Watershedology 101

Provided free to educators courtesy of
Western Virginia Land Trust
722 First St., SW, Suite L
Roanoke, VA 24016 www.westernvirginialandtrust.org

WATERSHEDOLOGY 101
For creative, cash-poor, and/or busy educators

Grade Levels/Ages:	Grades 2-4/Ages 7-9	
SOLs:	Science:	2.5, 2.8, 3.5, 3.6, 3.7, 3.9, 3.10, 4.5, 4.8 + ES.3 and LS.4
	History and Social Studies:	2.3, 2.5, 2.6, 2.7, 2.9, 2.10, 3.5, 3.6, 3.9, 3.10 + VS.1 and VS.2
	English:	2.2, 2.3, 2.5, 2.7, 2.8, 2.9, 2.11, 3.1, 3.2, 3.4, 3.6, 3.7, 4.1, 4.2, 4.3, 4.5, 4.6, 4.7

Program Description

While "Watershedology" is designed for use in conjunction with the Western Virginia Land Trust's "*Saving Our Land and Water*" DVD, it may also be used independently. The DVD emphasizes why we should "**S**ave **O**ur **S**cenery" (**SOS**) including rural landscape vistas, forests and clean-flowing streams.

"Watershedology" is designed to allow educators flexibility in choosing and customizing modules to address their specific goals within the wide range of topics, activities and applications presented. Priority has been given to ideas which: are quick and easy to do; take advantage of readily-available and inexpensive materials; are hands-on and/or interactive; nurture curiosity and creativity; and promote inquiry-based, concrete learning experiences as well as provide the basis for life-long learning skills.

About the Author:

Judy Hensley of Roanoke, VA, is passionate about water quality and has been active in protecting the environment her entire life. She has taught biology at Virginia Western Community College and is the former exhibits director at the Science Museum of Western Virginia. Judy has a bachelor's degree in biology from Emory and Henry College and a master's degree in biology from Old Dominion University. Reach her at hensley.j@att.net.

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Objectives

"Watershedology" offers a comprehensive lesson plan which provides avenues for children to make a positive connection with nature by reinforcing basic science concepts using an interdisciplinary approach.

Age-appropriate activities engage students in nature-based activities which make learning memorable and fun and instill in students a conservation ethic.

"Watershedology" incorporates activities which specifically address:

(1) in Science – conservation, diversity, erosion/sedimentation, forest, habitat, human impact, natural resources and watershed

(2) in English – expansion of vocabulary, exposure to non fiction, reading/writing exercises, and opportunities to develop print and electronic reference materials/resources

(3) in History/Social Studies – causes and effects of changes in community life, property rights, economic choices, public policy, maps and geography.

Background for Educators

Many people in our modern, technologically-oriented society suffer a disconnect from nature. Particularly vulnerable are children, especially those in urban and suburban environments. For example, many people really do not understand where the water that flows through their taps comes from or where it goes. More importantly, they probably do not know the impact their actions have on the quality of that water.

Using the major concepts associated with understanding a watershed, this lesson plan incorporates the land environment, especially forests; habitat, shelter and food chains; diversity; and natural resources. Human impacts include: farming, the increased occurrences of erosion and sedimentation, littering and non-point source pollution. Suggestions to resolve, mitigate and/or improve the effects of human impact include best management practices for water quality, water conservation, flood management, soil conservation and pollution effects.

The "*Saving Our Land and Water*" DVD, available on Western Virginia Land Trust's website, reinforces many of these concepts.

Did you know…

25% of all the development in Virginia has taken place in the past 15 years? That's 100 years of development packed into a decade and a half!

