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MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION

OCCURRENCE OF HIGH ARSENIC CONTENT IN GROUND WATER
COMMITTEE ON ESTIMATES (2014-15)

FIRST REPORT

SIXTEENTH LOK SABHA

LOK SABHA SECRETARIAT
NEW DELHI

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COMMITTEE ON ESTIMATES

(2014-15)

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MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION

OCCURRENCE OF HIGH ARSENIC CONTENT IN GROUND WATER

Presented to Lok Sabha on the 11 December, 2014

LOK SABHA SECRETARIAT

NEW DELHI

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[*] Elected vide Lok Sabha Bulletin Part-II No. 987 dated 03.12.2014 against the vacancy caused by the appointment of Shri Hari Bhai Chaudhary, Member of Lok Sabha in the Council of Ministers on 09.11.2014.

[†] Elected vide Lok Sabha Bulletin Part-II No. 987 dated 03.12.2014 against the vacancy caused by the appointment of Shri Ram Kripal Yadav, Member of Lok Sabha in the Council of Ministers on 09.11.2014.

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** retired on 30th November, 2014

INTRODUCTION

I, the Chairperson of Committee on Estimates (2014-15) having been authorized by the Committee to submit the Report on their behalf, present this first Report on 'Occurrence of High Arsenic Content in Ground Water'.

2. In India, around 80% of the rural population and 50% of the urban population use ground water for domestic purposes. Water quality issues like arsenic, salinity, nitrate, iron, flouride and heavy metals in water due to geogenic and anthropogenic reasons have been reported from various parts of the country. High arsenic content in ground water affects the human, animal, soil and plant systems. As many as 96 districts in 12 States have been affected by high arsenic contamination in ground water. 70.4 million people in 35 districts alone have been exposed to groundwater arsenic. Over one lakh deaths and 2 to 3 lakhs of confirmed cases of illness have reportedly been caused by groundwater arsenic. It is the duty of the State to improve the public health as enshrined in Article 47 of the Directive Principles of State Policy of the Constitution of India.

3. Over the years, the extent and magnitude of arsenic problem in groundwater has been asuming gigantic proportions. However, no holistic approach and concerted action was visible at the Central level to combat the arsenic issues. It is this lack of integrated approach and co-ordinated action, which prompted the Committee to examine the issue in detail.

4. The Committee's examination reveals that there have been no coordinated efforts to tackle the menace and there is no centralised authority to address the issues concerning arsenic contamination. There are no data from Government sources about the arsenic diseased people, animals and plants. There are gaps in monitoring and also in research efforts. There is no reference to arsenic contamination in National Water Policy 2012. There is no separate budgetary allocation to deal with arsenic issues. The Committee have recommended corrective measures in the report.

5. The Committee took oral evidence of the representatives of the Ministry of Water Resources, River Development and Ganga Rejuvenation on 15 September, 2014 and 13 October, 2014 and of the representatives of the Ministry of Agriculture (Department of Agricultural Research and Education and Department of Agriculture and Cooperation), Ministry of Environment, Forest and Climate Change and Ministry of Drinking Water and Sanitation on 13 October, 2014. The Committee took evidence of the representatives of the Ministry of Science and Technology including CSIR and the Ministry of Health and Family Welfare on 27 October, 2014. The Committee also heard the views of the experts on 22 September, 2014. Besides, the Committee also sought information and suggestions from all the State Governments and Union Territories in connection with examination of the subject.

6. The Committee considered and adopted this Report at their Sitting held on 8 December, 2014.

7. The Committee wish to express their thanks to the representatives of the various Ministries for tendering evidence before them and for furnishing requisite material in connection with the examination of the subject. The Committee also place on record their sincere thanks to the experts who appeared before the Committee besides furnishing written Memoranda desired by the Committee.

8. For facility of reference and convenience, the recommendations/observations of the Committee have been printed in bold in Part – II of the Report.

NEW DELHI;
8 December, 2014
Agrahayana 17, 1936 (Saka)

DR. MURLI MANOHAR JOSHI,
CHAIRPERSON,
ESTIMATES COMMITTEE.

PART – I10

BACKGROUND ANALYSIS

Chapter – I

Extent and Magnitude of Arsenic Contamination

The Indian scriptures attach great importance to the rivers and water bodies. One of the hymns in the Atharvaveda is as follows:

शं न आपो धन्वन्याः शमु सन्त्वनूप्याः।
शं नः स्वनित्रिमा आपः शमु याः कुम्भ आभृताः शिवा नः सन्तु वार्षिकीः।।(I.6.4)

"May the waters of desert be for our well-being; also for well-being the waters of the low lands. May the waters dug out from earth be for our well-being; also be beneficial for us (joy-giving to us)".

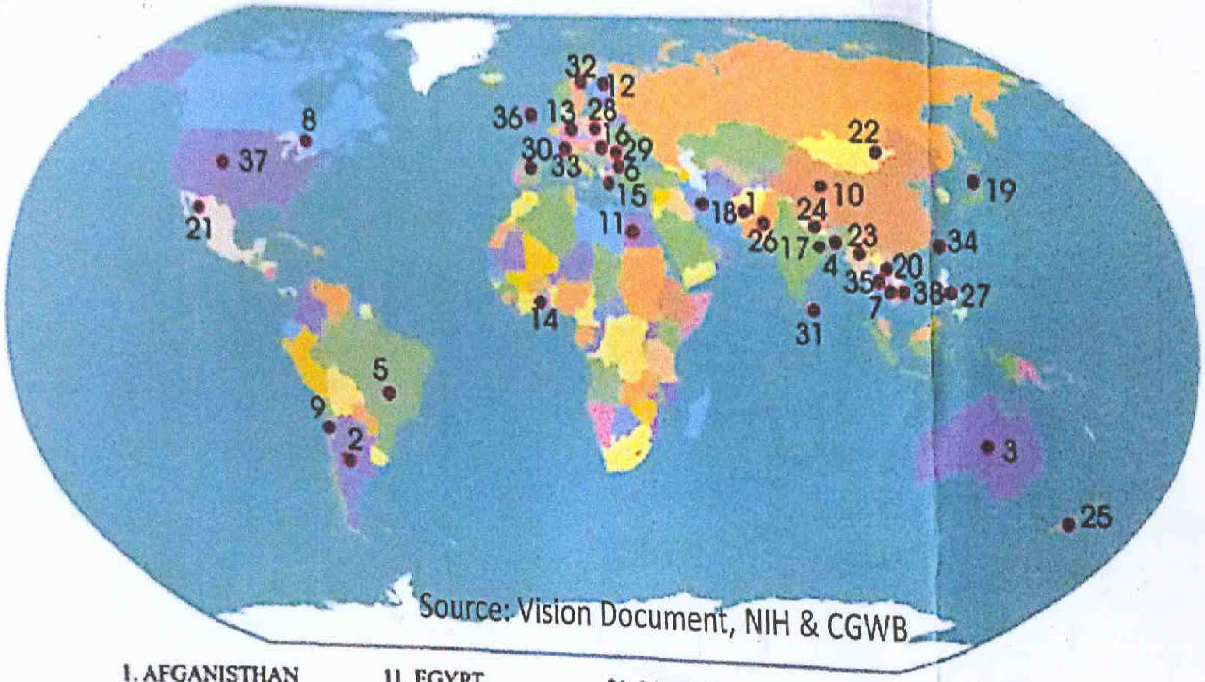
(i) Ground water arsenic contamination

In India around 80 per cent of the rural population and 50 per cent of the urban population use ground water for domestic purposes. Though ground water in major part of the country is potable, geogenic water quality issues like salinity, nitrate, iron, fluoride and arsenic have been reported from various parts of the country.

1.2 The first groundwater Arsenic incident and its health effects in India, according to CSIR were reported in 1976 in the Union Territory of Chandigarh. In 1982, groundwater Arsenic contamination and reports of individuals suffering from arsenicosis emerged in West Bengal. Later on groundwater contamination and the suffering of exposed individuals came to limelight in Bihar (2002), Uttar Pradesh (2003), Jharkhand (2004), and the Upper Ganga Plains of Uttar Pradesh (2009). In the Brahmaputra Plains, Arsenic contamination from Assam and Manipur was also reported between 2004 and 2006. The population of the 35 districts identified with ground water arsenic contamination in these six states is 70.4 million.

Distribution of areas affected by High Arsenic in Ground Water

Global Scenario

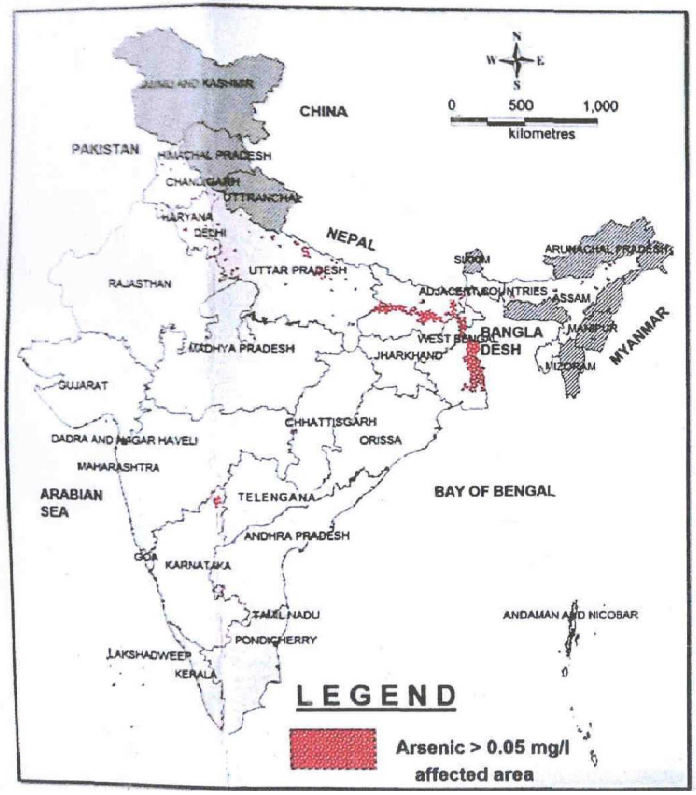


1. AFGANISTHAN
2. ARGENTINA
3. AUSTRALIA
4. BANGLADESH
5. BRAZIL
6. BULGARIA
7. CAMBODIA
8. CANADA
9. CHILE
10. CHINA
11. EGYPT
12. FINLAND
13. GERMANY
14. GHANA
15. GREECE
16. HUNGARY
17. INDIA
18. IRAN
19. JAPAN
20. LAO PDR
21. MEXICO
22. MONGOLIA
23. MYANMAR
24. NEPAL
25. NEW ZEALAND
26. PAKISTHAN
27. PHILIPPINES
28. POLAND
29. ROMANIA
30. SPAIN
31. SRI LANKA
32. SWEDEN
33. SWITZERLAND
34. TAIWAN
35. THAILAND
36. UNITED KINGDOM
37. USA
38. VIETNAM

Distribution of areas affected by High Arsenic in Ground Water

Indian Scenario

Contd...



Sr. No.	States	No of districts where Arsenic contaminated ground water is reported
1	Assam	18
2	Bihar	15
3	Jharkhand	1
4	Chhattisgarh	1
5	Haryana	13
6	Karnataka	2
7	Manipur	2
8	Punjab	6
9	Uttar Pradesh	20
10	West Bengal	8
	Total	86

1.3 The distribution of areas affected by high arsenic in ground water global scenario as well as Indian scenario is brought out in the attached maps. It may be seen that as many as 38 countries including India around the world are affected by arsenic in ground water.

1.4 Accorrding to the Director, National Botanical Research Institute (NBRI), Lucknow (Dr. Chandra Shekhar Nautiyal) arsenic is affecting over 150 million people worldwide through consumption of arsenic contaminated drinking water (Rehman et al . 2009)

1.5 The Department of Agricultural Research and Education (DARE), has stated that arsenic concentration in ground water is of great concern to the world since it affects the soil/plants/animal/human systems. The magnitude is considered to be the highest in Bangadesh followed by West Bengal, India. The scale of the problem is grave and unprecedented, covering a geographic area of 0.173 million square kilometer, while exposing 36 million people in the Bengal delta basin to risk.

1.6 As per the information furnished by the Ministry of Water Resources, River Development and Ganga Rejuvenation (M/o WR, RD &GR), the magnitude of Arsenic contamination in ground water state-wise is as under:

> "(i) West Bengal
> Arsenic contamination status in West Bengal from various studies carried out by different organisation reveals that out of 140150 samples analyzed for arsenic, 48.1% had found arsenic above 0.01mg/L and 23.8% above 0.05 mg/L. Importantly, 3.3% of the analyzed tube-wells had arsenic concentrations predicting overt arsenical skin lesions. A total of 187 (0.13%) had tube-wells were reported highly contaminated (>0.01 mg/L). The maximum arsenic concentration (0.37 mg/L) was found in Ramnagar village of GP Ramnagar II, Baruipur Block, in South 24 Paraganas district. Out of 19 districts of West Bengal 79 arsenic infested blocks in eight districts (Malda, Murshidabad, Nadia, North 24 Paraganas, South 24 Paraganas, Bradhaman, Howrah, Hooghly and Kolkata), have reported more than 3 mg/L arsenic concerntrations in tube-wells.

(ii) Bihar

In 2002, ground water arsenic contamination first surfaced in two villages, Barisban and Semaria Ojhapatti in the Bhojpur district of Bihar in the Middle Ganga Plain. The area is located in the flood-prone belt of Sone-Ganga inter-fluvial region. Investigations by Central Ground Water Board and Public Health Engineering Department, Bihar indicated contamination as hgih as 0.178 mg/L in the surrounding villages, affecting the hand pumps, which are generally at 20-40 m belowground surface. With ongoing study, more and more contaminated districts have surfaced. It was reported (CGWB, 2008) that by the year 2008, out of 38 districts, 15 districts covering 57 blocks are exposed to groundwater arsenic contamination above 0.05 mg/L. These districts are mostly distributed along the course of the river Ganga in Bihar except Darbhanga, Purnea and Kishangarj, which are in isolated and scattered places showing no distinct routes of connection to one-another. It was also predicted that the districts lying in the area where Ganga and other tributaries, originating from the Himalaya, shifted in course of time, would be arsenic contaminated.

(iii) Uttar Pradesh

Groundwater arsenic contamination in UP was first reported in 2003 from survey of 25 villages in Ballia district. Thereafter, with continued survey more districts were detected for arsenic groundwater contamination. 20 districts in Uttar Pradesh were found affected by arsenic groundwater contamination and people suffering from arsenical skin lesions. They used to drink water of hand pump operated tube wells. All those tube wells tap groundwater from shallow aquifer within about 20-30 m depth. Ironically it was interesting to note that, all the arsenic affected districts in Up and 12 districts in Bihar are aligned along the linear track of the river Ganga, so is the position in West Bengal where it is along the river Bhagirathi.

(iv) Jharkhand

During 2003-04, ground water arsenic contamination above 0.05 mg/L was first reported in the Sahibganj district of the Jharkhand, in the middle Ganga plan. Later on (2006-07), it was confirmed by CGWB through detailed investigation. Arsenic contamination is close to the Ganga River and in those areas from where the Ganga River shifted during recent past. The hand pump tube-wells of depth range 25-50 m were reported to be contaminated, and the affected areas had similar geological formations as in adjacent Bihar and West Bengal. The dug wells were reported free from arsenic contamination (CGWB, 2008).

(v) Assam

Ground water arsenic contamination in Assam above 0.05 mg/L was reported and the magnitude was much less compared to Ganga-padma-

Meghna plain. UNICEF reported arsenic contamination from Assam and found arsenic contamination in 18 out of 23 districts of Asam above 0.05 mg/L. No arsenic patient has been identified in Assam so far.

(vi) Manipur

Ground water arsenic contamination situation from Manipur state indicates that mainly valley districts of Manipur are arsenic contaminated. Arsenic has been reported by CGWB in the year 2004-05 in 4 samples of Thoubal and Bishnupur districts of Manipur. The wells have been abandoned as the State water supply depends only on surface water. In Manipur at present people are not using hand tube wells water for drinking, cooking and agricultural purposes. Arsenic patients have not been yet identified from states of Manipur.

(vii) Haryana

Presence of arsenic in ground water has been reported from 13 districts of the State. The concentration of arsenic in ground water has been reported from more than 0.05 mg/L (permissible limit as per BIS) at Koth Kalan, district Hissar to 0.07 mg/L at Nalvikhurd in Karnal district.

(viii) Punjab

In the State of Punjab State occurrence of arsenic in ground water has been found in wide spatial variation in 6 districts with ranges upto 0.4 mg/L at Harike in Amritsar district. Only 12 samples (4.6 %) were found to contain Arsenic above the safe limit of 0.05mg/l (BIS). Mansa, Amritsar, Gurdaspur, Hoshiarpur, Kapurthala, Ropar are the districts where Arsenic contamination above maximum permissible limit has been detected.

(ix) Karnataka

Department of Mines and Geology, Govt. of Karnataka has reported the presence of Arsenic in ground water in Yadgir (old Gulburga) and Raichur district. In Karnataka, Arsenic in groundwater is reported in areas of gold mining and associated activities. The leaching and enrichment of Arsenic is localized and the effect is likely to be more in the proximity of the dumpage in the phreatic aquifer and in bore wells along well defined lineaments passing through the dumpage. As per Rural Development and Panchayati Raj Engineering Department, Govt. of Karnataka, Bangalore, Arsenic free water is being supplied by installing pure drinking water plants.

(x) Chhattisgarh

Presence of high Arsenic ground water (>0.05 mg/L) in Kaurikasa, Joratarai, Sonsaytola, Muletitola & Telitola villages of AmbagarhChowki block of Rajnandgaon district has been reported. The range of Arsenic values in the analysed samples collected from ground water varies from

0.049 to 0.72 mg/L. All the ground water abstraction structures in the above mentioned five villages were not contaminated with high values of Arsenic (i.e. >0.05 mg/L) only a few ground water structures were contaminated by Arsenic. The contaminated well were sealed and alternative water supply arrangements were made."

1.7 The Ministry of Science and Technology (Department of Science and Technology) in a written note on the extent and magnitude of the arsenic contamination stated that the first groundwater Arsenic incident and its health effects in India were reported in 1976 in the Union Territory of Chandigarh. In this first report, it was suggested that the possibility of more wide spread groundwater Arsenic contamination, particularly in the Ganga river basin might be found in the future. In 1982, groundwater Arsenic contamination and reports of individuals suffering from arsenicosis emerged in West Bengal. Later on groundwater contamination and the suffering of exposed individuals came to limelight in Bihar (2002), Uttar Pradesh (2003), Jharkhand (2004), and the Upper Ganga Plains of Uttar Pradesh (2009). In the Brahmaputra Plains, Arsenic contamination from Assam and Manipur was also reported between 2004 and 2006. The population of the 35 districts identified with groundwater Arsenic contamination in these six states is 70.4 million. Out of the over 100,000 individuals screened for arsenicosis symptoms during survey were noted in Arsenic affected states, 9.7% have been registered with arsenical skin lesions. The DST further stated as under:-

"Instances of Arsenic contamination from several hitherto unaffected areas have also been reported from Assam, Uttar Pradesh, Chhattisgarh, Bihar, Tripura, Manipur, Arunachal Pradesh, Nagaland and Jharkhand. According to another study, more than 15 million people face Arsenic contamination in the five states bordering Bangladesh - West Bengal, Tripura, Assam, Mizoram, and Meghalaya. Arsenic levels in ground waters in some parts of Assam, Tripura, Manipur, Nagaland and Arunachal Pradesh was observed to be above 300 ppb (parts per billion).

Arsenic-contamination is reportedly present in 64 districts and 111 blocks of West Bengal. The worst-affected districts of West Bengal are Maldah, Murshidabad, Nadia, North and South 24 Parganas (including parts of Calcutta) and minor adjoining areas of Bardhaman, Hoogly and Howrah. Arsenic concentrations in ground water of the Bengal basin vary widely. In West Bengal, reported concentrations range between 5–4100 µg/L. In Bangladesh, the highest reported concentration is 4730 µg/L.

Out of 12 districts of West Bengal, 9 districts are severely affected by groundwater Arsenic contamination with several orders of magnitude higher Arsenic than the stipulated WHO standard for the permissible limit in drinking water (10 µg L^{-1})….

Several recent surveys have identified drinking water wells with elevated Arsenic concentrations in various parts of the middle Ganges plain, adjoining the river and upstream from the Bengal basin, in the states of Jharkhand, Bihar and Uttar Pradesh. Immediately upstream along the Ganges from Bhojpur in Bihar are the districts of Ballia, Ghazipur and Varanasi in Uttar Pradesh state, where widespread Arsenic contamination has recently been identified. Arsenic concentrations values in Ballia, Varanasi and Ghazipur reported that 46.5% of 4780 wells tested had of ≥10 µg/L.

In 30 villages and towns of Dongargaon, Mohala, and Ambagarh-Chowki of Rajnandgaon district of Chhattisgarh, about 30,000 population is directly exposed to Arsenic and more than 200,000 residents can be put under the category ‘‘at risk,’’ as per WHO guidelines. The village of Kaudikasa in this district which is the worst As-affected village in the entire central India, where the Arsenic levels in ground water is very high at certain points and has even shown a yearly mean of 3050 ppb at one particular hand pump.

Several studies suggested that the groundwater Arsenic contamination is mostly restricted to the alluvial aquifers of the Ganges delta comprising sediments carried from the sulphide-rich mineralized areas of Bihar and elsewhere surrounding the basin of deposition. However, recent studies indicated that the vast tract of Indo-Gangetic alluvium extending further to the west and the Brahmaputra alluvium have elevated concentrations of Arsenic in wells placed in the late Quaternary and Holocene aquifers.

Many areas within the North-eastern states of India with Arsenic concentration greater than 50 ppb have been reported. This implies that millions of people are at serious risk of poisoning by As. In 2007, it was reported that the Arsenic levels in many parts of Assam, Manipur, Tripura and Arunachal Pradesh were above 300 parts per billion (ppb).

A survey, conducted by the Assam state PHE department in collaboration with UNICEF for over a period of three years, found Jorhat district to be one of the worst Arsenic hit areas among the 17 districts in the state with high Arsenic contamination in the ground water. In Titabor subdivision of Jorhat district, comprising of 20 gaon panchayats, it is reported to have lethal levels of Arsenic in the groundwater.”

1.8 State-wise levels of arsenic contamination in ground water and the year of their detection as furnished by the M/o WR, RD & GR is as follows:

Sl. No.	State	Year of Detection	No. of Affected Districts	Level of Arsenic Contamination (in mg/l)
1	West Bengal	1983	08 districts	Up to 3.000*
2	Bihar	2002	15 districts	Up to 0.178
3	Uttar Pradesh	2003	20 districts	Up to 0.150
4	Jharkhand	2003	01 district	Up to 0.090
5	Assam	2003	18 districts	Up to 0.996
6	Manipur	2004	02 districts	Up to 0.500
7	Haryana	2003	13 districts	Up to 0.070
8	Punjab	2003	06 districts	Up to 0.400
9	Karnataka	2009	02 districts	Up to 1.000
10	Chhattisgarh	1999	01 district	Up to 0.720
		Total	86 districts	

* The Ministry of Water Resources, River Development & Ganga Rejuvenation in a note mentioned that the level of contamination was more than 3 mg/l.

1.9 As per the information furnished by Ministry of WR, RD & GR, presence of high arsenic in ground water has been reported from various districts of States as indicated below:

Sl. No.	Name of the State	Districts partly affected by arsenic in ground water (above 0.05 mg/l)
1	Assam	Sivsagar, Jorhat, Golaghat, Sonitpur, Lakhimpur, Dhemaji, Hailakandi, Karimganj, Cachar, Barpeta, Bongaigaon, Goalpara, Dhubri, Nalbari, Nagaon, Morigaon, Darrang and Baksha.
2	Bihar	Begusarai, Bhagalpur, Bhojpur, Buxar, Darbhanga, Katihar, Khagaria, Kishanganj, Lakhisarai, Munger, Patna, Purnea, Samastipur, Saran and Vaishali
3	Jharkhand	Sahibgunj
4	Chhattisgarh	Rajnandgaon

5	Haryana	Ambala, Bhiwani, Faridabad, Fatehabad, Hissar, Jhajjar, Jind, Karnal, Panipat, Rohtak, Sirsa, Sonepat and Yamunanagar
6	Manipur	Vishnupur, Thoubal
7	Punjab	Mansa, Amritsar, Gurdaspur, Hoshiarpur, Kapurthala and Ropar
8	Uttar Pradesh	Bahraich, Balia, Balrampur, Bareilly, Basti, Bijnor, Chandauli, Ghazipur, Gonda, Gorakhpur, Lakhimpur Kheri, Meerut, Mirzapur, Muradabad, Raebareli, Santkabir Nagar, Shajahanpur, Siddharthnagar, Unnao, Sant Ravidas Nagar
9	West Bengal	Bardhaman, Hoogly, Howrah, Malda, Murshidabad, Nadia, North -24 Parganas and South -24 Parganas
10	Karnataka	Raichur and Yadgir

1.10 The Ministry of Agriculture (Department of Agricultural Research and Education) (DARE) listed out 71 districts in 09 states as shown below having ground water arsenic contamination.

State	Districts	Number of Districts affected
West Bengal	Murshidabad, Maldah, Nadia, North 24 Paraganas,South24Paraganas,Bardhaman, Howrah, Hoogly, Kolkata, Coochbehar, North Dinajpur, and South Dinajpur	12
Assam	Sivsagar, Jorhat, Golaghat, Sonitpur, Lakhimpur, Dhemaji, Hailakandi, Karimganj, Cachar, Barpeta, Bongaigaon, Goalpara, Dhubri, Nalbari, Nagaon, Morigaon, Darrang and Baksha.	18
Bihar	Bhagalpur, Khagaria, Munger, Begusarai, Lakhisarai, Samastipur, Patna, Baishali, Saran, Bhojpur, Buxar and Katihar	12
Jharkhand	Sahibgunj	01
Uttar Pradesh	Ballia, lakhimpur, Kheri, bahraich, chandauli, ghazipur, Gorakhpur, basti, Siddarthnagar,	21

	Balrampur, sant Kabir Nagar, Unnao, bareilly, Moradabad, Raebareli, Mirzapur, bijnore, Meerut, Sant Ravidas Nagar, Shajahanpur and Gonda	
Chhattisgarh	Rajnandgaon	01
Manipur	Thoubal	01
Tripura	North Tripura, Dhalai and West Tripura	03
Nagaland	Mokokchung and Mon	02
Total no of districts affected.		71

1.11 It may be observed from the Tables given above as furnished by the M/o WR, RD & GR and DARE that there are huge differences in the data regarding number of districts and states affected by arsenic contamination in drinking water. While according to M/o WR, RD & GR, there were 86 affected districts in 10 States, as per DARE, there were 71 affected districts in 9 States. Collation of information furnished by the M/o WR, RD & GR and DARE reveals that the number of districts affected are 96 spread over 12 States.

1.12 Dissatisfied with differences in information furnished by different Ministries, the Committee sought clarification as to why the DARE did not have complete list of arsenic affected areas and whether there was no sharing and uploading of information among the Ministries / organizations concerned for taking appropriate measures. In response, DARE stated that the information of arsenic affected areas was obtained from the official website of the ministry of water resources (www.mowr.gov.in /forms/list.aspx?lid=327) which is in the public domain. Three states namely Haryana, Punjab and Karnataka have recently been added in the list but not uploaded in the website. Therefore, the Arsenic contamination in different districts of these three states has inadvertently been missed out.

1.13 Expressing concern about absence of reliable data, the Committee enquired as to why there is no centralized data available regarding the number of people affected by arsenic contamination and the nature of their disease. Responding to the query, the M/o WR, RD and GR stated that as per information received Ministry of Drinking Water &

Sanitation (MoDWS), data regarding nature of their disease pertains to Ministry of Health and Family Welfare. However, MoDWS has a centralized system to report arsenic contamination in drinking water on IMIS (Integrated Management Information System) of the Ministry. There are 1991 arsenic affected habitations in the country which are yet to be provided safe drinking water, wherein 29,45,091 number of people are at risk due to excess arsenic problem in drinking water as reported by States on IMIS of the Ministry as on 01/04/2014. The system of reporting drinking water contaminations including arsenic through IMIS of the Ministry is in vogue since the year 2009.

1.14 The Committee also sought information from the States and UTs regarding the extent of arsenic problem in their State/UT, its impact on agriculture crops/vegetables, details of steps/schemes for addressing the problem and their views/suggestions to improve the performance. Response from some of the States was received. The States of Daman & Diu and Dadra & Nagar Haveli, Kerala, Puducherry, Chandigarh, Rajasthan, Meghalaya, Andhra Pradesh and Manipur have stated that arsenic was not found in the ground water sources in their State. However, information from State of Assam revealed that arsenic was first detected in 2004. The total arsenic affected habitations within the State are 2570 number in 20 districts of Assam .Regarding measures to address the same, it was stated that the addressal measures in affected habitations is carried out by the Department by providing drinking water through adopting alternative.safe source like implementation of Piped Water Supply or ring wells as per feasibility. The information furnished by Assam Government also revealed that a total of 2147 number of arsenic habitations have been provided with alternative safe sources, like PWSS from surface source on ring wells with a back up of by PWSS 1201 number habitations and by spot sources 946 habitations.

(ii) Contamination of soil and vegetation

1.15 In the arsenic affected areas the water used from tubewells for irrigation is often arsenic contaminated. When arsenic contaminated ground water is used for crops irrigation, a part of this arsenic becomes incorporated into the food chain. It has been

reported that food is the second largest contributor of arsenic intake by people after direct ingestion of arsenic contaminated water.

1.16 In a joint memorandum submitted to the Committee, two experts (Dr. C.S. Nautiyal, Indian Institute of Tropical Research and Dr. R.D. Tripathi, Senior Principal Scientist, NBRI) stated that it is important to find out arsenic contamination levels in irrigation groundwater sources and related agricultural fields under paddy cultivation in geographical areas of India, like the Indo-Gangetic Plains (IGP) and Ganga-Meghna-Brahmputra basin and stated that groundwater extraction from tubewells for irrigation is adding large quantities of arsenic every year (around 1000 tonnes) in agricultural fields, resulting in high build-up of arsenic in soils and subsequent accumulation in crops and vegetables.

1.17 Citing that West Bengal, Jharkhand, Bihar and some districts of Uttar Pradesh as the main affected areas of arsenic contamination in ground water, the above mentioned experts stated in their memorandum that the groundwater, which was found unsafe for drinking water purposes in UNICEF survey during 2005, is continuously in use for irrigation of agricultural fields in the same region.

1.18 In a study conducted by CSIR-NBRI, samples of irrigation groundwater, paddy soil and paddy plant parts were collected from the eighteen blocks of the five administrative districts of Uttar Pradesh located in the Indo-Gangetic plains of Northern India. The field study revealed high variation in arsenic contents in water samples of the five districts (**Appendix – I**). The results showed that the irrigation groundwater has arsenic contents ranging between 0 and 312. The arsenic content in 'irrigation groundwater' is much higher than the recommended threshold limit for irrigation water.

1.19 In paddy soil, the Arsenic content ranged from 3 – 35 mg kg^{-1}. The Arsenic contents in the soil of the studied region showed that the values of Arsenic exceeded the typical world content, i. e. 5 mg kg^{-1} at most of the study sites. These sites were covering 26% of total soil samples of the study. Among these 17 villages; 2 are from

Dist. Ghazipur (Blocks: Jamania and Reotipur), 6 from Dist. Bahraich (Blocks: Phakharpur and Tejvapur), and 9 from Dist. Ballia (Blocks: Maniyar, Bairiya, Revati and Belhari). Srivastava and Sharma (2013) have also revealed 5-15 mg kg^{-1} of arsenic content in soil samples of the studied region and found contaminating locally grown sensitive crops (like beans, tomato, spinach, etc.). A significant ($p<0.5$) correlation was observed between arsenic contents in irrigation groundwater and paddy soils.

1.20 The uptake of arsenic in different paddy plant parts are exhibited in **Appendix – II**. Results indicated that the accumulation of arsenic (mg kg^{-1}) was in the roots (4.1 to 16.2) and in the grains (0.179 to 0.932). Seventeen paddy varieties have been found as commonly grown varieties in the study region. Out of these 17 paddy varieties, higher arsenic contents in grains (>0.5 mg kg^{-1}) were found in nine paddy varieties namely, Swarana sub-1, Kasturi, Sarjoo-52, Arize 6444, BPT-3291, Varadhan, IPB-1, Sugandha-4/Pusa-1121 and revealed that these varieties are more susceptible to high arsenic content in soil and accumulating comparatively higher arsenic in their grains. None of the samples of paddy grains exceeded recommended threshold limit of 1.0 mg kg. But, these eight paddy varieties were containing grain arsenic content unsafe for subsistence maximum daily tolerable dietary intake by human (Williams et al. 2005). The arsenic content in roots showed significant differences among paddy varieties, which showed an order of highest to lower as Bengal Juhi> Kalanamak> IPB-1> BPT-5204> Arize-6444> NDR-359. While, grain arsenic contents of Bengal Juhi, Kalanamak, NDR-359 and BPT-5204 were found in comparable low arsenic category and can be considered as low grain arsenic accumulating safe paddy varieties according to (Williams et al. 2005) (**Appendix – III**). There were significant varietal differences ($p<0.05$) in the arsenic contents contained in paddy plant parts were observed among all 17 paddy varieties grown in the studied region.

1.21 Council for Scientific and Industrial Research (CSIR), in a note on the subject stated that in a study, CSIR-NBRI monitored water and soil samples from three districts of West Bengal viz. Chinsurah (district Hooghly, latitude $22^0$53'N, longitude 88^0 24'E). Purbosthali (District Bardhaman latitude $23^0$15'N, longitude $87^0$45'E) and Birnagar

(district Nadia, latitude 22^0 53^0-24^0 12'N, longitude $88^0$01'-$88^0$48'E). The level of As in groundwater was found in the order Chinsurah < Purbosthali < Birnagar as 17, 27 and 53 µg l^{-1}, respectively. The soil As concentrations were positively correlated with the groundwater level and were 10.4, 12.6 and 15.5 µg g^{-1} respectively at these sites.

1.22 In another study conducted by CSIR-National Botanical Research Institute (CSIR-NBRI), samples of irrigation groundwater, paddy soil and paddy plant parts were collected from the eighteen blocks of the five administrative districts of Uttar Pradesh located in the Indo-Gangetic plains of Northern India. The field study revealed high variation in Arsenic contents in water samples of the five districts. The results showed that the irrigation groundwater has Arsenic contents ranging between 0 and 312 µg l^{-1}. The Arsenic content in irrigation groundwater is much higher than the recommended threshold limit for irrigation water (50 µg l^{-1}). The highest Arsenic content was recorded in the Belhari Block of Dist. Ballia (312 µg l^{-1}). The Arsenic contents (>100 µg l^{-1}) in waters were observed in the order Phakharpur (Bahraich) > Maniyar (Ballia) > Revati (Ballia) > Bansdeeh (Ballia) > Reotipur (Ghazipur) > Bairiya (Ballia) > Jamania (Ghazipur) > Saidpur (Ghazipur) > Belhari (Ballia) > Palia (Lakhimpur-Kheri) > Tejvapur (Bahraich) >Campieerganj (Gorakhpur) > Murlichhapara (Ballia) > Dubhad (Ballia) > Huzoorpur (Bahraich) > Jarwal (Bahraich) > Karanda (Ghazipur) > Issanagar (Lakhimpur-Kheri). Of the total water samples; 67% ranged between 100 and 200 µg Arsenic l^{-1}) and 15% above 200 µg Arsenic l^{-1}. In paddy soil, the Arsenic content ranged from 3 – 35 mg kg^{-1} (Fig. 2). The Arsenic contents in the soil of the studied region showed that the values of Arsenic exceeded the typical world content, i. e. 5 mg kg^{-1} at most of the study sites. These sites were covering 26% of total soil samples of the study. Among these 17 villages; 2 are from Dist. Ghazipur (Blocks: Jamania and Reotipur), 6 from Dist. Bahraich (Blocks: Phakharpur and Tejvapur), and 9 from Dist. Ballia (Blocks: Maniyar, Bairiya, Revati and Belhari).

Arsenic in food chain

1.23 The vision document entitled, "Mitigation and remedy of Ground Water arsenic menace in India" has pointed out that in the arsenic-affected areas the water used from tube wells for irrigation is often arsenic contaminated and when arsenic contaminated groundwater is used for crops irrigation, a part of this arsenic becomes incorporated into

the food chain. Many investigators consider water-soil-crop-food transfer, cooking water, and direct ingestion of arsenic contaminated water as the major exposure pathways of arsenic. Over 75% of this arsenic present in the crops is inorganic in nature. Arsenic gathers first of all in the roots, then in the stem and after that in the crop proper.

1.24 The Vision document further states that effects of this occurrence are far-reaching. First, as the people take in contaminated water along with contaminated food, the chances of damage become greater. Secondly, the food crops are sold off to other places, including uncontaminated regions where the inhabitants may consume arsenic from the contaminated food. Thirdly, the domestic animals, like cattle etc. in arsenic-affected areas regularly take in arsenic along with their drinking water and food, like straw. If human beings consume the meat from such infected animals, they may consume arsenic as well. A full-grown cow eats 10-12 kg straw and drinks 30-40 litres of water per day. From this example, it is possible to calculate how much arsenic cattle consume every day. Almost all of Southeast Asia uses rice as its staple food. Due to irrigation with contaminated water, rice grains could have excessive amounts of arsenic. According to a leading scientist, this contamination of rice with arsenic may give rice to a new danger in the South-East Asia.

