SECTION

1 Introduction

A "Minnesota Wetland Restoration Guide" was first published in December 1992 by the Minnesota Board of Water and Soil Resources (BWSR). This Guide had an emphasis on engineering design and provided technical guidance for restoring drained wetlands and their management. In more recent years BWSR has published additional guidance on restoring drained wetlands including establishing vegetation as part of restoration projects.

Information from these prior documents along with new concepts, strategies, and techniques are incorporated into the new, updated Minnesota Wetland Restoration Guide. Included is information from updated research and hands-on experience of practitioners from across the state. The result is a comprehensive multi-disciplinary document that offers sound engineering and ecological principals for restoring functional and sustainable wetlands in Minnesota.

Figure 1.1 *Shallow marsh restoration in Chisago County*

This section of the Minnesota Wetland Restoration Guide discusses the purpose and scope of the document, describes its organization and use, and lists and acknowledges its principal authors and development staff.

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1-1 Purpose

To understand the need for a Minnesota Wetland Restoration Guide, one must know exactly what wetlands are and why they are viewed as important in Minnesota.

Wetlands are a major landscape feature in Minnesota, covering upwards of 8.7 million acres or 16 percent of the land area in the state (U. of MN, 1984). Wetlands lie on a continuum between truly upland habitats and completely aquatic habitats such as lakes. They form as a result of constant or recurrent, shallow inundation or saturation at or near the soil surface. Although they are part of a continuum, they have been defined and classified for various purposes, including wildlife habitat assessment, implementation of wetland regulations, and others. Wetlands are defined as areas inundated or saturated at a frequency and duration sufficient to support vegetation adapted to life in saturated soil conditions. Indicators of soil, hydrology, and vegetation are used to define and delineate wetlands for wetland regulatory purposes.

When Europeans permanently settled in Minnesota in the 1800's, the state's wetlands were viewed as impediments to progress, particularly in the prairie regions where agricultural production potential was high. Many wetlands were subsequently drained in the early part of the 20th century for agricultural development. Later on, more wetlands were filled and drained for building of homes, roads, and overall modern development. Drainage for agricultural purposes continues to this day. In Minnesota, an estimated 9.7 million acres of wetlands have been drained or filled over the last one-hundred plus years (U. of M, 1984). Some areas of Minnesota have lost more than 90% of their original wetlands, primarily for agricultural production.

This loss of wetlands has led to significant changes in the hydrology, water quality, and wildlife populations in the state. Beginning in the 1970's, scientists and policy makers began to notice and document the detrimental effects that the loss of wetlands had on the landscape in Minnesota as well as other states with significant historical drainage. Scientific understanding of the functions that wetlands provide increased, and policy makers began to craft regulations to protect existing wetlands and to provide funding for conservation projects and programs that encourage the restoration of wetlands. Minnesota's wetlands are now widely appreciated for their multiple benefits, several of which are listed below:

Erosion control—Vegetation along lakes and streams reduce erosion caused by wave action.

Flood control—Wetlands reduce flooding by slowing excess water runoff during times of heavy rainfall.

Figure 1.2 *Wet meadow restoration in Houston County*

Ground water recharge and discharge—Some wetlands serve as a source of groundwater recharge while other wetlands are groundwater discharge areas, providing continuous water sources for rivers and streams.

Water quality—Wetlands improve water quality by filtering sediments, nutrients, and toxic substances out of water before it washes into rivers and lakes.

Rare species habitat—Approximately 43 percent of threatened or endangered species in the United States live in or use wetlands.

Recreation—Wetlands are used for canoeing, hunting, fishing, birding, and outdoor education.

Wildlife habitat—A wide variety of wildlife species such as fish, amphibians, reptiles, aquatic insects, birds, and mammals rely on wetlands for habitat.

