CHAPTER 3

FLOODPLAIN AND STORMWATER MANAGEMENT

SECTION 1

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FLOODPLAIN MANAGEMENT

1.1 INTRODUCTION

Floodplain management is a program that utilizes corrective and preventative measures to reduce flood damages to public and private properties and to promote public safety and general welfare of the community. Floodplain management program elements include, but are not limited to, floodplain management regulations, structural and non-structural flood mitigation measures, flood warning systems, emergency response procedures, operations and maintenance, flood insurance, and public education.

Areas that are subject to flooding should be regulated by each community through appropriate floodplain management practices. This section is intended to describe practical floodplain management guidelines that can be adopted and implemented by the local agencies to reduce future flood losses within their communities. The guidelines outlined in this chapter have been developed to meet or exceed the minimum standards imposed by the Federal Emergency Management Agency (FEMA) (44 CFR Part 60).

1.2 NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program (NFIP) was formed by Congress in 1968 to make federally sponsored flood insurance available in communities that agreed to adopt and actively enforce floodplain management regulations. Floodplain management regulations should be consistent with the minimum requirements

outlined in the Code of Federal Regulations (44 CFR Part 60). Communities are encouraged to adopt and enforce floodplain management regulations that exceed the minimum NFIP standards.

Working closely together with the participating communities and the state agencies, the NFIP program helps reduce future flood losses by regulating developments in the 100-year floodplains and by providing flood insurance coverage. National flood insurance coverage is available to property owners and occupants of insurable properties in the communities participating in the NFIP. Flood insurance is required for federal or federally insured loans for building structures located within the FEMA Special Flood Hazard Areas (SFHA). Flood Insurance Rate Maps (FIRM) depicting the SFHA are usually available to communities participating in the NFIP Regular Program. It is strongly recommended that all property owners of structures located within the 100-year floodplains obtain flood insurance coverage to protect their properties against future flood losses.

1.2.1 COMMUNITY RATING SYSTEM

Community Rating System (CRS) was implemented to encourage and recognize the communities actively carrying out their floodplain management programs that exceed the minimum NFIP standards. Under this program, NFIP participating communities can be rated as Class 1 through 10 based on their active floodplain management programs. The community's flood insurance premium can be reduced based on their current CRS rating.

Participation in the CRS program is voluntary and the detailed application procedures can be obtained from FEMA's website (www.fema.gov).

1.3 COLORADO FLOODPLAIN MANAGEMENT GOALS

When a significant flood event occurs, considerable public and private property damages can occur and there is a higher risk for loss of life. A health risk is also experienced as floodwaters can surcharge sanitary sewer systems and expose stream flows to potentially hazardous materials in the floodplain. These flood hazards are mostly caused by inadequate understanding, planning, and protection of existing and new developments within the floodplains. The collective effects of new developments outside of the floodplains can also increase the flood losses by increasing surface runoff and raising the base floodwater elevations.

The floodplain management guidelines outlined in this section are intended to guide future improvements in the 100-year floodplain in a manner that reduces the potential risks to both existing and future developments in the floodplain.

1.3.1 WATERSHED DEVELOPMENT CONDITION

The FEMA 100-year floodplain and floodway boundaries shown on the Flood Insurance Rate Maps (FIRM) are delineated to reflect the existing watershed and floodplain conditions at the time of their Flood Insurance Studies (FIS). Likewise, the minimum floodplain management guidelines imposed by FEMA (44 CFR Part 60) and the flood insurance rates are determined based on the existing conditions 100-year floodplain information.

However, as more developments occur within a given watershed, the previously estimated existing conditions 100-year peak flow rate and the associated floodplain limits may increase considerably. Since most FEMA FIRM maps are usually not updated frequently, the 100-year floodplain information shown on the FIRM maps may not accurately reflect the current floodplain conditions depending on the nature and amount of new developments.

Local communities are encouraged to develop future (built-out) conditions floodplain information, especially when the area plan indicates a substantial amount of future development. Once developed, communities may request FEMA to show future conditions floodplains on the FIRM maps in addition to the existing conditions floodplains.

Local agencies are encouraged to develop future (built-out) conditions floodplain information, especially when the area plan indicates a substantial amount of future development.

Communities should regulate and guide their proposed floodplain developments based on the floodplain management guidelines provided in this section and the available existing conditions 100-year floodplain information. If future (built-out) conditions floodplain information is available to local communities, then the proposed floodplain developments should be regulated based on the future conditions floodplain information.

1.4 LEVEL OF PROTECTION

The standard practice is to implement the floodplain management regulations based on a 100-year flood event. The 100-year peak discharge at a given point is the estimated peak discharge that has a 1% probability of occurrence in any given year. Flow rates in excess of the 100-year estimate can and will occur, but with lower probability. In those instances, typically the depth of flow and floodplain widths will be greater than indicated on the 100-year floodplain maps.

Therefore, the guidelines described in this chapter will not necessarily protect a property owner against flood events that exceed the 100-year peak flow estimate. A property owner may choose to provide a greater level of protection than what is required by the floodplain management guidelines, especially in the case of critical facilities, buildings that store hazardous materials, and where building content flood damage could be significant.

1.5 SOURCES OF FLOOD HAZARD AREA INFORMATION

Many watercourses in the State of Colorado have been analyzed by various engineering studies sponsored by local, state, or federal agencies. The 100-year floodplain information generated and/or published by FEMA can be found on the Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS). All floodplain data generated by other engineering studies should be available at the local Floodplain Administrator's office or the CWCB. The existing floodplain studies and delineations should be evaluated to determine if the information is still valid. When determined appropriate, the existing studies should be used to minimize duplication of work and to maintain continuity of the analysis.

The floodplain data is periodically updated to reflect changes due to floodplain modifications or the use of better technical data. Users of the floodplain information should check with the local Floodplain Administrator to ensure that the information is current.

1.6 REGULATORY FLOODWAYS

The floodway is defined as the channel plus any adjacent floodplain areas that must be kept free of encroachment so that the 100-year discharge can be conveyed with no more than one foot rise in the water surface above the base flood elevations (BFE). The floodway represents the community's regulatory limit of encroachment into the 100-year floodplain for those watercourses with the established floodway boundaries. Communities may choose to delineate floodways based on FEMA's 1-foot rise criteria or based on stricter criteria by allowing a lesser amount of rise above the base flood elevations (BFE).

