DIAGNOSTIC TECHNIQUES UTILIZED IN THE ANALYSIS OF FAILED SYSTEMS FOR RESIDENTIAL WASTE

APPROPRIATE TECHNOLOGY WORKSHOP #1

PRESENTED BY:
WOSSA
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RESIDENTIAL EVALUATION CHECKLIST
(HOMEOWNER TO FILL OUT)

NAME:_____ DATE:_____

ADDRESS:_____ PHONE:_____

_____

_____

DESIGNER:_____ INSTALLER:_____

1. NO. OF PEOPLE LIVING IN HOUSE: _____ADULTS _____CHILDREN / TEENS _____M _____F
2. LAUNDRY HABITS: _____LOADS/DAY CONSECUTIVE LOADS: YES / NO
   _____LOADS/WEEK _____
3. BRAND OF LAUNDRY DETERGENTS USED: _____ POWDER / LIQUID
4. BLEACH USED: YES / NO POWDER / LIQUID USE: _____CUPS/LOAD _____LOADS/WEEK
5. BRAND OF TOILET PAPER USED: _____ COLORED: YES / NO
6. GARBAGE DISPOSAL: YES / NO USE: _____TIMES/DAY _____TIMES/WEEK
7. DISHWASHER: YES / NO USE: _____TIMES/DAY _____TIMES/WEEK
8. IS A WATER SOFTENER USED: YES / NO _____
9. IS A TOILET BOWL SANITIZER USED: YES / NO _____
10. IS ANY FAMILY MEMBER USING A (LONG TERM) PRESCRIPTION DRUG OR ANTIBIOTICS: YES / NO
11. IS THIS THE FIRST HOME YOU LIVED IN THAT HAS SEPTIC SYSTEM: YES / NO
12. HOW OLD IS SYSTEM: _____YRS
13. HAS THE SYSTEM EVER BACKED UP: YES / NO _____
14. HAS THE ALARM LIGHT EVER BEEN ON: YES / NO _____
15. HAS THE SYSTEM EVER BEEN REPAIRED: YES / NO DATE: _____
16. HAS SEWAGE EVER SURFACED ON THE GROUND: YES / NO DATE: _____
17. DATE OF LAST PUMP OUT: _____
18. DO YOU HAVE A COPY OF THE ASBUILT DRAWING: YES / NO _____

EVALUATING THE HOMEOWNER'S CHECKLIST

Often a septic system problem can be resolved by reviewing the information provided on the questionnaire.

1. Number Of People Living In The Home:

   You may find that there are more people living in the home than was intended when the septic system was designed. You will need to check the water usage, (GPD). This information may be obtained from the water district, or if the home is on a well, by installing a water meter. The most accurate method of determining flow is by installing a timer or a counter on the septic pump. This measures only the water going to the disposal field.

2. - 4. Laundry Habits:

   Often all of the laundry will be done on one day. This practice can hydraulically overload the septic system or short circuit the septic tank. The homeowner may also use excessive amounts of detergent and bleach which can result in biological upset. Laboratory testing may be needed. The sample must be taken during overloading of the system.

5. Type Of Toilet Tissue:

   The type of tissue and whether it is colored or white, may have an effect on the TSS in the septic system. Most septic tank pamphlets recommend not using colored tissue, or tissue that does not break down. But I have to wonder, if you use a tissue that breaks down, where does it go and how does it get there. It probably goes to the bottom of the tank, but before it gets there, it may be increasing the TSS in the effluent from the tank. This is one of Aqua Tests' ongoing studies.

6. Garbage Disposal:

   A garbage disposal should not be used on a septic system. In many areas if you have a garbage disposal the regulations will call for added tank capacity. If a homeowner has a garbage disposal they must be advised to use it sparingly. In simple terms, you are taking solid waste and placing it in a liquid waste system. This will always increase maintenance costs.

7. Dishwasher:

   A dishwasher should not be operated at the same time you are doing laundry or taking showers. This can hydraulically overload the septic system.

8. Water Softeners:

   The reject water from water softeners may cause biological upset of the system.

9. Toilet Bowl Sanitizer:

   Toilet bowl sanitizers that contain chorine may increase the possibility of a biological upset of the system.

