STANDARDS
FOR
CONSTRUCTION OF PRIVATE WATER WELLS
AND WATER SYSTEMS

Indiana State Board of Health

Bulletin PWS 2
(formerly Bulletin SE 15)
July 1983

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INDIANA STATE BOARD OF HEALTH
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Developed in cooperation with the Division of Water, Indiana Department of Natural Resources, and the Indiana Well Drilling Contractors Association, Inc.

INDEX

PRIVATE WATER WELL STANDARDS

Safe potable ground water is one of man's most precious natural resources. It can be contaminated and made dangerous, even totally useless for drinking, by improper well drilling and pump installation practices.

To guide drillers and owners in the construction of safe, usable wells, the Indiana State Board of Health recommends the following Standards for the construction of wells and installation of pumps and appurtenances. Whenever a well is opened for repair, the work and materials used should also meet these Standards. Existing wells and water systems should be corrected and upgraded to meet these Standards.

Section 1
DEFINITIONS

As used in these Standards, the term:

1. "Annular space" means the space between two concentric cylinders or circular objects, such as the space between an upper enlarged drill hole and initial protective casing pipe and an outer construction pipe or inner liner pipe or between an inner liner pipe and lower drill hole. The expression of annular space shall be the difference in radii between the inside diameter of the larger cylinder and the maximum outside diameter of the smaller cylinder.

2. "Aquifer" means a formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

3. "Casing" means pipe installed to prevent unwanted solids or liquids from entering the interior of the well.

4. "Cement grout" means a thorough mixture of cement and water, with or without additives, of a consistency that permits it to be pumped or puddled.

5. "Clay slurry" means a fluid mixture of native clay formation or commercial clay or clay mineral products and water prepared with only the amount of water necessary to produce fluidity.

6. "Contamination" means the alteration of biological, chemical, or physical properties of water so as to render the water either actually or potentially detrimental, injurious, or harmful to health.

7. "Drainage system" means the piping within public or private premises, which conveys sewage, rainwater or other liquid wastes to the point of disposal, but does not include the mains of a public sewerage system or private or public sewage treatment plant.

8. "Drawdown" means the difference between the static water level and the pumping water level in a well.

9. "Drive pipe" means casing of sufficient strength to be driven into a hole of slightly smaller diameter than the outside diameter of the pipe.

10. "Ground water" means that part of sub-surface water which is in the zone of saturation, i.e., any water below the water table.

11. "Liner pipe" means either protective well casing pipe installed subsequent to initial construction to seal off a zone of bacterial or chemical contamination, or casing pipe installed during or subsequent to the initial well construction to seal off a caving formation.

12. "Person" means any individual, partnership, firm, corporation, institution, school, unit of government, or officer or employee thereof.

13. "Pitless adapters" means a watertight unit designed and constructed for permanent attachment to the well casing. The pitless adapter provides necessary vent, electrical, and discharge pipe connections while preventing the entrance of contaminants from surface or near surface sources from entering the well. It also permits termination of the well above the ground surface.

14. "Potable water" means water acceptable for drinking under prevailing governmental standards.

15. "Private water supply" means a source of water that is privately owned and managed and is not operated as a utility under rules of the Indiana Public Service Commission.

16. "Pump installer" means any person, firm or corporation who is duly registered as such with the appropriate agency, has paid the annual registration fee, and has obtained a permit to engage in pump installation if such a permit is required by the appropriate agency having jurisdiction.

17. "Pumping water level" or "dynamic water level" means the level of the surface of the water in a well when it is being pumped.

18. "Sanitary condition": (a) when referring to a well means that the construction of the well and appurtenances and the installation of the pumping equipment are such that the well and complete water supply system is effectively protected against entrance of contaminating matter; (b) when referring to the surroundings of a well means that the location and the surrounding area are free from debris or filth of any character and not subject to flooding.

19. "Static water level" means the level of the surface of the water in a well, or water pressure at the top of a well in the case of some artesian wells, when no water is being pumped or flows therefrom.

20. "Watertight construction" means cased and grouted construction through firm formations such as clay or rock. Through granular material like sand or gravel, it means that the casing pipe is of approved quality and assembled watertight.

21. "Well" means any excavation or opening into the ground made by digging, boring, drilling, driving or other method for the purpose of obtaining water from the ground, dewatering, returning water to the ground, or testing or observing the quantity or quality of ground water.

22. "Well cap" means a removable non-watertight apparatus or device used to cover the top of the well casing.

23. "Well driller" means any person, firm or corporation who constructs or supervises the construction of a well. Unless specifically exempted by State statute, all well drillers shall be licensed as a Water Well Drilling Contractor by the Indiana Department of Natural Resources and shall have paid the annual licensing fee.

24. "Well seal" means a removable apparatus or device used to close the well opening by maintaining a watertight closure between the upper casing of a well and the piping or equipment installed therein, in an attempt to prevent water from entering the well.

25. "Well vent" means an opening or outlet at the upper end of the well casing that allows equalization of pressure in the well with atmospheric pressure.

26. "Yield" means the quantity of water which may be produced from the well per unit of time once a stabilized pumping level is attained.

Section 2
LOCATION OF PRIVATE WATER SUPPLY WELLS

2.1 General Principles

Private water supply wells shall be located as follows:

A. In such manner that the well and its surroundings can be kept in a sanitary condition.

B. At the highest point on the premises consistent with the general layout and surroundings, but in any case in an area protected against surface water ponding, drainage or flooding. The finished well casing or pitless adapter shall extend at least one foot above the ground level or two feet above the maximum flood level in the vicinity, whichever is higher.

C. As far removed from any known or probable source of contamination as the general layout of the premises and the surroundings permit, but in no case closer than the minimum distances specified in Section 2.2 below.

2.2 Minimum Distances From Sources Of Contamination

See Indiana State Board of Health Bulletin S.E. 13 for separation distances to be used with wells for schools, factories, stores, institutions, and other semi-public places.

Private water supply wells and buried suction pipe serving a residence shall be installed the following minimum separation distances from potential sources of contamination. If the well terminates in creviced or highly porous formations, greater distances should be maintained.

