Earth Systems
Standard 4: Objective 1

Title: Midnight Dumpers

Brief Description: Will sample "wells" to try and find the source of groundwater contamination

Objective: Students should gain a greater understanding of how and why chemical dumping occurs. They will also better understand how pollution spreads through underground reservoirs.

Materials needed: Student sheets, master-copy of map (found on this website), 20 medicine jars or film canisters(amber color or dark but not transparent) , 600 popcorn seeds, food coloring, lid from a cardboard box, optional: candy bar prizes

Background Knowledge: Students should understand that water from rain and other sources sinks into the ground and is widely used for by humans for drinking and household use. Contaminants placed on the soil will sink in and pollute the groundwater. The contaminants will also "drift" as the groundwater moves or the contaminant spreads.

Time needed: 50 minutes

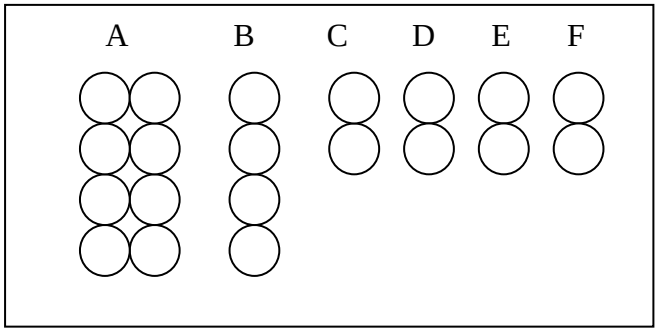
Safety/Security Concerns: None

Teacher procedures:
1. Make copies of the student sheets. Make an overhead copy of the city map, 1 per group.
3. Print off the map and teacher map key. This is a sample map. You should make enough map keys for each class you will do the activity with. It is important that in each class the dumping occurs in a different location, because news travels in a school. There are three versions of the activity available. Run off a classroom set of each student map and a teacher map for each version. On the teacher map, fill in the letters of each location going from F to A as the spill dilutes. E, should be close to the site and the letters move towards A as the location gets further from the contamination site. Be sure students do not see the keys during this activity.
4. Label and assemble the medicine jars with seeds in them according to the chart below. The medicine jars should be labeled by writing the letter on the bottom with permanent marker. The seeds should be dyed by soaking them in green food coloring overnight and drying them.

Medicine Jar Label	Number of Jars	Number of Yellow Seeds	Number of Green Seeds
A	8	18	2
B	4	15	5
C	2	12	8
D	2	9	11
E	2	6	14
F	2	3	17

5. You also may want to drill a hole in the top of the jar for students to shake out a seed. This is not necessary however, as students can also remove the cap and take out a seed. The advantage to having the hole is that students cannot see the contents of the rest of the jar.

6. Organize the jars according to letter on the lid of a cardboard box, as shown. Keeping the jars organized throughout the class period will make this activity run much more smoothly. As students return a jar to you, be sure to replace it in its designated area. You might also want to keep this hidden under you desk so your especially perceptive students don't catch on to the method.



7. Put the city map on the overhead so it is visible as students arrive into the classroom.
8. **Hook**: Ask the students to name the town. Tell them that this town has some serious problems with "Midnight Dumping." Expect a few snickers. Illegal dumping occurs often, especially in areas with a lot of messy industries. Ground water monitoring is done around gas stations and other industries to make sure they do not dump contaminants. Sometimes barrels are loaded on trucks, taken to isolated locations and dumped.
9. Pass out student sheets. Have students read the "Background Information" through the "Prediction."
10. Discuss the lab (especially the **background information**) with the students and answer any questions they might have. You may want to offer a prize to the team that correctly identifies the well with the most profit, or in the case of some classes, the least loss. Student may need a reminder on how to do an average. In this case it is to take the number of polluted seeds (green) and divide it by the total number of seeds (around 20) and multiply by 100%.
12. As students request wells, use your key to know which letter well (jar) they will receive. Don't let students have more than one sample at a time. They must exchange one sample for another.
13. Discuss the results of this activity with students when everyone has located the site.

Sample Scoring Guide:

Requirement	**Points Possible**
Purpose/Prediction Questions	4
Data Table Complete	10
Analysis Questions answered correctly	20
Conclusions valid and complete	8
Ended with profit	3
Total	**45**

Sample Answers:

1. Answers will vary, answers will vary.

2. Answers will vary, the pollution followed the flow of the water. There was no pollution directly upstream of the contamination site.

3. Answers will vary.

4. It is important so that authorities can stop the polluting, find the guilty parties, and clean up the contamination.

5. Midnight dumping occurs because it is a cheap way to get rid of waste. It is expensive for businesses to comply with all of the EPA and state laws on how to correctly treat and dispose of their waste.

6. Once pollution is on the ground it seeps through the pore spaces in the soil and into the aquifer or groundwater supply.

7. The more porous the soil the more quickly the pollution will spread. If the soil is very nonporous like clay, the consequences of dumping would not be as immediate.

8. As water is pumped out of a well it pulls the surrounding ground water towards it. This draws or attracts the pollution.

9. It is a good idea to test more than once so you get an accurate perspective of what the water is truly like inside the well. It was luck which seed you pulled out, you may have pulled out the same polluted seed 3 times, giving you a distorted picture of how polluted the water really was.

10. If you see illegal chemical dumping it is best to contact the local law enforcement.

Answers to Conclusions*:*

Answers will vary but should be detailed, relevant and in complete sentences.

