Study of Physico-chemical characteristics of Mithi River, Mumbai, Maharashtra

Submitted in partial fulfilment of the requirements
of the degree of

Bachelor of Engineering

by

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CERTIFICATE

This is to certify that the project entitled *"Study of Physico-chemical characteristics of Mithi River, Mumbai, Maharashtra"* is a bonafide work of "*Ubed-Ur-Rehman Shaikh*" (11CE49), "*Mohamad Altaf Shaikh*" (13CE71), "*Abdul Karim Kazi*" (13CE78), "*Najeer Shaikh*" (13CE82), submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of "Bachelor of Engineering" in Department of Civil Engineering.

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This project report entitled "***Study of Physico-chemical Characteristics of Mithi River, Mumbai, Maharashtra***" by "***Ubed-Ur-Rehman Shaikh-11CE49, Mohamad Altaf Shaikh-13CE71, Abdul Karim Kazi-13CE78 and Najeer Shaikh-13CE82***" is approved for the degree of "***Bachelor of Engineering***" in "***Department of Civil Engineering***".

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Declaration

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

The purpose of this research is based on the investigation of the water samples from Mithi River and sediments from its banks. The objective of the study was to determine the transfer of the pollution from the Mithi River to its adjacent bank soils. This investigation was carried out using several tests, which included pH, DO, Alkalinity, Chlorides, T.S.S (Total Suspended solids), T.D.S (Total Dissolved solids), C.O.D, B.O.D, and heavy metals present in Mithi river etc. The tests conducted on water samples of Mithi River and soil, Samples collected from the various locations. This was assessed through the test mentioned above. The result of the test indicates the water quality related environmental problems, it is must to have accurate information and to know precisely what the problem is, where it is occurring, how serious it is, and what is causing it. Such information is necessary for determining cost effective and lasting solutions to water related problems.

However, further investigations are highly recommended and should be carried out to understand further effects of pollution on Mithi River and its soil sediments.

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Abbreviation

pH	=	Potential of Hydrogen
DO	=	Dissolved oxygen
SS	=	Suspended Solids
TSS	=	Total Suspended Solids
BOD	=	Biological oxygen Demand
COD	=	Chemical Oxygen Demand
WHO	=	World health Organization
USEPA	=	United States Environmental Protection Agency
MEF	=	Ministry of Environment and Forests
CPCB	=	Central Pollution control board
MPCB	=	Maharashtra Pollution Control Board
ICMR	=	Indian Council of Medical Research
BIS	=	Bureau of Indian Standards
Ca	=	Cadmium
Cr	=	Chromium
Cu	=	Copper
Pb	=	Lead
Hg	=	Mercury
Ni	=	Nickle
Se	=	Selenium
Mo	=	Molybdenum
Zn	=	Zinc
Tl	=	Thallium
Sb	=	Antimony

Chapter 1

Introduction

1.1 General:

Water is a transparent and nearly colourless chemical substance that is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. Its chemical formula is H_2O, it means that its molecule contains one oxygen and two hydrogen atoms, which is connected by covalent bonds. Water is mainly referred to the liquid state of that substance that is obtained at a standard ambient temperature and pressure, but it is also often referred to its solid state such as ice or its gaseous state such as steam or water vapour. Its occurrence in nature is also in the form of snow, glaciers, ice packs and icebergs, clouds, fog, dew, aquifers, and atmospheric humidity.

Water on Earth moves through the water cycle of evaporation and transpiration, condensation, precipitation, and runoff, which usually reaches the sea. Evaporation and transpiration contribute to the precipitation over land. Large amounts of water are also chemically combined or adsorbed in hydrated minerals.

Water plays an important role in the world economy. Approximately 70% of the freshwater used by humans goes to agriculture. Fishing in salt and fresh water bodies is a major source of food for many parts of the world. Much of long-distance trade of commodities (such as oil and natural gas) and manufactured products is transported by boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating, in industry and homes. But the degradation in the quality of water has begun to raise a major concern in most parts of the world, one of which is also the Mithi River of Mumbai, one of the metropolitan city of in Maharashtra state of India.

The primary source of the Mithi River is the Vihar lake and also receives the overflow from Powai lake which is the secondary source. It meets the Arabian Sea at Mahim Creek after flowing at a stretch of 15 Kms, it flows along through many residential and industrial complexes of Powai, Saki Naka, Kurla, Kalina, Vakola, Bandra-Kurla complex, Dharavi and Mahim.
The Mahim Bay area is a nominated bird sanctuary where migratory birds come for nesting and it is full of mangroves. Before, when the river was not as pollutes as it is today it served as an important storm water drain for Mumbai, but after being used as sewer over past years its importance as a storm water drain has reduced and now poses as hazard during the period of high tide by flooding the city with the polluted water.

1.2 Heavy Metals

Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition [1, 2]. Heavy metals constitute an ill-defined group of inorganic chemical hazards, and those most commonly found at contaminated sites are lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni) [3]. Soils are the major sink for heavy metals released into the environment by aforementioned anthropogenic activities and unlike organic contaminants which are oxidized to carbon (IV) oxide by microbial action, most metals do not undergo microbial or chemical degradation [4], and their total concentration in soils persists for a long time after their introduction [5]. Changes in their chemical forms (speciation) and bioavailability are, however, possible. The presence of toxic metals in soil can severely inhibit the biodegradation of organic contaminants [6]. Heavy metal contamination of soil may pose risks and hazards to humans and the ecosystem through: direct ingestion or contact with contaminated soil, the food chain (soil-plant-human or soil-plant-animal-human), drinking of contaminated groundwater, reduction in food quality (safety and marketability) via phytotoxicity, reduction in land usability for agricultural production causing food insecurity, and land tenure problems [7–9].

The adequate protection and restoration of soil ecosystems contaminated by heavy metals require their characterization and remediation. Contemporary legislation respecting environmental protection and public health, at both national and international levels, are based on data that characterize chemical properties of environmental phenomena, especially those that reside in our food chain [10]. While soil characterization would provide an insight into heavy metal speciation and bioavailability, attempt at remediation of heavy metal contaminated soils would entail knowledge of the source of contamination, basic chemistry, and environmental and associated health effects (risks) of these heavy metals. Risk assessment is an effective scientific tool which enables decision makers to manage sites so contaminated in a cost-effective manner while preserving public and ecosystem health [11].

