

## PROBLEM WELLS

### Flowing Wells

Flowing artesian wells are water wells where the pressure in the aquifer (water-bearing geologic formation) forces ground water above the ground surface so that the well will flow without a pump. Several methods are used to construct flowing wells and to control the discharge of water from the well. To ensure that the artesian properties of aquifers are preserved and that environmental and personal property damage do not occur, water well contractors need to be fully prepared when completing wells in areas where flowing wells are encountered. The areas of Michigan where flowing wells occur need to be delineated so that county well permit programs become useful tools to regulate flowing well construction practices.

More detailed information on flowing wells can be found in the DNRE's Flowing Well Handbook. It contains detailed information on flowing well occurrence, case histories, well construction methods, discharge control, disinfection and plugging of flowing wells. To receive a copy of the handbook, visit the Well Construction Unit website at [www.michigan.gov/deqwaterwellconstruction](http://www.michigan.gov/deqwaterwellconstruction).

### Flowing Well Rules

#### Rule 121(c)

Prevent unnecessary discharge of water.

#### Rule 121(3)(a)

Confining layers must be preserved during well construction and any breeches must be sealed.

#### Rule 138

Flowing wells shall be grouted:

- To protect the artesian aquifer
- Prevent erosion of the overlying geologic materials
- Confine the flow to within the casing.

#### Rule 138(2)

Discharge control be provided to

- Conserve groundwater.
- Prevent the loss of artesian pressure.

Flow control shall consist of any of the following:

- Valved pipe connections.
- Watertight pump connections.
- Receiving tank.
- Flowing well pitless adapter.
- Packer.
- Other method approved by the health officer.

A flow discharge pipe shall not be directly connected to a sewer or other source of contamination.

## **Deviation to Allow Flowing Well to Discharge**

A flowing well that is constructed after April 21, 1994 (effective date of the well code revision) may be permitted to discharge water, if a deviation is issued local health department. The DEQ recommends that discharges be throttled back to not more than 10 percent of the unrestricted flow rate, unless a deviation is obtained. Before a deviation can be issued, the well owner or the owner's representative (well driller) must demonstrate any of the following:

1. Control of the flow is not practical - In some rare situations, controlling a flow may not be practical. The degree of difficulty in controlling the flow is increased if site conditions include a high artesian head, a large flow rate, a thin or unstable confining layer, or a shallow depth to the top of the artesian aquifer. This deviation condition also applies to situations where a technically sound but unsuccessful attempt has been made to control the discharge.
2. Control of the flow will likely result in the production of sand or turbidity in the water - While most flowing wells in unconsolidated geologic formations are completed with well screens, there may be cases where the contractor is not able to install one due to excessive uphole pressure. In such cases, the discharge rate should be reduced to the lowest pumping rate that will not result in sand or turbidity. It should be recognized, however, that barometric pressure changes, which affect aquifer head, can occasionally result in turbidity production, regardless of flow control mechanisms. Turbidity production may also be caused by insufficient well development.
3. The discharge is for a beneficial use – such as:
  - A. Maintaining water levels in a pond used for irrigation, fire protection, fish rearing, recreation, wildlife enhancement, or other commercial purpose.
  - B. Supplying a continuous flow of water for heating, cooling, industrial processes, irrigation, or power generation.

The *Flowing Artesian Well Discharge Deviation* form may be used by local health departments for issuing deviations to R 325.1638 of the well code.

Since many flowing wells are located near surface waters, the discharge of water from flowing wells frequently involves disposal into a lake, river, or stream. If the buried discharge line or spillway passes through a wetland, a soil erosion/sedimentation permit may be needed. Contact the local soil erosion/zoning office to find out whether a permit will be needed.

## **Discharge Control**

Proper control of discharge water from flowing wells consists of:

- (1) preventing the discharge of water from around the casing by tightly sealing the juncture between the borehole wall and the well casing, and
- (2) stopping or reducing the discharge of water from within the well casing.

The discharge of water from flowing wells can be stopped or significantly reduced, in most cases, if proper steps are taken during well construction. If the flow within the permanent casing is not stopped completely, it is recommended that the flow be reduced to approximately 10 percent of the unrestricted flow rate. If it is intended that the well flow more than 10 percent of the unrestricted flow rate, a deviation must be issued.

