

# ENVIRONMENTAL SOLUTIONS TEAM MEETING #5

## Description

Acting as Environmental Engineers, the Environmental Solutions Teams select the appropriate remediation technologies and develop a monitoring plan to address Hydroville's water quality problem.

## Student Outcomes

Students will:

- Experience how decision-making involves balancing costs, benefits, and personal values, or preferences.
- Develop a strategy for evaluating solutions to a complex problem.
- Use a decision chart to evaluate remediation options in light of specific goals.

## Team Products

- *Choosing Remediation Solutions for Hydroville*
- *Decision Chart*
- *Data Analysis Questions*
- *Press Release #5* (or PowerPoint Slides for Environmental Engineer)

## Prerequisites

- Background Activity 10: *Water Treatment Solutions for Homes*
- Background Activity 11: *Remediation Technologies for Contaminated Sites*



## National Standards

Subject Area Standards Covered: *Geography, Health, Language Arts, Math, Science, Social Studies, and Technology.*

See Appendix D for the complete list of national education standards.



## Teamwork Skill

Work with others to develop shared decisions and goals.



## Activity Timing

Time Estimate	Two to Three 50-minute Class Periods
30 min	Prep Time: photocopying team packets
Day 1	Teamwork Skill and Data Collection
Day 2	Data Analysis and Team Leader Assignment



## Materials

- Hydroville Journals
- Team binders

## Teacher Information

Review water treatment methods in Background Activity 10 and remediation technologies in Background Activity 11.



## Suggested Lesson Plan

### *Getting Started*

Photocopy and organize team packets. See *Pages to Photocopy*.

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## Day 1. Teamwork Skill and Data Collection

### *Doing the Activity*

1. Assemble students into their ES Teams.

### 2. Teamwork Skill

- a. As a class, create a T-chart (*Teamwork Skills* section, WS-1) for the suggested teamwork skill, “Work with others to develop shared decisions and goals.”
- b. As the teams work together completing their assignments, evaluate their performance using the *Teamwork Skills Practice Guide* (*Teamwork Skills* section, WS-2).
- c. Share a few of your observations with individual teams or with the class at the end of the period.

### 3. Data Collection

Refer to the *Water Quality Concept Map*. Ask the class, “Where are we now in this investigation?”

*Acting as Environmental Engineers, ES Teams recommend remediation technologies and a monitoring plan to address the water quality problem in Hydroville.*

4. Students may need time to organize their Hydroville Journals, Hydroville maps, remediation technology posters, and any other information about Hydroville either in their personal folders or in their team binders.
5. Hand out ES team packets, one to each team. Review team meeting’s objectives and team products on *ES Team Meeting #5 - Data Collection* (WS-1). Remind the team leaders (Environmental Engineers) of their responsibility during this team meeting. There are two parts to Data Collection.

### 6. Part I. Ranking Remediation Criteria

- a. Discuss *Choosing Remediation Technologies for Hydroville* (WS-2). Each team or the class as a whole will brainstorm other criteria and goals to add to Table 1 on Worksheet 2

including the concerns of the citizens of Hydroville. For example: clean water, no new taxes, responsible government, health, environment, etc.

- b. Students should refer to Worksheet 2, page 2 from Background Activity 1 or to the class generated transparency to review Hydroville stakeholders and their concerns. They add additional criteria and goals in the first column of Table 1.
- c. Remind students that the Hydroville City Council has stressed their top priorities:
  - To assure that the city's drinking water is safe and will be safe to drink in the future.
  - To provide solutions that does not cause a large increase in taxes or water rates for the citizens of Hydroville.
- d. ES teams represent the Hydroville City Council but since the council is an elected body, they also represent all the citizens of Hydroville. In column 2, teams describe in a few words why the criteria may be important to the stakeholders in Hydroville.
- e. Separately, teams come to a consensus and decide which criteria are most important to the City Council and the citizens of Hydroville. They then rank the criteria in column 3.



**Tips from Teachers:**

- To help with the team ranking, each team member chooses their top five criteria from Worksheet 2 and places them on a post-it note with its ranking points (5 from most important and 1 for least).
- One team member collects the post-its, puts the notes with the same goal together and tallies up the points. The goal with the most points would be the team's consensus as their number 1 ranked goal.

**7. Part II. Remediation Technologies for Hydroville**

- a. Teams refer to Worksheet 4: *Comparing Remediation Technologies* from Background Activity 11 to help them fill in Tables 2 and 3 on Worksheet 2.

**Wrap-up**

1. Each ES team must complete Worksheet 2 before proceeding to Day 2. Data Analysis.
2. When the teams are finished, they organize all worksheets and file in their team binder.

