APPENDIX E: GREEN INFRASTRUCTURE GUIDELINES

GOALS DISCUSSION

Green infrastructure is a life support system for communities. For the purposes of this Strategic Master Plan, "green infrastructure" is a network of open space designed to sustain natural systems, increase individual and community well being, and enhance economic vitality. It is a nature-powered life support system for Spokane that accommodates infrastructure objectives such as flood control, stormwater management, and microclimatic moderation. Green infrastructure provides basic environmental services within an overall framework that guides new development. While most urban residents understand the need to maintain built infrastructure such as roads and sewers, the need to upgrade their parks, riverfronts, and other natural areas is usually less apparent. The concept of green infrastructure repositions open space from a community amenity to a community necessity.

Green infrastructure should form a continuous network of patches and corridors. The patches act as anchors for various natural processes and provide destinations for wildlife, while the corridors link the patches and facilitate the flow of ecological processes. These components can range in size and shape depending upon the resources being protected, the ecological functions being accommodated, and the limitations of the surrounding urban context. Nearly all landscapes can be part of the green infrastructure network, from conservation areas and wildlife preserves to public parks and private backyards and even heavily used streetscapes and parking lots, if designed properly. The key is the application of natural systems to achieve multiple benefits. The strategies below focus primarily on opportunities for green infrastructure in Spokane's urban neighborhoods. Opportunities for preservation and restoration of specific native habitats in the Great Spokane River Gorge are discussed in Section 4.5 Habitat Preservation and Restoration Element. Together, the strategies below and the recommendations for habitat improvements suggest an interconnected network of green infrastructure that integrates surrounding communities into a healthy gorge environment.

Green infrastructure provides multiple benefits. Unlike traditional gray infrastructure, engineered to deal with specific problems and dependent on precise projections, green infrastructure is adaptable, improves with age, and provides diverse benefits to wildlife and people. It even costs less to maintain! Green infrastructure's benefits are rooted in a sustainable environment. This foundation is critical to protecting the health and quality of life of Spokane's citizens. These social benefits are, in turn, critical to ensuring the economic vitality of Spokane. Ultimately, the multiple benefits of green infrastructure are interrelated and the whole network is greater than the sum of its parts.

Green infrastructure supports habitat and protects species diversity. The protection of biological diversity is a function of habitat size, quality, and configuration. Even small patches of natural area can make an important habitat contribution if they are arranged to provide connectivity with the greater network. Wetlands and riparian corridors are especially important and play host to a tremendous number of species.

Green infrastructure protects water resources and helps manage stormwater. Many urban water problems are related to the increase in polluted runoff from impervious surfaces. Municipal storm water systems are efficient at reducing local flooding, but frequently discharge high volumes of polluted water into nearby creeks and rivers. The green infrastructure approach using bioswales and rain gardens reduces local flooding, soil erosion, and thermal and chemical pollution of receiving waters. Vegetation intercepts, slows, filters, and absorbs storm water. Wetlands also help buffer and control the effects of storm water, by holding the water, slowing it down, and releasing it slowly. Filtration of pollutants by vegetation and soil returns cleaner water to groundwater sources and water bodies.

Green infrastructure cleans the air, reduces greenhouse gases, and cools the community. The urban forest plays an important role in maintaining and enhancing local air quality because trees remove gaseous and particulate pollutants from the air. Trees also help moderate the urban heat island effect by providing shade and releasing water vapor. By absorbing carbon dioxide from the air during photosynthesis, trees and other vegetation also reduce one of the primary gases associated with global warming. Properly designed landscapes around buildings can even reduce the need for air conditioning and energy consumption, leading to regional environmental benefits.

Green infrastructure promotes public health. Green infrastructure's air and water cleansing properties improve respiratory health and reduces waterborne illness. Green infrastructure is a setting for physical activity and exercise of all kinds. Many studies also suggest that green infrastructure helps alleviate mental fatigue and stress. Green infrastructure also accelerates healing after trauma or sickness.

Green infrastructure promotes basic quality of life. Fundamentally, green infrastructure lets people relax in a comfortable and beautiful environment. Green infrastructure also helps people stay active and interacting with other people. As a shared public setting, green infrastructure is a place for cultural expression and communication. As a shared public process, green infrastructure involves people in planning, building, and maintaining their communities.

