Gruppo di Volontariato Civile (GVC)
Palestinian Hydrology Group (PHG)

WATER QUALITY MONITORING CAMPAIGNS MIDDLE AREA OF THE GAZA STRIP

in coordination with

Costal Municipalities Water Utility (CMWU)
Palestinian Water Authority (PWA)

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DRINKING WATER QUALITY MONITORING CAMPAIGNS

A. Background and framework of the campaigns

The drinking water quality monitoring campaigns were conducted in the framework of two projects, one funded by ECHO, the European Commission Humanitarian Aid Department, and implemented by Tdh-It (Terre des hommes-Italia) in partnership with GVC and PHG, and another funded by OCHA-HRF Pool Fund, and implemented by GVC in partnership with PHG.

In the framework of the ECHO funded project, in addition to the supply of a Reverse Osmosis Brackish Water Desalination Plant (RO-BWDP) to Al Bureij refugee camp, GVC and PHG conducted, in the period ranging from October 2008 to May 2009, a water quality monitoring campaign of the water provided by the municipal network, as well as the drinking water provided by private vendors in Al Bureij and Al Nusseirat refugee camp.

The campaign conducted under OCHA funding during the months of June, July and August 2009 targeted the areas of Al Nusseirat refugee camp not analyzed during the ECHO-funded campaign, along with the rural area of Wadi As Salqa located in the border zone of the Middle Area Governorate, east of Deir Al Balah city.

The main aim of the campaigns was to investigate drinking water contamination and to identify potential sources of contamination during the tankered water production and delivery process. For this reason, samples were taken from private desalination plants, from the tankering trucks, from the distribution points located in stores along the streets, as well as from the most common household storage units, including both larger Polyethylene (PE) storage tanks and 20 l jerrycans. Sample collectors also filled out a brief questionnaire regarding hygienic and usage factors for each water sample, in order to better determine possible causes of contamination throughout the water tankering process and the water storage system.

Consequent awareness activities were carried out on two levels. The first level was that of the household: families with water storage tanks showing the highest levels of contamination were visited by GVC and PHG staff, supported by Community Based Organizations, informed of potential sources of water contamination, and instructed on how to better care for their water tanks in order to diminish contamination levels. To this end, fliers on drinking water storage tank and jerry-can hygiene and upkeep were made. Some of these families were targeted for a pilot water storage tanks cleaning and chlorination campaign and for a re-testing campaign aimed at verifying microbial contamination reduction in the stored water after the campaign.

Other workshops were more specifically aimed at other stakeholders (municipalities, local water committees, private vendors and tankering companies) to make them aware about the situation and highlight the need of adequate regulations for the drinking water tankering process in its entirety, including water storage.

Findings of the campaigns were illustrated to the Gaza WASH cluster members, including MoH, PWA, and CMWU on 28 July 2009.

The campaigns were implemented in strict coordination with the CMWU (Costal Municipalities Water Utility), the PWA (Palestinian Water Authority), as well as the municipality of Al Bureij, Al Nusseirat and Wadi As Salqa.

B. Objectives of the campaigns

Although the study conducted under ECHO funding also aimed at monitoring piped water quality, the results illustrated in this report focus only on the findings of the water testing carried out on tankered water[1].

The main objectives of the present study were:

- Investigating the quality of drinking water provided by private vendors at the source (private desalination units), during transportation (water tankers), at the community level (distribution points), and finally, at the household level (storage systems);
- Comparing a refugee-camp area (Al Bureij and Nusseirat) with a rural border area (Wadi As Salqa) where drinking water habits differ and unmonitored and unregistered private agricultural wells are often used as sources of drinking water;
- Identifying specific hygiene habits and general circumstances tied to each sample in order to help determine both possible causes of contamination and strategies to lessen contaminating factors.

[1] In the framework of the ECHO funded project, water samples were also taken in the Al Bureij and Nusseirat refugee camps from the water sources (water wells) and from the network distribution nodes, as well as from the tap and from the roof storage tanks where piped water is stored. Water samples from these locations were taken before and after the installation of the brackish water desalination plant in the Al Bureij camp to monitor the improvement of the quality of the water distributed.

C. Sampling Methodology

Chemical *(pH, Cl, NO_3, TDS)* and microbiological investigations *(Total Coliforms –TC, Faecal Coliforms, –FC Faecal Streptococcus– FS)* were carried out on the water samples collected. For some of the private desalination units, further chemical investigations were done to measure levels of minerals.

A total number of 391 water samples were tested during the period October 2008 – August 2009[2]. The table below shows the exact location where samples have been taken.

Samples location	No. of samples analysed
Private desalination units	• 19 water samples (Annex I). • 10 water samples re- tested to confirm the pH at the storage tank where water is stored after the desalination process (Annex I.a).
Water tankers	• 15 water samples taken from the water tankers in Al Nusseirat and in Wadi As Salqa (Annex II and Annex II.a).
Drinking water distribution points	• 13 water samples taken from the distribution points in Al Bureij (Annex III). • 55 water samples taken from the distribution points in Al Nusseirat (Annex II.a and Annex III). • 11 water samples taken from the distribution points in Wadi As Salqa (Annex III).
Household drinking water storage tanks	• 91 water samples from the household storage tanks in Al Bureij (Annex I. and Annex IV). • 116 water samples from the household storage tanks in Al Nusseirat (see Annex I.a and Annex IV). • 24 water samples from the household storage tanks in Wadi As Salqa (see Annex IV). • 31 water samples retested after the cleaning and chlorination campaign (see Annex IV.a).
Domestic filters (domestic reverse osmosis desalination units)	• 10 water samples in Al Bureij (Annex V).
Private wells	• 8 water samples in Wadi As Salqa (Annex VI).

The sample size at household and community level was defined according to the estimated number of residents of each block of the camps, approximately targeting 3% of the households.

While in the framework of the ECHO-funded project, chemical and microbiological tests were conduced by the Public Health Laboratory of the Ministry of Health (PHL), in the framework of the OCHA-funded project, the water samples were analyzed by the Birzeit University testing laboratories' (BZUTL - Gaza branch).

A technician was appointed by the two Laboratories to ensure that water samples were collected following standard methods for microbiological analysis.

The Word Health Organization and the Palestinian Water Authority drinking water acceptability standards were used as a reference to evaluate the results of these campaigns (Annex A).

[2] pH from private desalination units was re-tested in October 2009.

I. FINDINGS AT PRIVATE DESALINATION PLANTS

During the month of July and August 2009, 9 water samples were taken from nine private desalination plants out of fifteen identified in the Middle Area.

In August, 10 water samples from six of the companies already surveyed in July were re-tested to confirm that biological contamination of water occurs after the desalination process, once the water is stored. Water samples were hence taken both from the outlet of the desalination unit and from the outlet of the storage tank where desalinated water is stored after treatment and before filling the trucks.

PRIVATE DESALINATION PLANTS (samples at the storage tank) MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	July – August 09	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	15			
Negative	12 (80%)			
Positive (TC/FC/FS)	3 (20,0%)			
1- 10 (CFU/100 ml)		0	1	0
11 -100 (CFU/100 ml)		3	0	0
More than 100 (CFU/100 ml)		0	0	0

Out of the 15 samples taken at the storage tanks used to store water after desalination treatment and before filling water tankers, 11 samples revealed no biological contamination, 3 revealed levels of total coliforms (12 colonies/100ml, 35 colonies/100 ml and 75 colonies/100ml), and 1 of these samples revealed also a faecal coliforms presence (10 colonies/100ml).
The four water samples taken at the outlet of the desalination plant, before storage, show no biological contamination.

PRIVATE DESALINATION PLANTS (samples at the outlet of the desalination unit) MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	August 09	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	4			
Negative %	100%			
Positive (TC/FC/FS)	0			
1- 10 (CFU/100 ml)		0	0	0
11 -100 (CFU/100 ml)		0	0	0
More than 100 (CFU/100 ml)		0	0	0

In addition, during the month of August, one water tanker was followed while on its delivery route and one sample was taken from the first customer's storage tank (see Annex I. for details of the results). No contamination was found in that sample. The same household storage tank was tested after one day of storage and then again after three days of storage. The water sample taken after one day of storage shows the presence of more that 100 total coliforms while that taken after three days of storage shows no biological contamination (Annex I).

With reference to chemical investigations, pH was below the acceptable level of 6.5 – 9.5 mg/l in 18 samples out of 19 samples, with values ranging from 4.4 to 6.3, with an average value of 5.4 (Annex I and I.a). Low pH was also confirmed in the samples taken at household and distribution point levels[3].

More complete chemical testing was also carried out on the final product, which clearly revealed an extreme demineralization of the water without any post-treatment process to compensate this loss of minerals.

