United States
Department of
Agriculture

Forest
Service

**Engineering
Staff**

Washington, D.C.

Engineering Field Notes

Engineering Technical Information System

Volume 13
Number 1
January 1981

1980 Field Notes Article Awards

Hand Pump Operation & Maintenance

Greenhouse Temperature Alarm System

More on Concrete Cylinder Transportation

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1980 FIELD NOTES ARTICLE AWARDS

The Certification and Technical Data Systems Workshop and the resulting Chief's Action Plan (see Field Notes, Volume 11, Number 10, October 1979) provide for cash awards and service certificates to be awarded to the authors of three Field Notes articles in each calendar year.

The material in Forest Service Manual 7113, which is in production, formally establishes the award system; the awards will be distributed based on responses of Field Notes readers.

Did an Engineering Field Notes article help you in the performance of your job during 1980? Did information published in Field Notes help you save money or time? Did you learn a new way to perform a task? Did you note potential benefits that could result from improved methods?

If the answer to any of these questions is "Yes," complete the article rating sheet on the following page. Select the three articles that were "most beneficial and useful"; rate these articles from 1 (highest) to 3; do not rate more than three articles. Wherever applicable, indicate the amount of money saved as a result of the article.

Cut out the page as indicated, fold carefully, and staple both ends of the folded sheet. The rating sheet must be received in the Washington Office by March 15, 1981, in order to have your selections considered.

Articles in Field Notes are intended to provide useful information for engineering personnel working on the ground, as well as for those who manage or supervise systems.

If you have a new way of accomplishing a job, or a better idea for handling problems, share your ideas, problem solutions, new methods, etc. Write an article for Field Notes, and maybe you will win a $100 cash award and certificate for 1981.

1980 Field Notes Article Rating Sheet

Article	Author	Choice (1,2,3)	$ Saved
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May			
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June			
Transportation of Concrete Cylinders	Robert D. Wildman, R-4	____	____
Construction Materials Sampling & Testing Handbook	E. J. Mandigo, WO	____	____
The Autostress Bridge	L. D. Bruesch, WO	____	____
November/December			
Concrete Cylinder Transportation	Steve Monlux, R-1	____	____
The Electronic Field Notebook	J. S. Campbell, WO	____	____
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HAND PUMP OPERATION AND MAINTENANCE

Environmental Engineering
Engineering Staff
Northern Region

The 1979 potable water inventory showed that 162 hand pumps are installed in wells in the Northern Region. To put this in perspective, 56 percent of all the wells in the Northern Region have hand pumps. The hand pump will probably remain the most common method of withdrawing well water at Forest Service campgrounds.

The hand pump does not require electricity and it is simple to use; these are major reasons it is so popular in the Forest Service. Also, hand pumps can operate in below-freezing weather for early and late season use.

Generally, the hand pump is popular with the public. The number of old red hand pumps on lawns and flower gardens indicates the nostalgia associated with this reminder of the past.

Sanitary surveys on hand pumps in the Region identified some recurring problems at many installations. Some deficiencies were associated with the design of the hand pump stands; others were associated with the installation (drainage, slabs, etc.). A new Regional standard drawing for the installation of hand pumps was approved in 1978, based on the input from the sanitary surveys.

This article describes the installation and maintenance of well hand pumps. It is intended for facilities engineers and district personnel responsible for maintaining water systems.

Hand Pump Description and Operation

A hand pump installation consists of a pump cylinder, drop pipe, pump rod, and pump stand. Figure 1 shows a typical hand pump installation.

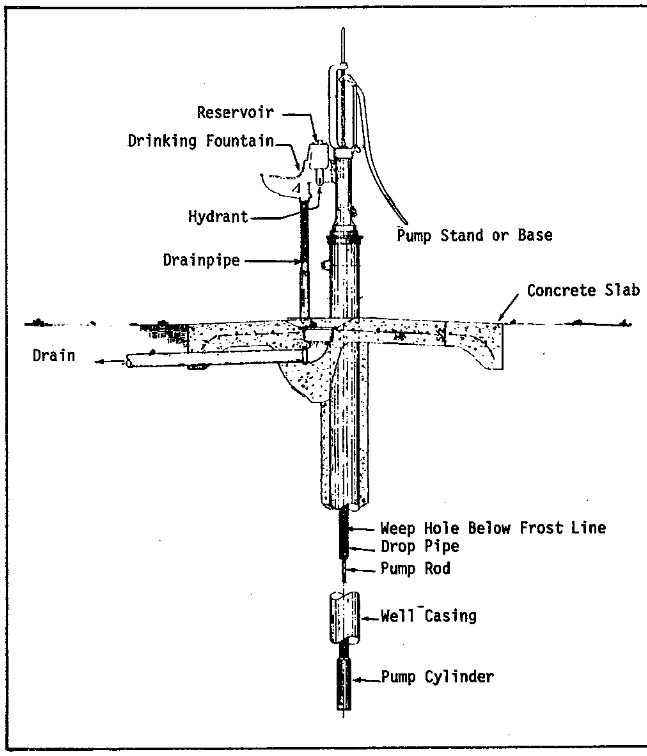


Figure 1. Hand pump stand with drinking fountain and hydrant

The pump cylinder is a single-acting piston pump, as shown in figure 2. The piston is connected to the pump handle by the pump rod, which is inside the drop pipe. Operating the pump handle moves the piston up and down in the pump cylinder.

