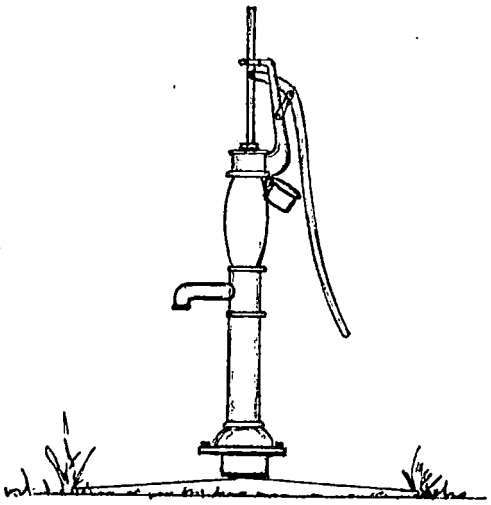
INSPECTOR'S HANDBOOK

WELL CONSTRUCTION



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WELL CONSTRUCTION

Harold Dolling

INTRODUCTION

This manual is intended to serve as an aid to inspectors on well construction. Since this type of work is a noteworthy departure from that found on normal highway construction, the average inspector will be unfamiliar with the procedures and terminology employed by the contractor and his men.

A glossary of these terms, therefore, has been included. The value of familiarization with well construction terminology is indicated by the insertion of this glossary at the beginning of the manual.

CONTENTS

ILLUSTRATIONS

GLOSSARY

LOG - A chronological record of the soil and rock formations which were encountered in the operation of sinking a well, with the thickness of each change in the formation.

AQUIFER - A geologic formation that is water bearing and which transmits water.

ALLUVIAL - Soil or earth deposited in place by action of running water.

CASING - Metal pipe used to line the borehole of a well, to prevent caving of borehole, to prevent undesirable water from entering the well or good water escaping from well.

CASING, PERFORATED - A casing in a well where the water enters through holes which have been cut in casing.

WELL SCREEN - In a gravel aquifer a screen is required to prevent the walls of the aquifer from caving into the hole, to exclude fine sand and to permit entrance of water.

PITLESS ADAPTOR - A water tight unit used to cap well.

GRAVEL PACK - The placement of a special gravel, type and size, between well screen and walls of borehole.

CABLE TOOL - A method of drilling wells by the use of cable tools. The hole is drilled by a heavy bit, which is alternately raised by a cable and allowed to drop, breaking and crushing the material. Material is removed from the hole by bailing.

ROTARY - A method of drilling wells where the drill bit is rotated in the hole, the rock being cut or abraded by knives or hard material set in the bottom of the bit and the waste material carried away by water or mud forced down the inside of the drill pipe and up on the outside.

AIR ROTARY - A drilling operation in which the chips are removed from drill hole by air instead of water and drilling mud.

GROUTING - The placement of Portland Cement slurry and/or specified additive in the area between casing and borehole wall to prevent contamination of well.

DRILLING MUD - A finely ground clay which is added to drilling water to aid in drilling operation by sealing cavities in borehole wall.

BENTONITE - A mineral which grows to twice its original size when in contact with water to aid in filling voids in soil.

STATIC WATER ELEVATION - The actual elevation a column of water will stand in a well as a result of the ground pressure.

DRAW DOWN - The change in surface elevation of water in the well as a result of the withdrawal of water therefrom.

TEST HOLE - A small diameter hole is drilled to determine proposed log of permanent well.

TEST WELL - A cased hole drilled at a specified distance from proposed permanent well to determine by instruments the effect of pumping rates of permanent well in the aquifer.

PUMP TEST - A test to pump well at various rates of time and flow to determine capacity of well.

ACIDIZING WELL - Operation in which acid is used for the purpose of dissolving or dislodging clogging material or incrustatation on the screen or in the sand around the screen or on walls of borehole in rock formations to increase flow of water.

DISINFECTING WELL - The application of chlorine to water for the purpose of disinfecting well.

DEVELOPING WELL - After well is completed the well is surged with a surging block or compressed air, by backwashing or overpumping, or by other approved methods to remove all foreign materials from well to improve well capacity.

DRIVE SHOE - A special hardened reinforcement placed at the bottom of casing to aid in driving casing into hard formations or seating casing into rock.

