



STAFF REPORT

Report To: Board of Supervisors **Meeting Date:** March 18, 2021

Staff Contact: Darren Schulz, Public Works Director

Agenda Title: For Possible Action: Discussion and possible action regarding the adoption, on second reading, of Bill No. 103, a proposed ordinance amending Title 12 and Title 18 Appendix of the Carson City Municipal Code ("CCMC") to establish various provisions implementing low impact development standards, establishing general requirements for compliance with low impact development standards, authorizing exemptions to compliance with low impact development standards under certain circumstances, adopting and incorporating by reference the Carson City Drainage Manual and repealing various provisions of Division 14 of Title 18 Appendix. (Dan Stucky, dstucky@carson.org and Robb Fellows, rfellows@carson.org)

Staff Summary: This will be the second reading of a proposed ordinance which, if enacted, will add a new chapter to Title 12 of the CCMC to implement low impact development ("LID") practices and standards in Carson City. The existing provisions of Division 14 of Title 18 Appendix of the CCMC would mostly be repealed, but a new section would be codified to adopt and incorporate by reference the "Carson City Drainage Manual" which contains the LID development standards.

Agenda Action: Ordinance - Second Reading **Time Requested:** 5 minutes

Proposed Motion

I move to adopt, on second reading, Bill No. 103, Ordinance No 2021-3.

Board's Strategic Goal

Sustainable Infrastructure

Previous Action

In 2018, the Carson Water Subconservancy District (CWSD) promoted LID use within the Carson River Watershed.

On May 17, 2018, the Board of Supervisors adopted the Carson City Storm Water Management Plan Update which includes the goal to incorporate LID into the development standards.

In 2019, CWSD assisted Carson City and other counties in draft LID ordinances.

On September 22, 2020 a draft LID ordinance and Drainage Manual was sent out for review and comments to the Nevada Builders Alliance and to various local engineering firms. One engineering firm returned comments which were included in the Drainage Manual.

October 20, 2020, direct mailings were sent to the Carson City Area Chamber of Commerce and the Nevada Builders Alliance. One email was received with questions about the impact of the LID development standards. A response was provided explaining the impact.

On October 28, 2020, the Planning Commission conducted a public hearing on the text amendment to CCMC Title 18 and on the Drainage Manual. The Commission voted 6-0, 1 absent to recommend approval.

On December 10, 2020 certified mailers were sent to the Carson City Area Chamber of Commerce and the Nevada Builders Alliance. On January 7, 2021, Aaron West from the Nevada Builders Alliance (NBA) responded with a letter expressing the desire to discuss the Drainage Manual and its impacts on their members. On February 2, 2021, a virtual meeting was held to review the Drainage Manual development standards and answer questions about the development standards and associated cost implications. The meeting was attended by four members of the building and development community and four engineers. All attendees of the meeting expressed a willingness to work through site specific issues that may arise during the design process after the new LID development standards are implemented. One change was made to the Drainage Manual as a result of the meeting.

On February 18, 2021, the Board of Supervisors unanimously approved the first reading of the ordinance.

Background/Issues & Analysis

LID is a storm water management approach to land development and redevelopment that works to manage storm water close to its source. Design principles are used that minimize disturbance, maintain or create perviousness and use on-site storm water treatment techniques. LID practices can be effective in reducing runoff quantity, enhancing groundwater recharge, preserving flood plain storage, and removing pollutants by filtration and biological processes before entering the City's storm drainage system.

Under the current Municipal Separate Storm Sewer System (MS4) permit issued by Nevada Division of Environmental Protection, the City is required to implement LID development standards. Division 14 of Title 18 Appendix of CCMC addresses the City's storm drainage development standards. The development standards are proposed to be modified to incorporate and promote the use of LID practices, as well as to modify the minimum design storm from a 5-year, 24-hour storm to a 10-year, 24-hour storm.

If adopted, this ordinance will enact LID development standards by establishing a new Chapter 12.20 in the CCMC, repealing the existing provisions of Division 14 of Title 18 Appendix of CCMC and establishing a new Section 14.05 in Division 14 to incorporate the Drainage Manual by reference. The LID development standards are located outside of the CCMC in the Drainage Manual, which was approved as a separate agenda item at the Board of Supervisors meeting on February 18, 2021.

Applicable Statute, Code, Policy, Rule or Regulation

NRS Chapter 244; Article 2 of the Carson City Charter; Titles 12 and 18 Appendix of the Carson City Municipal Code.

Financial Information

Is there a fiscal impact? No

If yes, account name/number: N/A

Is it currently budgeted? No

Explanation of Fiscal Impact: N/A

Alternatives

Do not adopt the ordinance, or provide alternative direction to staff.

Attachments:

[CarsonCity-LID Implementation Ordinance Draft_REVISED_FINAL_2021_second reading.pdf](#)

Board Action Taken:

Motion: _____

1) _____

2) _____

Aye/Nay

(Vote Recorded By)

SUMMARY: An ordinance implementing low impact development standards in Carson City.

BILL NO. 103

ORDINANCE NO. 2021-3

AN ORDINANCE RELATING TO UTILITIES; ESTABLISHING VARIOUS PROVISIONS FOR THE IMPLEMENTATION OF LOW IMPACT DEVELOPMENT STANDARDS; PROVIDING DEFINITIONS; ESTABLISHING GENERAL REQUIREMENTS FOR COMPLIANCE WITH LOW IMPACT DEVELOPMENT STANDARDS; AUTHORIZING EXEMPTIONS TO COMPLIANCE WITH LOW IMPACT DEVELOPMENT STANDARDS UNDER CERTAIN CIRCUMSTANCES; ADOPTING AND INCORPORATING BY REFERENCE THE CARSON CITY DRAINAGE MANUAL; REPEALING VARIOUS PROVISIONS OF DIVISION 14 OF TITLE 18 APPENDIX; AND PROVIDING OTHER MATTERS PROPERLY RELATED THERETO.

The Board of Supervisors of Carson City, Nevada, do ordain:

SECTION I:

That Title 12 (WATER, SEWERAGE AND DRAINAGE) is hereby amended by adding thereto a new chapter (**bold, underlined text** is added, [~~stricken~~] text is deleted) as follows:

12.20 – LOW IMPACT DEVELOPMENT

SECTION II:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, [~~stricken~~] text is deleted) as follows:

12.20.010 - Definitions

As used in this chapter, unless the context otherwise requires:

1. “Development” means the conversion of previously undeveloped or pervious surfaces to impervious surfaces and managed landscape areas, including the addition of impervious surfaces during redevelopment.

2. “Impervious surface” has the meaning ascribed to it in CCMC 12.17.010.

3. “Low Impact Development” or “LID” means a land development practice, modeled after nature, that improves and enhances water quality by reducing runoff and non-point source pollution through design techniques to mimic the pre-development hydrology of a site and effectively slow, capture, infiltrate, filter, detain, evaporate and hold runoff onsite. The term includes green infrastructure practices that use or mimic natural processes to infiltrate, evapotranspire or reuse stormwater runoff onsite.

4. “Redevelopment” means the replacement of impervious surfaces on a developed site. All new impervious surfaces added during redevelopment are considered development.

