

REGULATIONS AND INSTRUCTIONS

PART III



WATER WELL MINIMUM CONSTRUCTION STANDARDS

**CHEYENNE, WYOMING
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PART III

WATER WELL MINIMUM CONSTRUCTION STANDARDS

CHAPTER 1

PURPOSE

Section 1: Purpose and Scope.

(a) The State Engineer, having general supervision of the waters of the state, is authorized under Section 41-3-909 of the Wyoming Statutes to establish standards for construction of water wells to protect the use of the state's ground water resources. The enactment of federal and state environmental quality law and fostering of safe and clean water policy has prompted enhanced well head protection measures against contamination of ground water resources.

(b) Every well constructed or repaired with a withdrawal of well casing after the adoption of these standards must comply with them. Any deviation from these standards must be approved in writing by the State Engineer or his designee.

(c) It is the joint responsibility of the drilling and/or pump contractor(s) and well owners(s) to comply with these standards. Further, the well owner(s) must maintain a well in a condition so that it does not contribute to contamination (pollution) of the ground water supply.

(d) If compliance with these Water Well Minimum Construction Standards will not result in a well that is sufficiently sealed from either surface or subsurface contamination, then the drilling and/or pump contractor(s) and well owner(s) must use additional safeguards to protect the ground water supply and its users.

(e) Any waiver or variance to these Water Well Minimum Construction Standards can only be obtained by applying for the waiver or variance to the State Engineer in writing. The waiver or variance application shall state the nature of the waiver or variance and the reasons why the waiver or variance will not result in a well that will have a detrimental effect on the ground water resource.

(f) Other state and local regulations pertaining to well drilling and construction, ground water protection, and water quality regulations may exist that are either more stringent than these rules or that apply to a specific situation. It is the well driller's responsibility to understand and apply other regulations as applicable.

(g) Well owners and drillers are advised that local zoning ordinances or county board of health requirements may limit or restrict the actual well location, construction, and/or relationship to property/structure boundaries and existing or proposed concentrated sources of pollution or contamination such as septic tanks, drain fields, sewer lines, stock corrals, feed lots, etc., beyond the requirements of these standards.

(h) Well owners and drillers are advised that standards developed under Wyoming State Law, Title 37, Chapter 12, Article 3 (Damage to Underground Public Utility Facilities) apply.

(i) Well owners and drillers are advised that the State Engineer's Office maintains reporting requirements with regard to certain stages of well completion. These requirements are addressed in the Wyoming State Engineer's Office Part II Rules.

Section 2. Authority.

(a) The State Engineer has the authority to establish standards for the construction of wells. Pursuant to W.S. §41-3-909 (a)(vi) and the Wyoming Administrative Procedures Act; the State Engineer hereby adopts the following Water Well Minimum Construction Standards. Every well constructed after the adoption of these standards must be in compliance with these standards. Deviations from these standards must be approved by the State Engineer.

CHAPTER 2

REQUIREMENTS AND DEFINITIONS

Section 1: Statutory Requirements.

(a) “Any person who intends to acquire the right to beneficial use of any underground water in the state of Wyoming, shall, before commencing construction of any well or other means of obtaining underground water or performing any work in connection with construction or proposed appropriation of underground water or any manner utilizing the water for beneficial purposes, file with the state engineer an application for a permit to make the appropriation and shall not proceed with any construction or work until a permit is granted by the state engineer...” (W.S. §41-3-930)

(b) “An appropriator of underground water may change the location of his well to a point within the same aquifer in the vicinity of the original location, without loss of priority, by securing approval of the state board of control if the groundwater right has been adjudicated or if the groundwater right has not been adjudicated but the water has been applied to beneficial use. In cases involving domestic or stock water wells which are not adjudicated but the water has been applied to beneficial use, the state engineer may approve a change of location. If the right is not adjudicated and the water has not been applied to beneficial use, approval for the change in location may be granted by the state engineer.” (see W.S. §41-3-917(a))

(c) “It shall be unlawful for any person to construct, alter or rehabilitate a water well or install pumping equipment in a water well without a license as provided by [W.S. §33-42-101 through 33-42-117] unless the activity is exempted from the licensing requirements of [W.S. §33-42-101 through 33-42-117].” (W.S. §33-42-103(f))

(d) “Any person who drills, digs or constructs any works for the securing of underground water without having obtained a permit is guilty of a misdemeanor and upon conviction shall be punished under W.S. §41-3-616.” (W.S. §41-3-938)

(e) “Any person who withdraws underground water or who fails to stop or reduce the flow of underground water in violation of any order of the state engineer made pursuant to this act, or any person who does not have a permit, certificate or vested right to appropriate underground water who shall withdraw underground water from any well other than a well for stock or domestic purposes as defined in W.S. §41-3-907, is guilty of a misdemeanor and upon conviction shall be punished under W.S. §41-3-616.” (W.S. §41-3-919)

(f) “[T]he state engineer is authorized and empowered on advice and consent of the board of control... [t]o require the abatement of any condition, or the sealing of any well, responsible for the admission of polluting materials into an underground water supply.” (W.S. §41-3-909(a))

Section 2: Definitions. For the purposes of Part III of the Regulations and Instructions of the Wyoming State Engineer's Office – Ground Water Division, the following definitions apply:

(a) ACCESS PORT – An opening at the wellhead and/or within the discharge system where measuring devices or meters may be placed to measure water levels, pressure, or discharge.

(b) ACRE-FOOT – The volume of water required to cover one (1) acre to a depth of one (1) foot. One (1) acre-foot equals approximately 325,851 U.S. Gallons.

(c) AIR-HAMMER DRILLING – A system of drilling that employs a pneumatic bit that delivers percussion strikes to the formation while being slowly rotated. Cuttings are removed by the compressed air that drives the hammer bit.

(d) ALLUVIUM – Deposits resulting from the operations of rivers, streams, etc., thus including sediments laid down in riverbeds, flood plains, lakes, fans at the foot of mountain slopes, and estuaries.

(e) ANNULAR SPACE (ANNULUS) – The space between two cylindrical surfaces, one of which surrounds the other, e.g. concentrically; such as the space between the outer well casing and the borehole wall. An annular space also means the space between an inner well casing and outer well casing. The annular space is calculated as the difference in diameter of the borehole (D_b) and the outside diameter of the casing (D_c) divided by two $[(D_b - D_c)/2]$, or the difference in the inside diameter of a larger casing (D_l) and the outside diameter of a smaller casing (D_s) divided by 2 $[(D_l - D_s)/2]$.

(f) AQUIFER – “[A]ny underground geological structure or formation having boundaries that may be ascertained or reasonably inferred, in which water stands, flows or percolates.” (W.S. §41-3-901(a)(iii)). (*Also see Unconfined, Confined and Perched*)

(g) API – The American Petroleum Institute.

(h) ARTESIAN AQUIFER – See Confined Aquifer.

(i) ARTESIAN WELL – A well that derives its water from an artesian or confined aquifer where the hydrostatic pressure is greater than atmospheric pressure thereby raising the water level above the top of the aquifer. A flowing artesian well has a water level that is above the land surface.

(j) ASTM – American Society for Testing and Materials International.

(k) AWWA – The American Water Works Association

(l) BENTONITE – Clay composed predominantly of the clay mineral montmorillonite and used commercially in drilling fluids and well sealing products.

(m) **BOREHOLE LOGS** – Borehole logs measure and display the physical properties of the surrounding medium with a sensor located in a borehole. Some common borehole logging techniques are presented below:

(i) **Acoustic (Sonic) Velocity** – A borehole log in which the down-hole tooling has a sound transmitter at one end and two receivers spaced along it. The tool uses the difference in signal arrival time to calculate the sonic velocity through the strata.

(ii) **Caliper** – A borehole log which measures the size of the well bore. Used to measure the diameter of an uncased borehole in bedrock units. Can also be used to find the casing depth.

(iii) **Cement Bond (Bond)** – An acoustic log that measures and displays the return arrival time of an acoustic wave generated within the casing. When steel casing is strongly bonded to cement, most of the energy of the wave is carried through the casing; however, when the casing is not strongly bonded to the cement, most of the sound waves are carried along the casing and the arrival time will be much shorter.

(iv) **Focused (Focus)** – A borehole log wherein electrodes are designed to direct electrical current as a disk. This method can yield improved results in high resistivity strata.

(v) **Formation Density (Density)** – A borehole log which measures the rock density.

(vi) **Gamma-Gamma Radiation** – A borehole log in which a source of gamma radiation and a detector are lowered into the borehole. The log measures bulk density of the formation and fluids.

(vii) **Gamma-Ray (or Gamma)** – A borehole log which measures naturally occurring gamma radiation emitted by the surrounding strata.

(viii) **Induction (or Dual Induction)** – A borehole log which measures spontaneous potential, resistivity, and conductivity.

(ix) **Neutron Porosity (Neutron)** – A borehole log obtained by lowering a radioactive element, which is a source of neutrons, and a neutron detector into the well. The log measures the hydrogen atom density of the surrounding strata and provides an indication of the formation porosity.

(x) **Resistivity** – A borehole log which measures the resistivity between two current electrodes and two additional electrodes. Measures the electrical resistivity of the formation and contained fluids near the probe.

(xi) **Spontaneous Potential (or Self Potential) (SP)** – A borehole log made by measuring the natural electrical potential that develops between the formation and the

borehole fluids. The SP log is commonly used to assess the permeability of the surrounding strata.

