

Summary of Workshops to identify Sustainability Indicators for the Waynesville Watershed FINAL REPORT

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November 10, 2006

BACKGROUND

The Waynesville Watershed property occupies approximately 8600 acres in the Allens Creek area of Haywood County, North Carolina (Figures 1 and 2). The town of Waynesville began acquiring this property in 1913 for the purpose of creating a reservoir that would supply the town with high quality water for residential and commercial needs, and for flood control. The current property boundary includes all of the non-federally owned land that drains into the reservoir plus approximately 570 acres along Rocky Branch Creek that drain into Allens Creek north of the reservoir (outside of the true watershed for the reservoir).

In 2005, the Town of Waynesville conveyed a working forest conservation easement on approximately 7340 acres of the property. The working forest conservation easement does not include the 690 acres that were acquired with assistance from the Clean Water Management Trust Fund (CWMTF), or the 570 acres in Rocky Branch Creek sub-watershed (Figure 1). All forms of active management are precluded from the CWMTF tract, which is to remain in a forever wild state. There are no management restrictions on the Rocky Branch sub-watershed.

The working forest conservation easement was conveyed to forever prevent residential or commercial development within the watershed. The principle objective of the easement was to maintain high quality water resources on the property. Secondary objectives included: (1) the establishment and maintenance of productive forest resources for the generation of income for the Town of Waynesville, and to facilitate the economically sustainable production of forest resources in a manner that minimizes negative impacts and the duration of impacts on surface water quality, and scenic, educational and/or recreational benefits to the public, wildlife habitat, and other conservation values; (2) the protection of natural heritage values; (3) the creation of opportunities for environmental education; (4) the protection of scenic vistas (primarily for visitors on the Blue Ridge Parkway); and (5) the protection of other conservation values by ensuring that the property will forever retain its predominantly natural, scenic, and forested condition, and that native animals, plants, and plant communities on the property will be protected.

In 2006, the Town of Waynesville entered into an agreement with Western Carolina University to develop a comprehensive forest management plan for the watershed. The plan is being developed by the Western Carolina Forest Sustainability Initiative (WCFSI), which is housed in the Natural Resources Management Program at WCU, though individuals are contributing to this plan representing a variety of universities and organizations. The plan is to be completed in the spring of 2008.

In simple terms, the process for developing the forest management plan can be separated into 3 components. First, is the collection of biophysical data needed to document and describe the current condition of the watershed. Second, is the identification and articulation of specific forest management objectives for the watershed. And third, is to develop a strategy (i.e., the plan) for achieving the stated objectives given the current condition of the watershed.

In a very real sense, the second component (articulating specific forest management objectives) is the most difficult to achieve. This is due to the fact that (1) the watershed is a large land parcel that presents a wide variety of forest management options, and (2) varying residents of the town maintain different views on how the watershed should be managed, many of which might appear to be conflicting. In order to assist the town in working through this difficulty, WCFSI sought and received additional funding from the National Forest Foundation to engage in a public dialogue concerning the values and management goals for the watershed. The first part of that process was to host a series of workshops where people with different interests and backgrounds could identify their values for the watershed and the criteria they would use to monitor those values. This report summarizes the results of those workshops.

The Town welcomes input from interested Waynesville residents on the information presented in this report. A formal mechanism for public input is currently being developed. However, any reader is invited to submit their comments in writing to Town Manager Lee Galloway by e-mail (townmgr_waynesville@charter.net), by regular mail (16 South Main Street, Waynesville, NC 28786) or telephone 828-452-2491.

