

**Imperial College
London**

Report No. 55



**WHO Centre
Imperial College London**

**Management Review of a Waterborne Gastrointestinal Outbreak
La Misère Seychelles February 2010**



**Professor S Rawaf MD PhD FRCP FFPH
Director of WHO Centre Imperial College
London August 2010**

© WHO Centre Imperial College London 2010

The WHO Collaborating Centre for Public Health Education and Training Imperial College London was designated for such a function by the WHO Global Committee with the support of the British Government. The WHO Centre is part of the Department Primary Care & Public Health, School of Public Health, Faculty of Medicine, Imperial College London. It is involved in several international projects supporting health systems. Key to this is the development and enhancement of primary health care and human resource capacity, including public health training and educational with a particular focus on the escalating problem of non-communicable diseases worldwide. The Centre supports countries in strengthening institutional and individual quality and performance, promoting public health principles and preparing countries for man-made and/or natural disasters through emergency preparedness and planning. Our work focuses on health as complete physical, mental and social well-being, not merely the absence of disease. The WHO Centre remit extends around the world and includes all six WHO Regions.

Published August 2010

WHO Centre

Imperial College London
Faculty of Medicine
School of Public Health
Department of Primary Care & Public Health
Reynolds Building, 3rd Floor
St Dunstan's Road
London W6 8RF
UK

T: 0044 (0) 207.594.8603

E: whocentre@imperial.ac.uk

W: <http://www1.imperial.ac.uk/medicine/about/divisions/publichealth/pcsm/whocollaboratingcentre/>

Contributors:

UK

Prof S Rawaf, WHO Centre Imperial College London, UK
Prof R Dhillon, Northwick Park NHS Hospital, UK
Dr B. Patel, Health Protection Agency, UK
Dr G. Urwin, Colchester Hospital University NHS Foundation Trust, UK
Mr G. Fish, Chartered Institute of Environmental Health, UK
Ms E. Dubois, WHO Centre Imperial College London, UK
Ms E. Augustyniak, WHO Centre Imperial College London, UK
Mr J. Seidl, WHO Centre Imperial College London, UK

Mr K. Yap, Health Protection Agency, UK
Mr M. Orgad, Health Protection Agency, UK
Ms R Manuel, Health Protection Agency, UK
Mr R McEwan, Health Protection Agency, UK
Mr G Malcom, Kings College Hospital, UK

Republic of Seychelles

Dr J. Gedeon, Ministry of Health
Mr K. Ekelson, Public Utility Corporation
Dr P. Palmyre, PHD Laboratory, MoH
Staff at Anse Boileau Health Centre

Acknowledgments

The WHO Collaborating Centre Imperial College London has many people to thank for the collaborative work, in both the in Seychelles and London that made this assignment possible. To the Government of the Republic of Seychelles for inviting us to undertake this review. To Georgina Da Cambra for the logistical support and kind hospitality in both London and Seychelles. To the Seychelles' Public Health Commissioner and colleagues for their contribution and support. Equally, to the Public Utility Corporation's Managing Director and colleagues for their time and contribution.

A sincere thank you to all the staff of Anse Boileau Health Centre for their superb efforts in supporting our clinical work, especially for their commitment to assist our Team over the weekend and on a national public holiday and finally, to the local residents and patients who expressed appreciation of our work and provided useful insight to our review.

In London, I am most grateful to colleagues at the Health Protection Agency, UK. To Professor Anthony Kessel, Director of Public Health, for his support to endeavour in this important assignment; to Mr Kenny Yap and Mr Milan Orgad, International Office-HPA, for their professional and prompt action in coordinating the logistics and materials needed to make this assignment happen.

Last but not least to my colleagues at Imperial College London, Department of Primary Care and Public Health: Professor Azeem Majeed (Department Head) for his advice and continued support; Elizabeth Dubois, WHO Centre Deputy Director, for the coordination of this complex work at such a short notice and continuing efforts; Ela Augustyniak, our WHO Administrator for her gracious support during this time; to Johannes Seidl, our resident WHO Intern, for his skilful contribution to this report; and to our respected colleagues in the Department of Primary Care and Public Health.

A sincere thanks to the entire WHO Team to whom I am indebted for their superb support throughout the course of this assignment.

Professor Salman Rawaf MD PhD FRCP FFPHM
WHO Centre for Public Health Education and Training, Director
Imperial College London
September 2010

Table of Contents

Acknowledgments	3
List of Figures	6
List of Abbreviations	7
1 SUMMARY	8
2 INTRODUCTION AND BACKGROUND	10
3 FEBRUARY 2010 OUTBREAK DESCRIPTION	12
4 THE REVIEW METHODS	13
5 THE REVIEW FINDINGS	13
5.1 Public Health Department	13
5.1.1 Public Health Department Response – February 2010	13
5.1.2 Key Findings	16
5.1.3 WHO Team Assessment of Response and Findings – August 2010	17
5.2 The Public Utility Company	18
5.2.1 Public Utility Company Response – February 2010	18
5.2.2 Key Findings	19
5.2.3 WHO Team Assessment of Response and Findings – August 2010	21
5.3 The Construction Company ASCON	22
5.3.1 The ASCON Response – February 2010	22
5.3.2 Key Findings	22
5.3.3 WHO Team Assessment of Response and Findings – August 2010	22
5.4 Health Services	23
5.4.1 Health Service Response – February 2010	23
5.4.2 Key Findings	23
5.4.3 WHO Team Assessment of Response and Findings – August 2010	24
5.5 Laboratories	24
5.5.1 Diagnostic and Public Health Laboratories Response – February 2010	24
5.5.2 Key Findings	25
5.5.3 WHO Team Assessment of Response and Findings – August 2010	25
5.6 The Seychellois Government	25
5.6.1 Government Response – February 2010	25
5.6.2 Key Findings	26
5.6.3 WHO Team Assessment of Response and Findings – August 2010	26

5.7	Environmental Health Site Visits.....	26
5.7.1	WHO Team Site Visits – August 2010.....	26
5.7.2	Key Findings	27
5.7.3	WHO Team Assessment of Response and Findings – August 2010.....	28
5.8	Public and Patient Experience.....	29
5.8.1	Key Findings	29
5.8.2	WHO Team Assessment of Public and Patient Experience – August 2010.....	30
6	THE CURRENT SITUATION – AUGUST 2010.....	31
6.1	Water Supply.....	31
6.2	Monitoring and Surveillance	32
6.3	The Public.....	33
6.4	The Government	33
7	RECOMMENDATIONS.....	34
8	LIMITATIONS.....	38
9	LESSONS LEARNT	38
10	CONCLUSIONS	39
11	APPENDIX	40
11.1	Appendix A.....	40
11.2	Appendix B	43
11.3	Appendix C.....	44
11.4	Appendix D.....	47
11.5	Appendix E	49

