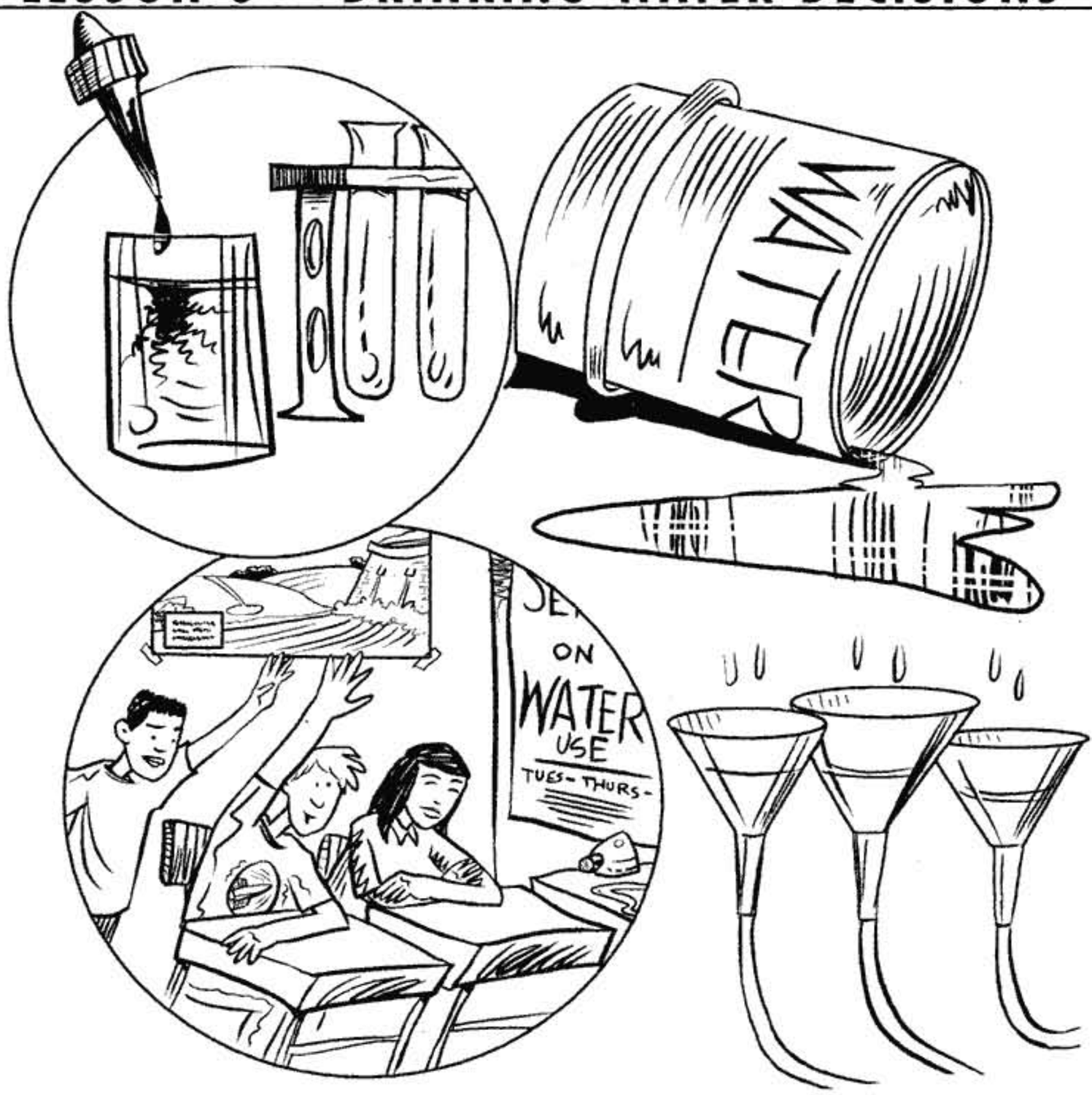
LESSON 6 DRINKING WATER DECISIONS



LESSON 6 DRINKING WATER DECISIONS

As individuals and communities, we are always making choices about water quality and health. This lesson explores several examples of such decisions.

The first activity introduces the fundamentals of drinking water quality. Students consider the two basic categories of drinking water contamination, biological and chemical, as they make a (hypothetical) personal decision in an emergency situation. The second activity expands the choice from individual to group, as a community weighs a range of health concerns to choose a water supply.

The third activity returns to the watershed concept, expanding on the idea of source protection. We all accept the maxim that it is easier to prevent a problem in the first place than to solve it later. ("A stitch in time saves nine.") Communities need economic activity; how can economic needs be balanced with the need for water resources? People make the decisions, and people must live with the consequences. Students can be assured that similar issues are being debated all around them every day.

LESSON 6 DRINKING WATER DECISIONS

ACTIVITY 6-1 CONTAMINANTS IN WATER

SUMMARY

Students confront a perilous short term emergency decision about drinking water. They consider what makes water safe to drink.

CONTENT AREAS

life science, math

GOAL

to distinguish between acute and chronic health effects and their causes in drinking water

TIME

one session

ADVANCE PREPARATION

- Copy student pages.
- Divide students into working groups.
- Optional: Have students read "Water and Germs."

TEACHER PROCEDURE

1. Tell the students they will be solving a problem, a hypothetical emergency situation. They will read and analyze it, and decide on a course of action. Each group will be asked to present its conclusion to the class.

2. Have students read the problem from the student page in their working groups. Allow time for them to discuss the problem and reach consensus on their answers to the questions. If there are conflicting opinions, allow time for students to develop their positions.

3. Once the groups have reached their decisions, have them report to the class. Encourage them to share the reasoning behind their decisions. See background information below to help students draw distinctions between short and long term exposures and heath effects.

4. Emphasize that there is no right answer to this problem; everyone must reach the decision that is right for him or herself. Try to make no value judgments; allow all viewpoints and lines of reasoning to emerge.