1.3 Sources of Heavy Metals

Heavy metals occur naturally in the soil environment from the paedogenetic processes of weathering of parent materials at levels that are regarded as trace ($< 1000\, mg\, kg^{-1}$) and rarely toxic [10, 13]. Due to the disturbance and acceleration of nature's slowly occurring geochemical cycle of metals by man, most soils of rural and urban environments may accumulate one or more of the heavy metals above defined background values high enough to cause risks to human health, plants, animals, ecosystems, or other media [14]. The heavy metals essentially become contaminants in the soil environments because (i) their rates of generation via man-made cycles are more rapid relative to natural ones, (ii) they become transferred from mines to random environmental locations where higher potentials of direct exposure occur, (iii) the concentrations of the metals in discarded products are relatively high compared to those in the receiving environment, and (iv) the chemical form (species) in which a metal is found in the receiving environmental system may render it more bioavailable [14]. A simple mass balance of the heavy metals in the soil can be expressed as follows [15, 16]. $M_{total} = Mp + Ma + Mf + Mag + Mow + Mip - Mcr + Ml$,(1) where "$M$" is the heavy metal, "$p$" is the parent material, "a" is the atmospheric deposition, "f" is the fertilizer sources, "ag" are the agrochemical sources, "ow" are the organic waste sources, "ip" are other inorganic pollutants, "cr" is crop removal, and "l" is the losses by leaching, volatilization, and so forth. It is projected that the anthropogenic emission into the atmosphere, for several heavy metals, is one-to-three orders of magnitude higher than natural fluxes [17]. Heavy metals in the soil from anthropogenic sources tend to be more mobile, hence bioavailable than paedogenic, or lithogenic ones [18, 19]. Metal-bearing solids at contaminated sites can originate from a wide variety of anthropogenic sources in the form of metal mine tailings, disposal of high metal wastes in improperly protected landfills, leaded gasoline and lead-based paints, land application of fertilizer, animal manures, biosolids (sewage sludge), compost, pesticides, coal combustion residues, petrochemicals, and atmospheric deposition [1, 2, 20] are discussed here under.

1.3.1 Fertilizers

Historically, agriculture was the first major human influence on the soil [21]. To grow and complete the lifecycle, plants must acquire not only macronutrients (N, P, K, S, Ca, and Mg), but also essential micronutrients. Some soils are deficient in the heavy metals (such as Co, Cu, Fe, Mn, Mo, Ni, and Zn) that are essential for healthy plant growth [22], and crops may be supplied with these as an addition to the soil or as a foliar spray. Cereal crops grown on Cu-deficient soils are occasionally treated with Cu as an addition to the soil, and Mn may similarly be supplied to cereal and root crops. Large quantities of fertilizers are regularly added to soils in intensive farming systems to provide adequate N, P, and K for crop growth. The compounds used to supply these elements contain trace amounts of heavy metals (e.g., Cd and Pb) as impurities, which, after continued fertilizer, application may significantly increase their content in the soil [23]. Metals, such as Cd and Pb, have no known physiological activity. Application of certain phosphatic fertilizers inadvertently adds Cd and other potentially toxic elements to the soil, including Fe, Hg, and Pb [24].

1.3.2 Pesticides

Several common pesticides used fairly extensively in agriculture and horticulture in the past contained substantial concentrations of metals. For instance, in the recent past, about 10% of the chemicals have approved for use as insecticides and fungicides in UK were based on compounds which contain Cu, Hg, Mn, Pb, or Zn. Examples of such pesticides are copper-containing fungicidal sprays such as Bordeaux mixture (copper sulphate) and copper oxychloride [23]. Lead arsenate was used in fruit orchards for many years to control some parasitic insects. Arsenic-containing compounds were also used extensively to control cattle ticks and to control pests in banana in New Zealand and Australia, timbers have been preserved with formulations of Cu, Cr, and As (CCA), and there are now many derelict sites where soil concentrations of these elements greatly exceed background concentrations. Such contamination has the potential to cause problems, particularly if sites are redeveloped for other agricultural or non-agricultural purposes. Compared with fertilizers, the use of such materials has been more localized, being restricted to particular sites or crops [8].

1.3.3. Biosolids and Manures

The application of numerous biosolids (e.g., livestock manures, composts, and municipal sewage sludge) to land inadvertently leads to the accumulation of heavy metals such as As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Mo, Zn, Tl, Sb, and so forth, in the soil [20]. Certain animal wastes such as poultry, cattle, and pig manures produced in agriculture are commonly applied to crops and pastures either as solids or slurries [25]. Although most manures are seen as valuable fertilizers, in the pig and poultry industry, the Cu and Zn added to diets as growth promoters and As contained in poultry health products may also have the potential to cause metal contamination of the soil [25, 26]. The manures produced from animals on such diets contain high concentrations of As, Cu, and Zn and, if repeatedly applied to restricted areas of land, can cause considerable buildup of these metals in the soil in the long run.

Biosolids (sewage sludge) are primarily organic solid products, produced by wastewater treatment processes that can be beneficially recycled [27]. Land application of biosolids materials is a common practice in many countries that allow the reuse of biosolids produced by urban populations [28]. The term sewage sludge is used in many references because of its wide recognition and its regulatory definition. However, the term biosolids is becoming more common as a replacement for sewage sludge because it is thought to reflect more accurately the beneficial characteristics inherent to sewage sludge [29]. It is estimated that in the United States, more than half of approximately 5.6 million dry tonnes of sewage sludge used or disposed of annually is land applied, and agricultural utilization of biosolids occurs in every region of the country. In the European community, over 30% of the sewage sludge is used as fertilizer in agriculture [29]. In Australia over 1,75,000 tonnes of dry biosolids are produced each year by the major metropolitan authorities, and currently most biosolids applied to agricultural land are used in arable cropping situations where they can be incorporated into the soil [8].

There is also considerable interest in the potential for composting biosolids with other organic materials such as sawdust, straw, or garden waste. If this trend continues, there will be implications for metal contamination of soils. The potential of biosolids for contaminating soils with heavy metals has caused great concern about their application in agricultural practices [30]. Heavy metals most commonly found in biosolids are Pb, Ni, Cd, Cr, Cu, and Zn, and the metal concentrations are governed by the nature and the intensity of the industrial activity, as well as the type of process employed during the biosolids treatment [31]. Under certain conditions, metals added to soils in applications of biosolids can be leached downwards through the soil profile and can have the potential to contaminate groundwater [32]. Recent studies on some New Zealand soils treated with biosolids have shown increased concentrations of Cd, Ni, and Zn in drainage leachates [33, 34].

1.3.4. Wastewater

The application of municipal and industrial wastewater and related effluents to land dates back 400 years and now is a common practice in many parts of the world [35]. Worldwide, it is estimated that 20 million hectares of arable land are irrigated with waste water. In several Asian and African cities, studies suggest that agriculture based on wastewater irrigation accounts for 50 percent of the vegetable supply to urban areas [36]. Farmers generally are not bothered about environmental benefits or hazards and are primarily interested in maximizing their yields and profits. Although the metal concentrations in wastewater effluents are usually relatively low, long-term irrigation of land with such can eventually result in heavy metal accumulation in the soil.

1.3.5 Metal Mining and Milling Processes and Industrial Wastes

Mining and milling of metal ores coupled with industries have bequeathed many countries, the legacy of wide distribution of metal contaminants in soil. During mining, tailings (heavier and larger particles settled at the bottom of the flotation cell during mining) are directly discharged into natural depressions, including onsite wetlands resulting in elevated concentrations [37]. Extensive Pb and zinc Zn ore mining and smelting have resulted in contamination of soil that poses risk to human and ecological health. Many reclamation methods used for these sites are lengthy and expensive and may not restore soil productivity. Soil heavy metal environmental risk to humans is related to bioavailability. Assimilation pathways include the ingestion of plant material grown in (food chain), or the direct ingestion (oral bioavailability) of, contaminated soil [38].