A. Independent clear water drain, rainwater downspout outlet, cistern, hydrant drain, or similar unit; building foundation drain connected to independent clear water or subsoil drain; well pit, pump pit, pressure-tank pit, pressure-tank access pit, subsurface pumproom or reservoir: 10 feet

B. Sanitary or storm sewer-connected foundation drain, or property lines: 15 feet

C. Stream, lake or pond shoreline, open ditch or waterway, sanitary or storm sewer line constructed of water works grade ductile or cast iron pipe with mechanical or push-on joints, or private residential fuel oil tanks: 25 feet

D. Watertight grease basin, septic tank, wastewater holding tank, privies utilizing solid wall wastewater holding tanks, subsoil drain or building sanitary or storm sewer other than specified in Section 2.2C above; sewer pump, floor drain connected to building sanitary sewer or below-ground swimming pool: 50 feet

E. Stable; milkhouse; feeding pen; livestock run; manure pile; animal barn with concrete floor; glass-lined storage facility; conventional silo; watertight milkhouse floor drain other than cast iron; or watertight sewer conveying manure juices; or loose-jointed field tile drain: 50 feet

F. Sanitary or storm sewer: 50 feet

G. Absorption field; solid liquid manure holding tank; silage storage pit; cesspool, dry well; or seepage pit or trench: 100 feet

H. Surface or subsurface tanks used to store chemicals such as gasoline, benzene, fuel oil, fertilizer, etc.: 100 feet

I. Septage or treated sludge disposal area; wastewater absorption; storage, retention or treatment pond; ridge and furrow waste disposal site; or spray irrigation waste disposal site: 500 feet

J. Uncovered salt or salt-mixture storage: (Note: The 1,500 foot minimum separation is only a guideline and greater distances may be required. Uncovered storage of salt or salt-mixtures is discouraged in all cases.) 1,500 feet

If the residence is located within 2,500 feet of an existing or proposed sanitary landfill, the Land Pollution Control Division of the Indiana State Board of Health should first be consulted concerning a recommended separation from the facility.

If the distance requirements set forth in this section cannot be met because of conditions at the well site, consult with the local health department for possible waiver based on special construction or favorable geologic conditions.

2.3 Relation to Buildings

With respect to buildings, the location of every new well shall be as follows:

A. When a well is located outside and adjacent to a building, it shall be located so that the center line of the well extended vertically will clear any projection from the building by not less than five feet.

B. Every well shall be located so that it will be reasonably accessible with proper equipment for cleaning treatment, repair, testing, inspection, and such other maintenance as may be necessary.

C. No well shall be located nor shall a building extension be constructed so that the top of the well will be within the basement of any building or building extension or under a building or building extension having no basement.

Section 3
WELL CONSTRUCTION

3.1 Well Design and Construction

Every well shall be:

A. Adapted to the geologic (earth structure) and ground water conditions existing at the site of the well to ensure full use of every natural protection afforded against contamination of water-bearing formations and to exclude known sources of contamination.

B. Designed to permit such supplementary construction as may be required to provide a sufficient and safe water supply and to protect and conserve ground water.

C. Tested for yield. The test pumping equipment should have a capacity at least equal to the pumping rate that is desired from the well during its normal usage. It is recommended that the test pump be operated continuously for a minimum of one hour and until the pumping water level has been determined and, at this point, the yield and drawdown recorded. Bailing may be used to give a rough estimate of the yield of the well, and may be the only practical way to test very weak wells, but it is not to be considered a reliable substitute for a pumping test for yields over 150 gallons per hour.

D. Capable of supplying sufficient water to meet required needs. If the yield is less than required, the owner shall be informed by the driller so that the owner may provide additional storage and the proper kind of pumping equipment to meet his needs.

3.2 Minimum Well Construction Requirements

A. Casing

1. All wells shall be cased to a depth of at least 25 feet below ground surface.

2. The casings of wells developed in sand or gravel shall extend watertight to or into the aquifer.

3. The minimum casing diameter for every new well should be at least four inches nominal inside diameter. Further, the inside well diameter shall be at least one inch larger than the maximum outside diameter of the permanent pumping equipment to be installed in the well.

4. Every drive pipe shall be fitted at its lower end with a standard drive shoe, threaded or welded onto the pipe so that the pipe rests on the internal shoulder of the shoe. The shoe shall have a beveled and tempered cutting edge of metal alloyed for this special purpose.

5. The casing of the well shall be steel or thermoplastic material and shall be of sufficient thickness and quality to protect the well against structural deficiencies during construction, and against contamination by surface water or other undesirable materials during the expected life of the well. Only recessed couplings may be used on threaded steel pipe or casing. Ferrous casing shall be new, first-class material meeting ASTM[1] Standards A-120 or A-53, or API[2] Standards API-5A or API-5L. No thin-walled, sheet-metal, used, reclaimed, rejected, or contaminated pipe or casing shall be used in a water well. New pipe or casing, when salvaged from water well test holes only, shall not be considered used or contaminated. Where corrosive water or soil is likely to be encountered, thicker walls in pipe or casing than those which appear in the following tables should be used.

[1] American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103
[2] American Petroleum Institute, 1271 Avenue of Americas, New York, NY 10020

Tables 1 and 2:

STEEL PIPE
MINIMUM STANDARDS OF DIMENSIONS AND WEIGHTS
STANDARD LINE PIPE [1]

Nominal Size in Inches	Diameters in Inches		Wall Thickness in Inches	Weights in Pounds per Foot	
	External	Internal		Plain Ends	T. and C.
4	4.500	4.026	0.237	10.79	11.01
5	5.563	5.047	0.258	14.62	14.90
6	5.563	6.065	0.280	18.97	19.33
8	8.625	8.071	0.277	24.70	25.44
10	10.750	10.192	0.279	31.20	32.20
12	12.750	12.090	0.330	43.77	45.40
14 OD	14.000	13.250	0.375	54.57	55.80
16 OD	16.000	15.250	0.375	62.58	64.08
18 OD	18.000	17.250	0.375	70.59	72.37
20 OD	20.000	19.250	0.375	78.60	80.70

MINIMUM STANDARDS OF DIMENSIONS AND WEIGHTS
STANDARD PIPE AND LINE PIPE [2]

Nominal Size in Inches	Diameters in Inches		Wall Thickness in Inches	Weights in Pounds per Foot
	External	Internal		Plain Ends Only
4	4.500	4.188	0.156	7.25
5	5.563	5.187	0.188	10.76
6	6.625	6.249	0.188	12.89
8	8.625	8.249	0.188	16.90
10	10.750	10.374	0.188	21.15
12	12.750	12.250	0.250	33.38
14 OD	14.000	13.438	0.281	41.21
16 OD	16.000	15.438	0.281	47.22
18 OD	18.000	17.438	0.281	53.22
20 OD	20.000	19.438	0.281	59.23

[1] These wall thicknesses in Standard Line Pipe may be threaded and coupled or welded.

