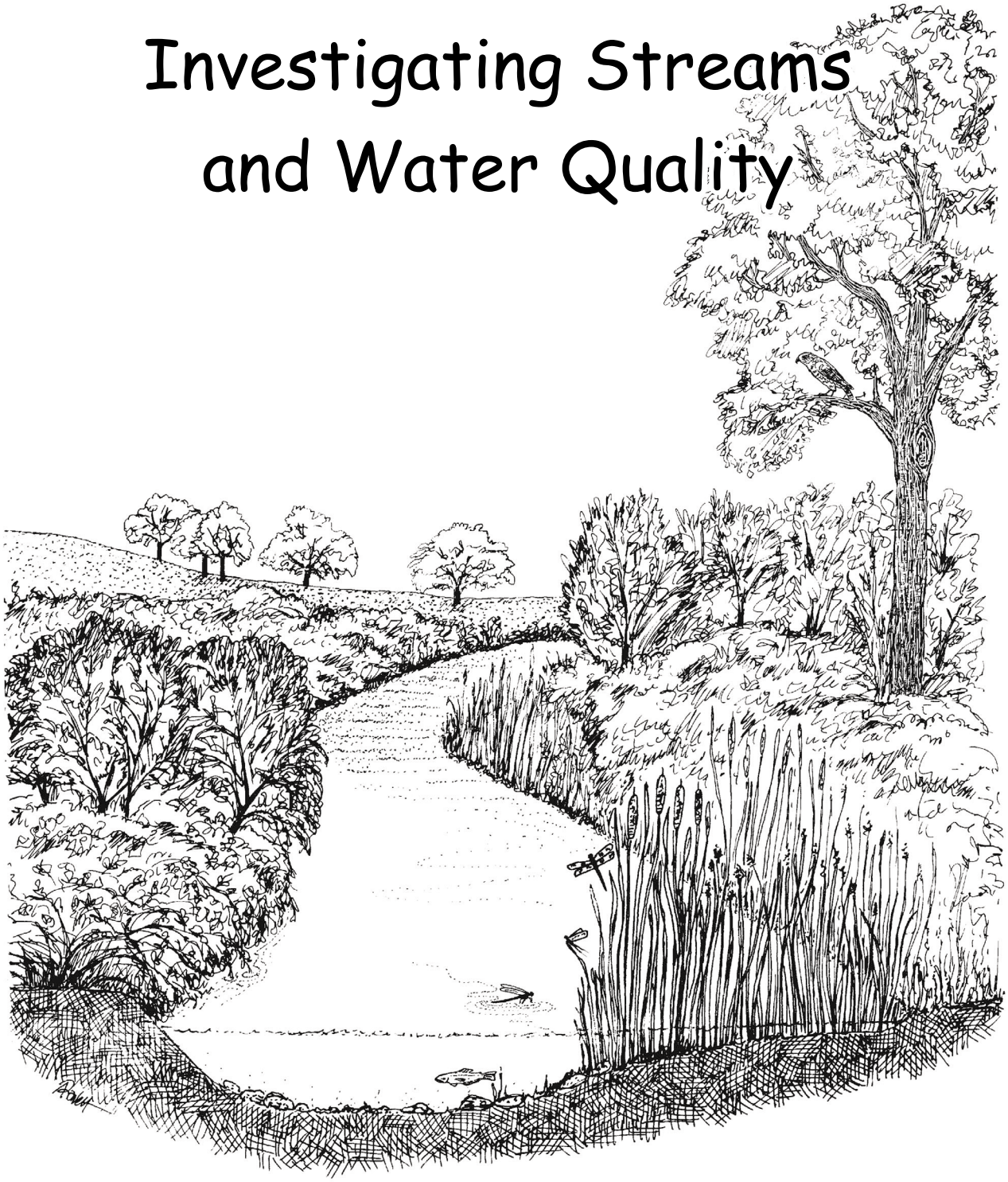
Life in Our Watershed

Investigating Streams and Water Quality



Student Workbook

Splash

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Activity I

Macroinvertebrates - Up close and personal

Your instructor will provide samples of aquatic macroinvertebrates. Examine them under a dissecting scope and complete the following exercises.

Draw a Macroinvertebrate

Draw a detailed picture of your macroinvertebrate in the space below.

Questions and Observations

Note any questions or observations about your macroinvertebrate in the space below.

Your Score _____

An Underwater World

Imagine you can shrink yourself down to the size of a macroinvertebrate. What do you eat? What eats you? What is it like to move and breath? There are wonders and dangers that await you in your underwater neighborhood. In the space below, write a story, a poem, or draw a cartoon about a typical day in the stream.

