Suggestions on Groundwater Quality Programmes as Input into Working Group on "Sustainable groundwater management" for the 12th Five Year Plan

The following points are summary of the proposed items to address the groundwater quality problems in India.

Overall Summary

1. **A National Water Quality Partnership (NWQP) –** across ministries, universities, research institutions and private institutions (companies/hospitals/civil society) coordinating a multi-disciplinary research and mitigation program. Such a programme is needed since there is no single agency or ministry which can assume full responsibility for the range of water quality problems given the current institutional setup. Given the graveness of the problem currently, therefore, the leadership for this proposed NWQP could be undertaken by the Planning Commission or with a special designated programme on Water quality separately or under a National groundwater programme. Else, the mandate of the Water quality Assessment Authority (WQAA) can be widened to include the NWQP also. Widening the scope of the WQAA would be a longer-term institutional option. A multi-disciplinary research program cutting across institutions should be coordinated by the NWQP. A grant fund should be made available for this research programme.
2. **Enforceable Standards for Drinking Water Quality** is urgently required in the country. A notification of standards at a national level is needed to impact enforceability to the standards for drinking water. Looking at practicality of enforcement by water supply service providers, a timeline can be associated with the standards to accord priority to adherence of different water quality parameters on an incremental basis.
3. **Minimum Water quality spatial/temporal sampling density** standards are needed across the country keeping into mind aquifer characteristics, population densities and modes of access to drinking water. Through such parameters, we need to define regional requirements to meet minimum sampling standards – especially dense monitoring networks in highly water quality affected pockets. This aim should be accompanied by a

timeline to achieve sustainable water quality sampling nationwide. This desired water quality sampling density can be achieved at three levels – indicative, numerical and analytical – using the three tier suggested laboratory structure described below. Also the already notified Uniform Water Quality Monitoring protocol may be followed from Sample collection, storage and transportation and upto following the analytical techniques.

4. **Revamping and Certification** of Laboratories should be introduced for both government and private water quality labs by NABL (three-tiers for range of testing facilities – primary, secondary and tertiary or referral testing facilities). This can allow for a large set of accredited labs across the country which can then be utilized for scaling up of water quality monitoring. District laboratories are also need re-define their role as Water quality data centres, involved in identifying need for data, coordinating sampling, analysis and dissemination. They could involve the efforts of certified private/research/academic laboratories for scaling up the effort for meeting the above minimum sampling standards.
5. **A National health programme for water quality** related health problems within the ministry of health need to be created. This programme should include establishment of diagnosis facilities in affected areas, execution of surveys and imparting training for mitigation measures. Specifically the surveys that can be carried out immediately are those on Fluorosis (Dental Fluorosis and Skeletal Fluorosis for children especially through School Health Surveys), Arsenocosis; Accurate databases for Enteretic related problems; Renal stone surveys; Relating incidences of other diseases such as high Cancer rates to possible water quality problems such as heavy pesticide use or industrial effluents). There is need to recognize the linkage between malnutrition and water quality related problems particularly in the context of urban/rural health poor.
6. **Agriculture related interventions**: Currently a national research program on salinity related aspects to agriculture exists within the ICAR network and the focus is on loss to agricultural productivity. However, there are several other linkages as with Iron and mainly, the transmission of contaminants such as pesticides/Fluoride/Arsenic through food irrigated with contaminated groundwater. No national statement currently exists on this subject. This aspect needs to be investigated and warrants a national research on this subject could be a partnership between ICAR and ICMR research laboratories.

7. **Ecological Approach to Water quality**: In the larger ecological picture, groundwater quality deterioration not just impacts human beings, but also results in ecological degradation. Therefore longer term and sustainable interventions will need an ecological framework which takes into account inter-linkages between ecological systems. Such an ecological systems framework needs to be developed to address water quality problems. A research programme within the Ministry of environment and forests can focus on this subject.
8. **Comprehensive Piloting of water quality mitigation** in some districts of each state can be done within the 12^{th} five year plan. A Water-Health Programme under the District Groundwater Programme can coordinate these district level programmes. This piloting should address achievement of water quality sampling complaint with above-defined minimum sampling standards, organizing related health surveys and addressing the problem comprehensively through drinking water, sanitation, health, agriculture, watershed, livelihood and related programmes.
9. **Intensive Capacity building** is needed for achieving all of the above towards addressing water quality problems for state and district level institutions through the proposed NWQP or a similar institutional setup.
10. **Groundwater Quality Data Management** is a crucial task at various levels. Due to wide variation in groundwater quality with space and time, there is a need for a dynamic, open access database which is a repository for all groundwater quality data collected across the country.

