Appendix A Postscript

No river can return to its source,
yet all rivers must have a beginning.

— Native American Proverb

In an age of heightened environmental sensitivity, green or natural design approaches are finding a strong foothold in the restoration and rehabilitation of stream ecosystems. Streambank soil bioengineering technology, however, has been used around the globe for centuries. A few designed systems were installed in the United States in the 1930s. Even for the next 40 years, few installations were truly integrated with complex stream restoration plans. It was not until the late 1970s that these less structural approaches for stream stabilization began to be used in place of hard engineered solutions. The Winooski River restoration is an early example of soil bioengineering techniques, combined with sound engineering approaches implemented in the 1930s (fig. E–1).

Later in the twentieth century, fluvial geomorphology and other emerging technologies proved important in stream restoration work. This emerging more natural design approach to design has often appeared to be more risky to landowners, regulators, and designers, since the collective experience in successful stream restorations was primarily focused on the physical stability of the system. Designing stream restorations with soil bioengineering practices combined with traditional engineering approaches requires similar attention to the strengths and performance criteria of materials, as well as their long-term durability, maintenance needs, and applicability to achieve the project's goals. This softer approach requires attention to the design requirements of the site conditions, and some term these less traditional methods a combination of science, engineering, and art (fig. E–2).

Figure E–1 Workers installing live willow stakes and brush matting on a terraced streambank, Winooski River, VT (September 1938)

