

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WATER WELL

(No.)

CODE 642

DEFINITION

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

PURPOSE

Provide water for livestock, wildlife, irrigation, human, and other uses.

Provide for general water needs of farming/ranching operations.

Facilitate proper use of vegetation on rangeland, pastures, and wildlife areas.

CONDITION WHERE PRACTICE APPLIES

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

This practice applies only to production wells. Specifically excluded are any types of wells installed solely for monitoring or observation purposes; injection wells; and piezometers. The standard does not apply to pumps installed in wells; above ground installations, such as pumping plants, pipelines, and tanks; temporary test wells; and decommissioning of wells (ASTM D5299).

FEDERAL, STATE, AND LOCAL LAWS

Well construction and installation shall comply with all federal, state, and local laws, rules or regulations. In California, counties are required to adopt well standards that equal or exceed those developed by the California Department of Water Resources. The operator is responsible for securing permits if required.

CRITERIA

Suitability of Site. The availability of ground water for its intended use at the site shall be determined by using reliable local experience and reviewing all available relevant geologic maps and reports; well records maintained by state and

federal agencies; and design, construction, and maintenance records of nearby wells. An appropriate level of investigation, including test well drilling, is conducted on-site, as needed, prior to well construction to determine site-specific hydrogeologic conditions.

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

Drilling Contractors. California State Law requires that wells be constructed by contractors licensed in accordance with the provisions of the Contractors License Law (Chapter 9, Division 3, of the Business and Professions Code) unless exempted by that act.

Well Head Protection. Wells shall be located a safe distance from potential sources of pollution, including unsealed abandoned wells. The allowable distance shall be based on consideration of site-specific hydrogeologic factors and shall comply with requirements of all applicable state or local regulations or construction codes.

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

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

The wellhead area shall be reasonably protected from damage that might be incurred by livestock, vehicles, acts of carelessness, and vandalism.

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

Use of Casing. Casing shall be installed to seal out undesirable surface or shallow ground water and to support the side of the hole through unstable earth materials. The intake portion of a well through stable geologic materials may not require casing.

Casing Diameter: Casing diameter shall be sized to permit satisfactory installation and efficient

operation of the pump, and large enough to assure that uphole velocity is 5 feet per second or less, to protect against excessive head loss.

Materials. Casings may be of steel, iron, stainless steel, copper alloys, plastic, fiberglass, concrete, or other material of equivalent strength and durability consistent with the intended use of the water and the maximum anticipated differential head between the inside and outside of the casing.

Steel well casings shall meet or exceed requirements specified in ASTM A589. Steel pipe manufactured for other purposes may be used if the quality of the pipe meets or exceeds requirements specified in ASTM A589.

Neither used steel pipe nor galvanized sheet metal pipe such as 'downspout' tile pipe shall be used as well casing. To prevent galvanic corrosion, dissimilar metals shall not be joined.

Only steel pipe casings shall be used in driven wells.

Plastic casings and couplings made of acrylonitrile-butadiene-styrene (ABS) or polyvinyl chloride (PVC) shall conform to material, dimensional, and quality requirements specified in ASTM F480.

Plastic pipe manufactured for water or irrigation pipelines may be used if the quality equals or exceeds requirements specified in ASTM F480.

If the water is to be used for human consumption, plastic pipe shall be approved by the National Sanitation Foundation.

Filament-wound fiberglass casings (glass-fiber-reinforced-thermosetting-resin pipe, RTRP) may be used if material meets requirements specified in ASTM D2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM D 2996 are not needed because the pipe is to be used for well casing.

Fiberglass pressure pipe, (reinforced plastic mortar pipe, RPMP, or fiberglass pipe with aggregate) shall meet or exceed requirements specified in ASTM D3517.

Casing Strength. Well casing wall thickness shall be sufficient to withstand all anticipated static and dynamic pressures imposed on the casing during installation, well development, and use. Required casing strength shall be determined as shown in NEH Part 631, Chapter 33, Investigations for Ground Water Resources Development, and summarized in Practice Specification 642.

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

Screen. Well screens shall be installed in any aquifer material likely to produce silt or sand. Well screens may be constructed of commercially manufactured screen sections, well points, or field-perforated sections. The length and open area of the screen shall be sized to limit entrance velocity of water into the well to less than or equal to 0.1 foot per second. Perforation by any method is allowable provided proper slot size and entrance velocity limits can be met.

Depth of the aquifer below ground surface and the thickness of aquifer to be penetrated by the well shall govern the position of the screen in the well. Maximum drawdown shall not be permitted below the top of the highest screen or pump intake.

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

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

The designed gradation and thickness of the gravel pack shall be provided by the contractor and shall be approved by NRCS prior to installation.

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

Installation. Casing shall extend from above the ground surface down through unstable earth materials to an elevation of at least 2 feet into stable material or to the top of the screen.

All wells shall be cased to a sufficient height (minimum of 12 inches) above the ground surface to prevent entry of surface and near-surface water.

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

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

Grouting and Sealing. The annulus surrounding the permanent well casing at the upper terminus of the well shall be filled with mortar containing expansive hydraulic cement (ASTM C845), 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. Water well standards issued by the State of California require that the grout seal extends at least 20 feet deep in agricultural and individual domestic wells. Exceptions to minimum seal depths can be made for shallow wells at the approval of the enforcing agency, where the water to be produced is at a depth less than 20 feet. In no case shall an annular seal extend to a total depth less than 10 feet below land surface. County and local requirements may be more restrictive.

The casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions. The upper surface of the base shall slope away from the well casing. Contacts between the base and the annular seal, and the base and the casing, shall be water tight and shall not cause the failure of the annular seal or the well casing.

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

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

Aquifer Development. For massive, unfractured rock that is unresponsive to well development procedures, the use of aquifer stimulation techniques may be considered to improve well efficiency and specific capacity. Techniques may

include dry ice, acidizing, explosives, or hydrofracturing, depending on the composition and structure of the formation.

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

The method of well development used shall be selected based on geologic character of the aquifer, type of drilling rig, and type of screen (Driscoll, chap. 15).

Disinfection. Wells shall be disinfected immediately following their construction or repair to neutralize any contamination from equipment, material, or surface drainage introduced during construction. The disinfection process shall comply with all local or state requirements.

Water Quality Testing. Sampling and testing shall comply with all applicable federal, state, and local requirements. These requirements vary according to the water quality parameters associated with the intended use(s) of the water. Refer also to NRCS Conservation Practice Standard 355, Water Well Testing, and to the California Water Well Standards.

Reporting. As required by California State Law, the well drilling contractor shall complete a Well Completion Report and file it with the California Department of Water Resources (DWR) in accordance with DWR instructions available online.

CONSIDERATIONS

The potential for adverse interference with existing nearby production wells shall be evaluated in planning.

The potential for ground water overdraft and the long-term safe yield of the aquifer shall be considered in planning.

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

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

Cultural Resources. NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with websites for additional information.

Endangered Species. Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses.

OPERATION AND MAINTENANCE

A plan for maintenance of a well shall be prepared. The well construction records shall be kept on file with the maintenance plan by the owner/operator. As a minimum, the plan shall include a statement of identified problems, corrective action taken, date, and specific capacity (yield per unit drawdown) of well before and after corrective action was taken.

REFERENCES

USDA-NRCS, Nov. 1998, Investigations for Ground Water Resources Development: National Engineering Handbook, Part 631, Chapter 33. <http://www.info.usda.gov/CED/ftp/CED/neh631-33.pdf>.

California Department of Water Resources, Nov. 1999, How to Fill Out a Well Completion Report: DWR Instruction Manual by Carl Hauge, 29 p., http://www.dpla.water.ca.gov/sd/groundwater/publications/wcr_instruction_pamphlet.pdf.

California Department of Water Resources, Southern District, 1998, California Well Standards: online integration of DWR Bulletins 74-81 and 74-90 (last modified June 10, 2004), http://www.dpla.water.ca.gov/sd/groundwater/california_well_standards/well_standards.html.

Driscoll, F.G., 1986, Groundwater and Wells: 2nd ed., Johnson Division, St. Paul MN, 1089 p.

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

642 – WATER WELL

I. SCOPE

The work shall consist of drilling, casing, and developing a well at the location shown on the attached map.

II. SITE PREPARATION

The area immediately surrounding the well site shall be cleared, smoothed, and graded to allow for a safe and dry working area.

III. WELL DIAMETER

The diameter of the well shall be adequate to permit satisfactory installation and efficient operation of the pump, and large enough to assure that uphole velocity is 5 feet per second or less, to protect against excessive head loss.

IV. CASING MATERIALS

The specific material requirements for the casing and other site requirements are as listed on the “Practice Requirement” sheet.

The well casing pipe shall be marked according to the ASTM specification for the material used.

All well casing pipe and couplings shall be homogeneous throughout and shall be free from visible cracks, holes, foreign materials, or other injurious defects. The well casing pipe and couplings shall be as uniform in color, density, and other physical properties as is commercially possible.

Casings may be of steel, iron, stainless steel, copper alloys, plastic, fiberglass, concrete, or other material of equivalent strength and durability consistent with the intended use of the water and the maximum anticipated differential head between the inside and outside of the casing. Only steel pipe shall be used for driven wells.

Steel

Steel pipe used for well casing shall meet or exceed requirements specified in ASTM A589.

The casing depth and nominal size shall be used to determine the minimum thickness for the steel water well casing, as shown in **Table 1**. A thinner casing may be used if it is determined that it will not collapse, based on analysis using the Timoshenko Elastic Formula and

guidelines set forth in NRCS National Engineering Handbook (NEH) Part 631, Chapter 33 (<http://www.info.usda.gov/CED/ftp/CED/neh631-33.pdf>). Thicker casing shall be used where corrosive conditions are expected.

Neither used steel pipe nor galvanized sheet metal pipe such as “downspout” tile pipe shall be used as well casing.

Plastic

Plastic pipe used for well casing may be made of acrylonitrile-butadiene-styrene (ABS) or polyvinyl chloride (PVC), and shall meet or exceed requirements specified in ASTM F480. Plastic casing for wells that provide potable water shall be NSF approved.

Used casing and casing with eccentricity > 1.5% (0.015) or other defects shall not be used.

The modulus of elasticity and SDR marked on the pipe shall be used to determine maximum allowable depth, as shown in **Figure 1**. Greater depths may be used if it is determined that it will not collapse, based on a site-specific determination of the maximum differential head using Clinedinst Equation provided in **Figure 1**.