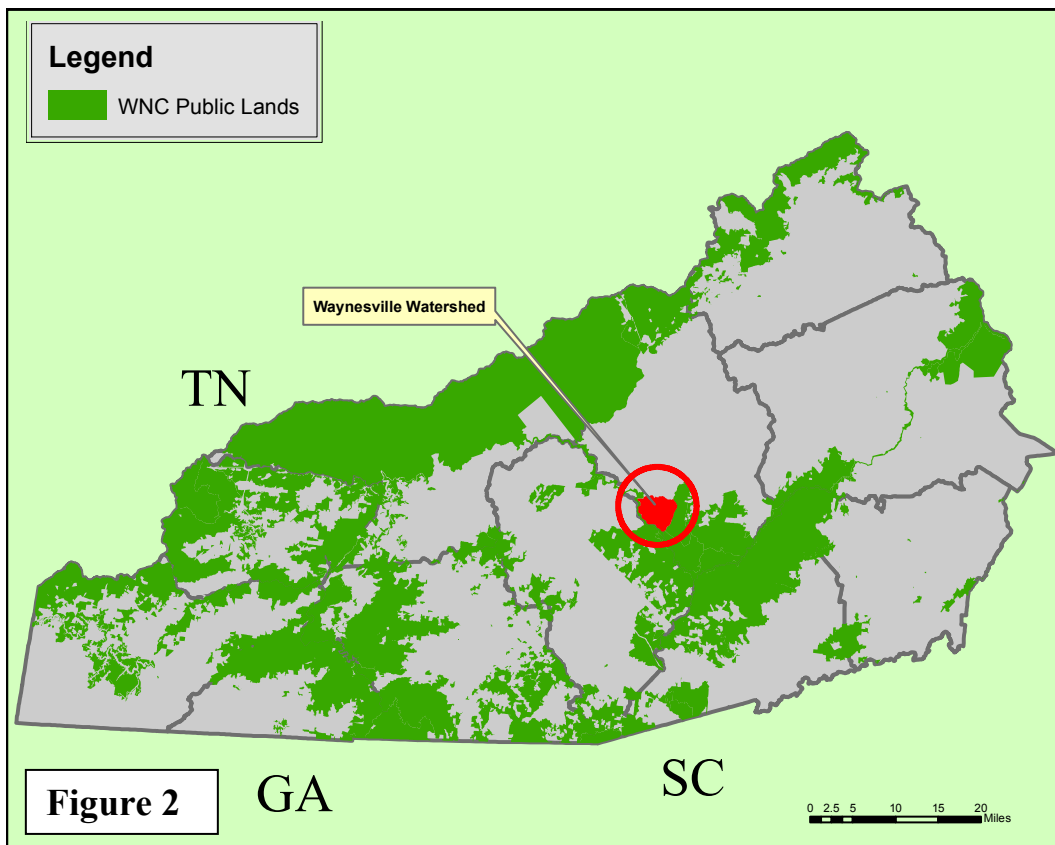
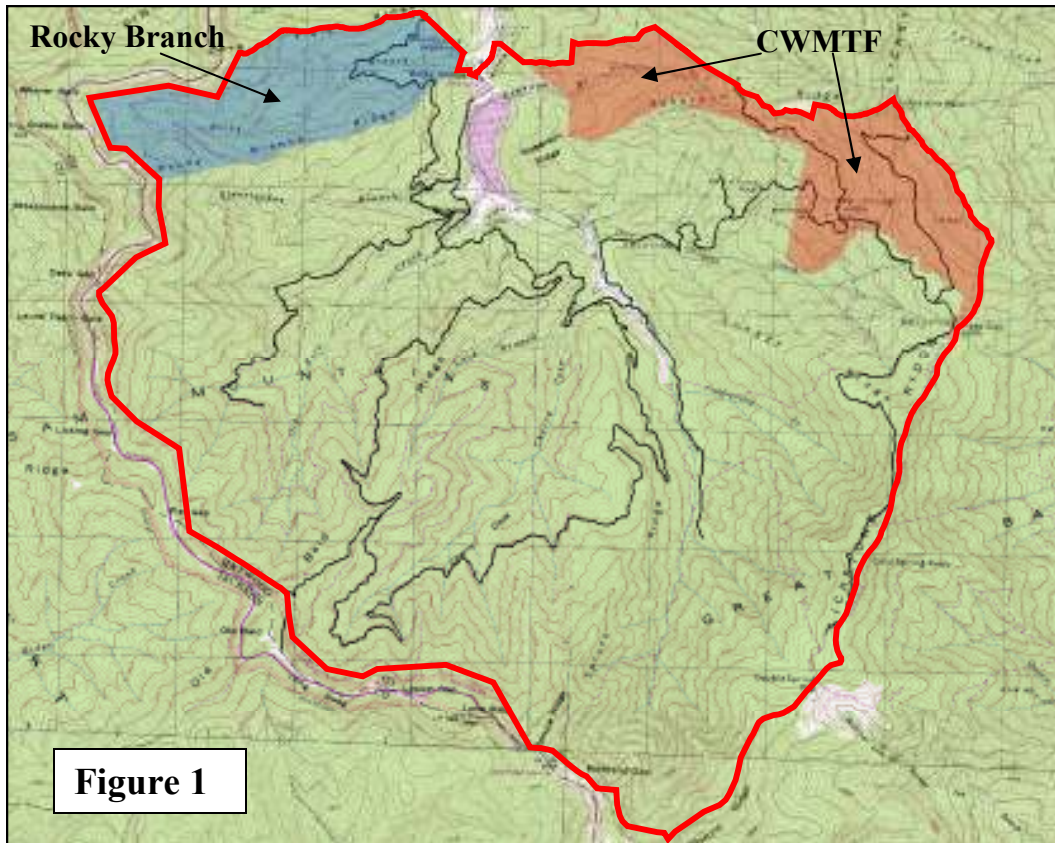


Table 1. List of participants in the two Indicators workshops in the summer of 2006.

Name	Affiliation	Workshops attended ¹
Mayor Henry Foy	Town of Waynesville admin	both
Lee Galloway	Town of Waynesville admin	both
Pat Maier	Waynesville resident	both
Peter Bates	Western Carolina University	both
Tom Martin	Western Carolina University	both
Rob Lamb	Western Carolina University	both
John Hagan	Manomet Center	both
Andy Whitman	Manomet Center	both
Dennis Desmond	Land Trust for the Little Tennessee	both
Michael Skinner	Balsam Mountain Preserve	both
Fred Cabbage	NC State University	2 nd
Karen Kaufman	Waynesville resident	1 st
Bill Skelton	NC Extension Service	1 st
Gordon Small	Waynesville resident	1 st
Jack Swanner	Waynesville resident	1 st
Bill Yarborough	Haywood Co. Soil & Water Cons. Dist.	1 st
Alison Melnikova	Waynesville student intern	both
Jerry Miller	Western Carolina University	1 st
John Williamson	Duke University	1 st

¹ 1st workshop held June 15, 2006; 2nd workshop held July 26, 2006

APPROACH

In the summer of 2006, WCFSI hosted two workshops designed to (1) identify potential public values to be sustained within the watershed, and (2) generate potential indicators (measures) that would inform the town over time whether those values were indeed being sustained. These workshops were facilitated by staff from the Manomet Center for Conservation Sciences, a non-profit research center based in Brunswick, Maine. Manomet uses a structured social process to help groups identify the values they seek to sustain, and to generate metrics, or indicators, that inform them of the status of their values over time.

A group of town residents, decision makers, and scientists was selected to participate in the workshop. The workshop participants are identified in Table 1. Efforts were made to ensure the group had diverse representation. Some of those invited were not able to attend; however, the workshop participants made a sincere effort to identify values that would be important to those not present. The group intends that the process used to identify watershed values be both open and transparent. There will be opportunities for members of the public to identify additional values.

