

12.0 DRAINAGE

The Project shall include all Work for the modification of existing drainage facilities, construction of new drainage facilities, and construction of Permanent Stormwater Quality Facilities (PSQF) and construction of new bridges to accommodate design flows for the ultimate I-25 and US 24 highway configuration, meet Project design criteria, and comply with the terms and conditions of the CDOT Municipal Separate Storm Sewer System (MS4) Permit, the City of Colorado Springs MS4 Permit, the requirements of this Section 12, and all other applicable permits and standards as included in the Contract Documents.

All storm drainage improvements constructed for the Project shall be designed to accommodate the drainage system needed for the ultimate I-25 and US 24 highway configuration with a minimal amount of future drainage system reconstruction will provide best value to the project.

There is a Preliminary Hydrology and Hydraulics Report and a Water Quality Approach technical memorandum included in the Reference Documents. These materials provide information regarding onsite and offsite drainage basins, peak flows and a conceptual layout of the proposed drainage and permanent water quality systems for informational purposes.

The Contractor shall design and construct a complete storm drainage system to intercept and remove surface runoff from I-25 and US 24, maintain surface, channel, and conduit flow through the Right-of-Way (ROW), and convey Fountain Creek and Monument Creek peak discharges through the new bridges. The Contractor shall also design and construct the storm drainage facilities to limit drainage-related hazards within and outside the ROW, while minimizing future operation and maintenance costs, public inconvenience, flood damages, and water quality impacts during construction.

All existing cross drains, storm drains, and drainage appurtenances to be abandoned shall be removed or plugged and filled with flow-fill in accordance with CDOT *Standard Specifications*, Section 202. All existing cross drains, storm drains, and/or drainage appurtenances to be included and/or utilized with the proposed drainage design shall; meet all Project hydraulic design capacity requirements and geometric requirements and shall be structurally verified by a Professional Engineer, and rehabilitated as necessary to meet an equivalent new design life, or; shall be removed and replaced with new materials.

All drainage facilities of the Project shall be constructed to meet Project design criteria. Where the hydraulic capacity or condition of existing drainage facilities are inadequate, existing facilities shall be replaced or supplemented as necessary to meet the Project design criteria.

The Contractor shall design drainage facilities compatible with existing or proposed drainage systems on adjacent properties, and shall preserve existing drainage patterns wherever possible. If existing drainage patterns must be changed due to design of the Project, the Contractor shall design and construct a solution that does not adversely impact property owners outside the CDOT ROW or easement areas, shall obtain approval from CDOT prior to construction and where drainage patterns are changed from existing, the Contractor shall secure all other necessary approvals, permits, and additional easements.

12.0.1 Standards

The Contractor shall design and construct the drainage systems in accordance with the requirements of the standards listed in Table 12.0-1. Where standards conflict, the more stringent standard shall apply.

TABLE 12.0-1 STANDARDS FOR DRAINAGE	
Author or Agency	Title
CDOT	<i>Standard Specifications for Road and Bridge Construction</i>
CDOT	<i>Standard Plans, M & S Standards</i>
CDOT	<i>Drainage Design Manual</i>
CDOT	<i>Bridge Design Manual, Section 16 – Hydraulics and Drainage</i>
UDFCD	<i>Urban Storm Drainage Criteria Manual, Volumes I, II and III</i>
CDOT	<i>Erosion Control and Storm Water Quality Guide</i>
CDOT	<i>Water Quality Guidance for Consultants</i>
City of Colorado Springs	<i>Drainage Criteria Manual</i>

12.0.2 Design Guidelines

Where the above standards do not address a certain design criteria or element, the design guidelines listed in Table 12.0-2 shall be utilized. Where guidelines conflict, the more stringent shall apply.

TABLE 12.0-2 DESIGN GUIDELINES FOR DRAINAGE	
Author or Agency	Title
AASHTO	<i>A Policy on Geometric Design of Highways and Streets</i>
FHWA	<i>Hydraulic Design of Energy Dissipaters for Culverts and Channels, HEC-14</i>
FHWA	<i>Evaluating Scour at Bridges, HEC-18</i>
FHWA	<i>Stream Stability at Highway Structures, HEC-20</i>
FHWA	<i>Urban Drainage Design Manual, HEC-22</i>
FHWA	<i>Drainage of Highway Pavements, HEC-12</i>
FHWA	<i>Bridge Scour and Stream Instability Countermeasures, HEC-23</i>
FHWA	<i>Design of Roadside Channels with Flexible Linings, HEC-15</i>
FHWA	<i>Design of Riprap Revetment, HEC-11</i>
FHWA	<i>Hydraulic Design of Improved Inlets for Culverts, HEC-13</i>
FHWA	<i>Design of Bridge Deck Drainage, HEC-21</i>
FHWA	<i>Hydraulic Design of Highways Culverts, HDS-5</i>

CDOT	<i>Erosion Control and Stormwater Quality Guide</i>
CDOT	<i>Water Quality Guidance for Consultants</i>

12.1 Administrative Requirements

12.1.1 Coordination with Other Agencies and Disciplines

The Contractor shall coordinate all drainage related issues with affected regulatory agencies where appropriate. The Contractor shall include CDOT in all contacts with appropriate regulatory agencies.

12.1.2 Permits

The Contractor shall adhere to the requirements of the various environmental and stormwater permits that are necessary for construction and operation of the Project. The Contractor shall follow the requirements of the latest CDOT Stormwater Management Plan (SWMP) template and appropriate specifications. The Contractor shall be responsible for complying with CDOT's MS4 Permit and Stormwater Consent Order #SC-081 023-1 (Consent Order). The Contractor shall be required to obtain all permits, unless otherwise indicated. The listing herein is not all-inclusive and it shall be the responsibility of the Contractor to determine all of the permits required to perform the Work. It is the responsibility of the Contractor to comply with the requirements of all permits. The Contractor shall refer to Section 5 for additional requirements. If conflicts exist between requirements of Section 5 and Section 12, the more stringent shall apply.

12.1.2.1 Colorado Discharge Permit System, Stormwater Construction Permit (CDPS-SCP)

CDOT has the authorization to discharge under the Colorado Discharge Permit System. Implementation of the permit requirements (i.e., SWMP, SWMP Site Map, and SPCC Plan) shall be a first construction item. Construction cannot begin until these items have been accepted by CDOT. CDOT will review the Contractor's stormwater management activities throughout the duration of the Project for verification of compliance with the CDPS-SCP, CDOT's construction section of the MS4 Permit, and Consent Order. The Contractor shall comply with CDOT *Standard Specifications*, Sections 101, 107 and 208.

The Contractor shall obtain a CDPS-SCP from the Colorado Department of Public Health and Environment (CDPHE) for construction of the Project prior to Work commencing. The CDPS-SCP shall be in the Contractor's name. The Contractor shall adhere to all requirements of the CDPS-SCP and the Construction Section of CDOT's MS4 Permit and the Consent Order. Most, but not all, non-compliance issues and necessary Best Management Practices (BMP) maintenance will be noted during Consent Order Monthly Inspections by CDOT, Regional Erosion Control Advisory Team (RECAT) inspections, in the 1176 inspection forms by the Erosion Control Supervisor (ECS), or in the daily stormwater log, as required by the Consent

Order. The Contractor shall prevent the discharge of any sediment or pollutants into any storm drains or receiving waters during the life of the CDPS-SCP.

12.1.2.1.1 Storm Water Management Plan (SWMP)

The SWMP work shall include the CDOT SWMP template and a SWMP Site Map that documents the detailed erosion/sediment control BMPs and their locations. The Contractor shall submit a SWMP and SWMP Site Map for Acceptance by CDOT. The Contractor shall submit a SWMP and SWMP Site Map for Acceptance by the Local Agency for work outside CDOT ROW. The Contractor shall fill out the current CDOT SWMP template, including BMP narratives. The SWMP shall clearly describe the relationship between the phases of construction and the implementation and maintenance of the stormwater management controls. Any major modifications (i.e., change modification orders or minor changes revisions) to the CDOT SWMP template shall be submitted to CDOT for Acceptance. The Contractor shall revise the SWMP Site Map as necessary based on actual construction activities throughout the duration of the CDPS-SCP. All BMPs shall be listed on the SWMP Site Map per the requirements of the CDPS-SCP.

