Central Pollution Control Board

Compliance Report in O.A. No. 06/2012, Order dated 03.01.2020

IN-SITU BIOREMEDIATION TECHNIQUES FOR WASTEWATER TREATMENT

In-Situ bioremediation techniques involve treatment at the site using aquatic plants and/or microbial remediation methods. In-Situ treatment systems can be commissioned in less time period (few months only), is easy to operate, and requires less energy as compared to conventional treatment technologies. In-situ treatment, depending on effluent characteristics, site conditions, and type of treatment systems, may either provide desired quality of treated effluent or act as supplementary to conventional treatment technologies. In any case, wherever feasible, it can be used as an interim remedial measure, and help in reducing pollution load or polishing of treated effluent from Sewage Treatment Plants. The common in-situ treatment systems are Microbial Bioremediation, Phytoremediation, Constructed Wetland System and Root Zone Treatment. Adequate space and appropriate flow are general requirements for adoption of these technologies.

A meeting was held at CPCB on 14th January, 2020 to consult experts including representatives from NEERI, TERI, Delhi University and other stakeholders.

Based on above, following models for in-situ treatment may be explored:

Model 1: - Microbial Bioremediation

Model 2: - Phytoremediation

Model 3: Constructed Wetland System (CWS) and Root Zone Treatment – CWS with Sub-Surface Flow

Model 4: - Microbial Bioremediation + Constructed Wetland System (CWS)

Details of above mentioned In-situ bioremediation techniques indicating methodology, parameters for the feasibility assessment, existing experiences, etc. are mentioned below:

Model 1: MICROBIAL BIOREMEDIATION

Methodology

Microbial bioremediation involves periodic or continuous dosing of special waste-treating microbes, fungi and /or plants and their products (such as enzymes) in adequate quantity to the wastewater mass. The effectiveness of bioremediation depends on both the wastewater characteristics and the microorganisms and the products that are used for dosing, (the dosing amount, frequency of dosing and the environmental conditions).

Microbial bioremediation could be intrinsic (within the drain using natural consortia of microorganisms) or *in vitro* (using an engineered treatment system).

Microorganisms are used to treat mainly the organic matter. Very small amount of inorganic materials and metals are also consumed as nutrients. Direct use of enzymes is done in biochemical treatment. Aerobic microbes need less time, whereas anaerobic microbes need more time.

Parameters for feasibility assessment

- Flow and retention time*:* This type of bioremediation requires retention time of *20 -30 hours, therefore may be suitable for drains with low flow.*

  Output of the process could vary where flow rates are variable and high, which could partly be due to rapid wash out of the material dosed from drains during high flow pulses.

  Drains often need interventions to slow down the flow rates. Also, the process being inherently slow will achieve good performance in due course of time.

  Domestic wastewater also gets mixed with the effluents from industries which invariably carry inorganic pollutants thereby impacting the microbial load.

  While there have been claims of successful treatment of municipal wastewater by bioremediation with various microorganisms and inoculums, these claims require reverification for a sustained period.

  The system requires a kind of bio-reactor to meet the retention time and as such it requires a large area /stretch to provide the requisite retention time and the microbial diversity is limited and is composed of consortia of known microbes.

- There is recurring cost for maintaining microbial consortia as bio-media has to be added in running stream on regular intervals.

- Further, the successful use of this bioremediation technique for in-situ treatment of wastewater-carrying drains, would necessitate the periodic removal of bio-sludge generated over time which will include periodic sludge removal from the drains to avoid choking of the drains and/or addition of pollution load on the receiving water body by transporting the sludge generated. This aspect is yet to be considered in the estimation of its success.

- There is a requirement for well-defined specifications in case of this type of bioremediation since the microbial composition and doses are usually trade secrets and claims are unverifiable and comparable.

Current application of microbial bioremediation carried out by NMCG in 144 drains depicts better results in drains having flow less than 10 MLD. Therefore, such intervention can be applied in low hydraulic load and its expected outcome shall be within 50 %.

Case Studies depicting experiences of Microbial Remediation techniques is summarized in *Annexure-I*.List of In-situ technological provider is attached as *Annexure-II*.

Model 2: Phytoremediation

Methodology

Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater.

Phytoremediation involves the removal of organic compounds and nutrients from wastewater through bio-sorption/uptake by pollution-tolerant aquatic plants (such as algae, water hyacinth, duckweeds, etc.) growing in the wastewater.Quite often suchplants grow along the littoral zones on either side of the drain.

