Connecticut's

Drinking Water Quality and Well Construction

CONNECTICUT DEPARTMENT OF PUBLIC HEALTH

Keeping Connecticut Healthy

Presented by:

Private Well Program

Environmental Health Section

PRIVATE WELLS

DIAGRAMS & SCHEMATICS

COURTESY OF:
American Association for Vocational Instructional Materials **(AAVIM)**
Athens, Georgia

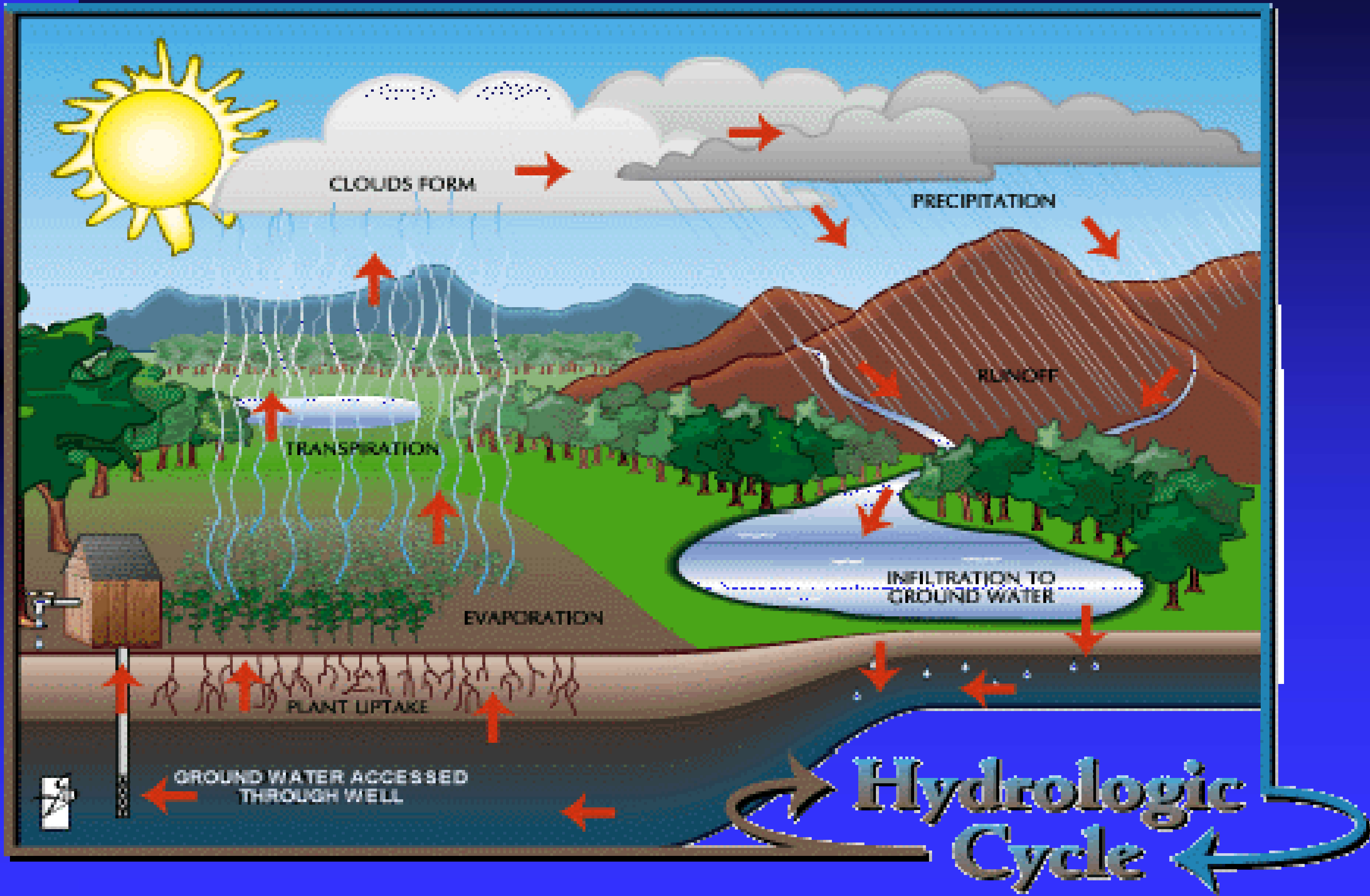
Midwest Plan Service-IA State University **(MPSISU)** Ames, Iowa

Water Systems Council **(WSC)** Chicago, Illinois

Hydrologic Cycle

- **Evapotranspiration** – liquid to vapor through evaporation and transpiration
- **Condensation** – vapor to liquid (clouds)
- **Precipitation** – rain, snow, hail, and sleet
- **Infiltration/percolation** – surface water and precipitation seepage into soil and rock formations some of which is taken up by the roots of vegetation and some which makes its way into groundwater
- **Runoff** – excess precipitation that is transported over land

Image adapted from: http://danpatch.ecn.purdue.edu/~epados/ground/src/title.htm, Ground Water Primer EPA Region 5 and Agricultural & Biological Engineering, Purdue University website.



Water Quality Regulations

- Federal Safe Drinking Water Act (SDWA)
- SDWA adopted into Connecticut Public Health Code (PHC) Section 19-13-B102(e) enforced by the DPH-Drinking Water Section (DWS) & applies to Public Water Systems
- Private Wells – PHC Section 19-13-B101 enforced by Local Health Departments (no Federal regulations)
- Connecticut General Statues 19a-37 *
- Well Drilling Code (WDC) 25-137 *
- State Building Code (SBC) 2905.3 *

{ * denotes nexus between various state codes }

Water Quantity Regulations

- WDC 25-128-39 (aka Well Drilling Code)
  - Yield versus Depth versus Storage

* 1.5gals./foot of 6” casing

** For new wells only

Private Well Jurisdiction

- CGS 19a-207-Duties of Local Officials
  - Local DoH/Agents must enforce CTPHC
  - Municipalities can adopt local ordinances that are consistent with/more stringent than the CTPHC
  - DPH Commissioner can enforce regulations if local DoH fails to enforce CTPHC violations
  - CGS 19-209a, codified in 19-13-B51m
  - Section 19-13-B51 requires DoH approval for all water supply wells

Well Jurisdiction (cont.)

- Federal Safe Drinking Water Act of 1974 for Public Water Systems
- CT received primacy to enforce act in 1976, codified in section 19-13-B102 of CTPHC
- MCLs in section 19-13-B101 mirror B102
- CGS 19a-37 (enabling legislation for B101)
- Well Drilling Code section 25-137 *
- State Building Code section 2905.3 *

PUBLIC ACT 07-244

- Amended & Clarified Secs. 19a-36, 19a-37 and 19a-209a CGS. Not codified in CTPHC, must be referenced in statutes themselves.

Private Well Regulations

(CTPHC section 19-13-B101)

- Require private well owners to conduct specific water quality tests after any new private well construction
- Require State certified drinking water laboratories to report water quality test results to the LHD *if* testing is conducted within 6 months (before or after) of the sale of the home
- Enforceable by Local Health Department
- EHS provides technical assistance to LHDs

B101 (cont.)

The sample must be a RAW water taken ahead of any treatment !!

“Qualified Individual” 19-13-B101(a)(10)

- …..or a person, including an owner or general contractor of a residential construction on which a private water supply system is located, found to be qualified by an approved laboratory…..
- 19-13-B101(b)-signed statement by qualified individual that well sample is from the proposed well that is expecting LHD approval.

Section 19a-26 CGS

- Well water samples submitted by LHDs shall have analytical fees waived.

Quality of Private Wells

- PHC -Sec. 19-13-B101 (d)(1)-Approval by local Director of Health
- PHC- Sec. 19-13-B101 (d)Minimum
- Monitoring requirements identified
  - Total coliform * Turbidity
  - Nitrate/Nitrite * Sulfate
  - Sodium * APPARENT COLOR
  - Chloride * Odor
  - Iron * Hardness
  - Manganese * pH

  - Sec-19-13-B102-(e)(2) - Inorganic
  - Sec-19-13-B102-(e)(3) - Pesticides, Herbicides & PCBs
  - Sec-19-13-B102-(e)(4) -Organic Chemicals

Water quality contaminants with established MCLs for private wells*

Parameter	MCL
1. Total Coliform Bacteria	Zero or Absent
2. Nitrate Nitrogen	10 mg/L
3. Nitrite Nitrogen	1 mg/L
4. Chloride	250 mg/L

* excludes any discretional DOH required VOC or SOC tests

** Not a Complete Listing

*** Lead & Copper have "action levels", not MCLs!

Private Water Supply System

- "Any source of private water supply serving a single <u>consumer</u> and less than 25 persons, and used for drinking or other domestic purposes".
- <u>Consumer</u> "means any private dwelling, hotel, motel, boarding house, apartment building , store, office building, institution, mechanical or manufacturing establishment or other place of business or industry to which water is supplied by a source of private water supply".

Private Well Testing for Volatile Organic Chemicals (VOCs)

- May be required by the DOH if there are reasonable grounds to suspect the presence of VOCs in the private water supply (i.e. properties located on or in proximity to land associated with the past or present production, storage, use, or disposal of organic chemicals or such information as derived from a phase 1 environmental site assessment)

Private Well Testing for Synthetic Organic Chemicals (SOCs)

- If during an initial private well test the nitrate concentration is at or greater than 10 mg/l a DOH has similar discretion as with VOCs to require testing for the following 7 pesticides and herbicides:

  Alachlor, atrazine, dicamba, ethylene dibromide (EDB), metolachlor, simazine and 2, 4-D

Groundwater Supplies

- ***Groundwater*** – that portion of subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated and flows freely into open holes
- ***Aquifer*** – a geologic formation having adequate permeability (porosity and/or fractures) to transmit and yield water
- Accounts for approx. 37% of drinking water in Connecticut
- In general, treatment is not necessary unless water quality fails to meet drinking water standards

Types of groundwater sources

- Drilled Bedrock Wells (most common domestic well)
- Gravel Pack Wells
- Naturally Developed Wells
- Shallow Dug Wells (water table wells)
- Springs
- Driven Well Points

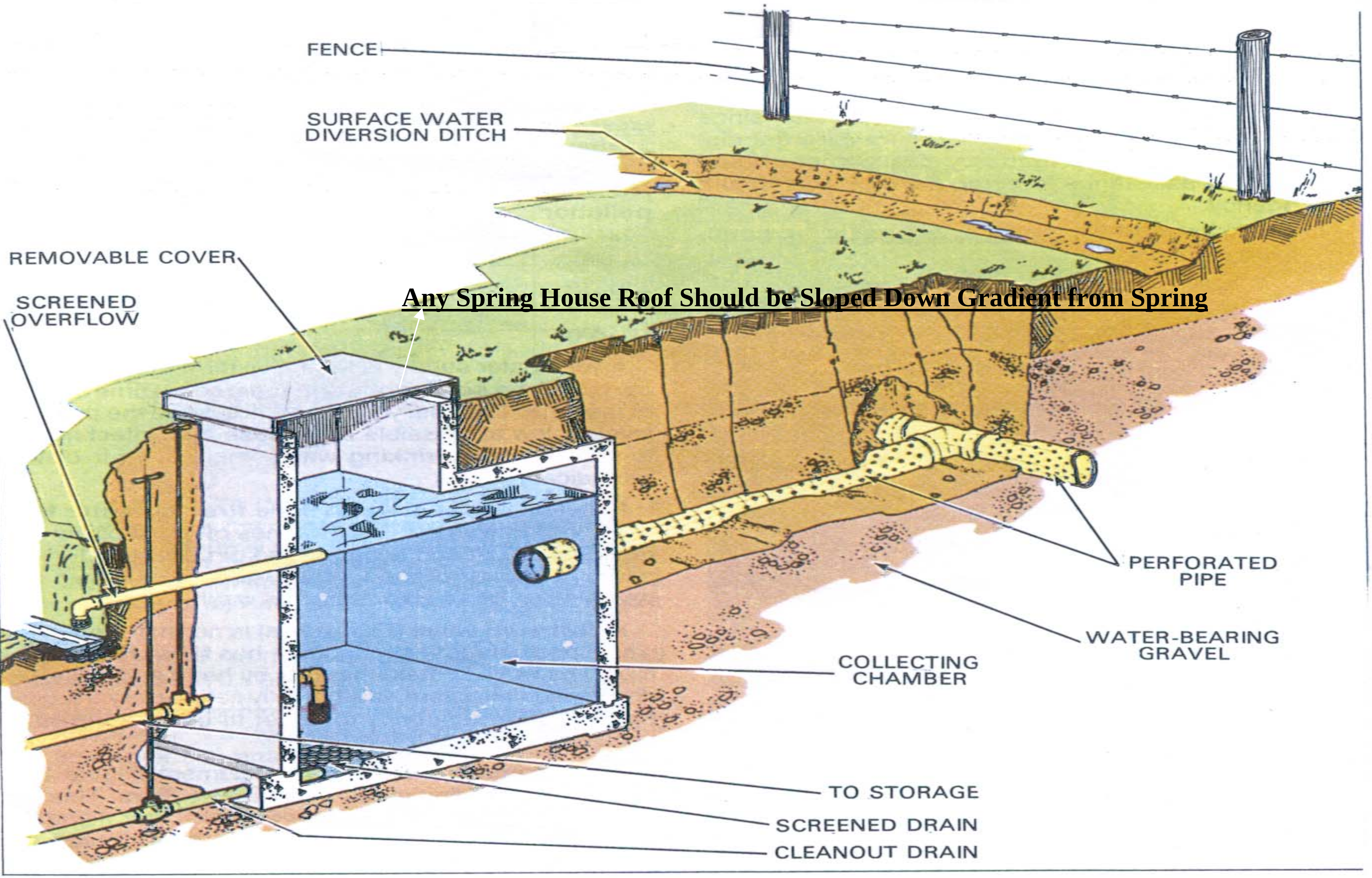


FIGURE 21. A design for collecting water from a spring that provides some protection against surface pollution and provides a means for entering and cleaning the collecting chamber.

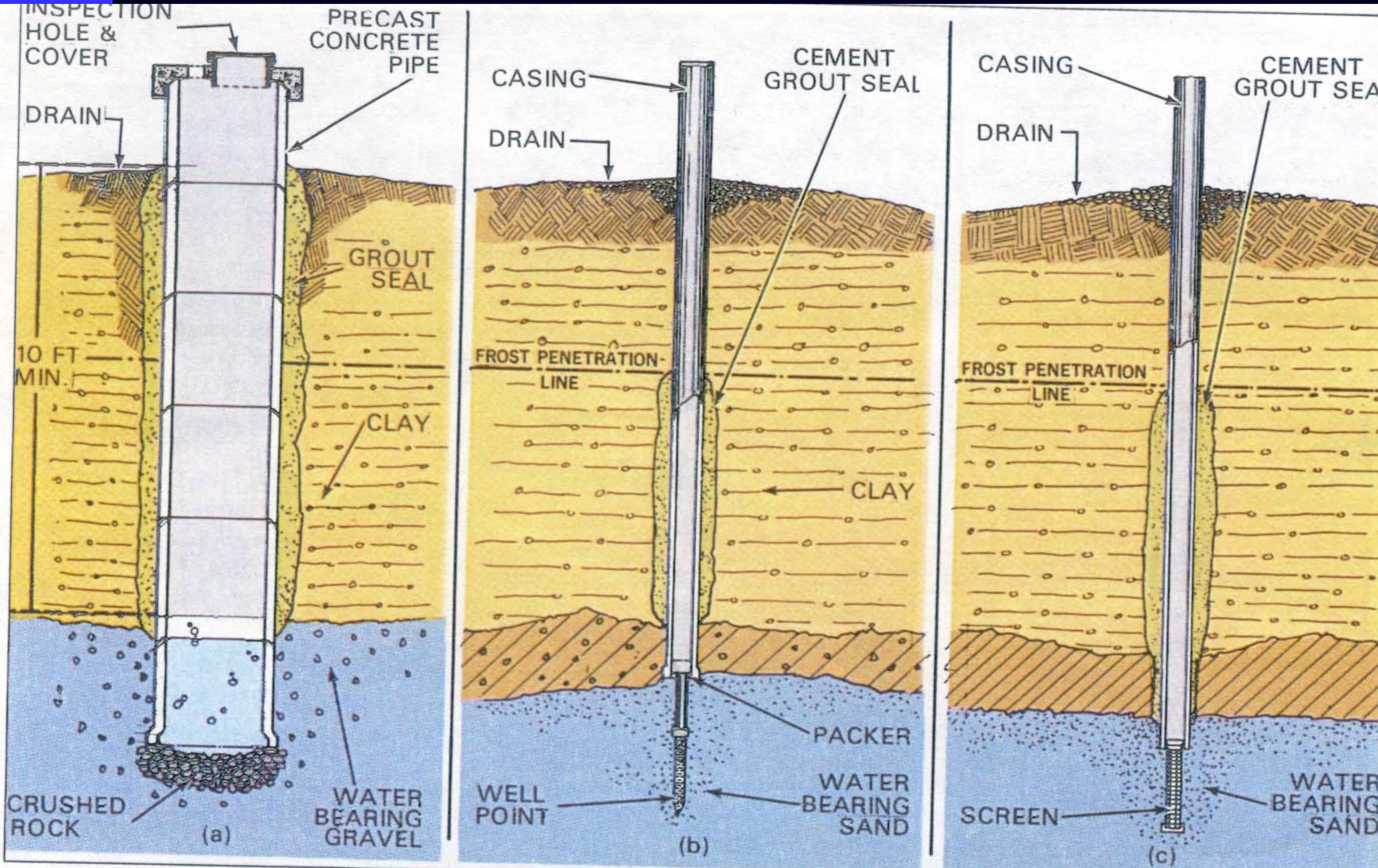


FIGURE 19. Methods of protecting wells from surface pollution, (a) Dug well. (b) Bored well with driven well point. (c) Drilled well.[21]