Contractor shall keep onsite at all times, all documents pertaining to the CDPS-SCP in the CDOT Stormwater Management Plan (SWMP) Notebook (provided by CDOT) to maintain compliance with the SCP. Upon permit inactivation, the SWMP Notebook shall be turned over to CDOT and become the property of CDOT Project files.

12.1.2.1.2 Best Management Practices (BMPs)

The Contractor shall install and maintain the construction BMPs for the Project in accordance with the CDOT Erosion Control and Stormwater Quality Guide and Sections 101, 107, and 208 of the Standard Specifications. Construction BMPs for the Project shall include, but are not limited to, those listed in the Standard Specifications, as well as, preservation of existing vegetation, surface roughening, tackifier or soil binder, soil retention blankets, temporary clean water diversions, storm drain and basins, protection of trees, hazardous waste and spill containment and saw water disposal, stabilized construction entrances, and pavement sweeping of the affected Project areas. The Contractor shall add a BMP narrative to the SWMP on how it is being used, and shall supply the manufacturer details to be placed in the SWMP Notebook. The Contractor shall have a complete supply of all necessary construction BMP Materials on Site at all times in preparation for construction water quality control emergencies.

Where permanent seeding operations are not feasible because of seasonal constraints (e.g., summer and winter months), the Contractor shall have mulch and mulch tackifier applied to disturbed areas to prevent erosion. Slopes shall be roughened at the end of each day. Concrete washout shall be contained

The Contractor shall use an extended term erosion control blanket or open weave textile on all disturbed slopes required to stabilize ditch / channel facilities to promote the establishment of vegetation. The Contractor shall use a Type 3.B erosion control blanket in areas with disturbed slopes with 4:1 (H:V) gradients or steeper, but not to exceed slope gradients of 2:1 (H:V). The Type 3.B erosion control blankets or open weave textile materials must have a 24-month typical functional durability, be designed for use on geotechnical stable slopes with slope gradients not

exceeding 2:1 (H:V), and able to withstand a maximum permissible shear stresses of 2.00 pounds per square foot as specified in FHWA Standard Specification for Construction of Roads and Bridges on Federal Highway Projects, FP-03, Section 713. All proposed roadside ditches, swales or other areas of concentrated flow shall be evaluated to determine the channel hydraulic shear stresses. Where hydraulic shear stresses are found to exceed the maximum allowable shear stresses of 2.00 pounds per square foot, a Type 5 turf reinforcement mat (TRM) or riprap armoring shall be designed and placed to protect against the design shear stresses in the proposed ditch / channel facility. All slopes gradients greater than or equal to 2:1 (H:V) shall utilize slope paving.

The maximum permissible shear stresses for a Type 3.B erosion control blanket and Type 5 TRM must meet or exceed the testing methods as identified in the FHWA Standard Specifications for Construction of Roads and Bridges of Federal Highway Projects, FP-03. The identified test method for Type 3.B erosion control blanket and Type 5 TRM will adhere to ASTM D6460.

Non-structural BMPs may include litter and debris control, street sweeping, and landscaping and vegetative practices.

12.1.2.1.3 Spill Prevention Control and Countermeasures Plan (SPCC Plan)

The Contractor shall prepare a SPCC Plan for Acceptance by CDOT and submitted 21 Days prior to NTP2. Plan will be in accordance with *Standard Specifications Section 208*. The SPCC shall establish operating procedures for handling pollutants and preventing spills. Pollutant sources include, but are not limited to, exposed and stored soils, paints, solvents, fertilizers or chemicals, vehicle tracking, management of contaminated soils, loading and unloading operations, outdoor storage activities, vehicle/equipment maintenance and fueling, significant dust or particulate generating processes, on-site waste management practices, concrete truck/equipment washing, dedicated asphalt and concrete batch plants, and non-industrial waste sources that may be significant such as trash and portable toilets.

12.1.2.1.4 Drainage

The Contractor shall be responsible for temporary drainage of the Project area during construction of the Project. The Contractor shall keep all existing storm drainage systems used for temporary drainage of the Project in operating condition during construction. Prior to the start of construction, the Contractor shall locate and clean all existing storm drainage systems in accordance with Section 202 of CDOT *Standard Specifications*. Throughout the duration of the permit, the Contractor shall continually protect inlets from sediment and pollutants and, if needed, shall remove any material deposited in the systems as a result of the Contractor's activities. All inlets shall be identified on the SWMP Site Map and shall follow the requirements of Section 208 of CDOT *Standard Specifications*.

12.1.2.1.5 Erosion Control Supervisor

The Contractor shall assign to the Project an employee or subcontractor to serve in the capacity of the Erosion Control Supervisor (ECS). The ECS shall be a person other than the Superintendent and shall be a person dedicated solely to erosion/sediment control. The ECS

shall be experienced in all aspects of construction and have satisfactorily completed an ECS training program authorized by CDOT. Certification that this requirement has been met shall be submitted to CDOT at NTP1. A list of authorized ECS training programs will be provided by CDOT upon request by the Contractor.

The Contractor's ECS responsibilities shall follow the duties as laid out in *Standard Specifications*, Section 208, in addition to the following:

1. Direct the removal of sediment, trash, and debris from the construction BMPs and other drainage facilities within the affected areas of the Project.
2. Prepare a written report documenting that BMPs are adequate for the Site conditions of the Project and are in good working condition after inspections requiring documentation. The reports shall be kept with the SWMP inspection documentation and submitted to the CDOT Region Water Quality Manager. The appropriate form for this report will be supplied by CDOT. The inspections shall be made during the progress of the Work, during Work suspensions, and for the duration of the CDPS-SCP. During Project Work stoppages, inspections shall take place at least once every 30 Days, and within 48 hours after each event that causes surface runoff. After construction is complete, inspections shall take place at least once every 30 Days until the permit can be closed.
3. When Work is occurring in a Local Agency's jurisdiction, conduct inspections according to the required intervals of the Local Agency.
4. Implement the necessary actions to reduce anticipated or presently existing water quality or erosion problems resulting from construction Activities. The criteria for this action shall be based on water quality data derived from any inspections and monitoring operations or by any anticipated conditions (e.g., predicted storms) that could lead to unsuitable water quality situations.

12.1.2.1.6 Inspections

During the Project, multiple inspections by CDOT and the Contractor and their ECS will be occurring. Inspections shall be on the appropriate CDOT Forms and shall follow the requirements in *Standard Specifications*, Section 208. Prior to work commencing, a pre-construction conference shall be held with the CDOT's Region Water Quality personnel. In addition, when the first phase of BMPs has been installed, the Contractor shall notify CDOT's Region Water Quality personnel to come out and inspect the BMPs for proper installation. Work shall not begin until the BMP installation inspection has occurred. CDOT's Region Water Quality personnel will be inspecting the Site on a monthly basis, as well as during the surprise Regional Erosion Control Assessment Team inspections. The Region Water Quality personnel may inspect the Project at any time and document any non-compliance issues that need to be resolved immediately by the Contractor. Fines may be assessed to the Contractor with the potential of Project shut downs, depending on the severity of the non-compliance. Prior to Final Acceptance of the Project construction, CDOT's Region Water Quality personnel shall be notified to perform a final walkthrough inspection. Any items identified for maintenance, replacement, or removal shall be done immediately or liquidated damages may be incurred upon the Contractor.

Based on the Consent Order, the Project Superintendent or ECS shall perform daily inspections of all BMPs to observe, record, and determine the effectiveness of all BMPs and to order their

maintenance if needed. The results of the daily inspections shall be recorded in a daily stormwater log, which will be provided by CDOT. The Contractor shall cooperate with Local Agencies that may perform their own stormwater inspections on this Project.

12.1.2.1.7 Colorado Discharge Permit System, Stormwater Construction Permit Closure

The Contractor shall be responsible for all stormwater permit requirements until the Project has achieved final stabilization (see Book 2, Section 17, Landscaping) and the CDPS-SCP permit can be closed. This includes the maintenance of all BMPs, maintenance of all seeded/landscaped areas, and removal of all BMPs once all erosion potential has been eliminated.