Figure CH3-F101 is a conceptual representation of a channel section showing the floodplain, flood fringe, and floodway limits. Encroachment into the designated floodway is prohibited unless it has been demonstrated using appropriate detailed engineering analyses that the proposed encroachment will not cause any rise in the 100-year water surface elevation. A "no-rise" certification, such as shown in Figure CH3-SF103, should be provided by a Colorado Registered Professional Engineer. Since the floodway is an extremely hazardous area, construction of new building structures in the floodway is strongly discouraged.

The flood fringe is the area between the delineated floodplain and floodway boundaries. New developments are generally discouraged in the flood fringe but may be allowed in the flood fringe in accordance with the development guidelines established in the floodplain management criteria. If the regulatory floodway has not been established, new development in the floodplain is allowed only if it can be demonstrated through appropriate detailed engineering analyses that the proposed development will meet the floodway criteria if a delineated floodway existed.

1.7 UNDETERMINED OR APPROXIMATE FLOODPLAIN

Many engineering studies have been performed to develop the needed floodplain information throughout the state. However, many areas that are subject to flooding have not yet been studied and/or designated as a 100-year floodplain. Areas outside of the designated floodplains can experience substantial flooding during a storm event. It is highly recommended that these undetermined flood hazard areas should be studied in detail to determine flow rates and the associated floodplain limits prior

to the issuance of a building or grading permit. CWCB designation is needed prior to regulating the newly studied areas.

Undetermined flood hazard areas should be studied in detail to determine flow rates and the associated floodplain limits prior to the issuance of a building or grading permit.

New developments within the identified 100-year floodplain will be allowed in accordance with the floodplain development guidelines outlined in this section. If new developments are proposed to encroach into or located adjacent to a previously delineated approximate 100-year floodplain, the previously delineated approximate floodplain limits should be restudied by using the detailed approach before the developments can occur.

Readers are referred to Chapters 10 and 11 of this Manual for detailed discussions on the floodplain delineation methods.

1.8 FLOODPLAIN DEVELOPMENT PERMIT REQUIREMENTS

A Floodplain Development Permit or equivalent local permit is required for all construction and development activities to be undertaken within 100-year flood hazard areas. These activities include, but are not limited to, building or enlarging a structure, remodeling or improving a structure, placing a manufactured home, mining, dredging, filling, grading, paving, excavating, and drilling within the 100-year flood hazard areas. In other words, any structural or non-structural activity that may affect flooding or flood damage should have a permit.

A Floodplain Development Permit from the local Floodplain Administrator is required before beginning any construction and development activities within a 100-year flood hazard area.

1.8.1 FLOODPLAIN DETERMINATION

Prior to the submittal of a building/grading permit or a development application, a Floodplain Determination for the proposed project site should be issued by the local Floodplain Administrator (Standard Form CH3-SF101). The Floodplain Administrator will determine whether the proposed project site is located within the 100-year flood hazard area shown on the community's floodplain map and/or FEMA FIRMs. Through this determination process, the Local Floodplain Administrator will identify the minimum requirements that may be imposed as a condition of approval for a Floodplain Development Permit.

A Floodplain Development Permit will be required before a building or grading permit can be issued for any construction and development activities within the 100-year flood hazard area.

The floodplain determination process will identify only minimum requirements. This determination is intended only to guide the applicant and the community in its application of the Floodplain Management Regulations. Additional requirements may be imposed during the project or permitting review process as additional technical information is presented or project modifications are made.

Property owners who wish to obtain a more detailed floodplain determination than can be provided from the existing data should obtain their own determination from a licensed and qualified professional. The applicant is encouraged to review those findings with the Floodplain Administrator before proceeding with project planning or design.

1.8.2 FLOODPLAIN DEVELOPMENT PERMIT APPLICATION

Before any construction and development activities can begin within a 100-year flood hazard area, the applicant should obtain a Floodplain Development Permit Application (Standard Form CH3-SF102) and the special conditions, as determined in the Floodplain Determination by the Floodplain Administrator. The permit application and the supporting documents should be submitted for evaluation and approval. The local Floodplain Administrator will evaluate the application to determine if the proposed project is consistent and complies with the community's goals and floodplain development guidelines. The permit will be approved or denied based on the compliance. A building or grading permit will not be issued without a Floodplain Development Permit.

1.9 ELEVATION CERTIFICATION

Unless the proposed development site has been removed from the 100-year flood hazard area through floodplain modifications and the appropriate floodplain map revision process, Elevation Certificates should be issued for all new and substantially improved structures. Readers are referred to Section 1, Chapter 5 for detailed discussions on the FEMA map revision process and to Section 1, Chapter 6 for definition of substantially damaged and substantially improved structures.

An Elevation Certificate should be certified by a licensed Professional Civil Engineer or Land Surveyor, confirming that the "as-built" lowest floor elevation (including basement and/or crawl space) is at or above the required elevations outlined below. The current FEMA Elevation Certificate Form should be used to certify building elevations. This certificate may also be required by an insurance agent for adjustment of flood insurance rates. A copy of the FEMA Elevation Certificate Form can be obtained from the local Floodplain Administrator or directly from the FEMA website (www.fema.gov).

All new, substantially damaged, and substantially improved buildings should be constructed to meet or exceed the following lowest floor (including basement and/or crawl space) elevation requirements. Non-residential buildings may be flood-proofed or elevated to the same elevation requirements.

- Zone AE — The lowest floor should be elevated at least one (1) foot above the 100-year base flood elevation (BFE).
- Zone AO — The lowest floor should be elevated above the highest adjacent natural grade by at least one (1) foot plus the 100-year flood depth specified.

- Zone A — The lowest floor should be elevated at least one (1) foot above the 100-year BFE determined by the community through a detailed engineering analysis.
- Zone X — The lowest floor should be elevated at least two (2) feet above the highest adjacent natural grade or the top of curb elevation.
- Zone D — The lowest floor should be elevated at least one (1) foot above the 100-year BFE determined by the community through a detailed engineering analysis.
- Other Zones — The lowest floor should be elevated at least one (1) foot above the 100-year base flood elevation (BFE).