5. Optional: After discussion is complete, have students complete a student reflection page. Questions might include:

    - What were the two or three most important issues in your decision?
    - Was there disagreement among group members? What was behind those disagreements?
    - Write a paragraph about this activity, including a topic sentence, a conclusion sentence, and at least two scientific points to back up your opinion.

ACTIVITY 6-1 CONTAMINANTS IN WATER

BACKGROUND INFORMATION

Biological versus chemical

Drinking water contaminants fall into two broad categories: biological and chemical. Generally speaking, biological disease-causing agents ("germs," such as bacteria and viruses, for example) make people sick soon after ingestion, often with only a single exposure; this is an acute health effect. Most chemicals, while they too can have acute effects at extremely high doses, rarely occur in high concentrations in the environment. They are most often experienced in low doses and in multiple exposures over long periods, increasing the risk of chronic health effects, such as cancer, organ damage, or birth defects.

The limit for biological pathogens (disease-causing microorganisms) in drinking water is zero, because single exposures may be sufficient to cause illness. Limits for chemicals, while sometimes very low, are not zero. Toxicologists ("toxin" means "poison," so toxicology is the study of poisons) have determined these limits through research. Even with daily exposure over a lifetime, the risks of negative health effects from these contaminants, at levels below the limits, are very small. (The chemical certainly will not cause acute illness at those levels.)

Disinfection

These two sets of contaminants intersect in an intriguing manner that poses problems for drinking water suppliers. One common method for eliminating bacteria or viruses is to treat drinking water with a disinfectant, such as chlorine. The interaction of chlorine (or other disinfectant) with biological material produces some levels of chemicals called disinfection by-products (DBPs). The level of DBPs depends on two factors: the concentrations of the disinfectant applied and the amount of biological material (precursors) in the water. These precursors might be simple substances such as leaf litter, algae, or other harmless material in the water, or the disinfectant's target: disease-causing microorganisms.

The choices

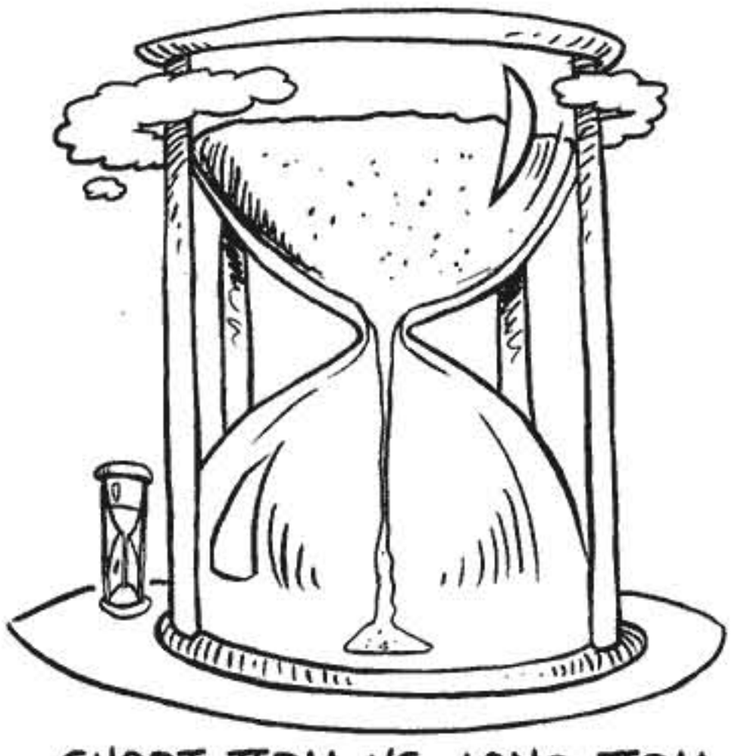
The assignment presents students with an emergency situation. Lost and severely dehydrated, they face a decision. Should they drink untreated stream water likely to carry disease-causing germs? Or should they treat the stream water with a chemical that will kill the germs but will produce a DBP? The DBP is suspected to cause cancer at some exposure levels.

After students have expressed their opinions, you can help them analyze their decision by asking about the short term and long term consequences of either decision.

First, the stream water.

Short term effects? Likelihood of significant diarrhea. Discomfort, far from medical care, difficult ride or flight out to safety the next day.

Long term effects? Only the unpleasant memories of a bout of diarrhea.



SHORT TERM VS. LONG TERM

Now, the treated water.

Short term effects? None. They won't get an acute health effect from a single exposure to the DBP chemical at that level.

Long term effects? Very small risk. Chronic health effects will occur only after long and repeated exposure. Since tomorrow they will be back home, drinking water that must contain less chemical than the limit, they will have had only a single exposure.

Some students may believe that the increased cancer risk even from that single exposure outweighs the inconvenience and discomfort of having diarrhea in a crowded rescue helicopter. Those students may choose to drink untreated water from the stream. However, when they return home to foods grown under common agricultural practices or breathe air downwind from a gasoline pump, a running automobile or a cigarette smoker, they should recognize that they are also increasing their exposure to carcinogens.

Calculating risk

How do toxicologists calculate risk? The Environmental Protection Agency (EPA) sets limits on contaminants at exposure levels that are expected to cause at most one case of cancer in one million exposed people.

In our case, the level of DBP in the treated water is twice the EPA limit. Suppose it were even higher, say 10 times the limit. Let us assume that this increases risk by a factor of 10, from one in a million ($1/10^6$, or 10^{-6}) to one in a hundred thousand (10^{-5}), based on life-time exposure at that level.

But in our example we don't have lifetime exposure. We only have one day's exposure if the campers drink 2 liters of this water. What part of a 70 year lifetime is one day? 70 years X 365 days/year = 25,550 days. Using only the order of magnitude, another conservative step, call that 10^4 days. Your risk is now $(10^{-5}) \times (10^{-4})$ or 10^{-9}, or 1 in a billion! That's 1000 times less risk than you might be exposed to under normal conditions in a public water system. With this in mind, that case of helicopter diarrhea would look pretty avoidable to a toxicologist. The point of this activity is to help students make their own decisions based more on analysis than on fear.