[3] The pH of the water samples analyzed from the distribution points and from the household storage tanks by the PHL in November 2008 showed an average of pH of 6.7 (Annex 3 and Annex 4, results during ECHO project) --a significant variation from the results obtained in July 2009 when testing the water treated at desalination plants, at the household storage systems and at distribution points at the BZUTL (Annex III ad IV, results during OCHA project). Further investigations were thus made during the period August-October and pH at private desalination units (drinking water source) was tested again by the PHL and by BZUTL, after calibration of their pH meters. These tests confirmed the pH below the acceptability standards.

PRIVATE DESALINATION PLANTS CHEMICAL ANALYSIS (Average values)								
Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	Cl^- (mg/l)	NO_3 (mg/l)	pH	T.D.S (mg/l)	F (mg/l)
3.7	1.7	0.3	20.6	39.7	9.3	5.4	77.8	0.09
World Health Organization guidelines for drinking water								
Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	Cl^- (mg/l)	NO_3 (mg/l)	pH	T.D.S (mg/l)	F (mg/l)
Min 30	min. 10, optimum level 20-30*	12	200	250	50	6.5 - 9.5	1000- 1200 min. 100, optimum level 250-500*	1.5
Palestinian Water Authority guidelines for drinking water								
Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	Cl^- (mg/l)	NO_3 (mg/l)	pH	T.D.S (mg/l)	F (mg/l)
100-200	150	12	200	600	70	6.5 - 9.5	1500	1.5

** WHO (2005a) Nutrients in Drinking Water, November, Geneva.*

TDS levels were extremely low, ranging from 23 and 197 mg/l, with only 5 samples out of 19 above 100 mg/l. Calcium ranged from 3 to 4.5 mg/l with an average value of 3.7 mg/l and magnesium ranged from 1 to 2 mg/l with an average value of 1.7 mg/l[4].

In the Gaza Strip, private vendors are competing among themselves in order to supply a product free of TDS, as over time consumers have become accustomed to the taste of low-minerals-content water. Thus, this competition is based on consumer expectations and not on awareness on potential health consequences of long-term consumption of demineralised water.

Since higher water hardness changes sensorial characteristics of drinking water or drinks and meals prepared with such water, Gazans, used to consuming low mineral content water, commonly call 'bad water' the water that causes the formation of a layer on the surface of coffee or tea.

Even though, over the past 25 years research has continued to support the beneficial role of minerals in water, there still a controversy going on about the negative health effects of drinking demineralised water.

The argument in favour of drinking demineralised water is that the amount of salt consumed by drinking softened water is insignificant when compared to overall daily salt intake. The arguments against drinking demineralised water are that water that has lost its own minerals will absorb minerals in our body, causing a mineral deficit. Moreover, in areas where diet is not an adequate source of some minerals, if demineralised water is used also for cooking, the loss of essential elements from food prepared with soft water is higher than loss from food cooked with hard water.

In the draft of the rolling revision of the World Health Organization guidelines for drinking-water quality, titled 'Health risks from drinking demineralised water', the possible health consequences of low mineral content water consumption are divided in the categories: direct effects on the intestinal mucous membrane, practically zero calcium and magnesium intake, low intake of other elements, loss of calcium, magnesium and other essential elements in prepared food, possible increased dietary intake of toxic metals, possible bacterial re-growth.

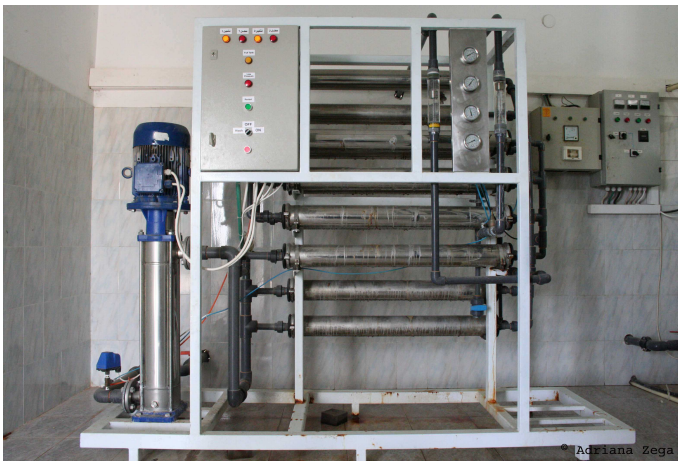
The aggressive nature of demineralised water results in the absorption of heavy metals and some organic substances from pipes, coatings, storage tanks (plastic and stainless steel), containers and hose lines. Moreover, the bacterial re-growth is encouraged by the lack of a residual disinfectant and by the possibly great availability of nutrients in aggressive water, particularly if it has a high temperature.

According to the World Health Organization, although drinking water cannot be relied on as a significant source of supplemental minerals in the daily diet, there is legitimate concern as to the lack of mineral balance in this drinking water, and its consequent ability to assure good health[5].

[4] Levels of TDS were also confirmed during the pH re-testing exercise (see Annex I.a)

[5] WHO (2007) Desalination for Safe Water Supply. Guidance for the Health and Environmental Aspects Applicable to Desalination.

In the late 1970's, the World Health Organization commissioned a study to provide background information for issuing guidelines for desalinated water. The final report, published in 1980 as an internal working document[6], concluded that "not only does completely demineralised water (distillate) have unsatisfactory organoleptic properties, but it also has a definite adverse influence on the animal and human organism". Salts are leached from the body under the influence of drinking water with a low TDS. Because adverse effects such as altered water-salt balance were observed not only in completely desalinated water but also in water with TDS between 50 and 75 mg/l, the team that prepared the report recommended a minimum level of TDS in drinking water of 100 mg/l and an optimum level of 250-500 mg/l for chloride-sulfate water and 250-500 mg/l for bicarbonate water.



Although no evidence is available to document harm to human health from harder drinking water, the World Health Organization recommends that the following levels of calcium, magnesium should be in drinking water:

- for magnesium, a minimum value of 10 mg/l and an optimum value of about 20-30 mg/l, and
- for calcium, a minimum value of 20 mg/l and an optimum value of about 50 (40-80) mg/l.

Many studies show that higher water magnesium is related to decreased risks of Cardiovascular Diseases (CVD). This relationship has been independently described in epidemiological studies with different study designs, performed in different areas, on different populations, and at different times. It has been suggested that the intake of water low in magnesium may be associated with a higher risk of motor neuronal disease, pregnancy disorders (so-called preeclampsia), sudden death in infants, and some types of cancer. Recent studies suggest that the intake of soft water, i.e. water low in calcium, is associated with a higher risk of fractures for children, certain neuro-degenerative diseases, premature birth and low weight at birth[7].

Fluoride ranged from 0.05 to 0.19 mg/l with an average value of 0.09 mg/l. Low fluoride intake is also a potential consideration with regard to the loss of fluoride from the bones. The optimal drinking water concentration of fluoride for dental health is generally between 0.5 to 1.0 mg/l and depends upon the volume of drinking water consumed as well as intake and exposure from other sources.

A WHO working group has recommended a minimum fluoride concentration of 0.2 mg/l, mainly concerning water provided to children under five. The recommended value of fluoride for drinking-water is up to 1.5 mg/l[8].

6 WHO (1980) Guidelines on health aspects of water desalination. ETS/80.4 WHO, Geneva.
7 WHO (2005a) Nutrients in Drinking Water, November, Geneva.
8 WHO (2007) Desalination for Safe Water Supply. Guidance for the Health and Environmental Aspects Applicable to Desalination.

II. FINDINGS AT WATER TANKERS

14 samples taken from private water tankers distributing drinking water in the Middle Area were analysed during the month of July 2009.

WATER TANKERS – AL NUSSEIRAT REFUGEE CAMP and WADI AS SALQA MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	July 09	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	14			
Negative	9 (64,2%)			
Positive (TC/FC/FS)	5 (35,8%)			
1- 10 (CFU/100 ml)		2	0	1
11 -100 (CFU/100 ml)		2	1	2
More than 100 (CFU/100 ml)		0	0	0

Three out of the eleven tankers were found to have faecal streptococcus contamination, two samples with values higher than 10 colonies per 100 ml. Two of these same contaminated tankers also revealed the presence of 30 colonies of faecal coliforms and colonies of total coliforms (respectively, 18 and 60 colonies/100ml). In addition, two tankers showed low levels of total coliforms presence (4-10 colonies/100ml).

A correlation between contamination and unsafe hygiene practices applied by the drivers while filling the tankers was not evident. The driver of the tanker with contamination as well as those of the tankers without contamination all stated that they cleaned their tankers approximately once a month. In all cases, during tanker filling the hose touched the ground and safety practices were not applied by these drivers while handling water. Moreover, all drivers claimed to completely empty their tanks before refilling them, and they stated that the frequency with which they refill is between 2-5 times per day. None of the tanker drivers ever adds chlorine to the water they transport.

