
GRADING & DRAINAGE

This chapter provides guidance for complying with specific federal, state, county, and city regulations applicable to floodplain management, water quality, and stormwater management. It presents guidance for preparing drainage reports and grading and drainage plans using the design standards and methodologies adopted by the City of Scottsdale, the Flood Control District of Maricopa County, the Arizona Department of Water Resources, and the Federal Emergency Management Agency.

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GENERAL INFORMATION

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GRADING & DRAINAGE

Section 4-1

GENERAL INFORMATION

4-1.000

- A. This chapter:
 - 1. Administers Chapter 37, the Stormwater and Floodplain Management ordinance, of the Scottsdale Revised Code.
 - 2. Provides guidance for complying with federal, state, county and city regulations applicable to floodplain management, water quality and stormwater management.
 - 3. Outlines requirements for preparing drainage reports and grading and drainage plans.
- B. This chapter is intended to provide guidance for designing meaningful flood protection, but such protection can be challenging because the natural grade has already been disturbed, existing development may constrain drainage options, or other reasons. In such cases, the Floodplain Administrator may require different or additional flood protections to:
 - 1. Avoid any increased danger or damage to persons or property, and
 - 2. Meet the general intent and purposes of the regulations.

GOVERNMENT AUTHORITIES

4-1.100

- A. FEDERAL AUTHORITIES
 - 1. Federal Emergency Management Agency (FEMA)
 - 2. US Environmental Protection Agency (EPA)
 - 3. The U.S. Army Corps of Engineers (Corps)
 - 4. The U.S. Department of Agriculture (USDA) Natural Resources Conservation Services
- B. STATE AUTHORITIES
 - 1. AZ Department of Water Resources (ADWR)
 - 2. AZ Department of Environmental Quality (ADEQ)
- C. LOCAL AUTHORITIES
 - 1. Flood Control District of Maricopa County (FCDMC)
 - 2. Maricopa County Department of Health
 - 3. City of Scottsdale (City)
- D. COORDINATION.

Applicants are responsible for coordinating with other interested parties, including utilities, federal and state agencies. Other agency permits may be necessary before applying for City permits. Applicants should consider the timeframes for obtaining those other permits.

STANDARDS

4-1.200

- A. 44 CFR http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?&c=ecfr&tpl=/ecfrbrowse/Title44/44tab_02.tpl
- B. ADWR State Standards <http://www.azwater.gov/azdwr/SurfaceWater/FloodManagement/StateStandards.htm>
- C. Drainage Design Manuals for Maricopa County <http://www.fcd.maricopa.gov/Pub/manuals/manuals.aspx>
- D. Scottsdale Design Standards and Policies Manual (DSPM) <http://www.scottsdaleaz.gov/design/dspm>

RESOURCES

4-1.300

A. FEDERAL

1. National Flood Insurance Act
<http://www.fema.gov/library/viewRecord.do?id=2216>
2. Flood Insurance Rate Maps (FIRMs) <http://www.fema.gov/hazard/map/firm.shtm>
3. Clean Water Act (CWA)
<http://www.epa.gov/owow/watershed/wacademy/acad2000/cwa/>
4. USDA Natural Resources Conservation Services (NRCS) soil survey maps
<http://www.nrcs.usda.gov/>
5. National Oceanic and Atmospheric Administration (NOAA)
<http://www.nws.noaa.gov/oh/hdsc/currentpf.htm>

B. STATE

1. ADWR <http://www.azwater.gov/azdwr/default.aspx>
2. ADEQ www.azdeq.gov/environ/water/permits/stormwater.html

C. LOCAL

1. Environmentally Sensitive Lands Ordinance (ESLO), Scottsdale Zoning Ordinance
2. Scottsdale Revised Code (SRC), particularly Chapter 37
<http://www.scottsdaleaz.gov/codes>
3. Scottsdale forms www.ScottsdaleAZ.gov/bldgresources/forms
4. Scottsdale aerial photos <http://eservices.ScottsdaleAZ.gov/dmc/>
5. Scottsdale Records Department <http://www.scottsdaleaz.gov/departments/CED>
6. Flood Control District of Maricopa County www.fcd.maricopa.gov
7. Maricopa County Health Department Standards
http://www.maricopa.gov/clk_board/Ordinances/P14_Health_Code.pdf

DS&PM

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- A. Acronyms
- B. Definitions

FLOODPLAIN MANAGEMENT

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FLOODPLAIN MANAGEMENT

GENERAL INFORMATION

- A. The City’s design, construction and documentation requirements for development in Special Flood Hazard Areas (SFHAs) and pending SFHAs are in SRC, Chapter 37 and this manual. Unless otherwise approved by the Floodplain Administrator, each project must conform to the City’s requirements.
- B. All habitable structures must be designed so that they will not flood in a base flood.

PERMIT REQUIRED

Appropriate permits are required before construction or development begins, including placement of manufactured homes, within any SFHA, as mapped on the FIRMs. Applications for permits shall be made on city forms and may include, but are not limited to, plans drawn to scale showing the nature, location, dimensions and elevation of the area of development, existing or proposed structures, fill, excavation, storage of materials, and drainage facilities. Specifically, the following information is required:

- 1. Proposed elevation in relation to NAVD 88 of the lowest floor (including basement) of all structures. In Zone AO, elevation of existing highest adjacent natural grade and proposed elevation of lowest floor of all structures.
- 2. Proposed elevation in relation to NAVD 88 to which any non-residential structure will be floodproofed.
- 3. Certification by an engineer that the floodproofing methods for any nonresidential structure meet the floodproofing requirements of Chapter 37.
- 4. BFE for all development within or contiguous to floodplains.
- 5. Description of the extent to which any watercourse will be altered or relocated as a result of proposed development. See Section 4-6.000, Drainage Report and Plans.
- 6. No-rise certification for development in floodways
<http://www.scottsdaleaz.gov/Assets/Public+Website/bldgresources/no-rise.pdf>

SPECIAL FLOOD HAZARD AREAS

- A. Portions of the City fall within special flood hazard areas, as mapped on the FIRMs. Special flood hazard areas are flood zone designations that begin with an “A” and require particular attention when being analyzed and designed for development, including alluvial fan flood zones which are designated as “AO” on the FIRMs.
- B. There are special requirements for developing on an alluvial fan in an AO Zone:
 - 1. Residential structures shall be constructed in accordance with SRC, Chapter 37.
 - 2. The Regulatory Flood Depth (RFD) must be determined to set the LF88 for residential structures in AO zones. The RFD = the HAG Elev + AO depth No.+ 1ft of freeboard.
 - 3. Site design and grading shall include adequate drainage paths around structures to guide floodwaters away from proposed structures. Structures shall not be placed in low spots or block active channels or flow paths.
 - 4. The proposed development must address all potential flood hazard impacts created by the project within the flood hazard zone (other areas of the alluvial fan), including adjacent and downstream areas beyond the AO Zone.

Section 4-2

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5. A property located below the apex of an alluvial fan, where the alluvial fan has not been structurally contained from the apex to the property, must protect its upstream perimeter with structural flood control measures. There are two analytical methods to design these measures:
 - a. If the actual flow rate reaching the perimeter is lower than the flow rate at the apex, the city staff may approve using the lower flow rate if flood control is demonstrated by sound engineering analyses.
 - b. Otherwise, the structural flood control measures must be designed to withstand the entire flow originating from the apex, plus tributary flows, during a base flood, based on existing watershed conditions (assuming that runoff from the upstream watershed will not increase in the future).

SUBSTANTIAL IMPROVEMENTS AND SUBSTANTIAL DAMAGE IN SFHAS

4-2.300

- A. This section applies when a structure in an SFHA is not in compliance with current standards, and:
 1. Improvements requiring a building permit are proposed; or
 2. Repairs to damage, requiring a building permit, are proposed.
- B. Upon application to the One Stop Shop for a building permit, if it appears that this section is applicable to the project, the applicant shall submit an appropriate Substantial Improvement/Substantial Damage Worksheet, available at the city's website. The Substantial Improvement/Substantial Damage Worksheet is a screening tool to establish which projects exceed 60% or are less than 40% of the structure's existing market value before the improvements or repairs.
- C. If it appears that the project costs between 40% and 60% of the structure's existing market value, the applicant shall provide an appraisal of the value of the existing structure (excluding land value and other improvements to the property such as a swimming pool or accessory structures, before improvements and/or repairs), and a signed construction proposal from an Arizona licensed contractor.
- D. An applicant may bypass the Substantial Improvement/Substantial Damage Worksheet, or challenge the Worksheet's calculation, by providing an appraisal of the value of the existing structure as described in C. above and a signed construction proposal from an Arizona licensed contractor.
- E. In case of substantial improvements or repairs to substantially damaged structures, defined as projects costing 50% or more of the value of the existing structure, the entire structure must be brought into compliance with the city's floodplain management regulations.
- F. See also Fig. 4.2-1. Building in a High Risk, Special Flood Hazard Area (SFHA), below.

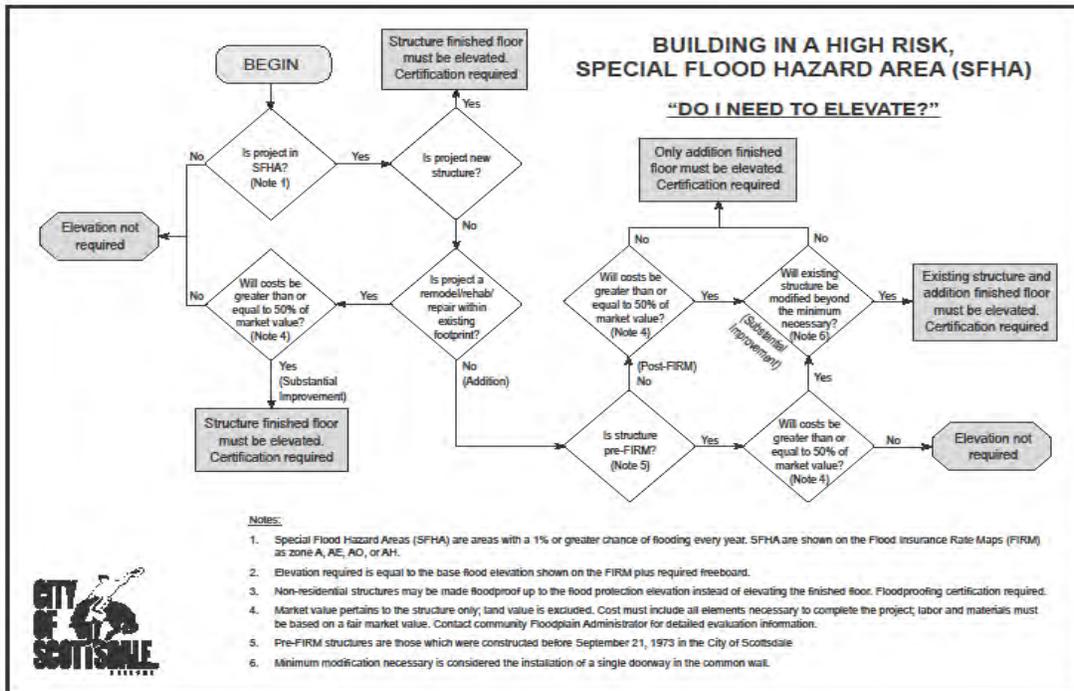


FIGURE 4-2.1 BUILDING IN A HIGH RISK, SPECIAL FLOOD HAZARD AREA (SFHA)

Refer to FEMA’s guide to substantial damage and substantial improvements.

<http://www.fema.gov/library/viewRecord.do?id=1636>

A link to the city’s substantial improvement/substantial damage worksheets is shown below:

<http://www.scottsdaleaz.gov/bldgresources/forms#s>

Please note that there is one worksheet for single-family residences and a separate one for commercial, industrial, and multi-family residential structures.

GARAGES IN SPECIAL FLOOD HAZARD AREAS

Refer to FEMA’s guide for garages:

<http://www.fema.gov/national-flood-insurance-program-2/garages>

4-2.400

STORMWATER MANAGEMENT

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STORMWATER MANAGEMENT

Section 4-3

GENERAL INFORMATION

4-3.000

- A. Use the design standards and methodologies described in the Drainage Design Manuals for Maricopa County which include Volume I Hydrology, Volume II Hydraulics and Volume III Erosion, and the DSPM. The DSPM prevails in any conflict between the Drainage Design Manuals for Maricopa County and the DSPM. Engineers should discuss any conflict with the appropriate city staff for resolution before submitting reports and plans for review.
- B. The City's stormwater storage requirements are contained in SRC, Chapter 37, Stormwater and Floodplain Management ordinance.

STORMWATER STORAGE

4-3.100

A. GENERALLY.

Stormwater storage facilities are designed primarily as detention facilities. Other stormwater management facilities, such as retention basins, dry wells, pumps and injection wells, are rarely acceptable and will only be allowed in accordance with the SRC.

B. TYPES OF STORMWATER STORAGE FACILITIES.

Stormwater storage facilities are rated for effectiveness, reliability and ease of maintenance. Rating 1 is the most preferred. Rating 4 is the least preferred.

- 1. Rating 1: Detention basins meeting the thirty-six (36) hour standard below.
- 2. Rating 2: Retention basins meeting the thirty-six (36) hour standard below, including the effect of sedimentation on evacuation time, as certified by an engineer or geologist. A retention basin shall be constructed instead of a detention basin only if:
 - a. There is no available outlet for a detention basin, or
 - b. Engineering analysis shows that available outlets would be overtaxed by detention basin outflow.
- 3. Rating 3: A drywell may be permitted, subject to the Floodplain Administrator's approval, if:
 - a. The owner demonstrates hardship that the owner did not create;
 - b. Gravity drainage is prohibitive because of the topography of the property and surrounding development;
 - c. A dual-chamber system is designed and installed to minimize sedimentation and pollution of the drywell; and
 - d. State and federal authorities issue the applicable permit(s).
- 4. Rating 4: Pumping or an injection well may be permitted, subject to the Floodplain Administrator's approval, if:
 - a. The owner demonstrates extreme hardship that the owner did not create;
 - b. A dry well is not feasible to evacuate the stormwater storage facility;
 - c. Gravity drainage is prohibitive because of the topography of the property and surrounding development;
 - d. State and federal authorities issue the applicable permit(s); and
 - e. The owner agrees to indemnify the city in case of pump failure, and records the agreement.

C. STORMWATER STORAGE FACILITIES VOLUME

1. Design Volume

- a. For new development, the standard formula for determining the required stormwater storage runoff volume is shown below.

$V_r = C(R/12)A$
<i>V_r = Required storage volume in cubic feet.</i>
<i>R = Precipitation amount = The depth in inches of the 100-year, 2-hour rainfall, from figure in Appendix 4-1C at the site.</i>
<i>A = Area in square feet of total disturbed area attributable to the development, including:</i> <i>(1) Easements, tracts and rights-of-way within the development, plus</i> <i>(2) Where the development includes improvements to the rights-of-way on the perimeter of the property, the area of those improvements up to the centerline.</i>
<i>C = Weighted average runoff coefficient over disturbed area</i>

- b. For redevelopment, the standard formula for determining the required stormwater storage runoff volume is shown below.

$V_r = \Delta C(R/12)A$
<i>V_r = Required storage volume in cubic feet.</i>
<i>R = Precipitation amount = The depth in inches of the 100-year, 2-hour rainfall, from figure in Appendix 4-1C at the site.</i>
<i>A = Area in square feet of total disturbed area attributable to the development, including:</i> <i>(1) Easements, tracts and rights-of-way within the development, plus</i> <i>(2) Where the development includes improvements to the rights-of-way on the perimeter of the property, the area of those improvements up to the centerline.</i>
<i>ΔC = Increase in weighted average runoff coefficient over disturbed area (C_{post} – C_{pre})</i>

- c. The storage requirement is not applicable to undisturbed, natural areas. Such areas on a site may be excluded from the area used in the storage requirement calculation.
- d. Stormwater storage facilities storing less than the 100-year, 2-hour rainfall may be approved in accordance with SRC, Chapter 37, Stormwater and Floodplain Management.