List of Figures

Figure 1 Map of Seychelles	10
Figure 2 Port of Seychelles	11
Figure 3 Sewage Pipe	12
Figure 4 Public Health Department	14
Figure 5 Construction site near La Misère.....	15
Figure 6 Sewage contamination.....	17
Figure 7 Sewage contamination.....	17
Figure 8 The new water supply by PUC.....	18
Figure 9 Water pipe.....	19
Figure 10 The Anse Boileau Health Centre.....	23
Figure 11 The Sub Centre in La Misère mountain area.....	23
Figure 12 Results for Giardia	24
Figure 13 Public Health Laboratory	24
Figure 14 Public Health Laboratory	25
Figure 15 Environmental Health Visit	26
Figure 16 Chemical assessment; taking water samples on site	27
Figure 17 Epidemic curve.....	29
Figure 18 Local residents waiting at Anse Boileau Health Centre.....	30
Figure 19 WHO Team Members	40
Figure 20 Protozoan Parasite Giardia intestinalis	44
Figure 21 Public Health Act of 1994.....	49

List of Abbreviations

DWI.....	Drinking Water Inspectorate
HPA.....	Health Protection Agency
GI.....	Gastrointestinal
MOH.....	Ministry of Health
PHD.....	Public Health Department
PUC.....	Public Utility Corporation
SOPs.....	Standard operating procedures
STP.....	Sewage Treatment Plant
UK.....	United Kingdom
WHO.....	World Health Organisation



WHO Centre Imperial College London

Management Review of a Waterborne Gastrointestinal Outbreak Republic of Seychelles – February 2010

1 SUMMARY

At the invitation of the Seychelles Government, the WHO Collaborative Centre Imperial College London organised a visit to review the February 2010 circumstances of a waterborne gastrointestinal (GI) outbreak in the La Misère Region of Mahé Island. The WHO Centre review was conducted under three principal contexts:

- **Public health:** aspects of clinical and public health assessment as manifested by the contamination in the area of La Misère;
- **Environmental health:** a review of water and sewage, related principally to the affected area of La Misère yet expanding to include the wider issue of water delivery and sanitation generally;
- **Socio-political:** the wider social aspects and implications of the incident in relation to government action, the impact of the outbreak on the population, lessons learnt, training and education and the proactive measures required for the prevention of similar incidents in the future.

The WHO Team consisted of five senior members ranging from medical microbiology, environmental, public health and primary care¹. Assessment of the situation² began with meeting Public Health Department (PHD) colleagues³. This was followed by a second roundtable discussion at the Seychelles Public Utilities Corporation (PUC)⁴.

¹ Team members arrived in Victoria over the course of two days beginning 12th August 2010 (see Appendix A).

² Friday, 13th August 2010.

³ Public Health Commissioner and Team, Environmental Health Officer, and WHO Liaison Officer

⁴ With the Managing Director and senior colleagues.

In a rapidly growing Seychelles economy, attention to health and safety is of both public and political importance. At a critical stage of rapid development across the islands, the provision and maintenance of good quality water and the safe disposal of sewage remain a high priority for local Seychellois. Public perception and public confidence are of paramount importance when considering the delivery of such a valuable and ubiquitous commodity.

In the context of the three themes aforementioned, the WHO Team have reviewed the February 2010 circumstances of a waterborne gastrointestinal (GI) outbreak following raw water contamination in the mountain region of Mahé Island and have provided 24 recommendations with the aim to strengthen public health services, to improve the provision of public utilities and ensure prevention of any such future events.

Through these recommendations are unique opportunities to secure a long term sustainable development of the islands without damaging the growth of the economy. The Seychelles Government will also want to prevent the detrimental effects to the vegetation, soil and natural resources in the Republic. This direction will be strengthened if they can ensure robust regulatory systems and charters are in place that secure public safety.

Catchment protection of raw water sources, effective treatment plants, adequate sewage disposal systems, protection of the local ecosystem including the prevention of deforestation, minimising natural *and* man-made soil erosion should receive high priority. These priorities then need to be maintained at a standard that protects both the environment and the public.

Improved standards in the supply of public utilities, public health and health care services can deliver what is required to achieve these protection goals. Through improved local and national governance, improved quality management systems, risk assessment exercises and a sustained education and training programme the Seychelles Government can make great strides in securing safety.

Investment in adequate disease surveillance systems aimed at early detection and rapid implementation of control measures would not only help prevent future incidents but also help reduce the size of an outbreak if one did develop.

The February 2010 contamination and subsequent waterborne gastrointestinal infection outbreak may have been prevented if the right planning measures had been in place and adhered to. With the right governance system in place, staff properly trained to manage risk and a public well informed on public health prevention, this incident might possibly have been mitigated. Fortunately this infectious episode resulted in no loss of life and very low morbidity. From this event many lessons can be learnt. The WHO Team hopes that the 24 recommendations found at the end of our review will be fully considered to ensure not only environmental and public safety but also the economic, social and cultural integrity of the Republic of Seychelles.

2 INTRODUCTION AND BACKGROUND

The Seychelles, an archipelago of 108 islands with a land area of 455km², are located 1,500 kilometres (932mi) from the east coast of the mainland Africa in the Indian Ocean. The main islands are Mahé, Praslin and La Digue and together they share the bulk of all economic activities. Victoria, the capital of Seychelles, is located on Mahé, the largest of the three islands. The climate on the islands is quite equable with a little temperature variety of 24 °C to 32 °C throughout the year.

The Seychelles estimated population in July 2010 is about 87,476. Generally, the state is regarded as a multi-ethnic melting pot due to its origin from three continents – Africa, Asia and Europe. Therefore, there are three official languages in Seychelles: Creole, French and English. The main religion is Roman Catholicism but there are also Anglican and Protestant churches and other denominations – Muslim, Hindu or Bahai.

The Republic of Seychelles achieved its independence from Great Britain on the 29th June 1976 and became a

Republic within the Commonwealth. The first multi-party presidential and national parliamentary elections were held in 1993. The current President and head of government, Parti Lepep - “The People’s Party”, is Mr. James Alix Michel. He replaced Mr. France Albert René in April 2004 after a term of office since 1977. Beside the Commonwealth, the Republic of Seychelles is a member of the United Nations, the African Union, and La Francophonie^{5,6}.

There are two rainy seasons one in July/August and the other in November/December. The majority of the water supply is sourced from precipitation on the mountains and rain forest. Raw water is extracted at multiple areas in mountain springs and rivers. It is filtered then treated with chlorine and supplied through multiple regional distribution system depending on side of the mountains and the highest of the settlements. Historically the supply from mountain streams, processing and delivery of clean water and disposal of sewage in septic tanks has served the Seychellois well. However, with the development of Seychelles as a