Background and Nature of the Groundwater Quality Problem

India is faced with an alarming range of water quality related diseases. Estimates made for some of these water quality related health problems suggest a massive endemic nature – Fluorosis (65 million (Susheela 2001), Arsenicosis (5 million in West Bengal (WHO 2002), but several magnitudes more unestimated from Assam and Bihar). Fluorosis caused by high Fluoride in groundwater leads to Crippling, Skeletal problems and severe Bone deformities. On the other hand, Arsenicosis leads to skin lesions and develops into cancer of lung and the bladder. There are 4,25,000 deaths due to Diarrhea annually in India (NICED 2004)). Disease burden estimated for these diseases also show high impacts in affected population – Fluorosis (DALY of 38.5 per 1000 population (Devotta et al, 2007); disease burden up to Rs. 5000 per capita per family due to disability (Indu et al, 2007)), Kidney stones related to poor hydration in water quality affected areas (Rs. 7500 per family per year (Indu and Rawal, 2007)). These health problems have a significant poverty signature – Fluorosis is aggravated by malnutrition of Calcium and by Anaemic conditions – further Fluoride intake increase Anaemia especially in women. Diarrheal problems are worsened by Anemic conditions. Similar malnutrition related links have also been established for Arsenicosis. These illustrate the self-selecting and reinforcing nature of such water quality problems on already debilitated persons spiralling them further down. Quite naturally therefore, we find less intensity of Fluorosis, for example, in well-fed populations, whereas they are aggravated with juvenile Osteoporosis-Rickets-Fluorosis with malnutritioned tribal children. Further intensifying the water quality problem is the finding of transmission of contaminants through food – grains, pulses, vegetables – grown with contaminated irrigation.

The response to tackle this massive problem however, is very weak. The following points illustrate the current state of affairs:

a) At present Central Ground Water Board is monitoring the ground water quality with about 15640 monitoring stations located all over India especially of shallow aquifers. There are about 3000 piezometers which are also being monitored especially for water level monitoring and not for water quality monitoring. Few State Ground Water Organizations are also monitoring the ground water level and quality in their respective states. Groundwater quality is being monitored especially during pre-monsoon period. Central Pollution Control Board, which is monitoring mainly the surface water pollution,

also maintains very limited number of ground water monitoring stations (about 500) located mainly in the industrial clusters. Adding to this sparse monitoring network, is the lack of uniformity in sampling and water quality parameters measured. All these lead to a data system which is not compiled, not comparable and has very low relevance to any public health problems emanating due to water quality. It is well known in the country that no one who wished to seriously act on water quality depends on these data sets. Even government agencies such as drinking water and sanitation department collect a large amount of one-time water quality data before their interventions. There is tremendous duplication of efforts, very poor data sharing and overall no dependable data on a national level.

b) Inspite of the high health burden pointed above, there is no national health programme for any water quality related problems. Hence, no official figure from the health department exists on any of these diseases based on surveys

c) There is a lack of institutional responsibility with respect to water quality. Whereas one agency considers water quality merely to understand groundwater, another focuses only on industrial pollution, whereas others relate only to the users eg. drinking water, irrigation, etc. Hence, responsibility of overall assessment does not lie with any single institution.

d) The unfortunate response today to the water quality problem is that families who can afford shift to expensive safer water supply by either buying treated water or by using expensive household purifiers. Quite understandably, this leaves out a majority of the population who face the brunt of the health burden. Not surprisingly therefore, the large proportion of the health burden of water quality problem is borne by the poorer – who also happen to be less aware of the cause of the problem. The beneficiaries in this situation are both private water and health service providers. The poor, further affected by malnutrition related conditions, are more prone to impact of these diseases, therefore further exacerbating their problem.

