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Impact of Urbanization on River and Its Surrounding Structures: Case of Nag River Nagpur

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Abstract: ***With quick urban sprawl, a lot of developed grounds have been replaced with building lands around the stream. Urbanization is influencing the physical process of river growth thus change stream structure and further influence the elements of stream framework. As a result the quality of water and soil is continuously deteriorating. This paper investigates the procedures and qualities of urbanization in Nagpur, concentrating on to the harm to river ecosystem and its reverse impact on surrounding structures. The paper looks at the ebb and flow situation of Nag stream, essentially moving through an urban setting of Nagpur city. Population variety demonstrates a continuous increment of enlisted population and a fast increment of skimming population that for the most part originates from neighboring regions in recent years. The quality of soil and extent of soil pollution and soil degradation and its effect can be seen on surrounding structures of the stream. The examination of pointers has been done and report was shaped in like manner. It was found that the effect of urbanization on the waterway framework was significant. Urbanization impacts on river system such as direct mixture of industrial waste water, human waste, garbage, riverbank concreting and low diversity of river style were widely observed. To check the impacts on surrounding structures samples of river water, soil by core test were collected along the stretch of river stream, air quality has been monitored by air pollution monitoring and testing equipment and tested in laboratory. Every pointer had particular sensibility to urbanization so they could be utilized to depict reverse attributes to surrounding structure.***

Keywords: urbanization, river ecosystem, pollution (air/soil/water), wastes, lab tests

1. Introduction

Since eighteenth century Industry Revolution came and there was a quick advancement of Science and innovation, extensive scale urbanization cleared over the world. In this way, it is assessed that more than 60% of the streams on the planet have been experienced large amounts of human modification. Stream frameworks have now turned out to be a one of the most deeply human-affected ecosystems in the earth. To approach the impact of human activities on stream framework as a multidiscipline point has been a concentration of research throughout the decades. Investigates exhibited the different effects of urbanization on river framework from various viewpoints. Looks into showed the different effects of urbanization on stream framework from various viewpoints. It had been viewed as that the change of geomorphology of stream frameworks was a vital and dismissed element of ecological change. The review consequences of SURIAN and RI-NALDI (2003) demonstrated that extensive channel modification, for the most part showed as entry point and narrowing brought about by human unsettling influence has been ordinarily perceived in Italian waterways and additionally in UK and America. Horton's research spurned quantitative methodologies to analyze river systems. Numerous works followed and developed his idea in many countries.

Form the past researches it has been identified that there are typical indicators or impact problems all of the rivers are facing. Some of the parameters are explained below why the river is getting polluted cause of urbanization. (YUAN Wen, Philip JAMES, YANG Kai 2006)1.

1.1 Urbanization in India

The Industrial Revolution in the eighteenth century brought on nations like United States and England to end up superpower countries yet the current condition is intensifying. India has around 300 million individuals living in metropolitan ranges. Water lines, streets and power are inadequate with regards to which is bringing about fall of expectations for everyday comforts. It is additionally adding to the issue of a wide range of contamination (Varshney, Democracy, Development, and the Countryside: Urban-rural Struggles in India, 30; Varshney, Ashutosh. Democracy, Development, and the Countryside: Urban-rural Struggles in India. Cambridge [England: Cambridge University Press], 1995.)2

India continues to be rural in its population composition. But with the rapid modernization one can see remarkable demographic changes. One such rapid change is the growth of urban centers and the population. The census 2001 reveals that 285 million people accounting to 27.78 per cent of the total population of the country lives in 4368 towns / urban areas. The urban population is one of the fastest growing in the country and it has exceeded the overall growth rate in population as well as the growth in rural population (see table below)

Trend of Urbanization in India (1901-2001)

Census Year	Total Population	Urban Population	Percentage of Urban Population to Total Population	Decadal Urban Growth Rate	No of Towns/ Urban Areas
1901	238396327	25854967	10.85	NA	1827
1911	252093390	25948431	10.29	0.36	1815
1921	251321213	28091299	11.18	8.26	1949
1931	278977238	33462539	11.99	19.12	2072
1941	318660580	44162191	13.86	31.98	2250
1951	361088090	62443709	17.29	41.4	2843
1961	439234771	78936603	17.97	26.41	2365
1971	548159652	109113977	19.91	38.23	2590
1981	683329097	159462547	23.34	46.14	3378
1991	846302688	217611012	25.71	36.47	3768

2001	-	285.31 Million	27.8	31.11	4368
2011	-	3.8 Billion	34.9	38.14	5147

Source: Urban Statistics Hand Book 2000, National Institute of Urban Affairs & Agricultural Research Data Book 2011.

1.2 Impact of Urbanization on river (Indian context)

Because of development of individuals from provincial to urban regions, physical development of the urban regions happens, which at last prompts to the urbanization. Rivers all through the world are experiencing anthropogenic weights like urbanization, industrialization and population development coming about into stream basin changes. Any characteristic framework like river basin is rich in its own way. All the biotic and abiotic components of a natural system interact with each other and the study of these interactions is called ecology. Therefore, stress on any component disturbs the entire system. A land area drained by its rivers and its tributaries is called a river basin. River basin helps to maintain the water cycle. They are also helpful in sustaining human as well as other forms of life and resources.

Urban advancement is connected with the land utilize changes, degradation of the water nature of streams, increased flooding, and aggravation in the river basin ecology. Flooding disasters in super urban areas like Mumbai surges in 2005 and Delhi surges 2010 left a lesson that the infringement of a characteristic waste framework for formative purposes may come about a danger to urban life.

Sustainable development in a river basin requires the information of the interrelations between urbanization, river basin ecosystem and climate. It also requires the learning of the instruments and systems accessible for better arranging and administration of a river. It is required to frequently screen, oversee and safeguard urban stream bowls to control their corruption**.** (Satyavati Shukla, Mohan V. Khirea, Shirishkumar S. Gedama 2003)

1.2.1 Nagpur

Figure 1: Map of Nagpur and its location in India
Source: Census of India

Nagpur city lies on the Deccan plateau of the Indian Peninsula and has a mean altitude of 310 meters above sea level. West of the Nagpur is occupied by the Deccan trap formation and the east part of the city is occupied by the metamorphic and the crystalline series.

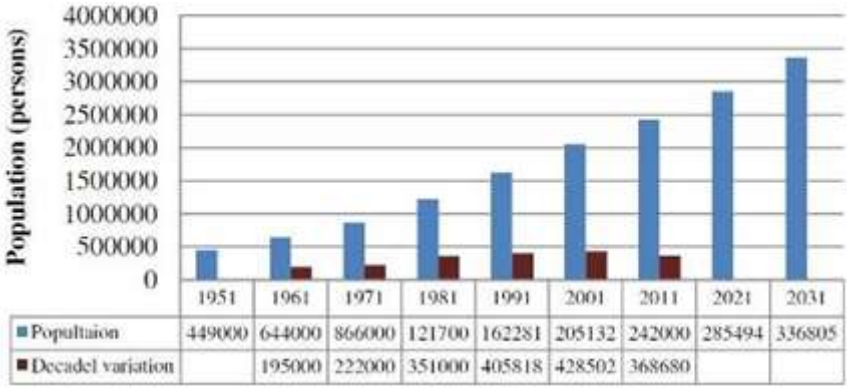
Topography of Nagpur is very suitable for its residents. People believe that Nagpur city is named after the Nag River. But although some believe its name is related to religious history of some kind, were people use to pry to Naga deities. Nag River has a stretch of 16.5km in city boundary and the watershed of this River or otherwise to say basin of this River is named as Central Zone. Soil in the surrounding areas of the city is black-cotton having clayey structure. The black cotton soil previously been used for agricultural purpose. But now it is covered with habitat, and industrial and developmental activities.

Climate – Extremely hot and dry summer and cold winter. Except for the monsoons, when the humidity is high, the air is generally dry. (Kanshik Gadpale 2013)

- Altitude (MSL) – 312.42 meters
- Annual average rainfall – 1161.54 mm
- Maximum temperature– 44 to 48 Cel
- Minimum temperature – 10 to 08 Cel

	2011	2001	1991
Population	2,497,777	1,275,750	1,222,027
Literates	2,095,419	1,102,638	992,781
Children (0-6)	248,678	129,522	119,156
Average Literacy (%)	93.17	96.2	90.02
Sex ratio	958		
Child sex ratio	920		

Source: Census of India



	1951	1961	1971	1981	1991	2001	2011	2021	2031
Popultaion	449000	644000	866000	121700	162281	205132	242000	285494	336805
Decadel variation		195000	222000	351000	405818	428502	368680		