[2] This lighter weight pipe, meeting ASTM Standards A-53 or A-120 and API Standard API-5L, is suitable for welding only.

6. Thermoplastic pipe used for water well construction shall comply with ASTM-F480, latest revision, "Standard Specification for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR)." Selected provisions of ASTM-F480-76 include:

   "Thermoplastic pipe materials for water well casing shall be acrylonitrile-utadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene rubber (SR) plastics compound (minimum 50 percent styrene and 5 percent rubber)."

   "Thermoplastic well casing pipe shall be marked at least every 1.5m (5 ft.) in letters not less than 5mm (3/16 in.) high in a contrasting color with the following information: nominal well casing pipe size (for example, 5 in.); well casing pipe standard dimension ratio (for example, SDR 21); type of plastic well casing pipe material (for example, ABS, PVC, or SR); the wording— "Well Casing"—followed by the impact classification (for example, IC-3); ASTM designation F480 including the year of issue, with which the well casing pipe complies; manufacturere's name (or trademark); and manufacturer's code for resin manufacture, lot number, and date of manufacture. Well casing pipe intended for potable water also shall include the seal or mark of the laboratory making the evaluation for this purpose spaced at intervals specified by the laboratory."

See Table 3 and Table 4.

Table 3: Diameters and Tolerance for Thermoplastic Water Well Casing and Pipe (ASTM F-480).

Nominal Pipe Size	Inches Outside Diameter Average	Inches Outside Diameter Tolerance On Average	Out-of-Roundness Tolerance SDR26 SDR21	Out-of-Roundness Tolerance SDR17 SDR13.5
4	4.500	0.009	0.050	0.015
5	5.563	0.010	0.050	0.030
6	6.625	0.011	0.050	0.035
8	8.625	0.015	0.075	0.045
10	10.750	0.015	0.075	0.050
12	12.750	0.015	0.075	0.060

Table 4: Wall Thickness and Tolerances for Thermoplastic Water Well Casing Pipe, in inches

Nominal Pipe Size	SDR26 Minimum	SDR26 Tolerance	SDR21 Minimum	SDR21 Tolerance	SDR17 Minimum	SDR17 Tolerance	SDR13.5 Minimum	SDR13.5 Tolerance
4	0.173	0.021	0.214	0.026	0.256	0.032	0.333	0.040
5	0.214	0.027	0.265	0.032	0.327	0.039	0.412	0.049
6	0.255	0.031	0.316	0.038	0.390	0.047	0.491	0.058
a. 8	0.332	0.040	0.410	0.049	b. 0.508	0.061	....	....
10	0.413	0.050	0.511	0.061	0.632	0.076	....	....
12	0.490	0.059	0.606	0.073	0.750	0.090	....	....

The minimum is the lowest wall thickness of the well casing pipe at any cross section.
All tolerances are on the plus side of the minimum requirements.

a. Dimensions below the line meet or exceed Schedule 40 in SDR 13.5, 17, 21 and 26.
b. Dimensions below the line meet or exceed Schedule 80 in SDR 13.5 and 17.

The minimum wall thickness of thermoplastic well casing to be used shall be at least equal to that of SDR-26 for wells 100 feet deep or less and SDR-21 for wells deeper than 100 feet. All of the thermoplastic casing within any one well shall be of the same type, grade and manufacturer.

Pipe selection for diameters and wall thickness and installation techniques shall be as provided in the latest edition of ASTM-F480 and the "Manual of Practices for the Installation of Thermoplastic Water Well Casing," as developed by the National Water Well Association and the Plastic Pipe Institute.

7. Other materials may be used for water well casing if specifically approved by the Indiana State Board of Health.

8. Steel or thermoplastic pipe or commercially manufactured cement tile may be used in dug or bored wells if the annular space between the casing and the soil is completely filled by a monolithic pour of dense, watertight, puddled or vibrated concrete measuring at least six inches thick, at all points including bells or joints. This casing shall be new material and construction shall meet the requirements of sections applying to other well types.

9. The casing pipe of any well shall project not less than 12 inches above the pumphouse floor or finished ground surface, and at least 24 inches above the highest flood level of record. No casing shall be cut off below ground surface except to install a pitless adapter. The adapter shall project not less than 12 inches above ground surface.

10. There shall be no opening in the casing below its top except by the use of a properly installed pitless adapter. The upper terminal of the pitless adapter shall meet the requirements of Section 6.8 for vents.

    Pitless adapter units shall be attached to the well casing by threading or welding in a manner that will ensure a watertight permanent connection. The adapter fitting should be a commercially-produced casting or shop-welded fitting, pressure tested to at least 100 psi with no weeping or leakage. Saddle-type fittings with heavy corrosion-resistant U bolts and rubber gaskets under system pressure at all times also may be used.

    The design of the pitless adapter shall be such that the pump tubing or column pipe cannot be dropped into the well by misalignment in assembly or reinstalling the internal parts of the adapter.

11. The well casing shall not be used as a suction pipe.

B. Sealing

1. The casings of wells completed in rock shall be firmly seated in sound rock. If broken or creviced rock is encountered above the aquifer, the casing shall be seated in sound rock. In areas where rock wells can be developed only in the upper fractured rock, casing may terminate in this formation if there is at least 25 feet of unconsolidated material above the rock. When there is less overburden and deeper strata will not produce potable water, the sub-standard quality of the well must be recognized. The State Board of Health should be consulted for the treatment necessary to provide a safe supply.

2. In a rock well, the annular space between the casing and the drill hole shall be sealed to a sufficient depth to prevent surface drainage water, or shallow subsurface drainage, from entering the hole. If rock is encountered within 25 feet of the surface, the hole shall be reamed at least four inches greater diameter than the casing so that a minimum two-inch annular space can be filled with cement grout. The casing should be extended at least 10 feet into the rock, or to a point at least 25 feet below the surface, whichever is deeper, and cement grout shall be used to seal the annular space.

