March, 2010

Prepared by:
Rural Water Supply and Sanitation Project - Western Nepal (RWSSP WN), Pokhara, Nepal

MODEL DISTRICT ARSENIC MITIGATION STRATEGY

This document contains key strategies to implement arsenic mitigation Program in arsenic affected districts, particularly focused on RWSSP WN Terai districts

Table of Contents

List of Tables

List of Figures

List of Annexes

List of Acronyms

AIMS	- Arsenic Information Management System
AIRP	- Arsenic and Iron removal Plant
As	- Arsenic
AsSC	- Arsenic Sub-committee
DACC	- District Arsenic Coordination Committee
DDC	- District Development Committee
DHO/DPHO	- District Health Office/ District Public Health Office
DTO	- District Technical Office
DWASH Unit	- District WASH Unit
DWASHCC	- District WASH Coordination Committee
DWIG	- District WASH Implementation Guideline
DWQIP	- Drinking Water Quality Improvement Plan
DWSS	- Department of Water Supply and Sewerage
ENPHO	- Environment and Public Health organization
HWSC	- Hand Washing Sub-Committee
IEC	- Information, Education and Communication
IMSC	- Information Management Sub-committee
KAF	- Kanchan Arsenic Filter
LSSC	- Laboratory Services Sub-committee
M&E	- Monitoring and Evaluation
NDWQSC	- National Drinking Water Quality Standard
NGO/CBO	- Non-governmental Organization/ Community Based Organization
NRCS	- Nepal Red Cross Society
O&M	- Operation and Maintenance
PoUSC	- Point of Use Sub-committee
ppb	- Parts per Billion
RVWRMP	- Rural Village Water Resources Management Project
RWH	- Rain Water Harvesting
RWSSP-WN	- Rural Water Supply and Sanitation Project in Western Nepal
RWSSSP	- Rural Water Supply and Sanitation Support Program
TW/DW	- Tube Well/ Dug Well
UC	- User's Committee
UNICEF	- United Nations Children's Fund
VDC	- Village Development Committee
VWASHCC	- VDC WASH Coordination Committee
WHO	- World Health Organization
WSPSC	- Water Safety Plan Sub-committee
WSSDO	- Water Supply and Sanitation Divisional Office
WUSC	- Water Users and Sanitation Committee

1. Background

1.1 Arsenic situation in Nepal

Groundwater arsenic contamination in Nepal is a new issue. The first evidence of arsenic contamination in groundwater in Nepal was reported in 1999 by the Department of Water Supply and Sewerage (DWSS) and the World Health Organization (WHO). Out of 268 tube well water samples tested, 9.0% of the samples exceeded 10 ppb, the WHO limit, and 0.7% exceeded 50 ppb of the Nepal Interim Standard indicating the possibility of arsenic contamination in groundwater in the Terai. Over the last few years since the finding of arsenic contamination in groundwater, governmental and non-governmental organizations such as DWSS, UNICEF, NRCS and several other agencies have been active in arsenic testing, undertaking arsenic mitigation programs as well as developing mitigation strategies and interventions. According to the updated summary of blanket arsenic testing by Arsenic Sub-Committee under National Drinking Water Quality Steering Committee (formerly National Arsenic Steering Committee, NASC), of 11,20,912 water samples so far tested in 20 Terai districts of Nepal, 5.7% water samples exceeded the WHO guideline value of 10 ppb and 1.8% water samples exceeded Nepal Standard of 50 ppb.

Table 1: Summary of blanket arsenic testing in 20 Terai districts (NASC, as of July, 2008)

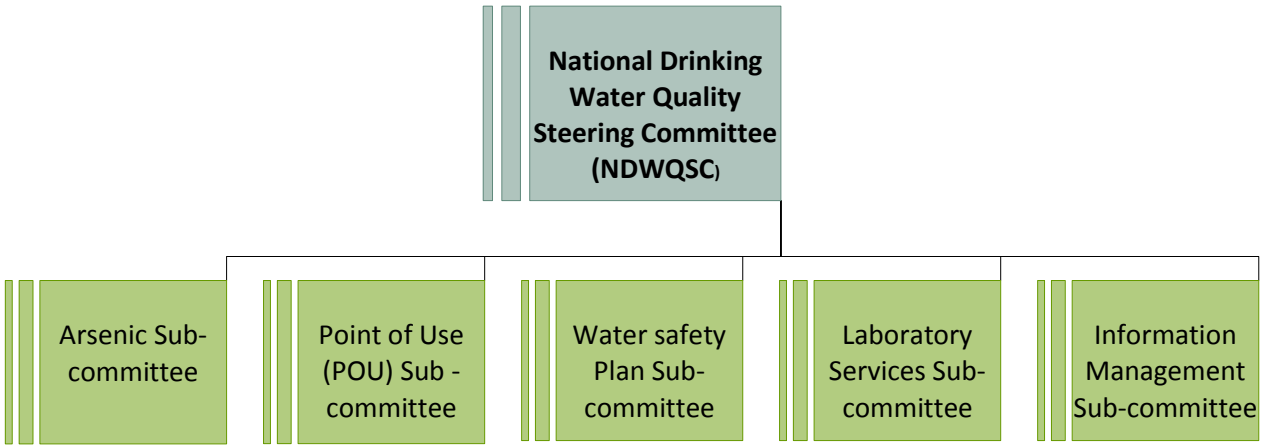
S.N.	District	Total no. of tests	Samples with Arsenic Concentrations			Max. conc^{n}. detected	Percentage exceeding	
			0-10 ppb	>10-50 ppb	> 50 ppb		10 ppb	50 ppb
1	Jhapa	97065	96296	715	54	79	1%	0.06%
2	Morang	112332	109865	2285	182	70	2%	0.16%
3	Sunsari	67085	64150	2519	416	75	4%	0.62%
4	Saptari	57094	53873	2630	591	98	6%	1.04%
5	Siraha	46625	39194	6112	1319	250	16%	2.83%
6	Dhanusha	60783	58026	2305	452	140	5%	0.74%
7	Mahottari	34007	33679	297	31	80	1%	0.09%
8	Sarlahi	50573	43235	6748	590	98	15%	1.17%
9	Rautahat	50506	39967	9393	1146	500	21%	2.27%
10	Bara	39837	35203	3147	1487	254	12%	3.73%
11	Parsa	28424	26071	1595	758	456	8%	2.67%
12	Chitwan	57628	57478	104	46	8	0%	0.08%
13	Nawalparasi	32219	23844	4418	3957	1200	26%	12.28%
14	Rupandehi	75396	72316	2567	513	2620	4%	0.68%
15	Kapilbastu	39915	36060	2662	1193	589	10%	2.99%
16	Dang	26949	26725	175	49	0	1%	0.18%
17	Banke	45191	43083	1840	268	270	5%	0.59%
18	Bardiya	61501	55646	3150	2705	181	10%	4.40%
19	Kailali	84543	74460	7193	2890	213	12%	3.42%
20	Kanchanpur	53239	47330	4313	1596	0	11%	3.00%
	Total	**1,120,912**	**1,036,501**	**64,168**	**20,243**			
	Percentage	**100%**	**92.5%**	**5.72%**	**1.8%**			

The total area of the Terai is 33,401 sq km, which is 23% of the total area of the country. Approximately 48% (13 million) of the total population of Nepal lives in the Terai. In Terai, where

almost a half of the total population of the country resides, about 90% population largely depends on groundwater extracted through more than 1,120,000 tube wells for drinking and other purposes. Based on recent arsenic testing results, it is estimated that over 1 million people living in Terai districts are exposed to arsenic exceeding the WHO guideline value, and nearly 300,000 people are exposed to arsenic above Nepal Standard through contaminated drinking water.

1.2 Institutional arrangements at National and District Level

The former National Arsenic Steering Committee (NASC) under DWSS was merged into National Drinking Water Quality Steering Committee (NDWQSC) as an Arsenic Sub-Committee. NDWQSC is currently chaired by Joint Secretary of Ministry of Physical Planning and Works (MPPW). There are 17 members from various government and non government agencies to coordinate and manage NDWQSC. There are five Sub-Committees (SCs) under NDWSC which is presented below in the figure.



