PBL Unit Title: Wake County Landfill Problem

Primary Subject Area: Earth/Environmental Science

Interdisciplinary Areas also Covered: Computer Technology Skills, English I, Algebra I, ELPS

Grade/Age Level: 9-12th Grade and Post-Secondary

Description of students' role and problem situation: Students act as concerned parties in Wake County reporting to an Advisory Committee on how to solve Wake County's pending landfill problem.

Educational Objectives: (Indicate if unit is interdisciplinary, but only list the objectives from primary subject area) Interdisciplinary Earth/Environmental Science Objectives: 1.06, 4.02, 5.07, 7.01, 7.02, and 7.03

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MEMORANDUM

Date: June 3, 2002

To: Concerned Parties:

- Town & City Mayors
- Environmental Organizations
- Regional Geologists
- Concerned Wake County Citizens
- Waste Management Services

From: Wake County Advisory Committee

Subject: Change in proposed landfill site

Wake County has a big problem with solid waste disposal. Every year Wake County generates large volumes of trash. Space to put this solid waste is running out. At current rates of landfill space consumption, the Wake County landfill will be completely filled by 2003. Furthermore, problems have risen with the location of a new landfill site in Holly Springs that could take years to resolve. Wake County solid wastes must be disposed of legally and properly. Shipping solid waste elsewhere is not an option. How can a new landfill site be agreed upon and waste be reduced?

In response to this problem, the Advisory Committee is asking each of you to present a proposal highlighting a possible solution to the landfill problem. Please present a proposal that is in compliance with Local and State Landfill regulations and is safe, convenient, and will assist in eliminating waste volume. An Advisory Committee meeting will be held on June 17, 2002 to discuss proposals and adopt a policy to proceed.

Curriculum Alignment Guide

Earth/Environmental Science Curriculum:

1.06 - Interpret topographic, soil, geologic, and other maps and images for:

- The location and identification of soils and rock types.
- The identification of erosional and depositional landforms.
- The evaluation of landforms resulting from tectonic activity.

4.02 - Evaluate water beneath the earth's surface:

- Storage and movement.
- Environmental impact of a growing human population.
- Impact of building and development.
- Causes of natural and manmade contamination.

5.07 - Analyze the effects of human activity on the environment and the influence of issues on weather and climate.

7.01 - Analyze the relationship between the potential of technology to improve the quality of life and the possible causes of stress on the environment.

7.02 - Analyze the interdependence of Earth's natural resources and systems, including land, air, and water, with the need to support human activity and reduce environmental impacts.

7.03 - Assess how society weighs the choices of economic progress, population growth and environmental stewardship and selects a balanced responsible course of action.

Interdisciplinary Curriculum Standards (Usual 9th Grade Classes):

Computer/Technology Skills:

1.1 - Practice ethical behavior in using computer-based technology for class assignments and projects.

2.1 - Practice and refine knowledge and skills in keyboarding/word processing/desktop publishing, spreadsheets, databases, multimedia, and telecommunications in preparing classroom assignments and projects.

2.2 - Select and use appropriate technology tools to efficiently collect, analyze, and display data.

3.2 - Use appropriate technology tools to efficiently collect, analyze, and display data.

3.3 - Use electronic resources for research.

3.4 - Use spreadsheets and/or databases to collect, record, analyze, and present data.

3.5 - Select and use technology tools for class presentations.

3.6 - Adhere to Fair Use and Multimedia Copyright Guidelines, citing sources of copyrighted materials in papers, projects, and multimedia presentations.

Algebra I:

3.02 - Identify properties and relationships of data in tables, graphs, and equations.

ELPS:

1.1 - Describe examples of recurring public problems and issues.

1.3 - Evaluate strengths and limitations of the economic, legal, and political systems in resolving problems.

1.4 - Make inferences regarding relationships among economic, legal and political problems.

1.6 – Compare differing points of view on the proper role of government in the personal lives of citizens.

2.3 - Demonstrate methods of promoting and inhibiting change through political action.

5.6 - Analyze the influence of environmental factors on specific economic activities.

5.7 - Analyze relationships between economic conditions and political decisions.

English I:

2.04 - Form and refine a question for investigation, using a topic of personal choice, and answer that question by:

- Deciding upon and using appropriate methods such as interviews with experts, observations, finding print and non-print sources, and using interactive technology or media.
- Prioritizing and organizing the information.
- Incorporating effective media and technology to inform or explain.
- Report (in written and/or presentational form) the research in an appropriate form for a specified audience.