ACTIVITY 6-1 CONTAMINANTS IN WATER

PROCEDURE

1. Read the following problem with your group and answer the questions at the end. There are not necessarily right answers to all these questions.

2. Share your conclusions in class discussion. Did other groups analyze the problem in the same terms that yours did?

A Water Emergency

You and four friends were climbing a mountain on a day trip. The summit was beautiful, and you spent too long admiring the view. On the way down it began to get dark, and then you lost the trail.

You spent an uncomfortable night in the woods. You started with only day trip provisions, so your food and water are gone, and you have awakened the next morning hungry and very thirsty. At last you find a trail, which leads to a shelter. Desperate for rescue, and extremely thirsty, you enter.

There is a portable phone there, and you call for help. The ranger who responds is relieved to hear from you, but says they are busy with a more urgent rescue, and they won't be able to reach you until tomorrow. Just stay right there, she tells you. You have shelter, and there are a few old mattresses and blankets. They will tell your families you are safe, and help will arrive sometime tomorrow.

As hungry as you are, you know you won't starve before being rescued. But thirst is another matter. You are dehydrated already, and you know that people can't live more than two or three days without water.

There is a stream behind the shelter that looks quite inviting, but you have been told never to drink untreated water in nature. In fact, there is a notice in the shelter warning hikers

that the stream is likely to contain Giardia, a microorganism that causes severe diarrhea, among other symptoms. The disease, called giardiasis, can lead to extreme dehydration requiring medical treatment.

In a cabinet, you find some tablets which will kill microorganisms, including Giardia, in drinking water. A note of caution on the package states, however, that the tablets will react with any organic matter in the water, from tiny bits of leaves or pine needles to microorganisms, to produce chemical by-products, and that these by-products (DBPs, for "disinfection by-products") are suspected human carcinogens (substances that increase the risk of cancer over long exposure). In fact, a note in the shelter states that using the tablets in this particular stream water will create a concentration of the DBPs twice as high as the EPA drinking water standard for lifetime exposure. The EPA limit for DBPs is 80 ppb (parts per billion). If you treat the water with that tablets, DBPs will be at least 150 ppb.

Some group members say they have had family members with cancer, and they aren't about to swallow any amount of cancer-causing material. Another knows a person who once had to go to the hospital because of giardiasis; it was indeed more serious than a typical case of diarrhea. She is very concerned about being that sick so far from medical care, and about the embarrassment of riding in a rescue helicopter during a severe episode of diarrhea.

You know you must drink some water to survive until you are rescued. You must decide whether to drink water from the stream untreated, and risk getting giardiasis, or to treat the water with the tablets and expose yourself to the chemical by-products.

1. Which would you choose: to drink the untreated stream water or to use the treatment tablets? Why? What were the factors in your decision?

2. Suppose the shelter had a small stove, and you could boil the water. Would this change your decision? Why?

3. What further information would you like to have had to help with your decision?

LESSON 6 DRINKING WATER DECISIONS

ACTIVITY 6-2 TOWN WATER SUPPLY

SUMMARY

Students consider a long term decision about water sources. They participate in a community planning process.

CONTENT AREAS

life science, physical science, social studies

GOAL

to learn to distinguish between acute and chronic health effects and their causes in drinking water

TIME

one or two class sessions

ADVANCE PREPARATION

- Create student working groups.
- Copy student pages.
- Read teacher background.

TEACHER PROCEDURE

1. Tell the students they will be making a water supply decision for a community. They will need to read and discuss the problem statement and a technical report, then answer questions, the last of which is their recommendation for action.

2. Assign students to their working groups, perhaps five or so students each. Instruct them to read the problem and the **Engineering Report**.

3. They will probably have questions for you as they try to understand the report. You can answer these group by group, or you may want to convene the whole class so they all hear the same discussion. They should answer the questions in their working groups.

4. Once groups have reached their decisions, have them report to the class. Emphasize that there is no right answer to this problem. Each group must find the recommendation that is right for them. Encourage them to share the reasoning behind their recommendations. If they have done the previous activity, 6.1, some of that background, on short and long term exposures and health effects, will be helpful.

5. Optional: After discussion is complete, have students complete a student reflection page. Questions might include:

- What were the two or three most important issues in your decision?
- Was there disagreement among group members? What was behind those disagreements?
- Write a paragraph about this activity, including a topic sentence, a conclusion sentence, and at least two scientific points to back up your opinion.

ACTIVITY 6-2 TOWN WATER SUPPLY

BACKGROUND INFORMATION

This activity asks students to act as town planners and citizens, deciding between two water sources for the future of their community. It is intended to broaden their understanding of drinking water issues and to suggest questions a consumer might ask about drinking water quality.

The technical report uses two acronyms, EPA and SDWA, which bear explanation. The Safe Drinking Water Act (SDWA) is a federal law, first passed in 1974 by the US Congress and signed by the President. The legislation directs the EPA (United States Environmental Protection Agency) to establish rules for drinking water quality and to assure that they are enforced across the nation. EPA accomplishes this by working with a single agency in each state (in Massachusetts, it is the Department of Environmental Protection, or DEP) to administer SDWA. States can make individual portions of their own laws more strict (but never less strict) than SDWA.

THE CASE STUDY

The prospective sources in the activity represent the two basic alternatives in water supply: water drawn from aquifers beneath the surface (groundwater), or water in natural (or constructed) water bodies on the earth's surface (surface water). An **Engineering Report** summarizes the issues with these alternatives.

A. Groundwater

The overriding issue in the groundwater proposal is the concentration of cadmium. Because the levels are far too low to cause acute health effects (illness soon after one or two exposures), the issue is the possibility of chronic health effects. Cadmium is our example, therefore, of any of about 70 substances regulated by SDWA to reduce chronic health effects from drinking water.