1.25 The Chairman, Arsenic Task Force, Government of West Bengal (Dr. K.J. Nath) during personal hearing stated as under:

> "In West Bengal and in other States of Bihar and UP where agricultural crop is being irrigated with arsenic contaminated water, there is a serious danger. An agricultural university has carried out with our request a study and it has been found that in some of the agricultural crops arsenic contamination has been found. Even in the rice grains and things like that. A Study is being conducted in consultations with British Scientists to see whether we can develop a particular type of grains where the off-take of arsenic would be minimal. But as such the danger is there and we are studying the problem. I must say that at the moment we have no readymade solution to the same. But first of all, as I said, we have to change our irrigation practice in agriculture. Profligate use of water is not necessary for most of the agricultural crops. If you restrict water use to certain extent then only it is possible. That study is also being done by

various agricultural scientists. There are various alternatives but it is a very serious issue and it should be looked into.''

1.26 Pointing out that more than 90% of the total ground water is used for irrigating the crops in arsenic affected areas, the Department of Agriculture and Education (DARE) stated that the results of ICAR Network project revealed that the arsenic levels are generally prohibitive in ground waters at shallow depths of <125 ft. The surface water (ponds, shallow wells) and groundwater at greater depths (>250ft) usually did not contain arsenic at toxic level. As more than 90% of the total groundwater is used for irrigating the crops in the affected areas, there are substantial accumulations of arsenic in the crop produce. The accumulation in crops was more in soils with high contamination. The boro or summer rice using large quantities of underground water during lean season contained more arsenic than Kharif rice. The boro or summer rice using large quantities of underground water contained more arsenic than Kharif rice.

1.27 DARE further stated that it is reported that crops like elephant-foot-yam, green gram, cowpea sesame, groundnut, etc. tended to show a build-up of arsenic in substantial quantities in different plant parts. A number of vegetables, namely cauliflower, tomato, bitter gourd, pointed gourd plant parts. A number of vegetables, namely cauliflower, tomato, bitter gourd, pointed gourd were also noted to accumulate arsenic in their economic produce. The distribution of arsenic content in plant parts generally followed the order: root>stem>leaf>economic produce.

1.28 The edible parts of leafy (spinach, fenugreek etc.) and underground vegetables (beet, radish etc.) contained much higher arsenic as compared to vegetables with fruit as edible part (brinjal, beans, ladies finger, tomato etc.). In general, fruit/grain of plants showed less accumulation of arsenic compared to root, stem and leaf. Arsenic intake by animals was low through drinking water and more through feed sources.

(iii) Sources of arsenic contamination

1.29 Arsenic is a naturally occurring element, comprising an average concentration of approximately 0.0002% of the earth's crust. Arsenic, derived from the Greek word

Arsenikon, meaning ‘’potent ‘’ – has been used as a curative as well as a poison. In historical times, arsenic and its derivatives were used to treat diseases like ulcers, cancer and syphilis.

1.30 Occurrence of arsenic in ground water is attributed to geogenic as well as anthropogenic causes. Due to various Physio chemical processes, arsenic is released into ground water from Arsenic bearing minerals present in the aquifer. There are two hypotheses for arsenic in ground water.

(i) Due to oxidation of arsenic bearing pyrite minerals which leads to release of soluble Arsenic in ground water

(ii) Due to the reducing condition, dissolution of arsenic bearing minerals like iron oxy hydroxides within the aquifer/ formation

(iii) Arsenic contamination in ground water is generally found in younger alluvium of Ganga Brahmaputra alluvium plains and deltaic parts.

Anthropogenic (Manmade) activities causing arsenic contamination are:

(iv) Application of fertilisers

(v) Industrial and mining activities

(vi) Burning of coal and leaching from coach ashes etc.

(vii) Anthropogenic contamination is localised in occurence.

1.31 A Vision Document on ‘Mitigation and Remedy of Groundwater arsenic menace in India’ brought out by National Institute of Hydrology, Roorkee and Central Ground Water Board has stated that widely accepted mechanisms of arsenic mobilization in groundwater are still to be established. However, based on arsenic geochemistry, three hypotheses describing probable mechanisms of **As** (arsenic) mobilization in groundwater specially, with reference to Holocene aquifers like in West Bengal and Bangladesh, have been suggested (Bose and Sharma, 2002). These are:

(i) Mobilization of arsenic due to the oxidation of **As**-bearing pyrite minerals: Insoluble **As**-bearing minerals, such as Arsenopyrite (FeAsS), are rapidly oxidized when exposed to atmosphere, realizing soluble As(III),

sulfate(SO_4^{2}), and ferrous iron (Fe^{2+}). The dissolution of these **As**-containing minerals is highly dependent on the availability of oxygen and the rate of oxidation of sulfide. The released As(III) is partially oxidized to As(V) by microbially mediated reactions. The chemical reaction is given by:

$FeAsS + 13Fe^{3+} + 8H_2O$ ----> $14Fe^{2+} + SO_4^{2-} + 13H^{+} + H_3AsO_4$ (aq.)

(ii) Dissolution of **As**-rich iron oxyhydroxides (FeOOH) due to onset of reducing conditions in the subsurface: Under oxidizing conditions, and in the presence of **Fe**, inorganic species of **As** are predominantly retained in the solid phase through interaction with FeOOH coatings on soil particles. The onset of reducing conditions in such environments can lead to the dissolution of FeOOH coatings. Fermentation of peat in the subsurface releases organic molecules (e.g., acetate) to drive reducing dissolution of FeOOH, resulting in release of Fe^{2+}, As^{+3}, and As^{+5} present on such coatings. The chemical reaction is given by:

$8FeOOH\text{-}As_{(s)} + CH_3COOH + 14H_2CO_3$ ----> $8Fe^{2+} + As_{(d)} + 16HCO_3 + 12H_2O$

where $As_{(s)}$ is sorbed As, and $As_{(d)}$ is dissolved As.

(iii) Release of **As** sorbed to aquifer minerals by competitive exchange with phosphate (H_2PO_4) ions that migrate into aquifers from the application of fertilizers to subsurface soil.

1.32 According to the aforesaid vision document, the second mechanism involving dissolution of FeOOH under reducing conditions is considered to be the most probable reason for excessive accumulation of arsenic in groundwater.

1.33 Pointing out that early explanations regarding arsenic in the ground water were false and that the arsenic is released as a result of reduction, not oxidation, the expert from IIT, Kanpur (Prof. Saumyen Guha) stated in his memorandum as follows:

> "Initially, experts believed that due to over exploitation of groundwater, the sulphide minerals (such as arsenopyrite or arsenic containing pyrite)

present in the aquifers were getting exposed to the air (brought in through the well) and oxidation of the pyrite were releasing the arsenic to the groundwater. While this was a plausible explanation, the problem was these minerals were rarely found in the Quaternary sediments of the regions affected by the high arsenic content in the groundwater. Also, if the arsenic was released due to oxidation of minerals, all the arsenic in the ground water will be in the oxidized state, i.e. As(V). In the affected region, about 50-60% of the arsenic was found in the reduced state, i.e., As(III). Therefore, an alternate explanation was necessary. Ours and some others work has shown that these early explanations were false and the arsenic is released as a result of reduction, not oxidation, barring a handful of select pockets.

On the sediments of the affected regions, the arsenic was mostly bound as 'inner sphere complex' in the amorphous iron oxyhydroxides precipitates. The rivers mobilized the arsenic from the source minerals in the upper reaches and they were deposited on the downstream sediments in the oxidizing environment because these sediments were exposed at the surface at that period of formation of this aquifer. This also explained why the arsenic was found in the lower reaches of the Ganges.

Since the arsenic was precipitated onto the sediments alongwith iron in the oxidizing environment it required reductive dissolution of iron to release the arsenic back into the groundwater. We have shown through specially designed field work that even though arsenic may be present on the sediment, it would not be released into the groundwater until the redox condition becomes iron-reducing. The large-scale setting in of reducing environment in the aquifer may have been triggered by enriched organic content in the aquifer from increased agricultural activities."

1.34 The Secretary, Department of Agriculture & Cooperation, Ministry of Agriculture informed that the lowering of water table due to pumping introduces oxygen into the water table which causes the breakdown of pyrites and releases arsenic, iron and sulphate into the water. When asked, how then arsenic is found in areas where there is no presence of pyrites like in U.P., the Secretary, Agriculture stated that there is no evidence to check this, still it is only a hypothisis.

The expert (Prof. Saumyen Guha) in this connection stated as under:-

"There are two things here. One is Arsenic chemistry as to why it is there. The earlier thinking was that Arsenopyrite is there and as you know Arsenopyrite is in the reduced form. It is mostly either Arsenopyrite or Arsenic-containing pyrites. There is a subtle difference between these two, and it is going to come out only when the pyrite mineral is oxidized

because it is a sulphide deposit. But what happened here is actually reduction. Here, Arsenic is bound as an inner-sphere complex in the Iron-oxide or Iron-oxyhydroxide precipitate on the sediment, and now it is well established.

When the agricultural activity increased in 1960s, all the agricultural lands were turned from one-crop land to three-crop land or in some places two-crops land, and there was huge amount of organic shower and then what happened is this. The redox ladder goes into action. Firstly, bacteria prefer Oxygen for respiratioin. If Oxygen runs out when you have organic material, then Nitrate is still there; when Nitrate runs out, then you have got Manganese; but there is no Manganese in these soil. So, it comes to Iron reduction and as soon as that happens, as arsenic was precipated as Iron oxyhydroxide, when you have Iron reduction, essentially Iron goes back into the solution and Arsenic that was bound goes back into the solution".

1.35 Sources of arsenic as explained in article jointly brought out by P. Bhattacharya (IITH Royal Institute of Technology Stockholm), A. Mukherjee (IIT, Kharagpur) and AB Mukherjee (University of Helsinki) submitted by Dr. Abhijeet Mukherjee (IIT, Kharagpur) are given below:

"Natural Sources

Arsenic in the alluvial plains and delta sediments of the Ganges-Brahmaputra-Meghna river system can be attributed to their potential provenance from the Himalaya Mountains and the Shillong Plateau. In addition, several isolated geological sources within the cratons in Peninsular India have been recognized in India, which may have contributed to this wide-scale arsenic contamination, as primary or secondary provenances. These are:

(a) the Gondwana coal seams in Rajmahal basin in eastern India (arsenic: 0.02%);
(b) Bihar mica-belt in eastern India (arsenic concentration ranges from 0.08 to 0.12%);
(c) Pyrite bearing shale from the Proterozoic-aged Vindhyan range containing in central India 0.26% arsenic;
(d) Son river valley gold belt in eastern India contains arsenic with average concentration of 2.8%;
(e) Isolated outcrops of sulfides in eastern Himalayas contain 0.8% arsenic

Probable connection to the Himalayan origin

The most extensive, as enriched provinces in the world are located in the foreland and other basins related to the Himalayan orogenic belt. The As

affected areas include the alluvial basins of the rivers Indus (Pakistan), Ganges and Brahmaputra (India and Bangladesh), Meghna (Bangladesh), Irrawady (Burma, presently Myanmar), Mekong (Cambodia and Thailand), and Red (Vietnam). Several workers suggested that the Siwalik Group, which acts as the immediate provenance of the Himalayan sediments, are the probable reservoir of the As. These sediments are transported downstream by the Indus-Ganges-Brahmaputra river systems.

However, Siwaliks cannot be the primary source of As, as it corresponds to a detrital foreland deposit that is being eroded away to modern foreland basins, and at most, might act as a secondary sink. This indicates that the orogenesis of the Himalaya is the main cause of high As groundwater in southeast Asia. There are two different schools of thoughts about the primary and secondary provenance of As in the various alluvial systems in the Himalayan foreland:

(a) the Quamdo-Simao (QS) volcanic and ophiolite province located north of the Namche Barwa syntaxis near Indo-Myanmar border, is the original source of As, and were transported during the Miocene toward the Siwalik foreland basin.
(b) the ophiolites in the Indus-Tsangpo suture zone is the original source of As, feeding the Siwalik Group during the Miocene and Pleistocene, before being removed by extensive weathering during the Holocene.

The combination of this strong tectonic activity in the Himalayas and a more humid climate during the Holocene probably lead to the sequential removal of As stored in the Siwalik sediments and its transportation by the Ganga-Brahmaputra river-system towards the Bay of Bengal, through the North Indian plain.

Anthropogenic Sources

There is dearth of information on contaminant contribution through anthropogenic sources in India. Several high temperature process, such as pyrometallurgical, non-ferrous metal mining and production, iron and steel manufacturing and coal combustion release arsenic to the environment. The probable contribution of arsenic from process industries depends on several factors: (a) the mineralogical composition of ore; (b) physiochemical properties of associated major and trace metals; (c) production technology and the efficiency of gas cleansing equipments. In addition, arsenic may be released to the hydrologic system from cement production, burning of wastes, and chemical industries in India.

High arsenic concentrations are reported in the mining areas of Rajasthan in western India, especially around the mining areas of Khetri Copper Complex and Zawar mines in Jhunjhunu and Udaipur districts respectively. In Bihar

belt, there are many open pit mines from where sulfides bearing copper and lead ores are mined. These ores contain arsenic in trace amounts, which, if mobilized, may significantly contaminate the groundwater resources. In addition, India is the third largest hard coal producer in the world; the coal mining area covers some 855 km2 and the total coal mines is 572 in 2004. Hence, coal mines are also a potential source of arsenic emission and the average concentration of arsenic in Indian coal ranges up to 0.15 – 40 mg kg-1. India produces over 100 million tons of coal fly ashes and the major part is dumped in the close vicinity of the plant sites. Concern has been raised due to leaching of arsenic during coal washing, combustion and ash.

Fertilizers and various pesticides, insecticides, herbicides, and fungicides often contain high concentration of arsenic and their widespread use are known to cause considerable groundwater contamination especially in the agricultural states of India such as documented in Punjab, Andhra Pradesh, Haryana, Karnataka, Tamilnadu, West Bengal, and Uttar Pradesh."

1.36 The Chairman, Arsenic Task Force, Government of West Bengal (Prof. K. J. Nath) in a note submitted to the Committee on 'Arsenic contamination of Ground Water: A critical threat to community health', submitted as follows:

"Though there have been localized causes of arsenic contamination due to anthropogenic factors like dumping of industrial waste, containing high amount of arsenic, the present crisis in the Indian sub-continent is due to geo-morphological reasons. Although arsenic occurs in alluvial sediments the ultimate origin of the arsenic must be in the outcrops of hard rocks higher up the Ganges catchment that were eroded in the recent geological past and then re-deposited in West Bengal and Bangladesh by ancient courses of the Ganges. At present, these source rocks have not been identified. It is also important to understand that arsenic does not occur at all depths in the alluvial sediments. Although there is not enough evidence to draw firm conclusions, it appears that high concentrations are restricted to the upper 150 meters of the alluvial sediments and offers prospects of obtaining arsenic free waters from deeper layers.

The mechanism of dissolution and desorption of arsenic from soil sediments to the ground water is not well understood. The most widely accepted theories include.

- Oxidation of arsenopyrite or arsenic-rich pyrite minerals (oxidation hypothesis)
- Reduction of arsenic-rich iron-oxyhydroxides (reduction hypothesis)

The most important ores of arsenic are arsenic pyrites, realgar and orpiment. The average concentration of arsenic in alluvial sand and clay has been reported to be 2.9 mg/kg and 6.5 mg/kg respectively in Bangladesh. There have been also reports of much higher concentration arsenic in soil from parts of Bangladesh and other countries. But the concentration of arsenic in ground water is not always dependant or proportional to the amount of arsenic in soils. Geochemistry of the soil and the environmental condition prevailing underground would have significant influence on the arsenic speciation and mobility. The dissolution & desorption of arsenic from sediments and reduction of pentavalent arsenate to trivalent arsenite, which is more mobile appear to be the most likely mechanism of ground water contamination in the Ganga Brahmaputra basin in Bangladesh & India. Having said this one should not also loose sight of the microbial and chemical reaction underground influenced by the agricultural and irrigational practices, use of phosphatic fertilizer and profligate use of ground water. It has also been reported by a group of scientists in India that due to heavy withdrawal of ground water, the aquifer was aerated and the pyrites rich in arsenic got oxidized which helped leeching of arsenic in soluble form in ground water. Many attribute the cause of arsenic concentration to the profligate use of ground water to support the "Green Revolution" since the 1960s, but there is no scientific evidence so far to support the theory. Though switching over from rain-fed cultivation to four-crop cycle with irrigation facility, supported by shallow bore wells had definitely disturbed the water table and ground water quality."

1.37 During personal hearing on 22 September, 2014, when asked as to why, along the running water in Indo Gangetic plain, there is more arsenic rather than in the rocky places, the expert from IIT Kharagpur (Dr. Abhijeet Mukherjee) stated as under:

"Sir, we have a hypothesis that recently got published and what we believe is that the source of the arsenic lies in the Himalayas and Shivalik Hills. The reason for presence of high arsenic in the sediments of Shivalik Hills is because the way the Himalaya was formed, there are some natural processes by which elements like arsenic and selenium come to the surface, and it is in geologic foreland basins. These foreland sediments which include our Indo-Gangetic Plain, gets enriched with arsenic carrying sediments from the Himalayas as the rivers like Indus, Ganges, and Brahamaputra flow from the Himalayas towards the sea.

As a consequence, arsenic is mostly present in the sediments, which are formed because of the riverine deposits, mostly the big rivers that come from the Himalayas. We see very similar scenarios in other Continents, in North America in the Rockies and also in the Central Asian Geologic

Foreland basins. We believe that this is the reason which is very natural, and it is throughout the world. It is not only in India.

The reason that the problem is most manifested in India is because of the high population that lives in the Indo-Gangetic plain and also because we have a lot of water related activities that we do from the ground water. As you might be certainly aware that India is now the largest ground water using country in the world. As a consequence, the problem which was originally very natural has also spread into other places, which were not initially having arsenic. We believe that it has spread from Uttar Pradesh, middle to southern Uttar Pradesh to most of Bihar (at least the Gangetic part of Bihar), to most of gangetic west bengal. Our recent study shows the presence of high arsenic in the plains of Assam, close to Brahmaputra valley, also in Arunachal Pradesh, Tripura and the areas, which are very adjacent to Brahmaputra river system."

1.38 According to the M/o WR, RD & GR the Indo-Gangetic alluvium and the Brahmaputra alluvium have higher concentrations of arsenic in localized pockets. Arsenic released during weathering of sulphide minerals is generally absorbed onto the surface of iron oxy-hydroxides that are precipitated under oxidizing conditions normally prevailing during the deposition of the Holocene sediments. Arsenic-containing ground water in Ganga-Brahmaputra River basins is hosted by the sediments deposited by the rivers during the late Quaternary or Holocene age (<12 thousand years). Lithology of those late Quaternary sediments includes sands, silt and clay. There is a thick layer of newer alluvium containing sand, silt and clay, which spread out by numerous rivers that originate from the Himalayas both in the North and Northeast. Most environmental arsenic problems, recognized so far, are the result of mobilization under natural conditions. Thus, the occurrence of arsenic in ground water in the Brahmaputra alluvial plains and Gangetic plains have been recognized as of geological origin with spread out resulting from its mobilization under natural hydro-geologic conditions.

1.39 Explaining the reasons for arsenic contamination in ground water, the M/o WR, RD and GR submitted that elevated level of arsenic in ground water or arsenic contamination is caused largely by natural processes and partly due to anthropogenic activities like application of fertilizers, burning of coal, leaching from coal-ash tailings and from mining activity. An example of the natural arsenic contamination of ground

water is the Ganga Bhramaputra basin, where the Late Quaternary or Holocene (< 11000 years) deposits host the contaminated ground water. The arsenic remains in solid phase**.** However, the mobilization process, which helps in arsenic release from minerals (aquifer framework) to ground water is yet to be fully understood. There are several hypotheses propounded by scientists for the mechanism of release of arsenic in to ground water by natural; as well as anthropogenic activity. As far as the natural process of arsenic contamination is concerned, there are broadly two hypothesis which are as below:

i. Mobilization of Arsenic due to the oxidation of Arsenic bearing pyrite minerals: Insoluble Arsenic bearing minerals, such as Arsenopyrite, are rapidly oxidized when exposed to oxygen, leading to releasing soluble Arsenic in to ground water. The dissolution of these Arsenic containing minerals is highly dependent on the availability of oxygen and the rate of oxidation of sulphide.

ii. Dissolution of Arsenic-rich iron oxy-hydroxides due to onset of reducing conditions in the subsurface: The arsenic remains adsorbed in iron oxy-hydroxide' which is released if a reducing condition is developed in the aquifer. The conducive environment for development of reducing condition in the aquifer are organic carbon availability in the sediment, water logging condition, sluggish ground water movement etc.

As regard hypothesis of anthropogenic contamination, release of Arsenic to ground water by competitive exchange with phosphate ions that migrate into aquifers from the application of fertilizers to subsurface soil is one of the possibilities**.** Localized contamination of arsenic is reported from other anthropogenic activity such as mining, burning of coal etc.

1.40 The Committee were curious to know as to why only the flood plains of Ganga, Brahmaputra and Imphal rivers have been affected by arsenic. The M/o WR, RD & GR stated in a written response that several studies suggested that Arsenic contamination in groundwater is mostly restricted to the alluvial aquifers of the Ganges delta comprising sediments carried from the sulphide-rich mineralized areas of Bihar and

elsewhere surrounding the basin of deposition. However, recent studies have indicated that the vast tract of Indo-Gangetic alluvium extending further to the west and the Brahmaputra alluvium have elevated concentrations of Arsenic in wells constructed in the late Quaternary and Holocene aquifers. Arsenic released during the weathering of sulphide minerals is generally adsorbed onto the surface of iron oxy-hydroxides that precipitated under oxidizing conditions. Besides**,** the reductive dissolution of iron oxides also transfers amounts of Arsenic in aqueous phases through biogeochemical interactions. Arsenic contaminated groundwater in Ganga–Brahmaputra River basin is hosted by the sediments deposited by the rivers during the late Quaternary or Holocene age (<12 thousand years). The occurrence of Arsenic in groundwater in the Bengal Delta Plain and Gangetic plains has been recognized as of geological origin with spread out resulting from the mobilization under natural hydro-geologic conditions. The sources of arsenic in ground water through natural process in Ganga Bhramputra plain has not been fully established so far.

1.41 To a pointed query as to whether there are difficulties, if any, in establishing fully the sources of arsenic in Ganga-Brahmaputra plain, the M/o WR, RD & GR in a written reply submitted that sources of arsenic in Ganga Brahmaputra plain is mostly the sediments having arsenic bearing minerals. However, the process of release of arsenic into ground water and particularly the local variation in the concentration of arsenic is yet to be fully understood, as it depends on various factors such as physic-chemical conditions, hydro geological characteristics of aquifers, dynamic nature of aquifers, presence of arsenic bearing minerals in the sediments etc. necessitating micro level studies.

1.42 Arsenic contamination in Chattisgarh is said to be not from flood plains of newer alluvium. Pointing out the source of arsenic contamination of ground water in Chhattisgarh and Haryana, the M/o WR, RD & GR submitted that the high arsenic ground water occurrence in eastern part of Chowki block, Rajnandgaon district, Chhattisgarh is confined to the early Proterozoic (2500 to 542 million years ago) meta volcanic-granite rocks along Kotri-Dongargarh rift zone. The intrusion of rhyolitic-granitic

magma, followed by the hydrothermal phase is considered to be responsible for Arsenic enriched sulphide mineralization and arsenic enrichment in bedrock in Chhattisgarh. The emplacement of basic rocks took place after the hydrothermal phase, the limited occurrence of arsenic in basic rocks is due to assimilation and remobilization reaction. The most severely affected villages are mainly situated on rhyolite and granite rocks close to shear zone. The relatively younger metabasic, basic and pyroclastic aquifers are less contaminated. In Haryana, where the arsenic in ground water is confined to the alluvial deposits, the mobilization process is likely to be geogenic i.e. due to geological formations different from Chhattisgarh.

1.43 Pointing out that arsenic is an important environmental contaminant and arsenic exposure is through food and water, the Ministry of Health and Family Welfare (Deptt. of Health) stated, in a summary of studies funded by ICMR on arsenic related contamination, that drinking water is the largest source of arsenic exposure. Underground water contamination with arsenic, induces toxicity and causes deteorating health. The level of arsenic in the environment (air & soil) is due to the manufacture of various agricultural products, melting of various metals, combustion of fossil fuels & pesticide production. Arsenic exists in both organic and inorganic forms, the inorganic form is considered more toxic.

(iv) Acceptable levels of arsenic

1.44 Actual levels of arsenic in different acquatic environments in India as given in an article jointly brought out by P. Bhattacharya, (KTH Royal Institute of Technology, Stockholm), A. Mukherjee (IIT, Kharagpur) and A.B. Mukherjee (University of Helsenki) as furnished by Dr. Abhijeet Mukherjee are given below:

Arsenic in different aquatic environments in India

Source	Water (mg/L)	Sediment (mg/kg)	Reference
Surface water			
Lake Chilka, Orissa	35	-	1
Alaknanda River, Devaprayag	6.3		6
Bhagirathi River, Devaprayag	4.6		6
Ganges, Bhagalpur	4.2		7
Bhagirathi-Hoogly (West Bengal)	0.3 to 4		8

Jalangi river	55 – 101		8
Ichamati river	37		8
Baitrani river	0.1 – 2.1		1
Mahanadi river	0.1 – 3		1
Ganges river	-	2-9	4
Brahmaputra river	-	2-6	4
Yamuna river	-	3-11	4
Narmada & Tapti River	-	3-5	4
Godavari river	-	4-14	4
Krishna river	-	2-5	4
Cauveri river		2-4	4
Shivnath River	100-300	-	4
Ground water			2
Western Bengal Basin, West Bengal	<1–4200	-	
Middle/Lower Ganges Plain, Bihar	<10–1654		
Middle/Lower Ganges Plain, Jharkhand	<1–620		
Upper Ganges Plain, Uttar Pradesh	<1–700		
Central Indian igneous terrain, Chattisgarh	<1–880		
Brahmaputra basin, Assam	<1–657		
Mineralised areas, Rajasthan	<1–13.8	-	3

1Konhauser et al. (1997), 2Mandal et al. (1996), 2von Bro¨mssen (1999), 3Madhavan and Subramanian (2000),4Subramanian et al. (1985), 6Chakrapani (2005), 7Mukherjee et al. (2007), 8Mukherjee and Fryar (2008), 9Pandey et al. (2002).

1.45 The acceptable limit of arsenic in drinking water according to World Health Organization (WHO) is 10 parts per billion (ppb) or 0.01 parts per million (ppm) or 0.01 mg/l. The M/o WR, RD & GR, however, stated that as per the recommendations of Bureau of Indian Standards (BIS), the maximum permissible limit for arsenic in drinking water is 0.05 mg/l as against WHO standard of 0.01 mg/l. In a written reply to a query as to when BIS fixed permissible limit of arsenic in drinking water as 0.05 mg/ l, the M/o Food, Public Distribution & Consumer Affairs submitted as follows:

> "The Present revised version of Indian standard on '' Drinking water, IS 10500" was published in the year 2012 **(Appendix – IV)**. This standard specifies the maximum acceptable limit of Arsenci as 0.01mg/l. However, in the absence of alternate source of water the permissible limit of Arsenic has been relaxed to 0.05mg/l maximum''.

1.46 With regard to the reasons for fixing the limit much higher than that of WHO, the M/o of Food, Public Distribution & Consumer Affairs stated as follows:

> "...the maximum acceptable limit of Arsenic as has been fixed as 0.01mg/l which is same as prescribed by WHO , but in the absence of alternate source of water the permissible limit of Arsenic has been relaxed to 0.05mg/l maximum.''

1.47 Concerned about the adverse input on the health of the people, the Committee questioned the Ministry of Food, Public Distribution and Consumer Affairs (BIS) as to whether they are certain that Arsenic contamination between 0.01mg/ l and 0.05 mg/l in drinking water will not cause any carcinogenic effects on human health. Responding to the query, the Ministry of Food, Public Distribution & Consumer Affairs stated that the above relaxation in the requirement of Arsenic was done by the BIS Sectional Committee on "Drinking water'' chaired by Director of National Environment Engineering Research Institute (NEERI). This Committee among other is also represented by Indian Council of Medical Research (ICMR), ministry of water resources, Indian Country office of World Health Organization as well as UNICEF.

1.48 It is observed from the Minutes of the 2nd meeting of Drinking Water Sectional Committee of BIS held on 28.01.2010 that UNICEF had pointed out that only 'arsenic' has a quantified permissible limit, for other toxic parameters, it is 'no' relaxation. The BIS Sectional Committee, however, noted in this regard that permissible limit of arsenic in Manual of Central Public Health and Environmental Engineering (CPHEEO) of the Ministry of Urban Development for water supply and treatment is also 0.5 mg/l and decided that permissible limit of 0.5 mg/l max for arsenic is justified in view of abundance of arsenic in ground water in several areas of the country and non-availability of alternate sources and decides to retain the same.

1.49 In the light of the fact that anthropogenic activities like mining, fertilizers and pesticide addition leads to arsenic contamination, the Committee enquired whether there are any regulations governing these activities to ensure that the risk of contamination is mitigated, the Ministry of WR, RD & GR stated in a written reply that the Ministry of Environment, Forests & Climate Change has notified general standard

for discharge of environmental pollutants which includes industrial effluents also for various recipient sources such as inland surface water, public sewerage, land for irrigation and marine coastal areas etc. The limit of discharge for arsenic in waste water has been defined for all the recipient sources as 0.2 mg/l. The industry specific standards have been specified for all the grossly polluting industries. Wherever pollution is not specified in industry specific standards, limits of General Standards for discharge are applicable.

1.50 Recognising the need for arsenic limits in rice, vegetables, fruits, etc., the Committee sought to know the standards in this regard. The Deptt. of Agriculture and Cooperation (DAC) stated in a written reply that UN Food Standard Body Codex Alimentations Commission has adopted a maximum level for arsenic in rice of 0.2 mg/kg. DAC further stated that the mandate of prescribing maximum acceptable limit of arsenic in various food crops etc. is vested with Food Safety & Standards Authority of India (FSSAI). FSSAI has, so far, prescribed maximum permissible limit of arsenic in various food commodities as follows:

S.No.	**Name of Food Commodities**	**Maximum acceptable limit of arsenic (Parts per million)**
1	**Milk**	**0.1**
2	**Beverages**	
	Soft drink intended for consumption after dilution except carbonated water	0.5
	Carbonated water	0.25
	Infant Milk Substitute and Infant Foods	0.05
	Turmeric whole and powder	0.1
	Juice of orange, grape, apple, tomato, pineapple and lemon	0.2
	Pulp and pulp products of any fruit	0.2
	Preservatives, anti-oxidants, emulsifying and stabilising agents and synthetic food colours	3.0 on dry matter
	Ice-cream, iced lollies and similar frozen confections	0.5
	Dehydrated onions, edible gelatine, liquid pectin	2.0
	Chicory-dried or roasted	4.0

	Dried herbs, finings and clearing agents, solid pectin all grades, spices	5.0
	Food colouring other than synthetic colouring	5.0 on dry colouring matter
	Hard boiled sugar confectionery	1.0
	Iron Fortified Common Salt	1.0
	Brewed Vinegar and Synthetic Vinegar	0.1
3	**Food not specified**	**1.1**

1.51 The Indian Standard on Drinking Water also specifies the maximum limits of Nitrate, Iron and Flouride. The comparative chart for the limits with respect to Nitrates, Flouride and Iron given in Indian Standard and WHO is given below:

Sl. No.	**Requirement**	**Indian Standard on Drinking Water, IS 10500: 2012, Maximum Acceptable limit**	**WHO, guidance value**
1.	Nitrate	45 mg/l	50 mg/l
2.	Flouride	1 mg/l (acceptable limit) 1.5 mg/l (permissible limit)	1.5 mg/l
3.	Iron	0.3 mg/l	No recommendation

CHAPTER II

Health Effects

(i) Arsenic Diseases

Drinking of water with high Arsenic content over a prolonged period leads to several diseases as documented by various researchers. These diseases are (i) Hyper Pigmentation, (ii) Keratosis,(iii) Weakness,(iv) Anemia, (v)Burning sensation of eyes, (vi) Swelling of legs, (vii) Liver fibrosis, (viii) Chronic lung disease (ix) Gangrene of toes,(x) Neuropathy,and; (xi) Skin cancer. The Ministry of Health & Family Welfare (Min. of H&FW) has pointed out that of these diseases only hyper pigmentation is reversible on removal from exposure. Other conditions are usually static or keep progressing. The treatment mainstay is removal of further exposure by provision of arsenic free water and symptomatic treatment for the manifestations.

2.2 According to the Council of Scientific and Industrial Research (CSIR), various types of skin manifestations and other Arsenic toxicity have been observed including melanosis, keratosis, hyperkeratosis, dorsal keratosis, non-pitting edema, gangrene and cancer. Overall prevalence of clinical neuropathy has been reported in various studies in populations of 24- Pargana-North, 24- Pargana-South, Murshidabad, Nadia, and Bardhaman districts of West Bengal and in the states of Bihar, Uttar Pradesh, Jharkhand and Chhattisgarh. The children in the Arsenic contaminated areas are often more affected than the adults. Most of the population suffering from Arsenic skin lesions is from a poor socio-economic background.

2.3 Explaining out the arsenic effect on human and animal health, DARE stated in a note that people exposed to chronic arsenic toxicity suffer from arsenical melanosis and hyperkeratosis, skin cancer, enlargement of liver, non-cirrhotic portal fibrosis, and respiratory disorders. In severe cases, gangrene in the limbs and malignant neoplasm are also observed. In animals also, the arsenic poisoning causes many abnormalities. The problem seems to have arisen due to more withdrawal of groundwater during lean period (when the groundwater availability in the aquifer is at its minimum) for summer

paddy, causing oxygenated decomposition of pyritic sediments containing high amounts of arsenic. These sediments upon oxidation release sulphuric acid that solubilizes arsenic. The solution moves down to aquifers in due course of time, polluting the groundwater. Arsenic is one of the most toxic elements to fish. Acute exposures can result in immediate death. Chronic exposures can result in the accumulation of the metalloid to toxic levels. In fish, bizarre morphological alterations, as well as early neoplastic alterations are produced in the liver.

2.4 The vision document 'Mitigation and Remedy of Groundwater Arsenic Menace in India' June 2010 brought out the effects on health as under:

> "The available health effect reports, after ingestion of arsenic contaminated groundwater, are mainly from the epidemiological study of chronic arsenic exposure. Number of incidents and studies related to acute arsenic toxicity are meager compared to chronic arsenic exposure. During the last decade plenty of chronic arsenic exposure incidents have been reported from Asian countries due to use of arsenic contaminated groundwater and associated health effects. More and more studies have been carried out to know various health effects due to chronic exposure. During the last decade 4 monographs (IARC 2004, IPCS 2001, NRS 1999, NRS 2001) along with large number of reports and special issues have been published to include the research activities of chronic arsenic exposure and various carcinogenic and non- carcinogenic health effects.
>
> It is evident now that inorganic arsenic exposure deactivates the function of enzymes, some important anions, cations, transcriptional events in cells and causes other direct or indirect effects. Such activities of inorganic arsenic result in numerous illnesses that have been also confirmed by repeated epidemiological investigations. Examples of the same are: (i) Dermal effects, (ii) Cardiovascular effects, (iii) Respiratory effects, (iv) Gastrointestinal effects, (v) Endocrinological effects (diabetes mellitus), (vi) Neurological effects, (vii) Reproductive and developmental effects, (viii) Cancer effects, and (ix) other effects. Symptoms of arsenicosis are primarily manifested in the form of different types of skin disorders such as skin lesions, hyperkeratosis and melanosis."

West Bengal's groundwater arsenic contamination and health effects surfaced in 1983. West Bengal is one of the worst arsenic affected areas in the world arsenic scenario. During last 25 years, more scientific and medical investigations have been carried out in this State by (a) School of Tropical Medicine (STM), (b) All India Institute of Hygiene and Public Health (AIIH&PH), (c) Central Ground Water Board (CGWB), (d) Centre for Study of Man and Environment (CSME), (e)

WB Government Public Health Engineering Department (PHED), (f) Arsenic group in Seth Sukhlal Karnani Memorial Hospital, and (g) WB Directorate of Health Services, Government of West Bengal (h) Kolkata Medical College, etc. In very preliminary work, medical group of School of Environmental Studies (SOES) examined around 96,000 individuals, including children (age range: infants to 11 years), for arsenic toxicity from arsenic affected villages of West Bengal and 9,356 of them showed skin lesions; in children, these numbers were 5.6% (n=14,000). Various types of skin manifestations and other arsenic toxicity were observed from melanosis, Keratosis, hyperkeratosis, dorsal keratosis, and non pitting edema to gangrene and cancer……

Arsenic exposure during pregnancy can adversely affect several reproductive endpoints. In several studies the association between arsenic exposure and adverse pregnancy outcome, including spontaneous abortion, preterm birth, stillbirths, low birth weight and neonatal and prenatal mortality have been documented from arsenic affected villages of West-Bengal and other States in India.