10. Medication:

    If there is someone in the family that is on long term antibiotics or medication, it may upset the septic tank, resulting in a high BOD_5 and TSS. Laboratory testing of the effluent is required to prove this.

11. First Experience With A Septic System:

    A family that has never lived in a home with a septic system need to understand that the amount of water put into the system in one day should never exceed the GPD shown on their septic design.

12. How Old Is The System:

    Generally, if a system fails within the first six months to one year of use, it is due to design or construction error. A system which fails after the first year may be due to owner abuse.

13. Has The System Ever Backed Up:

    In an older home with a gravity system, a back-up usually indicates that the tank needs pumping, there is a plugged baffle, undersized drainfield or homeowner abuse. To determine which it is, you will need to:

    a. Uncover the lid above the inlet of the septic tank and inspect the inlet baffle. If the baffle is plugged you may break the clogging by using a probe type tool or spraying a garden hose into the baffle. If the baffle is not plugged and the water level is below the inlet pipe, you have a blockage between the house and the tank.
    b. When you uncover the lid if you find the water level in the tank is above the inlet pipe, this would indicate a failed drainfield.
    c. If this system has a pump, always check the pump first. If the pump is working, then follow the above procedures.

14. Has The Alarm Light Ever Been On:

    If the disposal system is a gravity pump system, uncover and check the drainfield for flooding. A flooded drainfield may increase the back pressure on the pump, which will in turn reduce the flow to the drainfield causing the pump tank to flood. If the disposal system is a Pressure Distribution system, you may have plugged orifices which causes the same problems as a flooded drainfield in a gravity system.

15. Has The System Ever Been Repaired: &
16. Has Sewage Ever Surfaced On The Ground:

    If the system has been repaired you need to know how long ago the repair was done and the time of year. One of the most common mistakes made when repairing a system is to add drainfield to failing system without determining if the failure was caused by ground water infiltration. If a drainfield surfaces in the winter but not in the summer you have ground water infiltration. You must solve the ground water problem or the system will fail again.

17. Pump Out Information:

When you find out how often the septic tank has had to be pumped, it is important to note the time of year the tank was pumped. A tank that has to be pumped in the winter is usually an indication of ground water intrusion. Two other causes of frequent pumping are leaky water fixtures and homeowners who use their garbage disposals on a regular basis.

18. Asbuilt available:

It is important for both the homeowner and the contractor to have an asbuilt available when evaluating any system. An asbuilt should include dimensions from a reference point, like the corner of a building, to the primary components of the system. Anyone should be able to use a tape measure and the asbuilt, and be able to locate the tanks, filters or drainfield. Asbuilts should also include specifications on the tanks and pumps, if applicable.

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RESIDENTIAL EVALUATION CHECKLIST
(CONTRACTOR TO FILL OUT)

NAME:_____ DATE:_____

ADDRESS:_____ PHONE:_____

_____

_____

DESIGNER:_____ INSTALLER:_____

1. SEPTIC TANK SIZE: _____GALLONS
2. CONDITION OF INLET BAFFLE: CLEAN / PLUGGED / NO BAFFLE
3. CONDITION OF OUTLET BAFFLE: SCREENED / NO SCREEN / CLEAN / PLUGGED / NO BAFFLE
4. DATE SCREENS LAST CLEANED: _____
5. SLUDGE LEVELS IN SEPTIC TANK: 1ST COMP.: _____" FLOATING MAT: _____"
   2ND COMP.: _____" FLOATING MAT: _____"
6. SLUDGE LEVELS IN PUMP TANK: _____" FLOATING MAT: _____"
7. PUMP TANK SIZE: _____GALLONS
8. IS PUMP WORKING: YES / NO IF NO REASON: _____
9. DURATION OF PUMP CYCLE: _____MINUTES DEPTH OF PUMP DRAWDOWN: _____"
10. TYPE OF DISPOSAL SYSTEM: G PD M SF OTHER: _____
11. CONDITION OF DISPOSAL FIELD: WORKING / FLOODED / SURFACING / CLOGGED LINES
12. NATIVE SOIL CLASSIFICATION: 1 2 3 4 5 6 _____
13. C-33 SAND DESIGNATION: PASS / FAIL REASON: TOO COARSE / TOO FINE
14. DESIGN RATE FOR SYSTEM: _____GPD
15. ACTUAL WATER USE (GPD): AVERAGE: _____ HIGH: _____ LOW: _____