Chronic health effects are more difficult to explain than acute health effects. Acute effects, such as digestive tract illness from bacteria, are pretty certain to result from a single exposure within a few days. Chronic health effects take much longer exposure (years) to develop, don't occur in most of the people exposed, tend to be more serious (such as cancer or organ damage), and can result from quite low levels of contamination (depending on the contaminant).

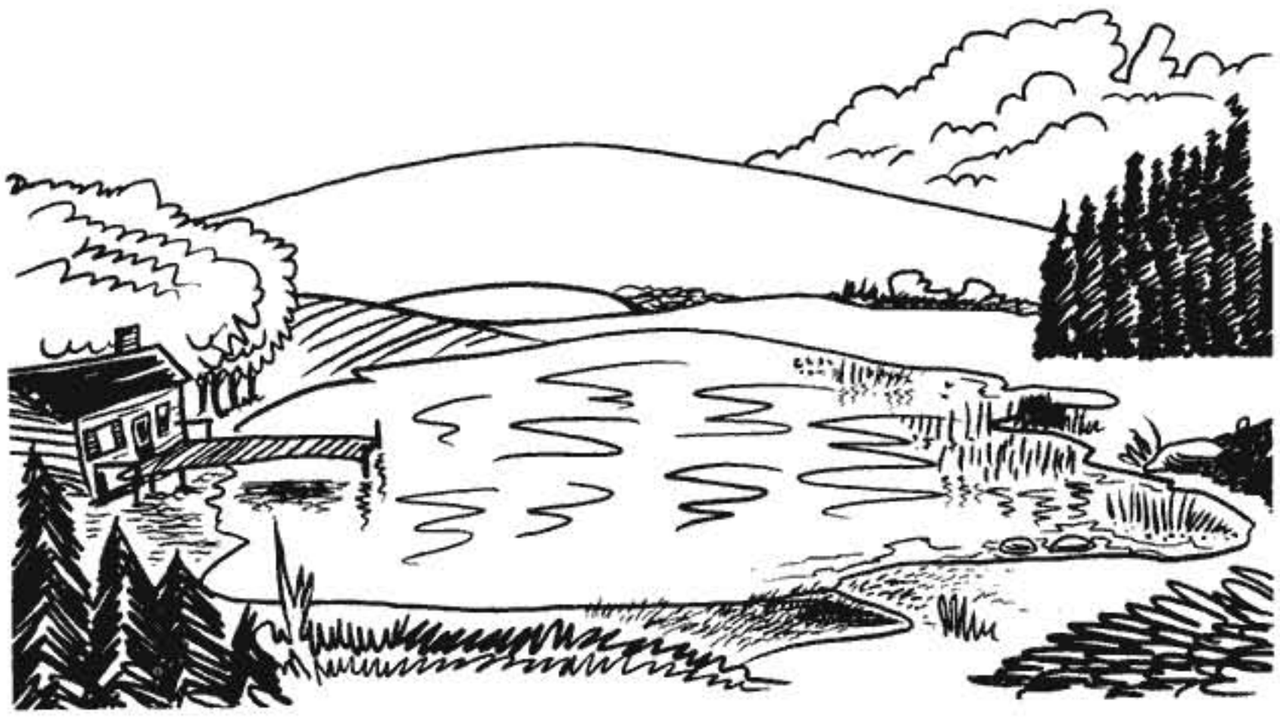
Regarding cadmium specifically, The Environmental Protection Agency (EPA) states, "Some people who drink water containing cadmium in excess of the Maximum Contaminant Limit (MCL) over many years could experience kidney damage." Note four points in that statement (emphasis added):

1. *Some* people,
2. *in excess* of the MCL (elevated exposure),
3. over *many years* (long term exposure),
4. *could* experience the health effect.

Perhaps exposure to tobacco smoke can best illustrate chronic health effects to your students. 1. Some people smoke much of their lives with no apparent ill effect. 2. While smoking increases the chance of certain illnesses, smoking heavily increases the chances more. 3. Health effects usually occur after long term exposure (years of smoking). 4. No one can say with certainty that a smoker will develop cancer or that a non-smoker won't. (This reinforces point 1.) But most people now accept that you can improve your chance of staying healthy by not smoking.

Could water be treated to remove cadium? Cadmium is dissolved in water as ions; that is, molecular sized particles. Cadmium could be removed by installing an ion exchange treatment system. The system would be fairly costly to build and would have ongoing operating costs. (Note: Boiling does not remove minerals such as cadmium or lead from drinking water. In fact, it may increase its concentration.)

B. Surface water



All bodies of surface water contain some level of bacteria and other microorganisms. The sources of these "germs" are primarily animals living around the lake. The microorganisms that cause disease are best suited to life in the digestive tract of an animal, where they can thrive and are likely to cause infections. The wastes of an infected animal carry the germs into the environment, where they begin to die off. But if some are ingested by a new host before they die, they can multiply rapidly, causing a new illness and producing millions of replicas to go forth into the environment. (This process is explained in more detail in "Water and Germs.")

Surface waters are much less likely that groundwater to contain significant levels of metals, such as cadmium, or organic chemicals such as industrial wastes. The water lacks the long contact time with natural minerals, such as cadmium, that it would have in an aquifer. Many organic chemicals are volatile; that is, they evaporate quite readily when exposed to the air, as they would be in our lake.

WHAT IS GIARDIA?

Giardia is an intestinal microorganism (actually a protozoan) that can cause severe diarrhea in people. It is of concern because it is so hardy in the environment. While bacteria such as E. coli die off quickly outside the warm, dark confines of an intestinal tract, Giardia oocysts, or eggs, can live for weeks in an aquatic environment, maturing to the parent organism when signaled by the body temperature of a new host. Giardia is also fairly resistant to chlorine, a common water industry disinfectant that is quite effective against bacteria. Ozone is a more effective disinfectant against Giardia.

ACTIVITY 6-2 TOWN WATER SUPPLY

DISINFECTION BY-PRODUCTS

DBPs were introduced in the previous activity. They occur when chemical disinfectants, such as chlorine, come in contact with organic matter in the water. The organic precursors might be the microorganisms targeted by the treatment, or just benign bits of plant matter or algae in the water.