The Manomet Process has four primary steps:

- (1) Identify the economic, social, and environmental values to be sustained.

- (2) Identify potential indicators (metrics) for each value.
- (3) Evaluate the indicators for scientific merit, affordability, and relevance to stakeholder interests.
- (4) Implement the indicators and begin a process of indicator public reporting.

The purpose of the workshops on June 15 and July 26, 2006, was to accomplish steps 1 and 2. Steps 3 and 4 will be completed over the fall and winter (2006-07). The following section provides the output of these 2 workshops. Interested readers are invited to download the summaries of each workshop at www.manometmaine.org/Waynesville.htm.

RESULTS

After a brief introduction to the principles of indicator selection and use, and Manomet's indicator selection process, participants engaged in a brainstorming session to identify possible environmental, economic, and social values that the town might seek to sustain in the watershed. The fundamental philosophy of the group was that the watershed's natural resources could and should be used to support a variety of environmental, economic and social values, so long as the primary value, clean and abundant drinking waters, would not be compromised in any way. After generating a list of all values, the group began a process of selecting indicators (measures) for each of those values. A second workshop was scheduled for July 26, 2006 because it was not possible to generate candidate indicators for all values in a single day. Below is a list and brief discussion of each value. The candidate indicators for each value are listed in Appendix 1.

[NOTE: The group wanted to be as inclusive as possible when considering values for the watershed, and thus considered all values that were raised. However, some of the values identified during the workshops are likely beyond the scope of a forest management plan. These include a number of business opportunities, such as, bottling and selling drinking water or allowing guided hunting and fishing trips in the watershed. These activities would require separate analyses by the town to determine whether they are consistent with the terms of the conservation easement and their commercial viability.]

Environmental Values – Water Quality and Quantity

Quantity of water: This value pertains to the amount of water provided by the watershed. The quantity of water is largely a function of the amount of rainfall in the watershed, which cannot be controlled. However, the rainfall-runoff relationships could be affected by changes in vegetation or land-cover (by, for example, fire, timber harvests, wind throw, increases in riparian and upland vegetation density, roads, etc.). Thus, the average amount of rainfall to the watershed could remain the same, but the amount of water available in the reservoir-stream system could theoretically increase or decrease. Also, the amount of water available for domestic use could be affected by reservoir siltation and a loss of reservoir capacity. Workshop participants felt it was important to monitor the amount of water the watershed is providing. This is already being measured by the Waynesville Water Department through reservoir levels and by-pass flows.

Non-turbid water: Quality of the water supply is also critical for the town. There are various ways to measure the quality of water. Workshop participants concentrated on making sure sediment was not getting into the watershed streams. Sediment not only reduces water quality but can affect the ecological health of aquatic network of the watershed. The town Water Department also monitors the quality of the water in the reservoir at the bottom of the watershed.

Contaminants in the water: Water coming out of the watershed should be free of any contaminants, such as petroleum or other organic pollutants, pesticides, excessive nitrogen or phosphorous, mercury or other heavy metals, and fecal coliform. Presently the Water Department monitors for these contaminants.

Drinking water standards: The town should make sure that water from the watershed meets or exceeds drinking water standards. This is not a problem in the relatively pristine Waynesville watershed, but workshop participants wanted to make sure this value was sustained for the long-term.

Aquatic habitat and health: A healthy aquatic system (plants and animals that live in streams) is usually indicative of good water quality. In fact, macroinvertebrates (insects that live in streams and help the aquatic system function) are often used as indicators of stream health. Parameters such as water temperature, dissolved oxygen, pH, and water flow are all important to sustaining aquatic health. Thus, in addition to clean water, workshop participants wanted to make sure those plants and animals that depend on the streams in the watershed remain healthy. This will help make sure the streams are not impacted by any of the other activities that might take place in the watershed, such as timber harvesting or related activities.

Quality and quantity of groundwater: Underground flow of water is very important to recharging headwater streams. Wetlands are also important buffers to flooding and stream erosion. Though difficult to measure and monitor, participants expressed a desire to maintain quality and quantity of groundwater. Research through Western Carolina University within the watershed may provide some data on groundwater.

By-pass flows: This has to do with the amount of water that passes through the watershed dam to supply Allen's Creek below the reservoir. The by-pass flow is mandated. However, as public water demands increase over time, by-pass flows could become jeopardized. By-pass flows should be sustained, although maintaining these flows during periods of drought may reduce the quantity of water available for town use.

Environmental Values – Ecological

Forest resistance and resilience: Forest *resistance* refers to the ability of the forest to resist change as a result of external stressors (natural or non-natural), such as air pollution, acid rain, disease, or catastrophic storms, such as hurricanes. Forest *resilience* refers to the ability of the forest to return to normal (pre-disturbance) conditions after a stress has occurred. Most of the concern is about non-natural stresses, such as introduction of a non-native (exotic) species. The best way to maintain resistance and resilience is to maintain a diversity of natural forest cover

types containing healthy and vigorously growing trees. WCFSI is currently working to monitor these parameters.

Diversity of native plants and animals: Sometimes referred to as “biological diversity,” or “biodiversity,” the participants felt it was important for the watershed to provide habitat for plant and animal species that naturally occur in western North Carolina. Thousands of plant and animal species are likely to live in the watershed. Because monitoring all these species, or even a few species, would be prohibitively expensive, participants felt that it was reasonable to assume that native species would be supported by providing a diverse and healthy forest, which is more cost effective to monitor. However, the group felt that it would be good to encourage volunteer biodiversity monitoring efforts within the watershed, such as those that might be done by various nature societies. For example, local birding groups might be interested in conducting breeding bird counts or wintering bird counts (e.g., Christmas Bird Count) within the watershed. Also, a town policy of encouraging plant and animal research in the watershed might increase information of plant and animal diversity.

