



Stormwater Division

MEMORANDUM

TO: Design Criteria and Construction Specifications (Vol. II of III) Holders

RE: ADDENDUM TO STORM DRAINAGE DESIGN CRITERIA AND CONSTRUCTION SPECIFICATIONS

FROM: Steve Bagley, PE FNSPE, City Engineer *SCB*

DATE: June 2008

Attached find addendum information for the Design Criteria and Construction Specifications -- Volume II of III -- Storm Drainage, published March 2007. This new information is effective immediately.

Insert the revised or new pages in your manual. New information includes:

- Replace pages vii and viii of the Table of Contents for Volume II, Storm Drainage. The pages with revised text or information are identified with "revised 6 / 2008."
- Replace pages 1,2,3,4,7,8,9, and 10 in Section 6 **and** Replace Detail 6-6, Standard Storm Water Bedding Detail. These changes allow for a different gradation for bedding of RCP and also ensure that if nothing is specified by the engineer the minimum of a structural concrete collar is placed when connecting to an existing system or different pipe material, etc.
- Replace Detail 7-1; Details 7-3a and 7-3b; and Details 7-4a and 7-4b. These revisions are a result of the changes made to the curb sections in Volume 1 -- Streets. (Please note that the street sections were changed as well, and the resultant changes to Drainage are not included here, but will be changed at a later date.)
- Replace page 1 and pages 15 through 20 in Section 12; **and** replace page 1 and pages 6 through 10 in Section 13. These revisions change the City's "Stormwater Management Plan" to "Erosion Control Plan" so it is not confused with the State's Stormwater Management Plan.
- Replace Figure 13-1, Map Symbols. This revises the old map symbol for straw bales to the new symbol for wattles.

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We promise to preserve and improve the quality of life for Greeley through timely, courteous and cost effective service.

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SECTION 6.0 STORM DRAINS

6.1 INTRODUCTION

Storm drains are required when other parts of the drainage system, primarily curb, gutter, and roadside ditches no longer have capacity for the additional stormwater runoff.

Except as modified herein, the design of storm drains shall be in accordance with the USDCM, Volume 1, Chapter, "Street/Inlets/Storm Sewers". Reference is made to follow specific sections in the USDCM for clarity. The user is referred to the USDCM and any other references cited for additional information and basic design concepts.

6.2 CONSTRUCTION MATERIALS/INSTALLATION OF STORM DRAINS

6.2.1 CONSTRUCTION MATERIALS

6.2.1.A STORM DRAIN PIPING MATERIALS

All storm drains within the City shall be constructed using one of the following materials and meet applicable standards as presented below:

TABLE 6.2.1.A - STORM DRAIN STANDARDS	
Pipe Material	Standard
Reinforced Concrete Pipe (RCP)	ASTM C-33, 76, 150, 260, 361, 443, 494 (Type A or D), 497, & 655, ASTM E 329 and AASHTO M 170, and 242 and FED Specifications (FS): SS-S-00210
Plastic Pipe (PVC)	AASHTO M304M-911, ASTM D-1784, 2122, 2321, 2412, & 3212, and ASTM D3034 DR35 or better, and with elastomeric gaskets per ASTM F477, and ASTM F679, 794, 949, & 1803
Aluminized Steel Pipe (ASP)	AASHTO M-36, 198 & 274 and ASTM A-760, 796, 798 & 891
Corrugated Steel for Culverts Only	AASHTO M-36, 167, 190, 218, 243, 245, 246, 264, 289 and ASTM A-444, 742, 760, 761, 762, 806, 819, 849, 885 and D-1056
High Density Polyethylene Pipe (HDPE)	AASHTO M-252, 294 (Type S), and Section 18 with rubber water-tight joints and ASTM D-1056 (Grade 2A2), 1248, 2321, 3212 & 3350 (cell class 324420C or higher) and F477 & 667

Notes:

Elliptical and arched pipe should be used only when conditions prevent the use of circular pipe

At the option of the Contractor, and with the City's written approval, non-reinforced concrete pipe conforming to ASTM-C14 and AASHTO M 86 may be used in lieu of reinforced concrete pipe for all sizes 36 inches in diameter and smaller. It shall meet the same D-load to produce the ultimate load under the three-edge bearing method as specified for reinforced concrete pipe in accordance with AASHTO M170, and the Contractor provides

written certification that it does so. Wall thickness of pipe may be increased as required to meet D-load requirement.

All requirements for reinforced concrete pipe, except those referring to reinforcement shall apply to non-reinforced concrete pipe.

The minimum class for RCP pipe shall be Class-III with flexible gasket material (water tight rubber gaskets) meeting ASTM C443 and gasket bell and spigot joints. The required pipe strength shall be determined from the actual depth of cover, true load, and proposed field conditions. A typical design strength calculation shall be submitted to the City for approval.

