GUIDELINES

FOR PLANNING, DESIGNING AND IMPLEMENTATION OF DEEP ROW ENTRENCHMENT (DRE) IN TOWNS

WITH < 20,000 POPULATION IN UTTAR PRADESH

An Intermediate Solution for Managing Faecal Sludge and Septage

This document has been prepared by Centre for Science and Environment on the request of SBM 2.0, Department of Urban Development, Uttar Pradesh. However CPHEEO guidelines should be adhered for implementation of DRE.

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LIST OF ABBREVIATIONS

ULB	Urban Local Body
DRE	Deep Row Entrenchment
FSS	Faecal Sludge & Septage
OSS	Onsite Sanitation Systems
STP	Sewage Treatment Plant
FSTP	Faecal Sludge Treatment Plant
O&M	Operations & Maintenance
CO_2	Carbon dioxide
MoHUA	Ministry of Housing and Urban Affairs
MoJS	Ministry of Jal Shakti
SBM(G)	Swachh Bharat Mission (Gramin)
DDWS	Department of Drinking Water and Sanitation
CPHEEO	Central Public Health & Environmental Engineering Organisation
HDPE	High-density polyethylene
KL	Kilo litre
DO	Dissolved oxygen
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
TSS	Total Suspended Solids
TDS	Total Dissolved Solids
NABL	National Accreditation Board for Testing and Calibration Laboratories
BIS	Bureau of Indian Standards

Glossary

Faecal Sludge: The accumulated semi-solid or solid portion that settled at the bottom of the septic tank or any other containment structure comprising 20% - 50% of the total septic tank volume is termed as faecal sludge.

On-site Sanitation: On-site sanitation is a system of sanitation whose storage facilities are contained within the plot occupied by a dwelling and its immediate surroundings.

Septage: Septage is the liquid and solid material that is accumulated in a septic tank after it has for a period of time. Septage is the combination of scum, sludge, and liquid from the household any other establishments.

Wastewater: Liquid wastes from households or commercial or industrial operations, along with any surface water/storm water. Wastewater is a broad term and used for any used water.

Vaccum tanker vehicle: A vehicle used for mechanized sludge removal from onsite sanitation systems like septic tanks, etc.

Leaching: It usually refers to the movement of dissolved substances with water (Here faecal sludge) percolating through soil.

1. Introduction

In Uttar Pradesh, Urban Local Bodies (ULBs) with population less than 20,000 have no proper treatment facility available for disposal of faecal sludge and septage (FSS). The collected faecal Sludge & septage from households is usually discharged into open ground or drains in an unregulated and ad hoc manner. This has negative implications for both public health and the environment.

To address this issue, Deep Row Entrenchment (DRE) commonly called as trenching can be adopted. It is a method of land application of faecal sludge or septage (FSS) as a controlled disposal method. This is a simple process used for controlled and safe disposal from Onsite Sanitation Systems (OSS) such as septic tanks in the absence of, or while awaiting more appropriate treatment facility to come up. Trenching enables disposal with mitigating and minimizing odours, nuisances and risk of exposure to pathogens. This should be noted that trenching should be considered as an interim solution only where treatment facilities such as Sewage Treatment Plants (STPs) or Faecal Sludge Treatment Plants (FSTPs) are not presently available in the nearby area say within 15 km distance. Trenching is recognized by Government of India as a solution for safely managing and treating faecal sludge for ULBs with less than 20,000 population.[1,2]

Disposal of untreated faecal sludge in trenches is not desirable as a long term strategy because it may pollute and ground and surface water sources due to its leaching effect.

Advantages

- Very simple & easy to construct
- Requires very low investment required
- No expensive infrastructure & pumps are needed
- Requires very limited or no Operations & Maintenance (O&M)
- Produces no visible nuisance, if properly planned, designed, operated & monitored
- Gain benefit from the planted trees/green covers (CO2 fixation, control soil erosion & economic benefits from the produces)

Disadvantages

- Leaching from the trench might pollute groundwater, if during planning process, site is not properly selected or if the ground water table is high.

1 Consultative document on Land applicability of Faecal Septage, CPHEEO, MoHUA, November 2020
2 Manual: Faecal Sludge Management, SBM (G), DDWS, Ministry of Jal Shakti, July 2021

2. Planning for trenching

The following aspects must be considered as part of the planning process for trenching:

- Estimation of the current and future FSS load to be disposed of and accordingly identification of the trenching locations.