Lowest floor elevation requirements exceed NFIP minimum requirements and are provided to account for the uncertainties in the estimated 100-year water surface elevations and the potential impacts created by future developments. Communities that are currently regulating their floodplain developments based on the future (built-out) conditions floodplain information may choose to adopt a less conservative lowest-floor elevation requirement that meet or exceed the minimum NFIP standards.

1.10 IMPROVEMENTS TO EXISTING BUILDINGS IN THE FLOODPLAIN

Applicants should obtain Floodplain Development Permits for improvements to existing buildings located within the 100-year floodplain. The lowest floor (including the basement and/or bottom of the crawlspace) of substantially improved or substantially damaged structures should be elevated to meet or exceed the lowest floor elevation requirements. The Elevation Certificate should be approved by the Floodplain Administrator prior to issuance of a Certificate of Occupancy.

1.11 FLOODPROOFING CERTIFICATION

New, substantially damaged, and substantially improved **non-residential structures** located within the 100-year floodplain can be floodproofed instead of elevating the structures above the 100-year flood elevations. Floodproofing consists of designing a structure in such a way that all parts are watertight and resistant to flood damage. Anytime a non-residential structure is flood-proofed, a registered professional engineer or architect should certify that the flood-proofing measures meet the National Flood Insurance Program (NFIP) Design Standards. Please refer to the following publications.

- FEMA, 1993 - Federal Emergency Management Agency, Flood-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas in Accordance with the National Flood Insurance Program, Technical Bulletin 2-93, 1993.

- FEMA, 1993 - Federal Emergency Management Agency, Non-Residential Floodproofing – Requirements and Certification for Buildings Located in Special Flood Hazard Areas in Accordance with the National Flood Insurance Program, Technical Bulletin 3-93, 1993.

The certificate should demonstrate that the building is floodproofed up to the same elevation as the lowest floor elevation which would have been required if the building was to be elevated to meet the lowest floor elevation requirements outlined in Section 1.9. The current FEMA Floodproofing Certificate Form should be used, and a copy of this form can be obtained from the local Floodplain Administrator or directly from the FEMA website (www.fema.gov). The Floodproofing Certificate may also be required by an insurance agent for adjustment of flood insurance rates. The Floodproofing Certificate should be approved by the Floodplain Administrator prior to issuance of a Certificate of Occupancy.

1.12 MANUFACTURED HOMES

Additions or placement of manufactured homes in the floodplain should be elevated and constructed on an approved foundation. The lowest floor of these manufactured homes should be elevated to meet the standards previously outlined in Section 1.9.

Manufactured homes in the flood hazard area should be anchored to resist floatation, collapse or lateral movement resulting from the hydrostatic and hydrodynamic loads associated with the 100-year flood flows. Tie-downs and anchors embedded in the ground can be used to securely fasten the homes. The site-specific soil types should be considered in choosing the appropriate anchoring methods.

1.13 DEVELOPING IN FLOODPLAINS

All new developments proposed within the 100-year flood hazard area will be required to obtain a Floodplain Development Permit from the local governing authority before any construction or development begins within the floodplain. Those who wish to develop in a floodplain should consider modifying the floodplain so that all new structures will be outside of the 100-year floodplain. A Floodplain Modification Study is required prior to issuance of a Floodplain Development Permit when there is a proposed modification to a 100-year floodplain or floodway.

Requests to modify the floodplain should be reviewed and approved by the affected local government agencies and the Colorado Water Conservation Board (CWCB). If

the proposed floodplain modification pertains to a FEMA-designated SFHA, the revision request should also be reviewed and approved by FEMA. Readers are referred to Chapter 5, of this Manual for detailed discussions on the floodplain revision (LOMA, LOMR, etc.) process. A brief description of each of these agencies and the roles they play follows:

Federal Emergency Management Agency (FEMA) - This agency administers the National Flood Insurance Program (NFIP). FEMA conducts Flood Insurance Studies and publishes Flood Hazard Boundary Maps and Flood Insurance Rate Maps, which show regulatory floodplain boundaries for many major drainageways. FEMA reviews all requests to modify the designated FEMA floodplains.

Colorado Water Conservation Board (CWCB) - The CWCB is the state agency with authority to review all floodplain information developed for zoning purposes for streams in the State of Colorado. CWCB reviews and approves floodplain information and designations at the request of a community or by acting on its own initiative.

Local Government Agencies –Local government agencies have the authority to adopt and enforce floodplain management regulations. All communities impacted by the proposed floodplain modification/designation should review the floodplain modification study submittals. Local government agencies include cities, counties, towns, Indian tribes, and flood control districts.

1.14 FLOODPLAIN MODIFICATION STUDY

A Floodplain Modification Study should be submitted for the following activities:

1. As an initial feasibility study to determine the potential utilization of a site with floodplain impacts.

2. Attempting to develop in the 100-year floodplain designated by FEMA, the CWCB, and/or the community with an activity that alters the floodplain characteristics.

3. Restudy and revision of a previously delineated floodplain.

4. Public works improvements effecting the designated 100-year floodplain

All non-exempt floodplain developments should prepare and submit a Floodplain Modification Study for review and approval by the local government agencies and the Colorado Water Conservation Board. The general outlines for a Floodplain Modification Study are provided in Section 1, Chapter 5. For modification of a FEMA floodplain, a CLOMR request report may be submitted in place of a Floodplain Modification Study. A Floodplain Modification Study or a CLOMR request report should demonstrate that the proposed project meets the floodplain development guidelines and that the upstream, adjacent, and downstream properties are not being adversely impacted.

All non-exempt floodplain developments should prepare and submit a Floodplain Modification Study for review and approval by the local government agencies and the Colorado Water Conservation Board.

1.14.1 SMALL ENCROACHMENT AREA EXEMPTION

If the floodplain encroachment resulting from the proposed activity is small, the applicant may claim exemption from the requirement of a Floodplain Modification Study provided that the applicant can demonstrate the following:

The proposed floodplain modifications do not remove more than 5% of the 100-year flow conveyance area for a given cross section, and the area removed by the proposed activity will be compensated by additional grading so that there is no net loss of effective flow conveyance area for the 100-year flow.

To claim an exemption, the applicant should submit the following information to the Floodplain Administrator:

- A topographic map showing the location of the proposed project site with the currently accepted floodplain delineation clearly shown.
- A plot of a surveyed cross section of the drainage channel where the maximum channel encroachment resulting from the new development is expected to occur. This plot should clearly show the existing and proposed grading and the currently accepted 100-year water surface elevation.

