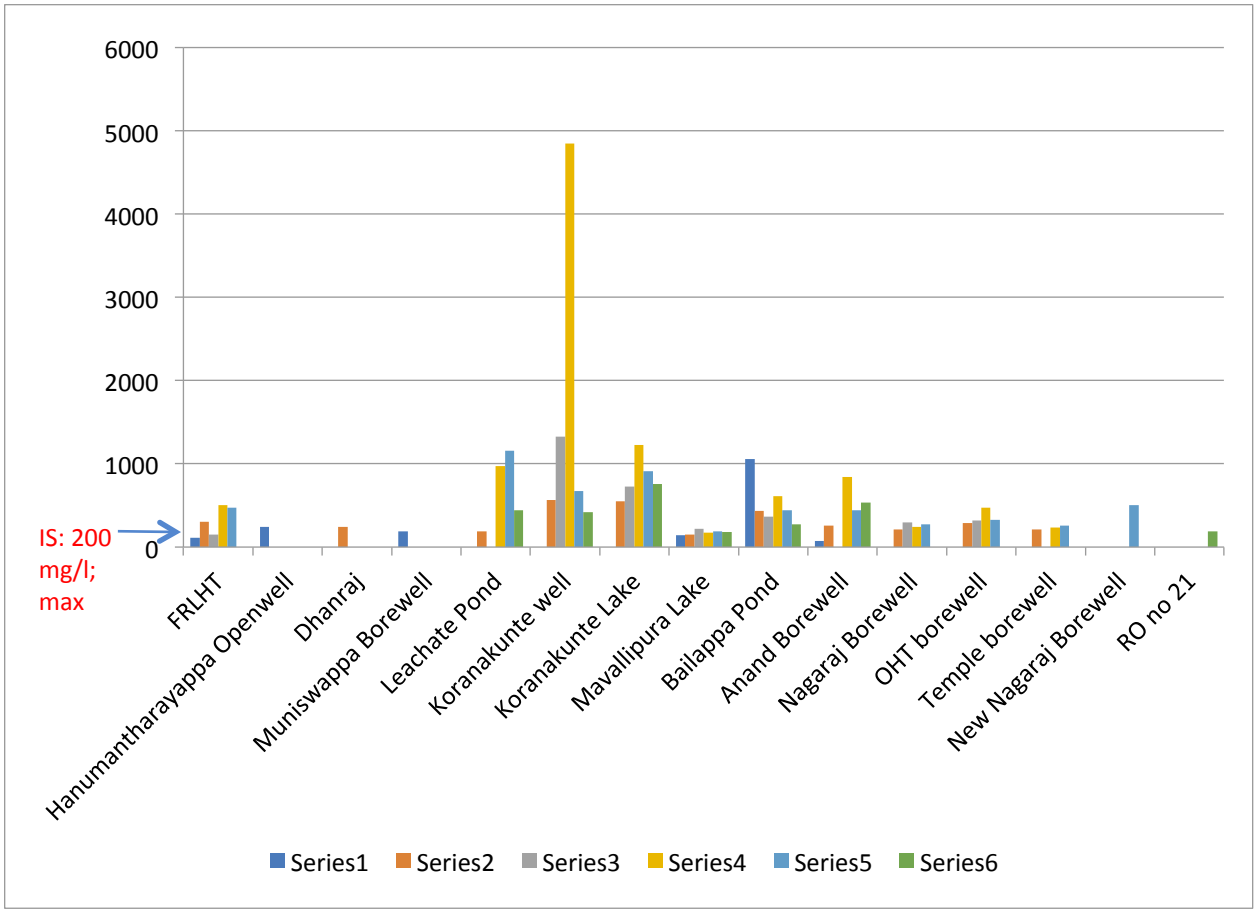
Total hardness is defined as the sum of the calcium and magnesium concentration, both expressed as CaCO3, in mg/L. The degree of hardness of drinking water has been classified in terms of the CaCO3 equivalent concentration and as follows:
Soft 0-60 mg/L – Medium 60-120mg/L – Hard 120-180mg/L – Very hard >180mg/L

Assessing hardness in water is the traditional measure of the capacity of water to react with soa. Hard water requires considerably more soap to produce a lather.

Year	**IS 10500:2012**	**WHO**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	200 mg/L Max	-	114	**300**	150	**504**	**472**	**476**
Hanumantharayappa Open well			**240**	-	-	-	-	-
Dhanraj Field Bore Well			-	**240**	-	-	-	-
Muniswappa Bore Well			187		-	-	-	-
Ramky Leachate Pond			-	190	ND	**970**	**1160**	**440**
Koranakunte Well			-	**564**	**1326**	**4850**	**670**	**420**
Koranakunte Lake			-	**552**	**728**	**1224**	**910**	**761**
Mavallipura Lake			140	148	**216**	172	188	180

Year	IS 10500:2012	WHO	2006	2009	2011	2012	2016	2017
Bailappa Pond			**1060**	**432**	**364**	**610**	**440**	**270**
Anand Bore Well			73	**256**	ND	**840**	**446**	**531**
Nagaraj Bore Well			-	ND	ND	ND	**272**	-
OHT Bore Well			-	ND	ND	ND	**330**	-
Temple Bore Well			-	-	ND	ND	**254**	-
New Nagaraj Bore Well			-	-	-	-	**501**	-
RO No 21			-	-	-	-	-	190

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.



Analysis: The desirable limit as per IS 10500/2012 is 200 mg/L, Max.
With the exception of Mavallipura lake site and the Reverse Osmosis Drinking Water plant at Mavallipura village, other samples displayhardness beyond desirable limits (200mg/L) in 2016 data. The Ramky leachate pond site displayed hardness beyond permissible limits at all-time points except 2009 (2006: 1060 mg/L, 2012: 720, mg/L 2016: 1160 mg/L). Both the Koranakunte Lake and open well displayed hardness beyond permissible limits in 2012 and 2016, ranging from 670 mg/L to 1012 mg/L.

Impact: Depending on the interaction of other factors such as pH and alkalinity, water with a hardness of exceeding 200 mg/l may cause scale deposition in the distribution system and cause scum formation. On heating, hard water forms deposits of calcium carbonate, and thus scaling results.

Total Dissolved Solids (TDS)

Risks or effects of Total Dissolved Solids –
Consumption of water with high amounts of TDS can result in gastro intestinal irritations and also has undesirable taste.

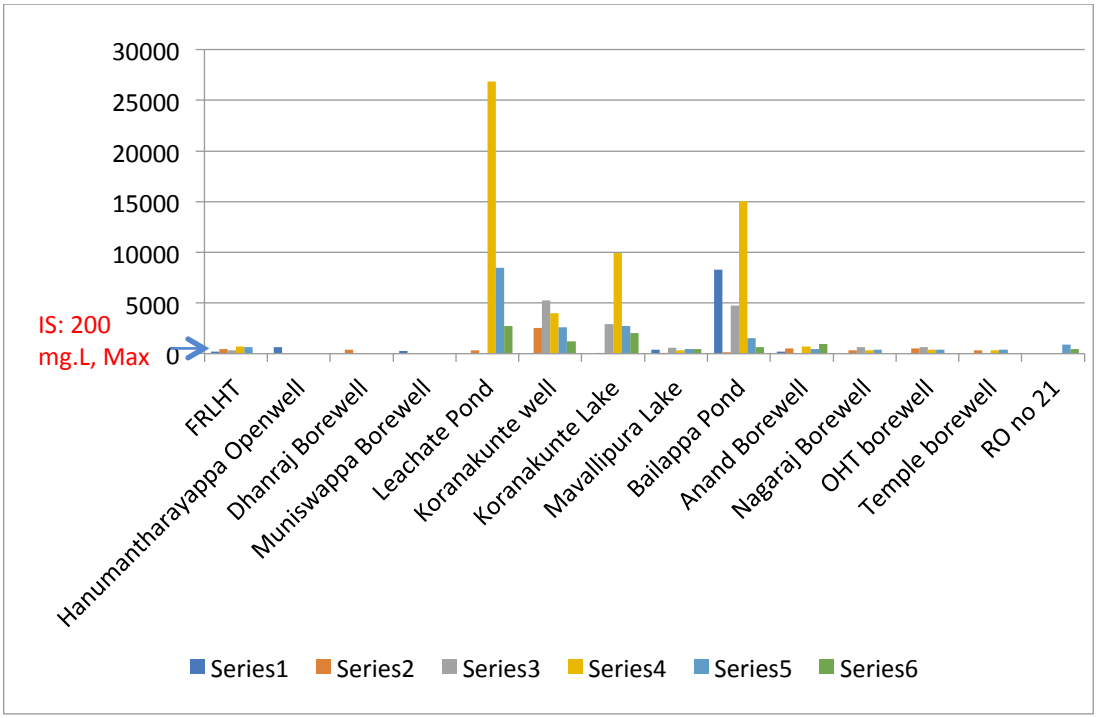
Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Total Dissolved Solids (TDS)	
IS 10500-1991	Desirable : 500 mg/l , Permissible : 2000 mg/l
Risks or effects	Hardness, scaly deposits, sediment, cloudy colored water, staining, salty or bitter taste, corrosion of pipes and fittings
Sources	Livestock waste, septic system Landfills, nature of soil Hazardous waste landfills Dissolved minerals, iron and manganese
Treatment	Reverse Osmosis, Distillation, deionization by ion exchange

Year	**IS 10500: 2012**	**WHO**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	500 mg/L Max	-	212	450	344	**715**	**647**	**990**
Hanumantharayappa Open Well			**648**	-	-	-	-	-
Dhanraj Field Bore Well Bore Well			-	390	-	-	-	-
Muniswappa Bore Well			272	-	-	-	-	-
Ramky Leachate Pond			ND	334	-	**26850**	**8500**	**2700**
Koranakunte Well			ND	**2530**	**5248**	**3970**	**2630**	**1240**
Koranakunte Lake			ND	2.5	**2902**	**9940**	**2724**	**2010**
Mavallipura Lake			378	4	**606**	325	460	445
Bailappa Pond			**8275**	121	**4775**	**15040**	**1524**	**625**
Anand Bore Well			198	**500**	-	**680**	446	**950**
Nagaraj Bore Well			-	360	**627**	330	400	-
OHT Bore Well			-	**500**	**642**	370	420	-
Temple Bore Well			-	360		345	373	-
RO no 21			-	-	-	-	**871**	430

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Total dissolved solids consists mainly inorganic salts, small amounts of organic matter, and dissolved gases. An increase in level of cations and anions in water having high TDS can increase hardness, corrosiveness, and contribute a salty taste to the water.



Analysis: The desirable Limit as per IS 10500/2012 is 500 mg/L (max). TDS remains beyond permissible limits (2000 mg/L) at sampling sites which are within a mile of the landfill, indicating, therefore, that the leachates from the landfills are impacting the quality of water. In Koranakunte well and the Koranakunte lake, TDS was beyond permissible limits at all recorded time points with highest measurement of 9940 mg/L (five times the permissible limit) in 2012. At the Ramky leachate pond, with the exception of the sample taken in 2009, TDS ranged from 4 to 13 times the permissible limit (2006: 8275 mg/L, 2012: 26850 mg/L, 2012: 8500 mg/L).

Impact: Water with high TDS is unacceptable for consumption and imparts an undesirable taste. It may also cause gastrointestinal infections.

pH-

Risks or effects of pH –
Low pH can result in corrosion of metals leading to a metallic taste of water. High pH gives water a bitter/soda taste and can result in the deposition of scales in plumbing systems.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

The pH of a solution is measured as negative logarithm of hydrogen ion concentration. At a given temperature, the intensity of the acidic or basic character of a solution is indicated by pH or hydrogen

ion concentration. pH values from 0 to 7 are diminishing acidic, 7 to 14 increasingly alkaline and 7 is neutral.

pH	
IS 10500-1991	Desirable :6.5 – 8.5, Permissible :No relaxation
Risks or effects	Low pH - corrosion, metallic taste High pH – bitter/soda taste, deposits
Sources	Natural
Treatment	Increase pH by soda ash Decrease pH with white vinegar / citric acid

The pH range that is acceptable for drinking water is between 6.5 to 8.5, per the Indian Standards.

Year	**IS 10500/2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	6.5-8.5	6.5-9.2	-	7.02	6.97	7.2	7.15	6.78	7.32
Hanumantharayappa Open Well			-	7.29	-	-	-	-	-
Muniswappa Bore Well			-	7.12	-	-	-	-	-
Dump Yard Bore Well			7.25	-	-	-	-	-	-
Ramky Leachate Pond			-	-	-	ND	8.41	8.37	8.37
Koranakunte Well			-	-	8.17	8.4	8.37	8.4	7.6
Koranakunte Lake			7.3	-	8.31	8	**9.31**	7.91	7.72
Dhanraj Field Bore Well			7.75	-	7.53	-	-	-	-
Mavallipura Lake			-	7.73	8.27	7.7	8.21	7.04	7.4
Bailappa Pond			-	8.22	**9.98**	**10.5**	**10.16**	8.23	7.3
Anand Borew Ell			-	6.58	6.74	ND	6.97	7.22	6.89
Nagaraj Borewell			7.8	-	7.52	7.6	6.97	6.97	-
OHT Bore Well			-	-	7.26	7.4	7.51	7.14	-
Temple Bore Well			-	-	7.21	ND	7.25	7.1	-
New Nagaraj Bore Well			**-**	-	-	-	-	-	6.58
Ro No 21			**-**	-	-	-	-	-	6.64

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: All samples from 2016 have pH within the permissible range of 6.5 to 8.5. It should be noted, however, that some sites close to the landfill were highly alkaline and displayed pH bordering, and also exceeding the upper limit of pH 8.5. For example, Ramky Leachate pond (8.37), Konnakunte well (8.4), and Bailappa check dam (8.23) have revealed high pH values consistently, or at least on one sampling occassion. At Koranakunte well, pH has been consistently high.

Impact: Highly alkaline water indicates a high presence of calcium and magnesium carbonates, which results in calcification of the water distribution system and imparts a bitter taste to drinking water. Low pH can result in corrosion of metals leading to a metallic taste of water. Both high and low pH levels are dangerous to life forms. Being exposed to, or consuming water that is highly alkaline or acidic can result in chronic illnesses, in humans and livestock. Besides, it drastically affects farm productivity as plants cannot survive in highly alkaline or acidic waters.

Colour -

Risks or effects of Colour–
Changes in the colour of water and the appearance of a new colour in water serve as an indicator that further investigation is needed.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Drinking-water should be colorless. Coloured drinking water, be they from surface or ground water aquifers, is indicative of pollution by leachates from landfills or industrial effluents.

Colour, Hazen Units	
IS 10500-1991	Desirable : 5 Hz. , Permissible : 25 Hz.
Risks or effects	Visible tint, acceptance decreases
Sources	Tannins, Iron, Copper, Manganese Natural deposits
Treatment	Filtration, Distillation, Reverse osmosis, Ozonisation

Year	**IS :10500:2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**
FRLHT BORE WELL	5 Hazen units, Max.	5 Hazen units, Max.	-	<5.0	ND	<2	1	<5
Hanumantharayappa Openwell			-	**10**	-	-	-	-
Muniswappa Borewell			-	<5.0	-	-	-	-
Ramky Leachate Pond			-	-	ND	-	**600**	>5
Koranakunte well			-	-	ND	3	**25**	**30**
Koranakunte Lake			-	-	ND	<2	**110**	**10**
Mavallipura Lake			-	**50**	ND	2	**10**	>5
Bailappa Pond			-	**500**	ND	3	**20**	**40**
Anand Borewell			-	<5.0	ND	ND	1	<5
Nagaraj Borewell			-	-	ND	<2	1	ND
OHT borewell			-	-	ND	<2	1	<5

Year	IS :10500:2012	WHO	2005	2006	2009	2011	2012	2016
Temple borewell			-	-	ND	-	1	<5

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable and permissible limit for Colour, is to be in the range of 5 and 15, calculated as Hazen Units. Samples that registered beyond permissible limits are Bailappa check dam (500, 2006; 40, 2016 in Hz units), Koranakunte open well (30 in 2016 per Hz units), Ramky leachate pond (Dark Brown colour) & Mavallipura lake (Blackish colour).

Impact: While a parameter such as colour might not directly impact health, highly coloured water raises concerns about the possibility of conatamination. Colour in water is also indicative of the presence of organic matter or metals and maybe the first indication of a potentially hazardous situation.

Alkalinity-

Risks or effects of Alkalinity –
Low Alkalinity (i.e. high acidity) causes deterioration of plumbing and increases the dissolution of metals including heavy metals from pipes, solder or plumbing fixtures.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Alkalinity refers to the capability of water to neutralize acid.

Alkalinity	
IS 10500-1991	Desirable : 200 mg/l , Permissible : 600 mg/lit
Risks or effects	Low Alkalinity (i.e. high acidity) causes deterioration of plumbing and increases the chance for many heavy metals in water are present in pipes, solder or plumbing fixtures.
Sources	Pipes, landfills Hazardous waste landfills
Treatment	Neutralizing agent

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
FRLHT BORE WELL	200 mg/L Max	-	-	108	-	118	-	**252**	**216**
Hanumantharayappa Openwell			-	128	-	-	-	-	-
Muniswappa Borewell			-	191	-	-	-	-	-
Ramky Leachate Pond			-	-	-	-	ND	**2540**	**925**
Koranakunte well			-	ND	ND	**1342**	ND	**644**	**498**
Koranakunte Lake			-	ND	ND	**715**	ND	**550**	**816**

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
Mavallipura Lake			-	176	ND	176	ND	140	149
Bailappa Pond			-	**1920**	ND	**1221**	ND	**376**	**279**
Anand Borewell			-	73	ND	ND	ND	130	129
Nagaraj Borewell			-	-	ND	198	ND	**214**	ND
OHT borewell			-	-	ND	**264**	ND	**276**	ND
Temple borewell			-	-	ND	ND	ND	**210**	ND
New Nagaraj Borewell			-	-	-	-	-	-	**259**
RO no 21			-	-	-	-	-	-	139

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable and permissible limit for Alkalinity is 200 & 600 mg/l respectively. Almost all samples were above desirable limit and two samples reported values that were beyond permissible limit. These are Koranakunte open well (2016: 644 mg/l) and Ramky Leachate pond (2006: 1920 mg/l, 2016: 2540 mg/l).

Impact: Highly alkaline water can affect the taste of water. Due to the high presence of salts, alkaline water can lead to depositions of salts in the distribution system. Low Alkalinity (i.e. high acidity) causes deterioration of plumbing and increases the dissolution of metals, including heavy metals from pipes, solder or plumbing fixtures.

Discussing Results of the Biological Parameters assessed for Drinking water

Risks or effects of Coliform Bacteria –
The presence of coliform bacteria indicate faecal contamination. Coliform bacteria can cause diarrhoea, urinary tract infections, haemolytic uraemic syndrome, bacteraemia and meningitis.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Coliform Bacteria-
Escherichia coli (E. coli) is a bacteria commonly present in the gastro-intestinal tract of humans, and is pathogenic in nature. E. coli provides conclusive evidence of recent faecal pollution and should not be present in drinking water.

Total Coliform Bacteria	
IS 10500-1991	95% of samples should not contain coliform in 100 ml 10 coliform / 100ml
Risks or effects	Gastrointestinal illness
Sources	Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring
Treatment	Chlorination , Ultraviolet, Distillation, Iodination

MPN Coliform Bacteria :

Year	**IS 10500:2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	0	0	-	0	**170**	0	**900**	**172**	0
Hanumantharayappa Open Well			-	**26**	-	-	-	-	-
Ramky Leachate Pond			-		-	-	**≥1600**	**345**	**14**
Muniswappa Borewell			-	**542**	-	-	-	-	ND
Dump Yard			**542**	-	-	-	-	-	ND
Dhanraj Field Bore Well			0	-	**≥1600**	-	-	-	ND
Koranakunte Well				-	ND	**>1600**	**230**	**278**	**12**
Koranakunte Lake			**175**	-	ND	**240**		**221**	**22**
Mavallipura Lake			-	**542**	ND	**>1600**	**900**	**278**	**18**
Bailappa Pond			-	**212**	ND	**>1600**	**120**	**221**	**18**
Anand Bore Well			-	**23**	**70**	-	**230**	**221**	**8**

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
Nagaraj Borewell			0	-	**≥1600**	0	**70**	**39**	**11**
OHT Bore Well			-	-	**23**	0	0	0	ND
Temple Bore Well			-	-	-	-	**23**	**2**	ND
New Nagaraj Borewell			-	-	-	-	-	**11**	-
Ro 21			-	-	-	-	-	-	**10**

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis:

Indian standards allow for 'zero' E. coli to be present in drinking water. Almost all water samples showed high levels of coliform bacteria. Even though there is an overall decrease in observed numbers from 2012 to 2016, the levels remain dangerously high. The decline may also be an indicator of water being too toxic for bacteria to survive. When compared across the years, with the exception of OHT borewell, all other sites revealed the presence of Coliform bacteria beyond permissible limits.

Impact: Consumption of water laced with faecal contaminants can result in stomach infections, vomiting, diarrhoea and in dehydration. The populations greatest at risk of infection are children, pregnant women and the elderly.

Discussing Results of the Chemical Parameters assessed for Drinking water

Nitrates

Risks or effects of Nitrates –
The risks of high amount of nitrate consumption include bladder cancer and ovarian cancer and metheoglobinemia.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

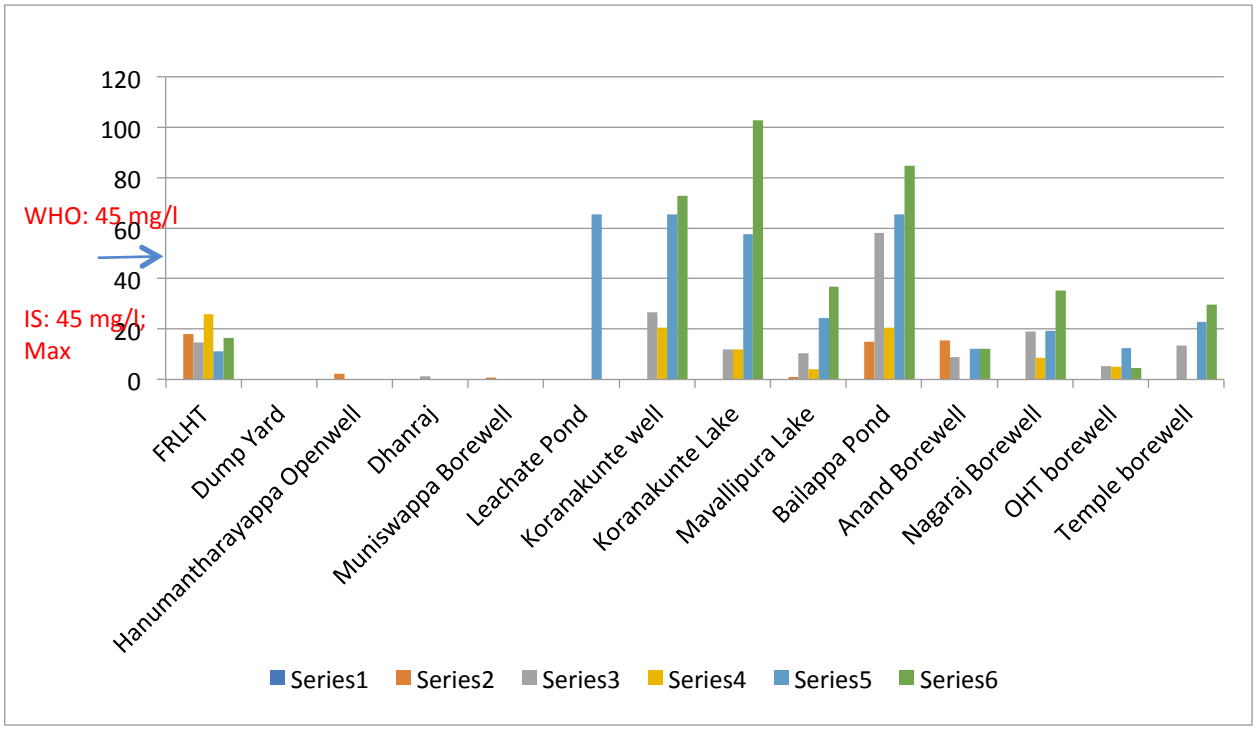
Nitrate is the most highly oxidised form of nitrogen which is commonly found in drinking waters. Unpolluted water contains minute amounts of nitrate. Significant sources of nitrate are chemical fertilizers, decayed vegetable and animal matter, domestic effluents, sewage sludge disposal onto land, industrial effluents and leachates from refuse dumps and also atmospheric washout. Nitrates are a nutrient that plants absorb and convert into cell protein. The growth stimulation of plants, especially of algae, may cause objectionable eutrophication in surface waters.

Year	IS 10500/2012	WHO	2005	2006	2009	2011	2012	2016
FRLHT BORE WELL	45 mg/L Max	50 mg/L	-	18.05	14.6	26	11.2	16.52
Dump Yard			0	-	-	-	-	-
Hanumantharayappa Openwell			-	2.22	-	-	-	-
Dhanraj Field Bore Well			0	-	1.2	-	-	-
Muniswappa Borewell			-	0.73	-	-	-	-
Ramky Leachate Pond			-	-	-	ND	**65.48**	**2344**
Koranakunte well			-	-	26.6	20.5	**65.45**	**72.9**
Koranakunte Lake			0	-	11.93	12	**57.5**	**102.8**
Mavallipura Lake			-	1.08	10.4	4	24.45	36.82
Bailappa Pond			-	15.03	**58.25**	20.5	**65.48**	**84.9**
Anand Borewell			-	15.37	8.9	ND	12.08	12.2
Nagaraj Borewell			0	-	19	8.5	19.21	35.31
OHT borewell			-	-	5.2	5	12.52	4.55
Temple borewell			-	-	13.4	-	22.85	29.62

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis:
Increase in level of nitrates at sites closer to landfill is worrisome. Of special concern is that some sites that had recorded safe level of nitrates in the past have crossed the desirable and permissible threshold of 45 mg/L over time. Like in Koranakunte well (2009: 26.6 mg/L, 2012: 24.2 mg/L, 2016: 72.9 mg/L), and in Koranakunte lake (2009: 11.93 mg/L, 2012: 57.42 mg/L, 2016: 102.8 mg/L). At sites that are over a mile away from the landfill, though they are within acceptable limits, there is a concerning upward trend that can be observed. (For example: at the temple bore well 2009: 13.4 mg/L, 2012: 18.5 mg/L,

2016: 29.62 mg/L). Mavallipura tank and Nagaraj well with recorded values above 35mg/L in 2016 show trends similar to temple bore well.



