5.

DISASTER EFFECTS AND PREPAREDNESS IN ENVIRONMENTAL HEALTH AND WATER SUPPLY

Notes by Eng Ronald Williams,
PAHO Area Engineer, Barbados
Presented by Dr. James St. Catherine
Medical Officer of Health, St. Lucia

DISASTER EFFECTS & PREPAREDNESS IN

ENVIRONMENTAL HEALTH & WATER SUPPLY

1. Introduction

- Link between area disaster occurrence and EH/Water supply implications.
- Need for EH/water supply personnel to develop sub-sector approach.
- Water and Sanitation Decade (1981-90)

2. Disaster Effects

2.1 Effects by type of Caribbean Disaster

a) Earthquakes

b) Volcanoes

c) Hurricanes

Primary: destructive winds, heavy rains

Secondary: Flooding, landslides, high waves, coastal erosion, wind-blown roofs and transmission lines.

Tertiary: impassable roads, lack of power/communication, fold spoilage, excessive debris.

2.2 Effects on Environmental Health Services

2.2.1 Water supply

- Adverse effects on structures and pipeline system, flooding of plant, intake damage, etc.

2.2.2 Waste-water Disposal

- Adverse effect on structures and sewer system, flooding of plant, outfall sewer damage, etc.

2.2.3 Solid Waste Management

- Heavy debris deposit throughout community, increase demand for solid waste removal and disposal

2.2.4 Food Sanitation

- Lack of food supplies, food spoilage/contaminatio destruction

2.2.5 Vector Control

- Increased breeding places for rodents, mosquitoes flies, etc.

2.2.6 Home Sanitation

- Demolished or damaged homes, poor sanitary contro overcrowding in unaffected areas.

3. Disaster Preparedness

- Preparedness effort and investment vital

3.1 Vulnerability Analysis

3.1.1 Water/Waste-water Systems

- Describe system, work out design disaster and eff ts and establish vulnerable and critical components.

3.1.2 EH Services

- Define services, establish vulnerable and critical components.

3.1.3 Health Care Facilities

- Describe location and define facilities, establish vulnerable and critical components.

3.1.4 Shelters/Relief Centres

- Describe location and layout, establish vulnerable and critical components.

3.2 Emergency Action Plans

- Data collection, action steps, recovery action, emergency equipment, assign personnel, system/service rehabilitation:

a) Water/Waste-water systems

b) EH Services.

3.3 Pre-Disaster Measures

3.3.1 Engineering Precautions

-Location: Above flood level, away from hazardous sub-soil or coastal areas, etc.

- Design: Lay water mains and sewer in separate trenches, design for high wind load, etc.

- Construction Materials: Material behaviour under stress is very relevant

3.3.2 Staff Training

- Skill inventory of utility personnel, appropriate training exercises.

3.3.3 Public Education

- Pre-disaster education of public, post-disaster information to and participation of public.

3.3.4 Shelters/Relief Centres

- Locate in low wind and non-flood areas with good access, ensure structural soundness and adequate environmental health facilities.

4. Conclusions

- Preparedness is what Disaster Management is all about.

6.

"VULNERABILITY ANALYSIS"

a. presentation

b. guidelines and results of group discussions

by Eng. Wilton Conliffe
Barbados Senior Public Health Engineer
and Eng. Robert Swart
PCDPPP/PAHO Sanitary Engineer

WORKSHOP ON EMERGENCY MANAGEMENT OF
ENVIRONMENTAL HEALTH AND WATER SUPPLY
ST.LUCIA 20-23 NOVEMBER 1984

a. VULNERABILITY ANALYSIS

by and

Eng. Wilton Conliffe
Senior Public Health Engineer,
Barbados.