Skin itching to sun rays, burning and watering of eyes, weight loss, loss of appetite, weakness, lethargy and easily fatigued limited the physical activities and working capacities.

Chronic respiratory complaints were also common. Chronic cough with or without expectoration was evident in more than 50%. As reported by the villagers, the unique sound of “cough of arsenicosis” was reported from adjacent village homes at night to create an unusual atmosphere. The cough may be painful and sputum may contain blood to be misdiagnosed as pulmonary tuberculosis. In late stages, shortness of breath might predominate.

Gastrointestinal symptoms of anorexia, nausea, dyspepsia, altered taste, pain in abdomen, enlarged liver and spleen, and ascites (collection of fluid and abdomen) were also observed in 50% patients.

- Moderate to severe anemia was evident in some cases.

- Conjunctival congestion, Leg edema was less common.”

2.5 With regard to effect of arsenic poisoning in children, the vision document states that infants and children are often considered more susceptible to the adverse effects of toxic substances than adults. Normally children under 11 years of age do not show arsenical skin lesions although their biological samples contain high level of arsenic. However exceptions are observed when (i) arsenic content in water consumed by

children is very high (≥1000 µg /l) and (ii) arsenic content in drinking water is not so high (around 500 µg/l) but the children's nutrition is poor. High arsenic content in their biological samples prove that children in the arsenic affected areas of the GMB plain have a higher body burden, though dermatological manifestations are few. The children in the arsenic contaminated areas are often more affected than the adults. Children's body try very hard to expel the poison from their systems, but in trying to do so; their internal organs become badly damaged. That in turn retards their further growth, both physical and mental. The sufferings of children in arsenic affected areas in GMB plain had also been reported in many literatures.

2.6 In a summary of studies funded by ICMR in arsenic related contamination, the Ministry of Health and Family Welfare (Department of Health) stated as follows:

> "Arsenic exposure during childhood is associated with hearing loss, lowering IQ affiliction of memory etc. Chronic exposure can lead to mental retardation & developmental disabilities such as physical, cognitive and psychological etc. Studies have shown that it causes oxidative stress & DNA damage in blood and brain. Arsenic has well known carcinogenic properties as well as cancer treating activities.
>
> Studies by Prof. A.K. Santra, Centre for Liver Research, Kolkata has shown firm association between chronic arsenic toxicity and hepatic fibrosis. It has been found that the prolonged exposure of arsenic, causes oxidative stress in liver followed by liver damage and finally hepatic fibrosis.
>
> Another studies by Dr. S.J.S Flora, Defence Research & Development, Gwalior and Dr. Pushpa Dhar, AIIMS, New Delhi, have shown that the exposure of arsenic during the early post natal life induces adverse neurological effects in hippocampus. Hippocampus is one of the major areas of brain association with learning and memory and is highly vulnerable to environmental contaminants. It has been observed that various nutritional supplements like Quercetin, Alpha lipoic acid, an effective antioxidants & aqueous extract of iron rich plants alone or along with chelating agents' administration could reduce arsenic induced oxidative stress and can also revert back the changes of impairment of learning and memory to substantial extent in children exposed to arsenic.

Another study by Dr. Prof. Karmakar, Jadavpur University, Kolkata, of arsenic role in AKT signalling pathway has shown that arsenic induces both necrosis and apoptosis and reduces the number of viable cells. Arsenic may directly or indirectly influence AKT activation. AKT plays a vital role in regulating the cellular fate after any kind of stress. AKT phosphorylation is essential for cell survival and it not only suppresses apoptosis but also stimulates cell growth by including growth promoting factors. Study by Dr. A.K. Giri, ICB, Kolkata, indicates that chronic arsenic exposure is also responsible for increased genetic damage in exposed population than in unexposed population. The overall study indicates that the exposed group is more prone to arsenic induced diseases, including the risk of cancer due to substantial chromosome damage in lymphocytes in exposed population and forms a sensitive group."

2.7 Some of the photographs showing arsenic patients as published in the vision documents "Mitigation and Remedy of Groundwater arsenic menace in India" as sourced from the School of Environmental Science (SOES) and some as furnished by the Deptt. Of Agriculatural Research and Education (DARE) are given in the following pages."

Photographs showing some arsenic patients from arsenic affected districts of Bihar.

: Arsenic affected districts along the Ganga river course in Bihar.

: Photographs showing Some arsenic patients from arsenic affected districts of Bihar (Source : SOES)

Photograph showing some arsenic affected patients from UP

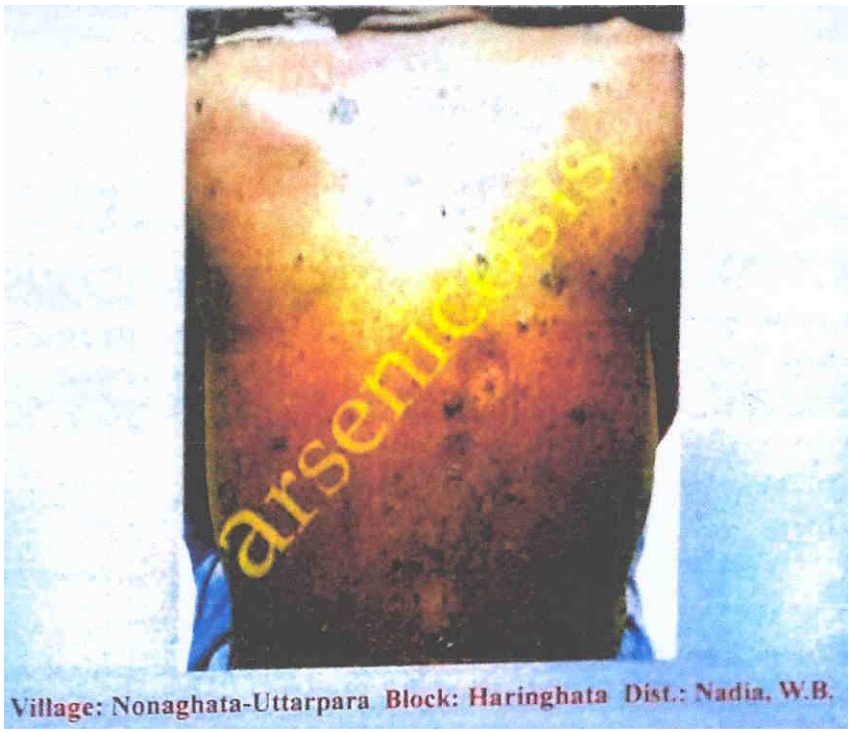
.: Photograph showing some arsenic affected patients from UP (Source : SOES)

Photograph showing cancer patient with arsenical skin lesions from Jharkhand state

Photographs showing some arsenic affected patients from West Bengal

Village: Nonaghata-Uttarpara Block: Haringhata Dist.: Nadia, West Bengal

Village:Ambikanagar Block: Deganga Dist.: North-24-Parganas, West Bengal



Village: Nonaghata-Uttarpara Block: Haringhata Dist.: Nadia, W.B.

Impact of arsenic contamination on fish health

- Change in albumin and globulin content, cholesterol and triglyceride levels.
- Marked difference in protein profiles
- proteomic changes of fish lens protein and formation of cataract

Typical eye lesions like bulging of eye-balls and cataract of lens were observed due to high As in water

(ii) Data regarding diseased population

2.8 In a memorandum submitted to the committee, an expert from IIT, Kanpur (Prof. Saumyen Guha) stated that the estiamte of number of people exposed to high arsenic containing groundwater vary. However, most estimates fall between 6-10 million people in India. The estimates of confirmed cases of illness due to arsenic poisoning fall in the range of 200,000 to 300,000. Estimates of death due to arsenic poisoning runs above 100,000.

2.9 To a query about the data regarding the number of people affected by arsenic contamination and the nature of disease affected by them, the Ministry of Water Resources, RD & GR stated that the Central Ground Water Board (CGWB) do not possess such information. Quoting ICMR, the Ministry of WR, RD&GR stated further that data on Arsenic affected individuals is not being routinely collected and information is not available from Central Bureau of Health Intelligence (CBHI), DGHS. However, ICMR through its institute in Kolkatta has conducted some research studies in West Bengal wherein the prevalence of Arsenic affected individuals was found to be 15.4% in males and 3.8% in females in 2006. In another groups the prevalence was 5% in 2008-09. Another study reported in 2012-13, the prevalence was 6.4% for Arsenic induced pigmentosis.

2.10 Disappointed with absence of data regarding arsenic affected people, the Committee raised a pointed query as to why there is no centralized data. The Min. of WR, RD & GR stated in response that health is a State subject and centralized data is collected by the CBHI in relation to the National Programs on various diseases along with other relevant health related data. No data regarding number of people affected by Arsenic is available centrally.

2.11 Admitting that there is no data on Arsenic affected population, a representative of the Ministry of Health and Family Welfare (M/o H&FW) stated during oral evidence on 27 October, 2014 as under:

> "In July last year, the Ministry wrote to all the States asking them to collect data so that they could come up with preventive and curative medical measures. This data is being collected by the States and now we have also asked them that once they have the data, they should collate the data, make a plan based on that data and then put it in their Project Implementation Plan under the National Health Mission so that we can fund it"

2.12 DARE informed in a note that abnormalities with symptoms akin to these of arsenic poisoning have been detected in 40% of animals (cattle and goats) inspected in the area.

2.13 AIIMS have also submitted a note regarding impact on health of people consuming arsenic in drinking water and its short-term and long-term consequences, the curability and availabilty or otherwise of the treatment for such diseases. The note reiterates the diseases already elaborated in the preceeding paragraphs.

CHAPTER - III

Monitoring of Arsenic in Ground Water and Soil

(i) Central Ground Water Board (CGWB)

Central Ground Water Board (CGWB) monitors ground water quality on regional scale once in a year, through a network of 12,946 ground water observation wells in different hydro geological units located all over the country. The main objective of ground water quality monitoring programme is to generate information on the distribution of water quality parameters on a regional scale as well as to create a background data base of different chemical constituents in ground water. In addition, ground water samples are also collected and analyzed from the exploratory wells drilled by CGWB, Special Studies and Ground Water Management Studies taken up in different areas as per the Annual Action Plan. The results and findings of the regular monitoring and various studies carried out from time to time are shared with the respective State Agencies.

3.2 The ground water quality monitoring is carried out with following purposes/objectives:

"

- Periodic monitoring of geogenic contamination of ground water.
- Identification of contaminated and contaminated free aquifers.
- As an input to determine the nature and extent of contamination.
- Reporting ground water contamination to state water supply authorities.
- Disseminating the information to the stakeholders."

3.3 More than 20,000 samples per annum are analysed in various regional water quality labs of CGWB for basic parameters, heavy metals as well as for pesticides in ground water samples.

3.4 CGWB has sixteen well equipped Regional chemical laboratories located in different parts of the country and attached with regional offices of Central Ground Water Board as shown below:-

Sl. No.	Region	States Covered	Location of Laboratory
1	North Western Himalayan Region (NWHR),Jammu	Jammu & Kashmir	Jammu
2	North Western Region (NWR),Chandigarh	Punjab,Haryana,Himachal Pradesh,Uttarakhand,Delhi & Chandigarh(UT)	Chandigarh
3	Northern Region (NR),Lucknow	Uttar Pradesh,special studies of Uttarakhand	Lucknow
4	North Central Region (NCR), Bhopal	Madhya Pradesh	Bhopal
5	Mid Eastern Region(MER), Patna	Bihar, Jharkhand	Patna
6	Eastern Region (ER), Kolkata	West Bengal, Andaman & Nicobar Islands, Sikkim	Kolkata
7	North Eastern Region (NER),Guwahati	Assam,Meghalaya,Arunachal Pradesh, Tripura,Mizoram, Nagaland,Manipur	Guwahati
8	South Eastern Region (SER),Bhubaneshwar	Odisha	Bhubaneshwar
9	North Central Chhattisgarh Region (NCCR)	Chhattisgarh	Raipur
10	West Central Region (WCR),Ahmedabad	Gujarat & Daman & Diu(UT)	Ahmedabad
11	Western Region (WR),Jaipur	Rajasthan	Jaipur
12	Central Region (CR), Nagpur	Maharashtra & Dadra & Nagar Haveli	Nagpur
13	South Western Region (SWR),Bangalore	Karnataka & Goa	Bangalore
14	South Eastern Central Region (SECR),Chennai	Tamil Nadu & Pondicherry(UT)	Chennai
15	Kerala Region (KR), Thiruvannanthapuram	Kerala, Lakshwadeep(UT)	Thiruvannanthapuram
16	Southern Region (SR),Hyderabad	Andhra Pradesh &Telengana	Hyderabad

3.5 The M/o WR, RD &GR informed that out of sixteen labs, 3 chemical laboratories namely Lucknow, Chandigarh and Hyderabad have got National Accreditation Board for Testing and Calibration Laboratories (NABL) accreditation. CGWB is in the process of getting remaining laboratories accreditation from NABL in a phased manner. The CGWB labs in Bangalore and Trivandrum have got empanelment certificate from concerned State Pollution Control Board. The process of accreditation of CGWB laboratories was initiated in April, 2011. The accreditation process involves fulfilling the requirements of standards as prescribed by NABL. It is observed from the information furnished on 19.11.2014 that during Twelfth Plan (till 2016-17) only 5 more chemical labs have been targeted for NABL accreditation. These are Jaipur, Bhubaneswar, Nagpur, Ahmedabad and Guwahati.

3.6 On being enquired as to whether CGWB has any mobile testing labs, the M/o WR, RD & GR stated in a written reply that Central Ground Water Board has the facility of portable arsenic testing kits for on-the-spot testing of arsenic in ground water. Central Ground Water Board do not have any Mobile testing lab. CPCB also has no functional mobile testing labs.

3.7 The Annual Action Plan (AAP) / Annual Work Programme of different Regional Chemical laboratories of Central Ground Water Board is formulated every year based on the availability of manpower and equipment as well as targets fixed in the EFC of XII plan. The target of analysis of 20,000 samples are also collected in short term studies and at times on the request of State Agencies. The progress of all the laboratories is monitored on monthly basis by a dedicated cell at Central Headquarters of CGWB under the overall contral of Member (Technology Transfer and Water Quality). Regular review meetings are being undertaken to ensure that the targets are achieved. Need based review meetings are being taken by Chairman/Member to address the bottlenecks, if any regarding the target/progress.

3.8 The M/o WR, RD & GR further stated that there is regular training programme being organized by Rajiv Gandhi Institute at Raipur for the Chemists of CGWB and professionals from various and Institutes. Chemists from CGWB also act as faculty and deliver lectures. Findings of chemical studies are published in national as well as international Workshops and Seminars in the form of research papers by the scientists of CGWB.

3.9 Observing from the data furnished by the Ministry of WR, RD &GR on state-wise number of water quality monitoring observation Wells of CGWB (as on 30.06.2014). The Committee pointed out that out of 12,946 WQ monitoring stations, more than thousand wells each have been located in four States viz. Orissa (1249), Karnataka (1129), Madhya Pradesh (1068) and Maharashtra (1058) and enquired whether there is any criterion in establishing water quality monitoring stations in each State. The Ministry of WR, RD & GR replied that CGWB is monitoring ground water level and quality of shallow aquifers on regional scale through network of existing observation wells in the Country. Water quality monitoring stations are generally existing dug wells, wherever water samples from existing dug wells cannot be collected, hand pumps are used for ground water quality sampling. Emphasis is given to select wells which are in regular use and tapping shallow aquifers.

3.10 The basic criteria followed in establishing/ identifying an existing dug wells as monitoring well are:-

The representative existing dug wells / open wells are selected as monitoring wells by the scientists of the CGWB after considering the local hydro geological conditions. While selecting the representative well following considerations *inter-alia* are made:

- The well should be in regular use and should not be fitted with motorized pump.
- The existing well should be tapping the shallow aquifer and represent single aquifer system.
- Attempts are made to establish at least one existing water quality monitoring well in each assessment unit.

- In the area where water samples cannot be taken from the identified existing monitoring well, samples are taken from nearby existing dug well/ hand pump to maintain the consistency of data etc.

3.11 The Committee sought to know whether there is any specific reason why Odhisa, Karnataka, Madhya Pradesh and Maharashtra have huge number of WQ monitoring stations. The Ministry of WR, RD & GR responded by saying that samples for water quality monitoring are collected from the representative existing dug wells. Major part of the said states is occupied by hard rock terrain where dug wells are common ground water abstraction structures, as compared to alluvial area, where hand pumps are prevalent. CGWB is in process of strengthening its monitoring network during XII Plan period to expand the network by bringing in its ambit a large number of existing dug wells in all the States.

3.12 Not satisfied with the reasons given for disproportionate number of monitoring stations in four States, the Committee enquired whether the existing network of 12,946 observations wells are adequate to monitor water quality in ground water in the entire country. The Ministry of WR, RD & GR admitted that the present density is not adequate. Therefore, in order to address this issue, CGWB has proposed to identify additional existing dug wells and converting into monitoring stations during XII Plan period.

3.13 Explaining the monitoring process, the Ministry of WR, RD & GR stated that the scientific officers of CGWB visit ground water observation wells four times a year in the country for ground water level monitoring and water quality samples are collected during pre-monsoon period. Based on the analysis and results of ground water regime monitoring, a report is prepared. As a follow up, the findings/results are shared with all concerned Central/State Agencies to take necessary remedial measures.

3.14 To a query about the constraints faced by CGWB, the Ministry of WR, RD & GR stated in a note as under:

> "The Board is headed by Chairman and has five Members under whom 18 Regional Offices function in different State capitals headed by Regional Directors. Besides, there are 17 Divisional Offices and 11 State Unit Offices, the CGWB has a strength of about 4159 personnel to fulfill its mandate. Out of these posts 1170 posts (644 –Direct Recruitment Quota, 522 – Promotion Quota and 4 Excadre Quota) are vacant (28%). The Board has placed the indent for filling up the vacant posts.
>
> To address the emerging challenges in ground water sector the ongoing scheme of ground water management and regulation has been expanded by including new component of Aquifer mapping and Management during XII plan period with an estimated outlay of Rs. 3319 crore. Sufficient financial provision exists under the scheme for implementation of NAQUIM. The physical and financial targets have been increased seven fold as compared to XI plan.
>
> A post of Member, Finance, CGWB has recently been created in CTWB for a better implementation of NAQUIM programme."

(ii) Water Quality Assessment Authority (WQAA):

3.15 The Water Quality Assessment Authority (WQAA) was constituted with effect from 29 May, 2001, by the Ministry of Environment & Forests under Environment Protection Act, 1986. The Joint Secretary (Administration), Ministry of Water Resources is the Member Secretary of the Authority. Water Quality Cell, Ministry of Water Resources is providing secretariat to WQAA and coordinates the activities of the constituent agencies of the Authority and undertakes various programmes/activities as decided by WQAA. The monitoring and assessment works of water quality are got done through Member Organizations of WQAA like CPCB, CWC, CGWB, NEERI (National Environmental Engineering Research Institute), etc.

3.16 Although the WQAA was constituted under the Chairmanship of Secretary, Ministry of Environment & Forests, the Secretariat is provided by the Ministry of MWR, RD & GR. Curious to know about the reasons for this peculiar arrangement, the

Committee sought information in this regard. The M/o WR, RD & GR stated in response as follows:

> "As per the information provided by WQAA, it was observed that the water quality monitoring programme was under implementation by different Central/State agencies but there was very little or no coordination among the agencies and no uniform procedure was followed for sampling, analysis, data storage and reporting.
>
> Ministry of Environment, Forests & Climate Change(MoEF&CC), therefore, after elaborate consultation with concerned departments decided to create an Authority at the Central level under 'The Environment (Protection) Act, 1986' with the mandate comprising of water quality monitoring and assessment issues as well as water quality management issues. MoEF&CC being the administrative ministry for The Environment (Protection) Act 1986, the Authority was constituted under the chairmanship of Secretary, MoEF&CC. As the Authority is an inter-ministerial body, Member Secretary of the WQAA was made from MoWR, RD & GR for effective coordination between the two ministries. The notification on Water Quality Assessment Authority (WQAA) in the year 2001 contained "*The Ministry of Water Resources shall create a cell to assist the Authority to carry out the assigned functions*". A cell was then created in MoWR to provide secretariat services to WQAA."

3.17 Unconvinced by the reply, the Committee further enquired whether the above arrangement is effective in realizing the objectives for which WQAA was set up. The M/o WR, RD and GR responded by stating that this arrangement is effective in realizing the objectives for which WQAA was set up.

> The Authority exercises the following powers and functions:-
>
> "I. To exercise powers under section 5 of the said Act for issuing directions and for taking measures with respect to matters referred to in clauses (ix), (xi), (xii) and (xiii) of sub- section 2 of section 3 of the Act.
> II. To direct the agencies (government/local bodies/non-governmental) for the following.
>
> (a) To standardize method(s) for water quality monitoring and to ensure quality of data generation for utilization thereof;
>
> (b) To take measures so as to ensure proper treatment of wastewater with a view to restoring the water quality of the river/water bodies to meet the designated-best-uses;

(c) To take up research and development activities in the area of water quality management;

(d) To promote recycling/re-use of treated sewage/trade effluent for irrigation in development of agriculture;

(e) To draw action plans for quality improvement in water bodies, and monitor and review/assess implementation of the schemes launched/to be launched to that effect;

(f) To draw scheme for imposition of restriction in water abstraction and discharge of treated sewage/trade effluent on land, rivers and other water bodies with a view to mitigating crisis of water quality;

(g) To maintain minimum discharge for sustenance of aquatic life forms in riverine system;

(h) To promote Rain water harvesting; (This mandate has been deleted vide MoEF notification No. SO-728 (E) dated 25th May, 2005)

(i) To utilize self-assimilation capacity at the critical river stretches to minimize cost of effluent treatment;

(j) To provide information to pollution control authorities to facilitate allocation of waste load;

(k) To review the status of quality of national water resources (both surface water and ground water; except-that due to geo-genic aspect)) and indentify "Hot Spots" for taking necessary actions for improvement in water quality;

(l) To interact with the authorities/committees constituted or to be constituted under the provisions of the said Act for matters relating to management of water resources;

(m) To constitutes/set-up State-level Water Quality Review Committees (WQRC) to coordinate the work to be assigned to such committees; and

(n) To deal with any environmental issue concerning surface and groundwater quality (except-that due to geogenic aspect) which may be referred to it by the Central Government or the State Government relating to the respective areas, for maintenance and/ or restoration of quality to sustain designated-best-uses."

3.18 The Committee observed from the above mandate that quality issues caused by geogenic sources have been excluded from the purview of WQAA. The Committee enquired whether the Ministry of WR, RD & GR has any suggestions to ensure efficient functioning of WQAA, the M/o. WR, RD & GR stated that as per information provided by

WQAA, a sub-committee for "Re-evaluation of powers and mandate of WQAA" was constituted by WQAA in its 9th meeting. The sub-committee in its report recommended that the Authority should focus on monitoring and assessment of water quality holistically and management aspects should be dealt by MoEF&CC and respective State Governments. The Authority accepted this report in its 10th meeting and the notification of the Authority with revised mandate on monitoring and assessment of water quality is underway. After the notification, the mandate of the Authority would be on monitoring and assessment aspect of water quality of surface water and ground water. It would help in bringing more efficient functioning of WQAA

3.19 It was further stated that the sub-Committee submitted its Report on 10th April, 2013. The sub-committee viewed that there is duplication of mandate of WQAA with other organizations/ministries, the management aspect should be taken up by MoEF&CC and respective State Governments and implementation of the existing mandate in terms of management aspects may not be achievable with the existing infrastructure and manpower. The sub-committee recommended that the WQAA should focus on monitoring and assessment of water quality of surface water and ground water and address all the related aspects holistically.

3.20 The Committee were informed that in the 10th meeting of WQAA, held on 30.05.2013, the Authority decided to include geogenic contamination in its mandate for monitoring and assessment aspects.

3.21 The revised mandate and powers of WQAA as recommended by the Sub-Committee are:

"

(i). To exercise powers under section 5 of the said Act for issuing directions for taking measures with respect to matters referred to in clauses (i), (ix), (xii), (xiii) and (xiv) of sub- section 2 of section 3 of the Act.

(ii). To direct the agencies (government/local bodies/non-governmental) for the following:

a. To review and direct the agencies to standardize the method(s) for water quality monitoring and to ensure quality of data generation for utilization thereof;

b. To promote research and development activities in the area of water quality monitoring and assessment;

c. To direct the agencies to review the status of quality of national water resources (both surface water & groundwater) and identify 'Hot Spots' based on the guidelines by WQAA for taking necessary actions for improvement of water quality;

d. To direct the agencies to interact with the authorities/ committees for matters relating to monitoring and assessment of water quality;

e. To direct the State Governments/U.T's to constitute/set-up state-level Water Quality Review Committees to coordinate the work to be assigned to such committees;

f. To review and address the inter-ministerial issues pertaining to water quality monitoring and assessment;

g. Nationwide training programme involving all stakeholders in water quality monitoring and assessment issues through workshops/seminars including international training/study tours for capacity building, international cooperation and sharing of information."

3.22 The following are the ongoing activities in WQAA:

- Revision of Uniform Protocol on Water Quality Monitoring (UPWQM): The revision of existing UPWQM has been completed by a Committee constituted by WQAA in its 10th meeting. The revised UPWQM is to be ratified by WQAA before notifying the same.
- Organization of data base on water quality at a single platform: CPCB has been directed by WQAA in its 10th meeting to establish Data Centre as a central repository for water quality data generated by all concerned organizations.
- Standardization of water quality laboratories: Directions have been issued to all concerned central and state government organizations to initiate process of accreditation of their laboratories with NABL for all the parameters enumerated in UPWQM.
- Rationalization and optimization of water quality monitoring stations: In view of the duplication of water quality monitoring by different organizations like NRCD (National River Conservation Directorate), CPCB (Central Pollution Control Board), SPCBs (State Pollution Control Board), CWC (Central Water Commission) and CGWB, a Committee approved by WQAA in its 1^{0th} meeting has taken up the task of rationalization and optimization of water quality monitoring stations in the country.

3.23 The future course of action accepted by WQAA in its 10th meeting is as follows:

"

- Devise mechanism for implementation of UPWQM by all States and Central Government agencies, as also its review from time to time.
- Preparation of guidelines for identification of pollution 'hot spots'.
- Rationalization and optimization of water quality monitoring network.
- Identification of training needs to implement the mandate of WQAA.
- Promotion of R & D activities in the field of water quality monitoring & assessment."

3.24 On being enquired by the Committee as to how CPCB monitors water quality, the M/o EF & CC in a written submission stated that CPCB is monitoring water quality at 2500 locations in 29 States and 6 Union Territories spread over the country. The monitoring network covers 445 Rivers, 154 Lakes, 12 Tanks, 78 Ponds, 41 Creeks/Seawater, 25 Canals, 45 Drains, 10 Water Treatment Plant (Raw Water) and 807 Wells. Among the 2500 locations, 1275 are on rivers, 190 on lakes, 45 on drains, 41 on canals, 12 on tanks, 41 on creeks/seawater, 79 on ponds, 10 Water Treatment Plant (Raw Water)and 807 are groundwater stations. Arsenic is one of the parameters among the specific group of trace metals analysed in water samples. The trace metals are found in traces (usually less than 1-10 ppm) and have been defined accordingly. Monitoring of water quality over the years does not reflect any detectable presence of arsenic contamination at any of monitored locations of the network.

3.25 One of the achievements of WQAA is stated to be regarding "minimum environmental flows in Indian rivers". However, on closer scrutiny, it is observed that there is hardly any worthwhile progress during the last 11 years except for constituting a working group in the year 2003 which took four years to submit its Report in 2007, followed by constitution of a Committee for implementing the working group's recommendations which submitted its Report in 2009. Eventually, the recommendations of the Committee have not been accepted by WQAA in its meeting held on 30th May, 2013. When asked to justify loss of 11 years without any fruitful results in ensuring minimum environmental flows in Indian, it was stated that the Authority felt the need to review the recommendations contained in the Report submitted by Working Group in 2007. For this purpose, a sub-Committee was constituted whose Report was

deliberated by the Authority in its meeting held on 30th May, 2013. The Authority did not accept the Report as it found that the recommendations were generic, i.e., it was not river-wise, and in that too, stretch-wise. However, these Reports provide the base work in the field of evaluation of minimum environmental flows in the rivers which can be used in future for further elaborate studies. Similarly, the Report submitted by the Committee on 'Legal and institutional implication of the implementation of the recommendations of the Working Group' submitted in 2009 gave its recommendations on the legal aspects of the issues involved in this matter. Therefore, these Reports would be of immense use for future development in this domain.

3.26 It is, however, observed that as on 19.11.2014 arsenic is not listed in CPCB's list of NABL accredited analytical parameters for water and waste water Laboratory, as evident from the list displayed in the CPCB website under the link infrastructure – Laboratories – Water and Waste Water Laboratories – List of NABL Accredited Analytical parameters.

(iii) Absence of Soil Monitoring

3.27 Concerned about absence of monitoring of arsenic content in soil as a result of arsenic contaminated ground water irrigation, the Committee enquired about water quality control for irrigation purposes. The Ministry of WR, RD & GR stated in a written reply that Central Ground Water Board (CGWB), monitors ground water quality of shallow aquifers on a regional scale, once in every year, during pre-monsoon (April/May) and generate background data on ground water quality. Ground water quality monitoring indicates the status of ground water contamination on regional scale. Besides this, ground water quality data is also generated during hydro geological studies and ground water exploration. The findings of ground water monitoring and various scientific studies indicate suitability or otherwise of quality of ground water for irrigation purpose. The data and reports are shared with State Government for taking necessary remedial measures. The Ministry WR, RD & GR informed on 19.11.2014 that soil analysis for contamination of arsenic is not being carried out by CGWB.

3.28 In response to a pointed query as to whether there is any plan to monitor the arsenic build up in soils in the arsenic affected areas and to take remedial action, DARE stated that ICAR is not monitoring the arsenic build up in soils. DAC, however, stated in this regard in a written reply that it relates to Ministry of WR, RD & GR which is mandated for periodical assessment of arsenic contamination in ground water.

CHAPTER – IV

Remediation

(i) Remedial Measures

The M/o WR, RD & GR have stated that the initiative to combat the menace of Arsenic hazards, in true sense, came into existence in the year 1992. From 1992 onwards, Government of West Bengal and Central Government, along with several academic Institutions and Non-Governmental Organizations, have initiated a number of measures coupled with action plan. Their main focus was on the detailed investigations to understand the physiochemical process and mechanism, alternate arrangement to supply Arsenic free water to the affected populace and the development of devices for Arsenic removal and their implementation at the field, etc. The steps and measures to combat the groundwater Arsenic menace also includes public awareness programs, devising and demonstrating some of the results acquired from scientific analysis. Some of the important steps taken by West Bengal Government are as follows:

“

i. Most of the infected hand pumps and tube wells, which were being used for domestic usages in the Arsenic affected areas, have been largely identified and put into hold for further usages.
ii. The problem of groundwater Arsenic contamination has been prioritized in the state and an ‘Arsenic Task Force’, comprising technical experts from different disciplines working in the state, has been constituted to prepare an Arsenic mitigation action plan report for the aquifers in the Arsenic infested districts.
iii. A ‘Master Plan’ has been prepared for the entire state under the guidance of the ‘Arsenic Task Force’; to provide Arsenic free water to the Arsenic affected villages using surface water and groundwater based schemes with the provision of Arsenic Treatment Unit.
iv. Public Health Engineering Department, Government of West Bengal has established district level chemical laboratories for detecting Arsenic content in groundwater. Those chemical

laboratories have been equipped with equipments to detect trace elements including Arsenic.

v. A number of surface water based schemes have been put into operation in places, wherever they are feasible, with provision of chemical treatment.

vi. Arsenic removal plants, based on various treatment technologies to treat Arsenic contaminated groundwater, have been installed in many places and put into operation to provide potable water to the affected populace where there were no access of other sources of potable water supply.

vii. Arsenic free deeper aquifers and wells explored and constructed by CGWB have been put to use by the state agencies for public water supply.

viii. Arsenic content in food chains and their effect on ingestion have been analyzed. However, what forms of arsenic, organic or inorganic, are present in groundwater and the degree of consequantial impact of arsenic containing food chains on human health is yet to be established.

ix. R&D studies focusing towards understanding source and causes, geochemical prcesses, extent of mobilization, social and health hazards, impact on food chains, etc. have been initiated."

4.2 To a specific query as to why it took almost 10 years to initiate steps to combat arsenic hazards in West Bengal, where the problem surfaced in 1983, the M/o WR, RD and GR, stated as follows:

> "After initial detection of Arsenic affected patiests in 1982-83, water analysis drive was taken to assess the contamination level. In the year 1988, Government of West Bengal under the aegis of Technology Mission, funded by Government of India, initiated a project to study the nature, extent and cause of contamination. A Steering Committee was constituted by the State to formulate further strategies, on the basis of the study which has submitted its report in June, 1991. Subsquently, the State Government constituted another committee for further study in 1992; the final report of this committee was submitted in October, 1994. The committee suggested mitigation plan recommended for funding. Accordingly, the State PHED started implementing measures through ARP and awareness raising programmes including exhibition etc. to co-ordinate different activities related to assessment and remediation of Arsenic contamination, the State Government constituted a Task Force in the year 1995, which was subsequently reconstituted in July, 1999, September 2001 and

further in September, 2003. This committee was chaired by Prof. Nath, President, Institute of Public Health Engineers India."

4.3 The M/o WR, RD & GR stated further in a note that the schemes adopted as remedial options can broadly be grouped as under:

"

i. Uses of surface water sources**:** Supply of surface water from ponds, rivers etc. for drinking purposes through pipe network system after suitable purification by conventional method of treatment viz. coagulation, flocculation, rapid sand filtration and disinfections, as an alternate option, have been put into practice in some places by the State Government.
ii. Exploring and harnessing alternate Arsenic free aquifer: The Arsenic contaminated zones mostly lie within the shallow aquifer (<100m bgl). But in many places the shallow aquifer is free from Arsenic contamination. Such risk free potential zones in the shallow aquifer provide scope for tapping. The deep aquifers (>100 m bgl) underneath the contaminated shallow aquifer, are normally Arsenic free. It is observed that properly designed tube wells are capable to harness deeper Arsenic free aquifer. Taking into consideration the above scientific propositions, the Public Health Engineering Department (PHED), Govt. of West Bengal, has put into operation, few water supply schemes tapping deeper Arsenic free aquifers for water supply.
iii. Removal of Arsenic from groundwater using Arsenic treatment plants/filters: A number of Arsenic removal devices, developed by various organizations, based on different scientific propositions have been put in practice. Central government, state government, academic institutions and few private organizations have implemented number of Arsenic removal devices in many places to provide treated Arsenic free water to the populace. These devices vary in size, filtering mechanisms, and mechanisms of operation. Based on the size, the schemes can be categorized as 'Arsenic Removal Unit (ARU)' and 'Arsenic Removal Plant (ARP)'. ARUs are those, whose inlet are directly connected to a hand pump or tube well. Arsenic Removal Unit is normally a small assembly which can meet requirement of water for a smaller section of people. ARPs, on the

other hand, are those units, which have the capacity to treat a large quantity of water and can cover a large section of populace. However, most of the Arsenic removal devices particularly, ARUs, failed to produce satisfactory results mainly due to the shortcomings in operation and maintenance. The Arsenic removal devices, whose O & M aspects are managed by community participation, could produce a satisfactory performance.

iv. Adopting rainwater harvesting/ watershed management practices: Rain water harvesting in Arsenic affected areas, can prove to be a promising alternative. The recharged water will lower the concentration of arsenic in ground water by way of ground water."

4.4 State-wise number of Arsenic affected habitations which are yet to be provided safe drinking water, as furnished by the Ministry of Drinking Water and Sanitation is given in **Appendix – V**.

4.5 In response to a suggestion made by an expert that water conservation and rain water harvesting be adopted to mitigate arsenic contamination as a long term measure, the M/o WR, RD & GR stated that water conservation, rain water harvesting and artificial recharge are measures which may augment ground water besides diluting Arsenic concerntraiton. Model designs for terrain specific artificial recharge and rain water harvesting structures along with tentative costs have been circulated to state governments for construction under MGNREGA and other schemes.

4.6 An expert (Dr. Ashok Ghosh, Prof. In Charge, Dept. of EWM, A.N. College, Patna) suggested inter-alia in a memorandum submitted to the Comittee that there is a need to gain understanding of arsenic mobility from a geological and fluid flow perspective and predict arsenic behaviour in rapidly shifting redo conditions towards development of drinking water treatment concepts (settlement scale). Responding to this suggestion, the M/o WR, RD & GR stated that CGWB has been involved in identification of arsenic free aquifers. Tube well construction

practices in arsenic infested areas must take into consideration proper sealing of contaminated zones from the deeper arsenic free zones. The reason for elevated arsenic concentration at depth is absence of invervening clay layers which restricts downward flow of contaminated water to deeper levels. For identification of arsenic free aquifer it is absolutely essential that hydraulic parameters and water quality of different water bearing zones are ascertained. CGWB has carried out scientific investigations in and around the arsenic areas including exploratory drilling as a part of ongoing activity under of ground water exploration to delineate of arsenic free aquifers. On identification of arsenic contamination during the exploratory drilling, arsenic contaminated zones are sealed and arsenic free zones are identified by CGWB and tapped for arsenic free water. The scientific parameters along with well design evolved are share with State Government as a Technology Transfer, for guiding them to take up future ground water development in arsenic affected areas. The wells constructed by CGWB tapping arsenic free zones are being haded over to the State Government departments for water supply. Further stated that under Aquifer Mapping and Management Programme (NAQUIM), CGWB has taken up aquifer mapping programme in quality affected areas including areas with arsenic contamination, wherein these issues are expected to be addressed.

