Appendix

Elementary Science Safety Contract

Safety issues are essential in a science teaching setting and must be discussed in all situations. At the beginning of each year, teachers outline proper procedures for handling supplies and equipment with students and establish expectations for safe conduct in the science classroom. To insure that all parties are aware of these expectations, students and parents sign a safety contract. A sample safety contract for elementary students follows. It can be adapted to specific situations.

I will:

- Follow all directions given by the teacher
- Wear safety goggles whenever the teacher directs
- Conduct myself in a responsible manner at all times when doing science both in the classroom and in an outdoor setting, i.e., field trips
- Handle animals respectfully
- Always wash my hand after handling chemicals, animals, plants, or soils
- Immediately report any injury or spill to the teacher
- Use proper techniques and be careful with equipment and sharp instruments

We have read and we understand these safety procedures, and this student agrees to follow all of them.

Student Signature **Date**

Parent/Guardian Signature **Date**

Please indicate if this student has any allergies or other medical problems the teacher should be aware of which could put the student or others at risk in the science activities.

Allergies:

Contact lenses:

Other:

Sample Record Keeping Sheet

Student Names	Story Web	Rough draft	Self-edit	Peer-edit	Adult edit	Final copy	Other

Wisconsin's Forests Are Forever And For Everyone

Journal Entry Page

Protected forestland yields little, if any, overland water runoff. Only when soils are fully saturated with water, slowing movement to the ground water table, will any significant overland flow occur from the forest. Of course, this is of most concern where the land is steepest. Moreover, water draining off land in row crops or from developed areas *into* the forest can create serious problems. This is due to the large, concentrated volumes of water which usually enter the forest at just a few points. Gullying and loss of productive growing sites are the result.

Strangely enough, there is water movement even within frozen soils, though in limited amounts. Since frost depths in protected Wisconsin forestland are quite shallow, of the permeable type and generally insulated by snow, frozen soils yield minimal runoff.

The water that moves into the soil is available for tree growth and to replenish the ground water table of the region. It is this ground water that we tap with our wells and which supplies springs and streams. The water provided by the green sponge is clear and pure, quite different from that water which flows off cropland and city streets!

Now that we understand what the green sponge does, how do we best protect this valuable contribution? By protecting and keeping intact that precious litter layer and the soil which it protects. Keep livestock and indiscriminate burning out of the forest, avoid draining runoff from cropland and developed areas into the forest, and utilize proper logging techniques when removing forest products. For further explanation of how to accomplish these goals, see your local forester.