The above problems can be tackled. They need a multiple institutional thinking at a variety of levels. It needs action from two main sectors – Water and Health- and at all levels from the Centre to State to District to Village levels. It will also need contribution from academia on

innovation and businesses towards acceptable solutions. Above all Panchayat communities and civil society need to be alert to the problem and demand action on these urgent problems.

Following is a description of the recommendations:

I) The Proposed National Water Quality Partnership (NWQP)

There is a need for national level coordinating group for a Water Quality Program called the National water quality partnership. This inter-disciplinary institutional group to coordinate national level activities on water quality should have participation from:

- M/o Water Resources: CGWB, CGWA, WQAA, NIH,
- M/o Env & Forests: CPCB;
- M/o Rural and Urban Development: Drinking water and sanitation depts. and programs
- M/o Health: NRHM, PHFI, AIIHPH, NICED, ICMR;
- International Agencies: UNICEF, WHO, Water Aid
- Science and Technology: GSI, DST
- M/o Agriculture: CSSRI, CAZRI;
- Key National and Regional Hospitals – AIIMS, Apollo, CMC;
- Standard: BIS
- National Research Institutions: IITs, NIOT, NGRI, NEERI, IISc, CSMCRCI, NEIST;
- Key Research Institutions Working on Specific Water quality Issues (Fluoride, Arsenic, Salinity, Biological);
- Private Companies which can contribute to solutions on Water quality sampling and mitigation
- Civil society organizations which are working on water quality problems
- SPCBs and WQRCs

Given that a national Water Quality Assessment Authority (WQAA) already exists, the mandate of this authority could be widened to include the coordination of the above. Staffing should be highly multi-disciplinary (water chemistry, environmental engineering, sociology, geology, etc.) given the complex nature of water quality issues. Or else, the coordination of the NWQP could

be under the Planning Commission directly or as a special mission separately or under a National Groundwater programme. The NWQP should be an apex body that defines the outlines of a National water quality programme. For example, it should define standards for water quality, sampling procedures, need for health surveys, mitigation measures at all levels and relevant roles for different agencies. It needs to play a central coordinating role, both receiving the demand for and directing action on water quality.

The NWQP should define a national multi-disciplinary research program to address questions of key importance. It should have subjects such as: Medical Geology, Public Health Epidemiology, Environmental Engineering and Medical Anthropology. It needs to address key issues of water quality such as (and not comprehensively defined here):

a) Sanitation, Groundwater Contamination and Enteretic Diseases;
b) Over-exploitation and Chemical Contamination (Salinity, Fluoride, Arsenic)
c) Nutritional Measures for Water Quality Health Mitigation (Biological, Fluoride, Arsenic)
d) Groundwater rejuvenation and recharge to address Water quality Deterioration
e) Agricultural Productivity and Water Quality
f) Community and Domestic Sustainable treatment of unsafe water (Options such as Ecological Treatment)
g) Heavy Metals from Industries and their migration from water into other media such as soil, cereals and vegetables.

Key Suggestion for the Plan: The Plan needs to work towards creation of the above proposed NWQP or towards strengthening existing institution such as the WQAA to perform the same role. It can provide availability of a common fund for grants towards action based research on these above subjects (a till g) with specified partnerships of research institutions, government agencies, civil society and communities. This fund should be strategized such that within the duration of the next Plan the major questions that can drive action are addressed. Ideally decision making on disbursement of these grants is made by the NWQP. Also, the prposed NWQP should be mandated to coordinate all further points in these recommendations.

II) Enforceability of Drinking Water Quality Standards

The Bureau of Indian Standards specifies guidelines for drinking water quality standards for the country. However, these standards are not notified by any ministry. The enforceability of these standards therefore is in question. A review needs to be done as to the problem of enforceability and suggestions needs to be taken on this aspect. A concern emanating on this subject from implementing agencies is that it might be impractical to notify the entire BIS guideline set currently as enforceable. This might them require a timeline towards enforceability with the most critical and widespread ones such as Biological contamination or say, Fluoride, being enforced initially and a timeline for further enforcement be decided.

