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EC70-788 How to Get a Good Irrigation Well

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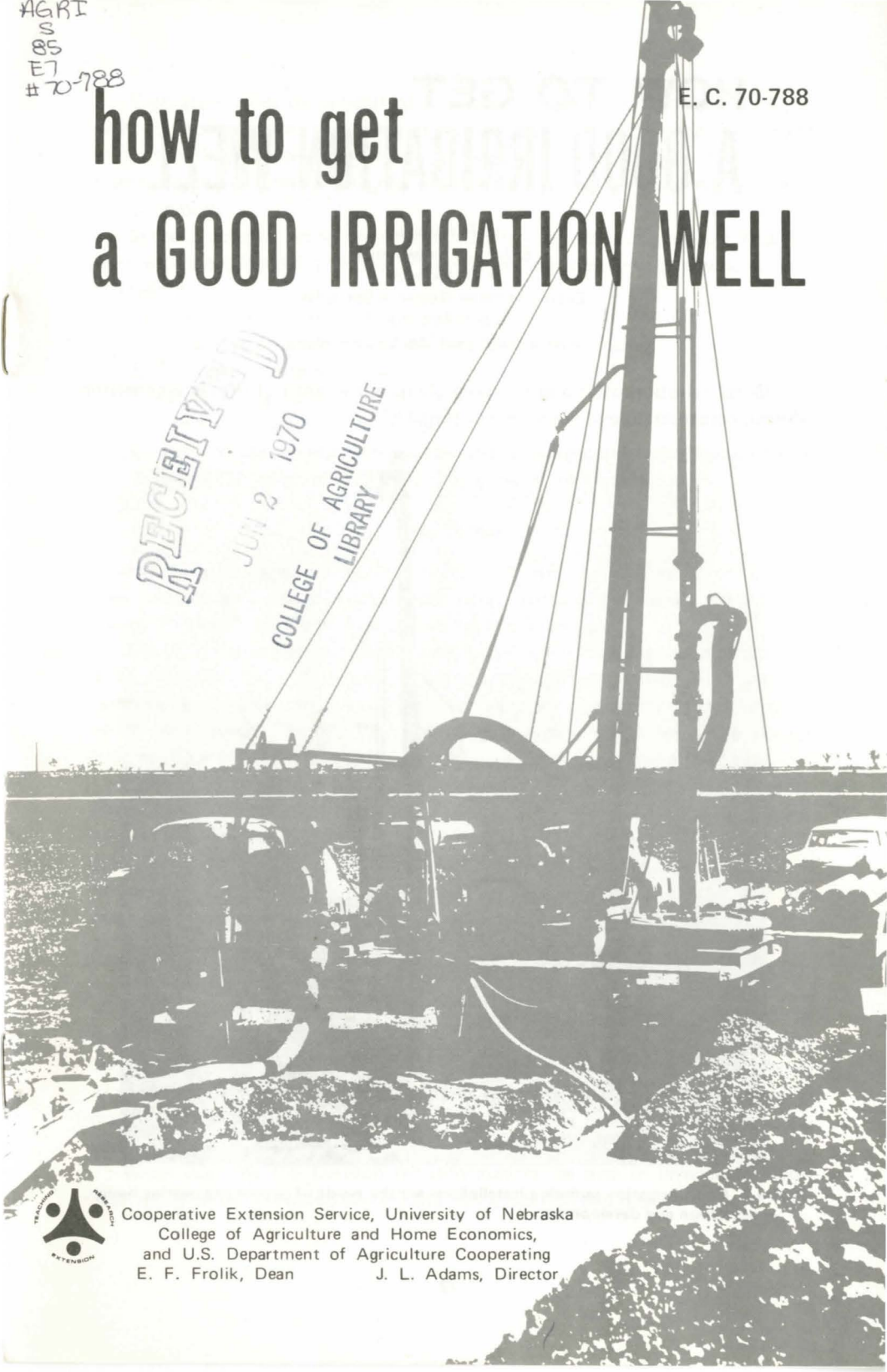

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HOW TO GET
A GOOD IRRIGATION WELL

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Good irrigation wells and pumping plants are a result of proper engineering design, construction and development (Figure 1).