Figure 2: Graph of Increase Population
Source: Census of India

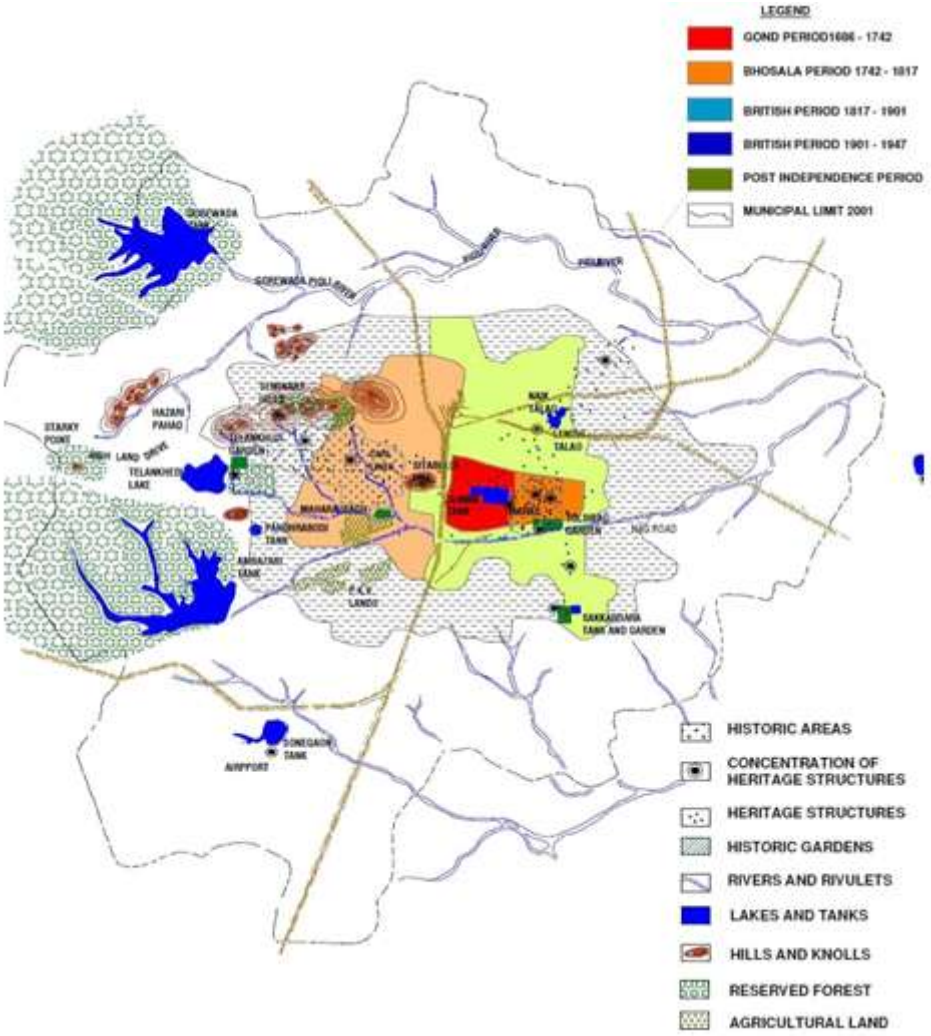


Figure 2: Historical development of Nagpur City
Source: (Nag River Basin Eco-Development Project), (Nagpur Municipal Corporation

1.2.2 Study area - Nag River

City of Nagpur is named after the Nag River. Nag River originates from a lake called Ambazari, which is located to the west of Nagpur City. Catchment of Ambazari lake was the present MIDC area and also some area beyond. Hence recharge of the lake was perennial. Overflow of lake constituted the river Nag. City of Nagpur has experienced very fast urbanization during the past 50 years. Exponential and rapid rate of growth has resulted in increased use of water which has increased generation of sewage. Settlement of population has been along the rivers cited above. Resulting wastewater is not being treated adequately thereby resulting in discharge of untreated waste water into these rivers thereby causing

i) Deterioration of quality of receiving water and ii) disturbing the eco system. It needs to be mentioned that, Environment Department, Govt. of Maharashtra has given a status of notified river to Nag river Classification of water of Nag River Basins/ Sub-Basin by Environment Department, Government of Maharashtra. Environment Department, Government of Maharashtra has classified 20 main rivers & their sub basins in A- I, A-II, A-III & A-IV on their best designated use.

Sr. No	Name of the River	Stretch of A-I class	A-II class	A - IV Class
1	Nag River	-	Origin to Ambazari Lake	Ambazari Lake are Confluence with Kanhan River

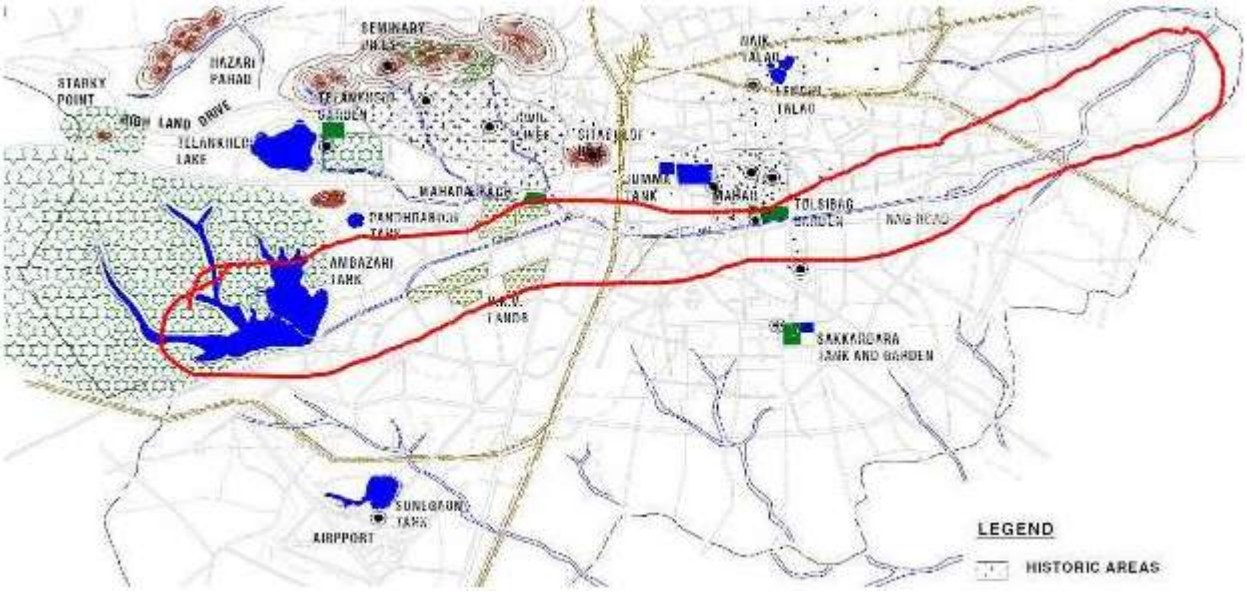


Figure 3: Physical Situation of Nag River

Source: Nagpur Municipal Corporation

1.2.3 Salient features of Nag River

- Origin - Ambazari Lake
- Major Tributaries - Bor Nallah, Pili river, Futala, Pora river
- Minor tributaries - 24 natural drains within city
- Width Meter - 12 to 40
- Length - 68 kms (17 kms within city)
- End point - confluence with Kanhan River
- Total area in Nag River catchment - 5620 Hectare

(Nag river basin report prepared by Maharashtra pollution control board regional office, Nagpur may-2011)

Nagpur Municipal Corporation has inadequate infrastructure to collect and treat the entire sewage generated from the city. Civic bodies have not been in a position to develop adequate environmental infrastructure for protection of environment resulting in increased pressure of environmental degradation primarily due to discharge of untreated / partially treated into the Nag river. Nag River stretch are from Ambazari Lake to Pardi Village, second from various localities of Nagpur town namely Shivaji Nagar, Ramdaspeth, Dharampeth, Civil Lines, Dhantoli, Indira Nagar, Chandan Nagar, Reshimbagh in the city up to the Pardi village Nag River acts as the storm water drainage for west (part), south, central & east Nagpur. Total length of Nag River is 17.00 Km up to the city limit. Its width ranges from 12 to 40 m and depth varies from 3 to 5.5 m. Total length of Nag River up to the confluence with Kanhan River at Agargaon is about 68 Km. **The seventeen kilometer stretch of Nag River is extremely polluted today.**

Sewage discharge into Nag River

1) Nalla sample carrying sewage of West Nagpur near Dande Hospital, Ravi Nagar Chowk, Nagpur.
2) Bore Nalla sample carrying sewage of Central Nagpur behind Naivadyam sangamchal before mixing to Nag River.
3) Nalla sample carrying sewage of Central Nagpur near Untkhana Bridge before mixing to Nag River.
4) Nalla sample carrying sewage of East Nagpur (Nandanvan Area) near Jagnade Chowk before mixing with Nag River.
5) Nalla sample carrying East Nagpur near Super Store, Jagnade Chowk, Nagpur before mixing with Nag River.
6) Nalla sample carrying sewage of East Nagpur near St.Xaviour School, Vyankatesh Nagar, and Nagpur before mixing with Nag River.
7) Nalla sample carrying sewage of East Nagpur (Hasanbagh) near Vyankatesh Nagar, Nagpur before mixing with Nag River.
8) Hudkeshwar Nalla sample carrying sewage of South Nagpur near bridge lawns before mixing with Nag River.
9) Nalla carrying sewage from Shivaji Nagar, Gandhi Nagar B/h LAD College

1.2.4 River Water Quality

There is a great difference between the water quality tested by MPCB and NEERI. Also MPCB has their monitoring location on places were least most possible pollution can be found if it is correctly tested. High court is directly blaming MPCB for making Nagpur city so crippled that its sewage water has polluted a distant A-II grade River. Instead of acting in direction to reduce pollution it seems that MPCB is so irresponsible for its deeds that MPCB has been indulge in de-notification of first stretch of Nag River that is an important part to restore and prevent the pollution of Nag rivers corridor inside the city and beyond. De-notification will cause heavy industrial activity in the watershed of first stretch of Nag River. That will directly and heavily impact the health of Nag River and citizens of Nagpur.

1.2.5 According to MPCB

River water quality according to MPCB suggests that the river is not highly polluted and can sustain fishes etc. MPCB only have three monitoring locations on Nag River and two on Pilli River. Location of these monitoring stations is shown

in. Temporal variation in BOD for Nag and Pilli River respectively is shown in and. Similarly for COD, DO and Temporal variation in River.