SECTION III:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, [~~stricken~~] text is deleted) as follows:

12.20.020 - Declaration of purpose.

1. The board hereby determines and declares that:

(a) It is necessary to establish stormwater and drainage management programs which protect water quality and water supply by the employment of a watershed approach that balances environmental, conservation and economic considerations.

(b) Urbanization has led to increased impervious surface areas resulting in increased water runoff, which causes the transport of pollutants to downstream waters.

(c) The establishment of LID standards are widely recognized as a sensible approach to the management of the quantity and quality of stormwater and non-stormwater runoff, and that such management may be properly accomplished by implementing standards and practices to maintain, improve or restore the natural hydrological contours of a site, reduce runoff, improve water quality and provide groundwater recharge.

2. It is the purpose of this chapter to manage rainwater and urban runoff to mitigate undesirable impacts of development and urbanization, and to establish LID standards to promote the public health, safety and welfare through the use of such standards and related incentives by:

(a) Ensuring that private and public development provide adequate protection for persons and property.

(b) Minimizing offsite runoff from any property.

(c) Minimizing and controlling the impact of erosion and pollution on the natural environment.

(d) Minimizing the cost of maintenance for drainage and flood control systems.

(e) Recognizing stormwater as a resource.

3. This section shall not be construed to convey a guarantee to any person that the implementation of LID standards or the compliance with such standards will fully mitigate or prevent the unauthorized discharge of pollutants into waters.

SECTION IV:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, [~~stricken~~] text is deleted) as follows:

12.20.030 - Applicability.

Except as otherwise specifically provided by this section and CCMC, the provisions of this chapter:

1. Apply to all development and redevelopment in the city, including the conditional use of a parcel that is zoned within a use district designated as Agriculture and which requires the issuance of a special use permit.

2. Do not apply to the primary permitted uses or the accessory permitted uses of a parcel that is zoned within a use district designated as Agriculture.

SECTION V:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, [~~stricken~~] text is deleted) as follows:

12.20.040 - General requirements.

Except as otherwise provided in CCMC 12.20.050, all development and redevelopment must satisfy the low impact development standards set forth in Division 14 of Title 18 Appendix of CCMC.

SECTION VI:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, [~~stricken~~] text is deleted) as follows:

12.20.050 – Exemptions.

1. An applicant for a building permit may request an exemption from the LID standards set forth in Division 14 of Title 18 of CCMC. An application for an exemption must:

- (a) Be made in writing;**
- (b) Be submitted to the city engineer; and**
- (c) Contain a detailed explanation describing the reason for the request.**

2. The city engineer, or his or her designee:

(a) Shall approve or deny the request in writing as soon as reasonably practicable;
and

(b) May approve the request only if it is determined that compliance with the LID standards would:

- (1) Be unsuitable for the building site;**
- (2) Interfere with existing drainage in such a manner as to cause damage to an adjacent property or a public right-of-way;**
- (3) Create or cause to be created a hazard to any person or property; or**
- (4) Create or cause to be created a detrimental impact on the public health, safety or welfare.**

3. An exemption that is granted pursuant to this section applies only to the building permit for which the request was made.

SECTION VII:

That Title 18 Appendix (CARSON CITY DEVELOPMENT STANDARDS), Division 14 (STORM DRAINAGE) is hereby amended by adding thereto a new section (**bold, underlined text** is added, [~~stricken~~] text is deleted) as follows:

14.05 – Low impact development standards.

1. In accordance with this section and chapter 12.20 of CCMC, all development and redevelopment must satisfy the low impact development standards described in subsection 2.

2. All low impact development standards are set forth in the *Carson City Drainage Manual*, as may be amended, which is hereby adopted and incorporated by reference. A copy of the *Drainage Manual* may be obtained, without charge, from the Carson City Public Works Department, 3505 Butti Way, Carson City, Nevada 89701, and on the Carson City Internet website at <https://carson.org/government/departments-g-z/public-works>.

SECTION VIII:

That Title 18 Appendix (CARSON CITY DEVELOPMENT STANDARDS), Division 14 (STORM DRAINAGE), Sections 14.1 (DRAINAGE POLICY INTRODUCTION AND BASIC PRINCIPLES), 14.2 (TECHNICAL CRITERIA), 14.3 (STORM DRAIN SYSTEM), 14.4 (DETENTION), 14.5 (TRASH RACKS), 14.6 (SUBMITTAL AND REVIEW PROCESS), 14.7 (DRAINAGE STUDY INFORMATION PAGE), 14.8 (CONCEPTUAL DRAINAGE STUDY), 14.9 (TECHNICAL DRAINAGE STUDY), and 14.10 (IMPROVEMENT PLANS) are hereby repealed with reservation of the section numbers as follows:

~~14.1 – [Drainage policy introduction and basic principles.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.1 of Division 14 of Title 18 Appendix – Drainage policy introduction and basic principles.)

~~14.2 – [Technical criteria.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.2 of Division 14 of Title 18 Appendix – Technical criteria.)

~~14.3 – [Storm drain system.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.3 of Division 14 of Title 18 Appendix – Storm drain system.)

~~14.4 – [Detention.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.4 of Division 14 of Title 18 Appendix – Detention.)

~~14.5 – [Trash racks.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.5 of Division 14 of Title 18 Appendix – Trash racks.)

~~14.6 – [Submittal and review process.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.6 of Division 14 of Title 18 Appendix – Submittal and review process.)

~~14.7 – [Drainage study information page.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.7 of Division 14 of Title 18 Appendix – Drainage study information page.)

~~14.8 – [Conceptual drainage study.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.8 of Division 14 of Title 18 Appendix – Conceptual drainage study.)

~~14.9 – [Technical drainage study.]~~ Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.9 of Division 14 of Title 18 Appendix – Technical drainage study.)

**14.10 – [~~Improvement plans.~~] Reserved.
(Editor’s note: Ord. No. 2021-3 , § 8, adopted March 18, 2021, repealed CCMC 14.10 of
Division 14 of Title 18 Appendix – Improvement plans.)**

SECTION IX:

That no other provisions of the Carson City Municipal Code are affected by this ordinance.

SECTION X:

This ordinance:

- 1. Does not apply to any application for a building permit that was submitted to the Carson City Department of Community Development before the effective date of this ordinance.
- 2. Shall be in force and effect from and after the first day of July 2021.