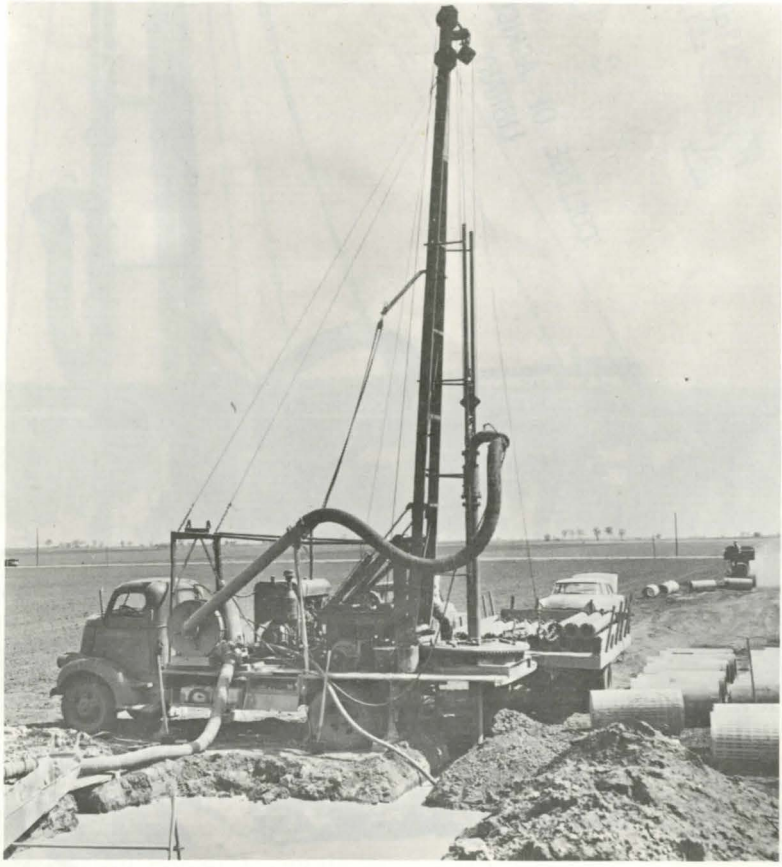

Figure 1. Good irrigation pumping installations are the result of proper engineering design, construction and development.

Even after 25 or more years of well-drilling experience, some new Nebraska wells pump sand or are being pumped below practical capacities. Some improperly designed pumping plants are using twice as much fuel as they should. Combinations of poorly designed wells and pumping installations cost landowners money.

Space precludes listing all details important to obtaining a good irrigation well and pumping plant. However, a prospective well owner should do the following:

1. Obtain the most reputable driller available.
2. Obtain water-bearing strata information by test drilling.
3. Determine the gravel pack.
4. Select casing material and screen.
5. Develop the well and test by pumping.
6. Select the pump according to the well capacity curve and irrigation needs.
7. Select the power unit to match the pumping requirements.

The Driller

Nebraska landowners normally do not employ engineers to prepare specifications and supervise construction and testing of their wells and pumping plants. Rather, they rely on well drillers for these services.

Selecting the driller may be the most important decision made in obtaining a good irrigation well. The well driller combines the knowledge of geologic formations and engineering experience with the art of operating the drilling rig. He is very much interested in obtaining a high yielding well. He derives satisfaction and a good reputation from successfully completing a good well.

Select a driller who will work with you and keep you informed on progress. Many drillers will expect you to sign a contract or agreement for the work done. In turn a written agreement may also contain your desires. Incorporating details prevents misunderstanding and may avoid unexpected extra charges.

Select a driller who will guarantee both his workmanship and that the pumping installation will meet Nebraska standards.

Test Drilling Tells

The possibility of obtaining enough groundwater for irrigation can be determined in a general way before test wells are drilled. The Conservation and Survey Division of the University of Nebraska has drilled a network of test holes in many areas of the state. The logs of the test drilling have permitted them to map in general the depth to and structures of water-bearing materials and the depth to water.

When you ask the Division for information, be sure to provide the legal description of the proposed drilling site, range, section and quarter section.

You should also require test drilling at the site, however.

