ORDINANCE NO. 3042

AN ORDINANCE OF THE CITY OF MESQUITE, TEXAS AMENDING CHAPTER 11 OF THE CODE OF THE CITY OF MESQUITE BY DELETING SECTIONS 11-26 THROUGH 11-40 OF ARTICLE II AND ADOPTING NEW PROVISIONS, THEREBY AMENDING AND EXPANDING DRAINAGE AND FLOOD HAZARD AREA REGULATIONS AND CONTROLS; PROVIDING FOR A PENALTY; PROVIDING A SEVERABILITY CLAUSE; AND DECLARING AN EMERGENCY.

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF MESQUITE, TEXAS:

SECTION 1. That Chapter 11 of the Code of the City of Mesquite is hereby amended by deleting sections 11- 26 through 11- 40 of Article II and adding new provisions relating to drainage and flood hazard area regulations to read as stated in the attached text entitled "CITY OF MESQUITE STORMWATER AND FLOOD PROTECTION ORDINANCE", in all other respects said Code and Chapter to remain in full force and effect.

SECTION 2. That should any word, sentence, clause, paragraph or provision of this ordinance be held to be invalid or unconstitutional the remaining provisions of this ordinance shall remain in full force and effect.

SECTION 3. That any person, firm, or corporation violating any of the provisions or terms of this ordinance shall be deemed to be guilty of a Class C Misdemeanor and upon conviction in the Municipal Court shall be punished by a fine not to exceed Two Thousand ($2,000.00) Dollars for each offense.

SECTION 4. That the present ordinances of the City of Mesquite are inadequate to ensure adequate drainage and flood protection creates an urgency and an emergency for the preservation of the public health, safety, and welfare and requires that this ordinance shall take effect immediately from and after its passage and publication of said ordinance, as the law in such cases provides.

DULY PASSED AND APPROVED by the City Council of the City of Mesquite, Texas, on the 17th day of July, 1995.

Cathye Ray
Mayor

ATTEST:

Lynn Prugel
City Secretary

APPROVED:

B.J. Smith
City Attorney

CITY OF MESQUITE
STORMWATER AND
FLOOD PROTECTION
ORDINANCE

JULY 1995

NDM NATHAN D. MAIER
CONSULTING ENGINEERS, INC.
DALLAS, TEXAS

00082

ORDINANCE NO. 3042

CODIFIED AS CHAPTER 6A OF THE MESQUITE CITY CODE OF ORDINANCES

INDEX

TABLES

FIGURES

ORDINANCE NO. 3042

ARTICLE 1

SECTION 1

TITLE, FINDINGS OF FACT, STATEMENT OF PURPOSE, AND SCOPE OF AUTHORITY

ORGANIZATION OF THIS ORDINANCE

SECTION A. Title

This Ordinance shall be known as the "Stormwater and Flood Protection Ordinance" of the City of Mesquite, and shall consist of a ninety-one (91) page document attached hereto and made a part of this Ordinance.

SECTION B. Findings of Fact

1. The drainage ways and flood hazard areas of the City of Mesquite, Texas, are subject to periodic inundation which may result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, and extraordinary public expenditures for flood protection and relief, all of which adversely affect the public health, safety, and general welfare.

2. These flood losses are created by the cumulative effect of obstructions in floodplains that increase flood heights and velocities and by the occupancy of flood hazard areas by uses vulnerable to floods and hazardous to other lands because they are inadequately elevated, floodproofed, or otherwise protected from flood damage.

SECTION C. Statement of Purpose

This ordinance sets forth the minimum requirements necessary to provide and maintain a safe, efficient, and effective drainage system within the City of Mesquite and to establish the various public and private responsibilities for the provision thereof. Further, it is the purpose of this ordinance to:

(1) Protect human life, health, and property;

(2) Minimize expenditure of public money for drainage related projects;

(3) Minimize damage due to drainage to public and private facilities and utilities such as water and gas mains, electric service, telephone and sewer lines, streets and bridges;

(4) Help maintain a stable tax base and preserve land values;

(5) Insure that potential buyers are notified that property is in an area of special flood hazard;

(6) Insure that those who occupy the areas of special flood hazard assume responsibility for their actions.

(7) Preserve the natural beauty and aesthetics of the community.

(8) Control and manage all stormwater runoff and drainage from points and surfaces within subdivisions.

(9) Establish a reasonable standard of design for development which prevents potential flood and stormwater damage.

