USAID/OTI Nigeria Lake Chad Basin Program

Water Quality Requirements for Prospective Contractors

ASSESSMENT OF APPLICABLE WATER QUALITY STANDARDS AND CRITERIA

USAID Recommended Water Quality Parameters:

- Health-Related Parameters:
    1) Arsenic
    2) Fecal Coliform
    3) Fluoride
    4) Nitrate (as NO_3)
- Operational-Related Parameters:
    5) Electrical conductivity (EC)
    6) Total Dissolved Solids (TDS)
    7) pH
    8) Turbidity

Additional Water Quality Parameters Required for Monitoring Potable Water Source in Nigeria

- Health-Related Parameters:
    9) Residual Chlorine (as CL_2)
    10) Nitrite
- Operational-Related Parameters:
    11) Taste
    12) Odor
    13) Color
    14) Iron (Fe^{+2})
    15) Aluminum (Al)

Table 1. Justification for key drinking water quality parameters

Water quality parameter	**Justification for inclusion**
Arsenic (As)	Arsenic is a naturally occurring metalloid found in many parts of the world. Consumption of arsenic at high concentrations can lead to death, while long-term exposure at lower concentrations through drinking water sources can lead to a severe chronic illness called arsenicosis. Long-term exposure can result in thickening of the skin, darker skin, abdominal pain, diarrhea, heart disease, numbness and cancer. Following the discovery of several cases of arsenicosis as a result of USAID-funded water supply programs in the 1990's, the Agency now requires the testing of arsenic in all water supply programs.
Fecal coliform	According to the WHO, the greatest risk to human health associated with drinking water is contamination by animal and human waste, which can lead to outbreaks of waterborne diseases. Therefore, the 'first priority in developing and applying controls on drinking-water quality should be the control of such outbreaks.' In general, the WHO has determined that the risk of contamination of water supplies with pathogens, particularly if they are from excreta, is far greater than the risk associated with chemical contamination. Fecal coliform, specifically Escherichia coli (E. coli), is a waterborne pathogen commonly linked to diarrheal disease, and is associated with both human and animal waste. The WHO estimates that diarrheal disease causes 1.5 million deaths annually, affecting mainly children in developing countries. Approximately 58% of these deaths are attributable to unsafe water supply, sanitation and hygiene. Other diseases that can be transmitted by microbial-contaminated

	water include typhoid fever, cholera, salmonellosis, dysentery, and botulism, as well as viral diseases including SARS, Hepatitis A, and Polio.
Fluoride (F-)	Fluoride is a naturally occurring anion of fluorine, which occurs in minerals and fluoride salts. In small quantities, fluoride can be helpful to human health and protect from tooth decay. However, in higher concentrations (above several parts per million), fluorides can cause pitting of teeth and skeletal problems including crippling fluorosis, anemia and stiff joints. Heavy concentrations of fluoride can be found naturally throughout northern Africa, the Middle East and central Asia.
Nitrate (NO3-)	Nitrate (NO3-) is an inorganic compound that is both produced synthetically and occurs naturally. Although nitrate does occur naturally in surface and groundwater, high levels of nitrate contamination in drinking water is most often due to improper treatment of animal wastes, leaching of septic or wastewater systems into drinking water sources, and excess fertilizer application with its subsequent infiltration or runoff into source waters. The consumption of high concentrations of nitrate (greater than 50 mg/L of NO3-) and the subsequent reduction of nitrate to nitrite (NO2-) can lead to methemoglobinemia in infants. The presence of nitrite in the blood converts hemoglobin to methemoglobin, which cannot carry oxygen, and can lead to brain damage or death at high enough concentrations. This process is often complicated by the presence of microbial contamination and subsequent gastrointestinal infection.
Electro-conductivity	Conductivity is a measure of the ability of water to pass an electric current, and is influenced primarily by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Healthy freshwater systems have a range of 150 and 500 µhos/cm (microsiemens per centimeter), but the value may vary greatly depending on the geology and mineral deposits. Sharp changes to electro-conductivity from baseline condition can indicate an influx of wastewater from industrial or agricultural activity. For this reason elevated electro-conductivity values may indicate the need for additional testing.
Total Dissolved Solids (TDS)	TDS is closely related to conductivity and is a measure of all ion particles that are smaller than 2 microns (0.0002 cm). Thus TDS is a close approximation of salinity (although dissolved organic matter and other compounds may be included in the TDS measurement). High TDS can also indicate high alkalinity or hardness. Sharp changes in TDS indicate changes to the overall water quality. Water hardness can influence the effectiveness of water treatment, and thus is useful to monitor in order to inform effective water treatment.
pH	pH is a measure of the balance between hydrogen ions (H+) and hydroxide ions (OH -), with a pH of 7.0 being neutral. Surface water sources normally range from a pH of 6.5 to 8.5, while groundwater sources can range from 6 to 8.5. In general, water with higher acidity (pH < 6.5) could be corrosive and contribute to elevated levels of metals (iron, manganese, copper, lead, and zinc) as a result of leaching from the aquifer substrate, plumbing fixtures, and piping. Waters with higher alkalinity (pH > 8.5) indicate hardness (high concentration of dissolved minerals, particularly calcium and magnesium) and could contribute to mineral deposits along the water supply network. Although hardness is not a health concern, it can be distasteful.
Turbidity	Turbidity is a measure of the clarity or cloudiness of water and could be caused by silt, sand, mud, chemical precipitates, algae, bacteria, and other microscopic organisms. Turbidity is easy to measure and can be an indicator of contaminant loading. Further testing will be required to determine specific contaminant loading.
Residual Chlorine	Chlorine is produced in large amounts and widely used both industrially and domestically as an important disinfectant and bleach. In particular, it is widely used in the disinfection of

