NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE STANDARD

WATER WELL (NUMBER)

CODE 642

DEFINITION

A hole drilled, dug, driven, bored, jetted or otherwise constructed to an aquifer for water supply.

In Montana, excavations and borings 25 feet deep or less are defined as springs and are not included in this standard.

PURPOSE

- Provide water for livestock, wildlife, irrigation, and other agricultural uses
- Facilitate proper use of vegetation, such as keeping animals on rangeland and pastures and away from streams, and providing water for wildlife.

CONDITION WHERE PRACTICE APPLIES

This practice applies on all land uses where the underground supply of water is sufficient in quantity and quality for the intended purpose.

This practice applies only to **new** production water wells **and existing flowing wells**. Specifically excluded are any types of wells installed solely for monitoring or observation purposes, injection wells, and piezometers. The standard does not apply to pumps installed in wells; above ground installations, such as pumping plants, pipelines, and tanks; temporary test wells; and decommissioning of wells (refer to NCPS No. 351, Water Well Decommissioning).

CRITERIA

Laws and Regulations. The investigation, design, or installation of water wells according to this standard shall adhere to all applicable local, State, Tribal, and Federal laws and regulations.

In Montana, the design and construction of water wells and rehabilitation of flowing wells in Montana is regulated by Montana Codes Annotated (MCA) Title 37, Chapter 43, and Administrative Rules of Montana (ARM), Title 36, Chapter 21. This Montana Practice Standard is written to conform to these regulations.

Water well pump criteria can be found in Pumping Plant (Code 533).

Suitability of Site. The availability of groundwater for its intended use at the site shall be determined by using reliable local experience and reviewing all available relevant geologic maps and reports; well records maintained by State and Federal agencies; and design, construction, and maintenance records of nearby wells. An appropriate level of investigation, including test well drilling, is conducted on-site, as needed, prior to well construction to determine site-specific hydrogeologic conditions.

The site shall be suitable for safe operation of the drilling equipment.

Well Head Protection. Wells shall be located at safe distances from potential sources of pollution, including unsealed abandoned wells. The allowable distance shall be based on consideration of site-specific hydrogeologic factors and shall comply with requirements of all applicable local, State, Tribal, or Federal regulations or construction codes. **New wells shall be 50 feet or more from septic tanks, 100 feet or more from drain fields, and 100 feet or more from animal waste storage structures. Montana Department of Environmental Quality (DEQ), Circular 9 specifies a 500-foot separation of new waste storage facilities from existing wells. The larger separation is recommended for new wells.**

NRCS, MT
October 2012

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard contact the Natural Resources Conservation Service.

NOTE: This type of font **(AaBbCcDdEe 123..)** indicates NRCS National Standards.
This type of font (AaBbCcDdEe 123..) indicates Montana Supplement.

Surface runoff and drainage that might reach the wellhead from potential areas of contamination, such as those used by livestock, shall be diverted.

Wells shall be located a safe distance from both overhead and underground utility lines and other safety hazards.

Borehole. Drilled, jetted, bored, and driven wells shall be sufficiently round, straight, and of adequate diameter, to permit satisfactory installation of inlet, well casing, filter pack, and annular seal, and passage of tremie pipe (including couplings), if used.

Use of Casing. Casing shall be installed to seal out undesirable surface or shallow groundwater and to support the side of the hole through unstable earth materials. The intake portion of a well through stable geologic materials may not require casing. **Pumps shall not be installed below the end of the casing. The full length of the hole shall be cased. Casing of wells producing gas shall be vented to the atmosphere in a manner that disperses the gas away from frost pits, surface structures, and any enclosed spaces.**

Casing Diameter. Casing diameter shall be sized to permit satisfactory installation and efficient operation of the pump, and large enough to assure that up-hole velocity is 5 feet per second or less for the designed discharge to protect against excessive head loss.

Materials. Casings may be of steel, iron, stainless steel, copper alloys, plastic, fiberglass, concrete or other material of equivalent strength and durability consistent with the intended use of the water and the maximum anticipated differential head between the inside and outside of the casing, using depth and material tables. **In Montana, outer casing shall be steel and extend a minimum of 18 inches above the local finished ground elevation or at least 18 inches above the local runoff level or established 100-year flood plain elevation and extend to a minimum depth of 18 feet (25 feet for domestic wells). Outer casing on a flood plain may be capped with a watertight seal and be vented above the flood plain elevation. Inner casing may be steel, or Polyvinyl Chloride (PVC) plastic pipe.**

Steel well casings shall meet or exceed requirements specified in ASTM A 589. Steel pipe manufactured for other purposes may be used if the quality of the pipe meets or exceeds requirements specified in ASTM A 589.

Only steel pipe casings shall be used in driven wells.

