Chapter- 8
Roadmap for Achieving Envisaged Targets

8.1 Important Milestones

Milestones are the events, which are envisaged as future course of actions to achieve the targeted goals. The targeted goals in this case are: (a) to make arsenic contaminated aquifers conducive to preserve groundwater quality and produce arsenic free groundwater to meet drinking and irrigation demands, (b) to find sustainable techniques and technologies for decontamination of aquifers from arsenic and for the removal of arsenic from contaminated water, (c) to scale up scope for unveiling alternate sources of water to meet the demand of potable water in the arsenic affected and vulnerable areas, (d) to eradicate health hazards, originating from ingestion of arsenic contaminated water, and (e) to make society responsive to unconscious usages of water. The milestones to achieve the above goals, as emerged from the chapter- 7: 'Work Ahead: Critical Concerns and Key Challenges,' can broadly be categorized as: (i) R & D work to be undertaken to reach at logical solutions to the arsenic calamity, (ii) immediate measures to provide arsenic free potable water to the people in the arsenic vulnerable areas, and (iii) activities to be undertaken for Capacity Building and Social Empowerment, and (iv) revisit to revise the National Standard for Arsenic in drinking water. The details of these envisaged tasks are as follows:

(i) **Emerging R & D Activities** - to prepare database, improvise and translate understanding of causes, geochemistry, genesis, aggravation, mobilization and dissolution processes of arsenic in groundwater for different hydro-geological settings to derive methods for in-situ remedy for decontaminating aquifers from arsenic; to devise cost effective, eco-friendly and socially accepted arsenic removal devices; to investigate feasibility of alternate sustainable water management (SW & GW) strategies to meet demand of water in the arsenic affected and vulnerable areas, to assess impact of arsenic in food chain and related health hazards, to ascertain health impact of arsenic contaminated groundwater, etc.

(ii) **Ensuring Arsenic Free Water-** activities and plan of actions to provide arsenic free drinking water to the people in affected and vulnerable areas,

(iii) **Capacity Building and Social Empowerment** - activities to promote public awareness, capacity building and social empowerment about importance of water and its effective usages, health related issues, ill-effects of using contaminated water, etc.

(iv) **Revisit to revise National Standard for Arsenic in drinking water:** to consider revision of the National Standard for Arsenic in drinking water in the light of the WHO's present guidelines.

8.1.1 Emerging R & D Activities

The technological opportunities, to resolve water scarcity in arsenic affected areas and, to get rid of groundwater arsenic menace, can be thought to be as under:

i) In-situ remedy of aquifers by decontaminating arsenic from infested aquifers,
ii) Use of groundwater after ex-situ treatment by arsenic removal devices,
iii) Use of surface water source as an alternate to the contaminated groundwater source,
iv) Exploring possibilities of tapping risk free deeper aquifers for supply of arsenic free groundwater.

Out of these four technological options, the most fascinating one is the in-situ removal of arsenic from aquifers and restoring the aquifers from arsenic vulnerability. Ensuring supply of drinking water to the populace in the arsenic affected areas is the primary requirement while the irrigation water requirement in the arsenic affected areas can't be overlooked. Agriculture is the life line of rural people and groundwater is the primary source for agricultural water requirement. Exploitation and usages of arsenic contaminated groundwater for agricultural purposes will not only spread the health hazards through the agricultural products but also help to widen the arsenic contaminated area. Thus, one has to look for a comprehensive solution to ensure supply of arsenic free water to meet demands of both drinking and irrigation requirement.

Although there are some commonly accepted hypotheses, explaining occurrences and mechanisms of arsenic in groundwater, however, causes, sources of parental materials including their geo-chemical behaviors and processes in different hydro-geological settings and speciation are still to be established. Techniques and technologies, available globally and indigenously, for arsenic removal mostly, deal with ex-situ arsenic removal methods i.e., removal of arsenic from contaminated water after it is taken out from contaminated aquifers. As such, no specific technique except an approach claimed by 'Queen's University researchers in Belfast' has been found stating withdrawal of arsenic free groundwater or in-situ treatment of arsenic contaminated aquifer. The claim of eco-friendly treatment technique of arsenic removal, that can ensure safe irrigation and potable water supply at an affordable cost, by the 'Queen's University researchers in Belfast', needs verification and on field application, before the technique is accepted for large scale adaptation. Further, a variety of ex-situ treatment technologies, which are mainly based on oxidation, co-precipitation, adsorption, ion-exchange and membrane process, have their own merits and limitations, and are mostly found unwarranted; in terms of efficiency, operation and maintenance, applicability/appropriateness of the technologies. The main disadvantages associated with those are: (i) they produce large