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FOREST & WATER

THE GREEN SPONGE

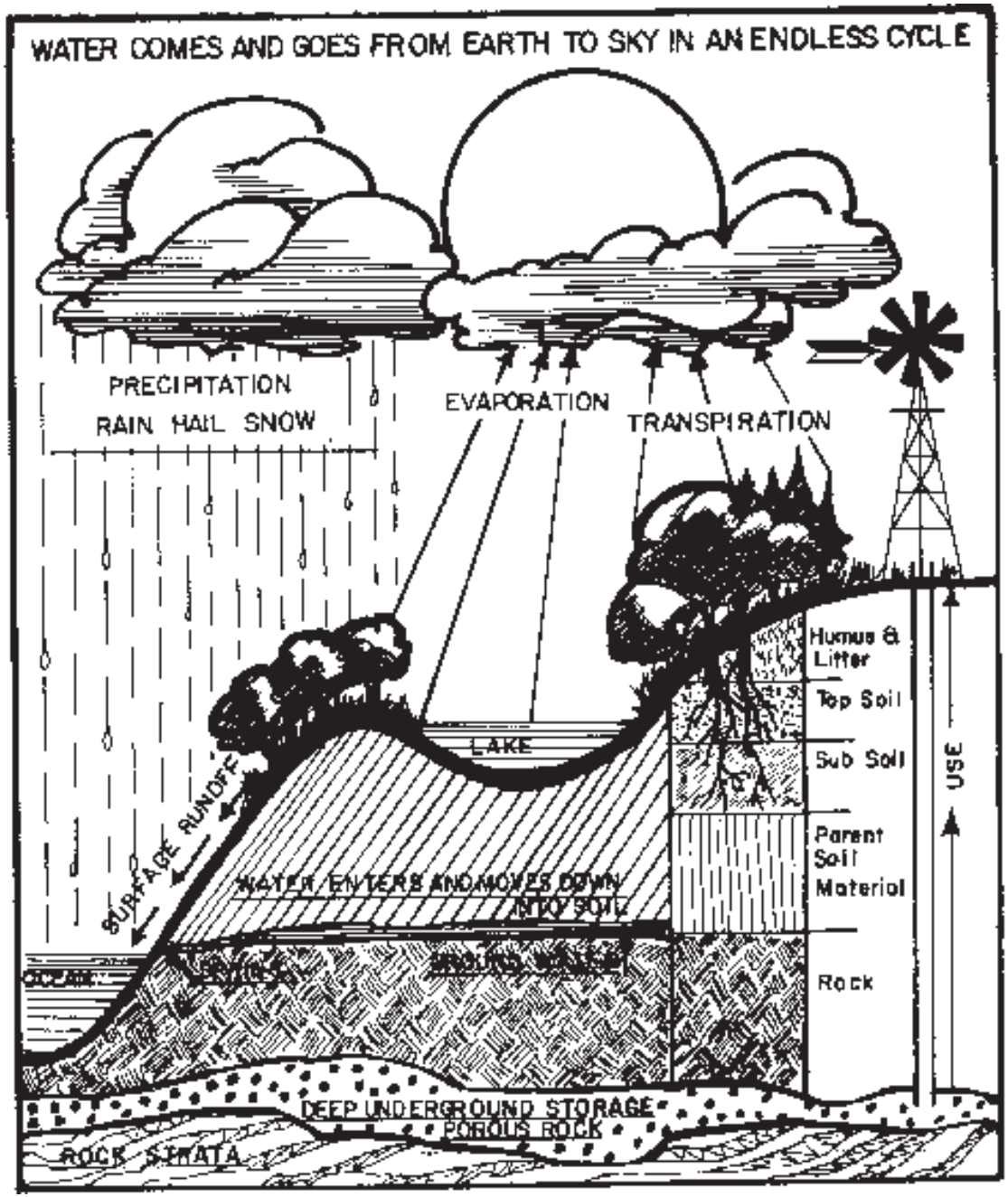
FOREST AND WATER - THE GREEN SPONGE

A forest like a sponge, you say? How can that be? Well, here's the story

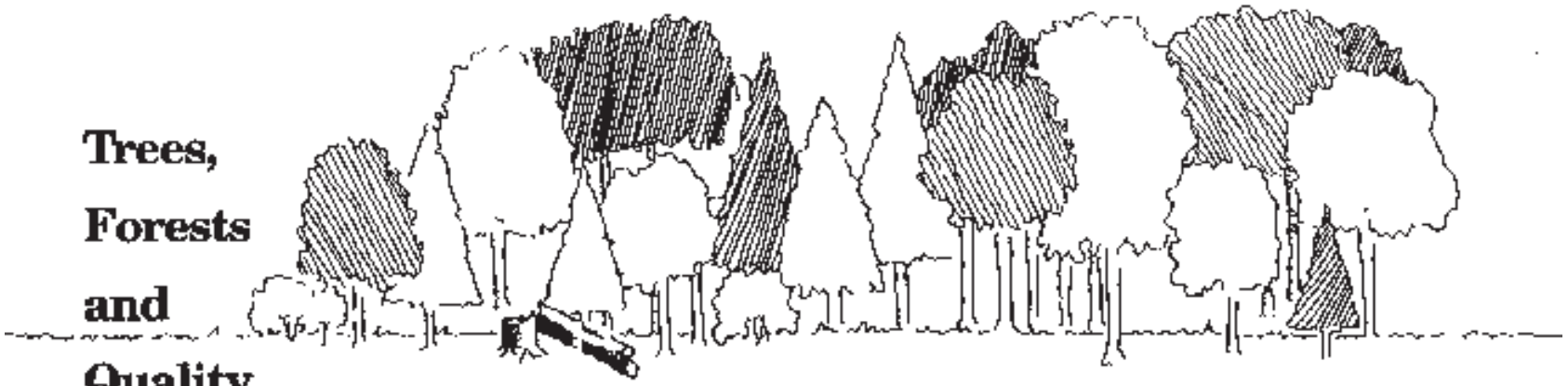
A forest is more than trees; it's all of the vegetation growing there, (and the animal life) plus the soil which produces them. The story of the sponge involves the soil and the vegetation it supports, but most particularly *soil* and *trees*. Trees use a lot of water through transpiration and evaporation. Water from the soil is absorbed by the roots, moves up the stem and into the air through openings in the leaves (transpiration). That's why the forest gives you that cooling or air conditioning effect. Rainfall is intercepted by leaves, limbs and trunk and some is evaporated into the air before it can reach the ground. What about the large amount of water (including snowmelt) that does reach the ground? It moves into the soil, just as the water that you might sprinkle on a *sponge*! So it's the forest soil that acts as the reservoir for the water. That is, as long as it's managed properly.

