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USE OF SURFACE WATER TO COMBAT GROUNDWATER POLLUTION: WITH SPECIAL REFERENCE TO GANGA WATER TREATMENT PLANT OF CHAKDAHA, NADIA, WEST BENGAL

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ABSTRACT

West Bengal is one of the largely arsenic contaminated states in India. In West Bengal, the groundwater in Nadia district is mostly affected by arsenic. The polluted water poses undoubtedly a great threat to the people of Bengal Delta living in and around the study area, Chakdaha. To save people from arsenic contamination, various short- term projects were taken previously decades ago, but unfortunately all those projects failed due to complicated operation, lack of maintenance and non- acceptance by the society people. The Govt. of West Bengal realised the severity of the problem and came forward to saving people from imminent danger. Hence is the establishment of this large Water Treatment Plant. The scheme in Chakdaha Block is named ' Surface Water Based Pipe Water Supply Scheme' based on the river Ganga (Hooghly). People of the study area are, therefore, greatly benefitted.The other advantages of the scheme are i) flood control, ii) groundwater retention, etc. Side by side, there maybe some disadvantages like i) siltation, ii) river water level getting low due to over exploitation of surface water. The research paper suggests using lentic water bodies and rain water as altermative source of water for sustainable development

KEYWORDS: Arsenic Contamination, Surface Water Treatment, Alum Dosing, Poly Electrolyte Process, Clariflocculator, Natural Coagulant.

I. INTRODUCTION

Resources that exist in nature without the interventions of human beings are natural resources.Water is one of the natural resources. It is such a resource that sustains our life. It is extremely necessary for human consumption and sanitation. It is also used for industrial purpose and agricultural production (Abdullahi et.al.,2014). But about 97.2% of water on the earth is saline and 2.8% is available as freshwater at any time. Out of the fresh water, 2.2% is available as surface water and 0.6% as groundwater. Out of 2.2% of surface water, 2.15% of fresh water exists in the form of glacier and polar ice cap and the remaining is in other form. On the other hand, out of 0.6% of groundwater, only 0.25% can be extracted economically (Raghunath,2014). Human beings mainly depend on groundwater. But the problem is that the quality of groundwater is deteriorating day by day due to some natural and manmade pollutants (Ray,2007). Groundwater may be contaminated by Arsenic (Chakraborty et.al.,2009), Fluride (Yadav & Garg, 2014), Iron (Hossain et.al,2013), chemical fertilizer having high amount of Nitrogen (Savci,2012) in agricultural sector, domestic sewage and discharge of industrial effluents (Sharma & Chaudhry,2013).

India is suffered by groundwater contamination in recent years. Groundwater is contaminated by several pollutants which vary from state to state. West Bengal is largely affected by Arsenic (Das,2013). In India, the groundwater Arsenic contamination was first surfaced in West Bengal in 1983 (Ghosh & Singh). In West Bengal, the district of Nadia is largely affected by Arsenic because this district lies within Ganga-Brahmaputra Delta (Das,2013) . This district has also a large amount of production of rice, which increases the amount of Arsenic in soil (Mondal & Poyla,2008). Among the Blocks of Nadia, Chakdaha is highly affected by Arsenic contamination.The State Govt. has taken up 'Mega Piped Water Supply Scheme based on River Ganga' in West Bengal. The scheme in Chakdaha block is named 'Surface Water Based Pipe Water Supply Scheme'.

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This Research Paper highlights function, limitation of 'Surface Water Based Pipe Water Supply Scheme' on the Ganga (Hooghly) River in Chakdaha Block as a preventive measure of Arsenic affected areas.

II. OBJECTIVE

The main objectives of the Research Paper are given below:

i) To focus the present status of Arsenic in the study area.
ii) To analyse the effectiveness of 'Surface Water Based Pipe Water Supply Scheme' as a preventive measure of Arsenic contamination.
iii) To highlight another effective treatment process to prevent Arsenic contamination.
iv) To focus the feedback of local people about this scheme in the study area.
v) To aware the people of the society that they can use the surface water not only to prevent Arsenic but also to prevent all metal contaminations.