amounts of toxic sludge, which needs further treatment before disposal into the environment, and (ii) they lack in proper operation and maintenance policy guidelines. In addition to those, the treatment devices, in many cases, are not economically viable and socially acceptable. The available arsenic removal technologies require refinement to make them suitable and sustainable for their large scale effective uses. Surface waters are free from arsenic contamination. Although usages of surface water sources with minor treatment through organized piped water supply system seems to be very expensive, it has been proved to be a feasible solution to supply potable water in many places in West Bengal, where surface water availability is assured. Moreover, investigations have revealed that deeper aquifers underneath the contaminated shallow aquifers are free from arsenic contamination. The deeper aquifers, which are risk free from future threat of contamination from the overlain aquifer, can provide a sustainable source of potential groundwater withdrawal. Groundwater arsenic contamination zones in most of the arsenic affected areas are in localized patches. Areas around the arsenic affected patches are free from arsenic contamination. Because of hydrogeological features and fluvial characteristics of the groundwater domain, in many cases all those freshwater zones are free from threat of intruding contaminants from the nearby infected zones. Possibility of tapping all those shallow freshwater zones can be explored. The top most layers of the shallow aquifers are recharged annually by monsoon rainfall. This recharge water remains free from arsenic for quite a long time till they are mixed up by natural processes or by any external intervention. Most of the arsenic affected areas in the Gangetic flood plains are along linear track of river courses. River water is free from arsenic and the river banks possess unique properties of filtration, storage and transmission of water. Exploring possibility of tapping top fresh water zones by radial collector wells and river banks storage by intake wells can be one of suitable propositions to investigate. Over and above, as such no comprehensive maps delineating arsenic vulnerable zones and potential freshwater zones of the arsenic vulnerable areas are available.

Recognizing the above needs and their importance, following three categorizes of R & D programmes are proposed to pursue simultaneously to achieve the goal against groundwater arsenic menace; these are: (i) Laboratory scale R & D programmes, (ii) Field level R & D programmes, and (iii) evolving strategies to translate the techniques and technologies to the benefit of the society. The laboratory scale R & Ds should aim at developing eco-friendly and economically viable arsenic removal treatment techniques, species identification and knowledgebase generation; while the field level R & D programmes should aim at developing appropriate methodologies for decontamination of aquifer from arsenic by improvising understanding of geo-chemical behavior, processes and mechanisms of mobilization, source identification, monitoring and mapping, management of aquifer. The third type of R & Ds could aim at developing strategies as to how techniques and technologies can be translated to the society for their acceptability and sustainability.

The detailed outlining of the three categories of R & D activities are illustrated in subsequent section:

(i) Laboratory scale R & Ds

The objectives of the laboratory R & D activities should primarily be to improve knowledgebase on physicochemical characteristics and behaviors of arsenic both in aqueous and solid phases, when it transforms from one condition to another by the attribution of other chemical constituents and to identify effective methods for removal/dissociation of arsenic from arsenic contaminated water or development of cost-effective and eco-friendly arsenic removal filters.

The laboratory based R &D activities could thus be focused on the following key areas:

- Identifying most promising arsenic removal devices among the existing techniques *(such as, Granular Ferric Hydroxide (GFH) of Pal Trockner (P) Ltd., Kolkata - a German Technology; Arsenic Removal Plant by Oxide India (Catalysts) Pvt. Ltd, Durgapur; and Apyron Arsenic Treatment Units by Apyron Technologies (P) Ltd. Representing of Apyron Technologies Inc., USA)* and improvising their defeats to make those eco-friendly, low-cost, efficient and socially acceptable;
- Developing alternate innovative eco-friendly, low-cost, efficient arsenic removal techniques & technologies;
- Study of behavior of arsenic with Fe, Mn, Ca, Mg, and bicarbonates and finding their characteristic behaviors for different physicochemical conditions;
- Development of eco-friendly and innovative methods for arsenic sludge treatment & management;
- Arsenic speciation and characterizing their environmental hazards under different hy drological, environmental, and ecological conditions; and translating scientific knowledgebase to resolve field problems;
- Laboratory analysis of samples to detect arsenic concentration, chemical compositions, characteristic behaviors, reaction and sorption kinetics, etc.
- Development of field kits, which are robust, reliable, cheap and simple enough to be used by relatively unskilled users in the villages.