A natural forest soil is deep and porus, that is, filled with air spaces and protected by a litter and humus layer. This litter layer protects the soil surface from the force of the raindrops, allowing water to move into the soil (infiltration). Undisturbed forest soil can absorb rainfall rates up to 50 inches per hour, 8-12 inches being common in Wisconsin (cultivated lands are a fraction of that). Any action that destroys or removes the litter layer reduces this beneficial action. Infiltration is further reduced when the soil is compacted. Compaction reduces the pore space in the soil, thereby reducing the amount of water that can move into and through it. Destruction of the litter layer and compaction will *both* result from livestock grazing; fire is detrimental in terms of litter layer loss.

Cutting trees has little effect on runoff as the litter layer remains intact. Careful removal of the logs on a well designed road system will minimize the amount of area disturbed. Proper drainage and seeding, together with typically rapid re-vegetation, returns the area to normal in 1-2 years after logging.



Trees, Forests and Quality Water



The Nation's forests are a rich resource of aesthetic quality, wildlife habitats, and wood products. Forested areas also produce some of the nation's best quality water.

■ **Forest land contributes to clean water in several ways.**

Well managed forests protect the soil and allow precipitation to soak into the ground reducing erosion and replenishing the water table.

Healthy forests protect against soil erosion and are efficient at retaining nutrients. Sediment, nitrogen, and phosphorus concentrations are low in streams draining lands with fully stocked and vigorous trees.

Streamside trees help stabilize streambanks, provide shade to cool streams for fish, and provide woody debris which is necessary in many areas for fish habitat and stable stream beds and banks

■ **Many factors affect water quality on forested watersheds.**

Some impairments are natural in origin because water quality is influenced by vegetation, soils, and geology. Even without human influences some waters are acidic, low in oxygen, or high in sediment.

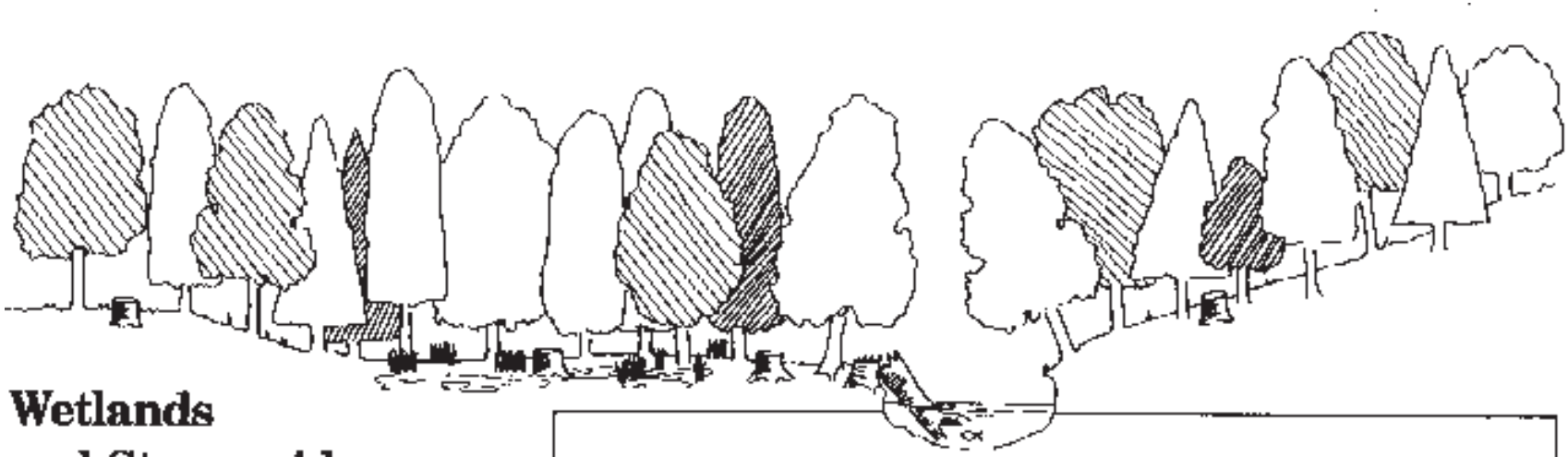
The impacts of human activities are often more apparent. Improper grazing, mining, highway construction, or forestry can change water quality on forested water sheds. Some of the impacts of these changes can last for decades.

