LES 4

O B S E R V A T O R Y
SCIENCE AND TECHNOLOGY (ST)
Teacher's Guide A
Second Year of Secondary Cycle Two

ECO-FRIENDLY BAGS

STUDENT LOG

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PROCEDURE AND EVALUATION: SSC2 – SCIENCE

Observatory / Guide
11129-A

Name: _____ Group: _____ ST

The case study

Growing pile of garbage despite recycling

Isabelle Mathieu, *Le Soleil*,
December 13, 2006

With the growing popularity of recycling and composting, you would think that we would be producing less garbage. But in Québec, the opposite is happening: the garbage heap is growing.

The amount of garbage sent to the incinerators and landfills in Saint-Tite-des-Caps and Saint-Joachim will have increased by roughly 1.7 percent in 2006, Benoît Delisle explained yesterday. Mr. Delisle was in charge of waste management for the municipal budget review.

"In our projections, we expected about 288 000 tonnes of waste. In fact, we will have received about 293 000 tonnes," said Mr. Delisle. "The amount of garbage is increasing significantly despite people's efforts to recycle and compost waste and to take hazardous materials to ecocentres."

Source: Isabelle Mathieu, "Plus de déchets malgré le recyclage," *Le Soleil* [online edition], December 13, 2006 (accessed May 2, 2008). *[Translation]*

Awareness campaign

The City of Québec will soon be distributing reusable grocery bags in all its districts in an attempt to counteract the continual increase in the amount of garbage the City collects. The bags will also be used to raise public awareness. Five recommendations on how to reduce the negative environmental impact of food packaging will be printed on one side of the bag. On the other side, a quiz will help consumers calculate the ecological footprint of their eating habits.

The City has commissioned the environmental group Green Youth to formulate the recommendations and write the quiz.

Local environmental groups foresee the benefits of the initiative and have applauded this effort by their municipal representatives.

Le Regroupement des organismes écologiques de la région de la Capitale-Nationale

November 14, 2007

In this context, you will play the role of an environmentalist.

Name: _____ Group: _____ ST

Creating the context

I ask myself questions

1. What is a raw material?

2. What is a material?

3. What types of packaging would you expect to find in a grocery store?

4. Who are the main players in the agri-food industry?

5. Who is the target audience for the recommendations you are going to write?

6. What questions should guide you in your information gathering?

Name: _____ Group: _____ ST

Creating the context (*continued*)

I must

7. Reformulate the goal of the case study.

I think

8. Do you think that different types of food packaging affect the environment? Explain your answer.

Name: _____ Group: _____ ST

Creating the context (*continued*)

What I know and what I must find out

9. Write the information you already know and the information you need to find out.

What I know	What I must find out

I prepare my work

10. Where will you find the information you need to do your work?

11. Define the main steps of your case study in chronological order.

Reflection

	Yes	No
Do I fully understand what I have to do?	☐	☐

Name: _____ Group: _____ ST

Gathering information

I do research

1. a) What is the degradation of materials?

b) What does the protection of materials involve?

2. a) What is a plastic?

b) What is a thermoplastic?

c) What are the greatest advantages of thermoplastics?

Gathering information (*continued*)

d) What is a thermosetting plastic?

e) What are the greatest advantages of thermosetting plastics?

f) What are the signs of degradation in plastics?

g) What are the main causes of degradation in plastics?

3. a) What is a ceramic?

b) What are the greatest advantages of ceramics?

Gathering information (*continued*)

c) What are the main causes of degradation in ceramics?

4. a) What is a composite?

b) Name some of the greatest advantages of composites.

c) What are the signs of degradation in composites?

5. a) What is a metal?

b) What is an alloy?

Name: _____ Group: _____ ST

Gathering information (*continued*)

c) What are the greatest advantages of metals and alloys?

d) What is the main cause of degradation in metals and alloys?

e) How can metals and alloys be protected?

6. a) What is wood?

b) What are the greatest advantages of wood?

c) What are the main causes of degradation in wood?

Name: _____ Group: _____ ST

Gathering information (*continued*)

7. What is a disturbance?

_____

_____

_____

_____

8. **a)** What materials are used to make each type of food packaging? Give two examples of food products that are packaged with each type of container.

Type of food packaging	Materials	Examples of uses
Plastic		
Glass		
Aluminum and steel		
Paper and cardboard		
Brick pack		

b) Agree with your teammates on the distribution of packaging types among team members. Remember that each team member is responsible for only one type of packaging but that the team must cover all five types.

c) Record the information that is relevant. Make sure that you cite the source of each relevant item of information you find.

Name: _____ Group: _____ ST

Gathering information (*continued*)

I apply my research results

Type of packaging chosen: _____

9. Apply what you have learned from your research by answering the following questions. Make sure that you cite your sources.

a) Name the raw materials used to make the type of packaging you are researching. Are they renewable materials? Explain your answer.

b) What are the advantages of this type of food packaging? Is using it good for the environment? Explain your answer.

Name: _____ Group: _____ ST

Gathering information (*continued*)

c) What are the disadvantages of this type of food packaging? Does using it harm the environment? If so, explain your answer.

d) What type of food requires the least energy to be brought to market?

e) What type of food requires the most packaging? individually wrapped foods? processed products? liquids? or other types of food?

f) What other information do you think is relevant?

Reflection

	Yes	No
Do I fully understand the concepts covered in this situation?	☐	☐

Name: _____ Group: _____ ST

Completing the case study

1. Share your information with your teammates. Work together to answer the following questions.

a) Who is the target audience for your awareness campaign?

b) Write your five recommendations. Remember to take your target audience into account.

Name: _____ Group: _____ ST

Completing the case study (*continued*)

c) For each of your recommendations, give an example of how it could be applied.

Reflection

	Yes	No
Have I considered other approaches?	☐	☐

Name: _____ Group: _____ ST

Validating the case study

I justify my approach

1. Justify each of your recommendations.

Name: _____ Group: _____ ST

Validating the case study (*continued*)

2. Suggest improvements to your work.

Name: _____ Group: _____ ST

My evaluation

Use the evaluation grid on the following page to evaluate yourself. Write A, B, C, D or E in the "Me" column of the chart below.