Significant Learner Characteristics

1. Want to be considered adults.
2. Out of touch with current issues.
3. Questioning of authority (rules, teachers, etc.).
4. Self-centered or consumed.
5. Limited understanding of abstract concepts.
6. Activism (for fairness, bandwagons, etc.)
7. Prefer group work
8. Care about grading (whether work will be graded)
9. Materialistic
10. Technology literate

Know/Need to Know Board

KNOW	NEED TO KNOW
1. Wake County has a problem with solid-waste.	1. What are some possible sites other than Holly Springs?
2. Space is running out at current location.	2. What are current laws for solid-waste disposal?
3. Current landfill is North Wake.	3. What is solid-waste?
4. It will be filled by 2003.	4. What are the roles of _____ organization?
5. Possible new location in Holly Springs.	5. What steps can be taken to find a new location?
6. Problems could take years to resolve at Holly Springs site.	6. Can recycling be increased?
7. Solid-waste must be disposed of legally and properly.	7. Why isn't shipping an option?
8. Shipping to other places is not an option.	8. Why are there problems with the Holly Springs site?
9. Wake County Advisory Committee is in charge of the proposal.	9. What is the volume of trash created in Wake County?
10. Meeting for this proposal will be held on June 17, 2002.	10. What costs are involved?
11. We are members of _____ organization.	
12. Large volumes of trash are generated.	
13. Proposal must comply with local and state landfill regulations, must be safe, must be convenient, and must eliminate waste volume.	

Problem Statement

How can we, as a concerned party in Wake County [insert role name here], create a proposal to solve Wake County's problem with losing the North Wake landfill in such a way that:

- A new landfill site is agreed upon
- Solid-waste disposal is in compliance with Local and State landfill regulations
- Waste disposal is safe and convenient
- Solid-waste volume is reduced
- Waste is not shipped anywhere else
- A good proposal is presented by June 17, 2002.

Role-specific conditions:

Town & City Mayors –

- Create a proposal that is fair to all townships involved

Environmental Organization Members –

- No environmental damage is done

Regional Geologists –

- A suitable landfill site is chosen

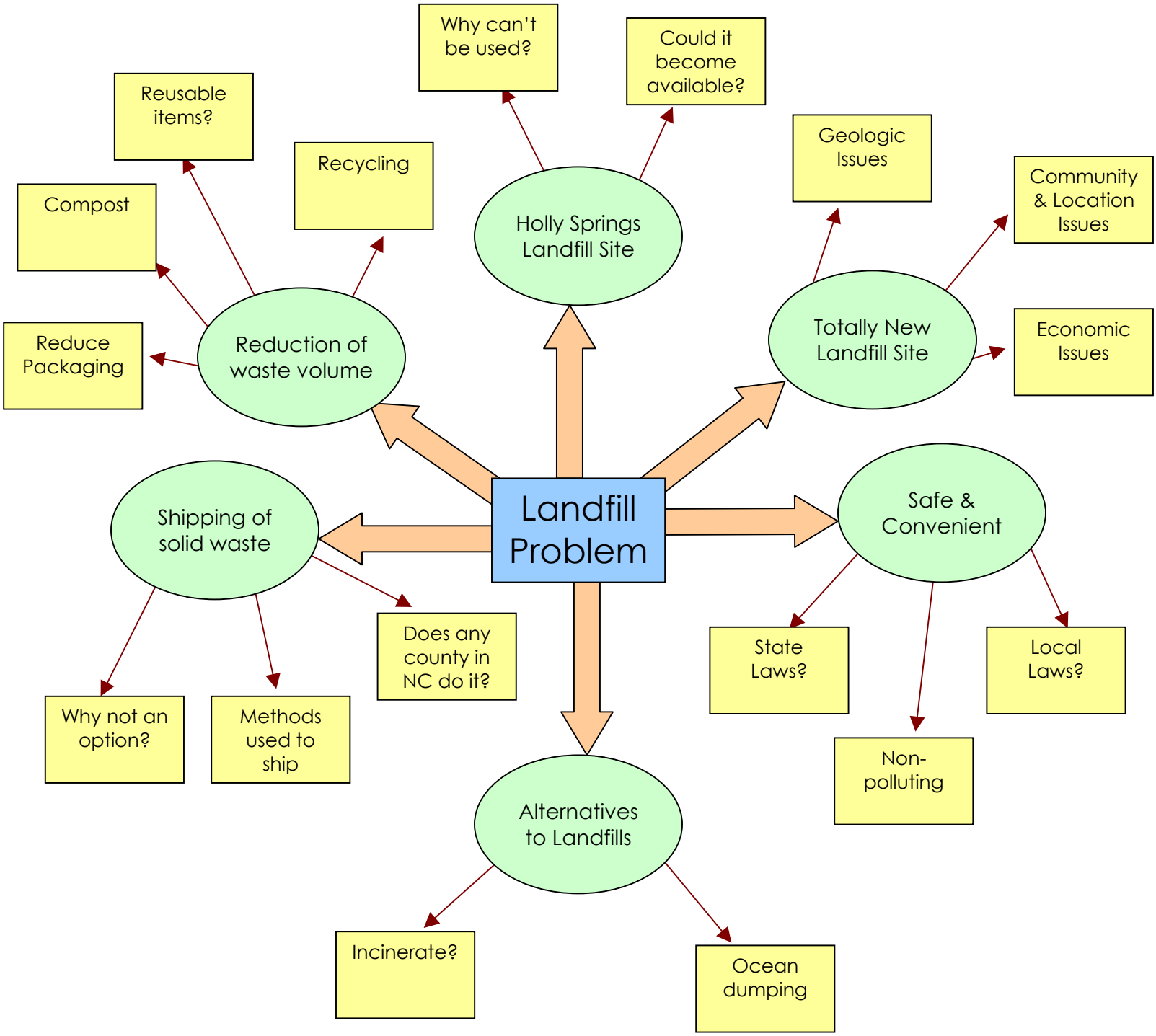
Concerned Wake County Citizens –

- The citizenship of Wake county is not inconvenienced

Waste Management Services –

- Waste services are not interrupted

Problem Map


Landfill Problem
Holly Springs Landfill Site
Why can't be used?
Could it become available?
Reduction of waste volume
Reusable items?
Recycling
Compost
Reduce Packaging
Totally New Landfill Site
Geologic Issues
Community & Location Issues
Economic Issues
Shipping of solid waste
Why not an option?
Methods used to ship
Does any county in NC do it?
Safe & Convenient
State Laws?
Local Laws?
Non-polluting
Alternatives to Landfills
Incinerate?
Ocean dumping

Reference List

Websites:

National Solid Waste Management Association (NSWMA)
http://www.nswma.org/index.htm

Solid Waste Management – Wake County, NC
http://www.co.wake.nc.us/solwaste

Division of Waste Management – NC Department of Environmental and Natural Resources (NCDENR)
http://wastenot.enr.state.nc.us/

"How Landfills Work" – How Stuff Works
http://www.howstuffworks.com/landfill.htm

Municipal Solid Waste Factbook – U.S. Environmental Protection Agency
http://www.epa.gov/epaoswer/non-hw/muncpl/factbook/internet/index.htm

The Basics of Landfills
http://www.ejnet.org/landfills/

Newspaper Articles:

Wrangling over Waste. (2002, May 29). The News and Observer, p. B1.

Court Hears Landfill Appeal. (2002, April 18). The News and Observer, p. B1.

Books:

Seldman, N. N., & Martin, L. R. (1986). An environmental review of incineration technologies. Washington, DC: Institute for Local Self-Reliance.

Noble, G. (1976). Sanitary landfill design handbook: the science and art of site selection, investigation, and design. Westport, CT: Technomic Publishing Company.

Brochures:

Wake County Solid Waste Management. (2001). Wake County School Recycling Program. [Brochure].

Wake County Solid Waste Management – Programs and Services. (2001). Reduce, Reuse, Recycle – Aggressive Waste Reduction Now. [Brochure].

Landfill Project Assessment

At the culmination of this project, students are expected to present their findings to the Wake County Advisory Committee. The Advisory Committee will evaluate the solution presented as a group, the instructor will evaluate the presentation, and individual self-evaluations for participation will also be completed.

The presentation of your solution to the Advisory Committee should include:

- A packet of information containing and outline of the suggested landfill site, including a map with the site marked, people that will be affected, local rock structure, and means to be used to prevent pollution.
- A memorandum outlining steps to reduce solid waste volume. This should include current programs used, possible programs that could be implemented, and 3 suggestions of which ideas are the most cost-effective.
- An electronic presentation highlighting suggestions to the Advisory Committee, including a brief outline of information given in the other 2 documents.
- A question and answer section to the Advisory Committee, where members may ask anyone in your group questions concerning your proposal.
- A self-evaluation form, to be completed following your meeting with the Advisory Committee, including reflections.