Unique plant and animal communities: Although a part of biodiversity, some plants, animals, or even habitat types are very special because they are unique or rare. Participants recognized that it would be desirable to sustain such rare species or habitats. The town should maintain records of the number and area of unique species and communities within the watershed.

Maintaining natural rates of change: Forests naturally undergo change, even in the absence of human intervention. Many scientists feel that a forest will be healthy if natural rates of change are occurring. If rates of change become abnormal, some species and other environmental values can be lost, including clean water. Unfortunately, natural rates of change can be problematic to define because change often occurs over long periods of time (decades or even centuries) and little data exist to inform scientists of ‘natural’ rates. A better approach might be to monitor the forest for impacts that would be considered unnatural and undesirable.

Wildlife habitat: This value was determined to be the same as ‘diversity of plant and animal species’ above. Some people equate “wildlife” with game species. However, the discussion at the workshop equated wildlife with *all* species, so most of the comments under “plant and animal diversity” applied to this value. One additional indicator, hard and soft mast-producing (berries, acorns, nuts) shrubs and trees, was added because mast is such an important food source for many animals. Mast can be monitored at least indirectly through vegetation surveys that are underway.

Exotic/invasive species: Exotic species are those that do not naturally occur in the U.S.; invasive species are those that do not typically occur in an ecosystem and are likely to harm native species. Exotic and invasive species are usually introduced, accidentally or on purpose, by humans. Exotic species can crowd out, or sometime directly kill, native species. Kudzu is a good example. Such effects are viewed as undesirable, and are oftentimes costly to mitigate. The chestnut tree, a common species in the east, was functionally eliminated from eastern forests by an exotic fungus from Asia, which arrived in New York in the early-1900s on a shipment of Asian chestnut wood. There is widespread concern that hemlock trees may be facing a similar fate due to the introduction and spread of the hemlock woolly adelgid. Workshop participants

viewed the introduction of invasive or exotic species as undesirable in the Waynesville watershed.

Native out-of-bounds species: Out-of-bound species are those species that would naturally occur in the watershed, but which have become overabundant and therefore threaten other values. In many parts of the mid-Atlantic region, the white-tailed deer has become overabundant and threatens many other plant and animal species. It is not clear what the deer population level is in the watershed, but it does not appear to be a problem at present. Species should be sustained within their normal range of density within the watershed.

Soil health: Soil health refers to maintaining fertile and productive soils, which are biologically intact and capable of support productive plant communities. This value also recognizes the importance of keeping soils in place so that they do not erode and introduce sediment into streams.

Economic Values – Timber and non-timber forest products

Timber: Considerable discussion ensued as timber revenue is the most immediate economic opportunity within the watershed. Most accessible portions of the forest were last cut in the 1940s/50s (though some large areas were later cut in the 1980's). As a result much of the watershed is currently in a mature forest condition that provides significant economic opportunity. The workshop discussion focused on sustaining, or enhancing, timber value over the long term, without compromising water quality, or any of the other values. It has been well documented that timber harvesting can be done in a manner that protects water quality when best management practices (BMPs) are employed. The conservation easement clearly states that BMPs will be followed. However, the group felt strongly that it was equally important to monitor the administration and effectiveness of BMP practices.

Non-timber forest products: The collection of ginseng, ramps, bloodroot, and other non-timber species might be permitted in the watershed. A fee or license system might be instituted provided that administration of the system does not cost more than the income derived from licenses, and that non-timber harvesting does not compromise the viability of the non-timber species, or any other value.

Water conservation/future water needs: If the town outgrows the capacity of the watershed to provide water to its residents, water could become costly for the town and its residents in the future. Workshop participants felt that it was important for residents to appreciate water conservation, and all the other present and future values that are a by-product of water conservation (such as the by-pass flows that are now possible in Allen's creek, below the reservoir).

Economic Values – Business opportunities

Selling water: Because the watershed provides an abundance of some of the cleanest water in North Carolina, could the town sell a portion of its excess water through a commercial water

bottling company? This might be a way for the town to bring in some revenue without compromising any of the other watershed values identified in this report. It was determined that a preliminary business analysis would be needed before indicators could be proposed.

Alternative energy opportunities: Could the town generate electricity at the dam? Again, it was determined that a business analysis would be needed before indicators could be proposed.

Guided fishing/hunting: Fishing and hunting might be permitted with a guide service. It was pointed out that fish tend to be quite small in the watershed streams (<6"). Fishing in the reservoir is not likely to be permitted since it is the town's water supply. Hunting and trapping within the watershed might be permitted on a controlled basis, through a local guide service. This might provide income for local guiding services and some small income through hunting and fishing licenses issued by the town.

Job Creation: All of the economic activities outlined in this report should represent employment opportunities for town residents. It was suggested that the town should establish incentives to employ Waynesville residents for any economic venture in the watershed.

Fish farming: Fish farming was proposed as a possible economic venture in the watershed. However, it is unlikely that fish farming in or near the reservoir would be permitted due to possible impacts on water quality. Further analysis of this idea would be needed before any venture was launched.

Reservoir capacity/reservoir structure: To ensure that water supply into the future is sustained, the capacity and integrity of the reservoir should be maintained.

Education (as an economic venture): The watershed has tremendous potential to serve as a focal point for natural resource and outdoor education (see social values below). It may be possible to develop an economic opportunity for the town by developing an education program. Would people or organizations pay for educational opportunities provided in the watershed? For example, if timber harvesting takes place in the watershed, courses might be offered to small woodlot owners on how to do ecologically-friendly forestry.

Tourism: Waynesville has become a tourist destination in its own right over the past decade. Could nature opportunities for tourists be provided in the watershed (hiking, birdwatching, fishing, bike riding, etc.). A thoughtful analysis of this would be needed before any specific venture was initiated.