Acrylonitrile-butadiene-styrene (ABS). ABS pipe used for water well casing shall meet or exceed the requirements specified in ASTM Specification D1527 (for Schedule 40 and 80 pipe) or D2282 (for SDR Series pipe). Neither ABS 1208 nor ABS 1210 shall be used; they do not meet the minimum strength requirements of ASTM F480.

Polyvinyl-chloride (PVC). PVC pipe used for water well casing shall meet or exceed requirements specified in ASTM D1785 (for Schedule 40, 80, and 120 pipe) or in ASTM D2241 (for SDR series pipe).

Fiberglass

The modulus of elasticity for fiberglass pipe shall be certified for use in determining maximum depth.

Fiberglass casing for wells that provide potable water shall be NSF approved.

RTRP. Glass-fiber-reinforced-thermosetting-resin pipe (RTRP) used for well casing shall meet or exceed requirements specified in ASTM D2996. Tests for long-

term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM D2996 are not needed.

RPMP. Reinforced plastic mortar pipe (RPMP) used for well casing shall meet or exceed requirements specified in ASTM D3517. The casing size and depth shall be used to determine the minimum thickness for the RPMP water well casing, as shown in **Table 2**. Thinner casing may be used if an evaluation using manufacturer's data documents that it will not collapse given the geologic, hydraulic, and construction conditions at the site.

Concrete

Concrete well casings shall be reinforced and shall meet or exceed the requirements of ASTM C76. The minimum 28-day compressive strength shall be 4,000 lbs./in².

Joints

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

Couplings used with plastic well casing may be solvent cement or threaded, and shall have a strength equal to or greater than the pipe to which they are attached. Couplings shall be made of a material compatible with the casing and recommended for use by the casing manufacturer. If they are made of material susceptible to corrosion, provisions must be made to protect them. Threaded couplings for SDR pipe shall conform to requirements set forth in ASTM F480.

Solvent cement must meet the requirements of the ASTM specification appropriate for the material used:

ABS	D2235
PVC	D2564

V. SCREEN AND FILTER PACK MATERIALS

Screen

All screen materials shall be homogeneous throughout and shall be free from visible cracks, holes, foreign materials, or other injurious defects.

The length and open area of the screen shall be sufficient to limit entrance velocity of water into the well to less than or equal to 0.1 feet per second.

Well screens may be constructed of commercially manufactured screen sections, well points, or field-perforated sections. Perforation by any method is allowable provided proper slot size and entrance velocity

limits can be met.

For naturally developed wells in which the screen is placed in direct contact with graded aquifer materials, the screen openings shall be such that 25 to 40 percent of the aquifer material is larger than the screen opening. The screen openings for aquifer material of near uniform size shall be slightly smaller than the average diameter of the aquifer material.

In wells using a gravel packed envelope, the screen shall have openings of a size that will exclude at least 85 percent of the gravel pack material.

Filter Pack

Where a filter pack is used, the designed gradation and thickness shall be provided by the contractor and shall be approved by NRCS prior to installation.

The filter pack materials shall be washed, screened, and disinfected with a solution of at least 100 mg/L chlorine. They shall consist of at least 95 percent rounded, dense, siliceous materials with less than 5 percent flat particles (such as mica), earthy or soft materials (such as clay, shale, or anhydrite), or highly soluble limestone or gypsum. The specific gravity of the filter pack shall equal or exceed 2.5, and the D₃₀ grain size shall be 4 to 12 times the D₃₀ grain size of the aquifer material.

The inside diameter of the tremie pipe shall be at least 12 times the diameter of the coarsest pack material if placed by gravity, and at least 10 times if pumped.

Filter pack materials shall be delivered to the well site on approval of the purchaser. Materials shall be protected from the weather and contamination until installed. Materials that come in contact with the ground shall not be used.

Pre-Packed Well Screens. A commercial prepacked well screen may be substituted for a conventionally installed (by tremie) filter pack, provided the screen/filter assembly meets criteria set forth in this specification.

VI. INSTALLATION

Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits. The owner, operator, contractor or other persons will conduct all work and operations in accordance with proper safety codes for the type of construction being performed with due regards to the safety of all persons and property.

The completed job shall be workmanlike and present a good appearance.

Drilling

Only clean, potable water shall be used in drilling fluid, whether employed alone or in combination with drilling

additives. If organic drilling fluids are used, they must be broken down chemically according to the manufacturer's recommendations before or during development.

Lead- and mercury-bearing materials shall be strictly prohibited from the wellhead area during construction.

Whenever there is an interruption of work on the well (e.g. overnight shutdown, inclement weather), the well opening shall be closed and secured with a cover designed to ensure public safety, prevent damage to the well, and prevent introduction of unwanted materials into the well. The contractor shall be responsible for any objectionable material that may fall into the well and the effect it may have on water quality, until completion and acceptance of the work by the land operator and NRCS.

Alignment. Drilled wells shall be round, plumb, and aligned so as to permit satisfactory installation and operation of a pump of the proposed size and type to the greatest anticipated depth of setting.

The maximum allowable horizontal deviation (drift of the well from vertical) shall not exceed two-thirds of the smallest inside diameter of that part of the well being tested per 100 feet of depth.