(ii) Remediation Technologies

4.7 To a query regarding filter equipments available for making water arsenic free at supply point itself, an expert from IIT, Kanpur (Prof. Saumyen Guha, Department of Civil Engineering) who appeared before the Committee on 22 September, 2014 stated as follows:

> "Essentially, AMAL Filter is being implemented in 15 to 20 villages. It was designed by Prof. Amal K. Dutta of BESU, and it is working sicne

1997-99. The main problem with it is that one does not know when the filter is exhausted because Arsenic analysis is not easy. So, what they do is that before they install the filter they go to that village and create a local user group and trian them for sampling. They bring the sample occasionally every 15 days to the lab; get it tested; and if the exorbitant has exhausted, then the BESU people once change the exorbitant. This has been going on for years now."

4.8 Adding further, the expert submitted as follows:

"For large scale, I recommend changing of the water source. Even if you try to remove arsenic at large scale, your economy will play out. In large scale, change it to surface water and treating them with standard water treatment procedure will actually be cheaper. I only recommended this filter for small scale pockets. Investing large money in water treatment system will not be a good idea. That is why, the solution has to be scale dependant."

4.9 The details of technologies for removal of arsenic from ground water and kits for field testing of arsenic as furnished by CSIR are brought out below:

(A) Ceramic membrane based cost effective technology with novel nano-sorbent for Arsenic and iron free potable water in rural India

4.10 The conventional processes for Arsenic removal involve chemical precipitation, oxidation and coagulation which often show lower efficiency, consumption of chemicals and produces toxic sludge. To overcome this, novel ecofriendly sorbent material has been developed having higher sorption capacity of Arsenic using a green synthesis technique.

4.11 Central Glass and Ceramic Research Institute (CSIR-CGCRI), Kolkata has developed a novel hybrid process consisting of adsorption of Arsenic by a proprietary media suspended in water and separation of the same by ceramic membrane filters under cross-flow filtration condition for simultaneous removal of Arsenic and iron from highly contaminated ground water containing 0.9 ppm – 1.3 ppm Arsenic and 5 ppm–12 ppm iron.

- The level of purification achieved is as per WHO recommended limits for Arsenic (<0.01 ppm) and iron (<0.3 ppm) in drinking water.
- The technology is capable of treating ground water containing higher concentration of Arsenic (up to 1.3 ppm) and iron (up to 12 ppm).

4.12 The technology for production of quality drinking water from Arsenic and iron contaminated ground water is based on the principle of aerial oxidation of As(III) & Fe(II), adding nano-colloidal media in water for adsorption of Arsenic and separation of suspended adsorbent using ceramic micro-filtration membrane modules developed by CSIR-CGCRI. Contaminated ground water is pumped to a tank containing the adsorbent media and the raw water is allowed to come in contact with the suspended media for a pre-determined time depending on the concentration of Arsenic and iron in the raw water. The contaminated water along with the colloidal media is then passed through tubular ceramic membrane module under pressure for separation of the media particles in the retentate stream and production of safe drinking water as the permeate. The adsorbent media is not required when only iron is present in the ground water.

4.13 Simultaneous removal of Arsenic, iron, turbidity from contaminated ground water and production of sparkling quality water (comparable to packaged/bottled water), low pressure (< 2 Kg/cm^2) operation and low power consumption (use of indigenous pump of 2HP or 3 HP) make the technology more attractive. The capacity community model plants can vary from 2500 LPD to 10, 000 LPD while the hand pump attached unit is generally of 2500-5000 LPD capacity for supplying drinking water to 500-1000 people.

4.14 The CSIR-CGCRI technology has been patented in Bangladesh (BD5912002, dated 28.03.2002), Chili (CL605-2002 dated 28.03.2002), Taiwan (TW91106287 dated 29.3.2002) and USA (Patent no. 7,014,771 dated March 21, 2006).

4.15 A pilot plant of 60 LPH capacity, based on this technique has been running for seven years using single channel ceramic tubes and providing sparkling quality water containing Arsenic (<10 ppb) and iron (<0.3 ppm) content conforming the WHO specifications.

4.16 Four community model plants (2500 LPD capacity) are in operation for community supply of drinking water in North 24 Parganas district of West Bengal.

4.17 CSIR-CGCRI is in the process of installing one 8 m^3/hour ceramic membrane based Arsenic and Iron Removal Plant in Ramchandrapur, Dist. Malda, West Bengal in collaboration with PHED, Govt. of West Bengal at the site provided by them. This plant has been developed by CSIR-CGCRI and the technology is transferred to M/s Porel Dass Water & Effluent Control Pvt. Ltd., Howrah.

(B) The following technologies for water purification using low cost ceramic membranes have been developed and demonstrated for mass application:

- Technology for Arsenic & Iron Removal form Groundwater (2500-5000LPD capacity);
- Technology for Iron Removal from groundwater (2500-10000LPD); and
- Membrane based pretreatment system for BRWO/SWRO Plants (10000LPD capacity).

Salient features

Technical

- The level of purification achieved is as per WHO recommended limits for Arsenic (< 0.01 ppm) and iron (< 0.3 ppm) in Drinking Water;
- Simultaneous removal of Arsenic and Iron from contaminated ground water makes the technology still more superior;
- The technology is capable of treating ground water containing higher concentration of Arsenic (up to 2.7 ppm) and iron (up to 13 ppm); and
- Minimum sludge generation to higher adsorption capacity of the colloidal media.

Operational

- The ownership of the plant by the local population;
- Management by local people, thereby generating employment;
- Operation and maintenance cost is raised by contribution of the users against supply of water; and
- The concept could be made operational for the basic reason that the quality of the purified water is much better than those available currently using alternative technologies.

Technology Utilization

- 63 Nos. Ceramic Membrane Based Community Model Plants installed for Iron & Arsenic removal, are in Operation in WB and North Eastern states (8 States); and
- 22 Nos. Iron Removal plants have been installed by Private Entrepreneurs (self / bank financing) under SSI sector with the opportunity of employment generation.

(B) Cation exchange resins for selective removal of Arsenic from water of normal salinity

4.18 CSIR-Central Salt and Marine Chemicals Research Institute (CSIR-CSMCRI) has developed cation exchange resins for selective removal of Arsenic from water containing up to 200 ppb Arsenic.

4.19 The technology developed helps in selective removal of Arsenic or fluoride from drinking water containing Arsenic up to 200 ppb or fluoride up to 10 ppm and requires

no electricity for operation of the plants.Water purification units from domestic size to community scale capacities can be madebased on the technology.

Technology Utilization

- 65 domestic and 10 community scale dearsenificating units containing the developed resin were installed in the Arsenic affected villages of West Bengal. Each domestic and community scale unit can produce 25 and 250 liters of Arsenic free waterper hour respectively. Arsenic concentration in treated water is within the limit prescribed by WHO;
- 10 domestic defluoridation units (25 liters/hour) have been set up in Gujarat and Tamil Nadu;
- Each of the community scale units produced ~ 200000 ltr. of Arsenic free water without regeneration of resin since their installation i.e. January-2013; and
- Another 50 dearsenification units are under fabrication for installation in West Bengal, under the scheme sponsored by MoEF.

(D) Chemo-Dearsenification Technology for Arsenic removal

4.20 CSIR-National Environmental Engineering Research Institute (CSIR-NEERI), Nagpur has developed aChemo-dearsenification technology using iron in the chemical form [i.e. Ferrous Sulphate ($FeSO_4.7H_2O$) and Ferric Chloride ($FeCl_3$)]to remove Arsenic from spiked waters. The technology involves the utility of the combination of $FeSO_4.7H_2O$ and H_2O_2(as Fenton's reagent) and the combination of $FeCl_3$ with $KMnO_4$for Arsenic removal.The process was found to be efficient for Arsenic removal

from ground water. The technology allows for installation of household Arsenic removal units in Arsenic affected areas.

The salient features of the technology are:

- Requires no power (electricity or battery);
- Environment-friendly;
- Easy to operate and maintain;
- Treated water quality as per WHO Guideline value; and
- Cost Effective.

4.21 Field evaluation of the developed Arsenic removal units was conducted using real life ground water samples from Kaudikasa village, Rajnandgaon District, Chhattisgarh. The developed units were tested with two ground water samples with higher Arsenic concentrations i.e. 929 and 2634 ppb to bring about Arsenic removal to desired concentrations. The developed units exhibited good removal efficiency using the field samples: the residual Arsenic concentrations where ≤ 10 ppb i.e. WHO guideline value for Arsenic. The measured values of pH, conductivity, turbidity, iron, manganese, sulphate, chloride, residual chlorine and potassium were also well within the desirable range as per BIS (**IS: 10500, 2012**).

Technology Implementation

4.22 Five household Arsenic removal units using Fenton's reagent have been successfully installed in the Arsenic affected area of Kaudikasa village of Chowki block in Rajnandgaon district of Chhattisgarh state of India. The technology was found to be cost effective, simple and easy to operate, environment friendly and most importantly reduces Arsenic concentration below 10 ppb, the WHO guideline value for Arsenic.

(D) Arsenic removal from water using calcined Mg–Al layered double hydroxide (LDH)

4.23 Inorganic adsorbents for removal of Arsenic from drinking water were developed by CSIR-North East Institute of Science and Technology (CSIR-NEIST), Jorhat in collaboration with Defense Research Laboratory (DRL) Tezpur at laboratory scale.Calcined Mg–Al layered double hydroxide (LDH) adsorbents were developed for Arsenic removal from water.

4.24 It was found that layered double hydroxide with the general formula $[M^{2+}_{(1-x)}M^{3+}_{x}(OH)_2]_xA_{x-n}H_2O$ due to their large surface area and high anion exchange capacity are good adsorbents for the removal of Arsenic from contaminated water. Laboratory results demonstrated that there is removal of 99.99% Arsenic from a solution of 100 ppb of Arsenic and the adsorbent required at saturation was 0.10g/20 ml Arsenic solution with 90 min of exposureat (30±1)℃. Factor s like pH, adsorbent dose and shaking time distinctly influenced the rate of Arsenic removal.

4.25 The Preliminary Cost Estimation on the basis of 2009 prices show that for the production of Mg-Al Layered Double Hydroxide on a 100kg/batch/day capacity plant, the cost of production is Rs 100/Kg. In due consideration of the high efficacy of the adsorbents and their reusability, the adsorbents are expected to be highly beneficial in the actual field conditions. CSIR-NEIST has carried further scale up study on the pilot

scale level production of these Arsenic removing adsorbent materials and is exploring technology transfer opportunities.

(E) Arsenic removal using naturally occurring minerals

4.26 CSIR-National Metallurgical Laboratory (CSIR-NML) has developed a process technology for Arsenic removal using naturally occurring minerals. It is helpful in Arsenic and iron remediation.

4.27 Field trial for about three months in 50 households in Sahebgunj district has shown that the technology is technically viable, i.e., it can remove iron and Arsenic present in water to the desired level. The sludge generated thereby can be easily contained, which however, requires a concerted methodology for its collection. This can be accomplished at the village level through panchayats and self help groups. The consumables' cost is very low and well affordable by all sections of people. Discussions are currently on-going for transfer of the technology.

CSIR Kits for Field Testing of Arsenic

(a) Standard Mercuric Bromide Stain method

4.28 CSIR-National Environmental Engineering Research Institute (CSIR-NEERI) has developed a facile method for Arsenic testing. It is based on the Standard Mercuric

Bromide Stain method and eliminates most of the drawbacks observed in the existing kits, available in market. The process is simple: the chemicals are added to the sample water and the colour developed is compared with colour strips provided in the kit to estimate Arsenic concentration in the water. The method provides for precise and accurate determination of Arsenic levels >50 ppb, with detection range of 0.01-1.0 mg/L Arsenic. A yellow stain is developed at low Arsenic concentrations, while a black spot is developed at high Arsenic concentration. The developed kit enables conduct of 100 tests per kit. The technology has been transferred to entrepreneurs.

(b) Semi-quantitative Arsenic detection kit

4.29 A semi-quantitative Arsenic detection kit has been developed by CSIR-CSMCRI which can detect Arsenic in ground water semi quantitatively up to 10 ppb and on wards-up to 500 ppb. The kit is equivalent to commercially available kits in the market. The performance of the kit has been found to be reproducible even after 1 year and can be stored at ambient temperature.About 150 test kits were distributed among the affected population of the area in 24 Parganas (N), WB.

4.30 When asked as to why no single effective filtration device has been developed that can meet the localised need of the rural people in the country even after 30 year of the problem first surfacing on a large scale, the M/o WR, RD & GR stated:

> "As per the information provided by Ministry of Drinking Water and Sanitation, there are a number of effective technologies for treatment of Arsenic in drinking water. Since each technology has its pros and cons and its selection is also dependant on cost of the technology, it is not appropriate for the Ministry to decide any single filtration system for Arsenic treatment. With support from CSIR-NEERI, Nagpur, the Ministry had documented "Handbook on Drinking Water Treatment Technologies" in the year 2011, which includes some of the most suitable technologies for treatment of variety of contaminants including Arsenic. The Technology Manual has again been got updated in the year 2013 with support of NEERI-Nagpur and has been provided to all the States."

(iii) <u>Medical Treatment</u>

4.31 Regarding curability of the arsenic diseases, the M/o H&FW stated that acute consumption for short term may cause gastrointestinal symptoms including nausea, vomiting and diarrhea, cardiopulmonary toxicity and neurological effects like headache, seizures and neuropathy. Intensive gut decontamination with chelating agents unithiol 3-5 mg/kg intravenously every 4-6 hours or dimercaprol 3-5 mg/kg intramuscularly with supportive therapy are the mainstays of treatment of acute cases.

4.32 Chronic consumption of drinking water with arsenic concentrations more than permissible limits may produce symptoms involving skin, risk of development of diabetes and cancer. Exposure of arsenic in pregnancy could result in fetal malformations. Management of chronic poisoning consists of termination of exposure and symptomatic supportive care.

4.33 On the question of preventive steps, a representative of the M/o H&FW stated as follows:

> "Sir, unfortunately, so far, all the preventive aspects have not been taken up by the Ministry of health. Only the curative aspect and the medical aspects have been looked after"

4.34 Emphasising the need for creation of National Health Programme for ground water quality related health problems, a Working Group on "Sustainable Groundwater Management" in its report submitted to planning Commission in 2011 suggested that a National Health Programme for ground water quality related health problems needs to be created, within the Ministry of Health, so as to forge convergence with groundwater quality monitoring. This programme should include establishment of diagnostic facilities in areas with severe health implications of ground water contamination, execution of surveys and imparting training for mitigation measures. Specifically the surveys that can be carried out immediately are those on flurosis , (Dental Flurosis and skeletal Flurosis for children especially through school health surveys), Arsenosis, accurate database for Enteretic related problems , renal stone surveys , relating to incidence of other diseases such as high cancer rates to possible water quality problems such as heavy pesticide use or industrial effluents). There is a need to recognize the linkage between malnutrition and water quality related problems particularly in the context of urban/health poor.

4.35 In response to a query as to what action was taken on the above suggestion, the representative of the M/o H&FW stated on 27 October, 2014 as under:

"Sir, to the best of my knowledge, this convergence has only taken place for Kala Azar. That is the only Inter-Ministerial Committee that we have right now. We do not have Inter-Ministerial Committee for arsenic, etc."

4.36 The representative of the M/o H &FW, added further in the connection:

"Unfortunately, the Ministry has not formulated any national programme for these ground water problems as yet. However when I called the experts last time, I had suggested a Task Force of experts to give us the recommendation of what kind of programme we should run. That we should be able to do soon."

4.37 In response to a specific query as to why despite the detection of arsenic contamination way back in early 1980's suitable steps were not taken to address the problem in its entirety, the witness stated as follows:

"As far as the State issues are concerned, we do not want to stop at saying that it is a State subject. Once the State Government brings up, the funding will be made available under the National Health Mission. That is not a problem. Even for diagnostics, we will be able to support them with funds.

Testing has been a major issue and as far as testing is concerned, I have discussed it with the experts and they feel that we could set up some kind of a testing facility at the district level to begin with, apart from the forensic facility which is available at the State level, and we will be advising all the States to prepare the plan for the districts. We will fund it under the National Health Mission.

Third, the basis of all this, if I may be permitted to say, has to be a national programme, which we need to formulate. Once we have a national programme in place, the policy or the direction that we are thinking of, will get inbuilt into that national programme. Testing will come from it and research will flow from it.

Prevention relates to not having arsenic mixed water. Unfortunately, in the country, even with the best of efforts, that has not yet happened. We need to do that. We need to get together with the Department of Drinking Water to ensure that we are able to achieve that. But till such time that we are able to achieve that, the Ministry's mandate will be to ensure that whoever is suffering from it, is cured and medicines are provided to him. For that we will try to build a programme and I am hopeful that we will try and bring back focus on to this, which was not there.

Next, we will constitute a task force and will try to see that drinking water remains a part of it because the major input will come from there."

4.38 In view of the involvement of multiple Ministries such as Ministries of (i) WR, RD & GR, (ii) Drinking Water and Sanitation, (iii) Agriculture (Department of Agriculture Research and Education and Department of Agricultural Cooperation), (iv) Health and Family Welfare (Department of Health), (v) Science and Technology (Department of Science and Technology), (vi) Environment and Forests and Research bodies such as ICMR, ICAR, CSIR etc., for tackling different aspects of arsenic contamination , the Committee sought to know during oral evidence of the Ministry of Health and Family Welfare whether there is any Central Task Force for dealing with arsenic problem. The representative of the Ministry of Health and Family Welfare stated during oral evidence on 27th October, 2014 that there is no Central task force dedicated towards arsenic as of now.

4.39 Regarding constitution of a Task Force, the representatives of the M/o. H&FW submitted as under:

"We will constitute the Task Force now and within two to three months, we should have a report with us, hopefully."

4.40 In response to a query as to the timeline for report of the Task Force, the witness stated as follows:

"Sir, I would say by February, if I may be permitted to say so. It is because we are still in the process of constituting the Task Force. We have not yet finalised that. But we should be able to do it."

4.41 To a query about the availability or otherwise of standard tests / methods / instruments for early detection of arsenic content in the body, the representative of M/o H&FW stated during evidence on 27 October, 2014 that:

"I have had a discussion with the experts who have suggested that there are two types of testing, which is possible. One is blood test sample, which the experts even sitting here, do not agree among themselves that it is conclusive. The second is a test of a nail and hair, which actually

establishes arsenic content. Unfortunately, that test is only available in the forensic science laboratories, right now; and we do not have it at the district level for testing. That is our problem as far as testing is concerned. So, we need to create some infrastructure."

4.42 In written response to a query as to why no health initiatives e.g. Mobile team to treat patients, provision of necessary medication at subsidized/no cost to all of the 'at risk' population was taken, the M/o Health and Family Welfare (ICMR), in a written reply stated that provision of health services is under the purview of State Government, since health is a state subject.

4.43 In response to a query as to whether any relief measures have been provided to affected citizens, in terms of medical care, compensation (for medical treatment costs), safeguards etc. the M/o Health and Family Welfare (ICMR), stated that the information relating to compensation and other relief measures may be available with the respective State Governments.

Socio Economic impact of arsenic contamination

4.44 Pointing out that the arsenic problem has a major effect on the socio economic structure, the vision document has observed that a good portion of 500 million people, living in the 569749 sq. km of the Ganga-Meghna-Brahmaputra belt, live in danger of drinking arsenic contaminated water. Around 30% of this populace is constituted of illiterate inhabitants who live below poverty line. Affected populace are those who are economically backward and lack in nutritious food. Women are affected the most compared to men. Further, infants and children are adversely affected than the adults. An arsenic patient loses his strength and cannot work outdoors, but his family incurs more expenses than before because of his illness. Many of them borrow money from the local moneylender who charges them a high rate of interest, i.e. 5-10 monthly compound interest. Often villagers lose all their earthly possessions including the roof over their heads, trying to pay the moneylender back. Society too, turns an arsenic patient into an outcast. The arsenic problem, thus, has a major effect on the socio-

economic structure. People often mistake symptoms of arsenic poisoning for leprosy or other contagious skin diseases, and thus marriage, employment, and even the simplest social interaction become impossible for the victim. Thus, an arsenic patient often becomes depressed and sometimes even tries to commit suicide.

4.45 The socio economic effects of Arsenic contamination are severe because people often mistake the symptoms of arsenic poisoning for leprosy or other contagious skin diseases, and thus marriage, employment and other social interactions become impossible for the victim. In response to a query as to whether the Government have any rehabilitation and reintegration program in place, to help the victims psychologically, the M/o WR, RD & GR stated as follows:

> "As per the information provided by the Ministry of Drinking Water and Sanitation (MoDWS), the Ministry is aware about the socio-economic issues pertaining to Arsenic contamination of drinking water. Excess Arsenic causes Melanosis and Keratosis, which may also lead to cancer and other diseases. MoDWS has advised States to paint the hand pumps in red colour where excess Arsenic has been found and not to drink Arsenic contaminated water. All the Arsenic affected States have been advised to focus on awareness generation activities in Arsenic affected habitations. For conducting IEC activities, the Ministry provided NRDWP-Support Funds (5%) as 100% Central share."

CHAPTER - V

Research and Development

(i) R&D Arsenic Mitigation

The Ministry of Science and Technology (Department of Science and Technology) launched Water Technology Initiative in the year 2007-08. A Technical Expert Committee constituted by the Government of India, identified 26 major water challenges prevalent in the country. One of these challenges was geogenic contamination due to Arsenic.

5.2 The R&D activities promoted by the DST focused primarily on the issues related to removal of Arsenic from the drinking water and detecting the presence of Arsenic in drinking water. The R&D challenges identified by the DST included the following.

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(i) Development of cost effective and efficient materials for Arsenic removal based on locally available resources.

(ii) Cost effective detection techniques with technical performance better or comparable to currently available alternatives

(iii). Development of household and community Arsenic removal systems based on indigenously developed materials

(iv). Field demonstration of developed systems to assess their suitability in specific social context."

5.3 The objective of the R&D activities was to develop adsorbents which were cheaper yet efficient for removal of arsenic from drinking water. Various types of adsorbents were prepared and their loading capacity was compared with other alternatives. Attempts were made to develop adsorbents superior to commercially available adsorbents for a wide range of operating condition i.e. pH & temperature, having larger surface area and higher adsorption capacity. Further, suitable encapsulation and stabilization of the developed material through appropriate

techniques was undertaken to enable their prolonged use with least adverse effect on the efficiency.

5.4 Considering the fact that Arsenic (III) removal was quite difficult, efforts were also made to develop improved methods besides chemical oxidant for faster conversion of Arsenic (III) to Arsenic (v). Recognizing the importance of developing low cost detection techniques for estimation of Arsenic in ground water, efforts were made to develop cost effective field test kits having shelf life, detector strip sensitivity, incubation time and interference due to presence of other contaminants, better than or at least comparable to commercially available imported test kits.

5.5 The promising leads obtained from the investigations of various materials were taken to the next logical steps which focused on lab scale studies of these materials for spiked as well as naturally contaminated Arsenic laden water.

5.6 The successful lab scale systems were up scaled and prototypes were tested in real field conditions. The systems which conformed to technical performance parameters and found large community acceptance were replicated in larger numbers to generate enough scientific data for validation.

5.7 Several R&D projects, involving water treatment systems/ processes, devices, materials, etc., for providing safe and adequate drinking water have reportedly been initiated. The DST has so far supported around 25 R&D projects at a total cost of Rs 675 lakh. The accomplishment of some of these projects is summarized in the table below:-

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S. No	Project(s)	Achievements
1	Development of low cost household filter for arsenic and other pollutant-free drinking water using modified laterite.	❖ Development of highly efficient modified laterite adsorbent (24 mg/g of Arsenic V). ❖ Design and installation of arsenic filter for domestic (120

	Field trial of low cost laterite based arsenic filter: Domestic and community scale Prof. Sirshendu De, Department of Chemical Engineering , Indian Institute of Technology, Kharagpur-721302	L/day) and community (500 L/day) scale integrated with alum dosing to remove iron and bacterio-static carbon to remove coliform. ❖ Evaluation of 10 domestic filter and 1 community filter revealed successful performance.
2	Implementation of Cost Effective Household Arsenic Remediation Technology in West Bengal. Demonstration of Cost-Effective and indigenous Domestic Arsenic Remediation Technology for Arsenic Mitigation in arsenic affected areas of India Save the Environment , Kailash Ghosh Road, Kolkatta- 700 008	❖ Technology sourced from Naval Materials Research Laboratory (NMRL) Ambernath (DRDO). ❖ Design of Cost effective, requires no power, environment friendly, easy to maintain & operate household Arsenic removal filter ❖ Utilisation of locally available processed waste of Steel Industry for co-precipitation of arsenic with iron. ❖ Demonstration in in North 24 Paraganas (West Bengal), Balia (UP) and Bhagalpur (Bihar).
3	Development of arsenic adsorbing polymeric beads and their performance study in packed bed columns Development of prototype systems to produce arsenic-free safe drinking water Prof. Priyabrata Sarkar Department of Polymer Science and Technology, University of Calcutta, 92 A.P.C. Road, Kolkata-700 009	❖ High capacity Arsenic adsorbing beads (17.5 mg/g of Arsenic V) based on synthesised nano-alumina dispersed in chitosan grafted poly-acrylamide. ❖ Development of ceramic filter candle containing adsorbents immobilized/ micro encapsulated in polymer matrix for removal of Arsenic from drinking water ❖ Interference and optimisation studies required to assess suitability for field use.

4	Field Application and Management of community based Arsenic Removal units in Rural Areas of West Bengal Dr. Asis Mazumdar School of water resource Engineering, Jadavpur University 188 Raja S.C. Mulik Road,West Bengal-700032	❖ Field model (800-1000 lt/hr) based on co-precipitation, adsorption and filtration mechanism developed for Arsenic removal. ❖ Hand-pump attached units demonstrated at 3 locations, each benefiting around 50 families. ❖ Unit does not operate under pressure. ❖ Possibility of upscaling for higher capacity
5	Field Test Kit for Arsenic in Water Prof. Priyabrata Sarkar, Department of Polymer Science & Technology, University of Calcutta, 92 A.P.C. Road, West Bengal, Kolkata	Mercuric bromide and silver nitrate detector element low cost kit for total arsenic and arsenate, ❖ Colorimetric sensor for ppb level arsenic contamination in drinking water. ❖ Dip Stick colorimetric sensor for detection of arsenate in drinking water.

6	Continuous Arsenic Removal Using Zero-valent Iron Filter (ARUZIF) from Drinking Water Development of continuous mode arsenic removal technology for drinking water based on indigenous zerovalent iron Dr Sanjeev Chaudhari, Professor, Center for Environment Science and Engineering, Indian Institute of Technology Bombay Powai, Mumbai- 400 076	❖ Development of a simple process that uses indigenous zero valent iron and a specially designed unit (which ensures good oxygen transfer, separation of Hydrous Ferric Oxide (HFO) flocs and uses locally available low cost granular media) for arsenic removal from drinking water. ❖ Two units operating at a flow rate of 600 litres per hour in villages of West Bengal from February 2008. ❖ 46 more such units have been installed in various parts of UP, Bihar, West Bengal and Assam.

7	Design consideration and field performance validation of high arsenic removal water filter packed with lab-bench developed materials: A lab-to-field technology transfer programme" Dr. S. Chakrabarti, Pesidency University, Kolkata.	❖ Synthesis of cost effective non hazardous Manganese incorporated Ferric oxide (MnFO) ❖ Arsenic removal using synthesized nanoparticles of MnFO ❖ Efficiency in removal of high Arsenic, Nitrate, Chloride, Phosphate contaminated water established. ❖ Sludge analysis indicates non hazardous nature of adsorbent
8	Ion-Specific Resins and Membrane based systems/processes to bring the level of Arsenic to WHO limits in drinking water Dr. K.M. Popat, CSMCRI, Bhavnagar.	❖ Pre-treatment of Arsenic contaminated water and removal of Arsenic by Reverse Osmosis (RO) process. ❖ Utilisation of sludge as bricks and no Arsenic leached out from these bricks ❖ Mercuric Bromide coated test strips developed for sensitivity upto 25 ppb. ❖ Use of indigenously developed Arsenic specific resin for final polishing of water being investigated.
9	Integrated technology for the removal of Arsenic from Ground Water Field scale trials of the ARI, Pune technology for the removal of arsenic from drinking water in Rajnandgaon District of Chhattisgarh. Dr. K.M. Paknikar, Scientist, Agarkar Research Institute, Pune	❖ Use of Microbacterium lacticum to oxidize arsenite (As3+) in groundwater rapidly to arsenate (As5+). ❖ Developed a unique 'integrated microbial oxidation alumina adsorption process for the removal of arsenic from groundwater rendering it completely safe. ❖ Feasibility on applicability of flat sheet liquid membrane based separation process for removal of Arsenic from groundwater.

10	Removal of Arsenic from Drinking water using polymeric membranes. Development of a low cost Adsorbent (Hydrogen Ferric Oxide) and household model for removal of Arsenic from Underground Water. Dr. U.K. Kharul, NCL, Pune Dr. G.P. Aggarwal, IIT Delhi Hauz Khas,Delhi	❖ Development of low pressure ultra filtration (UF) membrane process for effective and selective removal of Arsenic (As-V). ❖ Applicability of polyacrylonitrate (PAN) based negetively charged UF membrane for effective Arsenic removal. ❖ Membranes did not foul, worked for long and rejected 100% arsenic. However, efficacy reduced in the presence of Phosphate, Sulphate, Carbonate etc.
11	Development of Multichannel Ceramic Membranes with Optimum Channel Congiguration for up scaling the Technology for Purification of Arsenic Contamination Ground Water. Dr. S. Bandyopadhyay, Scientist, Central Glass and ceramic Research Institute, Jadavpur, Kolkata- 32	❖ Hybrid process using suspended adsorption media and cross flow micro-filtration for decontamination of Arsenic. ❖ Optimum Channel Configuration (Circular and Star) for minimising fouling of membrane surface.
12	Integrated Arsenic and Iron removal from contaminated ground water Dr. Robin Kumar Dutta, Department of Chemical Sciences, Tezpur University, Napaam, Tezpur, Assam**.**	❖ Development of a method based on oxidation-coagulation at optimum pH. ❖ Removes Arsenic as well as Iron from contaminated groundwater. ❖ Technique uses three common chemicals for coagulation and adsorption of Arsenic. ❖ Cost effective, user-friendly and works without electricity.

"

DST informed that most of the R&D projects were initiated since 2007. The field demonstration of these systems has taken place during 2012-13.

5.8 DST is stated to have promoted a network of researchers from leading R&D/ academic institutions working in the area of Arsenic from various parts of the country. It has been stated that DST and concerned R&D/ academic institutions have closely worked with district administration and line departments to facilitate allotment of land, accord necessary permission for treatment plants, facilitate provision of utilities, participation in setting up of plant and its operation, etc. Community interest was evinced through participation of local Non Governmental Organisations (NGOs) and field groups. Public Health Engineering Department (PHED) was involved in all the field demonstration initiatives.

5.9 The outcomes of these research efforts are also shared at various inter-ministerial fora including core committee on Arsenic mitigation.

5.10 The initiative of the DST is relatively nascent. However, the limited experience of the department has reportedly revealed the need to have last mile connectivity to translate the research outputs to field. DST has stated that while these R&D projects have proven their potential at lab scale, demonstration of capabilities of these technologies to provide convergent solutions with possible up scaling needs sustained efforts.

5.11 Evolving customized technological solutions for Arsenic removal from water suited to specific social context requires continued scientific and technological inputs. Recognising the immense value of the expertise developed and insight gained during the course of implementation of R&D activities for addressing water challenge related to Arsenic, the department is continuing this activity as part of the plan programme and proposes to develop synergies with state government, water resources Ministry and other stakeholders.

5.12 The Committee were interested in knowing how many of these research efforts have culminated into useful output in field. In response, DST indicated the following seven research efforts that have already culminated into useful output in field:

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i. AMRIT- Arsenic and Metal Removal by Indian Technology - Indian Institute of Technology Madras, Chennai, Tamil Nadu
ii. IITB Arsenic Filter (Zero Valent Iron based)- Indian Institute of Technology Bombay, Mumbai, Maharashtra
iii. DRDO Arsenic Removal Filter- NMRL-DIPAS/ DRDO, Mumbai/ Delhi
iv. Low cost Laterite base Arsenic Filter - Indian Institute of Technology Kharagpur, Kharagpur, West Bengal
v. Arsiron Nilogon- Tezpur University, Tezpur, Assam
vi. ARI groundwater arsenic treatment plant - Agharkar Research Institute, G G Agarkar Road, Pune, Maharashtra
vii. Arsenic Removal Unit- School of Water Resources Engineering, Jadavpur University, Kolkata, West Bengal"

5.13 When the Committee enquired whether there are any collaboration with global R&D institutions, DST stated in a written reply that two collaborative public- private R&D initiatives specific to arsenic removal are underway in country with leading US R&D institutions, under the aegis of Indo-US Science and Technology Forum (IUSSTF), a bilateral body co-promoted by DST and US Government. These are:-

i) Commercializing a patented Electro Chemical Arsenic Remediation (ECAR) technology which enables low cost affordable arsenic-remediation of water, within a sustainable service delivery model involving **Lawrence Berkeley National Laboratory, Berkeley, CA** and LIGTT Corporation, Oakland, CA, as US partners and Jadavpur University, Kolkata & Luminous Water Technologies Pvt. Ltd., New Delhi as Indian Partners. Under this model, safe water would be provided to school children while excess may be sold at a low cost affordable price. This public-private partnership would ensure that the plant is not abandoned due to failed maintenance that has plagued other implementations.

ii) Utilisation of a novel, locally-sourced Donnan Principle-based second generation Arsenic adsorbent (Donna-AFSorb) with a micro-franchise business model providing appropriate community-based or domestic water filters to villagers involving **Lehigh University, PA** , WIST, Inc., Brighton,

MA, as US partners and Rite Water Pvt. Ltd., Nagpur and Society for Technology with a Human Face, Kolkata is under implementation".

5.14 To a query as to the types of technologies which proved to be most efficient, cost effective, more acceptable and easy to operate and maintain, DST stated as under:

"In fact, this depends upon water quality. CSIR laboratories have developed water purification technologies, kits for arsenic testing and rice genotype which accumulates low arsenic when cultivated in arsenic contaminated water. Each of the water purification technologies developed by CSIR laboratories is unique in its own way, addresses the removal of contamination of one or more pollutants (arsenic, arsenic/iron, etc.) and can be deployed on domestic or commercial scales. The process of purification, treatment of sludge/ waste and the maintenance parameters largely depend upon the complexity of the technology. Arsenic concentration and variation in source water composition also impact the efficiency and applicability/appropriateness of a given technology. In addition to the technological parameters, the user parameters such as installation cost, operating cost, maintenance cost and requirement of skilled personnel, besides societal acceptance play an important role for a technology to be effectively utilized in the public domain. The user requirements vary widely and a portfolio of technologies that can enable one to choose an optimal one based on specific/identified need is thus desirable. The CSIR water purification technologies for arsenic contamination may thus provide options to the concerned stakeholder for necessary adoption. At community level CSIR's RO based technology has been found to be the most effective one."

5.15 The Committee asked about the reasons for lakhs of people facing arsenic menace and suffering arsenic related diseases despite a number of technological options for arsenic removal developed by CSIR and other organizations. In response, DST stated as follows:

"The issue is very complex. In addition to the efforts by the Government agencies, it requires partnership of the masses and corporates through Corporate Social Responsibility (CSR) framework. Technologies for arsenic removal developed by CSIR and other organizations address a very important issue of ground water contamination by the metalloid. The deployment of technologies for routine use is often dependent on the perceived gravity of the issue as well as the economics of suitable interventions. In the country, water is largely considered to be a commodity for which the public desires due Government interventions in terms of its supply and quality. The endeavor of providing quality potable water seeks the involvement of all stakeholders and it requires a continuous and

concerted effort for water source mapping, desired technology development and deployment. It requires partnership of R&D organizations, specific Government Departments/Ministries, industries and a sustainable business model, besides the acceptability of a technology by public at large. Like affordable health care, making available high quality potable water should also be taken in mission mode with an effective Public-Private Partnership model.

The research efforts have succeeded in demonstrating potential of technologies developed to provide potable water at reasonable cost to public. However, all these technologies could not be transferred to industry as rural water sector is not considered a lucrative sector by the industry. Having developed the technologies and demonstrating them successfully in field, the academicians/ scientists do not find further work challenging scientifically and mechanisms are limited to encourage them to convert their output to promote enterprises.

Globally, promising research leads from labs are picked up early by industries and converted into products/ processes. The industry perfects the process and also upscales the process to commercial level. In Indian context, as participation of established industry may not be possible in the early stage of development, direct support to research group for promoting start-ups may be considered by way of soft loan/ grant. A company incubated at IITM InnoNano Private Ltd has attempted to commercialise research outputs. Similar efforts by other research groups need encouragement. Policies regarding procurement at State level also need to support scientifically validated indigenous initiatives."