In addition to the above-mentioned tests, one tanker truck was followed on its route, and five samples were taken (see Annex II.a for detailed results). The first was taken at a private residence immediately after the tanker was refilled. No contamination was revealed. Other samples were taken at filling points at a coffee shop and at a supermarket, as well as at another private residence, as well as directly from the truck itself. Only one sample (that of the coffee shop distribution point) showed a TC level of 30 colonies/l00ml, while all other samples showed no contamination.

The same tanker was tested for free chlorine immediately after refilling and at the end of his route. Although the driver seemed to be chlorinating his water before distributing it, in both instances free chlorine was not revealed (chlorine is present in most disinfected drinking water at a concentration of 0.2-1 mg/l[9]).

[9] WHO (2004) Guidelines for Drinking-water Quality 3rd Edition. WHO, Geneva.

III. FINDINGS AT THE DRINKING WATER DISTRIBUTION POINTS

A total number of 77 water samples taken from drinking water distribution points (stainless steel storage tanks located outside of shops) were tested in Al Bureij, Al Nusseirat and Wadi As Salqa.
Results of Microbiological tests are illustrated by area in the following tables.

DRINKING WATER DISTRIBUTION POINTS – AL BUREIJ REFUGEE CAMP MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	Oct-Nov 08	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	13			
Negative	4 (30,8%)			Samples not tested for FS
Positive (TC/FC/FS)	9 (69,2%)			
1- 10 (CFU/100 ml)		8	3	
11 -100 (CFU/100 ml)		1	0	
More than 100 (CFU/100 ml)		0	0	

DRINKING WATER DISTRIBUTION POINTS – AL NUSSEIRAT REFUGEE CAMP (Block 5, New Block and other Blocks) MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	April-July 09	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	53			
Negative	14 (26,5%)			Only 30 samples tested for FS
Positive (TC/FC/FS)	39 (73,5%)			
1- 10 (CFU/100 ml)		18	14	8
11 -100 (CFU/100 ml)		12	1	6
More than 100 (CFU/100 ml)		8	0	3

DRINKING WATER DISTRIBUTION POINTS – WADI AS SALQA MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	July 09	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	11			
Negative	1 (9,1%)			
Positive (TC/FC/FS)	10 (90,9%)			
1- 10 (CFU/100 ml)		2	1	2
11 -100 (CFU/100 ml)		6	1	2
More than 100 (CFU/100 ml)		2	0	0

Contamination was found in stainless steel distribution tanks, where, out of the 77 samples tested, total coliforms was present in 57 samples (approximately 74%), with 28 samples revealing low levels of contamination (less than 10 colonies per 100 ml), 19 samples revealing medium levels of contamination (between 11-100 colonies per 100 ml), and 10 samples revealing high levels of contamination (more than 100 colonies per 100 ml).

In addition to this, 20 samples (approximately 26%) showed the presence of faecal coliforms, 18 samples with less than 10 colonies per 100 ml), and two samples revealed medium levels of contamination (between 11-100 colonies per 100 ml).

Out of the 30 samples tested for faecal streptococcus, 3 samples revealed a values higher than 100 colonies per 100 ml, while 18 samples (60%) revealed levels from 1 to 100 colonies per 100 ml.

Even though definitive conclusions regarding the relationship between water contamination at distribution points and the frequency of storage tank cleaning (as claimed by interviewed shop owners) would require further investigation, the information collected during this study shows some relations. The uncontaminated distribution points were the distribution points whose owners claimed to clean their water tanks with the highest frequency of those sampled: once every three days. All other distribution points stated that they cleaned their tanks with frequencies ranging from once a week to once every six months, or that they never cleaned them. The vast majority described their cleaning method either as flushing the tank out by using a water hose or as flushing by using a chlorine and water mix.

It should be noted that in both areas uncontaminated distribution point owners stated that they always completely emptied the water from their tanks before refilling.

None of the distribution points surveyed in either area is registered at the Ministry of Health or anywhere else, and none had ever tested their water quality. All distribution point tanks are located outside of shops directly on the streets, most on the pavement between the shop and the road, while some in Wadi As Salqa are on unpaved ground.

Overall contamination levels are not particularly affected by this difference, as all of these tanks are contaminated at analogous levels. The one uncontaminated tank sampled in Wadi As Salqa was, in fact, located on unpaved ground. The tanks are all slightly raised above ground level at approximately 0.5 meters to 1 meter but the spigot is always exposed to the open air, as is the air filter. All had closed lids and all distribution point owners claimed to leave these lids closed at all times except when filling. The uncontaminated tanks in Al Nusseirat and Wadi As Salqa were installed 1.5 and 2 years before this survey respectively, however this fact does not seem to affect overall survey results, as some of the contaminated tanks had been installed only one month before this survey. The oldest tanks were installed 7 years before this survey and showed medium levels of contamination.

Chemical tests confirmed the low pH and TDS levels, in line with the findings concerning desalination plant product water.

Chemical tests confirmed low levels of pH and TDS, in line with the findings concerning desalination plant product water and water tankers.

IV. FINDINGS AT DRINKING WATER HOUSEHOLD STORAGE TANKS

A total of 226 water samples taken from HH drinking water storage tanks (20 l jerry cans, 200 - 500 l PE tanks) were tested. Microbiological tests results by area are illustrated in the tables below.

DRINKING WATER HOUSEHOLD STORAGE TANKS – AL BUREIJ REFUGEE CAMP MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	Oct/Nov 08	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	88			
Negative	20 (22,7)			Samples not tested for FS
Positive (TC/FC/FS)	68 (77,2%)			
1- 10 (CFU/100 ml)		28	29	
11 -100 (CFU/100 ml)		26	16	
More than 100 (CFU/100 ml)		14	7	

DRINKING WATER HOUSEHOLD STORAGE TANKS – AL NUSSEIRAT REFUGEE CAMP (Block 5, New Block and other Blocks) MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	April-July 09	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	114			
Negative	31 (27,2%)			Only 93 samples tested for FS
Positive (TC/FC/FS)	83 (72,8%)			
1- 10 (CFU/100 ml)		27	29	24
11 -100 (CFU/100 ml)		35	4	11
More than 100 (CFU/100 ml)		20	5	1

DRINKING WATER HOUSEHOLD STORAGE TANKS – WADI AS SALQA MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	July 09	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	24			
Negative	3 (12,5%)			
Positive (TC/FC/FS)	21 (87,5%)			
1- 10 (CFU/100 ml)		10	0	2
11 -100 (CFU/100 ml)		5	1	4
More than 100 (CFU/100 ml)		6	0	0

88 household PE water tank and jerry-can samples were collected from the Al Bureij refugee camp, 114 from the Nusseirat refugee camp and 24 household samples were collected from the Wadi As Salqa area.

Very consistent levels of contamination were found, reaching an average of 80% of total coliforms contamination in all the target areas.

Faecal coliforms were present in approximately 40% of the samples, and 35% of the samples showed the presence of faecal streptococcus as well (see Annex IV. for more details regarding biological contamination totals).

The information collected during sampling shows that there is much variation as to where households place their drinking water storage tanks, with the kitchen, hallway, roof, and balcony being some of the most common areas.

Comparison of the location of non-infected storage tanks with respect to that of infected tanks offers some points for reflection: some of the most highly infected tanks where located in closed, dark spaces (in the kitchen, in the bathroom or in the garage). Some of the non-infected tanks were located in the yard and many were located on the roof. It can be assumed that faecal contamination was not detectable as consequence of the bactericidal effects of sunlight.

With relation to hygienic practices, most households with non-infected water tanks stated that they clean them at least once a week, which also appears to be true for most infected tanks, based on what their owners claimed. Some of the most infected tanks are cleaned quite rarely (for example once every 8 months). Almost all households surveyed claimed that there was always a lid on their drinking water storage tank, and the vast majority stated that they completely emptied their tanks before refilling them. Though this could lead to inconclusive evidence it should also be noted that cases revealing of some form of biological contamination in tanks were limited almost exclusively to households who admitted to not always emptying their water tanks completely before refilling, or never completely emptying their tanks before refilling. The size of drinking water storage tanks also does not appear to be influential, as the most common volumes used (200 and 500 l) did not influence the occurrence of contamination. Non-infected PE water storage tanks were all no more than 4 years old in both areas, while some of the most highly infected tanks had been bought 8-10 years before the present study. At the same time, the majority of tanks, both contaminated and non contaminated averaged to be 2-3 years old. Though most people surveyed stated that they did not use chlorine to clean their water tanks, the people who reported using chlorine all had no faecal contamination of any kind, though some total coliforms was found present.