PROPOSED on _____, 2021

PROPOSED by Supervisor _____

PASSED on _____, 2021

VOTE: AYES: SUPERVISORS: _____

NAYES: SUPERVISORS: _____

ABSENT: SUPERVISORS: _____

LORI BAGWELL
Mayor

ATTEST:

AUBREY ROWLATT
Clerk-Recorder

TEXT OF REPEALED SECTIONS

14.1 [~~Drainage policy introduction and basic principles.~~

~~Adequate drainage systems shall be provided in order to preserve and promote the general health, welfare, and economic well being of the region. Drainage is a regional feature that affects all of Carson City. Drainage plans shall be consistent with and integrated with the Carson City drainage master plan upon adoption. This characteristic of drainage requires coordination and cooperation from both the public and private sectors.~~

~~Storm water drainage systems are an integral part of the development process. The planning of drainage facilities shall be included in the development process and in preparation of improvement plans.~~

~~Drainage systems require space to accommodate conveyance and storage functions. When the space requirements are considered, the provision for adequate drainage becomes a competing use for space along with other land uses.~~

~~Storm drainage planning for all development shall include the allocation of space for drainage facility construction and maintenance, which may entail the dedication of right-of-way and/or easements. The provision of multi use facilities such as combining with parks, open space, and recreation needs is strongly encouraged.~~

~~14.1.1—Water Rights. All drainage systems shall be planned and constructed with consideration given to the existing water rights and applicable water laws.~~

~~14.1.2—Reasonable Use of Drainage. Downstream properties shall not be unreasonably burdened with increased flow rates, negative impacts, or unreasonable changes in manner of flow from upstream properties. Drainage problems shall not be transferred from one location to another. However, downstream properties cannot block natural or existing runoff through their site and shall accept runoff from upstream properties.~~

~~"Reasonable use of drainage" is defined for planning purposes, as providing an economic and hydraulically efficient drainage system which is demonstrated not to adversely and unreasonably impact downstream properties within reason. This "reasonable use of drainage" therefore allows development to occur while preserving the rights of adjacent property owners.~~

~~14.1.3—Change in Manner of Flow. Development shall tend to concentrate existing natural sheet flow into point flows at property lines. These point flows are generally associated with outlets from gutter flow, storm drains, and detention facilities. Downstream properties may experience a longer duration of storm flows, and greater flows in general due to a shortened time of concentration. Discharge of point flows on downstream property can cause increased erosion at the discharge point and further downstream. Therefore, downstream facilities shall be evaluated for runoff capacity during the design and review process. Mitigation of these point flows can be accomplished through~~

energy dissipaters or flow spreaders. Point flows shall be discharged to downstream properties at non-erosive velocities and depths of flow.

14.1.4 — ~~Diversion of Drainage. Development can alter the historic or natural drainage paths. When these alterations result in a local on-site drainage system that discharges back into the natural drainage way or wash at or near the historic location, then the alterations (inter-basin transfer) are generally acceptable. However, when flows from the local on-site drainage system do not return to the historic drainage way or wash, then inter-basin transfer may result. These inter-basin transfers are generally not acceptable. Planning and design of drainage systems shall not be based on the premise that storm water can be transferred from one basin to another unless part of an adopted city regional drainage system plan.~~

~~The flow of storm runoff shall be maintained within its natural drainage course unless reasonable use is demonstrated otherwise. When storm water is discharged into an existing drainage course, the peak discharge into the water course shall not adversely affect or cause damage to property along the drainage course now or in the future based on existing zoning and the Carson City master plan build-out conditions. Erosional impacts due to concentration of flows and increased flow durations shall be evaluated and mitigated.~~

14.1.5 — ~~Water Quality. Storm drainage improvements shall incorporate water quality and erosion controls in accordance with the Nevada "Handbook of Best Management Practices," this division, and accepted engineering practice. Storm drainage leaving a development may not be of a quality that shall adversely affect downstream uses.~~

14.1.6 — ~~Drainage Improvements. Drainage improvements consist of curb and gutter, inlets and storm drains, culverts, bridges, swales, ditches, channels, detention areas, and other drainage facilities required to convey design storm runoff to the point of discharge. Drainage improvements are further defined as on-site (private) facilities that serve a specific development and are privately owned and maintained or off-site (public) facilities. Public and private drainage facilities shall be constructed in accordance with the requirements of this division.~~

14.1.7 — ~~Floodplain Management. Floodplain management shall provide the guidance, conditions, and restrictions for development in floodplain areas while protecting the public's health, safety, welfare, and property from danger and damage. Development within the Federal Emergency Management Agency (FEMA) designated floodplains shall comply with CCMC, and requirements of the National Flood Insurance Program (NFIP).~~

14.1.8 — ~~Storm Runoff Detention. Detention is considered a viable method to reduce storm runoff from developed properties. Temporarily detaining storm runoff can significantly reduce downstream flood hazards as well as pipe and channel requirements. Storage also provides for sediment and debris collection which reduces maintenance requirements for downstream channels and streams.~~

Local detention storage for land development, which includes subdividing land, shall be required when the development increases flows and downstream conveyance capacities of the drainage system are not capable of handling non-detained flows, and the developer elects to not upgrade the existing storm drainage system. Onsite detention storage shall be sized to detain sufficient runoff to limit flows from a five (5) year storm (Q5) to their predevelopment condition.

The capacity of downstream conveyance systems shall be analyzed in accordance with this division and shall be based on runoff from the development as fully improved. Local detention can also be required when designated in flood or drainage master plans to reduce the peak rate in regional facilities.

Exemptions to the detention policy may be granted by the city for the following:

1. ~~Developments which discharge directly to a regional flood control facility, provided the facility is completed per the adopted plan and designed for the contributing flows.~~
2. ~~Locations where a local detention facility is designed and constructed to serve several developments and the contributing flows.~~
3. ~~Downstream facilities are upgraded to accommodate the increased flow.~~
4. ~~Where the downstream facilities are adequate to carry up to one hundred (100) year flows.~~

All exemptions are subject to approval by the city.

~~14.1.9 Lower Watershed Design. In certain circumstances, i.e., close to the drainage system's point of discharge, it may be desirable to not detain storm water runoff. The option to directly discharge shall be at the sole option of the city and after review of a flood route analysis.~~

~~14.1.10 Storm Runoff Retention and Infiltration. Storm runoff retention and infiltration has been used to eliminate the need for constructing outlet structures and for ease of construction. However, problems with retention basins and infiltration facilities include perpetual maintenance requirements, soil expansion, siltation, decreasing infiltration capacity, insect abatement and also poses a hazard to city groundwater resources through possible contamination.~~

~~14.1.11 Drainage Facilities Maintenance. An important part of all storm drainage facilities is the continued maintenance of the facilities to insure they shall function as designed. Maintenance of detention facilities involves removal of debris and sediment. Such tasks are necessary to preclude the facility from becoming unhealthy and to retain the effectiveness of the detention basin. Sediment and debris must also be periodically removed from channels and storm drains. Trashrack and street inlets must 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 must be repaired to avoid reduced conveyance capability, unsightliness, and ultimate failure.~~

~~All drainage facilities shall be designed to minimize facility maintenance as well as to provide ease of maintenance and include maintenance access to the drainage facility. The~~

owner of the drainage facilities shall be responsible for mosquito control and the method of control shall comply with Carson City environmental health department.

The property owner or developer shall be responsible for maintenance of all privately owned on-site drainage facilities including, but not limited to, inlets, pipes, channels, and detention basins, unless otherwise required or modified by separate agreement. Shall the property owner or developer fail to adequately maintain said facilities, Carson City shall be given the right to enter said property, upon proper notice, for the purposes of maintenance. All such maintenance costs shall be assessed against the owner(s). A maintenance agreement shall be provided to the city for all projects.