Casing

All wells shall be cased to a sufficient height above the ground surface to prevent the entry of surface and near surface water. The height of the casing above the ground surface shall not be less than one foot.

In consolidated formations, the casing shall extend through the overburden material to an elevation at least 2 feet into consolidated materials.

In unconsolidated formations, the casing shall extend to the screen.

Joining

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

Screen and Filter Pack

Where practical, the top elevation of the screen should be below the lowest water level expected during pumping and be located opposite the most permeable areas in water-bearing strata. Screens shall have a minimum length of 2 feet.

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

Centralizers. Provisions shall be made for centering the casing in the filter pack. Centering guides (centralizers)

shall be installed if casing and/or screen assemblies over 40 feet long are installed in drill holes having nominal diameters 2 inches or larger than the outside diameter of the casing.

To prevent galvanic corrosion, metallic guides shall be of the same alloy as the casing or screen assembly to which they are attached. Metallic guides shall not be directly welded to the screen, but rather on short sections of blank casing that can be inserted into the well at the desired interval.

Filter Pack. Where a filter pack is to be installed, the diameter of the drilled hole shall provide for adequate annular space to permit the passage of the tremie pipe(s), including couplings.

Filter pack material shall be placed with a tremie pipe from the bottom up in such a manner as to prevent segregation, bridging, or inclusion of excess material from the borehole sidewalls. The top of the tremie pipe shall be fitted with funnel fittings so the filter pack can be shoveled or dumped into the tremie. Clean water may be mixed with the filter pack to facilitate placement. The filter pack shall be placed so that the actual volume used can be calculated to within 10 percent.

Filter pack material shall extend a minimum of 20 feet above the top of the highest screened or perforated section and shall extend through the entire length of the water-bearing formation penetrated by the well.

Sealing and Grouting

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 water-bearing units where co-mingling of waters is undesirable.

A transition seal consisting of a 2-foot length of fine-grained sand shall be placed between the filter pack and the neat cement.

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.

The annulus surrounding the permanent well casing at the upper terminus of the well shall be filled with expansive hydraulic cement (ASTM C845), shrinkage-compensating concrete, bentonite-based grout, clay, or other material with similar sealing properties.

Dry additives should be mixed with dry cement before adding water to the mixture to ensure proper mixing, uniformity of hydration, and an effective and homogeneous seal. The water demand of additives shall be taken into account when water is added to the mix.

California Water Well Standards require that the grout seal extends at least 20 feet deep in agricultural and individual domestic wells. Exceptions to minimum seal depths can be made for shallow wells at the approval of NRCS, where the water to be produced is at a depth less than 20 feet. In no case shall an annular seal extend to a total depth less than 10 feet below land surface. County and local requirements may be more restrictive.

The casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions. The upper surface of the base shall slope away from the well casing. Contacts between the base and the annular seal, and the base and the casing, shall be water tight and shall not cause the failure of the annular seal or the well casing.

VII. APPURTENANCES

Sanitary well seal. On completion, the well shall be provided with a suitable threaded, flanged, or welded cap or compression seal to prevent entry of contaminants into the well.

Air release valves shall be placed in the well system to provide a positive means for air escape or air entrance as specified by the Engineer

Access Port. Every well shall be constructed with an opening of at least ¾ inch in diameter in the casing above the ground level to allow a measuring line to be inserted between the outside casing and the pump column. A removable cap shall be provided.

VIII. DEVELOPMENT

Wells to be completed without a filter pack in unconsolidated granular aquifers shall be developed following guidelines set forth in ASTM D5521. The method shall be selected based on the geologic character of the aquifer, type of drilling rig, and type of screen.

The well shall be developed at a continuous discharge rate of up to 120 percent of the anticipated normal production rate, until it has stopped producing detrimental quantities of solid particles and when the predetermined fraction of the filter pack has been removed.

If water from the well is intended for human consumption, sand content shall not exceed 10 mg/L when the well is pumped at a discharge rate of 150 percent greater than the anticipated normal production rate against the total lift.

The discharge at particular rates may be held constant for as long as 2 hours. The test pump shall have neither a check nor foot valve, so that backwashing occurs when the power is shut off. Any sand damage to the pump is the responsibility of the contractor.

After aquifer development is complete, the accumulated sediment shall be removed from the bottom of the well bore by pumping or bailing.

IX. DISINFECTION

The well shall be disinfected immediately following construction, following guidelines set forth in Appendix C of the California State Well Standards (http://www.dpla.water.ca.gov/sd/groundwater/california_well_standards/b74-81appendixc.html), and in accordance with any additional county or local requirements.

X. TESTING

Water Level and Yield

A pump test shall be conducted to estimate the capacity of the well. The test should last until an apparently stable pumping level has been achieved at a rate equal to that expected for the permanent pump.

The following data shall be collected and recorded on the Well Completion Report: date of test; static water level; corresponding values of discharge, drawdown, and length of test run; and water level measured approximately one day after the test.

Water Quality

Sampling and testing shall comply with all applicable federal, state and local requirements. These requirements vary according to the water quality parameters associated with the intended use(s) of the water. Refer also to NRCS Conservation Practice Standard 355 - Water Well Testing, and to Appendix D of the California Water Well Standards.

