Maine Farm-A-Syst

Farmstead Assessment System Fact Sheet 11

Irrigation Wells

Irrigation wells in Maine can provide a direct conduit for contaminants to reach groundwater supplies unless properly located, constructed, and protected. Groundwater is a source of drinking water for many of Maine's residents. It is critical that every effort be made to protect groundwater quality.

Irrigation wells can be constructed and maintained to assure that groundwater quality is protected. Improperly constructed or maintained wells can allow bacteria, pesticides, fertilizers, oil products, or other pollutants to contaminate groundwater.

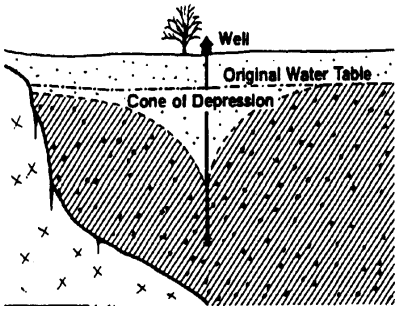
Topics Covered:

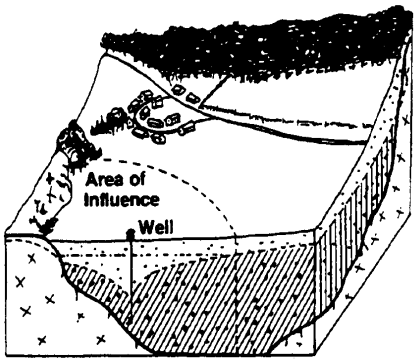
Understand Water in Your Well

When a well is pumping, groundwater flow changes direction in a portion of the watershed.

- Instead of moving toward the natural discharge area, the groundwater within the influence of the pump flows toward the well from every direction.

- The pumping well creates an artificial discharge area by drawing down (lowering) the water table around the well. This area of drawdown is called the cone of depression and the area it affects is the area of influence.





Every pumping well is surrounded by a cone of depression. when the amount of groundwater that is withdrawn by the pumping well is equal to the amount of groundwater recharge within the area of influence, the cone stops expanding.

- **The cone of depression does not always remain the same size**. If there is less rain and the well keeps pumping, the pump will pull water from a greater

distance, and the cone of depression will get deeper and wider. After heavy precipitation, with good recharge, it will get smaller.

- **Dug, driven point, or gravel packed wells** which draw water from the surficial deposits have a cone of depression that is generally round or oval showing that recharge is being drawn from all directions.

- **Bedrock wells** drawing water from linear fractures may have a narrow, elongated cone of depression reflecting recharge along the fracture.

- **Land use can change the size and shape of the cone of depression** and the ability of the aquifer to supply water. If there are a lot of impermeable surfaces (such as paved areas or buildings) covering a portion of the area of influence or its upland recharge area, then the rain water will not be absorbed into the ground and recharge the well. The water will runoff from those surfaces and flow overland to streams instead of recharging the groundwater. This will force the cone of depression for the pumping well to expand to compensate for the loss of groundwater recharge. The increased area of influence could cause more problems such as new sources of contamination. If there are too many impermeable surfaces there is the chance of a possible decrease in the yield of the well.

For more information on wells and geology refer to section 13 or the Maine Geological Survey website at http://maine.gov/doc/nrimc/mgs/mgs.htm .

Potential Contamination Factors

Several factors make irrigation wells vulnerable to potential contamination.

- Wells are located adjacent to or in cropland areas. This means that there is a high probability agricultural chemicals, pesticides, and fertilizers will be applied near the well.

Many irrigation wells are pumped using an internal combustion engine which means fuel and oil products are used at the well site.

- A spill of petroleum products at the well site could result in significant groundwater contamination.

- Application of chemicals through the irrigation water (chemigation) is becoming a common practice.

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Chemigation of pesticides is strictly regulated through the pesticide label. The label must contain specific instructions allowing for chemigation and all the chemigation requirements/equipment

- Backflow or back siphonage during chemigation without the proper safety equipment can allow chemicals to flow down the well directly into the groundwater. If this were to happen it would be, at least, a difficult and costly process to clean up, if it could even be done, not to mention the possibility of contamination of your own drinking water.

There are many potential sources of contamination at an irrigation well site. Preventing contamination at an irrigation well is important. Once groundwater is contaminated, it is very difficult, timely, and costly to clean up...if it can even be done. Contamination will move with groundwater and can eventually reach your or a neighbor's domestic water supply well, or a well used for public drinking water. Contaminated water can pose a serious health threat for those who use the water.