Other materials are generated by a variety of industries such as textile, tanning, petrochemicals from accidental oil spills or utilization of petroleum-based products, pesticides, and pharmaceutical facilities and are highly variable in composition. Although some are disposed of on land, few have benefits to agriculture or forestry. In addition, many are potentially hazardous because of their contents of heavy metals (Cr, Pb, and Zn) or toxic organic compounds and are seldom, if ever, applied to land. Others are very low in plant nutrients or have no soil conditioning properties [25].

1.3.6. Air-Borne Sources

Airborne sources of metals include stack or duct emissions of air, gas, or vapor streams, and fugitive emissions such as dust from storage areas or waste piles. Metals from airborne sources are generally released as particulates contained in the gas stream. Some metals such as As, Cd, and Pb can also volatilize during high-temperature processing. These metals will convert to oxides and condense as fine particulates unless a reducing atmosphere is maintained [39]. Stack emissions can be distributed over a wide area by natural air currents until dry and/or wet precipitation mechanisms remove them from the gas stream. Fugitive emissions are often distributed over a much smaller area because emissions are made near the ground. In general, contaminant concentrations are lower in fugitive emissions compared to stack emissions. The type and concentration of metals emitted from both types of sources will depend on site-specific conditions. All solid particles in smoke from fires and in other emissions from factory chimneys are eventually deposited on land or sea; most forms of fossil fuels contain some heavy metals and this is, therefore, a form of contamination which has been continuing on a large scale since the industrial revolution began. For example, very high concentration of Cd, Pb, and Zn has been found in plants and soils adjacent to smelting works. Another major source of soil contamination is the aerial emission of Pb from the combustion of petrol containing tetraethyl lead; this contributes substantially to the content of Pb in soils in urban areas and in those adjacent to major roads. Zn and Cd may also be added to soils adjacent to roads, the sources being tyres, and lubricant oils [40].

1.4 Need for Present Investigation:

The cause for most of the freshwater being polluted is due to the addition of organic material which is mainly sewage, as well as can also be food waste or farm effluents. Most of the dissolved oxygen is used by the bacteria and other micro-organisms that feed on organic matter and large populations are quickly develop.

Though oxygen is present in high quantities, even a small drop in the oxygen level can have a harmful effect on the aquatic life. Animals can be listed according to their ability to tolerate low levels of oxygen.

The Mithi River has been polluted by dumping of raw sewage, industrial waste and municipal waste. The water with the mixture of sewage and industrial waste is a threat to marine life; the river bed is full of sewage, garbage and vegetation growth like water hyacinth in many parts. As a result of dumping of the sewage, garbage, rubbish and other hazardous wastes into the Mithi River the need for cleaning it up is a comprehensive effort which should be done by Brihan Mumbai Municipal Corporation, Citizens, Maharashtra Pollution Control Board (MPCB) as well as NGOs, the damage done to the marine life and to the surrounding of the Mithi river by taking some relevant actions such as by immediately putting a stop to all the unauthorized industries which includes scrap dealers, scrap recyclers, waste oil recyclers etc.

1.5 Project Objectives:

- To analyse the surface water quality of Mithi River.
- To assess the transfer of heavy metals from water into bank soil sediments.
- To evaluate the overall pollution load of Mithi River.
- The terms of reference for such study were as follows,
- To fix 10 monitoring points along the stretch of Mithi river.
- Single set of samples to be collected and analysed at these points.
- Sources of pollution points be identified and samples collected for assessing the quality.
  Note: Entire sampling work was done post monsoon.
- Based on above findings, the report shall provide following,
  I. Mithi river water quality.
  II. Short term and Long term measures to control pollution of Mithi river.

Accordingly sampling and survey for river water at 10 locations was carried out and based on this data we are pleased to submit our report.

Chapter 2

Review of Literature

Klean (2004) MPCB appointed M/s. Klean Environmental Consultants (P) Ltd. Mumbai to submit their report by carrying out survey and sampling of Mithi river (vide letter No. MPCB/MS/TB/B-747 dated 14th May 2004). In order to get proper idea of pollution load, sampling was done over 12 days period during low tide and high tide at twenty (20) sampling points were selected starting from origin and sediment samples were collected from the river bed from the same locations. Sediments were collected during low tide with the help of scoop, as the river bed is shallow because of the accumulation of sludge. The water with mixture of sewage and Industrial waste is fatal to marine life and the river showed sign of total loss of such support system. Preliminary survey indicated that, the pollution levels have reached an alarming stage. To assess probable load of pollution in the Mithi river and plan to improve the quality of water in the river as well as its carrying capacity, a reconnaissance survey is proposed by Maharashtra Pollution Control Board (MPCB). For this purpose, Mithi river water is polluted right from its origin at Powai due to discharge of sewage from residential colonies. At various locations, our sampling indicated presence of industrial waste due to high values of COD, Oil & Grease, etc. and contribution of industrial waste cannot be ignored. The concluded that some steps taken will definitely benefit the city in the long run.

These steps include,

- Providing sewer lines and sanitation arrangement on both banks of the river.

- Proper garbage collection and disposal arrangement.
- Closure of unauthorized industries in these areas.

Manisha P. Trivedi *et al* (2012) collected water samples from three different sampling locations named Airport (L1), CST Kalina (L2) and BKC Taximen's Colony (L3). Airport site was thickly populated and had small scale industries including scrap dealers. Illegal industrial units, scrap dealers and oil mixing business at CST road near Kalina, have resulted in discharge of solid waste, organic waste, industrial waste, heavy metals, oils and tar in the river. The development of Bandra-Kurla Complex has resulted in unnatural diversion along the Mithi River at few places hence, affected natural flow of the river and the drainage. This part of the river is a dumping ground for garbage and the test showed higher values of suspended solids. They concluded that although Central Pollution Control Board (CPCB) is responsible for restoration and maintaining the wholesomeness of aquatic resources under Water Prevention and Control of Pollution Act 1974 passed by Indian Parliament, to maintain or restore the water quality at desired level it is important to have monitoring on regular basis. Also, to address water quality related environmental problems, it is must to have accurate information and to know precisely what the problem is, its source, its effect, and reason causing it, this information is necessary for determining cost effective and lasting solutions to water related problems.

Ravindra M. Mishra *et al* (2012) four sampling stations were selected. To ensure substantial pollution the sampling points were selected by considering the residential units and commercial activities near the sampling points. The investigation was carried throughout the year i.e. from Oct 2011 to Sept 2012. The physio-chemical parameters viz., pH, E.C., D.O., B.O.D., C.O.D., total hardness, total alkalinity, chlorides, nitrates and phosphates were analysed. It was observed that some of the parameters substantially exceeded the limits when compared with the standards set by BIS and CPCB. The River water was therefore heavily polluted with number of organic and inorganic pollutants. They concluded that a mechanism for the continuous monitoring of the river water and efforts to control discharge of waste in the Mithi River are required.