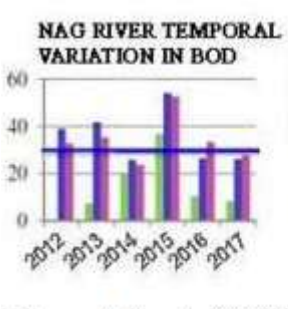


Figure 4: Graph of BOD

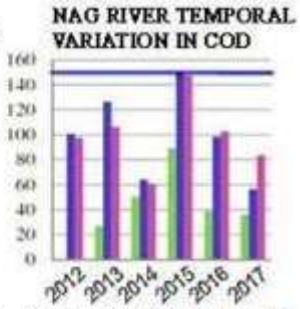


Figure 5: Graph of COD

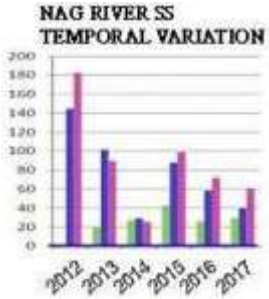


Figure 6: Graph of SS

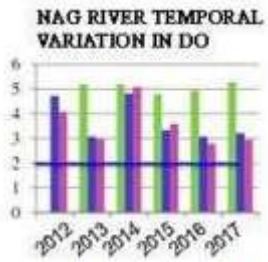


Figure 7: Graph of DO

Source: Maharashtra Pollution control Board, Nagpur

Assessment and Analysis of Nag River

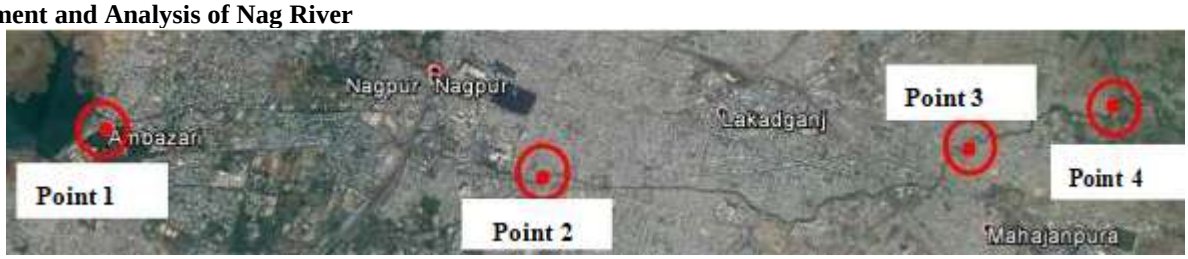


Figure 9: Nag River stretch (17 kms)

1.2.5.1 Visual Analysis of Nag River at various locations

Visual Analysis of Nag river is done throughout the stretch of Nag river of 17Kms (approx). The stretches have been divided according to the kilometers and land use planning. The analysis has been described from the **figure 8 Map of Land use planning with kilometers.** The nodes and catchments has been divided according to the zones of land use stretch. Visual analysis says that people are dumping there wastes in river banks because of poor waste management from NMC and as there is no door to door collection. Waste water is mixing with river water without any treatment and thus it has affected river ecosystem and almost killed the river animals and plants.

1) Chainage segment 0-720:

Figure 10: Origin of Nag River

Figure 11: Starting point

This stretch starts from overflow Point of Ambazari Lake, is the dam that is been created by Bhonsale empire to trap water. Stream then enters into area owned by Haldiram's Krazy castle a waterpark; it has been well maintained by Haldiram's. Almost all the area on Southern side of this stretch is open and has green cover.

2) Chainage segment 720-2750:

Figure 12: River channel in Shankar nagar

Almost half of the stretch has open green cover on southern side. While the remaining stretch passes through mixed and residential land use. Whereas in this area is more posh as compared to others resulting in good quality of waste water. As well as because of the presence of agricultural land nearby base flow is added to the stream and also the groundwater quality is good.

Node 1: NIT skating stadium Encroachment (concrete) by NIT skating stadium. (Nag River rejuvenation plan)

3) Chainage segment 2750-4635:

Figure 13: River channel at Central Mall

Most of the stretch is surrounded by residential and mixed land use. Central mall has the encroachment on the river bank and every waste from this mall is getting inside river.

Figure 14: River channel at behind dharampeth high school

In this area Natural vegetation is found in agricultural land. Therefore Groundwater and wastewater quality in this stretch is good. It is an important location to preserve the ecology of this area. This stretch has a 13 meter wide basin, because of deposition of garbage collected by water runoff from settlement and slums. Silt is deposited deposit on the edges of bank. (Nag River rejuvenation plan) Public road is in direct contact with the river. Masonry wall alongside the bed of river and have extensive vegetation. Well defined footpath accessible to public can become a landmark of the city. High amount of silt is extracted in this area in river cleaning drive my NMC.

Figure 15: Shiv Temple near Yashwant stadium

Node 4: Shiv Mandir near Yashwant stadium. It has Shiv Mandir, Ghats and heritage value. It was an important landmark in the past and now has a heritage value. At this point river gets boost in its flow and its size almost doubles. There are slums on both sides before reaching here.

4) Chainage segment 4635-5435:

Figure 16: River channel near Buldi bridge

At the starting point of this stretch there is a commercial land use on north side and afterwards it has mixed land use. Green covers Land use on Southern side of the stretch. Waste and untreated water from this area is injecting here in river but there is slightly less garbage dumping in this river. The concrete walls have been constructed thus can't access river this point.

5) Chainage segment 5435-6020

Figure 17: River channel at Mokshadham (Crematorium)

This stretch is mostly been covered by industrial, commercial land uses. And there is some mixed land use on northern side of western half of the stretch. Crematorium along its northern edge and on southern edge, encroached by crematorium by extending deck over it and dumping under its project. It is not possible to access the river edge along the Northern side. High compound wall is blocking visual access.

6) Chainage segment 6020-8748

This is a very short stretch with industrial, mixed and commercial land uses on northern side. And on south there are residential land uses. A major Nallah called as Hathi

Nallah is coming from north direction meets rivers in this stretch.

Figure 18: Slums and wastes coming from Hathi Nallah to Nag River

7) Chainage segment 8748-10410:

Figure 19: Tulsi Bagh bridge – Nag river

Only stretch surround by slums on both side. River basin here is wider and goes on widening. There is a bridge were sewer line enters near this bridge towards Northern edge through the slums. Heavy siltation, cattle can move in river course. The river bed might be wider but the flow of water through it is lesser than almost half its width. (Nag River rejuvenation plan)

Node 5: Residential edge- On northern side there are slums witch continue until node 6. Basin here is about 50 meter wide with hardened and heavy siltation on both sides. Therefore ½ of river has water flowing through it. Therefore river is continued to be treated badly.

8) Chainage segment 13070-15952:

Figure 20: River channel near Jagnade Chowk

Apart from the a patch in south side of the river which has residential land use, most of the river is covered by green cover and open spaces on both sides, which come under land use as green cover or may be agriculture or forest cover.

There is a one stream that is connecting near the end of this stretch of river.

1.2.5.2 Questionnaire Survey analysis at various Four at Nag River Stretch (120 people)

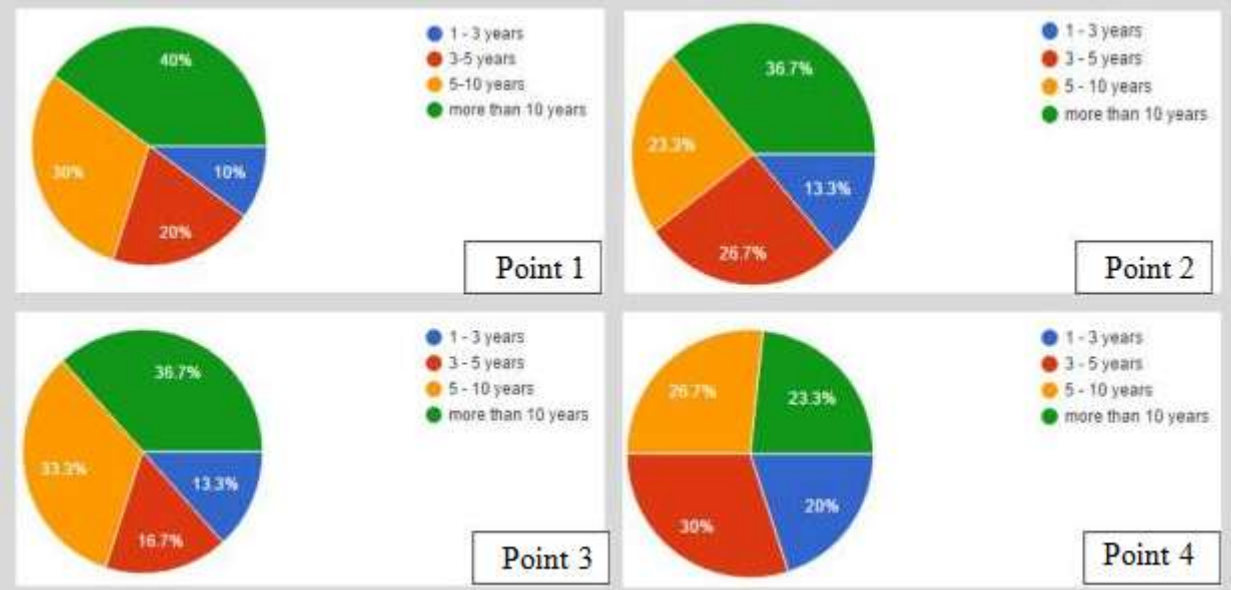


Figure 21: Graphs show percentage of people residing near Nag River.