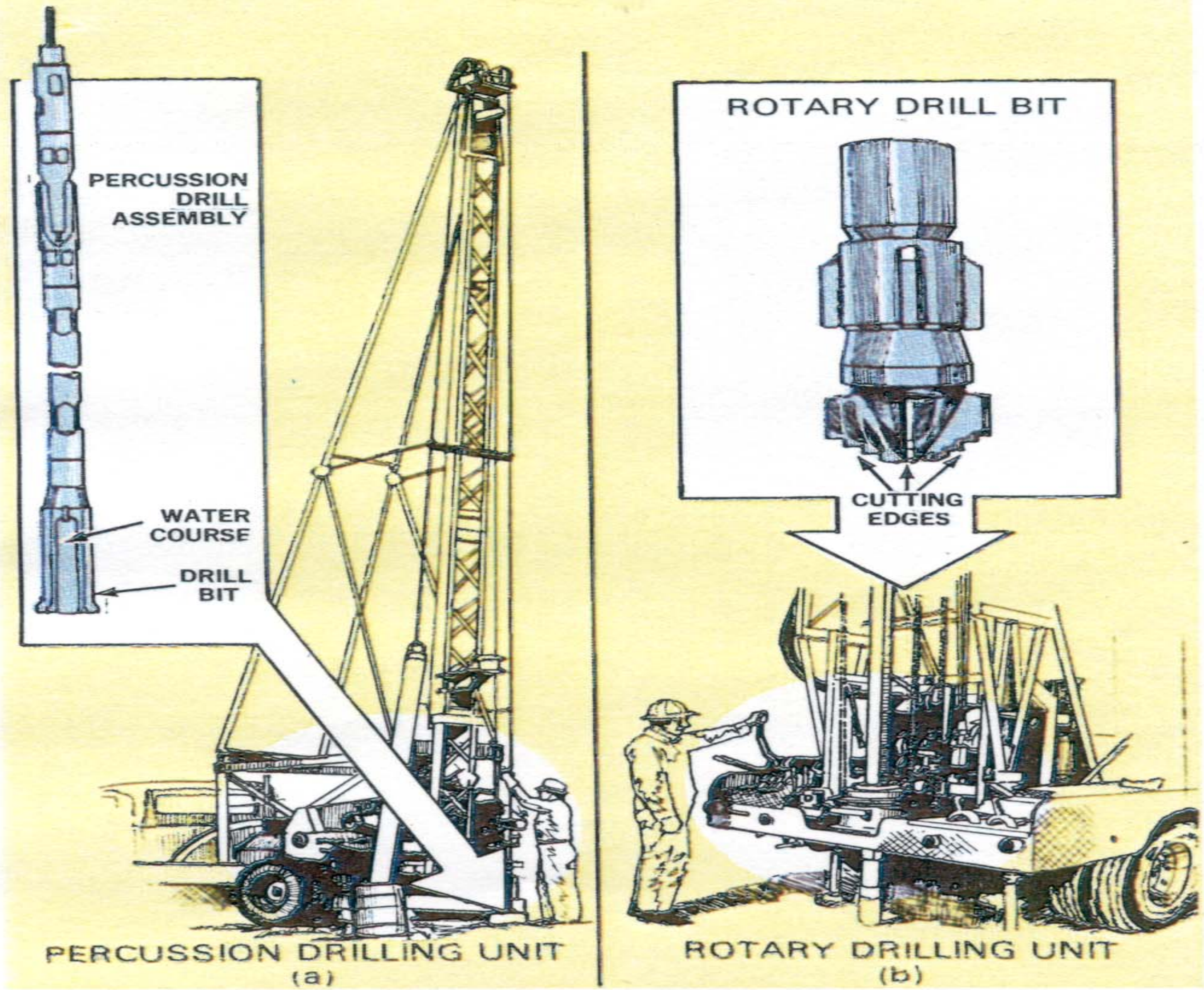


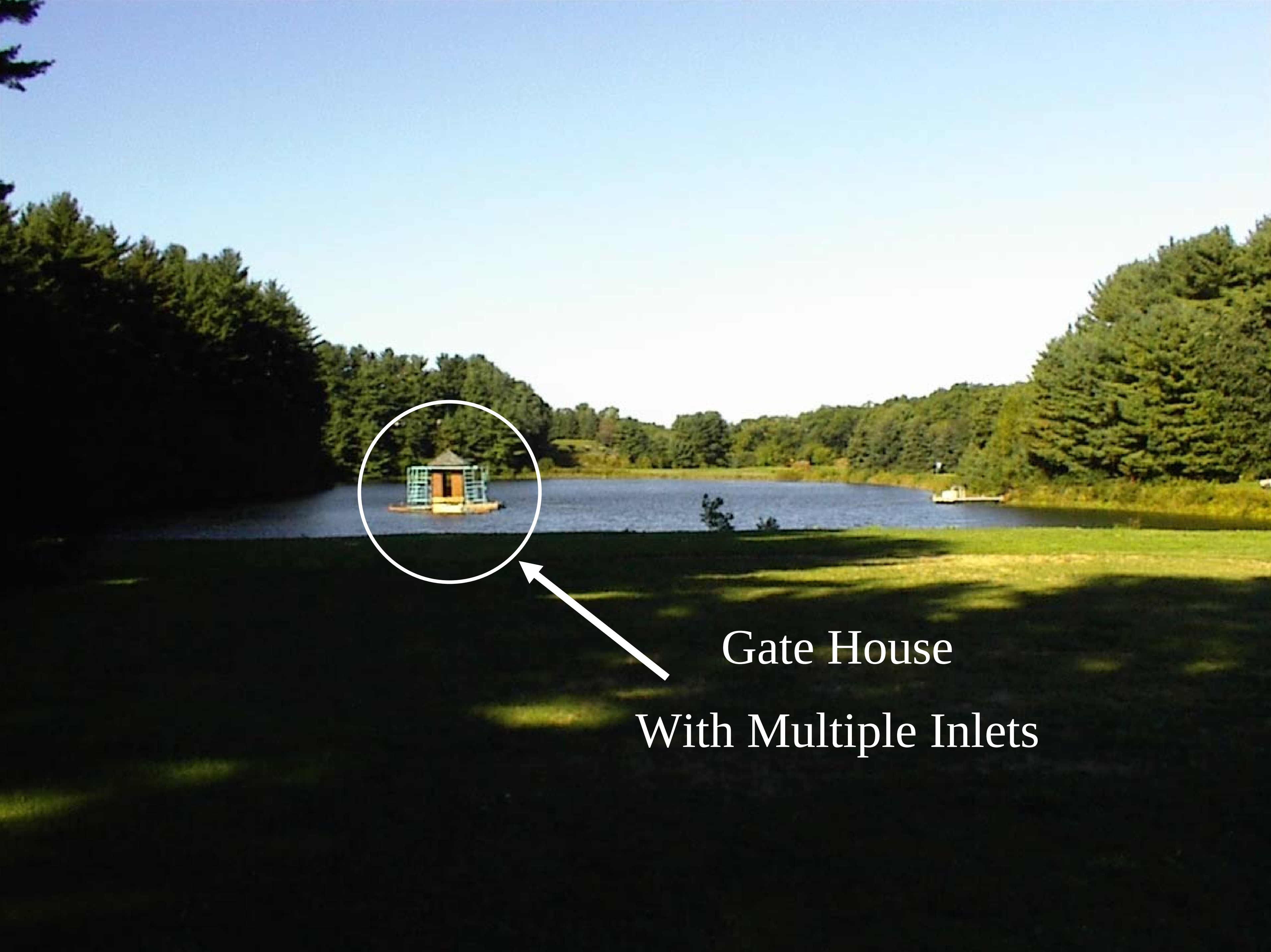
FIGURE 4. Machines used for drilling wells. (a) Percussion unit—one that punches and hammers its way through soil and rock. (Inset) One type of drill used with percussion machines. (b) Rotary unit—one that bites and crushes its way through soil and rock. (Inset) One type of rotary drill bit.

Factors affecting groundwater quality

- Geologic formations (topsoil, limestone, sand, gravel, granite,etc) encountered by the water during its flow history – natural contaminants/minerals
- Age of the water
- Man-made contamination
- Poor well construction, location and/or poor well maintenance practices

Surface Water Supplies

- ***Surface Water*** – all water that is open to the atmosphere and subject to surface runoff (Examples: lakes, ponds, streams)
- ***Reservoir*** – a natural or manmade body of surface water used for the storage of public drinking water
- Surface water accounts for approximately 63% of the public drinking water in Connecticut
- Required to be filtered and chemically treated prior to distributing to customers


Gate House
With Multiple Inlets

- A gatehouse with multiple inlets allows water to be drawn from various depths in the reservoir depending where the best water quality is available during various seasons of the year.

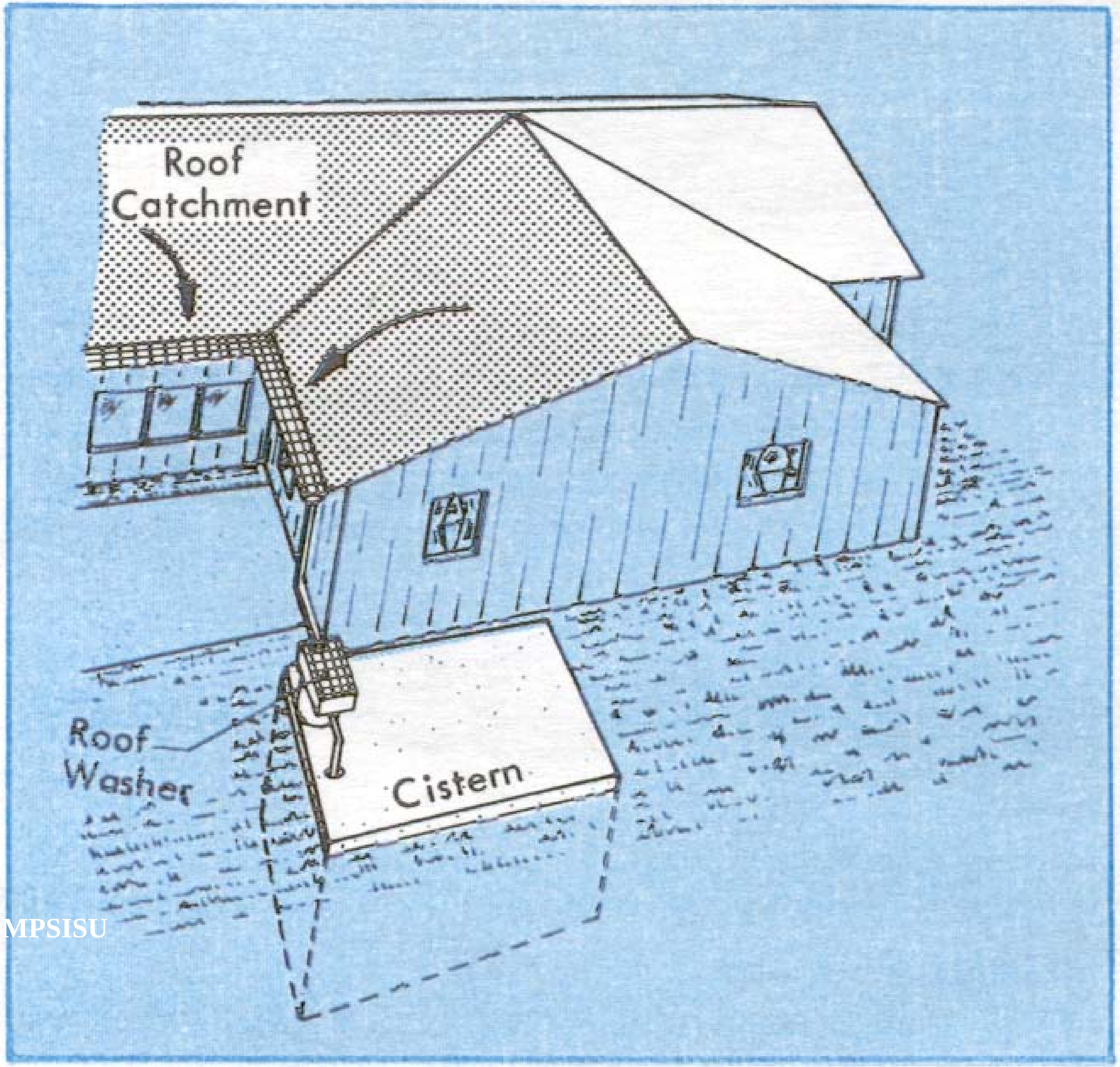


Fig 13. Roof catchment and cistern.

RAINWATER HARVESTING

- The last slide shows a practice that has been used historically in the Caribbean Islands. Now it is being implemented in many of our southwest & southeast states due to ongoing drought conditions there.

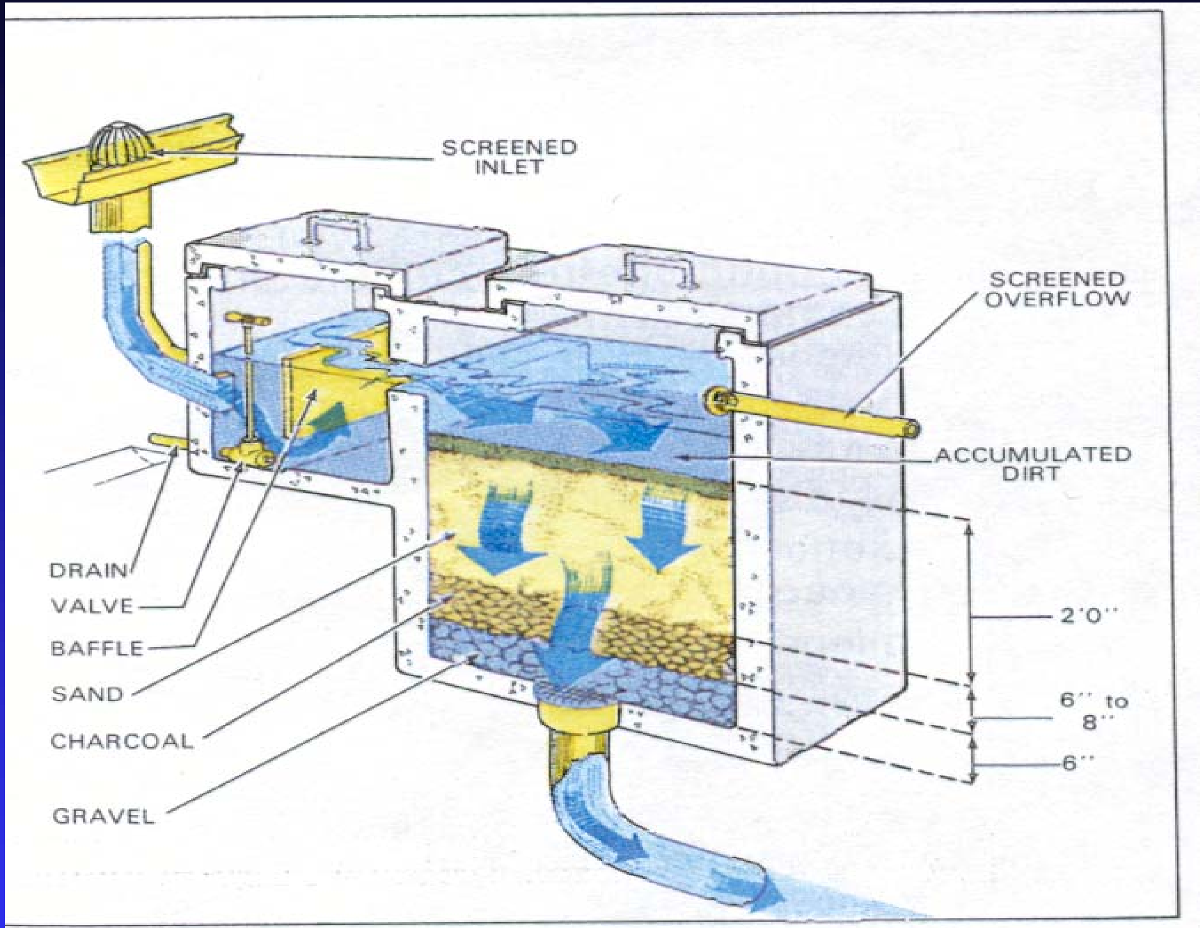


FIGURE 23. A sand filter of this type can be very effective in reducing pollution of cistern water if kept clean. If not cleaned regularly, it can be a source of pollution.

AAVIM

Maximum Contaminant Level (MCL)

- Health based standard established by EPA
- Defined as “the maximum permissible level of a contaminant in water that is delivered to any consumer of a public water system” in PHC Section 19-13-B102
- MCLs also apply to private wells under PHC Section 19-13-B101
- States can adopt EPA’s established MCLs or set their own as long as they are at least as strict as the Federal MCLs

Acute vs. Non-Acute Contaminants

- Acute contaminants pose an immediate and substantial health risk to consumers
  - E. coli Bacteria
  - Nitrate
  - Nitrite
- Non-acute contaminants pose long term health risks from chronic exposure

Interpreting Water Test Results

- Milligrams per liter (mg/L) = Parts per million (ppm)
- Micrograms per liter (μg/L) = Parts per billion (ppb)
- (ppm) x (1000) = ppb
- Less than (<) means no quantifiable amount of a particular contaminant was detected and the number following the < sign is the lowest concentration for which the testing procedure/equipment could detect for that specific contaminant
- Not Detected (ND) is similar to the < sign and means no quantifiable level of a contaminant was found above the Minimum Detection Limit (MDL)

Interpreting Water Test Results (cont.)

- Testing must be performed by a State approved laboratory identified on the water test report certified to perform analysis for the contaminants analyzed on the report
- Each contaminant level that is reported must be compared to the contaminants respective drinking water standard (MCL, Action Level, or Secondary Standard) and a determination made whether the level of a contaminant poses a health risk and/or warrants additional testing

Columbia Environmental Laboratory

Drinking Water Analysis

STATE OF CONNECTICUT
DEPARTMENT OF HEALTH
CERTIFICATION NUMBER
PH-0514

October 14, 2005

Raw water??

RE:

SAMPLING LOCATION:
SAMPLING / DELIVERY TIMES:

		STANDARD WATER ANALYSIS TEST RESULTS	STATE OF CONNECTICUT RECOMMENDED / MAXIMUM LEVELS	
pH	UNITS	7.1	6.4 - 10.0	RECOMMENDED RANGE
COLOR	UNITS	5	15	RECOMMENDED MAXIMUM
ODOR	0-5	0 (none)	3	RECOMMENDED MAXIMUM
TURBIDITY	NTU	2.7	5	RECOMMENDED MAXIMUM
ALKALINITY	mg/L	--	NO RECOMMENDED LEVEL	
CHLORIDE	mg/L	72	250	MAXIMUM ALLOWABLE
HARDNESS	mg/L	2.0	0-60 soft, 61-120 mod. hard 121-180 hard, >181 v. hard	
NITRITE AS N	mg/L	<.005	1.0	MAXIMUM ALLOWABLE
NITRATE AS N	mg/L	0.15	10.0	MAXIMUM ALLOWABLE
IRON	mg/L	<0.05	0.3	RECOMMENDED MAXIMUM
MANGANESE	mg/L	<.010	.050	RECOMMENDED MAXIMUM
SODIUM	mg/L	87	28	RECOMMENDED MAXIMUM
COLIFORM BACTERIA		0/100 ml	0/100 ml	MAXIMUM ALLOWABLE
Sulfate	mg/L	23		
Chlorine, Residual	mg/L	<.05		

For the parameters analyzed, this is a satisfactory potable drinking water supply. Persons on a low sodium diet should be aware that the sodium concentration exceeds the State of Connecticut recommended maximum of 28 mg/L. A high concentration of sodium is NOT a basis for the rejection of a drinking water supply.
If you have any questions, please feel free to call.

