Water Safety Framework:

Preliminary Water Quality Sampling and Analysis Strategy for the `Villages et Ecoles Assainis' National Programme

Prepared for UNICEF DR Congo

Democratic Republic of the Congo

UNEP

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1. Introduction

The *'Village et Ecoles Assainis'* or 'Healthy Villages and Schools' national programme, known by its French acronym VEA, is the government's main initiative to provide safe drinking water to rural and peri-urban populations in the Democratic Republic of the Congo (DRC). The programme was initiated in the 1990s by the Government of the DRC with the support of USAID. After a period of inactivity, the programme was re-launched across all 11 provinces of the country in 2006 by the Ministry of Health with UNICEF support, the programme has reportedly succeeded in providing safe drinking water to 2,883 villages and 1,000 schools comprising a total population of over two million people by end 2012[1]. A major scaling-up of the VEA programme to provide safe drinking water to an additional 6,000 villages and 1,250 schools with a total population of 4 million people is planned under its second phase from 2013-2017.

In planning for this major scale-up and motivated by the desire 'to do things better', the VEA programme is investing in several technical studies to be conducted during the course of 2013. The aim of these studies is to identify solutions and upgrade the VEA programme design with a view to enhancing programme quality and sustainability. Specifically, the VEA programme wants to develop a '*Water Safety Framework to ensure the delivery of safe and sustainable water services'*. This framework will materialize in the form of Water Safety Plans (WSP). WSP include several components on water quality monitoring and verification.

This document proposes a water quality sampling and analysis strategy to be implemented within the VEA water safety framework. The WSP steps of water quality monitoring and verification are integrated as presented in the WHO ''*Guidelines for drinking-water quality*" (2011) and "Water Safety Planning for Small Community Water Supplies" (2012). Therefore, it is important that this document is read in tandem with the UNICEF commissioned technical study '*Water Safety Plans for Village Assainis'*.

2. Key issues in developing a water quality strategy for WSPs

In designing a WSP strategy, a determining factor is that it needs to be adapted to the operational environment of the country in question. This is particularly true for post-conflict countries like the DRC, which faces exceptionally difficult infrastructure, human resource, financial, governance and security constraints. The DRC's operational challenges are saliently illustrated in the fact that this vast country, which is around two-thirds the size of Western Europe has less than 3,000 kilometres of paved roads. For comparative purposes, Switzerland which is less than two percent the size of the DRC has around 72,000 kilometres of paved roads.

It is thus clear that an ideal laboratory system for independent water quality testing, dependant on the availability of a good road network and reliable motorized transport for all sampling officers to ensure that samples are returned quickly within a few hours of being taken, is not a feasible option in the DRC. Therefore, while it may be possible to establish well-equipped laboratories in the DRC, as has been done by the *Office Congolais de Contrôle* (OCC) in several provincial capitals, it is not practically feasible to use these facilities for the purpose of routine water quality testing.

The second important factor to take into account is that as empirically demonstrated by the UNEP/Spiez Laboratory reconnaissance surveys in the Katanga Copperbelt and peri-urban/rural Kinshasa region conducted in May/June 2013, the principal risk to human health is from faecal contamination of drinking water supplies. Most of the shallow dugout wells and unconfined aquifers were found to be bacteriologically contaminated. Water storage vessels (plastic jerry cans) in the households also frequently tested positive for microbial contamination. On the other hand, point of use chlorination was generally found to be effective, but chlorine dosage and storage was problematic in some cases. Based on these findings, it is evident that water quality testing for microbiological contamination and residual chlorine is a priority.

In contrast, the UNEP/Spiez Laboratory reconnaissance survey evaluated chemical contamination to be of relatively low risk at present, although concerns were identified for a few water sources in peri-urban areas and more significantly regarding mining pollution in the Katanga Copperbelt over the medium term. While water quality testing for chemical contamination can be taken for new water sources and repeated at fairly long intervals, testing for faecal contamination needs to be carried out on a more regular basis. This is because the risk of microbial contamination is always present. Moreover, it is highly variable due to seasonal and temporal variations including due to changing land-use patterns.

In a country with very little transport infrastructure and an unforgiving tropical environment, it is not possible to rely on a laboratory infrastructure for water quality monitoring. (Photo credit: MONUSCO).

3. Purpose of the strategy

Despite the aforementioned operational constraints, it is still possible to carefully devise a practical water quality strategy that is adapted to the DRC's specific challenges. While the proposed strategy is relatively limited in scope focusing on essential parameters and potential problem substances associated with mining, agricultural and peri-urban areas, it should be considered as part of an incremental improvement process subject to regular revision and updating. As capacity in water quality testing is built, it should be possible to gradually expand the parameters and the frequency of testing. Furthermore, a three-step ''ladder'' approach is proposed allowing for the adaptation of the water quality strategy on an individual case-by-case basis (see section 6 on integrating water quality testing in the VEA programme).

The purpose of this document is to provide a realistic, effective and achievable water quality strategy as an integral part of the Water Safety Framework for the DRC VEA national programme. The strategy has been designed based on the principles of the WSP approach as described in the World Health Organization's (WHO) *Guidelines for drinking-water quality* (WHO, 2011), and the WHO *Guidelines for drinking-water quality - Surveillance and control of community supplies* (WHO, 1997). Although the strategy has been specifically designed for the national VEA programme, it is also relevant for other WASH sector initiatives in the country, particularly community-managed point sources comprising of protected springs and hand-pumps.

4. Water quality testing and the WSP Approach

Water Safety Plans is a risk management approach to water safety: the objective is to guarantee, at any given time, appropriate drinking water quality at the point of use. The WSP approach for DRC is developed based on the guidelines provided by the World Health Organization (WHO, 2012[2]). The key words that defines a WSP are “preventive” and “management”.

- Understanding and committing to achieving drinking-water safety are prerequisites to the implementation of any effective WSP.
- Water safety can be effectively and sustainably improved through the use of a preventive risk management approach.
- The WSP approach is meant to be flexible and adapted as needed.
- The greatest risk to drinking-water safety is contamination with disease-causing microorganisms.
- Risks to the safety of drinking-water are best controlled using a multiple-barrier approach.
- Incremental improvements to the water supply system can be made over time, with the aim to eventually achieve water quality targets or objectives.
- Any (sudden) change in the local environment should result in investigative action to confirm that drinking-water is safe or to provide information on how to undertake corrective actions.
- Any complaints about illness, taste, colour or smell require follow-up to ensure that the drinking water continues to be safe.
- Regular review of the WSP (including newly identified risks) is critical to ensure that water safety planning remains up to date and effective.

(WHO, 2012)

As discussed above, in the DRC context and particularly for community-managed water systems, it is not practically feasible nor is it recommended to solely rely on conventional water quality testing as a means for regularly monitoring the supply of safe drinking water to the population. On the other hand, water quality testing is a critical and powerful tool for verifying drinking-water safety that can be integrated in the formulation of Water Safety Plans with a view to reinforcing its practical implementation. What is therefore needed is that testing is made to fit within the WSP management approach to help control risks.

WSPs are in general composed by the following elements:

1. Identification of managers and users, and creation of a WSP team.
2. Description of the system, from catchment to point of use (the water supply chain)
3. Identification, in each element of the chain, of hazards and risks
4. Identification, for each risk, of reduction measures, control points and corrective actions
5. Definition of operation plan and validation process
6. Definition of improvement and emergency plans
7. Definition of communication plan, documentation and auditing

In presence of WSPs, what is traditionally known as "water quality surveillance" by external actors consists in the independent approval and auditing of the plans, notably for the commissioning of new water sources and subsequent auditing of the plans. Audits help in the implementation of a water safety plan by ensuring that water quality and risks are being controlled effectively. Audits should involve external review by an independent qualified third party and may also involve internal review by people with responsibilities for operating or overseeing the water supply. Auditing can have both an assessment and compliance-checking role and should be undertaken regularly.[3]

Validation and on-going verification of WSPs, on the other hand, are the internal quality control components of the WSPs, and need to be implemented by the operators of the plans. The entity doing external quality control shall not be the same entity doing the on-going verification of the plans. This is an elementary principle. According to the WHO Guidelines (2011), water quality testing can normally be undertaken in the following phases of WSP implementation including: (i) commissioning of new water sources; (ii) validation of process; (iii) operational monitoring and (iv) verification.