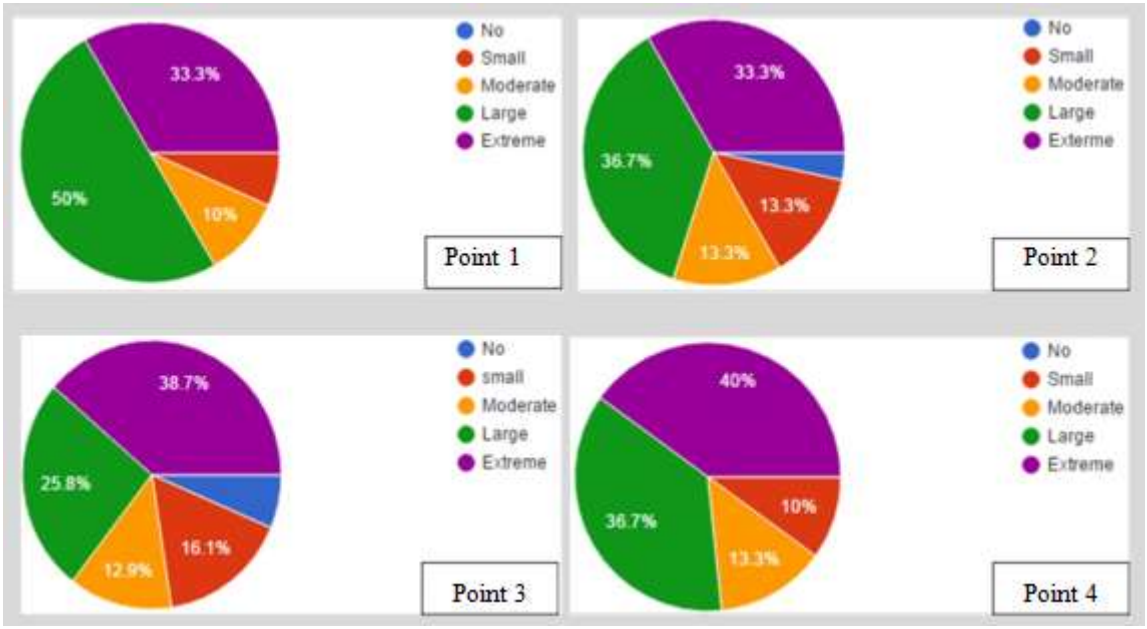


Figure 22: Graph shows the percentage of people saying Nag River water is polluted.

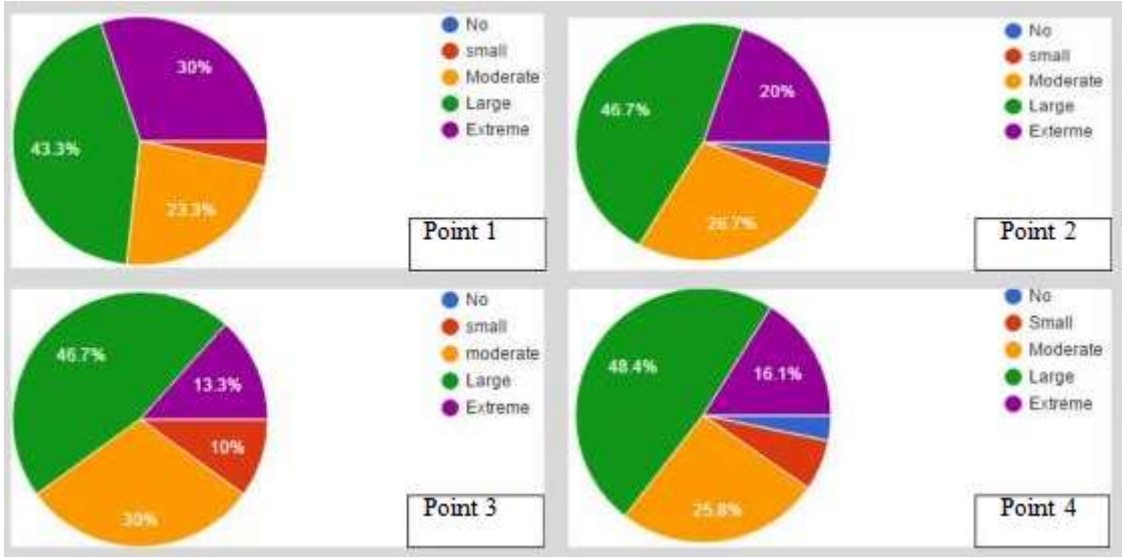


Figure 23: Graph shows the percentage of people saying there is effect on water quality of river because of urbanisation

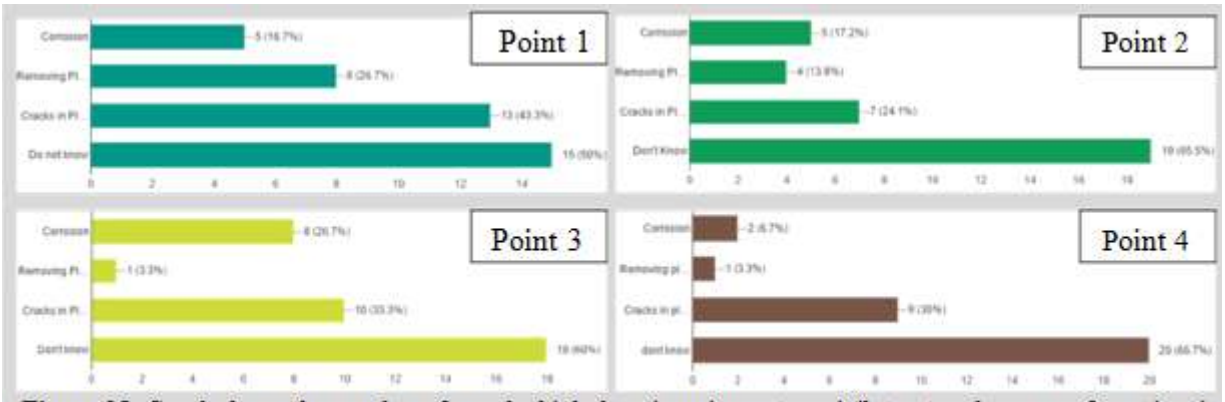


Figure 28: Graph shows the number of people think there is an impact on civil structure because of nag river is polluted

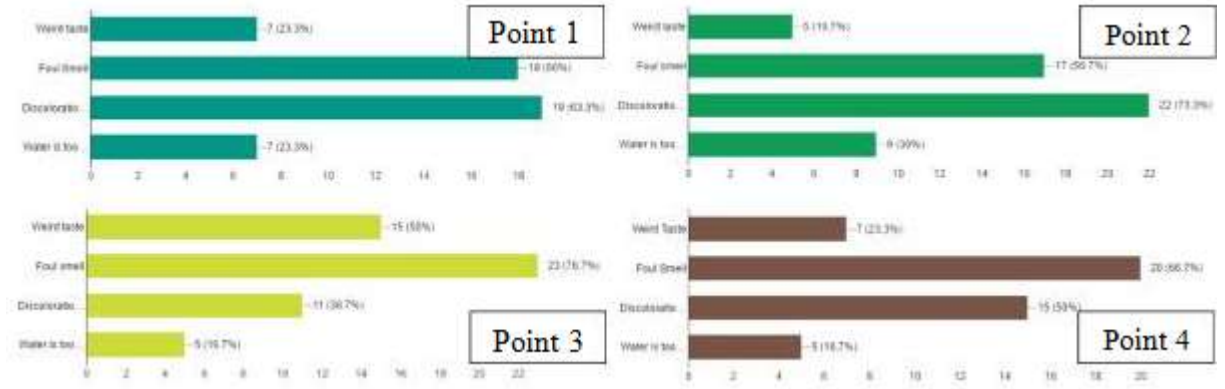


Figure 31: Description of the number of people facing problems because of bad air quality Because of polluted nag river – (Refer 4.2.2 Annexure 2)

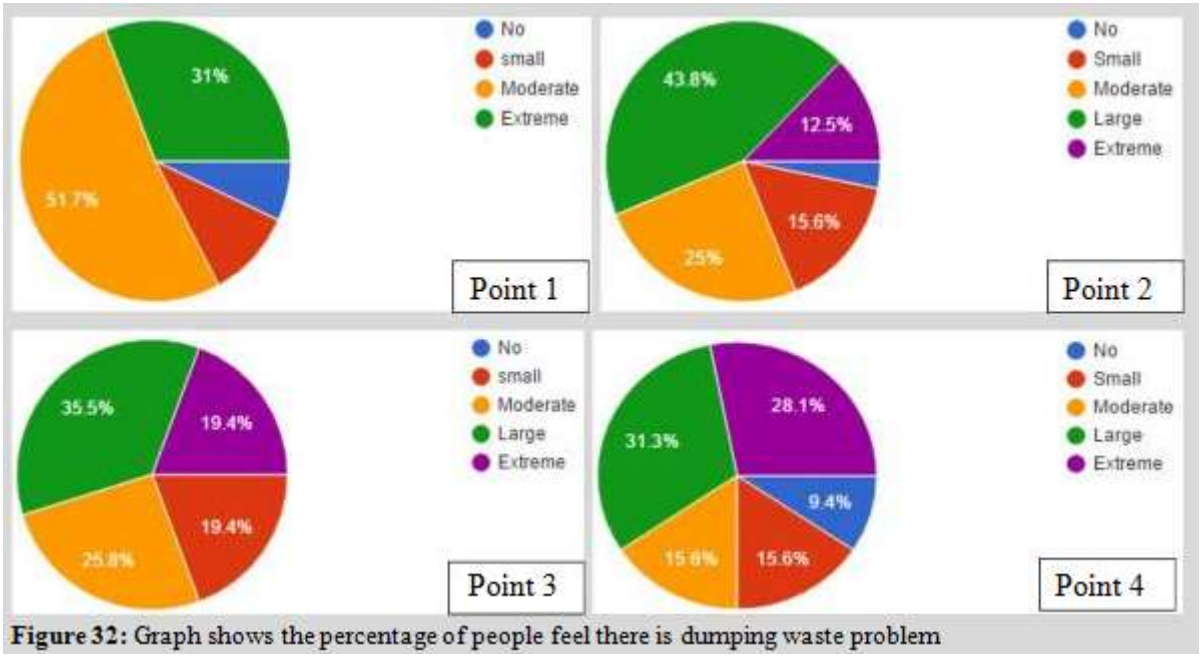


Figure 32: Graph shows the percentage of people feel there is dumping waste problem