12.1.2.2 Municipal Separate Storm Sewer (MS4) Permit

CDOT and the City of Colorado Springs have an MS4 Permit for the storm drain systems that it owns and maintains. The Contractor shall be responsible for complying with the terms and conditions of the CDOT and the City of Colorado Springs MS4 Permit that pertain to the Project and shall follow the requirements set forth in the New Development Re-Development section to comply with the required water quality standards. CDOT is currently in process of renewing the current MS4 permit. Should the permit be adopted prior to the NTP 1, the Contractor will need to adhere to the conditions of the permit in effect at the time of construction. The Contractor shall comply with the following design criteria:

1. The Project shall be considered as a Priority Development Project in accordance with Section 2, New Development and Redevelopment Program of the draft MS-4 permit. The following shall take precedence over the by the requirements contained in the draft MS-4 permit following:
 - A. All runoff from impervious areas of the Project shall be treated by a New Control Measure prior to discharge downstream.
 - B. New Control Measure Design Standards:
 - (i) Contractor shall make all attempts to collect surface runoff from all impervious areas of the Project, including existing and proposed pavement areas within the project and convey the runoff to an Extended Detention Basin (EDB). The EDB shall be designed in accordance with Urban Drainage Flood Control District (UDFCD) standards as specified in *UDFCD Urban Storm Drainage Criteria Manual, Volume III*. The EDB shall provide a 40-hour drain time for releasing the Water Quality Capture Volume (WQCV) of the entire area tributary to the EDB, shall detain the 100-yr storm event, have a concrete forebay, low flow channel, micropool, 100-yr spillway and reinforced concrete outlet control structure as detailed in Figures OS-5 and OS-6 of the *UDFCD Urban Storm Drainage Criteria Manual, Volume III*.

- (ii) In the event Contractor is unable to route the runoff from impervious areas of the Project to an EDB, the runoff shall be collected in a grass swale or vegetated roadside ditch with check structures designed and located at intervals within the channel to promote infiltration of the WQCV for the tributary area to meet either of the following requirements:
 - a) Pollutant Removal Standard: The Control Measure(s) is designed to provide for removal of Total Suspended Solids (TSS) equal to the mass of 80% of the expected annual TSS loading from stormwater runoff discharges from 100% of all tributary areas.
 - b) Infiltration Standard: The Control Measure(s) is designed to infiltrate the water quality capture volume (WQCV) for all tributary areas tributary to the PSQF.
 - (iii) In the event Contractor is unable to route the runoff from impervious areas of the Project to an EDB, or grass swale / vegetated roadside ditch with check structures, only then will the use of proprietary stormwater vaults may be allowed. Proprietary stormwater vaults shall achieve 80% Total Suspended Solids (TSS) removal and shall be certified accordingly by the manufacturer.
- C. Runoff from off-site areas outside CDOT ROW or easement areas shall be kept separate from the on-site pavement runoff and shall not be introduced into a Project PSQF. In the event offsite runoff cannot be separated from a Project PSQF, the PSQF shall be designed to provide WQCV for the entire area tributary to the PSQF.

The *Preliminary Hydrology and Hydraulics Report* and the *Water Quality Approach* technical memorandum included in the Reference Documents, provide information regarding drainage concepts, and preliminary locations for PSQFs that were determined to be feasible for implementation. The conclusions, recommendations, and design included in these documents shall be used as a starting point to develop and design a more detailed permanent stormwater quality improvement plan. The recommendations included in these documents describe the type and location of BMPs that shall be implemented. Based on the assessment, it is practical to intercept and provide stormwater quality treatment for the locations shown.

The Contractor shall immediately notify CDOT and the Local Agency of any suspected illicit or improper connections or discharges into any storm drain system that are discovered during design or construction of the Project. The Contractor shall contact the CDOT Illicit Discharge Hotline at 303-512-4426. CDOT and the Local Agencies will be responsible for investigation of the suspected illicit connection and implementing corrective action. The Contractor shall not maintain, reconnect, or otherwise allow discharge of improperly disposed materials into the storm drain system within the limits of the flows leaving the Project.

12.1.2.3 Construction Dewatering Permit

Contractor shall obtain a Construction Dewatering permit prior to discharging groundwater to the surface or back to the ground. Contractor shall be responsible for all sampling, monitoring, treatment and Discharge Monitoring Reports required by the CDW.

12.1.2.4 U.S. Army Corps of Engineers (USACE) Section 404 Permit

CDOT will obtain 404 permits for work consistent with the Basic Configuration in the Bear Creek, Fountain Creek and Monument Creek stream systems as further described in Book 2, Section 5, Environmental.

12.1.2.5 Pikes Peak Regional Floodplain Management, Floodplain Development Permit

CDOT will obtain a floodplain development permit for work consistent with the Basic Configuration in FEMA regulatory floodplains associated with Bear Creek, Fountain Creek and Monument Creek as further described in Book 2, Section 12.2.5, Floodplains.

The Contractor shall obtain a floodplain development permit for work required for the ARE 2a, 2b and 3.

12.2 Design Requirements

12.2.1 Drainage Design Software

The following software (most recent versions) may be used in performing drainage design calculations.

1. USEPA, EPA SWMM
2. SCS (NRCS). TR-20
3. USACE, HEC-HMS
4. USACE, HEC-RAS
5. FHWA, HY-8
6. Bentley, InRoads Storm and Sanitary
7. Bentley FlowMaster
8. UDFCD, UD-Detention
9. UDFCD, UD-Inlet
10. UDFCD, UD-Rational

All software used must be capable of creating summary tables for both all individual input values and all individual output values (including all hydraulic losses).

Other proprietary drainage design software and spreadsheets may be used if it is certified by the software developer that it meets the design requirements herein, and with prior Approval by CDOT. No software or spreadsheets created by design consultants may be used.

12.2.2 Data Collection

The Contractor shall identify all drainage-related issues utilizing available data, including but not limited to, requirements imposed by local, state, and federal government regulations, and official documents concerning the Project. Drainage related issues include, but are not limited to, areas with historically inadequate drainage (as evidenced by recorded flooding or citizen complaints), environmentally sensitive areas, and known drainage-related maintenance problems.

The Contractor shall obtain all relevant storm drainage improvement plans, drainage planning studies, and drainage reports for the Project area from all Local Agencies, Colorado Springs, FEMA, and CDOT.

The Contractor shall obtain existing and projected future land uses from all Local Agencies and shall design facilities to be compatible with drainage systems, existing or proposed, on adjacent properties.

The Contractor shall perform detailed mapping and surveys as required to verify locations of existing drainage features necessary for the proposed drainage design. The Contractor shall verify or identify boundaries, flow patterns, and land uses of drainage basins based on field observations.

The Contractor shall resolve all conflicts between Utilities and proposed drainage improvements in accordance with Book 2, Section 7, Utility Relocations.

12.2.3 Surface Hydrology

The Contractor shall complete the hydrologic analysis and determine the corresponding peak flows for local off-site drainage basins tributary to the Project. The design flow rates for both Upper and Lower Fountain Creek shall be as indicated in the "Hydrology Report for Fountain Creek, El Paso County CO", prepared for FEMA Region VIII, as revised April 2010, for the appropriate design event frequency. The design flow rates for Bear Creek shall be as indicated in the effective FEMA "Flood Insurance Study for El Paso County Colorado and Incorporated Areas", for the appropriate design event frequency. The existing drainage facilities convey off-site runoff under I-25 and US-24 and include cross culverts, concrete box culverts at Bear Creek, and bridges at Fountain Creek and Monument Creek. The Contractor shall perform revised hydrologic analyses for any locations where changes in off-site drainage patterns are proposed as a result of the design of the Project.

The Contractor shall perform the hydrologic analyses for all on-site drainage basins, and for all off-site drainage areas immediately adjacent to the Project that contribute non-concentrated runoff to the on-site drainage basins. The analysis shall be based on projected future land uses and the Ultimate Configuration.

The hydrologic analyses shall identify all impacts to any existing storm drainage system.

12.2.3.1 Design Frequencies

For all CDOT-owned facilities, the design frequency shall comply with Table 7.2, Table of Design Frequencies in the CDOT *Drainage Design Manual* except for design frequency of minor system storm drains on I-25 and US 24, which shall be the 10-year design frequency.

The design frequency for all other roadways in the Project area shall comply with the affected Local Agency's criteria.

12.2.3.2 Precipitation

Precipitation data for on-site drainage analysis shall be obtained from the National Oceanic and Atmospheric Administration NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume III – Colorado, 1973. For rainfall durations of one hour or less, rainfall intensity shall be obtained from Rainfall Intensity Curves included in the City of Colorado Springs Drainage Criteria Manual.

