FILTERS and SCREENS for IRRIGATION WELLS

Leaflet No. 446
U. S. DEPARTMENT OF AGRICULTURE

Because of the large volume of water that has to be pumped from wells for irrigating even a small farm, special equipment is required to put down the wells. Heavy well-drilling rigs must be used.

The well casing must be strong and durable and big enough to permit the installation of a pump of the required capacity. The well must be located where it will tap a good water-bearing formation. It should also be located, if possible, where it will serve the entire area to be irrigated at the least expense for the distribution system.

Washington, D. C. Issued April 1959

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. – Price 5 cents

FILTERS and SCREENS for IRRIGATION WELLS

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A properly designed irrigation well supplies water at a required rate and is relatively trouble free in operation. It provides a constant flow of water without excessive drawdown and without sand pumping. Filters and screens help satisfy these requirements.

A filter is gravel or sand screened to a size that holds back the sand in the water-bearing formation.

A screen is a perforated casing between the filter and the pump column. Its function is to permit water to flow into the well with the least interference and to keep the filter material from moving into the well.

The illustration on page 5 shows a common type of irrigation well and its pump, gravel filter, and screen.

The well driller usually determines how an irrigation well is to be drilled and developed. However, the farmer should understand the techniques involved in order to obtain a good well at a reasonable cost. Irrigation specialists of the Extension Service or the Soil Conservation Service, United States Department of Agriculture, may be able to advise on the development of an irrigation well.

WHY WELLS FAIL

Wells that pump sand sometimes fail because of cave-ins. The sand may also cause the pump to fail because it gets into the impellors or bearings of the pump and makes them wear excessively. Many gravel-filtered wells pump sand to the point of failure because the gravel used is too large. Poorly designed filters in other wells let sand move into the filter. The sand fills the filter voids and water cannot freely enter the well.

BEFORE DRILLING

Drill test holes, if possible, in areas of new irrigation well development. Test holes usually reveal the probable amount of water available. They yield samples of the formation in which the well is to be drilled. From such explorations and subsequent sieve analyses, it is possible to determine the filter and screen requirements.

When test holes are not used, analyze the water-bearing forma-

tion when the well is drilled. Results of the analysis should indicate the filter and screen requirements.

FILTERS

Function

A filter keeps fine sand from entering the well. It has the effect of increasing the diameter of the well bore, thereby increasing the yield of water.

The filter material fills cavities that may form near the casing because pockets of sand were removed in the drilling or development process. Since the filter can transmit water faster than the formation, the drawdown of the well may be reduced by the use of a filter.

Need

Filters may sometimes be omitted if the well is drilled in coarse sand or gravel. If the sieve analysis shows that the uniformity coefficient (see p. 8) of the material is more than 2, a filter is probably not needed. A natural filter can be developed. This consists of drawing the fine material from the water-bearing formation into the well by using a surge block. The fine material is then removed by bailing or with a sand bucket.

Even though the uniformity may be greater than 2, if the material is very fine sand (see pp. 7 and 8), a filter may be advisable in order that a screen with a larger slot size can be utilized. Wells drilled by the reverse-rotary process generally require a filter.

A sieve analysis of the formation helps determine the need for filters. If the driller is not equipped to sieve samples, well-screen manufacturers will generally perform this service.

Selection

The grain sizes of the formation must be determined either by sieving or by visual examination before the proper selection of the filter can be made. From the sieve analysis, the 50-percent size of the material can be determined (see p. 8).

The size of particles in the filter must bear a definite relationship to the size in the formation. Tests show that the 50-percent size of the filter must be 4 to 8 times the 50-percent size in the formation. For example, if the 50-percent size of the water-bearing material is 0.015 inch, then the 50-percent size of the filter should be 0.060 to 0.120 inch.

If it is not possible to have a sieve analysis made, the filter requirements may be determined by visual examination. An effective method of making a visual examination follows:

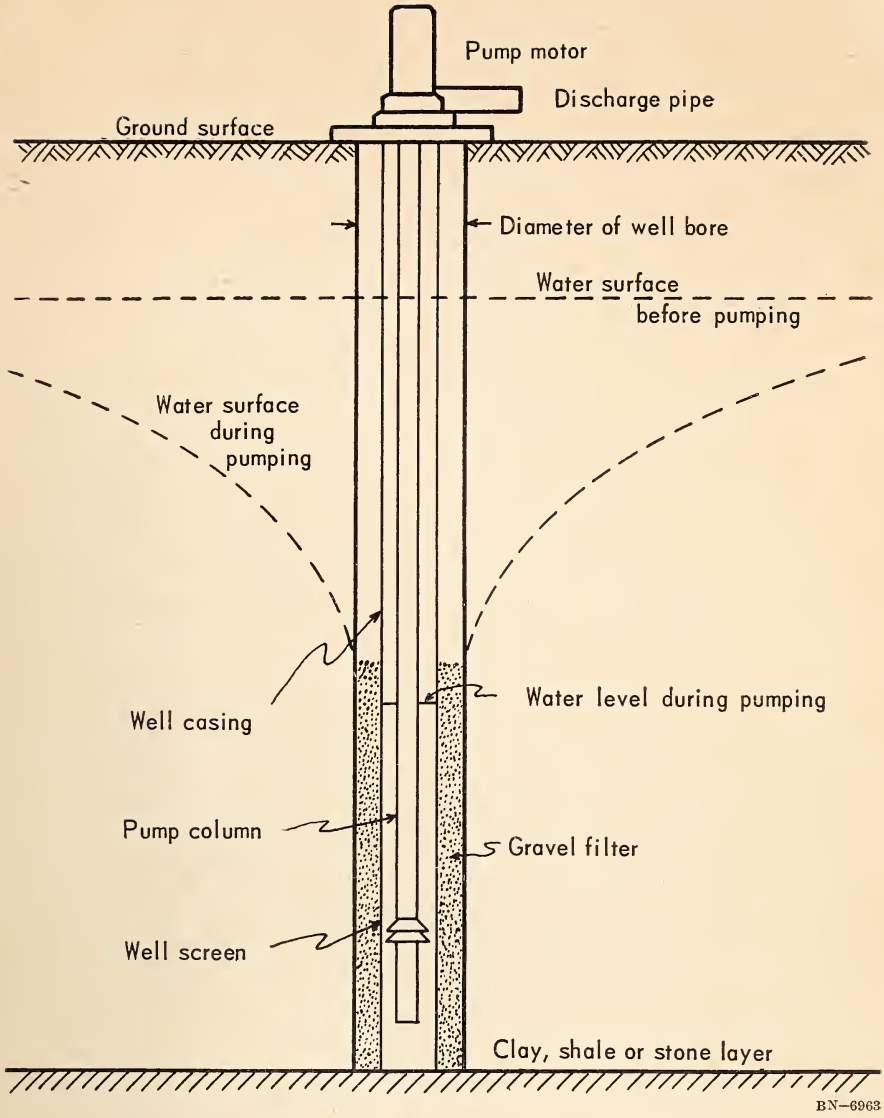
Compare a sample of the formation material with the photographs on page 7. Select the proper filter material by matching with one of the following pairs. If the formation material is *very coarse sand*, the filter material should be *medium gravel*, and so on.

Formation material:	*Filter material*
Very coarse sand	Medium gravel
Coarse sand	Fine gravel
Medium sand	Very coarse sand
Fine sand	Coarse sand
Very fine sand	Medium sand

Definitions of the material sizes listed appear on page 8.

Precautions

Check to see that all the particles in a filter are about the same size.



Diagrammatic view of a common type of irrigation well.

Material that passes one screen and is retained on the next smaller is acceptable. Sometimes it is difficult to obtain gravel screened in this manner. But generally it is best to reject gravel with a large range of particle sizes.

Check to see that crushed rock is not used for the filter.

Reject material that becomes soft and absorbs water.

Reject large material. Some drillers follow the principle that large filter material lets more water through and makes a better well. This is usually not true. A well equipped in this manner may fail because of sand movement. The

proper size of filter material needed can be determined by a sieve analysis or by visual examination.

SELECTION OF THE WELL SCREEN

A number of types and sizes of well screens are available. It is usually possible to consult a well-screen manufacturer or his representative about the type of screen suitable for a given condition.

The diameter of the screen is governed largely by the size of casing required by the pumping equipment. Generally, a screen 12 to 18 inches in diameter is used.

A screen should have a minimum of 10 percent open area. The length of screen or perforated opening may vary from ⅓ to ½ the depth of the water-bearing formation.

The width of the slots or perforations depends on the size of the filter material. Generally, they should be small enough to keep most of the filter material from passing into the well. The recommended size for each size of filter material follows:

Filter material:	*Screen openings (inch)*
Medium gravel	0.160
Fine gravel	0.080
Very coarse sand	0.040
Coarse sand	0.020
Medium sand	0.010

Either a manufactured screen or a factory-perforated casing should be used in the well. Torch-cut perforations are generally unsatisfactory since they cannot be cut uniformly in width. Perforations made by knives after the casing has been placed are not recommended unless unusual development problems exist.

INSTALLATION OF SCREEN AND FILTER

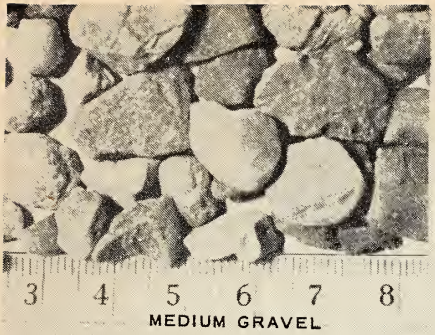
If a gravel filter is to be used, the well diameter must be large enough to accommodate a filter that is 6 to 8 inches thick. For a 12-inch screen, the well diameter should be 24 to 28 inches. With a 16-inch screen the corresponding range of well diameters would be 28 to 32 inches.