1.15 FEMA DESIGNATED FLOODPLAINS

If the proposed floodplain modification pertains to a FEMA-designated floodplain, a floodplain revision request should be submitted to FEMA for their review and approval. The applicant has an option to submit a request for a Conditional Letter of Map Revision (CLOMR) before the project is built and then follow the CLOMR with a Letter of Map Revision (LOMR) request, or wait until the project is completed and submit a request for LOMR without a CLOMR. It is recommended that the applicant choose the request for CLOMR option, since that process will allow the requester to modify the project design if required to do so by FEMA prior to construction. Please refer to Chapter 5 of this Manual for detailed discussions on the FEMA map revision procedures.

1.16 STORAGE OF MATERIALS IN THE FLOODPLAIN OR FLOODWAY

Storage of hazardous or floatable materials in the floodplain and floodway is prohibited. These materials represent a significant potential public health, environmental, or safety risks. Floatable materials can become lodged in culverts, bridges, and channels, reducing the flow conveyance capacity of these structures which will result in increased flood damages.

Storage of other materials in the floodplain and floodway is prohibited unless permitted by the Floodplain Administrator. Some storage of vehicles or other materials may be permitted depending upon location and type of materials stored as long as the material can be relocated in accordance with an emergency action plan that has been approved by the Floodplain Administrator. Recreational vehicles cannot be stored in the floodplain for longer than 180 consecutive days.

1.17 FENCING

Fencing in the floodplain is also subject to the approval of the Floodplain Administrator. The construction of fence in the floodplain can result in significant impacts to flood depths and flow distributions. Even open fencing such as chain link will collect floating debris, resulting in clogging and diversion of flood flows. Therefore, fencing within the floodplain should be approved by the Floodplain Administrator prior to construction.

1.18 CRITICAL FACILITIES

New critical facilities should be constructed outside of the 100-year flood hazard areas and the lowest floor should be elevated above the 500-year flood elevation. If the 500-year flood elevation is not available, the lowest floor should be elevated at least 3 feet above the 100-year flood elevation.

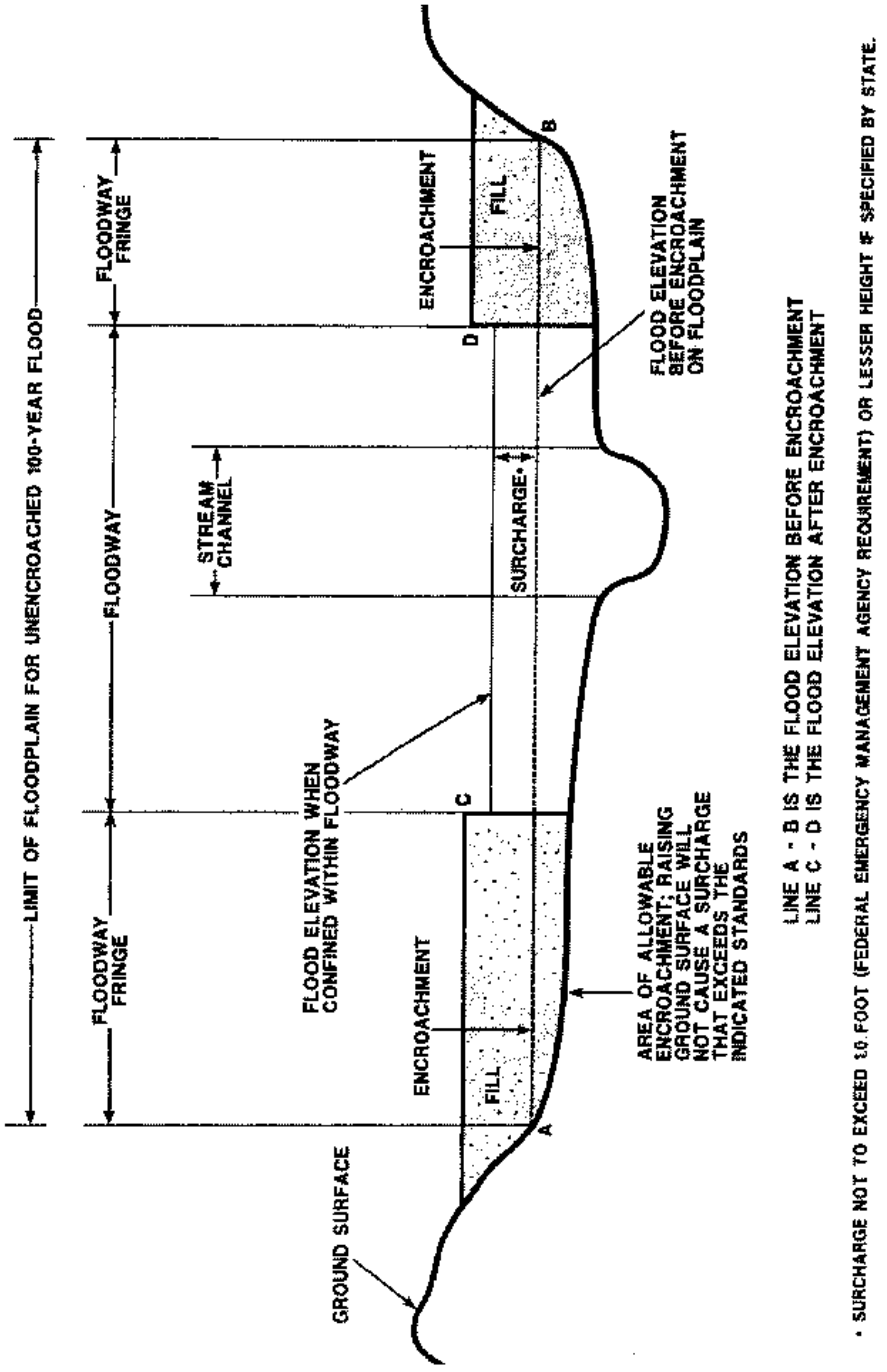
Critical facilities include, but are not limited to:

- Structures or facilities that use or store highly volatile, flammable, explosive, toxic and/or water reactive materials.
- Hospitals, nursing homes and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a flood.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for flood response activities before, during and after a flood event.
- Public and private utility facilities that are vital to maintaining or restoring normal services to flooded areas before, during and after a flood event.