## Flowing Well Discharge Deviation – EXAMPLE FORM

This is to allow for a deviation of the provisions of R 325.1638 of the Michigan Well Construction and Pump Installation Code (Part 127, 1978 PA 368). This deviation is authorized under R 325.1613.

Well owner \_\_\_\_\_ Home phone \_\_\_\_\_

Address \_\_\_\_\_ Work phone \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip code \_\_\_\_\_

Well site address \_\_\_\_\_

Well permit application date \_\_\_\_\_ Well permit number \_\_\_\_\_

Unrestricted flow rate \_\_\_\_\_ gpm Proposed discharge rate \_\_\_\_\_ gpm

### Reason(s) for deviation:

Control of flow not practical – Give reason(s) \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Flow control will result in sand/turbidity production.

Discharge is for beneficial use:

\_\_\_\_\_ Maintain water level in pond

\_\_\_\_\_ Fire protection

\_\_\_\_\_ Industrial process

\_\_\_\_\_ Heating/cooling

\_\_\_\_\_ Irrigation

Other \_\_\_\_\_

Person requesting deviation \_\_\_\_\_ Date \_\_\_\_\_

Local health department official \_\_\_\_\_ Date \_\_\_\_\_

Local Health Department \_\_\_\_\_

## METHANE/GAS WELLS

### Introduction

Methane gas can occur naturally in water wells and when it does, it presents unique problems for water well drilling contractors. The major concern relates to flammable and explosive hazards when water is used in small unvented or poorly vented rooms such as laundry rooms or showers. Methane should be suspected whenever the well water appears milky and effervescent. Problems such as “air-locking” of the pump or sputtering of water at the faucets may also indicate the presence of methane or other gases.

Methane (CH<sub>4</sub>) is the first member of the paraffin series of saturated hydrocarbons. Methane is a colorless, odorless gas and has an explosive limit between 5 to 15 percent by volume in air. Since it is lighter than air it rises: in a fire, it will be at the ceiling. Methane stays in solution below 42°F and evolves out of the water between 42 to 58°F. Above 58°F methane is a gas and will not stay in solution. Methane can be generated by the decomposition of carbonaceous matter in swampy or marshy areas and is often called “marsh gas.”

The gas that causes problems in water wells can occur in either bedrock or overburden wells. Methane is generated in source rock, then “stored” in a reservoir with some type of cap rock or impervious layer to contain the gas underground. In Michigan, these wells generally occur in areas underlain with Antrim or Coldwater shale formations of the late Devonian or early Mississippian period. These two shales are carbonaceous in nature and serve as the source rock. Gas from these sources may contain methane or may be nearly all nitrogen. A high nitrogen content gas can cause problems in pump operations, but it is not an explosive hazard.

Production type natural gas may also be occasionally encountered in water wells. This higher British Thermal Unit (BTU) gas may escape from an oil/gas well blowout or from a failure at an underground gas storage field.

### Rules

#### Rule 156a

Gases shall be vented.

- Vented to the outside atmosphere.
- Consultation for identification and treatment of gases.

#### Rule 163(4)

Abandoned wells discharging gases shall be plugged with neat cement or concrete.

### Sampling procedures

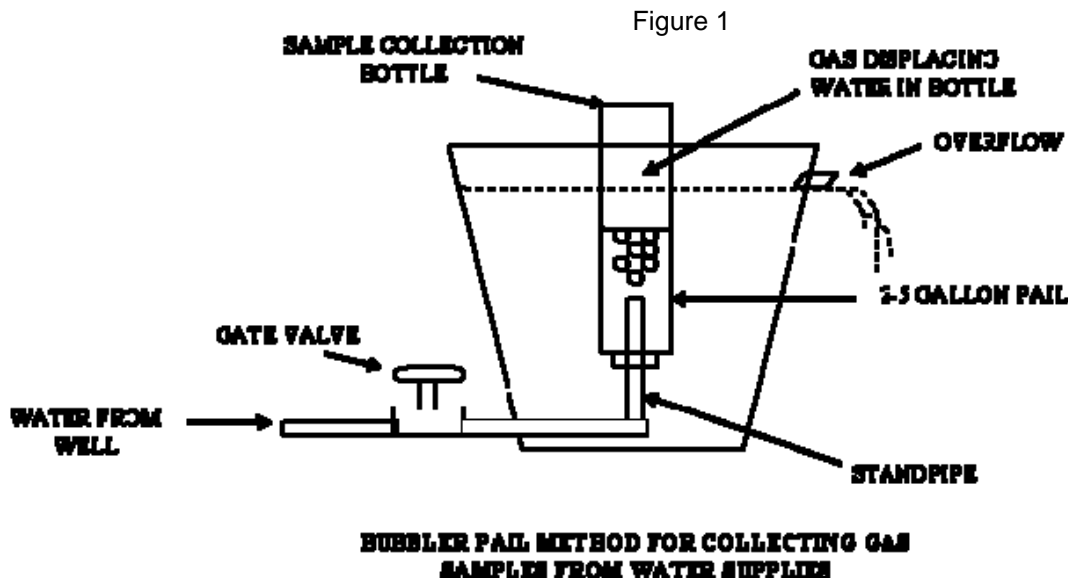
A simple qualitative test for methane can be done with the use of a plastic, narrow-mouthed milk carton and a book of matches. Use the following procedure:

1. Fill the gallon container up to the bottom of the narrow neck. Place hand over the mouth of the bottle. If methane is present, it will collect in the upper portion of the neck.
2. Bring a lighted match to the mouth of the bottle and quickly move hand away. The presence of methane will result in a brief wisp of blue or yellow flame. NOTE: It is important that a plastic container be used rather than glass because of possible breakage. This test should be performed outdoors and away from flammable materials.

The DNRE uses the bubbler pail method for collecting gas samples from water supplies. The

bubbler pail method can be constructed easily from a small pail (see Figure 1). Water enters the pail through an inlet near the bottom of the pail and rises up through a standpipe. The pail is filled with water during the sample collection. A sample collection bottle is filled with water and inverted over the standpipe and gas will accumulate by displacing the water in the sample bottle.

The flow rate and length of test should be recorded and submitted with the sample to the laboratory. Laboratory analysis of the gas is performed to determine the presence of methane and the percentage methane in water. Portable combustible gas meters can also be used for field determinations of methane levels.



The MDEQ considers less than 1 percent methane-in-water (by volume) as being safe from explosion hazards. If levels are above 1 percent, it is usually recommended that a methane removal system be installed on the water supply.

### Well Venting

Proper venting at the wellhead is essential. Methane gas is lighter than air and will exit through a vented well cap. The upward movement of water in the casing when the well is recovering after pumping will push the accumulated methane gas out the top of the well. If large amounts of combustible gasses (methane, ethane, butane, etc.) are present, the well vent should terminate above a person's head level to avoid ignition of the gases by lawnmowers, barbeque grills, cigarettes, etc.

### Gas Shrouds

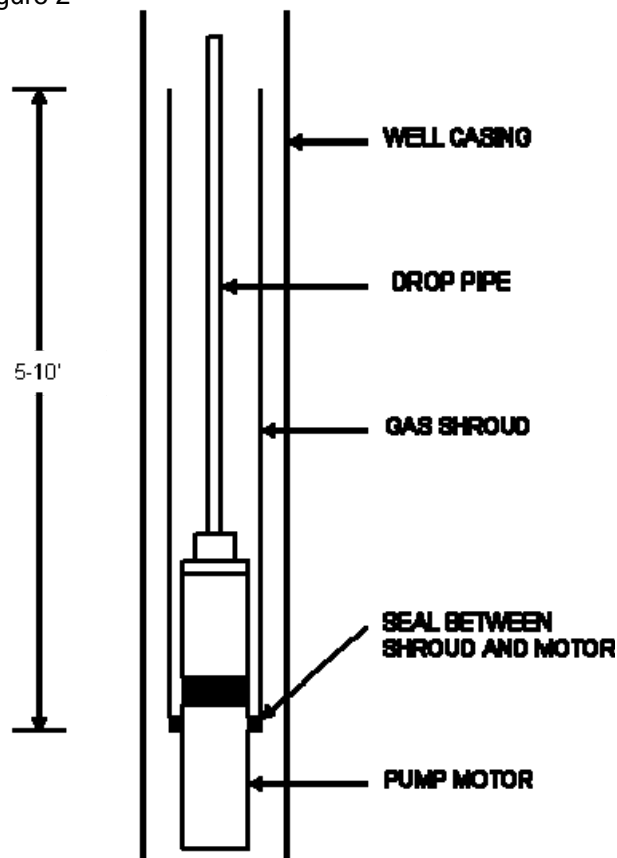
One method that has been successful in several gaseous water wells involves the installation of a gas shroud on the submersible pump (see Figure 2). The shroud will usually eliminate substantial amounts of gas and help prevent air locking of the pump, which is a common problem in gas producing wells. In some cases, the installation of a shroud on the pump has reduced the gas levels enough so that further treatment was not necessary.

