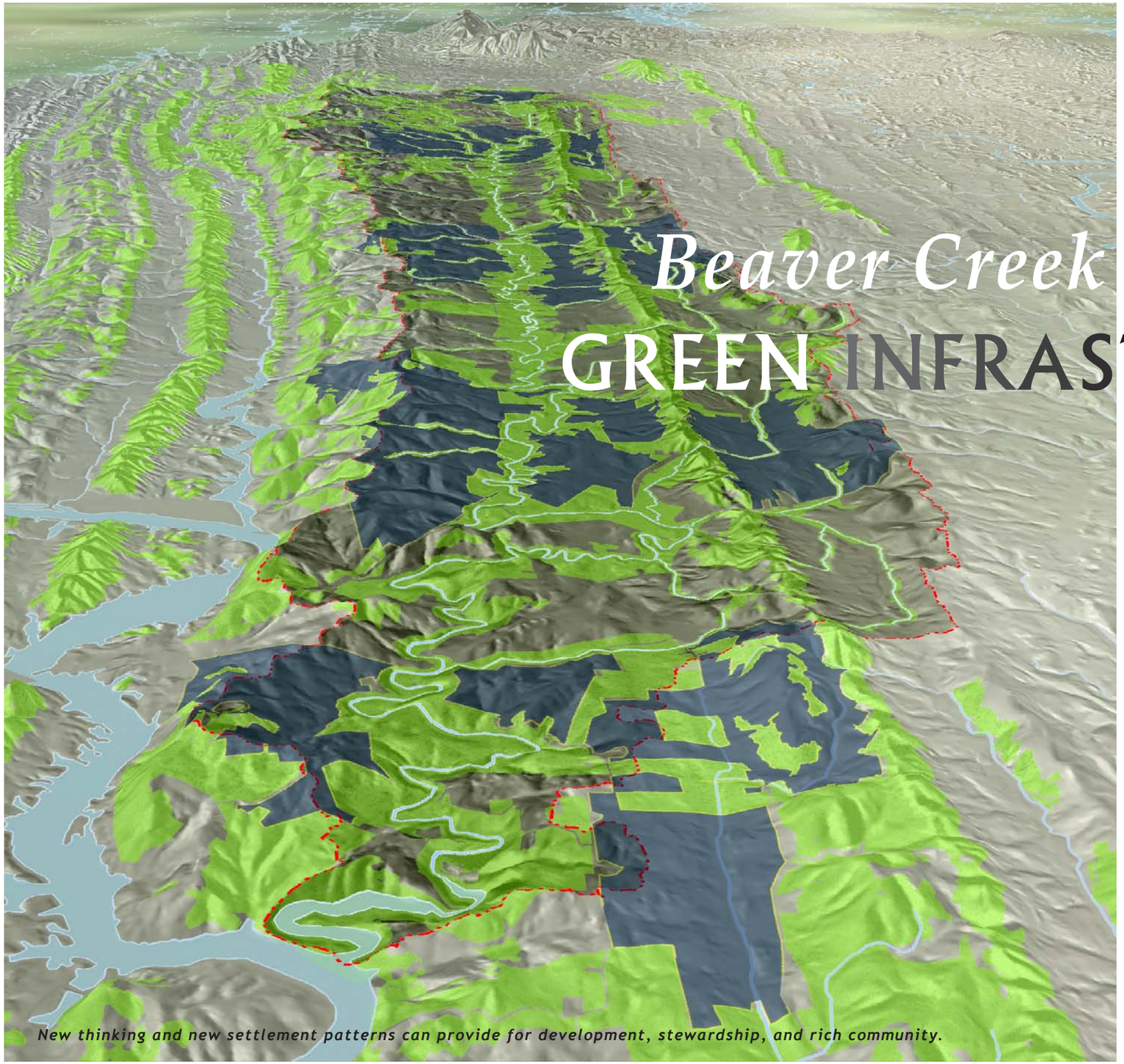
Beaver Creek Watershed GREEN INFRASTRUCTURE *plan*



New thinking and new settlement patterns can provide for development, stewardship, and rich community.

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Cover Image by Andrew Wunderlich
View of the Beaver Creek Watershed, looking up the valley, from southwest to northeast. Proposed communities surrounding town and village centers are shown in gray-blue. Proposed stewardship corridors network is shown in green. Creeks and water are shown in blue.

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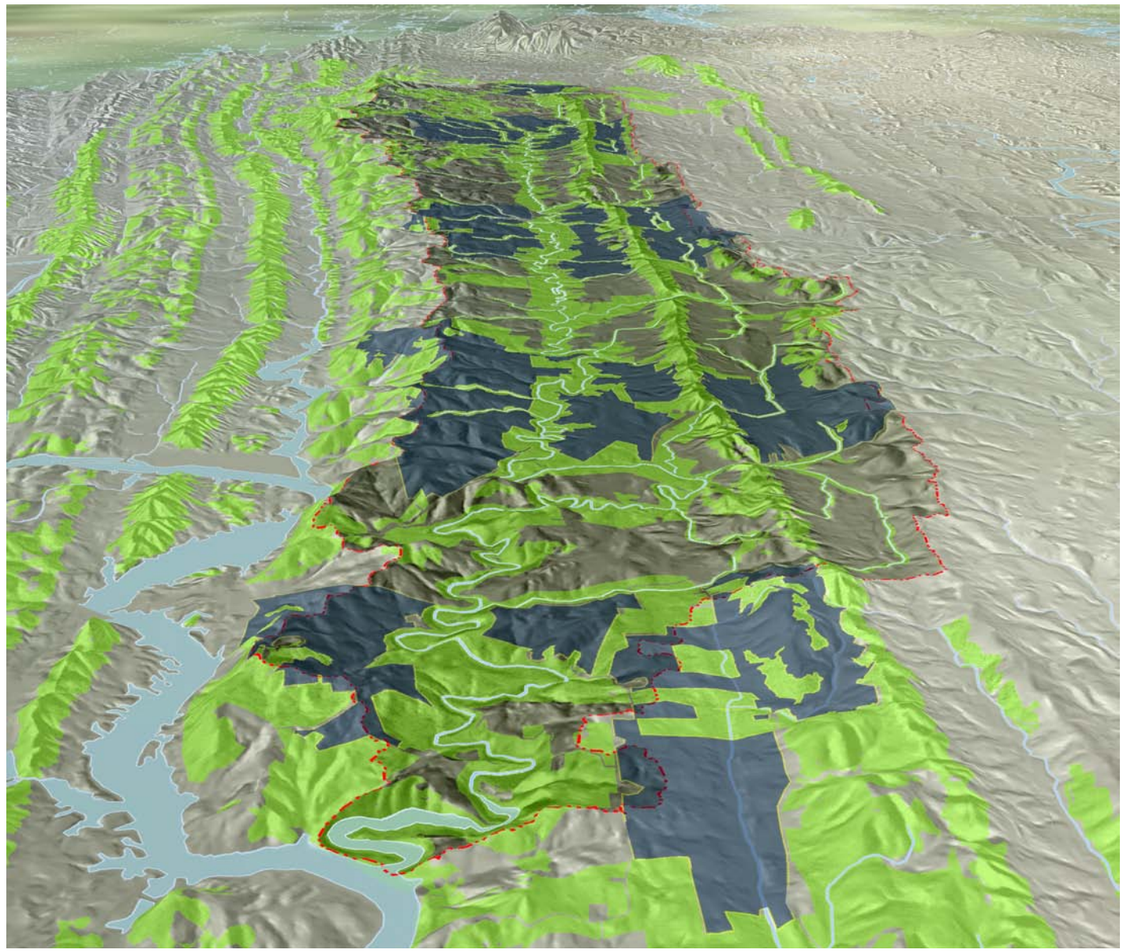


View of the Beaver Creek Watershed, looking down the valley, from southwest to northeast. Proposed communities surrounding town and village centers are shown in gray-blue. Proposed stewardship corridors network is shown in green. Creeks and water are shown in blue.

EXECUTIVE SUMMARY

sum

Good planning can reduce current problems and avoid creating many new ones. This project develops a plan for the Beaver Creek Watershed's green infrastructure, incorporating *smart growth* and *smart conservation* concepts.

A. BACKGROUND AND CURRENT CONDITIONS

Objectives

This plan uses the GREEN INFRASTRUCTURE approach:

- *To help protect and restore* naturally functioning ecosystems;
- *To propose* solutions that can improve water quality and mitigate flooding;
- *To enhance* recreation opportunities; and
- *To provide* a framework for future development.

Some of its further objectives are:

- *To identify* ways to connect communities and neighborhoods;
- *To identify* conservation buffers for riparian zone protection, flood mitigation, wetland protection, and habitat value, in support of future easements;
- *To identify* lands for greenway development; and
- *To identify* lands with significant historical, recreational, or visual value.

What Is Green Infrastructure?

Green Infrastructure is the supporting systems the landscape provides for a settlement— an interconnected system of natural areas and other open spaces managed for the benefits to people and the environment. This system interconnects elements of the natural and cultural infrastructure elements. Green Infrastructure includes natural areas, recreational places, infrastructure elements, heritage lands, and hazard areas.

Driving Issues in Beaver Creek

The Beaver Creek watershed has a history of impaired water quality and flooding of the valley floor. It is one of the most rapidly developing areas in Knox County. The creek is on the 303(d) list maintained by the Tennessee Department of Environment and Conservation (TDEC), which indicates that it violates water quality standards and is too polluted to support many of its designated uses. Beaver Creek is a priority watershed for riparian zone management and protection. Knox County is classified by the EPA as a National Pollutant Discharge Elimination System (NPDES) "Phase II" stormwater community (successor program to the Clean Water Act), which requires plans to be developed to address surface water pollution. The *Beaver Creek Green Infrastructure Plan* is a pilot project that anticipates a government response to Phase II requirements.

Rapid, sprawling, unplanned low-density residential development and corridor commercial development are driving open-space loss, habitat fragmentation, and the degradation of the scenic character and rural lifestyle the area once enjoyed.

Method

Our approach can be described as a knowledge-informed, analysis-driven, synthetic, and creative landscape design approach to planning issues. In very broad terms, we have conducted this study in stages of documentation, analysis, generation, synthesis, prioritization, and design.

B. THE LAND & ITS SETTLEMENT PATTERNS

In this section we examine basic patterns of the land that influence open space and development: terrain and slope, forest cover, and historic and present settlement patterns in the watershed.

Landform Elevation

The spirit of the Beaver Creek Watershed is heavily dependent on its relationship with its unique landscape.

The watershed's landform presents several potential issues that influence how people can settle in it:

- Steep slopes with thin clay soils, subject to landslides and erosion, particularly if tree cover is removed.
- Sinkholes, which are collapsed caves in limestone.
- Limited options for locating transport routes.
- Limited flat land, which increases pressure for development of farmland. This also leads to a dispersed urban pattern with large intervening areas of steep undeveloped land.

Existing Forest

Continuous forest corridors remain on the ridges, but development on the valley floor has significantly reduced the streamside forest.

The natural land cover in this region is dense forest, which once characterized the Beaver Valley. However, in the Beaver Creek Watershed, continuous forest corridors remain only on the ridges, while develop-

DRIVING ISSUES

Plan-initiating Issues

- Increased Flooding
- Poor Water Quality
- State "303d List" of Polluted Streams
- Conservation Easements

Related Issues

- Sprawl
- Open Space Loss
- Habitat Fragmentation
- Degrading Rural Character

BASIC METHOD OUTLINE

1) **DOCUMENT** existing green infrastructure networks.

2) **ANALYZE** each system to understand the issues.

3) **GENERATE** "corridor" proposals for ridge preservation, water feature protection, and heritage preservation.

4) **SYNTHESIZE** these into a composite stewardship pattern.

5) **PRIORITIZE** land for conservation programs.

6) **DESIGN** proposals within a conservation framework:
   - new and strengthened settlement centers
   - locations for conservation neighborhoods
   - locations for density gradients of settlement.

DESIGN a network of parks and greenways linking recreation land, centers, and communities.

ment on the valley floor has significantly reduced the streamside forest. Even these ridge forests are broken by many roads.

Continued deforestation results in multi-million dollar financial consequences, as well as quality-of-life consequences. In particular, loss of streamside forest contributes to flooding and degrades water quality and habitat in streams. Deforestation on slopes leads to erosion and possible landslides. Loss of trees anywhere in the watershed increases local temperatures, energy use, and rainfall runoff volume.

Existing Development

Much of the Beaver Creek Watershed is suburbanized already. Look south to North Knoxville to see the future of business-as-usual development in Beaver Valley. Sprawl covers former farms. There are no towns and no villages, only strip commercial.

From south to north, moving from Knoxville to north county fringes, unplanned suburban development is inversely proportional to agricultural land use. Over time, the commercial strip and the single family, low-density subdivisions are replacing rural farms and towns. Communities are losing their identity. The green farmland residents care about is disappearing.

New development is universally of the sprawl type. Commercial development is mostly automobile-oriented strip-type.

Neighborhoods & Centers

This analysis shows that the Beaver Creek Watershed's community structure follows none of contemporary planning's best practices.

Currently, shopping, home, work, and play are all in different low-density zones, and development practices rely on everyone driving to everything all the time. Neighborhoods are nowhere near the services these people need. All commercial development is linear and auto-oriented.

Conclusions

Out-of-control "sprawl" is merging the formerly distinct communities of Gibbs, Halls, Powell, Karns, and Solway. The new I-475 exits to the valley will accelerate this growth. The area's scenic beauty and rural landscape heritage is disappearing as farms convert to subdivisions. New residences are dispersed at low density, which is an expensive way to build. Commercial areas are located along highways. Everyone must drive or be driven, and no one can walk or bike. Due to this pattern of development, traffic is worse every year.

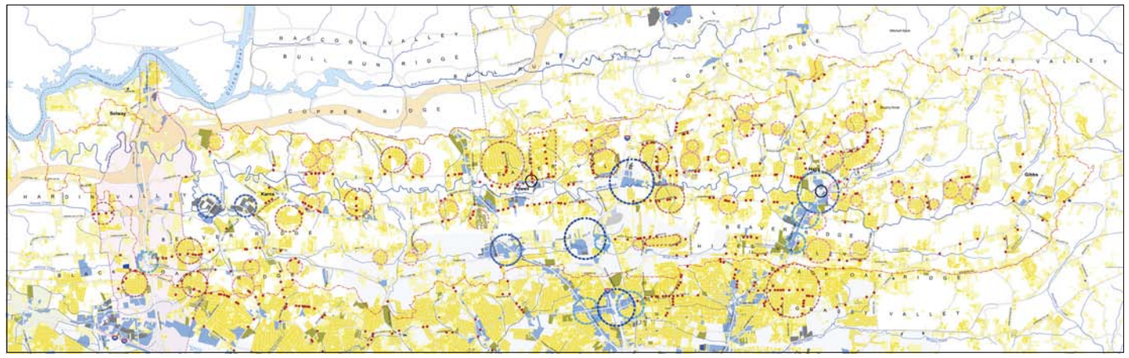
C. THE OPEN SPACE NETWORK

Planning Open Space

If a community wants to grow while maintaining a high quality of community health, safety, and welfare, it needs to identify lands that contribute to community values.

Beyond identifying land, the community must strategize to maintain these lands in an undeveloped or lightly developed state and work to connect these lands into an *Open Space Network*.

An OPEN SPACE NETWORK is an interconnected pattern of open space elements (parks, greenways, forests, wetlands, etc.) that allows the system to function in an integrated way. These elements must be interconnected so that people, water, and wildlife can move and flow between destinations as needed.



Neighborhoods and Centers Analysis: centers without neighborhoods; neighborhoods without centers.

Evaluation of Existing Parks and Greenways

Strengths
- *Good access to active recreation opportunities.*
- *Schools and libraries are linked to parks.*
- *Schools have sidewalks.*
- *Greenway segments are well-located.*

Weaknesses
- *No pedestrian network.*
- *Parks and greenways are unevenly distributed.*
- *Many new "close-to-home" parks are needed.*

GOALS FOR UNDEVELOPED OPEN SPACE

- **Identify Conservation Land:** To find the best places for conservation and development.
- **Protect the Public:** To maintain high health-safety-welfare value land, maximizing its contribution.
- **Save for the Future:** To "bank" good farm land for growing food locally in the future.
- **Foster Local Identity:** To separate communities and preserve rural heritage.
- **Weaving Networks:** To plan for a framework of heritage land and environmentally valuable land in an interconnected system.

Habitat Land and Farm Land

We have analyzed the land for its value as wildlife habitat and for farming, along with a comparative study of these different values. Both upland and riparian areas were ranked for habitat value, *based on the criteria* of patch size, interior patch habitat size, connectivity to other habitat patches of the same type, distance to water, and species richness.

- Riparian forest is already very rare; upland forest is disappearing rapidly with new development.
- Forest remains mostly on steep slopes and ridges, Beaver Ridge, and parts of Black Oak Ridge.
- Grassland is mostly farm meadows, with little or no native grassland habitat remaining. However, restoration of some grassland as native species preserves is recommended.

A community with vision will preserve its best farmland for the future. Our question was, Where is the best land for farming? We ranked parcels by their *soil suitability* for agriculture. The implication of this analysis is that working farms with good soil should be kept for future generations, and new development should be directed to land less suited for agriculture.

Land characteristics suggest potential land use. Some land is good for wildlife habitat and agriculture. Our analysis intersects *Land Valuable for Wildlife Habitat* with the *Agricultural Land Value* analysis. The resulting map should be consulted on every land-use decision for these parcels. It gives a concrete basis for adding agricultural and wildlife values to land decisions.

Conclusions

Both farmland and wildlife habitat are fragmented by sprawling suburbs. Together, using foresight, stewardship, and decisive action, the valley's valuable land, heritage, and beauty can be saved.

Without foresight, stewardship, and decisive action to guide development, the watershed will become just another sprawling suburb. Our analysis shows this with undeniable clarity.

D. PROTECTING THE WATER NETWORK

When it comes to water, our current land development methods have grave implications for public health and safety.

The Beaver Creek floodplain is growing. Streams and floodplains are dynamic features. *They change in response to changes made in the landscape uphill from the stream.* In the last 10 years, many more people, homes, and businesses have moved into the watershed. Changes caused by current development practices can be boiled down to two impacts:

1) *Stream water quality* is worse now than it used to be, and it continues to decline.
2) *Flooding* is worse now than it used to be, and it is getting even worse.

One of the most important things we did in this study was to assemble a map that included the water features that are important to water quality and flood mitigation. To protect these water features, we identified a *protective buffer* of land. In this buffer, natural characteristics of the land are maintained or restored for purposes of protecting water quality, maximizing stormwater storage, and promoting infiltration.

The buffer concept we used is one of *variable width with a minimum size*. Our buffer approach is based on three principles:

- *Create a continuous linear buffer* that protects the stream network, including Beaver Creek and its tributaries.
- *Protect streams and adjacent features together,* so the linear buffer is expanded to include associated floodplains, wetlands, springs, and sinkholes.
- *Protect chains of related features,* like sinkholes or wetlands that occur distant from a stream by uniting individual feature buffers into a linear buffer.

The EPA recommends dividing a buffer into three zones, where management practices vary from *protection* (closest to feature) to *conservation* (in the middle) to *stewardship* (furthest from the feature).

Zone 1: Protection, contains Beaver Creek and its tributaries, plus nearby springs, wetlands, sinkholes, and impacts (steep slopes).

Zone 2: Conservation, remains at a minimum width and expands whenever the floodplain extends beyond this minimum distance.

Zone 3: Stewardship, is an area at the edge of the buffer designated to provide a transition to the more groomed character of the places where people live.

Conclusions

The valley can definitely absorb more development. Conservation and development can coexist as complementary patterns.

The question is, What kind of development and in which places? This chapter covers our recommendation on answering the *"where"* part of this question, relative to water issues. We have identified a repeatable, rational method for incorporating protected lands into a system of WATER FEATURE BUFFERS. This approach can be applied anywhere in this region, yielding similar results.

E. COMPOSITE PATTERNS: GREEN INFRASTRUCTURE

Green Infrastructure is the supporting systems that the landscape provides for a city: an interconnected system of undeveloped natural areas and developed open spaces managed for benefit of people and the environment.

Our objective in this portion of the work was to identify the best land for conservation to achieve diverse goals for specific public benefits. Second, we linked these different conservation areas into an integrated network.

The Land Stewardship Network

In the Beaver Creek Watershed study, we've developed new patterns relevant for the ridge-and-valley type landscape.

In particular, we identified and proposed four types of STEWARDSHIP CORRIDORS that link together to create a composite LAND STEWARDSHIP NETWORK pattern:

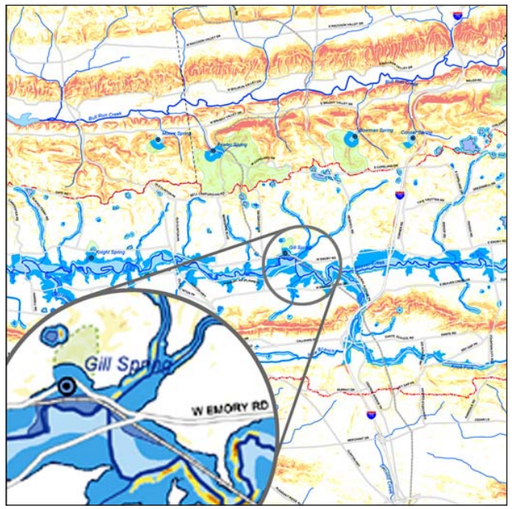
- STREAM PROTECTION CORRIDORS, which expand, link, and protect WATER FEATURE BUFFERS.
- GROUNDWATER PROTECTION CORRIDORS, which link strings of nearby springs and sinkholes in particularly sensitive areas where karst geology makes the groundwater system especially vulnerable.
- RIDGE PROTECTION CORRIDORS, which protect steep slopes and the forests on them.
- HERITAGE PROTECTION CORRIDORS, which include and connect RURAL RESERVES and tie these to the other corridors.

The LAND STEWARDSHIP NETWORK represents the land most valuable for conservation to the community as well as natural processes. Levels of recommended conservation and development vary as appropriate for each area's open-space value, existing land use, and other characteristics. This network forms a framework within which more intense development, such as IDENTIFIABLE NEIGHBORHOODS and VILLAGE CENTERS, can be targeted by planners and developers.

Conclusions

We have identified timeless patterns that should shape development in this landscape.

We propose solidly reasoned environmental and cultural stewardship as the foundation of the LAND STEWARDSHIP NETWORK. While this is one specific proposal, based on a long series of value choices and informed professional decisions, we believe that ANY proposal attentive to cultural conservation issues in this watershed would arrive at similar core concepts. Ridge, stream, and heritage protection, and their network connections, are deep, significant, timeless patterns.



Composite 3-Zone Water Buffer

The Composite Land Stewardship Network, made of Stream Protection Corridors, Ridge Protection Corridors, and Heritage Protection Corridors

F. A VISION FOR FUTURE DEVELOPMENT

Land, People, and Towns as an Integrated Living Fabric

The Beaver Creek Watershed is at a transitional point. A significant proportion of land ideal for development has already been developed, and sprawl is proceeding rapidly.

A Vision of the Possible

We outline in some detail in this study many of the pressing problems of this area under its current development scenario. It's worth noting, however, that the watershed's development does not have to result in undifferentiated sprawl. It can be planned and managed to help it mature into a place where:

- *Life feels like living in a traditional small town.*
- *Amenities of town living are just steps away from recreational opportunities and green parks.*
- *Children don't need mini-vans to reach soccer practice and scout meetings.*
- *Everyone can have clean air and water.*
- *The county meets its legal environmental obligations.*
- *Property values are strong.*
- *A relationship with nature is a daily event.*
- *Our important land heritage is honored.*
- *Businesses prosper from clustering and higher pedestrian traffic.*
- *Settlement and land form an integrated whole.*

To achieve this vision, we must rethink how our community builds. How we build on the land is the problem as well as the solution. Most of the issues facing the watershed are related to land-use patterns.

The Heart of Our Response: Three "Big Ideas" & One Underlying Perspective

Underlying everything in this report, and our approach, is the idea that the form of settlement grows out of an understanding of landscape context, both ecological and social.

Context informs, bounds the problem, and suggests the shape of, or at least the container for, design solutions. This perspective underlies the three "big ideas" and helps organize the complementary patterns of open space and settlement in the watershed. The LAND STEWARDSHIP NETWORK is shaped by a combination of topography, hydrology, ecology, and settlement. This network in turn shapes the FRAMEWORK OF OPEN SPACE that contains and shares boundaries with settlement centers. These settlement centers form a pattern of linked settlements, a CONSTELLATION OF CENTERS. Within settled areas, context also helps us determine where to recommend different types of neighborhoods creating a TAPESTRY OF NEIGHBORHOOD TYPES.

A Framework Of Open Space. *We need to regard conservation and development as complementary, rather than antagonistic, patterns. To achieve this, watershed residents need: 1) A clear, shared vision of the larger patterns of connectivity; 2) Knowledge about the relative value of land for different uses; and 3) A new definition of conservation that accommodates use.*

We propose two kinds of patterns to address current open-space fragmentation and to link conservation and development:

- LAND STEWARDSHIP NETWORK, which spatially defines the larger stewardship patterns in which individual properties participate.
- SPECTRUM OF CONSERVATION LAND, which allows for and defines a range of levels of conservation and types of human activities, based on the land's relative values for both.

A Constellation Of Centers. *We believe that the future of this landscape lies in an interconnected net of centers of different types, at three scales.*

Beaver Valley has a choice: a wall-to-wall carpet of sprawl or a more complex pattern of many centers where people live closer together in traditional towns and steward open land. In Beaver Creek, *residents are losing the places to which they once belonged,* while *their lives are lived from the automobile.* To address these two issues, we have proposed three kinds of patterns: TOWN CENTERS, VILLAGE CENTERS, and NEIGHBORHOOD CENTERS. Centers give a sense of identity and orientation. They also place homes close enough to each other to support walkable shopping and other services. Density is convenient.

A Tapestry Of Neighborhood Types. *Within available land, different kinds of neighborhoods, varied by density and organization, are distributed by coordinating an ideal town model with suitable use locations.*

Conservation is paid for by development, and if some areas are conserved by limiting development, others must be designated to absorb relatively more new development. We used two concepts about where more and less dense developments are located:

- The model SMALL TOWN, with its DENSITY GRADIENT (dense in the center to dispersed at the edge), and
- SUITABLE USE LOCATIONS, a cornerstone principle of good planning that locates different activities in the best places for each.

The Layout of Centers and Neighborhoods

Bringing Centers to Neighborhoods and Neighborhoods to Centers

Centers, when combined with their related neighborhoods, offer an amazing convergence of social, economic, and ecological benefits. The proposal for a CONSTELLATION OF CENTERS of varying scales is fundamentally different from existing sprawl development in two ways:

- *Mixed-use centers at all scales are tied to specific spatial territories.*
- *Centers are organized around walkable streets, rather than highways.*

It is important to envision how the landscape will look in twenty years when all the available land is built on. There are two options for growth: traditional

Proposed Parks and Soft-transit Network

towns and neighborhoods, or sprawl. This proposal organizes neighborhoods along a DENSITY GRADIENT that can be locally calibrated.

A CONSERVATION NEIGHBORHOOD (CN) clusters housing in one part of a site to preserve conservation features in another part of the site. CNs are especially important in a ridge and valley landscape. We devised a method for assessing the suitability of CNs in the watershed, based on a weighted ranking of two criteria: the presence of moderate slopes (15-25%), and the area's contribution to flood mitigation and water-quality improvement.

A Vision For Developed Open Space

The location of public places has, historically, been opportunistic and poorly tied to settlement structure. In this new vision, public space and settlement structure define each other.

The last step in this planning and design process is a proposal for a PARKS AND SOFT TRANSIT NET. Parks are located based on the FAMILY-OF-PARKS rule, in which the size of parks varies with the distance from home. Parks should never be too far away.

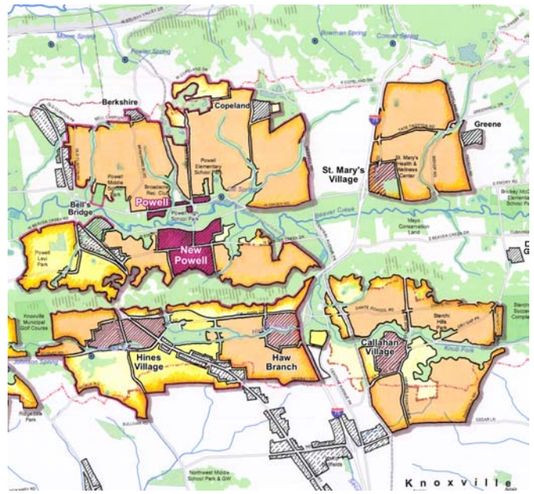
By this way of thinking, the city and county park system needs a few very large central parks and plazas, a few large nature parks, several big city parks, scores of medium-sized neighborhood greens (as many as there are neighborhoods), and a great number of small playlots and pocket parks, a few in each neighborhood.

The drawing on the facing page shows the proposal. The parks system serves each level of settlement center— town, village, and neighborhood— and provides a range of park-use types. The main differences between this proposal and conventional parks planning are:

- *Parks are tied to the structure of neighborhoods*, villages and towns.
- *Soft transit is a network*, not isolated elements.
- *An emphasis is placed on neighborhood greens located in neighborhood centers.*

We strongly believe that parks and public space belong at the heart of our communities and are central to community identity, social discourse, and quality-of-life. *Each settlement center is conceived of as having a neighborhood green, a village square, or a town plaza within it.*

The organization of the SOFT-TRANSIT NET is based on a series of principles:

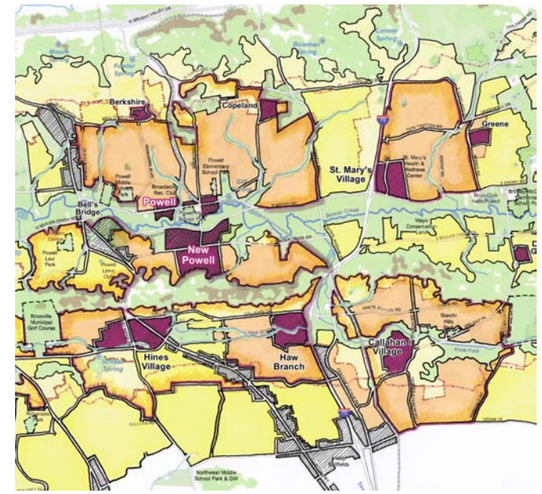


Detail of the proposed town and village centers, with adjacent neighborhoods around Powell

- The SOFT-TRANSIT NET must connect all of the parks in the FAMILY OF PARKS and link all of the public spaces within CENTERS.
- The system is designed for short and long walking loops and for longer biking and hiking loops.
- GREENWAYS use the LAND STEWARDSHIP NETWORK when possible.
- Tree-lined BOULEVARDS create main streets, slow traffic, and link existing neighborhoods.
- COMMUNITY GATEWAYS mark the entry to identifiable towns and villages.
- SAFE STREETS are streetscaped pedestrian routes where greenways are not possible.
- FOOTPATHS and EQUESTRIAN TRAILS connect settlements to more remote terrain.

G. CONSERVATION PROGRAMS

One of the major goals of this plan is to identify priority lands for conservation, including parcels where conservation easements are most appropriate. We identified priority parcels eligible for two government conservation programs, the Grassland Reserve Program and the Farm and Ranch Lands Protection program.



Detail of proposed future build-out development pattern, around Powell

H. CONCLUSIONS

Necessity For New Attitudes

Old attitudes created today's landscape; only new attitudes can ensure that the landscape of tomorrow is different.

Changing Beaver Creek's future requires new attitudes. The community as a whole needs to revise its understanding of land, nature, property rights, and social welfare, and to change how it understands the problems and what solutions are viable or desirable. In short, we must change our perceptions to see that:

- *Nature is everywhere in urban environments.*
- *Development patterns that create healthy community are fundamentally dependent on the majority of citizens holding to the importance of* "community values."
- *The patterns of our city and county are a reflection of what we collectively value. We have a choice to create a clear strong vision of the future or to settle for "sprawl-as-usual."*

SPECIFIC RECOMMENDATIONS IN BEAVER CREEK

- HERITAGE PROTECTION CORRIDORS
- WATER FEATURE BUFFERS
- GROUNDWATER PROTECTION CORRIDORS
- STREAM PROTECTION CORRIDORS
- RIDGE PROTECTION CORRIDORS
- FRAMEWORK OF OPEN SPACE
- LAND STEWARDSHIP NETWORK
- SPECTRUM OF CONSERVATION LAND
- A CONSTELLATION OF CENTERS
- A TAPESTRY OF NEIGHBORHOOD TYPES
- CONSERVATION NEIGHBORHOODS
- FAMILY OF PARKS
- SOFT TRANSIT NET
- CONSERVATION EASEMENTS

Next Steps

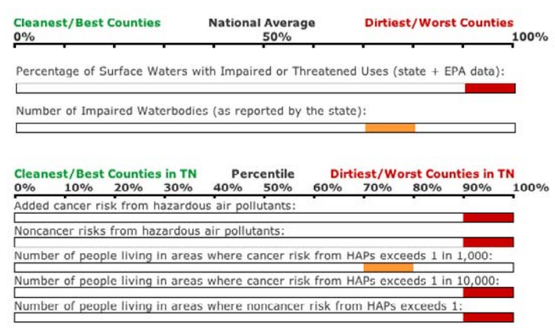
Don't just plan, act!

Continued Study and Implementation in the Beaver Creek Watershed

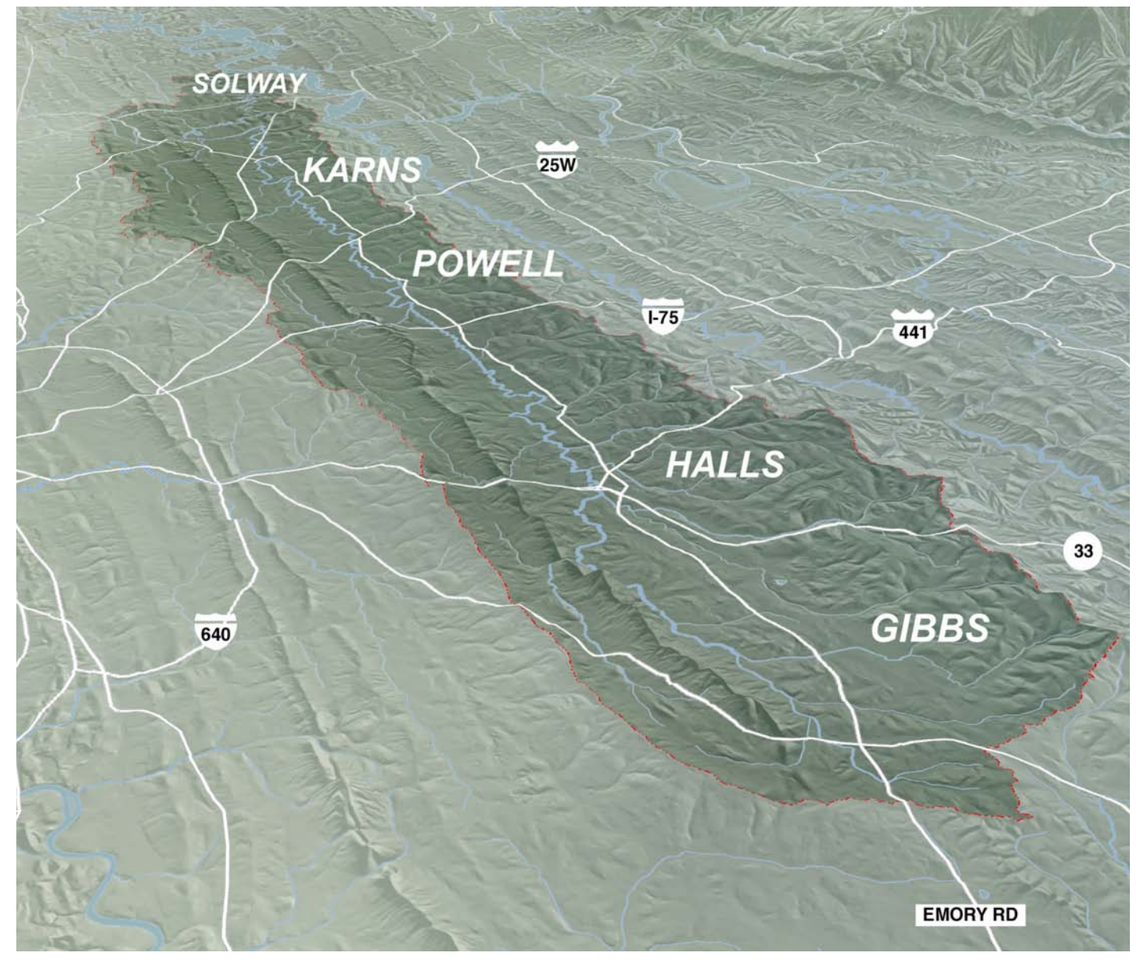
- Design subwatershed plans.
- Design detailed greenway plans.
- Coordinate with the Site Planning Roundtable.
- Create multi-tier development guidelines.
- Modify Metropolitan Planning Commission sector planning.
- Adopt form-based zoning.
- Use green infrastructure plan in MPC approvals.
- Use green infrastructure plan in stormwater permitting process.
- Prioritize and strategize conservation easements.

Expansion of this Work to Other Watersheds

- Expand to the rest of Knox County.
- Develop automated methods.



EPA ranks Knox County among the 10% most polluted counties for both air and water quality, and among the worst counties for air pollution health risks!



View of the Beaver Creek Watershed, looking up the valley, from northeast to southwest. Major roads are shown in white. In ridge and valley terrain, the location of valleys, ridges, and gaps heavily influences road location. The edge of the Cumberland Plateau escarpment appears in the upper right corner. Creeks and water are shown in blue.

BACKGROUND & CURRENT CONDITIONS

A

INTRODUCTION

Good planning can reduce current problems and avoid creating many new ones. This project develops a plan for the Beaver Creek Watershed's green infrastructure, incorporating *smart growth* and *smart conservation* concepts.

Beaver Creek's valley landscape and scenic ridges are a major reason why its residents love where they live. The natural character of the place defines it. Yet this identity is in peril. The Beaver Creek watershed has a history of impaired water quality and is one of the most rapidly developing areas in Knox County. The Tennessee Department of Environment and Conservation (TDEC) has given the entire creek a 303(d) designation, meaning that it violates water quality standards and is too polluted to support many of its designated uses. Knox County government, Knox Land and Water Conservancy, and the National Resources Conservation Service all consider Beaver Creek a priority watershed for riparian zone management and protection.

The *Beaver Creek Green Infrastructure Plan* is a project of the Green Vision Studio at the University of Tennessee's College of Architecture and Design. Professors Tracy Moir-McClean and Mark DeKay are the principle investigators. The plan is not a specific proposal for exactly what should happen in the valley, but rather, a visioning exercise intended to create a reference document. This plan can be used by a variety of individuals and institutions to guide decision making about preservation, conservation, and development patterns.

OBJECTIVES

This plan will use the *Green Infrastructure* approach:

- *To help protect and restore* naturally functioning ecosystems;
- *To propose solutions* that can improve water quality;
- *To enhance recreation* opportunities; and
- *To provide a framework* for future development.
- *To identify* ways to connect communities and neighborhoods;
- *To assess* relationships among green infrastructure, development patterns, and environmental impact;
- *To recommend* implementation strategies;
- *To develop* a context plan for individual conservation easements;
- *To identify* conservation buffers for riparian-zone protection, flood mitigation, wetland protection, and habitat value;
- *To identify* lands for greenway development and reforestation on private and public property; and
- *To identify* lands with significant historical, recreational, or visual value.

LOCATION

The Beaver Creek Watershed lies along the northern border of Knox County. It is entirely contained within the borders of the County and is the largest watershed in the County. It contains the communities (from southwest to northeast) of Solway, Karns, Powell, Halls and Gibbs. Its south boundary is Black Oak Ridge, and its north boundary is Copper Ridge. Beaver Ridge is contained within the watershed and is cut by several tributary creeks. Emory Road is the primary bottomland route within the watershed. The watershed is crossed by Pellissippi Parkway (SR 162), Oak Ridge Highway (US 25W), Interstate 75, Broadway Ave/Norris Freeway (US 441), and Manyardville Hwy (SR 33).

WHAT IS GREEN INFRASTRUCTURE?

Green Infrastructure is the supporting systems the landscape provides for a settlement— an interconnected system of natural areas and other open spaces managed for the benefit of people and the environment. This system interconnects natural and cultural infrastructure elements. Green Infrastructure is a complex system that includes:

- *Natural Areas*, such as waterways, wetlands, flood plains, wild areas, and forests;
- *Recreational Places*, such as parks, public greens and squares, greenways, and schoolyards;
- *Infrastructure Elements*, such as drainage swales, green pedestrian streetscapes, rail lines, and utility corridors;
- *Heritage Lands*, such as important open land in the valley, ridge tops, and historical sites;
- *Hazard Areas*, such as floodplains, steep slopes, and aquifer recharge zones.

We use the *Green Infrastructure* approach to help protect and restore naturally functioning ecosystems and to propose solutions that can improve water quality, enhance recreation opportunities, and provide a

Flooding along Beaver Creek

The Tennessee Department of Environment and Conservation (TDEC) has given the entire creek a 303(d) designation, meaning that it violates water quality standards and is ***too polluted*** *to support many of its designated uses.*

Green Infrastructure is an interconnected system of natural areas and other open spaces managed for the benefit of people and the environment.

framework for future development. This study also proposes ways to connect communities; develops a context plan for individual conservation easements; and identifies conservation buffers, greenways locations, and lands with significant recreational value.

The primary elements of the *Beaver Creek Green Infrastructure Plan* include the WATER NETWORK, the GREEN NETWORK, and the SETTLEMENT NETWORK.

- The WATER NETWORK includes the surface stream system, the groundwater system, wetlands, springs, and sinkholes.
- The OPEN SPACE NETWORK includes open space, wildlife habitat, urban forest, parks, and greenways.

GREEN INFRA. PLAN ELEMENTS

Water Network
- Identifies land to protect water quality
- Identifies land to mitigate flooding
- Proposes conservation buffers

Open Space Network
- Identifies good farmland
- Identifies riparian and upland habitat
- Proposes habitat restoration and linking opportunities
- Outlines parks and greenways linking communities to recreation land

Settlement Network
- Identifies patterns of development
- Proposes alternatives for new growth

- The SETTLEMENT NETWORK is the pattern of how humans settle the land, including roads, communities, districts, neighborhoods, and mixed-use centers.

DRIVING ISSUES IN BEAVER CREEK

The Beaver Creek watershed has a history of impaired water quality and flooding in the valley floor. The creek is listed as polluted by the state. It is a priority watershed for riparian-zone management and protection. Knox County is classified as a NPDES "Phase II" stormwater community (the successor program to the Clean Water Act), which requires it to develop plans to address surface water pollution. The *Beaver Creek Green Infrastructure Plan* is a pilot project that anticipates a government response to Phase II requirements. It is supported by local government agencies but not yet officially sponsored by local government administration.

Rapid, sprawling, unplanned, low-density residential development and corridor commercial development are driving open-space loss, fragmenting habitat, and degrading the scenic character and rural lifestyles that the area once enjoyed.

DRIVING ISSUES

Plan-initiating Issues
- Increased flooding
- Poor water quality
- State "303(d) List" of polluted streams
- Conservation easements

Related Issues
- Sprawl
- Open space loss
- Habitat fragmentation
- Degrading rural character

GENERAL METHODOLOGY

From the perspective of our study team, we were interested in two fundamental questions for investigation:

1) First, we wanted to know the nature of the spatial pattern that would arise as an expression of specific health, safety, and environmental goals. Among these goals are improving water quality, mitigating flooding, restoring streams, protecting the remaining forests, preserving wildlife habitat, and reconnecting the fragmented landscape with rural open space corridors. What form would the pattern of settlement and conservation take if we paid close attention to these issues? If we could use Green Infrastructure as a framework for development, what shape would it take?

2) Second, we were interested in producing a replicable method that can be repeated in other watersheds. The approach had to be based in the best methods of the design and planning professions and in the best science. The approach also had to be simple and inexpensive enough to be widely applied.

Basic Method Outline

Our approach can be described as a knowledge-informed, analysis-driven, synthetic and creative landscape design approach to planning issues. In very broad terms, we have conducted this study in stages of *documentation*, *analysis*, *generation*, *synthesis*, *prioritization*, and *design*. Problems of the magnitude and complexity of those we were asked to address in Beaver Creek are not possible to define concretely in terms of simple problem solving. Nor are the solutions possible by purely rational means. Nevertheless, we have attempted to base our proposals and analysis on sound approaches that can be replicated, on reliable data, and on explicit decision methods.

INITIAL STUDY QUESTIONS

1) What are the spatial implications of specific environmental goals?
- Water quality
- Flood mitigation
- Forest and stream restoration
- Wildlife preserves and corridors

2) How do we create a science-based method that is simple enough to be widely replicated?

1) Document

We organized our study of the landscape into four systems: the SETTLEMENT NETWORK, the WATER NETWORK, the OPEN SPACE NETWORK, and the Land itself, which underlies all of the others. We began by documenting the existing features, which also involved building a database using information from many sources. Source data came from Knox County-Knoxville-KUB Geographic Information System (KGIS), the U.S. Geological Survey (USGS), TDEC, the Tennessee Valley Authority (TVA), and other sources. To be useful, data from all these different sources had to be converted to standard formats and

projection systems using Geographic Information System (GIS) software.

2) Analyze

As we mapped these different networks, we looked for the important existing patterns, significant network fragments, and how the networks are more or less whole or fragmented. We identified important issues in each system as they related to the project's driving issues. This phase required mapping features from different sources onto the same map, generating specific kinds of analytic maps (such as those required to reveal the existing patterns of development). This phase also required us to generate new data layers we needed, such as maps of springs, sinkholes, utility lines, and so forth, which were unavailable from other sources. Many of the analyses generated in this stage, such as slope and elevation studies, landform sections, and park catchment areas, became the basis for later analysis and design stages.

BASIC METHOD OUTLINE

1) **DOCUMENT** existing green infrastructure networks.

2) **ANALYZE** each system to understand the issues.

3) **GENERATE** "corridor" proposals for ridge preservation, water feature protection, and heritage preservation.

4) **SYNTHESIZE** these into a composite land stewardship network pattern.

5) **PRIORITIZE** land for conservation programs.

6) **DESIGN** proposals within the land stewardship network:
   - new and strengthened settlement centers,
   - locations for conservation neighborhoods, and
   - locations for density gradients of settlement.

   DESIGN a network of parks and greenways linking recreation land, centers, and communities.

3) Generate

In this phase, we applied a set of criteria in generating proposals for three types of "stewardship corridors" that form the backbone of the watershed's green infrastructure. From our analysis of the landscape systems, we realized that there are three interrelated types of conservation land patterns that could be connected in a LAND STEWARDSHIP NETWORK. We called these STREAM PROTECTION CORRIDORS, RIDGE PROTECTION CORRIDORS, and HERITAGE PROTECTION CORRIDORS. In our STREAM PROTECTION CORRIDORS proposal, we created maps showing the physical implications of model stream and water feature ordinances, using a three-zone system of relative conservation. This WATER FEATURE BUFFER system was then expanded in the next stage by looking at its intersection with valuable heritage lands. The RIDGE PROTECTION CORRIDORS are derived from studies of the patterns of slope steepness and existing forest cover. We proposed HERITAGE PROTECTION CORRIDORS to protect the rural character of the land, to promote conservation of existing wildlife habitat, to save the best agricultural land, and to connect the other two types of corridors. Details of the methods for generating each of these corridors are covered in the chapters on Water Network (Section D) and Green Infrastructure (Section E).