Name: _____ Period:_____

Title: Midnight Dumpers

Background Information:

Water is stored in the ground as rain or snow sink into the soil and rock. When the water reaches a **non-permeable** layer, it can go no farther. It forms and underground layer of **saturated** rock material called an **aquifer.** Aquifers act as a very important reservoir for water in the hydrosphere. In Utah much of our drinking water comes from them.

Water is sometimes polluted as it travels through the ground. This happens because of chemical dumping, both legal and illegal. Some industries produce large amounts of waste as byproducts of their manufacturing. The Environmental Protection Agency (EPA), in cooperation with local and state governments sets limits and rules for how much waste can enter the environment and how it can be distributed. Many of these processes required by EPA are costly and time consuming for companies. This has led to an illegal practice known as "midnight dumping." In this practice wastes are illegally dumped, sometimes far from the place they were made.

The consequences of this type of dumping are far-reaching. This is because the waste is not only harmful where it is dumped, but it often seeps into the ground, moving through the pore spaces in the soil and contaminating the underground aquifer. The pollution then spreads as it travels with the flow of the underground reservoir. Excessive fertilizers and pesticides on your lawn can also pollute the aquifer. You should never dump anything on your lawn or down your drain that you wouldn't want to drink.

Purpose:

This lab simulates the effects of midnight dumping. In this case you are a firm hired by the city to find the source of illegal dumping. You must drill wells and sample the water in each well. The cleanliness, or lack thereof, of the water is represented by the color of popcorn seeds. A green seed is polluted water and a yellow seed represents clean water. The more green seeds in a well the more polluted that water is. How will you know your team is getting closer to the source of contamination?

Materials: Map, medicine bottles with 20 seeds in them

Procedures:

1. Look at the map and find 3 small dots. The darkest is a routine well sample that shows some pollution is present. The lighter colored dot shows a smaller amount of pollution and the white dot shows a clean sample.
2. Decide on the coordinates you want to "test" first.
3. Send a person up to get a test sample of "ground water" from your teacher. You may only test one well at a time.
4. Sample each by dumping the seeds and counting the green and yellow. Calulate a percentage by dividing the total number (20) into the number of green seeds and multiplying by 100%.
5. Each well drilled will cost you $1,000. You will be paid $10,000 for your work. Keep track of your costs.
6. Quit when you think you have the spot located. You will be charged $2,000 for an incorrect guess. So be very certain before you guess. Keep the site private from competing teams.

Predictions: Where (description of the site and the coordinates) do you think the contamination occurred and why.

Data:

Location	Number of Yellow Seeds	Number of Green Seeds	% pollutant	Total Cost for this Location	Total Costs Accrued

Analysis:

1. What site did you identify? How many spaces off were you?

2. What direction was the water flowing underground? How did you know this?

3. You started with $10,000. Subtract your total costs to find your profit or loss.

4. Why is it important to identify the correct spot?

5. Why does “midnight dumping” occur?

6. Where does pollution go that is dumped on the soil?

7. How could the type of soil influence the spread of pollution?

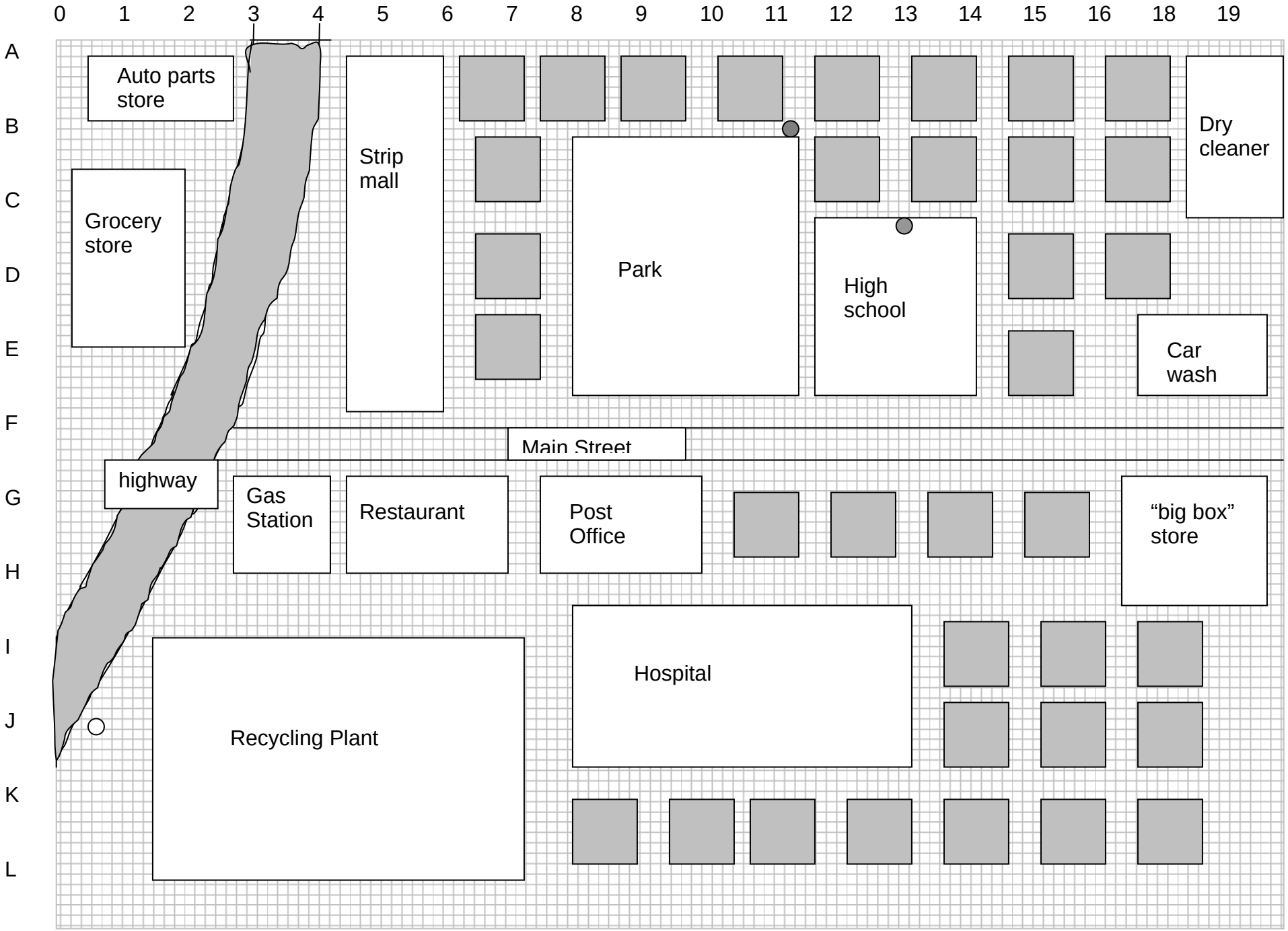
8. How does a well “attract” pollution?

