Maintaining Post Construction (Permanent) BMPs

Tom Williams
Stormwater
Utility Manager
Town of Parker

Erik Nelson
Stormwater
Management Engineer
Douglas County

Parker Stormwater Utility

- Created in 1999 to fund Drainage and Flood Control Program and Phase II Permit (including Post-Construction BMP Maintenance Program)
- Rate of $5.50/month for SFRP
- Non-Residential Property rate based on impervious area
- In 2009 rate will increase to $6.00/month
- Will automatically increase every year starting in 2010 based on Consumer Price Index (to offset inflation)
- Utility serves population of approximately 45,000 citizens

Town of Parker COLORADO

Parker Stormwater Utility

- Division of Public Works Department
- Staff includes:
  - 6 full-time Operations/Maintenance Staff
  - 4 Seasonal Staff
  - 3 Engineers
  - 1 Manager
  - Administrative and Finance Staff shared with other Departments

Town of Parker COLORADO

Post-Construction BMP Background

- Town has required Post-Construction BMPs as part of new development since 1998
- Approximately 100 existing Post-Construction BMPs in Town (primarily EDBs)
- 10 existing Regional Post-Construction BMPs that receive maintenance assistance through Urban Drainage and Flood Control District (all EDBs)
- In 2002 Town adopted UDFCD Volume 3 Criteria to provide better guidance for design engineers

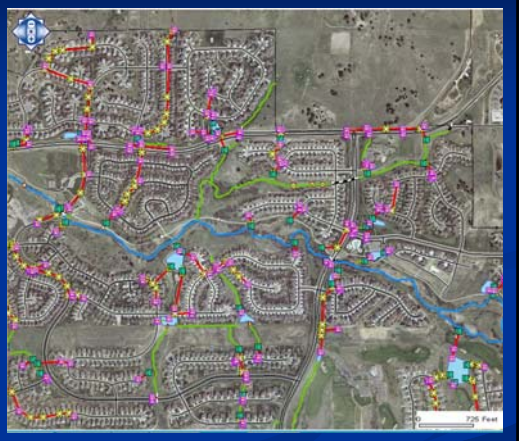
Where are your Post-Construction BMPs?

Hopefully, not here!

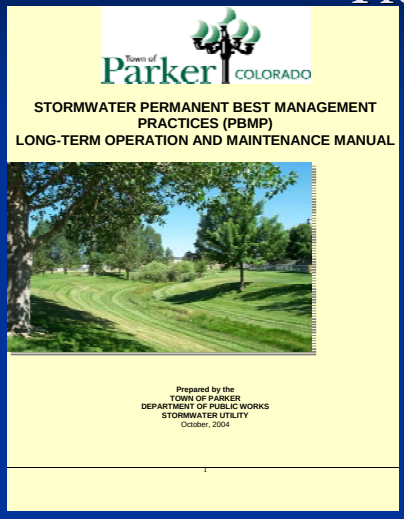
- In 2000, the Town performed an inventory of all stormwater facilities within corporate limits
- The inventory included Post-Construction BMPs
- GPS receivers with data dictionaries were used to keep track of information collected
- An inspection of each facility was performed during inventory
- Each facility was assigned a unique ID number
- Information collected is foundation of Maintenance Program

Parker GIS System

- The stormwater facility information collected was uploaded into Town GIS system
- This information is used by Stormwater Utility staff, utility locating staff, development review engineers and planners
- As new stormwater infrastructure is built (capital or development projects), Town criteria requires electronic as-builts are submitted to ensure new Post-Construction BMPs are properly located and inventoried
- Stormwater GIS system reviewed annually to keep it current



Post-Construction BMP Inspection Program

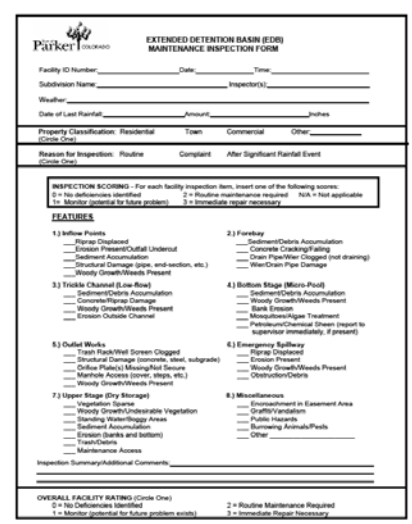


- In 2004, the Town developed a Post-Construction BMP Long-Term O&M Manual
- Manual provides a general overview on Post-Construction BMP functions and standard components/features
- Focused primarily on EDBs
- Provides training guidelines and protocols for inspections "What to look for"

Inspection Program

- All Post-Construction BMPs are inspected at least annually by maintenance staff
- All detention ponds (including EDBs) inspected annually
- All other drainage infrastructure (storm sewer, inlets, culverts, etc.) are inspected at least once every 5 years

Post-Construction BMP Inspection Program



EXTENDED DETENTION BASIN (EDB)
MAINTENANCE INSPECTION FORM

Facility ID Number:_____ Date:_____ Time:_____

Subdivision Name:_____ Inspector(s):_____

Weather:_____

Date of Last Rainfall:_____ Amount:_____ Inches

Property Classification: (Circle One) Residential Town Commercial Other_____

Reason for Inspection: (Circle One) Routine Complaint After Significant Rainfall Event

INSPECTION SCORING - For each facility inspection item, insert one of the following scores:
0 = No deficiencies identified 2 = Routine maintenance required N/A = Not applicable
1= Monitor (potential for future problem) 3 = Immediate repair necessary

FEATURES

1.) Inflow Points
___ Riprap Displaced
___ Erosion Present/Outfall Undercut
___ Sediment Accumulation
___ Structural Damage (pipe, end-section, etc.)
___ Woody Growth/Weeds Present

2.) Forebay
___ Sediment/Debris Accumulation
___ Concrete Cracking/Failing
___ Drain Pipe/Weir Clogged (not draining)
___ Weir/Drain Pipe Damage

3.) Trickle Channel (Low-flow)
___ Sediment/Debris Accumulation
___ Concrete/Riprap Damage
___ Woody Growth/Weeds Present
___ Erosion Outside Channel

4.) Bottom Stage (Micro-Pool)
___ Sediment/Debris Accumulation
___ Woody Growth/Weeds Present
___ Bank Erosion
___ Mosquitoes/Algae Treatment
___ Petroleum/Chemical Sheen (report to supervisor immediately, if present)

5.) Outlet Works
___ Trash Rack/Well Screen Clogged
___ Structural Damage (concrete, steel, subgrade)
___ Orifice Plate(s) Missing/Not Secure
___ Manhole Access (cover, steps, etc.)
___ Woody Growth/Weeds Present

6.) Emergency Spillway
___ Riprap Displaced
___ Erosion Present
___ Woody Growth/Weeds Present
___ Obstruction/Debris

7.) Upper Stage (Dry Storage)
___ Vegetation Sparse
___ Woody Growth/Undesirable Vegetation
___ Standing Water/Boggy Areas
___ Sediment Accumulation
___ Erosion (banks and bottom)
___ Trash/Debris
___ Maintenance Access

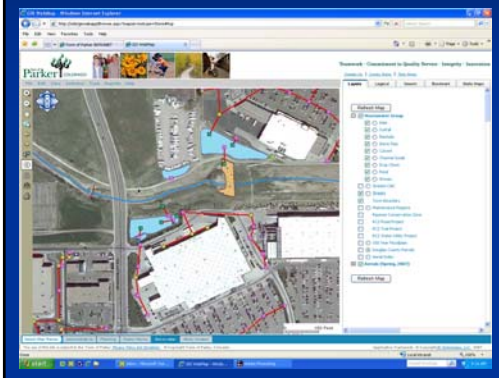
8.) Miscellaneous
___ Encroachment in Easement Area
___ Graffiti/Vandalism
___ Public Hazards
___ Burrowing Animals/Pests
___ Other _____

Inspection Summary/Additional Comments:_____

OVERALL FACILITY RATING (Circle One)
0 = No Deficiencies Identified 2 = Routine Maintenance Required
1 = Monitor (potential for future problem exists) 3 = Immediate Repair Necessary

- Inspection forms included in the O&M Manual
- Forms include information specific to each type of BMP (i.e. EDB, Grass Swale, etc.)
- Deficiencies/problems are documented on inspection forms
- Every facility receives an overall rating
- Information for each facility is then uploaded into GIS system for use in the maintenance program

GIS Web System



- IT and Engineering staff developed internal website-system linked to GIS Stormwater information
- Maintenance staff can perform queries on desktop computers based on facility type, facility inspection rating, maintenance needs, and location
- Web-system allows maintenance staff to produce/print maps of facilities that are in need of maintenance and inspection report information
- After required maintenance is performed, maintenance report is then uploaded into GIS system to update facility rating/condition

Routine Maintenance Program

Cleaning debris from outlet structure

Mowing of pond bank

- Routine Maintenance activities include:
  - Trash and debris removal
  - Mowing and trimming of native areas
  - Weed Control
  - Outlet Structure cleaning
  - May also include mosquito abatement (however, if necessary, BMP is most likely not designed correctly or needs maintenance

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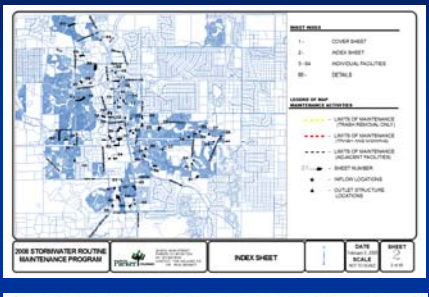
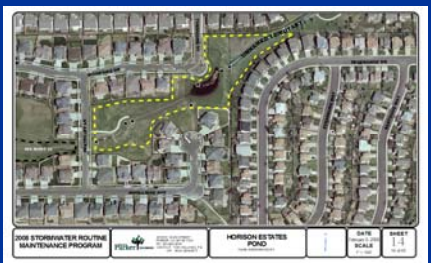
Routine Maintenance?