Green infrastructure enhances environmental and human health leading to far reaching economic benefits. By creating a healthy, comfortable environment for workers and customers, green infrastructure attracts businesses and increases sales. Green infrastructure also increases property values, attracts new investment in cities, and increases the tax base for municipalities. A green infrastructure approach focuses limited community resources on effective systems that achieve multiple benefits simultaneously, producing a strong and enduring return on public investment.

Green infrastructure solutions simply cost less. Traditional engineered solutions to stormwater management, microclimate control, erosion control, flooding, etc. require enormous public spending on energy-intensive materials and heavy construction, and the infrastructure begins deteriorating as soon as it is built. A living systems approach, on the other hand, requires less costly materials, lighter construction methods, and the systems only grow more valuable with age. They require a different approach to management, but are less costly and dangerous to maintain. Recently, environmental economists have begun to refer to natural conditions and processes as "natural capital" and "environmental services," assigning dollar values to them based on the value of their functions.

Green infrastructure provides a framework for growth. Green infrastructure guides the location, scale, and density of new development based on the long-term carrying capacity of the land and allows a community to maximize development potential where it can be accommodated efficiently and sustainably. By considering integrated environmental services alongside traditional organizing systems of circulation and utilities we can orchestrate an urban open space system that reduces dependence on expensive gray infrastructure while invigorating the City of Spokane.

Green infrastructure can be an organizing element for design. Green infrastructure elements that shade and cool buildings and pavement or drain and cleanse storm water have a natural logic to their arrangement. Working with these systems highlights the unique local character and climate that distinguishes a place, giving function and meaning to the shared environment. Green infrastructure elements can be integrated into a site plan to improve aesthetics and provide recreational resources while reducing the need for loud or ugly gray infrastructure.

GUIDELINES DISCUSSION

<u>Planning</u>

Poorly conceived urban development can degrade a river's natural processes and destroy or fragment wildlife habitat. The gorge is a unique and special part of Spokane. The highest standards of planning and design should be applied to protect the quality of the river environment and the surrounding landscape.

Planning should begin at the watershed scale. A watershed is an area of land that drains water, sediment, and other materials downslope to the lowest point. The water moves through a network of drainage pathways, both underground and on the surface. Generally, these pathways converge into streams and rivers, which become progressively larger as the water moves on downstream, eventually reaching an estuary and the ocean. All the water resources in the watershed are part of an interrelated system. Watershed planning begins with an evaluation of current and ideal conditions for each body of water in the watershed, as well as comprehensive mapping of land-use practices. Communities can create a watershed plan that designates the locations, levels, and types for new development or redevelopment that will protect or enhance the waterways of the watershed. By linking watershed restoration and community revitalization, it reduces or eliminates problems that public works agencies will otherwise struggle to solve in isolated downstream engineering. The City of Spokane, in its Comprehensive Plan, has endorsed the creation of watershed plans for all watersheds that are associated with the geographic boundaries of the city.

Buffer sensitive natural areas. Buffers are areas next to shorelines, wetlands, streams, and headwaters where development is restricted or prohibited. They protect a river's ecological integrity, enhance connections between wildlife habitats, and allow rivers to function more naturally. Buffers are a critical aspect of the City of Spokane's Shoreline Master Program. The current Program was written in 1982 and is due to be updated in the near future. Buffers protect fragile areas with steep slopes, erodible soils, wetlands, or endangered or threatened animal or plant species. To protect water quality and aquatic habitat a minimum buffer of at least 100 feet is recommended. Effective urban stream buffers have three lateral zones—streamside, middle, and outer. The streamside zone, ideally a mature riparian forest, protects the physical and ecological integrity of the stream ecosystem. This zone should be at least 25 feet wide and can accommodate only minimal interventions such as trail spurs and lookouts. The middle zone, mature forest or grassland that provides stream and upland development, can accommodate some stormwater management, access, and recreational uses. It extends from the streamside zone across the 100-year floodplain and adjacent steep slopes. The outer zone is the buffer's buffer, an additional 25' setback from the outer edge of the middle zone to the nearest permanent structure. Planning ordinances may specify either fixed or variable buffer widths. Variable buffers, which become wider in critical natural areas and narrower in stretches of more urbanized development, are initially more difficult to establish, but can be more ecologically sound. Buffers should be recorded on official maps and protected through conservation easements, regulations, and signage.