12.2.3.3 Hydrologic Methods

The Contractor shall perform the necessary hydrologic analyses using the following methods:

1. Areas less than 90 acres shall be evaluated using the Rational Method. The minimum time of concentration shall be 5 minutes.
2. Areas greater than 90 acres shall be evaluated using the SCS (NCRS) Hydrograph Procedure with the standard SCS (NCRS) 24-Hour Type II Cumulative Rainfall Distribution.

The hydrologic analyses shall be based on fully developed and Ultimate Configuration for all drainage basins.

12.2.4 Hydraulic Structures

12.2.4.1 Roadways

Roadway component geometric configurations shall be designed to provide adequate drainage and minimize hydroplaning and icing problems. Cross slopes shall be in accordance with the requirements of Book 2, Section 13, Roadways.

12.2.4.1.1 Roadway Profile

Longitudinal grades shall be in accordance with the requirements of the Book 2, Section 13, Roadways. Where minimum profile grades cannot be obtained in sag vertical curves, flanking

inlets shall be constructed in the curb and gutter, or adjacent to the solid barrier guardrail, as required in the CDOT *Drainage Design Manual*.

12.2.4.1.2 Allowable Flow Spreads and Depths

The Contractor shall design all roadway storm drain systems including gutters, inlets, inlet spacing, catch basins, laterals, and trunk lines using the design criteria given in Table 12.2-1.

All other roadways outside of CDOT right-of-way shall comply with the Local Agency’s criteria.

All ramps associated with US 24 and I-25 shall be designed in accordance with the flow spreads and depths provided in Table 12.2-1.

Table 12.2-1 ROADWAY STORM DRAIN DESIGN STORM AND SPREAD CRITERIA			
Road Classification		Design Frequency	Design Spread
Interstate 25, US 24 (Cimarron) & all associated ramps		10-year	Shoulder + 3 ft
		50-year (sump)	Shoulder
		100-year (continuous grade and sump)	Shoulder + 4 ft

12.2.4.1.3 Edge Treatment

In areas where the roadway pavement discharges runoff to Type 7 guardrail or curb, inlets shall be used to collect flow from the curb section, and the drains shall be piped to the bottom of the slope. Rundowns shall not be used to convey concentrated flows to the bottom of slopes. Erosion protection shall be constructed at the outfalls. See Section 12.2.4.5 below for more information.

12.2.4.1.4 Roadside Ditches and Open Channels

For roadside ditches along all existing and proposed roadways, the water surface profile shall have a minimum of one foot of freeboard for the 10-year return frequency peak discharge and shall not exceed edge of pavement for the 100-year return frequency peak discharge.

All open channels within the Project shall be designed to capture and convey the 100-year return frequency. Capacity shall be determined using Manning's Equation.

All ditches and open channels shall be evaluated to determine the channel hydraulic shear stresses. The Contractor shall use extended term Type 3.B erosion control blankets in disturbed areas with slopes between 4:1 (H:V) and 2:1 (H:V) and able to withstand a maximum permissible shear stresses of 2.00 pounds per square foot as specified in FHWA Standard Specification for Construction of Roads and Bridges on Federal Highway Projects, FP-03, Section 713. Where hydraulic shear stresses are found to exceed 2.00 pounds per square foot,

a Type 5 permanent turf reinforcement mat (TRM) or riprap armoring shall be designed and placed to protect against the design shear stresses in the ditches and open channels.

Flexible channel linings shall be designed in accordance with FHWA *HEC-15, Design of Roadside Channels with Flexible Linings*. Riprap channel lining shall be designed in accordance with FHWA *HEC-11, Design of Riprap Revetment*.

The geometric layout shall be in accordance with the *AASHTO Roadside Design Guide*, and shall consider hydraulics, safety, maintenance, long-term permanent erosion control, landscaping, and aesthetics.

All abandoned concrete diversion structures in roadside ditches and open channels shall be removed unless otherwise directed by CDOT.

All slopes gradients greater than or equal to 2:1 (H:V) shall utilize slope paving.

12.2.4.2 Cross Drains

Cross drains shall be defined as pipes or culverts that convey water from one side of I-25 / US 24 to the other. All cross drains shall be designed for the 100-year return frequency peak discharge for fully developed ultimate conditions with no inundation of the I-25 / US 24 paved shoulders. All cross drains shall be designed to accommodate the Ultimate Configuration.

Hydraulic design of cross drains shall be based on the procedures included in FHWA *HDS No. 5, Hydraulic Design of Highway Culverts*. Hydraulic design data shall be listed on the final Design Plans for each cross drain, including drainage area, peak discharges, allowable headwater elevation, and design headwater elevation.

The minimum allowable pipe size for cross drains shall be 36 inches in diameter and the pipe or culvert shall be reinforced concrete. Reinforced concrete end sections with toe walls, or headwalls with beveled edges and wingwalls, shall be provided for all cross drain ends regardless of size. For concrete box culverts, concrete aprons with a toe-wall shall be installed at the box culvert outlet with the necessary downstream scour protection. To reduce sizes, improved inlets may be utilized. Improved inlets shall be designed based on FHWA *HEC-13, Hydraulic Design of Improved Inlets for Culverts*.

Allowable headwater elevation for the 100-year return frequency peak discharge shall be designed as described in Chapter 9.2.2 of the COOT *Drainage Design Manual*. In addition, allowable headwater elevation shall be limited by the minimum of the following:

1. Non-damaging to upstream or adjacent property.
2. Below edge of roadway shoulder elevation.
3. Headwater/Depth ratio requirements shall be as shown in the CDOT Drainage Design Manual.
4. Overflow to another drainage basin.

The use of sag pipes or inverted siphons shall not be allowed.

Discharge systems at the cross drain outlet shall be designed to prevent scour of existing channels and embankments at the design flow rates.

Cross drains shall be continuous through the ROW. Bends or turns will not be permitted. Pipes connected to manholes or inlets placed in line with a cross drain will be referred to as a storm drain and shall follow the requirements for storm drains.

12.2.4.3 Storm Drains

Storm drains shall be defined as a network of pipes that connect inlets, manholes and other drainage features to an outfall. Cross drains connected to the storm drainage system are considered part of the system. Runoff from within the limits of the Project and stormwater draining onto the Project shall be collected and conveyed in a storm drain system designed for the design frequencies included herein. The storm drain system shall be designed to not worsen the existing conditions for properties outside the CDOT ROW or Easement. Ponding will not be permitted within the Project, except at specifically designed stormwater detention & PSQF facilities.

Hydraulic analysis and plans for storm drains that are connected to existing storm drain systems upstream or downstream of the Project must be coordinated with affected local agencies. The hydraulic analyses shall identify the impacts to the existing storm drain systems caused by the connections and proposed combined peak design discharges for the overall systems.

The minimum allowable pipe diameters for storm drain systems are shown in Table 12.2-4.

TABLE 12.2-4 MINIMUM ALLOWABLE PIPE DIAMETER	
Application	Minimum Diameter (inches)
Side Drain	18
Median Drain	18
Storm Drain Trunk Line	18
Connections: - Median drain to cross drain - Curb Inlet to trunk line	18 18

The use of sag pipes or inverted siphons will not be allowed.

Storm drains shall not decrease in size in the downstream direction. From upstream to downstream, pipe diameters shall remain constant or increase. All bends and turns shall occur within a manhole or inlet.

12.2.4.3 Hydraulic Design of Storm Drains

Storm drain system design shall be performed using hydraulic gradient analysis to account for all friction and minor losses. Friction losses shall be calculated using Manning’s Equation.

Minor losses at junctions, manholes, bends, and other appurtenances shall be calculated based on design procedures in the FHWA *HEC-22, Urban Drainage Design Manual*.

Storm drains under I-25 and US 24 shall be designed with the hydraulic grade line (HGL) at or below the crown of pipe for the 10-year return frequency peak discharge. The HGL shall be 1 foot below pavement and inlet grates where the pipe is sized to convey the 100-year discharge. Local Agency criteria shall be followed for storm drain system design outside of CDOT ROW. The hydraulic gradient shall be plotted for all storm drains in each storm drain profile.

The flow velocity of storm drains shall not be less than 3 feet per second for the 10-year return frequency peak discharge and shall not be greater than 22 feet per second for the major storm discharge (100-year).

12.2.4.3.2 Storm Drain Alignment and Profile

Storm drain alignments shall be straight between structures.

Profiles of all storm drains shall be straight grades between structures

The Contractor shall comply with Local Agency criteria for storm drains outside CDOT ROW.