The shroud seals to the top of the submersible pump motor, below the intake, and extends 5 to 10 feet above the top of the pump. The water must then travel upward and over the top of the shroud and downward to the pump intake. The dissolved gases will have a tendency to

continue upward rather than follow the water to the intake, allowing gases to escape from the well vent.

If casing is 5 inches or larger with a 4-inch submersible pump, a gas shroud can be easily fabricated from 4-inch thin wall plastic pipe. A few submersible pump manufacturers have shrouds available for 4-inch wells. A 3-inch submersible pump with a thin wall plastic shroud can also be used in a 4-inch well. It is important that a tight seal be made between the pump motor and the bottom of the shroud, since leakage will cause gaseous water to enter the pump intake. The bottom of the shroud must seal at the top of the motor to allow for proper motor cooling. Drillers have sealed the shroud to the motor by wrapping tape around the shroud or by slitting the thin-wall plastic near the bottom and clamping the shroud to the motor.

Figure 2



**GAS SHROUD ON SUBMERSIBLE PUMP**

### Vented Tank Method

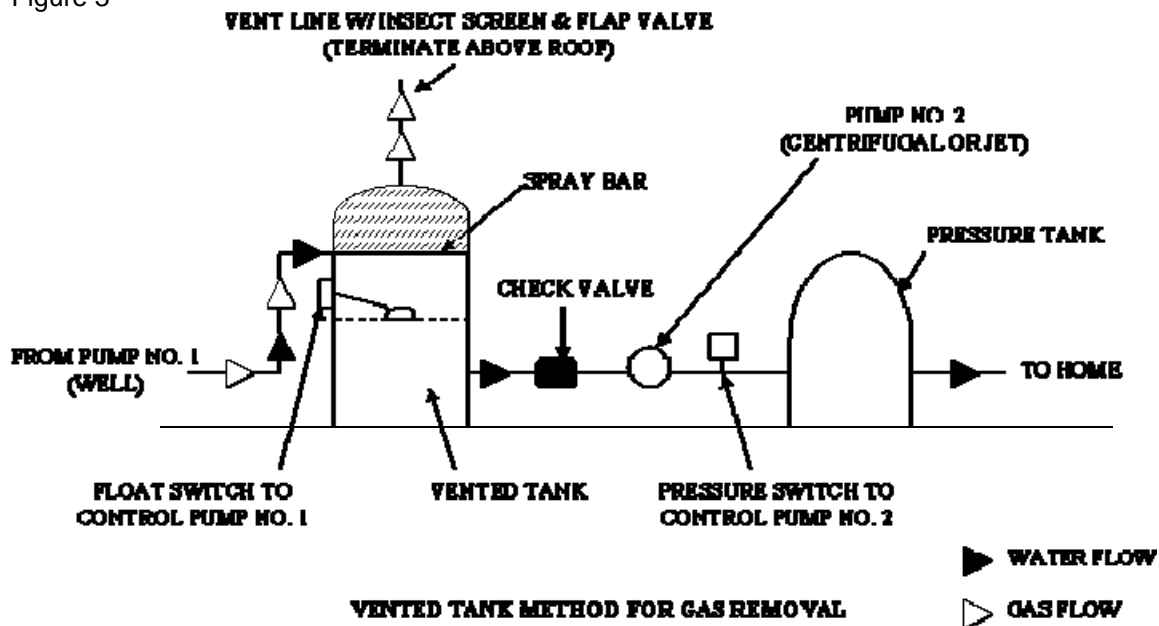
A gas removal system that has worked effectively on several installations in Michigan uses a vented storage tank with a spray bar mechanism (see Figure 3). The spray bar is a length of pipe with small holes drilled in it to disperse the water. Agricultural spray nozzles may also be used for this purpose.

Water from the well is sprayed upward through the spray bar into the vented tank and gas is liberated and exits through a vent pipe at the top of the tank. A float switch is used in the vented tank to control the well pump. A shallow well jet or centrifugal pump is then used to pump water from the vented tank into a precharged pressure tank to provide pressure for the distribution system.