1.19 UTILITIES

All utility and service facilities for new and substantially improved buildings should be designed and constructed to prevent flood damage and penetration of floodwaters during a 100-year flood event. These facilities include, but are not limited to, electrical, gas, plumbing, air-conditioning and heating equipments, phone, cable, and water supply systems. New and replacement sanitary sewer systems within the 100-year flood hazard areas should be designed and constructed to minimize penetration of floodwaters into the system.

Automatic backflow preventing devices should be provided for all new, substantially damaged, and substantially improved buildings with sanitary sewer and storm drain system openings below the 100-year water surface elevation.



VERSION: JANUARY 2006	REFERENCE: FEMA FLOOD INSURANCE STUDY	FIGURE CH3-F101 TYPICAL FLOODPLAIN CROSS SECTION

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Floodplain Determination Form

Applicant Information

Date _____

Owner/Applicant _____

Address _____ Telephone _____

Site Information

Project Title _____

Street Address _____

Cross Street/APN _____

Type of Development(s)

___ New Building
___ Building Addition/Modification
___ Grading/Paving
___ Fence
___ Material Storage
___ Equipment Storage

Description of Development(s) _____

_____

Floodplain Information

Property located in a designated floodplain? ___ Yes ___ No

Flood Zone _____

Map Source _____

Property located in a designated floodway? ___ Yes ___ No

Floodplain Development Permit Application Required? ___ Yes ___ No

Comments _____

_____

_____

_____

Signature of Authorizing Official Date

Flood Plain Development Permit Application Information

Date _____

Parcel Number _____ Permit Number _____

Owner _____ Telephone _____

Address _____

Contractor _____ Telephone _____

Address _____

Project Location/Directions _____

_____

Project Description

_____ Single Family Residential
_____ Multi-Family Residential
_____ Manufactured (Mobile) Home
_____ Non-Residential

_____ New Construction
_____ Substantial Improvement (>50%)
_____ Improvement (<50%)
_____ Rehabilitation

_____ Channelization
_____ Fill
_____ Bridge/Culvert
_____ Levee

Other/Explanations _____

_____

Flood Hazard Data

Watercourse Name _____

The project is proposed in the _____ Floodway _____ Floodway Fringe

Base (100-year) flood elevation(s) at the project site _____

Elevation required for Lowest Floor _____ / Floodproofing _____

Source Document / Report / Maps _____

_____

Proposal Review Checklist

_____ Site development plans depict the floodway and base flood elevations
_____ Engineering data is provided for map and floodway revisions
_____ Floodway certification and data document no increases in flood heights
_____ Subdivision proposals minimize flood damage and protect utilities
_____ Lowest floor elevations are above the base (100-year) flood level
_____ Manufactured (mobile) homes are elevated and adequately anchored
_____ Non-residential floodproofing designs meet NFIP watertight standards
_____ Other _____

Continued on next form.

Flood Plain Development Permit, continued

Permit Action

_____ **Permit Approved**: The information submitted for the proposed project was reviewed and is in compliance with approved flood plain management standards (site development plans are on file)

_____ **Permit Denied**: The proposed project does not meet approved flood plain management standards (explanation is on file)

_____ **Variance Granted**: A variance was granted form the base (100-year) flood elevations established by FEMA consistent with variance requirements of NFIP regulations Part 60.6 (variance action documentation is on file)

_____
Flood Plain Administrator's Signature Date

Comments _____

_____

Development Documentation

_____ **Map Revision Data**: Certified documentation by a registered professional engineer of as-built conditions for flood plain alterations were received and submitted to FEMA for a flood insurance map revision.

_____ **Fill Certification:** A community official certified the elevation, compaction, slope and slope protection for all fill placed in the flood plain consistent with NFIP regulations Part 65.5 for flood insurance map revisions.

_____ **Elevation Certificate**: Certified as-built elevation of the building's lowest floor _____; floodproofing level _____. An Elevation Certificate (Part II) completed by a registered professional engineer or land surveyor certifying this elevation is on file

_____ **Certificate of Occupancy or Compliance Issued** _____
Date

"NO-RISE" CERTIFICATION

THIS IS TO CERTIFY THAT I AM DULY QUALIFIED REGISTERED PROFESSIONAL ENGINEER LICENSED TO PRACTICE IN THE STATE OF COLORADO.

IT IS FURTHER TO CERTIFY THAT THE ATTACHED TECHNICAL DATA SUPPORTS THE FACT THAT THE PROPOSED _____ (NAME OF DEVELOPMENT) WILL NOT IMPACT THE 100-YEAR FLOOD ELEVATIONS, FLOODWAY ELEVATIONS, OR FLOODWAY WIDTHS ON _____ (NAME OF STREAM) AT PUBLISHED OR UNPUBLISHED CROSS-SECTIONS IN THE FEMA FLOOD INSURANCE STUDY FOR _____ (NAME OF COMMUNITY) DATED _____ (STUDY DATES) IN THE VICINITY OF THE PROPOSED DEVELOPMENT.

ATTACHED ARE THE FOLLOWING DOCUMENTS THAT SUPPORT MY FINDINGS:

1.) _____

2.) _____

3.) _____

SIGNATURE: _____

NAME (PRINTED): _____

COMPANY NAME: _____

DATE: _____

PHONE NUMBER: _____

ADDRESS: _____

_____

P.E. STAMP

CHAPTER 3

FLOODPLAIN AND STORMWATER MANAGEMENT

SECTION 2

STORMWATER MANAGEMENT

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2.1 INTRODUCTION

In urban areas, it is necessary to provide adequate stormwater conveyance systems in order to preserve and promote public safety and economic well being of the region. The storm drainage system planning and construction should be an integral part of the overall urbanization and development process. A stormwater conveyance system may include a combination of the following drainage facilities:

- Street with curb and gutter (Section 2, Chapter 14)
- Storm drain inlets, pipes, and manholes (Section 1, Chapter 14)
- Culverts and bridges (Section 2, Chapter 13)
- Ditches, swales, and open channels (Section 1, Chapter 13)
- Detention basins (Section 5, Chapter 13)
- Other drainage facilities

This section of the Statewide Manual contains practical guidelines and recommendations to help the local entities in developing their own storm drainage planning and development guidelines (i.e. maximum allowable street flooding depths, storm drain system design criteria, on-site detention basin requirements, etc.). Local government agencies should establish and enforce stormwater management regulations for the benefit of their communities. Local government agencies include cities, counties, towns, Indian tribes, and flood control districts.