Impact: The presence of high nitrate at different sampling sites indicates the possibility of high contamination from organic matter. The most susceptible population which can be impacted due to high levels of nitrate are infants. High nitrates present the high risk that they may convert into nitrites, which increases the risk of methemoglobinemia in bottle-fed infants, a condition in which haemoglobin can carry oxygen, but is not able to release it effectively for building body tissues.

Lead-

Risks or effects of Lead –
High intake of lead reduces mental capacity (IQ/ mental retardation), can cause blood disorders, hypertension and even death. Lead also interferes with kidney and neurological functions and hearing.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Lead is a heavy metal that should not be present in drinking water as it is a serious contaminant affecting particularly children. Lead in water supply systems may be due to corrosion of lead based pipes. In addtion, industrial and smelter discharges, mine wastes, and dissolution of lead from plumbing fixtures, contributes to lead in water. Besides, lead-based paints may also contribute to the presence of lead in water.

Lead, Pb	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Reduces mental capacity (mental retardation), interference with kidney and neurological functions, hearing loss, blood disorders, hypertension, death at high levels
Sources	Paint, diesel fuel combustion Pipes and solder, discarded batteries, paint, leaded gasoline Natural deposits
Treatment	Ion Exchange, Activated Carbon, Reverse Osmosis,Distillation

Year	**IS 10500/2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**
FRLHT Bore Well	0.01 mg/L Max	0.01 mg/L Max	-	<0.01	-	<0.01	-	<0.01
Hanumantharayappa Openwell			-	<0.01	-	-	-	-
Muniswappa Bore Well			-	<0.01	-	-	-	-
Ramky Leachate Pond			-	**0.3**	-	**0.77**	-	**0.33**
Dump Yard Bore Well			<0.01	-	-	-	-	-
Dhanraj Field Bore Well			**0.07**	-	-	-	-	-
Koranakunte Well			-	-	0	**0.04**	<0.01	<0.01
Koranakunte Lake			<0.01	-	ND	**0.03**	<0.01	<0.01
Mavallipura Lake			-	<0.01	0	<0.01	**0.2**	<0.01
Bailappa Pond			-	**0.3**	ND	**0.05**	**0.58**	<0.01
Anand Bore Well			-	<0.01	ND	ND	<0.01	<0.01
Nagaraj Bore Well			<0.01	-	ND	<0.01	<0.01	<0.01
OHT Bore Well			-	-	0	<0.01	<0.01	<0.01
Temple Bore Well			-	-	-	ND	<0.01	<0.01

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

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Analysis: The Ramky Leachate pond has revealed high levels of lead over the years. In 2006 it was 30 times over the acceptable limit, which increased to 77 times in 2011 and is about 33 times when analysed in 2016. Similarly, the Bailappa Pond, which also collects leachates, is revealing extremely high levels of lead. Considering the fact that the leachates have never been captured for treatment in appropriate treatment plants, it implies that this lead has found its way into all other surface and ground water aquifers in the impacted zone over time. This is indicated in the high presence of lead in Koranakunte lake and well. Though the presence of lead has not been found in other samples beyond the permissible limits, it may well be that this could be an outcome of occasional sampling. Only a thorough and regular sampling of water in the contaminated zones will indicate the actual and persistent presence of lead in the water systems of the impacted zone. Needless to state, the fact that at least three water samples have indicated very high presence of lead is a deeply worrying aspect.

Impact: Young children absorb 4-5 times more lead than adults. Further, the åccumulated lead is more persistently present in their bodies as the biological half-life may be considerably longer than in adults[72]. Further, lead is bio-accumulative in bones, teeth, the kidneys, liver and the brain. Lead has a particularly debilitating and life threatening impact on children, and other susceptible populations, such as pregnant women (foetuses are impacted adversely when mothers are contaminated by lead). Lead is extremely toxic to the nervous system, especially of children, and can interfere with calcium metabolism. It is also associated with renal tumors. High intake of lead makes children particularly vulnearable to rapid deterioration in their mental capacity (IQ/ mental retardation), and can cause blood disorders, hypertension, coma and even death. Lead also interferes with kidney and neurological functions and hearing.[73] There is simply no safe level of lead in blood.

Iron

Risks or effects of Iron–
High amounts of iron in water can impart a brackish colour, a rusty sediment, and also a bitter or metallic taste. Iron also promotes undesirable bacterial growth ("iron bacteria") within a waterworks and distribution system, resulting in the deposition of a slimy coating on the piping.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Iron is naturally present in drinking water, but seldom in concentrations greater than 10 milligrams per liter (mg/L) or 10 parts per million. Iron is mainly present in water in two forms: either the soluble ferrous iron or the insoluble ferric iron. Water containing ferrous iron is clear and colourless because the iron is completely dissolved. When exposed to air, the water turns cloudy and a reddish brown substance begins to form. This sediment is the oxidized or ferric form of iron that will not dissolve in water. As little as 0.3 mg/l can cause water to turn a reddish brown colour.[74]

Iron, Fe	
IS 10500-1991	Desirable : 0.3 mg/l , Permissible : 1.0 mg/l
Risks or effects	Brackish color, rusty sediment, bitter or metallic taste, brown- green stains, iron bacteria, discolored beverages
Sources	Leaching of cast iron pipes in water distribution systems Natural
Treatment	Oxidizing Filter , Green-sand Mechanical Filter

[72] The **biological half-life** or terminal **half-life** of a substance is the time it takes for a substance (for example a metabolite, drug, signalling molecule, radioactive nuclide, or other substance) to lose **half** of its pharmacologic, physiologic, or radiologic activity.

[73] Lead Poisoning and Health, World Health Organisation Fact Sheet, August 2017, accessible at: http://www.who.int/mediacentre/factsheets/fs379/en/

[74] Iron in Drinking Water – Factsheet, Illinois Department of Public Health, accessible at: http://www.idph.state.il.us/envhealth/factsheets/ironfs.htm

Year	IS 10500/2012	WHO	2006	2009	2011	2012	2016	2017
FRLHT BORE WELL	0.3 mg/L Max	0.1mg/L	0.05	0.02	<0.01	0.12	0.25	-
Hanumantharayappa Openwell			0.07	-	-	-	-	-
Muniswappa Borewell			0.05	-	-	-	-	-
Dhanraj Field Bore Well			-	0.21	-	-	-	-
Ramky Leachate Pond			-	-	-	**28.5**	**3.64**	**3**
Koranakunte well			-	**6.77**	<0.01	**4.92**	<0.1	0.2
Koranakunte Lake			-	**2.31**	<0.01	**2.44**	0.24	**5**
Mavallipura Lake			0.1	**5.88**	<0.01	**3.15**	**0.47**	**2**
Bailappa Pond			0.12	**2.71**	0.06	**2.16**	<0.1	0.2
Anand Borewell			0.05	**0.46**	ND	0.12	<0.1	<0.1
Nagaraj Borewell			-	0.07	0.1	0.16	<0.1	-
OHT borewell			-	0.04	0.1	0.08	<0.1	-
Temple borewell			-	0.06	ND	0.09	<0.1	-
New Nagaraj Borewell			-	-	-	-	-	0.2
Ro no 21			-	-	-	-	-	<0.1

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable limit (max) for Iron is 0.3 mg/l. In 2012, the concentration of Iron in Bailappa check dam was 2.16mg/l, Koranakunte lake 2.44mg/l, Koranakunte open well 4.92 mg/l, Ramky landfill leachate pond is 28.5 (95 times the acceptable limit) and in Mavallipura lake it is 3.15. And in 2016, Ramky leachate pond exhibited 3.64 mg/l and Mavallipura Lake 0.47mg/l.

Impact: Iron content in water may affect the taste and appearance of water. High amounts of iron in water can impart a brackish colour, a rusty sediment, and also a bitter or metallic taste. Iron also promotes undesirable bacterial growth ("iron bacteria") within a waterworks and distribution system, resulting in the deposition of a slimy coating on the piping.

Boron

Risks or effects of Boron–
The ingestion of large amounts of boron can affect the central nervous system.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Boron is an essential element for plant growth. Drinking water rarely contain more than 1.0mg/L and generally less than 0.1mg/L, concentrations which are considered innocuous for human consumption. Boron may occur naturally in some water or may find its way into a watercourse through cleaning compounds and industrial effluents. Boron can also result from wastewater discharges.

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016
FRLHT BORE WELL	0.5 mg/L Max	0.5 mg/L Max	-	<0.01	-	0.1	-	<0.5
Hanumantharayappa Openwell			-	<0.01	-	-	-	-
Muniswappa Borewell			-	<0.01	-	-	-	<0.5
Ramky Leachate Pond			-	<0.01	-	-	<0.01	<0.5
Koranakunte well			-	-	0.28	**4**	<0.01	<0.5
Koranakunte Lake			-	-	-	**2.2**	<0.01	<0.5
Mavallipura Lake			-	<0.01	0.32	0.4	<0.01	**1.24**
Bailappa Pond			-	<0.01	ND	**5**	<0.01	<0.5
Anand Borewell			-	<0.01	ND	ND	<0.01	<0.5
Nagaraj Borewell			-	-	ND	0.2	<0.01	<0.5
OHT borewell			-	-	0.44	0.08	<0.01	<0.5
Temple borewell			-	-	-	-	<0.01	<0.5

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable and permissible limit (max) for Boron is 0.5 and 1.0 mg/l. In the 2016 analysis, high levels of Boron (1.24 mg/L) were found at the Mavallipura Lake.

Impact: Though there is no clear scientific understanding of the impacts of Boron ingestion in humans, it has been revealed by experiments that high levels of boron ingestion has impacted the absorption of necessary minerals by the human body. In addition, there have noticeable impacts in testicular health and also in pregnant women when high levels of boron have been found in drinking water sources.[75]

Chloride

Risks or effects of Chloride–
High levels of chloride intake can result in bladder cancer and rectal cancer.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Chlorides are widely distributed in nature as salts of sodium (NaCl), potassium (KCl), and calcium ($CaCl_2$). Chloride in water may be considerably increased by treatment processes in which chlorine or chloride is used. Chloride finds its way into surface and groundwater from both natural and anthropogenic sources,

[75] *Boron in Drinking-water*, Background document for development of WHO Guidelines for Drinking-water Quality, 1998, accessible at: http://www.who.int/water_sanitation_health/dwq/boron.pdf

such as run-off containing inorganic fertilizers, landfill leachates, septic tank effluents, animal feeds, industrial effluents, irrigation drainage, and seawater intrusion in coastal areas.[76]

Chloride, Cl	
IS 10500-1991	Desirable : 250 mg/l , Permissible : 1000 mg/l
Risks or effects	High blood pressure, salty taste, corroded pipes, fixtures and appliances, blackening and pitting of stainless steel
Sources	Fertilizers Industrial wastes Minerals, seawater
Treatment	Reverse Osmosis , Distillation, Activated Carbon

Year	**IS 10500:2012**	**WHO**	**2006**	**2009**	**2011**	**2012**	**2016**
FRLHT Bore Well	250 mg/L Max	100 mg/L	20.49	123	35	249	219.93
Hanumantharayappa Openwell			229.92	-	-	-	-
Dhanraj Field Bore Well			-	53	-	-	-
Muniswappa Bore Well			20.99	-	-	-	-
Ramky Leachate Pond			-	38	-	**5880**	**2979.08**
Koranakunte Well			-	**980**	**2706**	**1932**	**1134.65**
Koranakunte Lake			-	**692**	**1521**	**3248**	**1274.6**
Mavallipura Lake			96.96	176	208	98	112
Bailappa Pond			**2127**	**1820**	**3405**	**6230**	**584.82**
Anand Bore Well			35.98	202	ND	**680**	226.93
Nagaraj Bore Well			-	48	56.5	62	69.48
OHT Bore Well			-	76	35	39	58
Temple Bore Well			-	48	-	39	52.48

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable and Permissible limit (max) for Chloride is 250 and 1000 mg/l. Higher concentration was seen in Bailappa check dam (2009: 1820 mg/l, 2012: 6230 mg/l, 2016:584.82 mg/l), Koranakunte lake (2009: 692 mg/l, 2012: 3248mg/l, 2016: 1274.6 mg/l), Koranakunte well (2009:980 mg/l, 2012:1932 mg/l, 2016: 1134.65 mg/l), Ramky leachate pond (2006: 2127mg/l, 2012:5880 mg/l, 2016: 2979.08mg/l), Anand borewell (2012: 680 mg/l).

Impact: Chloride increases the electrical conductivity of water and thus increases its corrosiveness. In metal pipes, chloride reacts with metal ions to form soluble salts, thus increasing levels of metals in drinking-water.

Free Residual Chlorine

Risks or effects of Free Residual Chlorine–
Taste and odour characteristics of phenols and other organic compounds present in a water supply may be intensified. Potentially carcinogenic chloro-organic compounds such as chloroform may be formed. Combined chlorine formed on chlorination of ammonia-or amine-bearing waters adversely affects some aquatic life.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Chlorine is the most widely used primary disinfectant and is also often used to provide residual disinfection in the distribution system. The chlorination of water supplies and polluted waters serves primarily to destroy or deactivate disease-producing micro-organisms.

Chlorine reacts with naturally occurring organic matter in raw water to form a range of unwanted by-products. Guideline values have been established for a number of these by products.

Year	**IS 10500:2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	0.2 mg/L Max	0.5-1.5 mg/L Max	-	<0.01	-	<0.01	-	<0.2	<0.2
Hanumantharayappa Open Well			-	<0.01	-	-	-	-	-
Muniswappa Borewell			-	<0.01	-	-	-	-	-
Ramky Leachate Pond			-	-	-	ND	<0.01	<0.2	<0.1
Koranakunte Well			-	-	ND	<0.01	<0.01	<0.2	<0.1
Koranakunte Lake			-	-		<0.01	<0.01	<0.2	<0.1
Mavallipura Lake			-	<0.01	ND	<0.01	<0.01	<0.2	<0.1
Bailappa Pond			-	<0.01	ND	<0.01	<0.01	<0.2	<0.1
Anand Bore Well			-	<0.01	ND	ND	<0.01	<0.2	<0.1
Nagaraj Bore Well			-	-	ND	<0.01	<0.01	<0.2	-
OHT Bore Well			-	-	ND	<0.01	<0.01	<0.2	-
Temple Bore Well			-	-	ND	ND	<0.01	<0.2	-
New Nagaraj Bore Well			-	-	-	-	-	-	<0.1
RO No 21			-	-	-	-	-	-	<0.1

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis:
Free residual chlorine was found within the Permissible limit (0.2 mg/l min) in all the water samples till 2016.

Impact: Taste and odour characteristics of phenols and other organic compounds present in a water supply may be intensified. The compounds most widely considered as representatives of chlorination by-products for the purposes of setting standards and monitoring are the trihalomethanes (THMs), such as chloroform, which are suspected Carcinogens as they produce free radicals in human bodies. Chlorine and THMS have been linked to various types of cancer, kidney and liver damage, immune system dysfunction, disorders of the nervous system, hardening of the arteries, and birth defects.[77] Combined chlorine formed on chlorination of ammonia-or amine-bearing waters adversely affects some aquatic life.

[77] See, *Chlorine in Drinking-water: The Good, the Bad and the Ugly*, accessible at: http://www.waterbenefitshealth.com/chlorine-in-drinking-water.html

Calcium and Magnesium as indicators of Hardness of Water,

Hardness may be defined as the soap destroying power of water. Hardness is classified as carbonate and non-carbonate. The carbonate hardness, designated as 'temporary' hardness, is due to the presence of calcium and magnesium biocarborates. The non-carbonate hardness, designated as 'permanent' hardness, is due to calcium and magnesium sulphates, chlorides and nitrates.

Calcium presence in Mavallipura waters:

Risks or effects of Calcium–
The presence of high calcium levels in water results in incrustation in plumbing systems. the continuous consumption of water with high calcium content can result in the development of kidney stones and also poses cardiovascular disease risk.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Year	IS 10500:2012	WHO	2006	2009	2011	2012	2016	2017
FRLHT Bore Well	75 mg/L Max	200 mg/L Max	28.05	72	35	**122**	**133.87**	**145**
Hanumantharayappa Openwell			63.32	-	-	-	-	-
Muniswappa Borewell			46.89	-	-	-	-	-
Dhanraj Field Bore Well			-	69	-	-	-	-
Ramky Leachate Pond			-	-	-	64	**156.31**	**112**
Koranakunte Well			-	-	-	**88**	32.06	**80**
Koranakunte Lake			-	-	44	24	36.07	56
Mavallipura Lake			35.27	-	38	32	40.08	40
Bailappa Pond			**120.24**	-	14	36	24.05	52
Anand Bore Well			18.03	**83**	ND	**221**	**114.63**	**152**
Nagaraj Bore Well			-	54	66	53	51.3	-
OHT Bore Well			-	**83**	**72**	**70**	**80.16**	-
Temple Bore Well			-	61	ND	56	52.1	-
New Nagaraj Bore Well			-	-	-	-	-	120
RO No 21			-	-	-	-	-	36

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis:
The desirable & permissible limit (max) for Calcium is 75 & 200 mg/l.
Calcium was found above the desirable limits in Ramky leachate pond (2006: 120.24mg/l, 2016: 156.31 mg/l), FRLHT (2009: 72 mg/l, 2012: 122 mg/l, 2016: 133.87 mg/l), Koramkunte well (2009: 118 mg/l, 2012: 88 mg/l), Anand's Residence Bore well (2009: 83 mg/l, 2012: 221 mg/l, 2016: 114.63 mg/l), Mavallipura village Bore well (2009: 83 mg/l, 2016: 80.16 mg/l).

Impact: High levels of calcium in drinking water can be attributed to the dumping of domestic waste, mainly skeletal waste of cooked meat. High levels of calcium leads to calcification of the water distribution system and changes in water taste. Continuous consumption of water with high calcium content can result in the development of kidney stones and also poses cardiovascular disease risk.

Magnesium
Magnesium is the fourth most abundant cation in the body and the second most abundant cation in intracellular fluid. It is a cofactor for some 350 cellular enzymes, many of which are involved in energy metabolism. It is also involved in protein and nucleic acid synthesis and is needed for normal vascular tone and insulin sensitivity.

Risks or effects of Magnesium–
High content of magnesium in water results in poor lathering. Magnesium along with sulphate is laxative in nature. High magnesium intake can also increase the risks for cardiovascular diseases.

Finding in 2016-17:
The water samples collected from closest village to landfill show values beyond the permissible limit.

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
FRLHT Bore Well	30 mg/L, Max	150 mg/L	-	10.69	30	15	**50**	**33.55**	27.22
Hanumantharayappa Open Well			-	19.93	-	-	-	-	-
Muniswappa Bore Well			-	17.01	-	-	-	-	-
Dhanraj Field Bore Well			-	-	17	-	-	-	-
Ramky Leachate Pond			-	-	-	-	**140**	**187.17**	**39**
Koranakunte Well			-	-	**67**	**269**	**180**	**143.42**	**54**
Koranakunte Lake			-	-	ND	**150**	**238**	**199.33**	**151**
Mavallipura Lake			-	12.63	ND	**29**	23	21.4	19
Bailappa Pond			-	**184.71**	ND	**80**	**130**	**92.37**	**34**
Anand Bore Well			-	6.8	12		**72**	**38.9**	**37**
Nagaraj Bore			-	-	19	**30**	28	**35**	-

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
Well									
OHT Bore Well			-	-	**31**	**32**	21	**31.6**	-
Temple Bore Well			-	-	15		24	**30.14**	-
New Nagaraj Bore Well			-	-	-	-	-	-	**49**
Ro 21			-	-	-	-	-	-	24

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable & permissible limit (max) for Magnesium is 30 & 100 mg/l.
Samples with Magnesium beyond the permissible limit are reported in Koranakunte Lake (199.3mg/l), Koranakunte open well (143.42 mg/l) and Ramky leachate pond (187.17 mg/l).

Impact: High content of magnesium in water results in poor lathering. Magnesium along with sulphate is laxative in nature. High magnesium intake can also increase the risks for cardiovascular diseases.

Copper

Risks or effects of Copper–
Copper has been shown to cause acute gastrointestinal discomfort and nausea at concentrations above about 3 mg/L. Consumption of high levels of copper can result in anemia, digestive disturbances, liver and kidney damage and gastrointestinal irritations.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and air. It has many practical uses in our society and is commonly found in coins, electrical wiring, and pipes. It is an essential element for living organisms, including humans, and-in small amounts-necessary in our diet to ensure good health. Copper salts are used in water supply systems to control biological growth of reservoirs and distribution pipes and to catalyse in oxidation of manganese. Corrosion of copper-containing alloys in pipe fitting may introduce measurable amounts of copper into piped water systems.

Copper, Cu	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : 1.5 mg/l
Risks or effects	Anemia, digestive disturbances, liver and kidney damage, gastrointestinal irritations, bitter or metallic taste; Blue-green stains on plumbing fixtures
Sources	Leaching from copper water pipes and tubing, algae treatment Industrial and mining waste, wood preservatives Natural deposits
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016
FRLHT Bore Well	0.05 mg/L Max	2 mg/L	-	<0.01	-	<0.01	-	<0.05
Hanumantharayappa Openwell			-	<0.01	-	-	-	-
Muniswappa Borewell			-	<0.01	-	-	-	-
Ramky Leachate Pond			-	-	-	ND	**0.36**	<0.05
Koranakunte Well			-	-	**0.06**	0.01	<0.01	<0.05
Koranakunte Lake			-	-	ND	<0.01	0.03	<0.05
Mavallipura Lake			-	<0.01	0	<0.01	0.01	<0.05
Bailappa Pond			-	**0.05**	ND	0.02	**0.05**	<0.05
Anand Bore Well			-	<0.01	ND	-	0.02	<0.05
Nagaraj Bore Well			-	-	ND	<0.01	0.01	<0.05
OHT Bore Well			-	-	0	<0.01	0.02	<0.05
Temple Bore Well			-	-	ND	ND	0.01	<0.05

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable & permissible limit (max) for Copper is 0.05 & 1.5 mg/l. Water samples from Koranakunte well (0.06 mg/l) and Ramky leachate pond (0.36 mg/l) drawn in 2009 and 2012 respectively showed high levels of copper.

Impact: Copper has been shown to cause acute gastrointestinal discomfort and nausea at concentrations above about 3 mg/L. Too much copper can cause adverse health effects, including vomiting, diarrhea, stomach cramps, and nausea. It has also been associated with liver damage and kidney disease. Consumption of high levels of copper can result in anemia, digestive disturbances, liver and kidney damage and gastrointestinal irritations.[78] In surface waters, copper is toxic to aquatic plants at concentrations sometimes below 1 mg/L. Similar concentrations may also be toxic to some fish. Significant concentrations of copper in water is a considerable environmental hazard.[79]

Manganese

Risks or effects of Manganese–
High levels of manganese makes water appear brownish in color, and alters the taste of water.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

[78] **Copper in Drinking Water Health Effects and How to Reduce Exposure,** Minnesota Department of Health Factsheet, accessible at: http://www.health.state.mn.us/divs/eh/water/factsheet/com/copper.html
[79] Chemistry for Environmental Engineering and Science, Sawyer, Clair, et. al., Tata McGraw Hill, 2003. (p. 720)

Manganese, Mn	
IS 10500-1991	Desirable : 0.1 mg/l , Permissible : 0.3 mg/l
Risks or effects	Brownish color, black stains on laundry and fixtures at .2 mg/l, bitter taste, altered taste of water-mixed beverages
Sources	Landfills Deposits in rock and soil
Treatment	Ion Exchange , Chlorination, Oxidizing Filter , Green-sand Mechanical Filter

Manganese is associated with iron minerals and occurs in nodules in ocean, fresh water and soils. Manganese is an element essential to the proper functioning of both humans and animals, as it is required for the functioning of many cellular enzymes. Manganese is used principally in the manufacture of iron and steel alloys and manganese compounds and as an ingredient in various products (IPCS, 1999; ATSDR, 2000). Manganese dioxide and other manganese compounds are used in products such as batteries, glass and fireworks. Potassium permanganate is used as an oxidant for cleaning, bleaching and disinfection purposes.

Year	**IS 10500:2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**
FRLHT Bore Well	0.1 mg/L Max	0.1 mg/L Max	-	0.03	-	<0.01	-	<0.1
Hanumantharayappa Open Well			-	0.04	-	-	-	-
Muniswappa Borewell			-	0.07	-	-	-	-
Ramky Leachate Pond			-	-	-	ND	**0.15**	<0.1
Koranakunte Well			-	-	**1.91**	**0.3**	**1.04**	<0.1
Koranakunte Lake			-	-	-	0.1	**0.13**	<0.1
Mavallipura Lake			-	**0.26**	**0.39**	**0.6**	0.02	<0.1
Bailappa Pond			-	**0.41**	ND	<0.01	**0.12**	<0.1
Anand Bore Well			-	0.03	ND	ND	0.02	<0.1
Nagaraj Bore Well			-	-	ND	0.02	0.01	<0.1
OHT Bore Well			-	-	0	<0.01	0.02	<0.1
Temple Bore Well			-	-	ND	ND	0.01	<0.1

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis*:* The desirable & permissible limit (max) for Manganese is 0.1 & 0.3 mg/l. Water samples drawn from different sites in the years 2006, 2009 and 2012 showed manganese above the desired levels. Highest levels of manganese was found in Ramky leachate pond in 2012 (0.15 mg/l), Koranakunte well in 2009 (1.91 mg/l), Koranakunte lake in 2012 (0.13 mg/l), Mavallipura lake in 2009 (0.39 mg/l), and in Bailappa pond in 2006 (0.41 mg/l).

Impact *High levels of manganese makes water appear brownish in color, and alters the taste of water. While manganese is a required mineral for humans, and certain amount of manganese must be consumed everyday, high intakes can have adverse health impacts. Most significantly, if waste*

accumulated in landfills contain manganese, burning that waste will release manganese into the atmosphere. Inhaling air/smoke with manganese fumes is known to causing neurotoxicity, called 'manganism', characterised by a 'Parkinson like syndrome"[80].

Sulphate

Risks or effects of Sulphate–
The presence of high suphate levels in water imparts a bitter, medicinal taste to water. The consumption of such water can result in a laxative effect leading to diarrhea and dehydration.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit with an exception of Ramky leachate pond which recorded 326 mg/l.

Sulphate ions usually occur in natural waters. Sulfates are also discharged into water from mines and smelters and from kraft pulp and paper mills, textile mills, and tanneries.