When the piston is drawn upward, the piston valve is closed by gravity and the pressure of the water above it. Water above the piston is forced from the cylinder, up the drop pipe, and out the spigot or fountain on the

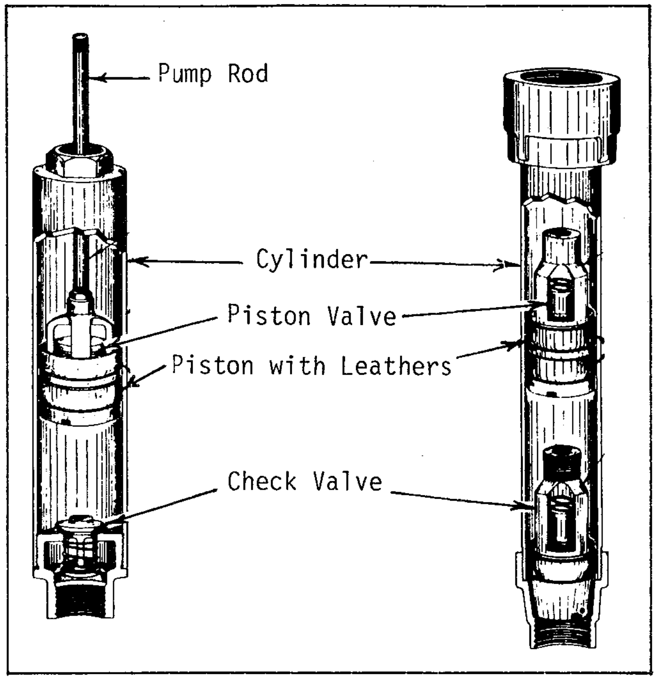


Figure 2. Typical pump cylinders

pump stand. At the same time, water is drawn into the lower portion of the pump cylinder through the check valve on the bottom of the cylinder.

As the piston starts downward, the check valve closes and the piston valve opens to allow the piston to move to the bottom of the cylinder. Water is trapped in the pump cylinder during the piston downstroke, then is forced upward into the drop pipe on the next upstroke.

The pump stand in the Region 1 standard hand pump drawing has a drinking fountain and hydrant rather than a spout. A reservoir on the pump stand holds a small amount of water to allow a flow from the drinking fountain for 5 to 10 seconds after pumping stops.

Another available pump stand has provisions for treating the water discharged from a hand pump. Figure 3 shows a pump stand with a water treatment base. The water flows from a fitting at the pump base, through the treatment unit, and back into the bottom of the reservoir unit. Treatment could include filtration, disinfection, ion exchange, etc.

Districts should consult facility engineers or zone environmental engineers before considering installation of a pump stand with a water treatment unit. In general, these units should be considered the last resort for bacteriological problems at a well site with a hand pump. A treatment system should not be used to hide obvious sanitary deficiencies in a pump installation.

Sampling and Testing

Normal operation of a hand pump maintained in good condition should have minimal effect on the district. System operation should consist primarily of collecting monthly samples for routine bacteriological monitoring.

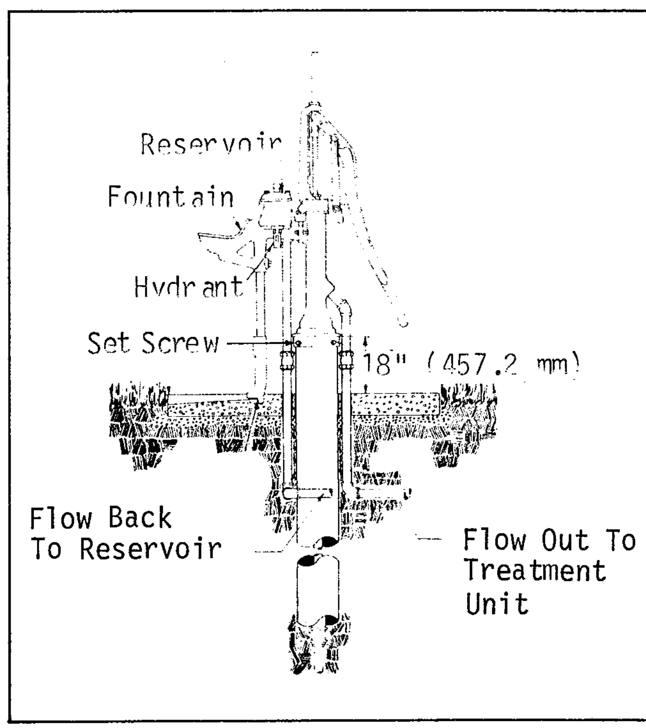


Figure 3. Pump stand with water treatment base

To collect a bacteriological sample:

1. Flush the well by pumping for 2 to 3 minutes.

2. Avoid sample contamination at the time of collection.

a. Keep the sampling bottle unopened until the moment it is to be filled.

b. During sampling, do not touch the threads on the cap and neck of the bottle. Do not place the cap on the ground while taking the sample.

3. Hold the bottle near the base, fill it three-quarters full, and replace the cap immediately. DO NOT RINSE THE BOTTLE BEFORE COLLECTING SAMPLE.

4. Complete collection form; return form and sample to the laboratory.

Generally, samples for chemical monitoring are required at 3-year intervals after the initial complete chemical analysis. The zone environmental engineers will notify the Forests when chemical tests are required at various sites.

If possible, collect samples for chemical analysis during the middle of the use period to minimize interference from rust, etc. Flush the well by pumping for several minutes. Collect and preserve the sample in accordance with instructions that should be included with the sample bottle.