III. METHODOLOGY

To analyse the effectiveness of 'Surface Water Based Piped Water Supply Scheme' various methods are applied in this research paper:

i) Primary data are collected from intensive household survey in the study area.
ii) Secondary data are collected from local panchayet and the office of Public Health Engineer.
iii) Information are collected from Literature Reviews.
iv) Some qualitative and quantitative methods have been used to analyse the effectiveness of the scheme.

IV. STUDY AREA

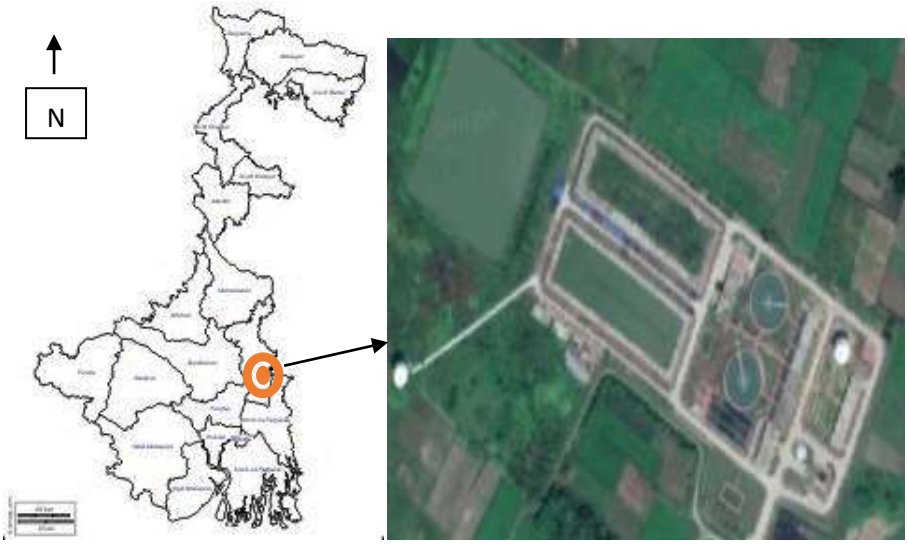

Fig 1: Location of the Surface Water Purification Plant of Chakdaha, Nadia

In order to highlight the problem of Arsenic contamination and focus the effective measures taken by State Govt. 'Surface Water Based Piped Water Supply Scheme' plant of Chakdaha block is selected as study area. It is situated at Palagacha of Chakdaha, Nadia (Fig 1). It is also situated along the course of Hooghly River, which is the source of water of the plant.

The town Chakdaha is situated in the district of Nadia in the state of West Bengal. Geographically it lies at coordinates of $23^0 80'$N and $88^0 52'$E. Severe Arsenic contamination is identified in Saguna, Gotra, Nikargachi, Sutra,Pumlia, Ghetugachi (Pal &Mukherjee,2009). The treatment plant is, therefore, situated almost near the Arsenic affected area to supply Arsenic-free water to people residing in and around. The main cause of the selection of study area is to aware people so that they can use the surface water not only for Arsenic prevention but also for prevention of other metal contaminations because surface water is less contaminated than groundwater.

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V. BACKGROUND OF THE ESTABLISHMENT OF 'SURFACE WATER BASED PIPE WATER SUPPLY SCHEME

Now a days groundwater contamination is a serious threat. Due to advancement of industrialization and globalization, rapid use of chemical toxic metal is increasing day by day. As a result, the contaminated surface water percolates through pore space of soil and the quality of groundwater is degrading. For using contaminated groundwater, different water borne diseases are occurred such as Melanisia, Keratosis, Non-pitting edema due to Arsenic contamination, Fluorosis due to Fluride contamination, Heamochromatosis due to Iron contamination etc.(World Health Organization,1996)

Research highlights that out of 23,259 affected habitats in total in West Bengal, 9000 habitats are affected by Arsenic mainly seen in Malda, South 24 pgs, Nadia, Hooghly, Mursidabad, Bardhaman and Howrah; 6,516 habitats are affected by Iron which is mainly notified in Midnapore, Howrah, Hooghly, Bankura;7,722 habitats are affected by salinity which is confined to the area of Midnapore and 21 habitats are affected by Fluoride which is confined mainly to the area of Birbhum. West Bengal is,therefore, mainly affected by Arsenic.