Van in EDB Forebay

Routine Maintenance Program





- Town's Routine Maintenance Program is primarily performed by outside contractors and seasonal employees
- Town has realized significant cost savings using outside contractors versus in-house staff for routine maintenance program
- UDFCD utilizes several contractors familiar with routine maintenance of drainage facilities
- Routine maintenance performed 3-4 times annually for each post-construction BMP

Restoration Maintenance Program

- Town's Restoration Maintenance program performed primarily by trained in-house staff
- Includes a variety of isolated or small-scale problems that can be addressed by small crews and equipment
- May require guidance from engineering staff depending on activity
- Stormwater Utility Fleet includes a variety of specialized equipment for restoration maintenance which includes:
  - Tracked Skid Steer (low bearing pressure – ideal for saturated conditions)
  - Mini Excavator (for confined/tight areas – smaller BMPs)
  - Small(er) Dump Trucks (tight/confined areas)
  - Jet-Vacuum Machine
  - Back-Hoe

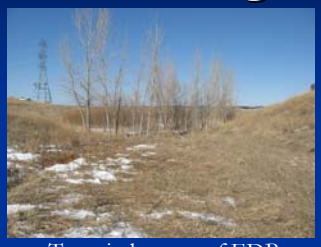
Restoration Maintenance Program Sediment Removal

Tracked Skid Steers

Mini Excavator

- EDB Restoration Maintenance activities includes sediment removal from:
  - Forebays
  - Micro-Pools
  - Trickle channels
  - Outfalls
- Frequency depends on tributary basin characteristics:
  - Residential vs. Commercial
  - Size of tributary basin
  - Construction BMPs implemented during basin development (KEY)

Restoration Maintenance Program
Vegetation Management



Trees in bottom of EDB

After Picture

- Vegetation management is critical in function of Post-Construction BMPs
- Dense woody vegetation in bottom of facilities and adjacent to structures should be removed
- Can clog under-drains and damage structures
- Routine mowing and thinning can help manage
- Remove before they become too big and neighbors fall in love with them
- Will have to be removed anyhow during major dredging operations

Restoration Maintenance Program

- Other program elements
  - Minor structural repairs
  - Erosion repairs to outfalls, trickle channels, basin embankments, spillways
  - Jet-Vacuum cleaning of outlet structure, pipes, drains
  - Re-vegetation

Rehabilitation Maintenance Program

- Town's Rehabilitation Maintenance program performed primarily by outside contractors and occasionally in-house trained staff
- Work consists of larger maintenance/operational problems and failures of post-construction BMPs
- Most work requires consultation with engineering staff to review original designs/as-builts or to prepare design/details for improvements to facilities
- Typically requires specialized maintenance equipment and operators
- May also require assistance from specialized contractors and consultants
- UDFCD a good resource for contractors and consultants with experience for this type of maintenance

Rehabilitation Maintenance Program Sediment Removal/Dredging

Long-Reach Excavators

Dredging retention pond

- EDB rehabilitation activities includes sediment removal from upper and lower stages
- Very expensive, time consuming, and disruptive to facility, surrounding area, and community
- Frequency depends on routine and restoration maintenance programs
- If routine and restoration maintenance is neglected, rehabilitation activities will be necessary as frequently as once every 10 years*
- If routine and restoration maintenance efforts are constant, may only be necessary once every 20 years (or longer)

Rehabilitation Maintenance Program Additional Elements

EDB Rehabilitation

Outlet Structure Improvements

- EDB rehabilitation activities include structural repair to forebays, outlet structures, trickle channels, energy dissipaters, outfalls, spillways
- Also include major erosion repair activities that involves extensive grading and erosion protection
- A quality inspection and restoration maintenance program can reduce costs

Town of Parker COLORADO

Post-Construction BMP Maintenance

- NPDES Phase I and II permits require post-construction BMPs as part of all new development
- Thousands of these facilities have been constructed in Colorado over the past 10 years (and thousands more are still to come)
- The vast majority are owned and operated by HOAs and other groups that have very little or no experience on proper maintenance and operation
- The necessary routine and restoration maintenance is being neglected for the vast majority of these facilities in Colorado
- When these facilities do fail, rehabilitation costs will be astronomical
- If you have not started, get started now!!!!

Douglas County Department of Public Works – Engineering Division

Staff includes:

- Director of Engineering Services
- Development Review Manager
- Environmental Engineer
- Drainage Engineer
- Stormwater Management Engineer
- Water Quality Technician
- 7 Development Review Engineers
- 3 Erosion (GESC) Inspectors
- 5 Engineering Inspectors
- Agreements Technician

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Douglas County Department of Public Works – Operations Division

Staff includes:

- Road & Bridge Manger
- 1 Special Projects Supervisor
- 6 Special Projects
- 2 Weed Control Specialists
- 4 Mower Operators

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Post-Construction BMP Background

- Douglas County criteria has required Post-Construction BMPs as part of new development since 1986
- Approximately 561 existing Post-Construction BMPs in County. 509 detention facilities, 36 water quality facilities and 16 retention facilities
- The County has utilized UDFCD Volume 3 Criteria since 1992 and is in the process of updating it's 1986 manual.

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Douglas County Current Operation and Maintenance Program for Post Construction (Permanent) BMPs

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Plat Note

- For "as long as we can remember" which means at least 15 years Douglas County has required a plat note for maintenance of stormwater facilities
- **Drainage easements are hereby granted to Douglas County across __ through __, for the purpose of accessing, maintaining, and repairing storm water management improvements**, including, but not limited to, inlets, pipes, culverts, channels, ditches, hydraulic structures, riprap, detention basins, forebays, micro-pools, and water quality facilities (collectively, the "Facilities") in the event the _____, its successors, and assigns ("System Owner") fails to satisfactorily maintain or repair said Facilities. A blanket access easement over the Subdivision is also granted to Douglas County, but only for the purpose of accessing the Facilities in the event that the drainage easements do not provide adequate access.
- **The maintenance and repair of the Facilities located in the Subdivision, as shown on the construction plans accepted by Douglas County or on the plat for the Subdivision, shall be the responsibility of the System Owner**. In the event such maintenance and repair are not performed by the System Owner to the satisfaction of Douglas County, then Douglas County shall have the right, but not the obligation, to enter said Subdivision, after ten (10) days prior written notice to the System Owner, unless there is an emergency, in which case Douglas County shall give notice as soon as practicable, to perform all necessary work, the cost of which shall be paid by the System Owner upon billing. In the event the System Owner fails to reimburse Douglas County within thirty (30) days after submission of the bill for the costs incurred, Douglas County shall have the right to enforce such obligation by appropriate legal action. It is the System Owner's responsibility to construct, maintain, and repair the Facilities in a manner consistent with all applicable plans approved or accepted by Douglas County.

Stormwater Information Management System

- The stormwater facility information was collected by summer interns
- Information uploading into County SWIM System
- This information is used by stormwater staff, development review engineers and inspectors
- As new infrastructure is built the County requires electronic as-builts'. As-builts' are then added to system

DOUGLAS COUNTY COLORADO

Conducting Regular Inspection of Post Construction BMPs Within Our Permit boundary

- Inspect each water quality facility within our NPDES Phase II permit Boundary
- Limited maintenance necessary due to limited amount of time in service

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Douglas County Proposed Operation and Maintenance Program

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Operating Permit Program

- Requires all owners for stormwater facilities to obtain an annual permit to ensure they perform required maintenance
- Requires owners to create or obtain Operation and Maintenance Manuals
- Enforced through stormwater ordinance

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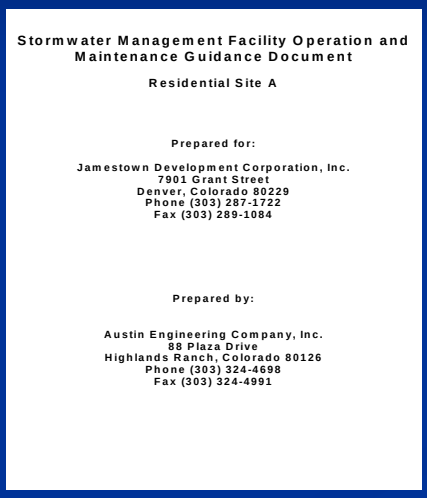
Operation and Maintenance Manuals



Stormwater Management Facility Operation and Maintenance Guidance Document

Residential Site A

Prepared for:

Jamestown Development Corporation, Inc.
7901 Grant Street
Denver, Colorado 80229
Phone (303) 287-1722
Fax (303) 289-1084

Prepared by:

Austin Engineering Company, Inc.
88 Plaza Drive
Highlands Ranch, Colorado 80126
Phone (303) 324-4698
Fax (303) 324-4991

- Fill in the blank template which was a modified version of Parker's Manual which is based on UDFCD's Guidance
- Developed and submitted with final design by the design engineer

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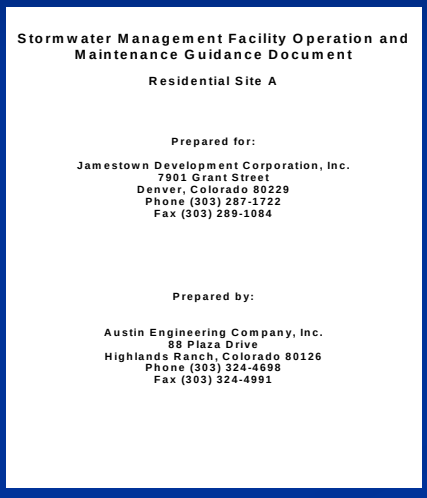
Operation and Maintenance Manual



Stormwater Management Facility Operation and Maintenance Guidance Document

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88 Plaza Drive
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Phone (303) 324-4698
Fax (303) 324-4991

- Provides guidance for homeowners associations or districts that may be responsible for facility maintenance
- For most approved project Douglas County has developed a manual for the project

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Operation and Maintenance Manual

- Document framework will be provided in an appendix
- It will provide general information relative to the inspection and maintenance of stormwater facilities, inspection equipment, and safety
- It will provide standard operating procedures for inspection and maintenance of specific BMPs and detention ponds
- It will provide standard inspection and maintenance forms

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Operation and Maintenance Manual

- Designer must provide specific information regarding the site or project, locations, sizes, and types of facilities, and access to facilities
- Designer must provide an overall site plan showing facility locations, public streets, and access locations
- Designer must provide a copy of the facility construction drawings

DOUGLAS COUNTY COLORADO

Douglas County, Colorado
Stormwater Management Facility Operation and Maintenance Manual

Project Name

Prepared for:

Developers Name
Developers Address
Developers Address 2
Developers City State and Zip Code
Developers Phone Number
Developers Fax Number

Prepared by:

Engineering Company
Engineers Address
Engineers Address 2
Engineers City State Zip Code
Engineers Phone Number
Engineers Fax Number