Water Withdrawal Law

It is very important to make sure you are not contaminating yours, your neighbor's, or the public's drinking water. Follow the water withdrawal law that was enacted in 2007 in this state. Certain farms have to report their water use. To find out if you are one of these farmers or to learn more about this law go to: http://www.maine.gov/agriculture/mpd/business/irrigation/index.html. At this site you can read a simple and informative fact sheet that the Maine Department of Agriculture developed to help you determine what steps you need to take to maintain your existing water withdrawals for irrigation for the next five years, develop an allowable water drawdown limit, and determine whether a new pond or well would be a better option for you in the future.

When digging a pond, or drilling a new well, you must start with a water management plan. You can find a good template at the following link: http://www.wcc.nrcs.usda.gov/nrcsirrig/
The second step is to visit the NRCS and DEP offices because you may need a permit.

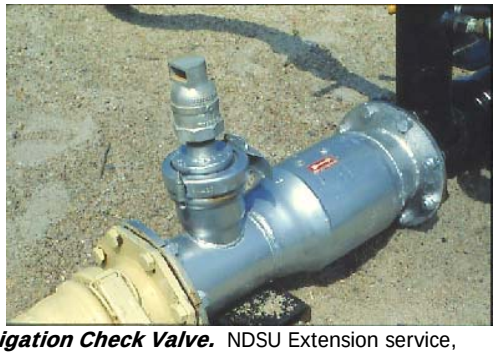
This reporting program started because a number of agencies and environmental groups were and still are concerned that certain watersheds may be in danger of being dewatered during drought conditions. It is important that the farmers report because if more than one farm is irrigating from the same water source it could lead to excessive draw down of that source.

Best Management Practices

Backflow Prevention

Use check valves and an anti-backflow device when filling pesticide sprayer tanks to prevent the chemical mixture from flowing back into the well and contaminating groundwater.

Backflow or back siphoning from pesticide mixing tanks allows chemicals to flow back into the well through the hose. The chemical in the supply tank and in the irrigation pipeline could flow or be siphoned back into the water source when the irrigation system shuts down. Inexpensive anti-backflow devices for hoses used to fill farm sprayers may be available from irrigation or spray equipment suppliers. If you don't have such a device, keep the hose out of the tank when filling the pesticide sprayer.

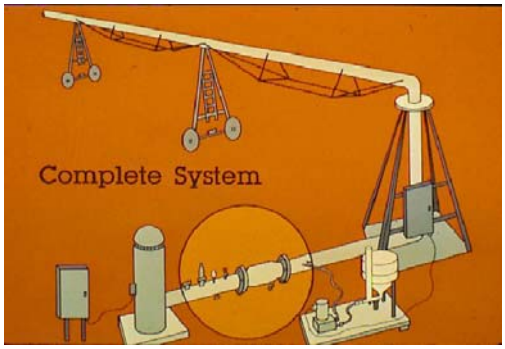


Chemigation Check Valve. NDSU Extension service, Department of Agricultural & Biosystems Engineering.

Consider purchasing an inexpensive plastic nurse tank. A nurse tank is filled with water at the well and then used to fill the sprayer away from the farmstead and away from the well. (For more information about preventing well contamination from pesticide mixing and loading practices, see Fact Sheet #2, Pesticide Storage and Handling.)

Injection systems should include the use of appropriate check valves and anti-siphon devices to prevent backflow of fertilizer and chemicals into water bodies.

You should also consider anti-backflow devices on all faucets with hose connections or maintain air gaps between hoses or faucets and the water level. The water could very easily flow backwards contaminating the well or any surface water you are pumping from. Otherwise, you risk having contaminated water in laundry tubs, sinks, washing machines, pressure washers, outside hydrants and swimming pools flow back through plumbing to contaminate your water supply.



Chemigation Check Valve Complete System. NDSU Extension service, Department of Agricultural & Biosystems Engineering.

Remember just because the pumping has stopped doesn't mean all the water is out of the piping, or if the system turns off unexpectedly, the water may not continue to flow forward out of the hose. Gravity could pull it back to the pumping source, i.e. irrigation well, pond or other type of surface water.

Water Applications

Not only is it important to make sure backflow prevention devices are in place to protect groundwater, but the amount of water distributed onto fields is also very important. Proper irrigation scheduling can result in significant savings in irrigation time, labor, energy, and water.

Schedule irrigations appropriately by accounting for the soil moisture and crop water use. Regular measurement of soil moisture is an accurate way of determining when to irrigate. It is critical that the determination of the water budget is done systematically and accurately so water needs of the crop are met without over-application.