Social Values

Public education: The watershed could be used as a demonstration or model forest for the public to learn about integrated management of forests for multiple values. A key component of the education could be the history of the watershed and sustainable natural resource management (e.g., for clean water, timber products, compatible recreation). Education activities might include K-12 school field trips, class field trips or labs for WCU and other colleges, bird tours,

annual watershed days, field trips led by other organizations in the area such as local conservation organizations, and extension opportunities, such as woodlot management for woodlot owners.

Public participation in watershed management: Local involvement in decision-making about management of the watershed was viewed as an important social value. Workshop participants wanted to develop mechanisms for Waynesville residents to become involved with the watershed. Such involvement would increase appreciation of the remarkable natural asset of the town.

Scenic/aesthetic qualities; watershed protection: The visual quality of the watershed is important, both from the perspective of the town below and the Blue Ridge Parkway above. All proposed activities in the watershed should protect its scenic quality.

Watershed infrastructure: Primitive roads (unpaved) or trails can be important for accessing different parts of the watershed to control fire, disease and other factors that might compromise a sustainability value. However, roads can also compromise stream integrity and water quality if not properly constructed. Nevertheless, some reasonable level of access to the watershed was viewed as desirable.

Contribution to scientific training and research: The town should encourage research and training within the watershed. However, participants did not want experimental studies that might use extreme conditions (e.g. clearcutting down to a stream bank) solely for the sake of gaining scientific knowledge. Any research project conducted in the watershed should be compatible with maintaining the full array of watershed values identified by the town. It was recognized that there could be a synergy between public education and research activities in the watershed.

Community pride for drinking water quality: Town residents should be proud that they have one of the cleanest and safest water supplies in North Carolina. The town should promote pride in the watershed and the water it provides. The town could host “watershed days” to link citizens to the watershed from which they get their water. The town might enter drinking water contests. There could be an annual newsletter that informs people about their water and its high quality. All of this would build local pride about the quality of the Waynesville water. Video media might be used to further explain the activities in the watershed (also see Education).

Quality of life: Having a watershed like Waynesville has contributes to a high quality of life. People generally like having open space in their community. They certainly like having clean water—this is perhaps the most important environmental value to most people. In essence, the watershed contributes to the overall quality of life for the residents of Waynesville. This high quality should be sustained by proper and careful management of the watershed for present and future generations.

NEXT STEPS

The town board is in the process of creating a citizen-based watershed advisory committee (WAC). It will be the responsibility of this committee to aid the town leaders in prioritizing the many values identified. Not all values can be pursued simultaneously. Some are already being sustained, such as clean abundant water. Some might be pursued in the near term (e.g. sustainable forest management). Others will take more analysis and consideration.

The town and the WAC will host an open meeting on December 12, 2006 to solicit public comment related to the values identified during these workshops and to consider additional values and indicators that might be presented. There is no single or correct set of values to guide the management of the watershed. Values evolve over time as the needs and wants of society change. The WAC will work to ensure that actions taken within the watershed protect and sustain the town's values.

We encourage the reader to become active in the charting the future of the Waynesville watershed. You can learn more about how you can participate by visiting the Town web site (www.townofwaynesville.org).

Table 1. List of candidate environmental, social, and economic values proposed by the workshop participants for the Waynesville watershed on June 15, 2006.

Value Set	Component (value to be sustained or maintained)
Environmental	<ul style="list-style-type: none"> Diversity of plant and animal communities Unique plant and animal communities Maintaining natural rates of change (maintaining landscape stability) Wildlife habitat Exotic/invasive species (reduce or eliminate) Native “out of bounds” species (prevent species from becoming overabundant) Soil health Forest resistance (immunity) and resilience (ability to recover) to stress (disease, air pollution, climate change, exotic plant species, etc.) Quantity of water Clean water- low sediment loads Contaminants in water (eliminate or minimize) Water quality – drinking water standards Aquatic habitat and health Quality and quantity of groundwater Bypass flows (around dam)
Social	<ul style="list-style-type: none"> Education (e.g. informing public about prior land use/cultural history, watershed wildlife, sustainable timber management; watershed field trips). Public participation in watershed management Scenic and aesthetic qualities of the watershed Manage infrastructure (roads) for protection of the watershed (e.g., fire, disease) Contribution to scientific training and research Community pride for drinking water quality Quality of life
Economic	<ul style="list-style-type: none"> Selling water (to other communities and bottled water) Timber revenue (including firewood sales) Non-timber products (ramps, ginseng, other botanicals, bloodroot, mushrooms, galax, moss) Guided fishing/hunting permitting (e.g., fly fishing) Job creation Fish farming Reservoir capacity Reservoir structure Educational center as a tourist destination (see “education” in Social values) Tourism Water conservation Future water needs in relation to economic growth)

APPENDIX A (List of Forest Values and Possible Indicators proposed by the workshop participants for the Waynesville watershed on June 15 and July 26, 2006.)