12.2.4.3.3 Inlets

Inlets are required at locations needed to collect runoff within the design criteria specified in Section 12. In addition, there are a number of locations where inlets may be necessary with little regard to contributing drainage area. These locations should be marked on the plans prior to any computations regarding discharge, water spread, inlet capacity, or bypass. Examples of such locations are as follows:

1. Sag points in the gutter grade
2. Upstream of median breaks and entrance/exit ramp gores and street intersections
3. Immediately upstream and downstream of bridges
4. Immediately upstream of cross slope reversals
5. On side streets at intersections
6. At the end of ditches or channels in cut sections
7. Behind retaining walls, curbs, shoulders or sidewalks to drain low areas
8. Where necessary to collect snow melt

Inlets shall not be located in a path where pedestrians are likely to walk.

CDOT M&S Standard Plans inlets shall be used within CDOT ROW. Type C and Type D inlets shall not be allowed within the roadway pavement limits. In the event a CDOT standard inlet cannot be used and the inlet is located within the pavement limits, the inlet shall be designed for

HL-93 or interstate alternate live loading and shall have traffic rated grates. When outside the roadway pavement limits, Type C and D inlets may be utilized.

Pedestrian-safe grates shall be used in pedestrian areas and bicycle-safe grates used in bicycle areas.

Concrete aprons shall be installed on all area inlets per the CDOT *M&S Standard Plans*.

Inlet hydraulic efficiency and spacing shall be determined based on design procedures in the FHWA *HEC-22, Urban Drainage Design Manual*. 100 percent of the bypass flow shall be added to the next downstream inlet.

For a continuous storm drain system, maximum inlet spacing shall be designed based on allowable flow spread or the manhole spacing criteria, whichever is less.

The sag vertical curve or sump area on a roadway requires inlets at the lowest point and flanking inlets on each side of the lowest inlet to provide relief from debris clogging. All sumps shall be designed in accordance with the criteria in Table 12.2.1. The flanking inlets shall be located such that the design criteria for ponding are met, even if the sump inlet is completely clogged

Inlets are required 10 feet upstream of the point where the highway cross slope begins to superelevate toward the opposite side to prevent pavement cross flow.

Slotted drains or trench drains will not be allowed in the traveled way or transverse to traffic flow on I-25 and US 24.

The use of scuppers or drainage slots in roadway and median barriers as a drainage element will not be allowed. Curb cuts or slotted barrier shall not be allowed for bridge deck drains.

Valley gutters across connecting streets will not be allowed. Drainage runoff shall be intercepted upstream from connecting streets for subsurface conveyance. Drainage shall be intercepted before concentrated flows cross lanes of traffic.

Access holes for inlets, catch basins, and manholes shall not be located in travel lanes of the I-25 mainline or US 24 traveled lanes.

Inlets shall be designed using the clogging factors included in the CDOT Drainage Manual.

12.2.4.3.4 Manholes and Junction Structures

Manholes and junction structures shall be incorporated into the storm drain system to provide access for inspection, cleaning, and other maintenance activities. Manholes shall be constructed at all junctions, changes in pipe size, drops, and grade changes. Manholes shall be provided at any change in horizontal alignment greater than 2 degrees. Manholes shall not be located in travel lanes of the I-25 mainline or US 24 travel lanes, including travel lanes in the Ultimate Configuration.

A lateral that is less than half the size (inside diameter) of the trunkline, and no more than 75 feet long may be connected to the trunkline with a prefabricated pipe wye or tee connection. Larger laterals shall be connected to the trunkline with a manhole.

The spacing of manholes shall be in accordance with the criteria identified in the CDOT *Drainage Design Manual*. The spacing of manholes outside of CDOT ROW shall be in accordance with Local Agency criteria. For storm drain diameters 60-inch or greater, manholes shall be located considering Site conditions that provide for staging of large-scale maintenance activities.

Manhole and junction structure floors shall be shaped to fit the pipe inverts to minimize hydraulic losses within the structure.

Manholes, junction structures, and vaults in roadside areas shall be designed to extend maximum of 2-inches above the finished grade all around the structure.

12.2.4.4 Drain Outfalls

Storm drain outfalls shall be designed such that the outlet elevation is as close as possible to the receiving drainageway flowline to prevent erosion. Outfalls shall be oriented in a downstream direction. Permanent erosion protection shall be provided at all outfalls and along the drainage flowlines where needed. Energy dissipaters shall be designed in accordance with the FHWA *HEC-14 Hydraulic Design of Energy Dissipaters for Culverts and Channels*, or UDFCD *Urban Storm Drainage Criteria Manual* Low Tailwater basins.

Grouted boulder rundowns must extend down to bedrock or to five (5) feet below the future bottom of channel in the receiving water, whichever is less.

Storm drain outfalls shall be evaluated for high flow conditions in the Fountain Creek and Monument Creek for the potential of water in the creek back flowing through the storm drain system resulting in flooding on state highways or local streets. Flap gates on storm drain outfalls shall be installed if backflow will result in flooding of state highways or local streets, or if required by local agencies.

The effects of tailwater in the receiving drainageway on the hydraulics of the outfall shall be evaluated. The design frequency of the tailwater of the receiving drainageway shall be based on the comparison of design discharge frequencies for coincidental occurrence included in the FHWA *HEC-22, Urban Drainage Design Manual*.

12.2.4.5 Scour and Erosion Control

Existing scour, rill or channel erosion issues within the Project limits shall be addressed by the Contractor.

Analyze all bridges and open-bottom cross drains for scour, and design appropriate protection/mitigation per *HEC-18, Evaluating Scour at Bridges, Fourth Edition*, and *HEC-23, Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance Third Edition*.

Analyze all channel changes, realignments and crossings for erosion and scour potential and design appropriate protection or mitigation per *HEC-20, Stream Stability at Highway Structures, Third Edition*.

The following minimum criteria apply to riprap layer thickness:

1. Thickness shall not be less than the spherical diameter of the D100 stone or less than 2.0 times the spherical diameter of the D50 stone, whichever results in the greater thickness.
2. Thickness shall not be less than 12 inches for practical placement.
3. The thickness determined by either Criteria 1 or 2 (above) shall be increased by 50 percent where the riprap is placed underwater to provide for uncertainties associated with this type of placement.
4. Oversized stones shall not be used.

Geotextile (Erosion Control Class 1) shall be used under all riprap per CDOT *M & S Standards*.

12.2.4.6 Sub-Drainage Systems

Sub-drainage systems (e.g., underdrains) shall be designed in accordance with the CDOT *Drainage Design Manual*. Sub-drainage systems may be discharged to the stormwater system in compliance with regulations for groundwater discharge and control of water quality.

Groundwater is expected to be encountered during construction of this Project. If groundwater is daylighted to the ground surface via storm drains (point source), a Subterranean Permit from CDPHE will be required. Upon completion of the Project, the permit will be transferred to CDOT. The Contractor shall be responsible for obtaining the permit. Refer to subsurface analysis in Book 2, Section 10, Geotechnical, Roadway Pavements, and Structure Foundations.

If underdrains are found to exist in certain locations, Contractor shall preserve the capacities and functionality of all existing groundwater drains encountered during construction, or replace drains if impacted by construction. Geotechnical investigations conducted on I-25 and US 24 are provided in the Reference Documents.

If the Contractor encounters wells or springs within the project limits, the Contractor shall protect the flow quantity, water quality, access, and availability of the wells and springs during and after construction.

12.2.4.7 Permanent Stormwater Quality Facilities

The conceptual permanent stormwater quality facilities included in the Water Quality Approach technical memorandum provide a conceptual plan that the Contractor may consider to address permanent stormwater quality requirements for the Project. Should the Contractor choose to use the concepts included in the conceptual plan, all needed refinements to the plan will be identified by the Contractor and implemented to ensure compliance with Project design criteria and also CDOT's MS4 Permit.

All runoff from impervious areas of the Project shall be treated by a PSQF prior to discharge downstream.