EFFLUENT SAMPLE COLLECTED FROM: _____

DATE: _____ TIME: _____

IN FIELD TESTING:

pH _____

TEMP _____ °C

DO _____ mg/L

LABORATORY TESTING:

BOD_5 _____ mg/L

TSS _____ mg/L

O&G _____ mg/L

FC _____

NO_3 _____

TREATMENT SYSTEM
CALIBRATION WORKSHEET

Job Name:_____ Date:_____

Address: _____

Type of system: PD MD SF - Other: _____

Design rate: _____ GPD No. of cycles per day (CPD): _____

Pump Tank Dimensions:

Hieght: _____" Length: _____" Width: _____" Gals.: _____

Panel: Simplex Duplex Other:_____ Mfg:_____ Model:_____

Pump: Mfg:_____ Model:_____ HP:_____ Volts:_____

Inch per minute drawdown: _____

Gal. per inch drawndown: _____

Gal. per cycle (GPC): _____

Pump run time: _____ Pump off time: _____

Timer Settings:

On time set at:_____mode Dial set at:_____ Changed to:_____

Off time set at:_____mode Dial set at:_____ Changed to:_____

Set for _____ cycles per day (CPD) and _____ GPD Changed to:_____

Float System:

Mid level alarm float (50% of tank storage capacity) set at:_____

High level alarm float set at:_____

Starting Numbers:

Cycle Counter:_____

EVALUATING THE CONTRACTOR'S CHECKLIST

1. Septic Tank Size:

/ The size of the septic tank is important. You may find after you check the GPD that you don't have the proper detention time. This may elevate the BOD_5, TSS, Oil and Grease and the DO in this system.

2.-4. Baffles:

The baffles in the septic tank are an important part of the septic tanks function. Without the baffles the septic tank will not properly separate the floating mat from the sludge on the bottom. Another value of the baffles is that they tell us how the system is being used. An example would be that if the inlet baffle plugs it may mean the system is being abused by the user. A plugged baffle may also mean that the tank needs to be pumped. An inlet baffle will also plug when the drainfield is not working properly or backing up.

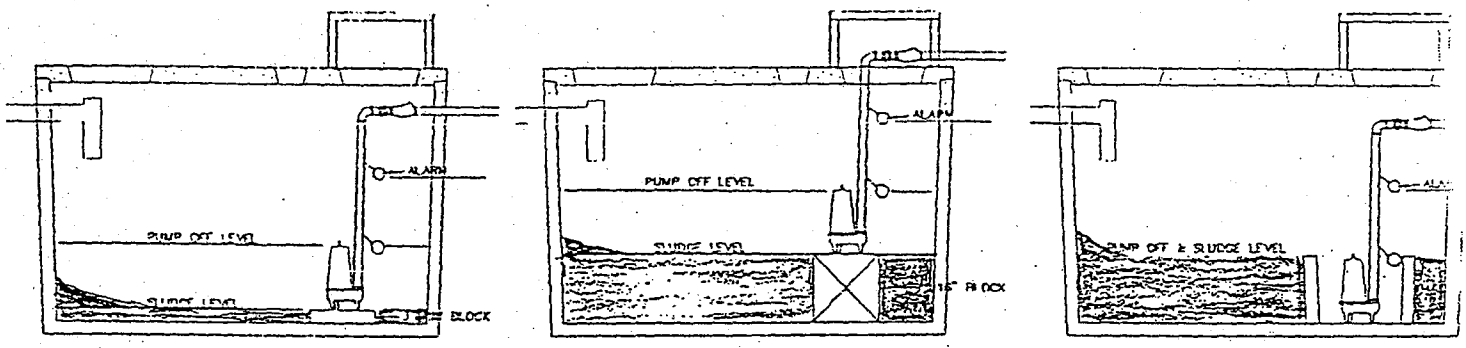
The screened outlet baffles that are being installed now in pressure distribution systems will prevent the larger suspended solids from passing out of the tank and prevent plugging of the orifices in the drainfield. A screened baffle is very helpful in evaluating a system. Most screened baffles will operate without plugging for many years. When a screened baffle plugs within the first two years of operation, the septic tank may not be working properly. When this happens lab tests are recommended to determine the reason or reasons for plugging. Test for BOD_5, TSS, O&G, DO & pH. The lab tests will determine if the system is working properly.