4) Synthesize

After generating the three types of stewardship corridors, we looked at how these different corridor systems might intersect with and reinforce each other. For several reasons, we sought to link these corridor systems into a coherent, highly connected, single network of land with environmental value. This approach provides continuity for wildlife movement, recreation, stormwater management, and soft- transit systems. WATER FEATURE BUFFERS and RIDGE PROTECTION CORRIDORS are primarily generated by natural characteristics of the land, while HERITAGE PROTECTION CORRIDORS cluster good agricultural, undeveloped, or low-density land to preserve farms and local character and to protect upland areas of water absorption that help mitigate floods. In all of these proposed corridors, existing development would remain in place.

5) Prioritize

We created methods to identify land in the LAND STEWARDSHIP NETWORK (corridors) and, in some cases, land not included in the corridor system (such as some prime agricultural land), suitable for various conservation programs. Farms and grasslands eligible for federal conservation-easement programs were identified. We ranked agricultural land by its soil value and also compared it to the value of the land as wildlife habitat. For each corridor, we have identified intersecting parcels and offered preliminary assessments of their relative merits or potential hazards for environmental quality.

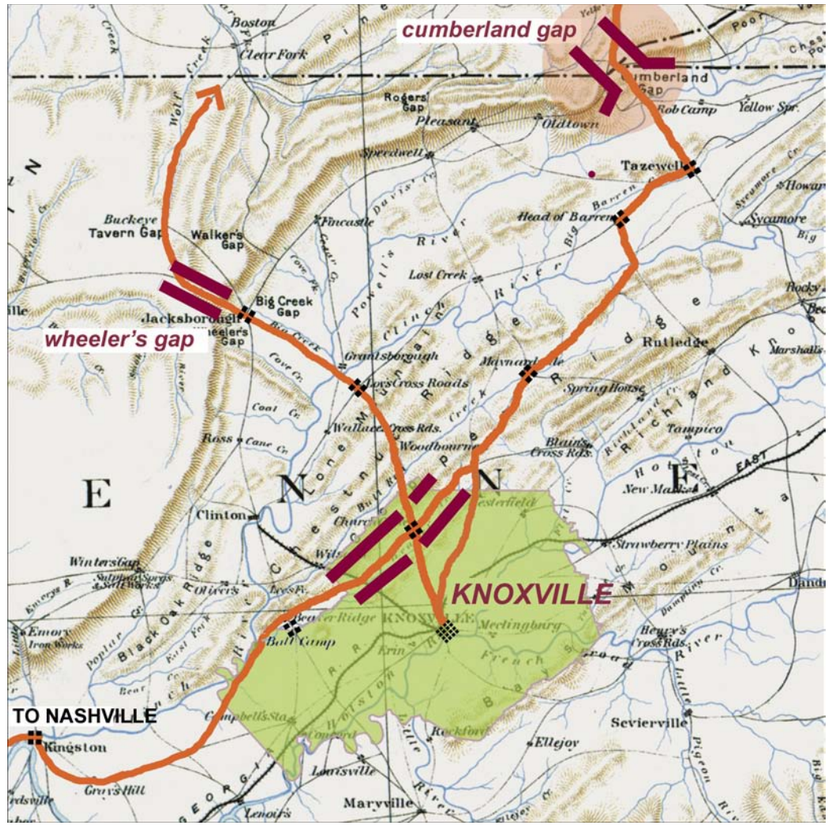
6) Design

The corridors of the LAND STEWARDSHIP NETWORK provide a framework of community open space that enhances the value of existing or new development in adjacent areas. In these potential development areas, our tasks became to:

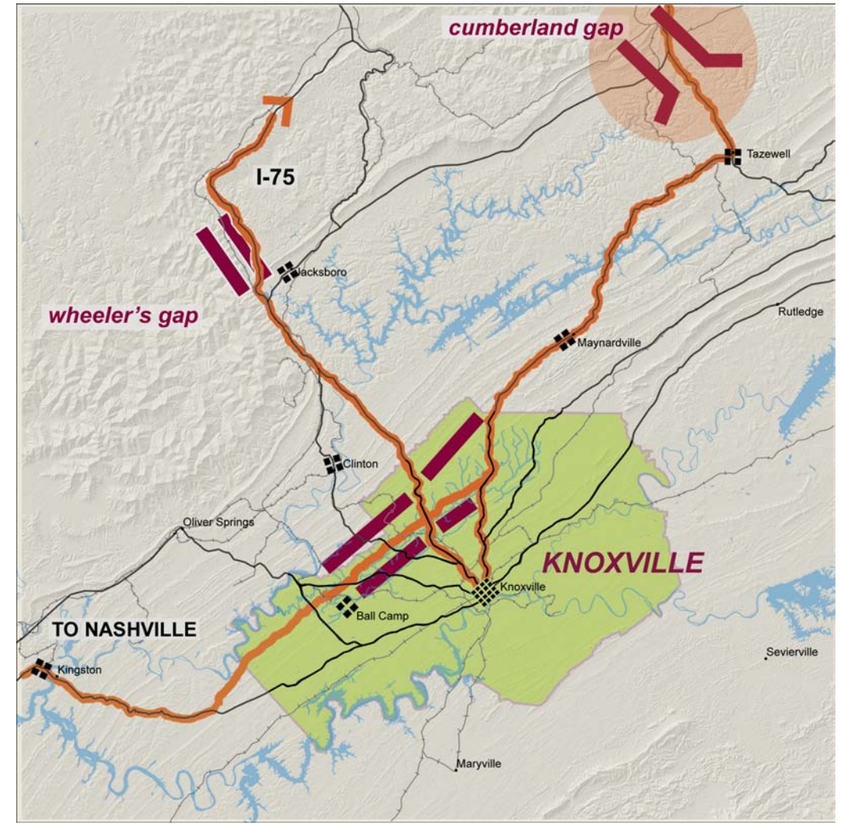
- Strengthen a sense of community identity.
- Promote *Smart Growth* through encouraging town, village and neighborhood centers in appropriate places.
- Encourage density near these centers to create walkable communities that can support transit, as a part of a TAPESTRY OF NEIGHBORHOOD TYPES.
- Locate the best places for interconnected, small-town-like neighborhoods, and also
- Locate the best places for clustered housing, what we call CONSERVATION NEIGHBORHOODS, in more environmentally beneficial areas.

Finally, after proposing a viable pattern for conservation and development, we designed a PARKS & SOFT-TRANSIT NETWORK that ties together each neighborhood center, village center, and town center and our CONSTELLATION OF CENTERS with each other and with the LAND STEWARDSHIP NETWORK. The stewardship system then provides for recreation as well transportation. This system includes greenways, parks, equestrian and walking trails, pedestrian-friendly boulevards, community gateways, and streetscape routes. The intent of design included in this study is to illustrate a future development alternative based on the ideas we propose in the study. It is not a proposal for specifically what to build.

We use the Green Infrastructure *approach to help protect and restore naturally functioning ecosystems, and to propose solutions that can improve water quality, enhance recreation opportunities, and provide a framework for future development.*



1860's Major Pikes, Landform, and Settlements



Present Day Major Pikes, Landform, and Historic Settlements

THE LAND AND ITS SETTLEMENT PATTERNS

B

THE LAND

In this section we examine basic patterns of the land that influence open space and development: terrain and slope, forest cover, and historic and present settlement patterns in the watershed.

Settlements and transportation routes are shaped and organized by underlying landform, particularly in areas like East Tennessee, where landform is so strong. Historically early stages of development tended to respect land conditions, avoiding floodplains, wetlands, good farmland and staying away from overly steep slopes. Over time, as the best land becomes built out, development tends to encroach on less ideal locations. Projects built in these poor locations have potential long-term, land-related problems, such as flooding, foundation problems, landslides and falling trees, and site and road erosion. Often the community as a whole inherits these problems and their costs.

Our objective in this analysis is to understand the place and the way people have settled the place, so we can, in a careful way, continue the tradition of respecting the land and building in appropriate places. Where and how we build is a reflection of our collective values for community, individuality, and our relationship to the land and its history.

Regional Context

The Beaver Creek Watershed is a part of a distinctive regional landscape called the Ridge-and-Valley District, lying in the Tennessee River Valley between the Cumberland Plateau and the Great Smoky Mountains. The ridge-and-valley pattern is one of long, narrow valleys and parallel ridges.

The locations of gaps in the ridges were primary determinants of trail and, later, road locations. Settlements grew up in convenient places where these gap-to-gap pikes crossed valley roads or waterways. This historic settlement pattern can still be seen today (see maps on page 14).

The pattern in Beaver Creek is set by this larger context. Maynardville Pike connects Knoxville to Maynardville and Tazewell before continuing on through the Cumberland Gap. I-75 follows a historic route from Knoxville to Speedwell and continues up to Rogers Gap. Oak Ridge Highway leads to Oliver Springs and on through Wheelers Gap.

LANDFORM ELEVATION

The Shape of the Land

The spirit of the Beaver Creek Watershed is heavily dependent on its relationship with its unique landscape.

The ridge-and-valley structure of the land can be easily seen in the long parallel ridges continuing on both sides of the watershed. The three ridges defining the watershed are strong perceptual containers and generally make travelling down the valley somewhat easier than crossing the ridges. Black Oak Ridge is softer (of less than 15% slope) and lower in elevation, and developed with suburban housing in places. Beaver Ridge is higher, narrower, steeper, and minimally developed. It is cut by tributaries, such as Cox Creek, Knob Fork, and Grassy Creek, which drain the narrow Hines Valley though gaps with names like Brown, Crippen, and Cheneworth. Copper Ridge has many unnamed gaps, corresponding to its more gentle slope, though it is steeper on the northwest side as it descends into Brushy Valley.

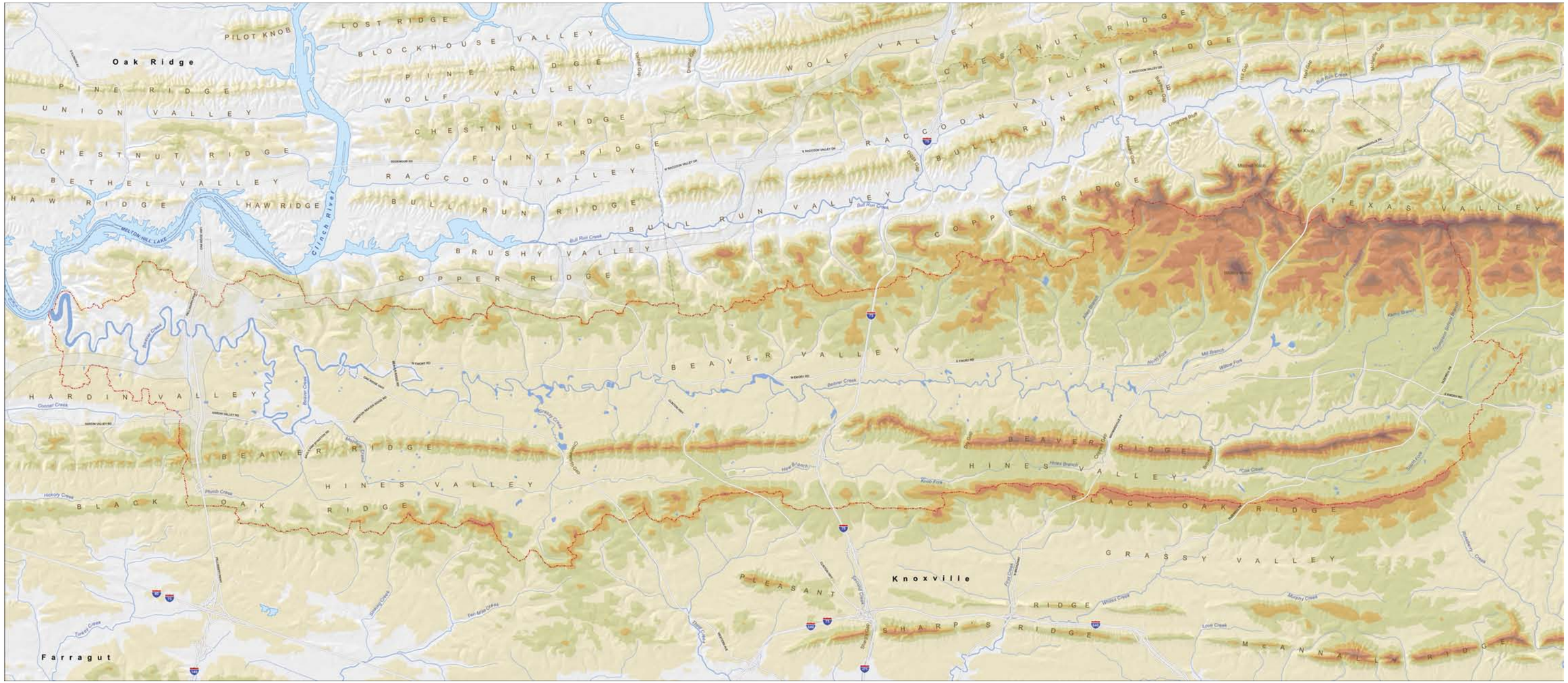
The main valley of Beaver Creek can be understood as having three parts: 1) an *Upland Headwaters* area above Maynardville Highway, which is sloped as a rounded bowl in the upper end and then tilted downstream; 2) a relatively *Flat Mid-Valley Floor*, in which the creek falls only a few feet from Halls to Karns and in which we find the widest floodplains in the valley; and 3) the *Lower Beaver Creek* section, from Pellissippi Parkway to the Clinch River, where the creek cuts into the hilly terrain and drops more steeply as it drops below the elevation of the valley floor.

This landform presents several potential issues that influence how people can settle in the watershed:

- Steep slopes with thin clay soils, which are subject to landslides and erosion, particularly if tree cover is removed.
- Sinkholes, which are collapsed caves in limestone.
- Limited options for locating transit routes.
- Limited flat land, which increases pressure for development of farm land. This also leads to a dispersed urban pattern with large intervening areas of steep undeveloped land.

The land's rural character in the lower watershed in the Solway area

Our objective in this analysis is to understand the place and the way people have settled the place, so we can, in a careful way, continue the tradition of respecting the land and building in appropriate places.



LANDFORM ELEVATION

What you see...

This map shows a rendering of *Elevation* (feet above sea level) displayed over a *Shaded Relief* map (Hillshade) of the study area. Note the three ridges defining the watershed: Black Oak Ridge is softer in slope and lower in elevation. Beaver Ridge is higher, narrow, and steep, cut by tributaries that drain narrow Hines Valley. Copper Ridge has many gaps, gently sloping on the southeast and steeper on the northwest. Note uplands above Maynardville Highway and a relatively flat mid-valley floor, and a section downstream from Pellissippi Pkwy. where Beaver Creek cuts into the terrain as it winds through hilly terrain.

How we did it...

The base layer is a *Shaded Relief* (Hillshade) generated in GIS software from United States Geological Survey *Digital Elevation Models* (DEMs). The elevation colors were also generated in GIS software from the same DEMs. We created custom bins of the elevation data, breaking the colors at particular points to reveal significant formal and structural characteristics of the land.

Elevation (feet)

- < 850
- 851 - 950
- 950
- 1,091 - 1,190
- 1,191 - 1,290
- 1,291 - 1,390
- 1,391 - 1,440
- 1,441 - 1,490
- 1,491 +

- Knox County Boundary
- Proposed Knoxville Parkway (SR 475)
- Wetlands & Water

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

Copyright 2005 Tracy Moir-McClean & Mark DeKay

LANDFORM & SLOPE

Major Topographic Features and Slope Steepness

Slopes greater than 25% are unsuitable for building and are very likely to be unstable, particularly if devegetated.

This map on page 20 shows major landscape features, slope steepness, and topography. We have used slope classes recommended by the Metropolitan Planning Commission (MPC). These are as follows:

- *Slopes greater than 40%,* which present extreme hazards for building and public safety. No building should occur in these areas.
- *Slopes between 25% and 40%,* which pose significant difficulties to building and potential public safety hazards and to which public services are expensive to provide. MPC guidelines currently limit development to 1 housing unit per 2 acres.
- *Slopes between 15% and 25%,* which offer moderate limits to development. MPC currently recommends a maximum of 2.5 housing units per acre in these areas.

Steep slopes are important in Beaver Creek because they harbor most of the remaining forest cover and the best wildlife habitat. Headwaters creeks, which have a great influence on water quality, are most often found on steep slopes. Steep slopes are found adjacent to Beaver Creek only in the lower section of the watershed.

EXISTING FOREST

Contiguous Areas of Upland and Riparian Trees

Continuous forest corridors remain on the ridges, but development on the valley floor has significantly reduced the streamside forest.

The natural land cover in this region is dense forest; once this was the case in Beaver Valley. Today, significant forests still live on ridges and along some stream corridors in the less-developed areas north of the Beaver Creek Watershed in Bull Run and Raccoon Valleys (see map on page 21). However, in the Beaver Creek Watershed, continuous forest corridors remain only on the ridges, while development on the valley floor has significantly reduced the streamside forest. Even these ridge forests are broken by many roads.

A study by American Forests estimates the annual value of the existing tree cover in Beaver Creek at $190.9 million for stormwater management and $5.3 million for air-pollution removal. The approximately 22,000 acres of trees are estimated to store almost a million tons of carbon in their cells and sequester an additional 7,500 tons annually, helping to reduce global climate change. Continued deforestation has real financial and quality-of-life consequences. In particular, loss of streamside forest contributes to flooding and degrades water quality and stream habitat. Slope deforestation leads to erosion and possible landslides. Loss of trees anywhere in the watershed increases local temperatures and rainfall runoff volume.

EXISTING LAND USE

The Pattern of What Humans Do on the Land

Much of the Beaver Creek Watershed is suburbanized already. Look south to North Knoxville to see the future of business-as-usual development in Beaver Valley.

From south to north, moving from Knoxville to North County fringes, unplanned suburban development is inversely proportional to agricultural land use (see map on page 22). Over time, the commercial strip and the single-family, low-density subdivision are replacing rural farms and villages. Still, this new development centers around the old radial routes that connect gaps. Topography still leaves its mark.

A significant amount of land in floodplains is still in agricultural use, but many poorly located projects are encroaching on the flood fringe. If current development continues, the extent of the flood plain will increase, and flooding problems will get worse.

Driven by outdated zoning, this haphazard development pattern has negative impacts on environmental quality: deforestation, polluted runoff, habitat destruction, air pollution, high energy consumption with all its pollution and impact on global climate. These are well-understood facts. Newer, larger roads thread through the same gaps, cutting into steep slopes to climb above or replace existing roads, rails, and streams. Jamming all of this infrastructure into narrow gaps affects water quality by increasing erosion, clearing streamside vegetation, and contaminating storm runoff with pollutants.

Conventional suburban development also does not recognize or protect many features of the water system, such as sinkholes, streams, springs, and wetlands. Development is beginning to encroach on streams and on steep slopes. As covered in greater detail in the "Protecting the Water Network" chapter, this has both safety and water-quality impacts.

EXISTING DEVELOPMENT INTENSITY

Residential Density and Commercial Clustering

Sprawl covers former farms. There are no towns and no villages, only strip commercial developments.

Old farms and farm settlements are disappearing into the suburbs. Communities are losing their identity. Green farmland residents care about is disappearing.

The map on page 23 shows development concentrated near radial routes (gap-to-gap pikes) and along the widest, flattest portion of the valley floor from Karns to Halls. Light or no development is found on steep slopes and ridges, although this is changing. Beaver Creek's headwaters area, at the Gibbs end of the watershed, is still primarily in agricultural and rural residential land use, except in the valley bottom, where several suburban developments line Beaver Creek.

New development is universally of the sprawl type. Commercial development is mostly automobile-oriented strip-type, with a number of "big box" shopping centers of varying ages. The watershed has no true non-residential single-use districts, except for the Pellissippi State campus. All non-residential zones are "mixed" (in a limited sense) districts. However, they are not the type of rich mixed-use districts that form thriving town centers. Two types predominate: 1) mixed office/industrial districts, for instance, the West Bridge Business Park in Karns, and 2) mixed commercial/community services, such as the center of Halls, which has retail, civic, and community uses.

Mixed-use strips follow the old radial routes that connect gaps and intensify where radial routes cross valley roads and at interstate interchanges. An example of this is where Clinton Highway crosses Callahan Drive in the Hines Valley. Residential intensity also concentrates near radial routes and along the valley floor from Karns to Halls.

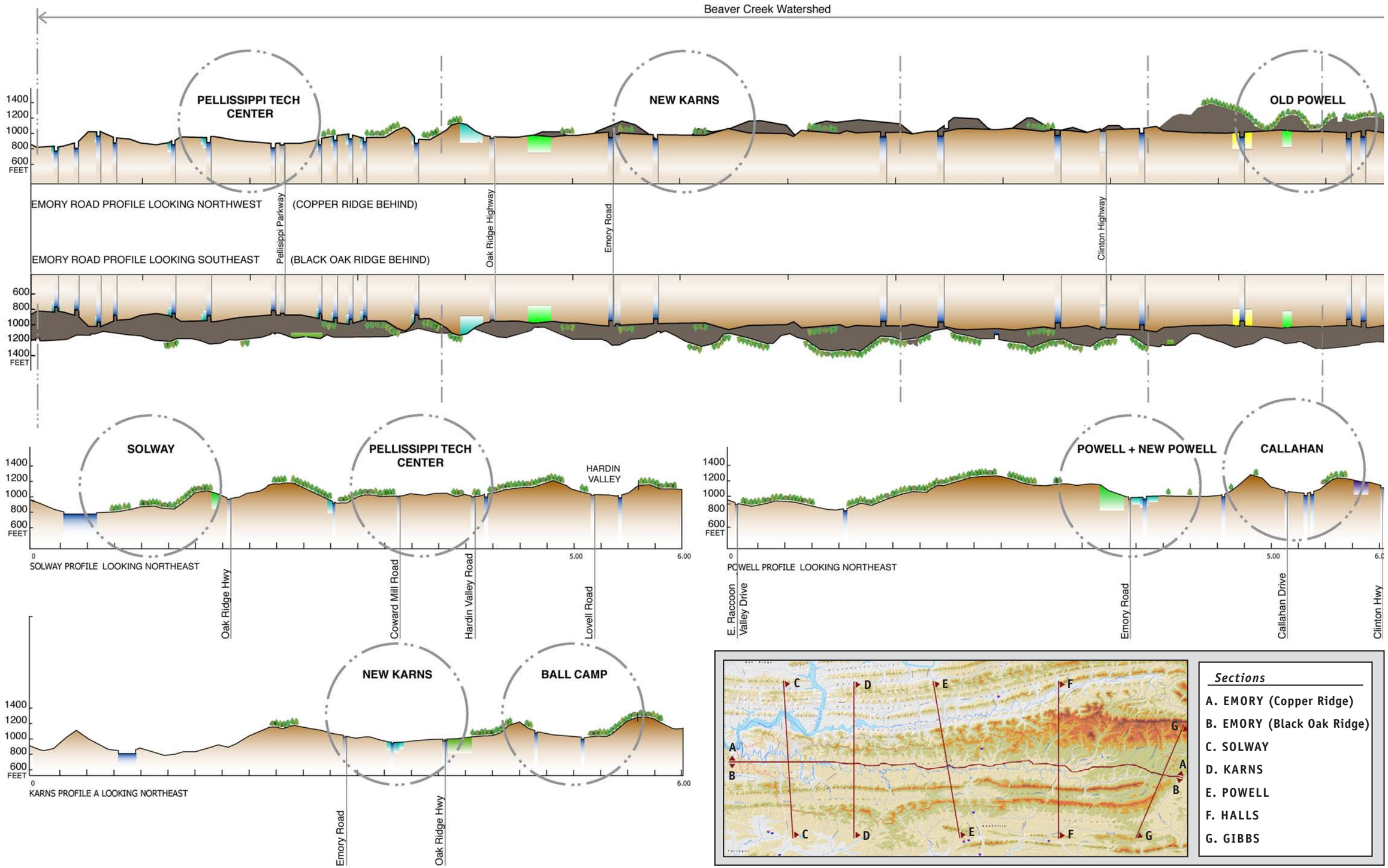
Land clearing in the Beaver Creek Watershed for new housing…nothing left standing.

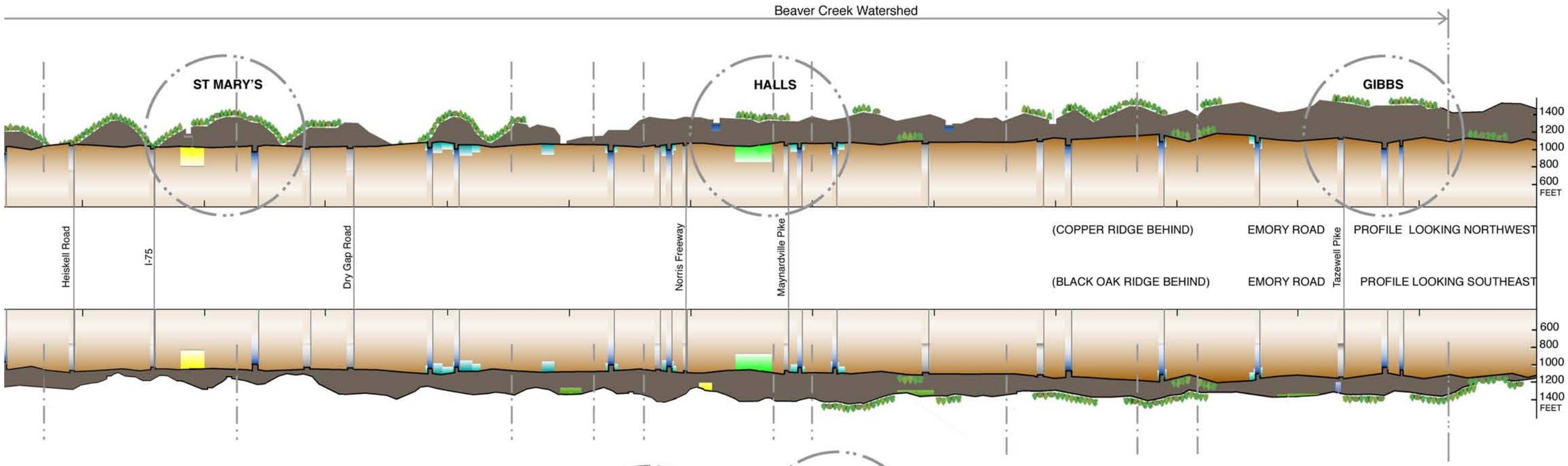
American Forests estimates the annual value of the existing tree cover in Beaver Creek at $190.9 million for stormwater management and $5.3 million for air-pollution removal.

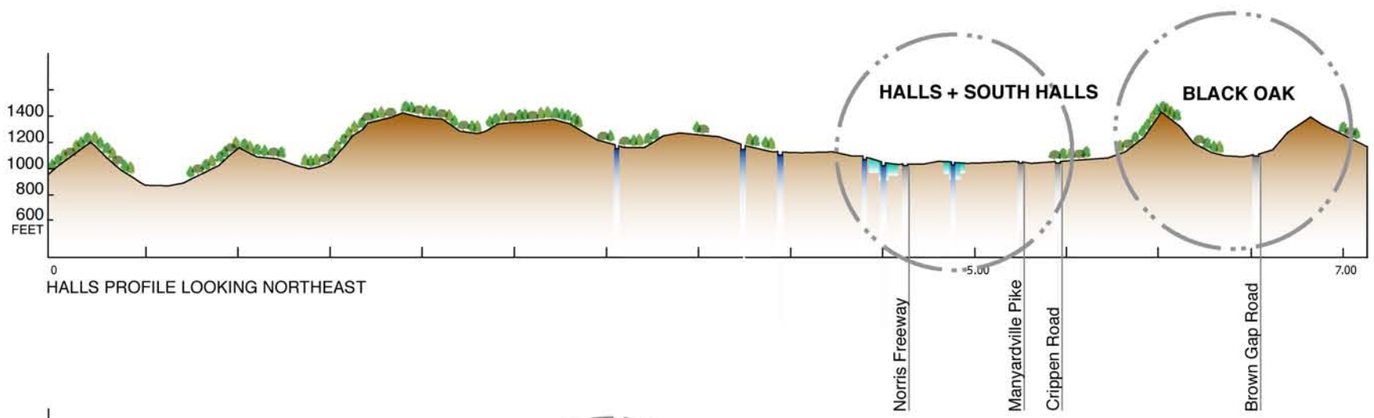
American Forests (December, 2002). *Urban Ecosystems Analysis Knoxville, Tennessee.* Washington, DC: American Forests.
P. O. Box 2000, Washington, DC 20013
202/955-4500; Fax: 202/955-4588
cgreen@amfor.org
www.american forests.org

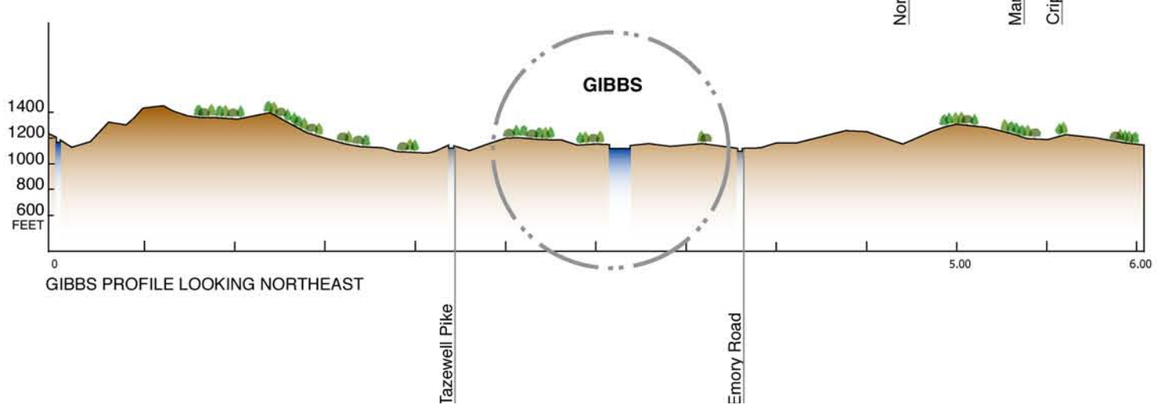
USGA Gap Analysis Program, http://www.gap.uidaho.edu/

Tennessee Gap Analysis data.
Jeanette Jones
Tennessee Wildlife Resources Agency, Nashville
Jeanette.Jones@state.tn.us, 615-781-6534


Beaver Creek Watershed
PELLISSIPPI TECH CENTER
NEW KARNS
OLD POWELL
1400
1200
1000
800
600
FEET
EMORY ROAD PROFILE LOOKING NORTHWEST
(COPPER RIDGE BEHIND)
EMORY ROAD PROFILE LOOKING SOUTHEAST
(BLACK OAK RIDGE BEHIND)
Pellissippi Parkway
Oak Ridge Highway
Emory Road
Clinton Highway
SOLWAY
PELLISSIPPI TECH CENTER
HARDIN VALLEY
0
5.00
6.00
SOLWAY PROFILE LOOKING NORTHEAST
Oak Ridge Hwy
Coward Mill Road
Hardin Valley Road
Lovell Road
POWELL + NEW POWELL
CALLAHAN
POWELL PROFILE LOOKING NORTHEAST
E. Raccoon Valley Drive
Emory Road
Callahan Drive
Clinton Hwy
NEW KARNS
BALL CAMP
KARNS PROFILE A LOOKING NORTHEAST
Emory Road
Oak Ridge Hwy
A
B
C
D
E
F
G
Sections
A. EMORY (Copper Ridge)
B. EMORY (Black Oak Ridge)
C. SOLWAY
D. KARNS
E. POWELL
F. HALLS
G. GIBBS





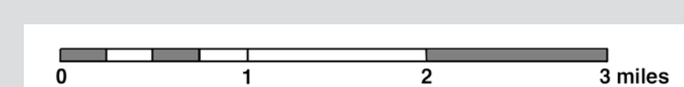


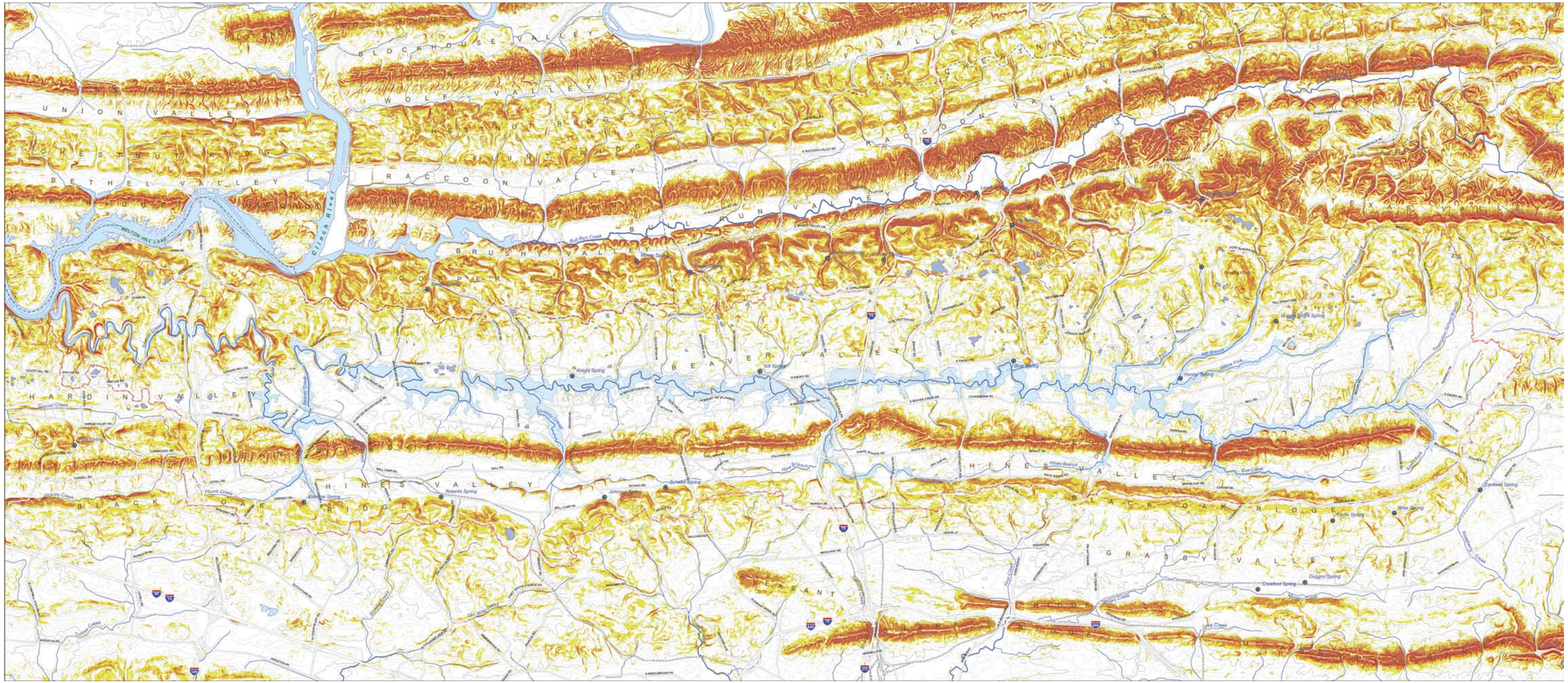
TERRAIN AND SETTLEMENT

Emory Road's profile (A, B) spans across the top of these two pages. It passes through four existing settlements (Karns, Powell, Halls, Gibbs) as it runs the length of the valley floor. Proposed locations for new centers of several communities are also shown on these section drawings (St. Mary's, Callahan, New Karns, Ball Camp, Black Oak). Profiles of ridges that influence these settlement locations, Copper Ridge (A above) and Black Oak Ridge (B upside down) are shadowed behind in dark brown. Notice how flat the Emory Road profile is in comparison to the cross sections (C, D, E, F, G).

Also note, each settlement is located where major roads cross the valley to pass through gaps (clearly visible in the ridges behind these settlements). Cross sections are cut through each community. These show that the watershed contains two valleys, Beaver Creek Valley and the narrower Hines Valley, and a small portion of a third, Hardin Valley at the southwest end of the watershed.

Because Hines is narrow, its communities are small, and function as satellites of communities in the larger adjacent valley. Hardin Valley communities depend on Farragut to the southwest. Cross sections also show the contrast between forested ridges and the cleared valley floor. Streams and rivers are shown in dark blue; wetlands, in light blue; parks, in green; and school parks, in yellow.




BLOCKHOUSE VALLEY
WOLF VALLEY
UNION VALLEY
CHESTNUT RIDGE
BETHEL VALLEY
RACCOON VALLEY
BULL RUN VALLEY
BRUSH VALLEY
COPPER RIDGE
BEAVER VALLEY
HARDIN VALLEY
HINES VALLEY
BLACK OAK RIDGE
GRASSY VALLEY
PEASANT RIDGE
Clinch River
MILTON HILL LAKE
Bull Run Creek
Beaver Creek
Knight Spring
Gill Spring
Blue Spring
Roberts Spring
Johnson Spring
Schaad Spring
Hickory Creek
Plum Creek
Turkey Creek
Hale Branch
Allen Branch
Sun Cabin
Grassy Bluff Spring
Hunter Spring
Yellow Fork
Mill Branch
Cardwell Spring
Wise Spring
Carte Spring
Duggan Spring
Crawford Spring
Lick Creek
Mulles Creek
Rock Creek
Tuckaleechee Creek
Tuckaleechee Cove Branch
Cove Branch
Cedar Creek
Cedar Lick Creek
Cedar Lick Branch
Sycamore Creek
Sycamore Branch
Ellis Creek
Ellis Branch
Ellis Spring
Knight Spring
Knoxville Spring
Cedar Spring
Cedar Lick Spring
Cedar Lick Branch
Cedar Lick Creek

EXISTING FOREST

What you see...

This map shows areas of existing forest larger than two acres, displayed over a *Shaded Relief* map (Hillshade) of the study area. Note that significant forests are present on ridges and along stream corridors in the lightly developed area north of Beaver Creek Watershed (Bull Run and Raccoon Valleys). In the Beaver Creek Watershed, continuous forest corridors remain on the ridges, but development on the valley floor has significantly reduced the streamside forest. Loss of streamside forest contributes to flooding and degrades water quality and habitat in streams.

How we did it…

The base layer is a *Shaded Relief* (Hillshade) generated in GIS software from USGS *Digital Elevation Models* (DEMs). The source data for the Forest layer is *Land Cover* from the EPA *GAP Analysis Program*, available through Tennessee Wildlife Resources Agency (TWRA). We combined all forest types into one, then cut data with roads and major power and pipe lines to obtain contiguous "forest patches." Riparian forest within 300 feet of surface water was isolated. The gridded raster data was converted to generalized contour outlines and then to polygons using common GIS functions. Forest areas less than 2 acres were eliminated.

- Watershed Boundary
- Knox County Boundary
- Wetlands & Water
- Proposed Knoxville Parkway (SR 475)
- Riparian Forest
- Upland Forest

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System
(TN, FIPS Zone 4100): North American Datum 1983 (feet)

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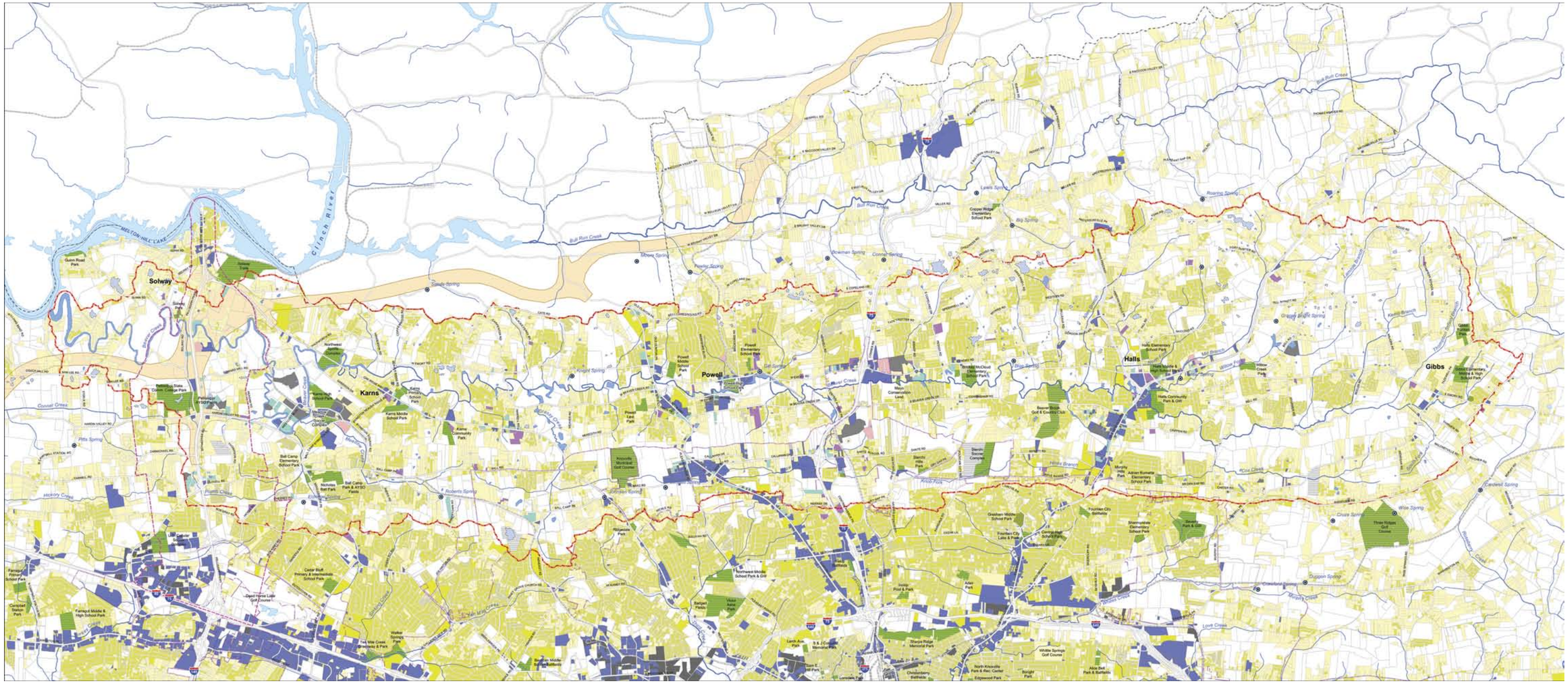

EXISTING LAND USE

What you see...

Major types of land uses are displayed as classes. This is a base-level analysis on which much of the settlement analysis is founded. Even in this map one can see that much of the Beaver Creek Watershed is suburbanized. From south to north, moving from Knoxville to North County fringes, unplanned suburban development gives way to agricultural land use. Sprawl has covered land previously used for farming. There are no towns and no villages, only strip commercial development.

How we did it...

KGIS uses dozens of very specific land-use categories. We grouped similar land uses together into classes. *Residential land* (yellow) is categorized as greater or less than 1-acre parcels. Parcels classed as *Unused* were grouped with *Agricultural* parcels (light brown). All types of *Commercial* parcels are grouped together, all *Industrial* uses together, all *Community* uses together, and so on.

- Sinkhole (USGS)
- Wetland (NWI)
- Utilities
- Govt. Owned
- Park
- Golf Course
- School Park
- Commercial
- Office
- Community
- Religious
- Industrial
- Watershed Boundary
- Proposed Knoxville Parkway (SR475)
- Pellissippi Tech Corridor
- Knoxville City and Urban Growth Boundary
- High, Medium, and Low Density Residential (<1 ac.)
- Very Low Density Residential (>1 ac.)
- Agriculture, Unused, or Not categorized by KGIS

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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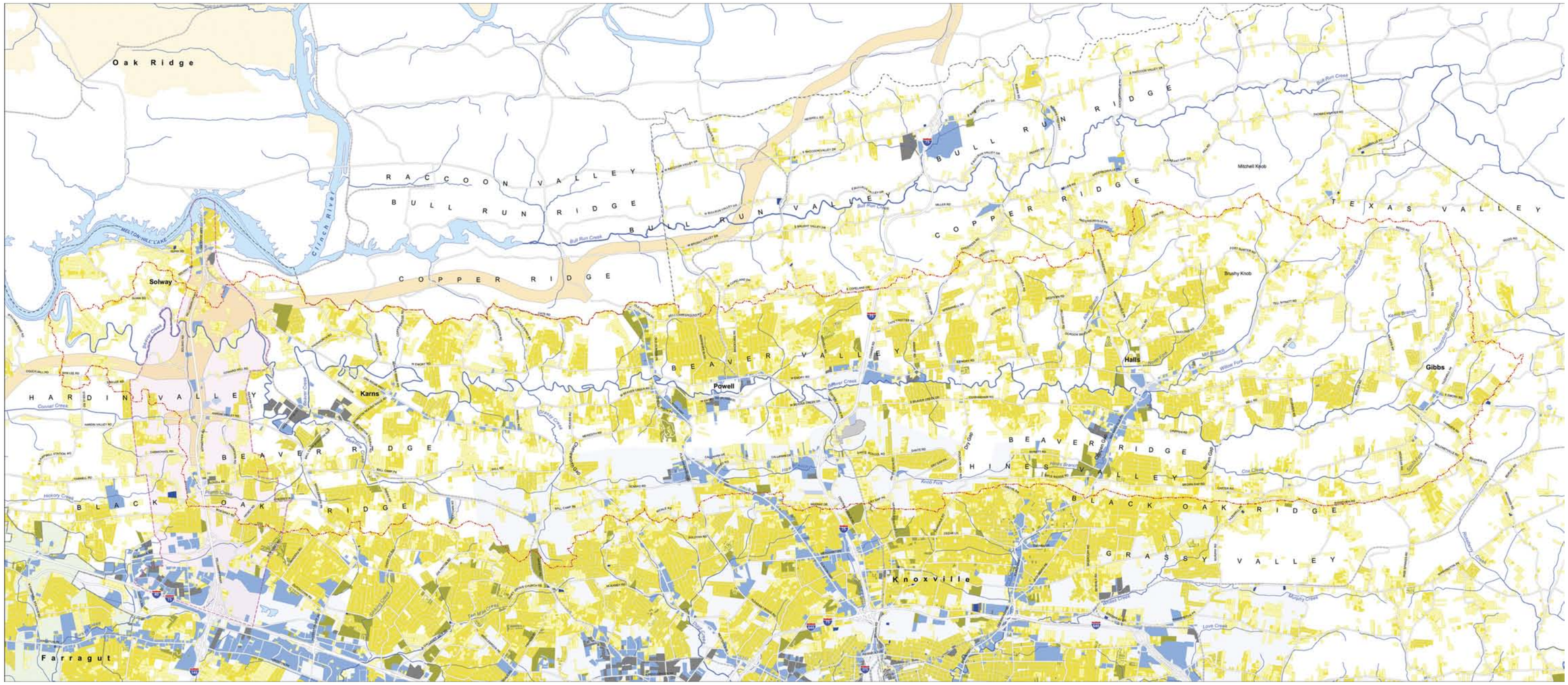

EXISTING DEVELOPMENT INTENSITY

What you see...

This map shows the general settlement pattern of developed areas in the watershed. Clusters of adjacent residential, commercial/mixed-use, and industrial parcels are identified. This has the effect of simplifying the pattern to show significant groupings of each use. The general effect of suburban sprawl can also be seen in the transitions from suburban Knoxville in the south, to the Beaver Creek watershed in the middle, and the more rural Bull Run and Raccoon Valleys to the north.

How we did it...

KGIS land-use categories were sorted into residential, commercial/mixed-use, and industrial/office and then queried to find parcels with similar uses within 200 feet of each other. *Residential* parcels were sorted by size and type (1 to 5 acre; 1/4 to 1 acre and 2 to 4 family; and < 1/4 acre and 5+ family). The *Mixed-Use* category includes a variety of community and cultural uses, such as schools, churches, and libraries.