Of the household water storage tanks found contaminated in the Al Bureij, Nusseirat and Wadi As Salqa areas, 31 were re-tested after cleaning and chlorination campaign carried out by PHG. A notable reduction of all contamination levels was evident: In all samples, faecal coliforms either decreased or was no longer present, while faecal streptococcus was present at a low level in only one sample (10 CFU/100 ml). Samples showed medium and low levels of TC contamination (11-100 CFU/100 ml). Detailed re-testing campaign results are provided in Annex IV.a.

V. FINDINGS AT DOMESTIC RO UNITS

DOMESTIC RO UNIT – AL BUREIJ REFUGEE CAMP MICROBIOLOGICAL ANALYSIS				
WHO guidelines for drinking water		**TC = 0 CFU/100 ml**	**FC = 0 CFU/100 ml**	**FS = 0 CFU/100 ml**
Date of sampling	April 09	TC (CFU/100 ml)	FC (CFU/100 ml)	FS (CFU/100ml)
N. of samples analysed	10			
Negative	4 (40,0%)			Not tested
Positive (TC/FC/FS)	6 (60,0%)			
1- 10 (CFU/100 ml)		5	3	
11 -100 (CFU/100 ml)		0	0	
More than 100 (CFU/100 ml)		1	1	

Insufficient upkeep of domestic RO units can be considered the cause of the above mentioned results. Moreover, there is no residual disinfecting effect on the water after it leaves the unit.

Tap water from the municipal network was tested before entering analyzed domestic units and shows no bacteriological contamination.

VI. FINDINGS AT PRIVATE WELLS

In addition to the monitoring of the quality of the drinking water distributed by private vendors, eight private and unregistered agricultural wells were sampled in Wad As Salqa (approximately 300-500 m from the border).

Six out of eight wells (75%) showed the presence of total coliforms, three at a medium contamination level (between 11 and 100 CFU/100 ml) and three at a high contamination level (more than 100 CFU/100 ml). Four of these same contaminated wells also revealed the presence of faecal streptococcus, all at low contamination levels (between 1 and 10 CFU/100 ml). No faecal coliforms were found in any of the samples. It can be assumed that biological contamination of these wells is mainly due to a presence of animals, typical of rural areas.

Chemical samples were highly variable from well to well. With the exception of two wells, chemical parameters are within acceptable Palestinian Water Authority limits. It is assumed that the high level of TDS (1350 - 2600 ppm) and Chlorine (460 - 1000 ppm) of those wells is related to the exploitation range (50 m^3/h – 15 m^3/h). The yield of the other wells ranges from 6 to 7 m^3/h.

None of this water is treated in any way. With the exception of the wells with highest levels of TDS, households stated that they used the other wells, where TDS ranges between 350 and 800 mg/l, as drinking water either routinely or from time to time.

Households who were not evacuated from their houses during the December 2008-January 2009 “Cast Lead” aggression also stated that they used these wells as their exclusive source of drinking water during that time out of necessity.

FINAL CONSIDERATIONS

Private desalination plants

Standards and procedures for private desalination units, tankers, and distribution points are not applied in Gaza. Water desalination and drinking water distribution processes are not regulated. Raising awareness on potential health risks related to the distribution and consumption of water with low TDS content and the establishment of a minimum palatable mineral content in drinking water are necessary.

It is interesting to note that while consumers are generally attracted by low TDS water out of habit, in remote areas supplied less regularly by the municipal network, the population declares that they drink (even if not on a regular basis) water with a TDS content of up to 800 mg/l.

The WHO and Desalination Guidelines encourage governments in areas with long term experience in drinking desalinated water to (1) consider the importance of mineral balance in drinking water-particularly calcium and magnesium - with regard to risks of osteoporosis and ischemic heart disease respectively, as well as fluoride in relation to a loss of fluoride in the skeletal structure; (2) consider guidelines for desalination water treatment, specifying the minimum content of the relevant elements such as calcium and magnesium and TDS; (3) assess the possibility of adverse effects arising from long-term consumption of drinking water with an ultra-low mineral content[10].

The pH of the water tested from private desalination units was found below the Word Health Organization and Palestinian Water Authority drinking water acceptability standards. Brackish water treatment is currently uncontrolled in the Gaza Strip. Adjustment of pH to a range of 6,6 - 9,5 is advised. Carbonation or use of other chemicals such as lime may be applied, and blending with some source water may be done to increase alkalinity and TDS and stabilize the water.

Drinking water distribution and storage

Regarding bacteriological contamination, the most significant source of contamination is the unsafe storage system, while transport appears to be only one of the potential causes of final contamination (36% of the water tested from water tankers resulted as being contaminated).

Water samples collected from the drinking water storage system at the community and household levels show a high bacteriological presence (TC) which can reach almost 91% in samples taken from distribution points and 88% in samples taken from household storage tanks, depending on the target areas.

Findings at drinking water storage systems located inside the house were compared with the samples taken from the municipal water stored in roof storage tanks. Faecal coliforms mostly appear in the drinking water stored in containers located inside the house (kitchen, bathroom, garage) while the water stored either in roof storage tanks or in places reached by the sunlight appears almost totally free of faecal coliforms. It is well known that the bactericidal action of sunlight is enough to decontaminate water from faecal coliforms, while some coliforms and faecal streptococcus may remain.

The table below illustrates the distribution of coliforms counted in drinking water storage systems.

CFU/100 ml	FROM DISTRIBUTION POINTS % MICROBIOLOGICAL ANALYSIS (CFU/100 ml)			FROM HOUSEHOLD STORAGE TANKS% MICROBIOLOGICAL ANALYSIS (CFU/100 ml)		
	TC	FC	FS*	TC	FC	FS
1- 10	49,12	90,00	47,62	38,01	63,74	61,90
11 -100	33,33	10,00	38,10	38,60	23,08	35,71
More than 100	17,54	0,00	14,29	23,39	13,19	2,38
Total %	**100,00**	**100,00**	**100,00**	**100,00**	**100,00**	**100,00**

* *Present only in 21 samples out of 41 samples tested for FS*

** *Present only in 42 samples out of 117 samples tested for FS*

The ratio FC/FS has been calculated only for the distribution points since the presence of faecal coliforms in the household storage tanks was slightly detected by sunlight bactericidal effect. Ratios range from 0 to 2, underlining the presence of animal faeces contamination.

10 WHO (2005a) Nutrients in Drinking Water, November, Geneva.

annAnnex I . FINDINGS AT PRIVATE DESALINATION PLANTS (19 samples)

OCHA HRF/OPT/0355/046																					
Sample			Chemical Results																	Microbiological Results		
Serial No.	Day	Date	Turbidity	EC	Nitrite	Ammonia	Sulfate	Alkalinity	Total hardness	Calcium	Magnesium	Potassium	Sodium	Phosphate	Cl^-	NO_3	pH	T.D.S	Fluoride	Fecal Coli	Total Coli.	Fecal Streptococcus
			PPM																	CFU/100ml		
1	Sun	12-Jul-09													26	2.5	4.4	51	0.13	0	12	0
2	Sun	12-Jul-09	0.3	100	0	0	18	5	16	3	2	0.2	17	0	23	2	4.8	55	0.05	10	35	0
3	Sun	12-Jul-09													80	0	4.6	197	0.08	0	0	0
4	Sun	12-Jul-09													51	6	5.2	107	0.13	0	0	0
5	Sun	12-Jul-09	1.4	140	0	0	15	20	19	4.5	2	0.5	18	0	25	8	5.2	72	0.05	0	0	0
6	Sun	12-Jul-09													56	24	5.3	141	0.08	0	0	0
7	Sun	12-Jul-09	0.7	270	0	0	20	7	12	3.5	1	0.4	27	0	42	15	4.7	130	0.05	0	0	0
8	Sun	12-Jul-09													25	11	5.6	66	0.1	0	0	0
9	Tue	14-Jul-09													30	16	4.7	64	0.19	0	0	0

Note: water samples taken at the storage tank used to store water after desalination process and before filling water tankers.

