

**Green Industry
Best Management Practices (BMPs)
for the Conservation and Protection
of Water Resources in Colorado**

Prepared for

The Green Industries of Colorado (GreenCO)
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Denver, CO 80222

Prepared by

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With support from:

The Colorado Water Conservation Board

Headwaters Consulting, LLC

Colorado Department of Public Health and Environment
Water Quality Control Division

(under a grant from the U.S. Environmental Protection Agency)



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May 2004

Dear GreenCO Member,

The following manual, "Green Industry Best Management Practices (BMPs) for the Conservation and Protection of Water Resources in Colorado" describes conservation practices for the Green Industry in Colorado. As a whole, GreenCO is dedicated to the conservation and preservation of all Colorado's precious resources which contribute to Colorado's natural environment and beauty. Since 1996, the Green Industries of Colorado (GreenCO) has been working with a diverse set of industry experts and partners to develop a water conservation and water quality protection program for its nine member associations. In May 2002, the first release of the BMP manual was developed and distributed to the green industry through the support of GreenCO, Wright Water Engineers, Inc., Colorado Water Conservation Board (CWCB), and Headwaters Consulting, LLC.

Coincidentally, following the initial release of the manual, the Green Industry was hit-hard by drought restrictions during 2002 and 2003. The drought has been a wake-up call for Green Industry professionals and communities alike, emphasizing that water conservation must become a way of life in Colorado, all the time, not just during a drought. In order to promote this reality to the Green Industry professionals and to provide increased training regarding water conservation practices, GreenCO decided to take the BMPs to the next level by revising the manual. A training course was also developed to accompany the manual.

The revisions were based on lessons learned from the drought experiences during 2002 and 2003. Key practices which were added include herbaceous plant care and water budgeting. The manual will continue to be updated periodically to remain current with the state-of-the-art practices for water conservation and water quality protection. If periodic updates are necessary, the GreenCO website will reflect the latest updates.

Although the BMP manual is copyrighted by GreenCO, it is our intent that this information be distributed widely amongst Green Industry professionals, municipalities, water districts, and others concerned with wise water use landscapes. Green Industry professionals should use this manual as general guidance with the recognition that some environmentally sensitive or drought-stricken areas may require modification of some practices.

Whether you're a Green Industry professional, homeowner, commercial property manager, or homebuilder, we hope you find this manual useful. If you have any questions, please contact GreenCO's Project Manager, Brenda O'Brien (brenda.obrien@comcast.net).

Sincerely,
GreenCO Board Members

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GreenCO BMPs

1. Drought and General Water Conservation Practices for Landscape Management
2. Drought and General Water Conservation Practices for Nurseries, Greenhouses and Growers
3. Education of Employees
4. Education of the Public
5. Fertilizer Application
6. Herbaceous Plant Care
7. Irrigation Efficiency (General Principles)
8. Irrigation System Design
9. Irrigation System Installation

10. Irrigation System Maintenance
11. Landscape Design
12. Landscape Installation and Erosion and Sediment Control
13. Landscape Maintenance
14. Lawn Aeration
15. Lawn Waste Disposal/Composting
16. Mowing
17. Mulching
18. Park, Golf Course and Other Large Landscape Design and Management
19. Pesticide and Herbicide Application
20. Pesticide, Fertilizer and Other Chemical Storage, Handling and Disposal
21. Plant Selection and Placement
22. Production Practices for Nurseries, Greenhouses and Growers
23. Regulatory Awareness and Compliance
24. Retail Practices for Nurseries, Greenhouses and Garden Centers
25. Revegetation of Drainageways
26. Riparian Buffer Preservation
27. Soil Amendment/Ground Preparation
28. Turf Management
29. Water Budgeting
30. Woody Plant Care
31. Xeriscape

Bibliography

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Appendix A: Basic Erosion and Sediment Control Practices

Appendix B: Permanent Stormwater BMPs

Appendix C: Summary of Potentially Applicable Regulations

Appendix D: Water Budget Calculator

Appendix E: Plant Water Requirement Estimates (Results of GreenCO/Colorado State University 2004 Crop Coefficient (Kc) Survey)

