Preface

The management of streams is a continuing balance between what people want and what plants and animals need. In an ideal world, a stream can satisfy both—in reality, the balance is ephemeral, at best, as streams evolve and humans continue to imprint their desires on the adjoining or upland landscape. Intervention is often needed when the balance becomes so skewed that the function of streams for either people or nature is at risk.

Just as one would consult a doctor regarding an illness affecting the body's function, one should consult a hydraulic engineer, stream ecologist, geomorphologist, aquatic biologist, or other riparian specialist for the diagnosis or treatment of a stream disorder or problem. An inappropriate or poorly designed restoration project can worsen or broaden the disorder. Site-specific designs based on sound, scientific experience are needed to properly select the size, orientation, and location of stream restoration techniques. Effective designs also need to include appropriate management techniques that remove sources of disturbance, allow the design elements to function well together, and enhance the stream's ability for ecological regeneration.

In planning and designing solutions to some stream problems, simply modifying adjacent land and riparian management practices may be all that is needed to improve degraded stream conditions. Streams are integrators of all upland problems, so some stream conditions are symptomatic of mismanagement of their surrounding watershed(s). In these cases, solutions may lie not only in restoring the stream directly, but in changing land uses and management practices throughout the entire watershed.

In a response to heightened environmental sensitivity, softer approaches are increasingly preferred by permitting agencies and the public. Green or natural engineering is making a strong foothold in the restoration of streams. One green technique, streambank soil bioengineering, has been used for centuries, historically with rock, wood, and native vegetation and now including developed plant materials and geosynthetics. Several large soil bioengineering projects were installed on United States streams (and rivers) in the 1930s, but these labor-intensive methods fell from favor largely until the 1960s. Many of the 1960s projects were not designed and constructed for habitat and landscape enhancement but primarily for structural controls. Przedwojski, Blazejewski, and Pilarczyk (1995) noted that the "application of living materials in civil engineering, including river training, is not as well managed as … earth and concrete structures." In the late 1980s to the present, stream restoration practitioners began to fully embrace green engineering and how-to guides and a one-size-fits-all design approach proliferated. New products and materials emerged, such as geosynthetics, specialized planting equipment, as well as selection and release of improved plant species for riparian areas. Engineers, hydrologists, and biologists also recognized the importance of including other disciplines such as fluvial geomorphologists to achieve comprehensive restoration goals.

Though there has clearly been impressive and needed movement toward green stream restoration, a paucity of supporting design research, engineering principles and scholarship exists. Robinson (2002) found that natural stream techniques had not been proven to the degree that conventional

riprap has been, and, thus, often appeared more risky to landowners, permitters, and designers.

The state-of-the-art is still developing, as well as the supporting science and technology. This handbook marks a beginning. It contains tools and guidance to support stream restoration activities—specifically tools to use in designing restoration solutions. The focus of this handbook is on the how-to. It provides the user with specific tools to perform analyses and designs. This handbook presents engineering and ecological assessment and design tools that are applicable to a wide range of stream restoration work. The information contained herein represents both green techniques and structural approaches.

Please note that this handbook makes no endorsement of one particular approach over another and is not intended as a requirement document for purposes of funding or permitting. The guidance provided can be used to design and implement some of the techniques used in stream restorations. It is anticipated that as new methods are validated, they will be added to this guidance document or a supporting Web site.

Executive Summary

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) has worked with private landowners since the 1930s to implement conservation plans that address their farm or ranch natural resource needs. Those plans often include voluntary measures to address problems associated with streams and, increasingly, to enhance habitat functions important to aquatic species of concern. In short, the agency works with the public in managing streams to meet their ecological needs and the needs of people who work and live nearby. NRCS technical assistance is based on science-based solutions that result in installed projects that range from relatively simple streambank protection to more complex plans covering watershed-scale stream and riparian restoration efforts involving multiple partners and agencies. There is a recognized need for the agency's technical guidance documents to be consistent, accurate, available, and current with stream-related innovations and improvements.

In 1998, an NRCS-led effort resulted in 15 Federal agencies producing the document entitled "Stream Corridor Restoration: Principles, Processes, and Practices" (NEH 653). Diverse groups of users, both nationally and internationally, are using this interagency document to plan stream corridor restoration projects. However, this document stopped short of providing specific design guidance tools that are required as the NRCS increasingly becomes involved in stream restoration projects that cover the full range of treatments, from natural to management to structural. These stream restoration projects require designs that can best be developed from a balance of skills in both engineering and ecology. This extensive document was assembled to ensure NRCS specialists and field personnel have the best design tools available.

The primary emphasis of this handbook is on how-to techniques; theory is only briefly discussed. Concise outlines, tables, and formulas are presented. While primarily an NRCS effort, stream and aquatic ecology experts from a variety of Federal, state, and local agencies, as well as private consultants and universities, contributed to the content.

Much of the information herein is not new; it is compiled from a rich system of existing guides used to treat or restore streams. Many of these legacy guides, however, consist of narrowly focused technologies primarily for engineered solutions, constructed earth channels, or bank armor, and do not fully integrate ecological, biological, or geomorphic criteria. NRCS developed guidance in the late 1980s and early 1990s for soil bioengineering practices, but these documents are dated and do not provide a system-based or holistic approach to analysis and design. Other information written and published by others, both inside and outside NRCS, provides guidance for balancing ecological goals with appropriate combinations of management and engineering designs. Guidance, tools, and procedures contained in this design handbook are those currently available for use—no additional research or development was specifically fostered for this effort. As appropriate, information was updated, reformatted, and edited to fit within the handbook's structure.

This handbook does not prescribe specific design procedures, nor does it assume that all stream restorations or rehabilitations will require structural

treatments. Successful and sustainable stream work requires a thorough, contextual understanding of dynamic physical, chemical, and biological processes; risks and limitations; and range of applications for appropriate tools. It also involves weighing the wide array of management and intervention options that can be used to attain the desired and achievable condition. The overall stream restoration planning process should result in clear and obtainable goals, which should be implemented through appropriate designs. The best-designed treatment cannot make up for rushed, cookie-cut, or poorly defined plans.

In summary, this assembly of tools will help designers achieve a balance of management and engineering techniques. It does this by providing NRCS and other stream practitioners with principles and methods to restore functions in ways that enhance the natural abilities of streams and stream corridors to self-repair and adjust to variations in sediment and water loads without substantially compromising the needs and goals of the adjacent landowners.