

Water harvesting from granite outcrops in Western Australia

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Abstract

The value of granite rock outcrops for water supply was noted by Lefroy in 1863, on his expedition to the area now known as the Goldfields. Since about 1890, public water supplies have been developed using runoff from rock catchments at approximately 200 locations throughout the Western Australian wheatbelt. Storage reservoirs are formed by concrete walls, reinforced concrete tanks or excavated earth tanks, which range from 500 kilolitres to 168 000 kilolitres. Runoff from rock outcrops is diverted to storage reservoirs using grouted rock or masonry walls on a slight gradient. Some measurements of runoff, and water storage and use characteristics are presented. Bores, wells and soaks have been developed in land adjacent to many granite outcrops. A review of the current situation gives the existing numbers of granite rock outcrops used for public water supply, along with the expected frequency and amount of use. The future role and value of rock catchments for wheatbelt water supply are described in the context of the Farm Water Plan.

Introduction

The unique hydrologic characteristics of inland south Western Australia result in a dearth of good quality surface runoff and groundwater. It is therefore not surprising that granite outcrops have been widely used for water supply development.

The value of granite outcrops as sources of water was recognised by early explorers. The Government, the Water Corporation, and the farming community currently use rock catchments for water supply and this use is likely to continue. However, some rock catchment water supply facilities may be surplus to current requirements, especially in the piped water scheme area, and a rationalisation process is being implemented as part of the Western Australia Farm Water Plan.

Early History

Erickson *et al.* (1973) refer to Lefroy, on his expedition in 1863 to the area now known as the Goldfields, having noted the value of the "bald hills" of granite for water supplies. A later example is given by Batchelor (1965) who described Holland's trek from Broomehill to Coolgardie in 1903. Holland dug a shallow well adjacent to a large granite rock on the east side of Lake Carmody, and obtained water from a gnamma at another site.

The discovery of gold at Coolgardie in 1892, and at Kalgoorlie in 1893 caused the population in Western Australia to increase from 49 782 in 1891, to 184 124 in 1901, and to 282 114 in 1911. The resultant increase in demand for water, grain and hay created an immediate need for water supplies for people and livestock. Davis (1977) reported that hundreds of shallow wells were constructed as public water supplies in many of the

remote Goldfields areas before 1900. Whittington (1988) quoted an 1894 Mines Department report showing illustrations of a gnamma hole and a shallow well associated with a granite outcrop. Whittington (1988) also described an excavated earth dam of 6 000 kilolitre capacity which was constructed before 1896 at Woolgangie, 130 kilometres east of Southern Cross. This Government dam collected runoff from a 60 ha rock catchment. The dam was 5 m deep. At that time, the daily demand for water by travellers and the railway construction contractor was 73 kilolitres. The Goldfields water supply scheme was constructed from 1896 to 1902.

Burvill (1979) reported that from 1905 the wheatbelt expanded into areas where springs and soaks of potable water occurred near granite rocks. Davis (1977) observed that hundreds of small excavated tanks were constructed in the cereal/sheep areas as agriculture began and developed. At least some of these supplies would have been adjacent to granite outcrops to take advantage of the regular runoff. Sutton (1925) described rock catchments as the best natural catchments for water harvesting, and included photos of a rock catchment in use on a farm at Koolberin, near Kulin.

Types of Water Supply

The simplest types of water supply associated with granite outcrops are gnammas, which are naturally-occurring reservoirs that collect runoff from the surrounding outcrop. Soaks and shallow wells are often located adjacent to granite outcrops where soil and rock formations are conducive to sub-surface water collection. Gnammas, soaks and shallow wells generally have a limited water yield and are therefore seldom used for public water supplies today. However, these sources of water were an important part of traditional Aboriginal culture.