9. Why is it a good idea to do more than one test on a well? What role did luck play in this lab?

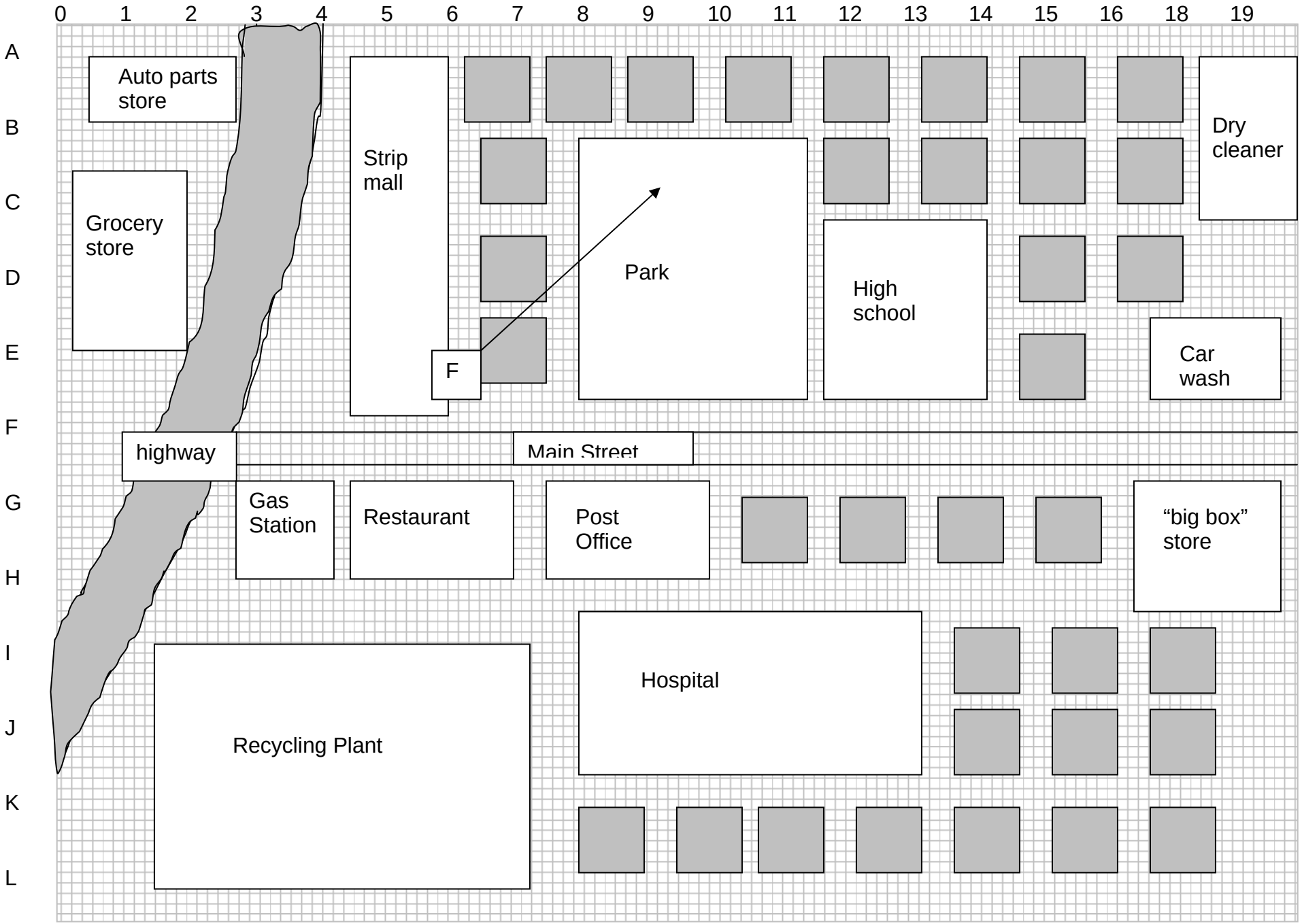
10. What should you do if you see someone illegally dumping or spilling chemicals?

