ITEM A

Groundwater Review Group

Position Paper

February 1994

Background to the Report

The members of the Groundwater Review Group (GWRG) set out here their views on the **geological aspects of groundwater issues and associated issues** which they identify as needing clarification in the light of a number of reports presented since 1989 as listed below.

This position paper has been prepared in order to identify key issues considered to be in need of further discussion and investigation

Principal relevant reports

1. BGS reports for 1989, 1991, 1992, 1993.
2. The Riley Working Party's Report (RWPR) of 1992 on safeguarding the island's water resources.
3. Dr J. S. Sutton's note (JSS)*Assessment of BGS Survey Reports* (principally those of 1991 and 1992).
4. The documentation provided by the Water Diviners' and Engineers' Group (WDEG).

Inevitably the geological issues cannot be divorced entirely from other approaches to the water question but every effort has been made to confine comment to the technical (primarily geological) evidence.

Issues Addressed

1. The complexity of Jersey geology.

2. The Group's views on how different rock types and lines of structural weakness might affect water storage and movement at depths below 30 to 40 metres.

3. The confusion created by use of a non-standard hydrogeological vocabulary by the WDEG.

4. The lack of evidence to support sources of water outside the island.

5. The compelling evidence for pollution as revealed by the hydrogeochemical studies of the BGS.

6. The water balance issue.

7. Conclusions and recommendations

1. The complexity of Jersey geology.

The members of the GWRG have always been concerned about the influence of the basement geology on the island's water resources. Their views agree with those of the WDEG and with JSS that the complexity of the local geology is such that it offers grounds for discussion of the BGS's views that : -

- the only groundwater that is seriously in contention for modelling and supply purposes is that contained within the first 40 metres and that . .
- these first 40 metres can be treated as if they behaved as an isotropic medium with uniform water behaviour characteristics.

Studies of a varied scientific nature, *e.g.* purely geological, geophysical, geochemical, over the past 60 to 70 years have created a three dimensional view of the subsurface geology of the island that is incomparably better than previously but still lacking in terms of samples taken from depth. The absence of a law compelling drilling operators to submit comprehensive logs of holes drilled -- the Channel Islands must be one of the few places where this is not the case -- has led to less evidence being available to confirm, contradict or refine the subsurface projections. In spite of this certain geological observations can be made with some certainty.

2. The Group's views on how different rock types and lines of structural

All the relevant hard rock types, *i.e.* that is those below the superficial deposits such as soil, sand and loam (loess), are more than 300 million years old and are highly indurated. The quantity

weakness might affect water storage and movement at depths below 30 to 40 metres.

of water that can be held by such rocks in their pore spaces is slight and movement of such pore water is infinitesimally slow.

During their 300 million years -- more in most cases -- of existence these rocks have been subjected to major tectonic stresses and strains at different periods. This has resulted in rocks which are one and all cut by a multiplicity of clean fractures such as joints and an abundance of more complicated fractures (faults and shears) often consisting or more or less crushed rock. It is in these varied fracture systems that water can be stored in considerable quantity and can be transmitted relatively easily.

The degree to which such fracture systems are 'open' to water movement can vary considerably from rock type to rock type and from shallow to greater depths beneath the surface. The fracture systems, like everything else, are affected by increasing pressure at depth from the overlying weight of rock. The effect of this is to close up fractures at significant depth and to compress crushed rock so that less and less water can be stored and less and less effective movement can occur. To an extent dependent on the rock type and its structure, rock can resist distortion by applied geotectonic stresses and this is the reason why spaces can exist below the surface. The classic example of major cavities is that of limestone caves. However, this situation is unusual and certainly does not apply in Jersey. The question is to what depth fracture systems in Jersey's rocks remain capable of containing accessible water at depth and whether this depth varies with the rock types.

Within the interplay of these factors, there is room for valid differences of geological opinion and emphasis. The members of the GWRG maintain that the conductivity of all the rock types is low as quoted in the BGS reports, *e.g.* pp 19 / 20 of the 1991 report. However, they consider that different rock types have responded differently to geotectonic stresses and that this may have led to different storage and movement capacities. Further, and more importantly, they recognise the existence of major lines of structural weakness which can be associated with many metres of more or less crushed rock, *e.g. grouting was soaked up by just such a crush zone on the site of the Val de la Mare dam in the early sixties.* These crush zones cut across all island lithologies though their importance in terms of width of crush zone varies from rock type to rock type. However, even though these differences exist such zones probably provide continuous water linkage over kilometre distances or more. The most important set of fractures of this sort are those trending 10 to 15 ° either side of ENE / WSW. The initiation of these fractures dates in some cases to more than 500 million years ago and extend kilometres deep into the local crust. Other faults and lines of weakness, particularly those trending NNW / SSE date from much younger periods of stress and are probably of lesser continuity both vertically and laterally.