2. First Flush Volume

- a. The first flush volume shall be calculated using the following formula: $V=CPA$, where:
 - V= the required first flush storage volume, in cubic feet;
 - C= the weighted average runoff coefficient for the disturbed area of the proposed development;
 - P= the required precipitation depth of 0.5 inches, converted to feet; and
 - A= the disturbed area of the proposed development, in square feet.
- b. Retention of the first flush volume is encouraged, if the stormwater storage facility will be fully evacuated within 36 hours, considering the effects of sedimentation on drawdown and using a factor of safety of 2. Infiltration

rates shall be determined by double-ring infiltrometer testing in accordance with FCDMC methodology.

3. Certified Volume
 - a. Before final acceptance, or before the issuance of a certificate of occupancy, the engineer/property owner must provide the City with certified, as built dimensions of the facilities, and the actual volume of storage provided.
 - b. The actual volume of storage provided must:
 - i. Be based on as-built topographic surveys performed by an engineer or surveyor;
 - ii. Reflect permanent, finished landscaping in place;
 - iii. Meet or exceed the required volume;
 - iv. Be constructed to perform as designed; and
 - v. Be certified by an engineer.
 - c. The volume of storage provided must equal or exceed the approved design volume before the City will issue a Certificate of Occupancy.

D. STORAGE FACILITIES DESIGN

1. Storage facilities shall be located to intercept the flows generated from the entire development, to the extent practicable.
2. Storage facilities shall be set back at least 5 feet from adjacent properties and right-of-way.
3. In-stream storage facilities are discouraged because they interrupt the natural flow of the wash and can create continual debris and sediment obstruction problems.
4. Storage facilities should be designed with a positive gravity drain system whenever possible.
5. Basin side slopes shall not exceed a 4:1 (4 foot horizontal to 1 foot vertical) ratio.
6. The depth of water in a facility shall not exceed 3 feet.
7. Facilities shall have an emergency spillway to safely direct overflow into a recognized watercourse.
8. Above-ground storage facilities contained by an embankment are generally prohibited. If above-ground storage facilities are permitted, they must be designed and constructed according to generally accepted geotechnical-, and, if necessary, structural-engineering principles. Slope stability, piping, seepage, sliding, overturning and material integrity shall be considered.
9. Except as provided in 10. below, stormwater storage facilities for residential subdivisions shall be located in a tract.
10. Stormwater storage facilities for a residential minor subdivision may be located on a private lot if the owner:
 - a. Provides a physical demarcation around the stormwater storage facility, to avoid interference with its purpose, in accordance with an approved plan, and
 - b. Dedicates unobstructed physical, legal and visual access from the right-of-way to the facility.
11. Storage basins and related facilities shall be designed to drain to a recognized watercourse. Unless otherwise approved by city staff, water may not generally be discharged onto a City street, gutter or alley.
12. A stormwater storage facility shall not detain or retain standing water longer than thirty-six (36) hours unless the facility is designed and constructed to be a permanent body of water with appropriate health, safety, and water quality

measures. Consistent with requirements specified in the Drainage Design Manual for Maricopa County, double-ring infiltrometer testing shall be required with a factor of safety of 2 to demonstrate adequate drawdown within 36 hours for retention basins.

13. Drain time should be maximized to ensure the effectiveness of the facilities. Drain time should generally be from 12 to 24 hours. Discharge from the basin may be regulated with a hinged orifice plate, with a minimum diameter of 6 inches, over the entrance of the outlet pipe if the outlet pipe meets the minimum size requirements. Storage facilities shall be equipped with a baffle, or other approved method, to keep oil, grease and other floatables in the basin. Baffles, if specified, shall extend 6 inches below the bleeder invert elevation.
14. Storage facilities shall be designed to consider regular maintenance activities, such as ease of access for inspection and removal of sediment, debris and other obstructions.
15. Stormwater storage may occur in a parking lot if the following conditions are met:
 - a. At least the first 50% of the required storage volume is provided in a stormwater storage basin or underground storage tank, if approved;
 - b. No more than 50% of the required storage volume is provided in the parking lot;
 - c. The depth of water does not exceed six inches in the parking lot; and
 - d. Interference with pedestrian traffic is minimized where the parking lot acts as a storage facility.

UNDERGROUND STORMWATER STORAGE POLICY

4-3.300

A. POLICY.

This policy supplements the SRC requirements for all stormwater storage.

Underground stormwater storage involves constructing underground tanks, pipes, or vaults that accept stormwater runoff by means of inlets and storm drain pipes. The City approves underground storage only after rigorous analysis of storage system location, specifications, access, operation and maintenance, liability, and signage.

B. PROJECTS QUALIFYING FOR UNDERGROUND STORMWATER STORAGE

Project must meet the following criteria:

1. Project must be located within an industrial, commercial, non-residential or multi-family development; no underground stormwater storage will be approved for single family residential developments.
2. Project must have a viable property maintenance organization or other maintenance mechanism to assume continued maintenance of the underground stormwater storage system and protect the public interest.

C. GENERAL CRITERIA FOR UNDERGROUND STORMWATER STORAGE SYSTEM DESIGN

1. Underground stormwater storage systems must demonstrate protection of public health, safety, and welfare as established by the SRC and related policies.
2. All underground stormwater storage elements must meet industry standards or stricter standards.
3. Storage system must not be located under buildings or parking garages.
4. The owner must dedicate a drainage easement to the City which meets the standards for all drainage easements.

5. Design must address:
 - a. Water quality protection measures to protect underground and surface water resources to meet applicable water quality standards.
 - b. Vector control within storage system.
 - c. Redundancy in case of storage system failure, with particular attention to the possibility of structure or street flooding, sediment accumulation, or storm events that are greater than the 100-year, 2-hour event.
 - d. Initial suspended sediment load removal.
 - e. At least a 75 year life of entire system, including the lining and coating of the underground storage tank.
 - f. Drainage by gravity. Pumped systems will only be considered if no other reasonable alternative exists.
- D. SPECIFIC CRITERIA FOR UNDERGROUND STORMWATER STORAGE DESIGN
 1. Outfall—underground storage systems must have some sort of outfall, such as gravity drains or pumps.
 2. Pipes—underground storage system pipes must have a smooth interior floor.
 3. Installation—excavation, bedding, and backfill procedures and materials must be in accordance with MAG standards.
 4. Access—a minimum of two access points must be provided for each underground storage system to enable inspections and removal of accumulated sediment and debris. Access must be in accordance with MAG standards.
- E. CRITERIA FOR OPERATIONS, MAINTENANCE AND LIABILITY
 1. Operations and maintenance generally—owner must provide:
 - a. Maintenance staff with expertise in operating, inspecting, and maintaining an underground stormwater storage system;
 - b. An Operations and Maintenance Manual on site for the system that includes:
 - (i) a schedule for inspections and maintenance, and
 - (ii) provisions for emergency operations due to power failure, pump failure, and clogged outlet structures;
 - c. A log of the inspections and required maintenance services.
 2. Inspections and maintenance required—In addition to maintenance required by the SRC and other applicable requirements, owner shall:
 - a. Inspect system after each storm event of 0.6 inch or more, and semiannually, preferably before summer and winter rains.
 - b. Remove accumulated trash and debris from inlet and outlet structures as needed to ensure free flow of stormwater.
 - c. Inspect all other elements of the drainage system (pipes, geotextiles, and stone) and repair/replace elements as needed for the storage system to operate at peak efficiency.
 3. Signage—Before receiving a certificate of occupancy, the owner must install signs at each end of the underground storage tank that read “Notice—Underground Stormwater Storage Tank.” The size, color, and locations of signs are subject to city staff approval.
 4. Liability—Owner assumes all liability for the design, construction, maintenance and failure of the underground stormwater storage system in perpetuity and hold the City harmless from any such liability. Before receiving a certificate of occupancy, the owner must record a signed and notarized document to this

effect, in a form satisfactory to the City Attorney, in the Maricopa County Recorder's Office.

STORMWATER STORAGE WAIVERS

4-3.400

A. WAIVER OF STORMWATER STORAGE REQUIREMENTS

See SRC, Chapter 37, for waiver criteria. A waiver approval does not relieve the developer of liability if flood damage occurs resulting from the waiver.

B. WAIVER OF FIRST FLUSH

Generally, there is no waiver for stormwater storage volume required to hold runoff from the first one-half inch of precipitation. However, the owner may provide a smaller basin and/or alternative stormwater controls, to the satisfaction of the Stormwater Quality Coordinator.

C. WAIVER PROCESS

To apply for a waiver, the developer shall complete and submit, with the final drainage report:

1. A Request for Stormwater Storage Waiver Form, including the attached in-lieu fee and in-kind contributions calculations sheet; refer to Stormwater Storage Waiver at <http://www.scottsdaleaz.gov/bldgresources/forms#s>; and
2. A certified engineering report or other satisfactory documentation that the project qualifies for a waiver.

The city staff may request additional information. The Floodplain Administrator may deny the waiver, approve it, or approve it with conditions.

Unless the project is designed to provide full storage, the City will not accept final improvement plans without a copy of the approved Waiver Form.

D. IN LIEU FEES

1. If stormwater storage is waived, the developer shall be required to pay an in lieu fee. In lieu fees may be applied to the construction of drainage improvements throughout the City. To calculate the amount of in lieu fees based on the volume of stormwater storage waived, see Section 4-3.200, Stormwater Storage, above; form at <http://www.scottsdaleaz.gov/bldgresources/forms#s>.
2. The Floodplain Administrator may approve in-kind stormwater management facilities to reduce the in lieu fee.

STREET DRAINAGE

4-3.500

A. ACCESS

Generally, street improvements for new development shall provide access to properties during a base flood. To prove access, an engineer must demonstrate that at least one structural roadway section with asphalt, concrete or compacted aggregate has a depth of flow no greater than 1 foot during a base flood. Refer to Fig. 4.3-1, Street Hydraulic Design Criteria Chart, for limits of inundation for specific street sections. Refer to SRC, Chapter 37, Stormwater and Floodplain Management, for exceptions to this provision.

B. GENERAL DESIGN STANDARDS

Streets may carry water from adjacent property and from local areas, but should not be used as major water carriers in lieu of natural washes or man-made channels. The design criteria below imply that water may flow deeper than a normal vertical curb height, for a short distance over sidewalk or other back-of-curb areas, but the flow is always confined to the right-of-way or drainage easements. Engineers should provide catch basins, scuppers, or similar facilities, together with necessary channels, at appropriate locations (particularly street sag areas) to remove water flowing in the streets to comply with the design criteria below.

HYDRAULIC DESIGN CRITERIA			
d_{max} = maximum depth at any point within the right-of-way			
Drainage Feature	Peak Frequencies		
	10-Year	25/50-Year	100-Year
Street with Curb & Gutter	Contain runoff within street curbs. For collector and arterial streets maintain one 12-foot-wide dry driving lane in each direction.	N/A	Contain runoff below the building's lowest floor. Confine runoff to street rights-of-way or drainage easements. d_{max} =8 inches.
Street without Curb & Gutter (Dirt Roads, Ribbon Curbs)	Contain longitudinal runoff within roadside channels with water surface elevation below pavement subgrade.	N/A	Contain runoff below the building's lowest floor. Confine runoff to street rights-of-way or drainage easements. d_{max} =8 inches.
Street without Storm Drain System	Add pipes or roadside channels if runoff from 10-year flood exceeds street capacity, unless waived per SRC, Chapter 37.	N/A	Add storm drain systems if a base flood inundates building's lowest floor. Provide catch basins, scuppers, etc. to remove water so d_{max} =8 inches.
Cross Road Culvert or Bridge for Major Collector & Arterial Streets	N/A	Convey runoff by culvert or bridge under street with no flow overtopping the street for a 50-year flood, except as provided in SRC, Chapter 37.	Convey runoff by culvert and by flow over the street so d_{max} =6 inches, except as provided in SRC, Chapter 37.
Cross Road Culvert or Bridge for Local and Minor Collector Streets, Local Residential* and Commercial/Industrial Streets	Convey runoff by culvert or bridge under street with no flow overtopping the street, except as provided in SRC, Chapter 37.	For a 25-year event, convey runoff by culvert or bridge and by flow over the street with so d_{max} =6 inches, except as provided in SRC, Chapter 37.	d_{max} =12 inches, except as provided in SRC, Chapter 37.
Any street or watercourse crossing that provides the only access to residential area.	N/A	N/A	Make all lots and structures accessible by at least 1 street with d_{max} =12 inches for a base flood, except as provided in SRC, Chapter 37.
*Local Residential Streets with Low Volume Average Daily Trips	See Low Volume Street Standards, Chapter 5		

FIGURE 4.3-1 STREET HYDRAULIC DESIGN CRITERIA CHART

C. VALLEY GUTTERS

Valley gutters are permitted on local streets to transport runoff when a storm drain system is not required. Valley gutters are generally not acceptable on collector or

arterial streets. In unusual cases, valley gutters may be necessary to convey runoff across a collector street. In such situations, the valley gutter shall be a minimum of 8 feet wide to lessen the impact on traffic.

D. ROADSIDE SWALES

Unless waived by city staff, swales must intercept and safely convey flow to the nearest recognized watercourse within the same watershed. If velocities exceed 5 feet per second, then the engineer must design the swale to provide erosion and scour protection. Swales are necessary to prevent:

1. Runoff and debris from washing onto the roadway,
 2. Erosion of roadway areas adjacent to the edge of pavement or curbing, and
 3. Roadway runoff from flowing into front yards, driveways, garages and homes.
- Refer to Figure 4.3-2, Typical Cross Section for Roadside Swales, on non-raised curb street or straight cross slope.

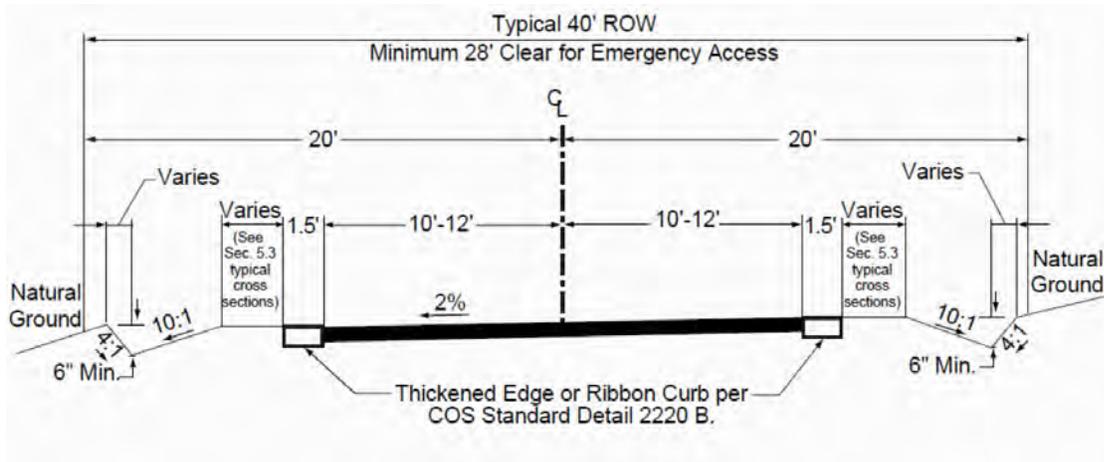


FIGURE 4.3-2 TYPICAL CROSS SECTION FOR ROADSIDE SWALES

E. WET CROSSINGS

For road wet crossings, calculate flow velocity for sediment erosion. Erosion control measures for scour protection must be evaluated and documented.