SSC2—Makes the most of his/her knowledge of science and technology				
Criteria*	Observable indicators	Me	Teacher	Comments
1	**Creating the context** Definition of the goal and description of the procedure		☐ With help	
2	**Gathering information** Selection of relevant information		☐ With help	
3	**Completing the case study** Relevance of the recommendations and examples		☐ With help	
4	**Validating the case study** Justification of the recommendations		☐ With help	

*** Evaluation criteria**

1 Formulation of appropriate questions
2 Appropriate use of scientific and technological concepts, laws, models and theories
3 Relevant explanations or solutions
4 Suitable justification of explanations, solutions, decisions or opinions

Evaluation grid

Name: _____ Group: _____

ST

SSC2 Makes the most of his/her knowledge of science and technology

Criteria*	Observable indicators	A	B	C	D	E
1	**Creating the context** Definition of the goal and description of the procedure	The goal of the case study is very clearly defined, and all of the steps in the procedure are relevant.	The goal of the case study is clearly defined, and most of the steps in the procedure are relevant.	The goal of the case study is not very clearly defined, OR some of the steps in the procedure are irrelevant.	The goal of the case study is not very clearly defined, AND some of the steps in the procedure are irrelevant.	The work must be done again.
2	**Gathering information** Selection of relevant information	All of the selected information is relevant. The advantages and disadvantages of the chosen packaging are clearly described.	Most of the selected information is relevant. Most of the advantages and disadvantages of the chosen packaging are clearly described.	Some of the selected information is relevant. Some of the advantages and disadvantages of the chosen packaging are clearly described.	The selected information is not very relevant.	The work must be done again.
3	**Completing the case study** Relevance of the recommendations and examples	All of the recommendations and examples are very clear and relevant.	Most of the recommendations and examples are clear and relevant.	Some of the recommendations and examples are clear and relevant.	The recommendations and examples are not very relevant.	The work must be done again.
4	**Validating the case study** Justification of the recommendations	The justification is relevant and very clear. All of the explanations are based on the scientific information gathered.	The justification is relevant and clear. Most of the explanations are based on the scientific information gathered.	The justification is partially relevant. Some of the explanations are based on the scientific information gathered.	The justification is not very relevant. The explanations are not based on the scientific information gathered.	The work must be done again.

*** Evaluation criteria**

1 Formulation of appropriate questions
2 Appropriate use of scientific and technological concepts, laws, models and theories
3 Relevant explanations or solutions
4 Suitable justification of explanations, solutions, decisions or opinions

Name: _____ Group: _____ ST

Unwrapping a problem

Many forms of packaging are certainly useful. They preserve and protect our food during transport and handling and provide information about the contents. They would be less necessary, however, if fewer processes and shorter distances separated producers and consumers. Our food often travels great distances, through complex systems of distribution.

The important fact to recognize about food packaging is that food is not simply packaged; it is over-packaged. Companies fill our garbage cans as they seek to enhance the visual appeal of their products. Packaging now represents advertising space, so it must stand out for the product to sell. Consumers, ecosystems and, most of all, future generations are paying the price.

DID YOU KNOW THAT…

- When packaging is included with leftover or uneaten food, kitchen waste easily represents a third of the contents of our garbage bags.[1]
- The processing and packaging involved in making a low-calorie frozen dinner amounts to a procedure in 15 steps. The energy spent on this process is 40 times greater than the food energy the dinner provides.[2]
- At 200 kg per person annually, we manufacture 80 percent more packaging today than in 1960.[3]

Although we give little value to packaging, we pay for it twice. First, at the store, where it is included in the price of our purchases, and then through our taxes, which cover the costs of waste management and environmental decontamination. In many cases, we pay more for the packaging than the price farmers receive for the fruits of their labour![4]

To evaluate the environmental cost of packaging, every step in its life cycle must be considered. We thus have to account for the following:

– the extraction of raw materials for its production
– the transportation of raw materials to the processing plant
– the transformation of raw materials
– the manufacture of the packaging
– the transportation of the packaging to the industry that will use it
– the packaging of products
– the transportation to a wholesaler
– the transportation to a retailer
– the transportation to the consumer
– the transportation of the discarded packaging to a landfill
– the cumulative impact of the packaging, once buried in a landfill, incinerated or recycled, on soil, air and water quality

The information that follows can help us evaluate the true environmental costs of the main types of food packaging. Note that most packaging is made from new materials because containers that come in direct contact with food cannot be made from recycled materials for sanitary reasons.

1. Brian Halweil, "Homegrown: The Case for Local Food in a Global Market," *Worldwatch Paper 163*, Washington: State of the World Library, November 2002, p. 21.
2. Claude Villeneuve and Suzanne Lambert, *La biosphère dans notre assiette*, Environnement Jeunesse (ENJEU), 1989.
3. Jean Robitaille and Claude Désy, *La Terre dans notre assiette*, Vol. 2, 2002, p. 4. See also Mathis Wackernagel and William Rees, *Notre empreinte écologique,* Montréal: Éditions Écosociété, 1996, p. 123.
4. Les Ami-e-s de la Terre, *Le guide vert des consommateurs*, Montréal: Libre Expression, 1991.

Unwrapping a problem (*continued*)

Paper and cardboard

Although paper and cardboard can be made from various raw materials, such as hemp, for the moment they are mostly made from timber. Our forests are turning into paper!

DID YOU KNOW THAT…

- Each year, an area of forest as large as Greece disappears from the surface of the Earth.[5] Logging, agricultural development and urban sprawl are the principal causes for this loss.
- A tonne of discarded paper represents the loss of 19 trees.[6]

Forests play an essential role in the ecological balance of the Earth. They transform carbon dioxide into oxygen and play a crucial role in the water cycle. The survival of a large number of plants, animals and other organisms is inextricably linked to forest ecosystems. Over 200 000 species—two thirds of all species found in Canada—depend on forests.[7] The forest is more than a stand of trees to be harvested; it is a habitat.

