GROUNDWATER AVAILABILITY MAPPING

Groundwater availability maps are an assessment of the expected and dominant groundwater resources for specified areas. They are based on published geological maps, existing groundwater information and general hydrogeologic principles, and are produced for regional planning purposes. These maps should not be used as a substitute for a detailed hydrogeological assessment where site specific information is required.

Background on Groundwater Occurrence

Groundwater is water which has percolated by gravity to fill the voids in the underlying soils or rocks and form a saturated zone. Having entered a groundwater system, water continues to move, although normally at a very slow rate, governed by the hydraulic conductivity and gradient. In formations where groundwater extraction is of consequence, it is mostly within the range of one or two metres per day to one or two metres per year.

Water-bearing formations which can yield useful supplies of water are called aquifers. The volume of water that can be held in an aquifer, the rate at which water can recharge it and be extracted out from it, and the rate at which water can move through it are all controlled by the geology of the aquifer. Variations in groundwater occurrence, quality, and yield are due to the inter-relationships of geology, climate, topography, soils and vegetation, but geology is the dominant factor.

For simplicity groundwater is considered to occur in three types of aquifer systems, classified by the physical storage properties offered by the host rocks:

- unconsolidated sediments
- porous rocks
- fractured rocks

Unconsolidated Sediments

Unconsolidated sediments are the most important water bearing formations in the State, generally providing shallower aquifers and larger yields than other aquifer types. They are mainly combinations of clay, silt, sand and gravel, and are more porous, more permeable and more readily recharged than other rocks.

Porous Rocks

Porous rocks are considered as being consolidated rocks which still retain a significant amount of their original or primary porosity. Such rocks are almost entirely sedimentary; in fact they were originally unconsolidated sediments, however cementation and compaction have made sedimentary rocks less porous. Additional or secondary porosity is created when fracture systems are superimposed on the rocks by subsequent stresses in the Earth's crust. Porous rocks generally provide more uniform groundwater systems than unconsolidated sediments or fractured rocks. Sandstones provide the most significant sedimentary aquifers with some formations extending over enormous distances, for example the Great Artesian Basin.

Fractured Rocks

Fractured rocks are usually not inherently porous, however they can have secondary porosity due to fractures , including joints and partings which provide storage for groundwater. These are caused by stresses due to processes such as folding, flexuring, faulting and cooling. Practically any consolidated rock is subject to fracturing, so a great variety of igneous, metamorphic and sedimentary rocks are involved in this category.

Normally, significant fractures are much less than one millimetre in width. Fractures tend to be more open near the surface due to stress and weathering relief. At greater depths, these fracture systems are usually too tight to act as aquifers. Recharge is essentially localised and is governed by climactic conditions, vegetation and soil cover, topography and the nature of the fracture system.

Groundwater Salinity

The quality of groundwater may be influenced by many factors with quality characteristics being imparted to the water even before it enters the groundwater system. Within the system, the nature and composition of the host formation will further affect the quality to varying degrees. The influence of the host formation is a function of the nature and chemical composition of its constituent minerals, whether the water has come in contact with them, and the duration of such contact.

Formations consisting almost entirely of quartz such as some sands, gravels, sandstones and quartzite's, will often contribute very little to the water in contact with them. Clayey and shaley rocks however usually will contribute salts to groundwater in contact with them. This is generally because of entrapped residues of salts, connate salts, left from the waters in which the sediments were deposited. Thus groundwater in contact with sedimentary rocks of marine deposition will usually have a high sodium chloride content, and those in contact with coal measure sequences tend to be high in sulphates, due to the oxidation of iron sulphides commonly associated with these rocks. For metamorphic rocks a large range of characteristics can be imparted to groundwater in contact with them. Much depends upon the nature and composition of the original rock as well as the intensity and nature of the metamorphism.

The limiting quality criteria applied to water will vary depending on its intended use. Water considered suitable for sheep may be quite unsuitable for human consumption or irrigation. A full chemical analysis of the water is normally required to properly assess the waters suitability for an intended use. Total Dissolved Salts (TDS) is often used as a guide to characterising the quality of the water, the higher the TDS the poorer the water quality. Electrical Conductivity, a measure of the electrical conductance of water, is generally comparable to TDS, an increase in electrical conductance indicates an increase in total dissolved salts. These measurements are frequently used as first assessment criteria when classifying waters.

Methodology for Preparing Groundwater Availability Maps

Geology was used to define the three aquifer systems; unconsolidated sediments, porous rocks, and fractured rocks, in which groundwater commonly occurs. The major geological units of the regions were defined from published geological maps and digitised into a Geographic Information System (GIS).

A search of the existing groundwater information from the Departments groundwater database provided yield and salinity information on individual bores. An assessment of the dominant water quality and yield information for the area was made based on groundwater

information from the database and hydrogeologic setting. Where specific bore or groundwater information was not available interpolation between data points and general hydrogeologic assessment by an experienced hydrogeologist was used to classify particular geological units and areas. This experience was based on years of field work in the region. Where conflicting TDS data between bores was found the median value was chosen. Local variations in water salinity can be expected due to isolated hydrogeologic conditions.

The confidence level in the map is variable depending on data availability. The groundwater yield data can be considered to be of high accuracy generally for the whole map. The main reason for this is because the yield classification categories cover a broad range in yields. Confidence level of groundwater salinities across the map is variable. There is little data to the northern section of the map but reliability is considered very good because the geological conditions in this area is well known. In the far south of the map, around the Goulburn area data is scarce and the groundwater salinities are based primarily on field experience. There are some boundaries that have been marked by a 'zig-zag' line as seen in the southeast section of the map. These indicate uncertain boundaries due to lack of data and it is unknown exactly where the boundary between classes should be placed.

Suitability Classification

Groundwater was classified into one of four definitions based on individual bore TDS and EC water quality information and a general suitability index used in the 1995 State of the Environment Report, Groundwater Sub-Chapter (Dept of Water Resources).

This classification is summarised in Table 1 and is based on the maximum concentration of salts for the intended purpose. It provides a general guide to the suitability of water for a particular use. These criteria are not precise as tolerance of water for a particular use may vary according to plant or stock type, soil type, nature and concentration of saline content, climate, duration of use and need. It is recommended that a more detailed analysis, including the major ions, pH as well as TDS and EC be undertaken to determine the suitability of a particular groundwater prior to its application.

Table 1 - Groundwater Salinity Classification

Total Dissolved Salts (TDS)	Classification	Suitability
<500 mg/L	"fresh"	Suitable for stock domestic and irrigation purposes as well as municipal use.
501-1500 mg/L	"marginal"	Suitable for stock, domestic and some irrigation purposes.
1501-5000 mg/L	"brackish"	Stock water, suitable for dairy cattle, beef, cattle, horses and sheep.
> 5000 mg/L	"saline"	Limited stock use.

Aquifers were further classified according to their expected yield;

Yield of <5 L/s - All stock and domestic, limited irrigation and industrial uses

Yield of 5-50 L/s - Most uses including, industrial, Town water supply, irrigation as well as stock and domestic uses

Yield of >50 L/s – All uses including industrial, Town water supply, irrigation as well as stock and domestic uses

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