SEPTIC SYSTEMS AND WELLS

Pillar To Post Continuing Education Program

PILLARTOPOST
HOME INSPECTORS

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Chapter 1

CHAPTER 1
Overview and Objectives

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Chapter 1

Overview and Objectives

Rural properties usually do not have the benefit of city supplied fresh water and city sewage treatment. Potable water has to be drawn from the earth. Sewage has to be treated on site and released back into the environment. All of this has to be done with great care so that water coming into the house is fresh and clean and that sewage leaving the house does not contaminate the fresh water or the environment.

The water supply and waste system is among the most important and complicated yet most home owners take it for granted. This presentation will give you insight into these two systems. You will gain an understanding of how these well and septic system works and how they fail.

This course will teach you:

- How a simple septic system works.
- Tips on care and maintenance of a septic system.
- All about wells.
- Problems encountered with wells and septic systems.

By the end of this session you should -

- Know the function of a septic tank.
- Know the purpose of the baffles in a septic tank.
- Know the function of a drainage field (leaching field).
- Understand why a septic tank has to be pumped out.
- Understand basic care of a septic system including what to flush and what not to flush.

- Understand why a septic system often fails when a new family moves into the house.
- Be able to list three obvious signs that a septic system is failing.
- Understand what a ***water table*** is.
- Be able to list three types of wells.
- Know what causes contamination of the well water.
- Know the difference between a shallow well and a deep well.
- Know the purpose of the pressure tank.
- Know common problems that occur with the water supply system.

This knowledge will:

- Help you to recognize obvious problems with the septic or water supply system.
- Answer client questions about rural properties.
- Show your clients that you are a knowledgeable professional.

Chapter 2

CHAPTER 2
Septic Systems

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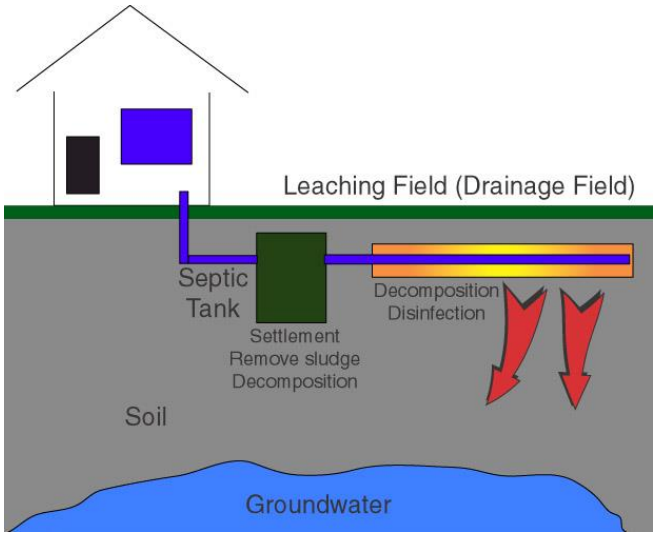
Chapter 2

Septic Systems

Introduction

The septic system is perhaps the least understood system in the rural home. Why? Because you can't see it. Homeowners assume that the system will keep on working because it has in the past. Many home owners do not know that regular maintenance is required. Let's have a look at this system that most people would rather not see close up!

This photograph shows a home with on site sewage handling. When raw sewage is flushed, it enters the septic tank. As it enters the septic tank, an equal volume of effluent from the tank is displaced and flows into the leaching field. The effluent gets disinfected by the soil as it moves on to join the groundwater.



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A septic system has to perform all of the functions that a city sewage treatment plant does –

1. Collect waste
2. Settlement to remove sludge
3. Decompose
4. Disinfect
5. Release clean water back into the environment

It is absolutely critical that all of the five steps are working perfectly otherwise dirty effluent can contaminate the land or the drinking water supply. If people knew that "what they flush, they eventually drink", they would probably take more of an interest in the system!