Likewise, it is important to caution that in the WSP context, water quality testing should not be carried out for its own sake or be used as a compliance and enforcement tool. There is always a risk that water quality testing may be turned into a hard-and-fast policing stick. Nevertheless, it is considered unlikely that this will be a major issue in the DRC, as the Ministry of Health is both the implementing agency for the VEA programme and has a mandate to monitor drinking water quality. As the manager of the VEA programme, the Ministry of Health clearly has a vested interest in integrating water quality testing to improve programme implementation, and not to undermine it through a top-down regulatory approach. Moreover, it was observed during the field visits that the Health Zone officers have good rapport with the communities of which they are indeed a part. This should further reduce the risk that water quality testing would be used by them as an arbitrary enforcement tool to condemn a large number of water supplies.

5. Organisational framework for water quality testing as part of a WSP

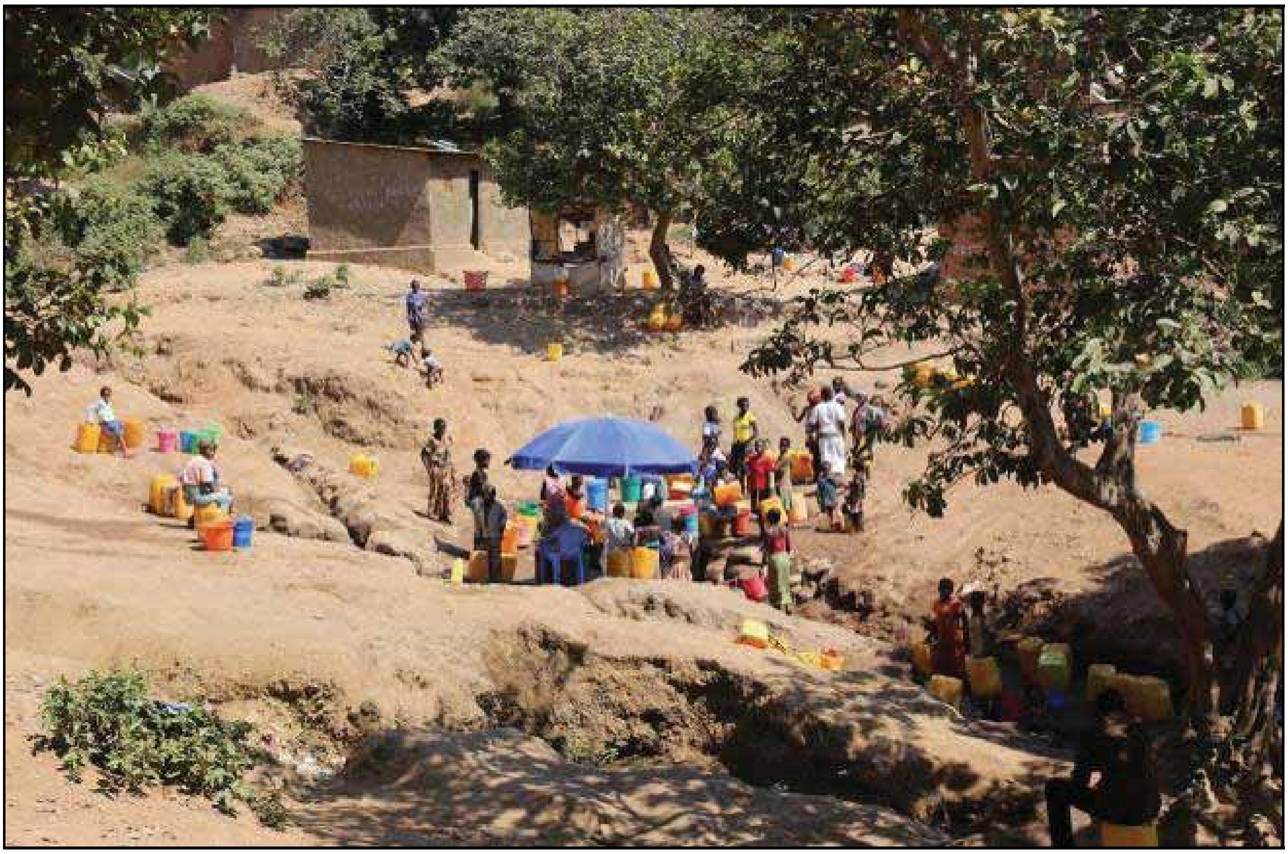
Based on the WHO Guidelines, a three tier arrangement is proposed for integrating water quality testing within the national VEA programme comprised of four main steps. In addition, a mandatory Level Zero and Level 1 for 'new water supply sources' is proposed that is considered to be the minimum level of "due diligence". Level Two for 'WSP verification monitoring' are to be directly integrated within the scope of the existing VEA programming framework by the operators of the plan. Level Three for 'WSP audits' is to be implemented progressively as part of the planned follow-up support provided after 'Healthy Village' certification by the Health Zones and targeted in areas with high risk factors (e.g. mining areas, peri-urban quartiers, etc.). It is proposed to insert these interventions within the VEA process itself, positioning each water quality testing intervention within a specific "Pas" (step) of the project cycle.

Level Zero: New water sources: "Identification of Hazards and Risks"

One of the first steps in developing a WSP is to describe and characterize the water system to identify potential hazards. As part of this assessment, physical, bacteriological, and chemical water analyses should be carried out to ensure that the water meets acceptable standards. The aim of this initial water quality test is to identify if a specific contaminant is of concern, establish a water quality baseline, and track changes in water quality over time. For example, the UNEP/Spiez laboratory reconnaissance survey found several wells in the Katanga Copperbelt and Kinshasa region to have naturally elevated concentrations of iron. While not posing a health problem, due to poor taste the local population has rejected to consume the iron-rich water preferring to resort to an unprotected source. This underlines the need to analyse all new drinking-water supply sources prior to their development to explore alternative solutions and ensure that investments are not squandered in a water point which will not ultimately be used by the population.

Gathering supporting information such as historical water quality data for the area of interest (e.g. from private companies, universities, OCC) should also be done as part of the assessment. It was also noted from the site visits that there is generally a need to improve understanding of the catchment area at the village level, including identifying from where the source water originates. This is important in order to have a better appreciation of potential vulnerable points that may compromise the integrity of the water system. It is therefore important for the VEA programme capitalise on local knowledge to better understand the origin and nature of water sources, and to the extent possible to compliment it with scientific hydrogeological knowledge.

Likewise within the WSP component of the VA process, the community or school performs a participatory hygiene and sanitation assessment of the environment with exercises considering awareness to finally prevent disease than to cure and strengthen the household economy. Using the WSP **catchment checklist**, the vulnerability of all the water sources of the village will be assessed, and this will help to understand pros and cons of each option for the water supply. An NGO or private sector service provider will conduct a technical feasibility study for each option identified by the community.[4]



Creating a protection zone around water sources is critical for safeguarding their integrity

In sum, the guiding principle for the VEA programme should be that *no new water supply source is commissioned and handed over to the community without a preliminary water quality test.* It is therefore recommended that comprehensive water quality testing is explicitly included as an integral requirement in the Healthy Village certification process.