SECTION D. Scope of Authority

Any person, firm, corporation, or business proposing to develop land or improve property within the City of Mesquite is subject to the provisions of this ordinance. This ordinance also applies to individual building structures, subdivisions, excavations and fill operations, and similar activities. The Scope of Authority extends to additional improvements on projects, developments, subdivisions, etc. which were previously permitted and/or constructed under the authority of prior ordinances or guidelines.

SECTION E. Organization of This Ordinance

This ordinance revises the provisions Chapter 11, Article II of the Code of the City of Mesquite "Comprehensive Drainage Ordinance" and subsequent revisions. Further, it expands and clarifies various aspects of these ordinances. The following list is a synopsis of the contents of each article.

Article 1 - discusses the purposes, scope, and authority of this ordinance, and provides a penalty for noncompliance with this ordinance.

Article 2 - lists and defines various terms used in this ordinance.

Article 3 - states general provisions related to implementation and enforcement of this ordinance.

Article 4 - overviews the administrative procedures to be followed for obtaining the necessary City drainage approvals related to building on or improving property.

Article 5 - explains the methodologies to calculate runoff quantities.

Article 6 - gives the design standards for building local drainage systems (i.e., enclosed storm sewers).

Article 7 - states additional design standards for specialty drainage system items.

Article 8 - presents the floodplain regulations, including the requirements to be met when reclaiming floodplain land.

SECTION F. Related Ordinances

In addition to this ordinance, the City of Mesquite has other ordinances, regulations, and specifications pertaining to drainage and storm sewer facilities. These other documents include the zoning and subdivision ordinances, and shall remain in full force and effect. If there is any conflict between such prior ordinance and this ordinance, this ordinance shall prevail.

ARTICLE 2

DEFINITIONS

Unless specifically defined below, words or phrases used in this ordinance shall be interpreted to give them the meaning they have in common usage and to give this ordinance its most reasonable application:

1. Angle of Flare

   Angle between direction of a wingwall and centerline of culvert or storm drainage outlet or inlet.

2. Appeal

   A request for review or interpretation of any provisions of this ordinance or a request for a variance.

3. Area of Shallow Flooding

   A designated AO or AH Zone on the Flood Insurance Rate Map (FIRM). The base flood depths range from one to three feet; a clearly defined channel does not exist; and the path of flooding is unpredictable and indeterminate.

4. Area of Special Flood Hazard

   The land in the floodplain within a community subject to a one percent or greater chance of flooding in any given year.

5. Base Flood

   The flood having a one percent chance of being equalled or exceeded in any given year, determined based upon FEMA guidelines and as shown in the current effective Flood Insurance Study.

6. Base Flood Elevation

   The water surface elevation resulting from the base flood.

7. Best Management Practices (BMP)

   Consists of schedules of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. This also includes treatment requirements, operating procedures, and practices to control construction site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

8. City

   The City of Mesquite, Texas, or the City Council of Mesquite.

9. Commencement of Construction

   The disturbance of soils associated with clearing, grading, or excavating activities or other construction activities.

10. Conduit

Any closed device for conveying flowing water.

11. Critical Feature

An integral and readily identifiable part of a flood protection system, without which the flood protection provided by the entire system would be compromised.

12. Design Flood

The flood having a one percent chance of being equalled or exceeded in any given year based upon fully developed watershed conditions.

13. Detention Basin

A dry basin or depression constructed for the purpose of temporarily storing storm water runoff and discharging all of that water over time at a reduced rate than would have otherwise occurred.

14. Developer/Builder

A person, partnership, or corporation engaged in the development of land and/or building of structures and not excluded by exemption sections of this ordinance.

15. Development

Any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, drilling operations, grading, or clearing.

16. Discharge

Any addition or introduction of any pollutant, storm water, or any other substance whatsoever into the municipal separate storm sewer system or into waters of the United States.

17. Discharger

Any person who causes, allows, permits, or is otherwise responsible for, a discharge, including, without limitation, any operator of a construction site or industrial facility.

18. Elevated Building

In the case of Zones A1-30, A, A99, AO, B, C, D, V1-V30, and any other designated FEMA Zone, an "elevated building" includes a building elevated by means of fill so that the finished floor of the building is at least two feet above the water surface elevation of the design flood.

19. Entrance Head

The head required to cause flow into a conduit or other structure; it includes both entrance loss and velocity head.