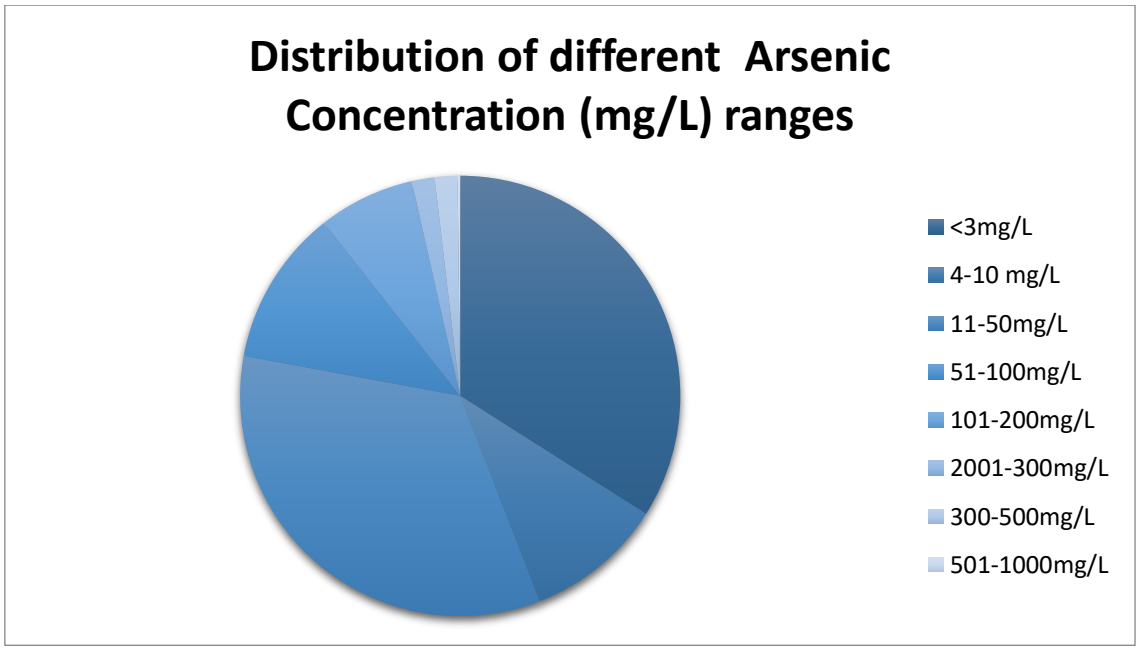

Fig 2: Distribution of Arsenic concentration in Chakdaha, Nadia, West Bengal

The study area of the research paper is mostly affected by Arsenic as it lies in Ganga Delta. Due to natural occurrence of changes, high concentration of Arsenic in deeper level of groundwater is noticed. It is identified mainly in Ganga Delta due to use of deep tubewell. The other cause is maximum production of rice making it highly sensitive to Arsenic.(Mondal & Poyla,2008). The use of several Arsenical pesticides is also the source of groundwater Arsenic Contamination.(Quazi et. al., 2011) The release of Arsenic by natural process in groundwater has been noticed from Holocene sediment comprising sand, silt, clay (Bhattacharya et. al.,1997; McArthur et. al,2004). The several sources of Arsenic have been identified in Ganga Delta are viz: Gondwana Coal Layer in Rajmahal Basin, Bihar- Mica Belt, Pyrite bearing shale from Vindhyan Range, Son valley Gold belt and Darjeeling Himalayan belt (Bhattercharya et. al,2002;Acharyya et. al,1993). According to WHO (World Health Organisation), the acceptable level of maximum concentration of Arsenic in safe drinking water is 0.01mg/L. But according to the School of Environmental Studies, 55.9% of total samples are in area where Arsenic concentration is less than 10mg/L, 22.1% are in area of less than 50mg/L. Arsenic concentration and 890% of total samples are in less than 100mg/L Arsenic concentrated area in Chakdaha. (Fig 2)

