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SANITATION FOR HEALTH AND CONVENIENCE

NORTH DAKOTA STATE DEPARTMENT OF HEALTH
Bismarck

Prepared
by
DIVISION OF SANITARY ENGINEERING
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Sanitation for Health and Convenience

A discussion of the items to take into consideration in the construction of residential water and sewerage systems, where public water and sewerage systems are not available.

This manual is written with the sincere desire of assisting farmers and rural residents in improving their water and sewerage facilities, thus improving their general health and prosperity.

Over half the population of North Dakota as enumerated in the 1940 census is classified as "Rural—Farm."

It is generally recognized that the economic well-being of the entire state is referenced to the prosperity of its farms. It is also generally recognized that the sanitary facilities ordinarily available to a farm family have not kept pace with those available to the urban dweller. No farm family can remain prosperous if constantly plagued with illness.

For these reasons it is appropriate that this effort of assistance be made. It is hoped that those families who live in smaller towns without municipal water and sewer facilities will find the principles outlined in this booklet of value also.

George F. Campana, M.D.
State Health Officer

ACKNOWLEDGMENT

Appreciation is expressed to the Division of Sanitation, Minnesota Department of Health, for the use of diagrams and material. Information from the Sanitary Manual of the Minnesota Department of Health was drawn upon heavily for this publication.

Also of important assistance in the preparation of this work has been the cooperation of the North Dakota Agricultural College department of agricultural engineering, and the Extension Service.

Others likewise have helped by contributing ideas and information to this publication and their cooperation has been of great value.

North Dakota
State Department of Health
1946

SANITATION FOR HEALTH AND CONVENIENCE

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RESIDENTIAL WATER SYSTEMS

1. GENERAL PRINCIPLES: A pure water supply is one of the most important foundations upon which the health of the family rests. Making safe your family's drinking water is the first duty of every person.

To be satisfactory for drinking, cooking and other domestic purposes, water should be incapable of causing discomfort or disease, and should be clear, practically free of color and odor, pleasant to the taste, and devoid of toxic salts or an excessive amount of dissolved mineral substance.

Municipalities which supply water to their citizens take many precautions to prevent any contamination of the water that might cause disease or physical discomfort among the consumers. Similar precautions should be taken in supplying water for individual homes. This applies not only to new or proposed water supplies but also to those that are already in use. By applying the principles contained in this manual, almost any person can determine for himself whether or not a small water supply is safe so far as conditions generally encountered in North Dakota are concerned, and if it is unsafe, can determine whether it should be abandoned or what corrections should be made.

To understand how a safe water supply may be obtained, it is necessary to be familiar with a few of the principles which underlie the spread of infectious diseases. It is known that most infectious diseases are caused by very minute forms of vegetable life called bacteria so small they cannot be seen without the aid of a powerful microscope. Many different varieties of bacteria are found in nature. Some kinds—and of these there are a very great number—are harmless to human beings. A few other kinds, known as disease-producing bacteria, will cause sickness, and sometimes death.

The diseases most likely to be conveyed by the water in North Dakota are typhoid fever, paratyphoid fever, diarrhea and dysentery. In order to bring about sickness, the bacteria which produce these diseases must find entrance to the body. This is probably always through the mouth. They then pass to the intestinal tract and invade the system. During the illness, and in some cases for a long time after apparent recovery from the disease, the body discharges of the patient contain great numbers of harmful bacteria. Discharges from animals and fowls may also contain bacteria capable of producing sickness in human beings.

There are many ways in which an unprotected water supply may become contaminated by disease-producing bacteria. Among these are, contamination of the well, pump, reservoirs or piping with infected material during construction or while repairs are being made; contamination of the water by material carried through an open slot in the top of the pump and by contaminated water used for priming; flooding of wells at the ground surface by surface water, or of wells located in basements or in pits either by water from the surface or by stoppage or backing up of drains; leakage of sewage or polluted surface water, through the well casing or curbing; and contamination of the supply through a physical cross connection with an unsafe cistern or plumbing or an unsatisfactory water supply. Sometimes water from a safe source is contaminated after it is drawn, by contact with dirty hands, fingers or unclean utensils.

What has been said is enough to indicate that in order to have safe water it is necessary that every possible precaution be taken to prevent contamination of the supply by disease-producing bacteria. To accomplish this end, the greatest care must be taken with regard to three important features connected with a water supply; namely, its **location**, its **construction**, and its **maintenance**. These features are discussed in detail in other sections of this manual.

2. LOCATION: A well or spring should be located on a site which has good surface drainage, at a higher elevation than and at a sufficient distance from privy pits, cesspools, septic tanks, sewers, absorption fields, highwater marks of lakes, streams, sloughs, ponds, etc., or other possible sources of pollution so that neither underground nor surface contamination can reach the supply. FIFTY feet is considered a safe horizontal distance from such sources of pollution under most conditions found in North Dakota. (One hundred feet for municipal wells.)

A location should be selected which will be above the point at which any surface flooding may occur. The top of the well should be at least 2 feet above the highest known high water mark, and it should be banked with earth, if necessary, to prevent the water of a lake, stream, slough, etc., from approaching nearer than 50 feet. The earth embankment should be protected against erosion where

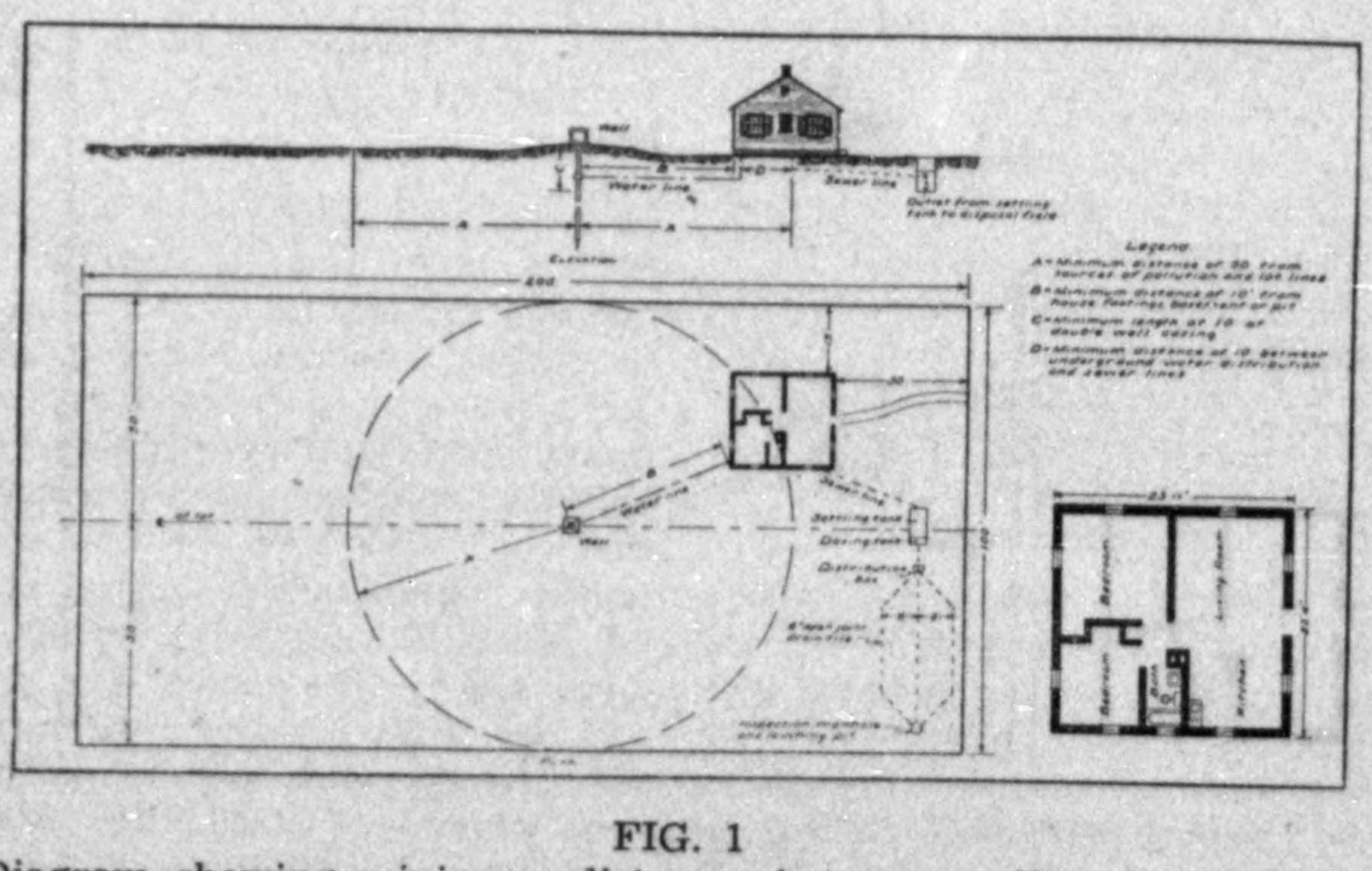

FIG. 1
Diagram showing minimum distances between well and sources of contamination where water supply and sewage disposal systems are both located on the same lot or farm yard.

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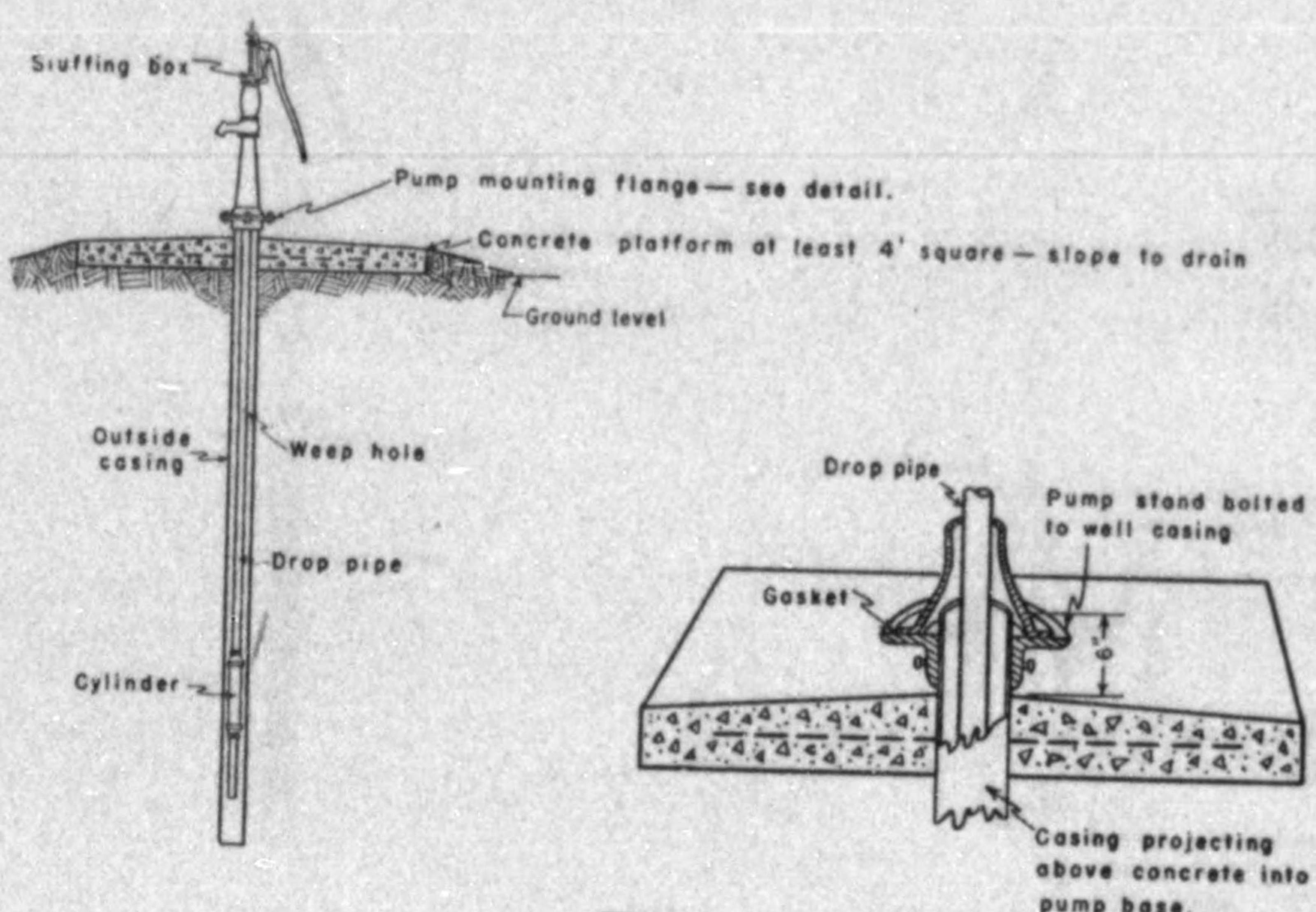

FIG. 2
Drilled Well Construction and Pump Setting.

necessary. The CONVENIENCE of the location should also be carefully considered.

It has previously been indicated that there should not be any sewer within 50 feet of a well or spring. This applies also to drains that carry surface or waste water to the sewer. It is recognized, however, that in some situations it may be impossible to meet this condition. To overcome the hazard brought about by having the distance less than that specified, all such drains or sewers within 50 feet of the well or spring, or of the suction pipe leading from the well or spring to a pump situated elsewhere, should be constructed of extra heavy cast-iron pipe with tested watertight joints. In any event, no such drain or sewer should pass within 30 feet of a well or spring or any part of a suction pipe which is not above the ground, even though the drain or sewer is constructed of extra heavy cast-iron pipe as previously specified. All such drains between 30 and 40 feet should have tested watertight joints with bell joint clamps or an acceptable equivalent.

Except as provided in paragraph 25, there should not be any pit or other unfilled space below ground level within 10 feet of a well, spring or buried suction pipe. (See Fig. 1.)

3. PUMPING APPARATUS: (a) Most wells are equipped with some type of iron pump, operated either by hand, windmill, gasoline engine, or electric motor. Many of the pumps in use for small water supplies are not satisfactory from a sanitary standpoint.

(b) Hand pumps should be of the force type with cylinders placed below or near the water level so that priming will not be necessary. Direct-lift, chain-lift, and bucket pumps are not satisfactory.

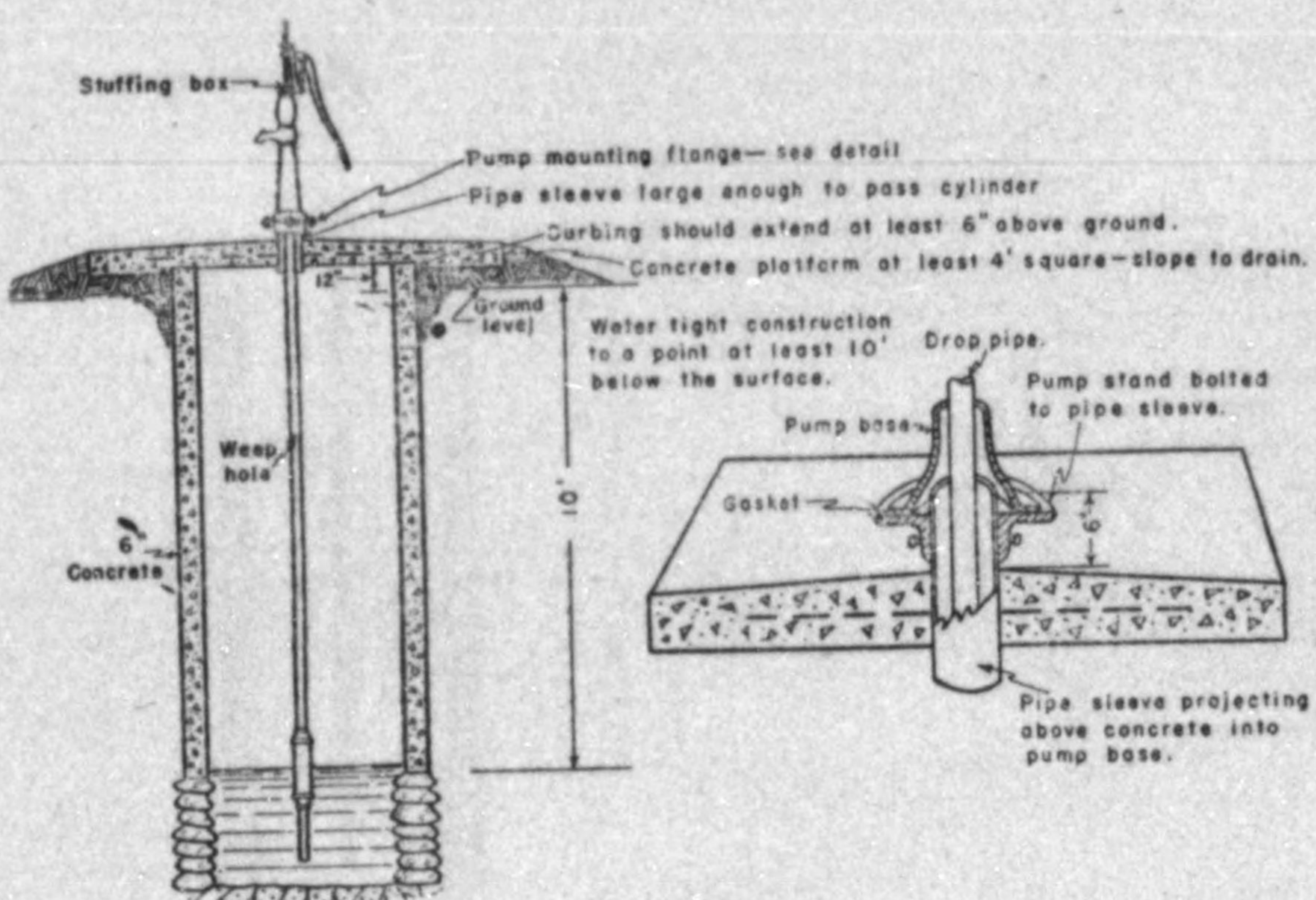

FIG. 3
Dug Well Construction Setting Pump with Pipe Sleeve.

(c) The pump base should be of the solid one-piece recessed type, cast integral with or threaded to the pump column or stand. Two-piece (split) open-work and adjustable bases are not satisfactory.

(d) The pump base should be of sufficient diameter and depth to permit a 6-inch well casing, or a 6-inch pipe sleeve used in the top of a dug well, to extend at least 1 inch above the pump stand to which the pump base is bolted.

(e) Provisions should be made for fastening the pump base rigidly to the casing and well top to prevent movement of the pump. This may be accomplished by the use of a flange or pump stand secured to the casing top. The flange type mounting is preferred. A pump brace may be used to provide stability to the pump setting. Suitable gaskets should be used between the pump base and the pump stand or the flange, as the case may be. Methods of setting hand pumps are shown in Figures 2 to 8.

(f) The pump head should be designed to exclude contamination by hands, dust, rain, birds, flies, etc., from the water chamber of the pump head. Force pumps are reasonably protected against such contamination by the stuffing box which surrounds the pump rod. Ordinary lift pumps with a slotted pump head top are open to contamination and should not be used.

(g) The pump spout should be of the closed, downward-directed type. The open type commonly used on "pitcher pumps" should not be used. Suitable types of hand pumps and pump settings as described in this section are illustrated in Figures 10 and 11.

(h) Pumping equipment can be obtained which makes the use of pits or sub-ground-level pump rooms unnecessary. Standard parts

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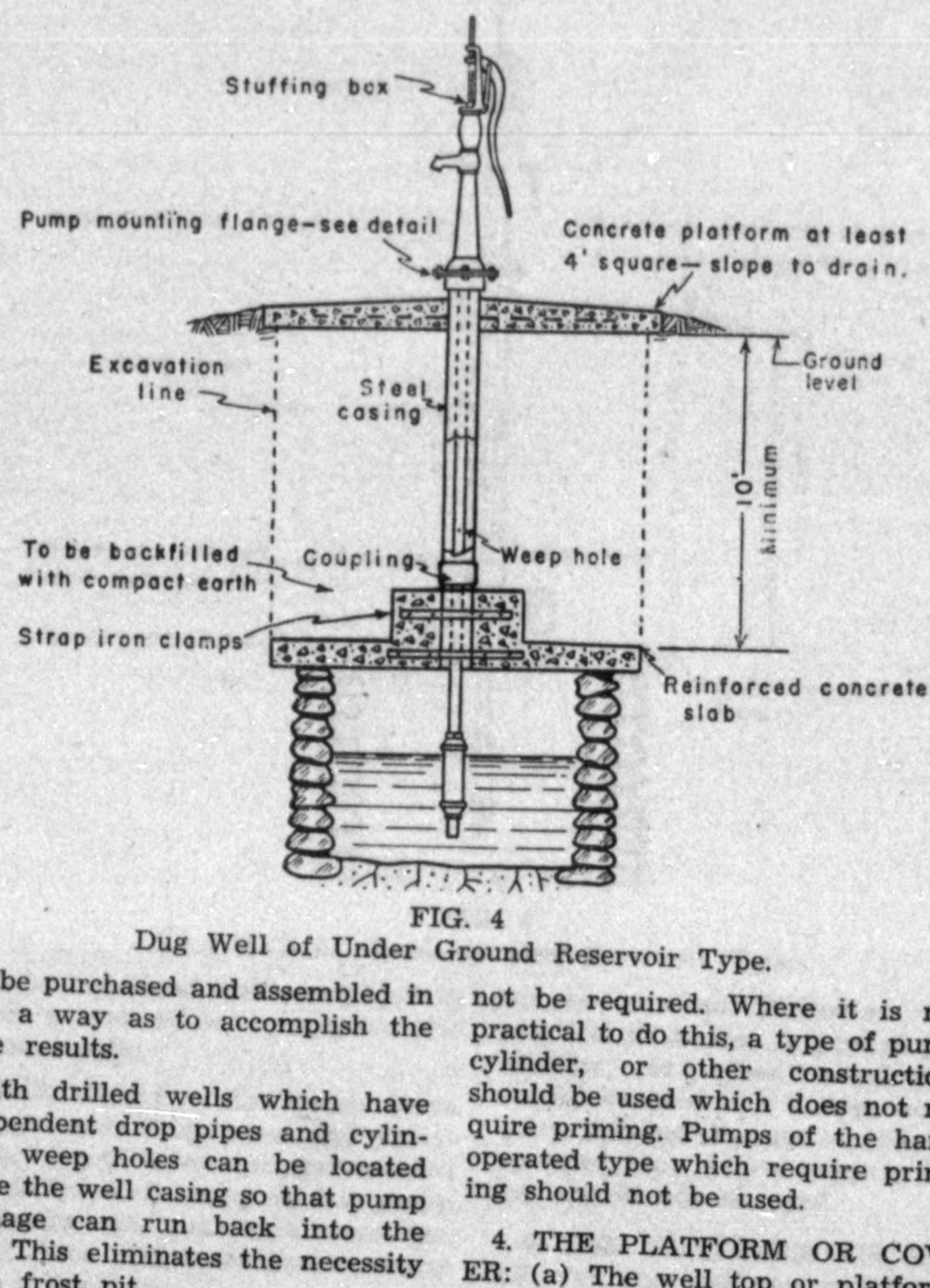

FIG. 4
Dug Well of Under Ground Reservoir Type.

can be purchased and assembled in such a way as to accomplish the same results.

With drilled wells which have independent drop pipes and cylinders, weep holes can be located inside the well casing so that pump drainage can run back into the well. This eliminates the necessity for a frost pit.

(i) A very common fault is "priming" the pump; this practice is a dangerous one from a sanitary point of view because the priming water may be contaminated. The pump cylinder should be placed near or below the level of the water in the well so that priming will not be required. Where it is not practical to do this, a type of pump cylinder, or other construction, should be used which does not require priming. Pumps of the hand operated type which require priming should not be used.

4. THE PLATFORM OR COVER: (a) The well top or platform for a drilled well should be a watertight, **Reinforced Portland Cement Concrete** slab at least 4 feet square of a minimum thickness of 4 inches. The slab should rest on compact earth. The concrete should be sloped from the well casing to the edge of the slab. The surface of the slab at its outer edges should

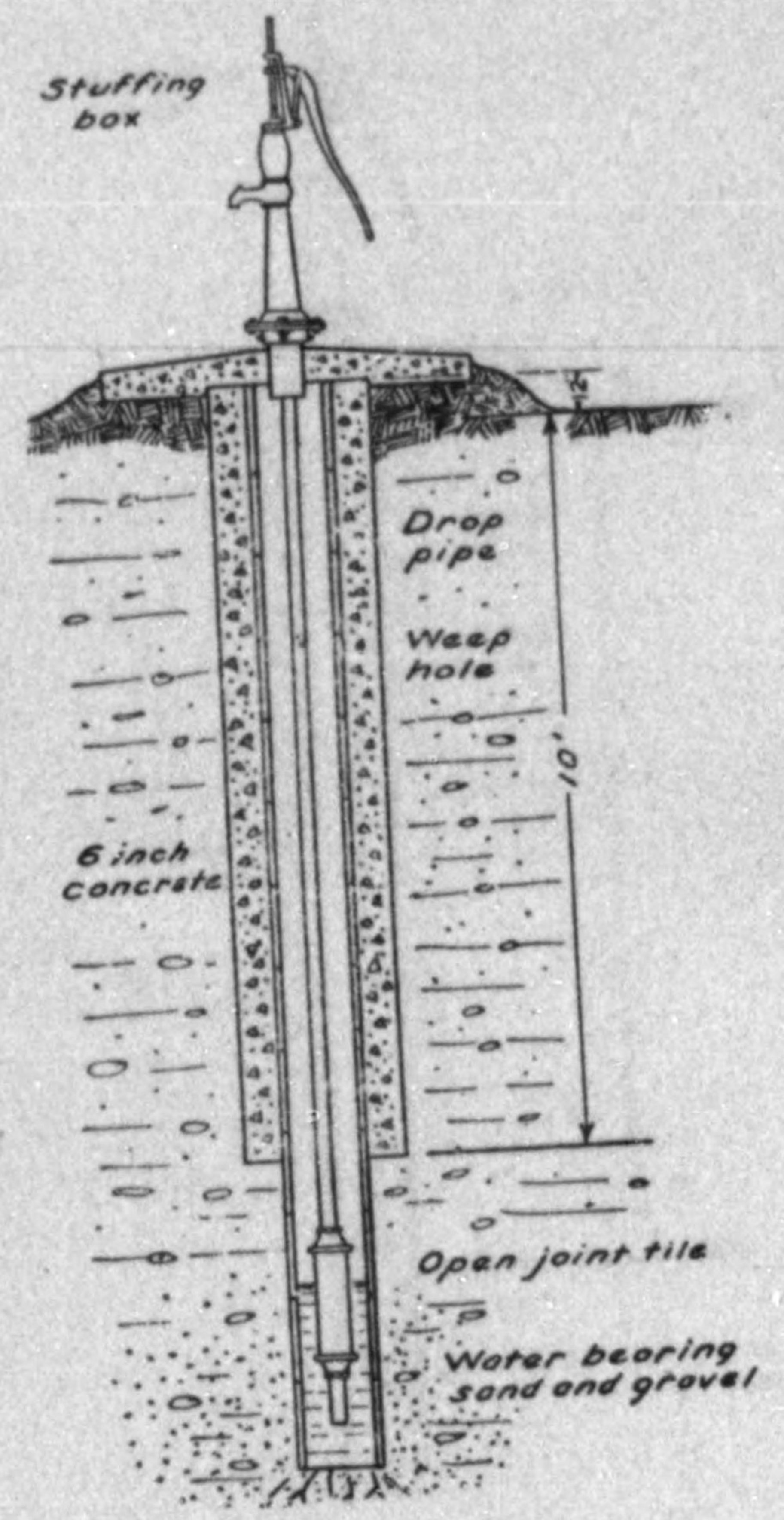

FIG. 5
Bored or Small Dug Well Construction.

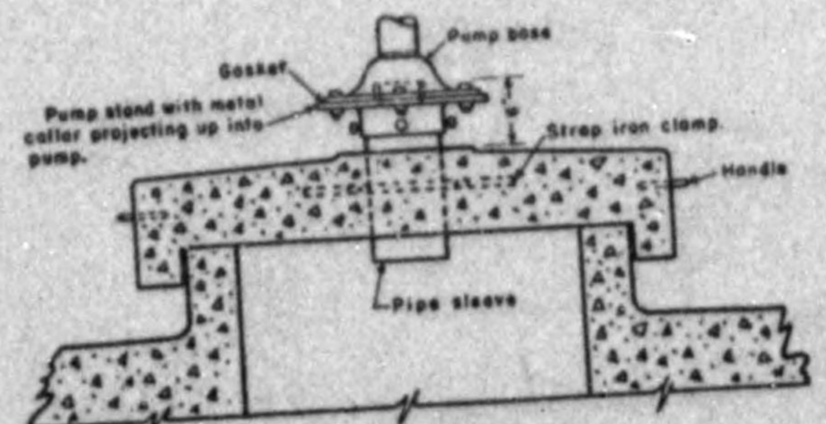

FIG. 6
Method of Installing Pump on Man Hole Cover to Dug Well or Reservoir.

be well above the surrounding ground surface. The concrete should be tamped thoroughly around the well casing and the pipe sleeve.

Drainage off the slab should be further established by placing a compact earth fill approach on all sides from the top edge of the slab to the natural ground level.

If desired, an annular space between the concrete platform and the well casing may be provided for movement of the platform. This annular space should be filled with an asphaltic or similar material which will provide a watertight joint and remain plastic at extreme low temperatures.

A properly constructed cover for a drilled well is illustrated in Figure 2.

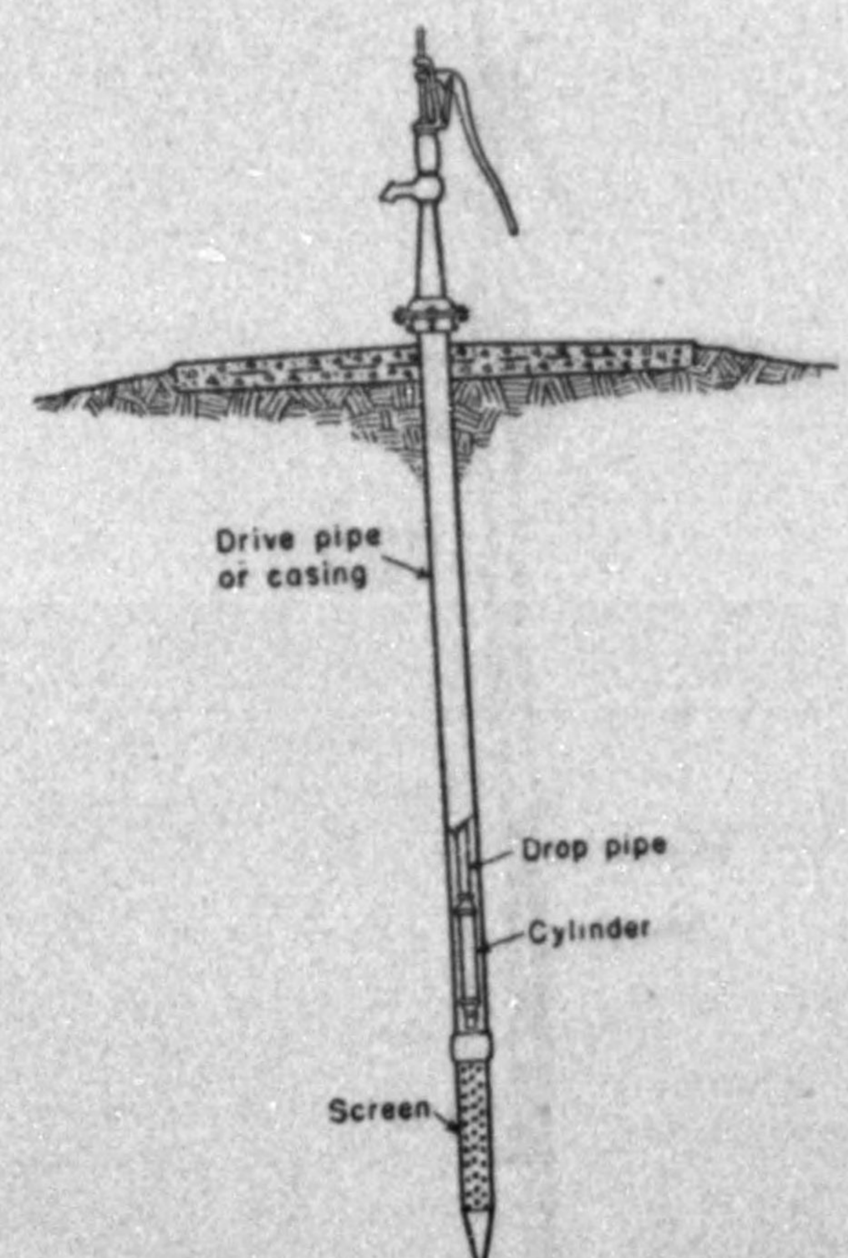

FIG. 7
Properly Constructed Driven Well.

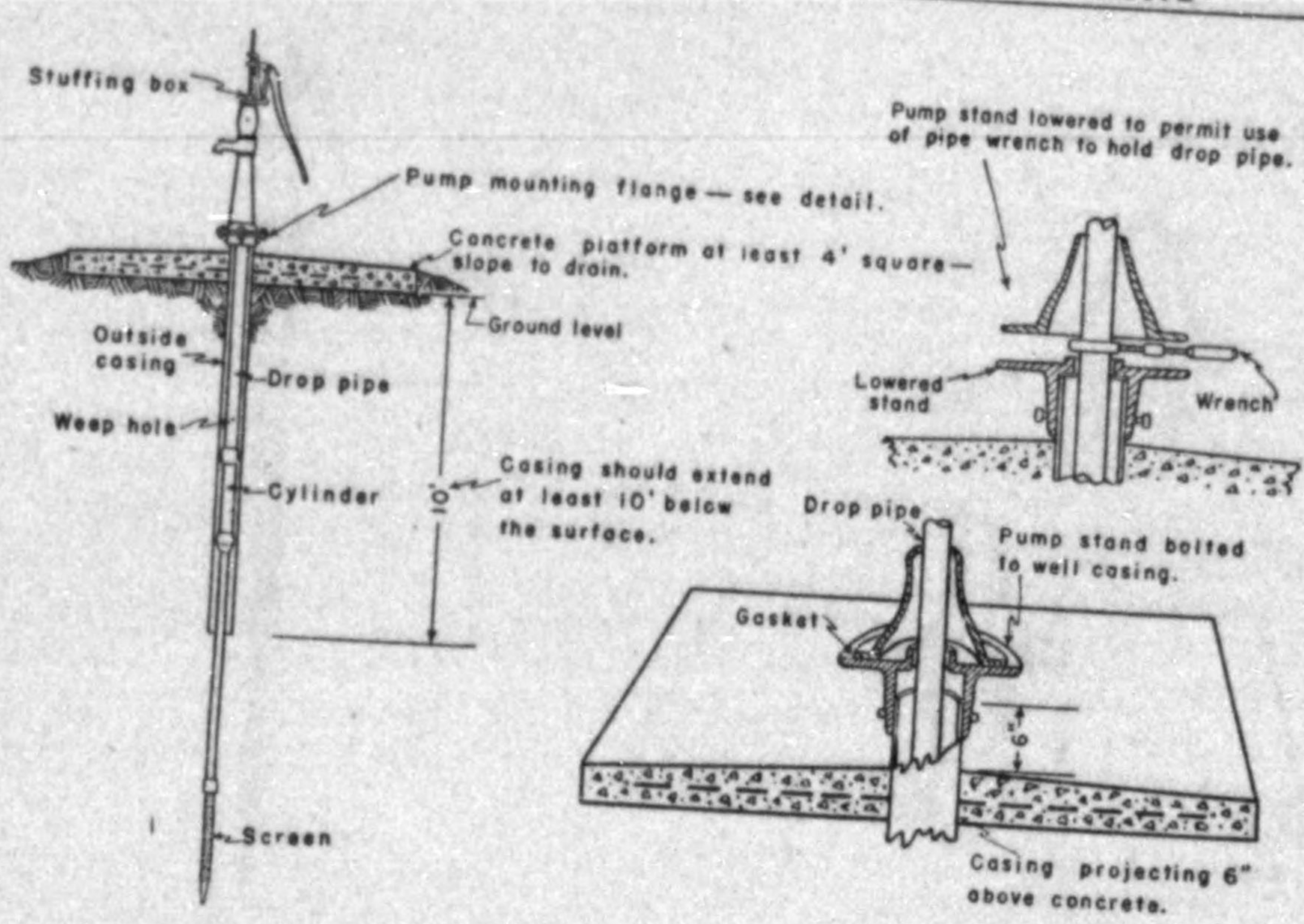

FIG. 8
Method for Protecting Driven Well and Removing Pump.

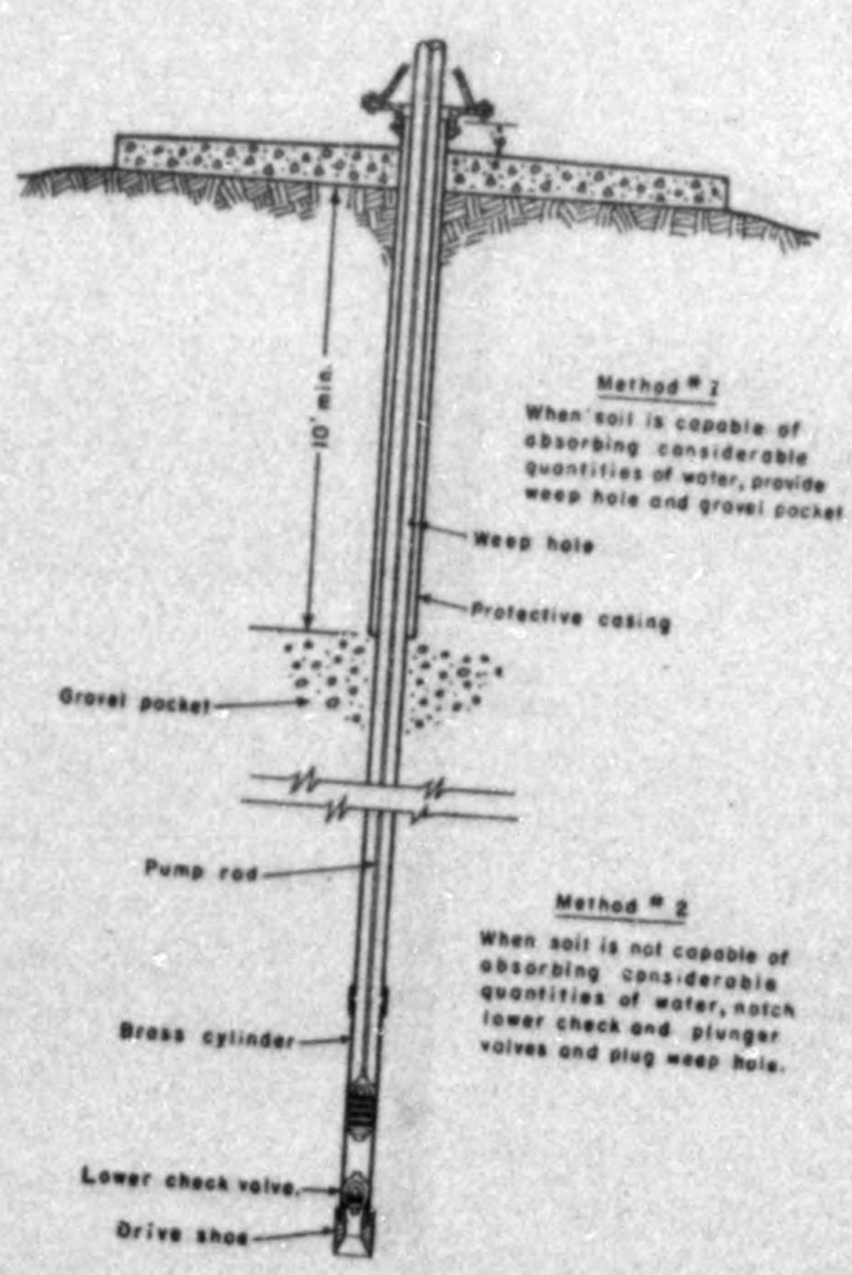

FIG. 9
Suggested Methods of Reconstructing an Existing Tubular Well.