To prevent galvanic corrosion, dissimilar metals shall not be joined in direct contact.

Plastic casings made of acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) shall conform to material, dimensional and quality requirements specified in ASTM F 480. **In Montana, plastic casing shall be PVC and shall conform to ASTM F 480.**

Filament-wound fiberglass casings (glass-fiber-reinforced-thermosetting-resin pipe, RTRP) may be used if material meets requirements specified in ASTM D 2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM D 2996 are not needed because the pipe is to be used for well casing. Joints shall meet requirements specified in section 3.8, ASTM F 480. **Use of this material is not allowed in Montana.**

Fiberglass pressure pipe (also called reinforced plastic mortar pipe, RPMP, or fiberglass pipe with aggregate) shall meet or exceed requirements specified in ASTM D 3517. **Use of this material is not allowed in Montana.**

Casing Strength. Well casing wall thickness shall be sufficient to withstand all anticipated static and dynamic pressures imposed on the casing during installation, well development and use. Required casing strength shall be determined as shown in NEH, Part 631, Chapter 32, Well Design and Spring Development.

Joint Strength. Joints for well casings shall have adequate strength to carry the load due to the casing length and still be watertight, or shall be mechanically supported during installation to maintain joint integrity. Such mechanically supported casings shall terminate on firm material that can adequately support the casing weight.

Screen. Well screens shall be installed in any aquifer material likely to produce silt or sand. Well screens may be constructed of commercially manufactured screen sections, well points, or field-perforated sections**, depending on aquifer lithology**.

The screen shall be constructed with the slot width determined from aquifer samples. Perforation by any method is allowable provided proper slot size and entrance velocity limits can be met. Screen open areas can range from 1 percent for field-perforated screens to 25 percent or more for continuous wire-wrapped screens. To assure good well efficiency, open areas should be designed to approximate aquifer porosity. High percentages of open area also make well development more effective.

The length and open area of the screen shall be sized to limit entrance velocity of water into the well in order to maximize water yield, while simultaneously preventing sand from being pumped into the well, and preventing screen corrosion and encrustation.

A conservative water well design will have a well screen entrance velocity of about 0.1 foot per second, which has been the common industry standard for many years. The American Water Works Association (AWWA) Standard A-100-06, however, no longer stipulates a maximum screen entrance velocity and cites recent research and testing that indicate that allowable well screen velocities are a function of the aquifer characteristics, the overall well design and intended performance, and the quality of the groundwater being pumped. For the purposes of this standard, the maximum recommended entrance velocity shall be less than or equal to 0.7 foot per second.

Depth of the aquifer below ground surface and the thickness of aquifer to be penetrated by the well shall govern the position of the screen in the well.

Maximum drawdown shall not be permitted below the top of the highest screen or pump intake.

Field perforated casing (saw cut slots, torch cut slots, Mills Knife, etc.) is allowed only for wells completed in stable aquifers composed of clean, coarse gravel or well consolidated rock or rock-like material.

Seals (Packers). Telescoped screen assemblies shall be provided with one or more sand-tight seals between the top of the telescoped screen assembly and casing.

Filter Pack. Installation of a filter pack around the well screen shall be considered under the following conditions: presence of a poorly graded, fine sand aquifer; presence of a highly variable aquifer, such as alternating sand and clay layers; presence of a poorly cemented sandstone or similar aquifer; a requirement for maximum yield from a low-yielding aquifer; and holes drilled by reverse circulation.

Pre-packed Well Screens. For heaving or caving sands, silty or fine-grained aquifers, and for horizontal or angled wells, a commercial pre-packed well screen may be substituted for a conventionally installed (by tremie) filter pack.

Installation. Casing shall extend from **1.5 feet** above the ground surface down **to a minimum depth of 18 feet (25 feet for domestic wells) and shall be made of steel. Surface casing shall extend** through unstable earth materials to an elevation of at least 2 feet into stable material or to the top of the screen.

All wells shall be cased to a sufficient height (minimum of **18** inches) above the ground surface to prevent entry of surface and near-surface water. **No casing is to be cut off below the ground surface except in the case of plugging and abandonment of the well.**

Casing for artesian aquifers shall be sealed into overlying, impermeable formations in such a manner as to retain confining pressure.

If a zone is penetrated that is determined or suspected to contain water of quality unsuitable for the intended use, the zone shall be sealed to prevent infiltration of the poor-quality water into the well and the developed portion of the aquifer.

Water well drillers shall adhere to all State licensing requirements and regulations.

Well Development. Well development shall be performed to repair damage done to the formation by the drilling process, and to alter the physical characteristics of the aquifer surrounding the borehole so that water will flow more freely to the well.

The method of well development used shall be selected based on geologic character of the aquifer, type of drilling rig, and type of screen.