Value Set	Component (value to be sustained or maintained)
Environmental	<p>Diversity of native plant and animal communities</p> <p>Condition Indicators</p> <ul style="list-style-type: none"> Number and area of cover (vegetation) types Number and area of native forest types Number and area of forest age classes (including multi-age stands) Number and area of herbaceous plant communities Plant habitat diversity Plant species diversity in each vegetation type Deadwood (logs and snags) <p>Pressure Indicators</p> <ul style="list-style-type: none"> Presence of insects and diseases (i.e. Hemlock adelgid) (-) Amount of roads (potential corridors for invasive species) (-) Timber harvesting (+ or -) Climate change (-?) Public use (+ or -) Active silviculture to create desired habitat diversity <p>Policy Response Indicators</p> <ul style="list-style-type: none"> Plan to involve citizen-scientists in monitoring Track climate change and manage accordingly <p>Unique plant and animal communities</p> <p>Condition Indicators</p> <ul style="list-style-type: none"> Number and area of unique plant communities (as defined by Natural Heritage Program) Number of rare and/or T/E species Population sizes (viability) of rare and/or T/E species <p>Pressure Indicators</p> <ul style="list-style-type: none"> Poaching of rare and/or T/E species (-) Harvesting of non-timber products (e.g., ramps) (-) <p>Policy Response Indicators</p> <ul style="list-style-type: none"> Written plan for how to manage/not manage unique plant communities Written plan to enhance populations of rare and/or T/E species <p>Maintaining natural (historical?) rates of change (maintaining landscape stability) Avoid accelerating change outside of the natural rate of change)</p> <p>Condition Indicators</p> <ul style="list-style-type: none"> Annual frequency and area of “natural” and “non-natural” landslides Area within natural (historical) range of variation in disturbance <p>Pressure Indicators</p> <ul style="list-style-type: none"> Degree with which forest management departs from natural (historical) range of variation Area in roads Clearcutting (acres/year) Large non-human disturbances (e.g., micro-bursts)(acres/year) <p>Policy Response Indicators</p> <ul style="list-style-type: none"> Application (and monitoring) of appropriate road building BMPs Written definition of natural (historical) range of variation Written harvest prescriptions consider natural range of variation at the stand and landscape levels for each harvest block <p>Wildlife habitat</p> <p>Condition Indicators</p> <ul style="list-style-type: none"> List of native terrestrial species (especially songbirds, water birds, conspicuous mammals/furbearers, insects) List of native fish species Hard mast (nuts and acorns) tree abundance/density Soft mast (fruits and berries) production Area of early successional forest habitat

- Pressure Indicators
 - Creating habitat for species of interest (e.g., rare species, game species, early-successional species, etc.)(+)
- Policy Response Indicators
 - Support volunteer bird count programs
 - Working with state agencies and universities to promote wildlife research in watershed

Exotic/invasive species (including plants, disease, and insects)

- Condition Indicators
 - List of exotic species in watershed
 - Rate of spread of exotic species
 - Spatial distribution of exotic species occurrences
- Pressure Indicators
 - From Forest Resistance: Exotic species eradication – acres treated /years
 - Salvage logging
- Policy Response Indicators
 - From Forest Resistance: Policy to control exotic and invasive species
 - Policies for salvage logging

Native “out of bounds” species

- Condition Indicators
 - Level of forest regeneration (e.g., deer browsing pressure)
 - Deer abundance
 - Turkey abundance
 - Red maple and other shade tolerant species
- Pressure Indicators
 - Levels of hunting (+)
 - Level of disturbance (e.g., natural, timber harvesting)(+ or -)
 - Aggressiveness (low, medium, or high) of management objectives regarding ‘out of bounds’ species in surrounding watersheds (e.g., promoting or controlling deer, turkey, etc.)
- Policy Response Indicators
 - Use monitoring data from surrounding watersheds (NF and NP)
 - Policy identifying goals for “out of bounds” species

Soil health

- Condition Indicators
 - Silt – soil erosion levels
 - Soil fertility
 - Soil nutrients
 - Soil organic matter content
 - Condition of exposed cut and fill areas on roads
- Pressure Indicators
 - See Aquatic Health
- Policy Response Indicators
 - Policy to restore historical soil condition (soil fertility, nutrients, organic matter content)
 - Policy for managing eroding/failing roads
 - See Aquatic health and Sedimentation policy response indicators related to BMPs and soil erosion
 - Policy for leaving slash and wood that could be sold for pulp

Forest resistance (immunity) and resilience (ability to recover) to stress (disease, air pollution, climate change, exotic plant species, etc.)

- Condition Indicators
 - Diseased trees- stems/acre
 - Lack of expected wildlife- percent of expected
 - Age of the plants/trees- age class distribution
 - Diameter growth rates of dominant crown class
 - Species
 - Species richness in a stand
 - Short-term change in the mortality rate of dominant and co-dominant trees
 - Balanced growth areas- age, diversity
 - Herb layer diversity
 - Volume-biomass/acres (relative to site quality)

- Age-class distribution and diversity of watersheds as a whole
- Growth/mortality and removal ratio (trees)
- Pressure Indicators
 - Exotic species eradication- #acres treated per year (+)
 - Forest restoration- fire, thinning- acres/yr (+)
 - Wildlife habitat improvement- acres/yr (+)
 - Reintroduction of blight-resistant American chestnut- acres/yr (+)
 - Increased tree vigor- average growth rate per year (+)
 - Increase in diversity across the landscape- age class distribution, etc. (+)
 - Removal of diseased trees- percentage removed/year. (+)
 - Air pollution (-)
 - Fire (can be positive) (-)
 - Drought stress (-)
 - Increase in exotic/invasive species (-)
 - Number of insect pests & diseases- exotics (-)
- Policy Response Indicators
 - Remove white pines and replace with hardwoods
 - If allow public use, user fees apply
 - Adopt a forest stewardship plan
 - Long-term measurement of indicators- policy for monitoring program
 - Policy to control exotic and invasive species
 - Policy to implement silvicultural treatments designed to increase “diversity” across the landscape.
 - Creation of an endowment to support these policies or other long-term funding plan.

