

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
ARIZONA

CONSTRUCTION SPECIFICATION CS642
WATER WELL

1 SCOPE

The work shall consist of installing and developing water well for livestock use and irrigation purposes pursuant to conservation practice standard 642. Materials specification for the installation of this practice is covered in MS642 and is attached as an appendix to this specification.

2 PERMIT AND NOTIFICATION

Before any construction work begins, the owner/contractor shall obtain the necessary permit for drilling a well from the Arizona Department of Water Resources (ADWR). Pursuant to ARS § 45-596, the owner shall also file a Notice of Intent to Drill with the ADWR.

3 SITE PREPARATION AND LOCATION

After receiving the geologic report, if required for the project, clear all trees, brush, and obstacles from the well site prior to setting the drill rig. The area immediately surrounding the well site shall be smoothed and graded to allow for a safe and relatively dry working area. The well site shall not be located within 100 feet of any septic tank system or sewage disposal area. It shall also have a minimum 100 feet separation from any landfill, hazardous waste facility or storage areas for such materials and underground storage areas of petroleum products unless authorized in writing by the Director of ADWR.

4 INSTALLATION

4.1 Drilling: Only clean, potable water shall be used in drilling fluids whether employed alone or in combination with drilling additives. Whenever there is an interruption of work on the well, such as overnight shutdown, during inclement weather, or periods between testing, et cetera, the well opening shall be covered and secured (by tack welding or other acceptable means) to ensure the public safety, prevent damage to the well, and prevent introduction of unwanted materials into the well. The contractor is responsible for any objectionable material that may fall into the well and any effect it may have on water quality or quantity until completion and acceptance of the work by the land operator and NRCS.

All alloys/materials containing lead, and paints and coatings containing lead or mercury, shall be strictly prohibited from introduction into any new or existing water well.

4.2 Joining: To prevent galvanic corrosion, dissimilar metals shall not be joined or appropriate protective measures as recommended by the supplier/manufacturer shall be implemented.

4.3 Well Diameter: The diameter of the well shall be adequate to meet the yield capacity of the formation in relation to the nature and extent of the water bearing area and to permit the installation of a pump to deliver the needed amount of water to the projected lift elevation. The inside diameter of the casing shall be as shown in the approved construction plan. The well diameter shall provide for adequate annular space to permit the placement of the filter pack, if needed.

4.4 Alignment: Drilled vertical wells shall be round, plumb and aligned to permit satisfactory installation and operation of a pump of the proposed size and type to the greatest anticipated depth of setting. Additional information on well alignment and tolerance can be found in AWWA standard A100, section 4.7.9. If there is any concern for plumbness and alignment, information provided in Appendix D of AWWA standard A100 may be used to test for the same.

4.5 Casing: Casing and joints shall be of sufficient strength and wall thickness to hold the borehole open and survive any grouting work and to support the load of the casing material. The first 20 feet of the casing shall be steel casing and extend a minimum of 12 inches above ground level. All casing and joints shall be made continuous and watertight from the top to the bottom of installation (except well screens) to maintain the quality of the water. In a two-ply casing, any annular space between the outer casing and the inner casing shall be completely sealed to prevent contamination of the well. The well may be drilled up to an additional 20 feet below the bottom of the casing to act as a sump for collecting fines.

4.6 Screens: Screens can be (i) punched or louvered pipe screens, (ii) wire-wound continuous slot screens or (iii) perforated pipe base screens. Screen diameter shall be such that a vertical velocity of less than 5 feet/sec will always be maintained within the screen barrel. If the pump setting is anticipated to be within or below the screen, minimum inside diameter of screen shall be per Table 3 of AWWA standard A100. Joints between screen sections and blank casing shall be welded or threaded and coupled.

Pre-packed well screens shall consist of an inner and outer screen, which are completely filled with uniform, well-rounded, pre-washed grains of silica sand of a specified gradation. The screen slot size shall be based on a sieve analysis of the water-bearing aquifer materials; the slot size shall retain 100 percent of the filter pack's minimum size designation. No minimum annular space is required for a pre-packed well screen if its outside diameter is equal to or less than the casing to which it is attached. Perforation by any method is allowable with the following provisions:

- Screen openings, for uniform size aquifer material, are smaller than the average diameter of the aquifer material,
- Pipe is not damaged,
- Screen openings, for non-uniform aquifer material, are smaller than 60 percent of the aquifer material,
- Screen openings, for filter/gravel pack will exclude at least 85 percent of the filter pack material,
- Length and open area of the screen can be sized to limit average entrance velocity of water into the well to less than or equal to 0.1 foot per second, and
- The required strength can be maintained.