14.1.12—~~Drainage Easements. Easements shall be provided where necessary for access and maintenance of the storm drain system.]~~

14.2 [~~Technical criteria.~~

14.2.1—~~Design Storm Events. Drainage facilities shall be designed to convey the run-off for the twenty-four (24) hour duration storm with a recurrence interval for a minor storm event (five (5) year) and a major storm event (one hundred (100) year).~~

14.2.1.1—~~Storm Runoff Determination. Storm runoff (rates and volumes) shall be determined in accordance with the following methods (other methods may be used if approved by development engineering):~~

Contributing Basin Area (A)	Computation Procedure
A ≤ 100 Acres	Rational formula, SCS TR-55, or HEC-1 SCS Unit Hydrograph or Kinematic Wave)
10 S.M. > A ≥ 100 Acres	SCS TR-55 or HEC-1 (SCS Unit Hydrograph or Kinematic Wave)
A > 10 S.M.	HEC-1 (SCS Unit Hydrograph or Kinematic Wave)

14.2.1.2—~~Rainfall. Rainfall data tables and storm design information shall be derived from the NOAA Atlas, latest edition, or other city approval.~~

14.2.1.3—~~Streets. The use of streets to convey 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 carrying capacity obtained for little or no drainage costs. In order to balance these two competing street uses, limits on the street carrying capacity are required based on the street classification related to emergency usage during storm and flood events.~~

The allowable street capacity for different roadway functional classifications shall be determined in accordance with Table 14.1 and Table 14.2. To ensure cleaning velocities at low flows, gutters shall have a minimum slope of four tenths of one percent (0.40%).

14.2.1.4—~~Culverts, Bridges, Valley Gutter and Dip Sections.~~ Culverts and bridges shall be installed where natural or manmade drainage channels are crossed by streets. Valley gutters, or "dip sections," shall be permitted on local streets. The amount of channel flow which crosses over the street shall be minimized (not more than 0.5 feet) to protect the street embankment and pavement from erosion damage as well as to protect vehicles and pedestrians from dangerous flow depths and velocities. Bridges and culvert crossings under streets shall be sized for the required design storm capacity in accordance with Table 14.1.

Table 14.1
Design Storm Events for Crossings

Design Storm Criteria	Design Storm Event (see Notes)
1. Local Streets	25-year return period, 24-hour duration
2. Arterial and Collector Streets	100-year return period, 24-hour duration
3. Developments (commercial, industrial, residential)	5-year return period, 24-hour duration

Notes:

1. All development shall provide emergency flow paths for a one hundred (100) year peak storm in accordance with Table 14.2.
2. Refer to section 14.3.1 for additional situations where the drainage system shall be designed for not less than a one hundred (100) year return period, twenty-four (24) hour duration.
3. Refer to section 14.1.8 for additional requirements for projects located within a floodplain.]

14.3 [~~Storm drain system.~~

14.3.1—~~Introduction.~~ The size of the storm drain system is generally governed by the design storm peak flows as shown in Table 14.2. There are conditions, however, when the storm drain system design shall be governed by the one hundred (100) year return period, twenty-four (24) hour duration storm flows. Storm drain systems shall be designed for not less than a one hundred (100) year peak storm for the following situations:

- 1.—~~Locations where street flow is collected in a sump with no allowable overflow capacity.~~
- 2.—~~Locations where the desired one hundred (100) year return period, twenty-four (24) hour duration storm flow direction is not reflected by the street flow direction during a one hundred (100) year return period, twenty-four (24) hour duration storm (i.e., flow splits at intersections).~~

~~If a storm drain is to be designed to convey one hundred (100) year return period, twenty-four (24) hour duration storm flows, then the inlets to the storm drain shall be designed accordingly.~~

Table 14.2
Design Storm Street Capacity Limitations

Roadway Functional Classification	Maximum Limits of Street Inundation (See Notes)
1) Arterial	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum forty eight foot (48') wide dry lane centered shall be maintained and in each direction twenty four feet (24'). Runoff in excess of street capacity shall be piped.
	Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot (1'). A minimum twelve foot (12') wide dry lane shall be maintained in each direction or twenty four feet (24') centered.
2) Collector	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum eighteen foot (18') wide dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped.
	Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be one foot (1'). A minimum twelve foot (12') wide dry lane shall be maintained centered.
3) Local or Industrial Street	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum twelve foot (12') wide dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped.
	Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be one foot (1'). Street flooded.

Notes:

- ~~1. Where no curb exists, encroachment onto adjacent property shall be allowed but must contained to not inundate structures.~~
- ~~2. Other criteria such as the Federal Housing Administration regulations may impose standards more restrictive than cited.~~

14.3.2—Design Criteria.

14.3.2.1—Allowable Storm Drain Capacity.

The storm drain capacity calculations shall begin at the storm drain outlet and proceed upstream, accounting for all energy losses. The Energy Grade Line (EGL) and Hydraulic Grade Line (HGL) shall be calculated to include all hydraulic losses including friction, expansion, constriction, bend, and junction losses. The available energy at all junctions and

transitions shall be checked to determine whether or not the flow in the storm drain shall be pressurized due to backwater effects even if the design flow is less than the full flow capacity of the storm drain.

If any section of the storm drain is pressurized due to backwater effects, then the storm drain system shall be designed to convey the design storm under surcharged or pressure flow conditions. The storm drain shall be considered surcharged when the depth of flow (HGL) in the storm drain is greater than eighty percent (80%) of full flow depth. The maximum level of surcharging for the capacity analysis shall be limited to maintaining the HGL to one foot (1') below the final grade above the storm drain at all locations. Special site conditions that warrant additional surcharging shall require locking type manhole covers or grated covers and shall be reviewed on a case-by-case basis by development engineering.

14.3.2.2 — Allowable Storm Drain Velocity. The maximum allowable storm drain velocity is dependent on many factors including the type of pipe, the acceptable wear level during the pipe design life, proposed flow conditions (open channel versus pressure flows), and the type and quality of construction of joints, manholes, and junctions. In consideration of the above factors, the maximum velocity in all storm drains and culverts shall not exceed the erosion resisting capabilities of the conduit and storm drain system, but in no case exceed fifteen feet (15') per second (fps).

All storm drains and culverts, and low flow outlets shall be designed to maintain a minimum velocity of three (3) fps at half or full conduit conditions, but in no case shall the storm drain slope be less than one fourth percent (¼%).

14.3.2.3 — Manning's Roughness Coefficient. All storm drain system hydraulic calculations shall be performed using Manning's formula. A Manning's roughness factor, or "n," shall be as defined by the specific pipe manufacturer provided that the coefficient is within the range of accepted engineering standards.

14.3.2.4 — Pipe Size. The minimum pipe size for storm inlet laterals and storm drain mains shall be fifteen inches (15") in diameter for round pipe, or an equivalent flow area for other pipe shapes.

14.3.2.5 — Minimum and Maximum Cover. The required cover over a storm drain pipe is dependent on many factors including the design pipe strength, pipe size, and cover material. For practical purposes, the storm drain shall be protected from potential surface disturbances and displacements. The minimum and maximum cover is dependent upon the design pipe strength.