20. Entrance Loss

Head lost in eddies or friction at the inlet to a conduit, headwall, or structure.

21. Environmental Protection Agency (EPA)

The United States Environmental Protection Agency, the regional office thereof, any federal department, agency, or commission that may succeed to the authority of the EPA, any duly authorized official of EPA or such successor agency.

22. Equal Conveyance

Principle of reducing stream conveyance for a proposed alteration with a corresponding reduction in conveyance to the opposite bank of the stream. The right of equal conveyance applies to all owners and uses and may be relinquished only by written agreements.

23. Erosion

The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. In this manual, erosion due to storm water runoff is the primary design issue.

24. Existing Construction

For the purposes of determining rates, structures for which the "start of construction" commenced before the effective date of December 19, 1977. "Existing construction" may also be referred to as "existing structures."

25. Facility

Any building, structure, installation, process, or activity from which there is or may be a discharge of pollutant.

26. Federal Emergency Management Agency (FEMA)

Federal agency which administers National Flood Insurance Program.

27. Final Stabilization

The status when all soil disturbing activities at a site have been completed, and a uniform perennial vegetative cover with a density of 70% of the cover for unpaved areas and areas not covered by permanent structures has been established, or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

28. Flood or Flooding

A general and temporary condition of partial or complete inundation of normally dry land areas from:

(1) The overflow of inland waters and/or

(2) The unusual and rapid accumulation or runoff of surface waters from any source.

29. Flood Insurance Rate Map (FIRM)

The official map on which the Federal Emergency Management Agency has delineated both the areas of special flood hazards and the risk premium zones applicable to the community.

30. Flood Insurance Study

The official report in which the Federal Emergency Management Agency has provided flood profiles, the water surface elevation of the base flood, as well as the Flood Boundary-Floodway Map.

31. Floodplain or Flood-prone Area

Any land area susceptible to being inundated by water from any source (see definition of flooding).

32. Flood Protection System

Those physical structural works for which funds have been authorized, appropriated, and expended and which have been constructed specifically to modify flooding in order to reduce the extent of the areas within a community subject to a "special flood hazard" and the extent of the depths of associated flooding. Such a system typically includes hurricane tidal barriers, dams, reservoirs, levees or dikes. These specialized flood modifying works are those constructed in conformance with sound engineering standards.

33. Flume

Any open conduit on a prepared grade, trestle, or bridge.

34. Freeboard

The distance between the design flood elevation and the top of an open channel, dam, levee, or detention basin to allow for wave action, floating debris, or any other condition or emergency without overflowing the structure.

35. Functionally Dependent Use

A use which cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term includes only docking facilities.

36. Harmful Quantity

The amount of any substance that will cause pollution of water in the State.

37. Highest Adjacent Grade

The highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.

38. Hydraulic Gradient

A line representing the pressure head available at any given point within the drainage system.

39. Levee

A man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

40. Levee System

A flood protection system which consists of a levee, or levees, and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices.

41. Local Jurisdiction

The local governing body in which the construction takes place (known also as the City).

42. Lowest Floor

The lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area is not considered a building's lowest floor, provided that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of FEMA under 44 CFR, 60.3.

43. Manager of Engineering

The person appointed to the position of Manager of Engineering by the City Manager of the City of Mesquite, or his/her duly authorized representative.

44. Manager of Field Services

The person appointed to the position of Manager of Field Services by the City Manager of the City of Mesquite, or his/her duly authorized representative.

45. Manning Equation

The uniform flow equation used to relate velocity, hydraulic radius, and energy gradient slope.

46. Manufactured Home

A structure transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. For floodplain management purposes, the term "manufactured home" also includes park trailers, travel trailers, and other similar vehicles placed on a site for greater than 180 consecutive days. The "manufactured home" does not include a "recreational vehicle".

47. Manufactured Home Park or Subdivision

A parcel or contiguous parcels of land divided into two or more manufactured home lots for rent or sale.

48. Maximum Extent Practicable (MEP)

The goal of pollutant reduction through the use of best management practices.

49. Mean Sea Level

For purposes of the National Flood Insurance Program, the National Geodetic Vertical Datum (NGVD) of 1929 or other datum, to which base flood elevations shown on a community's Flood Insurance Rate Map are referenced.

50. Municipal Separate Storm Sewer System (MS4)

The system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels or storm drains) owned and operated by the City and designed or used for collecting or conveying storm water, and which is not used for collecting or conveying sewage.