Installation

Figure 4 is the Region 1 standard drawing for the installation of hand pumps. This drawing has been reviewed and approved by the appropriate Departments of Health in the States included in the Northern Region. It should be used for the installation of hand pumps on new wells and the rehabilitation of existing hand pump sites. Deviations from these plans at sites with public water systems must be approved by the appropriate State Department of Health and the Regional Environmental Health Engineer. Deviations from the plans at other sites must be approved by the Regional Environmental Health Engineer.

During the installation of hand pumps:

1. Draining excess water from the concrete slab is important. During rehabilitation of a number of old hand pump installations, several wells had developed deep cavities under the old slabs and along the well casings. These cavities were as much as 6 feet or more deep. Excess water probably seeped under the slab and down the opening next to the well casing. Sometimes, small spaces are left between the casing and natural ground when wells are drilled. Surface water can percolate down and contaminate the groundwater. Also, rodents, snakes, etc., might live in a cavity under the slab and contribute to groundwater contamination.

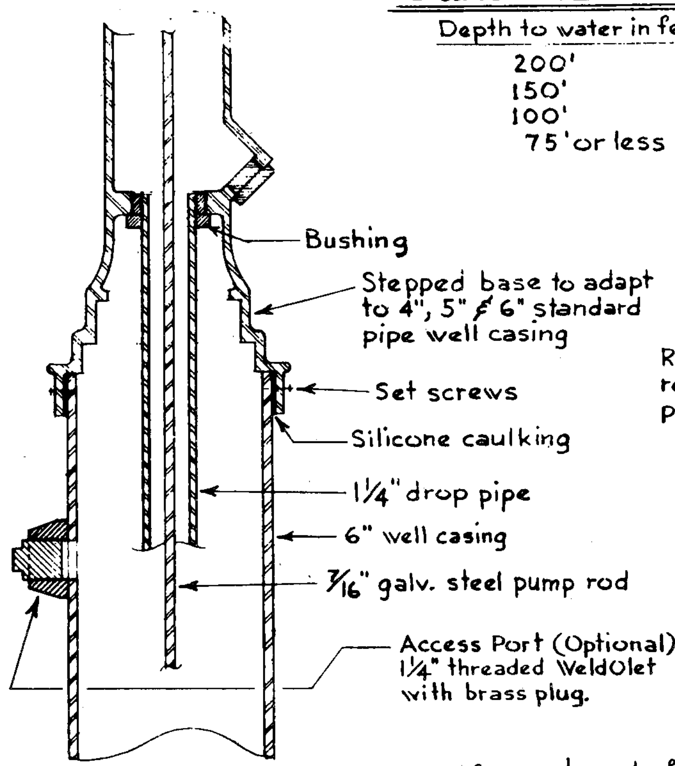
2. The length of the installed pump rod should be such that the piston does not hit the top of the cylinder when the pump handle is at the bottom of its travel. Such constant pounding can cause the pump rod to either separate at a threaded joint or damage the pump cylinder or piston. The threaded upper end of the round piston bar should be just above the packing nut when the piston is resting on the bottom of the cylinder; this allows the packing to be changed

PUMP CYLINDER SIZING GUIDE.

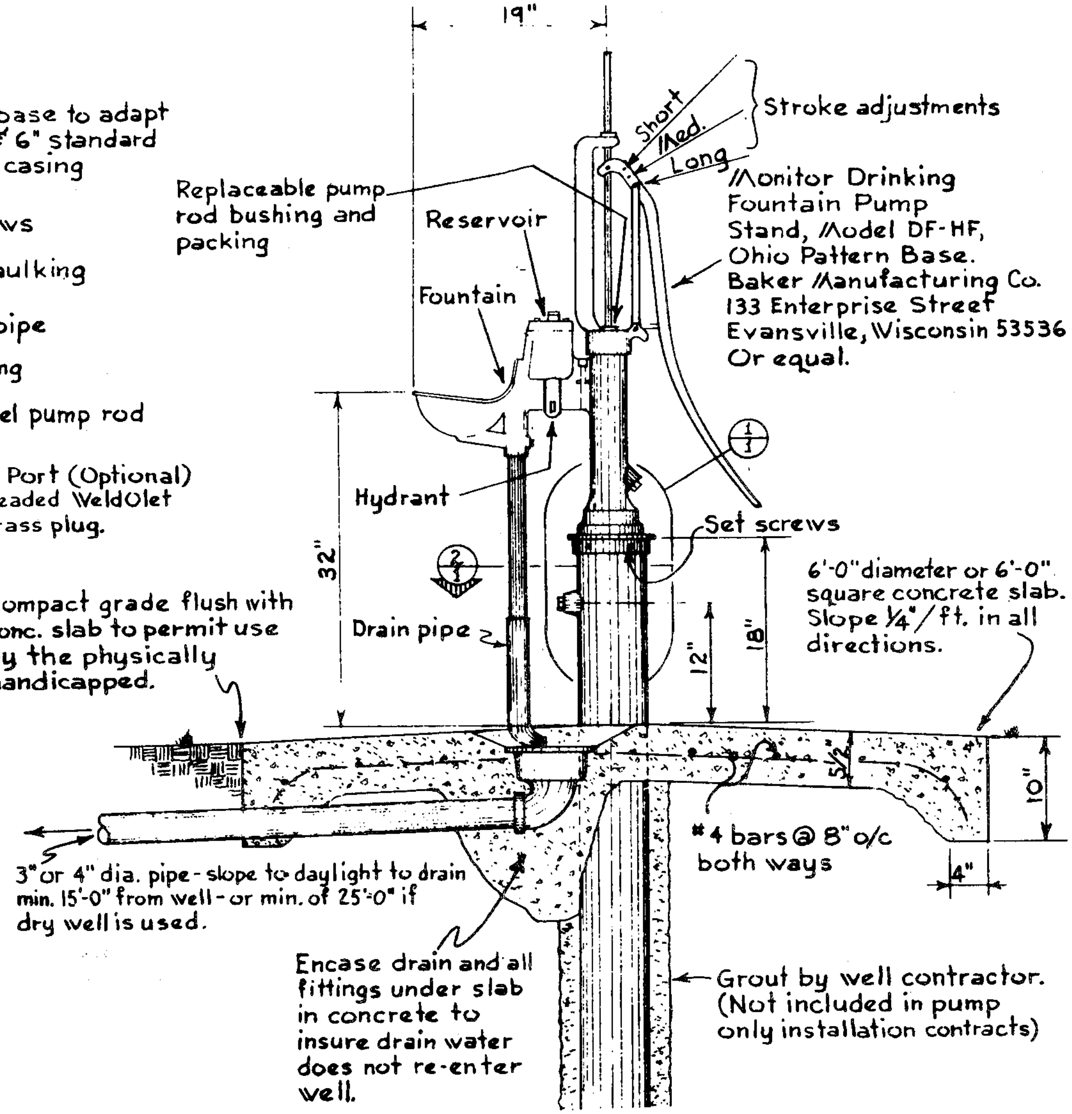
Depth to water in feet	Cylinder size
200'	1 11/16"
150'	2"
100'	2½"
75' or less	3"