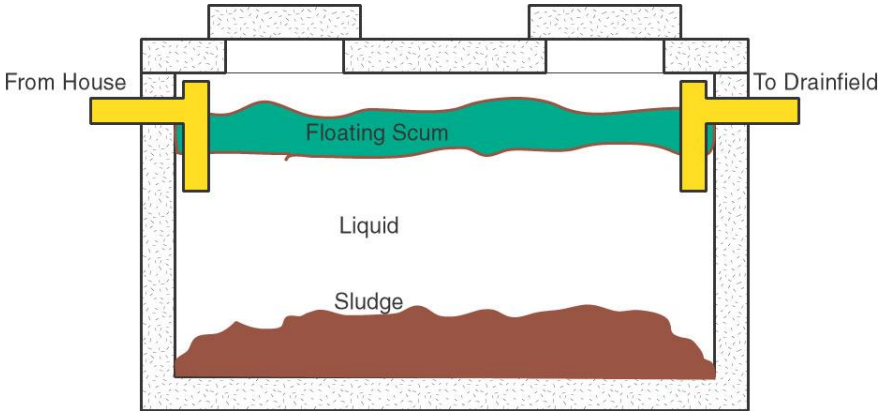
Components of a Septic System

The main components of a septic system are the ***septic tank*** and the ***drainage field*** (also called a ***leaching field***)

Septic Tank

The septic tank is a large holding tank. Anything that goes down the drain from the house goes here first. There are several functions of the septic tank:

1. ***Settlement and separation***. The solids separate from the liquids and the liquids from the oils. You end up with three layers. The top layer is oils, the middle layer is liquid effluent, and the bottom layer is solids. The top layer is often called "floating scum" – not a pretty term but quite descriptive. The middle layer is called liquid effluent or just effluent. The bottom layer is called solids or sludge.
2. ***Exclude sludge and oils from the drainage field***. A discharge baffle is configured so that only effluent can get out of the tank.
3. ***Partial decomposition***. Some of sludge decomposes in the tank and joins the effluent. Ultimately, the tank fills up with sludge and has to be pumped out.



This diagram is a simple septic tank. Let's look at how it works –

- Unless the tank has just been pumped, the tank is full all the time. When a volume of liquid enters the tank, the same volume leaves the tank at the other side.
- With a flush from the house, material enters the tank through the baffle on the left. The baffle is to keep the layers in the tank from mixing.
- Over a few hours, the solids sink to the bottom and the oils float to the top. Some of the solids break down and join the liquid effluent.
- Liquid effluent flows out of the baffle on the right. The baffle is to keep the oils in the tank. Oils would damage the drainage field.

Pumping the tank: After a couple of years (3 on average) the tank must be pumped out to remove the sludge and the floating scum. If the tank is neglected, the levels in the tank will build up enough that raw sewage (not properly separated) and oils will get into the drainage field. This could damage the field and could be very expensive to fix.

A septic tank design will target a pumping frequency of three years. Some municipalities require more frequent pumping regardless of the design frequency. The following is an approximate pumping frequency for various sizes of septic tanks under various loads.

Small tank (500 gallons)

- Two people in household – pump every 2.5 years
- Four people in household – pump every year

Large tank (1000 gallons)

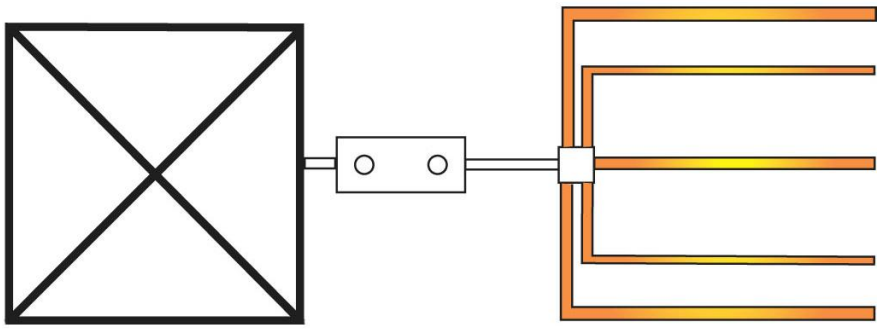
- Two people in household – pump every 6 years
- Four people in household – pump every 2.5 years

The small tank described above is actually too small for any application. Even with only two people, the pumping frequency is less than three years. Some municipalities won't even let you use a tank this small regardless of the design.

Drainage Field

The drainage field or leaching field takes the liquid effluent from the septic tank and disperses it into the soil. As the liquid effluent sinks into the soil, it is filtered and disinfected by the soil and the organisms in the soil.

