Citizen Science Fact Sheet W-1

Overview of Water Testing

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Overview

K-State's Citizen Science program educates citizens about water quality. The goal is to encourage landowners, students and individuals of all ages to take part in community water quality monitoring efforts.

This fact sheet outlines basic water quality tests and measures. It explains:

- what to test and why;
- how to collect samples;
- pros and cons of test kits vs. lab analyses; and
- where to order supplies.

Other publications in this series describe specific tests: how to run them, interpret results, and what to do if a reading indicates potential upstream or downstream problems. There are data sheets to help you visually assess your stream or river (W-9) and sample stream biota (W-8). Tips on forming your own stream team or citizen monitoring group are found in fact sheet W-10.

The Citizen Science water quality packet contains the following titles:

W-1 *Overview of Water Testing*
W-2 *Color, Odor, Temperature, and pH*
W-3 *Turbidity/Transparency*
W-4 *Nitrogen*
W-5 *Phosphorous*
W-6 *Total Coliform and E. coli Bacteria*
W-7 *Triazines (Atrazine)*
W-8 *Stream Biology*
W-9 *Stream Site Assessment*
W-10 *Starting a Water Monitoring Team*
W-11 *Water Monitoring Data Sheet*
W-12 *Interpretation Guide for Water Tests*

Citizen Science was developed by K-State scientists with funding from the Environmental Protection Agency (EPA) and the Kansas Department of Health and Environment (KDHE).

Water Quality Measures

Water quality can be measured in many ways. KDHE report 28-16 *River Basin Water Quality Criteria* lists numeric criteria for 215 possible contaminants including fecal coliform, 10 inorganic nutrients, 20 metals, 57 pesticides, 121 organic chemicals (benzene, hydrocarbons, etc.), and six radioactive substances. Many are of concern primarily in drinking water and water used for fishing, but most also have implications for overall aquatic life. Levels are listed for those known to have acute (immediate) effects and chronic (long-term) effects.

Public drinking water supplies are carefully regulated and monitored. For information on how to interpret water tests supplied by your municipal or rural water district, see K-State Research and Extension publications *Understanding your Water Test Report* (MF-912) and *Organic Chemicals and Radionuclides in Drinking Water* (MF-1142). These explain risks and implications for many different drinking water tests. Government regulations require wastewater treatment plants to submit frequent water test reports on effluent discharge.

Stream and lake ecologists, aquatic biologists, and others who study organisms in nature have a similar list of water quality criteria. In addition to possible toxic substances that can be measured, scientists are also interested in a stream or lake's ability to provide habitat for organisms, and in water temperature and the oxygen levels needed for optimal plant, fish, and other aquatic organisms.

In designing a test kit for on-farm use, we have used the following criteria to narrow the list of possible tests: Is this information useful for a farm manager? Is a test kit available? Is the test reasonably priced and fairly easy to use? Is the test accurate?

We have left out tests specifically for drinking water aesthetics, such as hardness, and things that affect the taste of the water, such as iron or sulfate. We did not include many of the tests wastewater treatment plants are required to submit, even though some of the factors they measure (such as nutrients in the water) apply to farms as well. We have also left out most pesticides because, though often present, most exist in such low levels that most test kits can't detect them. A quick test for atrazine is available commercially, however, and is described in fact sheet W-7.

Tests described in fact sheets

Color and odor – sensory analysis, early indicators of potential problems.

Temperature and pH – help understand the overall context for stream chemistry. These can also affect the other factors such as the toxicity of ammonia.

Turbidity/Transparency – indicates the load of silt and/or algae in the water.

Nitrogen (nitrate, nitrite, ammonia) and Phosphorus (orthophosphate) – these are all soluble forms of nutrients that increase algae and other plant growth, creating a condition known as eutrophication. Eutrophication occurs when these plant and algae die and decompose. They take up dissolved oxygen which can result in fish kills.

Total coliform and *E. coli* bacteria are indicators of contamination. Total coliform is found in soil and naturally will be present in surface water, but it shouldn't be found in well water used for human consumption. *E. coli* bacteria are indicator organisms that suggest that manure or human waste has come into contact with the water supply, increasing the risk of ingesting pathogenic microorganisms such as parasites, viruses, and other bacterial diseases.

Triazine/Atrazine – this test tells whether the EPA limit for triazines of 3 parts per billion (ppb) has been exceeded in the water sample.

In addition, the fact sheets provide information for visual assessment and biological monitoring of macroinvertebrates. This collection of field tests is similar to those used in other states and by professional field biologists, except that we did not include a dissolved oxygen test because of the difficulty in maintaining an accurate sample under field conditions (shaking the sampling bottle can result in error), and the lack of accurate kits in the low price range. Also, high-soluble nutrient loading (N and P) can result in lower oxygen later. These tests will alert you to a potential oxygen problem in the future.