CHANNEL DRAINAGE

A. CHANNEL LINING

1. The policies for channel lining city-wide are set forth in Section 2-1.902.
2. Channel sections shall be designed so the final finish grade is the surface of any channel lining or erosion protection. Channel capacity shall be designed to increase capacity to accommodate reductions in flow capacity from landscaping, revegetation and sediment accumulation, as shown in Fig. 4.3-3, Channel Lining Design Capacity.

4-3.600

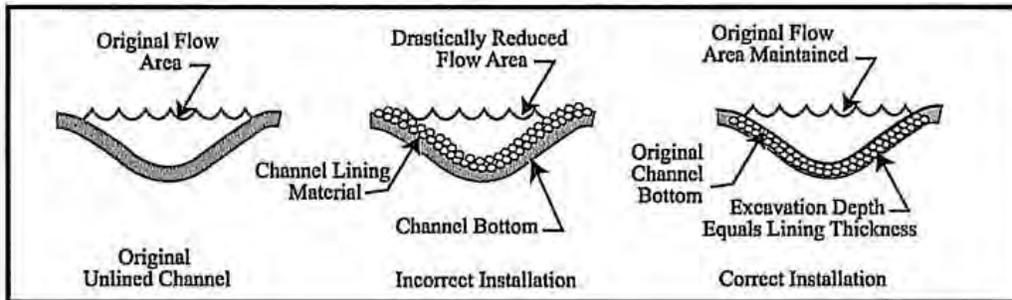


FIGURE 4.3-3 CHANNEL LINING DESIGN CAPACITY

CULVERTS AND STORM DRAINS

4-3.700

1. The minimum pipe size of culverts and storm drain laterals shall be 18 inches in diameter. Where debris may be expected, follow the FCDMC requirements for clogging.
2. Private culverts should be sized to manage the 100-year runoff, but should not be less than 15 inches in diameter when possible.. Culverts that do not have 100-year peak flow capacity must be designed to adequately convey the balance of runoff by channel or other means to the appropriate watercourse.
3. If a culvert invert is placed below the natural wash flowline, the design capacity of the culvert must be reduced by the cross-sectional area below this level.
4. Stormwater runoff cannot be conveyed in a culvert under structures, except to drain a fully laterally enclosed courtyard, where redundancy is required..
5. Manholes or junction structures are required at all horizontal and vertical changes in culvert alignment, pipe junctions, and changes in pipe diameter.
6. The hydraulic grade line in storm drains shall be no higher than six inches below the gutter line in a 10-year flood.
7. Minimum drainage easement widths shall be calculated using the following formula:

$$\text{Width} = \text{pipe outside diameter} + 2 \text{ feet} + 2 \times \text{depth to invert}$$

EROSION HAZARD MANAGEMENT

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EROSION HAZARD MANAGEMENT

Section 4-4

GENERAL INFORMATION

4-4.000

- A. The City uses, as a minimum, design standards and methodologies in the ADWR Erosion Hazard Guidelines and FCDMC Hydraulics Manual. These apply to:
 - 1. Structures that could fail or incur significant damage as a result of erosion.
 - 2. Proposed structures that, if built, could result in adverse impacts to adjacent properties.
 - 3. Watercourses that do not have identified erosion hazard zones.
 - 4. Watercourses within existing or proposed land divisions.
 - 5. Watercourses identified by the City as having significant potential flood hazards.
 - 6. Watercourses with drainage areas equal to or greater than 30 acres or a 100-year peak discharge estimate of more than 50 cfs, as estimated using the procedures in the FCDMC Hydrology and Hydraulics volumes.
- B. Erosion hazard zones consistent with ADWR may be required for all properties under development where watercourses will be left in an undisturbed state. The City may require further analysis (ADWR Level II or III) under certain geomorphic conditions where staff is concerned that erosion limits may exceed those estimated by a Level I analysis. The City may also require a slope stability analysis. In distributary flow watercourses, the stability of flow divergence locations and washes should be determined before approval of a proposed structure.
- C. Proposed modifications should not disturb the natural divergence location(s), especially if adjacent parcels may be adversely impacted.
- D. Erosion hazard guidelines should be applied to all divergent watercourses adjacent to the proposed structure.
- E. Proposed development design should limit vegetation removal and concentration of flow to an absolute minimum.
- F. The swales around a structure should daylight and broaden to the original sheet flow condition on the downstream side of structure. Appropriate scour and/or erosion protection may be required in the swale.

STORMWATER QUALITY

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STORMWATER QUALITY

Section 4-5

CONSTRUCTION GENERAL PERMITS

4-5.100

- A. ADEQ administers the Construction General Permit under the CWA. The City requires evidence that the development will comply with the ADEQ Construction General Permit, when applicable, before issuing development permits.
- B. Stormwater runoff from construction sites can include pollutants such as phosphorous, nitrogen, pesticides, petroleum derivatives, construction chemicals, solid wastes and sediment that adversely affect water quality. Compliance with the Construction General Permit will help prevent these pollutants from entering washes, lakes, other surface waters and the City's storm drain system.

HOW TO OBTAIN STATE AND CITY APPROVAL

4-5.200

- A. The operator of a construction site is responsible for applying for appropriate permits from ADEQ. The operator may be the owner, developer, general contractor or individual contractor responsible for operational control. When this responsibility is shared, all operators must apply for ADEQ approval. ADEQ will require a Notice of Intent (NOI) and Stormwater Pollution Prevention Plan (SWPPP).
- B. After ADEQ approval, the operator must include 2 copies of the approved NOI and SWPPP with improvement plan submittal to the City.

OPERATIONAL REQUIREMENTS

4-5.300

The operators must keep a copy of the SWPPP on site. In addition to ADEQ enforcement, the city may enforce stormwater management requirements, through inspections, responding to complaints and other means.

COMPLETING CONSTRUCTION

4-5.400

Once construction is completed, as defined in the Construction General Permit, the operators must send a Notice of Termination (NOT) to ADEQ and the City.

SECTION 404 PERMITS

4-5.500

The City requires developments to comply with Section 404 of the CWA.

ACTIVITIES REGULATED UNDER SECTION 404

4-5.600

- A. The US Army Corps of Engineers (Corps) and EPA jointly administer Section 404 of the CWA. The CWA regulates the discharge of dredged or fill material into washes, rivers, streams, lakes, certain man-made canals and other waters of the United States, including wetlands.

Examples of activities that might be regulated under this program include:

1. Stream crossings;

STORMWATER QUALITY

2. Dam construction and flow regulation;
 3. Water diversion for canals, irrigation systems and stock tanks;
 4. Streambed modification and stabilization; and
 5. Building subdivisions, master planned communities, nonresidential structures, highways and airports.
- B. Projects with minimal environmental impact require nationwide permits with a streamlined process. Projects with potentially significant impacts may require individual permits with public notice.
- C. Projects cannot jeopardize the continued existence of a threatened or endangered species or its critical habitat. Consult with the Corps or the US Fish and Wildlife Service for guidance concerning threatened and endangered species in the City.

SECTION 401 CERTIFICATION

- A. Before the Corps can issue a Section 404 permit, Section 401 of the CWA requires ADEQ to certify (possibly with additional conditions) that the draft permit complies with effluent limits, state water quality standards, and appropriate requirements of state law. No discharge of dredged or fill material is permitted if:
1. A practicable alternative exists that is less damaging to the aquatic environment, or
 2. The nation's waters would be significantly degraded.
- B. ADEQ may grant, deny or waive water quality certification for both individual and nationwide Section 404 permits.

4-5.700

COMPLIANCE REQUIREMENTS

The City will not issue any development permit without appropriate Corps action. An applicant must complete the City Section 404 Certification Form to assure that a project complies with Section 404 of the CWA, and submit the form with improvement plans. Refer to <http://www.scottsdaleaz.gov/bldgresources/forms#s>.

4-5.800

WASTE DISPOSAL SYSTEM LOCATIONS

- A. Waste disposal system locations shall comply with Arizona Revised Statutes, Section 48-3609. Refer to <http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/ars/48/03609.htm&Title=48&DocType=ARS>
- B. Waste disposal system locations shall comply with Maricopa County standards. Refer to <http://www.maricopa.gov/EnvSvc/AboutUs/pdf/C2S2.PDF> and http://www.azsos.gov/public_services/title_18/18-09.pdf

4-5.900

DRAINAGE REPORT AND PLANS

DRAFT

DRAINAGE REPORT AND PLANS

ACTIVITIES REQUIRING A DRAINAGE REPORT AND PLAN

4-6.100

An applicant may be required to submit a drainage report and plan when submitting any of the following applications. The specific nature of the drainage report and plan, and the requirements for submittal, will be determined during the pre-application process by a team of city staff.

1. Re-zoning or use permit
2. Master development plan
3. Preliminary and minor subdivision plat
4. Development Review Board case
5. Final plat and improvement plans
6. Permit to construct right-of-way improvements
7. Permit to construct any structure, except a drainage report is not required for a single family residential structure without a basement in Flood Hazard Zone X where stormwater runoff is unlikely to be hazardous to the structure or its occupants
8. Grading permit, unless the Floodplain Administrator waives the requirement
9. Modification or release of a dedicated drainage easement

TYPES OF DRAINAGE REPORTS AND PLANS

4-6.200

There are sequential levels of drainage reports and plans as development proposals range from broad and conceptual to project specific and detailed, as well as requirements for master-planned development proposals. Drainage reports and plans address stormwater flows and drainage issues that affect a proposed development, plus adjacent and nearby sites; and drainage solutions, in accordance with applicable ordinances and standards, to mitigate adverse effects resulting from the proposed development. Each drainage report and plan shall describe how the proposed development will manage stormwater runoff, the details of infrastructure to be constructed, the sequence of infrastructure installation, and any phasing of the project. Drainage reports and plans for single-family residences may vary from the sequence below, subject to city staff approval.

1. **Conceptual Drainage Reports and Plans.**
With re-zoning and use permit applications, the applicant shall submit a Conceptual Drainage Report and Plan that identifies the basic drainage conditions that apply to the site and possible stormwater management solutions that relate to the proposed development and unique condition of the site. In many cases, the Conceptual Drainage Report and Plan will be included in a Development Plan (DP) as identified in Section 7.800 of the Zoning Ordinance. The Conceptual Drainage Report and Plan shall show how the drainage systems on the site will relate to and extend existing drainage systems serving adjacent and nearby properties. The Conceptual Drainage Report and Plan shall establish the key elements for consideration in any future drainage reports and plans for the site, including applicable FEMA floodplain designations.
2. **Preliminary Drainage Report and Plans.**
With preliminary plat, minor subdivision, Development Master Plan and Development Review Board applications, the applicant shall submit a Preliminary Drainage Report and Plan. While a Preliminary Drainage Report and Plan will not contain sufficient

detail and accuracy to function as improvement plans, the Preliminary Drainage Report and Plan must provide detailed design concepts, specifications for proposed drainage facilities, and management plans for operating and maintaining the drainage facilities. The Preliminary Drainage Report and Plan presents the justification for final improvement plans and lowest floor elevations, the plan for connecting the proposed development to existing and planned drainage facilities on and adjacent to the site; pre- and post-project topography; and stormwater runoff calculations. The Preliminary Drainage Report and Plan shall also demonstrate consistency with any applicable Conceptual Drainage Report and Plan and stipulations associated with approval.

3. Final Drainage Report and Plans.

With improvements plans for final plats, construction plans for public infrastructure, and construction plans for on-site development, the applicant shall submit a Final Drainage Report and Plan. A Final Drainage Report and Plan is intended for construction and therefore must be fully detailed; compliant with the DS&PM and applicable regional, State and Federal statutes; and consistent with previously approved Preliminary Drainage Reports and Plans and stipulations.

4. Master Drainage Reports and Plans.

For multi-phased and complex development proposals, the city may require the applicant to submit a Master Drainage Report and Plan after a rezoning approval (by stipulation or per Section 7.800 of the Zoning Ordinance). A Master Drainage Report and Plan provides the basis for constructing major common drainage improvements that serve an individual phase or property within the proposed development, the entire proposed development, or a portion of the regional drainage requirements. A Master Drainage Report and Plan also establishes the drainage improvement requirements necessary for each phase of the development. A Master Drainage Report and Plan shall be submitted before or with the first preliminary plat or Development Review Board case for the site.

STANDARDS

- A. All drainage reports and plans should be prepared in conformance to the requirements in this chapter. Hydrology calculations may be performed using Drainage Design Management System for Windows (available at no cost through the FCDMC), HEC-1, HEC-HMS or the Rational Method. Hydraulic calculations may be performed using HEC-RAS. However, the city encourages sound, innovative design and the use of new techniques where special conditions or needs exist. With prior city staff approval, alternate methods, models and procedures may be used with appropriate supporting documentation.
- B. Development shall not increase peak discharge rates above the historic peak discharge rates for 10-year and 100-year storm events.
- C. Proposed grading shall be at least 0.5% to allow for positive drainage.
- D. At a minimum, drainage reports should meet the following standards:
 - 1. Reflect City, County, State and Federal requirements
 - 2. Use the best and most current data available
 - 3. Provide a clear narrative of the methods used, parameters selected in the analysis and conclusions drawn

4-6.300

4. Be technically and legally defensible
 5. Be well-organized and concise
 6. Provide safe, reasonable and reliable results
 7. Provide results that are consistent with adjacent jurisdictions
- E. All drainage reports and plans shall conform to the standards in Appendix 4-6A.

LIMITATIONS

The city does not guarantee the reliability of specific hydrologic methods, techniques and/or parameter values. The engineer is expected to validate the reasonableness of the estimated values and design the plan to keep the development and the city relatively safe from flooding. Refer to Appendix 4-6B, Warning and Disclaimer of Liability form. The owner must submit the completed Warning and Disclaimer of Liability form with each grading and drainage plan.

4-6.400

GRADING AND DRAINAGE PLANS—METHODOLOGY AND CALCULATIONS

A. METHODS FOR ESTIMATING PEAK DISCHARGE.

There are two methods to determine peak discharge:

1. The Rational Method (generally used for watersheds less than 160 acres that are regularly shaped and uniformly contoured). The methodology is provided in the FCDMC Hydrology Manual.
2. A rainfall runoff model using the Corps' HEC 1 Flood Hydrograph Package (generally used for watersheds that are larger than 160 acres, irregular in shape and contour, or if routing of flows is necessary).

B. WATERSHED CONDITIONS.

Watersheds are subject to change. Grading and drainage plans shall consider all watershed conditions that would result in the greatest peak discharge rate, to:

1. Size drainage facilities, and
2. Determine lowest floor elevations.

C. SPLIT-FLOW CONDITIONS.

Projects in northern parts of Scottsdale must address split-flow channel conditions where applicable. These splits in the alluvial channels usually include highly erosive soils and are generally unstable and unpredictable. In setting lowest floor elevations relative to upstream splits, assume that 100% of the flow could go either direction in any given flood event. For infrastructure design, the estimate of the actual split, based on a hydraulic analysis of the current channel cross sections, must include a minimum safety factor of 30% of the total flow. If there are extenuating factors affecting the stability of the split, the safety factor should be increased accordingly.

D. ENVIRONMENTALLY SENSITIVE LANDS.

For special considerations regarding Environmentally Sensitive Lands, refer to the City Zoning Ordinance Section 6.1010 and DS&PM Section 2-2.200. Modification of natural watercourses with a flow of 25 cfs or greater are addressed in the City Zoning Ordinance.