	swimming pools and is the most commonly used disinfectant an oxidant in drinking-water treatment. It is present in most disinfected drinking water at concentrations of 0.2–1 mg/l. The levels should be evaluated so as not to be any higher.
Nitrite (NO_2)	Nitrite (NO_2) is not usually present in significant concentrations except in a reducing environment, because nitrate is the more stable oxidation state. It can be formed by the microbial reduction of nitrate and in vivo by reduction from ingested nitrate. Nitrite can also be formed chemically in distribution pipes, or if chlorination is used to provide a residual disinfectant. Nitrite can also be produced as a result of nitrification in source water or distribution systems. In general, the most important source of human exposure to nitrate and nitrite is through vegetables (nitrate and nitrite) and through meat in the diet (nitrite is used as a preservative in many cured meats). In some circumstances, however, drinking water can make an occasional contribution to nitrite intake. In the case of bottle-fed infants, drinking water can be the major external source of exposure to nitrate and nitrite.
Taste Odor Color	The provision of drinking water that is not only safe but also acceptable in appearance, taste and odor is of high priority. Water that is aesthetically unacceptable will undermine the confidence of consumers, will lead to complaints and, more importantly, could lead to the use of water from sources that are less safe. Taste and odor can originate from natural inorganic and organic chemical contaminants and biological sources or processes (e.g. aquatic microorganisms), from contamination by synthetic chemicals, from corrosion or as a result of problems with water treatment (e.g. chlorination). Taste and odor may also develop during storage and distribution as a result of microbial activity Color, cloudiness, particulate matter and visible organisms may also be noticed by consumers and may create concerns about the quality and acceptability of a drinking-water supply.
Iron (Fe+2)	Anaerobic groundwater may contain ferrous iron at concentrations up to several milligrams per liter without discoloration or turbidity in the water when directly pumped from a well. On exposure to the atmosphere, however, the ferrous iron oxidizes to ferric iron, giving an objectionable reddish-brown color to the water. Iron also promotes the growth of "iron bacteria", which derive their energy from the oxidation of ferrous iron to ferric iron and in the process deposit a slimy coating on the piping. At levels above 0.3 mg/l, iron stains laundry and plumbing fixtures. There is usually no noticeable taste at iron concentrations below 0.3 mg/l, although turbidity and color may develop. No health-based guideline value is proposed for iron.
Aluminum (Al)	Aluminum is the most abundant metallic element and constitutes about 8% of earth's crust. Aluminum salts are widely used in water treatment as coagulants to reduce organic matter, color, turbidity and microorganism levels. Such use may lead to increased concentrations of aluminum in finished water. Where residual concentrations are high, undesirable color and turbidity may ensue. Aluminum intake from foods, particularly those containing aluminum compounds used as food additives, represents the major route of aluminum exposure for the general public. The contribution of drinking water to the total oral exposure to aluminum is usually less than 5% of the total intake. There is little indication that orally ingested aluminum is acutely toxic to humans despite the widespread occurrence of the element in foods, drinking water and many antacid preparations.