5. Sludge Levels In Tank:

I feel that all septic systems should be inspected and the sludge levels measured after one year of operation. By measuring the sludge levels in a tank and knowing when the tank was last pumped you can predict when the tank will need to be pumped in the future. Because the life style of individual families varies dramatically, I believe this is a better way to determine the frequency of pumping rather than a mandatory time period of three to five years as recommended by most regulatory agencies. Some families need to pump annually and others can go many years. A septic tank needs to be pumped when the sludge in the bottom of the tank is within 8" to 10" from the bottom of the outlet baffle. The floating mat also needs to be measured. If the floating mat is within 8" of the outlet baffle the tank probably needs to be pumped. If you have a two compartment tank, it may not be necessary to pump the second compartment if there are only a few inches of sludge on the bottom. A thick floating mat is usually the result of colored tissues, or tissues that don't dissolve, being used in the home.

6. Sludge Level In Pump Tank:

It is important to measure the sludge level in the pump tank. If the sludge has accumulated to a depth level with the bottom of the pump, the sludge should be pumped out as soon as possible or it will be picked up by the pump and plug the orifices in the disposal field.. In the monitoring of many systems we have found that the sludge in the pump tank may need to be pumped out more often than the septic tank. There is very little storage area in a pump tank for sludge. One method of increasing the sludge storage area in the pump tank would be to elevate the pump off the bottom, but this will result in a loss of storage capacity in the tank. Another way of increasing the sludge storage capacity in the pump tank is to place the pump in a small vault within the tank. This allows the pump to be submerged, per L & I requirements, while keeping the sludge away from the pump itself.



7. Pump Tank Size:

Before you can evaluate any system with a pump, you need to know the size of the pump tank. This is critical in determining the gallons per dose going to the disposal field. Most of the tanks you will be working with are precast tanks ranging in size from 500 gal. to 1000 gal. An easy formula for determining the gallons per dose in any precast tank is to divide the capacity of the tank (gallons) by the depth (inches) to determine the number of Gallons Per Inch (GPI). After you have determined the GPI, measure the depth of the draw down in the pump tank after a cycle to determine Inches Per Cycle. Then multiply GPI by Inches Per Cycle.

GALLONS PER INCH	
500 gal. tank (48" deep)	10.4 gal. per inch
750 gal. tank (48" deep)	15.6 gal. per inch
1000 gal. tank (48" deep)	20.8 gal. per inch

Many sand filters and mound systems have been successfully repaired by simply converting the pump tank to a surge tank. (This will work best if the pump tank has a minimum capacity of 900 gal.) The difference between a pump tank and a surge tank is that a pump tank works on demand and a surge tank has a time

controller that allows a system to be dosed over a twenty-four hour period. An example of this would be a family that does all their laundry on one day and may use up to a 1000 gal. of water within eight hours. This would severely overload a disposal system. A surge tank utilizes a timer that controls the flow and would allow only the amount of effluent the system was designed for to reach the disposal field within a 24 hr. period. The excess amount would be held in the surge tank until the daily flow goes below the design rate at which time it would be absorbed in the daily flows to the disposal field.

8. Is The Pump Working:

Add clean water to the pump tank until the "on" float is submerged. If the pump fails to turn on the first thing to check is the circuit breaker to the pump. If the breaker is on and the pump did not start you need to determine whether the problem is the pump or the float switch. The easiest way to determine this is to plug a power source directly to the pump. If the pump will start then the problem is the float switch. If the pump does not start you know the pump is bad.

9. Duration Of Pump Cycle:

Determining the pump cycle is one of the most important issues when you are inspecting a pump system. This is especially true if the system is a pressure system.