In addition, to ensure the sustainability of the water source, the aquifer yield should be evaluated periodically, particularly in densely populated peri-urban areas where the risk of groundwater depletion may be high as was observed during the field visit in Katanga where several sources had run dry after a few years of construction. Information on aquifer yield may already be available with relevant government departments in which case there may not be a need to carryout additional evaluation. Where needed, appropriate measures, including catchment area protection and rain water harvesting, may be taken to help increase aquifer yield.

Standard Operating Procedures – New Water Sources: Certification of new water point by independent actor (HZ or provincial lab)

i) Responsibility: Health zone officials or designated provincial analytical laboratories

ii) Sampling frequency: one-time testing before a new water source is developed/ commissioned or when an existing source is upgraded.

Note: For existing certified 'healthy villages', a one-time analysis should ideally be retroactively conducted

iii) Integration in VEA programming cycle:

For Spring Sources a two-step process is proposed for testing:

(a) Pre-protection: physical chemical and biological (Step 5, community action plan- PAC)

(b) Post- protection: biological (Step 7, impact assessment)

For dug and drilled wells, the water quality testing can take place on reaching the water table but before the physical construction of the water point in step 6 (implementation of the PAC). Another potential is option is to drill test tube wells prior to construction depending on cost.

iv) Equipment: appropriate laboratory analytical facilities

v) Parameters to be measured: The following water-quality data set is proposed as a standard template for testing newly commissioned sources:

Parameter	Indication, purpose	WHO Guideline and remarks	Recommended action for elevated concentrations
Microbiological: *E. coli* and thermotolerant coliform bacteria Total coliform	 Indicators for faecal contamination; Pathogen bacteria and viruses Indicator of the cleanliness and integrity	 Zero CFU (colony formation unit) per 100 ml water No guideline value	 Boil the water. Chlorinate, preferably using combined chlorine tablets as it has long

	of distribution systems and the potential presence of biofilms		shelf-life If clean PET bottles are available, Solar Disinfection (SODIS) method can be used.
Physical and organoleptic: pH Conductivity Turbidity Colour Odour	Taste, important in water treatment Stable conductivity indicates constant water quality and salinity Acceptability; important in water treatment Acceptability Acceptability	No guideline value No guideline value < 5 NTU No colour No odour	If chlorination is required and water is acidic, adjust pH to more neutral range by using neutralizing solutions (Soda Ash). Use a clean cloth to filter and remove the suspended particles To deal with colour and odour problems, a sand and charcoal filter can be used. Three pot filters can be developed at household level. No supply chain is needed.
General parameters Total hardness	Source characterization,	No guideline value	Hardness can be

	technical aspects		removed by softening (addition of lime and Na_2CO_3) or by ion exchange
Alkalinity	Source characterization, technical aspects	No guideline value	No remedial action required
Iron	Taste, acceptability, water treatment	As low as possible, No guideline value	Iron can be removed by aeration, sand filtration or by adsorption using activated carbon or other appropriate materials. [b]
Sulphate	Source characterization, taste, acceptability	No guideline value	High sulphate and chloride concentrations can be reduced using mostly by reverse osmosis
Chloride	Source characterization, taste, indicator of saltwater intrusion	No guideline value	
Fluoride	Risk of dental and skeletal fluorosis	<1.5 mg/l	Fluoride can be removed by adsorption/ precipitation/ membrane processes. If fluoride exceeds WHO guideline and it is not feasible to use this technology,

Dissolved Organic Carbon (DOC / TOC)	Source characterization, acceptability, water treatment	No guideline value	then abandon the water source. DOC/TOC can be removed by adsorption using activated carbon/ membrane process.
Anions – pollution indicators Ammonium Nitrate Nitrite	Pollution indicator for waste water Pollution indicator for waste water and agriculture activities Pollution indicator for waste water	No guideline value; (Switzerland: 0.1 mg/l) < 50 mg/l < 3 mg/l	Carryout an environmental inspection to identify and eliminate source of contamination, if possible. For remediation, adsorption/ion exchange or membrane processes can be used to remove the pollutants. However, as it is difficult to apply these technologies in the DRC rural context, it is recommended that if the WHO

			guideline values are exceeded, the water source is abandoned. [c]
ADDITIONALLY in Kinshasa peri-urban and rural regions	Mercury Zinc Arsenic Lead	< 6 µg/l for inorganic mercury (EU : < 1 µg/l) <600 µg <10 µg/l <10 µg/l	Carryout an environmental inspection to identify and eliminate source of contamination, if possible. For remediation, adsorption/ion exchange or membrane processes can be used to remove the pollutants. However, as it is difficult to apply these technologies in the DRC rural context, it is recommended that if the WHO guideline values are exceeded, the water source is abandoned. [c]
ADDITIONALLY in DRC mining regions or along contaminated rivers	Cobalt	No guideline value; limit values are in discussion in a range of 1-	Carryout an environmental inspection to identify and

and lakes, surface aquatic systems	Nickel Copper Mercury Zinc Arsenic	40 µg/l < 70 µg/l < 2000 µg/l < 6 µg/l for inorganic mercury (EU : < 1 µg/l) <600 µg <10 µg/l	eliminate source of contamination, if possible. For remediation, adsorption/ion exchange or membrane processes can remove the pollutants. However, as it is difficult to apply these technologies in the DRC rural context, it is recommended that if the WHO guideline values are exceeded, the water source is abandoned. [c]
ADDITIONALLY in agricultural regions	Pesticides, Herbicides	Guideline values are defined	Carryout an environmental inspection to identify and eliminate source of contamination, if possible. Raise awareness on appropriate pesticide application methods.

			For remediation, carbon filters/membrane processes can be used to remove the pollutants However, as it is difficult to apply these technologies in the DRC rural context, it is recommended that if the WHO guideline values are exceeded, the water source is abandoned.[c]

[a] It should be underlined that water sources with elevated pollutant concentrations need to be addressed on a case by case basis. While the remedial measures suggested may provide immediate solutions to deal with a specific problem, they do not necessarily address the source of the contamination. This requires more detailed study including repeat verification analysis; determining whether contamination represents acute or chronic health hazard; sanitary and environmental inspection of immediate water source vicinity and/or catchment; implementation of catchment protective measures; accessibility of alternative water sources; and availability and cost of treatment technology.

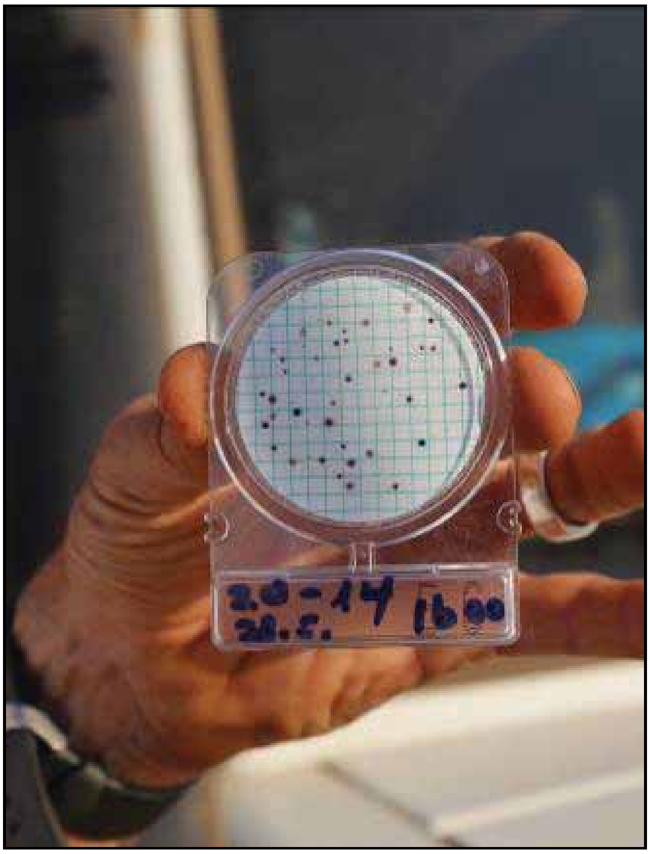
[b] Elevated concentrations of iron do not pose a health risk, so it is acceptable to use the water source even at high concentrations. However, if chlorination is required then it is important to lower the iron concentration as it will reduce the effectiveness of chlorination.