New development should be guided by smart growth principles. A number of related planning principles are often referred to collectively as "smart growth." These principles focus on creating diverse, walkable communities that accommodate transportation choices and conserve open space. Hallmarks of this approach include mixed land uses, compact site and building designs, and infill of existing communities. Walkable communities require goods and services that a community resident or employee needs to be located within an easy and safe walk. To foster walkability, communities must mix land uses and build compactly, and ensure safe and inviting pedestrian corridors. Open space preservation supports smart growth goals by preserving critical environmental areas, improving community quality of life, and guiding new growth into existing communities. Reuse and renovation of urban and suburban sites, especially brownfields, provide opportunities for economic development while restoring damaged lands and reducing future pollution. The City of Spokane, in its Comprehensive Plan, has endorsed many of these principles.

Water

Reducing impervious surfaces. The most obvious and least technical step is reducing the amount of paved and built surface. This preserves lands critical to the water system in a natural condition to recharge at its origins, maintaining base flow throughout the entire system. These areas presently absorb much of the rain that falls. If such land is covered over, the total volume of runoff generated increases significantly. Road widths and parking requirements should be kept to the bare minimum and the total length of residential streets can be reduced by narrowing lots to shorten the amount of frontage per home.

Install porous paving. There are nearly as many ways to make paving porous as there are types of paving. There are special treatments of asphalt, concrete, pavers, gravel, grids, and other materials that have open pores that allow storm water to penetrate to the underlying soil. Porous asphalt works like conventional bituminous asphalt, except that by omitting the two smallest aggregate sizes from the mix, water is able to flow directly through the pavement while structural integrity is maintained. Porous materials are especially suited to event and peak season parking and other areas that get limited use, but some porous paving solutions have been proven to stand up to heavy urban use with less maintenance and higher durability than conventional pavements. Bacteria living in the asphalt pores and subsurface recharge areas have been shown to break down many common surface run-off pollutants.

Direct surface runoff to a site drainage system. Runoff from new or existing impervious surfaces should be allowed to infiltrate the soil as close to where it falls as possible. Dealing with surface runoff from rooftops and impervious surfaces on site prevents discharges of unfiltered stormwater from accumulating to overload stormwater pipes or overflow into sensitive natural drainage systems and wetlands. Excess runoff also causes problems for humans through flooding and erosion. Stormwater management should mimic the pre-development rainfall response of a given site, making the built environment a functioning part of the hydrologic cycle. The green infrastructure stormwater management system is usually comprised of a series of individual elements in an interconnected, continuous system and can be designed to manage runoff volume and timing; treat pollutants; and provide a site amenity. Drainage features fall into three basic categories: infiltration, retention/detention, and biofiltration.

An infiltration system is ideal for stormwater management because it filters pollutants through the soil and restores natural base flows to groundwater and downstream water bodies. Infiltration systems can range from simple “rain gardens” to elaborate underground recharge beds. Site soil conditions generally determine if infiltration is feasible. It is also limited where high groundwater, steep slopes, or shallow bedrock is present. Infiltration basins can be either open or closed. Open infiltration basins, including ponds, trenches, swales, and other landscape features, are usually vegetated—the vegetation maintains the porous soil structure and reduces erosion. Infiltration trenches, also called rock pockets, are usually long, thin channels—often two or three feet deep—filled with coarse aggregage that encourages infiltration. They are generally located on the downhill side of any type of pavement such as roadways, driveways, and walkways. This feature can be combined with a bioswale to form an infiltration swale. Closed infiltration basins, or recharge beds, are uniformly graded drainage basins filled with coarse aggregate under the land surface. They can work in place of surface features where space is limited by the need for parking lots, playfields, or lawns. Recharge beds should not be located where bedrock is exposed or where the water table is at the surface. In Spokane, a surface infiltration feature is allowed to hold up to 6 inches of standing water for up to 3 days.

Retention and detention systems are designed primarily to slow runoff where soil or other site conditions do not allow adequate infiltration. Detention systems store runoff for one to two days after a storm and are dry until the next storm. Retention systems usually have a permanent pool that retains the runoff volume until it is replaced during the following storm. Properly designed retention/detention systems release runoff slowly enough to reduce downstream peak flows to their pre-development levels, allow fine sediments to settle, and uptake dissolved nutrients in the runoff where wetland vegetation is included. The permanent pool of a retention system and the storage volume in a detention basin are both sized equal to the runoff volume from the stormwater quality design storm, plus an additional 20% of this volume for sediment storage. Detention system outlets (orifices, perforated risers, weirs, etc.) are generally sized to release 50 percent of this volume within 12 to 16 hours, and the remainder in another 24 to 32 hours.