Key Suggestion for the Plan: A committee to review enforceability of drinking water quality standards and steps to move towards this direction

III) Minimum Water quality Monitoring density (spatial / temporal)

The existing set of water quality data briefly described above is insufficient for needs regarding to public health, agriculture or other purposes. There is very poor dependability on the existing data sets since they are very sparse and have low frequency with respect to time. As a result, any intervention on water quality needs to gather fresh data which do not add to any central database. This leads to duplication of efforts, wastage of resources and lack of common frameworks. Instead, it is essential to arrive at a common minimum sampling density guidelines depending on *aquifer conditions, type of problems, population density and access to drinking water* and attempt to reach such a density in a specified time period.

An illustration for deciding this desired density is provided here:

Table 1: Matrix of Variations for Desired Sampling Network Density

	Aquifer Type	Seriousness of Problem	Population Density	Density of Drinking water sources	**Desired Sample Network Density**
Biological					
Fluoride					
Salinity					
Arsenic					
Iron					
Fertilizers					
Pesticides					

A common network of required density for every region can be arrived by considered such a matrix as in Table 1.

The nature of sampling can be at different tiers – indicative, numerical and analytical – which can be performed by different types of laboratories as mentioned in the next section as by primary, secondary and tertiary level laboratories. For example, an indicative Fluoride testing at a primary level testing for a high Fluoride level will indicate the numerical concentration of Fluoride at a secondary level and further analysis on spread and transmission can be done by the tertiary labs on a selective basis. As an example, the aim could be to have *one primary level laboratory per 10,000 population, one secondary level laboratory per 1,00,000 population and one tertiary level laboratory per 1 million population*. The primary level laboratories should aim for comprehensive testing of drinking water sources in an indicative manner for the population under its jurisdiction. This would mean some proportion of the overall groundwater extraction structures (dug wells, bore wells, handpumps, etc) in the area, in some places just 5-10% and in other places with distributed drinking water sources, up to 60%-70% of all groundwater extraction structures. Out of these, around 20% samples (indicative proportion depending on cost

constraints and sampling criteria) should be referred to the next secondary level and a further 20% i.e. 4% of the original samples (indicative proportion depending on cost constraints and sampling criteria)) should be referred to the tertiary level (The percentages here are tentative and should be varied as shown in Table 1 depending on aquifer type, population density, etc.). Similarly, time frequency of testing should depend on the type of parameter being tested for and could be different for each parameter. Biological contamination on an indicative manner (for eg. using Hydrogen Sulphide strips) can be used on a monthly frequency, Fluoride testing can be done on a quarterly basis on indicative manner, etc. for all these a Uniform Water Quality Monitoring protocol may be followed from Sample collection, storage and transportation and upto following the analytical techniques which has already been notified by the WQAA.

However, if this sort of a groundwater quality monitoring needs to be achieved, it is not possible with the current institutional and infrastructural setup. One needs to think beyond existing modes of testing and think of ideas as below of certification of private and public laboratories.

Two examples can be cited for such tier structure of sampling strategy – that followed for example in Arsenic mapping in Assam and salinity related sampling networks existing in coastal Gujarat coordinated by non-governmental agencies.

Key Suggestion for the Plan: Defining matrices of desired sampling network density for water quality problems and for regions. Arrive at timeline to achieve such sustainable sampling and strategies to achieve it.

IV) Revamping of Laboratories and Certification

Most of the water analysis laboratories in India are old and the instruments are outdated and analysis is being carried out till date manually. It is highly recommended to modernize the labs of all the organizations which are involved in water quality monitoring. A lot of district water quality laboratories have unused equipment and staffing problems. Given the need for dense monitoring network as stated above, these district laboratories are currently unequipped to handle the magnitude of the problem. It is impractical to think of making monitoring networks more dense and based on local demand with the same system as now. There needs to be a re-think in what role these laboratories should play.