In Québec, 90 percent of the forest is public land. This means that it belongs to all of us. Many environmental organizations and trade unions agree that this publicly owned resource is being overused for the benefit of a few private companies.[8] Even the Auditor General of Québec has expressed concern in this regard, calling for tighter control of logging companies.[9]

The use of pesticides in forests and of various chemical agents in processing wood also affect human and environmental health. Although the situation has improved since the 1970s, paper mills remain a significant source of pollution. Their wastewater contains many chemicals used to produce and bleach paper.[10]

Glass

Glass is made from silica sand, sodium carbonate and lime. Secondary ingredients, such as iron sulphide, ferrochrome and cobalt, are added to colour the glass. Available in large quantities, these materials are mined in quarries all over North America. Glass is generally strong and easy to reuse, so it can be recycled indefinitely. Each tonne of recycled crushed glass saves 135 L of oil and 1.2 t of raw materials. As with all materials, however, the most environmentally friendly strategy is reduction at the source. Reusing glass containers should be a priority, whether by returning them for deposit or simply reusing them at home.

5. This equals 375 km^2 per day. United Nations Environment Programme (UNEP) [online].
6. Environment Canada [online].
7. Canadian Forest Service, *The State of Canada's Forests 1995–1996*, Ottawa: Natural Resources Canada, 1996, p. 6.
8. Coalition sur les forêts vierges nordiques, *Pour une enquête publique indépendante sur la forêt québécoise*, Paper presented to the Parliamentary Commission on the renewal of the forest regime, August 2000 [online]. The coalition represents 13 organizations, including the Centrale des syndicats du Québec (CSQ), the Fédération des producteurs de bois du Québec (FPBQ) and the Union québécoise pour la conservation de la nature (UQCN). Also see the documentary film by Richard Desjardins and Robert Monderie, *L'erreur boréale* [Forest Alert], 1999, and the essay by Pierre Dubois, *Les vrais maîtres de la forêt québécoise*, 2nd ed., Montréal: Éditions Écosociété, 2002.
9. Louis-Gilles Francoeur, "Québec contrôlera davantage les exploitants forestiers," *Le Devoir*, February 14, 2003, pp. A1 and A10. See also Christian Messier, "Des calculs qui souffrent de lacunes graves," *Le Devoir,* December 9, 2002.
10. Sierra Legal Defence Fund, "Pulping the Law: How pulp mills are ruining Canadian waters with impunity" [online report], May 15, 2001.

Unwrapping a problem (*continued*)

Plastic

Plastics are increasingly popular, but they are nonetheless made of nonrenewable resources, mainly petroleum or natural gas. The plastics used for food products account for 80 percent of all plastics produced. Although some types are recyclable, most plastics end up in landfills, where some of them take a century to degrade. Recycling plastic requires particularly expensive technology, which is barely—if at all—available in Québec. In fact, we send a lot of our recovered plastic to Ontario and the United States for recycling.

DID YOU KNOW THAT…

- Each week, Quebeckers bring home over 36 million plastic bags from the grocery store.[11]
- In Ireland, an environmental tax of about $0.25 per bag has reduced the number of bags sent to the garbage dump by 95 percent.[12]
- It takes 27 recycled mineral water bottles to make one polar fleece jacket.[13]

11. Based on 7 381 766 residents and five bags/resident.
12. Information obtained from Mathieu Guillemette, planning and research adviser, RECYC-QUÉBEC, March 4, 2003.
13. Isabelle Bourdial, "Plastiques: Des bouteilles recyclées en pull-overs," *Science & Vie* 925, October 1994, p. 111.

Aluminum

According to the Association de l'industrie de l'aluminium du Québec,[15] aluminum is the most abundant metallic element in the world because it makes up eight percent of the Earth's crust. It does not exist naturally in its pure form, however; it is usually found in the form of oxides. The source of aluminum most commonly mined is bauxite, an ore that is found especially in tropical and subtropical regions in the form of rocks or grains that vary in colour depending on their composition.

DID YOU KNOW THAT…

- Aluminum can be recycled indefinitely. Each kilogram of recycled aluminum saves eight kilograms of bauxite and four kilograms of chemicals. Recycling aluminum also saves 95 percent of the energy required to produce new metal from raw materials.[14]

A number of studies have raised questions about the environmental and social measures implemented by industries that mine bauxite in developing countries.[16] Bauxite is usually extracted from open-pit mines, which leads to deforestation, sometimes on a large scale, and to the destruction of local ecosystems.[17] Local communities often lose control over their living environment, and expropriations are common.[18] The environmental and social costs associated with bauxite are therefore high.

The environmental impact of the transportation of imported raw materials must also be considered, as well as the huge energy consumption of the major aluminum smelters. It takes an enormous amount of electricity to manufacture aluminum. Although new technology has made it possible to reduce polluting emissions from the processing plants, they still discharge highly toxic pollutants, such as dioxins and furans, into the atmosphere.

14. Association de l'industrie de l'aluminium du Québec, *L'aluminium recyclable*, 1986.
15. Association de l'industrie de l'aluminium du Québec, *L'aluminium: sa production et sa transformation*, 1986.
16. Mining Watch Canada [online].
17. Tim Clark, *Canadian Mining Companies in Latin America Community Rights and Corporate Responsibility*, Conference organized by the Centre for Research on Latin America and the Caribbean (CERLAC) of York University and by Mining Watch Canada, Toronto, May 9–11, 2002. (CERLAC Colloquia Paper, January 2003.)
18. *Ibid*.

Unwrapping a problem (*continued*)

Tin cans

Tin cans are usually made from steel coated with a thin layer of tin both inside and out. The environmental and social effects of the life cycle of tin cans are similar to those of aluminum cans, except for the long-distance transportation costs, because iron ore is mined in Canada. However, iron is heavier than aluminum, which adds to the transportation costs in a different way.

Tin cans have the advantage of being particularly easy to recover. Once recycled, they are used to manufacture building materials, for example.

Brick packs

Packaging of this type is made of three materials: paper, aluminum and plastic. The advantage of brick packs is that they preserve food for long periods of time and are light to transport. However, contrary to industry claims, brick packs are not an environmentally friendly type of packaging. Large amounts of energy are used for their production and for the transportation of all the materials that compose them. Since their appearance on the market, many thermos flasks and reusable containers have been replaced by "drink boxes," adding significantly to amounts of household waste. In Europe, some environmental groups have called for a boycott of this type of packaging to reduce its negative impact on the environment. In Québec, some municipalities accept brick packs for recycling, but this process also requires large amounts of energy.