51. Municipal Solid Waste

Solid waste resulting from or incidental to municipal, community, commercial, institutional, or recreational activities, and includes garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and other solid waste other than industrial waste.

52. Natural Drainage

The dispersal of surface waters through ground absorption and by drainage channels formed by the existing surface topography which exists at the time of adoption of this ordinance or formed by any man-made change in the surface topography.

53. Natural Floodway

The effective area of a channel, of a river or other water course and the adjacent land areas that must be reserved in order to discharge the "design flood" without cumulatively increasing the water surface elevation. This floodway differs from the FEMA "regulatory floodway."

54. New Construction

Structures for which the "start of construction" commenced on or after the effective date of December 19, 1977.

55. Open Channel

A channel in which water flows with a free surface.

56. Operator

The person or persons who, either individually or taken together, meet the following two criteria:

(1) they have operational control over the facility specifications (including the ability to make modifications in specifications); and

(2) they have the day-to-day operational control over those activities at the facility necessary to ensure compliance with pollution prevention requirements and any permit conditions.

57. Other Municipal Ordinances

Ordinances such as, but not limited to, zoning, subdivision, and erosion.

58. Owner

The person who owns a facility or part of a facility.

59. Person

Any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, governmental entity, or any other legal entity; or their legal representatives, agents, or assigns. This definition includes all federal, state, and local governmental entities.

60. Pollutant

Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical waste, biological materials, radioactive materials, rock, sand, dirt or cellar dirt generated as part of a construction project.

61. Pollution

The alteration, due to a construction project, of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the State that renders the water harmful, detrimental, or injurious to humans, animals life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

62. Probable Maximum Flood (PMF)

The flood magnitude that may be expected from the most critical combination of meteorologic and hydrologic conditions that are reasonably possible for a given watershed.

63. Probable Maximum Precipitation (PMP)

Theoretically the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a certain time of the year.

64. Qualified Personnel

Persons who possess the appropriate competence, skills, and ability (as demonstrated by sufficient education, training, experience, and/or, when applicable, any required certification or licensing) to perform a specific activity in a timely and complete manner consistent with the applicable regulatory requirements and generally-accepted industry standards for such activity.

65. Rational Formula

The means of relating runoff with the area being drained and the intensity of the storm rainfall.

66. Recreational Vehicle

Means a vehicle which is (i) built on a single chassis; (ii) 400 square feet or less when measured at the largest horizontal projections; (iii) designed to be self-propelled or permanently towable by a light duty truck; and (iv) designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational, camping, travel, or seasonal use.

67. Registered Landscape Architect (RLA)

A person who has been duly licensed and registered to practice landscape architecture by the Texas Board of Architectural Examiners.

68. Registered Professional Engineer (RPE)

A person who has been duly licensed and registered by the State Board of Registration for Professional Engineers to engage in the practice of engineering in the State of Texas.

69. Regulatory Floodway

The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the "base flood," as calculated by the Federal Emergency Management Agency, without cumulatively increasing the water surface elevation more than a designated height. This floodway is used by FEMA to determine compliance with its regulations.

70. Retention Basins

A pond or other water body which has been designed to have both a conservation pool for holding some water indefinitely and a flood storage pool for storing storm water runoff on a temporary basis for the purpose of reducing the peak discharge from the basin.

71. Sanitary Sewer (or Sewer)

The system of pipes, conduits, and other conveyance which carry industrial waste and domestic sewage from residential dwellings, commercial buildings, industrial and manufacturing facilities, and institutions, whether treated or untreated, to the sewage treatment plant serving the City (and to which storm water, surface water, and groundwater are not intentionally admitted).

72. Sediment

The soil particles deposited through the process of sedimentation as a product of erosion. These soil particles settle out of runoff at variable rates based on the size of the particle and soil type.

73. Site

The land or water area where any facility or activity is physica.ly located or conducted, including adjacent land used in connection with the facility or activity.

74. Standard Project Flood

Flood that has a magnitude of approximately one half of the probable maximum flood, as determined on a case-by-case basis using Corps of Engineers' current criteria.

75. Start of Construction

For a structure, "start of construction" includes substantial improvement and means the date the development or building permit was issued, provided the actual start of construction, repair, reconstruction, placement, or other improvement was within 180 days of the permit date. The actual start means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation; or the placement of a manufactured home on a foundation. Permanent construction of a structure does not include land preparation, such as clearing, grading, and filling, nor does it include the installation of streets and/or walkways; nor does it include excavation for basement, footings, piers, or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure.