ASP and HDPE pipe may be used for storm drain in parks, green belts, and other open space areas only upon approval of the City. Where corrugated metal pipe (CMP) is intended to be used as culvert material, the minimum gauge for the pipe shall be determined from Colorado Department of Transportation (CDOT) Standard Plan M-603-1, latest edition, for actual depth of cover. Site-specific calculations may be submitted utilizing the following structural design specifications: AASHTO – M167M / M167-04; ASTM - Standard Practice for Structural Design of Corrugated Steel Pipe, Pipe Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications, ASTM A796. The following, ASP, HDPE or CMP pipe shall not be used under railroad tracks within the City. PVC may be used provided a schedule 80 steel pipe acts as a sleeve as required by the American Railroad Engineers Association Specifications, AREA.

Also, when CMP is intended to be used as culvert material, site soil pH and Rmin, minimum resistivity, tests shall be performed. pH shall be measured for soil and water. Minimum resistivity shall be for soil and water and shall be determined in the laboratory and not in the field. Corrugated aluminum pipe may be used when the pH is between 7.2 and 9.0 and Rmin is 1,000 ohm-cm or greater. Galvanized steel corrugated pipe shall be used when the pH is between 6.0 and 10.0 and Rmin is 2000 ohm-cm or greater. Supplemental corrosion protection coatings approved by the City shall be applied to corrugated steel pipe when the pH is outside the above-stated range and/or Rmin is less than 2000 ohm-cm.

When ASP pipe is intended to be used as the storm drain pipe material, site soil pH and Rmin, minimum resistivity, tests shall be performed. PH shall be measured for soil and water. Minimum resistivity shall be for soil and water and shall be determined in the laboratory and not in the field. ASP pipe may be used when the pH is between 7.2 and 9.0 and Rmin is 1,000 ohm-cm or greater.

6.2.1.B BEDDING MATERIALS

RCP pipe and other rigid pipe systems are susceptible to failure due to improper bedding and backfill procedures. Bedding for RCP pipe shall be 3/8-inch squeegee, per the following gradation:

<u>SIZE</u>	<u>PERCENT PASSING</u>
3/8"	80-100
#4	0-80
#200	0-4

5.
 - a. Furnish and install temporary plugs at each end of Work for removal by others when work resumes. Plug must be secured in place and must be removable.
 - b. Plugs
 - b.1. Temporary plugs as supplied by pipe manufacturer.
 - b.2. Fabricated by Contractor of substantial construction.
 - b.3. Watertight against heads up to 20 feet of water.

6. Connections to existing structures:
 - a. Connect pipe to existing structures and pipelines where indicated.
 - b. Opening in structure shall have a minimum 3 inches clearance on all sides.
 - c. Adhere to pipe manufacturer's specifications.
 - d. Grout opening on inside with non-shrink grout.
 - e. Place structural concrete collar on outside.

7. Field Testing

- a. Acceptance Tests:
 - a.1. Alignment:
 - o Pipe shall be inspected by lamping the line or by physical passage where space permits.
 - o Contractor shall clean pipe of excess mortar, joint sealant, and other dirt and debris prior to inspection.
 - o Determine:
 - (1) Presence of any misaligned, displaced, or broken pipe.
 - (2) Presence of visible infiltration or other defects.

b. Deflection Testing:

b.1 Maximum installed deflections of flexible pipe shall be as follows:

Type of Pipe	Deflection – Percent of Mean Internal Diameter
ASP & CMP	5
PVC	5
HDPE	5

- c. City shall require Contractor to test flexible pipe after backfill has been in place 30 days and again after eleven (11) months if deemed necessary.
 - c.1. Provide rigid ball or mandrel deflection testing equipment and labor.
 - c.2. Obtain approval of equipment and acceptance of method proposed for use. Test shall be performed without mechanical pulling devices.
 - c.3. Remove and replace pipe exceeding deflection limits

6.2.2.C BACKFILL AND COMPACTION

The backfill is the area above the pipe bedding. The pipe trench shall be backfilled and compacted in accordance with Volume 1, Street Design Standards and Construction Specifications, Section 02595, Utility Cut and Backfill.

Backfill material may be local site material that is well-graded, non-cohesive granular material free of rocks, frozen lumps, foreign material or stones greater than 3" in any dimension, aggregate base course, or flowfill. Remove all debris including soda cans, rags, pipe banding material, etc. from the pipe trench before backfilling.