Eng. Robert Swart
PAHO/PCDPPP Sanitary Engineer

The simulation exercise carried out yesterday was an attempt to give you, the participants in this workshop, a feel for the problems which arise during and after a disaster. It demonstrated -adequately, in my opinion - the inadequacy and unreliability of information being received; the difficulty of utilising scarce resources, and the pressures, political and otherwise, which can be brought to bear on public officers in environmental health and water supply services in times of disaster. This morning, we learned in greater detail of the effects of disasters on these services. The question then is - can anything be done to migitate these effects? The answer, of course, is yes, and that is why we are all here in beautiful St.Lucia this week.

One of the speakers at the opening ceremony noted that it took two elements to make a disaster. The first is a natural phenomenon which is potentially devastating; the second is a vulnerable area where the devastation can take place. Our scientific and technical knowledge does not allow us to do very much about the former, but we are, as you will see today, in a position to do something - however little it may be - about the latter.

There are two ways in which we can attempt to mitigate the service disruption of a disaster. The one which comes readily to mind is <u>preparedness</u>, i.e. the development of plans indicating who does what, when and where in the event of a disaster. A second approach, however, is <u>prevention,</u> i.e. adopting measures <u>before</u> the disaster occurs which will give structures and services a greater chance of surviving the devastating natural phenomenon. A powerful tool call vulnerability analysis may be used in both these approaches.

What is vulnerability analysis? It has been defined as "the determination of the degree to which a system may be

/adversely

adversely affected, relative to its responsibility, by stress situations." It is the modern thinking that all organisations are systems, containing several components interacting with each other. A water utility, for example, is a system containing elements of collection, storage, treatment and distribution of water. An environmental health service is a system with elements of wastewater disposal, solid waste disposal, good hygiene, vector control, etc. Any potentially devasting natural phenomenon will have some effect on the system as a whole, but it may have a greater effect on some elements rather than others. In other words, some elements of the system are more vulnerable than others.

If we take the example of a hurricane, it is obvious that more damage is likely to occur to surface structures - building, power lines, etc., than to buried pipelines. The surface structures are therefore identified as being more vulnerable. This knowledge enables us to:-

1. make plans to eliminate or reduce the vulnerable components of the system, thereby increasing the reliability of the service;

2. highlight which elements of the system are likely to suffer most in any given potentially devastating natural phenomenon. thereby indicating where our priority interests should be after the phenomenon.

But is it merely sufficient to know the vulnerable components? Consider this example. There is, in a relatively remote part of the country, a single well serving a small village. The structure on the surface is falling apart, the area is prone to landslides, and the power supply is poor in the best of times. Not too far away, there is a booster station, structurally quite sound, which supplies water to 50% of the country's population. There is no emergency power supply at the booster station. One might reasonably argue that the well is more vulnerable than the booster station, however, no one can deny that the booster station is more critical to the country's total water supply. It is therefore not enough to merely identify the vulnerable elements, it is necessary to determine those elements whose operation is essential in order to meet basic demands after the disaster.

So, how do we do this vulnerability analysis, and identify vulnerable and critical elements? As an engineer, I advise you to approach the matter in a logical and systematic way, as the flow chart (attached) indicates.