E. THE RATIONAL METHOD.

4-6.500

DRAINAGE REPORT AND PLANS

1. Precipitation. Precipitation input is rainfall intensity, “I,” and can be obtained directly from NOAA 14 at http://hdsc.nws.noaa.gov/hdsc/pfds/sa/az_pfds.html [
2. Time of Concentration. Time of concentration “Tc” is the total time of travel from the most hydraulically remote part of the watershed to the concentration point of interest. The calculation of “Tc” must follow FCDMC Hydrology Manual procedures.
3. Runoff Coefficients. Use Fig. 4.6-2, Runoff Coefficients for Use with Rational Method, or equivalent to obtain the runoff coefficients or “C” values. Composite “C” values for the appropriate zoning category or weighted average values calculated for the specific site are both acceptable approaches.

RUNOFF COEFFICIENTS - “C” VALUE			
Land Use Composite Area-wide Values	Storm Frequency		
	2-25- Year	50-Year	100- Year
Commercial & Industrial Areas	0.80	0.83	0.86
Residential Areas-Single Family (average lot size)			
R1-190	0.33	0.50	0.53
R1-130	0.35	0.51	0.59
R1-70	0.37	0.52	0.60
R1-43	0.38	0.55	0.61
R1-35 (35,000 square feet/lot)	0.40	0.56	0.62
R1-18 (18,000 square feet/lot)	0.43	0.58	0.64
R1-10 (10,000 square feet/lot)	0.47	0.62	0.67
R1-7 (7,000 square feet/lot)	0.51	0.64	0.94
R1-5 (5,000 square feet/lot)	0.51	0.64	0.94
Townhouses (R-2, R-4, R-4R)	0.63	0.74	0.94
Apartments & Condominiums (R-3, R-5)	0.76	0.83	0.94
Specific Surface Type Values			
Paved streets, parking lots (concrete or asphalt), roofs, driveways, etc.	0.90	0.93	0.95
Lawns, golf courses, & parks (grassed areas)	0.22	0.28	0.30
Undisturbed natural desert or desert landscaping (no impervious weed barrier)	0.37	0.42	0.45
Desert landscaping (with impervious weed barrier)	0.63	0.73	0.83
Mountain terrain – slopes greater than 10%	0.60	0.70	0.80

Agricultural areas (flood-irrigated fields)	0.18	0.22	0.24
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FIGURE 4.6-2 RUNOFF COEFFICIENTS FOR USE WITH RATIONAL METHOD

F. HEC-1 MODEL.

1. Minimum submittals.
 - a. A printout of the input data
 - b. A schematic (routing) diagram of the stream network
 - c. The runoff summary output table, including drainage basin name, area, 100-year flow and 10-year flow values
 - d. Electronic input file(s) on CD or DVD
 - e. Supporting documentation and source material for parameter selection
 - f. A narrative detailing the impact of adjustments to the modeling parameters made to address warnings and error messages
2. Precipitation.

Determine precipitation values for HEC-1 modeling using the FCDMC Hydrology Manual, specifically PD and JD records for point rainfall and area reduction factors. Capital Projects shall use the ADOT manual and methodology when specified. Precipitation values are to be obtained from the Isopluvial maps for the specific frequency addressed, see Appendix 4-1C.
3. Infiltration.

Determine infiltration or soil losses using Green and Ampt (G&A) procedures per FCDMC Hydrology Manual. Use the following, most recent, applicable USDA NRCS soil survey maps of the area to determine the hydrologic soil group or surface soil texture for the G&A procedures:

 - a. Aguila Carefree Area
 - b. Parts of Maricopa and Pinal Counties
 - c. Eastern Maricopa and Northern Pinal Counties
4. Hydrograph Generation. Generate small basin or sub watershed hydrographs using the Clark unit hydrograph procedure or S-graph method as described in the FCDMC Hydrology Manual.
5. Time of Concentration (“Tc”). Use the estimated time of travel from the most hydraulically remote part of the watershed to the concentration point. The FCDMC Hydrology Manual is recommended for obtaining Tc.
6. Channel Routing. Use the Normal Depth (Modified Puls), eight point routing procedure as described in the FCDMC Hydrology Manual for channel routing.
7. Existing and Proposed Discharge Analysis. Use the following HEC 1 analysis procedures when necessary to compare existing and proposed discharge (runoff) conditions. Reflect full development conditions by:
 - a. Increasing the percentage of impervious surfaces on the LG card to show the amount of impervious surface that will exist after full development.
 - b. Recalculating the time of concentration (Tc) based on the proposed drainage system, after full development.
 - c. Subdividing, as necessary, the existing condition model to create concentration points that match the sub-watershed areas above each proposed storage facility after full development.
 - d. Modeling each proposed storage facility as it will physically exist after full development, with appropriate routing and combining operations through each facility and through the entire watershed. Modeling storage capacity

provided, as one hypothetical facility at the outlet with all upstream storage arbitrarily combined in the facility, is not acceptable.

- e. Analyzing the 10-year and 100-year frequency events, at a minimum.
- f. Comparing discharge values for existing and full development at concentration points just downstream from each proposed storage facility, other critical locations such as road crossings, and points where flows exit the development.

G. CALCULATION OF RUNOFF VOLUMES

1. Standard Formula for Runoff Volumes The standard formula for determining the required stormwater storage runoff volume is in Section 4-3.200 above.
2. HEC-1 Computer Modeling. HEC 1 modeling may be used for storage basin design, routing and analysis. Use modified Puls level pool routing option in HEC-1 for hydrograph routing through storage basins and lakes. For permanent lakes, assume no available storage below the normal water surface elevation.

H. METHODS FOR ESTIMATING WATER SURFACE ELEVATIONS AND INUNDATION LIMITS

The engineer may use any standard method for determining water surface elevations. The City prefers the U.S. Army Corps of Engineers' HEC-RAS, to determine inundation limits. If the applicant uses the U.S. Army Corps of Engineers' HEC-RAS Computer Models, the minimum required submittals for HEC-RAS are:

1. A printout and CD or DVD of the input and output data.
2. A plan of the contributing stream network and sub-basins with cross section locations and stationing, including flow obstructions, ineffective flow areas modeled and other appropriate parameters at a sufficient scale to support the modeling. Overlay the cross sections on the topographic workmap.
3. A detailed output summary table, including flow rates, velocities, water surface elevations, bank stations, n-values, ineffective flow stations, flow obstruction stations and other relevant parameters.
4. Cross section profiles.
5. Supporting documentation and source material for parameter selection.
6. A narrative to validate warning and error messages with details of the impact of adjustments to the modeling parameters on the output, if the city staff allows warning or error messages.

GRADING AND DRAINAGE PLANS—ADDITIONAL REQUIREMENTS BY PLAN TYPE

4-6.600

The following requirements are in addition to the above requirements depending on the type of plan or development. Some requirements may apply to other plan types depending on the nature of the project and improvements.

A. COMMERCIAL AND MULTIFAMILY

The plan must show:

1. The location, orientation and an outline of refuse enclosures, including approach slabs.
2. Details of driveways conforming to city standard details, plus existing gutter grades at tie in, longitudinal slopes, the location of grade breaks, sidewalk ramps, curb return radii, existing curb and asphalt removal and asphalt replacement.

DRAINAGE REPORT AND PLANS

3. Horizontal control for proposed buildings, drive aisles, parking space dimensions and any other substantial improvements.
 4. High and low points for driveway paving, with elevations.
 5. Building setback lines.
 6. Traffic and parking striping.
 7. Access to underground parking areas.
- B. RESIDENTIAL SUBDIVISIONS
- The plan must show:
1. Lot numbers.
 2. Tract names and street names from the final plat.
 3. Street, tract and rights-of-way widths, and street centerlines from paving plans.
 4. Street longitudinal and cross slopes.
 5. 10-year and 100-year peak discharge rates at curb cuts and catch basins.
 6. Flow path for small washes or swales through lots in custom residential subdivisions.
 7. High and low points within streets, with elevations.
 8. Building setback lines.
 9. Top of curb elevations at the intersection of lot lines with the tract or rights-of-way lines.
- C. CUSTOM SINGLE FAMILY RESIDENTIAL
- Requirements for single-family development can be found at <http://www.scottsdaleaz.gov/bldgresources/forms#s> or contact Plan Review at 480-312-7080.



Appendix 4-6A DRAINAGE REPORTS AND PLANS

- A. For all Drainage Reports and Plans, provide as required for the level of detail for each type of drainage report and plan described in section 4-6.200:
1. Analysis based on:
 - a. HEC-1, HEC-HMS, HEC-2 or HEC-RAS, Flowmaster, HY-8, Culvert Master and/or DDMSW; or
 - b. Nonstandard software, if approved by city staff, and if working nonstandard software is provided.
 2. Two bound copies (3 ring, GBC or Coil wire, no staples), with card stock front and back covers.
 3. Information for the entire project site and off-site at least fifty feet from site.
 4. Topography, based on current surveys, as follows:
 - a. For topography on site and 25 feet beyond the property line, as well as any area subject to a hydraulic model, show existing and proposed topography with minimum 1-foot contours, with 5-foot contour lines distinguished for readability. Exceptions may be considered on a case-by-case basis for substantial areas of undisturbed ground not subject to inundation in a base flood.
 - b. For off-site topography necessary to delineate watershed boundaries, show existing topography with minimum 2-foot contours. Subject to city staff approval, show spot elevations in lieu of 1-foot contours for development that does not have enough relief to use 1-foot contours.
 - c. All proposed contours must align with all existing contours.
 - d. Showing how topography influences stormwater runoff from the development and off-site watersheds.
 - e. Provide cross sections as necessary to adequately demonstrate how the proposed site grading will not adversely affect other property.
 5. Current color aerial photographs:
 - a. On-site, minimum 400 scale aerial photos, clearly identifying project site.
 - b. Off-site, minimum 800 scale aerial photos, showing project site in context.
 6. On-site photographs to support parameter selection.
 7. Drainage Plans: show 1-foot contours, 24" x 36".
 - a. Scales of Drainage Plans are shown below; alternate scales are subject to city staff approval.
 - b. All plans shall label substantial cut and fill areas with a directional arrow, with the slope expressed as horizontal to vertical (H:V).
 - c. All plans shall provide a legend for all line types, symbols and abbreviations used on the plan.



Appendix 4-6A

DRAINAGE REPORTS AND PLANS

- d. All plans shall be clearly readable even if reduced by 50%, as determined by city staff.
 8. Sufficient detail to allow thorough review.
 9. Plan Check Number and/or Case Number on the right margin of cover and each page.
 10. FEMA blocks, information and certification as required in Chapter 1.
 11. Completed and signed Warning and Disclaimer of Liability. See App. 4-1B in this Chapter.
 12. Full size plans/maps, folded, contained in pockets and listed in the Table of Contents.
 13. The Drainage Report and Plan, including all Chapters, Figures, Attachments, Plans, Maps and Appendices as a PDF file.
 14. A compact disk (CD) or digital video disk (DVD) containing the entire Drainage Report and Plan, including all Chapters, Figures, Attachments, Plans, Maps and Appendices with data files of analysis required above, all in PDF format. The CD and DVD shall be labeled and include the engineer's name, firm name, project name, date, and Plan Check Number and/or Case Number. The CD or DVD shall be in a case and placed in the separate folder in the Drainage Report and Plan. This CD or DVD shall also contain all hydrologic and hydraulic input and output files such as HEC-1 and HEC-RAS.
- B. For all Drainage Reports and Plans, provide:
1. Title Page:
 - a. Type of Report (Conceptual, Preliminary, Final or Master Plan).
 - b. Project Name.
 - c. Location.
 - d. COS Plan Check Number and/or Case Number.
 - e. Benchmark datum of NAVD 1988, or subject to city staff approval, a local benchmark with an elevation equation related to NAVD 1988, to nearest hundredth of a foot in the format LF88 = X,XXX.XX.
 - f. Engineer's seal, signature, and date, in accordance with AZBTR requirements.
 2. Table of Contents:
 - a. List of All Chapters, Figures, Attachments, Plans, Maps and Appendices.
 - b. Engineer's seal, signature, and date.
 3. Introduction:
 - a. Project Name, location, size and brief description (including scope of project).
 - b. Vicinity map.
 - c. Purpose and objectives of Drainage Plan.
 - d. Executive summary of findings, conclusions and proposals.
 - e. Special Conditions, if applicable, including project stipulations; erosion issues; 401 and 404 Permits; ADEQ Permits; AZPDES Permits; and stormwater storage waiver, wash modification and phasing proposals.



Appendix 4-6A

DRAINAGE REPORTS AND PLANS

4. Data Analysis Methods: Provide a narrative of, pre- and post-development, for on-site and off-site conditions:
 - a. Hydrologic procedures, parameter selection and assumptions.
 - b. Hydraulic procedures, methods, parameter selection, design criteria and assumptions.
 - c. Stormwater storage calculation methods and assumptions, including accounting for sediment.
 - d. Basis for setting lowest floor elevations relative to designated floodplains and adjacent washes; or outside a floodplain, relative to highest adjacent grade.
5. Conclusions.
 - a. Summarize the data analysis methods used.
 - b. State how the conclusions are reached.
6. References and Appendices: Provide the following technical data to support the conclusions, based on the level of detail required for each type of grading report and plan described in section 4-6.200.
 - a. Data and calculations
 - b. Peak flow calculations (e.g. Rational Method or HEC-1 printouts)
 - c. Channel design calculations including toe-down protection and drop structure design
 - d. Culvert design calculations
 - e. Floodplain calculations (e.g. Manning's and/or HEC-RAS printouts)
 - f. Stormwater runoff calculations
 - g. Storage volume calculations
 - h. Retention/detention basin inflow outflow analysis and design calculations
 - i. Street capacity calculations
 - j. Curb opening, catch basin calculations
 - k. Storm drain calculations
 - l. Sediment and scour calculations
 - m. Rip-rap sizing
 - n. Erosion/sediment control plan
 - o. Soils and or geologic analyses
 - p. Hydrologic and hydraulic data and calculations
7. Different information and format:
 - a. Chapter 1 provides additional information and requirements for submittals.
 - b. City staff may require additional information, or information in a different form from that required above, to address unique situations or assist city staff in thorough review of the Drainage Report and Plan.