NAGARSEKAR A. S. AND KAKDE U.B. (2014) The study dealt with the quantification of accumulated toxic heavy metals in sediments of Mithi River of Mumbai. It was performed at three different sampling locations along the flow of Mithi River for a period of 2 years from 2009-12. The different types of heavy metals were studied (Al, As, Cd, Cr, Hg, Ni, Pb, Sr and Mn). The results of the study indicated that the concentration level of these toxic heavy metals for the two assessed years increased by the factor of $1.2 - 5.8\ \mu g/g$. The results are clear indication of increasing pollution level of the Mithi River, thus creating negative environmental impact on biological life of river. They concluded that the results emphasises the need of regular scientific monitoring of different pollutants adversely affecting the environment and to reframe the pollution control strategies already in existence.

The following suggestions were made to reduce pollution levels in the Mithi River.

- Strict controls need to be introduced on the disposal of domestic sewage by Housing Societies and residential units. There are many sewage lines which dispose the sewage in the river. The sewage should be treated and then only allow to dispose off.
- Dumping of garbage into the river should be strictly prohibited.
- Strict implementation of all the Environmental laws to be followed.
- Modern sanitation systems should be adopted. Proper lavatories need to be built at different locations to prevent open defecation. The width of the Mithi River needs to be widened by relocating residential, commercial units, slums which obstruct the course of the river.

Aarti S. Nagarsekara and Umesh B. Kakde (2014) To determine the current status, Study was being undertaken for the determination of the present status of the toxicity levels of heavy metals in the water of Mithi River. The study covered a period of one year from October 2011 to September 2012 and 4 our sampling stations namely S1, S2, S3 & S4 were selected considering heavy population in the surrounding areas and possibility of pollution from point and non-point sources. The heavy metals (As, Hg, Pb, Cd, Cr, Al, Ni, Mn and Zn) were analysed. The study revealed that some of the metals crossed the permissible levels as prescribed by environmental authorities. Thus, they concluded that there is an increasing need in continuous monitoring of the pollution levels of Mithi River waters and a check on the disposal of sewage, waste water and effluents from residential and industrial units in the areas adjoining the river banks. The water cannot be used for any domestic or industrial purposes. Besides the various adverse effects of the heavily polluted waters on the people staying in areas adjoining the river banks, it is also ecologically damaging to the flora and fauna in the sensitive ecosystems near the river (e.g. Samil Ali bird sanctuary at Mahim). Therefore, a system of continuous monitoring of the quality of the water of river Mithi is required and also concentrated efforts are required from all concerned to reduce dumping of industrial and residential wastes in the river waters. The State Government, Municipal Authorities need to work together to achieve this.

E. R. Agharia *et al* (2014) study was performed for one year from June 2012 to May 2013 for understanding the physio-chemical properties of water samples collected along the Mahim Creek of Mumbai. The annual average Total Dissolved Solid (TDS) content of the Creek water was found to be 14614 ppm which was very much above the limit of 2100 ppm set by the Central Pollution Control Board (CPCB) for inland surface water. The annual average conductivity was found to be 24023 $\mu S^{-1}\ cm$ which was very much above the conductivity limit for inland surface water of 1000 $\mu S\ cm^{-1}$ set by CPCB for propagation of fisheries. The annual average hardness level of the creek water was recorded as 1696 ppm, based on the recorded value the creek water can be considered as very hard water. The hardness of creek water was supported from the high annual average concentration levels of calcium (545 ppm) and magnesium (209 ppm) in the creek water. The average annual alkalinity level was recorded as 334.7 ppm, which according to the UN Department of Technical Cooperation for Development can be considered as medium to strongly alkaline. The annual average chloride concentration level was found to be 4770 ppm which was above the US Environment Protection Agency (US EPA) standards of 250 ppm set for chloride in surface water. The overall annual average concentration of sulphate was found to be 605.5 ppm, which was very much above the limit of 400 ppm set by CPCB for inland surface water. It is feared that such high amount of sulphates may lead to pollution problems resulting in the formation of hydrogen sulphide gas. The average concentration level of reactive silica as SiO2 in the creek water was recorded as 495.3 ppm. Based on the previous study it is feared that such high level of Si at a pH greater than 5 may affect significantly in removal of the As (III) and also reduce the adsorption capacity of ferric hydroxide for As (V) and As (III) at a pH of approximately 6.8. They concluded that from the results it appeared that as India moves towards stricter regulation of industrial effluents to control water pollution, greater efforts are required to control the discharge of pollutants into the aquatic ecosystems.

P. U. Singare and S. E. L. Ferns (2014) The study was performed for the period of one year from June 2012 to May 2013 in order to understand the level of toxic heavy metals in the water of Mahim Creek near Mumbai. It was observed that the annual average concentration of heavy metals like Pb, Cd, Cr, Fe, Zn, Cu, Ni and Hg was found to be 0.68, 0.28, 0.15, 0.04, 2.93, 0.64, 1.29 and 0.31 ppm respectively. The average concentrations of Hg and Pb were found to be above the maximum permissible limit of 0.01 ppm and 0.1 ppm respectively set for inland surface water by Central Pollution Control Board (CPCB) of India. Hence, they concluded that there is a need that each industry should treat their effluents, in accordance with the legal requirements, before discharging these into the streams otherwise "Polluter pays" principle should be implemented. The current regulatory system in India for control of industrial discharges needs a complete improvement in terms of standards setting, monitoring and enforcement. The monitoring system for water quality needs to be strengthened both in terms of parameters monitored, water resources coverage and timely reporting to public domain. These steps are important in order to avoid irreparable ecological harm in the long term well masked by short term economic prosperity due to extensive industrial growth.

Ashwini V. Padalkar *et al* (2014) five different sampling stations were selected for the purpose of study. Sampling station: Mahim is the area of confluence of Mithi river with the Arabian Sea. This point is subject to maximum tidal influence and also represents the entire river water pollution as it is the final stretch of the river. Sampling station: Dharavi and Sampling station: Vakola are the areas surrounded by slum settlements. As a result, the water from these areas is subjected to a lot of domestic sewage inflow on a daily basis. The other two sampling stations are located on the upstream Sampling station: CST2 and downstream Sampling station: CST3 of bridge on Bandra –Kurla complex. These are industrial zones encompassing automobile spare factories, rubber tyre factories etc. The pH was found neutral at all stations. The values of temperature were also within similar values at all the five stations. The turbidity of the water was found to be highly fluctuating depending on sampling stations and season. These values were also very high as compared to the MPCB standards of 5 NTU. The values of conductivity showed variations according to sampling stations. The influence of sea water was maximum at Mahim, followed by Dharavi and Vakola. Dissolved oxygen was very low at all sampling stations. Organic loading in the form of B.O.D. and C.O.D. was very high at all the sampling points due to industrial effluent and discharge of sewage. The values of B.O.D. and C.O.D. were very high at all sampling points as compared to MPCB standards of 30 mg/L to 250 mg/L. Ammoniacal nitrogen values were lower as compared to the MPCB standards of 50 mg/L. Thus, they concluded that the studied physio-chemical parameters reveals that the water is neither fit for drinking purposes without any form of treatment nor for various other surface water usage purposes. It is clear from the analysis that industries and domestic wastewater discharge have negative impact on water resources near the industrial area. Serious water quality deterioration has taken place. Based on the water quality analysis, the water quality was found unfit for bathing, contact water sports and commercial purposes.