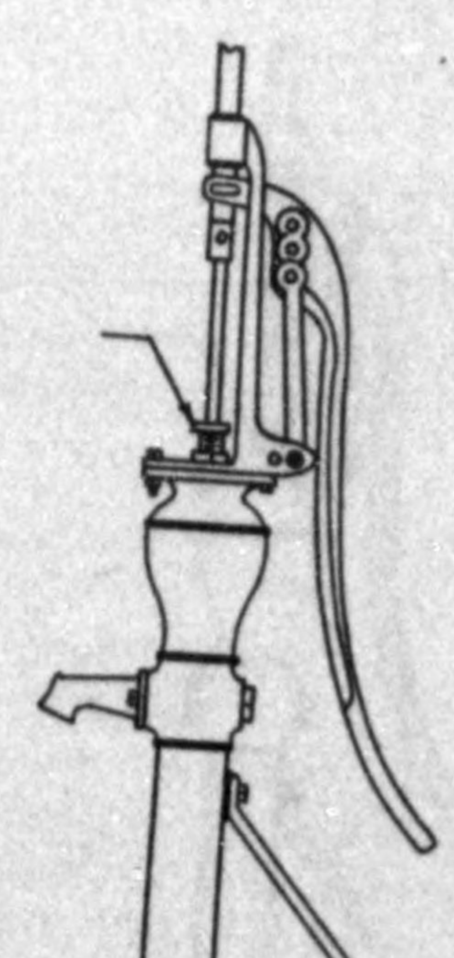

FIG. 10
Proper Type of Pump Head.

(b) The cover slab of a dug well should be of **Reinforced Portland Cement Concrete** of such thickness and so reinforced as to carry the load which will be imposed upon it, but in no case less than 4 inches thick. The proper pipe sleeve should be placed firmly where it is desired to have the pump, generally at the center, and the concrete should be thoroughly tamped around the pipe sleeve. A properly constructed cover for a dug well is illustrated in Figures 3 and 4. Figure 6 illustrates methods of setting a hand pump on a manhole cover for dug wells or reservoirs. A manhole is usually unnecessary and preferably omitted.

(c) The pipe sleeve that forms the drop pipe opening should be of a diameter sufficient to admit the pump cylinder, which is larger than the drop pipe for which it is constructed. It should be so placed in the concrete as to extend at least 6 inches above the platform. Details of this construction at the base of the pump are shown in the illustrations for each type of well.

(d) Manhole openings in the cover slab of a dug well should be curbed to a height of not less than 6 inches above the top surface of the cover slab. This curb may be built by having a cast-iron manhole frame set in the concrete slab, or the curb may be of concrete, provided it is poured with the slab or within 30 minutes after that portion of the slab is poured. The manhole cover must be watertight and constructed of metal or reinforced concrete, a gasket should be provided. It should overlap the curbing and extend downward around it at least 2 inches. Provision should be made for locking the manhole cover. A manhole is usually unnecessary and is preferably omitted.

5. DRILLED WELLS: Drilled wells are found most frequently in sections where water is reached only at considerable depth. The casing is generally of wrought iron or steel pipe which extends throughout the entire depth or to the water-bearing formation.

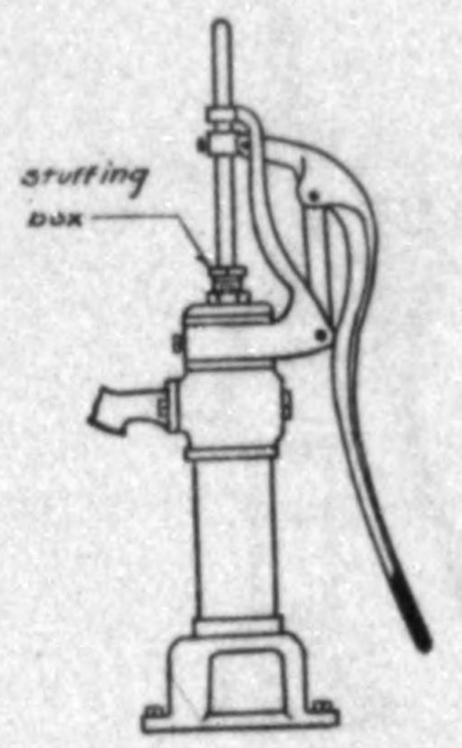

FIG. 11
Proper Type of Pump Head.

In the past, many drilled and driven wells have been constructed with pits in which the pumping equipment has been located. The purpose of this was in most cases to provide access to the working parts of the pump and to protect the exposed parts of the pump and piping against freezing. Such pits form receptacles in which waste water and contaminating material may accumulate. Any opening in the well casing permits this material to enter the well, thus endangering the safety of the supply. To prevent this, the casing should be extended 2 feet above the ground surface where a watertight connection can be made with the base of the pump. The floor of the pit should be broken up to permit natural drainage conditions as far as possible. The pit should then be filled with compact earth.

Another way in which surface water may gain entrance to this type of well is by following down the outside of the casing. This is made possible by the fact that in certain formations the process of drilling has a tendency to loosen the material immediately around the casing. In some formations, the soil around the drill hole will not settle back against the casing. Such conditions can best be remedied by forcing cement grout into the space between the well casing and the drill hole to a depth of at least 10 feet. The grout should be forced upward from the bottom of the space to be grouted. Tamping earth around the casing at the surface will help in some cases but is not as reliable as grouting.

The illustration in Figure 2, page 7, shows proper construction for a drilled well.

6. RECONSTRUCTING TUBULAR WELLS: A "tubular well" is one in which the cylinder is inserted within the casing, which is used both as a casing and a drop pipe. This type of well is subject to sanitary hazard because very frequently the casing is under suction. This is particularly serious because almost invariably such wells are surrounded by frost pits.

Frequently tubular wells as small as 2 inches in diameter are equipped with an inserted cylinder. These wells are generally provided with wooden rods, and a weep hole in a pit surrounding the well at the top. In order to eliminate the danger of the well being contaminated from the pit, the following procedures are suggested.

(a) Remove the check valve and install a 1⅝-inch cylinder with a 1-inch drop pipe. It will be necessary to replace the wooden rods with a steel rod—7/16 inches diameter may be sufficient in size. Break up the pit floor to restore natural seepage conditions, SEAL up the old weep hole in the casing, fill the pit with compact earth, and construct a satisfactory platform. This procedure converts the well to a standard drilled well.

(b) This method requires less change of equipment. Leave the weep hole open and install a 12-foot section of well casing outside of the old casing and place gravel around the bottom of the new casing for absorption purposes. Break up the floor of the old pit and fill it with compact earth. A new platform may be necessary. (See Method No. 1 in Fig. 9) Where clay soil is present follow the instructions in Paragraphs (a) or (c) which are preferable methods.

(c) The same procedure outlined under (b) may be followed, omitting the gravel pocket at the foot of the outside casing and notching the check valve in the plunger and also the lower check. The weep hole should be SEALED. This permits the water in the discharge pipe after pumping to drain back into the well. (See Method No. 2, Fig. 9)

7. DUG AND BORED WELLS: The dug well consists of an excavation made for the purpose of collecting water from the upper earth formation. Wells that are sufficiently small in diameter to be dug by means of an auger are usually classified as bored wells. To give satisfactory protection in excluding surface and shallow ground water,

the lining or casing of the well should be watertight for a distance of at least 10 feet below the ground surface, and to a greater depth if possible, the distance depending upon the character of the soil. Reinforced concrete not less than 6 inches thick and poured in one operation is satisfactory. If concrete pipe, vitrified tile pipe, cement asbestos pipe, galvanized well casing, corrugated metal pipe, or brick are used for curbings, they should be surrounded by concrete not less than 3 inches thick to a depth of at least 10 feet.

The casing should also extend high enough above the natural surface level to provide for grading which will permit drainage to be established away from the well in all directions. The cover of this type of well is very important; it must be watertight if the maximum protection is to be obtained. Various materials are used, the most common being wood or concrete. Reinforced concrete provides the only satisfactory cover. Wood is UNSATISFACTORY since it is impossible to keep it watertight when it is exposed to the weather. The concrete platform should be reinforced with steel wire or rods. It should be at least 4 inches thick.

Figure 3, page 8, shows a dug well which has been constructed so as to prevent the entrance of surface water. It will be seen that drainage has been established away from the well at the surface and that the casing for at least 10 feet below the normal ground surface consists of reinforced concrete through which water cannot penetrate. The platform is also made of reinforced concrete, and is so designed as to prevent contamination of the well at this point. The concrete platform is sloped to drain away from the pump. It should be noted that a pipe sleeve, large enough to pass the pump cylinder, is set so as to project above the concrete into the base of the pump. This sleeve is placed in position before the concrete well platform is poured. See detail of pump setting, Figure 3, page 8. This is a very important detail which should be followed in order to keep waste water from getting into the well through leaks which may occur at the base of the pump because of defective gaskets, loose bolts, etc. It should rarely, if ever, be necessary to enter the well because repairs to the pump may be made by drawing the drop pipe and cylinder out through the pipe sleeve. If it should become necessary to enter the well this may be done by removing the cover which is

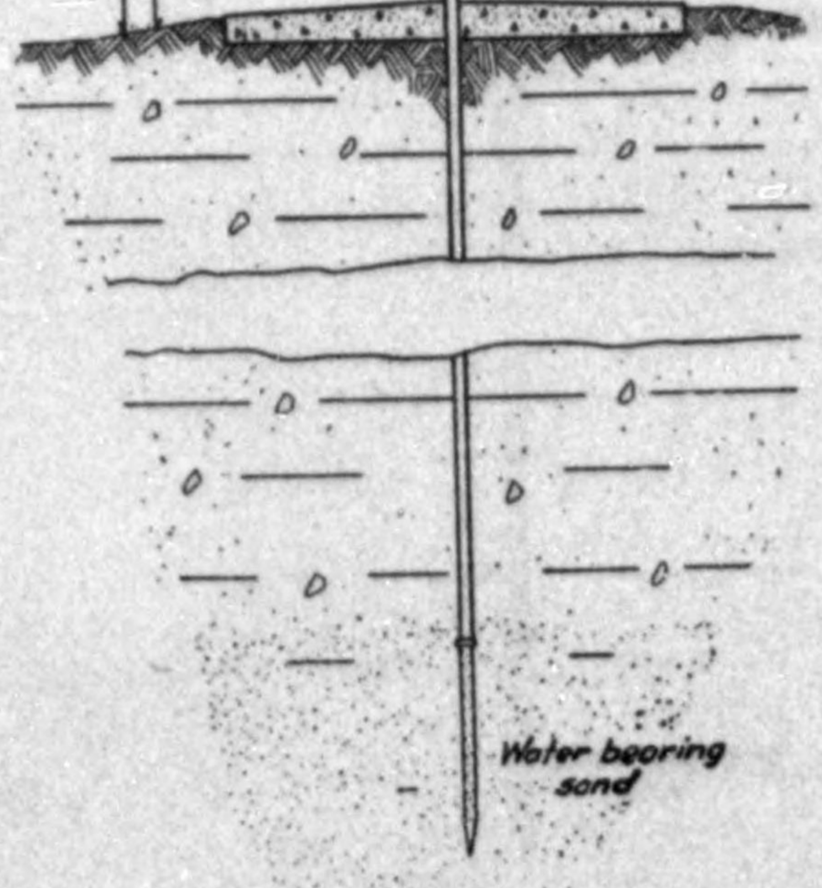

FIG. 12
Flowing Well Without Pump.

cast separate from the casing or curbing.

Figure 4 shows another method of constructing a dug well. This method, where the "underground reservoir" is more than 10 feet below surface, is preferable to that shown in Figure 3 and may be used advantageously in the reconstruction of existing dug wells that have unsatisfactory curbings or casings. Figure 5 shows a properly constructed bored well.

8. DRIVEN WELLS: The driven well is installed by driving directly into the earth successive lengths of iron pipe, the first of which is armed with a sharp, perforated, metallic well point. This type of well is found where water is reached relatively near the surface and where the earth formations are comparatively soft. Driven wells are frequently constructed with a single pipe for drawing the water to the surface without a separate outside casing. Additional protection should be secured for this type of well by providing it with an outside casing. This casing should be large enough to receive the pump cylinder. The well should be constructed at the surface in a manner similar to that shown in Figures 7 and 8, pages 10 and 11.

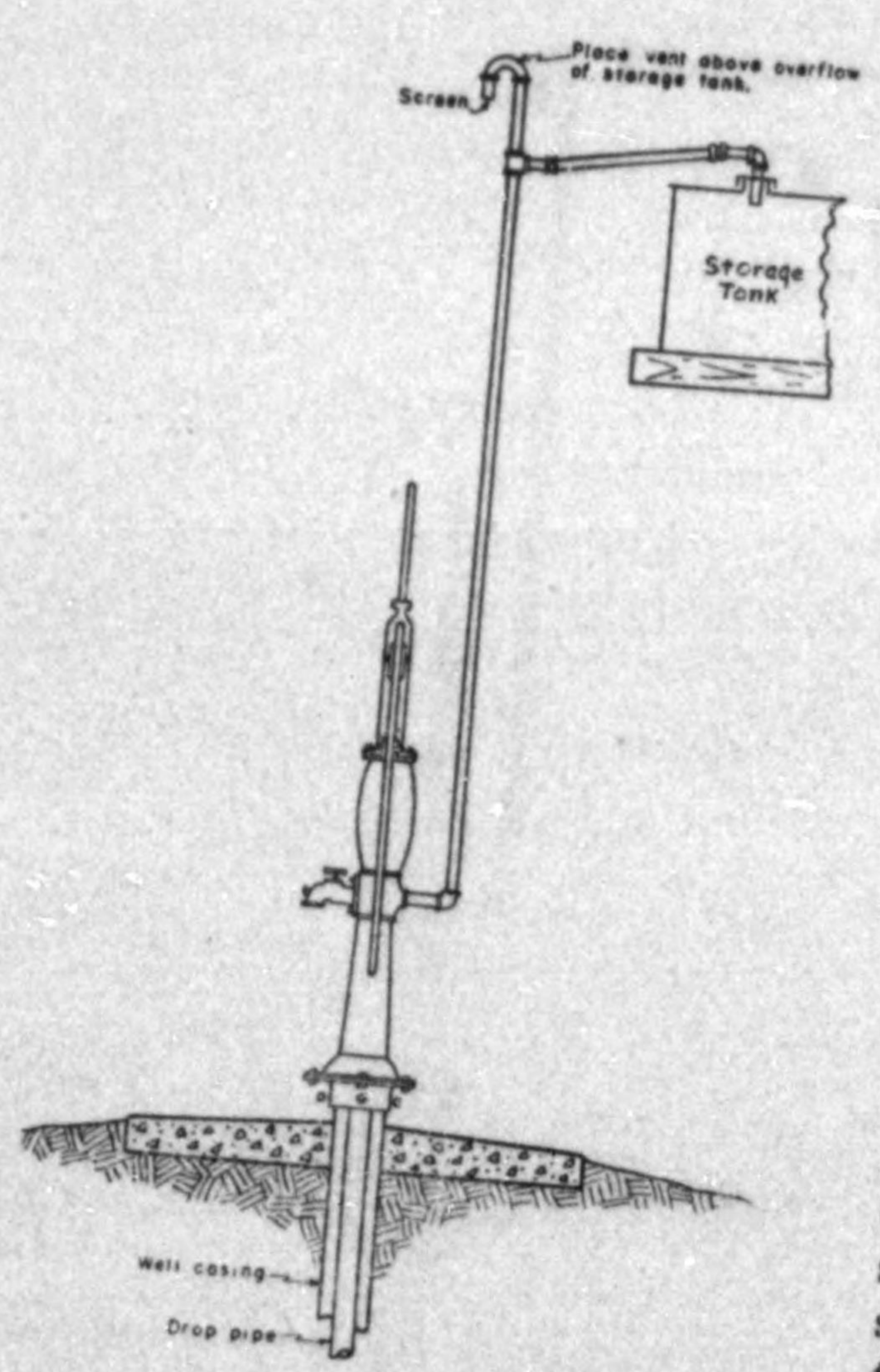

FIG. 13
Suggested Arrangement for Pumping to Overhead Storage Tank.

9. FLOWING WELLS: Occasionally the pressure on the underground water is sufficient to force it above the surface of the ground so that it will flow from the well without the necessity of pumping. A flowing well which is satisfactorily constructed is shown in Figure 12, page 14.

10. CHEMICAL SAMPLES: As water percolates through the earth formations it takes into solution some of the minerals and other soluble substances with which it comes in contact. The dissolved materials affect the physical and chemical properties of the water, making it hard, giving it taste and odor, and in some cases producing color. When water containing dissolved minerals is pumped to the surface and comes in contact with the oxygen of the air, some of the chemicals which were in solution may be precipitated, producing turbidity and apparent color. Other chemicals remain in solution and

can only be removed by some form of treatment.

Iron is commonly found in the subsurface waters of North Dakota and upon oxidation, following exposure to the air, the water develops a murky brown color, stains plumbing fixtures readily and precipitates a reddish sludge in the bottoms of containers upon standing. So far as is known iron has little sanitary significance.

Sulphates sometimes occur in water and in combination with magnesium are known as Epsom salts. If combined with sodium they are known as Glauber's salts. When these salts are present in excessive amounts, unless a tolerance to such water has been developed, the water may cause intestinal disturbances in persons drinking the water.

11. BACTERIOLOGICAL SAMPLES: It is essential to have complete data on the **location, construction and maintenance** of a water supply in order to make a satisfactory interpretation of analytical results.

It has been shown by investigations conducted by the North Dakota State Department of Health that nearly 50 per cent of unsafe supplies would be overlooked if the investigation was confined to laboratory examination of samples alone. By this is meant that nearly 50 per cent of the water supplies which had some defect in either location, construction, or maintenance did not show indications of contamination in the water at the time the samples were collected. The reason for this is that there did not happen to be present any contamination in the supply when the sample was taken.

From this information it can be seen that a bacteriological examination of water showing no contamination cannot be relied upon as indicating the safety of the water at all times unless the source is **properly located, constructed, and maintained.**

12. DISINFECTION: Indications of contamination are often found in the water from wells which have recently been constructed, even where the construction work has been done correctly, if care has not been taken to disinfect the well and pumping equipment thoroughly after the work has been completed. A supply may become contaminated when the system is opened for repair work, from handling of the equipment or from contact with foreign material. Water supplies should always be disinfected following new construction, or repair work, in order to destroy contamination which may be dangerous.

Disinfection of small water supplies can usually be accomplished by adding into the well one of the following: 2 pounds chlorinated lime per 1,000 gal. of water in the well or 8 tablespoons per 100 gal.; (mix the dry powder with some water and pour into well) 1 pint of laundry bleach such as Hilex, Clorox, Purex, BK liquid, Save-a-day, etc., per 100 gal; 12 tablespoons HTH (15) per 100 gal. Mix thoroughly. Let the chemical stay in the well overnight and then pump out.

13. PUMPING TO ELEVATED STORAGE: Where it is desired to store water in an overhead tank an arrangement as shown in Figure 13 may be used.

14. LIST OF SANITARY DEFECTS: The following list of sanitary defects on small water supplies where hand-operated pumps are used may be of assistance in examining such supplies:

15. (a) IMPROPER LOCATION OF WELL:

Well in pit or basement. Less than 10 feet from basement. Less than 50 feet from sewer, privy, cesspool, lake, river. Drainage toward well. Flooded by surface water.

16. (b) PUMPS:

Split type of pump may admit leakage.
Loose fastening to casing or pump platform.
Leaky or defective stuffing box on pump head—lack of stuffing box.
Cracked metal on water chamber.
Open top for priming pump.
Open slot type admits contamination to inside of pump.
Unprotected openings or vents on water chamber and spout.
Leaks at base of pump.
Open spout as in pitcher-type pump permits contamination to come in contact with the water.
Wooden pumps.

17. (c) PLATFORM:

Wooden platforms.
Cracks in concrete platforms.
Platform not sloped away from pump (drainage not good, depressions holding waste water).
Pump base set below surface of platform.

Platform curbed in a manner to obstruct surface drainage.
Platform below ground surface.

18. (d) CASING:

Tile, clay pipe, culvert pipe, wood, riveted metal pipe, brick and stone masonry. (Unless surrounded by 3" of concrete to a depth of 10 ft.)
No outside protecting casing.
Cracked or leaky casing.
Casing not carried above the platform into the base of the pump.
Annular opening at top of casing not covered.
Casing used as suction pipe.

19. SPRINGS: Springs are used to a limited extent as sources of water supply. Most springs consist of small basins in the surface formations from which the water overflows into some natural water course. Inasmuch as the source of water is unknown, the safety of spring water is open to QUESTION, especially if the spring is close to sources of gross pollution such as cesspools and sewers.

Because springs are usually unprotected at the surface, they are subject to contamination at any time. This contamination may be introduced into springs by surface drainage, by animals, by dipping with a pail or other container, or by dust, papers, etc., carried by the wind. Some springs, however, can be made safe if protected against surface contamination by the construction of reinforced concrete watertight casings and covers.

A discharge pipe should be provided so that the water can be collected in receptacles, and the dangerous practice of dipping into the water eliminated. The principles pertaining to the protection of dug wells can be applied to springs. Where the surface elevation is so low that the spring is subject to flooding with high water or from surface ditches, it should not be developed for domestic use.

Two types of protected springs are shown in Figure 14, below. These springs are provided with casings, covers, and discharge pipes. They are protected against flooding from above by intercepting and diversion ditches to carry away the surface drainage.

When the water enters the enclosing structure of springs or infiltration systems at points less than 10 feet below the ground surface, they may be protected by placing earth fill over the area involved (50 feet radius) to provide the necessary depth of 10 feet of earth over the points of flow.

Figure 15, page 19, shows a pump installation for obtaining water from a spring.

20. CISTERNS: (a) Cisterns are simply reservoirs for the storage of surface water, or rain water col-

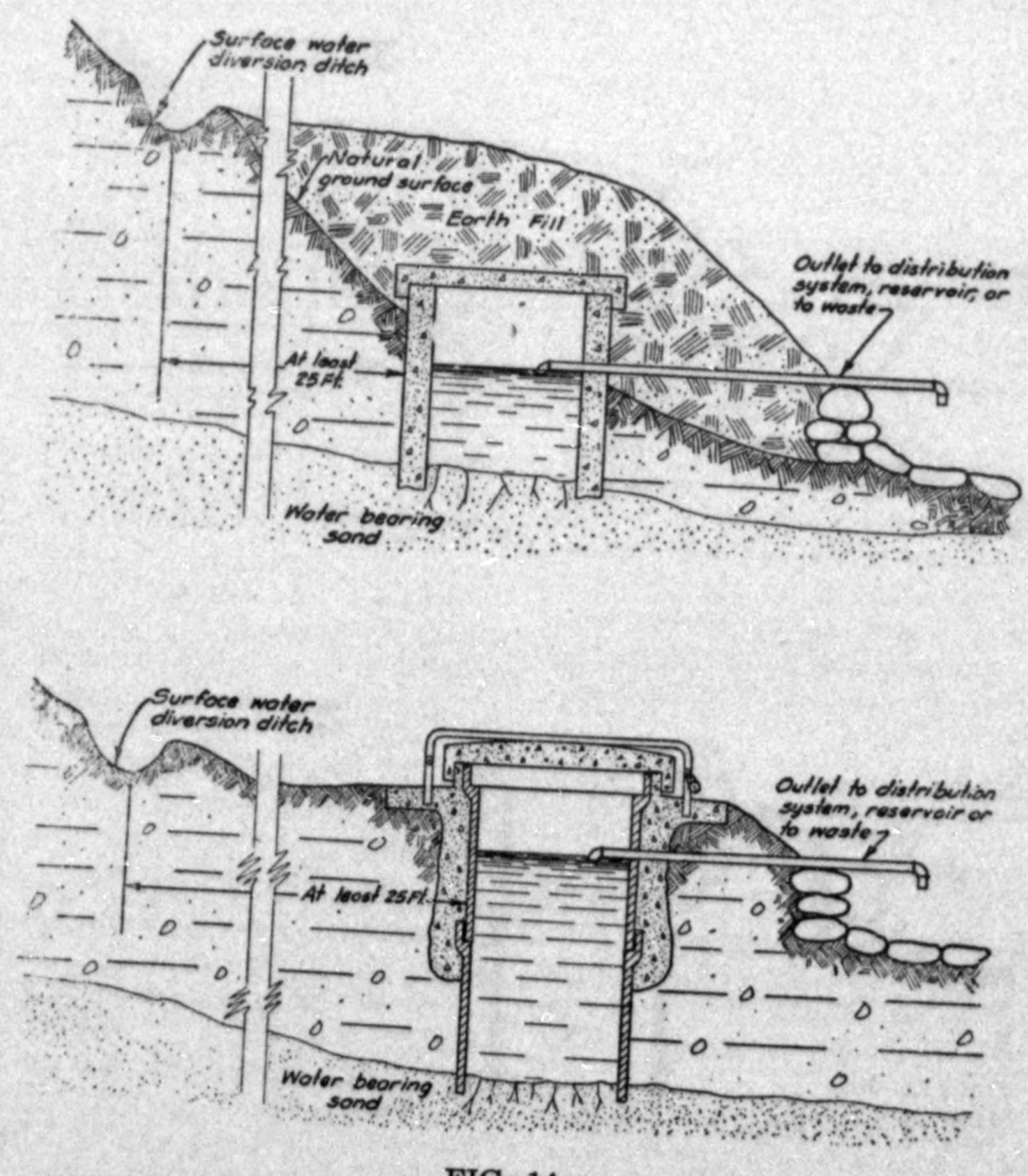

FIG. 14
Suggested Methods for Protecting Springs.

lected from the roofs of dwellings or other buildings. Cisterns can likewise be used to store water hauled from some pure and satisfactory water source. They are ordinarily located underground or in basements of houses, and are constructed of brick or stone masonry, reinforced concrete, and in some cases, of wood or galvanized iron. Cistern water supplies are commonly used as auxiliary supplies for providing soft water for kitchen and laundry purposes.

(b) A cistern is not considered as safe as a properly constructed spring or well for the reason that it is practically impossible to exclude contaminating material which is washed into it with the rain water from the roof. It is possible to install in cisterns sand filters which will remove a portion of this contaminating material but they cannot be relied upon to remove all the contamination which may be carried in with the water as it flows from the roof. A basement is not a safe location for a cistern or for the pumping equipment connected to one where the water is to be used for drinking and other domestic purposes.

(c) A cistern, the water from which is to be used for drinking and other domestic purposes should meet the same requirements for location as should wells. See paragraph 2. They should be built of watertight material, preferably reinforced concrete. Manhole openings in the cover should have raised edges and be provided with watertight covers of the overlapping type, the same as used for reservoirs. See Figure 30. The pump used for drawing water should be of a type which does not require priming.

Water from surface drainage or roof drainage should never be used for drinking purposes unless boiled.

When water from an approved source is placed in a cistern to be used for drinking or domestic purposes, the water should be sterilized as follows: Add 1 2/3 tablespoonsful of liquid laundry bleach or 1 teaspoonful chlorinated lime per 100 gal. of water; or ½ pint liquid laundry bleach or 3 tablespoonsful chlorinated lime per 1,000 gal. of water. **Increase** these dosages if a distinct chlorine taste is not observed.

The following partial list of sanitary **defects** on springs and cisterns may be of assistance in designing and examining such supplies:

21. DEFECTS IN SPRINGS:
Subject to flooding.

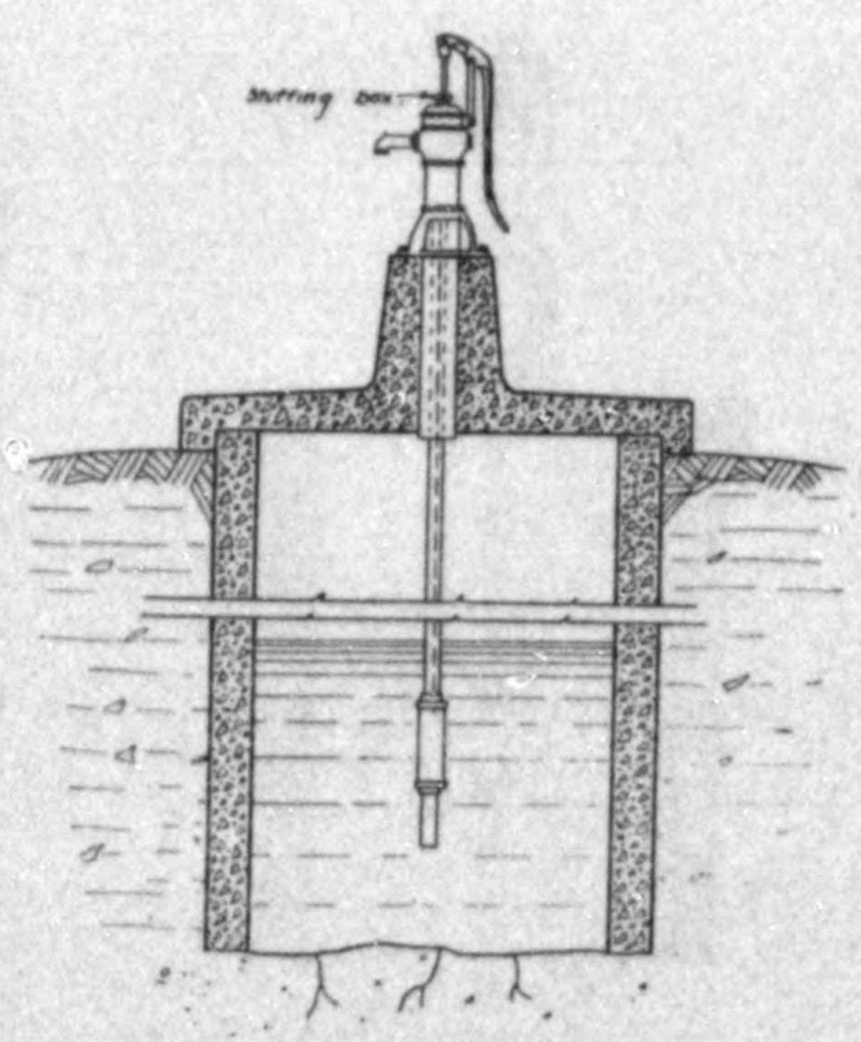

FIG. 15
Properly Constructed Spring, Using Pump to Draw Water

Too near sources of contamination.
Improper drainage.
Not properly curbed.
Located in or too close to basements.
Not properly covered.
Flow of water too close to ground surface.

22. DEFECTS IN CISTERNS:
Located in or too close to basements.
Too near sewers, cesspools, etc.
Too near barnyard drainage.
Drained to sewers.
Improper construction.

Residential Small Power-Pump Installations

23. GENERAL CLASSIFICATION: This group in general includes equipment for all small power-pump installations which are not included in the class used for municipalities. It includes small power-operated equipment such as that used for residences, small resorts, small institutions, schools, small industries and other similar establishments.

All requirements of location and construction set forth under Residential Wells, pages 5 to 7 apply to this class of equipment. General types of wells are shown in Figures 2 to 8.

24. LOCATION: (a) This group of water supplies is most often under the control of one who has other duties to perform and there appears to be certain advantages in having the well and equipment located in or adjacent to the building supplied with water. For the convenience of the operator, and for heating the pump house, this is an advantage, but, these advantages are offset by additional noise in the building, fire risk and, most important of all, SANITARY HAZARD to the water supply.

When locating a well in or adjacent to a building that is to be supplied with water it is very difficult to provide sufficient distance between the well and floor drains, sewers, sumps, or other sources of contamination. For the purpose of utilizing an existing well that is located away from the building such as a hand pump in a school

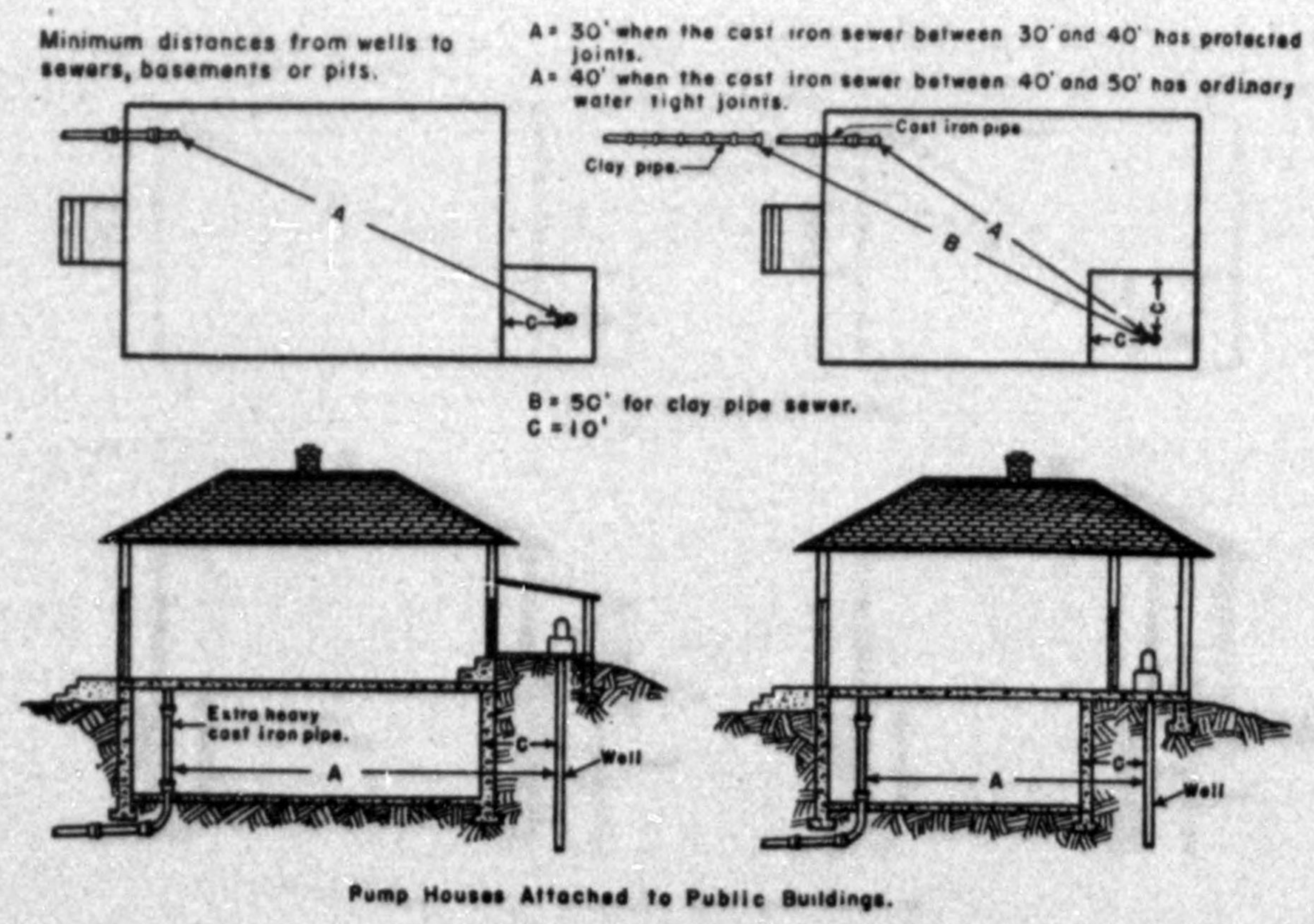

FIG. 16
Diagram showing typical arrangements and minimum distances from wells to sewers, basements or pits.

yard, a power-pump installation in a detached pump house is an advantage.

The safest and most satisfactory location for the pumping equipment is in a small pump house entirely detached from the main building. In this way, ample distance from sewers may be obtained. When an underground discharge is used it is not necessary to provide heat for the pump house. If the pump house is attached to the building, (see Fig. 16) the well (assuming that it is otherwise properly located with respect to sources of contamination) should be at least 10 feet from the inside wall of any basement, pit or other excavation provided with a suitable lining, **EXCEPT** for installations illustrated in Figure 18. For unlined pits, basements, or excavations, a distance of 50 feet should be the minimum.

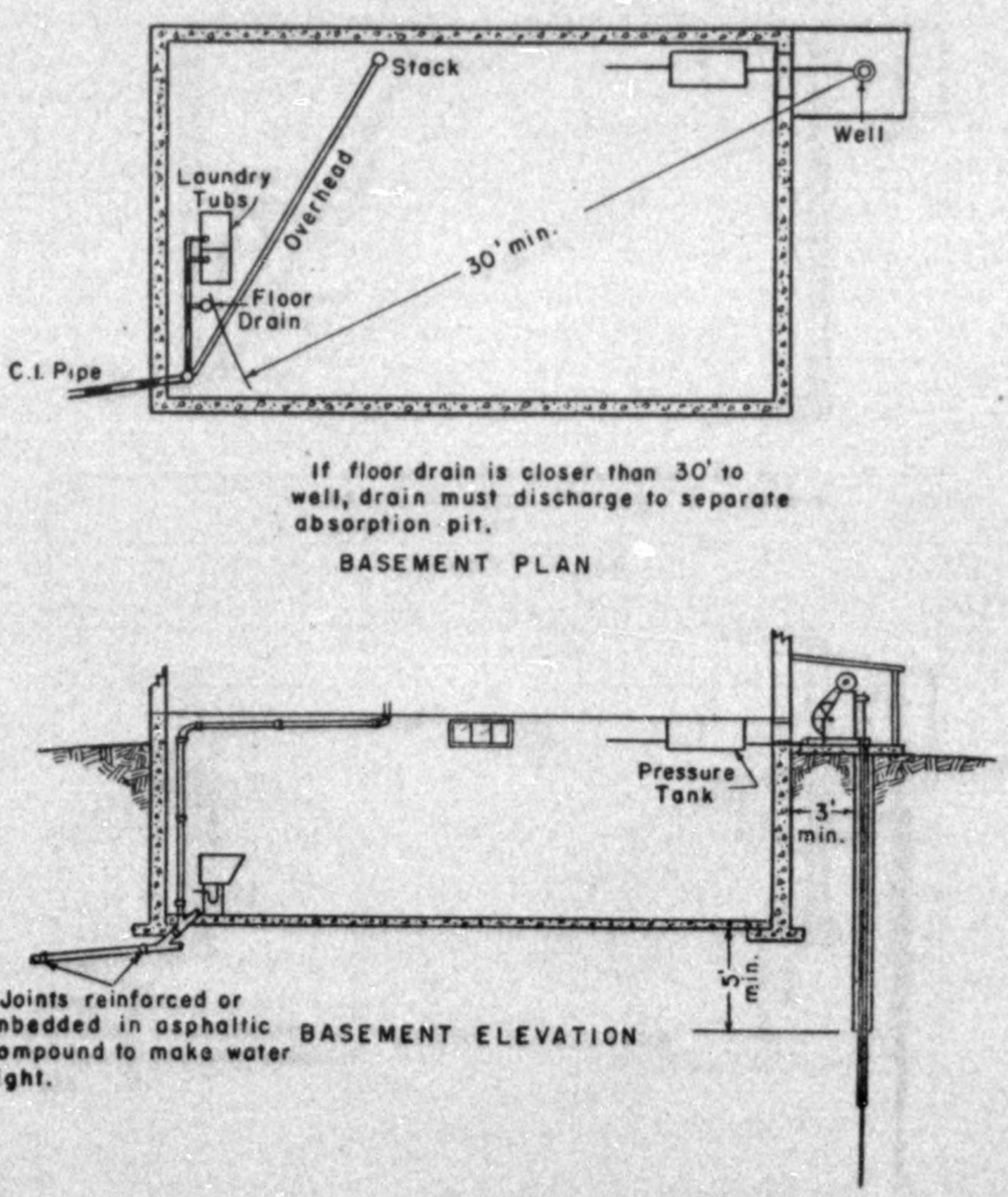

FIG. 17
Special well construction needed in the case of residences, small schools and similar structures.