Residential Intensity

- Very Low Density (Single Family, 1-5 acres)
- Low Density (Single Family < 1 acre & 2-4 Family)
- Medium Density (5+ Family & Parcels < 1/4 acre)

Non-Residential Intensity

- Commercial / Mixed Use, Occupied
- Commercial / Mixed Use, Vacant
- Industrial/Office, Occupied
- Industrial/Office, Vacant

- Proposed Knoxville Parkway (SR 475)
- Pellissippi Tech Corridor
- Knoxville City/Urban Growth Boundary
- Farragut
- Oak Ridge

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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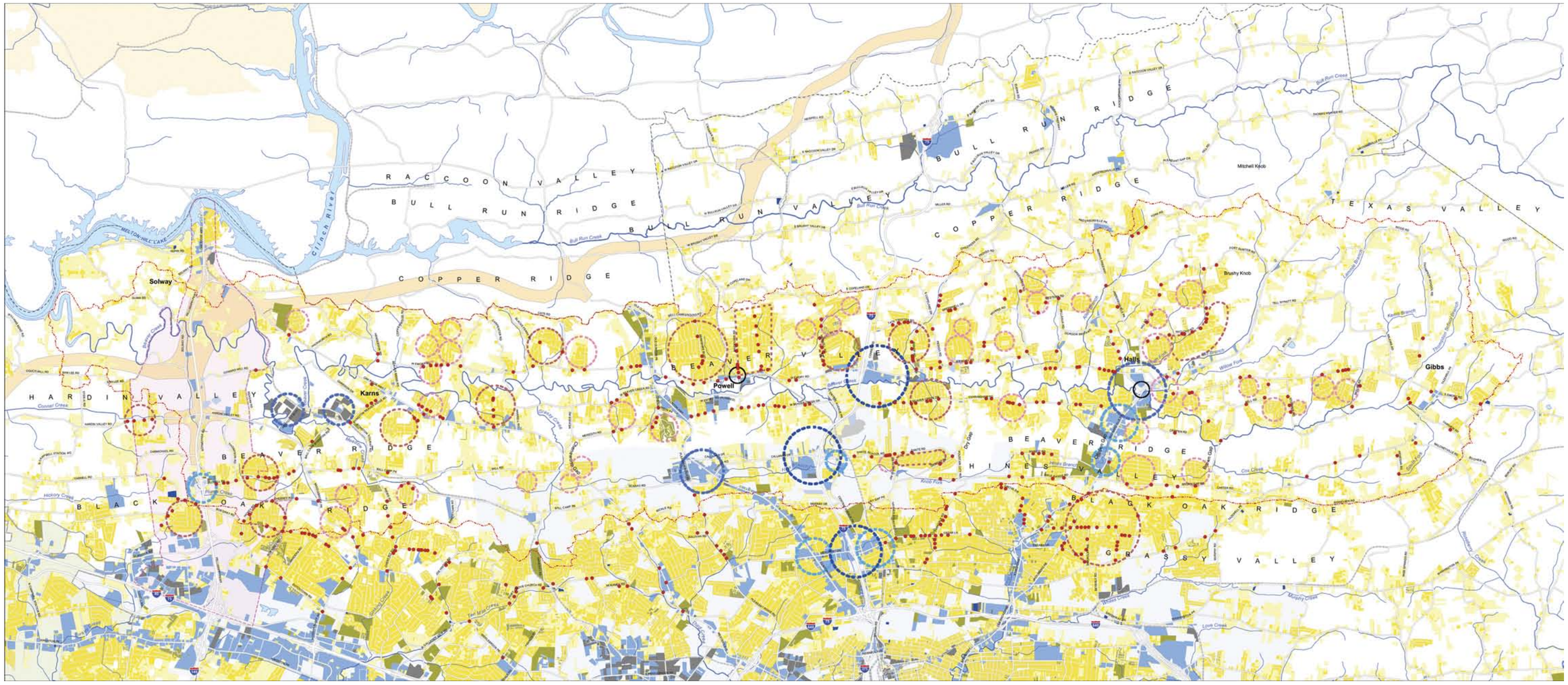

NEIGHBORHOODS & CENTERS ANALYSIS

What you see…

This map shows the pattern of mixed-use "centers" and residential "neighborhoods." Most commercial use has developed along the primary corridors, with nodes at major intersections. Most residences are on lots larger than ¼ acre. The pattern is discontinuous. Blue circles show COMMERCIAL CENTERS, almost all of which require driving. Neighborhood circles show developments with potential as IDENTIFIABLE NEIGHBORHOODS. Neighborhoods are weakly connected to centers by sharing outlets on arterial roads.

How we did it…

This map starts with analysis from the EXISTING DEVELOPMENT INTENSITY map. Red dots indicate outlets of residential development to major roads. Neighborhood circles show the developed residential areas that have internally connected streets, meet size criteria for neighborhoods, and have outlets onto the same road. A neighborhood has to be populous enough to support local services, but not too large to discourage residents from walking to amenities, such as a neighborhood green. Neighborhoods ½ to 1 mile across meet these criteria.

- Residential Outlets
- Existing Community Centers
- Neighborhood Areas (<= 1/2 mile)
- Neighborhood Areas (<= 1 mile)
- Interstate Commercial Centers
- Regional Commercial Centers
- Local Commercial Centers
- Watershed Boundary
- Knox County Boundary
- Proposed Knoxville Parkway (SR 475)
- Pellissippi Tech Corridor
- Knoxville City / Urban Growth Boundary
- Farragut
- Oak Ridge
- Very Low Density (Single Family, 1-5 acres)
- Low Density (Single Family 1/4 - 1 acre & 2-4 Family)
- Medium Density (5+ Family & Parcels < 1/4 acre)
- Commercial / Mixed Use Occupied
- Commercial / Mixed Use Vacant
- Industrial Office Occupied
- Industrial Office Vacant

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System
(TN, FIPS Zone 4100): North American Datum 1983 (feet)

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NEIGHBORHOODS & CENTERS

Centers with no neighborhoods; neighborhoods with no centers.

This analysis shows that the Beaver Creek Watershed's community structure follows none of the contemporary planning best practices.

This map examines existing centers and connectivity. Currently, shopping, home, work, and play are all in different low-density, single-use zones, a development practice that requires everyone to drive to everything all the time. Now, some shopping, like the mega-Wal-Mart store, belongs on a big auto-oriented street, but others, like the farm market, childrens' dance studio, and day-care center, could be "closer-to-home." Contemporary communities do not have a reasonable proximity between residences and local businesses. Neighborhoods are nowhere near the services they need. All commercial development is linear and auto-oriented.

However, there are underlying settlement patterns that can be used to strengthen communities, such as:

- *The historic pattern of small towns and villages*. Although the identity and boundaries of these communities, such as Halls, Powell, Karns, and Gibbs, is loose, they do provide a framework to build on.
- *The patterns of "crossroads"* created by the radial pikes intersecting with valley roads, such as Emory Road.

We find several types of existing, but weak, CENTERS in the valley. We use the term "center" here in a loose way. A CENTER is a locus of more intense non-residential activity. Later, we define centers in a more ideal way as foci of higher-intensity mixed-use activity serving a particular area. Some of the types remaining in the valley are:

- *Old Farm Villages* that are growing, such as Powell and Halls.
- *Crossroads Villages*, which have potential to grow stronger, such as Gibbs, Karns, and Solway.
- *Local Service Centers*, which are small commercial strips that serve nearby residential areas.

Identifying weak centers gives clues to latent structure within the settlement patterns. In later stages, we look for ways to grow these centers into towns instead of shopping strips, to link nearby neighborhoods to the centers, and to suggest locations for new centers where there are none to serve local residents.

To propose a new pattern that connects residents to centers, we also needed to know something about the patterns of neighborhoods and non-neighborhoods and about how people settle in the landscape. We examined clusters of housing with an eye to identifying viable neighborhoods and housing developments that could become neighborhoods. An IDENTIFIABLE NEIGHBORHOOD in this analysis has the following characteristics:

- *They have a radius of about 1/2 mile to 1 mile*. For many reasons, neighborhoods can't be too big or too small. In denser areas, this size would be smaller.
- *They are connected internally by roads or could be connected by pedestrian routes*. In Beaver Creek, many subdivisions empty onto the same road or back up to each other. In these cases, depending on property division, soft-transit connections among neighborhoods may be possible. Subdivision outlets are shown with red dots on the map.

We were also interested in what we call NEIGHBORHOOD CONNECTORS, which are sections of road that have a high density of subdivision outlet roads. Their proximity to two or more neighborhoods or neighborhood fragments make them potentially important to link subdivisions into communities, yet their traffic load poses potential barriers to the same function.

ISSUE	POTENTIAL RESPONSE
• **Community Merging & Corridor Sprawl,** which weaken community identity	• **Strengthen community boundaries** with existing natural features and Heritage Protection Corridors. • **Create strong Town, Village, and Neighborhood Centers** that add civic, commercial, and social interest and intensity to the watershed.
• **Farms & Rural Heritage at Risk,** as sprawl moves in rapidly	• **Preserve good farmland** + with federal farm and grassland preservation programs for eligible land, + with local conservation easements in Heritage Protection Corridors. • **Promote conservation neighborhoods** with clustered homes, preserving open space, vistas, and rural character.
• **Town-sized Populations without Town Centers,** which requires driving everywhere and weakens social connections	• **Identify existing + potential centers** at Town, Village, and Neighborhood scales. • **Transform strip commercial into towns and villages.** • **Encourage residential infill near village and town centers.** • **Encourage new, medium-density, mixed-use neighborhoods near Centers.** • **Discourage residential growth far from centers.**

CONCLUSIONS

Issues

Out-of-control sprawl is merging the formerly distinct communities of Gibbs, Halls, Powell, Karns, and Solway. The new I-475 exits to the valley will accelerate this growth. The area's scenic beauty and rural landscape heritage are disappearing as farms convert to subdivisions. New residences are dispersed at low density, which is an expensive way to build. Commercial areas are located along highways. Everyone must drive or be driven, and no one can walk or bike. Due to this pattern of development, traffic gets worse every year.

Fish and Wildlife Consumption Advisories: ALL KNOX COUNTY WATERSHEDS ARE UNDER A U.S. ENVIRONMENTAL PROTECTION AGENCY ADVISORY

Fish consumption advisories are a good indicator of the condition of a watershed because they are issued when the concentration of toxic substances in fish and shellfish exceed safe levels. Contamination of edible organisms indicates serious pollution problems in a waterbody, typically because persistent toxic chemicals have contaminated sediment or pathogens have contaminated the water column.

Source: Scorecard, the pollution information site, www.scorecard.org

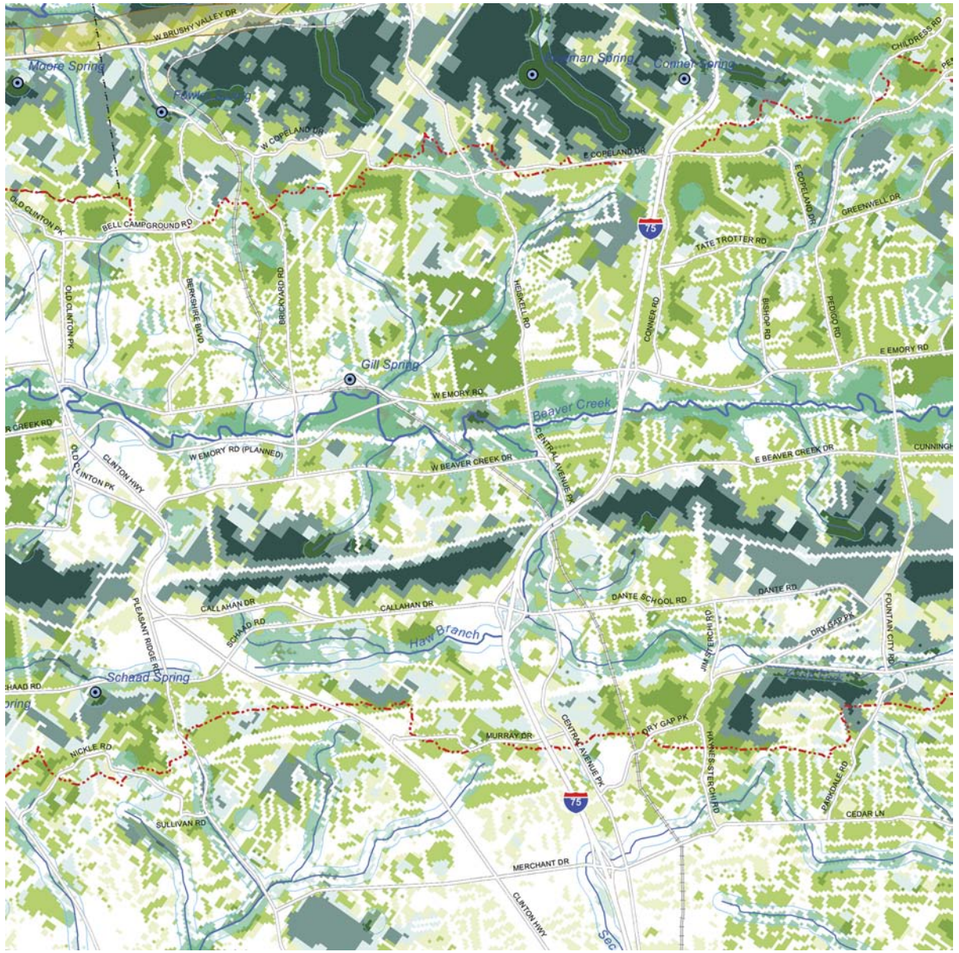
Low-density single-use zoning and development practice causes everyone to have to drive to everything all the time.

Potential Responses

The U. S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) and the Tennessee State Department of Agriculture administer programs to preserve farmland, forests, and grassland habitat through *conservation easement* programs. Areas eligible for these programs are identified later in this study.

HERITAGE PROTECTION CORRIDORS, relatively large blocks of land held in agricultural and rural uses, can be used as *community separators*, which give each community a distinct place in which to belong while preserving some of the last remaining productive land.

CONSERVATION NEIGHBORHOODS are especially important in the area above Maynardville Highway, where increases in impervious surfaces can severely affect downstream flooding by increasing upstream runoff. This type of neighborhood design *clusters housing* at moderate density while preserving open space, habitat, and land important to public health and safety, such as floodplains and stream buffers.



Upland Habitat Rank

Forest Patches	Grass Patches
Marginal	Marginal
Good	Good
Prime	Prime

Riparian Habitat Rank

Forest Patches	Grass Patches
Marginal	Marginal
Good	Good
Prime	Prime

Excerpt from map of "Land Value for Wildlife Habitat" showing areas around Powell. This analysis was conducted using TWRA data in a GIS software model similar to that used by Portland Metro (Oregon).

THE OPEN SPACE NETWORK

C

WHAT IS OPEN SPACE?

Open space is land with a very low intensity of settlement. It has many varieties, as *"developed"* open space, such as parks, plazas, and greenways, and *"undeveloped"* open space, such as farms, wetlands, and forests. Open space can also be either *"linear"* open space, such as formal streetscaped pedestrian routes, urban promenades, and hiking trails, or open space *"places,"* such as soccer parks, nature parks, and neighborhood greens. Together, these spaces form a fabric that provides many community benefits, including:

- Civic identity, symbolism, beauty, and character;
- Recreation, both active and passive;
- Ecological services to society, such as flood mitigation, water filtration, air-pollution control, and climate moderation; and
- Ecological values, such as providing habitat.

Only a small portion of the open space in a community is public land maintained as parks, athletic fields, greenways, school grounds, and so on. The majority is actually open land of different types and ownership, such as:

- Land with poor development potential (steep slopes, flood plains), often in private ownership as an extension of a developed parcel;
- Land being held for future development;
- Large parcel residential land;
- Land in agricultural use; or
- Recreational land in private ownership.

PLANNING OPEN SPACE

If a community wants to grow while maintaining a high quality of community health, safety, and welfare, it should identify lands that contribute to these community values.

Beyond identifying valuable open land, the community must develop a strategy for maintaining these lands in an undeveloped or lightly developed state and work to connect these lands into an *Open Space Network*.

An OPEN SPACE NETWORK is an interconnected pattern of open space elements that allow the system to function in an integrated way. The elements must be interconnected so that people, water, and wildlife can move and flow as needed. For instance, a greenway is useful as recreation if it forms a loop, but it is also useful for soft transportation and recreation if it links housing to shopping and is tied to other greenways. Similarly, if large patches of forest habitat are linked by forest corridors, wildlife can migrate from one place to another for food and genetic diversity. Networks avoid communities constituted of disconnected "islands."

Fortunately, much of the lands with high health-safety-welfare value, such as floodplains, wetlands, and steep slopes, have poor development potential. It is hard to build houses in a swamp or to build a grocery store on a mountainside. Often only a portion of a parcel needs to be maintained as open space. Areas of a parcel left undeveloped or developed as open space provide an amenity to the remainder of the parcel that can increase its value.

There are many ways to encourage maintenance of a parcel as open space, including:

- Owner incentives and tax breaks,
- Purchase for incorporation into a municipal or privately owned open space system, and
- Best practices and regulations for development.

In this study we categorized open land as developed or undeveloped. *Developed open space* is improved, owned, and maintained for use by a public or private community. Ownership can be public or private. It is land used and maintained for:

- Recreation,
- Community services and institutions, or
- Public passage.

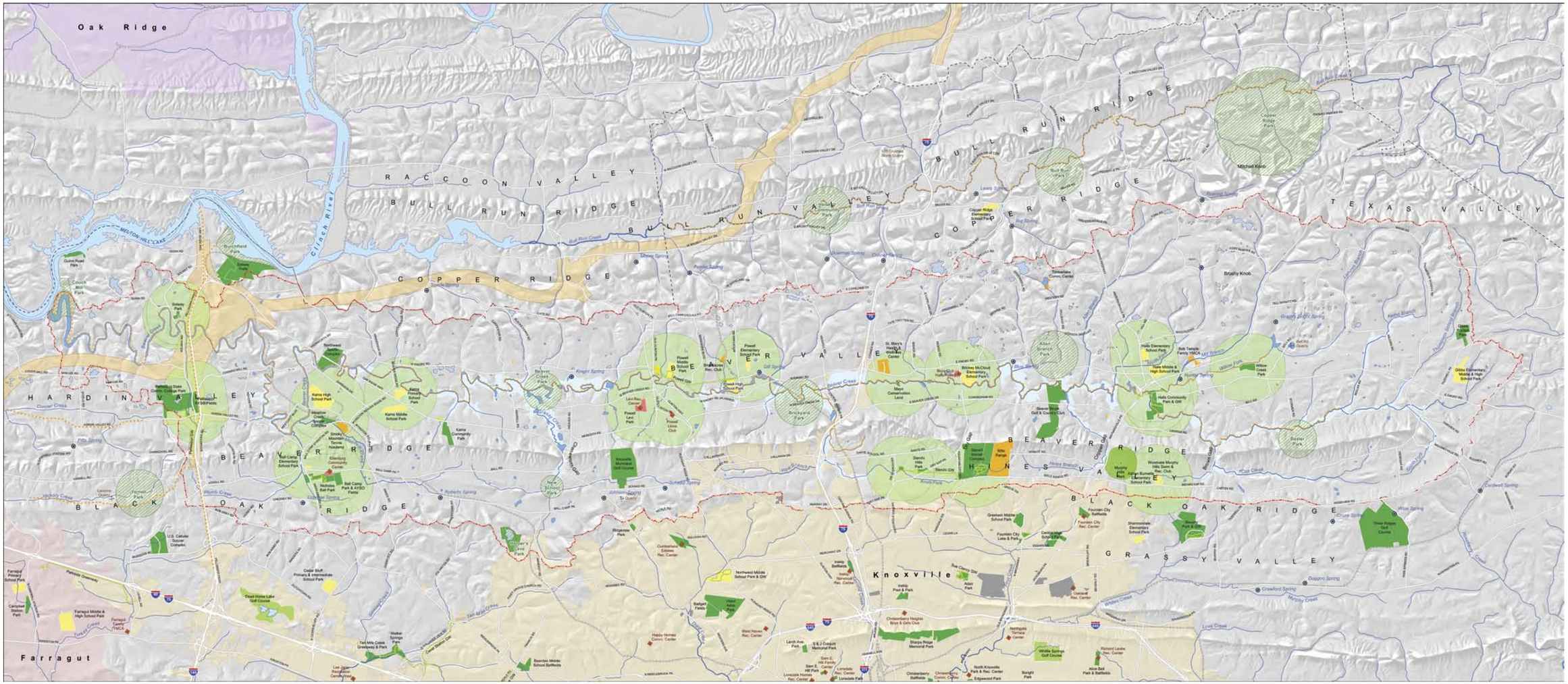
Undeveloped open space is land held in an undeveloped or lightly developed state. Ownership can be public or private. It can be land that is unsuited for development and also contributes to the community's health, safety, and welfare. It might be land with good agricultural value or land that is good for wildlife habitat. In some cases, it might be land that is temporarily undeveloped but is suitable for development in the future.

Our objective in this part of the project was to inventory existing open lands and to identify the best available land for open space. Next, we used this analysis to identify areas that are underserved by parks, identify the relative value of land for farming and wildlife, and develop network patterns for green infrastructure.

BENEFITS OF URBAN OPEN SPACE
The Trust for Public Land

- Mitigating air and water pollution
- Mitigating suburban sprawl
- Providing opportunities for recreation
- Reducing crime and fostering cohesive neighborhoods
- Attracting businesses
- Stabilizing property values

Forest and meadow open space in the watershed



EXISTING NEIGHBORHOOD PARK CATCHMENTS

What you see...

This map shows parks in different size classes and the areas served by mini-parks and neighborhood parks. Neighborhood parks are 2-20 acres and generally serve residents within ½ mile of the park. Mini-parks are less than 2 acres and serve an area less than ¼ mile away. The Beaver Creek watershed is well served by the larger active parks and sports complexes, but there are significant gaps in the distribution of neighborhood parks.

How we did it...

Parks are taken from our map of *Developed Open Space*. We classed the parks by size and generated buffers around parks. Larger parks have larger catchment distances. Size and catchment criteria are based on guidelines from the National Recreation and Park Association, standards used by Knox County for park planning.

- Watershed Boundary
- Knox County Boundary
- Sinkhole (USGS)
- Wetland (NWI)
- 500 yr. Floodplain
- Proposed Knoxville Parkway (SR 475)
- Recreation Activity (Private)
- Greenway
- Proposed Greenway
- Quarry
- Community Center
- Cemetery
- Proposed Park (1998 Plan)
- Golf Course
- City / County Park
- Community Use
- School Park
- Recreation Center Parcel

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System
(TN, FIPS Zone 4100): North American Datum 1983 (feet)

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DEVELOPED OPEN SPACE

As the watershed becomes more urbanized, parks and other community spaces must be diverse in size and character and distributed according to the population they serve.

Parks and green links are part of the settlement structure of a place. When this green civic infrastructure and the patterns of buildings and streets are planned together, a place with a rich, unique, local sense of place can emerge. An example of this way of thinking is Savannah, Georgia, where every neighborhood was planned around a public green.

When planning for open space in a developing area, civic green places have to be planned when towns and neighborhoods are being built. After the Civil War, Knoxville boomed, and city fathers did not include parks in expansion plans. Once an area is built, open land is scarce, and it is nearly impossible to acquire land for a viable park system and even harder to insert greenways. However, Knox County's strong topography has given us a second chance to build a parks and greenways system by preserving creek bottoms and ridges.

As a start, we need to know where the existing green places and green links are and how they relate to where people live.

GOALS FOR DEVELOPED OPEN SPACE

- **Recreation:** to provide public and private recreation (passive and active parks) within easy reach of all community residents.
- **Civic Life:** to support community services and institutions (schools, libraries, courthouses).
- **Soft Transit:** to provide safe public routes for non-drivers (children, elders, bicyclists, equestrians, and pedestrians) to participate in community life.
- **Weaving Networks:** to plan for a framework of places and connecting links that integrate open space into a unified functional system.

EXISTING NEIGHBORHOOD PARKS CATCHMENTS

The size of parks should vary with distance from home.

First we mapped all of the parks, school parks, greenways, and community recreation space in the watershed on a map we called *Existing Developed Open Space* (see the report CD-ROM). We also mapped the park and recreation facilities in the current county park plan (see sidebar reference). The map shows parks in different size classes. Areas served by *"close-to-home" parks* like *mini-parks* and *neighborhood parks* are shown with green circles. Neighborhood parks are 2-20 acres and generally serve residents within ½ mile of the park. Mini-parks are less than 2 acres and serve an area less than ¼ mile away. If watershed residents had good access to parks near their homes, this map would be mostly covered with the small green circles.

Evaluation of the Current System

Strengths

- *Good access to active recreation* opportunities (athletic fields). These parks are well-located to serve the community.
- *Schools and libraries are linked to parks.* Community institutions are sited in parks, joining recreation and educational opportunities.
- *Schools have sidewalks.* Knox County has prioritized providing minimal sidewalks near schools.
- *Greenway segments are well-located.* The City and County have begun building elements that *could, in theory,* become parts of a greenway system.

Weaknesses

- *No pedestrian network.* Existing sections of greenway and sidewalks, while well-located for a future network, don't yet add up to a usable network.
- *Parks and greenways are unevenly distributed.* Access to passive recreation and walking trails is not evenly distributed. Many areas of the valley lack easy access to quiet or passive recreation.
- *Existing trails cross private land.* No formal easements or agreements exist, leaving existing ridge trails in danger of disappearing as land changes hands.
- *Many new neighborhood parks are needed.* The community has significant needs for "close-to-home" parks to serve neighborhoods.

UNDEVELOPED OPEN SPACE

Undeveloped open space is land held in an undeveloped or lightly developed state because it provides high community health-safety-welfare value in that state. Several kinds of lands fall into this category, including forested land (see Land chapter) and land to protect water features and mitigate flooding, which we cover in the chapter on water. In this section, we further analyze existing undeveloped land in the Beaver Creek Watershed for its value as wildlife habitat and its value for farming. Since much of the undeveloped land in the valley is farm and grazing land, and much of that land is forested or otherwise good for wildlife, we also have made a comparative study of these different values.

GOALS FOR UNDEVELOPED OPEN SPACE

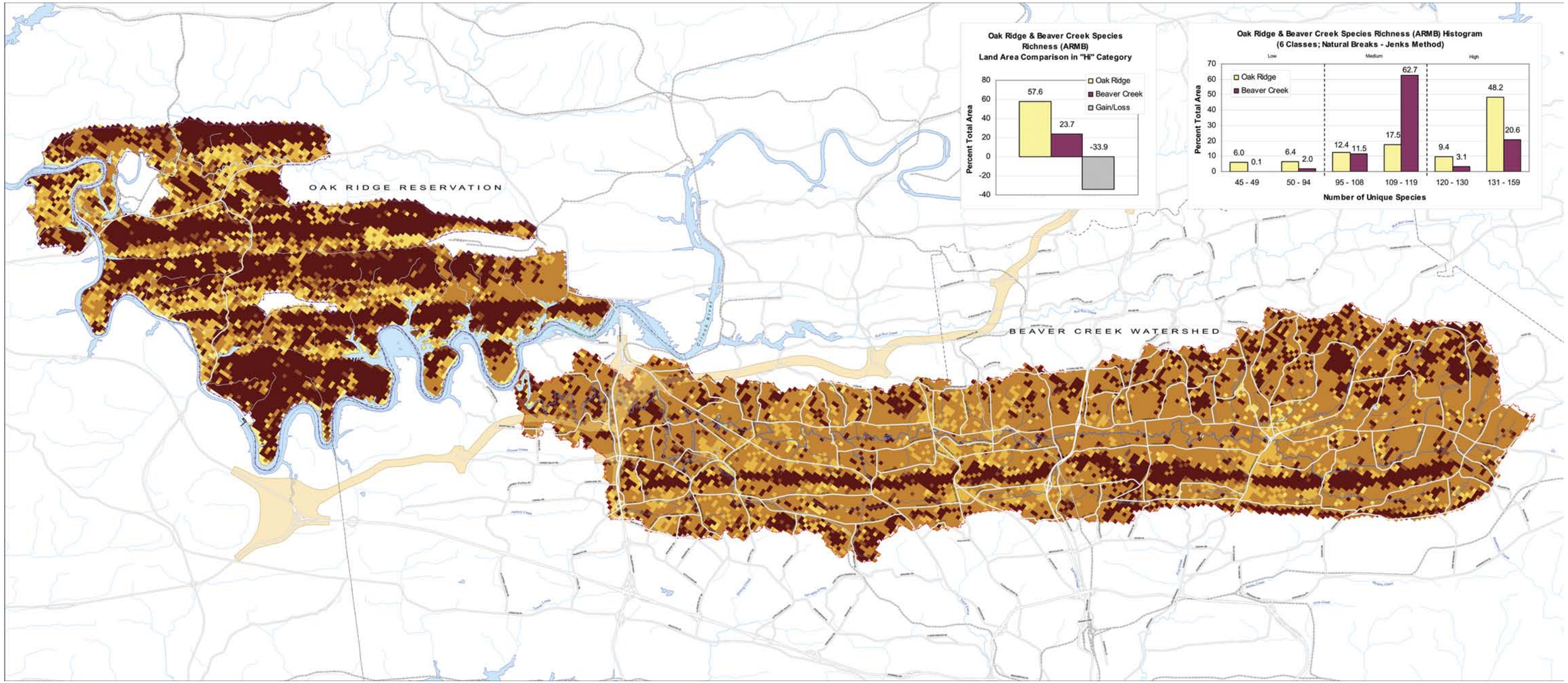
- **Identify Conservation Land:** To find the best places for conservation and development.
- **Protect the Public:** To maintain high health-safety-welfare value land to maximize its contribution.
- **Save for the Future:** To "bank" good farm land for growing food locally in the future.
- **Local Identity:** To separate distinct communities and preserve rural heritage.
- **Weaving Networks:** To plan for a framework of heritage land and environmentally valuable land in an interconnected system.

Our objective is to provide a rational, common-sense basis for identifying the best land for conservation, based on several types of community values, so that we can, in later steps of this planning process, design a connected LAND STEWARDSHIP NETWORK. This network will incorporate areas of highest conservation value for both nature and culture. As a framework, this idea implies that areas not good for conservation are therefore potentially good for development.

One in four citizens can not drive. When parks are too far away, parks that should be for people and nature become car parks, and many old, young, disabled, and poor people never get a chance to benefit from these life-enhancing public places.

MORE INFO on parks planning:

Knoxville Knox County Metropolitan Planning Commission and Knox County Parks and Recreation Department (Feb., 1998). *Knox County Park and Recreation Facility Plan.* Available from MPC.



SPECIES RICHNESS COMPARISON OF BEAVER CREEK WATERSHED & OAK RIDGE RESERVATION

What you see...

This map shows the total *number of unique species and depicts* both the Beaver Creek Watershed (right side) and the Oak Ridge Reservation (ORR) area (left side). The ORR area has been mostly undeveloped for decades and includes large areas of natural parklands. It offers a nearby comparison by which we can infer the impact of poorly planned suburban development on species richness. Much more land of high richness class can be seen in ORR than in Beaver Creek, in both upland and valley areas.

How we did it...

This is the same Tennessee Wildlife Resources Agency (TWRA) *Species Richness* data used in our *Total Species Richness* map. Species richness is an estimate of unique vertebrate species (amphibians, reptiles, mammals, birds) within a 100-meter cell. For purposes of comparing to a relatively undisturbed landscape, we omitted the highly developed national laboratory portions of the ORR area. Total species count is classed into six categories based on the Jenks natural breaks method in GIS.

Watershed Boundary
ORNL-TWRA Boundary
Knox County Boundary
Proposed Knoxville Parkway (SR 475)

Raster Info:

CellSize	215376 sq. ft.	4.94434 acres
OR Area	7126 cells	35233.4 acres
BC Area	11639 cells	57547.2 acres

Total Vertibrate Species Estimate

- 45 - 49 Species
- 50 - 94 Species
- 95 - 108 Species
- 109 - 119 Species
- 120 - 130 Species
- 131 - 159 Species

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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IDENTIFYING AND VALUING OPEN SPACE

In the following pages, we describe the process we used for finding open land with wildlife habitat value and value for farming. The general method used to develop a habitat assessment and propose a more healthy habitat network is as follows:

1) Identify Existing Habitat Areas.
We started by looking at quality and quantity of existing habitat in the watershed, using Land Cover data from TWRA developed as a part of the federal GAP Analysis Program. Our study area extended four miles outside the watershed, to avoid dividing patches on the boundary. While TWRA data identifies several forest and grass habitat types, we simplified to two classes: *Forest* and *Grassland*. Next we removed utility and road corridors to get a more realistic picture of the size and shape of habitat patches. Since *Riparian* (near water) and *Upland* areas support different species, we conducted separate evaluations of each. Riparian areas were defined as land up to 300 feet from water.

2) Assess for Wildlife Habitat Value.
Upland and riparian areas were ranked based on the criteria of patch size, interior patch habitat size, connectivity to other habitat patches of the same type, distance to water, and species richness. Larger patches have higher value because they generally support greater species variety and provide more habitat for interior-preferencing species. In this analysis, interior habitats are areas more than 200 feet from the patch's perimeter. Distance to water is important because all life needs water. Connectivity was simulated by counting the number of cells of the same habitat type (forest or grass) that were within a 1/2 mile of each cell. Species richness was ranked using TWRA data of predicted species counts. We weighted the to favor amphibians and reptiles, which, based on our analysis, are the species most affected by suburbanization. Totaling the scores for these criteria, we developed a composite value for Upland Forest, Upland Grassland, and Riparian Habitat

3) Connect the Most Important Habitat Patches.
The next step is to identify areas where patches can connect to form corridors. We combined this step with identifying land for the Heritage Protection Corridors, covered in the Green Infrastructure chapter. Detailed scientific assessment of habitat network structure was beyond the scope of this study.

SPECIES RICHNESS COMPARISON OF BEAVER CREEK WATERSHED & OAK RIDGE RESERVATION

The Effect of Suburban Sprawl on Biodiversity

We were interested in knowing what kind of effects sprawl has on biodiversity and which types of habitats were most affected by the suburban development that covers large areas of the Beaver Valley. The Oak Ridge Reservation (ORR) area is near the watershed, has been mostly undeveloped for decades, and includes large areas of natural parklands. Comparing the reservation to the watershed, we inferred the impact of the watershed's suburban development on species richness. We used a GIS analysis to count the unique species of four types of vertebrate classes (amphibians, reptiles, mammals, birds) per 100 meters, and classified each 100 m "cell" as High, Medium, or Low species richness using the Jenks Natural Breaks in the GIS.

We then calculated the percentage of High value cells as a portion of the total land area in each of the two study areas. We found that the Beaver Creek Watershed had 62% less High habitat value land for amphibian species and 59% less for reptile species. Bird biodiversity is relatively unaffected by suburban growth (High value land increased by 10%), although there are probably fewer bird species that prefer the interior forest and grass patches in the watershed, since it has less interior habitat than ORR. Prime mammal habitat actually increases with suburbanization (up 44%). Mammal increase may also represent a shift from forest species to urban-adapted species. For all species combined (the map shown), Oak Ridge Reservation has much more land classed as High richness, than the Beaver Creek Watershed, in upland and valley areas. We used these relative impacts of suburban development on species richness to weight the value of existing habitat areas in Beaver Creek toward reptiles and amphibians. This species richness criterion is only one of several used to value land for habitat.

LAND VALUE FOR WILDLIFE HABITAT

Land that Best Supports Diverse Flora and Fauna

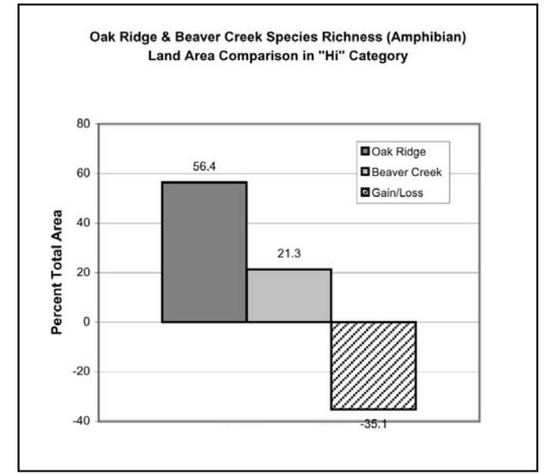
This map (following page) is the end result of the habitat value analysis. It shows the relative value of land to support wildlife habitat. Higher values (darker color) indicate land better suited for wildlife.

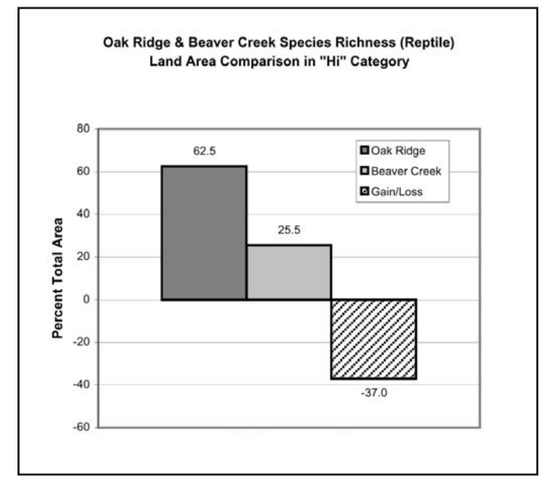
Land cover is either *Forest* or *Grassland* and can be located near water *(Riparian)* or farther away from water *(Upland)*. Upland is defined as any land not in the riparian zone, which is within 300 feet of water. Each of the four categories is ranked into Prime/Good/Marginal, based on a Jenks Natural Breaks distribution of their total scores.

Riparian Forest is already very rare, and upland forest is disappearing rapidly with new development. Riparian forest along Beaver Creek is almost gone, with virtually none above the Meadow Creek confluence. There are significant remaining stands in the lower section of Beaver Creek, in Solway, and just upstream from Pellissippi Parkway. Even small stands of riparian forest are considered highly valuable by ecologists, especially if they are locally or regionally rare.

Forest remains mostly on steep slopes and ridges, Beaver Ridge and Black Oak Ridge (particularly in the upper watershed). Most of the Copper Ridge forest is outside the watershed. The largest area of *prime forest habitat* in the study is just north of the upper watershed boundary, between Hill Road and Maynardville Highway, near Roaring Spring. This is a prime site for a REGIONAL NATURE PARK. Within the watershed, the largest prime forest patch is Brushy Knob, just west of Maynardville Pike. The upper watershed, above Maynardville Pike, has some connectivity of forests remaining but is in severe danger of losing its continuity if new development does not respect the forest and wetlands, as many remaining patches are already small and thin.

Grassland is most commonly farm meadows in the watershed, with little or no native grassland habitat remaining. Its habitat value, therefore, is mainly in its fence-line hedgerows that help link forest patches. However, restoration of some grassland as native species preserves is recommended to help regional biodiversity and provide learning and recreational birding environments for residents and school children.



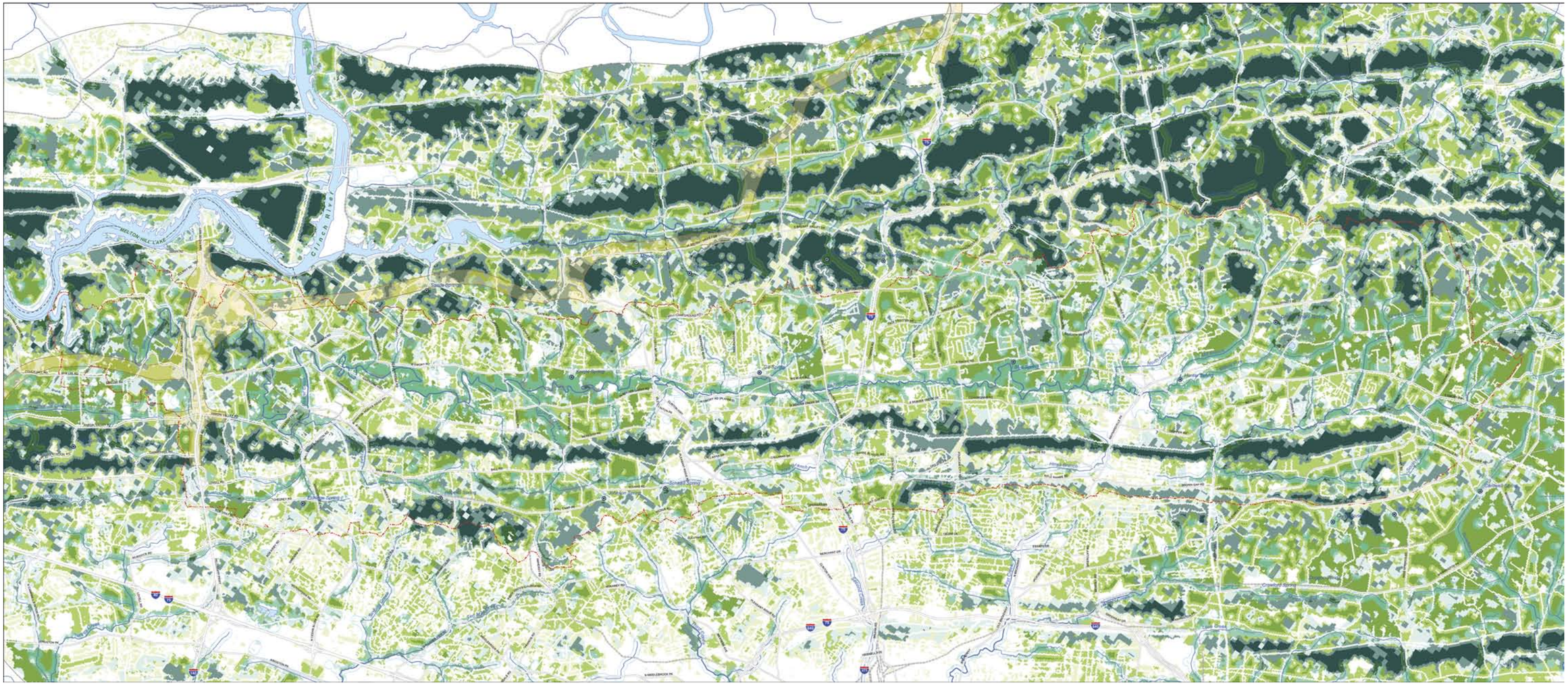


MORE INFO:

USGA Gap Analysis Program, http://www.gap.uidaho.edu/

Tennessee Gap Analysis data.
Jeanette Jones
Tennessee Wildlife Resources Agency, Nashville
Jeanette.Jones@state.tn.us, 615-781-6534

Portland (Oregon) Metro's Habitat Protection Program
- http://www.metro-region.org
- Portland's Scientific basis: *Metro's Technical Report for Goal 5* (Fish and Wildlife Protection), 2002.
- *Metro's Riparian Corridor and Wildlife Habitat Inventories*, April 2005.



LAND VALUE FOR WILDLIFE HABITAT

What you see...

This map shows the relative value of land to support wildlife habitat. Higher values (darker color) indicate land better for wildlife. Land cover is either *Forest* or *Grassland* and can be located near water *(Riparian)* or farther away from water *(Upland)*. Riparian Forest is already very rare, and upland forest is disappearing rapidly with new development. Forest remains mostly on steep slopes and ridges, while grassland is most commonly farm meadows.

How we did it...

We started with land cover and biodiversity data from EPA's *Gap Analysis Program*, available from TWRA. Overlaying with utility lines and roads yielded areas called *Habitat Patches*, classed as either *Forest* or *Grass*. Patches were then evaluated for 5 criteria: size, interior habitat area, connectivity to other patches of the same type, species richness, and distance to water. Distance to water and species richness (biodiversity) were applied separately to upland and riparian patches.

- Spring (USGS)
- Watershed Boundary
- Knox County Boundary
- Riparian Zone
- Proposed Knoxville Parkway (SR 475)

Upland Habitat Rank

Forest Patches	Grass Patches
Marginal	Marginal
Good	Good
Prime	Prime

Riparian Habitat Rank

Forest Patches	Grass Patches
Marginal	Marginal
Good	Good
Prime	Prime

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System
(TN, FIPS Zone 4100): North American Datum 1983 (feet)

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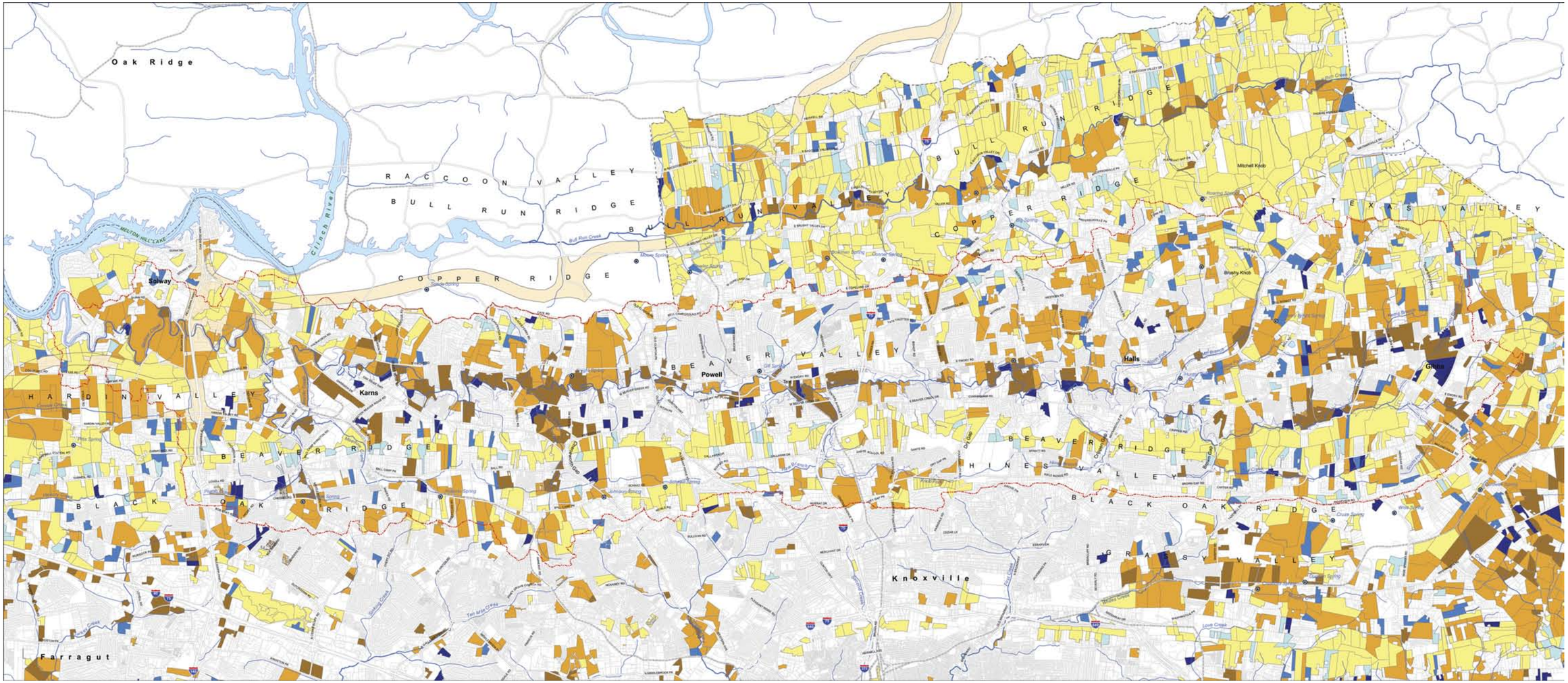

AGRICULTURAL LAND VALUE

What you see...

This map shows land used for agriculture, unused land, and large residential parcels, all ranked by their *soil suitability* for agriculture. Agricultural land, because it is usually relatively flat, is often good for housing and other urban development. This analysis allows us to identify the best farm land, so that new development can be directed to other areas, and working farms can be kept for future generations. Clustered housing on large residential parcels may allow remaining areas to be conserved for agricultural use.

How we did it...

Soils are ranked by the Natural Resources Conservation Service as poor, suitable, or prime for agriculture. Because very few parcels have only one soil type, we needed to determine which parcels were best for agriculture. For each parcel, we determined the average soil rating and then ranked the parcels in three equal interval classes. Agricultural parcels are 5 acres and greater. Residential parcels considered are zoned 1-4 family and are 10 acres or greater.