Parameters for feasibility assessment

- Flow and retention*:*It requires retention time of 7-8 days, *therefore may be suitable for drains with low flow*.
- Space:It requires an engineered site for impounding the wastewater to provide sufficient retention time i.e. 7 to 8 days.
- Pollution Load: It is best applied at sites with water having low contamination of organic, nutrients, or metal pollutants that are amenable to one of the following five applications: Phytotransformation, Rhizosphere Bioremediation, Phytostabilization, Phytoextraction, or Rhizofiltration.

- Since plants require ample time for growth in large quantities to treat the entire waste water, it requires excessively longer commissioning time or practically a stagnant pool of wastewater where the plants must be adequately developed and acclimatized.

Case Study: Information on Indian case study for remediation of wastewater only through Phytoremediation could not be sourced. Applications for contaminated ground water remediation have been reported internationally.

Model 3: Constructed Wetland System (CWS) and CWS with Sub-Surface Flow (Root Zone Treatment)

Methodology

CWS also uses principle of Phytoremediation techniques. It integrates microbial bioremediation, phytoremediation and root-zone treatment in addition to providing the benefits of oxidation pond and physical filters.

It is the designed and engineered natural system to treat sewage and other wastewaters. Selective aquatic plants having rich rhizospheric microbial diversity are grown in high density and sewage/wastewater is treated based on its flow by gravity. Not only cost is minimized, various pollutants (organic, inorganic, heavy metals) are remediated at various locations.

At each stage the turbulence generated in the system enriches the oxygen that makes microbial biodegradation of pollutants very efficient.The constructed wetland system can be used as *in situ* bioremediation and also as *ex situ* bioremediation.

The oxidation pond in constructed wetland systems simulates STP. The uniqueness of construed wetland system is the use of diverse aquatic plants together with their rich rhizospheric microbial communities. The diversity of these microbial communities are not found in any other remediation techniques for treatment of sewage.

Parameters for feasibility assessment

- Flow and retention time: The construction of wetlands requires large area hence large horizontal foot-print. The retention time within constructed wetland system is about 20 hours.
- Pollution Load: It can be designed for wide range of pollution load and effluent characteristics.
- Knowledge of wetland ecology and native wetland species is a pre-requisite.
- Periodic harvesting of the biomass is essential to maintain consistent performance.
- Design criteria is being developed for different kinds of wastewater under different climatic conditions.
- The constructed wetland system is scientifically proven and widely accepted alternate and/or complimentary technology to conventional technology for sewage treatment.
- It has been used by many countries in the world for the management of wastewater including sewage.
- DBT-CPCB has also brought out a manual onconstructed wetland system wherein several designs are described.
- Drains having width of 15-30 m are most appropriate for CWS technology as it slows down the velocity of wastewater and allows for establishing ponding along its length.

Case Studies depicting experiences of CWS techniques is summarized in *Annexure-I.*List of In-situ technological provider is attached as *Annexure-II*.

Model 4 is hybrid of different techniques, and feasibility assessment may be done considering requirements of selected techniques.

DECISION MATRIX FOR OPERATION OF IN-SITU TREATMENT SYSTEMS

In the current scenario the competent biological*in-situ* treatment system must have the following essential requirements:

i) In Situ treatment should be different from conventional centralized or de-centralized treatment system.

ii) It should be a rapid system having commissioning time of less than six to twelve months.

iii) The *in-situ* treatment system should have the ability to treat the sewage in a continuous manner throughout the year.

iv) The treatment system must have a well-defined inlet and outlet along with treatment length with minimum modification in natural drain structure.

v) The treatment system should work on zero/negligible power consumption.

vi) The treatment system should have a designed life and minimum operational constraints.

vii) It should not have high capital cost and recurring cost as compared with conventional *ex-situ* treatment technology currently in practice.

viii) The design life should be up to 15 years at optimum operation condition.

ix) In case of drains having flow >5 MLD, the system may be developed in modular form having 2-3 blocks of treatment within one treatment stretch.

x) The treatment system must be capable of degrading/reducing the soluble and insoluble organic materials.

xi) Removal efficiency of soluble BOD at the final designated outlet should not be less than 60% in terms of organic load reduction with treated wastewater quality at designated outlet of pH 6.5-8.5, DO ≥5mg/land BOD ≤ 20 mg/l, whichever is minimum.

xii) Monitoring of such system shall also be carried out with respect to bacterial consortium count as well as with conventional parameters (pH, BOD and COD).