In areas where a portion of the trench bottom is lower than the water table, line the trench and wrap the bedding material with a woven geotextile fabric meeting AASHTO M288 Specification for Class 2, Subsurface Drainage and Permanent Erosion Control. Lap fabric joints at least 12 inches. If the plans specify, furnish and install reinforced concrete cut-off walls at one hundred (100) foot intervals along the trench line.

Haunching is the area of bedding up to the pipe spring line. Granular material as outlined for the bedding shall be placed and consolidated evenly on each side of the pipe. The bedding materials shall be consolidated under the lower haunch of the pipe with shovel slicing and tamping. Care shall be taken to see that pipe alignment and cross-sectional areas are maintained.

Compaction machinery should not be used around flexible pipes until the select bedding is placed 12-inches over the top of the pipe and the first lift of backfill is placed.

6.2.2.D INSPECTION AND TESTING

Installation of the pipe bedding, haunching, and backfill up to a point 12-inches above the top of the pipe, shall be observed by the City. The City will provide acceptance testing during backfill operations. The Contractor shall take Quality Control tests in the pipe haunch area for pipe diameters 36-inches and larger. For pipes smaller than 36-inch diameter, begin tests at one foot above the pipe. Quality Control tests shall be taken as follows:

Schedules For Quality Control and Quality Assurance Sampling and Testing shall be per Streets Volume 1.

After backfill and compaction of the trench is completed, the pipe shall be inspected to detect any deformations, sags, or joint displacements. Rigid pipe shall be visually inspected for sags or displaced joints.

Upon completion of storm drain installation and prior to paving, the contractor shall notify the City. The Contractor shall be required to perform a pipe deflection test for flexible pipes with runs greater than 100' long in the presence of the City.

Flexible pipe, 48-inch diameter and smaller, may be tested with a "Go/No Go" deflection test gauge, which shall be pulled through the pipe. The maximum allowable deflection is 5 percent. The horizontal diameter shall not differ from the design diameter by more than 5 percent. Similarly, for pipes other than circular, the field-installed dimensions shall not vary more than 5 percent of the design dimensions. Any pipe that exceeds the maximum allowable deflection is to be removed and replaced.

The tests and inspection reports shall be submitted to the City prior to proceeding to the next phase of construction and prior to paving. The Contractor shall provide the City a letter of certification, prior to the issuance of building permits. The letter of certification shall state that the class, gauge, or stiffness of pipe is in accordance with the City's design for installation conditions encountered.