DRAINAGE REPORTS AND PLANS

- c. Additional information must conform to generally accepted engineering principles and practices to allow city staff to assess whether the Drainage Report and Plan meets city standards.
- C. For Conceptual Drainage Reports and Plans, provide the documents required in A. and B. above with further specifications below:
 1. Plans to a minimum scale of 1" = 40'
 2. The Report must include the phasing information, including:
 - a. Graphic of areas to be phased, with labels of phases.
 - b. Justification for phasing.
 3. The Plan must show and label, on separate pages, (1) pre-development, on-site and off-site, and (2) post-development, on-site and off-site:
 - a. Watershed and floodplain boundaries.
 - b. FEMA floodplain designations.
 - c. Dimensions and calculation of disturbed area.
 - d. Flow lines and flow rates; with dashed lines for flow line of watercourse bottoms.
 - e. Historical flow path entry and exit locations.
 - f. 100-year peak discharge rates at key concentration points.
 - g. Land use, building footprints, utilities and development conditions.
 - h. Existing watershed and drainage characteristics, network and patterns.
 - i. Location, description and purpose of existing and proposed drainage infrastructure; conveyance of off-site flows; connections to and probable effect on upstream and downstream drainage systems.
 - j. Existing drainage easements and rights-of-way, with the Maricopa County Recorder's number.
- D. For Preliminary Drainage Reports and Plans, provide the documents required in A., B. and C. above with further information and specifications below:
 1. Plans to a minimum scale of 1" = 30'.
 2. FIRMs.
 3. Proposed waiver of any stormwater storage requirement.
 4. Topographic plan resulting from proposed on-site grading.
 5. The Report must include the following descriptions and analysis:
 - a. Existing land use in the watershed area, and proposed land use resulting from development.
 - b. Explanation of parameters of analysis used.
 - c. Basis of selection of lowest floor elevations.
 - d. In AO Zones, the lowest floor elevations and highest adjacent grade (HAG), calculated as follows: Determine the Regulatory Flood Elevation (RFE) to set the LF88



Appendix 4-6A DRAINAGE REPORTS AND PLANS

- for residential structures. The RFE = the HAG Elev + AO depth No.+ 1 foot of freeboard.
- e. In local floodplains and special flood hazard areas, for all structures, show the lowest floor elevations, BFE, highest adjacent grade, and, in addition, for commercial structures, floodproofing elevations. If the lowest floor is below the base flood elevation, the design for protecting the interior of the structure. For calculating the BFE, see FEMA Publication 265: Managing Floodplain Development in Approximate Zone A Areas – A Guide for Obtaining and Developing Base (100-year) Flood Elevations at <http://www.fema.gov/library/viewRecord.do?id=1526>.
 - f. For all mechanical equipment and attendant utilities, in local floodplains and special flood hazard areas, show the lowest floor elevations, BFE, highest adjacent grade, and, in addition, for commercial structures, floodproofing elevations, if applicable.
 - g. Existing walls and provide top of wall elevations.
 - h. Wash cross-sections to show that the wash has adequate capacity and freeboard to convey runoff through the site.
 - i. Scour effects.
 - j. Proposed drainage infrastructure, including storage facilities design criteria, volume required (VR = XXX ft³), volume provided (VP = XXX ft³), and basin locations.
 - k. Management plans for operating and maintaining all drainage infrastructure.
 - l. Consistency with applicable ordinance requirements, standards, approved stipulations, General Plan (Land Use Element), Conceptual Drainage Report and Plan, Master Drainage Report and Plan, and other proposed developments affecting the site, including capital improvement projects.
 - m. Phasing information, including detailed graphic of areas to be phased, with labels of phases, and descriptions and analysis of all drainage Improvements to be constructed in each phase, timetables for each phase, impact of phased construction, and required interim drainage infrastructure. Each phase shall provide drainage infrastructure to serve that phase, and create no adverse impact off-site.
6. The Plan must show and label, pre- and post-development, on-site and off-site:
- a. Topographic or other physical discontinuities relative to adjacent properties.
 - b. Existing and proposed property lines and, for existing properties, assessor's parcel numbers.
 - c. COS Plan Check Number and/or Case Number for adjacent development that has occurred in the last 5 years.
 - d. 100-year peak discharge rate at all entry and exit locations, and flow concentration points.



DRAINAGE REPORTS AND PLANS

- e. Runoff from a base flood, and consideration of storm events more frequent than the base flood. Development shall not increase peak discharge rates above the historic peak discharge rate for any event up to and including the base flood.
 - f. Modeling results of flow amounts, velocities and routes.
 - g. Location of proposed drainage infrastructure, including storage facilities (with volume required, volume provided and drain times), and related to adjacent properties, regional drainage plans and existing drainage infrastructure.
 - h. Wash cross-sections, including flow rate, water surface elevation, velocity and top width.
 - i. Size, capacity and nature of off-site drainage infrastructure entering and exiting the project site.
 - j. Impact of development on project site and future development within fifty feet of project site.
 - k. Proposed drainage easements, including easements over watercourses with a 100-year peak discharge rate of 25 cfs or greater, showing the limits of the easement.
 - l. Upon city staff request, spot elevations.
- E. For Final Drainage Reports and Improvement Plans, provide the documents required in A., B., C. and D. above with further specifications below:
- 1. Plans to a minimum scale of 1" = 20' showing grade breaks and flow arrows.
 - 2. One-foot topographic contours based on a current survey for the entire development site to 25 feet beyond the property line and for off-site areas where a hydraulic model is necessary.
 - 3. Certification that all applicable local, state and federal permits have been obtained.
 - 4. Notice of Intent, Stormwater Pollution Prevention Plan and ADEQ checklist, as approved by ADEQ, as applicable.
 - 5. Proposed drainage easement agreements, including legal descriptions, title commitments and confirmation of easements signed by lienholders.
 - 6. Certification:
 - a. The plan relies on accurate figures and analysis.
 - b. The plan meets all applicable requirements and standards.
 - c. The plan reflects all elevations based on the city's benchmark of NAVD 1988, or subject to city staff approval, based on a local benchmark with an elevation equation related to NAVD 1988.
 - d. The plan is consistent with approved stipulations and the Preliminary Drainage Report and Plan.
 - e. All structures are safe from flooding.



Appendix 4-6A DRAINAGE REPORTS AND PLANS

- f. The development shall have no adverse impact on-site or off-site.
7. The Report must include the following descriptions and analysis:
 - a. Location of all on-site and off-site culverts, with number, material, size of pipes, and upstream and downstream invert elevation labels.
 - b. How topographic changes from the project affect drainage characteristics, including time of concentration.
 - c. Whether model was developed with subcritical, supercritical or mixed flow analysis.
 - d. Methods to address any erosion issues consistent with DSPM requirements.
 - e. Existing land use and Green Ampt soil characteristics for the site, including USDA NRCS soil survey maps.
 - f. Phasing information, including detailed timetables for each phase, and demonstrated compliance with applicable stipulations.
 - g. An appendix addressing city review comments, with cross-references to the revised Plan.
8. The Plan must meet standards for improvement plans, complete with detailed engineering and construction notes. The Plan must show and label, pre- and post-development, on-site and off-site:
 - a. On-site drainage sub-basins.
 - b. Limits of inundation for all watercourses with a 100-year peak discharge rate greater than 50 cfs.
 - c. 10-year and 100-year peak discharge rates for all washes entering and exiting the site, with intermediate locations of 10-year and 100-year peak discharge rates within the site at least 1 time per sheet per wash, at confluences and points of interest such as culverts, storm drains, utility crossings, and channel improvements, shown with a directional arrow in the following format: Q10/Q100 = xx cfs.
 - d. All existing and proposed walls, and top and base wall elevations at wall ends, changes in elevation, and as required by city staff.
 - e. Utilities labeled by type.
 - f. Easements labeled by type, such as drainage, water, sewer, access, public utility, sidewalk and natural area open space.
 - g. Dimensions, capacities, materials, cross-sections and typical details of proposed drainage infrastructure.
- F. For Master Drainage Reports and Plans, provide the documents required in A., B. and C. above with further specifications below:
 1. Plans to a minimum scale of 1" = 100'.



Appendix 4-6A DRAINAGE REPORTS AND PLANS

2. The Report must include the descriptions and analysis of all drainage Improvements to be constructed in each phase, the impact of phased construction, and required interim drainage infrastructure.
3. The Plan must show and label, pre- and post-development, on-site and off-site:
 - a. Existing land use in the watershed area, and modified land use resulting from proposed development.
 - b. Size, capacity and nature of off-site drainage infrastructure entering and exiting the project site.
 - c. All drainage improvements to be constructed in each phase and required interim drainage infrastructure.



Appendix 4-6B

WARNING AND DISCLAIMER OF LIABILITY

The City’s Stormwater and Floodplain Management Ordinance is intended to minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare which might result from flooding.

The Stormwater and Floodplain Management Ordinance identifies floodplains, floodways, flood fringes and special flood hazard areas. However, a property outside these areas could be inundated by floods. Also, much of the City is a dynamic flood area; floodways, floodplains, flood fringes and special flood hazard areas may shift from one location to another, over time, due to natural processes.

WARNING AND DISCLAIMER OF LIABILITY

The flood protection provided by the Stormwater and Floodplain Management Ordinance is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. Floods larger than the base flood can and will occur on rare occasions. Floodwater heights may be increased by constructed or natural causes. The Stormwater and Floodplain Management Ordinance does not create liability on the part of the city, any officer or employee thereof, or the federal, state or county government for any flood damages that result from reliance on the Ordinance or any administrative decision lawfully made thereunder.

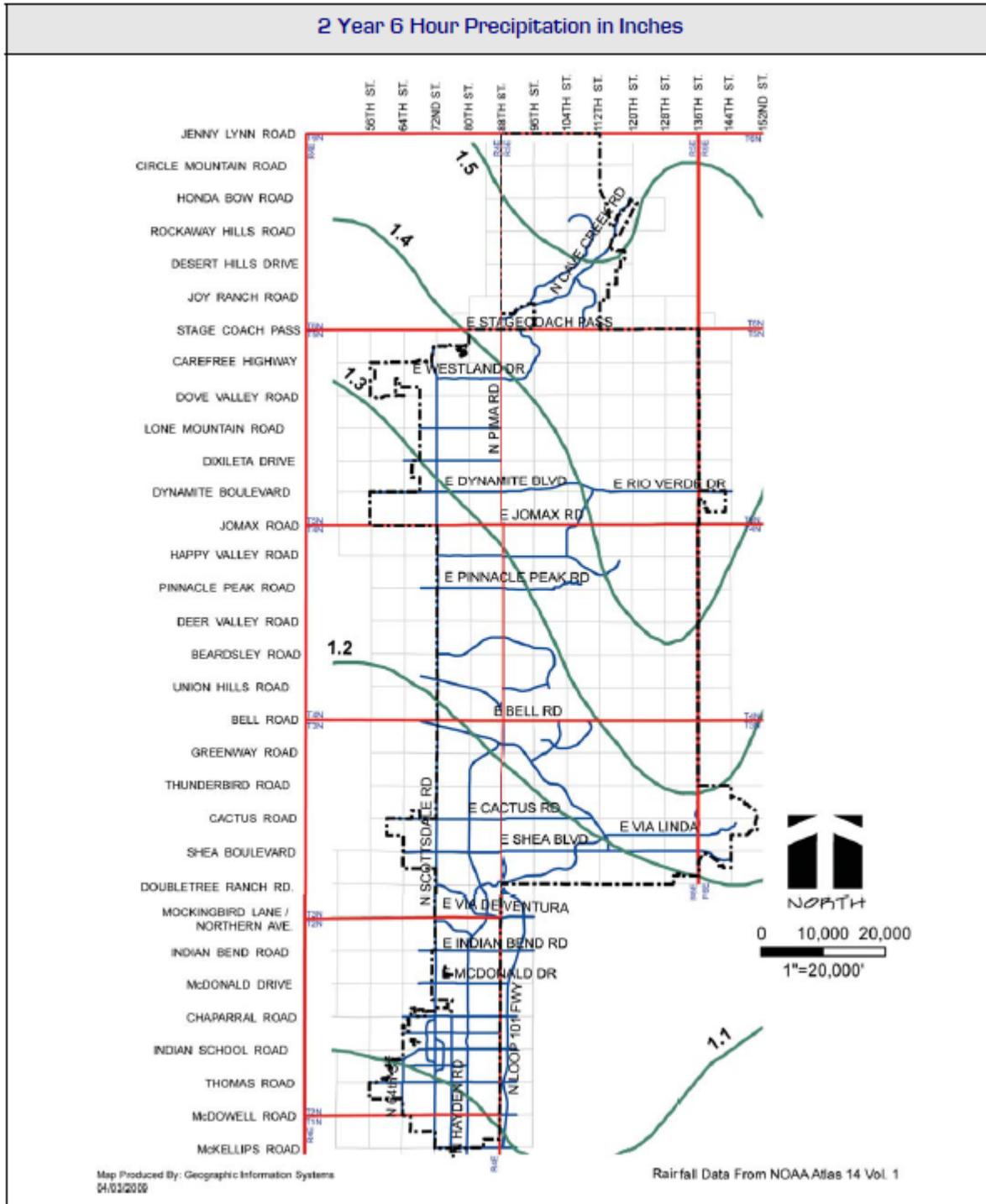
Compliance with the Stormwater and Floodplain Management Ordinance does not ensure complete protection from flooding. Flood-related problems such as natural erosion, streambed meander, or constructed obstructions and diversions may occur and have an adverse effect in the event of a flood. You are advised to consult your own engineer or other expert regarding these considerations.

I have read and understand the above.