Figure E–2a Streambank soil bioengineering techniques

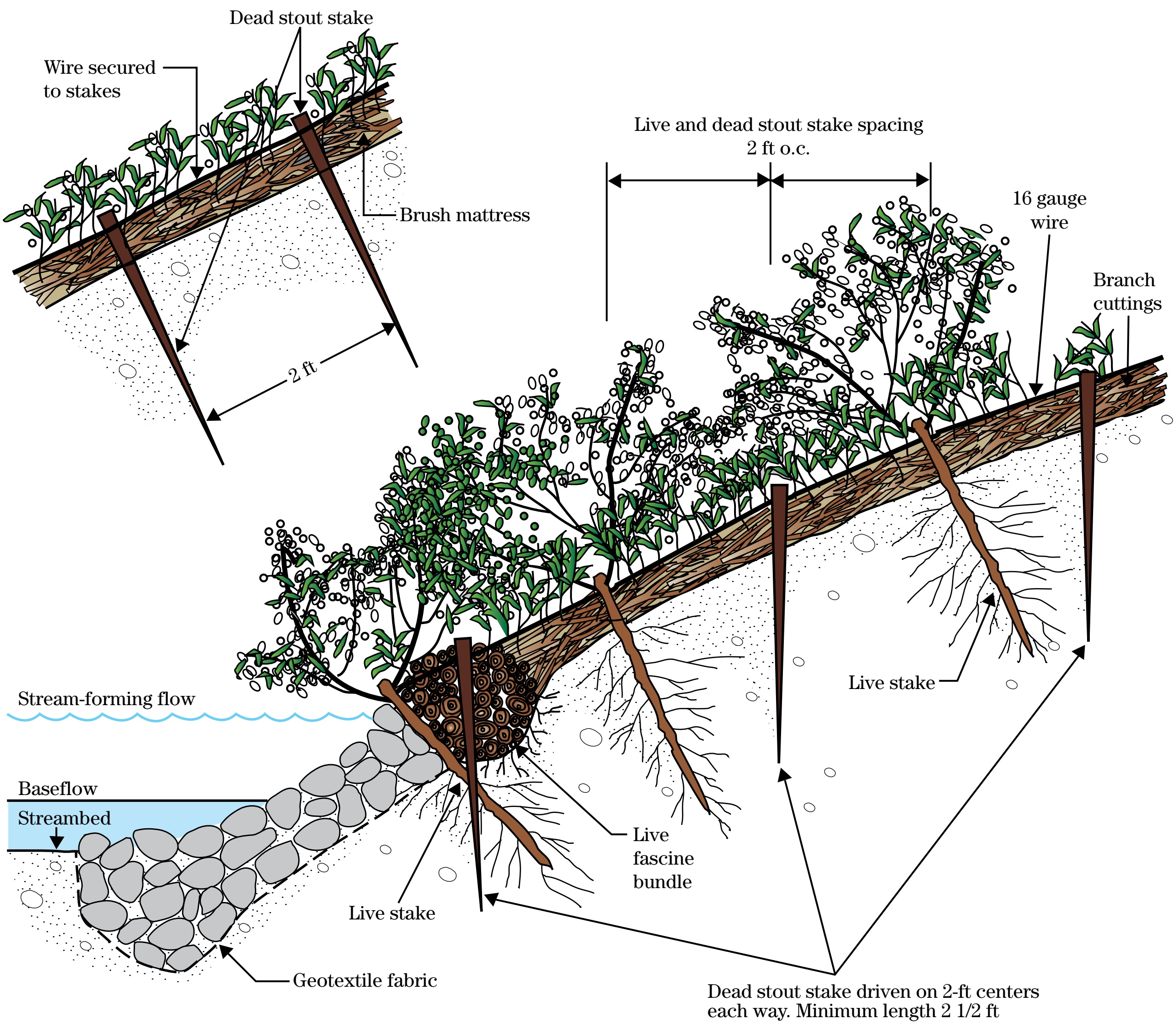
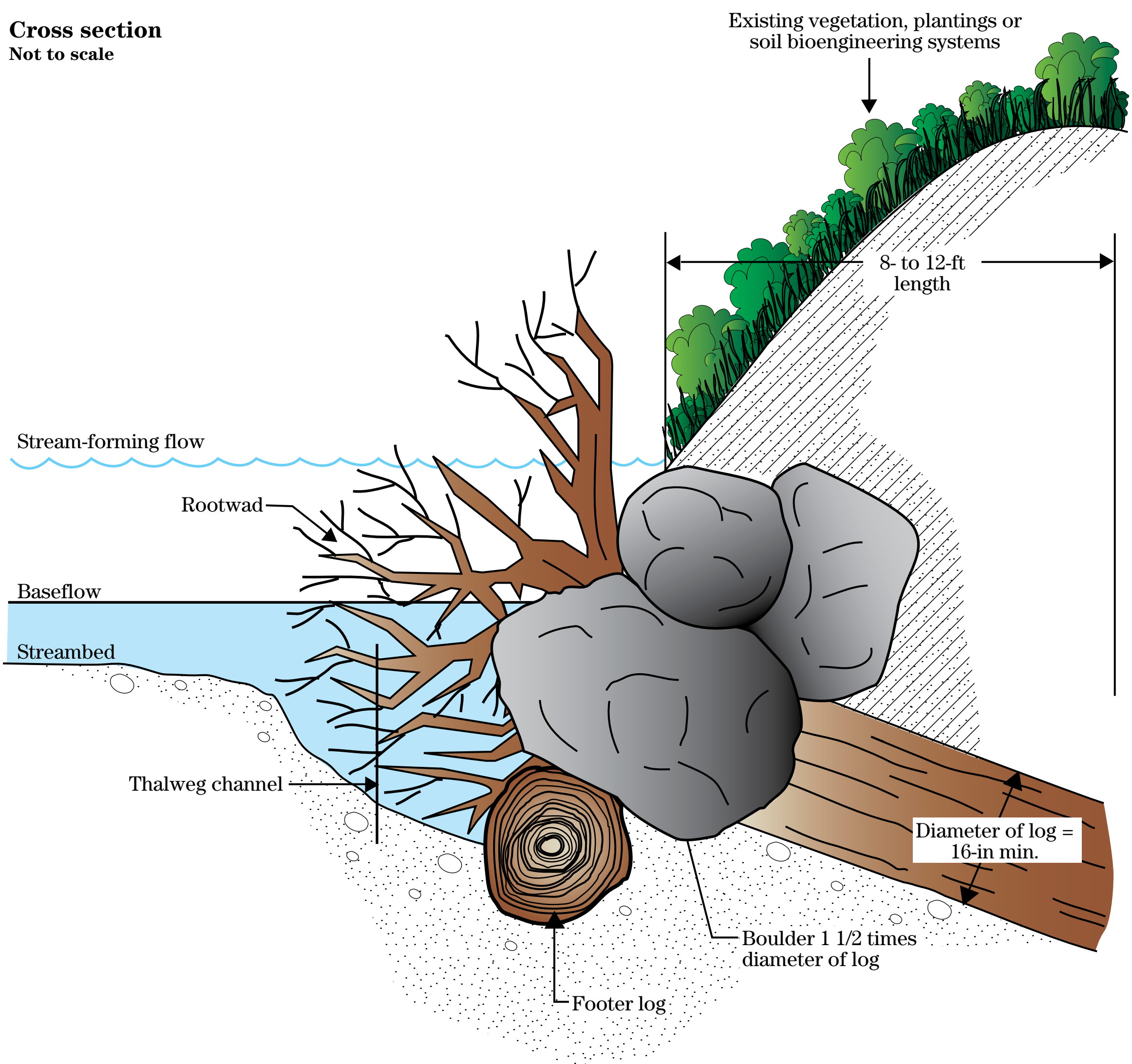


Figure E–2b Streambank soil bioengineering techniques—Continued



Except for the design details and materials used, the overall approaches are not new. Figure E–3 illustrates an early brush matting design detail that emphasizes plant materials for erosion control and bank stabilization.