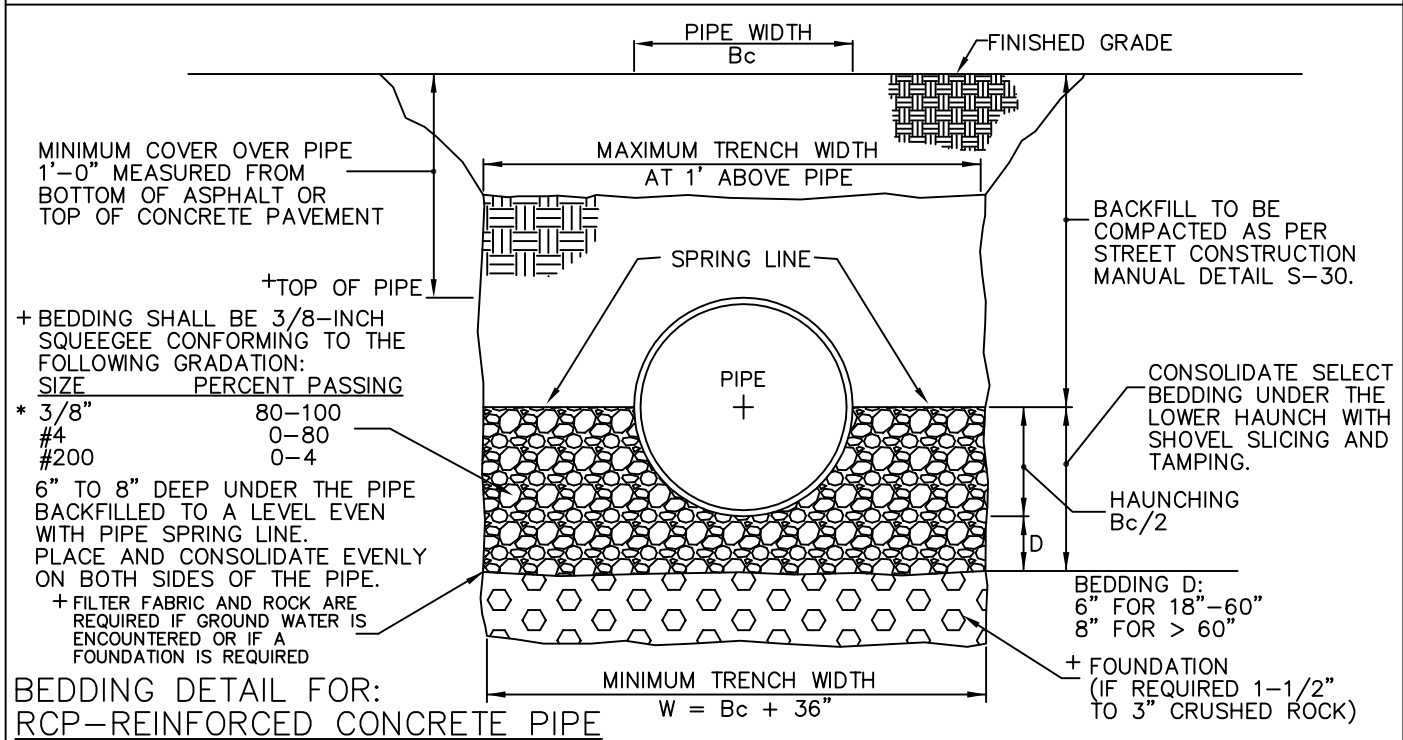
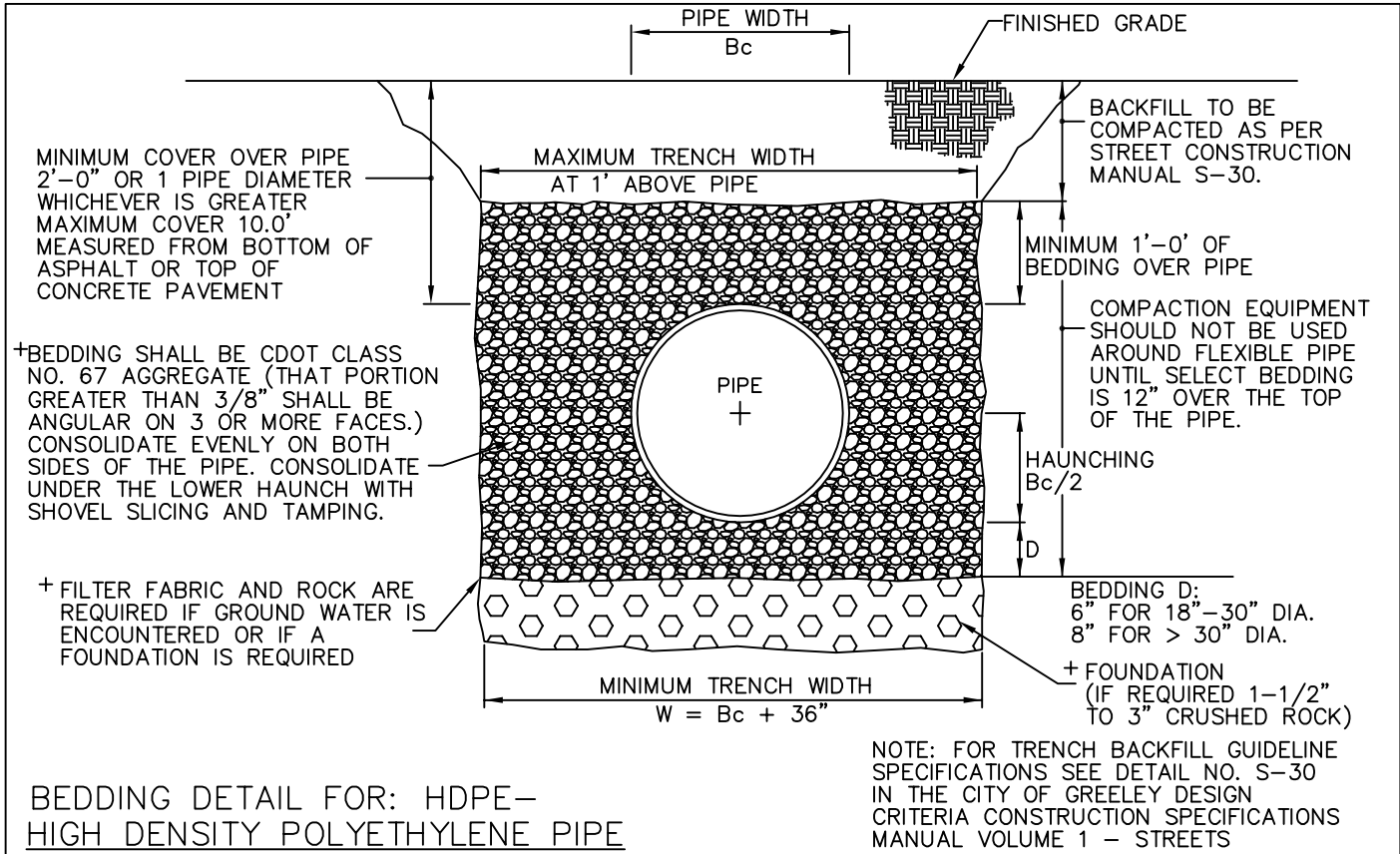
Inspection checklists for handling, storing, installing, and testing pipe are included at the end of this Section.