Plan Check #	Owner	Date

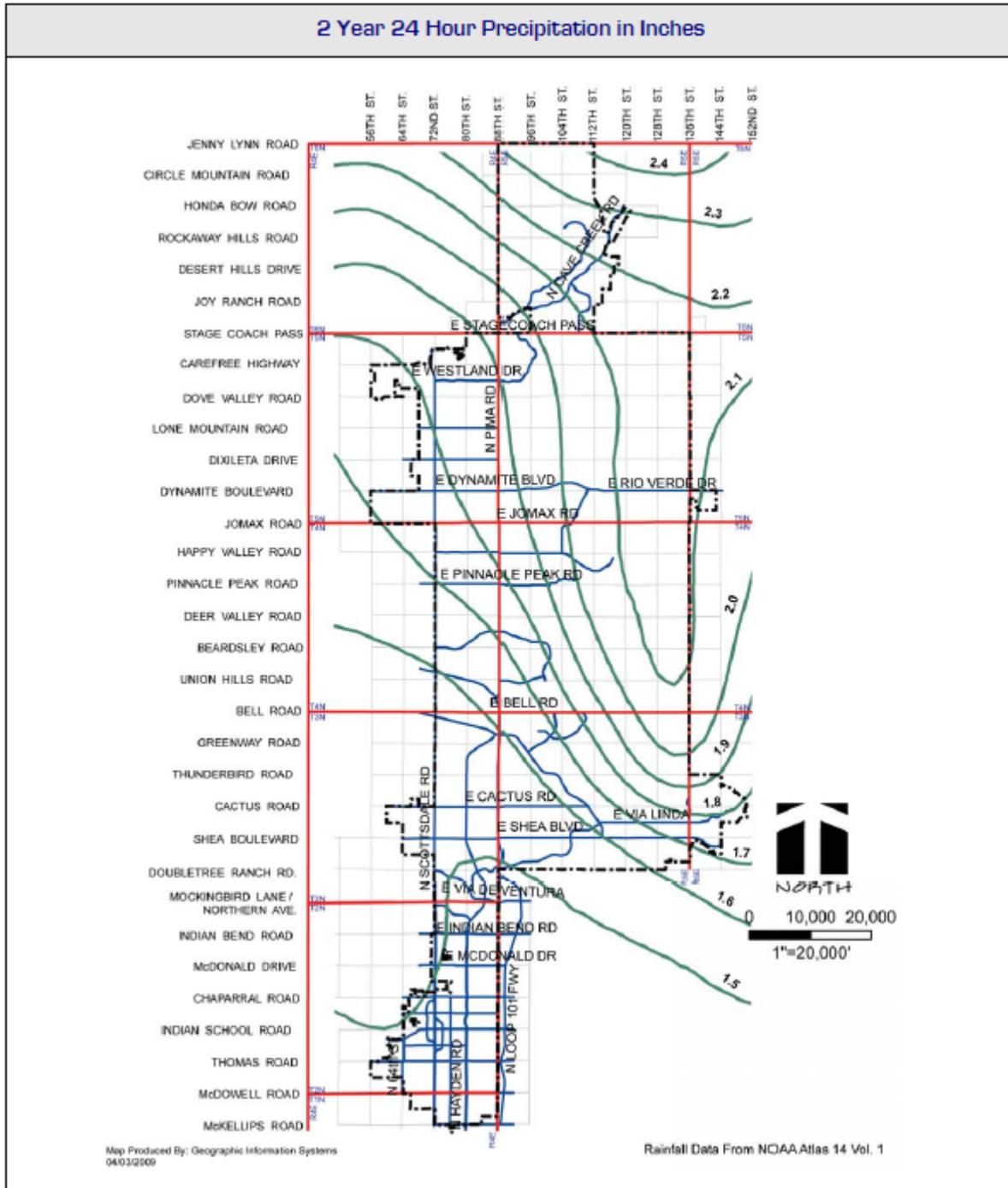


Appendix 4-6C ISOPLUVIALS



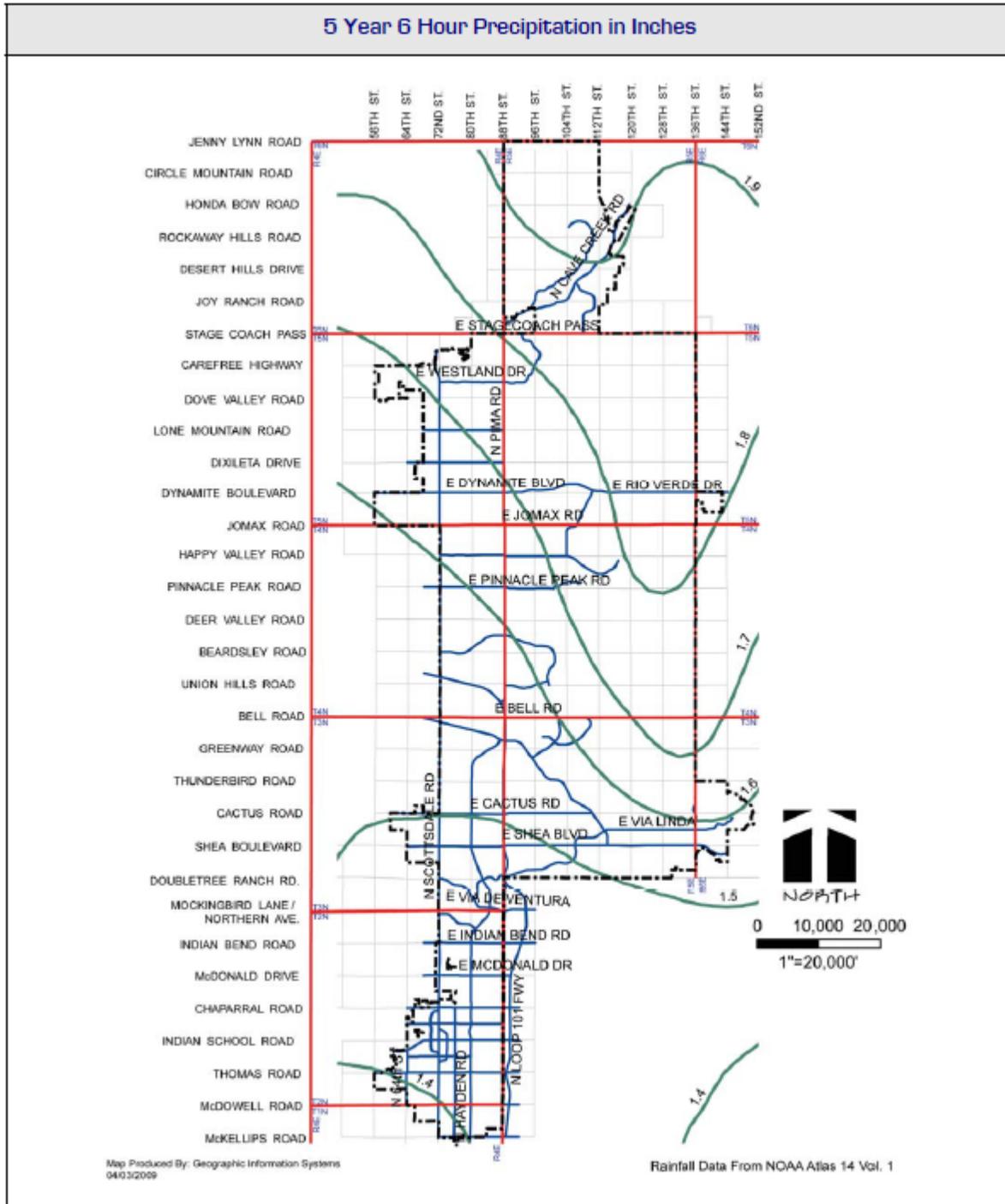


Appendix 4-6C ISOPLUVIALS



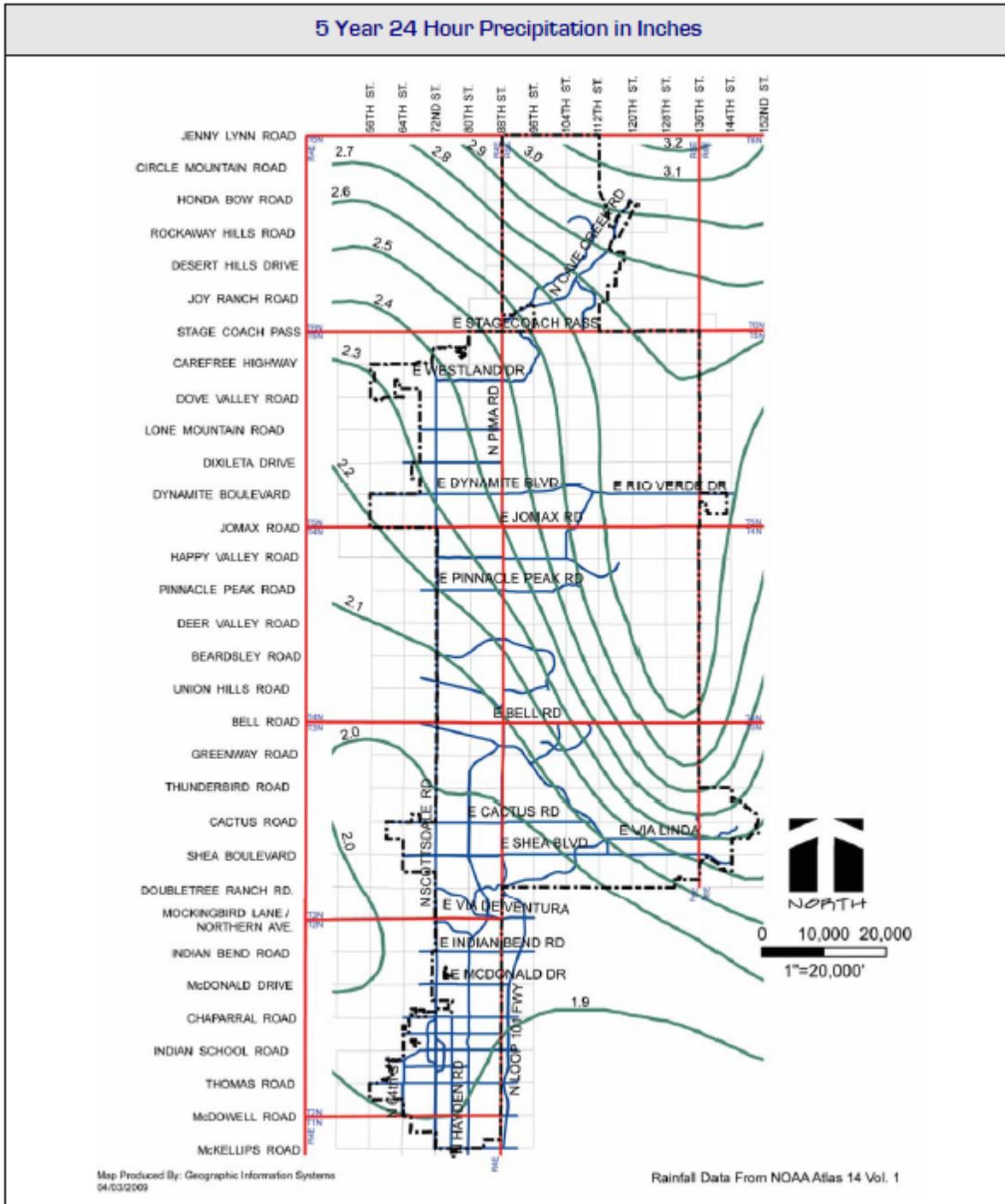


Appendix 4-6C ISOPLUVIALS



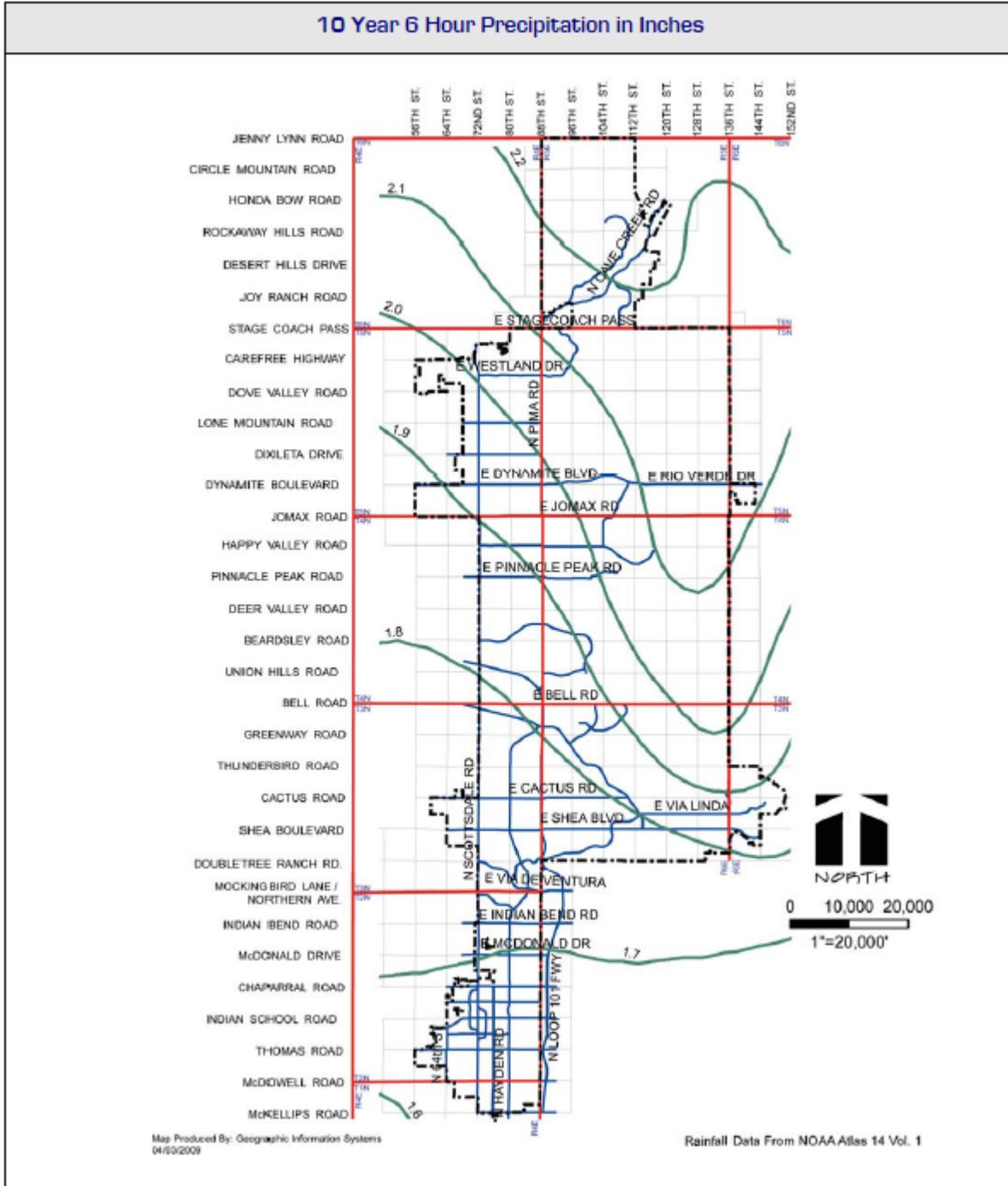


Appendix 4-6C ISOPLUVIALS