The water quality labs need to be modernized and to be accredited to NABL. Networking of laboratories is the need of the hour. Water Quality Labs especially important labs of different organizations like CGWB, CPCB, NIH, CWC and NEERI etc need to networked and the data shall be made available at one platform and implementation of district level programme management on ground water quality for catering to demand-based water quality data generation. Few of the laboratories need to be declared as referral laboratories immediately so that effective control on analysis can be assured. For the purpose of accreditation NABL can be requested to device a *three level accreditation process for primary, secondary and tertiary or referral laboratories.*

Primary level: Such laboratories need to be widespread and present at the level of a few thousands population (one per 10,000 population as suggested in the previous section). These certified laboratories could be even hosted in Gram Panchayats as has been experimented by WASMO in Gujarat. They can involve volunteers from the community and civil society. The analysis provided by these labs need only be indicative. Still there is standardization and quality control needed for such analysis; hence the certification. Perhaps, the process for this level of certification should be laid in the hands, not of NABL directly, but to the secondary level labs.

Secondary level: These labs, possibly at a block level (one per 1,00,000 population as suggested in the previous section), should be able to perform a basic level of water quality analysis which can quantify indicative problems from the primary level. They should be able to measure key problems of the areas they are located in. These labs need not be directly operated by any government agency. They could be located in universities, research institutions, schools or operated by private entrepreneurs much akin to testing laboratories for pathological requirements. These labs need to be directly certified by NABL. Also they would fall under the supervision of corresponding tertiary of referral labs below.

Tertiary level or Referral Labs: This level is what the district labs have aimed to be currently (one per 1 million population as suggested in the previous section). They could be located at a district or larger (2-3 districts) depending on the local need. They need to be certified by NABL for testing of all water quality parameters as required by the national standards. However, keeping into mind consideration that just a very few parameters such as trace pesticides might require operation of very expensive equipment requiring staff with higher skills, such parameters

could be left out of the requirements for these referral labs also. Eventually if testing costs drop down, such parameters could also be included. As for secondary level, the tertiary level labs should also be kept open to be in any institution, public or private.

The current district level should reinvent their role in this picture and transform into District Water quality data centres as will be described below.

Key Suggestion for the Plan: Three-tier certification of water quality laboratories (public and private).

V) National health programme for water quality

One major impediment towards solutions to water quality related health problems, is that they go undetected. In many cases, even if doctors diagnose patients correctly, they have not been imparted any training towards corrective measures. Also, there being no specific mission or programme for such water quality related problems, makes it difficult for district level health authorities to accord priority to such problems. Due to such a situation, basic diagnostic facilities do not exist for detection of such health problems also.

There is an urgent need therefore for the health ministry to take water quality related problems seriously by creation of a national mission or programme specific to water quality related health problems. Following is a list of activities within the next plan that can be performed by such a mission:

a) Carry out surveys on specific problems which can be carried out eg. Dental and skeletal Fluorosis, Arsenocosis, Renal Stones.
b) Identify referral hospitals in affected districts or set of districts which are equipped with diagnostic equipment or existing facilities are enhanced eg. existing urine and blood testing labs are enhanced with testing for Fluoride/Arsenic in such samples for affected areas.
c) Impart training for district to village level staff for diagnosis, referral, counseling and mitigation similar to UNICEF supported malnutrition centres currently in operation in many districts across the country.
d) Absorb water quality related health problems as a regular part of existing surveys of school health, NRHM, etc.

e) Focus existing programmes such as those on Nutrition for targeted measures of mitigation for affected population with respect to problems such as Fluorosis, Arsenicosis, Renal Stones, etc.

Apart from this, existing national institutions such as the Indian Council of Medical Research (ICMR), Public Health Foundation of India (PHFI), National Institute for Communicable and Enteric Diseases (NICED), etc. along with large research oriented private and public hospitals such as AIIMS and Apollo need to orient their research programmes towards these health problems in terms of epidemiology, etiology and mitigation. These could be achieved as part of the funded research grant as proposed earlier through the proposed NWQP.

Key Suggestion for the Plan: A national programme from the health ministry on water quality related health problems which includes creation of diagnosis facilities in affected areas, execution of surveys and imparting training for mitigation measures. Coordination of medical research on these problems with fund as proposed earlier directed by the proposed NWQP.