5.16 According to the Ministry of WR, RD & GR, in-situ remediation of arsenic from aquifer system or de-contamination of aquifer is the best technological option. It has, however, been stated that no R&D work regarding in-situ remediation of arsenic has been taken up by any Indian Institute. In a written reply to a specific query as to the reasons for not taking any initiative for R&D in this field by any Indian institute, the Min. WR, RD & GR stated as under:

"As per information available, in-situ remediation of Arsenic has not yet been taken up by any Indian Institute. However, as per the information available on the website, globally, since last two decades or so, a few institutions have initiated R&D for in-situ remediation of Arsenic, which are as under:

- United State Geological Survey, USA.
- School of Earth Sciences, University of Birmingham, UK.

- Utah Water Research Laboratory, Utah State University, USA.
- Queen's University Belfast, Northern Ireland, UK.

Prof. Dipankar Chakravarty Report, School of Environment Sciences, University of Jadhavpur; All India Institute of Public Health and Hygiene, and NIH are doing research in the field of Arsenic contamination and they are in touch with these four Institutions for developments of in-situ remediation of Arsenic."

5.17 To a specific query as to why Water Quality Assessment Authority (WQAA) has not funded any R&D project on arsenic contamination, M/o WR, RD & GR, in a written reply, stated as follows:

"As per information provided by WQAA, addressing the issues related with geogenic contamination is not under the mandate of WQAA. Arsenic being primarily a geogenic contamination, WQAA did not fund any R&D project regarding in-situ remediation of Arsenic in groundwater."

5.18 The Min. WR, RD & GR informed the committee that as per the information available on the website of PHED, the R&D Study on Efficacy of Arsenic Removal Plant for piped water supply scheme was first taken up at Sujapur in Kaliachak block of Malda district, West Bengal by PHED, Government of West Bengal in the year 1998. The R&D Study on Causes, Effects & Remedial Measures of Arsenic in parts of West Bengal was taken up by State Water Investigation Directorate, Government of West Bengal in the year 2000.

5.19 When enquired whether any effort has been made for collaboration or joint research between ICAR and other research institutes like NBRI , ICMR ,etc., in research activities of development of arsenic safe crops and water quality issues and in exchanging findings for appropriate follow-up action, DARE submitted as under:

"ICAR under National Agriculture Innovation Project (NAIP) funded project on 'Arsenic in food chain: cause, effect and Mitigation 'made collaboration with D.N. Guha Majumdar Research Foundation (a Medical Research Institution), Kolkata. However, no collaborative efforts were made with NBRI, ICMR and other institutions in this direction."

5.20 According to DARE, several weed species are noted to accumulate considerable amounts of arsenic in their biomass. However, such accumulation of arsenic does not necessarily lead to its detoxification per se unless the plant – accumulated toxin is effectively detoxifies within the plant body by its metabolic process. For this, a systematic search for phyto accumulating or phyto excluding plant species is necessary. In response to a query as to the status of research in this regard, DARE sated that the preliminary investigation has been made.

(ii) Development of Arsenic safe crops

5.21 It is observed from the joint memorandum submitted by two experts (Dr. C.S. Nautiyal, Director, CSIR-NBRI and Dr. R.D.Tripathi, Senior Principal Scientist, NBRI) that CSIR-National Botanical Research Institute, Lucknow in collaboration with Rice Research Station, Chinsurah, West Bengal under took the research work entitled "Characterization of low grain. Arsenic accumulating rice genotypes safer for human consumption" in 2006. Three sites were selected from West Bengal with different soil arsenic concentrations, in ascending order, Chinsurah<Purbosthali<Birnagar and cultivated about 300 rice genotypes over five years period Screening results indicated positive correlation between soil and rice grain Arsenic accumulation. Among the screened diverse rice genotypes, only nine cultivars viz., IET-4786, Dusmix-40 S Sankar, IR-64, Gotrabhog, Nayanmoni. CN 1643-3 and CN1646-2. CN1794-2-CSIR-NBRI were accumulating low grain Arsenic in grains at all the three sites. To validate the findings and reproducibility of results they further conducted multi-locational field trails (Chinsurah, Purbosthali, Birnagar, Gaighata, Durgapur, Beldanga) in different agro-climatic zones of West Bengal differing in soil profile and arsenic level.

5.22 According to the two experts, a multi-locational on-farm yield trial with ten rice genotypes including five previously identified low-grain arsenic genotypes (IET 19226, Nayanmoni, CN 1643-3, CN 1646-2 and CN 1646-5), three promising aromatic breeding lines (CN 1794-2, CN 1646-6, CN1719-1), one high grain arsenic line (BRG 12) and one popular high yielding variety (IET 4786) was initiated during 2012-2013 in six arsenic contaminated areas of different districts in West Bengal jointly by Rice Research

Station, Chinsurah, Government of West Bengal and CSIR-National Botanical Research Institute, Lucknow. Data from various seasons (Kharif 2011 & 2012 and Boro 2011-2012 & 2012-2013) demonstrated that rice cultivar CN 1794-2-CSIR-NBRI was the best cultivar amongst all trial entries with respect to low arsenic content in grains and highest grain yield. This variety has been found to be safe for human consumption as per provisional maximum tolerate daily intake (MTDI) of arsenic. Thus, CN 1794-2 CSIR-NBRI is proposed to be released for cultivation in vast arsenic affected belts of West Bengal.

5.23 The two experts also emphasised in their memorandum, the need for development of safe arsenic crops for the arsenic affected areas to restrict arsenic contamination in food chain. In response to this suggestion, the Min. of WR, RD & GR furnished the following information:

> "CSIR-NBRI has carried out work in collaboration with Rice Research station, Chinsura, Hoogly(WB) . The arsenic contamination of food grains has been assessed for west Bengal. The implications of consumption of arsenic contaminated rice grains are also documented in such areas.
>
> To overcome this menace, CSIR- NBRI has identified low grain arsenic rice cultivator (CN 1646-2, CN 1643-3, Gotrabhog and Nayanamoni), which has been recommended for growing in the state of west Bengal.
>
> National Botanical Research Institute (NBRI), a constituent organisation of Council for Scientific and Industrial Research (CSIR), has carried out work indicating levels of arsenic (As) in seeds of different paddy varieties presently cultivated in agricultural soils of Uttar Pradesh. Teh data covering 58 villages of five districts namely Gazipur, Bahraich, Ballia, Gorakhpur and Lakhimpur - Kheri indicates presence of arsenic.
>
> Under a University Grants Commission (UGC) project, A.N. College, Patna has conducted experiment in parts of Bhagalpur ditrict in Bihar where an irrigation borewell (32 m depth) has arsenic concentration of 1.020mg/L and mature plant irrigated by the water has As concentration of 0.136 mg/gm
>
> In pot experiment six varieties of rice viz. 9PNR 381, Turantha, Saroj, Sugandha, saran and Katarni) were taken. Out of these two varieties Saroj and Sugandha have been found to be Arsenic resistant , whereas the saran variety has been found as very low accumulator of As."

5.24 Enquired about the efforts made to develop arsenic safe crops, DARE submitted that rice varieties IET, 1444, Gotrabhog, Nyanmoni and Shatabdi have been identified relatively tolerant to arsenic toxicity.

5.25 To mitigate the problem of arsenic contamination the Department of Agricultural Research and Education (DARE) stated in a note that boro rice requiring more groundwater should be replaced with other suitable and less water demanding crops. Various legumes and pulses have great promise in this regard. While the farmyard manure application moderated the toxic effect of arsenic in soil-plant system, the phosphate application aggravated it. The reduced irrigation coupled with application of zinc sulphate also reduced the arsenic content in soils and plants while not affecting the yield. There should be more use of organic and green manures that moderate arsenic toxicity in soil-plant system by forming organo-arsenic complexes. The phytoremediation employing hyper-accumulating plant/microbial spp like brake fern (Pteris Vittata), water hyacinth (Eichornia crassipes) and others also hold promise in detoxification of arsenic from soils and aquatic systems. The Blue Green Algae (BGA) having ability of decontaminate soils of arsenic should be introduced in the paddy fields. A number of microbial species (e.g. the bacterial species, namely Proteus sp., Escherchia coli, Flavobacterium sp.; Corynebacterium sp. And Pseudomonas sp., the fungus, namely Candida humicola; the freshwater algae, namely Chlorella ovalis. Phaepdactuylum Tricornutum. Oscillatoria rubescens) have been reported to possess varying degrees of arsenic accumulating abilities.

5.26 In response to a query as to whether the Ministry of Agriculture help the farmers in case they are ready to shift to less water demanding plants from water intensive boro rice cultivation, the Secretary, Department of Agriculture & Cooperation, Ministry of Agriculture, was candid in his admission that the Deptt. had not so far thought of this issue at all in its crop husbandry programmes. He stated in this connection as follows :-

> "We work through the State Governments and we work through the district agencies of agriculture. They have limitations. Some States are better equipped than others but most of the States have limitations. Under our ATMA project, we have sanctioned three posts per block as

Extension Advisers and the subject matter specialists. That is basically to strengthen because we realize that in most States, after the 1980s there has been very miniscule recruitment in the agriculture extension services. We are doing that. But, more importantly, what we are trying to do and what we would like to do is this. So far what we had been doing till about three years was that we were implementing all our Schemes and Programmes on individual beneficiary-oriented approach. That was not visible, and it was not even monitored. It was not even a kind of technically back stoppable by our scientists because the spread was so huge. For the past three years what we have been trying to do is this. We operate now only in clusters. In the flat plain conditions, we operate in 100 hectares, and in the hills it becomes smaller. In the entire area, we cover in one big solid junk so that whatever technology we demonstrate is easily available and visible. The impact is that the neighbouring farmers also try and adopt it. We have had a lot of success in this technology, especially the BGREI and NFSM programmes in the eastern India. Having said that, I do recognize that we had not so far thought of this issue at all in our Crop Husbandry Programmes. I must confess that. If at all, it is I who is guilty of this because I should have thought of that. Now that it is being brought up, we will certainly look into this because this is a very important matter which will affect the long-term health of our people especially of that area."

5.27 The DARE suggested the following remedial options to combat the arsenic problem:-

"(i) Conjunctive use of ground and surface water.
(ii) Preference to growing non-edible and leguminous crops during dry season.
(iii) Storing of Arsenic contaminated groundwater in ponds and subsequent dilution with rainwater.
(iv) Recharge of groundwater with harvested rainwater, free of arsenic.
(v) Increased use of farm yard manure and other manures + green manure crops.
(vi) Application of appropriate amendments (zinc/iron salts as and wherever applicable).
(vii) Cost-effective phytoremediation options.
(viii) Capacity building and awareness programmes."

5.28 In response to a query as to whether any strategy has been worked out by the Ministry of agriculture or by any other Ministry to mitigate Arsenic build up in soils and

crops, DARE stated that based on the research findings, ICAR has suggested the following measures to mitigate arsenic build up in soils and crops :-

"(a) optimum conjunctive use of ground and surface water (e.g. use of harvested rain water during lean period)
(b) Irrigation with pond –stored ground water – decontamination being facilitated by rainfall and sedimentation
(c) Recharge of ground water resource with harvested rain water, free of Arsenic
(d) Enhancing the water use efficiency (through optimum water management) for ground water irrigation, especially for summer (boro) rice
(e) Preferring low water requiring, farmer attractive cropping sequence (especially for the lean period)
(f) Boro rice variety IET 1444 may be preferred in arsenic contaminated areas
(g) increased use of verminopost ,FYM and other manures + green manure crops , inclusion of pulses/ other legumes in cropping sequences , as well as application of appropriate amendments (zinc/ iron salts as and wherever applicable)
(h) cost effective phyto remediation options using Blue Green algae , Azolla and duxk weed
(i) creation of general awareness: mass campaigning, holding of farmers day field demonstrations."

5.29 Referring to the Government's proposed plan to replicate water intensive green revolution in eastern part of India, the Committee enquired whether any study was conducted to assess its impact on the spreading or otherwise of arsenic in ground water in Eastern India. In response, Secretary, Department of Agriculture & Cooperation, Ministry of Agriculture stated during evidence on 13 October. 2014 as follows:

> "Sir, it is an extremely important issue. The reason we introduce this programme called 'bringing Green Revolution into Eastern' India' was that we felt that the water tables there are so high and the soil is so fertile so that is an apt area to be exploited for production or increasing productivity. Production levels in Eastern India are far below their potential and that is reason why we chose that. Having said that, we also realized that especially, in those parts of Bengal where arsenic contamination has been found to be the maximum, we attributed – whether it is scientific or not, I do not know – that the excess drawl of ground water from shallow depths is probably the reason which is causing this. We had not taken cognizance of this so far but I think we shall. What we shall try and do is that make more focused efforts on conjunctive use of water instead of just tapping into easily available ground

water sources. Look at surface water at a major way. The point is that unless the arsenic gets washed out it will remain there. So whether it is crop or whether it is agriculture or whether it is animal husbandry or fisheries that contamination will be there. So that is difficult to get rid of. As the population density is so high in the area we just cannot wish away that we cannot do agriculture there. This is something that we will have to think about very carefully. I think we need to do this. Next week or the week after that Nepal, Bangladesh and ourselves are coming together and doing a programme on scientific exchange in respect of agriculture, focused basically on exchange of existing germplasm without need for further trials. We can take this programme on board as well because all three countries having similar agro-ecologies or having similar problems. So, as you have said, if we pull our resources, maybe we can find a way out which is more reasonable because right now, very frankly, these are all shots in the dark. The arsenic is still there. So unless it gets washed out, we cannot wish it away"

5.30 When enquired about the steps taken by Ministry of Agriculture to minimize the arsenic content in agriculture, dairy produce and meat products Secretary, Department of Agriculture & Cooperation, Ministry of Agriculture was candid in his admission that the Ministry was not focussing on the quality of ground water and stated during evidence as under:

"I must confess that so far the way that we go about disseminating agriculture practices, we have not been focusing on the quality of ground water. We obviously need to adopt that now into our systems.

Sir, there are two or three things that we need to do. There are certain crop varieties which are less susceptible to uptake of arsenics. Obviously, we need to promote that. But, more importantly, we also need to look at other models. Ideally I would suggest that agro-forestry is a great way forward. But I do not think that the landholding size of the farmers of that area is so small and they are so vulnerable and it is difficult for them to make a living on that."

5.31 The Ministry of Agriculture (DARE), in response to a query as to whether any action has been taken to ensure that arsenic laden agricultural produce is not consumed by human beings and live stock, submitted in a written reply that so far no comprehensive strategies have been worked out to ensure that arsenic laden agricultural produce is not consumed by human beings and live stock.

(iii) Research on medical treatment

5.32 Enquired about research on medical treatment of arsenic diseases, a representative of the Min. of Health and Family Welfare (Min. of H & FW) stated during oral evidence on 27-10-2014 as follows :-

> "We have had a brain-storming session last week only on the 20th in which we have called experts on arsenic to find out what are the further research areas which we can take up in future. In that, major issues have been highlighted. One is the effect of nutrition and the anti-oxidative stress on the effects of arsenic toxicity. Second, what the experts mentioned in that meeting was about treatment protocol."

5.33 Pointing out that high arsenic consuming group has irreversible oxidation stress, the M/o H&FW submitted a note on research carried out by ICMR's Regional Occupational Health Centre (ROHC), Kolkata, extract of which is as follows:

> "The human exposure to arsenic is being evaluated by clinical signs and symptoms sand by laboratory investigation like metabolic products of arsenic in urine. Objective of the present study was to detect and characterise suitable biomarker for detection of early exposure. All subjects were investigated for health status and antioxidant profile. Water and Urine samples were analysed for arsenic analysis. Significant rise (p. <0.001) in serum uric acid (UA) level, as preliminary oxidative stress marker, was observed in 58% cases of group testd population consuming >50µg/lit arsenic in drinking water. Morever, decline in Total Antioxidant Status (57% cases) of the >50 µg/lit group supported the elevation of serum UA. Arsenic induced skin pigmentation and keratosis was observed in 6.4% of teased population. Our study also indicated reduced oxidative stress parameters in a significant number of cases without signs and symptoms of arsenic exposure. Therefore, it may be concluded that the high arsenic consuming groups has irreversible oxidative stress, which leads to symptomatic disease."

5.34 Admitting that there is inadequate research on the arsenic contamination and its impact of health, a representative of the M/o H&FW during his deposition before the Committee stated as under:

"Sir, it is a fact that inadequate research has taken place. We have tried to find out whatever has been the research on this by various organisations. ICMR has only funded sporadic research projects outside ICMR. There is no central ICMR research on this.

The second is, All India Institute of Hygiene and Public Health, Kolkata did a survey in two districts of West Bengal and they have found certain prevalence. But in terms of the medical corrective treatment and the causes etc., there has been no centralised research. We have tried to find out further and I have been told that DRDO has also done a research on saniting agents which they say reverses the trend slowly and that I am told is under trial. Unfortunately we do not have evidence-based findings from any of this research so far."

5.35 A note submitted by the M/o H&FW on Research on arsenic in the water carried out by ICMR's regional Occupational Health Centre (ROHC), Kolkata, may be seen in **Appendix – VI.**

5.36 To a specific query as to whether ICMR is encountering any infrastructure and manpower problems for carrying out R&D and for treating patients, the representative stated as follows:

"Exactly for this purpose, we had this brainstorming session where we called the experts on arsenic and people who are working on arsenic to say what all they have done till now and what they would like future research to be concentrated on and they have given us these few points on which we will be constituting a Task Force soon."

CHAPTER - VI

Issues relating to arsenic

(i) Absence of Central authority for arsenic mitigation

Ministry of Water Resources, Government of India, *inter-alia*, is responsible for development, conservation, and management of water as a national resource; overall national perspective of water planning and coordination in relation to diverse use of water; ground water management; conjunctive use of surface and ground water and water quality assessment.

6.2 Central Ground Water Board, a sub-ordinate office of the Ministry of WR, RD & GR is the National Apex Organisation with the mandate to 'Develop and disseminate technologies, and monitor and implement national policies for the Scientific and Sustainable development and management of India's Ground Water Resources, including their exploration, assessment, conservation, augmentation, protection from pollution and distribution, based on principles of economic and ecological efficiency and equity. The main functions of the Central Ground Water Board are Ground Water Surveys, monitoring, exploration, resources assessment, management, dissemination of information and capacity building.

6.3 Regulation of ground water development & management is being done by CGWB through Central Ground Water Authority (CGWA) constituted under Section 3 (3) of the Environment (Protection) Act, 1986 to regulate and control development and management of ground water resources in the country and to issue necessary regulatory directions for the purpose.

6.4 The steps taken to combat Arsenic contamination during the last three decades by the Ministry of WR, RD & GR are as follow:-

> "A number of measures, steps and research studies have been initiated and put into practice mainly in West Bengal. The measures and steps are focused towards providing Arsenic free drinking water to the entire

population in the Arsenic infested areas, by arrangement of alternate freshwater sources as also by treating contaminated groundwater using Arsenic removal techniques."

6.5 During the last three decades, substantial amount of R & D work has been done to enrich knowledge in respect of the following:

"

- Identification of Arsenic poisoning through affected patients of West Bengal through drinking water pathway. (1983)
- Sampling of ground water for Arsenic contamination in West Bengal. (1983-onwards)
- Research on Arsenic mobilization in ground water, establishing extent of contamination in the entire State. (1985-onwards)
- Development of ex-situ technologies for removal of Arsenic from groundwater and adoption for water supply, analysis of ground water sample for establishing arsenic affected areas (1987-onwards)
- Search for alternate Arsenic/safe aquifer for community water supply as well as alternate sources from surface water supply (1993-onwards)
- Detection of Arsenic in the up streams of the Gangetic plains in 2003, the area which was earlier thought to be arsenic contamination free. (2003-onwards)
- Analysis of ground water samples from the entire Gangetic plain/ Brahmaputra plain and other Holocene deposit areas for demarcation of contaminated zones. (2003-onwards)
- Establishing Arsenic contamination areas in 10 States, research on mobilization of Arsenic in the affected States other than West Bengal. (2004- onwards)
- Adoption of removal technologies, search and alternate Arsenic safe aquifer based water supply and surface water dependent potable water supply schemes. (2005- onwards)
- National Institute of Hydrology (NIH), Roorkee and Central Ground Water Board (CGWB) under the aegis of Ministry of Water Resources has prepared a Vision Document entitled "Mitigation and Remedy of Groundwater Arsenic Menace in India: A Vision Document (2010)"

6.6 Asked about future plans, if any, for combating Arsenic contamination in ground water, the Ministry of WR, RD & GR stated that the abatement of arsenic contamination and supply of arsenic free potable water is in the domain of state government.

6.7 When asked to spell out clearly and categorically its exact role and responsibility in arsenic mitigation in ground water, the M/o WR, RD &GR, in a written reply submitted as under:

> "To fulfil the mandate, Central Ground Water Board (CGWB) has the responsibility to carry out scientific surveys, exploration, monitoring, management of Country's vast ground water resources. The data generated from these investigations provide a scientific base for user agencies and states for planning and management of ground water resources. CGWB is also taking up special studies on various aspects like artificial recharge, geogenic contamination etc. The data generated is disseminated through publications such as State Hydrogeological Atlases, State Reports, District Reports, Ground Water Year Books, Ground Water Exploration Report, District Ground Water Brochures, and Quarterly Bhujal Journal etc. Collaborative special Studies are also taken up with premier scientific/ Academic/ Public Sector organizations/ Institutes in field of Ground Water.
>
> In order to develop human resources through training of Ground Water professionals in the ground water domain, Rajiv Gandhi National Ground Water Training & Research Institute (RGNGWTRI) imparts training to ground water professionals and sub-professionals in ground water investigations, development and management techniques.
>
> A few R&D studies have been carried out jointly with other institutes of India mainly focusing on distribution of Arsenic and aquifer characterisation. In Arsenic affected areas, CGWB has constructed wells tapping Arsenic free aquifers under the ground water exploration programme. After the investigation, the Arsenic free exploratory wells are handed over to State Governments for water supply as provision of Arsenic free potable water is currently in the State domain.
>
> Considering the severity of arsenic contamination and its spread in different States, various technologies developed for its abatement in India and abroad, the Ministry of Water Resources, RD & GR took the initiative for preparing a vision document entitled "Mitigation and Remedy of Ground Water Arsenic Menace in India" by NIH and CGWB, taking inputs from various experts on Arsenic and available literature on the subject. The document was circulated by NIH to concerned State Governments. This document also suggests future strategies for remediation and mitigation of Arsenic in ground water.''

6.8 The Committee enquired about programme/scheme, if any, conceptualized by the Ministry of WR, RD & GR to deal with issues regarding arsenic contamination. In response, it was stated that CGWB does not have any specific programme to deal with the issues regarding Arsenic contamination in ground water. Asked as to why no

separate scheme for Arsenic remediation has been formulated till now, the M/o WR, RD and GR stated in a written reply that while Central Ground Water Board (CGWB) does not have any specific scheme on Arsenic contamination, yet in many instances CGWB has carried out scientific investigations in and around the Arsenic affected areas including exploratory drilling as a part of ongoing activities under ground water exploration to delineate arsenic free aquifers. Such wells, tapping Arsenic free aquifers are handed over to the State Government for further utilization.

6.9 The Ministry of WR, RD & GR stated in a note that CGWB carried out area specific ground water exploration for identification of arsenic free aquifers on request of State Government under its general programme. When asked whether CGWB should not suo moto, identify arsenic free 'aquifer, without waiting for the State Government concerned to make a request, the Ministry of WR, RD & GR stated as under:

> "Though Central Ground Water Board (CGWB) does not have any specific scheme on Arsenic contamination, in many instances CGWB has carried out scientific investigations in and around the Arsenic affected areas including exploratory drilling as a part of ongoing activity underground water exploration to delineate arsenic free aquifers. Wherever Arsenic is reported in ground water, CGWB in consultation with State Government selects exploratory drilling sites for carrying out ground water exploration for obtaining suitable sites in Government land."

6.10 When enquired whether it is not desirable for CGWB to draw up a programme in this regard, the M/o WR, RD & GR stated that taking up of aquifer mapping programme in arsenic affected areas is a part of NAQUIM (National Aquifer Mapping and Management Programme), wherein assessment of aquifer wise water quality and development of management plans are envisaged. This information will be shared with the concerned Central and State agencies for taking remedial measures.

6.11 Asked as to what action is taken when contamination is revealed on monitoring by CGWB, the M/o WR, RD&GR stated as follows:

> ''On confirmation of Arsenic contamination in ground water from monitoring by CGWB, the information is shared with the concerned agencies for taking

necessary remedial action. However, on identification of Arsenic contamination during the exploratory drilling, Arsenic contaminated zones are sealed and Arsenic free zones are identified by CGWB and tapped for Arsenic free water. The scientific parameters along with the well design are shared with State Government as a Technology Transfer, for guiding them to take up future ground water development in Arsenic affected areas. The wells constructed by CGWB tapping Arsenic free zones are being handed over to the State Government departments for water supply.''

6.12 The Ministry of WR, RD & GR further stated in this connection as follows:

"Remediation of arsenic is within the purview of drinking water supply agencies. However, CGWB carries out identification of arsenic free aquifers in the arsenic affected areas under normal ground water exploration programme and dissemination of technology for construction of wells tapping arsenic free aquifers."

6.13 To a query about the identified alternative sources, population benefitted from and the financial assistance, if any, given to the states, the Ministry of WR, RD and GR stated in a written reply as follows:

"Central Ground Water Board identifies deeper arsenic free aquifers as an alternative source, under normal ground water exploration programme. So far, 254 wells have been constructed in arsenic affected areas in the sates of Assam, Bihar, chattisgarh, Uttar Pradesh and west Bengal. Out of these, 167 wells have been handed over to respective state agencies for water supply. Considering average discharge of 10 lps in alluvium and 4 lps in hard rock, these wells are expected to cater the drinking water needs of about 24 lakhs of population. Remaining 87 wells are in process of being handed to the state Governments"

6.14 CGWB has taken up ground water exploration to delineate arsenic free ground water aquifers which are handed over to State Governments for water supply. The work for construction of wells in arsenic affected areas was started in the year 1997. The number of arsenic free ground water aquifers so far handed over to State Governments, state-wise and year-wise as furnished by M/o WR, RD & GR is given at **Appendix-VII.**

6.15 The Ministry of WR, RD & GR in a note submitted to the Committee stated that under the scheme of Ground Water Management & Regulation a National Inter-

Department Steering Committee having representatives from Central Ministries / Departments of State Governments has been constituted in 2013 to oversee and prioritize arsenic mapping and management programme. As per the decision taken during the first meeting of National Inter-Department Steering Committee (NISC), held in November 2013, areas prioritized for aquifer mapping should include 'Over-Exploited', 'Critical, 'Semi-Critical' areas, water quality affected areas, Bundelkhand area of U.P. and M.P (identified by Planning Commission) and priority areas identified by Ministry of Drinking Water and Sanitation. In the second meeting of the NISC, held in April 2014, prioritization of about 8.89 lakh sq.km area for aquifer mapping has been considered.

6.16 Asked about the time line for implementation of this prioritization, the Ministry of WR, RD & GR stated that for initiation of aquifer mapping in prioritized areas during the XII Plan is as follows:

- Areas where aquifer mapping already initiated: About 2.76 lakh sq.km
- Areas where aquifer mapping will be initiated during 2015-16: About 1.96 lakh sq.km
- Areas where aquifer mapping will be initiated during 2016-17: About 4.17 lakh sq.km"

6.17 State-wise details where aquifer mapping is initiated and yet to be initiated during the remaining period of XII Plan are given at **Appendix- VIII.**

6.18 Ministry of WR, RD & GR constituted a "Core Committee" for "Mitigation and Remedy of Arsenic Menace in India" in December, 2013 comprising 28 Members with Director, National Institute of Hydrology (NIH), Roorkee, as the Chairman to suggest and recommend actions to be taken by the Ministry on arsenic related matters. The recommendations of the Core Committee submitted on 15 October, 2014 are given in **Appendix- IX**. One of the major recommendations of the Committee is that each of the affected State should have an 'Arsenic Task Force' spearheaded by the nodal "National Arsenic Mission Task Force (NAMTF)' at Central level. The Central level task force should have proper linking mechanism with the affected State units. The 'NAMTF'

should have representation from the State departments together with related Central Government departments like Ministry of Drinking Water & Sanitation, Ministry of Urban Development, Ministry of Health and Family Welfare, Ministry of Environment, Forest & Climate Change, individual experts, R&D and academic personnel, medical professionals, economists, social scientists etc.

(ii) Lack of focus in the National Water Policy

6.19 It has been stated in the National Water Policy (2012) document (**Appendix-X**) that the present scenario of water resources and their management has given rise to several concerns. Two of these concerns regarding safe drinking water and over exploitation of ground water are access to safe drinking water and other domestic needs still continues to be a problem in many cases. Skewed availability of water between different regions and different people in the same region and also the intermittent and unreliable water supply has the potential of causing social unrest. (para 1.2-v). Ground water, though part of hydrological cycle and a community resource is still perceived as an individual property and is exploited inequitably and without any consideration to its sustainability leading to it's over exploitation in several areas. (para 1.2-vi).

6.20 One of the basic principles governing public policies on water resources as stated in para 1.3 (vi) of NWP is as under:

> "Safe Water for drinking and sanitation be considered as per-emptive needs, followed by high priority allocation for other basic domestic needs (including needs of animals), achieving food security, supporting sustenance agriculture and minimum eco-system needs. Available water, after meeting the above needs, should be allocated in a manner to promote its conservation and efficient use".

6.21 Stressing the need for mapping of aquifers to know the quantum and quality of ground water resources and the need to arrest the decline in ground water levels in over exploited areas, the NWP States as under:

> "Para 5.3 There is a need to map the aquifers to know the quantum and quality of ground water resources (replenishable as well as non-replenishable) in the country. This process should be fully

participatory involving local communities. This may be periodically updated.

Para 5.4 Declining ground water levels in over-exploited areas need to be arrested by introducing improved technologies of water use, incentivizing efficient water use and encouraging community based management of aquifers. In addition, where necessary, artificial recharging projects should be undertaken so that extraction is less than the recharge. This would allow the aquifers to provide base flows to the surface system, and maintain ecology."

6.22 Regarding quality problems in ground water, the policy states as follows:

"Para 6.7 There should be concurrent mechanism involving users for monitoring if the water use pattern is causing problems like unacceptable depletion or building up of ground waters, salinity, alkalinity or similar quality problems, etc., with a view to planning appropriate interventions.

Para 8.6 Quality conservation and improvements are even more important for ground waters, since cleaning up is very difficult. It needs to be ensured that industrial effluents, local cess pools, residues of fertilizers and chemicals, etc., do not reach the ground water.

Para 15.1 Continuing research and advancement in technology shall be promoted to address issues in the water sector in a scientific manner. Innovations in water resources sector should be encouraged, recognized and awarded."

6.23 Pointing out the extent and magnitude of the arsenic problems and taking note that there is no mention of mitigation of arsenic or other contamination in ground water as part of ground water management in the National Water Policy, the Committee enquired whether it is not a serious omission in the National Water Policy. In response, the M/o WR, RD and GR stated in a written reply as under:

"Issues related to ground water management have been covered in the National Water Policy, 2012 adopted by the National Water Resources Council, inter-alia, comprising Chief Ministers of all States and related Union Ministers. "Safe Water" for drinking has been defined as a pre-emptive need (para 1.3 (vi)), emphasizing necessary efforts for treatment of water (which includes ground water) and removal of all kinds of contamination – both anthropogenic and geogenic, like arsenic etc. The National Water Policy,

2012 has stressed on the need for mapping of aquifers to know the quantum and quality of ground water resources (para 5.3) and arresting trends of declining ground water level in over exploited areas (para 5.4)."

6.24 Noting that quality conservation and improvements are even more important for ground water, since cleaning up is very difficult (para 8.6), the National Water Policy, 2012 lays emphasis on ensuring that industrial effluents, local cess pools, residue of fertilizers and chemicals, etc. do not reach ground water. The National Water Policy, 2012 considers ground water as part of overall water resources. Arsenic contamination is one of the type of contaminations for which the National Water Policy, 2012 stresses on remedial measures through continuing research and advancement in technology (para 15.1).

6.25 The claim of the Ministry of WR, RD & GR in the above reply that the NWP emphasizes necessary efforts for treatment of water (which includes ground water) and removal of all kinds of contamination – both anthropogenic and geogenic, like arsenic etc. seems to be a far- fetched interpretation rather than an element of the policy.

6.26 Although arsenic contamination in ground water was first reported almost four decades ago and presently spread over 96 districts in 12 States and the population identified with groundwater arsenic contamination in 35 districts of six States is as much as 70.4 million, arsenic contamination does not find a mention in the National Water Policy 2012 for focused remedial action.

(iii) Absence of separate budgetary allocation

6.27 When information was sought on the budgetary targets and actuals for construction of Arsenic free wells, treatment of contaminated ground water and identifying Arsenic free aquifers, the Ministry of WR, RD and GR stated that there is no separate scheme in (CGWB) for this purpose. However, Central Ground Water Board carried out area specific ground water exploration for identification of Arsenic free

aquifers on request of state Government under its regular programme. These delineated arsenic free aquifers, if any, can be tapped for community water supply.

6.28 The physical and financial targets and achievements during 2012-13 and 2013-14 for aquifer mapping as furnished by the M/o WR, RD & GR, are as follows:

Physical Targets & Achievements

(In lakh sq.km)

SI.No.	Activities	Year	Target	Achievement
1.	Aquifer Mapping	2012-13	0.54	0.56
2.	Aquifer Mapping	2013-14	0.54	0.54

Financial Targets & Achievements (Scheme: Ground Water Management and Regulation)

(Rs. In crore)

SI.No.	Year	BE	RE	Actual
1.	2012-13	318	180	118.64
2.	2013-14	275	140	83.17

6.29 It may be observed from above that the actual achievement for 2012-13 in respect of Aquifer Mapping was in excess of the target by 2000 km and the target could be achieved roughly at one-third of the budget estimate that Rs. 118.64 cr. (37.3% of BE) and in 2013-14, the cost for undertaking aquifer mapping of 0.54 lakh sq.km was even much less at Rs. 83.17 cr. which was just 70% of the previous year's cost. When asked to clarify as to how this was possible and whether there was any over estimation of budget estimate the Ministry of WR, RD & GR stated in a written reply that the BE figures of 2012-13 were based on the assumption that the scheme will start in financial year 2012-13. However, since the CCEA approval of the scheme was received in September 2013, the physical and financial achievement of 2012-13 are based on

Actuals. Further, the BE for the year 2012-13 pertains to the scheme of Ground Water Management & Regulation, which include aquifer mapping besides other activities such as technological up gradation and regular ongoing activities (viz. ground water monitoring, assessment and regulation etc). The Aquifer Mapping component envisages outsourcing of the activities together with the internal capabilities of Central Ground Water Board (CGWB). In financial year 2013-14, in view of approval received only in September 2013, the physical and financial achievements are mainly due to the internal capabilities of CGWB.

6.30 B.E. for the year 2014-15 is stated to be of Rs. 153.32 crore for Major works (including aquifer mapping, artificial recharge works etc)and the target for aquifer mapping for 2014-15 is about 1.30 lakh sq.km.

6.31 Dissatisfied with the absence of separate budgetary allocation for water quality issues, the Committee enquired as to why there is no specific allocation for remediation of Arsenic from ground water/ surface water. The Ministry of WR, RD & GR stated in response that the programmes of Ministry of Water Resources, River Development and Ganga Rejuvenation and the Ministry of Drinking Water & Sanitation have different mandate. While the Ministry of Water Resources, River Development and Ganga Rejuvenation plan for overall water management; Ministry of Drinking Water & Sanitation addresses drinking water isues. Though there is no specific allocation for arsenic remediation, the water supply is being taken care by the concerned state Government Departments such as PHED, Jal Nigam etc. Ministry of drinking water and sanitation has further informed that budgets to states are given on fixed Inter State allocation criteria and that, up to 67 % of the NRDWP funds could be utilized for coverage as well as tackling water quality problems. Arsenic and fluoride are priority areas of the Ministry and therefore, 5% funds are earmarked for providing safe water in these areas of which 75% could be utilized for tackling for chemical contamination.

6.32 The CGWB added in this connection that the Central ground water board carries out area specific ground water exploration for identification of Arsenic free aquifers under its regular programme. Under the National Aquifer management programme, arsenic contaminated aquifers as well as arsenic free aquifers are identified. A sum of Rs. 325 crores has been allocated for the same for the year 2014-15. To address the emerging challenges in ground water sector the ongoing scheme of ground water management and regulation has been expanded by including new component of Aquifer mapping and Management during XII Plan period with an estimated outlay of 3319 crore. sufficient financial provision exists under the scheme for implementation of NAQUIM. The physical and financial targets have been increased seven fold as compared to XI Plan. A Post of Member, Finance, CGWB has recently been created in CGWB for a better implementation of NAQUIM Programme.

6.33 When enquired whether there is any budgetary allocation for carrying out research on diseases arising out of consumption of drinking water containing arsenic, the Ministry of H & FW stated in a written reply that there is no specific budget allocation for arsenic related diseases but Indian Council of Medical Research (ICMR) has been supporting studies on arsenic related disease throughout the period. ICMR has supported 20 ad-hoc projects conducted by various researchers in different institutions. In addition ICMR's Regional Occupational Health Centre situated in Kolkata has also been conducting research in diseases due to arsenic through intramural as well as extramural mode.