xiii) Biological remediation shall be accompanied with pre-treatment / physical solid liquid separation as drains carry large quantity of solid waste.

xiv) The generated sludge must be quantified and cleaned based on requirement preferentially at every 15 days within the defined stretch. If required that dredging should be done to maintain the depth.

xv) The system must not hinder the flow and not result in ponding at the upstream site of the drain.

xvi) Flow measuring device (such as V-notch, EM meter etc.) may be installed at the inlet/outlet of the treatment stretch so as to control the treatment based on flow and for calculation of daily treated volume for the cost calculation.

xvii) Treatment system shall be installed at such a location/manner and for such volume of drains that the treated effluent quality at defined outlet shall be maintained throughout the entire downstream stretch of the drain till confluence with the river. If required treatment system could be set up in series in entire drain stretch to meet the water quality at d/s stretches.

xviii) Treatment system shall be set up for inlet wastewater quality of BOD≥40mg/l.

xix) Performance of treatment system shall be monitored not only for criteria pollutants (such as BOD) but indicates parameters such as microbial count (bacteria, protozoa), DO etc. shall also be monitored to establish that the pollution reduction is due to the treatment intervention.

SUGGESTIVE WAY FORWARD

i. In-situ remediation technology may be applied in adjoining major and minor drains of Delhi stretch of river Yamuna.

ii. River Yamuna and its adjoining major and minor drains in Delhi stretch may be surveyed by expert teams in coordination with executive agencies (Delhi Irrigation and Flood Control Department / Delhi Jal Board / Delhi Development Authority) to ascertain the feasibility of above in-situ remediation technologies based on criteria set up for further implementation:

iii. Based on the survey, feasibility assessment, and decision matrix for expected performance, drains may be identified for in-situ treatment along with type of treatment.

iv. Design and detailed execution plan to be prepared by technology providers, may be executed by concerned agency (Delhi Irrigation and Flood Control Department / Delhi Jal Board / Delhi Development Authority).

v. An expert group may supervise the implementation and also document project execution and outcome for possible replication in other areas.

Overall outcome of project shall be helpful in improving water quality of drain / river but also help in rejuvenation of ecology of river Yamuna.

ANNEXURE-I

CASE STUDIES OF IN-SITU REMEDIATION

1. Microbial Remediation

i. **CPCB conducted two studies on microbial-remediation- one at Buddha Nala,Ludhiana, Punjab and the other at BakarganjNala, Patna, Bihar.**

- Cost of Project: Rs15 Crore, Flow of Budha Nallah-550 MLD
- Expected Outcome: 55-75 % of BOD
- Actual Reduction-15 % of BOD
- Monitoring of water quality at both the sites indicated that there was no substantial reduction in pollution load in terms of BOD and COD. Possible reasons for this may be lack of adequate retention/contact time, lack of microbial diversity essential for biodegradation of organic pollutants, and hydraulic and chemical shock loads due sudden discharge of non-domestic wastewaters.
- Current Status: Project Terminated

ii. **NMCG has identified 144 drains in Ganga river Catchment for Bio-remediation and engaged 06 firms for execution**. NMCG engage 3rd party laboratory to evaluate the project outcome.

- Cost of project: Drain-wise details attached as Annexure-A
- Expected Outcome: Not Known
- Actual reduction- Average BOD reduction – 56 %,
- Current Status- Non-operational

iii. **CSIR-NEERI's SeFlora technique for Bio-remediation of drain having flow less than 01 MLD**

- Cost of project: Construction Cost: Rs 2000 per MLD, O & M (02 years)- 05 Lakhs per drain (includes Manpower, Consumables, Electricity, Testing, Contingency and Miscellaneous Items)

- Efficacy:BOD<= 30 mg/l (40 % reduction), TSS<=100mg/l (40 % reduction).
- Current Status- Test Run at NEERI's Campus

2. Constructed Wetlands System

i. Centre for Environmental Management of Degraded Ecosystems (CEMDE), Delhi University in collaboration with DDA established constructed wetland at NeelaHauz near Sanjay Van.

- Cost of Project: Rs 10 Lakhs, Flow of Drain - 01 MLD
- Expected Outcome: 80 % reduction of BOD
- Actual Reduction- 90 % of BOD
- Project Started since November, 2016
- Recurring Activity: Annual harvest of dead biomass and annual cleaning of physical filters and removal of sludge from oxidation ponds.
- Impact: Restored dead NeelaHauz Lake
- Current Status: Operating

i. Irrigation and Flood Control Department, Delhi has installed In-situ Constructed Wetland System at Rajokari Water Body, Kh No. 1234/11.