Filtering the water before disinfection could eliminate most precursors and thus reduce DBPs, but it would greatly increase the cost of the lake water option. The DBP levels are low enough, in the engineers' opinion, that the benefit of filtration would be minimal.

DBPs complicate the issue of surface water treatment somewhat. While chlorine can eliminate most microorganisms and thus eliminate risk of acute illness, it can produce DBPs and thus introduce the question of chronic health effects. Even the highest DBP readings in our case study are well within SDWA standards, but the language is still sobering. When the risk is a chronic health effect, such as kidney damage or cancer, consumers' emotions become a factor in an otherwise analytical decision process.

SOURCE PROTECTION

Water suppliers, whether they use groundwater or surface water, recognize that pollution prevention, or "source protection," is their first and best step in assuring safe water supply. The lake receives precipitation runoff from its tributaries and the watershed lands, not just from the immediate shoreline. The most sensitive areas are the shorelines, however, and not just of the lake but of its tributary streams. Recent laws protecting river corridors and wetlands acknowledge the increasing awareness of their importance in protecting our surface waters.

Because the land around the lake is relatively undeveloped, and the town plans to protect the watershed by purchasing a good bit of it, the lake's freedom from pesticides and other chemicals is likely to continue. The risk might arise should development pressure in this beautiful area lead town officials to permit homes or other human activities near the water.

ANSWERS TO STUDENT QUESTIONS

Question 2. A power failure would shut down the pumping and monitoring of the groundwater system. Because the water needs minimal treatment, water quality would not be affected. Because the lake is in the hills above town, it will arrive by gravity, so there would be water in faucets and hydrants in a power outage. However, the treatment plant might be out of service, so people would need to take emergency measures such as boiling their drinking and cooking water.

ACTIVITY 6-2 TOWN WATER SUPPLY

PROCEDURE

Read and discuss the following problem with your working group. Then answer the questions at the end, stating your group's recommended course of action and the reason for your decision.

Your teacher will be available to help clarify definitions and other issues, but you should try to develop your own opinions.

You live in a small community where residents, until now, have depended on their own private wells for drinking water. The town has grown, a couple of small businesses have moved in and the local economy is looking bright. The businesses need ample water supply, and as houses have been built closer together, it has become clear that you need to establish a community water system. You must decide whether to develop

a) a groundwater system, with a town well, or
b) a surface water system from a nearby lake in the hills above town.

Several important issues emerge in the **Engineering Report**. Both sources, a well or the lake, could provide sufficient water not only for the town today but even if the town should grow in years ahead. Costs of either system are comparable; in either case, installing distribution pipes in the streets is a big part of the expense. The question comes down to water quality.

Read the **Engineering Report** on the following page. Then answer the four questions, the last of which is your recommendation concerning which water supply to develop.

ABBETT & SIEGEL ENGINEERING UNLIMITED

ENGINEERING REPORT

We have evaluated two possible water sources for the town: a groundwater system with wells, and a surface water system from the lake. Here are our results.

Groundwater Option

Testing has shown that concentrations of cadmium in the water at the proposed well site are about half the EPA limit for that contaminant. (The Safe Drinking Water Act (SDWA) standard is 10 parts per billion; test results range from 3 to 6 ppb.)

What is cadmium? Cadmium is a naturally occurring element, Cd on the periodic table. It is a member of the heavy metal group of elements; other natural metals are iron, lead, manganese, mercury and gold. Some of these metals, like lead, mercury, and cadmium, are considered toxic; that is, they cause health effects over long periods of even low levels of exposure; others, such as iron and manganese, are essential for human health and are not regulated under SDWA primary standards.

How did the cadmium get there? The cadmium is not a result of carelessness or pollution. Minerals like cadmium and the others are found in various rock formations, and where the rocks are rich enough to be considered ore, mining operations are developed to extract the metal for human use. Your area is not rich enough in cadmium to make mining profitable, but there is enough to impart background levels of cadmium to the ground water.

What are the health effect of cadmium? Short term, or acute health effects, are only possible at extremely high levels, thousands of times greater than in your well water. That is clearly not the concern here. In fact, people in the area have probably been drinking small amounts of cadmium every day in their private wells, and no one has gotten sick. However, EPA states, "Some people who drink water containing cadmium in excess of the Maximum Contaminant Limit (MCL) over many years could experience kidney damage."

Can the cadmium be removed from the water? Yes, but only by building a treatment system that would double the cost of the entire project and would require careful (and expensive) operation and maintenance.

ABBETT & SIEGEL ENGINEERING COMPANY

Surface Water Option

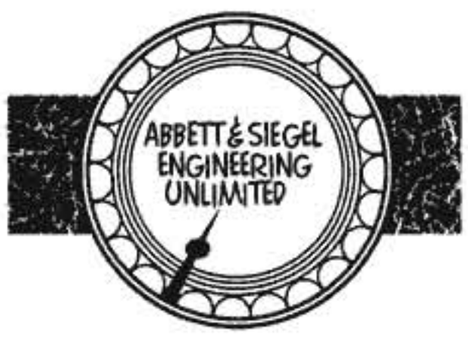
Like all surface waters (but unlike groundwater), the lake is exposed to plants and animals and their waste products. Testing of the lake water has confirmed the presence of the expected array of bacteria and viruses, only some of which cause illness. Some samples have also contained a microorganism called Giardia lamblia, which causes severe diarrhea.

Can the lake water be treated to protect consumers from Giardia and other microorganisms? Yes, the water can be disinfected with common disinfectant chemicals, such as chlorine and ozone, to kill the germs.

Will disinfection form harmful by-products? Because the lake has very low levels of organic matter, DBPs will average between 20 and 40 ppb; the current SDWA standard, or MCL, is 80 ppb. EPA states, "Some people who drink water containing trihalomethanes [a typical form of DBPs] in excess of the MCL over many years may experience problems with their liver, kidneys, or central nervous system, and may have an increased risk of getting cancer."