3. Cement grout that is used to seal a hole diameter larger than the casing should be composed of a thorough mixture of Portland cement and clean water at a rate of one bag (94 lbs.) of cement to five to six gallons of water so that it can be pumped or puddled into the annular space to seal it. If such a cement grout cannot be placed effectively, additives may be used provided shrinkage is held to a minimum and the mixture will form a watertight seal throughout the entire depth required to prevent objectionable waters from entering the hole. (See Figure 1).

4. Where pipe is driven through clay, silt, sand, or gravel into a hole of smaller diameter than the casing, and where such unconsolidated clays, silts, sand, or gravel are present to a depth greater than 25 feet below the surface, puddled bentonitic clay may be used to seal the annular space. Bentonitic clay should be kept puddled around the point where the casing enters the ground in order to maintain a seal around the drive pipe and couplings and to serve as a lubricating medium while driving the casing.

5. Whenever a casing is placed in a hole of larger diameter than the casing, the annular space between the casing and the wall of the hole shall be at least one inch minimum, and shall be sealed vertically from the rock or screen setting to the surface with either clay slurry or cement grout in the manner described in "2" and "3" above.

6. Bored wells constructed with a screen attached to the casing, and with a concrete cut-off seal at least 30 inches thick poured and puddled to fill the excavation 25 or more feet below ground surface, may be backfilled above the seal with clay slurry in such a manner that the resulting fill will be as resistant to seepage as the undisturbed earth around it.

C. Screens

Wells drawing from unconsolidated water-bearing formations, except those described in Section 3.3A and Section 3.3B, shall be fitted with screens which shall have adequate openings to provide the maximum amount of open area consistent with strength of the screen and the grading of the water-bearing formation or gravel pack. The openings shall permit maximum transmitting ability without clogging or jamming. Recommended screen materials include stainless steel, Everdur, fiberglass, PVC or ABS. Slotted pipe of any type and iron or mild steel screens are not acceptable. The desired open area of a screen shall permit the design capacity to enter through the screen openings with a velocity of less that 0.1 foot per second.

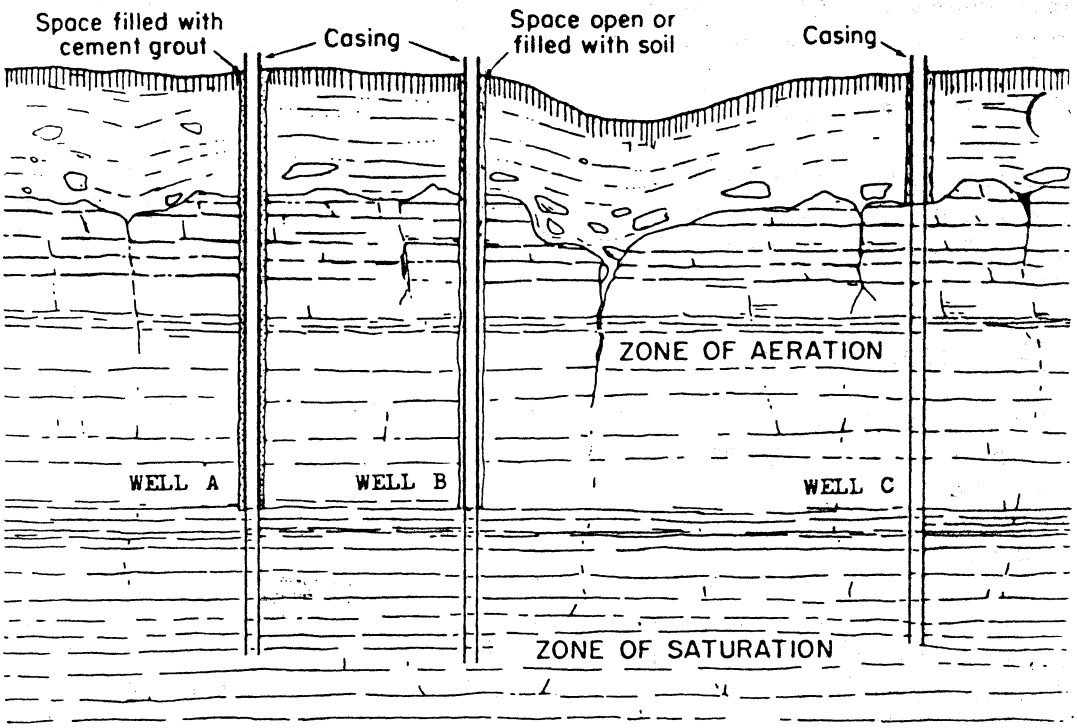

Figure 1. WHY GROUT? If the annular space around a casing is left open or is backfilled with loose material, as shown in Wells B and C, it acts as a conduit to drain contaminated surface water into the aquifer. When properly filled with cement grout, as shown in Well A, surface contamination is excluded.

D. Temporary Caps

Temporary caps shall be placed on wells until pumping equipment can be installed and shall prevent contamination from entering the casing.

E. Yield

Wells constructed as a source of water for a residence should have a stabilized yield of at least 300 gallons per hour (gph). If a lesser yield is the maximum amount of water obtainable from the aquifer, the owner shall be informed so that he may provide additional storage and the proper kind of pumping equipment to meet his needs.

F. Plumbness and Alignment

Each drilled well should be tested for plumbness and alignment. The bore of the hole shall be sufficiently plumb and straight to receive the casing without binding. The casing shall be sufficiently plumb and straight that it will not interfere with installation and operation of the pump.

G. Construction Water

Water used in the drilling process shall be obtained from a source which will not result in contamination of the well or water bearing zones penetrated by the well. All such water shall be treated so as to maintain a free chlorine residual of 100 ppm as an extra precaution.

H. Records

The well driller shall furnish the well owner with a duplicate copy of the information he supplies to the Department of Natural Resources in compliance with IC 25-39-1. The record shall include a log of the materials penetrated and their depth or thickness, and pumping test results.

3.3 Dug and Bored Wells

In addition to all other provisions of these Standards, dug and bored wells shall comply with the following:

A. Bored and dug wells are best finished utilizing "buried slab construction." (See Figure 2).

The well lining or curbing shall be terminated at a depth of 10 feet or more below the ground surface and a casing installed of standard steel or approved thermoplastic. Well casing shall meet the requirements in Section 3.2(A)5. This casing shall be firmly imbedded in or connected to a pipe cast in a reinforced concrete slab which shall be installed on top of the well lining.