■ **Forestry activities are compatible with water quality goals.**

Harvesting trees is an activity which occurs on about 2% of the nation's forest land each year. Good planning, harvesting, and reforestation practices can protect water quality during forestry activities.

Foresters support the use of what are called ***best management practices*** to control pollution during harvesting and reforestation activities. Many State forestry organizations conduct surveys to determine the use and effectiveness of these practices. The results show good compliance by landowners and forest managers.

Permanent land clearing or deforestation should not be confused with forest management activities.



Wetlands and Streamside or Riparian Forests

Forests that grow on wetlands and floodplains near streams and ponds are especially important to water quality. Approximately 50 million acres of forested wetlands remain in the lower 48 States.

For more information:

Wisconsin Department
of Natural Resources
Bureau of Forestry
P.O. Box 7921
Madison, WI 53707

These forested areas retain and transform pollutants.

Nitrogen is retained in plants or released as a gas through a natural process called denitrification.

Sediment and attached nutrients such as phosphorus are trapped and retained in the soil or plants.

Forested wetlands and floodplains should be recognized for their value:

Value for habitat	Streamside forests provide large woody debris for fish and riparian corridors for wildlife.
Value for flood control	Woody stems slow the velocity of flood water.
Value for water quality	Riparian forest buffers are effective in reducing ground water pollutants, trapping surface water pollutants, and lowering water temperature.
Value for timber	Wetlands and floodplains are important sources of high quality wood.

What You Can Do

- Manage your land to control pollution.
- Increase the proportion of forest land, especially near streams.
- Retain trees in land development projects.

Educator's Fact Sheet #1: "A History of Papermaking"

The ability to express thoughts through written communication has been at the center of civilization for centuries. Writing has enabled humans to learn, keep records, make transactions, spread news, and communicate with each other. Most of our important records are on paper—items like birth certificates, report cards, and marriage licenses. Although writing has been around for a long time, paper hasn't. In fact, putting thoughts down in written form wasn't always easy or practical.

Earliest Writing Surfaces

Early people discovered that they could make simple drawings on the walls of caves, which was a great place for recording thoughts, but wasn't portable. Imagine spending hours scratching a message into a heavy clay tablet and then having to transport it. That's exactly what the Sumerians did around 4000 B.C. Although this form of written communication was now portable, it still wasn't practical because of its weight. For centuries, people tried to discover better surfaces on which to record their thoughts. Almost everything imaginable was tried. Wood, stone, ceramics, cloth, bark, metal, silk, bamboo, and tree leaves were all used as a writing surface at one time or another.

The word "paper" is derived from the word "papyrus," which was a plant found in Egypt along the lower Nile River. About 5,000 years ago, Egyptians created "sheets" of papyrus by harvesting, peeling and slicing the plant into strips. The strips were then layered, pounded together and smoothed to make a flat, uniform sheet.

No major changes in writing materials were to come for about 3,000 years. The person credited with inventing paper is a Chinese man named Ts'ai Lun. He took the inner bark of a mulberry tree and bamboo fibers, mixed them with water, and pounded them with a wooden tool. He then poured this mixture onto a flat piece of coarsely woven cloth and let the water drain through, leaving only the fibers on the cloth. Once dry, Ts'ai Lun discovered that he had created a quality writing surface that was relatively easy to make and lightweight. This knowledge of papermaking was used in China before word was passed along to Korea, Samarkand, Baghdad, and Damascus.

By the 10th century, Arabs were substituting linen fibers for wood and bamboo, creating a finer sheet of paper. Although paper was of fairly high quality now, the only way to reproduce written work was by hand, a painstaking process.