Agricultural and Unused Parcels

- Poor for Agriculture
- Suitable for Agriculture
- Prime for Agriculture

Residential Parcels > 10 acres

- Poor for Agriculture
- Suitable for Agriculture
- Prime for Agriculture

- Spring (USGS)
- Watershed Boundary
- Knox County Boundary
- 500yr Flood
- Proposed Knoxville Parkway (SR 475)

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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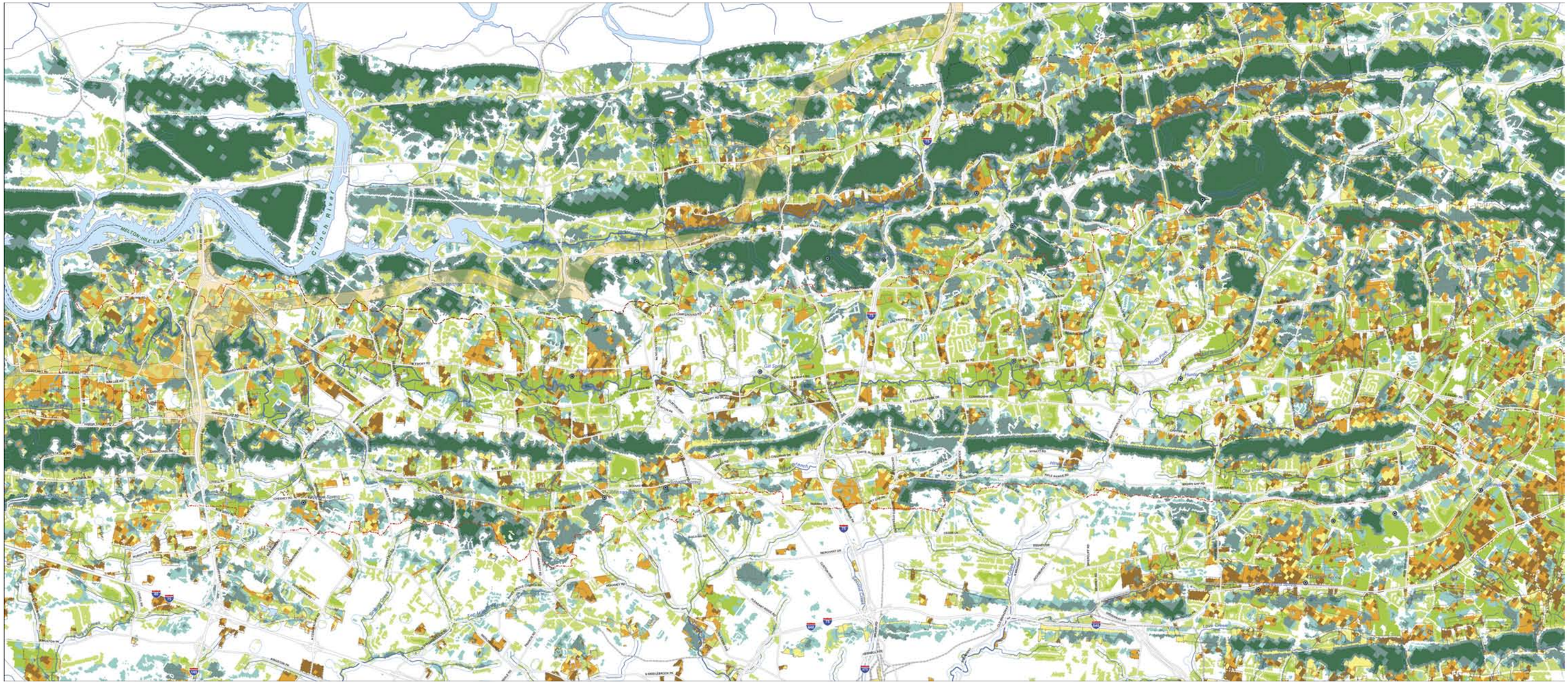

HABITAT VALUE VS. AGRICULTURAL LAND VALUE

What you see...

This map shows results of analysis that intersects land valuable for wildlife habitat with land valuable for agriculture. Some land is good for both. This analysis allows us to determine which is more important. Agricultural land is also under pressure for development; this map can help to determine which agricultural parcels are best kept available for working farms. When a farm parcel is to be developed, this map can help determine which natural areas to preserve.

How we did it...

We compared the values of land from the *Land Value For Wildlife Habitat* analysis with values of Soil Suitability for farming on agricultural and unused parcels from our *Agricultural Land Value* analysis. Habitat and Soils were ranked as 1/2/3, with 3 as best. Habitat was weighted to increase the value of riparian habitat and decrease the value of upland grasslands. The values in each cell were compared; If soil values were greater, the cell became agriculture. Upland grass patches and agricultural parcels are >5 acres in this analysis; upland forest is >2 acres.

Boundaries
- Knox County
- Watershed Boundary
- Riparian Zone
- Agricultural & Unused Parcels
- Proposed Knoxville Parkway (SR 475)

Forest Habitat
- Marginal
- Good
- Prime

Grass Habitat
- Marginal
- Good
- Prime

Agriculture
- Marginal
- Good
- Prime

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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AGRICULTURAL LAND VALUE

Soil Suitability for Farming

A community with vision will preserve its best farmland for the future. There's a saying "The only thing we know for certain is that change is certain." Knox County doesn't rely on locally grown food right now, but a reasonable chance exists that in the future we might (see "*Why Preserve Farmland For The Future?*", at right). A community with foresight needs to make it easier, not harder, for farm families to keep and farm their land, both as an important part of our culture and because what is now a pleasant luxury, like Grainger County tomatoes, may become a future necessity.

Our question was, Where is the best land for farming? We considered land used for agriculture, unused land, and large residential parcels, ranking them by their ***soil suitability*** for agriculture.

The implication of this analysis is that working farms with good soil should be kept for future generations, and development should be directed to land less suited for agriculture. This is important because agricultural land is often in competition with development interests. Land may be more valuable for building than for farming, giving owners incentive to sell, but this is not in the long-term interest of the local community. So the community needs to help owners find other options and incentives, such as government programs that support term or permanent conservation easements for prime farmland and for grassland with habitat potential. Farmland rankings are used in later steps of our planning process to identify parcels eligible for government easement purchase programs.

HABITAT VALUE VS. AGRICULTURAL LAND VALUE

Land Characteristics Suggest Potential Land Use

Some land is good for both wildlife habitat and for agriculture. Bottomland forest is a good example. Often, land in floodplains is cleared for farming, yet this is also usually prime wildlife habitat. This map shows the final results of the analysis sequence. Our analysis intersects *Land Valuable For Wildlife Habitat* with the *Agricultural Land Value* analysis. By doing so, we can determine (given value choices) which is more important.

ISSUE	POTENTIAL RESPONSE
• **Habitat Network Fragmentation** + Decline in amphibian and reptile species richness + Few ridge-to-creek links	• **Build an Open Space Network-RAPIDLY!** that protects water resources, ridges, habitat, and farm land, while channeling development. • **Value Reptile Habitat and Amphibian Habitat,** which are sensitive to suburbanization. • **Preserve Land for Linking Habitat Corridors,** for connecting prime habitat patches.
• **Special Habitats Disappearing** + Wetlands destroyed + Grassland habitat converted to pasture + Riparian forest almost extinct	• **Protect and Restore Wetlands;** since mostly gone, restoration is important. • **Preserve Remnant Riparian Forest,** and reforest the floodplains. • **Identify Land for Grassland Reserve Program,** which supports conservation easements.
• **Slopes and Ridges at Risk,** + Potential ridge-top development + Steep slope forests unprotected	• **Add Forest Criteria to Slope Protection, which achieves** many benefits, including protection of the largest remaining habitat areas. • **Develop Strong Ridge Protection Corridors,** to preserve Health-Safety-Welfare and habitat values by limiting development.

Why Preserve Farmland For The Future?

Because our small farms can't produce the huge quantities national and international food brokers require, East Tennessee agriculture land has relatively low value to food producers. So food sold in Knox County's grocery stores and eaten in it's restaurants is produced in areas with flatter land and longer growing seasons, like Southern California, Florida, and even South America. Our access to this food depends on inexpensive long-distance trucking, petroleum-derived fertilizers, and mechanized production, and these depend on inexpensive fuel. Our food prices are already rising with recent increases in fuel costs, and prices will surely go higher. Many American communities have started to plan for the time when prices hit the point where transportation becomes too expensive and local farm food, once again, becomes the best economic choice.

In later steps of our planning process, we used this map to help determine the best locations for HERITAGE PROTECTION CORRIDORS and to help develop the boundaries of the STREAM PROTECTION CORRIDORS. *In the future, we believe this map should be consulted on every land-use decision for these parcels. It gives a concrete basis for adding agricultural and wildlife values to land decisions.* This approach allows selective conservation on a large parcel, such as a farm, that includes land good for farming and land good for habitat. If farmland is developed, this map can help determine which natural areas to preserve.

CONCLUSIONS

Farmland and wildlife habitat are both fragmented by sprawling suburbs. Together, using foresight, stewardship, and decisive action, we can save the valley's valuable land, heritage, and beauty.

Without foresight, stewardship, and decisive action to guide development, the watershed will become just another sprawling suburb. Our analysis clearly demonstrates this.

Issues

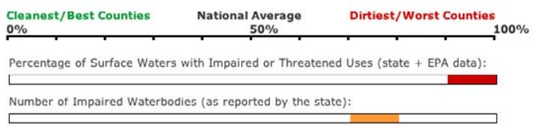
The Beaver Creek Watershed is quickly giving way to suburban sprawl. The new Knoxville I-475 Parkway will add more development pressure to communities at the southwest end of the watershed. We saw this first in the analysis of settlement and now, again, in our analysis of open space. Islands of suburban enclaves are sprouting faster than community planning can proceed, so home buyers end up with a new house but none of the small neighborhood parks, sidewalks, and walking trails that people want and use most. Without planning, forest and wetlands disappear, and pressure to develop "just a little more" of the ridges and slopes increases because the land is more expensive. There is nothing in the current development controls to encourage parks and greenways or to limit clear-cutting forests and ridge-top development such as that already seen in Knoxville to the south.

Potential Responses

Preserving individual parcels of environmentally valuable land is not enough. The *pattern* of conservation is paramount. The best solution is a strong *wildlife habitat network* and an *open space network* that preserves rural heritage and agricultural land. Later in this plan, we propose three integrated concepts of RIDGE, HERITAGE, and STREAM PROTECTION CORRIDORS. Such an integrated approach would have to address all of the individual responses listed in the table above plus others not covered in this study, such as unique/rare habitats and the integration of forestry production and habitat.

Water quality in the watershed can be characterized as poor, although it is somewhat better in the upper reaches of the creek and good on some tributaries (Cox Creek, Willow Fork, and Lammie Branch).

—The Beaver Creek Watershed Assessment



EPA ranks Knox County waterways as among the 10% most polluted counties in the USA!

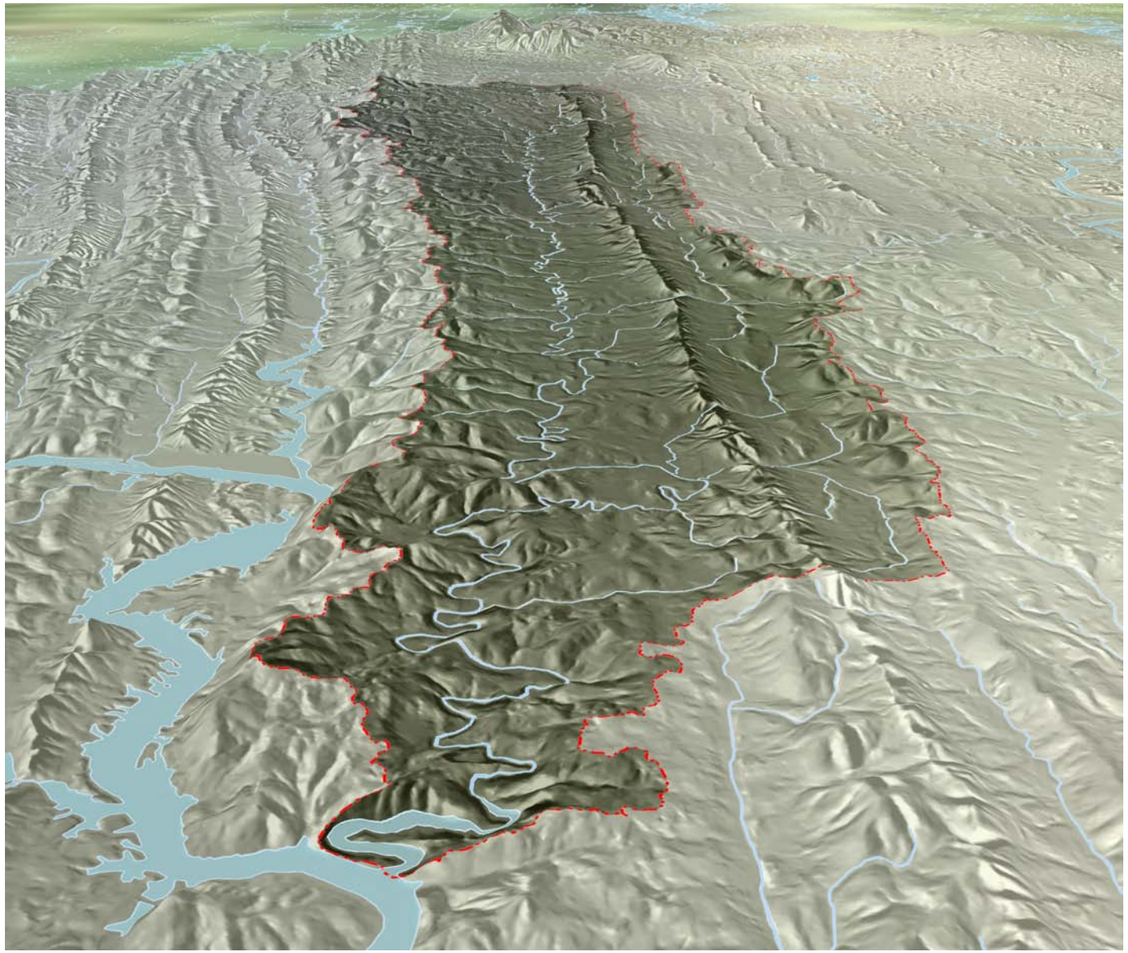
The Lower Clinch River Watershed, of which the Beaver Creek Watershed is a part, is ranked as the 9th most polluted watershed out of 49 major watersheds in the state of Tennessee, based on state and EPA data. Tennesee has the 9th most polluted waters in the USA.

Source: Scorecard, the pollution information site; www.scorecard.org

FOR MORE INFORMATION

Knox County Engineering and Public Works, Knox County Parks and Recreation, and Knox Land and Water Conservancy (2002). *The Beaver Creek Watershed Assessment*.

Ogden Environmental and Energy Services, Inc. (2000). *Beaver Creek Watershed Storm Water Master Plan*. Prepared for Knox County Engineering and Public Works Department.



View of the Beaver Creek Watershed, looking up the valley, from southwest to northeast. Creeks and water are shown in blue.

PROTECTING THE WATER NETWORK

D

INTRO: INCREASED FLOODING AND WORSENING WATER QUALITY

When it comes to water, our current ways of developing have serious implications for public health and safety.

Streams and floodplains are dynamic features, *which change in response to changes made in the landscape uphill from the stream*. Ten years ago, the Beaver Creek Watershed was a slowly suburbanizing rural area. Buildings constructed *during that time* were generally located on higher ground, above the floodplain. But the Beaver Creek floodplain is expanding. In the last 10 years, many more people, homes, and businesses have moved into the watershed. To build for these new residents, more forest and grassy meadows are cleared, low areas filled, and acres of paved parking lots, roads, and driveways are installed.

The effect of this rapid new development is to:

- *Decrease* the land surface's ability to absorb water;
- *Increase* the amount of stormwater running into a stream during a storm;
- *Increase* the sediment, pathogen, and nutrient load that stormwater carries into the stream;
- *Raise* the elevation of flood waters, thus increasing the horizontal area that flood waters cover; and
- *Reduce* the ability of floodplains on the creek and its tributaries to store flood water.

The overall impacts of changes in the watershed caused by current development practices can be boiled down to two themes:

1) Stream water quality is poor now, and development threatens to make it even worse.

> The primary impacts to Beaver Creek include sediment, nutrients, and pathogens from agricultural and urban runoff; nutrients and pathogens from municipal point sources, such as sewage treatment plants; and habitat alteration, due primarily to land development.
>
> —*The Beaver Creek Watershed Assessment, p. 2.*

The full length of the creek is included on the state's 303(d) list of polluted streams, which is maintained by the Tennessee Department of Environment and Conservation (TDEC).

2) Flooding is worse now than it used to be, and it is getting even worse. When the amount and volume of stormwater flowing toward a stream increases, it increases the elevation of flooding, so the flood covers more land (thus widening the floodplain). This means that homes or businesses that were close to the floodplain 50 or 70 years ago may now be flooding or in danger of flooding soon if current development practices continue.

Our Process for Addressing These Impacts

These two issues, increased flooding and declining water quality, are among the most important drivers of this project. In broad terms, our method for addressing them is summarized in the table (see sidebar). The result of this process is our proposal for WATER FEATURE BUFFERS, which includes STREAM PROTECTION BUFFERS and GROUNDWATER PROTECTION BUFFERS. Both use a *three-zone buffer system*.

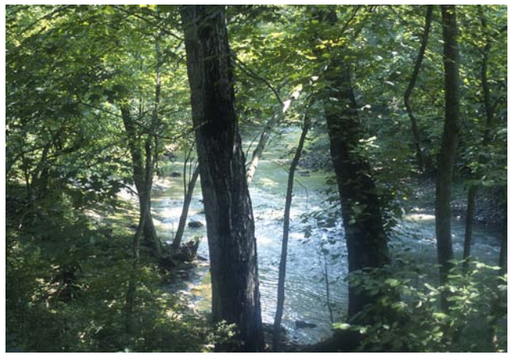
BEAVER CREEK SUBWATERSHEDS & BASINS

Understanding the network that needs protection.

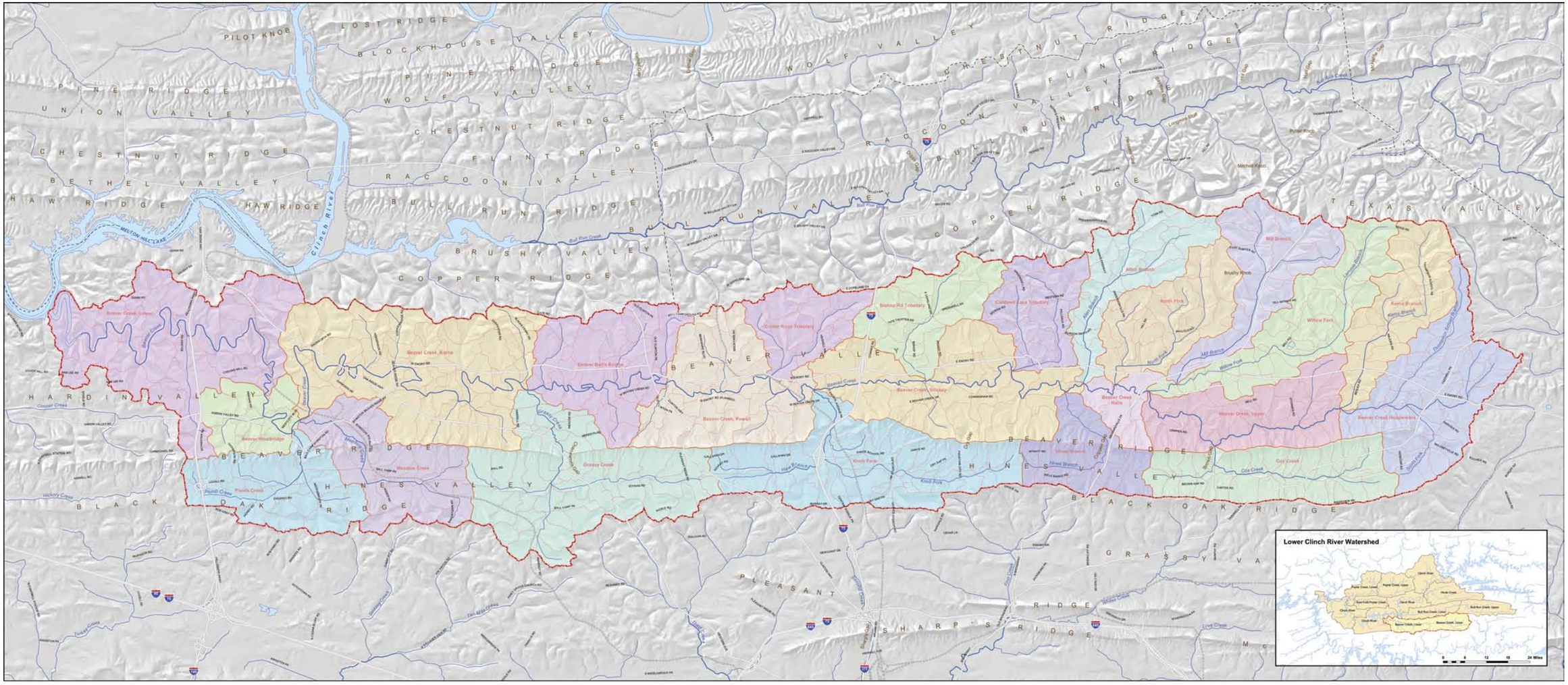
One of the most basic ways of understanding a stream network is to map the areas that drain to each creek. Stream networks and their contributing land areas are hierarchical— they nest within one another. Small drainages flow into creeks, which flow into larger creeks, which flow into rivers, and so on. We have thought of these catchment areas at three scales, as defined in the *Beaver Creek Stormwater Master Plan*: watershed, sub-watershed, and basin. These drainages are all defined by topography. Beaver Creek drains all of the land within its *watershed*. Its tributaries drain the *subwatershed areas*. Some land drains directly to Beaver Creek without first draining to a significant tributary. In this case, the map shows subwatersheds with names like *Beaver Creek, Lower,* and *Beaver Creek, Headwaters*. The smallest drainage division is the *basin*. Within each subwatershed lie numerous basins. Subwatershed boundaries show fine divisions of the drainage pattern, each one roughly 100 acres, as defined in the *Beaver Creek Stormwater Master Plan*.

BASIC WATER METHOD OUTLINE

1) **UNDERSTAND** the network that needs protection.
2) **IDENTIFY** features in the network to protect.
3) **IDENTIFY** the best strategies for protecting those features.
4) **IDENTIFY** priority areas of the watershed for protecting water quality and mitigate flooding.



Streamside vegetation provides many benefits to water quality and aquatic habitat.



BEAVER CREEK SUBWATERSHEDS AND BASINS

What you see...

Stream networks and their contributing land areas are hierarchical. Small drainages flow into creeks, which flow into larger creeks, which flow into rivers, and so on. Beaver Creek flows into the lower Clinch River. The inset map shows Beaver Creek in context of the lower Clinch River Watershed, which drains all of the land contained within it. Its tributaries drain the *subwatershed* areas, while *basin* boundaries show fine divisions of the drainage pattern. These drainages are all defined by topography.

How we did it...

The Beaver Creek *Watershed* and *subwatershed* divides were developed by consensus of the Beaver Creek Task Force and originate in delineation by the Center for Watershed Protection (CWP). *Basin* lines which delineate areas of about 100 acres, were drawn by Ogden Engineering for the *Beaver Creek Watershed Flood Study*. Background hillshade is generated from United States Geological Survey (USGS) 10-meter *digital elevation models* (DEMs). Stream lines come from USGS 1:100,000-scale digital topographic maps (DLGs).

Watershed Boundary
Subwatershed Divides
Basin Divides
Knox County Boundary

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System
(TN, FIPS Zone 4100): North American Datum 1983 (feet)

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EXISTING WATER FEATURES

Identifying the Features in the Network to Protect

Next, we asked the question: To protect water quality and mitigate flooding, what features in the water network do we need to protect? The answer we found was: To protect water quality in Beaver Creek, surface water as well as groundwater need to be protected.

Until today, much of the community's attention has focused on Beaver Creek and its tributaries, but the creeks are only a fraction of the story. At least part of the water in a stream network that flows year-round, like Beaver Creek, comes from groundwater sources. So, to properly protect water quality in Beaver Creek watershed, we must protect water features that feed the groundwater, known as *sinks*, and features where groundwater comes to the surface, known as *sources*.

One of the most important things we did in this study was to assemble a map that included the water features that are important to water quality and flood mitigation. A feature can't be protected, or a hazard avoided, if it isn't documented. While our map does not include every feature in the watershed, it is more comprehensive than the county's existing records. Ideally, watershed residents should review this map and mark the locations of other significant water features for possible addition to the map.

Knox County's database included stream network and surface water (lakes and ponds) data, and the 1998 *Beaver Creek Flood Study*, conducted by Ogden Engineering, which identified floodway and floodplains in the watershed. Because watershed floodplains are widening in response to development, we used the present 500-year floodplain to represent Beaver Creek's 100-year floodplain of the near future. However, KGIS did not have data layers for sinkholes, wetlands, or springs. Data on these features were available from other sources, so we created new data layers for these features. Wetlands are those found in the *National Wetland Inventory* (NWI). Springs and sinkhole boundaries were digitized from USGS 1:24,000-scale topographic (quadrangle) maps. In addition we mapped *catchments* (the surface land area that drains toward the spring) for each spring in the watershed. To better illustrate the way land sloped relative to each feature, the map is displayed over a hillshade (shaded relief view).

In addition to the features mapped, many land uses negatively affect water quality if they occur in a floodplain or adjacent to a source or sink. Existing land-use data needed to be reformatted and verified before an accurate map of land-use hazards could be made. To identify land use hazards, we recommend that the BCTF survey parcels that engage the water buffers (see the *Stream Corridor Preliminary Parcel Assessment* map in Section E) . Once these hazards have been identified, it may be possible to change practices on these sites, or encourage relocation of seriously detrimental uses to outside of the buffer, or to an off-site location.

WATER FEATURE BUFFERS

Strategies for Protecting Water Features

One of the commonly recommended land-use strategy for protecting water features from non-point source pollution is to identify a *protective buffer* of land around the feature. In this buffer, natural characteristics of the land are maintained or restored for purposes of protecting water quality, maximizing stormwater storage, and promoting infiltration. The buffers in this study are derived from *model ordinances* and *best practices* and use regionally specific guidelines whenever possible. Sources are listed in "Water Feature Concepts," at right.

Appropriate Minimum Buffer Widths

The buffer concept we used is one of *variable width with a minimum size*. We begin by explaining the minimums. Minimum required buffer widths vary in the literature, depending on the type of feature and its size. After consulting with water quality experts, we used the following minimum buffer widths:

Streams: Minimum buffer width depends on the stream's *order* (its place in the watershed's stream network). Beaver Creek is a *third-order stream*; its tributaries are *second order* or smaller. EPA's recommended minimum buffer widths are, as measured from the floodway line:

- *125 feet*, for third-order streams or larger, and
- *100 feet*, for first- and second-order streams.

Wetlands: In this project, wetlands receive the same protective buffer as a first-order stream, which is a minimum buffer of *100 feet*.

Sinkholes: The Minnesota Pollution Control Guidelines recommend protection of the area draining to the sinkhole (its catchment), which is preferable to a radial buffer. It was beyond our scope to map sinkhole catchments. So, in this project, sinkholes receive the same protective buffer as a first order stream, a minimum buffer of *100 feet*. A *300-foot "no build" setback* from sinkhole edges and a new *policy against filling sinkholes* are also recommended, because of the role these features play in recharging ground water; their influence on ground water quality; the unique wildlife habitat they provide; and, most important to homeowners, the damage to structures that can occur when a sinkhole caves in or enlarges.

Springs: Because some springs in the watershed are still used by animals and people as drinking sources, we applied a Florida ordinance for protection of single-point drinking sources (a wellhead or spring). The ordinance recommends a *500-foot protected radius* around the source. We reduced this protective area to protect *just the land that drained to the spring* (per EPA guidelines), because the context of application (East Tennessee) is steeply sloped.

A Spectrum of Protection and Use within Buffers

Dividing a buffer into zones facilitates creation of a gradual transition in protection practices between the protected edge of the stream and the developed landscape of a suburb or town. It also facilitates an associated *spectrum of uses* compatible with each protection level, allowing people living adjacent to a water feature to access and enjoy the water feature and the natural beauty of the buffer lands in a way that does not degrade the quality of those resources.

The EPA recommends dividing a buffer into three zones, where management practices vary from *protection* (closest to feature) to *conservation* (in the middle) to *stewardship* (farthest from the feature). Each zone has a minimum required width determined by guideline recommendations for that feature type.

Our buffer approach is based on three principles:

- *Create a continuous linear buffer* that protects the stream network, including creek and tributaries.
- *Protect streams and adjacent features together*, so the linear buffer is expanded to include associated wetlands, springs, steep slopes, and sinkholes.
- *Protect chains of related features*, such as sinkholes and wetlands that occur distant from a stream, by uniting closely located and related individual feature buffers into linear buffers.

WATER FEATURE CONCEPTS

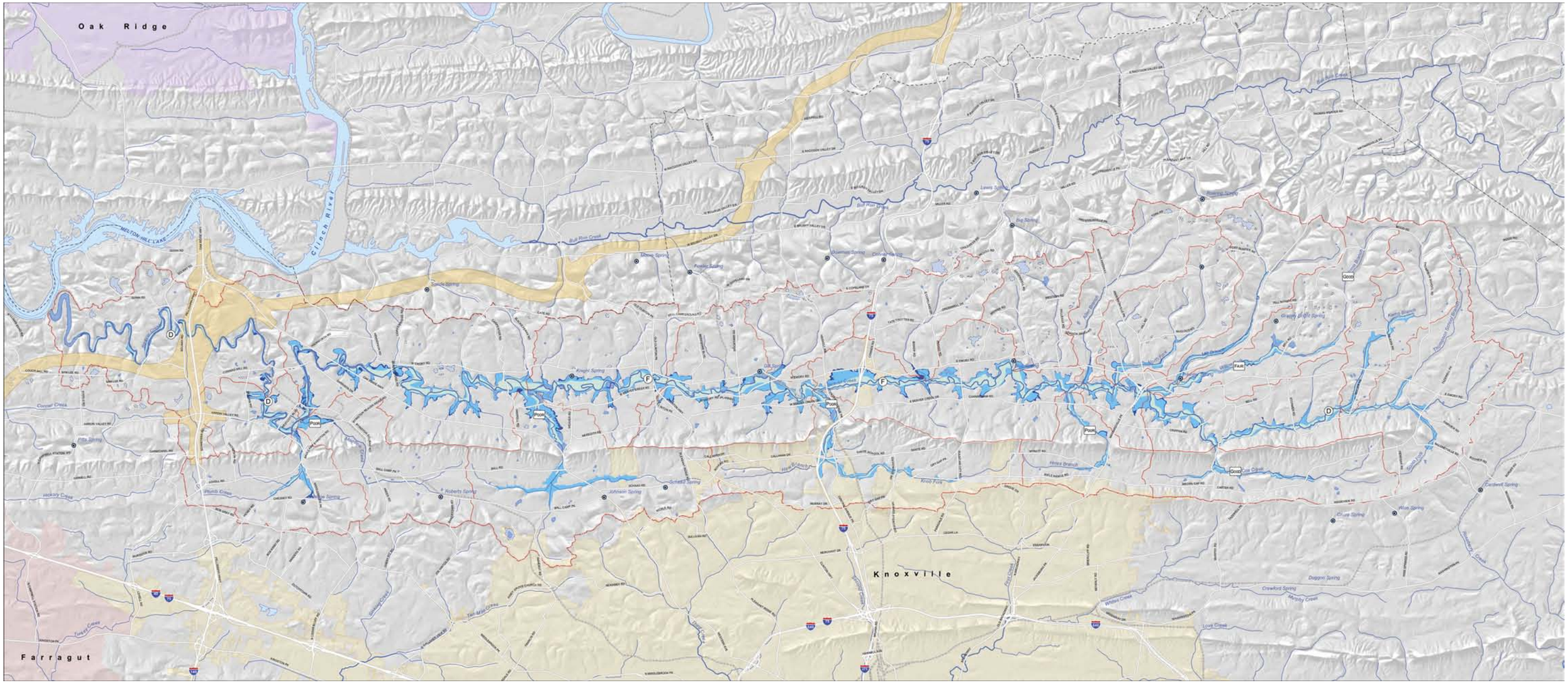
Sources are features from which we draw our water. They are sources for animal and human drinking, crop irrigation, and landscaping watering. Sources in Beaver Creek include springs, the stream network, ponds, lakes, and flooded quarries.

Sinks are features through which stormwater concentrates and infiltrates (sinks into) the ground. Sinks in Beaver Creek include floodplains, wetlands, and sinkholes.

Impact Amplifiers are features that locally increase the severity of runoff and decrease water quality. In this study, we identified steep slopes that were close enough to water features to negatively impact them.

Primary sources for water feature buffer width and character guideline include:

- Tennessee MS-4 Working Group (2004). "Water Quality Buffer Zone Policy." www.franklin-gov.com/engineering/STORMWATER/ms4.thm
- U.S. EPA (2002). "Aquatic Buffer Model Ordinance." Washington: U.S. Environmental Protection Agency. www.epa.gov/owow/nps/ordinance/buffers.htm
- U.S. EPA (2002). "Sourcewater Protection Model Ordinance." Washington: U.S. Environmental Protection Agency. www.epa.gov/owow/nps/ordinance/sourcewater.htm
- Florida DEP (1995). "Florida Chapter 62-521 Wellhead Protection Ordinance." Florida Department of Environmental Protection, www.dep.stste.fl.us/water/groundwater/wellhead.htm
- Minnesota Pollution Control Agency (2001). "Karst Workgroup Recommendations," Legislative Fact Sheet. www.pca.state.mn.us/water/groundwater/karst.html



EXISTING WATER FEATURES

What you see...

This map shows landscape features of the *water network*. Features can be either connected to the streams or connected to the groundwater system in the uplands. Springs and sinkholes are tied to the groundwater system, which, itself, eventually flows to the streams. Wetlands can be tied to either surface or groundwater systems. The floodway, floodplain, wetlands, and sinkholes detain water, which helps mitigate flooding. The subwatershed divides bound areas drained by tributaries of Beaver Creek.

How we did it...

Stream lines are taken from USGS 1:100,000-scale digital map data. Floodway and floodplain lines come from the *Beaver Creek Watershed Flood Study* (Ogden Engineering). Wetlands are those found in the *National Wetland Inventory* (NWI). Springs and sinkhole boundaries were digitized from USGS 1:24,000 topographic maps. The terrain image in the background is a *hillshade* generated from USGS (10 m grid) *digital elevation models* (DEMs).

- Spring (USGS)
- Wetland (NWI)
- Sinkhole (USGS)
- Watershed Boundary
- Knox County Boundary
- TVA Subwatershed Divides
- Proposed Knoxville Parkway (SR 475)
- Floodway Area
- 100 yr. Floodplain
- 500 yr. Floodplain

Water Quality Report Card

- (A) Excellent
- (B) Good
- (C) Fair
- (D) Poor
- (F) Very Poor

Tributary Condition

- E EXCELLENT
- GOOD GOOD
- FAIR FAIR
- POOR POOR

Source: TVA

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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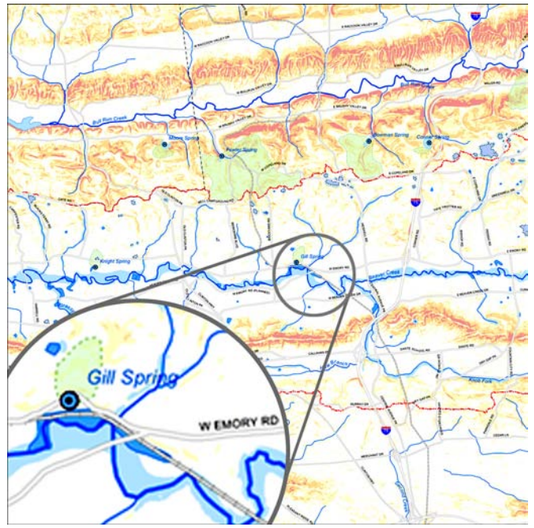

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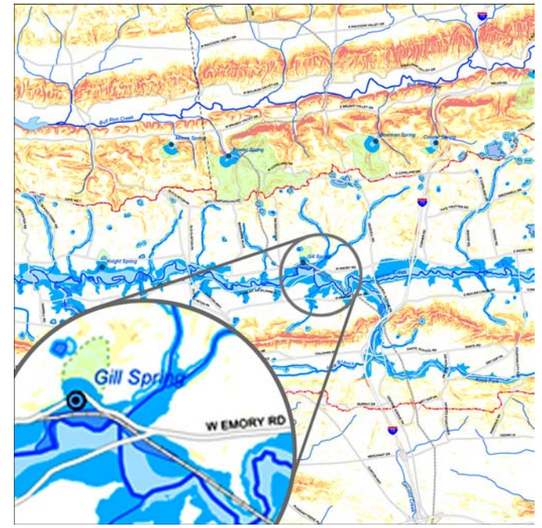

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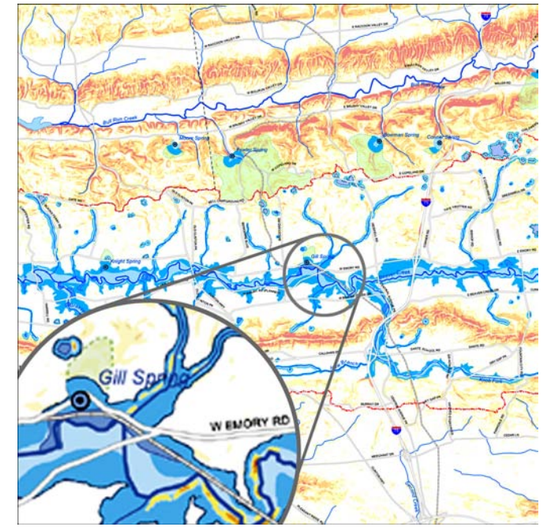


EXISTING WATER FEATURES

(full map on facing page)

What you see…

This map shows existing water features. The Federal Emergency Management Agency (FEMA) defined floodway for Beaver Creek is shown. Land catchments draining toward springs are also identified because ordinances and practices for drinking sources, which include springs, are defined for land draining toward the source.

For more details on this map and how we created it, see the full description on the facing page.

WATER FEATURE BUFFERS, ZONE 1 (PROTECTION)

What you see…

This map shows the building of Zone 1 of the three-zone buffer. Zone 1 "protection" is measured from the floodway or banktop. It is intended to protect from erosion the edges of features and to provide a band of high-quality filtering vegetation adjacent to the feature. The width of Zone 1 remains at the minimum (see p. 35 for dimensions) unless another feature or impact is near the stream.

Stream networks include wetlands, springs, sinkholes, and steep slopes close to the channel, so it makes sense to protect the edges of the stream and associated features with a single continuous zone. In this step, features and impacts that are close enough to the stream corridor that Zone 1 of their buffer will come close to, or overlap with, the stream's Zone 1 are identified. Within 75 feet of the floodway or 50 feet of smaller tributaries was considered close to the stream. Zone 1 from these "close" features and impacts were merged with the minimum Zone 1 buffer to create a composite Zone 1 for the stream network. For features and impacts distant from the stream, the Zone 1s merge only if the buffers touch or overlap.

At this point, the spatial pattern of the buffer network is clear. A network of linear buffers will follow the stream network, and 'islands' of buffer will occur around features and impacts distant from the stream corridor.

WATER FEATURE BUFFERS, ZONES 1+2 (CONSERVATION)

What you see…

This map shows the building of Zone 2 of the three-zone buffer. Zone 2 "conservation" is intended to conserve land and vegetation that contributes to protection of water quality and flood mitigation, while accommodating light uses compatible with its conservation function. Conservation can be achieved in several ways, ranging from purchase to conservation easements to regulations. Portions of Zone 1 and Zone 2 are already protected by various local, state, and federal regulations and recommendations. The majority of land included in the water buffer is in Zone 2. Restoration of native vegetation, including forest, is encouraged in Zone 2.

All Zone 2 distances are measured perpendicularly from the Zone 1 boundary. The Zone 2 "conservation" buffer also varies depending on the feature type. For streams, two additions are made: to protect water quality, 75 feet (streams with defined FEMA floodway) or 50 feet (smaller tributaries with no floodway line) is added, and to mitigate flooding the extent of the floodplain beyond the minimum Zone 2 width is added. For sinkholes and wetlands, which are groundwater recharge features, 50 feet is added. For springs, which are water sources, 450 feet uphill from the feature, within its catchment, is added.

WATER BUFFER COMPOSITE, ZONE 1+2+3 (STEWARDSHIP)

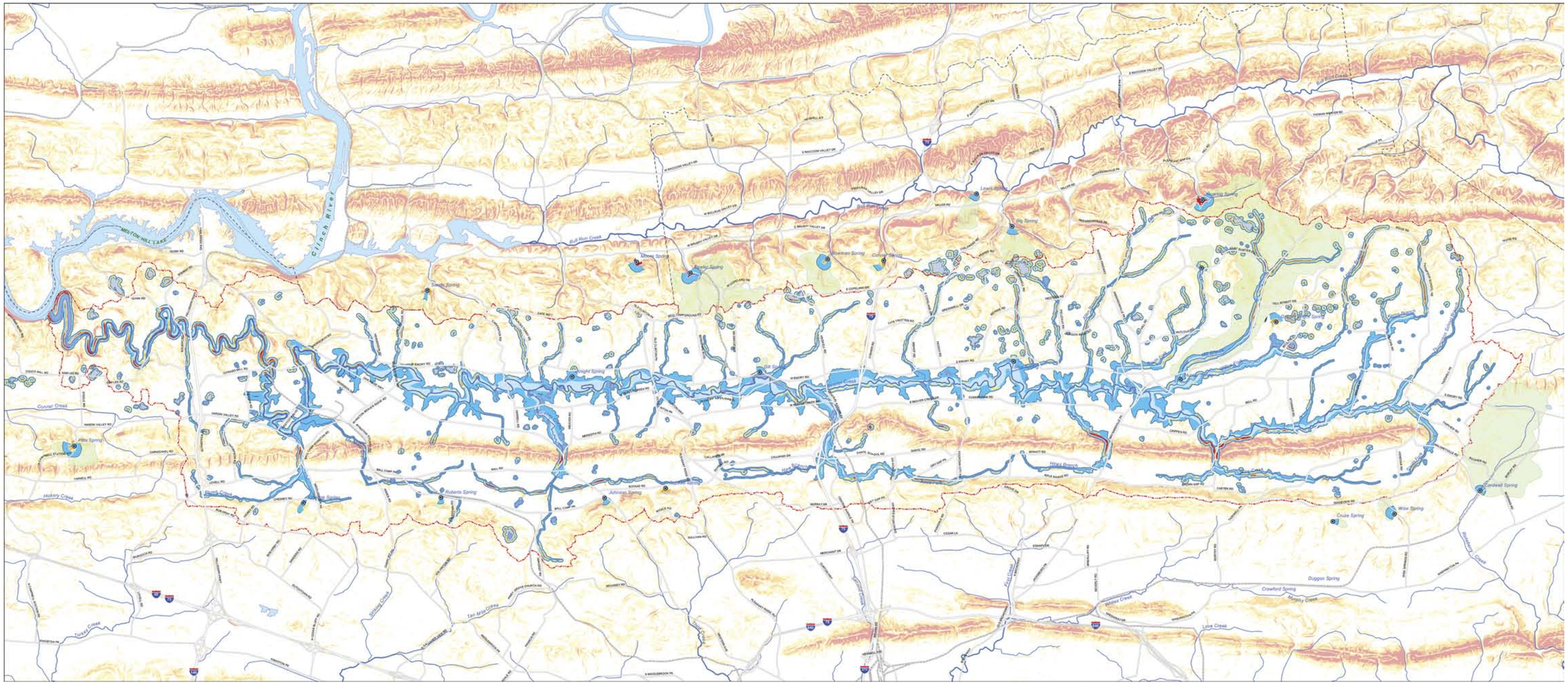
(full map on next page)

What you see…

This map shows the building of Zone 3 of the three-zone buffer. Zone 3 "stewardship" is intended to provide a transition between conservation lands included in Zone 2 of the buffer and the adjacent land-use. The Zone 3 transition adds 25 feet to the outside of the buffer, measured perpendicularly from the boundary of Zone 2. On the map above, Zone 3 appears as a barely visible line at the exterior edge of the buffer.

With the addition of Zone 3, the water buffer network is complete. The pattern is evident of a linear corridor buffer adjacent to the stream and buffer islands around features and hazards distant from the stream network.

For more detail, see the map text on the next page— and the diagram, "Best Practice Recommendations for Stream Protection Buffers, " on page 43.



WATER FEATURE BUFFERS

What you see...

Vegetated land near water features helps filter sediment and pollutants from runoff and stores flood water. This map shows a THREE-ZONE WATER FEATURE BUFFER system, based on *model stream protection ordinances.* Buffers are generated around streams, wetlands, springs, and sinkholes. Minimum impervious surfaces, along with dense natural vegetation, within these buffers help store water during storms, improve aquatic and riparian wildlife habitat, and clean our water.

How we did it...

The buffer system is based on Tennessee state and US EPA model ordinances. Buffers begin at the FEMA-defined floodway or, on smaller streams, at the creek centerline. Buffer width is a minimum of 125 feet each side on third-order streams like Beaver Creek and 100 feet on minor streams, wetlands, and sinkholes. However, buffer width is variable, increasing for adjacent steep slopes and flood plains. Spring buffers are 500 feet, limited to land draining toward the spring.

3-Zone Water Buffer
- Zone 1: Preservation
- Zone 2: Conservation
- Zone 3: Transition

Areas of Steep Slope
- 15 - 24%
- 25 - 39%
- > 40%

- Spring (USGS)
- Watershed Boundary
- Knox County Boundary
- Spring Catchment
- Wetland (NWI)
- Sinkhole (USGS)

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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Water Feature Buffers for East Tennessee

The diagrams that follow show how our three-zone buffer is created. Beaver Creek, its tributaries, plus nearby springs, wetlands, sinkholes, and impact amplifiers (steep slopes) are protected by a continuous linear buffer of variable width. This buffer is divided into the recommended three zones:

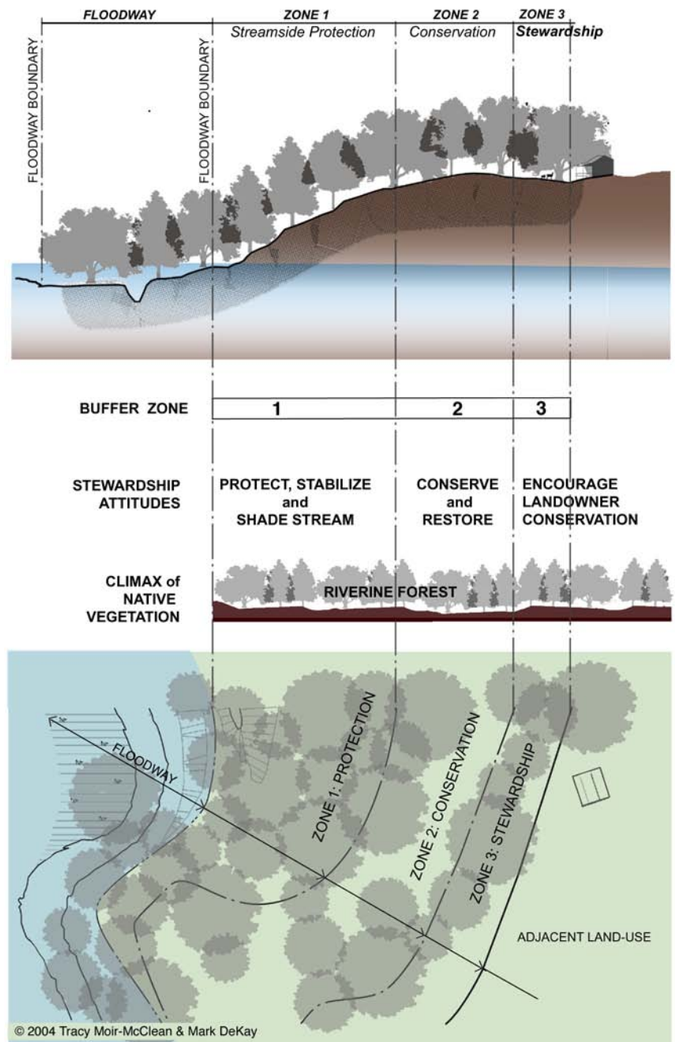
Zone 1 Protection, contains Beaver Creek, its tributaries, plus nearby springs, wetlands, sinkholes, and steep slopes. The width of Zone 1 remains at the minimum unless another feature is near the stream.