NOTES.

- Cylinders shall be brass lined cast iron barrels - 10" stroke.
- Use 7/16" galvanized steel pump rods.
- Use 1¼" galvanized steel drop pipe.



DETAIL. 1/1
3" = 1'-0"



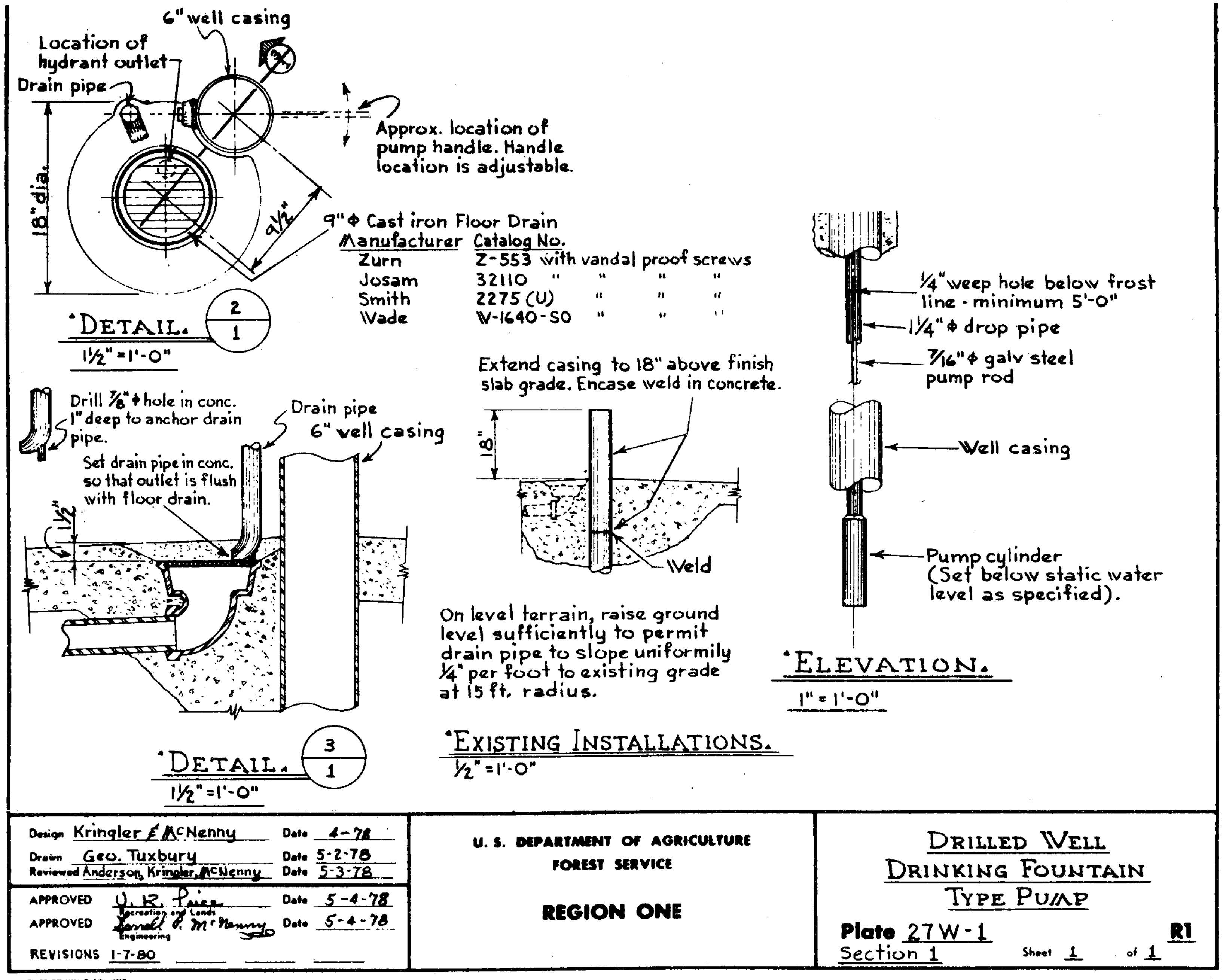


Figure 4. Standard drawing -- pump installation

without permitting the top of the threaded piston bar to drop below the level of the packing nut without temporary external support. Equal lengths of drop pipe and pump rod should be installed on pumps. Pump rod is available in standard lengths of 18, 20, and 21 feet (5.5, 6.1, and 6.4 meters), which correspond to the standard lengths of different types of pipe used for drop pipe. Normally, galvanized steel pipe is recommended for the drop pipe. Pump rods can be shortened by cutting to the desired length and rethreading the cut end.