Are there other contaminants in the lake water? What about cadmium? The lake water has very low levels of minerals, and no detectable cadmium. It was tested for about one hundred regulated pesticides and industrial chemicals; only tiny amounts of one or two were found, at trace levels far below SDWA limits.

Will the lake always stay this clean? What if the area around it becomes more developed? There are only a few summer cottages on the lake now. The cost of developing the lake for water supply includes purchasing the entire lake shore, including these cottages, and land along several brooks leading to the lake. A popular swimming beach on the lake would certainly be closed, and people would no longer be able to walk or run their dogs in the area.



NAME _____

DATE _____

QUESTIONS & CONCLUSIONS

1. Discuss the two alternatives with your group. What are the most important factors in your discussion?

2. Some citizens are concerned that pumping stations or treatment plants, especially small ones like yours would be, break down sometimes, or lose electric power during storms. Would a power failure present different risks depending on the water source, groundwater or lake, you chose? If so, what would those different risks be?

3. What further information would you like to have to help with your decision?

4. Based on the information available, do you think the town should develop the groundwater or the lake for its water supply?

LESSON 6 DRINKING WATER DECISIONS

ACTIVITY 6-3 WATERSHED CHOICES

SUMMARY

Students will choose five development projects to include within the watershed boundary of a reservoir. They will establish rules for those developments.

CONTENT AREAS

social studies, earth science

GOAL

to understand that regulations and source protection are important to maintaining drinking water quality

TIME

one or two sessions

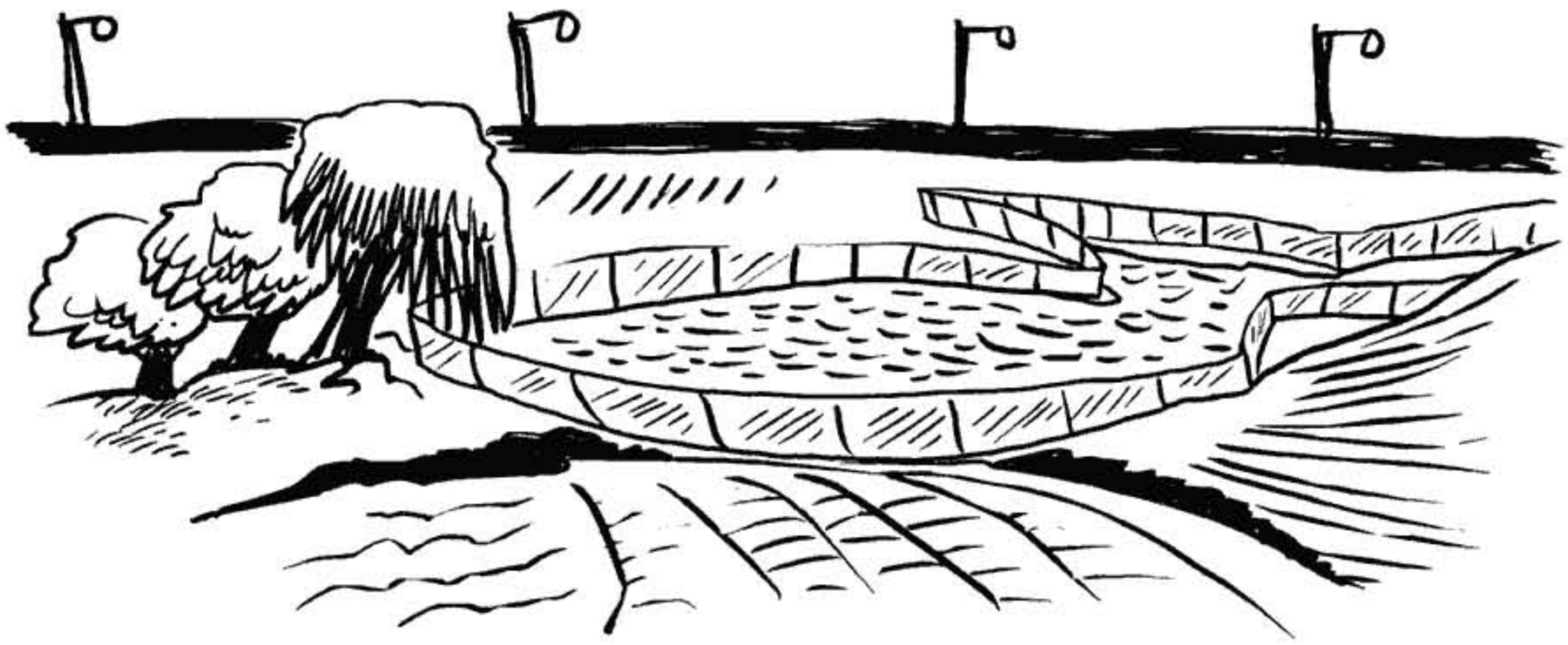
ADVANCE PREPARATION

- Create student groups
- Copy materials for each group.

BACKGROUND INFORMATION

Watershed protection is an important aspect of providing high quality drinking water. Protecting the watershed includes regulating development, monitoring activities, and creating public awareness. Rules and regulations help accomplish these goals. In this activity students will investigate and contemplate how development might affect water quality. They will then create regulations so that the effects of development will be minimized. There are no right or wrong answers; students should work together to weigh the issues and come to a conclusion.

Pollution is a complicated issue, but students might understand it best if you divide pollution into two categories: chemical and biological. Chemical contamination sources include pesticides, oil, or gasoline. Chemical contamination is most harmful through long-term exposure. Continued exposure through the water over several years may increase the risk for developing certain chronic diseases, including cancer. It is difficult to treat water for chemical contamination, so preventing it from entering the reservoir is usually a more successful tactic.



ACTIVITY 6-3 WATERSHED CHOICES

Biological contamination comes from living sources: human waste from septic systems, livestock waste from farms, and wild animal waste. These biological sources contribute microorganisms which may cause illness soon after ingestion. Small amounts of bacteria in the source water (the reservoir) are inevitable. That is why the water is treated to kill pathogens (disease-causing microorganisms).