District Arsenic Coordination Committee (DACC) has been formed at arsenic affected districts to coordinate and manage arsenic testing & mitigation activities at district level. The DACC is chaired by Local Development Officer (LDO) of the respective districts and Water Supply and Sanitation Divisional and Sub Divisional Offices (WSSDO) is member secretary and responsible for coordinating meeting as per requirements including documentation of decisions made during the meeting.

1.3 Existing policies, strategies and guidelines

- **Nepal's Interim Arsenic Policy 2001**: The Interim Nepal Guidelines and Policies for Arsenic in Drinking Water were adopted on 1st June 2001 by NASC. The policy provides guiding principles for all government and non-government agencies on formulating, designing and implementing arsenic testing and mitigation Programs. This interim policy has established permissible arsenic concentration values of 50 ppb for drinking water (interim arsenic standard). The policy focuses on immediate attention to be given by stakeholder agencies in identifying the existing "arsenic hot spots" and carrying out more testing on hot spots to better understand the extent and magnitude of arsenic contamination. The policy also highlights the need of health survey and health care issues as well as communication with communities.

  The Policy provides action guidelines for general planning and implementation by all the stakeholder agencies related to the following topics:
  - ✓ Capacity building Program
  - ✓ Arsenic Testing
  - ✓ Health Screening and case management
  - ✓ Communication and Awareness raising
  - ✓ Mitigation options and safe water alternatives

- ✓ Operational research including hydrological investigations
- ✓ Data management
- ✓ Coordination and Networking
- ✓ Hydrological investigations and
- ✓ Guidelines for installation of new tube wells.

- **Arsenic Mitigation Guideline for Drinking Water, 2005**: This guideline was prepared by DWSS in 2005, and is mainly focused on the arsenic mitigation process, development of various arsenic mitigation technological options, their costing process and implementation of options. The arsenic mitigation process/steps as described in the guideline are:
  - ✓ Identification of arsenic hot spots by meeting of District Arsenic Coordination Committee (DACC);
  - ✓ Orientation to communities at identified "hot spots" through mass meeting;
  - ✓ Selection of arsenic mitigation alternatives such as:
    - Immediate options: Installation of new shallow tube wells, Distribution of bio-sand filters, Dug well improvement;
    - Long term options: Installation of deep wells, pipeline water supply through deep boring;
  - ✓ Cost estimation of arsenic mitigation options
  - ✓ Implementation of arsenic mitigation options
  - ✓ Monitoring and supervision
- **National Drinking Water Quality Standards (NDWQS), 2062 BS and Implementation Directives for NDWQS, 2062 BS :** Government of Nepal has set and promulgated the National Drinking Water Quality Standards, 2062 as per the provisions of Water Resources Act 2049, Clause 18, sub clause 1. The standards were published in Nepal gazette on Ashadh 12, 2063 (June 26, 2005) and are legally effective from onwards the date of publication. The implementation of NDWQS has been divided in two phases: first phase, within a period of five years in the urban and small towns water supply systems and second phase, within five to ten years from the date of implementation in all rural community water supply schemes. The NDWQS includes 6 physical parameters, 19 chemical parameters and 2 microbiological parameters. The National Standard for arsenic in drinking water has been set as 50 ppb (0.05 mg/l).

1.4 Existing reports on arsenic testing and mitigation

- **State of Arsenic in Nepal, 2003**: The report was prepared by NASC with support from ENPHO and USGS in January 2004. It consists of national database of 18,635 arsenic tested tube wells with GIS mapping. The database contains key information on tested tube wells, users, location including GPS coordinates, arsenic concentration. The report also defines four classes of vulnerability and has been presented on maps at the district level based on the percentage of arsenic tested tube wells exceeding the WHO guideline. Four classes of vulnerability viz. low vulnerability, moderate vulnerability, moderately high vulnerability and high vulnerability to arsenic has been well defined in this report. The report also highlights some arsenic testing and mitigation initiatives been undertaken by various agencies. In addition, it indicates key recommendations to improve and update the national arsenic database.
- **State of Arsenic in Nepal, 2005**: This report prepared by NASC, with support from UNCIEF and consultancy support from GENSIS Pvt. Ltd., gives insight of data management by Arsenic Information Management System (AIMS). It gives also description of existing policies and guidelines on arsenic developed before 2005. It is an updated version of "The State of Arsenic in Nepal, 2003" report and database system. The rationale and objectives of the report are:
  - ✓ To develop a national standard for arsenic database;

- ✓ To conduct verification of arsenic information and location and transfer data into the database;
- ✓ To develop the Arsenic Information Management System (AIMS);
- ✓ To prepare a database User's manual and User's Training Guide and
- ✓ To analyze arsenic information, plot maps and prepare "The State of Arsenic in Nepal - 2005 Report".

The Final State of Arsenic report is in process of preparation which will provide complete arsenic database. It will include arsenic information of wells being tested at 20 Terai districts as well as database on arsenic mitigation options being provided to arsenic affected households.

1.5 Arsenic testing and mitigation initiatives in Nepal

In 1999, DWSS with support from WHO had conducted arsenic testing of 273 samples in three eastern districts (Jhapa, Morang and Sunsari). After this, several agencies had started to test at their respective Program areas. In 2001, DWSS with support from UNICEF had conducted grid method arsenic testing at all 20 Terai districts covering about 4,000 tube wells. Similarly, Nepal Red Cross Society with technical support from ENPHO has conducted arsenic testing of tube wells installed by Red Cross in 17 Terai districts from 2000 to 2003. Then DWSS/UNICEF had initiated arsenic blanket testing Program in 13 Terai districts in 2005/08 where every wells were tested for arsenic. Later in 2007/08, DWSS with support from UNICEF and UN HABITAT had conducted arsenic blanket testing in 7 remaining Terai districts. So far, 1,120,912 wells at 20 Terai districts were tested for arsenic and the summary of district wise arsenic test results is presented in table 1 above.

Several agencies had implemented arsenic mitigation Programs at arsenic affected districts with main aim to provide safe drinking water to arsenic affected households and communities. Some of the ongoing and completed arsenic mitigation Program is listed below:

- NRCS with financial support from Japanese Red Cross Society and technical support from ENPHO had implemented Drinking Water Quality Improvement Program (DWQIP) in 17 Terai districts from June 2000 to July 2003. During the Program, 85 arsenic free tube wells were identified and 72 new tube wells were installed as safe water options. In addition, arsenic removal filters were distributed to 495 and 66 community scale dug wells were improved to provide arsenic free water. Total of 22 Arsenic Iron Removal Plants were constructed at different communities of arsenic affected districts. Similarly, health survey of 15,131 people was conducted which had identified 435 arsenicosis cases. Intensive awareness raising campaign was conducted to create arsenic awareness among general public. Later in years 2004 and 2005, the DWQIP follow up Programs were implemented to monitor arsenic alternative options provided to households and communities, follow-up health examination, raise public awareness and build capacity of local stakeholders;
- Arsenic Mitigation Program in Seven Highly Affected Terai districts in Nepal, (December 2006- June 2007) was funded by UNICEF and DWSS and implemented by NRCS. The program was implemented in 81 VDCs and 1 municipality of 7 districts (Nawalparasi, Bara, Parsa, Rautahat, Sarlahi, Sunsari and Saptari). In total, 80 safe tube wells, 23 improved dug wells and 2779 Kanchan Arsenic Filters (KAF) were distributed to benefit about 3340 arsenic exposed households with 30,000 populations.
- During 2003-2007, several agencies such as DWSS, UNICEF, NRCS, ENPHO, Filter for Families, Leaders Nepal had distributed more than 7000 Kanchan Arsenic Filter (KAF) at highly arsenic affected communities. Similarly filters for families with support from DWSS/UNCIEF had distributed more than 950 SONO filters at households of Nawalparasi district during the pilot project;
- Rural Water Supply and Sanitation Support Program (RWSSSP/FINNIDA) had commenced arsenic mitigation activities at high arsenic affected VDCs of Nawalparasi, Rupandehi and

Kapilvastu districts. Several alternative options such as distribution of arsenic bio-sand filters, dug well improvement, rain water harvesting and installation of new tube wells were provided to arsenic affected households and communities;

- The ongoing National Arsenic Mitigation Program at nine arsenic affected districts will provide arsenic free water to more than 10,000 arsenic affected households through distribution of KAF, dug well improvement, new tube well installation and rain water harvesting system. NRCS has been implementing this Program with support from DWSS, UNICEF and UN HABITAT at Sunsari, Siraha, Sapatri, Sarlahi, Rautahat, Bara, Parsa, Banke and Bardiya.
- Currently, Rural Village Water Resource Management Project (RVWRMP) has been also promoting robust filter (improved version of arsenic biosand filter) at arsenic affected communities of Kailali district. In addition, the Arsenic Mitigation Master Plan was also prepared by RVWRMP for Kailali district.