(n) CABLE-TOOL DRILLING – A drilling technique which is operated by repeatedly lifting and dropping a heavy drilling string and drilling bit which pulverizes the encountered material.

(o) CASCADING WATER – Ground water which trickles or pours through cracks (or other openings), down the cased or uncased borehole above the water level in the well.

(p) CASING – Any conduit or pipe placed in a well to prevent borehole wall caving, to protect the production string and pump, and to prevent pollution of the well. Casing material is most commonly steel, PVC, or concrete.

(q) CEMENT BASKET – A device firmly attached to the casing string that is designed to tightly fit against the borehole wall that is intended to hold cement above a desired zone.

(r) CENTRALIZER – A device attached to the outside of a casing or liner to center it within a borehole or casing.

(s) COLLUVIUM – Loose rock and soil at the base of a cliff or steep slope.

(t) CONFINED (ARTESIAN) AQUIFER – An aquifer bounded above and below by confining units (or beds) and in which water levels in wells rise above the top of the aquifer.

(u) CONFINING FORMATION (CONFINING UNIT) – A geologic bed which displays a significantly lower vertical hydraulic conductivity than an adjacent aquifer.

(v) CONSOLIDATED – Combined or cemented into a single or solid mass; or lithified (e.g. bedrock formation).

(w) CONSTRUCTION – “[I]ncludes boring, drilling, jetting, digging or excavating, and installing casing, pump and other devices withdrawing or facilitating the withdrawal of underground water, or measuring the depth to the water table or flow of the well.” (W.S. §41-3-901(a)(v)).

(x) CONTAMINANT – Any material responsible for or contributing to pollution. See POLLUTION.

(y) CUBIC FEET PER SECOND (CFS) – A rate of flow. One (1) cfs equals 448.8 gpm.

(z) DEVELOPMENT – Cleansing of the drilled hole and formation to remove cuttings, fine grained materials, infiltrated drilling fluids, and/or to enhance aquifer

permeability. Development can be accomplished by surging, backwashing, jetting, airlifting, acid-fracture treatment, etc.

(aa) DRILLER – See WATER WELL DRILLING CONTRACTOR.

(bb) DRILLING MUD – A viscous liquid suspension, usually composed of water and a bentonite-based mixture, which is pumped through the drill stem to equalize formation pressures, lubricate and cool the drilling bit, and/or aid in removing drill cuttings to the surface.

(cc) DRILL PIPE (DRILL STEM) – Thick walled pipe used for drilling operations. Transmits rotation from the rotating mechanism on the drill rig to the bit. Drill collar, extremely heavy drill pipe, is usually placed in the drill pipe string just above the bit to provide extra weight and strength.

(dd) DRILLING RIG – The derrick, mast, or standing apparatus together with the power equipment, pumps, cable and tools used in well drilling. Usually truck-mounted or trailer mounted.

(ee) DRIVE POINT – A conical shaped point of steel placed at the bottom of a driven well's screen to aid in placing the screen at the desired depth.

(ff) DRIVE SHOE – A section of steel casing attached to the bottom of a driven casing. The drive shoe has a beveled edge and is designed for cutting through rock or other hard formations.

(gg) DRIVEN WELL – A well which is emplaced by forcefully driving a casing into the ground (usually deep soil or alluvial material). The leading end of the casing is usually fitted with a drive point.

(hh) DUG WELL – A large diameter well or trench constructed by digging down and intercepting the water table or shallowest water-bearing horizon.

(ii) FILTER (GRAVEL) PACK – Clean sand or gravel sized according to formation texture and emplaced in the annular space of a well between the perforated or screened interval(s) of the casing and the borehole wall in order to prohibit or decrease the entrance of formation material into the well, stabilize the borehole, and increase the efficiency of water production.

(jj) FLOWING WELL – An artesian well in which the water level stands above the land surface.

(kk) FORMATION – a body of rock or soil which has identifiable and distinctive lithic characteristics, is aerially extensive, can be mapped, and may be combined into groups or divided into members.

(ll) GALLONS PER MINUTE (GPM) – Unit of measure used to describe a flow rate.

(mm) GEL – A jelly-like fluid and colloidal material (natural or synthetic) dispersion mixture used as a drilling fluid.

(nn) GROUND (UNDERGROUND) WATER – “[A]ny water, including hot water and geothermal steam, under the surface of the land or bed of any stream, lake, reservoir, or other body of surface water, including water that has been exposed to the surface by an excavation such as a pit.” (W.S. §41-3-901(a)(ii)).

(oo) GROUT – A fluid mixture of water plus a cement-based or bentonite-based material that is stable, has low permeability, and possesses minimum shrinking properties such that it is an optimal sealing material for well casing or for well plugging.

(pp) HEAT PUMP WELL – Any well constructed to utilize the heat exchange properties of either ground water or of geological material penetrated in the well.

(qq) HYDROSTATIC PRESSURE OR HEAD – Pressure of water (or other liquid) upon a unit area due to the height at which the surface of the water column stands above the point where the pressure is measured. Expressed as pounds per square inch (p.s.i.) or actual feet of head.

(rr) LINER – Pipe (steel or plastic), which is smaller in diameter than installed well casing, that is used to reconstruct (deepen) a well or strengthen unstable conditions encountered at depth in a well.

(ss) LINER HANGER – A device used to attach or hang liners from the internal wall of a larger, upper casing string.

(tt) LOST CIRCULATION – Subsurface escape of drilling fluid from a drill hole into a porous, fractured, or cavernous formation.

(uu) LCM (LOST CIRCULATION MATERIAL) – Material added to drilling fluid in order to reduce or stop lost circulation conditions.

(vv) MILLIGRAMS PER LITER – Abbreviated mg/l, means milligrams of solute per liter of solvent.

(ww) MONITORING WELL – A ground water level observation well or a well from which water samples are retrieved for water chemistry analysis.

(xx) NEAT CEMENT – Used for ground or borehole sealing. Commonly known as Portland cement of various ASTM designations (Type I through Type V, Type K, etc.). May be mixed with calcium chloride (CaCl₂) for rapid set time or bentonite for lower conductivity, lower curing temperature, and resistance to shrinking/cracking.

(yy) NSF – NSF International, formerly National Sanitation Foundation.

(zz) NOMINAL SIZE – Used to describe standard sizes for pipe from 1/8 inch to 12 inches. The term “nominal” is used in designating the inside diameter of the pipe, because, in practice, the actual size varies somewhat.

(aaa) PACKER – A device used to seal or isolate. In the case of a telescoped casing and screen assembly, a packer is used to provide a sand-tight seal between the screened assembly and the casing. An inflatable packer is used to isolate zones of the casing or borehole for tests or casing repairs.

(bbb) PERCHED AQUIFER – Unconfined ground water which is bounded below by low-permeability material and separated from an underlying regional body of ground water by an unsaturated zone.

(ccc) PERFORATIONS – Puncturing, drilling, sawing, slotting, torchcutting, or other openings of a well casing emplaced in order to allow flow of water from the water-bearing interval(s) into a cased well. Perforations are typically installed with revolving wheel cutters, knives, or explosive charges and are created after the casing has been placed in the borehole.

(ddd) PERMEABILITY – A measure of the ability of a material to transmit fluids.

(eee) PERMIT – The record instrument on which the State Engineer grants permission to construct a well/spring and beneficially use the water for the purposes specified, together with any conditions and limitations attached.

(fff) PIEZOMETER – A nonpumping well, generally of small diameter, that is used to measure the pore pressures, water levels, or potentials. A piezometer generally has a short well screen through which water can enter.

(ggg) PITLESS ADAPTOR – A commercially manufactured, watertight unit or device designed for attachment to well casing which permits discharge from the well below the land surface to provide for a buried, frost-free discharge line.

(hhh) PLUGGED AND ABANDONED WELL (P&A) – Any well which has been filled or plugged so that it is rendered unproductive and prevents contamination of the ground water. A properly abandoned well will not produce water nor serve as a channel for movement of water or other material from the well or between water-bearing zones.

(iii) POLLUTION – “[A]ny impairment of the natural quality of such water, however caused, including impairment by salines, minerals, industrial wastes, domestic wastes or sewage, whether indrafted directly or through infiltration into the underground water supply.” (W.S. §41-3-901(a)(vi))

(jjj) POROSITY – The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment. Effective Porosity – the volume of the void

spaces through which water or other fluids can travel in a rock or sediment divided by the total volume of the rock or sediment. Primary porosity is the porosity that represents the original pore openings when a rock or sediment formed. Secondary porosity is the porosity that has been caused by fractures or weathering in a rock or sediment after it has been formed.

(kkk) POTENTIOMETRIC SURFACE – A surface that represents the level to which water will rise in tightly cased wells.

(lll) PRESSURE GROUTING – A process by which a grout is emplaced and confined within the borehole or casing of a well by the use of retaining plugs, packers, or a displacing fluid by which sufficient pressure is applied to drive the grout into and within the annular space or interval to be grouted.

(mmm)PUMP INSTALLER – See WATER WELL PUMP INSTALLATION CONTRACTOR.

(nnn) PUMP TEST – Pumping a well, usually at time of completion, to determine aquifer or well performance (e.g., drawdown, maximum efficient gpm, specific capacity, etc.).

(ooo) PUMPING WATER LEVEL – The water level achieved, during water well pumping, where the drawdown ceases or stabilizes.

(ppp) PVC CASING OR SCREEN – Polyvinyl chloride polymer (plastic) pipe.