(iv) Dearth of Steps to Stop Anthropogenic contamination

6.34 Asked about the steps taken to prevent manmade contamination of water by Arsenic such as from use of fertilizers, the M/o WR, RD& GR stated that in order to prevent the ground water contamination through anthropogenic activities, Ministry of Environment and Forests has notified general standards for discharge of environmental pollutants which includes industrial effluents also for various recipient sources such as inland surface water , public sewerage, land for irrigation and marine coastal areas etc.

The limit for discharge for arsenic in waste water has been defined for all the sources as 0.2 mg/l. The industry specific standards have been specified for grossly polluting industries.

6.35 One of the achievements of WQAA is stated to be regarding "Minimum environmental flows in Indian rivers". However, on closer scrutiny, the Committee observed that there was hardly any worthwhile progress during the last 11 years except for constitution of working group in the year 2003 which took four years to submit its report in 2007, followed by constitution of a committee for implementing the working group's recommendations which submitted its report in 2009. Eventually, the recommendations of the Committee have not been accepted by WQAA in its meeting held on 30th May, 2013.

6.36 When asked to justify loss of 11 years without any fruitful results in ensuring minimum environmental flows in Indian rivers, the Ministry of WR, RD & GR stated in a written reply that as per information provided by WQAA, the Authority felt the need to review the recommendations contained in the report submitted by Working Group in 2007. For this purpose, a sub-committee was constituted whose report was deliberated by the Authority in its meeting held on 30th May, 2013. The Authority did not accept the report as it found that the recommendations were generic, i.e., it was not river-wise, and in that too, stretch-wise. However, these reports provide the base work in the field of evaluation of minimum environmental flows in the rivers which can be used in future for further elaborate studies. Similarly, the report submitted by the committee on 'Legal and institutional implication of the implementation of the recommendations of the Working Group' submitted in 2009 gave its recommendations on the legal aspects of the issues involved in this matter. Therefore, these reports would be of immense use for future development in this domain.

Leather tanneries are said to lead to alarming levels of arsenic, cadminum, mercury, chrome VI, pesticides and other heavy metals which are potent source of renal neurological and skin diseases as indicated in the report of Facility of Ecological and

Analytical Testing conducted by IIT, Kanpur in the year 2002 on ground water in the villages situated near 350 odd tanneries. Some of the findings of the aforesaid study are given below:

Sl. No.	Discription of Samples	Arsenic content
1.	Tannery Effluent, Unnao	5.07 mg/l
2.	Ground water, Sheikhpur	0.64 mg/l
3.	Sludge sample, Jajmau	0.33 mg/l
4.	Sludge sample, Rooma	0.50 mg/l

(v) Lack of awareness

6.37 The Experts (Dr. C.S. Nautiyal, Director, CSIR, IITR, Lucknow and Dr. K.J. Nath, Ex. Director, All India Institute of Public Health and Hygiene (AIIPHH), Kolkata) in their Memoranda submitted to the Committee emphasized the need for awareness generation among the people regarding the arsenic problem and effort undertaken by the Government and agencies. One expert (Dr. K.J. Nath) suggested that people and media should have easy access to the scientific information but in no case these should be used for creating unnecessary panic among the people.

6.38 Reacting to the above suggestions to the M/o WR, RD & GR, stated in a written reply as follows:

> "As per the information provided by Ministry of Drinking Water and Sanitation (MDWS), the States have been advised to focus on Awareness Generation activities in arsenic affected habitations. For conducting IEC activities, the Ministry provided NRDWP-Support Funds (5%) as 100% Central share.
>
> The MDWS has advised States to paint red colour on the hand pumps where excess arsenic have been found and not to drink arsenic contaminated water.

Central Ground Water Board has organized several awareness generation programmes to make people aware about the ground water quality including Arsenic contamination in ground water and its impact on human health.

The findings of scientific studies carried out by Central Ground Water Board are shared with the concerned Central and State agencies and major publications are placed in web site in public domain."

6.39 When asked whether any steps have been taken to involve student community in mass awareness programmes regarding ground water contamination issues, the M/o WR, RD & GR, stated in a written reply that CGWB conducts Awareness raising programmes regularly in the form of mass awareness programme, painting competitions, water management & training programme wherein students are one of the target groups.

6.40 A Task Force of Planning Commission on formulating action plan for removal of arsenic contamination in West Bengal in its report of July, 2007 recommended that intensive awareness raising activities with regard to the relative health effects of drinking arsenic contamination water in order to introduce preventive measures in co-operation with local bodies, NGOs and others. To a specific query as to whether any awareness raising activities are being undertaken by the M/o Health and Family with respect to negative health effects of drinking arsenic contaminated water, the Ministry stated that specific awareness raising activity in health effects of arsenic contaminated water is not undertaken by Ministry of Health and Family Welfare.

6.41 In response to a query as to whether information about the remedial options has been disseminated for implementation in arsenic contaminated areas Department of Agricultural Research and Education stated that Farmers' awareness programme, workshops, training programme and medical checkups have been organised to educate people of affected areas under National Agricultural Innovation Project (NAIP) funded project on 'Arsenic in food chain: cause, effect and mitigation'between 2008-12. Radio

talks and Doordarshsn discussion on arsenic and environmental issues have also been deliberated by the scientists.

(vi) Lack of Co-ordination

6.42 At present the status of coordination with State Governments as stated by the Ministry of WR, RD & GR is as follows:

"

a. There is a steering committee chaired by the State drinking water supply department for clearing of drinking water supply schemes funded by Ministry of Drinking Water & Sanitation in contaminated areas.

b. State Ground Water Coordination Committee (SGWCC), Chaired by Principal Secretary dealing with ground water has been constituted for implementation of Aquifer Mapping Programme at State Level.

c. During the framing of annual work programme of Central Ground Water Board (CGWB) the State agencies are consulted.

d. Area under Aquifer Mapping and Management has been prioritized and duly vetted by the State Government agencies.

e. Under ground water exploration programme drilling sites are selected jointly with State Government departments.

f. Results and finding of studies of CGWB are regularly shared with respective State Government agencies."

6.43 Asked about the need for an integrated programme to monitor ground water and to combat arsenic contamination, the Ministry of WR, RD & GR stated in a written reply that more coordination and synergy between various Central and State Agency would give thrust for evolution suitable strategies for combating arsenic contamination of ground level.

6.44 In view of duplication of water quality monitoring by different organizations like National River Conservation Directorate (NRCD), Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs), Central Water Commission (CWC) & Central Ground Water Board (CGWB), the Ministry of WR, RD & GR stated that a committee approved by WQAA has taken up the task of rationalization and optimization of water quality and monitoring status in the country. When asked, how soon the task of

rationalization and optimization of water quality and monitoring status will be achieved, the Ministry of WR, RD & GR stated in a written reply that as per information provided by WQAA, the committee was formed on 12th July, 2013. Member Secretary, Central Pollution Control Board (CPCB) is the Chairman of the committee. Member Secretary, CPCB has informed that the committee is expected to finalize the report by December, 2014.

6.45 To a query as to how it is ensured that there is no overlapping of functions or conflicting stands between the Ministry of Water Resources and the Ministry of Drinking Water and Sanitation in handling the problem of Arsenic contamination, the M/o WR,RD &GR stated as follows:

> "Central Ground Water Board carries out ground water exploration of different aquifer systems in the country including Arsenic infested aquifers. The outcomes of such exploration programme are being shared with concerned State Government departments for development, and management of ground water resources by them.

6.46 The water supply is being taken care by the concerned State Government Departments such as PHED etc. the Ministry of Drinking Water & Sanitation has informed that 20% of the allocated funds under the National Rural Drinking Water Program (NRDWP) are earmarked for water quality problems. Further, it is indicated that the States may utilize up to 65% of funds released under NRDWP for improving water quality of ground and surface water. It has been further added that the programmes of Ministry of Water Resources, River Development and Ganga Rejuvenation and Ministry of Drinking Water and Sanitation are different. While Ministry of Water Resources, River Development and Ganga Rejuvenation plans for overall water management, Ministry of Drinking Water and Sanitation is one of the users only.

6.47 When enquired whether there is any Mission mode programme with other ministries concerned viz. Drinking water and Sanitation, Health and Family Welfare, WR, RD & GR, etc., to tackle the problem of arsenic contamination, the Secretary,

Department of Science and Technology (DST), stated during evidence on 27 October, 2014 as follows:

> "There is a major programme which the DST chairs. The Department coordinates with other departments and Ministries. It is called the War for Water. We have been pushing that programme not just with arsenic but with general problem of quality of water and availability of water including arsenic."

6.48 The Secretary, Department of Science and Technology further added as under:

> "There is a water mission. The War for Water Programme is chaired by the Secretary, Department of Science and Technology "

6.49 A representative of Department of Science and Technology added in this connection:

> "We have, as the Secretary said, Winning, Augmentation and Renovation for water, which addresses various issues related to contamination, that is, to find out research based technological solutions to address various water challenges in the country. Secretary is the Chairman of the Committee, Ministry of Drinking Water and Sanitation, Ministry of Water Resources, CWC, Central Ground Water Board are members of the Board. It is funded by the Department of Science and Technology."

6.50 Emphasizing the need for coordination action, the Vision document "Mitigation and Remedy of Arsenic contamination" brought out by National Institute of Hydrology, Roorkee and Central Ground water Board, New Delhi under the aegis of M/o WR, RD and GR states that even after spending huge amount of money for providing arsenic safe drinking water to the villagers from contaminated hand tube wells and other sources, the overall result suggests requirement of more concentrated and focussed efforts in planning and management to cope up with such gigantic calamity. Attempts made so far to combat the menace of groundwater arsenic contamination like to identify the causes, to provide arsenic free drinking water to people dependent on ground water supply, to reduce arsenic related social and socio – economic problems and to develop cost effective technology for eradication of arsenic contamination have

proven inadequate, fragmented and less responsive, as is evident from the rise in number of arsenic affected areas with every new survey . There is, therefore, a need for adopting holistic approach to resolve solution considering management of science and society resources together, but not merely healing the pain externally.

6.51 In view of the magnitude and impact of Arsenic contamination and the involvement of multiple Ministries / Organization in tackling different aspects of Arsenic contamination, it was enquired from the Cabinet Secretary of Government of India as to whether there is any comprehensive approach with an integrated policy, action plan and coordination. The Cabinet Secretariat in a note dated the 15th October, 2014 stated, *inter-alia* as under:

> "Presence of arsenic in sources of drinking water constitutes a major segment of the larger problem of presence of arsenic n ground water. As of 1.4.2014 , there are 1991 arsenic affected habitations in six states viz. Assam (424) , Bihar (357) , Karnataka(12), Punjab91), Uttar Pradesh (73) and west Bengal(1124) which are yet to be provided safe drinking water. As water supply is a state subject, state Governments /UTs are responsible for supplying drinking water. Government of India supplements efforts of the state by providing technical and financial assistance under the National Rural Drinking Water Programme (NRDWP) for providing safe and adequate drinking supply facilities in rural areas of the country, where a coordinated view of mitigation strategies is being taken. In order to combat water quality problem, up to 25% of the funds under NRDWP can be used for tackling water quality problems including the problem of arsenic levels. As part of the long term sustainable solutions, State Governments have been advised to provide alternate safe drinking water through surface based piped water supply schemes. As surface water bodies are at distant places, gestation time of commissioning these projects is high. However, states such as West Bengal and Assam have already such schemes. As an immediate short term solution, State Governments have been advised to adopt appropriate technologies which have been vetted / recognized by the CSIR laboratories. Alternative solutions of shallow dug wells or deep tube wells are taken up depending on the location of the arsenic free aquifers. The Ministry has directed the State Governments to provide safe drinking water atleast for drinking and cooking purposes in all theses 1991 arsenic affected habitations by March 2017 "

6.52 To a query as to whether any interim arrangement has been made in all these 1991 arsenic affected habitations to provide safe drinking water till regular arrangement

is ensured, the Cabinet Secretariat in a note dated the 3rd November, 2014 stated *inter-alia* as follows:

> "….M/o Drinking Water and Sanitation has informed that as a short term mesure , states have been advisesd to use treatment technologies vetted by CSIR labs. Some states have used absorption –co- precipitation technology based on activated alumina and other absorption media. Sates such as U.P. and Bihar are tapping water from uncontaminated 3rd aquifer (deeper aquifers) by providing 2-3 meter capping between the arsenic rich 2nd aquifer and deeper arsenic free aquifer in affected areas. States have also been advised to address reject management protocol, prepare comprehensive O&M plans and conduct training programmes for panchayats. The Ministry has also informed that they are reviewing the situation from time to time."

6.53 On the question of integrated policy, action plan and coordination, the Cabinet Secretariat, on 15th October, 2014 stated as under:

> "It may be seen that the issue of arsenic in ground water has multiple dimensions and as the mitigation and remedial measures are sector specific, they involve several ministries/ departments which are engaged with this issue. A more active engagement by different ministries/departments of the Central Government and State Governments would lead to an integrated approach and action plans for mitigation of adverse impact of arsenic on human, plant and animal health by effectively eliminating arsenic from drinking water and food supply chain."

6.54 When further enquired whether any specific action is proposed in this regard, the Cabinet Secretariat informed on 3rd November that as regards planning of an integrated approach, it has been decided to convene meeting of Committee of Secretaries with the concerned Ministries/ departments soon to discuss the matter.

PART-II

Recommendations / Observations of the Committee

High arsenic content in ground water is of great concern to the Committee as it affects the human/animal/soil/plants system and has caused over one lakh deaths and 2 to 3 lakhs of confirmed cases of illness. The Committee's examination of "Occurrence of High Arsenic Content in Ground Water" reveals that as many as 96 districts in 12 States have been affected by arsenic contamination in ground water with arsenic level of more than 3mg/l in one State as against the permissible limit of 0.01mg/l. 70.4 million people have been exposed to Ground Water arsenic contamination in 35 districts of six States alone. Abnormalities have been detected in 40% of animals in arsenic affected areas. The Committee are shocked to learn that in spite of the severity of arsenic contamination and its spread in different States over the last three decades, there have been no coordinated efforts to tackle the menace and there is no centralised authority to address the issues concerning arsenic contamination. There are no data from Government sources about the arsenic diseased people, animals and plants. There are serious gaps in monitoring and also in research efforts. There is no reference to arsenic contamination in National Water Policy 2012. There is no separate budgetary allocation to deal with arsenic issues. Though a Vision Document entitled "Mitigation and Remedy of Ground Water arsenic menace in India" was prepared by the National Institute of Hydrology (NIH) and the Central Ground Water Board (CGWB) in the year 2010, no concerted

action is visible. The Succeeding paragraphs of the Report deal with these issues in detail.

2. The Committee are at a loss to understand as to why there is no comprehensive data about affected districts/States and the magnitude of population exposed to arsenic, even thirty-eight years after first-arsenic contamination incident came to notice in Chandigarh. The information furnished by the Ministry of Water Resources, River Development and Ganga Rejuvenation (M/o WR, RD & GR) shows that 86 Districts in 10 States have arsenic contamination exceeding the permissible limit. The Department of Agricultural Research and Education (DARE) has, however, listed out only 71 Districts in 09 States having Ground Water arsenic contamination. The Department of Science and Technology (DST) has come out with yet another list of affected districts and States. Collation of information furnished by different Ministries shows that there are 96 districts in 12 States affected by ground water arsenic. According to the Council of Scientific and Industrial Research (CSIR), 70.4 million people have been identified with ground water arsenic contamination in 35 Districts in six States. The figure of affected population will be much higher if data about affected people in all the 96 districts are collected. All these conflicting data show that there had been no attempt to collect reliable data by any central agency. The Committee deplore such casual attitude and hardly need to emphasise that dependable, accurate and regular update of data are essential for providing perspectives with regard to public health, agriculture and other purposes. The Committee, therefore, desire that immediate

steps should be taken to draw up a central data base about arsenic affected districts/States not only for drinking water segment but also for irrigation and the data of human population, animals and crops exposed to arsenic.

3. According to the finding of Indian Council of Agricultural Research (ICAR), more than 90 per cent of the total ground water in arsenic affected areas is used for irrigating crops. Many investigators consider water-soil-crop-food transfer, cooking water and direct ingestion of arsenic contaminated water as the major exposure pathways of arsenic as reported by the vision document of NIH and CGWB. As the people take contaminated water along with contaminated food, the chances of damage become greater. The food crops sold off to inhabitants of uncontaminated regions lead to their consumption of arsenic contaminated food. The domestic animals in arsenic affected areas regularly consume arsenic laden drinking water, fish and food. Consumption of meat from such infected animals, causes arsenic intake. All these show the great danger of arsenic spread and call for urgent steps to ensure proper Ground Water management to minimize use of arsenic rich ground water for irrigation purposes. The Committee stress that remedial measures should be taken in this regard without loss of time.

4. The Committee are dismayed to learn that source of arsenic in ground water through natural processes in Ganga-Brahmaputra Plain has not been fully established during the last almost four decades. According to the M/o WR, RD & GR, elevated level of arsenic in ground water is caused largely by natural process and partly due to

anthropogenic activities like application of fertilizers, burning of coal, leaching from coal-ash tailings and from mining activity. There are several hypotheses propounded by scientists for the mechanism of release of arsenic into ground water by natural as well as anthropogenic activity, as described in section 2 - Chapter 01 of this Report. It has been, stated that sources of arsenic in Ganga-Brahmaputra plain is mostly sediments having arsenic bearing minerals. However, the process of release of arsenic into ground water particularly the local variation in the concentration of arsenic is yet to be fully understood, as it depends on various factors such as physico-chemical conditions, hydro-geological characteristics of aquifers, dynamic nature of aquifers, presence of arsenic bearing minerals in the sediments, etc. necessitating micro level studies. The Committee hardly need to stress that identifying the geogenic source of contamination is necessary to identify appropriate mitigation methods. It is not clear why no attempt has been made to identify the real cause of arsenic in ground water. No geogenic cause has been pointed out for the arsenic contamination in ground water. The Committee recommend that a time bound programme be implemented for identifying sources to conclusively establish the mobilization process which helps in arsenic release from minerals to ground water.

5. The Committee hold that there is no scientific basis for the Bureau of Indian Standards (BIS) to prescribe the maximum permissible limit for arsenic in drinking water as 0.05mg/l higher than the World Health Organisation's (WHO) standard of 0.01mg/l. BIS has

pleaded that relaxed standard of arsenic limit was effected in view of abundance of arsenic in ground water in several areas of the country and non-availability of alternate sources. The Committee do not accept this stand and would caution that there should be no compromise on the health of the people. It is the duty of the State to improve the public health which includes the provision of safe drinking water as enshrined in Article 47 of the Directive Principles of the State Policy of the Constitution of India. The Committee, therefore, urge that the relaxed arsenic permissible limit of 0.05mg/l in drinking water should be done away forthwith and acceptable limit of 0.01mg/l ensured.

6. The Committee are distressed to learn that there is no centralized data regarding the number of people affected by arsenic poisoning and it shows the casual attitude on the part of the Government. The Committee have been informed that Centralised data is collected by the Central Bureau of Health Intelligence (CBHI) in relation to only the national programmes on various diseases. Arsenic intake causes serious ailments like hyper pigmentation, keratosis, anaemia, swelling of legs, liver fibrosis, chronic lung disease, gangrene, neuropathy, cancer, etc. According to one expert, there are 2 to 3 lakhs of confirmed cases of illness and over one lakh deaths due to arsenic poisoning. In animals too, the arsenic poisoning causes many abnormalities. It has been stated that arsenic is one of the most toxic elements to fish and acute exposure results in immediate death. The Committee express their strong displeasure as to why in spite of such serious diseases caused to human beings

and animals, no steps were taken to collect relevant data or initiate appropriate diagnostic and curative measures. Considering the fact that there are as many as 12 arsenic affected States and huge population affected by arsenic poisoning, the Committee fail to understand as to why no national programme on arsenic mitigation and treatment has been launched as recommended by the Working Group of Planning Commission. The Committee recommend that at least now, a national programme be launched in this regard and immediate steps taken to ensure regular collection of relevant data and providing appropriate diagnostic and curative measures both for human beings and for cattle by the M/o H&FW and by the Department of Animal Husbandry, Dairying & Fisheries respectively. The Committee should be apprised of the action taken in this regard within one month.

7. No convincing reasons have been given by the Central Ground Water Board (CGWB) as to why 4,504 out of its 12,946 water quality monitoring stations have been located disproportionately in just four states viz. Orissa, Madhya Pradesh, Maharashtra & Karnataka. The CGWB monitors ground water quality through a network of 12,946 ground water observation wells with the objective of, *inter-alia,* periodic monitoring of geogenic contamination of ground water. The Committee, in this connection note that water quality monitoring is done not only by CGWB but also by Central Pollution Control Board (CPCB), States Pollution Control Boards (SPCBs), Central Water Commission (CWC) and National River Conservation Directorate (NRCD). The Committee emphasise that there should be no

duplication of water quality monitoring efforts. The Committee desire that additional water quality monitoring stations being set up by CGWB should be located in such places as to conform to a rationalized and optimized network of water quality monitoring stations.

8. Accreditation by National Accreditation Board for Testing and Calibration Laboratories (NABL) recognizes the technical competence of laboratories. The process of accreditation of CGWB laboratories was initiated in April 2011 and only 03 out of 16 chemical laboratories of CGWB (Lucknow, Chandigarh & Hyderabad) have been accredited so far. The accreditation process involves fulfilling the requirements of standards as prescribed by NABL. The Committee see no reason why only five more labs have been targeted for NABL accreditation during the 12th Plan. The Committee urge that serious efforts should be made to get NABC accreditation for all the remaining 13 labs of CGWB before the end of 12th Plan.

9. It transpired during the examination of the subject that the functioning of CGWB is constrained by paucity of staff. As against its sanctioned strength of 4195 personnel, 1170 posts are lying vacant. It is obvious that no organization can function efficiently and effectively unless there is optimum manpower. The Committee recommend that necessary steps should urgently be taken to ensure that CGWB has full complement of staff at the earliest.

10. The Committee are startled to hear from the Ministry of Environment & Forests that monitoring of water quality over the years by the Central Pollution Control Board (CPCB) at 2500 locations

(covering 445 rivers, 45 drains, 807 ground water stations etc. spread over all the 29 States and 06 Union Territories) does not reflect any detectable presence of arsenic contamination at any of the monitoring locations. The Committee suspect that the information displayed in the CPCB's website as on 20-11-2014 suggests a different story. Arsenic parameter is nowhere in the list of chemical analyses of CPCB, as evident from the list of NABL accredited analytical parameters displayed in the website. Obviously, CPCB's monitoring cannot show any arsenic contamination. The Committee strongly recommend that there should be an immediate relook at the testing parameters by the M/o EFCC / CPCB and the lacuna, if any, in this regard should be addressed. The Committee need to be apprised of the factual position and action proposed in this regard.

11. Precious little has been done by Water Quality Assessment Authority (WQAA) constituted in the year 2001 to deal with, *inter-alia,* any environmental issue concerning surface and ground water quality and reviewing the status of quality of natural water resources. One of the achievements of WQAA is stated to be regarding "minimum environmental flows in Indian rivers". However, on closer scrutiny, it is observed that there is hardly any worthwhile progress during the last 11 years except for constituting a working group in the year 2003 which took four years to submit its report in 2007, followed by constitution of a committee for implementing the working group's recommendations which submitted its report in 2009. Eventually, the recommendations of the Committee have not been accepted by WQAA in its meeting held on 30th May, 2013. Strangely, WQAA's

mandate excluded quality issues arising due to geogenic aspect. This lacuna has been corrected only recently by revision of its mandate. The Committee suggest that WQAA should focus on monitoring and assessment of water quality of surface water/ground water and address all related aspects holistically. For this purpose, the Committee recommend that sufficient budgetary provisions be made available for equipping WQAA with sophisticated equipments and trained human resource. This would bring in more efficient functioning of WQAA.

12. Unfortunately, no monitoring of arsenic build-up in soil, crops and vegetables has been undertaken by any organisation. DARE has stated that ICAR is not monitoring the arsenic build-up in soils. DAC claimed that M/o WR, RD & GR is mandated for periodical assessment of arsenic contamination in ground water including arsenic build-up in soils. The M/o WR, RD & GR have informed that soil analysis for arsenic contamination is not carried out by CGWB. M/o EFCC and CPCB have not done any study on the build-up of arsenic in soil, crops and vegetables. The Committee never expected that their queries on issues of national importance would be shuttled from one Ministry to another without yielding desired information. The Committee desire that the Cabinet Secretary should sort-out the issue and intimate the Committee as to whose responsibility is it to monitor arsenic build-up in soils, crops and vegetables and ensure that necessary steps are taken in this regard under intimation to the Committee. The Committee further desire that a special National Sample Survey should be conducted to ascertain all water quality

problems and to devise an appropriate remedial plan. The Committee recommend that there should be a mechanism for constant monitoring of contamination levels in water and soil throughout the country for taking timely corrective measures.

13. There are a number of arsenic removal devices, developed by various organizations based on different scientific propositions. These devices vary in cost, size, filtering mechanisms and mechanisms of operations as summarized in Chapter III of this report. The Committee have been informed that most of the arsenic removal devices have failed to produce satisfactory results mainly due to shortcomings in operations and maintenance (O&M). The Committee agree with the M/o WR, RD & GR that arsenic removal devices, whose O&M aspects are managed by community participation, could produce satisfactory performance. The Committee hope that appropriate steps will be taken to enlist community participation to operate and maintain the arsenic removal devices in the arsenic contaminated areas. The Committee would also recommend that arsenic testing kits should be distributed free in affected areas. The Committee feel that further R&D efforts need to be undertaken to address the problems relating to O&M.

14. The Committee are displeased to note that no national health programme has so far been formulated for ground water quality related health problems as suggested by the working group of Planning Commission in the year 2011. During his deposition before the Committee, a representative of the M/o Health & Family Welfare emphasised the need to formulate a national programme in this

regard and assured that a task force would be constituted to look into arsenic issues and would be asked to submit its report by February, 2015. He also assured that funds would be provided to State Governments under National Rural Health Mission for diagnostic facilities, treatment and medicine for arsenic diseases. The Committee expect that action is taken in this regard promptly as promised, with sufficient budgetary provision. The Committee also desire that a detailed report should be made to Parliament regularly every six months (say April and November) bringing out the efforts made and progress achieved state-wise in treatment of arsenic affected people under the proposed National Health Programme.

15. Arsenic affected people are economically backward and loose their earthly possession in the process of arsenic treatment. The Committee feel that it is the duty of the State to provide them relief. The Committee, therefore, recommend that arsenic affected people should be provided treatment and medicines free-of-cost. They should also be provided with health insurance and life insurance with the cost of premium borne by the Government.

16. The Committee recommend that there should be an annual conference of Health Ministers of all States to discuss and decide about ways and means to address water quality related health problems and decide appropriate remedial measures. This forum can also be used for annual assessment of progress and the results achieved.

17. The Committee appreciate the commendable work done by the Department of Science and Technology (DST) and the Council of

Scientific and Industrial Research (CSIR) in promoting a network of researchersfromleading R&D/academic institutions working in the area of arsenic. The work done by CSIR-National Botanical Research Institute (NBRI) in identifying arsenic safe rice genotype CN1794-2CSIR-NBRI deserves a special mention. This variety is proposed to be released for cultivation in vast arsenic affected belts of West Bengal. The Committee also note that the DST's promotion of research efforts initiated in 2007 have resulted in development of 07 different devices for arsenic removal. The Committee in this connection would suggest that DST/CSIR should explore collaboration with global R&D institutions in arsenic related areas particularly for *in-situ* remediation of arsenic from aquifer system for which no R&D work has been taken up by any Indian Institute.

18. The Committee find that in the areas of medical curative treatment and the causes, there has been no centralized research. A representative of the M/o H&FW admitted during his oral evidence before the Committee that medical research of arsenic causes and treatment has been inadequate. The Committee need not over emphasise that there should be a focused research for medical cure of arsenic diseases. The Committee are sure that any discovery of cost effective medicine and treatment procedure will be well received not only in our country but also in other arsenic affected countries, as there is huge population of arsenic affected people world-wide.

19. The Department of Agricultural Research and Education (DARE) has pointed out the need for a systematic search for phyto-accumulating or phyto-excluding plant species to identify species

which effectively detoxifies within the plant body by its metabolic process. By way of remedial options to combat arsenic problem, DARE has suggested, among other things, conjunctive use of ground and surface water, recharge of ground water by rain water harvesting, increased use of farmyard manure and cost effective phyto-remediation options. Unfortunately, it appears that DARE has not pro-actively promoted these measures and generated an awareness about the arsenic impact on agriculture. So much so even the Secretary, Department of Agriculture and Cooperation was not aware of arsenic impact on plants and vegetations. The Committee are unhappy that so far no comprehensive strategies have been worked out to ensure that arsenic laden agricultural produce is not consumed by human beings and live stock. The Committee exhort DARE that in consultation with the Department of Agriculture and Cooperation and other concerned Ministries, appropriate strategies should be worked out and implemented within three months of presentation of the report under intimation to the Committee.

20. The Secretary, Department of Agriculture and Cooperation was candid in his admission that the Department had so far not thought of the ground water arsenic impact on agriculture and promised to adopt such agricultural practices as to promote crop varieties which are less susceptible to uptake of arsenic and other measures which would minimize arsenic in agricultural produce. It is a matter of satisfaction to the Committee that the Committee could create awareness at very high level about ground water arsenic impact on the agricultural sector. The Committee recommend that the remedial

measures suggested by DARE should be incorporated in the crop husbandry programme and the measures vigorously promoted to minimize the arsenic impact.

21. According to an expert, arsenic has affected over 150 million people worldwide through consumption of arsenic contaminated drinking water. It is learnt that as many as 38 countries including, USA, UK, Canada, Australia and China have been affected by high arsenic in ground water. DARE has pointed out that arsenic concentration in ground water is of great concern to the world since it affects the soil, plants, animals-human systems. The Committee feel that India can render possible help to other arsenic affected countries with remediation technologies, arsenic removal devices and arsenic safe crop genotypes, etc. and would urge the Government to take suitable steps in this regard.

22. The Committee find that the problem of ground water arsenic contamination, in spite of being very grave, has not received deserved attention due to lack of its focus in the National Water Policy-2012. The arsenic contamination in ground water was first reported almost four decades ago and presently spread over 96 districts in 12 States. The population identified with arsenic contamination is as much as 70.4 million and 2 to 3 lakhs of confirmed cases of arsenic illness. In view of the seriousness of the problem, the Committee urge that there should be a specific focus in the National Water Policy to address this humongous problem, by appropriate addendum to the National Water Policy-2012.

23. The Committee regret to note that there is no separate budgetary allocation for arsenic related issues or for that matter for any water quality issues. At present, funding for water quality is made only through the National Rural Drinking Water Programme under the Ministry of Drinking Water & Sanitation. The Committee strongly recommend that there should be a separate budgetary head of expenditure for water quality with a sub-head for arsenic contamination in order to adequately meet the fund requirements. Similarly, there is no specific budget allocation for arsenic related diseases under the Ministry of Health & Family Welfare. Now that a National Programme for Ground Water related health problems is proposed to be formulated by the Ministry of Health & Family Welfare, there should be a separate budgetary head for the new national programme with sufficient funding.

24. The M/o EFCC have reportedly notified general standards for environmental pollutants which include industrial effluents also for various recipients sources, *inter-alia,* land for irrigation. The limit for discharged arsenic in waste water has been defined for all the sources as 0.2mg/l. As already stated in a preceding paragraph, the Water Quality Assessment Authority has done nothing so far to ensure minimum environmental flows. The Central Population Control Board has not included 'Arsenic' in their chemical analyses for testing of waste water. The Committee in this connection note that analytical testing of effluents of leather tanneries conducted by IIT Kanpur in the year 2002 showed alarming levels of arsenic, cadmium, mercury and other heavy metals. The arsenic level of tannery effluent

at Unnao was as high as 5.07 mg/l as against the prescribed limit of 0.2 mg/l. Thus, anthropogenic causes of arsenic content in ground water and in soils have remained unaddressed. The Committee view this failure seriously and urge the Ministry of Environment & Forests to immediately look into the shortcomings and take urgent remedial steps to ensure that anthropogenic sources of arsenic in water and soil are plugged. The Committee also recommend that there should be a survey of all industries on the river side to check the quality of their effluents and adherence to environmental standards. They should be closed if they fail to adhere to effluent standards besides being imposed heavy penalty. Huge amount of pesticides and chemical fertilizers also leach into the groundwater and river and their contents in soil and in river water should be carefully studied to take appropriate preventive steps.

25. The Committee observe that public awareness campaigns to make people aware about arsenic contamination in ground water and its impact on human health do not appear to have created sufficient awareness about the problem. CGWB has reportedly organized several awareness generation programmes regularly in the form of mass awareness programme, painting competition, water management and training programme wherein students are one of the targeted groups. The Ministry of Drinking Water and Sanitation provides funds through NRDWP to focus on awareness generated activities in arsenic affected habitations. The Ministry of Health & Family Welfare, however, have not undertaken any specific awareness raising activity in health effects of arsenic contaminated water despite

the recommendation of a Task Force of Planning Commission in the year 2007. DARE has claimed that farmers' awareness programme, workshop, training programme and medical check-ups have been organized to educate people of affected areas under the National Agricultural Innovation Project (NAIP) on 'Arsenic in Food Chain: Cause, Effect & Mitigation' between 2008-12. The Committee feel that frequent and sustained campaigns through print and electronic media would also be necessary in addition to other local progammes mentioned above, for effective awareness campaign.

26. It is a matter of serious concern that in spite of grave multi-dimensional arsenic problem being faced by vast parts of the country for the past decades, the Govt. have not thought it fit to identify a Central agency to tackle the arsenic menace. Repeated queries to M/o WR, RD & GR as to who is responsible for abatement of arsenic contamination at the Central level have not yielded any specific information. The M/o WR, RD & GR attempted to shift the responsibility by simply stating that abatement of arsenic contamination in drinking water is in the domain of State Governments. The Committee do not approve of this stand. The very fact that the problem of arsenic contamination is spread over 96 districts in 12 different States with huge human and animal population having been affected by arsenic poisoning calls for immediate Central intervention. At the Central level, there are as many as seven Ministries / Departments and a number of Central organizations which are required to handle sthis problem, besides State Governments and their agencies. These are Ministry of Water Resources, River

Development & Ganga Rejuvenation, Ministry of Drinking Water & Sanitation, Ministry of Health & Family Welfare, Department of Agriculture and Cooperation, Department of Agricultural Research and Education, Department of Animal Husbandry, Dairying & Fisheries, Min. of Science & Technology, Central Ground Water Board, Central Ground Water Authority, Water Quality Assessment Authority, Council of Scientific & Industrial Research, Indian Council of Agricultural Research, National Botanical Research Institute, Indian Council of Medical Research, etc. There should be a single authority at the Centre to look at the issue of arsenic problem holistically and take appropriate coordinated corrective measures. The Ministry have failed to convince the Committee of any concrete action taken by them. It is callous negligence on the part of the Government that they had not taken any action in the past in this regard. It is only after the matter has been taken up by the Committee, a Core Committee headed by the Director, NIH has recommended in its report submitted on 15 October, 2014, that each of the affected States should have an 'Arsenic Task Force' spearheaded by the model 'National Arsenic Mission Task Force' (NAMTF) at Central level. It is indeed intriguing as to why the ministries and departments of the Government of India remained oblivious of the said Core Committee while deposing before the Committee. The Committee deprecate the lapse on the part of the representatives of ministries/departments concerned who appeared before them . The Minutes of the meeting of the Core Committee should be furnished to the Committee. The Committee urge the Government to ensure functioning of the Core Committee on war

footing. Results of the action taken should be made available to the Committee within 3 months.

27. It was enquired from the Cabinet Secretary as to whether there is any comprehensive approach with an integrated policy, action plan and coordination for tackling different aspects of arsenic contamination. In response, a vague reply was received on 15 October, 2014 stating that a more active engagement by different Ministries/Departments of the Central Government and State Governments would lead to an integrated approach and action plans for mitigation of adverse impact of arsenic on human, plant and animal health by effectively eliminating arsenic from drinking water and food supply chain. Not satisfied with the reply, the Committee enquired whether any specific action is proposed in this regard. The Cabinet Secretariat responded on 3rd November, 2014 by stating that as regards planning of integrated approach, it has been decided to convene meeting of Committee of Secretaries with concerned Ministries/Departments soon to discuss the matter. It is strange that Cabinet Secretariat has not taken the cognizance of the existence of the Core Committee. The Committee desire that the Committee of Secretaries including those of the Ministries/Departments mentioned in the preceding para of this report should consider the matter and ensure that an integrated policy and effective co-ordination mechanism is in place for planning and implementation of all arsenic related issues and the removal of arsenic contamination should be taken on a Mission mode.