3. The weep hole in the drop pipe should be drilled rather than torch cut to ensure a clean hole of proper size. Check the weep hole by operating the hand pump until water is discharged from the spout. Let the pump stand idle for 30 to 60 seconds and operate the pump again. If water is discharged from the spout within the first one or two up-and-down motions of the handle, either the weep hole is plugged or it is not large enough.

4. The pump cylinder should be installed below the lowest anticipated water table level to eliminate any pollution hazard associated with priming the pump with nonpotable water.

5. Substituting another type of pump for the pump stand shown on the drawing (figure 4) should not be done unless the two pump stands are equivalent. The most important features that preferred pumps have are a stainless steel piston bar and a replaceable pump rod bushing and packing where the piston bar moves up and down through the top of the pump base. Districts should consult with facility engineers or zone environmental engineers before purchasing another type of hand pump.

6. The hydrant outlet should be located over the floor drain.

7. The optional threaded access port near the top of the well casing is recommended for all hand pump installations for two important reasons:

a. The well can be disinfected without removing the pump.

b. The water level in the well can be measured conveniently.

Startup/Shutdown

A condition survey is a physical inspection of the hand pump. The following list summarizes typical items to be checked during a condition survey:

1. The drainage system should be open and functioning properly.

2. The concrete slab should not have any cracks; open spaces under the slab should be filled.

3. Nuts and bolts should be tight; gaskets should be intact at watertight joints.

4. The pump stand and its major components should not be cracked or broken.

5. The pump rod bushing and packing should be snug.

6. The weep hole should be open.

A condition survey on each hand pump installation should be performed in the spring before system startup and after the system is shut down in the fall. Year-round sites should have condition surveys at least once a year.

A condition survey performed when the system is shut down in the fall is useful in identifying maintenance items to be corrected before the system is opened for the next season. Materials can be ordered during the winter for installation early next season. A condition survey before system startup can determine if any additional damage has occurred during the winter from vandalism, frost action, etc.

The steps for seasonal hand pump startup and shutdown are summarized below:

Startup

1. Install pump handle.

2. Perform condition survey.

3. Complete necessary maintenance.

4. Flush well by pumping until discharge is clear of rust, sediment, etc.

5. Take water sample for bacteriological testing; remove pump handle.

6. If bacteriological test is satisfactory, open the water system for use; install the pump handle.

7. If the bacteriological test is unsatisfactory, chlorinate the well and repeat all steps starting with 4. Flush the well until the free chlorine residual drops below 0.5 mg/l.

8. If subsequent bacteriological samples continue to show contamination, request a sanitary survey from the forest facilities engineer.

Shutdown

1. Perform condition survey.

2. Remove pump handle.

Maintenance

Like other pieces of machinery, hand pumps have maintenance requirements. The following paragraphs describe common maintenance procedures. Numbers in parentheses refer to part numbers of a typical pump, shown in figure 5. Figure 6 shows the parts nomenclature of a typical pump cylinder.

Drainage System

The drain pipe should be cleaned as needed to keep excess water draining from the slab area.

Slab

The concrete slab should be replaced if open cracks develop in it. Hairline cracks in a steel-reinforced slab generally should not be considered a threat to the sanitary quality of the well water. The ground level around the slab should be maintained at the slab elevation so surface water cannot collect in low spots or form channels under the slab. The chances of rodents burrowing under the slab should be reduced by maintaining the ground level at slab elevation.

Pump Stand

Nuts and bolts on the stand should be tight. Gaskets on the reservoir cover (25) and the tank-to-base (40) connection should be maintained in a water-tight condition. Cracked components such as the pump base (36), reservoir cover (17), etc., should be replaced as

Key Number	Description	Quantity
1	Handle & pin assembly—includes key no. 2 & 3	1
2	Pump pin	1
3	Cotter pin	2
4	Upper piston guide	1
5	Cap	1
6	Set screw 1/2" (12.7 mm)-13NC × 1 1/2" (38.1 mm)	3
7	Flat piston bar	1
8	Packing nut	1
9	Valve stem packing, Graphite rope 1/8" (3.2 mm) dia. × 23" (584.2 mm) long	1
10	Piston bar	1
11	Fulcrum & cap pin	1
12	Fulcrum	1
13	Fulcrum & handle pin	1
14	Cotter pin	2
15	Hex cap screw 3/8" (9.5 mm)-16 × 1 3/4" (44.5 mm) L.	4
16	Valve handle & shaft assembly	1
17	Cover	1
18	Valve spring	1
19	Snap ring	1
20	Spring washer cupped	1
21	Spacer	1
22	Valve	1
23	Washer	1
24	Hex lock nut	1
25	Cover gasket	1
26	Strainer	1
27	Spout	1
28	Nozzle	1
29	Reservoir assembly—includes key Nos. 27, 28, 33, 40, 41 & 26	1
30	Drain pipe 1" (25.4 mm) std. pipe × 23 3/16" (589.0 mm) L.	1
31	Drain assembly—includes key no. 32	1
32	Set screw 7/16" (11.1 mm)-14NC × 1/2" (12.7 mm) L.	2
33	Pipe plug—3/4" (19.1 mm) NPT	1
34	Pump bushing 2" (50.8 mm) × 1 1/4" (31.8 mm)	1
35	Set screw—base 1/2" (12.7 mm)-13NC × 2" (31.8 mm) L.	4
36	Base—includes key nos. 40 and 34 for DF-HF.	1
37	Bolt—tank to base 7/16" (11.1 mm)-14NC × 2" (12.7 mm) L. with nut	2
38	Packing washer	1
39	Lower guide flange	1
40	Gasket—tank to base	1
41	Expansion plug	1
42	Base—includes key nos. 40 & 34 for DF-HC.	1
43	Valve parts—includes key nos. 18, 19, 20, 21, 22, 23, & 24	1
44	Fountain unit assembly includes key nos. 15, 16, 17, 25, 29, 30, 31, 32, and 43.	
45	Washer	1