The deterioration of environmental quality at various points in the river requires urgent remedial measures to improve the water quality. Major recommendations required for the improvement in water quality are given:

- Immediate closure of all unauthorized activities discharging industrial effluent along the river course.
- Provision of septic tanks for individual hutments or combined sewage treatment plants along the residential settlements along the river stretches.
- Provision of garbage collection and disposal systems at regular stretches to prevent citizens from dumping trash in the river.
- Dredging of the entire length of the river to clear blocked stretches and to improve the carrying capacity of the river.
- Provision of buffer strips along both the banks of the river for proper maintenance and management

Prakash Korgaonkar, S K Ukarande (2016) four sampling points were selected Saki Naka, near Saki Naka, near Kurla, near Mahim Causeway and the following tests were conducted (pH, D.O., C.O.D, B.O.D, T.S.D, Chlorides). They concluded that according to the baseline parameters of Mithi water, it is polluted black water with toxic metal substances contamination and high level of nitrogen. This has an adverse effect on the flora and fauna of Mithi. The sewer system is not adequate and sufficient due to slums which adds load on the river water level with several open-air channels sanitation risks. In addition to it due to unloading of oil tanks and toxic metallic substances black sting occurs in the water. To bridge the gap found in existing scenario many alternatives are listed in the chapter. The scope for present work is to analyse the existing data of water quality of Mithi and based upon it to work out feasibility of construction of diversion head works to channelize the black water to local STP's and ETP's for tertiary treating the water for recycle and reuse to fulfil the water demand. Also, other solutions are to avoid dumping of solid waste directly in course of river by barricading existing roads or bridges having direct access to shores or course of river and recommendations.

Shruti Handa and Rahul Jadhav (2016) sampling was done during summers to maintain uniformity with the data available. The study was conducted in 2013 and 2015. Water was collected in clean, autoclaved one litre plastic containers. The samples were brought to the laboratory immediately and kept at 4°C to maintain its condition very close to the time it was sampled. The analysis was carried out within 4 hours of water collection. The digestion was carried out by standard methods (APHA, 2005; Trivedi R.K 1988). $5ml$ aqua regia was added to appropriate amount of sample and was allowed to digest at around 75°C. The volume was reduced to near dryness. Further, nitric acid was added until white residue was formed. This residue was dissolved with nitric acid. Once dissolved, it is filtered through Whatmann filter paper and the final volume is made to $100ml$ using distilled water. The heavy metals were analysed by atomic absorption spectroscopy (Thermo Elemental, AAS Solar Series) and Inductive coupled plasma-optical emission spectroscopy, model. ARCOS, (SPECTRO). The samples were prepared in triplicates to obtain a constant result. The study was an attempt at assessing the heavy metals present in the downstream areas of Mithi River which probably has a visible amount of industrial activities and habitation. The values taken from sources mentioned for the year 2004, 2010 and 2011 have been compiled with the studies which include the values from 2013 and 2015 and thus concluded the data interpreted the presence of heavy metals in the river. The concentrations of metals except for Lead are within the permissible limits suggested by the CPCB but none fit into the WHO limits for drinking water. An overall view shows that the values for most of the indexes at 2013 was the lowest as compared to the other period mentioned. This could be owed to the action taken by the state government which shut a huge number of polluting industries on its banks. Additionally, NEERI reported an improvement in the river water in the following year. The samples taken in 2015 again showed deterioration in the quality of water. Thus, continuation of stringent laws and a combined effort by the Government and the people can help the river inch back to its original form.

Rushikesh S. More and Sakshi S. Chaubal (2016)**.** the water samples were collected from four different locations and investigated. In this investigation attempts were made to study the current health status of Mithi river. In the study at all the sampling locations most of the water quality parameters were within the standard limits by BIS. However, MPN count indicates that the water is non-potable and cadmium concentration is found to be higher in concentration beyond permissible range in all the seasons. However, zinc and copper concentration for all the water samples are within the permissible range thus they concluded that the problems related to the environment and its ecosystem need to be discussed seriously. People should be educated about their activities which affect the natural ecosystem with a different approach. Proper policies and programs towards solving problems should be implemented, the present data on Mithi river also points out to the need for regular monitoring of water resources.

Chapter 3

Sampling and Methodology

3.1 Area of Study

The area selected for the current study is the stretch of flow of Mithi River that originates from Powai Lake till the part where it meets the Arabian Sea that is the Mahim Creek. 10 sampling stations are selected for the collection of sample and soil sediments as listed below in the table.

Table 3.2: Location of Sampling point.

Sr. No.	Location of sampling point	Latitude	Longitude
1	Arey road	19.135424	72.896763
2	Saki Vihar road	19.132338	72.896946
3	JVLR	19.129222	72.884346
4	Military road	19.118435	72.885792
5	Sakinaka, Andheri-Kurla road	19.106153	72.884750
6	MTNL road	19.100858	72.879529
7	Air India road	19.078857	72.876164
8	Kapadia nagar, CST road	19.074106	72.872408
9	Kalanagar, sion bandra link road	19.051968	72.848100
10	Mahim Creek	19.048234	72.838241