If you are working with a gravity pump system, the time of the dose is not as critical as the volume per dose. For example, if the system is to receive 400 GPD and doses four times a day you need to be sure the float is set to dose 100 Gallons Per Cycle (GPC). (Per the chart above, if the pump tank is a 1000 gal. tank, the float would need to be set for a draw down of appx. 5".) The time it takes to pump the 100 gal. is not critical.

In a pressure distribution system, the gallon dose may be the same as above but the time of each dose is very critical. Generally you would be dosing 30 to 50 GPM, so with a 100 GPC the pump run time would be between two and three minutes.

When you are checking a pressure system you may find that the run time has increased from the original design or is greater than five minutes This may indicate the orifices in the disposal system have started to plug. It is not uncommon to find a Pressure Distribution system where the pump will run for an hour. This is the cause of many pump failures. For this reason, if you are replacing a failed pump on a pressure system you must run a minimum of two cycles to determine if the orifices are plugged. If you replace the pump, and do not check to see if the orifices are plugged, the pump will more than likely fail again, very soon.

10. Type Of Disposal Field:

Make sure you know the type of disposal field you are working with.

11. Condition Of Disposal Field:

Gravity System, equal distribution: If the drainfield is surfacing in one area, check the distribution box to make sure the flows are going equally to all lines. When you determine which line is surfacing, raise the invert in the distribution box going to the flooded line. This will increase the flows to the other lines.

Gravity System, serial distribution: This is the easiest of all systems to evaluate. If flooding is occurring at the end of the drainfield, the drainfield is completely flooded. If flooding is occurring somewhere else in the system other than the end, you probably have a broken step-down downstream from the flooded area.

Pressure Distribution: The most common problem with pressure distribution on a slope is that the upper line orifices will begin to plug. This will overload the lower lines. You can usually tell by the vegetation over the drainfield. The vegetation will be lush over the lower lines. You can also uncover the lines and look for ponding. To correct this problem you will probably need to clean the orifices in all of the lines. This is accomplished by either vacuuming out the lines or uncovering the ends and brushing out the lines. Occasionally it is necessary to install valves on the lower lines to decrease the flows to the lower lines and increase flows to the upper lines.

Mounds and Sand Filters: If a mound or sand filter is surfacing out the top, it may be the result of hydraulic or biological overloading. First check to see that the system is receiving the proper gallons per day and check the peak flow for a given day. This can often be accomplished by reviewing the questionnaire the home-owner fills out. If in reviewing the questionnaire you feel the homeowner may be abusing the system it would be a good idea to run laboratory tests to determine if the system is biologically overloaded. To determine if the system is salvageable, dig a hole in the gravel bed to the sand, run the system through a cycle and measure the time it takes for the water to go down in the hole. If the water stays ponded for a long time, you will probably need to take the bed apart and remove the biomat. However, if the water goes down in the hole and the system is equipped with a timer, you need to reduce the gallons per cycle. If the system is not equipped with a timer you would want to consider converting the pump tank to a surge tank utilizing a timer. The mound or sand filter may recover when dosed intermittently.

12. Classification Of Soil:

Anytime you are evaluating a failing system it is important to test the soil to be sure that the system was properly sized. The most common error made in soil classification is made in Type 1 soils. In testing Type 1 soils we use a sieve test which measures particle size but has no consideration for the compaction factor in its native environment. A true Type 1 soil will not stand vertically when you dig a hole. If the wall will stand vertically, there is a great deal of compaction. A percolation test is a simple method of determining Type 1 soil. If after testing, it has a percolation rate greater than one minute per inch, it is not a Type 1 soil. As a result of improper evaluation of Type 1 soil, many of our inground mounds have

failed because the loading rate of the native soil is slower than the imported C-33 sand.

13. C-33 Sand Designation:
    It is important when evaluating any system utilizing sand to run a sieve test on the sand to make sure it meets the C-33 sand standards.

14 Design Rate For System:
    It is impossible to evaluate any system without knowing the original design rate.

15. Actual Water Usage:
    When evaluating a failing septic system you must determine the actual water volume going into the system. This may be determined by water meter readings if the system is on public water. Remember to only check the usage during winter months. A more accurate way of measuring flow to the system is to install a counter or timer on the pump. This will also allow you to measure peak flows if you do daily readings.