OCHA HRF/OPT/0355/046						
Serial No.	Day	Date	Description of sample (Al Bureij)	Microbiological Results		
				Fecal Coli	Total Coli	Fecal Streptococcus
10	Mon	10-Aug-09	Water sample taken at the outlet of the desalination plant before storage	0	0	0
11	Mon	10-Aug-09	Water sample taken at the storage tank used to store water after desalination process	0	0	0
12	Mon	10-Aug-09	Water sample taken at HH storage tank at the moment of filling by truck	0	0	0
13	Tue	11-Aug-09	Water sample taken at HH storage tanks - sample after one day of storage	0	>100	0
14	Thu	13-Aug-09	Water sample taken at HH storage tanks - sample after 3 day of storage	0	0	0
15	Tue	11-Aug-09	Water sample taken at the storage tank used to store water after desalination process	0	75	0
16	Tue	11-Aug-09	Water sample taken at the storage tank used to store water after desalination process	0	0	0
17	Tue	11-Aug-09	Water sample taken at the outlet of the desalination plant before storage	0	0	0
18	Tue	11-Aug-09	Water samples taken at the storage tank used to store water after desalination process	0	0	0
19	Tue	11-Aug-09	Water sample taken at the outlet of the desalination plant before storage	0	0	0
20	Tue	11-Aug-09	Water samples taken at the storage tank used to store water after desalination process	0	0	0
21	Tue	14-Aug-09	Water sample taken at the outlet of the desalination plant before storage	0	0	0
22	Tue	14-Aug-09	Water sample taken at the storage tank used to store water after desalination process	0	0	0

Annex I.a FINDINGS AT PRIVATE DESALINATION PLANTS (pH re-testing in 10 samples)

Serial No	Day	Date	Description of sample (Middle Area)	pH (Note 1)	pH (Note 2)	T.D.S (Note 3)
1	Mon	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	5.2	5.5	45
2	Mon	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	4.7	5.1	44
3	Mon	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	6.2	6.3	56
4	Tue	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	5.9	6.2	108
5	Thu	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	5.4	5.6	67
6	Tue	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	5.5	5.4	36
7	Tue	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	5.3	5.5	23
8	Tue	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	5.3	5.5	75
9	Tue	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	5.8	5.9	87
10	Tue	20 Oct 09	Water sample taken at the **storage tank** used to store water after desalination process	6.3	6.6	55

Note 1: results from the Public Health Laboratory of the Ministry of Health (PHL), after calibration of the pH meter.
Note 2: Birzeit University testing laboratories' (BZUTL - Gaza branch).
Note 3: GVC/PHG Portable T.D.S meter

Annex II. FINDINS AT WATER TANKERS (14 samples)

OCHA HRF/OPT/0355/046											
WATER TANKERS AL NUSSEIRAT AND WAI AS SALQA											
Sample				Chemical Results				Microbiological Results			
Serial No.	Day	Date	Location	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus	
								CFU/100ml			
1	Sun	5-Jul-09	Al-Nusseirat			5.65	114	0	18	2	
2	Sun	5-Jul-09	Al-Nusseirat			5.86	66	0	10	0	
3	Sun	5-Jul-09	Al-Nusseirat			5.14	97	0	0	0	
4	Sun	5-Jul-09	Al-Nusseirat			4.98	55	30	60	16	
5	Mon	6-Jul-09	Al-Nusseirat			4.76	83	0	0	0	
6	Mon	6-Jul-09	Al-Nusseirat			5.4	75	0	0	0	
7	Mon	6-Jul-09	Al-Nusseirat			5.24	60	0	0	0	
8	Tue	7-Jul-09	Al-Nusseirat			5.35	84	0	0	0	
9	Wen	8-Jul-09	Al-Nusseirat			5.1	136	0	0	0	
10	Thu	9-Jul-09	Al-Nusseirat			4.81	92	0	0	16	
11	Thu	9-Jul-09	Al-Nusseirat			4.57	72	0	0	0	
12	Mon	13-Jul-09	Wadi As Salqa			5.12	97	0	0	0	
13	Mon	13-Jul-09	Wadi As Salqa			4.6	249	0	0	0	
14	Tue	14-Jul-09	Wadi As Salqa			5.8	70	0	4	0	

Annex II.a FINDINGS FOLLOWING WATER TANKER (5 samples)

OCHA HRF/OPT/0355/046								
Serial No.	Day	Date	Location	Description of sample	Free Chlorine	Fecal Coli	Total Coli.	Fecal Streptococcus
1	Mon	27-Jul-09	Household storage tank Al Nusseirat	Water sample taken at HH storage tank at the moment of filling by truck	Not revealed	0	0	0
2	Mon	27-Jul-09	Coffee shop storage tank Al Nusseirat	Water sample taken at distribution point at the moment of filling by truck		0	30	0
3	Mon	27-Jul-09	Supermarket water storage tank Al Nusseirat	Water sample taken at distribution point at the moment of filling by truck		0	0	0
4	Mon	27-Jul-09	Household storage tank Al Nusseirat	Water sample taken at HH storage tank at the moment of filling by truck		0	0	0
5	Mon	27-Jul-09	Water Tanker	Water sample taken at the truck after refilling and at the end of his route	Not revealed	0	0	0

Annex III. FINDINGS AT THE DRINKING WATER DISTRIBUTION POINTS (13 samples in Al Bureij, 53 in Nusseirat and 11 in Wadi As Salqa)

ECHO/-ME/BUD/2008/01009							
DRINKING WATER DISTRIBUTION POINTS AL BUREIJ							
Serial No.	Day	Date	Chemical Results			Microbiological Results	
			pH	NO_3	Cl^-	Total Coli.	Fecal Coli
						CFU/100ml	
1	Tue.	18-Nov-08	7.7	7.8	50.2	0.	0.
2	Tue.	18-Nov-08	8.2	8.5	53.8	1	1
3	Tue.	18-Nov-08	7.5	9.2	28.6	3	0.
4	Tue.	18-Nov-08	7.2	8.0	43	1	0.
5	Tue.	18-Nov-08	6.4	27.7	35.8	4	0.
6	Tue.	18-Nov-08	6.8	5.6	53.7	2	0.
7	Wed.	19-Nov-08	5.9	6.4	53.7	20	5
8	Wed.	19-Nov-08	6.4	6.1	21.5	0.	0.
9	Wed.	19-Nov-08	6.4	20.7	21.5	4	0.
10	Wed.	19-Nov-08	6.0	29.7	35.8	0.	0.
11	Wed.	19-Nov-08	6.6	15.6	57.3	3	0.
12	Wed.	19-Nov-08	8.1	7.5	53.7	9	2
13	Wed.	19-Nov-08	5.2	30.3	25.1	0.	0.

Note: pH not reliable due to wrong calibration of the pH meter (see Annex I.a)

ECHO/-ME/BUD/2008/01009							
DRINKING WATER DISTRIBUTION POINTS AL NUSSEIRAT (Block 5 & New Block)							
Serial No.	Day	Date	Chemical Results			Microbiological Results	
			pH	NO_3	Cl^-	Total Coli.	Fecal Coli
						CFU/100ml	
1	Mon	30-Mar-09	6.3	38.1	43.0	0	0
2	Mon	30-Mar-09	8.8	4.3	35.9	23	10
3	Mon	30-Mar-09				17	10
4	Mon	30-Mar-09	7.3	78.2	50.2	0	0
5	Mon	30-Mar-09				20	20
6	Tue	31-Mar-09	7.6	10.7	25.1	25	1
7	Tue	31-Mar-09	7.8	10.7	21.51	42	0
8	Tue	31-Mar-09	7.4	32.7	35.9	6	0
9	Tue	31-Mar-09				0	0
10	Tue	31-Mar-09	7.2	26.8	21.5	4	0
11	Wed.	1-Apr-09	6.8	45.5	57.4	0	0
12	Wed.	1-Apr-09	6.8	36.9	57.4	0	0
13	Wed.	1-Apr-09				2	1
14	Wed.	1-Apr-09	6.8	40.9	78.8	3	0
15	Wed.	1-Apr-09	6.9	37.6	57.4	0	0
16	Sun	5-Apr-09	6.4	40.6	71.7	18	2
17	Sun	5-Apr-09	6.7	25.9	78.9	0	0
18	Sun	5-Apr-09	6.2	37.8	57.4	0	0
19	Sun	5-Apr-09	6.3	37.4	71.7	0	0

ECHO/-ME/BUD/2008/01009							
DRINKING WATER DISTRIBUTION POINTS AL NUSSEIRAT (Block 5 & New Block)							
			Chemical Results			Microbiological Results	
			pH	NO_3	Cl^-	Total Coli.	Fecal Coli
20	Sun	5-Apr-09	7.0	37.8	78.9	2	1
2	Sun	5-Apr-09	6.7	36.6	50.2	50	0
22	Sun	5-Apr-09	6.7	37.4	57.4	0	0
23	Sun	5-Apr-09	7.0	37.6	71.7	0	0

Note: pH not reliable due to wrong calibration of the pH meter (see Annex I.a)