While the motivation for restoring wetlands to increase and maintain these functions in the landscape is there, the knowledge of how to do it effectively and efficiently is evolving. Unlike wildlife habitat restoration and management, which has been advancing since the 1930's, wetland restoration as a science has only been around since the 1970's and 80's. Some restorations are relatively simple; others can be quite complicated with serious legal and land use consequences. In addition, the variability of wetlands and landscapes throughout the country make it difficult to identify techniques and approaches that work in all situations and landscapes. This guide is an attempt to collate and organize the body of information related to approaches, techniques, and considerations for restoring wetlands in Minnesota.

The purpose of the Minnesota Wetland Restoration Guide is to promote the implementation of high quality wetland restorations that are both sustainable and functional. It is part of an ongoing collaborative effort by a variety of government officials, land and water managers, and non-government organizations to improve the science and decision making process when locating and designing wetland restoration projects.

Emphasis is on providing sound, practical restoration techniques and strategies that will replicate and replace historic wetland conditions and that will provide a number of functions and values that could include erosion control, flood control, ground water recharge and discharge, improved water quality, habitat for rare species and other wildlife, and recreational opportunities.

The information contained in this Guide is intended to assist professionals and nonprofessionals alike in considering, planning, developing, and implementing high quality wetland projects of all types and sizes. It is, however, written for the professional "practitioner" and is therefore considered a technical document. The Guide offers an interdisciplinary approach to planning and development that considers all aspects to achieve a successful project. It recognizes that as part of implementing a project and achieving a set of desired wetland functions or goals, carefully developed design plans for construction and vegetation establishment are required. These plans must consider and utilize sustainable restoration strategies that fit the landscape and are in harmony with other surrounding land-uses. It also recognizes that the restoration of wetlands and their associated upland vegetative buffers requires an integrated approach to project completion. The combination of engineering and ecological principals together makes a project successful.

With such a wide range of potential users, applications, and an endless variety of wetland project types, the Guide cannot provide solutions for every possible situation. It does provide a mix of general and highly detailed information that most professional and non-professional users will find useful.

1-2 Scope

Figure 1.3 *Restoration of forested bog*

The Minnesota Wetland Restoration Guide is intended to be a comprehensive, technical reference to plan, evaluate, design, implement, maintain and monitor wetland projects. It attempts to provide answers to many common "why" and "how" questions that arise in all phases of a project. The information is applicable to a wide variety of wetland systems found in Minnesota as well as much of the upper Midwest region of the United States. While the Guide is intended to be comprehensive, it is not the only source, nor is it an exhaustive source, of information relating to wetland restoration and creation. Users of this Guide are encouraged to consult with other resource professionals and use additional technical references when evaluating, planning, designing, and implementing their own wetland projects.

Figure 1.4

While some restorations are relatively simple, others can be quite complicated and involve significant administrative, legal, technical, and engineering efforts to complete. The variability of wetland types and landscapes throughout the state, specific site conditions, or even the purpose or program for which a project is being considered make it difficult to identify restoration techniques and strategies that work in all situations. To the extent practicable, the guidance provided is intended to apply to a variety of project types and situations. Certainly, some variations in approach to completing a project will apply or be necessary. As a result, some of the information presented will seem extreme or overly excessive for some projects, and yet be very applicable to others. In addition, some of the information presented may seem rather basic to persons experienced in certain aspects of wetland work. However, this same information may provide valuable insight to those with less experience or other backgrounds.

The information presented in the Guide is not intended to supersede existing local, state, or federal requirements, either from a regulatory or engineering perspective. Users of the Guide are strongly encouraged to consult with the appropriate regulatory and permitting authorities before undertaking any wetland project. Only such direct consultation will help project proponents comply with the applicable wetland and construction related regulations.

The Guide is intended to be a comprehensive technical resource when restoring drained and altered wetlands across Minnesota's diverse landscape. While the Guide does include occasional discussion and guidance with regard to strategies to create wetlands, it is not intended to be a comprehensive resource for those types of projects. Readers are encouraged to seek more specific guidance from other resources when attempting to create wetlands.

The terms "restoration", "creation", and "enhancement" are often used interchangeably and have been defined by resource professionals in a variety of ways. For the purpose of this Guide, these terms are defined and used as follows:

- **Wetland restoration** refers to re-establishing or rehabilitating a former or degraded wetland, with the primary goal being restoring its natural, historic wetland functions to a close approximation of the original.