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Definitions

best management practices: control measures to mitigate the quantity and quality of runoff into water caused through land use; frequently abbreviated BMPs

greenway: a stretch of undeveloped land, close to an urban area, kept for recreational use

non-point source pollution: runoff from many diffuse sources; frequently abbreviated NPS pollution

riparian: of, on or relating to the banks of a natural course of water

viewshed: the landscape or topography visible from a geographic point, especially that having aesthetic value

watershed: the region of land whose water drains into a specified body of water

Key Terms/Concepts

algae
aquatic
aquifer
basin
bedrock
blue way
buffer
conservation
contamination
deforestation
diversity
erosion
filter feeders
food chain
forest
habitat
human impact
impervious
ground water
mitigate
natural resources
photosynthesis
pollution
prevention
reforestation
rip rap
runoff
sedimentation
shelter
soil
stewardship
substrate
terrestrial
turbidity
wetland

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Outline

I. Introduction

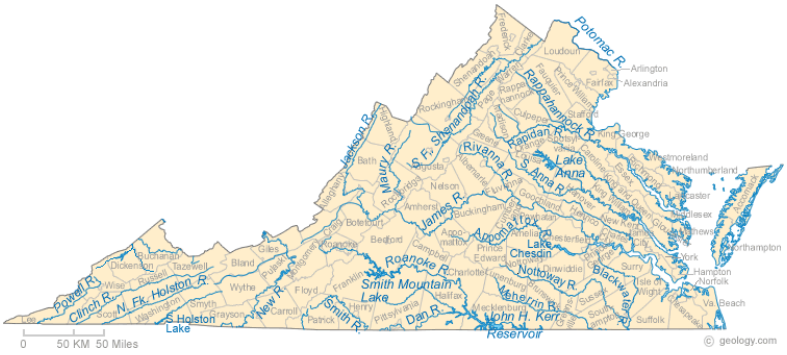
In central and southwestern Virginia, there are four major watersheds or river basins:

(1) the Roanoke River Basin with land that drains into the 410-mile long Roanoke River, flowing south into Albemarle Sound in North Carolina;

(2) the James River Basin including the James River, flowing from its source in West Virginia east into the Chesapeake Bay;

(3) the New River Basin with the New River, one of Earth's oldest rivers, beginning in North Carolina and flowing northward where it eventually empties into the Ohio River; and

(4) the Tennessee-Big Sandy River Basin, whose lands drain into the Holston River and Clinch River systems and eventually join the Mississippi River, emptying into the Gulf of Mexico.



The Clinch River has the greatest diversity of species (approximately 42) of freshwater mussels in the entire world, although many of them are in serious decline. Globally threatened and/or endangered species that call these waters home include the Roanoke logperch, Shenandoah salamander and seventeen species of mussels including the Appalachian monkeyface and James spinymussel. See www.dcr.virginia.gov/natural_heritage/nhrinfo.shtml for a complete list of state and federal, plant and animal, threatened and endangered species.

To attain the best possible water quality for the plants and animals (including humans) that depend on it, we need a basic understanding of who and what affects our water. We need to remember that what happens upstream affects downstream. We need to appreciate the critical role trees and other vegetation in a riparian buffer play in: providing shelter, habitat, food, shade and cooling, especially important along stream and river banks; reducing erosion and sedimentation; cleansing the air; and serving as migration corridors.

Below are several ideas (of which there are thousands) to help build in young people a connection to and an appreciation of the value of green, open spaces found in rural vistas and forests as well as clean-flowing streams. Students are encouraged to develop their own legacies of conservation as an integral, valued part of their quality of life.

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II. Pre-activities

1. Students should have an understanding of the water cycle.

2. Other pre-activities should heighten students' awareness of the natural world and sharpen their observation skills. Suggestions include:

- Take a "field trip" to the school yard to find evidence of animal life. Students may hear evidence, for example bird songs or cricket chirps. Students may see proof of the animals in their habitats by finding feathers, nests, eggshells or leaves eaten by insects. Remember: take only photographs and leave only footprints.
- Plant seeds in a see-through chamber to reinforce the plants' need for soil (to anchor roots, and to obtain water and nutrients).

- To expand this idea, use different substrates such as soil, rocks, clay and/or sand.

  Have students touch each type and predict in which the seed(s) will grow best.

- Send students on a scavenger hunt to find various objects. Remember: take only photographs and leave only footprints. Students may draw, color and/or write descriptions. For example, ask them to find something soft (feather), yellow (dandelion), hard (rock), or from a tree (cone, leaf or twig). Students might trace the outline of various leaves or make a bark rubbing of a tree. If field guides are available, have students identify their objects. Have them work as teams. Ask them to share their results with other students when they return to the classroom.

- Provide tree-related snacks such as nuts, fruit or syrup.