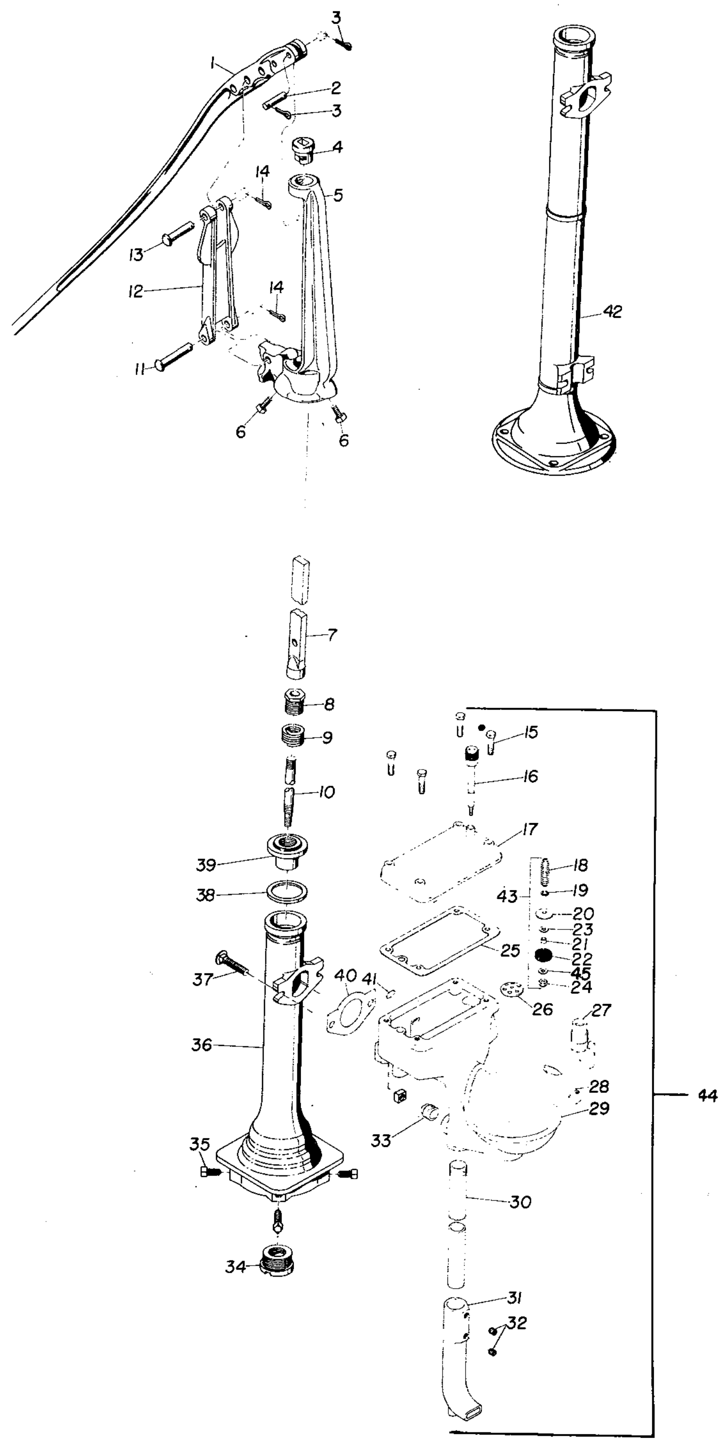


Figure 5. Pump nomenclature

Key Number	Description	Cylinder Size	Quantity
—	Figure 1	(In.-mm)	
1	Upper cap	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	1 1 1 1
2	Gasket	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	3 3 3 3
3	Cylinder barrel, brass lined	2 × 12 (50.8 × 304.8) 2 × 15 (50.8 × 381.0) 2-1/4 × 12 (57.2 × 304.8) 2-1/4 × 15 (57.2 × 381.0) 2-1/2 × 12 (63.5 × 304.8) 2-1/2 × 15 (63.5 × 381.0) 3 × 12 (76.2 × 304.8) 3 × 15 (76.2 × 381.0)	1 1 1 1 1 1 1 1
—	Figure 2		
4	Plunger stem	2 × 12 (50.8 × 304.8) 2 × 15 (50.8 × 381.0) 2-1/4 × 12 (57.2 × 304.8) 2-1/4 × 15 (57.2 × 381.0) 2-1/2 × 12 (63.5 × 304.8) 2-1/2 × 15 (63.5 × 381.0) 3 × 12 (76.2 × 304.8) 3 × 15 (76.2 × 381.0)	1 1 1 1 1 1 1 1
5	Hex nut, 7/16"-14NC		1
6	Plunger poppet	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	1 1 1 1
7	Cup leather	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	2 2 2 2
8	Plunger assembly	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	1 1 1 1
—	Figure 3		
9	Check valve guide	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	1 1 1 1
10	Check valve	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	1 1 1 1
11	Check valve facing	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	1 1 1 1
12	Check valve washer		1
13	Hex nut, 5/16"-18NC		1
14	Check valve assembly	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	1 1 1 1
15	Lower cap assembly	2 (50.8) 2-1/4 (57.2) 2-1/2 (63.5) 3 (76.2)	1 1 1 1
—	Figure 4		
16	Plunger stem		1
17	Plunger spring		1
18	Plunger poppet		1
19	Plunger valve facing		1
20	Machine screw 5/16" (7.9 mm)-18NC × 3/4" (19.1 mm) L.		1
21	Cup leather		2
22	Poppet assembly		1
23	Plunger assembly		1