Zone 2 Conservation, remains at a minimum width and expands whenever the floodplain extends beyond this minimum distance. The largest acreage included in the water buffer is found in Zone 2. While it may seem that areas near the stream are being made unavailable for development, this is not the case, because floodplains included in Zone 2 were never suitable for development. All the map does is clearly illustrate how much land near the creeks floods and how important it is to preserve this capacity in order to keep existing homes and businesses safe.

Zone 3 Stewardship, always remains at its 25 foot width. It is an area at the edge of the buffer designated to provide a transition between the more natural character of the buffer and the more groomed character of the places where people live and work.

An important principle of these buffers is to: *Place buffer land in the least restrictive buffer zone that "does the job."* Features like streams, banks, springs, wetlands, sinkholes, and steep slopes near the feature are located inside the highest protection of Zone 1.

Floodplains are conserved as part of the Zone 2 conservation buffer. Floodplains can serve other purposes, if additional use does not compromise the floodplain's ability to do its main job of storing and infiltrating flood water. So floodplains are located in the conservation zone. Traditionally, farmers understood the dual character of floodplains by letting respected "bottomland" fields rest during spring flood season and using them for grazing or short-season crops, like hay, when they dried out in the summer months. We can expand this concept to our modern life by including passive recreation as a compatible Zone 2 use. Maintaining the Tennessee River floodplain as an open field for walking, tossing a Frisbee®, and picnics in Knoxville's *Sequoyah Hills Park* is a local example of this type of use.



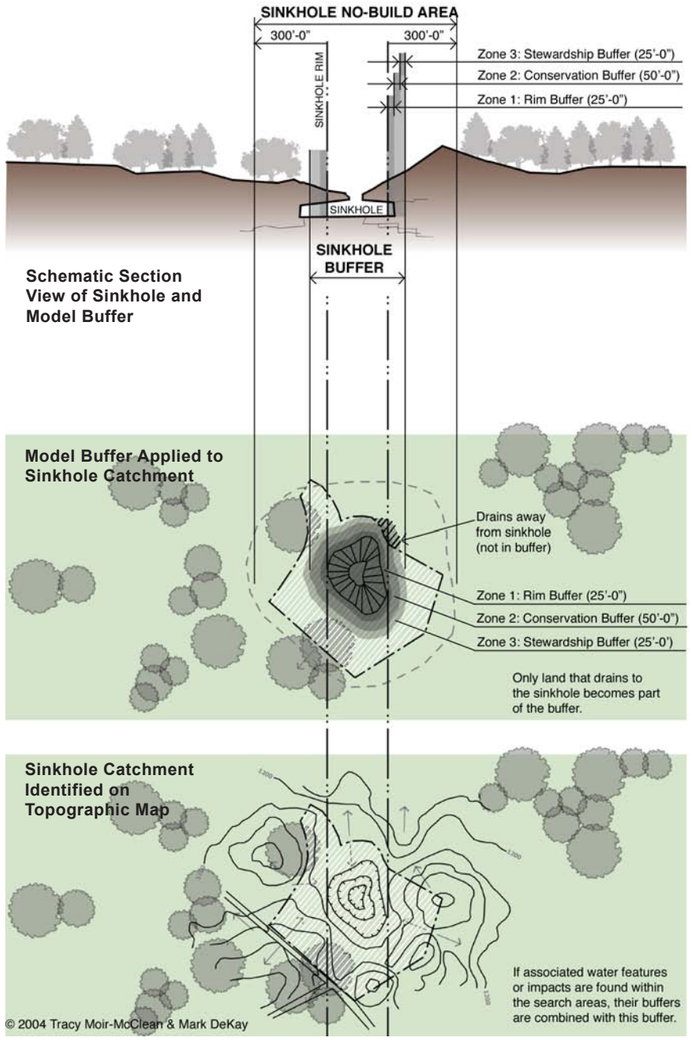
Best Practice Recommendations for Stream Protection Buffers

Filling the floodplain is like adding marbles to a full glass of water; it doesn't take many marbles to send water running over the rim!

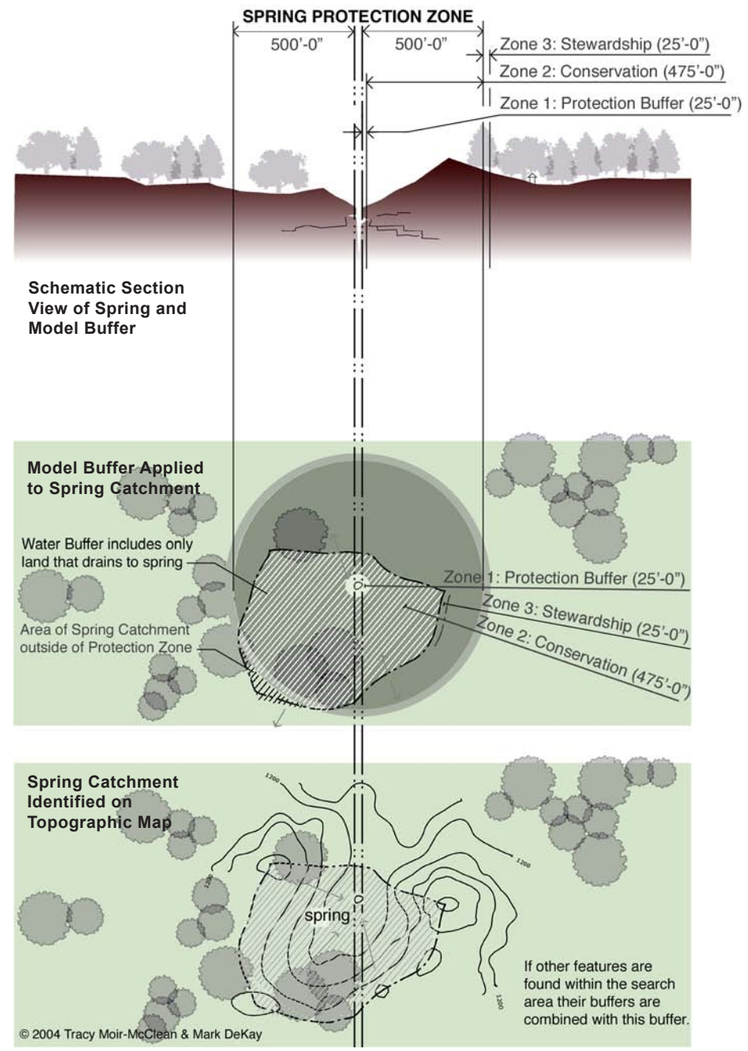
TDEC has designated Beaver Creek as a partially supporting stream, which means water quality is too impaired to support some of its designated uses such as providing domestic, agricultural, and industrial water supplies, supporting aquatic life and wildlife, and providing recreation.

—The Beaver Creek Watershed Assessment

Typical commercial development: A sea of impervious parking and single-story buildings seal the ground from rainwater while directing torrents of rainwater to streams, which pick up pollutants in the process. We now have the technology and knowledge to avoid this.



Model Buffer Recommendations Applied to Sinkholes



Model Buffer Recommendations Applied to Springs

FEATURE BUFFER DETAILS

Springs

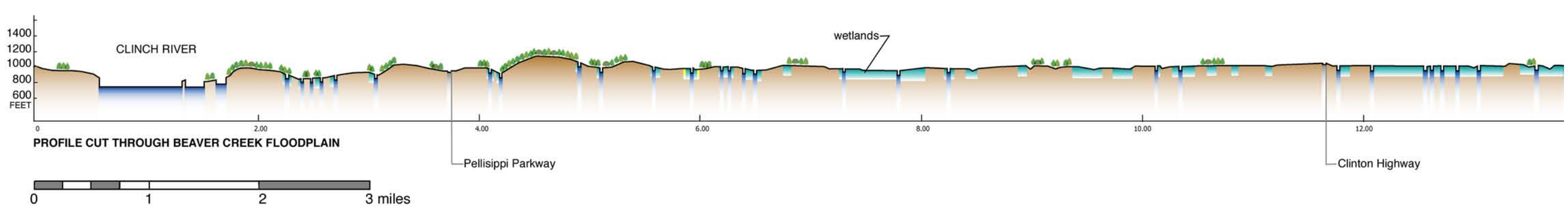
In Beaver Valley, springs may serve as water sources for people or animals or for water used on plants that people eat or touch. Therefore, they receive a much wider protective zone to make sure that water quality is high. Given the steep topography in the watershed, this buffer only occurs within the spring's catchment, as mapped on the existing water features map.

Sinkholes and Wetlands Buffer *(when found as disconnected islands)*

In the ridge-and-valley topography, a large number of sinkholes, wetlands, lakes, and other water features are located in the higher reaches of the watershed, "upland" from the creeks. These features either contribute to, or draw their water from, the groundwater, so their protection is vital for protection of water quality. In this study, we recommend that these upland features receive a three-zone buffer, similar to the stream network buffer. Because these upland features do not have floodplains, the area included in their individual "islands" of buffer is significantly smaller than along creeks that have floodplains.

Feature Chain Buffers (linear)

In karst topography, underground streams and caverns are common features. Over time, the limestone "roof" of underground features close to the surface can thin, weaken, and collapse. The result is a sinkhole, or a chain of sinkholes that follows the route of the underground geologic feature. If a sinkhole holds water, a wetland or lake can result. When chains of features occur, there are dual purposes for linking these features:



ISSUE	POTENTIAL RESPONSE
• **Flooding in the Watershed** + Property damage + Potential loss of life + Reduced property value and property use	• **Conserve Land that Mitigates Flooding,** through: + Farm and forest preservation + Conservation neighborhoods + Protecting and reforesting floodplains + Sinkholes and high-infiltration soils • **Reforest Anywhere in the Watershed**
• **Degraded Water Quality** + Silt and Erosion + Pathogens + Nutrients (fertilizers, etc.) + Toxins (potential) + Aquatic Habitat Impacts	• **Relocate Conflicting Floodplain Activities,** such as those whose runoff needs special cleanup • **Protect and Restore Riparian Forests** along Beaver Creek and its tributaries. • **Establish Vegetated Filtration Buffers** on streams and upland water features.
• **Worsening Problems Dues to New Development** + Increased impervious surfaces, thus runoff + Needless removal of vegetation	• **Promote Low-Impact Development Practices** that minimize impervious surfaces, slow runoff, filter water on-site, and increase local infiltration. • **Fit Development Intensity to Infiltration Capacity:** 1) Locating denser development on impervious land, 2) Locating CONSERVATION NEIGHBORHOODS on more pervious lands, and 3) Limiting development on high-value conservation land (steep slopes, floodplains, headwaters lands). • **Plan for Small-Footprint "Smart Growth" by:** 1) Supporting mixed-use live/work/shop TOWN CENTERS with COMMUNITY BOUNDARIES around each town and village. 2) Substituting TOWN NEIGHBORHOODS for suburban subdivisions in new development. 3) Planning pedestrian-oriented neighborhoods that support public transit.

- *Safety:* The likelihood of another sinkhole forming between two sinkholes in a chain is significant, since the route of underground feature may continue though the area between.
- *Habitat continuity:* Linking allows wildlife to use the land between sinkholes to move through the uplands; often a sinkhole chain can be linked to a surface stream, thereby increasing its habitat value.

CONCLUSIONS

The valley can definitely absorb more development. Conservation and development can coexist as complementary patterns.

The question is, What kind *of development in* what places? *Current practices answer this question by looking narrowly at facilitating the movement, use, and housing of people's goods and services.*

We suggest that development and conservation should be planned as complementary elements of the places in which we live. The list of "what to facilitate" should include natural cycles that support the health, safety, and welfare of our communities and the land they are built on. If so, the development, construction, and land-use zoning strategies we use will change.

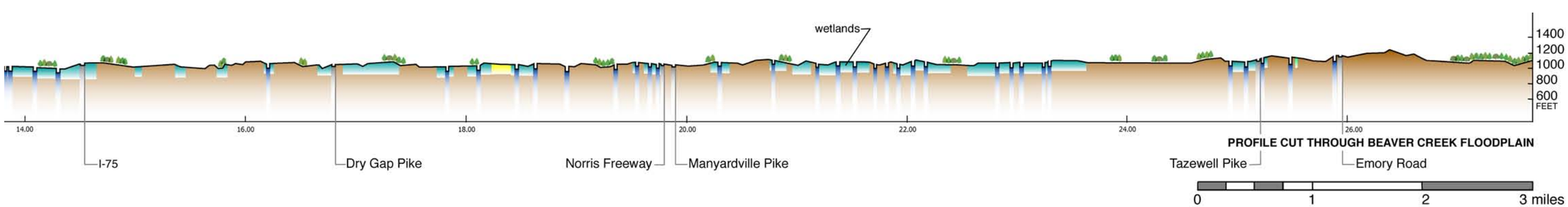
This chapter has covered our recommendation on answering the "*where*" part of this question, relative to water issues. It has explained our proposal and methods for identifying land that protects or improves features in the water network, both as part of the surface water system and the groundwater system.

Actions similar to those recommended are critical to mitigating current and future flooding, improving water quality, and avoiding the adverse impacts of the continued business-as-usual development.

We have identified a repeatable, rational method for incorporating protected lands into a system of WATER FEATURE BUFFERS. *This approach can be applied anywhere in this region, yielding similar results.*

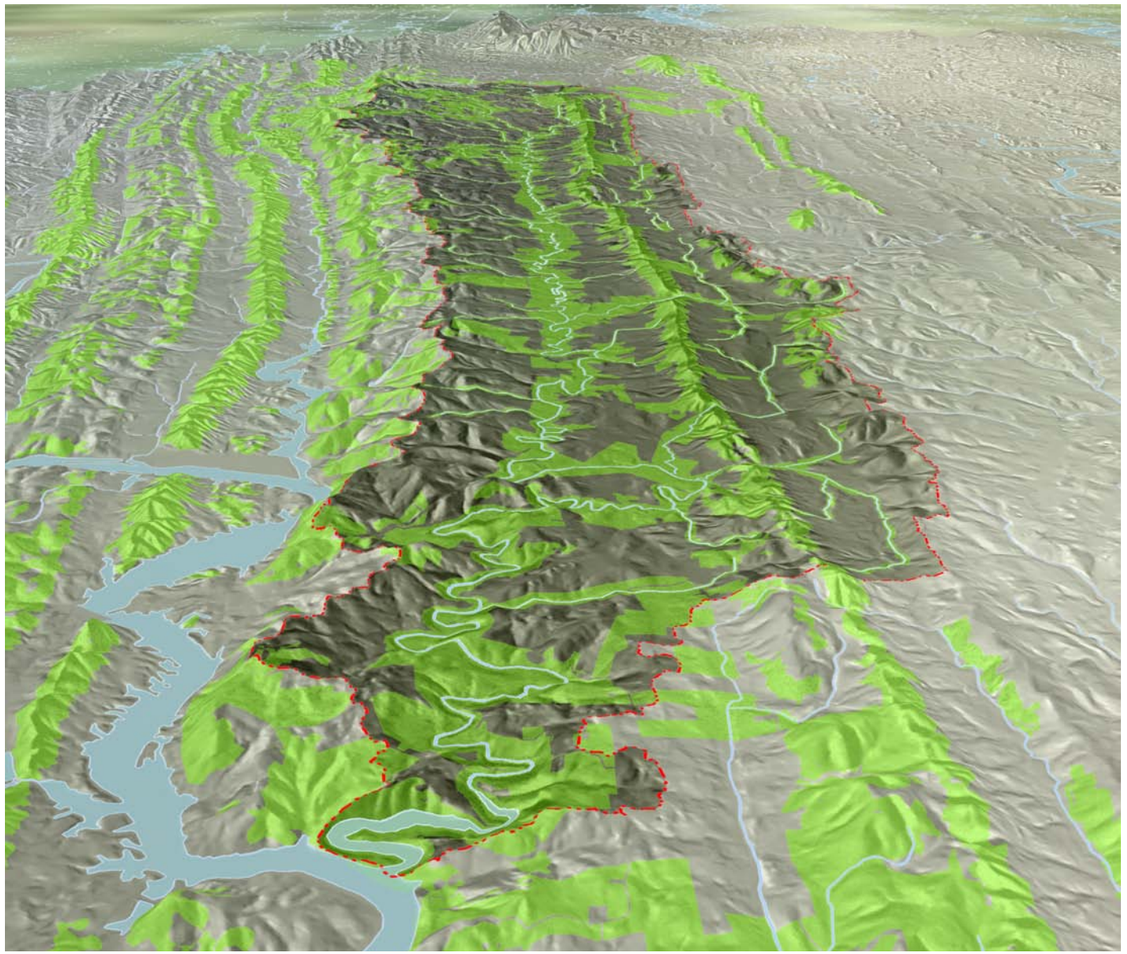
This analysis has several implications for later parts of this study, many of which are outlined in the table. There are also a few actions beyond the scope of this study that should be considered in further studies or actions by Knox County, including:

- *Update the KGIS database* to include verified mapping of sinkholes and more information about wetlands and springs.
- *Digitize a more detailed stream layer* to better document first- and second-order streams. Our analysis is based on streams from the USGS 1:100,000-scale digital topographic maps. Local land-use decisions at the parcel level need to be based on more detailed data. This is a priority.
- *Identify impact parcels* with land uses that may degrade the designated WATER FEATURE BUFFERS. (See the *Stream Corridor Preliminary Parcel Assessment* map at the end of Section E)



Infrastructure — "the substructure or underlying foundation…on which the continuance and growth of a community or state depends"

— Webster's New World Dictionary



View of the proposed STEWARDSHIP CORRIDORS NETWORK *looking up the valley, from southwest to northeast. Corridors are shown in green.*

COMPOSITE PATTERNS: GREEN INFRASTRUCTURE

GREEN INFRASTRUCTURE IN BEAVER CREEK

Green Infrastructure is the supporting systems that landscape provides for a community: an interconnected system of undeveloped natural areas and developed open spaces managed for benefits to people and the environment.

Green infrastructure is an interconnected network of waterways, wetlands, forests, wildlife habitats, and other natural areas; greenways, parks, and floodplains; and urban woodlands, wild areas, and other open spaces that support native species. Green infrastructure maintains our local and regional ecological processes, such as cleaning our water and air, moderating the climate, and helping with flood control, thus contributing directly to the health, safety, and quality-of-life of our community.

The characteristics of the landscape vary from place to place, making some areas more ecologically beneficial than others and some better suited for different types of human activities than others. In an urban area that is already critically ecologically degraded and fragmented, the city and county need to act quickly to protect remnant critical areas and plan for rebuilding the fabric of its natural systems.

The idea of *green infrastructure* is different from the more generic idea of *green space*, as summarized in the following table.

GREEN SPACE	GREEN INFRASTRUCTURE
• Something that is nice to have.	• Something that we must have. Protecting and restoring our natural life support system is a necessity, not an amenity.
• Isolated parks, recreation site, or natural areas.	• Interconnected systems of natural areas and other open spaces managed for the benefits to people and the environment.
• Often viewed as self-sustaining.	• Must be actively maintained and at times restored.

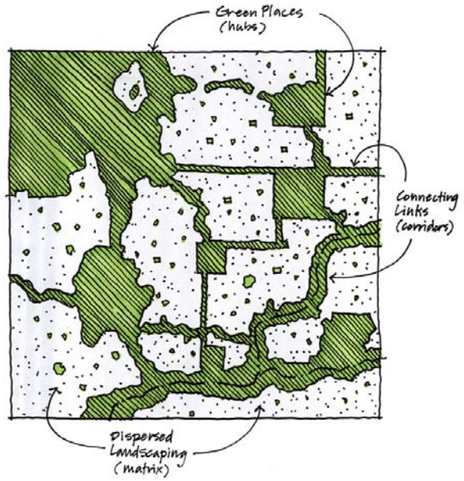
THE STRUCTURE OF GREEN INFRASTRUCTURE

Ecosystems, including the urban ecosystem, function in a healthy way only when they are structured in the pattern of a network.

A Green Infrastructure Network at its most basic level includes ***three basic elements*** *combined in an interconnected way to create the* ***pattern*** *of a network: Green Places, Connecting Green Links, and Dispersed Landscaping.*

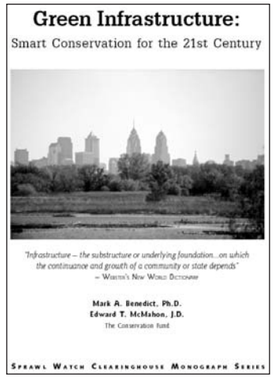
Each of these occurs at many scales. *Green Places* are protected areas, such as large and small parks and squares, forest stands, significant wetlands, and floodplain lands. *Connecting Green Links* hold the system together and help plants, animals, and people move between ecologically, recreationally, and socially significant places. These links range in size from a thin greenway route to corridors of land wide enough to include green places inside their borders. The system of places and links forms a framework that is, *to differing degrees*, protected from development. *In the space between* the elements of this framework, where land is relatively more developed, the green infrastructure takes the form of distributed elements, such as trees along streets, vegetated back yards, and fencerows, that we call *Dispersed Landscaping*.

GREEN INFRASTRUCTURE GOALS
• Protect, restore ecosystem function
• Conserve heritage land and rural character
• Improve water quality
• Enhance recreation
• Provide a green frame for future development



Conceptual components of a Green Network

The urban and suburban green infrastructure is complicated. Like their wilderness counterparts, plants and animals that live in our communities need *patches* of good habitat that function as *hubs* in their habitat network and a way to get from one chunk of territory to another (*habitat corridors*, which are the *connecting links* in their network) without getting run over by a truck or stopped by a railroad barrier. People also develop preferences for particular places and routes in their environment. Our movements can be thought of in the same way: moving from one territory (like home) to another (a friend's home or work or school).



MORE INFO:

Other project examples, as well as additional information about green infrastructure concepts and approaches, can be viewed at www.greeninfrastructure.net

Benedict, Mark A. and Edward T. McMahon (2001). *Green Infrastructure: Smart Conservation for the 21st Century.* Washington: Sprawlwatch Clearinghouse.

A green infrastructure network does many things simultaneously: *it serves as a web that is a pedestrian transportation system as well as a recreational system, a flood protection strategy, a park system, an urban forest, a stormwater filtration system, and a climate-moderating technology. This network simultaneously helps create neighborhood identity and support transit—all while making a great place to live!*

However, our use of and travel through our settlements is complicated because of our preference for a variety of vehicles, routes, and speeds, dependent on our activity and intent. When engaged in business or commerce, we want to move quickly, a task the MAJOR ROAD NETWORK optimizes. When we socialize, exercise, or relax, we often want to slow down and enjoy the trip and our surroundings. Planning of the slower SOFT TRANSIT NET, used for more leisurely travel, was neglected for at least 70 years on the mistaken assumption that major roads and automobiles made slower forms of travel obsolete. What we now realize is that people enjoy the choice between soft and fast transit, and those who don't drive *depend* on the soft transit net.

Because it also serves recreation, soft transit connects us to settlements as well as the surrounding landscape. Its routes coordinate with the organization of the settlement fabric (the patterns of buildings, streets, and public spaces) and the natural fabric. Because fast cars and pedestrians are not always a pleasant or safe mix, *soft transit routes* are most successful if most of their routes avoid the major road network and locate on slower streets parallel to the main transportation arteries.

In this strange landscape of multiple overlapping networks, we have a great opportunity for double- or multiple-dipping. We can form a more robust green infrastructure network by connecting together the valuable green places— recreational land, habitat, flood plains, parks, and squares— with greenways, vegetated utility and rail corridors, and green pedestrian routes.

ELEMENTS OF THE NETWORK

The pattern of a GREEN INFRASTRUCTURE NETWORK ***configures the network's constituent elements:*** ENVIRONMENTAL VALUE ZONES, RURAL RESERVES, STEWARDSHIP CORRIDORS, ***a*** FAMILY OF PARKS, ***the*** SOFT TRANSIT NET, ***and*** URBAN FORESTS.

Referring to our three simple, conceptual components of the green network, *Green Places*, *Green Connecting Links*, and *Distributed Landscaping*, let us elaborate on the larger patterns that make up a GREEN INFRASTRUCTURE NETWORK:

Green Places

ENVIRONMENTAL VALUE ZONES include all surface water, such as lakes, springs, creeks, and rivers, plus floodplains, wetlands, significant wildlife habitat, steep slopes, and sinkholes and other groundwater recharge areas. These zones also may include buffering land that protects them. The features of these zones may connect to a stream network or stand alone.

RURAL RESERVES are lands used primarily for agriculture, ranching, forestry, or other rural activities and kept in a lightly developed state. These are important to preserve rural character in appropriate places, to protect farm life and its economy from real estate pressures, and to help build the larger pattern of COMMUNITY BOUNDARIES. Boundaries give identity to communities while constraining sprawl and promoting walkable, transit-friendly development patterns.

The FAMILY OF PARKS pattern organizes parks using the rule that the size of parks should vary with the distance from home and that, therefore each kind of park has a catchment area. It helps make sense of the many scales of parks— regional parks, central parks, city parks, neighborhood parks, and pocket parks—and of the many types of parks— nature parks, athletic parks, and more formal greens and squares.

Green Connecting Links

The LAND STEWARDSHIP CORRIDORS link and incorporate RURAL RESERVES and ENVIRONMENTAL VALUE ZONES to create LAND STEWARDSHIP NETWORKS that serve local communities and ecosystems. They may contain within them routes of the SOFT TRANSIT NET and elements of the FAMILY OF PARKS. *Green Places* that are part of a county or regional open-space network are also linked to, or located within these corridors, providing opportunities for residents to enjoy and experience green infrastructure resources.

The SOFT TRANSIT NET pattern organizes the configuration of linear, non-motorized transportation into a system. Its sub-elements include GREENWAYS, EQUESTRIAN TRAILS, FOOTPATHS, SAFE STREETS, BOULEVARDS, and SIDEWALKS. These routes are found within the LAND STEWARDSHIP NETWORK and also within neighborhoods and even urban fabric. They help to connect the FAMILY OF PARKS together and link NEIGHBORHOOD CENTERS to VILLAGE CENTERS or TOWN CENTERS.

Distributed Landscaping

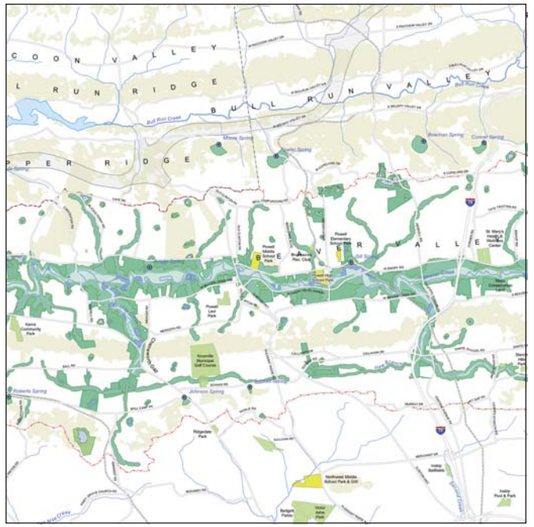
The URBAN FORESTS pattern recognizes the value of trees as cover on land with many different types of uses, both within the designated GREEN INFRASTRUCTURE NETWORK and also within the developed urban and suburban fabric. Reforesting the settled landscape can take many forms; some of its sub-patterns include FLOODPLAIN FORESTS, FORESTED BOUNDARIES, FOREST PARKS AND CEMETERIES, CIVIC NURSERIES, NEIGHBORHOOD GROVES, STREET ORCHARDS, and PARKING ORCHARDS. Urban forests provide enormous environmental benefits by reducing air pollution, providing wildlife habitat, slowing and absorbing rain water runoff, creating a cooler summer climate, and conserving energy used to cool buildings.

A RIDGE & VALLEY STEWARDSHIP NETWORK

In the Beaver Creek Watershed study, we've developed new patterns relevant for ridge-and-valley landscape.

In particular, we identified and proposed four types of STEWARDSHIP CORRIDORS that link together to create a composite LAND STEWARDSHIP NETWORK pattern:

- STREAM PROTECTION CORRIDORS, which expand, link, and protect WATER FEATURE BUFFERS, a type of ENVIRONMENTAL VALUE ZONE.
- GROUNDWATER PROTECTION CORRIDORS, which link together strings of nearby springs and sinkholes in particularly sensitive areas where karst geology makes the groundwater system especially vulnerable. In our mapping, these corridors are displayed with the stream protection corridors.
- RIDGE PROTECTION CORRIDORS, which protect steep slopes and the forests on them. In the case of Beaver Valley, because of the nature of the terrain and the degree of previous settlement, these corridors are almost synonymous with *steep slope zones* as defined by MPC. In other watersheds, the corridors might be expanded to include more protective buffer lands or larger areas of forests.
- HERITAGE PROTECTION CORRIDORS, which include and connect RURAL RESERVES and tie these to the other corridors.



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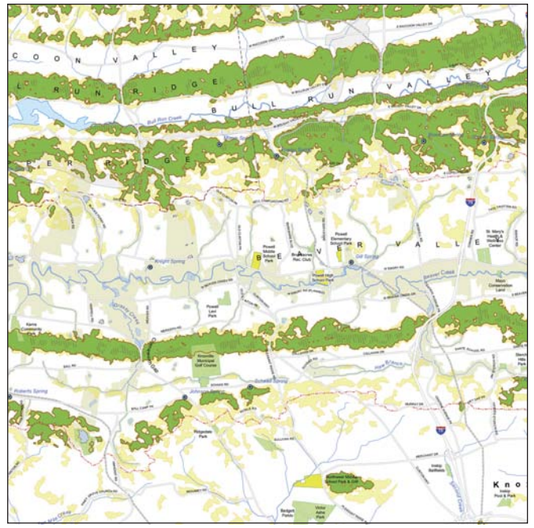

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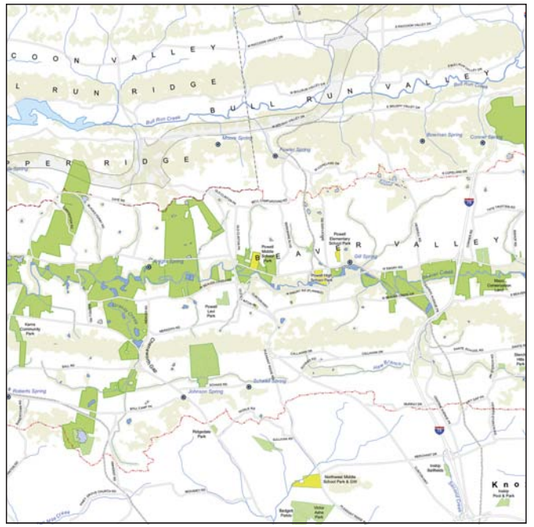

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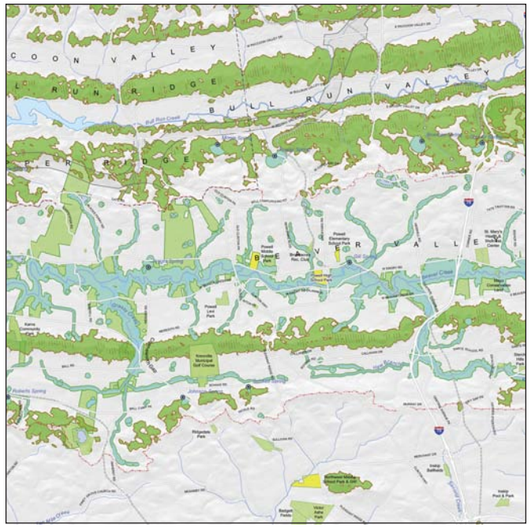


STREAM PROTECTION CORRIDORS

(full map on report disk)

What you see…

This map shows a proposal for Stream Corridors to protect and steward valuable open-space land near streams and groupings of groundwater features. The Stream Corridors expand the WATER FEATURE BUFFERS pattern, which conserves land for protecting water quality and mitigating floods, to include adjacent land with high open-space value. These corridors include areas of nearby habitat and good agricultural soils. They also link many water features together into a more connected network.

How we did it…

We began with the map of WATER FEATURE BUFFERS. We then searched for parcels intersecting the buffer zone that had high open-space value. These were lands found in the HABITAT VALUE VERSUS AGRICULTURAL LAND VALUE analysis to have value as riparian wildlife habitat, prime upland grassland habitat, and prime or good agricultural soils. We also included parcels that linked nearby water features to the stream network and linked chains of features (such as wetlands and sinkholes) together into GROUNDWATER PROTECTION CORRIDORS.

RIDGE PROTECTION CORRIDORS

(full map on report disk)

What you see…

This map shows recommended stewardship areas to protect forests and steep slopes. Areas protected include slopes above 25% plus adjacent forested areas with slopes above 15%. Areas in the RIDGE PROTECTION CORRIDORS offer significant public health and safety benefits, including landslide and flood mitigation. Conservation in these areas should be maximized.

How we did it…

We began with the Slope Areas map and identified areas with slopes above 25% that were larger than 2 acres in size. Then we identified areas with slopes greater than 15% adjacent to these 25%- plus slope areas. These adjacent 15% slope areas were intersected with forest areas already identified in the HABITAT VALUE VERSUS AGRICULTURAL LAND VALUE map. This showed us which 15% slopes had significant forests. The 25%- plus slope areas first identified, plus adjacent forested 15% slope areas, became the RIDGE PROTECTION CORRIDORS.

HERITAGE PROTECTION CORRIDORS

(full map on report disk)

What you see…

Suburban sprawl is destroying the visual beauty of the rural landscape and the farming way of life. This map shows land recommended for preservation and stewardship in its rural character, allowing for agricultural and rural residential development. These lands offer multiple benefits to citizens and communities. They are selected to preserve large farms and farming areas, to provide open-space separation between communities, and to link ridges with creek valleys.

How we did it…

We used analysis from the HABITAT VALUE VERSUS AGRICULTURAL LAND VALUE map to identify good farmland and good habitat areas. We considered several types of undeveloped land for inclusion: prime and good farmland, especially parcels over 20 acres; remaining forests; prime grassland habitat; and riparian habitat areas. We then looked for patterns that would connect RIDGE PROTECTION CORRIDORS to the STREAM PROTECTION CORRIDORS and the GROUNDWATER PROTECTION CORRIDORS in relatively wide swaths that would also help create COMMUNITY BOUNDARIES. Where possible, we chose stream routes and parcels that provided the best network continuity.

LAND STEWARDSHIP NETWORK

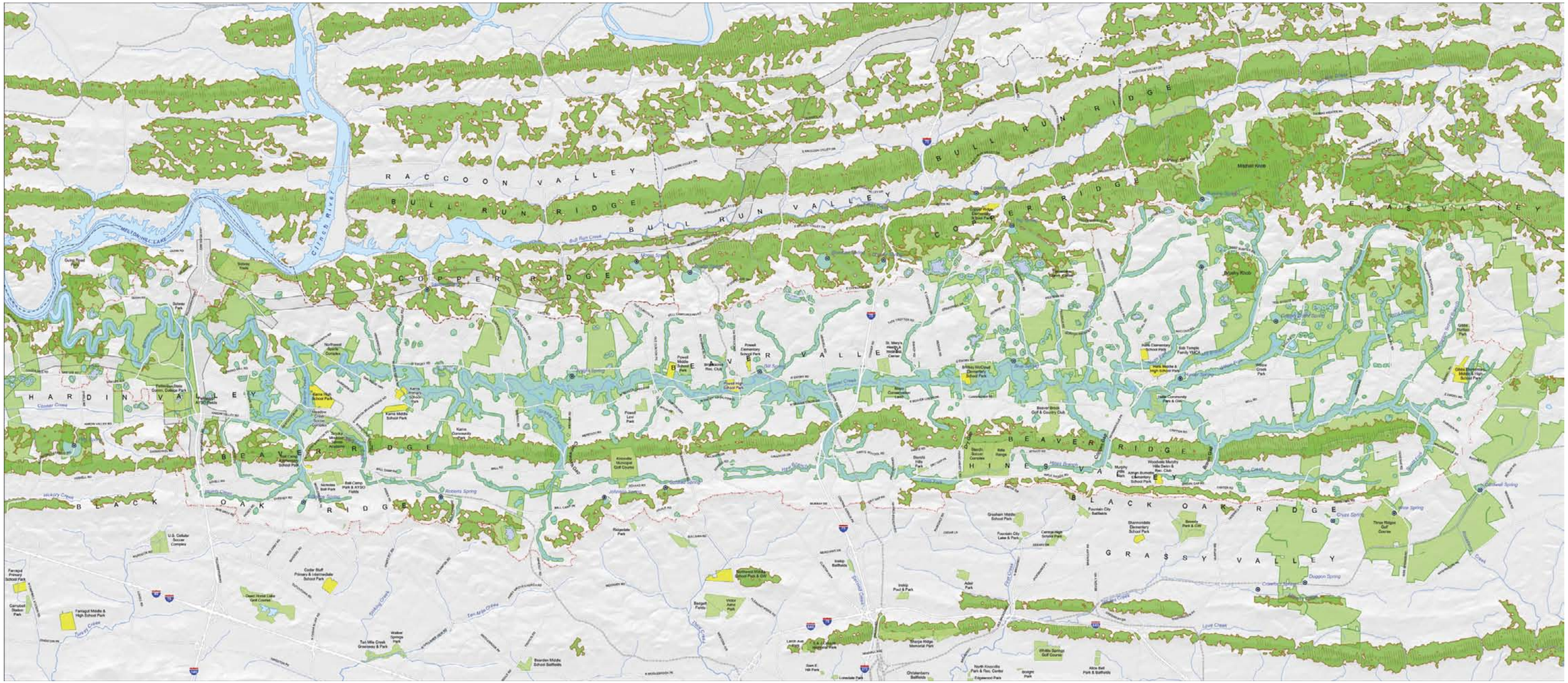
(full map on next page)

What you see…

This map shows the composite pattern of land stewardship. It is the sum of three corridor types: Stream, Ridge, and Heritage. It represents the land most valuable for conservation to the community and to natural processes. Keep in mind while looking at this map that a large portion of land recommended for conservation is characterized by steep slopes or floodplain that is poorly suited for, even hazardous, if developed. Recommended levels of conservation and development vary as appropriate for each area's open-space value, existing land use, and other characteristics. This network forms a framework within which (in the light-gray areas) more intense development, such as IDENTIFIABLE NEIGHBORHOODS and VILLAGE CENTERS, can be targeted by planners and developers.

How we did it…

The three major components of this network come from the RIDGE PROTECTION CORRIDORS map, the STREAM PROTECTION CORRIDORS map, and the HERITAGE PROTECTION CORRIDORS map. This composite network pattern is the sum of the three corridor lands. For clarity, the parcels in the STREAM and HERITAGE CORRIDORS are displayed as the same color. The WATER FEATURE BUFFERS are shown overlaid on the STREAM and HERITAGE CORRIDORS parcels.


RACCOON VALLEY
BULL RUN RIDGE
BULL RUN VALLEY
COPPER RIDGE
DEER VALLEY
HARDIN VALLEY
BEAVER RIDGE
BLACK OAK RIDGE
HINES VALLEY
GRASSY VALLEY
TEXAS VALLEY
Clinch River
Bull Run Creek
Beaver Creek
Fort Creek
Love Creek
Ten Mile Creek
Roberts Spring
Dogwood Spring
Cave Spring
Mishel Knob
Karns High School Park
Karns Middle School Park
Powell Middle School Park
Powell High School Park
Powell Elementary School Park
Powell Community Park
Powell Lee Park
Farragut Middle & High School Park
Farragut Primary School Park
Cedar Bluff Primary & Intermediate School Park
Bearden Middle School Baffields
Knoxville Municipal Golf Course
Fountain City Lake & Park
Graham Middle School Park
Carter High School Park
Shannondale Elementary School Park
Sharps Ridge Memorial Park
Christenberry Baffields
Three Ridges Golf Course
Bearden Park
Ridgedale Park
Lonsdale Park
Edgewood Park
Adair Park
Inskip Pool & Park
Inskip Baffields
Bearden Hills Park
Bearden Soccer Complex
Northwest Middle School Park & Gym
Northwest Sports Complex
Karns Community Park
Karns Meadow Soccer Complex
Meadow Creek Soccer Complex
Bell Camp Park & AYSO Fields
Northside Soccer Complex
Bell Camp Park & Ballfields
Farragut Soccer Complex
U.S. Cellular Soccer Complex
Campbell Station Park
Tuckaleechee Park
Tuckaleechee Boys Comm. College Park
Tuckaleechee Soccer Complex
Tuckaleechee Ballfields
Tuckaleechee Trails
Tuckaleechee Park
Tuckaleechee Creek
Tuckaleechee Creek Trail
Tuckaleechee Creek Soccer Complex
Tuckaleechee Creek Ballfields
Tuckaleechee Creek Park

SCALES OF GREEN INFRASTRUCTURE

In any organized system, there are many scales. Each network contains smaller networks and is, simultaneously, a part of a larger network.

Like the places we live in the East Tennessee region, Green Infrastructure needs to be planned and organized at a several scales of human experience:

- *Regional Scale:* the Nine Counties Region
- *County or Watershed-Cluster Scale*
  Knox County contains portions of 13 creek and 5 river watersheds (1)
- *Watershed Scale:* Beaver Creek Watershed
- *Community Scale:* Karns, Gibbs, and Powell
- *Neighborhood Scale:* Broadacres Neighborhood.

A healthy network must function at all scales, because people and nature function across scales. For instance, raindrops on a roof soon move overland to small tributaries, into Beaver Creek, and onward to the Clinch and Tennessee Rivers. In the process, water moves from a very local, site-specific scale to a regional scale. A person going from home to neighborhood to shopping mall also moves across scales. Each scale has its own unique issues, but all scales have some common intentions, such as:

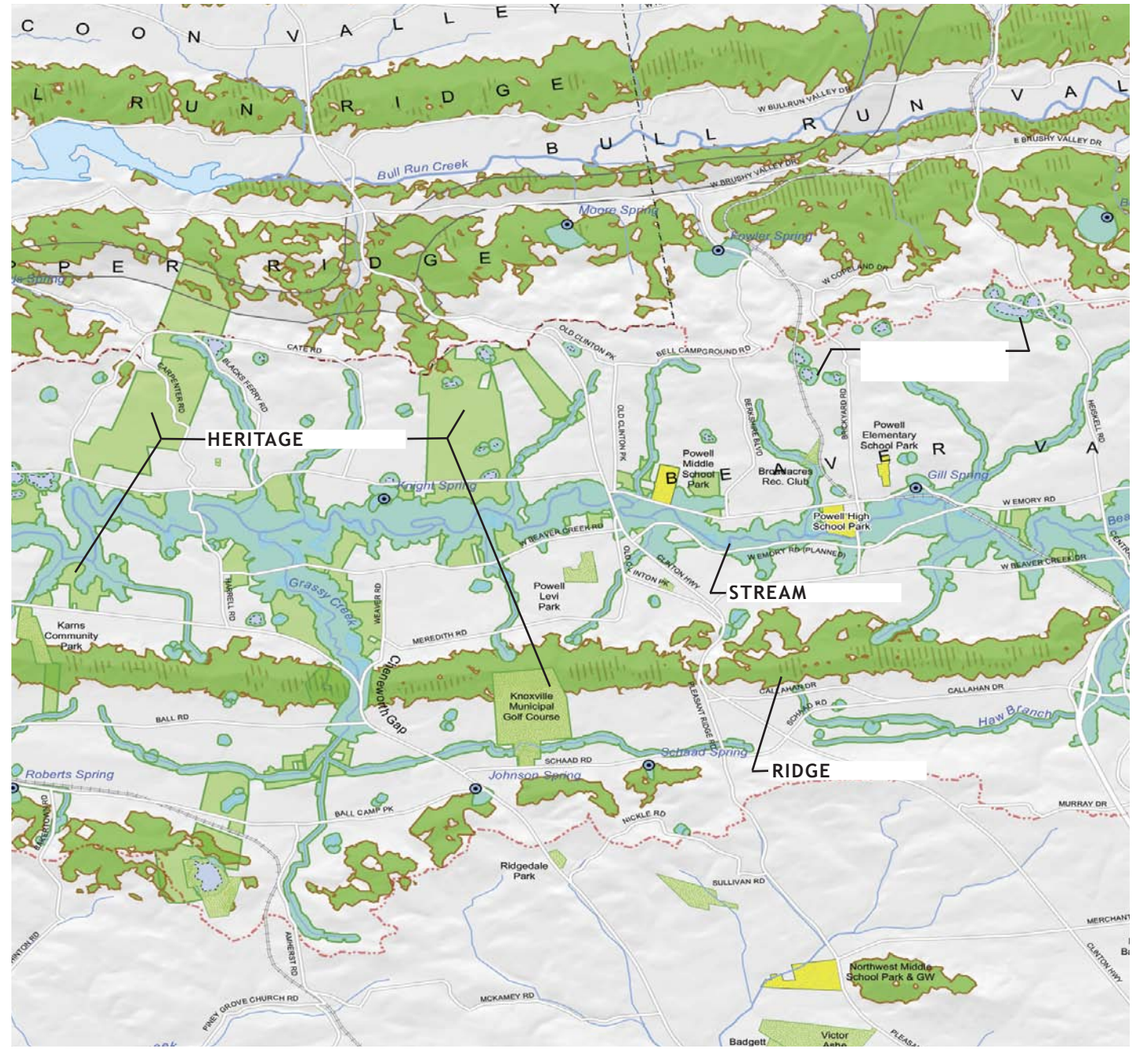
- Connecting homes, shopping, schools, civic life, recreation, and work places;
- Preserving land that offers significant health-safety-welfare value to the community;
- Linking undeveloped and developed open space to manage ecological services (2).

This report studies Green Infrastructure at the scale of a major creek watershed.

PRELIMINARY PARCEL ASSESSMENTS

Parcels shown on the maps (pp. 52, 53) engage protective buffers and should be examined to identify:

- Parcels that contain uses or surfaces detrimental to the protected environmental feature.
- Parcels where protective easements or Best Management Practices (BMPs) would maximize protection of the buffered environmental feature.
- Parcels with natural features worth preserving or restoring, which are well situated for contributing to the LAND STEWARDSHIP NETWORK. These parcels may be considered for acquisition when they are placed on the market.



Detail of LAND STEWARDSHIP NETWORK *in the central section of the watershed.*

CONCLUSIONS

We have identified timeless patterns that should shape development in this landscape.

We propose solidly reasoned environmental and cultural stewardship as the foundation of the LAND STEWARDSHIP NETWORK. We believe, while this is one specific proposal, based on a long series of value choices and informed professional decisions, that ANY proposal attentive to cultural and environmental conservation issues in this watershed would arrive at similar core concepts. While the details might vary, such as what steepness of slope to use or how far from a sinkhole a buffer should extend, these decisions are a matter of degree. However, ridge, stream, and heritage protection and their network connections are deep, significant, timeless patterns.

The network patterns proposed here form a strong framework for reshaping the settled landscape of Beaver Creek Watershed into a healthier, safer, and better place to live.