The drainage system shall collect surface runoff from all impervious areas of the Project, including existing and proposed pavement areas within the Project, and convey the runoff to an EDB. The EDB shall be designed in accordance with UDFCD standards as specified in UDFCD *Urban Storm Drainage Criteria Manual, Volume III* and shall store the WQCV of the entire area tributary to the EDB. The WQCV, which is the equivalent to 0.5 inches of rainfall, shall be stored in the EDB and released over 40 hours. The post-construction runoff peak flow for the 100-year event shall also be detained in the EDB and released so as to not exceed that of the pre-construction condition. 50% of the 100-yr detention storage volume will be allowed for WQCV storage. The EDB shall have a concrete forebay, low flow channel, micropool, 100-yr spillway and reinforced concrete outlet control structure as detailed in Figures OS-5 and OS-6 of the *UDFCD Urban Storm Drainage Criteria Manual, Volume III*.

An all weather vehicle maintenance access shall be provided to the EDB forebay and outlet structures. Access surface shall be constructed with 12" of Class 6 aggregate base course. The access road shall have a turnaround at the end. Every effort shall be made to embed the outlet structure into the EDB embankment grading. Required EDB maintenance and operation appurtenances and their design requirements are described in *UDFCD Urban Storm Drainage Criteria Manual, Volume III*.

In the event Contractor is unable to route the runoff from impervious areas of the Project to an EDB, the runoff shall be collected in a grass swale or vegetated roadside ditch with check structures designed and located at intervals within the channel designed to promote infiltration of the WQCV of the tributary area to either provide for removal of Total Suspended Solids (TSS) equal to the mass of 80% of the expected annual TSS loading from stormwater runoff discharges from 100% of all tributary areas or infiltrate the WQCV for all tributary areas tributary to the PSQF.

In the event Contractor is unable to route the runoff from impervious areas of the Project to an EDB, or grass swale / vegetated roadside ditch with check structures, only then will the use of proprietary stormwater vaults may be allowed. Proprietary stormwater vaults shall achieve 80% TSS removal and shall be certified accordingly by the manufacturer. The proprietary stormwater vaults, if proposed on the Project, shall be located outside of the travel lanes to allow maintenance activities of such facilities without disruption to traffic or the closing of lanes. If Proprietary stormwater vaults are located outside of the paved shoulder, they shall be no further than five horizontal feet from the edge of pavement.

Runoff from off-site areas outside CDOT ROW or easement areas shall be kept separate from the on-site pavement runoff and shall not be introduced into a Project PSQF. In the event offsite runoff cannot be separated from a Project PSQF, the PSQF shall be designed to provide WQCV for the entire area tributary to the PSQF including the runoff from the offsite areas.

12.2.4.8 Bridges and Deck Drainage

Bridges over drainageways shall be designed in accordance with the CDOT Drainage Design

Manual and the CDOT Bridge Design Manual. Scour analyses shall be completed for all existing and proposed bridges based on the procedures in the FHWA *HEC-18, Scour at Bridges*, and *HEC-20, Stream Stability at Highways*. Scour countermeasures shall be designed in accordance with the FHWA *HEC-23, Design of Countermeasures*. Bridge deck drainage systems shall be designed in accordance with the FHWA *HEC-21 Bridge-Deck Drainage Systems*.

The existing bridges over Fountain Creek shall be removed and replaced and additional bridges shall be added as required to accommodate new ramps and trail crossings. The Contractor shall construct new roadway bridges that are at least as long as the existing bridges that they replace and are long enough and high enough to accommodate construction of a tier 1 trail within the waterway at an elevation that is above the flood level specified for the waterway and has a minimum of 12 foot of vertical clearance. Concrete box culverts (CBC) shall not be used. For all peak discharge return frequencies analyzed, the new bridges shall not result in inferior hydraulic performance in comparison to the existing bridges in the project area.

All pedestrian bridges associated with the project shall be single span and shall incorporate break-away anchorage and tethering systems. All portions of the low chord of the pedestrian bridges shall be above the 10-year frequency flood elevation (assuming concurrent 10-year frequency peak flows in upper and lower Fountain Creeks and Monument Creek). The tethering system must be designed and constructed in a manner that minimizes the potential for damage to adjacent structures and minimizes the potential for blockage of waterways and adjacent structures. The bridges must be designed in a manner that does not impede flow in the waterways.

Bridge deck drainage systems are required for Highway Bridges when flow spread limits due to the design storm are exceeded, and to limit flow across expansion joints to less than 1.0 cubic foot per second (cfs) for the 10-year return frequency peak discharge. Gutter flow at both ends of bridges shall be intercepted. Stormwater flowing toward the bridge shall be intercepted prior to the approach slab. Stormwater flowing away from the bridge shall be intercepted prior to leaving the approach slab. This stormwater shall be directed to an appropriate outfall. Bridge deck drainage systems shall be designed in accordance with the FHWA *HEC-21, Bridge Deck Drainage Systems*.

All bridge deck drain inlets shall be grated. The bridge deck drainage system shall be compatible with the structural reinforcement, components, and aesthetics of the bridge. Outfalls shall be positioned to avoid corrosion of structural members, and splash on vehicular traffic and pedestrian areas below the bridge. Adequate erosion protection shall be constructed at all outfalls. Downspouts for bridge drains shall be minimum 10-inch diameter galvanized steel pipe, and shall meet the requirements of ASTM A53, Grade B, and Standard Weight Schedule

12.2.4.9 Stormwater Pumping Stations

The use of stormwater pumping stations shall not be permitted.

12.2.5 Floodplains

The Basic Configuration impacts FEMA regulatory floodplains associated with at least 4 waterways: Monument, Upper Fountain Creek, Lower Fountain Creek and Bear Creek. CDOT will obtain a floodplain development permit for work in the floodplain that is consistent with the Basic Configuration. The CDOT application for the floodplain development permit and the floodplain development permit are contained in Book 3, Section 12. The Contractor shall develop hydraulic models of the waterways and crossing structures to demonstrate that the hydraulic performance of the Contractor's design is consistent with or has less negative impact on the regulatory floodplain than the hydraulic performance documented in the CDOT application for the floodplain development permit.

If the Contractor's design is not consistent with the conditions documented in the CDOT application for the Floodplain Development Permit, the Contractor shall obtain a new Floodplain Development Permit from the Pikes Peak Regional Floodplain Administrator for any Work associated with the project that impacts FEMA regulatory floodplains prior to any grading and/or construction within the limits of the effective regulatory floodplains.

The project is located within an area that has been analyzed for re-mapping of the FEMA regulatory floodplain by FEMA. The regulatory floodplains shown on the updated FIRMS will be based on lower flow rates in Fountain and Monument Creek and thus will be narrower and have lower elevations than the regulatory floodplains shown on current effective FIRMS (and or LOMRS). FEMA's current schedule anticipates that the updated FIRMS will be issued as "preliminary" on June 6, 2014 and become effective on February 4, 2015. As documented in the CDOT application for the Floodplain Development Permit, the design and hydraulic analysis of proposed facilities shall be consistent with flow rates and floodplain boundaries associated with updated FEMA FIRMS.

Upon completion of construction in the floodplains the Contractor shall obtain a Letter of Map Revision (LOMR) from FEMA to revise the FEMA Flood Insurance Rate Maps (FIRM) to reflect the completed project condition. The Contractor shall provide all additional mapping and surveying required to analyze and document proposed and constructed changes to the waterways. The Contractor shall be responsible for all FEMA and local agency fees associated with revised or new floodplain development permits and all required FEMA map revisions.

Floodplain Administrator Contact:

Keith Curtis PE, LEED® AP, CFM
Floodplain Administrator
Pikes Peak Regional Building Department
2880 International Circle
Colorado Springs, CO 80910
Email: keith@pprbd.org
Fax: (719) 799-2698
Cell: (719)-200-8871

12.2.6 Area Specific Drainage Requirements and/or Information

12.2.6.1 Fountain Creek

Fountain Creek Specific Design Criteria

Fountain Creek is divided into two sub-reaches within the project area. The reach below the confluence with Monument Creek is known as Lower Fountain Creek and the Portion above the confluence is known as Upper Fountain Creek.

Upper Fountain Creek

The Contractor shall reconstruct Upper Fountain Creek between the north side of the US-24 bridge and the confluence with Monument Creek. The reconstructed channel shall include a 15' wide, 2' deep low flow channel and a minimum of 65' wide vegetated floodplain bench sloped at a minimum of 2 percent towards the low flow channel with approximate equal portions of the floodplain bench on each side of the low flow channel. The slopes at the outer edges of the floodplain bench shall be 3:1 or flatter. The sides of the low flow channel shall be lined with boulders and or anchored coir rolls as appropriate for the locations consistent with the details contained in the Architectural Design Requirements. The floodplain bench shall be vegetated in accordance with the Architectural Design Requirements. Where riprap armoring is utilized it shall be soil riprap in accordance with the requirements contained in the current Urban Storm Drainage Criteria Manual.

