2nd Version

ITN
Bangladesh

Water Safety Plan

For
Dug Well in
Rural Water Supply System

DPHE

April, 2006

Introduction

The first edition of the model water safety plan for Dug well was prepared in December, 2004 for use in Bangladesh. The model WSP was then tested by several organizations in their respective pilot projects to observe its appropriateness for application under local context. The pilots were implemented over a period from February to November 2005 with slight difference in their durations. The experience of the pilots has been captured and documented in March, 2006. Based on the experience and lessons gained from the pilots projects the first edition has been revised.

Below is the process through which WSP for Dugwell was developed and revised:

- A workshop was organized by APSU in November, 2004 with the sector professional from government organization, NGOs and Development partners.
- During the workshop one group was assigned to prepare the outline of a model WSP for Dugwell through systematic analysis and consultative process.
- During November and December, 2004 a complete WSP document for Dugwell was prepared as a first edition.
- During March, 2006 APSU organized a workshop to review the first edition in the light of the experience gained from the pilots.
- Based on the review results and recommendations of the March, 06 workshop ITN-BUET and DPHE has revised the first edition to form the second edition of the model WSP (for Dugwell) as of April 2006.

Now, it is expected that the government and non-government organizations can apply this version of Water Safety Plan (WSP) directly. However, if they feel that there is need to make further changes based on their own water supply system the concerned organization can do that keeping a record of the changes made. A separate sheet is added in the following page to keep record of the changes already made or to be made in future.

Document Change Record Sheet

Location	Changes made	Remarks
General Page-2	Insertion of *Document change record sheet*	To be filled in by individual organization making changes in the document
Page-3	Insertion of *Document development history and approval table*:	To be updated by individual organization implementing the WSP
Table 2	Rewrite description of process steps: 'water source', replace 'distribution' by 'transportation' delete the approval table below	
Table 3	Shifting of 'iron' from safety parameters to aesthetic parameters	
Table 6	Add a column for additional control measures Delete last 2 columns: 'Basis' and 'action required'	
Table 6 DW0	Delete 2nd item of DW0	
Table 6 PSF2	Add a hazardous event on leafy trees overhang on pond	
PSF3	Add a hazard event on contamination by lizard and vermin at water chamber	
PSF5-8	- Rewrite existing control measures - Rewrite additional control measure column	At present no specific control measures are in place except some general hygiene messages
Table 7	Change of order of the Tables. Table-8 was brought to front as Table 7 and renamed as *Operational Monitoring schedule*	
	Table 7 was brought down as Table-9 and renamed as Improvement Action Plan.	
	Specify the support programmes and link them to Table 10:Improvement Action plan	
Table-8	Add one monitoring activity for vermin protection	
Table10	Add this table to delineate various support programmes for smooth implementation of WSP	

Proformas

1. The WSP Team

The first step of implementing the WSP is to form a team of people from implementing organization/s and DPHE working on water safety plans for Dugwells. It is preferred that the team will include people having different discipline and those with technical ability to develop and implement WSP.

Table 1

Name	Organization	Title	Role in WSP team	Contact Information	
				Address	Telephone, E-mail

The WSP documents are dynamic documents. As new information and experience becomes available about the water supply technology system and as the system improves the WSPs can be improved and modified to reflect these changes. Therefore, the implementing organizations should assign a person who will be responsible for updating the WSP and disseminate it to WSP team members through a set process of the organization.

Document development history:

Edition	***Date***
1st edition	*November 2004 by Guy A. Howard, APSU*
2nd edition	*April 2006 by SG Mahmud , ITN*
3rd edition	*……..*

Document Approved by: *Name: ……*

Date:……..