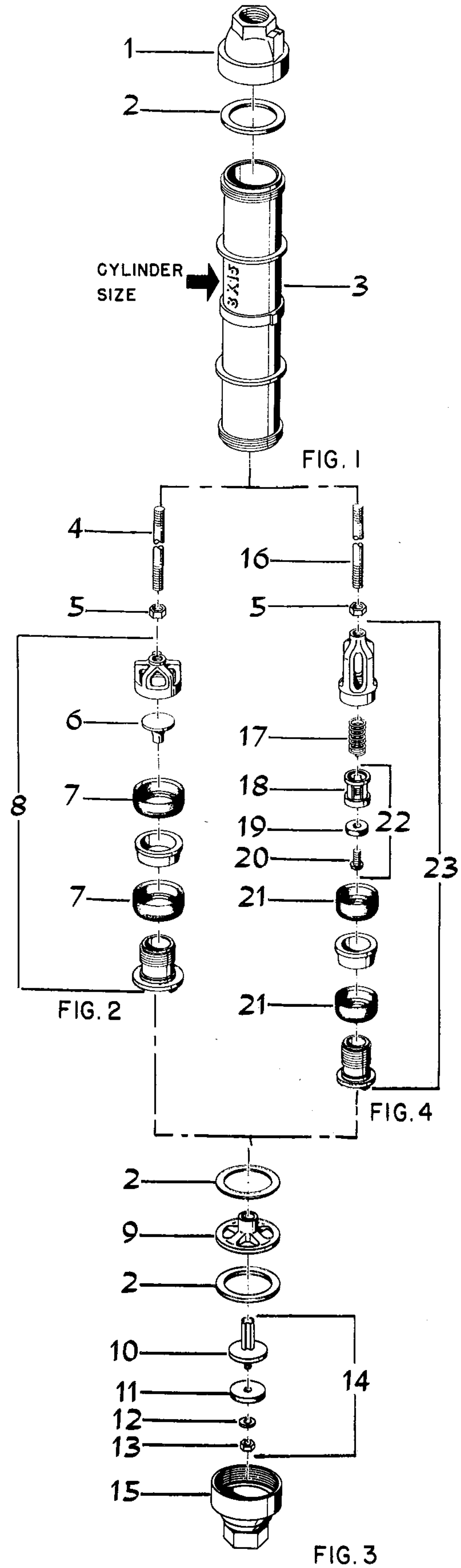


Figure 6. Pump cylinder nomenclature.

quickly as possible to protect the sanitary quality of the water.

Packing Nut and Packing or Stuffing Box

Properly maintaining the pump rod packing is one of the most important items in protecting the sanitary quality of the water from a hand pump. The packing nut (8) is located at the top of the pump base. The packing nut and packing (9) form a watertight seal where the piston bar (10) moves up and down through the top of the pump base (36). Normal maintenance will require the periodic tightening of the packing nut, which compresses the packing against the piston bar to maintain the watertight seal. The packing nut should be tightened to the point that there is no side movement in the piston bar through the nut and there is a slight drag on the piston bar when the pump is operated. If water bubbles around the packing, the packing nut is not tight enough. Eventually, the packing or the packing nut will have to be replaced, as described below:

1. To replace packing:

a. Loosen packing nut (8) and slide nut up piston bar (10) to provide access to packing (9).

b. Remove remainder of old packing with a fine-pointed tool such as a small screwdriver.

c. Install new valve stem packing (9) recommended by pump manufacturer.

d. Slide packing nut down piston bar and tighten to form watertight seal.

2. To replace packing nut (and packing, if needed):

a. Remove pump pin (2) at connection between pump handle (1) and flat piston bar (7).

b. Remove upper piston guide (4) and unthread flat piston bar (7) from piston bar (10).

c. Loosen packing nut (8) and remove by sliding up the piston bar (10).

d. Replace pump packing (9), if needed.

e. Install new packing nut by sliding down over the piston bar and tighten to form a watertight seal. Complete the assembly by reversing the disassembly procedure. The smooth surface of the piston bar (10) that slides through the valve stem packing (9) and the packing nut (8) should not be scratched or gouged with the jaws of pliers, pipe wrenches, etc. Damaging the surface of the piston bar will cause rapid failure of the valve stem packing.

Upper Piston Guide

The upper piston guide (4) will wear in the direction of the pump handle as the flat piston bar (4) rubs against the guides. As the upper piston guide wears, the piston bar (10) will tend to wear on one side of the packing nut. The watertight seal at the packing nut might be disrupted if the packing nut wears to one side. A thin layer of heavy-bodied grease on the upper piston guide and the handle side of the flat piston bar should prolong the life of the guide. Replace the upper piston guide when wear exceeds 1/8 inch (3.2 mm).