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The concept for this best management practices (BMP) manual was developed by the Green Industries of Colorado (GreenCO). The nine member industries of GreenCO that supported the development of this manual include the Associated Landscape Contractors of Colorado (ALCC), Colorado Chapter of the American Society of Landscape Architects (ASLA), Colorado Association of Lawn Care Professionals (CALCP), Colorado Greenhouse Growers Association (CGGA), Colorado Nursery Association (CNA), Garden Centers of Colorado (GCC), International Society of Arboriculture/Rocky Mountain Chapter (ISA/RMC), Rocky Mountain Sod Growers Association (RMSGGA), and Wholesale Florists of Colorado (WFC). In addition, the following agencies were invaluable partners in the development of this manual: Denver Water, Colorado State University (CSU) Cooperative Extension and Northern Colorado Water Conservancy District (NCWCD).

Development of the manual and its initial release was made possible through the Colorado Water Conservation Board, which provided funding for the manual in keeping with its goals of conserving, developing, protecting and managing Colorado's water for present and future generations. The Colorado Department of Public Health and Environment Water Quality Control Division provided funding for the revision and second release of the manual.

The authors, Jane Clary and Rachel Peterson of Wright Water Engineers, Inc., would like to thank Beth Conover and Genevieve Wozniak of Headwaters Consulting, who served as the overall project manager for GreenCO, as well as the GreenCO BMP Advisory Committee and other industry professionals who provided advice and review of the manual.

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Dick Ruppel, Horizon Turf, RMSGA
Don Schlup, Scienturfic, RMSGA
Kristen Sirovatka, ALCC
Paul Thomas, Wenk Associates
Keith Williamson, Little Valley Wholesale Nursery, CNA

In keeping with GreenCO's desire not to "reinvent the wheel" when high-quality information on relevant BMPs was already in existence, the following written materials were relied upon heavily and may have been partially reproduced or adapted into this manual:

- Colorado State University Cooperative Extension. 2004. *Planttalk* Colorado Web site: www.ext.colostate.edu/ptlk.
- Colorado State University Cooperative Extension. 2004. Gardening On-line Web site: www.coloradogardening.com.
- Denver Water. 2004. Denver Water Conservation and Xeriscape Web sites: http://www.denverwater.org/cons_xeriscape/cons_xeriscapeframe.html. Also Denver Water brochures. (*Particularly with regard to information related to Xeriscape, a term copyrighted by Denver Water in 1981.*)
- Irrigation Association Water Management Committee. 2001. *Turf and Landscape Irrigation Best Management Practices*. Falls Church, VA: Irrigation Association. Also see www.irrigation.org.
- Panter, K.L., S.E. Newman, and R.M. Waskom. 1998. *Pollution Prevention in Colorado Greenhouses*. XCM-206 (www.ext.colostate.edu/pubs/garden/xcm206.pdf). Ft. Collins, CO: Colorado State University Cooperative Extension.
- Urban Drainage and Flood Control District. 1999. *Urban Storm Drainage Criteria Manual, Volume 3, Stormwater Best Management Practices*. Denver, CO: UDFCD.
- Urban Drainage and Flood Control District. 2001. *Urban Storm Drainage Criteria Manual, Volume 2*. Denver, CO: UDFCD.

- Wright Water Engineers and Denver Regional Council of Governments. 1996. *Guidelines for Water Quality Enhancement at Golf Courses Through the Use of Best Management Practices*. Denver, CO: DRCOG.

Purpose and Limitations

The purpose of this manual is to consolidate and improve upon Green Industry Best Management Practices (BMPs) for the conservation of water resources and protection of water quality. These BMPs include a variety of design, installation, maintenance, grower and retail practices relevant to the Green Industry and the public that they serve. This document is an initial building block for the Green Industry to use in further developing common industry-wide standards.