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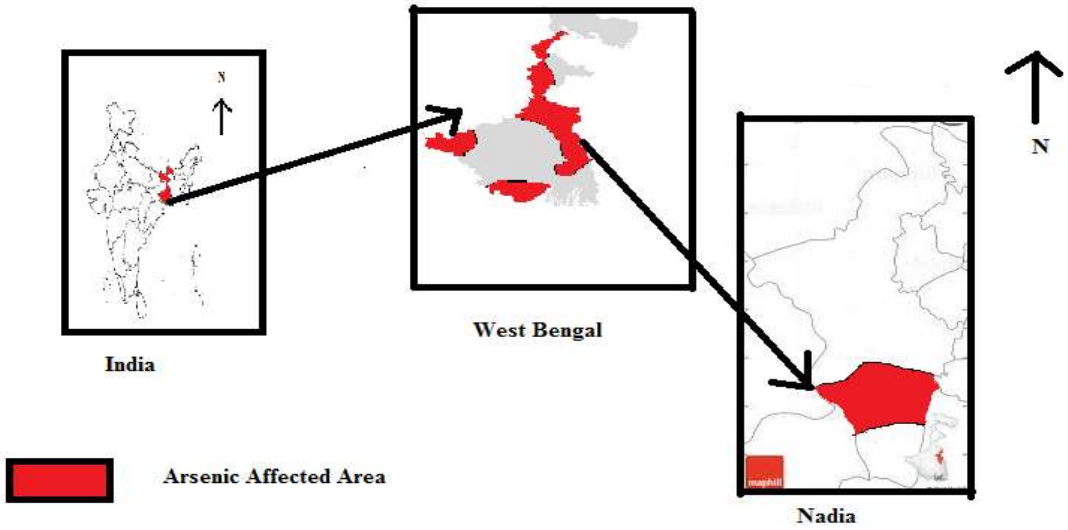

Fig 3: Concentration of Arsenic in India ,West Bengal and Nadia

Chakdaha is highly affected by Arsenic. Many people are affected by this contamination.Soon after the detection of geogenic and anthropogenic arsenic contamination of groundwater, various short- term measures like i) installation of hand pump tubewells at deeper aquifer ii) installation of Arsenic removal units attached to the Hand Pumps iii) construction of new dug wells etc. were taken up. However, most of those short- term measures failed because of complicated operation and lack of maintenance issues and non-acceptance by the society people.Hence is the establishment of this large Water Purification Plant.

VI. ABOUT THE PLANT OF CHAKDAHA , NADIA

Fig: 4 Water Treatment Plant of Chakdaha

- The Salient features of this Surface Water Based Piped Water Supply Scheme are given below:(Fig: 4)
- Name of the Scheme – Surface Water Based Piped Water Supply Scheme for Arsenic Affected Areas of Chakdaha (Part)
- Block of Nadia District.
- Name of the Blocks Covered – Chakdaha (Part)
- Number of Village Covered –Rural:191 Nos, Census Town: 1 No.
- Number of Rural Habitation – 266 Nos (**Arsenic affected 155 habitations**)
- Total Mouza – 114
- Population Served – 5 Lakh, 15 Thousand 999 persons
- Design Population (2028) – Total 4,86,904 (Rural: 4,68,376 and Urban: 18,528)
- Command Area – 22611.7 Hectares