Table 2. Water supply process description

Step	Description
Water source	Abstraction from groundwater via an improved dugwell. Generally withdrawal is via a hand pump, however, rope and bucket system is also observed.
Water treatment	In most dug wells, water is not treated at the source, as a consequence, no other chemicals are currently added to the water in terms of treatment and need not be considered further. In some wells, chlorine is added the well and therefore chlorine residual is important. Some designs include a sand filter, but no chemicals are added so these need not be considered further.
Transportation of water	Water is carried to the home by households, generally using clay or metal pitchers, plastic jars etc.
Storage at Homes	Although water is not treated, after distribution, water is transferred into a kalshi for storage in the kitchen area. Storage kalshis are generally kept above the floor but are not covered.
Any special controls required?	Contamination of stored water must be controlled. For hanpdump, priming water quality control is important. Where rope and bucket used, prevention of introduction of contamination from the bucket must be avoided.
Water quality requirements?	Water quality is compared against the Bangladesh Standards for drinking water (GoB, 1997) and will be informed by the results of the QHRA.

Table 3. Intended uses of water and nature of consumers

Intended Use	Intended Consumer
❑ Water is obtained from dugwells and is intended for use in the home for drinking and cooking. ❑ A caretaker looks after the well. ❑ Water should meet safety and quality (aesthetic) standards i.e. the Bangladesh Drinking Water Standards (GoB, 1997): ❑ Safety (subset of parameters): o *E. coli* o Turbidity o Free chlorine residual (where chlorinated) o Arsenic o Nitrate o Manganese ❑ Aesthetic requirements (includes sanitation and clothes washing issues): o Taste not unpleasant o Colour o Iron o Turbidity	❑ The users of the water are people residing in villages and include the healthy, young, old, pregnant and immunocompromised. ❑ Misuse of the water has been observed through priming of the pump with water of potentially a lower quality than sourced from the dugwell. A number of users transport water in vessels that are not kept solely for drinking water use and store water in unsanitary conditions, which can lead to contamination. Controlling these risks requires hygiene education about the safe water chain by hygiene education staff working at the Union and Upazila level. ❑ Dug wells are tested for arsenic on commissioning and community was informed of the results. At present no system is in place for community to access water quality testing, but this is being established in the DPHE Upazila office.

Table 4. Technology description (should be supported by community water and sanitation maps prepared for individual communities and sanitary surveys)

To be completed by each organisation applying WSP for Dug well

Issue	Information	Attached documents
Standard design		
Usual setting		
Materials specification		
Source protection measures required		
People served by an individual facility		
How technology is managed		
Training requirements		
Requirements for tests prior to commissioning		
Data on facilities constructed		

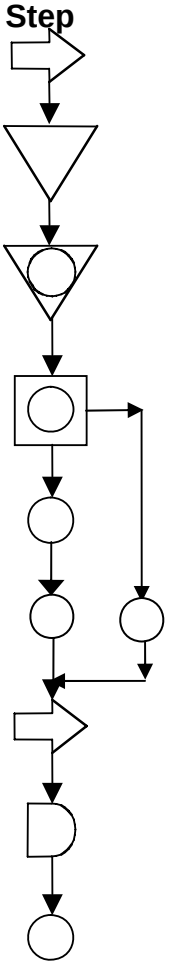
Date Prepared: ----------

Date Revised: ----------

Date Approved: ----------

5. Process flow diagram for Common Dugwell (with Sand filter).

Code	Step	Description	Responsibility
DW1		Source (catchment)	Agencies, community
DW2		Source (groundwater)	Agencies, community
DW3		Dugwell	Caretaker
DW4		Handpump	Caretaker
DW5		Sand filter	Villagers
DW6		Water collected in vessel	Villagers
DW7		Water transported in vessel	Villagers
DW8		Storage at point of use	Villagers
DW9		Use	Villagers



Symbols:

Key:

Operation

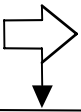
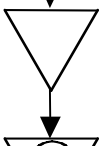
Transport

Storage

Inspection

Delay

Table 5. Process flow diagram for Dugwell without Sand Filter.