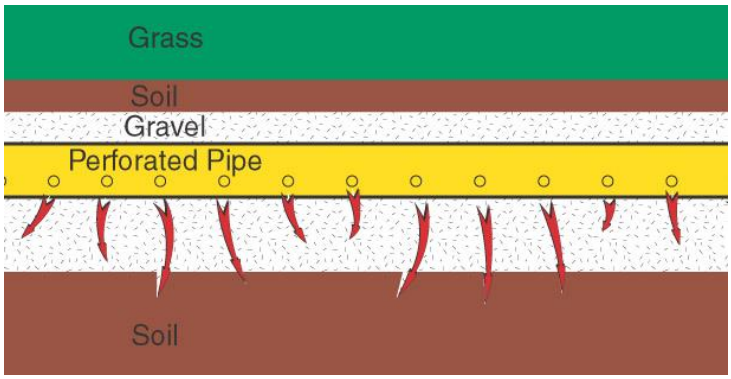
The drainage field is essentially a network of perforated pipes. It is carefully designed so that when a volume of liquid effluent is discharged into the drainage field, the liquid spreads over a large area in the field.



The diagram above is a plan view that shows a house, septic tank and drainage field. The house is on the left. The object in the middle is the septic tank. On the right hand side is the network of pipes that makes up the drainage field.

The size of the drainage field depends on the type of soil and the size of the septic tank. In some areas, the soil is just not good enough to handle the liquid effluent so the soil has to be removed and good soil trucked in to replace the poor soil.

The technology has evolved and you may encounter more complicated systems out there.



The diagram above shows a cross section of the leaching field. You can see a perforated pipe 'leaching' effluent into the ground. The effluent starts its journey downwards. Eventually, the disinfected liquid effluent joins the ground water.

Care and Maintenance

A septic system is an expensive item. Regular maintenance can save major repair down the road. For example, anything you can do to keep the leaching field in good shape is very important. Replacing the leaching field can be very expensive and disruptive.

Septic Tank: Here are a few tips to help care for your septic tank:

- Have your septic tank pumped regularly. Every three years is a good benchmark. Your septic system technician can give you a better idea of the recommended frequency of pumping based on the size of the tank and the number of people in your household and also based on pumping history.
- Have the system inspected when it is pumped and ideally between pumps as well. In a perfect world, you would have the system inspected every year. The benefit to inspection is that a problem can be detected before it damages the system. For example, if the exit baffle breaks off in the septic tank, oils can get into the leaching field and destroy the field. If you catch the broken baffle early, you may save the cost of a new leaching field.
- A kitchen sink disposal is not recommended if you have a septic system. Grinding up food waste and adding it to the septic tank just increases the load on the septic system.
- Limit the greases and oils that go into the system. For example, don't pour or rinse greases and oils down the kitchen sink.
- Reduce water use. In general, the less water you

use, the less the system has to process. At the very least, repair running toilets, replace old toilets with low volume toilets and use flow restrictors on shower heads.
- Don't flush paper towels, coffee grounds, cigarette butts, chemicals.

The picture above is the inside of a septic tank that has just been pumped. We know it has been pumped because it's not full. Recall that a septic tank is full during steady state operation. If a gallon goes in, a gallon comes out. Here we can see the inlet baffle with liquid dripping out of it.

Drainage Field: Here are a few tips for maintaining the drainage field
- Don't plant shrubs or trees in the drainage field. The drainage pipes are not very deep. Any deep rooted shrubs or tress will get into the pipes. Grass is good as the root mass only goes a few inches into the soil.
- Keep the drainage field from being flooded. The field should be located and designed so that it won't flood during a rain but make sure downspouts from the house are not flooding the field.
- Heavy loads could crush the pipes. Vehicles for example.

The photo on the right shows a septic tank inspection. One of the hatches has been dug up. The hatch is open, ready for inspection. You can see some of the tools of the trade including a large mirror on a pole used for inspecting the inside of the tank.

In this picture, you can see inside a full septic tank. You can see the inlet baffle. The inspector has dropped a rod into the tank to check the levels

Failure, Repair and Replacement

One of the most common times for a septic system to fail is when a new family moves in. The system may have been working fine for years and then a new family applies different loads and the system fails. For example, compare these two families:

- Family 1: Retired couple, children have moved out.
- Family 2: Couple with three teenage children. All five need a shower first thing in the morning before work or school.

If family 2 buys the house from family 1, a septic system that has been teetering along for years may suddenly fail. This is the reason why people buying a rural home are strongly advised to have the septic system inspected.