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- Number of Zones – 13 Nos.
- Per Capita Service Level – Rural – 49 **Litre per capita per day**(lpcd) (considering **30% population** to be served through **house connection @ 70lpcd** and **70%** to be served through **street hydrants @ 40 lpcd**)
- Daily Water Demand – Raw Water; 33.39 **Million litre per day** (MLD). Clear Water;31.72 MLD, Net Water; 28.55MLD
- Source of Water – Surface Water of River Hooghly
- Treatment Plant Capacity – 32.74 MLD
- Treatment Methodology – Conventional Treatment (**Coagulation and Flocculation, Clarification, Rapid Gravity**
- **Filteration and Disinfection**)
- Over Head Reservoir (OHR) – 12 (twelve) Nos. new to be provided in each zone over and above exixting 02(tow) Nos.
- Sanctioned Estimated Cost – Rs. 118.98 Crores under NRDWP (**National Rural Drinking Water Programme**)
- Date of Commencement – 24.12.2009
- Date of Commissioning – June 2012
- Cost of production of water – Rs. 7/Kl.
- Total Distribution – 800 Km.
- Location of Intake – Near Mukundanagar Ghat under Par Niamatpur Mouza.
- Treatment Plant – Palagacha
- Water Quality – Under BDL (Below Detection Level).

VII. PROCESS

Different Arsenic Water Purification processes are seen all over the world. In Mediterranean Region, Chemical Precipitation, Activated Carbon Adsorption (Iron oxide Carbon), Membrane Filteration (Nanofilteration, Reverse Osmosis, Electro dialysis) and Ion- Exchange processes are used to prevent Arsenic (Sorlini et. al,2015). In Pakistan Sono-3-Kolshi Filter, Three Gagri System, Stevens Institute Methods are used for Arsenic prevention in drinking water. (Hasmi & Pearce,2011). In theUnited States, small 'Under Sink' has been used to remove Arsenic from drinking water. Reverse Osmosis, Ion exchange and activated alumina have been considered but not commonly used in the United States.

In our study area, the situation is somewhat different. The main moto of this project is to reduce Arsenic contamination by using Surface Water to combat Groundwater pollution as the groundwater is largely affected by Arsenic pollutants (Mondal & Poyla,2008).As shown in the Fig 3., research has revealed that surface water is quite safe in relation to groundwater with respect to heavy metal and Arsenic. But other physicochemical and biological parameters should be checked before consumption as a drinking water. For this reason pH, total dissolved solid (TDS) presence of essential minerals, Nitrates, Phosphate, Amonia, Total Alkalinity, Hardness and Dissolved Oxygen (Physicochemical parameter) should be taken into consideration and Coliform Bacteria (Biological Parameter) should also be identified. First of all, the selection of site is very important to get good quality of water from surface water (Ganga). Hence the place is selected at Mukundanagar under Par Niamatpur Mouza under Payradanga gram panchayet and Block Ranaghat I(Fig: 5), near the Ganga, and the purification centre is selected at Palagacha near TatlaI Gram panchayet of Chakdaha Block. The distance between the two is only 4 km.

The following steps are taken in this aspect:
A.Jar Test- The water of probable selected sites is tested by the process called Jar Test to select and quantify a treatment programme for removal of suspended solid or oil from raw water. It is conducted on a four or six place gang stairrer which can be utilized to stimulate mixing and settling condition in a clarifier.

B.Alum Dosing- After Jar Test Alum dosing make 48 hours under mechanical stair is done.

C.Mineral Testing- After settling the necessary mineral and their presence should be observed because minerals are needed for our body.

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A

B

Fig: 5 Surface Water Collection Site (Mukundanagar Ghat, GP- Pyradanga, Block- Ranaghat I)

The above steps are achieved at the river water collection sites (Mukundanagar). After these steps, the raw water is pipe lined at 4 km away from collecting zones. Now the following steps are necessary:

In the study area Surface water is purified by Conventional Treatment (Coagulation and Flocculation, Clarification, Rapid Gravity Filtration and Disinfection).(Fig 4)

Water from Ganga river is collected in the Inlet Well of the Plant.

1. Here primarily Chlorination process is used to destroy the germs.
2. Now water is brought in the Partial Flume where Poly Electrolyte process is used to purify water.
3. Generally in the rainy season alum is charged with water so that the correct value of pH is maintained.