Very truly yours,
John C. Burrell

46 ppm Na → 100 ppm
92 ppm Na → 200 ppm
plus background Na

Coliform Bacteria

- Coliform organisms are commonly found throughout the environment and also in the digestive tracts and feces of warm-blooded animals
- Their presence indicates that contamination may be entering the water system thereby creating an unsanitary condition
- Generally do not cause disease by themselves, however, if present, it is assumed that disease causing organisms (pathogens) may also be present

Total Coliform MCL

- MCL for total coliform bacteria is zero or absent
- Multiple analytical techniques used to perform coliform analysis
- Results are most often reported as present/absent
- Results may also be expressed in <u>numerical format</u> as # colonies/100ml (good for resamples)
- If results indicate presence of coliform, sample is further analyzed for fecal coliform or E.Coli

Why is total coliform bacteria used an indicator of the bacteriological quality of drinking water rather than pathogens themselves?

- Total coliform bacteria is used as a baseline for the following reasons:

  1. Relatively easy test to perform

  2. Reliability of the test results

  2. Results obtained relatively quickly (24 hrs)

  3. Relative ease of sample collection

  4. Relatively inexpensive test

Common Sources of Coliform Bacteria

- Well casing not adequately sealed into bedrock
- Missing, broken, or non-watertight well caps
- Flooded well pits
- Septic systems or other sources of pollution within the zone of influence of the well
- Repair work done to the water system not followed by disinfection (pump replacement, plumbing work)

Common Sources of Coliform Bacteria (cont.)

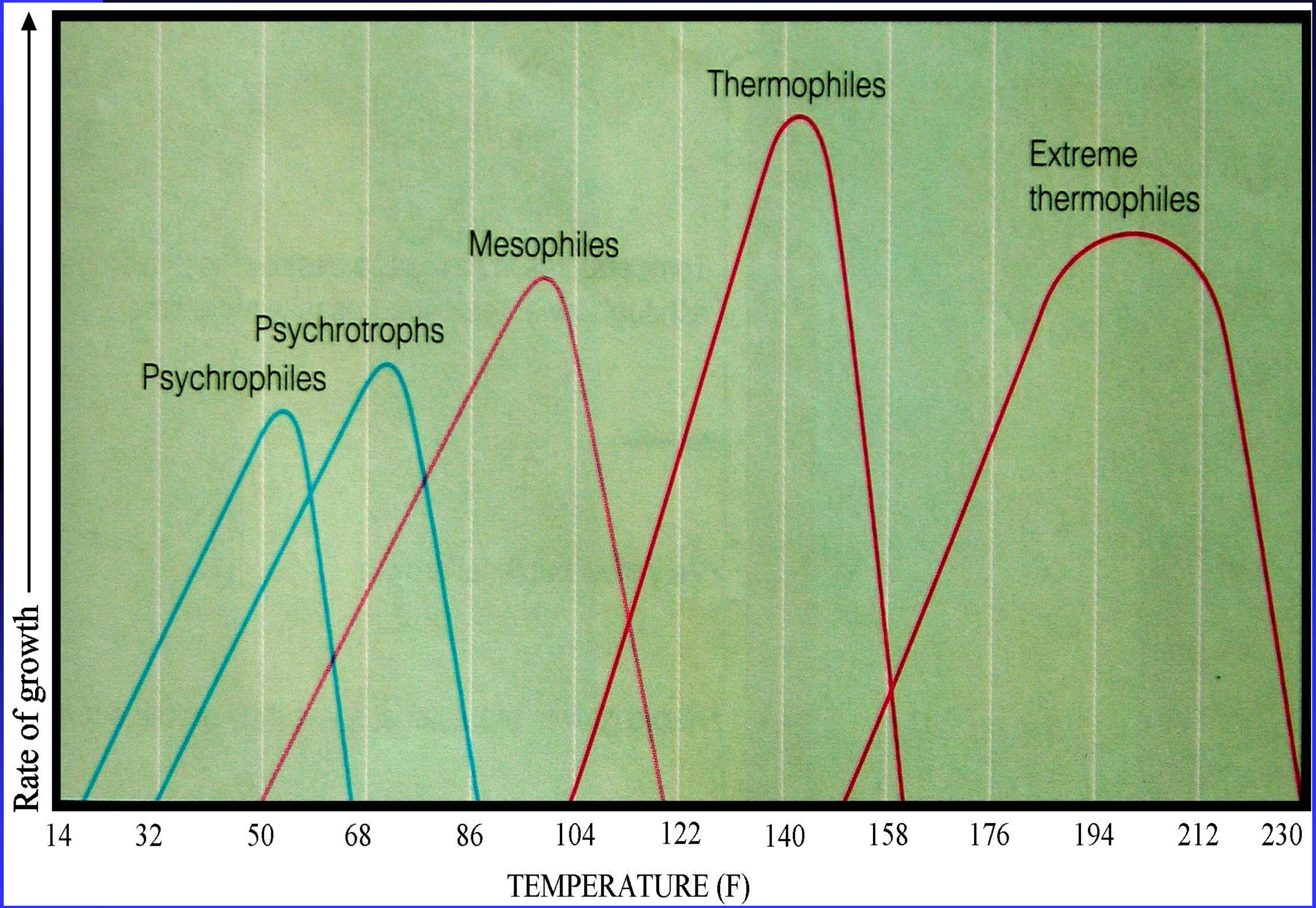
- Inadequately protected neighboring wells
- Cross-connections with non-potable water systems
- Lack of casing surface grout, 10 feet
- Leaking Pitless Adapter
- Cracked casing, leaking casing joints/welds

E. Coli Bacteria/Fecal Coliforms

- Indicator organisms
- The presence of E. Coli bacteria or fecal coliforms is an indicator of fecal contamination and poses an acute health risk to consumers
- Many strains of E. Coli may not pose a health risk, however, some strains like E. Coli 0157:H7 can be fatal to an infected person
- The presence of E. Coli or fecal coliform increases the likelihood that other disease causing pathogens are present that can pose a significant health risk

Sources of E. Coli Bacteria

- Septic systems
- Rodents (mice, rats, squirrels, etc.) entering and falling into dug wells or improperly vented atmospheric storage tanks
- Vermin nesting beneath drilled well caps that do not provide a watertight sanitary seal
- Submerged well heads in areas where animal feces are present and storm water run-off enters the well



Thermophiles
Extreme thermophiles
Mesophiles
Psychrotrophs
Psychrophiles
Rate of growth
14
32
50
68
86
104
122
140
158
176
194
212
230
TEMPERATURE (F)

Heterotrophic Plate Counts (HPC)

- EPA uses HPC as surrogate for free chlorine residual. CFR 141.72 & 141.74.
- Good indicator of extent of contamination & sanitary condition of the water.
- Indicator of gross surface water or water table contamination.
- High counts, >500, could be indicative of improper chlorination of pipes/wells and will negate coliform results (>200).

Common Pollution Sources

- Subsurface sewage disposal systems
- Storm drainage systems
- Buried fuel oil and propane tanks
- Ponds and streams
- Application of Fertilizers, Pesticides, Herbicides
- Improper disposal of hazardous waste
- Construction site “bury” holes

pH

- pH is measured on a scale of 1-14

Acidic pH	< 7
Neutral pH	$= 7$
Alkaline pH	> 7

- Recommended range of pH is 6.4-10
- Groundwater in CT commonly have a pH < 6.4 typically a caused by dissolved <u>carbon dioxide</u>
- A pH level below 6.4 is not a health concern but an indication that excessive plumbing corrosion may be taking place

Turbidity

- Turbidity is a measure of the ability of light to pass through water
- Caused by suspended material in water
- For protected groundwater sources turbidity is typically the result of elevated levels of naturally occurring minerals in water (predominantly iron and manganese in CT) and usually is not a health concern when associated with these minerals
- Used as a surrogate for microbial (viral) contamination in EPA’s SDWA

Nitrate and Nitrite

- Both are acute parameters
- Can be an indicator of septic or fertilizer influence
- More frequent monitoring recommended if nitrate level is above 5 mg/L.
- Nitrate level can vary seasonally. More frequent monitoring may pick up seasonal variation.
- Nitrite is an indicator of fresher pollution. Usually associated with extremely high coliform counts. Nitrate is a breakdown product.

Nitrite Nitrogen

- MCL = 1.0 mg/L
- Seldom found at high concentration in drinking water as it is rapidly converted to nitrate in oxygenated waters
- Indicates recent contamination from septic systems, fertilizers, or other sources of ammonia decomposition
- Similar health effects as nitrate only at lower concentrations

Nitrate Nitrogen

- MCL = 10 mg/l and considered an acute health risk
- May cause methemoglobinemia ("blue baby disease") by displacing oxygen in the blood
- Particularly harmful to young children (under 5 years at risk), pregnant or nursing mothers, and "at risk" adults with certain health conditions (ex. chronic anemia, pulmonary disease)
- Sources of pollution include: septic systems, fertilizers, agricultural land

Sodium

- Notification level (ONLY) is 28 mg/L for PWS
- Elevated sodium levels are only a health concern to persons who are on a sodium restricted diet due to health conditions such as high blood pressure or hypertension
- Community PWSs are required to notify their customers annually of the sodium content of the water if it exceeds 28 mg/L
- Non-Community PWSs (TNC, NTNC) are not required to notify customers of sodium content
- Also indicative of softener backwash

Chloride

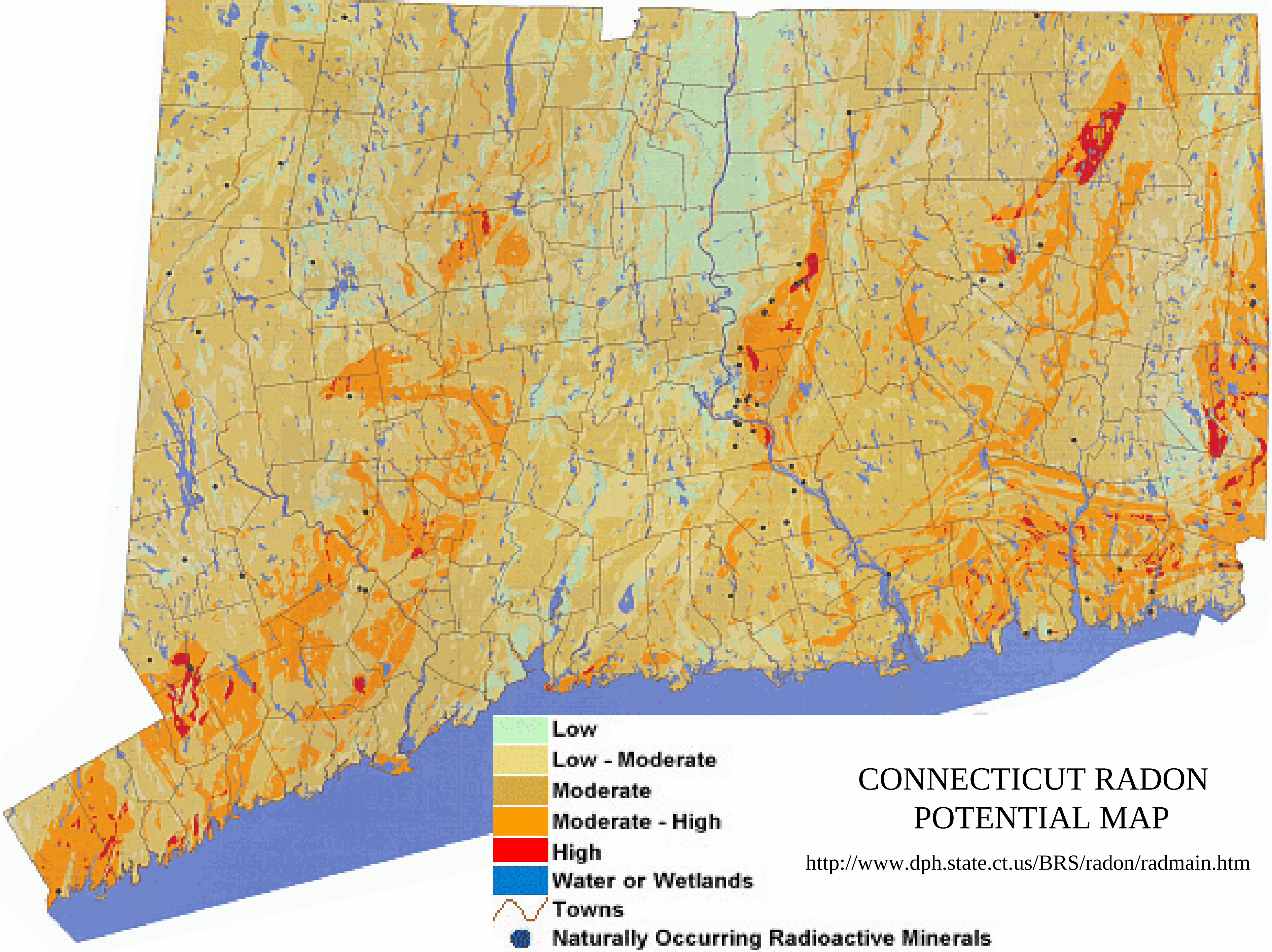
- Secondary aesthetic standard set by EPA is 250 mg/L
- CT has set a State MCL of 250 mg/L
- High chloride levels may cause excessive plumbing corrosion and impart a brackish (salty) taste to water
- Chloride can be naturally occurring or manmade pollution
- Typical contamination sources include road salt and salt water intrusion to wells near the shoreline
- Often indicative of on-site softener backwash

Natural Radioactivity

- Only Community PWS required to test
- Gross Alpha (screening test) – if results above 15 picocuries per liter (pCi/l) test for:
  - Radium 226 and 228
  - Uranium

Natural Radioactivity (cont.)

- Radon
  - not currently a regulated contaminant in water
  - Alpha emitter – risks from inhalation
  - High levels in water may contribute to elevated indoor air radon levels of >4pCi/l
  - High velocity exhaust fans in shower/laundry room



CONNECTICUT RADON POTENTIAL MAP

http://www.dph.state.ct.us/BRS/radon/radmain.htm

Man-made Contaminants

- ***Volatile Organic Chemicals*** – Hydrocarbons and Chlorinated Solvents (Fuel oil, gasoline, chemical solvents)
- ***Synthetic Organic Chemicals*** – Pesticides, Herbicides, and PCBs
- ***Inorganic Chemicals*** (Heavy Metals) – lead, cadmium, chromium, mercury, etc. – some are naturally occurring (examples: arsenic, fluoride, beryllium) but rare in CT at elevated levels

Secondary Drinking Water Standards

- Secondary contaminants do not have MCL's and are not considered to present a risk to human health above the standard
- Established by EPA as guidelines for aesthetic considerations such as taste, color, and odor
- In CT color (true) is a MCL for PWS

Color and Odor

- Standards, not MCL's.
- Color limit is 15, apparent color-private wells, true color-public water systems. (is an PWS MCL).
- Odor limit is 2.
- Subjective tests performed at the laboratory.

Aesthetic Parameters

- Aesthetic parameters include:

  1. Iron
  2. Manganese
  3. Hardness
  4. Sulfates
- Most common water quality complaint due to taste, odor, color, or staining of plumbing fixtures, glassware, or laundry.

Iron

- Secondary standard is 0.3 mg/L
- Levels above 0.3 mg/L may cause discolored water and orange/brown staining of plumbing fixtures, laundry, etc.
- Very common in CT groundwater at levels exceeding 0.3 mg/L
- Common treatment systems include oxidation/filtration or water softening
- No known adverse health effects for consumers

Manganese

- CT DPH has set a Manganese Action Level of 0.5 mg/L which is considered a health based standard (no Federal health based standard)
- Manganese Levels > 0.5 mg/L may pose an increased health risk to the central nervous system particularly to young children or the elderly

Manganese (cont.)

- Secondary Standard is 0.05mg/l
- Levels above 0.05 mg/L may cause discolored water, dark brown/black staining of fixtures and laundry

Iron/Manganese Bacteria

- Often, but not always, present with elevated iron or manganese
- Non pathogenic,nuisance microbes that affect aesthetic quality of water
- Periodic superchlorination of well *may* work
- Often requires an oxidizer continuous feed

Hardness

- No secondary standard for hardness
- "hard water" … 150 mg/L $CaCO_3$
- Treatment is not recommended unless it is a nuisance
- Requires a DEP permit to discharge
- (see detailed article on Webpage@DPH-EHS-Private Wells)

Sulfate

- No MCL set for this contaminant
- There is a secondary (aesthetic) standard of 250 mg/l.
- Sulfate is a constituent of hardness
- In the presence of certain bacteria, odor problems (rotten egg) may develop.
- Above 1000 mg/l, laxative effects are possible.

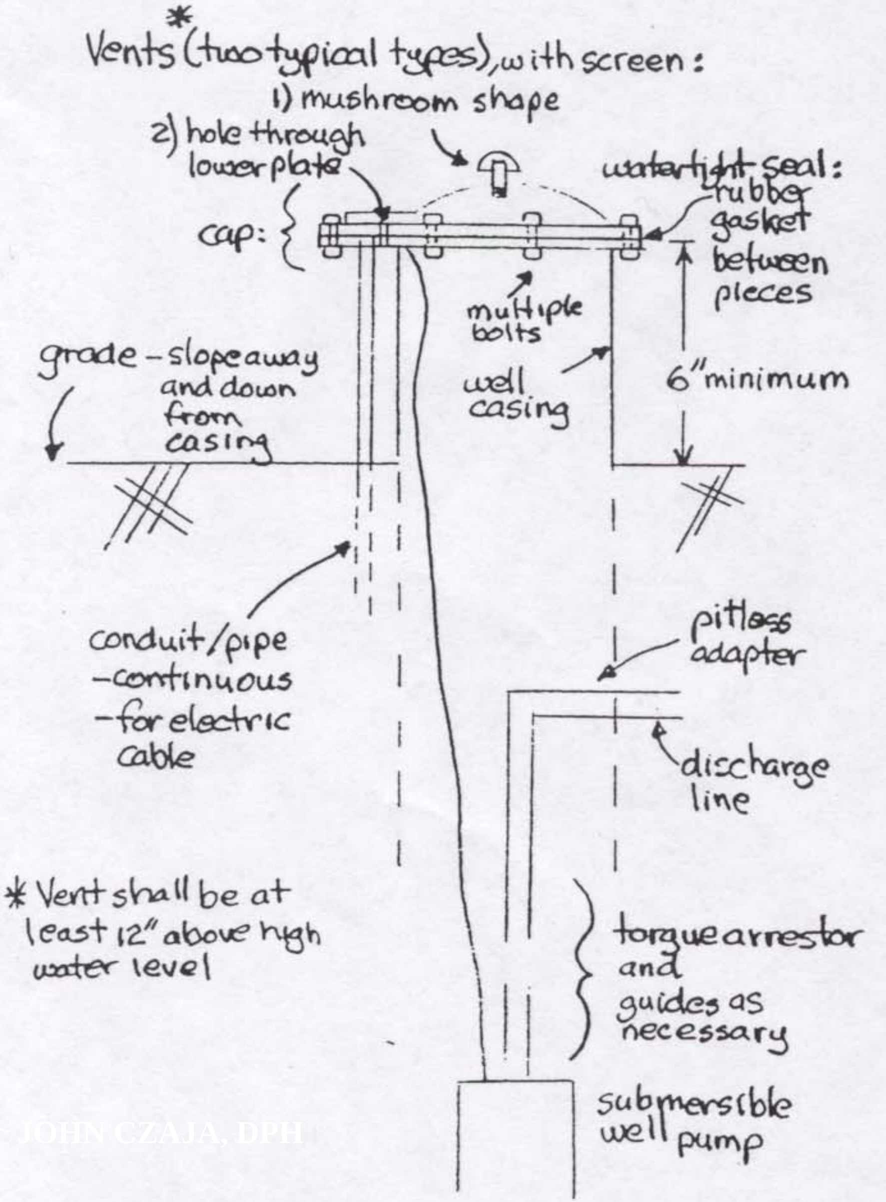
Well Construction

- Section 19-13-B51a-m provides the minimum Public Health Code well construction requirements for <u>all</u> water supply wells in CT
- Chapter 482 of the Connecticut General Statutes provides the description of organization, rules of practice, and regulations for the well drilling industry (water supply and non-water supply wells) commonly referred to as the "<u>Well</u> <u>Drilling</u> <u>Code</u>"

Well Construction (cont.)