The sum of all the fractures affecting Jersey's geology above a depth of, say 5 km, creates a mosaic of splintered rock which varies from place to place but which is always present to some extent. The degree to which the fractures store water and allow movement is conditioned eventually by depth (weight of overburden) but is affected by local factors such as intensity of fracturing. Given a connection along fractures the force driving water movement is head -- the pressure of the water above resulting from its weight. The direction of water movement is in the direction of least pressure **in whatever direction this may be -- upwards, eastwards, westwards, downwards it makes no difference.** The pressure at any point is determined by the nature of the three dimensional fracture system and the relative forces of water head and containment.

Given these basic geological conditions, the members of the GWRG cannot accept the notion of *streams* of underground water. Such a phenomenon cannot exist at depth in Jersey. It is also the reason why water sources outside the bounds of the island are an irrelevancy. Our water does not come from France.

3. The confusion created by use of a non-standard hydrogeological vocabulary by the members of the WDEG

The concept of *streams* as used by the members of the WDEG is not valid hydrogeological usage in the context of Jersey and like areas of hard rock geology.

The expression *surface water* is used by the WDEG to mean what hydrogeologists understand by groundwater.

The general approach to the hydrogeochemical data by the WDEG is dismissive and this cannot be accepted. Not only is the BGS work in this area of high quality it uses a vast array of modern techniques that have proven their worth time and again. The way in which the WDEG talk about nitrates for instance shows a profound misunderstanding of soil chemistry.

4. The lack of evidence to support sources of water outside the island.

The pre-Mesozoic rocks of the Normanno-Breton Gulf and surrounding coasts of Brittany and Normandy reflect a long history of deformation and the area has become divided into a considerable number of different groundwater regimes separated by major faults and/or deep seated lines of shear. The Mesozoic and later Quaternary deposits occur in patchy, relatively thin deposits, which form no continuous outcrop. Neither of these two situations allow for an effective transfer of groundwater over any significant distance.

5. The compelling evidence for pollution as revealed by the hydro-geochemical studies of the BGS

The BGS present abundant evidence of a sort that the members of the GWRG would not seek to question. However, there are areas where more information would be desirable and others where points of detail require clarification. It would be hard to ignore all this data and relyon the unsupported *evidence by assertion* of the WDEG.

6. The water balance issue

As Dr J.S. Sutton has rightly pointed out, all the calculations on the water balance ultimately return to the question of how much of the rain that falls in any one year finds its way into the groundwater system. Both we and the BGS are fully aware of the problem and the latter are always seeking to refine the model used (at the moment they are doing a detailed study of one catchment zone). However, even taking the highest estimate of inflow, there is substantial cause for concern in the amount of water abstracted from boreholes in Jersey compared with the likely renewable resource. We do not question this.

We would like BGS to take the uncertainties both of recharge and of geological complexity more into account when estimating resource potential and using computer modelling. This is particularly important if they persist with MODFLOW which we do not accept as a sound computer model for Jersey.

7. Conclusions and recommendations

We have confidence in the basic approach employed by the BGS but would wish them to:

1. **modify their resistance to considering deeper levels of water resource,**
2. **consider geological conditions and associated structure as important controls on water storage and movement and draw up a programme of investigation to address these,**
3. **provide a more detailed appraisal of the effects of weathering,**
4. **look closely at the MODFLOW computer model,**
5. **have geologists at new water bore sites and**
6. **take greater account of drillers' depths.**

Our consideration to Dr Sutton's work leads us largely to agree with him apart from his insistence on the complete rejection of the water balance equation.

The WDEG have produced little hard evidence -- they talk about much evidence but have not published it in scientifically acceptable form -- to justify claims which are reasonable in one or two instances but mostly an emotional appeal for belief in their assertions.

With respect to water divining -- and we do not wish to devalue the undoubted ability of diviners to locate good sites for wells and boreholes -- it cannot be accepted as a valid methodology to determine a water policy for Jersey.

Our approach to the current state of information is well summed up in the following quotation : -

The best you can do in science is to present data in as valid a way as possible, put it out for peer review, get it accepted, publish it and discuss *it. If somebody then comes along and says, "Well, all this is rubbish," but has no new or specific evidence for saying that, it neither supports nor goes against the original data. It's rather meaningless.* Jonathan Kaplan, 1993.

We support ongoing monitoring and accept the need for Legislation to compel owners to allow such monitoring and to compel drilling enterprises to lodge logs of all bores made. Unfortunately, a number of difficulties and, in particular, the poor response of many important borehole users apparently make this step inevitable.

Groundwater Review Group

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February 1994