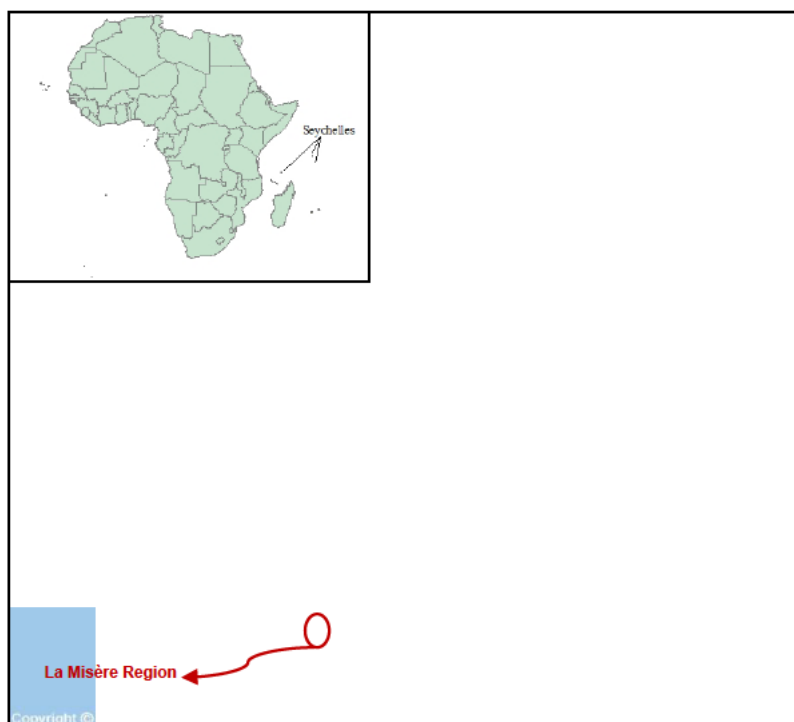


Figure 1 Map of Seychelles

⁵ Accessed 25th August 2010: <http://www.who.int/countries/syc/en/>

⁶ Accessed 25th August 2010: http://www.seychelles.com/en/about_seychelles/index.php

major tourist destination and increased development of the hillsides with luxury housing the need for water is increasing. There is a need to keep the supply of water is balanced with demand. There is also a need to ensure that good quality water for all is the norm throughout the islands. Water is one of the most precious commodities in the Seychelles. It is everyone's responsibility to protect this resource.

The biggest threat to Mahé Island is overdevelopment. The government, ministers and the Seychellois community should be mindful of these dangers and should discourage short term development strategies without considering the long term impact of these matters and the possibly detrimental, irreparable harm, to the structure and the very fabric of the Seychelles. Preservation of this valuable resource will protect the islands culture, legacy and sustain the local population.



Figure 2 Port of Seychelles

Further to our meeting with the PUC, the WHO Team was informed that Mahé Island currently has a reservoir with the capacity of 950,000 cm³ (50-52 days' supply) and a second reservoir of 50,000 cm³ (which lasts two days).

There are two major water treatment plants and 17 other plants which service the island. The majority of the water is extracted from mountain streams filtered through sand which is then chlorinated and supplied to residents. There are two desalination plants: one with a 5000 litre capacity and the other with a 2500 litre capacity. Two main sewage plants service 20% of the sewage on Mahé Island. One is located in the Victoria area and the other serving Beau Vallon. The remaining 80% of the sewage is managed through septic tanks. It is worth noting that the general granite base of the Seychelles Islands may not be ideal for this type of 'soil' percolation disposal.

3 FEBRUARY 2010 OUTBREAK DESCRIPTION

Further to the two initial joint meetings with colleagues from the PHD and PUC, the WHO Team was informed that waterborne sewage contamination at La Misère was 'discovered' on the 14th February 2010. A local resident reported the raw sewage pipe openly discharging on to the ground near the natural water source stream and informed the PUC. At our meeting PUC also stated that their staff took immediate measures to cut the water supply to the residents of La Misère (approx. 486 metres). Temporary measures were taken to supply local residents with water in bowsers. Subsequently, large polypropylene tanks were provided to store water delivered from the bowsers for those residents located at the top end of La Misère. For residents further down the mountain, but still supplied by the La Misère tank, four pumping stations pumped water to Beau Voir (approx. 470 metres). Residents in the lower half of La Misère distribution area were also supplied through the Beau Voir tank. The WHO Team was informed that additional chlorine was pumped into the system⁷.

The sewage pipe discharge overflow from the uncontrolled sewage tank at the top of the mountain was established as the primary source of contamination. This sewage tank was located on a large construction site of where approximately 1000 contracted workers from the Indian subcontinent temporarily resided. This significant quantity of labour was commissioned by the construction company ASCON. *It is unclear to us if the Seychelles Authorities were, in fact, aware of the sheer quantity of foreign workers operating on the site at the time of the incident.*



Figure 3 Sewage Pipe

⁷ It is worth noting that during clinic visits, residents subsequently mentioned the bleaching of clothes and that during our health assessments, patients complained of symptoms of burning and itching skin.

4 THE REVIEW METHODS

Under the ascribed Terms of Reference (see Appendix A) the WHO Review was conducted under three methods:

- **Epidemiological:** [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
- **Environmental:** [REDACTED]
[REDACTED]
[REDACTED]
- **Laboratory:** [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
- **Other:** [REDACTED]
[REDACTED]

5 THE REVIEW FINDINGS

Using the above methods, we report firstly the reviews of local responses to the outbreak in February 2010 including those of the PHD (and environmental health), the PUC, the health services and the Government. Secondly, we report local key findings. Finally, we report on our WHO Team assessment of those responses focusing particularly on the environment, public and patient experiences (which includes the clinical examinations we have conducted), organisations, standards and procedures and overall handling of the February 2010 outbreak.

5.1 Public Health Department¹¹

5.1.1 Public Health Department Response – February 2010

On 13th August 2010, the WHO Team met with Dr Jude Gedeon, Public Health Commissioner and a team of officials from the Ministry of Health including senior environmental health officers. The WHO Liaison Officer for Seychelles, Cornelia Atsyor was also in attendance. In their briefing, we informed that the Public Health Department received

⁸ Patient assessment performed on two occasions, 14th and 16th August by WHO Team were supported by local Anse Boileau Health Centre staff.

⁹ See Appendix B.

¹⁰ The Public Health Laboratory, the hospital diagnostic laboratory, and PUC's company laboratory.

¹¹ We believe that the incident was reported to the Public Utility Corporation (PUC) on the afternoon of 13th February and not the 14th as documented. Action was taken by PUC in disconnecting water supply without informing Public Health Department, although the Ministry of Environment were informed.

a complaint on 14th February 2010¹² related to a foul tap water smell supplied by PUC at La Misère. A Public Health Department visit to the site was immediately arranged. Staff noted that upon arrival, the PUC site had already been altered and the supply of water disconnected. Residents informed PHD officials that the source of the contamination originated from a construction site located at the top of the mountain. The site was run and managed by a private company trading under the name of ASCON.

The construction site was visited by an investigating team from the Ministry of Environment, Public Utility Corporation (responsible for water and sewage) and the Ministry of Health. At this time it was confirmed, the PHD added, that the source of contamination was coming from an overflow pipe connected to a holding tank serving a cluster of toilets on the construction site. The water runoff terminated in a small river tapped by PUC as one of the main catchment areas which supply treated water to approximately 2000 people in lower La Misère/Souvenir Region. Samples were collected by PUC at different intervals upriver, at the discharge outlet and the PUC treatment plant¹³.