- Cost of Project: Rs 77.19 Lakhs,
- Flow of Drain – 600 KLD
- Expected Outcome: 80 % reduction of BOD
- Actual Reduction- 84 % of BOD
- Project Started since November, 2016
- Impact: Substantial reduction in BOD concentration
- Current Status: Operating

ii. CSIR-NEERI has developed Phytorid Technology for Water Body Rejuvenation – Ex-Situ remediation.

- Cost of Project: Civil Construction – Rs 2.2 crore per MLD, O &M- Rs 20 Lakhs per MLD (includes Manpower, Consumables, Electricity, Testing, Contingency and Miscellaneous Items)

- Location of Project: Pan-India (300 sites), Largest Plant – 03 MLD
- Land Requirement: 1500 m^2 per MLD
- Efficacy: BOD <= 10 mg/l, TSS<=30 mg/l
- Current Status: Operating in Pan-India.

iii. CSIR –NEERI has developed RENEU Technology (Restoration of Drains Viable for Flow between 1-10 MLD)

- Cost of Project: Civil Construction – Rs835 Lakhs per MLD, O &M- Rs255 Lakhs per MLD (includes Manpower, Consumables, Electricity, Testing, Contingency and Miscellaneous Items)
- Location of Project: Jhusi, Prayagraj (06 Drains), Work Order received to implement RENEU in 10 drains at Gorakhpur
- Treatment Mode: In-situ; Flow of Drain 1-10 MLD (180-200 m stretch required), more than 10 MLD (200-600 m stretch required)
- Efficacy: BOD <= 30 mg/l (40 % reduction), TSS<=30 mg/l (40 % reduction).
- Current Status: Operating in Pan-India.

iv. Farhad Contractor & Team developed DEWATS system at Sathyamangalam – Ex-Situ remediation

- Cost of Project: Civil Construction – Rs 8 Lakhs
- Flow of Drain: 0.3 MLD
- Location of Project: **Sathyamangalam**
- Treatment Mode: Ex-situ;
- Efficacy: Not Available
- Current Status: Commissioning Stage.

v. JamiaMilliaIslamia, University, Delhi has developed Ex-Situ Treatment for Mehrauli Complex, QutubMinar

- Cost of Project: Civil Construction – Rs06 Lakhs
- Flow of Drain: 0.4 MLD
- Location of Project: Mehrauli Complex, QutubMinar
- Treatment Mode: Ex-situ;
- Land requirement: 01 acre

- Project Started: 2001 and completed in 2001
- Efficacy: 75 % BOD reduction
- Current Status: Defunct.

vi. **JamiaMilliaIslamia, University, Delhi has developed Ex-Situ Treatment near Lodhi Hotel, Lodhi Road, Delhi**

- Cost of Project: Civil Construction – Rs06 Lakhs
- Flow of Drain: 1.0 MLD
- Location of Project: Near Lodhi Hotel, Lodhi Road, Delhi
- Treatment Mode: Ex-situ;
- Land requirement: 01 acre
- Project Started: 2009 and completed in 2009
- Efficacy: 70 % BOD reduction
- Current Status: Defunct.

ANNEXURE-II

List of Technological Provider

A. Provided by DJB

S.No	Project Location	Intervention	Target Pollutant	Executing Agency	Department
1	Delhi Jal Board HQ	Constructed Wetland	BOD, COD, TSS, Nutrients	Centre for Science and Environment	Delhi Jal Board
2	Sonia Vihar Sewage Pond	Aeration, Floating Wetland, Screen	BOD + Organic Pollutants	NEERI Through ESS Environment Consultant Pvt Ltd.	NEERI
3	Rajokri Floating Wetland Phytoremediation	Phytoremediation Floating Wetland	Ammonia, Nitrate, Phosphates, Nutrients	Green Solutions (Under CSR)	NEERI
4	Shahdara Lake Rejuvenation East Delhi	Constructed Wetland (Phytorid Technology)	BOD, COD, TSS, Nutrients, Fecal Coliform	NEERI through Technogreen Solutions, Pune	East MCD
5	Ghogha Drain treatment, Bawana	Constructed Wetland (SWAB Technology)	BOD, COD, TSS, Nutrients	L.K Builders (Civil)	Irrigation and Flood Control
6	Rajokri Drain Treatment and Waterbody Rejuvenation	Constructed Wetland (SWAB Technology)	BOD, COD, TSS, Nutrients	Mahesh Builders (Civil)	Irrigation and Flood Control