Development of the areas that are subject to 100-year flooding should be regulated by each community through appropriate floodplain management practices. Detailed discussions on the floodplain development management guidelines are provided in Section 1, Chapter 3.

2.2 NEW DEVELOPMENT DRAINAGE GUIDELINE

All new developments should be constructed to provide adequate stormwater conveyance and detention facilities. New developments should not adversely impact adjacent or downstream properties by increasing flows or changing the manner flows are delivered to the receiving facilities. Also, drainage problems should not be transferred from one basin to another (basin transfers). The following general drainage development guidelines should be followed:

New developments should not adversely impact adjacent or downstream properties by increasing flows or changing the manner flows are delivered to the receiving facilities.

1. Limit the flows from developing properties to their pre-development condition flows. This may be achieved by providing local on-site or regional detention or retention basin facilities. Depending on the downstream receiving drainage facility type and condition, changes in both peak flow rate and total runoff volume may need to be addressed.

2. Transition flows from developing properties to their predevelopment paths on downstream properties.

3. Maintain flows in their natural drainage basins

2.2.1 DRAINAGE REPORT SUBMITTAL

Appropriate drainage reports should be prepared for the proposed development, following the guidelines presented in Section 3, Chapter 5, and be submitted to the local jurisdictions for their review and approval.

Depending on the complexity of the proposed drainage system and the size and type of development (i.e., planned community vs. small subdivision), a Drainage Master Plan may be required in addition to individual development drainage reports. Individual development drainage plans and reports should be prepared to be consistent with all applicable regional or area drainage master plans.

2.3 DRAINAGE PLANNING GUIDELINES

Storm drainage facilities can be generally divided into two categories: Local and Regional Facilities. Local facilities are the storm drainage facilities that are required to collect and convey surface runoffs from an individual development project to its outfall drainageway. The local facilities may consist of curb and gutter, inlets and storm sewers, culverts and bridges, swales, ditches, channels, detention areas, and other drainage facilities. Regional drainage facilities are typically designed to serve a larger area, which may include multiple development sites and projects. The regional facilities may consist of channels, storm drain main lines, culverts and bridges, regional detention basins, and other facilities that carry runoff from local facilities to an ultimate outfall location. Generally, regional facilities can eliminate the need for some of the local facilities (i.e. local detention basins and small channels).

2.3.1 DRAINAGE MASTER PLANNING

Since drainage considerations and problems are regional in nature and do not respect development and/or jurisdictional boundaries, drainage facilities should be studied and planned using regional/watershed-wide approaches.

Local entities and/or developers should prepare detailed regional drainage master plans that will set forth site requirements for new developments and identify the required regional drainage improvements. Drainage Master Plans should be reviewed and adopted by the affected local entities. Since drainage problems do not respect jurisdictional boundaries, a successful drainage master plan may require regional cooperation in accomplishing the goals.

2.3.2 NATURAL DRAINAGEWAYS

Natural drainageways are considered an important element that contributes to the image and livability in an urban environment. Their values extend beyond that of conveying floodwater, to their uses as trails and open space corridors and wildlife habitats.

Development projects should not adversely affect natural drainage facilities or natural watercourses, and should conform to the following general guidelines:

1. Natural drainageways should remain in their natural state to the extent possible. All proposed modifications including any erosion mitigating measures should be approved by the local agency prior to the construction.

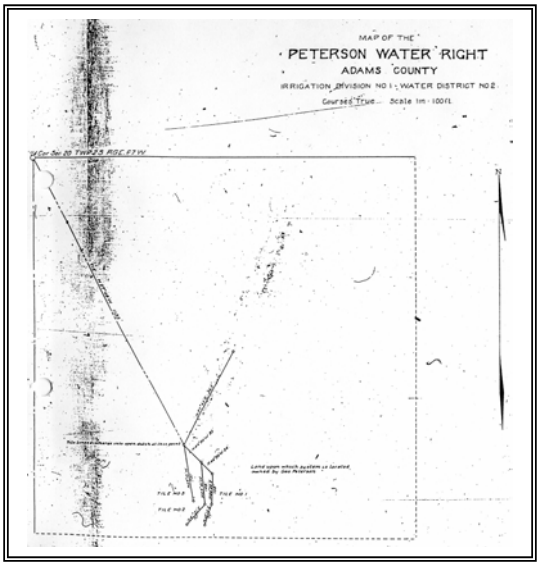
2. Fencing should be provided along the drainageways that are determined to be hazardous due to steep side slopes, high velocities, and flow depths.

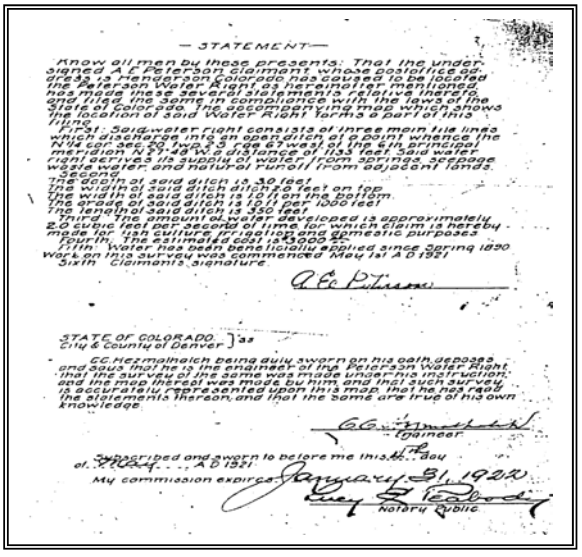
3. Some natural drainageways may migrate horizontally, therefore, developments should be sufficiently setback from the drainageways. The required setback distance should be determined appropriately depending on the stability and material of the drainageway.

2.3.3 WATER RIGHTS

When the drainage system interferes with existing water rights, the value and use of the water are affected. The existing drainageways and storage locations frequently interrelate with the water rights, which should be addressed when planning the facility to preserve their integrity. Drainage facilities should be planned and constructed with proper recognition given to the existing water rights and applicable water laws.