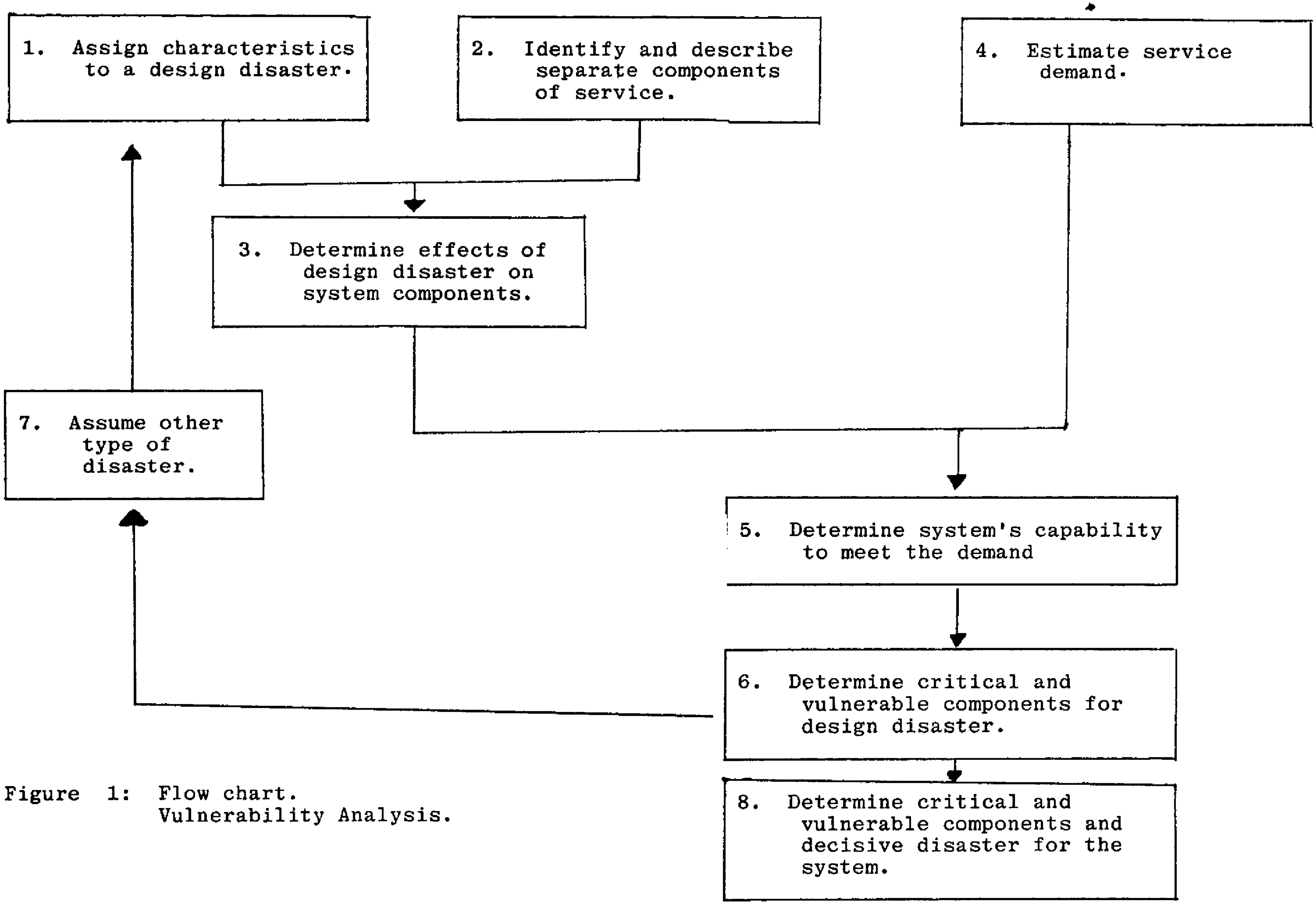


Figure 1: Flow chart.
Vulnerability Analysis.

Step 1: ASSIGN CHARACTERISTICS TO DESIGN DISASTERS.

This should be done primarily by studying the records of past disasters. The most important items are: frequency, magnitude and hazard areas. In other words: which type of disaster is liable to strike with which frequency, which magnitude and where. The greater the risk in an area is that a specific disaster will strike, the more detailed the study should be. Knowledge of past disasters in the country should be supplemented by information on disasters in similar areas in other countries.

Step 2: IDENTIFY AND DESCRIBE COMPONENTS OF SERVICE.

All necessary information on the service has to be collected, which can help to identify and describe the system. This comprises:

- identification of components:
  e.g. for water supply:
  - collection works
  - transmission
  - treatment
  - storage
  - distribution
  - power supply
  - manpower
  - materials and supplies
  - communications.

  e.g. for solid waste management:
  - collection
  - storage
  - disposal
  - vehicles
  - manpower
  - materials and supplies.

- assessment of operations, including problem areas in normal times, responsibilities of components and planned developments.

To illustrate this, let us have a look at an example. In figure 2, the Antigua Water System is shown, simplified to its basic components.