- **Wetland creation** refers to the construction of wetlands in locations where they did not previously exist. Wetland creations are often referred to as constructed wetlands. Some wetland creations are conducted in uplands adjacent to pre-existing or restored basins.

- **Wetland enhancement** refers to activities performed in existing and altered wetlands that heighten, intensify, or improve one or more specific wetland functions. Wetland enhancements can be difficult to distinguish from wetland restorations: both can occur when working in partially drained or degraded wetlands.

Due to the close relationship of wetland enhancements to wetland restorations, the term "restoration" used throughout this Guide will refer to both restoration and enhancement.

It is often difficult to determine or achieve a wetland's pre-altered condition or function due to the extent of alteration in the wetland and its surrounding landscape. For the purposes of this Guide, restoring hydrology to the extent feasible and practicable in a drained or altered wetland, combined with the successful establishment of native vegetation, meets the definition of restoration.

Ecologists and wildlife biologists have developed various wetland classification systems that primarily rely on vegetation and hydrology conditions to identify different wetland types. Throughout this Guide, specific wetland types are identified when certain aspects, strategies, or techniques are applicable to a particular situation. The wetland classification system used in this Guide follows a plant community classification system developed for Minnesota and Wisconsin (Eggers and Reed, 1997). Recognizable names are used to describe the vegetation, hydrology, and landscape position. Figure 1.5 illustrates the relationship of the Eggers and Reed classification system compared to Cowardin et al. and USFWS Circular 39. The table below compares the three classification systems.

Figure 1.5 ***Wetland Classification System Comparison***

Eggers & Reed	Cowardin et al.	USFWS Circular 39
Shalllow, Open Water	Palustrine or Lacustrine, littoral; aquatic bed, submergent, floating, and floating-leaved	Type 5: Inland Open Fresh Water
Deep Marsh	Palustrine or Lacustrine, littoral; aquatic bed, submergent, floating, and floating-leaved; and emergent; persistent and nonpersistent	Type 4:Inland Deep Fresh Marsh
Shallow Marsh	Palustrine; emergent; persistent and nonpersistent	Type 3: Inland Shallow Fresh Meadow
Sedge Meadow	Palustrine; emergent; narrow-leaved persistent	Type 2: Inland Fresh Meadow
Fresh (Wet) Meadow	Palustrine; emergent; broad and narrow-leaved persistent	Type 1: Seasonally Flooded Basin or Flat; Type 2 Inland Fresh Meadow
Wet to Wet-Mesic Prairie	Palustrine; emergent; broad and narrow-leaved persistent	Type 1: Seasonally Flooded Basin or Flat; Type 2 Inland Fresh Meadow
Clacareous Fen	Palustrine; emergent; narrow-leaved persistent; and scrub/ shrub, broad-leaved deciduous	Type 2: Inland Fresh Meadow
Open Bog	Palustrine; moss/lichen; and scrub/shrub; broad-leaved evergreen	Type 8: Bog
Coniferous Bog	Palustrine; forested: needle-leaved evergreen and deciduous	Type 8: Bog
Shrub-Carr	Palustrine; scrub/shrub; broad-leaved deciduous	Type 6: Shrub Swamp
Alder Thicket	Palustrine; scrub/shrub; broad-leaved deciduous	Type 6: Shrub Swamp
Hardwood Swamp	Palustrine; forested; broad-leaved deciduous	Type 7: Wooded Swamp
Coniferous Swamp	Palustrine; forested; needle-leaved deciduous and evergreen	Type 7: Wooded Swamp
Floodplain Forest	Palustrine; forested; broad-leaved deciduous	Type 1: Seasonally Flooded Basin or Flat
Seasonally Flooded Basin	Palustrine; forested; broad-leaved deciduous	Type 1: Seasonally Flooded Basin or Flat