(qqq) RECOVERY WELL – A well primarily designed to remove contaminants, groundwater, or both, usually in an attempt to contain contaminants or contaminated groundwater to an area already effected.

(rrr) REHABILITATION – Restoring a well to its most efficient condition. This may be accomplished by chemical and mechanical methods.

(sss) ROTARY DRILLING – Drilling technique which employs a rotating drill string through which drilling mud is pumped down hole to cool the drill bit and remove cuttings to the surface via the borehole outside the drill pipe. Compressed air is also used, in lieu of drilling fluid, to remove cuttings. Reverse circulation rotary drilling is a method in which drilling fluid flows from the ground surface down the borehole and is pumped back to the ground surface through the drill pipe. The reverse rotary method can be effective for drilling large diameter boreholes and for drilling in unstable material.

(ttt) SANITARY WELL CAP (SEAL) – A vented watertight wellhead cap that prevents the intrusion of foreign fluids (runoff, chemical liquids, animal waste, etc.) or debris.

(uuu) SATURATED – All voids are filled with water.

(vvv) SHALE BASKET – A device firmly attached to the casing string designed to tightly fit against the borehole wall that is intended to prevent materials from falling into the intervals below the shale basket setting.

(www) SLIM HOLE – A small diameter exploration borehole drilled to obtain stratigraphic or structural information.

(xxx) SPRING – A point location where ground water emanates from bedrock or soil to the land surface.

(yyy) SQUEEZE JOB – Usually a secondary cementing or grouting process where the sealant is pumped into a borehole through the bottom of the casing or through perforations at key depths in the casing in order to obtain fluid or formation shut off.

(zzz) STATE ENGINEER – The State Engineer or his designee.

(aaaa) STATIC WATER LEVEL – (1) The elevation or level of the water in a well when the pump is not operating. Usually measured in depth below the land surface or from the top of the casing. (2) The level or elevation to which water would rise in a tube connected to an artesian aquifer when the well is shut in. Usually measured in psi or feet above ground level.

(bbbb) SURFACE (CONDUCTOR) CASING – Retaining pipe, usually large diameter steel, concrete or culvert material installed in the uppermost portion of the well between the borehole wall and the inner well casing.

(cccc) SURFACTANT – An agent that reduces the surface tension of the liquid in which it is dissolved. Used in air-based drilling to produce foam and during development to disaggregate clays.

(dddd) TREMIE PIPE (GROUT PIPE) – A small diameter conductor pipe, hose or tubing used in down hole placement of well construction material (cement, grout mixture, gravel pack, etc.).

(eeee) UNCONFINED (WATER TABLE) AQUIFER – An aquifer that has no overlying geologic unit preventing or restricting the vertical or upward movement of water.

(ffff) UNCONSOLIDATED – A loose aggregation or not combined nor cemented into a single or solid mass; or unconsolidated deposit (e.g., alluvium).

(gggg) WATER TABLE – The water surface of an unconfined aquifer.

(hhhh) WATER WELL DRILLING CONTRACTOR (DRILLER) – “[A]ny person responsible for or causing the construction, equipping, test pumping or development of any water well for compensation or otherwise as provided by [W.S. §33-42-101 through 33-42-117].” (W.S. §33-42-102 (a)(iii))

(iii) WATER WELL PUMP INSTALLATION CONTRACTOR (PUMP INSTALLER) – “[A]ny person who is in the business of installing pumping equipment in water wells for compensation or otherwise as provided by [W.S. §33-42-101 through 33-42-117].” (W.S. §33-42-102 (a)(iv))

(jjjj) WELL – “[A]ny artificial opening or excavation in the ground, however made, by which underground water is sought or through which it flows under natural pressure or is artificially withdrawn, and a series of wells developed as a unit and pumped collectively by a single pumping unit shall be considered as one (1) well.” W.S. §41-3-901(a)(iv) “[A]ny artificial opening in the ground for the production of groundwater or the disposal of water underground, including developed springs, test wells, monitoring wells, deep well ground beds (cathodic protection bores), geothermal or heat exchange wells, drive points and excavations for the purpose of artificial recharge to the groundwater bodies or disposal of wastes. The term "well" does not include excavations made for the dewatering of construction sites, mines or oil and gas wells, and the prospecting for and removal of mineral products, nor wells for the production of the media for secondary oil recovery.” (W.S. §33-42-102(a)(v))

For the purpose of this document, the following well types are described:

- (i) Type I – Dug Wells
- (ii) Type II – Natural Filter Wells
- (iii) Type III - Artificial Filter Wells
- (iv) Type IV – Partially-Cased Open Borehole Wells
- (v) Type V – Fully-Cased Wells
- (vi) Type VI – Conversion of Existing Oil or Gas Wells, or Exploration Test Wells into Water Wells

(kkkk) WELL (DRILL HOLE) CUTTINGS – Rock chips or particles cut by the action of the drill bit and removed from the hole. Cutting samples collected and identified at evenly spaced intervals provide a lithologic log (detailed description of rock material encountered in the drill hole).

(llll) WELL SCREEN – A commercially manufactured structurally supporting filter device that allows inflow, retains select material, and is the access for aquifer development and future aquifer maintenance. Screen may be continuous-slot wire-wrapped, pre-packed, louvered, or bridge-slotted or any other commercially manufactured product which is produced for the purpose of water well screening.

CHAPTER 3

WELL CONSTRUCTION

Section 1: Water Well Siting.

(a) General Considerations.

(i) All wells shall be sited and constructed in such a manner that the well does not act as a conduit for the transmission of contaminants from either above or below ground to the ground water resource. All restriction and setback distances contained in this section are intended for production wells and do not necessarily apply (but does not constitute exemption) to choice of location for monitor wells, test wells, dewatering wells, recovery wells, or oil and/or gas wells which produce by-product water.

(b) Relation to Land Surface.

(i) Water wells shall be located such that there is adequate surface drainage away from the well and situated such that the well is easily accessed for repairs, maintenance, and inspection. For all wells, the top of the casing shall extend at least 18 inches above the finished land surface grade. Well casing may not be terminated at or near the base of underground well vaults or placed in basements. In the special case of ground water monitor wells constructed flush with the land surface, the wells shall be capped with an impact-resistant and water-proof cap.

(c) Relation to Property Lines.

(i) Every well shall be located at least 10 lateral feet from any property line or boundary.

(d) Relation to Buildings, Structures and Overhead Obstructions.

(i) When a well is proposed to be located adjacent to a building or any other standing structure, it shall be placed to be as accessible as may be necessary. The well shall be placed such that the building or any overhead projection from the building will not be within a 10-foot radius of the surface casing. The well owner is responsible for maintaining adequate spacing and access following construction.

(ii) Where overhead utility lines or other overhead obstructions are present, minimum distances from all equipment shall be maintained in accordance with OSHA standards.

(e) Setback Distances from Contaminant Sources.

(i) Water wells shall be located the minimum lateral distance from any common pollutant sources listed below:

| SOURCE | MINIMUM DISTANCE TO WELL |
|----------------------------|--------------------------|
| Livestock Containment Pens | 50 feet |
| Livestock Sewage Lagoons | 50 feet |
| Sewer | 50 feet |
| Septic Tank | 50 feet |
| Disposal (Leach) Field | 100 feet |

(ii) Beyond minimum distances, an attempt shall be made to locate the well upgradient from contaminant sources.

Section 2: Water Well Construction.

(a) The driller or person/entity engaged in construction of a water well shall have in their possession, at the well site, a copy of the approved permit or the permit number.

(b) Knowledge of the properties and depth of the producing aquifer zone, the nature of the overlying formations, and the proposed use of the well will dictate the type of construction required. The following described well types are established:

(i) Type I – Dug Wells – Dug wells are excavations that penetrate from the ground surface down to the first-encountered aquifer. Dug wells are usually simple pits, elongate trenches, or large diameter, lined shafts constructed by hand or using excavating machinery (e.g., a backhoe). A typical construction diagram for Type I wells is illustrated in Appendix C-1.

(ii) Type II – Natural Filter Wells – Natural Filter Wells are constructed to obtain water at various depths from unconsolidated alluvial/colluvial deposits or severely weathered rock material that can be effectively stabilized and developed after placement of perforated casing or well screen. Wells of this type are usually completed into an unconfined aquifer (confined, perched conditions may be encountered) and may be dug or constructed by jetting, boring, driving, drilling, or a combination of methods. Horizontal wells that drain water from very coarse sand and gravel-sized material and often located near streams are considered Natural Filter Wells. A typical construction diagram for Type II wells is illustrated in Appendix C-2.

(iii) Type III - Artificial Filter Wells – Artificial Filter Wells are also referred to as “gravel pack,” “sand pack,” or “filter pack” wells. This type of well is designed to obtain water from unconsolidated to poorly consolidated deposits or bedrock formations by placing filter pack in the annulus, opposite the completion interval. The filter pack (or material contained in “channel pack” well screen) acts as a formation

stabilizer, a filter to prevent fine-grained material from entering the well, and also serves to increase the yield of the well. This type of well is constructed by boring or drilling. A typical construction diagram for Type III wells is illustrated in Appendix C-3.

(iv) Type IV – Partially-Cased Open Borehole Wells – Partially-Cased Open Borehole Wells are also referred to as “open-hole” wells. This type of well is designed to obtain water from consolidated formations that are stable enough to preclude the need for perforated casing or well screen. Overlying formations, however, are cased and sealed to prevent caving and cross-connection of water from vertically separate aquifers. Flowing wells are commonly the result of this type of well construction when head elevation is greater than ground surface elevation. A typical construction diagram for Type IV wells is illustrated in Appendix C-4.

