Quality of Groundwater, Proceedings of an International Symposium, Noordwijkerhout, The Netherlands, 23–27 March 1981, W. van Duijvenbooden, P. Glasbergen and H. van Lelyveld (Eds.), *Studies in Environmental Science*, Volume 17

PROTECTION OF GROUNDWATER IN RELATION TO WASTE DISPOSAL IN WESSEX WATER AUTHORITY

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INTRODUCTION

Wessex Water Authority as one of the ten water authorities in England and Wales has the responsibility of liaising with waste disposal authorities which are the County Councils to ensure that both groundwater and surface water resources are not polluted by waste disposal activities. All new waste disposal sites require both planning permission and a site licence and both these authorisations are referred to the water authority for comment. Conditions can be requested for inclusion on both so that adequate protection is afforded. Failure for agreement on conditions necessary can be referred to the Secretary of State for decision.

Several water authorities have developed aquifer protection policies in which the aquifers are specified as either requiring various degrees of protection or in some cases as being of minimal resource value and therefore not justifying protection.

Within Wessex no aquifer protection policy as such has been developed although the general policy adopted in waste disposal liaison is to discourage waste disposal sites on aquifers. However taking a realistic view and bearing in mind the need to balance the various interests involved, as required by Government, each site is looked at on its individual merits and disadvantages and sites on aquifers are permitted, subject to adequate safeguards, if the need is sufficiently great.

In addition, preference is given to the "contain and treat" approach rather than the "dilute and disperse" unless adequate evidence is available to support the latter.

Of the 9918 km^2 total Wessex area 36% is outcrop of the wide range of aquifers found in Wessex and these provide water for approximately half of the total public water supply demand which is around 900 megalitres per day at present. Clearly with groundwater contributing such a high proportion of potable supplies it is essential that due regard is given to its protection in siting waste disposal sites.

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The practical approach of looking at sites individually and accepting sites on aquifers where sufficient reliable evidence is provided to show that no harmful effects to groundwater will result has been well accepted by the counties, this being demonstrated by the fact that only one site has been referred to the Secretary of State for decision due to failure to agree between Wessex and a county.

The result of this policy has been a very wide range of types of site operating within Wessex and the following sections present brief descriptions of three sites on aquifers of significant difference. In addition an example is presented of what may be considered by many to be the ideal type of site which is not on an aquifer and avoids many of the potential pollution problems that can occur at other locations.

DESCRIPTION OF THREE AQUIFER SITES IN WESSEX

Site A. Contain and Treat by Control of Groundwater Levels

The first site considered is a disused quarry situated in the Clifton Down limestone strata of the Carboniferous Limestone series, this being a massive limestone through which flow takes place in discrete natural conduits and fissures.

A river flows from east to west within 200 metres of the southern end of the quarry. The level of the river is some 30 metres above the base of the quarry which is at its maximum about 50 metres deep. The quarry is over a kilometre long and about 200 metres wide.

Prior to tipping groundwater entering the quarry, about 1 Ml/d, was pumped out from a sump at the southern end into the river and over the years this resulted in a cone of depression around the quarry with groundwater levels in the limestone being some 27 metres above the quarry base.

Although the limestone is fissured and theoretically an aquifer it is of relatively low permeability and it is not considered to have significant potential as a water resource at this location. There are no existing licence abstractions from the limestone and bearing in mind the need to balance the water and waste disposal aspects of the problem it was not considered justified to protect the groundwater within the limestone for its own sake.

If refuse was deposited in the quarry and no dewatering of the quarry was performed the level of leachate within the tipped refuse would increase until it reached a level at which outflow into the river was possible.

To protect the quality of the surface waters generally it is essential that leachate is prevented from entering them.

To ensure this, the proposals are for a drainage system which will collect all incoming groundwater and leachate from rainfall together in a sump near the southern end of the quarry and pumping from the sump would maintain a groundwater gradient into the quarry as at present. High rates of run-off due to heavy rainfall would be stored in an onsite reservoir of sufficient capacity to cope with storm events of a return period of about 50 years and the storage capacity of the refuse itself will be utilised as temporary retention capacity for storm events after the first few layers have been deposited.