Alum is used in the rainy season because of the effect of recent acid rain. Moreover, various types of industrial disposals from factories and mills i.e. pollutants are mixed with water making it acidic. As a result of this, the value of pH becomes acidic. So alum is used to make water free from acid and the value of pH becomes correct which is safe for human consumption.

Polyelectrolyte is such a process which makes the pollutants remaining in the water insoluble from soluble component through the Ion exchange. Moreover along with this the **Clerk** process i.e. the process of transforming soluble salt to insoluble salt mixing Quicklime/Wet Lime ($Ca(OH)_2$) with water. At this stage a certain amount of Quicklime/Wet Lime is used so that it can be mixed equally with water. In consequence of it, insoluble salt remains precipitated under water.

$$\underset{\text{(Calcium Bi-Carbonate)}\\\text{(Soluble Salt)}}{Ca(HCO_3)_2} + \underset{\text{(Calcium Carbonate)}\\\text{(Insoluble Salt)}}{Ca(OH)_2} \longrightarrow CaCO_3\downarrow + H_2O$$

$$\underset{\text{(Magnesium Bicarbonate)}\\\text{(Soluble Salt)}}{Mg(HCO_3)_2} + \underset{\text{(Calcium Carbonate)}\\\text{(Insoluble Salt)}}{Ca(OH)_2} \longrightarrow CaCO_3\downarrow + \underset{\text{(Magnesium Carbonate)}\\\text{(Insoluble Salt)}}{MgCO_3} + H_2O$$

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1. After that water is passed through the **Clariflocculator** Machine which is a machine having two cylindrical tank of which the internal tank is used for flocculation. There are many centrifuge tools in the internal tank to whirl water where the insoluble tiny salts are accumulated and transformed into large granular salt,whereas water is purified in the outer tank.
2. Then the water is passed into a rectangular tank named sedimentation tank. In this tank the flow of water is very slow. So the insoluble salt becomes sediment in the tank and purified water flows out of the tank.
3. Now the water is sent to sand filter tank. In this tank ,some harmful bacteria and smaller particles existing in that water are separated from the water and the water becomes more purified. The backwash for sand is necessary at regular intervals to regenerate its original properties and potentialities.
4. Now the water is oxidized under block condition. And an exposed side wall for sunlight penetration through a glass is arranged. Again, a special covered grassbed is set above to make the water cool.
5. In spite of those measures taken, it is seen that some bacteria still exists in that water. So, Chlorine dozing process is applied to remove bacteria from water. After Chlorine dozing, the purified water becomes useful for drinking. This drinking water is stored in a reservoir. Now the drinking water is distributed through pipeline forhuman consumption.
6. In pump house the standardization of Chlorine should maintain at the level of 0.2 mg/L.(Fig: 6).
7. The accumulation of sludge in the overall process are stored in a reservoir, which is potentially effective for the production of Bio-gas which can be used as a source of Non conventional and renewable resource of energy.