Community and on-farm water testing

The purpose of community and on-farm water testing is to:

- Help you to know more about your community and/or farm, to help you with management decisions.
- Identify potential "hot spots" in your community or on your farm that may be high in nutrients or areas that may be contributing sediment, *E. coli* bacteria, or even pesticides to your drinking water, livestock water sources, or downstream neighbors.
- Help you meet your stewardship goals.

Nearly everyone would like to be a good steward. Whether you manage a farm that has been in your family for several generations, have recently purchased a farm, or simply live in a rural community, you probably would like to leave your watershed in as good a shape as possible. Stewardship goals also require some benchmark data, along with specific data on soil and water quality on your farm. Citizen Science fact sheets were developed to explain types of water data that will be most helpful and details on how to collect and interpret these data.

Commercial labs can conduct a variety of water tests. These labs provide accurate and often timely results. Labs must be state certified to analyze drinking water samples for regulatory purposes (see page 12), but most labs, certified or not, perform stringent quality control on the procedures, including frequent use of check or known samples and replicate samples. They often participate in multi-lab comparisons of common samples.

Quick tests, or test kits, are also available for many water tests. Many of these are used in classroom demonstrations and learning activities. As water quality has become a more important issue, many citizen and student stream teams have begun educating young people about the ecology of streams and lakes, how to identify a healthy stream, and where their water comes from. Some of these test kits are qualitative or designed simply to provide indicators of water quality. Other tests kits are quantitative, and their results are similar, if not identical, to commercial test labs. The variability of the accuracy of the test kits is quite high however, and some test-kit developers do more testing of their test kits than others.

Because test kit quality varies, we conducted a study to compare test kits to lab results. Only field test kits that compared favorably or are considered to be fairly accurate are mentioned in this fact sheet series. If you use test kits other than those recommended, we suggest running a set of 10 or more samples using both the test kit and a commercial lab to check the accuracy.

The advantages of using a quick test, or field test, for on-farm testing include immediate results (except for the incubation time required for total coliform and *E. coli* tests) and confidentiality (you are the only one that sees the results). Because test kits are less expensive than commercial, professional lab tests, many samples may be run and sampling may be repeated several times. For example, test kits are handy for sampling both before and after a rainfall, to get an accurate picture of what is happening on the farm.

This series of fact sheets explains field test kit methodologies, where to obtain test kits and how to use them, and how to interpret results. Commercial lab addresses are provided on page 12 if you would like to double check some samples or use these labs instead of the test kits.

Water tests

Background

Water is a complex mixture of biological, chemical and physical interactions. Nutrients are not static but exist in the mineral form, bound or attached to the surface of particles, as part of the tissue of living organisms, and as part of the decaying organic matter. The temperature and biological activity of the water affect the amount of each nutrient that is soluble.

Nutrient tests in these test kits measure only the mineral, or readily available forms of nitrogen and phosphorus. For nitrogen, this may be in the form of nitrate, nitrite, or ammonia. The phosphorus test measures orthophosphate, which is sometimes called reactive phosphate. High levels of readily available N or P will affect water quality downstream and may cause eutrophication, which is a depletion of oxygen due to excess plant growth and subsequent die-off. Lack of oxygen causes fish kills and is sometimes the first sign there are problems upstream.

Kansas is divided into major watershed areas, or river basins, and subbasins or sub-watersheds, defined as the area of land that drains into a particular stream, river, or lake. Maps are available on the Web at *http://water.usgs.gov/nawqa* or directly from agencies such as KDHE, United States Geological Survey, Natural Resource Conservation Service, or Kansas Biological Survey.

In Kansas, there are two major watershed regions: water that drains into the Missouri River (Region 10) and water that flows to the Arkansas, White, and Red River Basins (Region 11). These two regions in Kansas are divided into 12 subregions, or basins, and 92 watersheds. The average size of these watersheds is 885 square miles, and each has a unique eight-digit code (HUC-8) classification number and name, usually referring to a significant hydrological feature in the watershed (river or stream).

Watershed maps deal primarily with how the surface water flows over a certain area of land, but the groundwater flow and recharge may also be related to surface water characteristics. Water flows from high points in the landscape to the lower points, picking up nutrients and sediment along the way. In some places, this water also enters the ground, recharging springs, seeps, and shallow aquifers.

Below each river is an area of underground water, and lateral flow of water beneath the surface can feed into a river. In times of low rainfall, it can flow away from the river and enter underground aquifers that may be sources of well water for farms, municipalities, and rural water districts. All of the water from Kansas eventually flows into the Mississippi river, which then contributes to the water quality in the Gulf of Mexico.

When addressing water quality concerns, agencies distinguish between “point-source”

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or "nonpoint source." With point-source pollution, one can point to a factory, a wastewater treatment plant, or basically a pipe or a "point" from which water flows. Nonpoint source pollution reaches streams, lakes, and ponds from a generalized area from natural precipitation. This type of pollution is much more difficult to regulate, and prevention requires voluntary action and personal responsibility.