Conclusions: In complete sentences explain 2 concepts that you learned by completing this activity.

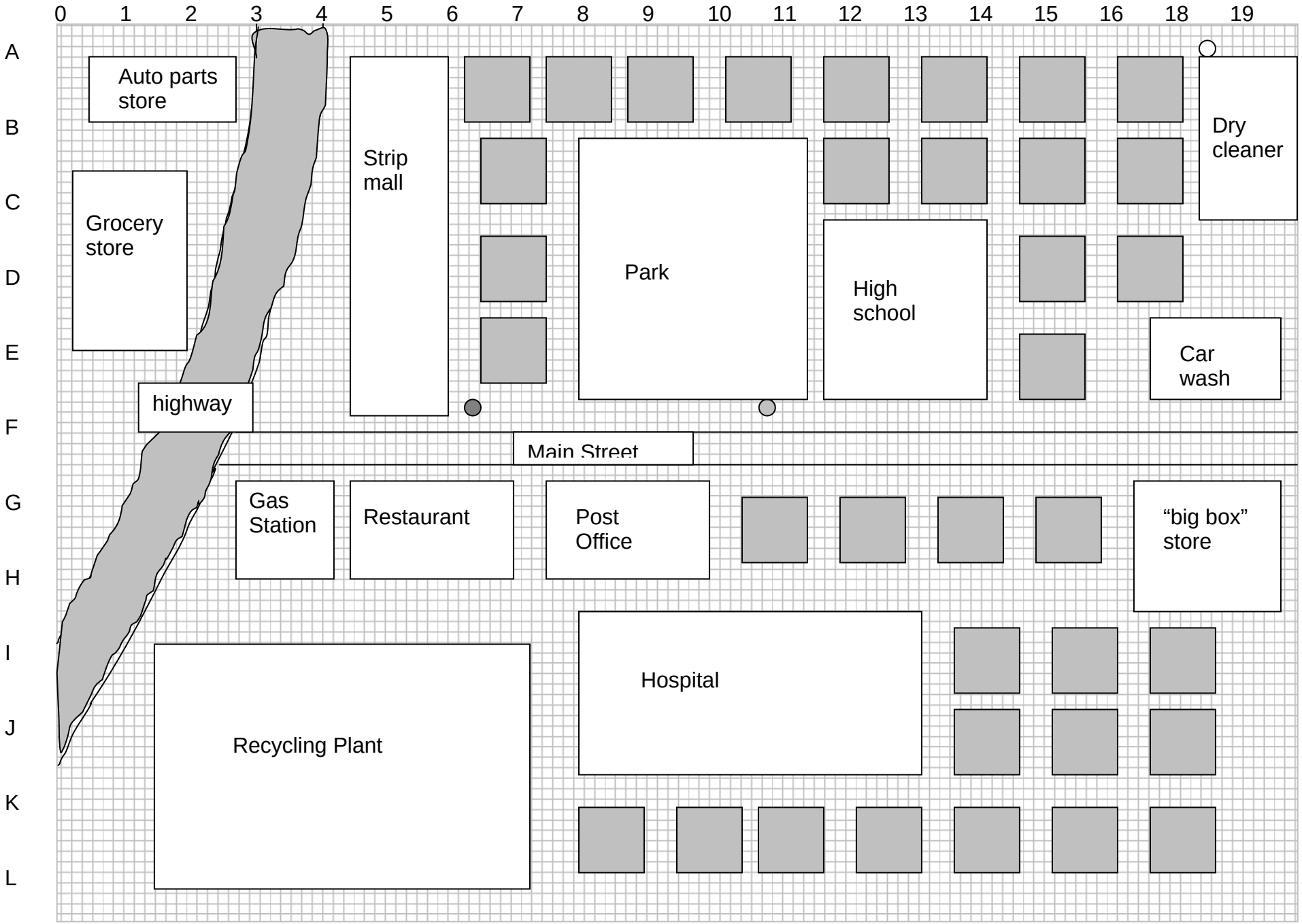
Anytown-Student 1



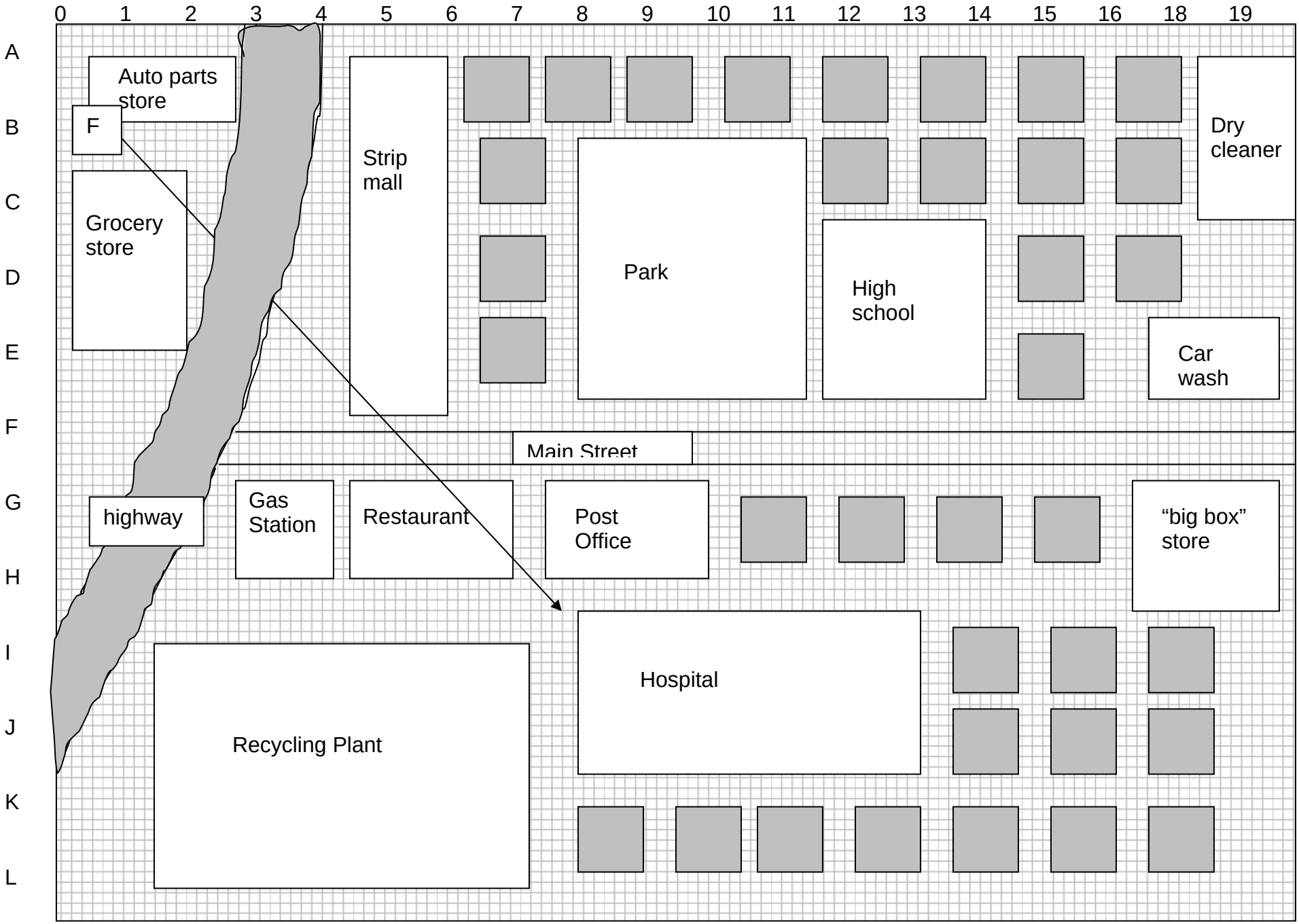
Anytown-teacher 1



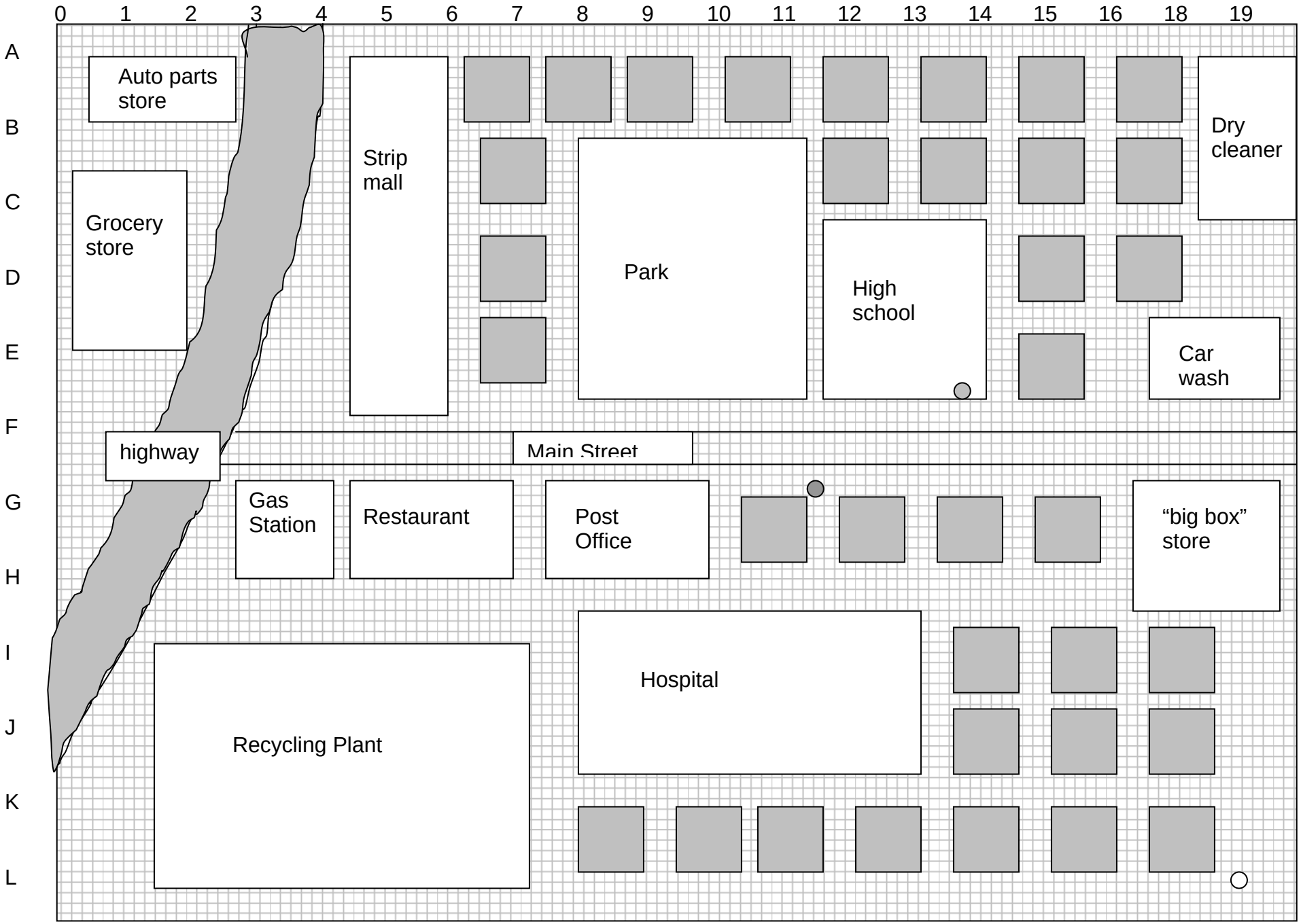
Anytown-Student 2



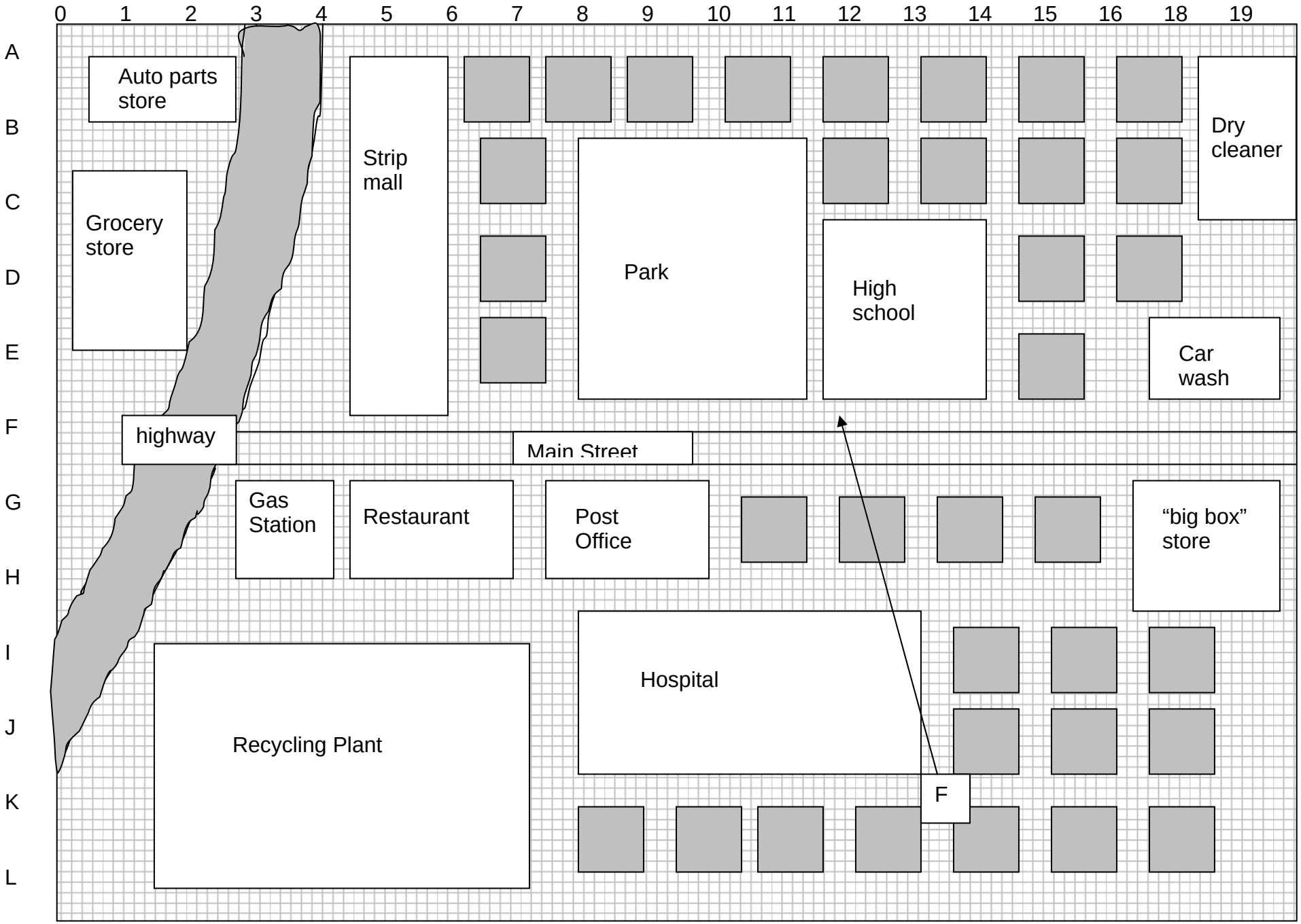
Anytown-teacher 2



Anytown-student 3



Anytown-teacher 3



Tainted Plume No Closer to SLC Drinking-Water Well

It rained enough not to have to draw from well

By Judy Fahys

The Salt Lake Tribune

A chemical plume inching toward an east bench drinking-water well in Salt Lake City made no progress this summer.

That's good news for residents who have been worried that the perchloroethylene, a dry cleaning and degreasing solvent, might end up in their water. It's also good news for public officials who have been pushing for federal funding that can be used to address the contamination before the chemical makes the well unusable.

Salt Lake City Council member Dave Buhler said a U.S. House budget contains $700,000 to address the chemical plume. Now he's hoping the U.S. Senate will include the money, too.