Figure 33: Graph shows the number of people saying there is bad impact on health due to river water pollution

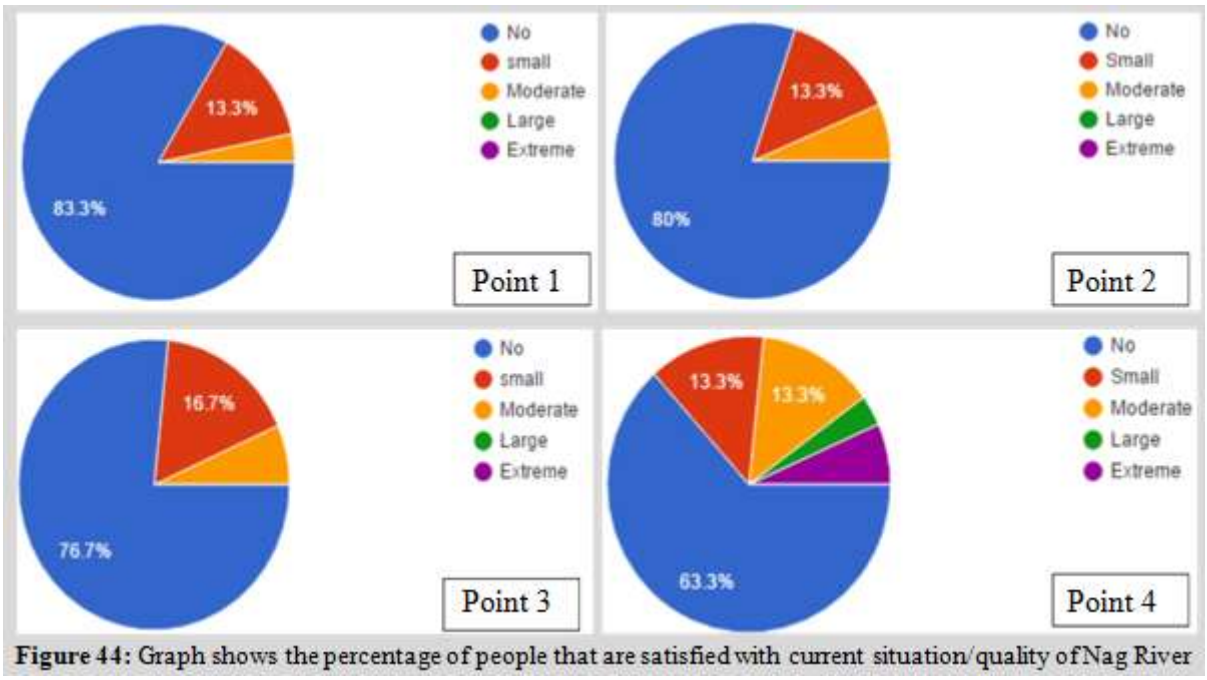


Figure 44: Graph shows the percentage of people that are satisfied with current situation/quality of Nag River

Analysis

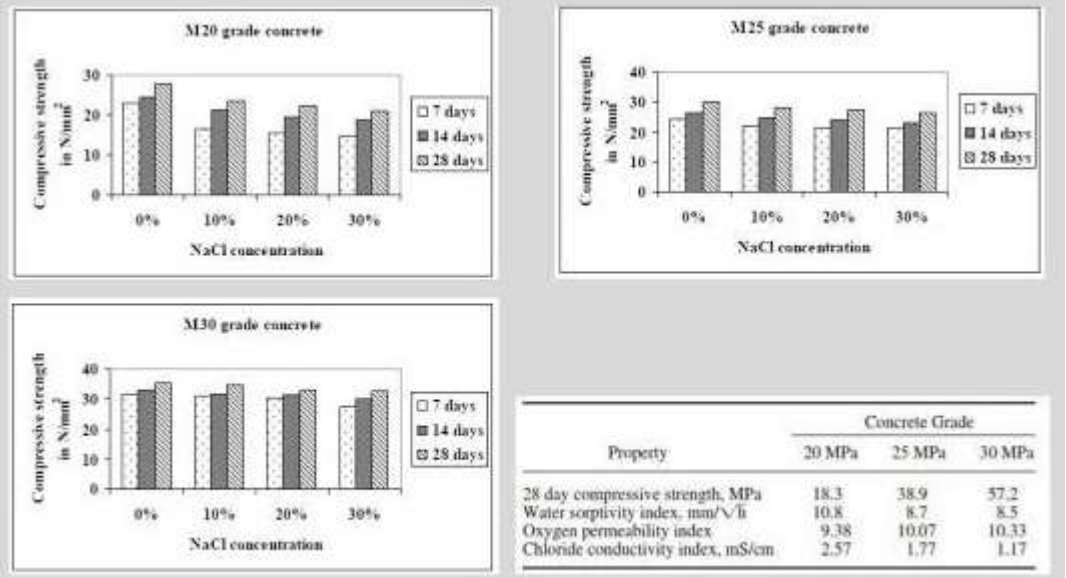
The river stretch of 17kms within the city limits has n number of dumping of solid waste, industrial waste water injection near 3rd and 4th point of study. The real test that MPCB and NMC are facing is that the contaminated water in Nag River is dirtying An II class waterway. Annoy River is a tributary to Kanhan River and Kanhan River is then tributary to Vainganga River which is An II class stream. The purpose for this situation is that Nagpur city as of now deliver around 450 MLD of sewerage, out of it just 70 MLD is getting treated. As indicated by MAHAGENCO's concurrence with NMC under venture of "reuse of waste water" by JNNURM; sewage water from stream will be dealt with and after that sent to MAHAGENCO for era of power.

In spite of the fact that the issue of contaminated water will be dealt with by reusing it somewhere else, the to a great degree dirtied water in stream streaming inside the city will be the issue for city itself. Bother stream is just streaming sewage, yet the junk, strong waste that is been dumped gets stored onto the banks of waterway and stream bed. Rubbish stalls out on numerous courses. This make sewage more contaminated with lethal chemicals and parasites. Many kids' living close to the bank of the waterway observed to have respiratory infections. Dirtied water of stream is debasing the ground water of surrounding territory. Numerous Ranges were individuals have deficient water supply utilize water from their well to bathe purposes, even at times for drinking. Contact with lethality causes malignancy. And in addition smell leaving stream is extremely irritating for citizens. Every one of the developments that are been found close to the stream are facing inverse to the waterway to confine eye contact with her. Municipality Labors also don't feel wrong to dump waste into the stream that should be lifted from Bins into the trucks for transfer at dumping stations.

People's perception on how the river water and its quality got reduced due to increase in urbanization is that dumping of waste mainly plastic, untreated or semi treated waste water of residences and factories are largely polluting the water and air. Thus it is making hazardous impact on human health and on structure. People have mainly complaint of bad smell and because of that headache and stomach related problems we are facing throughout the river stretch. Air quality is also keep deteriorating due to mixing of harmful fumes from polluted river water to air.

1.3 Laboratory Tests and analysis

Refer Annexure 2 – Lab Test Reports



Property	Concrete Grade 20 MPa	25 MPa	30 MPa
28 day compressive strength, MPa	18.3	38.9	57.2
Water sorptivity index, mm/√h	10.8	8.7	8.5
Oxygen permeability index	9.38	10.07	10.33
Chloride conductivity index, mS/cm	2.57	1.77	1.17

Figure 55: Effect of NaCl on compressive strength of concrete on M20 M25 and M30 grade resp

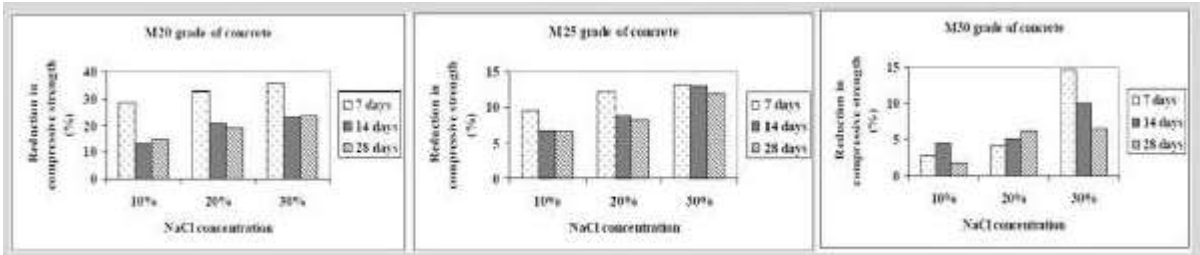


Figure 56: Percentage of reduction in compressive strength - M20 M25 and M30 grade concrete