Farm runoff is generally classified as a nonpoint source of some pollutants. However, on a farm or in your community you may know of areas where no runoff occurs. You may also know of an abandoned well, a tile drain, or a gully leading from an animal feeding area where pollutants can get to streams or groundwater. These critical areas, when combined, all contribute to nonpoint source pollution. Monitoring kits will help you identify these areas of concern, and to find out if they are contributing or not. Then you can monitor efforts to remediate problem areas.

The Clean Water Act was passed by the United States Congress in 1972 to protect water quality. This act covers both point and nonpoint source pollution. Recently, a process to establish limits for point and nonpoint source pollution, called "Total Maximum Daily Loads," or TMDLs, was implemented (*www.kdheks.gov/tmdl/index.htm*). Each watershed in the United States was rated according to this criteria. Seventeen pollutants are identified as causing water quality violations in Kansas streams.

Fecal coliform bacteria is the most frequently violated water quality standard, followed by low dissolved oxygen (often caused by excess nutrients), sulfates, and chloride. Accelerated eutrophication (often caused by excess nutrients) is the most common water quality problem in Kansas lakes. Other common water quality problems in Kansas streams are pesticides and sediment load.

Individual farms are not tested or monitored as part of this TMDL program. Efforts in this area are strictly voluntary, but to reach the goals of reducing pollutants it is important to target greatest contributors. Using soil and water test kits along with the *River Friendly Farms* assessment tool (S-138), landowners can document whether there are areas of the farm that might contribute runoff that would add to the stream or river's TMDL problems, and then monitor progress as practices change or add structures to reduce or eliminate the source. Within a community, best management practices can be implemented in parks and on other public lands to reduce or eliminate polluted runoff, including storm drains (*www.kdheks.gov/TMDL/index.htm)*.

General sampling protocols

Start with this set of fact sheets, a map of your proposed sampling sites – your farm, a watershed, a stream – and the tools for sampling and analysis. You will need to order your own test kits, so allow two to three weeks for delivery. (See page 11 for sources.)

Plan when to sample. In some cases, you may want to sample the same sites once a year at the same time. You may also want to sample an area during low water flow and compare it to a time of high water flow. Another project might be to sample the same set of sites during each season of the year. The number of samples you collect and frequency of collection depends on your interests and the question you would like to answer. The minimum number of samples would be two: one sample from the field and a control sample of distilled water.

The number of sampling sites also depends on you and your question. Six would be the most we would recommend for a particular project. It can take up to an hour to collect a sample from the field if you have to drive to a site, walk to the pond or river, collect the sample, walk back, drive back, etc. Running the tests will only take a few minutes per sample for each test, but if you run all the tests, allow for a minimum of about two hours for six samples. It will probably take more time the first time you do this. You can see that on each sampling day you should allow four to eight hours of time, depending on how many samples you collect and how many people work together. This can be done in less time if sampling sites are close to each other and several people cooperate, each collecting a sample or running certain tests and sharing results. Samples can also be collected on one day or an afternoon, and then refrigerated overnight and run the next day.

Fill out the planning sheet at the end of this fact sheet to clarify your sampling goals and come up with a sampling plan. The next sections cover basic tools and specific tips for sampling lakes and ponds, streams, rivers, springs, and other types of water.

Consider safety at all times. This includes not sampling when there is a risk of lightning during a heavy thunderstorm, for example, even though you want to catch the runoff from a faraway field. Also, don't sample with small children near water, unless they are carefully supervised and/or fitted with life jackets.

Some water sampling books recommend wearing rubber boots and gloves to avoid contamination with water. This would be necessary if you think your source is heavily polluted – if it contains raw sewage for example. This is probably not necessary for most outdoor water sources, and should not be necessary if you sample your home water supply. Common sense should also be one of your tools.

Examples of Uses for Water Test Kits in Kansas

Is this well water and pond water safe for my cows to drink? A one-time sample collection of water from two farm wells from hydrants, the watering tank, and a pond were sampled. The primary tests of interest were nitrate-nitrogen and *E. coli*, but the other tests were run, too. In this case study, all water tests were negative for *E. coli* and low in nitrate nitrogen.

Does fencing my ponds improve the drinking water quality for my cattle? A one-time sampling of two fenced ponds and two unfenced ponds, along with some alternative water sources was conducted. The fenced ponds had significantly lower *E. coli* than the unfenced ponds, and the alternative water sources had no *E. coli*, except one where it was so close to the ground that cattle had stepped in and defecated near the small concrete trough.

Is the water better quality when it comes on my farm or when it leaves my farm? All the water quality parameters were tested. On one farm, the *E. coli* was higher in water above the farm, because of an upstream neighbor's feeding area runoff, and the *E. coli* counts steadily declined as samples were collected ½ mile, 1 mile, and 2 miles downstream. Other factors were unchanged. On a second farm, the upstream sample had no *E. coli* and low levels of nutrients, while samples collected mid-farm were extremely high in phosphorous and *E. coli.* Downstream from the center of the farm, levels decreased. The source seemed to be runoff from a hog-feeding area and a recently manured crop field.