Aquifer Development. For massive, un-fractured rock that is unresponsive to well development procedures, the use of aquifer stimulation techniques may be considered to improve well

efficiency and specific capacity. Techniques may include dry ice, acidizing, explosives, or hydro-fracturing, depending on the composition and structure of the formation.

Grouting and Sealing. The annulus surrounding the permanent well casing at the upper terminus of the well shall be filled with mortar containing expansive hydraulic cement (ASTM C 845), bentonite-based grout, or bentonite chips and pellets, in accordance with State requirements. The length of the grout seal shall be no less than 10 feet and not less than the minimum specified in state or locally applicable construction codes. **Montana regulations specify a minimum of 18 feet (25 feet for domestic wells).**

The casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions from the outside of the casing to prevent contamination. The slab shall slope away from well.

A positive seal (grouted in place) or packer shall be provided between the casing and the less pervious material overlying the aquifer of artesian wells, and in all aquifers where co-mingling of waters is undesirable.

Access Port. An access port with a minimum diameter of 0.5 inch shall be installed to allow for unobstructed measurement of depth of the water surface, or for a pressure gage for measuring shut-in pressure of a flowing well. Access ports and pressure gages or other openings in the cover shall be sealed or capped to prevent entrance of surface water or foreign material into the well. Removable caps are acceptable as access ports.

Disinfection. Wells shall be disinfected immediately following their construction or repair to neutralize any contamination from equipment, material, or surface drainage introduced during construction. The disinfection process shall comply with all Local or State requirements. **For wells that might be used for domestic purposes, a back flow prevention device shall be placed in the delivery system to prevent contamination of the well/aquifer (see NEM, Part 503, Subpart A).**

Water Quality Testing. Sampling and testing shall comply with all applicable Federal, State and Local requirements. These requirements vary according to the water quality parameters associated with the intended use(s) of the water.

Production: Wells shall include provisions for the conservation of groundwater and other natural resources (flowing wells will be controlled by valves, pumped wells will be controlled by float valves or timers, etc.). Flowing wells with valves shall be protected from freezing.

Rehabilitation of Existing Wells. There are many existing flowing wells that require rehabilitation to protect and conserve natural resources. These wells commonly have no or inoperable control valves and/or leaking casing. Design and installation of rehabilitation procedures must be done by a Montana Licensed Water Well Contractor.

CONSIDERATIONS

The potential for adverse interference with existing nearby production wells should be evaluated in planning and designing the water well.

The potential for groundwater overdraft and the long-term safe yield of the aquifer should be considered in planning.

If practicable, wells shall be located in higher ground and up-gradient from sources of surface contamination or flooding. In determining gradient, both pumped and un-pumped conditions should be considered.

Potential effects of installation and operation of the well on cultural, historical, archeological, or scientific resources at or near the site should be considered in planning.

Fencing of the well and associated equipment should be considered to prevent contamination and damage by wildlife, livestock, or human activity.

Some important aquifers in Montana produce various gasses. Formations known to produce gasses include the Fort Union Formation, Judith River Formation, Eagle Sandstone, and Kootenai Formation. These gasses may be toxic (hydrogen sulfide), explosive (methane), or asphixiants (carbon dioxide, nitrogen). Wells producing gasses need to be vented to the atmosphere from the casing and/or production tubing. The vent shall be at an elevation above ground level sufficient to disperse the gas in a non-hazardous manner, 8 feet above the ground surface is recommended. Wells producing more than 2 cubic feet of gas per minute should not be

developed for use as stock water wells. Vents shall be terminated with a close return and screened to exclude animals and debris.

Some shallow wells in gravel aquifers may inhale and exhale due to varying atmospheric pressure. These wells will also require ventilation above ground level and outside of structures.

Frost Pits. Frost pits shall not be placed around a well. Frost pit shall be placed a minimum of 25 feet from a well and the connecting trench filled with thoroughly compacted clay soil.

Frost pits (valve pits, man holes, etc.) are not recommended for use with flowing wells or wells that produce gases. Frost pits are not recommended for other wells and pipelines. Frost pits can be a confined space as defined by OSHA and require special entry procedures not commonly practiced by inexperienced and non-qualified personnel. Frost pits can be hazardous due to the accumulation of flammable and/or asphyxiating gases from certain geological formations. They also facilitate the entry of contamination into the well and aquifer, and they may provide exposure to electrical and biological hazards. It is recommended that variable-speed pumps, pitless adapters, pump houses, direct burial tanks, street valves, and other direct burial devices be used instead of pits. Closed cell foam, pressurized rubber bladder inserts, or vegetable oil filling can be used to protect flowing well heads from frost damage to casing.