[c] Instead of using the WHO guideline value as the basis for the decision to abandon/close water source, it is also possible to consider the standards set in other countries in the region with similar background as DRC.

vi) Reporting: The water quality test results should be transmitted to the Ministry of Health headquarters in Kinshasa for consolidation into a national water surveillance data base. This should help facilitate information exchange with stakeholders (e.g. for site selection of new water sources) as well as monitor water quality trends.
vii) Cost: The cost for water quality analysis should be built-in with the installation cost. Where feasible the cost may be recovered from the water source maintenance fund. University laboratories typically provide competitive rates for comprehensive water quality analysis.

Level One: Certification- *approval of WSP by independent quality control*

The purpose of WSP certification is to obtain evidence on the performance and effectiveness of control measures in reducing identified risks. For it should never be taken for granted that the WSP is working properly. One of the tools that can be used to accurately confirm that the barriers and mitigation measures put in place under the WSP are effective at eliminating or reducing the identified risks is through water quality testing. For example, as was poignantly demonstrated by the microbial filtration testing during the UNEP/UNICEF field visits which showed widespread contamination of household jerry cans. It is not a prerequisite, however, that validation rely on water quality testing. In some cases and depending on the type of control measures installed, site inspection for example may be sufficient.



Membrane filtration testing of household storage containers showed widespread microbial contamination of jerry cans. Faecal *E. coli* colonies appear blue on the Petrifilm.

For the VEA programme, certification will essentially be limited to microbial hazards and should typically be carried out as part of the Healthy Village certification process at Pas 7 (l'Etude d'Impact). It is also important to distinguish between the testing to take place during the validation, which is typically a one off test to approve the initial WSP implementation, from day-to-day management and WSP verification by the operators. Furthermore, as VEA is a formally sanctioned government process it would be judicious to promote water quality testing as a primary tool for validation so as to underpin the credibility of Healthy Village certification with objective technical information.

Standard Operating Procedures – WSP Certification

i) Responsibility: Health Zone WASH Supervisor/Provinical Laboratory (if necessary)

ii) Sampling frequency: One time testing to assess the effectiveness of the WSP control measures in reducing risks.

iii) Integration in EVA programming cycle: To be incorporated under Step 7 Impact Study (*'Etude d'Impact'*).

iv) Equipment: Standard water quality test kits. No need for advanced instruments.

v) Parameters to be measured: *E. coli*, total coliforms, pH, turbidity, colour, odour, residual chlorine (wherever chlorination is practiced). Ideally, this should be expanded over time to include other key indicators of change in water quality including hardness, ammonia, nitrate, and conductivity. Include any substances that were identified to be of concern in the initial testing of new water sources in Level Zero.

In areas where water sources are suspected of being contaminated with enteric viruses and protozoa, testing for bacteriophages and bacterial spores may be necessary

<u>Note:</u> The WHO Guidelines underline the *'shortcomings of traditional indicators, such as E. coli, as indicator organisms for enteric viruses and protozoa. Viruses and protozoa more resistant to conventional environmental conditions or treatment technologies, including filtration and disinfection, may be present in drinking water in the absence of E. coli.'* WHO suggests that in circumstances where water sources are suspected of being contaminated with enteric viruses and protozoa, it may be necessary to test for *'more resistant microorganisms, such as bacteriophages and/or bacterial spores, as indicators of persistent microbial hazards'.* This concern was also raised in discussions with the head of the microbial section of the CRAA laboratory (University of Lubumbashi) who questioned the effectiveness of *E. coli* testing in detecting microbial contamination of some water sources in the Katanga Copperbelt which are known to be infected with protozoa such as *Giardia intestinalis*. In which case it may be necessary to test the effectiveness of WSP control measures in eliminating protozoa and viruses using indicators such as *Clostridium perfringens* and *Bacteriodes fragilis* as recommended by WHO. Indeed, it is noteworthy that during the visit to the CRAA laboratory, testing for bacteriophages and bacterial spores were being done to assess microbial hazards in newly commissioned water sources.

vi) <u>Reporting:</u> Results should be reported to *Médecin Chef de Zone de Santé* for inclusion in the Healthy Village certification file and the national EVA database.

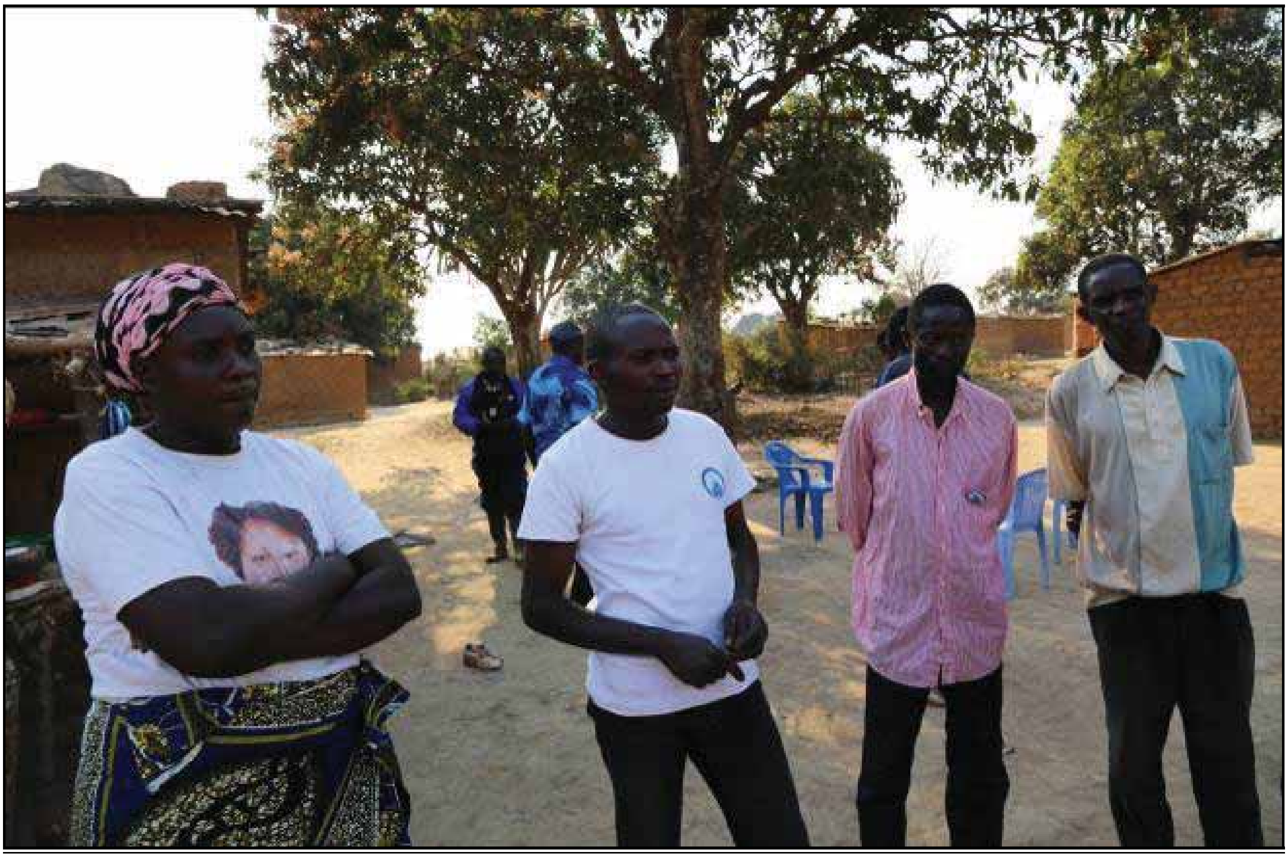
vii) <u>Cost:</u> The cost for water quality analysis should be built-in with the installation cost. Where feasible the cost may be recovered from the water source maintenance fund.