- SBC sec. 608.17.
- If the newly constructed well is to remain idle for an extended period the well should be chlorinated and securely capped.
- PHC requires the pump installer to chlorinate the well. (19-13-B51k c)

- The following slides show the various components of well construction and how jet and shallow well pumps work.



DPH, WSS Schematic - Not to Scale

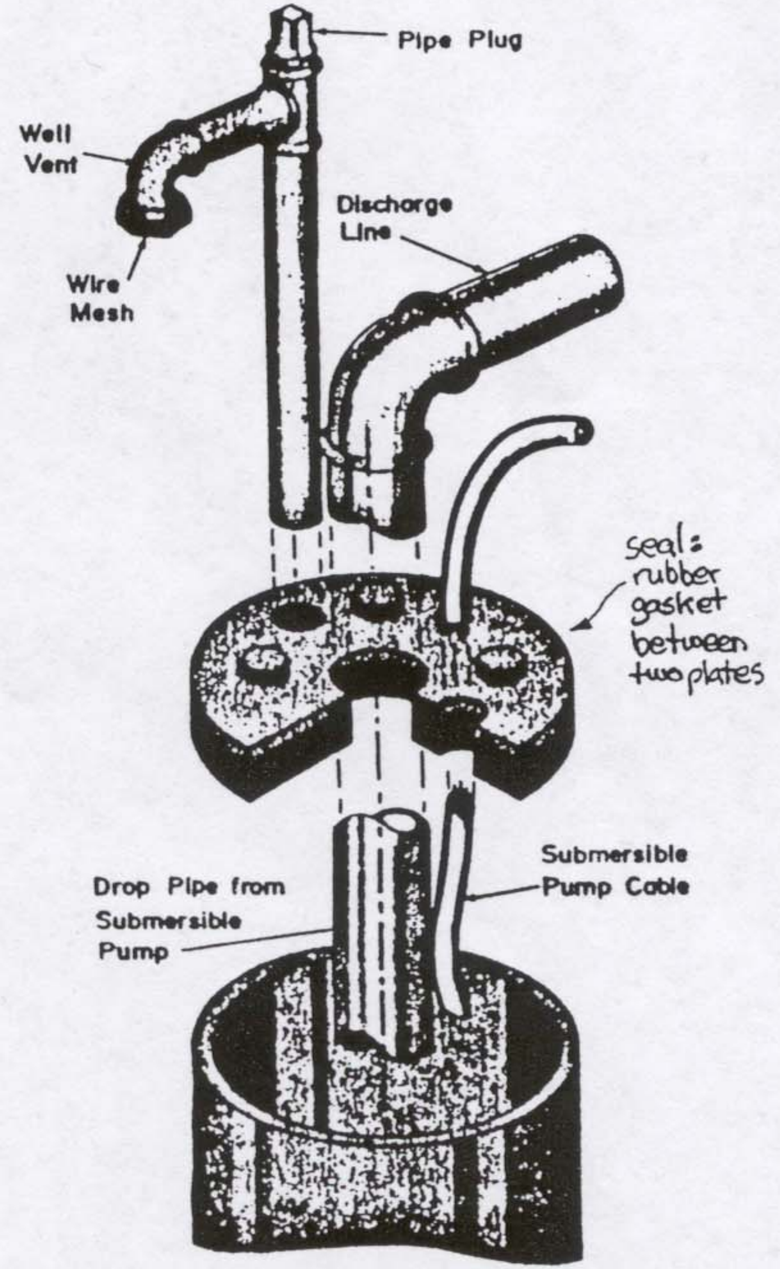


FIGURE 9. Well seal for submersible pump installation.

EPA Manual of Individual Water Supply Systems

Figure 12.2. Examples of various items mentioned in this chapter: Tank tee connects water supply to the pressure tank; torque arrestor stops effect of motor torque on pipe; cable guard holds pipe and motor cable in center of well; and lightning arrestor protects pump motor and control box from power surges.

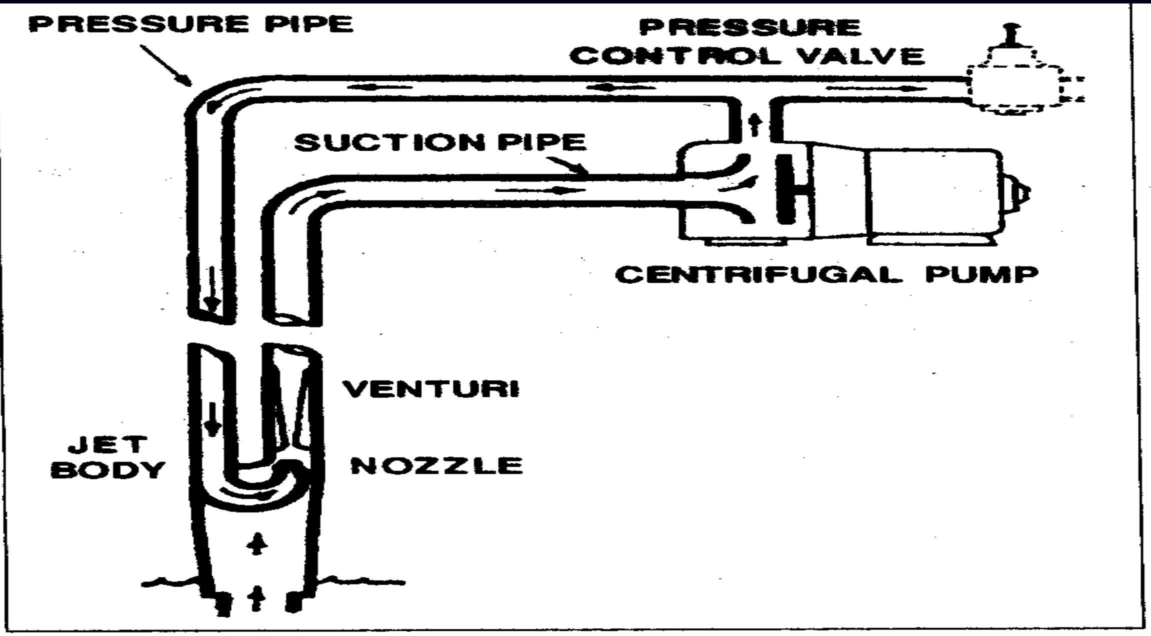


Figure 4.4. Arrangement of components in a deep-well jet system. The ejector, located down in the well, is connected to both a pressure pipe and a suction pipe.

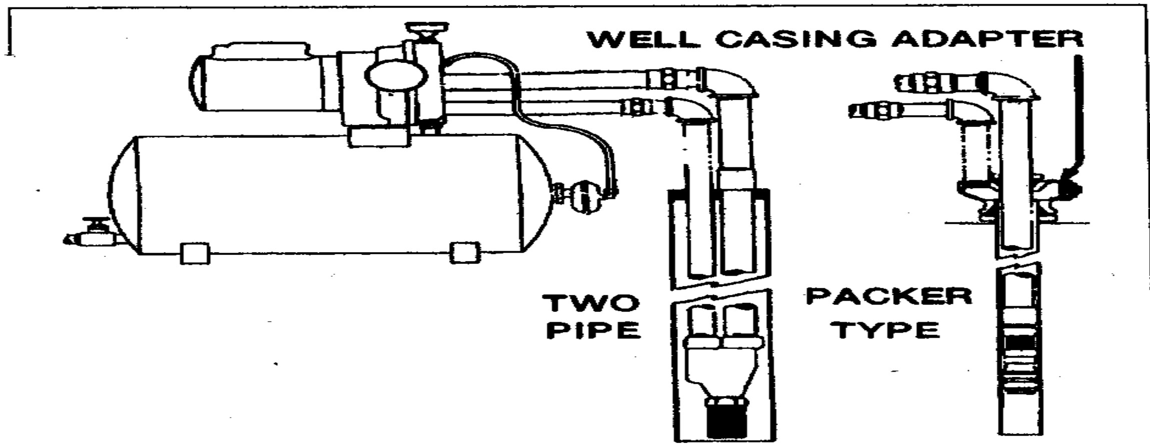


Figure 4.5. Alternate deep-well jet installations: the two-pipe system (left) and the packer type (right). The latter requires a special well casing adapter and a special ejector which fits tightly against the casing.

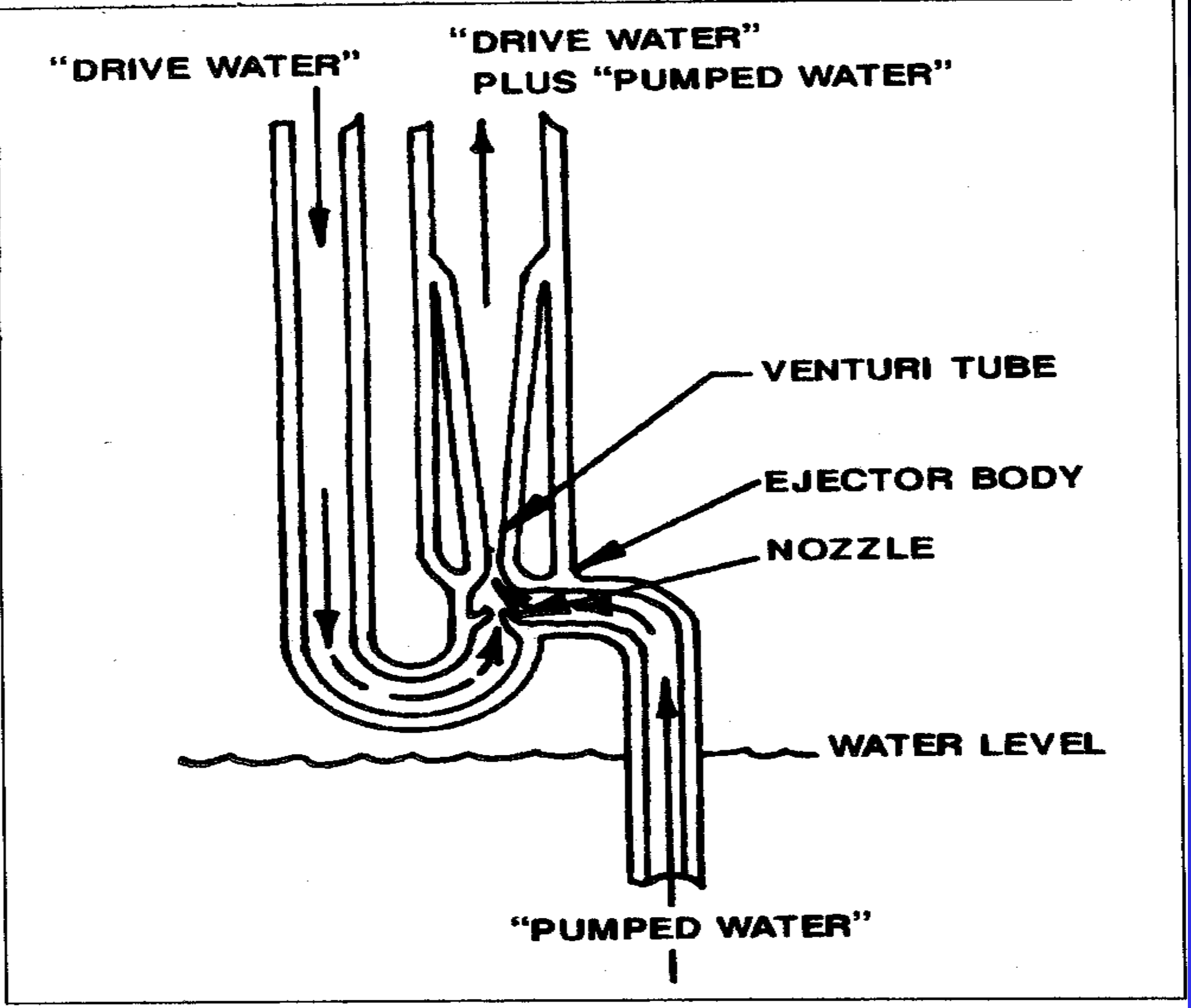


Figure 4.1. Operation of the ejector. High-velocity flow of drive water creates a partial vacuum at the nozzle discharge. Atmospheric pressure forces the pumped water in the vacuum area nozzle. A combination of drive water and pumped water flows through venturi, where the pressure increases as velocity decreases.

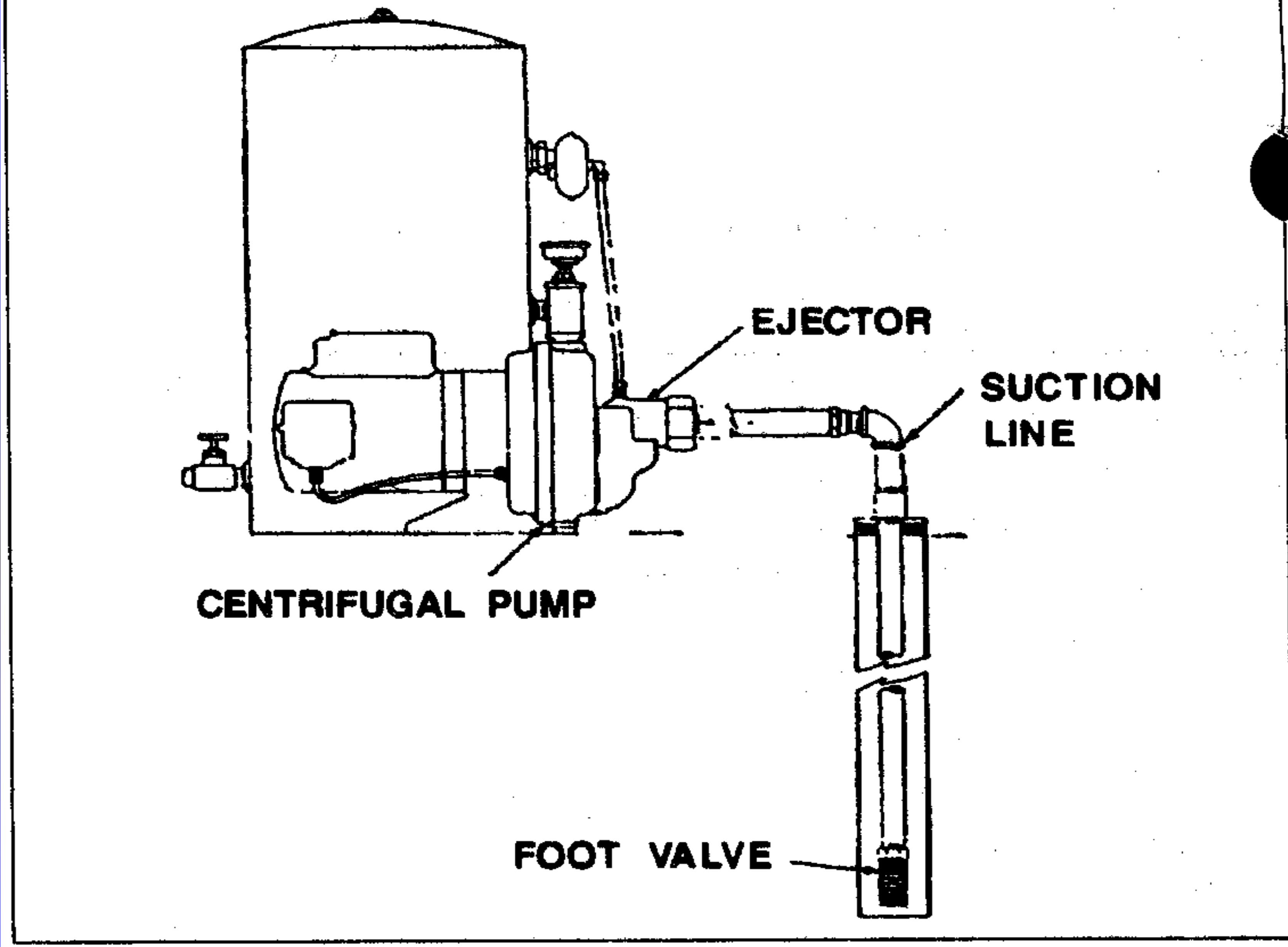


Figure 4.3. Typical shallow-well jet pump installation. Suction line from ejector can deliver water from a well depth of about 25 feet.