By the 12th century, papermaking reached Europe. In 1450, Johannes Gutenberg, a German, invented the printing press. Books and other important documents could now be reproduced quickly. This method of printing in large quantities led to a rapid increase in the demand for paper.

Paper in Early America

Papermaking is one of the oldest American industries. Only 19 years after the Pilgrims came to America, a printing press was set up in Cambridge, Massachusetts. At that time, paper was still being shipped from England and Europe.

In 1690, William Rittenhouse built a paper mill near Germantown, Pennsylvania, the only one in the New World until 1710. By 1775, there were fewer than 20 paper mills in the colonies. As the population in America grew, so did the need for more paper.

Early on, papermakers realized that they needed to locate their mills near populated areas that could provide a reliable supply of old rags, which were their main raw material. They also realized that they needed to be near a large supply of fresh water, both for turning the mill machinery and for washing the rag fibers.

In 1789, a Frenchman named Nicholas-Louis Robert invented a prototype of a machine on which paper was formed on a continuous sheet of wire cloth. But it was two prosperous London brothers, Henry and Sealy Fourdrinier, who developed the first practical version of this paper machine in 1804. Many modern paper machines are now referred to as "fourdrinier" machines.

By 1810, there were 185 paper mills in the United States. As existing mills expanded and new mills began production, rags became scarce. American papermakers began experimenting with alternative raw materials, such as tree bark, sugar cane waste, straw, and cornstalks.

Development and Growth in Wisconsin

In 1848, a paper mill was established in Milwaukee, producing paper for the Milwaukee Sentinel & Gazette. The paper was made from rags, with production climbing to 90 reams a week, "enough to supply the entire press of the state." Three months later, President Polk signed legislation enabling Wisconsin to become a state.

Financial troubles, dam washouts, and difficulties obtaining an adequate supply of rags prevented the industry from becoming firmly established in southern Wisconsin. Although the Milwaukee area declined as a papermaking center, it is today a regional and national center for printing and paper converting.

A plentiful supply of fresh water is necessary for good papermaking, so it was natural for the industry to begin developing further north along the banks of some of the state's major rivers, including the Fox, Wisconsin, Chippewa, Menominee, Peshtigo, Eau Claire, Flambeau and others. Much of the industry took over old lumber mill and flour mill sites and established new waterpower sites.

The first paper mill in the Fox River Valley was started in Appleton in 1853 to produce a coarse grain rag paper and straw wrapping paper. This mill burned in 1859, but was immediately rebuilt and made about four tons of wrapper and manila daily.

Between 1850 and 1875 paper mills were started at Waterford, Beloit, Sparta and Fond du Lac. An 1870 edition of the Winnebago Country Press detailed the manufacturing process of a local mill. It said the mill turned out 3,000 pounds of paper a day with rags from as far away as Milwaukee and Chicago.

The Fox River was fairly well established as the papermaking center of Wisconsin by 1872. Natural advantages had much to do with this. Lake Winnebago, at the upper end of the Fox, drains down to Green Bay about 35 miles away. During its travel, the water drops a total of 170 feet, with dams spaced all along the length of the river to provide many sites for power.

If there is any one year significant to the paper industry in Wisconsin, it is 1872. This year was the beginning of huge industry growth in the founding of paper mills. It was this year that Colonel H. A. Frambach, a Civil War veteran, brought the Keller groundwood process to the Fox River Valley, enabling papermaking from wood pulp. The process was invented in Germany in 1844 when Friedrich Keller experimented by pressing wood sticks against a grindstone and adding water to create small fibers suitable for making paper. This mechanical process is still used today to produce groundwood pulp.

In 1873, Colonel Frambach co-founded a mill in Kaukauna—the first mill to install a machine for grinding pulpwood logs. Soon after, other pioneers in wood pulp manufacturing were producing paper from poplar trees. The paper industry, particularly after introduction of the groundwood process, found that Wisconsin offered all that it needed to be successful—abundance of pure water, raw materials, power, skilled labor, and ready access to good markets.

The Civil War stimulated a greater demand for newspapers; it was followed by an era of invention and industrial growth. When wood was beginning to outgrow its original single purpose as lumber, and wood pulp was becoming widely used for papermaking, many of the lumber companies moved away, leaving millions of acres of cut forests. The paper industry eventually played a large role in reforesting Wisconsin.