In a recently held workshop similar to this one, the representatives from APUA, the Antigua Public Utilities Authority, identified the major components of their service and listed as the main operational problem areas the lack of adequate communication facilities, shortage of spares and equipment and the absence of standby generators for the well fields. This is in normal circumstances.

Step 3: DETERMINE EFFECTS OF DESIGN DISASTER ON SYSTEM COMPONENTS.

After choosing a specific disaster, each component will be considered separately. In general, a combination of information on previous disaster effects, sound technical judgement and common sense, provides the basis for the assessment. The last two factors yield conditions which will make the analysis more subjective, than objective. However, especially since the exact magnitude of the expected effects may be less important than the assessment of the extend of the damage to the component relative to that to another component, also a sound (though subjective) judgement of a competent person will provide the necessary information. In developing countries, Environmental Health systems often operate in near emergency conditions. The data in the system's disturbances and breakdowns, referred to under Step 2, provide very good information for the formulation of the assumed effects on the system.

It is important not only to describe the expected effects on each component, but also to assess the remaining capability.

Let us go back to our Antigua example. During the workshop, the main effects of a hurricane upon the system to be expected according to the participants were:

- power cuts affecting the well-fields (the supply line from the dam is provided with stand-by generators).
- destruction of pump sheds in the well-fields and damage to electrical switch gear.
- contamination of well-fields with polluted surface water.
- structural damage to HQ, Parham booster station and Grays Hill treatment plant (at least lost of roof).
- damage to transmission and distribution pipelines predominantly in the mountainous southern part of the island, where pipes are exposed especially when crossing valleys, gullies.

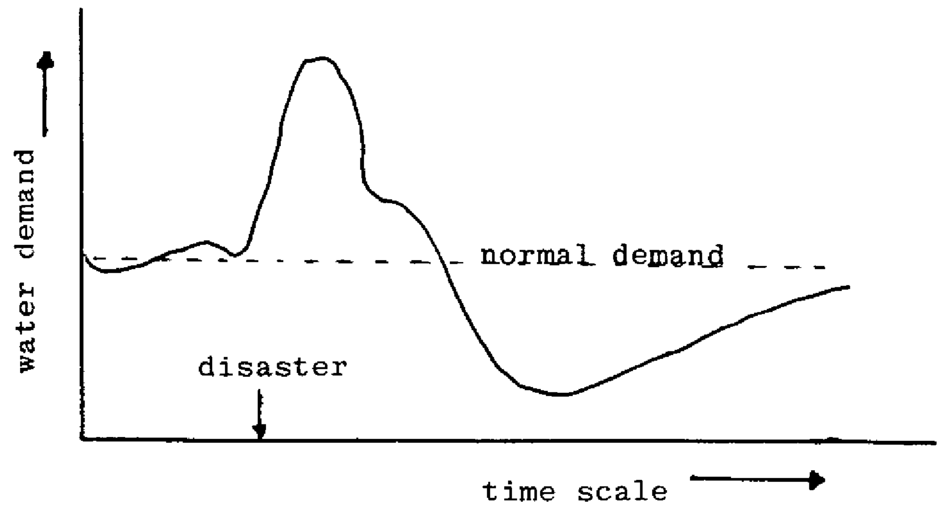
This step can be carried out systematically by using a analysis worksheet, an example of which is shown in figure B.

Step 4: ESTIMATE SERVICE DEMAND.

The demand from the Environmental Health and Water Supply Services, after a major disaster is different from the normal demand. For instance, in a country where most of the population has access to sanitary facilities, in normal times the role of the Public Health Department will be limited to regular inspection of these facilities However, when these facilities will be damaged (e.g. pit latrines after a hurricane) the demand, placed upon the Public Health sector, to provide adequate facilities will increase enormously.

For Water Supply, immediately after a disaster, the minimal consumption in order to satisfy the basic needs of the population will be much lower than the consumption before the disaster. This is shown in figure 4.