(ii) Field level R & Ds

The primary objectives of the field level R & Ds should be to devise mechanisms and methods for remedy of contaminated aquifers from arsenic; to devise optimal aquifer management strategies; to explore possibility of developing alternate water management strategies in the arsenic affected areas; to study the effect of arsenic in food chains and on human health; to study the social responses and societal impact on groundwater arsenic contamination, etc.

The field level R & D activities could be in the following key areas:

- Diagnosis survey of the arsenic vulnerable areas and preparing thematic maps on GIS environs showing arsenic affected, arsenic vulnerable and freshwater zones;
- Delineation of arsenic free aquifers including deeper aquifers; and assessment of their yields and potential to tap, including preparation of thematic maps on GIS environs ;
- Detection of genesis of arsenic in Ganga-Brahmaputra flood plains and finding reasons of large scale activation in Holocene aquifers;
- Improving understanding of sorption kinetics of arsenic both in solid and water phases for different physicochemical and geo-chemical conditions, dissolution and reduction potential of arsenic in different state-of-affairs chemical composition and enhancing knowledgebase on arsenic mobilization processes under different hydro-geological settings;
- Development of appropriate sustainable in-situ remedial techniques employing innovative ideas/techniques including phyto-remediation and bioremediation;
- Modeling studies to evolve sound aquifer management strategies including arrest spreading, harness fresh aquifer zones, study of movement of arsenic in aquifers for different stresses in the groundwater domain, etc.;
- Evolving alternate water management strategies in arsenic vulnerable areas to meet demand of irrigation water requirement including feasibility studies for adaptation;
- Impact of fertilizers and pesticides infiltration to the arsenic contaminated aquifers;
- Pilot scale study to translate, test effectiveness and adaptation of the in-situ arsenic removal technique claimed by Queen's University, Belfast;
- Pilot scale study for in-situ removal of arsenic from As-Fe interrelationships or other innovative methods;
- Exploring possibility of tapping monsoon groundwater recharge (top most layer of shallow aquifer) using radial collector wells and river bank storages by infiltration galleries/ intake wells;
- Pilot scale studies to test efficiency and effectiveness of different technological advancements, propositions and concepts for in-situ arsenic remedy;
- Impact of arsenic in food chains and health risk assessment;
- Impact of arsenic groundwater contamination on health, society, environment, and socio-economic issues, etc.

(iii) R & Ds to roll-over

The techniques and technologies expected to be developed at the laboratory and field level R & Ds should finally roll over to the field. Most of the techniques and technologies fell short to produce satisfactory results because of many unforeseen and undefined factors, such as; implementing agencies do not even know as to how go about, social unacceptability, complicated O & M, etc. One has to have, therefore, a clear idea as to how the task is to be implemented and operated to get its targeted benefits. So, the R & D activity, in such case, could be to evolve methods as to how a socially acceptable public-private-people entrepreneurship for implementation, operation and maintenance of the schemes can be translated to the field to derive sustainable benefits.

8.1.2 Ensuring Arsenic Free Water

In order to provide arsenic free potable water to the populace in the arsenic affected areas, the following alternate measures as a stopgap arrangement can be initiated: (i) in areas where population density is relatively more and the area is under the grip of arsenic effect and there are limited scope for alternate freshwater supply; arsenic removal devices, by choosing the best working model among the existing devices under the public-private partnership with community participation in the O and M, would be a suitable proposition to adopt, (ii) in areas where freshwater aquifers can be tapped using hand pump with no risk of arsenic contamination; installation of new hand pumps can provide a reasonable solution, (iii) the areas where deeper aquifers can be tapped with no future risk of contamination from the overlain aquifer; supply of potable groundwater by exploration of deeper aquifers can provide a sound solution, and (iv) the places where the surface water supply can be ensured as an alternate source of groundwater; fitting piped surface water supply scheme (although expensive) can be a reasonable proposition to adopt.

During the past few years, many small scale arsenic removal devices have been developed, field tested and used in West Bengal. Out of 10 such tested arsenic removal devices, few have proved satisfactory performances both in terms of arsenic removal efficiency, and O & M. The schemes in which regular O & M are entrusted with the local community are found to have produced successful results. Arsenic removal devices attached with Hand Pumps and tube wells developed and marketed by M/s Pal Trockner Foundation Ltd, India in association with Harbauer GmbH, Germany; by Oxide India (Catalysts) Pvt. Ltd, Durgapur; and by Apyron Technologies (P) Ltd. representing of Apyron Technologies Inc., USA are those devices and schemes, which have shown satisfactory performances in the field. Comparison of photographs (Figs. 8.1 and 8.2) taken during November, 2008 representing two similar type of schemes marketed by M/s Pal Trockner Pvt. Ltd. located in a kilometer distance apart, one with care of O & M, other one without care of O & M, clearly revealed that sustainability of a scheme mainly depends on how do one nurtures the scheme rather than the sophistication of the scheme.