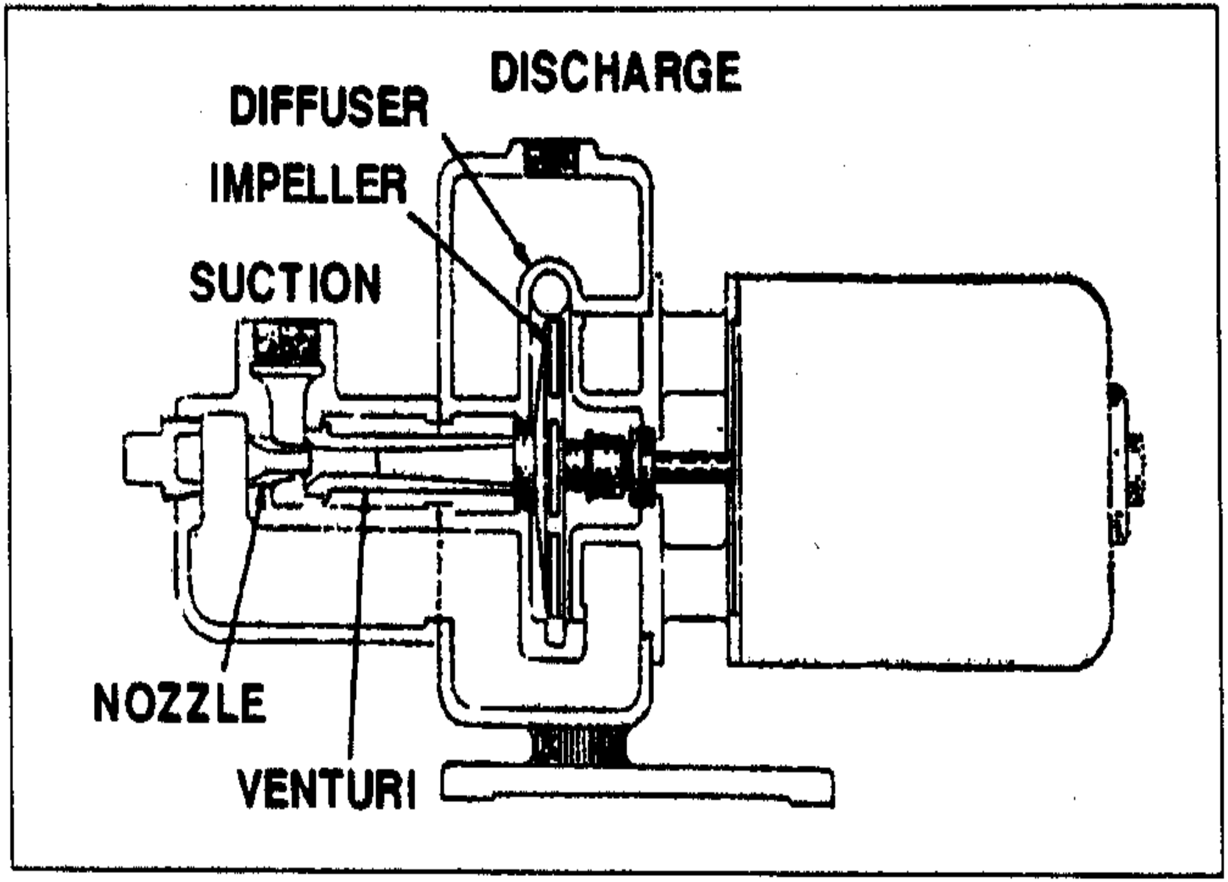


Figure 4.2. Shallow-well jet pump. Note that the ejector is mounted on the pump body itself, rather than down in the well.

WSC

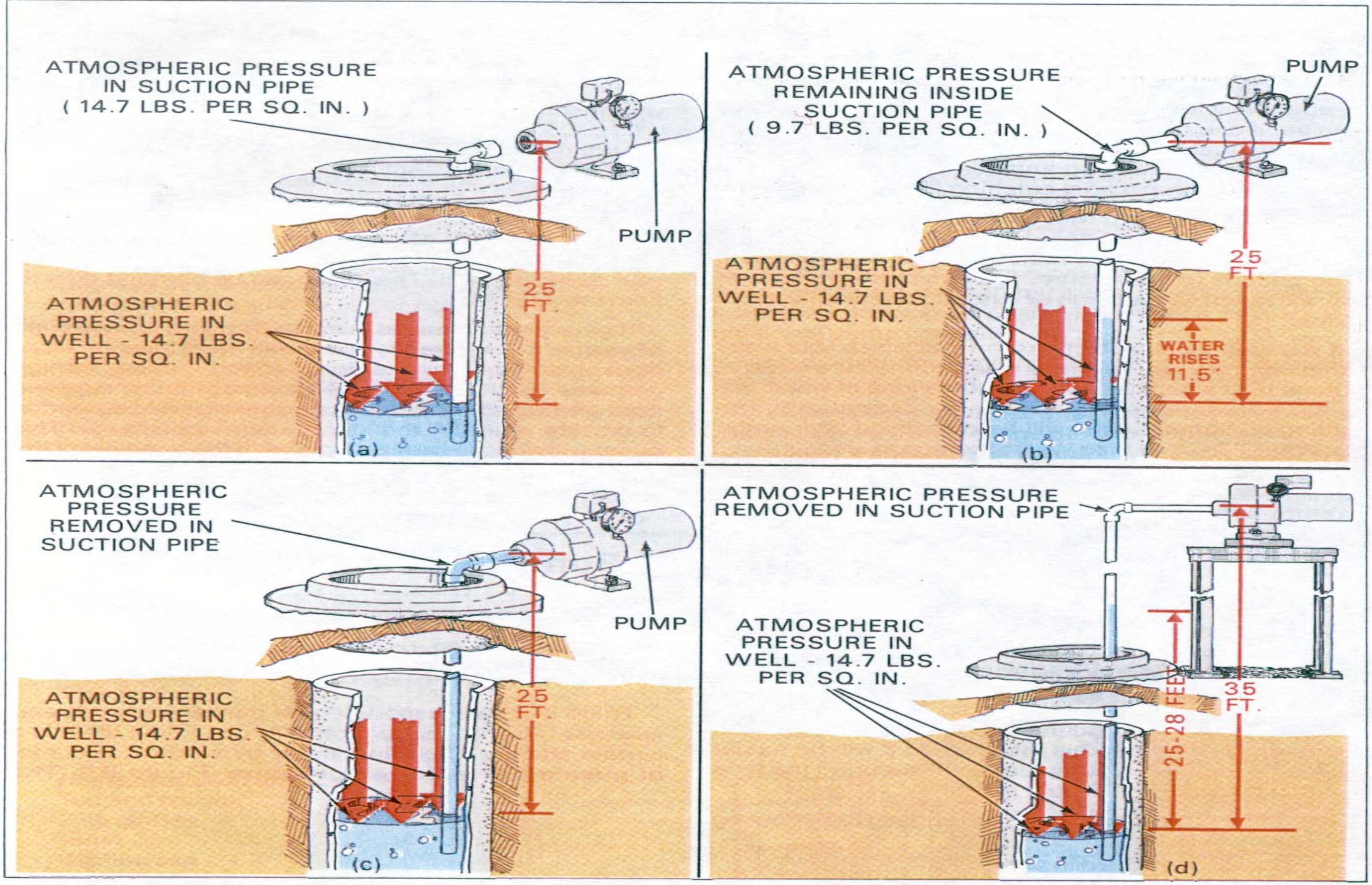


FIGURE 64. How a pump lifts water by suction. (a) With the pump suction pipe disconnected, atmospheric pressure on the water in the well and the water inside of the pipe is the same—14.7 pounds per square inch (at or near sea level). (b) When the suction pipe is connected to the pump and the pump is started, air pressure in the suction pipe is reduced (a partial vacuum develops) and the water rises from the well into the pipe. (c) As pumping action continues, all air is pumped from the suction pipe so that atmospheric pressure pushes the water into the pump. (d) If the pump is raised too high above the water source, there is not enough atmospheric pressure to push the water into the pump.

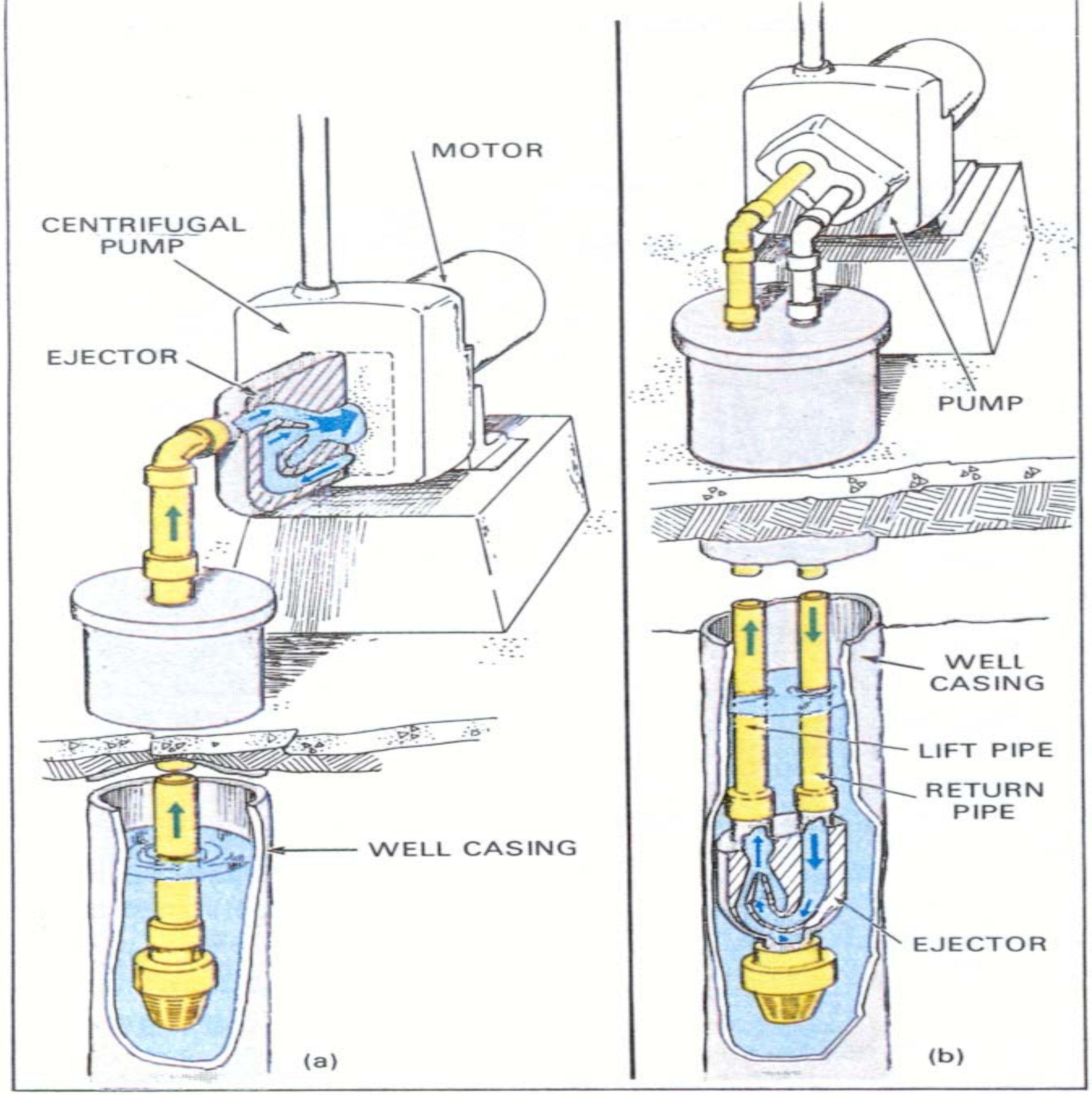


FIGURE 73. (a) With a shallow-well jet pump, the ejector is mounted close to the pump impeller. (b) With a deep-well jet pump, the ejector is usually mounted just above the water level in the well, or else submerged below water level.

AAVIM

WELL DRAWDOWN

- 2 Simple Methods

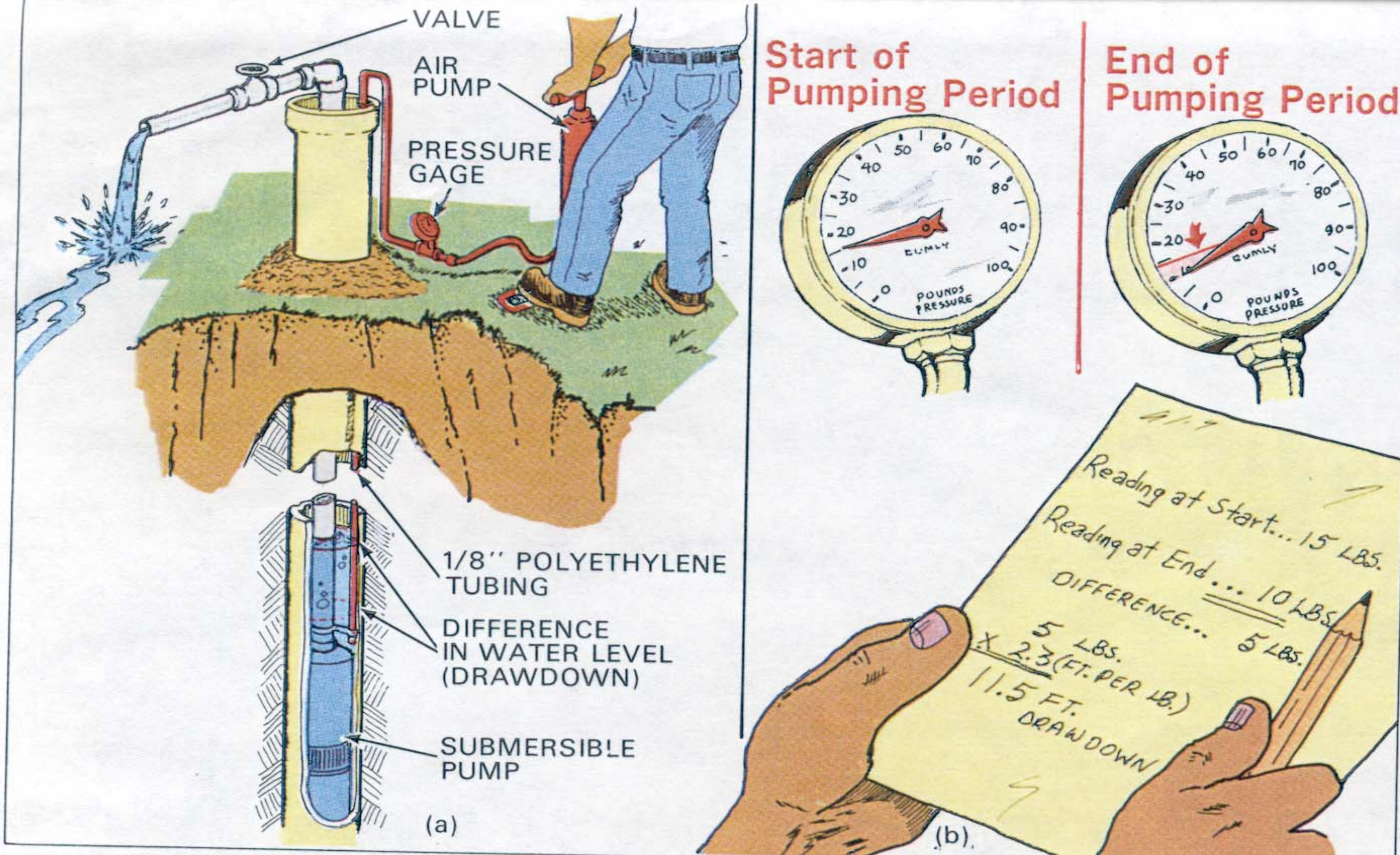


FIGURE 11. (a) Arrangement for checking drawdown in wells of small diameter. (b) Procedure for determining amount of drawdown. (A column of water 2.3 feet high causes a pressure of 1 pound per square inch.)

AAVIM

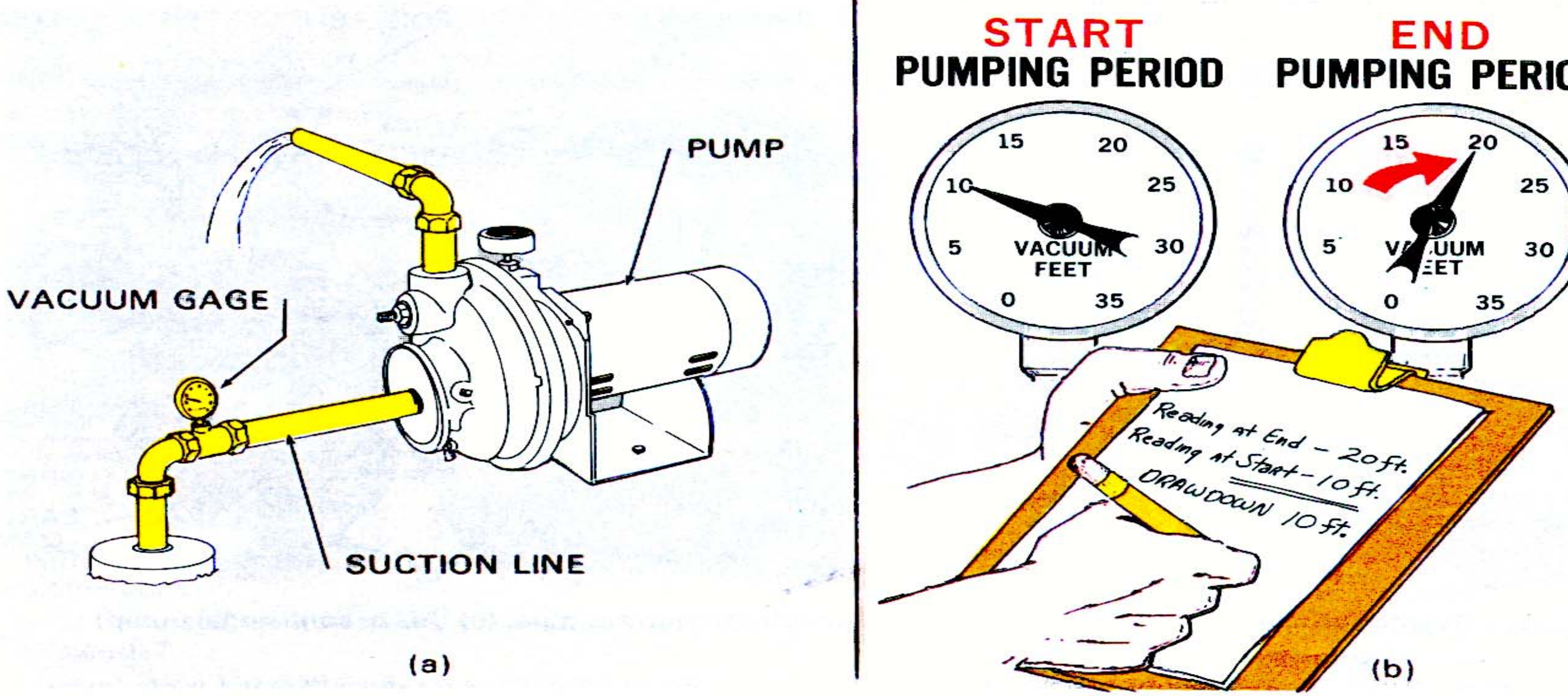


FIGURE 12. **(a) Arrangement for checking drawdown on a driven well. (b) Figuring drawdown from vacuum gage readings.**

If you have a small-diameter jetted or driven well, the pump suction line may be the only means you can use to check drawdown. In this case you will need to use a **vacuum gage.** Use a piston pump for testing—one that is in good condition. It will lift water by suction as much as 25 feet, under most conditions. Proceed as follows:

1. *Connect suction side of pump to well drive pipe (Figure 12a).*
2. *Insert gage in suction line.*
3. *Start pumping operation.*
4. *Check gage reading immediately and record.*
5. *Check gage reading at end of test period.*
6. *Subtract lower reading from higher reading (Figure 12b).*

Most vacuum gages are *calibrated in feet.* If yours indicates calibration in feet, you have the feet of drawdown already determined.