- Other ideas: have students bird watch with binoculars; send them into the "field" with hand-held magnifying glasses to do "belly botany" as they see up close and personal the "secret" life among the blades of grass.

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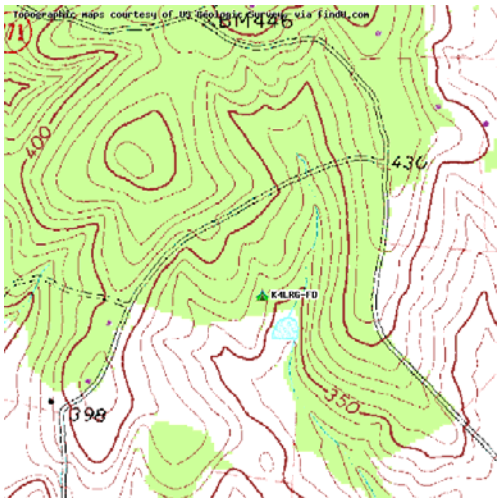
III. Focus/theme activities

These activities will give children a depth of experience in several key areas to help them develop an understanding of the interrelated nature of factors that impact conservation issues.

Watershed model

Use the watershed model to illustrate how the land and its vegetative cover are connected to water and its quality, wildlife, and the effects of human activities. The watershed catches precipitation; and the land either absorbs the precipitation or carries it as runoff. Runoff occurs when the precipitation rate exceeds the substrate's (usually soil) saturation rate.

The watershed model can be adapted in various ways to accomplish numerous types of observations. Students working in groups can make models to realistically represent the actual watershed in which they live. Use maps* to locate mountain ranges, valleys, and bodies of water including lakes, rivers and streams. Where appropriate, incorporate a forest ecosystem, farmed land, residential subdivisions, industrial areas and a landfill. Other models might feature a series of different substrates to illustrate the water-holding capacity of soil, gravel/pebbles/rocks, clay and/or sand.



* Maps can be obtained through local planning commissions. Google Earth is a powerful tool available on the Internet. Photos and videos also make useful teaching adjuncts.

Use a 15 x 11 x 3 aluminum roasting pan as the basin for your watershed model. Use clay to model the landforms. Suggested materials to detail your model include: blue food coloring for rain, green food coloring for fertilizer, and cocoa or coffee for pollutants. Use pieces of plastic or aluminum foil for roads and other impervious surfaces. Use small twigs or pine cones for trees. Use small bits of moss, pieces of sponges, florist foam or carpet for wetlands or riparian buffers. Vegetable oil can substitute for motor oil.

Have students "make it rain" on the watershed with spray bottles. For scientifically-correct data, be sure each student starts with the same amount of water and spritzes an equal number of times. Students should note the effects of water running down mountains, how much water it takes to flood a stream with pebbles (rip rap) on the banks versus vegetation, the differences in various community types, etc.

Have students record their observations, write summaries and/or report their results to the class. They should understand how land-water systems are interconnected via drainage patterns, and how humans and their communities impact the land and water.

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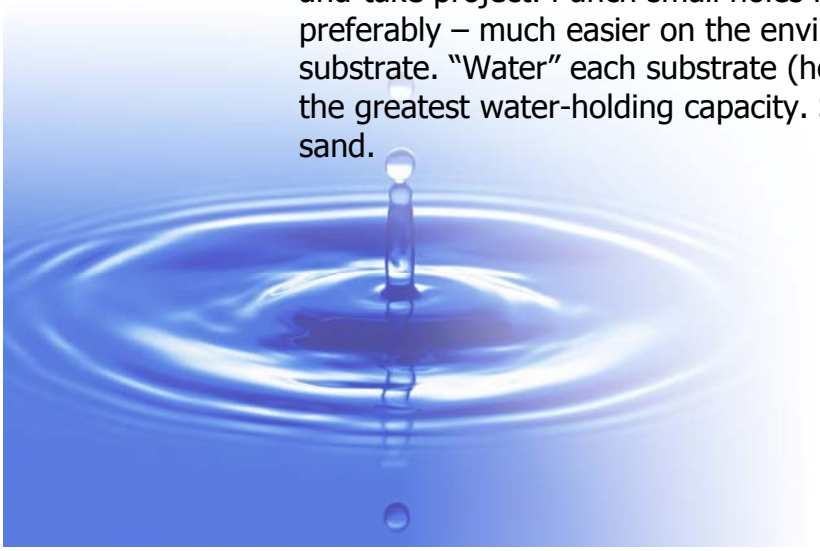
Expansion ideas include:

- Observe your schoolyard surfaces and record the directions of water flow. Assess the terrain of your schoolyard to decide where the highest elevations are. Divide into groups; and by dropping tennis balls from the highest elevation(s), determine how they move: whether they take a circuitous or straight route, how fast they travel, if any of the balls end up the same place, etc. Predict what will happen on different surfaces including concrete/asphalt, grass, soil and mulch. Use a measuring cup to quantify water used and a stopwatch to determine rate of flow. Test various surfaces and report the results.

- Fill a box, representing a storm drain, with "pollutants". Hold the box over an aquarium (representing a body of water). Create storm-drain runoff using a sprinkler-type watering can, so the pollutants are carried into the body of water. Ask students how to "fix" this. How hard will it be to get the pollutants out of the water? Would it be easier to manage the water quality if the pollutants never got to the water? What are ways we can accomplish this?

- Starting with your schoolyard, use maps to create a "watershed address". For example: drainage ditch, unnamed stream, "XYZ" Stream, "ABC" River and Chesapeake Bay. Have students make a large raindrop out of construction paper and move it through the watershed. Add to the raindrop what it might pick up on its journey through the watershed.

- Students can demonstrate at home what they have learned in school with a make-and-take project. Punch small holes in the bottom of disposable cups (paper preferably – much easier on the environment) and fill each with a different substrate. "Water" each substrate (holding over a sink or outside) to see which has the greatest water-holding capacity. Substrates may include soil, rocks, clay, and/or sand.



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Erosion/sedimentation and riparian buffers

To illustrate the effects of erosion and sedimentation, set up a series of dirt bottles. Use clear, 2-liter drink bottles. In bottle #1, place three inches of potting soil in the bottom and carefully fill to the top with water, trying to disturb the dirt as little as possible. In bottle #2, place three inches of potting soil, fill to the top with water and shake well, resulting in a high degree of turbidity. Note the date the bottles are set up and observe them for a month.

Expansion ideas include:

- In each bottle, put a white strip with a symbol to "read". Have students try to read the symbol in the "turbidity" bottle at intervals throughout the observation period. Compare to the undisturbed bottle. This reinforces how long particles stay suspended in water.
- Set up a second turbidity bottle, and then pour the contents through a coffee filter into another bottle. Compare the amount of suspended sediment particles to the original turbidity bottle and the undisturbed bottle. Plant roots in riparian buffers act as filters, holding soil in place and minimizing erosion.
- Research native plants to determine which are adapted to a riparian environment, providing food, habitat and nesting opportunities for wildlife.
- Use various media for the substrates: soil, rocks, clay, and/or sand.

Discuss the causes of erosion and sedimentation. The major causes are stream-bank erosion due to loss of the riparian buffer, deforestation, livestock in the streams, and non-point source pollution from farm land, storm-water runoff and impervious surfaces.

Discuss the effects of erosion and sedimentation on wildlife, including downstream. Sedimentation affects the ability of algae to photosynthesize (basis of the food chain), bivalve mollusks such as mussels to filter feed, and fish to respire via their gills. Sediment carries with it pollutants which are toxic to wildlife as well as an overload of nutrients which has negative effects in natural settings.