If methane or other combustible gases (e.g. ethane, butane, pentane, hexane) are present, the vent line that eliminates gas from the system should terminate above the roof line of the building. The vent should be screened and turned down to prevent insects and debris from entering. It is recommended that a flap-type

check valve be installed on the vent line to allow the tank to vent to the outside only. This will minimize the intake of airborne bacteria, spores, pollen, etc., into the vent line. In addition, the check valve will place the tank under negative pressure when the second pump is operating, further increasing the liberation of gas from the water.

Figure 3



Water retention time in the vented tank is critical. The tank should be adequately sized to allow the water to remain in the tank for several minutes to optimize gas liberation. Also, the location of the tank inlet and outlet should prevent short circuiting of water flow through the tank.

### Air Release Valve Method

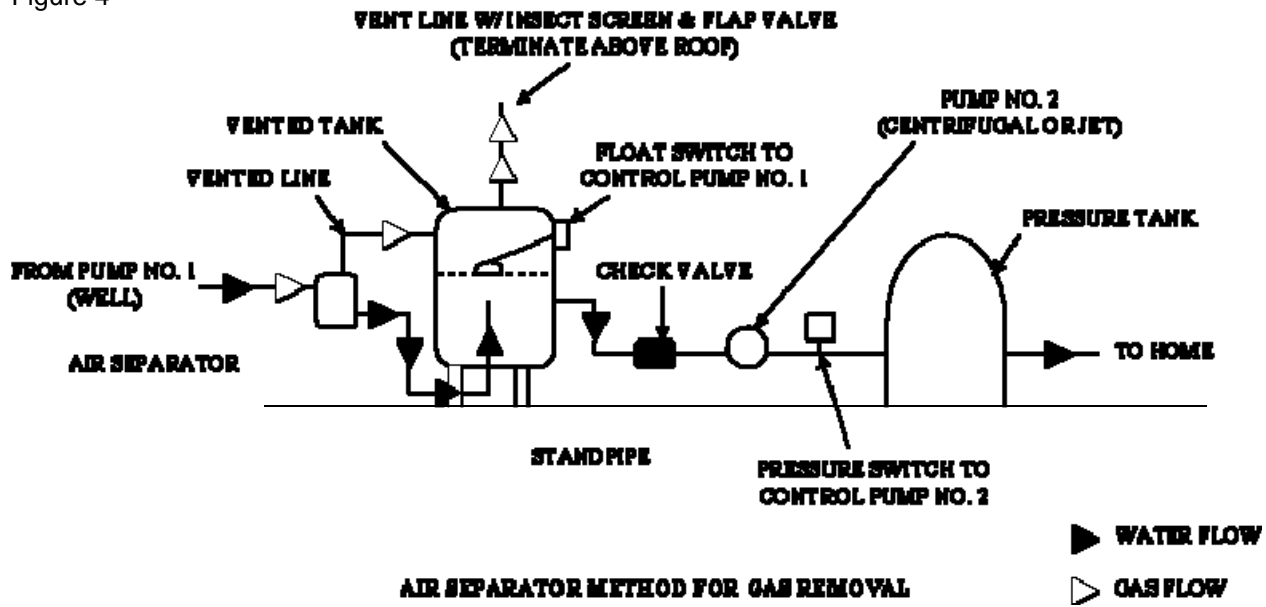
Another system involves the use of an air release valve on a galvanized storage tank. Gas is released from the air release valve when the liquid level is lowered to a predetermined point due to the accumulation of gas in the upper part of the tank. The vent line from the air release valve is terminated above the roof line of the building.

Since the tank remains pressurized, gas liberation does not occur as readily as in those systems using a vented tank. Several systems using air release valves tested by the MDEQ have not been effective in removing large amounts of gas.

### Air Separator Method

The air separator is a cylindrical device with an inlet near the top, outlet near the bottom, and air vent on top. Water flowing through the unit creates a centrifugal force that causes heavier, gas-free water to move toward the outside. Lighter gas-entrained water moves toward the center due to a low velocity vortex being created within the air separator. The gas rises and exits through a vent line into the top of a vented tank. A vent from the tank terminates about a foot above the roof line of the building.

Figure 4



Water from the air separator enters the bottom center of the vented tank through a smaller diameter standpipe. The smaller diameter of the standpipe lowers the pressure and increases water velocity and turbulence in the tank, which induces further gas-water separation.