Code	Step	Description	Responsibility
DW1		Source (catchment)	Agencies, community
DW2		Source (groundwater)	Agencies, community
DW3		Dugwell	Caretaker
DW4		Handpump	Caretaker
DW5		Water collected in vessel	Villagers
DW6		Water transported in vessel	Villagers
DW7		Storage at point of use	Villagers
DW8		Use	Villagers

Symbols:

Key:		
		Operation
		Transport
		Storage
		Inspection
		Delay

Table 6. Hazard analysis

Process Step	Hazardous Event	Hazard Type	Control Measures current	Risk	Control Measures Planned
DW0 Social exclusion	Poor members of community excluded from use of source because of income, gender to other social barriers	Social		U	Ensure that all members of the community involved in water supply development from start
DW1 Catchment around source	Leaching from over-application of fertilisers or organic waste dumps	Nitrate, nitrite and ammonia		U	Fertilisers not used within at least 10m of the well Waste dumps located at least 10m from the well
	Faecal contamination through sub-surface leaching from human or animal waste	Microbial (B,V) Nitrate	Country wide social mobilization for sanitation Prevent open defecation by community	S	- Provide fence around dug well - Prevent animal yard/pen within 10m of well - establish safe distance for installing pit latrine(if no specific guidance then use 10m from well as a default)
DW2 Groundwater used for dug well	Presence of natural chemicals in dug well	Arsenic, manganese	Dugwell construction manual, which suggests use a test borehole to expected depth before digging well And testing of all water sources prior to commissioning	S	
DW3 Dug well	Ingress of contaminated water through poorly sealed joints in the well lining	Microbial (B,V,P)	Joints between rings are prepared effectively and are strong and impermeable	S	
	Ingress of contaminated surface water into the well	Microbial (B,V,P)	Ensure apron around the well (at 2.5-3 ft from headwall) slopes way from well and in good condition Ensure headwall height at least 3 ft Ensure cover in place on the well Prevent defecation (human or animal) within 10m	S	Fencing around dug well to prevent animal damage
	Introduction of faecal material through using an insanitary bucket	Microbial (B,V,P)	Have a single dedicated bucket for water withdrawal ensure it cannot be placed on the ground	S	
	Introduction of contamination surface water during inundation	Microbial (B,V,P)	Ensure adequate drainage around dug well	S	
	Well is a breeding ground of *A.Aegyptae*	Biological	Ensure vents have mosquito meshing in good condition	S	Ensure all vents have mesh in good condition

	Breakthrough of pathogens because of under-chlorination	Microbial (B,V[1])	Ensure well is regularly chlorinated with sufficient concentration of chlorine	S	Chlorinate well at least twice per year
	Raised turbidity in well from poor construction and/or siting	Turbidity, microbial (B,V)	Site well away from stagnant surface water and ensure construction prevents sand boiling	U	Ensure well siting appropriate and standard design used
DW4 Handpump	Ingress of contaminated water from pump	Microbial (B,V,P)	Pump platform at least 3ft and pump attachment is firm Proper drainage around platform to discharge water at least 10 ft from well	I	Ensure pump located to side of well and has proper drainage
	Contamination introduced through use of contaminated priming water for handpump	Microbial (B,V,P)	Ensure pump foot valve in good condition Ensure only clean water is used to prime handpump	S	Install new seat valves Replace pump with direct action pump, but may require casting reinforced cover slab with inspection hatch & cover
DW4A Sand Filter	Media dries and biologically active layer is inactivated	Microbial (B,V,P)	A constant head device is constructed in the filter	S	
	Improper grading of filter media	Microbial (B,V,P)	Ensure filter media in each bed is of appropriate size and follows standard design	S	
	Flow rate decreased	Microbial (B,V,P)	Filter media cleaning and replacement schedule followed	S	
	Contamination of water by lizard and vermin	Microbial (B,V,P)	-	S	Provide lizard and vermin proof cover
	Handpump, gasket or valves damaged	Physical, Microbial (B,V,P)	Handpump, bucket and valves kept in good condition through regular maintenance	S	Caretakers training
DW5 Water collected in vessel	Collected water becomes contaminated due to dirty container	Microbial (B,V,P)	Vessel should be cleaned regularly with clean water and if possible soap or washing powder	S	Hygiene education in community
	Water becomes contaminated from unclean hands used to direct water into vessel	Microbial (B,V,P)	Ensure that vessel is put close to spout to allow direct entry of water	S	Hygiene education in community
DW6 Transport of water	Water becomes contaminated during transport in an uncovered container	Microbial (B,V,P)	Ensure vessel has a cover	U	Hygiene education in community
DW7 Storage at point of use	Water becomes contaminated from animals in home	Microbial (B,V,P)	Ensure vessel is covered at all times when water not being used Water stored at elevated levels	S	Hygiene education in community