Reference:
This manual is adapted from Town of Parker, Colorado, *STORMWATER PERMANENT BEST MANAGEMENT PRACTICES (PBMP) LONG-TERM OPERATION AND MAINTENANCE MANUAL*, October 2004

DOUGLAS COUNTY COLORADO

Stormwater Management Facility Operation and Maintenance (O&M) Manual

Project Name

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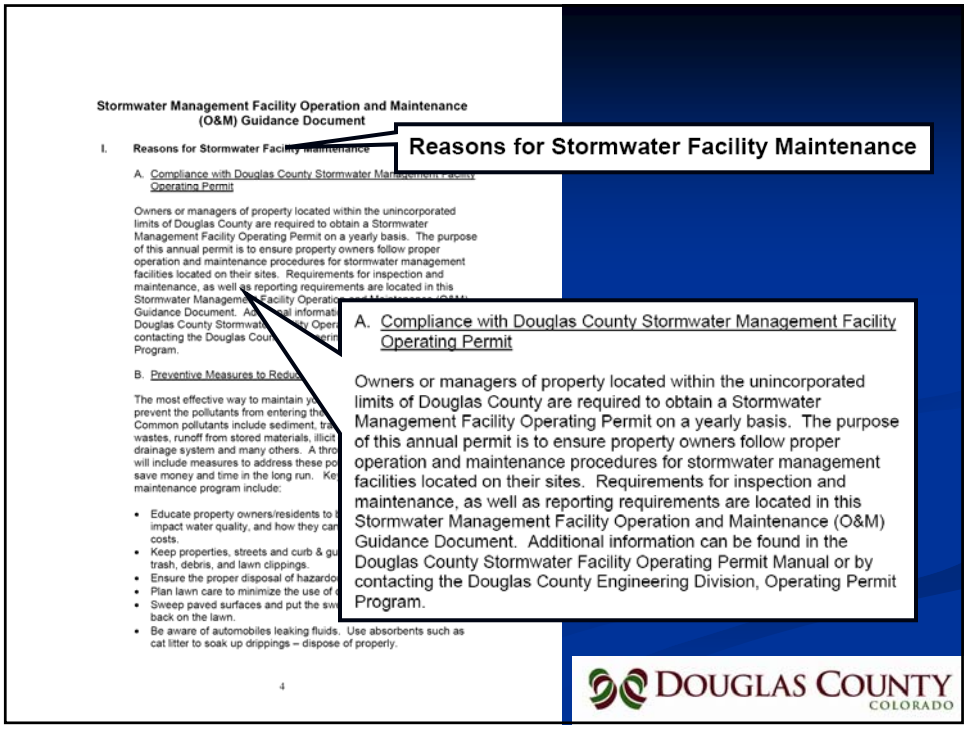
Stormwater Management Facility Operation and Maintenance
(O&M) Guidance Document
I. Reasons for Stormwater Facility Maintenance
A. Compliance with Douglas County Stormwater Management Facility Operating Permit
Owners or managers of property located within the unincorporated limits of Douglas County are required to obtain a Stormwater Management Facility Operating Permit on a yearly basis. The purpose of this annual permit is to ensure property owners follow proper operation and maintenance procedures for stormwater management facilities located on their sites. Requirements for inspection and maintenance, as well as reporting requirements are located in this Stormwater Management Facility Operation and Maintenance (O&M) Guidance Document. Additional information can be found in the Douglas County Stormwater Facility Operating Permit Manual or by contacting the Douglas County Engineering Division, Operating Permit Program.
B. Preventive Measures to Reduce
The most effective way to maintain yo
prevent the pollutants from entering the
Common pollutants include sediment, tra
wastes, runoff from stored materials, illicit
drainage system and many others. A thro
will include measures to address these po
save money and time in the long run. Ke
maintenance program include:
Educate property owners/residents to b
impact water quality, and how they can
costs.
Keep properties, streets and curb & gu
trash, debris, and lawn clippings.
Ensure the proper disposal of hazardo
Plan lawn care to minimize the use of c
Sweep paved surfaces and put the swe
back on the lawn.
Be aware of automobiles leaking fluids. Use absorbents such as cat litter to soak up drippings – dispose of properly.
4
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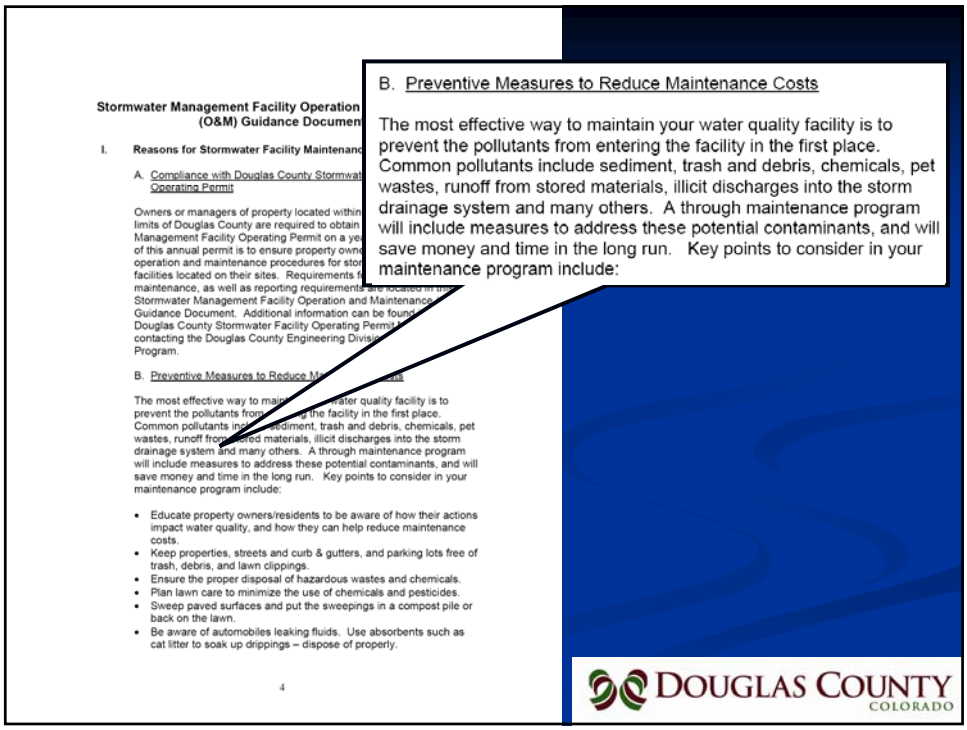
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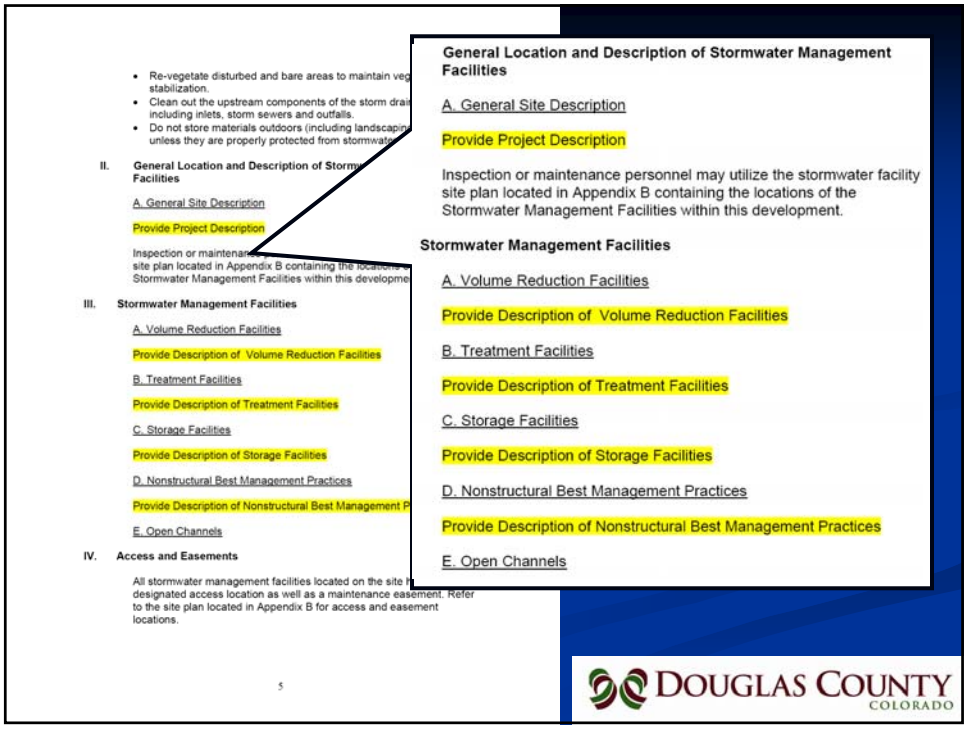
Common pollutants in
wastes, runoff fr
drainage system and many others. A through maintenance program
will include measures to address these potential contaminants, and will
save money and time in the long run. Key points to consider in your
maintenance program include:
Educate property owners/residents to be aware of how their actions impact water quality, and how they can help reduce maintenance costs.
Keep properties, streets and curb & gutters, and parking lots free of trash, debris, and lawn clippings.
Ensure the proper disposal of hazardous wastes and chemicals.
Plan lawn care to minimize the use of chemicals and pesticides.
Sweep paved surfaces and put the sweepings in a compost pile or back on the lawn.
Be aware of automobiles leaking fluids. Use absorbents such as cat litter to soak up drippings – dispose of properly.
4
B. Preventive Measures to Reduce Maintenance Costs
The most effective way to maintain your water quality facility is to prevent the pollutants from entering the facility in the first place. Common pollutants include sediment, trash and debris, chemicals, pet wastes, runoff from stored materials, illicit discharges into the storm drainage system and many others. A through maintenance program will include measures to address these potential contaminants, and will save money and time in the long run. Key points to consider in your maintenance program include:
DOUGLAS COUNTY
COLORADO