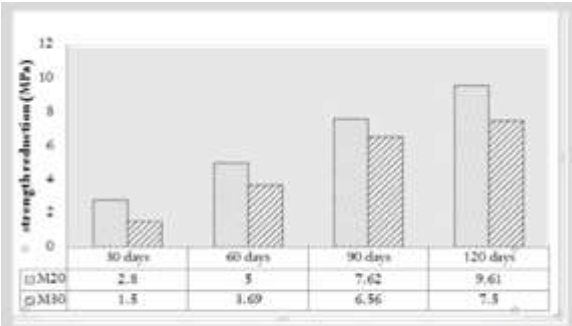


Figure 57: Reduction in mass loss due to alkaline test

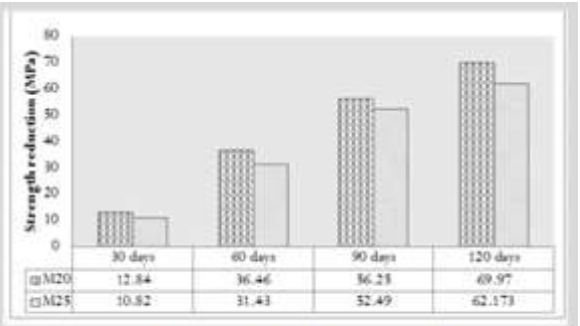


Figure 58: Strength loss due to acid attack

Analysis

Form the laboratory tests reports it has been found that amount of heavy metals, Lead, Arsenic etc. is high and it varies at different points thus the human health is deteriorating and having liver and stomach problems. As the amount of BOD COD is very less at third and fourth point of study with harmful carcinogenic materials is present in river water river ecosystem has died and almost no species can sustain in river.

Laboratory results of water shows the amount of salts and acids present in water is increasing from point two to tail of the river. Fig 56, Fig 57 and Fig 58 shows that the strength and corrosion is reducing as the slats and acids presents in water is harming the concrete structure and thus reducing the concrete life by fifteen years (aprox.) at point 4.

BOD, COD and DO is not meeting the standards because of wastes and industrial waste water is mixing in it without treatment or partially treatment on waste water. Hence the river ecosystem died slowly and self-cleaning, purification and oxygenation process stopped completely.

The test results of Core Tests of soil shows that there is presence of salts and acids thus it is coming in contact with concrete as the pollution form river is penetrating through soil and thus the concrete life is reduces to ten to fifteen years varies at points of study .

2. Conclusion

Urbanization is one of the most powerful and visible anthropogenic forces on Earth. With rapid urbanization and economic development, Nagpur has experienced significant change in population and other socioeconomic indicators. The rapid urban sprawl has resulted in a large amount of cultivated lands being replaced with building lands. The urbanization in Nagpur has also shown in the change of other indicators. Urbanization has also created serious environmental problems in Nagpur, including its climatic and ecological effects and environmental pollution. Urbanization has also placed a heavy burden on the atmosphere and water quality and environmental sanitation in Nagpur. Every town has a different way of interacting with its river, influenced by its socio cultural background, physical structure and environmental scenario. Consequently, a single approach cannot be applied to all rivers, as these factors also play an influential role in the revival and rejuvenation of the river scheme. Each city has a close and unique association with the river, which has to be addressed in the river development. Also merely developing waterfronts as recreational and economic zones will not be successful if the waterfronts they are fronting are contaminated and unclean. There is a need for integrated governance, better institutional mechanism in the form of interdepartmental co-ordination and sharing of information and resources for the successful implementation of projects and effective restoration of the quantity, quality and ecology of the river. Through the development takes place with urbanization but it should be in planned manner. Increased population close to river definitely disturb and intervenient the channel. Thus people residing besides the river have bad impact on civil structure as well as on human health and ecosystem. The impact can be seen up to 400mts from the river banks on both sides.

References

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[11] Ann I Riley book - Restoring Neighbourhood Streams
[12] https://islandpress.org/book/restoring-neighborhood-streams

Annexure

4.2.1 Annexure 1

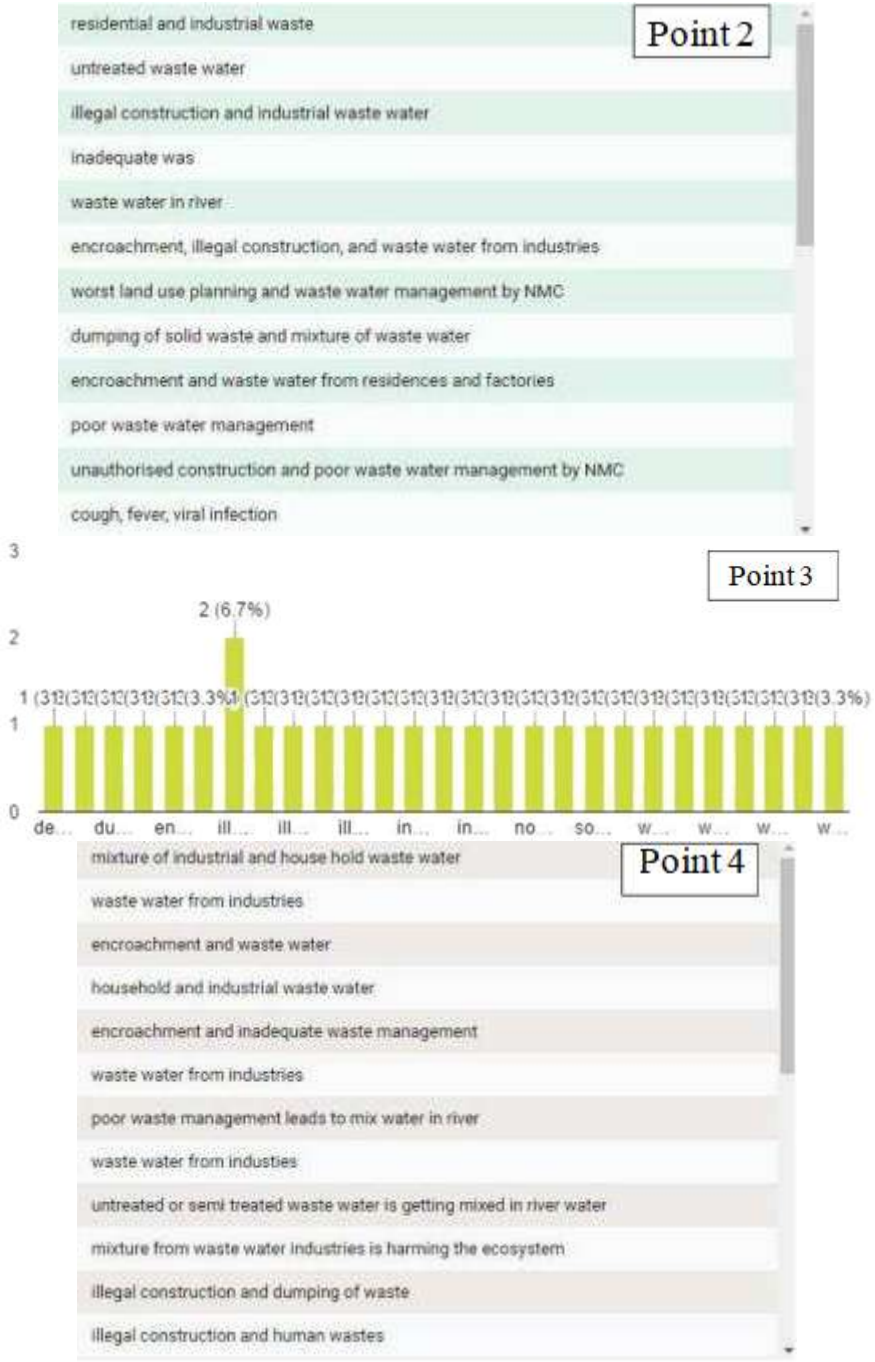


Figure 25: These are the factors with reference to urbanization have an impact on river water quality