Replacing a septic system is very expensive. There are newer regulations all the time that make it even more challenging and expensive. Early detection and repair is the best option but in some cases there is no other option but to replace the system.

Septic Tank Replacement: A septic tank may have to be replaced because it is too small or because it is damaged. This involves digging up the tank and replacing it.

Drainage Field Replacement: A drainage field may have to be replaced if it can no longer absorb the effluent at the rate that it is supplied. Here are a few points on drainage field failure and replacement -

- One of the more common causes of failure of a drainage field is oil or grease getting into the drainage field. If the system is not pumped on schedule or an outlet baffle breaks off, oils can get past the outlet baffle and flow into the drainage field. The oils coat the particles in the soil and the soil can no longer soak up effluent (percolate).
- One of the tricks that a septic technician may be able to use is to add more pipes to the drainage field. New pipes are added between the existing pipes (interstitial space). You end up with new pipes in fresh soil. This may or may not work depending on the soil.
- In many municipalities, you cannot build a house on a lot unless there is room for two drainage fields. If one field fails, you still have space for a second field.
- If the soil is not good enough, you may have to dig out the existing soil and truck in good soil. This can get very expensive.
- Regulations are getting tougher on septic systems. A system that may have been acceptable years ago may no longer be acceptable. If your system fails, you may not be able to install a similar system because the new regulations will kick in. In some cases you may be better to do an extensive repair rather than a re-build.

Signs of trouble:
Periodic septic inspection is a great idea. In the mean time, you should recognize obvious signs of trouble:

- Odors in the drainage field area.
- Wet or mushy spots in the drainage field.
- Sewage surfacing in areas.
- A plumbing backup could also be a sign of septic trouble, or it could just be a blocked drain.

Summary – Septic Systems

- The two main components of the septic system are the septic tank and the drainage field (leaching field).
- The septic tank is a settlement tank. Solids, liquids and oils separate into layers.
- There is partial decomposition of the solids in the septic tank. Solids that don't decompose will build up in the tank and eventually have to be pumped out.

- The drainage field deals with the liquid effluent. Effluent is distributed evenly over a large area of soil through a system of underground pipes.
- The effluent decomposes and is disinfected in the ground. The purified liquid then joins the ground water
- Proper care of the septic system is critical for long term operation of the drainage field.
- A septic tank should be pumped on a regular schedule and inspected periodically.
- Don't flush things that don't decompose quickly.
- Care of the septic system is much less costly than repairs or replacement.

Check Your Knowledge

Answer the questions below in the spaces provided

1. **True or false? A septic tank is full all the time unless it is new or it has recently been pumped.**

2. **True or false? If a septic system is not working properly it can contaminate the land and the drinking water supply.**

3. **List the two main components of a standard septic system:**

_____

_____

4. **If the septic tank were never pumped, what would eventually happen?**

_____

_____

_____

_____

5. **True or false? A septic tank is full all the time unless it is new or it has recently been pumped.**

6. **What is the purpose of the drainage field?**
   a. To Take the greases and oils from the septic tank and disperse it into the soil.
   b. To take the liquid effluent from the septic tank and disperse it into the soil.
   c. Settlement and decomposition of the sludge.
   d. To help drain rain water into the septic tank.

Chapter
3

CHAPTER 3
Wells

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Chapter 3

Water from the Earth

If you dig down into the earth, in most areas, you will eventually reach the water table. The water table is where the soil is saturated with water. If you dig a hole below the water table, the hole will fill up with water. This is called a well. The water table can be as shallow as zero feet and as deep as hundreds of feet.