XI. REPORTING

Reports concerning the construction, alteration, or destruction of water wells shall be filed with the California Department of Water Resources in accordance with the provisions of Sections 13750 through 13755 (Division 7, Chapter 10, Article 3) of the California Water Code.

The contractor shall complete a Well Completion Report and file it with the appropriate DWR office. A copy shall be provided to the landowner.

XII. ABANDONMENT OF A DRY HOLE

If a dry well is to be permanently abandoned, it shall be completely filled in such a manner that vertical movement of water within the well bore cannot occur. Refer to Conservation Practice Standard 351, Well Decommissioning.

XIII. MEASUREMENT

The amount of well drilling is measured to the nearest foot of well drilled and cased. Wells abandoned for causes other than actions of the contractor will be included in the measurement.

The amounts of pipe and well screen installed are measured to the nearest linear foot at the time the riser is assembled. Pipe and well screen that cannot be salvaged from wells abandoned for causes not attributed to actions of the contractor will be included in the measurement.

The couplings, special fittings, and appurtenances are counted at the time the riser is assembled. Couplings, special fittings, and appurtenances that cannot be

salvaged from wells abandoned for causes not attributed to actions of the contractor will be included in the measurement.

The time required to develop the well is measured to the nearest half-hour. Time required to develop wells abandoned for causes not attributed to actions of the contractor will be included in the measurement.

Table 1. Minimum thickness for **steel** water well casings

O.D. (inches) ->		Nominal Casing Size (in)									
		4	5	6	8	10	12	14	16	18	24
Casing Depth (feet)	10-50	18	16	14	12	12	12	12	10	8	3/16
	51-100	16	14	12	12	12	10	10	8	7	7/32
	101-150	16	14	12	12	10	8	8	7	7/32	9/32
	151-200	16	14	12	12	10	8	7	7/32	7/32	5/16
	201-300	14	12	10	10	8	7	7/32	1/4	9/32	7/16
	301-500	12	12	10	8	3/16	7/32	1/4	9/32	5/16	7/16
	501-800	12	10	3/16	3/16	1/4	9/32	5/16	3/8	3/8	5/8

Thickness in U.S. Standard Gauge*

Thickness in inches

* 18 Ga = 0.048 in; 16 Ga = 0.60 in; 14 Ga = 0.075 in; 12 Ga = 0.105 in;
10 Ga = 0.135 in; 8 Ga = 0.164 in; 7 Ga = 0.179 in

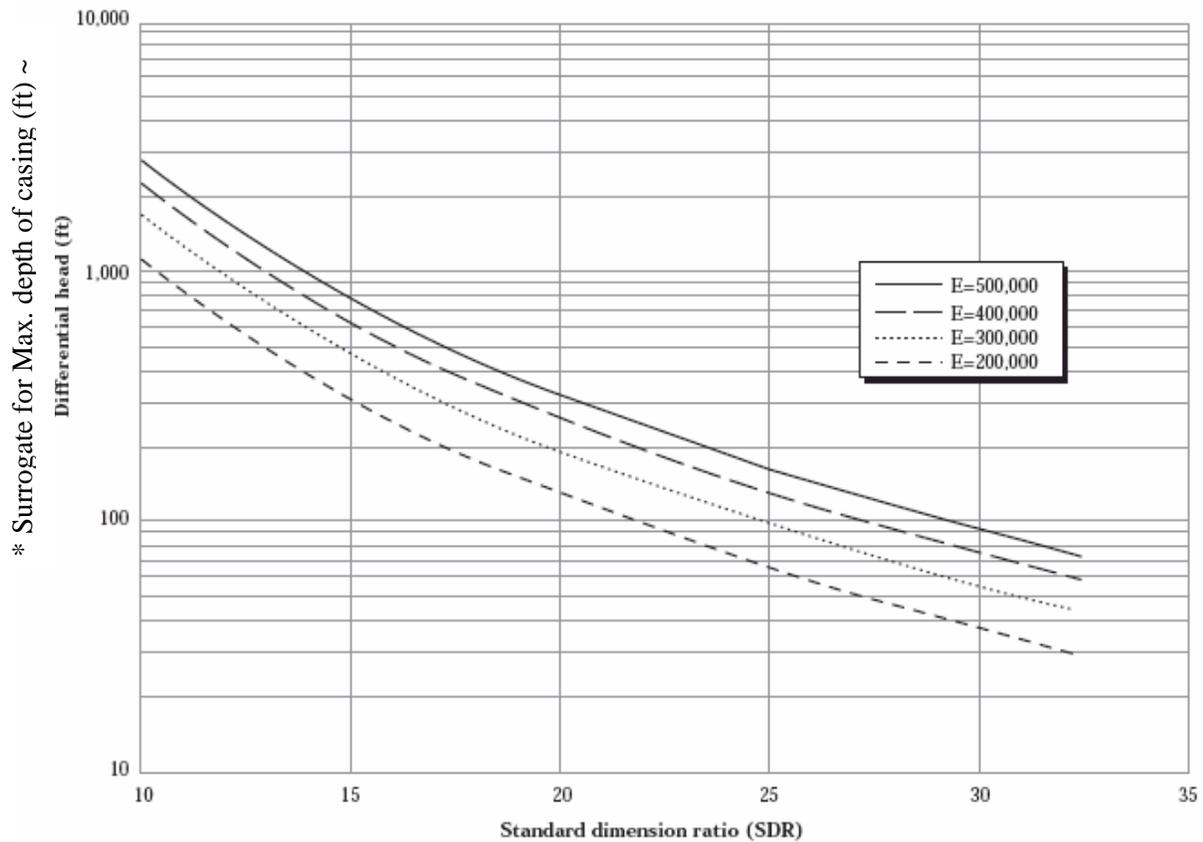
Table 1 values are based on information from two sources: 1) Suggested minimum thickness for steel water well casing in Roscoe Moss Company's "A Guide to Water Well Casing and Screen Selection" (http://www.roscoemoss.com/c-s_selection.html); and 2) Differential head limitations for Grade B carbon steel casings listed in Table 33-1 of NRCS NEH Part 631, Chapter 33, Investigations for Ground Water Resources Development (<http://www.info.usda.gov/CED/ftp/CED/neh631-33.pdf>). Note that maximum differential head \neq casing depth, resulting in relatively conservative values.