The polluted water from the quarry would then be pumped at a rate and at times agreed with the water authority to a sewer for treatment at a sewage treatment works or to a private onsite treatment works to be treated to a sufficiently high standard to permit the effluent to be discharged to the river. Technically this presents a satisfactory way of ensuring that the level of leachate in the tipped refuse is kept at a sufficiently low level to prevent pollution of the surface waters until such time that the quality of the water within the refuse is of acceptable quality to be discharged direct to the river.

The solution at this particular site has therefore been to permit a waste disposal site on an aquifer but to manage it in such a way that nearby groundwater will flow into the site so that pollution can be prevented from entering the aquifer and thence entering surface waters which need to be protected.

Site B. Contain and Treat by Lining the Site

The second site considered is also on a limestone aquifer but the Jurassic Great Oolite Limestone series which differs from the Carboniferous limestone in as much as the flow of water through the aquifer takes place in a larger number of less well defined fissures although overall of greater permeability. The site is a quarry which was produced by excavation of stone from the Forest Marble strata which overlies the Great Oolite limestone. There are faults in the vicinity of the quarry and any leachate percolating through the Forest Marble could enter into the Great Oolite groundwater which constitutes the major source of supply in the area.

Initially the proposal for the waste disposal site was opposed because it was on an important aquifer. However the need was sufficiently great that permission was granted subject to the site being lined to prevent any leachate entering the groundwater. A condition of the planning permission was that the floor of the quarry be graded so that all surface water and leachate drained via channels to a sump from where it was sewered to a sewage treatment works. To contain the leachate, the base and sides of the quarry were covered with 0.75 millimetre thick butyl sheeting protected by 75 millimetres of fine aggregate beneath and covered by a further 150 millimetres of fine aggregate.

This was the first lined site within the Wessex area and it was essential that adequate monitoring was undertaken to determine the effectiveness of the lining and to this end two 150 millimetre diameter observation boreholes were sunk to help monitor water quality and water levels near the site. Data have been collected from these boreholes and other boreholes in the area and from the site itself for a number of years.

An inherited site in basically the same geological situation was in operation and monitoring of the groundwater quality in the vicinity of this unlined site which accepted basically the same type of waste provided a good method of identifying any impact that the lined site was having on the quality of the groundwater due to any failure of the lining.

The results of the investigations show that some pollution of one of the observation boreholes is occurring and this indicates that some leachate from the lined site is entering the groundwater and this throws some doubt on the effectiveness of the lining. The leachate only appears at this borehole at certain times and the possibility of a direct fissure contact from the site to the borehole or surface contamination rather than general leakage could be the cause. However it has been shown that no pollution has occurred at any distance from the site and that the lining does act as an effective method for containing the majority of the leachate. Further investigations are continuing so that predictions of safe distances of unlined disposal sites from supply sources in this type of aquifer can be made.

Here again a site on an aquifer has been permitted with a totally different method of solving the problem. Because of the significance of the aquifer to public supply it was essential that the leachate produced was prevented entering into the aquifer and the use of an artificial butyl rubber lining has provided an acceptable solution.

Site C. Dilute and Disperse Approach

The third type of site considered is typified by a quarry in the chalk which is of the cretaceous strata which is a hard shelly limestone through which flow takes place in a high number of small fissures and cracks. The site was an inherited waste disposal operation which had been operating for many years prior to the formation of Wessex and the site accepted both domestic and trade waste without any apparent pollution of local sources occurring.

The site was referred to Wessex because although it was an existing site which had been initiated prior to planning permission being required it did require the issue of a site licence after the Control of Pollution Act came into force. The difficulty which presented itself to Wessex was that because it was an unlined site in an aquifer it was almost certain that some leachate was entering the groundwater and the Chalk is the most important aquifer in

Wessex and must be protected. From the limited amount of hydrogeological information available it was quite likely that the leachate entering the groundwater could flow in a direction towards a private licensed groundwater abstraction from a spring which was used for the potable supply for an agricultural estate. Samples of water taken at this supply showed no indication of any pollution from the waste disposal site.

Because the site was in operation it was not considered sensible to oppose the site licence but to request adequate conditions to safeguard the nearby source and the water resources generally. It was decided therefore that as one of the conditions which were necessary to enable authorisation to be given an observation borehole should be placed between the site and the source which was several hundred metres away from the site. This example is typical of many inherited sites throughout Wessex.