1.6 Rural Water Supply and Sanitation Project Western Nepal (RWSSP-WN)

Rural Water Supply and Sanitation Project in Western Nepal (RWSSP-WN) is supporting implementation of WASH Program in eight (Myagdi, Baglung, Parbat, Tanahun, Syangja, Kapilvastu, Rupandehi and Nawalparasi) districts of western development region and one district in mid-western development region (Pyuthan). The Communities are the implementers and the DDC and VDCs are the executing agencies of the program. The project duration is 4 years, starting from 1st August 2008 to 31st July 2012.

Altogether there are four major outputs of the WASH program:

i. Total Behavioral Change in Hygiene and Sanitation;

ii. Well-functioning domestic water schemes managed by inclusive WUSCs;

iii. Strengthened institutional capacity of local bodies to facilitate the WUSCs and

iv. WASH sector policies, strategies and guidelines at the central and local level prepared.

Providing access to safe drinking water at arsenic affected communities of three Terai Program districts (Kapilvastu, Rupandehi and Nawalparasi) is key project activity of RWSSP-WN project. RWSSP-WN will provide required technical and institutional support to DDCs and VDCs to implement arsenic mitigation Program activities. In addition, RWSSP-WN will help DDC in formulating district wise policies, strategies, guidelines on arsenic testing and mitigation.

2. Goal and Objectives of the Strategy

The main goal of this arsenic mitigation strategy is to provide guidance and directions to district level policy makers, implementers and relevant stakeholders for implementing arsenic mitigation Program at community level.

The general objectives of the Model Arsenic Mitigation Strategy are to:

- Support on formulation of arsenic mitigation plan of action and set up mitigation activities by analyzing district arsenic situation;
- Identify key steps of mitigation process;
- Provide clear ideas on selecting technical viable, social acceptable and economically feasible arsenic mitigation options at community level;
- Provide strategic guidelines on capacity building activities at district and community level;
- Guide for creating functional coordination mechanism among the relevant stakeholders at district level;
- Assist in setting up institutional arrangements at district level;
- Provide guidance establishing mechanism to update and upgrade arsenic information management & database system at district level;
- Guide for establishing knowledge and information dissemination mechanism at district level.

3. Arsenic Mitigation Strategy

3.1 Key Steps and activities

Key steps and activities of arsenic mitigation strategy are presented in figure 2 below. The arsenic mitigation strategy includes following seven key steps and activities:

Step 1: Blanket Testing and Data Analysis - During the first step, field arsenic testing of the non-tested tube wells by blanket testing (2000-2007), newly installed tube wells after blanket testing and of the tube wells having arsenic concentration more than 50 ppb will be carried out either in all VDCs or selected program VDCs of the districts. On sample basis, laboratory tests will also be carried out. The arsenic blanket testing results data (AIMS and the blanket testing) of specific district will be processed and analyzed for identifying number of arsenic contaminated tube wells and households drinking water from those tube wells. AIMS include all the required data including number of affected households and populations presented in GIS mapping.

The following figure gives the possible methods of field and laboratory testing of arsenic. The mostly used kits of testing are HACH, Digital kit and ENPHO arsenic field test kits and in the laboratory, AAS (Atomic Absorption Spectrophotometer) method is widely used in Nepal.

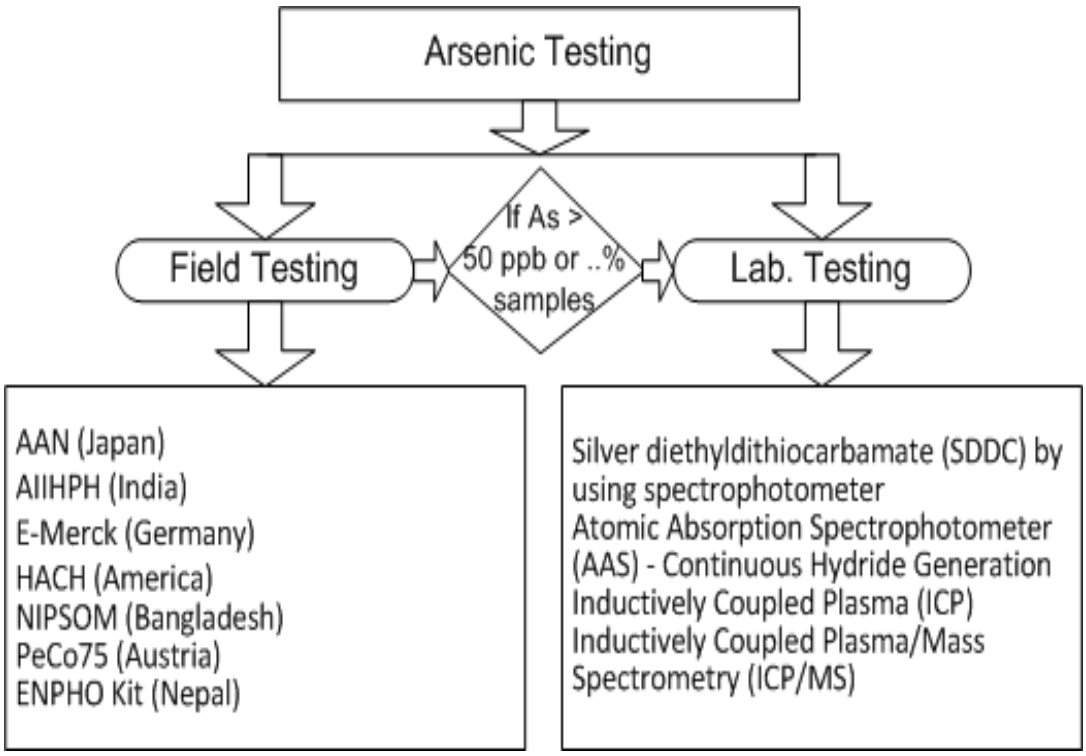


Figure 1: Possible Options of Field and Laboratory Testing of Arsenic

Step 2: Identification of arsenic hot spots – Based on data analysis, a list consisting VDC/Municipality with arsenic contaminated tube wells should be prepared. Then the VDCs should be categorized into medium risk and high risk VDCs. The VDCs with less than 20 number of contaminated tube wells should be categorized as medium risk while VDCs with more than 20 number of arsenic contaminated tube wells should be categorized as high risk VDCs. Priority should be provided to high risk VDCs and mitigation plan should be developed accordingly.

Step 3: Collection of field information - Arsenic mitigation survey format should be developed to collect detail information on mitigation measures such as viability of sharing arsenic safe tube wells at communities; which mitigation options do the communities prefer; which one is the most

appropriate mitigation option in accordance with field conditions (long term vs. short term); commitment/contribution from the community/household etc. The questionnaire format should also include questions on awareness level of people on arsenic and arsenic mitigation options. The household survey should be administrated by field staff and should fill up the form by questioning and field observation. The field staff should be provided with adequate orientation on conducting household survey. Based on the collected data and information, consolidated report with key findings and recommendations should be prepared.

Step 4: Formulation of arsenic mitigation plan - The fourth step consists of formulation of arsenic mitigation plan. The VDC wise arsenic mitigation plan should be prepared based on data analysis, findings and recommendations from field survey report. The mitigation plan will consist of guideline on what mitigation option should be provided in what condition and how. This plan will also provide technical and social information on each mitigation options and their implementation model. It should also clearly reflect application of long term and short term arsenic mitigation options. The plan should include strategic activities with timeline and detailed budget for each activity. The plan should be shared among the key district stakeholders and should be finalized and approved incorporating comments.