Supplies with larger water yields are more likely to involve the construction of walls, weirs or tanks. Engineered water supplies consist of a storage reservoir

formed by constructing a concrete wall or weir in a rock valley, or by excavating an earth tank in clay subsoil adjacent to a granite outcrop. In such cases, runoff from the rock catchment is invariably collected using grouted stone or masonry walls surveyed on a slight gradient. A gradient of 1 in 200 was stated by Fernie (1930).

Collecting drains on the early structures were formed from slabs of exfoliated granite rock, which were roughly shaped and cement-grouted to form walls up to 0.6 metre high. There has been an increasing use of prefabricated concrete slabs for collecting-drain construction since about the mid-1960s.

Major Developments, 1921 to 1971

Fernie (1930) provided very detailed descriptions of water supply design and construction by the Government in the present central wheatbelt area. He referred in particular to supplies constructed during the 1920s at the following locations; Kondinin Rock, Egg Rock, Geelakin Rock, Karlgarin A, Glenelg Hills, Wilgoyne, Narembeen, Knungagin, Barbalin and Waddouring. A reservoir behaviour study was reported for a proposed reservoir at Gramphorne Rocks.

The Public Works Department (Anon 1946) described the No. 1 District Water Supply, which consisted of 600 kilometres of pipeline, three major rock catchment sources (Waddouring, Barbalin and Knungagin), which was designed to supply water to 200 000 ha of farmland, four towns, seven railway sidings and railway requirements at two locations, one on the Mt Marshall rail loop, the other on the Dowerin to Merredin rail loop. It also described the No. 2 and No. 3 District Water Supplies which each utilised rock catchment runoff. The No. 2 District Supply distributed water through 129 kilometres of pipeline to Narembeen, and to 48 000 hectares of farmland. The No. 3 District Supply distributed water through 74 kilometres of pipeline to Kondinin, and to 17 000 hectares of farmland. The water source information for the No. 1, No. 2 and No. 3 District Supplies are summarised in Table 1.

The Public Works Department (Anon 1946) also presented data relevant to water supply of some wheatbelt towns. Those with water supplies derived from rock catchments (1946 population in brackets) included Bruce Rock (600), Wagin (1200), Dangin and Quairading

(500). Fernie (1930) stated that drains, channels and intake works were designed on a rainfall intensity of 25 mm per ha. Although these rates were exceeded several times in a few years, the nature of the construction has ensured that no damage has occurred to structures and surrounding land.

The Public Works Department (Anon 1946) reported that following construction of the District Water Supplies in the 1920s, it was State Government policy to provide excavated earth tanks for public water supply. It was stated that 554 excavated tanks were constructed to provide for the horse traffic of the day. It was also stated that where possible, local small rock catchments were exploited to provide runoff to these excavated tanks, although it was also observed that these rock catchments were "relatively few".

Davis (1977) makes reference to public water supply construction that he was directly involved in at Dingo Rock and Hyden Rock in the period 1948 to 1951. He also referred to the following supplies which were constructed in the period 1963 to 1971; Mt Madden, Karlgarin B, Gramphorne, North Cleary, Dulyalbin and Roe Dam. Davis (1977) also referred to plans having been prepared for water supply construction on another nine granite rock outcrops. Lack of funding had delayed these projects, although one of those listed, Mt Hampton was constructed in 1994/95.

Value of Granite Outcrops as Sources of Water Supply

Measurements of runoff have been made from the 42 ha Puntapin Rock at Wagin, and from the 26.3 ha Hyden Rock at Hyden. The runoff measurements indicate an annual rainfall-runoff relationship of 45 to 47 per cent, although from individual storms, 80 per cent runoff may occur.

Fernie (1930) gave detailed design information for water yield from three classes of rock catchment. The design information was expressed as initial daily storm loss, and percentage runoff from additional daily rainfall. A daily rainfall threshold value of 1 to 5 mm is indicated by Fernie (1930), depending on rock surface character, steepness, the occurrence of rock breaks, total catchment area and time of year. Fernie (1930) stated that for daily rainfall greater than the threshold rainfall, between 60 and 90 per cent runoff could be expected, depending on the granite outcrop characteristics.