Level Two: WSP Operational monitoring

WSP operational monitoring is the routine checking of WSP control measures by communities themselves to confirm that they are working as planned and are protecting drinking water safety and public health. As it is 'grass root' monitoring by community members, operational monitoring monitoring consists of quick and easy observations and measurements. For the simple point sources (protected springs, hand-pumps) developed under the VEA programme, the operational monitoring will for the most part rely on visual site inspections by the person responsible for the day-to-day operation of the water system. Examples include checking the structural integrity of the fence or concrete plinth surrounding the well head. This type of direct assessment is very similar to sanitary inspections, although time intervals and reporting format may vary.

Water quality parameters selected for operational monitoring should be simple enough to be performed by community operators and able to provide a timely (ideally near instantaneous) indication of performance to allow for rapid operational adjustments in case of a problem. Typical parameters include colour, odour, turbidity and chlorine residual/pH (if chlorination is practiced). During the UNEP/UNICEF field mission in May/June 2013, it was noted that many of the Healthy Village committee members had completed secondary school education and would be capable to perform basic testing with minimal training. They also expressed an enthusiasm to participate in water quality testing to quickly implement corrective actions and to solicit assistance from Health Zone staff if needed.

Microbial testing using H_2S strip bottles can be a practical tool for communities



Healthy Village committee members were enthusiastic to carryout water quality testing

Standard Operating Procedures -WSP operational monitoring ***by operators (Level 2)***

i) Responsibility: Healthy Village committee (participatory water quality testing by communities)

ii) Sampling frequency: Water quality testing should in principle be carried out as part of the regular physical assessments of the water source point performed by the operator during the 12-month warranty period and then the committee, and may be incorporated as part of the WSP maintenance monitoring or sanitary inspections schedule (e.g. regular six-month WSP community auto-evaluation).

As a minimum, community-based water testing should be carried out following a significant incident that may change water quality conditions (e.g. heavy rainfall), an abnormal change in water appearance (brown or cloudy water), or an emergency situation (e.g. flood, epidemic outbreak or increase in water borne diseases, broken sewage pipeline near drinking water source, chemical pollution spill). It would also be useful for communities to occasionally sample the household storage containers (jerry cans) to check if contamination is occurring when water is transported and/or stored.

iii) Equipment: bacteriological, pH and residual chlorine tests (if chlorine is used for disinfection). Required testing materials to be obtained from the Health Zone centre. No instrument or electricity supply source is needed. Where feasible the cost may be recovered from the water source maintenance fund.

Wherever chlorination is practiced, pH and free chlorine residual should be tested using simple visual comparators

iv) <u>Integration in VEA programming cycle:</u> It is suggested that the water quality aspects of verification monitoring be integrated in post-certification component of the regular six-monthly WSP community auto-evaluation and KAP+ survey.

v) <u>Parameters to be measured:</u> Turbidity; colour; odour; taste; and pH and free chlorine residual (wherever chlorination is practiced) and qualitative bacteriological analyses using the H_2S (hydrogen sulphide) strip bottles. If a problem is detected then corrective actions should be implemented. The Health Zone WASH Supervisor should also be informed if additional support is needed.

vi) <u>Reporting:</u> Any results of concern should be reported to the Health Zone WASH supervisor.

vii) <u>Cost:</u> Where feasible the cost should be recovered from the drinking water supply maintenance fund.

Level Three: WSP Verification

For a final confirmation that safe drinking water supply is being achieved and maintained, it is necessary to carryout periodic verification monitoring. In many respects, verification monitoring is similar to operational monitoring except that it is normally done by someone not involved in the day-to-day operations of the water point, such as a public health officer/inspector. The parameters measured in verification monitoring are more detailed and include water quality testing for faecal indicator organisms and hazardous chemicals. Moreover, the results are typically cross-checked against national drinking water quality standards, or if not available as is the case in the DRC, with WHO Guideline values. WSP verification is a rolling process that should be regularly carried out after the Healthy Village certification.

It should also be underlined that the primary purpose of verification monitoring is not so much to assess compliance of individual water points but rather to inform strategic planning. This is particularly true in the DRC context as the sampling frequency proposed is too low to enable timely detection of water quality problems.

Standard Operating Procedures –WSP verification

i) Responsibility: Designated provincial analytical laboratories

ii) Sampling frequency: Water quality testing should ideally be carried out twice a year, once in the dry season and once in the wet season by the Health Zone WASH supervisors. Given the difficulties in sampling the high number of water sources dispersed over a large area, a progressive rolling sampling scheme (e.g. 20-30 percent/annum) could be established where each Healthy Village water supply source is tested once over 3-5 year cycles as per WHO recommendations (WHO, 2011). Alternatively, if local conditions do not allow, then water testing by WASH inspectors should be done randomly (5-10% of water sources) every 3-5 years. As part of verification, it would also be highly useful for the WASH inspector to carryout random sampling of household storage containers for bacteriological contamination.

Health Zone WASH officers have an important role in WSP verification

iii) Equipment:

Full Parameter testing: appropriate laboratory analytical facilities

Reduced parameter: bacteriological, pH and residual chlorine tests. Required testing materials to be obtained from the Health Zone centre. No instrument or electricity supply source is needed.

iv) Integration in VEA programming cycle: WSP verification monitoring should be carried out as a rolling programme of visits following Healthy Village certification.

v) Parameters to be measured: Faecal coliforms, total coliforms, nitrate, ammonia, turbidity, pH, conductivity, colour, odour, hardness, residual chlorine (wherever chlorination is practiced), alkalinity, chloride, sulphate, and fluoride. Depending on the results of the Level Zero tests for new sources, measurements for any elements with high concentrations should be added especially if these include iron, mercury, arsenic, cadmium and lead. In active mining regions, testing for copper, cobalt, zinc, and nickel should be done.

Note: Monitoring of specific pathogens, such as bacteriophages or bacterial spores, may also be included under very specific circumstances where water sources are suspected of being contaminated with enteric viruses and protozoa, or where there has been a recent waterborne disease outbreak.

vi) Reporting: The Health Zone WASH inspector should report the results to the provincial WASH inspector, who should transmit the data to the Ministry of Health headquarters in Kinshasa for consolidation into a national water surveillance data base.