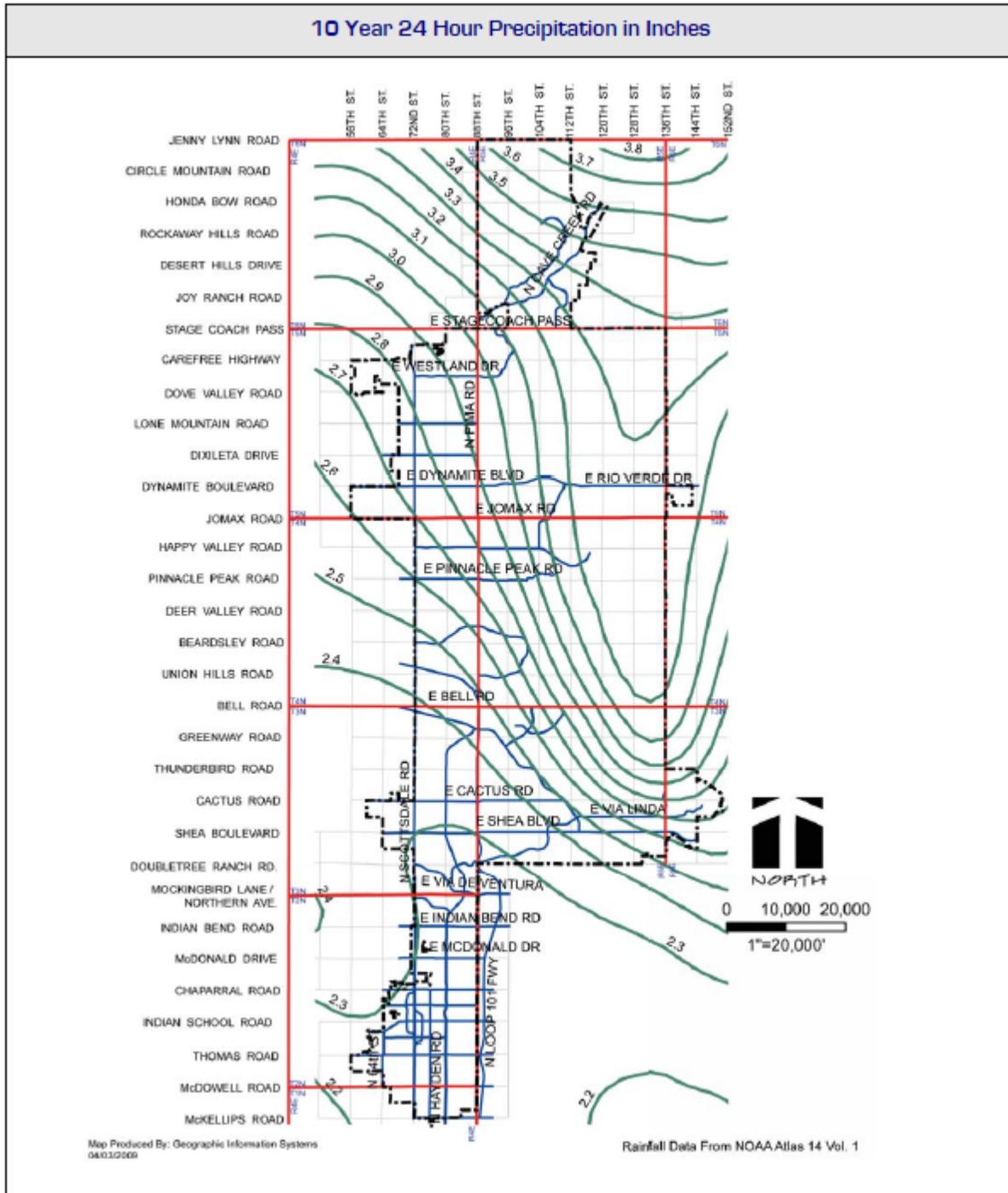


Appendix 4-6C ISOPLUVIALS



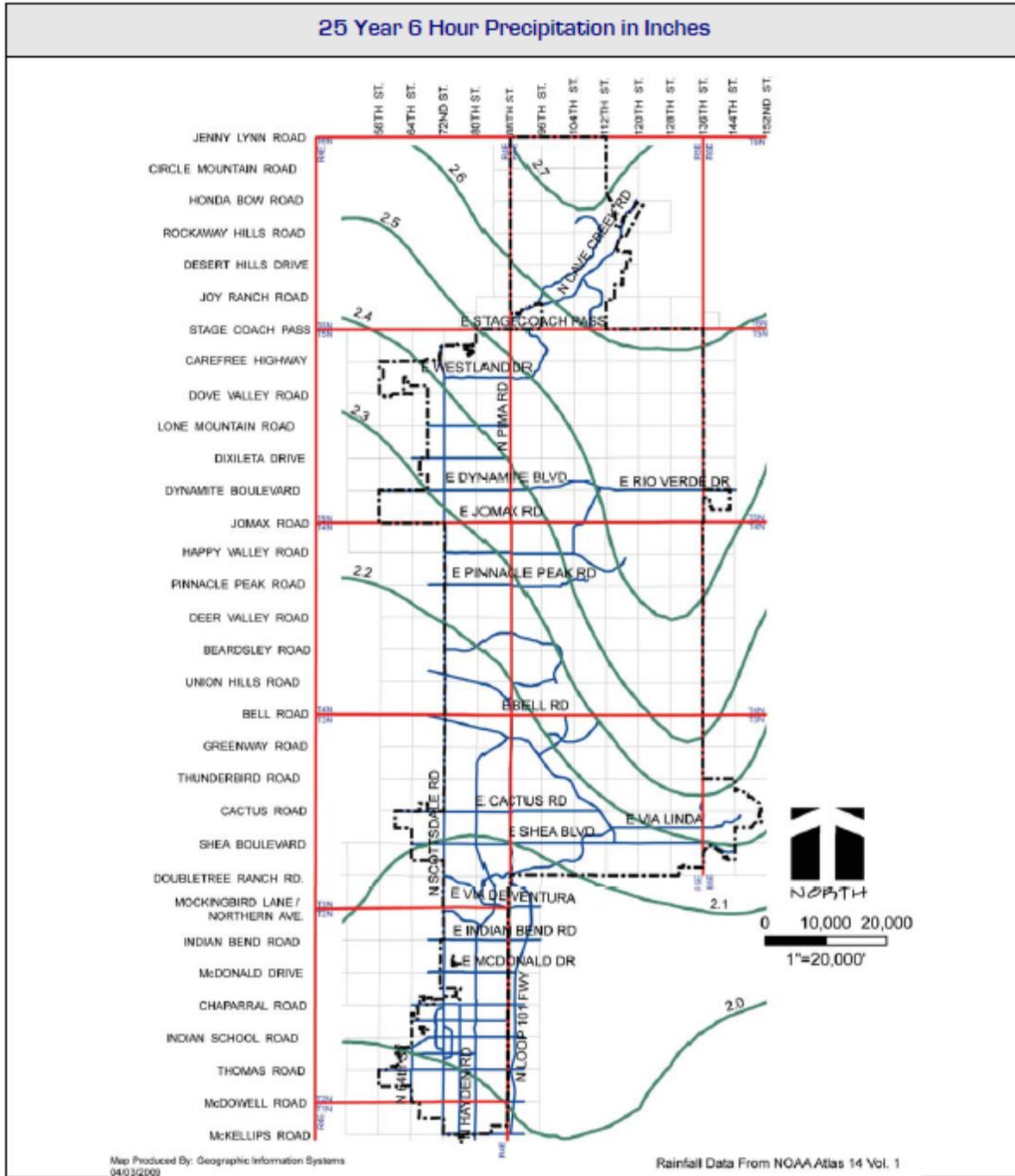


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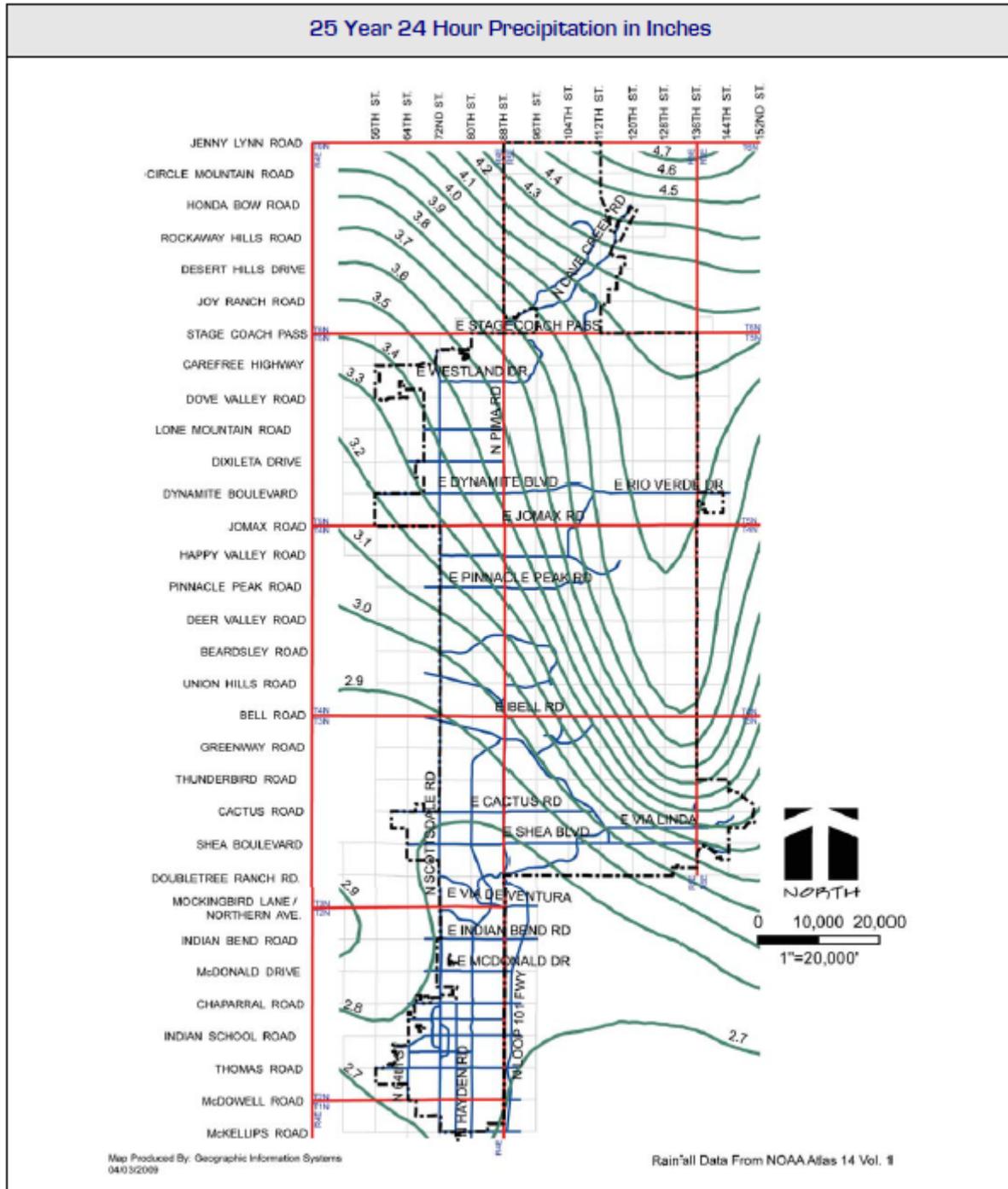


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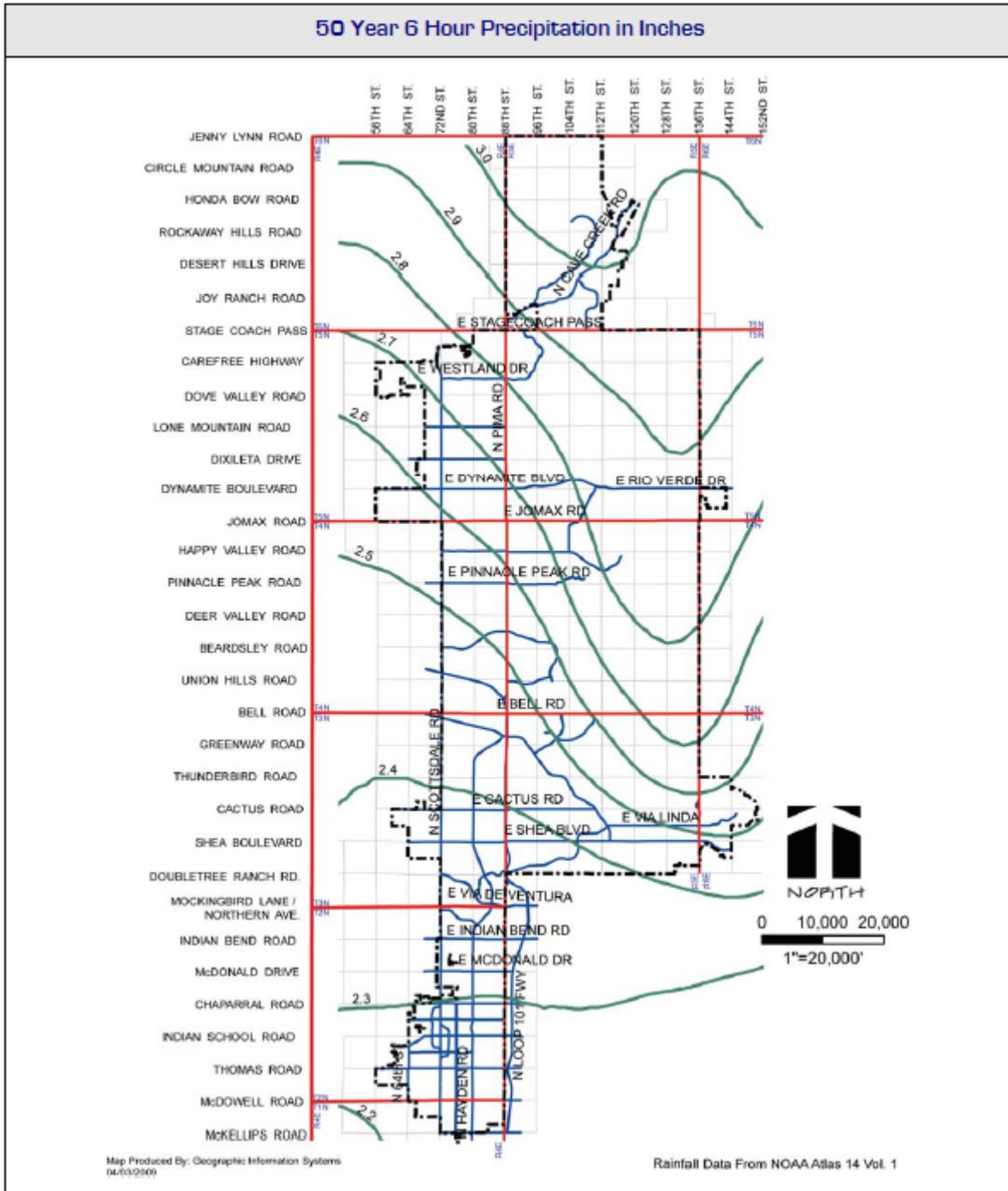