Some vacuum gages are *calibrated in inches of mercury.* If yours is that type, multiply your reading by 1.13 to get the feet of drawdown.

One precaution—in checking drawdown by this method, it is necessary that all pipe connections be airtight. Otherwise, your reading will not be accurate.

There is no way of telling *how dependable a jetted, driven, bored, or dug well* will be under dry conditions except to depend on your experience, or your neighbor's experience. Since wells of this type are supplied from water that soaks down from the ground surface to the water table, they are usually affected by dry weather.

Well Location

- Reasonably high point on property
- In a direction away from groundwater flow from existing or potential sources of pollution (Example: upgradient from septic and drainage systems)
- Protected against surface wash
- As far away from property line as possible

- Placing wells in a parking lot or roadway subjects the well head to vehicular damage and volatile organic surface wash contamination.

- How to properly protect a well head from damage if it must be placed in harms way.

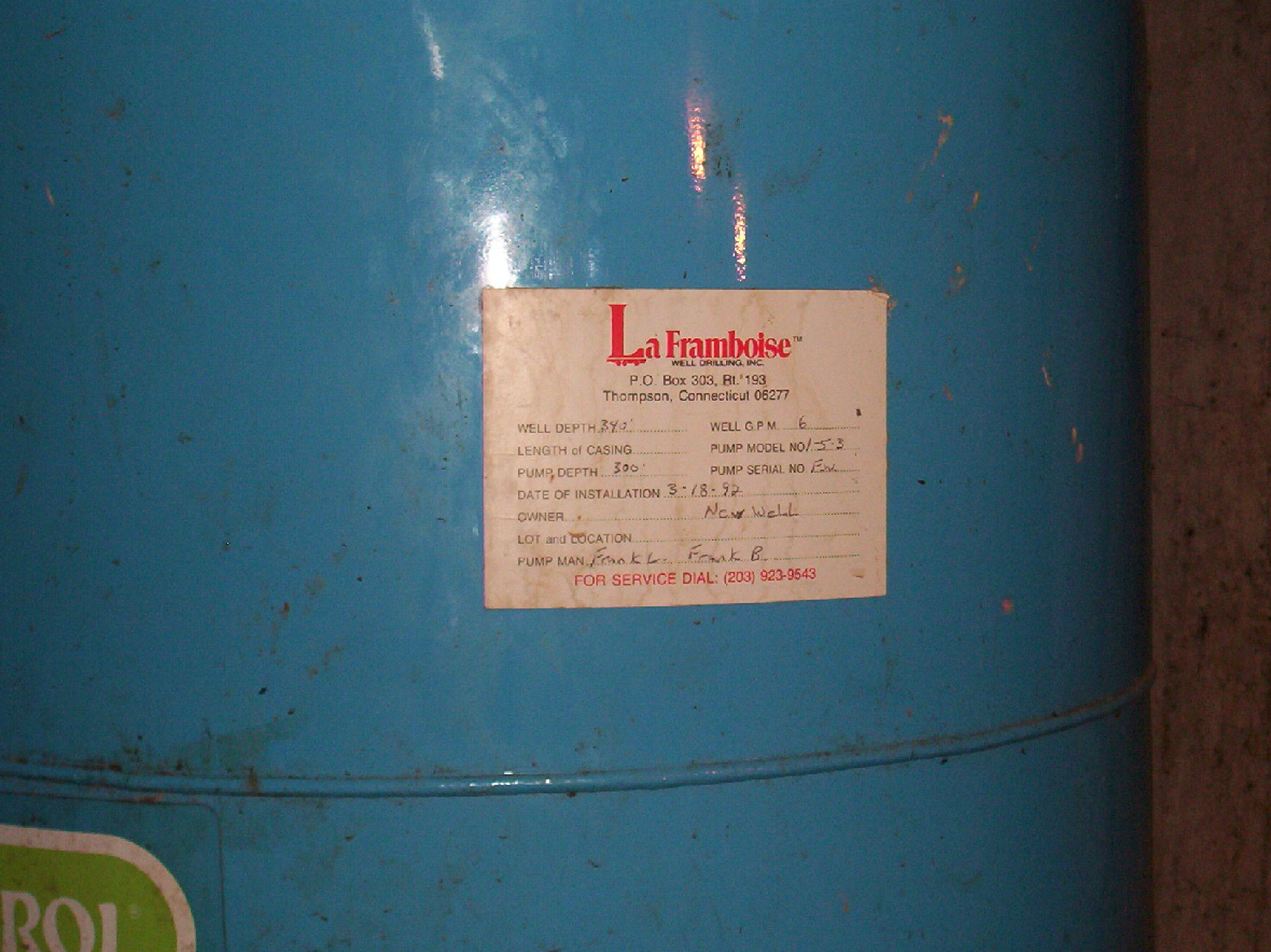
WHAT WERE YOU THINKING??

- A Cement Tile placed in a Pond, with the Pond water being the source for the well- Yecch!!

- A six foot wide caisson well that taps into and carries water from an aquifer that creates the pond around the well. Both the well water water and pond water are identical and highly mineralized and, obviously, subject to bacterial contamination. >>>>>>>>>>

Separation Distances

- Inspectors may not be able to determine well pumping rate to establish required separation distances
- Pump control panels, water meters, or stickers/magic marker notes on pressure tank can be helpful in determining pumping rate
- If pumping rate cannot be determined use minimum requirements for a <10gpm well


La Framboise™
WELL DRILLING, INC.
P.O. Box 303, Rt. 193
Thompson, Connecticut 06277
WELL DEPTH 340'
WELL G.P.M. 6
LENGTH of CASING
PUMP MODEL NO 1-5-3
PUMP DEPTH 300'
PUMP SERIAL NO
DATE OF INSTALLATION 3-18-92
OWNER New Well
LOT and LOCATION
PUMP MAN Frank L. Frank B.
FOR SERVICE DIAL: (203) 923-9543

Radial Separation Distances
Minimum Requirements

	<10 gpm	10-50 gpm	>50 gpm
Sewage System	75 ft	150 ft	200 ft
Surface Water	25 ft	50 ft	50 ft
Storm Drainage	25 ft	50 ft	50 ft
Foundation Drainage	25 ft	50 ft	50 ft
Other Pollution Sources	75 ft	150 ft	200 ft

Section 19a-206 CGS

- The above statute gives the LDH wide authority in instances where proper sanitary distances cannot be obtained when a new replacement well is being sited for an existing occupied home with a failed well. Pursuant to the CT State Building Code, “Dwelling units shall be provided with a supply of potable water in the amounts and pressures specified ….” (P2901.1 SBC). If not, the home

19a-206 CGS (continued)

- could be condemned and declared unfit for human occupancy. This statute says in part "(the local Heath Director) shall examine all nuisances and sources of filth injurious to the public health, cause such nuisance to be abated…..which in their judgment may endanger the health of the inhabitants."
- This wording would certainly apply to an

- occupied home with a failed well when a 75 foot sanitary radius cannot be found on the property for the new well. You have the discretion to grant an exception for the siting of the replacement well because you are making an existing condition better and you are preventing condemnation of the home. You would note these reasons on the well permit and perhaps require additional

- precautions like:
- * extra lengths of casing into bedrock
- * more frequent bacteriological testing
- * well yield must be <10gpm
- * minimal separating distance must be 50 feet or more (old code requirement, pre 1971)
- homeowner acknowledges this action

Sanitary Radius and Property Boundaries

- Whenever possible, the sanitary radius of a well should be under the control of the well owner for sanitary protection from activities on adjacent properties
- Siting a well to close to a property boundary can also restrict development on adjacent properties (i.e. inability to locate a subsurface sewage system at least 75 ft. from the well)

Sanitary Radius Encumbrance

- A private well yielding <10gpm with a 75 foot sanitary radius encumbers 17,663 sq. feet or 41% of an acre !!
- Present code does not require entire sanitary radius to be located on the property served by the well.

Well Casing

- The casing must extend a minimum of 6" above the established grade at the well or well pit/pump house floor
- The Primary Casing Shall Be New Steel

  * WDC 25-128-43(d)
- Grout Annular Space 10' Down From Ground Surface (2 reasons) >>>>>>>>

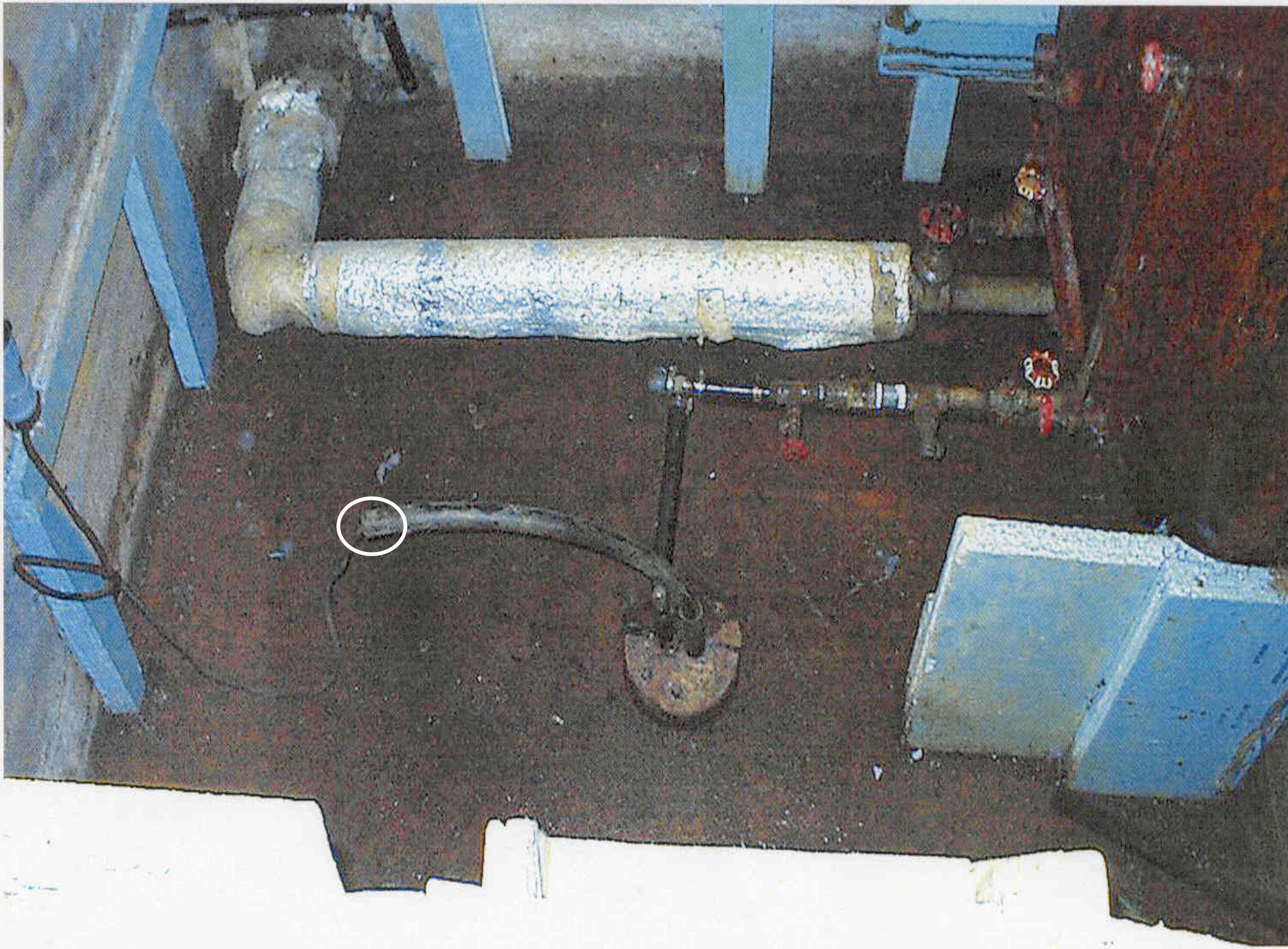
The 2 Reasons ?

- Surface Water has to Travel at least 10 feet down through the soil before it enters the well and,
- It protects the steel casing from varying levels of groundwater around the well and inhibits the drying/wetting action that promotes corrosion of the casing.

Watertight Well Caps

(drilled wells equipped with pitless adapters)

- In CT, drilled well caps must meet PAS-97 (Pitless Adapter Standard – 1997) standard developed by the Water Systems Council (WSC)
- PAS-97 standard was implemented in December 2000
- Although vented, PAS-97 well caps offer a watertight joint between the well cap and the well casing
- Well vents (for wells with a >10 foot drawdown) must be screened to prevent vermin entrance
- Use of electric conduit as a vent line >>>>>>>



Well #1 Vented Through Electrical Conduit

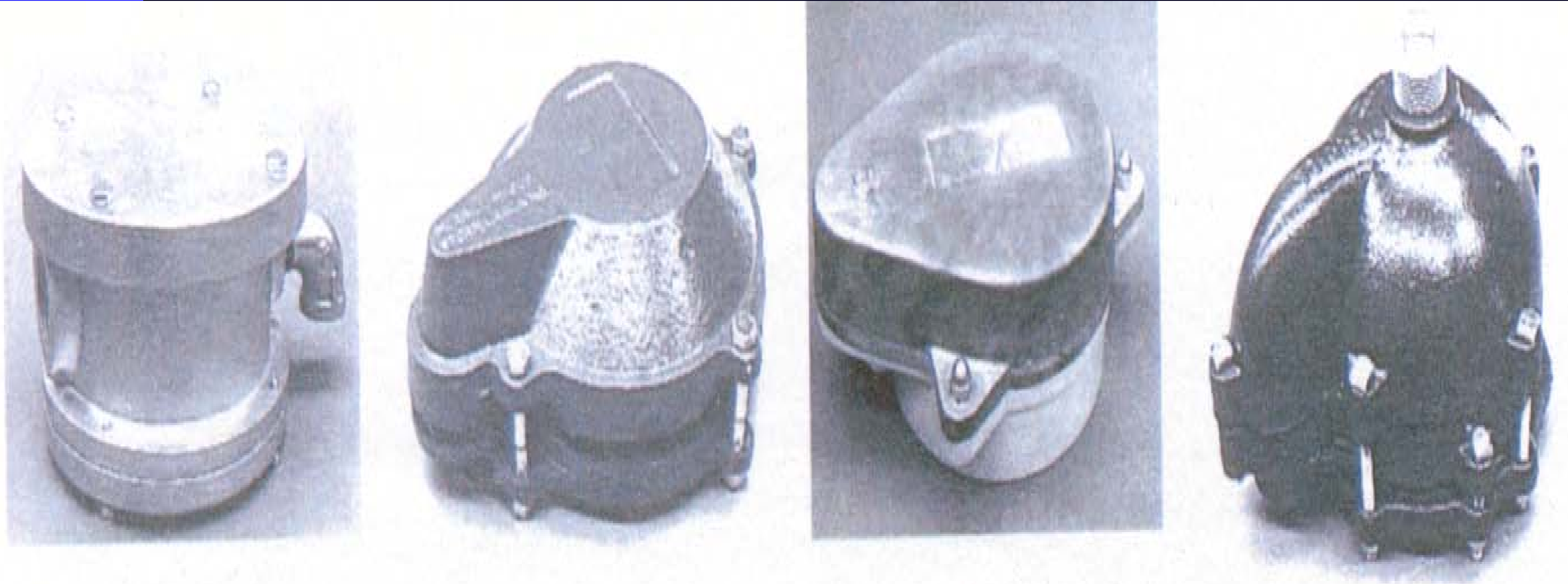


Figure 13.7. Examples of PAS-97-approved watertight well caps to cover top of well casing above ground.

- Properly constructed and, when necessary, vented wells (public & private)

New Scitico Well #2A

- A well that needs a grommet/sealing for the electrical conduit hole and a well pit drain that needs a screen. Both the distal and proximal ends of the drain line should be screened to prevent vermin infestation.

BAD Well Caps

(wells equipped with pitless adapters)

- Generally do not provide a watertight joint between the cap and the well casing allowing insects and mice to enter the well
- Easy to remove or knock off
- Very common on wells installed before 2001

Pond View Apts.-Plainfield Well #1 Disconnected

Sanitary Seals

(wells **NOT** equipped with pitless adapters)

- Sanitary seals have an upper and lower split plate with a compression gasket that allows for piping penetrations through the top of the well
- Acceptable for wells located within structures such as:
  1. Well house
  2. Basement
  3. Well pit

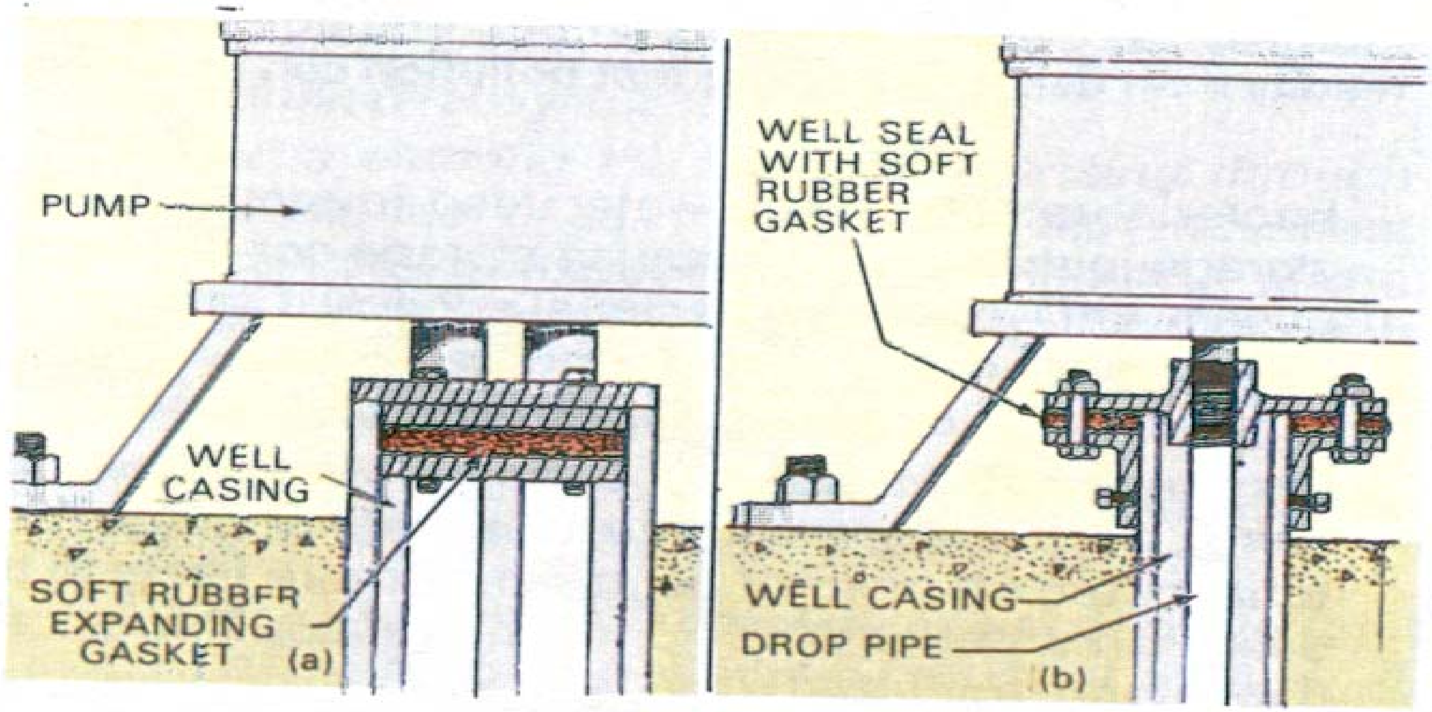


FIGURE 20. Two types of well seals. The seals are designed to keep water from entering the well casing at the top where the pump connections enter. As the steel plates are tightened, the rubber gasket expands against the pipe(s) and well casing to form a seal. (Many states require a pitless adapter instead of a well seal).

