***Note:** The following activity and information provided about landfills and landfill design is basic in content and may not reflect specific requirements for your or any other locality. For laws and regulations on landfilling in your area, please contact your local regulatory authority, the Department of Environmental Protection (DEP), or the Environmental Protection Agency (EPA).*

ACTIVITY: LANDFILLS

School--or work--is over for the day. You come home and you're hungry! You open the refrigerator and what do you find? Quite a selection - bread, cheese, sandwich meats, orange juice, soda, apples, and cookies.

But for each of the above items you remove from the refrigerator, you take out more than just something to eat. You are also taking out…

- the plastic bag holding the bread
- the wrapping from around the cheese
- the foil that is covering the meat
- the carton holding the orange juice
- the aluminum soda can
- the apple cores and stems
- the cardboard box and plastic cookie tray

All of these materials - plastic, cardboard, aluminum, food remains - become waste when you no longer need them. But will throwing your waste into the trash simply make it disappear? Unfortunately not.

In your neighborhood, you may be required to *recycle* - to separate items that can be reused (aluminum, glass, some plastics, newspapers, etc.) from those that cannot be reused. The items that are reusable are placed into special recycling bins to either be picked up by a company that will process your recyclables, or you may be required to take your recyclables to a recycling center. These recyclables will then be made into something new - new aluminum cans, new glass bottles, new plastic containers, and into many other objects, as well.

What objects do you see that are, or can be, made of recycled materials…

- in your classroom?
- in the cafeteria?
- at home?
- in the park?
- in the store?

Most items that can be recycled are stamped with a special symbol. Draw a picture of a commonly used symbol that means something was made from recycled materials or that it can be recycled.

The items you place in your household trash that are not reusable will be picked up by a waste management company using a garbage truck. When it reaches the waste management facility, some of your trash may be burned (incinerated) and the energy produced will be used as fuel. But most of your trash will be placed into a landfill.

What is a landfill?

A landfill is a low area of land that is filled with alternating layers of waste and soil.

Why do we need landfills?

We need landfills because we cannot recycle or incinerate all of the waste that we generate, and a landfill is a place to put this non-reusable waste.

Can anything be put into a landfill?

No.

Hazardous waste (dangerous chemicals and other substances that are unsafe) is not allowed in a landfill.

What do you think are some examples of hazardous waste?

Materials that can be recycled should not be dumped into landfills.

Are you required to recycle in your neighborhood?

What items are recyclable where you live?

Fruit and vegetable scraps, leaves and grass should not be placed into a landfill. In what ways can they be used?

How many kinds of landfills are there?

There are many types of landfills, but the most common are:

Municipal Solid Waste (MSW) Landfills

These landfills are designed to hold waste from homes, businesses, and schools. Almost any type of waste can be put into an MSW landfill. Food waste, glass, metal, paper, plastic, furniture and tires are examples of waste that is acceptable. Large appliances may also be placed into an MSW landfill, as long as they do not contain any hazardous materials.

Waste that cannot be placed into an MSW landfill would be hazardous waste or waste that is considered recyclable. Example: A refrigerator that still contains its cooling fluid (freon) cannot be placed into an MSW landfill until the freon is safely removed.

Construction and Demolition Landfills (C&D)

C&D landfills are designed to hold construction waste, such as lumber, insulation, roofing shingles, glass, steel, concrete - anything non-hazardous that is used for construction, or that is the result of demolition. Waste that is placed into MSW landfills may also be placed into C&D landfills.

Many items that are used in the construction of roads and buildings are recyclable, such as lumber, concrete and asphalt, and they should be recycled whenever possible instead of placing them into a landfill.

Industrial Landfills

Factories and manufacturing plants will often build an industrial landfill at their business location. An industrial landfill would be used to dispose of waste from the factory or plant, such as metals and casting molds (the engine in your car would be made in a casting mold).

Many items that are used in factories and manufacturing plants are recycled in-house instead of placing them into a landfill. Most of the hazardous waste generated by a manufacturing plant or factory remains at the site. It is treated to make it non-hazardous and reused or placed in storage.

LET'S SEE WHAT'S INVOLVED IF YOU WANT TO BUILD A MUNICIPAL SOLID WASTE (MSW) LANDFILL NEAR YOUR NEIGHBORHOOD…

It is important to know about landfills -- why we use them and how they are used. If you are planning to build a landfill, you have to do a lot of research. So, the first thing you need to do is find out exactly ***WHAT*** you need to do.

YOUR FIRST STEPS

There are several steps required before you can build a landfill. The first three will be to:

1. Collect data (information) about the soil and the land in your area.
2. Find a specific location that is acceptable for a landfill.
3. Tell the public what you want to do.