Sulphate, SO_4	
IS 10500-1991	Desirable : 200 mg/l, Permissible : 400 mg/l
Risks or effects	Bitter, medicinal taste, scaly deposits, corrosion, laxative effects, "rotten-egg" odor from hydrogen sulfide gas formation
Sources	Animal sewage, septic system, sewage By-product of coal mining, industrial waste Natural deposits or salt
Sulphate Treatment	Ion Exchange, Distillation , Reverse Osmosis

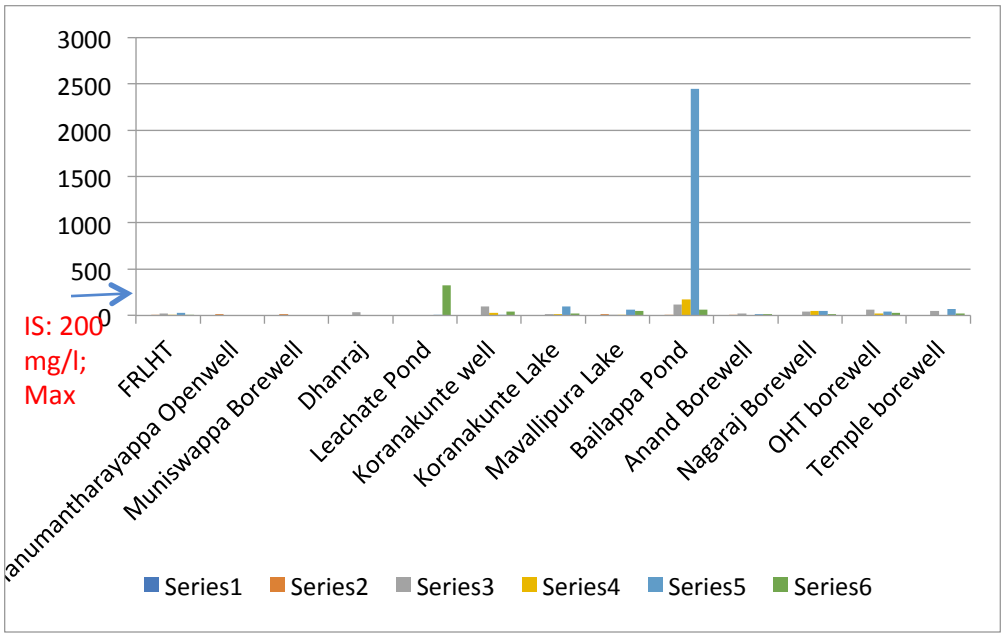
Year	**IS 10500:2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	200 mg/L Max	-	-	10.31	21.2	9	27	10.22	11.75
Hanumantharayappa Open Well			-	12.34	-	-	-	-	ND
Muniswappa Borewell			-	17.35	-	-	-	-	ND
Dhanraj Field Bore Well			-	ND	36	-	-	-	ND
Ramky Leachate Pond			-	-	-	ND	3.2	**326**	ND
Koranakunte Well			-	-	98	30	7.3	40	ND
Koranakunte Lake			-	-	12.8	13	98.4	22.37	ND
Mavallipura Lake			-	15.63	10	1.6	66.2	51.25	ND
Bailappa Pond			-	9.87	118	175	**2450**	61.48	ND

[80] Manganese in Drinking-water, World Health Organisation Factsheet, 2011, accessible at: http://www.who.int/water_sanitation_health/dwq/chemicals/manganese.pdf

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
Anand Bore Well			-	8.91	24.8	ND	12.8	16.34	ND
Nagaraj Bore Well			-	-	45	50	49.2	17.44	ND
OHT Bore Well			-	-	64	18	44.2	30.21	ND
Temple Bore Well			-	-	50.3	ND	69.2	24.23	ND

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable & permissible limit (max) for 200 & 400 mg/l. Water sample from Bailappa pond drawn in 2012 showed sulphate at a whopping level of 2450 mg/l. In 2016, the sulphate level at Ramky leachate pond was at 326 mg/l.



Impact: High levels of sulphate in water can affect the taste of the water, it lends a bitter, medicinal taste to water. The consumption of such water can result in a laxative effect leading to diarrhea and dehydration.

Fluoride

Risks or effects of Fluoride–
The consumption of water high in fluoride can result in dental and skeletal flurosis.

Finding in 2016-17:
The water samples collected from closest village to landfill show values in close approximation of desirable limit with an exception of Konamkunte Lake, Konamkunte open well, Bailappa Check dam, and Mavallipura Village Lake.

Traces of fluorides are present in many waters; higher concentrations are often associated with underground sources.

Fluoride, F	
IS 10500-1991	Desirable : 1.0 mg/l, Permissible : 1.5 mg/l
Risks or effects	Brownish discoloration of teeth, bone damage
Sources	Industrial waste Geological
Treatment	Activated Alumina, Distillation, Reverse Osmosis, Ion Exchange

Year	**IS 10500 /2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	1.0 mg/L Max	1.5 mg/L Max	-	0.33	0.21	0.4	0.22	**0.96**	**0.97**
Hanumantharayappa Open well			-	0.6	-	-	-	-	-
Muniswappa Bore well			-	0.49	-	-	-	-	-
Dump Yard Bore Well			0.34	-	-	-	-	-	-
Ramky Leachate Pond				-	-	-	0.19	0.64	2
Dhanraj Field Bore Well			0.38	-	0.22	-	-	-	-
Koranakunte Well			-	-	0.31	0.4	0.35	**1.48**	**0.9**
Koranakunte Lake			-	-	0.31	0.4	0.53	**1.19**	**1**
Mavallipura Lake			-	0.95	0.23	0.5	0.42	**1.21**	<1
Bailappa Pond			-	**1.3**	0.45	0.5	0.74	**1.23**	0.4
Anand Bore Well			-	0.34	0.26	ND	0.28	**0.95**	0.3
Nagaraj Bore Well			0.48	-	0.27	0.5	0.29	0.87	-
OHT Bore Well			-	-	0.24	0.5	0.36	0.65	-
Temple Bore Well			-	-	0.27	ND	0.29	0.86	-
New Nagaraj Bore Well			**-**	-	-	-	-	-	0.5
RO No 21			**-**	-	-	-	-	-	0.4

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable & permissible limit (max) is 1 & 1.5 ppm respectively. Almost all samples were in close approximation of desirable limit with an exception of Koranakunte Lake (2016: 1.9 ppm), Koranakunte open well (2016: 1.4 ppm), Bailappa Check dam (2016: 1.23 ppm), and Mavallipura Village Lake (2016: 1.21 ppm).

Impact: Intake of excessive fluoride leads to the formation of dental and skeletal fluorosis, a condition in which the skeletal system loses its strength resulting in pain and impairment of muscles. The incidence of fluorosis in Mavallipura is rather high.

Phenolic compound

Risks or effects of Phenolic Compounds–
Consumption of phenolic compounds may lead to the damage of the central nervous system and also induce cancer.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Phenols are defined as hydroxyl derivatives of benzene, and its condensed nuclei occur in domestic and industrial wastewaters, natural wastes and potable water supplies. Odoriferous and objectionable tasting chlorophenols are formed as a result of chlorination of water containing phenol. They are also present in municipal wastewaters. Presence of phenols may lead to objectionable taste in chlorinated drinking water and hence its monitoring is essential. Phenols can be removed from drinking water by super-chlorination (chlorinedioxide or chloramines treatment) ozonation and activated carbon adsorption.

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016
FRLHT Bore Well	0.001 mg/L Max	0.002 mg/L Max	-	<0.001	<0.001	<0.001	-	<0.001
Muniswappa Bore Well			-	<0.001	-	-	-	-
Hanumantharayappa Open Well			-	<0.001	-	-	-	-
Ramky Leachate Pond			-	-	ND	ND	<0.001	<0.001
Koranakunte Well			-	-	<0.001	<0.001	<0.001	<0.001
Koranakunte Lake			-	-	-	<0.001	<0.001	<0.001
Mavallipura Lake			-	<0.001	<0.001	<0.001	<0.001	<0.001
Bailappa Pond			-	<0.001	-	<0.001	<0.001	<0.001
Anand Bore Well			-	<0.001	-	ND	<0.001	<0.001
Nagaraj Bore Well			-	-	-	<0.001	<0.001	<0.001
OHT Bore Well			-	-	<0.001	<0.001	<0.001	<0.001
Temple Bore Well			-	-	ND	ND	<0.001	<0.001

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: Permissible limit (max) is 0.002 mg/l. Phenolic compound was found within the Permissible limit in all the water samples till 2016.

Impact: Consumption of phenolic compounds may lead to the damage of the central nervous system and also induce cancer.

Mercury

Risks or effects of Mercury–
High levels of mercury in humans can result in loss of vision and hearing, intellectual deterioration, kidney disorders, nervous system disorders and even death.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Mercury is a metallic element that occurs naturally in the environment. The solubility of mercury compounds in water varies: elemental mercury vapour is insoluble, mercury (II) chloride is readily soluble, mercury(I) chloride is much less soluble and mercury sulfide has a very low solubility. Inorganic mercury compounds are rapidly accumulated in the kidney, the main target organ for these compounds. The biological half-time is very long, probably years, in both animals and humans. Mercury salts are excreted via the kidney, liver, intestinal mucosa, sweat glands, salivary glands and milk; the most important routes are via the urine and faeces.

Mercury, Hg	
IS 10500-1991	Desirable : 0.001 mg/l, Permissible : No relaxation
Risks or effects	Loss of vision and hearing, intellectual deterioration, kidney and nervous system disorders, death at high levels
Sources	Fungicides Batteries, fungicides Mining, electrical equipment, plant, paper and vinyl chloride Natural deposits
Treatment	Reverse Osmosis, Distillation

Year	**IS 10500:2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**
FRLHT Bore Well	0.001 mg/L Max	0.006 mg/L	-	<0.001	<0.001	<0.001	-	<0.001
Hanumantharayappa Open Well			-	<0.001	-	-	-	-
Muniswappa Bore Well			-	<0.001	-	-	-	-
Ramky Leachate Pond			-	-	-	-	<0.001	<0.001
Koranakunte Well			-	-	<0.001	<0.001	<0.001	<0.001
Koranakunte Lake			-	-	ND	<0.001	<0.001	<0.001
Mavallipura Lake			-	<0.001	<0.001	<0.001	<0.001	<0.001
Bailappa Pond			-	<0.001	ND	<0.001	<0.001	<0.001
Anand Bore Well			-	<0.001	ND	ND	<0.001	<0.001
Nagaraj Bore Well			-	-	ND	<0.001	<0.001	<0.001
OHT Bore Well			-	-	<0.001	<0.001	<0.001	<0.001
Temple Bore Well			-	-	ND	ND	<0.001	<0.001

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable limit for Mercury (max) is 0.001 mg/l. Mercury was found within the desirable limit in all the water samples.

Impact: Inorganic mercury compounds are rapidly accumulated in the kidney, the main target organ for these compounds. The biological half-life is very long, probably years, in both animals and humans. Mercury salts are excreted via the kidney, liver, intestinal mucosa, sweat glands, salivary glands and milk; the most important routes are via the urine and faeces. High levels of mercury in humans can cause loss of vision and hearing, intellectual deterioration, kidney disorders, nervous system disorders and even death.

Cadmium

Risks or effects of Cadmium–
Cadmium is highly toxic. It causes the disease 'itai-itai' which is a painful rheumatic condition. Cadmium also affects the cardio vascular system, gastro-intestinal and also can cause hyper tension. Cadmium also causes generally cancers in laboratory animals and has been linked epidemiologically with certain human cancers.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Cadmium occurs in sulphide minerals that also contain zinc, lead or copper. The metal is used in electroplating, batteries, paint pigments and in alloys with various other metals. Cadmium is usually associated with zinc. Cadmium is highly toxic and has been implicated in some cases of poisoning through food. Cadmium may enter water as a result of industrial discharges or the deterioration of galvanized pipe.

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
FRLHT Bore Well	0.003 mg/L Max	0.003 mg/L Max	ND	<0.01	ND	<0.01	ND	<0.003	ND
Hanumantharayappa Open Well			ND	<0.01	ND	ND	ND	ND	ND
Muniswappa Bore Well			ND	<0.01	ND	ND	ND	ND	ND
Ramky Leachate Pond			ND	ND	ND	ND	**0.07**	<0.003	BDL
Koranakunte Well			ND	ND	0	<0.01	**0.05**	<0.003	BDL
Koranakunte Lake			ND	ND	ND	<0.01	**0.04**	<0.003	BDL
Mavallipura Lake			ND	**0.03**	0	**0.01**	**0.01**	<0.003	ND
Bailappa Pond			ND	**0.05**	ND	**0.01**	**0.08**	<0.003	BDL
Anand Bore Well			ND	<0.01	ND	ND	<0.01	<0.003	ND
Nagaraj Bore Well			ND	ND	ND	<0.01	<0.01	<0.003	ND
OHT Bore Well			ND	ND	0	**0.1**	<0.01	<0.003	ND
Temple Bore Well			ND	ND	ND	ND	<0.01	<0.003	ND
RO no 21			ND	ND	ND	ND	ND	ND	BDL

'-'Indicates sample from this location not taken that year. ND- Not Done for that location. BDL: Below Desired Level.

Analysis: The desirable limit (max) for 0.003 mg/l. In 2012, water samples drawn from different sites contained high levels of cadmium – Ramky leachate pond (0.07 mg/l), Koranakunte well (0.05 mg/l) and lake (0.04 mg/l), and Bailappa pond (0.08 mg/l). Water sample from Bailappa pond drawn in 2006 also contained 0.05 mg/l of Cadmium which is way higher than the maximum permissible limit.

Impact: Cadmium is highly toxic and has been implicated in some cases of poisoning through food. The presence of high cadmium levels indicates that steel and battery waste has been dumped at the landfill. Cadmium has a long half-life of 10-35 years. Cadmium causes the disease 'itai-itai' which is a painful rheumatic condition. Cadmium also affects the cardio vascular system, gastro-intestinal and also can

cause hyper tension. Laboratory animals exposed to high levels of Cadmium have developed cancers. Epidemiological evidence suggests human cancers can be an outcome of cadmium exposure.

Arsenic

Risks or effects of Arsenic–
The immediate symptoms of acute arsenic poisoning include vomiting, abdominal pain and diarrhoea. These are followed by numbness and tingling of the extremities, muscle cramping and death, in extreme cases. The intake of arsenic also results in gastritis, gastroenteritis, neuropathies, melanosis, jaundice, neuritis, psoriasis, and poses an increased risk for cancer of the urinary bladder, lung and skin.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Arsenic is a natural component of the earth's crust and is widely distributed throughout the environment in the air, water and land. It is highly toxic in its inorganic form. The greatest threat to public health from arsenic originates from contaminated groundwater.

Arsenic, As	
IS:10500-1991	Desirable: 0.05 mg/l Permissible: No relaxation
Risks or effects	Weight loss; Depression; Lack of energy; Skin and nervous system toxicity
Sources	Previously used in pesticides (orchards) Improper waste disposal or product storage of glass or electronics, Mining Rocks
Treatment	Activated Alumina Filtration, Reverse Osmosis, Distillation, Chemical Precipitation, Ion exchange, lime softening

Year	**IS 10500:2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	0.01 mg/L Max	0.01 mg/L Max	-	<0.01	<0.01	<0.01	-	<0.01	<0.01
Hanumantharayappa Open Well			-	<0.01	-	-	-	-	-
Muniswappa Bore Well			-	<0.01	-	-	-	-	-
Ramky Leachate Pond			-	-	-	-	<0.01	<0.01	ND
Koranakunte Well			-	-	<0.01	<0.01	<0.01	<0.01	ND
Koranakunte Lake			-	-	-	<0.01	<0.01	<0.01	ND
Mavallipura Lake			-	<0.01	<0.01	<0.01	<0.01	<0.01	ND
Bailappa Pond			-	-	ND	<0.01	<0.01	<0.01	ND
Anand Bore Well			-	-	ND	ND	<0.01	<0.01	ND
Nagaraj Bore Well			-	-	ND	<0.01	<0.01	<0.01	ND
OHT Bore Well			-	-	<0.01	<0.01	<0.01	<0.01	ND
Temple Bore Well			-	-	-	-	<0.01	<0.01	ND

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable & permissible limit (max) for Arsenic is 0.01 & 0.05 mg/l. Arsenic was found within the permissible limit in all the water samples.

Impact: Arsenic is highly toxic in its inorganic form. The greatest threat to public health from arsenic originates from contaminated groundwater. The immediate symptoms of acute arsenic poisoning include vomiting, abdominal pain and diarrhoea. These are followed by numbness and tingling of the extremities, muscle cramping and also death in extreme cases. The intake of arsenic also results in gastritis, gastroenteritis, neuropathies, melanosis, jaundice, neuritis, psoriasis, and poses an increased risk for cancer of the urinary bladder, lung and skin.[81]

Cyanide

Risks or effects of Cyanide–
The risks of cyanide intake include damage to the thyroid gland and nervous system. Cyanide may lower vitamin B12 levels and hence exacerbate vitamin B12 deficiency.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Cyanides are occasionally found in drinking-water, primarily as a consequence of industrial contamination and disposal of cyanide contaminated waste.

Cyanide	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Thyroid, nervous system damage
Sources	Fertilizer Electronics, steel, plastics mining
Treatment	Ion Exchange, Reverse Osmosis, Chlorination

Year	**IS :10500:2012**	**WHO**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	0.05 mg/L, Max	0.07 mg/L	<0.01	<0.01	<0.01	-	<0.05	<0.05
Hanumantharayappa Open well			<0.01	-	-	-	-	-
Muniswappa Bore well			<0.01	-	-	-	-	-
Ramky Leachate Pond			-	-	-	<0.01	<0.05	ND
Koranakunte well			-	<0.01	<0.01	<0.01	<0.05	ND

[81] Arsenic in Drinking-water, World Health Organisation Factsheet, 2011, accessible at: chttp://www.who.int/water_sanitation_health/dwq/chemicals/arsenic.pdf

Year	IS :10500:2012	WHO	2006	2009	2011	2012	2016	2017
Koranakunte Lake			-	-	<0.01	<0.01	<0.05	ND
Mavallipura Lake			<0.01	<0.01	<0.01	<0.01	<0.05	ND
Bailappa Pond			-	-	<0.01	<0.01	<0.05	ND
Anand Bore Well			-	-	-	<0.01	<0.05	ND
Nagaraj Bore Well			-	-	<0.01	<0.01	<0.05	ND
OHT Bore Well			-	<0.01	<0.01	<0.01	<0.05	ND
Temple Bore Well			-	-	-	<0.01	<0.05	ND

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable limit (max) for Cyanide is 0.05 mg/l. Cyanide was found within the permissible limit in all the water samples.

Impact: Cyanide is acutely toxic to humans. It affects the thyroid gland and the nervous system. Cyanide may lower vitamin B12 levels and hence exacerbate vitamin B12 deficiency.

Zinc

Risks or effects of Zinc–
Concentration above 5mg/L can cause a bitter astringent taste in water. High intake of zinc can result in stomach cramps, nausea and vomiting.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Zinc is an essential and beneficial element for human growth. Zinc commonly enters the domestic water supply from deterioration of galvanized iron and dezincification of brass. In such cases, lead and cadmium also may be present because they are impurities of zinc used in galvanizing. Zinc in water may also be the result of industrial waste pollution.

Zinc, Zn	
IS 10500-1991	Desirable :5 mg/l, Permissible : 15 mg/l
Risks or effects	Metallic taste
Sources	Leaching of galvanized pipes and fittings, paints, dyes Natural deposits
Treatment	Ion Exchange Water Softeners, Reverse Osmosis, Distillation

Year	IS :10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
FRLHT Bore Well	5 mg/L Max	15.0 mg/L	-			<0.01	ND	<0.4	<0.4
Hanumantharayappa Open well			-	0.02	-	-	-	-	-
Muniswappa Bore well			-	0.04	-	-	-	-	-
Ramky Leachate Pond				-	-	-	0.7	0.8	ND
Dump Yard			<0.01	-	-	-	-	-	ND
Dhanraj Field Bore Well			0.1	-	-	-	-	-	ND
Koranakunte Well				-	0.16	0.01	0.5	<0.4	ND
Koranakunte Lake			0.02	-	ND	0.01	0.07	<0.4	ND
Mavallipura Lake			-	0.04	0.11	<0.01	0.04	<0.4	ND
Bailappa Pond			-	0.1	ND	0.01	0.08	<0.4	ND
Anand Bore well			-	0.04	ND	ND	0.08	<0.4	ND
Nagaraj Bore well			<0.01	-	ND	<0.01	0.03	<0.4	ND
OHT Bore well			-	-	0.05	0.07	0.06	<0.4	ND
Temple Bore well			-	-	ND	ND	0.04	<0.4	ND

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable & permissible limit (max) for Zinc is 5 & 15 mg/l. Zinc was found within the permissible limit in all the water samples.

Impact: High levels of zinc imparts an undesirable taste to water. High intake of zinc can result in stomach cramps, nausea and vomiting.

Chromium

Risks or effects of Chromium–
High intake of chromiumcan result in skin irritation/allergic dermatatis, skin and nasal ulcers, lung tumors, gastrointestinal effects, damage to the nervous system and circulatory system. Chromium accumulates in the spleen, bones, kidney and liver.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Chromium, Cr	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Skin irritation, skin and nasal ulcers, lung tumors, gastrointestinal effects, damage to the nervous system and circulatory system, accumulates in the spleen, bones, kidney and liver
Sources	Septic systems Industrial discharge, mining sites Geological
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Chromium is found chiefly in chrome-iron ore. The most common forms of chromium that occur in natural waters in the environment are: trivalent chromium (chromium-3) and hexavalent chromium (chromium-6). Chromium-3 is an essential human dietary element. It is found in many vegetables, fruits, meats, grains, and yeast. Chromium-6 occurs naturally in the environment from the erosion of natural chromium deposits. Chromium salts are used extensively in industrial processes and may enter a water supply through the discharge of wastes, especially the disposal of batteries into domestic waste streams. Chromium may exist in water supplies in both the hexavalent and the trivalent state, although the trivalent form rarely occurs in potable water.

Year	**IS :10500:2012**	**WHO**	**2005**	**2006**	**2009**	**2011**	**2012**	**2016**	**2017**
FRLHT Bore Well	0.05 mg/L Max	0.05 mg/L	-	-	-	<0.01	-	<0.05	<0.05
Hanumantharayappa Open well			-	<0.01	-	-	-	-	-
Muniswappa Bore well			-	<0.01	-	-	-	-	-
Ramky Leachate Pond			-	-	-	-	<0.01	<0.05	ND
Muniswappa Bore Well			<0.01	-	-	-	-	-	ND
Dhanraj Field Bore Well			<0.01	-	-	-	-	-	ND
Koranakunte Well			-	-	0	ND	<0.01	<0.05	ND
Koranakunte Lake			<0.01	-	ND	<0.01	<0.01	<0.05	ND
Mavallipura Lake			-	<0.01	0	<0.01	<0.01	<0.05	ND
Bailappa Pond			-	<0.01	ND	<0.01	<0.01	<0.05	ND
Anand Bore Well			-	<0.01	ND	ND	<0.01	<0.05	ND
Nagaraj Bore Well			<0.01	-	ND	<0.01	<0.01	<0.05	ND
OHT Bore Well			-	-	0	<0.01	<0.01	<0.05	ND
Temple Bore Well			-	-	-	ND	0.01	<0.05	ND

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable limit (max) for Chromium is 0.05 mg/l. Chromium was found within the permissible limit in all the water samples.

Impact: There are demonstrated instances of chromium being released to the environment by leakage, poor storage, or inadequate industrial waste disposal practices.

High intake of chromium can result in skin irritation/allergic dermatatis, skin and nasal ulcers, lung tumors, gastrointestinal effects, damage to the nervous system and circulatory system. Chromium accumulates in the spleen, bones, kidney and liver.

Aluminium

Naturally occurring aluminium as well as aluminium salts used as coagulants in drinking-water treatment is the primary sources of aluminium in drinking-water.

Risks or effects of Aluminium–
Aluminium can be neurotoxic to humans.

Finding in 2016-17:
The water samples collected from closest village to landfill show values within the permissible limit.

Year	IS 10500:2012	WHO	2005	2006	2009	2011	2012	2016	2017
FRLHT Bore Well	0.03 mg/L, Max	0.10 mg/L	-	<0.01	ND	0.01	ND	<0.03	<0.03
Hanumantharayappa Open well			-	<0.01	-	-	-	-	-
Muniswappa Bore well			-	<0.01	-	-	-	-	-
Ramky Leachate Pond			-	-	-	ND	<0.01	<0.03	ND
Koranakunte Well			-	-	0	ND	<0.01	<0.03	ND
Koranakunte Lake			-	-	ND	**0.06**	<0.01	<0.03	ND
Mavallipura Lake			-	<0.01	0	**0.9**	<0.01	<0.03	ND
Bailappa Pond			-	<0.01	ND	**0.1**	<0.01	<0.03	ND
Anand Bore well			-	<0.01	ND	ND	<0.01	<0.03	ND
Nagaraj Bore well			-	-	ND	<0.01	<0.01	<0.03	ND
OHT Bore well			-	-	0	**0.05**	<0.01	<0.03	ND
Temple Bore well			-	-	ND	ND	<0.01	<0.03	ND

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Analysis: The desirable & permissible limit (max) for Aluminium are 0.03 and 0.2 mg/l. Aluminium was found within the permissible limit in all the water samples.

Impact: Aluminium can be neurotoxic to humans.

Biochemical Oxygen Demand (BOD) & Chemical Oxygen Demand (COD)

Risks or effects of Biochemical Oxygen Demand –
Excess BOD results in accumulation of organic matter and further results in eutrophication or dying of lakes.

Finding in 2016-17:
The water samples collected from closest village to landfill show values in all of the three lakes were much greater than that of the ideal value of 3mg/l.

The Biochemical Oxygen Demand is an empirical standardized laboratory test which measures oxygen requirement for aerobic oxidation of decomposable organic matter and certain inorganic materials in water, polluted waters and wastewater under controlled conditions of temperature and incubation period. The BOD test is applied for fresh water sources (rivers, lakes), wastewater (domestic, industrial), polluted receiving water bodies, marine water (estuaries, coastal water) and also for finding out the level of pollution, assimilative capacity of water body and also performance of waste treatment plants.