(v) Type V – Fully-Cased Wells – Fully-Cased Wells are drilled to produce water from an aquifer containing multiple water-bearing intervals. Water production is achieved by screening and/or perforating opposite one or more of the most viable water-producing aquifer zones. Overlying formations are cemented or grouted off to prevent caving and aquifer cross-connection. Wells of this type are usually drilled relatively deep and generally intercept aquifers under confined conditions. A typical construction diagram for Type V wells is illustrated in Appendix C-5.

(vi) Type VI – Conversion of Existing Oil or Gas Wells, or Exploration Test Wells into Water Wells.

(A) Existing oil and gas wells, seismic test holes, or mineral exploration holes may be converted for use as water wells, provided that the wells can be completed to conform to minimum construction standards cited herein.

(B) Information on geologic conditions encountered in the well at the time of the original well drilling shall be used to determine what special construction standards shall be met in order to eliminate all movement of pollutants into the well or along the annular space. If no original geologic information is available, a specified borehole log suite may be required to supplement known information.

(C) A permit to appropriate ground water must be obtained from the State Engineer prior to commencing construction of the well.

(D) Before any oil or gas exploration hole or well is converted for use as a water well, the Wyoming Oil & Gas Conservation Commission should be contacted in order to comply with that Commission’s regulations.

(c) Annulus.

(i) If a fill pipe for gravel is installed, the diameter of the well bore must be four (4) inches larger than the largest diameter of the casing plus the largest diameter

of the fill pipe for gravel. A fill pipe for gravel or any other pipe to provide access to the interior of the well bore must be completely surrounded by the seal.

(ii) All wells shall be constructed with at least a 2-inch annular space surrounding the outermost casing and extending not less than 20-feet below ground surface.

(d) Casing.

(i) Casing, surface casing (conductor pipe), liners, and screens shall be of new or new-like contaminant-free material and free of pits, cracks, breaks, and corrosion. All pipe, casing, couplings, and screen must meet applicable ASTM, API, NSF, and/or AWWA standards. Casing shall be of adequate strength and durability to protect the well against structural failures during construction and use and protect against the entrance of contaminants during the expected life of the well.

(ii) All casing shall be selected in accordance with the design of the well, depth of the well, and conditions at the well site. The most common casing materials allowed for use are carbon-steel and thermoplastic (PVC). Less common casing materials such as pre-cast concrete, fiberglass, stainless steel, aluminum, various alloy and non-ferrous metal casing types are allowable where use/conditions dictate and steel or plastic cannot be used. Choice of casing material, diameter, and wall thickness shall be based on:

(A) Maximum Pumping Rate and Flow Capacity Over the Life of the Well: The production casing shall be greater than or equal to one nominal size larger than the down-hole pump assembly.

(B) Geology and Aquifer Conditions: Where multiple casings are warranted (surface casing, liners, screens, etc.), provisions shall be incorporated to prevent misalignment, to seal/secure the annulus between casings, and to prevent or secure from borehole caving.

(C) Installation Method: Difficulty in handling and load strength must be considered for various well designs, depths of drilling, specific geologic conditions, and grouting requirements. Re-entered wells (e.g., for liner placement or plugging back and completing abandoned oil and gas test wells) should be assessed for competency of the existing casing.

(D) Plumbness and Alignment: A well shall drift off plumb no more than one degree per 100 feet of borehole. The alignment shall allow a 40-foot long section of pipe, ½-inch less than the inside diameter of the casing, to pass freely from the top of the casing through anticipated pump setting depth.

(E) Water Quality: The effects of formation waters that may cause corrosion, cross-connection of vertically separate aquifers, bacterial growth, surface water influx, etc., shall be avoided by proper casing selection and installation.

(F) Well Devices: Decisions on casing material and dimensions also depend on outfitting of the well which may include choice of pumps, motors, wiring, transducers, sampling tools, floats, adapters, airline, caps, seals, etc.

(iii) All casing types must achieve watertight connections according to directions from the manufacturer.

(A) Metal pipe must be welded or joined with threaded couplings. If the joints are welded, the weld shall be made using welding rods of equal quality to the most noble metal, shall be at least as thick as the wall thickness of the well casing, and shall be fully penetrating. Spot welding of joints is prohibited.

(B) PVC pipe may be glued, flush joint thread and coupled, or spline-lock coupled.

(C) All solvents, pipe dope, and glue must be NSF approved or an acceptable equivalent. Rivets or screws used in the casing joints shall not penetrate the inside of the casing.

(iv) Casing shall be installed in accordance with the drilling method used, borehole condition, formation characteristics, and comprehensive/tensile strength of the casing material. Only steel casing, equipped with proper drive shoe or drive point, can be used if the casing is to be installed by jacking or driving. PVC casing shall be installed only in an oversized drilled hole without driving. PVC casing shall conform to industry standards and shall be manufactured for the purpose of water well casing.

(v) Casing made of, or which has been exposed to, hazardous or potentially harmful materials, such as asbestos, shall not be used.

(e) Lost Circulation Material.

(i) The introduction of lost circulation materials (LCMs) shall be limited to those products which will not present a potential medium for bacterial growth or contamination. Only LCMs which are non-organic and can be safely broken down and removed from the borehole may be utilized. Cottonseed hulls, shredded newspaper, or cedar chips are examples of LCMs which are not allowed.

(f) Well Completion.

(i) Well completion refers to the method employed to allow water to enter the well from one aquifer. This is accomplished via perforations in the casing or well screens set adjacent to water-bearing intervals or by allowing water to enter the well through the open bottom of the casing. Multiple completions, or wells completed into two or more vertically separate aquifers, are not allowed

(A) The well driller shall:

(I) Install well screens constructed of material which is compatible with adjoining casing and is corrosion resistant.

(II) Install well screens or well intakes that prevent the continued production of sand, silt, or turbid water.

(III) Not install screen or perforated casing within the zone of maximum dynamic pumping level to prevent cascading water, except in the case of monitor wells, recovery wells or test wells.

(B) Type II and III wells shall be constructed with well screen (as defined in Chapter 2) commercially manufactured for the purpose of well construction and sized appropriately for the grain size of the aquifer materials to be developed by the well.

(g) Filter Pack.

Filter pack (or gravel pack) material shall consist of clean, well-rounded, chemically stable grains that are smooth and uniform. The filter material should not contain more than 2% by weight of thin, flat, or elongated pieces and should not contain organic impurities or contaminants of any kind. Type III Wells should be gravel (filter) packed opposite the perforated or screened zone(s) and no more than five (5) feet above the zone(s). The interval above the gravel pack must be sealed, as described in these rules, to prevent fluid cross-contamination from the surface or from a shallow aquifer.

(i) All filter material shall be placed using a method that through common usage has been shown to minimize bridging of the material between the borehole and the casing and excessive segregation of the material after it has been introduced into the annulus and before it settles into place.

(ii) It is not acceptable to place filter material by pouring from the ground surface unless proper sounding devices are utilized to measure dynamic filter depth, evaluate pour rate, and minimize bridging and formation of voids.

(h) Well Sealing/Grouting.

(i) Well casing shall be sealed to prevent vertical movement or leakage of fluid in the annular space between casing and borehole wall. Non-Slurry bentonite grouts must be in place before significant hydration occurs. Plans for well construction shall include allowances for maximum effective emplacement of grout as a seal to protect the source aquifer and/or assure structural integrity of the entire cased well. Well cuttings are not allowed to be used as grout, filler, or aggregate material for well sealing.

(ii) Selection of grouting material shall meet the technical requirements for making a proper seal. Grout products shall meet applicable ASTM, API, NSF,

AWWA, or other recognized industry standards. Grout shall be prepared according to manufacturer's directions and shall be mixed as engineered for specific site requirements. Water wells permitted under the DEQ-WQD may alternately use any grout mixture specified by DEQ-WQD. For all other wells, the following are approved grout materials:

(A) Neat Cement Grout Slurry must consist of a mixture of Portland Cement and not more than 6 gallons of clean water per bag (1 cubic foot or 94 pounds) of cement.

(B) Sand Cement Grout Slurry must consist of a mixture of Portland Cement, sand, and water in the proportion of not more than 1 part by weight of sand to 1 part of cement with not more than 6 gallons of clean water per bag of cement (1 cubic foot or 94 pounds).

(C) Concrete Grout Slurry must consist of a mixture of Portland Cement, sand and gravel aggregate, and water in the proportion of at least 1 part by weight of aggregate to 1 part of cement with not more than 6 gallons of clean water per bag of cement.

(D) Nonslurry Bentonite Grout must consist of chipped or pelletized bentonite varieties that are hydrated to manufacturer's specifications.

(E) Cement/Bentonite Grout Slurry must consist of a mixture of cement and bentonite in the proportion of not more than 6.5 gallons of water and 3 to 5 pounds of powdered bentonite per 94-pound sack of Portland cement.

(F) Bentonite Grout Slurry means an inorganic mixture of a minimum 20% by weight solids bentonite, with polymers, water, or other additives for the yield/rate control, which forms a low permeability seal (not greater than 1×10^{-7} cm/sec), and is mixed to the manufacturer's specifications.

(iii) All wells shall have an annular surface seal of grout extending not less than 20 feet below ground surface or to useable water below ground surface. The surface seal must be placed in at least a 2-inch annular space. The completed surface seal must fully surround the outermost casing, be evenly distributed, and be free of voids.