The first chapter of this handbook provided an introduction to stream restoration and introduced four major guiding principles for any efforts to restore streams:

- Base designs on ecological principles, as well as physical ones.
- Integrate the disciplines of fluvial geomorphology, hydrology, aquatic and riparian ecology, and hydraulic and geotechnical engineering.
- Design for site-specific response in the context of the watershed scale.
- Consider ecological costs and values, as well as project costs, in addition to long-term costs for maintenance of engineered solutions to channel problems.

Figure E–3 Conceptual drawing that provided some design details for early restorations

Even more fundamental than these underlying principles is the question of what are the intended outcomes in working with stream systems. The needs of the stream must be satisfied, as well as the needs of people who are connected to the stream. Many river restoration projects are, at best, compromises between rehabilitation and restoration, since restoring some streams to historical, ecologically self-sustaining conditions may be impossible due to irreversible changes in watershed land use, cover, or other issues. Most river restoration projects are actually re-creations of the river to meet the changed needs of the watershed. Experience has shown that the most successful and cost-effective designs are those that are self-repairing and sustainable, with little or no need for future human intervention. Where feasible, this should be the primary goal of any river restoration.

A basic principle in stream related work must be to integrate the natural physical, biological, and chemical processes that shape stream systems. The primary question is, “Does this design element replicate what is found in the stream system, and will it result in a naturally functioning and self-repairing ecosystem?” The ultimate challenge is whether the restoration will satisfy these ecological needs, as well as the needs of the land user or community. The balance may be tipped heavily in favor of those who own land near the stream or are connected in some way to the stream. However, opportunities to plan for real restoration of the stream’s ecology exist, even where the first impulse is to just stabilize bank erosion with some enduring measures.

A design is most likely to result in a healthy aquatic or riparian community if the interdependence between flora, fauna, hydrologic and hydraulic characteristics, ground water, and soil are recognized.

Other conditions and variables must also be considered:

- What is the source of the problem? Some rivers are damaged beyond an eroding bank or an unstable reach. The real causes or destabilizing effects may be difficult to understand simply because the scope of disturbance may be so large.
- What are the natural flow conditions for the stream? How do the flow conditions affect the

ecological functions of the stream, and what is the natural flow regime that needs to be restored?

- How does human development affect the stream system? What are the stages of development and their effects on the watershed and its streams? What conditions or changes can be predicted in the near and distant future?
- Is the stream on its way to recovering, or is it continuing to degrade?

These and many other considerations make it difficult for planners and designers to predict appropriate restoration/rehabilitation measures. Nonetheless, the recognition that stream systems are dynamic—that they can be sensitive to changes, as well as resilient to others—should be an underlying principle for any stream work.

This handbook marks another incremental step in our growing understanding of the natural physical, biological, and chemical processes that shape streams and their corridors and the ability to work in harmony with them all. Although some stream work must be focused simply on conveying streamflow within boundaries designed not to move or erode, such as in urban stormwater drainage projects, opportunities abound to plan and design stream projects that improves the environment for plants and animals, as well as for people.

In closing, the Winooski River restoration project is again offered as an example of a long-term successful restoration (figs. E–4 through E–7).

When you put your hand in a flowing stream,

you touch the last that has gone before

and the first of what is still to come.

— Leonardo da Vinci

Figure E–4 Winooski River, VT, in 1938 just before restoration. Note the arrow for common point for following sequence of pictures.

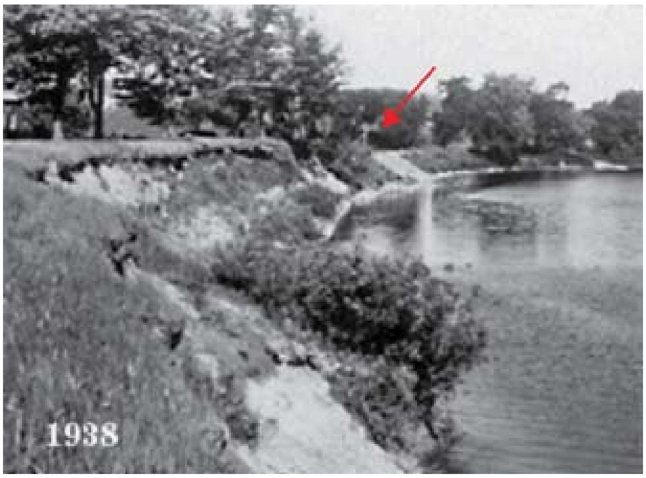


Figure E–5 Winooski River, VT, during construction in 1938. Note the work being done by hand.

Figure E–6 Winooski River in 1938 after completion of restoration work and establishment of vegetation.

Figure E–7 Winooski River in 1995, nearly 60 years after restoration. Tree-boring documented the trees as those that were planted in 1938