Source: Adapted from Laure Waridel, *L'envers de l'assiette: et quelques idées pour la remettre à l'endroit*, Montréal: Les Éditions Écosociété / Environnement Jeunesse (ENJEU), 2003, pp. 24–29. *[Translation]*

Name: _____ Group: _____ ST

Plastics

The plastics industry: unlimited possibilities

The plastics industry has been experiencing a period of growth in recent years, with no sign of abatement. Plastic is gradually replacing materials such as wood, metal or glass. Its strength, versatility, durability and lightness make it ideal for a wide variety of applications, such as packaging, building, transportation (in cars), electrical appliances, furniture, sports equipment and medical equipment.

New applications and technology have been developed to design increasingly sophisticated plastics, presenting new challenges in recovery and recycling. Current waste management systems must be adapted to deal with these innovative products.

The environmental issue

Two different views

The recognized qualities of plastics have led to their widespread use in the manufacture of consumer goods. However, these same properties (such as resistance to physical and chemical factors) make them questionable from an environmental point of view. The longevity of plastics and their dispersal in the environment affect terrestrial and marine ecosystems. The manufacture of plastic products is also linked to the depletion of hydrocarbons, a nonrenewable resource. Some environmental groups have focused their attention on PVC products because they are associated with potentially toxic ingredients, such as phthalates and chlorine.

From another point of view, the Environment and Plastics Industry Council (EPIC) argues that plastic is lighter than other materials and that more products can be transported per packaging unit in plastic because of its strength. For this reason, plastic wrap and containers can be thinner. Due to its low density, manufacturing plastic requires less raw material and less energy. In addition, plastic reduces the weight of packaging for transport and consequently lowers energy consumption. The EPIC stresses that all the overall production of plastics uses less than three percent of the world's petroleum reserves.

Buried under the sea

When plastic is sent to a sanitary landfill, it remains stable and inert; in other words, it does not decompose. Consequently, plastic does not tend to affect soil quality, produce greenhouse gases or generate leachate that could contaminate groundwater. Biodegradable plastics pose a different problem. When they end up in a landfill, they can degrade in anaerobic conditions (without oxygen) and are therefore likely to produce both greenhouse gases and leachate.

Unfortunately, plastic packaging is not always recycled or even taken to a landfill. According to the *Worldwide Home Environmentalists' Network*, nearly 120 000 pieces of plastic are floating in every square kilometre of the world's oceans, causing the deaths of over a million sea birds, 100 000 marine mammals and an incalculable number of fish each year. . . .

Plastics (*continued*)

Recycling

In some cases, post-industrial waste is easier to recycle than post-consumer waste. Post-industrial waste is usually produced in large quantities and is often uncontaminated, which facilitates recycling. Post-consumer waste, on the other hand, must be collected, sorted, decontaminated and cleared of any material added for marketing purposes (labels and receipts, for example).

Once they have been collected, residential and industrial plastics are taken to sorting centres where they are separated according to resin type and bundled for transportation. When a bleach bottle, sorted with other objects made of high-density polyethylene, arrives at a recycling centre, it will undergo one of three recycling procedures:

1. Conventional or generic recycling

This method consists in returning plastic waste to a form of resin (grains, liquids, powders, flakes or pellets). The recovered material must be homogeneous, and each type of resin must be treated separately. The contents of the bundles are inspected, ground, washed and then placed briefly in a separation tank to separate the resins from contaminants. The material is then dried because even the slightest residual humidity can cause problems in the finishing stage of production. The flakes are liquefied with both heat and pressure. The resulting mixture is filtered and then cast into thin straws that will be reduced to fine grains. The grains will become the raw material for manufacturing new products. Note that containers produced by conventional recycling are never used for food products.

2. Bulk recycling

In bulk recycling, less attention is paid to the different types of resins and the degree of contamination. The basic material is made up of a mixture of plastics that are recycled without pretreatment as long as they contain no more than a certain amount of impurities. The greatest advantage of this type of recycling is the elimination of the sorting stage. The mixed plastics are liquefied and moulded directly into substitute building materials or plastic lumber.

3. Chemical and thermal recycling

Chemical and thermal procedures transform plastic waste into either monomers or petroleum. Through contact with certain chemicals (methanol or ethylene glycol), some post-consumer plastics decompose into monomers. This procedure, which is called *depolymerization*, is used especially with polyethylene terephthalate (PET). The advantage of depolymerization lies in the creation of resins that can be used to make food and drink containers (with 25 percent recycled content).

To obtain new petroleum-based substances, plastics must be heated to a temperature equivalent to the melting point of aluminum. This process is called *thermal depolymerization*. At this level of intense heat, plastics are converted into liquid petroleum products that will be refined into plastic derivatives, such as petroleum ethers and lubricants. Some recycling facilities turn plastic waste back into light gases that are burned on site.

The plastics recovery and recycling industry in Québec

The plastics recovery and recycling industry has grown considerably over the last 25 years. The number of plastics recovery services has multiplied, and there are now more than a dozen facilities for conditioning and recycling plastics in Québec. Several of these companies must bring in supplies from outside the province to meet demands for recycled material.

Plastics (*continued*)

The issues

Plastic conditioning in Québec

Conditioning (shredding, washing, granulation, pelletizing) is a step in the transformation of recycled material before it is sent to a recycling facility where it will be incorporated into various finished products. Conditioning and recycling plastics represents an important industry in Québec.

The companies that condition plastics are currently struggling with certain common problems. To solve these problems, in 2007 they created a committee called the Conseil québécois des transformateurs de matières plastiques recyclables [Québec council for processors of recyclable plastics]. The council members lobby for the improvement of the quality of plastic bundles, increased local supplies (by increasing recycling and limiting the export of bundles to Asian markets) and the mandatory integration of recycled content in finished products.

Resins that are difficult to recover

Some resins are difficult to recover because only small quantities are made available through conventional collection methods. In most cases, curbside collections focus on two main types of resins: high-density polyethylene (for example, bleach bottles) and polyethylene terephthalate (for example, water bottles). They are favoured because they are widely available, are in high demand and sell for high prices.

For other resins, such as polystyrene and low-density polyethylene, the main difficulties lie in recovery, conditioning and the development of new markets. The low density of these plastics is a barrier to profitable recycling. Significant fluctuations in the prices of certain resins have also made it difficult to maintain a constant supply of high-quality materials.