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**Day 2. Data Analysis and Team Leader Assignment**

**Doing the Activity**

1. Make a transparency of the *Decision Chart* (WS-4). Demonstrate how to use the decision chart to rate various solutions against goals and criteria.
2. Work through an example problem on a decision chart using the Transparency. You may have to use more than one transparency master if the class brainstorms many goals/criteria or actions/solutions. Use the following problem or have the class brainstorm a problem statement of their own.
  - a. Problem Statement: "If your family were to go out for dinner tonight, where should they go for dinner?"
  - b. Discuss "Who are the stakeholders in this decision?" *Parents, children, friends, etc.*

- c. Goals/Criteria: Brainstorm possible goals or criteria for each stakeholder and list them across the top of the chart.
    - Children: *tastes good, fast, foods they like, etc.*
    - Parents: *low cost, healthy, filling, atmosphere, etc.*
  - d. Solutions/Actions: Brainstorm multiple possibilities and write possible solutions in the rows down the left side of the chart. *These will be a list of local restaurants or other possibilities.*
  - e. In each cell under “Goals/Criteria,” have students agree on whether the action meets the goal (+), doesn't affect the goal (n/a), or doesn't meet the goal (-). Emphasize that these rankings are subjective but should be based on the best factual information available. Look at the overall ratings on the decision chart for each solution/action and decide the best overall solution(s) or action(s) to the problem statement.
3. Discuss *ES Team Meeting #5 - Data Analysis (WS-3)*. Discuss what it means for a team to come to a “consensus”. Stress the importance of working together to agree on the best remediation solution for cleaning up the contaminated sites in Hydroville. Remind the teams that there is no one solution to Hydroville’s drinking water problem. They use the decision chart to help them put together the best combination of technologies to meet the criteria and budget that they have.
  4. Students work as a team to answer the *Data Analysis Questions*. The Team Leader is the recorder.
  5. Remind team leaders about their final assignment which summarizes their team’s findings and hypothesis(es).

**Note:** If you have more than two leaders per meeting, they should share the responsibility of leading the meeting, but write separate press releases and slides.
  6. Assign due date for press release or slides for team leader(s). The press release or slides should be submitted along with the team *Data Analysis Questions* and any other team products.

### **Wrap-up**

1. Teams modify their existing hypothesis or develop new hypotheses based on the information that they just collected and analyzed.
2. Teams turn in their worksheets or they can put them in their team binder for the team leaders for reference.
3. Remind teams that they are responsible for organizing what is in their team binder.

### **Assessment**

The following student products can be used for assessment:

Group

- *Choosing Remediation Solutions for Hydroville (WS-2)*
- *Decision Chart (WS-4)*
- *Data Analysis Questions (WS-5)*



## Resources

See the Hydroville Water Quality Curriculum Web Resources webpage for current links:  
[http://www.hydroville.org/links/wq\\_resources.aspx](http://www.hydroville.org/links/wq_resources.aspx)

### Hardcopy Resources:

*Exploring Environmental Issues: Focus on Risk*. 1998. Project Learning Tree. American Forest Foundation. Washington D.C. Campbell, V., Jerome, B., & Loftstrom, J.  
[http://www.plt.org/cms/pages/21\\_21\\_14.html](http://www.plt.org/cms/pages/21_21_14.html)

*Decisions Based on Science. Pages 41-45*. National Science Teacher Association. (1997). NSTA Press  
<http://www.nsta.org/recommends/ViewProduct.aspx?ProductID=12171>



## Teacher Keys

### *Choosing Remediation Solutions for Hydroville (WS-2)*

Table 1. Ranking remediation technology criteria for Hydroville

Criteria/Goals	Importance to Hydroville Stakeholders	Rank
Short-term Effectiveness	<i>Answers will vary</i>	
Long-term Effectiveness		
Permanence		
Risk Reduction		
Low Initial Costs		
Low Continuing Costs		
<i>Answers will vary</i>		

Table 2. Effectiveness of remediation technologies

Remediation Solutions	Contaminated Site	
	Land (soil, waste)	Groundwater
Waste Excavation	X	
Groundwater Extraction		X
Bio Cap	X	
Impervious Cap	X	
Carbon Adsorption		X (organic contaminants)
Ion Exchange		X (metal ions and nitrate)

Table 3. Possible combinations of clean up solutions for Hydroville.