(A) If a temporary surface casing is utilized, the surface casing shall be removed in conjunction with the placement of the seal. Alternatively, conductor casing may be sealed permanently in place to a depth of at least 20 feet with a minimum 2-inch annular seal between the largest outside diameter of the surface casing and borehole wall. If the temporary surface casing is to be removed, the surface casing shall be withdrawn as sealing material is placed between the outermost permanent well casing and borehole wall. The sealing material shall be kept at a sufficient height above the bottom of the temporary surface casing as it is withdrawn, to prevent caving of the borehole wall.

(iv) Type I wells, as defined in this section, (b)(i), shall be constructed with a watertight curbing extending, at a minimum, from 18 inches above the natural ground level to the static water level. The curbing shall consist of poured cement grout or casing surrounded by cement grout. Concrete block with cement grout and rock with cement grout may also be used. The poured cement grout shall not be less than 6-inches thick. If casing is to be used, the minimum annular space between the casing and the borehole shall be three inches. A typical construction diagram for Type I wells is illustrated in Appendix C-1.

(v) Type III Wells, as defined in this section, (b)(iii), shall be grouted from immediately above the gravel packed interval and shall terminate at the ground surface or at the base of a pitless adaptor. The seal shall close off all zones above the gravel-packed interval. If a gravel tube is installed, it shall be sealed with a water-tight cap. A typical construction diagram for Type III wells is illustrated in Appendix C-3.

(vi) Type IV Wells, as defined in this section, (b)(iv), shall have the entire production casing string grouted from bottom to top before well completion. The well shall be drilled and cased at least 10 feet into the upper portion of the target aquifer. If permeability factors or hydrostatic conditions in the target aquifer will jeopardize a successful grout job, then the well shall be drilled, cased and cemented into the first overlying formation which will provide for secure sealing and completion. According to W.S. §41-3-909 (a)(vii), flowing and non-flowing wells are required to be "...constructed and maintained as to prevent the waste of underground water either above or below the land surface." Grouting shall be accomplished by either one or several methods in which grout is pumped directly in the annulus (by tremie or grout pipe) or circulated to the annulus by positive displacement from inside the casing. Before grouting, clean water or other suitable drilling fluid mixture shall be circulated to clear the borehole and provide conditions for optimal bonding. Engineered grout volume calculations must include an excess allowance (e.g. 25%, 50%, 100%, etc.) for losses in the subsurface. It is allowed to introduce cement or concrete (e.g. Redi-Mix) from the land surface to finish a grout job so long as a complete seal is attained. A cement bond log of the well may be required to assure that an adequate seal was set in place. If leaks occur around the well casing or adjacent to the well, the driller shall complete the well with seals, packers, and/or grout to eliminate the leak. A typical construction diagram for Type IV wells is illustrated in Appendix C-4.

(vii) Type V Wells, as defined in this section, (b)(v), shall be grouted from the ground surface or the base of the pitless adaptor to the bottom of the casing. A typical construction diagram for Type V wells is illustrated in Appendix C-5.

(i) Well Development – Following construction, all wells shall be cleaned and developed to remove drilling fluids, drill cuttings, and other foreign materials. Proper well development functions to establish the best hydraulic connection between the well and the source aquifer. The well driller shall develop every new well until the produced water does not contain appreciable amounts of sand, silt, or turbidity. Chemicals used as development aids such as agents used in acid fracturing, carbon dioxide (CO₂) injection,

formation deflocculation treatment, etc., are also allowed; however, notification to WDEQ-WQD is required prior to application or introduction of a foreign substance into a well that is a public water supply source.

Section 3: Water Well Equipping.

(a) All new and old wells (including hand-dug) shall be capped or sealed so that they do not present a hazard and to prevent the unintended entry of contaminant matter, surface water, animals, or foreign objects, by utilizing either a welded plate or a sanitary well cap. All vents installed in the well casing shall open downward and be screened to prevent the entrance of foreign material. Wells shall be equipped with a minimum ½-inch diameter access port for water level and drawdown measurement (unless a flowing well).

(b) Pitless Adapters.

(i) Pitless adapters must be designed and constructed to be water tight and to prevent contamination of the ground water resource and any potable water. Pitless adapters must be compatible with the casing material. The driller or pump installer shall ensure that the pump and column weight do not exceed the casing strength.

(ii) Where a pitless adapter is to be installed, the grout seal must extend from the pitless unit to at least 20-feet below the ground surface (or to useable water below ground surface). The area around the pitless unit and surface string may be filled with bentonite or clean earth to grade level.

(iii) The components of a pitless adapter must allow sufficient clearance for the insertion and removal of the down-hole pumping assembly.

(c) Pumps and Pumping Equipment.

(i) Special care must be exercised when replacing a pump because bacteria can easily contaminate what is pulled from the well (pump, drop pipe, electric wire) and it is difficult to disinfect portions of the electric wire and drop pipe that are above water level. When pulling a pump, the electric wire should not be allowed to touch the ground. This may be accomplished by laying plastic on the ground, utilizing a mechanical system that winds up the electric wire as it is withdrawn from the well, or other appropriate means. The drop pipe should be placed on pipe racks or other precautions should be taken to keep it from contacting the ground. If contamination does occur, special care must be taken to disinfect the contaminated areas.

(ii) A flow meter with instantaneous flow rate and totalizing capability shall be installed on discharge lines of all water wells or well systems whenever the State Engineer permit conditions require a flow meter and subsequent reporting of volumetric use. The flow meter shall be installed in accordance with the manufacturer's instructions.

(iii) All pumping systems shall be designed not to exceed the permitted pumping rate as established by the State Engineer permit, under normal operating conditions. All electrical and plumbing installations and connections shall be performed and maintained in accordance with the existing electrical and plumbing codes, and shall meet the equipment-manufacturer's specifications.

(iv) The pump and downhole assembly shall be at least one nominal size smaller in diameter than the production casing.

(v) Pumps shall be installed in accordance with the manufacturer's recommendations and shall provide for proper cooling.

(d) Flowing wells are required, by W.S. §41-3-909(a)(vii), "...to be so capped or equipped [valved] that the flow of water can be stopped when the wells are not in use..." In addition, the flow shall be controlled in such a manner as not to exceed the flow rate as established by the State Engineer permit. Additional precautions may be necessary to prevent freezing of the wellhead or piping.

(e) Unless specifically designed as an injection well, directional flow controls shall be installed and maintained to prevent water from being forced or siphoned back into the well.

(f) For irrigation wells with in-line chemical injection systems or for other wells that are cross-connected with potential contaminant sources or water source(s) of lesser quality, a backflow prevention device (reduced pressure assembly, single/double check valve, etc., with vacuum relief) shall be installed to protect the wellhead from backpressure or back siphonage.

(g) For multiple wells which are connected by a common conveyance system, controls shall be maintained to ensure that one pump does not overpower another pump and allow water to be injected into one well bore.

(h) All electrical installations shall be performed and maintained in accordance with existing electrical codes. A properly licensed electrician must perform all electric wiring which impacts the operation of the pump or pumping system. This includes wiring from the pump to the control boxes to the main power supply such as the breaker box in a house. Licensed Water Well Pump Installation Contractors are advised that additional licensing requirements may be required by the Wyoming State Fire Marshal's Office. The electric wire should be adequately attached to the drop pipe for support and be installed in accordance with manufacturer's recommendations.

(i) All plumbing or water supply distribution from the well to the point of entry hookup shall be installed and maintained in accordance with existing plumbing codes.

CHAPTER 4

WELL COMPLETION AND MAINTENANCE

Section 1: Disinfection.

(a) Each person who repairs, modifies, works on, or otherwise affects the physical components of a well shall clean and disinfect the pump, electrical wiring and controls, drop pipe, and all other equipment each and every time the pump, electrical wiring and controls, drop pipe, and other equipment is placed into the well. In addition, each person (or crew) who performs the above tasks shall maintain at all times on every well site, adequate chlorine compounds to disinfect the well in accordance with the table found in Appendix A.

(b) The well driller shall:

(i) Clean all casing, tools, drilling equipment, and materials prior to beginning the drilling and construction of every well.

(ii) Clean all pumping equipment and well construction materials (including sand or gravel used in an artificial filter-packed well) before placing them in the well or borehole.

(iii) Ensure that only potable water is used for drilling and for mixing of sealing material.

(c) The pump installer shall:

(i) Clean all pumping, wiring, and other equipment prior to placement in the well.

(ii) Clean all materials that may come in contact with down-hole equipment.

(d) All wells used for drinking or sanitary use shall be disinfected after construction, reconditioning, or repair (e.g., submersible pump replacement) and before the well is placed into, or returned to, service.

(i) Following drilling:

(A) If calcium hypochlorite is used, it shall be slowly poured down the casing and at least 30 minutes shall pass to allow the tablets to fall through the water and dissolve.

(B) If sodium hypochlorite is used, the solution must reach all parts of the well. To accomplish this, a tube shall be suspended through the well casing so that it

reaches the bottom of the well. After it reaches the well bottom, it shall be withdrawn as the sodium hypochlorite solution is pumped through the tube.

(C) After the chlorine has been applied, the well shall be surged at least three times to improve the mixing and induce contact of the chlorinated water with the adjacent aquifer.

(ii) Following pump installation:

(A) Chlorine shall be introduced so that an average chlorine residual of 100 mg/l is in the entire volume of water in the casing and all parts of the plumbing system (pump, drop-pipe, wiring, pitless assembly, etc.) for a minimum contact period of not less than two (2) hours (overnight is preferable) before flushing and ridding the chlorine solution from the well.

