PAN AMERICAN HEALTH ORGANISATION

VULNERABILITY ASSESSMENT OF THE DRINKING WATER SUPPLY INFRASTRUCTURE OF MONTSERRAT

EXECUTIVE SUMMARY

Introduction

Montserrat is an island dependency of Great Britain located in the Leeward Islands of the Eastern Caribbean at longitude 16° 45 minutes North and latitude 62° 10 minutes West.

The island is volcanic in origin and has been subject to low intensity earthquake swarms. Due to its location, it is exposed to the annual Atlantic hurricane season between June and November each year.

Based on the Scope of Services in the Contractual Services Agreement Contract No. CSA-071-97, the Contractor carried out a vulnerability assessment of the drinking water supply infrastructure of Montserrat with the view of recommending mitigation measures to limit damage to the water supply systems from volcano, earthquake or hurricane. Visits were made to Montserrat in mid-April and mid-May 1997 with the view of collecting relevant available information and inspecting conditions, in particular the effects of the volcanic activity on water supply.

Meetings were held with relevant personnel in Government and the private sector and the Aid Agencies. Inspections of main water supply installations were also carried out. The various elements of the water supply system are indicated on Figures 3, 4 and 5.

The volcanic activity commenced in July 1995 and has gradually moved through various phases of periodic activity with the most significant being in late June 1997.

As a result, the degree of risk to inhabitants has increased, as would be noted by the difference between Figures 6 and 7, Volcanic Risk Maps of February and July 1997 respectively.

As a result of the recent increase in activity and ash falls on a wider area, there has been a concern over the effects on water quality both in the immediate and long term future. Current indications are however, that while rainfall water analyses show high levels of acidity and periodic high levels of fluorides, drinking water sources do not reflect similar concerns.

The report addresses the issues under three main titles:-

- Emergency Planning and Preparedness,
- Existing Water Systems and their Vulnerability,
- Mitigation Measures.

Emergency Planning and Preparedness

Experiences of Hurricane Hugo in 1989 and the current volcano crisis have permitted the Montserrat Administration a base of experience on which to draw on.

However, the uncertainties of a volcano crisis extending over the period from July 1995 to date, without any indication as to cessation of activities, does not provide any high degree of certainty for long term planning

While a significant amount of effort has been put into emergency planning and preparedness and its implementation, the current living conditions are of a temporary nature

A large proportion of Montserratians have clearly indicated their concerns about continuing to live in the environs of such uncertainty and have departed the island At the time of this report it is understood that approximately half of the original 10,000 population (about 5,000 persons) remain on the island.

If the uncertainty continues to prevail with respect to the temporary nature of the existence of the population and also with respect to the activities of the volcano, outward migration is likely to continue.

While emergency planning and preparedness has continued to be a significant effort in day to day activities, the time has come where physical planning implementation for redevelopment must play a major role if conditions are to be improved.

A decision to commence the approach to physical planning and implementation for redevelopment must be based around sound scientific advice with the knowledge of the ultimate risk and a firm plan for evacuation known by all If the extent of risk is an acceptable one, positive steps must therefore be made to the future.

With the reduction in population and hence reduction in human resources, every effort should be made to utilise available resources in the most efficient and effective manner

Available information and knowledge must be drawn from the widest possible range of sources. It is therefore suggested that an organisation drawing from the broadest range of expertise in the public and private sectors be formed on an ad hoc basis as a support group to the principal decision makers

The principal decision makers including His Excellency the Governor and the Chief Minister and Ministers would liaise with such a group through the Minister who would be identified for planning and development. The organisation, which for the purpose of reference could be considered the Montserrat Redevelopment Task Force, would have a Chairman and representatives of the public and private sectors as indicated in Figure 15 In addition, they should have a Secretariat and a full time Secretary who is familiar with Government organisations and who would have linkages with specific personnel in the relevant Ministries and Departments and Authorities.