The position of the screen in the well shall be determined by the depth of the aquifer below the ground surface and the thickness of aquifer to be penetrated by the well. The top of the screen shall be located below the lowest water level expected in the well. Well screens should be plugged at the bottom either by a plate made of the same material as the screen or by a self closing valve. The plate can be welded or threaded.

4.7 Filter/Gravel Pack: Filter pack material shall be carefully placed to prevent segregation and should extend a minimum of 10 feet above the top of the highest screened or perforated section and should extend through the entire length of the water-bearing formation penetrated by the well.

For naturally developed wells in which the screen is placed in direct contact with aquifer materials, the screen slot size should be based on the D40 size of the aquifer materials, so that 60 percent of the material

can pass and 40 percent will be retained. The D50 size is acceptable if the water is highly corrosive, or if there is doubt about the reliability of the sample. For wells in which a filter pack is used, the screen slot size should be such that 90 percent or more of the filter material is retained. The length and open area of the screen should be sized to restrict the entrance velocity of water into the well to less than or equal to 0.1 ft/sec.

Commercial pre-packed well screens may be substituted for a conventionally installed filter pack if one of the following conditions applies:

- Heaving or caving sands are present;
- The aquifer is silty or fine-grained;
- The well is horizontal or angled; or
- Appropriate materials are not available for a conventional filter/gravel pack.

Filter/Gravel pack can be installed by using any one of the methods listed in Appendix B of the AWWA standard A100. The contractor shall select the method best suited for the specific site conditions. When a gravel pack is installed, the annular space between the outer casing and the inner casing shall be sealed. Sealing can be achieved either by welding a cap at the top or by filling with cement grout from the bottom of the outer casing to the surface.

4.8 Grouting and Sealing: In constructing and developing a well, the contractor shall take all reasonable precautions to protect the production aquifer from contamination by drilling materials. All foreign materials, such as drilling fluids, filter cake, lost circulation materials or any other organic or inorganic material introduced into the aquifer during well construction shall be removed when the construction is completed.

The annulus surrounding the permanent well casing at the upper terminus of the well shall be filled with expansive hydraulic cement (ASTM C 845), shrinkage-compensating concrete, bentonite based grout, clay, or other material with similar sealing properties. The length of the grout seal shall be at least 19 feet and not less than the minimum specified in state or locally applicable construction codes.

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. A similar positive seal shall be provided to separate aquifers where co-mingling of waters is undesirable.

A packer or similar retaining device, or a small quantity of sealant that is allowed to set, shall be placed at the bottom of the interval to be sealed before final sealing operations begin to form a foundation for the seal.

4.9 Surface Seal: On completion, each well shall be provided with a surface seal which will consist of a steel casing, with 12 inch extended above the ground level and grouted with continuous cement grout from the bottom of the grout zone to the surface of the land. The minimum annular space between the casing and the borehole for placement of grout shall be one and one half inches.

If the water is intended for human consumption, the casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions

Grouting and sealing can be installed by any one of the methods listed in Appendix C of the AWWA Standard A100. The contractor shall select the method best suited for the specific site conditions.

4.10 Foundation and Transition Seals: A transition seal shall be placed in the annular space to separate filter pack and cement-based sealing materials. The top of the transition seal shall be measured to ensure that no bridging has occurred during placement.

4.11 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.

4.12 Access Port: Every well shall be constructed with an opening of at least ½ inch in diameter in the casing and at least 12 inches above ground level, to allow a water level measuring line to be inserted between the outside casing and the pump column. A removable cap shall be provided for such openings.

4.13 Testing of Well: A non-flowing well shall be tested for its pumping capacity in gallons per minute. The pumping capacity shall be measured by the discharge of the pump after continuous operation for at least four (4) hours. For a flowing well (see special aquifer condition in section 7), the pumping capacity shall be measured as the natural flow at the land surface, averaged over four (4) hours.