25. WELLS ADJACENT TO RESIDENCES, SMALL SCHOOLS AND SIMILAR STRUCTURES: It is recognized that there are frequently conditions in connection with residences and small schools or other similar structures where it is difficult to have the well as far as 10 feet away from a basement and still provide the pump house with heat from the central heating unit. In such installations the hazards to the water supply involve the pump capacity, the distance to sewers, the distance from the basement and the water-tightness of the basement walls and floor in the vicinity of the well. It should not be constructed nearer than **3 feet** to the outside walls. Since the value of the **7 feet** of earth filtration is lost by locating

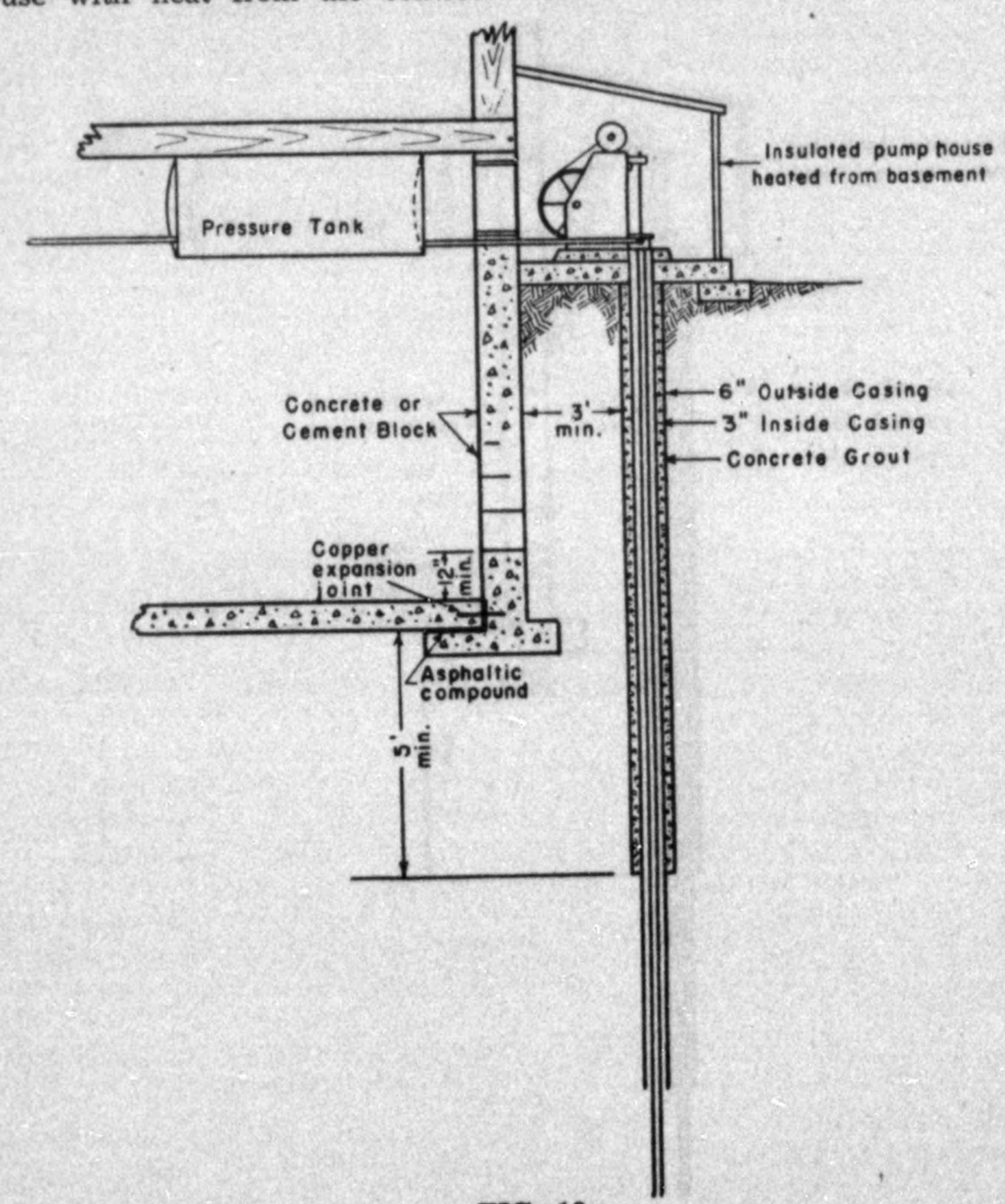

FIG. 18
Suggested well construction for residences, small schools and similar structures.

the well 3 feet from the building, a compensating **additional** protection should be provided by improving the other defense items. This can be done by strengthening the walls and floor of the basement near the well, limiting the capacity of the pump, and adding further protection to the well casing.

Although not considered the **EQUAL** in safety to the regular construction with the well **10 feet** from the basement the following construction is acceptable:

For wells having a capacity of not more than 20 gallons per minute.

(a) The well may be located as near as 3 feet to the outside of the basement walls.

(b) No sewer or drain in the ground even if constructed of extra-heavy cast-iron pipe with tested watertight joints and bell joint clamps, should be nearer than 30 feet to the well.

(c) If under-drainage is provided for the building foundation it should not be connected to a storm or sanitary sewer. It may be arranged to discharge to a free outlet onto the ground surface or to a satisfactory soil absorption system. If under-drainage is necessary and is connected to any sewer the well should be located at least 50 feet from the under-drains at its nearest point to the well.

(d) The casing should be extended above ground and there should be no pit.

(e) The basement floor within 10 feet of the well should be **at least** 6 inches thick and the basement wall for a height of 12 inches above the basement floor and within 10 feet of the well should be constructed of concrete and poured integrally with the basement floor, or equivalent construction with metal expansion joints should be provided.

(f) An **additional** outside well casing of a diameter at least 3 inches larger than the inside well casing should extend from the pump base to a point at least 5 feet below the level of the basement floor. The annular space between the two casings should be filled with Portland cement grout. Light weight pipe may be used for the outside casing, or 6 inches of grout substituted in lieu of an outside casing.

For construction as outlined above, see Figures 17 and 18, pages 22 and 23.

This construction will require careful planning of a house, school building or other similar structure to make sure that sewers and connecting floor drains in the ground can be located **30 feet** away from the well.

If the strata from which the water is obtained should be less than 2 feet in thickness, or the material in the water-bearing strata be so coarse as to reduce the effectiveness of natural filtration, the pumping rate should be reduced and/or the well located farther away from the building, that is, far enough to provide the necessary protection to the well. This will vary according to local conditions. See Paragraph 2.

(g) The above construction should be complied with for new buildings. For existing buildings suitable repairs may be made to that part of the basement adjacent to the well to make this type of well installation acceptable.

26. PUMP ROOM FLOORS: Every pump room floor should be water-tight, should be well above the ground at the outside edges, and should slope away from the pump, well casing, pipe sleeve, or suction pipe in all directions. Pump houses located on side-hill slopes should have at least 50 per cent of the floor area above natural ground level. The door, opening outward, should be located on that part of the floor above ground.

27. PUMPS: The discharge tee, together with the valves, should be preferably above the pump room floor. Underground discharges that are properly constructed may be used where a heated pump house is not provided as shown in Figures 19 and 20.

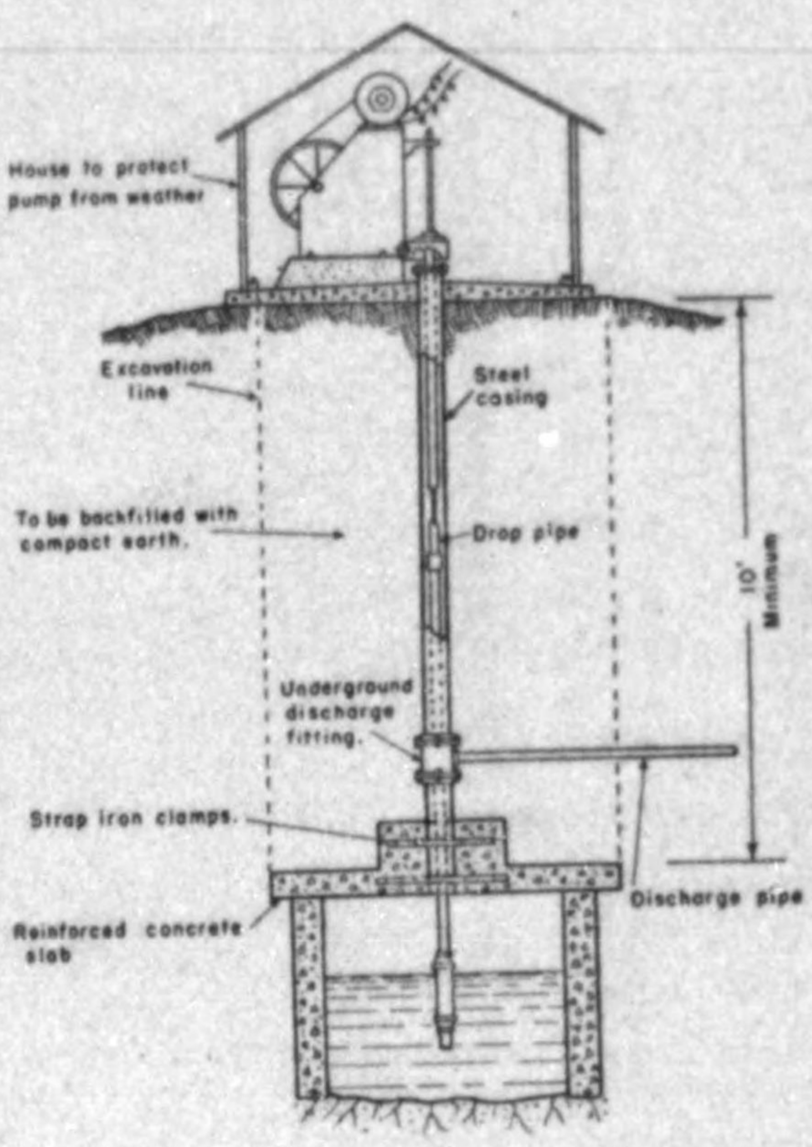

FIG. 20
Typical underground discharge makes heated pump house unnecessary.

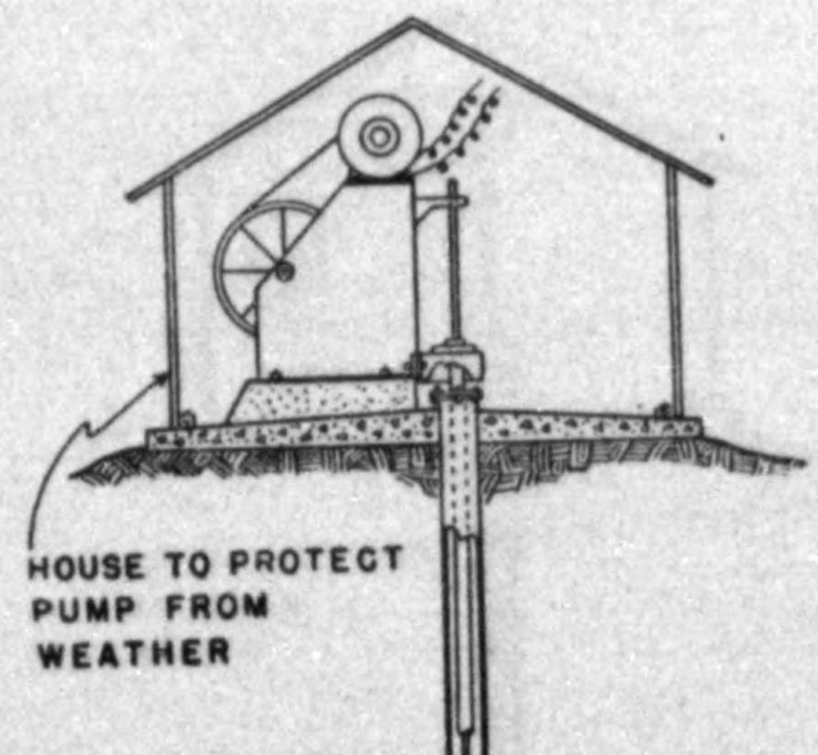

FIG. 19
Underground discharge makes heating of pump house unnecessary.

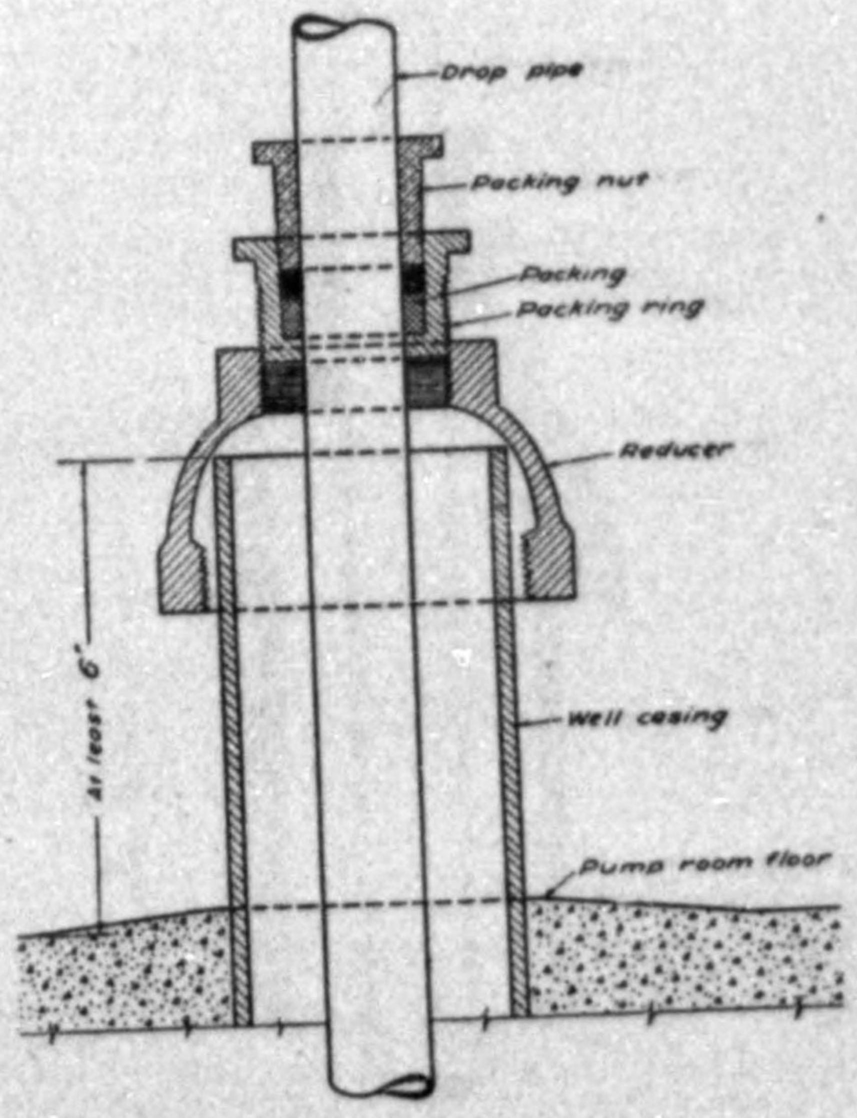

FIG. 21
Stuffing box connection to drop pipe at top of casing or pipe sleeve.

Any pump placed immediately over the well casing or pipe sleeve should have a watertight metal base to form a cover for the well. The base plate should be recessed on the under-side to permit the casing or pipe sleeve to extend into it at least 1 inch above the level of the concrete foundation, thus forming an overlapping cover with edges projecting below the top of the casing or pipe sleeve. When the pump is not equipped with such a base plate, a form of casing-head connection made up of fittings, such as overlapping caps, reducers with stuffing boxes, bushings, pipe clamps, etc., may be used to obtain a watertight or acceptable overlapping cover. See Figures 21 and 22.

When it is necessary, a separate watertight cover of this type should be provided. Good drainage should be established away from the well and off the base plate so as to prevent the accumulation of waste water at this point. Rubber tubing is not satisfactory for waste-water connections around or over the base of the pump. Metal tubing should be used for vents, waste and lubricating water, and water-level gages.

Figure 23 illustrates a small power pump for a drilled well situated in an insulated pump house.

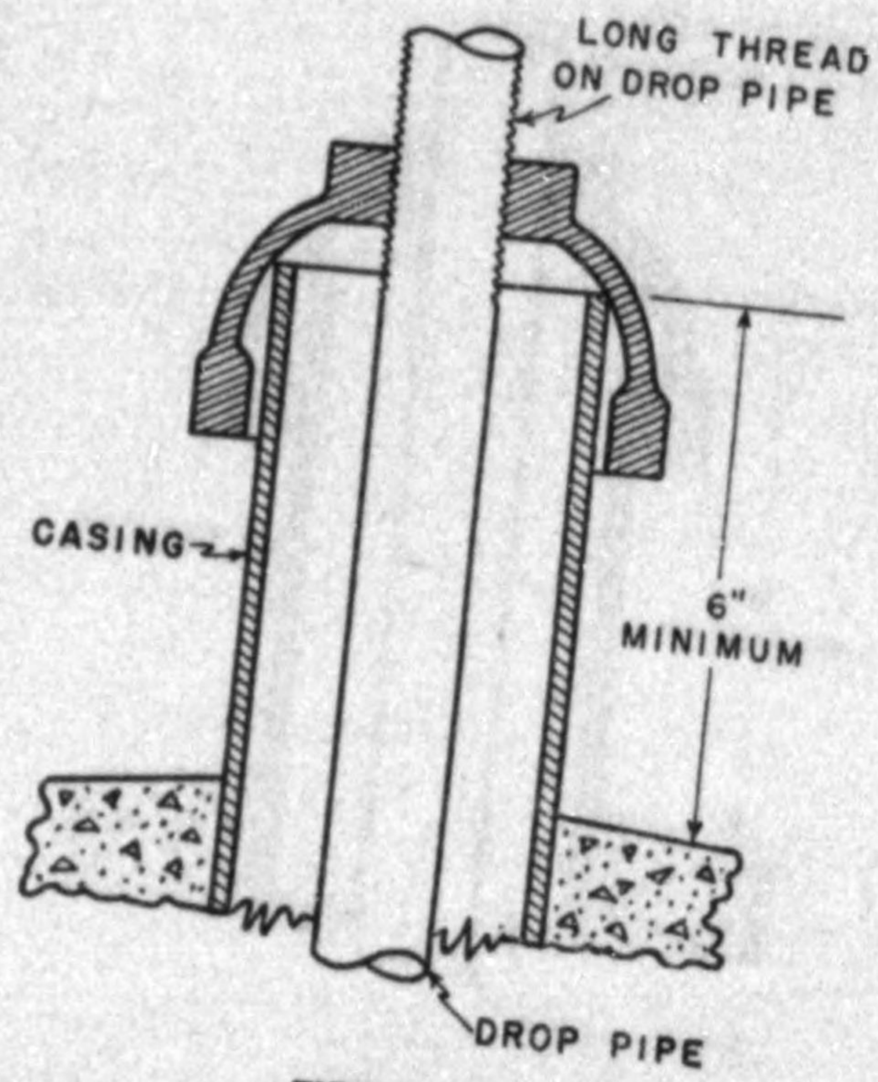

FIG. 22
Method of closing annular opening at top of casing with overlapping cover.

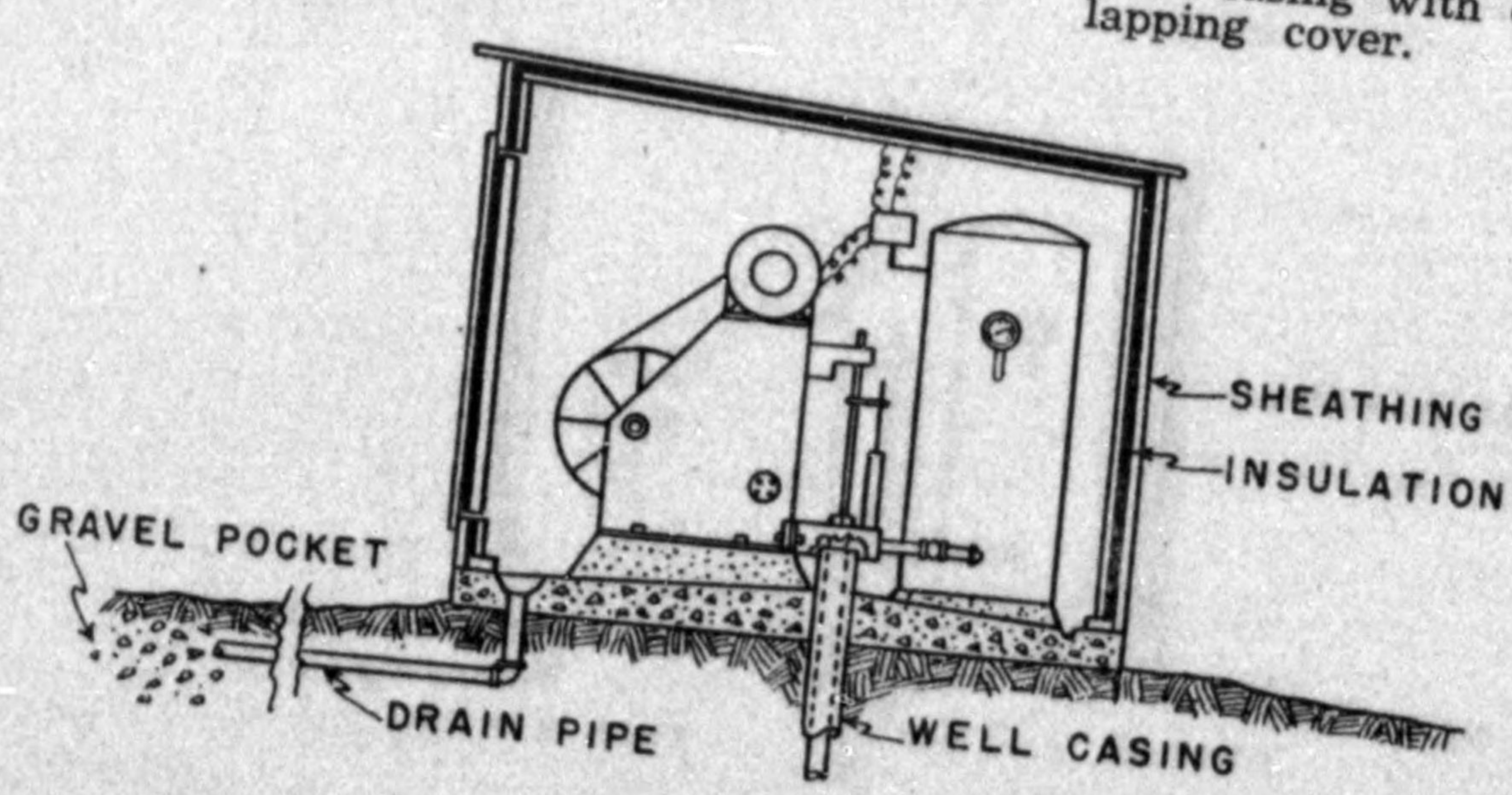

FIG. 23
Drilled well in an insulated pump house.
The installation of a suitable heating arrangement is usually necessary.

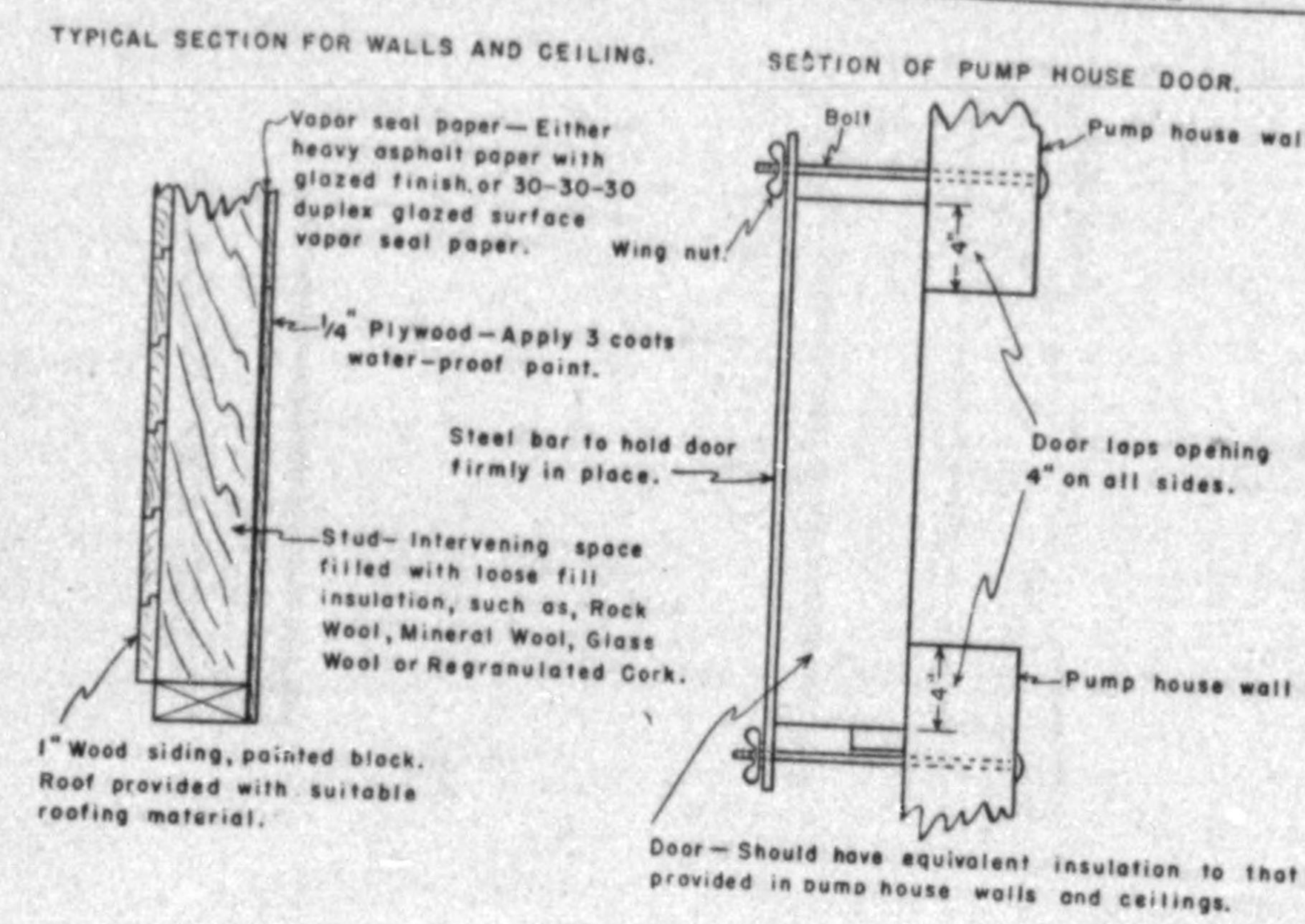

FIG. 24
Details of construction for insulated pump house.

See page 37 for a discussion of the types of pumps.

28. UNDERGROUND DISCHARGE INSTALLATIONS: Two types of underground discharges are shown in Figures 25 and 26. The one shown in Figure 25 may be fabricated from stock materials. It should be noted that this construction requires a cylinder of the tubular type with a drop pipe the same size as the cylinder. The other type shown in Figure 26 provides a special withdrawable casting which allows the use of a drop pipe having a smaller diameter than the cylinder. With either type, a small pump house should be provided to protect the pump motor from the weather.

29. AIR VENTS ON PUMPS AND WELLS: The absence of an air vent on a well tends to cause leaks around the cover or base plate of the pump. Unless other adequately protected openings serve as vents, every well with a power pump should be provided with a satisfactory vent. Such a vent should be located at least 24 inches above the floor. If the opening on the vent faces upward, it should be covered on the top and sides by an overlapping hood. A screened opening on the end of a gooseneck pointing downward provides a satisfactory vent. A vent of the hooded type fitted with a check valve may also be installed on the discharge pipe if desired. The vent should be not less than 1 inch in diameter, or should be of sufficient additional diameter to prevent high air velocities through the vent. Copper screen of 16 or more meshes per inch is advisable for screening these vents.

30. WATER LUBRICATION: Lubrication of water-supply equipment has been found in some instances to have been a means of

introducing contamination into the water. Equipment provided with fittings for lubrication by means of pressure-operated grease guns may move infected grease onto surfaces exposed to water or even directly into the water mains or channels. Meters, plug valves, or other equipment which bring grease or oil into mains, wells or the conduits in which the water flows should not be used.

Pump bearings situated in any well below the pump-room floor should be lubricated with water taken from within the well, from the reservoir or distribution system supplied with water from the original source of water supply.

31. SUCTION PIPES: (a) When a leak occurs on a submerged suction pipe, water from outside will be drawn in if the pump is in operation or may flow in by gravity at other times. This characteristic of suction piping makes it necessary to provide as much protection against contamination for suction piping as for the water source itself. Suction piping laid in the ground should be protected from contamination (1) descending vertically from the surface immediately over the pipe and (2) moving laterally through the earth formations from a distance.

(b) For protection laterally the distance requirements set forth in

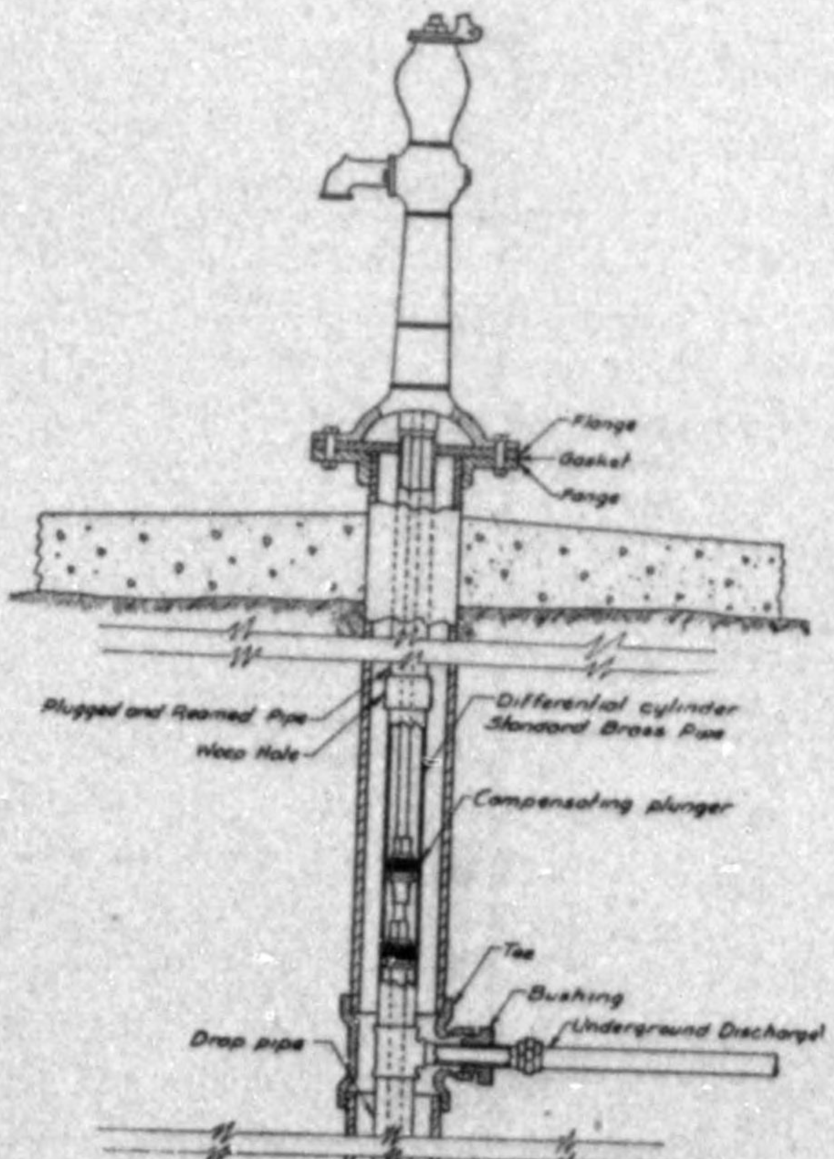

FIG. 25
Drilled well construction using standard tee and underground arrangement to discharge water below frost line.

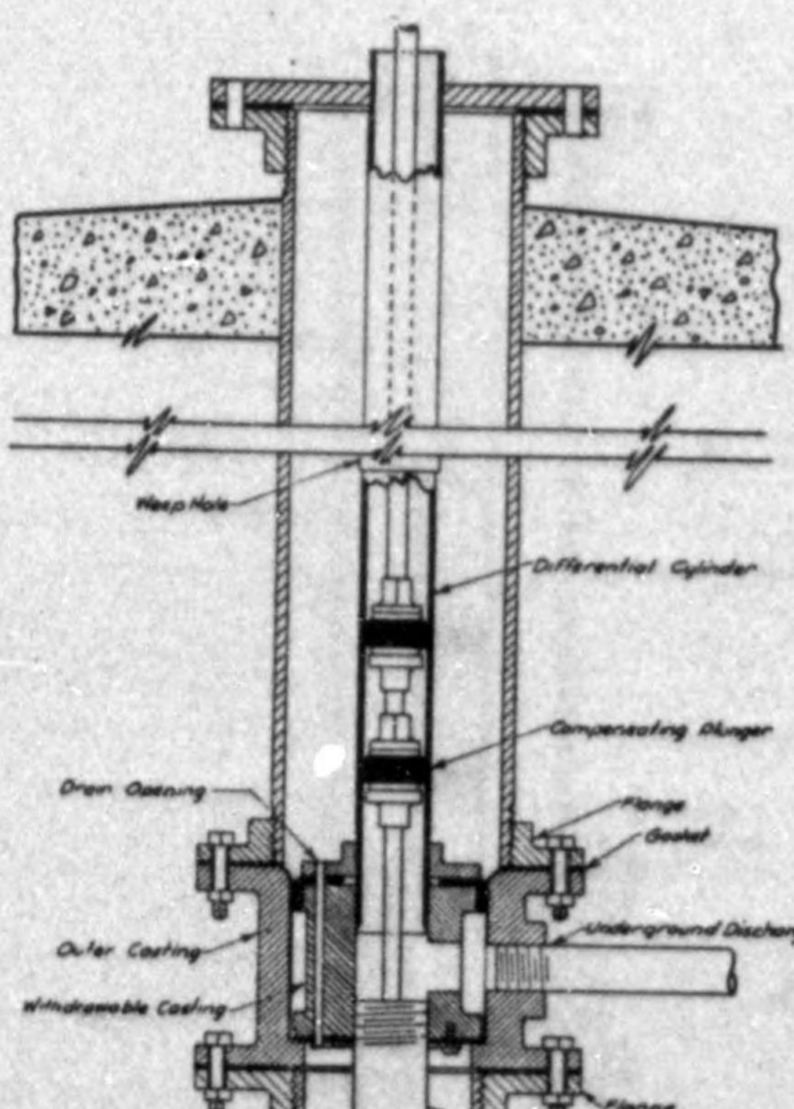

FIG. 26
Properly constructed drilled well with underground discharge arrangement.

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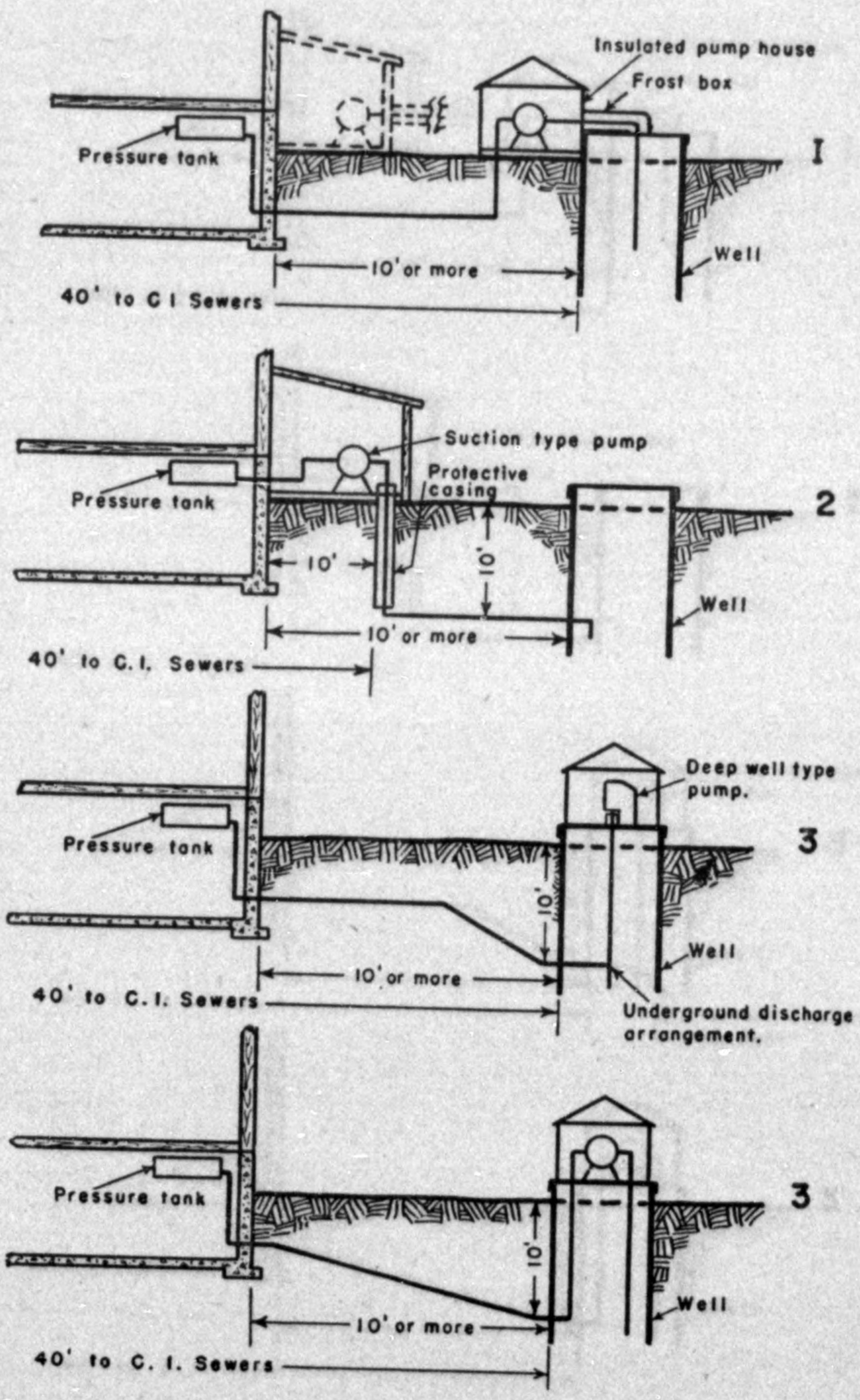


FIG. 27
Suggested arrangements of taking water from a dug well or reservoir numbered in the order of their preference.

Paragraph 2 for sources of supply should apply. Ordinarily no cesspool, sewer, privy or other source of contamination should be located nearer than 50 feet to a suction pipe. Under some conditions depending on the character of the soil, slope of the ground, degree of contamination, etc., greater distances may be necessary.

(c) All suction piping, such as that leading from detached wells or reservoirs, when laid underground, should be at least 10 feet below the surface of the ground, or special protection should be provided. The surface contamination is generally retained in the upper zone of the earth, and the filtration may not be sufficient to prevent the contamination reaching the suction pipe.

All that part of any suction pipe within 10 feet of and below the surface of the ground should be surrounded by a watertight outer casing pipe. In the case of a suction pipe rising to a pump house, the outer casing should extend at least 12 inches above the ground and 6 inches above a platform or floor surface. The annular opening between the protective casing pipe and the suction pipe should be properly covered at the top in a manner similar to that used for covering the top of a drilled well.

The annular space between the suction pipe and the protective casing should be filled entirely with some suitable material which will prevent the accumulation of any leakage in considerable quantity inside the casing around the suction pipe. Asphalt compounds or cement grout may be used for this purpose. Horizontal suction pipes which are located underground within 10 feet of the surface may be protected by placing sufficient earth filling on the surface to provide a total of 10 feet of covering over the piping. By placing the pumps directly over the well, sump or reservoir, or locating the suction pipe above ground, and in a frost box where necessary, the hazards of a suction pipe located less than 10 feet below ground level will be avoided.

Figure 27 shows several arrangements of suction piping and pump with a dug well, numbered in the order of their preference.

32. PRIMING: Water for priming pumps on any water system should be taken directly from the reservoir or distribution system that is supplied with water from the original source of the water supply. Priming devices should be so constructed that they will not expose the water to dust, drippings, or other sources of contamination.

33. COOLING WATER: Water used for cooling parts of engines, air compressors, pumps, or other equipment should not be returned to any part of the water system. The water may be wasted to floor drains by means of a gap discharge above ground level. Such waste lines should not be connected directly to sewers, drains, etc.