A test hole drilled at the proposed site is the beginning of a good irrigation pumping installation. Guess work is nearly eliminated by this one operation.

Exact data obtained shows the levels and thickness of water-bearing materials and the grain sizes of the permeable materials. This data is from the exact spot where the irrigation well will be drilled.

Without a test hole, the question whether the main well was drilled to the best depth for maximum water yield will always be unanswered. More than one test hole may, and often should, be drilled to locate the best materials. The test hole normally should penetrate the entire depth of all water-bearing materials.

You should receive a complete and accurate log of each test. Samples of each formation at intervals of 5 to 10 feet and of formation change below the water table should be kept for reference and analysis. These samples of sand, sandstone, and gravel are helpful in determining screen slot size and estimating potential yields.

In general the irrigation well should be drilled to the bottom of the deepest water-bearing materials. This will give the best hydraulic advantage for inflow to the well.

Gravel Pack

Most irrigation wells in Nebraska are of the gravel pack type. You may need to settle on the diameter of the casing before drilling starts (Figure 2).

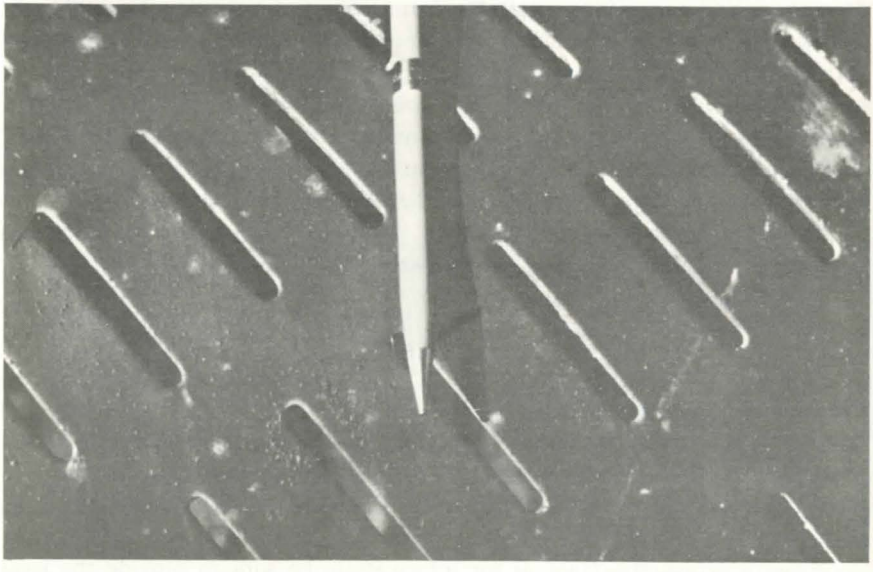

Figure 2. Gravel packs should be about 6 inches thick and the average gravel pack particle diameter 4 to 6 times larger than the average size of gravel in the natural formation.

The reason is that the bore-hole size helps determine how thick the gravel pack will be. Generally, the pack should be no less than 3 inches and no more than 9 inches thick. Thus an 18-inch diameter casing in a 30-inch hole would have a 6-inch thick gravel pack. In general, the thicker the pack, the harder it will be to remove any sediments or "drilling mud" lodged in the formation during the drilling process.

The gravel pack should be placed in the well in a way that will avoid bridging or segregation of large and small particles.

Installations which pump fine sand are usually the result of too high a pump rate and/or mismatched gravel pack. Overpumping causes high screen inlet velocities. This causes the fine sands to be pulled into the well from the natural aquifer. Gravel pack material must be small enough to hold back the fine sands when the well is pumped at a reasonable rate.

The average particle size of the gravel pack should be four to six times the average particle size of the aquifer. Gravel pack and formation material sizes are determined by sieve analysis. Proper gravel pack will help to eliminate sand pumping. Sand in the water greatly shortens the life of the pump impeller, bearings, and sprinkler nozzles.

"Nebraska Grade A Road Gravel" is suitable for packing irrigation wells providing the average size of the gravel in the natural aquifer does not grade out smaller than "course sand." If natural water bearing gravels in a well average "medium sands" or smaller, then a finer gravel pack than "Grade A" will be necessary to keep out the fine sands (Figure 3).