- Assessment of ground water level based on the latest data from Central Ground Water Board (CGWB), Ministry of Jal Shakti or any other relevant source should be done before finalizing any site for trenching.

- The selected site should have all the required clearances from the concerned authorities like the state pollution control board, revenue department, etc. The required clearances include no objection certificates, consent for construction of trench, etc.

- The sites must be selected based on suitability for trenching which includes following considerations:

DO's	DON'Ts
1. Flat surface for easy operations. 2. Trench should be atleast 500 m radius away from human settlements, schools, hospitals, restaurants and any type of institutional building. 3. Ground soil should preferably have good permeability. 4. Should receive a minimum of 4 hours of sunlight daily for 100 consecutive days in a year. 5. Should be fenced well so that no animal can reach.	1. Construct in a flood-prone area. 2. Construct in landslide-prone area. 3. Construct in water resource recharge zones such as watersheds/upstream of surface water bodies or recharge areas of aquifers. 4. Construct in rocky terrains. 5. Trench should not be surrounded by trees.

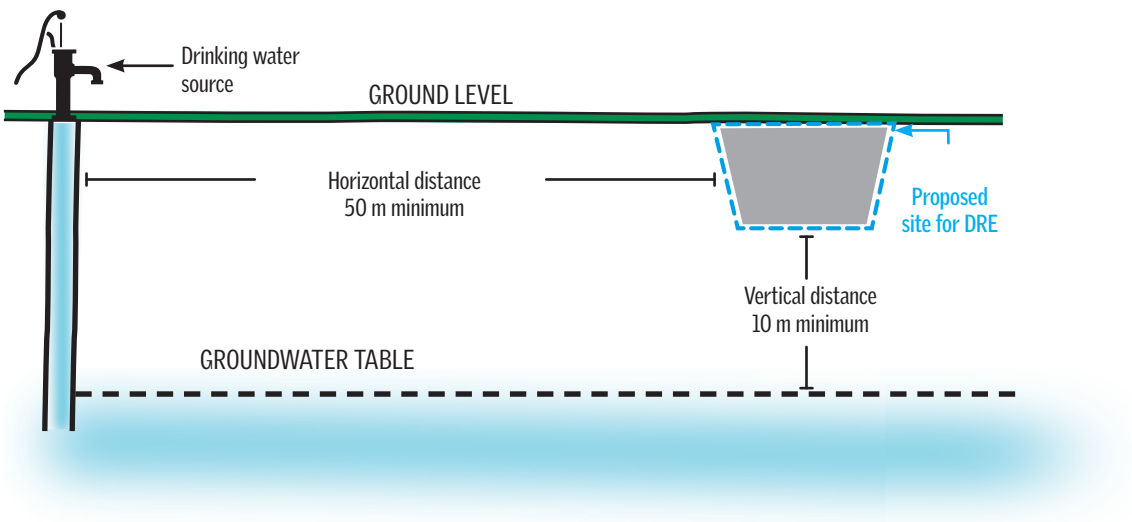
In addition, a duly filled out form (Attached as Annexure I) shall be approved and signed by the Executive Officer for site selection and design criteria to be submitted to the State SBM office for record and monitoring purposes.

3. Designing of trenches

The following design considerations should be kept in mind while designing trench:

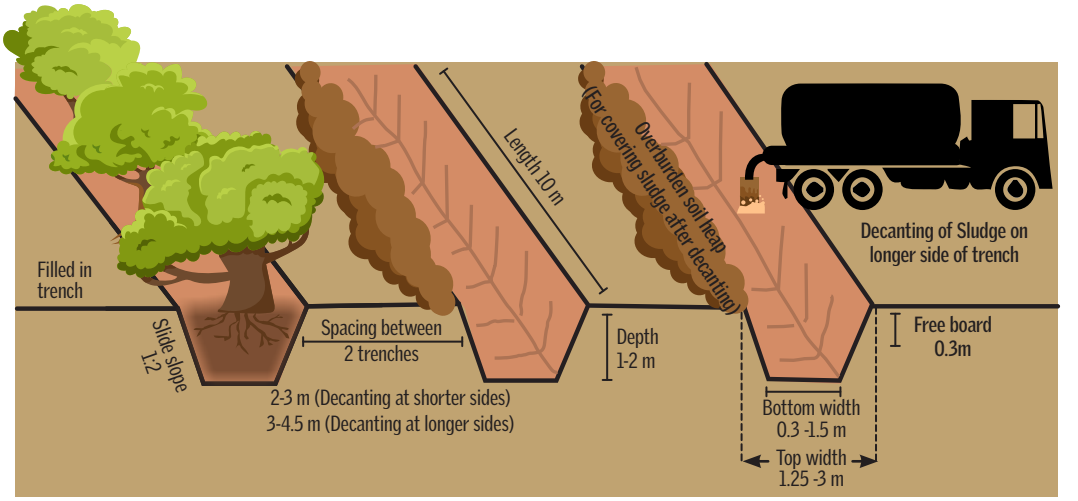
- Trench dimensions should be majorly based on type of soil & quantity of Faecal sludge & Septage to be disposed of?
- The permissible horizontal distance between the trench & surface water sources and the vertical distance between bottom of the trench & ground water table should be maintained as illustrated in Figure 1.
- Access roads to reach the trenching site & inner road between the trenches should be designed properly for easy movement of the tankers.
- Fencing to protect the trenching area to be done. Trees can be planted along the fencing to reduce the odour & give the site an aesthetic look.
- Warning signage should be placed appropriately.
- An elevated curb along the four sides of the trench for obstructing water to pass into the trench and making the trench stronger so that the side walls do not fall/break.
- Provision of tarpaulin sheet for protection from rain.

Figure 1. Minimum safe distance to avoid ground/surface water contamination



Source: MoJS, July, 2021

Figure 2. Illustrative representation of a DRE site



Source: MoHUA, November, 2020

The trenches are dug parallel to each other and also to the slope of the land as shown in Figure 2. Their dimensions can be decided as outlined in the following table.

Table 1. Dimension and design considerations of DRE trench

DESIGN CONSIDERATION	RANGE	CRITERIA/REMARK
Depth of trench	1 m to 2 m	Bottom of trench should be at least 10 m above highest water table level
Bottom width of trench	0.3 m to 1.5 m	Depending on amount of Faecal sludge, width can be decided
Top width of trench	1.25 m to 3 m	
Length of trench	No specified length as it depends on site and area available. Generally, it can be taken as 10 m	Length should be parallel to the contour of the land
Side slope of trench	1:2	Depends on area available
Space between two consecutive trenches (edge-to-edge)	2 m to 3 m (If desludging vehicles decants at shorter edges of the trench)	Depending on area available and also taking into consideration space to maneuver desludging vehicles
	3 m to 4.5 m (If desludging vehicles decants at longer edges of the trench)	
Free board	0.3 m from top	Trench is filled upto 0.3 m from top and then backfilled with excavated soil.

DESIGN CONSIDERATION	RANGE	CRITERIA/REMARK
Sand layer at the bottom of the trench	0.3 m thickness	Needs to be provided when groundwater depth at site is equal to vertical permissible limit (10 m) and there are no surface water sources near the site.
Agri film/HDPE layer Along the slopes and bottom of the trench	Based on the area of the trench	Needs to be provided when groundwater depth as well as surface water sources at the site are equal to or less than permissible vertical and horizontal limit i.e. 10 m and 50 m respectively.
Urea application	Quantity depends on area to be covered without leaving any space. (1 kg is sufficient for each decanting)	Should be applied after every decanting of faecal sludge at the trench

After digging trenches, bunding should be provided at the edges with the dug up soil. This will help prevent ponding of the trenches during the rainy season. Additionally, vegetative cover could be provided at the periphery of the site for odour control.

Note-

1. Side slope is important to avoid caving in of the trench due to the movement of the desludging vehicle or an earth moving machine when the soil is in the water saturated state as it may result in accident at the site during the O&M.
2. Application of using Agri film/HDPE layer is only recommended where the risk of groundwater contamination due to leaching is significant and it should be properly assessed on site to site basis. Refer Annexure IV for the groundwater level data in districts of Uttar Pradesh. In general, agri film/HDPE layer is not recommended as it reduces the efficiency of dewatering, drying and mineralization of sludge in the trench.[3]
3. Application of Urea is advised as it minimizes the odour from the decanted sludge and subsequent contamination to the surrounding environment.
4. Space between two consecutive trenches can be decided based on the requirement and availability of area so that desludging vehicles can either decant from shorter or longer sides of the trench. It is important to even out the sludge throughout the trench such that efficiency of dewatering is not hampered.