The inheritance of the many sites on aquifers which have operated without problem for many years has resulted in acceptance of the "dilute and disperse" approach in many locations at which for new sites such an approach might be thought inadvisable. Considerable hydrogeological justification would be needed in order to permit this approach at new sites especially where potable sources are involved.

A NON-AQUIFER SITE IN WESSEX

As stated in the introduction to this paper the general policy adopted by Wessex is that sites on aquifers are discouraged where possible but the three examples sites clearly illustrate that flexibility is used in applying this policy and sites on aquifers are permitted. However the waste disposal site discussed in this section is perhaps nearer to the type of location preferred by Wessex.

Along the north western boundary of Wessex Water Authority is the Severn Estuary the foreshore of which are large areas of flat alluvial deposits which are used mainly for agriculture but the quality of the land and the hydrological regime are such that it is used mainly for grazing rather than arable. Because there are no aquifers of any potential in this vicinity sites located here do not have any major groundwater pollution problems to overcome. The problems here are more of ensuring that any leachate produced is contained within the confines of the site itself and is prevented from entering the surface watercourses which abound in this area.

A recent proposal has been to develop a site of some 48 hectares in extent which will be created by building mounds of refuse to a height of about 10 metres above ground level and landscaping the finished site and reinstating to as good if not better agricultural land than it is at present.

To ensure that all contaminated water is contained within the confines of the site it will be surrounded with a system of bunds and cut-off ditches to ensure that no polluted water enters the watercourses on the agricultural land surrounding the site. To ensure that no subsurface flow occurs beneath the bund the top metre of the ground will be excavated and then reinstated with sufficient compaction to ensure that there are no permeable layers through which lateral flow could take place.

The method of dealing with the leachate will be on-site treatment which will be a combination of recirculation, storage, grass plot irrigation prior to disposal via an outfall to the nearby estuary. Such discharges to estuaries and indeed all rivers requires a consent to discharge and for this site the consent standards which have been requested are 80 mg/l BOD, 80 mg/l suspended solids, with the flows being limited to 1 megalitre per day during winter months and 0.5 megalitres per day during summer months. It is estimated that when the site is producing the maximum volume of leachate this could be of the order of 80 megalitres per annum.

The proposed methods of on-site treatment have not been tried before on such a scale in Great Britain and therefore no absolute guarantee can be given that the needed 80:80 consent standard will be met at all times. Fortunately a large sewage treatment works is in the immediate vicinity of the site and this was an important consideration in the initial selection of the site. Although it might be expensive to treat the leachate at this works and indeed some form of extension might well be needed, it does offer a very good long stop if on-site treatment proves incapable of meeting the required standards.

If the necessary authorisations are granted the end product will be a site in a non-aquifer area with therefore no groundwater problems and it will be managed in such a way that the only discharge to surface water will be to an agreed standard which will ensure that there are no detrimental effects to water resources.

CONCLUSION

Descriptions of three very different types of sites on aquifers have been presented which illustrate the wide range of sites that can result from adopting a practicable and reasonable approach to waste disposal. Clearly a much narrower range of types of site would result if a very firm inflexible approach was adopted which might make the water authority's role simpler but would be very much against government guidelines and would not be the optimal way of disposing of waste to land.

Whilst it is accepted, and indeed encouraged, that such a wide range of sites should result in an area of such wide geological variation as Wessex it is clear that many of the problems can be reduced by locating waste disposal sites in areas away from aquifers and perhaps the last site described offers a way ahead for the future.

It may be suggested that with the results of research work carried out in the United Kingdom and abroad sufficient evidence is available to encourage the adoption of a "dilute and disperse" approach to waste disposal on aquifers rather than the "contain and treat" policy which is favoured in many cases by Wessex. Certainly Wessex does not disregard the "dilute and disperse" approach and, where adequate, reliable information can be provided to show that particular locations lend themselves to this approach its adoption has been, and will be, accepted. However the aquifers described in this paper predominate within Wessex and for these the groundwater flow is generally through discrete fissures, cracks and faults rather than interangular and it is felt that it would be unwise at present to permit the widespread adoption of the dilute and disperse theory as a general policy.