14.3.2.6 — Manhole and Junction Spacing. A manhole, catch basin, or junction box shall be located at all changes in pipe size, direction, elevation and grade for all pipes with a diameter (or rise dimension) of less than forty eight inches (48"), and at the end of all public storm drain lines (unless the storm drain daylights at the end of the line). Maximum spacing between manholes or junction boxes shall be three hundred fifty feet (350'). For pipes with a diameter (or rise dimension) of forty eight inches (48") and greater, the designer shall

consult with development engineering for location of manholes and junctions based on hydraulic and maintenance considerations.

14.3.2.7—Horizontal Alignment. The horizontal alignment of storm drains shall be generally straight between manholes and/or junctions. All storm drains shall be placed within the right-of-way dedicated for public streets unless the use of easements is approved by development engineering.

When storm drains are to be installed in existing streets, factors such as curbs, gutters, drainage ditches, sidewalks, traffic conditions, pavement conditions, future street improvement plans, and existing utilities shall be considered by the design engineer when selecting the storm drain location and alignment.

14.3.2.8—Utility Clearances. Storm drains and culverts shall be located to minimize potential contamination and disturbance of water supply and sanitary sewer mains. Additional requirements may be imposed by the local utility companies, or the Nevada Division of Health. Where requirements differ, the more stringent shall apply.

14.3.2.9—Storm Inlet and Catch Basin Types, Locations, and Capacity Factors. Standard storm inlet and catch basin details are included in the standard details. The allowable use of these storm inlet and catch basin types is presented on Table 14.3. Allowable inlet capacity factors for each of the standard inlets and catch basins are also presented on Table 14.3. These capacity factors shall be applied to the theoretical capacity of the inlets and catch basins to account for conditions which decrease the capacity of the standard inlets. These conditions include plugging from debris and sediment, pavement overlaying, variations in design assumptions, and the general deterioration of the inlet and catch basin conditions over time. All catch basins shall have sumps (seventeen inches (17") minimum, twenty four inches (24") maximum).

Catch basins or inlets shall be installed at low points of vertical curves, at all street intersections, and at sufficient intervals to intake the design storm peak flow such that flows shall not interfere with traffic or flood adjoining property in accordance with the requirements of Table 14.2. Catch basins and inlets at street intersections shall be located on the upstream side of the intersection and upstream of crosswalk locations.

When storm drain pipes are connected to a catch basin, inlet, or manhole with concrete/grout, both the inside and outside of the catch basin, manhole, or inlet shall be grouted at the pipe connection.

14.3.3—Materials.

14.3.3.1—Pipe Material and Shape.

The material and shape of the storm drain shall be in accordance with the "Standard Specifications for Public Works Construction." Round, square, or rectangular reinforced concrete pipe (RCP) in accordance with ASTM C 789 or C 850 shall be used for storm drain construction under roadways, driveways and other traffic areas. Reinforced concrete pipe shall be at a minimum Class III, or the appropriate class when design requires a greater pipe support strength. Other pipe materials as approved by the city for storm drain use, with

the exception of corrugated metal (permitted for residential driveway culverts), are permitted outside of roadway or traffic areas.

14.3.3.2 — Manholes. Precast manhole tees are not allowed where there is a change in storm drain slope or alignment or where there are intersecting storm drain mains or laterals. Pipes may be directly cast into the manhole base. Gasketed joints, locking type manhole covers, and/or grated manhole covers for pressure flow conditions may be required.

14.3.3.3 — Storm Drain Outlet Protection. Storm drain outlets shall be designed to prevent the receiving channel from scour erosion or sediment deposition and shall be constructed with outlet protection for discharges to channels with unlined bottoms in accordance with the following:

Outlet Velocity (fps)	Minimum Outlet Protection
Less than 5	Rip-rap protection
Between 5 and 15	Rip-rap protection or Energy Dissipater
Greater than 15	Energy dissipater

For channels with unlined bottoms, the outlet discharge velocity shall not exceed the maximum allowable channel velocity without an energy dissipation structure. Specifications for the outlet protection shall be submitted with the improvement plans.

14.3.4 — Storm Drain Hydraulic Analysis. A hydraulic analysis of all storm drains shall be performed and submitted to development engineering as part of the technical drainage report. Storm drain hydraulic and capacity analysis shall account for changes in flow conditions (open channel versus pressure flow) in the HGL and EGL calculations. Both the HGL and the EGL for the design flow shall be included on storm drain improvement plans as part of the drainage report.

**Table 14.3
Allowable Storm Inlet Types and Capacity Factors**

Inlet or Catch Basin Type	Permitted Use	Permitted Location Condition	Capacity Factor
Catch Basin Type 1	Private Use Only	Sump	0.65
Catch Basin Type 1A	Street with Curb and Gutter	Continuous Grade Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65
Catch Basin Type 3	Landscaped or Unimproved Areas	Sump	0.50
Catch Basin Type 4	Street with Curb and Gutter	Continuous Grade Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65

Notes:

1. Capacity factor is applied to the theoretical inlet capacity to obtain the allowable inlet capacity to account for factors which reduce actual inlet capacity.

14.3.5 — Design Standards for Culverts. Culverts shall be designed and constructed using the following standards. The analysis and design shall consider design flow, culvert size and material, entrance structure layout, outlet structure layout, and erosion protection.

14.3.5.1 — Culvert Sizing Criteria.

14.3.5.1.1 — Design Frequency. As indicated in section 14.2.1.4 (culverts), all culverts shall be designed to pass the flow from the design storm including an overflow section where permitted.

14.3.5.1.2 — Minimum Size. The minimum culvert size shall be eighteen inches (18") diameter for round pipe or an equivalent flow area for other pipe shapes.

14.3.5.2 — Culvert Materials. Culverts shall be RCP in accordance with the standard details under roadways, and other traffic areas. For rural residential driveways CMP is allowed. The use of dip sections rather than culverts are encouraged for rural residential driveway crossings.

14.3.5.3 — Outlet Protection. Outlet erosion protection for discharges to channels with unlined bottoms shall be provided as follows:

Outlet Velocity (fps)	Required Outlet Protection
Less than 5	Rip rap protection
Between 5 and 15	Rip rap protection or energy dissipater
Greater than 15	Energy dissipater

Specifications for the outlet protection shall be submitted with the improvement plans.

14.3.5.4 — Headwater Criteria. The maximum headwater for the design storm for culverts greater than thirty six inches (36") diameter or a culvert rise of thirty six inches (36") shall be one and one half (1.5) times the culvert height. The maximum headwater for culverts with a height of thirty six inches (36") or less shall be five feet (5') if adjacent properties are not adversely affected.

14.3.5.5 — Alignment. Whenever possible, culverts shall be aligned with the natural channel to reduce inlet and outlet transition problems.

14.3.5.6 — Temporary Crossing. Temporary crossings are defined as dip road sections with a culvert sized to pass nuisance flow, or a culvert system that does not meet criteria presented in this manual. Temporary crossings shall be reviewed on a case by case basis.

Consideration shall be given to the following items:

1. — Drainage area contributing to crossing.

- 2.— Level of roadway traffic.
- 3.— Vertical and horizontal roadway alignment (sight distance).
- 4.— Alternate access routes.
- 5.— Time frame for temporary crossing (time to construction of permanent crossing).
- 6.— Current and projected development density.
- 7.— Twenty five (25) year and one hundred (100) year storm flows.