3 https://jjmup.org/wq/gwd.php

4. Operation & Maintenance (O&M)

The operation and maintenance of the DRE must be done systematically. Some of the key aspects are as follows:

4.1 Process of disposal into the Trenches

- The trench facility operator must maintain a logbook noting down the date and time of collection and disposal, source of the sludge and the details of the ULB emptier or registered private operator.

- The sludge should be emptied in an even layer into the trench and a layer of urea (approximately 1 kg) should be sprinkled /applied over it and then should be covered with a fine soil layer to prevent exposure to air and vectors and finally allowed to dry for 2 to 3 days before next sludge load is decanted in the trench. Once filled to the desired height, usually 0.3 m from the top, the trench should be covered with a soil layer to avoid odours and to maintain a favourable environment for digestion and dewatering.

- Risk of caving in due to bad designing, must be avoided. After the entire trench is filled, it caves primarily due to leaching and decomposition of the sludge after some time. The time taken for this caving to occur depends on several factors such as weather, soil type, biological activity etc. but most importantly on improper sizing of the trench especially the side walls. Therefore, after the caving occurs, it should be filled with soil again to maintain the surface flat.

- Three months after the trench gets filled, again as outlined in the previous point, the trenches can be planted with trees or used as a green space. For further sludge disposal, a new trench might be identified and used keeping in mind the site selection parameters.

4.2 Precautions to be taken during O&M

- Avoid sludge disposal before and during rainfall season. This can be done by not emptying the on-site containments during this time.

- The DRE site must be used to dispose of only faecal sludge from residential, and commercial buildings (like schools, colleges, hotels/

resorts and offices). No other waste such as food waste from restaurants or industrial waste of any nature whatsoever shall be disposed of on DRE sites.

- All on-site personnel including the emptier should use appropriate personal protective gear and must undergo regular health check-ups preferably arranged by the ULB.

- The DRE site must be demarcated, fenced with GI wire mesh of 3 inch by 3 inch and provided with appropriate signages so that there is no trespassing by humans or animals including for grazing.

- During disposal, if sludge spills outside the trench by accident, it must be applied /treated with lime to stabilize it.

4.3 Monitoring Activities

- ULB must ensure mandatory monthly testing of water sources in the vicinity (within 100 to 150 feet) of the DRE site to ensure there is no contamination happening. The testing can be done by Jal Nigam/Jal Sansthan or any private NABL accredited lab as per prescribed BIS standards for water quality. Bacterial contaminants such as faecal coliform and total coliform are the most important parameters to be tested along with DO, BOD, COD and TSS.

- ULB can also setup boreholes up to groundwater table in the eight directions (North, East, South, West, North-east, North-west, South-east, South-west) 3 m from the DRE site to assess any contamination due to DREs through groundwater sample analysis. This can be done twice in a year (one during dry season and one during wet season).

- It is desirable that ULB also carry out soil testing at the DRE site after a year to ensure there is no contamination. Additional parameters such as pH, Nitrate, Phosphate, Residual Free Chlorine, Chloride, Alkalinity, Turbidity, Total Dissolved Solids (TDS), Fluoride, Sulphate, Total Hardness, Calcium, Magnesium, Arsenic, Copper, Aluminium, Manganese and Iron can also be tested.

Note- The dried sludge (stabilized bio-solids) from the trenching site can be either used as a fertilizer in municipal gardens/parks or on green patches developed on the road dividers. As an alternative trees can also be planted on top of or alongside filled trenches.