B. List of Agencies, Consultants and Locations mentioned in Guidelines for Root Zone Treatment - 2003

Sl. No.	Name	Address	Place	Tel/Fax	Mail
1.	Billore, Prof. Dr. S.K	Professor Vikram University, Institute of Environment .in Management and Plant Sciences	Ujjain - 456010	0734-2511226	billore@bom4.vsnl.net.in
2.	**Central Leather Research Institute (CLRI)**	**Adyar**	**Chennai 600020**	**044-491-6351 Fax 24911589**	root@niclai.ernet.in

Sl. No.	Name	Address	Place	Tel/Fax	Mail
3.	Central Pollution Control Board (CPCB)	Parivesh Bhawan, East Arjun Nagar	Delhi 110032	011-2221955, 22305792,Ext .	cpcb@alpha.nic.in scskn@cpcb.de!hi.nic.in
4.	Centre for Environmental Studies (CES)	Anna University	Chennai 600025	044 2354717, Fax 2354717	nvasu30@yahoo.com
5.	Centre for Scientific Research (CSR)	Auroshilpam	Auroville 605101	0413-622168, 622277, Fax 622057	CSR@auroville.org.in
6.	Emanuel, K.V.	Unido, 1st Floor, TNPCB, 100, Anna Salai, Guindy.	Chennai 600032	044-2353158 Fax - 2353156	unido@giasmdo1.vsnl.net.in
7.	Joshi, Dr. Himanshu	IIT Roorkee, Dept. of Hydrology, 32/4, Niti Nagar, IIT Roorkee	Rourkee 247667	01332-70625, 285403(R), 285390(0), Fax-275360	joshifuy@iitr.erner.in
8.	Inspiration	Mankoottathil, Diwan's Road, Ernakulam.	Cochin 692016	0484-353402, Fax 370502	inspire@md2.vsnl.net.in
9.	Ion Exchange India Ltd	Tiecicon House, Dr. E. Moses Road, Mahalaxmi	Mumbai 400001	022-4939520 (-28) Fax 493 8737	ionxchng@giasbm01.vsnl.net.in
10.	Kraft & Associates , 7	Rangapillai Street, Flat E	Pondicherry 605001	0413-339429, 335883, Fax 337348, 335883	kraftaas@satyam.net.in
11.	Lucent Technologies Finolex Ltd *(Location)*	Plot No 344, Village Urce, Taluk Maval	Pune 410506	02114-24347, 25139, 25142, Fax 25140	
12.	V.K. Kapoor Netaji Subhash Institute of Technology *(Location)*	Azad Hind Fauz Marg, Sector 3, Dwarka	New Delhi 100045	25099056	vkkapoor@nsit.ac.in
13.	Tata Energy Research	Habitat Centre,	New Delhi	Fax	

Sl. No.	Name	Address	Place	Tel/Fax	Mail
	Institute (TERI) *(Location)*	Lodhi Road	110003	24682145	

C. List of NMCG

1. M/s Maple,
2. M/s Greenway,
3. M/s JM Enviro,
4. M/s FVIL-INGEO,
5. M/s ORIPL
6. M/s NACOF

ANNEXURE-A

COST ESTIMATION FOR BIO-REMEDIATION

Sno.	District	Name of Drains	As per Contract			Actual Discharge
			Discharge (MLD)	Rate per MLD	Amount	
1	Farrukhabad	Dhimarpur drain	1	4427.00	805714.00	0.92
2	Fatehgarh	HathikhanaNala	6.88	1350.00	1114560.00	8.12
3	Kanpur	GolaghatNala	1.44	1350.00	233280.00	1.79
4	Kanpur	SattiChaura	1.54	1350.00	249480.00	1.34
5	Kanpur	GuptaarGhat Drain (Overflow)	3.5	1350.00	567000.00	3.16
6	Kanpur	Ranighat Drain (Overflow)	2	1350.00	324000.00	2.53
7	Kanpur	DabkaGhatNala (Overflow)	2.56	1350.00	414720.00	30.35
				1350.00		52.80
8	Unnao	City Jail Drain (Dakari drain)	9.33	4427.00	7517311.62	12.02
9	Shuklaganj	Ganga Vishu Drain	0.5	1950.00	87750.00	0.07
10		Indira Nagar Drain	3.5	1950.00	614250.00	2.82
11	Dalmau	PadvaNala/(Muraibagh) Shankar Nagar	1.203	1450.00	156991.50	1.20
12	Kunda	DuarNalaBabaganj	1.1	4427.00	886285.40	16.31
13	Allahabad	A.D.A. Colony Nala (Overflow)	2.91	4427.00	2344627.74	3.84
14		JondhwalGhat Drain (Overflow)	1.15	4427.00	926571.10	6.16
15		RajapurNala (Overflow)	18	55888.00	120718080.00	22.10
16		Tv Tower Nala (Overflow)	2.45	4427.00	1973999.30	7.92
17		Sadar Bazar Nala (Overflow)	3.67	4427.00	2956970.38	4.42