Bioswales are vegetated slopes and channels designed and maintained to transport shallow depths of runoff slowly over vegetation. While swales in Spokane sometimes refer to flat-bottomed, shallow vegetated depressions, they can also be linear features that move surface runoff along a vegetated channel that filters the water as it passes across the plant surfaces. Bioswales are effective if flows are slow and depths are shallow. Grading the site and sloping pavement in a way that promotes sheet flow of runoff generally achieve this. For biofilter systems, features that concentrate flow, such as curb and gutter, paved inverts, and long drainage pathways across pavement, must be minimized. The slow movement of runoff through the vegetation provides an opportunity for sediments and particulates to be filtered and degraded through biological activity. In most soils, the biofilter also provides an opportunity for stormwater infiltration, which further removes pollutants and reduces run-off volumes. Some variations include: meandering the bioswale to lengthen its journey, adding check dams to slow the water, and adding small basins to hold sediment. A drain inlet can be included to empty any overflow during particularly heavy storms, but a bioswale should be capable of infiltrating most or all of the rain from normal showers, and should at least be able to deal with the storm's first flush. While many bioswales are planted with mowed turfgrass, more diverse planting provides additional biofiltration, trapping sediment and encouraging infiltration of water through the root channels, as well as a habitat and open space amenity.

Conserve and reuse water. Conventional water management imports and exports water over very long distances. From a sustainability perspective, the smaller the quantity of water and the shorter the diversion from natural flows, the less potential for harm. The Spokane Valley/Rathdrum Prairie Aquifer is the sole source of drinking water for more than 450,000 people and it is being drawn down at an unsustainable rate. Reducing groundwater in the aquifer affects flows in the Spokane River. Recognizing regional limitations of water supply means choosing landscape plants adapted to Spokane's climate, especially natives. Rain barrels and cisterns can be used to collect rainwater for reuse in flushing toilets or landscape irrigation. Graywater from sinks and showers can even be used to for subsurface drip irrigation in the landscape.

Restore or "daylight" historic streams and springs. Daylighting means restoring previously piped, culverted, or otherwise buried water courses to a free flowing surface channel. This slows the velocity of runoff and brings the flow into contact with the soil, vegetation, air, and sunlight. Water quality is improved because the microorganisms such as aerobic bacteria breakdown complex organic molecules into simple compounds and carbon dioxide. This work transforms pollutants into nutrients that can then be used by plants and fish. Daylighting also allows increased infiltration and groundwater recharge. Water movement is maintained and water quality regained. The hillside springs of Peaceful Valley are excellent candidates for daylighting and restoration.

<u>Soil and Vegetation</u>

Minimize site disturbance. Landowners and designers can affect the protection of healthy sites by choosing appropriate places to build. Locate building envelopes on the least healthy, already disturbed areas of sites. Everything outside the envelope is treated as a protected area during construction. The envelope may even form the basis of covenants that limit the use of non-native vegetation and structures to an area immediately surrounding the building. Thoughtful site design, construction sequencing, and structural practices such as silt fences and temporary seeding help to reduce erosion and sedimentation during the construction process. Also be sure to protect existing vegetation, avoid grade changes near trees, use the lightest machinery possible, and promptly restore any temporary disturbance. If soils have been compacted or otherwise damaged, restore them onsite by light tilling, with organic amendment if necessary.

Grow Spokane's urban forest. Urban forests create healthy terrestrial systems for people and wildlife. They maintain comfortable temperatures, clean pollutants from the air, and produce oxygen. Planting more urban forest would make Spokane an even more delightful place to live while potentially saving millions of dollars in stormwater infrastructure, health, and energy costs. A healthy urban forest is more than a streetscape of large potted plants. Its integrity is a function of its vertical and horizontal structure—the roots, microbes, soil, ground topography, ground cover, shrubbery, understory, and canopy; the patches and corridors harboring wildlife and connecting important natural features. Its integrity is also a function of its species and age diversity—a range of native species appropriate to a variety of microclimates; seedlings, mature vegetation, even fallen "nurse logs." Also key to a sustainable and successful urban forest is its relationship to built structures and systems—proximity to neighborhoods, dimensions of streetscapes; and its self-regulation—independence from intensive regimes of mowing, pruning, irrigating, fertilizing, and chemical spraying.