• Re-vegetate disturbed and bare areas to maintain veg
stabilization.
• Clean out the upstream components of the storm drai
including inlets, storm sewers and outfalls.
• Do not store materials outdoors (including landscapin
unless they are properly protected from stormwate
II. General Location and Description of Stormw
Facilities
A. General Site Description
Provide Project Description
Inspection or maintenan
site plan located in Appendix B containing the location
Stormwater Management Facilities within this developme
III. Stormwater Management Facilities
A. Volume Reduction Facilities
Provide Description of Volume Reduction Facilities
B. Treatment Facilities
Provide Description of Treatment Facilities
C. Storage Facilities
Provide Description of Storage Facilities
D. Nonstructural Best Management Practices
Provide Description of Nonstructural Best Management P
E. Open Channels
IV. Access and Easements
All stormwater management facilities located on the site h
designated access location as well as a maintenance easement. Refer
to the site plan located in Appendix B for access and easement
locations.
5
General Location and Description of Stormwater Management Facilities
A. General Site Description
Provide Project Description
Inspection or maintenance personnel may utilize the stormwater facility site plan located in Appendix B containing the locations of the Stormwater Management Facilities within this development.
Stormwater Management Facilities
A. Volume Reduction Facilities
Provide Description of Volume Reduction Facilities
B. Treatment Facilities
Provide Description of Treatment Facilities
C. Storage Facilities
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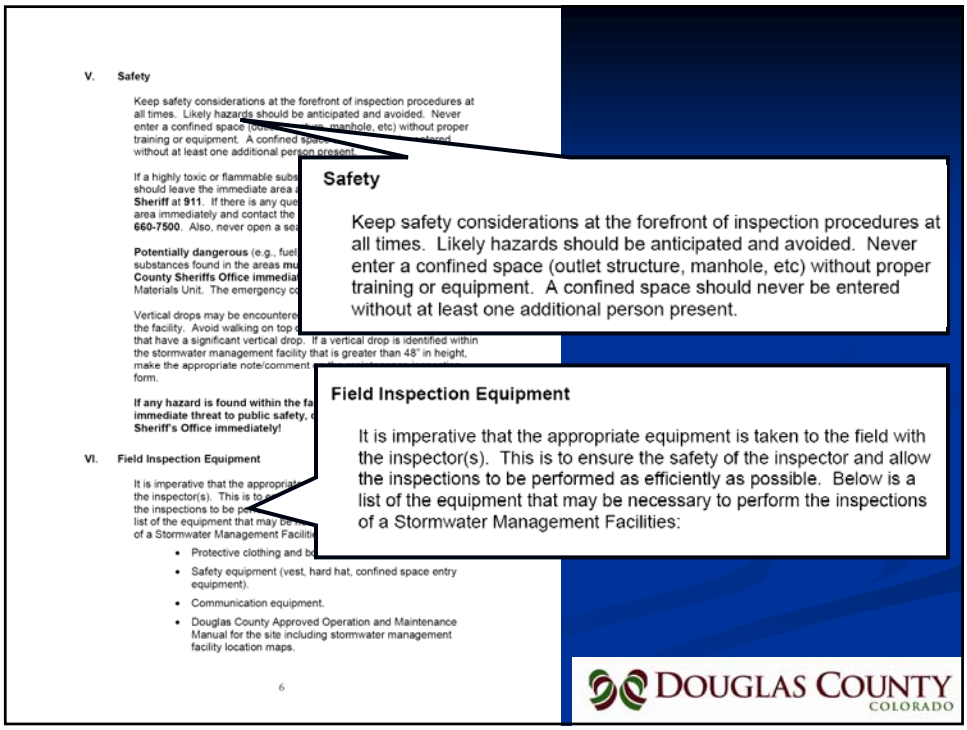
DOUGLAS COUNTY
COLORADO


V. Safety
Keep safety considerations at the forefront of inspection procedures at
all times. Likely hazards should be anticipated and avoided. Never
enter a confined space (
manhole, etc) without proper
training or equipment. A confined spa
without at least one additional person present.
If a highly toxic or flammable subs
should leave the immediate area
Sheriff at 911. If there is any que
area immediately and contact the
660-7500. Also, never open a sea
Potentially dangerous (e.g., fuel
substances found in the areas mu
County Sheriffs Office immedia
Materials Unit. The emergency co
Vertical drops may be encountere
the facility. Avoid walking on top
that have a significant vertical drop. If a vertical drop is identified within
the stormwater management facility that is greater than 48" in height,
make the appropriate note/comment
form.
If any hazard is found within the fa
immediate threat to public safety,
Sheriff's Office immediately!
VI. Field Inspection Equipment
It is imperative that the appropriat
the inspector(s). This is to
the inspections to be pe
list of the equipment that may be
of a Stormwater Management Facilit
• Protective clothing and b
• Safety equipment (vest, hard hat, confined space entry equipment).
• Communication equipment.
• Douglas County Approved Operation and Maintenance Manual for the site including stormwater management facility location maps.
6
Safety
Keep safety considerations at the forefront of inspection procedures at all times. Likely hazards should be anticipated and avoided. Never enter a confined space (outlet structure, manhole, etc) without proper training or equipment. A confined space should never be entered without at least one additional person present.
Field Inspection Equipment
It is imperative that the appropriate equipment is taken to the field with the inspector(s). This is to ensure the safety of the inspector and allow the inspections to be performed as efficiently as possible. Below is a list of the equipment that may be necessary to perform the inspections of a Stormwater Management Facilities:
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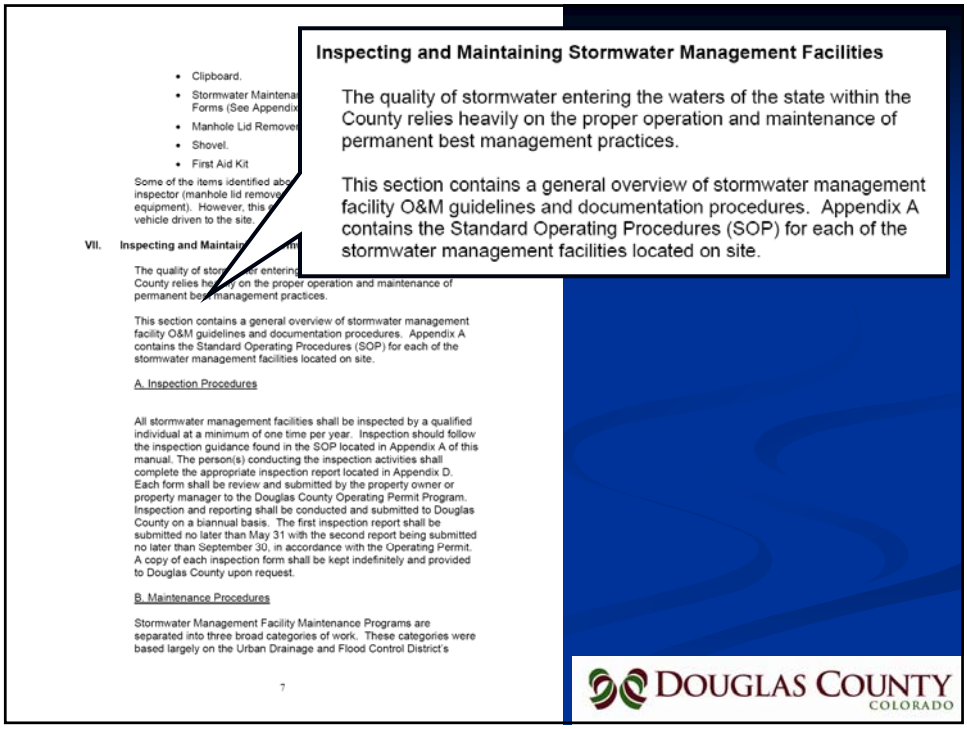
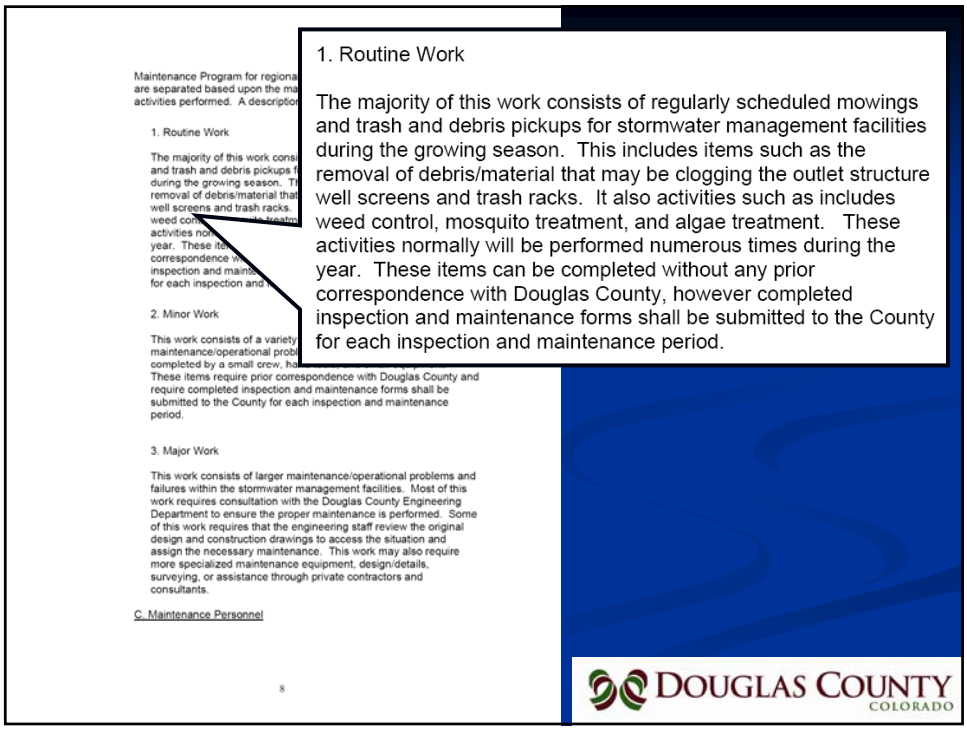
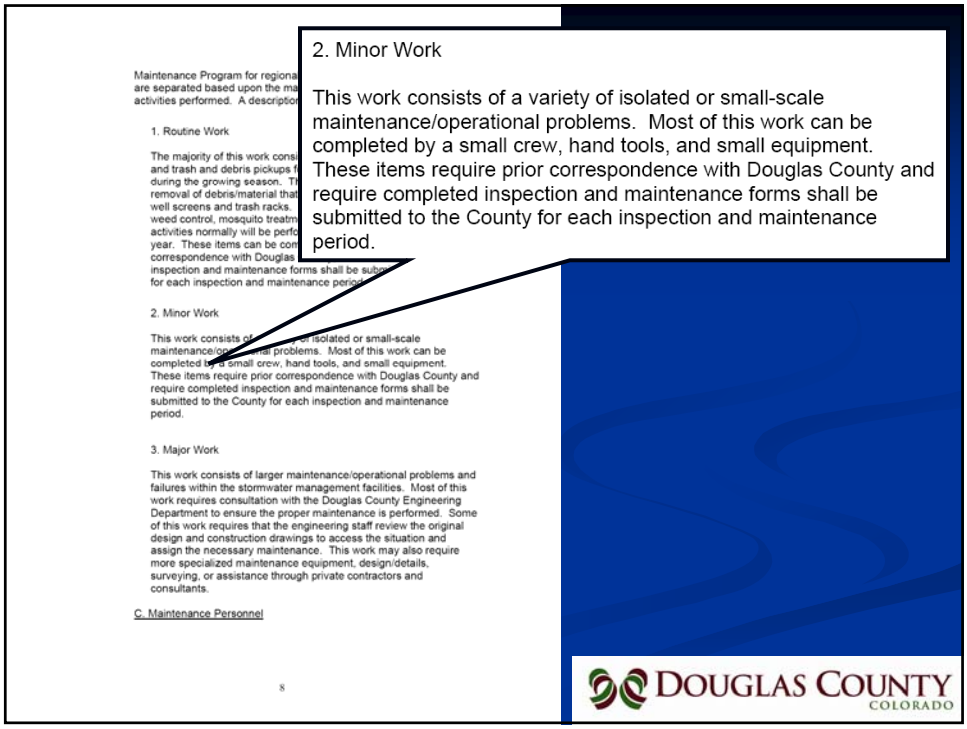