Complicating the pollution issue is the fact that we use chemicals to kill the bacteria. When chlorine combines with organic matter in the water disinfection by-products (DBPs) are created. DBPs are regulated and monitored just as other contaminants in the water. The less contamination in the water, the less chemical you have to use to kill bacteria, and the fewer DBPs will result.

Regulations and water testing are an important component of maintaining water quality. Drinking water quality is regulated at the federal level by the Safe Drinking Water Act (SDWA) passed by Congress in 1974. Regulators study the scientific literature on a wide range of chemical and biological contaminants, setting maximum contaminant levels (MCLs) and required treatment technologies, based on that research. Most people agree, however, that keeping source water as clean as possible is the first step toward safer drinking water. Preventing a pollution problem is usually easier and more cost effective than solving the problem after it happens. This activity helps students understand the role of planning in the prevention of problems.

TEACHER PROCEDURE

1. Review the term watershed with students. (Activity 5.1 is good preparation.) Explain to them that a watershed is an area of land that drains into a body of water. Remind them that along with the water, contamination can also enter the reservoir.

2. Describe the activity to students. Each group is a planning board for towns in the reservoir's watershed. Students should review the ten proposals for land use and decide which five to accept. They should then determine where the projects can be located and specify any regulations for the accepted proposals. Emphasize that they are responsible for maintaining as a high a level of water quality as possible.

3. Give each student a copy of the student pages.

4. When students have completed their proposal selections, have them report to the rest of the class.

ACTIVITY 6-3 WATERSHED CHOICES

INTRODUCTION

Your group is the planning board for towns located within the watershed of a local drinking water supply. You have decided to allow the development of five projects who want to site facilities in the watershed. The board has received applications from ten organizations who want to use the land. You must decide which proposals to accept and what regulations those groups must follow. Remember, these are proposals. You can specify any restrictions you want on the accepted proposals. 10,000 people use this water every day and expect it to be safe to drink. They are relying on the board to make thoughtful decisions about development.

PROCEDURE

1. Review the ten proposals for land use.

2. Discuss them with the members of your group. You may want to make a list of positive and negative things about each proposal.

3. Decide which five proposals you want to accept.

4. Decide where on the map each proposal should be located.

5. Make a short list of regulations that those organizations must follow in order to use the land.

6. Present your recommendations to the class.

PROPOSALS FOR LAND USE

1. Clark's Pig Products Company

We want to establish a fifty acre pig farm. We propose to raise 5,000 pigs each year for sale to slaughter houses. Modern odor control will be implemented. Our proposal will creating new farming jobs and will add tax money to the towns.

2. Camping Haven

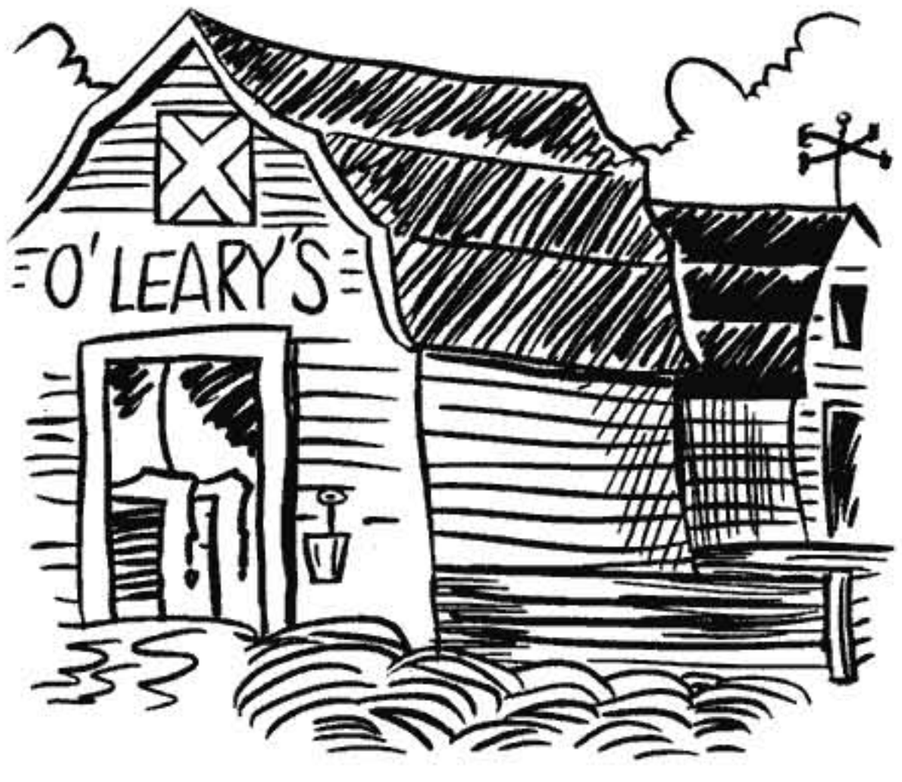
We want to create a 25 acre campground. We would like to have 50 sites for tent camping only. We would need three bath houses with toilets and showers. We would like to be near a river where campers can swim. We will only allow pets on leashes.

3. McClure's Marvelous Gas and Go

We want to create a gas station and mini-mart. We need a half acre of land. We would have eight filling areas for regular gas and two for diesel fuel for trucks. Our market would sell automotive products such as oil and wiper fluid, as well as groceries. We would be open 24 hours a day, seven days a week. We will meet all state required precautions against gasoline spillage.

4. Pat's Potato Chip factory

Pat's Potato Chips are the most popular in this region. We want to open a new production facility. We need a ten acre site. We pretreat all of our oil and potato peel waste before it leaves the factory. We will have five delivery trucks that will leave our site each morning and return that afternoon.