This manual should be used to enhance the professional qualifications and judgement of the Green Industry—it is not a regulatory document. Green Industry professionals should use this manual as general guidance with the recognition that some environmentally sensitive or drought-stricken areas may require modification of these practices. This document is not a design manual; instead, it provides overviews of key BMPs and directs the user to relevant design and certification manuals, where appropriate.

As technological and horticultural advances occur, this manual will need to be updated periodically to remain current with the state-of-the-art practices for water conservation and water quality protection. For the most recent version of this manual, please refer to the GreenCO Web site (www.greenco.org) or the Colorado Water Conservation Board Web site (www.cwcb.state.co.us).

Background

The Green Industries of Colorado (GreenCO) is an umbrella trade organization representing the common interests of nine landscape-related trades:

- Associated Landscape Contractors of Colorado (ALCC)
- Colorado Chapter of the American Society of Landscape Architects (ASLA)
- Colorado Association of Lawn Care Professionals (CALCP)
- Colorado Greenhouse Growers Association (CGGA)
- Colorado Nursery Association (CNA)
- Garden Centers of Colorado (GCC)
- International Society of Arboriculture/Rocky Mountain Chapter (ISA/RMC)
- Rocky Mountain Sod Growers Association (RMSGGA)
- Wholesale Florists of Colorado (WFC)

GreenCO members represent diverse interests including sod growers, landscape architects, greenhouse growers, nurseries, retailers, contractors, lawn care professionals, arborists and florists. Each of GreenCO's members has in common an economic dependence on built landscapes.

In 1996, GreenCO began working to help the Green Industry develop an understanding and strategy to respond to challenges posed to the industry by potential water shortages related to either population growth or drought. Representatives from GreenCO's nine trade associations worked with diverse partners including Colorado State University Cooperative Extension, the Colorado WaterWise Council, Denver Water and the Colorado Water Resources Research Institute. GreenCO worked proactively to support water conservation and quality goals without specific regulatory pressure.

Looking to the future, GreenCO recognizes that the economic health of the industry and the health of the state's water resources are inextricably linked. Its water-related goals are to:

- Realize significant, measurable improvements in water quality and conservation statewide through improved and efficient landscape practices.
- Ensure the future health and competitiveness of the Green Industry in Colorado in the face of new standards and regulations.
- Provide improved water management tools and resources for GreenCO member businesses and their customers.

To realize these goals, GreenCO identified the development of industry-wide BMPs as a first step toward getting its “house in order” by compiling and improving industry-wide standards for tools and technologies that support water conservation and quality.

Definition of Best Management Practices (BMPs) and Principles

The simplest way to define a BMP for purposes of this manual is a voluntary activity undertaken to reduce water consumption and protect water quality. Appropriateness of the BMPs may vary depending on site-specific and regional conditions. The term BMP has been selected for use in this manual primarily for consistency with other national and international efforts to protect water quality. For example, the U.S. Environmental Protection Agency (EPA), the state of Colorado (including the Nonpoint Source Council and the Water Quality Control Division), regional organizations such as the Denver Regional Council of Governments, local governments, as well as many others, have retained the term BMP in ordinances, regulations and guidance manuals.

Most of the BMPs in this manual are relevant to both water quality and water conservation and are based on these basic principles:

1. Healthy landscapes enhance water quality and the environment. Inclusion of green areas in urban settings helps minimize pollutant-laden runoff to waterbodies and allows precipitation in urban areas to infiltrate into the soil, rather than overload natural drainageways. Landscape features such as grass swales, vegetated buffer strips along waterways, constructed wetlands and other well-vegetated areas are key components of good stormwater management. Well-vegetated areas are particularly important in reducing sediment loading to streams and lakes.
2. Over-irrigation is the leading source of water waste in landscaping. Landscapes (including their irrigation systems) are water-efficient when they are properly designed, installed and maintained according to sound landscaping and water conservation principles. The term "Xeriscape" was copyrighted by Denver Water in 1981 to help make water-conserving landscaping an easily recognized concept based on these seven principles: comprehensively designed landscapes, healthy soil, practical turf areas, proper plant selection and placement, efficient irrigation, mulching and good maintenance.
3. Water budgeting is an effective tool for designing and maintaining water-efficient landscapes during both normal and drought conditions. An outdoor water budget identifies the amount of water needed for healthy landscapes. Comparison of actual water used to the water budget provides a basis for adjusting water usage to reduce water waste.
4. It is easier to prevent or reduce pollution by controlling it at its source, rather than correcting its impacts. For the Green Industry, this means minimizing runoff from landscapes, properly applying and/or minimizing pesticide and fertilizer usage, and minimizing erosion and sediment-laden runoff at landscaping sites.