*Answers may vary. Students will have many other combinations of ideas*

<b>Description of Contaminated Area in Hydroville</b>	<b>Source and/or Specific Contaminants to be removed</b>	<b>Effective Remediation Technologies</b>
<i>Old Hydroville Dump</i>	<i>Trash, hazardous waste, and contaminated soil</i>	<i>Waste Excavation Impervious Cap Bio Cap</i>
<i>Groundwater in aquifer east of the dump</i>	<i>Chromium, TCE, Vinyl Chloride</i>	<i>Groundwater extraction Carbon Adsorption Ion Exchange</i>
<i>Groundwater entering Treatment Plant #2</i>	<i>Chromium, TCE, Vinyl Chloride</i>	<i>Groundwater extraction Carbon Adsorption Ion Exchange</i>
<i>Groundwater and Surface Water entering Treatment Plant #1</i>	<i>nitrates</i>	<i>Ion Exchange</i>
<i>Tap Water in certain homes</i>	<i>Corrosion of distribution pipes/ lead and copper</i>	<i>Ion Exchange</i>

**Decision Chart (WS-4)**

*Answers will vary*

**Data Analysis Questions (WS-5)**

*Answers will vary, but should reflect the selections on the team's decision chart.*



## PAGES TO PHOTOCOPY

**Note:** Unless indicated, make one copy per student of all Handouts. For ease of photocopying, Transparency Masters appear first in the student pages.

### Handouts and Transparency Masters

Day	What is Needed	Type*
<b>ES Team Packet (one per team)</b>		
<b>1</b>	<i>ES Team Meeting #5 – Data Collection</i>	WS-1
	<i>Choosing Remediation Technologies for Hydroville</i>	WS-2
<b>2</b>	<i>ES Team Meeting #5 – Data Analysis</i>	WS-3
	<i>Decision Chart</i>	WS-4
	<i>Data Analysis Questions</i>	WS-5
	Option 1: Press Release for Hydroville Times <i>and</i> Press Release Scoring Guide	<i>See ES Team Meeting #1</i>
	Option 2: PowerPoint Slides for Team Presentation	<i>See ES Team Meeting #1</i>

\* Type = Transparency Master (TM), Background Reading (BR), Worksheet (WS), Map (M)

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## WORKSHEET 1: ES TEAM MEETING #5 – DATA COLLECTION

### Introduction

In this team meeting, your team leader is an Environmental Engineer who needs your help. Your team will use the process of decision analysis to weigh the pros and cons of each remediation technology, keeping in mind the priorities of the city council and the concerns of the Hydroville citizens (stakeholders).

In Team Meeting #5, your Environmental Solutions team will:

- ✓ Have Team Leader #5 in the role of an Environmental Engineer.
- ✓ Prioritize criteria for remediation solutions.
- ✓ Use a decision chart to weigh the pros and cons of each remediation solution.
- ✓ Choose various remediation technologies for the teams solution.
- ✓ Develop a monitoring plan to check the water quality in Hydroville.
- ✓ Calculate total cost for remediation and monitoring.

### Materials

- Hydroville Journals
- Team binder
- References:
  - Worksheet 4: *Comparing Remediation Technologies* (from BA 11)
  - Worksheet 2, page 2: *Hydroville Stakeholders* (from BA 1)
  - Remediation technologies posters (from BA 11)
- ES Team Packet
  - Worksheet 2: *Choosing Remediation Technologies for Hydroville*

### Part I. Ranking Remediation Criteria

1. Assemble your Environmental Solutions (ES) team. Team Leader #5, Environmental Engineer, will coordinate the activities for this meeting. The team leader reads the ES Team Meeting #5 instructions to all team members.

2. On Worksheet 2: *Chooseing Remediation Solutions for Hydroville*, find Table 1 which lists criteria for remediation technologies that you learned about in Background Activity 11.

**Note:** If you need the definition for each criterion, refer to Worksheet 4: *Comparing Remediation Technologies* from Background Activity 11.

3. As a team, brainstorm other criteria and goals that you could add to Table 1. Include the point-of-view of the citizens of Hydroville, as well as the Hydroville City Council's top priorities. For example: clean water, no new taxes, responsible government, health, environment, etc.

**Note:** See Worksheet 2, page 2 from Background Activity 1 to review the Hydroville stakeholders and their concerns from the Water Quality video.

#### The Hydroville City Council has stressed their top priorities:

- To assure that the city's drinking water is safe and will be safe to drink in the future.
- To provide solutions that do not cause a large increase in taxes or water rates for the citizens of Hydroville.



4. In column 2, describe in a few words why the criteria or goals that you listed are important to the stakeholders in Hydroville.
5. In your team, discuss which criteria are most important to the citizens of Hydroville. As a team, come to a consensus which goal has the highest priority, and which is second and so on. In column 3, rank each of the criteria from highest priority (#1) to lowest. This ranking will help in the decision-making process when you have to select the most appropriate remediation solutions.