OCHA HRF/OPT/0355/046									
DRINKING WATER DISTRIBUTION POINTS AL NUSSEIRAT (other blocks)									
Sample			Chemical Results				Microbiological Results		
Serial No	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus
							CFU/100ml		
1	Thu	9-Jul-09					0	3	0
2	Thu	9-Jul-09			5.44	62	0	>100	0
3	Thu	9-Jul-09					0	3	0
4	Thu	9-Jul-09			6.05	65	4	3	0
5	Thu	9-Jul-09					4	9	0
6	Thu	9-Jul-09			5.44	64	3	16	5
7	Thu	9-Jul-09					0	>100	14
8	Thu	9-Jul-09			5.91	64	4	>100	2
9	Thu	9-Jul-09					0	10	0
10	Thu	9-Jul-09			5.6	59	0	13	0
11	Thu	9-Jul-09					0	60	0
12	Thu	9-Jul-09			5.07	89	0	0	0
13	Thu	9-Jul-09					0	0	5
14	Thu	9-Jul-09			4.77	36	0	>100	>100
15	Thu	9-Jul-09					2	20	3
16	Thu	9-Jul-09			6	56	0	70	0
17	Thu	9-Jul-09					0	3	0
18	Thu	9-Jul-09			4.69	36	0	7	0
19	Thu	9-Jul-09					0	10	10
20	Thu	9-Jul-09			5.3	54	0	11	18
21	Thu	9-Jul-09					6	>100	>100
22	Thu	9-Jul-09			6.07	65	0	10	>100
23	Thu	9-Jul-09					0	>100	40
24	Thu	9-Jul-09			5.3	50	2	60	20
25	Thu	9-Jul-09					0	>100	14
26	Thu	9-Jul-09			6.03	64	0	10	8
27	Thu	9-Jul-09					0	9	24
28	Thu	9-Jul-09			6.08	168	8	>100	10
29	Thu	9-Jul-09					0	50	10
30	Thu	9-Jul-09			4.57	72	0	0	0

OCHA HRF/OPT/0355/046									
DRINKING WATER DISTRIBUTION POINTS WADI AS SALQA									
Sample			Chemical Results				Microbiological Results		
Serial No	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus
							CFU/100ml		
1	Mon	13-Jul-09			4.84	53	0	6	0
2	Mon	13-Jul-09					0	40	0
3	Mon	13-Jul-09					20	>100	16
4	Mon	13-Jul-09					0	>100	8
5	Mon	13-Jul-09					0	6	0
6	Tue	14-Jul-09			5.4	108	0	0	0
7	Tue	14-Jul-09					0	20	0
8	Tue	14-Jul-09			5.2	74	0	14	0
9	Tue	14-Jul-09					0	25	45
10	Tue	14-Jul-09			5.6	56	0	70	0
11	Tue	14-Jul-09					9	30	4

Annex IV. FINDINGS AT DRINKING WATER HOUSEHOLD STORAGE TANKS (88 samples in Al Bureij, 114 in Nusseirat and 24 in Wadi As Salqa)

ECHO/-ME/BUD/2008/01009							
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL-BURAIJ							
Serial No.	Day	Date	Chemical Results			Microbiological Results	
			pH	NO_3	Cl^-	Total Coli.	Fecal Coli
						CFU/100ml	
1	Mon	20-Oct-08	7.5	29.1	71.7	100	0
2	Tue	21-Oct-08	6	38.8	35.8	>100	100
3	Tue	21-Oct-08	7.4	37.8	43.0	0	0
4	Wed	22-Oct-08	7.8	37.6	50.2	>100	80
5	Thu	23-Oct-08	7.9	17.2	50.2	>100	100
6	Sun	26-Oct-08	5.5	35.9	42.6	6	6
7	Sun	26-Oct-08	6.1	9.9	56.2	>100	30
8	Sun	26-Oct-08	6.7	35.3	35.5	5	0
9	Sun	26-Oct-08	7.9	35.1	42.5	1	0
10	Sun	26-Oct-08	7.8	10.5	63.9	0	0
11	Sun	26-Oct-08	7.8	11.5	56.7	0	0
12	Mon	27-Oct-08	5.8	15.7	50.2	0	0
13	Mon	27-Oct-08	5.6	62.7	57.7	1	1
14	Mon	27-Oct-08	5.4	34.5	35.8	1	0
15	Mon	27-Oct-08	8.3	62.7	50.2	0	0
16	Mon	27-Oct-08	7.6	3.8	86.0	0	0
17	Mon	27-Oct-08	7.6	6.8	50.2	35	18
18	Mon	27-Oct-08	7.9	6.2	50.2	3	2
19	Mon	27-Oct-08	6.7	6.1	57.4	12	10
20	Mon	27-Oct-08	5.8	35.3	43.0	0	0

ECHO/-ME/BUD/2008/01009							
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL-BURAIJ							
Serial No.	Day	Date	Chemical Results			Microbiological Results	
			pH	NO_3	Cl^-	Total Coli.	Fecal Coli
						CFU/100ml	
21	Mon	27-Oct-08	5.8	39.3	43.0	3	3
22	Sun	2-Nov-08	7.7	29.8	35.8	2	1
23	Sun	2-Nov-08	7.2	32.3	21.5	4	2
24	Sun	2-Nov-08	6.6	33.95	35.8	60	30
25	Sun	2-Nov-08	8.2	21.35	32.3	6	3
26	Sun	2-Nov-08	7.4	32.05	28.6	70	60
27	Sun	2-Nov-08	7.1	6.63	46.6	>100	5
28	Sun	2-Nov-08	6.4	19.25	43.0	>100	0
29	Sun	2-Nov-08	6.6	5.58	50.2	30	8
30	Sun	2-Nov-08	6.5	6.46	43.0	9	4
31	Sun	2-Nov-08	8.2	9.46	71.7	18	3
32	Mon	3-Nov-08	5.8	6.3	43.0	1	1
33	Mon	3-Nov-08	5.9	34.8	100.4	30	8
34	Mon	3-Nov-08	6.0	32.4	35.8	70	20
35	Mon	3-Nov-08	6.1	34.8	14.3	8	1
36	Mon	3-Nov-08	6.1	30.3	57.4	11	6
37	Mon	3-Nov-08	6.0	35	43.0	0	0
38	Mon	3-Nov-08	6.7	7.8	50.2	50	18
39	Mon	3-Nov-08	6.5	6.1	89.6	23	4
40	Mon	3-Nov-08	6.3	30.5	43.0	2	2
41	Mon	3-Nov-08	5.6	32.6	32.3	65	15
42	Tue	4-Nov-08	8.4	5.9	57.4	10	2
43	Tue	4-Nov-08	8.6	7.3	64.5	65	35
44	Tue	4-Nov-08	6.0	30.6	28.7	7	0
45	Tue	4-Nov-08	6.4	5.8	50.2	25	1
46	Tue	4-Nov-08	6.6	28.1	32.3	0	0
47	Tue	4-Nov-08	7.5	5.6	46.6	0	0
48	Tue	4-Nov-08	8.7	5.8	43.0	0	0
49	Wed	5-Nov-08	8.0	7.5	57.4	19	1
50	Wed	5-Nov-08	8.1	7.2	60.9	1	0
51	Wed	5-Nov-08	6.7	8.2	60.9	18	11
52	Wed	5-Nov-08	6.7	34.1	43.0	0	0
53	Wed	5-Nov-08	6.6	37	39.4	0	0
54	Wed	5-Nov-08	6.9	6.4	60.9	8	0
55	Sun	9-Nov-08				8	0
56	Sun	9-Nov-08				1	0
57	Sun	9-Nov-08				0	0
58	Sun	9-Nov-08	7.6	44.2	35.8	2	0

ECHO/-ME/BUD/2008/01009							
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL-BURAIJ							
Serial No.	Day	Date	Chemical Results			Microbiological Results	
			pH	NO_3	Cl^-	Total Coli.	Fecal Coli
						CFU/100ml	
59	Sun	9-Nov-08				1	0
60	Sun	9-Nov-08				30	0
61	Mon	10-Nov-08				5	0
62	Mon	10-Nov-08				0	0
63	Mon	10-Nov-08				0	0
64	Mon	10-Nov-08				0	0
65	Tue	11-Nov-08				0	0
66	Tue	11-Nov-08				0	0
67	Tue	11-Nov-08				>100	>100
68	Tue	11-Nov-08				>100	>100
69	Tue	11-Nov-08				50	50
70	Tue	11-Nov-08				2	0
71	Tue	11-Nov-08	6.7	7.4	57.4	>100	>100
72	Tue	11-Nov-08	5.8	32.2	28.7	0	0
73	Tue	11-Nov-08				2	1
74	Tue	11-Nov-08				>100	>100
75	Tue	11-Nov-08				30	0
76	Tue	11-Nov-08				10	2
77	Tue	11-Nov-08				50	10
78	Sun	16-Nov-08				15	2
79	Sun	16-Nov-08				20	1
80	Sun	16-Nov-08				80	80
81	Sun	16-Nov-08				80	50
82	Sun	16-Nov-08				>100	50
83	Sun	16-Nov-08				20	6
84	Sun	16-Nov-08				>100	>100
85	Sun	16-Nov-08	8.0	21.4	86.0	>100	>100
86	Sun	16-Nov-08				>100	>100
87	Sun	16-Nov-08				10	5
88	Sun	16-Nov-08				10	10