34. VALVE BOXES: Every valve box on a buried suction pipe should project at least 6 inches above the floor if in a building or room, and at least 12 inches above the ground surface if not enclosed in a building. The top of the box should be provided with a cover of the same overlapping type as hereinbefore prescribed for manholes.

35. INSULATED PUMP HOUSES:

(1) Construction:

Figure 23 illustrates a suggested construction of an insulated pump house. Some of the details of the construction are given below.

A. The pressure tank may be located in the pump house so the heat from the water in the tank can be utilized.

B. Inside Walls—one-fourth inch plywood. In order to protect the plywood against moisture and to provide a vapor-seal for the insulation, the plywood should be painted with either aluminum paint or a paint that has a varnish base. White is preferable as a color.

C. Vapor-Seal Paper—Special precautions should be taken to provide a vapor-seal. Some kind of vapor-seal paper should be used underneath the plywood. Heavy asphalt paper with a glazed surface is recommended. The vapor-seal paper should be lapped at least 2 inches at all joints. Ordinary building paper is not effective as a vapor-seal.

D. Insulation—In most cases, a loose-fill insulation such as rock wool, mineral wool or regranulated cork placed between the studs will be used. The insulating value of most rigid insulating board is approximately the same as loose-fill insulation and may be used, provided an equivalent thickness is used.

E. Door—The door should be provided with insulation equivalent to that of the walls and ceiling, and it should be constructed so that there will not be any material leakage of air between it and the building. One way of accomplishing this is shown in Figure 24. With the type of construction illustrated, an entire side of the building may be made to serve as the door, and if it is so desired, the door may be made rather small, that is just large enough to admit the hands for oiling the pump motor and adjusting the switch. This construction will necessitate removal of the pump house for any major repairs in the pump.

F. Outside Paint—If it is desired to absorb as much heat from the sun as possible, the outside of the building should be painted black. Covering the siding with black roofing paper or black asphalt shingles will also accomplish this.

G. Waste Water Removal—To facilitate the removal of any leakage from the pump, condensation, or other waste water the pump room floor drain should discharge into a gravel pocket. The gravel pocket should be located at least 30 feet from the well. The drain pipe should be constructed of extra-heavy cast-iron pipe with water-tight joints. There should not be any direct connection from a pump room to a sanitary or storm sewer.

H. Additional Protection—Installations of this type may be further protected by placing clean straw on the ground surrounding the pump house and by providing insulation around the discharge pipe for a distance of 5 to 6 feet. **Do not use manure.**

I. Method of Heating—Electric light bulbs have been used successfully in a number of installations, but there is the disadvantage that they burn out rather frequently and this may cause difficulty

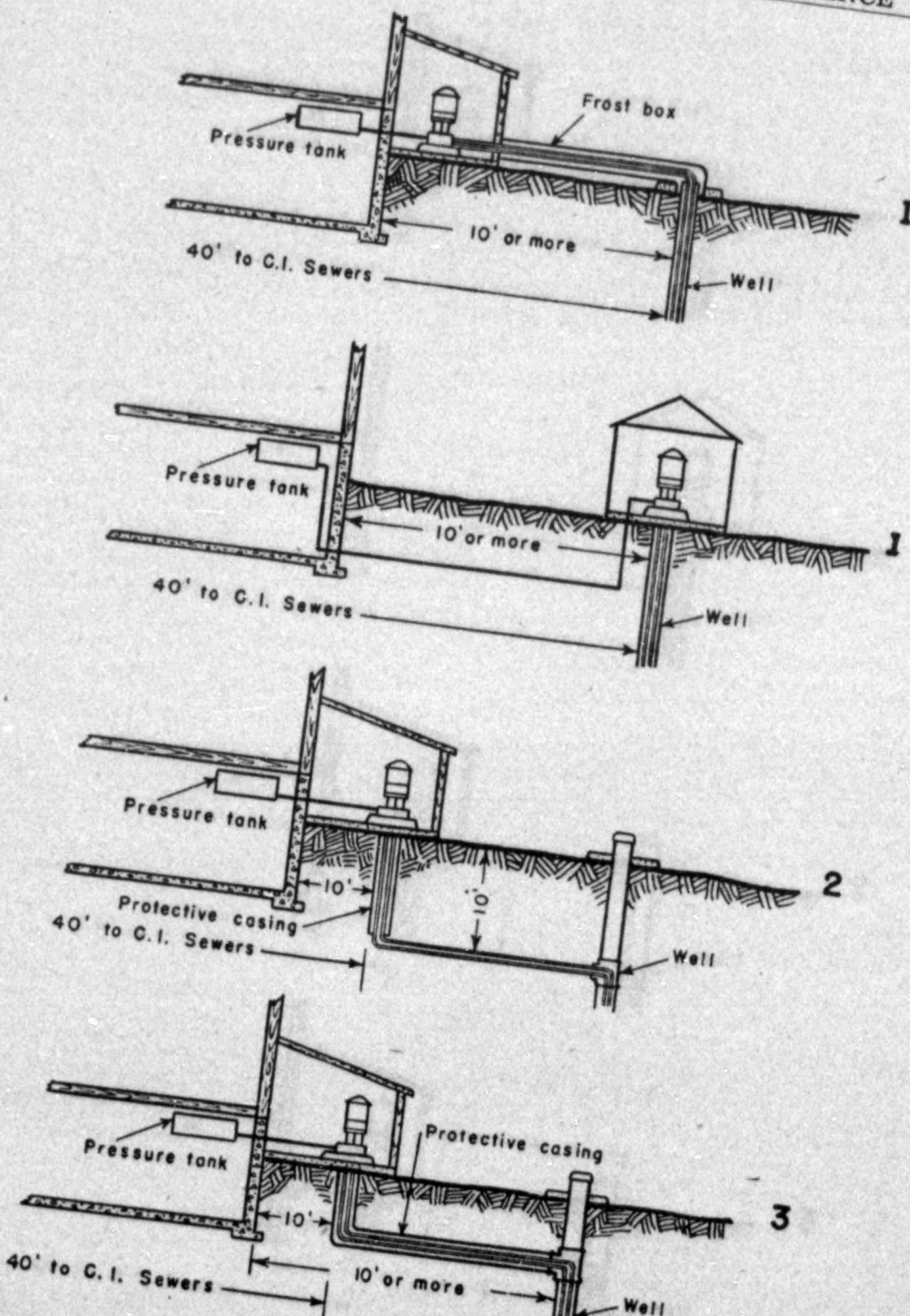


FIG. 28
Typical ejector centrifugal pump installations numbered in the order of their preference.

because there is no way of knowing when this may happen. Resistance-heater units are much more dependable from this standpoint. The most satisfactory arrangement is to use a resistance-heating unit in conjunction with a thermostatic control. It is preferable to have the capacity of the heating unit in considerable excess over the computed heat loss. The thermostat should be located near, but not on, the floor, and it should be shielded from radiation from the heating unit.

When electricity is not available a small coal burning heater may be used. Briquettes are a clean convenient form of coal fuel to burn. A small heater burning kerosene or distillate is also satisfactory.

36. THE EJECTOR CENTRIFUGAL PUMP: It is not necessary to locate a pump of the ejector centrifugal type directly over the well. The same requirements for installation and for avoiding pits, basements, and sources of contamination apply to the ejector type of pump as to other pumps.

Figure 28, page 32, illustrates typical installation arrangements.

37. AIR LIFT SYSTEMS: Where water is pumped by means of an airlift system, the air compressors should be placed in a room as free as possible from dust and at such an elevation as will make flooding impossible. The compressed air from the compressor should be discharged into an air storage tank so designed as to extract from the air any oil or oil mist which may have entered during its passage through the compressor. In order to minimize the possibilities of oil contamination, the use of oil traps, filters and as little oil as will provide satisfactory operation of the compressor is recommended. The air intake of any air lift system or mechanical aerating apparatus should be at least 6 feet above the floor surface if indoors, and 10 feet above the ground if out of doors. The air intake should be so constructed as to prevent the entrance of birds, insects, dust, rain, snow, or other contaminating material.

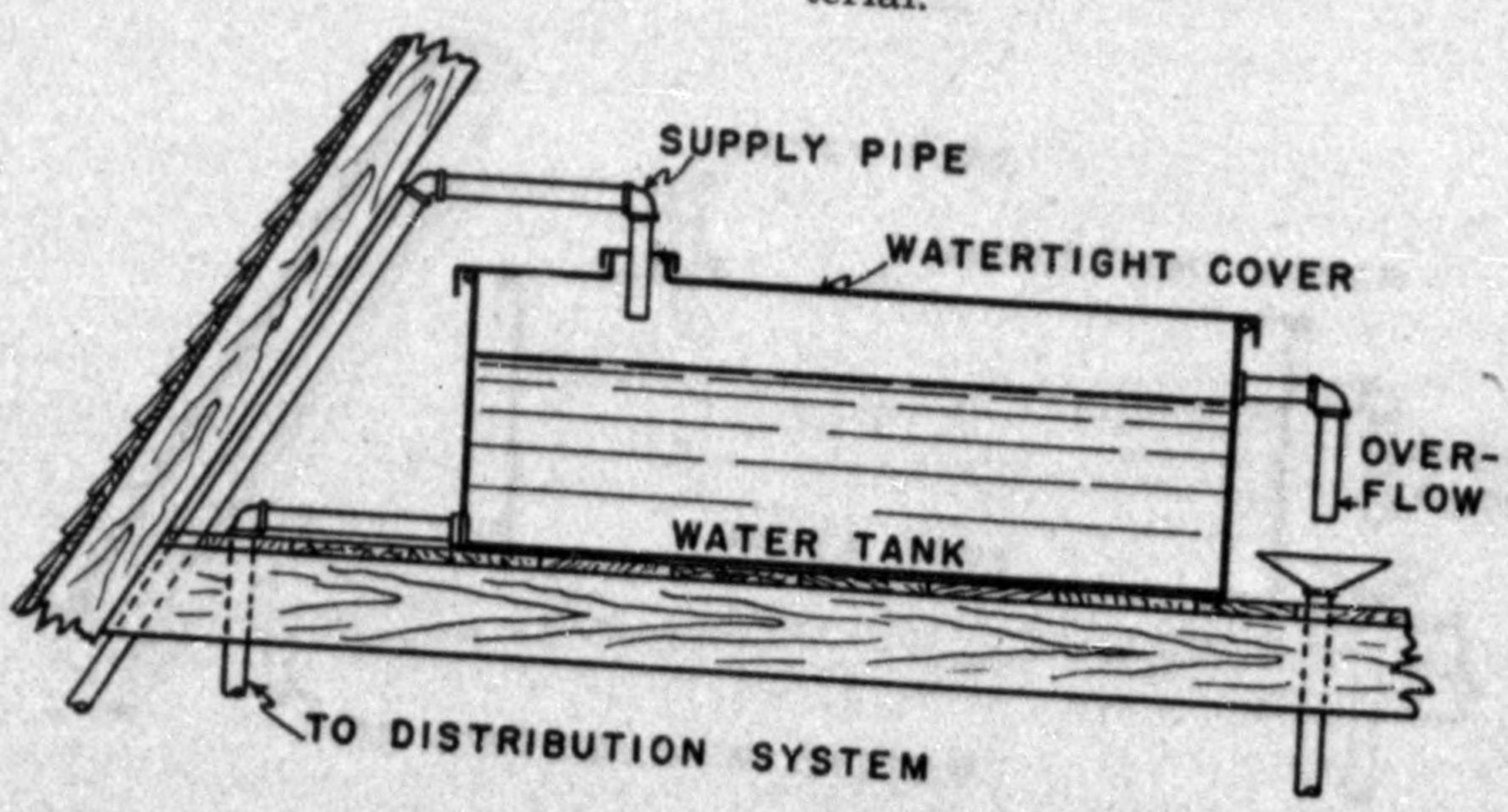


FIG. 29
Water storage tank located in the upper part of a building.

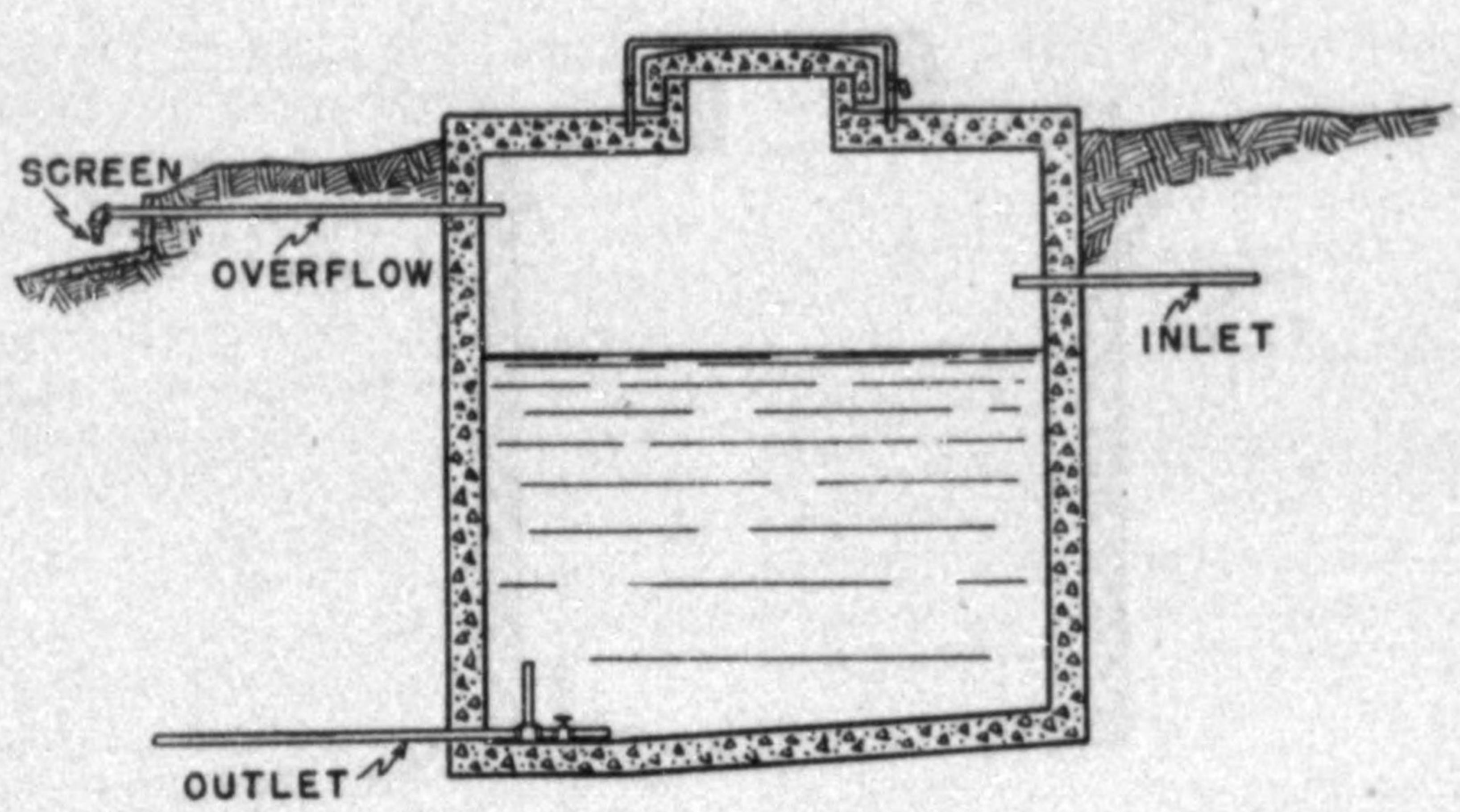


FIG. 30
Water storage reservoir located in the ground.

38. SMALL STORAGE TANKS AND RESERVOIRS: (a) Small power-pump installations usually include a water storage tank. For the storage of water, reservoirs and tanks are located on hills, in the tops of buildings or on towers outside of buildings so that the force of gravity may be utilized to distribute the water under pressure to the buildings at lower elevations. Figure 29 illustrates a small tank in the upper floor of a building and Figure 30 shows a satisfactory type of ground reservoir. For tanks in buildings the overflow may be run to outside and should be screened or it may be arranged to discharge into a waste sink. Such tanks should be provided with watertight covers to prevent rain water, dust, insects, mice or other small animals from getting into them. Manhole openings on reservoirs should be constructed with raised edges. The cover should have a gasket and should be of a solid material which overlaps the opening as shown in Figure 30.

(b) A great many steel pressure tanks are also used for the storage of water. Air is pumped into the tank with the water and is compressed in the upper portion of the tank. When a faucet is opened the air expands and forces the water from the tank. Pressure tanks should not be located in basements or in pits below ground level where they are subject to flooding. They may be suspended from the basement ceiling or placed on supports so that the tank will be above ground level. Such tanks should not be buried under ground but should be located above ground where they cannot be flooded. A great deal can be accomplished in maintaining the desired temperature of water by means of insulating the tanks.

(c) Water level control devices on tanks are desirable and should be so designed and installed that the entrance of dust, birds, insects, etc., will be prevented. Figure 31 shows a method of protecting openings for float indicator cables;

however, electric and pressure controls are preferred.

39. SMALL DISTRIBUTION SYSTEMS: Water pipes should NOT be laid in the same trench with sewer pipes. The distance between any water pipe and a sewer should not be less than 10 feet at any point, measured horizontally. There are times when the crossing of a water pipe and sewer pipe cannot be avoided. The water pipes should be at a higher elevation than sewer pipes if possible and all that portion of the sewer lying within 10 feet horizontally of the water pipe should be of extra heavy cast-iron pipe with leaded and caulked joints. The use of a flexible, corrosion-resistant pipe such as copper or lead is acceptable for water pipe.

There should not be any physical connections to other water supplies which may be unsafe for domestic use. Any connection or arrangement by which unsafe water may be discharged or drawn into a safe water-supply system should be eliminated. Any physical connection between a safe and a questionable or unsafe water supply constitutes such a cross connection even though it is separated by cutoffs or check valves. Frequently, in private homes where cistern water is used, the piping is so arranged that the cistern water can be pumped into the piping that is used to carry the drinking water. Such an arrangement constitutes a cross connection and should be eliminated.

Of considerable hazard to water supplies is plumbing which is improperly designed and improperly installed. The installation of plumbing should be in accord with the requirements of the State Plumbing Code. All discharges or other openings on the drinking water supply which can be submerged, as for example, those in sinks, bath tubs, and flush-valve toilets that are directly connected to the water system, etc., provide a means whereby contamination can be drawn into the system under certain conditions. Such construction and forms of plumbing should be avoided. A copy of the State Plumbing Code may be obtained for 50 cents by writing to the State Plumbing Board, Bismarck, N. Dak.

40. WATER SUPPLIES FOR CREAMERIES, PASTEURIZATION AND OTHER RELATED TYPES OF MILK PROCESSING PLANTS: Water supplies for creameries and pasteurization plants should comply with the requirements herein. Because milk can be a carrier of disease producing organisms, the milk waste so generally found on the floors of milk plants may be the means of carrying disease producing bacteria immediately to the well casing or close to it, partic-

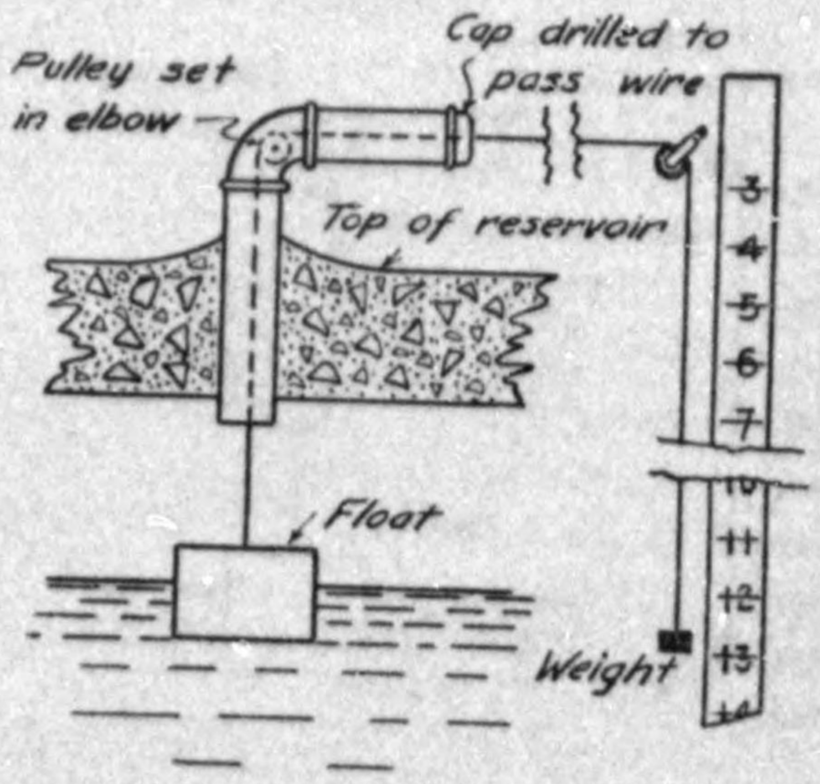


FIG. 31
Water level indicator for reservoir.

ularly if there are cracks in a cement floor. For this reason, a well should not be located nearer than 10 feet to the edges of a floor where milk processes are carried on.

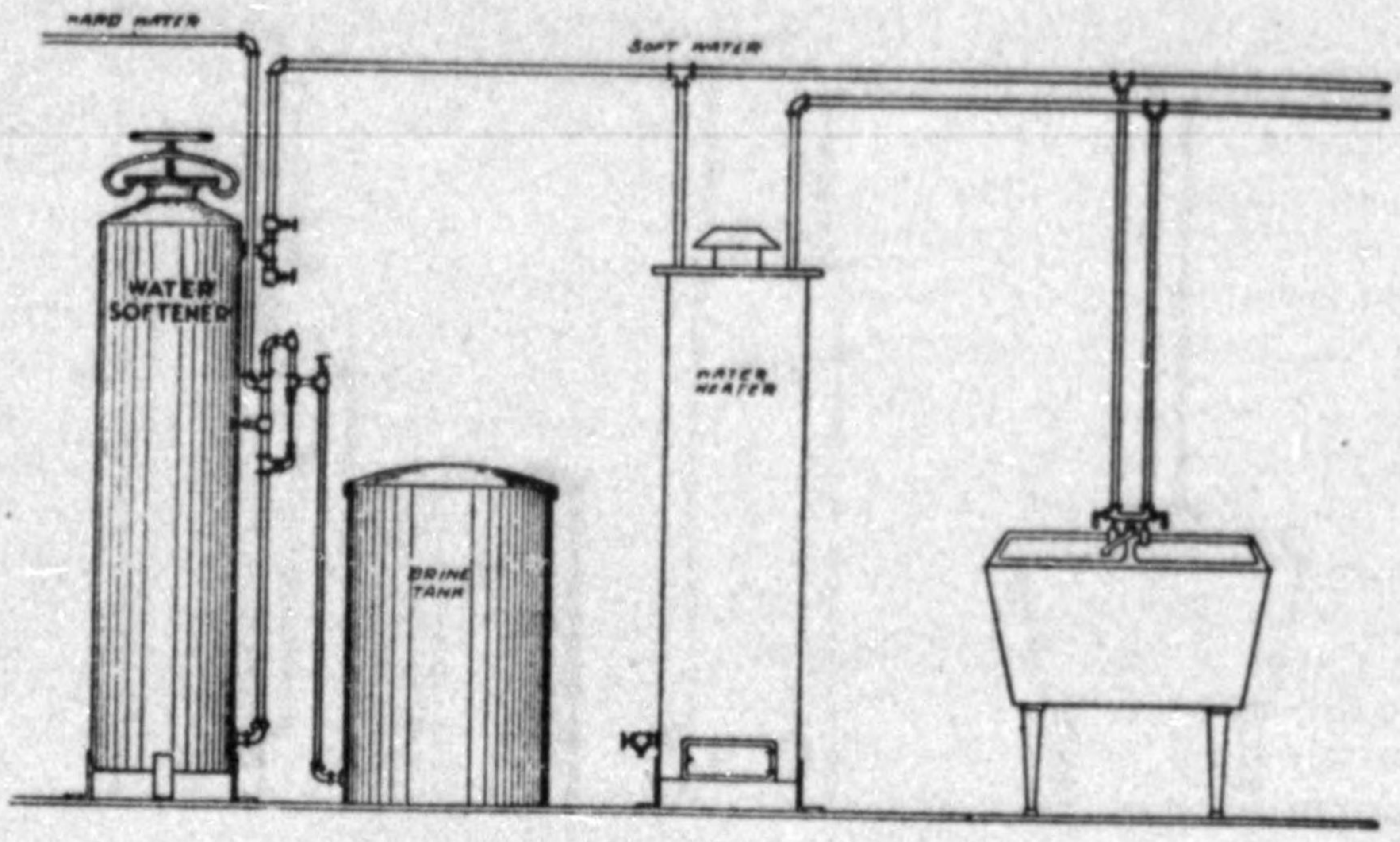
It has been found that proteolytic bacteria have gained entrance to creamery water supplies where the wells have been located in or immediately adjacent to the plant, and have been the cause of odors and off-flavors in butter. To prevent such difficulties it is recommended that the well be located at least 50 feet from the plant, and the water delivered to the plant under pressure.

41. DISINFECTION: Indications of contamination are often found in the water from wells which have recently been constructed, even where the construction work has been done correctly, if care has not been taken to disinfect the well and pumping equipment thoroughly after the work has been completed. A supply may become contaminated when the system is opened for repair work, from handling of the equipment or from contact with foreign material. Water supplies should always be disinfected following new construction, or repair work, in order to destroy contamination which may be dangerous.

Disinfection of small water supplies can usually be accomplished by introducing into the well 1 pound of calcium hypochlorite (chlorinated lime). When possible, the chemical should be scattered over the surface of the water in the well so that the powder will sink to the bottom, thereby permeating the supply. If this cannot be done, the chemical may be mixed with 5 gallons of water and poured into the well. The water containing the chemical should be permitted to remain in the well and the distribution system for a period of at least 12 hours, following which water should be pumped to waste until the odor and taste of the chemical have practically disappeared.

42. HOUSEHOLD WATER SOFTENERS: Where the household water supply is hard, a water softener can usually be used to soften the water. Water softened in this way is generally more satisfactory for household use. A special sand known as Zeolite is generally used for the softening agent in these water softeners. This mineral has the ability to take lime and magnesia out of water and when the Zeolite sand is soaked in a solution of ordinary salt it will give the lime and magnesia up again.

The ability of Zeolite to take up lime and magnesia from water and to give it up again when soaked in a salt solution is made use of in household softeners in the following way: A tank, about the size of a hot water tank but provided with special valves and top, is almost filled with the Zeolite sand. This tank is connected to the plumbing system in such a way that the water to be softened must pass through the Zeolite sand bed. As the hard water passes through the Zeolite the lime and magnesia are removed. This process is continued until the Zeolite has removed all the lime and magnesia it can. Then the softener must be regenerated or reconditioned. This is accomplished by arranging the valves so a salt solution can be passed through the Zeolite sand and then into a



HOUSEHOLD WATER SOFTENER WITH SUITABLE PLUMBING CONNECTIONS

Fig. 32

Proper temperature and pressure relief valves should be installed in conformance with the State Plumbing Code. This is important to eliminate the danger of violent explosions.

waste line or sewer. The salt solution removes the lime and magnesia from the Zeolite and puts it in a condition to soften more water.

Household softeners may be obtained through local dealers. It is advisable to have a sample of the well water analyzed before a softener is installed. Most of the companies selling water softeners will run a test on samples of water sent to them. Some waters cannot be softened successfully by the Zeolite softener. With this information a person can then determine how successful a water softener would be and the amount of salt and time necessary to keep it in working condition. Usually they will work satisfactorily with a relatively low upkeep cost if they are properly installed and given the proper attention. It is desirable to arrange the piping so that the water used for the toilets, watering lawns, drinking purposes, etc., does not pass through the softener. By so doing it will not be necessary to recondition the softener so often. See Fig. 32 for a typical water softener installation.

Types of Pumps

All pumps used for water supply purposes can be classified into two types. The positive action pumps and the non-positive action pumps.

43. POSITIVE ACTION PUMPS: The **shallow well piston pump** has the cylinder and piston located above the ground surface. It is suitable for lifts up to 25 feet and for direct discharge into watering trough or sink. If this pump is to be used as a force pump and operate against a pressure, it must be fitted with a stuffing box around the plunger rod at the top of the pump. When fitted with a

stuffing box the pump will discharge against any pressures that the working parts of the pump will withstand, but usually does not exceed 200 to 300 pounds per square inch.

The **deep well plunger pump** is similar in construction to the shallow well piston pump, but the cylinder and the piston are located at or near the level of the water in the well. This pump will bring water from a well of practically any depth and will pump against practically any pressure that the pump and power unit will withstand. To operate as a force pump it must be fitted with a stuffing box as described under "the shallow well piston pump."

The **rotary pump** most commonly used is the gear type. This pump is most widely used as an oil pump for auto and tractor engines. Its use for domestic water supplies is limited because of lubrication difficulties, and when it has become worn its efficiency is lowered.

44. NON-POSITIVE ACTION PUMPS:

Centrifugal pumps. The types of centrifugal pumps most commonly used are the volute and turbine. Both types have rotating impellers which develop pressure by the outward whirl of the water. Water enters at the center of the impeller. The main difference in the two pumps is in the construction of the housing that receives the water from the impellers.

The **turbine pump** has an impeller driven by a motor. The impeller rotates inside of a housing. The rim of this housing has vanes which receive the water from the impeller and lead to the discharge end of the pump. The impeller is usually placed at or below the water level. The size and construction of this pump makes it possible to install it in the well with a shaft leading up out of the water. The pump is usually called a deep well turbine pump. Several impellers or stages are added when it is necessary to lift water a great distance. Each stage will develop 30 to 60 feet of head, depending upon the size and speed of pump. Turbine pumps are made to operate at a certain speed and should be operated at that speed to give maximum efficiency. Both oil-lubricated and water-lubricated turbines are available. The water - lubricated pump should be used for drinking water.

The **volute pump** has a spiral case around the impeller. This case increases in size from a point near the discharge around, in direction of rotation to the discharge. This reduces the velocity of the water and adds to the pressure developed by the impeller, thus greatly improving the head and efficiency. The construction of the volute pump is such that it must be installed at the surface or in a pit. However, pit installations are not recommended from a sanitary standpoint. Its size does not permit it to be placed down in a well of normal diameter. It will operate at various speeds and under varying conditions. It can be used as an irrigation, well, sump, or drainage pump.

Propeller pumps. This pump is a screw type. The screw consists of spiral, auger-like blades which revolve on an upright shaft. The pump operates best against a lift of 3 to 6 feet. It will handle dirty, sandy water and can be operated at various speeds. It has a high discharge, but a low lift per stage.

Multivane turbine pumps. This is a centrifugal pump with a special impeller. The impeller is a disk with a large number of radial vanes. This construction allows the pump to attain higher pressures than with ordinary impellers. At normal speed this pump can operate against a pressure head of 350 feet. It is usually made in the smaller sizes of less than 300 gallons per minute discharge.

Injector or jet pumps. These pumps are the centrifugal type with an injector added. The injector is located below the water level in the well and consists of a jet and a venturi or throat that changes velocity energy into pressure. The pump impeller is located at the surface, but two pipes must lead into the well. One pipe supplies by-passed water to the jet or intake to the pump and the other carries the water from the injector to the pump. These pipes may be side by side or concentric. This pump is especially well adapted to domestic water supply systems. It has few moving parts and they are located at the surface. The foot valve below the injector in the well is the only part that is not at the surface that may need some attention. This foot valve is necessary to hold the pressure in the system when the pump is not in operation. This pump is suitable for deep well operation for lifts up to about 100 feet.

45. PUMP INSTALLATION CHART*

*Taken from "Pump Engineering" by Kenneth R. Frost and published by Farm Implement News.

There are several variations of the pumps discussed. To aid in selecting the proper pump for a given condition, a pump installation chart is provided on page 41. The pumps listed are generally of the type used for the various pressures, vertical lifts and discharges given. The chart is based on operating characteristics, economy and dependability of the individual pump without any particular regard to sanitary features. A choice of several types is given when one pump does not have any particular advantage over another. Pumps other than those specified may be used, depending on specific conditions, and may be necessary to obtain a dependable, sanitary installation.

Problem based on the use of the chart.

Problem: What type of pump should be used for a vertical lift of 40 feet, 35 pounds pressure and 15 gallons per minute discharge?

Answer: The discharge is between 0-20 g.p.m. Read downward in the "vertical lift in feet" column to "25-100." Then read across to the right until under "0-40" pounds pressure. The type of pump is the "VC JW" or the volute, centrifugal, with jet in well. This is commonly known as the injector or jet pump.

46. CONTROLS FOR PUMPS:

Safety valve. Motor or windmill driven positive action pumps must be provided with a spring-type safety valve to release the pressure should the discharge be closed. This safety valve is not necessary on hand-operated pumps.

Air chamber. Piston and plunger types of pumps should be equipped with an air chamber to eliminate water hammer and reduce strain on pump system. An air dome near the pump discharge will serve the purpose.

Air bleeder. Pressure tanks must have some air in them to function properly. Water passing through tanks carries some air with it. It is necessary to provide some means to replace this air. A bleeder valve should be used on the suction side of shallow well pumps. They may be manually or automatically controlled. Deep well pumps usually have a small air pump to supply air to the pressure tank.

Foot valves. Priming difficulties can be minimized by installing a foot valve at the lower end of the suction pipe. Some types of pumps must have a foot valve.

Strainers. A strainer should be placed at the end of the suction line of all pumps to prevent objects from becoming lodged in the valves.

Automatic controls. Fully automatic controls can be installed on pumping systems using pressure tanks.

PUMP INSTALLATION CHART

Discharge	Vertical Lift in Ft.	Pressure in Pounds per Square Inch.				
		0	0-40	40-60	60-150	150-300
		Type of Pump				
0-20 G.P.M.	0		VC or SWP	VC or SWP	MC or SWP	SP
	0-6	VC or SWP	VC or SWP	VC or SWP	MC or SWP	R or SWP
	6-15	VC or SWP	VC or SWP	VC or SWP	MC or SWP	R or SWP
	15-25	VCJP or SWP	VCJP or SWP	VCJP or SWP	SWP	SWP
	25-100	VCJW	VCJW	VCJW	MCIW-DWP	DWP
	100-500	DWP	DWP	DWP	DWP	DWP
20-100 G.P.M.	0		VC	VC	MC or MVC	SP
	0-6	VC	VC	VC	MC or MVC	R or MVC
	6-15	VC	VC	VC	MC or MVC	R or MVC
	15-25	VCJP	VCJP	VCJP	MCIW-MCJW	DWP
	25-100	VCJW	VCJW	VCJW	MCIW-MCJW	DWP
	100-500	DWP	DWP	DWP	DWP	DWP
100-300 G.P.M.	0		VC	VC	MC or MVC	MVC
	0-6	VC	VC	VC	MC or MVC	MVC
	6-15	VC	VC	VC	MC or MVC	MVC
	15-25	VCJP	VCJP	VCJP or DWT	MCIW or DWT	DWT
	25-100	MSPS-DWT	VCJW-DWT	VCJW-DWT	MCIW-DWT	DWT
	100-500	MSPS-DWT	DWT	DWT	DWT	DWT
300+ G.P.M.	0		VC	VC	MVC	MVC
	0-6	PS	VC	VC	MVC	MVC
	6-15	MSPS or VC	VC	VC	MVC	MVC
	15-25	MSPS-DWT	DWT	DWT	DWT	DWT
	25-100	MSPS-DWT	DWT	DWT	DWT	DWT
	100-500	MSPS-DWT	DWT	DWT	DWT	DWT

DWP -- Deepwell Plunger
DWT -- Deepwell Turbine
PS -- Propeller Screw
MC -- Multivane Centrifugal
VC -- Volute Centrifugal
R -- Rotary Pump
SWP -- Shallow Well Piston
MSPS -- Multi-stage Propeller Screw
MVC -- Multi-stage Volute Centrifugal
MCIW -- Multivane Centrifugal with Impeller in Well
MCJW -- Multi-stage Centrifugal with Jet in Well
VCJP -- Volute Centrifugal with Jet in Pump (1 Stage)
VCJW -- Volute Centrifugal with Jet in Well (1 Stage)
SP --- Spray Pump

Residential Sewage Disposal Systems

47. GENERAL DEFINITION: The sewage from a residence usually consists of wastes from toilets, bathroom and laundry, and the liquid wastes from the kitchen. A public sewer system provides the most satisfactory method of disposing of sewage, and whenever such a system is available, connection to it should be made. The following material is for guidance in the location, construction and operation of an independent system when public facilities are not available.

48. PLUMBING SYSTEM: The plumbing system of a building includes the water-supply distributing pipes, the fixtures and fixture traps, the soil, waste, and vent pipes, the house drain, and the storm-water drainage, with their devices, appurtenances and connections within the building and to a point 5 feet outside the foundation walls. The drainage from roofs, areaways, and foundation drains should not be discharged into the plumbing system.

Good plumbing is essential to the proper functioning of the drainage system of any building or individual dwelling. Unless all fixtures are properly installed and connected, the sewage will not be carried from the building in a safe and sanitary manner. All fixtures must be properly trapped and vented to prevent odors being discharged into the rooms of the building.

There should not be any physical connections between the water distribution system and the drainage system, and all plumbing installations should be made in such a manner as to prevent any possible contamination of the water supply system. The North Dakota State Plumbing Code which contains minimum standards and requirements is recommended for plumbing installations. Copies of this code may be obtained for 50 cents from the State Plumbing Board, Bismarck, North Dakota.

49. HOUSE DRAIN: The house drain, which receives discharge from soil, waste and other drainage pipes inside the walls of the building, should be constructed of extra heavy cast iron, not less than 4 inches in diameter, and terminate at least 5 feet outside the basement wall where it connects with the house sewer.

50. HOUSE SEWER: The house sewer, which carries the sewage from the house drain to the septic tank or other sewage disposal unit, should be constructed of bell-and-spigot extra-heavy cast-iron or vitrified clay pipe. The size of the pipe should be determined by the plumbing-fixture loading, but in no case should cast-iron pipe be less than 4 inches in diameter nor clay pipe less than 6 inches. Cast-iron pipe should be used where the earth formations are composed of loose-textured material, fissured rock, limestone, lignite, or scoria. Portland cement mortar or other suitable material should be used for joints on vitrified clay pipe, and lead should be used on cast-iron pipe. Special precautions should be observed in obtaining watertight joints in areas where roots of trees or shrubs are likely to reach the sewer. In such cases, and in freezing weather, hot poured joints are recommended. The most essential features to be observed in the construction of the house sewer are listed as follows:

51. LOCATION OF SEWER WITH REFERENCE TO WATER SUPPLY (See Fig. 33):

a. Vitrified clay pipe should not be located nearer than 50 feet, horizontally, to any well, spring, cistern or other source of water supply, or to pumping apparatus, suction pipe, filter or other features of any water supply. In special cases, where it is impossible or not practicable to obtain a 50-foot distance, special construction is necessary to provide additional safeguards. In no case should sewer pipe be nearer than 30 feet to a source of water supply or appurtenances thereto. The special construction required is as follows:

(1) Between 40 and 50 feet extra-heavy cast-iron pipe with tested, watertight joints.
(2) Between 30 and 40 feet extra-heavy cast-iron pipe with tested, watertight joints having bell-joint clamps or an acceptable equivalent.

b. The sewer should not be nearer than 10 feet, horizontally, to any water pipe under pressure. Where a sewer crosses a water pipe which is under pressure, the water pipe should be above the sewer, and all that part of the sewer within 10 feet of the water pipe should be constructed of extra-heavy cast-iron pipe with watertight joints.