HOST COUNTRY REGULATIONS

In the spring of 2018 Nigeria's Federal Government launched NIS 554:2015: Nigerian Standards for Drinking Water Quality (NSDQW). A goal of this updated document includes promoting the availability of safe drinking water for all Nigerians. The document updated standards that had been previously issued in 2005, and includes changes to criteria for compliance and enforcement, as well as reporting forms for water quality.

The document states that these standards were developed through entering consultations with all stakeholders, including development organizations with responsibilities related to water quality. The NSDQW includes references to the Nigerian Industrial Standards for Potable Water and Natural Mineral Water, the National Guidelines and Standards for Water Quality in Nigeria, the World Health Organization (WHO) guidelines for drinking water quality, the International Organization of Nigeria (ISO), and to various national legislations (including the Water Resources Act No.101, of 1993; the Public Health Act of 1958, and the National Water Supply and Sanitation Policy of 2000, issued by the Federal Ministry of Water Resources).

WORLD HEALTH ORGANIZATION (WHO) GUIDANCE

The World Health Organization has set forth global water quality standards in their Guidelines for Drinking Water Quality, 4th Edition, Incorporating the First Addendum (2017). This document provides the overall framework for ensuring safe drinking water management with a focus on health-based targets and water safety plans. For many parameters (e.g., fecal coliform) they provide only recommended best operational practices to reduce or eliminate contaminants, and not specific guideline values.

INVENTORY OF SELECTED WATER QUALITY STANDARDS

The drinking water quality parameters summarized in Tables II-A and II-B are the basis of water quality monitoring for this program. Note that samples are collected and analyzed at least once during the construction of the water point / borehole and once at the commissioning of the water source.

After commissioning the new water supply source, the parameters are tested at the frequency suggested below for each parameter. The USEPA guidance values below are from the USEPA *National Primary Drinking Water Regulations*.[1] The WHO guidance values are from the WHO *Guidelines for Drinking-Water Quality* (WHO, 2017).

According to the Nigerian Standards for Drinking Water Quality (NIS-554-2015), Section 5.3 ('Minimum Parameters for Monitoring'), Table 7 indicates the parameters that are indicative of quality of drinking water and shall be controlled on a regular basis. These are included in Table II-A and Table II-B, below. In addition to the eight parameters required by USAID, these additional seven parameters have been added, according to the requirements of Nigeria.

[1] USEPA National Primary Drinking Water Regulations: https://www.epa.gov/ground-water-and-drinking-water/table-regulated-drinking-water-contaminants#Inorganic And: https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf

World Health Organization Guidelines for Drinking Water Quality 4th edition: https://www.who.int/water_sanitation_health/publications/drinking-water-quality-guidelines-4-including-1st-addendum/en/

TABLE **ERROR! NO TEXT OF SPECIFIED STYLE IN DOCUMENT.**-A: APPLICABLE HUMAN HEALTH-RELATED DRINKING WATER QUALITY PARAMETERS OF CONCERN

USEPA GUIDANCE			Nigeria Standards for Drinking Water Quality (NSDQW) [2018]		WHO GUIDANCE	
Parameter	**Limit**	**Frequency**	**Limit**	**Frequency**	**Limit**	**Frequency**
Arsenic	0.01 mg/l	quarterly	0.01 mg/l	N.S.	0.01 mg/l	N.S.
Fecal Coliform*	00/100 ml	quarterly	0 cfu/100 ml	N.S.	00/100ml	N.S.
Fluoride	4.0 mg/l	N.S.	1.5 mg/l	95% compliance over 1 year period	1.5 mg/l	N.S.
Nitrate (as NO_3)	10 mg/l	N.S.	50 mg/l	N.S.	50 mg/l	N.S.
Residual Chlorine	0.8 mg/l	N.S.	0.2 – 0.25 mg/l	N.S.	Recommended less than 0.5 mg/l **	N.S.
Nitrite	1 mg/l	N.S.	0.2 mg/l	N.S.	3 mg/l	N.S.