The invert of the low flow channel shall be lined with cobbles or soil riprap of appropriate size and thickness. The reconstructed channel shall have a longitudinal design slope of 0.7 percent. All components shall be designed to remain stable in the 100-year design flood and to the extent practical shall maintain sediment transport through the reach. The water surface associated with the 100-year design flow shall not be increased from the existing condition.

The contractor shall construct a stable vertical transition between the existing channel at the north side of the US-24 Bridge and the reconstructed channel downstream within 150 linear feet of the US-24 Bridge. The vertical transition shall accommodate passage of fish in both upstream and downstream directions.

In the portions of the reconstructed channel that are to accommodate a tier 1 trail, the surface of the trail shall be constructed 4 feet above the channel bottom and above the 2-year maximum water surface elevation assuming concurrent 2-year frequency peak flows in upper and lower Fountain Creeks and Monument Creek).

Lower Fountain Creek

The Contractor shall construct the project in a manner that minimizes impacts to Lower Fountain Creek. In areas where the tier 1 trail is re-constructed the surface of the trail shall be constructed above the 10-year maximum water surface elevation.

12.2.6.2 Bear Creek

The existing box culvert under I-25 shall be extended to accommodate the proposed I-25 widening. Construction activities shall be confined to the I-25 right-of-way. The Contractor shall coordinate all work on the upstream end of the Bear Creek Culvert with the City of Colorado Springs and adjacent property owners. The culvert extensions shall include reconstruction of the trail that currently passes through the existing culvert. New portions of the trail shall be elevated above the bottom of the culvert extensions a distance that is equal to or greater than the distance that it is elevated in the existing culvert and shall be of the same configuration as the trail in the existing culvert including the railing. Vertical clearance above the trail in the culvert extensions shall not be less than the clearance above the trail through the existing culvert. Portions of the trail at both ends of the culvert extension will require reconstruction in order to facilitate suitable grades and alignment.

Adequate erosion protection and energy dissipation shall be provided at the downstream end of the extended culvert to protect the culvert, downstream channel, adjacent trail and power pole.

12.3 Construction Requirements

Drainage facilities shall be constructed in accordance with the CDOT Standard Specifications, Standard Plans, and M & S Standards. Within City of Colorado Springs right of way, drainage facilities and all inlets shall be constructed in accordance with City of Colorado Springs standards.

Drainage facilities shall be designed to accommodate the construction phasing of the Project.

The Contractor shall survey BMPs according to Section 6.13 of the CDOT Survey Manual to confirm the design volume had been provided during construction and documented in the As-Built Plans. This work shall be prior to Final Acceptance. The Contractor shall map for inclusion into CDOT's GIS system, all new and existing (remaining) outfalls.

12.3.1 Pipe Material Selection Policy

The Contractor shall comply with the CDOT Design Bulletin Pipe Material Selection Policy which is included in Book 3. The most current version as signed by the CDOT Chief Engineer at the time of the Request for Proposals (RFP) shall be utilized.

Clarifications of the CDOT Pipe Material Selection Policy are as follows:

1. Trial installations are not allowed on this Project.
2. Contractor shall be required to sample soil and water.

3. "Project Manager" implies "Contractor."
4. Contractor shall provide a Sampling Schedule for Pipe Selection for CDOT Review.
5. Pipe material selection shall be submitted to CDOT for Acceptance as part of the Drainage Reports.
6. Aluminum alloy pipe shall not be used.

12.3.2 Project Special Provisions

Subsection 603.07(a) shall include the following:

Joints for all circular reinforced pipes shall be made with confined rubber gaskets. Concrete collars shall be required at all nonstandard joints (not tongue and groove or bell and spigot), and at all connections to existing pipe.

Subsection 624.03 shall include the following:

Joint systems irrigation systems, cross drains, and storm drains shall be watertight. Testing of joints shall be performed by the Contractor in accordance with approved methods. Should any section of irrigation system, cross drains, and/or storm drains fail to meet the test requirements, it shall be corrected at the Contractor's expense.

12.4 Deliverables

12.4.1 Master Plan Drainage and Water Quality Report

12.4.1.1 Drainage Reports

Interim Drainage Reports shall be prepared by the Contractor and submitted for review prior to issuance of Released for Construction documents that include the subject drainage facilities.

A Final Drainage Report, incorporating addenda to previously submitted Interim Drainage Reports, shall be prepared by the Contractor and submitted for Acceptance.

Interim Drainage Reports and Final Drainage Report shall demonstrate that the drainage facility design conforms to the intent of drainage design for the Ultimate Configuration presented in the Master Plan Hydrology and Hydraulics Report and Master Plan Water Quality Report. Where modifications to the drainage design for the Ultimate Configuration is needed, the Interim Drainage Reports and Final Drainage Report shall identify the modifications and demonstrate that the modifications will conform to the Master Plan Hydrology and Hydraulics Report and Master Plan Water Quality Report.

The interim and final drainage reports shall follow the documentation procedure in chapter 4 of the CDOT *Drainage Design Manual*.

The drainage reports shall include the following:

1. Basic design data, design assumptions, hydrologic and hydraulic methodologies, assumptions, model inputs and outputs, detailed calculations, computations, and computer printouts, relevant design criteria, circumstances influencing design,

discussion of all drainage issues and drainage facilities, appropriate maps, figures, and plans.

2. Rationale for sizing and selection of all drainage elements, including catch basins, storm drain systems, cross drains, ditches, swales, BMPs, extended detention facilities, and pipe materials selection
3. Hydraulic data sheets with a summary of hydraulic design information for each Storm Drain and Cross Drain.
4. A delineation of contributing basins, existing drainage patterns for both highway and cross-drainage flows, drainage parameters, extended detention basin sizing, discharge characteristics, and other information necessary for the design of the drainage system. All drainage reports shall include documentation of any tributary flows from areas outside of each construction segment as defined by the Contractor.
5. Documentation that the proposed runoff will be controlled and treated in accordance with Book 2 Section 12 and all drainage and water quality permits.
6. Documentation of existing drainage discharge rates, outfall locations and pond release rates.
7. Documentation of the impact of proposed drainage designs on existing drainage facilities.
8. Documentation of compatibility with the Ultimate Configuration.
9. Calculations, analysis, and all related information used in developing conclusions and recommendations for BMPs in accordance with CDOT New Development Redevelopment (NDRD) requirements.
10. Maintenance Exhibit, showing entities (CDOT, and/or City of Colorado Springs) responsible for maintenance of various portions of the project area.

In addition to the documentation procedure in Chapter 4 of the CDOT *Drainage Design Manual*, the Contractor shall closely follow the report outline below. The section and subsection headings shall be maintained at a minimum. If a section or subsection is not used, the reason it is not applicable to the Project shall be specified. New sections or additional subsections shall be added as necessary to fully document the drainage design.

Drainage Report Outline

- 1 INTRODUCTION
 - 1.1 Location of Improvements
 - 1.2 Description of Improvements
 - 1.3 Discussion of Drainage Investigation
- 2 CROSS DRAINAGE, DRAINAGEWAY, AND IRRIGATION DITCH CROSSINGS
 - 2.1 Location and General Discussion
 - 2.2 Hydrology and Design Flow Development
 - 2.2.1 Information Sources
 - 2.3 Agency Coordination (i.e. FEMA, local agencies)