In 1888, the first paper mill was built on the Wisconsin River. Central Wisconsin would soon become another intensive area for papermaking.

Throughout its history, the Wisconsin paper industry has used recycled materials. When the first mill began in 1848, recycled cotton rags were the sole source of fiber. The use of recycled white wastepaper as a source of fiber was first reported in Wisconsin in 1873. Cotton fibers were the bulk of this recycling, although wood fibers from imported papers were probably included.

Recycling mills in Wisconsin had an annual capacity of 180,000 tons by 1925. By 1950 capacity had increased to nearly 300,000 tons. In the late 1970's, capacity was approaching one million tons. Today, Wisconsin's recycling mills turn 2.5 million tons of wastepaper into new, useful products annually.

The Wisconsin paper industry has proved to be one of the state's most stable economic contributors. Technological advances, an ability to adapt, and quality management have carried the industry through periods of economic challenges and business transitions.

Educator's Fact Sheet #2: "How Pulp and Paper Is Made"

The process of making paper has not changed—at least, fundamentally—since its discovery. But with almost two centuries of improvements and refinements, modern papermaking is a fascinating, high tech industry. Here's a "primer" on the industrial papermaking process.

Raw Materials

Trees and recycled wastepaper are the primary raw materials used in paper manufacturing (some paper grades rely on cotton or other fibrous material). But, examining these raw materials more closely, you'll see that papermakers really use "cellulose." It comes from three main sources: logs harvested in the forest, recycled waste paper, and sawdust and chips recycled from sawmills making lumber. Papermakers can use hardwood and softwood trees. Hardwoods, or deciduous trees which shed their leaves in the fall, commonly used in Wisconsin include aspen, maple and birch. Softwoods are the coniferous, or evergreen, trees such as pine (red, white, Jack), spruce and tamarack.

Woodpulp Preparation

When raw logs arrive at the mill, machines strip off their bark, reduce the wood to chips, and ready it for the paper manufacturing process by turning it into pulp, or a mixture of wood fiber and water. The wood can be reduced to a fibrous state by mechanical means (chopping or grinding), "cooking" the wood chips in pressurized containers, or combinations of both. The preparatory process removes lignin which is the "glue" that makes trees rigid and able to grow tall. Some paper companies choose not to own pulp mills. Instead, they purchase "market pulp" from other producers that has been demoisturized for ease in shipping and handling.

Preparing Recycled Wastepaper

From its early years, the paper industry has recovered discarded products—first rags, then recycled wastepaper—and used them as a raw material. Recycled wastepaper also needs preparation before it is ready for the paper machine. For example, paper grades need to be sorted and inspected to assure the right types are used for the grade of paper to be produced. All non-paper substances—such as dirt, debris, staples, paper clips, tape and adhesives (called "stickies")—are removed to avoid contaminating the pulp and new paper products.

Some companies can use virtually all recycled fiber as a raw material, others can incorporate some—the percentage depends largely on the physical attributes, or characteristics, needed in the new products being manufactured.

It is important to remember that wood fibers cannot be recycled endlessly. Generally, they can be reused only about five to seven times before they become unusable for further papermaking. That means new wood fiber will always be needed in paper manufacturing. However, the U.S. and Wisconsin paper industries are committed to even greater recycling achievements. In 1989 for example, papermakers announced a voluntary goal to recover and reuse 40 percent of all available wastepaper in the nation by 1995. By 1993, the goal had already been surpassed, prompting the industry to set a new goal to recover 50 percent of all the paper used in the nation by the end of the century. Today, Wisconsin's paper industry is a national leader in the utilization of recycled wastepaper, turning more than 2.5 million tons into new, useful products annually. The volume recycled by Wisconsin paper companies has more than doubled since 1980.

Final Pulp Preparation

The pulp passes through cleaners and screens and may be whitened if needed for the grade of paper being manufactured. Additives like dyes, pigments, sizing or resins are sometimes added to provide the paper or paperboard (thicker paper used for boxes and containers) with the appropriate finish or physical characteristics for its intended end use.