VI) Agriculture related interventions

Groundwater quality problems cause a major burden to agriculture and through agriculture. Salinity results in loss of agricultural productivity and infeasibility of crops. Iron problems result in loss of equipments, especially pumps and pipes. Of critical importance also is the transmission of contaminants through the irrigation route. Though studies of individual cases are available, no statement on a national level as yet has been made. This requires a major national research effort. Since the practice of using wastewater directly for irrigation without treatment is widespread in city outskirts for vegetable production, there has been observation of several contaminants in such produced food. Also, existing contaminants in groundwater such as fluoride and Arsenic find their way into food crops. Are such examples isolated ones without cause for larger concern or do they pose a threat nationwide are unanswered questions. The presence of pesticides in food is also a wide threat, not directly always through groundwater though. The threat from such transmission of contaminants through food is especially a major concern within areas locally where such problems emanate since food becomes another sources apart from water for entry to contaminants into the human body. The problem therefore requires urgent attention from the agriculture ministry and warrants a national research effort at fact-finding. Since this research

would involve aspects related to health, there could be a collaborative program with the ICAR and ICMR research laboratories. Such research needs to lead to comprehensive plans to tackle the existing problems such as possibly encouraging non-food crops with contaminated irrigation water, regulating pesticide use, promoting organic agriculture, bio-remediation based solutions to clean-up of affected aquifer, etc.

Key Suggestion for the Plan: Review nationwide the transmission of contaminants through food – from wastewater and from contamination groundwater. The research programme could be funded by the earlier proposed central fund and it needs to arrive at actionable goals for solving these problems.

VII) Ecological approach to Water quality

Often missed is the larger ecological picture within which water quality problems are set. An overall ecological degradation is accompanied with groundwater quality problems. These problems not just affect humans, but also animals, birds and vegetation. The solutions sometime also do not lie always in simple protection of aquifers or treatment of water, but in looking at the larger ecological picture. Degradation of wetlands for example in many places across the country is intimately linked with deteriorating groundwater quality problems. Cattle drinking contaminated groundwater are also affected health-wise and ultimately affect their milk productivity. Native forests have a role to play in recharge to aquifers, and when they are lost, there is an emanation of groundwater quality issues. This larger ecological picture must not be lost when thinking about the country as a whole. Making this link and looking at interventions based on such linkages to address the groundwater quality problem can provide much longer term and sustainable solutions. Unravelling and working on this link requires a massive effort from the ministry of environment and forests on a nation-wide scale.

Key Suggestion for the Plan: Developing ecological approach to addressing water quality problems. National research programme funded by above designated central fund leading to actionable goals on this front.

VIII) Piloting of water quality mitigation

Given all above recommendations at larger levels in terms of standards, research, sampling, and health programme, it is necessary to pilot programmes at district level on a comprehensive basis. Within these selected districts, concepts such as minimum sampling density, 3-tier structure of laboratory testing, health diagnosis and surveys and various mitigation measures from water, health, agriculture and other programmes need to be implemented. A Water-Health programme as part of the District groundwater programme can coordinate the following:

a) Reviving District laboratories and transforming them into District Water Quality Data Centres (DWQDC) for wider dissemination; data collection and testing through certified referral labs; personnel for awareness and communication; periodic publishing of data in local newspapers
b) A Water-Health Programme as part of District Groundwater Program defining data requirements for aquifer characterizing, local spatial and temporal variations of important water quality problems – this is defined within context of minimum sampling standards defined by NWQP and local specific needs as defined by a district groundwater programme.
c) The 3-tier structure of laboratory – primary, secondary and tertiary (referral) – can be setup. In this, the primary level of testing on an indicative level could be assigned to capable and interested Gram Panchayats or Schools.
d) The District health programmes need to coordinate health surveys as required for localized water quality problems. These can also be part of School Health surveys, Nutrition Programmes, etc. The District Water-Health programme can coordinate with such surveys and maintain databases of these surveys. These surveys would also define the need for water quality monitoring.
e) There needs to be District to Village Panchayat participation for some components of participatory surveillance and qualitative aspects – periodic qualitative testing, highlighting data needs, participating in implementation of mitigation programmes
f) The district Water Health programme as part of a groundwater programme can coordinate testing of the following ideas:
    i) Groundwater recharge as a means of rejuvenating water quality affected aquifers – This concept is especially relevant in some salinity affected areas, especially those affected