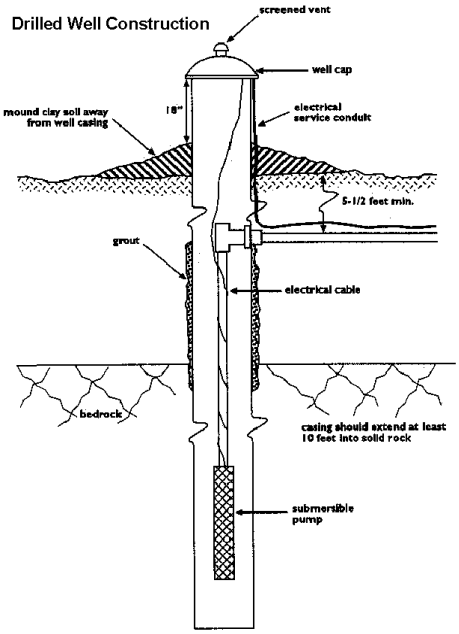
Well Types

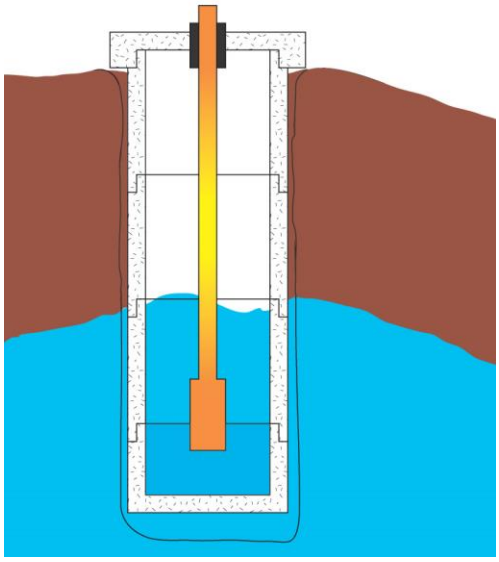
There are three common well types; dug well, bored well and drilled well.

Dug Well: A dug well is a shallow well. It's called a dug well be cause it may be dug out by hand. This type of well is usually a very large diameter well.

Bored Well: A bored well is created using boring machinery. It is still a fairly large diameter shaft – maybe 3 feet in diameter.

Drilled Well: This is where it gets interesting. If the water table is a long way down, a machine is used to drill a narrow shaft sometimes hundreds of feet into the ground.





The diagrams above show two well types. The diagram on the left is a drilled well. The drilled well may extend down hundreds of feet. In this case a shaft has been drilled to the bedrock and then deep into the bedrock to find a good supply of water.

The diagram on the right shows a bored well. This well is made of concrete sections and is extended down below the water table. The well fills up to the water table height.

Well Water Quality

Ground water versus surface water: A good well draws fresh and clean water from deep in the earth. Surface water is not fresh and clean. It's important to keep surface water, such as rain water, out of the well. The ground around the top of the well should drain surface water away to keep surface water from contaminating the well. The well casing is usually sealed to exclude surface water but it's still important to keep surface water from getting there in the first place.

Other contaminants: Surface water is not the only contaminant of wells. Well water can become contaminated from the septic system. For example, if your septic system is too close to your well, there could be crossover contamination. While there are many local regulations, as a first guess, your well must be at least 50 feet from a septic tank and 75 feet from the drainage field. Other contaminants may include impurities in the soil, fertilizers and other chemicals and any number of local contaminants.

Water Testing

It's a good idea to have your well water tested regularly. It is something that can be done by the homeowner. Water sample kits are readily available in rural areas from a drugstore or from a public health department. It's a simple matter of collecting a sample from a tap and indicating the tests you would like done on the water. Follow the detailed instructions from the lab. Here are a few general tips for sampling:

- Water sample must be done using the sample container supplied by the lab. Instructions will be included in the package.
- Make sure you take the sample when you know you will be able to deliver the sample within 24 hours.
- Make sure you remove aerator screens from the tap. Take the sample from an indoor tap, not a hose or hose faucet.
- The end of the faucet should be disinfected with an alcohol swab and then the tap should be left running for three or four minutes.
- When collecting the sample, don't touch the inside of the lid or the inside of the bottle.
- Don't rinse out the bottle.
- Keep the sample cool until you return the sample to the drop-off location.

A standard water test only tests for bacteria including total coliform and E.Coli. If you would like tests for metals or chemicals such as pesticides, you will have to find a lab that will do these tests.

Getting Water into the House

The first challenge is to dig a well that can deliver fresh clean water. The second challenge is to get the water out of the well and into the house. A pump is needed but what kind of pump? The pump may be located in the house (jet pump) or the pump may be located in the well (submersible pump). Is a submersible pump better or is a jet pump better? Each is ideally suited to its task. The jet pump is ideal for shallow wells; the submersible pump is ideally suited to deep wells.

The photographs above show two pumps. The pump on the left is a submersible pump. This submersible pump is long and slender so it can fit down the narrow shaft of a deep drilled well casing. The pump on the right is a shallow well pump with its pressure tank beneath.