Separate treatment of resins

The conventional, and most profitable, recycling procedure for plastics requires separate treatments for each type of resin. Most conditioning and recycling facilities transform only the most profitable resins, such as high-density polyethylene (HDPE) and polyethylene terephthalate (PET).

Resins that are incompatible and difficult to distinguish

Because they are chemically incompatible, resins liquefy at different temperatures. Moreover, resins cannot be mixed together in conventional recycling because their particular molecular chains will not bond when the materials melt. If resins are mixed, the result is a fragile, breakable plastic because, theoretically, inter-molecular bonds are missing in the new material. Injecting chemical binders would help different resins hold together, but these binding substances are very expensive.

Recycling companies therefore request that sorting centres classify plastics by resin, which leads to certain difficulties in identifying them. Some sorting centres choose to sell mixtures of plastics at a lower price.

Plastics (*continued*)

Specific cases

1. Shopping bags

It is estimated that between 1.4 and 2.7 billon shopping bags (mostly plastic bags) are distributed in Québec every year. This is the equivalent of about five bags per person per week.

Nearly 6200 tonnes of plastic bags (mostly shopping bags) are recovered every year through curbside recycling programs, while about 42 000 tonnes of plastic bags, including shopping and garbage bags, are thrown in the garbage. The recycling rate is therefore 13 percent. In Québec, 21 out of 36 sorting centres, providing curbside recycling for approximately 60 percent of the population, accept plastic bags.

Plastic bags represent less than two percent of the total tonnage of waste generated every year in Québec by the residential sector. It seems then that the issue of plastic bags relates more to their value as a symbol of our consumer society and their potential effect on the environment than to their actual tonnage.

Degradable bags are offered by an increasing number of stores and are gaining popularity among consumers. Besides their dispersal throughout the natural environment and their negative impact on birds and marine wildlife, the issue of shopping bags primarily involves traditional plastic bags and degradable bags, with regard to three main problems:

- the overconsumption of shopping bags
- the impact of degradable bags on recycling
- the question of composting degradable bags

a) The overconsumption of shopping bags

The best way to reduce consumption of shopping bags is reduction at the source; in other words—no more bags! When a bag is absolutely necessary, consumers should opt for a reusable bag. Many stores have voluntarily begun to offer reusable bags to reduce the number of plastic bags they distribute. This measure has met with great success in Québec and is worth pursuing.

b) The impact of degradable bags on recycling

Sorting centres, municipalities and recovery and recycling facilities are concerned that degradable bags might undermine the quality of recycled plastics if the bags are discarded in recycling boxes. . . .

c) Can degradable bags be composted?

There are many types of degradable bags, with different properties, particularly with regard to their content in heavy metals and the rate at which they decompose.

To avoid confusion between the terms *biodegradable* and *compostable*, compostable plastic bags are now identified with the certification seal of the new Canadian certification program for compostable plastic bags, conferred by the Bureau de normalisation du Québec (BNQ), the provincial standards office.

The main objective of this program is to help consumers and other users distinguish compostable plastic bags from other degradable bags, and, ultimately, to ensure the quality of the resulting compost. The development of the certification program was financed by RECYC-QUÉBEC, the City of Montréal and other partners from the private sector. It is an initiative of the RECYC-QUÉBEC section for compostable waste. . . .

Plastics (*continued*)

How to do your part

The challenge of managing plastic waste, as with all other types of waste, is to identify ways to apply the 4R-D principles: reduction at the source, reuse, recycling and resource recovery, in that order, before resorting to disposal.

There are many ways of reducing and reusing plastic packaging and containers. For example, it is better to choose a reusable cup than a polystyrene foam cup for your coffee. When shopping, take a bag only if you really need one, and if you do, choose an environmentally friendly reusable bag. You can find other uses for plastic containers (such as yogurt containers) or plastic bags before recycling them. Contact your municipality to find out which types of plastics are accepted in your curbside collection and to learn some practical tips to ensure that the plastics you discard are recycled (for example, by rinsing containers). . . .

Source: RECYC-QUÉBEC, Centre de documentation, "Les plastiques" [online information sheet] (accessed May 2, 2008). *[Translation]*

Name: _____ Group: _____ ST

Glass

The context

Different types of glass, all infinitely recyclable

Nothing is lost, nothing is created—as long as glass is pure and properly sorted. Glass, excluding those types that contain lead, is distinctive in that it can be recycled indefinitely. It keeps its properties when it is reused to manufacture products similar to its source product. But before we even think of recycling, we should use glass containers as many times as possible. One striking example of reuse is beer bottles, which are washed and refilled 20 times before they are recycled.

The raw material for glassmaking is always silica sand, an inexhaustible resource. However, there are many kinds of glass, so they must be classified before they can be recycled. One type of glass is the hollow glass used especially by the food industry for bottles and jars. Once recovered, this type of glass is divided into four categories: green glass, brown glass, colourless glass (also called *clear glass*) or mixed glass. Another type is flat glass, which is used to make windows, including car and store windows. There is also a wide range of specialized glasses, which are resistant to chemicals, heat or microwaves. Finally, optical glass is used in cameras, telescopes, microscopes, binoculars, glasses and other optical instruments.

The recycling of each of these types of glass is managed in a specific way. This information sheet deals with the recovery and recycling of hollow glass.

A history that goes back 14 000 years

Nature was the first glassmaker. The Egyptians sculpted their beds from a volcanic rock called *obsidian* 12 000 years BCE. The first glass shaped by human hands dates back to around 7000 BCE, but the first glass vase (similar to modern-day vases) was not made until 1500 BCE. The first fruit jars were luxury items in affluent English homes of the mid-19th century. Finally, glass production was industrialized in 1903, with the invention of an automatic glass-blowing machine by Michael Owens. The machine opened the way to high-speed production of containers of uniform weight, size and capacity.

Glass (*continued*)

The environmental issue

Eliminating glass: eliminating resources

Glass is an inert material with no negative impact on the environment when it is buried in landfills, apart from the space it takes up. However, manufacturing glass from recovered waste results in a significant net gain of energy (up to over 30 percent in some cases) and avoids some of the environmental risks associated with glassmaking from raw materials. Recycling one glass bottle saves enough energy to light a 100-W bulb for four hours![1]

RESOURCE SAVINGS AND WASTE REDUCTION ACHIEVED BY RECYCLING GLASS

Energy or waste	Reduction (%)
Energy used	4–32
Air pollution	20
Water pollution	N/A
Mine tailings	80
Water used	50

Source: C. Pollock, "Mining Urban Waste: The Potential for Recycling," *World Watch Paper 76*, 1987.