The Minnesota Department of Natural Resources has developed a three-volume series of statewide plant community field guides organized by Minnesota's ecological provinces. These guides are intended to promote better understanding of the patterns and processes that characterize and influence Minnesota's upland and wetland vegetation. The guides contain keys to the identification of native plant communities in Minnesota and fact sheets with information on community composition and structure, landscape setting, soils, and natural history. Summaries of ecological systems highlight the ecological processes that shape the terrestrial and palustrine vegetation of the state. The field guides are intended for anyone interested in the variety and ecology of Minnesota's native vegetations. The hierarchical construction of the plant community classification and its linkage to ecological map units are specifically designed to meet the needs of land managers, field surveyors, and researchers working at a variety of scales.

Figure 1.6

1-3 Organization and Use

The Guide is structured to reflect the typical process that might be used when restoring a wetland. It is comprised of six unique sections that, if followed sequentially, will lead a user through the entire planning, design, implementation, management, and monitoring process.

The experience and training of each individual will influence how they approach and use the Guide. Professionals with training and experience in natural resource restoration may find it best to skip to a specific section, chapter, or technical guidance document. In contrast, nonprofessionals or those with limited experience may find it best to work through the Guide sequentially to better understand the complete process and all of the considerations involved in completing a successful project. In this case, the user should consult the Guide in the earliest stages of project consideration and follow the basic process defined by the section order.

The Guide has been designed to meet the needs of practitioners working on a variety of wetland projects ranging from landowner-initiated conservation projects to projects mandated to meet certain regulatory requirements. The Guide does not attempt to address policies, procedures, or implementation requirements of any specific regulatory or conservation program, nor does it intend to supplant any requirements that a particular program may have. For example, certain wetland regulatory programs in Minnesota may specify detailed requirements on what, how, when, and where to monitor a recently completed project. This may differ from the Guide's more generalized monitoring recommendations.

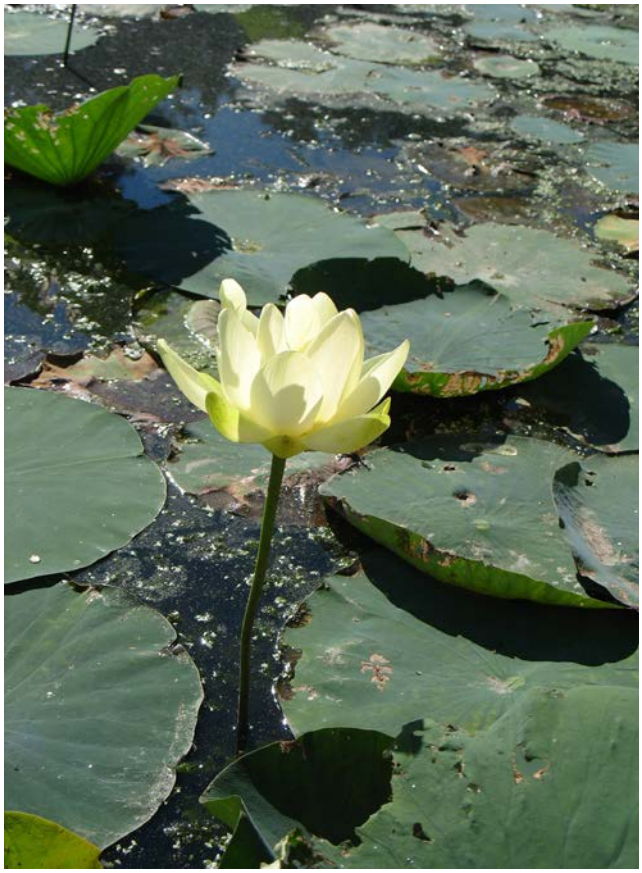
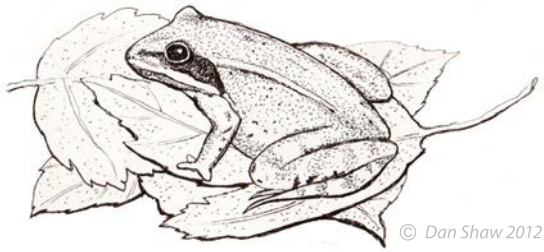


Figure 1.7 *White water lily*



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The Guide is divided into six sections: 1- Introduction; Identifying and Planning a Project, 2 - Site Assessment and Evaluation, 3 - Engineering Design and Construction, 4 - Vegetation Establishment, and 6 - Site Monitoring and Management. Although each section deals with a separate component or stage of a project's development, they are closely tied and should be used in a complementary fashion. Figure 1.8 diagrams the structure of the Guide and is followed by a summary of the contents of each section.