A centrifugal pump was used to pump water from the vented tank into the school's pressure tanks. A float control on the vented tank controls the submersible pump in the well, and a standard pressure switch located downstream from the centrifugal pump controls the repumping operation.

### Conclusion

Methane and other dissolved gases can be removed from water supplies, however, the additional equipment and space necessary may be prohibitive for small domestic systems. Whenever vented tanks are used, oxidation can cause turbidity problems in certain ground waters, which may make further treatment necessary. Additional field research is needed in the area of methane removal so that low cost treatment methods can be developed.

Water well drilling contractors, engineering firms, or other regulatory agencies that have had experience with other methane removal systems are encouraged to share their experiences.



## **SAND AND TURBIDITY IN WELLS**

### **Introduction**

New wells occasionally pump a small amount of sand or turbidity initially. Well drilling contractors should not place a well into service that is producing sand or turbidity. Once a well is put into routine service, the intake area generally stabilizes. Sand grains bridge on the outside of the well screen and sand production ceases. Existing wells can occasionally develop sand/turbidity (ST) problems after several years of service. Over time, corrosion of metallic casing or screens can allow sand or sediment to enter a well. Erosion in the production zone, loss of a drive-shoe seal, and overpumping can cause ST problems. Persistent ST problems can be challenging to correct.

No single approach will solve all ST problems. Some are easily cured while others can be stubborn. It is important to determine whether the ST problem is an isolated case or if it is surrounded by other wells with the same problem. Most often, an ST problem is an isolated case and can be corrected.

### **Sand & Turbidity Rules**

#### **Rule 139(1)**

Well shall be fitted with a screen that is properly sized to produce sand-free water.

#### **Rule 139(5)**

Well shall be developed and pumped to waste until the water is clear.

#### **Rule 121(2)**

Well shall be adequate in size, design and development for the intended use.

### **Problems Associated with Sand & Turbidity Production**

While ingestion of small amounts of sand or sediment from a water well is not a health concern, their presence can be aggravating and troublesome. Excessive sand and other sediment can damage and decrease service life of the following: pump impellers or bearings, which can decrease pump efficiency, pressure tanks, valves, geothermal heat pumps, water treatment devices, water heaters, aerators, plumbing fixtures, dishwashers, clothes washers, and dryers, clothing and linens, finishes of appliances, automobiles, countertops, sinks, utensils, showers, and glass. Severe sand and turbidity problems can cause reduction of septic system capacity, and plugging of lawn irrigation systems, showerheads, water softener resin tanks, and water lines.

### **Complaint Evaluation & Problem Diagnosis**

Investigation of a sand and turbidity complaint should involve first and foremost, confirming the problem. A site visit to check the severity of the ST problem and determine the nature and source of the particulate matter is crucial. Is it sand, silt, clay, scale, drilling fluid, or something else that needs to be identified in a laboratory? Sand has a distinctive, hard, gritty texture, while silt feels slippery and claylike. Precipitated iron scale can also cause turbidity. This reddish/brown/orange scale usually rubs away between the fingers, leaving a colored residue. A black scale that leaves a residue with a rotten egg or sewage odor when smeared between the fingers, may be attributed to sulfate-reducing bacteria.

Sometimes turbidity is the result of biofilm formation due to microbial growth in the well. Turbidity can also be due to residual bentonite drilling fluid used in rotary drilling operations or

bentonite grout that may have infiltrated the filter-pack or native permeable formation surrounding the well screen.

Well construction details on the well record should be analyzed, and the depth and geologic formation sequence of the problem well to other wells in the vicinity should be compared. Surrounding wells that produce clear water may have been completed in a different aquifer or at a different zone within the same aquifer.

If a replacement well was drilled, it is good to ask the owner if the old well produced sand. If the replacement well is free of sand, the observed sand residual may be coming from the distribution system. If so, correction will involve thorough flushing of the plumbing system.

It is important to determine when the problem began and how often it occurs. Some questions to ask the well owner are:

1. Was the ST problem present as soon as the well was placed into service?
2. If the ST problem started after the well was placed into service, how long afterward did it appear?
3. Was the casing hit by a vehicle or did a lightning strike occur just before the ST problem started? If so, the casing could have been damaged, allowing sand to enter.
4. Is the ST production continuous or sporadic?
5. Does the ST problem clear up with extended pumping or does it worsen?
6. Were there any major increases in water demand (e.g., installation of a lawn irrigation system, pump replaced with higher capacity pump, etc.)? Increased pump capacity will increase water entrance velocity into the well, enabling the water to carry sand into the well.
7. Does the problem exist at particular faucets, out buildings, or individual pipelines?