We were then informed that the construction company, ASCON, was advised by the Public Health Department (environmental health services) to have the holding tank pumped by a company called STAR Seychelles on a regular basis to ensure that no overflow of raw sewage and to provide a soak away pit on the system as a contingency in case of breakdown in the schedule. To our knowledge nothing was done. As we understand the circumstances, ASCON failed to heed the advice of Public Health Department. *It is significant to note that no penalty or legal action was sought against ASCON for breach of policy, contract or failure to enforce public health law.*¹⁴



Figure 4 Public Health Department, MOH

At this meeting we were also informed that a pit, excavated near the holding tank, was full at the time of the visit on 14th February 2010 and that effluent was running through a sawed off pipe connected to the holding tank and discharging onto open ground and into the local river (This was documented in a two pages report by the Department of Public Health on 14th February 2010). *We believe that the Department of Health and other officials had underestimated the risks to public health at that time and focused primarily on the foul smell emanating from the construction site.*

It was also disclosed that the developer and construction company ASCON had previously been advised to regularly pump the holding tank to ensure no contaminated overflow. Again, as we understand, this advice was not heeded by the private company resulting ultimately in the river becoming contaminated with raw sewage.

It is significant to note up to this stage there appeared to be a lack of urgency and subsequent follow up by PHD staff with regard to potential risk of the situation.

¹²Note that the Managing Director of PUC described his frustration at being refused entry to the construction site and also about the time it took to get access via the Ministry of Environment.

¹³ The WHO Team does not have access to the dates of these specimen collections.

¹⁴ Seychelles Public Health Act of 1994. S.I. 44, Section 7, point 6(1), See Appendix E.

On 14th February and subsequent dates the Public Health Department team agreed and clustered various actions to address issues regarding the contamination. These actions included:¹⁵

- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]

[REDACTED]



Figure 5 Construction site near La Misère.

¹⁵ On 8th March 2010, more precise actions were documented by a Shadow Committee [*Brief report on La Misère (Souvenir) water source contamination including some recommendations following shadow committee meeting of 8th March 2010*]. These included actions not mentioned in the 14th February 2010 report, for example: immediate closure of La Misère Water Treatment Plant by PUC; cleaning and disinfection of water storage tanks, disinfection and flushing of water networks; cleaning of customer tanks by PUC; advise customers to boil water before consuming; the on-site placement of public health officers and at the Providence sewage treatment plant to monitor and ensure that the sewage discharge from the site was managed correctly to prevent a re-occurrence; increasing the sewage tank holding capacity by building a second buffer holding tank in case of a breakdown of the existing system; testing of soil, river, tank water; decontamination of storage tanks with chlorine; to flush the water line.

5.1.2 Key Findings

The ASCON construction site was previously visited by Public Health Officers on:

- 4th December 2009 (written report produced)
- 15th January 2010 (written report produced)
- 6th February 2010 (no report documented)
- 11th February 2010 (no report documented)

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

¹⁶ See Appendix C

¹⁷ During a meeting with the MoH, we were presented with data from 19th February 2010 which detected enteric pathogens: *Salmonella*, *E. Coli* and *Vibrio* species. *E. Coli* may be an indication of sewage contamination of the soil.

¹⁸ On 17th August 2010 visit we viewed the construction site with a smaller area part of the abandoned US Satellite Observation/ Early Warning Unit. We believe most of the contamination originated from this area near the mountain top.

¹⁹ PHD's letter dated 11th Dec 2009.

²⁰ See Seychelles Public Health Act of 1994. S.I. 44, Section 7, point 5, Appendix E.

²¹ WHO Guidelines for Drinking-water Quality, Vol.1, Page 99. Geneva 2008.

[Redacted text]

5.1.3 WHO Team Assessment of Response and Findings – August 2010

[Redacted text]



Figure 6 Sewage contamination

[Redacted text]



Figure 7 Sewage contamination

[Redacted text]

²² As early as October 2009.

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

5.2 The Public Utility Company

5.2.1 Public Utility Company Response – February 2010

[Redacted text block]



Figure 8 The new water supply by PUC, August 2010.

[Redacted text block]

²³ Please note footnotes 2 which indicates the mountain walker must contacted PUC on the afternoon of 13th rather than 14 Feb 2010. Please also note the difference in term of who reported the incidents (foul smell by the public reported to PHD vs passerby reported a leakage to PUC). This apparent lack of communication and coordination between agencies is a serious gap in terms of a national emergency preparedness plan and must be immediately considered. Furthermore, the lack of joined up training may also be a contributing factor to such a disjointed partnership

²⁴ "An immediate visit to the site was arranged and it was noted that the PUC site had already been altered and the supply of water disconnected" the public health department reported on 14th February (time of visit is not documented). It is unlikely that the Public Health Department visit happened after 7:30pm.

[Redacted text block]

5.2.2 Key Findings

[Redacted text block]

[Redacted text block]



Figure 9 Water pipe

[Redacted text block]

[Redacted text block]

²⁵ While typical waterborne pathogens are able to persist in drinking-water, most do not grow or proliferate in water. Microorganisms like *E. coli* and *Campylobacter* can accumulate in sediments and are mobilized when water flow increases. After leaving the body of their host, most pathogens gradually lose viability and the ability to infect. The rate of decay is usually exponential, and a pathogen will become undetectable after a certain period. Pathogens with low persistence must rapidly find new hosts and are more likely to be spread by person-to-person contact or poor personal hygiene than by drinking-water. (WHO Guidelines for Drinking-water Quality, Vol.1, Page 124. Geneva 2008).

[Redacted text]

[Redacted text]

[Redacted text]

[Redacted text]

[Redacted text]

[Redacted text]

5.2.3 WHO Team Assessment of Response and Findings – August 2010

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text]

[Redacted text]

[Redacted text]

5.3 The Construction Company ASCON

5.3.1 The ASCON Response – February 2010

[Redacted text]

5.3.2 Key Findings

[Redacted text]

5.3.3 WHO Team Assessment of Response and Findings – August 2010

[Redacted text]

[Redacted text]

[Redacted text]

[Redacted text]

²⁶ Terms of Reference, Section 7, was also not attained and is highlighted in this report's Limitations, page 39.

²⁷ This confirmation is received with scepticism from the WHO Team as they too were denied access to the premises hence making it impossible to know much less regulate, the quantity of immigrant workers coming to the Seychelles.

[REDACTED]

5.4 Health Services

5.4.1 Health Service Response – February 2010

[REDACTED]

5.4.2 Key Findings

[REDACTED]



Figure 10 The Anse Boileau Health Centre



Figure 11 The Sub Centre in La Misère mountain area

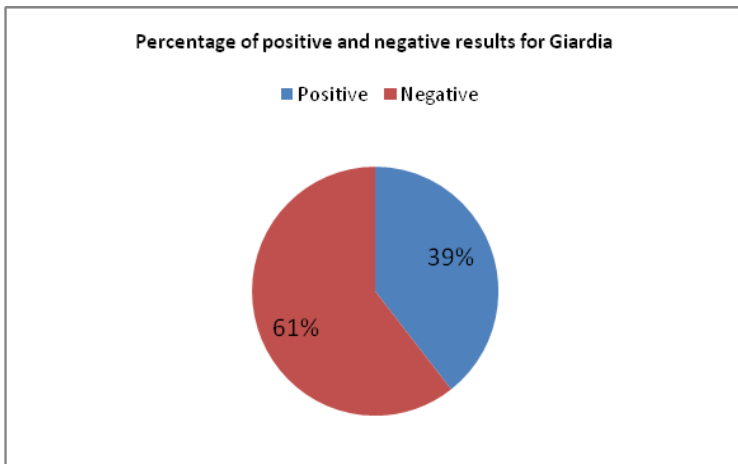


Figure 12 Results for Giardia 19 Feb - 27 April 2010

5.4.3 WHO Team Assessment of Response and Findings – August 2010

[Redacted text block]