WELLS

General

All well plans and specifications are approved by the State Department of Health and Natural Resource Council prior to letting.

Wells to supply water vary in size and depth and method and type of construction. Water sources may be from unconsolidated formations and are called sand or gravel wells, alluvial, or drift. Or, if the water source is from a consolidated formation, it is referred to as a rock well.

There are three major types of well drilling operations. They are rotary, air rotary, and cable tool. The rotary or air rotary may be used in drilling either a sand and gravel well or a rock well. The cable tool is used primarily for drilling a rock well.

The Geology Section of the Materials Department will provide assistance for determination of the various geologic formations and water bearing strata.

The American Water Works Associations' specification A 100-66 for deep wells is an excellent guide for drilling a well.

Location of Well

The well shall be located as shown on plan. If there is any major variation from this location, notify the Roadside Development Section before proceeding. A grade

stake shall be set near this point so that each change and depth in the underlying formations can be noted as to elevation. A grade stake shall also be set at each test hole site.

Anticipated Log

The inspector should familiarize himself with the log shown in the plans of proposed well.

Information shown in the log may have been obtained from a previous test well in this specific area or an anticipated log projected from information obtained from other wells drilled in this locality or surrounding area. If the anticipated log is used, it is possible that the actual log for the well being constructed may vary considerably.

Project Plans

Since each well site is different, the resulting product (water) from the well can vary greatly both in quality and quantity. When wells are drilled in rest areas opposite each other, the quality will not vary as much as the quantity. This is due to depth of water bearing strata or aquifer, coarseness of the gravel, depth of gravel, or the tightness of the aquifer. The production may vary considerably even though the wells are in the same vicinity.

Review of Records and Samples Required

It is necessary for the inspector to be well acquainted with the records and samples required. In many cases, especially with a gravel packed well, drilling of a well once started is continuous until the well is drilled to the full depth; the screen, well casing, and gravel pack is then placed and the hole back-filled with clay to avoid caving. In the drilling of a rock well, the contractor may choose to drill continuously to a point 5' into rock or deeper to insure the casing is set in solid rock. Usually a deep rock well drilled with rotary drill is a continuous operation. The contractor may choose to use a temporary casing through the alluvial or drift area over laying rock. In some cases, a casing may be required for a project for drilling through the drift area and will be noted on plans or special provisions.

Once a pump test is started, pumping shall be continuous for eight hours at the various rates required.

1. Drilling samples documented in field book for samples collected every 5' of depth or at any change in the formation. Driller will have sacks to collect samples. The contractor cooperates with

the State Geological Survey by providing collected samples of drilling chips.

2. Materials approval required for pitless adaptor, permanent casing, and cement used for grout, for all wells. Materials approval for well screen and gravel for a gravel pack well. Design approval should be secured for screen and pitless adaptor. (4 copies to be sent to Roadside Development Section for rest area wells by the Resident Construction Engineer.) Screen manufacturers have their own designs for screens. The size of the slot openings is determined by screen manufacturer from an actual sample taken from the water bearing strata. This is usually done by drilling a test hole first to determine the depth of aquifer and to collect a sample of the sand and gravel. The manufacturer to furnish copies of recommended slot opening. Drilling samples should be taken from permanent well and documented in the field book for every five feet of depth or change in formation.

3. Well performance test report. The pumping test shall be performed as outlined in special provisions and shall be recorded on a tabulated form as follows:

WELL PERFORMANCE TEST

Well:_____ Rest Stop:_____

Date	Time	S Static Water Level	D Depth to Water	DD Drawdown S-D	Pumping Rate

4. Water samples shall be collected by the contractor for analysis by a qualified laboratory.

Development

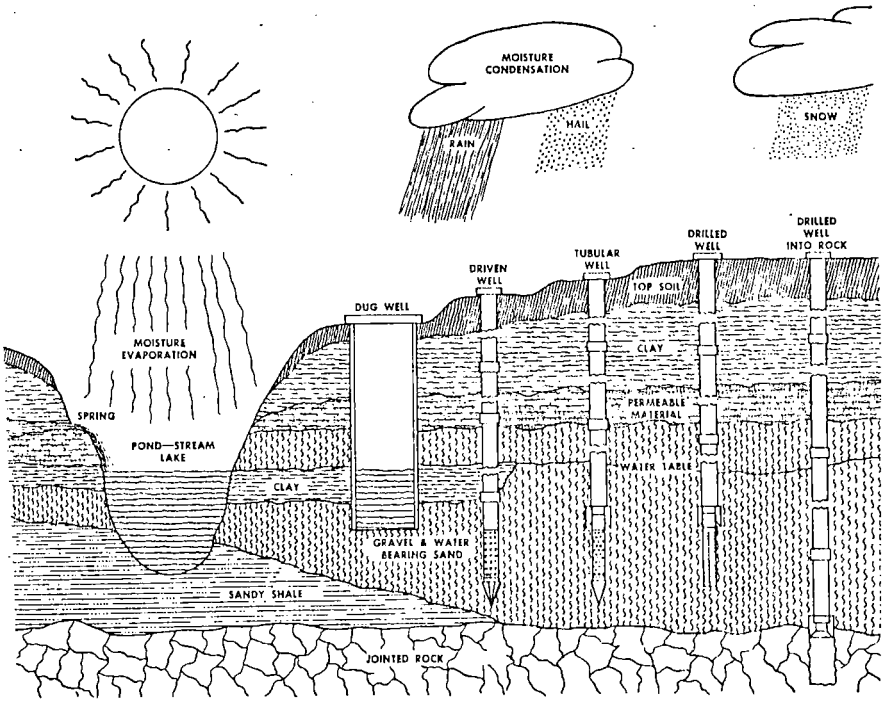
Upon completion of the well the contractor will develop the well so that it will produce its greatest capacity. If the contractor has used drilling mud in his drilling operation, the well should be surged and pumped until water is clear.

Construction Related Items

The well should be completed as indicated on the plan and specifications.

Clean Up of Area

Upon completing well, the contractor shall fill all holes dug, seal test holes to avoid contamination of permanent well, remove all equipment and leave area in an acceptable manner.



Types of Water Wells

Wells are generally classified according to the method of construction such as dug, bored, driven, tubular, or drilled, each being essentially an opening in the ground from which a supply of water is to be obtained.

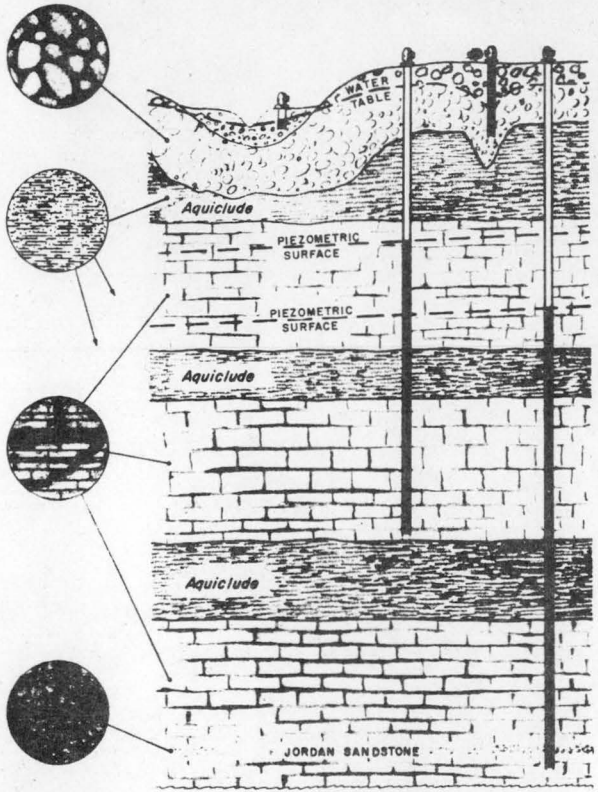
The first three types are usually shallow, generally not over 50 feet in depth. The tubular and drilled wells are developed by well drilling machines capable of penetrating through hard consolidations and rock formations to depths of 1000 feet or more.

Water is easily stored and flows freely in the open spaces between grains of sand or gravel.

Water is stored in large quantities in aquicludes but, because the open spaces in the rocks are extremely small it is not transmitted readily.