Apart from the VDC wise arsenic mitigation plan, a clustered arsenic mitigation plans should be prepared. This clustered mitigation plan should consist of the clustering of the VDCs in to zones as per their arsenic concentration, geographical location, tube well depths, aquifer types, feasible mitigation technologies and the mitigation options adopted so far.

Step 5: Identification of arsenic mitigation options – Based on VDC wise arsenic mitigation plan, logistics including materials for providing the identified options should be arranged. Materials should be procured in line with provided specifications, quality and quantity and should be stored safely.

Step 6: Implementation of mitigation plan – The sixth step is to implement arsenic mitigation Program activities based on VDC wise mitigation plan. Basically it consist of field level interventions such as mass awareness raising campaign, focus group discussions, community level orientation and trainings, installation and construction of arsenic mitigation options, regular coordination meetings at community level. A wide variety of training and IEC materials on arsenic, its health effects and mitigation options should be developed prior to these field level interventions. NDWQSC had developed variety of training and IEC materials on arsenic which can be reprinted and used during the implementation of field activities. The health screening and survey should be conducted to identify and manage arsenicosis cases.

Step 7: Monitoring & Evaluation and reporting - The final step is to perform monitoring and evaluation of implemented mitigation activities. M&E will provide prospect on achievements and challenges/limitations during implementation and will also provide an idea for modifications to overcome the challenges. Three levels of monitoring and evaluation (National, District and Field) should be done to assess The reports on mitigation activities should be documented and key findings including lessons learnt should be shared among key stakeholders on regular basis through workshops, coordination meetings, publications, websites and email.

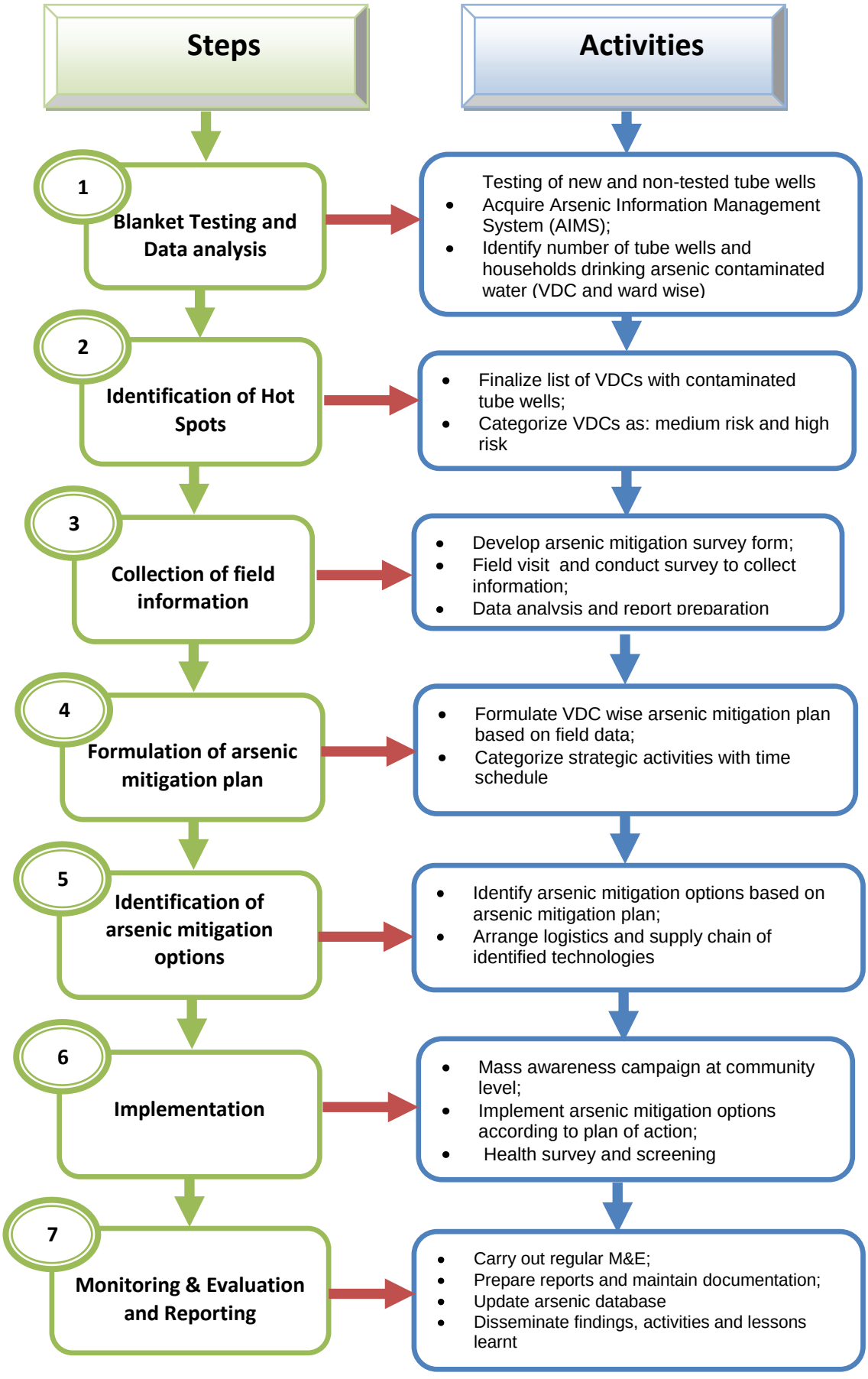

Steps
Activities
1
Blanket Testing and Data analysis
Testing of new and non-tested tube wells
Acquire Arsenic Information Management System (AIMS);
Identify number of tube wells and households drinking arsenic contaminated water (VDC and ward wise)
2
Identification of Hot Spots
Finalize list of VDCs with contaminated tube wells;
Categorize VDCs as: medium risk and high risk
3
Collection of field information
Develop arsenic mitigation survey form;
Field visit and conduct survey to collect information;
Data analysis and report preparation
4
Formulation of arsenic mitigation plan
Formulate VDC wise arsenic mitigation plan based on field data;
Categorize strategic activities with time schedule
5
Identification of arsenic mitigation options
Identify arsenic mitigation options based on arsenic mitigation plan;
Arrange logistics and supply chain of identified technologies
6
Implementation
Mass awareness campaign at community level;
Implement arsenic mitigation options according to plan of action;
Health survey and screening
7
Monitoring & Evaluation and Reporting
Carry out regular M&E;
Prepare reports and maintain documentation;
Update arsenic database
Disseminate findings, activities and lessons learnt

Figure 2: Key steps and activities of arsenic mitigation strategy

3.2 Arsenic Mitigation Options

Arsenic mitigation options include two measures: Using arsenic free water sources and treating arsenic contaminated water by using several technologies. The figure below illustrates various arsenic mitigation options.