Clipboard.
Shovel.
First Aid Kit
Some of the items identified abo
inspector (manhole lid remove
equipment). However, this
vehicle driven to the site.
VII. Inspecting and Maintain
The quality of stor er entering
County relies he y on the proper operation and maintenance of
permanent be management practices.
This section contains a general overview of stormwater management
facility O&M guidelines and documentation procedures. Appendix A
contains the Standard Operating Procedures (SOP) for each of the
stormwater management facilities located on site.
A. Inspection Procedures
All stormwater management facilities shall be inspected by a qualified
individual at a minimum of one time per year. Inspection should follow
the inspection guidance found in the SOP located in Appendix A of this
manual. The person(s) conducting the inspection activities shall
complete the appropriate inspection report located in Appendix D.
Each form shall be review and submitted by the property owner or
property manager to the Douglas County Operating Permit Program.
Inspection and reporting shall be conducted and submitted to Douglas
County on a biannual basis. The first inspection report shall be
submitted no later than May 31 with the second report being submitted
no later than September 30, in accordance with the Operating Permit.
A copy of each inspection form shall be kept indefinitely and provided
to Douglas County upon request.
B. Maintenance Procedures
Stormwater Management Facility Maintenance Programs are
separated into three broad categories of work. These categories were
based largely on the Urban Drainage and Flood Control District's
7
Inspecting and Maintaining Stormwater Management Facilities
The quality of stormwater entering the waters of the state within the County relies heavily on the proper operation and maintenance of permanent best management practices.
This section contains a general overview of stormwater management facility O&M guidelines and documentation procedures. Appendix A contains the Standard Operating Procedures (SOP) for each of the stormwater management facilities located on site.
DOUGLAS COUNTY
COLORADO


Maintenance Program for regiona
are separated based upon the ma
activities performed. A descriptio
1. Routine Work
The majority of this work consi
and trash and debris pickups f
during the growing season. Th
removal of debris/material that
well screens and trash racks.
weed con e treatm
activities nor
year. These ite
correspondence w
inspection and maint
for each inspection and
2. Minor Work
This work consists of a variety
maintenance/operational probl
completed by a small crew, ha
These items require prior correspondence with Douglas County and
require completed inspection and maintenance forms shall be
submitted to the County for each inspection and maintenance
period.
3. Major Work
This work consists of larger maintenance/operational problems and
failures within the stormwater management facilities. Most of this
work requires consultation with the Douglas County Engineering
Department to ensure the proper maintenance is performed. Some
of this work requires that the engineering staff review the original
design and construction drawings to access the situation and
assign the necessary maintenance. This work may also require
more specialized maintenance equipment, design/details,
surveying, or assistance through private contractors and
consultants.
C. Maintenance Personnel
8
1. Routine Work
The majority of this work consists of regularly scheduled mowings and trash and debris pickups for stormwater management facilities during the growing season. This includes items such as the removal of debris/material that may be clogging the outlet structure well screens and trash racks. It also activities such as includes weed control, mosquito treatment, and algae treatment. These activities normally will be performed numerous times during the year. These items can be completed without any prior correspondence with Douglas County, however completed inspection and maintenance forms shall be submitted to the County for each inspection and maintenance period.
DOUGLAS COUNTY
COLORADO


Maintenance Program for regiona
are separated based upon the ma
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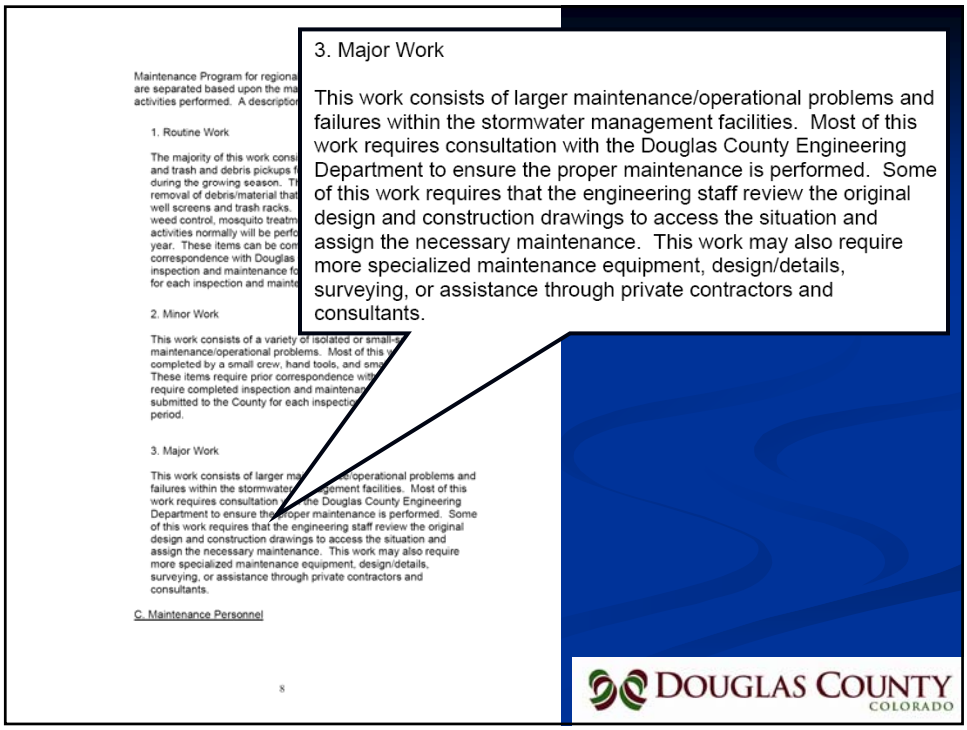
weed control, mosquito treatm
activities normally will be perfo
year. These items can be com
correspondence with Douglas
inspection and maintenance forms shall be subm
for each inspection and maintenance period.
2. Minor Work
This work consists of
maintenance/op
completed by a small crew, hand tools, and small equipment.
These items require prior correspondence with Douglas County and
require completed inspection and maintenance forms shall be
submitted to the County for each inspection and maintenance
period.
3. Major Work
This work consists of larger maintenance/operational problems and
failures within the stormwater management facilities. Most of this
work requires consultation with the Douglas County Engineering
Department to ensure the proper maintenance is performed. Some
of this work requires that the engineering staff review the original
design and construction drawings to access the situation and
assign the necessary maintenance. This work may also require
more specialized maintenance equipment, design/details,
surveying, or assistance through private contractors and
consultants.
C. Maintenance Personnel
8
2. Minor Work
This work consists of a variety of isolated or small-scale maintenance/operational problems. Most of this work can be completed by a small crew, hand tools, and small equipment. These items require prior correspondence with Douglas County and require completed inspection and maintenance forms shall be submitted to the County for each inspection and maintenance period.
DOUGLAS COUNTY
COLORADO