The plan of actions under this task could be as follows:

(i) Reviving and strengthening of existing arsenic removal plants/units wherever possible by the replacement of components of successful system under the public-private partnership linking the community participation in the O & M;

(ii) Installation of new Arsenic removal plants (efficient and effective system among the existing) with existing hand pumps and tube wells in arsenic vulnerable areas where no such schemes exist, under the public-private partnership with community participation in the O & M;

(iii) Installation of new hand pumps to tap and provide fresh potable groundwater to the inhabitants residing in the arsenic vulnerable areas;

(iv) Installation of new tube wells to tap deeper aquifers and creating infrastructure to supply risk free potable water to the people in the arsenic vulnerable areas;

(v) Developing scope and infrastructure for piped surface water supply schemes ,wherever feasible, to ensure potable water to the people of arsenic vulnerable areas;

8.1.3 Capacity Building and Social Empowerment

Most of the arsenic removal technologies, rolled over to the field, have failed because of ignorance in O & M, and inadequate awareness in the society. The general notion of the society with regard to water and about water related schemes are: (i) water is in plenty and god gifted, and it has no threat from any unforeseen hazards rather it is the cleaner of all pollutants; and (ii) society has no responsibility, control and accountability on the provisions/schemes created by the government. While the effectiveness and benefits of a facility do not come merely by its creation rather by nurturing the created facility from time to time to derive its long term benefits. Thus, in water related schemes giving direct benefit to the society, and which bothers the society on its non-functioning or non-existence; involvement of the society in the O & M and making society responsible and knowledgeable can solve many problems associated with the water scarcity issues in the arsenic affected areas. In many rural areas, there is a belief that groundwater is plenty and can be drawn on demand and is also risk free from any contamination. *To cite an example in this regard; a recent field investigation made to an arsenic affected area in Ojha Patti in Bhojpur District, Bihar, it was observed that village people preferred to drink hand pump operated tube well water from arsenic affected area than the bore well operated overhead tank water provided by the Govt. of Bihar. On query, villagers replied that overhead tank water is stored water and not regularly pumped, and therefore, is not fresh, whereas the hand pump water is drawn on demand and hence better than overhead tank water. These notions signal lack of adequate literacy and know-how.*

Figure 8.1 : Photograph showing a hand pump connected with Arsenic removal filter developed by M/s Pal Trockner Foundation Ltd, India, successfully operating under the community participation in O & M in Barasat, West Bengal.

Figure 8.2 : Photograph showing a hand pump connected with similar Arsenic Removal filter located at about one km. distance apart but not under the responsibility of community participation in O & M, found non-functional due to minor maintenance.

Efficiency, effectiveness and sustainability of a technologically challenged scheme can be achieved by capacity building among the human resources to be involved in development, implementation, and O & M of the system, whereas usages of water, water-literacy, and health related issues can be achieved through mass awareness programme.

The following tasks are thus proposed:

(i) Establishment of a network of water quality testing laboratories in each arsenic affected States, having provision of one level-II category laboratory in each district with scope to detect primary chemical constituents and selected toxic elements,

(ii) Training of personnel involved in the technological developments to acquire advanced knowledgebase and know-how,

(iii) Training of junior level personnel with the implementing agencies, NGOs involved in the area, Panchayat Officers; who in turn shall impart training to the personnel to be in volved in O & M,

(iv) Mass awareness and campaign programme for the society through local Panchayati raj network.

8.1.4 Revision of the National Standard for Arsenic in drinking water

In addressing the key-concerns and in developing a National Plan of Action for providing Arsenic safe water to the community, the 1st key-step is to establish a National Standard for Arsenic in Drinking Water. It is strongly felt that the National Standard for Arsenic in drinking water is to be set linking the issues related to the social, cultural & health benefits in line as set by the WHO. Many health scientists strongly feel that standard should be strictly based on health risk and no compromise should be made on economic consideration. It is, therefore, recommended that the standard for Arsenic in treated water should be 10 ppb; but the threshold value for rejection of a water source could continue to be 50 ppb for sometime to come. BIS and the Dept. of Consumer Affairs should take an unequivocal stand in this matter

8.2 Approaches for Achieving Milestones

Government of India has launched a number of countrywide development schemes as Societal Missions emphasizing to provide basic amenities to the society for its multi-faceted development. These schemes are:

(i) Bharat Nirman, 2005-2009.