4.2.2 Annexure 2

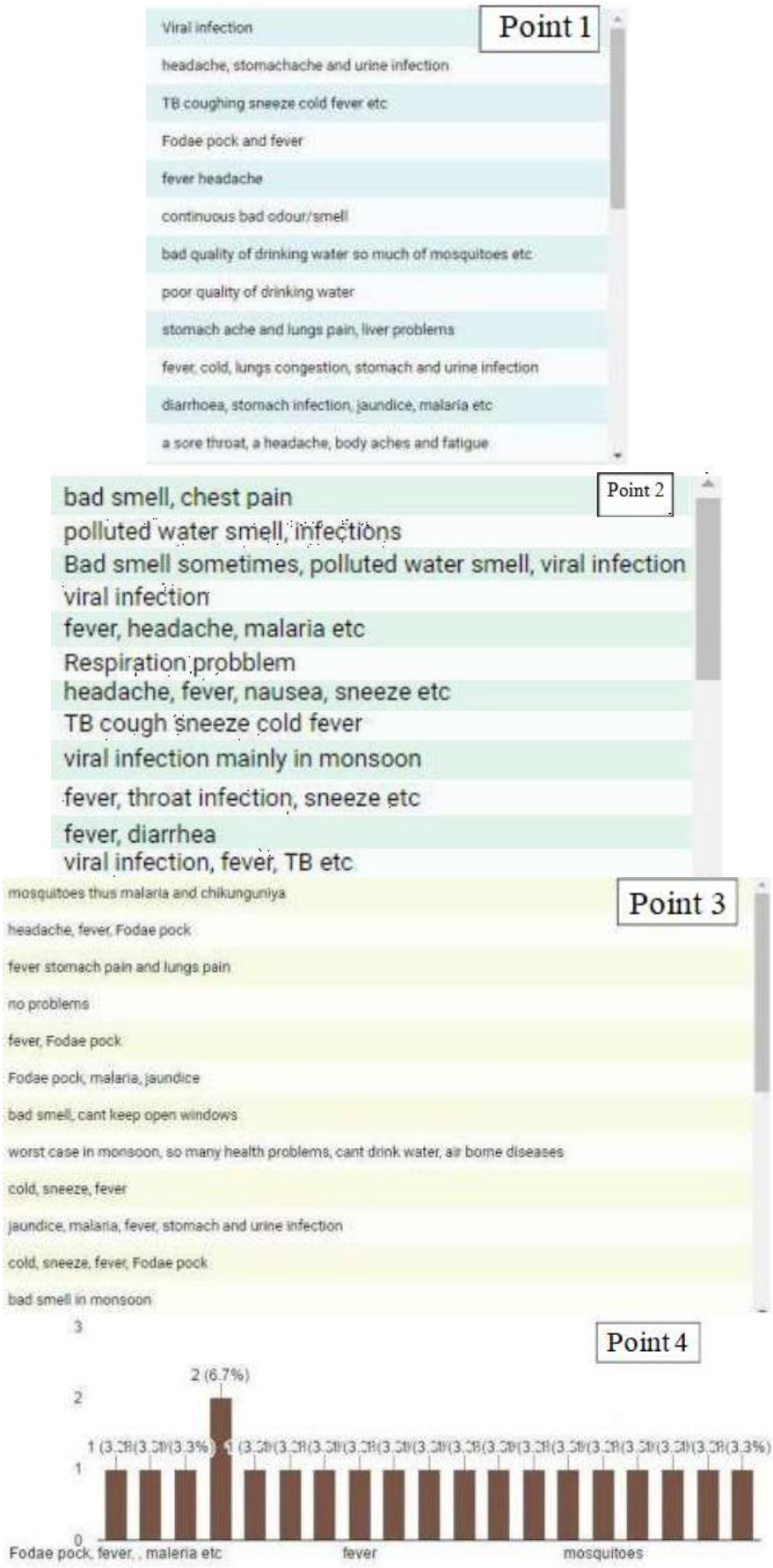
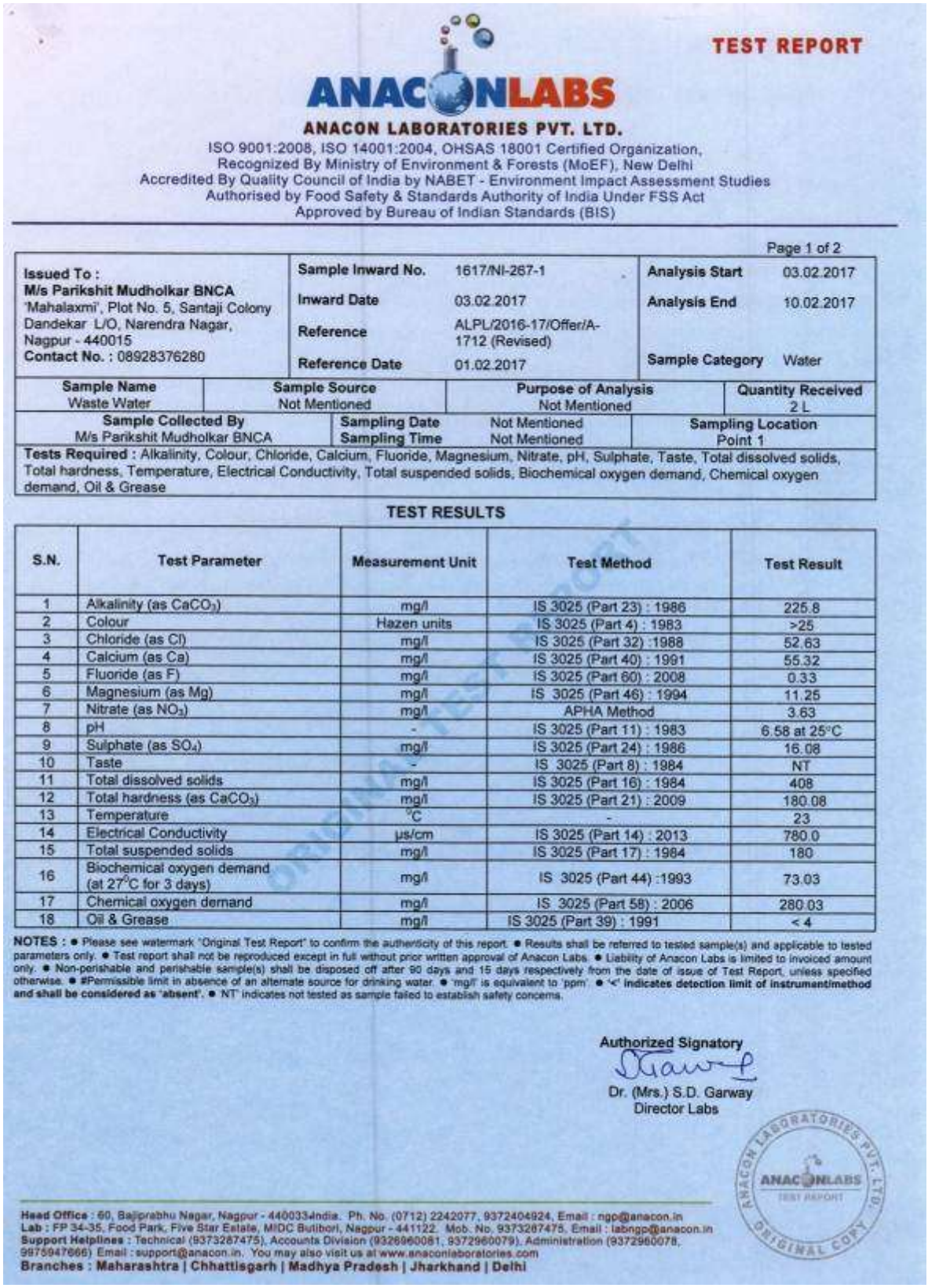


Figure 31: Description of the number of people facing problems because of bad air quality because of polluted nag river

4.2.3 Annexure 3

4.2.3.1 Lab Test reports (water) Point 1



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	Inward Date	03.02.2017	**Analysis End** 10.02.2017
	Reference	ALPL/2016-17/Offer/A-1712 (Revised)	
	Reference Date	01.02.2017	**Sample Category** Water

Sample Name	Sample Source	Purpose of Analysis	Quantity Received
Waste Water	Not Mentioned	Not Mentioned	2 L

Sample Collected By	Sampling Date	Not Mentioned	Sampling Location
M/s Parikshit Mudholkar BNCA	Sampling Time	Not Mentioned	Point 1

Tests Required : Alkalinity, Colour, Chloride, Calcium, Fluoride, Magnesium, Nitrate, pH, Sulphate, Taste, Total dissolved solids, Total hardness, Temperature, Electrical Conductivity, Total suspended solids, Biochemical oxygen demand, Chemical oxygen demand, Oil & Grease

TEST RESULTS

S.N.	Test Parameter	Measurement Unit	Test Method	Test Result
1	Alkalinity (as $CaCO_3$)	mg/l	IS 3025 (Part 23) : 1986	225.8
2	Colour	Hazen units	IS 3025 (Part 4) : 1983	>25
3	Chloride (as Cl)	mg/l	IS 3025 (Part 32) :1988	52.63
4	Calcium (as Ca)	mg/l	IS 3025 (Part 40) : 1991	55.32
5	Fluoride (as F)	mg/l	IS 3025 (Part 60) : 2008	0.33
6	Magnesium (as Mg)	mg/l	IS 3025 (Part 46) : 1994	11.25
7	Nitrate (as NO_3)	mg/l	APHA Method	3.63
8	pH	-	IS 3025 (Part 11) : 1983	6.58 at 25°C
9	Sulphate (as SO_4)	mg/l	IS 3025 (Part 24) : 1986	16.08
10	Taste	-	IS 3025 (Part 8) : 1984	NT
11	Total dissolved solids	mg/l	IS 3025 (Part 16) : 1984	408
12	Total hardness (as $CaCO_3$)	mg/l	IS 3025 (Part 21) : 2009	180.08
13	Temperature	°C	-	23
14	Electrical Conductivity	µs/cm	IS 3025 (Part 14) : 2013	780.0
15	Total suspended solids	mg/l	IS 3025 (Part 17) : 1984	180
16	Biochemical oxygen demand (at 27°C for 3 days)	mg/l	IS 3025 (Part 44) :1993	73.03
17	Chemical oxygen demand	mg/l	IS 3025 (Part 58) : 2006	280.03
18	Oil & Grease	mg/l	IS 3025 (Part 39) : 1991	< 4