ANNEXURE-I

Form to be filled by ULB for planning Deep Row Entrenchment (DRE) in the ULB

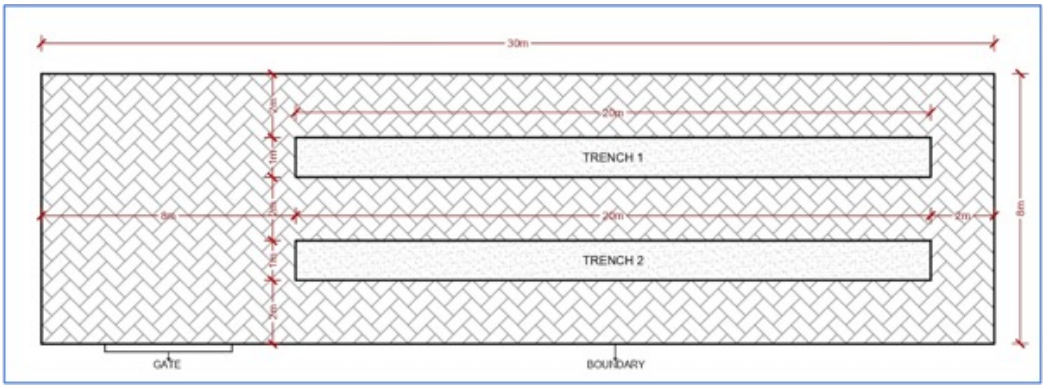
Sr. No.	Activity	
1	**Site Selection Criteria**	**Yes/No**
a)	Identification of possible sites (No. of sites identified)	
b)	Site above high flood level (HFL)	
c)	Site is not prone to water-logging	
d)	Water table deeper than 10 m from bottom level of the trench	
e)	Surface water body minimum distance – Greater than 50 m	
f)	Whether the soil type is porous	
g)	Whether the site terrain is flat	
h)	Distance between nearest habitation and site - 500m Minimum	
i)	All weather road accessibility for vacuum tanker vehicle	
k)	Distance of site from town centre < 15km	
2	**Trench Design**	**Value**
a)	Top width of the trench (Recommended - 1.25 m to 3 m)	
b)	Bottom width of the trench (Recommended - 0.3 m to 1.50 m)	
c)	Height/depth of the trench (Recommended -1 m to 2 m)	
d)	Length of the trench (Recommended -10 m to 20 m)	
e)	Side slope (Recommended 1:2)	
f)	Space between two consecutive trenches if, more than 1 trench (Recommended 2-3 m for decanting from shorter side and 3-4.5 m for decanting from longer side)	
g)	Number of trenches	
h)	Photos of the site with GPS location	

Executive Officer
(Name of the ULB) with seal/stamp
Date

ANNEXURE-II

Example for calculating Area required for Deep Row Entrenchment

Figure 3. Typical plan for 2 trenches assuming decanting from shorter side



A trench size of bottom width of 0.3 m and top width of 1 m, a depth of 1 m and length of 20 m. The volume of this trench would be
V=½(top width+bottom width)*depth*length
=½(1+0.3)*1*20
=13 m^3

Then, the volume of the trench would be 13 m^3. For constructing two trenches like this which is spaced 2 m apart, and a setback of 2 m from the fence and a sufficient space of entering of a truck, the length of the site would be (6+20+2) = 28 m and the width of the site would be (2+1+2+1+2) = 8 m. The area taken up would be 28*8= 224 m^2 which is roughly 250 m^2.

These two trenches would take care of a volume of 26 m^3 i.e. 26 KL. It implies that the trench will get full, irrespective of time period if, a vacuum tanker of 3000 litres capacity decants at the trench or a 4000 litres capacity decants 6 times or a tanker of 5000 litres capacity decants 5 times.

Once the trench gets filled, it can be left alone for 6 to 8 months to leach and decompose and then the trench can be emptied with precautions and reused. The trench size and numbers thus can be decided based on the septage quantity emptied in the town.

ANNEXURE-III

Cost Estimate- An example from Chunar[4]

Taking example from Chunar experience by CSE, approximate cost of the trenching including design and construction of the system would be around ₹35,000, whereas the monthly expense of operating the trench is estimated to be ₹3150.