(iii) See Appendix A for mixing proportions. Chlorine compounds intended for home laundry use, pool, or fountain use should not be used if they contain additives such as antifungal agents, scents, etc.

Section 2: Spring Developments.

(a) “W.S. §41-3-902. **Spring waters; perfection of right to use; limitation.** All springs and spring waters where the yield does not exceed twenty-five (25) gallons per minute and where the use is for domestic or stock purposes only, shall be considered as groundwater. Perfection of the right to use spring water up to twenty-five (25) gallons per minute for domestic and stock use shall be made in accordance with the laws pertaining to groundwater”

(b) Developed spring flow that is 25 gallons per minute or less and is utilized for stock and/or domestic use is to be permitted with the State Engineer underground water permitting procedures. Developed spring flow in excess of 25 gallons per minute, or for uses other than domestic or stock watering, must be permitted under State Engineer’s Office surface water permitting procedures. For the purposes of water right permitting, springs or seeps shall be improved or perfected by some artificial means of collection and/or conveyance. Springs with no artificial means of collection and/or conveyance cannot be claimed nor permitted under State of Wyoming water laws. Accepted means of spring development can range from simple piping to an impoundment, to spring box collection and associated delivery systems. If the spring is a domestic source of drinking water, setback allowances from contaminant sources should be employed the same as for well siting and protection for entrance of animals or other foreign material shall be provided.

Section 3: Water Well Rehabilitation.

(a) When a water well is to be rehabilitated to increase efficiency, all equipment used shall be clean and as sterile as possible to prevent well to well or well to

aquifer cross-contamination. All chemical or biological agents to be introduced into a well shall meet ASTM, API, NSF and/or AWWA standards approved for the application of well rehabilitation. Physical rehabilitation of the well including jetting, scrubbing, bailing, etc. shall be performed in a manner that does not compromise the integrity of the well casing materials, filter pack, and grout materials. When acidizing or flocculating agents are pumped or removed from a well, it may be necessary to obtain clearance from the Wyoming Department of Environmental Quality – Water Quality Division (WDEQ-WQD) for the surface discharge of these agents.

(b) If, in the repair of a well, the old casing is withdrawn, the well shall be recased in conformance with these rules.

(c) If a liner is installed to prevent leakage of undesirable water into a well, the annular space between the casing and liner shall be completely sealed by packers, casing swedging, pressure grouting, or other methods which will prevent the movement of water between the casing and liner.

Section 4: Water Well Plugging and Abandonment.

(a) When a well is temporarily removed from service, it shall be kept in a state of good repair. The top of the well casing shall be sealed with a secure watertight cap that will prevent tampering and entrance of contaminants, animals, or debris.

(b) The well owner is responsible to ensure that any well (including any test well or replaced well) which is permanently abandoned or removed from service shall be entirely plugged to prevent contamination from the surface or any other source and to remove any further hazard potential that an unused well or abandoned drill hole might pose. All pumps, pipe, wiring, caps, and other obstructions/debris that may interfere with adequate plugging operations shall be removed from the well. Suitable cement-based mixtures or bentonite mixtures shall be used for grouting material. If a well is permitted under DEQ-WQD rules, those rules may be consulted for abandonment procedures. For all other wells, an abandoned well shall be plugged by one of the following methods in accordance with type of well completion and subsurface geologic and /or hydrostatic conditions:

(i) Dug wells or excavations [Type I Wells, see Section 6(a)(i)] exposing the shallow water table shall be filled to static water level with clean fill such as gravel or sand. The remaining hole is to be filled with bentonite to 2-feet below ground surface. The remaining 2 feet shall be filled with native soil and mounded slightly at the top to allow for settling.

(ii) If possible, casing shall be removed from Type II Wells [See Section 6(a)(ii)] prior to plugging procedures. Cased or uncased wells in unconsolidated formations shall be destroyed by placement of clean fill, such as gravel or sand, opposite the completed (screened, perforated interval) or water bearing zone and then grouting to the surface. The upper surface portion of the cased well must be cut off a minimum of 18

inches below ground level and the area back-filled with enough clean soil material to allow for settling.

(iii) Type III, gravel pack wells [See Section 6(a)(iii)] shall be grouted from bottom to top in order to accomplish a complete seal. Grout slurries shall not be poured from the land surface through a column of water. In order to place the grout in wells with water columns, it shall be pumped via tremie pipe by positive displacement or similar method (pressure grouted) from the bottom of the well to a sufficient elevation such that an uninterrupted seal may be emplaced to the land surface. The upper surface portion of the cased well must be cut off a minimum of 18 inches below ground level and the area back-filled with enough clean soil material to allow for settling.

(iv) Plugging of open-hole completed wells [Type IV Wells, see Section 6(a)(iv)] shall consist of grouting the entire well. Necessary pressure grouting procedures shall be utilized to permanently seal off flow and/or pressure of the artesian aquifer such that surface or subsurface leakage will not occur.

(v) Type V Wells [see Section 6(a)(v)] shall be decommissioned in the same manner as that prescribed for Type III Wells.

(vi) Type I, II, or III wells may alternately be grouted from bottom to top with bentonite grout to create a complete seal.

(c) If there is any question of proper procedure for extraordinary plugging/abandonment conditions, the State Engineer's Office, Ground Water Division must be consulted for instruction before commencement of plugging activities.

(d) Upon completion of plugging and abandonment of a water well, the well owner shall report the date and method of abandonment to the State Engineer's Office, Ground Water Division with reference to the State Engineer permit number issued for the well and the well location.

Section 5: Water Quality.

(a) The State Engineer recommends that a water quality sample be collected after well construction and aquifer testing is complete. The sample should be collected in an acceptable manner and container and submitted to a qualified laboratory for chemical and/or biological analysis. Additionally, the State Engineer recommends that water quality samples be collected and analyzed at periodic intervals during the life of the well for both chemical constituents and biological materials.

(b) If the water well is to be developed for human consumption serving fifteen (15) or more service connections, or twenty-five (25) or more persons, for sixty (60) days or more a year, regulations developed under the Federal Safe Drinking Water Act apply. Specific requirements of the Act are available from the Water Supply Section Region VIII, U.S. Environmental Protection Agency, 1595 Wynkoop St, Denver, CO 80202.

The provisions of Chapters 3, 11 and 12 of the Wyoming Water Quality Rules and Regulations also apply. You are advised that plans and specifications covering the proposed construction, installation, or modification of any public water supply system designed for this purpose are required to be submitted to and a permit to construct obtained prior to the start of construction from, the WDEQ-WQD, Herschler Building – 4W, Cheyenne, WY 82002; phone number: 307-777-7781.

CHAPTER 5

APPENDICES

Appendix A

DISINFECTION TABLE*

(PRODUCES A 100 mg/l SOLUTION PER 10 FEET OF CASING LENGTH)

| NOMINAL CASING OR BOREHOLE DIAMETER (inches) | GALLONS OF WATER PER 10 FEET OF CASING (gal/10ft.) | 6% Chlorine HOCl <small>Clorox, Purex, Sno-White, White Magic, etc. (Sodium Hypochlorite)</small> | 10% Chlorine HOCl <small>Liquid Bleach (Sodium Hypochlorite)</small> | 70% Chlorine HOCl <small>“High Test” (Calcium Hypochlorite)</small> | 100% Chlorine Cl₂ |
|--|--|---|--|---|-------------------------------------|
| | | fluid oz. | fluid oz. | dry oz. | fluid oz |
| 4 | 6.5 | 1.7 | 0.9 | 0.1 | <0.1 |
| 5 | 10.2 | 2.6 | 1.4 | 0.2 | 0.1 |
| 6 | 15.0 | 3.8 | 2.0 | 0.3 | 0.2 |
| 8 | 26.0 | 6.6 | 3.5 | 0.5 | 0.35 |
| 10 | 40.8 | 10.4 | 5.4 | 0.8 | 0.5 |
| 12 | 58.7 | 14.9 | 7.8 | 1.1 | 0.8 |
| 16 | 104.4 | 26.5 | 13.9 | 2.0 | 1.4 |
| 20 | 163.2 | 40.8 | 21.2 | 3.3 | 2.2 |
| 24 | 235.0 | 59.7 | 30.6 | 4.5 | 3.1 |
| 36 | 528.7 | 132.2 | 68.7 | 10.6 | 7.1 |
| 48 | 940.0 | 235.0 | 122.2 | 18.8 | 12.5 |

For 50 mg/l solution, divide values by 2; for 200 mg/l solution, multiply values by 2.