14.3.5.7— Multiple Barrel Culverts. Multiple culverts may be used if available fill height limits the size of culvert needed to convey the flood flow.

14.3.5.8— Inlet and Outlet Configuration. Culverts shall be designed with protection at the inlet and outlet areas. The culvert inlet shall include a headwall with wingwalls or a flared end-section.

The outlet area shall also include a headwall with wingwalls or a flared end section. Where outlet velocities exceed the limitation set forth in Section 14.3.5.3 (outlet protection), an energy dissipater shall be required.

14.3.5.9— Structural Design. All culverts shall be designed to withstand, as a minimum, an H-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges" and with the pipe manufacturer's recommendations.

14.3.6— Drainage Channels. When open drainage channels are permitted, the potential for erosion and scour shall be determined, and submitted as part of the drainage report. Recommended mitigation measures to prevent erosion and sediment deposition shall be identified and incorporated into design of the drainage channels. Flow velocities in drainage shall not exceed the maximum permissible flow velocities for the design storm as recommended in the American Society of Civil Engineers (ASCE) Manuals and Reports of Engineering Practice No. 77, "Design and Construction of Urban Storm water Management Systems."

Side slopes for unlined channels shall be 3:1 (horizontal to vertical) or flatter. Side slopes for lined channels shall be 2:1 (horizontal to vertical) or flatter. The use of rip rap as a channel lining is discouraged due to maintenance requirements.

All drainage channels that are not located within public rights of way shall be located in easements dedicated to the city or the appropriate entity, and shall be provided with a permanent maintenance access road in accordance with Section 12.11.14 (improved maintenance access) to provide access for maintenance.]

14.4 [~~Detention.~~

14.4.1— Introduction. The main purpose of a detention basin is to temporarily store runoff and reduce peak discharge by allowing flow to be discharged at a controlled rate. This controlled discharge rate shall be determined so that post-development runoff shall not exceed pre-development runoff leaving the site.

Detention facilities shall be designed by and financed by developers or local property owners. The facilities are intended to allow development by protecting a site from existing flooding conditions or to protect downstream property from increased runoff caused by development.

14.4.2—~~Detention Facilities. Detention facilities shall comply with the following:~~

- ~~1.— Impounding of water for storm water control purposes shall comply with regulations of the Nevada state engineer for the construction of dams where pertinent.~~
- ~~2.— The potential for use of detention basins for multiple uses must be reviewed with the parks department, and if acceptable to the city, must be designed to accommodate these additional uses.~~
- ~~3.— Basins shall be sited within drainage easements.~~
- ~~4.— Detention basin outlet capacity shall be based on the downstream channel capacities (existing or build-out conditions) with consideration given to inflows occurring downstream of the detention basin and changes in flow conditions and hydraulics due to the use of the upstream detention basin, and shall not exceed the pre-developed flow rate (up to the design storm) for the affected property (see section 14.1.2.5 (storm runoff detention)).~~
- ~~5.— In channel detention basins shall be required to safely pass the probable maximum flood discharge as a minimum.~~
- ~~6.— Detention ponds shall be designed to include provisions for security, public safety, landscaping, and erosion control.~~
- ~~7.— Basins shall be drained in not more than forty-eight (48) hours. (Drain time is defined as the time from the end of precipitation until the basin is drained of ninety percent (90%) of design capacity.)~~
- ~~8.— Design of all detention basins shall include emergency spillways for one hundred (100) year storms protected against erosive forces.~~
- ~~9.— A minimum of one foot (1') of freeboard is required above the emergency spillway design water surface elevation.~~
- ~~10.— Basin discharge shall be self-regulating (passive).~~
- ~~11.— Generally detention basins shall have side slopes no steeper than 5:1 horizontal to vertical. Access to basins shall be provided by a paved ramp with slope no steeper than 6:1 horizontal to vertical with a minimum width of twelve feet (12').~~

14.4.6—~~Flow Restrictor Outlets. The flow restrictor outlet shall be sized to control discharge from a basin as set forth in section 14.1.9 (storm runoff detention). Outfall from a flow restrictor shall be provided by a culvert or pipe conduit. The types of flow restrictors for parking lot detention may be under sidewalk weirs or pipes.~~

14.4.7—~~Spillways. All detention facilities shall have the ability to pass flows in excess of the design storm without endangering the structural integrity of the facility or diverting flows from their historic drainage pattern. Impacts to downstream properties shall be considered when siting and designing the spillway(s).~~

14.4.8— Sizing Requirements. All detention basins shall have emergency spillways which safely pass, as a minimum, a hydrograph developed by using the one hundred (100) year return period, twenty four (24) hour duration storm.

14.4.9— Embankment Protection. Embankments shall be protected from structural failure from overtopping. Overtopping can be caused by a larger than design inflow, or from obstruction of the low flow outlet. Embankment protection shall be provided by embankment armoring (i.e. rip rap), use of slopes of 5:1 (horizontal to vertical) or flatter, or by a design overflow section (i.e., emergency spillway). The invert of the emergency spillway shall be set equal to or above the design storm water surface elevation.

14.4.10— Maintenance Requirements. All detention facilities shall be designed to minimize maintenance and to allow access by equipment and workers to perform maintenance.]

14.5 [~~Trash racks.~~

All outlet works, the upper end of all closed conduits, and low flow conduits shall be provided with a trash rack for debris control. The trash rack shall provide a maximum bar spacing not to exceed two thirds (2/3) of the outlet opening or diameter. The total area of the trash rack shall allow for passage of the design outlet flow with fifty percent (50%) of the trash rack blocked.]

14.6 [~~Submittal and review process.~~

The purpose of the submittal and review process is to determine whether or not the drainage plan and improvements for a given project meet Carson City drainage requirements. These requirements include overall facility planning to assure an integrated and coordinated design as well as design standards to assure consistent design and analysis. Drainage study submittal requirements for all land development in Carson City are presented in the following section and summarized in Table 14.6. The submittal requirements are intended to provide the necessary information for each development, and minimize review time. The submittal and review process does not relieve the design engineer of the responsibility to provide a correct and safe drainage design, nor the developer to properly construct the designed drainage facilities.

By reviewing and approving drainage designs for given developments, Carson City shall not assume liability for improper drainage design, nor guarantee that the final drainage design review shall absolve the developer or designer of future liability for improper design or construction.

**Table 14.5
Drainage Study Submittal Requirements**

Land Development and/or Land Action Process	Required Drainage Submittals(5)
Parcel Map:	Conceptual Study

Improvement Plans	Technical Study
Subdivision (including planned unit developments):	
Conceptual Plan	Conceptual Study
Tentative Map	Conceptual Study
Improvement Plans	Technical Study
Building Permit	Technical Study
Clearing, Grading, Filling and/or Excavation	Conceptual Study
Other:	
MPR/CLU	Conceptual Study
Special Use Permit	Conceptual Study
Project Review	Technical Study
Development Master Drainage Plans	Technical Study
Transportation Studies	
Floodplain Modification Study	Technical Study
Conditional Letter of Map Revision,	
Letter of Map Amendment, Letter of Map Revision, etc.	