### **Sample Collection**

An investigator should collect a sample of the sand or sediment. They can do this by running water into a clean, white 5 gallon pail from the sample tap or outside faucet that bypasses the water softener. To determine the ST problem's source, it is best to isolate the well from the pressure tank and piping. Before collecting a well sample for sand verification, be sure that the pump is running. This will ensure that the sample represents new water and not water stored in the well. Distribution system samples can be obtained from toilet tanks (if no filter is present) or from filter housing, if a sediment filter is present. Allow sand to settle.

To help diagnose the source of the sand, inspect the sand and compare grain size to well screen slot size shown on the well record. For example, if the well record shows a 20 slot (0.020 inch opening) and the sand sample is about 0.010," the contractor may have selected an improper well screen. Portable sieves and gauges can be used to identify particle sizes.

If the screen slot is smaller than the sand sample (e.g., screen slot is 0.010 inches and the sand is in the 0.020 – 0.030" range), improper well screen selection is not the problem. The following causes are possible: (1) the screen may have been damaged during installation, (2) the casing may have been damaged, or (3) the neoprene packer between the screen and casing may be faulty.

In filter-packed wells, sand problems may result from improper filter-pack sand selection, bridging of filter-pack above screen, non-uniform or incomplete placement of filter-pack, non-centered screen, or insufficient development.

## Common Correction Methods

No single approach will solve all ST problems. Some are easily cured while others can be stubborn. It is important to determine whether the problem is an isolated case or if it is surrounded by other wells with the same problem. Most often, an ST problem is an isolated case and can be corrected.

An important factor to consider is the type of well development method and extent of development used by the well driller. Premature termination of the well development stage by the contractor is a common cause of ST problems in new wells. Further development or using alternate development methods may resolve the problem. Ask the driller to explain how the well was developed and the proposed corrective action. One of the following methods may be applicable:

1. Replace the well screen with one having smaller slot openings.
2. Use a portable air compressor or drilling rig compressor to redevelop the screen until the well is sand-free at a pumping rate at least twice that of the permanent pump. A well will generally remain sand free if the permanent pumping rate is lower than the discharge rate used during final development.
3. Switch to a different development method than that used initially. For example, if the well was developed with air, redevelopment with a plunger may be successful. Another technique is to water jet within the well screen. A high pressure, high velocity water stream is injected through a pipe placed within the screen. Jets or nozzles near the end of the pipe, or on a special jetting tool, force water horizontally through the screen openings. Sand-laden water is then air lifted out of the well.
4. Resetting the screen at a different elevation may solve the problem. Sometimes, deepening the well a few feet will move the screen into a zone with different sand gradation.
5. If redevelopment is unsuccessful, or if screen replacement is not possible, replacement of the well with a filter-packed well (also known as "gravel-packed") may be necessary. This involves placing specially selected filter sand outside the well screen. Filter-packing technology has reduced sand production problems throughout Michigan.
6. Reduction of the pumping rate may alleviate ST production. Decreasing the pumping rate lowers the water entrance velocity. Therefore, the energy of the water to carry suspended solids is reduced. Installation of a flow-restricting valve on the pump drop pipe may provide relief.
7. The installation of an additional well screen (if sufficient formation is present) is a common correction method. The added intake area lowers the water entrance velocity.
8. While performing corrections to remedy a sand and turbidity problem, the well depth should be checked and compared to the depth reported on the well record. Sediment that has accumulated in the bottom of the borehole should be flushed out.
9. Sand and turbidity problems in existing wells can result from mineral incrustation or biofilm formation. Partial screen plugging increases water entrance velocity and energy. The faster-moving water is able to carry particulate matter more readily. Rehabilitation of a well to restore well yield can correct the problem.