Sealed Pump Flanges

Many older model pump stands have flanged pump bases bolted directly to the concrete pad or to a sealed pump flange mounted on top of the casing. The flange gaskets in these connections must be maintained to provide a water-tight seal and prevent contamination of the well. Mounting bolts must be tight and the flange gaskets must be in good condition.

Well Disinfection

The well should be disinfected whenever the pump stand is raised or removed for maintenance. The disinfection procedure is described below:

1. Pour chlorine solution into the well just before installing pump cylinder and drop pipe assembly. This shall be a solution of 2 cups (0.0005 m^3) of 5% chlorine bleach diluted with 5 gallons (0.0189 m^3) of potable water. Chlorine solution should be diffused into the well through a water hose or pipeline as the line is alternately raised and lowered.

2. After installation, operate the hand pump until a distinct chlorine odor is detected in the discharge.

3. Remove the pump handle and allow the chlorine solution to remain in the well at least 24 hours.

4. After at least 24 hours, flush the well until the free chlorine residual is less than 0.5 mg/l. Take water sample for bacteriological testing. Remove pump handle.

5. If bacteriological test is satisfactory, open the water system for use. Install the pump handle.

Well Cleaning or Flushing

Some wells are not cleaned adequately at the low pumping rate of hand pumps. As a result, eventually, accumulations of sediment, rust particles, etc., might affect the physical quality of the well water. At some sites, periodic well cleaning can be beneficial. Districts should consult facility engineers or zone environmental engineers on specific installations. Portable pump jacks with gasoline engines are available to operate the pump cylinder mechanically.

Spare Parts

Districts should consider stocking the following common spare parts for hand pump maintenance:

1. Packing nuts (8)
2. Graphite rope packing (9)
3. Gaskets (25, 40)
4. Upper piston guide (4)
5. Reservoir cover (17)

Use a standard brand of hand pump in order to reduce required parts inventory on a District.

GREENHOUSE TEMPERATURE ALARM SYSTEM

Al Vanderpoel, Civil Engineer
Nicolet National Forest, R-9

The Forestry Sciences Laboratory at Rhinelander, Wis., has several greenhouses and growth rooms in which experiments are conducted on forest products. The large investment in time and effort in the research of this work warranted the installation of a Thermalarm temperature warning device. In addition to the standard system provided by the manufacturer, the Lab installed an isolation light panel to indicate the unit causing the problem.

The Lab bought the basic system from Thermalarm Products, Inc., Effingham Falls, N.H. Fifteen temperature sensors were installed in the various greenhouses and growth rooms; each sensor has an adjustable high and low alarm limit. In addition, three failure relays were installed on the boilers providing heat to the rooms equipped with sensors. These relays activate an alarm system when the temperature reaches a predetermined high or low setting.

The alarm sytem also includes a phone-alert unit, which will dial as many as five different telephone numbers with a prerecorded message to warn of either a temperature problem or a boiler failure. The phone-alert plugs into a telephone jack; it also uses a backup battery power supply in case electrical power is off. This package has an individual unit test system.

Because of the size of the Forestry Sciences Lab and the number of alarm units required to cover the area, the system includes an isolation light panel. This panel was constructed at the Lab; it has 25 low-voltage bulbs, each corresponding to a separate sensor unit (with 7 spare circuits.) The light panel detects any unit that is causing a problem. This eliminates the need to search five buildings.

The light panel was constructed from a 24-inch by 24-inch (0.6-m by 0.6-m) standard electrical box; the light bulbs are mounted in the front cover. Each bulb number corresponds to a location listed on a chart attached to the unit. Sensor wires from the temperature alarm and boiler failure relays run into the light panel unit, and then into the phone-alert unit. A relay on each incoming positive wire isolates the signals. A diode, attached in line, prevents the battery current from traveling back through the system and lighting all the bulbs. Thus, positive contact must be made for any bulb to light, and the relays isolate the signal. Also, the system has a switch that tests all the light bulbs at once to see if any have burned out. This switch feeds power directly from the battery to the bulbs.

This system is complex in design, but simple in operation. The prebuilt alarm components solve the problem, and the isolation light panel helps to find the unit in trouble and to test the system. With the time and money already invested in the greenhouse research projects, the system will have to work only once -- on a cold February night -- to save many times its cost.

MORE ON CONCRETE CYLINDER TRANSPORTATION

Michael A. Kelly, Materials Engineering Technician
Mt. Hood National Forest, R-6

Editor's Note: This article is a response to "Transportation of Concrete Cylinders," which appeared in Field Notes, Volume 12 Number 6, June 1980. Another response, "Concrete Cylinder Transportation," appeared in the November-December 1980 issue of Field Notes, Volume 12 Number 7.

"Transportation of Concrete Cylinders" overlooks an important point. The carrier described in that article is a rectangular box with 8 holes cut for 6-inch (152.4-mm) diameter concrete cylinders. According to AASHTO T23-80I, "Making and Curing Concrete Compressive and Flexural Strength Test Cylinders in the Field," cylinders must be packed in "suitable containers surrounded by wet sand or wet sawdust" for shipping. The cylinder carrier described in the article appears to be impractical for placing wet sand or wet sawdust around the cylinders.

Placing the cylinders in a rectangular box and filling the box with wet sand or sawdust eliminates any "clanging together and rolling around" in the back of a pickup. Field Notes readers should know that failure to follow the proper AASHTO procedure during cylinder transportation results in nonconformance with the Forest Service Standard Specifications.

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Forest Service—USDA
Engineering Staff (RP-E Bldg)
Attn: Gordon L. Rome, Editor
P.O. Box 2417
Washington, D.C. 20013

Telephone: (Area Code 703) 235-8198

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