1. Collecting Data

There are many types of maps, photographs and reports that are used to collect data about an area where you want to build a landfill.

Maps:

Topographic Map - This type of map shows the high and low areas of the ground. It also shows how water moves through the soil, and where the streams and wetlands are located.

Soil Map - This kind of map is usually used by farmers. It shows the kind of soils that are near the surface of the land.

Land Use Map - This map shows different "zones," areas where there are restrictions as to the use of the land. For instance, an area that is covered with trees might not be able to be cleared and used for a landfill.

Transportation Map - A transportation map is used to show roads, railroad lines and airports. It also is used for finding out the direction and distance for transporting loads of waste from one location to another.

Water Use Map - Water use maps are used to show wells (holes made into the earth to reach and hold water), how much liquid each well can hold, and water supply lines (pipes that carry water from one location to another).

Flood Plain Map - This type of map shows areas near major rivers that flood with water.

Geologic Map - Geologic maps show the features of the land and soil. They also indicate the different kinds of soil in a particular area, such as layers of clay and sand.

Pictures: 

Aerial Photographs - These photographs are taken by cameras that are mounted in an aircraft, and are used to show where a potential landfill would be built. The pictures will show the landscape, lakes and streams - the entire surrounding area where you would like to build a landfill.

Reports: 

Waste Type Report - A waste type report identifies the type of waste that is available in the surrounding area, and the kind of waste that will be allowed in a particular landfill. The type of waste you are allowed to place into the landfill will determine the design of the landfill.

Waste Volume Report - This report estimates the amount of waste that is generated in an area. The area will be where you would get the waste for your landfill, such as a particular neighborhood or part of a city.

Landfill Volume - This report estimates the amount of waste and cover (cover is usually soil that is spread over the top of the garbage every day) that will be placed into the landfill.

Landfill Equipment - A landfill operator must find out what kind of equipment would be required to operate his landfill. Also, the type of waste coming into the landfill will determine if special trucks for hauling would be required.

Recycling and Incineration (burn waste to ashes) - Recycling and incineration are two methods that cut down the amount of waste that is put into a landfill. A landfill operator will need to know if recycling or incineration is required for certain kinds of waste. If you incinerate waste, the ash that remains may be placed into a landfill as waste.

2. Finding a Location

Regulatory agencies provide strict rules about where landfills *cannot* be sited (located). In many cases, they cannot be sited close to:

- Lakes or ponds
- Rivers
- Flood plains
- Highways
- Public parks
- Critical habitat areas (where endangered species live)
- Wetlands
- Airports
- Water supply wells

If a landfill was built near one of these locations, what problems might be occurring?

3. Informing The Public

Your family, friends, neighbors and people living in and around your town should be informed if, and where, a landfill might be sited in their area. This information will allow them to understand what you are doing, and it gives them the chance to express their concerns. The dangers and benefits of a landfill, noise, dust, odors and increased traffic on the roads will need to be discussed.

List 3 reasons why you would not want to have a landfill in your area.

If you were planning to build a landfill, how would you address these concerns?

SELECTING A LANDFILL SITE

After you review all the maps and reports that you used in your collection of data, you will select one or two possible sites for your landfill. You will then hire professionals to perform detailed studies (investigations) of the locations you chose.

Two studies that are usually required are:

1. On Site Geotechnical Investigation. This investigation is used to get data about the different layers of soil at a site. A map of the water underground will also be prepared. The geotechnical investigation will include:

a. Subsoil Investigation. Samples of soil underground will need to be collected. The information generated from this investigation includes: the thickness of each layer of soil, the size of the soil grains, if there are any cracks in the layers of clay, how much natural moisture is present, and where the bedrock is located.

b. Seismic Hazard Investigation. When earthquakes occur, the ground will often move. A seismic hazard investigation is used to determine if, during an earthquake, movement of the soil located at the very bottom of a landfill would make the base of the landfill settle (drop) further into the earth.

2. Borrow Source Investigation. This study is a drawing that will show the layers and types of soil you will place in and around the landfill. Generally, you "borrow" soils from other "sources" to use in your landfill.

Following are types of borrowed sources and how they are used in a landfill:

Clay Clay is composed of very fine particles. It is used as a primary liner (used at the base of the landfill) or secondary liner (used as a special layer on top of a man-made liner) in a landfill. Clay is also used as a barrier layer on top of the landfill. Certain kinds of plastic or man-made textiles may be used as liners instead of or in addition to clay.

Sand Sand is a loose granular material that results from the disintegration of rocks. It is used for drainage or to cover a layer of clay. Sand is usually placed on top of the liner that is used at the bottom of the landfill. Pea gravel (pebbles as small as peas) is often used along the liner on the side of the landfill, since it won't wash away as easily as sand.