## **Other Causes**

Some additional causes of ST problems are:

- An unsealed annular space - sediment can move downward from the annulus into the well intake during pumping. A complaint that a well becomes cloudy after a rainfall, or subsidence around the casing are likely signs of an ungrouted annulus.
- Placement of bentonite grout adjacent to the well screen.
- A failing check valve above a submersible pump can also cause a sand and turbidity problem because of the surging action of water exiting the drop pipe.
- In bedrock wells, sand or turbidity may be the result of inadequate sealing between the casing and the bedrock or leakage around the drive shoe. Sediment can enter from a sand-bearing formation above the bedrock. Sometimes, reseating the drive-shoe will resolve the problem.
- Sloughing shale formations or friable sandstone zones can cause sand and turbidity problems. Correction can often be achieved by installing a liner with packers to isolate the problem strata.
- Some flowing wells may produce slight turbidity when the flow is restricted or upon severe changes in barometric pressure.

## **Filters and Separators**

If the ST problem is present because of geological limitations and the well has been properly designed, correction options may be limited. Sediment filters and sand separators do not correct the source of the problem, but can be effective at preventing particles from reaching the water distribution system. Their use should be considered only if the ST problem is geologically controlled. Devices such as filters or separators should be used only as a last resort and not as a substitute for proper well design or development. Always try to address ST problems at their source.

## **Clean-up of Water System**

After the source of the ST problem has been corrected, sediment should be flushed from the water distribution system. Failure to do so will result in residual sand or sediment continuing to show up at sinks, showers, and toilets. To the well owner, it will appear as though the problem has not been corrected.

Once clear water is being produced from the well, all distribution system piping should be flushed. Hook a garden hose to a tap at the end of the building opposite from the pressure tank. Do not discharge the hose into the septic system. Turn on the tap and flush at full force. Gently tap exposed plumbing lines to loosen sediment. Remove and clean showerheads and aerator screens from faucets. Drain water heater and pressure tank (several flushings may be needed). Be sure to turn off power to hot water tank before draining. Clean any sand filters and filter housings that may be present. Contact a water treatment dealer to flush sediment that has accumulated in the water softener resin tank. Injecting compressed air into pipelines also helps eliminate sand or other sediment.

## LOW CAPACITY WELLS

### Introduction:

What is a low capacity well? Generally, it is considered one with a production rate of less than 5 gpm. Most areas of Michigan provide well owners with more than enough well water to meet their needs. However, there are a few areas (e.g. the "Thumb", far southeast Michigan, certain areas of the Upper Peninsula, etc.) that produce less than 5 gpm. Since some areas in Michigan only produce 2-3 gpm, a minimum well capacity is not listed in the well construction code. In addition, local groundwater conditions are taken into consideration when evaluating low capacity wells.

### Well Owner Conservation Efforts:

Simple changes in water use habits may be enough to meet peak water demands where water shortages occur infrequently. Peak water demands on the well can be reduced by changing the timing of water-using activities or by reducing the amount of water used. Examples of changing the timing of water use include: spreading laundry loads throughout the week instead of doing all loads in one day and having some family members shower at night rather than all showering in the morning.

Reducing the amount of water used involves water conservation. This might include changes in water use behaviors such as taking shorter showers or not washing the car. Changing water use behavior to spread out peak water use may be inconvenient at times but there is no added cost involved. A more permanent but costly water-conservation solution is to install water-saving devices like front-loading clothes washers or low-flush toilets.

### Well Construction Considerations:

Changes to well construction practices can sometimes overcome the obstacles associated with low capacity wells. These changes should be discussed with the well owner prior to well installation. Some considerations when constructing wells in low production areas are:

- Use a different formation, if possible.
- Practice longer or more rigorous initial development. Rigorous Development (mechanical surging, high velocity jetting, air burst development) can remove drilling fluid damage done to the formation by the drilling operation. It also alters the basic physical characteristics of the aquifer 1-2 feet around the screen allowing water to flow more freely into the well.
- Screen considerations:
  - o Install a greater length of screen. Doubling the well diameter only increases the well yield by 10%. However, doubling the screen length can double the well yield.
  - o Use larger screen openings
    - Continuous slot wire wound screen .... 20-40% openings
    - Saw Cut Plastic Screen: ..... 10-12% openings
    - Slotted Casing ..... 2-5% openings
  - o Change the shape of the screen openings
    - V-shaped (widest to outside) - no clogging
    - Straight cut - clogs easily, increases drawdown
    - Perforations - creates turbulence & encrustation
  - o Use filter pack
  - o Install multiple screens - together or spaced

- Install drawdown seals.
- Restrict pump capacity by a flow control Valve.
- Increase pressure tank storage capacity. This may require modifying the pressure settings to increase available storage.
- Install a storage reservoir/re-pump system, which must be approved by the local health department prior to installation.