16. Effluent Sample Collection:
    If you think that a system has been biologically overloaded and feel that laboratory testing is needed, it is important that the person collecting the samples is familiar with Standard Methods. If the samples are drawn improperly the test results will not be a true representation of the effluent. Often it is more practical to hire a technician that is familiar with Standard Methods to draw the samples than to take a chance on having someone draw the samples that is not familiar with the correct procedures.

17. In Field Testing:
    pH testing: The normal range for a septic tank is 6.5 - 7.2. This is the range that septic systems work best.
    Temperature: The normal range for a septic tank is about 50°F (10°C).
    Dissolved Oxygen: This is the most critical field test you can perform. First you need to check the water supply in the home to determine the DO of the water supply. The easiest place to check this is in the toilet tank. The normal range is 3.0 - 6.0 mg/L You should then check the DO in the effluent. This will normally be .5 - 1.0 mg/L. However, in some areas with a deep well, we have found the oxygen level in the water supply at zero. In this case the oxygen level in the septic tank should be zero. An elevated DO in the septic tank would indicate ground water infiltration, surface water infiltration or leaky plumbing fixtures in the home.

18. Laboratory Testing:
    BOD_5 stands for Biological Oxygen Demand over a five day test period. The normal range for residential BOD_5 is 130 mg/L. to 230 mg/L. When evaluating BOD_5, if the value is lower than 130 mg/L, this is probably the result of water infiltration. If the number is higher than 230 mp/L there is a biological upset in the system.

DIAGNOSTIC TECHNIQUES

MONITORING FREQUENCY USING NUMBER METHOD

WATER SUPPLY	SITE	METHOD
PUBLIC WATER	HOME ON ONE ACRE OR MORE = 1	CONVENTIONAL SYSTEM 1
WELL	HOME ON ONE OF ACRE OR MORE = 2	GRAVITY SYSTEM WITH PUMP 2
EITHER	HOME ON BODY WATER - DRAINFIELD 100 FT. FROM WATER = 3	PRESSURE DISTRIBUTION DRAINFIELD 3
EITHER	HOME ON BODY WATER WITH SHELLFISH = 4	MOUND - SAND FILTER 5
EITHER	BUSINESS WITH HIGH STRENGTH WASTE = 10	ALL APPROVED PROPRIETARY SYSTEM 5
EITHER	BUSINESS WITH LOW STRENGTH WASTE = 2	EXPERIMENTAL SYSTEM 7
EITHER	HOME ON BODY OF WATER - DRAINFIELD LESS THAN 100 FT = 6	
EITHER	HOME ON BODY OF WATER - DRAINFIELD LESS THAN 50 FT = 8	
EITHER	HOME ON BODY OF WATER - DRAINFIELD BEHIND BULKHEAD WALL = 10	

FREQUENCY OF MONITORING

SITE & METHOD NUMBER	MONITORING FREQUENCY
2	4 YEARS
3 TO 5	2 YEARS
5 TO 8	1 YEAR
8 TO 10	2 TIMES YEARLY
OVER 10	4 TIMES YEARLY

TSS stands for Total Suspended Solids. The normal range for residential is 71 mg/L. An elevated TSS is usually the result of a septic tank that is hydraulically overloaded.

Oils and Grease. The normal range for residential is 10 - 20 mg/L. An elevated oil and grease value can be the result of doing all the laundry on one day or the cooking habits (heavy use of cooking oils, salad dressings, etc.) of the household. Family members that use bath oils, skin softeners, etc. can also increase this value.

Fecal Coliform. Generally this test is performed to determine whether the ground water is being contaminated or not.

Nitrate (NO_3). This test is performed to determine what effect the disposal system is having on the ground water.

A septic tank system is a living breathing population of microorganisms that function very well and will have a long life in the average residential environment. However, if the system was not properly installed, maintained on a regular basis, or is abused by the homeowner, it may have a very short life.

This paper does not have all the answers to the problems that you will run into, but it may provide you with information that will help you to determine why a system is failing.