IV. Post-activities

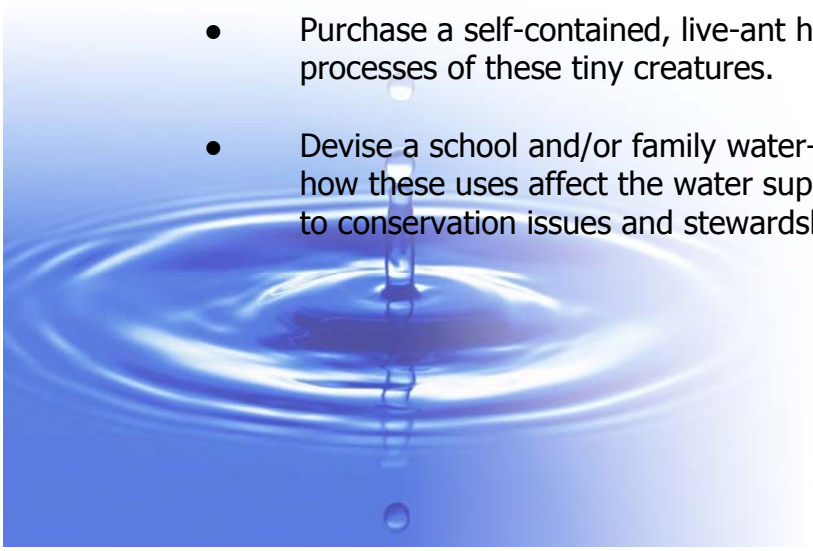
The opportunities for creative and applicable ideas for post-activities are almost limitless. Presented below are several areas for consideration.

Research / resources / reference materials

- Students find and access applicable websites. Especially interesting might be webcams that monitor nature sites.
- Students research which animals benefit from riparian buffers, i.e., those that use the stream banks for food, shelter and habitat. Examples may include dragonflies, raccoons, beavers, crayfish, frogs, snails, clams, mussels, ducks and geese. Draw pictures of tracks some of the animals might leave. Are any of the animals endangered? Are any found only in this part of the world? Are any found globally?
- Students look up key words to expand their listening and speaking vocabularies.
- Start a journal and/or album to compile pictures of and notes about riparian and other native plants as well as the animal life. Pictures might come from students' drawings, the Internet, magazines or camera photos.

Classroom projects

- Make an "In the News" bulletin board to post applicable articles.
- Exchange information/materials with someone in another part of the watershed or a different watershed.
- Set up a terrarium. Try to reflect features of your watershed including different elevations, soil, rocks and a water source.
- Purchase a self-contained, live-ant habitat, allowing students to observe the life processes of these tiny creatures.
- Devise a school and/or family water-use survey. Compile the results and discuss how these uses affect the water supply and quality in your area. Tie the discussion to conservation issues and stewardship.



History/social studies-related projects

- Using a compass, map the schoolyard, including the features that were documented in the tennis ball-contours experiment (from above). Make up symbols and a legend. Design a compass rose.

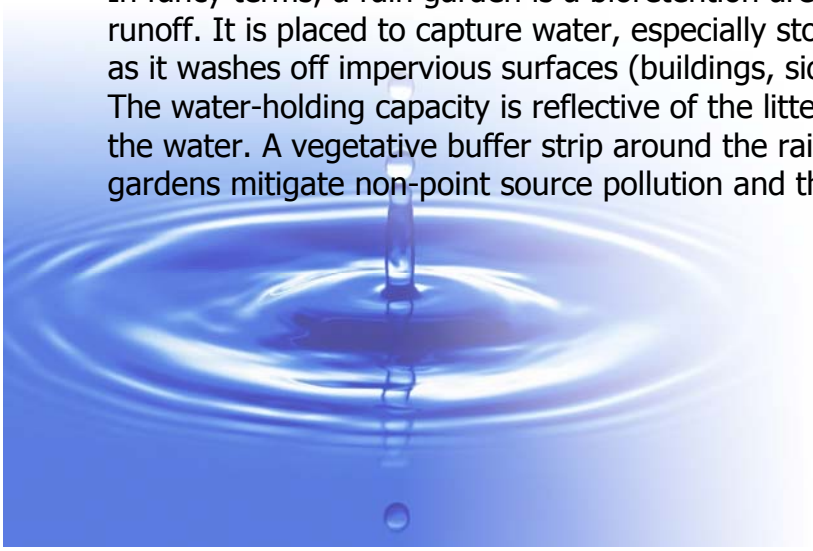
- Find historical maps of your area and compare their features to present-day features. How has the community changed through time? Areas to consider are forests, streams and rivers; roads and railroads; the growth of towns into cities; and how ownership of the land might have changed. How did the geography of the area affect these changes? What economic and government decisions influenced these changes? How would these changes impact the watershed? How will future changes impact the watershed? How do public policies and economic choices affect property rights?