[1] Chlorination is not effective for protozoa

DW8 Use	Water becomes contaminated because dirty utensils used to scoop water from storage	Microbial (B,V,P)	Use clean dipper or cup to withdraw water Tip water from container into drinking vessel	S	Hygiene education in community
	Water becomes contaminated because users dip unclean fingers into the pot	Microbial (B,V,P)	Use clean dipper or cup to withdraw water Tip water from container into drinking vessel	S	Hygiene education in community
	Water contaminated because dirty drinking utensil used	Microbial (B,V,P)	Use clean cup for drinking	S	Hygiene education in community

NB: B = bacteria; V = viruses; P = protozoa

S = significant; U = uncertain; I = insignificant

Table 7. Operational Monitoring Schedule.

Process Step	Performance Indicator	Monitoring		Critical Limit	Corrective Action		Supporting Programs
Catchment around source	Land use close to dug well	What:	Land-use around dug well	No latrines, animal pens, waste dumps or fertiliser use within 10m of the well	What:	Re-siting of latrines, animal pens, waste dumps Stop fertiliser use	Training of committee and caretaker Education and motivation of communities to change defecation practice (see sec.#1 of Table 10)
		How:	Catchment inspection		How:	Use of local bye-laws and community dialogue	
		When:	Monthly		When:	As soon as identified	
		Where	In catchment area (10m radius from well)		Who:	Community committee	
		Who:	Caretaker and committee				
Groundwater	Quality of groundwater used for dug well	What:	Tests for arsenic, manganese and other key chemicals	All chemical parameters meet GOB standards	What:	Paint Arsenic contaminated tubewells red and provide alternative source	Develop local testing capacity Arsenic awareness-raising campaigns Ongoing screening programmes Periodic checking to ensure paint has not worn off
		How:	Field test kits		How:	Through ongoing testing programme	
		When:	Before commissioning water supply Periodic tests		When:	On detection of arsenic above GOB standard	
		Where	At source		Who:	Community supply: Implementing organization (e.g. NGO, LGI or DPHE) Household supply: LGI and household	
		Who:	Community supply: NGO or DPHE Private supply: LGI and/or household arranges for test				
Dug well	Sanitary maintenance of well	What:	Condition of well lining, headwall, cover, apron and bucket (if used)	No cracks in protection works, cover in place and bucket (if used) stored properly	What:	Repairs to protection works. Replace cover and seal properly Replace bucket	-Caretaker training and O&M manual (see sec.2 of Table 10)
		How:	Sanitary inspection		How:	Re-grouting of concrete works Cast cover Purchase new bucket	
		When:	Monthly		When:	Protection works: within 7 days Bucket: within 1 day	
		Where	At the well		Who:	Caretaker	
		Who:	Caretaker				