Shallow Well

A shallow well is a well that is less than about 25 feet deep. The reason for the 25 foot limit is that this is the practical limit that you can suck water up using a pump that applies only a suction from the top. If the well is deeper than 25 feet you have to add some push from the bottom of the well. The most common shallow well pump is the jet pump.

Deep Well

As we have already identified, a deep well is one that is deeper than about 25 feet. A deep well will need a pump that can push from the bottom not just suck from the top. Deep well pumps are either submersible pumps or a jet pump where the injector assembly is located inside the well.

Jet Pump

The most common type of well pump is a jet pump. A jet pump is actually two pumps in one. There is the main pump body, which is a centrifugal pump and there is an injector body – called "the jet". A jet pump will pull water up from a well as deep as 25 feet.

Note: A jet pump can be configured to pump from a much deeper well than 25 feet. The injector body is removed from the jet pump and placed in the well instead of on the main pump body. This increases the depth greatly because the pump is now pushing water up from the well rather than pulling from the top.

Submersible pump

In the last sections we introduced the fact that for deep wells, you have to push the water from inside the well rather than sucking it up from the surface. A pump that is ideally suited for this task is the submersible pump. The submersible pump can pump water up hundreds of feet from deep in the well. The submersible pump is a more expensive pump and if it ever breaks down, it's expensive to remove and replace.

If the home has a submersible pump, you won't hear the pump motor but you may notice a jump in water flow when there is a tap running and the pump kicks in.

Pressure Tank

The pressure tank is a pressurized reservoir of water. The operation of the system is as follows –

- When you turn on a tap in the house, water is drawn from the pressure tank.
- As water is drawn from the tank, the pressure decreases.
- When the pressure in the tank drops below a set point, the pump comes on and fills the tank with more water and the pressure goes back up.
- Ideally, you would get smooth even flow of water. If you are running water at a tap or shower, you will notice when the pump kicks in but it should be subtle.

How does the pressure tank perform these functions? It's actually a very simple device. The pressure tank is just a reservoir with air in it. Let's expand on the previous description and look at the cycle of operation –

1. Pump turns on and water starts to fill the pressure tank
2. The air in the tank gets compressed.
3. The pressure in the tank builds as the air is compressed more and more.
4. Once the pressure reaches the operating pressure, the pump shuts off. Now you have a pressure tank that is full of water and compressed air.
5. Now imagine you turn on a tap. The pressurized air drives the water out of the tank and through the plumbing system.
6. The air expands and the pressure decreases. Once the pressure drops below a set point, the pump kicks in and the cycle starts from the top.

Problems with the System

Your health depends on a supply of clean water. The water supply system is a critical system. In time, things do go wrong. Here is a short list of problems that can crop up with the water supply system.

- Well water contamination
- Not enough water from the well
- Well runs dry during a dry period
- Pump failure
- Pressure tank failure (or poor performance)
- System out of adjustment

Water contamination: There are several things that can affect the quality of the water. The water supply can become contaminated from a defective septic system or the proximity of the septic system to the well. Contamination can originate from surface storm water or contaminants in the soil or in the water table itself. Well water should be tested regularly to provide early warning of a problem before it affects health.

Not enough water: As water is drawn from the well, new water flows in. The amount of water you can pull from the well is a function of the volume of the well and how fast fresh water can replenish the well. If the volume / recovery rate combination does not supply the amount of water that you need for you lifestyle, you either have to change your lifestyle or modify the well. A well expert can let you know what to expect from your well by doing some measurements and testing.

Well runs dry: The depth of the water table may vary from year to year and from season to season. While there may be plenty of water in the spring, a dry summer may mean that the well runs dry. Home buyers are advised to find out about the performance history of the well from the seller. Additionally, a well expert can measure the depth of the well and give you an indication of how it will perform.

Pump failure: Like any mechanical systems, the pump will eventually fail. The pump has to be maintained and repaired. Any and all of the parts can and will fail including –

- ***Foot valve*** – this is a ***one way valve*** at the end of the pipe that runs from the house to the well. It is located under water in the well. As water is sucked up from the house, the foot valve allows water to flow. Once the pump shuts off, the foot valve prevents water from flowing back. If the foot valve fails, the pipe looses its prime and the system will not function.
- ***Piping*** – piping problems, such as leaks, happen with rural systems just as they would happen in urban systems.