Note: pH not reliable due to wrong calibration of the pH meter (see Annex I.a)

ECHO/-ME/BUD/2008/01009							
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL NUSSEIRAT (Block 5 & New Block)							
Serial No.	Day	Date	Chemical Results			Microbiological Results	
			pH	NO_3	Cl^-	Total Coli.	Fecal Coli
						CFU/100ml	
1	Mon	6-Apr-09	7.2	37.3	50.2	10	0

ECHO/-ME/BUD/2008/01009							
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL NUSSEIRAT (Block 5 & New Block)							
Serial No.	Day	Date	Chemical Results			Microbiological Results	
			pH	NO_3	Cl^-	Total Coli.	Fecal Coli
						CFU/100ml	
2	Mon	6-Apr-09	7.6	37.8	53.8	11	4
3	Mon	6-Apr-09				3	0
4	Mon	6-Apr-09				4	0
5	Mon	6-Apr-09				1	0
6	Tue	7-Apr-09	7.6	41.3	50.2	1	0
7	Tue	7-Apr-09				0	0
8	Tue	7-Apr-09				0	0
9	Tue	7-Apr-09	7.9	34.3	64.5	1	0
10	Tue	7-Apr-09				0	0
11	Wed	8-Apr-09	6.2	22.1	43.0	0	0
12	Wed	8-Apr-09	6.1	43.9	43.0	0	0
13	Wed	8-Apr-09				13	2
14	Wed	8-Apr-09				3	0
15	Wed	8-Apr-09	7.1	46.5	57.3	0	0
16	Sun	12-Apr-09				0	0
17	Sun	12-Apr-09				0	0
18	Sun	12-Apr-09				40	1
19	Sun	12-Apr-09				6	1
20	Sun	12-Apr-09				8	3
21	Wed	15-Apr-09				0	0

Note: pH not reliable due to wrong calibration of the pH meter (see Annex I.a)

OCHA HRF/OPT/0355/046									
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL NUSSEIRAT (Other Blocks)									
Sample			Chemical Results				Microbiological Results		
Serial No.	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus
							CFU/100ml		
1	Sun	5-Jul-09			6.5	145	0	10	0
2	Sun	5-Jul-09					>100	>100	30
3	Sun	5-Jul-09					6	8	0
4	Sun	5-Jul-09			5.9	145	0	4	0
5	Sun	5-Jul-09					0	>100	10
6	Sun	5-Jul-09					6	10	0
7	Sun	5-Jul-09			5.1	87	0	0	0
8	Sun	5-Jul-09					0	30	0
9	Sun	5-Jul-09					0	0	0
10	Sun	5-Jul-09			5.9	98	0	50	0

OCHA HRF/OPT/0355/046									
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL NUSSEIRAT (Other Blocks)									
Sample			Chemical Results				Microbiological Results		
Serial No.	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus
							CFU/100ml		
11	Sun	5-Jul-09					7	50	0
12	Sun	5-Jul-09					10	>100	4
13	Sun	5-Jul-09					>100	>100	10
14	Sun	5-Jul-09			5.4	53	2	>100	0
15	Sun	5-Jul-09					10	>100	6
16	Sun	5-Jul-09					0	0	0
17	Sun	5-Jul-09			6.6	140	0	10	6
18	Sun	5-Jul-09					0	40	0
19	Sun	5-Jul-09			5.8	102	0	30	10
20	Sun	5-Jul-09					0	5	0
21	Sun	5-Jul-09			5.3	55	0	0	0
22	Sun	5-Jul-09					7	20	5
23	Sun	5-Jul-09					>100	>100	>100
24	Sun	5-Jul-09			5.0	78	10	80	0
25	Sun	5-Jul-09					0	0	0
26	Sun	5-Jul-09					40	>100	6
27	Mon	6-Jul-09					5	20	0
28	Mon	6-Jul-09			5.3	63.4	6	>100	0
29	Mon	6-Jul-09			5.7	61	0	10	0
30	Mon	6-Jul-09					0	0	0
31	Mon	6-Jul-09					0	0	0
32	Mon	6-Jul-09			5.0	104	0	8	0
33	Mon	6-Jul-09					0	2	2
34	Mon	6-Jul-09					0	>100	8
35	Mon	6-Jul-09			5.9	76	0	4	3
36	Mon	6-Jul-09					10	18	6
37	Mon	6-Jul-09					0	10	0
38	Mon	6-Jul-09			5.2	57	5	30	28
39	Mon	6-Jul-09					10	12	8
40	Mon	6-Jul-09					0	24	4
41	Mon	6-Jul-09			5.2	63	0	0	0
42	Mon	6-Jul-09					0	0	0
43	Mon	6-Jul-09					6	80	0
44	Mon	6-Jul-09			5.1	56	0	50	6
45	Mon	6-Jul-09					0	>100	0
46	Mon	6-Jul-09					0	40	7
47	Mon	6-Jul-09			4.9	74	5	TMC	6

OCHA HRF/OPT/0355/046									
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL NUSSEIRAT (Other Blocks)									
Sample			Chemical Results				Microbiological Results		
Serial No.	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus
							CFU/100ml		
48	Mon	6-Jul-09					0	10	4
49	Mon	6-Jul-09					0	0	0
50	Mon	6-Jul-09			5.0	100	0	24	0
51	Mon	6-Jul-09					3	>100	0
52	Mon	6-Jul-09					0	>100	3
53	Mon	6-Jul-09			4.9	62	0	38	0
54	Mon	6-Jul-09					0	60	10
55	Tue	7-Jul-09					0	24	5
56	Tue	7-Jul-09					0	3	20
57	Tue	7-Jul-09			5.3	53	0	22	22
58	Tue	7-Jul-09					0	16	6
59	Tue	7-Jul-09					0	8	0
60	Tue	7-Jul-09			5.1	82	5	0	5
61	Tue	7-Jul-09					8	10	30
62	Tue	7-Jul-09					20	>100	20
63	Tue	7-Jul-09			6.7	193	0	0	18
64	Tue	7-Jul-09					0	20	15
65	Tue	7-Jul-09					0	4	50
66	Tue	7-Jul-09			6.1	83	1	5	0
67	Tue	7-Jul-09					0	0	0
68	Tue	7-Jul-09					16	60	18
69	Tue	7-Jul-09			4.4	92	0	20	0
70	Tue	7-Jul-09					0	0	0
71	Tue	7-Jul-09					20	35	0
72	Tue	7-Jul-09			5.8	126	0	>100	0
73	Tue	7-Jul-09					0	0	0
74	Tue	7-Jul-09					0	3	0
75	Tue	7-Jul-09					2	14	0
76	Tue	7-Jul-09			5.9	137	0	0	0
77	Tue	7-Jul-09					0	0	0
78	Tue	7-Jul-09					>100	>100	0
79	Tue	7-Jul-09					6	20	0
80	Tue	7-Jul-09					0	24	0
81	Tue	7-Jul-09					7	18	0
82	Wed	8-Jul-09					0	>100	0
83	Wed	8-Jul-09					>100	>100	4
84	Wed	8-Jul-09			5.5	59	0	0	0

OCHA HRF/OPT/0355/046									
DRINKING WATER HOUSEHOLD STORAGE TANKS- AL NUSSEIRAT (Other Blocks)									
Sample			Chemical Results				Microbiological Results		
Serial No.	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus
							CFU/100ml		
85	Wed	8-Jul-09					3	>100	30
86	Wed	8-Jul-09					0	40	0
87	Wed	8-Jul-09			5.5	79	0	14	0
88	Wed	8-Jul-09					0	0	0
89	Wed	8-Jul-09					0	0	0
90	Wed	8-Jul-09			4.8	65	0	0	0
91	Wed	8-Jul-09					0	0	0
92	Wed	8-Jul-09					2	40	0
93	Wed	8-Jul-09			5.0	50	0	3	0

OCHA HRF/OPT/0355/046									
DRINKING WATER HOUSEHOLD STORAGE TANKS - WADI AS SALQA									
Sample			Chemical Results				Microbiological Results		
Serial No	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus
1	Mon	13-Jul-09			5.8	82	0	10	0
2	Mon	13-Jul-09					0	0	0
3	Mon	13-Jul-09					0	>100	0
4	Mon	13-Jul-09			5.7	114	0	9	0
5	Mon	13-Jul-09			5.8	67	0	0	0
6	Mon	13-Jul-09					0	15	12
7	Mon	13-Jul-09					0	10	8
8	Mon	13-Jul-09			8.0	1350	0	18	16
9	Tue	14-Jul-09					0	>100	0
10	Tue	14-Jul-09					20	>100	60
11	Tue	14-Jul-09			5.5	63	0	>100	0
12	Tue	14-Jul-09					0	4	3
13	Tue	14-Jul-09					0	30	0
14	Tue	14-Jul-09					0	>100	0
15	Tue	14-Jul-09					0	60	0
16	Tue	14-Jul-09					0	8	0
17	Tue	14-Jul-09			5.5	63	0	6	0
18	Tue	14-Jul-09					0	0	0
19	Tue	14-Jul-09					0	6	0
20	Tue	14-Jul-09			5.9	57	0	12	20