(ii) Accelerated Rural Water Supply Programme (ARWSP) & Pradhan Mantry Gramodaya Yojana (PMGY) - Rural Drinking Water.

(iii) National Rural Employment Guarantee Act-2005 (NREGA).

All these schemes have component and relevance dealing with providing safe drinking water to every habitation. It is proposed to link and operationalize the activities emerging from this mission of providing arsenic free groundwater and decontaminating aquifers from hazards of arsenic to the above Govt. of India societal schemes.

Ministry of Water Resources, Government of India, also provides financial assistance for R & D projects through its different 'National Committee'; the related committees are:

(i) Indian National Committee on Ground Water (INCGW) - Secretariat with the Central Ground Water Board,

(ii) Indian National Committee on Hydrology (INCOH) - Secretariat with the National Institute of Hydrology, Roorkee.

8.2.1 Bharat Nirman (2005-2009)

'Bharat Nirman' is a time-bound plan for action in rural infrastructure by the Govt. of India in partnerships with State Governments and Panchayat Raj Institutions in the areas of irrigation, road, rural housing, rural water supply, rural electrification and rural telecommunication connectivity.

The task envisaged under the 'Drinking Water' component of the 'Bharat Nirman' is to provide every habitation safe source of drinking water. In addition, all habitants, which have slipped back from full coverage to partial coverage due to failure of source and habitations, which have water quality problems, is to be addressed.

The Ministry of Rural Development, Department of Drinking Water Supply, is responsible for meeting this goal in partnership with State Governments. The programme instrument of the Government of India is a Centrally Sponsored Scheme of Accelerated Rural Water Supply Programme under implementation since 1972-73, which is funded on a 50% matching share basis between the Government of India and the State Governments. The norms set in the scheme are:

- 40 liters per capita per day(lpcd) of safe drinking water for human beings,
- 30 lpcd additional for cattle in the Desert Development Programme Areas,
- One hand pump or stand post for every 250 persons,
- The water source should exist within 1.6km in the plains and within 100 meters elevation in the hilly areas.

Water quality problems due to excess arsenic have got a special mention in the 'Bharat Nirman' document.

8.2.2 Accelerated Rural Water Supply Programme (ARWSP) & Pradhan Mantry Gramodaya Yojana (PMGY) - Rural Drinking Water.

The Rural Water Supply Programme of Government of India, Ministry of Rural Development, Department of Drinking Water Supply, provides scope for action plans institutionalizing community participation in the capital cost sharing, O & M and WQM& S for pilot schemes in the water quality affected habitations. Providing safe drinking water in the Arsenic affected areas is one of the priorities of the mission. The Rural Water Supply supportive activities are also aimed at: (i) to ensure sustainability in scientific methodologies, (ii) to human resource development for sustainable management of rural water supply schemes by community participation and empowerment together with adequately trained professional and sensitized planners, administrators and decision makers, and (ii) to research and develop for providing scientific and

technological inputs to improve performance, cost effectiveness and management practices of ongoing programmes. Further a new initiative in the form of Pradhan Mantry Gramodaya Yojana (PMGY) for Rural Drinking water started from 2000-2001 provides scope for taking up Projects /schemes on sustainability. The rationale of funding should be based on following factors:

- Competing demand of groundwater for irrigation, industrial and other purposes,
- Excessive withdrawal of ground water without taking into consideration the recharge,
- Low electricity tariff for agricultural and industrial use,
- Lack of scientific input and management of ground water,
- Misuse of precious water and treating it as a free, ever lasting commodity,
- Lack of sustainability principle in withdrawal of ground water etc.

Under PMGY-Rural Drinking Water in water stressed area 25% fund of sub-mission programme of ARWSP has been earmarked for taking up projects /schemes based on rainwater harvesting, artificial recharge and sustainability.

8.2.3 National Rural Employment Guarantee Act-2005 (NREGA).

The National Rural Employment Guarantee Act-2005 (NREGA), operationalized under the Ministry of Rural Development, Department of Rural Development, Government of India, has the objective to enhance livelihood security in rural areas by providing at least 100 days of guaranteed wage employment in a financial year to every household, whose adult members volunteer to do un-skilled manual work. In addition, the Act also has provision of semi-skilled wages in the form of mate with educational requirements between class-5 and class-8. The financing patterns of wages as mentioned in the NREGA are as follows: the Central Govt. will bear; (a) entire cost of un-skilled manual workers, (b) 75 percent of the cost of material and wages for skilled and semi-skilled workers, and (c) administrative expenses as may be determined by the Central Govt. While the State Govt. will bear: (a) 25 percent of the cost of material and wages for skilled and semi-skilled workers, and (b) administrative expenses of the State Employment Guarantee Council.

