

GROUNDWATER POLLUTION SITE ASSESSMENT

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Purpose

This exercise uses an actual groundwater site as an example of how a geologist evaluates a hazardous waste spill. The students are provided with the subsurface data on the site and are asked to map the spill, find its source and determine how fast the spill is spreading.

Definitions

Air Stripper - one way of removing contamination from groundwater.

Groundwater - water in the rocks beneath the surface of the earth.

Isoconcentration map - a contour map where the contour lines mark levels of equal concentration of petroleum products.

Water table - the surface where the ground is saturated below with groundwater and above with air.

Teacher Information

This exercise originated exactly the way it is described in the student exercise. The students worked on the problem and reported the results to the Department of Environmental Conservation. The site has now been cleaned up through the work of our class but it took over 10 years of hard work by the students.

Most gas stations store their gasoline and diesel fuel below ground in what are called underground storage tanks (UST). All too frequently these tanks leak; you would not believe the horror stories. The fuel seeps through the surface sediment or rock until it reaches the water table. Here, the petroleum will lie flat on the surface of the groundwater. In an area like the northeast, the water table has a slope similar to the local topography. This means that the water table slopes toward a stream or lake. Since the fuel is floating on the top of the water table it will eventually float down this slope into the streams and lakes.

A leaking UST is usually detected because more fuel is going into the tank than is coming out. When this happens the gasoline station must locate and trace the spill. Several wells will be drilled around the leaking tank and samples of the groundwater will be taken and analyzed for petroleum product. The highest petroleum concentration will be closest to the leak and, hopefully, it will decrease away. If the location of the leak is unknown, all you have to do is trace the increasing concentration until you reach the highest concentration indicating the source area.

To detect which way the leak is flowing, you have to contour the surface of the groundwater table. The data you will have will be water table elevation above sea level. Contour this as you would any other contour map. The petroleum will flow down the ground water surface perpendicular to the contour lines.

Student Exercise

The Worksheet conducts you and your students through the site assessment.

The students should do the contouring first.

Then they should note the direction of groundwater flow by drawing arrows perpendicular to the contour lines on the contour map of the groundwater table.

Then they can locate the source of the leak by locating the highest hydrocarbon concentration on the isoconcentration map.

WORKSHEET

On a bus ride, you notice a groundwater treatment system with an air stripper tower at a gas station adjacent to a lake. This indicates that there was some sort of groundwater contamination problem there, and since the lake is the reservoir for your drinking water supply, it merits further investigation.

In the 1970's, a law called the Freedom of Information Act was adopted. This allows citizens access to public records, including environmental data such as drilling logs, groundwater gauging data and groundwater sampling results. You visit your local Environmental Conservation office to have a look at the data associated with the site. The data is given to you below.

The goal of this exercise is for you to determine if this groundwater pollution problem presents a threat to the drinking water supply. You will do this by performing your own site assessment using the data provided.

You will be provided with the following data:

- site maps
- groundwater gauging data
- groundwater sampling data.

Using this data, you will be able to generate the following items:

- groundwater contour map
- isoconcentration map.

After analyzing the data and constructing maps, you will be able to examine the spill and determine it's present and future effects on the aquifer and on the lake.

Follow the directions to complete each step.

Groundwater Contour Map

1. The well gauging data provided is from October 21, 1988. The depth to groundwater was measured in nine monitoring wells. The ground elevation was surveyed at the top of each monitoring well. To find the elevation of the water table, you need to subtract the depth to groundwater from the elevation of the top of the well.

Example:

$$\begin{array}{r} \text{top of well elevation} = 84.30 \text{ feet} \\ \underline{-\text{depth to groundwater} = -7.02 \text{ feet}} \\ \text{elev. of water table} = 77.28 \text{ feet} \end{array}$$

2. Determine the water table elevation in each monitoring well.
3. Take one copy of the site map, and write in the groundwater elevations at each well (write in pen). Write in the elevation of the surface in the lake also.
4. Using PENCIL, contour the groundwater elevations using a contour interval of 0.5 feet. Label each contour line.
5. Determine the direction of groundwater flow (perpendicular to the contour lines and down the slope of the groundwater table), and draw an arrow that indicates flow direction.

Groundwater Gauging Data

Date: October 21, 1988

Performed by: Groundwater Technology, Inc.