The casing shall be a minimum six inches in diameter and extend from the concrete slab to at least 12 inches above finished ground surface. The annular space between the casing pipe and the well bore shall be filled with clean earth thoroughly tamped to minimize settling.

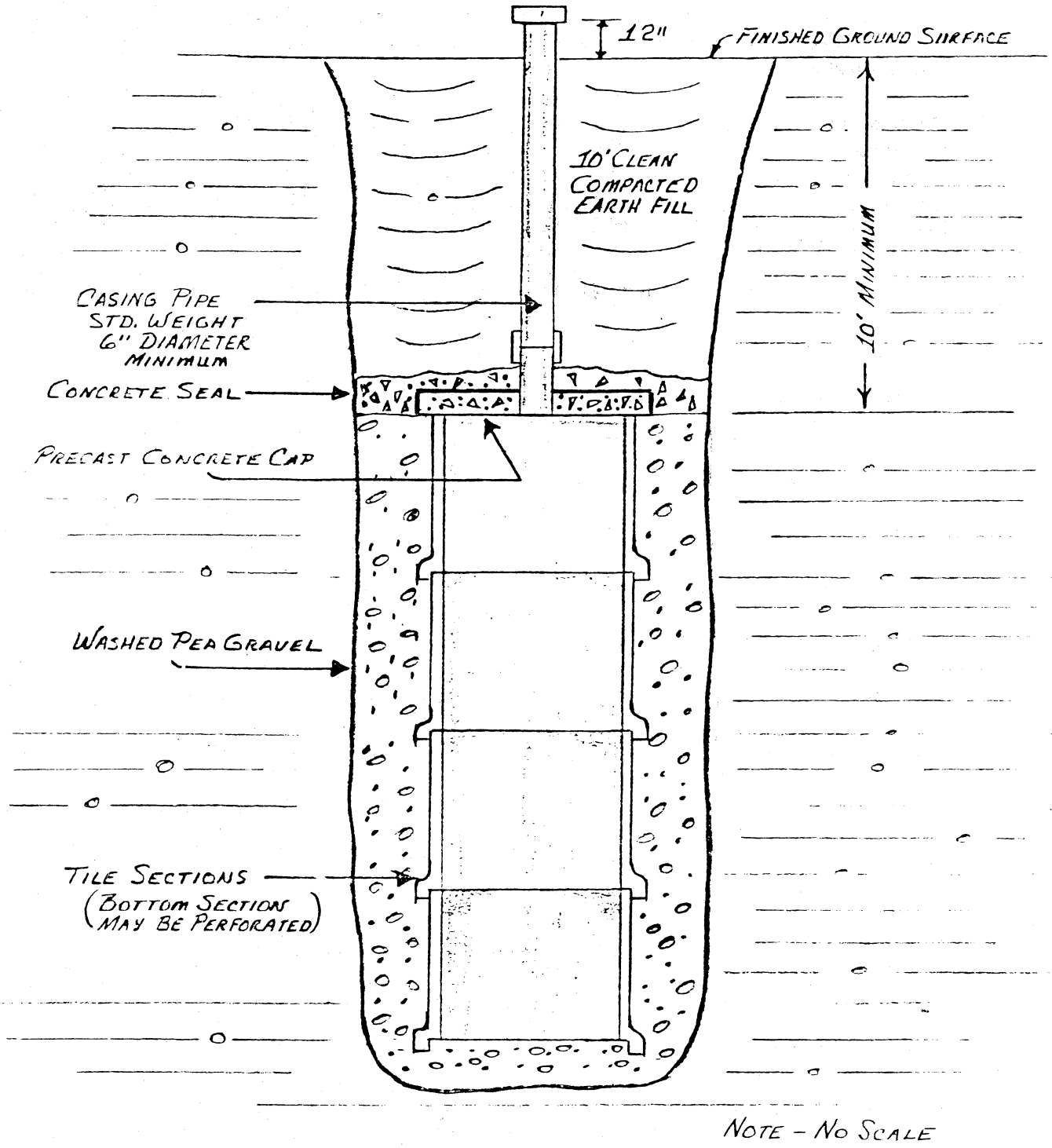
BURIED SLAB CONSTRUCTION
12"
FINISHED GROUND SURFACE
10' CLEAN COMPACTED EARTH FILL
10' MINIMUM
CASING PIPE STD. WEIGHT 6" DIAMETER MINIMUM
CONCRETE SEAL
PRECAST CONCRETE CAP
WASHED PEA GRAVEL
TILE SECTIONS (BOTTOM SECTION MAY BE PERFORATED)
NOTE - NO SCALE

Figure 2

The diameter of the well bore below the buried slab shall be a minimum of four inches greater than the outer diameter of the well casing and shall be filled with pea gravel to the well bottom. When more than one formation bearing suitable water exists, the lower formation shall be used.

B. Bored and dug wells that are not finished as "buried slab" wells shall comply with the following: (also see Figure 3) Every bored or dug well shall have a continuous watertight lining of steel casing or concrete extending from ground surface to a depth of at least 10 feet below the ground surface. There shall be no opening in the lining for a pump discharge line.

When more than one formation bearing suitable water exists, the lower formation shall be used. The lining in the producing zone shall readily admit water and shall be structurally sound to withstand external pressures.

Steel curbs shall be whole or have welded joints. The contractor shall be responsible for installation of the watertight lining or curbing.

The open space between the excavation and the installed lining or curbing from the ground surface to a minimum of 10 feet below ground level shall be sealed with cement grout, bentonite or puddled clay. The inside diameter of the well bore below the lining or curbing shall be a minimum of four inches greater than the outside diameter of the well casing and shall be filled with pea gravel to the well bottom.

The casing shall extend at least 12 inches above finished ground surface. A cover slab at least four inches thick, adequately reinforced and having a diameter sufficient to extend to the outer edge of the casing shall be provided. Adequate sized pipe sleeves shall be cast in place in the slab to accommodate the vent and the type of pump or pump piping proposed for the well. The slab shall be constructed without joints and with sides which overhang the casing at least two inches. The top of the slab shall be sloped to drain to all sides and a watertight joint made where the slab rests on the well lining using a mastic compound. A manhole, if installed, shall consist of a metal curb cast in the slab and extending four inches above the slab. The manhole shall have a watertight cover having sides to overhang the curb at least two inches.