AAVIM

Well pits

- To be avoided whenever practical
- When necessary:
  - Large enough to permit ready access to equipment (electrical lines, pump, sanitary seal, water service line)
  - Watertight construction
  - Screened gravity drain to daylight
- Look for standing water or evidence of standing water

Common Well Pit Deficiencies

- Non-watertight construction
- Location (low lying areas, base of steep slopes) where groundwater table is higher
- Well head located below high ground water table (best time to inspect would be Feb-May and after a period of heavy precipitation)
- Inadequate or no drainage, cemented pit floor

Common Well Pit Deficiencies

- Inadequate protection from surface water entering pit (pit cover flush with or below grade)
- Poor drainage characteristics (slow perc rate) of natural soils (clay, silt)
- Often buried and can be difficult to find
- Excessive corrosion due to damp environment

- Pit bottom appears to be well drained note, past condensation on pit walls. >>>>>>

- Well seal with expanding rubber gasket >>

Flooded Well Pits

- What’s inside >>>>

- Well pit located at edge of pavement and at toe of slope >>>>>


BLAZER

What's Inside ?

- Note oily sheen on water –iron bacteria or VOCs ?? >>>>>>

TANK DISCONNECTED WELL PIT SHOWS SIGH OF RECENT FLOODING

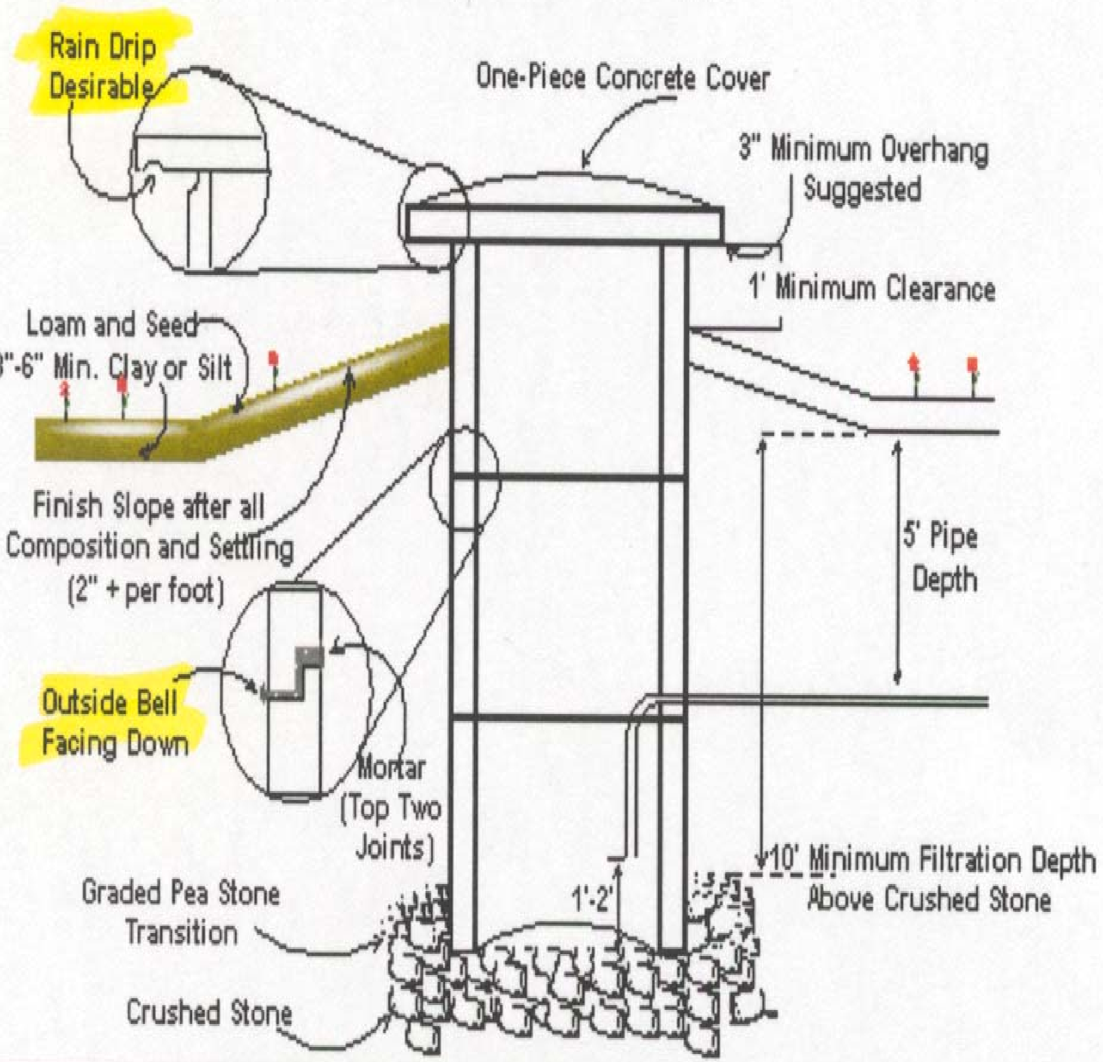
Buried Well Heads

- No well should EVER be directly buried
- Difficult to locate for repair work , esp. wells with plastic piping
- Homeowner may unknowingly locate sources of pollution within well's sanitary radius
- Look for vent stack in house roof, usually on same side as septic system
- See what side of basement wall well discharge line enters

Dug wells

- Tend to be older, poorly constructed, and more susceptible to contamination than drilled wells.
- PHC Requirements:
  - 6 in. above grade.
  - 4 in. thick concrete sidewalls.
  - Watertight to 10 ft. below the ground surface.
  - 4 in. thick reinforced concrete cover which overlaps the sidewalls by a minimum of 2 in.,
  - A "rain drip".

Dug Well Design



Dug Wells
Common Problems

- Variety of construction methods
- Age
- Difficult to properly seal well cover allowing rodents, snakes, etc. to enter well
- Masonry joint deterioration between casing material (precast concrete, brick, stone) allowing seepage
- Roots from nearby large trees often break through loose joints in masonry

- Field Stone Casing with no Grouting provides easy passage of surface water to well without sufficient soil filtration.

- Ditto-note iron staining of field stone and unscreened pipe of unknown use >>>>

Springs

- A natural spring is a concentrated discharge of groundwater that appears as a flow of water at the ground surface by means of natural hydraulic action
- Most roadside springs or springs on nature trails tend to be poorly constructed and susceptible to surface contamination
- Many springs surface in undesirable locations that increase their vulnerability to contamination (base of steep slopes)
- Same PHC construction criteria as a dug well

- Emergency spring for a public water system


PUBLIC WATER
SUPPLY
NO TRESPASSING


NORFOLK-COLEBROOK
GARDEN CLUB

NOTA BENE !!

- Spring is at road level with land behind spring below road, yet water is flowing with a substantial hydraulic head-the spring’s source is some distance and at a higher elevation from the spring itself. Go find the actual spring!!
- As with many older springs the pipe could be lead, not black or galvanized iron..>>

- This springhouse is definitely NOT secured.


PEPSI

- Don’t know what it is but, it shouldn’t be there !
- Note lime efflorescence on stone. >>>>

- Note excessive condensation dripping off ceiling into spring basin bringing with it possible arsenic and/or coliform contamination. Venting of both spring roof peaks would minimize this condition. >>

- A manmade pristine spring basin but, overflow pipe should be screened at BOTH ends. >>>>>

- A typical cement cast spring basin/well pit cover with dual Bilco hatches (scuttles).

Home Plumbing

- SBC mandates electrical grounding to metallic house piping
- Galvanic & Flux Induced Corrosion, all new plumbing must be <u>thoroughly</u> flushed and do not allow water to stagnate in new plumbing

#*+#!!! GROUNDS #**#!!!

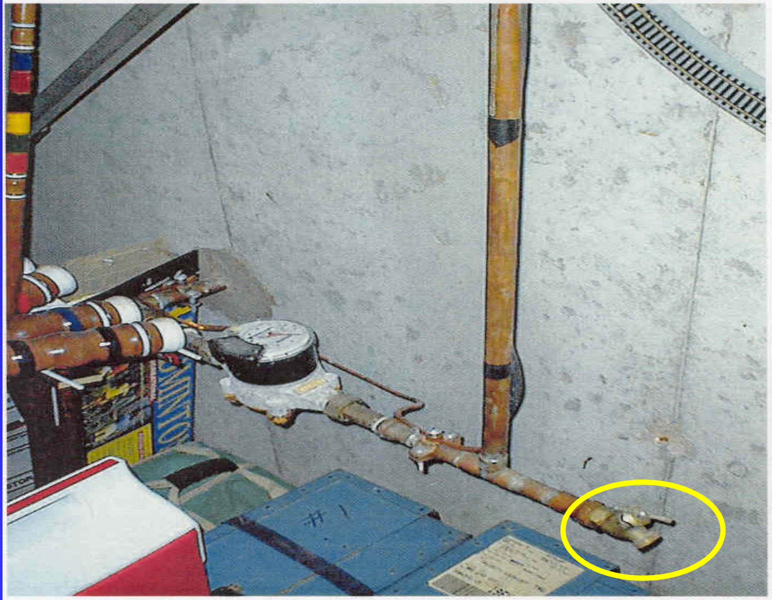
- Discouraged by the AWWA
- Have a licensed electrician check your home's plumbing
- Stray electrical currents (faults) can accelerate metallic pipe corrosion
- (see detailed article on Webpage @DPH-EHS-Private Wells)

Double grounds in basement floor
Monaco house

- Note in the top slide that the insertion of clear plastic tubing has nullified the ground strap above it.
- The bottom slide shows the installation of a faucet that allows draining of the homes domestic plumbing as during power outages and possible pipe freezing.

Disconnected Ground Wire
73 Cardinal Drive

#129



Typical Grounding Configuration
11 Cardinal Drive

#130

59ppm Copper 3rd floor
47 Cardinal Drive

#132

Home Plumbing (cont.)

- House plumbing must have more resistance that ground rods or grounding system (<25 ohms)
- Semi-annual flushing of hot/cold water storage tanks, hot water heaters, HTHP release valves
- Proper pressure tank sizing-well pump short cycling

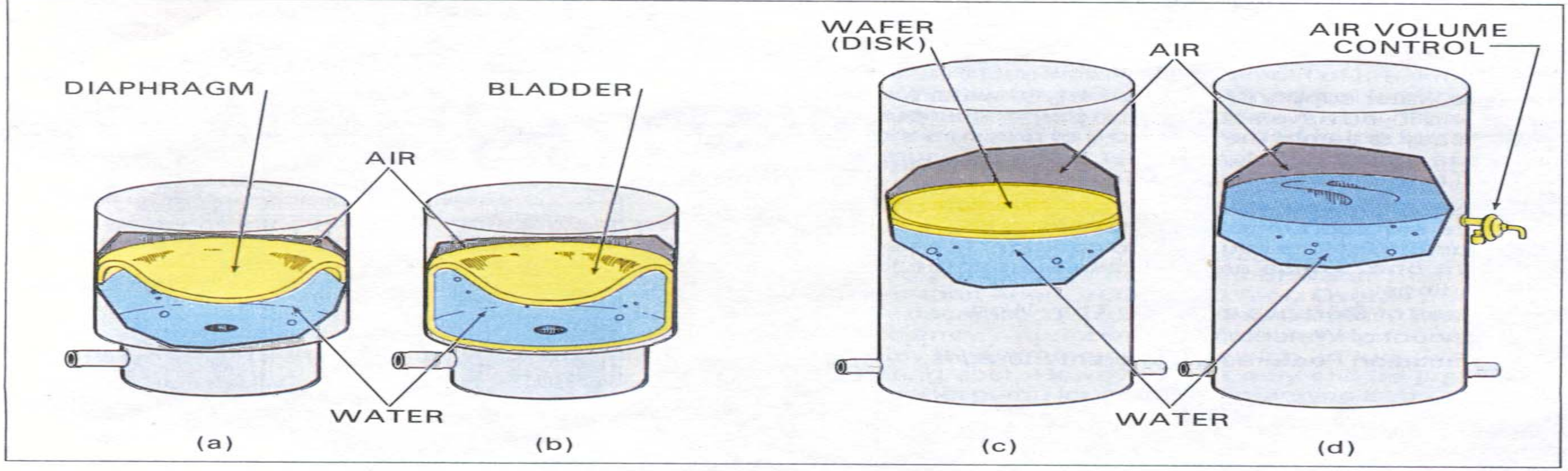


FIGURE 83. Types of pressure tanks. (a) Diaphragm, (b) Bladder, (c) Plain steel with floating disk, and (d) Plain steel.

the plumbing system. When the pump cut-in pressure has been reached, the pump will start automatically and begin to restore the water in the tank. As the water enters the tank, the captive air is compressed and the pressure increases until it reaches the cut-out (pump stops).

(2) PLAIN STEEL TANK WITH FLOATING WAFER TANK. The floating wafer type pressurized storage tank is illustrated in Figure 83c. It uses a wafer to reduce the air and water contact area. The wafer rides on the surface of the water. An air charging valve is used to replace the air. At installation, the tank is supercharged through the charging valve. Since the wafer doesn't completely separate the air from the water, subsequent supercharging is necessary. The water inlet and outlet are located near the bottom of the tank. This tank must be installed in the vertical position.

It should be noted that the plain steel tank with floating wafer air separation will deliver no additional draw-down unless it is supercharged after installation. After supercharging, the water level cannot drop to the outlet connection or air will escape under pressure to the fixtures.

(3) PLAIN STEEL TANK. The plain steel storage tank is shown in Figure 83d. This type of pressure tank can be designed for use in a vertical or horizontal position. The tank discharge should always be located near the bottom of the tank. This type has no barrier separating the air from the water. The tank has connections for an outlet and inlet near the bottom. There is also a separate connection for the air volume control usually located at the level where the water will be when the pump starts.

The main factor in the designs that affects the size pressure tank required is the initial pressure. As the initial tank pressure (precharge) increases, the draw-down increases up to a precharge pressure equal to the pump cut-in pressure. After this pressure has been reached, any further increase in the precharge pressure will result in a reduction in draw-down. Plain steel tanks are pressurized by pumping water into the tank. The water compresses the trapped air and increases its pressure. The water that is pumped into the tank to increase the pressure to the low pressure switch setting (pump cut-in) remains in the tank between pump cycles. The wafer type design is supercharged (pressurized with air at the job site) 5 psig below the low pressure switch setting in order to prevent the air from escaping. The water that is pumped into the tank between the 5 psig differential remains in the tank.

b. Gravity Feed and Pumped Storage

When the water source is of limited yield, you have to select a well pump with a discharge capacity that is somewhat less than the water yield from your well or provide a secondary water storage supply.

It must be sized so it is large enough to meet your peak demands and allow some reserve. Once the proper storage tank has been installed, the well system is now considered to have an adequate water supply and the pressure storage tank can be sized in relation to the pump capacity.

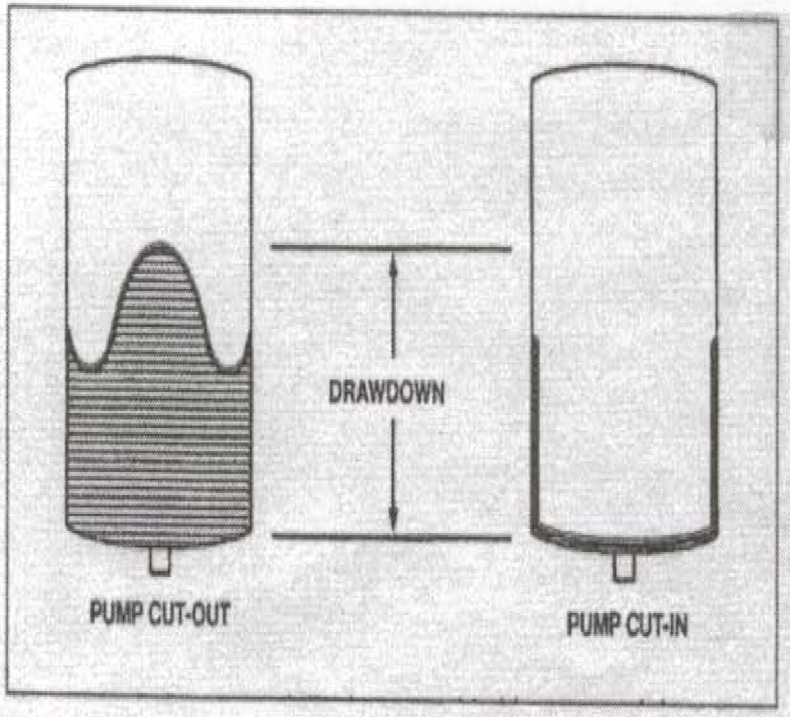


Figure 11.2A. Precharged diaphragm- or bladder-type tank for supplemental supply.