4.14 Water Quality Testing: If required by the NRCS and/or the landowner, water quality testing for well water shall be per Conservation Practice Standard 355.

4.15 Capping/Abandonment of Open Wells: If the drilling of a well site results in a non producing well or a so called dry hole, the contractor shall either install a cap on the well per Arizona Administrative Code, Title 12, Chapter 15, Article 8, Section R12-15-822 or abandon the well in compliance with ADWR requirements. Abandonment of a well is covered in the Conservation Practice Standard 351, “Well Decommissioning”. The contractor shall also comply with the requirements in the “Well Abandonment Handbook” published by ADWR and made an integral part of Practice Standard 351. If the requirements in Practice Standard 351 and ADWR Handbook are in conflict, the more restrictive requirement shall govern.

Appendix H of AWWA standard A100 provides additional information on the decommissioning of test holes, partially completed wells, and abandoned completed wells.

5 WELL AND AQUIFER DEVELOPMENT

Wells to be completed without a filter pack in unconsolidated granular aquifers shall be developed following guidance provided in ASTM D 5521, Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers. The method shall be selected based on geologic character of the aquifer, type of drilling rig, and type of screen.

For massive, un-fractured rock formations unresponsive to water well development procedures, the use of aquifer stimulation techniques may be considered in order to improve well efficiency and specific capacity. Depending on the composition and structure of the formation, techniques may include dry ice, acid, explosives, or hydro fracturing.

Upon completion of the well and before conducting the yield and drawdown tests, the contractor shall develop the well to remove fines, drill cuttings, drilling fluids, and additives deposited on the borehole face and in adjacent portions of the aquifer during the drilling process. If organic drilling fluids are used, they must be broken down chemically according to the manufacturer’s recommendations before or during development.

After aquifer development is complete, the accumulated sediment shall be removed from the bottom of the well bore by pumping or bailing. The well shall be developed at 120 percent normal anticipated production until it stops producing excessive quantities of solid particles. The permanent pump shall not be used for either of these purposes.

Section 4.8 and Appendix E of AWWA standard A100 provide additional information Well Development.

6. DISINFECTION

All water wells shall be disinfected immediately following their construction or repair to remove bacteriological contamination that may be unsafe for consumption by livestock. Prior to final disinfection, the well shall be cleaned thoroughly to remove all foreign substances, such as grease, soil, sediment, joint dope, and scum. All pump parts shall be thoroughly cleaned before being placed in the well. Surfaces of all components above the static water level as well as the entire pumping system, and all storage tanks, pipes, faucets, valves, and hydrants must be flushed or washed down with a sterilizing solution.

Disinfection of well water shall be in accordance with the procedures prescribed in AWWA standard C654. Sampling and testing shall be per ASTM D 6771.

7. SPECIAL AQUIFER CONDITION (ARTESIAN WELL)

Construction of artesian wells shall be in accordance with Arizona Administrative Code, Title 12, Article 8, Section R12-15-812 “Special Aquifer Conditions” which is incorporated by reference in this specification.

8. OTHER REQUIREMENTS

The owner/contractor shall comply with the following additional requirements to be in compliance with A.R.S. Title 45, Chapter 2, Article 10 and the rules adopted by ADWR.

- a. The contractor undertaking the well construction work must have a current and active well drilling license issued by ADWR.
- b. The well drilling operation shall be under the direct supervision of a qualified representative of the well drilling contractor.
- c. The drill rig shall not be removed from the well site unless one of the following two conditions is satisfied:
 - i. The well is constructed in full compliance with the Arizona Administrative Code, Title 12, Article 8, Section R12-15-811 and R12-15-812 with either a sealed cap or equipped with a pump, or
 - ii. The well is abandoned in compliance with Arizona Administrative Code, Title 12, Article 8, Section R12-15-816.
- d. The well shall not be used as a storage or disposal site for sewage, or other toxic materials that have potential for polluting the ground water.

- e. The owner/contractor shall provide a Notification of Well Drilling Commencement to the ADWR in accordance with the Arizona Administrative Code, Title 12, Article 8, Section R12-15-851.
- f. When the construction is completed, the owner shall file a well completion report with the Director of ADWR pursuant to A.R.S. § 45-600(B).
- g. For wells drilled in tribal areas, the owner/contractor shall obtain all necessary permits for well drilling from the respective tribal administration and also comply with other requirements before and after the drilling of the well.