Notes:

* Analysis for thermos-tolerant coliforms (TtC) bacteria, or Escherichia coli.

** Section 12.1 Guidelines for Drinking Water Quality section on Chlorine, under 'Treatment performance' – 'a few tenths of a milligram per liter to act as a preservative during distribution;' The words 'a few' are interpreted to mean 5 or less.

N.S. Not specified in the guidance

TABLE **ERROR! NO TEXT OF SPECIFIED STYLE IN DOCUMENT.**-B: APPLICABLE OPERATIONAL-BASED DRINKING WATER QUALITY PARAMETERS OF CONCERN

USEPA GUIDANCE			Nigeria Standards for Drinking Water Quality (NSDQW) [2018]		WHO GUIDANCE	
Parameter	**Limit**	**Frequency**	**Limit**	**Frequency**	**Limit**	**Frequency**
Electrical Conductivity (EC)(1)	1600 µS/cm	N.S.	1000 µS/cm	N.S.	N.S.	N.S.
TDS	500 mg/l	N.S.	500 mg/l	N.S.	1000 mg/l	N.S.
pH	6.5-8.5 S.U.	N.S.	6.5-8.5 S.U.	N.S.	6.5-8.5	N.S.
Turbidity	5 NTU	N.S.	5 NTU	N.S.	4 NTU recommended	N.S.
Taste	Unobjectionable	N.S.	Unobjectionable	N.S.	Acceptable to consumer	N.S.
Odor	3 threshold odor number	N.S.	Unobjectionable	N.S.	Acceptable to consumer	N.S.
Color	15 TCU	N.S.	15 TCU	N.S.	15 TCU	N.S.
Iron (Fe^{+2})	0.3 mg/l	N.S.	0.3 mg/l	N.S.	0.3 mg/l recommended	N.S.
Aluminum (Al)	0.05 to 0.2 mg/l	N.S.	0.2 mg/l	N.S.	0.2 mg/l for small facilities	N.S.

Notes:

(1) The value of electrical conductivity (EC) is based on the State of California secondary MCL for drinking water from the range of EC at 900 to 1600 µS/cm. (California State Water Resources Control Board, 2010)

(2) USEPA has not promulgated guidance values for turbidity; however, per the USEPA Surface Treatment Rule, in drinking water systems, turbidity must not exceed 5 NTU; systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples for any two consecutive months: http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=500025GQ.txt

RATIONALE FOR SELECTION OF SITE-SPECIFIC WATER QUALITY PARAMETERS:

The Nigerian Standards for Drinking Water Quality Section 5.2 identifies the above minimum parameters for monitoring. It notes that aluminum parameters are subject to monitoring water that is treated using aluminum compounds, that residual chlorine parameters are subject to monitoring in water that is treated.

Water quality samples will need to be taken during and after the implementation/rehabilitation of water access points to ensure that water to be delivered to communities complies with relevant national and international quality standards, as outlined in Tables II-A and II-B, above.
Sampling will follow nationally established protocols, in which samples are protected and passed through a recorded chain of custody between source and laboratory.

Eight water quality tests that must be performed by the Implementing Partner in all cases where water supplies are developed and/or rehabilitated are tests for; (1) the presence of arsenic, (2) the detection of fecal coliforms, (3) fluoride, (4) nitrate, (5) electrical conductivity, (6) TDS, (7) pH, and (8) turbidity. Additionally, as required by the Government of Nigeria, the following parameters will also be tested for: (9) residual chlorine, (10) nitrite, (11) taste, (12) odor, (13) color, (14) Iron and (15) aluminum.

Initial water quality testing as well as testing for the minimum of the subsequent four quarters following construction or rehabilitation is the responsibility of the Implementing Partner. When feasible, the Implementing Partner will also set in place capacities and responsibilities to provide reasonable assurance that ongoing drinking water quality monitoring occurs.