Is there fertilizer or pesticide runoff from my corn field? A one-time sample of water standing in a ditch downhill from a relatively flat cornfield after a recent rain revealed high levels (over 50 ppm) of nitrate nitrogen, and triazine (atrazine) higher than 3 ppb.

Is this river safe to swim in? Can we eat the fish? Samples from the Kansas River in an area popular for canoeing and fishing revealed marginally high *E. coli* levels, low levels of nitrate, no detectable atrazine (lower than 3 ppb), but high levels of phosphorous and *E. coli* in water coming out of a pipe. There are no test kits for heavy metals, so things like lead and mercury would have to be analyzed by a commercial lab. We concluded that swimming is safe as long as you don't open your mouth too much, and as far as we could tell it would be safe to eat the fish, but we called the municipality responsible for treating the sewage effluent coming out of the pipe because their disinfection system appeared to be malfunctioning. They are allowed to release phosphorous into the river, even though it resulted in heavy moss and plant growth near the output from the pipe.

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Basic tools

You can order a basic water-sampling scoop from one of the suppliers listed on page 11. Or you can make one from items around the house such as a pole and small can or plastic cup. Be sure the scoop is sturdy, can be easily cleaned and has a reach of at least 3 to 6 feet. It is possible to collect water without the scoop, but your chances of keeping your shoes clean and not falling in are better with a long-handled scoop. We found through experimentation that it is not necessary to rinse the scoop with chlorine or Lysol between samples, but it should be clean before using and rinsed with the water you are sampling at least twice before collecting a sample for analysis.

A special sampler for use off of high bridges can be helpful if you are sampling rivers or large streams from public roadways. One type of sampler is a plastic tube with spring-loaded end-gates made out of plastic balls. The tube is lowered on a rope to just under the water's surface. A jerk on the rope releases the end-gates, capturing the sample in the tube. A simpler device could probably be created from a small bucket or other container with a weight on it and a rope.

You will also need sample containers. We use the small plastic containers used by labs for urine samples, but a similar-sized glass or plastic container that has been washed, rinsed well, and dried will work. You'll need about one cup to one pint of sample. Sterile containers can be purchased from suppliers and from commercial water test labs, but small cup or pint jars from home are suitable.

Be careful when carrying glass to the field. Seal the lid tightly for the trip home. When holding the containers, don't put your fingers on the inside because you could contaminate the sample with bacteria on your hands. The containers don't have to be sterilized in boiling water because bacteria don't live under dry conditions. Any container that has been well washed and dried will be sterile enough to run the *E. coli* test. If you are unsure, run a "blank" or distilled water sample to see if your container has zero *E. coli*.

When you go to the field, take the scoop, sample containers labeled with the date and location, thermometer, and turbidity/transparency tube. Record the temperature in the field. We also recommend recording turbidity in the field because that reading takes about a quart of water. This saves hauling water back to your kitchen or other testing area, and because particles will not have had time to settle out, the turbidity will be close to what it is in nature.

We also suggest running the rest of the samples at an indoor site (classroom, kitchen etc), or at least a flat table out of the wind. It is helpful if there is a sink, running water or jug of distilled water and a waste container for used test strips, glass, etc. Take along a pint or quart jar for wastewater, too, because it is best not to dispose of test waste on the ground. There won't be much, and it is not hazardous. The phosphorus test and the ammonia test generate a small amount of water mixed with reagent waste.

You may dispose of the glass tubes and plastic test strips in your normal household waste, but take care so no one will accidentally get cut on the glass ampoules. The liquid waste and rinse water can be flushed down the sink with extra water into a normal wastewater system. Take your clipboard and data sheet both to the field site and to the location where you run the tests.

Assemble and practice using equipment before going to the field.

Set up and sampling

1. Decide on your question. This will help you figure out where to sample, how often, and which tests to run.
2. Order test materials, including a water scoop and bridge sampler if necessary.
3. Assemble maps needed. Take copies of the data sheets included in fact sheet W-11.
4. On sampling day, allow enough time for collecting and running the samples, or refrigerate the samples and run them the following day. Do not store samples more than 24 hours.
5. Take data sheets, water scoop, sample jars, thermometer, and turbidity tube to the field. Record the temperature and turbidity in the field. If there is enough time, complete the visual stream assessment (W-9) at the same time. When doing the biological assessment, also take a kick net, rubber boots, and a bucket with a lid or other container for transporting samples.
6. Assemble the filled sample jars at an area with a table, good lighting, running water and a sink, or have a jug of distilled water and a waste collection jar handy. Run the chemical and *E. coli* tests in the order listed on the data sheet (W-11). Record the results.
7. The interpretation guides in the individual fact sheets and summarized in W-12 should help. If you need help with interpretation, share your data with the Citizen Science project leader, your local watershed specialist or other adviser.

Lakes and ponds

Because lakes and ponds have layers, somewhat like soil, be conscious of the depth of sampling with the scoop. Biologists who study lakes and ponds use specialized sampling equipment to collect samples from various depths. For on-farm sampling, we will only collect surface water.