U.S. liquid measure - 1 gal = 4 qt = 8 pt = 128 fl oz

U.S. dry weight measure - 16 oz = 1 lb

*Modified from National Ground Water Association, Manual of Water Well Construction Practices and State of Missouri Well Construction Rules

Appendix B
CONVERSION TABLES

VOLUME CONVERSIONS FOR WATER

1 cubic foot = 7.48 gallons = 62.4 lbs

1 cubic foot = 28.317 liters

1 gallon = 231 cubic inches

1 gallon = 8.3 pounds

1 gallon = 4 quarts = 3.7853 liters

1 cubic yard = 27 cubic feet

1 cubic yard = 202 gallons

1 liter = 0.264 gallon

1 liter = 2.205 pounds

1 cubic meter = 2204.5 pounds

1 cubic meter = 1000 liters

1 cubic meter = 35.4 cubic feet

1 cubic meter = 265 gal

1 acre-foot = 43,560 cubic feet

1 acre-foot = 325,851 gallons

1 million gallons = 3.0684 acre-feet

RATES OF FLOW

1 second-foot/day = 1.984 acre-feet/day

1 second-foot/day = 86,400 cubic feet

1 cubic foot/second = 448.8 gal/min

1 cubic foot/second = 646,317 gal/day

1 gallon/minute = 192.5 cubic feet/day

1 gallon/minute = 0.00442 acre-foot/day

1 gallon/minute = 1.61 acre-feet/year

1 cubic meter/second = 35.31 cubic feet/second

1 cubic meter/second = 70.02 acre-feet/day

1 acre-foot/day = 0.32585 million gallons/day

LENGTH

1 inch (in) = 2.54 centimeters (cm)

1 foot (ft) = 12 in

1 meter (m) = 39.37 in = 3.28 ft = 100 cm

1 centimeter = 10 millimeters (mm)

AREA

1 square inch (sq in) (in²)

1 square foot (sq ft) (ft²) = 144 in²

1 acre (a) = 43,560 ft²

1 square mile = 640 acres

WEIGHT

1 pound (lb) = 16 ounces (oz)

1 pound = 453.6 grams (g or gm)

1 pound = 7,000 grains (gr)

1 kilogram (kg) = 1,000 grams = 2.205 pounds

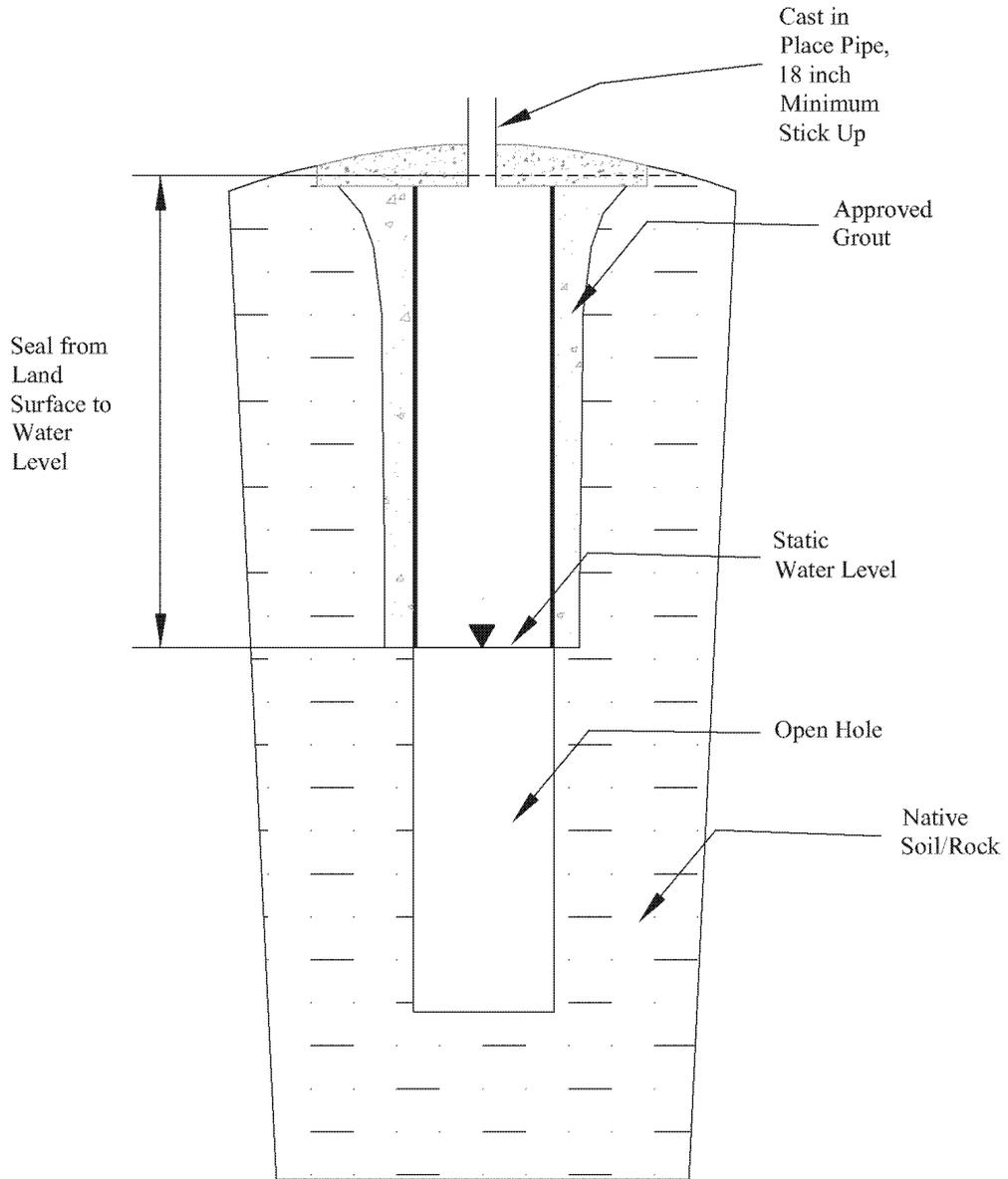
PRESSURE

1 bar = 100 kilopascals

1 bar = 14.5 pounds/square inch

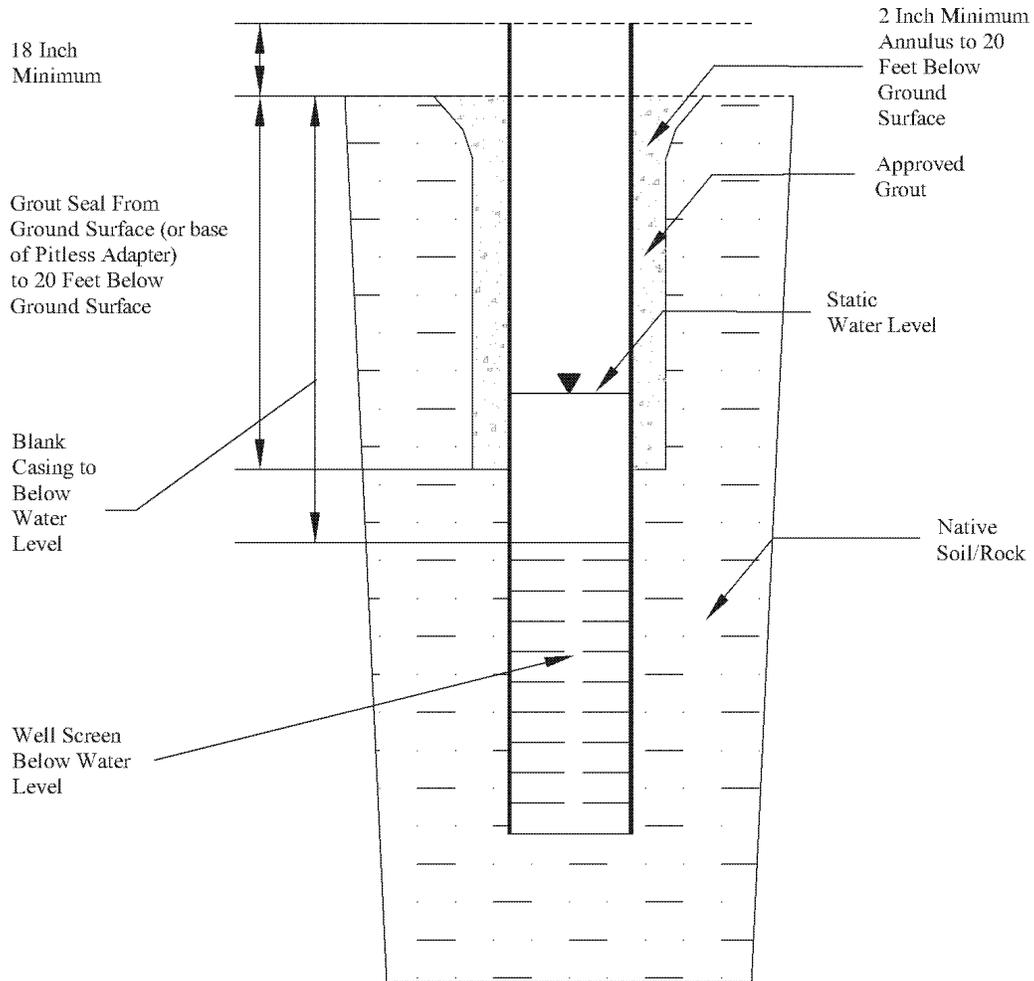
1 pound/square inch = 2.31 feet of water