76. Storm Water

Storm water runoff, snow melt runoff, and surface runoff and drainage.

77. Storm Water Pollution Prevention Plan (SWPPP)

A plan required by either the Construction General Permit or the Industrial General Permit and which describes and ensures the implementation of practices that are to be used to reduce the pollutants in storm water discharges associated with construction or other industrial activity at the facility.

78. Structure

A walled and roofed building, a manufactured home, a gas or liquid storage tank, or a substation that is principally above ground.

79. Substantial Improvement

Any combination of repairs, reconstructions, or improvements of a structure, the cumulative cost of which equals or exceeds 50 percent of the initial market value of the structure either:

(1) before the first improvement or repair is started, or

(2) if the structure has been damaged and is being restored, before the damage occurred.

For the purpose of this definition, "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure. Incremental improvements over a period of time, the cumulative cost of which equals or exceeds 50 percent of the market value at the time of the first improvement, shall be considered as a "substantial improvement."

The term does not, however, include either:

(1) any project for improvement of a structure to comply with existing State or local health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions or,

(2) any alteration of a structure listed on the National Register of Historic Places or a State Inventory of Historic Places.

80. Surety

A corporation surety bond, cash, or certificate of deposit.

81. Time of Concentration

The estimated time in minutes or hours required for a drop of water to flow from the most remote point in the drainage area to the point at which the flow is to be determined.

82. Use

Any purpose for which a building or other structure or a tract of land may be designed, arranged, intended, maintained, or occupied; or any activity, occupation, business, or operation carried on, or intended to be carried on, in a building or other structure or on a tract of land.

83. Use Permit

The permit required before any use may be commenced.

84. Variance

A grant of relief to a person from the requirements of this ordinance when specific enforcement would result in unnecessary hardship. A variance, therefore, permits construction or development in a manner otherwise prohibited by this ordinance.

85. Violation

The failure of a structure or other development to be fully compliant with this ordinance. A structure or other development without the FEMA elevation certificate prior to a certificate of occupancy, other certifications, or other evidence as required by the City Manager, is presumed to be in violation until such time as that documentation is provided.

86. Watershed

The area drained by a stream or drainage system.

87. Waters of the United States

All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; all interstate waters, including interstate wetlands; all other waters the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce; all impoundments of waters otherwise defined as waters of the United States under this definition; all tributaries of waters identified in this definition; all wetlands adjacent to waters identified in this definition; and any waters within the federal definition of "waters of the United States" at 40 CFR 122.2; but not including any waste treatment systems, treatment ponds, or lagoons designed to meet the requirements of the federal Clean Water Act.

88. Water Surface Elevation

The height, in relation to the NGVD of 1929 (or other datum, where specified), of floods of various magnitudes and frequencies in the floodplains of riverine areas.

89. Wetlands

Areas identified and designated by the U.S. Army Corps of Engineers as wetlands. (ORD 2726 - Bird Sanctuary)

ARTICLE 3

GENERAL PROVISIONS

SECTION A. Lands to Which This Ordinance Applies

This ordinance shall apply to all areas of land within the jurisdiction of the City of Mesquite, Texas. Certain provisions of this ordinance apply only to special flood hazard areas within the jurisdiction of the City of Mesquite, while other provisions exempt certain other tracts. These limited areas of application are explained in the applicable provisions (See Article 8, Section A). This ordinance also extends the Scope of Authority to additional improvements on projects, developments, subdivisions, etc. which were previously permitted and/or constructed under the authority of prior ordinances or guidelines.

SECTION B. Basis for Establishing the Areas of Special Flood Hazard

The areas of special flood hazard identified by the Federal Emergency Management Agency in a scientific and engineering report entitled "The Flood Insurance Study for the City of Mesquite," dated December 19, 1977, with accompanying Flood Insurance Rate Maps and Flood Hazard Boundary-Floodway Maps and any revision thereto are hereby adopted by reference and declared to be a part of this ordinance. The Flood Insurance Study is on file in the office of the Manager of Engineering.