5.5 Laboratories

5.5.1 Diagnostic and Public Health Laboratories Response – February 2010

[Redacted text block]



Figure 13 Public Health Laboratory

[Redacted text block]

[Redacted text block]

[Redacted text block]

5.5.2 Key Findings

[Redacted text block]

5.5.3 WHO Team Assessment of Response and Findings – August 2010

[Redacted text block]



Figure 14 Public Health Laboratory

[Redacted text block]

5.6 The Seychellois Government

5.6.1 Government Response – February 2010

[Redacted text block]

5.6.2 Key Findings

[Redacted text block]

5.6.3 WHO Team Assessment of Response and Findings – August 2010

[Redacted text block]

5.7 Environmental Health Site Visits

5.7.1 WHO Team Site Visits – August 2010

[Redacted text block]



Figure 15 Environmental Health Visit

[Redacted text block]

[Redacted text block]

5.7.2 Key Findings

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]



Figure 16 Chemical assessment; taking water samples on site

²⁸ The storage tank here was nearly empty at the time of our visit.

[Redacted]

[Redacted]

[Redacted]

From our site visit it was concluded that PUC's official view on the prevalent use of septic tanks across the island needs to be clarified. Anecdotally PUC added that most (residents) did not maintain these tanks and that regular sludge removal was rare²⁹. Numerous questions arose from our environmental visit that need to be addressed by PUC. For example:

- [Redacted]
- [Redacted]
- [Redacted]

5.7.3 WHO Team Assessment of Response and Findings – August 2010

[Redacted]

[Redacted]

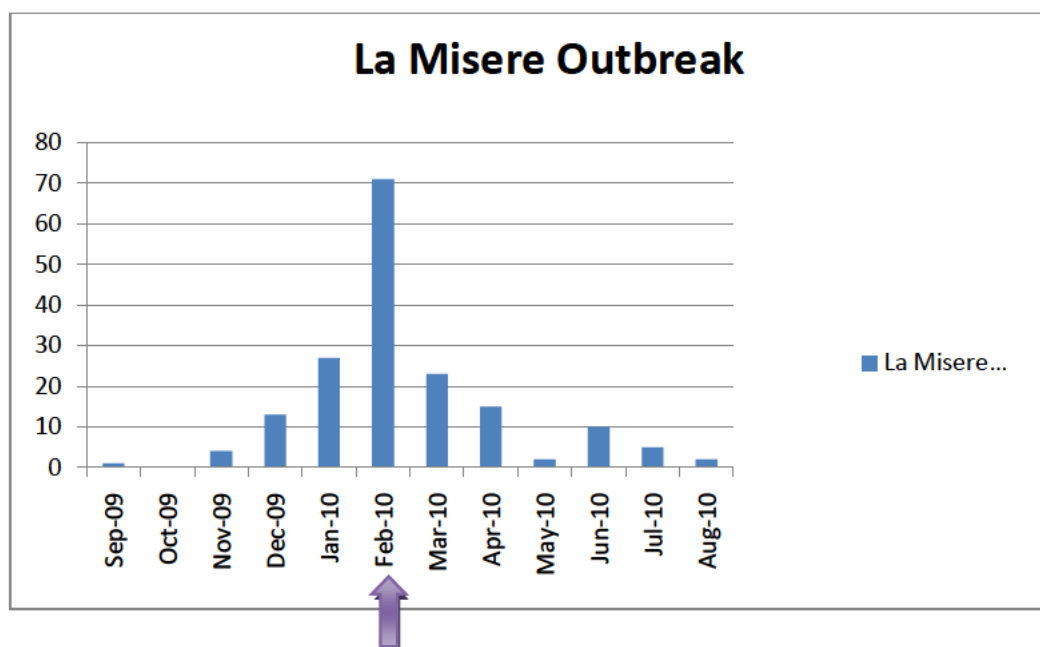
²⁹ This was confirmed during a household visit where a local resident's tank access had been concreted over and contained foul water.

5.8 Public and Patient Experience

5.8.1 Key Findings



Figure 17 Epidemic curve (251 patients): It did show clearly that the contamination must started sometime much earlier than 14th February 2010



The general public³¹ expressed serious concern about the handling of the outbreak, adding that the unknown outcome and long term impact such an infection may (or may not) have on their families' health. Many cast doubt on how the water was treated as painful symptoms continue. This apprehension appeared exacerbated by suggestions by local solicitors of financial compensation.³² From our clinical assessment, clearly some residents were asymptomatic and presented to clinic purely on the promise of legal compensation.

³⁰ "The site was previously visited by Public Health Officers on various occasions (4th December 2009, 15th January 2010, 6th February 2010 and 11th February 2010)". Public Health Commissioner Report on the 14th February 2010.

³¹ From those we met at the clinic on the 14th and 16th August and those we visited on site in La Misère on the 17th August 2010.

³² The figure of \$50,000 - \$100,000 US Dollars were mentioned by many patients we examined at the Clinic on 14th and 16th August 2010. Many apparently believe that this is inevitable and it is a matter of time.

[Redacted text block]

5.8.2 WHO Team Assessment of Public and Patient Experience – August 2010

[Redacted text block]

[Redacted text block]



Figure 18 Local residents waiting at Anse Boileau Health Centre, 14th August 2010

Four (1.6%) of the cases were < 1 year old, twenty (8%) were 1-4 years old, fifty-nine (23.5%) were 5-19 years old, one-hundred thirteen (45%) were 20-49 years old, and fifty (20%) were >50 years old.

[Redacted text block]

³³ These were sent to the UK Reference Lab at King's College London.

[Redacted]

[Redacted]

6 THE CURRENT SITUATION – AUGUST 2010

6.1 Water Supply

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

There are a number of examples of poor practice once we looked closely. Due to time restraints, we were unable to fully survey the whole system. However, from our review we are able to extrapolate the following:

[Redacted]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

6.2 Monitoring and Surveillance

The PUC and Public Health Department continues to conduct close monitoring, including testing and will keep the residents informed. In fact the PUC has completely reviewed its sampling regime and increased monitoring substantially. Final clearance for normal usage of the water can be issued by the public health department health after (i) the construction work is completed and formal sanitation systems have been brought on-line satisfactorily at the palace site (ii) experience of the PUC water tests have shown the water to have met the prescribed standard of cleanliness over a reasonable period of time; and (iii) no residents are presenting with water borne diseases (see our comments above and also the WHO Guidelines)

6.3 The Public

During discussions with local residents of La Misère mountain and assessments of as many as 251 patients (including the “worried-well”), a level of anxiety among them is undeniable.

This of course is fuelled by uncertainty with regard to long-term health, the unknown and often we found, unexplained expectation of the duration of illness and symptoms. Anxiety was also heightened by the lure and promise of financial compensation purportedly promoted by island solicitors.