Table 2. Minimum wall thickness for reinforced plastic mortar (RPMP) water well casings

Casing Depth (feet)		Diameter (inches)							
		8	10	12	14	16	18	24	36
Casing Depth (feet)	10-60	0.17	0.17	0.19	0.22	0.25	0.28	0.38	0.48
	61-200	0.23	0.28	0.34	0.34	0.36	0.40	0.48	0.65
	201-300	0.23	0.28	0.34	0.40	0.46	0.46	0.48	0.65
	301-500	0.29	0.36	0.43	0.46	0.46	0.46	0.57	0.82
	501-750	0.33	0.41	0.46	0.46	0.46	0.52	0.57	0.82

Table 2 values are taken from Table 33-4 of NRCS NEH Part 631, Chapter 33, Investigations for Ground Water Resources Development (<http://www.info.usda.gov/CED/ftp/CED/neh631-33.pdf>), which reports minimum wall thicknesses based on maximum differential head for different size casings] Note that maximum differential head \neq casing depth, resulting in relatively conservative values. No information regarding the method of calculation and/or the source of the data was provided.

Figure 1. Maximum depth* of casing for **plastic** pipe.



Taken from Figure 33-2 in the National Engineering Handbook (NEH) Part 631, Chapter 33, Investigations for Ground Water Resources Development (<http://www.info.usda.gov/CED/ftp/CED/neh631-33.pdf>). Curves are generated using the Clinedinst Equation, which may be used to interpolate between curves and/or for direct calculation:

$$P_{cr} = \frac{2E}{(1-u^2)[SDR(SDR-1)^2]} \quad \text{where} \quad \text{Differential Head (ft)} = 2.31(P_{cr})$$

P_{cr} = critical collapse pressure (psi); E = Young's modulus of elasticity (psi); u = Poisson's ratio (assumed =0.38); SDR = standard dimension ratio (casing O.D./wall thickness of casing in inches)

* Differential head applies to the difference in water levels between the inside and outside of the casing. Maximum casing depth is here assumed to serve as a conservative surrogate for the maximum differential head

OPERATION AND MAINTENANCE ITEMS

A properly operated and maintained well is an asset to your farm. This well was designed and installed to provide water utilization. The estimated life span of this system is at least 10 years. The life of this system can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This program will require you to perform periodic operation and maintenance to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program.

Maintain the well cover securely in place.

Protect the area from being damaged by agriculture machinery, vehicles, or livestock.

All fences, railings, and/or warning signs shall be maintained to provide warning and/or prevent unauthorized human or livestock entry.

Do not allow any foreign debris to accumulate in the immediate vicinity.

Maintain soil and vegetative covering to the design conditions.

Eradicate or otherwise remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.

Check metal surfaces for rust and other damage especially sections in contact with earthfill and with other materials. Repair or replace damaged section and apply paint as a protective covering.

Keep all surface water from entering or accumulating at the immediate vicinity of the well site.

Immediately repair any vandalism, vehicular, or livestock damage to any earthfills, spillways, or outlets of other apparatuses.

Other items specific to your project are listed on "Practice Requirement" sheet.

U.S DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
CALIFORNIA

**PRACTICE REQUIREMENTS
FOR
642 – WATER WELL**

For: Business Name _____
Job Location _____
County _____ RCD _____ Farm/Tract No. _____
Referral No. _____ Prepared By _____ Date _____

IT SHALL BE THE RESPONSIBILITY OF THE OWNER TO OBTAIN ALL NECESSARY PERMITS AND/OR RIGHTS, AND TO COMPLY WITH ALL ORDINANCES AND LAWS PERTAINING TO THIS INSTALLATION.

Installation shall be in accordance with the following drawings, specifications and special requirements. NO CHANGES ARE TO BE MADE IN THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF THE NRCS TECHNICIAN.