All measurements in feet

Well	Top of Well Elevation	Depth to Groundwater	Water Table Elevation
MW-1	84.30	7.02	
MW-2	98.69	21.30	
MW-3	100.71	22.57	
MW-4	99.07	21.53	
MW-5	102.07	23.23	
MW-6	88.36	10.98	
MW-7	82.90	5.69	
DEC-10	84.43	7.20	
DEC-11	85.66	8.53	
B-1	98.25	20.82	
B-2	100.48	22.53	
LAKE	80.69	3.50	

Water Table Elevation:

$$\begin{array}{r} \text{top of well elevation} = 84.30 \text{ feet} \\ \underline{-\text{depth to groundwater} = -7.02 \text{ feet}} \\ \text{elev. of water table} = 77.28 \text{ feet} \end{array}$$

Isoconcentration Map

1. The groundwater quality data below indicates the hydrocarbon concentration in each monitoring well measured in parts per billion.
2. Using another site map, write the hydrocarbon concentration at each well. ND means that no hydrocarbons were detected in the well.
3. Contour the hydrocarbon concentrations using a 5000 ppb contour interval, starting at 1000 ppb, then 6000 ppb, and 11,000 ppb.
4. Shade each interval with colored pencils, and provide a key to the colors. Label the map "Dissolved Hydrocarbon Isoconcentration Map."

Groundwater Sampling Data

Analyzed by: Hudson Environmental Services, Inc.

Sampling Date: February 20, 1995

Well	Hydrocarbon Concentration in ppb
MW-1	ND
MW-2*	8,618
MW-3	7.8
MW-4**	153.5
MW-6	15,265
MW-7	4,897
MW-8	ND
B-1	2,236
B-2	53.5
RW-1	777.7
RW-2	ND
RW-3	947
DEC-10*	36
DEC -11	ND
Lake	ND

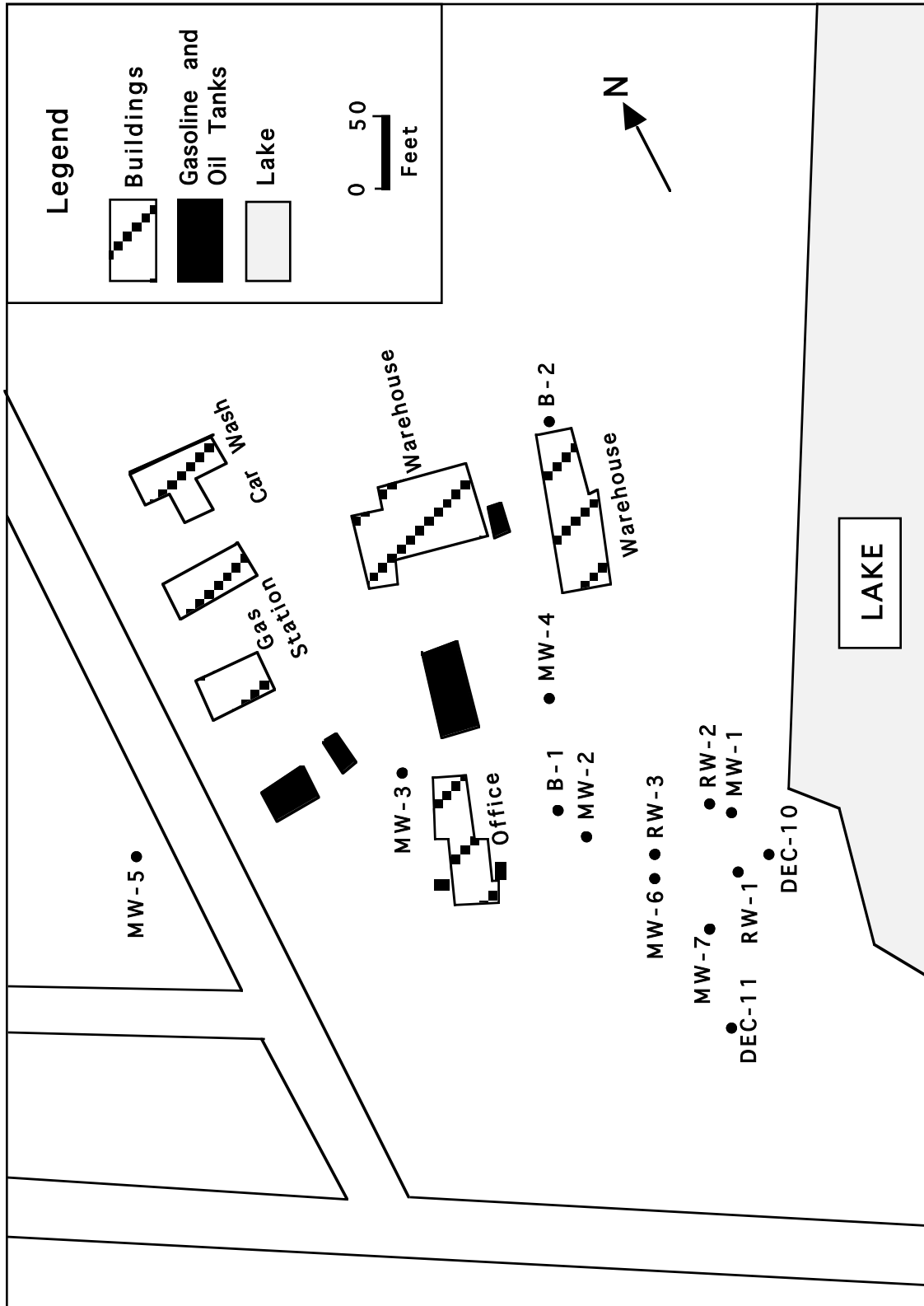
* A fingerprint analysis identified gasoline as the petroleum product in these wells.

