

The image is a collage of three photographs. The top photo shows a long, metal irrigation system stretching across a field. The middle photo shows two people, one in a plaid shirt, kneeling and examining a sample in a field with a dog nearby. The bottom photo shows a man in a cap operating a water pump. A large red graphic element is on the right side of the page.

3.1.3 WATER SOURCES

Where should you put your well?

The number of wells, approximate locations, and well diameters need to be estimated before obtaining resource consents and to allow an approximate water supply cost to be calculated, in order to determine if irrigation is likely to be financially viable.

Obtain background information

- Find out at what depth groundwater is likely to be found and in what quantities.
- Talk to neighbours or locals familiar with the groundwater in the area.
- Talk to well drillers.
- Contact the local regional council for details about groundwater in the area.
- Talk to irrigation consultants who have been involved in groundwater studies in the area.
- If you think it will help, talk to a water diviner. (Some farmers have established wells under the guidance of water diviners with good success, while others have not been so fortunate).
- Find out as much as possible from your regional council about how water levels fluctuate within seasons and from season to season. You need to ensure that you can still obtain a reliable supply of water during droughts.

Number of wells

In areas where groundwater is freely available and the required flow rate is likely to be obtained from one well, only one well is required, but a contingency plan should be available should that well fail to produce. Often, it is a matter of trying a different location or going deeper than originally intended.

Where groundwater is not so freely available, or the quantities of water required are large, it is likely that more than one well is required. Use the background information to try to estimate how much water you will be likely to get from each well. From your estimate of how much water you need, you can calculate the number of wells. Once again, you need a contingency plan in case wells fail to produce. It is often wise to budget for the cost of an additional well.

Location of wells

Factors that affect well locations include:

- likely location of aquifers
- flow rate required
- location of power supply
- the design of the irrigation system
- the effect on the hydraulics of the irrigation system
- proximity of neighbours' wells
- the effect of pumping on neighbours' wells
- the effect of pumping on streams
- distance from the coast (in case of saltwater intrusion).

Without doing a detailed design, it will not be possible to fully account for all of the above factors, but an estimate of their effects on the cost of the system and on effects relating to obtaining consents should be made. Although an approximate location for wells is required in order to apply for resource consents, the exact location will be decided as part of the final design process.

To save on the costs of putting in new power lines, many people place wells close to existing lines on roadways. Quite often, this is at the bottom of properties and has a serious and long-term effect on the hydraulic efficiency and pumping costs for the irrigation system. Although initial savings can be made in capital investment, long-term annual operating costs can quickly exceed the cost of capital.

Diesel pumping systems often allow for more flexibility regarding well location. Some systems use portable diesel systems to pump from different locations, depending on the area that needs to be irrigated.

If groundwater is shallow, galleries or shallow wells may be dug with clamshell excavators. For deeper groundwater, properly constructed wells are

advised. Generally, the deeper the groundwater, the more reliable the supply. Shallow wells are often hydraulically linked to rivers or streams that can become very low in late spring/summer/autumn and can dry up in extreme cases.

In areas where more than one well may be required, allow for possible locations for additional wells in a way that allows them to be spaced as widely as possible, as far away from neighbours as possible.

Water diviners will often recommend locations that may not be suitable for good hydraulic design. Whether you accept their advice is a personal decision.

On flat ground, the well should be placed near the centre of the land to be irrigated. This results in the lowest pipeline cost, because shorter runs and smaller pipe diameters can be used. If the property is sloping, the well should be placed towards the high end of the property. However, depending on the degree of slope and length of run, the highest point is not usually the optimum location. As a guide, on typical Canterbury farms with a fall of 1 in 100 to 1 in 200, the well could be located about one-third of the distance from the top of the farm, thus pumping one-third uphill and two-thirds downhill.

Sometimes, more than one well is required to feed into a single system. Proper location of each well is vital to the cost and the long-term operation of the system. Multiple water supply systems can be hydraulically complex, and experts should be consulted.

Other factors to consider are the drowning risks to young children and the risk of groundwater contamination by chemicals, nitrates, etc.

The best advice is to have a number of options designed and priced for a range of well positions *before* the wells are drilled. Remember, you pay for installation costs once; you pay for design inefficiencies for the life of the system. There is no cost to the user to transport electricity through wires, but the cost to push water through pipes is ongoing.