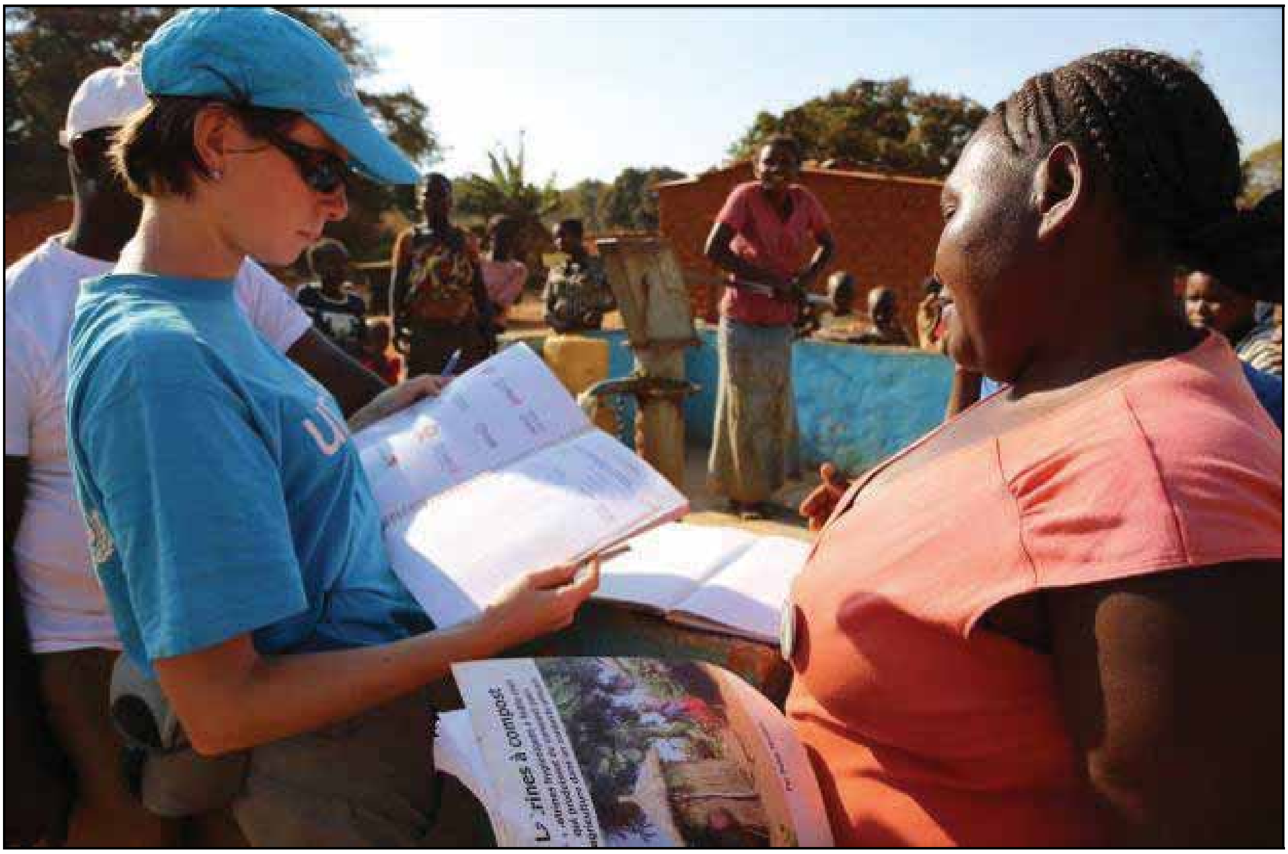
vii) Cost: The cost can potentially be recovered from the maintenance fund of the village. This potential community contribution will need to be assessed for feasibility based on the capacity and willingness to pay.

In the first phase of the programme (2008-2012), most of the water sources (93 percent) in the VEA programme are protected springs, which were generally found by the UNEP/Spiez Laboratory survey to be at greater risk of contamination.

6. Integrating water quality testing in the VEA programme

In upgrading the VEA programme, it is proposed that water quality testing is operationally embedded in two of the 8 « steps » that a village must complete to achieve 'healthy' status, and subsequently during the post-certification period:

- Testing of new spring sources proposed for development to be included in Step 5 'Community Action Planning' (*'Plan d'Action Communautaire (PAC)').*, and for boreholes and dug wells at Step 6.
- Testing for WSP approval by independent actors (part of validation) for all new water supplies to be included in Step 7 'Impact Study' ('Etude d'Impact'). For already certified 'healthy villages', a one-time water quality test should ideally be retroactively conducted based on a rolling sampling programme carried out over a 3-5 year period as part of "post-certification" exercise.
- Testing for WSP operational monitoring by community operators to be included from the time the water point is operational and routinely in post-certification (every six month as part of the WSP community auto-evaluation in post-certification)
- WSP verification monitoring testing to be carried out by independent actors as part of the Healthy Village post-certification monitoring and support, based on the level of risk and the rolling sampling plan.



A guiding principle for Healthy Village certification should be that no new water supply source is commissioned and handed over to the community without a preliminary water quality test.

It is understood that the final decision on the adoption of water quality testing within the VEA programme will need to balance the benefits and costs of water quality analysis. Depending on the level of available local resources and capacities, a three-step “ladder” of water quality testing options that allows for future upgrading is proposed:

- ❖ <u>Minimum:</u> Mandatory testing of new water sources (Level 0 New Sources and Level 1 Certification). Retroactive analysis to be performed for already certified ‘healthy villages’.
- ❖ <u>Moderate:</u> In addition to the above minimum level, testing included in operational monitoring.
- ❖ <u>Robust:</u> In addition to the above moderate level, testing is included in WSP verification as a follow-up rolling programme for certified ‘healthy villages’.

Noting the existing seven norms for 'healthy villages', it is proposed that the VEA programme consider adding a specific criteria to its 1st norm on water quality. This could be formulated as follows: 'At least 95 percent of water samples tested conform to WHO water quality guideline values for microbiological and chemical parameters'.

While numerous commercial field kits for on-site testing are available, it is critical that the supply chain and running cost for consumables is carefully studied.

7. Overview of Water quality testing options

A - Provincial Laboratories. Based on the assessment of provincial laboratories in Kinshasa and Katanga provinces, the DR Congo has the pre-requisite capacity to carryout water quality testing for essential parameters. It should be noted, however, that these are the two provinces with reportedly the most advanced laboratories in the country, and other provinces lack the capacity and equipment to carryout comprehensive analysis. Based on the duplicate sample results provided, only the Office Congolais de Control (OCC) laboratories provided accurate results that were consistently comparable with the results of the SPIEZ laboratory. The four other laboratories visited (University of Kinshasa, INRB, CRAA, provincial public health laboratory) are specialized in microbiological analysis, and appear to be able to conduct reliable and accurate analysis for different bacteria, viruses and protozoa. However, they do not have the required equipment and methods to carryout analysis for standard parameters such as nitrates/nitrites required for basic drinking water quality testing.

Moreover, for certain problem substances namely heavy metals only the OCC has the required equipment to achieve the required low detection limits and provide reliable and accurate results. The main obstacle with relying on the OCC is its elevated rates, which for many WASH actors may exceed the budget available for an initial analysis of new water resources. Furthermore, only the OCC laboratory in Lubumbashi has the capacity to carryout comprehensive analysis of the required parameters. Transferring samples collected from throughout the DRC to the OCC laboratory in Lubumbashi would represent a considerable logistical and financial burden. Strengthening laboratory capacity to carryout water quality analysis, including at selected universities and institutes, would appear to be a judicious and cost-effective long-term solution. For details see "Report III: Laboratory capacity assessment - Capacity building for drinking water quality control''.

B - Portable Water Quality testing kits. A wide range of portable water quality testing kits is currently available in the market. The suitability of these testing kits should be examined based on the following criteria: i) technical efficiency; ii) range of parameters measured; iii) requirements for consumables and spare parts available locally; iv) independence from power supplies; v) cost; vi) ease of use including portability; and vii) safety. Dependence on non-standard glassware, and particularly consumables (such as microbiological culture media, reagents for chemical tests) is an issue of particular importance that needs to be carefully examined. These items are often expensive and may only be available from the manufacturer of the portable equipment. In the DRC, where delays in importation and problems with transport are legion, it is critical that the supply chain and the running cost for purchasing consumables is established before any decision on testing options is made.