USEPA Guidance		
Parameter	**Limit**	**Frequency***
Arsenic	0.01 mg/l	quarterly
Fecal Coliform	00/100 ml	biannually
Fluoride	4.0 mg/l	
Nitrate (as NO3)	10 mg/l	

USEPA Guidance		
Parameter	**Limit**	**Frequency**
Electrical Conductivity	1600 µS/cm	
TDS	500 mg/l	
pH	6.5-8.5 S.U.	
Turbidity	5 NTU	

ROUTINE MONITORING AND TESTING

Although the NSDWQ does not stipulate the frequency of testing of water samples, USAID guidance is that testing for Arsenic take place quarterly and for fecal coliforms at least twice a year. It is suggested that other water quality parameters are tested at least annually, or more frequently if indicated by staff at the government reference laboratories. Given the on-ground realities and the remoteness of project sites, the frequency of in-country testing for all water quality parameters will be decided on with the host-government but will occur at least annually. The Implementing Partner will make efforts to empower communities and local government bodies to continue testing once the site is handed over by providing training and testing kits, where possible.

Nigeria's Standards for Drinking Water Quality, Section 2 and Section 5.4 refers to NIS/IEC 17025: 2005, which has since been superseded by ISO/IEC 17025: 2017–General Requirements for the competence or testing and calibration laboratories—as applicable to all organizations performing laboratory activities, regardless the number of personnel. Section 7 highlights how the owner of the system shall pay for testing and approval. As indicated otherwise in this document, Section 5.3 indicates the minimum parameters for monitoring as being the eight parameters required by USAID, plus an additional seven identified by the Nigerian Government (see II.A., above). Section 7.2 indicates that the State and Federal Ministries of Water Resources and Health shall cover the cost of routine drinking water quality monitoring.

PROCEDURES AND PROTOCOLS FOR COLLECTION, MEASUREMENT, SAMPLE PRESERVATION AND TRANSPORT TO LABORATORIES.

Procedures and protocols for the collection, measurement, sample preservation and transport to laboratories, according to guidance on sampling is, according to the World Health Organization Guidelines for Drinking-Water Quality (2017), outlined in the following ISO standards, relevant to this program.

ISO Standard Number:	**Name of Document**
5667-1: 2006	Sampling—Part 1; Guidance on the design and sampling programs and sampling techniques.
5667-5: 2006	Sampling—Part 5: Guidance on sampling of drinking water and water from treatment works and piped distribution systems.
5667-11: 2009	Sampling—Part 11: Guidance on sampling of groundwaters.
5667-14: 2014	Sampling—Part 14: Guidance on quality assurance and quality control of environmental water sampling and handling
5667-20: 2008	Sampling—Part 20: Guidance on the use of sampling data for decision making—Compliance with thresholds and classification systems.

DOCUMENTATION OF AVAILABILITY OF RESOURCES

The Nigerian Standards for Drinking Water Quality stipulate (Section 5.4) that laboratories contracted to perform water quality surveillance conduct water testing in compliance with NIS ISO 17025: 2005, as defined by the International Organization for Standardization (ISO). This has since been replaced by ISO ISO/IEC 17025.2017.

Guidance provided below on sampling is adopted from the U.S. Environmental Protection Agency (EPA) manual Guide to Drinking Water Sample Collection: https://www.epa.gov/sites/production/files/2017-04/documents/quick-guide-drinking-water-sample-collection-2ed-update-508.pdf. Bottle sizes and preservatives are from the European EPA guide: https://www.epa.ie/pubs/advice/drinkingwater/privatewatersupplieshandbook/Section%204.pdf

TABLE **ERROR! NO TEXT OF SPECIFIED STYLE IN DOCUMENT.**-B: AVAILABILITY OF RESOURCES FOR SAMPLE COLLECTION AND LABORATORY ANALYSIS