To make sure the samples are representative, you might consider sampling from two or more spots in the lake or pond and analyzing each sample separately. For example, even on a small pond, collect one sample from where the water flows into the pond, and a second sample near the dam or where the water may flow out. You may also simply sample from two edges – the north edge, and the south edge, for example.

Reach out with the scoop, so you aren't sampling mud along the edge, rinse the scoop with the pond water, and then reach out a second time and collect a sample from the top 6 to 8 inches or so. Go to the second site, rinse the scoop again, and collect the second sample from a similar depth. If the pond is extremely shallow, sample shallow, so you don't include any mud from the bottom that would change the results. Use common sense when collecting these samples and consider safety first. You might want to use boots so you can get close to the water, rather than reaching out too far and risking falling in.

Springs, streams and rivers

Springs, streams, and rivers are even more dynamic than lakes and ponds, and sampling design should be carefully considered before going to the field. Take out the map of your farm or community sampling area, and with blue highlighters, mark the areas where springs are located and where streams or rivers run through your property. Think also of your questions as you determine your sampling design.

If a stream runs though a large part of your property, you may want to sample several spots. For example, an interesting sampling design might be to sample upstream as far as possible, either at the spring that feeds the stream, if it is located on your property, or at the point at which the stream flows from your neighbor's land onto your land.

Individuals or groups can sample local rivers for chemical and biological properties or perform a visual site assessment.

Then look at how each field is used along the way and think about how each field might be contributing to water quality. Choose three or four more points along the stream to check how each field management area might be either improving or degrading stream quality. On your farm, for example, you might collect the first sample at the property boundary. The second sample could be below where a tile drain flows into the stream. The third sample might be below a cattle pasture, the fourth below an area where a riparian buffer has been planted, and the fifth sampling point is where the stream leaves the property. A sixth sampling point might be the spring located in the middle of the cattle pasture.

If the stream is large, or is a major river, you may not see many changes from the upper to the lower end because the water flowing through your property dilutes water coming from your land and changes are masked by the volume of water. But if the stream is small or intermittent, you might see big changes or effects of runoff. Use the scoop to collect the samples and choose a representative site where water is flowing to sample.

In a small experiment we compared sampling in the middle of the stream vs. the edge, and deep vs. shallow. We got the same results from the middle of the stream and from the edge but found that deep samples often contained more silt and mud, which affected results. We recommend sampling near the edge of the stream from the surface of flowing water if possible. Use common sense and safety precautions so you are not at risk of falling or slipping into the stream, especially if the stream is running high and fast.

The timing of sample collection also is important. The base flow of the stream (low water flow), or the water flowing from springs upstream, will be a good baseline for comparison. If possible, collect baseline samples in the spring, summer, fall, and winter from each location.

These samples will probably be low in nutrients, sediment, and bacteria, unless there is a wastewater treatment plant upstream from your farm, one of your upstream neighbors has a failing septic system, or if there is a site nearby where livestock can walk in the stream. If one of your baseline samples is high, that would be good to know. Baseline samples will give you something to compare to your rainfall runoff samples.

To find out what your farm is contributing, repeat the sampling of all of your stream sites soon after a major rainfall. Try to sample within 12 hours of observing field runoff of water. These numbers may all be high, but you might also observe some interesting patterns. Do this more than once and repeat this at different seasons of the year if possible. You might choose to sample two field runoff times in the spring, one in the summer and again in the fall. You can also sample before putting livestock into the pasture, and again later after they have been in the pasture for a few weeks. Your sampling design and frequency will depend on the questions you want to answer about your farm.

Field runoff

Sampling field runoff will need to be timed to correspond to times of high rainfall or at least enough rainfall to generate field runoff. These samples are best if collected at the same time you are sampling your stream, in a post-runoff or post-rainfall period. As you collect water samples, observe gullies, ditches, and culverts that feed into the stream from your land. Take extra containers with you to the field and label them as you go. Also feel free to collect water from pools and puddles in the fields, or on the field edges. Even if these are not flowing into the stream now, you may gain valuable information about the potential contribution of these areas during a major storm. Six or 10 of these "field source" samples will probably be enough to give you an idea of which areas may be hot spots or potential areas of concern. They may also ease your mind by showing that your fields are in good shape.

Use the same water scoop that you used for the pond and stream samples, but be especially careful to collect a shallow sample, so mud is not mixed in with the water if at all possible. Professional water monitoring equipment is sometimes used to collect a series of samples during a rainstorm. These subsamples are combined to create a representative sample of the flow over a period of time. This monitoring equipment is expensive, however, and requires frequent maintenance to keep the batteries operational and the tubes and wires intact. Your subsample will be a snapshot sample, or only one point in time, but it will give you a good idea of what is going on. Time series samples of rainstorms show that the first flush of water is usually the highest in nutrients and other materials that may run off the land, and subsequent samples are lower. If you can sample soon after the water is flowing, you will get the highest values. If you wait a day or two, the values will be lower. Write down in your sampling notes not only where you sampled, but when you sampled with respect to when it started to rain and note the total amount of rainfall on that date.