Recovery

Glass recovery

AMOUNTS OF GLASS WASTE, POLICY[2] TARGETS AND QUÉBEC RECOVERY RATES IN 2006

Sector	Potential amount (tonnes)	2008 objectives (%)	Target (tonnes)	Amount recovered	
				(tonnes)	(%)
Curbside collection	147 000	60	88 000	59 000	40
Deposit-bearing non-refillable containers	29 000	80	23 000	22 000	77
ICI[3]	70 000	95	67 000	36 000	51
Total	**246 000**	**70**	**185 000**	**117 000**	**44**

1. Glass Works, sponsored by Consumer Glass.
2. *Québec Residual Materials Management Policy, 1998–2008.*
3. Industrial, commercial and institutional sector.

Glass (*continued*)

Recycling

How glass is recycled: washing, crushing, melting and remoulding

Once glass has been collected and sorted by type and colour, it is conditioned, which means that it is carefully cleaned and ground into particles. Special equipment is needed to sort glass and especially to remove any contaminants that could hinder recycling (metal, ceramics, food, porcelain, crystal, paint, etc.). If different types of glass are mixed together, the quality of the recycled product will be compromised, and the processing equipment may not work. For example, if hollow glass is mixed with Pyrex glass, streaks of colour appear on the sides of the finished products.

Finely crushed glass, called *cullet*, is mixed with sand, lime and sodium carbonate, melted in an oven and then moulded into a new product. The higher the proportion of cullet in the new glass, the more pure (completely free of contaminants) the cullet must be. . . .

The glass recovery and recycling industry in Québec

Québec is home to nearly 50 glass recovery facilities, including 36 sorting centres, mostly located in the Montréal area and in Montérégie. There are also about 10 companies that recycle glass in the province, again mostly in the Montréal area.

How to do your part

Clean bottles

Putting a bottle in your blue box is a good idea; putting a *clean* bottle in the box is even better! Rinsing bottles before you return them to the store makes a big difference for recycling companies. If rinsing bottles seems like too much work, at least do not use your empty bottles as ashtrays or mini-garbage cans. There is no need to remove paper or plastic labels, however; the labels burn off during recycling. If you really wish to remove something, concentrate instead on the metal or plastic caps. Your recycler will thank you!

Source: RECYC-QUEBEC, Centre de documentation, "Le verre" [online information sheet] (accessed May 2, 2008). *[Translation]*

Name: _____ Group: _____ ST

Metals

The environmental issue

The fragile state of metals

Landfills are extremely acidic and humid—ideal conditions for the formation of rust on ferrous metals. A heavy concentration of iron oxides is not good for the environment, but since they occur in considerable amounts in nature, it seems safe to assume that they do not represent a serious threat.

Nonferrous metals are equally fragile. In their common metallic form, copper, lead and aluminum are stable and do not decompose. However, when placed in a highly acidic environment, they turn into salts that are harmful to humans and wildlife.

During incineration, the noncombustible nature of metals must be taken into account: they melt and mix with the ashes, absorbing heat and hindering the combustion of other waste.

A new world record in steel production in 2005

According to the latest statistics from the International Iron and Steel Institute, 1129.4 million megatonnes (Mt) of raw steel were produced in 2005, an increase of 5.9 percent over production in 2004.

China has seen the highest increase—over 69 Mt, or more than 24.6 percent—for a total production of 349.4 Mt. China's contribution to the global production of steel has increased from 26.3 percent in 2004 to 30.9 percent in 2005.

North America registered a drop of 7 Mt, or 5.3 percent, for a total production of 127 Mt.

Retrieved from Dechetcom, January 27, 2006. *[Translation]*

Recovery

Limited disposal thanks to widespread recovery

. . . Metal waste is recovered by three main networks. The industrial, commercial and institutional (ICI) sector is served by private businesses that market different kinds of metal waste. The metal fetches a good price on the market, and recovery is a well-established practice. Second, curbside collections of recyclable materials are managed at the municipal level. Finally, all consumers can claim deposits on non-refillable beer and soft-drink cans. The ICI sector is the largest producer of metal waste, but it is also the biggest recycler, recovering 98 percent of all recycled metal. The remaining two percent comes from the municipal sector and is divided almost equally between curbside collections and cans returned for deposit. . . .

Metals (*continued*)

The Québec Residual Materials Management Policy

The Québec Residual Materials Management Policy, *1998-2008* set specific recovery goals:

- 95 percent of metal waste generated by regular industrial, commercial and institutional activities (The current rate is 87 percent.)
- 60 percent of household ferrous and nonferrous metals (The current rate is 16 percent.)
- 80 percent of non-refillable beer and soft-drink cans marked "Return for deposit" (The current rate is 74 percent.)

. . . Soft-drink bottlers and breweries have signed agreements with RECYC-QUÉBEC regarding deposits on non-refillable containers. The agreements target soft drinks and beer sold in aluminum cans. A deposit of 5 or 20 cents (depending on the volume of the can) is collected at the time of sale and refunded to clients when they return the cans.

AMOUNTS OF METAL WASTE, POLICY TARGETS AND QUÉBEC RECOVERY RATES IN 2004

Sector	Potential amount (tonnes)	2008 objective (%)	Target (tonnes)	Amount recovered (tonnes)	Recovery rate (%)
Curbside collection	82 000	60	49 200	13 000	16
Deposit-bearing non-refillable containers	14 000	80	11 200	10 300	74
ICI	1 600 000	95	1 520 000	1 391 700	87
CRD[1]	46 000	60	27 600	Ind.[2]	Ind.
Total	**1 742 000**	**93**	**1 608 000**	**1 415 000**	**81**

1. Construction, renovation and demolition sector.
2. The amount of metal recovered by the CRD sector is included in the amount for the ICI sector.

Recycling

Metals can be recycled indefinitely

Recycling metals is profitable because it takes less energy than producing metal from raw materials. The energy saved each year by recycling in the international steel industry is equal to the annual power needs of 18 million families.[3] Saving raw materials reduces mining operations, refining and transportation. For example, each tonne of recycled steel saves 1135 kg of iron ore, 635 kg of coke (coal) and 54 kg of limestone.[4] Finally, recycling slows mine development, which often disrupts landscapes and ecosystems.