The Chairman of the Task Force should be someone who holds the respect of both the public and private sectors and with a wide range of knowledge of Montserrat. The Chairman should be from the private sector primarily because the long term redevelopment of Montserrat would have to be generated by the private sector, after a period of external support. Also a person from the private sector would have a higher degree of flexibility in his communications with the public and private sectors with possibly greater influence in tapping financial resources in a limited manner to bring about what may be catalysts in the redevelopment process

Besides the physical redevelopment, some consideration must be given to institutional reform, at least in the short term, with the reduced usable land area and human resource. Basically, there will be a dependency upon certain individuals, in particular those from the professions, to cover a range of sectors if the resource is not otherwise available There is a deficiency to some extent in some sectors already, as highlighted by the unavailability of engineering services at the Water Authority. As an example, establishment of an engineering structure to cover all areas of engineering in the redevelopment process might encourage senior people with substantial experience to satisfy the requirement, while creating spaces for others to develop within a range of the management structure, which at present does not exist and is unlikely to exist in the future in the case of the disparate number of existing organisations

Existing Water Systems and their Vulnerability

Montserrat's main supply of water comes from springs emanating between the face of the volcanic core and the overlying pyroclastics and agglomerates

Groundwater potential has been realised in the Farms/Trants Valley, but this area is currently in the Unsafe Zone, and its redevelopment is currently in question.

The other area of possible groundwater resource is the Belham Valley area but testing has not been completed and the extent of the source is uncertain

In the present situation, dependency must therefore be on the spring sources

The two main sources at Killiecrankie and Monkey, producing some 35% of the daily capacity of the system, are on the southern face of the Centre Hills, the face most exposed to the activities of the volcano Access to these sources is also currently through the Unsafe Zone hence long term maintenance is still a question

The springs emanating on the western and northern side of the Centre Hills are therefore the ones to be given greatest attention at this time.

Hope, Lawyers and Olveston are the three main sources in the south western section of the Safe Zone that provide the more significant flows. Along with Quashie these sources would satisfy during average flow conditions, the demand of the current population

With the reduced number of sources there is a higher degree of risk in a disaster. With the pending hurricane season, in addition to the uncertainties of volcanic activity, there should be an increase in the security of supply from the aforementioned sources

Previous experiences indicate that Hope and Lawyers springs are the two least affected by hurricanes. They should therefore receive some priority in the redevelopment process

The springs in the north of the island on the northern face of Centre Hills produce relatively small quantities of water However the main population centre is shifting to the north and there is and will continue to be a need for larger volumes of water to be stored and distributed in that area

With respect to water storage facilities, the major portion is located in the Unsafe Zone leaving only approximately one million gallons of storage in the Safe Zone Of the storage in the Safe Zone approximately 60% of it is located at Hope In the current situation Hope therefore becomes the base from which distribution to the north will have to take place.

Mitigation Measures

Water quality maintenance must be the prime activity in an ongoing water testing programme within the current capacity of the Montserrat Water Authority

Every effort should however be made to establish a sound base line on water quality and it is proposed that a full set of samples be collected from all sources that can be reached and forwarded to the Government Laboratory in Antigua, or elsewhere, for full chemical and bacteriological analyses

The foregoing is considered essential at this early stage, as with the oncoming rainy season and the recent distribution of ash from the volcano, the conditions are ripe for change in water characteristics if change is going to take place. It is considered essential that trends in these circumstances be established at an early stage in order to develop some prediction model prior to any adverse impact creating an emergency in satisfying water quality requirements Trends will help to determine the need for any action and it is therefore essential that full chemical analyses be carried out on a monthly basis over the next six months at least.