Ditches that have direct flow rights from a stream are controlled by headgates. Drainage improvements, which alter the quantity (or quality) of the water available to the headgate, affect the ability to divert water. Other ditches obtain all or portions of the rights by intercepting the shallow groundwater (seepage right). If the water right has not been abandoned or transferred to another location, the drainage design (including the sub-surface system) should be planned and constructed to preserve the water right. Similar situations can also occur when planning drainage facilities near reservoirs.





2.3.4 ALLUVIAL FANS

Alluvial fan flooding is quite different than riverine flooding. Alluvial fan flooding can be characterized by unpredictable flow paths, mud-flows, high flow velocity, and erosion and sediment deposition. Alluvial fans typically do not have a well-defined channel capable of conveying 100-year flows, although, it is not unusual to have smaller defined channel(s). Typically, flood flows do not spread over the entire alluvial fan surface, but are conveyed down from the apex to the toe of the fan by a network of old and new flow paths/channels.

Alluvial fans consisting of sand and fine sediment, are subject to radical changes in shape, direction, depth, and flow carrying capacity during storm events. These changes increase the potential flood hazards of developing on alluvial fan areas and require additional analysis and drainage facility design to provide safe and effective facilities to accommodate these hazards.

For detailed discussions on this topic, readers are referred to Section 2, Chapter 12 of this manual.

2.3.5 MULTI-PURPOSE USES

If possible, storm drainage facilities should be designed to accommodate multi-purpose uses. In addition to confining and conveying storm runoff, some drainage facilities (i.e. detention basins, open channels, etc.) can be planned and designed as open spaces, parks, wetlands, wildlife habitats, water quality enhancement facilities, etc..

Storm water runoff is an urban resource. Whereas the runoff can be a liability to urbanization, storm runoff has potential for beneficial use. This use, however, should be compatible with adjacent land uses and Colorado Water Law. When storm water runoff is treated as a resource, quality aspects of the water become important. This in turn relates to issues such as street cleaning practices,

solid waste collection and removal services, and regulations on the development of raw land to control erosion and resulting silt loads. These practices influence succeeding water uses.

2.3.6 FLOOD CONVEYANCE IN IRRIGATION DITCHES AND CANALS

There are a number of active, semi-active, or abandoned irrigation ditches and canals within the State. These irrigation facilities were originally designed with flat slopes and limited flow conveyance capacities to mainly convey irrigation water to farmers, settlers, and other users. Because the canals and ditches were usually designed to traverse watersheds, many of these facilities have historically intercepted storm runoff from the upstream rural and agricultural type basins. However, with urbanization of the upstream basins, the storm runoff entering the irrigation facilities have increased in rate, quantity, and frequency.

Since the irrigation facilities are not designed and constructed to safely convey storm runoff flows, they should not be used as outfall points for urbanized area storm drainage systems, unless it can be proven safe through appropriate detailed engineering analysis and the facility owner's written consent can be secured. Since the owner's liability from ditch failure increases with the acceptance of storm runoff, the responsibility should be clearly defined before a combined system is approved.

In evaluating the interaction of irrigation ditches with a major drainageway for the purpose of basin delineation, the ditch should not be utilized as a basin boundary due to the limited flow capacity of the ditch. The ditches will generally be flowing full or near full during major storms and, therefore, the tributary basin runoff would flow across the ditch. Drainage analysis should assume that an irrigation ditch does not intercept the storm runoff from the upper basin and that the upper basin is tributary to the basin area downstream of the ditch.

2.3.7 WATER QUALITY AND CONSTRUCTION ACTIVITIES

A number of studies by the Environmental Protection Agency (EPA) and others have shown that site disturbances due to construction and resulting urbanization decreases the quality of storm runoff from the natural conditions. The clearing and stripping of land for development can cause highly localized erosion rates with subsequent deposition and damage to offsite properties. Whereas erosion and sedimentation is a natural process, the intensity is

increased by development, which can destroy the aesthetic and practical values of other properties, streams, and lakes.

Planning and design of new storm drainage facilities should be prepared to minimize adverse impacts or improve the water quality of the resulting storm discharge. For detailed discussions on the NPDES Storm Water Program and practical guidelines and considerations for design of stormwater quality improvement facilities, readers are referred to Chapter 15 of this Statewide Manual.

2.3.8 DRAINAGE FACILITIES MAINTENANCE

An important part of all storm drainage facilities is the continued maintenance of the facilities to insure they will function as designed. Maintenance of detention facilities involves removal of debris and sediment. Such tasks are necessary to preclude the facility from becoming a health hazard and to retain the effectiveness of the detention basin. Sediment and debris should also be periodically removed from channels and storm sewers. Trashrack and street inlets should be regularly cleared of debris to maintain system capacity. Channel bank erosion, damage to drop structures, crushing of pipe inlets and outlets, and deterioration to the facilities should be repaired to avoid reduced conveyance capability, unsightliness, and ultimate failure.

Storm drainage facilities should be designed to minimize facility maintenance needs as well as to provide ease of maintenance and should include maintenance access to the entire drainage facility. A minimum 15-foot wide drainage easement should be provided for all publicly and privately maintained drainage facilities. If new storm drainage facilities are to be maintained by private parties, the responsible property owner or developer should provide an acceptable and perpetual funding and maintenance of all privately owned drainage facilities. Should the property owner or developer fail to adequately maintain said facilities, the governing entity having jurisdiction over the property should be given the right to enter said property, upon proper notice, for the purposes of maintenance. All such maintenance costs incurred by the local entity should be reimbursed by the responsible owner or developer.

2.4 RECOMMENDED DESIGN CRITERIA

Storm drainage facilities for developed areas should be designed to safely handle both minor and major storm events. Minor storm drainage systems should be designed to collect and convey commonly occurring storm event runoffs, generally 2- to 10- year storm events. For a typical development project, the minor storm conveyance system may consist of street curb and gutter, inlets and storm drain pipes, roadside ditches and swales, etc. Major storm drainage systems should be designed to safely convey infrequent storm events, generally 50 to 100-year storm events.