A vent shall be installed and shall consist of a metal pipe extending above the slab with the open end turned down and not less than six inches above the slab. The open end shall be covered with 16 mesh or finer screen of durable material.

3.4 Other Wells and Structures

Dewatering wells, irrigation wells, heating and cooling supply and return wells, temporary service wells, construction water wells, process wells and other structures for withdrawing ground water or lowering of water levels or water tables regardless of location, length of intended service, or original use or intent, shall be constructed in accordance with these minimum standards. Wells used strictly for monitoring are exempted from the requirement of a minimum four-inch diameter.

BORED OR DUG WELL - UPPER TERMINAL

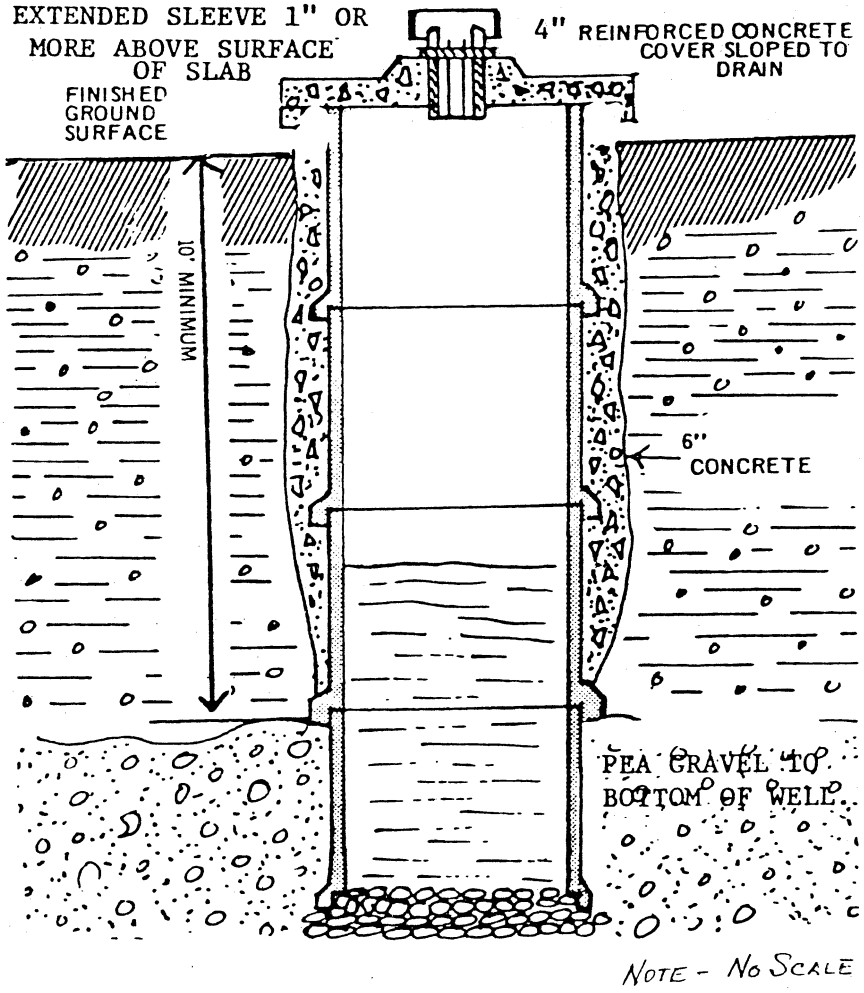

Figure 3

Section 4
OTHER USES OF WELLS

4.1 Disposal Prohibited

No well or well-like structure may be used for the disposal of sewage, waste, or drainage or other material that might contaminate potable water. All disposal wells must be approved by the Indiana Stream Pollution Control Board prior to construction.

4.2 Recharge or Return Wells

If a well is to be constructed or used for the purpose of returning uncontaminated water to the ground, it is necessary to prevent aeration of the returned water and to prevent any adverse changes in the water quality from the quality water naturally occurring in the return well.

The return pipe should discharge at least five feet below the static water level in the return well. Return wells shall be constructed to meet all provisions of these Standards. However, it is generally considered good design to provide two to three times as much open screen area for a recharge well as for a supply well.

Section 5
ABANDONMENT OF WELLS

5.1 Abandonment Criteria

Unsealed abandoned wells constitute a hazard to public health, safety, welfare, and to the preservation of the ground water resource. The sealing of such wells presents a number of problems, the character of which depends upon the construction of the well, the geological formations encountered, and the hydrologic conditions. To seal an abandoned water well properly, several things must be accomplished: (1) elimination of a physical hazard; (2) prevention of ground water contamination; 3) conservation of yield and maintenance of hydrostatic head of aquifers; and (4) prevention of the intermingling of desirable and undesirable waters.

The basic concept governing the proper sealing of abandoned wells is the restoration, as far as feasible, of the geohydrologic conditions that existed before the well was drilled and constructed, for an improperly abandoned well might serve as an uncontrolled invasion point for contaminated water. Any well that is to be permanently abandoned should be completely filled in such a manner that vertical movement of water within the well bore, including vertical movement of water within the annular space surrounding the well casing, is effectively and permanently confined to the specific zone in which it originally occurred. If all these objectives can be accomplished, all the rules for sealing wells heretofore presented will be fulfilled.

To seal an abandoned well properly, the character of the ground water must be considered. If the ground water occurs under unconfined or watertable conditions, the chief problem is that of sealing the well with impermeable material so as to prevent the percolation of surface water through the original well opening, or along the outside of the casing, to the water table. If the ground water occurs under confined or artesian conditions, the sealing operation must confine the water to the aquifer in which it occurs, thereby preventing loss of artesian pressure by upward circulation of water to the surface, to a formation containing no water, or to one containing water under a lower head than that in the aquifer which is to be sealed.

5.2 Abandonment Procedures

All wells and test holes to be abandoned, including dewatering wells, construction wells and temporary wells, shall be filled with cement grout, bentonite tablets or a thick bentonite slurry opposite each water-bearing formation and in the top 40 feet of the hole. The remainder of the hole may be filled with puddled clay or other impermeable material that will permanently prevent migration of fluids in the hole. Sand, gravel, slag, and crushed limestone are not desirable materials to use in filling a hole because they are permeable, but they may be used opposite aquicludes to bridge between zones of cement grout, bentonite tablets or thick bentonite slurry. If salt water, water of undesirable chemical or bacteriological quality or contaminants are entering or might enter the well, the entire hole shall be filled with cement grout.