Solution channels and fissures in limestone are conduits in which ground water can move and be stored.

Water is stored and readily transmitted in the open spaces in sandstone.



General water-bearing characteristics

SURFICIAL AQUIFERS
Gravels and sands in this zone produce moderate-to-large quantities of good quality water

In general, this zone does not yield water or yields small quantities of poor quality water. Locally, some sandstones yield small quantities of good water

UPPER BEDROCK AQUIFER
Yields small-to-moderate quantities of water; the Gilmore City and Hampton Formations (p. 38) generally are the better producers

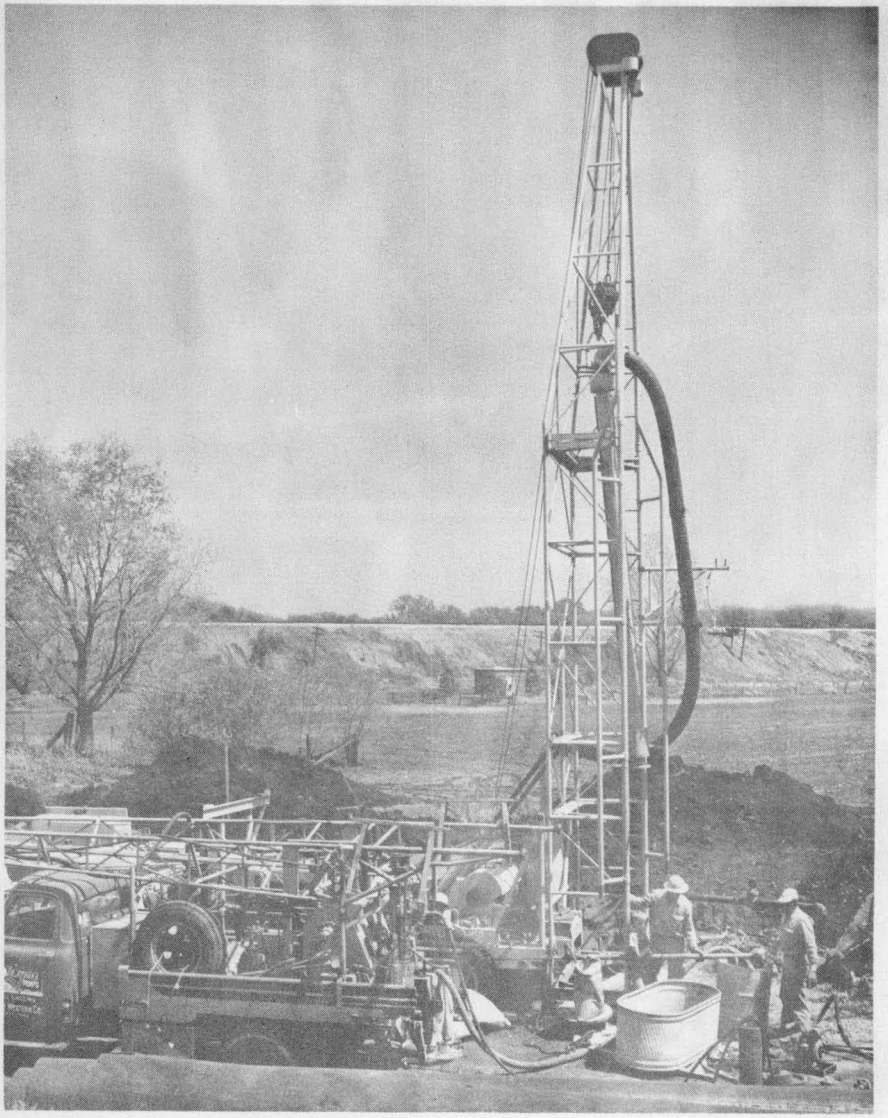
For the most part, this unit produces little water although locally, some beds produce small-to-moderate quantities

MIDDLE BEDROCK AQUIFER
Yields moderate quantities of fair-to-good quality water in the northern part of the area; elsewhere the water is highly mineralized

In general, this zone is not considered a good water-producing zone and is usually bypassed in favor of water from the lower bedrock aquifer