	Collection and Field Measurement			**Laboratory Analysis and Reporting**
Parameter	**Bottle Type**	**Bottle Volume**	**Preservative**	**Notes on storage after preservation**
Arsenic	Plastic or glass	500 ml	Nitric Acid (HNO3) to pH<2	I month holding time
Fecal Coliform	Plastic or glass, and sterile	200 ml	Sodium Thiosulfate if sample is chlorinated; store in cooler at 2 to 8 degrees Celsius	Hold time 30 hours, though 6 hours best.
Fluoride	Plastic	500 ml	Cool to less than or equal to 4 degrees Celsius	Hold time one month
Nitrate (as NO3)	Plastic or glass	100 ml	Add H2SO4 to pH<2; Cool to less than or equal to 4 degrees Celsius	Hold time of 48 hours
Residual Chlorine	Test tubes	100 ml	None	Analyze immediately on site
Nitrite	Plastic	100 ml	Cool to less than or equal to 4 degrees Celsius	Hold time of 24 hours
Electrical Conductivity (EC)	Plastic or glass	500 ml	Cool to less than or equal to 4 degrees Celsius	Hold time of one day
Total Dissolved Solids	Plastic or glass	500 ml	Cool to less than or equal to 4 degrees Celsius	Hold time of one day
pH	Plastic or glass	500 ml	Cool to less than or equal to 4 degrees Celsius	Hold time of one day
Turbidity	Plastic	500 ml	Store in the dark	Hold time of 24 hours
Taste	Glass	500 ml	Maintain at ambient temperature	Hold time of 24 hours
Odor	Plastic or glass	500 ml	Cool to less than or equal to 4 degrees Celsius	Hold time of one day
Color	Plastic	250 ml	Cool to less than or equal to 4 degrees Celsius	Hold time five days
Iron	Plastic or glass, acid washed	100 ml	Acidify with HNO3 to pH I - 2	Hold time of I month
Aluminum	Plastic or glass	250 ml	Acidify with HNO3 to pH I-2	Hold time of I month

OPERATIONAL SUSTAINABILITY

SOURCE PROTECTION

Source protection is an inexpensive, long-term means of protecting the quality of drinking water.

Nigeria's National Water Policy of July, 2004 includes water resource protection as one of its guiding principles, stating 'protection measures shall be based on both regulatory and market-based approaches to water management.' Until or unless defined protection zones are established around well sites, measures to protect water sources include fencing off wells and water abstraction points from livestock, ensuring soak away pits are maintained to reduce water ponding and vector breeding around the water point, assigning individuals to clean and maintain the water points and providing them with maintenance education, such as how to repair cracked concrete splash pads and replace pump parts.

The Code of Practice for Water Well Construction—Nigerian Industrial Standard addresses specific source protection measures to be used, such as ensuring that water used for cooling parts of engines, air compressors and other equipment shall not be returned to any part of the groundwater system, that broken or defective casings, screens fixtures and seals are repaired and replaced.

Code of Practice for Water Well Construction—Nigerian Industrial Standard (Standards Organisation of Nigeria; 2010)

STAKEHOLDER PARTICIPATION / OPERATION AND MAINTENANCE

Before any water or sanitation construction or improvement takes place, members of the local community in which the action will take place will be engaged with during participatory meetings. This will be to confirm their interest in the action, to determine the best siting of the water point, and to ascertain that they will attend hygiene and sanitation training sessions, as well as delegate members to participate in the subsequent operation and maintenance of the point. Key contacts will be designated by community members to act as liaisons with the contractor, with construction monitoring staff, and with third party trainers designated by the Implementing Partner.

The construction/rehabilitation of any water point will in parallel be associated with training of local community members. All members will be trained in hygiene and sanitation to reduce the incidence of water borne diseases, and selective members—chosen by the community—will be trained in operation and maintenance (O&M) of the water and sanitation points. This training will include routine 'housekeeping' to ensure that sites are kept clean and that fencing is maintained to keep livestock away. It will also include technical training in repairing pumps, pipes and concrete splash pads.

Trainees will also be given contact information for pump manufacturers in the event of malfunctions or breakage of components that are covered by a warrantee. Contractors will have responsibility for the installation, construction of water and sanitation works and will provide training to community members or host government staff in sanitation, O&M. Where possible, the Implementing Partner will designate third party educators to deliver sanitation and O&M training to the communities.

Additional resources can be found in the following relevant publications.
Operation and Maintenance of Rural Water Supply and Sanitation Systems (WHO, 2000)

TRAINING

Training to community members should be made in two subjects: hygiene and sanitation, and operation and maintenance. Provision of clean water is not enough to ensure a reduction in sickness and disease; it

must be accompanied by knowledge of how to keep hands and contact surfaces clean in order to ensure that water remains clean from source to the point where drinking takes place. Ideally, the entire community that will use the water point for potable water should be trained, by specialists, in subjects that include hand washing, transportation, storage and use of water, as well as sanitation issues regarding defecation and latrines.
Additional resources can be found in the following relevant publications, as identified at the USAID GEMS website.
Workshops for Community-led total sanitation (CLTS Foundation 2010)
Handbook for Community-led Total Sanitation (Plan UK, 2008)
USAID Sector Environmental Guidelines: Water Supply and Sanitation (USAID, 2015)

Operation and maintenance training should be provided to selected members of a community who have been designated with the responsibility of carrying out these activities to ensure that water supply points continue to function as design. The training will cover topics such as ensuring that fencing is maintained to keep livestock away from water points, repair of cracked concrete spillways and splash pads, and repairs of water pumps.