The general increase in water salinity in wheatbelt farmlands tends to increase the value of the water supplies developed from granite outcrops. The water salinity of rock runoff is less than 50 mg L⁻¹ total dissolved solids. Bettenay & Hingston (1963) reported that by far the best quality (less than 1500 mg NaCl L⁻¹) and most reliable sources of groundwater are to be found near the large granite bosses in the wheatbelt. Water supplies based on granite outcrops are very dependable and the amount of stored water does not vary from year to year as much as in farm dam water harvesting systems. Many farmers therefore value these supplies as sources from which to cart water. Granite rock runoff has very low turbidity, and is therefore quite suitable for pesticide spraying operations on farms. In those areas

Table 1

Water source information for the No. 1, No. 2 and No. 3 District Supplies.

WATER SOURCE	GRANITE OUTCROP CATCHMENT AREA (ha)	RESERVOIR STORAGE CAPACITY (kL)
Barbalin	110	168 000
Waddouring	35	36 000
Knungagin	65	100 000
Narembeen	48	69 000
Kondinin	28	43 000
TOTALS	286	416 000

where farm dam water is generally turbid, rock catchment runoff has additional value.

Current Utilisation of Rock Catchments

Several rock catchments are linked into the Water Corporation's piped water scheme, and the rock catchment runoff supplements the total scheme supply. The Water Corporation has estimated (Chamberlain, *pers. comm.*, 1996) that more than 625 Agricultural Area dams and tanks exist, and that approximately 200 of these directly utilise runoff from rock catchments. The more significant supplies with strategic value to the farming community are documented by Hauck *et al.* (1996). The water supply facilities at each site vary, along with the intensity of use.

Following development of a site as a water supply,

there is relatively little regular disturbance of the site by water users. In most instances, the water reservoir is located such that gravity inflow occurs from the catchment, and gravity outflow to a loading point (standpipe) occurs. This allows regular truck access to the standpipe to occur some distance from the rock outcrop, thus resulting in minimal environmental impact on the immediate surrounds of the granite outcrop.

Surveys of water carting practice have shown that many farmers within close proximity of rock catchment water supplies use these supplies on a regular basis rather than as emergency water sources. The Farm Water Plan is encouraging these farmers to reduce the amount of water carted, and to be more self-sufficient on their own properties. However, the need for a well-distributed network of emergency water sources will remain a vital part of Government response plans during times of severe water deficiency.