9. MEASUREMENT

This work shall be complete according to these specifications and shall include all necessary materials for service and operation of this Practice. Necessary components to the completion of this practice includes and are not limited to; disinfection, sampling, water quality testing, grouting, sealing, well caps and all other materials and labor used to install the well.

The final well depth shall be as determined by the well driller. Depth of the well shall be equivalent to 150–feet below the draw down level which is established at the end of a 24 hour pump draw down test. Discharge rate for the pump test shall correspond to the designed well production rate.

10 ITEMS OF WORK AND CONSTRUCTION DETAILS FOR THIS PROJECT:

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
ARIZONA

MATERIAL SPECIFICATION MS642
WATER WELLS
APPENDIX TO CS642

1 SCOPE

This specification governs the quality, material criteria and properties of drilling fluid materials, casing materials, well screen materials, gravel-pack materials, and grouting and sealing materials used in the construction of water wells used for water supply for livestock use and irrigation purposes under NRCS Conservation Practice Standard code 642.

2 MATERIAL

2.1 DRILLING FLUID MATERIAL: When drilling a water well, drilling fluids are used to help remove the formation cuttings, minimize the damage to the formation and stabilize the borehole. Drilling fluids also provide hydrostatic pressure to prevent formation fluids from entering the well bore and keep the drill bit cool.

A Drilling Fluids: Two primary types of drilling fluids acceptable for water well drilling are: (a) fresh water based drilling fluids and (b) air based drilling fluids. Drilling fluids are normally used with other additives to improve their effectiveness. Two types of drilling fluid additives are acceptable for drilling of water wells:

1. *Dissolved Additives: These are further classified as:*
 - a. *Mud thinning agents*
 - b. *Inorganic phosphates*
 - c. *Surfactants*
 - d. *Drilling detergents*
 - e. *Foaming agents*
 - f. *Natural and synthetic polymers*
2. *Nondissolved Additives: These are further classified as:*
 - a. *Native solids (clays and sands)*
 - b. *Bentonite*
 - c. *Density increasing materials*
 - d. *Loss circulation materials. These can not be used in the production zone.*
 - e. *Drilling detergents*
 - f. *Foaming agents*

2.2 CASING MATERIAL: All casing material shall be new or in near new condition. Supplier/manufacturer shall provide a certificate of compliance to the purchaser. Casing can be made of steel or plastic only. Use of fiberglass, concrete, or other material of equivalent strength and durability shall be allowed if a variance for use of such material is granted by the Arizona Department of Water Resources (ADWR) and the State Conservation Engineer. No casing materials containing asbestos shall be allowed. Steel and plastic casings can be used in drilled wells. Only steel pipe casings shall be used in driven wells.

A **Steel Casing:** Steel casing materials can be further classified as single-ply casing materials and two-ply casing materials.

1. *Single-Ply Casing:* Table 1 lists the applicable ASTM specifications for the single-ply steel casing materials.

Table 1 Single-Ply Steel Casing Material and Applicable Specification

Type of Single-Ply Steel Casing Material	Applicable ASTM Specification	Applicable ASTM Volume
Black and hot dipped, zinc coated, welded and seamless single-ply carbon steel well casing pipe	ASTM A53	01.01
Electric –fusion (arc) welded single-ply steel well casing pipe	ASTM A139	01.01
Seamless and welded carbon steel water-well pipe (threaded and coupled)	ASTM A 589	01.01
High strength, low alloy, hot and cold rolled, single-ply steel well casing sheets	ASTM A606	01.03
Welded, unannealed, single-ply stainless steel well casing pipe	ASTM A778	01.01

For minimum thickness of single-ply steel casing, refer to Table 4 of AWWA Standard A100 for Water Wells.

2. *Two-Ply Casings:* Table 2 lists the requirements for physical and chemical properties of high strength corrosion resistant steel material used for two-ply casings.