6.2.3 CONNECTIONS TO EXISTING STORM DRAIN

Connection to different pipe materials shall be made using manholes or transition sleeves. Details for connection to different materials shall be provided by the Design Engineer. If nothing is specified, a minimum of a structural concrete collar shall be installed.

6.2.4 PIPE INSPECTION CHECKLIST

- Before unloading, inspect pipe and fittings for any obvious transportation damage.
- Check each pipe section and fitting for proper markings on pipe.
- Check for correct ASTM or AASHTO Specification.
- Pipe diameter, class or strength designation.
- Manufacturer or trade name.
- Date of manufacture.
- Number assigned to each pipe corresponding to laying diagram if required.
- Check each pipe section for external and internal damage.
- Check gaskets for damage and proper markings or identifications.
- Check that all pre-inserted gaskets are in place.
- Check lubricants, cleaners, or adhesives for conformance.
- Check flexible pipe for axial or longitudinal deformation.
- Mark each pipe that is rejected or needs to be repaired to prevent usage.
- Compare field repair procedures with manufacturer's requirements.
- Document repairs with photos, names of personnel, dates, equipment, and supplies.
- Pipe stored in accordance with manufacturer's instructions.
- Pipe stored on flat area, with joints supported.
- Pipe shall not be stacked higher than allowed by manufacturer.
- Procedures followed that will not allow the pipe to become deformed during storage.
- All blocks, chocks, wedges are intact and firmly in place.
- PVC/HDPE pipe is protected from long-term (greater than 30 days) exposure to sunlight.
- Pipe is protected from adverse weather, harmful chemicals, dirt or debris accumulating on the interior of the pipe.
- Gaskets are protected from dust and grit, solvents, and petroleum-based greases and oils, and other agents having a harmful effect on the gasket.
- Stringing of pipe is in accordance with manufacturer's recommendations.
- Pipes are blocked to prevent movement due to wind or accidental bumping.
- Pipe joining surfaces shall be cleaned of any dust, dirt, and debris accumulation prior to installing gasket and joining.
- Interior of pipe is free of dirt and debris.
- Access to roads, driveways, etc., shall be maintained.
- If stringing of pipe is required along roadway, is pipe orientated (angular rotation) properly, is pipe a safe distance from traffic, and is proper flasher signage present to protect traveling public.



REVISIONS	
3/31/07	+ UPDATE DETAIL
6/03/08	* UPDATE DETAIL



NOTE: FOR TRENCH BACKFILL GUIDELINE
SPECIFICATIONS SEE DETAIL NO. S-30
IN THE CITY OF GREELEY DESIGN
CRITERIA CONSTRUCTION SPECIFICATIONS
MANUAL VOLUME 1 - STREETS

STANDARD STORM WATER
BEDDING DETAIL
DETAIL 6-6

DATE: JUNE 2008

SCALE: N.T.S.

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SECTION 12.0 STORMWATER QUALITY ENHANCEMENT

12.1 REGULATORY BACKGROUND

Since the National Environmental Policy Act of 1969 (NEPA), much attention has been given to the control of erosion and sedimentation by Federal, State and local governments. Numerous laws and regulations governing land-disturbing activities have been developed and published. Some important legislation that affect construction activities in regard to erosion and sediment control are:

1. The Clean Water Act (sections 401,402 and 404)
2. Senate Bill 40 (SB40) Wildlife Certification (Title33, article 5, CRS)
3. The Colorado Water Quality Control Act (Title 25, article 8, CRS)
4. City of Greeley Ordinance #33,1994 (Chapter 14.15) (Established Stormwater Management Program)
5. City of Greeley Ordinance #15, 1996 (Chapter 09.18) (Grading & Soil Erosion Control)
6. City of Greeley Ordinance #32,1999 (Chapter 14.16) (Prohibits Illegal Dumping into City's Stormwater Drainage System)

Of particular importance are the National Pollutant Discharge Elimination System (NPDES) Phase II stormwater regulations issued by the Environmental Protection Agency (EPA). In 1999, the regulation was extended to include smaller municipalities as well. The Phase II Stormwater Permit Regulation required small municipalities (<100,000 population) to obtain NPDES MS4 Permit coverage. **The phase II regulation also reduced the minimum size of construction projects requiring NPDES permits from 5 acres of disturbed area to just 1 acre.**

Colorado is an NPDES state, which means the EPA's authority to issue NPDES permits is delegated to the state regulatory agency, the Colorado Department of Public Health & Environment (CDPHE). CDPHE implements and enforces the NPDES Programs through the Colorado Discharge Permit System (CDPS) program.