Currently, springs and reservoirs at Hope overflow because of the lack of capacity to transfer water to the north. Until the recent events of the volcano, the demand for water was primarily in the south west to Plymouth and its environs. In such a supply situation it was necessary to transfer water from Lawyers to the south. This required a pumping station south of Lawyers pumping to Hope. Such a transfer is not necessary at present and it is proposed that the pumping station south of Lawyers be reinstalled in a reverse flow condition to pump water from Hope northwards For this to take place it will be necessary to bypass the reservoir at Lawyers and St Peter's as well as bypass the pumping station at St. Peter's to deliver water to as high an elevation as possible in the northern area, which in current circumstances appears to be Fogarthy. A more detailed assessment utilising the plans of the systems, which were not available at the time of this report, should be carried out to determine if flows may be pumped to a higher elevation

The foregoing is considered a step prior to the provision and installation of new equipment understood to be under consideration.

It is also proposed that prior to installation of any new equipment the location should also be reviewed with respect to utilising the stored energy level at Hope to its maximum thereby reducing pumping cost to the north After the reassessment of the system the intent should be to place any new water storage facilities at the highest practical elevation in the northern system to be able to service the entire area without pumping In the event of disaster such as a hurricane and the possible severance of pipelines

and road accesses and with the major storage at Hope in the south there would be limitations in the transfer of water to the north

While in the initial step it is proposed that only 100,000 gallons storage be implemented, it may be necessary in the circumstances to significantly increase such levels of storage within a short period of time. Such a decision should however be taken after knowledge of resettlement patterns

The proposed 100,000 gallon storage, along with existing storage in the area, should be adequate for about two days supply in current circumstances, with reservoirs along the western side satisfying their immediate areas

Because of the exposure of existing supply mains to damage, in particular from flood flows resulting from hurricane, and possible damage to main road links, in particular at ghauts, for similar reasons it is proposed that the susceptible sections of the supply mains be identified and either relocated or acceptably strengthened and protected from the adverse effects of hurricanes, which include falling debris and trees which can damage over-ground exposed pipes even if they are protected above the level of flood flows

As mentioned earlier, there is a need to upgrade the spring intakes in particular, because of the reduced capacity available, and in particular the current level of exposure to damage and ingress of foreign matter, which could have a significant impact on water quality. The proposals are that after subsurface investigations a determination be made on installation of subsurface intake screens behind impermeable barriers with graded filter surrounds to prevent the direct ingress of any polluted surface water as well as collecting the maximum available output from the springs Such screens would be collecting longitudinally along the line of flow into subsurface chambers from which the supply mains would take water to the storage facility

The supply mains from the aforementioned chambers are also exposed in many instances along the valley sides and it is proposed that at a suitable location below the hydraulic gradient from the intake that the supply mains be diverted out of the valley direct to the storage reservoirs as is practical Detailed inspections and surveys would need to be carried out along with the sub-surface investigations proposed

A major factor in the aforementioned works is the need for adequate accesses to the spring intakes Here again it is proposed that adequate access roads be provided for at least four wheel drive vehicles which would also allow for tracked or large rubber tyred tractor vehicles to work in carrying out the redevelopment works.

In addition to the aforementioned there are a number of miscellaneous items of work proposed such as repairs to reservoirs, in particular the steel tanks where there has been a degree of corrosion which requires attention. Another major item for consideration is that of chlorination, in particular at Hope and the north, the two extremities of the system.

The foregoing may be considered immediate needs with the most immediate need utilising the available resources and reversing flow past Lawyers to the north.

Based on earlier work by Howard Humphrys and Partners Limited and more recently by T. B. Kennedy, proposals have been made for improvement to the water supply systems.

With the Physical Planning Unit proposals in mind and recent events, a review of these two proposals was carried out and a range of the proposed works extracted for more detailed consideration in the next phase of redevelopment.

The principal emphasis is still in the northern area of the island. The proposals are for the installation of new supply mains to the area and distribution within the area, as well as added storage facilities. Priority in the supply mains would be a new linkage from Hope to the north. Prior proposals allow for a 6" main as far as St. Peter. While such is included in the proposals that follow, it is suggested that some reconsideration be given to this matter to allow for the stored energy level at Hope to be transferred as far north as possible. This could lead to a larger diameter main being laid from Hope to the north. This would lead to lower pumping cost in the long term to what may be the more major population centre of the future.