SECTION C. Penalty Clause

Any person, firm or corporation violating any of the provisions of this ordinance shall be deemed guilty of a misdemeanor and, upon conviction, shall be punished by a penalty or fine not to exceed the sum of Two Thousand Dollars ($2,000.00) for each offense, and each and every day such offense is continued shall constitute a new and separate offense. In addition, the violator shall pay all costs and expenses involved in the case. Nothing herein contained shall prevent the City of Mesquite from taking such other lawful action as is necessary to prevent or remedy any violation. Article 4, Section C.3 states an additional penalty against persons proceeding with construction without obtaining the necessary permits from the City of Mesquite.

SECTION D. Repealing Clause

The Drainage; Flood Control Ordinance, Chapter 11, Article II, Section 11-26 through 11-40 of the new Code of the City of Mesquite (Ordinance No. 2720) heretofore adopted by the City Council of Mesquite, Texas, shall be and the same are hereby expressly repealed. All provisions of all ordinances conflicting with the provisions hereof are hereby repealed. All other ordinances and provisions of such ordinances not expressly in conflict with the provisions hereof shall remain in full force and effect.

SECTION E. Abrogation and Greater Restrictions

This ordinance is not intended to repeal, abrogate, or impair any existing easements, covenants, or deed restrictions. However, where this ordinance and other ordinance, easement, covenant, or deed restriction conflict or overlap, whichever imposes the more stringent restrictions shall prevail.

SECTION F. Interpretation

In the interpretation and application of this ordinance, all provisions shall be:

(1) Considered as minimum requirements;

(2) Liberally construed in favor of the governing body; and,

(3) Deemed neither to limit nor repeal any other powers granted under State statutes.

SECTION G. Warning and Disclaimer of Liability

The degree of flood protection required by this ordinance is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. Larger floods can and will occur on rare occasions. Flood heights may be increased by man-made or natural causes. This ordinance does not imply that land outside the area of special flood hazards or uses permitted within such areas will be free from flooding or flood damages. This ordinance shall not create liability on the part of the City of Mesquite, any officer or employee thereof or the Federal Emergency Management Agency for any flood damages that result from reliance on this ordinance or any administrative decision lawfully made thereunder.

SECTION H. Severability

If any section, paragraph, clause, phrase, or provision of this ordinance shall be adjudged invalid or held unconstitutional, the same shall not affect the validity of this ordinance as a whole or any part or provision thereof, other than the part so decided to be invalid or unconstitutional; nor shall such unconstitutionality or invalidity have any effect on any other ordinances or provisions of ordinances of the City of Mesquite.

ARTICLE 4

ADMINISTRATION

SECTION A. Duties of City Officials

1. Duties of the City Manager

The City Manager is hereby appointed to administer and implement the floodplain management portions of this ordinance, including Article 8 and other appropriate sections of 44 CFR (National Flood Insurance Program Regulations) pertaining to floodplain management. The duties of the City Manager or his designee shall include but not be limited to:

- Review and approval of all Development Permits to determine that the permit requirements of this ordinance have been met and that all necessary State and Federal permits have been obtained;
- Obtain and record the actual elevation in relation to mean sea level of the lowest habitable floor, including basement of all new or substantially improved structures, and whether or not the structure contains a basement;
- Maintain for public inspection all records pertaining to the provisions of this ordinance, including floodproofing certifications;
- Notify adjacent communities and the Texas Natural Resources Conservation Commission prior to any alteration or relocation of a watercourse, and submit evidence of such notification to the Federal Emergency Management Agency;
- Require that maintenance is provided within the altered or relocated portion of said watercourse so that the flood-carrying capacity is not diminished;
- Make interpretations, where needed, as to the exact location of the boundaries of the areas of special flood hazards (for example, where there appears to be a conflict between a mapped boundary and actual field conditions); and
- Obtain, review, and reasonably utilize any base flood elevation data available from a Federal, State or other source, in order to administer this ordinance when base flood elevation data has not been provided.

2. Duties of the Manager of Engineering

The Manager of Engineering is hereby appointed to administer and implement the storm drainage system portion of this ordinance, and to assist the City Manager with the technical aspects of the floodplain management portions of this ordinance.

SECTION B. Responsibilities of Owners

The owner or developer of property to be developed shall be responsible for all storm drainage flowing through or abutting such property. This responsibility also includes drainage directed to that property by ultimate development as well as the drainage naturally flowing through the property by reason of topography. It is the intent of this

ordinance that provision be made for storm drainage at such time as any property affected is proposed for development, use, or modification.