12.2 INTRODUCTION

The character of the urban landscape affects both the quantity and the quality of stormwater discharged to receiving waters during and after each runoff event. The quality of stormwater runoff from developed lands and urbanized areas can be impacted by some or all of the sources and contaminants shown below. The increase in impermeable areas such as rooftops, parking lots and paved surfaces acts directly to impact stormwater quality by decreasing the opportunity for stormwater to infiltrate and percolate into the ground, and the absence of natural surfaces and vegetation allows for increased runoff velocity and pollutant carrying forces.

TABLE 12.2 POSSIBLE SOURCES OF POLLUTANTS IN STORMWATER

POSSIBLE SOURCES OF POLLUTANTS IN STORMWATER	
Source	Contaminant
Vehicles, Machinery and Industry	Metals, Lubricants, Solvents, Paints
Lawn Care, Gardening	Pesticides, Herbicides, Fertilizers

lecting excess bituminous material from the roadway after removal of pavement markers.

12.5.4.E STREET SWEEPING AND VACUUMING

Practices to remove sediment transported onto streets to prevent the sediment from entering a storm drain or watercourse.

These practices are implemented anywhere sediment is tracked from the project site onto public or private roads, typically at points of egress.

1. Limitations

Sweeping and vacuuming may not be effective when soil is wet or muddy.

2. Design Guidelines

- a. Visible sediment tracking shall be swept and vacuumed on a daily basis.
- b. If not mixed with debris or trash, consider incorporating the removed sediment back into the project.

12.5.4.F VEHICLE AND EQUIPMENT MANAGEMENT

Practices used during vehicle and equipment fueling, cleaning, and maintenance to prevent associated stormwater pollutants from entering storm drains and watercourses.

Facilities or designated construction work areas where vehicles and equipment are fueled, cleaned, or maintained.

1. Standards and Specifications

- a. Perform cleaning, washing, and maintenance in a centralized station offsite. Onsite activities are highly discouraged.
- b. Designated onsite stations should preferably be located indoors on impervious surfaces 50 feet away from watercourses, configured with a sump, and bermed to collect the wastewater.
- c. Wastewater shall not be discharged into the City Of Greeley right-of-way. Wastewater shall be contained for percolation and evaporation.
- d. Constructed berms shall be durable and leak proof.
- e. Eliminate or reduce the amount of toxic or hazardous solvent used.
- f. Use proper waste or recycling drums for used or spilled fluids. Separate and recycle materials when possible.
- g. Use drip pans or absorbent materials under equipment to catch and contain leaks.
- h. Do not pour liquid waste into floor drains, sinks, or storm drain inlets.
- i. Avoid hosing down work stations.
- j. Routinely check vehicles and equipment for leaking oil or fluids.
- k. Proper spill and illicit discharge reporting and cleanup procedures shall be followed for both hazardous and non-hazardous materials.

12.6 THE EROSION CONTROL PLAN

A site specific Erosion Control Plan shall be submitted to the City for review and approval. The Erosion Control Plan should be consistent with the site's drainage report and shall be included within the required drainage report for the project.

NOTE: The Construction Permit from the Colorado Department of Public Health, Water Quality Control Divisions requires a Stormwater Management Plan (SWMP) be prepared. The Erosion Control Plan may or may not meet this requirement. It is up to the design engineer to determine if they have developed an adequate SWMP to meet the state requirements.

12.6.1 PRELIMINARY EROSION CONTROL PLAN

The following information shall be included within the Preliminary Erosion Control Plan which shall be submitted along with the Preliminary Drainage Report (refer to Section 2.3 of these Criteria) for the site:

1. Name, address and telephone number of the applicant and the Professional Engineer preparing the report.
2. Project description; briefly describing the nature and purpose of the development, the total area of the site, the area of disturbance involved, and the project location, including township, section and range.
3. Existing site conditions should be described, including existing topography, vegetation, and drainage. If wetlands are present on the site they must be described: location, aerial extent, and type. It is the applicant's responsibility to determine and comply with all other federal or state regulations regarding the impact of development on wetlands.
4. A vicinity map indicating the general area and property lines for the site should be included. Acceptable scales range from 1" = 1000' to 1" = 2000'.
5. An exhibit or map of existing and proposed drainage features or facilities, and basin boundaries (existing and proposed) for the site. Complete basin boundaries shall be shown for all basins extending off of the site.
6. Neighboring areas must be described as to land use and existing features, such as adjacent streams, lakes, structures, roads, etc.
7. A description of the stormwater quality management-planning concept for the site.
8. Preliminary sizing and location of the selected BMP's.
9. A discussion of the maintenance requirements for all proposed BMP's, including suggested schedules, costs and designation of responsible party.