Dug well	Drainage around well	What:	Prevention of inundation	Drains in good condition and clean	What:	Repair damaged to drains and clean	-Caretaker training
		How:	Sanitary inspection		How:	Mortar over cracks	
		When:	Monthly		When:	Within 3 days	
		Where	Drainage around well		Who:	Caretaker	
		Who:	Caretaker				
	Protective maintenance of well	What:	Prevention of mosquito breeding	No damage to mosquito mesh on vents	What:	Repair damaged mesh on vents	-Caretaker training
		How:	Sanitary inspection		How:	Replacement of mesh	
		When:	Monthly		When:	Within 3 days	
		Where	Mesh on vents and inside the well		Who:	Caretaker	
		Who:	Caretaker				
	Chlorination of dug well	What:	Effective chlorination	Smell or taste of chlorine is present	What:	Dose chlorine according to O&M instructions provided	-Caretaker training -Chlorination schedule -Sanitary maintenance of dug well
		How:	Smell and taste		How:	Use drip feed or porous pot chlorinator	
		When:	Daily after chlorination until no chlorine detected		When:	Once no taste or smell of chlorine in the dug well	
		Where	At well		Who:	Caretaker	
		Who:	Caretaker				
	Quality of dug well water	What:	Turbidity of water	Water is not visibly turbid	What:	Determine cause of turbidity and take action	Tubewell mechanic training Support for rehabilitation of dug wells
		How:	Visual inspection		How:	Rehabilitation or upgrading of dug well (e.g. cast permeable slab for base of well or install filter)	
		When:	Monthly		When:	Within 1 year	
		Where	Water from well		Who:	Caretaker, tubewell mechanic, Sub-Assistant Engineer	
		Who:	Caretaker				
Handpump	Sanitary maintenance of pump platform	What:	Sanitary condition of pump platform	Cracks in platform Pump loose at point of attachment	What:	Fill cracks with mortar	-Caretaker training
		How:	Sanitary inspection		How:	Using appropriate mix of mortar	
		When:	Monthly		When:	Within 7 days	
		Where	At pump platform		Who:	Caretaker	
		Who:	Caretaker				

Handpump	Proper drainage around pump	What:	Sanitary drainage around pump platform	Drains are blocked or stagnant pools form within 30ft	What:	Clear drains	Caretaker training Provision of basic maintenance tools
		How:	Sanitary inspection		How:	Using shovel	
		When:	Monthly		When:	Within 7 days and before rains arrive	
		Where	At pump platform		Who:	Caretaker	
		Who:	Caretaker				
Sand filter	Development of biofilm	What	Submergence of sand bed	Sufficient water head above the sand bed	what	Maintain minimun water level on the sand bed	-Caretaker training
		How	inspection		How	Install constant head device or close the underdrain tap	
		When	daily		when	immediately	
		Where	On sand bed		who	caretaker	
		who	caretaker				
	Filter clogging	What	Filter flow rate	Water height below overflow pipe	What	Cleaning of sand bed	-Manitenance manual -Caretaker and community training (see sec. # 2 of Table 10)
		How	Water height above sand bed/overflow		How	Scraping of top sand layer	
		When	Once in a month		When	Within one day of overflow	
		Where	At the filter outlet		who	Community and Caretaker	
		who	caretaker				
	Chlorination	What	Chlorine dosing	Chlorine smell disappeared	What	Ensure proper dosing	-Caretaker training -chlorine dose schedule (see sec #3 ofTable 10)
		How	Smell of chlorine from tap water		How	Refill/repair chlorine dosing device	
		When	daily		When	immediately	
		Where	At chlorinator		who	caretaker	
		who	caretaker				
Post source	Hygienic water use	What:	Hygiene practice during collection, transport and storage	Water collection, transport and storage is hygienic	What:	Key hygiene messages	Development of hygiene education materials and training of community hygiene promoters (see sec.#6 Table 10
		How:	Hygiene inspection		How:	Hygiene education session/leaflets/mass media	
		When:	Regularly within community		When:	Ongoing	
		Where	With households and in community		Who:	Community hygiene promoter	
		Who:	Community hygiene promoter				

Table 8. Surveillance and Verification schedule.

Activity	Description	Frequency	Responsible Party	Records
Effectiveness of water safety management	Regular meetings with community and/or water and sanitation committee	Regular sample of communities visited each year	NGO/DPHE	Data stored at local levels (VBO or UP) and transferred to national water supply information centre
Reduction of social exclusion to source	Regular meetings with community and/or water and sanitation committee	Regular sample of communities visited each year	NGO/DPHE	
Sanitary inspection	Inspection form to include all major hazard events (up to 21 parameters) that may occur due to poor infrastructure condition and poor catchment protection	Source: twice per year (dry season and monsoon) Household: random selection of households	NGO/DPHE	
Testing of microbial quality	TTC (Thermotolerant coliform) analysis using either field kit (DelAgua, Potatest etc) or laboratory Confirmatory testing for *E.coli* on 10% of positive samples	Source: twice per year (dry season and monsoon) to coincide with sanitary inspection Household: random selection of households	NGO or DPHE	
Testing of chemical quality	Arsenic Nitrate	On installation Twice per year	NGO/DPHE	
	Manganese Iron	On installation Once per year In response to complaints	NGO/DPHE	
	Free chlorine pH	If chlorination used Twice per year (dry season and monsoon) to coincide with sanitary inspection	NGO/DPHE	
Testing of physical quality	Smell Turbidity Colour Taste	Twice per year (dry season and monsoon) to coincide with sanitary inspection	VBO/DPHE	