Time water applications to avoid water movement beyond the rooting zone. Weather patterns should be assessed before each irrigation. Irrigation should not fill the soil to field capacity. Deficit irrigation techniques that leave room in the rooting zone for additional moisture from rainfall have been demonstrated to protect groundwater without yield reductions. In order to provide sufficient storage capacity in the event that rainfall follows irrigation, the soil should not be completely saturated.

If the water moves beyond the rooting zone, the roots won't take it in. when this happens the water carries those chemicals to the nearest water source.

Adjust water application amounts to meet varying crop demands at different growth stages. Irrigation has the potential to meet these variable demands more readily than dry land agriculture, thus maintaining a stable environment for plant growth. Large amounts of unused residual chemicals are not likely to be left in the soil if management results in vigorous plant growth throughout the year. The potential for chemical leaching and groundwater contamination is diminished.

Irrigation water must be applied uniformly and accurately. A functional flow meter and accurate pressure gauge, either at the pump or on the pipeline near the point of discharge, is essential for accurate application of irrigation water and chemicals.

Nighttime irrigation can result in substantially higher irrigation efficiencies due to reduced evaporation. For example, a sprinkler system which operates at 70% efficiency during the day may operate as high as 90% efficiency at night.

Chemigation

Before starting chemigation, it is extremely important to make sure that the well has been properly constructed and that safety precautions such as backflow prevention are in place.

Chemicals should be mixed and injected in areas that are located away from water bodies and wells, and provisions should be made to contain any spills which might occur.

> Be aware of where the runoff water will go, how to handle your particular chemicals and who to call for help in case of a spill. Refer to fact sheets #2-5.

Producers should give special attention to calibrating injection equipment to assure that intended rates are applied to the crop. Recommended rates of either chemicals or water should not be exceeded; excessive amounts waste money and can easily be carried with runoff or groundwater seepage into water sources.

During any chemigation application, periodically monitor the irrigation system and chemical injection equipment to be certain that both are operating properly. Monitoring is particularly important if there is a chance for loss of electric power.

New Wells

New wells are expensive – but they are a good investment for the future. Getting the most from such an investment means locating the well away from contamination sources and working to maintain the quality of the well. Some simple principles:

- Follow all state recommended minimum separation distances.
- **Locate your well on ground higher than surrounding pollution sources** such as fuel tanks, livestock yards, septic systems or pesticide mixing and storage areas. Where practical, locate the well as far as possible from your fields or other pesticide use areas.
- If necessary, build soil up around the well so that all surface water drains away from it.
- Avoid areas that are prone to flooding.
- **Groundwater flow generally follows surface drainage patterns.** Unless you know the exact direction of groundwater flow on your property, locate the well so that any pollution sources are between the well and the nearest stream, river or lake. Groundwater generally flows from upland areas and discharges to a surface water body. In all cases, locate your well on ground higher than surrounding pollution sources.
- Make the well accessible for pump repair, cleaning, testing and inspection.
- **Hire a competent well driller and pump installer.** Make sure the driller disinfects the well with chlorine after construction and tests the water for bacteria

after drilling (as required by state law). He should provide you with detailed information about the well's depth and construction.

- Well construction must be such that agricultural chemicals cannot reach the aquifer directly down the well or around the well casing.

- When constructing your irrigation well be sure to follow regulations that are in place for wells.

Source Water Protection / Wellhead Protection Area

Almost half of Maine's population depends on groundwater for its drinking water supply from either private or public wells. We are lucky to have some of the best water supplies in the world, and it is our job to keep them safe. Being aware of potential problems on your property that might pollute drinking water sources is important. You may not even know that there is a potential threat. Taking the time to read and fill out the applicable Farm-A-Syst sections is a great first step. From there you will sit down with a district employee or someone trained in Farm-A-Syst to discuss some possible solutions such as best management practices (BMP) that can be applied. BMPs are a method, measure, or practice that, when correctly installed or performed, will prevent, reduce, or minimize water pollution. In this case, the focus is on drinking water supplies and the areas that provide them with water.

There are some laws that pertain to areas within a source water protection zone that don't apply to other landowners. Be sure to check with your local water district and municipality for local ordinances or if you are unsure if you live in a source water protection area.

It is the landowner's responsibility to know local and state laws pertaining to their land, although it is hard to navigate sites and wade through the legal jargon of written laws.