Where the improvement or construction of a storm drainage facility is required along a property line common to two or more owners, the owner hereafter proposing development of the property shall be responsible for the required improvements at the time of development, including the dedication of all necessary rights-of-way or easements, to accommodate the improvements.

Where a property owner proposes development or use of only a portion of the property, provision for storm drainage shall only be required in that portion of the property proposed for immediate development, except as construction or improvements of a drainage facility outside that designated portion of the property is deemed essential to the development of that designated portion.

Owners shall provide for stormwater runoff and design drainage related facilities in accordance with and/or in a compatible manner with any future City of Mesquite master drainage study and plan in effect at the time when plans for drainage facilities are submitted to the City for approval.

Owners and Associations shall provide the dedication of drainage easements and shall perform maintenance activities within the dedicated easements as required by this ordinance.

In addition, owners may be required to provide at their expense a preliminary drainage study for the total area to be ultimately developed. This study shall be submitted to the Manager of Engineering as a part of the submitted data for consideration of preliminary plat or site plan approval for the portion of the property proposed for immediate development.

SECTION C. Permits

The City of Mesquite has several permits related to storm drainage. Some of these permits are listed below and explained in detail in the following paragraphs. Permits required by other ordinances may also be needed.

- Development Permit

1. Development Permit

All developers, owners, or builders shall obtain and submit for approval a Development Permit application for new construction, placement of fill, new manufactured home sites, alteration of a waterway, substantial improvements to existing structures or manufactured homes, or improvements to existing structures, or manufactured homes in the floodplain of the design flood that will result in increasing the overall outside dimensions of the structure or manufactured home. The application form can be obtained from the Manager of Engineering's office. The Manager of Engineering uses this form, along with duplicate copies of the accompanying engineering or architectural plans, to identify those construction or renovation projects that would occur in a flood hazard area. As a minimum, the engineering or architectural plans shall show, to scale:

a. The nature, location, dimensions, and elevations in relation to mean sea level of the area in question.

b. The elevation in relation to mean sea level and the location of existing or proposed structures, fill, storage of materials, and/or drainage facilities.

c. The elevation in relation to mean sea level to which an existing non-residential structure shall be floodproofed, the location of the foregoing.

d. Any off-site facilities or conditions that may either affect on-site conditions or be affected by on-site conditions.

e. Developers, owners, or builders shall also obtain a Development Permit prior to filling in a floodplain; channelizing, impounding, realigning, deepening, or otherwise modifying a natural drainage way; making improvements, substantial or otherwise, to existing structures or manufactured homes in a floodplain if the improvements result in the increase of the overall outside dimensions of the structures or manufactured homes; or otherwise reclaiming floodplain land. Article 4, Section D.2 identifies the information that must be submitted to the Manager of Engineering. No floodplain alterations shall begin until a permit is issued by the Manager of Engineering.

If an existing non-residential structure is proposed for floodproofing, then a certificate sealed by a registered professional engineer in the State of Texas shall be submitted stating that all of the floodproofing criteria listed in Article 8, Section B will be met. Construction or renovation projects cannot begin until the City issues the Development Permit.

2. Elevation Certificate

Developers, owners, or builders adjacent to the design flood plain, other existing creeks, swales or ditches or other flood prone areas as designated by the Manager of Engineering Services shall complete an elevation certificate prior to issuance of a Certificate of Occupancy by the City. Elevation Certificate forms can be obtained at the Manager of Engineering's office.

3. Proceeding Without the Applicable Permits

Any developer, owner, or builder who fails to obtain the applicable Development or other necessary permits before beginning the subject project is in violation of this ordinance. Furthermore, any act or omission of any owner or developer of land subject to the provisions herein which has as its effect the circumventing of the intent and purpose of this ordinance shall be considered in violation of same. In addition to the penalties outlined in Article 3, Section C, no Building Permit, plat, site plan, or Certificate of Occupancy shall be issued for any construction, reconstruction, or development upon any land where such construction, reconstruction, or development is not in conformity with the requirements and intent of this ordinance. Any one who violates any of the terms and provisions of this ordinance shall be denied a Building Permit, etc., until the violation is corrected.

4. Deviations from Permit Terms

Permits may be revoked by the Manager of Engineering if, upon periodic inspection, he determines that the work is not progressing in accordance with specifications of the approved plan and permit.