Silty Soil Silty soil is a mixture of loose materials - rock particles, sand and clay. It is used as a protective layer over the final cover of clay on top of a landfill. It is also used for berms (mounds of soil encircling a landfill).

Topsoil Topsoil is surface dirt that includes organic matter (decomposed plants and animals). It is used for the top layer of the final cover on a landfill. Vegetation is placed over topsoil.

There are three types of "covers" used in a landfill.

On the attached Final Cover diagram, identify where the above-referenced soils are used in a final landfill cover, layering them correctly.

FEASIBILITY REPORT

The professionals you hire to investigate your sites will complete a feasibility report for each site. These reports will indicate if the sites you chose can be used as landfills, and they will also indicate what type of waste can be disposed in each landfill.

The type of information that is provided in the feasibility report is:

1. Geotechnical Information. This is a detailed description of the soil and rocks, and a drawing of the topography (high and low areas of the ground).

2. Hydrogeology Information. This report details the water that is flowing underground - how deep the water is under the surface, the direction in which the water flows, and how the water flows (gradients, divides, etc.).

3. *Environmental Impact.* A study must be done to determine what will happen if a landfill is placed on a particular piece of land.

- How will it affect the plants?
- How will it affect the animals?
- How will it affect the water under the ground (groundwater)?
- How will it affect the water on top of the ground?
- How will it affect the air directly above the landfill?
- How will it affect the air in the surrounding area?

4. *Conceptual Design.* A drawing of the landfill should be included in the feasibility report. It will show:

- How deep the landfill will be.
- How much the landfill will hold.
- The type of liner that will be used at the bottom of the landfill.
- The kind of material that will be used for the liner.
- The system that will be used to remove leachate (liquids that drain out of or accumulate in the landfill).
- Where the leachate will be stored and treated.
- How you will keep most of the landfill gas from escaping into the air.
- The final design of the landfill cover (the purpose of using a cover is to limit the amount of water that will seep into a landfill).
- What the final use of the landfill will be and how it will look. (Will it simply be covered with grass or used as a park or other recreational facility?)
- How the water that accumulates on the top of and around the landfill will be drained away from the landfill (stormwater drainage; rain, melting snow, etc.)

5. *Have a Contingency Plan.* You should include some type of plan detailing what you would do if something should go wrong with your landfill. An example might be to list the steps you would take if the groundwater near your landfill was starting to change.

What could happen to the groundwater under and around your landfill?

In what ways could you deal with these problems?

What other problems besides groundwater contamination could occur at your landfill and how would you solve them?

It is important to keep in mind that the main environmental threat of a landfill is water pollution, and we have covered many very important issues that need to be dealt with in order to make a landfill safe.

BUILDING YOUR LANDFILL

The town has not objected to your building a landfill nearby. And based on the feasibility reports that were prepared, the regulatory authority will permit you to build a municipal solid waste (MSW) landfill on one of the sites you chose. Remember, an MSW landfill is the landfill that is used most often to receive waste from your home, hotels, restaurants, schools and office buildings.

In your MSW landfill, you will be placing general waste (such as food waste and miscellaneous glass, metal, paper and plastics), and since your neighborhood recycles aluminum cans, glass bottles, newspapers, office paper and cardboard boxes, you may not place these items into your landfill. They must be picked up by or taken to a recycling facility. Leaves, grass clippings and other yard debris may not be placed into your landfill.

Now you can start building your landfill.

Today's landfills are designed to contain and isolate waste in ways that protect the environment. You must keep in mind, therefore, that safety is your number one concern:

- The waste contained in your landfill will need to be properly separated from the water and soil around it.

- You will need a drainage and treatment system to remove the rainwater and other liquids that accumulate inside the landfill liner (leachate), as well as handle any water run-off from the surface of your landfill.

- You will need to have groundwater monitoring wells placed around your landfill so that technicians can check the groundwater for possible changes and contamination.

- You must be concerned with the strong odorous gases (mainly methane) that are generated from the deterioration of the waste in your landfill. Some landfills have the capability to collect the gas and make it available for use as a commercial fuel.

You must also think about how you will keep the trash in your landfill from blowing onto your neighbor's property, as well as keep the landfill from out of view. Berms are used to encircle landfills, and are covered with topsoil and vegetation (usually grass) as soon as they are built. The vegetation is required to keep the surface from eroding (washing away) due to rain or the freezing and thawing of the soil. Tall fences and rows of trees are also used to surround the landfill to keep out people and animals, and to keep the trash from blowing away. Birds must also be controlled and kept away from the landfill.