- Get tree cookies from a forest ranger. Determine the age of the trees and relate the "age" rings to changes in the community. If there are no "old" trees in the community, why not?

V. Extended activity

Be an advocate and lobby for putting a **rain garden** on your school's property and/or the yards of your students. Enlist as many volunteers as needed to make it happen! A rain garden is a superior teaching tool and a definite benefit to the ecosystem. Use this as an opportunity to have students research native plants and their adaptations to various habitats. Choose plants particularly attractive to pollinators such as butterflies, bees and birds like hummingbirds.

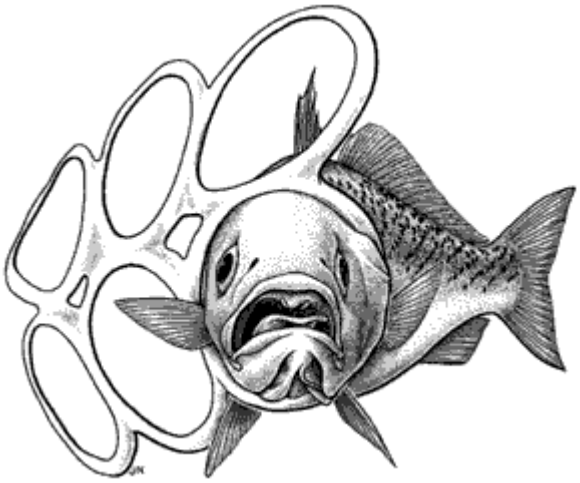
In fancy terms, a rain garden is a bioretention area – a specialized garden designed to reduce runoff. It is placed to capture water, especially storm water, so it can slowly filter into the ground as it washes off impervious surfaces (buildings, sidewalks, asphalt) or down slopes of the terrain. The water-holding capacity is reflective of the litter layer in a forest ecosystem, which soaks up the water. A vegetative buffer strip around the rain garden enhances its ecological value. Rain gardens mitigate non-point source pollution and therefore promote the health of the watershed.



Other benefits of rain gardens include trapping pesticides, fertilizers and oil that can harm aquatic life. They replace high-maintenance lawns, help replenish ground water and create habitats for wildlife. This natural, low-tech approach nurtures in students an appreciation of green, outdoor spaces and teaches them stewardship values for our natural resources.

Expansion ideas include adding a toad abode (clay pot with a "door"); bird houses, baths and feeders (if the students are willing to commit to caring for these additions); wind chimes; a solar-powered water fountain; and/or rain gauge. You might consider setting aside an area that does not get mowed and/or leaving a downed tree to decompose. The Chesapeake Bay Foundation's website has details on many of these ideas (and more!); see http://www.cbf.org. Their material can be adapted for a wide range of watersheds.

VI. What Can I Do?



As they learn about the critical role nature plays in the quality of life, students will have a foundation for their leadership in promoting sound stewardship of our natural resources. There are many ways to help students and interested adults expand and continue a long-term commitment to preserving a lasting legacy. Listed below are a few ideas:

- Monitor proposed legislation at state and federal levels; write legislators to support laws with merit.
- Write local legislators to suggest ways to improve/enhance ecological conditions in your area. Support: greenways and blue ways; the value of open, green spaces; protection of water quality to provide fishable and swimmable waters; preservation of viewsheds; restoration of riparian buffers; and Best Management Practices (BMPs).
- Help monitor water quality in local streams.
- Don't litter, do pickup trash, do participate in clean-up events. Be sure to "disable" plastic six-pack rings properly so they cannot hurt wildlife. If you don't know how to do this, "google" it!
- Reduce, reuse, recycle.
- Compost.
- Solicit yards to in which to establish backyard habitats. Plant vegetation including tree seedlings and native plants including riparian species and wildflowers.
- Volunteer to help groups who support causes in which you believe.

VII. Resources

In this day and age of the Internet and search engines, educators have powerful tools available to find almost unlimited resources; it would be impossible to list all the really good ones. The Western Virginia Land Trust (WVLT) is, however, interested in compiling a list of resources (electronic and otherwise) that educators find most useful. Please mail or email your suggestions. We will make the information available on our website as it accumulates.

IX. Suggestions

Constructive input for how to improve is always welcome. Please feel free to mail or email comments.

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Thank You!