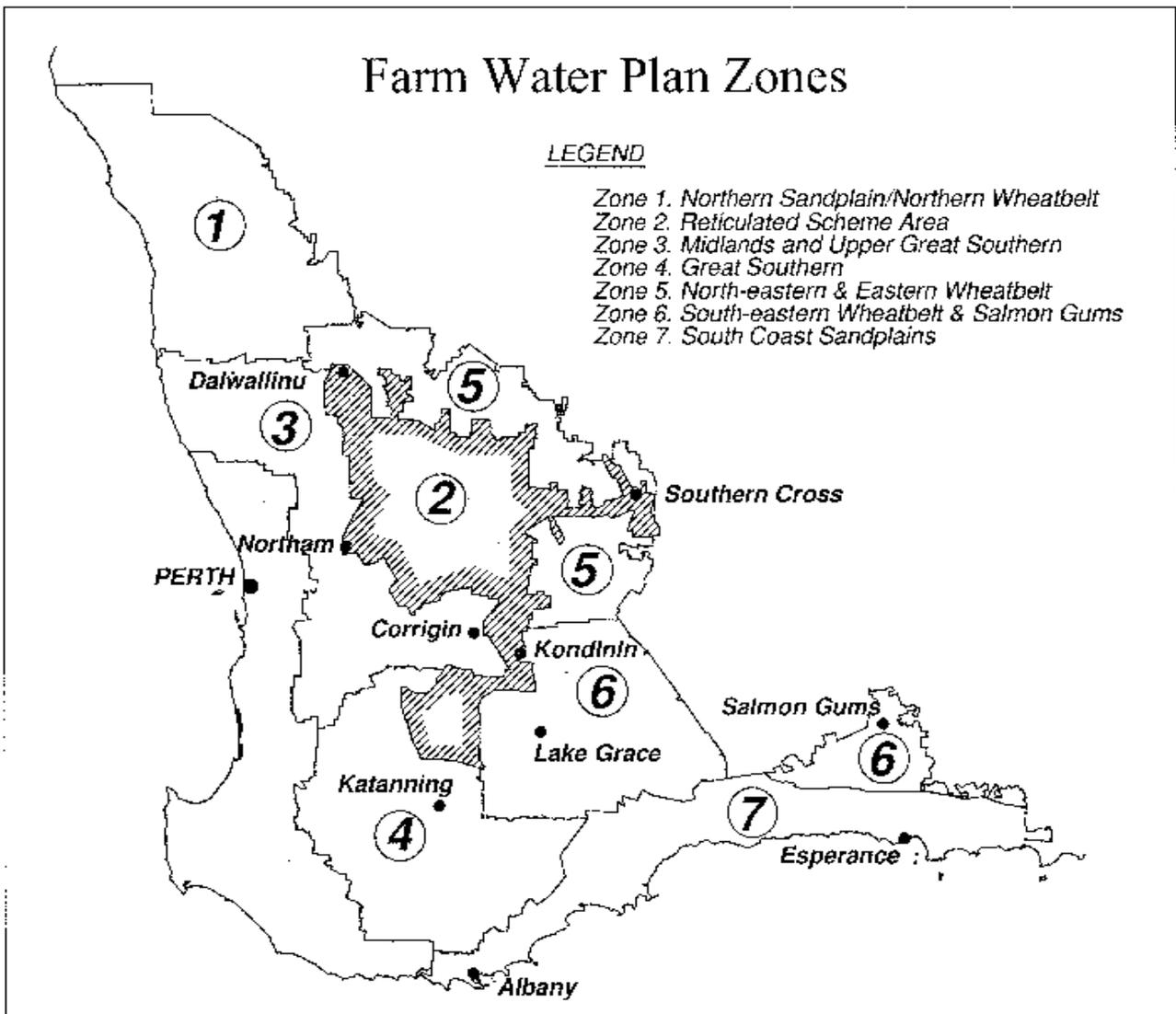


Figure 1. Map of Farm Water Plan Zones for south-western Western Australia (from the Office of Water Regulation).

Farm Water Plan

A Western Australian Farm Water Plan has been developed to cater for farm water supply shortages in dryland farming areas (Fig 1). The Farm Water Plan consists of six major integrated elements, one of which is the rationalisation of Agricultural Area dams and tanks (AA dams and tanks). These water supply facilities include the rock catchment water supplies. Many existing rock catchment water supplies are no longer needed for water supply purposes due to the surrounding farms now being served by a Water Corporation piped water scheme.

Government agencies are currently reviewing the network of AA dams and are identifying those dams and tanks for which there is an ongoing role. Disposal of surplus AA dams and tanks will be managed jointly by the Office of Water Regulation, the Water Corporation and the Water and Rivers Commission. Facilities to be disposed of will be offered to the Department of Conservation and Land Management, Local Governments, community groups or individual farmers. The disposal arrangements will, wherever possible, preserve any existing water supply value of the facilities. The network of AA dams and tanks in southern agricultural districts from Albany to Esperance is incomplete, and there is a clear need for more emergency farm water supplies to be provided in those areas.

The Office of Water Regulation is actively liaising with Local Government in these areas to establish permanent emergency farm water supply facilities.

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