One of the goals of the NREGA is the new way of doing business, as a model of governance reform anchored on the principles of transparency and grass root democracy. Water conservation and water harvesting is one of the works envisaged in the NREGA. The key stakeholders are: wage seekers, Gram Sabha, Panchyati Raj Institutions, Programme Officer at the Block level, District Programme Coordinator, State Government, Ministry of Rural Development. The operational aspects, rules of the NREGA and roles of Stakeholders are well defined in the Act.

8.3 Operational Framework

'Bharat Nirman' provides scope for action plan in rural infrastructural; 'Accelerated Rural Water Supply Programme (ARWSP) & Pradhan Mantry Gramodaya Yojana (PMGY) - Rural Drinking Water' provides scope for action plans institutionalizing community participation in the capital cost sharing, O & M and WQM& S for pilot schemes and taking up R & D Projects/schemes including human resource development and capacity building; INCGW and INCOH under the Ministry of Water Resources also provide financial assistance for R & D Programmes and Projects, and the National Rural Employment Guarantee Act-2005 (NREGA) gives scope to involve local semi-skilled/skilled persons for facilitating the activities in operation and maintenance of the system.

The provision of creating a network of water quality testing laboratories in each arsenic affected State having provision of one level-II category laboratory in each district is kept out of scope of the operational framework of activities. There is a need to evolve a policy decision and a National guideline for such activity to roll over.

The plan of activities can be pursued linking with the above mentioned GOI schemes as follows:

(i) Within the given scope of the 'Bharat Nirman' scheme, which has the provision of providing one hand pump or stand post for every 250 persons to ensure 40 liters per capita per day (lpcd) of safe drinking water for human beings, provision of new hand pumps in all arsenic fringe areas of affected States to tap arsenic free shallow aquifers and to ensure supply of potable groundwater with 50:50 financial share by the Central and the respective State Government can be extended.

(ii) The Accelerated Rural Water Supply Programme (ARWSP) under the Ministry of Ru ral Development, which provides scope for action plans institutionalizing community participation in the capital cost sharing; initiatives for installation of new schemes for safe drinking water supply in water quality affected habitations with capital cost sharing by the Central and the respective State Government, can be extended to install new arsenic removal plants and to create new tube wells to tap risk free deeper aquifers in the arsenic vulnerable areas for ensuring safe drinking water supply to the people in the arsenic affected areas in all seven States. The Stand posts along the roadside to facilitate supply of water can be extended from the provision of 'Bharat Nirman' scheme. The mechanism of capital cost sharing by the community participation can be similar as is being followed in ARWSP.

(iii) For reviving and strengthening the existing non-functional and defunct arsenic removal units/plants/schemes by the components or as a complete new setup of existing successful arsenic removal devices (applicable for West Bengal only), one-time financial aid on 50:50 capital cost sharing between the Central and the State

Government can be extended under the provision of Accelerated Rural Water Supply Programme (ARWSP).

(iv) Implementation of the schemes related installation of arsenic removal devices can be through public-private partnership with responsibilities of O&M on the local community, i.e., the executing agencies while framing the schemes should make sure that the O & M are adequately outlined through involvement of local community. This can be achieved by devising mechanism of charging very nominal price on arsenic treated water. This approach can help in two ways: one, some money will be generated, which in turn can be used for routine minor O & M, the other one, beneficiaries of the scheme will have the feeling of ownership and conscientiousness. This approach has been found success fully running in West Bengal wherever deployed.

(v) R & D schemes on demand driven areas can be entrusted to potential lined organizations/academic institutions under the Prime Minister's Gramodaya Yojana (PMGY) of Ministry of Rural Department, and INCGW & INCOH of Ministry of Water Resources. Joint R & D programmes in collaboration with foreign experts/ agencies (where foreign currency is involved) can be operated under the Rural Water Supply supportive programmes of Ministry of Rural Department, while the in-house R & D programmes can be supported from INCGW & INCOH of Ministry of Water Resources.