Public concerns are:

[REDACTED]

6.4 The Government

A majority of the public we met viewed the intervention and action of the government was inadequate. Furthermore, some residents added that the Government actually did very little and do not care about their public. This perception may have been prevented and today may pacify this mood with more transparent communications. Public relations in a time of crisis need to be at their very best performance.

7 RECOMMENDATIONS

Clearly from the evidence we have collected through site visits, interviews, documents reviews, epidemiological surveys, clinical examinations and samples of stools and water taken we came to the conclusions that:

[Redacted text block containing multiple lines of obscured content]

Our Recommendations fall in the following areas: General recommendations, Public Health Department and Health Services, the Public Utility Company and the Government. We also made some key recommendations for capacity building of human resources, infrastructures and operating procedures and standards.

Recommendation 1

[Redacted text block for Recommendation 1]

Recommendation 2

[Redacted text block for Recommendation 2]

Recommendation 3

[Redacted text block for Recommendation 3]

Recommendation 4

[Redacted text]

Recommendation 5

[Redacted text]

Recommendation 6

[Redacted text]

Recommendation 7

[Redacted text]

Recommendation 8

[Redacted text]

Recommendation 9

[Redacted text]

Recommendation 10

[Redacted text]

Recommendation 11

[Redacted text]

Recommendation 12

[Redacted text block]

Recommendation 13

[Redacted text block]

Recommendation 14

[Redacted text block]

Recommendation 15

[Redacted text block]

Recommendation 16

[Redacted text block]

Recommendation 17

[Redacted text block]

Recommendation 18

[Redacted text block]

Recommendation 19

[Redacted text block]

Recommendation 20

[Redacted text]

Recommendation 21

[Redacted text]

Recommendation 22

[Redacted text]

Recommendation 23

[Redacted text]

Recommendation 24

[Redacted text]

8 LIMITATIONS

This report has been prepared pursuant to a commission by the Republic of Seychelles Government. Its intent was to review the management of a local waterborne gastrointestinal outbreak in February 2010 and provide background information for consideration of future recommendations. Limiting factors to review include:

Review timeframe; additional time spent in the Seychelles would have allowed for further analysis, information and responses to outstanding questions;

Denied access to construction site

Denied access to construction company staff

Denied access to senior level government decision-makers

The absence of a local rainfall report³⁴ ascribed to the report.

9 LESSONS LEARNT

Many lessons can be drawn from this experience. Local official and the public alike are fortunate that serious infections (e.g. Cholera, Hepatitis A, serious Salmonella infection) did not occur as the result of the water contamination. The government and local officials must take serving the public, and ensuring the public's safety, more seriously.

Handling of the crisis could have been improved through a more prompt and transparent response. Leadership and improved emergency preparedness is needed. This shortfall has contributed to the poor management of the crisis.

Partnership working is of paramount importance during a crisis and this was clearly lacking as all levels of the response. This incident may have been preventable had the right systems been in place and their respective mechanisms for regulatory review.

³⁴ Microbial contamination by E. coli in collected rainwater is quite common. Pathogens such as Cryptosporidium, Giardia, Campylobacter, Vibrio, Salmonella, Shigella and Pseudomonas have also been detected in collected rainwater. A significant reduction of microbial contamination can be found in rainy seasons when catchments are frequently washed with fresh rainwater. *WHO Guidelines for Drinking-water Quality, Vol.1, Page 99. Geneva 2008.*

10 CONCLUSIONS

The WHO Team has reviewed and described a waterborne outbreak caused by contamination of a public water supply serving the Western Region of Mahé Island, La Misère, in the Republic of Seychelles. Late detection contributed to the huge public health impact of the outbreak. This outbreak highlights the importance of non-complacency regarding the detection of affected sources. Decontamination water and questions from media or clinicians regarding suspected outbreaks need to be investigated thoroughly and promptly. Provision of safe drinking water across the islands must be addressed as a national priority.

11.1 Appendix A

Assignment Protocol/Terms of Reference Project 'Feb' – Republic of Seychelles GI Outbreak August 2010

Background

The WHO Collaborating Centre for Public Health has been asked by the Seychelles Government and the Ministry of Health to assemble an independent team of UK experts on a consultant basis to investigate a GI and skin disease outbreak in the Republic of Seychelles. Spillage of raw sewage, believed to be related to the unsanitary living conditions of the labourers working at a large construction projects, has contaminated the water tables and is affecting a community of approximately 300 households. More than 1000 unskilled workforce are on the site of the contamination area.

The Investigation Team

A small team led by an experienced Director of Public Health will be assembled and consisting of:

1. Consultant in Communicable Disease Control (CCDC): Prof Salman Rawaf
2. Medical Microbiologist (x2): Dr Gillian Urwin and Dr Bharat Patel
3. Hospital Consultant: Prof Ram Dhillon
4. Senior Environmental Health Officer: Mr Geoffrey Fish
5. Public Health Specialist / Nurse: Elizabeth Dubois



Figure 19 WHO Team Members

E. Dubois, G. Urwin, R Dhillon, S Rawaf, G. Fish, B. Patel

Method of Working

1. An immediate team meeting will be held in London (virtual if not possible) to agree the plan of working;
2. All staff involved in patient assessment must submit proof of clinical qualification(s);
3. On arrival the team will meet with the Public Health Authority/Ministry of Health to confirm and proceed with plan of action;
4. A meeting will be held with the construction company in question;
5. On site the team will assess the:
 - a. response of the local force to the outbreak;
 - b. response of the Health care centre in the affected area;
 - c. response of the local authorities;
 - d. laboratory performance and quality of the test carried out;
 - e. ongoing treatment of sewage and water;
 - f. manner in which the site was managed after the contamination was discovered;
 - g. current status and impact of pipe replacement systems in residential areas.
6. Working collectively, the investigating team will sample a cohort of infected patients including children (N=100) will be interviewed (see the interview questionnaire). Clinical and lab assessments will also be undertaken to confirm the conditions;
7. A sample (N=150) of the unskilled workforce from the construction site will be identified and subjected to clinical and lab assessments;
8. On-site soil and water samples (10 each) will be taken from contaminated and uncontaminated sources. Samples will be assessed and compared to those taken from workers and patients;
9. Full analysis of the clinical, soil and water data will be undertaken;
10. No dye is available in the Republic of Seychelles for testing;
11. The transport of samples back to the UK is to be arranged from the UK using certified packaging and be UN3373 compliant;
12. On site, all team members will communication with local officials and medical personnel; further suggestions or reports must be discussed and submitted via Rila;
13. All preliminary findings will be discussed with Seychellois authorities;
14. A WHO Collaborating Centre Final report will be submitted in full compliance with public and patient confidentiality and anonymity.

The team will be supported by other expertise from the UK through the Health Protection Agency as and when needed.

Local administrative support will be provided to the team by the Seychelles government.

Reporting and Handling of the Media

Preliminary findings will be reported as well as at each subsequent stage of the investigation. A final report will be submitted to the Seychellois Government.

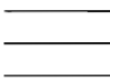
The local and national media will be handled by the team leader.