Maintenance Program for regiona
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correspondence with Douglas
inspection and maintenance fo
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This work consists of a variety of isolated or small-s
maintenance/operational problems. Most of this w
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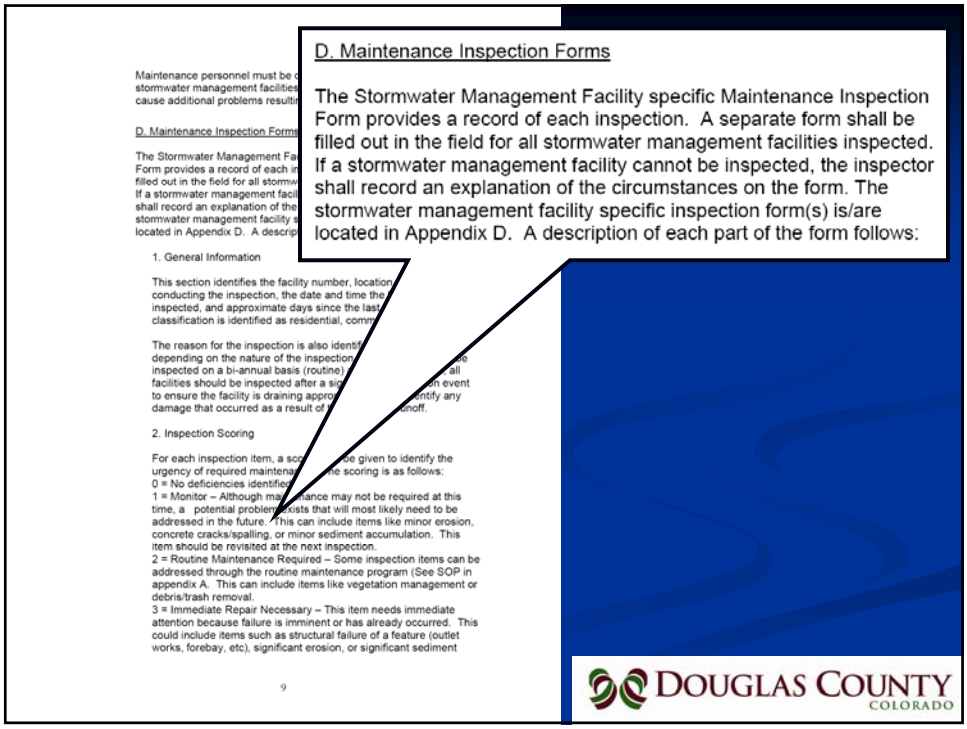
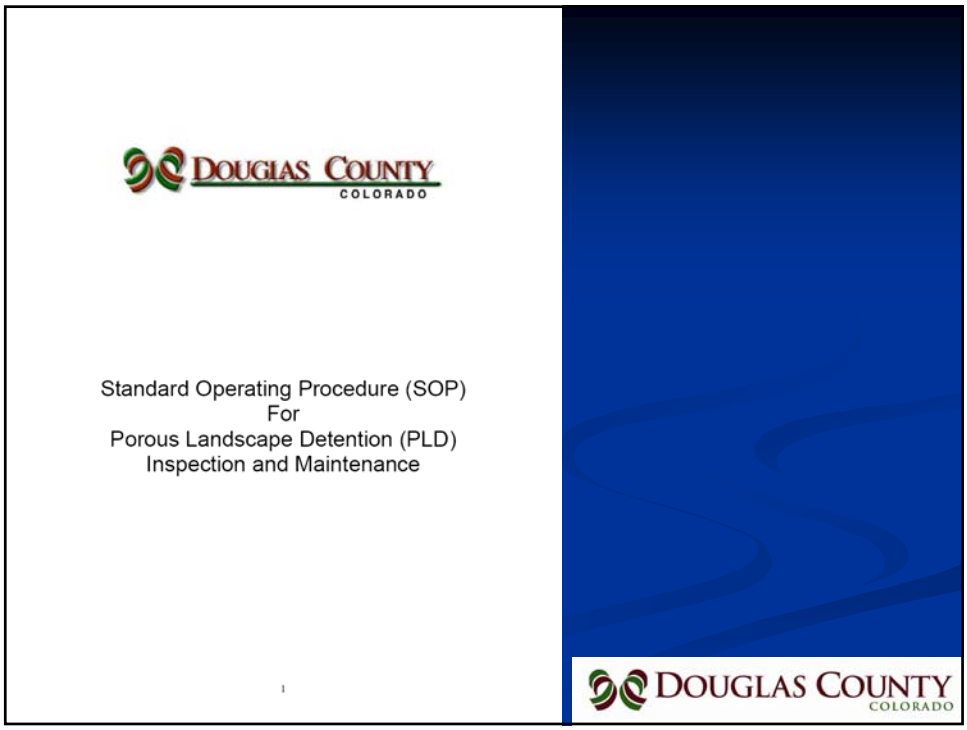
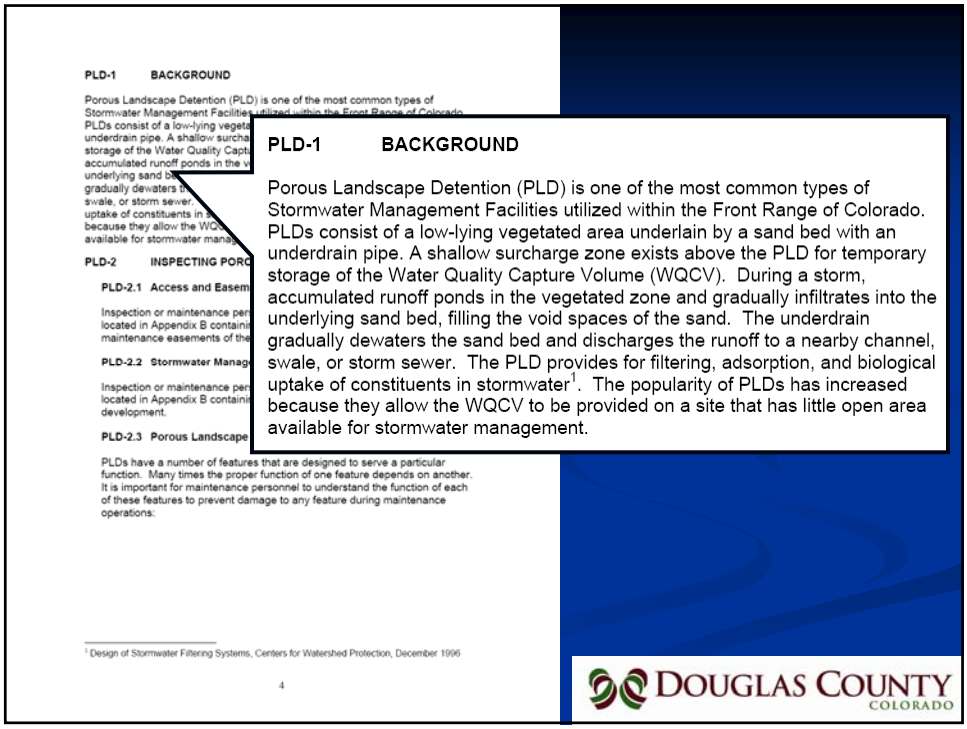
These items require prior correspondence wit
require completed inspection and maintenan
submitted to the County for each inspectio
period.
3. Major Work
This work consists of larger ma
failures within the stormwate
work requires consultation
Department to ensure th
of this work requires that the engineering staff review the original
design and construction drawings to access the situation and
assign the necessary maintenance. This work may also require
more specialized maintenance equipment, design/details,
surveying, or assistance through private contractors and
consultants.
C. Maintenance Personnel
8
3. Major Work
This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. Most of this work requires consultation with the Douglas County Engineering Department to ensure the proper maintenance is performed. Some of this work requires that the engineering staff review the original design and construction drawings to access the situation and assign the necessary maintenance. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants.
DOUGLAS COUNTY
COLORADO


D. Maintenance Inspection Forms
The Stormwater Management Facility specific Maintenance Inspection Form provides a record of each inspection. A separate form shall be filled out in the field for all stormwater management facilities inspected. If a stormwater management facility cannot be inspected, the inspector shall record an explanation of the circumstances on the form. The stormwater management facility specific inspection form(s) is/are located in Appendix D. A description of each part of the form follows:
1. General Information
2. Inspection Scoring
DOUGLAS COUNTY
COLORADO


DOUGLAS COUNTY
COLORADO
Standard Operating Procedure (SOP)
For
Porous Landscape Detention (PLD)
Inspection and Maintenance
DOUGLAS COUNTY
COLORADO


PLD-1 BACKGROUND
Porous Landscape Detention (PLD) is one of the most common types of Stormwater Management Facilities utilized within the Front Range of Colorado. PLDs consist of a low-lying vegetated area underlain by a sand bed with an underdrain pipe. A shallow surcharge zone exists above the PLD for temporary storage of the Water Quality Capture Volume (WQCV). During a storm, accumulated runoff ponds in the vegetated zone and gradually infiltrates into the underlying sand bed, filling the void spaces of the sand. The underdrain gradually dewaters the sand bed and discharges the runoff to a nearby channel, swale, or storm sewer. The PLD provides for filtering, adsorption, and biological uptake of constituents in stormwater[1]. The popularity of PLDs has increased because they allow the WQCV to be provided on a site that has little open area available for stormwater management.
DOUGLAS COUNTY
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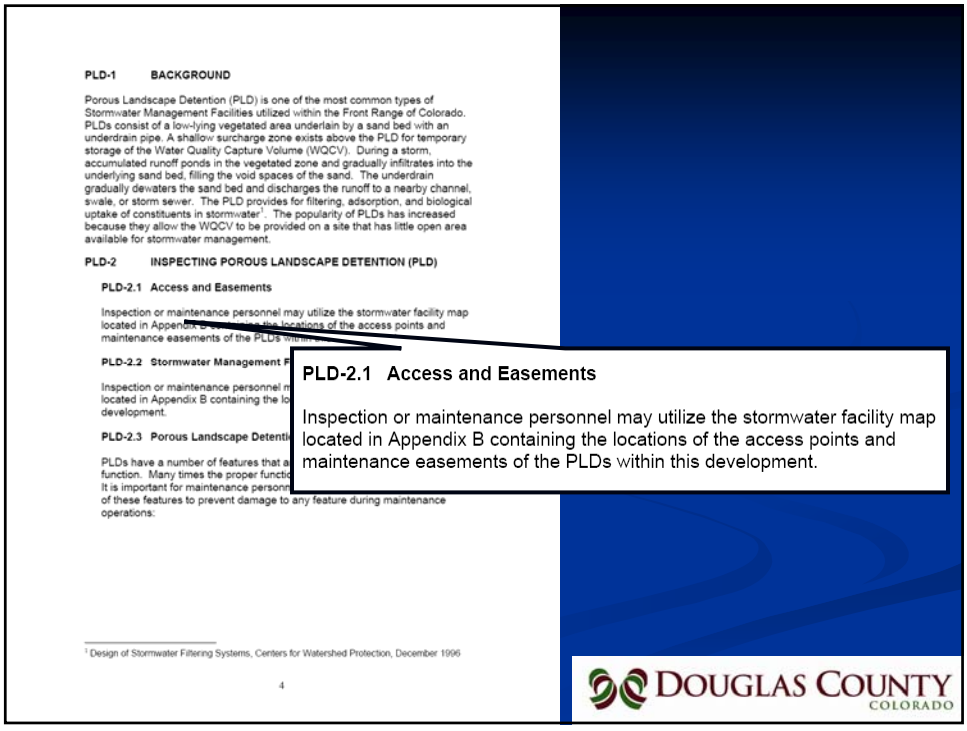
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PLD-2 INSPECTING POROUS LANDSCAPE DETENTION (PLD)
PLD-2.1 Access and Easements
Inspection or maintenance personnel may utilize the stormwater facility map located in Appendix B containing the locations of the access points and maintenance easements of the PLDs within this development.
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Inspection or maintenance personnel may utilize the stormwater facility map located in Appendix B containing the locations of the access points and maintenance easements of the PLDs within this development.
DOUGLAS COUNTY
COLORADO

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PLD-2 INSPECTING POROUS

PLD-2.1 Access and Easements

Inspection or maintenance personn
located in Appendix B containing th
maintenance easements of the PLD

PLD-2.2 Stormwater Manageme

Inspection or maintenance personn
located in Appendix B containing th
development.