- 2.4 Description of Structural Design (i.e. for non-CDOT standard CBCs)
- 2.5 Hydraulic Design
- 2.6 Irrigation Ditch Crossings
- 2.7 Drainageways and Floodplains
- 2.8 Scour Analysis
- 2.9 Bank Stabilization
- 3 ROADWAY DRAINAGE SYSTEMS
 - 3.1 General Discussion
 - 3.2 Design Coordination
 - 3.2.1 Adjacent Segments
 - 3.2.2 Agency Coordination
 - 3.3 Drainage Basin Delineations & Characterization
 - 3.3.1 Existing Basins
 - 3.3.2 Proposed Basins
 - 3.4 Hydrology and Design Flow Development
 - 3.5 Pavement, Median and Roadside Drainage
 - 3.5.1 Inlet/Catch Basin Spacing Design
 - 3.5.2 Storm Drain Design
 - 3.5.3 Roadside Ditch and Channel Design
 - 3.5.4 Erosion Control Design
- 4 PERMANENT BEST MANAGEMENT PRACTICES
 - 4.1 Assumptions and Methodologies
 - 4.1.1 Allowable Release Rate Discussion
 - 4.2 Hydrology and Hydraulics
 - 4.2.1 Storage and Outlet Design Documentation
 - 4.3 Adherence to the CDOT MS4 Permit and NDRD requirements
- 5 APPENDICES
 - 5.1 Hydrologic Analysis
 - 5.1.1 On-Site Hydrology
 - 5.1.2 Off-Site Hydrology
 - 5.1.3 Precipitation Data
 - 5.1.4 Soil Survey
 - 5.1.5 Land Use
 - 5.1.6 FEMA Maps
 - 5.2 Hydraulic Analysis
 - 5.2.1 Spread width, Inlet and Storm Drain Calculations
 - 5.2.2 Roadside Ditch and Channel Calculations
 - 5.2.3 Hydraulic Grade Line Calculations

- 5.2.4 Drain Outfalls, Scour and Erosion Control Calculations
- 5.2.5 Sub-Drainage Systems
- 5.3 Permanent Best Management Practices
 - 5.3.1 Extended Detention Basin Calculations
 - 5.3.2 Stage Storage Calculations
 - 5.3.3 Trickle Channel Calculations
 - 5.3.4 Water Quality Structure Calculations
- 5.4 Basin Maps
 - 5.4.1 Existing and Proposed On Site Basin Maps
 - 5.4.2 Off Site Basin Maps (full size 22" x 34" sheets)
- 5.5 Maintenance Exhibit

The Contractor shall submit 3 hard copies of all Interim Drainage Reports and 3 hard copies of the Final Drainage Report. All drainage reports shall be signed and sealed by a Colorado Licensed Professional Engineer.

The Contractor shall submit one electronic copy of all signed and sealed drainage reports in PDF format.

All drainage reports shall include electronic copies of all computer analysis input and output files in the native file format.

12.4.4 Water Quality Report

The purpose of the Water Quality Report is to document permanent water quality design decisions for compliance with the CDPHE. All decisions shall adhere to the NDRD program as part of CDOT's overall MS4 permit.

Interim Water Quality Reports shall be prepared by the Contractor and submitted for review prior to issuance of Release for Construction documents that include the subject drainage facilities.

A Final Water Quality Report, incorporating addenda to previously reviewed reports, shall be prepared by the Contractor and submitted for Acceptance. No Addenda to the Final Water Quality Report will be allowed.

The Water Quality Reports shall reference the applicable drainage report for all technical aspects and design calculations.

The Contractor shall submit 3 hard copies of all Interim Water Quality Reports and 3 hard copies of the Final Water Quality Report. All Water Quality Reports shall be signed and sealed by a Colorado Licensed Professional Engineer.

The Contractor shall submit one electronic copy of all signed and sealed Water Quality Reports in PDF format.

The Water Quality Reports shall closely follow the report outline and requirements as listed in the Region 6 Permanent Water Quality Documentation, CDOT, dated April 19, 2011.

The Water Quality Report Outline as listed in the above mentioned document shall be maintained at a minimum. If a section or subsection is not used the reason it is not applicable to the Project shall be specified. New sections or additional subsections shall be added as necessary to fully document the design.

12.5 Deliverables

12.5.1 Drainage Design Deliverables

The Contractor shall prepare plans for all drainage related facilities for the Project in a format that follows the documentation procedure in chapter 4 of the CDOT Drainage Design Manual, and the *CDOT CADD Manual* and *CDOT Drafting Manual*.

The Contractor shall submit all applicable plans with each Drainage Report.

All deliverables shall follow the Quality Management Plan for the Project as described in Book 2, Section 2, Project Management.

The Contractor shall include the following for all drainage plan deliverables:

PLAN VIEW

1. Provide the location of all existing and proposed storm drains. Provide a label for each proposed storm drain location. The Contractor shall establish a labeling system that is specific to each proposed storm drain system and provide a table to summarize all pertinent information. The table shall include at a minimum the Drain Line and Sheet Number where the profile can be found.
2. Provide the location of all existing and proposed inlets, manholes, end sections, and outlet protection. Provide a label for each proposed inlet, manhole, end section, outlet structure and outlet protection. Include a table that summarizes all pertinent information. The table shall include, at a minimum, the Label ID, Station & Offset, Item, Length, Pay Depth, and Notes.
3. Provide all existing and proposed grading.
4. Provide all Utility locations.
5. Provide location of ROW lines.

PROFILES

1. Provide profiles for all proposed storm drains. Include the Label ID from plan view sheets, station and offset, invert elevations, rim elevations, structure depth, slopes, sizes, material, utility crossings, existing and proposed finished grade lines, the design flow for the 10-year and 100-year event, and the calculated HGL for the 10-year and 100-year event.

2. Provide profiles for all proposed cross drains. Include the Label ID from plan view sheets, station and offset, invert elevations, slopes, sizes, material, utility crossings, and existing and proposed finished grade lines. Provide the drainage area of contributing basin, 100-year discharge, and headwater elevation on all applicable profile sheets for cross drains.

DRAINAGE DETAILS

1. Include details for all non-standard CDOT items.

BMP DETAILS FOR EDB

1. Provide each EDB in plan view. Provide existing and proposed contours that define limits of overall facility. Include access roads, overflow location or structure, forebay, trickle channel, micropool, and outlet structure. Include all locations of Utilities and property lines. Include point labels to define location and elevations within the facility.
2. Provide a table summarizing each point label. The table shall include at a minimum the Point Label, Station & Offset, Northing, Easting, Elevation and Notes.
3. Provide a cross section of the EDB from where flows enter the pond to the outlet structure. Label elevations for the WQCV. Include slopes and elevations of all features.
4. Provide a geometry plan of the EDB from where flows enter the pond to the outlet structure. Include access roads.
5. Provide specific details for the forebay, trickle channel, micropool, and outlet structure.

12.5.2 As-Built Documents

Clearly label and locate all items of Work with station, offset, and elevation information based on surveys of what was actually built in the field. Provide summaries of all As-Built drains with the following hydraulic information, at a minimum: pipe/culvert size, invert elevations, slope, 10-year flow (Q10), 100-year design flow (Q100), and HGL.

Provide certification for the EDB as-built volumes, water surface elevations and orifice plates stamped by a Colorado Professional Engineer.

12.5.3 Deliverable Table

At a minimum, the Contractor shall submit the following to CDOT and all applicable review agencies for Review, Approval, and/or Acceptance. The Contractor shall identify and coordinate all required approvals by CDOT and outside agencies.

Deliverable	CDOT review, Acceptance or Approval	Schedule
Interim Drainage Reports	review	Prior to Released for Construction Documents
Interim Water Quality Report	review	Prior to Released for Construction Documents

**FINAL REQUEST FOR PROPOSAL
I-25 / CIMARRON STREET (US 24) INTERCHANGE DESIGN-BUILD PROJECT
IM 0252-423, SUB ACCOUNT 19039
BOOK 2 – TECHNICAL REQUIREMENTS
SECTION 12 – DRAINAGE**

Deliverable	CDOT review, Acceptance or Approval	Schedule
Interim Bridge Hydraulics Report	review	Prior to Released for Construction Documents
Final Drainage Report	Acceptance	Prior to issuance of Released for Construction Documents
Final Water Quality Report	Acceptance	Prior to issuance of Released for Construction Documents
Final Bridge Hydraulics Report	Acceptance	Prior to issuance of Released for Construction Documents
Revised Floodplain Development Permit (if required)	Acceptance	Prior to issuance of Released for Construction Documents
FEMA Approved CLOMR (if required)	Acceptance	Prior to issuance of Released for Construction Documents
FEMA Approved LOMR	Acceptance	After project is constructed (will need design services after construction)
Sampling Schedule for Pipe Selection	Review	Prior to NTP2
Groundwater Elevations at Pond Locations	Review	Prior to NTP2
SWMP Site Map	Acceptance	Prior to RFC.
Spill Prevention Control and Countermeasure Plan	Acceptance	21 Days prior to the NTP2
SWMP Plan(s)	Acceptance	Prior to RFC
EDB Certification	Acceptance	Prior to final project acceptance
Drainage Plans, Profiles, and Details	Acceptance	Prior to RFC