Assessment Instrument – PowerPoint Presentation

Criterion	Best	Mediocre	Bad
Format and Visibility	• Project contains a title page with group member names and a conclusions page. • Project is visible and readable to members of the class and Advisory Committee. • Project uses color choices that aid in readability.	• Project contains crude title and conclusion pages. • Project is not easily visible and readable to members of the class of Advisory Committee. • Project uses color choices that do not help with readability.	• Project is missing title and/or conclusion page. • Project is not visible to members of the class and Advisory Committee. • Project uses color choices that hinder readability.
Spelling and Grammar	• Project contains no spelling errors. • Project uses correct grammar.	• Project contains few spelling errors. • Project uses correct grammar in most cases.	• Project contains many spelling errors. • Project uses correct grammar on rare occasion.
Contents and Chronology	• Project contains information on both new landfill location and solid-waste reduction methods. • Project is presented in the order of: title page, landfill information, solid-waste reduction, and	• Project contains little information on landfill location and solid-waste reduction methods. • Project is presented in an order not consistent with: title page, landfill information, solid-waste reduction, and	• Project contains little to no information on landfill location and solid-waste reduction methods. • Project is presented in an order that does not reflect the requirements of the project design.

	conclusions	conclusions.	
Speech and Participation	• Group members speak in a manner that is easy to understand and is clear. • All group members actively participate during the presentation.	• Group members speak in a manner that is not easy to understand or is not clear. • Most group members actively participate during the presentation.	• Group members speak in a manner that is not easy to understand and is not clear. • Few group members actively participate during the presentation.

Assessment Instrument – Self-evaluation

Please answer the following questions about you PBL experience:

1. How did your group work together?
   A. effectively B. somewhat effectively C. ineffectively
   Reflect:

2. How well did your group members participate?
   A. all participated B. most participated C. few participated
   Reflect:

3. How would you rate your performance during the project?
   A. excellent B. average C. poor
   Reflect:

4. How would you rate your group's performance while meeting with the Advisory Committee?
   A. excellent B. average C. poor
   Reflect:

5. How would you rate your own performance while meeting with the Advisory Committee?
   A. excellent B. average C. poor
   Reflect:

6. What was the best aspect of your group's presentation?

7. What needs to be improved in your group's presentation?

8. What was the best part of this project?

9. How might this project be improved?

10. Reflect on the entire PBL experience. What skills did you learn? Did you enjoy it? Etc.

11. Please share any other comments.

Alternative Solutions

Solution 1:

- Wake County should continue to pursue the current proposed site in Holly Springs.
- Wake County should use current solid-waste reduction measures currently in place, such as recycling. The recycling program should be enforced more regularly.

Pros:

1. Approval for the site has already been granted by the state.
2. The site is easy to access.
3. No new court proceedings (new law-suits, etc.) are needed.
4. No new employees are needed to carry out plan.
5. Enforcement of recycling should increase the occurrence of recycling.
6. Rock structure of the area is great for this purpose, and should help prevent water contamination.

Cons:

1. There is no guarantee court proceedings will be done in time.
2. Waste reduction from the current recycling efforts may not be enough.
3. Difficulty for North Wake landfill employees to get to work in Holly Springs.
4. Citizens in and township of Holly Springs will be ticked off.

Consequences:

1. The economy of Holly Springs could be permanently damaged.
2. There is a possible risk of increase in disease due to added air pollution in Holly Springs.

Solution 2:

- Wake County should choose a new site not within a Wake County township. It should have a good local rock structure, and in this example, the site is named "Middle of nowhere."
- Wake County should make recycling mandatory, with the consequence of a hefty fine. Disposal of yard waste into landfills should also be stopped, and perhaps moved to a separate site for composting.

Pros:

1. Citizens in and township of Holly Springs will be quite happy.
2. Solid-waste reduction is significantly reduced.
3. Revenue will be created through fine collections.
4. "Middle of nowhere" site will tick off less people because only a few will be inconvenienced or displaced.
5. Compost could be sold to make money.
6. Site should have a rock structure conducive to landfill creation.

Cons:

1. "Middle of nowhere" site may be more difficult to access.
2. Citizens of Wake County may not like new disposal procedures or rules.
3. Money will need to be spent on new employees to enforce recycling, collect fees, run composting center.
4. Enforcing of recycling will be difficult to carry out.
5. The site will have to be approved by the state.

Consequences:

1. The site may run into legal trouble like Holly Springs, which could take even longer to solve.
2. Site could cause a large amount of traffic in a now rural area, increasing noise and air pollution.

Preferred Solution:

The preferred solution is, of course, subject to change pending a good solution presented by a group of students or proposed by someone else, etc.

For the two solutions above, I prefer Solution 2. This is because the students completing the problem have to do a lot of work to come up with the new site. They have to look at geologic maps, locate a good site based on rock structure, find out how to get the site approved, decide how to create a new recycling and composting program, etc. The solution shows that the students have covered many different issues in depth, and considered every possible solution. Though Solution 1 could

be arrived at through the same set of steps and covering of the issues, it could also be arrived at through little to no work at all.