Capital Expenditure

Sr. No.	Item Description	Unit	Quantity	Rate (₹)	Amount (₹)
1.	Hiring earth mover (JCB)	Hours	5	1300.00	6500.00
2.	HDPE liner underlying sludge (3x layer)	m2	250	40.00	10000.00
3.	HDPE liner for covering during rain	m2	90	40.00	3600.00
4.	Fencing	m2	20	600.00	12000.00
	Sub-Total				32100.00
	Add 10% for contingencies				3210.00
	Total Cost				35310.00

Operational Expenditure (For 1 month)

S. No.	Item Description	Unit	Quantity	Rate (₹)	Amount (₹)
1.	Urea (per trip basis) *Assuming 1 trip per day	Kilograms	30	05.00	150.00
2.	Personnel for adding earth over decanted faecal sludge (per day basis)	Day	30	100.00	3000.00
	Total				3150.00

4 https://www.cseindia.org/trenching-for-safe-management-of-faecal-sludge-and-septage-9720

ANNEXURE-IV

Groundwater level (Pre and post monsoon) in districts of UP (Source: Ministry of Jal Shakti)

Ground water level in UP

Sr. No.	District	in meter below ground level	
		Pre Monsoon	Post monsoon
		2020	2020
1	AGRA	31.15	30.23
2	ALIGARH	13.76	14.22
3	AMBEDKAR NAGAR	7.06	2.82
4	AMETHI	6.56	4.68
5	AMROHA	12.04	12.09
6	AURAIYA	7.97	6.21
7	AYODHYA	6.59	4.23
8	AZAMGARH	4.81	1.59
9	BAGHPAT	19.27	20.17
10	BAHRAICH	3.85	2.76
11	BALLIA	5.17	2.22
12	BALRAMPUR	3.9	3.08
13	BANDA	7.81	5.83
14	BARABANKI	5.62	4.34
15	BAREILLY	6.08	5.93
16	BASTI	3.99	2.23
17	BHADOHI	10.4	6.18
18	BIJNOR	9.14	8.17
19	BUDAUN	13.63	14.35
20	BULANDSHAHR	9.11	9.52
21	CHANDAULI	5.63	2.76
22	CHITRAKOOT	10.86	8.99
23	DEORIA	4.04	1.81
24	ETAH	12.04	12.7
25	ETAWAH	11.4	10.23
26	FARRUKHABAD	14	13.35
27	FATEHPUR	15.14	13.69
28	FIROZABAD	22.34	22.87
29	GAUTAM BUDDHA NAGAR	8.27	9.21
30	GHAZIABAD	12.16	11.85
31	GHAZIPUR	6.87	4.26

Sr. No.	District	in meter below ground level	
		Pre Monsoon	Post monsoon
		2020	2020
32	GONDA	4	2.77
33	GORAKHPUR	5.07	2.11
34	HAMIRPUR	16.5	13.99
35	HAPUR	12.24	13.57
36	HARDOI	5.9	4.62
37	HATHRAS	17.08	17.82
38	JALAUN	8.8	9.93
39	JAUNPUR	9.01	6.77
40	JHANSI	8.71	6.61
41	KANNAUJ	16.63	16.87
42	KANPUR DEHAT	11.59	10.51
43	KANPUR NAGAR	11.11	10.42
44	KASGANJ	7.2	7.77
45	KAUSHAMBI	17.55	15.74
46	KUSHINAGAR	3.72	1.88
47	LAKHIMPUR KHERI	6.31	4.08
48	LALITPUR	8.95	5.61
49	LUCKNOW	9.17	8.27
50	MAHARAJGANJ	3.66	2.16
51	MAHOBA	7.44	8.02
52	MAINPURI	11.06	11.76
53	MATHURA	7.49	8.06
54	MAU	5.35	2.62
55	MEERUT	13.18	13.01
56	MIRZAPUR	10.15	6.54
57	MORADABAD	8.51	10.53
58	MUZAFFARNAGAR	11.18	11.06
59	PILIBHIT	3.76	3.06
60	PRATAPGARH	10.18	8.56
61	PRAYAGRAJ	8.52	7.27
62	RAEBARELI	7.26	7.65
63	RAMPUR	7.08	6.51
64	SAHARANPUR	10.31	9.67
65	SAMBHAL	15.26	15.15
66	SANT KABIR NAGAR	4.3	1.97
67	SHAHJAHANPUR	6.33	6.2
68	SHAMLI	18.13	18.45
69	SHRAWASTI	3.39	2.29

Sr. No.	District	in meter below ground level	
		Pre Monsoon	Post monsoon
		2020	2020
70	SIDDHARTHNAGAR	8.16	8.86
71	SITAPUR	6.77	6.67
72	SONBHADRA	10.41	5.1
73	SULTANPUR	6.1	4.38
74	UNNAO	7.9	5.27
75	VARANASI	11.53	7.66

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