Additional resources can be found in the following relevant publications.
Operation and Maintenance of Rural Water Supply and Sanitation Systems (WHO, 2000)
Water Supply and Sanitation (Waterfund)

CORRECTIVE MEASURES

The selection of the corrective measures to implement when water quality guidance levels are exceeded depends on a variety of factors, most of which depend on potentially unique site characteristics. The two most important issues to consider prior to implementing a corrective response are:

• Does the exceedance present an immediate health risk to consumers?

• Are there alternative water sources that are accessible and safe?

Notes: Exceedances will be recorded.

In the case of arsenic and fecal coliforms, the Implementing Partner will notify and consult with the relevant USAID/OTI members regarding the exceedance and appropriate responses.

If the water quality testing completed following the commissioning of the water point indicates that contaminant levels exceed the thresholds established in this WQAP, additional sampling and analysis for the given parameters will be performed to confirm the initial results. If these confirm the exceedance, then well disinfection will take place with chlorine prepared with calcium hypochlorite to achieve 100 parts per million residual chlorine. Additional testing will then take place, and if exceedance still exists sometime after the treatment, the decision of whether to close the water point will be made in consultation with USAID/OTI.

In the case that there is immediate danger to life and health, actions will be taken in communication with USAID and the local community to immediately restrict access to the water point and find an alternative water supply for the affected community.

A. HUMAN HEALTH-RELATED DRINKING WATER QUALITY PARAMETERS OF CONCERN:

This describes the specific corrective actions that will be undertaken if any of the health-related drinking water quality parameters listed in Table II-A are exceeded.

Response protocol for exceedance of limits. If at any time drinking water quality tests conducted by the Implementing Partner indicate that contamination levels in a drinking water supply exceed the limits indicated above, the Implementing Partner will take the following actions:

a. If any of the levels are exceeded, the following will be performed (if there is no immediate danger to life and health):

- an additional round of sampling and analysis for the given parameters will be performed to confirm the initial results;
- if the second round of sampling/analysis confirms the exceedance, an investigation of the potential source of contamination will be performed;

b. If arsenic levels are exceeded, the IP will notify the appropriate authorities, and investigate alternative safe water sources. If alternative sources are available, then:

- Access to the alternative source will be provided; and,
- The water point with the exceedance, shall be disassembled, or equipped to otherwise prevent groundwater withdrawal.

c. If fecal coliform is detected, the IP will work with the appropriate authorities as well as the local water management committee to ensure that the following measures are implemented:

- An investigation of potential sources of contamination, and removal of the contamination, if possible;
- Examination of the well construction will be conducted to ensure that the concrete apron and casing are sealed and in good condition and the well head is elevated such that runoff flows away from the concrete pad;
- The sampled well will be disinfected via the shock chlorination technique.

NOTE: REQUIRES ADDITIONAL USAID AUTHORIZATION;
- Outreach to community members will be completed (through radio announcements, community meetings, etc.) to boil water;
- Purification tablets, like Aquatab™, will be distributed, and community members will be educated on proper use; or,
- Access to the water point may be restricted, if possible, to non-drinking water, non-domestic uses only (e.g., that water is used for irrigation purposes only, or livestock watering).

d. If fluoride levels are exceeded, the IP will complete the following measures:
- An investigation of the presence of health effects (i.e. dental or skeletal fluorosis), additional sources of fluoride (e.g. brick tea consumption), will be performed, if possible;
- Alternative low-fluoride sources of water will be used; if possible, and, blending of the two sources will be executed; or,
- Fluoride treatment will be installed that is available and acceptable to the community, such as bone charcoal, contact precipitation, clay, activated alumina, calcium chloride, monosodium phosphate, and Nalgonda; or,
- Access to the water point will be restricted to non-drinking water, non-domestic uses only (i.e., that water is used for irrigation purposes only).