5. Both improved water quality and water conservation are dependent on behavior changes. Education of both the end user (homeowner/landscape owner) and Green Industry professionals (growers, retail owners, landscape designers, installation and maintenance professionals) is necessary for behavior change to occur. It takes more than a nice manual on a shelf for improved water quality and conservation to happen. BMPs must be integrated into a variety of Green Industry professional training and certification programs and actually put into practice in the field. Both Green Industry businesses and the public must recognize the value of water quality and water conservation, and the consequences of failing to implement these BMPs, in order for behavioral change to occur.

List of BMPs

Hundreds of individual practices have been consolidated into 31 general BMPs described in this document and summarized by industry in Table 1 including:

1. Drought and General Water Conservation Practices for Landscape Management
2. Drought and General Water Conservation Practices for Nurseries, Greenhouses and Growers
3. Education of Employees
4. Education of the Public
5. Herbaceous Plant Care
6. Fertilizer Application
7. Irrigation Efficiency (General Principles)
8. Irrigation System Design
9. Irrigation System Installation
10. Irrigation System Maintenance
11. Landscape Design
12. Landscape Installation and Erosion and Sediment Control
13. Landscape Maintenance
14. Lawn Aeration
15. Lawn Waste Disposal/Composting
16. Mowing

17. Mulching
18. Park, Golf Course and Other Large Landscape Design and Management
19. Pesticide and Herbicide Application
20. Pesticide, Fertilizer and Other Chemical Storage, Handling and Disposal
21. Plant Selection and Placement
22. Production Practices for Nurseries, Greenhouses and Growers
23. Regulatory Awareness and Compliance
24. Retail Practices for Nurseries, Greenhouses and Garden Centers
25. Revegetation of Drainageways
26. Riparian Buffer Preservation
27. Soil Amendment/Ground Preparation
28. Turf Management
29. Water Budgeting
30. Woody Plant Care
31. Xeriscape