Analysis: Potable water should have BOD concentration less than or equal to 2 mg/L. BOD of 3mg/l is ideal for lakes, however in all of the three lakes the values found were much greater than that of the ideal value of 3mg/l.

Biochemical Oxygen Demand

Year	IS 10500/1991	2005	2006	2009	2011	2012	2016	2017
FRLHT BORE WELL	2mg/l	-	ND	0	0.2	0	ND	ND
Dump Yard		**44**	-	-	-	-	-	-
Dhanraj Field Bore Well		0	-	-	-	-	-	-
Ramky Leachate Pond		-	ND	0	-	**2149**	ND	ND
Koranakunte well		-	ND	**81.6**	**240**	**470**	ND	ND
Koranakunte Lake		**20**	ND	**35.3**	**180**	**150**	ND	ND
Mavallipura Lake		-	ND	**23.5**	**51**	-	ND	ND
Bailappa Pond		-	ND	**131**	**270**	**139**	ND	ND
Anand Borewell		-	ND	0	-	0	ND	ND
Nagaraj Borewell		0	ND	**32**	0.1	0	ND	ND
OHT borewell		-	ND	0	0.2	0	ND	ND
Temple borewell		-	ND	0	-	0	ND	ND

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Impact: High BOD indicates water contaminated with organic matter usually from sewage/ faecal matter. If the water is contaminated with sewage, then the water would be unsafe for consumption.

Chemical Oxygen Demand

Overall the leachate pond samples remain heavily contaminated. At one of the site visits, it was informed that the leachate treatment plant has never worked since the setting up of the landfill. Reason cited was lack of funding.

Year	2005	2006	2009	2011	2012	2016	2017
FRLHT Bore Well	-	ND	0	**<2**	0	ND	ND
Dump Yard Bore Well	**140**	-	-	-	-	-	-
Dhanraj Field Bore Well	0	-	0	-	-	-	-
Ramky Leachate Pond	-	ND	**<25**	-	**6016**	ND	ND

Year	2005	2006	2009	2011	2012	2016	2017
Koranakunte well	-	ND	**204**	**944**	**1316**	ND	ND
Koranakunte Lake	70	ND	**91.8**	**496**	**376**	ND	ND
Mavallipura Lake	-	ND	**61.2**	**192**	-	ND	ND
Bailappa Pond	-	ND	**367.2**	**976**	**376**	ND	ND
Anand Borewell	-	ND	0	-	0	ND	ND
Nagaraj Borewell	0	ND	**81.6**	**<2**	0	ND	ND
OHT borewell	-	ND	0	**<2**	0	ND	ND
Temple borewell	-	ND	0	-	0	ND	ND

'-'Indicates sample from this location not taken that year. ND- Not Done for that location.

Impact: High COD indicates the presence of organic matter making the water unsafe for consumption.

2.1.2 Contamination pathways

Before the land near Mavallipura village was leased out for dumping of the city garbage, the water was fit for human or livestock consumption. Villagers recall their healthy living state and that the Mavallipura cows were considered highest milk yielders in the region.

As figure 2 indicates on page 22, except for Subhedarpalya Village, all other settlements are situated downstream of the Mavallipura landfills. There are two contamination pathways: One through percolation of leachates into ground water aquifers over the past 15 years and the other is the leachates draining untreated into local wells, borewells, ponds, lakes, etc. Thus, the overall surface and ground water sources have been rendered unfit for drinking or domestic use.

This dumping of millions of tons of waste in the Mavallipura without any processing or attending to environmental norms and standards has adversely impacted the quality of streams flowing downstream into the Arkavathy river. The tanks of Kormanakunte, Mavallipura, Shivakote and Arvara Kandapur village lakes are particularly impacted. Such continuous contamination is in gross violation of the 11 Nov 2003 Notification of the Karnataka Dept. for Ecology and Environment, which regulates against pollution of the watershed of Thippagondanahalli reservoir and Arkavathy river, major drinking water sources of Bengaluru.

2.1.3 Water infrastructure and community management strategies

Before the landfill started the source of water for villagers were open wells, lakes, ponds and bore wells. The villagers said that the quality water then was not colored, had no odor or any sediment and that they would drink directly from the source. All that was necessary was to filter the water with a cloth and that too occasionally. Villagers recall that illnesses amongst them was rare. In contrast now, almost every other person is ill, which villagers say is a direct outcome of pollution from the landfill: "We never knew what it meant to fall sick or to have a disease back then. But now we see grandchildren aged between 2

to 15 year old falling sick or even dying. It is more painful to see the little ones in pain". Such statements from villagers were common during fieldwork.

In response to the appeals for rehabilitating their drinking water source, the High Court has issued various directions. On 31/10/2014, for instance, the Court observed that "the Commissioner of BBMP who is present before Court assures us that through water tanks, potable water would be supplied to the villagers of Mavallipura and adjoining villages forthwith and they would also make some permanent arrangement regarding water supply." Subsequently RO plant were installed in the villages. Of the 5 RO plants installed in Mavallipura 2 plants are not working currently. But besides this intervention, there has not been any effort to tackle the sources of pollution of the water bodies of the area.

2.1.4 Conclusion

Based on the water samples collected and analysed in March 2016 and September 2017, and comparing these with results obtained from earlier sampling efforts, it is clearly evident that all drinking water and other water bodies of Mavallipura and other villagers impacted by the landfills have been contaminated. This has heightened the health and environmental risks to the local populations.

2.2 Health survey

As part of this study, Environment Support Group undertook a primary health survey during September 2017 in some of the villages impacted by the landfills at Mavallipura. In particular, the survey focussed on Mavallipura and Kurubarahalli villages of Shivakote Panchayat, Yelahanka taluk, and Ramagondanahalli and Subedarpalya villages of Gantiganahalli Panchayat. These are villages which are within a kilometre or two of the landfills, and are also all downstream.

Snow-ball sampling technique was adopted to conduct this survey. This is a technique in which affected individuals/family introduces to the researcher another person who is sick or affected in any way. Thereafter, personal interviews with victims and also focus group discussions with villagers were conducted in order to gather information of the possible health impacts from the landfills. Emphasis was laid on assessing the incidence of communicable and chronic diseases, and also the levels of morbidity and mortality. In addition, the survey focused on the condition of the environmental health of the area.

The survey was conducted by qualified medical doctors and assisted by ESG staff. The sample is taken from a pool of approximately 900 families, or a total population of 4500. In order to maintain the confidentiality of the information shared and privacy of the persons interviewed, the actual names are not provided in the report and will be made available on a need to know basis.

Village	Families (approx.)	Population (approx.)
Mavallipura	180	900
Kurubarahalli	80	400
Ramagondanahalli	600	3000
Subedarpalya	40	200
Total	**900**	**4500**

Findings of the survey:

With regard to children, it was discovered from the survey that there is very high incidence of respiratory disorders (like frequent cough), bronchopneumonia, meningitis, skin infections (fungal) and susceptibility to vector borne diseases (dengue) and also widespread viral fever episodes. In addition, developmental malformations were noticed.

In the case of women, several reported constant headaches, skin infections, respiratory disorders, and menstrual disorders. In addition, diabetes mellitus, was observed in many cases. Similarly, menstrual and skeleto-muscular disorder were common. There were also several cases where Hysterectomy (uterus removal surgery) had been performed. Besides, there were instances of Lung cancer, Kidney Failure, and the rare Fatty Liver condition were reported, which seem to be too high an incidence for the population surveyed. Vector borne diseases like Dengue, Chickungunya and other psychosomatic disorder.

Men also had Skin Infection, Respiratory Disorders, Diabetes Mellitus, Esophagus Cancer, Kidney Failure, Cardiac Arrest, Vector borne diseases like Dengue and other psychosomatic disorder.

2.2.1 Cases of morbidity and mortality

Report of recent assessment of the morbidity and mortality in impacted villages around Landfill area:

Impacts on Children:

Case 1 (Bronchopneumonia and skin infection): A male boy, aged 1.4 years, resident at Subeydarpalya, and the house is less than half a kilometre from the landfills. The child had Bronchopneumonia Indistress when he was five month old. (Baby was admitted on 12/09/2016 and discharged on 17/09/2016 in K.K.Hospital.) Currently suffering from recurrent skin infections, and developed pustules on hands and legs recently. The child is currently undergoing treatement for the infection, which the doctor has said could be due to contact with contaminated water.

Case 2 (fungal infection): A male boy, 4 years old, resident of Subeydarpalya and lies less than half a kilometre from the landfill. He suffers from recurrent fungal infections. He has also developed white

patches on his back, and around his waist and legs. The condition recurs if treatment is not ongoing. He is the elder brother of the child mentioned in Case 1.

Observation: Cases 1 and 2 are brothers. The family is poor and financially burden by the children taking ills constantly.

Case 3 (Hirschsprung disease): A female baby, four months old, and is diagnosed with Hirschsprung's Disease. Hirschsprung's (HIRSH-sproongz) disease is a condition that affects the large intestine (colon) and causes problems with passing stool. This is a congenital disorder and and results from missing nerve cells in the muscles of part or the entire colon of the baby. The baby was admitted in M.S.Ramaiah Hospital on 17/05/2017 and discharged on 31/05/2017 for treatment of this disorder.

Case 4 (Age with Dehydration): A two years female child, resident of Subeydarpalya and is diagnosed as Age with Dehydration. She resides less than half a kilometre from the landfill. The child was admitted in K.K.Hospital on 08/07/2017 and discharged on 12/07/2017. Her hospitalisation cost the family approx. Rs 17,000/-.

Case 5 (Viral fever): A 5 year old male, resident of Subedarpalya. Suffered from viral fever, which became critical, and had to be hospitalised at K. K. Hospital during 27/2/2017 to 4/3/2017. The cause of the fever was not established. The cost of hospitalisation was approx. Rs 16,000/-.

Observation: Cases 4 and 5 are siblings. The family is poor and has been struggling to meet the medical costs. It is also noted that the father of the children has suspected Dengue.

Case 6 (Duodenal perforation): A 13 year old male resident of Kuruburahalli and diagnosed with Duodenal perforation, possibly caused due to bacterial infection. He was admitted in M. S. Ramaiah Medical Hospital on 06/07/2017 and discharged on 25/07/2017. The boy has suffered trauma due to severe abdominal pain and constant bilious-vomiting. The family spent Rs. 1,56,000/- on the child;s treatment and BBMP has assisted in supporting part of the hospitalisation costs. The boy is still recovering from the surgery.

Case 7 (Dengue): A 11 year old female, suffered from dengue and had to be hospitalised in Aveksha Hospital, which cost the family Rs. 85,000/- approximately.

Observation: Cases 6 and 7 are siblings. The father is an autorickshaw driver and is the sole earner for the family. He reported that his wife is also unwell presently. Overall, the high costs of dealing with the children's illnesses and now supporting a sick wife, has made it extremely difficult to make ends meet, and the man is visibly distressed and depressed.

Case 8 (Psoriasis): A 5 year old female child, resident of Mavallipura, about a mile from the landfill. The child presents skin lesions which is eczematic all over the body. With scaling and reddish inflammation all over, the child is constantly complaining of continuous itching and is in trauma. Its only when lubricants

are applied that some relief is felt by the child. The condition was first observed when the child was 1 month old. It started from scalp area, which gradually extended to the entire body after a year. Since then, several different and repeated treatment approaches have been tries and at various hospitals including, Yelahanka Hospital, Malleshwaram Homeopathic Hospital, Baptist Hospital and St. John's Medical College Hospital. The family has also tried folk medicines to relive the child of her misery. Based on signs and symptoms presented by child, the disease has been diagnosed as Psoriasis.

Case 9 (Oral Cancer): A 11 year old female, resident of Kurubarahalli, diagnosed with Hemangioma Tongue, an extremely rare form of oral cancer. Hemangiomas are tumors identified by rapid cell (endothelial) proliferation in early infacy, followed by involution over time; vascular malformation result from anomalous development of vascular plexuses. Hemangiomas of the oral cavity are not common pathologic entities, but the head and neck are common sites. The child was admitted in M.S.Ramaiah Hospital on 28/04/2016 and discharged on 5/05/2016. She complained of swelling over right side of tongue from infancy, which has increasingly manifest over the past 2 years with occasional bleeding. The child underwent surgery (Resection of right side of Tongue) on 30/4/2016. Currently, the condition is recurring, increasing in size, and the child complains of pain and slurred speech.

Impacts on Women

Case 10 (Lung Cancer): A 50 year old female, recently died of Lung Cancer. She is survived by 3 children (Female- 2 & Male – 1). She was a home-maker and resided less than half a kilometre from the landfill. She is not known to have had any habit such as smoking or chewing tobacco. The family has spent between Rs. 5-6 lakhs on her treatment. In the later stages of her life, the cost of her medicines were exhorbitant: Rs.6000/- per vial. Which the family could not afford and hence the treatment was stopped. The family raised loans to sustain the hospitalisations bills and have not been able to repay them yet. Family members blame the constant fumes due to burning of garbage in the landfills as a chief cause for the the woman's suffering and eventual death.

Case 11 (Fatty liver, skin infection and skeleto-muscular disorder): A 65 year old female, resident of Subeydarpalya, suffers from Fatty Liver, Skin infection and Skeletal-muscular pain. She has 7 Children (Female- 4 & Male- 3) and is a home-maker. Her house is located less than half a kilometre of the landfill. The woman was operated for fatty liver about 2-3 years ago, on which her family spent approx. Rs. 2-3 lakhs. She also suffers from recurrent skin infections and has developed large pustules on her hand and fingers. The skin treatment has cost her an additional Rs. 1 lakh. Doctors who attend to her have informed her skin ailments are due to constant exposure to contaminated water. She has also developed skeletal-muscular disorders and complains of severe pain, difficulty in mobility, stiffness of joints and limbs, etc. The family consumes water now provided from an RO Plant and sometimes buy tanker water from Ramagondanahalli Bore well. It was also shared to the survey team that the family has lost 8-10 Cattle and 4 Goats due to consumption of water contaminated by leachates.

Case 12 (Renal Failure): A 27 year old female, resident of Mavallipura is diagnosed with Renal/Kidney

Failure. She has no habits (tobacco/smoking/alcohol). Before the landfill was situated, the family consumed water from village minitank or handpump. Now they consume drinking water from community RO plant. The family has no land or livestock. Her main source of income is to work as a farm labourer. She is currently undergoing dialysis. To cover the cost of her treatment, the family has sold her jewelry and also taken loans. With two small daughters, aged 3 years and 5 year old, the lady cries "I want to live only for my daughters. Who will look after them if some mishap happens to me?" She believes that the landfill has polluted the entire village and caused a situation in which every family is suffering and frequently there is mourning in the villages.

Case 13 (Pleural Effusion): A 38 year old female, resident of Mavallipura, is diagnosed with Pleural effusion (water in lungs). She used to do work as a labourer on daily wages. But due to her frail health, she now is at home. She has four daughters who are now studying in college. The expenditure on her health has exceeded Rs. 3,00,000/-. She has taken loans from private people which they are struggling to repay and instead are paying a steep interest of Rs. 6000/month. She has visited several hospitals to find a cure and has also been admitted for over 10 days in Saptagiri Hospital and for 3 months at Rajiv Gandhi Hospital.

Before the landfills were located, the family consumed water directly local wells and handpumps. However, the leachates have contaminated these waters, which have turned grey. The family resorts to consuming this water after filtering it through cotton cloth and also boiling. The lady complains that it is extremely difficult to live in the impacted area because of the stench and mosquitoes. Her major worry is that none of her daughters are finding grooms and so the family is resorting to placing them in relatives houses far away so they may get married.

Case 14 (Menstrual disorder): A 40 year old female, resident of Kurubarahalli, suffers from menstrual disorder. She has been asked to undergo surgery at M.S. Ramaiah Hospital but is unable to afford the operation. She says her health deteriorated after landfill came up. Without any option, till recently they were consuming water contaminated by the landfills. Over the past year, however, they have been relying on the RO plant for water. Without land, their main income is from farm labour, which is about Rs. 6000-7000/- per month, they have no land. Her husband has daily wage job, but now works for only 2-3 days a week, as there is not much farming taking place. She is the mother of two children. One of them, a son, suffers from regular bouts of fever, after recovering from dengue. But his condition is not improving as he complains of joint pain. The overall condition of the family is rather depressing, given the constant health setbacks and economic impoverishment.

Case 15 (Skeletal-muscular disorder and depression): A 42 year old female who lost her husband to a cardiac arrest that he suffered when police lathi-charged the villagers protesting against dumping in the landfills during 2012. She complains of severe pain due to skeletal-muscular disorders, and is visibly depressed. Despite chronic back pain, she is unable to take treatment due to costs involved. She stays alone in her crumbling home and ties flowers to earn some extra income. She has 3 daughters; all

married and settled elsewhere. Even though she lost her husband during the protest against the landfills, no compensation has been extended to her as yet.

Case 16 (Menstrual Disorder): A 42 year old female, resident of Mavallipura, suffers from Menstrual Disorder. She was working at Ramky along with her husband. When she started demanding health insurance from the company, she was fired from her job. Since then she is working at home as a tailor. During her work days at Ramky, they drank water directly from the company's bore well. Now she gets water for household needs from the RO plant. Due to the menstrual disorder she has been suffering over 7-8 years now, she is in acute pain and suffers high blood loss. This has rendered her weak, and she resorts to taking pain-killer injections to bear the pain. Without any savings she has no option but to work through her ailments as her husband has Oesophagus cancer. She is the main bread winner and has to take care of three children who are constantly sick with fever. The youngest, who is seven years old, complains of frequent headaches and is forced to skip school regularly. To sustain the mounting medical bills, the family has borrowed commercially, and unable to pay back the loans are resorting to servicing the interest at about Rs. 6-7000/ month. She complains all the family's ailments are due to the landfill, yet no one cares to remedy the situation. She also reports that doctors have rarely made a connection with the landfill and her family's constant ill-health.

Impacts on Men:

Case 17 (Oesophagal Cancer): A 43 year old male, resident of Mavallipura, and diagnosed with Oesophagal Cancer. He was working in the M/s Ramky operated landfill for 3 three years, when he was diagnosed with cancer. The company did not attend to his medical needs. He was operated in March 2017 and is now under chemotherapy. He was a major bread winner for the family, but now is unable to work. To attend to this medical needs, the family has sold all their valuables, drawn loans and have run up over Rs 3-4 lakhs loans already.

Observation: Cases 16 and 17 are wife and husband. The entire family is economically depressed, has no stable income. The children who are small are also frequently sick.

Case 18 (Diabetes Mellitus and Skin Infection): A 60 year old male, resident of Mavallipura, has Diabetes Mellitus and also suffers from skin infection. He used to work in fields near landfill for several years. He has developed white patches on his hands. Initially he took treatment, but now due to lack of financial resources, he has discontinued treatment for both Diabetes and skin infection.

Case 19 (Renal Failure): A 38 year old male, resident of Mavallipura, is diagnosed with Renal Failure. He has no habits (tobacco/smoking/alcohol). No associated family history of renal failure. Before the landfill the family consumed water from village minitank or handpump. Without any other source of water, the family continued to consume water from these very sources as they got contaminated by the landfills. Of late the family has shifted to consuming water from the community RO plant. The family has no land or livestock. He has two dependent family members. His monthly income is Rs 5467/- (works in the

canteen of the Indian Railways as daily wager) and he remains the only earning member in family. His treatment has cost him Rs. 18-20 lakhs and much of this has been serviced by loans.

Case 20 (Typhoid and Dengue): A 26 year old male, resident of Ramagondanahalli, is diagnosed with Typhoid. He resides at a distance of ≤1km from the landfill. About six months ago, he suffered from dengue. He has no other habits (tobacco/smoking/alcohol). Before the landfill the family consumed water from village minitank or handpump, from which they were forced to drink even as these sources got contaminated by the leachates from the landfill. Of late, the family is getting drinking water from community RO plants that have been recently set up. He has two dependent family members. Before the landfill, the household had 1 acre land, 7-8 cattle and 20-30 goat and sheep. Now all they are left with are 3 cattle. Most of their cattle, and all sheep and goat have been sold as there is no grazing pasture and the water is heavily polluted, constantly exposing livestock to infections. The frequent illnesses he is suffering from has had a debilitating impact on the family's economic situation as well. When suffering from Dengue, he was admitted to K.K.Hospital and spent Rs. 25,000 – 30,000/-. The family has taken loans from local villagers to pay for the treatment. He also complains of skin allergy and bronchial problems. He reports that his father passed away at the age of 74 years in 2014 due to a neurological disorder. (To attend to the father's illness, the family sold 1 gunta of land and spent over Rs 3 Lakhs. Now is mother, aged 58 years, is also sick and is suffering from skin infections.

Victims of Mavallipura's Toxic Legacy

Case 1, Male, 1.4 years (Bronchopneumonia and skin infection) 	**Case 6, Male, 13 years (Duodenal perforation)** 	**Case 8, Female, 5 years (Psoriasis)** 
Case 9, Female, 11 years (Oral Cancer) 	**Case 11, Female, 65 years (Fatty liver, skin infection and skeleto-muscular disorder)** 	**Case 12, Female, 27 years (Renal failure)** 
Case 16, Female, 42 years (Menstrual Disorder) 	**Case 17, Male, 43 years (oesophagal cancer)** 	**Case 19, Male, 38 years (renal failure)** 
	Case 20, Male, 26 years (typhoid and dengue) 	

2.2.2 Health implication of Mavallipura landfills

Three reports prepared by ESG (2010, 2013 and 2017) on the contamination levels in water samples drawn from different sites reveals the persistence of various contaminants in water due to the leachates flowing out of the landfills. There appears to be a direct impact of these on the quality of health of the local villagers, particularly of Mavallipura, Subeydarpalya, Ramagondanahalli and Kurubarahalli.

The cause for the morbidity and mortality in this select population can be potentially due to the unhygienic environment near the landfills and the resulting contamination of ground and surface water bodies. Approximately 900 families, or 4500 individuals, live in these impacted villages. As a result, the local residents are reporting very high rates of susceptibility to infectious and chronic diseases/disorders, a fact confirmed by health surveys conducted by ESG.

The health survey conducted in 2010 revealed that even when children were well-nourished, they fell sick frequently. In addition, the immunity levels were low. The situation appears to have drastically worsened in subsequent years, as morbidity rates are high and several have died contracted cancer and also died.

As per a recent study published in the journal – The Lancet Oncology[82], the recorded incidence of cancer in India for 2012 was 94 per 100 000 people. Except breast, cervical, and colorectal cancers, all other cancers in Indian women have a recorded incidence of less than five per 100,000 women. All cancers in Indian men except oral, lung, stomach, colorectal, pharyneal, and oesophageal cancers have an incidence of five per 100,000 men or less.

From the health survey conducted in 2013, in a population of 2,500 in the above-mentioned villages, two men (a case each of stomach cancer and adenocarcinoma) and one women died of oral cancer between 2010 and 2012. From the health survey conducted in 2017, two cases of cancer – one lung cancer and one oesophagus cancer and one case of oral cancer (hemangioma tongue) was observed in the same area.

Other diseases which have been known to affect the villagers, as revealed in the health surveys of 2010, 2013 and 2017, are gastroenteritis, skin infections, meningitis, cardiovascular disease and kidney failures, to name but a few. It is important to note that two people had died from kidney disease as reported in ESG's report of 2013. All the mortality cases are amongst those who have lived within a radius of a mile from either Bailappa's landfill or Ramky's landfill. This could possibly be due to the constantly high levels of TDS, nitrates, BOD and COD and the repeated incidence of skin infections, vomiting and diarrhoea in the affected populations.

The occurrence of skin infections and musculo-skeletal disorders is quite widespread, as is the spread of infectious diseases such as dengue, chikungunya, viral fevers, etc. Kidney failures is increasingly being reported amongst young men and women and this possibly be due to exposure to contaminated water.

Lead and boron are above desirable limits as per IS 10500 (2012): Drinking water. Lead is absorbed more in children than in adults, and the biological half-life of lead may be longer in children than in adults. The content of lead was found to be above desirable levels in water samples drawn from different sites in the years 2006, 2011, 2012 and 2016. Boron was present in levels in excess of the desirable limits in 2011 in water samples drawn from different sites.

In the water analysis conducted during 2017, Magnesium is another element that was found above desirable levels according to IS 10500 (2012): Drinking water. Cardiovascular diseases were observed in all the three health surveys conducted by ESG. Cadmium is highly toxic to humans, and was found to exceed the desirable levels of the Indian standards for drinking water at different sites in 2012. It is observed that cadmium has a long biological half life (upto 35 years). Cadmium has been known to affect the cardio-vascular system, gastro-intestinal system and can also cause hypertension.

Chronic intake of water which has high fluoride content leads to dental and skeletal flurosis. The fluoride content of water samples obtained from different sites exceed Indian standards in 2016. Fluorosis is a condition in which the skeletal system loses its strength resulting in pain and impairment of muscles. It has been observed that the incidence of fluorosis in Mavallipura is rather high.

The increasing frequency of livestock deaths is also a cause for worry. Not only has milk production in cattle reduced, the villagers report, but that the life span of cattle has also reduced. In addition, Shepherds report that due to the consumption of toxic pasture and water, the weight of sheep and goats is below par.

While the above-mentioned case of diseases/disorders is only indicative of the linkages between the contaminated environment, particularly of drinking water, a comprehensive study along with monthly monitoring of drinking water is critical to establish the true nature and extent of the adverse impacts of the landfills in Mavallipura.

3 Environmental Status and impacts of Landfills in and around Bengaluru

3.1 Introduction:

Bangalore has an estimated population of over 11 million today. It is known that villages around Bangalore have become victim to the massive and largely illegal dumping of about 4,000 tons of solid waste generated daily in the city. For years they have quietly endured the obnoxious impact of Bangalore's callousness. Efforts have been underway in dealing with the waste legacies of Mavallipura and Mandur. The High Court of Karnataka had directed at the very inception of hearing the aforesaid batch of PILs and made it clear that the dumping of waste in villages and landfilling as a waste management option must end. Despite the judicial orders and knowing the horrific impacts of their landfill toxic legacies, not one landfill in the metropolitan area is managed as per the norms and standards. This is true for approved landfills, and is particularly true for those that are unapproved – such as the use of quarry pits, or simply the dumping of waste in lowlands, lakes, forest areas, etc.