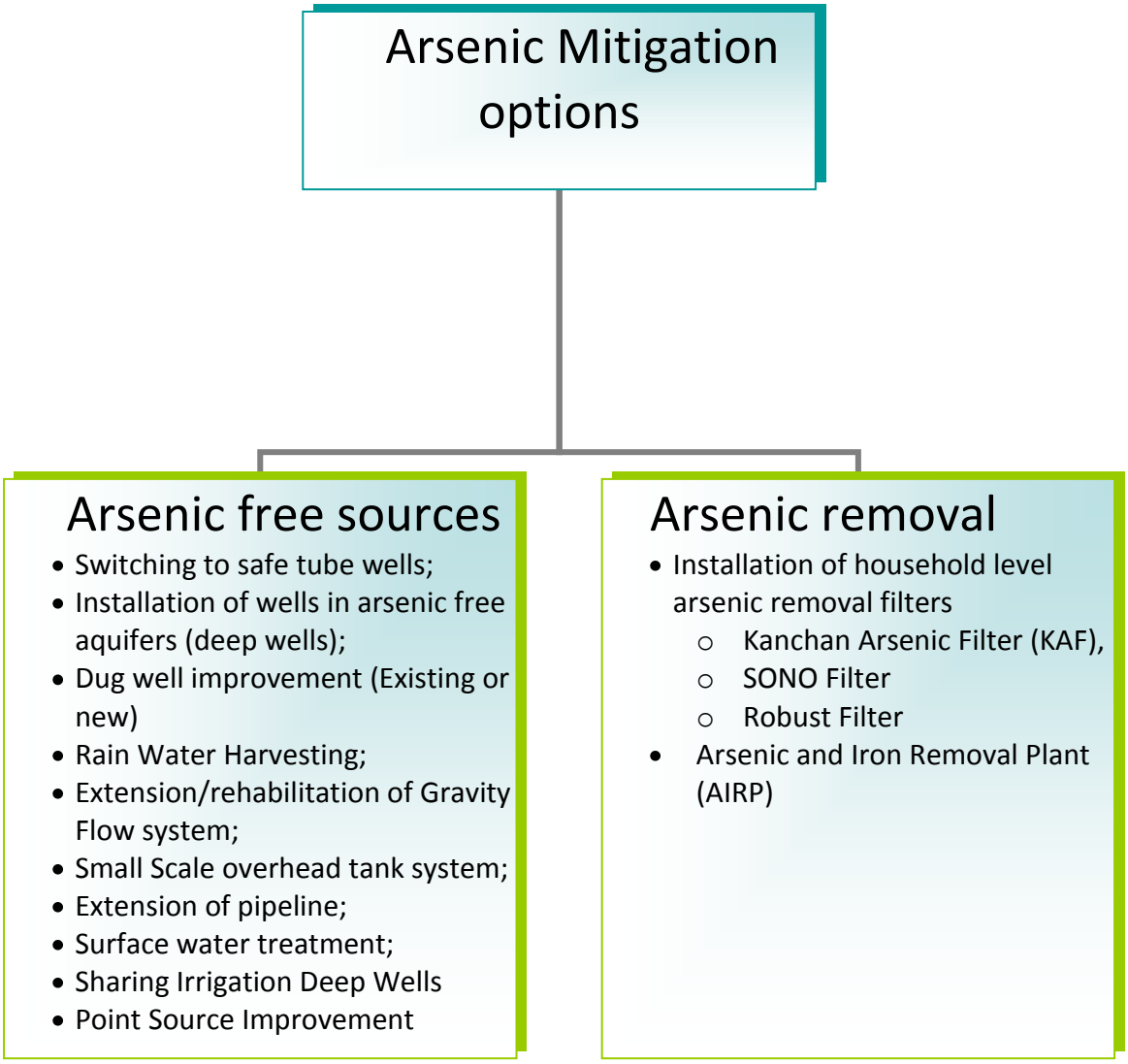


Figure 3: Arsenic Mitigation Options

The NDWQSC had approved four options (Safe tube wells, Improved dug well, Rain Water Harvesting and Household level arsenic removal filters) as alternative options for arsenic mitigation. The arsenic mitigation guideline endorsed by NDWQSC (formerly NASC) has categorized installation of shallow tube wells, distribution of arsenic removal filters and dug well improvement as immediate (short term) mitigation options and has also provided guidelines for construction/installation of such options at arsenic affected households/communities.

Based on the NDWQSC guideline on arsenic mitigation, description of installation of tube wells, dug well improvement, distribution of arsenic removal filters and installation of RWH and also the options others than these has been provided below in the following sections:

3.2.1 Installation of tube well in safe aquifer

Before installation of new tube wells, the depth of contaminated tube wells installed at that specific location should be identified. In the context of Nepal, previous studies and research showed that arsenic concentration doesn't have any correlation with the depth. However, the data analysis with relation to arsenic concentration and depth of wells showed that most of tube wells with high value of arsenic (above 50 ppb) have depths of less than 50 m and the majority of wells deeper than 50 m have arsenic values below 50 ppb (State of arsenic in Nepal, 2003). Therefore, the installation of new tube wells should be done below 50 m. If report of Hydro-geological study of sediments and aquifer analysis is available for the particular location, findings and recommendations of the study should be considered before tube well installation. Aquifer sealing should be carefully done between contaminated aquifer and safe aquifer for preventing possible chances of cross contamination. Technicians should be trained on new tube well installation with appropriate aquifer sealing techniques.

The tube well should be installed preferably at public locations such that many households have access to safe tube well. According to NDWQSC guideline, a newly installed tube well should cover 6 to 10 arsenic affected households and tube well users committee with one care taker should be formed for smooth O&M of the installed tube well. In addition, 20% of total cost should be users' contribution (in form of cash or labor) for installation of new tube well. The members of users committee and caretaker should be provided with O&M training and O&M fund should be created to get tube well spare parts.

After fifteen days of tube well installation, water should be tested for arsenic concentration. If result shows arsenic concentration below 50 ppb then the tube well can be used for drinking and cooking purposes. But if the result shows arsenic content above 50 ppb, it should be stopped for drinking and cooking purposes and should be replaced with other alternative options. The water quality facilities should be determined for analyzing arsenic of tube well water at least once in every year.

3.2.2 Dug well improvement

It is common that the sanitary and physical conditions of existing dug wells are usually poor. In many cases, water from open dug wells are found to be microbiologically contaminated and are often found free from arsenic contamination. Therefore, improvement of the physical and sanitary conditions of the existing dug wells and their utilization to substitute the contaminated hand pumps is effective and sustainable solution of arsenic mitigation. If existing dug well is not available, the new dug well can be constructed at safe aquifer.

The previously abandoned dug well usually contains lot of debris and mud. All these waste and muddy water should be carefully and thoroughly removed from the dug well. Debris can be removed manually while muddy water can be pumped out using water pump used for irrigation. Water should be pumped out until clear water is visible. Precautions should be taken before entering inside the dug well. For sanitary protection, concrete apron with proper drainage system should be constructed around the dug well and the wall of dug well should be raised and covered with concrete slab to prevent from any possible contamination. Plastering of inner part of dug well up to water level should be done to stop seepages of contaminated water from outside. Hand pump should be used to extract water from improved dug well. Previous studies have found increased in arsenic concentration at fully covered dug wells due to inadequate aeration process. Hence, ventilation system should be included around the dug well wall so that there is enough aeration process and arsenic concentration of dug well water doesn't increase. After the completion of construction works, pot chlorination should be done to disinfect dug well water. Pot chlorination is a simple, easy and effective water treatment method. A clay pot with several small holes at the bottom is filled from bottom to top first with a layer of pebbles, then gravel, then a mixture of

bleaching powder and sand (1 part bleaching powder to 2 parts sand), and finally another layer of pebbles. The pot is then lowered into a well. One and a half kilograms of bleaching powder will ensure chlorination for up to one week for a well that sustains a withdrawal rate of approximately 1000 liters per day.

In order to coordinate and manage the construction and improvement works, dug well users committee should be formed. This committee will be responsible for managing and supervising construction and improvement works. It will also have to ensure that all materials were correctly used and stored after each day of construction works. After the completion of dug well improvement, training on effective O&M including pot chlorination should be provided to the users committee. The modest mechanism of creating O&M fund should be developed to buy spare parts. Community people should be also educated on preventing contamination of their drinking water during fetching and handling. The users committee will be also responsible for collecting 20% of total cost as users' contribution which can be in the form of cash or labor contributions.

Dug well should be accessible to many arsenic affected households and the improved dug well water should be used only for drinking and cooking purposes. It should be strictly followed as dug well often tends to dry up during summer time. Arsenic concentration of dug well water should be tested at least once in every year to ensure that the users are consuming arsenic free water.

3.2.3 Distribution of arsenic removal filters

There are three different types of household level arsenic removal filters (KAF, SONO filter and Robust filter) being distributed in arsenic affected households in Nepal.

a) Distribution of KAF:

Kanchan Arsenic Filter (KAF) can be constructed by using locally available materials such as plastic container with lid (50 L), plastic basin, pipe fittings and accessories, filter media (sand, gravel), 5 kg iron nails and some brick chips. Before the distribution and installation of KAF at selected households, the construction of KAF and media preparation should be done in advance. KAF should be constructed and installed only by trained technicians. Hence, three days hands training on KAF construction should be conducted to the field technicians. The manual with detailed steps and procedures of KAF construction, media preparation and installation should be provided to trained technicians. During the KAF construction, media preparation and installation, the technicians should follow the specific instructions as illustrated in the manual. The technical supervisor should monitor if the technician has been following the specified instructions to construct and install filter or not. All the filter materials including media should be checked for any damages or of inferior quality prior to dispatching at the field for installation. In case of any damage or low quality, the replacement should be made immediately.