Notes:

1. A technical drainage study may be required by development engineering in lieu of, or in addition to a conceptual drainage study.
2. If the city does not perceive a flooding hazard with the proposed development, then the development may be approved subject to review and approval of the drainage study and acceptance of conditions of approval by the owner.
3. All floodplain modification studies shall be prepared in accordance with FEMA requirements and the CCMC.
4. Development engineering may waive this requirement.
5. Carson City reserves the right to request additional information of the developer/design engineer after a drainage study has been submitted.

Drainage studies shall be submitted for all development where new impervious surface coverage equals or exceeds ten thousand (10,000) square feet, except for single family residences. Additionally, drainage studies may be required by development engineering where a proposal may endanger the life, safety and welfare of the public. Three (3) copies of the required drainage studies and attachments shall be submitted to development engineering for review with

the required applications or improvement plans. Additional copies, as necessary, shall be submitted as requested by development engineering. All submitted reports shall be clearly and cleanly reproduced. Copies of charts, tables, nomographs, calculations, or other referenced material shall be legible.]

14.7 [~~Drainage study information page.~~

~~A drainage study information form page shall be included with all drainage study submittals. The drainage study information page shall be used to provide basic information regarding the proposed development to catalog the submittal for filing, distribution, and retrieval purposes.~~

~~The drainage study information page shall be bound at the front of the drainage study. The drainage study information page shall contain the seal and signature of the professional engineer licensed in Nevada who is responsible for the drainage study.]~~

14.8 [~~Conceptual drainage study.~~

~~A conceptual drainage study is a descriptive report which addresses existing and proposed drainage conditions. The conceptual drainage study documents the existing drainage conditions of the project site and presents the details of the proposed drainage system. Additionally, it includes sufficient data to evaluate storm flows and proposed mitigation.~~

~~The conceptual drainage study shall contain sufficient information in order for development engineering to make a recommendation to the appropriate Carson City hearing body.~~

~~14.8.1 Conceptual Drainage Study Outline. The conceptual drainage study shall contain a brief narrative letter, a calculation appendix (if required), and a drainage plan in accordance with the following outline:~~

- ~~I.— Introduction~~
 - ~~A.— Drainage study information page~~
 - ~~B.— Project name, type of study, study date~~
 - ~~C.— Preparer's name, seal, and signature~~
 - ~~D.— Description of project~~
 - ~~E.— Existing site conditions~~
 - ~~F.— General location map (8 ½" x 11" is suggested)~~
- ~~II.— Existing and Proposed Hydrology~~
 - ~~A.— Discuss existing and proposed drainage basin boundaries~~
 - ~~B.— Provide design storm and one hundred (100) year return period, twenty four (24) hour duration storm flow calculations for both on and off site flows~~
 - ~~C.— Discuss existing drainage problems (if applicable)~~
 - ~~D.— Discuss on-site and downstream drainage~~
 - ~~E.— Discuss floodplain (if applicable)~~
 - ~~F.— Existing irrigation~~
 - ~~G.— Tributary exhibit~~

- III.—Proposed Drainage Facilities (on-site and off-site)
 - A.—Discuss routing of flow in and/or around site, downstream, and location of drainage facilities
 - B.—Discuss mitigation measures
 - C.—Discuss floodplain modifications (if applicable)
 - D.—Provide exhibit
 - IV.—Conclusions
 - A.—Compliance with the CCMC and the Carson City development standards
 - B.—Compliance with FEMA (if applicable)
 - C.—Discuss effect of development on off-site flow rates and properties
 - D.—Implementation measures necessary for project completion
 - V.—Exhibits
 - A.—Drainage plan
 - B.—FEMA floodplain map (show on drainage plan also)
 - VI.—Calculations Appendix (if required)
 - A.—Runoff calculations
 - B.—Street and drainage facility capacity calculations (if applicable)
 - C.—Detention calculations (if applicable)
- 14.8.2—Conceptual Drainage Plan. An 8½" × 11" or larger legible drainage plan which covers the development area shall be submitted and bound with the conceptual drainage study. The plan shall contain as a minimum the following:
- 1.—Locate and label development boundary,
 - 2.—Locate and label adjacent streets,
 - 3.—Locate and label known one hundred (100) year floodplains,
 - 4.—Locate and label existing and/or planned local flood control facilities,
 - 5.—Show flow paths,
 - 6.—Identify design inflow points and design outflow points and corresponding design storm and one hundred (100) year return period, twenty four (24) hour duration storm flow rates,
 - 7.—Show existing and proposed topography,
 - 8.—Show time of concentration path for developed and existing conditions.]

14.9 [~~Technical drainage study.~~

The technical drainage study shall discuss, at a detailed level, the existing site hydrologic conditions and the proposed drainage plan to accommodate or modify site drainage conditions in the final development plan for the site. The technical drainage study shall address both on-site and off-site drainage analysis and improvements necessary to mitigate the impact of the proposed development on downstream properties.

14.9.1— Technical Drainage Study Contents. The technical drainage study shall be in accordance with the following outline and contain as a minimum the information listed:

I.— Title Page

A.— Drainage study information page

B.— Project name, type of study, date of preparation, and revisions

C.— Preparer's name, seal and signature

II.— General Location and Development Description

A.— Location of Property

1.— Street location and assessor's parcel number(s)

2.— City, state highway and local streets within and adjacent to the development

3.— Township, range, section, 1/4 section

4.— Drainage basin(s) encompassing the development

5.— Location of development in relationship to existing drainage facilities

6.— Names of surrounding developments

7.— General location map (8½" x 11" is suggested)

B.— Description of Property

1.— Area in acres

2.— Existing site conditions (buildings, drainage structures, floodplains, and other site conditions that may impact the project)

3.— General site topography, ground cover, and soil maps

4.— Existing irrigation facilities such as ditches and canals

5.— Adjacent and downstream developments, drainages and infrastructure

C.— Project Description

1.— Purpose and nature of land disturbing activity; include estimated amount of grading

2.— Critical areas on the site which have the potential for serious erosion and/or sedimentation, or other drainage problems

III.— Drainage Basin Description

A.— Off-Site drainage description

1.— Discuss historic drainage patterns (overland flow, channelized flow, points of discharge) for off-site flows which enter the project site

2.— Discuss off-site flows which enter the project site

3.— Provide map of drainage basins

4.— Discuss drainage basin characteristics (topography, area, land use, coverage, soil types, erosion potential, etc.)