Family drinking water, private wells, and livestock water

Though these test kits were designed primarily with surface water sampling in mind, some of the tests can also be used to sample your drinking water and livestock water sources. In particular, the nitrate test strips and the *E. coli* tests are relevant. The other tests, such as turbidity, probably don't apply, and phosphorus is rarely found in groundwater.

Feel free to use the nitrate test strips and Petrifilm bacteria tests to sample your water. If the tests come out with a zero reading, you can be pretty confident that your water, at least now, is acceptable with regard to these two particular tests. If your readings come out high, for example, more than 10 ppm for nitrate, or they show significant numbers of total coliform or *E. coli*, have them confirmed by a commercial lab and consult with someone about taking care of the problem. If the tests come out somewhere in between, it might be good to have an independent commercial lab run tests to verify that your water is safe. The atrazine test, with a detection limit of 3 ppb, will probably not pick up anything in your well water. But commercial labs can run a pesticide screen and also look for traces of hydrocarbons from buried fuel tanks or leaks. This information might be helpful if these are concerns on your farm.

Food safety is becoming a bigger issue and often makes front page news. A new assessment tool, *Food-A-Syst*, has been developed at K-State. Similar to the *River Friendly Farms* notebook (S-138), it guides producers in assessing on-farm food safety risk factors. In addition, on-farm testing for *E. coli* is available and can be used with the *E. coli* Petrifilm plates described in fact sheet W-6. Used in combination with the 3M Quick Swab, Petrifilm can help detect contamination of packing boxes and crates, packing shed tables, and even the surface of the fruits and vegetables themselves. See page 11 for ordering information.

Creating a local stream team

Throughout the country, students and adults have been working together to supplement the monitoring efforts of local and state agencies. Sometimes the goals of these "stream teams" are to educate youth about the water cycle, to encourage their connection with the environment, and increase observational skills in a natural setting. In these cases, the experience and observation skills are what is important, and the data are not typically saved. This is usually the case with younger children.

In some states (Alabama and Iowa, for example), adult volunteers are an active part of their state's monitoring effort, and they use test kits similar to those described in these fact sheets. Typically volunteers are trained and certified annually. Data are collected in a standardized fashion and results are posted on Web sites. Fact sheet W-10 in this series lists several state and national programs that offer information, Web sites, and program support that may be helpful to you or your group. The field tests described in this series correlated well with KSU lab results, and could be used with confidence in adult citizen monitoring, as long as standard protocols are

Working with a biologist is a good way to learn about microinvertebrate sampling and identification.

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followed, the test kits do not have outdated components, and volunteers have received a minimum level of training. Combining these tests with other tests (visual assessment, aquatic insects etc), gives a more complete picture of the health of water ecosystems.

The water tests described in these fact sheets are appropriate for student teams. In our evaluation of other test kits, some of which are widely used by student teams, we found some that were highly inaccurate, especially in measuring the nutrient content of water. We would like to encourage farm, ranch, and rural families to participate in water monitoring and cooperate with local stream teams. Forming teams is a good way to help build a sense of community and can be a positive experience for all involved.

Resources

The next few pages include a list of test kit suppliers and Kansas water testing labs, price comparisons for test kits vs. costs of testing by commercial labs, and a project planning sheet. For the latest on any of this material, visit our Web site: *www.oznet.ksu.edu/kswater* or call Citizen Science project leaders or K-State watershed specialists. Contact information is also available on the Web. Organizations that might be helpful to you and your project are listed in fact sheet W-10, *Starting a Water Monitoring Team/Project.*

Glossary

Base flow – that portion of a stream's flow contributed by sources of water other than precipitation runoff. Where used in the context of stream classification, the term refers to fair weather flow sustained primarily by springs or groundwater seepage, wastewater discharges, irrigation return flows, releases from reservoirs, or a combination.

Ecological integrity – the natural or unimpaired structure and functioning of an aquatic or terrestrial ecosystem.

Groundwater – water located under the surface of the land that is or can be the source of supply for wells, springs, or seeps, or that is held in aquifers and the soil profile.

Non-point source – any of a variety of diffuse sources of water pollution including, but not limited to, precipitation runoff, the aerial drift and deposition of air contaminants, and the intrusion and seepage of subsurface brine or other contaminated groundwater.

Point source – any discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or floating craft, from which pollutants are or may be discharged. This term includes structures or site conditions that act to collect and convey storm-water runoff from roadways, urban areas, or industrial sites. Point sources do not include agricultural storm-water discharges or irrigation return flows. Point sources are regulated by a permitting program, National Pollution Discharge Elimination System (NPDES) permits, administered in Kansas by KDHE.

Precipitation runoff – means the rainwater, or the meltwater derived from snow, hail, sleet, or other forms of atmospheric precipitation, that flows by gravity over the surface of the land and into streams, lakes, or wetlands.