**Table 1
Summary of GreenCO BMPs by Industry**

BMP	BMP Description	Member Industries								
		ASLA	ALCC	CALCP	CGGA	CNA	GCC	ISA	RMSGGA	WFC
Drought and General Water Conservation Practices for Landscapes	Manage landscapes using the most water-efficient techniques during drought conditions.	X	X	X	X	X	X	X	X	
Drought and General Water Conservation Practices for Nurseries, Greenhouses and Growers	Properly irrigate nursery and greenhouse crops with the minimum amount of water waste during drought conditions.				X	X	X	X	X	
Education of Employees	Educate industry employees on water quality and water conservation practices.	X	X	X	X	X	X	X	X	X
Education of the Public	Model and teach water conservation and water pollution prevention to the general public and consumers of green industry products.	X	X	X	X	X	X	X	X	X
Fertilizer Application	Properly apply fertilizers, based on the specific needs of plants, particularly as identified by appropriate soil or plant tissue tests.		X	X	X	X	X	X	X	
Herbaceous Plant Care	Properly plant and maintain herbaceous plants to maximize plant health and conserve water.	X	X	X	X	X	X	X		
Irrigation Efficiency	Properly design, install and maintain irrigation systems to ensure uniform and efficient distribution of water, thereby conserving water and protecting water resources.	X	X	X	X	X	X	X	X	
Irrigation System Design	Design the irrigation system for the efficient and uniform distribution of water.	X	X	X	X	X	X	X	X	
Irrigation System Installation	Install the irrigation system according to the irrigation design specifications, which should be in accordance with manufacturer's specifications, local code requirements and sound principles of efficient and uniform water distribution.		X	X	X	X	X	X	X	
Irrigation System Maintenance	Maintain the irrigation system for optimum performance, ensuring efficient and uniform distribution of water. Modify the irrigation system as needed to provide supplemental water for maintaining healthy plants without wasting water.		X	X	X	X	X	X	X	
Landscape Design	Plan and design landscaping comprehensively to conserve water and protect water quality.	X	X	X	X	X	X	X	X	
Landscape Installation/Erosion and Sediment Control	Minimize erosion and control sediment leaving the construction site during landscape installation.	X	X	X		X		X	X	
Landscape Maintenance	Practice landscape maintenance appropriate for the site including practices such as pruning, weeding, mulching, fertilization and attention to the irrigation system.		X	X				X	X	
Lawn Aeration	Aerate lawns to reduce thatch, thereby improving nutrient and water uptake, reducing runoff and reducing compaction.		X	X					X	
Lawn Waste Disposal/Composting	Dispose of yard waste to minimize adverse impacts to the environment by keeping waste out of storm drains. Recycle and compost organic materials whenever possible.		X	X	X	X	X	X	X	
Mowing	Mow lawns to the proper height and at the proper frequency to maintain turfgrass health, thereby minimizing the need for pesticide and fertilizer application and reducing water usage.		X	X					X	
Mulching	Use organic mulches to reduce water loss through evaporation, to reduce soil loss due to exposure to wind and runoff, to suppress weeds, and to provide a more uniform soil temperature.		X	X	X	X	X	X		
Park, Golf Course and Other Large Landscape Design and Management	Large landscaped areas such as parks and golf courses should be well designed and properly managed to be an environmental amenity and to minimize runoff to waterbodies.	X	X	X				X	X	
Pesticide and Herbicide Application	Apply pesticides and herbicides at minimal levels in accordance with the label and targeted to specific disease and weed problems.		X	X	X	X	X	X	X	
Pesticide, Fertilizer and Other Chemical Storage, Handling and Disposal	Pesticides, herbicides, fertilizers, fuel and other maintenance chemicals must be properly applied, stored, handled and disposed of to prevent contamination of surface water and groundwater.		X	X	X	X	X	X	X	
Plant Selection and Placement	Select appropriate plants for the site, place plants in appropriate locations and group plants according to similar water needs (i.e., "hydrozoning").	X	X	X	X	X	X	X	X	
Production Practices for Nurseries, Greenhouses and Growers	Nurseries, greenhouses and other growers should implement a variety of source, structural, cultural and managerial controls to minimize pollution of water resources. Irrigation practices that minimize off-site transport of pollutants also typically conserve water.				X	X		X	X	
Regulatory Awareness	A variety of local, state and federal environmental regulations impact landscaping and nursery operations. Green industry professional should be aware of these regulations and comply with their requirements.	X	X	X	X	X	X	X	X	X
Retail Practices for Nurseries, Greenhouses and Garden Centers	Retail businesses should operate in a manner to maintain the health of plants, to conserve water and to promote water conservation and water resource protection to the general public.				X	X	X	X	X	
Revegetation of Drainageways	Establishment of a robust cover of vegetation is critical to the proper functioning of engineered drainage structures such as grass-lined channels, detention basins, retention ponds, and wetlands.	X	X	X				X	X	
Riparian Buffer Zone Preservation	Preserve wide, undisturbed natural riparian areas along streams.	X	X	X				X		
Soil Amendment/Ground Preparation	Evaluate soil and improve, if necessary, to promote efficient water usage and healthy plants.	X	X	X	X	X	X	X	X	
Turf Management	Plan, properly install and maintain practical turf areas.	X	X	X					X	
Water Budgeting	Calculate the water needs of irrigated landscapes based on plant types, land area and irrigation system efficiency. Use the calculated water budget to apply water according to the needs of the plants and manage irrigation.	X	X	X	X	X	X	X	X	
Woody Plant Care	Properly plant and maintain prune or trim trees, shrubs and other woody plants to maximize the plants' health.	X	X	X	X	X	X	X		
Xeriscape	Implement the seven basic landscape principles of Xeriscape: planning and design, soil improvement, zoning of plants, practical turf areas, efficient irrigation, mulching and appropriate maintenance.	X	X	X	X	X	X	X	X	