Sno.	District	Name of Drains	As per Contract			Actual Discharge
			Discharge (MLD)	Rate per MLD	Amount	
18		SaloriNala (Amitabh Bacchan Culvert) (Overflow)	10	55888.00	67065600.00	10.19
19		BasnaNala	5	1440.00	864000.00	9.40
20		Arail Road Bridge Nala	2	55888.00	13413120.00	2.62
21	Jhunsi	LoteyHarenNala	4.45	55888.00	29844192.00	7.44
22		Shastri Bridge Nala	6.1	1450.00	1061400.00	6.10
23		Old GT Road Nala	3		109100000.00	
24		Savitry Nagar Bajar (New Jhusi)	3.5			
25		Savitry Nagar (New Jhusi)	3			
26		KriyaYogashram	2.5			
27		Primary School, UltaKila	2			
28		LakadiyaNala	4.5			
29		MawaiyaNala	26.06	55888.00	174772953.60	25.67
30		Arail Drain No.-2 (Kharkauni drain)	2.88	1400.00	483840.00	2.72
31		Sachcha Baba Ashram Drain	1.14	1400.00	191520.00	1.45
32	Mirzapur	Khandawa, Mirzapur	4.2	1498.35	1145338.74	29.96692
33	Mirzapur	Bisundarpur Drain	1.58	1857.96	534274.98	1.6079
34	Mirzapur	MorchaGhar Drain	1.64	1857.96	554563.90	1.7832
35	Mirzapur	Balaji temple	2.2	1857.96	743927.18	3.4181
36	Mirzapur	Basvariya Drain	1.13	1857.96	382108.05	3.9503
37	Ghazipur	AnzahiGhat, Ghazipur	3.91	1657.068	1179202.73	10.99

Sno.	District	Name of Drains	As per Contract			Actual Discharge
			Discharge (MLD)	Rate per MLD	Amount	
38	Ghazipur	StimerGhat, Ghazipur	3.24	1657.068	977139.86	2.67
39	Ghazipur	CollecterGhat, Ghazipur	3.14	1657.068	946981.22	3.11
40	Ghazipur	DadriGhat, Ghazipur	3.23	1657.068	974123.99	1.92
41	Ghazipur	Sai Mandir, Ghazipur	3.11	1657.068	937933.63	2.14
42	Ghazipur	D.M Banglo, Ghazipur	3.14	1657.068	946981.22	2.65
43	Ghazipur	BadaMahadeva (Gora Bazar)] Ghazipur	3.92	1657.068	1182218.59	4.75
44	Ghazipur	BadaMahadeva (Adarsh Bazar), Ghazipur	1.27	1657.068	383014.70	4.67
45	Saidpur	Ward No. 15 MalhiyaBasti Drain, Saidpur	1	1657.068	301586.376	0.91
46	Zamania	Kankarwa Drain, Zamania	1.01	1657.068	304602.2398	0.92
47	Zamania	KarpurimaiGhat Drain, Zamania	2.8	1657.068	844441.85	2.54
48	Ramnagar	RambhagGhat Drain, Ramnagar	8.2	1146.74	1711394.78	8.2
49	Varanasi	Nakkhi Drain, Varanasi	1.86	1146.74	388194.42	10.5
50	Varanasi	Samneghat Drain, Varanasi	1.17	1146.74	244186.82	4.1
51	Mughalsarai	Railway Drain, Mughalsarai	9	1146.74	1878360.12	16.105
52	Mughalsarai	Ganda Drain, Mughalsarai	3	1146.74	626120.04	4.9
53	Balia	KatharNala, Balia	19.6	1146.74	4090650.93	18.9
Total			**222.213**		**559965563.01**	**463.01**