Surface waters – all (1) streams, including rivers, creeks, brooks, sloughs, draws, arroyos, canals, springs, seeps and cavern streams, and alluvial aquifers associated with these surface waters; (2) lakes, including oxbow and other natural lakes, and man-made reservoirs, lakes, and ponds; and (3) wetlands, including water bodies meeting the technical definition for jurisdictional wetlands given in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (January, 1989).

Watershed – the land that drains into a particular tributary, stream, or river. Sometimes the larger areas are called basins, the medium-sized areas are called subbasins, and the smaller areas are watersheds.

Source: Adapted from "River Basin Water Quality Criteria," KDHE Report 28-16 pp. 185-188

Sources for test kits

Catalog item numbers are in italics. Call the company or use their Web site for current prices and ordering information.

3M Microbiology Products
3M Center, Building 275-5W-05
St. Paul, MN 55144-1000
1-800-328-1671
www.3M.com/microbiology
E-mail: *microbiology@3M.com*
These are the plates for the coliform and *E. coli* bacteria:
6484-50 EC plates
6414-500 EC plates
6432-50 quick swabs (for surfaces)
6433-250 quick swabs (for surfaces)

CHEMetrics, Inc.
Route 28
Calverton, VA 20138-9850
1-800-356-3072
www.chemetrics.com
E-mail: *prodinfo@chemetrics.com*
K-8510 Ortho P kit
R-8510 Ortho P refill
A-8500 refill solution

Hach Company
P.O. Box 389
Loveland, CO 80539-0389
1-800-227-4224
www.hach.com
E-mail: *orders@hach.com*
27553-25 ammonia test strips
27454-25 nitrate/nitrite test strips
27456-50 pH test strips

LaMotte Company
P.O. Box 329
802 Washington Ave.
Chestertown, MD 21620
1-800-344-3100
www.lamotte.com
1066 armored non-mercury thermometer

Silver Lake
P.O. Box 686
Monrovia, CA 91017
1-888-438-1942
www.silverlakeresearch.com
WS-289 Atrazine test kit

Lawrence Enterprises Inc.
P.O. Box 344
Seal Harbor, ME 04675
207-276-5746
www.watermonitoringequip.com
60 cm tube Transparency/turbidity tube

Ward's
P.O. Box 92912
Rochester, NY 14692-9012
1-800-962-2660
www.wardsci.com
21V 0211 water scoop w/ 3' handle
21V 0212 water scoop w/6' handle
18W-274 plastic bottles
18W 2972 sterile pipets (500)(for E. coli tests)
21V1021 economy water sampler – for bridge sampling

WATER

W-1
Overview

Water testing labs

Some commercial laboratories do tests for drinking, irrigation, and livestock water suitability, and wastewater. Some do pesticide screens. Drinking water analysis for public water supply regulations must be tested by state-certified laboratories. Below is a list of labs in Kansas at the time this publication was prepared. For more up-to-date information, check KDHE's Web site: *http://kdheks.gov/envlab* or K-State Research and Extension publication, *Testing to Help Ensure Safe Drinking Water*, MF-951 at *http://www.oznet.ksu.edu/library/h20ql2/MF951.PDF*.

Some water tests are only accurate if performed on fresh water (within 24 hours of sampling), so it is a good idea to choose a lab near where you live and deliver the samples there as soon as possible after sampling. Labs typically supply sterile containers for total coliform and *E. coli* bacteria samples, so call ahead to arrange for containers. Because the incubation time for bacteria is 48 hours, many labs do not take samples on Fridays or before holidays. It is a good idea to contact the laboratory to arrange for sample delivery, and to inquire about test availability and prices.

Commercial Water Testing Labs

City	Laboratory	Telephone
Andover/Benton	Dean's Water Lab Inc.	316-733-2682
Auburn	Environmental Laboratories Inc.	785-256-7330
Dodge City	Servi-Tech Laboratories	620-227-7123
Hutchinson	SDK Laboratories	620-665-5661
Kansas City	Keystone Laboratories Inc.	913-321-7856
Lenexa	Pace Analytical Services Inc.	913-599-5665
Olathe	Analytical Management Laboratories, Inc.	913-829-0101
Salina	Continential Analytical Services Inc.	785-827-1273
Topeka	M.D. Chemical and Testing Inc.	785-862-3500

Source: Kansas Environmental Laboratory Certification program: www.kdheks.gov/envlab