Laboratory Equipment for Testing

The team is expecting the use of local services including laboratory facilities at Victoria Hospital. The following supplies will be transported by the UK team to be used on-site:

1. Dipslides Easicult TTC (Pkg of 10) for soil and water contamination testing (further information is needed)
2. The team is exploring the possibility of supplying stool disposable testing equipment
3. Discussion with HPA is continuing for the best tests appropriate in a country with limited resources.

11.2 Appendix B



11.3 Appendix C

Neglected communicable tropical diseases: gastrointestinal infection and *Giardia intestinalis*

Neglected communicable (tropical) diseases are a key area of concern for our society. In 2006 the WHO clearly formulated that neglected tropical diseases (NTD) affect an estimated one billion people, primarily poor populations living in tropical and subtropical climates. Infections are attributed to unsafe water and poor sanitation with children most vulnerable to infection.

One-hundred percent of low-income countries are affected by at least five simultaneously NTDs and more than 70 % of countries and territories that report the presence of NTDs are low-income and lower middle-income economies. Many neglected tropical diseases can be prevented, eliminated or even eradicated with improved access to existing safe and cost-effective tools.

In 2004 WHO reported an incidence of 4.6 billion episodes and 2.2 million deaths due to diarrhoea per year, of these 1.8 million deaths in developing countries³⁵. The most common etiologic agents are species among the viruses rotavirus, calicivirus, astrovirus and enteric adenovirus; the bacteria *E. coli*, *Shigella*, *Salmonella*, *Campylobacter* and *Vibrio cholera*, and the parasites *Giardia*, *Entamoeba histolytica*, *Cryptosporidium*, *Cyclospora* and *Isospora*³⁶.

Infectious Agent

Giardia intestinalis is a small, flagellated, protozoan parasite that inhabits the small intestine. Endemic in humans and over 40 species of animals (zoonotic infection) it is the most commonly reported intestinal parasite in the world (Farthing, 1989; Adam 1991) with prevalence rates ranging from 1 to 90+%. Infection follows ingestion of the cysts and excystation in the stomach. The trophozoites which emerge from the cysts have a pear-shaped body and are believed to feed primarily upon mucosal secretions. After detachment from the intestine, the trophozoites form cysts and are passed out in the faeces, often in large numbers.



Figure 20 Protozoan Parasite *Giardia intestinalis*; HPA

³⁵ WHO: The global burden of disease update: 2004 update. http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/ 2004.

³⁶ O’Ryan M, Prado V, Pickering LK: A millennium update on pediatric diarrheal illness in the developing world. *Semin Pediatr Infect Dis* 2005, 16(2):125-136.

Mode of Transmission

Transmission occurs by exposure to faecally contaminated environmental surfaces and objects, person-to-person contact or ingesting faecally contaminated food or water. *Giardia* cysts in water at low temperature remain viable for up to two months³⁷. *Giardia* cysts are highly resistant to chlorine and other oxidants commonly used for water treatment.

The endemic nature of *Giardia* infections in humans and animals, environmental resistance, together with the low infectious dose needed to establish colonisation within a new host, all point toward the potential for waterborne spread of this disease (Erlandsen 1994).

Outbreaks

As population pressures increase and human related activity occurs in water catchment areas, the potential for faecal contamination of water by human sewage becomes greater. Despite the obvious potential for zoonotic transmission, most waterborne outbreaks of *Giardia* have been traced back to human sewage contamination.

These outbreaks of giardiasis show that consumption of surface water, a lack of complete conventional treatment, and improper operation or malfunction of equipment were common causes. Small water treatment systems that used otherwise good quality surface water of low turbidity seemed to be most commonly affected. Lin concluded that these and other outbreaks had been caused by lack of filtration, improper filter operations, inadequate chlorination, cross connections to sewers, and drinking contaminated surface waters³⁸.

The removal and inactivation of *Giardia* cysts from raw water is complicated by the protozoan's small size and resistance to commonly used oxidants such as chlorine. The multiple barrier approach to water treatment is by far the best approach to elimination of these parasites and other waterborne pathogens³⁹.

Clinical Presentation

Symptoms usually begin 1–2 weeks after becoming infected with the parasite and are self-limiting within 2–4 weeks. However, some patients develop a syndrome of chronic diarrhoea that may result in malabsorption. Rarely, reactive arthritis has also occurred, following infection with *Giardia*.

Giardiasis can cause a variety of intestinal symptoms or signs, which include diarrhoea (often with foul-smelling, greasy stools), abdominal cramps, bloating, flatulence, fatigue, anorexia, and nausea. These symptoms may lead to weight loss and dehydration. Fever and vomiting are uncommon. Some people infected with *Giardia* have no symptoms at all.

³⁷ Bingham AK, Jarroll EL, Jr., Meyer EA, Radulescu S: *Giardia* sp.: physical factors of excystation in vitro, and excystation vs eosin exclusion as determinants of viability. *Exp Parasitol* 1979, 47(2):284-291.

³⁸ Accessed 15th August 2010: <http://www.hyperionlab.ca/giardia1.html>

³⁹ Accessed 15th August 2010: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/protozoa/chap_8-eng.php

Diagnosis

Because detection of *Giardia* can be difficult, patients may be asked to submit several stool samples over several days. Most often, stool specimens are examined microscopically by using different techniques (e.g., wet mount with iodine, trichrome, or immunofluorescent antibody staining, and/or enzyme immunoassays for detection of *Giardia* sp. antigens).

Treatment

Diarrhoea should be managed with adequate fluid replacement to prevent dehydration. Several antimicrobial drugs (i.e., tinidazole, metronidazole, nitazoxanide, paromomycin, furazolidone, quinacrine) are available by prescription.

Key features of neglected tropical diseases:

- Neglected tropical diseases affect an estimated one billion people, primarily poor populations living in tropical and subtropical climates. They frequently cluster geographically and overlap; individuals are often afflicted with more than one parasite or infection.
- 100 % of low-income countries are affected by at least five neglected tropical diseases simultaneously.
- More than 70 % of countries and territories that report the presence of neglected tropical disease are low-income and lower middle-income economies.
- Infections are attributable to unsafe water, poor housing conditions and poor sanitation.
- Children are most vulnerable to infections of most neglected tropical diseases.
- Many can be prevented, eliminated or even eradicated with improved access to existing safe and cost-effective tools.