PLD-2.3 Porous Landscape Dete

PLDs have a number of features that are desi
function. Many times the proper fun
It is important for maintenance personnel to understand the function of each of these features to prevent damage to any feature during maintenance operations:

PLD-2.3 Porous Landscape Detention (PLD) Features

PLDs have a number of features that are designed to serve a particular function. Many times the proper function of one feature depends on another. It is important for maintenance personnel to understand the function of each of these features to prevent damage to any feature during maintenance operations:

[1] Design of Stormwater Filtering Systems, Centers for Watershed Protection, December 1996

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DOUGLAS COUNTY COLORADO

Table PLD-1
Typical Inspection & Maintenance Requirements Matrix

	Sediment Removal	Mowing Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Removal/ Replacement	Structure Repair
Inflow Points	X		X				X
Landscaping	X	X	X	X	X		
Filter Media	X	X	X	X	X	X	
Underdrain System						X	
Overflow Outlet Works	X		X				X
Embankment		X	X	X	X		

Table PLD-1
Typical Inspection & Maintenance Requirements Matrix

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Landscaping	X	X	X	X	X		
Filter Media	X	X	X	X	X	X	
Underdrain System						X	
Overflow Outlet Works	X		X				X
Embankment		X	X	X	X		

maintained appropriately and erosion has occurred. Any erosion within the vicinity of the inflow point will require maintenance to prevent damage to the structure(s) and sediment transport within the facility. It is imperative that material utilized to correct erosion

5

DOUGLAS COUNTY COLORADO

Table PLD-1
Typical Inspection & Maintenance Requirements Matrix

	Sediment Removal	Mowing Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Removal/ Replacement	Structure Repair
Inflow Points	X		X				X
Landscaping	X	X	X	X	X		
Filter Media	X	X	X	X	X	X	
Underdrain System						X	
Overflow Outlet Works	X		X				X
Embankment		X	X	X	X		

PLD-2.3.1 Inflow Points

Inflow points or outfalls into PLDs are the point of stormwater discharge into the facility. An inflow point is commonly a curb cut with a concrete or riprap rundown. In limited cases a storm sewer pipe outfall with a flared end section may be the inflow point into the PLD.

An energy dissipater (riprap or concrete wall) is [illegible] immediately downstream of the discharge point [illegible] protect the PLD from erosion. In some cases, [illegible] outfall can have a toe-wall or cut-off wall [illegible] structure to prevent undercutting of the [illegible]

The typical maintenance items that are required at inflow points are as follows:

a. Riprap Displaced – Many times, because of, the repeated impact/force of water, the riprap can shift and settle. If any portion of the riprap rundown or apron appears to have settled, soil is present between the riprap, or the riprap has shifted, maintenance may be required to ensure future erosion is prevented.

b. Erosion Present/Outfall Undercut – In some situations, the energy dissipater may not have been sized, constructed, or maintained appropriately and erosion has occurred. Any erosion within the vicinity of the inflow point will require maintenance to prevent damage to the structure(s) and sediment transport within the facility. It is imperative that material utilized to correct erosion

5

PLD-2.3.1 Inflow Points

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DOUGLAS COUNTY COLORADO

Table PLD-1
Typical Inspection & Maintenance R

	Sediment Removal	Mowing Weed control	Trash & Debris Removal	Erosion
Inflow Points	X		X	
Landscaping	X	X	X	X
Filter Media	X	X	X	X
Underdrain System				
Overflow Outlet Works	X		X	
Embankment		X	X	X

PLD-2.3.1 Inflow Points

Inflow points or outfalls into PLDs are the point of stormwater discharge into the facility. An inflow point is commonly a curb cut with a concrete or riprap rundown. In limited cases a storm sewer pipe outfall with a flared end section may be the inflow point into the PLD.

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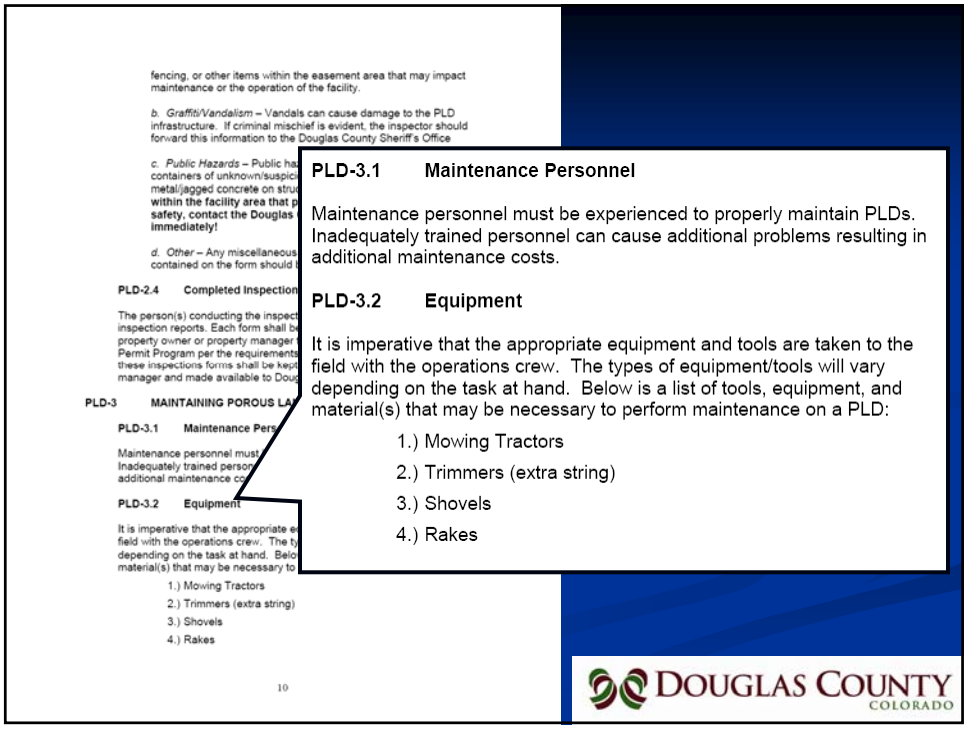
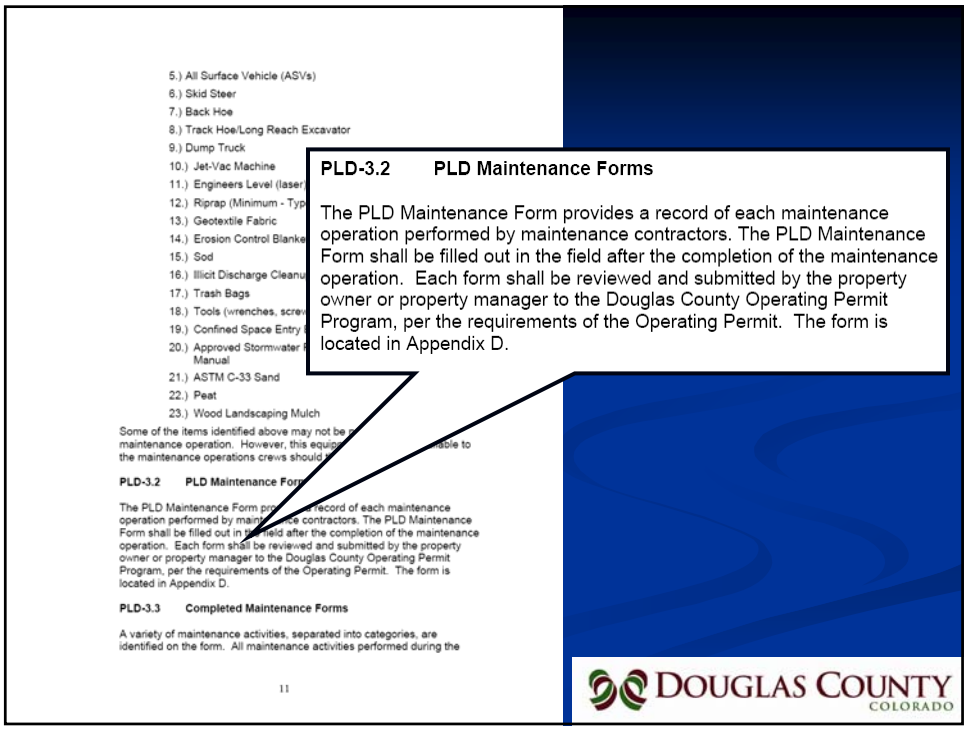
5

DOUGLAS COUNTY COLORADO


fencing, or other items within the easement area that may impact maintenance or the operation of the facility.
b. Graffiti/Vandalism – Vandals can cause damage to the PLD infrastructure. If criminal mischief is evident, the inspector should forward this information to the Douglas County Sheriff's Office
PLD-2.4 Completed Inspection
PLD-3 MAINTAINING POROUS LA
PLD-3.1 Maintenance Pers
PLD-3.2 Equipment
1.) Mowing Tractors
2.) Trimmers (extra string)
3.) Shovels
4.) Rakes
10
PLD-3.1 Maintenance Personnel
Maintenance personnel must be experienced to properly maintain PLDs. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.
PLD-3.2 Equipment
It is imperative that the appropriate equipment and tools are taken to the field with the operations crew. The types of equipment/tools will vary depending on the task at hand. Below is a list of tools, equipment, and material(s) that may be necessary to perform maintenance on a PLD:
1.) Mowing Tractors
2.) Trimmers (extra string)
3.) Shovels
4.) Rakes
DOUGLAS COUNTY
COLORADO


5.) All Surface Vehicle (ASVs)
6.) Skid Steer
7.) Back Hoe
8.) Track Hoe/Long Reach Excavator
9.) Dump Truck
10.) Jet-Vac Machine
11.) Engineers Level (laser)
12.) Riprap (Minimum - Typ
13.) Geotextile Fabric
14.) Erosion Control Blanke
15.) Sod
16.) Illicit Discharge Cleanu
17.) Trash Bags
18.) Tools (wrenches, scre
19.) Confined Space Entry
20.) Approved Stormwater
Manual
21.) ASTM C-33 Sand
22.) Peat
23.) Wood Landscaping Mulch
Some of the items identified above may not be
maintenance operation. However, this equip
the maintenance operations crews should
able to
PLD-3.2 PLD Maintenance Form
The PLD Maintenance Form pro
operation performed by maint
Form shall be filled out in t
operation. Each form shall be reviewed and submitted by the property owner or property manager to the Douglas County Operating Permit Program, per the requirements of the Operating Permit. The form is located in Appendix D.
PLD-3.3 Completed Maintenance Forms
A variety of maintenance activities, separated into categories, are identified on the form. All maintenance activities performed during the
11
PLD-3.2 PLD Maintenance Forms
The PLD Maintenance Form provides a record of each maintenance operation performed by maintenance contractors. The PLD Maintenance Form shall be filled out in the field after the completion of the maintenance operation. Each form shall be reviewed and submitted by the property owner or property manager to the Douglas County Operating Permit Program, per the requirements of the Operating Permit. The form is located in Appendix D.
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COLORADO

operation must be identified on the form. These maintenance activities are described in more detail later in this Manual. Maintenance forms shall be completed by the contractor performing the required maintenance items. The form shall then be reviewed by an authorized agent of the property owner and submitted to Douglas County to the attention of:

Douglas County Engineering Division
Attn. Stormwater Facility Operating P
100 3rd Street
Castle Rock, Colorado 80104

PLD-3.4 PLD Maintenance Ca

A typical PLD Maintenance Pro
of work: Routine, Minor and M
variety of maintenance activ
maintenance activity can b
general to the overall facil
categories and briefly describes the t
PLD.