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How big should your well be?

The diameter of well that you should install depends on the likely depth of the well, how deep the pumping water will be, the type of pump, and the likely pumping flow rate.

Surface pumps

It is usually possible to use a surface pump where pumping water levels are expected to be less than 6 metres below ground level.

Well diameter depends on the size of suction or dip pipe that goes from the pump down the well. It is usually not more than 8-10 metres long and is sized to match the inlet size of the pump and to keep friction in the suction pipe to an acceptable level. Pump supply companies can advise. If foot valves or shallow well jet pumps are used, the well casing must be large enough to get these components down to the required depth.

With some wells, particularly those with artesian flows (water levels above ground level), pump suction pipes can be connected directly to the well casing. In these circumstances, well diameter depends on construction requirements and on the pumping flow rate (see below).

Well depth is also an issue. With very deep wells, the friction loss in the well casing can be significant, increasing the effective drawdown. Friction in the well casing should be kept as low as possible.

Submersible pumps

Where pumping water levels are typically deeper than 6 metres from the surface, submersible pumps are often used. The following table provides some guidance on the diameter of well that should be drilled for situations where submersible pumps will be needed.

Anticipated well yield (m ³ /h)	Nominal pump bowl size (mm)	Typical pump power (kW)	Optimum well casing diameter (mm)	Minimum well casing diameter (mm)
< 10	100	<5	150	125
8-20	150	<7.5	200	150
15-60	150	<30	200	175
16-80	200	<40	250	200
35-120	200	<90	250	225
80-220	225	<130	300	250
100-250	250	<150	300	275
150-350	275	<230	350	300
250-500	300	<400	400	350

Well diameter is generally one size larger than the nominal pump or motor diameter. It is possible in some circumstances to install submersible pumps of the same diameter as the well; installation may, however, be difficult, because of the small clearance between the pump motor and well casing. In addition, high water velocities can cause excessive drawdown in the well, significantly reducing the available flow.

If the well diameter is much larger than the pump diameter, shrouds may be needed to ensure proper motor cooling. Pump suppliers can advise.

Other issues

Small diameter wells usually have higher drawdown for a given flow rate than large diameter wells, thereby decreasing the amount of water that can be pumped and increasing pumping lift and pumping costs. Increasing well screen diameter does not, however, generally result in large increases in capacity. Doubling the diameter will often only increase the flow by about 10%.

Well drillers are usually reluctant to install small diameter wells in deep or difficult strata, because of the higher risk of something going wrong.

For deep wells, it is sometimes necessary for construction reasons to reduce the diameter in the deeper portion. Given that the diameter of the well at the depth a submersible pump will be installed has to be able to accommodate the pump diameter, it may be necessary to start the well two or three sizes larger than the nominal pump diameter.

Using a diameter that is too small may limit the size of submersible pump that can be installed, thereby restricting pumping capacity even if the well has the extra capacity.

In general, it is better to have a well that is larger than needed than to have a well that is smaller than needed.

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What should you expect from a well driller?

The drilling of a well is a costly exercise for most farmers and involves the risk of not finding water.

Before formally engaging a well driller, you should have obtained information about issues such as whether electricity is available, where the well should be placed, and approximately how much water you are expecting to find.

As most well drillers will not start drilling until you have a land use consent to install a bore from your regional council, make sure that you have that available in time.

Choosing a well driller

Price is often seen as the most important criteria in choosing a well driller, but the lowest quote may not necessarily be the best. A number of other factors must also be considered:

- reputation of well driller
- standard of equipment
- ability to complete the job
- start time
- time to complete the job
- quality of work.

Quotes

When obtaining a quote, you should make sure that the quote specifies the materials to be used and allows for all costs involved in installing a production irrigation well. It should include:

- diameter and type of well casing
- diameter and type of well screen
- establishment and disestablishment costs
- cost per metre of cased depth
- cost per metre of open hole
- cost per metre of screen
- cost per hour for well development
- cost per hour for well testing
- estimated starting and completion dates
- estimated hours for completion.

Well completion

Regardless of the quality of the well drilling, it is imperative that an irrigation well is properly screened, developed and tested. Some well drillers may take shortcuts in these areas, which almost always end in sub-standard well performance and operational life.