A total of 25% cash contribution or 5 kg iron nails should be acquired as user's contribution towards the filter. After the filter installation, user should be provided with orientation on filter O&M including sludge disposal. The KAF O&M sticker should be attached onto the filter body and the user should be thoroughly briefed on O&M procedures as illustrated in the sticker. The filter users should be also oriented on keeping filter surroundings clean and on safe water storage of filtered water. The filtered water should be tested for arsenic after fifteen days of filter operation to ensure filter is producing arsenic free water.

b) Distribution of SONO filters:

SONO filter was developed in Bangladesh which consist of two plastic buckets (filtration unit and storage unit), special media – Composite Matrix Iron (CMI) for arsenic removal, sand & gravel and steel stand. Besides CMI, all materials can be found locally and CMI should be procured from Bangladesh. The intensive training should be provided to field technicians before installation of

SONO filter at selected households. They should be also provided with technical manual and guidelines to correctly install the filter. Since the CMI needs to be deployed from Bangladesh, it is very important to make sure earlier order has been placed and materials should be delivered at least one month before filter installation. All the materials including CMI, filter bucket, stand, sand and gravel need to be checked for any possible damages and of inferior quality. The immediate replacement should be made in case of any damages or low quality materials.

A total of 25% cash contribution should be acquired as user's contribution towards the filter. After the filter installation, user should be provided with orientation on filter O&M including sludge disposal. The O&M leaflet or poster should be handed over to the user and the user should be thoroughly briefed on O&M procedures. The filter users should be also oriented on keeping filter surroundings clean and on safe water storage of filtered water. The filtered water should be tested for arsenic after fifteen days of filter operation to ensure filter is producing arsenic free water.

c) Distribution of Robust filter:

Robust filter basically is improved version of concrete arsenic bio-sand filter. Filter body is made up of reinforced concrete which is then filled up with specified quantity of sand and gravel as filter media. Similarly, 5 kg of iron nails (as in KAF) is placed into the diffuser box covered with a layer of brick chips. The filter should be constructed only by trained technicians and order for required quantity of filter should be placed earlier to filter distribution and installation at arsenic affected households. If there is no filter technician at local level, then hands on training on Filter Construction should be provided to active local entrepreneurs or technicians. The technical manual, guidelines should be provided to trained technicians and they should follow the instructions provided in the manual during filter construction and installation. As mentioned in KAF and SONO filter distribution sections, 25% users' contribution should be acquired and O&M orientation should be provided to the filter users. The filtered water should be tested for arsenic after fifteen days of filter operation to ensure filter is producing arsenic free water.

3.2.4 Installation of Rain Water Harvesting (RWH) system

Collection of drinking through rain water harvesting has been approved by NDWQSC as one of the arsenic mitigation measures at arsenic affected communities. RWH system is feasible both in household level and institutional level. However, the feasibility of RWH depends on types of catchment surface. A roof of typical Terai houses is usually made up of thatch and tiles which are not feasible for collecting water through RWH system. In such case, a layer of plastic sheet should be placed at the roof and rain water can be collected by gutter. The use of locally available materials should be encouraged for cost effectiveness and simple O&M of the system.

For guttering, wooden planks and bamboo gutters are usually local available and cheap. These gutters, however, do have problems of durability as the organic material will eventually rot away and leak. Therefore, aluminum, PVC or galvanized metal gutters are recommended because of their strength. For collection of rain water, various types of storage reservoirs can be used. These include plastic tank, steel drums, ferro-cement water jar, concrete water tank, water tank built of bricks and ferro-cement. Plastic tank may be suitable for installation of RWH at household level whereas concrete or ferro-cement water tank can be constructed for installation of RWH at institutions. Ferro-cement water jar is commonly used as storage reservoir for RWH systems installed at mountainous districts in Nepal. The excess water after storage can be recharged into groundwater through soak pits and dug well.

The first rains should be used to flush away the dust, bird droppings, leaves etc. that lie on the roof surface. To prevent these pollutants and contaminants from getting into the storage tank, the first rainwater containing the debris should therefore be diverted or flushed away. A coarse filter preferably made of nylon or a fine mesh can be used to remove dirt and debris before the water

enters the tank. To protect water quality, good system design including O&M is essential. The use of filters and first flush devices will further improve water quality. Further treatment through POU drinking water treatment options such as boiling, filtration, Chlorination and SODIS can be undertaken if there are concerns about the water quality.

The users should be trained and educated on correct O&M procedures. The collected rain water should be strictly used only for drinking and cooking purposes as amount of collected rain water may not meet water demand for other domestic uses.

3.2.5 Extension/Rehabilitation of Gravity Flow System

If the condition of the existing distribution systems is found poor, but water is found arsenic free the system should be rehabilitated in condition that the rehabilitation is feasible, affordable and community accept the full operation and maintenance responsibility of the system and also contributes into the rehabilitation according to the District WASAH Implementation Guideline.

3.2.6 Small Scale Lift Overhead Tank System

In some areas the installation of the deep tube wells could be an attractive option of short term arsenic mitigation. However it is necessary to verify that deep aquifer is free from arsenic contamination and that the percolation of contaminated water into the deep aquifers is prevented. This option is anyhow recommended to be used only if a) the deep aquifer if free from Arsenic contamination, b) the percolation of arsenic waster into the deep borehole is prevented, c) the construction unit cost defined in the DWIG are not exceeded and that d) the operation and maintenance of the system is affordable to the community to manage and that the community is ready to take the responsibility of operation and maintenance.

3.2.7 Sharing Irrigation Deep Wells

The deep irrigation tube wells if properly maintained and arsenic testing is carried out to verify whether they are free from arsenic contamination could be used as the very useful sources of arsenic free drinking water. These irrigation tube wells could also be used to construct the overhead tank distribution projects to serve large number of community people. If quality testing of the installed irrigation tube wells and promotion of their use if found safe and if their use is technically and economically feasible it is recommended to mitigate the arsenic problems of the area by using these wells.

3.2.8 Surface Water Treatment

Surface water treatment option could be a good option for the arsenic affected settlements near by the surface water source. It involves construction of weir/dam at source, conveyance of water to the treatment plants and then distribution of treated water to the communities. Technically, the system is sound but it may require trained personnel for the operation of the treatment plants.

3.2.9 Pipeline Extension

Pipeline extension from the semi-urban or urban overhead water supply systems to the arsenic affected settlements could be one of the best options of arsenic mitigation. This requires good design of extension distribution pipeline and sufficient water at source to meet the demand.

3.2.10 Point Source Improvement

If there are natural springs, artisan waters and wells available, these could be considered as priority option. If properly protected from contamination these natural sources could be used as a good substitution for contaminated wells. Protection and maintenance of all available natural sources of the area and promotion of their use for receiving waters at least for the drinking and cooking should be carried out in the affected communities whereby the risks of arsenic exposure

could be reduced significantly. Water quality testing of such identified sources before and after protection should be conducted.

3.2.11 Arsenic and Iron Removal Plant (AIRP)

By this method, conventional iron and manganese removal can result in significant arsenic removal through co-precipitation and absorption into ferric or manganese hydroxides. This mechanism involves same methodology as in coagulation and filtration. This system can remove arsenic up to 70% and it is easy and economical method for removal of arsenic at community level. Combination of AIRP and lift overhead system may result better performance in operation and maintenance, but it is still to be researched. The method is technically sound but community have not been able to manage properly.