As indicated above, water quality testing for 'Level One: WSP water point certification' and 'Level 3: WSP verification' can be performed by a wide variety of reasonably priced test kits. Some of the well known brands which may be appropriate include: i) Wagtech WTP Potatest (R); ii) Sandbera & Schneidewind and iii) HACH water quality test kit. In India, for example, more than twenty water quality field test kits are available on the market. Several of these kits may also be appropriate in the DRC context including: CPCB (Central pollution Control Board, India), Jal Dhara, TWAD Board (Tamil Nadu Water and Drainage Board) which typically analyse between 8-11 water quality parameters. Based on a comprehensive performance evaluation of field water quality test kits carried out by the UNICEF India Office in 2005, the aforementioned kits were all reported to have functioned well[5]. In India, UNICEF developed its own water quality test kits which are being used to obtain rapid assessment of water quality. The pilot scale studies carried out by the India Institute of Technology on water quality surveillance using test kits proved very successful. Moreover, in Tamil Nadu state, the Water Supply and Drainage Board also developed there own test kit and provided it to all panchayats (lowest Government administrative unit) to carryout water analysis. As and when there is a major problem, water samples are analyzed in fully equipped laboratories. Training the trainers was the approach used by the government. The cost for the test kits in India varies from USD 30 to USD 300. The charge per sample analyses is less than one US dollar.

Simple visual colour comparators can be used for measuring residual chlorine and pH

C - Community-based tests. For 'Level Two: WSP operational monitoring' by local communities, the turbidity and colour tests can be performed visually using a glass. Simple visual colour comparators can be used for measuring residual chlorine and pH. For qualitative microbiological contamination, H_2S strip bottles are sufficient. This can be imported or locally manufactured in a university laboratory. UNICEF typically obtains the H_2S strip bottles at a subsidised rate of around 0.5 US cents per bottle from India. The India Institute of Technology Madras (IIT) has prepared the kits for around 0.05 US cents per bottle. The cost for fabrication of the H_2S strip bottles is equally split between the cost of the bottle and the chemicals used. It is estimated that if the H_2S strip bottles are prepared locally in the DRC, it can be done at less than 20 percent of the cost of commercially available H_2S bottles.

Finally, the selection of water quality testing options is not only based on the technical methods, but it is also equally important that adequate resources are devoted for training to ensure appropriate use of the selected test kits and consideration is made of the significant bottlenecks for the logistics of managing the supply chain of water quality testing supplies. Priority should be given to areas presenting elevated risk levels.

8. Prioritizing sampling locations

As it will not be possible for the VEA programme to undertake extensive surveillance of all water points at least in the short-term, the ideal approach would be to start by designating "high risk areas" requiring water quality testing. The DRC lacks, however, the baseline water quality, hydrogeological and land use data to identify and map priority sites in the level of detail required for operational purposes. Given this data vacuum, a schematic approach for designating priority sites focusing on two main areas is proposed:

i) areas affected by cholera outbreak and other waterborne epidemics, particularly in peri-urban centers; and

ii) mining regions with known pollution problems, namely the Katanga Copperbelt region and artisanal gold mining sites (given the risk form mercury use) in Ituri, South Kivu, and northern Katanga.

While this still covers a relatively large territory, it should nevertheless be feasible to develop a more practical sampling regime targeting these sites. Focusing on these higher-risks areas initially, will allow to pilot-test the above propose methodology, and assess its cost, before refining it and scaling it up nationally in the future.

Widespread microbial contamination of shallow dugout wells was found in the UNEP/Spiez Laboratory survey. The dugout well in this photo (not a VEA water point) is considered to be at the epicenter of a recent cholera outbreak in Likasi town (Commune Kikula). Although point of use chlorination was in this case found to be effective, it remains a very high risk source and should be prioritized for integration in the VEA programme.

Furthermore, the matrix below provides a generic scheme for ranking priority areas for water quality testing at the local level. It also proposes a water quality testing method based on the risk associated with water source type and physical accessibility.

RISK / ACCESSIBILITY	LOW	MEDIUM	HIGH
LOW	A	B	C
MODERATE	D	E	F
HIGH	G	H	I

Low Risk Areas: Hand pumps with depth of more than 15 meters. This depth is not a hard and fast rule, and will vary based on hydro-geological conditions (e.g. confined/unconfined aquifer). However, a depth of 15 meters is adopted as a thumb rule. (Note: in active mining areas activities the risk is considered to be moderate to high).

Medium Risk Areas: Shallow hand pumps (depth less than 15 meters), protected springs.

High Risk areas: Dug wells, shallow hand pumps near wastewater drains in peri-urban areas. Unprotected or poorly built/maintained protected springs. Hand pumps/ protected springs in active mining areas. Areas experiencing cholera or waterborne epidemics or a reported increase in waterborne disease incidence.

Based on the risk matrix, presented above, orientations are proposed for each of the nine risk categories. The risk matrix is meant to assist in adapting the application of the three tier water quality testing approach to field realities including level of risk, physical accessibility and the availability of resources. These orientations should be applied to prioritize the WSP approval and auditing by independent actors of the WSP SOPs.

A: Observe for any abnormal activities (including more than usual number of sick people). If there is any abnormality, check for turbidity (using a glass), odour and smell. If any problem, boil the water prior to drinking. In the event the problem results, refer to the Health Zone centre.

B: Observe for abnormal activities, including more than usual number of sick people. If found, check for turbidity (using a glass), odour and smell. If any problem detected, boil the water prior to drinking. Report to the nearby Health Zone centre to do the analyses of water samples at source and household level (H_2S strip).

C: Observe for abnormal activities; Do the test for turbidity, colour, odour and H_2S strip. If problem is there either chlorinate the water or boil it. Carry out the H_2S strip testing at suspected households.

D: Check for turbidity (using a glass), odour and smell. Boil the water. Inform the Health Zone WASH Supervisor on the need for water analyses, which should include FC, TC, ammonia, nitrate, turbidity and pH. Also H_2S strip testing at suspected households. Suggest for remedial measures.

E: Check for bacteriological quality using H_2S, turbidity, colour odour. If problem is there chlorinate the water or boil the water. Also carryout H_2S strip testing at suspected households. Inform the health zone to analyse for FC, TC, ammonia, nitrate, turbidity and pH.

F: Check for bacteriological quality using H_2S, turbidity, colour, odour, residual chlorine if chlorination is practiced. H_2S strip testing at suspected households. If problem is there, chlorinate or boil the water. Inform the Health Zone centre, which should analyze for FC, TC, ammonia, nitrate, pH, turbidity, iron, copper, hardness, chlorides, and sulphates.

G: Always chlorinate or boil the water. If any problem is observed (turbidity, colour, odour, taste) report to Health Zone centre, which should analyse for FC, TC, ammonia, nitrate, pH, turbidity, hardness, alkalinity, sulphates, and chlorides.

H: Always chlorinate the water. Check the chlorinated sample for residual chlorine. Also H_2S strip testing at households. Health Zone WASH officer to carryout water sample twice a year in dry and rainy seasons for FC, TC, ammonia, nitrate, pH, turbidity, hardness, alkalinity, sulphates, chlorides, iron, arsenic, mercury and copper.