FIGURE 4: VARIATION IN WATER DEMAND DURING A DISASTER



Step 4: Con't

The increase in "consumption" immediately after the disaster is caused by losses through leaks and damages, while in many disasters water is withdrawn from the system for fire extinguishing purposes.

Step 5: DETERMINE SYSTEM'S CAPABILITY TO MEET THE DEMAND.

After having assessed the disaster impact on the service components and thedemand after the selected disaster, it can be established, if and to what extent the needs can be satisfied.

If the needs cannot be satisfied by the remaining service capacity, steps should be taken urgently to mitigate this situation.

A conclusion for the Antigua Water system in this respect is, that one of the mentioned main water sources will be sufficient, only when operational, to satisfy the needs of he population, if appropriate distribution methods will be applied.

Step 6: DETERMINE CRITICAL VULNERABLE COMPONENTS FOR THE DESIGN DISASTER.

If the system fails to meet the demand, it will then be possible to identify the key or critical components of the system that are primarily responsible for failure. In our example, the Antigua Water System, confronted with a hurricane, has its most vulnerable components in its groundwater production line, but since in general the surface water production line can provide enough water to cover the basic needs, the most critical components for the overall water situation might be found in the weakest links in this line, e.g. the vulnerable structure of the booster station. Focussing on this line and going back through the steps, other critical areas

Step 6: Con't

can easily be defined: rapid response to irregularities here are hampered by lack of communication facilities, spare parts and supplies.

Step 7: ASSUME OTHER TYPES OF DISASTER.

The vulnerability analysis process should be repeated for all types of disasters the country is prone to: earthquakes, hurricanes landslides, floods, etc. In general, the major part of the disaster effects will be similar for most natural disasters, thus limiting the amount of work to be done.

For instance, earthquakes have effects on services which are similar to hurricanes, but there are some differences. For example, underground pipe breakages are more likely to occur, while changes in groundwater bodies and damage to well casings affect well production.

Step 8: DETERMINE CRITICAL AND VULNERABLE COMPONENTS FOR THE SYSTEM.

When a vulnerability analysis has been done for all possible disasters, a final determination of critical and vulnerable components can take place.

To go back to the Antigua example. The country is hit by another type of disaster even more frequently than by hurricanes: drought.

It is interesting to realize, that the vulnerability analysis for a drought gives opposite results here: not the groundwater production is most directly affected by a drought, but the surface water.

In the Antigua case therefore, both lines are equally important and critical components are identified accordingly.

The stepwise vulnerability analysis as outlined above is intended to be a guideline. Each professional may adopt his own methodology in order to suit the needs of his specific system.

WORKSHOP ON EMERGENCY MANAGEMENT

OF

ENVIRONMENTAL HEALTH AND WATER SUPPLY

ST. LUCIA 19-23 NOVEMBER 1984

b. GUIDELINES AND RESULTS OF GROUP DISCUSSIONS ON VULNERABILITY ANALYSIS

The participants were asked to analyze in the stepwise way as outlined in the presentation, of their own system, as a whole or partly. The handout on the following pages including tables served as guideline

The groups choose the system to be analyzed and the disaster type to take into account:

- St. Vincent & the Grenadines: system: water supply North Western part of the country; disaster: freak storm
- St. Lucia: system: environmental health service; disaster: hurricane
- Grenada: system: water supply greater at St. George's area; disaster: hurricane
- Dominica: system: water supply Roseau; disaster: rainstorm

In the following the results are represented of an afternoon's group work, as adopted from the rapporteurs, unchanged by the course instructors.

As the results show the objective of the group discussions: training in a systematical vulnerability analysis approach, was fully reached. As follow-up a detailed assessment, requiring additional data, has to be completed back at work.

IMPORTANT: ONE GROUP MEMBER WILL TAKE NOTES AND SERVE AS RAPPORTEUR FOR THE PRESENTATION OF RESULTS AFTER THE GROUP SESSION. THESE NOTES SHOULD BE READIBLE IN ORDER TO BE INCLUDED IN THE WORKSHOP REPORT.