12.6.2 EROSION CONTROL PLAN

In addition to items numbered 1 through 9 as required in the Preliminary Erosion Control Plan, the following information must be included within the Final Erosion Control Plan, which shall be submitted along with the Final Drainage Report (refer to Section 2.4 of these Criteria):

1. A discussion of the final design, sizing and location of the selected BMP's.
2. Hydrologic, hydraulic and all other calculations used to size and design the selected BMP's.
3. A final site and grading plan indicating the path of all stormwater flow and the location of stormwater control and stormwater quality facilities.

4. Final construction drawings of the proposed stormwater quality improvements, if appropriate.

12.7 EXTERIOR TRASH COMPACTORS

This new requirement applies to all commercial stores as detailed below.

1. The area of the exterior trash compactor shall be provided with curb all around except the entry to prevent surface water from entering the trash compactor area drain. The entry side must be ramped in a manner to channel surface water away from the entry edge. The trash compactor curbed area shall slope to a low point where an area drain, like a catch basin, shall be provided.
2. For exterior trash compactors the area drain shall be connected to the storm water drainage system via a double compartment grease/sand interceptor to intercept sediment and any oil and grease fluid leakage from the compactor.
3. For interior trash compactors the area drain shall be connected to the sanitary sewage system.
4. The interceptor shall be a minimum of 750 gallon capacity per UPC definition for Grocery stores, Hardware stores, and Lumber yards.
5. The interceptor for all other type stores shall be a minimum of 350 gallon grease and sand trap.
6. A 4 inch drain connection will be adequate for the area involved.
7. The area drain need not be trapped and vented. The grease/sand interceptor shall serve as the trap and shall be properly vented per the City of Greeley's current Plumbing Code.
8. The access manhole covers over the interceptor compartments shall be accessible while the trash compactor is attached to the building and functioning, to allow cleaning and inspections to occur without moving the trash compactor.

12.8 SWIMMING POOLS, SPAS, JACUZZIS, FISHPONDS AND FOUNTAINS

This is a new section discussing the regulatory issues regarding the discharge of water from swimming pools, spas, Jacuzzis, fishponds and fountains. These facilities often contain chemicals used for sanitizing or cleaning purposes. These chemicals (such as chlorine or copper-based algaecides) may be damaging to the environment if the wastewater is allowed to flow to the Cache la Poudre River by way of storm drains. It is illegal to discharge filter backwash and chlorinated water into the storm drains.

Filter backwash shall be discharged into the sanitary sewer system and not into the street. Backwash water has a heavy concentration of chlorine and other chemicals that are good for treating sewage water, but are damaging to natural aquatic environments. Additionally, backwash leaves a residue of contaminated diatomaceous earth (DE) along the gutter and street. If filter backwash cannot be discharged to the sanitary sewer, a catch basin should be installed to remove the DE prior to draining it into a landscaped area.

Federal law allows **dechlorinated pool water** to be released to the environment, if the following criteria are met:

1. The residual chlorine does not exceed 0.1 mg/l (parts per million)
2. The pH is between 6.5 and 8.5
3. The water is free of any unusual coloration

4. There is no discharge of contaminated filter media.
5. There is no discharge of acid cleaning wastes.

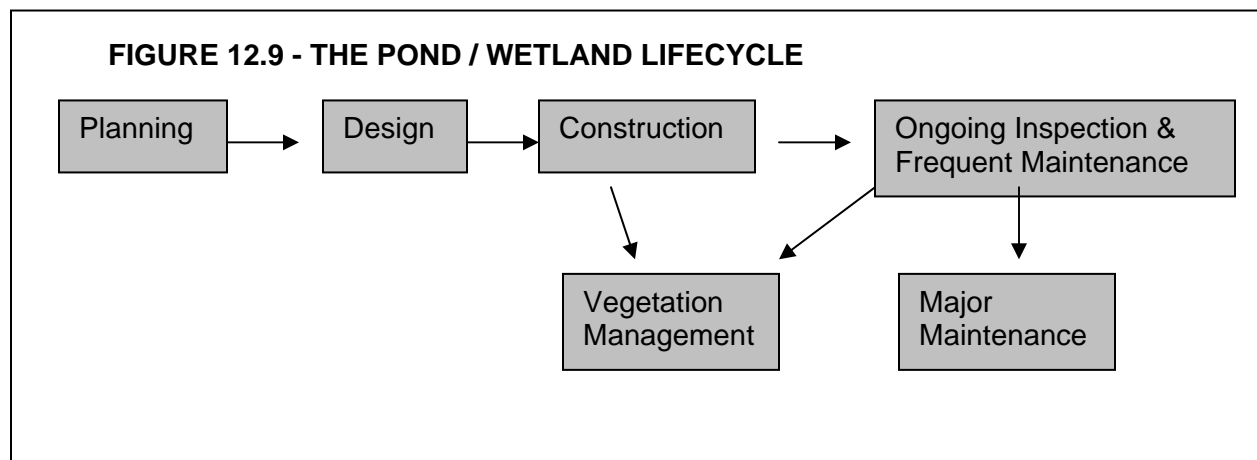
12.9 POST CONSTRUCTION: LONG TERM OPERATION & MAINTENANCE OF STRUCTURAL CONTROL BMP'S