1. Drawings, No. _____
2. Practice Specifications _____
3. Type of casing: _____ Size _____ in; Wall thickness _____ in.
4. Length of casing _____ Length of perforated section _____
5. Type and size of perforations: _____
6. Gravel pack gradation: _____
7. Special Requirements: _____

8. Special Maintenance Requirements: _____

PRACTICE APPROVAL:

Job Classification: (Ref: Section 501 NEM)

Show the limiting elements for this job. This job is classified as, Class _____

Limiting elements:	Units
<u>Purpose of Well (domestic/nondomestic)</u>	_____ ea
<u>Design Yield</u>	_____ gpm
_____	_____
_____	_____

Design Approved by: _____ Date: _____

LANDOWNER'S/OPERATOR'S ACKNOWLEDGEMENT:

The landowner/operator acknowledges that:

- a. He/she has received a copy of the drawings and specification, and that he/she has an understanding of the contents, and the requirements.
- b. He/she has obtained all the necessary permits.
- c. No changes will be made in the installation of the job without prior concurrence of the NRCS technician.
- d. Maintenance of the installed work is necessary for proper performance during the project life.

Accepted by: _____ Date: _____

PRACTICE COMPLETION:

I have made an on site inspection of the site (or I am accepting owner/contractor documentation), and have determined that the job as installed does conform to the drawings and practice specifications.

Completion Certification by:

/s/ _____ Date _____

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

642 – WATER WELL

OPERATION AND MAINTENANCE

Sponsor/Land user: _____ Date: _____

Address: _____

Location GPS Coordinates Map Datum: _____ E _____ N _____

Quad Sheet Name _____ SEC _____ T _____ R _____

A properly operated and maintained water well is an asset to your operation. All wells will eventually require some degree of maintenance or rehabilitation, regardless of construction methods or materials used. This time span depends on many factors, including:

- * Aquifer characteristics
- * Ground water chemistry
- * Well design and materials
- * Well installation procedures
- * Pumping rates and equipment quality

This practice will require you to perform periodic operation to maintain satisfactory performance. The estimated life span of this installation is at least 10 years. Here are some recommendations to help you develop a good operation and maintenance program:

GENERAL RECOMMENDATIONS

- Follow all manufacturer's instructions on operation and maintenance for the pump and any additional appurtenances installed.
- Keep accurate, detailed records, including a copy of the driller's log; design information about the casing, screen, filter pack, development, pump, and appurtenances; pump test dates and results; maintenance dates and details; and well and pump performance.
- Monitor output, looking for variations in volume, turbidity, color, and sand content. Also monitor the pump for any unusual noise, vibrations, or increased temperature.
- Check concrete pad and any visible grout seals for cracking or settlement.
- Check condition and security of well cap, air vent, and power line.
- Test water quality at regular intervals, depending on the local water quality and intended use of the water.
- Check level of aggregate in filter-packed wells, and refill as needed.

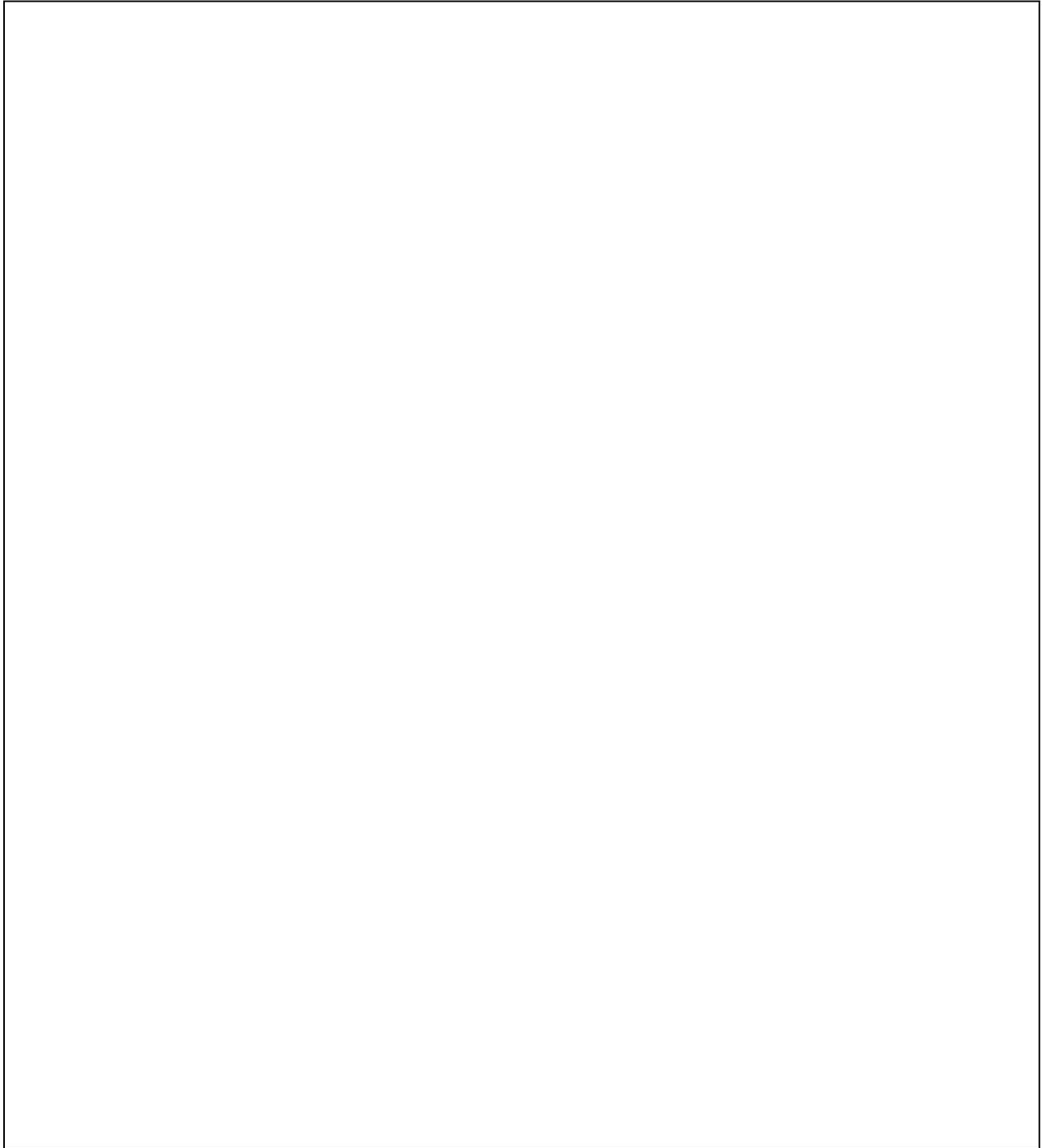
- Exercise shut-off valves regularly so that they remain functional. Monitor the ground surface in vicinity of well for wet spots or seeps. Check flow rate periodically. Keep well shut off when not being used to maintain pressure and conserve resources.
- All fences, railings, and/or warning signs shall be maintained to provide warning and/or prevent unauthorized human or livestock entry.
- Do not allow trash or debris to accumulate in the wellhead area.
- Inspect for damage from rodents or burrowing animals. Repair any damage. Take appropriate corrective actions to alleviate further damage.
- Check metal surfaces for rust and other damage especially sections in contact with earthfill and with other materials. Repair or replace damaged section and apply paint as a protective covering.
- Keep all surface water from entering or accumulating at the immediate vicinity of the well site.
- Immediately repair any vandalism, vehicular, or livestock damage.