Table 9. Validation schedule

Process Step	Hazardous Event	Validation
All processes	Introduction of pathogens and presence of arsenic	Use of verification data in quantitative health risk assessment model to assess changes in potential disease burden
Social inclusion	Members of community have no/restricted access to water source	Community meetings demonstrate that access is assured to all
Catchment	Introduction of pathogens and nitrate via hazardous events identified in form 6	Combined analysis of water quality and sanitary inspection data from verification to assess whether protection measures have been effective
Dug well	Introduction of pathogens into well via hazardous events identified in form 6	Combined analysis of water quality and sanitary inspection data from verification to assess whether protection measures have been effective
	Effectiveness of chlorination at dug well	Combined analysis of microbial and chorine data from verification to assess effectiveness of chlorination Results of research into cost-effective chlorination practice for dug wells
	Presence of arsenic in dug well	Drill test borehole and test water for presence of arsenic and other major chemicals prior to construction. Use of verification of data to demonstrate performance in relation to arsenic
	Breeding of mosquitoes in dug well	Mesh shown to be effective in preventing entry of mosquitoes into tank
Handpump	Introduction of pathogens at pump platform via hazardous events identified in form 6	Combined analysis of water quality and sanitary inspection data from verification to assess whether protection measures have been effective
Post source	Introduction of pathogens at via hazardous events identified in form 6	Analysis of water quality and sanitary inspection data from verification to assess whether hygiene education has been effective

Table 10. Improvement Action Plan.

Issue Identified Issue	Action Required	Procedures or Records?	Responsibility	Time Frame	Status
1. Sanitary protection measures at dug well	All wells should have an apron of 2.5-3 ft around dug well which is sloped away from the well, headwall should be at least 3 ft high, cover should be at least 6" wider than dug well radius, there should be proper drainage around well. All dug wells should have handpumps.	Follow approved standard designs	DPHE staff and NGOs responsible for commissioning or undertaking construction	Short	
2. Maintenance of well	Develop O&M manual for DW Train Caretakers(Provision of notes and tools for basic sanitary maintenance); the training should cover: -maintenance of filter flow rate; -cleaning of filter bed; -change of media; -repair hand pump; repair/replace tap; -general maintenance of hygiene around DW.	Follow standard training and develop minimum community maintenance pack	DPHE staff and NGOs responsible for developing and implementing the community education support programme	Short	
3. Dug well chlorination	All dug wells should include chlorination DWs with filter should have chlorination at the holding chamber (after filter)	Need to develop guidance on chlorination of dug wells	- DPHE /NGOs to develop guidelines for chlorination -GW Circle of DPHE	Short	
4. Confirmation of arsenic status	All dug wells must be tested for arsenic before they are handed over to community	Use field tests kits with cross-checking of 20% in laboratory	DPHE staff and NGOs responsible for commissioning or undertaking construction	Short	
5. Handpump design and maintenance	Pump must be firmly attached to platform and platform should be at 1m in diameter. There should be proper drainage around pump	Follow approved standard designs	DPHE staff and NGOs responsible for commissioning or undertaking construction	Short	
	New well should have direct action pump and pumps requiring priming on existing wells should be replaced.	Install approved standard direct action pumps	DPHE staff and NGOs responsible for commissioning or undertaking construction	Medium	
6. Ensuring safe water handling post source	Provide hygiene education programmes to community to include: -washing of hands before water collection; -washing of vessels before collection of water; -keeping the vessel covered; -storing of water at clean and elevated place; -safe handling of water during usage.	Follow guidelines on hygiene education	NGO/hygiene promoter	Medium	