Quantity of water

- Condition Indicators:
 - Water usage by customers
 - Water over spillway
 - Total water flow (already gathered)
 - Annual runoff
 - Reservoir capacity
- Pressure Indicators:
 - Drought (-)
 - Vegetative cover in the watershed (- +)
 - Rainfall (+)
 - Water usage by customers (-)
 - Rising per capita consumption (-)
 - Degradation of pipe infrastructure below reservoir(-)
 - Selling water to other entities (-)
- Policy Response Indicators:
 - Water conservation program
 - Water pricing

Clean water- low sediment loads

- Condition Indicators
 - Sediment monitoring: background monitoring of current levels at locations throughout the watershed (TSS, mg/L; turbidity in NTUs)).
 - Measurements of fines at water treatment plant (mg/L)
 - Project-level monitoring (mg/L; NTUs)
 - Sedimentation rate- historical (can assess over decades with cores)(cm/yr)
 - Sediment rate / load (have to measure discharge to get load); will be automated just above reservoir soon.
 - Geochemical fingerprinting (can tell where sediment is coming from in watershed)(EXPERIMENTAL measure)
 - Benthic macro invertebrates (integrate information over a longer time frame)
 - Measure of embeddeness (how much fine sediment is in the stream bed) – a relatively poor indicator
- Pressure Indicators
 - miles of unimproved road (-)
 - number of stream crossings (-)
 - number/density/severity of natural landslides (-)
 - severity of storm events (-)
 - stream bank erosion (-)
 - Intensity and frequency of forest logging (-)
 - Intensity and frequency of fire, windthrow (-)
 - Unstable and unprotected cut banks and fill slopes (-)
 - Number of improved stream crossings (+)

- Measures of compliance with BMPs (+)
- Miles of road improvement (+)
- Policy Response
 - Inventory of the condition and classification of the existing road system for sedimentation impact
 - BMPs for all types of land disturbance; e.g., effective buffer widths, adjusted for slope, and monitoring of their effectiveness
 - Good contract administration
 - Policy to identify good contractors and equipment and methods (timber, road building, etc.).
 - Post-disturbance assessment policy- someone to go look at the site and assess.
 - Develop models for sound assessment and management tools (e.g., numerical models). (As a predictive tool).

Contaminants in water

- Condition indicators
 - Levels of petroleum/man-made organics
 - Pesticide concentration (esp. if gypsy moth spraying)
 - Mercury concentration
 - Nitrogen and phosphorous (cations) concentrations
 - Concentration of heavy metals (required by state)
 - Dissolved O2 concentration
 - Fecal coliform levels (measure at head of the stream)
- Pressure indicators
 - Equipment operating in watershed (-)
 - Air pollution (-)
 - N and P leads to changes in plant cover (-)
 - Public use of watershed (-)
- Policy Response indicators
 - Good contract administration
 - Good written BMPs for contaminants from equipment
 - Address issues with TVA
 - Address issues of air quality, mostly to southwest

Water quality

(follow existing water quality standards and water plant testing protocols)

Aquatic habitat/health

- Condition Indicators
 - water temperature
 - Dissolved O2 concentration
 - Discharge rate
 - Sedimentation rates
 - Stream substrated/embeddedness
 - Amount of coarse woody debris
 - Stream geomorphology
 - N, P, C nutrient levels
 - pH
 - Macro invertebrates (state uses index)
 - Fish community (state uses an index); periodic, recurring survey
 - Riparian zone condition (measures of mature forest within XXX' of the stream).
 - Canopy cover over stream
 - Amphibian survey
- Pressure Indicators
 - Road building (-)
 - Timber harvesting (-)
 - Stream crossings (-)
 - Forest composition and age (- or +)
 - Natural landslides (-)
 - Channel instability (-)
 - Sedimentation (-)
 - Acidic deposition from the air; will affect above parameters (-)
- Policy Response Indicators
 - BMPs for road crossings and timber harvesting and other activities
 - see sedimentation policies fs

Quality and quantity of groundwater

(indicators to be developed by experts)

Bypass flows

Condition Indicators

Level of flows

Pressure Indicators

Water district growth (-)

Drought (-)

Reservoir capacity (+)

Water district demand (-)

Water conservation (+)

Policy Response Indicators

Municipal policy for maintaining minimum bypass flows

TVA or state policy requiring minimum bypass flows

Social

Public education

Indicators to be developed. Possible public education ideas discussed were:

- A demonstration forest for watershed monitoring and management for schools, adult informal education, community colleges, and universities; perhaps could evolve into a tourist destination.
- Communicate that the watershed is not sacred ground that it has been 'touched' before. It has a long history of natural resource use.
- Pull together the history of the watershed (WCU staff)
- Host annual 'watershed days'
- Wild bird tours
- Hiking trail to mine
- Hikes led by Little Tennessee Land Trust
- Extension opportunities in watershed (how to do eco-friendly forestry)

Public participation (in watershed management)

Indicators to be developed. Possible mechanisms for participation discussed included:

- The Watershed Advisory Committee should be reflective of Waynesville citizenry.
- Biannual public education/consultation/outreach meetings
- Public needs to be kept apprised of what is going on in the watershed – public education meeting with opportunity for public feedback, reporting via town web site, alert press, etc.
- The Watershed Advisory Committee should be open with the public about its activities and decisions.
- Press release, public forum with posters about watershed and this indicator selection effort; develop a form to get comments from the public about proposed values to sustain.
-

Scenic/aesthetic qualities/viewshed protection

Indicators to be developed. Scenic issues discussed included:

- No clearcutting unless required to sustain a particular public value.
- Maintaining viewshed from the Blue Ridge Parkway.
- Using computer visualization software to predict viewshed changes as a result of any timber harvesting.
- "Feather" harvest unit edges to minimize hard edges.
- Managing logging slash, but explain to the public that slash is good for wildlife and good for forest soils.