Appendix 4-6C ISOPLUVIALS



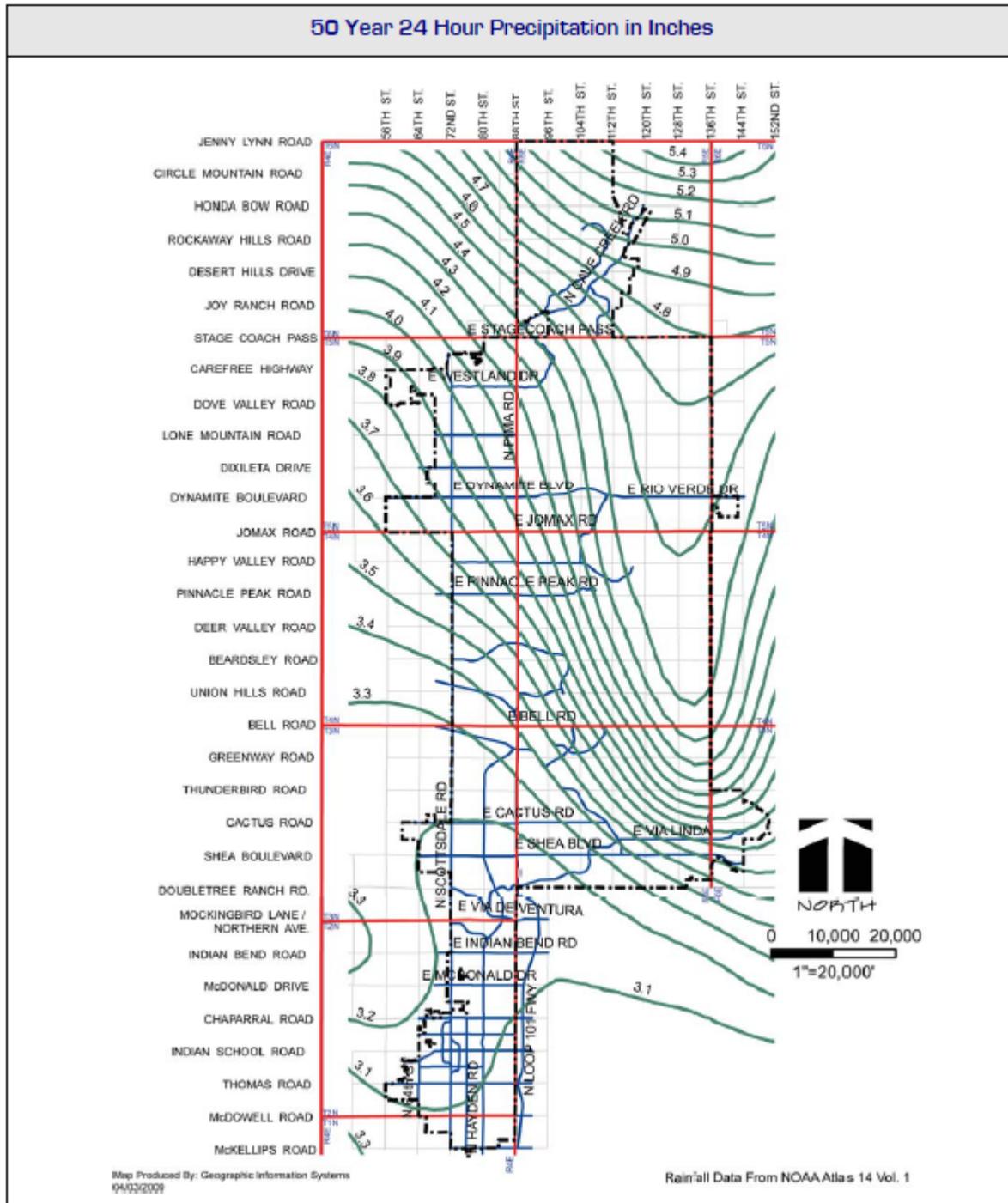


Appendix 4-6C ISOPLUVIALS



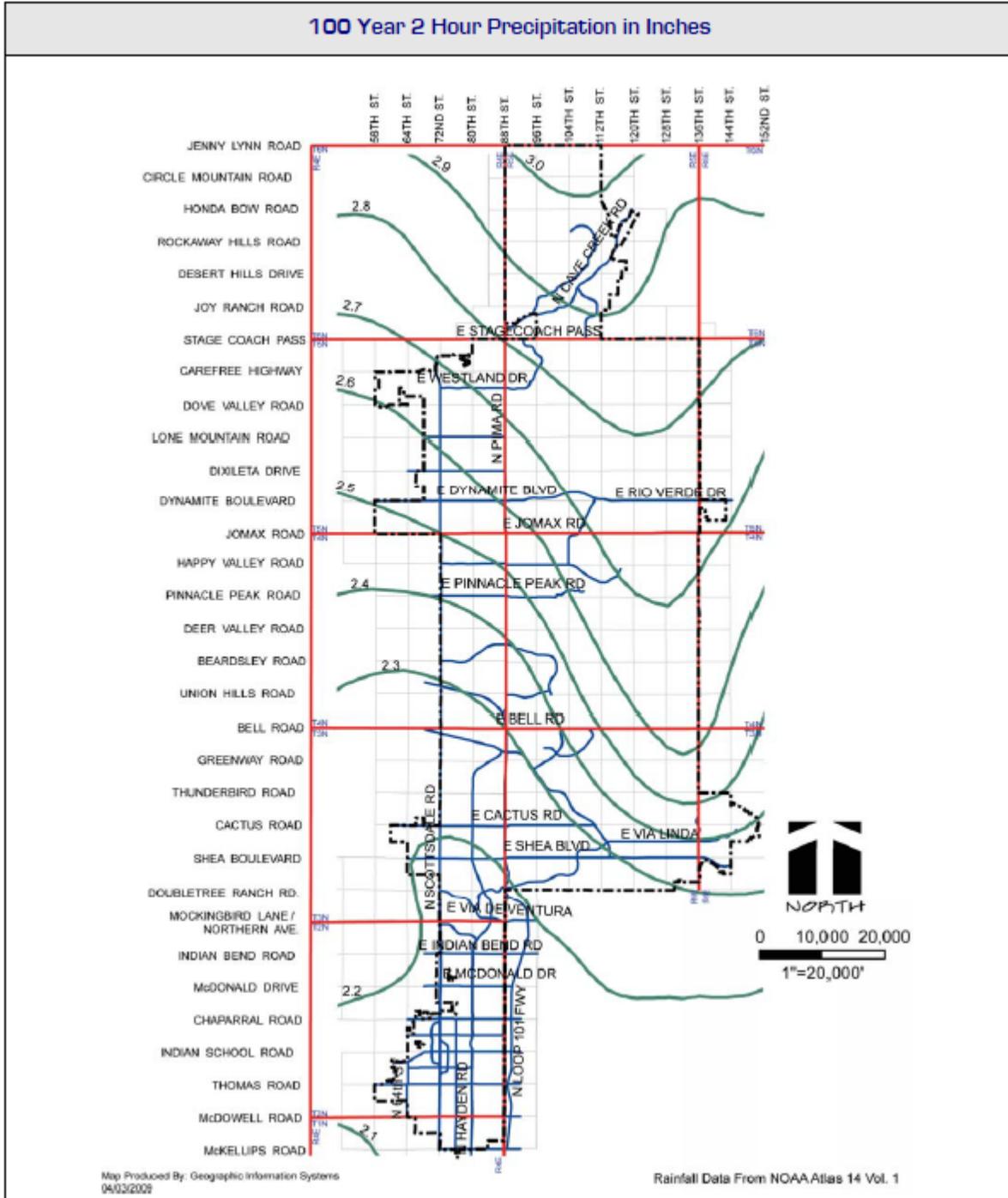


Appendix 4-6C ISOPLUVIALS



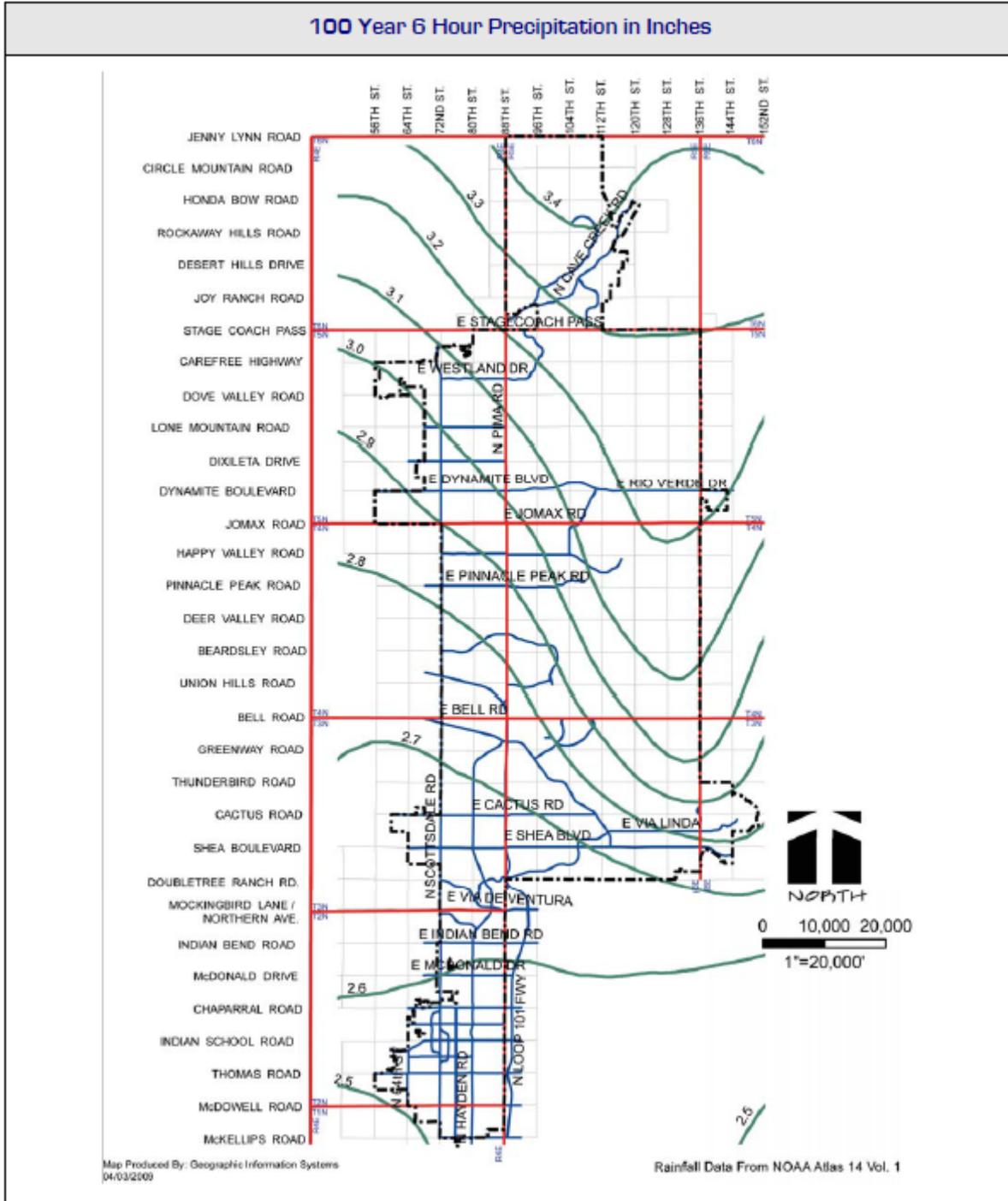


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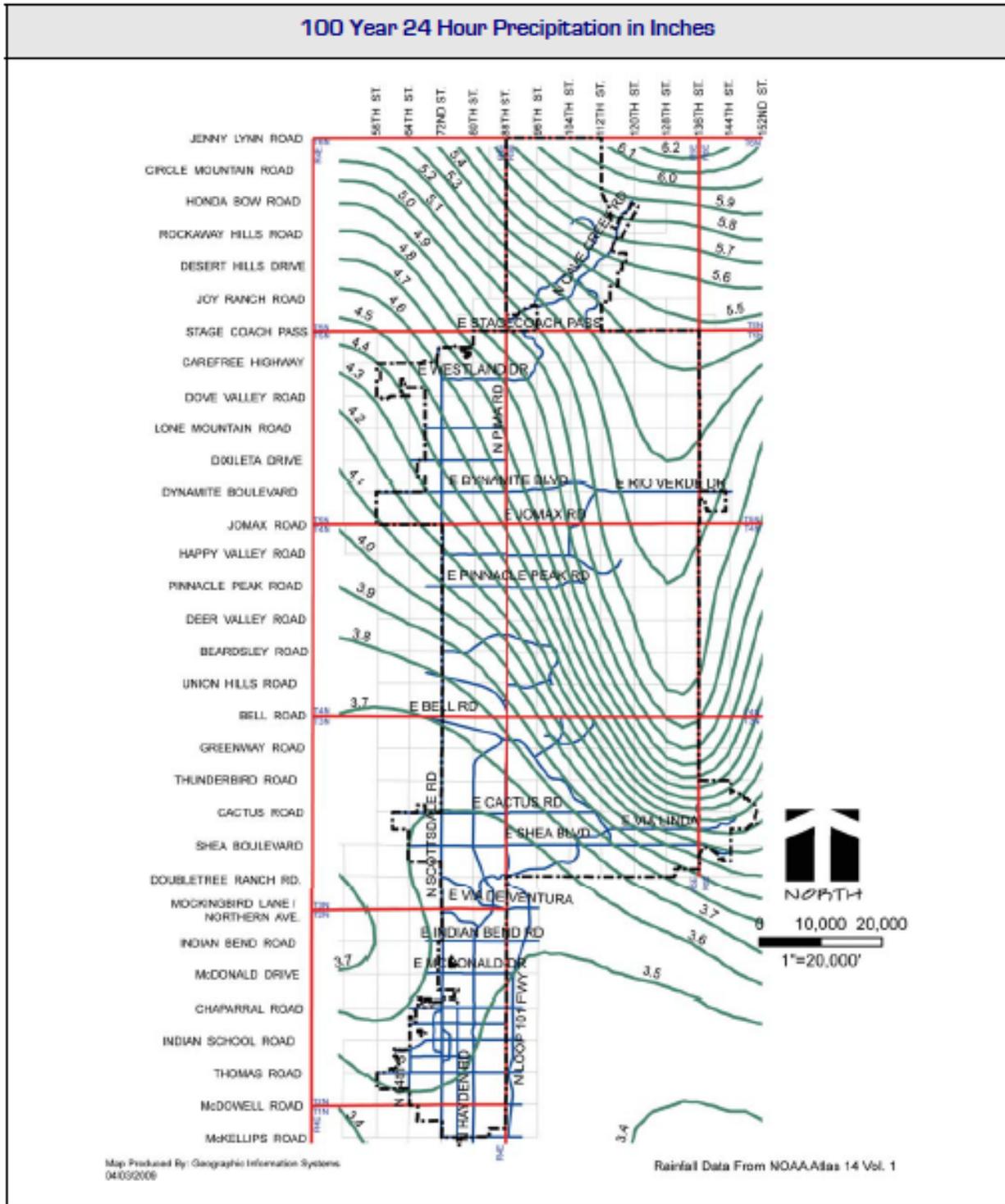


Appendix 4-6C ISOPLUVIALS





Appendix 4-6C ISOPLUVIALS



DRAINAGE EASEMENTS

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DRAINAGE EASEMENTS

4-7.000

GENERAL INFORMATION

A. DRAINAGE EASEMENT REQUIREMENTS

Drainage easements are required over:

1. Watercourses, except those regulated by the ESLO, with a 100-year, 6-hour peak discharge rate of 25 cfs or greater,
2. Watercourses regulated by the ESLO with a 100-year, 6-hour peak discharge rate of 50 cfs or greater, and
3. All drainage and stormwater storage facilities.

Easement forms are available at www.ScottsdaleAZ.gov/bldgresources/forms.

B. EXTENT OF DRAINAGE EASEMENT DEDICATION

A drainage easement shall be dedicated to the city to the limits of stormwater inundation from a base flood for the watercourses described above, plus drainage and stormwater storage facilities. Drainage easement dedications shall encompass all physical structures and sufficient area to access and maintain the facilities, including a 10-foot setback from the property line. If the drainage easement is not contiguous to right-of-way, a minimum 16-foot access easement, to maintain the drainage facility with mechanical equipment, shall also be dedicated, regardless of who maintains the drainage facility.

If a stormwater storage facility is fenced or barricaded, the access easement shall include a 20-foot setback between the fence or barricade around the perimeter of the facility. If a stormwater storage facility is not fenced or barricaded, the access easement shall include a 10-foot setback around the perimeter of the facility.

C. MAINTAINING A DRAINAGE EASEMENT

1. Unless otherwise indicated on the document dedicating the drainage easement or in a recorded agreement, the property owner is responsible for maintaining the drainage easement.
2. In addition to the requirements for maintaining a drainage easement in the Stormwater and Floodplain Management ordinance, the owner shall:
 - a. Inspect the drainage facilities after each storm event of 0.6 inch or more, and semiannually, preferably before summer and winter rains.
 - b. Remove accumulated trash and debris from inlet and outlet structures as needed for the free flow of stormwater.
 - c. Inspect all other elements of the drainage system (pipes, geotextiles, and stone) and repair/replace elements as needed for the storage system to operate at peak efficiency.

D. RELEASING A DRAINAGE EASEMENT

1. A drainage easement may be released only if the applicant documents one of the following circumstances:
 - a. Upstream flows have been physically cut off or diminished;
 - b. More detailed or accurate topographic mapping and/or aerial photography show the original dedication is incorrectly located; or
 - c. The original hydrology is outdated or in error.

DRAINAGE EASEMENTS

2. The applicant must complete and submit the Application to Release Existing Drainage Easement Form with a comprehensive drainage report that justifies the release as described above. See www.ScottsdaleAZ.gov/bldgresources/forms.
3. The city staff may determine that retaining the easement is in best interest of the city, and may not grant the release. The city staff may impose reasonable conditions before releasing a drainage easement. Once all conditions have been satisfied, as determined by city staff, city staff shall grant the release.

PRELIMINARY GRADING PERMITS

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PRELIMINARY GRADING PERMITS

Section 4-8

GENERAL INFORMATION

4-8.000

- A. The second plan review of the improvement plans must be completed before applying for a preliminary grading permit.
- B. Before a preliminary grading permit is issued:
 - 1. All substantial grading and drainage issues associated with a project must be resolved to the satisfaction of the engineering reviewer.
 - 2. The owner must submit a letter to the city acknowledging that the city is not responsible for potential changes to the project, and committing to complying with the final approved plans.
 - 3. The City Council must have approved the final plat for the project. This requirement may be waived by the Building Official.
 - 4. The owner must obtain a Native Plant Permit. The Native Plant Permit number shall be placed on the improvement plans submitted for the preliminary grading permit.
 - 5. If applicable, the owner must obtain a Haul Route Permit.
 - 6. If applicable, the owner must obtain a Stormwater Storage Waiver and pay any required in lieu fee.
 - 7. The completed No Conflict signature box must be placed on the cover sheet, signed and dated and all applicable No Conflict letters submitted.
 - 8. The owner must provide a copy of the approved AZPDES Notice of Intent (NOI) and SWPPP.
 - 9. The owner must provide a completed Section 404 Certification form; and if applicable, a copy of the permit from the US Army Corps of Engineers.
 - 10. The owner must submit 3 full size sets of grading plans (24 inches x 36 inches).
 - 11. The owner must meet any other project specific requirements to issue a final grading permit.
- C. A preliminary grading permit is subject to review and approval by city staff.

STOCKPILE PLANS

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STOCKPILE PLANS

Section 4-9

GENERAL INFORMATION

4-9.000

Upon city staff approval, an applicant may temporarily store on-site excess soil from construction operations. To receive approval, the applicant must submit:

1. A letter signed by the applicant stating the duration of the stockpile and the methods used to control dust.
2. A plan prepared in conformance with grading and drainage plan requirements, showing the stockpile location.
 - a. The stockpile may not be located on, or within, any public utility, easement, right-of-way or watercourse.
 - b. The plan must provide at least one cross-section through the stockpile, labeling the sideslopes and the maximum height of the stockpile, and show the total volume of the stockpile.
 - c. The plan must show and label all NAOS areas.
 - d. The plan must manage drainage runoff from the stockpile and upstream watersheds by considering stockpile location, stockpile design and grading, and/or temporary stormwater storage.
3. A Native Plant Permit for the area to be used for stockpile. The Native Plant Permit number shall be placed on the stockpile plan.