Trucks and other vehicles leaving the landfill are not allowed to spread waste onto the roads or the surrounding area. Tires may need to be washed before the vehicles leave the landfill, or roads made of coarse gravel or surfaced with "rumble strips" could be used to help remove debris that is stuck onto the tires.

Name two methods that could be used to keep birds away from your landfill without harming them or the environment around your landfill, or by creating a disturbance to your neighbors.

As far as the management of your MSW landfill, the basic daily routine goes like this:

1. Municipal solid waste is picked up by a trash truck throughout a designated neighborhood. The driver will write each trip in a log and assign a number, writing the date, the route where he picked up the waste, and type of waste picked up. By doing this, he is identifying the "waste stream" and this information becomes part of the landfill records.

2. Trucks carrying loads of waste enter the landfill, and the trash is unloaded at only *one* designated area at a time. The trash is never dumped from over the edge of the landfill.

3. A bulldozer is usually used to spread, compact and level out the pile of waste. (Other specialty equipment can be used, as well.)

4. At the end of the day, soil (or other daily cover) is spread over the waste to keep the trash from blowing around, to help cover up the odors, and to help keep animals and birds out of the waste.

5. The groundwater monitoring wells will be checked daily to ensure that the quality of the groundwater around your landfill does not change.

Draw or build a model of your MSW landfill based on the information provided.

WHAT DO YOU DO WITH A LANDFILL AFTER IT IS FULL AND IT CAN HOLD NO MORE WASTE?

When a landfill is full, it is sealed with a layer of clay, and several layers of other types of soil are placed on top of the clay (the final cover). You will notice that the very top of many landfills will also be covered with grass, and large pipes and tubes will be sticking out of the ground on top of the landfills. These pipes and tubes are part of the leachate and gas removal systems.

The leachate and groundwater monitoring equipment (wells) will usually be monitored for several years to ensure the landfill is operating properly and safely. Odorous gas will also continue to emit from the landfill for as long as the waste degrades, and it must be monitored, as well.

Instead of leaving your landfill looking like a giant hill of grass, you can be creative and turn what was once only a pile of trash and soil into a usable, safe place for the public to enjoy. Many owners have turned their landfills into gardens, parks, golf courses, and hills for sledding.

What do you want to do with your landfill when it is full? Draw a picture or make a model.

What do you need to do to ensure both the landfill and your final project is safe for many years to come?

Based on what you know about recycling, what kind of equipment (benches, light poles, signs, etc.) will you be using for your final project and which ones can be made from recycled materials?

From which type of recycled material could each piece of equipment be made?

Since the ultimate goal is to decrease the amount of waste that goes into a landfill, what steps could you take as a consumer to decrease the amount of waste that *you* contribute to a landfill?

Congratulations! You have reached the end of Activity 1, having been provided with some basic concepts and tools for developing a municipal solid waste landfill.

Refer to the list of terms used in the landfill activity.

We thank you for participating in this assignment. If you would like help with solutions to any of the questions posed, please feel free to contact us.

EREF would be interested in knowing when your class completes this landfill activity. You can send details, photos and comments to EREF at *foundation@erefdn.org* or mail them to:

Assistant Director of Development and Communications
Educational Activity 1
120 S. Fayette Street
Alexandria, Virginia 22314

We look forward to hearing from you!

EREF reserves the right to display photos of your completed projects (with accompanying credit, of course) at meetings or conferences held worldwide.

WHAT ELSE CAN YOU DO TO LEARN MORE ABOUT LANDFILLS AND MANAGING OR REDUCING WASTE?

- Contact a landfill operator in your area and ask about a tour.

- If a landfill in your area will be closing, you may want to find out if there will be a contest to design how it will finally be used. Your school could submit a design.

- Contact a local recycling center and ask about a tour.

- Contact the manufacturers of some products used in building landfills and request material samples for use in your classroom (materials such as plastic landfill liners and synthetic membranes, drainage materials, etc.).

- Contact your local government or visit their websites for landfill and recycling program information for your area.

- Do a study about "packaging" at home: When your parents return from shopping for groceries, before the items are put away, make a list of the type of packaging that is used to package each product (paper, plastic, foil, cardboard, etc.). Answer the following questions:

    1. What is the purpose of each kind of packaging used (for safety, to keep out air, to keep moisture in, etc.)?

    2. Are there any products that have more packaging than you feel is necessary? Explain.

    3. Is there a different type of packaging you feel should be used to wrap a particular product? Explain what it would be and how it would be used.

    4. If you think there is a better way to package a product to minimize waste, write a letter to the manufacturer explaining your ideas. Manufacturer information is generally provided on all packages.

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