If frost pits are used, several options are available to reduce the risks involved. Pits shall be installed 25-50 feet from the well. Air release, three-way valves, and ventilation pipes can be installed between the well and the pit to reduce the potential for gases to migrate from the well bore to the pit. A well compacted length of trench installed between the vent/well head and the pit will restrict the flow path of leaking gases. Fans or compressed air can be used to ventilate the pit prior to entry. Various types of air analysis devices can be used to test air quality in pits prior to entry. Spark-proof switches are available for use with wells that could produce combustible gases.

Entry ladders should be permanently mounted to the side of the pit and have vertical grab bars that extend at least 42 inches above the lip of the entry opening. Pits should be mouse proof to reduce Hanta Virus exposure and to avoid trapping other wildlife. Close inspection of the pit should be made prior to entry to check for spiders, centipedes, scorpions, or other venomous animals.

The top of the pit walls should extend at least 18 inches above the local ground surface or flooding surface, whichever is greater, to reduce the potential for flooding of the pit by runoff. Sections of trenches adjacent to the pit should be well compacted to reduce the potential for surface runoff to follow the trench into the pit and cause flooding.

If the frost pit is placed around the well, the casing must extend 18 inches above the local ground surface or local flooding surface. Waterproof electrical equipment can be used to reduce the electrical shock hazard. The lid or closure should be strong enough to resist accidental traffic by domestic and wild animals. Do not install frost pits in areas of permanent or seasonal high water tables.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses. A record of the installation of this practice shall be made and shall include the following information:

- Location of the water well by Global Positioning System, latitude/longitude, township/range, or other georeferencing convention, of such precision that it can be readily re-located
- Date of completion of the water well
- Name of landowner
- Name, title, and address of person responsible for the water well
- Total depth of the water well
- Length of casing and screening
- Inside diameter of well bore or casing
- Type of casing material or schedule (e.g., standard weight steel, or PVC sch-80)
- Static water level measured from ground surface
- Water chemistry before and after disinfection.

All water wells and rehabilitation procedures for existing flowing wells are to be completed in accordance with the above noted Montana State regulations (ARM and MCA) and as local practices and the water well contractor's experience indicates. Water Well Contractors are licensed professionals, designated by the State of Montana to be qualified to design and construct water wells and rehabilitate existing flowing wells in accordance with Montana State regulations. No one else is authorized to do so.

OPERATION AND MAINTENANCE

A plan for maintenance of a water well shall be prepared. The well construction records shall be kept on file with the maintenance plan by the owner/operator. As a minimum, the plan shall include a statement of identified problems, corrective action taken, date, and specific capacity (yield per unit drawdown) of water well before and after corrective action was taken. **If wells fail to perform as indicated by the water well contractor, it is the operator's responsibility to contact the water well contractor to properly address the problems. If the water well contractor fails to correct any deficiencies, then the State Board of Water Well Contractors is authorized to perform the appropriate work at the contractor's expense.**

MONTANA REGULATIONS

Water well installation is regulated by the Board of Water Well Contractors under Title 37, Chapter 43, Montana Codes Annotated and Title 36, Chapter 21, Administrative Rules of Montana. These regulations stipulate who can design and construct water wells. Water well contractors are tested, licensed, and bonded by the State of Montana to insure compliance with State regulations and to protect the consumer from improper well design and construction practices. Appropriate well designs are included in the above noted regulations; see Title 36, Chapter 21, ARM. State regulations, licensing procedures, and bonding provide adequate protection for groundwater resources and the consumer so that further design stipulations are not required by the NRCS.

Concerning the availability of additional appropriations of groundwater, if anticipated well yield is greater than 35 gpm, or if the proposed well site is within a Controlled Ground Water Area, or if the annual use rate exceeds 10 acre feet, the land owner must apply for and receive a "Permit to Appropriate Water", Form 600, from the Montana DNRC Water Rights Regional Office before site investigations or drilling begins.

A Notice of completion of Groundwater Development, DNRC Form 602, shall be completed and filed with the Montana Department of Natural Resources (DNRC).

REFERENCES

National Engineering Handbook (NEH), Part 631, Chapter 32, Well Design and Spring Development

Electronic Field Office Technical Guide (eFOTG), Section IV,
http://efotg.sc.egov.usda.gov/treemenuFS.aspx

Administrative Rules of Montana, Title 36, Chapter 21
http://mtrules.org/gateway/ChapterHome.asp?Chapter=36%2E21

Montana Codes Annotated, Title 37, Chapter 43,
http://data.opi.mt.gov/bills/mca_toc/37_43.htm

Department Circular DEQ 9, Montana Technical Standards for Concentrated Animal Feeding Operations, Montana Department of Environmental Quality, Feb. 2006, 116 pages
Montana Department of Natural Resources, DNRC Water Resources Division, Water Rights Forms:
http://dnrc.mt.gov/wrd/water_rts/wr_general_info/wrforms/wr_forms.asp