** A fingerprint analysis identified fuel oil as the petroleum product in this well.

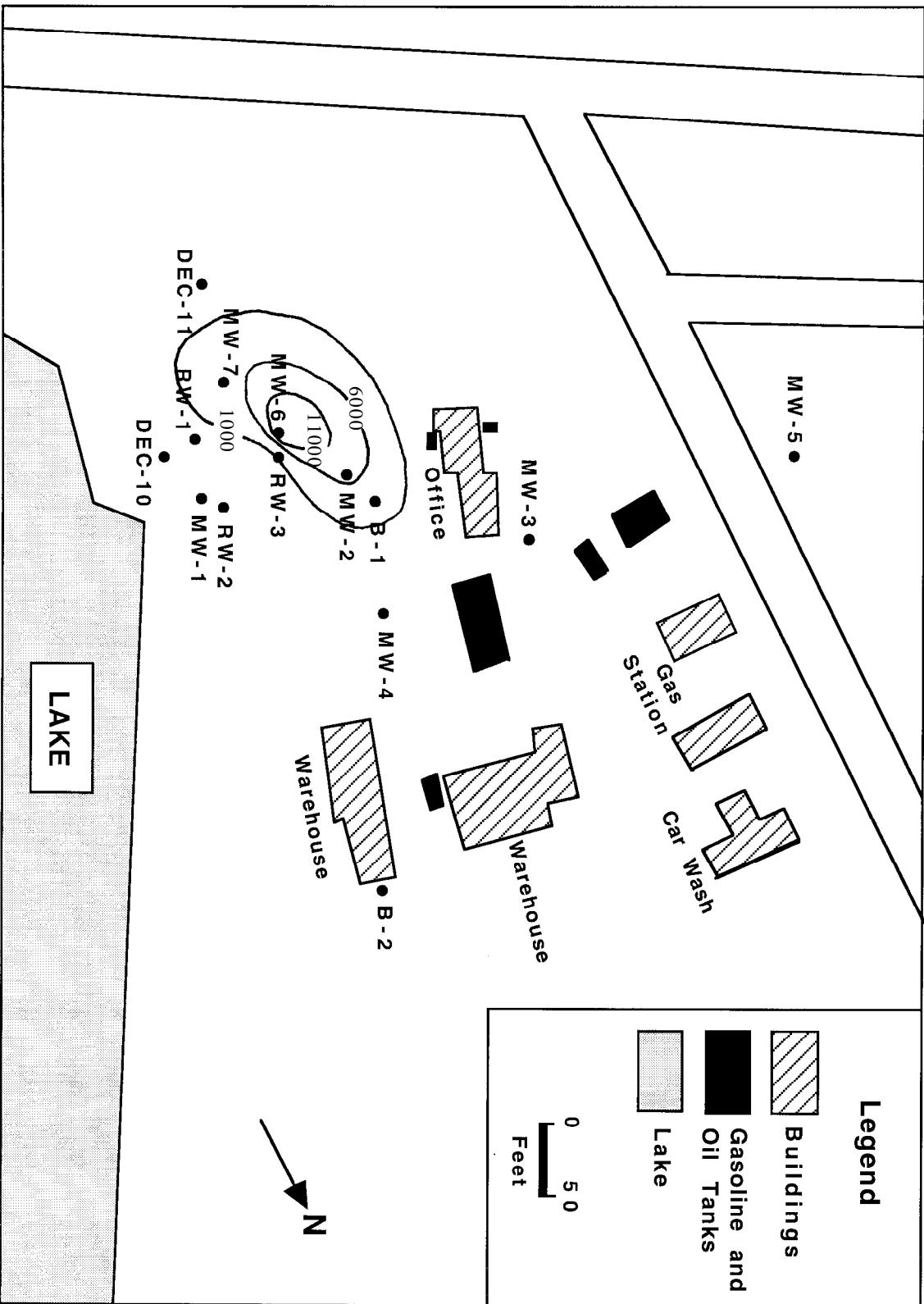
Questions

What is the source of the petroleum contamination? What evidence did you use to locate it?