Your Score _____

Vocabulary I

Define the following words and phrases.

aquatic macroinvertebrate

tributary

food web

watershed

runoff

Your Score _____

Activity II-A

Designing an Experiment

To measure the effects of two urban runoff pollutants on an aquatic macroinvertebrate, imagine putting live *Daphnia magna* into vials containing three types of water:

1. Mock Pollutant #1 (red water)
2. Mock Pollutant #2 (blue water)
3. Clean Water

How would you set up this experiment? Using the three types of water listed above, and an unlimited number of *Daphnia* and vials, describe what your experiment would look like. Answer the following questions to get started.

How many vials will you use?

What kind of water will you put into each vial?

How many *Daphnia* will you put into each vial?

After two days, you could find one of the following results:

1. The *Daphnia* survived in all water types.
2. The *Daphnia* died in all water types.
3. The *Daphnia* survived in some water types but died in others.
4. Something completely different happened.

How could you explain all of these possible outcomes? Make certain that your experimental design would be able to explain each outcome if it occurred.

Creating Instructions

1. Get into groups of three or four.
2. Set up a mock experiment using the three types of water and the vials provided by your teacher.
3. Write out step-by-step instructions on how to set up your experiment. Number each step. Write these instructions so clearly that any student could understand them and be able to repeat your experiment.
4. Draw your experimental design in the space provided. Draw the vials and what is inside each of them (polluted or clean water, each imaginary *Daphnia*).
5. Select one person from your group to draw your design and write your hypothesis on the front board.
6. Clean up your lab station. Leave it the way you found it – ready for the next class.
7. Sit back at your desk.

Instructions (Number your steps.)

Draw your experimental design

Your Score _____

Notes from Class Discussion

Review your experimental design with the class and answer the following:

A. If the purpose of this experiment is to determine what Polluted Water #1 and #2 will do to the *Daphnia*, why do we need to include *Daphnia* in the Clean Water as well?

B. What are the *variables* and what is the *control* in our experiment?

C. Draw a diagram of the final experimental design as agreed upon by the class.

Your Score _____

Vocabulary II-A

Define the following words and phrases.

bacteria

first flush

effluent

heavy metals

storm drain

protozoa

sewage

sanitary sewer

wastewater

wastewater treatment plant

Your Score _____

Activity II-B

Storm Water Pollution Bioassay
Lab Report

I. Purpose

II. Hypothesis

III. Materials

Storm Water Pollution Bioassay
Lab Report

IV. Methods

V. Diagram of Experimental Design

Your Score _____

Storm Water Pollution Bioassay
Lab Report

VI. Results

Record your results in Data Table 1 below.

Data Table 1

	Control				Variable #1				Variable #2		
	Day 1	**Day 2**	**Day 3**		**Day 1**	**Day 2**	**Day 3**		**Day 1**	**Day 2**	**Day 3**
Vial 1											
Vial 2											
Vial 3											
Total											
% Survival											

Calculations

· The total of the **Day 1** values is equal to 100% survival.