Step 1: ASSIGN CHARACTERISTICS TO A DESIGN DISASTER (15 minutes).

Discuss and evaluate past disasters in your country, the most disaster prone areas and select a disaster type for the purpose of this workshop.

Step 2: IDENTIFY AND DESCRIBE COMPONENTS OF SERVICE (30 minutes).

Review all available information on the policy and objectives of the selected service, infrastructure, resources, levels of services presently being provided and weaknesses of the present system in normal times.

Make a list of distinguishable components in table 1, first column.

Step 3: DETERMINE EFFECTS OF DESIGN DISASTER ON SYSTEM COMPONENTS (30 mins).

Review information on past disasters and assess the expected impact of the selected disaster upon the components. List these effects in the second column of the table.

Step 4: ESTIMATE SERVICE DEMAND (15 minutes).

Identify changes in service demand after the disaster.

Step 5: DETERMINE CRITICAL AND VULNERABLE COMPONENTS (30 minutes).

For the selected disaster, it can be determined now in which areas the capacity of the hit system will not be able to meet the demand .

Information to be used for this purpose: weak areas in normal circumstances (step 2), disaster effects (step 3) and service demand (step 4).

List the five main areas of concern in table 2.

Step 6: DESIGN CORRECTIVE MEASURES (if time permits).

For the selected disaster, the five most critical areas have been listed in step 5.

Discuss and list for these 5 areas possible corrective measures in table 2.

TABLE 1: VULNERABILITY ANALYSIS WORKSHEET

System:	Assumed disaster:
Analysts:	Date:

COMPONENTS	EFFECTS ON COMPONENTS

TABLE 2: VULNERABILITY ANALYSIS CRITICAL AREAS

CRITICAL AREAS	CORRECTIVE MEASURES
1.	
2.	
3.	
4.	
5.	

Country: St.Vincent and the Grenadines

Date: 21.11.84

Assignment: Vulnerability Analysis related to the Water Supply

Step 1. Past Disasters: Freak Storms, Volcanic Ash fall, Land Slides (Excessive) Hurricanes, Fires (See pg. attached)

Effects on Water Supply -

Broken Lines, Water shortage; Turbidity, High demand on chlorination, Increased man-power and Finance.

Disaster Prone Areas:

North Western part of the island - Dalaway Water System - Freak Storm.

Step 2. Policy: Whenever the Water Supply is suspect-

1. All inlets are immediately closed
2. There is a switch to standby supply
3. Treatment of closed supply with chlorine
4. Distribution of water purification tablets
5. Truck borne water, if no standby is available.

Objective: To maintain a supply of po table and relatively safe water to the population.

Infrastructure: Intake lines and rivers, Tanks (Sedimentation, distribution), Pipelines, Chlorination plants.

Resources: Personnel:- 9 workers (Supervisor, Care-taker, Chlorinator Operator, Other unskilled workers).

Other:- 1 vehicle, a Chlorination plant

/Levels of Services.

Levels of Services: Institutional, Industrial, Domestic and Commercial services offered. Service is to approx. 70,000 people.

Weaknesses in Present System in Normal Times:

Fluctuation
Turbidity
Low Pressure
Shortage.

Step 4. Service Demand:

Increased demand - 100%
Trucking service becomes necessary
Switching to other intakes
Distribution of containers (5 gal) to households
Closure of some industries
Increased manpower
Increased demand for transportation
Increased use of chlorine
Increased laboratory testing and chemicals

PAST DISASTERS

1.	Volcanic Eruptions 1979	Massive evacuation of people, damage to crops and property, loss of employment and live stock.
2.	Hurricane David 1979	Damage to homes, and live stock.
*3.	Freak Storm 1981	Damage to bridges, water systems, loss of live stock, property, Gastro enteritis outbreak.
4.	Fire	Loss of property, damage to goods, Loss of employment.

* Selected Freak Storm/ Flash Flood of 1981

TABLE I: VULNERABILITY ANALYSIS WORKSHEET

SYSTEM: DALAWAY WATER SUPPLY — ASSUMED DISASTER: FREAK STORM

North Eastern area of St.Vincent.