The lack of rigorous compliance with commitments made before the High Court and their enforcements, such as to bio-mine the waste, has created extremely complex pathways of contamination around these large landfills. The setting of waste processing units and bio-methanation plants in the city was supposed to have provided relief. But their operation has been tardy, in many cases, and most of the bio-methanation plants have remained dysfunctional due to poor management and regulatory impediments. All this has been a matter of serious enquiry by the High Court. In fact, the Judges have taken keen interest in ensuring that the waste is managed locally based on segregation at source, composting and recovery of recyclable material within the wards. But the lack of sincere application of rules and judicial directives, has created an emergent crisis of having to deal with massive loads of mixed waste every day, and the response has been to dump, not process waste.

Despite the court's intervention in the evolution of Mavallipura and Mandur and progressive orders by the High Court, to prevent other such detrimental development, such scenarios are repeating manifold again today in Bangalore's peri-urban areas. Abandoned quarries have become a major site for dumping waste, and this is being done without securing statutory environmental clearances or even making an effort to contain the damage to the local area due to the immediate and extensive leaching of pollutants.

A prime example of such colossal neglect is the Bellahalli quarry, where mixed waste is dumped, and this is threatening the safety of flight movements of Indian Air Force and civilian planes, as the Yelahanka Air Force Station and Jakkur Civil Aviation Training Aerodrome, are located less than 5 kms from this dumpsite. Both defense and civil aviation authorities have again (after refusing to grant a No Objection Certificate to Mavallipura landfill in the letter dated 14th August 2004) raised alarm at the heightened risk

of air crashes that are likely given the high density of scavenging bird populations such poorly managed dumping grounds attract. But there clearly does not seem to be any intent on the part of the BBMP or the State Government to respond to this call for action.

This section details the background to the decisions of developing some of the key landfill areas in and around Bengaluru and also provides a glimpse of the prevailing conditions. The following compilation is based on primary data collected during multiple field visits by ESG in 2016 and 2017, and secondary data collated.

3.2 Overview of approved and unapproved Landfills in Bengaluru

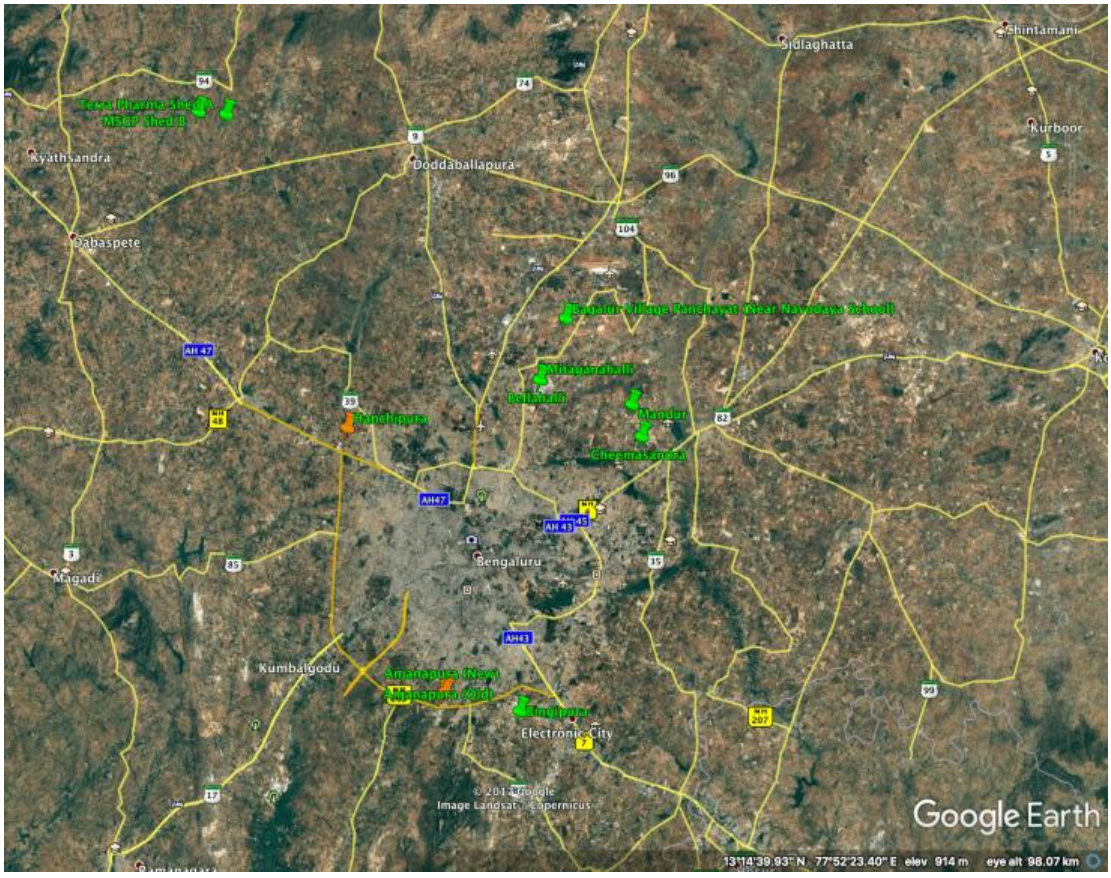


Figure 3 Google Overview of approved and unapproved landfill sites in Bengaluru

Landfill Site	Site Area: Total 670.1 acres	Approval and Operational Status	Distance from Cubbon Park
Bingipura	20 acres	Abandoned quarry, EC not secured and closed shut due to local protests	About 20 kms.
Cheemasandra	10 acres	Abandoned quarry, Environmental Clearance (EC) not secured and closed shut due to local protests	About 25 kms.
Terra Firma (Doddaballapura)	93 acres	EC extended, but poorly managed and forced shut due to local protests. Concerns remain over encroachment of commons	About 66 kms.
MSGP (Doddaballapura)	100 acres	EC extended, but poorly managed and locals have protested. Receiving waste currently.	About 70 kms.
M/s Ramky (Mavallipura)	48 acres	EC extended, but poorly managed and forced shut due to local protests. Concerns remain over encroachment of commons	About 30 kms.
Mandur (North and South)	34.10 and 135 acres	EC extended, but poorly managed and forced shut due to local protests. Concerns remain over encroachment of commons	About 30 kms.
Anjanapura (old and New)	5 and 20 acres	Abandoned quarry, EC not secured and closed shut due to local protests	About 18 kms.
Hanchipura and Thutadagudadahalli	5 acres	Abandoned quarry, EC not secured and currently receiving mixed waste which is dumped.	About 22.5 kms.
Bellahalli and Mittaganahalli	Over 200 acres	Abandoned quarry, EC not secured and currently receiving mixed waste which is dumped.	About 22 kms.

3.2.1 Bingipura

Dates of Field Visit: 19th March 2016 and 20th September 2017

Figure 4 Close proximity between Bingipura quarry and Bingipura Lake (Photo: 2017)

Over 20 acres of an abandoned quarry has been used for dumping mixed/unsegregated waste near S Bingipura, Hullimangala Post, Jigani Hobli, Anekal Taluk about 30 kms. south of Bangalore centre. Over 250 families reside in the vicinity of the quarry/dumping ground. The quarry pits collect rainwater and this along with the toxic leachates of the accumulated waste flows relentlessly into Bingipura Lake, which is barely a kilometre away. This has caused extensive damage to the local environment and affected the health of the local communities. Besides, it has resulted in the collapse of farming, and created toxic conditions for rearing livestock.

Figure 5 Mud-capped quarry leaking out leachate (Photo: 2016)

The waste received in Bingipura is largely from Bommanahalli City Municipal Council, Jayanagar, Hosur road and Electronic City. In 2013, the villagers blocked garbage trucks in an effort to contain the extensive contamination of their environment and health due to relentless dumping of waste. In fact, the KSPCB in its status report dated 24th April 2013[82] filed before the Hon'ble High Court of Karnataka in the instant writ petition confirmed that the dumping site had been "closed in view of public protest" and clarified that the "activity is stopped by BBMP". However, a couple of years later, during the Ganesha and Dasara festival seasons when waste accumulated across the city, the then Minister for Bangalore Development Mr. Ramalinga Reddy visited the village and assured villagers that Rs. 4.80 crores will be invested to clean up the mess and provide respite to the villagers from the pollution and consequent damage to their health.[83] Following on this assurance, BBMP promised a variety of precautionary measures, including that it would treat the leachates and also provide free drinking water to the impacted communities. However, garbage dumping resumed.[84] But BBMP's assurances were not followed upon forcing the villagers to protest and shut down the landfill once again.

Figure 6 Plastic waste floating in the rain water combined with leachate (Photo: 2017)

The environmental management effort that is visible at the site is the mud capping of the waste lying in the quarry. However, the effort does not seem to be successful as the capping has slipped exposing the waste and the rainwater that has collected in the quarry pits has created small floating islands of plastic waste. In addition, there are frequent incidents of the accumulated waste catching fire due to build-up of Methane gas from the decomposing organic waste.

[82] According to KSPCB report submitted in the Hon'ble High Court in WP 24739/12 c/w WP 46523/12, *viz*., Status report of Municipal Solid Waste Processing and Disposal in BBMP Area dated 24 April 2013.

[83] See, *Proesting village residents relent, garbage dumping to resume*, The Hindu, Bangalore, 14 September 2015, accessible at: http://www.thehindu.com/news/cities/bangalore/protesting-village-residents-relent-garbage-dumping-to-resume/article7648801.ece.

[84] See, *Dumping waste at S. Bingipura resumes*, The Hindu, Bengaluru, 16 September 2015, accessible at: http://www.thehindu.com/news/cities/bangalore/dumping-waste-at-s-bingipura-resumes/article7657014.ece.

With no plan in place for treating leachates from this unapproved and unscientific landfill, villagers report that most of their drinking water sources have been contaminated. There has been no supply of alternative drinking water to impacted communities. In fact, several private water truck operators are seen withdrawing water from ground water aquifers and supplying it to Electronic City and other parts of Bangalore.

3.2.2 Cheemasandra

Dates of Field Visit: 2nd June 2016 and 20th September 2017

Figure 7 Landfill at Cheemasandra mud-capped and closed in 2012. (Photo: 2017)

This landfill was closed on 4th February 2012 as the Karnataka State Pollution Control Board denied authorization. In the statement filed by the Board before the High Court of Karnataka, stated that this landfill was operated "without any processing activity" and that "this is an old landfill site and BBMP has called for tender by utilizing the existing dumped waste using bio-mining". It is spread over about 10 acres.

As of date, the BBMP has not taken any bio-mining activity as it was directed to by KSPCB. Consequently, the accumulated waste, even though mud-capped, is leaching out putrid effluents into the surrounding farms, ponds, and lakes. It is plausible that ground water has been contaminated due to leachate. This has imposed great difficulties on the local communities in sourcing drinking water and they are compelled to trek long distances to fetch water from a local steel factory.

Figure 8 Leachate continues to emit from the landfill till date. (Photo: 2017)

No steps have been taken to rehabilitate or provide basic amenities to the villagers who have been suffering due to extensive contamination of water and soil, even several years after the landfill has been forced to shut down.

3.2.3 Doddaballapura

Dates of Field Visit: 2nd June 2016 and 15th September 2017

There are two landfill sites located within 2-3 kms at Doddaballapura Taluk, about 50 km North of Bangalore. Both are operated as Public-Private Partnership initiatives.

Figure 9 Mixed waste dumped on the land at Terra Firma's processing site, attracting stray animals (Photo: 2016)

M/s Terra-Firma Biotechnologies Ltd. was accorded Environmental Clearance (EC) on 23rd June 2008[85] by the State Level Environment Impact Assessment Authority, Karnataka. According to the EC, the project involves comprehensive processing of waste received in an area of approximately 84 acres in Gundlahalli village.[86] The approved capacity is 600 MT of waste per day. However, it is reported that this facility received waste diverted from Mavallipura landfill, which was closed in July 2012, and the capacity at M/s Terra Firma increased to 1000 TPD. As per the report filed by KSPCB in the High Court of Karnataka, the facility was required to install sufficient infrastructure for processing 600 TPD of compost and also produce Refuse Derived Fuel (RDF), vermi-compost and bio-methanation of 6 MW capacity.

Figure 10 Smoke plumes emitting from the accumulated waste at Terra Firma's processing site

The plant is currently not in operation as it has suffered a series of emergencies, especially massive fires. In March 2015, a major fire broke out at the landfill site and toxic plumes from the massive mountains of waste catching fire spread over a radius of five km causing widespread trauma and damage to the health of local communities from Gundlahalli and other surrounding villages.[87] It is also reported by villagers that the leachate treatment system available on site is largely non-functional and grossly under capacity. As a result, leachate find its way into a deep valley that cuts through the facility and which is a major feeder

[85] No. SEIAA: 33: IND: 2007, State Level Environment Impact Assessment Authority, Karnataka, 23rd June 2008.

[86] However, according to KSPCB reports submitted in the Hon'ble High Court in WP 24739/12 c/w WP 46523/12, *viz.*, *Status report of Municipal Solid Waste Processing and Disposal in BBMP Area* dated 24 April 2013, it is reported that a land area allocated for the project is 93 acres. It is not clear if the land belongs to the project proponents. A review of the Record of Rights, Tenancy and Crops relating to these parcels of land reveals that they are held by one or several of the Directors of the M/s Terra Firma Biotechnologies Ltd. and it is reported in such records that it is agricultural land. However, the local villagers contend that the land is their common grazing pastures and that it has been illegally grabbed by the Project proponents without consent of the Local Panchayats, and converted into the Terra Firma dumping zone.

[87] See, *Major fire at Terra-Firma landfill*, Deccan Herald, 21 March 2015, accessible at: http://www.deccanherald.com/content/466928/major-fire-terra-firma-landfill.html.

channel of the region carrying rain and such other surface run-off into the Arkavathi River. In effect, large volumes of leachates are finding their way untreated into major drinking water source of Bangalore.

Several assurances by the BBMP to remedy the situation were not kept forcing the local communities to block trucks moving into the facility during March 2016, in effect shutting down the plant. This resulted in an intervention by the Chief Minister of Karnataka.[88] While this process was underway, the facility caught fire again in April 2016.[89] This resulted in the closure of the facility, a fact that is reflected in the map of landfills and waste processing facilities available on the BBMP website.

Figure 11 Piles of mixed waste lying un-processed at MSGP processing site. (Photo: 2016)

Villagers report that the fires are set off intentionally by M/s Terra Firma employees, particularly when the waste is dry, so that volume can be reduced and space made available to receive more waste for dumping, not processing. According to media reports, M/s Terra Firma has been accused in July 2015 of receiving bio-medical and industrial waste from M/s Biocon India, and this resulted in a complaint to the Police and also to the KSPCB, which lead in investigations being launched. As per the report, then Chairman Dr. Vaman Acharya confirmed the waste had originated from M/s Biocon. It is not clear from KSPCB's website if the investigation was carried forth to its logical conclusion.[90]

Another instance of M/s Terra Firma being embroiled in a controversy with regard to allegation that it had packaged burnt garbage as vermi-compost. Again, investigation has been launched by Regulatory Authorities, but it is not clear if this too has been taken to its logical end.[91]

The other facility is by M/s MSGP Infra Tech Pvt. Ltd., which was accorded Environmental Clearance (EC) on 15th May 2013[92] by State Level Environment Impact Assessment Authority, Karnataka. According to

[88] See, *Terra-Firma closure leads to indiscriminate dumping*, The Hindu, 05 April 2016, accessible at: http://www.thehindu.com/news/cities/bangalore/terra-firma-closure-leads-to-indiscriminate-dumping/article8434655.ece.
[89] See, *Residents choke in smoke as fire broke out at Terra Firma landfill*, Deccan Herald, 28 April 2016, accessible at: http://www.deccanherald.com/content/543140/residents-choke-smoke-fire-breaks.html.
[90] See, Biocon waste dumped at landfill to be tested in Bengaluru, Times of India, 8 July 2015, accessible at: https://timesofindia.indiatimes.com/city/bengaluru/Biocon-waste-dumped-at-landfill-to-be-tested-in-Bengaluru/articleshow/47980596.cms.
[91] See, After 10 days, the culprits remain unidentified in vermicompost scam, Citizen Matters Bengaluru, 12 June 2015, accessible at: http://bengaluru.citizenmatters.in/after-10-days-the-culprits-remain-unidentified-in-vermicompost-scam-7429.

the EC, the project involved comprehensive processing of waste received in an area of approximately 90 acres within Mudlakalenahalli and Chigaranahalli villages, "for a capacity of 750 TPD of municipal solid waste management. The total land area is 90 acres. Out of which, 5 acre area is for common facilities (roads, office etc..), 5 acres area is for recycling facility, 10 acres area is for composting facility, 20 acres area is for landfill facility, 4 acres area is for peripheral green belt and 46 Acres area is for social forestry etc...".[93] This plant too has experienced major fires, and in one incident of September 2015 it took five days to douse the fire. The BBMP is reported to have initiated action against the Project Proponents for their failure in managing the facility as per the norms.[94]

The combined environmental damaged caused by these two landfills is substantial. Both these facilities have not conformed with the EC conditions in many respects. Most evident is the fact that, both facilities do not have operational leachate treatment units, and as a result of which the leachates are seeping into local wells, lakes, ground water aquifers and the impact is evident in serious deterioration of water quality in borewells too. Besides, the stench from these facilities is carried for several km all around the 200 acres spread of the landfills where garbage is essentially dumped, not processed. There has not been any effort either by KSPCB or BBMP in attending to short-term and long-term implications to public health and environment from such intensive pollution over such a large area.

[92] No. SEIAA: 30: IND: 2012, State Level Environment Impact Assessment Authority, Karnataka, 15th May 2013.
[93] However, according to KSPCB reports submitted in the Hon'ble High Court in WP 24739/12 c/w WP 46523/12, *viz.*, Status report of Municipal Solid Waste Processing and Disposal in BBMP Area dated 24 April 2013, it is reported that a land area allocated for the project is 100 acres.
[94] See, *Fires draw the ire of villagers*, The Hindu, 16 September 2015, accessible at: http://www.thehindu.com/news/cities/bangalore/fires-draw-the-ire-of-villagers/article7658292.ece.

3.2.4 Mandur

Dates of Field Visit: 2nd June 2016 and 20th September 2017

There are two landfill sites located adjacently at Mandur, Bangalore East Taluk, approximately 25 kms. from North East of Bangalore Center. Both are operated as Public-Private Partnership initiatives.

Figure 12 Tonnes of waste lying on top of mud capped Mandur Landfills (Photo: 2016)

One landfill site spread over approximately 135 acres (Mandur South) is being operated by M/s Srinivasa Gayathri & Resource Recover Pvt. Ltd., since 2005. The other site of approximately 34.10 acres (Mandur North) is being operated by M/s Organic Waste India Pvt. Ltd., since 2005.95 According to the report filed by Technical Committee in the High Court of Karnataka, Mandur (North and South) facilities had a capacity of 1000 MTPD each.96 According to a study97, about 400-450 garbage trucks were dumping garbage every day. It is estimated that this amounted to about 2000-2250 tons of garbage dumped at Mandur every day, which is roughly half the total waste generated in Bangalore[98].

Mandur landfills are located on erstwhile grazing pastures (gomala), and is surrounded by at least three densely populated villages. The operators of the landfills are largely resorted to dumping waste in large pits dug out without providing any environmental control systems. The garbage piled up is about 200 ft. high, and locals satirically refer to these mounts as "Nandi Hills".99 In 2012, after villagers started protesting against the garbage being dumped at Mandur sites, BBMP began covering up the waste with mud to avoid the stench, which was spreading over wide area.100 The landfills attract large flocks of scavenging birds such as kites and packs of dogs are a common sight. This has turned movement of villagers and their cattle into a highly hazardous operation. On numerous instances, packs of feral dogs

[95] According to KSPCB report submitted in the Hon'ble High Court in WP 24739/12 c/w WP 46523/12, *viz.*, *Status report of Municipal Solid Waste Processing and Disposal in BBMP Area* dated 24 April 2013.

[96] According to Technical Committee report submitted in the Hon'ble High Court in WP 24739/12 c/w WP 46523/12, *viz.*, Evaluation of Technology for processing existing waste at Seven Landfill sites of BBMP, Bangalore dated 03 January 2013.

[a] Bengaluru, 27 November 2015, accessible at: https://www.researchgate.net/publication/284724767_Concept_Paper_on_Power_Generation_from_Municipal_Solid_Waste.

98 As per the action taken report of BBMP submitted to Honrouble HC in WP 46523/12 C/W WP 24739/12 dated 4.3.2013

[99] See, *Mandur: Hell on Earth*, Video documentary, Deccan Herald, Bengaluru, 14 July 2014, accessible at:
Part I: https://www.youtube.com/watch?v=ZLRRHrNHK5g
Part II: https://www.youtube.com/watch?v=qmHJr7K3-Mo

[100] Ibid.

have attacked livestock of villagers.101 In fact, in one case a woman was attacked by these dogs and killed.102

Leachate generated from the waste piled up seeps out of the landfills and is contaminating ground water aquifers and nearby lakes.103 The villages directly impacted by this contamination are Mandur, Gundur, Kamasundra and Bidarahalli. This has forced everyone to purchase drinking water from outside the area, which has burdened the finances of most families. Farmers are highly distressed due to extensive soil contamination. Some farmers report that after the landfills commenced operations, pest attacks on crops and horticultural farms have substantially increased. In fact, they bemoan that this has grossly affected the productivity of Bangalore Blue Grapes and Mangoes, which are special produce of this region.104

Locals report that their health has significantly deteriorated since the landfills were introduced into their grazing pastures. Children are worst affected. The situation is so bad that children prefer not to go to school in the local areas and drop out as schools are infested with mosquitoes. Several children choose to go to school far away from Mandur. The incidents of diseases have also substantially increased in the general population and there are high rates of respiratory disorders, allergies, dengue, miscarriages and renal failures being reported.105

In February 2013, a major fire broke out at the Mandur landfills and toxic plumes spread over neighboring villages resulting in extensive trauma and damage to their health. It took almost a week to contain the fire.106 Before this, the villages have consistently been protesting the extensive damage the landfills were causing them that hundreds of even chose to rally from Mandur to all the way to Bangalore by walk in order to draw attention to their plight.107 Several such protests have marked the operations of these landfills.

Lack of effective attention and response to attending to this dire situation by BBMP resulted in local villagers blocking garbage trucks moving into the landfills.108 This drew the attention of Chief Minister

[101] See, *Mandur: Hell on Earth*, Video documentary, Deccan Herald, Bengaluru, 14 July 2014, accessible at:
Part I: https://www.youtube.com/watch?v=ZLRRHrNHK5g
Part II: https://www.youtube.com/watch?v=qmHJr7K3-Mo
[102] See, Dogs maul a woman to death on Bengaluru outskirts, villagers live in fear, The News Minutes, 30 October 2015, accessible at: http://www.thenewsminute.com/article/dogs-maul-woman-death-bengaluru-outskirts-villagers-live-fear-35583.
[103] See, *Mandur: Hell on Earth*, Video documentary, Deccan Herald, Bengaluru, 14 July 2014, accessible at:
Part I: https://www.youtube.com/watch?v=ZLRRHrNHK5g
Part II: https://www.youtube.com/watch?v=qmHJr7K3-Mo
[104] Ibid.
[105] Ibid.
[106] See, A haze of smoke envelops Mandur landfill, The Hindu, 13 February 2013, accessible at: http://www.thehindu.com/news/cities/bangalore/a-haze-of-smoke-envelops-mandur-landfill/article4408443.ece.
[107] See, A walkathon to uproot garbage woes of Mandur, DNA, 21 December 2012, accessible at: http://www.dnaindia.com/bangalore/report-a-walkathon-to-uproot-garbage-woes-of-mandur-1780153.
[108] See, Heavy rains bring back Bangalore's garbage crisis, Hindustan Times, 7 June 2014, accessible at: http://www.hindustantimes.com/india/heavy-rains-bring-back-bangalore-s-garbage-crisis/story-EhfdLqYi1yx4bVV2lXgQ6L.html.

Siddaramaiah who visited the landfills, and realizing the truth of the matter ordered that landfills should not receive waste after 1st December 2014.109 M/s Srinivasa Gayathri Resource Recover Ltd.'s contract was terminated, as they did not perform their obligation as per the contract with BBMP.110

Further, BBMP accepting the recommendation of the Expert Committee on Solid Waste Management submitted to the Hon'ble High Court of Karnataka, decided to initiate Bio-mining and Bio-remediation of the accumulated waste, and tenders for the same have been issued.111 Recent report suggest that M/s Zonta Infra Tech Ltd., a German Company, has evinced interest in bio-mining about 30 lakh tons of accumulated waste at Mandur, on the condition that the land be leased to them for three decades.112 While all these proposals are being debated, there has been no substantive action on the part of BBMP, State Government in extending any relief to the impacted communities who continue to suffer from the extensive contamination of their soil, water, air and their health.

Figure 13 Lakhs of tonnes of waste lying at Mandur landfills emitting leachate which flows on the ground surface. (Photo: 2017)

[109] Ibid.

[110] Submission of BBMP Commissioner in the Hon'ble High Court order dated 31st October 2014 in WP 24739/12 c/w WP 46523/12.

[111] Submission of BBMP in the Hon'ble High Court order dated 18th June 2014 in WP 24739/12 c/w WP 46523/12.

[112] See, 30 lakh tonnes: German firm to clean up Mandur trash, Deccan Chronicle, 26 September 2017, accessible at: http://www.deccanchronicle.com/nation/current-affairs/260917/30-lakh-tonnes-german-firm-to-clean-up-mandur-trash.html.

3.2.5 Anjanapura

Date of Field Visit: 20th September 2017

Figure 14 Mud capped quarry at Anjanapura (Photo: 2017)

Throughout the 2000s, BBMP has used an abandoned quarry of five acres extent at BDA Layout at Avallalli, South of J P Nagar in Bangalore to dump waste. According to a report by BBMP Technical Committee (SWM), approximately 100 TPD of waste has been dumped here for several years.113 As it is a quarry there is absolutely no effort at all in containing the environmental damage the dumped waste is causing. In fact, the waste dumping ended in 2013 in view of public protest.114 Again, BBMP has called for tenders to bio-mine the legacy waste.115 However, during a visit to the site, it was observed that the accumulated waste has been merely mud-capped and no bio-mining process has taken place till date.

Figure 15 Dumping at the quarry at Anjanapura adjacent to the old quarry (Photo: 2017)

In fact, a worrying aspect here is that disregarding the concerns of local communities; an adjacent quarry of approximately 20 acres is now being used as dumping site. The area is populated by community of waste-pickers who are eking a living from by salvaging useful material from the construction and demolition waste, and also plastic and other dry waste, that is being dumped here.