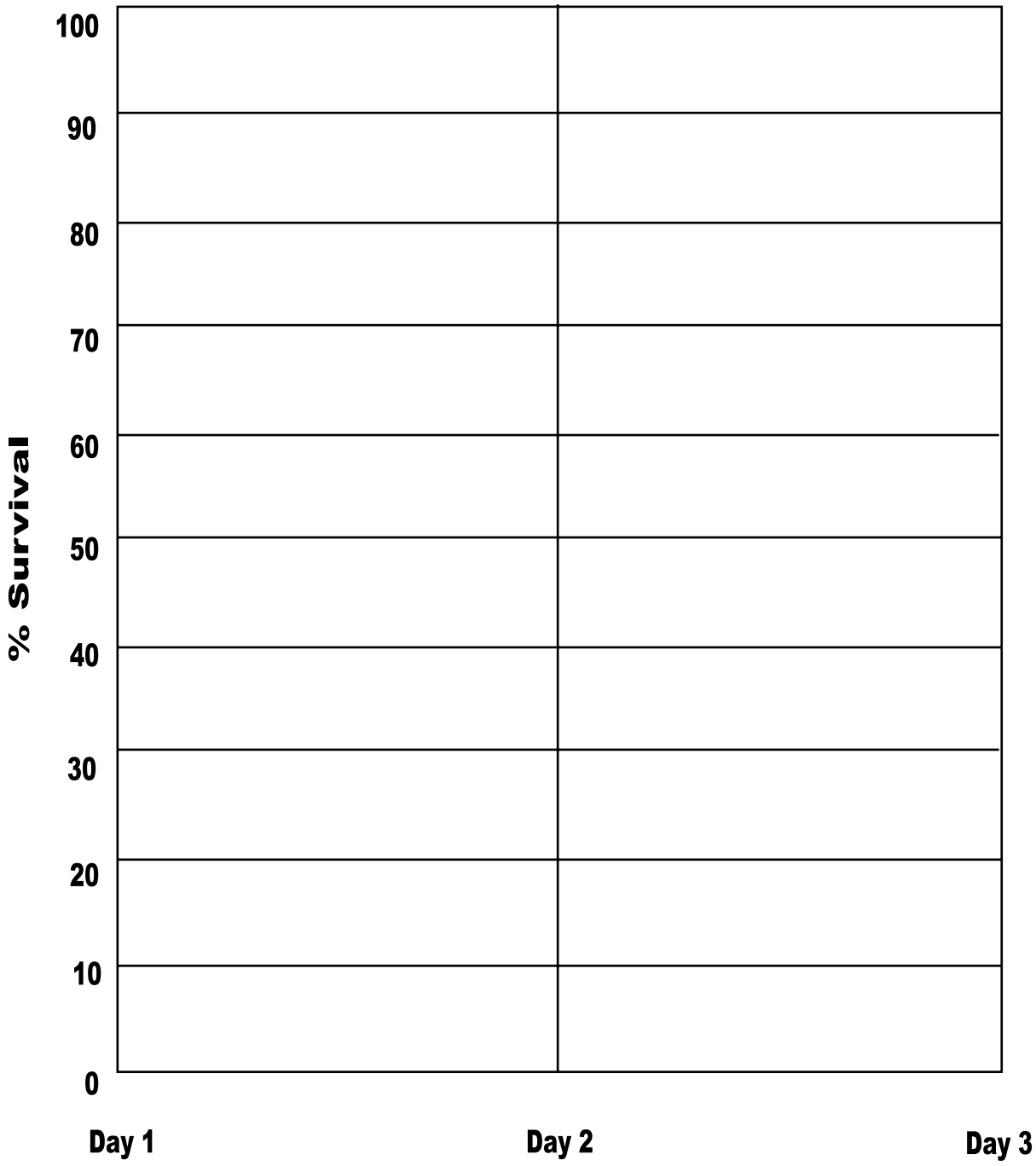
· Calculate the **Day 2** and **Day 3** values for percent survival as follows:

$$\frac{(\textbf{Day 2}\ \text{Total})}{(\textbf{Day 1}\ \text{Total})} \times 100 = \textbf{Day 2}\ \text{Percent (\%) Survival}$$

$$\frac{(\textbf{Day 3}\ \text{Total})}{(\textbf{Day 1}\ \text{Total})} \times 100 = \textbf{Day 3}\ \text{Percent (\%) Survival}$$

Storm Water Pollution Bioassay
Lab Report

Plot your results from Data Table 1 on the graph below.



Storm Water Pollution Bioassay
Lab Report

Description of Your Results
Describe your results in your own words. Include a description of your graph.

VII. Conclusions

Your Score _____

Vocabulary II-B

Define the following words and phrases.

bioaccumulate

bioassay

control

pollutant

variable

Your Score _____

Activity III

During this activity you will design a new neighborhood that can decrease the amount of urban runoff pollutants in your community.

Step 1
Obtain a grid sheet from your instructor. The grid represents the area of town that you will develop. It is 1.5 square miles of grassland covered hills and oak trees. Each square on your piece of paper equals 0.008 square miles, or about 5 acres.

Using this sheet, your group must design a new part of town using the guidelines and challenges below.

Step 2
Guidelines

1. In your groups, design a new section of town that includes the following features:

Feature	Number of squares	Color
Stream	Draw this first! Your stream must cross through at least 30 squares; width of stream may vary	Blue
Shopping mall parking lot	22	Red
Shopping mall buildings	8	Pink
Homes	36	Green
Freeway	Must cross through 12 squares and take up 1/3 of each square it crosses through	Black

2. Start by drawing your stream first. It must cross through at least 30 squares, and you can vary its width. After drawing your stream, plan how you will add your shopping mall, homes, and freeway to your grid.

Challenges

1. Shopping malls, parking lots, homes, and freeways add impervious surfaces to the watershed that rain cannot penetrate. One challenge of this activity is to include features in your grid that will slow down and filter the runoff from all impervious surfaces before the runoff reaches your stream. (See #5-#10 in the table "Ways to Decrease Urban Runoff Pollution" on page 16 of the Student Handbook.)

2. See if you can design your new neighborhood while keeping at least one square between the stream and any freeway, homes, or shopping mall features. (See #9 in the table "Ways to Decrease Urban Runoff Pollution" on page 16 of the Student Handbook.)