5.3 Other Wells and Structures

The abandonment of all wells, well-like structures or excavations, construction wells, temporary wells and test wells shall meet the same criteria and be accomplished via identical procedures described in Section 5.2.

Section 6
WATER SYSTEM INSTALLATION

6.1 Water System Installation and Construction

The installation of every pump and water system shall be planned and carried out so that the pump will be:

A. Installed in such manner that the pump and its surroundings can be maintained in a sanitary condition.

B. Properly sized so as to produce the volume of water necessary to reasonably meet the requirements of its intended use.

C. Designed to meet the well's characteristics and be durable in design and construction.

D. Installed in such manner as to provide adequate protection against contamination of any character from any surface or subsurface source.

6.2 Upper Well Terminal

Well casing, curbs, and pitless well adapters shall terminate not less than 12 inches above the finished ground surface, and at least 24 inches above maximum high water level as given by the most recent U.S. Geological Survey or other appropriate agency's flood plain elevation map. No casing shall be cut off or cut into below ground level except to install an approved pitless adapter.

6.3 Pitless Well Adapter

Pitless well adapters designed to replace a section of well casing or for attachment to replace a section of well casing, or for attachment to a well casing, shall be so designed and constructed that the point or points of field attachment of the pitless well adapter to the well casing and all water contact surfaces on parts in contact with the ground shall be under the pressure of the water system. The cap, casing cover or sanitary seal shall be self-draining and overlap the top of the casing extension with a downward flange.

There shall be no openings in the cover, within the outside diameter of the casing or casing extension except for a factory installed vent. Such factory installed vent shall meet the requirements of Section 6.8.

6.4 Hand and Windmill Pumps

Every shallow well type hand pump and every deep well type hand pump head and windmill pump shall be so designed and fabricated that no unprotected opening connecting with the interior of the pump exists. The spout shall be of the closed type, turned down.

A hand pump shall be connected firmly to the well casing pipe by threading or by bolting the pump flange to a well casing pipe flange with gasket separation so as to effectively seal the top of the casing, except that when a well is located so that the top is at least two feet above flood level, a hand pump may be installed by bolting a structured base with recesses to the casing.

6.5 Power-Driven Pumps

All power-driven pumps located over wells shall be mounted on the well casing, a pump foundation, or a pump stand, so as to provide an effective well seal at the top of the well. Extension of the casing at least one inch into the pump base will be considered an effective seal provided the pump is mounted on a base plate or foundation in such a manner as to exclude dust and insects, and the top of well casing is at an elevation at least two feet above any known flood water level, not in a basement and at least 12 inches above finished ground surface or building floor.

A. Where the pump unit is not located over the well and the pump delivery or suction pipe emerges from the top thereof, a watertight expanding gasket or equivalent well seal shall be provided between the well casing and piping. A similar watertight seal shall be provided at the terminal for a conduit containing a cable for a submersible pump.

B. All submersible pumps should have at least one check valve located in the discharge pump column line above the pump and inside the well casing. A check valve shall not be permitted between the well and the inlet side of the pressure tank.

6.6 Pumphouses

Unless the power-driven pump installation is of weather-proof and frost-proof construction, it shall be protected by a structure which permits removal of the pump and column pipe for maintenance and repair. The pumphouse floor shall be constructed of impervious material and shall slope away in all directions from the well.

6.7 Protection Against Freezing

All water lines and pump and water system components shall be protected from freezing.

6.8 Vents

All vent piping shall be of adequate size to allow rapid equalization of air pressure in the well and shall be not less than one-half inch in inside diameter. Vent openings shall be located in such a manner as to prevent contamination of the well. The vent opening shall terminate at least 12 inches above the finished grade and shall be turned down, secured in position, reasonably tamper-proof, and be screened with not less than a 16-mesh screen or filtered in such a manner as to prevent the entry of insects.

Particular attention shall be given to proper venting of wells in areas where toxic or inflammable gases are known to be a characteristic of the water. If it is determined that these types of gases are or may be present, all vents shall be extended to discharge to outside atmosphere at a height where the gases will not be a hazard.

6.9 Pump Bearing Lubrication

Lubrication of bearings of power driven pumps shall be with water or oil which will not adversely affect the quality of the water to be pumped. Oil lubricated line shaft turbine pumps shall not be permitted.

A. Water lubrication. If a storage tank is required for lubrication water, it shall be designed to protect the water from contamination.

B. Oil lubrication. The reservoir of an oil lubricated submersible pump shall be designed to protect the oil and the well water from contamination. The oil shall not contain substances which will cause contamination, odor or taste in the water being pumped. Oil lubricated line shaft turbine pumps shall not be permitted in potable water installations.

6.10 Sampling Faucets

In all pressure water systems, provision shall be made for collection of water samples ahead of chlorination or any other treatment by installation of a faucet on the discharge side of and as close as possible to the pump. The sampling faucet shall have a smooth turned-down nozzle. A hose bib shall not be used. All-brass pet cocks with 90° turned-down spigots are acceptable as sampling taps, but one-half inch I.P.S. is the recommended minimum size.

6.11 Suction Pipes Connecting Pump and Well

All buried suction pipes shall be enclosed in a pipe conduit having a minimum wall thickness equivalent to a well casing of the same size, and the annular space shall be constantly subjected to full water system pressure. They shall be located in accordance with the distance requirements in Section 2.2. No suction line shall be located beneath a sewer.

6.12 Materials Prohibited

No material may be used in the well or pump installation that will result in the delivered water being toxic or having an objectionable taste or odor. Plastic pipe shall not be used unless it has been approved by and bears the seal of the National Sanitation Foundation for use with potable water and has the physical properties required to withstand the torque and load to which it will be subjected.

6.13 Offset Pumps and Pressure Tanks

Offset pumps and/or pressure tanks shall be located where they are readily accessible. They shall not be located in a crawl space unless the crawl space is drained to the ground surface beyond the crawl space, either by gravity or means of a sump pump, and a minimum of four feet of clear working space is provided between the floor of the crawl space and the floor joist overhead. If located in a crawl space, the pump and/or pressure tank shall be located within five feet of the point of entry. The access opening should be at least two feet high and two feet wide.