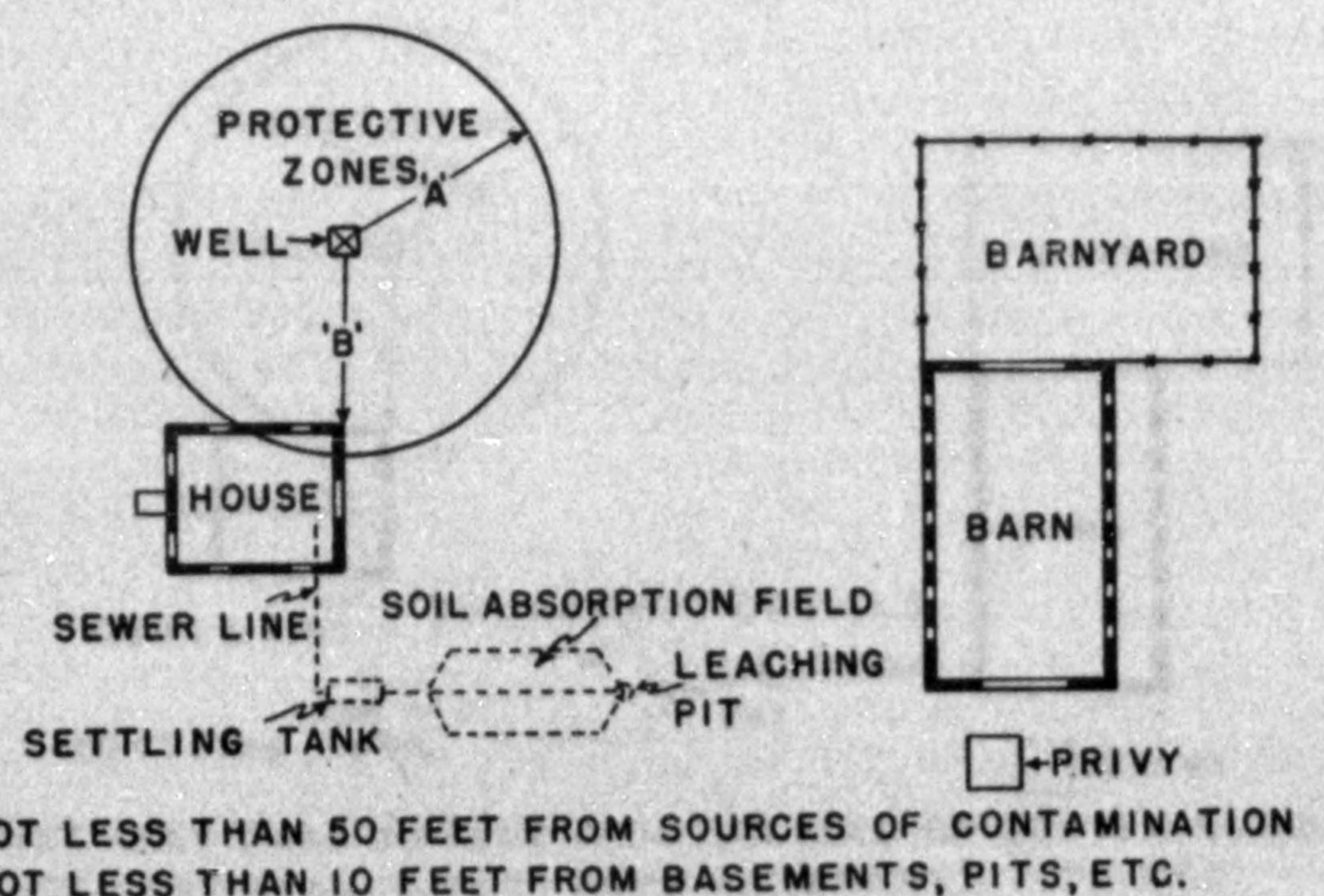


FIG. 33
Diagram Showing Limitation of Distances Between Well and Sources of Contamination for Farm Property

Note: Location of Septic Tank (Settling Tank)
The distance "A" not less than 100 feet in case of a "Public Well."
Field Distribution Box is not shown.
Dosing Tank is not shown.
(It is Desirable to have a field distribution box and dosing tank).

If the water pipe is a suction line greater distances are necessary.

52. MINIMUM SIZE OF PIPE—Six-inch bell-and-spigot type vitrified clay, or 4-inch extra-heavy cast-iron pipe.

53. GRADE—For 6-inch pipe the minimum fall should be 1 foot per 100 feet, or one-eighth inch per foot (one-quarter inch is preferable). For 4-inch pipe, one-quarter inch to one-half inch fall per foot should be used.

54. MANHOLES — A manhole should be provided at all changes in grade or alignment and at intervals not more than 300 feet apart.

55. CLEANOUT — A cleanout should be provided in the house sewer so that a tool can be inserted for removing obstructions.

THE SEWAGE DISPOSAL SYSTEM—THE SEPTIC TANK (Also called settling tank)

56. FUNCTION: Domestic sewage is composed principally of water with a small amount of mineral and organic matter. It is the purpose of the septic tank to remove as much as possible of the suspended matter from the sewage so that the liquid can be disposed of more easily. The settleable material of the suspended matter in the sewage will be deposited in the bottom of the tank and is retained in the tank until it is sufficiently decomposed so that it may be removed and properly disposed of at regular intervals. Experience has shown that approximately 2½ cubic feet of digested sludge may be expected to accumulate in the septic tank per person per year. (See Care and Operation, Page 48)

57. LOCATION OF SEPTIC TANK:

a. The septic tank should be located at least 50 feet from any source of water supply or appurtenances thereto. (100 feet in case of city wells). The septic tank should be at a lower elevation than the water supply. (See Figure 33.)

b. The tank should be so located that it will not be subject to flooding by surface water.

c. The tank should be as far as practicable from any dwelling, stream or lake and in no case nearer than 25 feet to a dwelling or 50 feet to a lake or stream.

58. DESIGN FEATURES: (See Figure 34 or Figure 35.):

a. The minimum capacity of the tank should be 500 gallons. A larger size is usually desirable.

b. Steel reinforced concrete construction is preferred.

c. The walls of the tank should extend to the surface of the ground if possible.

d. The cover should be constructed of reinforced concrete. Movable reinforced concrete cover slabs may be used. If desired, the walls of the tank may terminate at a point not less than 12 inches below ground surface in which case a 6-inch tile should be imbedded in the cover slab at the inlet end of the tank, and a manhole opening of not less than 24 inches in diameter should be placed in the center of the tank cover. The edges of the manhole opening should extend to ground surface and

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the opening should be provided with a suitable manhole cover.

59. FINAL DISPOSAL: Septic tanks do not remove or destroy all disease-producing bacteria from the sewage nor do they COMPLETELY dissolve all solids. Their function is to remove the solids by sedimentation before applying any methods of final disposal.

Careful consideration should be given to the final disposal of sewage from the septic tank because of the dangers which may result from improper installations. And because of the possibility that underground waters may become contaminated, sewage should not be disposed of into any opening which connects the surface of the ground and water table such as an abandoned well, cesspool, sink hole, shaft, pit excavation or fissured or channelled rock formations. Soil absorption systems or pits should

FIG. 34
A Typical Reinforced Concrete Septic Tank (Settling Tank)
(Steel reinforcing bars not shown).
It is Desirable in all installations to also have a dosing chamber
(See Fig. 35)

be situated at least 10 feet above the water table wherever possible. Hazards to underground waters may also be encountered in swampy areas or other areas where the water table may be less than 10 feet from the surface of the ground.

Sewage should not be discharged into a pond, lake, stream, highway or drainage ditch, or onto the surface of the ground.

Where conditions are satisfactory for doing so, the best method of disposing of the overflow from septic tanks is absorption into the soil by means of a drain-tile system. When such a system is used, the ground should contain a large proportion of sand and gravel which will absorb water readily.

60. SOIL ABSORPTION SYSTEM (See Figure 36):

The length of drain tile depends upon the character of the soil and the quantity of sewage. In order to facilitate the absorption of sewage into the soil, the absorption system should comply with the following provisions:

61. FOR DRAIN TILE—

1. Slope of tile should be 6 inches per 100 feet.

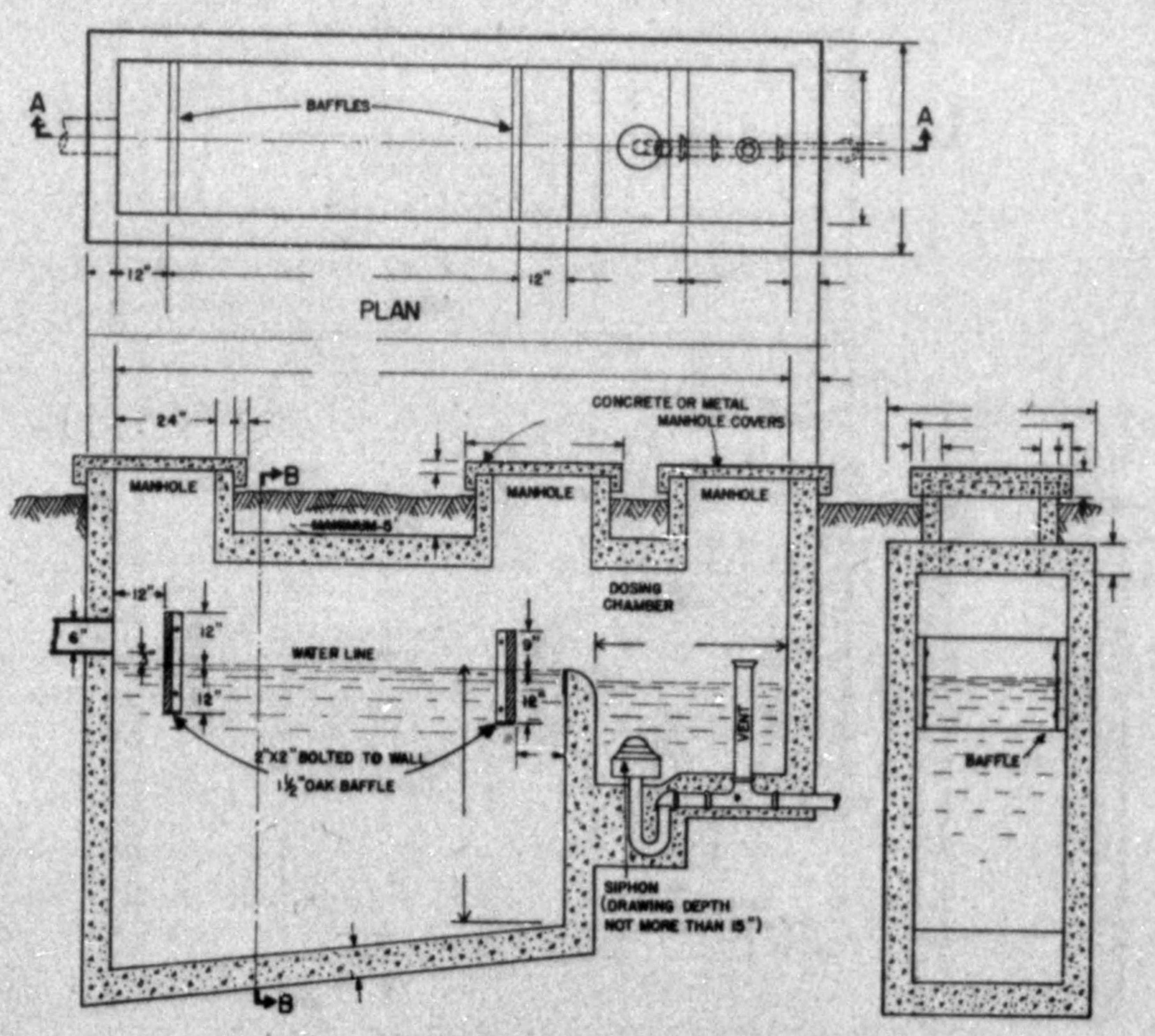


FIG. 35

Typical Concrete Septic Tank (Settling Tank)

(Steel reinforcing bars not shown)

Dosing chamber is shown. Bottom of septic tank may be constructed level instead of sloped if level construction is easier.

2. Drain tile should not be less than 4 inches, preferably 6 inches, in diameter, and 12 inches long.
3. Joints between tile, one-quarter inch. The upper half of joint covered with a strip of asphalt-treated paper.
4. Tile surrounded by broken stone or coarse gravel.
5. Preferred depth of tile 3 to 5 feet. (Electric sump pumps should be used for basement drainage if such drainage would necessitate greater depths.)
6. Maximum length of lateral 100 feet.
7. Spacing between laterals not less than 8 feet. Greater spacing is desirable.
8. Tile lines to converge to inspection manhole and absorption pit.
9. Maximum depth of absorption pit (leaching pit)—10 feet.

The approximate length of drain tile required, based on a sewage flow of 50 gallons per person per day and a trench 18 to 24 inches wide, is as follows:

Coarse sand or gravel ....12 feet per person.
Fine sand ....20 feet per person.
Fine sand with some clay or loam .....30 feet per person.

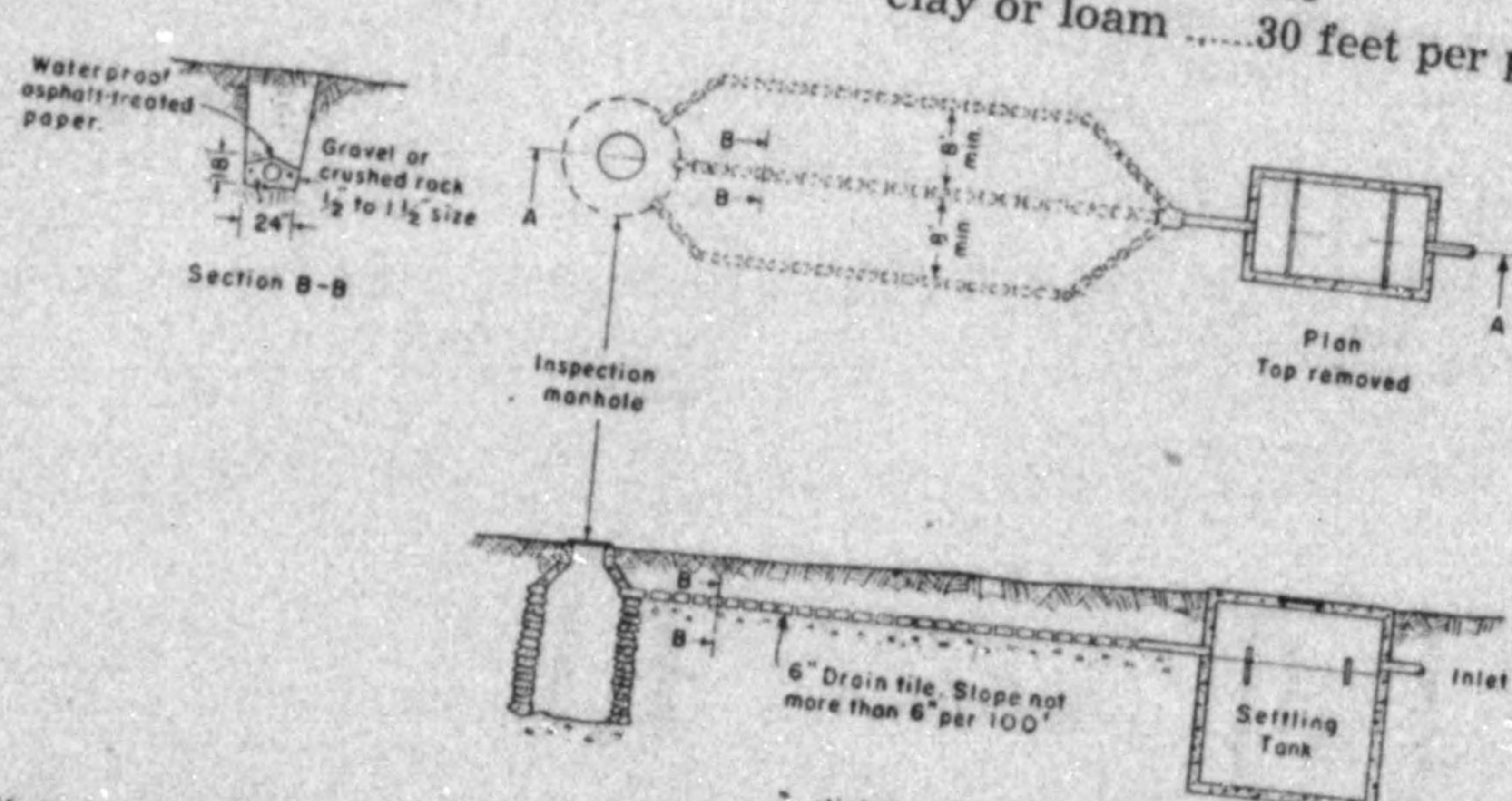


FIG. 36
Field Distribution Box is not shown. Dosing Tank is not shown. (It is desirable to have a field distribution box and dosing tank).

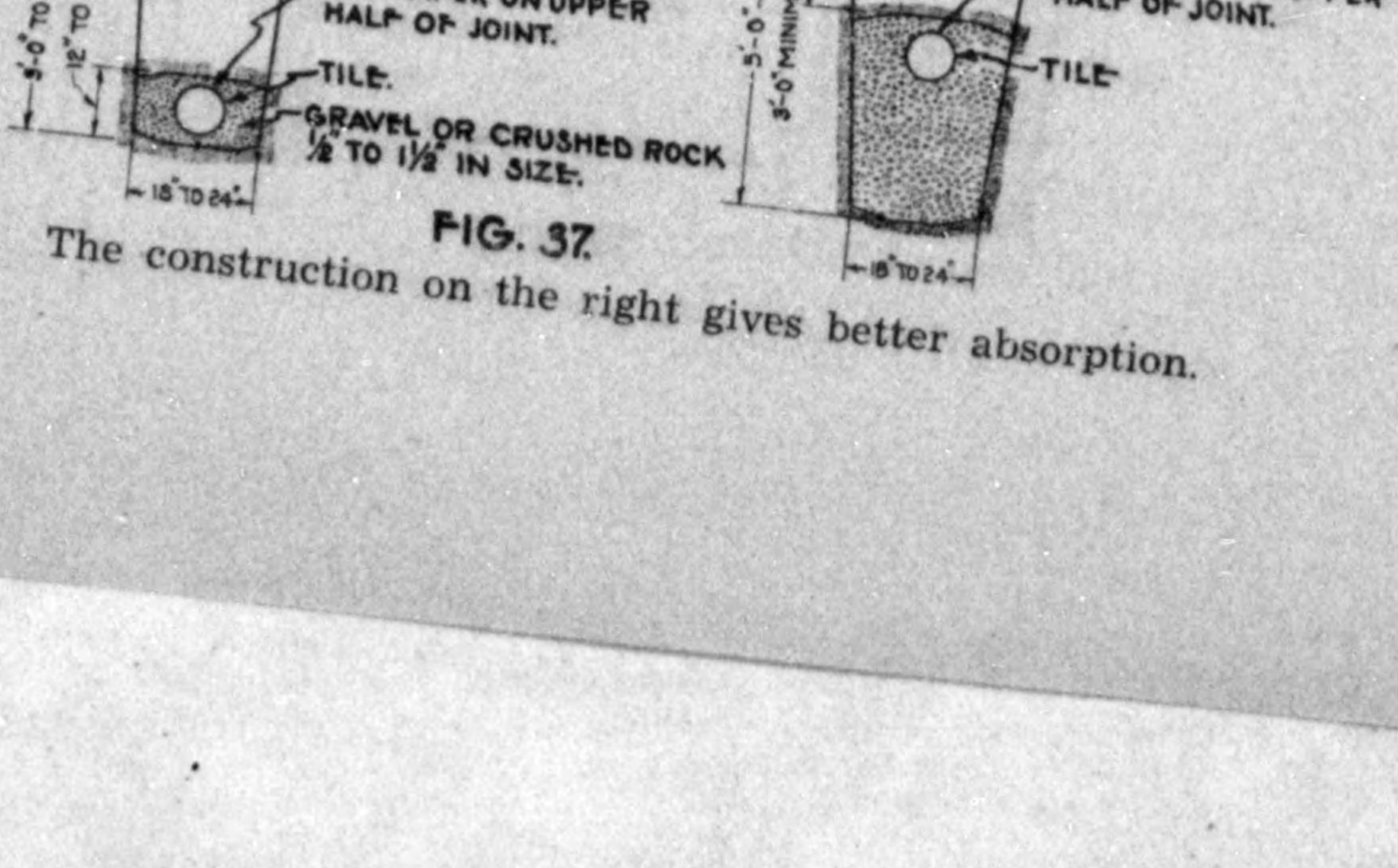


FIG. 37
The construction on the right gives better absorption.

Heavy clay, very fine sand, and quicksand........................ Unsuitable for soil absorption and soil absorption should not be attempted.

Where soil conditions are unfavorable, better absorption may be obtained by deepening the trench and backfilling with a few feet of coarse gravel upon which the tile are laid and then covered as in the usual type of drain tile absorption system.

This difference is illustrated in Figure 37.

Where soil conditions are favorable, and the quantity of liquid is not large, an absorption pit, or leaching pit may be used to supplement, or in some cases be used, instead of tile drains. Absorption pits should **not** be confused with so-called cesspools which are operated without septic tanks. A cesspool is not recommended as a substitute for a septic tank, as its period of use is limited and it is dangerous when excavated into or close to water-bearing formations.

62. USE OF FIELD DISTRIBUTING BOX:

The installation of a distributing box is desirable for all types of soil absorption systems and is necessary for some types.

A distributing box is a box or chamber into which the septic tank effluent discharges and from which the sewage enters the tile subsurface absorption lines, permitting regulation of flow into these lines and inspection of the quality of the septic tank effluent.

The distributing box should be connected to the septic tank by a short tight sewer line and located at the upper end of the distribution field (soil absorption field).

The inlet pipe should enter at one end of the box about 2 inches above the bottom. Sides of the box should extend to within 6 inches of the surface and the box should be provided with a removable cover. Drain lines should be constructed with their flow line at the bottom level of the box and all set at the same elevation. They should take off straight in the desired direction. Horizontal bends should be avoided where possible, but when necessary they should be made with tight joints. When set at the same elevation and operating under the same head, all pipes of the same size are more likely to receive an equal quantity of flow.

The size of the box need not be more than 18 inches in width, nor longer than is necessary to accommodate drains for effective outlet capacity. (See Fig. 38.)

63. USE OF DOSING TANKS: (See Figure 35.) Dosing tanks with automatic siphons are DESIRABLE in all installations and should always be provided when the total length of distribution tile exceeds 300 feet. The liquid capacity of the dosing chamber should be sufficient to fill all field lines from one-half to three-quarters full at each discharge, and the discharges should not occur more frequently than at 2-hour intervals. The dosing tank can usually be constructed as part of the septic tank. Reference should be made to the manufacturer's bulletins for standard capacities and details of sewage siphons.

64. CARE AND OPERATION:

1. Newspaper or other heavy paper, sticks, rags, rubbish, garbage,

etc., should not be thrown into toilets or sinks as they may clog the sewer or interfere with the action of the treatment plant.

2. Sludge should not be permitted to accumulate in the tank to a depth of more than 2 feet before it is removed, as a greater depth will reduce the efficiency of the plant. The depth of the sludge may be determined by measuring with a pole. The most favorable time for the removal of sludge is in the fall when cool weather reduces the menace of flies and odors.

3. The sludge should be pumped from the tank and buried in shallow trenches, or disposed of in an area not readily accessible to human beings or animals, and where it will not endanger any water supply. If the sludge must be transported to some suitable site where it can be buried, it should be carried in watertight containers.

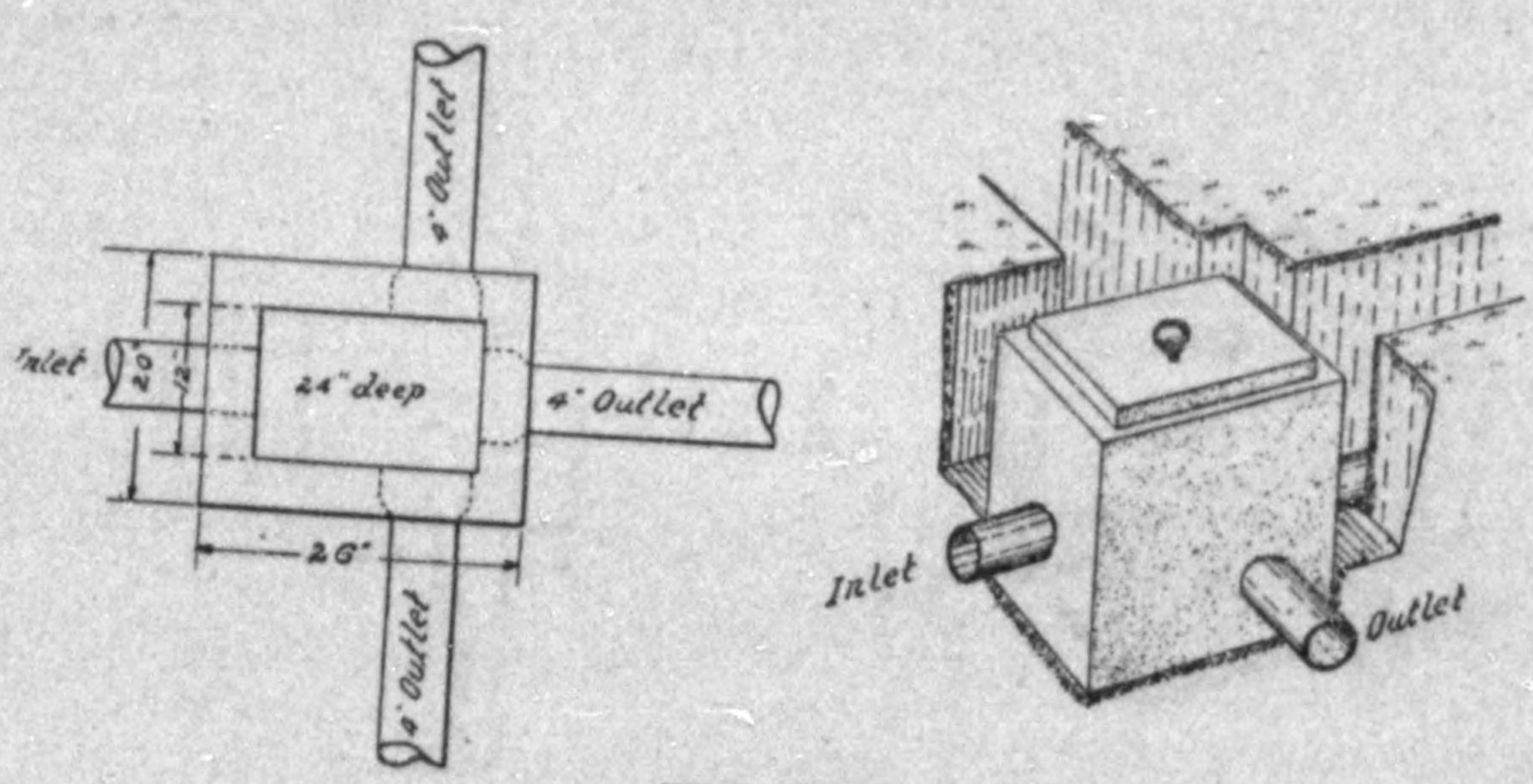


Fig. 38
Field Distribution Box

65. DON'TS FOR SEWERAGE SYSTEMS

1. DON'T drain your basement into your septic tank. This necessitates deep placement of the tank, resulting in difficulty of cleaning and improper functioning of the tile absorption field. An exception can be made if the slope of the area is suitable. For example if the home is located on a side hill.
2. DON'T place the tile in the absorption field closer than 3 feet to the ground surface or deeper than 6 feet. Generally speaking, from 3 feet to 5 feet is the most desirable depth.
3. DON'T drain your septic tank into an old well. To do so might contaminate the underground water.
4. DON'T expect the septic tank to run itself indefinitely. Like any scientifically constructed waste disposal system, it requires routine attention.
5. DON'T waste money on magic "ferments" or chemicals to reduce or liquify sludge in the septic tank. These are useless and some sludge settles out which must be removed, preferably about once a year.
6. DON'T try to use a cesspool as a substitute for a septic tank.

66. IMPORTANT POINTS ON REINFORCED CONCRETE

The sand and gravel for concrete should be clean and free of silt and clay.

The water should be clean. Water that is fit to drink and pleasing to the taste is satisfactory for concrete.

For most construction a 1-2-3 mix is desirable. This means 1 part of cement, 2 parts of sand and 3 parts of gravel.

It is cheaper and better not to use pit run sand and gravel for concrete. The sand should be screened out from the gravel. Only in this way can the proportions of 2 parts of sand to 3 parts of gravel be obtained.

Do not use shovel measure. Buckets of the same size can be used to measure the cement, sand, and gravel or wooden measuring boxes can be constructed.

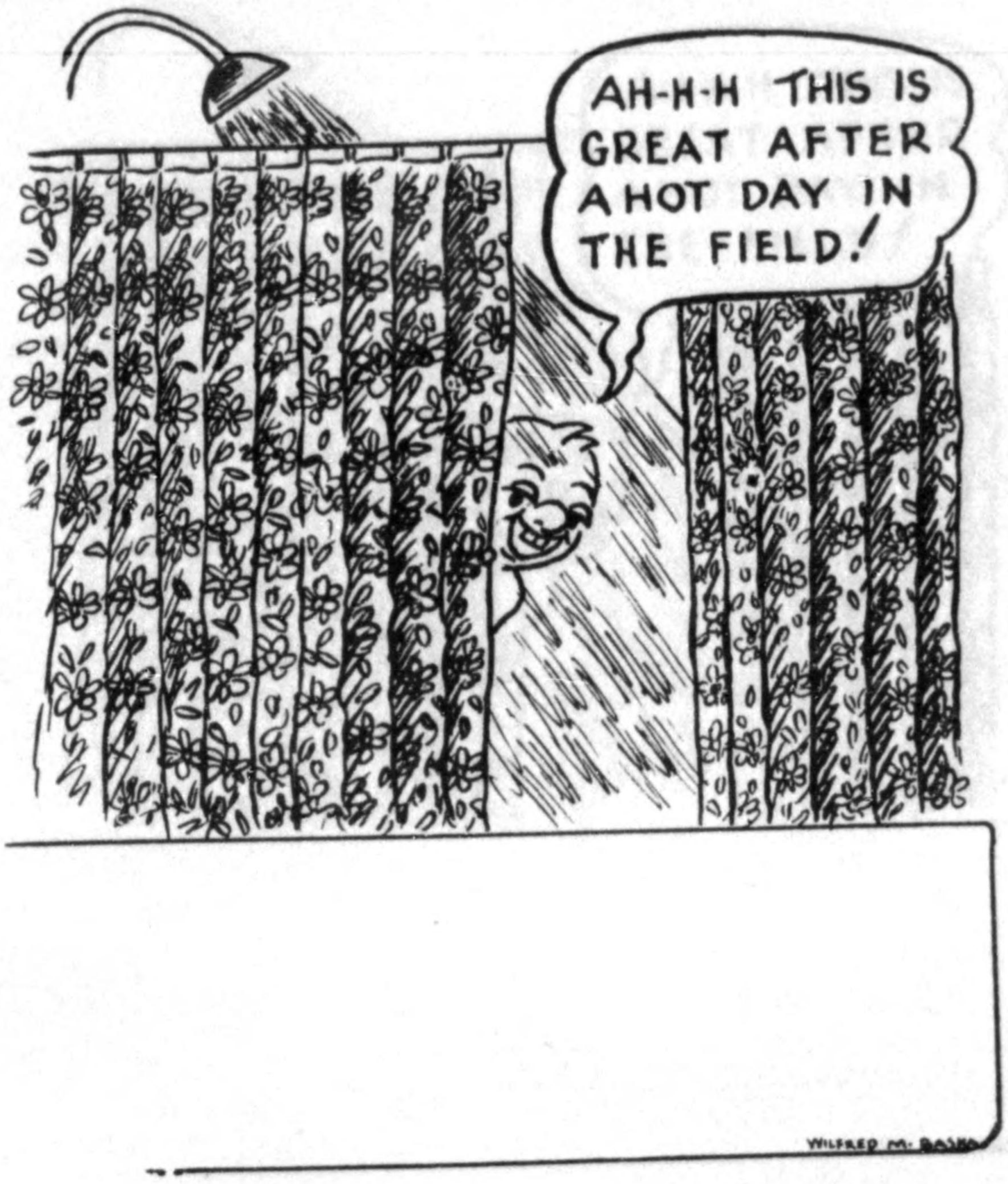
The quantity of water for each sack of cement is VERY IMPORTANT in concrete construction.

Use ONLY enough water to make the mix PLASTIC and WORKABLE. Do not use a soupy mix. ONLY in this way can a FIRM DENSE quality of REINFORCED CONCRETE be OBTAINED.

In North Dakota less than 5,000 rural dwellings have running water and only 4,105 have flush toilets or non-flush toilets in the structure. (From the 1940 Census.)

From July 1, 1943 to June 30, 1944, a period of 12 months, **FIFTY** percent of the water samples submitted to the State Health Department from private wells were unfit for drinking purposes. A review of the construction details of the wells showed that **EIGHTY-EIGHT** percent were subject to contamination and therefore potentially dangerous.

The correction of these conditions should be the concern of all.


AH-H-H THIS IS GREAT AFTER A HOT DAY IN THE FIELD!

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IOWA
SCHOOL SANITATION MANUAL

PART III

Sanitary Standards *for* School Water Supplies

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STATE DEPARTMENT OF HEALTH
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GENERAL INSTRUCTIONS

1. School officials should be cognizant of their responsibility for providing a safe water supply for the school.
2. County superintendents, school superintendents and school boards are encouraged to ascertain the status of water supplies at schools within their respective jurisdictions and promote development and proper maintenance and operation.
3. Proposals for all school water supply construction or reconstruction should be submitted to the State Department of Public Instruction and the State Department of Health for review and approval before such projects are started.
4. Water samples should not be submitted from supplies that are obviously poorly located or improperly constructed. Rather, the necessary protection should be provided and samples submitted following reconstruction and disinfection.
5. Assistance for the development of a water supply or protecting the existing supply may be obtained from the State Department of Health, upon request, without charge.

FOREWORDS

An adequate supply of water, safely drinkable, is of much importance to every one of Iowa's schools. The physical well-being of both teacher and pupil is involved. Laboratory analysis has revealed undesirable contamination in many instances, and so this manual of sanitary standards has been prepared. It seeks to furnish, in a form that is readily understood, practical information having to do with the selection of a suitable type of school well, its proper location and construction, and its efficient maintenance.

Jessie M. Parker

Superintendent of Public Instruction

Drinking water supplies have long been recognized as potential sources of illness. Past experience with widespread water-borne epidemics from public and semi-public water supplies behooves us to give particular attention to public school water supplies because of the large number of children that may be exposed by such an outbreak.

Laboratory analysis of samples of water from school wells and private wells submitted to the State Hygienic Laboratory have indicated undesirable contamination in a vast majority of cases. Subsequent inspections, in many cases, have revealed that only minor reconstruction was necessary to provide adequate protection. This manual is primarily for the purpose of outlining simple and practical suggestions for proper location and construction of wells. It is hoped, therefore, that this manual will be used as a guide for the development of new wells or the reconstruction of old wells.

Walter L. Bierring

Comissioner

State Department of Health

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ILLUSTRATIONS

Sanitary Standards for School Water Supplies

INTRODUCTION

Most underground water occurring in sand or gravel deposits overlain with clay or loam is of satisfactory bacterial quality at its source. Loam, fine sand or a mixture of the two constitute excellent natural filtering media for removing objectionable bacteria, almost always found in surface waters. This is particularly true of the upper layers of soil which support abundant bacteria life. These bacteria exert a tremendous purifying effect upon surface water, by virtue of the fact that they feed upon the organic matter present in water, converting it into humus and inorganic material. These organisms thrive only in the presence of air (oxygen) and hence do not penetrate to any great depth, usually not more than three or four feet.

Clay is practically impervious to the passage of water. Consequently, if a water-bearing vein of sand or gravel is overlain with several feet of clay, the water in such formation is likely to be of good bacterial quality. Therefore, unless the underground water has been contaminated with sewage from deep cesspools or privy vaults penetrating to or near the water-bearing formation, such water is usually found to be free from objectionable bacteria.

The above does not apply to water occurring in creviced limestone or very coarse gravel. In creviced limestone, contaminated water may gain access to these formations through sinkholes or outcroppings of the rock along streams and travel a distance of a mile or more underground without undergoing any appreciable purification. Therefore, water from shattered limestone formations near the surface must always be viewed with suspicion.

In coarse gravel formations, while the situation is not as serious as in limestone, contamination will travel considerable distances without undergoing adequate purification.

Without proper location, construction, and protection it is possible for contaminated surface or immediate subsurface water to gain access to the well. Usually at an isolated school it is easily possible to locate a well at a safe distance from a source of serious contamination. Therefore the most important factor is the proper construction of the well, and this manual deals principally with this phase of water supply development. It is realized, however, that a complete discussion to include all problems likely to arise, is impossible. The State Department of Health, therefore, invites inquiry on specific problems in water supply development where additional service may be required.

The most satisfactory type of water supply for a school is a pressure system, preferably from a public or municipal supply known to be safe and dependable. In the majority of isolated schools, however, such a supply is not available and other sources must be developed.

Shallow wells (depth less than 100 feet) are the chief source of supply for most schools. This type of well usually furnishes a sufficient quantity of water but is the most readily contaminated and special care must be taken in the location and construction. Drilled or driven wells are preferable to dug wells wherever ground formations permit their use because it is easier to construct and maintain drilled and driven wells free from pollution. They are also generally cheaper than approved dug wells of the same depth. In the case of double tubular wells, having both casing and drop pipe, where approved types of pumps are used, pits for frost protection may be more readily avoided than with single tubular wells. Double tubular wells are therefore preferable to single tubular drilled or driven wells.

WELL LOCATION

Wells should be located at a sufficient distance from barnyards, privies, cesspools, sewers, soil pipes or pipes which are directly connected to a sewer, septic tank or cesspool, or other pipes through which sewage may back up from any source, and other fixed sources of pollution so that underground pollution will be prevented. A minimum distance of 100 feet from any of the above sources of pollution is desirable. All drains which carry sewage or contaminated water located within 50 feet of a school well should be constructed of cast iron pipe with leaded joints or other watertight construction, and in no case should the drain be less than 20 feet from the well. All drains ranging from 50 to 100 feet from a well should be constructed of vitrified clay bell and spigot sewer pipe with tight cement mortar or bituminous joints.

A cesspool is the least desirable method of sewage disposal. Cesspools actually penetrating any water-bearing sand or gravel, or shattered and creviced limestone should never be permitted. If a cesspool must be used it should not be more than 12 feet deep nor within 3 feet of a ground water stratum and should be at least 100 feet from the well. Where coarse gravel, limestone, disintegrated rock or other porous material that will permit a rapid flow of water is encountered above the water-bearing strata and especially when near the ground surface, the above distances will not apply. In case the water is obtained from limestone, disintegrated rock, etc., and other porous formations which lie near the surface, little protection can be secured by greater distance and such a supply cannot be considered satisfactory unless its safe quality is demonstrated by frequent bacteriological analyses.

Well sites should be properly drained and, where possible, at a higher elevation than nearby sources of pollution such as barnyards, privies, septic tanks, subsurface filters, etc. If the well is located so that surface water runoff must pass over or near the well, the area immediately surrounding the well should be filled with clean earth or clay. The earth fill should extend at least 15 feet in all directions from the well and graded to an elevation of at least two feet above the highest known surface water elevation. Further, the well platform should extend at least six inches above the surface of the ground or fill at the well.

WELL CONSTRUCTION

In the construction of a well, proper attention must be given to the depth at which safe water can be obtained and to methods of excluding surface run-off and shallow contaminated ground waters. The minimum depth for safe water will vary with different soil formations and will also depend somewhat upon the extent to which the district is developed.

In the northeastern and eastern portion of the state where limestone formations are encountered near the surface, shallow subterranean streams are apt to be contaminated at points far removed from the well site. Wells deriving water from these shallow formations are therefore likely to produce an unsatisfactory water and should be avoided if possible. Deep wells deriving water from formations below the shattered limestone formations are much more dependable if properly constructed to exclude the shallower contaminated waters.

In other sections of the state subterranean streams are less readily contaminated by seepage from sources of pollution at or immediately below the ground surface. Hence, if proper precautions are taken in locating the well relative to evident sources of pollution in the immediate vicinity, a fairly dependable water may be derived from shallower depths. Ordinarily, however, the upper 10 feet of soil may be subject to intermittent contamination and should not be developed as a source of drinking water supply.