"The only thing that is a little bit of a disappointment is that the city would have to put any [matching] money in it," said Buhler.

Perchloroethylene, also called PCE, has been a problem all over the nation, everywhere there are dry cleaners. Colorless and sweet-smelling, the chemical travels readily in underground water and only small amounts are needed to contaminate a water supply.

It is considered a possible carcinogen to those who are chronically exposed. But, in small amounts, it can cause dizziness, sleepiness, headache, nausea and skin irritation.

Jeff Niermeyer, deputy director of the Salt Lake City Department of Public Utilities, said there is an ongoing investigation by state and federal environmental protection officials to identify the source of the contamination. Three wells in the area have detected levels of perchloroethylene between 11 and 320 parts per billion (ppb).

The contamination is bounded by 500 South and Sunnyside Avenue (825 South) and by Guardsman Way (1580 East) and 1300 East.

In the city well, at 500 South and 1500 East, a test in 2004 turned up 2 ppb of perchloroethylene, about 3 ppb under the maximum level allowed by the U.S. Environmental Protection Agency.

It rained enough this year that the city did not have to rely on the 500 South and 1500 East well, Niermeyer said. That helped prevent the contamination from being drawn into the water supply.

"We did test it," he said, "and it did not test with any PCE in it."

And, if the federal dollars come through, it should be relatively simple to treat any contaminated water that does enter the system.

In a January meeting about the plume, many residents said they did not want to have the area designated for cleanup under the federal Superfund because that might take a considerable amount of time and the stigma might be attached to nearby property.

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What is it?

Perchloroethylene is a solvent commonly used in dry cleaning and as a metal degreaser. It also can be found in paint stripper, spot remover and shoe polish.

Perchloroethylene can cause liver and kidney damage and the U.S. Environmental Protection Agency is re-evaluating its likelihood of causing cancer. In smaller doses, it can cause dizziness, headache, nausea, confusion and skin irritation.

The book and movie A Civil Action is based on one community's lawsuit blaming the chemical for a leukemia cluster near Woburn, Mass.

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Ogden recreation center development stalled by solvents in groundwater

Kristen Moulton
The Salt Lake Tribune

OGDEN - Petroleum and solvents in the soil and groundwater beneath what was once a downtown mall are stalling Ogden's effort to build a high-adventure recreation center.

City officials met with state environmental scientists Wednesday and agreed to conduct more tests to determine the extent of the pollution, according to Steven Thiriot, a Department of Environmental Quality manager.

How long the tests will take and whether the state will require the city to clean up the pollution is not yet clear.

Preliminary tests show pollution in excess of state standards for drinking water, although there are no municipal wells in the area.

The source isn't known, but it could have been auto-repair businesses that operated on or near the property decades ago, leakage from sewage pipes or from nearby underground fuel tanks.

In one test hole on the 1.5-acre site, the concentration of diesel fuel residue was 1,040 times higher than the level at which the state requires action. Soil samples showed high concentrations of benzene, naphthalene, diesel and gasoline, all residuals of petroleum.

The concentration of the solvent tetrachloroethylene (TCE) in the groundwater of one test hole was at 13 parts per billion, more than twice the contaminant level the state allows for drinking water, Thiriot said.

Thiriot, who is manager of site assessment for the state's Superfund program, said the TCE concentration found so far is not a grave concern.

But TCE is heavier than water, so more tests are needed to determine whether the groundwater underlying the future recreation center is seriously polluted.

"If they increase in concentration as we go deeper, then we've got a problem," Thiriot said.

The test holes dug by the city's consultants earlier this summer went only 16 feet deep, and hit groundwater at 12 feet.

Thiriot said the additional tests will go deeper and also will test for metals, such as chromium or lead.

Ogden City, which bought the old Ogden City Mall in 2001 and spent the next few years demolishing it, had hoped to begin construction this summer on what the mayor considers the catalyst for the new mall: an adventure center with a wave pool, climbing wall, wind tunnel and bowling alley.

Potential lenders, however, required the soil and groundwater tests, and when test holes were bored into the ground, the odor of petroleum was unmistakable.

Dave Harmer, Ogden's community-development director, said he hopes the pollution can be handled easily. "I don't think the issues there are all that serious," he said.

The city already watched the project's cost climb by $2 million this summer when it missed a deadline to begin construction. The contractor, R&O Construction of Ogden, agreed to no more cost increases if construction was under way by today.

Now, says Harmer, "We are susceptible to additional cost increases."

The complicated financing the city is relying on for the $18 million project involves two sets of bonds and two lenders.

And because of redevelopment-agency law affecting tax-increment financing, construction must be launched by Dec. 31.

Petroleum and its components can cause organ damage and some have been proved to cause cancer. The solvent tetrachloroethylene (PERC or TCE) is used for dry cleaning and metal degreasing. Exposure to very high concentrations can cause dizziness, headaches, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness and even death. Research is inconclusive about whether it can cause cancer.

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Sept. 1, 2005

Egg Farms Pays Fine for Waste Spill

By Joe Baird
The Salt Lake Tribune

Posted: 10:13 AM- A Cache County poultry company responsible for a spill of up to 2 million gallons of chicken waste into the Cub and Bear Rivers in 2005 has agreed to pay a six-figure fine and develop plans and facilities to ensure that such a spill does not occur again, the state Division of Water Quality announced Friday morning.

Ritewood Egg, based in northern Cache County, will pay a $105,000 penalty in three installments, develop a nutrient management plan and construct improved retention and disposal facilities as part of a negotiated settlement with the division completed last week.