EXAMPLES FROM OTHER CITIES

- **Montgomery County, Maryland,** *Legacy Open Space*—a comprehensive open-space initiative that will target and protect exceptional resource lands over a 10-year period.
- **Palm Beach County, Florida,** *Linked Open Space Network —Conservation Greenways/Wildlife Corridors*, incorporates a system of conservation greenways, wildlife corridors, trails and other conservation and recreational spaces.
- **Kingston/Lenoir County, North Carolina,** *Green Infrastructure Plan*—a community green infrastructure plan encompassing conservation and recreation objectives as well as hazard mitigation.

- Springs
- BC Watershed
- Knox County Boundary
- Wetlands
- Sinkholes
- School Parks
- Parks
- 40% + Slope Area
- Ridge Protection Corridors
- Water Feature Buffers
- Heritage/Stream Protection Corridors
- Proposed Knoxville Parkway (SR 475)

NOTES

1) *5 River Watersheds:* Lower Clinch, Tennessee, Little, French Broad, and Holston Rivers; *13 Creek Watersheds:* Bull Run, Beaver, Flat, Richland, Roseberry, First, Second, Third, Fourth, Ten Mile, Turkey, Stock, and Tuckahoe Creeks.

2) A healthy ecosystem provides important support and services that maintain the quality of life and health of our local communities. These services includes maintaining water quality and controlling flooding; improving air quality; moderating climate; providing habitat for the animals, plants and birds we enjoy, and so on.

STREAM CORRIDOR PRELIMINARY PARCEL ASSESSMENT

What you see...

This map shows parcels that overlap the WATER FEATURES BUFFER. It is intended to be useful in 1) determining parcels that potentially conflict with the WATER FEATURES BUFFER and 2) identifying parcels for potential expansion of the water buffer into a STREAM PROTECTION CORRIDOR. Marginal agricultural (Ag) parcels are good for conservation, particularly if they contain riparian forest. Adjacent prime and good Ag land should remain in Ag use. All but low density residential uses in the buffer are potential conflict areas. Commercial and industrial parcels should be examined for their potential impacts on water quality.

How we did it...

The WATER FEATURES BUFFER shown on this map comes from the WATER FEATURES BUFFERS map. Prime and good agricultural parcels are taken from the *Agricultural Land Value* analysis. Land use for other parcels are taken from the *Existing Land Use* analysis.

- Watershed Boundary
- Knox County Boundary
- Water Feature Buffer
- Riparian Forest
- Utilities
- Govt. Owned
- Park
- Golf Course
- Commercial / Mixed Use (Occupied)
- Commercial / Mixed Use (Vacant / Consider conversion potential)
- Industrial / Office (Occupied)
- Industrial / Office (Vacant / Consider conversion potential)
- Prime and Good Agricultural (Preserve)
- Marginal Agricultural (Consider conversion potential)
- Low and Medium Density Residential (< 1 ac.)
- Very Low Density Residential (> 1 ac.)
- Proposed Knoxville Parkway (SR 475)

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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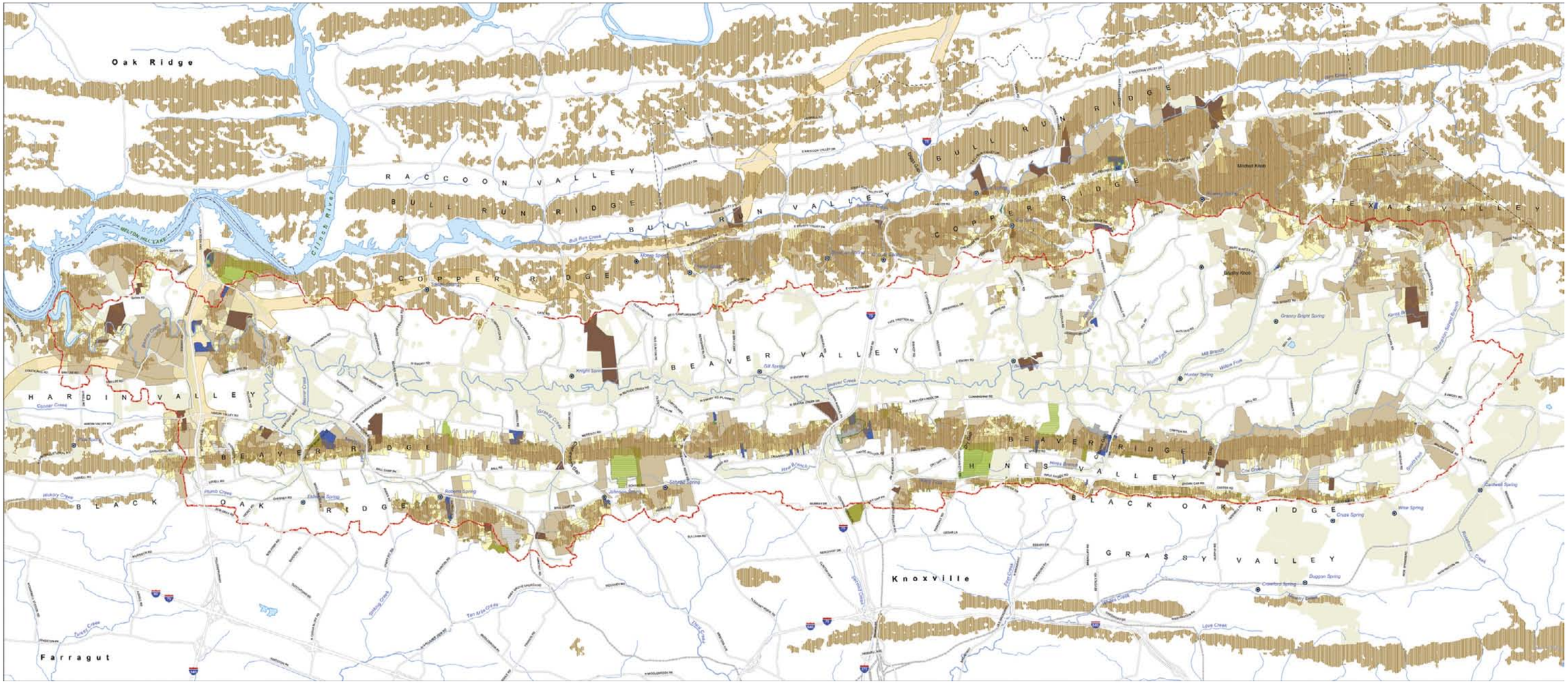

RIDGE PROTECTION CORRIDORS PRELIMINARY PARCEL ASSESSMENT

What you see...

This map shows parcels that overlap with RIDGE PROTECTION CORRIDORS. This map helps identify areas that are either: 1) already developed at density higher than preferred, or 2) potentially available for conservation easements. To reduce erosion, forests upslope of good agriculture parcels should be preserved. Marginal agricultural land can support forests and should be considered for easements. Commercial/industrial uses may conflict with conservation goals, as does a higher-density residential use. Parks and government-owned parcels are prime candidates for preservation actions.

How we did it...

The RIDGE PROTECTION CORRIDORS come from the RIDGE PROTECTION CORRIDORS map. Prime and good agricultural parcels are taken from the *Agricultural Land Value* analysis. Land uses for other parcels are taken from the *Existing Land Use* analysis.

- Watershed Boundary
- Knox County Boundary
- Utilities
- Govt. Owned
- Park
- Golf Course
- Ridge Protection Corridor
- Commercial / Mixed Use (Occupied)
- Commercial / Mixed Use (Vacant / Consider conversion potential)
- Industrial / Office (Occupied)
- Industrial / Office (Vacant / Consider conversion potential)
- Prime and Good Agricultural (Preserve)
- Marginal Agricultural (Consider for easements)
- Low and Medium Density Residential
- Very Low Density Residential
- Conservation Corridors
- Proposed Knoxville Parkway (SR 475)

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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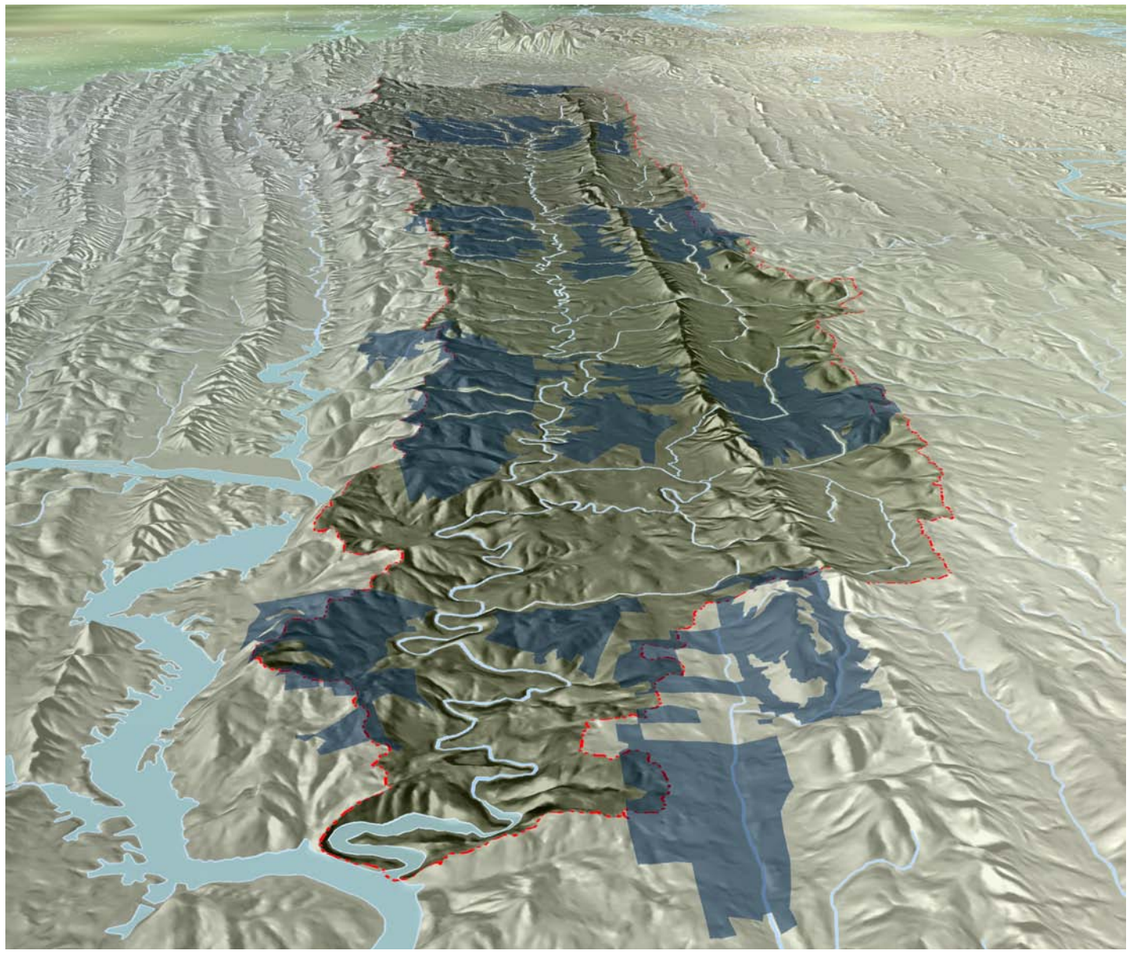

View of the proposed TOWNS AND VILLAGES, *looking up the valley, from southwest to northeast. Communities are shown in gray-blue.*

A VISION FOR FUTURE DEVELOPMENT

F

INTRO: FUTURE DEVELOPMENT

Land, People, and Towns as One Living Fabric

The Beaver Creek Watershed is at a transitional point. A significant proportion of land that is ideal for development has already been developed, and sprawl is proceeding rapidly.

Some older development near creeks may be compromised by flooding if new development adds significantly to the stormwater burden in the valley. If current trends continue, Beaver Creek Watershed will resemble the north Knoxville suburbs to the south of Black Oak Ridge. That is, there may be significant flooding problems, little continuous open space, and communities that blur into each other. However, the Beaver Creek Watershed's development does not have to result in undifferentiated sprawl. It can be planned and managed to help it mature into a place where:

- *Residents experience traditional small town living.*
- *Amenities of town living are just steps away from recreational opportunities and green parks.*
- *Children don't need mini-vans to reach soccer practice and scout meetings.*
- *Everyone has clean air and water.*
- *The county meets its legal environmental obligations.*
- *Property values are strong.*
- *Residents develop a daily relationship with nature.*
- *Our important land heritage is honored.*
- *Businesses prosper from clustering and higher pedestrian traffic.*
- *Settlement and land form an integrated whole.*

A significant group of watershed residents is committed to creating a positive future, as evidenced by the creation of the B. C. Watershed Association and funding of this study. In this section, we offer an example of a way of resettling the valley that could simultaneously:

- Foster economic abundance,
- Enrich quality of life,
- Preserve environmental vitality,
- Foster civic community,
- Cultivate local place relationships.

To achieve all this, we have to rethink how we as a society build. How we build on the land is the problem as well as the solution.

The impetus for this study is the need to clean up the water in already polluted streams and keep flooding problems from getting worse in the face of rapid, poorly planned suburban growth. Water pollution is mainly from non-point sources, such as suburban lawns, roads, and parking lots. Clearly, more of the same development practices will definitely make water quality worse. More of the same practices means cutting trees and paving over vast acreage, causing increases in stormwater runoff and more downstream flooding. Flooding is projected to increase over the next 20 years—if nothing new is done (1).

These are problems that can not be solved without intelligent land use and design.

The same is true of other environmental issues, like deforestation and habitat fragmentation. The same is true of solving quality-of-life issues, like avoiding suburban traffic congestion as the area is built out. How we organize building on the land determines what kind of business and jobs are in our communities even as it affects the mobility and autonomy of children, the poor, and the elderly. Our old conventional settlement patterns are much of the problem, so we will have to think differently if we are to solve these problems.

THE HEART OF OUR RESPONSE: THREE "BIG IDEAS" & ONE UNDERLYING PERSPECTIVE

CONTEXT-SENSITIVE DESIGN

Underlying everything in this report—all of our approach—is the idea that the form of settlement grows out of an understanding of landscape context, both ecological and social.

To understand anything, we have to see it as a part of the larger systems of which it is a part. We began this project by understanding the significant patterns of the land and its past and current settlement patterns. We found the road system to be mostly a result of terrain and the original settlement to be a result of major roads intersecting with other roads and with watercourses and railroads.

The current distribution and areas of population and the location of commercial and mixed-use activities are a result, even today, of these underly-

The Beaver Creek Watershed's development does not have to result in undifferentiated sprawl. It can be planned and managed to help the watershed mature gracefully.

(1) Ogden Environmental and Energy Services, Inc. (2000). *Beaver Creek Watershed Storm Water Master Plan.* Prepared for Knox County Engineering and Public Works Department.

ing patterns of place. Context informs and bounds the problem and suggests the shape of, or at least the container for, design solutions. This perspective underlies the three "big ideas" that follow.

This combination of terrain, hydrology, ecology, and settlement was the context for developing our proposal for a NETWORK OF OPEN SPACE in the form of the LAND STEWARDSHIP NETWORK. The underlying characteristics of the land and the ways people settled it in the past help shape what land remains open and what land is currently best for conservation. Context further informs our proposal for locating new centers of settlement and for strengthening old centers. It sets much of the pattern, CONSTELLATION OF CENTERS. Context helps us determine where to locate different types of neighborhoods are situated in the pattern TAPESTRY OF NEIGHBORHOOD TYPES.

Contextual thinking is the foundation and the modifier of two other major types of design thinking that we use: *Process Thinking,* in which we understand how function is a basis for form, and *Typological Thinking,* in which we adapt well-known solutions to recurrent problems.

A FRAMEWORK OF OPEN SPACE

We need to regard conservation and development as complementary rather than antagonistic patterns: To achieve this, watershed residents need: 1) a clear shared vision of the larger patterns of connectivity, and 2) a new definition of conservation that accommodates human use.

First, much of Beaver Valley is already built in a pattern of low-density sprawl. That means that the value of remaining open land is rising. There are two main problems in the current system:

1) *Sprawl fragments open space* into smaller and smaller islands, breaking a functional system into a heap of isolated parts.
2) *In a settlement, conservation and development are complementary—not antagonistic.* The choice is not between wilderness or "anything goes," but rather a range of conditions that lie between these extremes. We need a new idea of this relationship.

We propose two kinds of design patterns to address these two issues:

- A LAND-STEWARDSHIP NETWORK, which spatially defines the larger land-stewardship patterns in which individual properties participate. Though we propose boundaries for these corridors, it is the larger ideas that are important, the ideas of ridge, stream, and heritage corridors. Incorporated into planning and development processes, these ideas can guide the thousands of decisions it will take to build such a pattern collaboratively over time.
- SPECTRUM OF CONSERVATION LAND, which allows for and defines a range of levels of conservation and types of human activities, from the extremely low human use *streamside protection zone,* the innermost zone of the three-zone WATER FEATURES BUFFER, to clustered housing in CONSERVATION NEIGHBORHOODS.

Together, these, with several other patterns, form the bones of the FRAMEWORK OF OPEN SPACE, the major component of the GREEN INFRASTRUCTURE NETWORK.

A CONSTELLATION OF CENTERS

We believe that the future of this watershed's landscape lies in an interconnected net of centers of different types at three scales.

Beaver Valley has a choice: a wall-to-wall carpet of sprawl or a more complex pattern of many centers with the character of traditional towns, combined with stewardship of open land.

Beaver Creek Watershed is primarily suburban and rural in character. Its fabric is differentiated only by linear highway-oriented commercial strips that have little relationship to where people live. There are two main problems with this current model:

1) *Residents are losing the places they belong.* The identity, character, and uniqueness of the watershed's communities is being diluted by rapid growth. It is fast becoming a "geography of nowhere";
2) *Life is lived from the automobile.* This disenfranchises the 25% of residents who do not drive and absorbs many hours of time from drivers who aid them.

We have proposed three kinds of patterns, discussed in further detail later in this chapter, to address these two issues: TOWN CENTERS, VILLAGE CENTERS, and NEIGHBORHOOD CENTERS. Centers give a sense of identity and orientation. They also provide the density necessary to support walkable shopping and other services, without requiring residents to drive long distances. By increasing the intensity of activities and buildings in centers, rural reserves may be preserved at the periphery of communities to separate one from the next, further defining a sense of "our town" and "our home place."

These three kinds of centers are configured in the CONSTELLATION OF CENTERS pattern in three ways:

- *Location based on transportation,* which has two main principles: 1) the linking of centers along major valley roads, and 2) the linking of minor centers in the tributary Hines Valley to town centers in the main Beaver Creek Valley. Both of these sub-patterns recognize the context of the landscape and existing road patterns while also supporting future public-transit options.
- *Size and spacing based on travel time.* Spacing, in ideal terms, is based on travel time from the edge of a community's related neighborhoods (its catchment) to its center. This sets maximum distances that can be served by different types of centers. Each center has at least three catchments: for walking, biking, and driving. The actual configurations of communities in the watershed are also modified by locations of pre-existing development and the pattern established by the LAND STEWARDSHIP NETWORK.
- *Variations in the mix of uses,* which allow for different emphases in different centers. TOWN CENTERS will have the richest mix of uses, while VILLAGE CENTERS might specialize in employment, shopping, or entertainment. NEIGHBORHOOD CENTERS may simply provide neighborhood services.

A TAPESTRY OF NEIGHBORHOOD TYPES

Within available land, different kinds of neighborhoods, varied by density and organization, are distributed by coordinating an ideal town model with contextual suitability.

Everyone has a fond vision of the ideal American small town, with its main street, commercial core, town square, and housing that gets more dispersed the farther one moves from the center. But in a growing area, this ideal has to adapt its to local conditions.

A community can not grow economically and in population while also conserving and preserving significant amounts of land areas, unless it finds places within the community that can absorb the extra pop-

WHAT IS A PATTERN?

Patterns *are recurring successful spatial configurations (ways of organizing streets, buildings, and other element of the places in which we live) that are repeatedly used in settlements or landscapes in response to recurring types of problems.*

For example, a recurring problem could be the need for a place for young children to play, that allows children to form social groups with other children, to develop a sense of independence within a safe context, and to have a place that belongs equally to all children, allowing democratic social skills to emerge. The pattern solution could be a small park close to home with a playground. Planners usually give patterns descriptive names (the park mention above could be a POCKET PLAYGROUND).

MORE INFO

For an extended discussion of the theory of patterns, see:

Alexander, Christopher (1979). *A Timeless Way of Building*. New York: Oxford Univ. Press.

For many examples of design patterns, see:

Alexander, Christopher, et al. (1977). *A Pattern Language: Towns Buildings, Construction*. New York: Oxford Univ. Press.

ulation. At one level, it is arithmetic. If we want the watershed to grow, then a certain number of people need housing. If we create policies and programs to discourage housing developments in stewardship corridors (say, to preserve productive farms), then the people that would have settled on the developed farm land need homes in other areas. Therefore, we need ideas about where more-dense and less-dense developments are located:

- The model SMALL TOWN, with its DENSITY GRADIENT (dense in the center to dispersed at the edge) is a good archetype. It makes a great place to live. You can walk to many daily destinations. It fosters a sense of place and community, and most importantly it offers a variety of different lifestyle options for places to live. In an ideal, flat, unsettled landscape, such a town might be built with a town center surrounded by concentric rings of neighborhoods where average density (households per acre) decreases as you move further from the core. However, Beaver Valley is neither undeveloped nor flat.
- SUITABLE USE LOCATIONS, a cornerstone principle of good planning, says that different activities should each be located in the best places for them. The characteristics of the landscape vary from place to place, making some areas more ecologically beneficial than others and some better suited for different types of human activities than others.

Suitability is based on the ecological characteristics of the land and on the settlement structure that exists there. The intersection of these two patterns allows us to locate things sensitively in the landscape and to create all of the benefits of small-town patterns.

INTENTIONS & DESIGN PATTERNS

Intentions *are our reasons for the actions we take. They provide the energy that motivates us to seek solutions.*

Patterns *are a method of recording and repeating solutions that resolve recurring problems of settlements or landscapes (see* HOW DO PATTERNS BUILD A NETWORK?*). When a community's intentions change, new patterns and new networks that reflect those changed intentions are needed.*

Green Infrastructure reflects some old and some new intentions and ambitions that stakeholders hold for the watershed. The table on this page shows some of the larger intentions that organize the development vision presented in this chapter. Each intention relates to several other intentions. Collectively, these intentions describe a "change in direction" that can positively affect Beaver Creek's future. Design patterns that help achieve each intention are in the right column. Each pattern connects to several other patterns, both larger and smaller than itself. Together, these patterns form a kind of *pattern language* that a community can use to build its common vision of towns, villages, and neighborhoods and the open land that surrounds them.

INTENTION	DESIGN PATTERNS
A FRAMEWORK OF OPEN SPACE	
• Preserve a critical core of remaining open space. • Provide distinct community boundaries.	• STEWARDSHIP CORRIDORS NETWORK
• Provide for a rich mix of conservation and development.	• SPECTRUM OF CONSERVATION LAND
• Link neighborhoods to centers. • Link centers to other centers. • Facilitate mobility for non-drivers. • Provide recreation accessible to neighborhoods.	• SOFT TRANSIT NET
A CONSTELLATION OF CENTERS	
• Strengthen existing centers. • Encourage new centers in centerless neighborhoods and communities.	• TOWN CENTERS • VILLAGE CENTERS • HAMLET CENTERS
• Connect housing to nearby parks. • Foster neighborhood social relationships.	• NEIGHBORHOOD CENTERS
• Provide for a diverse mix of housing and life-style options.	• SMALL TOWN DENSITY GRADIENT
A TAPESTRY OF NEIGHBORHOODS TYPES	
• Locate housing to support commercial centers. • Support walking and biking to town amenities. • Absorb development diverted by conservation. • Support efficient transit with appropriate density.	• TOWN NEIGHBORHOODS
• Promote development of compatible character in existing neighborhoods.	• SUBURBAN INFILL NEIGHBORHOODS
• Build appropriately in high-value environmental conservation areas. • Buffer the Land Stewardship Network with low-impact development.	• CONSERVATION NEIGHBORHOODS
• Build appropriately in high-value cultural conservation areas.	• RURAL HERITAGE ZONES

HOW DO PATTERNS BUILD A NETWORK?

Individual patterns *describe single elements. Individually these elements are useful, but assembled into a bigger picture (a network) they become really effective. Each decision maker, whether landowner or mayor, must understand the role of a smaller pattern in building a larger, shared network pattern. This is one of the keys to the elusive structure of wholeness that a great place to live exhibits.*

Continuing our example:
When children are young, they need a safe place to play close to home - a POCKET PLAYGROUND. As your children grow, they outgrow their POCKET PLAYGROUND and need SCHOOL PARKS, SPORTS PARKS, and NATURE PARKS. Knox County organizes these individual park patterns into a group of parks that serves families in the watershed and creates a pattern that we call a FAMILY OF PARKS.

By combining FAMILIES OF PARKS that serve all Knox County residents with safe bicycle routes between places (GREENWAYS, FOOT PATHS, and SAFE STREETS) the County can create a PARKS AND SOFT TRANSIT NETWORK that allows a family to bicycle safely from Copper Ridge to Knoxville's waterfront.

PROPOSED TOWN, VILLAGE, & NEIGHBORHOOD CENTERS

What you see…

This map shows proposed locations of mixed-use activity centers at three scales of settlement, along with their catchment areas. Centers are important to the identity and function of areas they serve. Their increased density and balanced mix of uses promotes local services, transit, and public space. TOWN CENTERS and VILLAGE CENTERS might include public squares or greens, commercial uses mixed with multifamily housing, civic buildings, and a transit stop. NEIGHBORHOOD CENTERS might include parks, row houses, and local services. Centers are connected by the SOFT TRANSIT NET. See the table on page 68 for a complete listing of proposed centers.

How we did it…

We first divided the landscape into neighborhood-sized areas that we call spatial domains. These domains are identified by their boundaries, which are a combination of natural features, such as steep slopes and water, along with human-made features, such as highways, railroads, and other major roads. Each domain is roughly the size of a good IDENTIFIABLE NEIGHBORHOOD, about a half-mile in diameter. Villages are about a mile across; Towns, about two miles. We located some centers based on the Neighborhoods & Centers Analysis map and some based on the potential for an area to grow in population and to coalesce into a center over time.

- BC Watershed
- Knox County Boundary
- Wetlands
- Sinkholes
- Parks
- 40% + Slope Area
- Stewardship Corridors
- Town Centers
- Village Centers
- Neighborhood Centers
- Existing Commercial/Mixed Use
- Town Neighborhoods
- Suburban Neighborhoods
- Conservation Neighborhoods
- Proposed Knoxville Parkway (SR 475)

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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PROPOSED TOWN, VILLAGE, & NEIGHBORHOOD CENTERS

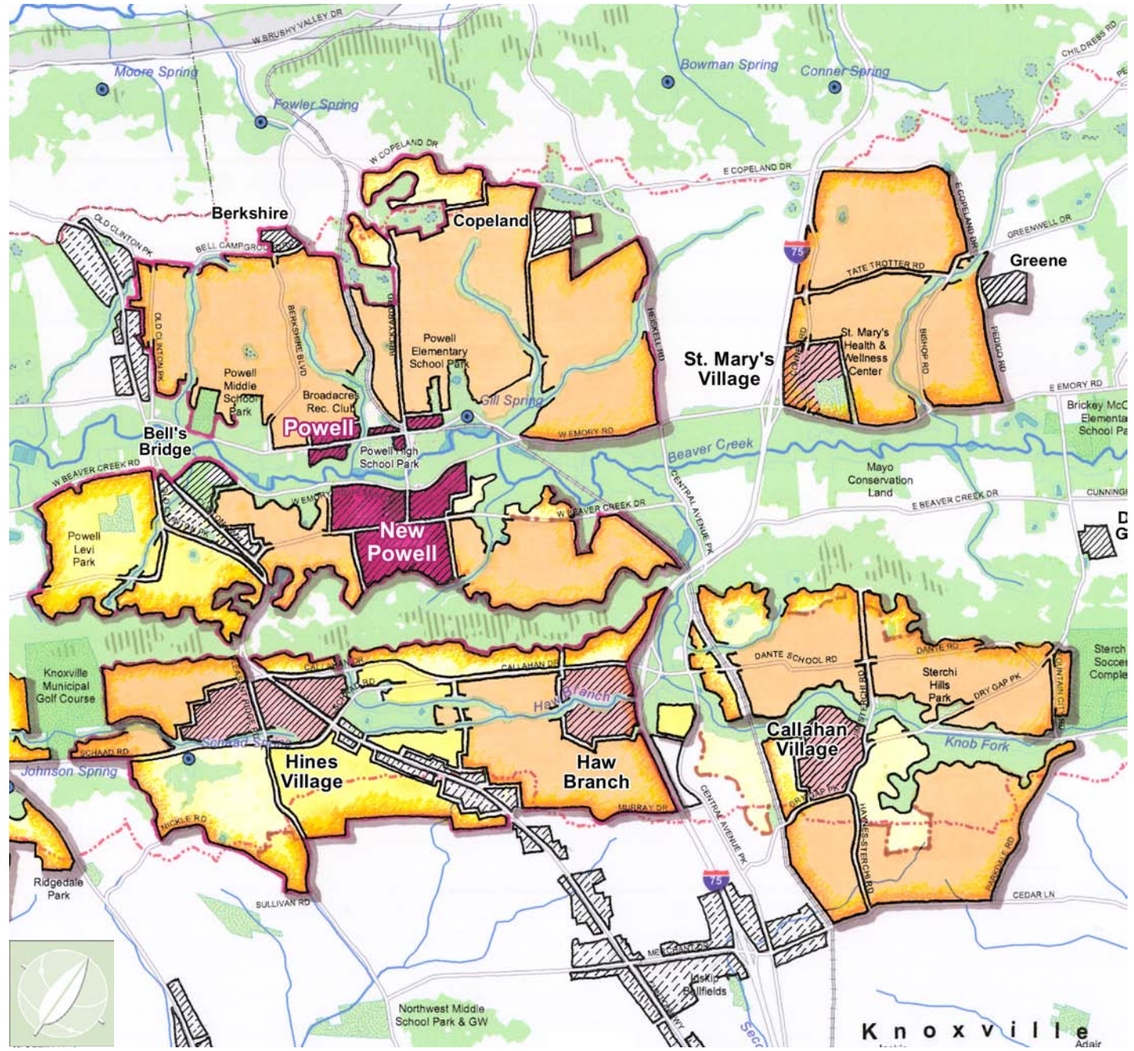
Bringing Centers to Neighborhoods and Neighborhoods to Centers

The experience of CENTER organizes our work, social, and family lives. Energy, variety, and intensity of activities increase as we approach the center of a place. It may be roughly in the middle or geometrically eccentric, but in any case, it is the social and symbolic heart of the place. In this proposal, we locate three sizes of centers, which are, from larger to smaller, Town, Village, and Neighborhood Centers.

Centers, when combined with their related neighborhoods, offer an amazing convergence of social, economic, and ecological benefits. Socially, they bring people together for planned as well as chance meetings and increase mobility for everyone, including children and elders. Economically, they offer a density of pedestrian traffic to support business and a place for businesses to benefit from adjacency to other businesses. Ecologically, they reduce automobile use and land used for buildings and streets.

The map shows a proposal for a CONSTELLATION OF CENTERS of varying scales. This is fundamentally different from existing sprawl development in two ways:

- *Mixed use centers at all scales are tied to specific spatial territories*. Sprawl connects residences to the nearest MAJOR ROAD, and that's it. Everyone drives, and community destinations line the major roads, competing for attention from drive-by shoppers. In contrast, CENTERS connect to the MAJOR ROAD NETWORK *and* nearby residents (via SOFT TRANSIT routes). Businesses reach local and drive-by shoppers. *Residents can choose* to bike, walk or drive to either their local center or other centers, which, based on the principle of *Variations in the Mix of Uses*, will naturally have other employers, shops, and services.
- *Centers are organized around walkable streets, rather than highways*. WALKABLE STREETS and the concentration of activity in centers make walking to daily needs efficient and increase the number of households close to the center's amenities. This does not mean that all commercial activities will be located in centers. *Highway commercial sites* are still the appropriate locations for muffler shops, gas stations, car dealers, shipping warehouses, and drive-through fast-food joints.



Where are Town, Village, and Neighborhood Centers located?

We have used several strategies for locating proposed centers in the Beaver Creek Watershed. The existing context of the structure of neighborhoods and our identification of existing, though weak, centers come from our *Existing Centers and Neighborhoods* map in the chapter, "Land and its Settlement Patterns." For existing centers, we proposed strengthening and, in places, expanding them. In others, such as Halls, we proposed a shift from all linear highway commercial to a string of three centers: Halls, South Halls, and Black Oak.

New centers are located based on a number of interacting factors. A new center might be located:

- Within areas of "centerless" populations.
- To be spaced appropriately relative to other nearby centers.
- Along existing or potential transit routes, in ways that allow transit to efficiently link centers.
- For accessibility to existing subdivision outlets.
- Near community institutions, such as schools. libraries, and recreation centers.
- On vacant land with potential for new neighborhood growth.

Locations for new centers are often close to old farm hamlets that have been absorbed into suburbia. While original community identities have faded, the locations remain identifiable. This is not surprising, because of the strong order imposed on the road and settlement structure by landform.

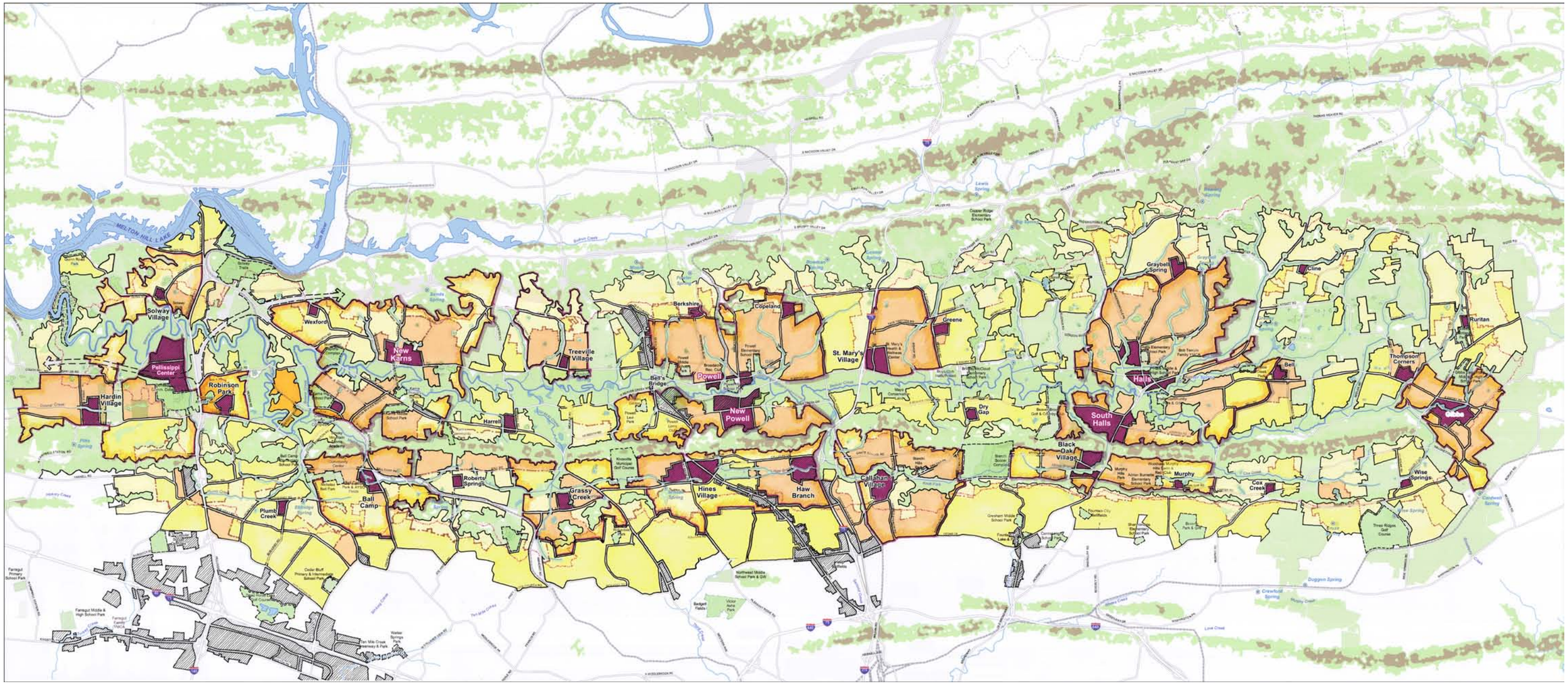
See the table on page 68 for a complete listing of proposed centers.

- BC Watershed
- Knox County Boundary
- Wetlands
- Sinkholes
- Parks
- 40% + Slope Area
- Stewardship Corridors
- Town Centers
- Village Centers
- Neighborhood Centers
- Existing Commercial/Mixed Use
- Town Neighborhoods
- Suburban Neighborhoods
- Conservation Neighborhoods
- Proposed Knoxville Parkway (SR 475)

Detail of proposed town and village centers, with adjacent neighborhoods around Powell.

- Where some commercial or mixed use is present.
- Near crossroads.
- With one border on a major arterial road and containing or bordering at least one road with potential to become a slower SAFE STREET or BOULEVARD.

Boulevards, town parks, and well-landscaped mixed-use areas form the core of village and town centers. The core is surrounded by walking-oriented neighborhoods with smaller, single-family lots; quality condominiums; town homes; apartment houses; and pocket parks.



PROPOSED FUTURE SETTLEMENT PATTERN

What you see…

If some areas of the landscape are to be conserved for their health-safety-welfare benefits, and development activities limited there, then, to accommodate growth, other areas must increase in density. This map shows our proposal for the pattern of future development in the Beaver Creek Watershed within the LAND STEWARDSHIP NETWORK. Areas not recommended for stewardship are likely places for development. This plan is designed to create traditional American towns and villages, which are mixed-use, moderate-density, walkable communities that also support public transit.

How we did it…

Based on the locations of centers in the *Proposed Town, Village, and Neighborhood Centers* map, we located neighborhoods within the areas not designated in the LAND STEWARDSHIP NETWORK, according to the pattern DENSITY GRADIENT, where possible. Typically, medium-density TOWN NEIGHBORHOODS are adjacent to Centers, while SUBURBAN-INFILL NEIGHBORHOODS represent existing low-density development. CONSERVATION NEIGHBORHOODS are located based on the *Conservation Neighborhood Potential* map in areas we did not select for one of the other development types.

- BC Watershed
- Knox County Boundary
- Wetlands
- Sinkholes
- Parks
- 40% + Slope Area
- Stewardship Corridors
- Town, Village, and Neighborhood Centers
- Existing Commercial/Mixed Use
- Town Neighborhoods
- Suburban Neighborhoods
- Conservation Neighborhoods
- Proposed Knoxville Parkway (SR 475)

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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PROPOSED FUTURE SETTLEMENT PATTERN

A tapestry of neighborhood types distributed to create livable towns fitted to their place.

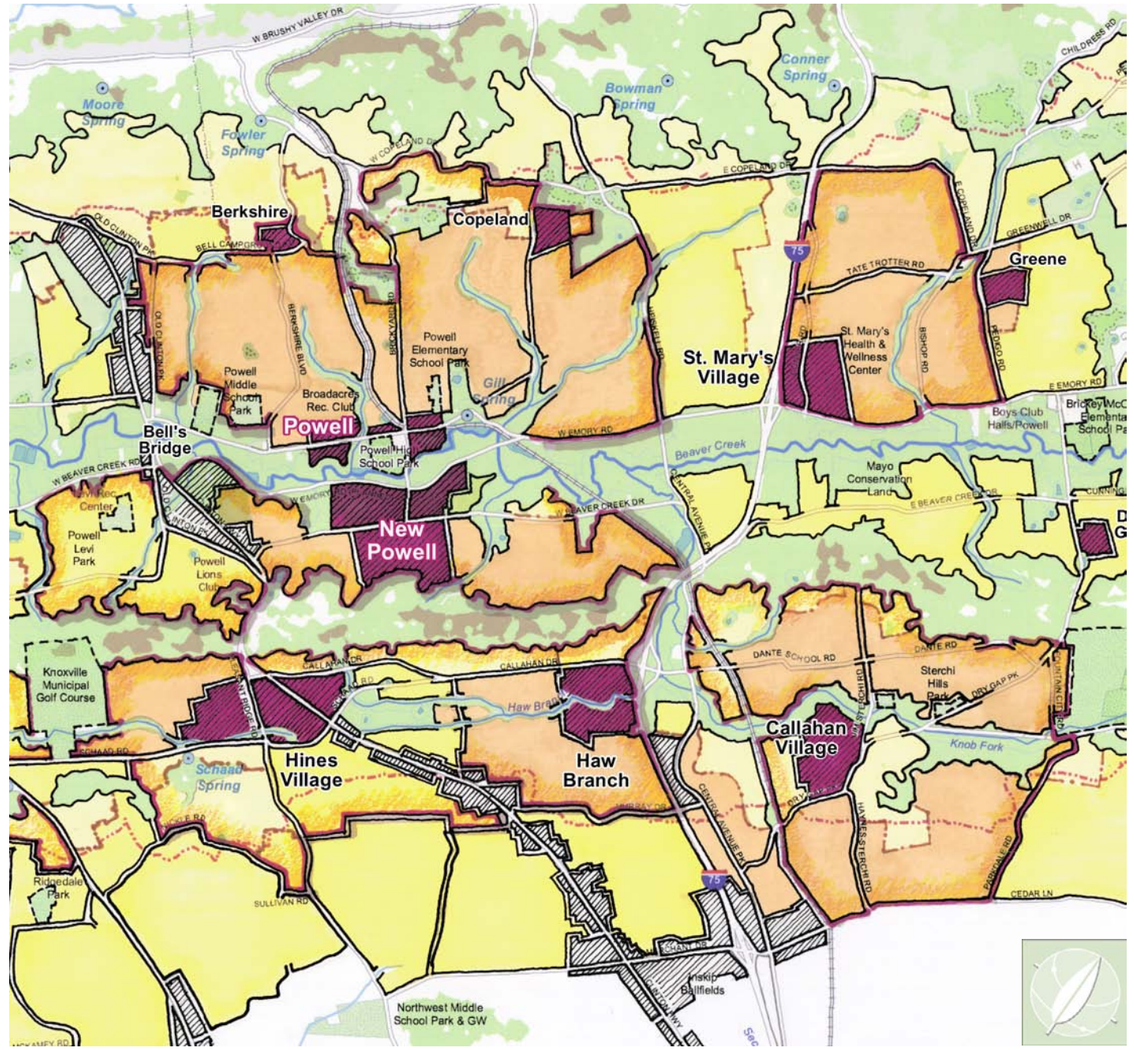
It is important to envision how the landscape will look in 20 years when all the available land is built on. There are two options for growth: 1) traditional towns and neighborhoods or 2) sprawl.

The drawing shows our proposal for a build-out version of a conservative vision for traditional towns and neighborhoods that is sensitive to the environment, to existing patterns of development, and to the residents' desire for preserving rural character as much as possible. Though it is but one possibility, we strongly believe that the principles used to create it are sound and that other versions using the same principles would yield a similar essential structure, though the details may vary. What is important at this point is a viable future vision, not the exact details of how it is implemented. That will come later, once people agree on a course of action to save the valley.

To envision the business-as-usual alternative, simply imagine every major road corridor in the watershed at three to five lanes wide, bounded on both sides by the development currently seen along Oak Ridge or Maynardville Highway. In between, imagine hundreds of dead-end, disconnected streets lined with one-third acre lots and suburban housing. Now imagine stop lights every quarter mile and an hour-long drive from Gibbs to the Pellissippi Campus.

Types of Neighborhoods

The drawing shows several kinds of neighborhoods, which we outline briefly below. It is important to note that we have not cited anything specific about the density or development types or architectural styles of these neighborhoods. These are questions for public process and later design guidelines. While there are density thresholds to support different kinds of commercial facilities in a center or to support different kinds of public transit, we have really suggested here only a density spectrum. The calibration of that spectrum to specific values and neighborhood forms is beyond our scope and should include public input in a more detailed planning study of local areas. To understand the way the proposed neighborhood types make a DENSITY GRADIENT, see A "DENSITY GRADIENT OF NEIGHBORHOOD TYPES."



Detail of proposed future build-out development pattern, around Powell.

Town Center Neighborhoods (L-5)

These could be places like Savannah, GA, or Charleston, SC. Town and village centers contain a mix of uses, including residential and non-residential buildings, plus some mixed-use buildings, such as apartments over shops. Therefore, it is not just a business district, but also a neighborhood for people who choose it. It may have apartment buildings and row houses with yards and yard-houses but no detached single-family dwellings. Some of the areas shown are already partly developed; in these, infill could increase the number of households to support town life.

Town Neighborhoods (L-4)

These neighborhoods resemble neighborhoods like Fourth-and-Gill and Old North Knox in Knoxville. They are quiet and green and might have a mix of small-lot, single-family houses and duplexes, many with rear-yard houses or home offices, row houses, and quality condominiums and apartment houses. Like traditional neighborhoods, they are mixed use: They are within walking or biking distance of a grocery, neighborhood services, shopping, and recreational opportunities offered in the neighborhood center and in the town or village center.

Though it is but one possibility, we strongly believe that the principles used to create this proposal are sound and that other versions built on the same principles would yield the a similar essential structure, though the details might vary.

A DENSITY GRADIENT OF NEIGHBORHOOD TYPES
A Scale for Calibration with Local Input

Level 5:	• TOWN CENTER NEIGHBORHOOD
Level 4:	• TOWN NEIGHBORHOOD • CONSERVATION NEIGHBORHOOD-L4
Level 3:	• SUBURBAN INFILL NEIGHBORHOOD • CONSERVATION NEIGHBORHOOD-L3
Level 2:	• RURAL RESERVES • STEWARDSHIP CORRIDORS *(land not in Level 1)*
Level 1:	• WATER FEATURE BUFFERS • STEEP SLOPE ZONES

Suburban Infill Neighborhoods (L-3)

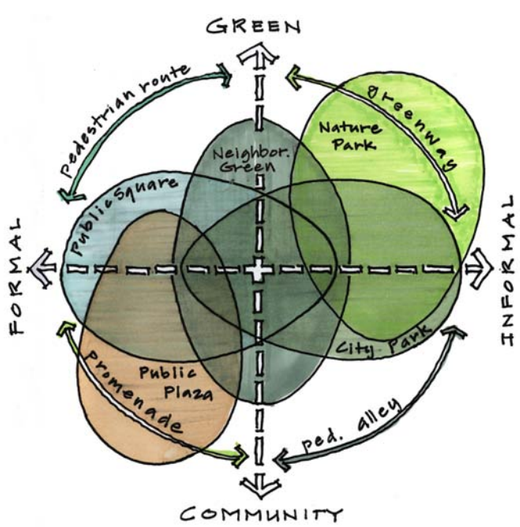
These neighborhoods are existing suburban neighborhoods. Infill is recommended only in areas where conventional suburbs predominates and conservation neighborhoods are *not* indicated. These neighborhoods have parcels from 1/4 to 2 acres. Infilling might involve completing the pattern with new housing or allowing rear-yard units. Low density, few sidewalks, and cul-de-sac streets that funnel traffic to a few main transportation arteries mean residents rely heavily on cars to reach services and recreation. We recommend no more new neighborhoods of this type.

PRINCIPLES RELATING PUBLIC SPACE & SETTLEMENT STRUCTURE

The Overriding Principle:
Public space is defined by the structure of the city, and the structure of the city is defined by its public space.

Sub-Principles
- *Greens, squares, and plazas are located to reinforce centers.*
- *Large parks are located to reinforce edges.*
- *Safe Streets and Boulevards connect formal civic places.*
- *Greenways are located to reinforce community edges or to connect parks and centers.*

Together, public space and urban structure form a compound pattern that is richer than either could attain individually.