Debriefing Instrument

Review of Student-Generated Solutions:

- To review student-generated solutions, all students will watch each group's presentation of their solution to the Advisory Committee.
- The students will be giving a PowerPoint presentation to the entire classroom, and a solution information packet and memorandum to each group for later review.

Rating of Solutions:

- To rate the solutions presented, students will use a pros, cons, consequences, rating, and justification chart, like the one shown here.

	Pros	Cons	Consequences	Rating	Justification
Solution 1					
Solution 2					
Solution 3					
Solution 4					
Solution 5					

- Each student will rate each solution presented based on what they think is the "best" solution, with one being the best, and the total number of solutions being the worst. Each rating must have some sort of justification.
- Each group will total the ratings for each solution, and a representative from each group will come and write their group's ratings on the board.

One Best Solution:

- By the time students are to generate a "best" solution, hopefully the ratings should make it clear which one or two solutions are preferred by the class.
- The teacher should coach the students to explain why they chose the best solution that they did.
- Some examples of questions to ask might be:
    - What caused Solution ___ to be the "worst" solution?
    - Why did you choose Solution ___ as the best solution?
    - Is there anything about the "best" solution that could be better?
    - Could any two solutions be combined to make a better one? How?
- Preferably, the teacher or a student volunteer will go to another board and write up the "best" solution as it is rated, then when asking the above coaching questions, the "best" solution could be changed to make it better, based on student comments and consensus.

Coaching by Teacher:

- After students have generated one "best" solution, the teacher will distribute question sheets based on concepts that the student should have learned during the PBL lesson. This sheet is enclosed at the end of this document.
- Students will discuss with their groups each of the questions, and determine if they covered the discussed topic.
- Teacher will coach students through any important issues or concepts that did not arise during the investigation of the problem.
- Some examples of questions to ask might be:
    - What geologic maps did you use for your investigation? Would a more localized map have helped in choosing a site?
    - How did you determine what rock types mattered for site choices? What types of rock do you think should be present at a landfill site? Why?
    - What are some means of reducing waste? How did your group choose the solid-waste reduction method that would work best?
    - Did you find any information about how other cites or counties reduce waste?

- What laws in North Carolina or Wake County affected your landfill placement?

Debriefing Session Student Questions

Please respond to each question based on whether or not your group obtained information about each of the following. Please answer each question honestly and thoroughly.

1. What geologic maps, if any, did you use to determine a landfill site?

2. How easy was it to obtain information from a geologic map?

3. What prior knowledge did you have to use to obtain information from a geologic map?

4. What rock types did you determine were best for landfill sites? Why?

5. What laws did you encounter from either North Carolina or Wake County that affected the placement of your landfill?

6. List all the different solid-waste reduction methods you discovered?

7. How did you determine which ones would work best?

8. Did you model your plan after a particular city or county? If so, why? If not, did you find this information?

Coaching Questions

The questions are presented in this order for each category: Cognition, Metacognition, and Epistemic Cognition.

Meeting the Problem:

1. Are you familiar with the terms given, such as landfill, solid-waste, trash, and disposal?
2. What are some resources needed to solve this problem? What are some agencies in Wake County you might contact for help with this problem?
3. How does the problem regarding solid-waste in Wake County relate to you? Could this problem affect you?

Know/Need to Know Board:

4. How do you know that solid-waste cannot be shipped to another location?
5. Why is it important for Wake County to reduce the amount of solid-waste that it generates?
6. How can you use your "need to knows" to help you decide what to research? How do your "need to knows" relate to the proposal you must give to the Advisory Committee?

Writing Problem Statements:

7. What is the deadline for your meeting with the Advisory Committee? What items must you present to them?
8. What conditions might be your priority as the _____ group? Why?
9. Will the other groups involved in this problem have the same priorities in their conditions? Should you consider their needs while coming up with a "good" solution?

Information Gathering & Sharing:

10. What are some waste reduction methods already in place in Wake County? How can you verify that?
11. Now that you know what is happening at the landfill site in Holly Springs, does that change your thinking about where your landfill should be?

12. Why is it important for the landfill to follow State and Local Landfill regulations? Are these laws necessary? Why?

Generating Possible Solutions:

13. What is the next step if you think this solution (insert solution here) is the best?
14. What method did you use for choosing this landfill site as a group? Why is it a good choice?

Will all concerned parties be happy with your landfill site and waste reduction strategies? Who might be unhappy with your solution? Why?