Is the pollution a threat to the lake? How can you tell?

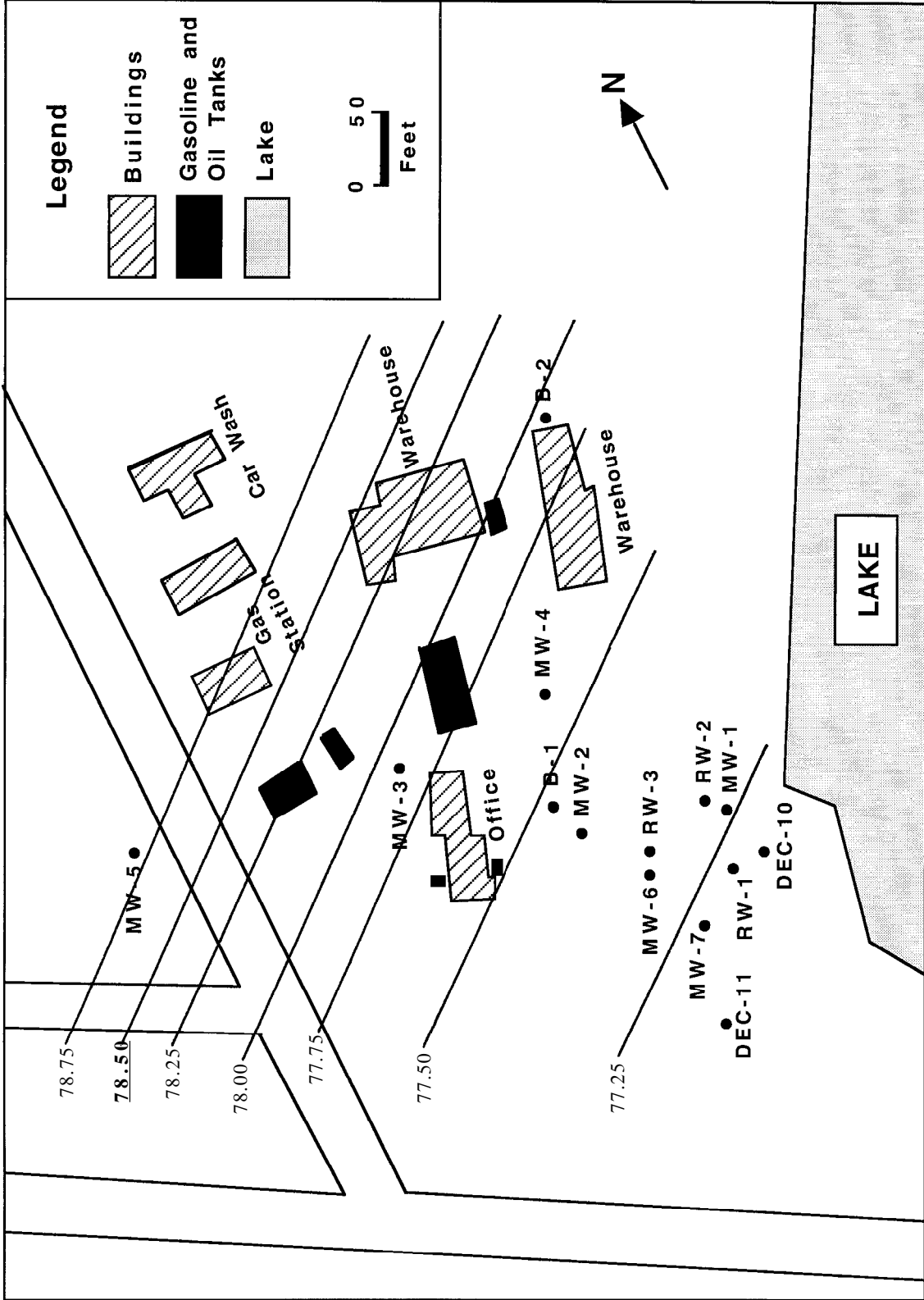


Groundwater Assessment Site Map



Groundwater Assessment Site Map

ANSWER - ISOCONCENTRATION MAP



Groundwater Assessment Site Map

ANSWER - GROUNDWATER TABLE CONTOUR MAP