In protecting the well against the entrance of surface or shallow subsurface waters, several items should be observed regardless of the type of well being constructed. The well top should be raised above the surrounding ground sufficiently to insure proper drainage. In all cases the top of the well platform should be at least 6 inches above the surface of the ground or fill at the well. The top of the casing should extend at least one inch above the platform into the pump base, or if a flanged pump setting is used more casing extension is required. Plates 1 and 2 show in detail two hand pump settings commonly used to insure a water-tight pump setting. Plates 14, 15, 16, 17, 18 and 19 show motor driven pump installations.

Well platforms or curbings, and manhole covers, should be of permanent materials, such as reinforced concrete, steel, wrought iron or cast iron. *Wood should never be used even for manhole covers.*

All openings through well tops or pump platforms should be constructed with raised shoulders and overlapping manhole covers to exclude waste water or other pollution. Well pits should be avoided and waste water should be prevented from standing around the well by providing adequate drainage.

Other items pertaining to the particular type of well being constructed must also be observed. These are enumerated as follows for the various types of wells common in this state, with accompanying detailed sketches on proper construction.

Dug and Bored Wells. *Plates 3, 4, 5, and 6.* The walls of dug and bored wells should be water-tight to a depth below the natural ground

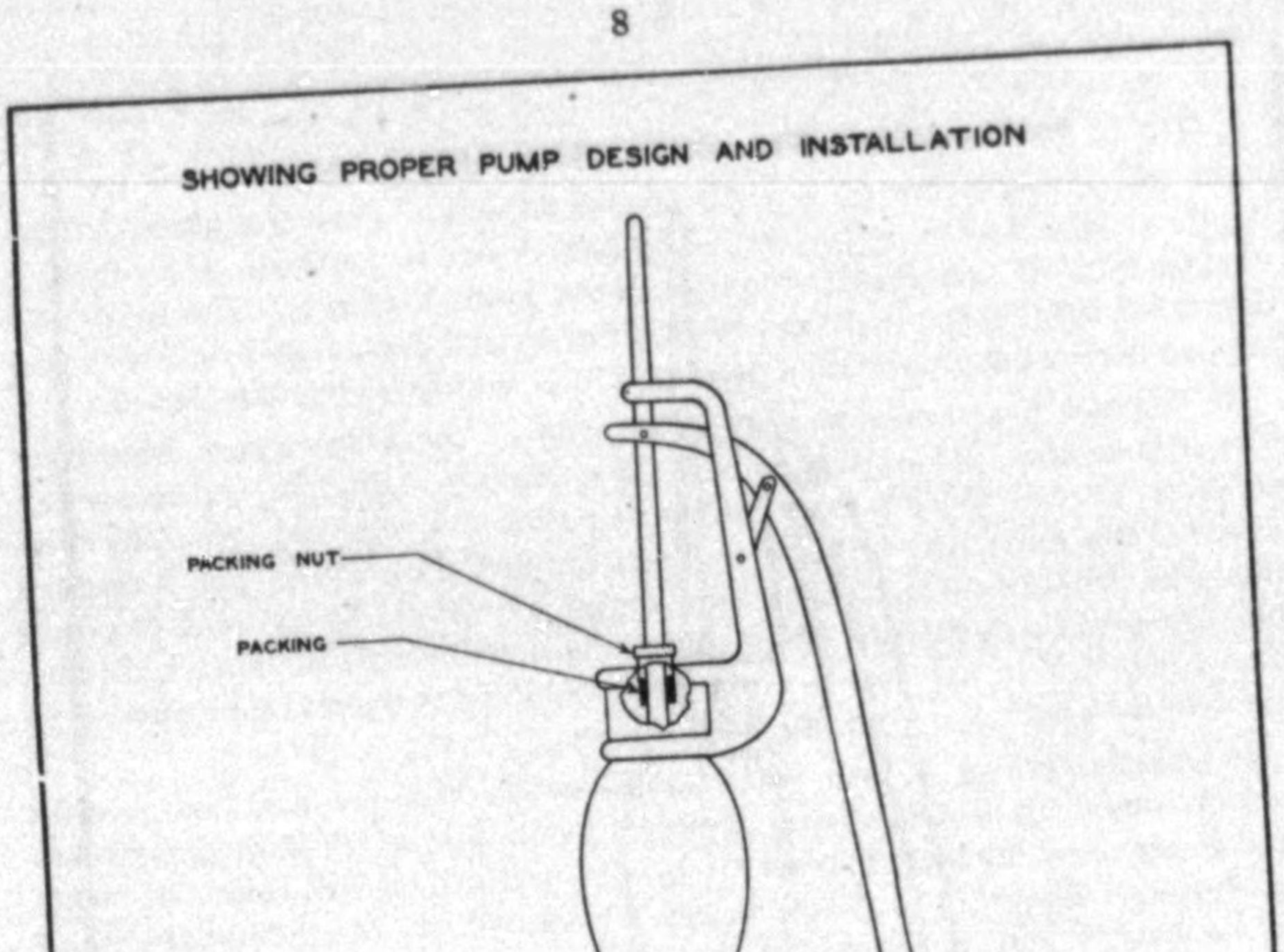

SHOWING PROPER PUMP DESIGN AND INSTALLATION
PACKING NUT
PACKING
PUMP SPOUT MUST TURN DOWN
IF CONCRETE PLATFORM IS NOT WATER TIGHT AROUND PUMP SLEEVE OR WELL CASING, AN OAKUM AND ASPHALT OR LEAD SEAL SHOULD BE PROVIDED
DROP PIPE
PUMP BASE
GASKET
SCREWED OR BOLTED FLANGE
SLOPE
1"
12"
PUMP SLEEVE OR WELL CASING
PROVIDE STRAP IRON CLAMP FOR SUPPORT WHEN SLEEVE IS USED
STATE DEPARTMENT OF HEALTH, DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 1

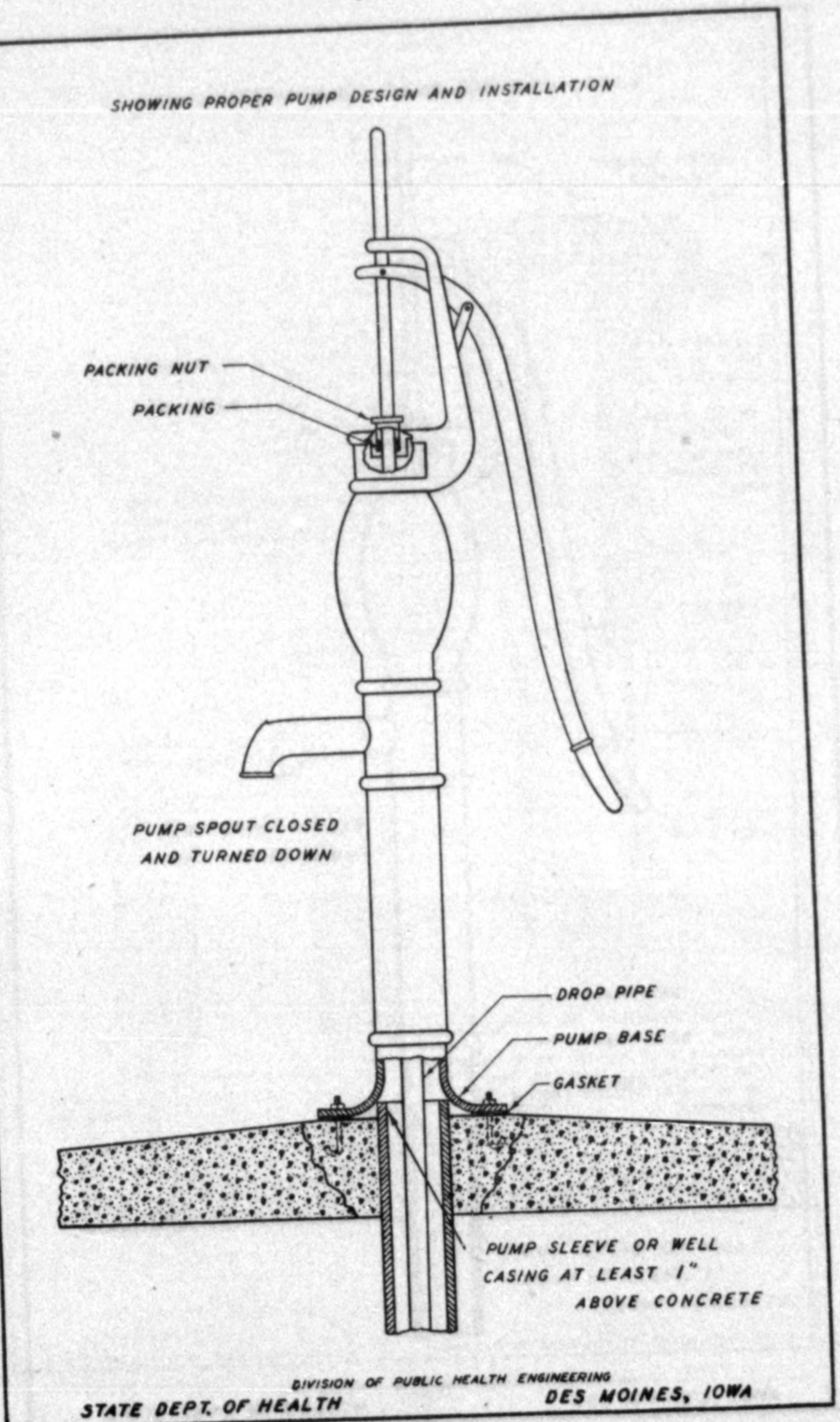

SHOWING PROPER PUMP DESIGN AND INSTALLATION
PACKING NUT
PACKING
PUMP SPOUT CLOSED AND TURNED DOWN
DROP PIPE
PUMP BASE
GASKET
PUMP SLEEVE OR WELL CASING AT LEAST 1" ABOVE CONCRETE
DIVISION OF PUBLIC HEALTH ENGINEERING
STATE DEPT. OF HEALTH
DES MOINES, IOWA

Plate 2

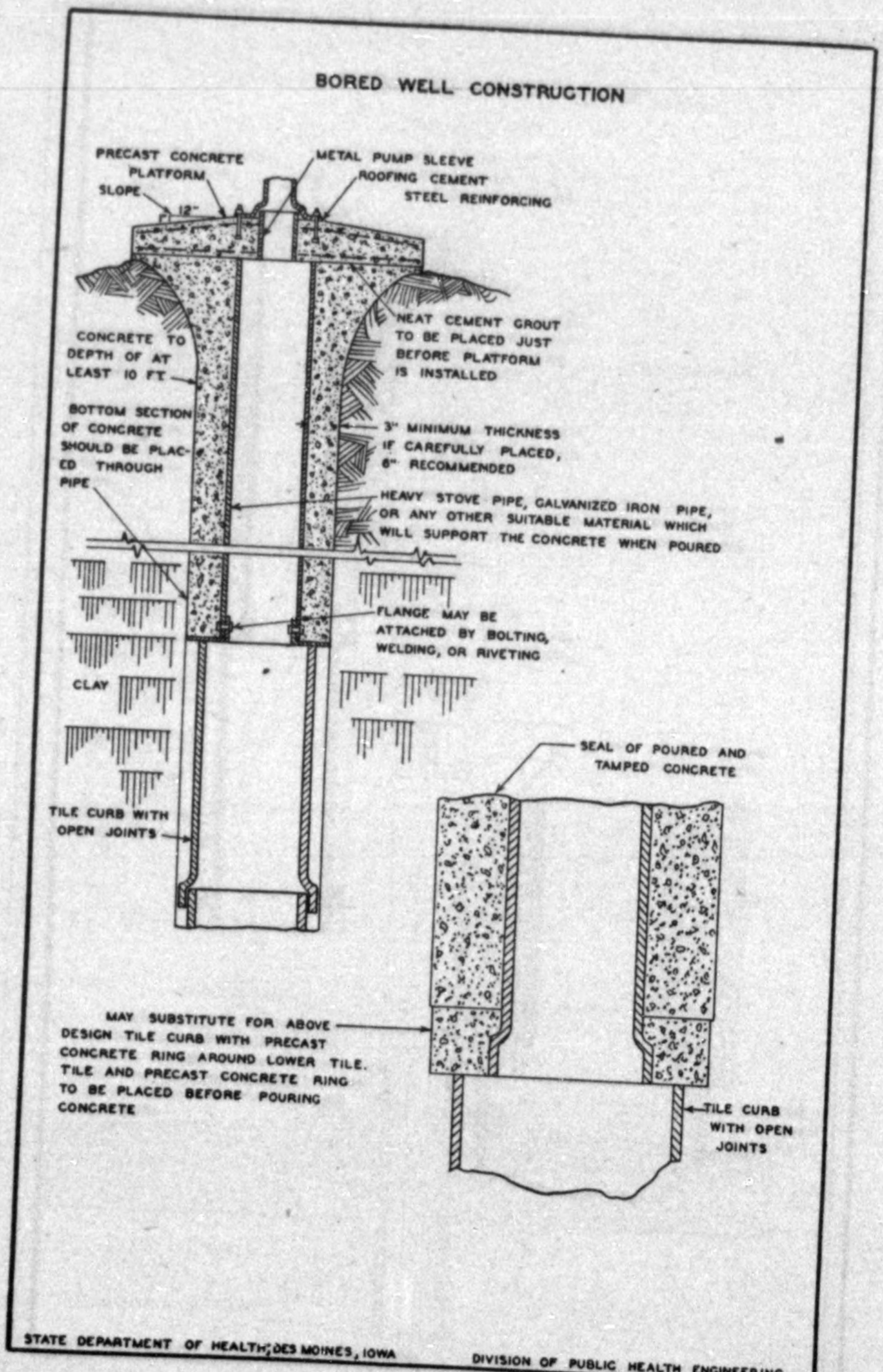

BORED WELL CONSTRUCTION
PRECAST CONCRETE PLATFORM
SLOPE
12"
METAL PUMP SLEEVE
ROOFING CEMENT
STEEL REINFORCING
CONCRETE TO DEPTH OF AT LEAST 10 FT.
NEAT CEMENT GROUT TO BE PLACED JUST BEFORE PLATFORM IS INSTALLED
BOTTOM SECTION OF CONCRETE SHOULD BE PLACED THROUGH PIPE
3" MINIMUM THICKNESS IF CAREFULLY PLACED, 6" RECOMMENDED
HEAVY STOVE PIPE, GALVANIZED IRON PIPE, OR ANY OTHER SUITABLE MATERIAL WHICH WILL SUPPORT THE CONCRETE WHEN POURED
FLANGE MAY BE ATTACHED BY BOLTING, WELDING, OR RIVETING
CLAY
TILE CURB WITH OPEN JOINTS
SEAL OF POURED AND TAMPED CONCRETE
MAY SUBSTITUTE FOR ABOVE DESIGN TILE CURB WITH PRECAST CONCRETE RING AROUND LOWER TILE. TILE AND PRECAST CONCRETE RING TO BE PLACED BEFORE POURING CONCRETE
TILE CURB WITH OPEN JOINTS
STATE DEPARTMENT OF HEALTH, DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 3

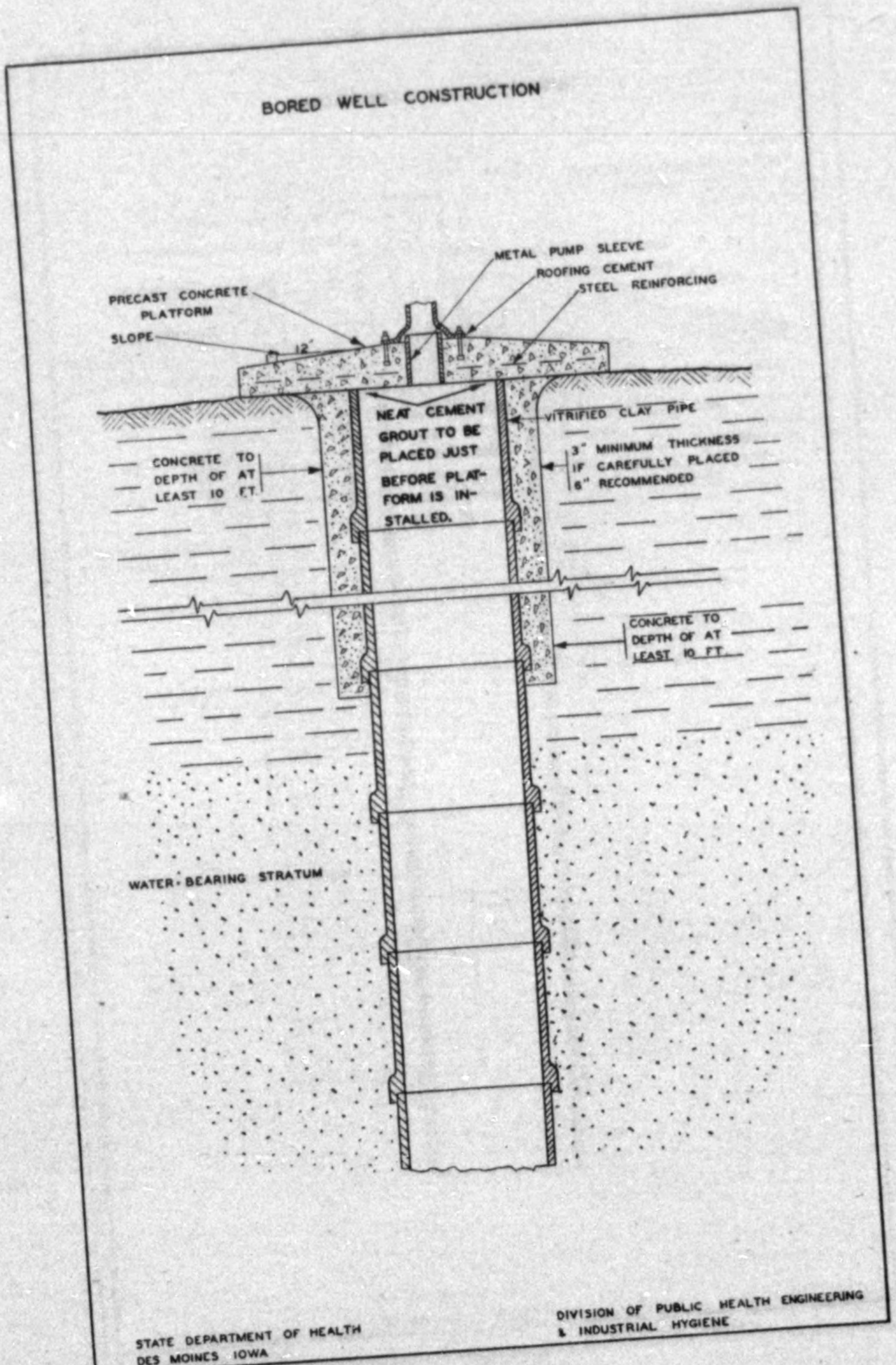

BORED WELL CONSTRUCTION
METAL PUMP SLEEVE
ROOFING CEMENT
STEEL REINFORCING
PRECAST CONCRETE PLATFORM
SLOPE
12"
NEAT CEMENT GROUT TO BE PLACED JUST BEFORE PLATFORM IS INSTALLED.
VITRIFIED CLAY PIPE
CONCRETE TO DEPTH OF AT LEAST 10 FT.
3" MINIMUM THICKNESS IF CAREFULLY PLACED 6" RECOMMENDED
CONCRETE TO DEPTH OF AT LEAST 10 FT.
WATER-BEARING STRATUM
STATE DEPARTMENT OF HEALTH
DES MOINES IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING & INDUSTRIAL HYGIENE

Plate 4

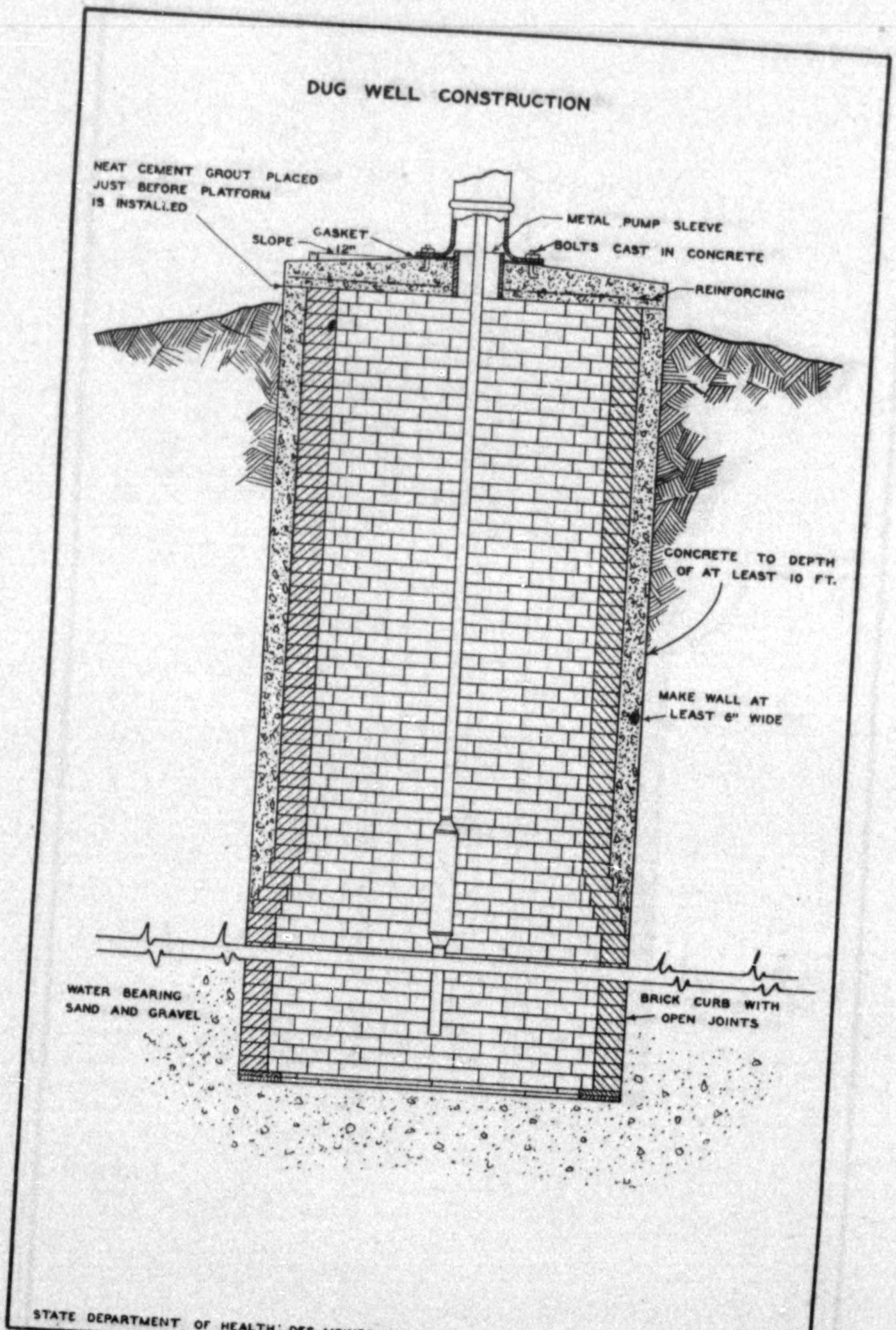

DUG WELL CONSTRUCTION
NEAT CEMENT GROUT PLACED JUST BEFORE PLATFORM IS INSTALLED
SLOPE
GASKET
12"
METAL PUMP SLEEVE
BOLTS CAST IN CONCRETE
REINFORCING
CONCRETE TO DEPTH OF AT LEAST 10 FT.
MAKE WALL AT LEAST 6" WIDE
WATER BEARING SAND AND GRAVEL
BRICK CURB WITH OPEN JOINTS
STATE DEPARTMENT OF HEALTH, DES MOINES, IOWA DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 5

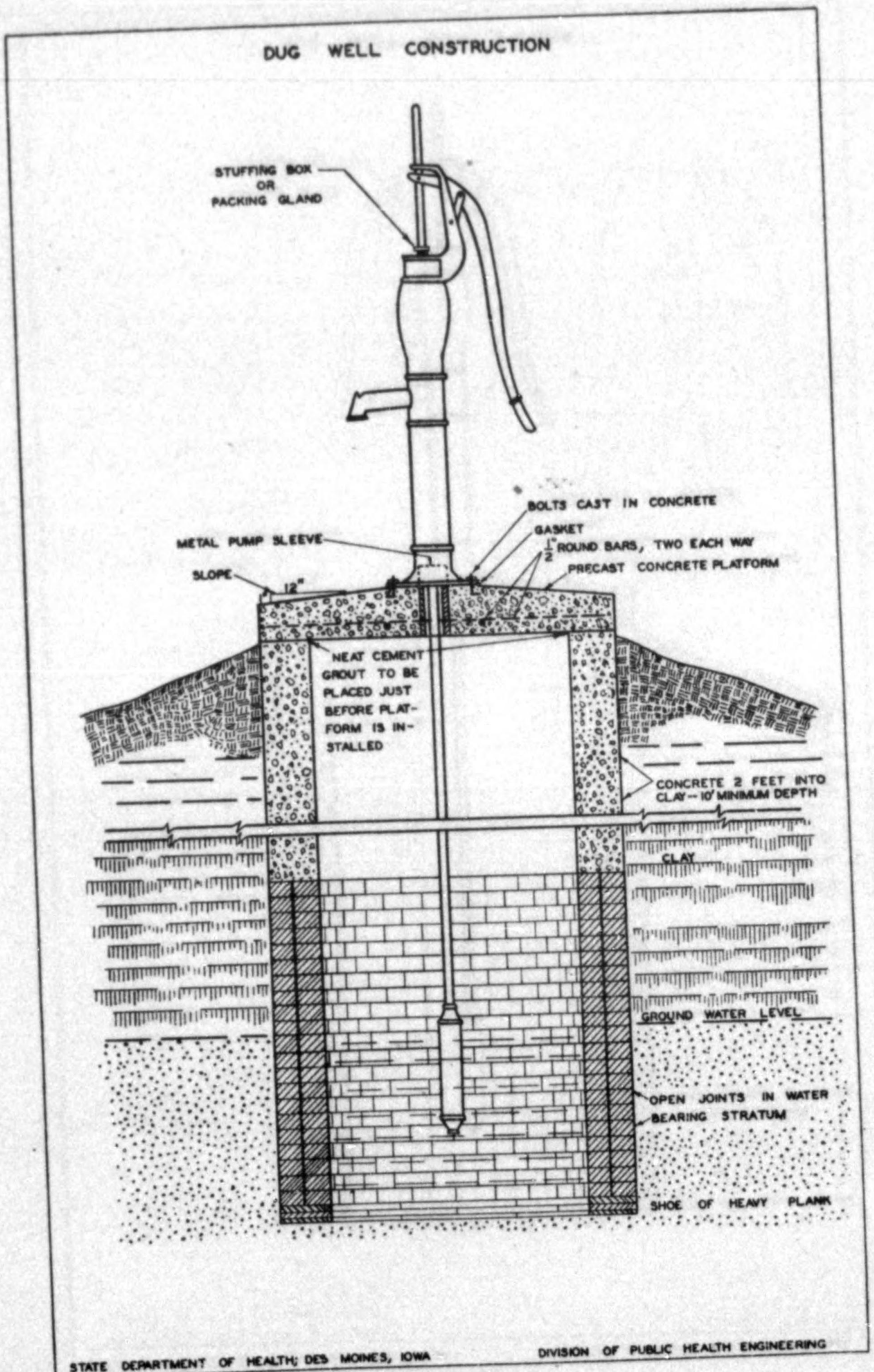
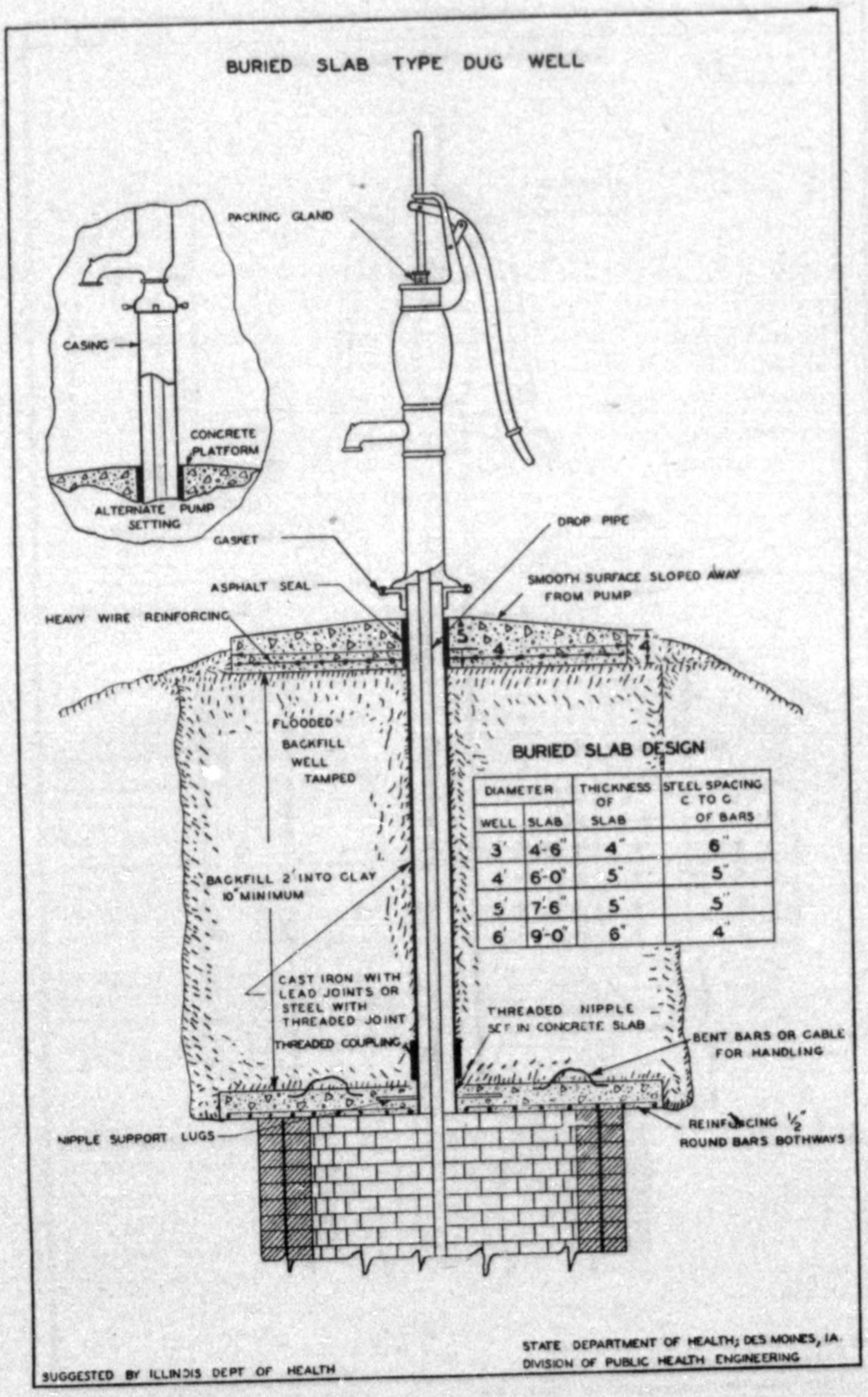

DUG WELL CONSTRUCTION
STUFFING BOX OR PACKING GLAND
BOLTS CAST IN CONCRETE
GASKET
1/2" ROUND BARS, TWO EACH WAY
PRECAST CONCRETE PLATFORM
METAL PUMP SLEEVE
SLOPE 12"
NEAT CEMENT GROUT TO BE PLACED JUST BEFORE PLATFORM IS INSTALLED
CONCRETE 2 FEET INTO CLAY—10' MINIMUM DEPTH
CLAY
GROUND WATER LEVEL
OPEN JOINTS IN WATER BEARING STRATUM
SHOE OF HEAVY PLANK
STATE DEPARTMENT OF HEALTH; DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 6



DIAMETER		THICKNESS OF SLAB	STEEL SPACING C TO C OF BARS
WELL	SLAB		
3'	4'-6"	4"	6"
4'	6'-0"	5"	5"
5'	7'-6"	5"	5"
6'	9'-0"	6"	4"

Plate 7

surface at least 10 feet, and preferably carried two feet into clay or other similar water sealing formations. This may best be accomplished by constructing a reinforced concrete wall six inches thick. Brick or tile walls or metal pipe make convenient interior forms for pouring the concrete walls and may be left in place. Clay or concrete pipe walls are not satisfactory unless surrounded with at least six inches of concrete to a depth of at least 10 feet, since it is extremely difficult to secure water-tight joints with the pipe alone.

In some cases a durable metal casing may be used, but it should be installed as described for double tubular wells. An exception to this is when light gauge metal pipe is used to form a bored well for concreting, as shown on Plate 3.

No matter what type of curbing is used, the annular space between the excavation and the outside of the curbing should be filled in such a manner as to prevent surface water or shallow ground water from running down the outside of the curbing and thence into the well or into the water-bearing strata. Where such an annular space occurs, the downward passage of contaminated water may be prevented by backfilling above the water-bearing strata, preferably with puddled clay, mortar or concrete, although clean earth may be used if carefully placed. If concrete is used, the entire quantity should be placed at one pouring to eliminate the possibility of leaky construction joints. Gravel or sand should not be used.

The well platform should be a water-tight reinforced concrete slab of a minimum thickness of four inches, with all openings constructed with raised shoulders to exclude all waste water or other pollution. A sufficient amount of rich cement mortar should be used in sealing the well platform to the sidewalls to insure it being water-tight.

The drop pipe opening through the well platform should be formed by a length of iron pipe sleeve of sufficient diameter to admit the pump cylinder. This pipe sleeve should always be cast into the platform (placed in top when concrete is being poured) and should extend at least one inch above the raised concrete shoulder and into the pump base.

Manholes are usually unnecessary and often admit pollution to the well. If a manhole is built, the shoulder or ring should extend at least two inches above the slab surface and should be covered by a solid, water-tight lid of cast iron, steel or reinforced concrete which should have over-hanging vertical edges covering the exterior of the shoulder or ring at least 1½ inches. The cover should be firmly bolted or locked in place.

Buried Slab Type of Dug Well. *Plate 7.* A buried slab type of dug well, as shown by Plate 7, suggested by the Illinois State Department of Health, is recommended for the construction of new wells or reconstruction of existing wells. The construction as indicated should provide satisfactory surface and immediate subsurface protection for dug and bored wells.