Table 2: Material Specifications for Two-Ply Steel Casing⁽¹⁾

Material Properties	Description	Specification Limits
Chemical Properties	Carbon	0.20% – 0.30 %
	Manganese	0.85% - 1.30%
	Phosphorous	0.05% maximum
	Sulfur	0.05% maximum
	Silicon	0.12% maximum
	Copper	0.20% maximum
Physical Properties	Yield strength (psi)	55,000 – 70,000
	Ultimate strength (psi)	80,000 – 95,000
	Elongation, percent in 8 in.	17 – 25
	Rockwell “B” hardness	80 – 90
	Elastic ratio	69 - 73
Properties obtained from AWWA A100 Table 2		

Two-ply casing shall consist of an inner and an outer section and each section shall be 4 feet long. Both sections shall be welded along their longitudinal seams and processed such that the outer casing fits snugly to the inner casing. The ends of the sections shall be finished such that the two

sections shall fit snugly around the entire circumference when the ends are placed together. The circumferential joints of the inner and outer sections shall be staggered by placing the inner section joints midway between the outer section joints. After assembly, all outer section joints shall be electrically welded.

For minimum thickness of two-ply steel casing, refer to Table 5 of AWWA Standard A100 for Water Wells.

Alternately, Table 3 provides the maximum depth of installation of steel casing.

Table 3: *Maximum Depth of Installation of Steel Casing*

Wall thickness (uncoated)	Casing Size (in.)									
	4	5	6	8	10	12	14	16	18	24
	Outside Diameter (in.)									
	4.500	5.563	6.625	8.625	10.75	12.75	14.00	16.00	18.00	24.00
Maximum depth (ft.)										
20 Ga (0.036)	60	35	20	0	0	0	0	0	0	0
18 Ga (0.048)	140	75	45	20	0	0	0	0	0	0
16 Ga (0.060)	250	145	90	40	20	0	0	0	0	0
14 Ga (0.075)	460	260	160	80	40	25	20	0	0	0
12 Ga (0.105)	1,040	630	400	200	110	70	50	35	0	0
10 Ga (0.135)	1,810	1,140	750	390	220	135	105	70	50	0
8 Ga (0.164)	2,660	1,740	1,190	640	360	230	180	125	90	0
7 Ga (0.179)	3,130	2,090	1,450	790	460	290	230	160	110	0
3/16 (0.188)	3,415	2,300	1,610	890	520	330	260	180	130	60
7/32 (0.219)	4,430	3,070	2,200	1,260	750	500	390	270	200	90
Sch 40 (0.237)	5,035	---	---	---	---	---	---	---	---	---
¼ (0.250)		3,880	2,840	1,680	1,030	690	550	390	290	130
Sch 40 (0.258)		4,090	---	---	---	---	---	---	---	---
Sch 40 (0.280)			3,490	---	---	---	---	---	---	---
9/32 (0.280)				2,140	1,350	910	730	520	390	180
5/16 (0.312)				2,625	1,690	1,160	930	680	510	240
Sch 40 (0.322)				2,785	---	---	---	---	---	---
11/32 (0.344)					2,065	1,445	1,175	860	650	310
Sch 40 (0.365)					2,325	---	---	---	---	---
3/8 (0.375)						1,970	1,420	1,055	800	390
Sch 40 (0.406)						2,045	---	---	---	---
Sch 40 (0.438)							1,975	---	---	---
7/16 (0.438)								1,490	1,145	580
Sch 40 (0.500)								1,970	---	---
Sch 40 (0.562)									1,965	---
Sch 40 (0.668)										1,645

2. *Plastic Casing:* Thermoplastic or plastic casings shall be made of Acrylonitrile-Butadiene-

Styrene (ABS), Poly-Vinyl-Chloride (PVC) or Styrene Rubber (SR) and shall conform to the requirements in ASTM F480.

Plastic pipe manufactured for water or irrigation pipelines can be used if it is NSF certified and if the quality of the pipe equals or exceeds that specified in ASTM F 480. Refer to Table 4 for the maximum depth of installation of SDR pipes and Table 5 for the Schedule 40 and Schedule 80 pipes.

***Table 4: *Maximum Depth of Installation (feet) for Selected Plastic Pipe (SDR-PR)*¹**

Material			
SDR	PVC	ABS	SR
13.5	1080	950	865
17	515	450	415
21	265	230	210
26	135	115	105
32.5	65	N/A	N/A

* These depth values are based on the hydraulic collapse pressure in Table K.4 (for PVC), Table K.5 (for ABS) and Table K.6 (for SR) of AWWA Standard A100 for Water Wells. These values are obtained by rounding down the equivalent depths to the nearest 5 feet.