Screening

Screening involves placing a length of well screen in the well across the aquifer formation to allow water to flow from the aquifer to the well and to exclude sand and gravel. Stainless steel screens are highly recommended, although other materials such as PVC can be used for small diameter wells. The older methods of using a gas torch to cut slots in casing or using explosives are not recommended.

Casing perforators are becoming widely used to punch holes through casing walls, particularly to provide access to aquifers higher up the profile. They should not, however, be used as a replacement for properly screened wells.

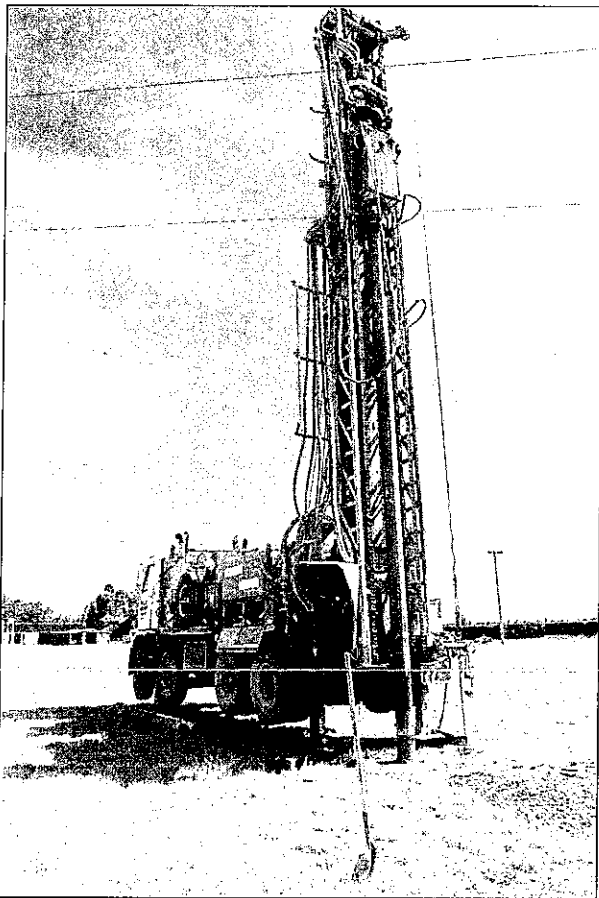
Development

Development is the process of removing sand and clay material from around the well screen to improve the flow into the well. This opens up the aquifer, increasing well capacity, and reduces the opportunity for fine particles to enter the screen and possibly damage the pump. It is a vital part of the construction and should continue until no further significant improvement in well capacity can be obtained. Sand content should not exceed 10 ppm (10 fine grains in a 5 litre bucket). Except in rare circumstances, it is better to spend more rather than less time on well development.

Testing

Once a well has been screened and developed for irrigation, it should be tested by pumping at a flow rate exceeding the desired yield or up to the maximum recommended flow rate for the well. Drawdown must be measured at the same time. An adequate test is normally 5-6 hours pumping, with flow rates stepped up in 1-2 hour intervals. Where aquifers are less extensive, with possible storage limitations, longer tests should be carried out. The information provided by this test allows well capacity to be accurately estimated, an assessment of the standard of development to be made, and aquifer transmissivity to be calculated. This information is extremely helpful for resource consent applications.

As with development, proper testing is vital. Do not accept drillers' estimates or a quick bale test.



Issues/disputes

Most disputes involving well drilling occur when a well takes too long to complete, is poorly constructed, or does not produce the desired quantity of water.

There is always uncertainty with well drilling, and it is impossible to predict exactly what will happen. All of these issues can, however, be dealt with under a contract. For example, excessively bent wells or broken casing should be the driller's responsibility. The owner usually bears the risk of a dry hole, but the contract should clearly spell out who pays for what. Sometimes, the casing can be recovered, and a credit should be given.

Where completion times are critical, penalty clauses can be used, but it is better to start early to ensure a quality finish.

The biggest problem usually occurs when a well does not produce as much water as expected, and a decision must be made to either try more development, go deeper, accept as is, or drill another well. This is usually an owner decision based on the advice of the driller. If there is any doubt, obtain a second opinion.

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