5.— Identify design storm and one hundred (100) year return period, twenty-four (24) hour duration storm flows for each drainage basin and sub-basin impacting or impacted by the project site

6.— Discuss downstream flow paths, rates, and conveyance capacity

B.— On-site drainage description

1. Discuss historic on-site drainage patterns and capacity of the property (flow directions through site and at property lines)
 2. Discuss historic drainage patterns of upstream runoff
 3. Provide map of drainage basins
 4. Discuss historic drainage basin characteristics (topography, area, land use, coverage, soil types, erosion potential, etc.)
- C. Floodplain Information
1. Identify all FEMA regulated floodplains which impact the subject site. Locate same on drainage plan
 2. Note lowest floor and other pertinent elevation(s)
 3. Floodplain/floodway calculations where pertinent
- D. Previous Drainage Studies
1. Identify previous drainage studies for the site, and provide a copy if required by Carson City
 2. Identify previous drainage studies or previously approved projects which affect the site, and provide copies of the studies if required by Carson City
- IV. Proposed Drainage Facilities
- A. General Description
1. Discuss criteria and methodology
 2. Discuss proposed on-site drainage system plan and layout
 3. Discuss proposed off-site drainage system plan
- B. Compliance with Regulations and Adopted Plans
1. Discuss compliance with FEMA floodplain regulations and CCMC, and all proposed modifications to or verifications of the FEMA regulated floodplain through the subject site
 2. Discuss compliance with previously approved drainage studies for the subject site
 3. Identify individually all requests for variances from the requirements of the drainage criteria
- C. Hydrologic Criteria
1. Discuss design rainfall computations
 2. Discuss design runoff computations
 3. Discuss peak flow rates from off-site areas and facilities
 4. Discuss off-site limiting conditions and constraints (see section 14.1.3 (increase in rate of flow))
 5. Provide schematic of pre- and post-development time of concentration paths and calculations
- D. Facility Design Calculation
1. Discuss design calculations for the on-site drainage system (design storm and one hundred (100) year storm flows)

- a. — Street and ditch flow calculations
 - b. — Storm drains, inlets, and ditch flow calculations
 - c. — Channel and culvert flow calculations
 - d. — Other hydraulic structure flow calculations (trash rack, grates, etc.)
 - e. — Detention storage and outlet design calculations and flows
 - f. — Provide detail of control structure device
 - g. — Erosion and sediment deposition and mitigation measures during construction
 - h. — Permanent stabilization description of how site shall be stabilized after construction is complete
2. — Discuss design calculations for the off-site drainage system that is accepting post-development runoff, and impacts from same
 - a. — Street flow calculations
 - b. — Storm drain, inlets, and ditch flow calculations, including velocities
 - c. — Channel and culvert flow calculations
 - d. — Other hydraulic structure flow calculations
 - e. — Alluvial fan analysis and calculations (when required)
 3. — Discuss floodplain/floodway calculations as related to FEMA requirements and compliance with CCMC
 4. — Discuss maintenance access and potential maintenance requirements, and maintenance responsibilities
 5. — Discuss easement requirements for the proposed drainage facilities
 6. — Discuss phasing of all drainage facilities
 7. — Energy and hydraulic grade lines
- V. — Conclusions
- A. — Compliance with drainage laws
 - B. — Compliance with the CCMC
 - C. — Compliance with FEMA requirements
 - D. — Compliance with development standards
 - E. — Effectiveness of proposed drainage facilities to control storm runoff
 - F. — Impact of proposed development on off site property and facilities
 - G. — Mitigation of impacts and implementation schedule
- VI. — Appendices as Required by Report.
- 14.9.2 — Technical Drainage Study Plan. A detailed drainage plan(s) for the subject site shall be submitted with the technical drainage study. The plan(s) shall be on a 24" x 36" drawing at an appropriate scale (a scale of 1" = 20' to 1" = 200' is recommended). The following information shall be shown on this drawing, except that the off-site drainage basin boundaries may be shown at an appropriate legible scale on an exhibit:
1. — Property lines and streets (roads) including right-of-way widths within one hundred feet (100') of the development.

- 2.— Street names, grades and widths.
- 3.— Existing contours and proposed elevations sufficient to analyze drainage patterns extending a minimum of one hundred feet (100') past property lines of the project limits. If required by development engineering, more extensive off-site topography shall be required.
- 4.— Existing drainage facilities and structures, including ditches, storm drains, channels, street flow direction, and culverts. All pertinent information such as material, size, shape, slope, and location shall also be included.
- 5.— Limits of existing floodplains based on flood insurance rate maps (FIRM), and best available information. Provide tie to FEMA datum if all or a portion of the site is within a FEMA regulated floodplain, and base flood elevation information when available. Establish base flood elevations if not determined on FIRMs.
- 6.— Proposed on-site drainage basin boundaries. Include off-site drainage basins if same runoff enters project.
- 7.— Proposed future on-site and off-site flow directions and paths for design storm and one hundred (100)-year storm flows at pertinent locations.
- 8.— Proposed street and ditch flow paths and slopes. Trace peak flows leaving project site to nearest drainage facility; identify capacity and improvements, if needed.
- 9.— Proposed storm drain locations, type, size, capacities, depth of flow, and slope. Include inlet types, sizes and locations, and manhole locations. Correlate to drainage calculations.
- 10.— Proposed channel alignment with typical cross-section. Provide street cross-sections showing design storm and one hundred (100)-year return period, twenty-four (24) hour duration storm depth of flow.
- 11.— Proposed culvert locations, type, size, and slope.
- 12.— Miscellaneous proposed drainage facilities (i.e., hydraulic structures, etc.).
- 13.— Easement widths and boundaries (existing and proposed).
- 14.— Ditch and channel sections with lining, if required.
- 15.— Construction details including control structure and identify construction materials.
- 16.— Legend for all symbols used on drawing.
- 17.— Scale, bar scale, north arrow, date bench mark, title block, professional engineers signature, seal.
- 18.— Energy grade lines (EGL's) and hydraulic grade lines (HGL's) for storm drain and channel storm runoff.
- 19.— Show emergency flow paths for one hundred (100)-year peak storm.]

14.10 [-Improvement plans.

Where drainage improvements are to be constructed, the improvement plans (on 24" x 36" sheets) and specifications shall be submitted to development engineering. Approval of the final improvement plans by development engineering shall be obtained prior to issuing construction

permits, building permits, or grading permits. Plans for the drainage improvements shall include the following as a minimum:

1. Storm drains, inlets, outlets and manholes with stationing, elevations, dimensions, type and horizontal control indicated.
2. Culverts, end sections, and inlet/outlet protection with dimensions, type, elevations, and horizontal control indicated.
3. Channels, ditches, and swales (including side/rear yard swales) with lengths, widths, cross-sections, grades and erosion control (i.e., rip rap, concrete, grout) indicated.
4. Checks, channel drops, erosion control facilities and measures.
5. Detention pond grading, low flow channels, outlets, landscaping, fencing, and maintenance access.
6. Other drainage related structures and facilities (including underdrains and sump pump lines).
7. Maintenance access considerations.
8. Drainage easements and right of way with horizontal distance to improvements.
9. Plan and profile sheets showing all improvements.
10. Details for drainage structures, facilities, and improvements, including detention basin outlet control structures.
11. Erosion and sedimentation control plan.

The information required for the plans shall be in accordance with sound engineering principles, this manual, the Standard Details, and the "Standards Specifications for Public Works Construction." Construction documents shall include geometric, dimensional, structural, foundation, bedding, hydraulic, landscaping, specifications, and other details as needed to construct the drainage improvements. Improvement plans shall be signed and sealed by a professional engineer licensed in Nevada and be in accordance with the approved drainage report/drawings.]