6.14 Chemical Feeding into Wells

No chemicals or compounds other than chlorine or sodium hypochlorite shall be fed or introduced into a well by pumping, pouring or siphonage at any time while the well and water system are in normal, regular use and operation. Further, chemical treatment accomplished above ground after water is pumped from a well shall be accomplished in such a manner as to prevent accidental feeding or back siphonage into the well.

Section 7
DISINFECTION AND SAMPLES

7.1 Disinfection

The well contractor shall be responsible for properly disinfecting any new well or well subjected to repairs or pump maintenance upon completion of the work. Disinfection also shall be accomplished by the pump installation contractor after the pump installation is completed. Sufficient chlorine shall be introduced to give a dosage of 100 parts per million to the water in the well.

> CAUTION: When working with chlorine, persons shall be in a well-ventilated place. The powder or strong liquid should not come in contact with skin or clothing. Solutions are best handled in wood or crockery containers because metals are corroded by strong chlorine solutions.

To prevent contamination of the well or aquifer, it is desirable to maintain a chlorine residual of 100 parts per million in the well bore during the drilling process. Under these conditions the well need not be disinfected until the pump is set. Every new, modified or reconditioned water source, including pumping equipment and gravel used in gravel wall wells, shall be disinfected before being placed in service for general use.

Such treatment shall be performed both when the well work is finished and when pump is installed or reinstalled.

The casing pipe should be thoroughly swabbed to remove oil, grease and joint dope, using alkalies if necessary to obtain clean metal surfaces. The well or other ground water development equipment, including the pumping equipment and gravel used in gravel well construction, shall be disinfected with a solution containing enough chlorine to leave a residual of 25 parts per million in the well after a period of at least 24 hours.

7.2 Disinfection Procedures

The following procedures shall be used for disinfection:

A. Drilled-type well disinfection

1. Determine the amount of water in the well by multiplying the gallons per feet by the number of feet of water in the well, using the following table:

Diameter Well in inches	Gallons per foot
4	.65
5	1.00
6	1.50
8	2.60
10	4.10
12	6.00

2. For each 100 gallons of water in the well, use the amount of chlorine liquid or compound given in the table below. Mix this total amount in about 10 gallons of water. If dry granules or tablets are used, they may be added directly to drilled wells; however, agitation of the water in the casing must be accomplished to ensure a uniform disinfectant residual.

Amount of Disinfectant Required for Each 100 Gallons of Water for 100 ppm Chlorine Concentrations:

Laundry bleach (5.25% chlorine)	Hypochlorite granules (70% chlorine)
3 cups	2 ounces

1 cup = 8 ounce measuring cup
(2 cups = 1 pint; 4 cups = 1 quart)

1 ounce = 1 heaping tablespoon granules
(16 ounces = 1 pound)

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3. Pour this solution into the well making sure the casing walls are wetted before the seal or cap is installed.

4. Connect one or more hoses to faucets on the discharge side of the pressure tank and run them into the top of the well casing. Start the pump, circulating the water back into the well for a least 15 minutes. Then open each faucet in the system until a chlorine smell or taste appears. Close all faucets. Seal the top of the well.

5. Let stand for at least 12 hours, preferably 24 hours.

6. After standing, operate the pump, discharging water from all outlets until all chlorine odor and taste disappears.

B. Dug-type well disinfection

1. The amount of disinfectant required is determined primarily by the amount of water in the well. The table below shows the amount of chlorine to use for each foot of water in the well, according to its diameter.

Diameter of well (in feet)	3	4	5	6	7	8	10
Amount of 5.25% laundry bleach to use per foot of water (in cups)	1½	3	4½	6	9	12	18
Amount of 70% hypochlorite granules to use per foot of water (in ounces)	1	2	3	4	6	8	12

2. To determine the exact amount of bleach to use, multiply the amount of disinfectant indicated as determined by the well's diameter times the number of feet of water in the well.

3. This total amount of bleach should be added to approximately 10 gallons of water, and splashed around the lining or wall of the well. Be certain that the solution has contacted all parts of the well, using the entire amount of disinfectant. Seal the top of the well.

4. When this is done, pump enough water so the strong chlorine odor is evident. When the odor is detected, stop the pumping and allow the solution to remain in the well overnight.

5. After standing, operate the pump, discharging water from all outlets until all chlorine odor and taste disappears.

7.4 Water Samples

After pumping the well to remove all the disinfectant, a water sample shall be collected from the installation in a sterile bottle provided by a certified laboratory for bacteriological analysis. Before the installation is satisfactory to be placed in service for human consumption, the samples shall contain less than two coliform organisms per 100 milliliters of water. If the first sample does not provide a satisfactory analysis, the disinfection procedure shall be repeated and another sample analyzed. This procedure shall continue until the test results are satisfactory.

In addition to bacteriological testing, a chemical analysis of water obtained from each new drilled well shall be made. The analysis shall include:

Total hardness, as $CaCO_3$
pH (laboratory)
Specific conductance, as umhos
Alkalinity (Total) as $CaCO_3$
Chlorides, as Cl
Iron, as FE (Total)
Manganese, as Mn (Total)
Nitrates (NO_3)
Fluoride

It also is desirable to make in-the-field tests for hydrogen sulfide (H_2S).

It shall be the well owner's responsibility to obtain the required samples and have the laboratory tests made. Copies of the bacteriological and chemical analysis reports shall be filed by the well owner with the Indiana Department of Natural Resources.

The well driller and/or water system installation contractor are responsible for construction and installation of the well and/or water system in accordance with these Standards and acceptable industry practices. If these criteria are met, the well driller and water system installation contractor shall not be responsible for the quality nor the quantity of water obtained.

Section 8
QUALIFICATIONS

It is recommended that well drillers be certified by the National Water Well Association in the appropriate "Water Well Driller" certification category for the work they are accomplishing.

It is further recommended that water system installations be made by persons certified as a "Pump Installer" in the appropriate category of the National Water Well Association certification program.

Section 9
SPECIAL CIRCUMSTANCES

9.1 Waivers

In the event that special conditions seem to make construction under these Standards impossible or impractical, the local health department should be consulted for possible waiver of requirements.

9.2 Additional Rules, Regulations and Standards

The Indiana General Assembly has authorized Indiana's individual counties and certain other governmental units to adopt rules, regulations and standards governing the construction and repair of wells and water systems.

Further, the individual counties can enact licensing, registration and permit requirements for wells and water systems in addition to State Licensing of Water Supply Contractors by the Indiana Department of Natural Resources.