21	Tue	14-Jul-09					0	4	0
22	Tue	14-Jul-09					0	>100	0
23	Tue	14-Jul-09					0	4	0
24	Tue	14-Jul-09			5.2	59	0	4	0

Annex IV.a RE-TESTED DRINKING WATER HOUSEHOLD STORAGE TANKS (After Cleaning and chlorination campaign)

ECHO/-ME/BUD/2008/01009

RE-TESTED DRINKING WATER HOUSEHOLD STORAGE TANKS - AL BUREIJ

Sample							RE- TESTED SAMPLES RESULTS		
Serial No.	Date	pH	NO_3	Cl^-	Total Coli.	Fecal Coli	Date	Total Coli.	Fecal Coli
1	20-Oct-08	7.5	29.1	71.7	100	0	10-Jun-2009	6	4
2	21-Oct-08	6.0	38.8	35.8	> 100	100	16-Jun-2009	100	25
3	22-Oct-08	7.8	37.6	50.2	>100	80	10-Jun-2009	40	0
4	23-Oct-08	7.9	17.2	50.2	>100	100	10-Jun-2009	6	4
5	2-Nov-08	7.1	6.63	46.6	>100	5	10-Jun-2009	70	25
6	2-Nov-08	6.4	19.2	43.0	>100	0	10-Jun-2009	25	2
7	11-Nov-08				>100	>100	15-Jun-2009	0	0
8	11-Nov-08				>100	>100	10-Jun-2009	0	0
9	11-Nov-08	6.7	7.4	57.4	>100	>100	10-Jun-2009	0	0
10	11-Nov-08				>100	>100	16-Jun-2009	3	0
11	16-Nov-08				>100	50	16-Jun-2009	>100	>100
12	16-Nov-08				>100	>100	15-Jun-2009	0	0
13	16-Nov-08	8.0	21.4	86.0	>100	>100	15-Jun-2009	3	1
14	16-Nov-08				>100	>100	10-Jun-2009	2	0

Note: pH not reliable due to wrong calibration of the pH meter (see Annex I.a)

OCHA HRF/OPT/0355/046

RE-TESTED DRINKING WATER HOUSEHOLD STORAGE TANKS - AL NUSSEIRAT

Sample										RE- TESTED SAMPLES RESULTS				
Serial No	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus	Day	Date	Fecal Coli	Total Coli.	Fecal Streptococcus
1	Sun	5-Jul-09					>100	>100	30	Sun	2-Aug-2009	0	0	0
2	Sun	5-Jul-09					10	>100	4	Sun	2-Aug-2009	0	10	0
3	Sun	5-Jul-09					>100	>100	10	Sun	2-Aug-2009	0	18	0
4	Sun	5-Jul-09					10	>100	6	Sun	2-Aug-2009	0	0	0
5	Sun	5-Jul-09					7	20	5	Sun	2-Aug-2009	0	0	0
6	Sun	5-Jul-09					>100	>100	TMC	Sun	2-Aug-2009	0	>100	0
7	Sun	5-Jul-09			**5.0**	**78**	10	80	0	Sun	2-Aug-2009	0	0	0
8	Sun	5-Jul-09					40	>100	6	Sun	2-Aug-2009	0	0	0

OCHA HRF/OPT/0355/046														
RE-TESTED DRINKING WATER HOUSEHOLD STORAGE TANKS - WADI AS SALQA														
Sample										RE- TESTED SAMPLES RESULTS				
Serial No	Day	Date	Cl^-	NO_3	pH	T.D.S	Fecal Coli	Total Coli.	Fecal Streptococcus	Day	Date	Fecal Coli	Total Coli.	Fecal Streptococcus
1	Mon	13-Jul-09					0	>100	0	Wed	29-Jul-2009	0	0	0
2	Mon	13-Jul-09					0	15	12	Sun	2-Aug-2009	0	0	0
3	Mon	13-Jul-09					0	10	8	Wed	29-Jul-2009	0	6	0
4	Mon	13-Jul-09			**8.0**	**1350**	0	18	16	Sun	2-Aug-2009	0	20	0
5	Tue	14-Jul-09					20	>100	60	Wed	29-Jul-2009	0	40	0
6	Tue	14-Jul-09			**5.5**	**63**	0	>100	0	Sun	2-Aug-2009	0	0	0
7	Tue	14-Jul-09					0	>100	0	Wed	29-Jul-2009	0	>100	0
8	Tue	14-Jul-09			**5.9**	**57**	0	12	20	Wed	29-Jul-2009	0	0	10
9	Tue	14-Jul-09					0	>100	0	Sun	2-Aug-2009	10	>100	0

Annex V. FINDINGS AT DOMESTIC RO UNITS (10 samples in Al Bureij)

ECHO/-ME/BUD/2008/01009								
Domestic RO unit – AL BUREIJ								
Serial No.	Day	Date	Chemical Results				Microbiological Results	
			pH	NO_3	Cl^-	T.D.S	Total Coli.	Fecal Coli
							CFU/100ml	
1	Tue	21 April 09					**0**	**0**
2	Tue	21 April 09	6.8	5.4	86.0		**10**	**6**
3	Tue	21 April 09					**0**	**0**
4	Tue	21 April 09					**0**	**0**
5	Tue	21 April 09					**120**	**100**
6	Tue	21 April 09					**2**	**0**
7	Tue	21 April 09	6.8	6.4	93.2		**5**	**0**
8	Tue	21 April 09					**10**	**3**
9	Tue	21 April 09					**10**	**4**
10	Tue	21 April 09					**0**	**0**

Annex VI. FINDINGS AT PRIVATE WELLS

OCHA HRF/OPT/0355/046										
PRIVATE WELLS WADI AS SALQA										
Sample			Chemical Results					Microbiological Results		
Serial No.	Day	Date	Cl^-	NO_3	pH	T.D.S	Fluoride	Total Coli.	Fecal Coli	Fecal Streptococcus
1	Mon	13-Jul-09	200	16	6.9	538	0.9	>100	0	10
2	Mon	13-Jul-09	110	10	6.8	433	0.7	35	0	6
3	Mon	13-Jul-09	1000	28	7.3	2600	1.25	>100	0	7
4	Mon	13-Jul-09	260	45	7.3	800	0.65	0	0	0
5	Mon	13-Jul-09	210	30	7.1	650	1.25	12	0	0
6	Mon	13-Jul-09	100	9	5.8	353	1.9	40	0	10
7	Mon	13-Jul-09	460	60	7.4	1350	1.5	>100	0	0
8	Tue	14-Jul-09	130	15	7.1	481	0.95	0	0	0
9	Wed	29-Jul-09						0	0	0

Annex A. Word Health Organization and Palestinian Water Authority drinking water acceptability standards

Indicator	Unit	PWA (2006) Max. Value	WHO Min/ Max health based guideline value
Total Coliform*	**Colony/100ml**	Absent	Absent**
Fecal Coliform	**Colony/100ml**	Absent	Absent**
Fecal Streptococcus	**Colony/100ml**	Absent	Absent**
pH	**pH**	6.5 - 9.5	6.5 - 9.5**
TDS	**mg/l**	1500	1000-1200** min. 100, optimum level 250-500***
Conductivity	**mS/cm at 20° C**	400	400
Turbidity	**NTU**	4	5 NTU**
Nitrate	**mg/l as NO_3^-**	70	50**
Ammonium	**mg/l as NH_4^-**	0.5	1.5**
Chloride	**mg/l as Cl^-**	600	250**
Sulphate	**mg/l as SO_4^{-2}**	400	250**
Calcium	**mg/l as Ca^{+2}**	100-200	Min. 30***
Magnesium	**mg/l as Mg^{+2}**	150	min. 10, optimum level 20-30***
Sodium	**mg/l as Na^+**	200	200**
Potassium	**mg/l as K^+**	12	12
Fluoride	**mg/l as F^+**	1.5	1.5**
Alkalinity	**mg/l as $CaCO_3$**	400	200**
Hardness	**mg/l as $CaCO_3$**	600	200**

* *PWA – Requires 95% of samples to be completely free from contamination, while the remaining 5% must contain less than 5 colonies/100ml.*

** *WHO (2004) Guidelines for Drinking-water Quality 3rd Edition. WHO, Geneva. WHO (2008) Guidelines for Drinking-water Quality. 2nd Addendum to Third Edition. WHO, Geneva*

*** *WHO (2005a) Nutrients in Drinking Water, November, Geneva.*