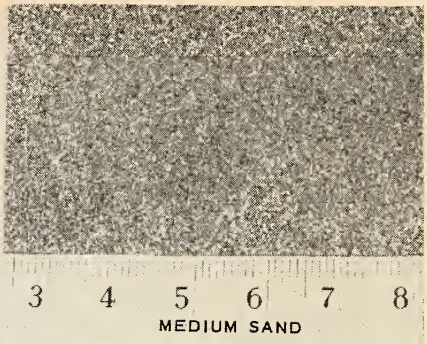
It is important that the screen be centered in the well so that the filter has uniform thickness. When a gravel filter is to be installed, the casing should generally be equipped with a guide shoe to insure centering the casing in the well and to prevent the gravel from shoving the casing to one side.

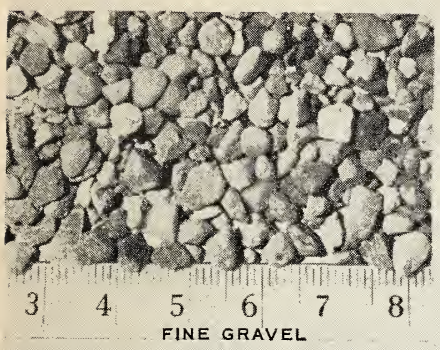
If a uniform material is used for the filter, little difficulty will be experienced in placing the filter. If the material used has a large range of sizes, different sizes may become separated during placement. This is undesirable. Layers of fine material may form and may prevent the flow of water. Layers of coarse material may also form and let the formation sand pass through the filter into the well.

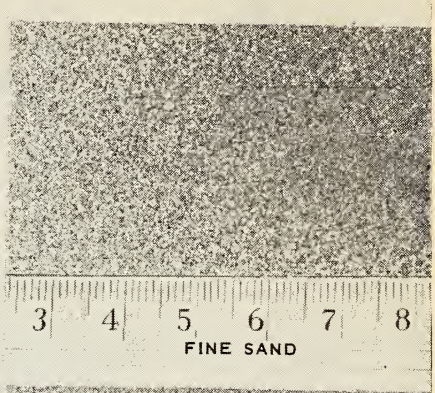
Special equipment used for placing filters prevents these possibilities. This equipment usually consists of a 4-inch pipe or tremie (a hopperlike apparatus) that extends to the bottom of the well. This pipe is filled with filter material and then slowly retracted from the well. The well driller will be familiar with this equipment.

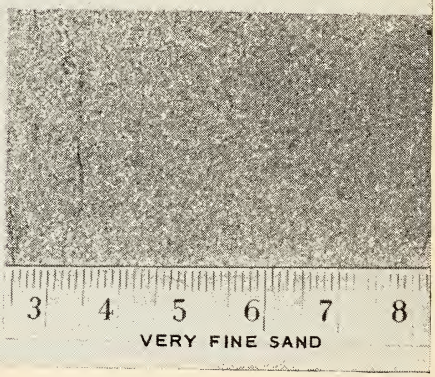
If the filter material is uniform in size, it can be shoveled in from the top of the wall and good results obtained.

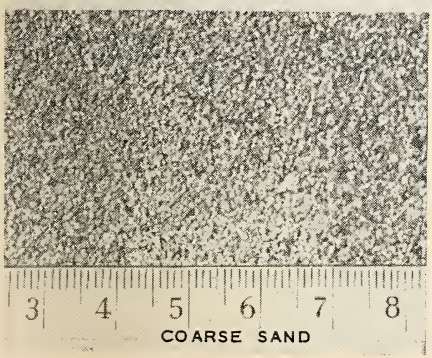












Samples of gravel and sand that can be used to determine filter and screen requirements for irrigation wells (see pp. 4 and 6.) (Method and pictures by courtesy of H. F. Smith, Illinois State Water Surveys Division, and Water Well Journal. Scale divisions between digits are millimeters.)

DEFINITIONS

Uniformity coefficient.—The ratio between the 60-percent size and the 10-percent size of the material.

Percent-size of a material.—An established percentage of the material passes through a given size of sieve.

Medium gravel.—Particles are 4.0 to 8.0 millimeters in size (0.157 to 0.315 inch).

Fine gravel.—Particles are 2.0 to 4.0 millimeters in size (0.079 to 0.157 inch).

Very coarse sand.—Particles are 1.0 to 2.0 millimeters in size (0.039 to 0.079 inch).

Coarse sand.—Particles are 0.50 to 1.00 millimeter in size (0.020 to 0.039 inch).

Medium sand.—Particles are 0.25 to 0.50 millimeter in size (0.010 to 0.020 inch).

Fine sand.—Particles are 0.10 to 0.25 millimeter in size (0.004 to 0.010 inch).

Very fine sand.—Particles are 0.05 to 0.10 millimeter in size (0.002 to 0.004 inch).

U. S. GOVERNMENT PRINTING OFFICE: 1959