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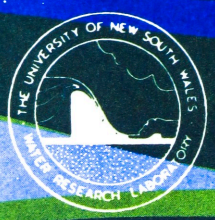

THE UNIVERSITY OF NEW SOUTH WALES

water research laboratory

Manly Vale, N.S.W., Australia

Report No. 111

EXTRACTION OF WATER FROM UNCONSOLIDATED SEDIMENTS

A LITERATURE SURVEY

by

C. R. Dudgeon and K. C. Yong

April, 1969

The University of New South Wales

WATER RESEARCH LABORATORY.

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Preface

The literature survey which is the subject of this report was carried out at the request of the panel controlling the Australian Water Resources Council project "Extraction of Water from Unconsolidated Sediments". Its purpose was to outline the present state of knowledge and current research into the subject and thus be a guide to the formulation of a programme of laboratory research. Because of the limited time available a detailed review of the literature was not attempted. Only a broad picture of the current state of knowledge was sought.

The work was carried out at the Water Research Laboratory of the University of New South Wales. The literature search and printing of the report was made possible by a grant from the Water Resources Council.

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April, 1969.

1. Introduction

This literature survey is the first step in a project to investigate means of increasing the efficiency of extracting water from unconsolidated sediments.

Interest in utilising water from these sources in Australia has been increased by recent droughts and the discovery of extensive resources during accelerated prospecting programmes.

Most of the aquifers being developed at this stage or likely to be developed in the near future are relatively shallow. They are tapped by dug wells or by percussion or rotary drilled wells which for the most part are less than a foot in diameter and one hundred feet in depth. Two important features of wells in these aquifers are the mobility of the particles in the aquifer surrounding the well and the relatively small drawdowns which may be called on to provide the head difference to force water into the well. These demand careful design of well casings and development of the zone near the well to prevent unwanted particle movement while keeping head losses to an absolute minimum. Unfortunately, the state of knowledge of the hydraulics of flow in this zone and the effect of various drilling, development and operation techniques on the aquifer in this zone is incomplete.

The aim of this literature survey has been to delineate the areas of existing knowledge and fields of current research. It has been concentrated mainly on literature relating to the well and its casing and that portion of the aquifer immediately affected by the well.

The work has been carried out with the assistance of a grant from the Water Resources Council.

2. Abstracts and Other Publications Searched

Applied Science and Technology Index.

Engineering Index (1945 to 1968).

Hydraulic Abstracts (Delft Hydraulics Laboratory).

Geophysical Abstracts.

Hydata (1965 to 1968).

U. S. Geological Survey, Water Supply Papers, 1958-1968.

U. S. Government Scientific Research and Development Papers, 1962 to 1968.

Water Pollution Abstracts.

In addition to the above publications, recent issues of all relevant journals were searched for papers not yet abstracted.

3. Brief Review of Literature

The reader's attention is drawn to the annotated bibliography "Water Wells" published as Archives Series Report No. 13 by the University of California, Berkeley, Water Resources Center (April 1963). This publication takes into account literature on wells which appeared during the period 1940 to 1961. No attempt has been made to duplicate all the references quoted in this bibliography and it should be consulted alongside this present report. Some of the more important references will be found in both works. In the present work there will also be found many references dated earlier than 1961 which are not included in the University of California bibliography since some topics, such as well tests, were not included in that work.

Because only a limited amount of time was available for carrying out the present literature survey, no critical review of the literature as a whole has been made. This must await more detailed consideration. However, a great number of the papers referred to have been collected at the library of the University of N. S. W. Water Research Laboratory and it has been found possible to define those areas in which further research is required.

The references have been grouped into the following categories:-

A. Books dealing with wells or flow to wells.

B. Bibliographies relating to wells.

C. Groundwater Exploration and Utilisation in various regions.

D. Investigation of Aquifers.

E. Hydraulics of Flow through Porous Media.

F. Well and Aquifer Models.

G. Well Hydraulics - General.

H. Well Hydraulics - Effect of Diameter of Well.

I. Well Hydraulics - Gravel Packs.

J. Well Design - General.

K. Well Screens and Casings.

L. Construction, Development, Operation and Maintenance of Wells.

M. Analysis of Well tests.

N. Galleries.

O. Design of Well Fields.

P. Mathematical Analysis of Aquifer Problems.

Of the topics listed, those headed E to M are of particular interest in a consideration of flow in and near the well. They are discussed briefly below.

There is a growing amount of useful literature on non-Darcy flow through granular media. Since this type of flow may occur in close vicinity to the well, an understanding of the laws which govern it and techniques available for computing non-linear flow nets is required. There is still agood deal of basic research to be done, particularly in predicting flow parameters from measurable physical characteristics of the aquifer material.

Unfortunately, when it comes to the more particular problem of the hydraulics of flow in and near a well the literature provides less information. There are few recent references to such vital matters as the effect of well diameter, gravel packing and screens and a great deal more information is required to enable a designer to select the optimum well size, screen type and development technique for a particular location. There are a number of rules of thumb and statements in design manuals

which do not appear to have been thoroughly tested and which, in some cases, may be influenced by the wish to promote certain commercial products. There is available data on the hydraulic characteristics of a range of screen types but little in the way of measurements of the effects of various constriction and development techniques on the properties of the aquifer near the well and the well's ultimate performance. Information on the reasons for the decrease in flow from a well with time and methods of combating this is also inadequate.

There is an abundance of literature on the analysis of pumping tests but this relates mainly to the determination of aquifer properties in general, not to proving the efficiency of the construction or diagnosing problems at the well itself. Research work is required here on the best methods to instrument wells so that local problems can be detected and possibly remedied.

The overall impression gained from the literature is that insufficient research is in progress into all aspects of well design, construction, operation and maintenance. This is probably due to the difficulty and cost of carrying out laboratory work at a sufficiently large scale.

It appears from this survey that the following matters should be the subject of further research in a laboratory equipped with appropriate facilities:-

(i) A detailed and critical review of the literature cited to allow the most up-to-date criteria for well design to be formulated.

(ii) Further research into the behaviour of flow at high rates through granular materials, with particular emphasis on predicting the flow rate-hydraulic gradient relationship in a particular granular medium from measurable physical properties of the medium.

(iii) The incorporation of non-Darcy flow theory into the hydraulics of flow through the well screen and surrounding aquifer.

(iv) The effect on flow rates and hydraulic losses of well diameter, screens and development techniques with the aim of minimising local head losses near the well and lowering costs of construction.

(v) Maintenance techniques. Methods of minimising the rate of fall-off in production of a well should be investigated. The economics of maintenance versus new well construction should be considered.

(vi) Development of instrumentation and techniques to indicate the efficiency of the performance of a newly constructed well and to detect problems arising during operation.

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