***Table 5: Dimensions and Maximum Depth of Installation for PVC-12454
Schedule 40 and Schedule 80 Plastic Pipe¹**

Nominal Diameter (inch)	Outside Diameter (inch)	Schedule 40			Schedule 80		
		Minimum Wall Thickness (inch)	SDR	Maximum Depth (feet)	Minimum Wall Thickness (inch)	SDR	Maximum Depth (feet)
2	2.375	0.154	15.4	705	0.218	10.9	2180
2-1/2	2.875	0.203	14.2	920	0.276	10.4	2560
3	3.500	0.216	16.2	600	0.300	11.7	1730
3-1/2	4.000	0.226	17.7	450	0.318	12.6	1355
4	4.500	0.237	19.0	360	0.337	13.4	1140
5	5.563	0.258	21.6	240	0.375	14.8	805
6	6.625	0.280	23.7	180	0.432	15.3	720
8	8.750	0.322	26.8	120	0.500	17.3	495
10	10.750	0.365	29.5	90	0.593	18.1	420
12	12.750	0.406	31.4	75	0.687	18.6	385
14	14.000	0.437	32	70	0.750	18.7	380
16	16.000	0.500	32	70	0.843	19.0	360

* These depth values are based on the hydraulic collapse pressure in Table K.4 of AWWA standard A100 for Water Wells. These values are obtained by rounding down the equivalent depths to the nearest 5 feet.

- 2.3 **WELL SCREEN MATERIAL:** Unless otherwise specified, the material used for well screen and its fittings shall be American Iron and Steel Institute (AISI) type 304-stainless steel. Material supplier/manufacturer shall provide a certificate of compliance to the purchaser.
- 2.4 **GRAVEL PACK MATERIAL:** Gravel pack material shall be a clean washed material free of shale, dirt, clay, mica, and other organic impurities and conform to the property requirements listed in Table 6. The material shall also not contain copper, lead, manganese, iron or other heavy materials in quantities or forms as to adversely affect the quality of well water.

Table 6: Material Specifications for Gravel Pack (Source AWWA A100)

Material Properties	Specification Limits
Average Specific Gravity	≥ 2.50
Minimum Specific Gravity	≥ 2.250
Thin, elongated pieces with maximum to minimum dimension ratio more than 3	≤ 2% by weight
% gravel that is soluble in hydrochloric acid	≤ 5% by weight
Gravel pack to formation ratio (ration of 50 th or 70 th percentile retained of both materials)	6:1 to 4:1
Uniformity Coefficient	≤ 2.5

Gradation of gravel pack material shall be performed per ASTM C136 and the selected gradation should conform to the limits listed in Table 6. Table 6 is derived from the information contained in AWWA A100.

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), or bentonite-based grout. 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.

If the water is intended for human consumption, the casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions.

- 2.5 **GROUTING AND SEALING MATERIAL:** Cement mortar containing expansive hydraulic cement (ASTM C845) or bentonite based grout shall be used to seal the annulus surrounding the permanent well casing for the first 19 feet of buried length. For the remaining portion, any grouting and sealing materials meeting the requirements in Table 7 will be acceptable. When concrete seal is used, it shall not be placed in an annular space with less than 3 inch in radial thickness.

Table 7: *List of approved grout and sealant materials*

Material Type	Applicable Specification	Properties	Specification. Limit
Neat Cement	ASTM C 150	Type of cement Water content Bentonite Calcium Chloride	Type 2 ≤ 6 gal./sack ≤ 6% by weight ≤ 2% by weight
Expansive Hydraulic Cement	ASTM C 845	Per ASTM C 845	Per ASSTM C 845
Concrete	ASTM C33	Type 2 Cement Water content Slump Coarse aggregate Sand Max. Agg. size	5.3 sacs/cu. Yd. ≤ 7gal./sack of cement ≤ 4 53% 47% 3/4 inch
Bentonite Grout	Manufacturer's instructions	Solid content	≥ 20%
Information provided in this table is derived from AWWA A100			

- 2.6 **ADDITIONAL INFORMATION:** Refer to AWWA Standard A100 for Water Wells for additional information not covered in this specification.