ASLA = American Society of Landscape Architects
ALCC = Associated Landscape Contractors of Colorado, Inc.
CALCP = Colorado Association of Lawn Care Professionals
CGGA = Colorado Greenhouse Growers Association
CNA = Colorado Nursery Association
GCC = Garden Centers of Colorado
ISA = International Society of Arboriculture
RMSGGA = Rocky Mountain Sod Growers Association
WFC = Wholesale Florists of Colorado

Organization of BMP Descriptions

The BMPs in this manual are listed alphabetically. Each of the BMP descriptions is in the form of a fact sheet including the following information:

- Brief description of the BMP.
- Identification of the BMP's applicability to design, installation, maintenance, grower or operation activities.
- Identification of the BMP's relevance to various GreenCO member industries.
- Basic practice guidelines to follow when implementing the BMP.
- Regional or industry considerations/adaptations.
- Key references for more detailed information.

The discussion of each BMP is limited to several pages with the intention that the BMP sheets can be taken out of this notebook for easy reference and distribution. Because it is expected that users of this manual may focus on individual BMPs rather than the manual in its entirety, there may be redundancy among some BMP descriptions. Efforts have been made to minimize this redundancy by cross-referencing the user to related BMPs.

One important aspect of the BMP descriptions focuses on regional considerations for implementation of the BMP. Because climate and topographic conditions along the Front Range vary considerably from the western slope of Colorado, some practices that work well in one location may not work well in others, or may require special adaptations. Where appropriate, these types of considerations have been identified in the BMP descriptions.

This BMP manual is not intended to serve as a design and specification manual; instead, it compiles and summarizes into one document the key BMPs spread across the nine trades within the Green Industry. For many of the BMPs, entire workbooks and certification manuals are already in place, providing detailed guidance on the practice. In these cases, the "key references" identified in the BMP fact sheets can be obtained for more detailed guidance. A comprehensive list of these references is also provided at the end of this document.

Literature Review

A key component of this project was to identify to the degree to which the Green Industry BMPs have been developed. As a companion to this manual, a notebook of existing publications has been compiled. As a credit to the environmental awareness already present in the Green Industry, the majority of the BMPs included in this manual already have high quality publications, brochures and other materials available from multiple sources. Most of the industry certification manuals also cover many of these BMPs. The challenge to the Green Industry is ensuring that BMPs are implemented more broadly among its individual members. This manual will serve as a key step towards achieving this goal.

In general, the written information on Green Industry water conservation and water quality BMPs was consistent among sources, at least in principle, even if the details of the practice varied somewhat. Given the broad scope of this manual, primary emphasis has been given to communicating the basic principles. Where differing recommendations exist with regard to supporting details for the BMP, the source of the recommendation has been provided with an acknowledgement that recommendations may vary among industry professionals. An example relates to fertilizer application. Most key sources agree on the basic principles that fertilizer application should be timed to the needs of the plants and that fertilizer should not be over-applied. However, significant variation in recommended fertilizer application rates exists among references and member industries. In the case of lawn fertilizer application, a table of recommendations prepared by CSU Cooperative Extension experts was included as reasonable guidance for the industry with an acknowledgement that best professional judgement and site conditions should be taken into consideration.

Some of the key information sources that industry professionals may be interested in obtaining that have been important resources in developing this manual include industry certification manuals, industry web sites, local government ordinances, CSU Cooperative Extension resources, publications developed in other states experiencing water shortages and several other key resources. A few of the most relevant resources from over 200 documents used in development of this manual are listed below.

Industry Certification Manuals

Associated Landscape Contractors of America

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