If you are living or operating in a source water protection area (the surface and subsurface areas surrounding a drinking water supply for a public water system where activities can contaminate the supply) or wellhead protection area (an area used to protect groundwater, a form of source water) you should pay extra special attention. We have tried to find pertinent information pertaining to this section. You can find links to these laws along with helpful information in the following Contact & Reference section as well as in appendices A: Law and Regulations & B: Resources.

The following, authored by Maine Drinking water program, is excerpted from the document "Best Management practices for Groundwater Protection". This manual is intended for the use of local officials, public water suppliers and landowners in Maine. It is intended to encourage educated decisions, informed practice, and directed planning in regard to groundwater protection, particularly in the vicinity of public drinking water supply wells. http://www.maine.gov/dhhs/eng/water/forms/Sections/BMPv2%200A.htm

C. Chemical Spreading or Spraying

Major potential problems: Some agricultural chemicals are very soluble. If they are applied during a seasonal period of groundwater recharge (principally during the rainy spring season), much of the chemical applied will contaminate groundwater rather than being agriculturally useful.

BMPs for spreading of agricultural chemicals:

1. Irrigation schedules shall be coordinated with pesticide and nutrient application to minimize the possibility of leaching. Do not apply to frozen ground, or immediately before storm events.

L. Wells

Definition: Wells are structures (usually vertical shafts) used to access groundwater for extraction or monitoring purposes.

Major potential problems: Wells provide a possible conduit for contaminants originating in surface water or upper aquifers to migrate to groundwater below. Wells placed within the same Zone of Groundwater Contribution will interfere with each other, causing a reduction in the Safe Yield of both.

BMPs for wells:

1. Wellheads shall be designed such that surface water does not enter groundwater through the borehole around the well casings.

2. Wells that are no longer in service for extraction or monitoring shall be abandoned in a manner appropriate to prevent the entry of contaminants and mixing of separate subsurface water-bearing zones. This may involve the use of bentonite and/or cement grout where a water-tight seal is deemed necessary.

3. High yielding wells (for uses other than domestic purposed) will only be allowed in a WHPA if a safe yield analysis, conducted by a Maine Certified Geologist, can demonstrate that there is sufficient water for both the new well and the public water source.

Contacts and References

Who to call about…

Certified well water testing laboratories

A listing is available from the Maine Department of Health and Human Services, Center for Disease Control Division of Environmental Health, Drinking Water Program. (207) 287-2070

Interpreting well water test results

Maine Department of Health and Human Services, Center for Disease Control Division of Environmental Health, Drinking Water Program (207) 287-2070

Your County Extension office

Drinking water quality standards

U.S. Environmental Protection Agency's Safe Drinking Water Hotline. 1-800-426-4791
10:00 A.M. to 4:00 P.M. Eastern time.

Maine Department of Health and Human Services, Center for Disease Control, Environmental and Occupational Health Program (207) 287-3201

Financial assistance

For information on whether you qualify for financial assistance in replacing your well due to contamination, contact the Maine Department of Environmental Protection, Bureau of Hazardous Materials and Solid Waste Control. (207)287-2731

For information on current cost share programs for conservation practices contact your local NRCS office.

What to Read about…

Publications are available from sources listed at the end of the reference section. (Refer to number in parentheses after each publication.)

Groundwater, groundwater flow

Groundwater handbook for the State of Maine, 2nd edition, 1987, by W. Bradford Caswell, Maine Geological Survey, Bulletin 39, 135 p. (1)
Sand and Gravel Aquifer Maps (1)

Groundwater and Wells, 2nd edition, 1986, by Fletcher G. Driscoll, Johnson Filtration Systems Inc., St. Paul, MIN, 1108 p. (3)

Wells, private water systems

Groundwater and Wells, 2nd edition, by Fletcher G. Driscoll (3)

Contamination, testing and interpretation

Pilot study-Pesticides in groundwater - Final report, 1989, Maine Geological Survey Open-File Report No. 89-2, 43 p. (1)
Public Health Lab list of tests (2)
Local Extension Educator

Well abandonment

Groundwater and Wells, 2nd edition, 1986, by Fletcher G. Driscoll (3)

Websites:

This link will take you to the Natural Resources Conservation Service (NRCS) Conservation Practice Standards. Here you can find technical guides that are the primary scientific references for NRCS. They contain technical information about the conservation of soil, water, air, and related plant and animal resources.
http://efotg.nrcs.usda.gov/treemenuFS.aspx

One of the best sources of information on chemigation requirements is this web page http://www.cdpr.ca.gov/docs/emon/grndwtr/chem/chemdevices.htm . It also references the EPA pesticide registration notice that shows what must be put on labels for any pesticide that is allowed to be used in an irrigation system (Chemigation) http://www.epa.gov/PR_Notices/pr87-1.html .