by salinity ingress as has been demonstrated in coastal Gujarat. Several organizations such as the Agha Khan Rural Support Programme (AKRSP) have been working on several salinity mitigation measures such as coastal tidal regulators, well sealing, watershed measures such as small check dams and interlinking of local water bodies. These measures have been able to create a temporary fresh water bubble in local pockets, however, in absence of demand control measures of groundwater, this fresh water gets pumped out and salinity ingress on a large scale remains.

ii) Domestic and Community Water treatment: In this context, a lot of options are being created today for water treatment at the domestic and at the community level. Several organizations such as Nandi foundation in Andhra Pradesh are practicing community based water treatment where the entire cost of O and M is met by the community. Many of these are Reverse Osmosis (RO) plants which are also effective in removal of some types of contaminants such as Fluoride. However, RO technology is expensive, has high maintenance costs and is high on water usage since the concentrated waste water needs to be rejected. At the domestic level, a lot of development has been happening in India recently. Two major industries the Tatas and Hindustan Level (Indian arm of UniLever), have developed low cost filters (less than Rs 1000) which run without electricity and aim to remove a reasonable bacterial load. Several other filters are also available such as Terrafil (made from Terracota, produced by IMMT – Institute of Minerals and Materials Technology), iron removal filters made of clay and rice husk in eastern India, Activated alumina based filters for Fluoride and Arsenic removal, use of Moringa Olifera for removing turbidity and bacteria, Bio-sand filters for bacterial removal. Inspite of the low cost and ease of use, widespread adoption of domestic water filters has yet not picked for most of rural India.

iii) Ecological treatment and other sustainable means on a community level: On a community level, basic water treatment for pathogens and recycling of wastewater for recharging can be achieved by different types of ecological treatment. Such technologies for water treatment can be approached in different directions such as reed bed treatment, DEWATS type solutions etc. There have been pilots conducted of several of these options across the country with some successful cases of community led action. On a

longer term sustainable level, such options are useful, however they require sufficient land area, maintenance and interest from the community.

iv) Decentralized waste management: Sanitation and waste management programmes have a key role in helping prevent contamination to groundwater from household waste/ Especially in dense settlement, such risk is higher and pose serious threat to public health. The problem is that in most of the current sanitation programmes, the latrine pits are being constructed have a water output that is high enough to transmit pathogens to the water table. Also these on-site latrines are in direct contact with the soil or rock beneath. These two factors above i.e. higher risk of wet toilets and low water availability, necessitates one solution in the form of double vault latrine, or as being promoted now as Ecological Sanitation (Ecosan) options in for such high risk areas. This involves urine separation, maintenance of two separate chambers, and usage of soil/ash/dry leaves after every usage. However these require a high level of cultural change and frequent maintenance of the chambers, something which is quite difficult to bring about on an individual, distributed and household scale. Further, solutions such as DEWATS – Decentralized wastewater treatment systems – that are now being piloted in the country need to be upscaled. Such interventions are at a community level and with proper participation, several success stories are coming up across the country.

v) From the perspective of health programmes, a cell can be created within the district hospital for diagnosis of local water quality related health programmes. This would be the main referral cell of the district which is referred to by the channel of health workers from village to PHC/CHC and to the district hospital. Once patients are documented through this procedure, appropriate mitigation options need to be conveyed. For several water related health problems, there are different options that a medical practitioner can suggest. In the specific case of Fluorosis, different nutrition related measures are effective. It is possible to achieve a high degree of success in various health related problems just by addressing malnutrition. Various nutrition deficiencies right from early age, make patients susceptible to variety of health problems which include water quality related ones, especially since the bioavailability and absorption of contaminants in the body increases with such malnutrition. Targetting existing nutrition programmes, therefore, towards addressing water quality related health problems will provide major

dividends not only in tacking these problems, but also in addressing widespread problems such as Anaemia and Rickets, as has been demonstrated in recent epidemiological and evidential studies.