Green Spokane's roofscapes. Green roofs or ecoroofs are living, vegetative roofing alternatives that cover impervious surfaces with permeable plant material. A green roof typically doubles the service life of the underlying waterproofing; dramatically reduces storm water runoff; conserves energy and cools the air; reduces the heat island effect; and provides ecological and aesthetic values in the built environment. Extensive greenroofs are lightweight veneer systems of thin layers of drought tolerant self-seeding vegetated roof covers using colorful sedums, grasses, mosses and meadow flowers requiring little or no irrigation, fertilization or maintenance. Intensive greenroofs are more elaborately designed roof landscapes, such as roof gardens and above/underground parking garage roofs, that are intended for human interaction and will need to be engineered to conform to the load requirements.

Use living and flexible materials to retain slopes. Bioengineering uses plants, sometimes in conjunction with mechanical methods, to build living structures on vulnerable slopes, especially at the interface between soil and water. Bioengineering or biotechnical erosion control includes a wide array of applications. Almost all make use of the ability of some plants to sprout from a fresh cut branch stuck in the soil. The most vigorous of these are willows, poplars, or dogwood. Cuttings may be tamped directly into the earth as live stakes, staked to slopes for coverage as wattles and brushmattresses, buried lengthwise in trenches as fascines, interspersed with layers of fill soil as brush layering, or stacked and backfilled as live crib walls. Various mats and mulches, of jute, coire, or straw, help to prevent erosion until the cuttings take root and hold the slope. Even vertical surfaces can be planted with a greenwall approach. This entails using stackable blocks, crib walls, troughs, gabions, etc. with spaces for vegetation to take root. Bioengineering and greenwalls are as effective as conventional concrete structures for slope retention, but offer numerous aesthetic and ecological benefits.

Green Building

Spokane should encourage all new building to meet the highest green building standards possible. Leadership in Energy and Environmental Design, LEED^{TM}, is a green building rating system developed by the US Green Building Council (USGBC). It lays out a comprehensive and measurable framework for sustainable development (www.usgbc.org/LEED/). The guidelines above cover many of the issues related to two of the LEED system elements—Sustainable Sites and Water Efficiency. Three additional topics that are important to green building are Energy and Atmosphere, Materials and Resources, and Indoor Air Quality.

Energy consumption can be dramatically reduced through practices that are economical and readily achievable. According to the USGBC, "improving the energy performance of buildings lowers operations costs, reduces pollution generated by power plants and other energy-production equipment, and enhances comfort. Most energy-efficiency measures present an excellent rate of return. It is essential to consider a building's energy load as a whole and to integrate synergistic energy-efficiency measures in order to maximize savings. For example, reduction of energy loads through improved glazing, insulation, daylighting and use of passive solar features may allow the design team to downsize or even eliminate HVAC systems."

Building material choices are important in sustainable design because of the extensive network of extraction, processing, and transportation steps required to process them. According to the USGBC, "construction and demolition waste constitute about 40% of the total solid waste stream in the United States. One of the most effective strategies for minimizing the environmental impacts of material use is to reuse existing buildings. When new materials are used in buildings, it is important to consider different sources. Salvaged materials can substitute for new materials, save on material costs and perhaps add character to the building. Recycled content materials reuse waste products that would otherwise be deposited in landfills. The use of local materials supports the local economy and reduces the impacts of transportation. The use of rapidly renewable materials and third-party certified wood minimizes the impact of natural resource consumption to manufacture new building material. Finally, job site waste management reduces construction debris volumes by recycling and reusing these materials."

The indoor environment is a significant source of potential health problems. According to the USGBC, "Americans spend an average of 90% of their time indoors, where levels of pollutants may be two to five times—and occasionally more than 100 times—higher than outdoor levels. An increasing number of legal cases emphasize the need for optimal indoor environmental quality (IEQ) strategies. Such strategies reduce potential liability for design team members (including building owners), increase the resale value of the building, and increase productivity of building occupants. In fact, case studies suggest that IEQ improvements can increase worker productivity by as much as 16%, resulting in rapid payback for IEQ capital investments. IEQ strategies include issues related to indoor air quality such as increased ratios of filtered outside air, ventilation effectiveness, moisture management, and control of contaminants. Specifying materials that release fewer and less harmful contaminants is better. Other IEQ issues to consider include daylighting and lighting quality, thermal comfort, acoustics, occupant control of building systems, and access to views. All of these issues have the potential to enhance the indoor environment and optimize interior spaces for building occupants."