## **Part II. Remediation Technologies for Hydroville**

1. Review your team answers to Worksheet 4: *Comparing Remediation Technologies* from Background Activity 11 to help you remember the advantages and effectiveness of each of the technologies that you studied.
2. In Table 2, put an “X” in the column of the type of contamination that the technology will treat. Be specific if the technology only removes one type of contaminant at a site.
3. Use the Hydroville Maps and worksheets from previous ES team meetings to help your team complete Table 3. In the first column, list specific areas or sites in Hydroville that may be contributing to contaminants in Hydroville’s drinking water. List the source or sources of the contamination and the specific contaminants that you found.
4. Now use Table 2 to list all the effective remediation technologies that could be used to clean up the problem.
5. Save Worksheet 2 in your team binder for use in Day 2: Data Analysis.



## WORKSHEET 2: CHOOSING REMEDIATION SOLUTIONS FOR HYDROVILLE

Table 1. Ranking of stakeholders' criteria and goals (Note: 1= highest priority)

Criteria/Goals	Importance to Hydroville Stakeholders	Rank
Short-term Effectiveness (done in one year)		
Permanent Solutions		
Reduce Risk of Exposure		
Low Initial Costs		
Low Continuing Costs		



Table 2. Effectiveness of Various Remediation Technologies (Use Worksheet 4 from Background Activity 11 to help fill in the table.)

Remediation Technology	Contaminated Site	
	Land (soil, waste)	Groundwater
Waste Excavation		
Groundwater Extraction		
Bio Cap		
Impervious Cap		
Carbon Adsorption		
Ion Exchange		

Table 3. Possible clean up solutions for Hydroville

Description of Contaminated Area in Hydroville	Specific contaminant and/or source to be removed	Effective Remediation Technologies (List all that might work)



## WORKSHEET 3: ES TEAM MEETING #5 – DATA ANALYSIS

### Introduction

Working with the recommendations of the Environmental Engineer, your team you will need to select the combination of remediation technologies to help solve the water quality problem in Hydroville. You will base your decision on the criteria and remediation technologies you discussed during Data Collection. A decision chart will be used to help your team in to make this final decision.

### Materials

- Hydroville Journal
- Team binder
- ES Team Packet
  - Worksheet 2: *Choosing Remediation Solutions for Hydroville*
  - Worksheet 4: *Decision Chart*
  - Worksheet 5: *Data Analysis Questions*

### Procedure

1. Appoint a recorder for this part of the team meeting. The team leader reads the instructions and coordinates the discussion.
2. Now it is time to decide on your team's solution. To help you do that you will use a decision analysis tool called a *Decision Chart* (Worksheet 4). Remember that there is no one correct solution, but many different solutions. You have to choose the one that will fit your budget and best meet the goals of the Hydroville City Council and the citizens of Hydroville.
3. First define the problem, that is, what problem are you trying to solve. In this case: *Which combination of remediation technologies is the best solution for Hydroville's drinking water problem?* Put this on the top of your decision chart.
4. On top of the decision chart, under "Criteria / Goals", list your team's top five criteria or goals that you identified in Table 1 on Worksheet 2.
5. Now you need to brainstorm combinations of technologies or actions that could solve Hydroville's drinking water problem. Use Table 3 on Worksheet 2 to help you put together five different solution possibilities. List these down the left hand side of the decision chart.
6. There is one solution that you should take into account and that you may not have thought of: *Take no immediate action and regularly monitor the drinking water from treatment plants.* Add this to the Decision Chart as solution six.
7. Next your team needs establish a rating system for your decision chart. How will you indicate if the solution meets the criteria. You might use a system of pluses for meeting the criteria and minuses for not meeting the criteria. You could use a zero or NA if the solution is neutral or not applicable to the goal. Define your rating system at the bottom of the chart.
8. Use your rating system to evaluate each solution against each criteria or goal.



9. Now look over the chart. Which of your solutions best meets all of the criteria and goals of the stakeholders in Hydroville? This is the solution that you will recommend to the Hydroville City Council.
10. As a team, discuss and answer *Worksheet 5: Data Analysis Questions*. Refer to the remediation technologies posters and worksheets.
11. Your team leader assigns a recorder to fill in the worksheet with the answers that the team agrees are correct.
12. Turn in all of the worksheets or put them in their team binder.

### **Team Leader #5 Assignment**

Each team leader will complete a final assignment after each ES team meeting to summarize the team's findings and hypothesis(es). There are two options in this assignment:

- 1) Write a press release that will appear in the *Hydroville Times* **or**
- 2) Create six or seven PowerPoint slides to be used in the team's final presentation.

Your teacher will give you further instructions for this assignment. If there is more than one team leader, both students need to write individual assignments.



### WORKSHEET 4: DECISION CHART

Define the Problem: \_\_\_\_\_

	Criteria / Goals					
Technologies/ Actions						

Rating System:

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