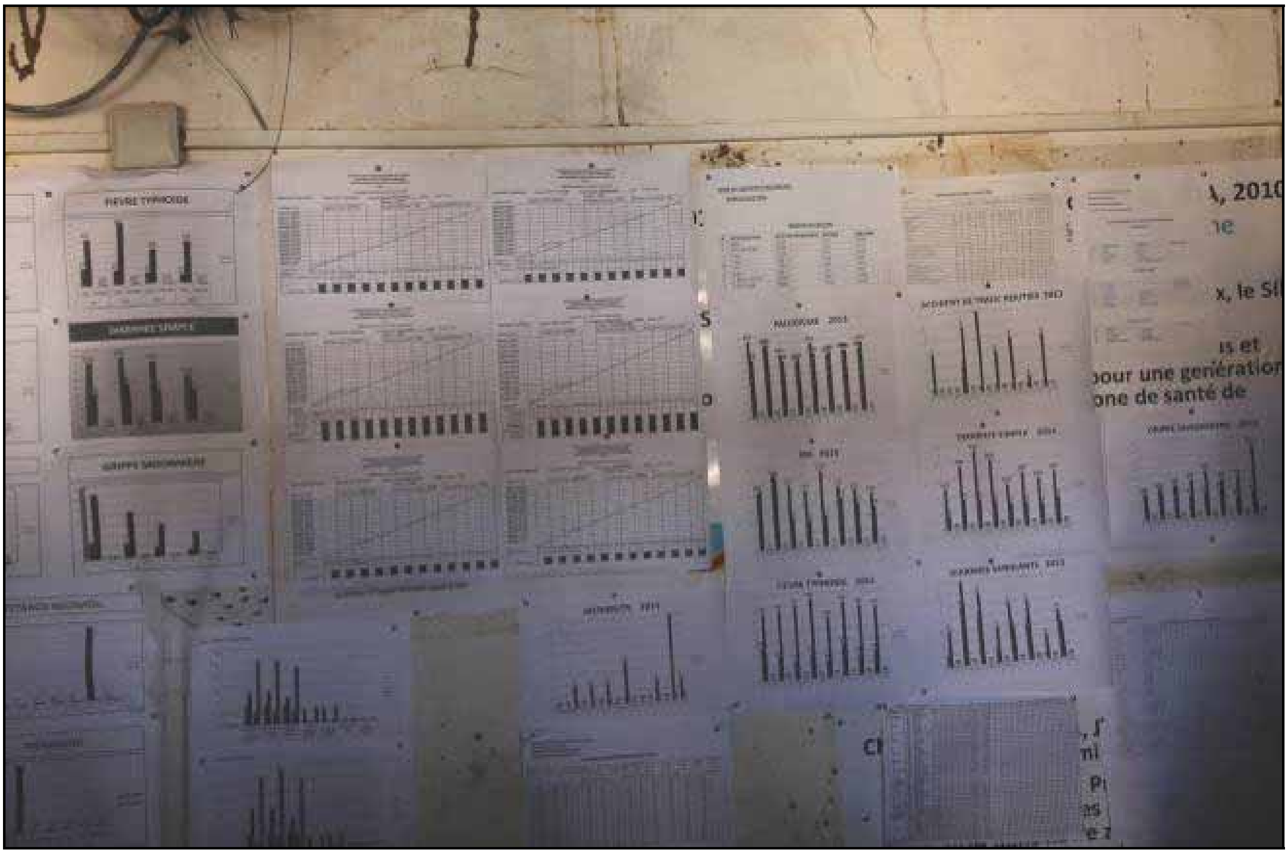
I: Always chlorinate the water/boil the water. Check the bacteriological quality and residual chlorine concentration at regular intervals both at source and household level. If problem is found, get it checked by Health Zone centre, which should analyse for FC, TC, ammonia, nitrate, pH, turbidity, hardness, alkalinity, sulphates, chlorides, iron, arsenic, mercury and copper. If high value is found, do the detailed analyses in the designated laboratory facility.

Note:

- Copper, cobalt, arsenic, mercury and lead analyses are typically needed only for active mining areas.
- Irrespective of the risk condition and accessibility, advice the household to clean the water storage vessel before filling it and keep it in closed condition to avoid contamination.

9. Information management

Water quality testing will generate considerable volumes of data. Establishing a computerised data management system at the national level to rapidly archive, analyse and present this information would be an extremely useful tool for both operational and strategic planning. It may also be possible to extend computerization to the provincial levels depending on available resources and capacity. A web-based Geographic Information System (GIS) platform would be a powerful way for sharing water quality results in real-time, especially if geo-referencing data is included with sample collection. An example of this is the display of data on water quality in selected East African cities through UN-HABITAT's partnership with Googlel.org in the h2.0 Information Services to Inform and Empower on www.h20initiative.org. It may be feasible to include such an application under the on-line 'Healthy Village Database' (*Base de Donnée Village Assaini*: http://www.ecole-village-assainis-bdd.cd/va/). At the regional and national level, an annual report on water quality could also be prepared and circulated to promote information sharing within the sector. Notwithstanding the information exchange scheme selected, it is important that there is a clear road map on how this will be done.



A computerised information system is needed to manage the large volumes of data generated by water quality testing

10. Recommendations

The generic water safety plans (WSPs) will be directly integrated into the VEA project cycle. Thus all new villages/schools will develop the WSP as part of their process to become a Healthy Village/ School. For villages and schools certified prior to the roll-out in 2014, the preparation of the WSP will be conducted progressively as part of the post-certification support and monitoring.

However, prior to introducing water quality testing component in the VEA programme at scale (250 health zones), it is recommenced that several pilot projects are implemented to demonstrate its viability in the DRC context. The purpose of the pilot project will be to fully document the successes and challenges of introducing water quality testing in different regions of the DRC, so that the lessons learned can be used for scaling-up in the VEA programme as well as for wider advocacy in the WASH sector. The following approach is proposed:

1) Implement demonstration project for the independent quality control of WSPs

The purposes of the pilot are to demonstrate that water quality testing can be successfully implemented in the DRC context, provide a local model and help build local capacity and experience. Based on their vulnerability to water pollution, it is provisionally proposed that three pilot projects are carried out in high risk areas: (i) Katanga Copperbelt region; (ii) Kinshasa peri-urban; and (iii) gold mining areas of South Kivu province or Ituri district. It is also suggested that the geographic scope of the pilot be at Health District level and that it is implemented within an 18 month period.

2) Evaluate demonstration project

Upon completion of the demonstration project, an external review should be carried out to inform the VEA strategy for scaling-up. Key issues to consider in the pilot evaluation include: (i) feasibility of wider implementation under existing resources and capacities; (ii) the longer-term added value for the VEA programme; (iii) a budget estimate (including for training, equipment and supporting materials); and (iv) how the challenges faced were addressed.

3) Establish strategy for scale-up

Based on the experience gained from the demonstration project, the VEA programme should re-evaluate this "initial" strategy and develop a detailed plan for scale-up and dissemination beyond the VEA programme to the water sector in DRC. Key points that need to be considered include a review of roles, responsibilities and capacities. A workshop involving WASH stakeholders and international partners may also be organised to present the process and outcome of the demonstration project highlighting benefits, timeframes, as well as challenges and opportunities for wider replication.

Finally, given that the DRC lacks drinking water quality regulations and standards, it is necessary that these are established in order to underpin water quality testing with legal backing. The pilot project can help inform the judicious selection of substances that are of concern under national circumstances. In setting the standards a number of factors will need to be taken in consideration including prioritisation of the most important parameters to measure for public health protection, acceptable risk level, cost of testing, allowance for regional differences including between large urban centres and community-managed rural supplies and water points, technology requirements, and enforcement capacity of institutions.

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[1]Base de Données Village Assaini:
http://www.ecole-village-assainis-bdd.cd/va/modules/rapport/

[2] "Water safety Planning for Small Communities" WHO, 2012

[3] WHO, 2012.

[4] Reference to WSP Framework, Pas A Pas, Roberto Saltori, Sept 2013

[5] For further information, see UNICEF/Shriram Institute for Industrial Research (2005). "Evaluation of Water Quality Field Test Kits."

More technical information available at:
http://www.unep.org/disastersandconflicts/
or: postconflict@unep.org

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