Minnesota Restoration Guide Structure

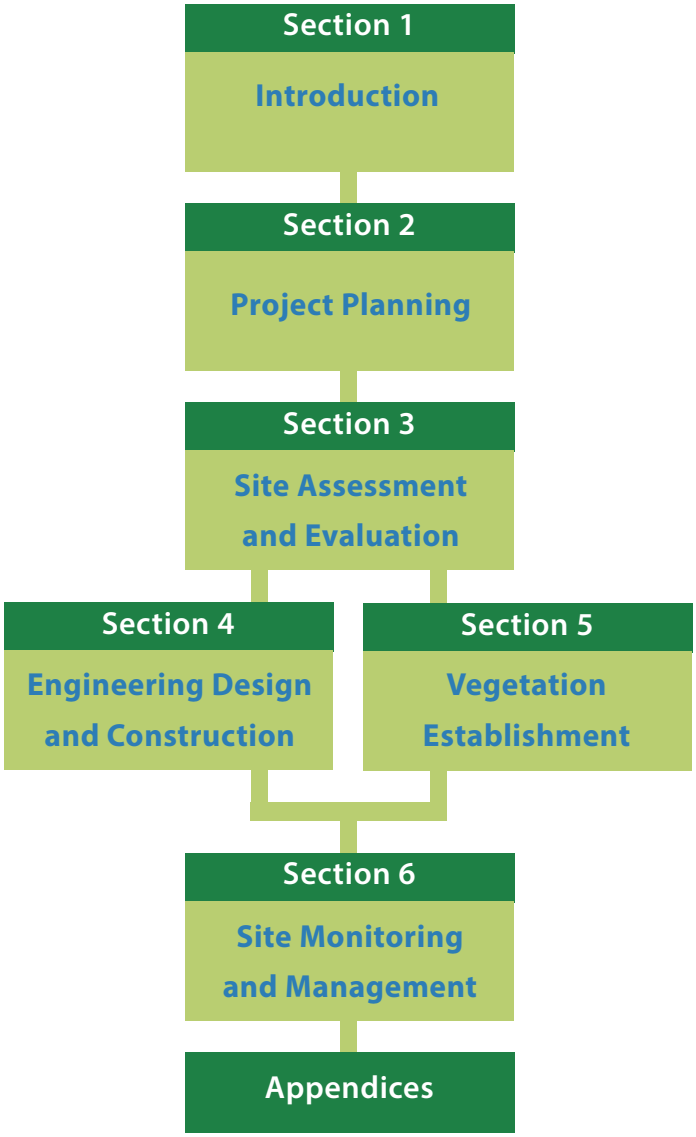
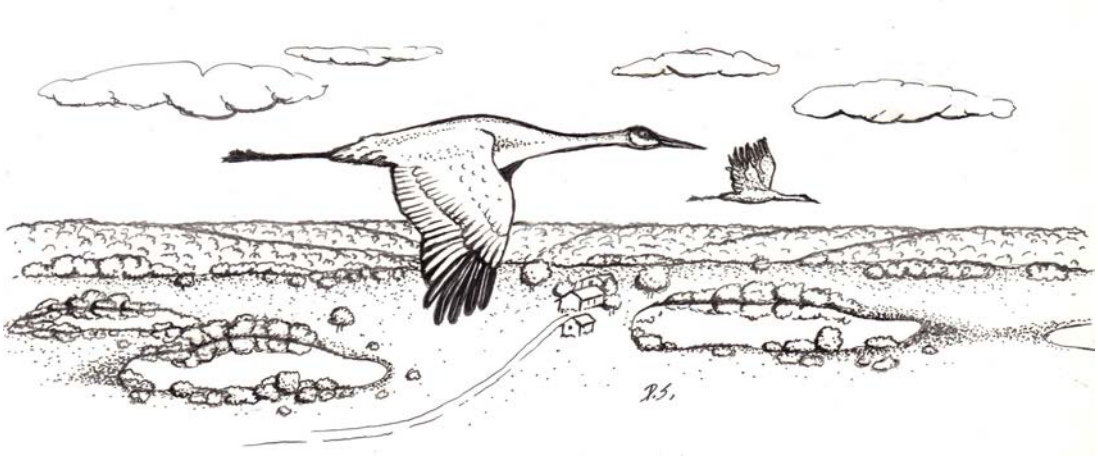