Fig : 6 Pump house and Storage Tank

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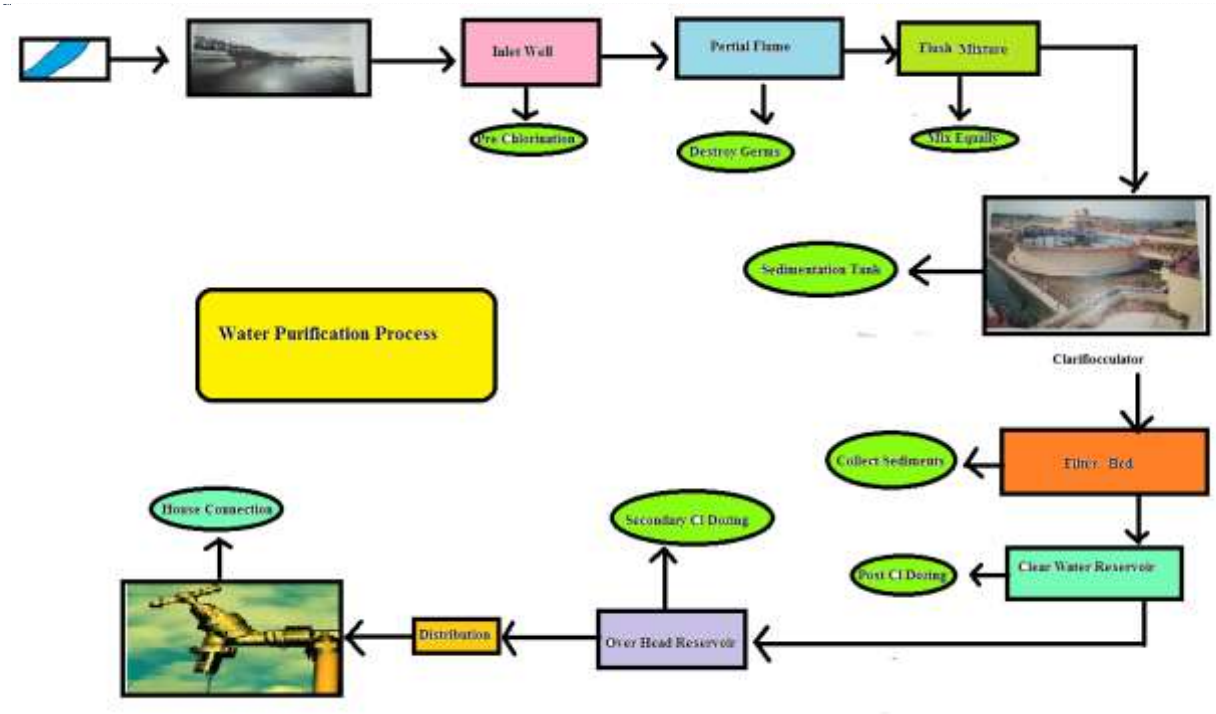

Fig 7: Water Purification Process

VIII. HOUSE HOLD SURVEY REPORT ABOUT THE PLANT

- **Duration of Water Supply-** 9 AM – 11AM in morning and 3.30 PM-5.30 PM in evening
- **Costing –** Free of Cost
- **Quality-** Iron Free and Good Quality. No bad odour
- **Taste-** Normal
- **Service-** Good
- **Service Time-** Daily
- **Force of Water-** Normal
- **Wastage-** No Report

IX. ADVANTAGE

i) **Ground WaterRetention:** Before the installation of this scheme people in this area depended mainly on groundwater. And with the increase of the growth of population per year, the groundwater level was being gradually decreased.At present human beings use surface water excessively. It is expected that the level of groundwater will be increased.It will definitely maintain balance in nature. It is also expected that , the future generation will be greatly benifitted. Groundwater retention, therefore, may be considered as the major advantage if surface water is used largely.

ii) **Flood Control:** Another benefit of usage of surface water is flood control. Flood is a cumulative natural hazard in the flood plain of monsoon in India as well as in Asia. The problem of river flooding is the great concern in West Bengal (State of India).(Sanyal and Lu,2005). Chakdaha Block of Nadia district of West Bengal is situated along the eastern course of Hooghly River. Sinuosity indicates that the eastern side of Hooghly river is very high in comparison to the western side (Goswami, 1983). So Chakdaha is affected by flood almost every year. If the surface water of Hooghly river is widely used, there is possibility of flood control.

iii) **Surface Water Purification:** By surface water treatment plant, surface water of river as well as lake is purified, which is the main moto of Ganga Action Plan. As a follow up, purified water is being used in this area for drinking and other domestic uses. This purified water is also being used in agriculture and so on.

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iv) **Others**

a) Lower operating cost due to low-cost chemical addition.
b) By the distribution of purified water, the quality of life and the hygienic condition in the study area have already improved.
c) Previously, by the huge abstraction of ground water affected the human beings. But, by the use of treated surface water nature and human beings are being saved from pollution.
d) d)The most significant advantage of the system is maintaining sustainable development. The protection of the environment as well as the improvement of the quality of life in the area is ensured.
e) Apert from Arsenic, the odour, turbidity, bacteria and other organic contaminants are removed simultaneously.