From these pilots, there needs to be good documenting of local experiences by the District Water-Health Programme and these inputs would need to feed into Drinking Water, Sanitation, Irrigation, Watershed, Health and related programmes. This documenting is critical since the learning can then be utilized into a nationwide level as district level water quality programmes.

Key Suggestion for the Plan: Piloting district water quality programmes as part of groundwater programme and testing of ideas given in these suggestions

IX) Intensive capacity building

The National Water quality Partnership (NWQP) needs to take charge of intensive capacity building needs for water quality programmes across the country. Especially at the district level and below, there will be a lot of benefit from capacity building for executing these ideas. This can be coordinated by the proposed District Groundwater programme. Listed below is some types of training that can be conducted:

a) Training for 3 tier structure of laboratories – for staff of these labs
b) Training for carrying out health surveys such as Dental Fluorosis – for health staff
c) Training for doctors and health workers for diagnosis, counseling and mitigative measures for water quality related health problems
d) Training for district/village water and sanitation committees/Panchayats towards analysis of water and health information in formation of water and sanitation plans
e) Inductance into Curriculum: Water quality related syllabi into variety to related disciplines – Medicine, Public Health, Social Work, Water resource and environmental Engineering.

Key Suggestion for the Plan: Form a water quality capacity building plan composed of training, enhancement courses and curriculum changes for widening the availability of skilled personnel to work on this issue

X) Groundwater quality data management

There is a current initiative for collating all water related data into one platform at the central level in the form of the proposed NWR-IC – National Water Resources Information Centre by the Central Water Commission. Especially, for groundwater quality, if the NWR-IC needs to be used for wider dissemination, it has to be capable for handling the data as proposed to be generated in Section 2 and 3 above. In that sense, there needs to be a large effort in maintaining the database, error-checking and consistency and making it user-friendly. Keeping in mind the nature of users – Panchayats/District level line departments/Public Health authorities/Irrigation departments/ NGOs etc. – the usability factor is critical and so is participation from end users in design of this database.

Key Suggestion for the Plan: Envisaging a groundwater quality database in line with a national groundwater quality data collection plan with participation from end-users

List of Abbreviations

NWQP: National Water Quality Partnership

WQAA: Water Quality Assessment Authority

NABL: National Accreditation Board for Testing and Calibration Laboratories

ICAR: Indian Council for Agricultural Research

ICMR: Indian Council for Medical Research

WHO: World Health Organization

BIS: Bureau for Indian Standards

NICED: National Institute for Cholera and Enteric Diseases

CGWB: Central Groundwater Board

CGWA: Central Groundwater Authority

NIH: National Institute for Hydrology

CPCB: Central Pollution Control Board

NRHM: National Rural Health Mission

PHFI: Public Health Foundation of India

AIIPH&H: All India Institute for Public Health and Hygiene

UNICEF: United Nationals Children's Fund

WHO: World Health Organization

DST: Department for Science and Technology

GSI: Geological Survey of India

CSSRI: Central Soil Salinity Research Institute

CAZRI: Central Arid Zone Research Institute

AIIMS: All India Institute for Medical Sciences

CMC: Christian Medical College

IIT: Indian Institute of Technology

NIOT: National Institute for Ocean Technology

NGRI: National Geophysical Research Institute

NEERI National Environmental Engineering Research Institute

IISc: Indian Institute for Science

CSMCRCI: Central Soil and Marine Chemicals Research Institute

NEIST: North east Institute of Science and Technology

SBCB: State Pollution Control Board

WQRC: Water Quality Review Committee

CWC: Central Water Commission

DWQDC: District Water Quality Data Centre

AKRSP: Aga Khan Rural Support Programme

RO: Reverse Osmosis

IMMT: Institute for Minerals and Materials Technology

DEWATS: Decentralized Water and Wastewater treatment systems

Ecosan: Ecological Sanitation

PHC: Primary Health Centre

CHC: Community Health Centre