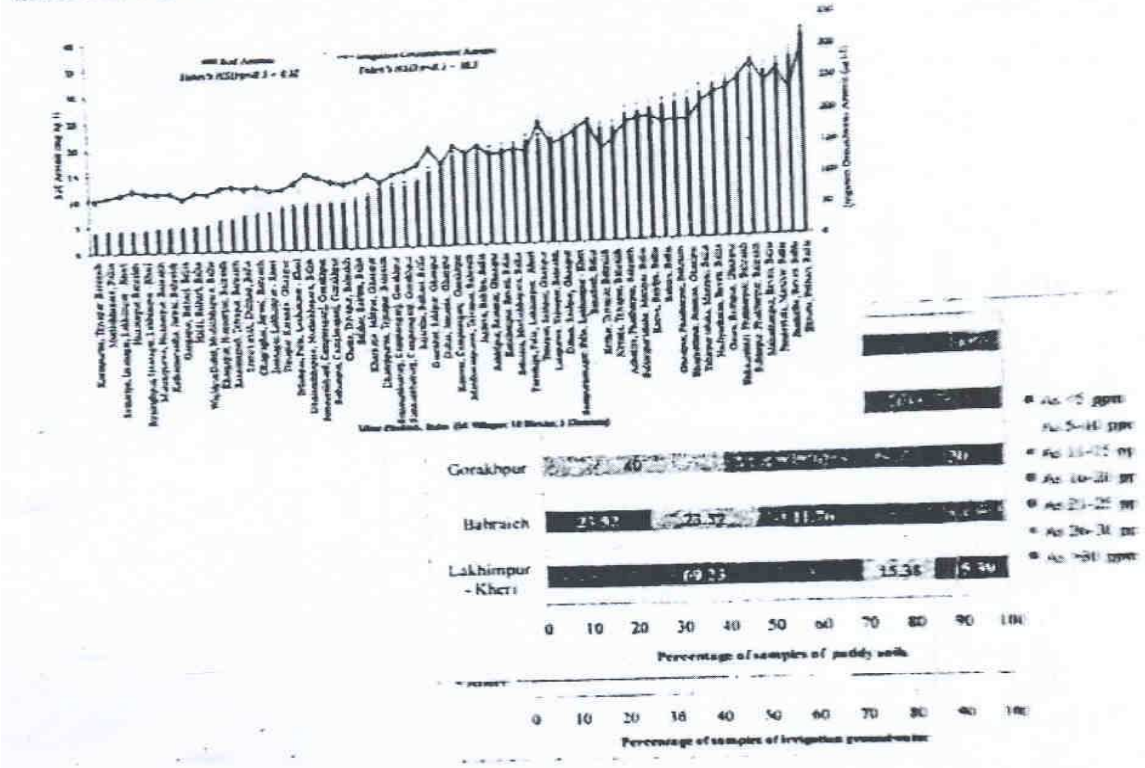
28. The Committee have dealt with arsenic related issues in detail in this report. Other major contaminants viz. fluoride, iron, nitrate, salinity and other heavy metals in water are no less serious as they impact the health of millions of people. The Committee are of the view that water quality issues demand focused attention. This can be achieved only if there is a separate department for the purpose. The Committee, therefore, recommend that a separate department of water quality issues should be created within the Ministry of Drinking Water & Sanitation.

NEW DELHI;
8 December, 2014
Agrahayana 17, 1936 (Saka)

DR. MURLI MANOHAR JOSHI,
CHAIRPERSON,
ESTIMATES COMMITTEE.

Appendix I
(vide Para No. 1.18 of the Report)

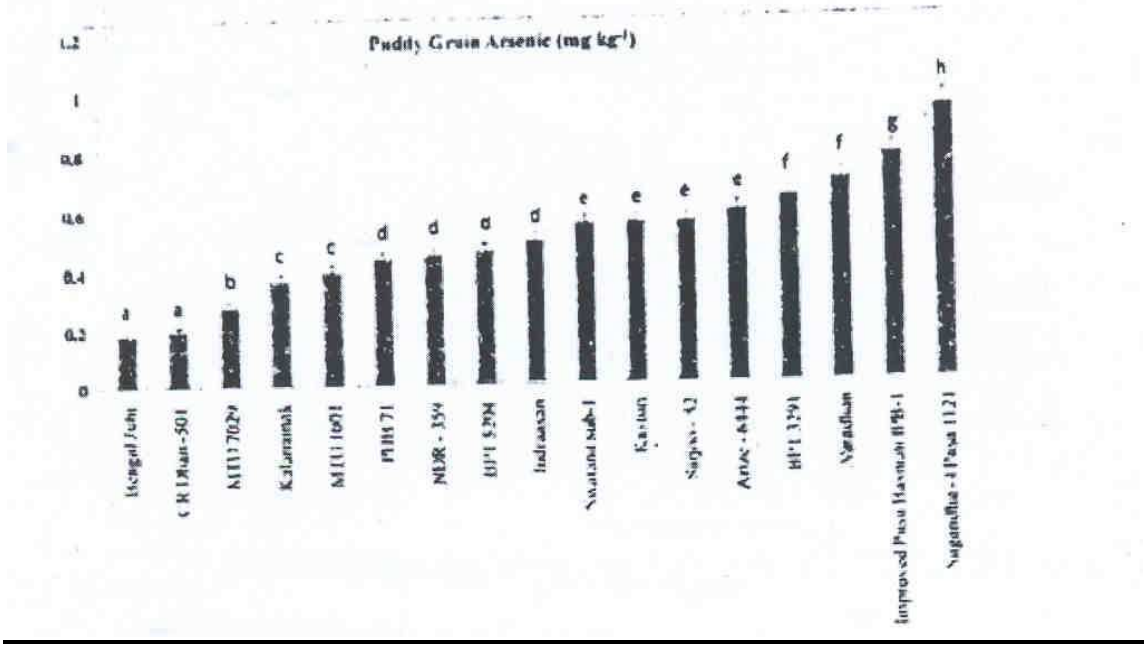
Fig. 2: Arsenic contents (Mean=SE) of irrigation groundwater and paddy soil samples in the middle IGP region



Number of villages (N=5), Ballia (21), Ghazipur (9), Behraich (17), Lakhimpur Kheri (6), Gorakhpur (5)
Depth of soil 5-45 cm.

Appendix II
(vide Para No. 1.20 of Report)

Fig. 3: Averaged arsenic contents (Mean±SE) of grain samples of different paddy varieties grown in the middle IGP region. Bars with different alphabets are significantly different at $p<0.5$ using Tukey's Test HSD.



Appendix III
(vide Para No. 1.20 of Report)

Table 3: Arsenic in grains of different paddy varieties presently cultivated in agricultural soils of Uttar Pradesh (covering 58 villages located in 18 blocks of five districts)

Paddy Varieties	Grain Arsenic (mg kg^{-1})	For subsistence diet (Williams et al., 2005)
Bengal Juhi	0.179^{a}±0.054	Safe
501 (IET 19189)	0.196^{a}±0.029	Safe
MTU 7029 (IET 5656)	0.281^{b}±0.076	Safe
Kalanamak	0.369^{c}±0.044	UnSafe
MTU 1001	0.397^{c}±0.031	UnSafe
PHB 71	0.438^{cd}±0.024	UnSafe
NDR – 359 (IET 11005)	0.455^{d}±0.058	UnSafe
BPT 5204	0.463^{d}±0.071	UnSafe
Indrasan	0.465^{d}±0.084	UnSafe
Swarna sub-1 (IET 20266)	0.532^{e}±0.064	Unsafe
Kasturi (IET 8580)	0.555^{e}±0.037	Unsafe
Surjoo – 52	0.576^{e}±0.091	Unsafe
Arize – 6444 (IET 16434)	0.590^{e}±0.048	Unsafe
BPT 5291 (IET 7244)	0.637^{f}±0.066	Unsafe
Varadhan (IET 18940)	0.694^{f}±0.094	Unsafe
Improved Pusa Basmati (IPB-1) (IET 18990)	0.774^{g}±0.016	Unsafe
Sugandha–I/Pusa 1121 (IET 18004)	0.932^{h}±0.099	Unsafe
HSD ($p<0.5$)	0.059	

Values with different alphabets differ significantly at $p<0.5$ using Tukey's Test HSD.

Appendix IV
(vide Para No. 1.45 of the Report)

Indian Standard

DRINKING WATER — SPECIFICATION

(Second Revision)

1 SCOPE

This standard prescribes the requirements and the methods of sampling and test for drinking water.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard the following definition shall apply.

3.1 Drinking Water — Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

4 REQUIREMENTS

Drinking water shall comply with the requirements given in Tables 1 to 4. The analysis of pesticide residues given in Table 3 shall be conducted by a recognized laboratory using internationally established test method meeting the residue limits as given in Table 5.

Drinking water shall also comply with bacteriological requirements (*see* 4.1), virological requirements (*see* 4.2) and biological requirements (*see* 4.3).

4.1 Bacteriological Requirements

4.1.1 *Water in Distribution System*

Ideally, all samples taken from the distribution system including consumers' premises, should be free from coliform organisms and the following bacteriological quality of drinking water collected in the distribution system, as given in Table 6 is, therefore specified when tested in accordance with IS 1622.

4.2 Virological Requirements

4.2.1 Ideally, all samples taken from the distribution

Table 1 Organoleptic and Physical Parameters
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Colour, Hazen units, *Max*	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
ii)	Odour	Agreeable	Agreeable	Part 5	a) Test cold and when heated b) Test at several dilutions
iii)	*p*H value	6.5-8.5	No relaxation	Part 11	—
iv)	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
v)	Turbidity, NTU, *Max*	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, *Max*	500	2 000	Part 16	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, *Max*	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, *Max*	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, *Max*	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, *Max*	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, *Max*	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, *Max*	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl_2), mg/l, *Max*	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, *Max*	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, *Max*	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, *Max*	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, *Min*	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, *Max*	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, *Max*	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, *Max*	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, *Max*	0.5	No relaxation	Clause 6 of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO_3), mg/l, *Max*	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C_6H_5OH), mg/l, *Max*	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, *Max*	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO_4) mg/l, *Max*	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30
xxi)	Sulphide (as H_2S), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, *Max*	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as $CaCO_3$), mg/l, *Max*	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, *Max*	5	15	IS 3025 (Part 49)	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 3 Parameters Concerning Toxic Substances

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Cadmium (as Cd), mg/l, *Max*	0.003	No relaxation	IS 3025 (Part 41)	—
ii)	Cyanide (as CN), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 27)	—
iii)	Lead (as Pb), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 47)	—
iv)	Mercury (as Hg), mg/l, *Max*	0.001	No relaxation	IS 3025 (Part 48) Mercury analyser	—
v)	Molybdenum (as Mo), mg/l, *Max*	0.07	No relaxation	IS 3025 (Part 2)	—
vi)	Nickel (as Ni), mg/l, *Max*	0.02	No relaxation	IS 3025 (Part 54)	—
vii)	Pesticides, µg/l, *Max*	See Table 5	No relaxation	See Table 5	—
viii)	Polychlorinated biphenyls, mg/l, *Max*	0.000 5	No relaxation	ASTM 5175* or APHA 6630	—
ix)	Polynuclear aromatic hydrocarbons (as PAH), mg/l, *Max*	0.000 1	No relaxation	APHA 6440	—
x)	Total arsenic (as As), mg/l, *Max*	0.01	0.05	IS 3025 (Part 37)	—
xi)	Total chromium (as Cr), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 52)	—
xii)	Trihalomethanes				
	a) Bromoform, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	b) Dibromochloromethane, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	c) Bromodichloromethane, mg/l, *Max*	0.06	No relaxation	ASTM D 3973-85* or APHA 6232	—
	d) Chloroform, mg/l, *Max*	0.2	No relaxation	ASTM D 3973-85* or APHA 6232	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 4 Parameters Concerning Radioactive Substances

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 14194	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Radioactive materials:				
	a) Alpha emitters Bq/l, *Max*	0.1	No relaxation	Part 2	—
	b) Beta emitters Bq/l, *Max*	1.0	No relaxation	Part 1	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 5 Pesticide Residues Limits and Test Method

(*Foreword* and *Table* 3)

Sl No.	Pesticide	Limit µg/l	Method of Test, Ref to	
			USEPA	AOAC/ ISO
(1)	(2)	(3)	(4)	(5)
i)	Alachlor	20	525.2, 507	—
ii)	Atrazine	2	525.2, 8141 A	—
iii)	Aldrin/ Dieldrin	0.03	508	—
iv)	Alpha HCH	0.01	508	—
v)	Beta HCH	0.04	508	—
vi)	Butachlor	125	525.2, 8141 A	—
vii)	Chlorpyriphos	30	525.2, 8141 A	—
viii)	Delta HCH	0.04	508	—
ix)	2,4- Dichlorophenoxyacetic acid	30	515.1	—
x)	DDT (*o, p* and *p, p* – Isomers of DDT, DDE and DDD)	1	508	AOAC 990.06
xi)	Endosulfan (alpha, beta, and sulphate)	0.4	508	AOAC 990.06
xii)	Ethion	3	1657 A	—
xiii)	Gamma — HCH (Lindane)	2	508	AOAC 990.06
xiv)	Isoproturon	9	532	—
xv)	Malathion	190	8141 A	—
xvi)	Methyl parathion	0.3	8141 A	ISO 10695
xvii)	Monocrotophos	1	8141 A	—
xviii)	Phorate	2	8141 A	—

NOTE — Test methods are for guidance and reference for testing laboratory. In case of two methods, USEPA method shall be the reference method.

Table 6 Bacteriological Quality of Drinking Water[1)]

(*Clause* 4.1.1)

Sl No.	Organisms	Requirements
(1)	(2)	(3)
i)	*All water intended for drinking*:	
	a) *E. coli* or thermotolerant coliform bacteria[2), 3)]	Shall not be detectable in any 100 ml sample
ii)	*Treated water entering the distribution system*:	
	a) *E. coli* or thermotolerant coliform bacteria[2)]	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample
iii)	*Treated water in the distribution system*:	
	a) *E. coli* or thermotolerant coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample

[1)]Immediate investigative action shall be taken if either *E.coli* or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause shall be determined by immediate further investigation.

[2)]Although, *E. coli* is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests shall be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

[3)]It is recognized that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for progressive improvement of water supplies.

APPENDIX – V
(Vide para no. 4.4 of the report)

NUMBER OF ARSENIC AFFECTED HABITATIONS WHICH ARE YET TO BE PROVIDED SAFE DRINKING WATER

(As Reported on online IMIS of the Ministry of Drinking Water & Sanitation by States)

(as on 01/04/2014)

S.No.	State	Number of Arsenic affected habitations
1	BIHAR	357
2	CHATTISGARH	0
3	HARYANA	0
4	JHARKHAND	0
5	KARNATAKA	12
6	PUNJAB	1
7	UTTAR PRADESH (Data under reconciliation)	73
8	WEST BENGAL	1124
9	ASSAM	424
10	MANIPUR	0
Total		**1991**

APPENDIX VI

(vide Para No. 5.35 of Report)

Research on arsenic in the water carried by out by ICMR's Regional Occupational Health Centre (ROHC) (E), Kolkata

Regional Occupational Health Centre (ROHC), Kolkata conducted studies on arsenic contamination of drinking water and its public health impact in West Bengal. In India, West Bengal is the worst affected state with approximately 26 million people residing in 9 districts out of 19 districts exposed to ground water arsenic concentration above 0.05 mg/l through contaminated ground water most commonly from hand pump tube wells. Approximately 300,000 people in West Bengal are expected to have signs and symptoms of chronic arsenic toxicity.

ROHC(E), Kolkata has been carrying out studies on arsenic in West Bengal with the help of local authorities of Govt. of West Bengal. Studies on environmental exposure monitoring and health status of arsenic exposed population in a few districts (N-24-Parganas and Murshidabad) of West Bengal has been done to observe the gravity of the problem. ROHC (E) is also undertaking studies on the oxidative stress and identification of suitable biomarkers of chronic arsenic toxicity for early diagnosis and treatment. There are other organizations in West Bengal who are also involved in studies on arsenic in West Bengal. Regional Occupational Health Centre (Eastern), Kolkata has been undertaking research on Arsenic affected population in West Bengal since 2003-04. The studies undertaken by the Centre are within the state of West Bengal. A clinico-epidemiological study supported by WHO, undertaken by the Centre on Arsenic exposed population of two Gram Panchayats (GP) in Katlamari village of Murshidabad district, West Bengal, during 2006, reported water arsenic level in 179 tube wells of which 62.9% tube wells reported arsenic level above 50pg/lit. The highest value of water arsenic level in tube well water reported was 949.9µg/lit. The study also reported arsenic content in urine, hair and nail among the selected population. Medical examination of 296 subjects (144 male and 151 female subjects) was also done. The study reported 15.4% cases of arsenicosis (As per WHO criteria) in male and 3.8% in female and 19.1% male and 5.6% female respectively among the subjects exposed to water arsenic >50 µg/lit. **(Ref.: Report on "Clinico-Epidemiological Study of Arsenic Exposed Population in West Bengal" funded by WHO — 2006).**

Besides, the Centre has carried out a study in Asoke Nagar area of North 24-Parganas district in 2008-09. In the study 56 tube wells water samples were examined for water arsenic content and found that 26% of these tube wells were having arsenic level >50 µg/lit. 270 exposed subjects examined for arsenicosis, showed 5% subjects (7% male and 4% female) were having definite arsenicosis as per WHO criteria, **(Ref.: NIOH Annual Report 2008-09).**

During 2009-10 the Centre carried out another study on hemolytic profile in arsenic exposed population of West Bengal. In this study water arsenic level in 324 tube wells was reported, 38.5% tube wells have values higher than 50µg/lit. In this study 404 subjects were clinically examined for diagnosis of arsenic related diseases. 46.75% of the tube wells reported higher arsenic level in water (>50 µg/lit). The screening test showed the evidence of premature destruction of red cell in specific arsenic exposed cases which may lead to the occurrence of hemolytic anaemia among the population in the study area. **(Ref.: NI01-1 Annual Report 2009-10 & 2010-11).**

Studies on the Oxidative Stress induced toxicity of Arsenic in human

It is well documented that arsenic exposure through drinking water causes different types of symptoms covering almost all human body system. The human exposure to arsenic is being evaluated by clinical signs and symptoms and by laboratory investigation like metabolic products

of arsenic in urine. Objective of the present study was to detect and characterize suitable biomarker for detection of early exposure. The study was conducted at Habra II, North 24 paraganas, West Bengal and n=108 subjects were recruited for conducting study. All subjects were investigated for health status and antioxidant profile. Water and urine samples were analyzed for arsenic analysis. Significant rise ($p<0.001$) in serum uric acid (UA) level, as preliminary oxidative stress marker, was observed in 58% cases of group of tested population consuming >50µg/lit arsenic in drinking water. Moreover decline in Total Antioxidant Status (57% cases) of the >50µg/lit group supported the elevation of Serum UA. Arsenic induced skin pigmentation and keratosis was observed in 6.4% of tested population. Our study also indicated reduced oxidative stress parameters in a significant number of cases without signs and symptoms of arsenic exposure. Therefore, it may be concluded that the high arsenic consuming group has irreversible oxidative stress, which leads to symptomatic disease. **(Ref: Annual Report NIOH 2012-13)**

APPENDIX – VII
(vide Para No. 5.35 of Report)

Details of State-wise, year-wise Arsenic free Wells constructed in Arsenic affected areas by CGWB

State	Year	Number of wells handed over	Number of wells yet to be handed over	Total
Assam	2009	0	4	4
	2010	2	5	7
	2011	5	6	11
	2012	0	8	8
	2013	0	6	6
	2014	11	0	11
Sub total Assam		**18**	**29**	**47**
Bihar	2005	4	0	4
	2006	4	0	4
	2007	2	0	2
	2009	6	0	6
	2010	3	1	4
	2011	0	1	1
	2012	6	1	7
Sub total Bihar		**25**	**3**	**28**
Chhattisgarh	2002	2	0	2
	2005	4	0	4
Sub total Chhattisgarh		**6**	**0**	**6**
Uttar Pradesh				
	2006	4	4	8
	2007	1	1	2
	2008	5	0	5
	2009	3	0	3
	2010	1	0	1
	2011	4	0	4
	2012	1	1	2
	2013	1	1	2
	2014	1	0	1

Subtotal Uttar Pradesh		**21**	**07**	**28**
West Bengal	1997	6	3	9
	1998	5	3	8
	1999	3	2	5
	2000	2	3	5
	2001	5	2	7
	2002	9	3	12
	2003	3	0	3
	2004	10	3	13
	2005	5	4	9
	2006	9	4	13
	2007	8	6	14
	2008	7	3	10
	2009	8	0	8
	2010	0	3	3
	2011	4	1	5
	2012	6	1	7
	2013	6	4	10
	2014	1	3	4
Sub total (West Bengal)		**97**	**48**	**145**
Total (India)		**167**	**87**	**254**

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APPENDIX – VIII
(vide Para No. 6.17 of Report)

STATEWISE STATUS OF AQUIFER MAPPING DURING XIITH PLAN

S. No.	State / UT	Area in which aquifer mapping initiated (sq.km)	Area in which aquifer mapping yet to be initiated (sq.km)
1	ANDAMAN AND NICOBAR	1348	0
2	ANDHRA PRADESH	14421	47429
3	ARUNACHAL PRADESH	1100	927
4	ASSAM	5635	0
5	BIHAR	3715	3889
6	CHANDIGARH	115	0
7	CHHATTISGARH	4596	7127
8	DADRA AND NAGAR HAVELI	0	490
9	DAMAN AND DIU	112	0
10	DELHI	1483	0
11	GOA	516	934
12	GUJARAT	19448	62146
13	HARYANA	24211	17679
14	HIMACHAL PRADESH	4477	3183
15	JAMMU AND KASHMIR	10158	332
16	JHARKHAND	4295	2070
17	KARNATAKA	24079	69230
18	KERALA	3794	1406
19	LAKSHADWEEP	32	0
20	MADHYA PRADESH	15727	54181
21	MAHARASHTRA	11176	31391
22	MANIPUR	155	539
23	MEGHALAYA	1600	200
24	MIZORAM	700	0
25	NAGALAND	400	394
26	ORISSA	4292	12208
27	PUDDUCHERY	432	0
28	PUNJAB	11612	36917
29	RAJASTHAN	31330	110315
30	SIKKIM	750	0
31	TAMIL NADU	17411	52259
32	TELANGANA	11023	27218
33	TRIPURA	559	2975
34	UTTAR PRADESH	32205	58569
35	UTTRAKHAND	7811	0
36	WEST BENGAL	6232	8146

Note-Aquifer maps are expected to be ready after a period of three years since initiation.

APPENDIX – IX
(Vide para no. 6.18 of the report)

Recommendations of the 'Core Committee' on "Mitigation and Remedy of Arsenic Menace in India"

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1 Demand driven R & Ds

(i) Prepare a compendium of works done and the results thereof on various aspects; viz. technological initiatives and interventions, alternate water supply arrangements, socio-economic and socio-cultural impacts, agricultural and health impacts, etc.

(ii) Initiate diagnostic survey of the arsenic affected/vulnerable areas, prepare arsenic risk and vulnerability maps and delineate arsenic safe aquifers, both shallow and deep, including assessment of potential yield to tap arsenic safe water;

(iii) Encourage development and certification of field testing kits, which are robust, reliable, affordable and simple enough to use by relatively unskilled users in the villages;

(iv) Undertake the task of comprehensive Life Cycle Assessment (LCA) and Social audit of reportedly successful and promising arsenic removal technologies and initiate steps to scale-up the implementation of most potential ones;

(v) Standardize the process of monitoring and analytical practices of arsenic detection by accreditation of concerned laboratories through NABL (National Accreditation Board for Testing and Calibration Laboratories) ;

(vi) Encourage detection of genesis of arsenic occurrence in Ganga-Brahmaputra flood plains, finding reasons of large scale activation in Holocene aquifers, assessment of arsenic mobilization under different hydro-geo-chemical settings in order to evolve sound aquifer management strategies;

(vii) Encourage development of innovative and cost-effective arsenic removal techniques/technologies, both ex-situ & in-situ, including arsenic detection technologies;

(viii) Encourage development of eco-friendly and innovative methods for arsenic sludge treatment & management;

(ix) Encourage development of alternate water supply and management strategies viz. Bank Filtration (BF), Managed Aquifer Recharge (MAR) in arsenic affected/vulnerable areas to meet demand of safe drinking and irrigation water requirements including feasibility studies for overall water management;

(x) Encourage development of arsenic resistant crops.

2 Ensuring supply of Arsenic safe potable water in Arsenic affected areas

The potential interventions for ensuring drinking water supply in the arsenic affected/vulnerable areas can be as follows:

(i) Revive and strengthen the non-functional arsenic removal schemes displaying potential by appropriate interventions. The public-private partnership and the community participation models may be effectively explored for better O & M results;

(ii) Develop appropriate mechanisms for arsenic sludge management while scaling-up the arsenic removal schemes. Few potential sludge management techniques reported such as, mixing of arsenic sludge with concrete in controlled ratio, and with clay for burning for brick manufacturing may be given special consideration;

(iii) Install new tube wells with appropriate sealing to arrest inter-aquifer contamination to tap safe deep aquifers, and create infrastructure to supply risk free potable drinking water in the arsenic affected/ vulnerable areas;

(iv) Develop infrastructure for secured drinking water supply schemes based on surface water sources, wherever feasible, and encourage planned rainwater harvesting schemes for groundwater recharge in the

vulnerable aquifers to ensure potable water to the people of arsenic vulnerable areas.

3 Human Interface: health risk assessment

The recommendations under this category are as follows:

(i) Detailed epidemiological study to assess impact of arsenic contaminated water on human health;

(ii) Investigation and assessment of impact of arsenic biomagnifications in food chains especially during different stages of paddy cultivation and harvesting and consequential health risks;

(iii) Assessment of impact of arsenic contamination on socio-cultural and socio-economic aspects.

4 Social sensitization and capacity building programmes

The potential interventions for social sensitization, empowerment and capacity building programmes may be as follows:

(i) Promote mass awareness programmes for social sensitization and empowerment through NGOs and local Panchayati raj networks using existing government schemes viz. IEC;

(ii) Establish and strengthen water quality testing laboratories in each arsenic affected State with a network of level-II category laboratory in each district having scope to detect physic-chemical, microbiological constituents and selected toxic elements. All the laboratories should be accredited by NABL. In the event of problems faced due to the sheer scale of the recommended step, a network may be created to begin with linking the existing sophisticated laboratories in various research and academic institutions;

(iii) In the district hospitals, appropriate facilities for diagnosis and treatment and also rehabilitation of Arsenicosis patients should be created;

(iv) Awareness and training of medical practitioners and the Para medical staff should be conducted for Arsenicosis diagnosis and treatment/management;

(v) Personnel at the Senior and Junior levels involved in the technological handling, operation and maintenance of related schemes/projects should be trained at regular intervals in order for them to acquire routine and advanced knowledge and know-how. The skills of trained personnel should be used appropriately. NGOs and Panchayat personnel in the area should be involved to the extent possible;

(vi) Appropriate steps should be taken to update the educational curriculum at school and professional levels to make them more information based regarding Arsenic occurrence, its effects and the solutions. Existing information with the international agencies like WHO and other national agencies may be utilized.

5 Institutional and governance issues

Institutional and governance issues, which connect science and the society, would play an important role to achieve the goals emphasized under section (2.2), (2.3) and (2.4). The 'Committee' thus proposes the following under this category:

(i) Each State can have an 'Arsenic Task Force' spearheaded by the nodal 'National Arsenic Task Force (NATF)' having proper linking mechanism with the affected State units. The 'NATF' can have representation from the State wing together with concerned central government officials like Ministry of Water Resources, River Development & Ganga Rejuvenation, Ministry of Drinking Water & Sanitation, Ministry of Urban Development, Ministry of Health and Family Welfare, Ministry of Environment, Forest & Climate Change, Ministry of Science & Technology, individual experts, R & D and academic personnel, medical professionals, economists, social scientists etc. The NATF can approach and work in collaboration with other national and international organizations working in groundwater sector such as, World Bank, NABARD, UNESCO, WHO, UNICEF, and UNDP. The "NATF' should be vested with legal and financial powers with a proper administrative setup. The "NATF' can have the roles of facilitating the activities of R & D, supply of Arsenic safe potable water, health risk

assessment, social sensitization and capacity building program, implementation of programs and other matter related to arsenic;

(ii) A dedicated exclusive website may be launched by the proposed 'National Arsenic Task Force" providing a linkage between all concerned stakeholders. This may be employed for Information dissemination on all aspects on one hand, as well as gathering responses and opinions on the other.

(iii) The developed technologies may be allowed to be duly protected but should be available free of cost directly or through technology transfer for common use;

(iv) Evolve methods/mechanisms for scale-up of potential arsenic removal techniques/technologies under public-private partnership for implementation, operation and maintenance of the schemes and develop rope-in methods for translating effective and sustainable techniques/technologies from lab to field.

(v) Motivate small entrepreneurs in production and maintenance of low-cost household Arsenic removal devices and their after sale services. Government may play a pro-active role in subsidising the household devices for rural people.

(vi) Set-up a single-window based project review, clearance and monitoring mechanism to help build confidence among service providers and stakeholders, for efficient and effective management of tasks with minimum chance of duplication;

(vii) Promote the tasks as a 'Mission' with specific time line and review mechanisms from time to time. To achieve the goals of the 'Mission', the arsenic related activities at the Centre should be dealt under a single umbrella having responsibility with the 'Ministry of Drinking Water and Sanitation', Government of India.

R & D service providing Organizations/Institutions on Arsenic in India

(i) All India Institute of Public Health & Hygiene, Kolkata

(ii) A. N. College, Magadh University, Patna

(iii) BARC, Trombay, Mumbai

(iv) Bengal Engineering & Science University, Sibpur, West Bengal.

(v) Central Ground Water Board

(vi) Geological Survey of India, Kolkata

(vii) IITs Bombay, Kanpur, Kharagpur, Roorkee, Guhawati (Departments of Earth Sciences, Environmental Engineering, Hydrology & Water Resources, etc.)

(viii) Indian Institute of Sciences, Bangaluru

(ix) Indian School of Mines, Dhanbad

(x) Indian Institute of Toxicological Research (IITR), Lucknow

(xi) Jadavpur University, Kolkata (School of Environmental Studies, School of Water Resources Engineering, Department of Geology, and Department of Chemistry)

(xii) Kalyani University, West Bengal

(xiii) National Environmental Engineering Research Institute (NEERI), Nagpur

(xiv) National Institute of Hydrology (NIH), Roorkee

(xv) National Geophysical Research Institute (NGRI) , Hyderabad

(xvi) Public Heath Engineering Department of States

(xvii) State Groundwater Departments

(xviii) School of Environmental Sciences, Jawaharlal Nehru University, New Delhi

(xix) School of Tropical Medicines, Kolkata

(xx) Water Technology Mission, ICAR.

R & D service proving organizations/Institute on Arsenic contamination in Food chains

(i) Agricultural Universities in Bihar, U. P., Punjab, Haryana

(ii) Bidhan Chandra Krishi Viswavidalaya (BCKV), West Bengal

(iii) ICAR Institutes in different states.

Service providing organizations for Social & Environmental impact assessment

(i) Centre for Studies of Man & Environment, Kolkata

(ii) Indian Institute of Social Welfare & Business Management (IISWBM), Kolkata

(iii) Institute of Economic Studies, Patna

(iv) Institute of Social Sciences, New Delhi

(v) School of Social Sciences, JNU, New Delhi
(vi) Tata Institute of Social Sciences, Mumbai

Some foreign Organizations/Institutions working on Arsenic

(i) CSIRO, Adelaide, Australia

(ii) Department of Earth Sciences, University College of London, UK

(iii) Harbauer GmbH, Germany

(iv) KTH- Royal Institute of Technology, Stockholm

(v) Massachusetts Institute of Technology, USA (Civil Engineering Department)

(vi) Queen's University, Belfast, UK

(vii) Swiss Federal Institute for Aquatic Science & Technology, Switzerland

(viii) University of Guelph, Canada

(ix) US-EPA & USGS

(x) University of Berkeley, USA

APPENDIX – X
(vide Para No. 6.19 of the Report)

Government of India

Ministry of Water Resources

NATIONAL WATER POLICY (2012)

1. PREAMBLE

1.1 A scarce natural resource, water is fundamental to life, livelihood, food security and sustainable development. India has more than 18 % of the world's population, but has only 4% of world's renewable water resources and 2.4% of world's land area. There are further limits on utilizable quantities of water owing to uneven distribution over time and space. In addition, there are challenges of frequent floods and droughts in one or the other part of the country. With a growing population and rising needs of a fast developing nation as well as the given indications of the impact of climate change, availability of utilizable water will be under further strain in future with the possibility of deepening water conflicts among different user groups. Low consciousness about the scarcity of water and its life sustaining and economic value results in its mismanagement, wastage, and inefficient use, as also pollution and reduction of flows below minimum ecological needs. In addition, there are inequities in distribution and lack of a unified perspective in planning, management and use of water resources. The objective of the National Water Policy is to take cognizance of the existing situation, to propose a framework for creation of a system of laws and institutions and for a plan of action with a unified national perspective.

1.2 The present scenario of water resources and their management in India has given rise to several concerns, important amongst them are;

(i) Large parts of India have already become water stressed. Rapid growth in demand for water due to population growth, urbanization and changing lifestyle pose serious challenges to water security.

(ii) Issues related to water governance have not been addressed adequately. Mismanagement of water resources has led to a critical situation in many parts of the country.

(iii) There is wide temporal and spatial variation in availability of water, which may increase substantially due to a combination of climate change, causing deepening of water crisis and incidences of water related disasters, i.e., floods, increased erosion and increased frequency of droughts, etc.

(iv) Climate change may also increase the sea levels. This may lead to salinity intrusion in ground water aquifers / surface waters and increased coastal inundation in coastal regions, adversely impacting habitations, agriculture and industry in such regions.

(v) Access to safe water for drinking and other domestic needs still continues to be a problem in many areas. Skewed availability of water between different regions and different people in the same region and also the intermittent and unreliable water supply system has the potential of causing social unrest.

(vi) Groundwater, though part of hydrological cycle and a community resource, is still perceived as an individual property and is exploited inequitably and without any consideration to its sustainability leading to its over-exploitation in several areas.

(vii) Water resources projects, though multi-disciplinary with multiple stakeholders, are being planned and implemented in a fragmented manner without giving due consideration to optimum utilization, environment sustainability and holistic benefit to the people.

(viii) Inter-regional, inter-State, intra-State, as also inter-sectoral disputes in sharing of water, strain relationships and hamper the optimal utilization of water through scientific planning on basin/sub-basin basis.

(ix) Grossly inadequate maintenance of existing irrigation infrastructure has resulted in wastage and under-utilization of available resources. There is a widening gap between irrigation potential created and utilized.

(x) Natural water bodies and drainage channels are being encroached upon, and diverted for other purposes. Groundwater recharge zones are often blocked.

(xi) Growing pollution of water sources, especially through industrial effluents, is affecting the availability of safe water besides causing environmental and health hazards. In many parts of the country, large stretches of rivers are both heavily polluted and devoid of flows to support aquatic ecology, cultural needs and aesthetics.

(xii) Access to water for sanitation and hygiene is an even more serious problem. Inadequate sanitation and lack of sewage treatment are polluting the water sources.

(xiii) Low consciousness about the overall scarcity and economic value of water results in its wastage and inefficient use.

(xiv) The lack of adequate trained personnel for scientific planning, utilizing modern techniques and analytical capabilities incorporating information technology constrains good water management.

(xv) A holistic and inter-disciplinary approach at water related problems is missing.

(xvi) The public agencies in charge of taking water related decisions tend to take these on their own without consultation with stakeholders, often resulting in poor and unreliable service characterized by inequities of various kinds.

(xvii) Characteristics of catchment areas of streams, rivers and recharge zones of aquifers are changing as a consequence of land use and land cover changes, affecting water resource availability and quality.

1.3 Public policies on water resources need to be governed by certain basic principles, so that there is some commonality in approaches in dealing with planning, development and management of water resources. These basic principles are:

(i) Planning, development and management of water resources need to be governed by common integrated perspective considering local, regional, State and national context, having an environmentally sound basis, keeping in view the human, social and economic needs.

(ii) Principle of equity and social justice must inform use and allocation of water.

(iii) Good governance through transparent informed decision making is crucial to the objectives of equity, social justice and sustainability. Meaningful intensive participation, transparency and accountability should guide decision making and regulation of water resources.

(iv) Water needs to be managed as a common pool community resource held, by the state, under public trust doctrine to achieve food security, support livelihood, and ensure equitable and sustainable development for all.

(v) Water is essential for sustenance of eco-system, and therefore, minimum ecological needs should be given due consideration.

(vi) Safe Water for drinking and sanitation should be considered as pre-emptive needs, followed by high priority allocation for other basic domestic needs (including needs of animals), achieving food security, supporting sustenance agriculture and minimum eco-system needs. Available water, after meeting the above needs, should be allocated in a manner to promote its conservation and efficient use.

(vii) All the elements of the water cycle, i.e., evapo-transpiration, precipitation, runoff, river, lakes, soil moisture, and ground water, sea, etc., are interdependent and the basic hydrological unit is the river basin, which should be considered as the basic hydrological unit for planning.

(viii) Given the limits on enhancing the availability of utilizable water resources and increased variability in supplies due to climate change, meeting the future needs will

depend more on demand management, and hence, this needs to be given priority, especially through (a) evolving an agricultural system which economizes on water use and maximizes value from water, and (b) bringing in maximum efficiency in use of water and avoiding wastages.

(ix) Water quality and quantity are interlinked and need to be managed in an integrated manner, consistent with broader environmental management approaches inter-alia including the use of economic incentives and penalties to reduce pollution and wastage.