In accordance with the National Pollution Detection and Elimination System (NPDES) Phase II, structural BMP's like detention and retention ponds are to be actively maintained to ensure the long term operation and maintenance.

Stormwater ponds and wetlands are popular stormwater structural BMP's for a number of reasons including aesthetics, pollutant removal capability, habitat value and relatively low maintenance burden. Stormwater wetlands can provide diverse habitat for aquatic and terrestrial species. The large permanent pool volume of ponds and wetlands enhances pollutant removal because of relatively long residence times, reduced flow velocities and their ability to retain settled sediments and pollutants. Stormwater wetlands also provide biological uptake of pollutants through contact between wetland plants and stormwater runoff.

Stormwater pond maintenance is related to the entire pond lifecycle, depicted in Figure 12.9 and needs to be considered in the design phase.

FIGURE 12.9 – THE POND / WETLAND LIFECYCLE



Maintenance is necessary for a stormwater pond or wetland to operate as designed on a long-term basis. The pollutant removal, channel protection, and flood control capabilities of ponds and wetlands will decrease if:

1. Sediment accumulates in the pond, reducing the storage volume
2. Debris blocks the outlet structure
3. Pipes or the riser are damaged
4. Invasive plants out compete the wetland plants
5. Slope stabilizing vegetation is lost
6. The structural integrity of the embankment, weir, or riser is compromised.

Pond and wetland maintenance activities range in terms of the level of effort and expertise required to perform them. Routine pond and wetland maintenance, such as mowing and removing debris or trash, is needed multiple times each year, but can be performed by property owners. This could include Home Owner's Associations and Business Owners. More significant maintenance such as removing accumulated sediment is needed less frequently, but requires more skilled labor and special equipment. Inspection and repair of critical structural features such as embankments and concrete structures, needs to be performed by a qualified professional (e.g., professional engineer) that has experience in the construction, inspection and repair of these features.

Property owners and responsible parties need to recognize and understand that neglecting routine maintenance and inspection can lead to more serious problems that threaten public safety, impact water quality, and require more expensive corrective actions.

A typical inspection/maintenance frequency for Ponds and Wetlands is presented below in Table 12.9(1).

TABLE 12.9(1) - TYPICAL INSPECTION / MAINTENANCE FOR PONDS AND WETLANDS

Frequency	Inspection Item	Skill Level	Maintenance Items
Monthly to Quarterly or After A Storm Event (>1 ")	Inspect low flow orifices and other pipes for clogging Check the permanent pool or dry pond area for floating debris and undesirable vegetation Check banks for erosion	0	Mowing – minimum Spring & Fall Remove debris in and around trash racks, water quality boxes and trickle pans.
One time – After First Year	Ensure that at least 85% of vegetation survive Check for invasive plants and noxious weeds	1-2	Replace vegetation as needed
Every 1 to 3 years	All routine inspection items listed above Inspect riser, barrel and embankment for damage Inspect all pipes Monitor sediment deposition in facility and forebay	3	Repair pipe and riser as needed Forebay maintenance and sediment removal when needed.
2-7 years	Monitor sediment deposition in facility and forebay	3	Forebay maintenance and sediment removal when needed
10 -25 years	Remote television inspection of reverse slope pipes, under drains, and other non-accessible piping.	3-4	Sediment removal from main pond/wetland Pipe replacement if needed

The skills level needed to diagnose a problem during inspection is listed below and referenced in the above table.

Skill Level Description

0 No special skills or prior experience required.

- 1 Maintenance crew member or citizen with prior experience with ponds and wet lands
- 2 Agronomist with experience with plants within ponds and wetlands
- 3 Contractor or Inspector with extensive pond and wetland maintenance issues.
- 4 Professional Engineer