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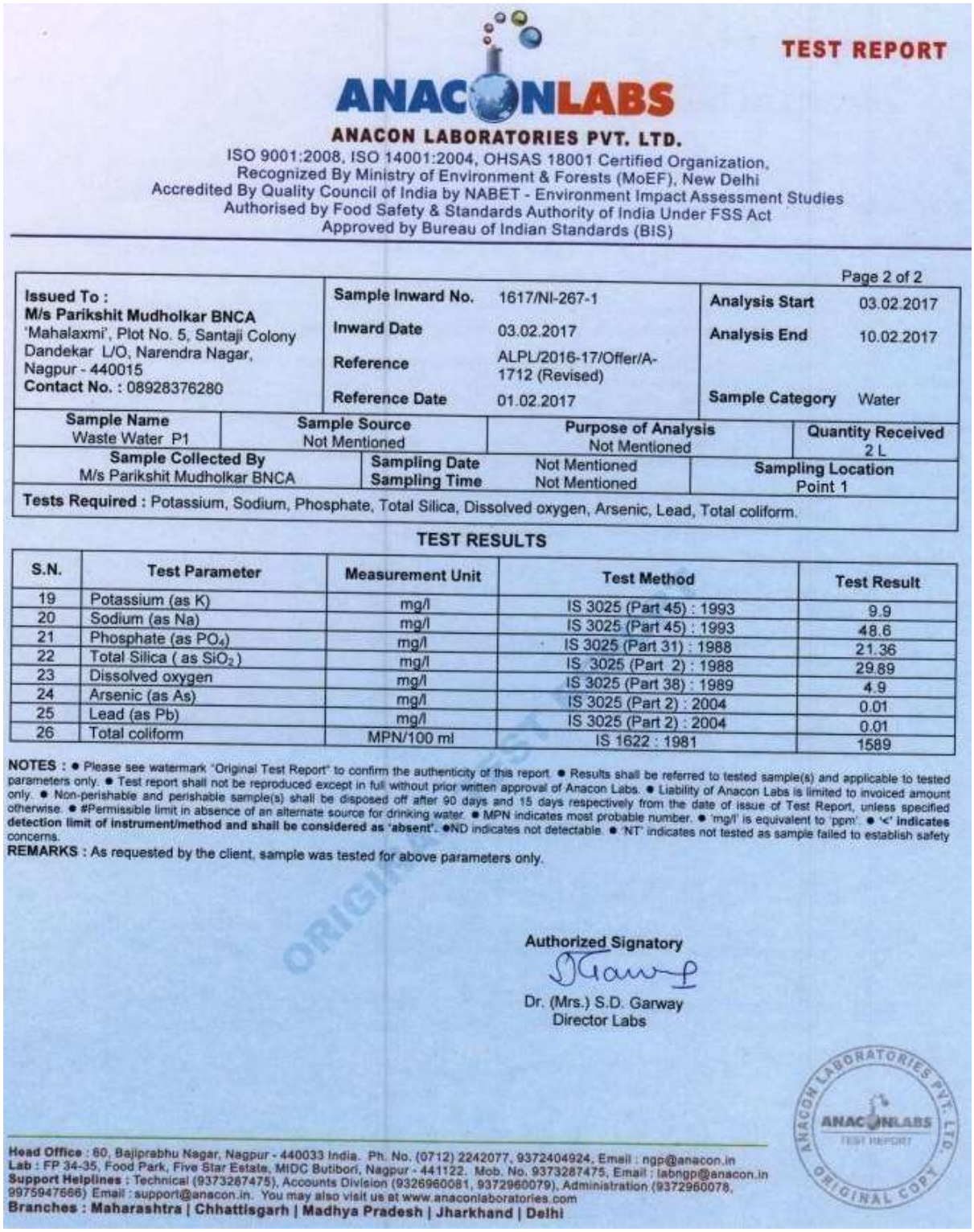

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	Inward Date	03.02.2017	**Analysis End** 10.02.2017
	Reference	ALPL/2016-17/Offer/A-1712 (Revised)	
	Reference Date	01.02.2017	**Sample Category** Water

Sample Name	Sample Source	Purpose of Analysis	Quantity Received
Waste Water P1	Not Mentioned	Not Mentioned	2 L

Sample Collected By	Sampling Date / Sampling Time	Sampling Location
M/s Parikshit Mudholkar BNCA	Not Mentioned / Not Mentioned	Point 1

Tests Required : Potassium, Sodium, Phosphate, Total Silica, Dissolved oxygen, Arsenic, Lead, Total coliform.

TEST RESULTS

S.N.	Test Parameter	Measurement Unit	Test Method	Test Result
19	Potassium (as K)	mg/l	IS 3025 (Part 45) : 1993	9.9
20	Sodium (as Na)	mg/l	IS 3025 (Part 45) : 1993	48.6
21	Phosphate (as PO_4)	mg/l	IS 3025 (Part 31) : 1988	21.36
22	Total Silica (as SiO_2)	mg/l	IS 3025 (Part 2) : 1988	29.89
23	Dissolved oxygen	mg/l	IS 3025 (Part 38) : 1989	4.9
24	Arsenic (as As)	mg/l	IS 3025 (Part 2) : 2004	0.01
25	Lead (as Pb)	mg/l	IS 3025 (Part 2) : 2004	0.01
26	Total coliform	MPN/100 ml	IS 1622 : 1981	1589

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REMARKS : As requested by the client, sample was tested for above parameters only.

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4.2.3.1 Lab Test reports (soil) Point 1

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	Inward Date	03.02.2017	**Analysis End** 10.02.2017
	Reference	ALPL/2016-17/Offer/A-1712 (Revised)	
	Reference Date	01.02.2017	**Sample Category** General

Sample Name	Sample Particulars / Details	Quantity Received
Soil	Point 1	1 Kg

Sample Collected By	Description/Physical condition/Packaging
M/s Parikshit Mudholkar BNCA	Dark brown colour granular solid/Satisfactory/In plastic bag

Tests Required : pH, Electrical Conductivity, Sand , Silt , Clay, Total Organic matter, Bulk density, Porosity, Sulphate , Sodium , Moisture, Infilteration rate, Macronutrients

TEST RESULTS

S.N.	Test Parameter	Measurement Unit	Test Method	Test Result
1	pH (5% Aq. Extract)	-	Lab SOP ANqD/Che/2B5	7.46 at 25°C
2	Electrical Conductivity (5% Aq. Extract)	µs/cm	Lab SOP ANqD/Che/2B5	1379
3	Sand	%	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India)	58
4	Silt	%	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India	25
5	Clay	%	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India)	17
6	Total Organic Matter	g/100g	IS 2720 Part 22	8.63
7	Bulk density	g/cm³	IS 2720 (Part 3) : 1980	1.148
8	Porosity	%	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India)	24.117
9	Sulphate (as SO_4)	mg/kg	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India)	0.14
10	Total Sodium	mg/kg	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India)	0.20
11	Moisture	g/100g	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India)	6.54
12	Infiltration rate	mm/hr	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India)	12
	Macronutrients			
13	Total Nitrogen (as N)	g/100g	Method Manual, Soil testing in India (Department of agriculture & corporation, Govt of India)	0.14
14	Total Potassium (as K)	g/100g	EPA 3050 B	0.13
15	Total Phosphorous (as P)	g/100g	EPA 3050 B	0.26

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REMARKS : As requested by the client, sample was tested for above parameters only.

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4.2.3.2 Lab Test reports (water) Point 2

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	Inward Date	03.02.2017	**Analysis End** 10.02.2017
	Reference	ALPL/2016-17/Offer/A-1712 (Revised)	
	Reference Date	01.02.2017	**Sample Category** Water

Sample Name	Sample Source	Purpose of Analysis	Quantity Received
Waste Water	Not Mentioned	Not Mentioned	2 L

Sample Collected By	Sampling Date / Sampling Time		Sampling Location
M/s Parikshit Mudholkar BNCA	Sampling Date Sampling Time	Not Mentioned Not Mentioned	Point 2

Tests Required : Alkalinity, Colour, Chloride, Calcium, Fluoride, Magnesium, Nitrate, pH, Sulphate, Taste, Total dissolved solids, Total hardness, Temperature, Electrical Conductivity, Total suspended solids, Biochemical oxygen demand, Chemical oxygen demand, Oil & Grease

TEST RESULTS

S.N.	Test Parameter	Measurement Unit	Test Method	Test Result
1	Alkalinity (as $CaCO_3$)	mg/l	IS 3025 (Part 23) : 1986	239.8
2	Colour	Hazen units	IS 3025 (Part 4) : 1983	>25
3	Chloride (as Cl)	mg/l	IS 3025 (Part 32) :1988	54.56
4	Calcium (as Ca)	mg/l	IS 3025 (Part 40) : 1991	57.02
5	Fluoride (as F)	mg/l	IS 3025 (Part 60) : 2008	0.63
6	Magnesium (as Mg)	mg/l	IS 3025 (Part 46) : 1994	11.57
7	Nitrate (as NO_3)	mg/l	APHA Method	3.63
8	pH	-	IS 3025 (Part 11) : 1983	6.69 at 25°C
9	Sulphate (as SO_4)	mg/l	IS 3025 (Part 24) : 1986	16.84
10	Taste	-	IS 3025 (Part 8) : 1984	NT
11	Total dissolved solids	mg/l	IS 3025 (Part 16) : 1984	458
12	Total hardness (as $CaCO_3$)	mg/l	IS 3025 (Part 21) : 2009	190.08
13	Temperature	°C	-	25
14	Electrical Conductivity	µs/cm	IS 3025 (Part 14) : 2013	802.2
15	Total suspended solids	mg/l	IS 3025 (Part 17) : 1984	200
16	Biochemical oxygen demand (at 27°C for 3 days)	mg/l	IS 3025 (Part 44) :1993	86.66
17	Chemical oxygen demand	mg/l	IS 3025 (Part 58) : 2006	295.68
18	Oil & Grease	mg/l	IS 3025 (Part 39) : 1991	< 4

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