X. DISADVANTAGE

i) **Other Metal Contamination:** Baghirathi-Hooghly river of West Bengal is mostly affected by toxic metal contaminants. Many textile industries are situated along the bank of Baghirathi-Hoogly river. High concentration of Cromium (Cr) is mixed in this river (Sanyal et. al,2017).Concentration of Cadmium, Cobalt, Cromium, Copper, Nickel, Lead in the water and sediments of the river Ganga in UP are reported (Subramaniun et. al,1987). Various heavy metals, such as Fe, Mn, Zn, Cu, Cd, Cr, Pb and Ni are found from surface water samples of river Ganga in West Bengal, along with a significant seasonal variation for Fe, Mn, Cd, and Cr (Kar et. al,2008). But in surface water purification plant of the study area, only As, Fe, Mn and F are detected.
ii) **Harmful effect of Alum Dozing:** The use of alum-based coagulant in drinking water has risk effect on consumer health. Besides, alum based coagulant is expensive also (Ghawi,2017). The use of eco-friendly natural coagulant is, therefore, suggested for safe human health.
iii) **iii)Use of Conventional Energy:** In the water purification plant of the study area, thermal energy is used. For this reason, the amount of conventional energy source is decreasing rapidly.
iv) **Lowering Water level of Surface Water:** By the excess intake of surface water for drinking and domestic purpose, the level of surface water may be decreased in future. Sedimentation may also be occurred.
v) **High Maintenance Cost:** The maintenance cost of water purification plant is huge.

XI. RECOMMENDATION

In different states or districts in India, different diversified chemical contaminants are found in different forms in groundwater. The purification process adopting different techniques may cost higher. Hence we may use lentic and lotic as surface water source that may cost less. Hope, this process is likely to be adopted in future course of action. The recommendations are as follows:

i) **Using Natural Coagulant:** The use of alum-based coagulant in drinking water has bad effect on consumer health. So natural coagulant is suggested for water purification, such as *Cucurbita pepo* as a coagulant for Copper removal (Deepthi et. al,2017), *Moringa oleifera* seed for removal of Turbidity and heavy metal (Ghawi, 2017), *Moringa peregrine* seed for removal of Arsenic etc.(Bazrafshan et. al,2013).All these natural coagulants are eco-friendly and they are safe for human health.
ii) **Checking all metal contaminants:** In the study area, only As, Fe, Mn, F etc metals are detected in surface water purification plant but other toxic metal such as Cr, Pb, Zn, Cu etc are not detected in the plant. Naturally, when a consumer drinks the water, he may be affected. So it is suggested that all the metals should be detected in the plant.
iii) **Using other processes of water purification:** In the water purification plant in the study area mainly conventional purification process (Coagulation, Focculation, Rapid gravity filter, Clarification and Disinfection) is done. But there are other processes, like Reverse Osmosis, Membrane Filteration etc. These processes may also be followed.
iv) **Using non-conventional energy:** In the purification plant, mainly thermal energy is used. As a result the amount of source of thermal energy (mainly coal) is being decreased. If the plant uses non-conventional energy (Bio-gas), the source of thermal energy may be saved for future generation as the source of thermal energy is limited.
v) **Using other source of water (Lentic Water) :** The purification plant is mainly based on river Hooghly. But other sources of water source of water such as ponds, sewage water, rain water storage

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etc may also be used. If river water is excessively used, the river may go dry up, and over siltation may be occurred.

vi) **Maintenance:** Maintenance should be done in the purification plant. Proper maintenance of all machines should also be done.

XII. CONCLUSION

The study area is steeped with Arsenic contamination in groundwater. It is really a major problem as it may cause health hazards at any time. In order to prevent this contamination, Surface Water Based Purification Treatment may be done. It is the valuable project of the State Government for Arsenic prevention. A huge number of people of this study area is being benifitted by this plant. But, excessive use of surface water may decrease the water level and there is possibility of occurring siltation. It is, therefore, suggested if the plant uses other sources of water simultaneously, the problem may be overcome

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