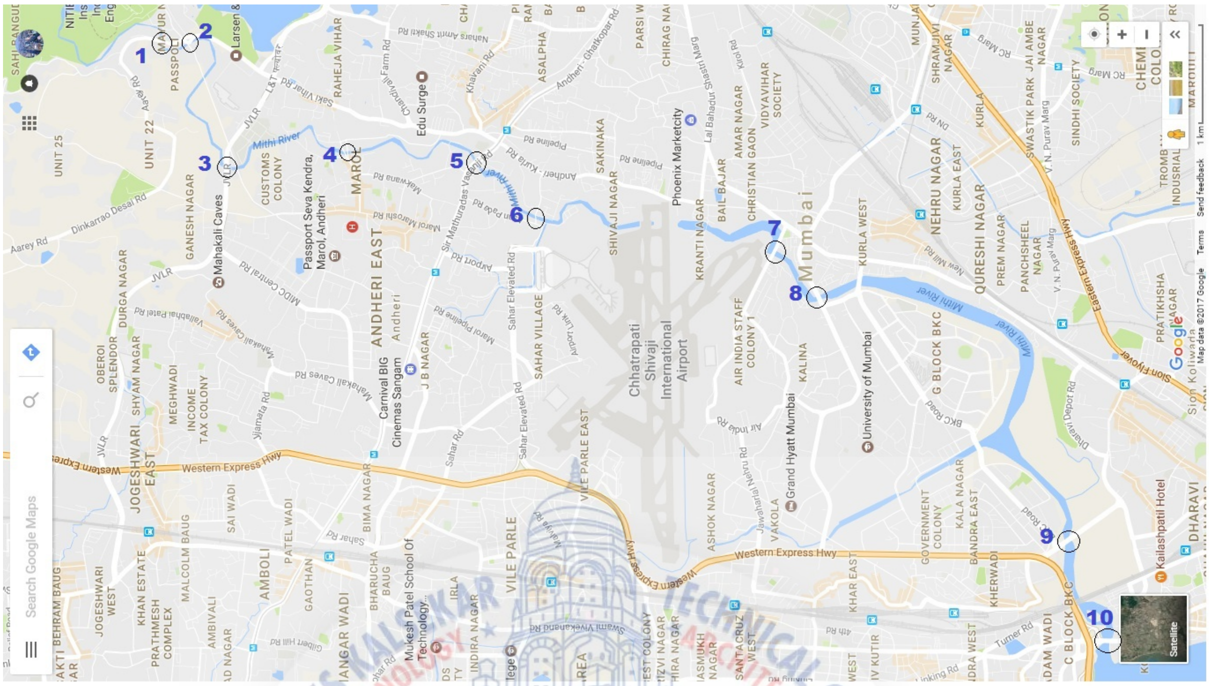

Figure 3.1 Sampling Points

3.2 Climatic and Topographical Factors

Originating at Powai, Mithi river flows from Saki Naka, Safed Pool, around Santacruz airstrip, passing through thickly populated and industrial area like Jarimari, Bail Bazar, old airport road, Kalina (CST road), Vakola, Bandra Kurla complex, Dharavi and ends at Mahim creek. It serves as combined sewer for the area carrying sewage as well as stormwater to sea. River bed is narrow in the initial stretch and is about 10 meters wide but at Bandra Kurla complex it is much wider.

The river passes through congested residential colonies including slums, which let out raw sewage in the river and also throw garbage in it. Due to this reason, the river bed is full of sludge, garbage and vegetation growth like Hyacinth in many parts as can be seen from photographs enclosed for various locations. Cattle sheds in areas like Bail bazar, Jarimari, Andheri Kurla road etc. contribute animal waste.

At CST road junction and on the road from Lal Bahadur Shastri Marg (LBS Marg) to Santacruz airport there are many unauthorized industries like Oil refiners, Barrel cleaners, scrap dealers etc. who dump sludge, oil, effluent and garbage in the river.

In order to assess water quality of Mithi river, the topography of area through which river flows was studied. Sampling points were selected at a distance of about 800 meters to 1 km and wherever convenient for water and sediment sampling. As there are many road bridges crossing the river, these locations were used for convenience.

3.3 Sample Collection Procedure

All samples were analysed in our laboratory and at each location single set of sample was collected and conditioned to determine various parameters, as specified in "Standard Methods". All the samples were transferred to the laboratory within four hours of collection.

3.4 Flow Measurement of Mithi River

As Mithi river is subjected to tidal flows, river water level changes substantially. due to tidal variation. As the specific gravity of sea water is high, at the time of high tide, river water swells upstream and at low tide, water level at some points reduces to few feet. This variation makes it difficult to estimate flow of water in such short duration of time. Hence no effort was made to estimate water discharge in Mithi river at this juncture.

3.5 Methods Used for Analysis

Table 3.2: Analytical methods for various parameters

Sr. No.	Parameter	Equipment and Method
1	pH	Digital pH meter
2	D.O.	APHA-4500-0.C
3	S.S.	IS: 3025-1964
4	T.D.S	IS: 3025-1964
5	C.O.D.	IS: 3025 (PART 58)
6	B.O.D.	IS: 3025 (PART 44): 1964
7	Chlorides	APHA-4500Cl- B
8	Alkalinity	IS: 3025.1964

3.5.1 pH Meter

Calibrating the instrument

Step 1

In a 100 mL beaker take pH 9.2 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 9.2, using the calibration knob adjust the reading to 9.2. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 2

In a 100 mL beaker take pH 7.0 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 7.0, using the calibration knob adjust the reading to 7.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 3

In a 100 mL beaker take pH 4.0 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 4.0, using the calibration knob adjust the reading to 4.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue. Now the instrument is calibrated.

Testing of Samples

- In a clean dry 100 ml beaker take the water sample and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well.
- Now place the electrode in the beaker containing the water sample and check for the reading in the pH meter. Wait until you get a stable reading.
- Take the electrode from the water sample, wash it with distilled water and then wipe gently with soft tissue.

3.5.2 C.O.D.

Step 1

Place 20 ml sample in the 50 ml reflusing flask add 0.4 gm $HgSO_4$ several boiling chips 30 ml Conc. $H_2 2SO_4$ 10 ml $K_2Cr_2O_7$.Dilute the mixture to 140 ml. Add the sulphuric acid very slowly with mixing to dissolve measure.

Step 2

Attach the flask to container and start the cooling water mix thoroughly burn heat is applied avoid local heating retain to mixture for 2 hours' dilute mixture to about twice its volume with distilled water cooled to room temperature and titrate excess dichromate with standard ferrous magnesium sulphate using ferroin indicator. Take end point of sharp colour change from blue green to reddish brown reflux water in the same manner blank consisting of distilled water equal in volume to that of sample together with the reagent.

3.5.3 B.O.D. Incubator

Step 1

Preparation of dilution water. Aerated distilled water for 30 mins. Add 1mL with of phosphate buffer magnesium sulphate calcium chloride and hexachloride solution for each litre of dilution water and mix thoroughly.

Step 2

Selected two B.O.D. bottles. Fill the B.O.D. bottles with sample and dilution factor for sewage sample 7% dilution is used

Step3

Select suitable dilution factor. It is usually necessary to prepare a suitable dilution of sample according to the expected B.O.D. Determine the D.O. place after B.O.D. bottle in the incubator determine the final D.O.

Step 4

Dilution water control. Fill the B.O.D. bottle with inserted dilution water determine the D.O. and after incubation do not depletion obtained as a blank correction it should not be more than 0.2 mg/l.

Step 5

The 5-day B.O.D. is calculated using the formula.

3.5.4 Total Dissolved Solids (T.D.S.)

Step 1

Take an evaporating dish of suitable size, make it clean, dry at $103 - 105°C$, cool in a desiccator and note the initial weight(W1).

Step 2

Filter about 100 ml to 250 ml of sample through filter paper and take the filtrate in evaporating dish.

Step 3

Evaporate the sample in a hot air oven at $180 \pm 2°C$ and after the whole water is evaporated, cool the evaporating dish in a desiccator and take the final weight (W2)

3.5.5 Alkalinity

Step 1

After collection of sample, analyse as soon as possible.

Step2

Take 100 ml sample in 250 ml conical flask and add 2 to 3 drops of phenolphthalein indicator. If no colour is produced, the phenolphthalein alkalinity is zero

Step3

If pink colour develops, titrate with 0.02 NH_2SO_4 till it disappears of pH is 8.3.

Step4

Next, add 2-3 drops of methyl orange to the same flask and continue titration to pH is down to 4.5 or orange colour change to pink. Note the volume of H_2SO_4 added.