Below is a link to “Manual of Best Management Practices for Maine Agriculture” put out by the Maine Department of Agriculture, Food & Rural Resources Division of Animal Health & Industry. January 2007. This resource has links to all the different BMPs that apply to a farm.
http://mainegov-images.informe.org/agriculture/narr/documents/BMPManual2007.pdf

This manual doesn't have any of the actual BMPs written out. It is literally a guide that will lead you to other links. To make things a little easier you will find direct links to BMPs suggested by the manual that pertain to this specific section.

- **Irrigation Water Management – Code 449.** NRCS electronic Field Office Technical Guide
  http://www.nrcs.usda.gov/technical/efotg/

- **Sprinkler Irrigation Systems – Code 442**. NRCS electronic Field Office Technical Guide**,**
  http://www.nrcs.usda.gov/technical/efotg/

- **Trickle Irrigation in the Eastern United States. NRAES – 4,**
  http://www.nraes.org/

- **Agronomy: Soil Quality is Critical Factor in Management of National Resources.** South Jersey RC&D Council, Inc.,
  http://www.sjrcd.org/ag/agronomy.htm

- **National Management Measures for the Control of Non-Point Pollution from Agriculture.** EPA Manual 841-B-03-004.
  http://www.epa.gov/owow/nps/agmm/index.html

- **WIN-PST (Windows Pesticide Screening Tool).** National Water and Climate Center, USDA, NRCS.
  http://www.wsi.nrcs.usda.gov/products/W2Q/pest/winpst.html

- **Chemigation Safety Measures.** University of Minnesota Extension Service.
  http://www.extension.umn.edu/distribution/cropsystems/DC6122.html

- **Chemigation and Fertigation: Anti-Pollution Devices for Irrigation Systems.** North Carolina Department of Agriculture and Consumer Services.
  http://www.ncagr.com/SPCAP/pesticides/chemigation2003.pdf

- **Pesticides and Groundwater: A Guide for the Pesticide User.** NRAES – 34,
  www.nraes.org

Facts on Well water Contaminants from the EPA
http://www.epa.gov/OGWDW/hfacts.html

Title 38: Waters and Navigation Chapter 3: Protection and Improvement of Waters
http://janus.state.me.us/legis/statutes/38/title38ch3sec0.htm

A list of the Major EPA Laws and Programs That Could Affect Agricultural Producers. June, 2007.
http://www.epa.gov/agriculture/agmatrix.pdf

Chemigation equipment and calibration procedures. University of Wyoming cooperative extension service. http://ces.uwyo.edu/PUBS/Wy1023.pdf

Convincing Your Town to Adopt a Wellhead Protection Ordinance

http://www.maine.gov/dhhs/eng/water/Templates/Sections/Source%20Water%20Protection/model%20ord1.htm

What types of land uses have the potential to contaminate groundwater?
http://www.maine.gov/dhhs/eng/water/Templates/Sections/Source%20Water%20Protection/model%20ord5.htm

Prohibited Land Uses
http://www.maine.gov/dhhs/eng/water/Templates/Sections/Source%20Water%20Protection/model%20ord8.htm

Economic Impacts of Groundwater Contamination
http://www.maine.gov/dhhs/eng/water/Templates/Sections/Source%20Water%20Protection/model%20ord4.htm

The Model Ordinance
http://www.maine.gov/dhhs/eng/water/Templates/Sections/Source%20Water%20Protection/model%20ord7.htm

North Dakota State University
http://www.ag.ndsu.nodak.edu/abeng/chemindex.htm

South Dakota State University Cooperative Extension Service
http://agbiopubs.sdstate.edu/articles/FS862.pdf

Virginia Cooperative Extension
http://www.ext.vt.edu/pubs/farmasyst/442-901a/442-901a.pdf

Best management Practices for Groundwater Protection
http://www.maine.gov/dhhs/eng/water/forms/Sections/BMPv2%200A.htm

See "Appendix A: Laws and Regulations" and "Appendix B: Resources" for additional links.

Acknowledgments

Revision Editors of Farm-A-Syst Fact Sheet #11: Megan Wooster, AVSWCD; Susan Gammon, AVSWCD; Andrews Tolman, State of Maine CDC Drinking Water Program. (2008)

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Supplemental information from North Dakota State University Cooperative Extension, South Dakota State University Cooperative Extension, and Virginia Cooperative Extension.