3.3 IEC and training materials

A wide variety of IEC, and Training materials on arsenic and arsenic mitigation options have been developed by Arsenic sub-committee of NDWQSC which are listed below:

- Generic brochure on Arsenic;
- Leaflets, booklets and pamphlets;
- Flip chart with illustrations on arsenic, arsenic testing and mitigation options;
- Poster on mitigation options ;
- Poster on health effects;
- Calendar;
- Flex on four arsenic mitigation options;
- Flex on health effects;
- Factsheets on introduction to arsenic and four mitigation options;
- Danglers;
- KAF O&M sticker;
- Technical manual;
- Training manual and guideline;
- Radio jingles and spots;
- Documentary on arsenic and its mitigation options

These IEC, training and AV materials can be reproduced or reprinted with permission of NDQWSC. These materials can be used and distributed during mass awareness raising campaign, trainings, focus group discussions and household visits. For any modifications on these materials, prior permission from NDWQSC should be sought. Any additional materials or guidelines can be developed by the Program as per need and should be shared among key stakeholders for reference and use.

3.4 Capacity building training Program

For the effective implementation of Program activities, capacity building activities should be conducted at three levels (District, Project and Community levels). Some key training Programs have been identified and presented below but more training can be conducted as per need.

Table 2: Capacity Building Training Program at Various Levels

SN	What training/ orientation?	Key contents	To whom?
A>	**District Level :**		
1.	Orientation on arsenic, and Program activities	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Arsenic mitigation options; • Existing Policies and guidelines; • Coordination mechanism; • Current program activities on arsenic mitigation	District level stakeholders such as representatives from government agencies, NGOs, CBOs and DACC members
2.	District level Technicians and implementers training on arsenic mitigation	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Technical Details on Arsenic mitigation options; • Practical and demonstration on various mitigation options.	Technicians from DTO, WSSDO and active NGOs;
3.	Health officials training on arsenic	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Arsenic mitigation options; • Case detection and management; • Levels of case referral	Health officials from DPHO; Medical doctors
4.	Local Journalists training on arsenic	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Arsenic mitigation options; • Arsenic awareness through mass media	Local journalists
B>	**Project Level:**		
1.	Training on arsenic, health effects and mitigation options	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Arsenic mitigation options	Project and field coordinators and lead TBC facilitators
2.	Training on arsenic, health effects and mitigation options	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Arsenic mitigation options; • Arsenic awareness through Total Behavior Change campaign ; • Effective household survey	Field staff, community mobilizers
3.	Training on filter construction, installation, O&M and troubleshooting	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic mitigation options; • Technical details of filters; • Hands-on filter construction and installation	Filter technicians, local entrepreneurs
4.	Database management and systematic documentation	• Overview of AIMS; • Updating and entering data onto AIMS; • Troubleshooting	Database managers, operators

SN	What training/ orientation?	Key contents	To whom?
C>	**Community level:**		
1.	Orientation on filter O&M	• Key filter components; • O&M procedures; • Simple troubleshooting; • Safe water storage and hygienic handling of filter	Filter users
2.	Orientation on tube well O&M	• Tube well parts; • O&M procedures; • Creating O&M fund; • Troubleshooting using tool kits	Tube well users committee and care taker
3.	Orientation on dug well O&M	• Dug well parts; • O&M procedures; • Pot chlorination • Creating O&M fund; • Troubleshooting using tool kits	Dug well users committee and care taker
4.	Training on arsenic to village leaders and social workers	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Arsenic mitigation options; • Arsenic awareness and coordination	VDC secretary, social workers and leaders from arsenic affected VDCs and communities
5.	Health workers training on arsenic and its health effects	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Arsenic mitigation options; • Case detection and management; • Levels of case referral	Health workers from health posts of arsenic affected communities
6.	School teachers training on arsenic	• Overview of arsenic, sources and chemistry of arsenic; • Health effects due to arsenic consumption; • Arsenic in Nepal; • Arsenic mitigation options; • Role of school teachers and students on disseminating messages on arsenic	School teachers from arsenic affected VDCs

Participatory and interactive approaches should be adopted while conducting training sessions. The trainers/facilitators should apply different teaching-learning methods such as mini-lectures, brain storming sessions, question-answer, demonstrations, group discussions, practical works, case studies, role play and field visits. Multimedia projector, PowerPoint slides and training & IEC materials such as flip chart, posters, flex, AV materials can be used to facilitate the training Program when and where feasible.

3.5 Monitoring and Evaluation

Regular monitoring and evaluation of arsenic mitigation Program activities is very important for enhancing the project activities, understanding the strengths and weaknesses, tracking the overall progress against designated project objectives, and making appropriate changes in the existing methods/tools towards eliciting better outcomes.

A modest institutional framework has been proposed and presented below in figure for effective M&E of Program activities including maintaining good coordination and communication among the stakeholders. The proposed institutional framework consists of three level of M&E system: Community Level, District Level and National Level.

Table 3: Monitoring and Evaluation at different levels

SN	Level of M&E	Who?	What to do?
1.	Community level	V WASH CC	• Perform regular M&E of field level activities; • Ensure execution of decisions made by DWASHCC and NDQWSC; • Supervise if field level activities being implemented following guidelines in systematic and coordinated manner; • Provide regular feedbacks; • Support Program staff on implementation of Program activities
2.	District Level	D WASH CC	• Perform M&E of Program activities in coordination with VDC WASH CC; • Provide strategic directions to implement Program activities in coordinated manner; • Ensure execution of decisions made by NDQWSC; • Support VDC WASH CC in decision making processes; • Endorse M&E guidelines and systems; • Provide regular feedbacks; • Auditing of fund flow and use;
3.	National Level	NDWQ Steering Committee	• Endorse M&E policies and guidelines; • Designate representative for regular M&E of Program activities.

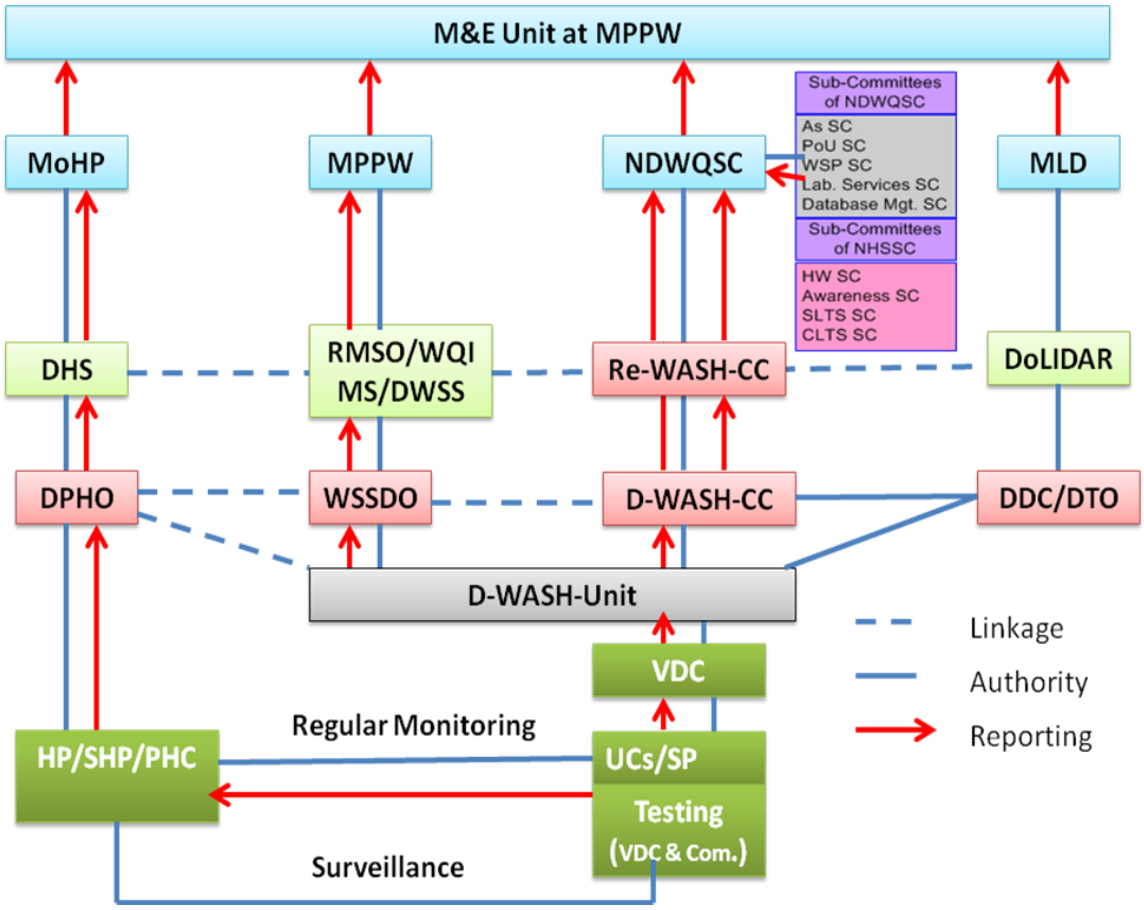


Figure 4: Institutional Framework for Monitoring, Reporting and Evaluation

Several M&E activities should be performed at project level for effective implementation of Program activities and to ensure sustainable use of arsenic mitigation options being provided.