Step5

In case pink colour does not appear in step 3 after addition of phenolphthalein continue as in above.

Step 6

Calculate Total (T), Phenolphthalein (P) and methyl orange (MO) alkalinity as follows and express in mg/l as CaCO3.

Step7

After addition of phenolphthalein indicator, no colour appears phenolphthalein alkalinity =0

Step8

If, pink colour develops➞ pink to colourless (end point) ➞ A

Step9

Next, add 2-3 drops of methyl orange➞ titrate ➞orange to pink (end point) ➞B.

3.5.6 Dissolved Oxygen (D.O.)

Step1

Collect the sample in B.O.D. bottle (300 ml capacity) taking care to avoid any bubbling. Fill the sample to the neck of the bottle. Be sure that air Bubble have not been trapped under the stopper and maintain a water seal around the stop per until ready for the next step of analysis.

Step2

Add 1 ml of manganous sulphate followed by 1 ml of alkali-iodide-azide solution. The tip of the pipette should be below the liquid level while adding these reagents.

Step3

Place the stopper carefully to exclude air bubbles and mix by inverting the bottle repeatedly for at least 15 mins. An equivalent amount of 2 ml of the contents will come out of the bottle after placing the stopper. Allow the precipitate to settle leaving about 150 ml of clear supernatant.

Step4

Carefully remove the stopper and immediately add 1 ml of conc. H_2SO_4, close the bottle and mix gentle inversion until the precipitate completely dissolves.

Step5

Titrate 100 ml or 250 ml ,contents of the bottle with sodium thiosulphate solution using starch as an indicator. At the end point the blue colour turns to colourless. The starch indicator is usually added towards the end of the titration when a straw pale colour is obtained.

3.5.7 Total suspended solids

Step 1

Assemble filtration apparatus and begin suction.

Step 2

Wet the filter paper with a small volume of reagent grade water(double distilled water).

Step 3

Stir sample with a magnetic stirrer and while stirring pipette a measured volume of sample onto the fibre.

Step 4

Wash with 3 successive 10 ml volume of distilled water, allowing complete drainage between washing and continue suction for about 1 minute the filtration is completed

Step5

Carefully remove the filter paper from filtration apparatus and transfer into aluminium-weighing dish as a support

Step 6

Dry for at least 1 hr at 103 to 105°C in hot oven. Cool in a desiccator and weigh.

Step 7

Repeat cycle of drying, cooling, desiccating and weighing until a constant weight is obtained, or weight change is less than 4% of previous weight 0.5 mg whichever is less. Duplicate determination should within 5% OF the average.

3.5.8 Chlorides

Step 1

Standardise $0.1N$ $Na_2S_2O_3$ by $0.1N$ $K_2Cr_2O_7$ solution. $0.1N$ potassium dichromate is prepared by dissolving 4.904 g anhydrous $K_2Cr_2O_7$ of primary standard quality in distilled water and diluted to $1000ml$.Store in a glass stoppered bottle.

Step 2

To 80 ml of distilled water, add with constant stirring 1 ml.conc.H_2SO_4,10 ml $0.1N$ $K_2Cr_2O_7$ and $1g$ KI.

Step3

Let reaction mixture stand for 6 min in dark and then add 2 ml of starch indicator before titrating with $0.1N$ $Na_2S_2O_3$ titrant.

Step4

The colour changes from blue to colourless end point.

Chapter 4

Results and Discussion

pH :

Standards of pH
Drinking water WHO (1984) = 6.5 to 8.5; MWH (1975) = 7.0 to 8.5 (Acceptable) and beyond 6.5 to 9.2 (Cause of rejection) IS 10,500 (1983,1991) = 6.5 to 8.5 (Beyond this range the water will affect the mucous membrane and/or water supply system.) USEPA (1974) = 6.5 to 8.5. **Effluent discharge** IS: 2490 (1981) = 5.5 to 9.0 MOEF, Schedule - *VI*, (1993) 5.5 to 9.0

There is no significant change in pH as pH varied from 6.86 to 7.28. This also implies that there was no Alkaline / Acidic discharge at the time of sampling. pH of most natural water falls within the range of 4 to 9. The majority of waters are slightly over 7.0 because of presence of carbonate and bicarbonate. The pH increases during day due to photosynthesis activity because of consumption of CO_2,pH value is High at CST Road due to discharge of garages waste and battery acids, where as it declines at night due to respiratory activity.

Dissolved Oxygen (DO):

Standards of D.O.
Drinking water IS: 10500 (1991) = No Standards **Effluent discharge** MOEF (1993) = No Standards Stream Standards (CPCP, 1979) Class A = 6 mg/L; Class B = 5 mg/L; Class C = 4 mg/L; Class D = 4 mg/L MOEF (2000) notification = 5 mg/L or more for bathing water.

Dissolved oxygen was present at origin as well as near kalanagar. However, samples between these locations had very low or Nil Dissolved Oxygen probably due to high organic load contributed by sewage or decomposed garbage. It is one of the most important water quality parameter is the amount of dissolved oxygen (DO) present. The DO levels are natural and waste water depend on the physical, chemical, and biological activities in the water body. The oxygen deflecting substances reduces the available DO. During summer month, the rate of biological oxidation is highly increased, while, unfortunately, the DO concentration is at minimum due to higher temperature.

Biological Oxygen Demand (BOD):

Standards of B.O.D
Drinking water No BOD standard has been prescribed by WHO (1984), IS 105000 (1983, 1991), MHW (1975) or USEPA (1974) or ICMR (1963). **Effluent discharge** 30 mg/L, (MOEF, 1993); IS: 2490 (1981) = In inland surface water; 350 mg/L (Public sewers); 160 mg/L (Land for irrigation and marine coastal areas). In India, Central pollution control board (CPCB) recommends BOD measurements at 27°C for 3 days. For bathing water (MOEF,2000) =3mg/L or less.

BOD values varied significantly wherever Mithi river flows through thickly populated areas like Sakivihar Road, MTNL Road, etc. High BOD all along the river course indicates presence of domestic sewage as well as decomposed organic matter in the form of garbage, animal waste etc. BOD Represents the demand of oxygen required by aerobic organisms in water. The presence of organic matter in water increases the biochemical oxygen demand. In unpolluted waters/rivers, the BOD is usually 50 mg/L or lower. Higher value of BOD results in the depletion of D.O. This reduces the availability of oxygen for living organisms, like fish, plants etc. and leads to stress on aquatic plants, animals and ultimately death. River water having BOD values more than 50 mg/L is considered as moderately polluted and when the level is more than 100 mg/L it is said to be highly polluted. BOD value is less at CST Road due to Inorganic waste. It has been observed that BOD values are higher in polluted waters and lower in pollution free water

Chemical Oxygen Demand (COD):

Standards of C.O.D
Drinking water: No COD standard has been prescribed by WHO (1984), IS 10500 (1983, 1991), MHW (1975) or USEPA (1974) or ICMR (1963)
Effluent discharge: 250 mg/L, into inland surface waters and marine coastal areas (MOEF, 1993, IS 2490, 1981)

Presence of organic matter and chemical compounds in water demands oxygen for oxidation process. COD is a measure of organic pollution of water. It measures indirectly the presence of organic matter in H2O. Higher values of COD indicate that there is high organic pollution leading to a depletion of dissolved oxygen COD is an indicator of organic pollution in surface water. This is a danger to aquatic ecosystem. The sampling stations S2 is surrounded by industrial units and dense population of slums which discharge sewage, and industrial effluents increasing pollution to a very vulnerable state and sampling station S8 is surrounded by garages and slums which discharge oil refiners, barrel cleaners, scrap dealers who dump sludge, oil, effluent and garbage in the river.