Paper Manufacturing

Now the pulp is ready for the paper machine. Here it is more than 99% water and less than 1% fiber. The slurry is sprayed from the headbox onto a moving, continuous loop of fine, wire screen. After the water in the pulp slurry drains through the screen, a damp mat of wood fibers bonds together forming a new sheet, or web, of paper. Then the web moves to the press section, being carried by a moving felt. There the paper is compressed and more water is squeezed out. Next it moves to a long series of dryers, or steam-heated cylinders, that evaporate more water. The paper machine typically is 150 inches to 300 inches wide and 100 yards long, or as long as a football field. When it arrives at the end of the machine, the new paper generally has a moisture content of just 4% to 6%.

Finishing and Converting

Some paper grades are coated, particularly if they are going to be used in printing and publishing. The coating process can occur on the paper machine or be done on a separate machine. New paper also can be directed through a vertical column of steel rollers—or calendar stack—to further smooth its surface. Paper coming off the paper machine is wound into a jumbo roll weighing many tons. Depending on the eventual use of the paper it may next be cut, slit, and rewound into many smaller rolls, or cut into sheets. The final step needed to transform new paper into retail products is called "converting." It may by done by the paper manufacturer or it may be accomplished by other facilities.

Educator's Fact Sheet #3: "Wisconsin's Paper Industry Today"

Centuries of invention and innovation have evolved paper from a basic writing surface to a commodity that we would have much difficulty living without. Paper manufacturing is big business worldwide, including Wisconsin, the nation's leading papermaking state. As you might expect, the economic benefits to Wisconsin are impressive.

Paper Production Tops 5 Million Tons

Paper facilities in the Badger State produce about five million tons of paper annually. Wisconsin has been the nation's leading paper manufacturing state for more than 30 years; presently the output here is more than one million tons greater than in Alabama, the nation's second leading papermaker. More than one million tons of paperboard products, primarily used in a wide array of protective packaging, also are produced here annually. The value of shipments from Wisconsin's paper companies tops $12.4 billion annually, while the combined shipments of paper and other forest products is valued at nearly $16.8 billion.

Employment for More Than 52,000

More than 52,000 people are employed as papermakers in jobs noted for good wages and stability. Pulp and paper manufacturing accounts for about one in every 11 Wisconsin manufacturing jobs.

The industry's workforce earns more than $2.2 billion annually; and their average wage is nearly 30% greater than those in all other manufacturing employment and more than 70% higher than the average weekly wage for all employment in Wisconsin.

Paper manufacturing supports jobs for more than 125,000 others—persons employed outside of papermaking as clerks, bankers, teachers, lawyers, truckers, carpenters, doctors, electricians, butchers and bakers—all of the many retail, wholesale, service, transportation, government and related jobs that comprise the economic fabric of society. Moreover, economists measure a $3.8 billion impact on Wisconsin's economy as paper industry wages are spent on goods and services, rent and mortgages, income and property taxes, saved and invested.

Papermaking is the key component of Wisconsin's forest products industry which includes loggers and manufacturers of lumber, furniture and other wood products. With 99,000 employees, the forest products industry, including paper manufacturing, is the leading employer in 14 counties and second or third largest in another 24 counties. And, many of the state's 1,800 forest products firms are based in rural communities, helping assure viable economies statewide.

Thousands more jobs are closely linked to papermaking "upstream and downstream" — such as suppliers to the industry or its customers.

Many Jobs Linked to Papermaking

About 6,000 persons are employed by companies that design and manufacture papermaking machines and related equipment. They produce more than $830 million in goods annually for use in Wisconsin, the United States and around the world.

Installations of new papermaking equipment, plant expansions and facility upgrades generate employment for several thousand more construction and skilled trade workers annually.

Wisconsin's paper industry purchases more than $6.1 billion in goods and services annually.

Convenient access to quality Wisconsin-made paper is a big reason why there's a vigorous, growing printing industry here. More than 53,000 printers earn nearly $1.4 billion in annual wages. Those economic benefits are shared across the state as about half of all printing and publishing positions are in Milwaukee and southeast Wisconsin.

A Positive Future Through Capital Investments

The outlook for the industry and its beneficial impact on the Wisconsin economy is positive. Although papermaking is a very competitive business sector, companies here are investing enormous amounts of capital in manufacturing and environmental protection equipment and facilities.

For example, more than $720 million was invested by Wisconsin papermakers during a recent three-year period in capital projects to help assure they continue to be world-class competitors with a bright future in Wisconsin.