(x) The impact of climate change on water resources availability must be factored into water management related decisions. Water using activities need to be regulated keeping in mind the local geo climatic and hydrological situation.

2. WATER FRAMEWORK LAW

2.1 There is a need to evolve a National Framework Law as an umbrella statement of general principles governing the exercise of legislative and/or executive (or devolved) powers by the Centre, the States and the local governing bodies. This should lead the way for essential legislation on water governance in every State of the Union and devolution of necessary authority to the lower tiers of government to deal with the local water situation.

2.2 Such a framework law must recognize water not only as a scarce resource but also as a sustainer of life and ecology. Therefore, water, particularly, groundwater, needs to be managed as a community resource held, by the state, under public trust doctrine to achieve food security, livelihood, and equitable and sustainable development for all. Existing Acts may have to be modified accordingly.

2.3 There is a need for comprehensive legislation for optimum development of inter State rivers and river valleys to facilitate inter-State coordination ensuring scientific planning of land and water resources taking basin/sub-basin as unit with unified perspectives of water in all its forms (including precipitation, soil moisture, ground and surface water) and ensuring holistic and balanced development of both the catchment and the command areas. Such legislation needs, inter alia, to deal with and enable establishment of basin authorities, comprising party States, with appropriate powers to plan, manage and regulate utilization of water resource in the basins.

3. USES OF WATER

3.1 Water is required for domestic, agricultural, hydro-power, thermal power, navigation, recreation, etc. Utilisation in all these diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered.

3.2 The Centre, the States and the local bodies (governance institutions) must ensure access to a minimum quantity of potable water for essential health and hygiene to all its citizens, available within easy reach of the household.

3.3 Ecological needs of the river should be determined, through scientific study, recognizing that the natural river flows are characterized by low or no flows, small floods (freshets), large floods, etc., and should accommodate developmental needs. A portion of river flows should be kept aside to meet ecological needs ensuring that the low and high flow releases are proportional to the natural flow regime, including base flow contribution in the low flow season through regulated ground water use.

3.4 Rivers and other water bodies should be considered for development for navigation as far as possible and all multipurpose projects over water bodies should keep navigation in mind right from the planning stage.

3.5 In the water rich eastern and north eastern regions of India, the water use infrastructure is weak and needs to be strengthened in the interest of food security.

3.6 Community should be sensitized and encouraged to adapt first to utilization of water as per local availability of waters, before providing water through long distance transfer. Community based water management should be institutionalized and strengthened.

4. ADAPTATION TO CLIMATE CHANGE

4.1 Climate change is likely to increase the variability of water resources affecting human health and livelihoods. Therefore, special impetus should be given towards mitigation at micro level by enhancing the capabilities of community to adopt climate resilient technological options.

4.2 The anticipated increase in variability in availability of water because of climate change should be dealt with by increasing water storage in its various forms, namely, soil moisture, ponds, ground water, small and large reservoirs and their combination. States should be incentivized to increase water storage capacity, which inter-alia should include revival of traditional water harvesting structures and water bodies.

4.3 The adaptation strategies could also include better demand management, particularly, through adoption of compatible agricultural strategies and cropping patterns and improved water application methods, such as land leveling and/or drip / sprinkler irrigation as they enhance the water use efficiency, as also, the capability for dealing with increased variability because of climate change. Similarly, industrial processes should be made more water efficient.

4.4 Stakeholder participation in land-soil-water management with scientific inputs from local research and academic institutions for evolving different agricultural strategies,

reducing soil erosion and improving soil fertility should be promoted. The specific problems of hilly areas like sudden run off, weak water holding capacity of soil, erosion and sediment transport and recharging of hill slope aquifers should be adequately addressed.

4.5 Planning and management of water resources structures, such as, dams, flood embankments, tidal embankments, etc., should incorporate coping strategies for possible climate changes. The acceptability criteria in regard to new water resources projects need to be re-worked in view of the likely climate changes

5. ENHANCING WATER AVAILABLE FOR USE

5.1 The availability of water resources and its use by various sectors in various basin and States in the country need to be assessed scientifically and reviewed at periodic

intervals, say, every five years. The trends in water availability due to various factors including climate change must be assessed and accounted for during water resources planning.

5.2 The availability of water is limited but the demand of water is increasing rapidly due to growing population, rapid urbanization, rapid industrialization and economic development. Therefore, availability of water for utilization needs to be augmented to meet increasing demands of water. Direct use of rainfall, desalination and avoidance

of inadvertent evapo-transpiration are the new additional strategies for augmenting utilizable water resources.

5.3 There is a need to map the aquifers to know the quantum and quality of ground water resources (replenishable as well as non-replenishable) in the country. This process should be fully participatory involving local communities. This may be periodically updated.

5.4 Declining ground water levels in over-exploited areas need to be arrested by introducing improved technologies of water use, incentivizing efficient water use and encouraging community based management of aquifers. In addition, where necessary, artificial recharging projects should be undertaken so that extraction is less than the recharge. This would allow the aquifers to provide base flows to the surface system, and maintain ecology.

5.5 Inter-basin transfers are not merely for increasing production but also for meeting basic human need and achieving equity and social justice. Inter-basin transfers of water should be considered on the basis of merits of each case after evaluating the environmental, economic and social impacts of such transfers.

5.6 Integrated Watershed development activities with groundwater perspectives need to be taken in a comprehensive manner to increase soil moisture, reduce sediment yield and increase overall land and water productivity. To the extent possible, existing programs like MGNREGA may be used by farmers to harvest rain water using farm ponds and other soil and water conservation measures.

6. DEMAND MANAGEMENT AND WATER USE EFFICIENCY

6.1 A system to evolve benchmarks for water uses for different purposes, i.e., water footprints, and water auditing should be developed to promote and incentivize efficient use of water. The ‘project’ and the ‘basin’ water use efficiencies need to be improved through continuous water balance and water accounting studies. An institutional arrangement for promotion, regulation and evolving mechanisms for efficient use of water at basin/sub-basin level will be established for this purpose at the national level.

6.2 The project appraisal and environment impact assessment for water uses, particularly for industrial projects, should, inter-alia, include the analysis of the water footprints for the use.

6.3 Recycle and reuse of water, including return flows, should be the general norm.

6.4 Project financing should be structured to incentivize efficient & economic use of water and facilitate early completion of ongoing projects.

6.5 Water saving in irrigation use is of paramount importance. Methods like aligning cropping pattern with natural resource endowments, micro irrigation (drip, sprinkler, etc.), automated irrigation operation, evaporation-transpiration reduction, etc., should be encouraged and incentivized. Recycling of canal seepage water through conjunctive ground water use may also be considered.

6.6 Use of very small local level irrigation through small bunds, field ponds, agricultural and engineering methods and practices for watershed development, etc, need to be encouraged. However, their externalities, both positive and negative, like reduction of sediments and reduction of water availability, downstream, may be kept in view.

6.7 There should be concurrent mechanism involving users for monitoring if the water use pattern is causing problems like unacceptable depletion or building up of ground waters, salinity, alkalinity or similar quality problems, etc., with a view to planning appropriate interventions.

7. WATER PRICING

7.1 Pricing of water should ensure its efficient use and reward conservation. Equitable access to water for all and its fair pricing, for drinking and other uses such as sanitation,

agricultural and industrial, should be arrived at through independent statutory Water Regulatory Authority, set up by each State, after wide ranging consultation with all stakeholders.

7.2 In order to meet equity, efficiency and economic principles, the water charges should preferably / as a rule be determined on volumetric basis. Such charges should be reviewed periodically.

7.3 Recycle and reuse of water, after treatment to specified standards, should also be incentivized through a properly planned tariff system.

7.4 The principle of differential pricing may be retained for the pre-emptive uses of water for drinking and sanitation; and high priority allocation for ensuring food security and supporting livelihood for the poor. Available water, after meeting the above needs, should increasingly be subjected to allocation and pricing on economic principles so that water is not wasted in unnecessary uses and could be utilized more gainfully.

7.5 Water Users Associations (WUAs) should be given statutory powers to collect and retain a portion of water charges, manage the volumetric quantum of water allotted to them and maintain the distribution system in their jurisdiction. WUAs should be given the freedom to fix rates subject to floor rates determined by WRAs.

7.6 The over-drawal of groundwater should be minimized by regulating the use of electricity for its extraction. Separate electric feeders for pumping ground water for agricultural use should be considered.

8. CONSERVATION OF RIVER CORRIDORS, WATER BODIES AND INFRASTRUCTURE

8.1 Conservation of rivers, river corridors, water bodies and infrastructure should be undertaken in a scientifically planned manner through community participation. The storage capacities of water bodies and water courses and/or associated wetlands, the flood plains, ecological buffer and areas required for specific aesthetic recreational and/or social needs may be managed to the extent possible in an integrated manner to balance the flooding, environment and social issues as per prevalent laws through planned development of urban areas, in particular.

8.2 Encroachments and diversion of water bodies (like rivers, lakes, tanks, ponds, etc.) and drainage channels (irrigated area as well as urban area drainage) must not be allowed, and wherever it has taken place, it should be restored to the extent feasible and maintained properly.

8.3 Urban settlements, encroachments and any developmental activities in the protected upstream areas of reservoirs/water bodies, key aquifer recharge areas that pose a potential threat of contamination, pollution, reduced recharge and those endanger wild and human life should be strictly regulated.

8.4 Environmental needs of Himalayan regions, aquatic eco-system, wet lands and embanked flood plains need to be recognized and taken into consideration while planning.

8.5 Sources of water and water bodies should not be allowed to get polluted. System of third party periodic inspection should be evolved and stringent punitive actions be taken against the persons responsible for pollution.

8.6 Quality conservation and improvements are even more important for ground waters, since cleaning up is very difficult. It needs to be ensured that industrial effluents, local cess pools, residues of fertilizers and chemicals, etc., do not reach the ground water.

8.7 The water resources infrastructure should be maintained properly to continue to get the intended benefits. A suitable percentage of the costs of infrastructure development may be set aside along with collected water charges, for repair and maintenance. Contract for construction of projects should have inbuilt provision for longer periods of proper maintenance and handing over back the infrastructure in good condition.

8.8 Legally empowered dam safety services need to be ensured in the States as well as at the Centre. Appropriate safety measures, including downstream flood management, for each dam should be undertaken on top priority.

9. PROJECT PLANNING AND IMPLEMENTATION

9.1 Considering the existing water stress conditions in India and the likelihood of further worsening situation due to climate change and other factors, water resources projects should be planned as per the efficiency benchmarks to be prescribed for various situations.

9.2 Being inter-disciplinary in nature, water resources projects should be planned considering social and environmental aspects also in addition to techno-economic considerations in consultation with project affected and beneficiary families. The integrated water resources management with emphasis on finding reasonable and generally acceptable solutions for most of the stakeholders should be followed for planning and management of water resources projects.

9.3 Considering the heavy economic loss due to delay in implementation of projects, all clearances, including environmental and investment clearances, be made time bound.

9.4 Concurrent monitoring at project, State and the Central level should be undertaken for timely interventions to avoid time and cost over-runs.

9.5 All components of water resources projects should be planned and executed in a pari-passu manner so that intended benefits start accruing immediately and there is no gap between potential created and potential utilized.

9.6 Local governing bodies like Panchayats, Municipalities, Corporations, etc., and Water Users Associations, wherever applicable, should be involved in planning of the projects. The unique needs and aspirations of the Scheduled caste and Scheduled Tribes, women and other weaker sections of the society should be given due consideration.

9.7 All water resources projects, including hydro power projects, should be planned to the extent feasible as multi-purpose projects with provision of storage to derive maximum benefit from available topology and water resources.

10. MANAGEMENT OF FLOOD & DROUGHT

10.1 While every effort should be made to avert water related disasters like flood sand droughts, through structural and non-structural measures, emphasis should be on preparedness for flood / drought with coping mechanisms as an option. Greater emphasis should be placed on rehabilitation of natural drainage system.

10.2 Land, soil, energy and water management with scientific inputs from local, research and scientific institutions should be used to evolve different agricultural strategies and improve soil and water productivity to manage droughts. Integrated farming systems and non-agricultural developments may also be considered for livelihood support and poverty alleviation.

10.3 In order to prevent loss of land eroded by the river, which causes permanent loss, revetments, spurs, embankments, etc., should be planned, executed, monitored and maintained on the basis of morphological studies. This will become increasingly more important, since climate change is likely to increase the rainfall intensity, and hence, soil erosion.

10.4 Flood forecasting is very important for flood preparedness and should be expanded extensively across the country and modernized using real time data acquisition system and linked to forecasting models. Efforts should be towards developing physical models for various basin sections, which should be linked to each other and to medium range weather forecasts to enhance lead time.

10.5 Operating procedures for reservoirs should be evolved and implemented in such a manner to have flood cushion and to reduce trapping of sediment during flood season. These procedures should be based on sound decision support system.

10.6 Protecting all areas prone to floods and droughts may not be practicable; hence, methods for coping with floods and droughts have to be encouraged. Frequency based flood inundation maps should be prepared to evolve coping strategies, including preparedness to supply safe water during and immediately after flood events. Communities need to be involved in preparing an action plan for dealing with the flood/ drought situations.

10.7 To increase preparedness for sudden and unexpected flood related disasters, dam/embankment break studies, as also preparation and periodic updating of emergency action plans / disaster management plans should be evolved after involving affected communities. In hilly reaches, glacial lake outburst flood and landslide dam break floods studies with periodic monitoring along with instrumentation, etc., should be carried out.

11. WATER SUPPLY AND SANITATION

11.1 There is a need to remove the large disparity between stipulations for water supply in urban areas and in rural areas. Efforts should be made to provide improved water supply in rural areas with proper sewerage facilities. Least water intensive sanitation and sewerage systems with decentralized sewage treatment plants should be incentivized.

11.2 Urban and rural domestic water supply should preferably be from surface water in conjunction with groundwater and rainwater. Where alternate supplies are available, a source with better reliability and quality needs to be assigned to domestic water supply. Exchange of sources between uses, giving preference to domestic water supply should be possible. Also, reuse of urban water effluents from kitchens and bathrooms, after primary treatment, in flush toilets should be encouraged, ensuring no human contact.

11.3 Urban domestic water systems need to collect and publish water accounts and water audit reports indicating leakages and pilferages, which should be reduced taking into due consideration social issues.

11.4 In urban and industrial areas, rainwater harvesting and de-salinization, wherever techno-economically feasible, should be encouraged to increase availability of utilizable water. Implementation of rainwater harvesting should include scientific monitoring of parameters like hydrogeology, groundwater contamination, pollution and spring discharges.

11.5 Urban water supply and sewage treatment schemes should be integrated and executed simultaneously. Water supply bills should include sewerage charges.

11.6 Industries in water short regions may be allowed to either withdraw only the make up water or should have an obligation to return treated effluent to a specified

standard back to the hydrologic system. Tendencies to unnecessarily use more 11 water within the plant to avoid treatment or to pollute ground water need to be prevented.

11.7 Subsidies and incentives should be implemented to encourage recovery of industrial pollutants and recycling / reuse, which are otherwise capital intensive.

12. INSTITUTIONAL ARRANGEMENTS

12.1 There should be a forum at the national level to deliberate upon issues relating to water and evolve consensus, co-operation and reconciliation amongst party States. A similar mechanism should be established within each State to amicably resolve differences in competing demands for water amongst different users of water, as also between different parts of the State.

12.2 A permanent Water Disputes Tribunal at the Centre should be established to resolve the disputes expeditiously in an equitable manner. Apart from using the „good offices‟ of the Union or the State Governments, as the case may be, the paths of arbitration and mediation may also to be tried in dispute resolution.

12.3 Water resources projects and services should be managed with community participation. For improved service delivery on sustainable basis, the State Governments / urban local bodies may associate private sector in public private partnership mode with penalties for failure, under regulatory control on prices charged and service standards with full accountability to democratically elected local bodies.

12.4 Integrated Water Resources Management (IWRM) taking river basin / sub-basin as a unit should be the main principle for planning, development and management of water resources. The departments / organizations at Centre / State Governments levels should be restructured and made multi-disciplinary accordingly.

12.5 Appropriate institutional arrangements for each river basin should be developed to collect and collate all data on regular basis with regard to rainfall, river flows, area irrigated by crops and by source, utilizations for various uses by both surface and ground water and to publish water accounts on ten daily basis every year for each river basin with appropriate water budgets and water accounts based on the hydrologic balances. In addition, water budgeting and water accounting should be carried out for each aquifers.

12.6 Appropriate institutional arrangements for each river basin should also be developed for monitoring water quality in both surface and ground waters.

12.7 States should be encouraged and incentivized to undertake reforms and progressive measures for innovations, conservation and efficient utilization of water resources.

13. TRANS-BOUNDARY RIVERS

13.1 Even while accepting the principle of basin as a unit of development, on the basis of practicability and easy implementability, efforts should be made to enter into 12 international agreements with neighbouring countries on bilateral basis for exchange of hydrological data of international rivers on near real time basis.

13.2 Negotiations about sharing and management of water of international rivers should be done on bilateral basis in consultative association with riparian States keeping paramount the national interest. Adequate institutional arrangements at the Center should be set up to implement international agreements.

14. DATABASE & INFORMATION SYSTEM

14.1 All hydrological data, other than those classified on national security consideration, should be in public domain. However, a periodic review for further declassification of data may be carried out. A National Water Informatics Center should be established to collect, collate and process hydrologic data regularly from all over the country, conduct the preliminary processing, and maintain in open and transparent manner on a GIS platform.

14.2 In view of the likely climate change, much more data about snow and glaciers, evaporation, tidal hydrology and hydraulics, river geometry changes, erosion, sedimentation, etc. needs to be collected. A programme of such data collection needs to be developed and implemented.

14.3 All water related data, like rainfall, snowfall, geo-morphological, climatic, geological, surface water, ground water, water quality, ecological, water extraction and use, irrigated area, glaciers, etc., should be integrated with well defined procedures and formats to ensure online updation and transfer of data to facilitate development of database for informed decision making in the management of water.

15. RESEARCH & TRAINING NEEDS

15.1 Continuing research and advancement in technology shall be promoted to address issues in the water sector in a scientific manner. Innovations in water resources sector should be encouraged, recognized and awarded.

15.2 It is necessary to give adequate grants to the States to update technology, design practices, planning and management practices, preparation of annual water balances and accounts for the site and basin, preparation of hydrologic balances for water systems, benchmarking and performance evaluation.

15.3 It needs to be recognized that the field practices in the water sector in advanced countries have been revolutionized by advances in information technology and analytical capabilities. A re-training and quality improvement programme for water planners and managers at all levels in India, both in private and public sectors, needs to be undertaken.

15.4 An autonomous center for research in water policy should also be established to evaluate impacts of policy decisions and to evolve policy directives for changing scenario of water resources.

15.5 To meet the need of the skilled manpower in the water sector, regular training and academic courses in water management should be promoted. These training and academic institutions should be regularly updated by developing infrastructure and promoting applied research, which would help to improve the current procedures of analysis and informed decision making in the line departments and by the community. A national campaign for water literacy needs to be started for capacity building of different stakeholders in the water sector.

16. IMPLEMENTATION OF NATIONAL WATER POLICY

16.1 National Water Board should prepare a plan of action based on the National Water Policy, as approved by the National Water Resources Council, and to regularly monitor its implementation.

16.2 The State Water Policies may need to be drafted/revised in accordance with this policy keeping in mind the basic concerns and principles as also a unified national perspective.

Annexures

MINUTES OF SECOND SITTING OF THE COMMITTEE ON ESTIMATES (2014-15)

The Committee sat on Monday, the 15th September, 2014 from 1100 hrs. to 1410 hrs. in Room No. 53, Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

MEMBERS

2. Shri Sultan Ahmed
3. Shri Kirti Azad
4. Shri Kalyan Banerjee
5. Shri Dileep Singh Bhuria
6. Shri Ashwini Kumar Choubey
7. Shri Ashok Chavan
8. Col. Sonaram Choudhary
9. Shri Ramen Deka
10. Shri Kalikesh N. Singh Deo
11. Shri Sanjay Dhotre
12. Shri P.C.Gaddigoudar
13. Dr. Sanjay Jaiswal
14. Smt. Darshana Vikram Jardosh
15. Smt. Kavitha Kalvakuntla
16. Shri Vinod Khanna
17. Shri K.H. Muniyappa
18. Shri Ravindra Kumar Pandey
19. Shri K N Ramachandran
20. Md. Salim
21. Shri Arvind Sawant
22. Shri Kirti Vardhan Singh
23. Shri Rajesh Verma
24. Shri Ram Kripal Yadav
25. Shri Jai Prakash Narayan Yadav

SECRETARIAT

1.	Shri A. Louis Martin	-	Joint Secretary
2.	Shri S. Chatterjee	-	Director
3.	Shri Srinivasulu Gunda	-	Additional Director
4.	Shri U.C. Bharadwaj	-	Deputy Secretary

LIST OF REPRESENTATIVES

MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

1.	Shri Alok Rawat	-	Secretary
2.	Dr. Amarjeet Singh	-	Addl. Secretary
3.	Shri Sunil Kumar Kohli	-	Joint Secretary & FA
4.	Shri Rajiv Ranjan Mishra	-	JS & Mission Director, National Mission for Clean Ganga
5.	Shri Pradeep Kumar	-	Commissioner (SP)

MINISTRY OF DRINKING WATER & SANITATION

1.	Shri Satyabrata Sahu	-	Joint Secretary (Water)

CENTRAL GROUND WATER BOARD

1.	Ms. Urvilla Khati	-	Chairman (CGWB)

2.	Dr. R.C. Jain	-	Member (SAM)
3.	Dr. K.M. Najeeb	-	Member (SML)
4.	Shri K.C. Naik	-	Member (TT & WQ)
5.	Dr. Dipankar Saha	-	Member (RGI)
6.	Shri K.B. Biswas	-	Member (ED & MM)

NATIONAL INSTITUTE OF HYDROLOGY

1.	Dr. N.C. Ghosh	-	Sci 'G" & Head, Ground Water Hydrology Division
2.	Dr. C.K. Jain	-	Sci 'G' & Head, Environmental Hydrology Division

. At the outset, the Chairperson welcomed the representatives of the Ministry of Water Resources, River Development and Ganga Rejuvenation and the other officials to the sitting of the Committee and drew their attention to Direction 55(1) of 'Directions by the Speaker, Lok Sabha' regarding confidentiality of the proceedings of the Committee.

2. A representative of the Ministry of Water Resources, River Development and Ganga Rejuvenation made a power point presentation on the subject 'Occurrence of High Arsenic Content in Ground Water'. The Committee sought clarification on various issues related to the subject to which representatives of the Ministry responded. To the points to which the representatives could not readily respond, the Chairperson desired the Secretary of the Ministry to furnish detailed written replies within ten days.

4. A verbatim record of the proceedings has been kept.

The Committee then adjourned.

MINUTES OF FIFTH SITTING OF THE COMMITTEE ON ESTIMATES (2014-15)

The Committee sat on Monday, the 22 September, 2014 from 1100 hrs. to 1500 hrs. in Room 53, Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

Members

2. Shri Sultan Ahmed
3. Shri Kirti Azad
4. Shri Kalyan Banerjee
5. Shri Dileep Singh Bhuria
6. Shri Ashwini Kumar Choubey
7. Col. Sonaram Choudhary
8. Shri Ramen Deka
9. Shri Kalikesh N. Singh Deo
10. Shri Sanjay Dhotre
11. Shri P.C. Gaddigoudar
12. Smt. Kavitha Kalvakuntla
13. Shri Nalin Kumar Kateel
14. Shri P. Kumar
15. Shri Ravindra Kumar Pandey
16. Shri Arvind Sawant
17. Shri Ram Kripal Yadav
18. Shri Jai Prakash Narayan Yadav

SECRETARIAT

1.	Shri A. Louis Martin	-	Additional Secretary
2.	Shri S. Chatterjee	-	Director
3.	Shri Srinivasulu Gunda	-	Additional Director
4.	Shri U.C. Bharadwaj	-	Deputy Secretary

2. At the outset, the Chairperson welcomed the Members to the sitting of the Committee. Thereafter, the Committee heard the views of each of the following experts on the subjects shown below:-

Experts on the subject 'Occurrence of Arsenic Content in Ground Water'

1.	Dr. C.S. Nautiyal	-	Director, CSIR – National Botanical Research Insitute and CSIR – Indian Institute of Toxicology Research, Lucknow
2.	Dr. K.J. Nath	-	Ex. Director, All India Institute of Hygiene and Public Health Kolkata
3.	Dr. Abhijeet Mukherjee	-	Assistant Professor, Geology & Geophysics, IIT Kharagpur

4.	Prof. Saumyen Guha	-	Department of Civil Engineering, IIT Kanpur

Experts on the subject 'Rural Water Supply and Sanitation Programme'

1.	Prof. Purnendu Bose	-	Department of Civil Engineering, IIT Kanpur
2.	Shri A. Kalimuthu	-	Director, Water for People, New Delhi

3. The experts appeared before the Committee one after another. The Chairperson drew the attention of each expert to Direction 55(1) of Directions by Speaker, Lok Sabha regarding confidentiantly of the proceedings of the Committee. On the subject 'Occurrence of Arsenic Content in Ground Water', the hearing was broadly focused on the extent of the problem in the country, causes, impact on human health, soil and agriculture, crops and vegetables and technological options available to provide arsenic safe water in the affected areas etc. One of the experts also suggested enactment of a legistation on 'Drinking water Security'.

4. On the issue of rural water supply and sanitation, the experts referred to the WHO guidelines on improved sanitation, sanitation targets and status viz-a-viz Millennium Development Goals, improvement of rural water supply in the country, etc. The experts also responded to the queries of the Members regarding cheap and low cost toilets, bio-degradation, chemical treatment, etc.

5. In respect of the points, for which the information was not readily available, the experts were asked to furnish written replies at the earliest.

Hearing of experts concluded.

6. Thereafter, the Committee deliberated and decided to invite information from all the State Governments as to what action has been taken by them to mitigate arsenic contamination and also on rural water supply and sanitation.

7. A verbatim record of the proceedings has been kept.

The Committee then adjourned.

MINUTES OF SIXTH SITTING OF THE COMMITTEE ON ESTIMATES (2014-15)

The Committee sat on Monday, the 13th October, 2014 from 1100 hrs. to 1330 hrs. in Room No. '53', Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

MEMBERS

2. Shri Kirti Azad
3. Shri Kalyan Banerjee
4. Shri Dileep Singh Bhuria
5. Shri Ashwini Kumar Choubey
6. Col. Sonaram Choudhary
7. Shri Ramen Deka
8. Shri Kalikesh N. Singh Deo
9. Shri P. C. Gaddigoudar
10. Smt. Kavitha Kalvakuntla
11. Shri Vinod Khanna
12. Shri P. Kumar
13. Shri K. H. Muniyappa

14. Shri Ravindra Kumar Pandey

15. Shri J.C. Divakar Reddy

16. Shri Md. Salim

17. Shri Ganesh Singh

18. Shri Rajesh Verma

19. Shri Ram Kripal Yadav

20. Shri Jai Prakash Narayan Yadav

SECRETARIAT

1. Shri A. Louis Martin – Additional Secretary

2. Shri S. Chatterjee – Director

3. Shri Srinivasulu Gunda – Additional Director

LIST OF REPRESENTATIVES

MINISTRY OF AGRICULTURE

(i) DEPARTMENT OF AGRICULTURE & COOPERATION

1.	Shri Ashish Bahuguna	Secretary, DAC
2.	Shri R.B. Sinha	Joint Secretary (NRM), DAC

3.	Shri C.M. Pandey	Additional Commissioner (NRM),

(ii) DEPARTMENT OF AGRICULTURE RESEARCH AND EDUCATION

1.	Dr. A.K. Sikka	DDG (NRM)
2.	Dr. Suresh Kumar Chaudhary	ADG (SWM)

2. At the outset, the Chairperson welcomed the representatives of the Ministry of Agriculture and the Department of Agriculture Research and Education to the sitting of the Committee for evidence on the subject 'Occurrence of High Arsenic Content in Ground Water' and drew their attention to Direction 55(1) of 'Directions by the Speaker, Lok Sabha' regarding confidentiality of the proceedings of the Committee.

3. A representative of the Department of Agriculture Research and Education made a power point presentation regarding 'Occurrence of High Arsenic Content in Ground Water'. The Committee sought clarification on various issues related to the subject to which representatives of the Departments responded. To the points to which the representatives could not readily respond, the Chairperson desired the Secretary of the Ministry to furnish detailed written replies.

4. A verbatim record of the proceedings has been kept.

The Committee then adjourned.

MINUTES OF SEVENTH SITTING OF THE COMMITTEE ON ESTIMATES (2014-15)

The Committee sat on Monday, the 13th October, 2014 from 1500 hrs. to 1745 hrs. in Room No. '53', Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

MEMBERS

2. Shri Kirti Azad
3. Shri Kalyan Banerjee
4. Shri Dileep Singh Bhuria
5. Shri Ashwini Kumar Choubey
6. Col. Sonaram Choudhary
7. Shri Ramen Deka
8. Shri Kalikesh N. Singh Deo
9. Shri P. C. Gaddigoudar
10. Smt. Kavitha Kalvakuntla
11. Shri Vinod Khanna
12. Shri P. Kumar
13. Shri K. H. Muniyappa

14. Shri Ravindra Kumar Pandey

15. Shri J.C. Divakar Reddy

16. Shri Md. Salim

17. Shri Ganesh Singh

18. Shri Kirti Vardhan Singh

19. Shri Rajesh Verma

20. Shri Ram Kripal Yadav

21. Shri Jai Prakash Narayan Yadav

SECRETARIAT

1. Shri A. Louis Martin – Additional Secretary

2. Shri S. Chatterjee – Director

3. Shri Srinivasulu Gunda – Additional Director

LIST OF REPRESENTATIVES

MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

1.	Shri Alok Rawat	-	Secretary
2.	Dr. Amarjit Singh	-	Addl. Secretary
3.	Shri Sunil Kohli	-	Joint Secretary & FA
4.	Shri Pradeep Kumar	-	Commissioner (State Projects)

5.	Shri K.A. Roy	-	OSD (GRBA)
6.	Ms. Urvilla Khati	-	Chairman (CGWB)
7.	Dr. R.C. Jain	-	Member (SAM), CGWB
8.	Dr. K.Md. Najeeb	-	Member (SML), CGWB
9.	Shri K.C. Naik	-	Member (WQ & TT), CGWB
10.	Shri K.B. Biswas	-	Member (ED & MM), CGWB
11.	Dr. D. Saha	-	Member (RGI), CGWB
12.	Dr. N.C. Ghosh	-	Sci 'G', National Institute of Hydrology
13.	Dr. C.K. Jain	-	Sci 'G', National Institue of Hydrology

MINISTRY OF ENVIRONMENT, FORESTS & CLIMATE CHANGE

1.	Ashok Lavasa	-	Secretary
2.	Shri Susheel Kumar	-	Additional Secretary
3.	Dr. Rashid Hasan	-	Advisor
4.	Dr. A B Aholkar	-	Member Secretary Central Pollution Control Board

MINISTRY OF DRINKING WATER & SANITATION

1.	Mrs. Vijay Laxmi Joshi	-	Secretary
2.	Shri Satyabrata Sahu	-	Joint Secretary (W)
3.	Saraswati Prasad	-	Joint Secretary (S)

2. At the outset, the Chairperson welcomed the representatives of the Ministry of Water Resources, River Development & Ganga Rejuvenation, Ministry of Drinking Water and Sanitation and the Ministry of Environment Forests & Climate Change to the sitting of the Committee for evidence/further evidence in connection with examination of the subjects (i) Occurrence of High Arsenic Content in Ground Water and (ii) Rural Water Supply and Sanitation Programme and drew their attention to Direction 55(1) of 'Directions by the Speaker, Lok Sabha' regarding confidentiality of the proceedings of the Committee.

3. The Committee discussed various issues related to the subjects viz. 'Occurrence of High Arsenic Content in Ground Water' and 'Rural Water Supply and Sanitation Programme'. To the points to which the representatives could not readily respond, the Chairperson desired the Ministries to furnish detailed written replies.

4. A verbatim record of the proceedings has been kept.

The Committee then adjourned.

MINUTES OF EIGHTH SITTING OF THE COMMITTEE ON ESTIMATES (2014-15)

The Committee sat on Monday, the 27th October, 2014 from 1100 hrs. to 1410 hrs. in Room No. '62', Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

MEMBERS

2. Shri Sultan Ahmed
3. Shri Kirti Azad
4. Shri Dileep Singh Bhuria
5. Shri Ashwini Kumar Choubey
6. Shri Haribhai Chaudhary
7. Shri Ashok Chavan
8. Col. Sonaram Choudhary
9. Shri Ramen Deka
10. Shri Sanjay Dhotre
11. Shri P. C. Gaddigoudar
12. Dr. Sanjay Jaiswal
13. Smt. Darshana Vikram Jardosh
14. Shri Nalin Kumar Kateel
15. Shri P. Kumar
16. Shri K. H. Muniyappa
17. Shri Ravindra Kumar Pandey
18. Shri K.N. Ramachandran
19. Shri Md. Salim
20. Shri Arvind Sawant
21. Shri Kirti Vardhan Singh
22. Shri Rajesh Verma
23. Shri Ram Kripal Yadav
24. Shri Jai Prakash Narayan Yadav

SECRETARIAT

1. Shri A. Louis Martin – Additional Secretary
2. Shri S. Chatterjee – Director
3. Shri Srinivasulu Gunda – Additional Director

LIST OF REPRESENTATIVES

MINISTRY OF HEALTH & FAMILY WELFARE
(DEPARTMENT OF HEALTH)

1.	Dr. C.K. Mishra	-	Additional Secretary & MD (NHM)
2.	Dr. H.K. Kar	-	Medical Superintendent, Dr. RML Hospital
3.	Dr. Ramesh	-	HOD, Dermatologist, SJH
4.	Dr. Y. K. Gupta	-	HOD, Pharmacology, AIIMS

MINISTRY OF SCIENCE AND TECHNOLOGY
(DEPARTMENT OF SCIENCE & TECHNOLOGY)

1.	Dr. K. Vijay Raghavan	-	Secretary, DST
2.	Dr. D. R. Prasada Raju	-	Scientist – 'G'/Head, TMC

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
(COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH)

1.	Dr. P.S. Ahuja	-	D.G., CSIR
2.	Dr. Sudeep Kumar	-	Head, PPD, CSIR
3.	Dr. Anupama	-	Joint Secretary (Parl.), DSIR, CSIR

2. The Committee first took evidence of the representatives of the Ministry of Health & Family Welfare (Department of Health) in connection with the examination of the subject 'Occurrence of High Arsenic Content in Ground Water'. The Chairperson drew their attention to Direction 55(1) of 'Directions by the Speaker, Lok Sabha' regarding confidentiality of the proceedings of the Committee.

3. The Committee then held discussion with the representatives of the Ministry of Health and Family Welfare (Deparatment of Health) on the subject. The representatives responded to the points raised by the Committee. To the points which could not be readily responded to by the representatives of the Ministry, the Chairperson directed them to furnish detailed replies.

The witnesses then withdrew

4. Thereafter, the representatives of Ministry of Science and Technology (Department of Science and Technology) and Council of Scientific and Industrial Research (CSIR) were called in. The Chairperson drew their attention to Direction 55 of Directions by the Speaker, Lok Sabha'. The representatives of the Ministry and CSIR made power point presentation on the subject.

5. The Committee held discussion with the reprsentatives on the subject 'Occurrence of High Arsenic Content in Ground Water'. The representatives responded to the queries raised by the Committee.To the points to which the representatives could not readily respond, the Chairperson directed them to furnish detailed written replies.

6.. A verbatim record of the proceedings has been kept.

The Committee then adjourned.

MINUTES OF NINTH SITTING OF THE COMMITTEE ON ESTIMATES (2014-15)

The Committee sat on Monday, the 8th December, 2014 from 1500 hrs to 1615 hrs in Room No. '52-B', (Chairpersons' Chamber), Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

MEMBERS

2. Shri Sultan Ahmed
3. Shri Kalyan Banerjee
4. Shri Dileep Singh Bhuria
5. Shri Ashwini Kumar Choubey
6. Shri Om Birla
7. Col. Sonaram Choudhary
8. Dr. Sanjay Jaiswal
9. Smt. Darshana Vikram Jardosh
10. Smt. Kavitha Kalvakuntla
11. Shri K. H. Muniyappa
12. Shri K.N. Ramachandran
13. Shri Arvind Sawant
14. Shri Ganesh Singh
15. Shri Kirti Vardhan Singh
16. Shri Sudheer Gupta

SECRETARIAT

1 Shri P.V.L.N. Murthy –Joint Secretary
2. Shri P.C. Koul – Director
3. Shri Srinivasulu Gunda – Additional Director
4. Shri U.C. Bharadwaj – Deputy Secretary

2. At the outset, the Chairperson welcomed the Members to the Sitting of the Committee and informed them of the election of two new Members viz. Shri Om Birla and Shri Sudheer Gupta to the Committee. The Committee welcomed the new Members.

3. The Committee then took up for consideration the draft Report on 'Occurrence of High Arsenic Content in Ground Water' pertaining to Ministry of Water Resources ,River Development and Ganga Rejuvenation and adopted the same with certain modifications. The Committee then authorized the Chairperson to finalize the Report in the light of modifications suggested and factual verification and present the same to Lok Sabha.

The Committee then adjourned.