Your Score _____

Step 3
After all groups have finished, compare plans and answer the following questions.

1. Do all the plans look similar?

2. Are there unique elements in each plan? If so, list a few of them.

3. If you could redo your plans, would you include design ideas from others to improve your own plan? If so, what are they?

4. Do you feel you have ideas that would improve the plans of others? If so, what are they?

Your Score _____

Step 4
Now that you are more aware of ways to reduce urban runoff pollution, look around your neighborhood to see if you can identify areas with and without impervious surfaces. The next time you travel around town, look for large detention basins in newer developments, vegetated swales, or other runoff-reducing measures.

Vocabulary III

Define the following words and phrases.

impervious surface

non-point source

point source

pathogen

Clean Water Act

Your Score _____

NOTES	
Questions	Topics
SUMMARY	

NOTES	
Questions	Topics
SUMMARY	

Glossary

anaerobic bacteria – bacteria that can live without oxygen

aquatic macroinvertebrate – one of a diverse group of animals that live in water, are big enough to see without a microscope, and have no backbone

bacteria – single-celled organisms without a nucleus (prokaryotes)

bioaccumulate – to build up or concentrate within living tissue

bioassay – a method for determining the toxicity of a substance by measuring its effects on a test organism when compared against the effects of a control

biosolids – the solid byproducts of secondary wastewater treatment that can be used as fertilizer for some plants

cholera – a type of intestinal disease

control – in a scientific experiment, the "non-treatment" against which the effect of other treatments can be measured

detention basin – an large, manmade hole in the ground for temporary storage of stormwater runoff

dysentery – a type of intestinal disease that causes severe diarrhea

digesters – enclosed structures without oxygen in which anaerobic bacteria break down solid waste material, producing methane gas and biosolids as byproducts

effluent – water that is discharged into a stream

first flush – the first heavy rainstorm of autumn that washes accumulated pollutants from surfaces in the watershed into runoff

food web – the interconnected feeding relationships within an ecosystem

heavy metal – naturally occurring elements with high molecular weights (e.g., arsenic, mercury, selenium, cobalt, chromium, copper, zinc, cadmium) that are transformed by microorganisms into toxic compounds which can then enter biologic cycles

impervious surface – hard ground cover that prevents or retards the entry of water into the soil and increases runoff, such as asphalt, concrete, rooftops

landfill – a site where waste materials (trash) are buried under a thin layer of soil

lime – a white powder, calcium oxide (CaO), that can be used to reduce odors

non-point source – a source of pollutants which is either so common or so widespread that its origins are difficult to pinpoint

outfall – the place where water from a treatment plant, factory or storage facility flows into a stream

oxygen reactor – large open tanks at a wastewater treatment plant into which air is bubbled to provide oxygen for the rapid breakdown of wastes by bacteria and protozoa

pathogen – a microscopic disease-causing organism

point source – a single source of pollutants which is detectable and identifiable, such as the end-of-point discharge from a factory

pollutant – something that contaminates something else or deteriorates its condition, especially a harmful chemical or other waste material discharged into the water or atmosphere

protozoa – single-celled organisms with a nucleus (eukaryotes); wastewater treatment operators use protozoa to control levels of bacteria in an oxygen reactor

runoff – water that flows off artificial and natural surfaces and into streams

sanitary sewer – a system of pipes that carries wastewater to a wastewater treatment plant

sediment – soil deposited in stream bottoms

sewage – the combination of organic waste and wastewater generated by residential and commercial establishments

storm drain – covered pipe openings along street gutters that carry runoff directly into streams

tributary – a stream that feeds into a larger stream

variable – the condition in an experiment that changes due to the effects of the treatment(s) under investigation

wastewater – water that is flushed or washed from the inside of homes and businesses from sinks, toilets, showers, baths, washers, etc.

wastewater treatment plant – a facility where wastes are removed from water by biological, chemical, and physical processes

watershed – an area of land that sheds rain water into an interconnected network of streams

Student Scoresheet

Lesson	Activity	Your score
I	Draw a macroinvertebrate	
	Write a story	
	Vocabulary I	
	Test I	
II-A	Experimental Design	
	Vocabulary II-A	
	Test II-A	
II-B	Lab Report sections I-V	
	Lab Report sections VI-VII	
	Vocabulary II-B	
	Test II-B	
III	Neighborhood Design	
	Comparing Designs - questions	
	Vocabulary III	
	Test III	
	Total score	

Instructor's comments:

Sacramento
Regional
County
Sanitation
District

CITY OF SACRAMENTO
DEPARTMENT
OF UTILITIES