MAINTENANCE PLAN

Inspection and routine maintenance schedules should be established, based on the individual characteristics of the well and pump. Evaluations are particularly important for high yield irrigation wells and those wells where even a temporary interruption in water supply would have serious economic consequences.

The evaluation should include a careful inspection of the site and equipment, and the performance of a pumping test. Normally, high-capacity wells should be pump tested annually. Every few years may be sufficient for low-capacity wells pumped intermittently at low rates. Follow the manufacturer's instructions for high capacity wells.

SPECIFIC RECOMMENDATIONS FOR YOUR WATER WELL



CONTACT YOUR LOCAL NATURAL RESOURCES CONSERVATION SERVICE OFFICE FOR ANY ADDITIONAL TECHNICAL ASSISTANCE YOU MIGHT NEED FOR IMPLEMENTATION OF THIS OPERATION AND MAINTENANCE PLAN FOR YOUR WATER WELL.

STATEMENT OF WORK
Water Well (642)

These deliverables apply to this individual practice. For other planned practice deliverables refer to those specific Statements of Work.

DESIGN

Deliverables:

1. Design documentation that will demonstrate that the criteria in NRCS practice standard have been met and are compatible with other planned and applied practices.
 - a. Practice purpose(s) as identified in the conservation plan.
 - b. List of required permits to be obtained by the client.
 - c. Impacts on adjacent properties and structures.
 - d. Compliance with NRCS national and state utility safety policy (NEM Part 503-Safety, Subpart A - Engineering Activities Affecting Utilities 503.00 through 503.06).
 - e. Practice standard criteria related computations and analyses to develop plans and specifications including but not limited to:
 - i. Hydrogeology
 - ii. Wellhead Location and Protection
 - iii. Materials
 - iv. Environmental Considerations (e.g. water quality)
2. Written plans and specifications including sketches and drawings shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.
3. Design Report and Inspection Plan as appropriate (NEM Part 511, Subpart B Documentation, 511.11 and Part 512, Subpart D Quality Assurance Activities, 512.30 through 512.32).
4. Operation and Maintenance Plan
5. Certifications that the design meets practice standard criteria and comply with applicable laws and regulations (NEM Subpart A, 505.03(b) (2)).
6. Design modifications during installation as required.

INSTALLATION

Deliverables

1. Pre Installation conference with client and contractor.
2. Verification that client has obtained required permits.
3. Staking and layout according to plans and specifications including applicable layout notes.
4. Installation inspection (according to inspection plan as appropriate).
 - a. Actual materials used.
 - b. Inspection records
5. Facilitate and implement required design modifications with client and original designer.
6. Advise client/NRCS on compliance issues with all federal, state, tribal, and local laws, regulations and NRCS policies during installation.
7. Certification that the installation process and materials meets design and permit requirements.

CHECK OUT

Deliverables

1. As-Built documentation.
 - a. Extent of practice units applied
 - b. Drawings
 - c. Final quantities
2. Certification that the installation meets NRCS standards and specifications and is in compliance with permits (NEM Subpart A, 505.03(c) (1)).
3. Progress reporting.

STATEMENT OF WORK
Water Well (642)

REFERENCES

- NRCS Field Office Technical Guide (eFOTG), Section IV, Conservation Practice Standard - Water Well, 642.
- NRCS National Engineering Manual (NEM).
- NRCS National Environmental Compliance Handbook
- NRCS Cultural Resources Handbook