Appendix C-1
TYPE I WELLS



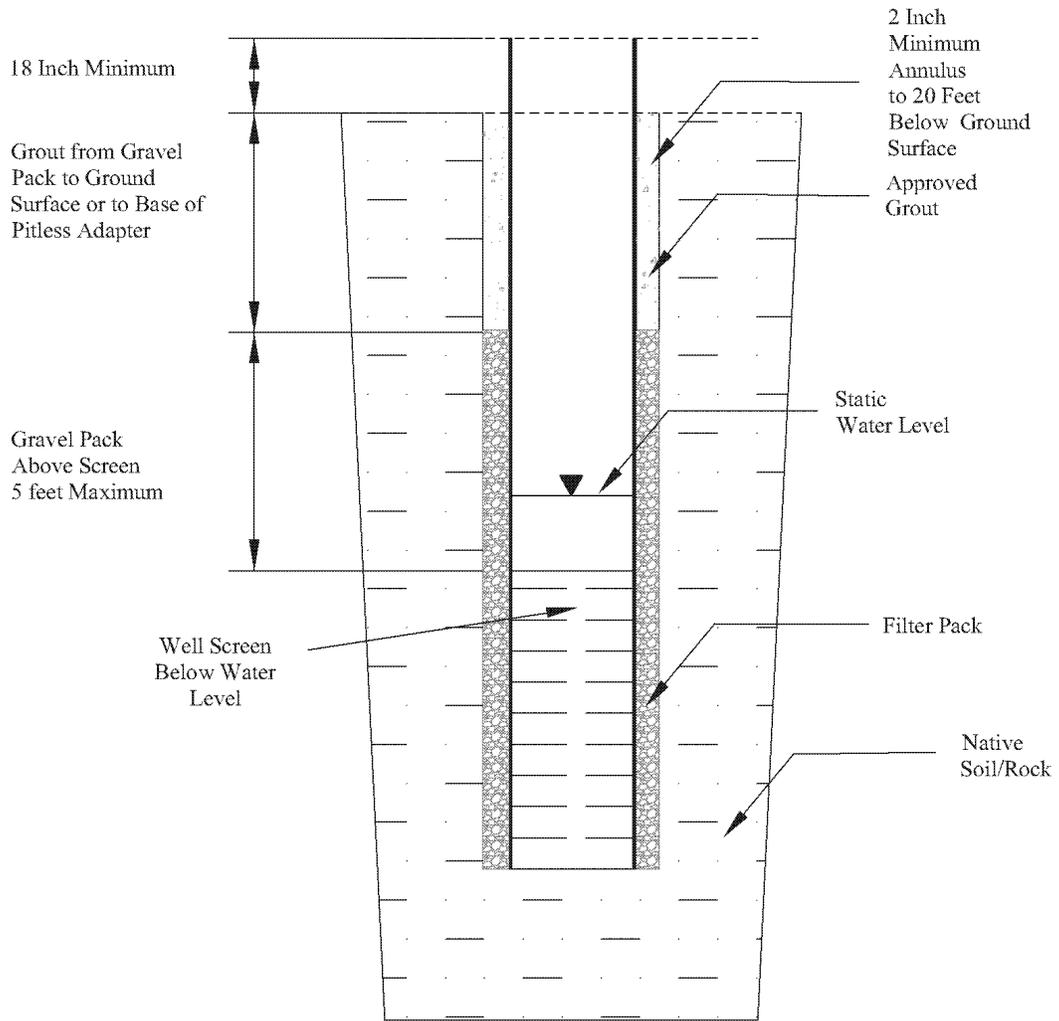
Version 11.20.2009

Appendix C-2
TYPE II WELLS



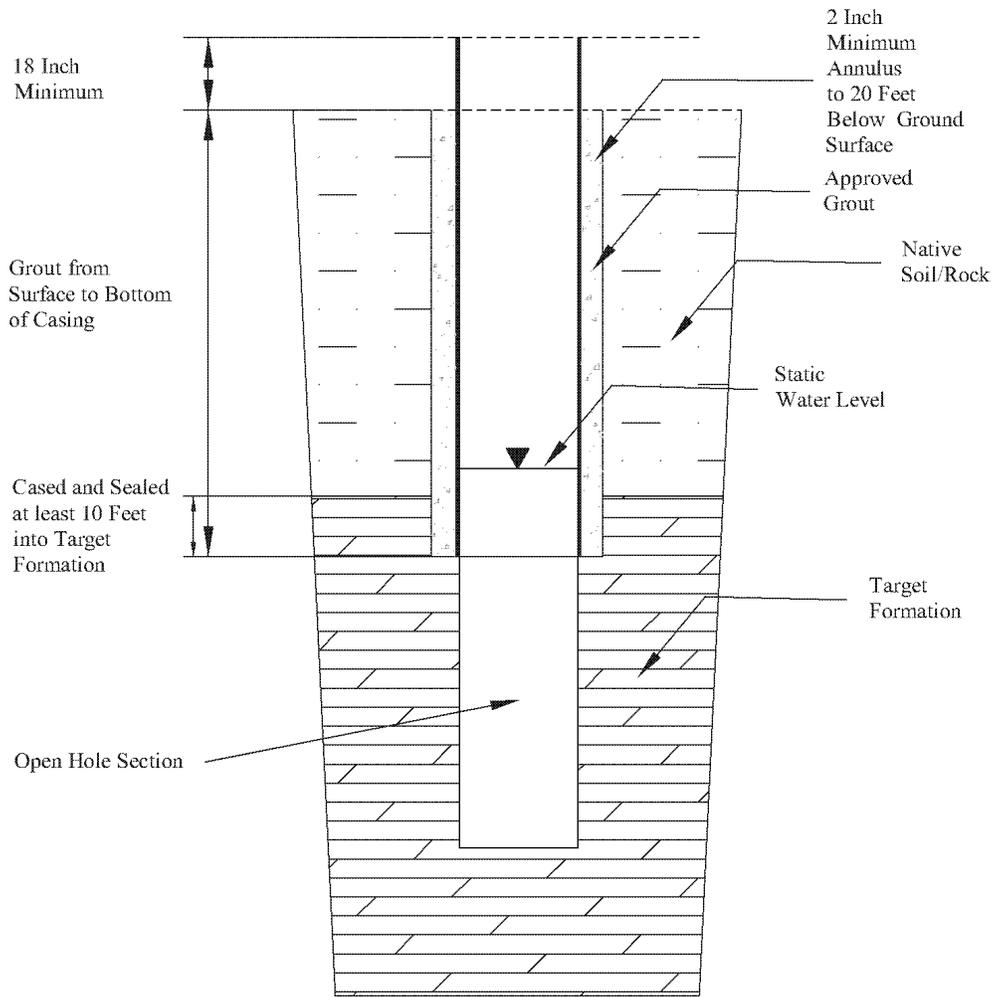
Version 11.20.2009

Appendix C-3 TYPE III WELLS



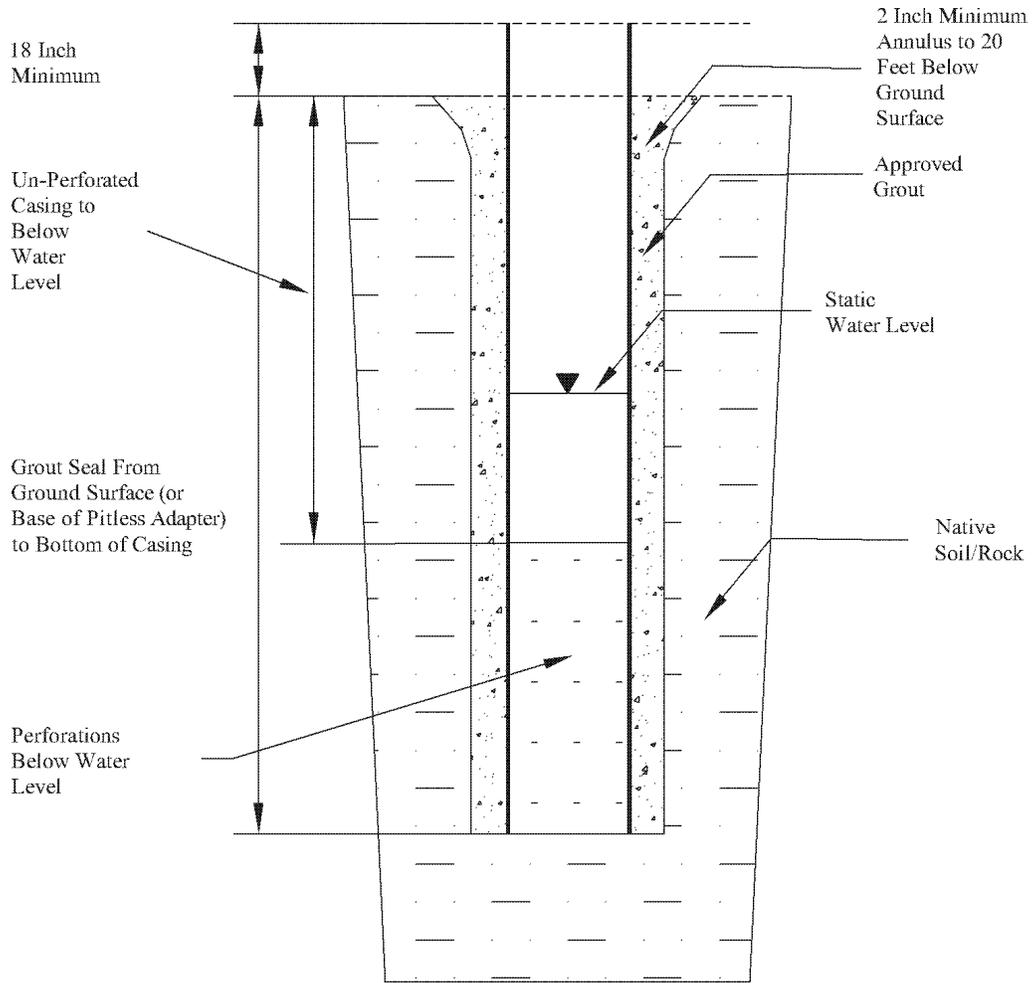
Version 11.20.2009

Appendix C-4 TYPE IV WELLS



Version 11.20.2009

Appendix C-5
TYPE V WELLS



Version 11.20.2009