Higher COD values If this parameter is considered as indicator of industrial pollution then COD, BOD, Oil and Grease exceeded tolerance figures at following sampling point locations CST road, Saki Vihar road. This shows presence of industrial activity, either authorized or unauthorized. taking place in these areas.

Alkalinity:

Standards of Alkalinity
Drinking water: IS 105000 (1991) = 200 mg/L (maximum), beyond this limit taste becomes unpleasant. 600 mg/L (permissible in the absence of alternate source). **Effluent discharge:** MOEF (1993) = No Standard

The Alkalinity of water ranges between 130 to 280 mg/L indicating presence of fresh water. Alkalinity itself is not harmful to human being, still the water less than 100 mg/L are desirable for domestic use. The alkalinity of water is a measure of its capacity to neutralise acids. Alkalinity is a measure of the water ability to absorbed H+ without significant pH Change. That is alkalinity is measure of buffering capacity of water. It is the sum of all the titrable bases. The major portion of alkalinity in natural water is caused by hydroxide, carbonate, and bi-carbonate.

Total Dissolved Solids:

Standards of TDS
Drinking Water ICMR (1963) = 500 mg/L (maximum) to 1500 mg/L (maximum) WHO (1984) = 1000 mg/L (maximum) WHO (1993) = 1000 mg/L (consumer complaint is taste) IS: 10500 (1983,1991) = 500 mg/L (maximum) (beyond 500 mg/L palatability decreases and may cause).

Similar to chloride, TDS level was high at last 2 stations and thereafter TDS level varied between 1000 to 1600 mg/L. TDS at Bandra Kurla road and Samhita Industrial complex, was noted high probably due to discharge of some chemicals. A large number of solids are found dissolved in natural waters, the common ones are carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron, etc. In other words, TDS is simply the sum of the cations and anions concentration expressed in mg/L. The result of determination of TDS can be used to check the accuracy of analyses. This is accomplished by comparing the value of calculated TDS with the measured value TDS.

Total suspended solids

Standards for Suspended Solids
Drinking Water IS: 10500(1991): No standards **Effluent Discharge MOEF (1993): General Discharge standards for wastewater effluent:** In Inland surface water: 100mL In public sewers: 600 mg/L. On land for irrigation: 200mg/L In marine coastal areas: 100 mg/L (For process Water) and for cooling water effluent 10 % above TSS of influents. **BIS standards for discharge of industrial and sewage effluents (IS: 2490:1982)** In Inland surface water: 100 mg/L In public sewers: 600 mg/L In marine coastal areas: 100 mg/L. (For Process Water) On land for Irrigation: 200 mg/L Sewage farming: 300 mg/L

TSS level was high at Saki Vihar road and CST road stations and thereafter TSS level varied between 100 to 300 mg/L. TSS at Saki Vihar road and CST Road, was noted high. Due to discharge of RMC plant and slums near the Saki Vihar. The TSS determination is extremely valuable in the analysis of polluted water. The Major parameter used to evaluate the strength of domestic wastewater and determine the efficiency of treatment unit.

Chlorides

Standards of Chlorides
Drinking Water IS:10500(1991) =0.2 mg/L (residual free chlorine, minimum). To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/L **Effluent discharge** MOEF (1993) =1.0mg/L (Total residual Cl_2, maximum), for discharge in inland surface water and marine coastal areas.

Chlorides were high for 2 sampling stations near the kalanagar and Mahim creek were as high as 21000 mg/L. However, for remaining 8 stations the chloride levels was low in the range of 500 to 800 ppm indicating that sea influx is limited to last 3 stations. Chlorine is primarily added to the water for destroying the harmful microorganisms in water and waste water. This done to eliminate to reduce the growth of microorganisms in water. To eliminate or reduce the taste, odour, and colour of the water.

Chapter 5

Conclusion

It is revealed from the results that the concentration levels for several physiochemical parameters have exceeded the maximum permissible limits. It can therefore be concluded that the waters of the Mithi River are substantially polluted due to various pollutants. Therefore, the water cannot be used for any domestic or industrial purposes. Several adverse effects are caused by the polluted water of the "River "on the health & hygiene of the people staying in adjoining areas near the river. It is also ecologically damaging the aquatic life of the River and the Arabian Sea besides it also going to affect the mangrove ecosystem which serves the lungs of the city and Salim Ali bird sanctuary at Mahim, where migratory birds come for nesting is nearby. Therefore, a mechanism for continuous monitoring of the quality of the water of river Mithi is required. Also, concentrated efforts are required from all concerned to reduce dumping of industrial and residential wastes in the river waters.

Strict controls need to be introduced on the disposal of domestic sewage by Housing Societies and residential units. There are many sewage lines which dispose the sewage in the river. The sewage should be treated and then only allow to dispose of. Dumping of garbage into the river should be strictly prohibited. Strict implementation of all the Environmental laws to be followed. Modern sanitation systems should be adopted. Proper lavatories need to be built at different Mithi river water is polluted right from its origin at Powai due to discharge of sewage from residential colonies. At various locations, our sampling indicated presence of industrial waste due to high values of COD, Oil & Grease, etc. And contribution of industrial waste cannot be ignored.

The Mithi river pollution control needs consideration of the following aspects for clean-up.

1) Domestic sewage due to residential colonies as well as hutments in the thickly populated area.

2) Industrial waste generated by authorized as well as unauthorized industries.

3) Animal waste due to cow sheds in various areas.

4) Garbage dump by citizens all along its course.

5) Industrial sludge and rejects discarded by recyclers at Kalina and CST Road.

Some step taken in these directions will definitely benefit the city in the long run. These steps include:

(a) Providing sewer lines and sanitation arrangement on both banks of the river.

(b) Proper garbage collection and disposal arrangement

(c) Closure of unauthorized industries in these areas.

Short Term Measures these include following.

1. Immediate closure of all the unauthorized activities which discharge industrial effluents, sludge, oil and chemicals.

2. Provide proper garbage collection system to prevent citizens from dumping the same into the river.

Long term measures to minimize pollution in Mithi river include the following.

1. Plan for sewers on both the banks of Mithi river and provide Sewage treatment plants at various locations. Such plants can be provided wherever proper drainage lines exist today.

2. Dredge the entire length of Mithi river bed to improve its carrying capacity.

3. Provide proper garbage collection stations for the benefit of hutment dwellers

Further Heavy metals present in Mithi River can be studied as future scope. Heavy Metals like Mercury, Zinc, Cadmium, zinc and etc.,

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