ANALYSTS: Messrs LYNCH, SHORTTE, MURPHY & BONADIE. — DATE:

COMPONENTS	EFFECTS ON COMPONENTS
1. INTAKE	
(a) 86% No 24) (b) 14% Dalaway)	Silt and debris possibly contamination
2. SEDIMENTATION BASIS	Turbidity and silt
3. CHLORINATION PLANTS	Increased wage
4. DISTRIBUTION LINES	Broken
5. STORAGE TANKS	Shortage of water, silt
6. AIR VALVES	Air collection
7. GATE VALVES	No effect
8. PRESSURE REDUCING VALVES	Possibly blockage from silt.
9. COMMUNICATION	Loss of contact with workers
10. MATERIALS AND SPARE PARTS	Delay in restoration of water supply

TABLE II: VULNERABILITY ANALYSIS CRITICAL AREAS

CRITICAL AREAS	CORRECTIVE MEASURES
1. BROKEN MAINS	None known except to re-route lines. (financial implications) Installation of a second line Maintain a supply of adequate spares
2. CONTAMINATION	More security e.g. fencing to prevent animals and unauthorised persons gaining access to intakes. HEALTH EDUCATION ON USAGE OF PESTICIDES
3. TURBIDITY	IMPROVEMENT OF FILTRATION - Adoption of the use of coagulants
4. BLOCKAGE OF ACCESS TO SYSTEM	Discourage deforestation - Encourage reforestation
5. MOBILITY TO TRANSPORT WATER BY OTHER MEANS	Purchase of two water trucks More water containers Access roads.