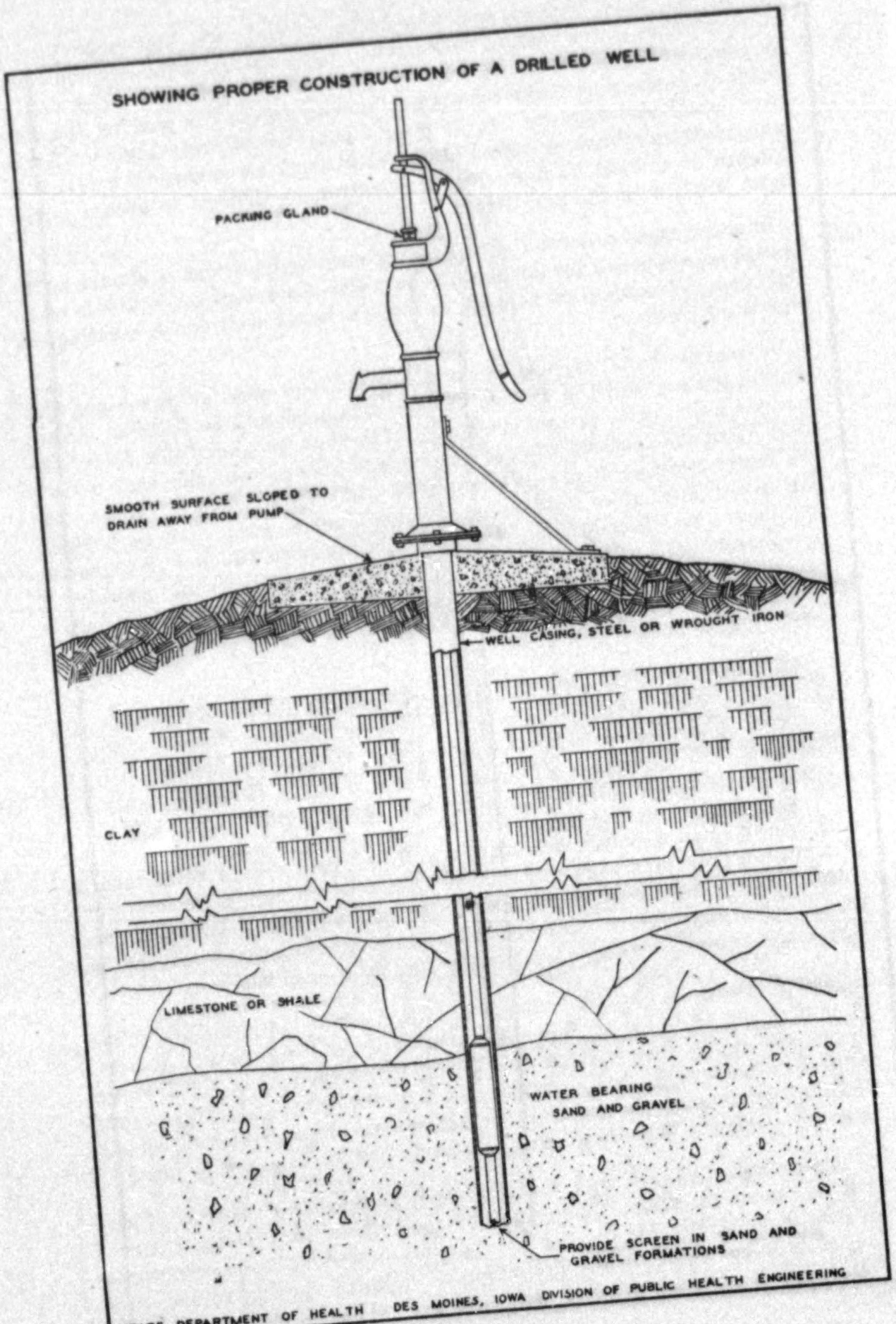

SHOWING PROPER CONSTRUCTION OF A DRILLED WELL
PACKING GLAND
SMOOTH SURFACE SLOPED TO DRAIN AWAY FROM PUMP
WELL CASING, STEEL OR WROUGHT IRON
CLAY
LIMESTONE OR SHALE
WATER BEARING SAND AND GRAVEL
PROVIDE SCREEN IN SAND AND GRAVEL FORMATIONS
STATE DEPARTMENT OF HEALTH DES MOINES, IOWA DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 8

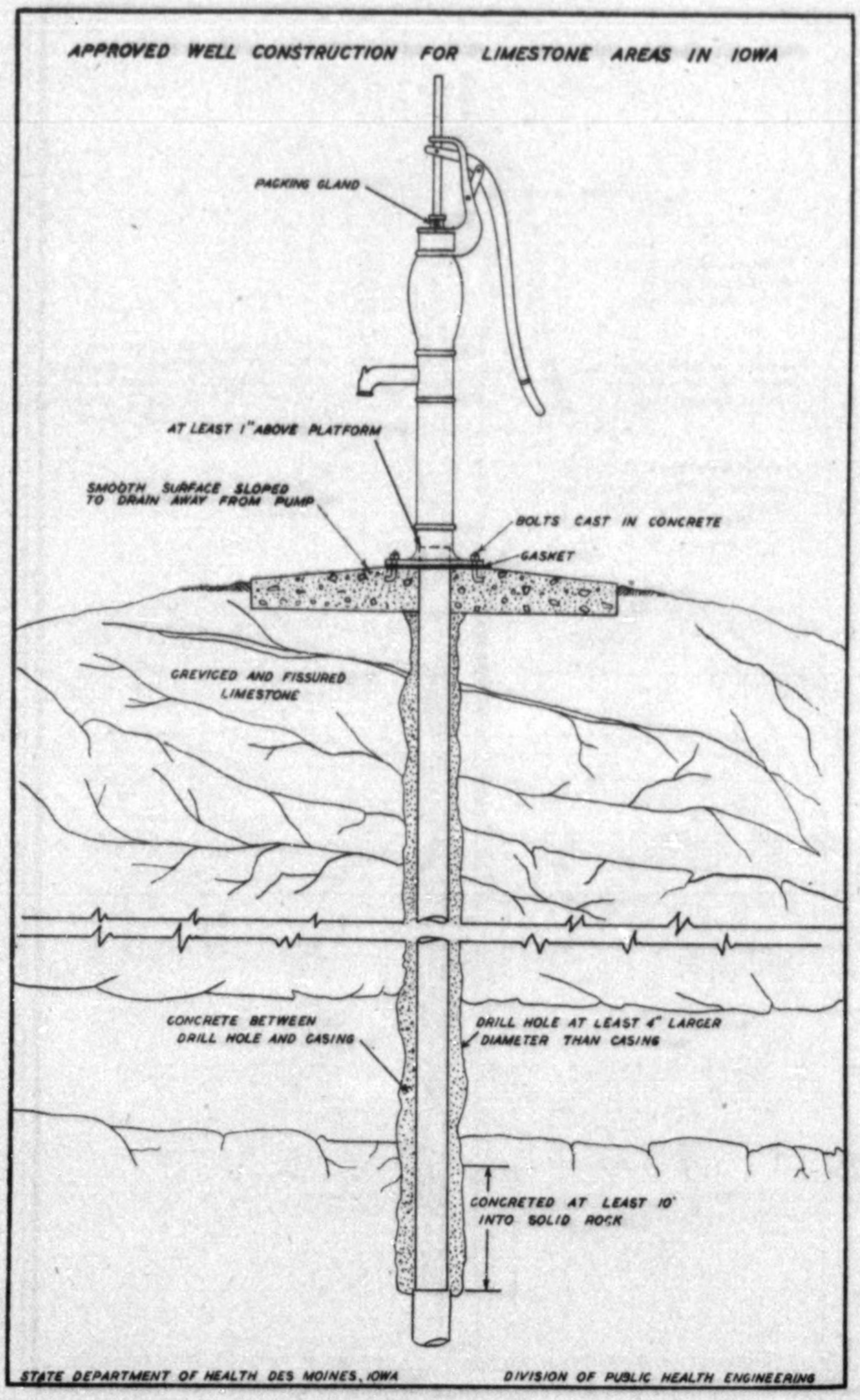

APPROVED WELL CONSTRUCTION FOR LIMESTONE AREAS IN IOWA
PACKING GLAND
AT LEAST 1" ABOVE PLATFORM
SMOOTH SURFACE SLOPED TO DRAIN AWAY FROM PUMP
BOLTS CAST IN CONCRETE
GASKET
CREVICED AND FISSURED LIMESTONE
CONCRETE BETWEEN DRILL HOLE AND CASING
DRILL HOLE AT LEAST 4" LARGER DIAMETER THAN CASING
CONCRETED AT LEAST 10' INTO SOLID ROCK
STATE DEPARTMENT OF HEALTH DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 9

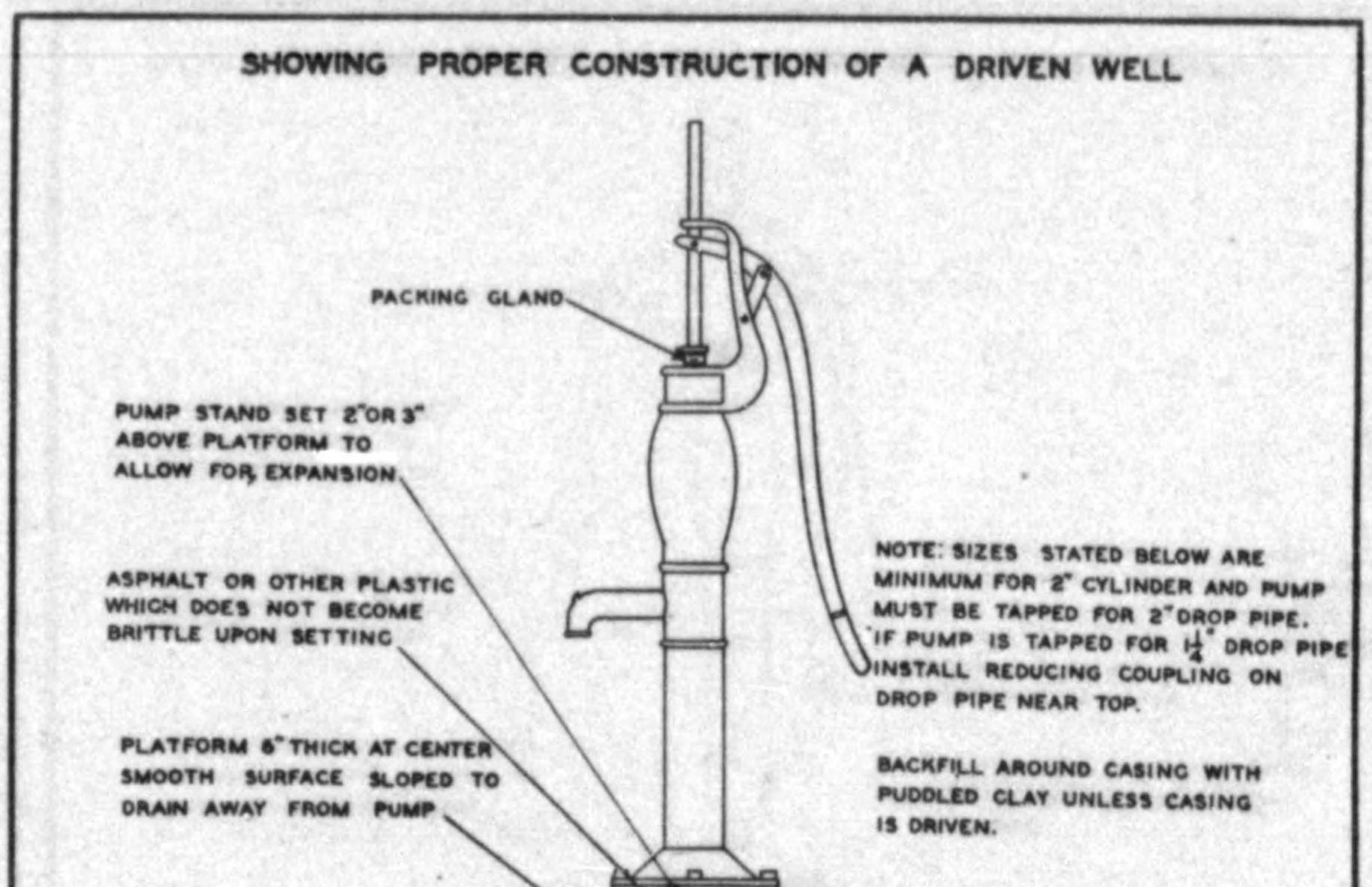
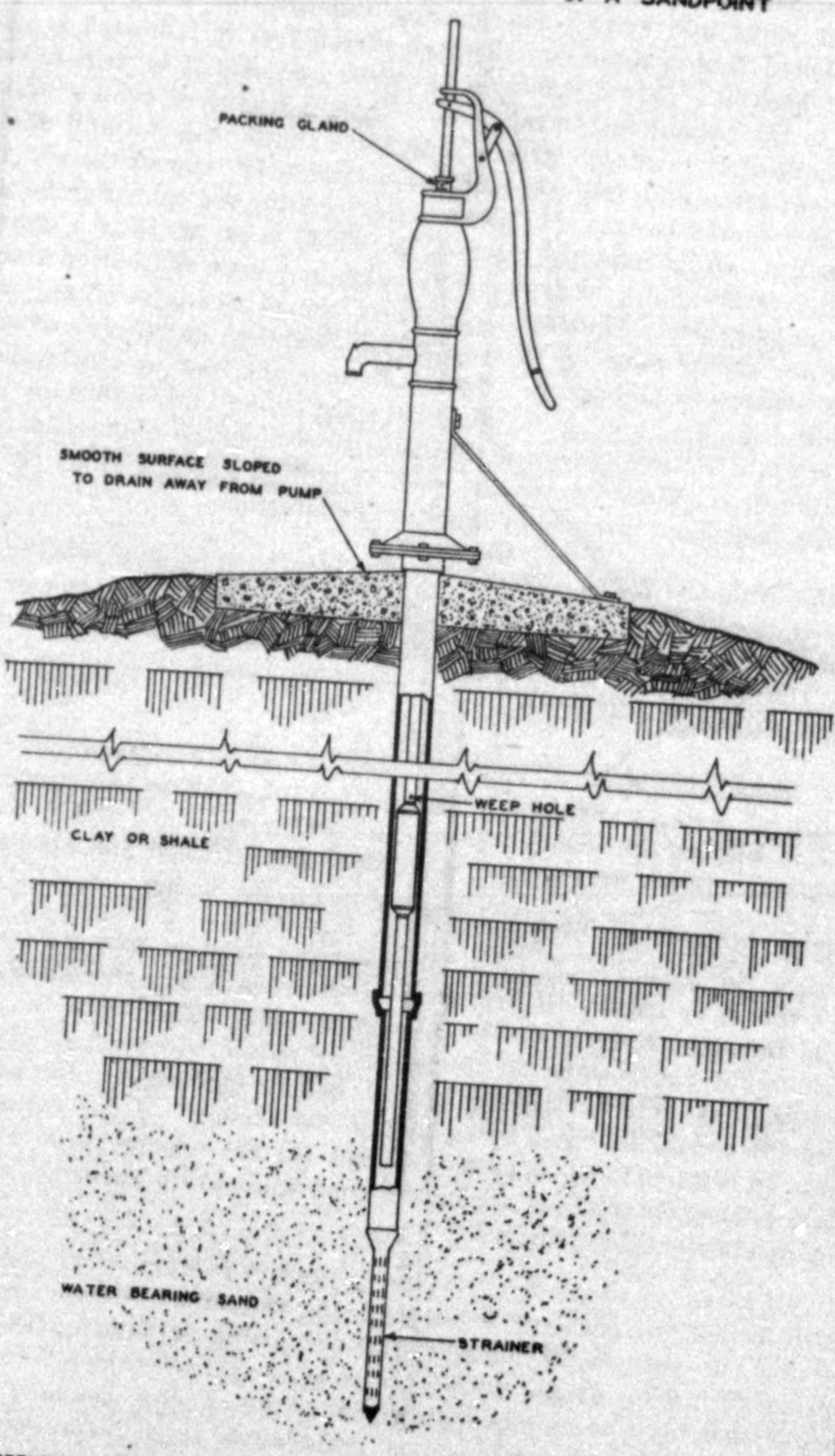

SHOWING PROPER CONSTRUCTION OF A DRIVEN WELL
PACKING GLAND
PUMP STAND SET 2" OR 3" ABOVE PLATFORM TO ALLOW FOR EXPANSION
ASPHALT OR OTHER PLASTIC WHICH DOES NOT BECOME BRITTLE UPON SETTING
PLATFORM 6" THICK AT CENTER SMOOTH SURFACE SLOPED TO DRAIN AWAY FROM PUMP
NOTE: SIZES STATED BELOW ARE MINIMUM FOR 2" CYLINDER AND PUMP MUST BE TAPPED FOR 2" DROP PIPE. IF PUMP IS TAPPED FOR 1½" DROP PIPE INSTALL REDUCING COUPLING ON DROP PIPE NEAR TOP.
BACKFILL AROUND CASING WITH PUDDLED CLAY UNLESS CASING IS DRIVEN.
3½" STD. WELL CASING DRIVEN OR SET IN BORED HOLE
2" GALVANIZED STEEL DROP PIPE
WEEP HOLE IN DROP PIPE
CLAY
MIN. 10'-0"
18"
OPEN TYPE "EUREKA" CYLINDER
WATER BEARING SAND
STRAINER
STATE DEPARTMENT OF HEALTH DES MOINES IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 10

SHOWING PROPER CONSTRUCTION OF A SANDPOINT



STATE DEPARTMENT OF HEALTH; DES MOINES, IOWA — DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 11

The accompanying plate includes a table indicating various diameter slabs required for different diameter wells. Also, included are thicknesses of slabs and reinforcing spacing required for construction. It will be noted that a minimum distance of ten feet is indicated for the depth of backfill. This distance is not fixed and should be variable according to the formations encountered. That is, if clay or similar impervious material is available within reasonable limits, this backfill should be carried down and into the impervious material approximately two feet. Care should be taken in placing the backfill, and tamping the material well so as to minimize settling in which event there is a definite possibility of breaking the well casing extending from the buried slab to the pump platform. Under no conditions should tile pipe of any kind be used for casing between the two slabs. Seamless metal pipe of some kind is absolutely necessary. Cast iron, wrought iron or steel pipe is recommended. The pipe is fastened securely in the buried slab, as indicated in Plate 7. In the case of threaded steel pipe, the nipple should be set in the slab. However, in the case of bell and spigot joints in cast iron pipe, lead joints properly poured are satisfactory.

Double Tubular Wells. *Plates 8, 9, 10, and 11.* A double tubular well is one equipped with both a casing and a drop pipe. This type of well should be cased with threaded joint iron or steel pipe except where it passes through solid rock, in which there is no danger of caving or inflow of mud, silt, or sand.

The casing should be of sufficient size to allow the production of the quantity of water required. This is important, because the capacity of the well will be limited by the amount of water which the casing or screen section will pass with a reasonable loss of head and also by the size of the well cylinder which can be placed in the casing.

Where the casing ends in a water-bearing sand or gravel formation and a screen or strainer is used, the joints between the screen and casing should be made tight in order to prevent sand flowing into the casing which might cause wear on the pump or reduce the yield of the well. Further, the joints at the top of the cylinder and screen for a driven sandpoint should be such as to permit the removal of the cylinder, as shown on Plate 11. The outside casing for the sandpoint on Plate 11 should also extend into a formation that will absorb seepage from the weep hole above the cylinder.

In all cases, steps should be taken to prevent contaminated water from upper formations passing downward along the outside of the casing and entering the well at the lower end of the casing or entering the water-bearing formation which is to be used as a source of supply. A satisfactory seal may be obtained by grouting the opening between the casing and the drill hole with cement grout or in some instances puddled clay. Sealing the opening between the drill hole and the casing into an impervious stratum should be practiced in all the limestone areas in Iowa. Plate 9 shows proper well construction for limestone areas.

Pits are undesirable and unnecessary for double tubular wells and consequently should not be used. Plate 12 shows the detail of an underground discharge which may be used to prevent freezing and also eliminates the necessity of a well pit. This underground discharge attachment may be used to eliminate existing pits as well as in the development of new supplies.

Sandpoint Wells. *Plates 10 and 11.* Sandpoint wells are used advantageously in a number of areas throughout Iowa. A satisfactory water supply may be obtained from a sandpoint well if general sanitary standards are observed, including location and construction standards previously set forth for other types of wells. Plates 10 and 11 showing proper sandpoint construction indicate two types of sandpoints, including items of construction for sanitary protection. Ordinarily a sandpoint should never be developed as a drinking water supply at a depth less than 15 feet because of intermittent contamination of ground waters at shallower depths.

Double tubular sandpoint wells as shown on Plates 10 and 11 are preferred over single tubular wells. Further, the well platform and pump setting should conform to the standards set forth within this manual.

CISTERNS

Cisterns or underground reservoirs for the storage of rain water are considered unsatisfactory as a source of a drinking water supply. Rain water as drained from the roof is usually highly colored, has a flat taste and contains excessive quantities of dirt, soot, bird-droppings, and other foreign materials. Furthermore, the water generally contains objectionable bacteria and may include pathogenic or disease-producing organisms. The use of cistern water is therefore not recommended, but where other supplies are not available, the quality of cistern water may be improved by proper construction and treatment. Where a ground water supply positively cannot be obtained and a cistern water must be used, the State Department of Health should be consulted on the proper construction, maintenance and treatment of such a supply.

TYPE OF HAND PUMP

The pumping equipment for hand pumped wells should be constructed and installed in such a manner that the entrance of contaminated water or contaminating material into the well or water chambers of the pump will be prevented. Hand pumps should be of the lift type with cylinders placed below the water level so that priming will be unnecessary. Chain and bucket pumps are not satisfactory.

The pump case should be of the solid one-piece recessed type, cast integral with or threaded to the pump column or stand. Two-piece (split) open-work and adjustable bases are unsatisfactory. It should be of sufficient diameter and depth to permit at least a six-inch well casing, or pipe sleeve used in the top of a dug well, to extend at least one inch above the concrete shoulder on which the pump base will rest. Provisions should be made for fastening the pump base rigidly and watertight to the well platform or casing. This may be accomplished

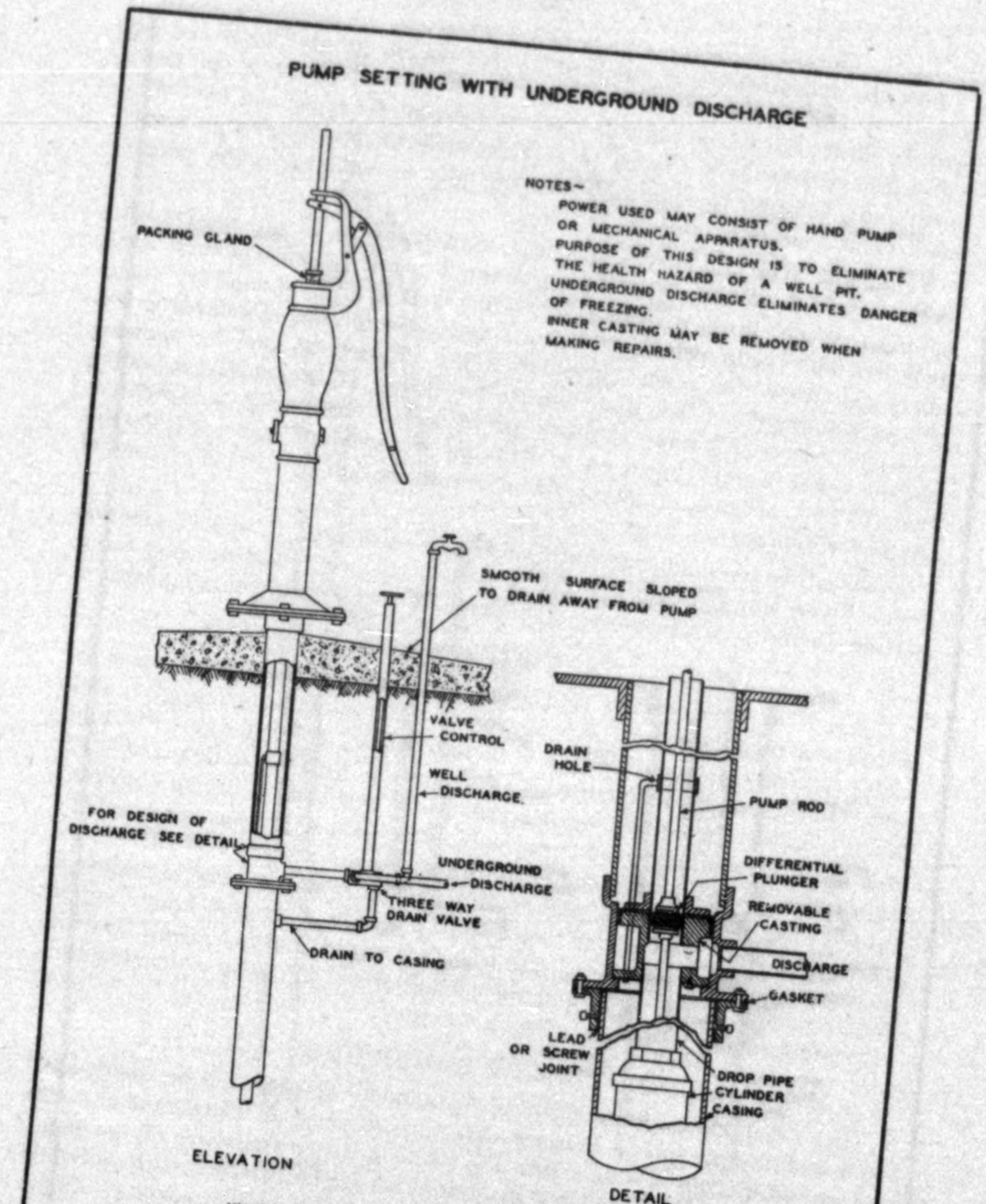

PUMP SETTING WITH UNDERGROUND DISCHARGE
NOTES—
POWER USED MAY CONSIST OF HAND PUMP OR MECHANICAL APPARATUS.
PURPOSE OF THIS DESIGN IS TO ELIMINATE THE HEALTH HAZARD OF A WELL PIT.
UNDERGROUND DISCHARGE ELIMINATES DANGER OF FREEZING.
INNER CASTING MAY BE REMOVED WHEN MAKING REPAIRS.
PACKING GLAND
SMOOTH SURFACE SLOPED TO DRAIN AWAY FROM PUMP
VALVE CONTROL
WELL DISCHARGE
FOR DESIGN OF DISCHARGE SEE DETAIL
UNDERGROUND DISCHARGE
THREE WAY DRAIN VALVE
DRAIN TO CASING
ELEVATION
DRAIN HOLE
PUMP ROD
DIFFERENTIAL PLUNGER
REMOVABLE CASTING
DISCHARGE
GASKET
LEAD OR SCREW JOINT
DROP PIPE
CYLINDER
CASING
DETAIL
VALVE CONTROL
WELL DISCHARGE
UNDERGROUND DISCHARGE
DRAIN
VALVE CONNECTION
STATE DEPARTMENT OF HEALTH; DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 12

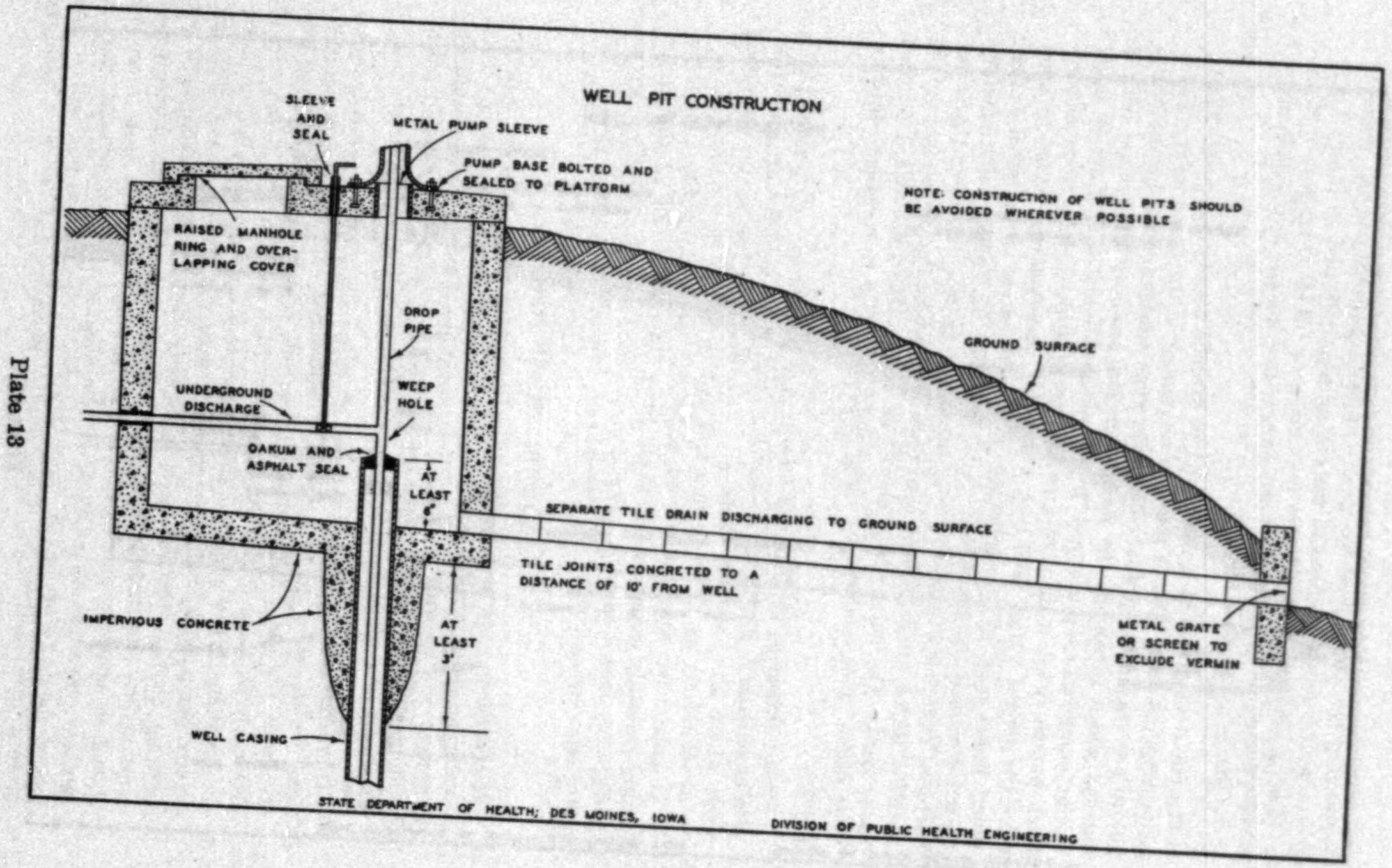

WELL PIT CONSTRUCTION
SLEEVE AND SEAL
METAL PUMP SLEEVE
PUMP BASE BOLTED AND SEALED TO PLATFORM
NOTE: CONSTRUCTION OF WELL PITS SHOULD BE AVOIDED WHEREVER POSSIBLE
RAISED MANHOLE RING AND OVER-LAPPING COVER
DROP PIPE
GROUND SURFACE
UNDERGROUND DISCHARGE
WEEP HOLE
OAKUM AND ASPHALT SEAL
AT LEAST 6"
SEPARATE TILE DRAIN DISCHARGING TO GROUND SURFACE
TILE JOINTS CONCRETED TO A DISTANCE OF 10' FROM WELL
IMPERVIOUS CONCRETE
AT LEAST 3'
METAL GRATE OR SCREEN TO EXCLUDE VERMIN
WELL CASING
STATE DEPARTMENT OF HEALTH; DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 13

by securing the pump base by means of bolts imbedded in the concrete or by use of a flange secured to the casing top, indicated on Plates 1 and 2. Roofing cement, other plastic materials, or other suitable watertight gaskets should be used between the pump base and the concrete shoulder or the flange as the case may be.

The pump head should be designed to exclude contamination by hands, bird-droppings, flies, etc., of the water chamber in the pump head. Force pumps are reasonably protected against such contamination by the stuffing box which surrounds the pump rod, but ordinary lift pumps with a slotted pump head top are open to contamination and should not be used. Such pumps fitted with sliding, overlapping sleeves, or a hood casting over the slotted pump head top, are fairly satisfactory. Existing open pump heads may be protected to a limited extent with metal covers fastened around the pump rod. It is believed that many unsatisfactory bacterial results are caused by bird-droppings gaining access to the water chamber in the pump head due to improper protection of the slot in the pump head. The pump spout should be of the closed downward directed type rather than of the open type commonly used in so-called "pitcher-pumps."

Pumps should be so designed as to make the use of well pits or pump pits unnecessary. Pits from a sanitary standpoint are discouraged. However, where pits exist or where pits are necessary for winter operation to accommodate an existing pump, Plate 13 should be rigidly followed. It is imperative that the pit be absolutely watertight, the top of the casing carefully sealed, and a drain provided terminating at the ground surface for free discharge. *The pit drain shall never be connected into any other sewer or drain tile.* Pits should be avoided whenever possible.

MOTOR DRIVEN PUMPS

Motor driven pumps are desirable for school water supplies whereby a water pressure system may be provided within the schoolhouse. Such a system will provide a convenient drinking water supply within the building and also be available for limited fire protection as well as development of a water-carried sewage system.

There are several different types of motor driven well pump installations which meet present sanitary standards. In all cases sanitary standards for the construction of the well proper must be followed as previously outlined within this manual. Plates 14, 15, 16, 17, 18, and 19 show various types of motor driven pump installations, including motor driven pump with underground discharge, well pump house, well pit adjacent to basement, well in basement, motor driven pump well pit construction, and shallow well with remotely located pump. These types should be carefully studied before purchasing a pump so as to meet the sanitary standards as outlined. In the case of an existing well, the selection should be predicated upon the type of installation that will fit into present construction or, if necessary, reconstructed to meet sanitary standards.

The most desirable motor driven pump installations are those shown on Plates 14 and 15. Such installations incorporate all the desired sanitary protection with the minimum possibility of contamination gaining access to the well. Further, the pump and well are readily accessible for repair and maintenance. A small pump house, if carefully insulated, may be adequately heated with an oil lantern, small oil burner or small electric heater to prevent freezing. For reasons of sanitary protection and accessibility of operation and maintenance of both well and pump, every effort should be made to make installations as shown on Plates 14 or 15.

The next desirable motor driven pump installation is that shown on Plate 16 with the pump pit adjacent to the schoolhouse. This type of installation provides accessibility for operation and maintenance of the well and pump although the pit type of construction is not considered comparable sanitary protection with that shown on Plates 14 and 15 without well pits. Experience has proven that a well pit always constitutes some sanitary hazard where flooding may occur.

Plate 17, showing the well and pump in the basement, is less desirable construction than Plate 16 due to inaccessibility for well repair. Most basements do not have sufficient head-room for pulling a pump or repairing the well.

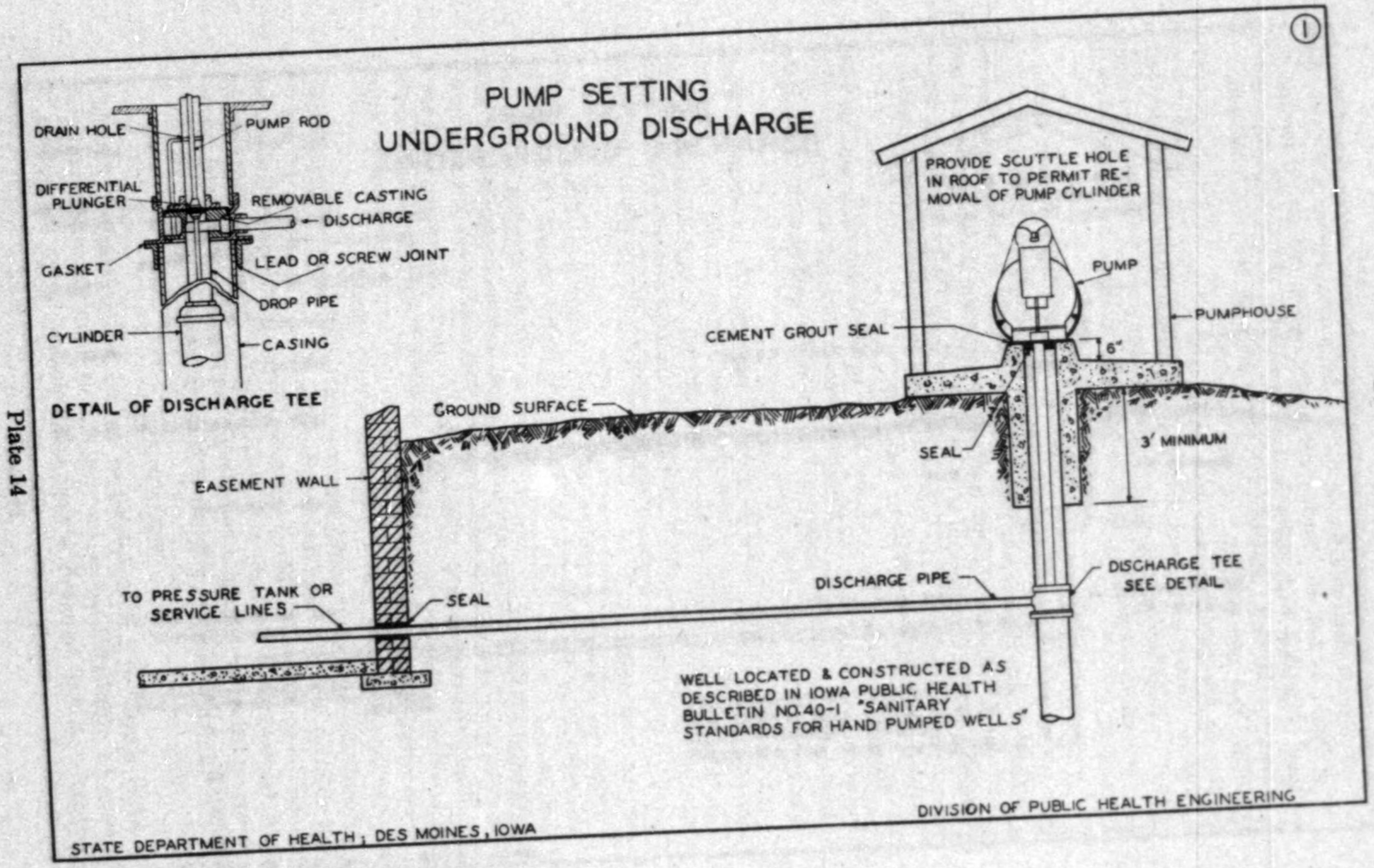
A well pit remote from the schoolhouse as shown on Plate 18 is less desirable than the construction shown on Plates 14 and 15. This well pit depends upon a drain line to keep the pit from flooding which may become clogged thereby jeopardizing the sanitary protection of the water supply. The well and pump, however, are readily accessible for maintenance and repair.

Plate 19, showing a shallow well with remotely located pump is less desirable than the installations shown on Plates 14 and 15 due to the possibility of the suction line developing a leak and drawing in contaminated water. Because the pipe line is under suction it should be at least 10 feet below the ground surface out of the range of shallow subsurface contamination or encased with an annular ring of concrete at least 6 inches thick. Plate 19 shows the well and pump are accessible for maintenance and repair, however, the underground suction line must be given particular consideration as a potential sanitary hazard.

In all cases of new motor driven pump installations or major repair on existing installations, the construction shown on Plates 14 and 15 should be followed. If this is not practicable under local conditions, select from Plates 16, 17, 18, and 19 the type of installation that may be incorporated after carefully considering sanitary protection and accessibility for maintenance and repair of both well and pump.

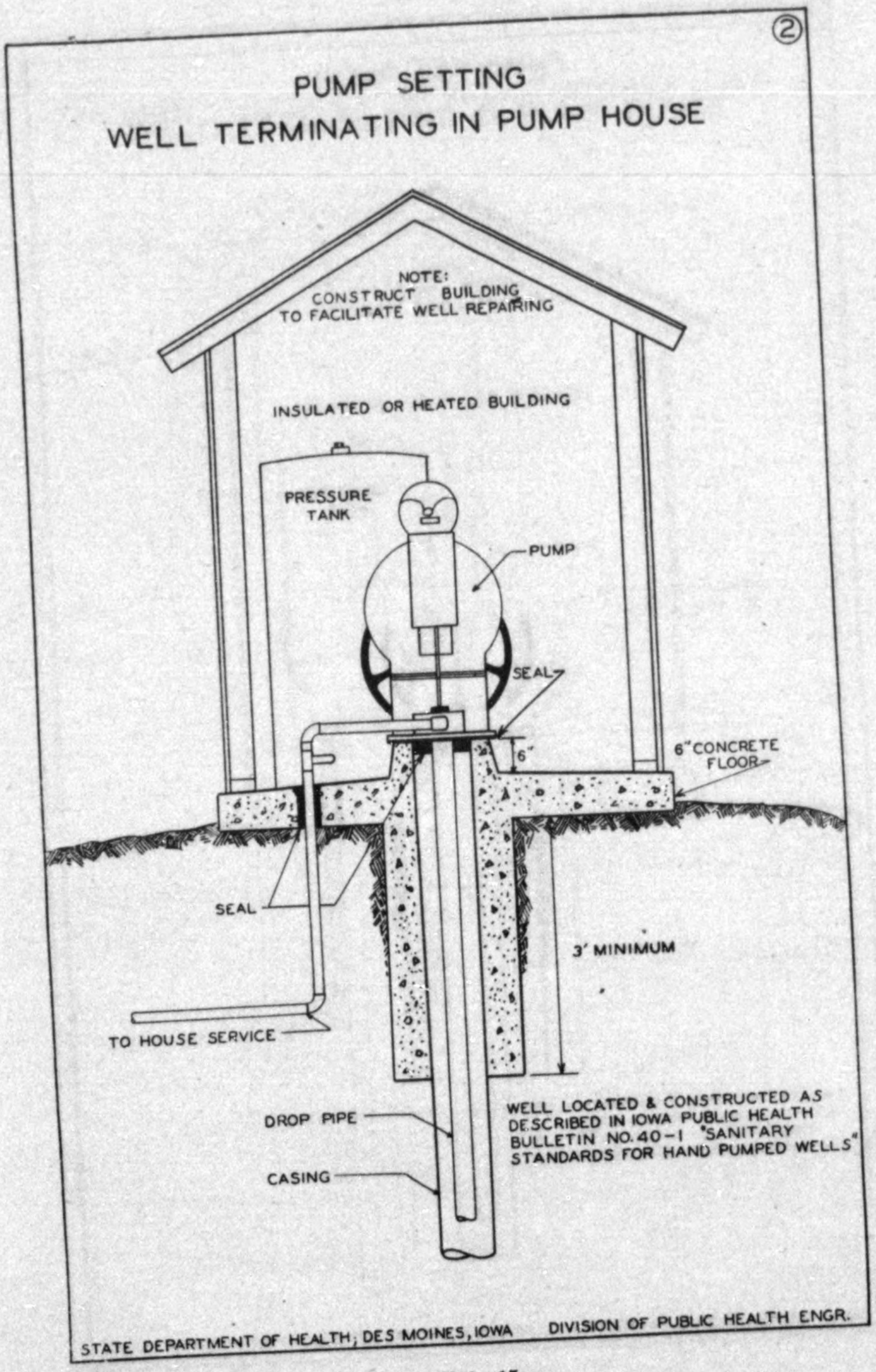
DISINFECTION

After a new well is completed or an old well is repaired, it should always be disinfected before the water is used for drinking or culinary purposes. A well is nearly always contaminated during the process of construction or repair from tools, casing, surface contamination, new



PUMP SETTING
UNDERGROUND DISCHARGE
DRAIN HOLE
PUMP ROD
DIFFERENTIAL PLUNGER
REMOVABLE CASTING
DISCHARGE
GASKET
LEAD OR SCREW JOINT
DROP PIPE
CYLINDER
CASING
DETAIL OF DISCHARGE TEE
PROVIDE SCUTTLE HOLE IN ROOF TO PERMIT REMOVAL OF PUMP CYLINDER
PUMP
PUMPHOUSE
CEMENT GROUT SEAL
6"
GROUND SURFACE
SEAL
3' MINIMUM
EASEMENT WALL
DISCHARGE PIPE
DISCHARGE TEE SEE DETAIL
TO PRESSURE TANK OR SERVICE LINES
SEAL
WELL LOCATED & CONSTRUCTED AS DESCRIBED IN IOWA PUBLIC HEALTH BULLETIN NO.40-1 "SANITARY STANDARDS FOR HAND PUMPED WELLS"
STATE DEPARTMENT OF HEALTH; DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 14



②
PUMP SETTING
WELL TERMINATING IN PUMP HOUSE
NOTE:
CONSTRUCT BUILDING
TO FACILITATE WELL REPAIRING
INSULATED OR HEATED BUILDING
PRESSURE
TANK
PUMP
SEAL
6"
6" CONCRETE
FLOOR
SEAL
3' MINIMUM
TO HOUSE SERVICE
WELL LOCATED & CONSTRUCTED AS
DESCRIBED IN IOWA PUBLIC HEALTH
BULLETIN NO. 40-1 "SANITARY
STANDARDS FOR HAND PUMPED WELLS"
DROP PIPE
CASING
STATE DEPARTMENT OF HEALTH, DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGR.