[113] According to Technical Committee report submitted in the Hon'ble High Court in WP 24739/12 c/w WP 46523/12, *viz.*, Evaluation of Technology for processing existing waste at Seven Landfill sites of BBMP, Bangalore dated 03 January 2013.

[114] According to KSPCB report submitted in the Hon'ble High Court in WP 24739/12 c/w WP 46523/12, *viz.*, Status report of Municipal Solid Waste Processing and Disposal in BBMP Area dated 24 April 2013.

[115] According to KSPCB report submitted in the Hon'ble High Court in WP 24739/12 c/w WP 46523/12, *viz.*, Status report of Municipal Solid Waste Processing and Disposal in BBMP Area dated 24 April 2013.

3.2.6 Hanchipura and Thutadagudadahalli

Dates of Field Visit: 21st March 2016 and 15th September 2017

Figure 17 Waste dumped on the land and smoke arising from it at Hanchipura site (Photo: 2016)

Figure 16 Waste lying in the open at Hanchipura site (Photo: 2017)

This is an illegal dumping site at Sai Ram Layout, Nagasandara, Bangalore North district Bangalore-560073. This site is outside BBMP limits. Solid waste is being dumped by private mini-trucks on a 5 acres private land. The owner of the land, collects money from nearby houses for dumping their waste on his land. It is located within a residential area.

3.2.7 BBMP's 'Scientific Landfills' for inert, construction and demolition waste at quarry pits

In March/April 2016, BBMP identified 8 quarry pits and sought Environmental Clearance (EC) for these from the State Level Environment Impact Assessment Authority, Karnataka to develop them into "scientific landfills" for disposing inerts (7) and one for disposing construction and demolition (C&D) waste. Out of these 8 quarry pits, two of them, namely Mittaganahalli and Bagalur were held not suitable by KSPCB due to close proximity (4.5km) Yehalanka Air Base in 2012[116]. The locations of these quarry pits are at Bellahalli, Mittaganahalli, Bagalur, Agrahara, Mylsandra, Maragondanahalli and Muddaiahnapalya, dispersed all over Bengaluru. In response to these applications, the State Level Expert Appraisal Committee (SEAC) prescribed Terms of Reference117 (TORs) for preparing EIA/EMP Report based on one season baseline data, other than monsoon, making it conditional that the study had to be done by any environment consultant duly accredited by NABET/QCI.

[116] KSPCB letter dated 21.11.2012 in response to BBMP dated 9.10.2012 regarding inspection of identified sites for processing wet garbage/landfill

[117] SEIAA 05 IND 2016, SEIAA 06 IND 2016, SEIAA 07 IND 2016, SEIAA 08 IND 2016, SEIAA 09 IND 2016, SEIAA 10 IND 2016, SEIAA 11 IND 2016 and SEIAA 13 IND 2016, State Level Environment Impact Assessment Authority, Karnataka, 6th April 2016 and 11th April 2016.

The TORs prescribe compliance with Master Plan, Wild Life (Protection) Act, 1972, MSW Rules 2000, and also mandate that NOC needs to be obtained from nearby airports. As a standard practice, the TOR also determine that the facilities should be compliant with standard environmental norms for landfills such as leachate management systems, air and water monitoring units, odour control systems, etc. The conditions imposed also require conduct of public hearing as per EIA Notification, 2006.118 The TORs are valid for a period of three years for submission of EIA/EMP Report. As of date, the required studies are yet to be conducted, and thus the question of clearance based on public hearing does not yet arise.119

Figure 18 Waste dumping at Bagalur Quarry. Now converted into a park. (Photo: 2016)

Of the identified quarry pits, even as Environmental Clearance (EC) are yet to be issued, BBMP has already started dumping waste in Bellahalli, Mittaganahalli, and Bagalur Quarries. As of September 2017, Bagalur waste dump has been transformed into a park.120 A matter of grave concern is that these three operational dumping sites are extremely close to Yelahanka Air Force Station, Government Flying Training School at Jakkur and Kempegowda International Airport. Whether the other quarry pits are being used for dumping waste has not been verified. A detailed report of the implications follows.

3.2.7.1 Bellahalli and Mittaganahalli

Dates of Field Visit: 2nd June 2016 and 20th September 2017

These are abandoned quarries used for dumping mixed waste and is located about 25 kms North of Bangalore centre off the Bellary road. The quarries extend over 400 acres. It is reported that the quarries were originally identified for receiving only inerts121. However, it has now become as major site for dumping mixed solid waste and receives over 200 garbage trucks daily accounting for almost 1600 tons waste per day – which is roughly half of the waste generated in Bangalore in the period 1.2.2013-28.2.2013[122].123 From visual observation it appears that mixed waste is being dumped over half the area of the quarries.

[118] SEIAA 05 IND 2016, SEIAA 06 IND 2016, SEIAA 07 IND 2016, SEIAA 08 IND 2016, SEIAA 09 IND 2016, SEIAA 10 IND 2016, SEIAA 11 IND 2016 and SEIAA 13 IND 2016, State Level Environment Impact Assessment Authority, Karnataka, 6th April 2016 and 11th April 2016

[119] A review of the SEIAA, Karnataka website reveals that the applications are still at the TOR stage as on date.

[120] See, How this Bengaluru Quarry went from garbage dump to beautiful park, The Better India, 20 September 2017, accessible at: https://www.thebetterindia.com/116053/bagalur-landfill-park-bbmp/.

[121] SEIAA 09 IND 2016 and SEIAA 11 IND 2016 State Level Environment Impact Assessment Authority, Karnataka, 6th April 2016 and 11th April 2016

[122] as per the action taken report of BBMP submitted to Honrouble HC in WP 46523/12 C/W WP 24739/12 dated 4.3.2013

Figure 19 Mixed waste dumped at Bellahalli and Mittaganahalli quarries without obtaining Environmental

vicinity of the quarry, have turned eutrophic and this indicates the leachates from the quarry/dumping site is contaminating their waters. This has caused extensive damage to the farmers in the downstream area who report that their loss in agricultural productivity are upto 75% due to pollution. They also report that due to the mixed waste dumping, there is steep increase in rodent population which is adversely affecting their capacity to farm, store agricultural produce and is also major cause of worry to human health.

Figure 21 Bellahalli and Mittaganahalli quarries are currently used as a garbage (MSW) dumping site by BBMP. Photo source: BBMP SWM Department Website.

It is notified by BBMP that the abandoned quarry is to be converted into a playground/park. As a matter of fact, in the aforesaid statement made by KSPCB before the Hon'ble High Court does not indicate that the quarry has ever been proposed for filling of either construction and demolition debris or mixed waste. However, the BBMP website reveals that this quarry is now being used for dumping mixed waste.[124] Kannuru and other local lakes, which are in the immediate

Figure 20 BBMP designated the land for park (Photo: 2016)

It is a matter of grave concern that these quarries have been allowed to turn into waste dumping ground overlooking the fact that it is proximal to two airports. A major defence facility, the Yelahanka Air Force Base of Indian Air Force, is barely 4.5 kms. from the landfill.

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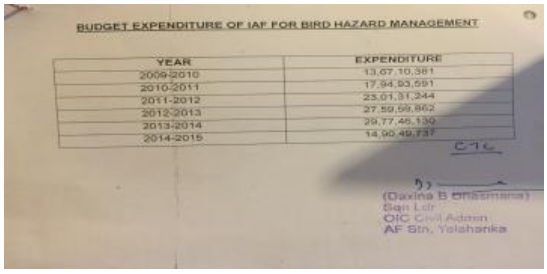
[123] See, **"***Rodents from rotting trash killing farmer's yield in Bengaluru backyard"*, Times of India, Bangalore, 03 April 2017, accessible at: http://timesofindia.indiatimes.com/city/bengaluru/rodents-from-rotting-trash-killing-farmers-yield-in-bengaluru-backyard/articleshow/57981918.cms. See also BBMP is dumping 200 trucks of waste at Bellahalli village in Bengaluru North Taluk**a** video report of the extensive damage caused waste dumping at Bellahalli as reported by Btv Kannada, 8th Feb. 2017 accessible at: **https://www.youtube.com/watch?v=1yDkLuCHYXc.**

[124] See Figure 21.

The Government Flying Training School at Jakkur is also located within 5 kms. from the landfill. Given the manner in which waste is carried by hundreds of trucks to the quarry to be dumped without any effort of capping the landfill, attracts hundreds of scavenger birds, such as kites and crows. It can be observed at these quarries that the birds hovering over the quarry/dumping ground conflicts with the flight paths of wide bodied transport, training and fighter aircrafts taking off or approaching Yelahanka Air Force Base. That these quarries were opened up for waste dumping, and that too without any safeguards being built to protect the local air bases and populations from a worst-case scenario of air crash due to a bird hit, is extremely shocking. This is because it is a matter of record that in the aforesaid PIL filed by ESG, a major ground is that the Mavallipura landfills were developed barely 5.8 km from the western end of the Yelahanka Air Force Base runway strip. Evidence was produced in Court that this presented a clear and present danger to the flight movements from the base as they risked bird hits.

In fact, the Air Commodore Mr. S C Gulati, Air Officer Commanding, Air Force Station, Yelahanka, submitted a detailed statement in the aforesaid PIL and the following are extracts from the statement dated 02/12/2014:

> "Bird activity poses major threat to flight safety as a collision between bird(s) and aircraft can result in major aircraft damage including fatality of crew and passengers. Resultant collateral damage on the ground from an aircraft crash due to bird hit can also be severe." [A brief note highlighting the catastrophic effect on safety of flight operations due to bird hits was enclosed in which it is reported that about 90% of birds collisions with aircraft occur near airports.]
>
> "Bird Hazard Management is a major activity of the flight safety wing of the Indian Air Force (IAF). Substantial funds are expended for this activity." [A note annexed reveals that IAF has spent anywhere between Rs.13 crore and Rs. 30 crores on Bird Hazard Management during the period 2009-2015. It was also reported in the note that between 1993-2010, there were 26 incidents where IAF aircrafts suffered bird hits. All of these incidents caused a loss of aircraft and five of them involved fatalities. The IAF put the financial damage of aircrafts lost due to bird hits at Rs. 26.8 crores.][125]


BUDGET EXPENDITURE OF IAF FOR BIRD HAZARD MANAGEMENT

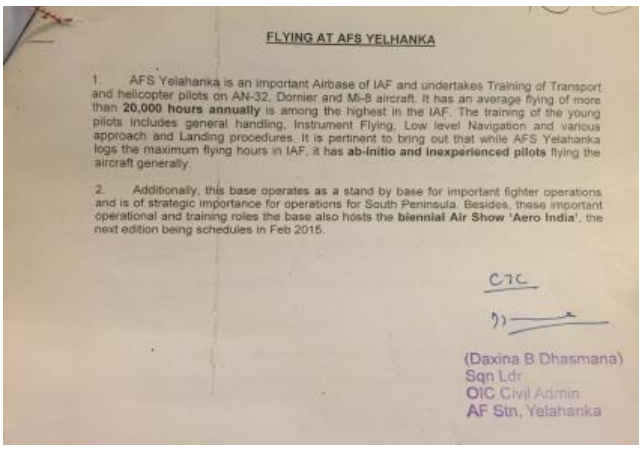
YEAR	EXPENDITURE
2009-2010	13,07,10,381
2010-2011	17,94,93,591
2011-2012	23,01,31,244
2012-2013	27,59,59,862
2013-2014	29,77,46,130
2014-2015	14,90,49,737

(Daxina B Bhasmana)
Sqn Ldr
OIC Civil Admin
AF Stn, Yelahanka

Figure 22 Indian Air Force Budget for Bird Hazard Management

[125] See figure 22.

Yelahanka Air Force Station "is major training air base of the IAF with intensive flight operations of various types of aircrafts and helicopters operating at low altitudes in the local flight area extending to the radius of 10 kms. of Yelahanka air base. Yelahanka air base also host the biennial Air Show 'Aero India'. It also is an emergency standby air field for the Bangalore International Airport Limited (BIAL)." [In a note annexed, it is reported that "AFS Yelahanka is an important air base of IAF and undertakes Training of Transport and Helicopter pilots on AN-32, Dornier and Mi-8 aircraft. It has an average flying of more than **20,000 hours annually** is amongst the highest in the IAF. The training of the young pilots includes general handling, Instrument Flying, Low Level Navigation, and various approach and landing procedures. It is pertinent to bring out that while AFS Yelahanka logs the maximum flying hours in IAF, it has **ab-initio and inexperienced pilots** flying the aircraft generally. Additionally, this base operates as a standby base for important fighter operations and is of strategic importance for South Peninsula."][126] Emphasis in original.



FLYING AT AFS YELHANKA

1. AFS Yelahanka is an important Airbase of IAF and undertakes Training of Transport and helicopter pilots on AN-32, Dornier and Mi-8 aircraft. It has an average flying of more than **20,000 hours annually** is among the highest in the IAF. The training of the young pilots includes general handling, Instrument Flying, Low level Navigation and various approach and Landing procedures. It is pertinent to bring out that while AFS Yelahanka logs the maximum flying hours in IAF, it has **ab-initio and inexperienced pilots** flying the aircraft generally.

2. Additionally, this base operates as a stand by base for important fighter operations and is of strategic importance for operations for South Peninsula. Besides, these important operational and training roles the base also hosts the **biennial Air Show 'Aero India'**, the next edition being schedules in Feb 2015.

CTC

(Daxina B Dhasmana)
Sqn Ldr
OIC Civil Admin
AF Stn, Yelahanka

Figure 23 Criticality of Air Force Station Yelahanka to the security of India.

"Like various operational air bases of IAF, various measures are undertaken at Yelahanka Air Base to combat Bird Hazard. These preventive measures are also undertaken in areas outside the air base upto 20 kms. radius from the airbase. One such case in point was action by the IAF to demolish a fish pond at Razak Palya village." [A note enclosed revealed that between 1995-2014, there were anywhere between 1 bird strike (1995-96) and 10 bird strikes (2011-12) annually. It is only between 1996 and 1999 and in the year 2000-2001 that there were no incidents recorded.[127] In fact, higher bird hit incidence have been recorded in years corresponding with the operation of the Mavallipura landfills.]

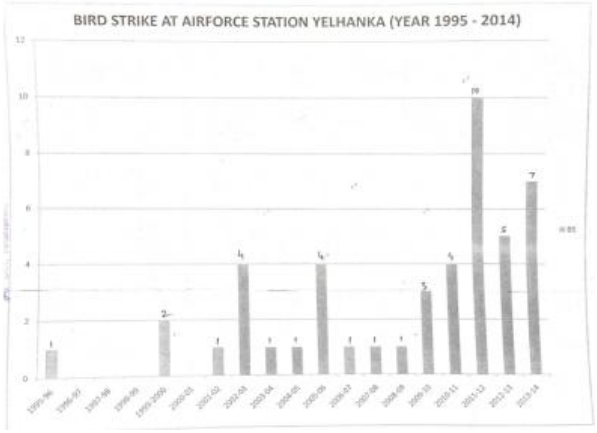


Figure 24 Bird Strike at Airforce Station Yelahanka (Year 1995-2014)

[126] See figure 23.
[127] See figure 24.

> "The landfill and/or any solid waste management facility is bound to obtain an NOC from the air base/airport within a radius of 20 kms. as per the rules.[128] The AirCraft Act, 1934 also caters for avoiding such dangerous projects from affecting flight safety by making it mandatory for such project within 10 kms. from an air base/airport to obtain mandatory clearance from the Director General of Civil Aviation."
>
> "Bird strike hazard can be even more disastrous for civil flights as the number of casualties can be much higher due to the large number of passengers carried. As Yelahanka is a standby airfield for BIAL, any bird threat in Yelahanka can be a potential disastrous for civil flight diverted to Yelahanka by BIAL. A letter from BIAL to the Karnataka State Pollution Control Board makes the dangers of the Mavallipura landfill/processing facility amply clear." [A letter from Squadron Leader M K Vats, Flight Commander (Flight Safety Officer) for Air Officer Commanding to Member Secretary KSPCB dated 14 Aug 2004 is enclosed in which it is reported that Mavallipura landfills are within 7.5 kms. of the Yelahanka Air Force Base and that "this will definitely affect the safety of the pilots and precious government assets like aircrafts". Therefore, "a NOC as proposed by you" for Mavallipura landfills "cannot be issued for constructing the above structure irrespective of the technology being used". Similarly, on 15th Sept 2014, Mr. Lakshminarayana S, Vice President – Engineering and Maintenance of Kempegowda International Airport Bengaluru in a letter to Senior Environmental Officer of KSPCB cited the fact that landfills were coming too close to the Bangalore and Yelahanka Airports, that this was in violation of applicable standards and "it is most advisable that such Waste Management Units are housed at locations far away from any aviation activity" and "it is ideal that activities which have remote chance of affecting aviation be kept out of the vicinity". Citing such concerns, the Officer provided details of a 2012 crash of an Nigerian Aircraft which killed all 153 people on board and reason cited was bird hit. The Officer continued to state "we are sure, at Bengaluru, none of us want such incident to happen" and thereby requested KSPCB to not give "permission to dump Municipal Solid Waste at Mavallipura or any other location which will endanger safe aircraft operation".]

To add to the worries of these airports and flight safety officers, a very recent report of the Director General of Civil Aviation states that more than 4000 aircrafts suffered strikes by birds and animals in about 80 airports over the past five years and that such collision increased substantially from 607 in 2012 to 839 in 2016 in India. A Senior Official of DGCA is reported to have said that accidents spike during the rainy months from July to October and that in the year 2014 alone "domestic airlines lost more than Rs. 25 crores in……bird hits".[129]

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[128] Item 10 of Schedule III of MSW Rules, 2000 states that landfill sites coming up within 20 kms. of an airport/ air base must and should secure "necessary approvals" from the relevant airport/ air base authority. This rule was further strengthened in the MSW Rules 2016, wherein it was categorically stated that any landfill proposed between 10 kms. and 20 kms. of an airport can only come up after securing prior consent of airport authority. This means and implies that there is no question of any landfill coming within 10 kms of the Aerodrome Reference Point of any airport/ air base.

[129] See, Air scare: Birds, Wild Animals hit two planes every day in India, Hindustan Times, 25 September 2017, accessible at: http://www.hindustantimes.com/india-news/air-scare-two-planes-hit-birds-wild-animals-everyday-in-india/story-EfSK1HbOCoUVYe5dqECYNJ.html.

Figure 25 Geomembrane lined sheets are torn apart across the quarries and waste leading to direct contact with ground (Photo: 2017)

From the above, it is more than evident that Bellahalli and Mittaganahalli quarries/dumping ground needs to be immediately shut down for garbage dumping given the high risk that it presents to the very high density of flight movements in the area. In addition, it is a matter of grave concern that the geo-membrane lining of the dumping grounds has broken down and this is causing extensive damage to surface and ground water aquifers, thus resulting in a major public health crisis and also causing extensive damage to farming and other natural resource dependent livelihood of the local communities.

It is highly disturbing that these dumping grounds operated by M/s Karnataka Rural Infrastructure Development Limited, are in gross violation of the EIA Notification and MSW Rules have commenced operation even as the State Environment Impact Assessment Authority has mandated in TORs dated 11th April 2016[130] that the use of the quarries for dumping is subject to NOC being accorded by the airports within a 20 km radius. In this case, it would mean that M/s KRIDL should have sought permission from Yelahanka Air Force Base, Government Civil Aviation Training School at Jakkur and the Kempegowda International Airport of Bengaluru.

Figure 26 Tonnes of mixed waste is dumped at the quarries while the TORs issued are for dumping of inerts only (2017)

[130] SEIAA 11 IND 2016 and SEIAA 09 IND 2016, State Level Environment Impact Assessment Authority, Karnataka, dated 11th April 2016.

4 Environmental Status and impact of Waste Processing Sites in Bengaluru

4.1 Introduction

This section presents the status of the common municipal solid waste processing facilities that have been established over the past two or three years in Bengaluru. In view of this report, Environment Support Group visited all these facilities mentioned below with the aim to evaluate their impact on environment and human settlements.

In W.P. 46523/2012 c/w W.P. 24739/2012, the Principal Bench of the High Court of Karnataka (comprising Chief Justice Mr. Vikramjit Sen and Justice Mrs. B. V. Nagarathna) issued a series of unprecedented directions on 22nd November 2012 to promote processing and management of municipal solid waste generated in every ward and Assembly constituency of Bengaluru. These directions were issued as the High Court took into careful consideration both short-term and long-term objectives to resolve the prevailing crisis of municipal solid waste management. The Court took note of the widespread concern that landfills devastate public health and environmental conditions of local communities and observed that *landfills are only a temporary solutions and the future of cities lies in their capacity to process and manage waste locally*. Thus, the waste processing facilities in local areas was promoted with the intent of ensuring organic waste is composted in the ward, or within the local Assembly constituency,[131] and that way the opportunity of recovering value from recyclable waste is very high. Only inert waste was approved for landfilling, and that after taking all necessary precautions.

These waste processing plants were perceived as an interim measure to deal with the overwhelming waste burden[132]; until ward committees were set up in conformance with the Constitutional 74th Amendment (Nagarpalika) Act, 1992. Once the Ward Committees became functional, the idea was that the ward level waste processing units (2 wet waste and one dry waste processing unit in each ward as directed by the High Court) would become operational[133]. The idea, finally, was that the waste generated every day would be essentially processed within a ward, and the common waste processing sites were to be used for processing segregated organic waste into manure, or in recovering recyclables so that the need for landfilling of waste would be drastically eliminated.

While these orders were issued by the Karnataka High Court in 2012, a 2014 review by the Comptroller and Auditor General of India (CAG) strongly criticized the state of solid waste management in

[131] Bengaluru has 198 wards that make up the Bruhat Bengaluru Mahanagara Palike, and the greater metropolitan area population is represented through 28 Assembly constituencies.

[132] W.P. 24739/2012 *Kavit Shankar v. State of Karnataka and Ors.* c/w W.P. 46523/2012 *Environment Support Group and Ors. v. Bruhat Bengaluru Mahanagara Palike and Ors.* order dated 13/Nov/2013.

[133] Ibid, order dated 22/Nov/2012.

Bengaluru.[134] The CAG observed in its audit that there was an absence of a notified policy for solid waste management, resulting in lack of direction for effective management and scientific disposal of waste. The CAG also observed that that inadequate operational controls resulted in weak financial management, leading to unfruitful and excess expenditure as well as diversion of funds. The CAG held that BBMP also lost the opportunity of availing Rs. 280 crores central assistance under JNNURM for SWM projects due to delay in preparation of Detailed Project Report.[135] Further, the CAG reported that efficiency in collection of segregated waste was poor and no efforts had been made to promote waste segregation at source. Lack of scientific processing facilities at landfill sites, in particular non-compliance with the standards prescribed in MSW Rules, resulted in extensive open dumping of mixed wastes all over Bengaluru. This exposed the population to avoidable public health hazards.

In conformance with the directions of the Karnataka High Court, BBMP established seven common municipal solid waste management facilities (CMSWMF) in and around the Bengaluru city. The idea was to establish these plants across Bengaluru, so that the collected waste need not travel across the city, thus cutting down transport costs. The Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC) was appointed as Nodal Agency to set up these waste management facilities in the BBMP area.

While these seven-common solid waste processing facilities were set up to convert wet waste into manure employing mechanical processes, the result is not as expected. Many sites have reported poor management, resulting in several being shut down or becoming un-operational. Protests from local communities against the pollution and stench caused by these plants is common feature of all plants. As none of these plants have a functional leachate treatment system, the local surface and ground water aquifers are impacted adversely, resulting in a drinking water crises in the local area. This is because most of the plants are located in peri-urban areas that are almost entirely dependent on ground water for all their needs.

A major issue of concern is that, in stark contrast to the directions of the Karnataka High Court that the processing plants are distributed across the city so that effort and cost invested in transport of waste to processing sites is minimized, it is seen that 5 of the seven sites are straddled along the western part of Bangalore. This is also the area that feeds into the Arkavathy and Cauvery watersheds. Given that none of the processing sites have a functional leachate treatment system, and it is observed in each case that

[134] Indian Audit and Accounts Department, *Report of the Comptroller and Auditor General of India on Local Bodies for the year ended on March 2013*, Report No. 5 of the year 2014, p. 125, Government of Karnataka,
accessible at: http://www.cag.gov.in/sites/default/files/audit_report_files/Karnataka_Report_5_2014.pdf

[135] There was a proposal (July 2007) in the fifth State Level Empowered Committee (SLEC) of Jawaharlal Nehru National Urban Renewal Mission (JNNURM) to seek central assistance under JNNURM for SWM projects in Bangalore. For this purpose, BBMP had entrusted (September 2007) the work of preparation of a Master Plan and a Detailed Project Report (DPR) to M/s. Infrastructure Development Corporation (Karnataka) Limited, Bangalore (IDECK) at a cost of `97.80 lakh. The Master Plan and DPR were to be submitted by February 2008 and April 2008 respectively. The IDECK submitted the final Master Plan and DPR in March 2009 after a delay of 12 months. As a result, the project was not funded under JNNURM and BBMP lost the opportunity of availing assistance of Rs. 280.17 crore

the leachates have already contaminated local water bodies, it is more than likely that over time these leachates will not only damage quality of water in local aquifers, but also find their way into the already polluted river systems.

This raises a serious concern about the compliance of these processing sites with the directions of the Karnataka High Court in WP 30084/2012[136], wherein the chief concern is about the implementation of the 18th November 2003 Notification[137] of Government of Karnataka that prevents the location of hazardous processes within the watershed of the Arkavathy river and Thippagondanahalli reservoir, a major drinking water source for Bengaluru. In fact, the Court has ruled that compliance with this Notification is absolute, and highlighted the critical importance of "authorities concerned in implementing in letter and spirit the notification dated 18.11.2003"[138]. As a matter of fact, these concerns were also raised by the Karnataka State Pollution Control Board in its Proceedings of the 22nd MSW Authorisation Committee held on 10th September 2014, wherein BBMP was directed to secure approval for the Seegehalli, Kannahalli and Doddabidirakallu processing plants from the Dept. of Ecology and Environment, in regard to the compliance with the T. G. Halli Notification. Further, concerns have been raised about the siting of the the Lingadheeranahalli facility as it is abutting an ecologically sensitive zone, i.e., the B. M. Kaval forest. Earlier this year, the extremely rare Smooth Coated Otter was sighted here, which is a first for Bengaluru.[139] There is concern that the leachates from this facility may be affecting the chances of survival of the Smooth Coated Otter. The region is also known to be a major elephant corridor, besides serving as a critical habitat for passage of wildlife from Bannerghatta National Park to Ramanagara and Magadi range.