Further water storage facilities are proposed at this later stage with possibly the increment of another 100,000 gallons storage facility.

In addition, the pumping station proposed for St. Peter's, which should be reviewed, should be installed in a permanent location at the highest possible elevation to maximise the stored energy level at Hope. It should be noted here that in the longer term future, some consideration could be given to Killiecrankie and Monkey being utilised in the northern system and hence any new supply mains from Hope to the north should take into account the possible higher level of Killiecrankie and Monkey and be installed with mains with a higher pressure rating, permitting use of the higher level of energy storage at Killiecrankie and Monkey.

Because of the necessity to maintain and improve water quality, all of the intake structures should be improved, as was proposed for Hope and Lawyers. This upgrade would also be supported by the improvement of accesses, not only to the intakes, but also in some cases to storage reservoir facilities.

This is essential because in the times of disaster where supply mains are affected, it would be necessary for tanker trucks to be able to access the reservoir locations for collection of water for distribution

While more detailed consideration has been given to plant and equipment needs, it is noted that proposals have been made for the supply of a back hoe and jack hammer and land rover. These are considered basic essentials until such time as further consideration may be given to any further need An option for the aforementioned works may be for external contractors to provide the required services, in which case plant and equipment acquisition may not be necessary

The Proposed Mitigation Measures and Preliminary Cost Estimates are summarised at the end of Section 4 of the main report.

Longer term development needs would be subject to policy reviews, institutional reform and planning based on information and knowledge gained, including work carried out prior to and during the recent volcano events.

As mentioned earlier, prior studies should be addressed including those aforementioned and those with respect to development of new sources in particular at the Belham Valley.

In summary, the success of the planning and implementation measures outlined above will rely heavily on the actions and decisions of the principal decision makers However, no principal decision making body can respond to the indicated needs within the time frame required if they do not have a substantial resource to drawn on to provide the required information and knowledge to make the decisions, and the required expertise and manual resources to implement the decisions.

While it is appreciated that water supply redevelopment is not the only significant factor to be addressed, it is a very basic need and one without which the redevelopment process will not succeed. On the other hand, redevelopment of water supply in an inadequate and inappropriate manner may influence redevelopment trends which may not permit sustainability, far less future redevelopment for Montserrat.

To do nothing would be disastrous. To do something in small increments in as quick a manner as is necessary permits lessons to be learnt from one step to another while the levels of uncertainty reduce

Utilising as broad as possible an advisory base in the redevelopment process reduces the likelihood of adverse decision making

With the formation of a Task Force as referred to earlier, the principle of a strategic choice approach to the planning and implementation, which is anchored in utilising the best available information and knowledge at any point in time for development in an incremental manner towards broader horizons, allows for flexibility in effective and efficient decision making.

In the process of effective and efficient decision making there will be need for considerable judgement due to the limitations on quantitative information bases. Drawing on the broadest base of information and knowledge from the available resources, in particular the human ones, reduces levels of uncertainty and allows a higher degree of comfort in judgements for decision making

At the core of the process is the choosing mode. From this, one shapes the options towards designs which allow for comparisons. The comparisons are cycled back into the same mode allowing for choice and development towards implementation. The process allows for identifying the need for more information while developing clearer objectives and brings about greater coordination to a level where implementation takes place on an as-required basis, in an increment that provides for an acceptable level of uncertainty. Whatever is done from now on will not only carry the high level of uncertainty over the risk of volcano, hurricane and seismic activity but the unknown with respect to the future of Montserrat as perceived by the Montserratians themselves. Their involvement in a Task Force and sub-committees of such a Task Force, in liasion with the principal decision makers, not only makes them part of the decision making process but in the current situation could be a psychological boost in living with the risk and preparing for a future.