The Douglas County Stormwater Fac
identified a variety of maintenance ac
maintenance activities range in magn
reconstruction of the PLD filter media
description of each maintenance acti
actions:

PLD-3.5 ROUTINE MAINTENANCE A

The majority of this work consists of schedu
pickups and landscape care for the PLD du
includes activities such as weed control. T
performed numerous times during the year.
prior approval by Douglas County, however,
maintenance forms shall be submitted to the
maintenance period.

The Routine Maintenance Activities are summarized below, and further described in the following sections.

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PLD-3.4 PLD Maintenance Categories and Activities

A typical PLD Maintenance Program will consist of three broad categories of work: Routine, Minor and Major. Within each category of work, a variety of maintenance activities can be performed on a PLD. A maintenance activity can be specific to each feature within the PLD, or general to the overall facility. This section of the SOP explains each of the categories and briefly describes the typical maintenance activities for a PLD.

The Douglas County Stormwater Facility Operating Permit Program has identified a variety of maintenance activities that are typical of PLDs. The maintenance activities range in magnitude from routine trash pickup to the reconstruction of the PLD filter media or underdrain system. Below is a description of each maintenance activity, the objectives, and frequency of actions:

DOUGLAS COUNTY
COLORADO

Table PLD-2
Summary of Routine Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenanc Action
Mowing	Twice annually	Excessive grass height/aesthetics	2"-4" grass height
Trash/Debris Removal	Twice annually	h & debris in	Remove and disp of trash and debri
Overflow Outlet Works Cleaning	As needed - after significant rain events – twice annually minimum	d outlet ponding e outlet	Remove and disp of debris/trash/sedim to allow outlet to function properly

Table PLD-2
Summary of Routine Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Mowing	Twice annually	Excessive grass height/aesthetics	2"-4" grass height
Trash/Debris Removal	Twice annually	Trash & debris in PLD	Remove and dispose of trash and debris
Overflow Outlet Works Cleaning	As needed - after significant rain events – twice annually minimum	Clogged outlet structure; ponding water above outlet elevation	Remove and dispose of debris/trash/sediment to allow outlet to function properly
Weed Control	Minimum twice annually	Noxious weeds; Unwanted vegetation	Treat w/herbicide or hand pull; consult Douglas Co Weed Inspector

PLD-3.5.4 Weed Control

Noxious weeds and other unwa
needed throughout the PLD. T
through mechanical means (m
Consultation with the Douglas
recommended prior to the use
utilized sparingly and as a last
should be in accordance with t

Frequency – Routine – As nee

PLD-3.5.5 MINOR MAINTENACE ACTIV

This work consists of a variety of isolated or
problems. Most of this work can be complet
small equipment. These items **require** appro
inspection and maintenance forms shall be s
inspection and maintenance period. In the e
dewatered, care should be given to ensure sediment, filter mate
pollutants are not discharged. All dewatering activities shall b
Douglas County.

Table PLD-3
Summary of Minor Maintenanc

Maintenance Activity	Minimum Frequency		Mainten Acti
Sediment/Pollutant Removal	As needed; Based on infiltration test	Sediment build-up; decrease in infiltration rate	Remove and of sediment
Erosion Repair	As needed, based upon inspection	Rillying/gullying of embankments	Repair erode revegetate; a cause
Jet Vac/Cleaning underdrain system	As needed, based upon inspection	Sediment build-up /non draining system	Clean drains; if needed

PLD-3.5.6 Sediment/Pollutant Removal

Sediment/Pollutant removal is necessary to ensure proper fu
of the filter media. The infiltration rate of the PLD needs to b
checked in order to ensure proper functioning of the PLD.
Generally, a PLD should drain completely within 12-hours of

14

Table PLD-3
Summary of Minor Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Sediment/Pollutant Removal	As needed; Based on infiltration test	Sediment build-up; decrease in infiltration rate	Remove and dispose of sediment
Erosion Repair	As needed, based upon inspection	Rillying/gullying of embankments	Repair eroded areas & revegetate; address cause
Jet Vac/Cleaning underdrain system	As needed, based upon inspection	Sediment build-up /non draining system	Clean drains; Jet-Vac if needed

storm event. If drain times ex
maintenance of the filter medi

Generally the top 3-inches of
each removal period. Additio
to be removed if deeper sectio
contaminated. New filter med
filter media. It is critical that o
Society for Testing and Materi
in the replacement of the filter

ASTM C-33 Sand Standard

US Standard Sieve Size (Number)	T
9.5 mm (3/8 inch)	
4.75 mm (No. 4)	
2.36 mm (N	
1.18 mm (No. 16	
600µm (No. 30)	
300µm (No. 50)	
150µm (No. 100)	

In addition only Peat Moss tha
shall be utilized with the filter

pH (Units)	7.6
Total Salts (MMHOS/CM, 1:5)	2.28
Organic Matter (%)	20.22
Moisture (%)	21.43
Dry Matter Basis:	
Nitrogen - Total (%)	0.780
Nitrogen - Organic (%)	0.773

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ASTM C-33 Sand Standard

US Standard Sieve Size (Number)	Total Percent Passing (%)
9.5 mm (3/8 inch)	100
4.75 mm (No. 4)	95-100
2.36 mm (No. 8)	80-100
1.18 mm (No. 16)	50-85
600µm (No. 30)	25-60
300µm (No. 50)	10-30
150µm (No. 100)	2-10

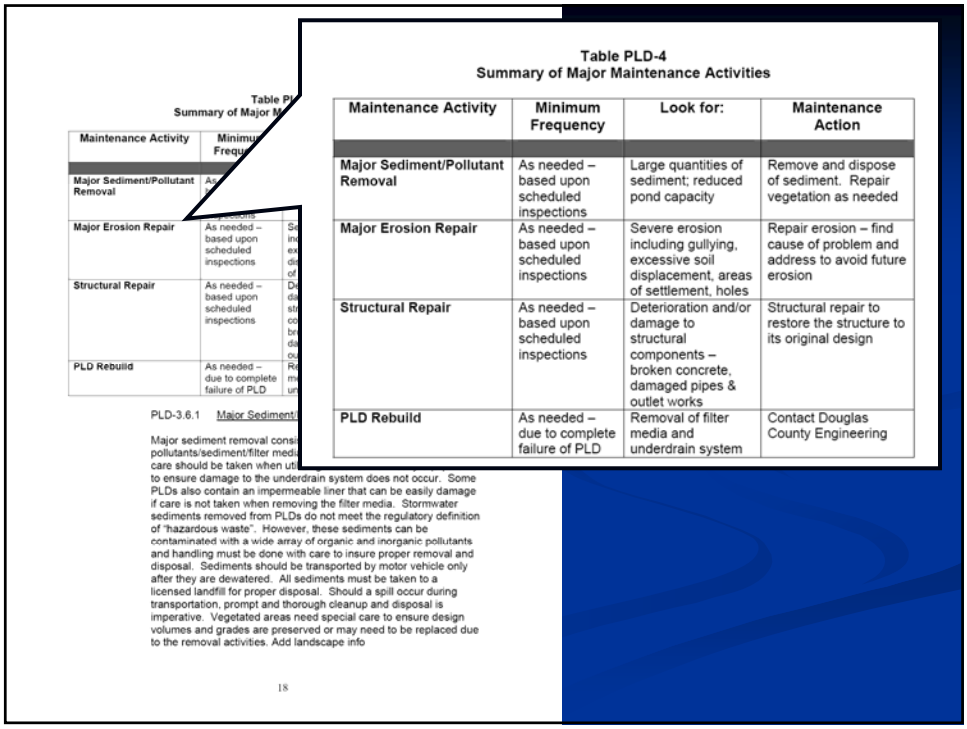

Table PLD-4
Summary of Major Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Major Sediment/Pollutant Removal	As needed – based upon scheduled inspections	Large quantities of sediment; reduced pond capacity	Remove and dispose of sediment. Repair vegetation as needed
Major Erosion Repair	As needed – based upon scheduled inspections	Severe erosion including gullying, excessive soil displacement, areas of settlement, holes	Repair erosion – find cause of problem and address to avoid future erosion
Structural Repair	As needed – based upon scheduled inspections	Deterioration and/or damage to structural components – broken concrete, damaged pipes & outlet works	Structural repair to restore the structure to its original design
PLD Rebuild	As needed – due to complete failure of PLD	Removal of filter media and underdrain system	Contact Douglas County Engineering

PLD-3.6.1 Major Sediment/

Major sediment removal consi
pollutants/sediment/filter medi
care should be taken when uti
to ensure damage to the underdrain system does not occur. Some PLDs also contain an impermeable liner that can be easily damage if care is not taken when removing the filter media. Stormwater sediments removed from PLDs do not meet the regulatory definition of "hazardous waste". However, these sediments can be contaminated with a wide array of organic and inorganic pollutants and handling must be done with care to insure proper removal and disposal. Sediments should be transported by motor vehicle only after they are dewatered. All sediments must be taken to a licensed landfill for proper disposal. Should a spill occur during transportation, prompt and thorough cleanup and disposal is imperative. Vegetated areas need special care to ensure design volumes and grades are preserved or may need to be replaced due to the removal activities. Add landscape info

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Questions?

Thank You