PROPOSALS FOR LAND USE

5. Dandy Dairy Farm

We propose a 100 acre dairy farm. We will have 50 milk cows in our barn. We will feed them with hay we grow on our land which will be fertilized with the cow manure from our herd. Our products are organic and we do not treat our cows with hormones. We pride ourselves on the proper treatment of our animals and land. Our farm will have jobs for the farmers in the area.

6. Housing Development

We propose a 100 unit condominium complex on 15 acres of land. We want to include a playground, paved walking paths, three swimming pools, and a parking area for 200 cars. We want to dig a well for the water supply and create septic systems for waste disposal. These units will be more affordable than equivalent houses in the area.

7. Nature Preserve

We want to create a place where the public can enjoy the land around the reservoir. We propose a five acre nature preserve that will include one of the three wetlands in the watershed. Each wetland has rare species of plants that are not found anywhere else in the state. We would have a small visitors center and a bathroom with a septic system. Picnicking would be allowed near the visitor's center only. A ranger would be on site during all hours of operation.

PROPOSALS FOR LAND USE

8. Highway Department

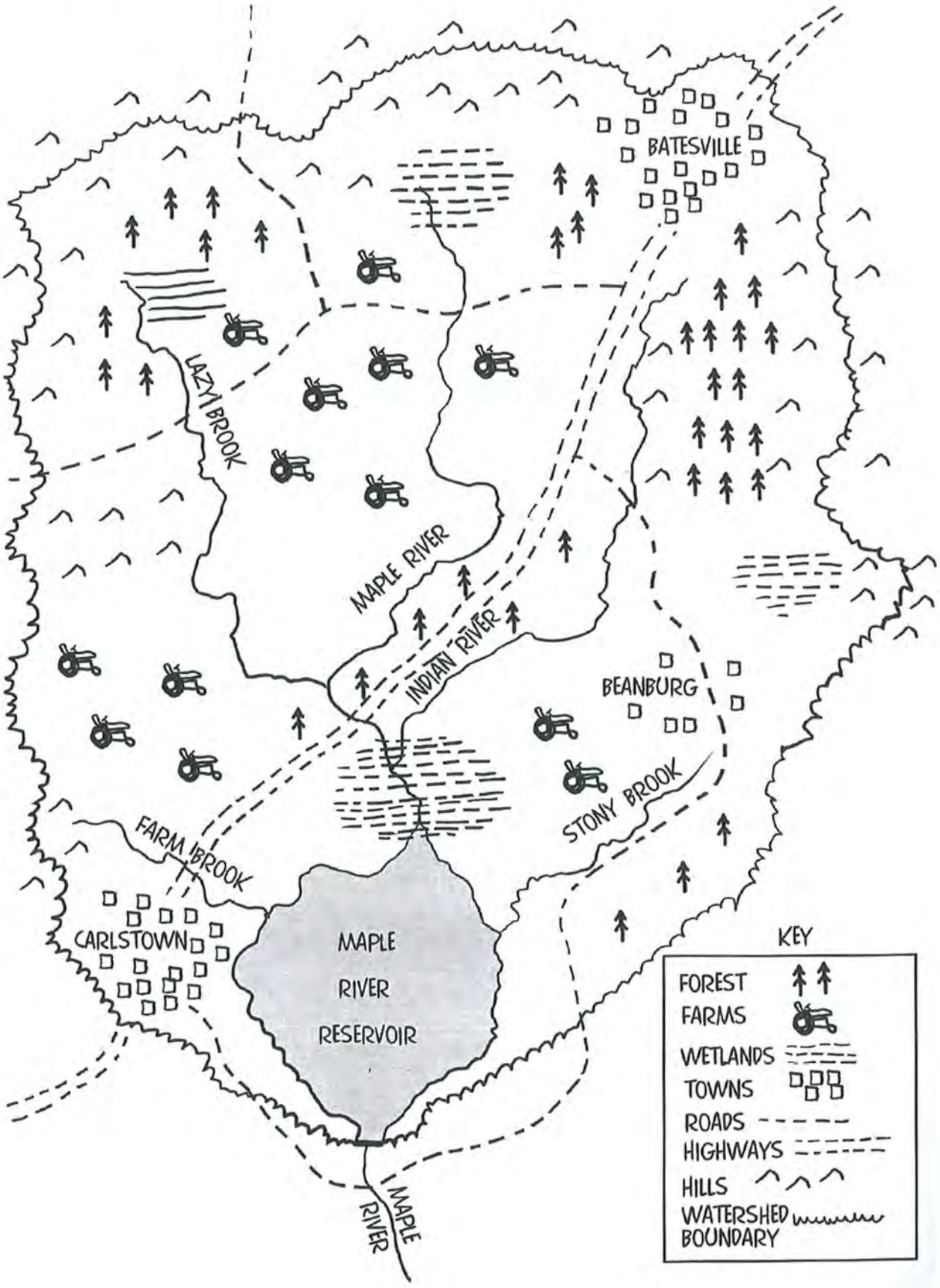
We want to expand the highway between the two towns on opposite ends of the reservoir from two lanes to four lanes. This expansion would bring in greater truck traffic, especially those providing home heating oil to the communities in the area. Many of the people in the area work for our department and this would benefit them in terms of salaries and work hours. (Right now these trucks travel out of the watershed to use the state highway to get to these communities.)

9. Pressure Treated Lumber Products

We produce high quality pressure treated lumber products for purchase by the general public and contractors. Lumber will be delivered here daily by trucks. We will chemically treat the lumber and store it on a one acre paved lot where our customers can view it. We will have products for building swing sets, porches, and play equipment. We would like to be located near a river for waste disposal. Our company will create many new jobs for this region.

10. Strawberry Fields

Due to our advanced techniques in pesticide applications we grow the biggest and best strawberries in the nation. We propose ten acres of strawberry fields. We would install a computerized irrigation systems for maximum crop production. During the summer, citizens can pick their own strawberries. We host a lovely strawberry festival in June with music, clowns, pony rides, and strawberry shortcake.


BATESVILLE
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INDIAN RIVER
BEANBURG
STONY BROOK
FARM I BROOK
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