Figure 1.8. *Diagram of the Minnesota Restoration Guide Structure*



Section 1
Introduction

Introductory information such as the purpose, scope and definitions used in the Guide, information about how the Guide is organized and should be used, and background information about wetlands and their classification.

Section 2
Planning

Initial steps in planning and identifying a wetland restoration project including: identifying a site, purchasing the property or applying for program enrollment or project acceptance, assessing and evaluating the site, and then establishing specific goals, objectives, and measurable outcomes for a project.

Section 3
Site Assessment and Evaluation

Assessing and evaluating wetland restoration projects. Discusses the various methods used to investigate, survey, and collect site information and describes how this information fits into the overall project evaluation.

Section 4

Engineering Design and Construction

Comprehensive instruction for the use of hydrologic, hydraulic, and engineering design analyses, which are principles that apply to most types of restoration projects. Guidance on designing a project: prioritizing restoration strategies, and preparing construction plans, specifications, and contracts. Detailed information relating to coordinating project construction.

Section 5
Vegetation Establishment

Site preparation, establishment and short-term maintenance strategies for wetlands and surrounding uplands. Developing a vegetation plan and selecting specific seed mixes and plant materials best suited for each site.

Section 6
Site Monitoring and Management

Project monitoring and strategies for long-term site management of wetland and surrounding uplands. Recommended site monitoring schedules and inspection checklists are included as well as information about advanced site monitoring that allows for measurement of specific goals, objectives, and project outcomes or performance standards.

Appendices

Each section of the Guide, where applicable, has its own set of appendices. The information provided in each appendix varies by section and includes forms, checklists, drawings, details, etc. Also included in the appendices are a number of technical guidance documents with comprehensive details on specific items referenced in the text of the associated section. Included are specific documents for such topics as outlet structures, drainage manipulation strategies, and site maintenance strategies. These separate documents are intended to regularly be updated with the latest information and knowledge available.

Figure 1.9 *Sneezeweed in a restored wet meadow*

1-4 Acknowledgements

The Minnesota Wetland Restoration Guide has been developed to be a comprehensive document that address all types of wetland restoration conducted in Minnesota. As a result, professionals from a wide range of agencies and organizations were involved in its development. We would like to acknowledge the following individuals for their involvement in guiding the overall structure and development of the Guide:

Laurie Fairchild *(USFWS)*, Mark Gernes *(MPCA)*, Jyneen Thatcher *(Washington Conservation District)*, Al Kean *(BWSR)*, Doug Norris *(MDNR*), and Ray Norrgard *(MDNR)*.

Staff from the following agencies and organizations also played a key role in the development and review of the Guide: Anoka Conservation District, Barr Engineering, Martin County Soil and Water Conservation District, Minnesota Board of Water and Soil Resources, Minnesota Department of Agriculture, Minnesota Department of Natural Resources, Minnesota Department of Transportation, Minnesota Pollution Control Agency, United States Department of Agriculture Natural Resources Conservation Service, Prairie Restorations Inc., United States Army Corp of Engineers, United States Fish and Wildlife Service, University of Minnesota, Oakes Forestry, Pheasants Forever, and Ducks Unlimited.