Public Space Types

Conservation Neighborhoods (L-3 or L-4)

A CONSERVATION NEIGHBORHOOD (CN) clusters housing in one part of a site to preserve conservation features in another part of the site. It is similar to the concept of planned residential (PR) zoning, except that development in a CN zone *prioritizes* conservation and preservation of conserved features, such as open wildlife habitat, wetlands, and other land important to public health and safety, such as floodplains and stream buffers. In our proposal, conservation neighborhoods occur where our analysis indicates the *suitability* is high and where land is not currently developed. CNs are a good idea on larger parcels where land is zoned for residential neighborhoods and some high-value conservation areas are on the parcel. Best practices for roads, driveways, landscape, yards, and buildings, shaped by conservation goals, are recommended in these neighborhoods. Conservation buffers, easements, and wildlife areas are amenities and features of these neighborhoods. A conservation neighborhood may have an overall gross density like that of a SUBURBAN NEIGHBORHOOD (L-3) or a TOWN NEIGHBORHOOD (L-4), or, in rare cases, a TOWN CENTER NEIGHBORHOOD (L-5). For instance, the gross density might be 4 units/acre (200 houses on 50 acres), equal to that of a typical post-war subdivision, while the local density in the area where housing is clustered on 20 acres might be 10 units/acre (200 houses on 20 acres, with 30 acres of undeveloped open land). By using different housing types and/or by moving the houses closer together, there is less infrastructure, lower site-development costs, and more open space in more beneficial configurations.

Where are proposed Conservation Neighborhoods located?

- In the area above Maynardville Highway, where decreases in infiltration capacity (by paving associated with development) can severely affect downstream flooding by increasing runoff.
- In other areas with high infiltration capacity.
- In buildable areas with steeper slopes.
- Adjacent to land in the LAND STEWARDSHIP NETWORK.

Rural Reserves (L-2)

RURAL RESERVES are the main component of the HERITAGE PROTECTION CORRIDORS. They are exactly what the name implies, areas where the watershed's historic rural living pattern of working farms and residential farms is maintained. In these areas no subdivision of existing parcels into parcels of, for instance, less than 20 acres, should occur. However, a farm might have homes for several family members on the same tract. Of course, many smaller lots already exist in some areas designated for rural reserves, so these would remain as they are.

Where are Rural Reserves located?

- In areas recommended for the RURAL HERITAGE CORRIDORS (see Chapter E), typically land between existing communities that is currently rural in character.
- In flood-mitigation catchment areas (see conservation neighborhood suitability discussion below).
- On the fringes of the STREAM PROTECTION CORRIDORS.

CONSERVATION NEIGHBORHOOD SUITABILITY

Locating the best places for planned developments that preserve open space with clustered housing.

CONSERVATION NEIGHBORHOOD type development is recommended based on weighted ranking of two criteria: 1) the presence of moderate slopes (15-25%) and 2) the area's contribution to flood mitigation and water-quality improvement. Two factors determine an area's flood-mitigation contribution: *position in the watershed* and *infiltration potential* (ability of surfaces in the area to absorb stormwater). These factors also correlate to water quality.

The graphics on the next page outline the method we used to create the suitability analysis. On the map of *Conservation Neighborhood Suitability* (turn to next page), areas are ranked for their potential to support CNs as follows:

- ***High Potential*** *(dark orange)* areas are strongly recommended for CNs. They tend to have a combination of relatively steep slopes and/or high infiltration potential. Areas with slopes above 25% are excluded. The criteria of *position in the watershed to mitigate floods* adds land in subwatersheds above Maynardville Highway into this category.
- ***Medium Potential*** *(medium orange)* are recommended for CNs if the parcels contain significant protected features or share a significant length of parcel boundary (>25%) with the LAND STEWARDSHIP NETWORK.
- ***Low Potential*** *(light orange)* are not recommended for conservation development, because relatively flat slopes and/or low infiltration potential mean the area makes a low contribution to conservation goals. Many areas ranked low are already developed.

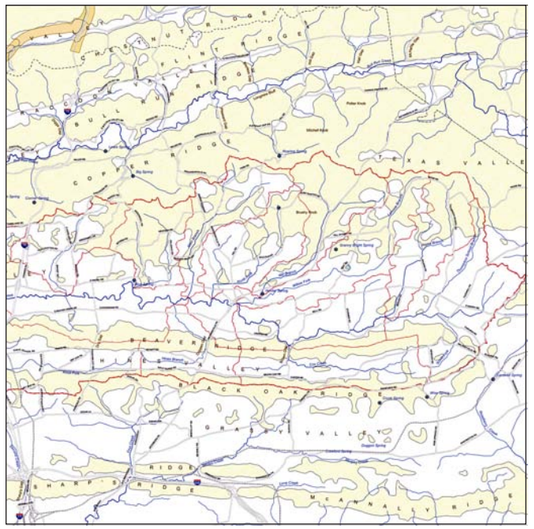
A VISION FOR DEVELOPED OPEN SPACE

The location of public places has, in recent history, been opportunistic and poorly tied to settlement structure. In this new vision, public space and settlement structure define each other.

Public space is defined by the structure of the settlement, and the structure of the settlement is defined by its public space. Together they form a compound pattern that is richer than either could attain individually. For example, without the larger settlement structure to support them, community places do not function as environments for community life. They need to be accessible and lively for people to want to frequent them. Similarly, a neighborhood is not entirely whole unless it has a strong center around which neighborhood life is oriented; without the center, it is just a small region of houses where home life and public life never mix, and we don't know our neighbors. In turn, a center won't be a NEIGHBORHOOD CENTER unless it has a public place where local people meet, socialize, drink coffee, and play with children; public space without public life is only a vague area with little significance to anyone.

We propose a simple common design language that connects, in a single network, public space in town, village, and neighborhood centers with green open spaces—linking places with paths.

Public Space includes places and paths— developed "rooms" as well as "corridors." Public space can have a range of different design characters, from the highly urbanized to the highly naturalized. Public spaces come large and small, more formal and more informal.



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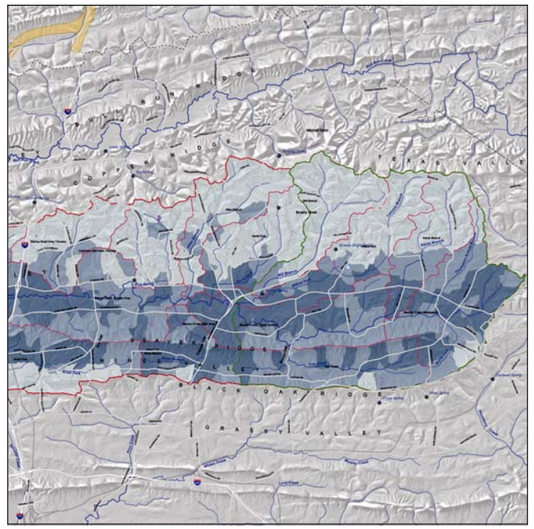

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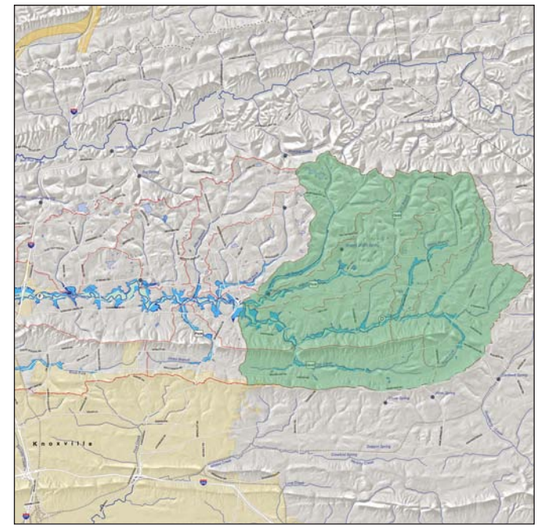

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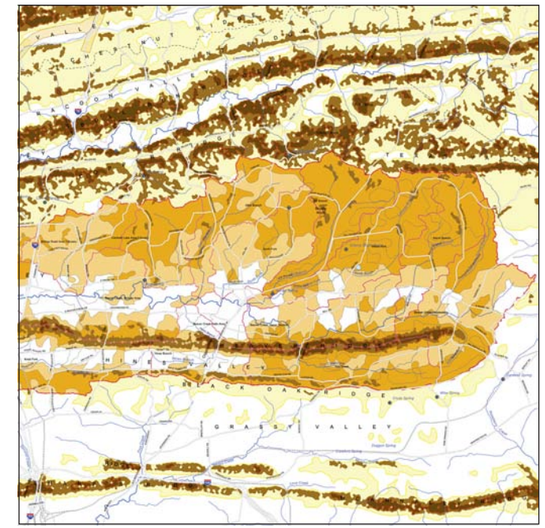


15 PERCENT SLOPE AREAS, GENERALIZED

(full map on report disk)

What you see…

This map shows contiguous areas of slopes 15% and greater in light yellow. The Metropolitan Planning Commission's (MPC) development guidelines recommend density limitation on steep slopes to prevent landslides and erosion, protect forests, and preserve the region's character. Steep slopes are poor choices for urban development and most often correspond to thin, poor-quality soils and heavy forest cover. When vegetated, they play an important role in flood mitigation and preserving water quality. These areas are good candidates for lower-density development in the form of CONSERVATION NEIGHBORHOODS.

How we did it…

From USGS *digital elevation models* (90 m cells), we generated *slope classes* in 5% intervals. Areas over 15% were grouped (reclassed) together. *Contour lines* were interpolated from the reclassed raster (grid cell data). The contour lines were converted to *slope zone* polygons and areas under 2 acres were eliminated, based on MPC size guidelines for 15% slope zones. These areas were then traced over to help remove small irregularities and to generalize the shapes for analysis.

RUNOFF INFILTRATION POTENTIAL

(full map on report disk)

What you see…

This map shows a rating of the land's capability for absorbing rainfall runoff. This capability is primarily a function of two factors: 1) the *soil type* and 2) the degree of *impervious land cover*. Soils with high clay content are relatively impervious. More developed areas have more paving and buildings which block water from soaking into the ground. Areas of greater infiltration (light blue) are important because they slow runoff and help reduce flooding and erosion and filter pollutants from water; their important functions should be preserved. Areas with poor infiltration (dark blue) might be better for development.

How we did it…

The *Beaver Creek Flood Study* (by Ogden) calculates "*Curve Numbers*" for each basin area (roughly 100 acres) shown on the map. Curve Number is an index of *infiltration potential* that is used in the Soil Conservation Service (SCS) TR-55 runoff calculation model. Determining Curve Numbers involves the digital overlay of land-use data (from KGIS), soil type (from NRCS), and drainage basins (Ogden) in a GIS software. We have ranked the curve numbers into three classes based on the Center for Watershed Protection's 10% and 25% *imperviousness thresholds* for water quality.

SUBWATERSHEDS ABOVE MAYNARDVILLE HIGHWAY

What you see…

The *Beaver Creek Flood Study* identifies areas above Maynardville Highway as critical to flood control downstream, in the central portion of Beaver Creek Valley. It recommends minimizing impervious surfaces in this area to avoid increasing runoff speed and volume. The Center for Watershed Protection guidelines call for a 10% imperviousness limit to keep water quality high. Since conservation neighborhoods have less impervious cover than conventional practices, the area shown is a good location for these types of development.

How we did it…

We simply selected areas defined by the subwatershed boundaries, as shown in our *Subwatersheds and Basins* map. Since water is the issue of concern, we used watershed divide lines instead of roads to define the area.

CONSERVATION NEIGHBORHOOD SUITABILITY

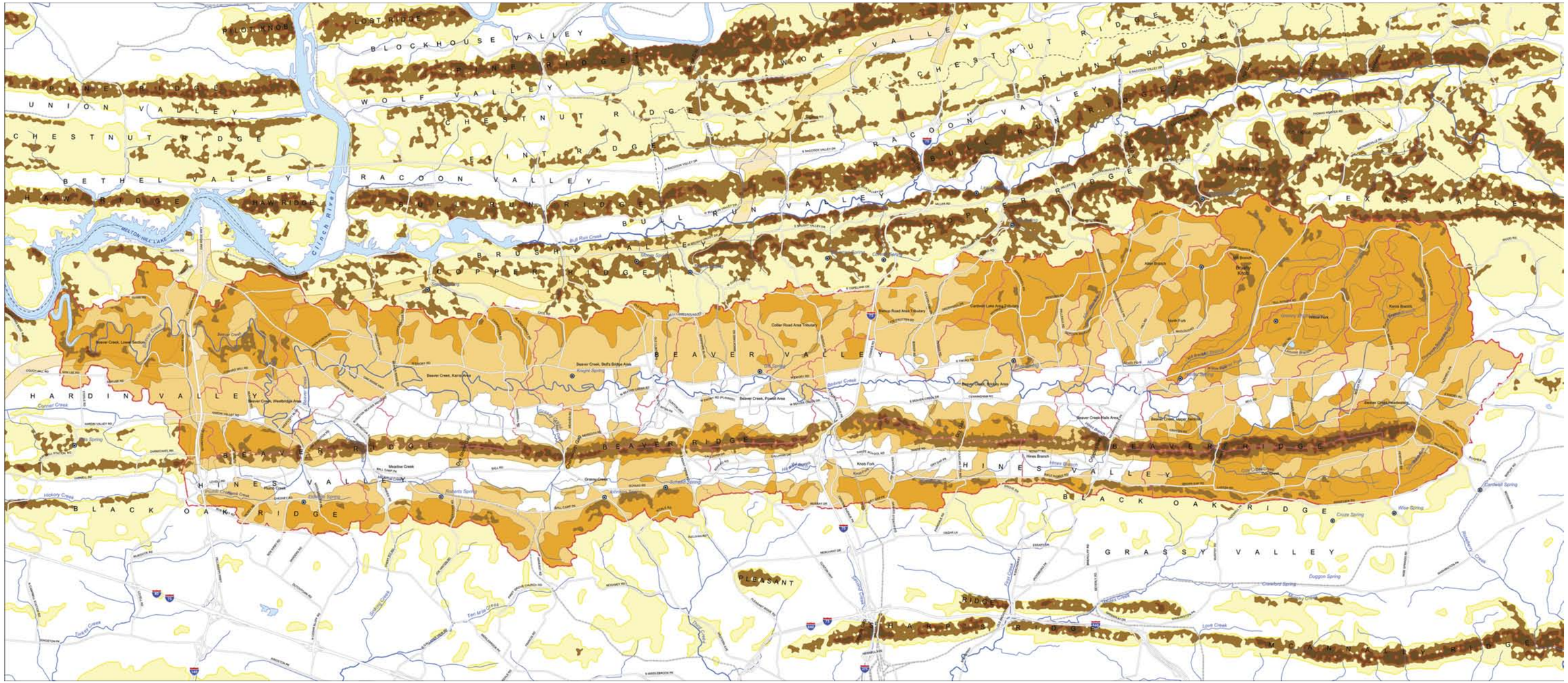
(full map on facing page)

What you see...

This map shows *land suitability* for CONSERVATION NEIGHBORHOODS (CNs). This form of development clusters housing to conserve open-space and valuable environmental features, while reducing development costs. The rating is based on: 1) slopes over 15%, 2) infiltration potential, and 3) location in the upper sub-watersheds. Compared with conventional suburban development, CNs reduce impervious surfaces, which are important in protecting water quality and reducing flooding.

How we did it...

We assigned points for the three criteria and added them to yield a composite suitability rank. Land greater than 15% slope received 2 points and less than 15%, 0. Infiltration potential was ranked Low/Medium/High, based on a natural breaks ranking of curve number. Higher is better. These were then weighted to account for greater significance of location in the upper watershed. Lower watershed points were: 0/1/2 for Low/Medium/High infiltration potential and 1/2/4 in the upper watershed. These points were then added to the slope points, and the sums were then grouped into three classes in GIS, based on Jenks natural breaks.



CONSERVATION NEIGHBORHOOD SUITABILITY

What you see...

This map shows *land suitability* for CONSERVATION NEIGHBORHOODS (CNs). This form of development clusters housing to conserve open space and valuable environmental features, while reducing development costs. The rating is based on: 1) slopes over 15%, 2) infiltration potential, and 3) location in the upper sub-watersheds. Compared with conventional suburban development, CNs reduce impervious surfaces, which are important in protecting water quality and reducing flooding. All areas shown are not available for development. Some are already substantially developed. Slopes above 25% are not suitable for this type of development.

How we did it...

From the USGS *digital elevation models*, we generated a map of *Generalized Areas >15% Slope*. For *infiltration potential*, we used U.S. Soil Conservation Service *Curve Number* ratings (a function of soil type & land cover) for the 100-acre basins, taken from the *BC Flood Study*. Basins were ranked using Center for Watershed Protection's 10% and 25% *imperviousness thresholds* for water quality. To reduce flooding, the *BC Flood Study* strongly recommended limiting impervious surfaces above Maynardville Hwy. We assigned points for the three criteria and added them to yield a composite suitability rank.

- BC Watershed
- Knox County Boundary
- BC Subsheds
- 40% + Slope Area
- 25 - 39% Slope Area
- 15-24% Slope Outside BC

Cons. Neighborhood Suitability

- Low: < 15% slope/low infiltration
- Medium
- High: >15% slope/high permeability

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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The Family of Parks Rule

The size of parks should vary with the distance from home.

Parks should never be too far away. A playground or POCKET PARK should be within two to three minutes walk or a couple of blocks from every home. It can be the size of two house lots, perhaps no bigger than 100 to 150 feet square. A NEIGHBORHOOD GREEN or PUBLIC SQUARE should be in the heart of every neighborhood, no more than five minutes walk, about a quarter-mile from every home (and never more than one-half mile, even in a suburban neighborhood). Larger CITY PARKS or COUNTY PARKS should be scattered evenly throughout the city and take about 20 minutes or less to reach on public transportation, which is a distance of less than two miles. CENTRAL PARKS and CENTRAL PLAZAS and NATURE PRESERVES serve the whole city and county. Significant travel time and effort should be required to reach only these parks.

Therefore, it follows that the city and county park system needs a few very large central parks and plazas, a few large nature parks, several big city parks, scores of medium-sized neighborhood greens (as many as there are neighborhoods), and a great number of small playlots and pocket parks, a few in each neighborhood.

The National Recreation and Park Association recommends a minimum of 6.25 acres of close-to home parks per 1000 residents. The Beaver Creek Watershed falls into portions of the MPC planning sectors of Northwest County, North County, and Northeast County. According to the County Parks Plan (1998), these sectors had 2.69, 2.88, and 2.35 acres of close-to-home parks per 1000 residents. This indicates that the desired level of service is not being met and *many more neighborhood and community parks are needed.* Although some parks have been built in recent years, population has also increased dramatically.

PROPOSED PARKS AND SOFT TRANSIT NET

Connecting Communities With Each Other and With Open Space.

This drawing (see next page) shows our proposal for an integrated FAMILY OF PARKS and a SOFT TRANSIT NET that knits them together. The parks system serves each level of settlement center: town, village, and neighborhood, and provides a range of park use types. The main differences between this proposal and conventional parks planning are:

- *Parks are tied to the structure of neighborhoods*, villages, and towns. Small parks are in the heart of the neighborhood and *close to homes*, whereas larger parks are *between communities* to help reinforce their boundaries.
- *Soft transit is a network.* Greenways can be much more than pleasant creekside paths to nowhere. They can help link together the places people want to go. Along with trails and sidewalks, greenways become part of a connected network of transportation as important to non-drivers as roads are to drivers.
- *An emphasis on neighborhood greens in neighborhood centers.* Recently, Knox County's efforts have focused on acquiring fewer, larger, consolidated parks, especially with an emphasis on active sports. These parks serve organized team sports and people who drive, but these parks can't be a part of daily life because most residents favor parks that are close to home. Strategies to acquire land for smaller local parks are needed.

NRPA PARK TYPE	CATCHMENT RADIUS	SIZE
Mini Park	< ¼ mile to residence	2500 square feet- 2 acres
Neighborhood Park	1/4-1/2 mile	2-20 acres
School Park	varies, depending on size	varies between neighborhood and community size
Community Park	1/2-3 miles	20-50 acres
Large Urban Park	entire community	50+ acres, 75 acres optimal
Sports Complex	entire community	25+ acres, 40-80 acres optimal

Recommended Park Planning Standards from the National Recreation and Park Association

Proposed New Parks

The *Knox County Park and Recreation Facility Plan* (1998) proposes a number of new parks and greenways for the Beaver Creek Watershed. We find their recommendations for larger parks to be, with minor exceptions, well-considered. Most of these we have included in our plan:

- ***Couch Mill/ Williams Bend Park:*** 50 acres of TVA land at the mouth of Beaver Creek, which has potential as a nature preserve.
- ***Burchfield Park:*** A strip along the Clinch River on TVA and county land.
- ***Harper's Cave Park:*** 55 acre tract on Black Oak Ridge, with wetlands around a large sink hole.
- ***Beaver Creek Park:*** 40 (Knox County plan recommendation) acres along Beaver Creek at the confluence with Grassy Creek. The plan shows this as a sport park, but its location in major floodplains suggests reforestation and a mix of active and passive uses. Given its potential for flood water storage, *this park could be much bigger,* as we have drawn it.
- ***School parks:*** most of these are constructed or are underway at Hardin Valley Elementary, Karns schools, and Brickey Elementary.
- ***Beeler Park:*** along Beaver Creek, between Halls and Gibbs. We propose shifting this upstream, closer to the Gibbs Village, to take advantage of significant riparian forests and to make it accessible by foot or bike from Gibbs.

The plan also shows several proposed parks outside the watershed. We have included these and indicated speculative boundaries:

- ***Yarnell Park***: a passive park along Hickory Creek on Yarnell Road.
- ***Heiskell Community Park:*** an active park along Bull Run Creek. We have not shown boundaries for this park.
- ***Bull Run Park:*** a large, mixed-use park on upper Bull Run Creek. We do not show boundaries for this park.
- ***Copper Ridge Park:*** a large regional nature park on Copper Ridge that would border the Beaver Creek Watershed. The park plan intelligently located this nature reserve in the largest remaining areas of prime forested wildlife habitat that we found in our habitat assessment. For illustration only, we have shown a size slightly over 1,000 acres with a speculative boundary encompassing large parcels.

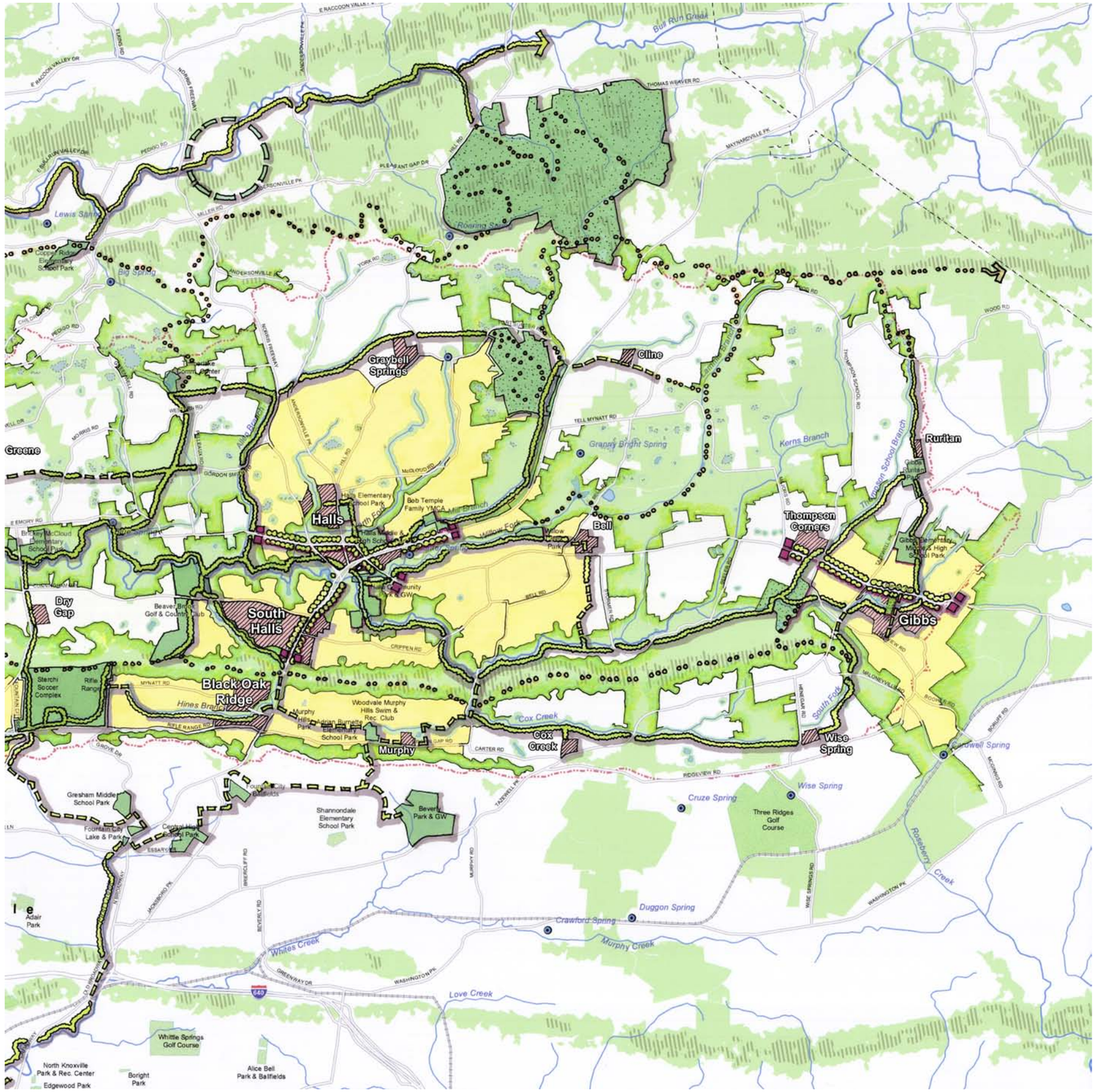
The configuration of how all the hubs (parks, greens, squares) and links (trails, greenways, boulevards, safe streets) fit together forms the Soft Transit Net's comprehensive pattern.

MORE INFO on parks planning:

Knoxville Knox County Metropolitan Planning Commission and Knox County Parks and Recreation Department (Feb., 1998). *Knox County Park and Recreation Facility Plan.* available from MPC.

Mertes, James D. and James R. Hall (1995). *Park, Recreation, Open Space and Greenway Guidelines.* Ashburn, VA: National Recreation and Park Association.

Clinch River
Melton Hill Lake
Bull Run Creek
Solway Village
Pellissippi Center
Hardin Village
Robinson Park
Wexford
New Karns
Bynington
Harrell
Treeville Village
Berkshire
Powell
Copeland
New Powell
St. Mary's Village
Greene
Roberts Springs
Ball Camp
Grassy Creek
Hines Village
Haw Branch
Callahan Village
Plumb Creek
Knoxville
Farragut
Conner Creek
Hickory Creek
Sinking Creek
Ten Mile Creek
Grassy Creek
Moore Spring
Bowman Spring
Conner Spring
Robertis Spring
Eldridge Spring
Knoxville Municipal Golf Course
Dead Horse Lake Golf Course
Cedar Bluff Primary & Intermediate School Park
Farragut Middle & High School Park
Farragut Primary School Park
Campbell Station Park
U.S. Cellular Soccer Complex
Northwest Middle School Park & GW
Victor Ashe Park
Badgett Fields
Inskip Ballfields
Inskip Pool & Park
Adair Park
Sharps Ridge Memorial Park
Christenberry Ballfields
Lonsdale Park
Sam E. Hill Park
Larch Ave. Park
S & J Colquitt Memorial Park
Ridgedale Park
Bearden Middle School Ballfields
Walker Springs Park
Teri Mile Creek Greenway & Park
Karns Community Park
Karns Middle School Park
Powell Middle School Park
Powell Elementary School Park
Broadacres Rec. Club
Powell Levi Park
Sterchi Hills Park
Sterchi Soccer Complex
Nicholas Ball Park
Ball Camp Elementary School Park
Bearden High School Park
Karns High School Park
Meadow Chase Soccer Complex
Knoxville Soccer Club Fields
Solway Park
Glenn Road Park
Northwest Complex
Conservation Land
St. Mary's Health & Wellness Center
Bearden Elementary School Park
Pitts Spring
Johnson Spring
Powell Spring
Gill Spring
Bull Run Creek
W RACCOON VALLEY DR
E RACCOON VALLEY DR
W BULLRUN VALLEY DR
E BULLRUN VALLEY DR
W BRUSHY VALLEY DR
E BRUSHY VALLEY DR
E COPELAND DR
E EMORY RD
E BEAVER CREEK DR
W BEAVER CREEK DR
N BEAVER RIDGE RD
N CAMPBELL STATION RD
YARNELL RD
LOVELL RD
BOB GRAY RD
BALL CAMP PK
BALL RD
MEREDITH RD
CALLAHAN DR
DANTE RD
MERCHANT DR
PLEASANT RIDGE RD
N MIDDLEBROOK PK
KINGSTON PK
MCKAMEY RD
PINEY GROVE CHURCH RD
DUTCHTOWN RD
N CEDAR BLUFF RD
PELLISSIPPI PKWY
CANTON PKWY
MERIDIAN RD
HERSKELL RD
MILLER RD
TATE TROTTER RD
GREENWELL DR
CEDAR LN
MURRAY DR
WOBLE RD
MICHAUD RD
CHESNEY RD
JOE WHITOLD RD
HARVEST RD
FRANCIS RD
MIDDLEBROOK PK
WESTERNAVE
HERSHELL LANE
N CAMPBELL STATION RD
KINGSTON PK
I-75
I-40
I-140
I-640
I-275



PROPOSED PARKS AND SOFT TRANSIT NET

What you see…

This map shows our proposal for an integrated FAMILY OF PARKS and a SOFT TRANSIT NET that knits them together. The parks system serves each level of settlement center— town, village, and neighborhood— and provides a range of park use types. GREENWAYS use the LAND-STEWARDSHIP NETWORK when possible. Tree-Lined BOULEVARDS create main streets and slow traffic. COMMUNITY GATEWAYS mark the entry to identifiable towns and villages. SAFE STREETS are streetscaped pedestrian routes adjacent to streets where greenways are not possible. FOOTPATHS and EQUESTRIAN TRAILS connect settlements to more remote terrain.

How we did it…

After establishing the location of *Proposed Town, Village, and Neighborhood Centers*, and filling out the *Proposed Future Settlement Pattern* (see previous maps in this chapter), we compared this pattern to the map of *Existing Neighborhood Parks Catchments* to find neighborhoods poorly served by parks. This helped us locate new neighborhood centers. A small neighborhood green (park) should be at the heart of each neighborhood center. We consulted the analysis of *Land Value For Wildlife Habitat*, along with the *Knox County Parks and Recreation Plan*, to identify places for new NATURE PARKS. We then linked each of the parks with soft transit routes, using GREENWAYS whenever possible and appropriate.

- BC Watershed
- Knox County Boundary
- Wetlands
- Sinkholes
- Parks
- Proposed Park (1998 Plan)
- Stewardship Corridors
- Pedestrian Footpaths and Equestrian Trails
- Proposed Knoxville Parkway (SR 475)
- 40% + Slope Area
- Town, Village, and Neighborhood Centers
- Neighborhoods near Centers
- Community Gateways
- Tree Lined Boulevards
- Safe Streets
- Greenways

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System
(TN, FIPS Zone 4100): North American Datum 1983 (feet)

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See the map on page 58 for a locations of all of the of the proposed centers lited in the table.

PROPOSED PUBLIC SPACE IN SETTLEMENT CENTERS

Town Plazas for Town Centers

- Pellissippi Center
- New Karns
- Powell/New Powell
- Halls/South Halls

Village Squares for Village Centers

- Solway Village
- Hardin Village
- Robinson Park
- Ball Camp
- Treeville Village
- Grassy Creek
- Hines Village
- Haw Branch
- Black Oak Village
- Gibbs
- St. Mary's Village
- Callahan Village

Neighborhood Greens for Neighborhood Centers

- Wexford
- Harrell
- Roberts Springs
- Plumb Creek
- Bell's Bridge
- Berkshire
- Copeland
- Dry Gap
- Greene
- Murphy
- Cox Creek
- Graybell Spring
- Cline
- Bell
- Thompson Corners
- Wise Springs
- Ruritan

Parks and Public Space in Centers

Park system proposals are often developed as if in a vacuum, disconnected from the spatial design of city or town. We strongly believe that parks and public space belong at the heart of our communities and are central to community identity, society, and quality of life. Although the scale of our drawings (see maps on pages 58 & 59) does not allow us to show it, *each settlement center is conceived of as having a neighborhood green, a village square, or a town plaza within it.*

A list of the existing and proposed centers is at the top of this page. Although a few centers have parks nearby, a school park or a playing field cannot properly house the social and symbolic functions of settlement centers. These require greens, squares, and plazas. The following definitions are from the *Lexicon of New Urbanism*, version 3.1 (1).

- A GREEN is "a medium-sized public space available for unstructured recreation, circumscribed by building facades, its landscaping consisting of grassy areas and trees, naturalistically disposed and requiring only limited maintenance."
- A SQUARE is "a public space, seldom larger than a block, at the intersection of important streets. A square is circumscribed spatially by frontages; its landscape consists of paved walks, lawns, trees, and civic buildings, all formally disposed and requiring substantial maintenance."
- A PLAZA is "a public space at the intersection of important streets, set aside for civic purposes and commercial activities. A plaza is circumscribed by frontages; its landscape consists of durable pavement for parking and trees requiring little maintenance."

The idea is that the larger the settlement, the more formal the public space at its center, and further, that buildings and community activities appropriate to each scale are oriented to the public space. For example, a NEIGHBORHOOD GREEN might be surrounded by townhouses and a corner store. A VILLAGE SQUARE might be bounded by local institutions, such as a branch library or school, churches, townhouses, and shops. A TOWN PLAZA might be fronted by sidewalk cafes, rows of retail shops with apartments and offices above, and important civic buildings, such as a courthouse, town hall, a larger library, or post office.

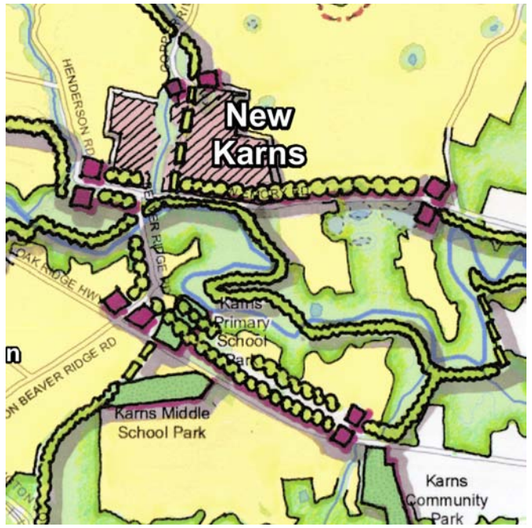
Acquiring Land for Parks and Public Space

This proposal recommends a considerable increase in open space and "close-to-home parks". If the community wants these amenities, a proactive partnership of public, private, and government participants needs to work together to identify and assemble funding sources and incentives to protect or acquire land for the open space network. Included in these initiatives, we recommend organizing educational materials and guidelines to help neighborhood associations identify and help acquire small parcels (1-2 vacant lots) suitable for pocket parks.

The Proposed Soft Transit Net

The organization of the soft transit system is based on a series of principles:

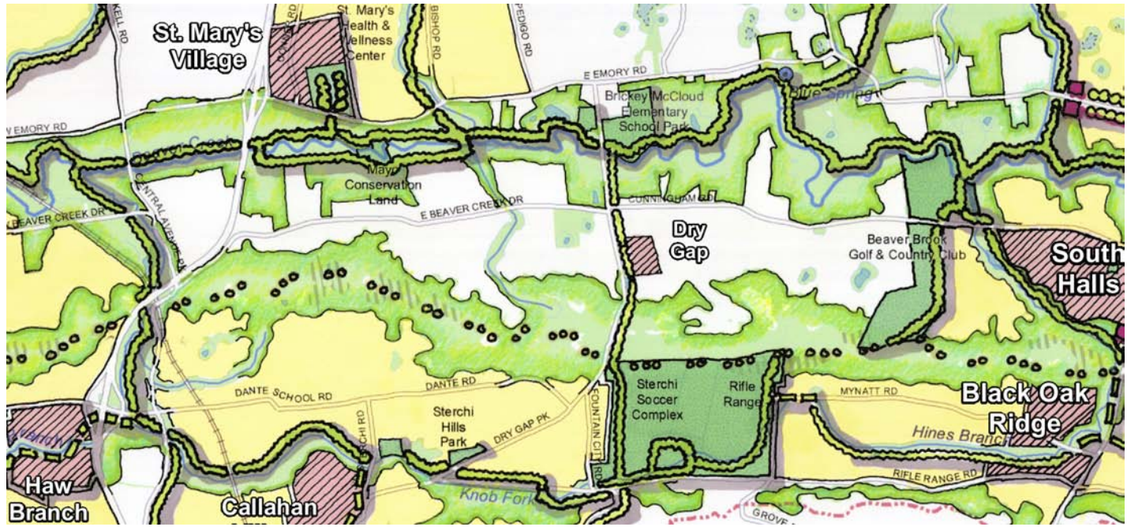
- The SOFT TRANSIT NET must connect all of the parks in the FAMILY OF PARKS and link all of the public spaces within town, village, and neighborhood CENTERS.
- Where possible, the system is designed for short and long walking loops and for longer biking and hiking loops. Loops interconnect to increase variety and flexibility of routes.
- GREENWAYS use the LAND STEWARDSHIP NETWORK when possible. Typically, they follow creeks, but occasionally are within RIDGE CORRIDORS or HERITAGE CORRIDORS.
- Tree-lined BOULEVARDS create main streets, slow traffic, and link existing subdivision outlets together. These occur in the major towns and villages along Emory Road and in Pellissippi Center. Highways are for connecting towns. When a highway enters a town, it should become a slower, pedestrian-friendly BOULEVARD.
- COMMUNITY GATEWAYS mark the entry to identifiable towns and villages. They are located at the ends of boulevards.
- SAFE STREETS are streetscaped pedestrian routes adjacent to streets in places where greenways are not possible. When a greenway enters a center, and is not within a water feature buffer, it converts to a SAFE STREET. Safe Street paths can be designed to accommodate different levels of use and multiple non-motorized travel modes.



Detail of soft transit elements around New Karns center

MORE INFO

(1) Duany Plater-Zyberk & Co.. (March, 2002). *The Lexicon of New Urbanism, version 3.1.*



Detail of Soft Transit Net, showing walking, biking, and hiking loops of trails and greenways

Detail of proposed Beaver Creek Park and connections

- FOOTPATHS and EQUESTRIAN TRAILS connect settlements to more remote terrain. These follow the ridges and begin where more durable and well-travelled routes leave the neighborhoods.

Greenways

Again, we may refer to the *Knox County Park and Recreation Facility Plan* (1998), which planned a number of greenways that we have included in our proposal, such as the following:

- ***Beaver Creek Greenway,*** running the entire length of the creek, from its mouth to the end of Beaver Ridge, near Gibbs.
- ***Knob Fork Greenway,*** along the Knob Fork tributary, connecting the Beaver Creek Greenway to Sterchi Hills Park and
- ***Willow Fork Greenway,*** along the Willow Fork tributary, connecting the Beaver Creek Greenway to Willow Creek Park.

We also show on the drawing some greenways included in the *County Park Plan*, which are outside the watershed, such as:

- ***Conner Creek Greenway,*** in Hardin Valley.
- ***Bull Run Greenway,*** along the length of Bull Run Creek.

Our proposed greenway network for the watershed links to and extends greenways shown in the *Knox County Parks Plan* and Knoxville's planned greenway network. These include links to greenways on creeks with headwaters near the Beaver Creek Watershed divide including ***First Creek***, ***Second Creek***, ***Third Creek***, ***Ten Mile Creek***, and ***Turkey Creek*** (see map, p. 66). We assume that extensions of greenways beyond the County Parks Plan and Knoxville's initial visions to create a unified network are desirable, over time.

The *County Parks Plan* envisioned a greenway along Pellissippi Parkway, connecting the Clinch River to the Turkey Creek Greenway and Ten Mile Creek Greenway. Our proposal is slightly different. We follow a similar route on Turkey Creek, but Pellissippi is an undesirable greenway corridor from an experiential and health point of view. Instead, we cross Black Oak Ridge via a ***Plumb Creek Greenway*** which branches off of a ***Hines Valley Greenway*** running the length of the valley along several tributaries to Beaver Creek (see map, p. 66). This valley greenway connects several neighborhood and village centers.

CONCLUSIONS

We propose a vision for the future development of the Beaver Creek Watershed, based on an integrated pattern of settled areas and stewardship land, fitted to its existing social and ecological context, and knitted together with a soft transit net.

This proposal is based on replicable patterns that relate to each other in complex but flexible ways, and it is driven by network thinking. It is a vision that illustrates a way of building, not a proposal for what to build. What is actually built *can be far better than our vision*, because the *actual participants* know the watershed and can incrementally adjust and change their actions over time to fit each new development into the community and the land.

Nevertheless, a larger vision is needed to guide the hundreds of thousands of decisions any new development pattern of this scale requires. All participants, and especially residents and developers, need a clear understanding of the larger pattern that his or her actions are helping to build. That is why we have tried to be clear about the ideas and patterns involved in this vision and reveal, as much as is possible in a report like this, the nature of the methods used.

In summary, the land tells us much about how and where to build, from its ecological and physical structure as well as from the social patterns of how humans have already occupied it. By listening carefully to what the land tells us, we can identify where it is best to locate more households, like in a town, and where it is best to steward the land to preserve its vital ecological services and its special historic character.

To be clear, this is a ***Vision Plan****, not a proposal about specific boundaries for new zoning, exact locations of proposed parks, or specific alignments for greenways.*

Thinking in this way, we ask as we work through the hundreds of options along the way:

- ***How shall we build in ways that suit the systems of the land and of the residents?***

But *fitness to context* is not the only determinant of the location and layout of human settlements. There are also two other perspectives (the careful reader may have noticed) that we have made use of in this process: the *individual's experience* of everyday life and the need for *places where an ordinary, everyday sense of community or of nature can occur.*

From the perspective of the individual we ask:

- ***How shall we build now so that our children and grandchildren are safe and healthy and share in the legacy of community our land holds?***

From the perspective of the community we ask:

- ***How shall we settle this land so that it reflects the values of watershed residents and communicates clearly to all what we care about most?***

We invite you to ask these three questions for yourself and see if you find some answers in these proposals.

Thousands of acres of grassland and productive farm land remain in the Beaver Creek Watershed.

Poorly planned housing fragments and paves hundreds of these irreplaceable acres each year.

FOR MORE INFORMATION

USDA Natural Resources Conservation Service
http://www.nrcs.usda.gov/programs/

Knox County USDA Service Center,
4730 New Harvest Lane, 865-523-3338
1) Natural Resources Conservation Service
2) Farm Service Agency

The Land Trust Alliance
http://www.lta.org

Knox Land and Water Conservancy
Kim Pilarski, kpilarski@ntown.net
(865) 632-1702

CONSERVATION EASEMENTS & PROGRAMS

G

INTRO

One of the major goals of this plan is to identify priority lands for conservation, including parcels where conservation easements are most appropriate. Both governmental and non-government organizations use conservation easements and other techniques to conserve valuable land. In Beaver Creek, the question was, *What land is most important to conserve and therefore is a priority for applying easements and other conservation strategies?*

CONSERVATION EASEMENTS

The results of this study can be used to prioritize acquisition of conservation easements (see "About Conservation Easements," in the box at right). Parcels in the LAND STEWARDSHIP NETWORK are all good candidates for easements and other forms of conservation protection (see "Summary of Conservation Options" at right). Land in the system of corridors in the network can be further prioritized.

Within the STREAM PROTECTION CORRIDORS, land in the WATER FEATURE BUFFERS is higher priority than land outside the buffers. Although all three zones of the buffers are very functionally important, land in the innermost Zone 1 is most important to water quality, while land in Zone 2 is next important. From the standpoint of flood control, conserving all of Zone 1 and 2 is critical, and Zone 3 is the next priority. Zone 1 has great potential for relatively easy regulatory protection by the county. Zone 2 has ample precedent for legal regulatory protection, although it is poorly protected under current policy. Ideally, conservation organizations should pursue regulatory controls to protect the WATER FEATURE BUFFERS, but failing local political courage, may have to pursue voluntary protection with easements and other tools. Ideally, local government would find ways to protect the demonstrated public health, safety, and welfare benefits by conserving land in the buffer, leaving non-governmental organizations to focus on land within the STREAM PROTECTION CORRIDORS but outside the buffers. Also, a second priority in the stream corridors is any land of high value for wildlife habitat.

Within the RIDGE PROTECTION CORRIDORS, land for conservation can be prioritized by slope class, and within slope class, by the presence of existing forests and the lack of existing development. Slopes over 40% are, on one hand, the most dangerous and potentially unstable, while on the other hand, they are the least likely to be developed and are probably the best protected slopes under the current MPC practices. Slopes between 25% and 40% are routinely approved for development by MPC at rates that exceed MPC's own guidelines, and, therefore, can be considered under significant threat to development and, consequently, under threat of degradation of their functions as conservation land. We recommend protection of these lands to be pursued as a priority over steeper slopes. Also, a second priority in the ridge corridors is any land of high value for wildlife habitat.

As with the water buffers, there are very poor existing regulatory controls over development in steep

ABOUT CONSERVATION EASEMENTS
source: The Land Trust Alliance

A conservation easement (or conservation restriction) is a legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land to protect its conservation values. It allows you to continue to own and use your land and to sell it or pass it on to heirs.

When you donate a conservation easement to a land trust, you give up some of the rights associated with the land. For example, you might give up the right to build additional structures, while retaining the right to grow crops. Future owners also will be bound by the easement's terms. The land trust is responsible for making sure the easement's terms are followed.

Conservation easements offer great flexibility. An easement on property containing rare wildlife habitat might prohibit any development, for example, while one on a farm might allow continued farming and the building of additional agricultural structures. An easement may apply to just a portion of the property and need not require public access.

A landowner sometimes sells a conservation easement, but usually easements are donated. If the donation benefits the public by permanently protecting important conservation resources and meets other federal tax code requirements—it can qualify as a **tax-deductible charitable donation.** The amount of the donation is the difference between the land's value with the easement and its value without the easement.

Property tax savings may result from placing an easement on your property.

Perhaps most important, a conservation easement can be essential for passing land on to the next generation. By removing the land's development potential, the easement lowers its market value, which in turn lowers estate tax. Whether the easement is donated during life or by will, it can make a critical difference in the heirs' ability to keep the land intact.

SUMMARY OF CONSERVATION OPTIONS

- Conservation easement
- Outright land donation
- Donation of undivided partial interests
- Donation of land by will
- Donation of remainder interest in land with reserved life estate
- Bargain sale of land
- Lease
- Mutual covenant

Source: "Conservation Options: A Landowner's Guide," Land Trust Alliance

Grassland in the Beaver Creek Watershed

GRASSLAND PRESERVATION

What you see...

This map identifies grasslands that may be eligible for the *Grassland Reserve Program*, a U.S. Dept. of Agriculture, Natural Resources Conservation Service (NRCS) voluntary conservation easement program. It pays landowners in permanent or term agreements to protect and restore grasslands, emphasizing grazing and habitat under threat of conversion to other uses. All remaining grassland in the Beaver Creek Watershed can be considered under threat of conversion by development.

How we did it...

The *Grasslands Reserve Program* requires at least 40 contiguous acres of grassland, except under special circumstances. From our *Land Value For Wildlife Habitat* analysis, we identified grassland patches of good or prime quality and >40 acres. Highlighted parcels shown are agricultural lands (from current KGIS land use data) that intersect these large grass patches. The size (acres) of grass within each parcel was calculated and is available for NRCS program applications.