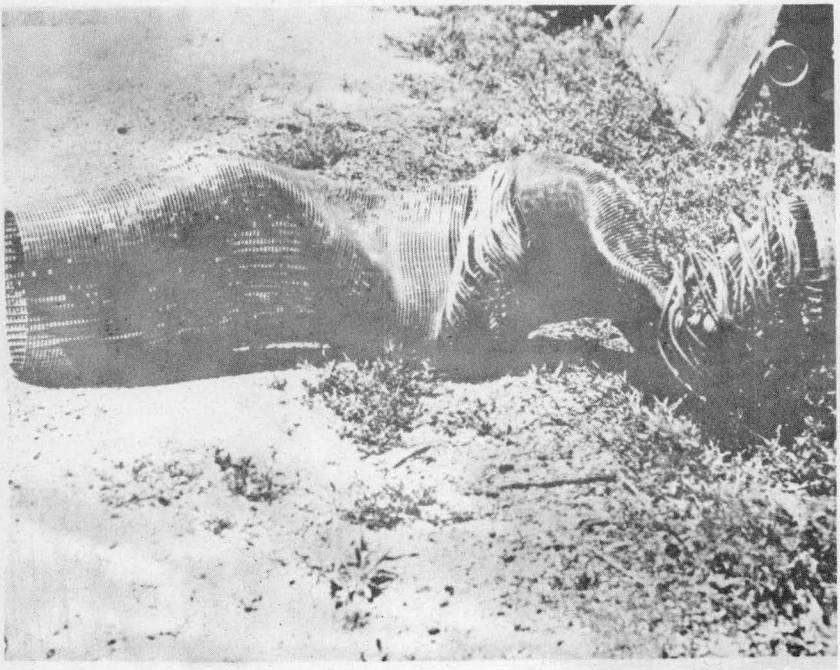
LOWER BEDROCK AQUIFER
Yields moderate-to-large quantities of relatively good quality water. Water is increasingly mineralized to the southwest.

Placing screen in well showing centering guides on screen to assure proper placement of screen.

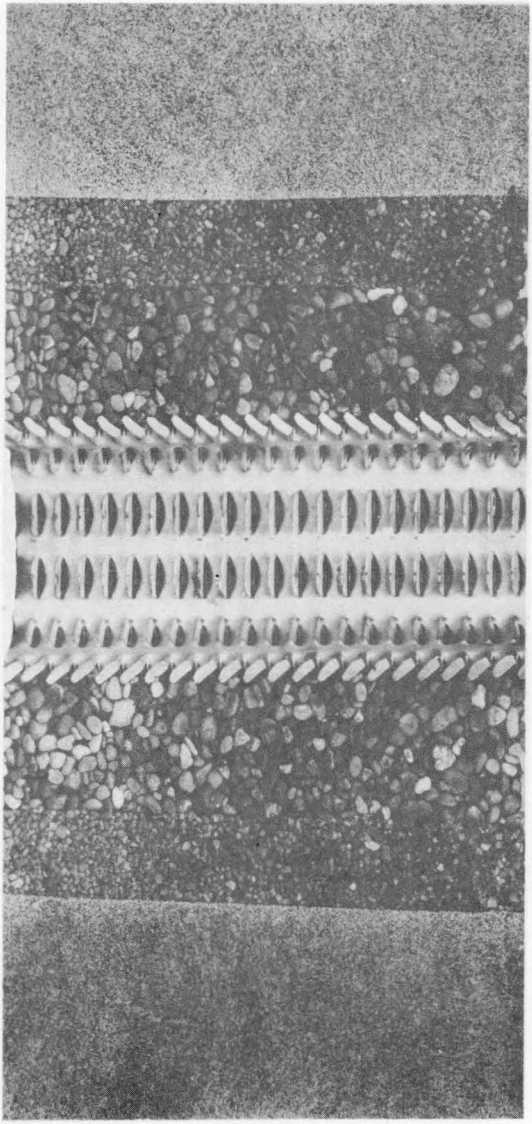


Rotary drilling rig.

Old cable tool rig placing casing.



Collapsed screen can result with improper handling.



Cross section of gravel pack well showing cross section of screen with gravel surrounding screen.

NOTES