WATER

W-1
Overview

Water Test Cost Comparison: Test Kits vs. Commercial Labs

Name of test	Type of test	Approximate cost per test	Source company	Comparable cost for commercial test
Color	Sight	$0.00	None	NA
Odor	Smell	$0.00	None	NA
pH	Test strip	$0.26	Hach *(27456-50 pH test strips)*	$2.00–5.00
Temperature (to interpret the ammonia test)	Armored, non-mercury thermometer	$18.75 one-time cost for multiuse item	LaMotte *(1066 armored non-mercury thermometer)*	NA
Turbidity/ Transparency	Plexiglass tube	$34.00 one-time cost for multi-use item	Lawrence Enterprises Inc. *(transparency/ turbidity 60cm tube)*	$6.00–10.00 for total suspended solids
Nitrate/Nitrite	Test strips	$0.60	Hach (*27454-25 nitrate/nitrite test strips)*	$1.00–15.00
Ammonia	Test strips	$0.60	Hach (*27553-25 ammonia test strips)*	$1.00–15.00
Ortho-phosphate	Colormetric glass ampule	$1.07	CHEMets *(K-8510 Ortho P kit)*	$2.00–15.00
Total coliform and *E. coli* bacteria	Petrifilm	$1.54	3M *(6484 50 EC plates)* and Wards Scientific (*18W 2972 sterile pipets –500)*	$16.50–25.00
Triazine/ Atrazine	Test strip	$5.00–10.00	Silver Lake *(WS-289 Atrazine test kit)*	$75.00–150.00
You may also need:				
Water scoop and/or bridge sampler	Use to collect water samples	$24.00 one-time cost for multi-use item	Ward's Scientific *water scoop w/3' handle (21V 0211)* *w/6' handle (21V 0212)* or use a homemade one. For bridge sampling – *economy water sampler (21V1021)*	Use the same sample collection equipment.
Sample containers	1 cup to 1 pint	$0.00	From kitchen, clean and dry	Obtain from lab.

W-1
Overview

Citizen Science Planning Sheet

Name of farm/school/community site:____

Name or names of people participating in group:____

____

____

The main question this project will answer is: ____

____

____

____

We will answer the question by sampling at the following locations: (see attached map) ______

____

____

____

____

____

We will conduct the following water tests:

Kind of test	Date 1:	Date 2:	Date 3:	Date 4:
	Number of tests taken			
pH				
Turbidity				
Temperature				
Nitrate N				
Ammonia N				
Phosphorus				
E. coli				
Atrazine				

Expected results? ____

____

____

____

____

WATER

W-1
Overview

Citizen Science Planning Sheet – Example

Name of farm/school/community site: *Kansas River near Manhattan, Wamego and St. Marys*

Name or names of people participating in group: *Joe Smith and Amy Jones*

The main question this project will answer is: *Does the water quality change as it moves downstream from Manhattan, through Wamego and then to St. Marys?*

We will answer the question by sampling at the following locations: (see attached map) *Bridges at Manhattan (K-177), Wamego (Hwy 99) and St. Marys (Co Rd) will be used because they are accessible to the public. During a spring canoe float, we will sample several intermediate points.*

We will conduct the following water tests:

Kind of test	Date 1: *Feb. 15*	Date 2: *May 15*	Date 3: *Aug. 15*	Date 4: *Nov. 15*
	Number of tests taken			
pH	*3*	*3*	*3*	*3*
Turbidity	*3*	*6*	*3*	*3*
Temperature	*3*	*6*	*3*	*3*
Nitrate N	*3*	*6*	*3*	*3*
Ammonia N	*3*	*6*	*3*	*3*
Phosphorus	*3*	*6*	*3*	*3*
E. coli	*3*	*12*	*3*	*3*
Atrazine	*3*	*6*	*3*	*3*

Expected results? *We do not expect to find high nutrients, atrazine or E. coli in the winter (February or November) samplings, but would like to see what baseline levels are. We will do a visual assessment then and see how the spring high-flow times affect the river in these locations. We will look at stream biology during our spring canoe trip, do intermediate point samplings for nutrients, and sample several locations for E. coli, for example, if we see pipes in the river or see livestock near the river. There may be high levels of nutrients, E. coli, and atrazine at the spring sampling. These may be high in August, too, or remain low.*

Test Kit Prices*

Tests	Cost for 25-30	Cost for 50-60
Multiple use items (one-time purchase)		
Temperature	$20.00	$20.00
Turbidity	34.00	34.00
Sampling scoop	24.00	24.00
Test kits and supplies		
Phosphorus kit (30 tests/kit)	52.80	52.80
Phosphorus kit refill (30 tests/refill)	N/A	21.50
Ammonia strips (25 tests/bottle)	16.50	33.00
Nitrate/nitrite strips (25 tests/bottle)	15.50	31.00
pH strips (50 tests/bottle)	13.50	13.50
E. coli plates (25 tests/pack)	40.00	80.00
Pipettes (25, but assumes bulk purchase)	4.00	8.00
Triazine kit (~$7 per test)	none purchased	70.00 (10 tests)
Total cost	**$220.30**	**$387.80**

*Prices are current as of 2006. Check the company catalog for updates.

- Keep in mind that you don't always need to run all the tests listed. For example, we usually don't run the triazine test unless we have reason to suspect it is present. Individual tests can be used if the budget does not allow for the whole kit to be purchased.
- Different numbers of tests come with each kit from the manufacturer. For example, 30 phosphorus and 25 nitrate tests come in a kit.
- Rather than purchasing a sampling scoop, you can make one using a container tied securely to the end of a 6-foot-long pole.
- Contact information for suppliers is on page 11.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

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