Figure 27 Smooth Coated Otter spotted in Tataguni area of B. M. Kaval Forest, a first for Bengaluru

BBMP was directed by the High Court to setup waste processing facilities in Assembly Constituencies to reduce the transportation cost so that waste is processed in the local area itself and the practice of transporting the waste outside the city and dumping in villages can be avoided. The High Court specifically ordered to ameliorate and decentralise waste management in the city, based on an aggressive promotion of segregation of waste at source to improve the possibility and effectiveness of wet waste processing locally. This would imply that every Assembly constituency would be a zone in which a processing station would be located. The lack of conformance with this sense of the direction is,

136 See, WP No. 30084/2012 Suo Moto case of Hon'ble High Court of Karnataka in which Karnataka State Pollution Control Board is arraigned as Principal Petitioner.

137 Notification of the Government of Karnataka declaring the Formation of a Conservation Zone and regulating activities in the watershed of Arkavathy River and Thippagondanahalli Reservoir, No. FEE 215 ENV 2000, dated, 18th November 2003.

138 WP No. 30084/2012, order dated 16th September 2013.

139 See, "Smooth-coated otter spotted for the first time in city", The Hindu, 30th May 2017, accessible at: http://www.thehindu.com/news/cities/bangalore/smooth-coated-otter-spotted-first-time-city/article18620405.ece

in itself, demonstrative of the distortion in the skewed location of the waste processing plants. Not only does this overload the pollution loads in a region of the metropolitan area, but also raises major concerns of the gross injustices that the impacted populations have to suffer on account of the majority of the city's populations.

During visits by ESG Team to the Kannahalli and Seegehalli waste processing facilities (on 03rd July 2017), local communities expressed grave concern that there was no prior consultation with them in so locating these facilities. As these facilities are still receiving mixed waste, every site has reported high levels of contamination of local water resources, and the stench from several of these facilities has spread over a very large area. The situation is particularly difficult during the monsoon and festive seasons. Except revealing the location of these processing facilities on a map displayed on BBMP's website, there is no information on compliance with standards, or is any documentation relating to statutory compliance (monthly or half-yearly monitoring reports, etc.) about these solid waste management facilities made available.

All these facilities should receive only wet waste, but they are currently receiving mixed waste due to poor implementation of waste segregation at source. Mixed waste at these facilities takes more time to process, as dry and wet waste have to first be segregated. Consequently, Operators are not able to process the design capacity daily. As a result, huge piles of waste are accumulating in open areas of the facility and contaminating wider areas due to discharge of untreated leachates and stench generated.

All the common municipal solid waste management facilities are required to have leachate treatment plants and odour control facility on site. But on visit to these facilities it was discovered that not one of the facility had this critical environmental safeguard in place. Some of the facilities were required to also have sanitary landfills on site, but only Seegehalli MSW facility had constructed the same. The seven facilities, taken together have a backlog of nearly 18000 tonnes of RDF and 20000 tonnes of compost.[140] This is due to the lack of streamlining of how waste is brought to these facilities (in mixed forms), and consequent disruption in the processes instituted.

4.2 Impact on Human and Environmental Health

Huge piles of mixed waste stocked up at these facilities, slow processing of organic waste, foul stench spreading over several kilometres and percolation of untreated leachate are some of the key adverse impact of these facilities. These facilities were setup without any involvement and consent of the local impacted communities. No prior information was shared with the local communities, when decisions were taken to site the facilities near to their village. Each of these facilities is close to human habitations,

[140] See, Waste processing plants are up and running again, The Hindu, 5th July 2017, accessible at: http://www.thehindu.com/news/cities/bangalore/waste-processing-plants-are-up-and-running-again/article19211499.ece.

or local water bodies and wetlands. The spread of stench, large amounts of garbage lying untreated for long periods has substantially increased populations of flies and mosquitoes. The impacted households and residents have been demanding that the waste processing facility be shut down unable to tolerate the foul odour and contamination of their surroundings by the untreated leachates released from the facility. During the visit, it was reported that the experience of living in such conditions is traumatic. The leachates are flowing downstream into ponds and lakes and affecting ground water aquifers, hence polluting the sources of water for humans and cattle. It was observed that workers rarely used protective gear while working at these facilities. Workers also report that they were not paid regularly or missed their Pension Fund payments, a complaint that was particularly strident at the Kannahalli Facility visit.

Communities living around Kannahalli Lake, Sompura Lake, Soma Sundarapalya Lake, and Rayasandra Lake have complained and protested several times due to untreated leachate flowing and contaminating local water bodies and ground water aquifers. This is equally true of the Karnataka Compost Development Corporation unit where the leachates have found their way into well waters, adjacent to Sundarapalya lake. Farmers complain that this contamination is affecting their farms and livestock.

In the case of Lingadheeranahalli waste processing facility, the condition has been so bad, local communities report that they have preferred to challenge the Environmental Clearance (EC) accorded by State Environmental Impact Assessment Authority, Karnataka before the National Green Tribunal, Chennai. NGT has stayed the operation and questioned the EC extended to the processing facility initially, but the matter was then brought to the Karnataka High Court, which stayed the NGT decision.[141] An appeal was preferred against the High Court decision, and the Supreme Court directed the Karnataka High Court to decide on the forum to hear the grievances. The Karnataka High Court decided to direct the proceedings to be heard by the National Green Tribunal, Chennai, where the matter is now pending adjudication. During the pendency of these proceedings, the plant operators have secured consent under the Water and Air Acts, which has now been also challenged before the NGT.[142]

4.3 Way Forward

The High Court directed the setting up of waste processing units with the intention of promoting progressive waste management strategies for a large metropolitan region such as Bengaluru. The idea was to decentralise waste management to municipal wards, and in this manner to substantially reduce unnecessary transport of waste over long distances. The overarching idea was to ensure every one of the 198 wards would have their own waste composting and recycling units, to make the waste management environmentally sound, efficient and also economically viable. To oversee these operations at a local a level, the Ward Committees (which the state had hesitated to establish over 25 years in a functional manner), was made mandatory by the Karnataka High Court directives. BBMP has recently complied with

[141] Application No. 110/2015, *Jayaram Gouda v. Union of India, MoEF and CC*, NGT (SZ) dated 29 May 2015.
[142] Appeal No. 44/2015, *Jayaram Gouda v. Union of India, MoEF and CC*, NGT (SZ).

Court directives and set up Ward Committees and much is expected from them to ensure not merely waste management strategies are managed locally, but that these statutory bodies also work in building programs for educating and creating awareness among the citizens. The High Court determined that decentralization in the system of MSW management would lend efficacy and prevent bottlenecks now impacting the entire city. These directions were issued in 2012, and in 2017 they are yet to be complied with. In the meantime, the seven regional waste processing sites have been made operational, and their less than optimal functioning, for reasons explained before, are creating a host of avoidable problems, especially for local impacted communities.

What follows is a detailed description of each of the processing facilities, their location, operational processes underway in handling waste and also issues and concerns relating to each of the plants.

4.3.1 Overview of Seven Common Municipal Waste Management Facilities in Bengaluru

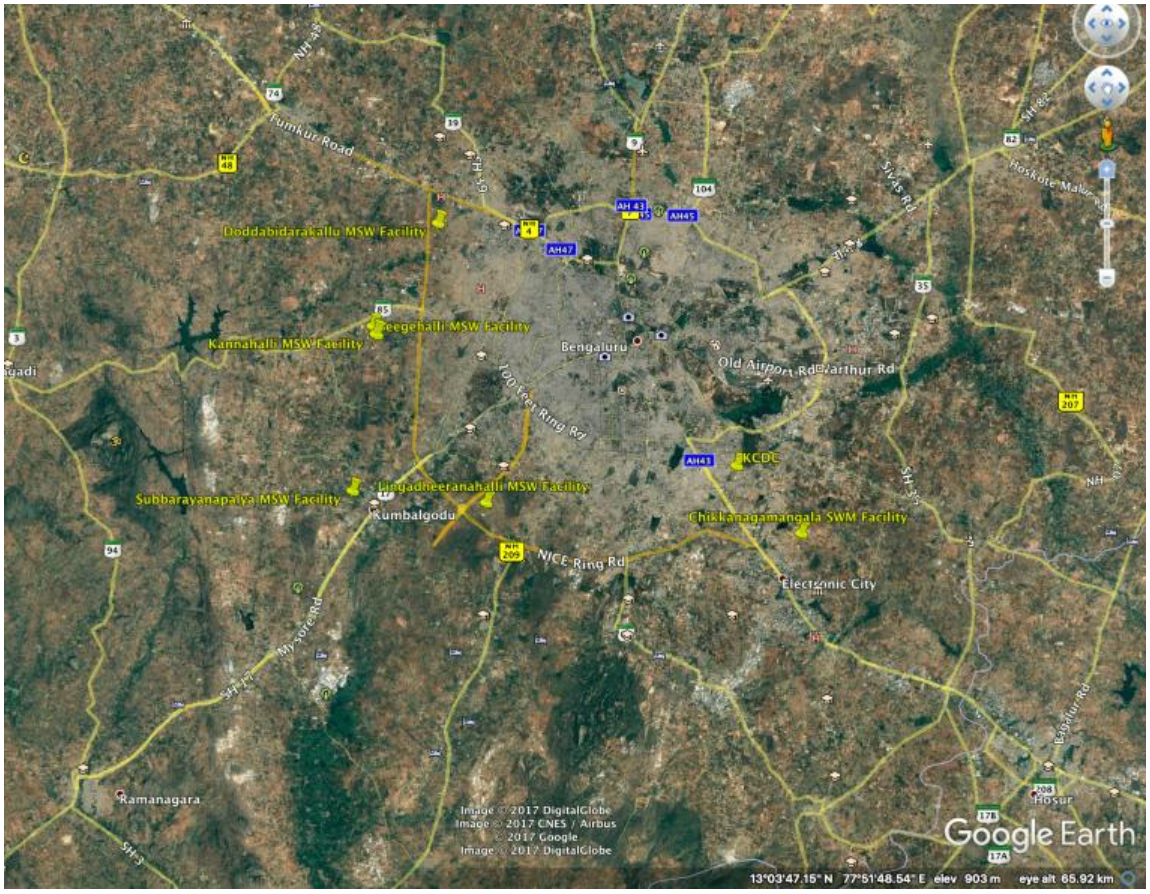

Figure 28 Google overview of Seven Common Municipal Waste Management Facilities in Bengaluru

CMSWMF Site	**Site Area (Approx.) Total: 118 acres**	**Legal and Operational Status**	**Distance from Cubbon Park**
Kannahalli	23 acres	EC accorded dated 15 July 2015[143]	About 20 kms.
Seegehalli	8 acres	EC accorded dated 15 July 2015[144]	About 20 kms.
Lingadheeranahalli	11 acres	EC accorded dated 19 June 2015[145]	About 17 kms.
Subbarayanapalya	11 acres	EC accorded dated 15 July 2015[146]	About 27 kms.
Doddabidarakallu	11 acres	EC accorded dated 15 July 2015[147]	About 18 kms.
KCDC	29 acres	EC unavailable on SEIAA website.	About 15 kms.
Chikkanagamangala	25 acres	EC accorded dated 07 August 2015[148]	About 19 kms.

[143] SEIAA 14 IND 2014
[144] SEIAA 14 IND 2014
[145] SEIAA 12 IND 2014
[146] SEIAA 10 IND 2014
[147] SEIAA 11 IND 2014
[148] SEIAA 9 IND 2014

4.4 Factsheets about the seven facilities

4.4.1 Development of Integrated Municipal Solid Waste Treatment and Scientific Landfill facility

at Survey No. 85, Kannahalli Village, Yeshwanthpur
Date of Field Visit: 03rd July 2017

Figure 29 Google Earth overview of the Kannahalli MSW Treatment Plant (Including elevation details from MSW Plant to Kannahalli lake downwards)

GEOGRAPHICAL LOCATION

This plant is located at an elevation of 831 meters (Longitude: 77°26'47.0"E Latitude: 12°58'08.2"N). It is in Survey No: 85. This plant location in a BDA layout and is adjacent to a school, bus depot, agricultural land, lake, etc. This plant is in catchment area of Tippagondannahalli reservoir. The area is used intensively for grazing cattle.

PROJECT SITE DESCRIPTION

- Construction Year: 2015
- Consultants: eParivarthan
- Client: Karnataka Urban Infrastructure Development and Finance Corporation,
- Total Site Area: 97124 sqm;
- Built-Up Area: 27908 sqm;
- Storage Capacity: 10000 tonnes,
- Processing Capacity: 500 tonnes mixed waste.
- Current in-take: 15-20 trucks per day i.e. 300 tonnes wet waste.
- Current Stock of Compost at the unit: 7000 tonnes.
- Factory Licence: Renewed.
- KSPCB Clearance: Expired. Applied for renewal.
- No Sanitary landfill available at the site.
- No leachate treatment plant installed.
- No odour control facility

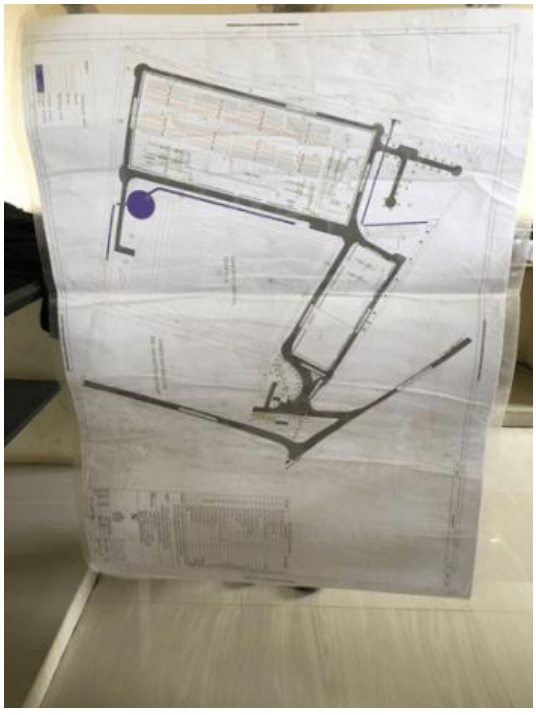

Figure 30 Kannahalli MSW Facility details s

Figure 32 Refinement trommel (4mm)

OPERATIONAL DESCRIPTION

This plant works in four stages:

- Pre-sorting,
- Windrow,
- Pre-preparatory,
- De-composting and finishing line (> 4mm)

Figure 33 Final Compost under the Shed A (damaged due to fire accident)

The Unit involves destoning process involving 4mm trommel. It takes approximately 2 months to turn the waste into fine compost. A major portion of the rejects is sent to ACC cement factory for use as fuel in their boilers. As the demand for the remain rejects is low, they now lie in huge piles in the open, and are a fire hazard. The plant has a leachate tank and the evacuated leachate is sent to BWSSB's Mailasandra Plant at Kengeri, Bangalore for further treatment.

The fine compost manure is packed in 50 kg packets for sale. The manure is sold at Rs. 2500/metric ton. The workers in the facility have not been provided Personal Protective Gears.

IMPACTS AND DISCUSSION

-

Figure 35 Mixed waste piled up in open

Figure 34 Actual Plant (No landfill space and absence of leachate treatment within the Plant)

- Leachate flows into ponds, storm water drains and joins the Kannahalli lake.
- Health hazards: Foul odour smell spreads upto 2-3 km radius and it has increased the presence of flies and mosquitoes tremendously.
- Substantial increase in psychosomatic disorders because of the odour.
- Dermatological, respiratory diseases, fatigue, no appetite, body pains extensively reported in local populations.
- Adverse impact on vegetation is reported.
- Families have left homes and relocated unable to bear the stench. Value of their properties has

drastically reduced. No buyers.
Two fire incidents occurred in Sept 2015 and Oct 2016. In Oct 2016, major fire broke out and it took over 10 days to contain it. This spread toxic plumes over large areas. The fires resulted in a loss of Rs. 7 crores, as stored RDF & equipment shredder and bailer was reduced to ashes.
Villagers have been blocking garbage trucks, and stopping the unloading of garbage in the facility, in protest against pollution of their neighbourhood.

4.4.2 Development of Integrated Municipal Solid Waste Treatment and Scientific Landfill facility, Seegehalli Village, Yeshwanthpur

Date of Field Visit: 03rd July 2017

Figure 36 Google Earth overview of the Seegehalli MSW Treatment Plant (Including elevation details from MSW Plant to Kannahalli lake downwards)

GEOGRAPHICAL LOCATION

This plant is located at an elevation of 871 meters (Longitude: 77°26'32.4"E Latitude: 12°58'25.9"N) in Seegehalli village off State Highway 85 (Magadi Road). This plant is adjacent to schools, Bus depot, agricultural land, lake, etc. The area is also used for cattle grazing.

PROJECT SITE DESCRIPTION

- Construction Year: 2015
- Consultants: eParivarthan
- Client: Karnataka Urban Infrastructure Development and Finance Corporation,
- Total Site Area: 31602.46 Sqm;
- Built-Up Area: 10116.99 sqm;
- Storage Capacity: tonnes,
- Processing Capacity: 200 TPD mix waste,
- Current in-take: 30-40 TPD
- Leachate Tank: 20000 L
- Sanitary landfill available at the site.
- No leachate treatment plant installed.
- No odour control facility.

Figure 37 Seegehalli MSW Facility layout plan

Figure 38 Piles of mixed waste

OPERATIONAL DESCRIPTION

This plant works in four stages:

- Pre-sorting (200mm and 100mm trommels),
- Windrow (35mm and 16mm trommels)
- Pre-preparatory,
- De-composting and finishing line (<4mm)
- Sanitary Landfill site.

Figure 39 Sanitary Landfill site

It takes approximately 40 days to turn the waste into fine compost. The fine compost manure is then collected and packed for sale at Rs. 2300-2500/metric ton. The rejects are mainly sent to ACC cement factory. A Sanitary landfill is also being developed on site. The plant has a leachate tank and periodically the leachates are evacuated by trucks to BWSSB treatment plant.

[Note: No Protective Gears provided for workers.]

IMPACTS AND DISCUSSION

1 Plant is close to human habitation, local water bodies.
2 Leachate flows into pond, storm water drains and joins the Kannahalli lake.
1 Health hazards: Foul odour smell travels over 2-3 km radius.
2 Flies and mosquitoes swarms have increased.
3 Increased psychosomatic tendencies because of the odour.
4 Dermatological, respiratory diseases, fatigue, no appetite, body pains increasingly being reported.
5 Adverse impact on farming productivity reported after facility has come up.
6 Several families have left homes and relocated unable to bear the stench and smoke.
7 Value of properties is reported to have drastically reduced. No buyers.
8 Villagers have been blocking garbage trucks, and stopping the unloading of garbage in the facility, in protest against pollution of their neighbourhood.

Figure 40 Seegehalli plant close to human habitation.

Figure 41 piled up waste heavily corroborate in contaminating the atmosphere due to foul odour.

4.4.3 Common Municipal Solid Waste Management Facility, Lingadheeranahalli

Date of Field Visit: 24th June 2017

Figure 42 Google Earth overview of the Lingadheeranahalli MSW Treatment Plant (Including elevation details from MSW Plant to Sompura Lake downwards)

GEOGRAPHICAL LOCATION

This facility is located at an elevation of 832 meters (12°52'33.81"N and 77°30'24.98"E). It is situated in Ward No: 198 and Survey No:16A and 21/1. This Plant is located in the midst of BM Kaval Forest and is surrounded by BBMP and BDA Layouts. Sompura lake is barely a kilometer downstream. This Plant is also close to Turahalli Reserve Forest (approx. 2 kms) and within a kilometer of NICE road (0.85kms). Recently, there has been sighting of the extremely rare smooth-coated Otter in the BM Kaval forest patch, within a mile of this facility. This is fish dependent species and known to survive in streams and rivers. There is concern that the leachates from this facility may be affecting the chances of survival of the Smooth Coated Otter, which has been spotted in B. M. Kaval Forest, adjacent to this processing site. This is significant because this highly threatened animal, which is entirely dependent on streams and rivers for its survival has never been sighted before this close to Bengaluru.

PROJECT SITE DESCRIPTION

- Construction Year: 2015
- Implementing Agency: Bruhat Bengaluru Mahanagara Palike
- Consultants: M/S Shah Technical
- Client: Karnataka Urban Infrastructure Development and Finance Corporation,
- Operator for O&M: M/S Infrastructure and Leasing Financial Service (IL&FS)
- Estimated Project Cost: Rs. 40.28 Cr.
- Total Site Area: 45,570 sqm;
- Built-Up Area: 18,960 sqm;
- Storage Capacity: 6000 tonnes,
- Processing Capacity: 200 tonnes mixed waste.
- Current in-take: 6-7 trucks per day.
- Workers: 25-30 employed
- No leachate treatment plant installed.
- No odour control facility

Figure 43 Lingadheeranahalli MSW Facility details

Figure 44 piles of mixed waste and leachate flowing

OPERATIONAL DESCRIPTION

This plant works in four stages:

3 Pre-sorting,
4 Windrow,
5 Pre-preparatory,
6 De-composting and finishing line (<4mmm)

Figure 45 MSW Plant (Left Arrow) and local resident houses (Right Arrow)

The Unit involves destoning process employing 4mm trommel. It takes approximately 2 months to turn the waste into fine compost. The fine compost manure is then collected and packed for sale at Rs. 800/tonne, which is a subsidized rate offered to farmers through Agriculture Department. The rejects are diverted to ACC cement factory. The plant has a leachate tank and leachates are sent to BWSSB Mailasandra Plant at Kengeri, Bangalore for further treatment.

IMPACTS AND DISCUSSION

7 Plant is close to human habitation (20-30 meters)
8 Sompura lake a kilometre downstream
9 Local communities not consulted when the plant was sited in an area designated for a Civic Amenity site.
10 Leachate flows into pond, storm water drains and joins the Sompura lake.
9 Foul odour spreads over 2-3 km radius
10 Presence of flies and mosquitoes has increased tremendously.
11 Psychosomatic disorders increasingly reported.
12 Dermatological, respiratory diseases, fatigue, no appetite, body pains being reported increasingly from local residents.
13 Several families have left homes and relocated.
14 Value of their properties has drastically reduced. No buyers.
15 Villagers have been protesting and blocking garbage trucks, demanding the facility be stopped.

Figure 46 Final Compost

Figure 47 Sompura Lake

4.4.4 Karnataka Compost Development Corporation, Near Kudlu Main Road, Madiwala Post

Date of Field Visit: 06th July 2017

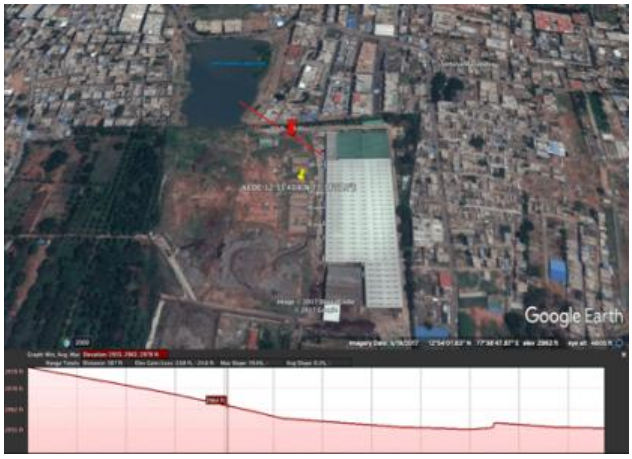

Figure 48 Google Earth overview of the KCDC MSW Treatment Plant (Including elevation details from MSW Plant to Somasundarapalya lake downwards)

GEOGRAPHICAL LOCATION

This plant is located at an elevation of 907 meters (Longitude: 77°38'57.2"E Latitude: 12°53'47.4"N). It is in Ward No: 191. This plant is located in the midst of a residential locality and is adjacent to Somasundarapalya lake.

PROJECT SITE DESCRIPTION

Construction Year: 1975

- Consultants: WAPCOS Limited,
- Client: Karnataka Urban Infrastructure Development and Finance Corporation,
- Total Site Area: 29 acres
- Workers: 50
- Storage Capacity: 20000 tonnes,
- Processing Capacity: 500 tonnes mixed waste.
- Current in-take: 15-20 trucks per day i.e. 150 metric tonnes segregated waste.
- Leachate Tank: 50000L (50% used within the plant for compost and 50% goes to BWSSB)
- This Corporation is floated by Karnataka Agro Industries Corporation, Bruhat Bengaluru Mahanagara Palike and Karantaka State Co-Operative Marketing Federation Limited with 52%, 24% and 24% shares respectively.
- No leachate treatment plant installed.
- Bio-filters (Odour control facility) available but not effective.

Figure 49 KCDC MSW Facility layout Plan

gure 50 Piles of mixed waste and leachate flowing

Figure 51 piles of waste lying to get dry via traditional method (contaminating the atmosphere due to its heavy odour)

OPERATIONAL DESCRIPTION

This plant works in four stages:
Pre-sorting (200mm and 100mm trommel),
Windrow (32 available windrows),
Pre-preparatory (35mm and 16mm trommel),
De-composting and finishing line (less than 4mm trommel)

It takes approximately 40-50 days to turn the waste into fine compost. The fine compost manure is then collected and packed for sale at Rs. 2500/metric ton loosely. The manure is also sold at Rs. 800/metric ton to farmers with government subsidies KCDC the difference amount. The rejects are sent to ACC cement factory. The plant has a leachate tank and the collected leachates are evacuated to the BWSSB treatment plant at Kengeri for further processing.
No Personal Protective Gears have been provided to the workers.

IMPACTS AND DISCUSSION

- Plant is close to human habitation, and water bodies.
- Foul-smelling sewage (leachate) flows into the lake through a channel behind the KCDC Unit, polluting Somasundarapalya lake. On one end of the lake bed, construction waste and gravel have piled up, adding to the pollution in the lake.
- Local residents complaing that the unit is not managed well and they constantly suffer from stench and water pollution.
- Ground-water contamination (open-well) is visible.
- The stench from the plant is carried over 2 kms radius. There is dense swarm of flies and mosquitoes.
- Villagers have been blocking garbage trucks, and stopping the unloading of garbage in the facility as they find the plant impacting their capacity to live in the area.