Manage infrastructure (roads) for protection of the watershed (e.g., fire, disease)

Indicators to be developed. Discussion ideas included:

- Maintaining roads for access to control fires and disease.
- Apply BMPs and use watershed as a demonstration/model forest area.
- Small woodlot owner training
- Opportunities with other outreach entities (extension, woodland owners association, Cradle of Forestry)

Contribution to scientific training and research

Indicators to be developed once specific research and training programs are proposed.

Discussion points included:

- See Wildlife Habitat value policy response indicators
- Keep a list/description of scientific research projects
- Town is willing to allow the watershed to be used for research and training
- Research must not be detrimental to any watershed values (i.e. it is not to be used for studying catastrophic clearcuts like those at Coweeta or Hubbard Brook)
- There are opportunities for synergy between research, education, outreach, and tourism.

Community pride for drinking water quality

No indicators were selected. A program to build community pride should be developed. Ideas discussed included:

- Have "watershed days," where citizens are invited to the watershed to learn about it.
- The town should enter drinking water contests.
- Develop a watershed brochure.
- Develop an annual newsletter that informs the public about activities in the watershed and ecology of the watershed.
- Develop a public understanding of the very high quality of Waynesville's water, and the associated high quality of life contributed to by the watershed.
- Share watershed data with the public.
- Develop video media of current logging practices (see NC pro-logger training program, NC extension programs, etc.)

Quality of life

No indicators were selected. See community pride in drinking water above, and education opportunities. There are many examples of community 'quality of life' indicators that could be developed for Waynesville. An annual survey is one approach to measure quality of life.

Economic

Selling water (to other communities and bottled water)

Condition Indicators

- Projected surplus water levels
- Revenues from selling water

Pressure Indicators

- Town population growth (-)
- Regional population growth (+)
- Local water demand (-)

Policy Response Indicators

- Economic assessment of water sales opportunities

Alternative energy opportunities (hydropower, wind power)

Condition Indicators

- Revenues from selling energy/\$ saved from using energy
- Projected energy supplied

Pressure Indicators

- Town population growth (-)
- Local energy demand (+)
- Energy prices (+)

Policy Response Indicators

- Economic assessment of alternative energy opportunities using the watershed.

Timber revenue (including firewood sales)

Condition Indicators

- Timber volume (species, size, grade)
- Revenue from timber harvesting (by product class)
- Acres treated (harvested)

Pressure Indicators

- Timber market conditions (for different species and product classes)(+)
- Availability of loggers/ logging infrastructure (+)
- Bio-fuel markets (+)
- Public attitudes about timber harvesting (+ or -)
- Forest certification (Southern Forest Network, SLMF, etc.) (+)
- Conservation easement monitoring (+)
- Level of university involvement (+)

Policy Response Indicators

- Regular forest inventory
- Timber growth and yield modeling
- Discounted cash flow analyses
- Having a well-developed forest management plan
- Having a well-developed Watershed Advisory Committee

Non-timber forest products (NTFPs) (ramps, ginseng, other botanicals, bloodroot, mushrooms, galax, moss)

Condition Indicators

NTFP inventory levels (#/acre, lbs./acre, etc.).

Pressure:

NTFP harvesting levels.

Policy Response:

Have a well-developed NTFPs management plan with licensing system (different for each NTFPs)

Discussion points:

- Are town residents comfortable with harvesting NTFPs?
- What is the economic value of NTFP? We need an assessment.
- Could we promote wild cultivation of NTFPs (e.g., ginseng)
- Understand any easement restrictions for NTFP harvesting?
- At one time rhododendrons were transplanted from the watershed for public landscaping.

Guided fishing/hunting permitting (e.g., fly fishing)

No indicators were selected. An assessment of opportunity should be conducted first.

Discussion issues:

- Guided fishing best suited for Rocky Branch Stream, but still might be too small for good fishing.
- Hunting/fishing should be supervised in order to control access and negative impacts on watershed.
- Fishing might be marketed as a unique experience for southern Appalachian Brown Trout.
- There has been regular interest in guided fishing in non-stocked areas.
- Could develop guided hiking in Rocky Branch Stream area.
- Does the town want people to go into the watershed? This question should be addressed by the Watershed Advisory Committee.
- What does the conservation easement say about public access?

Jobs/Job creation

No indicators were selected at this time. But, the number of jobs supported by the watershed could be monitored.

Fish farming

No indicators were selected. The Watershed Advisory Committee should study feasibility before indicators can be selected.

Change in reservoir capacity (due to silting)

No indicators were selected. This may be monitored by the Water Department.

Reservoir structure

No indicators were selected. This should be monitored by the Water Department

Educational center as a tourist destination

No indicators were selected. The feasibility of an Education Center needs to be determined.

Tourism

No indicators were selected. A tourism feasibility assessment must be conducted.

Quality of life

No indicators were selected. There are many examples of 'quality of life' indicators. The Watershed Advisory Committee may develop a set of quality of life indicators appropriate for Waynesville residents.

Water conservation

No indicators were selected. Per capita consumption is already measured. A program in water conservation would make a good policy response indicator. The effect of such could be measured through per-capita water consumption; the number of installed low-volume toilets, etc.

Increase in demand of water (interface with economic growth)

No indicators were selected (see water conservation).

Minimizing operating and administration costs for the watershed.

No indicators were selected. The volunteer Watershed Advisory Council will make sure costs are in line with affordability. Revenue from the watershed should more than offset operating and administration costs.

**FURTHER READING**

Hagan, J.M., and A.A. Whitman. 2006. Biodiversity Indicators for Sustainable Forestry: Simplifying Complexity. *J. Forestry* 104:203-210. (available on-line at www.manometmaine.org)

Hagan, J.M., and A.A. Whitman. 2004. A Primer on Selecting Biodiversity Indicators for Forest Sustainability: Simplifying Complexity. *Forest Mosaic Science Notes* 2004-1. (available on-line at www.manometmaine.org).