Figure 3. Well screens must be matched to the gravel pack material. In general, most slots are too wide.

Screen, Slot Width and Casing Material

Well screens serve two purposes: To allow water to flow into the casing and to hold back the gravel pack. In general, use as many feet of screen as possible but keep the top of the perforation below the water-pumping level (approximately 40 percent of the depth of water in the well).

Low screen inlet velocities of near 0.1 foot per second are best. This is accomplished by providing as much open area in the screen as possible. For example, a 10-foot section of 18-inch diameter screen with 10 percent open area will allow 1,000 gallons per minute to flow in at low inlet velocities of 0.1 foot per second or less.

Slot width should be narrow enough to hold back 85 percent of the gravel pack material during the process of well development. A 1/8-inch screen will hold back 85 percent of "Nebraska Grade A Road Gravel."

Type of casing material used is a matter of personal preference unless the wells are drilled in areas of known poor water quality.

Steel, plastic or fiberglass should be used where acid treatment may be needed after a period of time. Acid is used to remove incrustations from well screens in waters high in calcium and magnesium carbonates.

Concrete casing should be used where waters are corrosive. Isolated spots in Nebraska have waters containing hydrogen sulfide, which indicates that the water is corrosive to metal.

Keep all perforations below the pumping level. Intermittent dewatering of the screen may plug the perforations. Screens above the pumping level may allow water to cascade down the well resulting in aerated water. The corrosion and incrusting potential of water is greatly increased when the water contains air.

If the hole has been drilled where water bearing sands and gravels are separated by clay layers, a difficult decision will need to be made regarding placement of screen. Seek advice from your well driller, the Conservation and Survey Division, and the Agricultural Engineering Department. If the water bearing formation at the bottom of the well appears to be quite productive, it may be best to limit the screen to that area to avoid potentially cascading waters.

Well Development and Test Pumping

Well development cleans out the well and gives an accurate record of the capacity of the well in gallons per minute from various lifts. This data is necessary for proper pump selection in order to stay within the capabilities of the well and meet the irrigation requirements of the land.

Well development may be done by surging, jetting, back washing, and by other methods. This should be done immediately after the casing has been set. Back washing is often used in Nebraska. Back washing is pumping at a certain

rate with a sudden stop that allows water to rush back into the well. Pumping is resumed at increased rates until maximum yield is obtained. The water should be relatively clear at each development rate. The well should be tested at five progressively greater discharge rates and water level recorded at each rate. Each testing point should be approximately 20 percent of the maximum rate. Adequate test pump equipment is necessary to determine the maximum capacity of the well.

Do not exceed 60 percent drawdown of the standing water in a well if maximum well life and efficient pumping conditions are desired. Pumping a well to the bottom not only decreases the life of the well but may impair the pump by erosion of the metal from the impeller, causing the pump to operate inefficiently and pump less water.

Test pumping gives information on the capacity of the well. Stay within its limitations and don't pump it down to the last drop.

Pump

The pump brand can be selected before the well is drilled but the pump bowl and impeller assembly should never be selected before the test pumping results are available. Economical pumping costs are a result of matching drawdown, yield capacities of the well and irrigation distribution system requirement with pump performance curves.

Turbine pumps should have a preliminary impeller adjustment when installed and then a final adjustment after about 100 hours of actual field operation.

Deep well turbine pumps have either a semi-open type impeller or an enclosed type. Adjustment for efficiency can be critical on both impeller types, depending on their design. Pumps must be selected by using test pumping data, and the individual farm pumping requirements.

Keep all records such as well log, complete test pumping data, pump setting and length of perforated casing for future needs.

Specifying that the pumping plant upon completion shall meet the Nebraska Deep Well Irrigation Pumping Plant Standards can assure you of an installation that is correctly designed, properly adjusted and highly efficient.

If you need more detail and specifications for irrigation wells than are given here, consult the 1968 American Society of Agricultural Engineer Yearbook. "Designing and Constructing Water Wells for Irrigation". Extension Circular 57-702, "Nebraska Minimum Standard for Irrigation Wells". Extension Circular 67-760, "Adjustment of Vertical Turbine Pumps for Maximum Efficiency". The book Ground Water and Wells by E. E. Johnson.