3. Steel Recycling Institute, August 2004.
4. Canadian Steel Producers Association.

Metals (*continued*)

Metals must be separated and carefully decontaminated before recycling. It is important for the metals to be properly sorted and free of any foreign matter or dangerous substances in order to achieve a high-quality product. . . .

Better sorting to protect the environment

If any complex products, such as batteries and electric or electronic materials containing heavy metals (lead, chromium, cadmium and mercury), end up among recycled metals, the resulting emissions may contain contaminants. . . .

Recent improvements and future possibilities

New technologies

Despite the high rate of metal recovery (over 80 percent), significant amounts are still thrown out. Identifying new sources of supply will create further opportunities in metal recovery and recycling. The development of new treatment procedures with electric and electronic equipment will also offer interesting possibilities for resource recovery. . . .

How to do your part

Returning aluminum cans to the store and putting all aluminum and ferrous metal products in your blue box are two small steps that can make a big difference for the environment. For large objects, contact your municipality to find out when the next collection will be or call a scrap metal collector. You can find the scrap metal collector closest to you by consulting commercial directories under *scrap sales, used steel, scrap metal,* or *recycling*.

Many furniture stores offer a free recovery service for old electrical appliances when you buy a new one. Waste sorting and recovery centres and secondhand stores will also accept metal objects to repair and resell them.

Source: RECYC-QUEBEC, Centre de documentation, "Les métaux" [online information sheet] (accessed May 2, 2008). *[Translation]*

Name: _____ Group: _____ ST

Paper and cardboard

The context

Recycled in Québec, delivered all over the world

Canada is the world's leading producer and exporter of newsprint, and Québec supplies 46 percent of its production. This type of paper represents a fraction of all pulp and paper production, an industry that employs almost 30 000 people. Paper mills, which are found in every region of Québec except Laval, produced nearly 10 million tonnes of pulp, paper and cardboard in 2006, an increase of two percent since 2003.[1]

Glossy or matt paper, corrugated or flat cardboard . . . paper and cardboard products are all made from cellulose, a raw material extracted from trees. However, in recent years the industry has changed its source of supply. Instead of freshly cut trees, it draws on material from the wood processing industry. Today, over 60 percent of paper and cardboard is made from wood chips and scrap wood from sawmills—materials that were once considered garbage. Recycled fibres often represent over 20 percent of the supply, depending on it eventual use.

Paper and cardboard represent 20 percent of household waste in Québec; they rank second after compostable materials, which count for 44 percent of waste.[2] In 2006, a little over half of paper waste was recovered and used rather than thrown out. According to the Paper Recycling Association, the Canadian pulp and paper industry recycled approximately 49 percent of all paper and cardboard used in Canada in 2006 into new products.

TABLE 1: Categories of recyclable paper and cardboard

Type	Description
Corrugated cardboard	Material used for containers and other corrugated cardboard products, especially boxes
Boxboard	Containers of solid fibre, such as cereal boxes, shoe boxes and packaging for dry goods. The category also includes folding paper cartons, setup boxes and similar boxboard products.
Newspapers	Newspapers, special news (for example, de-inked newspaper), unsold newspapers and white blank news
Office paper	Dry paper, usually from offices, including printouts that are mostly white and coloured paper without mechanical pulp
Kraft paper	Kraft paper and kraft paper bags from supermarkets and industrial or commercial facilities. They must be sorted to eliminate plastic and wax.
Mixed paper	A mixture of various qualities of paper, not limited to type of packing or fibre content
Magazines	Dry coated magazines, catalogues, coated mechanical sections, mixed mechanical sections and flyleaf shavings
Pulp substitutes	Unprinted bleached papers and cardboard
Other fibres	Specialty papers such as glassine, carbon paper and paper with wet strength, poly-coatings, hot-melt glue, etc.

1. Québec Forest Industry Council.
2. RECYC-QUÉBEC, *Caractérisation des matières résiduelles du secteur résidentiel au Québec 2006–2007,* 2007.

Paper and cardboard (*continued*)

Recovery

A recycling box full of paper

Even if we recycle little paper compared to the total amount produced, paper still takes up a lot of space in our recycling boxes. About 65 percent of the contents of a typical family's recycling box is paper and cardboard.[3] . . .

Recycling

Recycling paper: a long history

Even though recycling is new to some cities, the tradition of recycling in the Canadian paper industry dates back nearly 200 years. In 1805, linen and cotton rags were recovered in Montréal and Québec and sent to Canada's first paper mill, in Saint-André-d'Argenteuil, Québec, to produce newsprint and wrapping paper.[4] Almost two centuries later, the Canadian pulp and paper industry invested over 1.7 billion dollars in research and development between 1989 and 1998, with the intention of manufacturing paper and packaging from recycled fibres.[5]

In addition to protecting forest resources, recycling paper and cardboard represents a 25-percent net gain in energy resources and circumvents certain environmental risks associated with manufacturing paper from raw materials. The considerable effort made to recycle pulp and paper has relieved some of the pressure on Québec forests. The table below shows the amounts of paper and cardboard recycled by Québec mills. After newsprint, corrugated cardboard is the most commonly recycled product.

TABLE 6: Amounts of paper and cardboard recycled by Québec mills, 1996–2006 (thousand tonnes)

Category	1996	1998	2000	2002	2004	2006
Boxboard	13	13	12	39	22	28
Corrugated cardboard	425	391	459	512	546	627
High-quality white paper	319	342	385	391	400	411
Computer and office paper	9	10	13	10	6	4
Newsprint	500	517	697	926	919	897
Mixed paper	49	46	46	42	31	43
Magazine paper	118	134	150	91	134	153
Other fibres	91	115	102	84	73	49
Total	**1524**	**1568**	**1864**	**2095**	**2131**	**2212**

Source: Pulp and Paper Products Council.

3. RECYC-QUÉBEC, *Caractérisation des matières résiduelles du secteur résidentiel au Québec 2006–2007,* 2007.
4. Canadian Forest Products Association, 2004.
5. Pulp and Paper Products Council (PPPC).