Division Director Walt Baker said the agreement will now be posted for review and a 30-day public comment period.

"This is one of the higher penalties we have ever assessed," Baker said. "Penalties over $100,000 are rare. But it all depends on the egregiousness of the incident." The chicken spill manure occurred on or about March 7, 2005, when high precipitation from a spring snowstorm raised water levels in the company's waste retention pond, causing it to leak and flow down into a field that sat adjacent to a culvert. The culvert runs into the Cub River, which in turn flows into the Bear River.

Fearing the continuing snowfall would cause the pond to overflow, Ritewood employees breached the pond's earthen retention berm, allowing more waste to flow down to field and culvert.

The company did not have a discharge permit to release the flows.

The Division of Water Quality's notice of violation says that between the leak and the breach, the company lost control of 2 million gallons of chicken manure and carcasses. The company disputes that much waste actually got into the water.

But testing after the three-day event showed high levels of bacteria in the Cub, and further downstream in the Bear.

"This was the equivalent of raw sewage," Baker said.

But he added that environmental damage to the rivers was limited, because of the high flows at the time and the fact that the irrigation season had not yet begun.

Today's classes canceled while crews clean mercury spill at middle school

By Nate Carlisle
The Salt Lake Tribune

Posted: 7:42 AM- Classes were canceled today at Vernal Middle School while crews cleaned up a mercury spill in the school parking lot.

A team from the U.S. Environmental Protection Agency was deployed from Denver to clean the site, which district business administrator Randy Upton said may include tearing up carpet in a few places.

A parent reported the toxin about 8 a.m. Thursday. When staff from the TriCounty Health Department confirmed mercury was present later that morning, classes were dismissed and students were sent home.

A teacher reported soreness on the roof of her mouth, but Joseph Shaffer, director and health officer for TriCounty, said it was unlikely the teacher will be diagnosed with mercury poisoning.

Two to 3 tablespoons of mercury were spread over an area about 20 yards by 40 yards, extending from a sidewalk on the school's west side into a staff parking lot, Shaffer said. Glass, possibly from some kind of container, was found in the area, but Shaffer said it couldn't be determined whether the glass was related to the spill.

The toxic element is not used in science classes at Vernal Middle School, Upton said.

Vernal Police Chief Gary Jensen said he wants to determine if the spill was intentional or an accident.

"It's a little weird," he said. "Clearly we want to see where the mercury came from and why."

The middle school, located about 175 miles east of Salt Lake City, enrolls about 800 students.

Mercury exposure can cause irritation to the lining of the mouth, the lungs, the airways and the eyes; increased blood pressure and pulse; nausea; vomiting, diarrhea, and rashes. Acute exposure to mercury vapor can affect the brain and central nervous system, according to the Environmental Protection Agency.

Fierce weather blamed for big chemical spill, outages
Tank of hydrochloric acid tips, causes vapor cloud

By Jason Bergreen and Judy Fahys
The Salt Lake Tribune

Posted: 1:46:45 PM- The tail end of a line of thunderstorms Wednesday evening knocked over a 13,000-gallon tank of hydrochloric acid, releasing a chemical plume and forcing the evacuation of an industrial area on the west side of Salt Lake City and closures of Interstate 215 and several city streets.

About 12:30 p.m. a tank of sulfuric acid corroded sending a second chemical plume into the air. Emergency crews were expected to have both spills cleaned-up by 4 a.m.

The tank spilled hydrochloric acid at LA Chemical, 2334 W. Directory Row, just after 5 p.m., releasing a vapor cloud, said Salt Lake City Fire Department spokesman Dennis McKone. Police closed off a two-block area around the spill site, shutting down streets in the industrial zone to about 25 businesses, most of which were already closed.

About 7:30 p.m., firefighters noticed a 10,000-gallon tank of sulfuric acid close by was also corroding and leaking. It was only a matter of time before the sulfuric acid tank would give way.

By 10:30 p.m., the sulfuric acid tank was in such bad shape that firefighters and Hazmat crews were pulled out of the area.

In the meantime, the evacuation zone had been expanded until it included everything west of I-215, south of 500 South, east of Bangerter Highway and north of California Avenue, McKone said. Police kept people from entering these boundaries, although no residential homes in the area had been evacuated.

"Everything east of I-215 is safe at this time. Residents of Glendale and Rose Park are safe at this time," McKone said at midnight. But that danger could change with the wind, which was blowing to the northwest, away from Salt Lake City. Should the wind change direction to the east some time during the night, then evacuations of residential areas could occur, McKone said.

Hydrochloric and sulfuric acids affect the respiratory system, making it hard to breath and causing burning in the throat and lungs.

LA Chemical employees reported the three-alarm incident around 5 p.m. No employees were injured by the chemicals, McKone said. Two hazardous materials specialists were taken to the LDS Hospital in fair condition after inhaling too much of the hydrochloric acid.

About 60 firefighters and hazardous materials investigators from Salt Lake City and West Valley City originally responded to the incident, but Salt Lake City police, Salt Lake County sheriff's and Utah Highway Patrol personnel came on the scene as it unfolded.

Blustery winds from the storm also caused blackouts to 20,000 Rocky Mountain Power customers in Salt Lake and Utah counties. Power had been restored to 9,000 customers by 10 p.m., said power spokesman Dave Eskelsen. Homes and businesses in the Avenues neighborhood, Sugar House, Sandy and Magna were expected to have power back on by early morning, he said.

Downed power poles and trees interfered with main circuit lines, causing the outages.