(vi) Training of personnel aboard to acquire specialized knowledgebase would be in accordance with the requirement of the joint R & D programmes with the foreign collaborators. Training of personnel of the implementing agencies, NGOs, skilled /semi skilled mates, etc. can be extended conceiving programmes under the Pradhan Mantry Gramodaya Yojana (PMGY) and INCGW & INCOH of Ministry of Water Resources. Mass awareness and social empowerment programmes can be supported under the ARWSP of Ministry of Rural Development and INCGW & INCOH of Ministry of Water Resources in the mission mode by the trained personnel of the implementing agencies, NGOs, etc.

(vii) Activities related to operation, routine supervision and care of the arsenic removal schemes can be supported under the **NREGA**. One semi-skilled mate for each arsenic removal scheme covering nearly 250 persons, and two semi-skilled mates for each arsenic removal scheme covering more than 250 persons can be involved for the purpose of operation, routine supervision and care. Material requirement for this purpose can be extended as per the provision laid down in the **NREGA**. While maintenance such as, change of filters, painting of the device, etc. can be done from the marginal tariff to be charged from the beneficiaries on the treated potable water. Any technical faults or unwarranted failure of the scheme can be supported from the scope of **NREGA**. Disposal of the used arsenic removal filters and the toxic sludge to a designated location could be one of the responsibilities of each mate besides other routine tasks.

The framework of activities and their operating linkages to various ongoing Government schemes are schematically shown in Fig. 8.3.

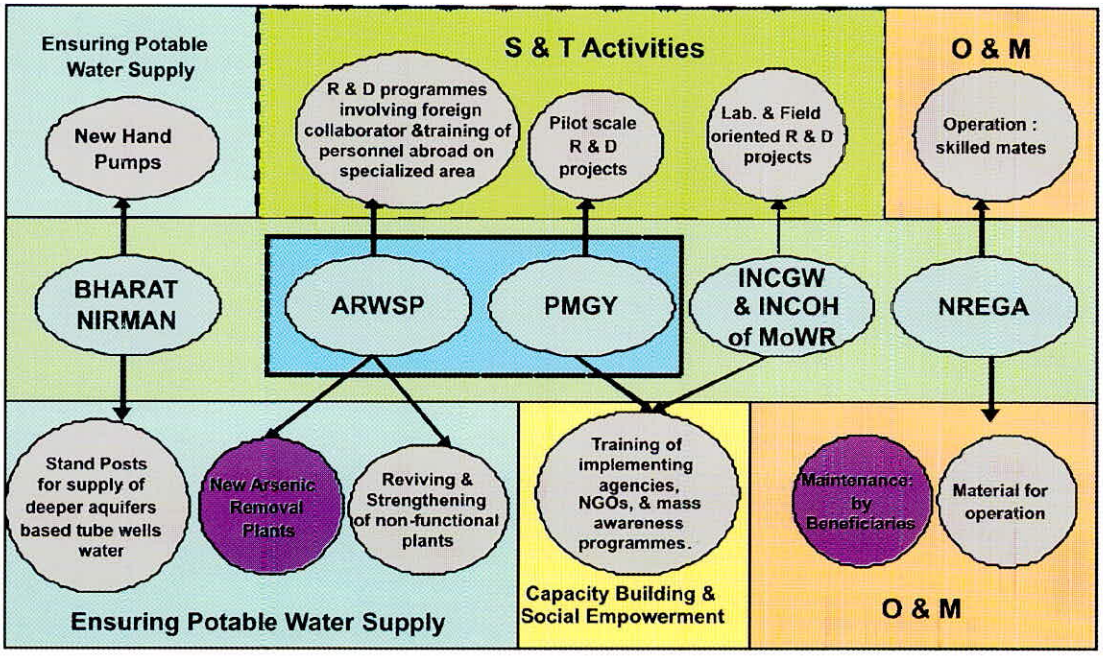

Figure 8.3: Framework of different activities and their operational linkages with Government of India schemes. *(Note: the mode of operation of the schemes shall be through joint ventures of Central Government and respective State Governments as per the provision laid down under different schemes).*

8.4 Mechanisms for Implementation of Envisaged Activities

The plan of actions envisaged in the document primarily deals with three aspects: (i) formulation and implementation of social sector schemes, (ii) promoting future R & D programmes, and (ii) programmes for mass awareness and social empowerment. The formulation and implementation of different social sector schemes as envisaged in section 8.4, can be through initiating dialogues between the Central Govt. and the State Govts., and largely can be based on mutually agreed terms & conditions. The formulation and implementation of the schemes shall be the sole responsibility of the respective State Governments. While the responsibilities in formulation and execution of R & D programmes on different demand driven areas shall solely rest on the Central Government. The programmes of mass awareness and social empowerment can be through joint initiative of Central and State sector departments with involvement of other public and private sector units.