Paper and cardboard (*continued*)

American laws require recycled content

Finished paper and cardboard products almost always have some recycled content. Canadian and Québec producers of packaging and printed materials require a percentage of recycled material, out of concern for the environment, while their American counterparts are required by law to incorporate recycled content in their products. For example, in California, newsprint had to contain 25 percent recycled content in 1992. The required proportion went up to 60 percent in 2000. Paper recovered in Québec and Canada thus benefits from the good intentions of local producers and from legislation that leads to massive exports (75 percent in 2006) to American markets. Without a doubt, the paper industry in Québec is one of the major partners in the Québec and Canadian recycling industry.

The paper and cardboard recovery and recycling industry in Québec

There are nearly 150 paper and cardboard recovery companies in Québec, some of which collect only paper and cardboard and others, such as sorting centres and eco-centres, which recover these fibres among other types of waste. More than a quarter of these operators are in Montréal and Montérégie, and about 30 others are in the Québec area and the region of Chaudière-Appalaches. Over 30 paper and cardboard recycling companies operate throughout the province. More than half of them are concentrated in the Estrie, Montérégie and Centre-du-Québec regions and in the Montréal area. The Centre-du-Québec region alone is home to one fifth of all the province's recycling operations.

The toxicity of ink in recycling

From an environmental point of view, recycling printed paper, which represents the largest part of recovered post-consumer paper and cardboard, entails some problems that may, in some cases, exceed the disadvantages of traditional waste treatment, such as disposal.[6] Even if printed paper can be recycled as is for future uses, such as the manufacture of cellulose insulation and other building materials, it must be de-inked if it is fine paper or new newsprint. Almost 30 percent of paper waste is not recyclable and remains, after treatment, as de-inking sludge, a toxic cocktail of bioaccumulable heavy metals from the inks and organo-chlorines generated by the bleaching process. In 2005, 1.7 million tonnes (wet weight) of mixed sludge (including de-inking sludge) were produced. A little over a third of such sludge is sent to landfills, almost 25 percent is incinerated, and over a quarter is reused in the agricultural sector.[7]

6. A. Rajotte, "Dossier environnement," *L'ingénieur,* August 1994.
7. Québec, Ministère du Développement durable, de l'Environnement et des Parcs, *Bilan annuel de conformité environnementale – Secteur des pâtes et papiers*, 2005.

Paper and cardboard (*continued*)

The newsprint, cardboard and pulp that Québec exports in large quantities to the United States must include recycled content to respect American laws. To meet this requirement, the paper industry in Québec imports large amounts of recovered paper waste because the amount collected in Québec is insufficient. However, the de-inking sludge generated by paper production remains on Québec land, where it must be treated. Better ways of managing toxic sludge must be found.

Recent improvements and future possibilities

Vegetable inks or a use for de-inking sludge

Fortunately, the increasingly widespread use of vegetable inks is reducing the toxicity of sludge, which can be returned to the earth through application on farmland. In addition, traditional de-inking sludge can be used as an impermeable layer when closing sanitary landfills or covering abandoned mines. Research is underway to explore these avenues of development. . . .

Source: RECYC-QUÉBEC, Centre de documentation, "Les papiers et les cartons" [online information sheet] (accessed May 2, 2008). *[Translation]*

Name: _____ Group: _____ ST

Brick packs

Brick packs preserve food products such as milk, fruit juice, tomatoes, soups, sauces, tofu, soy drinks, and wine. The containers are made of six superimposed layers composed of the following three materials:

- paper (75 percent), for stiffness and strength
- plastic (polyethylene—20 percent), for watertightness and protection from microorganisms in the surrounding air
- aluminum foil (5 percent), to stop flavours and aromas from deteriorating and keep out air, light and anything else that could degrade the food

These containers, made of high-quality new pulp, are excellent raw materials for the paper mills that recycle them. In Canada, the fibres obtained from recycling brick packs are used to manufacture various products, such as tissues, paper towels, boxes, boxboard or the white outer covering of drywall panels.

Plastic recyclers recover and recycle the plastic and aluminum by combining these two materials and transforming them into pails and plant pots. . . .

Source: Adapted from Nieves Di Gianni, *Bulletin d'information du Collège de Rosemont* [online edition] XXXIV, 25, March 24, 2008 (accessed May 2, 2008). *[Translation]*

Name: _____ Group: _____ ST

Ecological footprints

Most of the tests used to calculate an individual's ecological footprint are divided into sections that correspond to the main categories of human activity: food, housing, transportation, waste, etc. The following questions are examples of questions that could appear in the *Housing* section of a qualitative evaluation of a person's ecological footprint.

1. **What type of home do you live in?**
   - **a)** Apartment or condominium 1
   - **b)** Townhouse 2
   - **c)** Single-family house 3
2. **How many people live in your home?**
   - **a)** 5 or more 1
   - **b)** 4 2
   - **c)** 2 4
   - **d)** 3 3
   - **e)** 1 5
3. **What type of energy is used to heat your home?**
   - **a)** Renewable energy (solar, wind, geothermal, etc.) 1
   - **b)** Hydroelectricity 2
   - **c)** Natural gas 3
   - **d)** Fuel oil 4
   - **e)** Wood 5

As you can see, the fewer points you collect, the smaller your ecological footprint is. For example, people who live in a condominium or an apartment have smaller ecological footprints than people who live in a single-family house, because they use less energy to heat their homes. On the other hand, if they use wood for heating, their footprints will be bigger because burning wood causes a lot of pollution and greenhouse gases and is not very energy-efficient.

Can the planet provide for everyone?

A person's ecological footprint is usually measured in hectares per year. How many hectares does it take to provide individuals with wheat to make flour for their daily bread for 365 days? or to feed the animals that end up on their plates over the same period? How many hectares does it take to grow the fruit they eat, the tea or coffee they drink, the cotton in their shirts, the wood to heat their homes? Not to mention the energy they burn for transportation and the area of land it takes to absorb the waste they produce and decontaminate the water they use.

The total virtual area calculated by adding up all these hectares is proportional to an individual's overall consumption, including every aspect of his or her life (food, clothing, travel, entertainment, etc.). . . .

Source: Hubert Reeves and associates, "Soyez D.D.D," *Journal de Montréal* [online edition], April 13, 2008 (accessed May 2, 2008). *[Translation]*