For the purpose of sizing storm drainage facilities, both minor and major design storm events need to be defined. The recommended design criteria presented in this section are based on the most commonly used minor and major design storm events of 5-year and 100-year, respectively. The criteria presented herein are provided as an example, and local entities may modify the criteria before adopting, depending on the needs of the adopting agency.

2.4.1 STORM RUNOFF DETERMINATION

The storm runoff peak, volume, and timing provide the basis for all planning, design, and construction of drainage facilities. The best method for determining storm runoff is to measure the runoff from a flood with a known intensity and recurrence interval. Since this approach is not practical in Colorado due to lack of availability of long term rainfall/runoff data, the hydrologic analytical methods presented in Chapter 9 of this Statewide Manual should be used to estimate both minor and major storm runoffs.

2.4.2 STREETS

The use of streets to convey storm runoff, although naturally occurring, interferes with the primary function of the street for transportation purposes. Streets are, however, an important component in the storm drainage system due to their large storm runoff carrying capacity obtained for little or no additional drainage related costs. In order to balance these two competing street uses, limits on the amount of flow conveyed in streets are required based on the street classifications (local, collector, and arterial) related to emergency usage during flood events. The following street flow conveyance design limitations should be used:

1. MINOR ON-SITE STORM EVENT (Q_5)

   A. Flood flows in streets should be contained within street R/W.

   B. The product of maximum flow depth (feet) times velocity (ft/s) should not exceed 6.

   C. Maximum limits of street inundation:

Local	12 foot width dry centered
Collector	18 foot width dry centered
Arterial	48 foot width dry centered

2. MAJOR ON-SITE STORM EVENT (Q_{100})

   A. Flood flows in streets should be contained within street R/W.

   B. The product of maximum flow depth (feet) times velocity (ft/s) should not exceed 8.

C. Maximum limits of street inundation:

Local	Street flooded
Collector	12 foot dry centered
Arterial	24 foot width dry centered

3. The buildings that are adjacent to streets should be set sufficiently above the 100-year water surface elevation in the street to prevent flood damage.

4. Streets which intersect State Highways, the criteria of the Colorado Department of Transportation should be followed for design of storm drains and inlets at said intersections.

2.4.3 STORM DRAIN SYSTEM

A storm drain system is used when flows exceed the allowable street flow conveyance capacity for the minor and/or major storm events. The system usually consists of inlets, conduits, manholes, and all appurtenances.

Storm drains are usually a part of the minor storm drainage system and are required when the other parts of the minor system, primarily curb, gutter, and roadside ditches, no longer have capacity for additional runoff. The size of the storm drain system is generally designed to convey the minor storm flows. However, there are conditions when the storm drain system design will be governed by the major storm flows. A partial listing of some of the possible situations are as follows:

1. Locations where street flow is collected in a sump with no allowable overflow capacity.
2. Locations where the street cross-section is such that the allowable depth of flow in the street is limited to the curb height (i.e. elevated streets with negative slopes at the ROW line).
3. Locations where the designed major storm flow direction is not reflected by the street flow direction during a major storm (i.e. flow splits at intersections).
4. Locations where the subject storm drain system is accepting flows from an upstream storm drain system or branch, which is designed for major storm capacity.
5. Regional storm drains.

If a storm drain system is to be designed to carry major storm flows, the inlets to the storm drain should be designed accordingly. Storm drains may be designed as open channel or pressure conduits. Storm drains with pressure flows should be designed to withstand the forces of such pressure in accordance with the appropriate standards. The placement of storm drain inlets should be determined by a thorough analysis of the drainage area and streets involved. These inlets should be located where sump (low-spot) conditions exist or where allowable street capacities are exceeded.

For detailed discussions on the design criteria of storm drain systems, readers are referred to Chapter 14 of this Statewide Manual.

2.4.4 OPEN CHANNEL

Open channels (including ditches and swales) can be used to convey minor and/or major storm runoffs. Open channels can be generally categorized as either natural or artificial. Natural channels include all watercourses that are carved and shaped naturally by the erosion and sediment transport process. Artificial channels are those constructed or developed by human efforts.

The recommended technical criteria and design standards for hydraulic evaluation and design of natural and artificial open channels are provided in Section 1, Chapter 13. Discussions and hydraulic standards are provided for various channel types anticipated to be encountered or used in the State of Colorado.

2.4.5 CULVERTS AND BRIDGES

Culverts and/or bridges should be provided where natural or manmade channels are crossed by roads and streets. Culverts and bridges have been successfully used to convey surface water through or beneath roadways, railroads, other embankments, and engineered structures.

Inadequately designed culverts or bridges can force flows out of the conveyance system, and the flows may take an alternate path and cause damage away from the channel. Undersized structures can also cause increased flow depths upstream of the crossing location. All new and replacement culverts and bridges should be designed to not adversely impact surrounding properties by increasing the water surface elevations and/or by diverting flows out of the channel to a different flow path.

The amount of flow crossing over the road should be minimized to protect the road embankment and pavement from erosion damage as well as to protect vehicles and pedestrians from dangerous flow depths and velocities. The recommended design criteria for culverts and bridges are provided in Section 2, Chapter 13.

2.4.6 STORM RUNOFF DETENTION

Onsite or regional detention basins are commonly used to mitigate the increase in flows caused by urbanization and increased impervious areas. Detention is also considered a viable method to reduce urban drainage costs. Temporarily detaining storm runoff can significantly reduce downstream flood hazards as well as reduce pipe and channel sizes in urban areas. Storage also provides for sediment and debris collection, which helps to maintain water quality in downstream channels and streams.

The recommended detention basin design criteria are provided in Section 5, Chapter 13. In general, detention basins should be designed to mitigate increase in flows caused by urbanization and increased impervious areas for both minor and major storm events.

2.4.7 STORM RUNOFF RETENTION

Storm runoff retention basins have been used to eliminate the need for constructing outlet structures and for ease of construction. However, problems with past retention basins including soil expansion, siltation, and lack of infiltration capacity have created a nuisance to the general public. Further, runoff retention has the potential of depriving downstream water rights of their legal right to the retained water. Each potential site will have different site constraints that will require individual evaluation of suitability for retention purposes at said site. The use of storm runoff retention basins should be minimized, except where significant environmental, recreation or recharge benefits are apparent. Standards for design of such facilities should be established by the local entity on a site by site basis.