e. If nitrate or nitrite levels are exceeded, the IP will complete the following measures:
- An investigation of potential sources of contamination, such as nearby agricultural fertilizer application, or leaking septic tanks, will be performed, and removal of the contamination will be completed, if possible; or,
- Access to the water point will be restricted to non-drinking water, non-domestic uses only (i.e., that water is used for irrigation purposes only).

f. If residual chlorine levels are exceeded, the IP will complete the following measures:
- Access to the alternative source will be provided; and,
- Access to the water point will be restricted to non-drinking water, non-domestic uses only, and
- Depending on the level of excess, the well will be pumped of a series of days until the level of residual chlorine has reduced to that which is acceptable. When this level is reached, the well can again be utilized for use as originally intended.

B. OPERATIONAL-BASED DRINKING WATER QUALITY PARAMETERS OF CONCERN:

g. If electrical conductivity or TDS levels are exceeded, the IP will complete the following measures:
- The IP will perform additional testing for individual constituents of conductivity including, chloride, sodium, nitrate, calcium, magnesium, and sulfate, to ensure these constituents are not present at levels above the host country regulatory limits.
- An investigation of potential sources of contamination will be performed, and removal of the contamination will be completed, if possible; or,
- Access to the water point will be restricted to non-drinking water uses only (confirm that elevated conductivity does not preclude use for irrigation or for livestock watering).

[1] Alternatives may include surface waters, rainwater, drilling a deeper borehole at this location, or investigating local low fluoride groundwater in the immediate area.

[1] These treatment processes are described in the 2006 WHO Guidance entitled, "Fluoride in Drinking Water," accessed at: http://www.who.int/water_sanitation_health/publications/fluoride_drinking_water_full.pdf

h. If pH levels are outside of the range (i.e. below 6.5 or above 8.5), the IP will complete the following measures:

- An investigation of potential anthropogenic sources of contamination, such as nearby industrial activities including mining, will be performed, and an investigation of alternative sources of water supply will be completed, if possible;
- An investigation of potential natural sources, such as subsurface geology, will be performed, to confirm that the low or high pH is a result of natural conditions;
- If the pH exceedance is due to natural conditions, such as local geology, an investigation of the potential of corrosion of the existing or proposed water supply extraction and distribution infrastructure (e.g. corrosive metal piping and pumping equipment) will be performed;
- If pH exceedances, could result in corrosion, and leaching of metals from water supply equipment, then testing will be conducted for metals appropriate water treatment (e.g. neutralizing filter[2]) will be installed, at the water point, or at the point of use (e.g. in the residence); or,
- Access to the water point will be restricted to non-drinking water, non-domestic uses only (i.e., that water is used for irrigation purposes only).

i. If turbidity levels are exceeded, the IP will complete the following measures:

- An investigation of potential sources of contamination, and removal of the contamination, if possible;
- Water treatment that is available and acceptable to the community, such as fiber, cloth or membrane filters, granular media filters, sedimentation systems, moringa flocculation, sand filters, will be installed (or provided for household use) to remove turbidity; or,
- Access to the water point will be restricted to non-drinking water, non-domestic uses only (i.e., that water is used for irrigation purposes only).

j. If taste, odor or color levels, or levels of Iron or Aluminum are exceeded, the IP will complete the following measures:

- An investigation of potential sources of contamination, and removal of the contamination, if possible.
- If the parameters are considered unacceptable to the community, the access to the water point will be restricted to non-drinking water, non-domestic uses only (such as for irrigation purposes).
- Consultation with the local water engineering delegate should be made so a final decision can be made in consultation with the water quality laboratory as to actions that may be taken to improve the situation.

[2] Neutralizing filters include selected media to neutralize pH. For acidic (low pH) water, the neutralizing filter would contain calcite (marble chips) or ground limestone (calcium carbonate) or magnesia (magnesium oxide) to raise the pH. In most cases, water supply will not have a high pH; however, certain alkaline lakes (i.e. soda lakes) have pH between 9 and 12. For high pH water, acidic solutions or CO_2 can be added to the water at the point of use to lower the pH; however, these systems are not recommended in community village level water supply systems.