- ***Gauges*** – the pressure gauge may become defective and show an inaccurate reading. This does not affect the operation of the system.
- ***Pressure switch*** – the pressure switch is the device that sets the operating pressure of your plumbing system. It sets the pressures at which the pump turns on and off. A defective or improperly adjusted pressure switch may cause improper cycling or excessively low pressures.
- ***Motor*** – no motor, no water!
- ***Pump and injector components*** – these components get constant action. They eventually wear and have to be repaired or replaced. It should be no surprise that moving parts eventually fail and that rust from water on steel will accelerate this.

Pressure Tank Failure: The pressure tank may fail because it rusts through or it leaks. It may also become non-functional if it looses it charge of air. If the tank looses its air, it cannot perform its function and the entire system will operate erratically. This is a fairly common problem with older style pressure tanks. Fortunately, old tanks can be recharged easily as long as there are no leaks. It is not a common problem with newer tanks because they have a membrane that helps to prevent air loss.

Summary - Wells

- There are three general classifications of wells; dug well, bored well and drilled well.
- Water quality can be compromised by surface water, damaged or defective septic system, contaminants in the soil or water table.
- Submersible pumps are good for deep wells.
- Surface pumps are only good for relatively shallow wells.
- The pressure tank is a reservoir for water and it creates smooth operation of the system.

Check Your Knowledge

Answer the questions below in the spaces provided

1. **True or false? A drilled well may be hundreds of feet deep.**

2. **If you dig a hole in the ground and you dig deeper than the water table, what will happen?**

_____

_____

3. **True or false? To increase the water volume of a well, you can slope the land around the well to funnel rain water into the well.**

4. **What is the purpose of the pressure tank?**
   a) **To provide a smooth even supply of water**
   b) **To prevent pipe hammer**
   c) **To prevent corrosion in the plumbing system**
   d) **To pump water from a deep well**

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Chapter 7

CHAPTER 7
CEP Quiz

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CEP Quiz – Septic Systems and Wells

Name_____

1. True or false? Once filtered through the soil, effluent ultimately makes its way to the groundwater.

2. List two things that you should not flush down a septic system (there are several possible answers)

   _____

   _____

3. Proper care for a septic system includes having it pumped out
   a. Once a year
   b. Once every three to five years
   c. Every ten years
   d. You don't have to pump it out since the effluent simply leaks into the drainage field.

4. The purpose of the ***outlet*** baffle on the septic tank is to:
   a. Encourage mixing of solids and liquid effluent
   b. Prevent scum and solids from flowing into the drain field
   c. Limit mixing of solids and liquids in the septic tank when waste flows into the tank
   d. To pump out the tank when required

5. The purpose of the ***inlet*** baffle on the septic tank is to:
   a. Encourage mixing of solids and liquid effluent
   b. Prevent scum and solids from flowing into the drain field
   c. Limit mixing of solids and liquids in the septic tank when waste flows into the tank
   d. To pump out the tank when required

6. True or false? Odors and wet spots in the drain field could indicate failure of the septic system.

7. True or false? A dug well is a small diameter well that goes deep into the earth.

8. True or false. Surface water can contaminate a well. We don't want surface water to get into the well.

9. True or false? A common time for a septic system to fail is when a new family moves into the house.

10. The other term for a drainage field is

    a. A sump field
    b. An effluent field
    c. A leaching field
    d. A drop field

Chapter 8

CHAPTER 8

Presentation Evaluation

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Presentation Evaluation – Septic Systems and Wells

TECHNICAL CONTENT	Excellent	Average	Poor	No Opinion
Presenter's knowledge of subject matter	○	○	○	○
Ability to keep you interested	○	○	○	○
Discussion / overview / recap	○	○	○	○
How well did this course meet your expectations?	○	○	○	○

Comments:

_____

_____

ORAL PRESENTATION	Excellent	Average	Poor	No Opinion
Explanation of objectives	○	○	○	○
Voice (volume, clarity, speed)	○	○	○	○
Answers question clearly	○	○	○	○

Comments:

_____

_____

VISUAL PRESENTATION	Excellent	Average	Poor	No Opinion
Voice (volume, clarity, speed)	○	○	○	○
Answers question clearly	○	○	○	○
Effectiveness of visual aids	○	○	○	○
Presenter's eye contact	○	○	○	○

Comments:

_____

_____

MATERIAL HANDOUTS	Excellent	Average	Poor	No Opinion
Effectiveness of handouts	○	○	○	○

Comments:

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