Figure 52 KCDC plant adjacent to houses (left arrow) and leachate contamination of Somasundarapalya lake (right arrow)

Figure 53 contaminated well-water of local-residents

4.4.5 Municipal Solid Waste Processing Facility, Chikkanagamangala Village, Sarjapur Hobli, Anekal Taluk

Date of Field Visit: 06th July 2017

Figure 54 Google Earth overview of the Chikkanagamangala MSW Treatment Plant (Including elevation details from MSW Plant to Rayasandra lake)

GEOGRAPHICAL LOCATION

This plant is located at an elevation of 922 meters (Longitude: 77°41'08.96"E Latitude: 12°51'32.21"N). It is in Survey No: 31. This plant is located in the midst of a residential locality, adjacent to bus depot, agricultural land, lake, etc. Cattle grazing is observed around the plant. The plant is close to Chikkanagamangala Village (0.5kmeast), Sriramapura Village (1.12km North), Doddanagamangala Village (1.4km West), Bhovi Phaya Village (1.2km South), Rayasandra Lake (1.14km Northwest), Konappana Lake (1.44km Southwest).

PROJECT SITE DESCRIPTION

- This facility is not operational now. It is awaiting review of BBMP's to consider its re-operation.
- Project Proponent: Bruhat Bengaluru Mahanagara Palike
- Nodal Agency: Karnataka Urban Infrastructure Development and Finance Corporation,
- Total Site Area: 25 acres;
- Storage Capacity: 6000 tonnes,
- Processing Capacity: 500 TPD mixed waste.

Figure 56 Refinement process via trommels

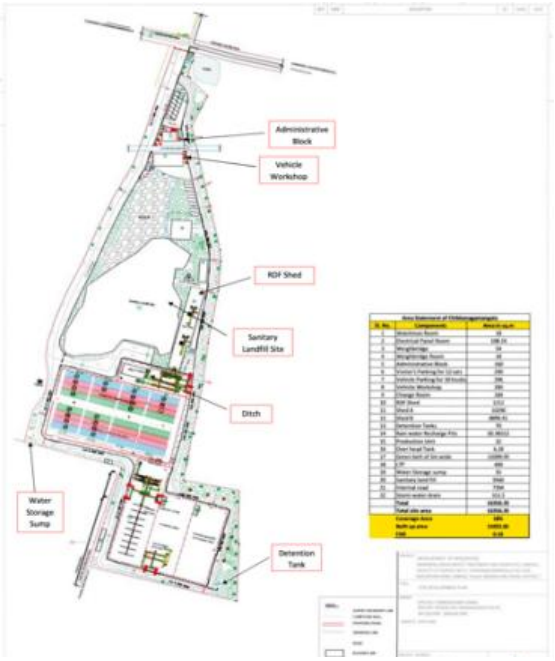

Figure 55 Chikkanagamangala MSW Facility layout plan

- Leachate tank capacity: 35000 L Trucks: 40 trucks i.e. 500 TPD (once it is start working)
- Workers: 120 workers (when operational)
- No Sanitary landfill available at the site.
- No leachate treatment plant installed.
- No odour control facility

OPERATIONAL DESCRIPTION

This plant works in four stages:

- Pre-sorting/ Segregation area,
- Windrow,
- Pre-preparatory,
- De-composting and finishing line (less than 4mm trommel)

Figure 57 Accumulated fine compost lying at the plant

It takes approximately 2 months to turn the waste into fine compost. The fine compost manure is then collected and packed for sale. The rejects are sent to ACC cement factory. The plant has a leachate tank and the collected leachates are sent to BWSSB's Kengeri treatment plant for further processing.

IMPACTS AND DISCUSSION

11 Plant is close to human habitation and water bodies.

12 Local ponds, storm water drains and the Rayasandra lake are constantly under threat of contamination from leachates of this plant.

16 Villagers have frequently blocked this plant unable to live in the area due to stench and pollution from the plant when it was operational.

Figure 58 Plant location close to human habitation and local water bodies

Figure 59 Actual Plant (No landfill space and absence of leachate treatment within the Plant)

4.4.6 Common Municipality Solid Waste Management Facility, Subbarayanapalya

Date: 15th September 2017

Figure 60 Google Earth overview of the Subbarayanapalya MSW Treatment Plant.

GEOGRAPHICAL LOCATION

This plant is located at an elevation of 922 meters (Longitude: 77°25'51.4"E Latitude:12°52'57.4"N). It is in Survey No: 143. This plant is located in a peri-urban area and is surrounded by horticultural farms and grazing pastures. The site is located at an elevation of 775 meters (2542 feet) and is sloping from West to East towards the natural nullah adjacent to the project site. The site is located about a mile from the Bangalore-Mysore State Highway (SH-17).

PROJECT SITE DESCRIPTION

- This site was used for dumping mixed waste from 2004-05, an operation that continued till about 2011.
- KUIDFC engaged AECOM India Private Limited to carry out an Environmental Impact Assessment (EIA) study for the upcoming CMSWMF at Subbarayanapalya. Based on this Environmental Clearance was granted in 2015, and the plant started operations to process segregated waste.
- However, due to poor management, the facility stopped has stopped receiving waste over the past one year. The ongoing activity is to process the legacy waste of 2500 tonnes and 1000 tonnes of RDF.
- Project Proponent: Bruhat Bengaluru Mahanagara Palike
- Nodal Agency: Karnataka Urban Infrastructure Developmen t and Finance Corporation,
- Total Site Area: 11 acres;
- Processing Capacity: 200 TPD.
- Leachate tank capacity: 35000 L
- Trucks: Not receiving waste from past one year
- Workers: 19 (Labours, operators, and supervisor)
- No leachate treatment plant installed.
- No odour control facility.

Sl. No.	Item	Details
1	Project Type	Common Municipal Solid Waste Management Facility
2	Proposed waste treatment technology	Windrow composting in a closed shed
3	Project Cost	28.73 crores
4	Design Period	Designed for 10 years
5	Water requirement	51 KLD
6	Waste water generation	24 KLD (completely utilized within the site)
7	Source of water	Construction water will be sourced from treated wastewater sourced from authorized tanker supply and around 27 KLD water will be abstracted from borewells during Operation Phase.
8	Power requirement	500 kilo-watt (kW) electrical connection which will be obtained from Bangalore Electricity Supply Company Limited (BESCOM). A DG set of 200 kilo volt amps (KVA)

Figure 61 Subbarayanapalya MSW Plant details

Figure 62 Pre-sorting Area

OPERATIONAL DESCRIPTION

This plant works in four stages:

- Pre-sorting/ Segregation area,
- Windrow, (200mm, 100mm, 35mm and 16mm trommels)
- Pre-preparatory,
- De-composting and finishing line (less than 4mm trommel)

Figure 63 Accumulated waste lying at the plant

It takes approximately 2 months to turn the waste into fine compost, which is bagged and sold. The rejects are sent to ACC cement factory. The plant has a leachate tank from which collected leachate is evacuated to BWSSB's Kengeri treatment plant.

IMPACTS AND DISCUSSION

- Plant is close to human habitation and local water bodies.
- Local people complaing that poor management of waste processing has spread stench in the surrounding areas.
- The long term dumping of waste and the failure to contain the spread of leachates polluting surrounding water bodies has had a debilitating effect on local farm productivity. It has also affected the quality of water in drinking water sources.
- There are 8 villages within 2km radius from the project site.
- Due to protests from villagers, this facility has stopped receiving garbage.

Figure 64 Local water body near the facility

4.4.7 Common Municipality Solid Waste Management Facility, Doddabidarakallu, Yeshwanthapuram Hobli, RR Nagar zone

Date: 15th September 2017

Figure 65 Google Earth overview of the Doddabidarakallu MSW Treatment Plant.

GEOGRAPHICAL LOCATION

This plant is located at an elevation of 922 meters (Longitude: 77°28'46.8"E Latitude: 13°01'51.2"N). This plant's location is close to residential locality. The site is about half a kilometer from the Bangalore-Mysore Infrastructure Corridor (BMIC). The plant is surrounded by residential neighbourhoods: Thirumalapura –1.03km (northwest), Gangondanahalli – 1.81km (southwest), Peenya industrial area – 3.43km (southeast), Yeshwantpur – 7.32km (southeast), Nelamangala – 9.7km (northwest)

PROJECT SITE DESCRIPTION

- The proposed project site was used for dumping mixed solid waste from 2007 till about 2012. There were no efforts to process the waste or contain the damage.
- The proposal is to compact and cap the existing waste within a designated area.
- Legacy waste of nearly 18000 tonnes is required to be processed.
- In the same area, a common municipal solid waste management facility was commissioned in 2015.
- Ward No.: 40.
- Project Proponent: Bruhat Bengaluru Mahanagara Palike
- Nodal Agency: Karnataka Urban Infrastructure Development and Finance Corporation,
- Total Site Area: 11 Acres (44500 Sq Mt);
- Processing Capacity: 200 TPD.
- Leachate tank capacity: 30000 L
- Trucks: 5-7 per day
- Workers: 50 (Labours, operators, and supervisor)
- No leachate treatment plant installed.
- No odour control facility.

Figure 66 Doddabidarakallu SWM Layout Plan

OPERATIONAL DESCRIPTION

This plant works in four stages:
Pre-sorting/ Segregation area,
Windrow, (200mm, 100mm, 35mm and 16mm trommels)
Pre-preparatory,
De-composting and finishing line (less than 4mm trommel).

It take approximately 2 months to turn the waste into fine compost, after which the manure is bagged and sold. The rejects are sent to ACC cement factory. The plant has a leachate tank from which the collected leachates are sent to the BWSSB's Kengeri treatment plant for further processing.

gure 67 Pre-sorting area and leachate flowing

gure 68 Accumulated waste on one side and e compost on the other side lying at the plant

IMPACTS AND DISCUSSION

Plant is close to human habitation and local water bodies.
Due to poor management leachate flows into ponds, storm water drains and joins other local water bodies. This plant still does not have leachate treatment plant on site.
Poor management of waste processing and back log of piles of waste has spread stench into the surrounding areas.
Villagers have been protesting the operation of this facility.

5 Conclusion

As Bangalore's toxic legacy continues due to a still messy situation in how solid waste is managed, this report is an effort to present the gap that prevails in conforming with judicial orders that have been issued during 2012-17 in matters of solid waste management, and the compliance or lack of it. The focus is on appreciating the impacts on all publics whose health and environment are affected by the state of affairs. As residents of the city generate waste, the impact of the waste accumulated on them is often in focus. But what is not in focus often is the adverse impact of this waste on communities who did not generate the waste and are yet recipients of the waste: primarily rural communities in the peri-urban and rural areas around the Bengaluru metropolis.. An urban and peri-urban environment allowed to be neglected by unattended regulatory mechanisms, of the messy outcomes of out-sourcing the collection of waste to contractors who have failed to conform with basis norms of collecting, handling and processing waste, is resulting in a rapidly decreasing quality of life for Bangalore's citizenry.

In this section, we outline the human and social-economic impacts of the case of Mavallipura and the other landfills around Bangalore so as to highlight the failure of governance and regulatory mechanisms and also to draw attention to the long term implications of such neglect. We argue that urgent attention, enforcement, and remediation is needed to claim back a human city by managing solid waste in a manner that guarantees dignity of workers who handle waste and in this manner as socially just and ecologically sustainable system would emerge. Such an effort requires all participants in the waste stream – generators, processors, workers, administrators, regulators, and victims, to recognise the urgency of the matter and to work together in enforcing crucial elements of the Karnataka High Courts' directions. These include the importance of ensuring there is civil and civic responsibility on the waste generator's part, that enforcement mechanisms are diligently complied with, there is transparency and accountability at all levels, environmental education of the overall waste management stream is commonplace and there is conscious attention to the importance of ethical human resource management, particularly in regard to the SWM workers – be they in collection, processing, transporting or disposal operations.

In this sense, solid waste management is a pivotal domain of the overall urban governance structure and practice, and for this to ensure sustainable outcomes for the city, it takes individual responsibility, but more importantly institutional accountability.

Building on the earlier sections, this part of the report aims to first, present the socio-economic impacts suffered by citizens affected by the landfilling practices in Mavallipura and other sites, which has largely escaped public attention sparing when the victims protest against being dumped on in sheer desperation. Second, we reiterate the gaps between the regulatory and judicial orders and argue that the lack of care for impacted population and waste workers is a visible and gross indicator of not merely a lack of sensitivity, but a stark reflection of a highly divided society. Restoring individual and institutional

responsibility, and dignity of labour in SWM work, is an imperative to realise a humane and healthy city. Third, we articulate a way forward, of implementing the bottom-up participation and planning that is essential to ensure not merely solid waste, but also all other civic responsibilities, are attende to as per Constitutionally prescribed objectives in securing the well-being of all citizenry.

5.1 The never-ending toxic legacy of Mavallipura: Impoverishment of communities

The findings on socio-economic consequences of the health impacts that the communities have been enduring stem from a health survey conducted in the villages of the catchment area where the two landfills are located in Mavallipura: that operated by Bailappa and the other by Ramky. The discussion shows that the resulting economic vulnerability is driving families into poverty and also impacting entire community's future prospects. Besides, it is decreasing societal cohesion and leading to the death of the village spirit.

Increased economic vulnerability

There is Increased economic vulnerability and distress in communities impacted by landfills. This is due to loss of livelihood as landfill leachates contribute significantly to degradation of the soils and water systems, which drastically affects farm productivity. Besides, contamination of drinking water sources affect the survival rates of livestock, which invariably end up consuming landfill leachate contaminated water. These contaminants work their way through the food webs, and are often bio-accumulative.. Most critically, the contamination of drinking water sources contributes to high levels of morbidity in landfill impacted communities.

Many of the families interviewed are/were daily wage labourers. They all narrate that prior to the landfill, they had a wage every day of the week. Agricultural activity was lush in the area and hence there was enough of work, as fields of Ragi, Jowar and other cereals would characterize the landscape. Today some seasonal vegetable fields exist and daily wagers have work only for 2-3 days a week, making it difficult for them to make ends meet.

Previously, Mavallipura was famous for having the highest yield of milk in the area. Today most of the families have lost their cattle, as grazing grounds are diverted and water sources are polluted. This has increased the mortality rates of cattle, as pastoral and farming communities find the veterinary expenses to keep them alive too high a burden.

Some villagers featured in the health survey are impacted to such an extent that they are not able to work anymore, hence further decreasing the family's economic security. While some stay at home and

can't go after any productive activity, others had to opt for home-based occupations (like tailoring) to continue to assist with household expenses.

Financial burden of ill health

As the health survey demonstrates, chronic illnesses, recurrent fevers and medical conditions requiring immediate attention or intervention, push the villagers to very frequent visits to doctors and hospitals. The required medical attention represents a considerable financial burden on them. Households with family sizes of 4-5 members, state that about one half or sometimes even two thirds of their household revenue is used up for medical concerns. When one family member underwent high cost medical intervention and hospitalization, the family further gets trapped into a debt spiral as they are forced to borrow money from family or private lenders to finance the treatment. The interest burden amounts to 6000-7000 INR/month for a loan of 3lk INR. Very often they are unable to pay the loans in time. It is important to understand this accumulation medical expenses in light of the immediate cures that increasingly impoverished villagers seek. The faster the cure, the sooner can the villagers get back to work to support their family. Therefore, allopathic interventions that can trigger more side effects are sought out.

Treatments for minor concerns such as recurrent fevers, colds, back pain etc. are treated symptomatically for rapid relief. Many public health studies in the context of poverty show, that the affected often take treatment until the symptoms are felt and seen, as soon as the symptoms wear off, they often stop the treatment in view of saving that expenditure. Such a response often leads to recurrent or latent disease that emerges later or in different manifestations. When one family member endured sustained medical problems requiring hospitalization or expensive medication, compromises on the health status of other family members are compromised or go untreated.

Figure 69 Abandoned houses near the landfill site at Mavallipura

To escape tendencies to be driven into poverty due to medical expenses and loss of livelihood, we observed on the site nearest to Bailappa's landfill derelict and empty houses. We were told that families owned these houses, but experiencing the environmental calamity around them and to avoid ill health, these families abandoned their own houses to go and live in dwelling

units constructed by the Karnataka Slum Development Board, exposing them increasingly to vulnerabilities of an urban nature.

Community impacts

In light of so much physical suffering across age groups, the community lamented that despite being so close to the city, their living "conditions were worse than living in the forest". Lack of bus facilities with good connectivity to the city was failing families to get proper and timely treatment, or even access livelihood options. Accessing medical facilities represented a logistical nightmare for the villagers, as the nearest health care centers were at Belkere and Hesarghatta. Villagers avoided the Ayurvedic center located close to Mavallipura, as they could not afford the treatment or felt they did not have the luxury of time for the Ayurvedic system's deliberate curative impacts to take effect.

The manifest disease burden makes villagers take frequent medical consultations. Doctors often stated that the environment in Mavallipura was not good "Nimma Uranalli Vaata Varana sariyage illa" (the air in the village is contaminated). Women and children suffered from chronic illnesses. Infectious skin diseases, respiratory problems, higher incidence of cancer cases and kidney failure and widespread dengue occurences along with recurring and lapsing fevers, especially in children, was a common narrative during fieldwork. Many mothers of daughters stated that young girls in the community were rather weak, that they were not able to work as they could when they were that age. Women also stated observing increasingly "Gharbaghosha" (uterine) problems particularly those relating to delivery of babies.

Repetitively, community members stated that in villages around the landfill, young and women and men could not find grooms and brides. Enquiring matrimonial parties wouldn't want to enter an alliance with an inhabitant of these villages surrounding landfill, well knowing the environmental pollution they were exposed to for years could affect health that may manifest in later years. Besides, it was simply a case of not wanting to be in an area of continuous and unbearable stench. While seeking suitable alliances, parents placed their daughter to be married with family elsewhere to avoid the stigma of belonging to Mavallipura.

The landfill has even altered the way the village celebrates festivals, as now no relatives come to celebrate with them in the village and stay over. This fearing contracting of diseases from the water and also being infected by mosquito borne infections, especially Dengue and Chickenguniya which is rampant. One woman stated "the body is constantly in a diseased state. So there never any mental happiness to celebrate or feel good about anything."

Another very disturbing impact is on school-going children. Some families stated that their children dropped out of school because of the mosquito threat or stench at the school, which is close to the

landfills. A more healthier school would mean greater expense, including on transport, which the family could ill afford.

5.2 Mavallipurisation: The multiplication of ill-effects through institutionalized irresponsibility

This report has brought evidence from various sites, across different forms of waste dumping illegalities, that the tragedy unfoldin in Mavallipura is merely indicative of what is being repeated across Bangalore's periphery and villages. Unfortunately, we see these impacts as elaborated in previous chapters repeated in newer sites and zones, as solid waste malpractices are systematically wrecking the lives of entire communities, their livelihood systems and causing deleterious impact on environmental quality.

Reviewing landmark judicial orders for compliance by the municipal government reveals that there is weak regard for the environmental protection and safeguarding people's health. This is reason for serious breach in citizens' confidence in democratic institutions that are supposed to serve public interest as per well defined Constitutional imperatives, and national and state laws.

The gaps between the enforcement of judicial orders and the actual practices are wide and contrary to regulatory specifications:
1) Decision-making regarding municipal solid waste management according to the Constitutional mandate, statutory provisions and paritucularly the Municipal Solid Waste Management Rules 2016 require the system to be decentralized and transparent, yet devolution has not happened. Ward committees are yet to be made fully operational and cultivate the capacity to function optimally.
2) After the court's investment into the Mavallipura case, the phasing out of the practices of dumping in landfills was directed.. But Section 3 on landfills shows an expansion of this practice.
3) Orders regarding bio-mining of legacy waste in landfills have not been enforced and untreated leachates continue to pollute soil and water.
4) Decentralisation of the waste management sites have been ordered by the High Court, so that needless transportation of waste for processing is avoided, and that waste is processed locally everywhere. However, a concentration of these sites emerges in the western arc of the city's fringe. This concentration of landfill sites and the state of affairs of its management, is increasingly contributing to the pollution of the of the catchment area of the Arkavathi basin, a precious source of drinking water for the city and surroundings.

As depicted in section 3, it is astonishing that landfills were allowed to come up again (!) near airports, when the High Court had spoken with great concern about the Indian Air Force's worry over waste dumping being allowed near its bases and other civilian airports. But the close proximity of Bellahalli landfill to the Yelahanka Air Force Station indicates that the risk that pilots and passengers are put to, and in a disaster even residents on ground, are not taken seriously as they should be. The geographic

dispersion of various dumping sites across peri-urban Bangalore makes it financially impossible to decontaminate such vast tracts of lands that are extensively polluted. It could be several centuries before nature could recover from this pollution and the debilitating impacts would first be felt by current populations, and generations to come. Also in terms of urban planning, the landfills are concentrated in the northern and western arc of the city, making pollution (air, noise) and high cost of transport a major impediment to sustainable management choices.

Environmental commons such grazing pastures (Gomala land), village forests (gundathopu), tanks, rivers, livestock and private agricultural fields have been destroyed, and intergenerational efforts to conserve, sustainably use and in recent times to feed the city have been wasted. Landfill pollution across such vast tracts of land threaten the quality of food supplied to the city, of villages around, and compromises the the potential for domestic and international exports that the Bengaluru region has always been famous for. Villages abutting the metropolitan region are known to be securing water for the thirsty city's fringes. But with over-extraction of ground water aquifers, the tankers need to fetch water further away, adding increasing cost to a critical resource. As landfills contaminate peripheral and faraway villages, and particularly contaminate ground water aquifers, the weakening capacity of the city to sustain its water demands is dragging it into a politics of increasing vulnerability.

In view of the public health calamity and its disastrous effect on environment and the community, governmental apathy is being tolerated and is not remedying the situation, thus resulting in further marginalisation of communities.

Communities in Mavallipura and other villages impacted by landfills have gravely spoiled the health of community members, impoverished them by increasing medical expenses and depriving them of multiple livelihood strategies they had cultivated to support their families. It is an irony and unjust that the cost of dumping the city's waste is bourne by impoverished rural communities in forms of increasing medical expenses. In other words, impacted parties are asked to bear disproportional risks of society. The general good is served at their expense. These aggrieved communities are not assisted in providing them access to proper and affordable medical care and facilities. Nor are they given awareness of the source of their problems and the potential evaluation of the impact on their health, nor have the responsible polluters been penalized and forced to deliver the assistance as directed by Court.

Non-compliance of statutory norms and Court directives in cleaning-up the mess that has been caused, is an environmental disaster that can only be fully comprehended in consultation with impacted communities. Across all landfilling sites, affected communities told us that they were not informed of the upcoming dumping plans; that they were always surprised by the decisions to dump the city's waste in their commons. Only when they saw the trucks rolling into their village, did they understand the scale of the operation and foresaw their bleak future. Non-disclosure of information and non-consultation of affected communities are tolerated despite the prescription in the 73rd and 74th Constitutional

Amendments, which clearly mandate decentralization and a bottom-up approach to planning and a basic right to participation in village and municipal decision-making through public consultations, ward committees and village panchayats.

As compiled in section 1 a wide range of progressive directions have been issued to facilitate a humane and ecologically viable remedy to the present solid waste management system, which have also influenced, informed and caused reform of the national laws relating to solid waste, as is evident in the Municipal Solid Waste Management Rules, 2016. But systematic non-compliance, non-enforcement, negligence and mis-interpretation of the *status quo* presents a scenario which is not very different from what prevailed in 2012 when the Karnataka High Court began to attend to and monitor the situation in a systematic manner when the city's garbage crisis was triggered. Bangalore's toxic legacy continues to be emblematic of the gross failure in civic governance. The municipal solid waste management practice has grossly violated these several legal provisions and has ripped communities and publics of their basic rights. Circuits of corruption, an apparatus of endemic inefficiency and the lack of enforcement have threatened the citizens' environments, their drinking water sources and food security that has unfairly advantaged private gain and vested political power.

5.3 Pathways to secure Bangalore's future

It is of prime importance to recognise that all means to fix the harmful *status quo* of municipal solid waste management are available, ranging from legal orders, policy guidelines, SWM rules, infrastructure, expertise, administrative capacity and civic involvement. We would like to draw the attention of the Hon'ble High Court of Karnataka that through the SWM case, the struggle demanding establishment of Constitutionally mandated Ward Committees in Bangalore per Constitutional 74th Amendment (Nagarpalika) Act, 1992, fought by so many groups, networks and individuals across Karnataka, and that over 25 years, finally ended in April 2017 when the constitution of these critical citizen interface and monitoring committees came to be established. As the Court attended to various details of the solid waste management systems, a pool of spirited citizens approached the administration wanting to contribute in their capacity to better the city. It is the strengthening of this process that is of paramount importance in making Bengaluru a city that could be a model for the country to emulate. Much work remains to be done to ensure this achievable reality becomes and actuality of municipal governance.

In principle, the prevailing deplorable situation of municipal solid waste mismanagement should be communicated as a very detrimental NIMBY (not in my back yard) problem. As Edelstein (2004) notes in his book on "Contaminated Communities"[149], when people don't have to deal with their own waste problems there is little pressure for conservation, recycling, waste cycling, cleanup and waste reduction. When waste goes somewhere else, there is no incentive to be responsible for the consequences of waste. This is moral issue that needs intercommunity solidarity and investment.

[149] Contaminated Communities: Coping with Residential Toxic Exposure, Michael R. Edelstein, Westview Press, 2004.

We appeal to the Karnataka High Court to ensure the civic administration complies with its directives and that governmental agencies take responsibility to empower citizenry (adults and children), ward committees and government departments to tackle the situation. This can be achieved in the following ways, amongst others:

- Through deploying a public pedagogy about suffering communities, emphaising on waste segregation at source, conscious tot the long term ecological and health impacts of SWM mismanagement
- To restore ecological and citizens' health damaged by harmful SWM practices and work towards the prevention of further ill-health
- To hold private contractors and operators liable to their inactions
- To restore dignity of Pourarkamikas by ensuring they are supported with necessary infrastructure, health care, occupational health needs, just and regular wages, security of service, which are essential to enhancing their social status as the first doctors of the city
- To scope requirements of compensation of those affected by the pollution, which made their lands infertile, killed their livestock and made their bodies toxic.

As shown in this report the mis-governance of municipal solid waste has far-reaching impacts beyond health and environmental degradation, as an entire generation and their descendants are deprived of a freedom to live up to their full potential and ambitions.

In conclusion, the report argues that there has been extensive lack of compliance with environmental and public health standards prescribed in law and as directed by the Karnataka High Court in regard to the siting and operation of waste processing sites and landfills in Bengaluru. As a consequence, Bangalore's toxic legacy due to mis-management of solid waste, continues to affect adversely affect environment and human health, much more extensively now than was the case in 2012.