Table 4: Monitoring and Evaluation of Different Mitigation Options

SN	What to monitor?	Who?	What to do?
1.	Monitoring of Filters	Field staff, community motivators	• Observation of filter through household visits; • Check any O&M problems; • Water Quality Testing of filtered water as indicated in testing schedule; • In case of any technical problems that cannot be solved, contact filter technicians; • Record keeping
2.	Monitoring of dug well	Field staff, community motivators	• Observation through community visits; • Check any O&M problems; • Meetings with users committee; • Water Quality Testing of dug well water as indicated in testing schedule; • In case of any technical problems that cannot be solved, contact field technicians; • Record keeping
3.	Monitoring of tube well	Field staff, community motivators	• Observation through community visits; • Check any O&M problems; • Meetings with users committee; • Water Quality Testing of tube well water as indicated in testing schedule; • In case of any technical problems that cannot be solved, contact field technicians; • Record keeping
4.	Monitoring of filter construction and installation	Project coordinator or senior technician	• Pay visit at construction site/place; • Observe and verify if the filter construction and installation has been done with provided instructions
5.	Monitoring of overall Program activities	Team leader, M&E officer and senior staff	• Field visits; • Observations of provided mitigation options; • Meeting with VDC WASH CC, users committee, and users; • Provide feedbacks.

A modest M&E systems should be developed to provide guidelines for effective M&E activities. The M&E systems should include checklist, guidelines, M&E formats and record keeping procedure. D- WASH CC will then endorse the M&E systems for its execution.

Monitoring schedule of key parameters to be analyzed is presented in table below.

Table 5: Monitoring Schedule

Option/Test	Arsenic	Coliform organisms	Iron	Chlorine
Filters	Randomly select filters and test once every month.	Test once every month (same schedule as arsenic test).	Test once every month (same schedule as arsenic test).	

Option/Test	Arsenic	Coliform organisms	Iron	Chlorine
New Tube well	Test once every month.	Test once every month	Test once every month	
Improved DW	Test once every month.	Test once every month	Test once every month	Test once every month
Test Method	Arsenic Test Kit or Laboratory	Presence/Absence vial test or Laboratory test	Iron Test Kit or Laboratory	Chlorine Test Kit

Note: Monitoring of the provided options and water quality can be done as per need.

3.6 Arsenic Testing

Arsenic can be analyzed either in the laboratory or in the field using filed test kits. Each method has its own advantages and limitations. Decisions on selection of arsenic testing methods should be made after accessing advantages and limitations of a particular method and purposes of arsenic testing. A brief comparison of field and laboratory testing is given in the following table:

Table 6: Comparison between Field and Laboratory Testing

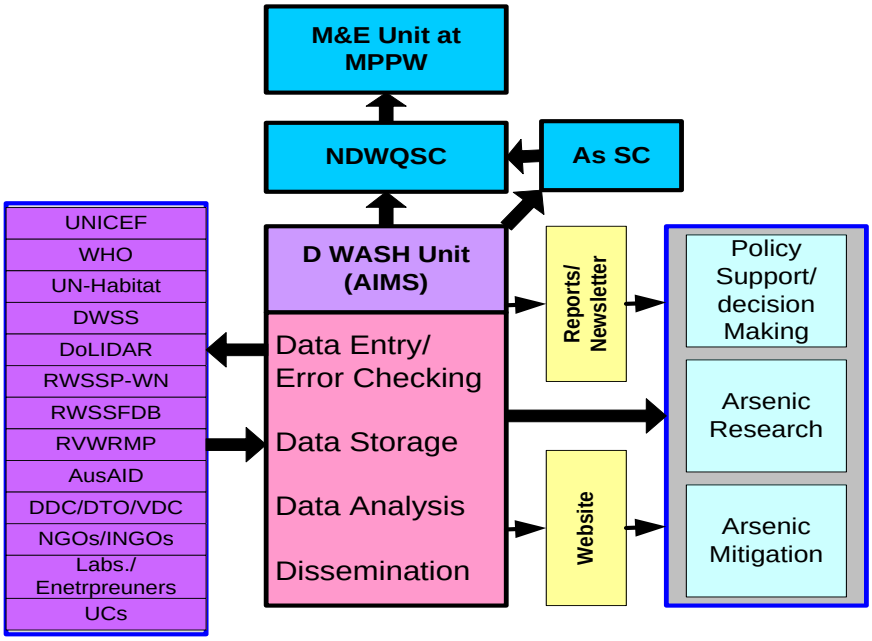
Field Test	Laboratory Test
• Give semi quantitative result; • Results may not precise; • Testing cost is low and can be conducted by non-technical personnel after providing orientation; • Good for blanket testing and monitoring purposes.	• Arsenic can be detected as low as 5 μg/l level and usually precise; • Data are reliable and can be used for scientific purposes. • Testing cost is expensive and needs trained personnel for analysis

As mentioned in previous section, the monitoring of provided mitigation options should be performed in regular basis. In addition, trend of installation of new tube wells by individuals is also growing. Hence, there should be arsenic testing facilities established at district level so that general public have access to this facility. For monitoring and testing of individual tube well water, well equipped laboratory can be established at district level or testing can be done by using simple arsenic field test kits. The decision of selecting test method should be made by DWASHCC. Several key considerations should be taken into account while making this decision. These include: affordability; demand for arsenic testing; availability of competent human resource; sustainability; access to supplies of chemicals, reagents including spare parts. After making the decision, staff for arsenic analysis should be nominated and trained of water quality analysis, quality control and record keeping systems. DWASHCC should decide on cost of per sample test.

3.7 Database management

Database management is an integral part of any Program as it provides information, data and reports of Program activities. Database is also important for M&E processes. A systematic district level database management flow chart is presented below in the figure. An updated and complete version of AIMS should be provided to DWASH Unit for updating database system at district level. For this, DWASHCC should select competent staff and the staff should be trained on proper operation and management of AIMS. Access on updating and maintaining AIMS should be provided to the trained staff only. S/he should able to provide required information, report and data as when requested by DWASHCC or any other authorized agencies.

Figure 5: Database Management



3.8 Roles and responsibilities of key stakeholders

There are several key stakeholders involved in arsenic testing and mitigation Program at district level. The list of stakeholder and their respective responsibilities has been presented in figure below.

Figure 6: Proposed Activities and Responsibilities in Arsenic Monitoring

ACTIVITIES	RESPONSIBILITY
Sampling	Laboratories or UCs
Testing	Lab./UC/VDC
Analysis	D-WASH Unit
Actions of Mitigation	D-WASH Unit
Awareness/Advocacy	D-WASH Unit
Reporting of Results	UC/Lab./D-WASH Unit
Coordination among Stakeholders	D-WASH-CC
Information Management	D-WASH Unit/WSSDO
Water Safety Plan	UCs
Financing	D-WASH Unit/UCs
Enforcement	D-WASH Unit
Technical Assistance	D-WASH Unit /WSSDO
Capacity Building	D-WASH Unit/ WSSDO
Development (Policy, Strategy, Technology)	D-WASH-CC

3.9 Sources of funding

Several government agencies, UN agencies, I/NGOs, private sectors can be good sources of funding for arsenic mitigation and monitoring program. For the individual TW and DW, the users or the UCs should also be source of funding for sampling and testing of Arsenic. The discussions on funding opportunities and collaboration can be made among these stakeholders during NDWQSC meeting.