11.4 Appendix D

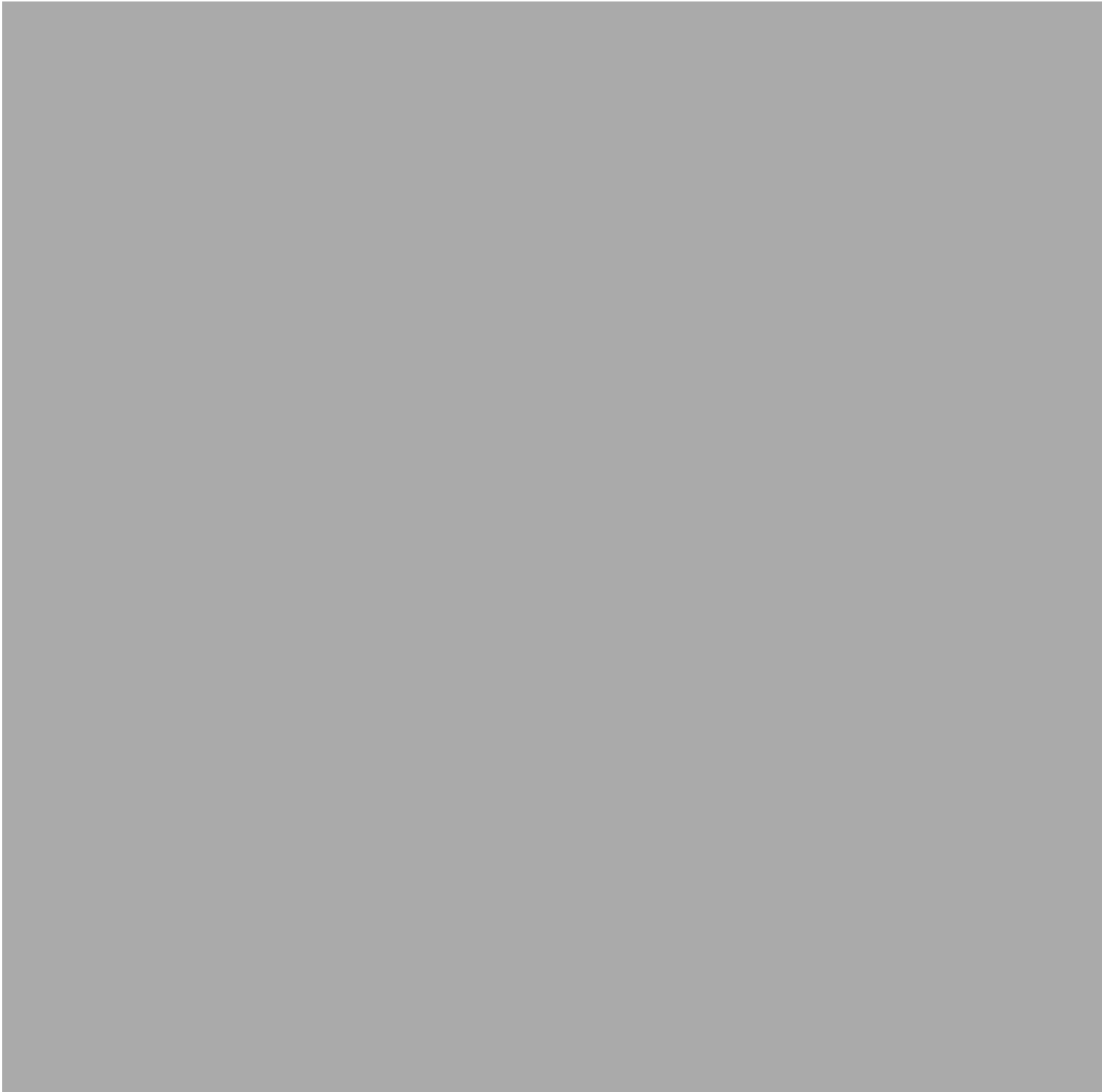
Our Findings – Flowchart

Summary Charts: Incident timeline, actions taken, WHO Team Assessment

[Our Assessment](#)

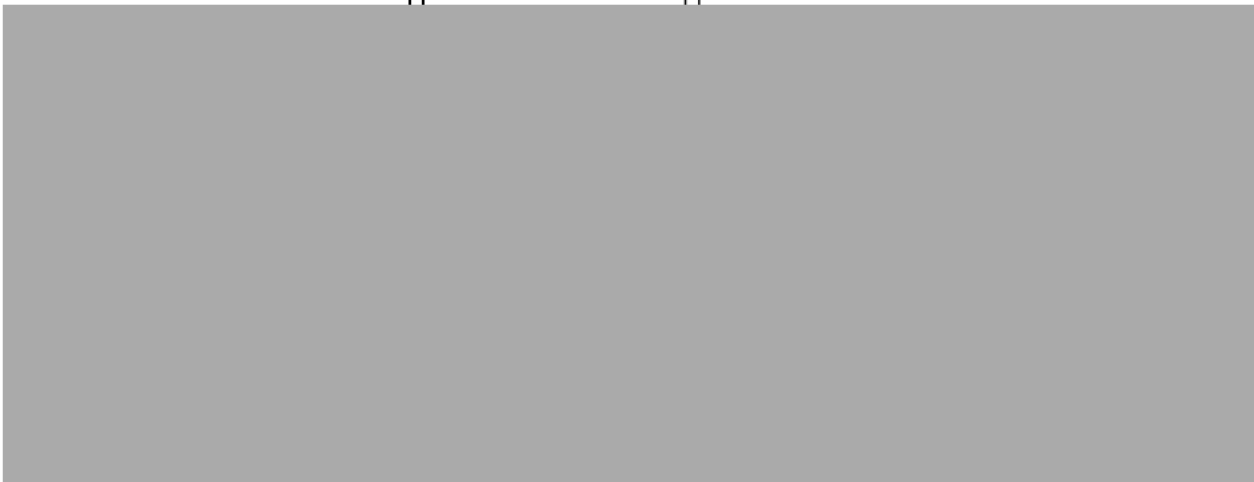
[Incident Timeline](#)

[Actions Taken](#)





WHO Review of the Responses
13 to 18th August 2010



11.5 Appendix E

<u>Existing Regulations</u>	
S.I.44 of 1994	
PUBLIC HEALTH ACT (Cap. 194)	
Public Health (Water Examination) Regulations, 1994	
In exercise of the powers conferred by section 7 of the Public Health Act, the Minister of Health hereby makes the following Regulations –	
1. These Regulations may be cited as the Public Health (Water Examination) Regulations, 1994.	Citation
2. In these Regulations	Interpretation
“drinking water” means water used for drinking or domestic purposes;	
“swimming pool water” means water in a swimming pool used for public bathing purposes, where contamination can result in involuntary consumption of the water, and whether or not admission to the pool is gained by payment.	
3. (1) The standard relating to the wholesomeness, purity, and quality of drinking water is specified in Scheduled I .	Standard of drinking water
(2) Drinking water shall conform to the standard specified in Schedule 1.	
4. (1) The standard relating to swimming pool water in specified in paragraphs 2, 3, 4, 7, and 9 of Schedule II .	Standard of Swimming pool Water and requirement of swimming pools.
(2) Swimming pool water shall conform to the standard specified in sub regulation (1)	
(3) No swimming pool shall be used or made available for use unless all the provisions in Scheduled II are complied with.	
5. An environmental health officer authorised under the Public Health Act may enter any premises at any time to take samples of drinking water for examination, to ascertain the wholesomeness of the water issued, serves or used on those premises or at source for drinking or domestic purposes, and to ascertain the purity levels of swimming pool water.	Authorised officer to collect samples
6. (1) Where the Medical Officer of Health is of the opinion that any drinking water in any premises is unwholesome or polluted or does not conform to the standard prescribed in these Regulations, he may, by notice in writing, direct the occupier or the person having the charge, control or management of the premises to cease from issuing, serving or using the water for drinking or domestic purposes.	Pollution or unwholesomeness
(2) The Medical Officer of Health may, by notice in writing, direct the owner or the person having the charge, control or management of any swimming pool (including those owned by the Government) to	

Figure 21 Public Health Act of 1994