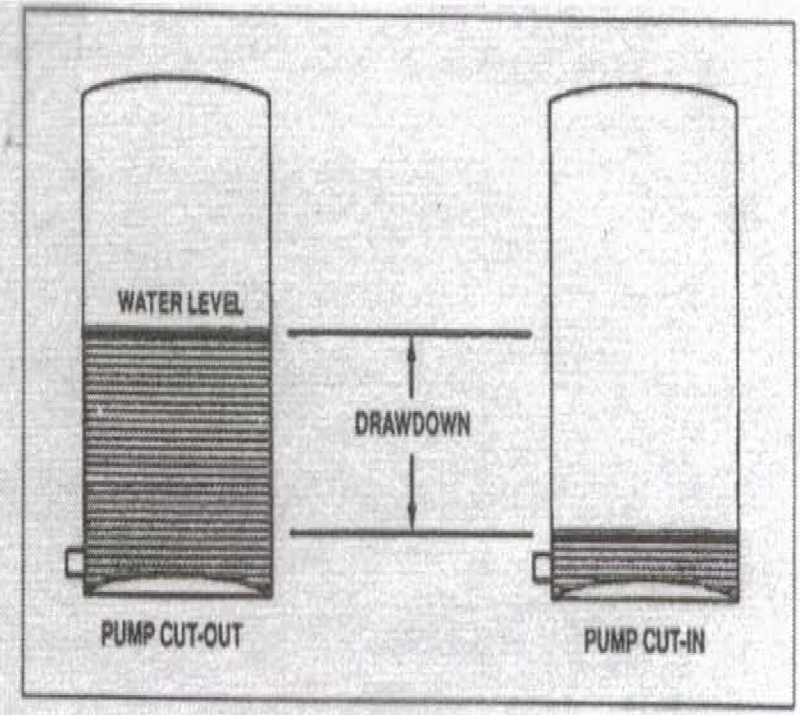
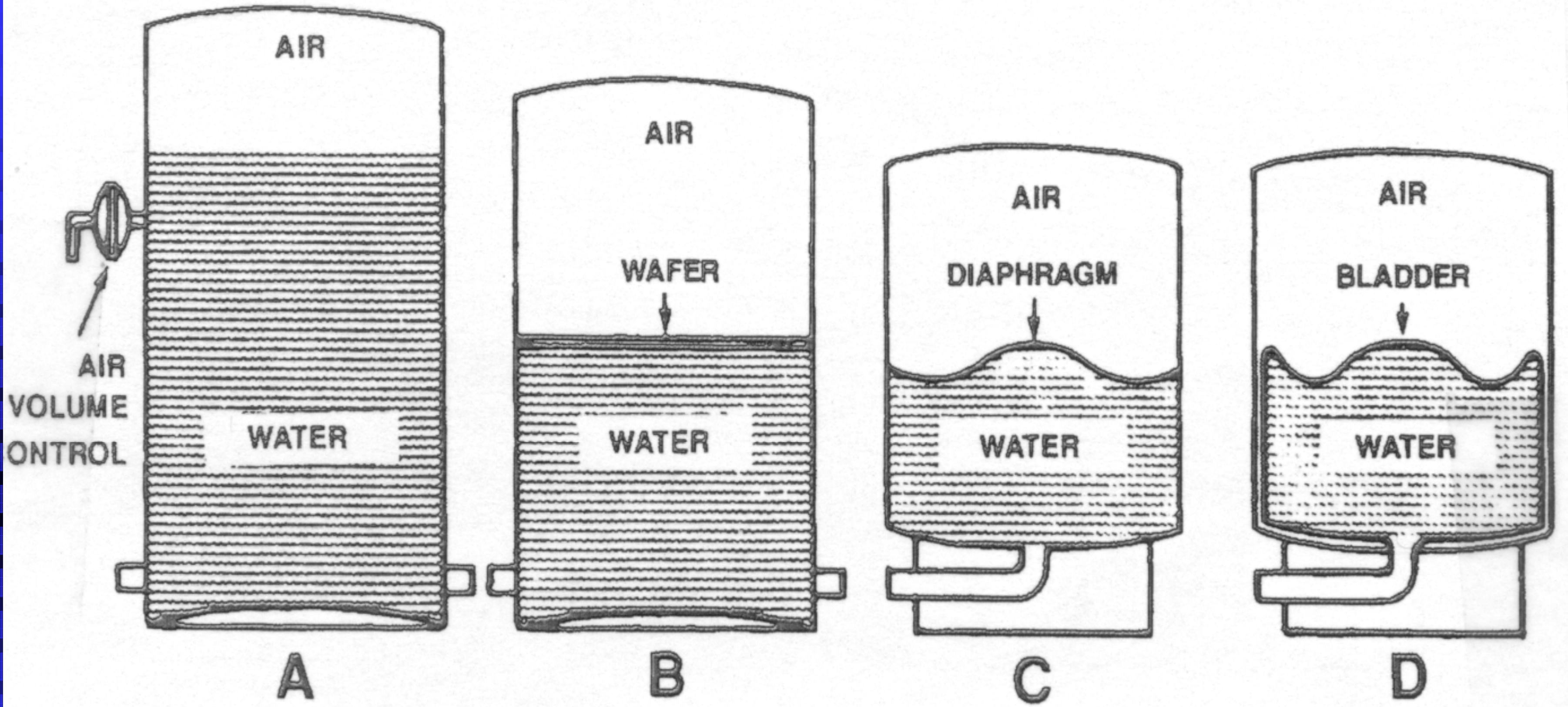


Figure 11.2B. Supercharged float or wafer-type tank for supplemental supply.

WSC



igure 11.1. Types of pressure storage tanks. Figure 11.1A shows plain steel anks; Figure 11.1B, the plain steel tank with float or wafer; 11.1C, the iaphragm tank; and Figure 11.1D, the bladder tank.

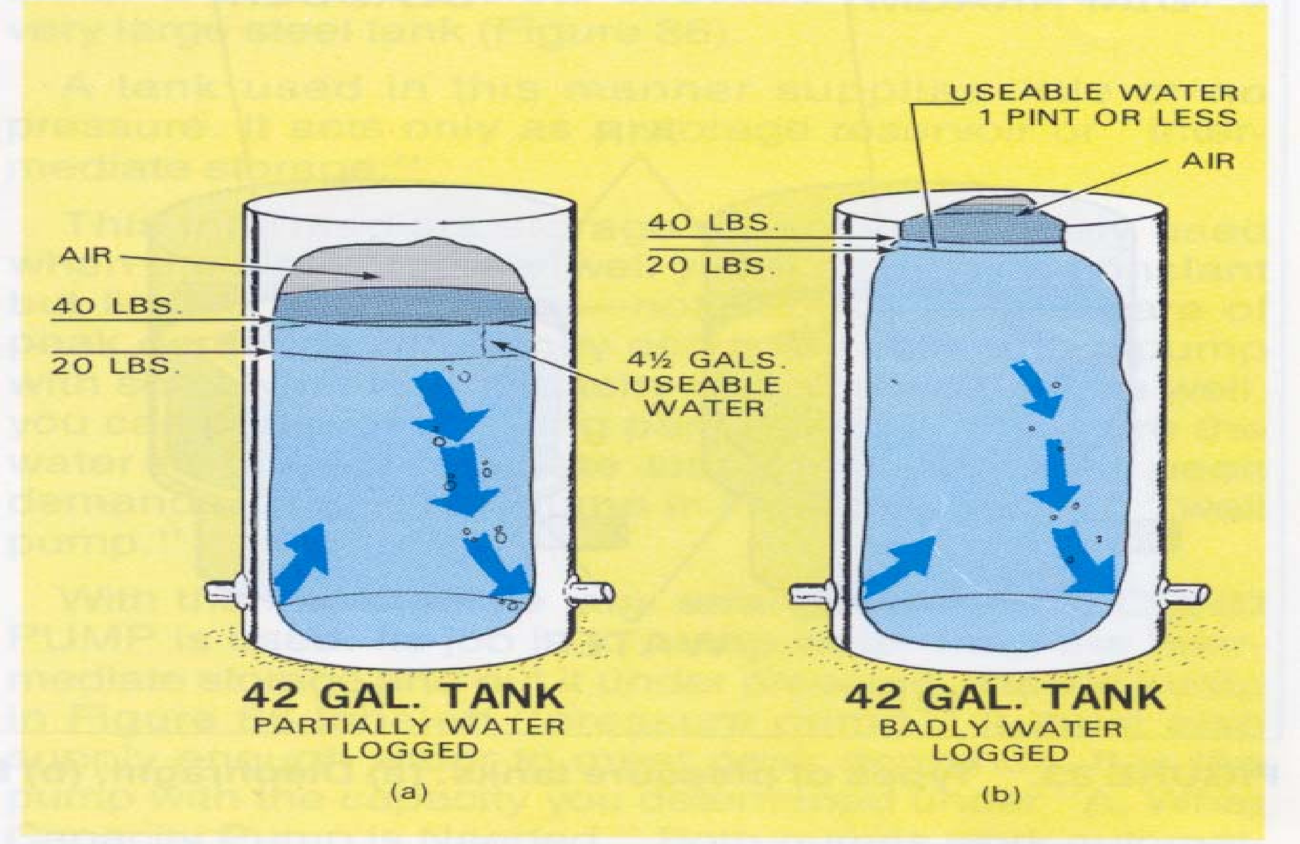


FIGURE 82. Water-logged pressure tank. (a) This is a condition where the air in the tank is gradually absorbed by the water until the tank can deliver only about 4¼ gallons of water of a 42-gallon tank as the pressure drops from 40 pounds to 20 pounds. (b) An extreme water-logged condition. Almost all of the air supply has been absorbed. Withdrawal of a pint or less of water from the tank reduces the pressure from 40 pounds fo 20 pounds pressure.

AAVIM

Internal Tank Corrosion

- The following slide shows where a typical non-bladder pressure tank will corrode. The circled area is where the water level moves up and down during well pump cycling. This intermittent wetting/drying of the tank's inner surface encourages corrosion and eventually leads to pinhole leaks and tank failure. >>>

80-gallon Pressure Tank in 1 Building

Automatic water systems

When using large standard galvanized tanks, a constant air cushion is required for proper operation of the water system.

The illustrations show the percent of tank volume as related to the pressure gauge reading. To determine the amount of water you will receive as drawoff from the tank, you should subtract the smaller number from the larger number to get the percentage. Then multiply by the size of the tank to get the gallons drawoff.

Example: 50 lbs. = 77.3
minus 30 lbs. = 67.2
= 10.1%
× 120 gallon tank (size of tank)
= 12.12 gallons drawoff

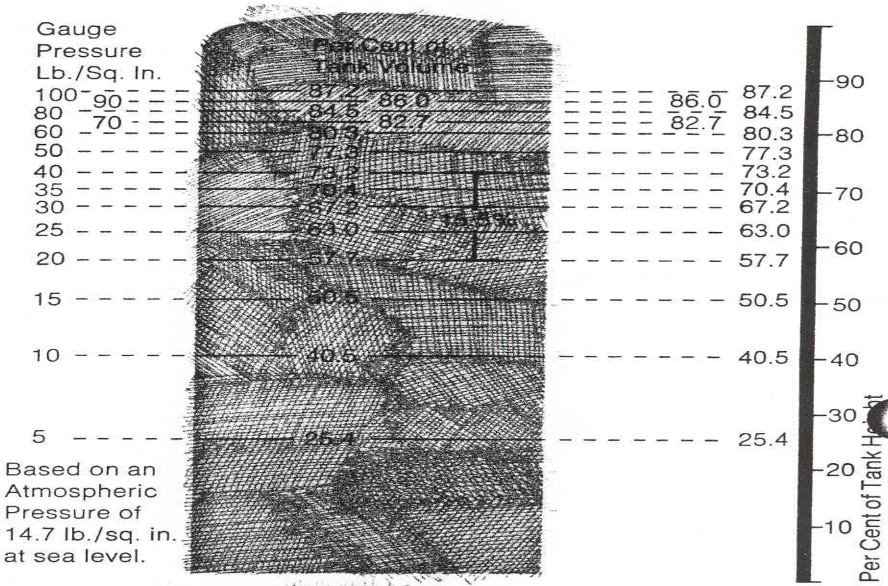
The Procedure is as Follows:
The drawoff capacity of a standard galvanized tank can be increased by adding air.

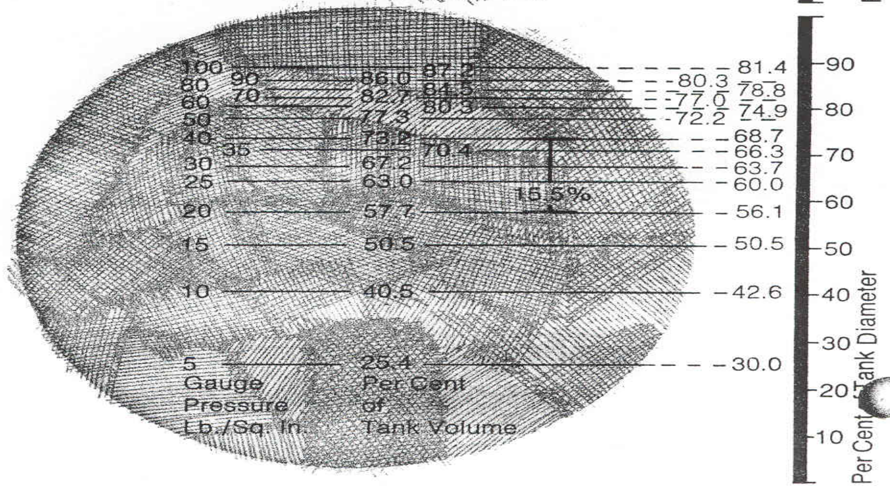
1. First you should hook up the tank to the system and cycle it several times under normal operating conditions.

2. Once this is accomplished, you should drain your tank until the gauge reads zero (0). Although the gauge reads zero, you still have some water in the tank.

3. The precharge of air should be added at this time equal to the cut-in pressure of the pressure switch. By having some water in the tank, your precharge will not escape out the discharge pipe leaving the tank.

4. This will enable you to receive approximately double the amount of drawoff.





6-Well-X-Trol WX-350 Pressure Tanks, Total Useable Volume @180 gals.

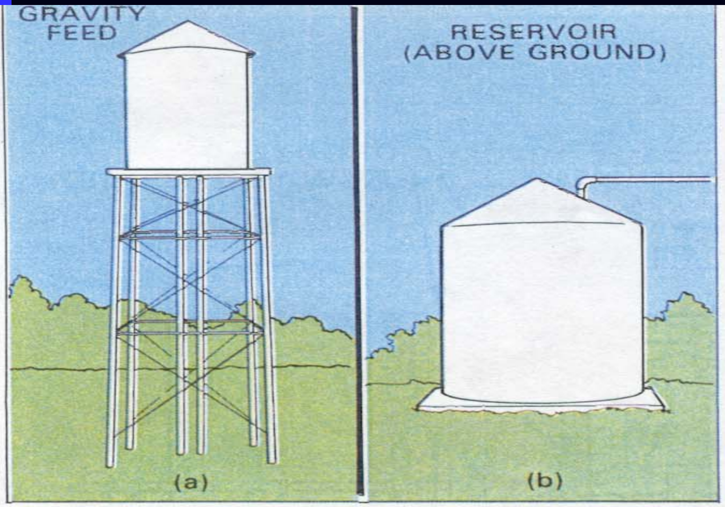


FIGURE 84. (a) Gravity tank. Depends on tank height to supply pressure. It can be used to store comparatively large quantities of water. (b) Reservoir. A surface or underground storage. It provides no pressure unless built about the level of the buildings it supplies. It is usually used to store large quantities of water.

There are two types of non-pressurized storage (Figure 84):

(1) Gravity-feed Tanks (Figure 84a).
(2) Pumped Storage (Figure 84b).

(1) GRAVITY FEED TANKS. A gravity tank is a large water storage located well above the level of the buildings. The higher the storage tank above your water-use outlets, the more pressure there is at your faucets. Water develops a pound of pressure for each 2.3 ft of elevation (height). To supply a minimum of 20 psig of pressure at your building, a tank would have to be mounted 46 feet (2.3 ft x 20 psig) higher than your faucets (Figure 85). As you can see from the illustration, the quantity of water being stored has nothing to do with pressure at your faucets. WATER LEVEL HEIGHT IS WHAT CAUSES PRESSURE.

In hilly country, the tank is usually placed on a hill to get needed elevation. In level areas, it may be located in an attic or on a tower built especially for tank support (Figure 84a).

In most areas, it is difficult to get enough tank height to provide satisfactory pressure. But, if you are in an area where you can get ample tank height, and your water source provides a limited amount of water, a gravity tank is one method of supplying the extra water storage you need for peak demands.

(2) PUMPED STORAGE RESERVOIRS. In this discussion, reservoirs refer to those water storages built approximately at pump level. They may be constructed either above or below ground. They usually consist of either a poured-concrete structure (Figure 84b), or a very large steel tank (Figure 86).

A tank used in this manner supplies little or no pressure. It acts only as a storage reservoir or "intermediate storage."

This intermediate storage reservoir is widely used when the water source (well yield) provides a constant but limited flow of water—not enough to take care of peak demands when they occur. By selecting a pump with somewhat less capacity than the yield of the well, you can pump over a long period of time and store the water in the intermediate storage to meet the peak demands. This is the pump in Figure 86 labeled "well pump."

With the intermediate tank arrangement, a SECOND PUMP is used. Its job is to pump water from the intermediate storage and put it under pressure. It is the pump in Figure 86 labeled "pressure pump." It must also supply enough water to meet peak demands. It is the pump with the capacity you determined under "A. What Capacity Pump is Needed." Both pumps work automatically. The well pump is controlled by water-level sensors located in the intermediate storage tank. The pressure pump is controlled by a standard pressure switch.

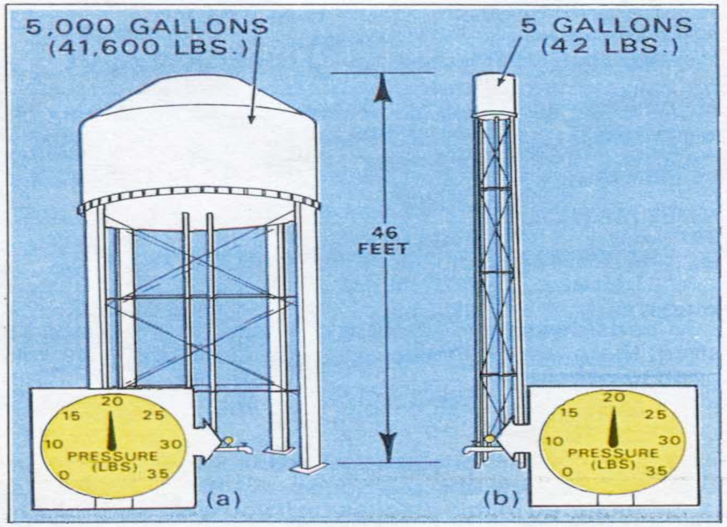


FIGURE 85. The pressure a gravity tank will provide is determined by how high the tank is above the level of your faucets. (a) A 5,000 gallon tank provides no more pressure than (b) a 5-gallon tank mounted at the same height.

- The following slide shows an installation of an RPZ device with NO isolation valves for maintenance or device removal. As with all mechanical devices, it must be properly maintained to work as it should. >>>>>

Pump house #1. Diesel fuel tank is located on top of the roof.

Private Well Webpage

- Main DPH Webpage-www.ct.gov/dph
- Hor. Routing Bar> “Programs/Services”
- Alph. Listing-Scroll to “Private Wells”
- Scan Page for var. listings/regulations
- Return to Top->>Side Bar “Publications/Reports”
- Scan Page-much information
- Or Call us at 860-509-7296