Plate 15

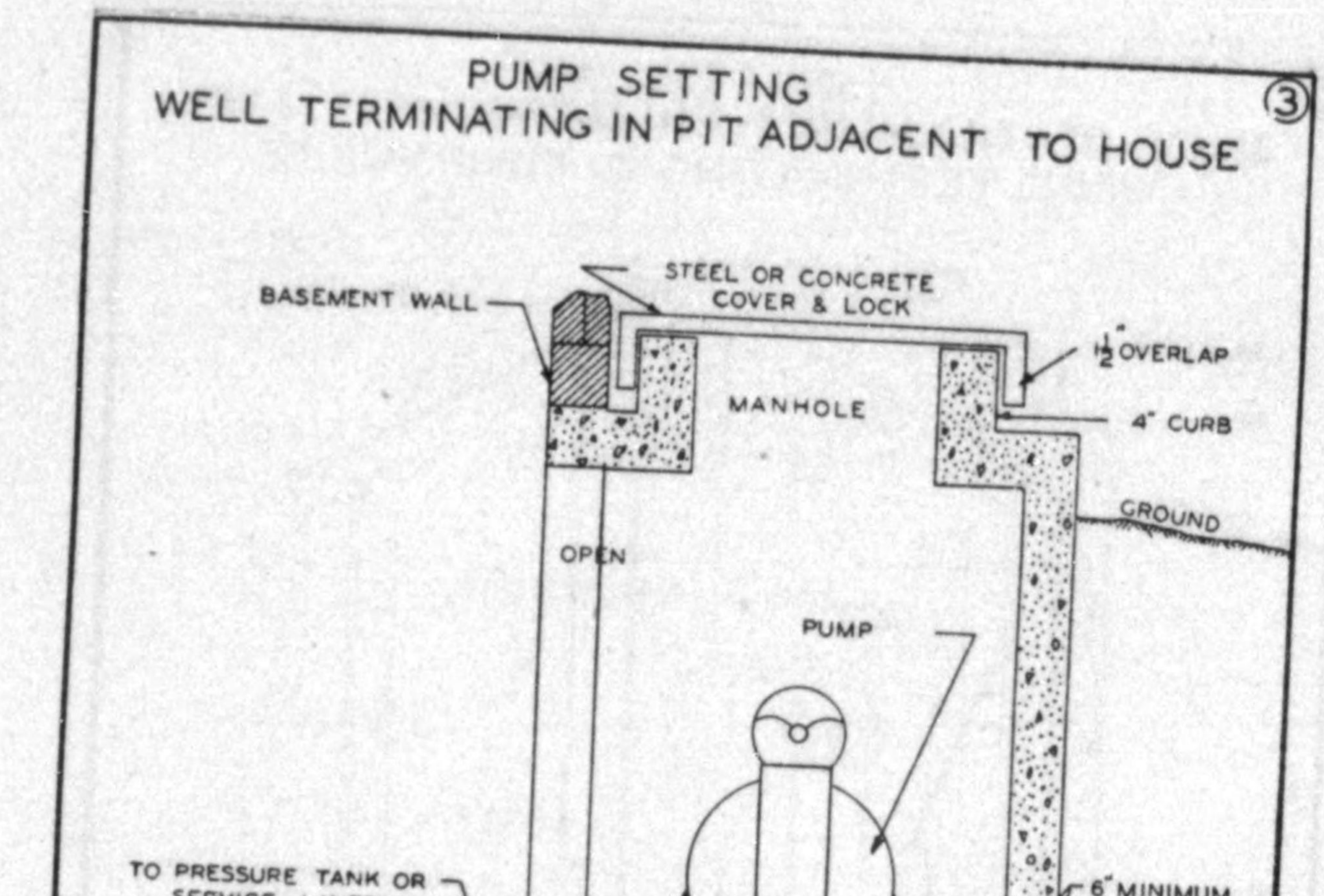

PUMP SETTING
WELL TERMINATING IN PIT ADJACENT TO HOUSE
3
BASEMENT WALL
STEEL OR CONCRETE COVER & LOCK
1½" OVERLAP
MANHOLE
4" CURB
GROUND
OPEN
PUMP
TO PRESSURE TANK OR SERVICE LINES
6" MINIMUM
FLOOR SLOPE TOWARD BASEMENT
6"
12" MIN.
FLOOR DRAIN
3' MINIMUM
SOIL PIPE
SEAL
DROP PIPE
NOT LESS THAN 10'
CASING
WELL CONSTRUCTION AS DESCRIBED IN IOWA PUBLIC HEALTH BULLETIN NO 40-1 "SANITARY STANDARDS FOR HAND PUMPED WELLS"
STATE DEPARTMENT OF HEALTH, DES MOINES, IOWA
DIVISION OF PUBLIC HEALTH ENGINEERING

Plate 16

DECLASSIFIED E.O. 12065 SECTION 3-402/NNDG NO. 775013

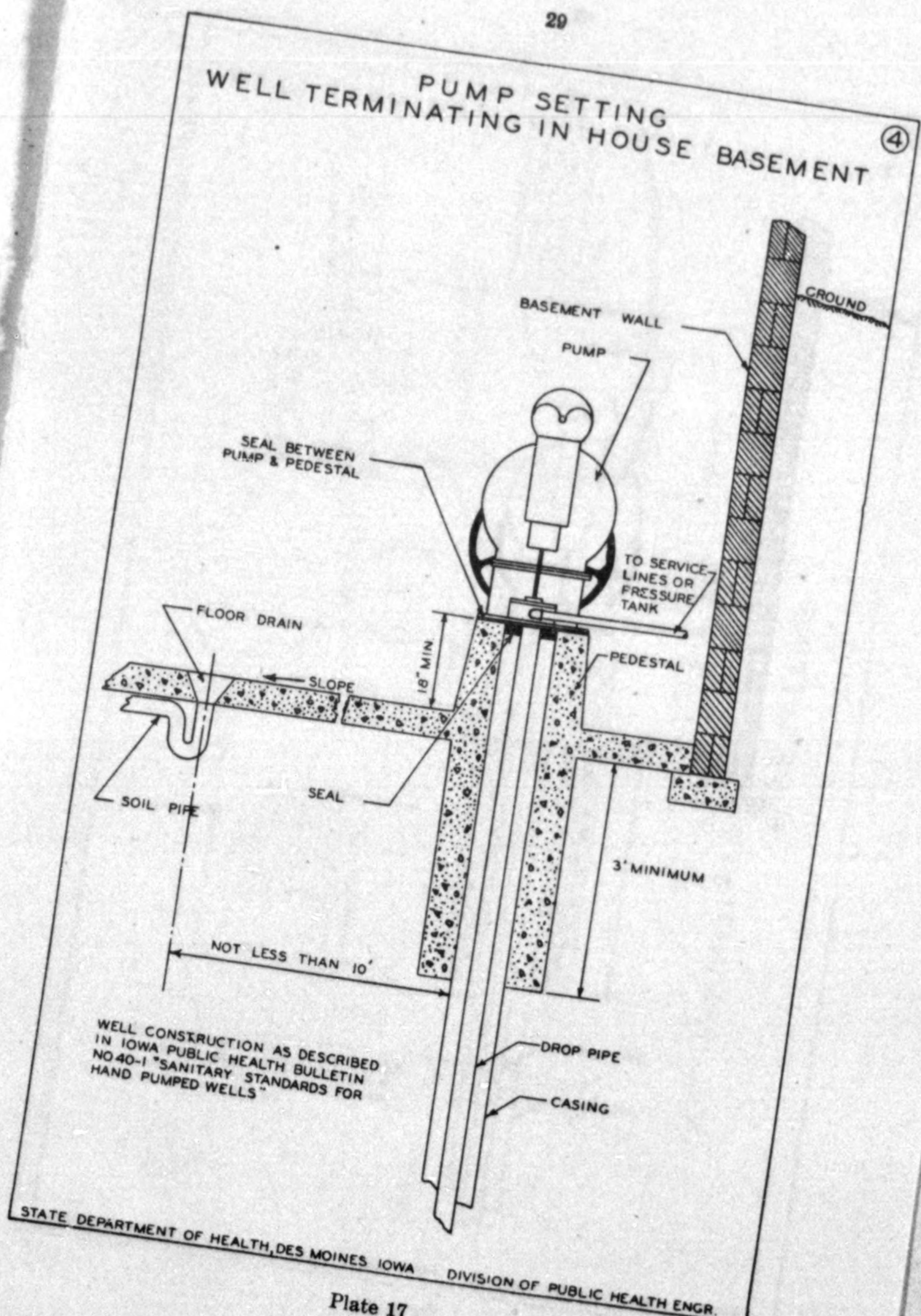
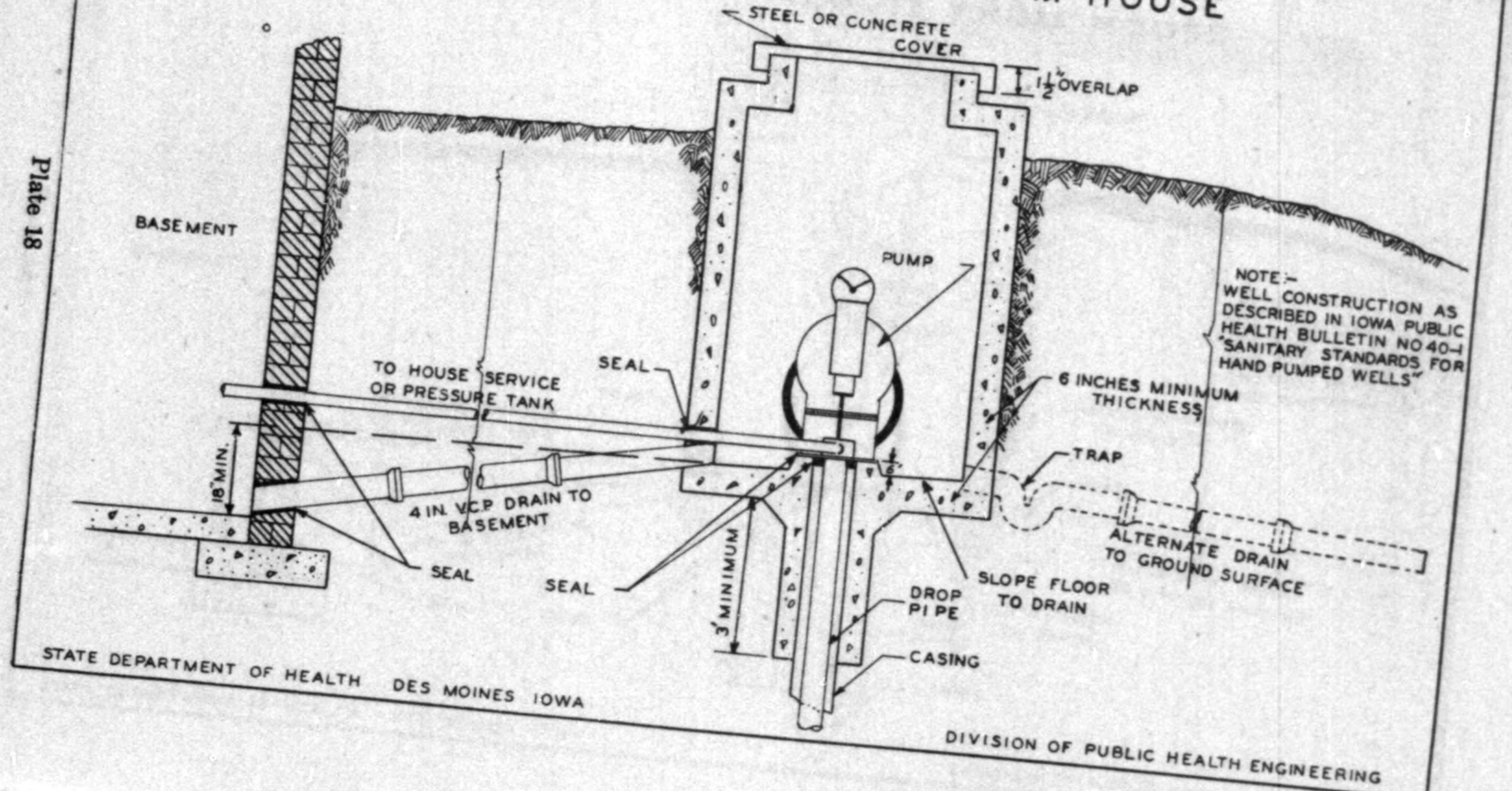
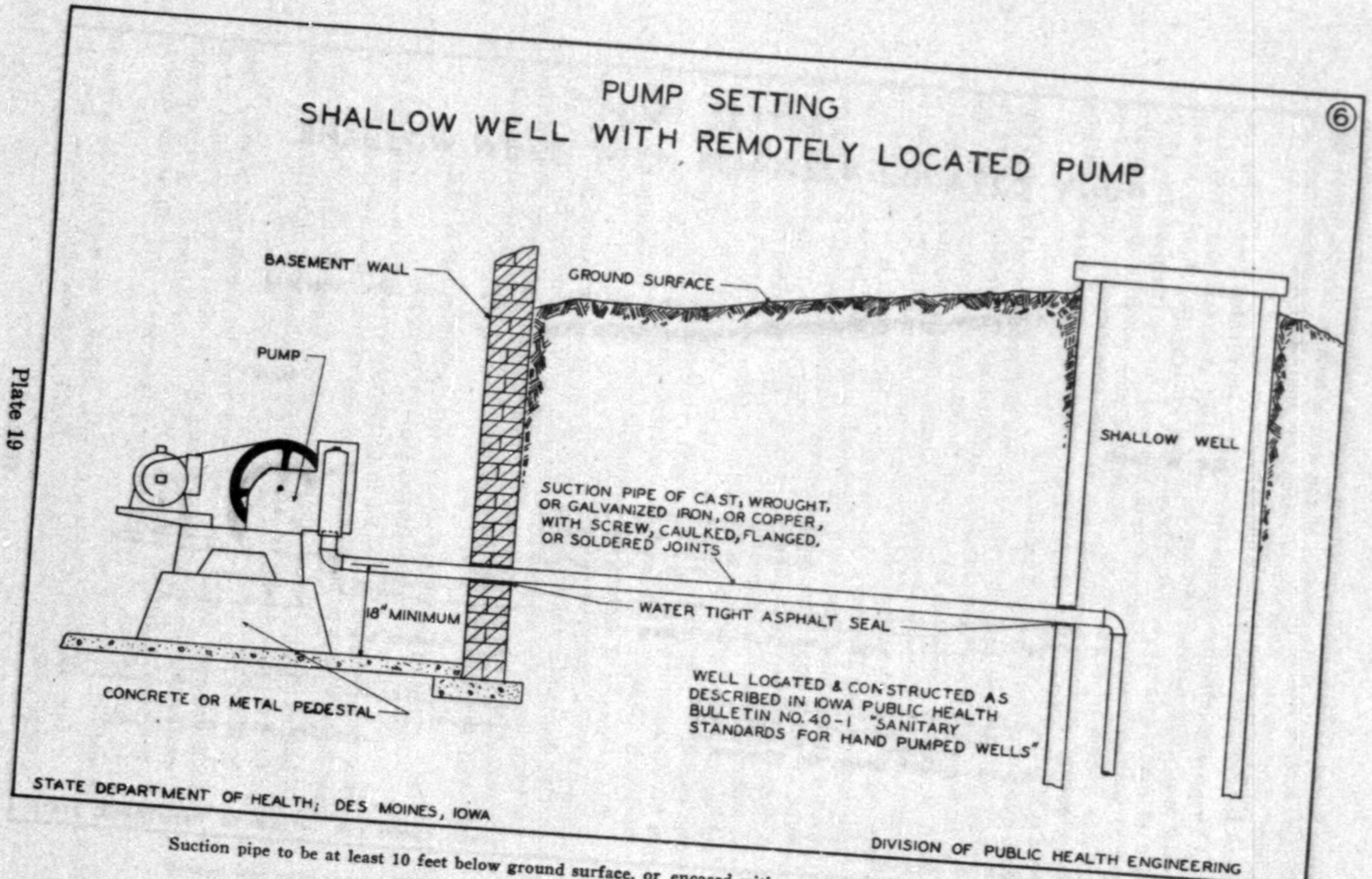


Plate 17

Plate 18

PUMP SETTING
WELL TERMINATING IN PIT REMOTE FROM HOUSE





Suction pipe to be at least 10 feet below ground surface, or encased with annular ring of concrete at least 6 inches thick leathers, etc. This contamination may contain pathogenic or disease-producing bacteria, and disinfection of the well is advised for the protection of the water users. Subsequent laboratory analyses should be made to check the bacterial character of the supply.

A cheap and effective disinfecting agent is chlorinated lime. This material is a white powder and can be purchased at almost any drug store and at many grocery stores. The amount of available chlorine present varies with different manufacturers and also for the purpose for which it was intended. However, the chlorinated lime found in drug and grocery stores, in most instances, has an available chlorine content of 25 per cent—that is, in each pound of the chlorinated lime there is actually one quarter of one pound of chlorine.

For the ordinary hand pumped well, one half pound of chlorinated lime with 25 per cent available chlorine is sufficient for disinfection. Before the well is treated it should be pumped thoroughly to remove all dirt and other material. This is important to obtain effective disinfection. For a dug well, the chlorinated lime powder may be applied direct—that is, just dumped into the well. In case of a tubular well, it is necessary to mix the chlorinated lime with water and pour into the well. One-half pound of chlorinated lime may be mixed with approximately five gallons of water. Further, it is suggested that at least 10 or 15 gallons of water be added to the well after the chlorine solution is added so as to assure mixing of the solution in the well, and to force the water column down in the casing for thorough disinfection. Also, the well should be pumped to fill the cylinder and drop pipe with chlorinated water. After a well is treated it should be allowed to stand approximately 12 hours.

The adequacy of disinfection should be checked by subsequent bacterial examination. Samples of water should not be submitted for analysis for several days after the well has been disinfected and thoroughly pumped. Chlorine is likely to persist in small quantities for several days after treatment, and unless all of the chlorinated water has been pumped from the well, the analysis will not represent the true bacteriological character.

TREATMENT OF SMALL QUANTITIES OF WATER FOR DRINKING PURPOSES

If a water supply is known to be bacterially unsafe for drinking, but must be used, it can be made safe by one of the following methods:

1. Boiling is the safest and best method. Water that has been *boiled for full two minutes* is safe. Boiling produces no objectionable taste and odor.

2. Chlorinated lime. This material may be purchased in most drug stores and grocery stores in one pound cans with a strength of 25 per cent available chlorine. Add 3 level teaspoons of the powder to one gallon of water, stirring thoroughly and allow the lime to settle.

   One teaspoon of this solution is sufficient to sterilize one gallon of clear water. The solution should be thoroughly mixed with the clear water and allowed to stand at least 30 minutes before drinking. If the water is not clear, the amount of solution should be increased to two teaspoons. A sufficient dosage to produce a perceptible chlorine taste is encouraged.

This solution deteriorates in the presence of air and sunlight, and should be kept in a tightly stoppered colored bottle in a dark place. Fresh solutions should be made up at least every week or ten days.

Sodium hypochlorite can be used instead of chlorinated lime. There are on the market prepared solutions of varying chlorine content and also tablets containing sodium hypochlorite. One teaspoon of a one per cent solution of chlorine is sufficient to sterilize 15 gallons of clear water. If the water is not clear, two teaspoons for each 15 gallons should be used.

BACTERIOLOGICAL EXAMINATION OF WATER

Unfortunately, there is no practicable laboratory method of examining water for the presence of actual disease-producing bacteria. A relatively simple and reliable laboratory method of determining the presence of so-called coliform organisms is known. The normal habitat of these bacteria is the intestinal tract of warm-blooded animals; hence, the presence of these bacteria in water indicates that the water is contaminated with human or animal intestinal discharges. Since such discharges may at any time contain actual disease-producing bacteria, water containing these coliform organisms is considered unsafe for human consumption.

Obviously, surface water and very shallow-lying water usually contains these bacteria, and if inspection of a well reveals possibility of access of such water, bacteriological examination of the water is a useless procedure as such examination will usually reveal presence of these objectionable organisms.

Before submitting a sample of water to a laboratory for examination, a careful inspection should be made to determine that there is no possibility of surface water entering the well at or near the top. If the well does not meet the sanitary standards set forth within this manual or there are obvious sources of pollution, a sample should not be collected. Rather, the well should be provided with adequate structural protection and disinfected before samples are collected. Even with good construction, there is always the possibility that shallow water-bearing veins have become contaminated, or that a casing has become perforated.

Containers for water samples may be obtained from the State Hygienic Laboratory, Water Division, Iowa City, Iowa. Samples must be collected in containers furnished by the laboratory if bacteriological examination is desired. Examinations will not be made of samples collected in other bottles.

DRINKING WATER DISPENSERS

Sanitary methods of dispensing water at a school are equally as important as adequate protection at the source of water supply. Sanitary dispensing of drinking water must be considered if full student health protection from contaminated drinking water is to be realized. Where pressure systems are available, sanitary slanting jet type drinking fountains or individual paper drinking cups should be used. The vertical jet bubbler fountains are insanitary and should not be used. Where drinking water is transported to the schoolhouse, sanitary containers and dispensers should be provided. Water should never be dipped from a container with drinking cups. The common drinking cup is prohibited.

Drinking Fountains

A properly constructed drinking fountain is a convenient and sanitary means of dispensing drinking water in schools with pressure systems. Such fountains should be conveniently located for accessibility and constructed so as not to constitute a health hazard. A drinking fountain that permits nose and mouth drippings to come in contact with the fountain water inflow pipe opening provides means for the spread of diseases and particularly those of the respiratory group including colds, influenza, scarlet fever, diphtheria, etc. The vertical jet bubbler type of drinking fountain, therefore, constitutes a health hazard and cannot be approved.

Approved drinking fountains are of the slanting jet type complying with the standards adopted by the America Public Health Association. These standards are set forth as follows:

1. The fountain should be constructed of impervious materials such as vitreous china, porcelain, enameled cast iron, other metals, or stoneware.
2. The jet of the fountains should issue from a nozzle of non-oxidizing, impervious material set at an angle from the vertical, and at an elevation above the edge of the bowl, so that the end of the nozzle will not be flooded in case a drain from the bowl of the fountain becomes clogged.
3. The end of the nozzle should be protected by non-oxidizing guards to prevent the mouth or nose of persons using the fountain from coming into contact with the nozzle.
4. The inclined jet of water issuing from the nozzle should not touch the guard, thereby causing spattering.
5. The bowl of the fountain should be so designed and proportioned as to be free from corners which would be difficult to clean or which would collect dirt.
6. The bowl should be so proportioned as to prevent unnecessary splashing at a point where the jet falls into the bowl. Self-cleansing anti-splash rims are recommended.
7. The drain from the fountain should be connected to a separate waste pipe.

8. The water supply pipe should be provided with an adjustable valve fitted with a loose key or an automatic valve permitting the regulation of the rate of flow of water to the fountain so that the valve manipulated by the users of the fountain will merely turn on or off.

9. The control valve should be operated preferably by knee or foot action to avoid possible hand contamination.

10. The height of the fountain at the drinking level should be such as to be most convenient to persons utilizing the fountain. The provision of several step-like elevations to the floor at fountains will permit children of various ages utilizing the fountain. Elevations may be difficult to provide, however, at fountains recessed in walls.

11. The rate of flow and the pressure should be such that the water will not splash over the bowl. It should be at a rate not less than one-half gallon per minute and at nozzle pressure not exceeding 5 pounds per square inch.

12. The waste opening and pipe should be of sufficient size to carry off the water promptly. The opening should be provided with a strainer.

Most of the existing bubbler type of fountains may be readily converted to the slanting jet type of drinking fountain. Usually such a conversion requires only minor changes and small expenditure.

Sanitary Water Containers and Dispensers

Water containers for transporting water to the schoolhouse should preferably be metal and provided with an overlapping cover. The containers should be cleaned and disinfected regularly. Cleaning may be accomplished with warm soapy water and disinfection with boiling water or with some chlorine compound as described in another part of this manual.

Dispensers should be of impervious material such as vitreous china, porcelain, enameled cast iron, glass, stoneware, or non-oxidizing metals. A suitable spigot or tap should be incorporated for withdrawing water together with a collection or drip pan for waste water. The dispenser should preferably be the inverted bottle type; however, the jar type is satisfactory if provided with an overlapping cover. *Open containers or pails are prohibited.*

Drinking Cups

Individual sanitary paper drinking cups are satisfactory. The paper cups should be of known sanitary quality and stored in a clean accessible place. *Common drinking cups of any type are prohibited.* Individual glasses or cups properly identified and which are carefully cleaned and disinfected regularly and stored in a sanitary place are reasonably satisfactory. However, without facilities for frequently cleaning and disinfecting, the use of individual cups is discouraged.

O. H. D. FORM NO. 575 NOVEMBER 27, 1944

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SEPTIC TANKS
AND
SUB-SURFACE TILE SYSTEMS

GREAT SEAL OF THE STATE OF OKLAHOMA 1907

BUREAU OF ENVIRONMENTAL SANITATION
OKLAHOMA STATE HEALTH DEPARTMENT
G. F. Mathews, M. D., Commissioner

SEPTIC TANKS AND SUB-SURFACE TILE SYSTEMS

With the continual increasing use of modern sanitary conveniences which depend upon running water for their operation has come the demand for a satisfactory and economical means for the disposal of the sewage that comes from the home and small institution. This sewage usually consists of wastes from toilets, bathroom and laundry, and the liquid wastes from the kitchen. Those so fortunately located as to be served by a public sewer system have this problem solved, but the rest must seek other means, and in most all cases the septic tank with subsequent treatment has been used for this purpose. The septic tank when properly designed, constructed and operated will in most instances prove very satisfactory, but the indiscriminate use of these tanks should be discouraged, unless each proposed installation is given the consideration needed to determine what effects its use will have on the sanitary quality of adjacent water supplies and how and where the partially treated and dangerous effluent can be disposed.

The septic tank receives sewage which is potentially dangerous and at its best can only remove approximately 75% of the solid matter. The effluent from the tank will still contain a large portion of dangerous material in solution or suspension, besides the bacteria present, and its ultimate disposal is a problem calling for a carefully considered decision.

RULES AND REGULATIONS:

The State Health Department has adopted the following rules for regulating the use of septic tanks and the necessary disposal systems:

(1) No privy, cesspool or reservoir, into which a privy, water closet, bath-tub, lavatory, sink or stable is drained, except it be water tight, shall be installed in water bearing strata which may be used for drinking or culinary purposes, nor in porous soil where seepage or percolating surface or ground water may carry the pollution or infection of the contents of such privy vault, cesspool or reservoir, into a well, spring, or any source of water which may be used as a public or domestic water supply.

(2) All water tight privy vaults, reservoirs, or cesspools named in section (1) shall be emptied and cleaned whenever filled. No disinfectant, lime, deodorant, or other chemicals should be used in the pit. A cup of kerosene may be used twice a month during summer months if necessary to prevent mosquito breeding or to reduce odors. The contents of privy vaults shall be removed and disposed of in remote and safe locations or by incineration.

(3) No privy vault, water closet, cesspool, sink, laundry or stable drain shall open into any street, alley, ditch or stream, nor into any drain except into the public sewers of the city or into disposal systems equipped with filters of adequate capacity.

Factory, creamery, and other industrial wastes or drainage shall not be discharged into any street, alley, ditch or stream. Adequate treatment shall be provided for all such wastes.

(4) The discharge of the drainage from water closets, bathtubs, lavatories and the effluent from any type of disposal plant into abandoned wells or to water bearing strata or into creviced strata reaching water bearing strata which may be used for domestic or public water supply, is prohibited.

SEPTIC TANK

The purpose of the septic tank is to retain as much of the suspended solids as will settle out in a reasonable length of time, then the decomposition of these solids by biological action. The solid material that settles in the bottom of the tank after a period of time undergoes a process of decomposition that tends to stabilize the sludge. The tank must be large enough to prevent sudden surges through the tank from disturbing the settling action of the solids. The tank must also be large enough to provide adequate sludge storage. As shown on Figure A the smallest tank recommended should have a capacity of 500 gallons. If more than 20 persons are to be served, the septic tank should be designed according to Figure B. These larger tanks require the use of a dosing tank and automatic siphon. Waste containing large amounts of grease cannot be discharged into a septic tank without causing many difficulties. A grease trap is not necessary for the average size dwelling. Whenever a grease trap is necessary it should be installed in the line receiving the grease and so placed that discharges from toilets will not enter the trap.

LOCATION:

The septic tank should be located so the natural drainage is toward the septic tank and away from well or water supply. If possible, it should be located at least 100 feet from the water supply.

CONSTRUCTION FEATURES·

The sewer line from the house to the septic tank should be constructed of bell and spigot joint tile not less than 6" in diameter with water tight joints, and having a fall of not less than one foot in 100 feet. The line from the septic tank to the tile disposal field should be constructed of bell and spigot joint tile not less than 6" in diameter with water tight joints. If cement joints are to be used a length of hemp or jute equal to the circumference of the pipe should be dipped in cement grout and caulked into the joints and the rest of the joint filled with cement mortar. Make all the concrete used in these tanks water tight using a mixture of 1 part cement, 2 parts sand and 4 parts crushed rock or gravel. Care should be exercised in the amount of water used in the concrete. Only enough water should be added to make the concrete spade well and no more water should be added. After the concrete is placed in the forms it should be well tamped so as to eliminate the voids and to secure a dense water tight concrete.

DOSING TANK AND AUTOMATIC SIPHON

If more than 20 persons are to be served by the septic tank a dosing tank and automatic siphon are necessary. The purpose of this tank and siphon is to insure distribution of the septic tank effluent throughout the entire disposal field. The dosing tank receives the septic tank effluent and when the tank fills to a predetermined level the siphon automatically discharges the entire content of the dosing tank into the tile field. The tank then begins to fill again and the process is repeated. After determining the length of tile necessary the dosing tank should be designed to equal 50% of the cubical content of the tile in the disposal field into which the septic tank effluent is to be discharged. The size of siphon needed is shown in Figure B.

DISPOSAL OF THE SEPTIC TANK EFFLUENT

Effluent from the septic tank contains suspended and dissolved solids that will not settle in the septic tank, as well as large numbers of bacteria. It is necessary to give this sewage additional treatment and the two methods that are most often used are the sub-surface absorption and the sub-surface filtration methods. With the absorption method the earth is depended upon to absorb all of the tank effluent that is discharged into the tile field. With the filtration method a filtration trench is constructed for filtering the sewage, and an outlet to a stream or ditch must be provided into which the filtered effluent can be discharged. The type of final disposal to be used depends on the location and the water absorbing characteristics of the soil. The tile field should be located at least 100 feet from the water supply and the natural drainage should be toward tile field and away from the water supply.

A distribution box should be constructed as shown on Figure C. The purpose of the distribution box is to distribute equally the sewage to the several laterals. The layout of the tile field will depend upon the topography of the ground. and Figure D shows layouts of tile fields that will accommodate most any slope in the ground surface.

SUB-SURFACE ABSORPTION SYSTEM:

If the soil is relatively porous and capable of readily absorbing water the absorption system should be used. Using this method the earth is depended upon to absorb all of the tank effluent that is discharged into the tile field. Large numbers of bacteria are present in the top few inches of the soil and it is these bacteria that stabilize sewage absorbed by the soil. The number of bacteria decreases rapidly with the depth of the soil and for this reason it is very necessary to keep the absorption field within 18 to 24 inches of the ground surface. If the tile is placed deeper than 24 inches from the ground surface successful operation of the tile field cannot be expected in most instances.

The construction of the sub-surface absorption trench is shown on Figure C. The tile should be 4 inches in diameter laid with open joints 1/4" wide and on a grade not to exceed 2" fall per 100 feet. The trench should be dug 18" wide and 10" of gravel placed around the tile, as shown on Figure C. Tar paper strips or 16 mesh copper screen wire should be placed over the upper half of the joint to keep out the gravel or soil. The laterals should be spaced 10 feet apart and Figure D shows several methods of laying out the tile field, depending upon the topography of the ground. The amount of open joint absorption tile required depends on the porosity of the soil and the number of persons served. Not less than 250 feet of tile should be installed. The maximum length of any one lateral should be 100 feet. If more than 10 people are to be served the following footage of tile per person is to be used.

Type of Soil	Feet of Tile Per Person Served	
	Dwelling	School
Sandy clay or loam	25	12
Clay with some sand or gravel	50	24
Heavy clay	Recommend Sub-Surface Filtration	

If it is possible, the following test should be made and the table shown above should then be disregarded. These soil tests are valuable in determining the length of tile needed per capita.

A hole about 1' square and 18" deep (the depth of the proposed trenches) is dug at the site of the proposed absorption system. This hole is filled to the depth of about 6" with water, taking care to wet the soil before pouring the water in for the test if it appears dry. It is well to repeat the test to eliminate the effect of a very dry soil.)

The time that it takes the surface of the water in the hole to fall one inch is then observed.

With this information the amount of tile required per person for average conditions may be taken from the following table:

Time for water to fall 1 inch	Length of tile per person required	
	Dwellings	Day Schools
10 seconds or less	15 feet	3.7 feet
15 seconds	16 "	4.0 "
30 seconds	17 "	4.3 "
45 seconds	18 "	4.6 "

1 minute	20 feet	5.0 feet
2 minutes	25 "	6.3 "
3 minutes	29 "	7.2 "
4 minutes	33 "	8.0 "
5 minutes	36 "	9.0 "
10 minutes	48 "	12.0 "
15 minutes	60 "	15.0 "
30 minutes	95 "	24.0 "
45 minutes	130 "	32.0 "
1 hour	165 "	42.0 "

The test should not be made in a hole that has been exposed for some time to a hot summer sun nor should hot water be used or the resulting length of tile indicated by the table will be too small. Neither should the test be made in frozen soil or with ice water or the result will indicate an unnecessary length of tile.

SUB-SURFACE FILTRATION SYSTEM:

Where the soil is tight and does not readily absorb the sewage, a sub-surface filtration trench is recommended. The details of the construction of a filter trench is shown on Figure C. The septic tank effluent is discharged into the upper tile of the trench, then it filters down through the sand and is collected in the lower tile, from which it is discharged into a stream or ditch. Disinfection of the filtered effluent is necessary where domestic water supplies or bathing beaches may be affected. The top tile line should be vented at the lower end to facilitate filtration. The trench should be 3½' wide at the top, 2½' wide at the bottom and a minimum depth of 3½'. The lower tile line is laid in the bottom of the trench and covered with 6" of gravel ranging in size from 1/2" to 1-1/2". The next 24" is filled with coarse sand which provides the filter medium. The top tile line is centered in a layer of gravel 6" deep placed on the sand bed and the remainder of the trench is filled with soil. Tar paper strips or 16 mesh copper screen wire should be placed over the upper half of the joint to keep out the gravel and sand. The tile should be laid on a grade not to exceed 2" fall per 100 feet, and the trenches should be spaced 10 feet apart. The amount of filter trench should not be less than 100 feet. The length of the laterals should not be over 100 feet.

If more than 10 people are to be served, the following footage of filter trench per person should be constructed: For a dwelling, 10 feet per person; and for day schools, 6 feet per person.

CARE AND MAINTENANCE OF THE SYSTEM

1. Successful operation of the tank is dependent upon bacterial and biological action, so extreme care must be exercised to exclude disinfectants and acids from the sewage.

2. If a grease trap has been installed, the grease must be skimmed from the trap frequently to keep the grease from entering the septic tank. The frequency of cleaning will depend upon the amount accumulated.

3. At least yearly the depth of sludge should be determined in the septic tank and when the sludge depth exceeds 18" in the shallow end of the tank most of the sludge should be removed from the tank and buried. Never remove all of the sludge from the septic tank. If all of the sludge is removed at one time the efficiency of the tank will be impaired until the bacterial and biological action has again reached normal.

4. Unsatisfactory operation of the tile disposal field is known at once by the appearance of sewage at the surface of the ground. This may be caused by clogged tile, excess sewage, or insufficient amount of tile. It is then necessary to re-

construct or make an addition to the tile field.

USE OF STEEL SEPTIC TANKS

If a steel septic tank is to be used, the volume and depth below the water line should conform to the volume and depth as shown on plates #1 and #2 according to the number of persons to be served.

The thickness of the steel should not be thinner than 12 gauge metal and the tank should be thoroughly coated inside and outside with an asphaltic or coal tar base paint.

The baffle arrangement should be essentially the same as shown on plates #1 and #2 according to the number of persons served and under no circumstances should the baffle extend down to the bottom of the tank.

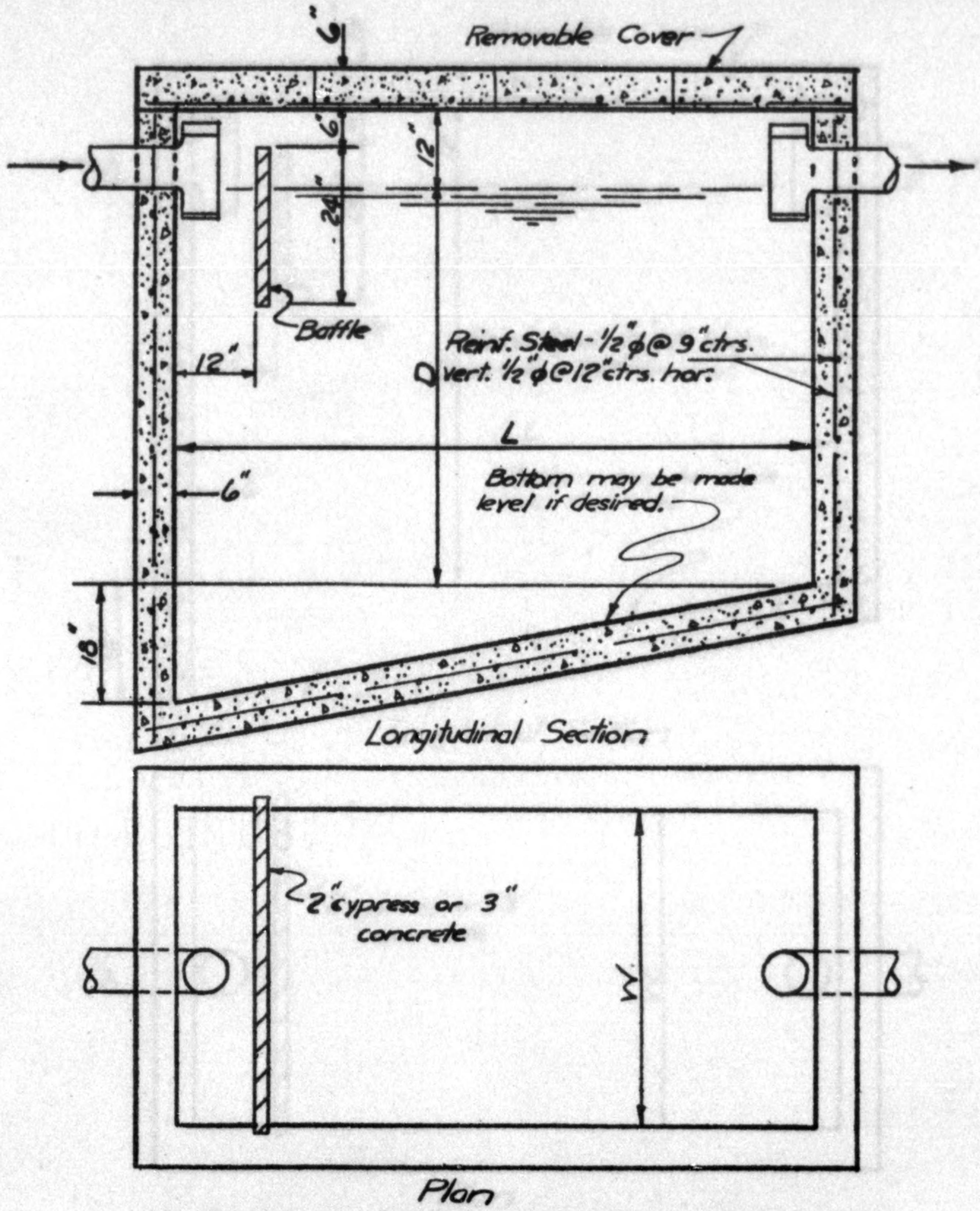
NOTE: TO ENGINEERS AND ARCHITECTS

When plans for the construction of septic tanks and tile fields are submitted to the State Health Department for approval, they should show, in addition to the structural details and layout plan, the following information:

1. The elevations of the building outlets.
2. The elevations of the septic tank inlet and outlet.
3. The elevations of the distribution box.
4. The elevations of both ends of each tile line.
5. The topography of the ground over the tile field.

Plans and specifications must be submitted in duplicate and must bear the seal of a registered engineer or licensed architect.

The location of any drinking water supply located on the grounds must be shown.



No. of Persons		Inside Dimensions			Capacity in Gallons
Dwelling	School	L	W	D	
10	15	6'-0"	3'-0"	4'-0"	500
20	30	7'-0"	4'-0"	5'-0"	1000

DETAIL OF SEPTIC TANK

FIG A