MAP 1 ST. VINCENT AND THE GRENADINES

SHOWING TOWNS VILLAGES AND MEDICAL FACILITIES

DALAWAY WATER SUPPLY ⊙

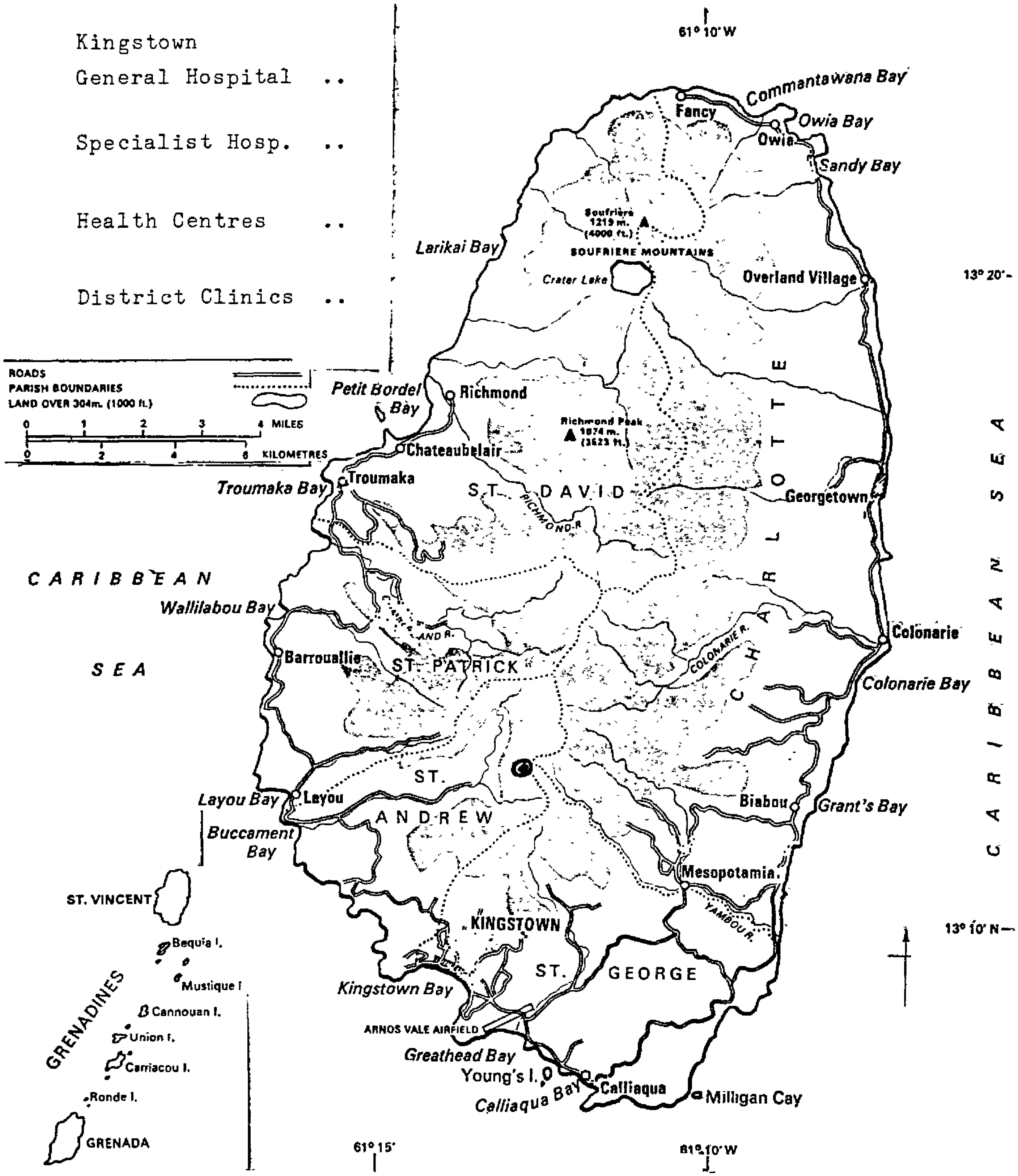
Kingstown

General Hospital ..

Specialist Hosp. ..

Health Centres ..

District Clinics ..



7.

ROLES AND RESPONSIBILITIES OF ENVIRONMENTAL HEALTH SERVICES IN DIFFERENT DISASTER PHASES

Notes by: Eng. Ronald Williams,
PAHO Area Engineer, Barbados
Presented by: Eng. Wilton Conliffe
Barbados Senior Public Health
Engineer

Roles and Responsibilities of Environmental Health Service in Different Disaster Phases

1. PRE-DISASTER PHASE

   1.1 General: Emergency operations planning, warning and alert, evacuation, education of public, training of personnel, stockpiling of equipment and supplies, selection of shelters and relief centres.

   1.2 EH Service:

   (a) EH Data Collection and/or Classification

   (b) EH Emergency Operations Planning (and vulnerability assessment)

   (c) Training of EH, Relief and Other Personnel

   (d) EH Education of Public

   (e) Stockpiling of EH Equipment and Supplies

   (f) EH Aspects of Shelter/Relief-Centre Selection

   (g) Protective Measures for EH Systems

2. DISASTER PHASE

   2.1 General: Evacuation, rescue, first-aid and medical care, recovery and disposal of corpses, fire-fighting, immediate damage survey.

   2.2 EH Service:

   (a) Mobilization of Relief Centres and Shelters

   (b) Environmental Impact Survey(Immediate)

   (c) Commence Organization of Clean-up and EH Rehabilitation

3. POST-DISASTER PHASE

   3.1 General: Continued rescue and care of victims, restoration of communications, relief (provision of temporary shelter, food, medical care, public health, environmental control, welfare services), detail damage survey and assessment, emergency repairs, coordination of activities, rehabilitation and reconstruction.

3.2 EH Service:

(a) Relief Measures

- EH aspects of relief centres, temporary shelters,.etc.

(b) Environmental Health Impact Survey and Assessment(Detail)

- Community: EH and related works and systems

- Health Care Facilities

(c) Membership in Disaster Management Team

(d) Public Information

(e) EH Rehabilitation Measures and Projects

- Data collection, design, documentation and funding

-----0-----