The method of operation of different activities could be as follows:

A. Formulation and implementation of social sector schemes

- By initiation of dialogues between Central Govt. and the State Govts.
- State Government has the responsibility to formulate and implement the schemes; Central Government can provide technical inputs in formulation and implementation of the schemes, if necessary.

B. R & D Programmes

The R & D programmes on envisaged areas shall be by invitation of project from the resource persons/Institutions/Organizations in India. The R & D programmes involving foreign collaborators shall also be by invitation from selected Institutions/Organizations. Following are some of the resource/expert Institutions/ Organizations that can be entrusted with R & D programmes according to the areas of expertise and mutual interest.

Type of R & D programmes	Broad areas	Name of the Institutions/ Organizations
Laboratory Scale R & Ds	Arsenic removal filters & devises; innovative techniques for arsenic removal, Laboratory based research & chemical analysis, etc.	(i) All India Institute of Public Health & Hygiene, Kolkata. (ii) Bengal Engineering College, Howrah. (iii) Indian Toxicological Research Institute, Lucknow. (iv) Indian Institute of Technology Roorkee, Kanpur, Delhi. (v) Indian Institute of Sciences, Bangalore. (vi) School of Environmental Studies, Jadavpur University, Kolkata. (vii) Water Technology Mission, ICAR. (viii) School of Tropical Medicine, Kolkata (ix) Kalyani University, W.B
		(i) BARC, Trombay, Mumbai. (ii) Central Ground Water Board. (iii) Geological Survey of India, Kolkata (iv) Indian School of Mines, Dhanbad. (v) National Institute of Hydrology, Roorkee. (vi) National Geophysical Research Institute, Hyderabad.

Field level R & Ds	Monitoring, mapping, feasibility studies, modeling studies, pilot scale studies, deeper aquifers detection, source, age and genesis detection, Geochemical study, watershed management study, pilot study for in-situ remedy, etc.	(vii) State Public Health Engineering Departments. (viii) State Ground Water Departments. (ix) School of Water Resources Engineering, Jadavpur University, Kolkata. (x) School of Fundamental Research, Kolkata. (xi) A.N College, Magadh University, Patna (xii) Dept of Applied Geology, ISM University, Dhanbad (xiii) Dept of Geology, Sahebganj College, Sahibganj, Jharkhand (xiv) Centre for Ground Water Studies (NGO)
	Arsenic in Food Chains	(i) Bidhan Chandra Krishi Viswavidhalaya, West Bengal, (ii) Agricultural University, Bihar. (iii) Agricultural University, U.P.
	Social & environmental impact analysis, public-private entrepreneurship, etc.	(i) Indian Institute of Social Welfare & Business Management (IISWBM) (ii) Centre for Studies of Man & Environment, Kolkata, (NGO) (iii) Institute of Economic Studies, Patna,
Foreign Organizations	Collaborative studies	(i) CSIRO, Adelaide, Australia. (ii) Harbauer GmbH, Germany. (iii) Queen's University, Belfast, UK. (iv) Swiss Federal Institute for Aquatic Science & Technology, Switzerland. (v) University of Guelph, Canada. (vi) US-EPA & USGS. (vii) Department of Earth Sciences, University College of London, Gower Street, London WCIE 6 BT, UK. (viii) UNICEF (ix) WHO

C. Mass Awareness and Social Empowerment programmes

The mass awareness and social empowerment programmes can be implemented in a two tier process under the overall coordination of selective Central agencies and the State Public Health Engineering Departments. In the first tier, training of personnel from the State implementing departments, Panchayati Raj Institutions, and selected NGOs can be trained by expert group(s) devising suitable mechanisms; in the second tier, the trained personnel will disseminate the campaign and awareness programme to the rural masses. The programme can be operationalized by suitable outsourcing mechanisms.

Some of the resourceful institutions/NGOs who could be involved for mass awareness programmes are:

(i) Panchayati Raj Institutions - a Government Institution.
(ii) Centre for Environmental Studies, New Delhi - NGO.
(iii) Ram Krishna Mission Seva Sangh- NGO
(iv) Centre for Ground Water Studies, Kolkata - NGO.
(v) Paschim Bangya Bigyan Mancha -NGO
(vi) Loksiksha Parisad, Ramkrishna Mission -NGO