- Spring (USGS)
- BC Watershed
- Knox County Boundary
- Grass Patches (40 Acres or larger)
- Agricultural Parcels >= 5 Acres
- Agricultural Parcels
- Grassland Eligible (40 Acres or larger)
- Conservation Corridors
- Proposed Knoxville Parkway (SR 475)

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System (TN, FIPS Zone 4100): North American Datum 1983 (feet)

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slope areas. MPC does have recommended density guidelines, but they are clearly ineffective. Better development rules would address both the *magnitude* of development (such as a density rule) and the *pattern* of that development, such as requiring CONSERVATION NEIGHBORHOODS to be clustered on lower elevations or flatter slopes on a site. Ideally, steep slopes would be better protected by legal and regulatory means, and we recommend that non-governmental organizations pursue this path, which has ample precedent in other jurisdictions. Yet, failing the long-term vision and political will to effect the needed changes in development policy, critical lands in need of slope protection should be conserved by conservation easements or other techniques.

There are several types of government-sponsored land conservation programs. In most, the federal government pays landowners in permanent or long-term agreements to protect and restore land valuable to society for its conservation or agricultural function. Two programs seemed to fit this study area: the Grassland Reserve Program and the Farm and Ranch Lands Protection program. Within the HERITAGE PROTECTION CORRIDORS, lands that are eligible for federal assistance under these programs are a priority for conservation easement attention. The next priority is land that can connect these valuable parcels to other lands in the stream and ridge corridors. Also, a second priority in the heritage areas is any land of high value for wildlife habitat.

Of course, of prime importance in considering where to focus conservation easement efforts is the building of a connected network pattern. Preserving fragments with conservation easements or other means, even if many important fragments are preerved, will be a failure in the end.

Each action must help build a larger pattern that creates a new whole.

Greenway Easements

A *greenway easement* can work within a conservation area and requires public access to the land. These can be written to meet a variety of different situations–paved or unpaved trail, donated or purchased, built and maintained by a government or another agency, stand-alone easement or piggybacked on a utility or conservation easement, from a few feet wide (Powell Greenway) to a green space swath of land around a trail (Halls Greenway).

GRASSLAND PRESERVATION

As a part of this task, we looked for parcels that might be eligible for government conservation programs.

The *Grassland Reserve Program* (GRP) is a voluntary program that helps landowners restore and protect grassland, including rangeland, pastureland, shrub land, and certain other lands, while maintaining the areas as grazing lands. The program emphasizes support for working grazing operations; enhancement of plant and animal biodiversity; and protection of grassland and land containing shrubs and forbs under threat of conversion to cropping, urban development, and other activities that threaten grassland resources.

GRP is authorized by the Food Security Act of 1985, as amended by the Farm Security and Rural Investment Act of 2002 (2002 Farm Bill). The USDA Natural Resources Conservation Service (NRCS) and USDA Farm Service Agency (FSA) administer the program, in cooperation with the USDA Forest Service. Funding for the GRP comes from the Commodity Credit Corporation (CCC).

Offers for enrollment must contain at least 40 contiguous acres (not necessarily in one parcel), unless special circumstances exist to accept a lesser amount. Eligible land includes privately owned and tribal lands, such as grasslands; land that contains forbs or shrubs (including improved rangeland and pastureland); or land that is located in an area that historically has been dominated by grassland, forbs, or shrubs and which has the potential to serve as wildlife habitat of significant ecological value.

Methodology

For the Grassland Preservation analysis, we established two criteria. First, we found areas of at least 40 contiguous acres of upland grassland, based on the *Habitat Land Value* analysis map. We used values from this map of 1 (prime habitat) and 2 (good habitat), along with all of the areas of *riparian grasslands*. Then, we identified the agricultural parcels within the watershed that contained or intersected these grassland patches. The *Grassland Preservation* analysis map displays agricultural parcels that contain any amount of grass within those parcels, plus all continuous grass patches over 40 acres.

VALUE OF CONSERVATION AMENITIES TO DEVELOPERS

- Increased profit and property value
- Increased sales or rental fees
- Positive effect on the developer's local reputation
- Gives a competitive edge and faster market absorption
- Increased community support for projects

VALUE OF CONSERVATION AMENITIES TO RESIDENTS

- Attractive views and neighborhood character that won't "go away"
- Increase prestige of neighborhood and town
- Preservation of big trees
- Privacy
- Convenient easy access to local parks, nature, and nearby recreational amenities
- Faster resale of homes, higher prices
- Increased sense of belonging to a special community

FARM PRESERVATION

The *Farm and Ranch Lands Protection Program* (FRPP) is a voluntary program that helps farmers and ranchers keep their land in agriculture. The program provides matching funds to state, tribal, or local governments and non-governmental organizations with existing farm and ranch land protection programs to purchase conservation easements. FRPP is reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill). The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) manages the program.

The program favors preserving prime farm land in the neighborhood of other farm land. *Only one farm in the county (and the first in Tennessee) has so far been protected under this program.*

This information provides Knox County and the local NRCS representatives with sufficient information to proceed with a strategy to prioritize applications under these programs. There is no cost to the County to participate in these programs.

The Cruze family, whose Knox County farm is the first in the state protected under the Farm and Ranchland Protection Program

FARMLAND PRESERVATION

What you see...

This map identifies lands potentially eligible for the *Farm and Ranch Lands Protection Program*, a U.S. Dept. of Agriculture, Natural Resources Conservation Service (NRCS). It is a voluntary conservation easement program that pays landowners a portion of their land value to keep their land permanently from being converted to non-agricultural use and to develop conservation programs for erodible soils. Remaining farmland in the Beaver Creek Watershed is under threat of conversion by development.

How we did it...

The *Farm and Ranch Lands Protection Program* requires farms with at least 50% prime soils, large enough for farming, and surrounded by parcels that can support farming. In GIS software, we calculated the percentage of each agricultural parcel's prime soil. Rankings of soil for agricultural uses come from NRCS soil maps. Highlighted parcels meet these criteria. Next, we searched for other agricultural parcels near the candidate parcels. The area of prime soils within each parcel was calculated for use in NRCS program applications.

- Springs
- Watershed Boundary
- Knox County Boundary
- Ag Parcels >= 50% Prime Soil, >= 40 Acres
- Ag Parcels >= 50% Prime Soil
- Ag Parcels Near Prime Parcels
- Conservation Corridors
- Proposed Knoxville Parkway (SR 475)

0 1 2 3 4 Miles

Projection Info: State Plane Coordinate System
(TN, FIPS Zone 4100): North American Datum 1983 (feet)

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To qualify for the Farm and Ranch Lands Protection Program, the land offered must be part or all of a farm or ranch and must:

- Contain prime, unique, or other productive soil or historical or archaeological resources.
- Be included in a pending offer from a state, tribal, or local government or non-governmental organization's farmland protection program.
- Be privately owned.
- Be covered by a conservation plan for any highly erodible land.
- Be large enough to sustain agricultural production;
- Be accessible to markets for what the land produces;
- Be surrounded by parcels of land that can support long-term agricultural production.
- Be owned by an individual or entity that does not exceed the Adjusted Gross Income (AGI) limitation.

Methodology

For the Farmland Preservation analysis, we established three goals. First, we found agricultural/unused parcels that have at least 50 % "prime" rated soil. Second, we identified agricultural/unused parcels that are near or adjacent to these "prime parcels." Last, we identified all agricultural parcels that are contained by or intersect the HERITAGE PROTECTION CORRIDORS. The *Famland Preservation* map displays clusters of agricultural land that are a good potential for preservation under this program.

CONCLUSIONS

This analysis shows many remnant areas of large grassland patches greater than 40 acres. Many of these are also located along the Beaver Creek stream system; whole others are parts of upland farms. The best candidates for conservation are areas of large grassland patches that are zoned for agriculture and where the pattern of grassland is the least fragmented. In some cases, a parcel may be partly in forest and partly in grassland. The map of *Habitat vs. Agricultural Land Value* should be consulted to help further identify the best parcels or groups of parcels for conservation.

This analysis shows that scores of parcels meet soil criteria of the Farm and Ranchlands Protection Program, while a dozen or more clusters of agricultural parcels remain intact.

Priorities outlined in this chapter can be used to develop a comprehensive, strategic approach to implementing ideas in this *Green Infrastructure Plan* by means of conservation easements and other conservation techniques.

I dream big but nothing is impossible.... If we could all be for what is right and good and honest....

Carol (garden club president)

The Beaver Creek Watershed is a life source of our community. A healthy watershed helps protect the public drinking-water supply and the plants and animals that rely on clean water. It also enhances our recreational opportunities. By continuing to protect the Beaver Creek Watershed, we can ensure that Powell is a great place to live and an even better place for our children and grandchildren to grow and thrive.

Allison (consultant)

We need to take care of the Beaver Creek Watershed and the land that surrounds it for the sake of our children and grandchildren. The overwhelming development ($100 M in next 18 months) makes the watershed vulnerable to over-development and environmental concerns that cannot even be calculated with computerized modeling technology available today....Low Impact Development (LID) is being considered by some responsible landowners/developers who have spent a lifetime in the area and want to do the right thing for the area. They all realize what Beaver Creek could become and want to work with the watershed to make that happen.

David (energy expert)

We need to take care of Beaver Creek and our land in the watershed because we have a responsibility to be good stewards of our natural resources. We are holding this land only for a time, and it passes to our children when we are gone. Good parents make things better for their children.

The best way to grow our communities and businesses is to make our area a desirable place in which to live. No parents want to live next to a smelly creek they have to keep their kids away from. Poor stewardship creates slums from which residents and businesses flee.

Shannon (newspaper writer)

CONCLUSIONS

H

NEW PERSPECTIVES, NEW SOLUTIONS

Broader perspectives can help community stakeholders find better solutions.

The current state of our suburban landscape, in its environmental quality and its associated quality of life, is a product of our collective current ways of thinking and the attitudes we hold. Today's suburban landscape reflects solutions focused on solving problems on a local scale. For example, a landowner might divert floodwater storage from his parcel by building up the ground level with fill dirt. However, elevating that site doesn't stop natural processes like flooding; it just shifts flood storage to someone else's property and degrades water quality downstream from the site. When current development practices like filling floodplain are followed, quality of life starts declining well before a community reaches an efficient level of land development. Changes to conservation and development patterns proposed in this study can contribute to the health and growth of both the larger landscape and the local community. Suggested changes reflect a new way of thinking about the relationship between nature and development. How the community sees the land, nature, property rights, and social welfare determines how it understands the problems and what solutions it considers viable or desirable.

We have identified some of the many relatively new attitudes and ways of thinking that are embodied in this plan. These are summarized in the table at right.

NARROW PERSPECTIVE	BROADER PERSPECTIVE
ATTITUDES ABOUT NATURE	
• Nature exists outside of the places we live. • Nature is a special place where we retreat from everyday life on weekends and vacations. • Conservation and development are competing and must be balanced. • Conservation land is off-limits to humans.	• Nature permeates towns, neighborhoods, and yards. • People need the benefit of access to nature as part of their everyday lives. • Conservation and development are a single, interlinked pattern that must be designed together. • Conservation land is used in an intensity gradient.
ATTITUDES ABOUT LAND USE	
• Good decisions solve a problem at hand. • What I do on my land is my decision. • Competing interests win or lose. • All the important decisions are made by the government. • *Regulation:* I can do anything that's not illegal. • Conservation limits development potential.	• Good decisions solve the problem at hand, while also resolving many purposes. • My decisions about my land have effects on the community beyond the boundaries of my land. • Competing interests seek cooperative solutions. • Important decisions are made everyday by each person who lives, works, or owns land in the watershed. • *Stewardship:* I have the opportunity to choose to do things that exceed the legal minimum. • Conservation increases adjacent development potential and land value.
ATTITUDES ABOUT TOWN PLANNING	
• Infrastructure is designed to be optimized for one function or purpose. • Infrastructure follows development. • Suburbs depend on downtown areas. • The driver is king: The automobile is the primary driver of a development pattern.	• Infrastructure is designed to meet multiple objectives: function, recreation, transit, beauty, etc. • Development and infrastructure are planned together. • Suburbs use downtown resources but need their own local town and village centers. • Little pink bikes matter: Soft transit for children and non-drivers is just as important as mechanized transit.

Beaver Creek provides the backbone of the communities that dot its borders. From Gibbs to Solway, the creek provided life for the budding settlements that came to it for water and to hunt the game that once also sought its life. Today, the creek continues to support life in the communities around it. If cared for, it could again provide a water source, recreation, and a place to find solitude. Without our care, Beaver Creek could become a major source of pollution....We need Beaver Creek for the growth of our area. Our children need the legacy of a clean Beaver Creek to enhance their future.

Margaret (community activist)

Decisions that benefit ourselves and the larger community of which we are a part come from expanding the circle of what we consider relevant to decision making to include our neighbors, our neighborhoods, our towns, and how we all connect to each other and to nature.

For where your treasure is, there will be your heart also.

Luke 12:34

FOR MORE INFORMATION

(1) Knox County Engineering and Public Works, Knox County Parks and Recreation, and Knox Land and Water Conservancy (2002). *The Beaver Creek Watershed Assessment*.

Attitudes About Nature

Nature is everywhere in urban environments. If we ignore its presence in planning for development, we pay the cost as a society for this ignorance in the form of landslides, floods, polluted water, foundation failures, the urban heat effect, and the loss of wildlife. Acknowledging its presence, we have the potential to realize the promise of the suburbs: nature close to urbanity. In these proposals, nature is not in the country or the wilderness, nor merely in parks. Rather, it permeates all forms of settlement to varying degrees. The seeming opposite is also true: human use permeates all of nature to varying degrees. This leads us to the necessity of conceiving of one landscape with patterns of settlement and conservation that are always considered together. *If decisionmakers and stakeholders regard nature and development as complementary and utilize their collective expertise in service of innovative, collaborative solutions, land and community quality can improve*.

Attitudes About Land Use

To develop a better community, individual landowners need to think beyond than their own parcels. This involves a shift from placing paramount value on individual land rights to recognizing that individual actions on a parcel have consequences for the whole watershed and its communities, especially when many landowners optimize their own individual gain. No individual landowner should be entitled to develop or add value to land, if that added value creates significant costs to others or decreases the value of another's property within the larger community of landowners. Current planning ordinances usually recognize some rights of adjacent property owners, but certain effects of poor development— like flooding, pollution, increased traffic, and so on— occur at some distance from the altered site. Better education of landowners concerning these broader effects can increase community support for ordinances and practices that manage the "big picture".

Considering that the broader effects of each project undertaken in the watershed shifts development thinking from parcel-centric to community-centric, from "mine" to a more-inclusive "we" that embraces individual and community rights and quality of life. Decisions that benefit ourselves and the larger community of which we are a part come from expanding the circle of what we consider relevant to decision-making to include our neighbors, our neighborhoods, our towns, and how we all connect to each other and to nature.

Attitudes About Town Planning

The patterns of our city and county are a reflection of what we collectively value. If we are going to shift to more-healthy development patterns that serve people and nature for the long term and reverse the dangerous and unhealthy trends of the present, then our values about how and what is planned also have to shift. There are tough choices ahead, choices that must be made. *One choice is between two ways of living on the land: 1) more of the same sprawl designed for a world where land is cheap and plentiful and we move to a suburb further from our job when the sprawl becomes intolerable or 2) an integral landscape of town, village, and neighborhood centers within a framework of green infrastructure where we live minutes from work and walk on the greenway after dinner*.

This entails shifting our attitudes about building at the edge of the city. It means a city without suburbs, because every neighborhood has the green of the suburbs as well as all of the rich community institutions and relationships that town life entails. It means cars become one of several options for routine trips. With the latter scenario, streets become public places again, and we can invest in the mobility of all our citizens. Little pink bikes matter. So do strollers and running shoes, trolleys, and buses and being able to live independently when you can't drive. *Full mobility* has two implications: First, getting the most out of our public infrastructure dollars by making infrastructure corridors multifunctional, and second, organizing the patterns of development to make using a range of transport modes possible.

REVIEW OF MAJOR FINDINGS FROM THE BEAVER CREEK WATERSHED ASSESSMENT (1)

Here we review some of the relevant findings and recommendations found in two important studies that preceded this plan, the *Beaver Creek Watershed Assessment* (1) and the *Beaver Creek Stormwater Master Plan* (2). Much of our work is based on addressing the land-use implications of findings from these studies. Items marked with asterisks (*) at the end are specifically addressed by proposals in this *Green Infrastructure Plan*.

Status of the Watershed

- The Water Resources Research Center (WRRC) at the University of Tennessee used land-use data from MPC to estimate the extent of impervious surfaces in the watershed at 18%.*
- Road projects in the watershed will likely result in increased development pressures.*
- Water quality in the watershed can be characterized as POOR. The entire length of Beaver Creek is on the 303(d) list maintained by the Tennessee Department of Environment and Conservation (TDEC). This list is a compilation of waters that violate water-quality standards.*
- The primary impacts to Beaver Creek include sediment, nutrients and pathogens from agricultural and urban runoff; nutrients and pathogens from municipal sewage treatment plants; and habitat alteration due to land development.*

Flood Mitigation

- Controlling development, particularly above Maynardville Highway, is perhaps the most effective flood-mitigation strategy for this watershed.*
- The recent Knox County Stormwater Ordinance expanding the no-build/fill zone in the Beaver Creek floodplain should be enforced and boundary lines made available.
- Work should continue to define floodplains on Beaver Creek tributaries.
- Low-impact development that limits impervious surfaces and manages open space should be encouraged and supported.*
- Use conservation easements to prevent development of sensitive parcels. Acquisition of such easements should be investigated for large undeveloped parcels and parcels bordering streams, especially above Maynardville Highway.*

Wetlands

- Work with the Army Corps of Engineers to identify non-agricultural wetlands and with NRCS to identify agricultural wetlands.
- Monitor development activity in known wetland areas. Develop individual action plans for the most severely affected or threatened areas.
- Investigate conservation easements for wetland protection.*

Stream banks

- The most severely affected stream-bank sites should be identified and an action plan should be developed for each one.
- Healthy and adequately sized riparian buffers with native plants are critical on Beaver Creek and its tributaries.*

Ridge tops

- Ridge tops and steep slopes should be protected not only for their beauty, but also because they are often unsuitable, if not unsafe, for development.*
- Ridge tops and slope-protection areas are excellent candidates for conservation easements.*
- Watershed partners should support the adoption of a Knox County Ridge-top Protection Ordinance.

Parks and Greenways

- The county should work to develop the Beaver Creek Greenway included in its *County Greenway Plan* and investigate other greenway and trail routes mentioned in the assessment report.*
- Aggressively pursue conservation easements for greenway routes, especially on commercial parcels adjacent to the creek.*
- Identify locations for future parks to address the shortage of parks in the watershed.*

REVIEW OF MAJOR RECOMMENDATIONS FROM THE BEAVER CREEK WATERSHED STORMWATER MASTER PLAN [2]

- Flooding in Beaver Creek is a natural condition. The floodplains are quickly filled once water rises out of the banks.
- Undeveloped natural floodplains are important for flood storage and water quality preservation.*
- Large-scale structural flood-mitigation measures on Beaver Creek are not cost-effective in reducing or eliminating existing flooding.
- Non-structural alternatives are the least costly and most effective way to reduce the future flood potential for the watershed. Development management in key areas can be effective in limiting the increase in future flooding.*
- Regulatory controls should be instituted on new development and re-development upstream of Maynardville Highway to control future peaks and volumes.*
- Regulations should be developed to limit flood fringe filling on Beaver Creek and its tributaries.
- Wetlands and other sensitive areas should be identified and protected, as they provide natural water quality buffers and flood storage.*

LESSONS LEARNED IN THIS STUDY

Current Conditions of Land and Settlement

Flooding and poor water quality are significant issues in the watershed. These problems have significant consequences for quality of life, health, and safety, and environmental quality. The costs to society to fix them in the future will be substantial, unless preventative actions are taken. Specific cleanup plans for water quality are currently required on a medium time horizon. Without improvement, EPA punitive actions are a possibility in the future.

The least-cost preventative actions that are needed all involve changes in development patterns and the practices, policies, design, planning, and regulation that create the way we settle in the land.

The watershed's flooding and water-quality problems are increasing. Future flooding is expected to be worse than current flooding if nothing is done. Suburban development practices and their associated areas of impervious cover are a major driver of these water problems. In addition, the pattern of development is deforesting the landscape, fragmenting wildlife habitat, destroying stream-bank vegetation, altering aquatic habitats, degrading the rural character and scenic beauty of the area, reducing air quality, increasing traffic congestion, and consuming open space. It is hard to argue that the quality of life for local residents under the current development scenario is anything but worsening.

The formerly distinct communities of Gibbs, Halls, Powell, Karns, and Solway are fading into the north Knoxville suburbs, like Fountain City did years ago. The new I-475 exits to the valley will accelerate this growth. The area's scenic beauty and rural landscape heritage is disappearing as farms convert to subdivisions. New residences are dispersed at low density, which is an expensive way to build. Commercial areas are located along highways. Everyone must drive or be driven, and no one can walk or bike. Due to this pattern of development, traffic is worse every year.

Our analysis yields a few important patterns about what exists in the watershed now:

- *Significant areas of unprotected steep slopes and ridge tops occur in the watershed*, particularly along Beaver Ridge and Black Oak Ridge. Steep slopes are also found on Copper Ridge, portions of which are within Knox County, but most lie outside of the watershed boundary.
- *Continuous forest corridors remain on the ridges*, but development on the valley floor has significantly reduced the streamside forest.
- *Existing settlement and road locations are heavily influenced by topography.*
- *Much of the Beaver Creek watershed is suburbanized already.*
- *There are no towns and no villages, only strip commercial areas. Farms are disappearing.*

Non-structural alternatives are the least costly and most effective way to reduce the future flood potential for the watershed. Development management in key areas can be effective in limiting the increase in future flooding.

FOR MORE INFORMATION

(2) Ogden Environmental and Energy Services, Inc. (2000). *Beaver Creek Watershed Storm Water Master Plan.* Prepared for Knox County Engineering and Public Works Department.

NEW SPATIAL PATTERNS FOR THE BEAVER CREEK WATERSHED

HERITAGE PROTECTION CORRIDORS

This pattern is relatively large blocks of land held in agricultural and rural uses and character. These rural reserves can become COMMUNITY SEPARATORS, which give each community a distinct place in which to belong, while preserving some of the last remaining productive and forested land. (See page 48.)

WATER FEATURE BUFFERS

The buffer system proposed in this study is designed to preserve water quality and to mitigate flooding. It has secondary potential for recreation, greenways, and wildlife habitat. Based on EPA recommendations, we have designed a buffer in three zones, where management practices vary from protection (closest to feature) to conservation (in the middle) to stewardship (furthest from the feature). Each zone has a minimum required width determined by guideline recommendations for that feature type. (See page 39.)

Our buffer approach is based on three principles:

- A continuous linear buffer that protects the stream network, which includes Beaver Creek and its tributaries.
- Protect streams and adjacent features together, by expanding the linear buffer to include associated wetlands, springs, and sinkholes.
- Protect chains of related features, such as sinkholes or wetlands that occur distant from a stream by uniting individual feature buffers into linear buffers wherever possible.

GROUNDWATER PROTECTION CORRIDORS

This pattern links together strings of nearby springs and sinkholes in particularly sensitive areas where karst geology makes the groundwater system especially vulnerable. In our mapping, these corridors are displayed with the stream protection corridors. (See page 48.)

STREAM PROTECTION CORRIDORS

This pattern incorporates stream buffers and expands them to include valuable adjacent open-space lands that contribute to network continuity. (See page 48.)

RIDGE PROTECTION CORRIDORS

This pattern protects steep slopes and the forests on them. In the case of Beaver Valley, because of the nature of the terrain and the degree of previous settlement, these corridors are almost synonymous with STEEP SLOPE ZONES as defined by MPC. In other watersheds, the corridors might be expanded to include more protective buffer lands. (See page 48.)

LAND STEWARDSHIP NETWORK

This pattern is the composite, interconnected network pattern that knits together RIDGE PROTECTION CORRIDORS, STREAM PROTECTION CORRIDORS, and HERITAGE PROTECTION CORRIDORS to define a watershed-wide system of green infrastructure. (See page 48.)

SPECTRUM OF CONSERVATION LAND

This pattern allows for and defines a range of levels of conservation and types of human activities, from the extremely low-human-use streamside protection zone, the innermost zone of the three-zone water features buffer, to clustered housing in conservation neighborhoods. (See page 56.)

A CONSTELLATION OF CENTERS

We believe that the future of this landscape lies in patterns of an interconnected net of centers of different types at three scales.

We have proposed three kinds of patterns: TOWN CENTERS, VILLAGE CENTERS, and NEIGHBORHOOD CENTERS. Centers give a sense of identity and orientation, provide the density necessary to support walkable shopping and other services, and correlate with open space that helps define community edges. (See page 56.)

These three kinds of centers are configured in the constellation pattern in three ways:

- Location is based on transportation.
- Size and spacing are based on travel time.
- Variations occur in the mix of uses.

A TAPESTRY OF NEIGHBORHOOD TYPES

Within available land, different kinds of neighborhoods, varied by density and organization, are distributed by coordinating an ideal town model with contextual suitability. (See page 56.)

We have designed these proposals based on locating different neighborhood types according to two main sub-patterns:

- The model SMALL TOWN, with its DENSITY GRADIENT (dense in the center to dispersed at the edge), which supports local commercial activity, sense of community, and a range of lifestyle choices.
- SUITABLE USE LOCATIONS, which is the principle that different activities should be located in the places best suited to them.

CONSERVATION NEIGHBORHOODS

This pattern clusters housing at moderate density while preserving open space, habitat, and land important to public health and safety, such as floodplains and stream buffers. This type of development is especially important in the area above Maynardville Highway, where increases in impervious surfaces can severely affect downstream flooding by increasing upstream runoff. (See page 62.)

FAMILY OF PARKS

This is the idea that parks should never be too far away and that the size of parks should therefore vary with the distance from residents' homes. We have used this principle to propose new parks of various sizes. On the related principle that parks should be tied to neighborhood and town structure, we have conceived of each proposed settlement center as having a neighborhood green, a village square, or a town plaza within it. (See page 65.)

SOFT TRANSIT NET

This pattern organizes the system of trails, walks, and greenways for non-motorized transportation that knits together the parks and civic place of the community. GREENWAYS use the LAND STEWARDSHIP NETWORK when possible. Tree-Lined BOULEVARDS create main streets and slow traffic. COMMUNITY GATEWAYS mark the entry to identifiable towns and villages. SAFE STREETS are streetscaped pedestrian routes adjacent to streets where greenways are not possible. FOOTPATHS and EQUESTRIAN TRAILS connect settlements to more remote terrain. (See page 65.)

CONSERVATION EASEMENTS

These are legal instruments designed to protect from inappropriate development environmentally valuable portions of a property. They are voluntary and may involve tax incentives, tax deductions, or payments to the owner from government or private sources. The NRCS (Natural Resources Conservation Service) and the Tennessee State Department of Agriculture administer programs to preserve farmland, forests, and grassland habitat through conservation-easement programs. Areas eligible for these programs are identified in this study. (See page 71.)

Open Space

Islands of suburban enclaves are forming in the Beaver Creek Watershed faster than community planning proceeds, so home-buyers end up with a new house but without the small neighborhood parks, sidewalks and walking trails that people want and use most. Without planning, forest and wetlands disappear, and pressure to develop "just a little more" of the ridges and slopes increases because the land is more expensive. There is little in the current development controls to encourage parks and greenways or to limit clear-cutting forests and ridge-top development.

Our analysis yields a few important patterns about open space in the watershed now:

- *There is no pedestrian network.* Existing sections of green-way and sidewalks, while well-located for a future network, don't yet add up to a usable network.
- *Parks and greenways are unevenly distributed.* Access to passive recreation and walking trails is not evenly distributed. Many areas of the valley lack easy access to quiet or passive recreation.
- *Many new neighborhood parks are needed.* The community has significant needs for close-to-home parks to serve neighborhoods.
- *The habitat network is increasingly being fragmented.* There are few ridge-to-creek links, isolating wildlife from water sources.
- *Reptile and amphibian biodiversity are dramatically diminished by suburbanization*, relative to our more protected comparison area of the Oak Ridge Reservation.
- *Special habitats are disappearing.* Wetlands are relatively rare; grassland habitat has been converted to meadows; riparian forests are almost extinct.
- *Slopes and ridges are at risk of degradation by development.*

The Water Network

The type of rapid building currently dominating development patterns in the valley is having incremental, but cumulative, effects on the water system by:

- *Decreasing* the land surface's ability to absorb water.
- *Increasing* the amount of stormwater running into a stream during a storm.
- *Increasing* the sediment, pathogen, and nutrient load that stormwater carries into the stream.
- *Raising* the elevation of flood waters, thus increasing the horizontal area that flood waters cover.
- *Reducing* the ability of floodplains on the creek and its tributaries to store floodwater.

The overall impacts of changes in the watershed caused by current development practices can be boiled down to two themes:

1) Stream water quality is poor now, and development threatens to make it even worse.

2) Flooding is worse now than it used to be and continues to get worse.

In response to these worsening problems, we have proposed WATER FEATURE BUFFERS, which include STREAM PROTECTION BUFFERS and GROUNDWATER PROTECTION BUFFERS. Both use a *three-zone buffer system.* In this buffer, natural characteristics of the land are maintained or restored for purposes of protecting water quality, maximizing stormwater storage, and promoting infiltration. The buffers in this study are derived from *model ordinances* and *best practices*, using regionally specific guidelines whenever possible.

Composite Patterns: Green Infrastructure

Our analysis of open space and existing development patterns indicated that undeveloped open space is being fragmented. Ecosystems, including the urban ecosystem, are able to function in a healthy way only when their network structure remains intact. This healthy functioning includes many ecological services to society, plus the opportunity for people to move through and use the network.

A Green Infrastructure Network includes ***three basic elements*** combined in an interconnected way to create the ***pattern*** of a network: green places, connecting green links, and dispersed landscaping.

In the Beaver Creek Watershed study, we've developed new patterns relevant for the ridge-and-valley landscape.

In particular, we identified and proposed four types of STEWARDSHIP CORRIDORS that link together to create a composite LAND STEWARDSHIP NETWORK pattern: STREAM PROTECTION CORRIDORS, GROUNDWATER PROTECTION CORRIDORS, RIDGE PROTECTION CORRIDORS, and HERITAGE PROTECTION CORRIDORS, which include and connect RURAL RESERVES and tie these to the other corridors.

The network patterns proposed here form a strong for reshaping the settled landscape of Beaver Creek Watershed into a healthier, safer, and better place to live.

Future Development Patterns

We propose a vision for the future development of the Beaver Creek Watershed, based on an integrated pattern of settled areas and stewardship land, suited to its existing social and ecological context, and knitted together with a soft transit net.

The Beaver Creek Watershed is at a transitional point. A significant proportion of land that is ideal for development has already been developed, and sprawl is proceeding rapidly. Environmental problems are worsening and quality of life is degrading as pollution increases and forests and farms disappear.

We believe that it is not only possible to arrest these trends, but also to alter course and help the watershed mature gracefully and achieve a higher vision of a good and thriving community settling appropriately on the land.

To achieve a community vision of economic abundance, a rich quality of life, environmental vitality, a participatory civic community, and close relationships to the local place, we have employed a context-sensitive approach that designs and organizes future development proposals around three big ideas. Context-sensitive design shapes the form of settlement with an understanding of ecological and social landscape context.

The three major organizing ideas in our proposals are a FRAMEWORK OF OPEN SPACE, a CONSTELLATION OF CENTERS, and a TAPESTRY OF NEIGHBORHOOD TYPES. Key to each of these is rigorous analysis of the most suitable locations for different types of development and conservation. Yet, location is not the only factor; locational criteria have to be balanced with intentions and visions about how a community wants to live and grow. These visions are presented as replicable patterns with inherent characteristics. These patterns are, nevertheless, quite flexible in their specifics.

To the patterns of towns, villages, and neighborhoods; land stewardship corridors; and conservation areas, we have also added a vision for an interconnected network of soft transit (greenways and pedestrian infrastructure) and parks. While all of this may seem like an ambitious development vision (and it does put forth a challenge to all of us), it is nothing larger than the visions our ancestors had when settling this land the vision behind building interstates

We believe that it is not only possible to arrest these trends, but also to alter course and help the watershed mature gracefully and achieve a higher vision of a good and thriving society settling and appropriately

While all of this may seem like an ambitious development vision (and it does put forth a challenge to all of us), it is nothing larger than the visions our ancestors had when settling this land.

Essentially, the current development system rewards minimum performance and discourages community values. The county needs a new system that rewards community values and discourage low performance.

through and around our city, or the visions of progress held collectively by citizens as Knoxville grew into an industrial center in an earlier era.

In the next few decades, substantial development will occur in this watershed anyway. ***The question, for all of us, is what shall our collective vision be?***

THE NATURE & USE OF THIS PLAN

The plan is intended as a *visioning exercise* to create a reference document that can be used by a variety of individuals and institutions to guide decision making about preservation, conservation, and development patterns.

Limits and Precision

A range of data sources was used to produce this plan. Each original data layer had its own scale and precision. The general patterns are quite accurate and can be readily used to make decisions at the planning scale of the maps produced (1:36,000). However, decisions at the parcel scale should be made with reasonable judgement. For instance, when viewed at a scale required to examine an individual parcel, stream lines and the water buffers generated from them should be field-verified. Stream lines in this study come from the USGS 1:100,000 scale mapping. This is a much more coarse scale than the detail used by KGIS in mapping parcel lines. So the stream lines will not always match the parcel line that sometimes is intended to be defined by the stream itself.

Similarly, soil and land cover data used for some of the analyses originate at a raster cell size of 30 m (about 100 ft) or 100 m (about 300 ft), so when viewed up close at the parcel scale, a distinct jagged edge of squares can be seen. These boundaries should not be taken as precise lines, but rather, they should be interpreted as defining generalized zones on a property.

NEXT STEPS

Continued Study and Implementation in the Beaver Creek Watershed

The following are our recommendations for how this plan can be carried forward in Beaver Creek.

Design Subwatershed Plans. This watershed scale plan can be used as the basis for developing more detailed sub-watershed plans. Planning studies of narrower scope and greater detail will help create specific visions for each neighborhood, town, and village. Many concepts have been proposed here, but specific locations and layouts have not.

Identify Impact Parcels. Some land uses may degrade the designated WATER FEATURE BUFFERS. (See the *Stream Corridor Preliminary Parcel Assessment* map at the end of Section E). These parcels need to be identified and specific remediation strategies developed to protect water quality.

Design Detailed Greenway Plans. The *Parks and Soft Transit Plan* shows a conceptual layout for new parks and greenways. Specific parks site parcels and alignments for greenways, trails, boulevards, and safe streets must be identified with participation by local communities. Doing so will allow focused acquisition of conservation easements (or use of other available acquisition instruments) by public and non-profit agencies.

Develop a Watershed Plan. The *Green Infrastructure Plan* will be used by the Beaver Creek Task Force in its TDEC-funded "Watershed Planning Process." The watershed plan will be included in a computer water-quality model performed by the BC Task Force as part of a sediment and nutrient reduction Best Management Practice (BMP) plan.

Coordinate Planning and Development and Update Permitting Reviews. More often than not, the infrastructure required to support development, including parks, roads, sewers, and so forth, is planned as a response to proposed or already-built development. Public services respond to patterns mostly unregulated and unplanned and carried out by private developers in inherently fragmented ways. This creates costly and inefficient public infrastructure and services. It also prevents an integrated pattern, like what this plan proposes, from being built. A neighborhood green cannot be inserted into a subdivision after the subdivision is built.

Therefore, watershed and community stakeholders need to become pro-active in seeking long-range visioning assistance from public planning agencies (with private consulting assistance where required) to identify through physical planning (rather than policy planning alone) the type, location, and form of development that communities desire. Although the ideas we proposed in this plan can be grown incrementally, the broad patterns of the soft transit network, public transit, and constellation of centers have to be identified in advance of development.

Coordinate with the Site Planning Roundtable. The Knox County Site Planning Roundtable is developing new consensus standards for site planning to protect water quality. Many of the recommendations in this plan can inform planning at the site scale to protect water quality, particularly the slope protection and water feature protection corridor designations and the three-zone water buffer proposals.

Create Multi-Tier Development Guidelines. While many of this report's recommendations can be used to update regulations and practices that guide Knox County development, not all of them should or can be made into legal requirements. Nevertheless, the existing system does not reward superior design quality or environmental performance. A clear multi-tiered development control-and-guidance system could maintain legal minimum standards (albeit improved ones), offer incentives to landowners and developers to achieve higher standards of quality and performance, and contribute to building settlement patterns of value to the community. Essentially, the current system rewards minimum performance and discourages community values. The county needs a new system that rewards community values and rewards higher quality standards and performance.

Modify MPC Sector Planning. The authors believe it is time for MPC to consider revision of sector boundaries. Growth has made significant changes in the settlement structure that defined original MPC sector boundaries. Planning methods like those used in this study require boundaries that are a product of human building and natural features. Nevertheless, whatever subareas are used for county planning, the recommendations from this study, which, for the issues studied, are much more detailed than those found in the three overlapping sector plans, should be referenced and included where possible in conducting the next updates to those MPC sub-plans.

Adopt Form-based Zoning. Current policy-based zoning codes and other development guidelines are insufficient for achieving the vision, quality of place, and environmental performance of proposals set forth in this plan. The County should consider form-based zoning codes that define the physical parameters and characteristics of the neighborhoods, towns, and communities that the community wants to see built. In a community as desirable as Knox County, growth will happen. Let it be the kind we all can support.

Form-based zoning utilizes a graphics-based code that is coordinated with a REGULATING PLAN that identifies the disposition, location, and boundaries of elements described in the code, including the different neighborhood and district types, open space, public space, and transportation. The regulating "plan" is not necessarily just one plan, but is rather a base plan that gives the layout of a *settlement structure framework*, together with any modifying overlays, which can apply to specific conditions, such as water systems, transit networks, green infrastructure, streets and public space, and so on.

This report's map of *Proposed Future Settlement Patterns*, which identifies a spectrum of neighborhood types ranging from conservation neighborhoods to town centers, could serve as a starting point for developing a REGULATING PLAN for the Beaver Creek watershed.

The second major part of form-based zoning are definitions, both graphic and written, of the DESIGN PATTERNS. The DESIGN PATTERNS define elements of the plan. These patterns could consist of two parts: *geometric organization* and *standards*, which define characteristics of the pattern. Design patterns should be defined in at least two tiers: *fixed codes* (legal minimums) and *flexible standards*, which may be either performance-based or prescriptive rules, depending on the situation (see further discussion of *Multi-tiered Development Guidelines* on p. 82).

Use G.I. in MPC Approvals. The recommendations and design patterns in this plan can and should be used by MPC staff, the MPC Commissioners, and the County Commission in review of zoning cases, particularly in cases of determining the appropriateness of rezoning and in the establishment of requirements for approval of use-on-review plans. Development proposals that contribute in significant ways to building this collective vision of shared community-valued settlement patterns should be given high priority relative to those that do not.

Use G.I. Stormwater Permitting. The recommendations and design patterns in this plan can and should be used by the County Stormwater Division in site-review processes, stormwater permitting, and developing recommended practices, such as in the *County Stormwater Manual*.

Prioritize and Strategize Conservation Easements. The recommendations and design patterns in this plan can and should be used by Knox Land and Water Conservancy and other nongovernmental organizations in prioritizing conservation easements. A plan for acquisition specific, prioritized conservation easements should be developed immediately, in consultation with related efforts by the county and NRCS. These plans should identify which easements and acquisitions needed to support the *Green Infrastructure Plan* are best pursued by Knox County or a "parks foundation" (such as those that acquire land for public parks), which by the federal or state government (such as farm, grassland, forest, and wetland easements), and which are best negotiated and held by NGOs.

Expansion of this Work to Other Watersheds

The *Beaver Creek Green Infrastructure Plan* is the first of its kind in the state. The concepts used in and methods created for this plan are appropriate for most other watersheds in the region of East Tennessee and similar watersheds in much of the Southern Appalachians and Cumberland Plateau. More extreme terrain or other landscapes that vary significantly from the terrain studied here may require revisions to the methods used. More urbanized areas require a modified method for analyzing the patterns of existing settlement structure.

Expansion to the Rest of Knox County. The authors believe that the methods used in the Beaver Creek Watershed (which comprises about 18% of the county's land area) can be readily transferred to the remainder of Knox County and the City of Knoxville. It is both politically and ecologically expedient to adopt similar standards and development expectations for landowners across the county.

Development of Automated Methods. Cost and time required for defining stewardship corridors in future plans, such as the definition of the three-zone WATER FEATURE BUFFER lines, would be greatly reduced if more automated models for GIS analysis are written (computer programmed). A GIS model takes an established methodology, ordinarily carried out by a long sequence of computing procedures by an expert GIS analyst, and programs the computer to perform many of these repetitive and time-consuming tasks, allowing them to be carried out by a somewhat less-skilled user in less time.

Missing Background Data Required for Other Watershed Green Infrastructure Plans

There are a few actions beyond the scope of this study that should be considered in further studies or actions by the county, including:

Update the KGIS database to include verified mapping of sinkholes, more detailed and current mapping of wetlands, and location of springs and spring catchments. These data are *required* for expansion of the water feature buffer concepts to other watersheds.

Digitize a more detailed stream layer to better document first- and second-order streams. Our analysis is based on streams from the USGS 1:100,000-scale digital topographic maps. Local land-use decisions at the parcel level need to be based on more detailed data. *This is a priority*.

Digitally map FEMA floodway and floodplain lines. County and City government must do whatever is necessary to expedite the final production and release of these data. These data are *required* for expansion of the water feature buffer concepts to other watersheds.

Digitally map utility lines, including major power lines and pipelines. This does not currently exist in the KGIS database. We used these data in evaluating land for wildlife habitat value and in establishing eligibility for various government conservation programs, because these infrastructure lines create breaks and boundaries in the habitat pattern.

Delineate subwatersheds. This study benefited from prior work by TVA and the Center for Watershed Protection in delineating the boundaries of subwatersheds. This should be done for any future watersheds to be planned. It could be started now.

Conduct engineering flood studies similar to those conducted as part of the *Beaver Creek Stormwater Master Plan*. This type of study idnetified flooding implications of future development and defined in a careful way current and future flood zones. It included data— such as small *basin* delineation, *curve number* for each basin (based on soil type and land cover), and identification of critical areas for minimizing impervious surfaces— that became a significant part of our analyses. Knowing which areas, if developed improperly, will have significant impacts on down-

The County should adopt new, form-based zoning codes that define the physical parameters and characteristics of the neighborhoods, towns, and communities that the community wants to see built. Growth will happen. Let it be the kind we all can support.

stream flooding is critical to intelligent planning. This background analysis was particularly important in establishing criteria for identifying land for the HERITAGE PROTECTION CORRIDORS and for locating CONSERVATION NEIGHBORHOODS.

Suggested Refinements of the Method

Available time, funding, or expertise limited this study in a few ways. Were the study to be conducted again in Beaver Creek or in other locations, the authors suggest the process be modified to include:

- *Mapping of spring catchments based on field monitoring.* This could be done by faculty and students in the Department of Environmental Engineering at the University of Tennessee at a quite reasonable cost.
- *Identification of undocumented sinkholes and springs* in the watershed, based on local knowledge.
- *Mapping of sinkhole catchments based on topography.*
- *A refined method for assessing land value for wildlife habitat,* based on greater input and review by local wildlife experts.

FINAL THOUGHTS

Most reports end with a compelling argument by the authors that the ideas and future visions presented should be put into action quickly. And for Beaver Creek, the window of opportunity for action is rapidly closing. Most of the factual arguments have been made, and we would like to end by expressing some of the reasons today's Beaver Creek residents are determined to take care of their creek, their homes, and their land. The table to the right contains selected quotes from watershed residents, in answer to the question, *Why do we need to take care of Beaver Creek and our land in the watershed?*

It was, after all, their ambitions, collaboration, and fund-raising efforts that supported this report. We offer a vision, but it is their work that will transform this vision into a plan for the community. And we sincerely hope that work gets done, because our efforts in the watershed have brought us to understand just how wonderful life in Beaver Creek's communities could become.

By promoting the green infrastructure of our watershed, we are also promoting the health and well-being of our community and helping maintain the quality of life associated with Northwest Knox County.

Tim (resident and UT employee)

Animals such as deer, turkey, hawks, foxes, and others benefit more indirectly from having a healthy watershed. Siltation, destruction of wet areas, and filling in the floodplain all have, at some level, negative impacts on these species.

Bob (outdoorsman)

Why do we need to take care of Beaver Creek and our land in the watershed?

for OUR COMMUNITY

Voices from today's BC citizens:

- "Due to the large amount of construction in our area, we're losing much of our community's original landscape."
- "We need to take care of the Beaver Creek Watershed and the land that surrounds it for the sake of our children and grandchildren."
- "The natural and cultural resources of the Beaver Creek Watershed are vital to the health and sustainable development of the community."
- "The best way to grow our communities and businesses is to make our area a desirable place in which to live. No parents want to live next to a smelly creek they have to keep their kids away from."

Future Voices (imagined):

- "We take care of our own; we've reclaimed our creek."
- "The creek is now a blessing in our community."
- "All of Knoxville envies where we live."
- "This is the first place I've lived where my neighbors are my friends. I guess it's because our children play together every night in the park."

for NATURE

Voices from today's BC citizens:

- "Beaver Creek is one of the keys to the diversity of wildlife in North Knox County. Populations of wood ducks, mink, muskrats, beaver, snakes, mussels, at least four species of turtles, crayfish, and fish directly depend on the creek for survival."
- "Clean water is a gift from GOD not to be destroyed."
- "With all the building and all the dirt that has settled into the creek, we must find a way to deepen it back to its natural state."
- "If we do not take preventive measures on the front end of this development, there will be no Beaver Creek to take care of in the future..."

Future Voices:

- "Hiking and fishing are back again."
- "I'm so glad that my kids can hunt for crayfish and watch turtles and beaver in the creek— just like I used to."
- "Through innovative methods, water quality is continuously improving."
- "Government, industry, community, and nature are really working together to protect the watershed."

for OURSELVES and OUR FAMILIES

Voices from today's BC citizens:

- "Those of us who live along and draw our water from the Beaver Creek have a responsibility to keep our own water source in life-sustaining shape."
- "The integrity of Beaver creek serves as a foundation of beauty and a reminder of the natural resources that surround us."
- "The new flood plan [line] goes across my house, putting it over the top of my sofa and chairs!"
- "If cared for, the Beaver Creek Watershed could again provide a water source, recreation, and a place to find solitude into the future."

Future Voices:

- "I love having a park right down the street and a sidewalk so the kids can bike there"
- "I 'm so glad I joined the stream cleanup team; it has really made a difference."
- "It's all paid off for me now; having a protected green space behind us really increased my property value."
- "Walking by our creek is a peaceful way to start my day."

The day will come when we will need Beaver Creek and the watershed area. We had better take care of it NOW!! Clean water is a gift from GOD not to be destroyed.

Jim (fisherman)

Most people can survive without food for several weeks, but as Hurricane Katrina so painfully pointed out, a human cannot survive even a few days without clean water. We can't prevent a natural disaster but we can prevent inadvertent and thoughtless destruction of our life-sustaining resource right here in our back yards.

Margie (nurse)

As a community, we have a responsibility to encourage sensible and sustainable growth along Beaver Creek. This means that the government, civic interest groups, and the development community need to work together to protect this area, both from an environmental standpoint as well as economic.

Dwight (government official)

Our actions today will affect our children and grandchildren and their ability to live in the Beaver Creek Watershed. If we do nothing and continue to selfishly develop without taking into consideration the affects of drainage on the area, we will eventually make our water source contaminated to the point of being unusable and the Beaver Creek Watershed uninhabitable.

Sharon (community relations expert)