Field changes to storm sewer plans can be made only upon approval by the Manager of Engineering. Record drawings shall be submitted to the Manager of Engineering at the completion of the project.

SECTION D. Plan Requirements

Plan requirements for stormwater drainage systems and floodplain alterations are listed below. All engineering plans shall be sealed by a professional engineer who is registered in the State of Texas and experienced in civil engineering work. The total cost for such engineering plans and specifications shall be borne by the owner or the developer and shall be furnished to the Manager of Engineering for review and approval.

1. Drainage Plans

As part of the platting process, drainage plans shall be prepared. These plans shall include drainage facilities for both off-site and on-site drainage so that the proper transition between the two can be maintained. Criteria for on-site development shall also apply to off-site improvements.

The construction of all improvements shall be in accordance with the current Standard Specifications for Public Works Construction by the North Central Texas Council of Governments as amended by the City of Mesquite, and Design Standards of the City of Mesquite.

The drainage plans shall include:

a. Drainage Area Map

1. Use 1"=200' scale for the development and up to 1"=2000' for creeks and off-site areas, provide that the scale is adequate for review, and show match lines between any two or more maps.
2. Show existing and proposed storm sewers and inlets.
3. Indicate sub-areas for each alley, street, off-site, etc.
4. Indicate contours on map for on- and off-site.
5. Indicate zoning on drainage area.
6. Show points of concentration.
7. Indicate runoff at all inlets, dead-end streets and alleys, or to adjacent additions or acreage.
8. Provide runoff calculations for all areas showing acreage, runoff coefficient, inlet time, and storm frequency.
9. Indicate all crests, sags, and street and alley intersections with flow arrows.
10. Show limits of each plan profile sheet.

b. Plan Profile Sheets

1. Show plan and profile of all storm sewers on separate sheets from paving plans.
2. Indicate concrete cushions or embedment where applicable.
3. Specify reinforced concrete Class III pipe unless otherwise noted. Use heavier pipe where crossing railroads, deep fill or heavy loads.
4. Indicate property lines along storm sewer and show easements with dimensions.
5. Show all existing utilities in plan and profile of storm sewers.

6. Indicate existing and proposed ground line and improvements on all street, alley, and storm sewer profiles.
7. Show hydraulic gradient with computations.
8. Show laterals on trunk profile with stations.
9. Number inlets according to the number designation given for the area or sub-area contributing runoff to the inlet.
10. Indicate size and type of inlet on plan view, lateral size and flow line, paving station and top of curb elevation.
11. Indicate quantity and direction of flows at all inlets, stubouts, pipes and intakes.
12. Show future streets and grades where applicable.
13. Show water surface at outfall of storm sewer velocity, and typical section of receiving water body.
14. Where fill is proposed or trench cut in creeks or outfall ditches, specify compacted fill and compaction criteria.
15. Show size of pipe, length of each pipe size, stationing at one hundred foot intervals in the plan view.
16. Begin and end each sheet with even or fifty foot stationing.
17. Show diameter of pipes, physical grade, discharge, capacity of pipe, slope of hydraulic gradient, and velocity in the pipe in the profile view.
18. Show elevations of flow lines at 100-foot intervals on the profile.
19. Give bench mark information.
20. Show capacities, flows, velocities, etc., of the existing system into which the proposed system is being connected.
21. Show details of all connection boxes, headwalls on storm sewer, flumes or any other item not a standard detail.
22. Provide lateral profiles and where utilities are crossed, show all utilities in profile.
23. Show headwalls and specify type for all storm sewers at outfall.
24. Show if curbing in alleys is needed to add extra capacity.
25. Provide flat grade on alleys and streets at discharge into streets.
26. Show curve data for all storm sewers.
27. Tie storm sewer stationing with paving stations.
28. On all dead-end streets and alleys, show grades for drainage overflow path on the plan and profile sheets, and show erosion controls.
29. Specify concrete strength for all structures.
30. Provide sections for road, railroad and other ditches with profiles and hydraulic computations. Show design water surface on profile.

c. Bridge Plans

1. Show the elevation of the lowest member of the bridge and 100-year water surface elevation.

2. Indicate borings on plans.
3. Provide soils report.
4. Show bridge sections upstream and downstream.
5. Provide hydraulic calculations on all sections.
6. Provide structural details and calculations with dead load deflection diagram.
7. Provide vertical and horizontal alignment.

d. Creek Alteration and Channel and Ditch Plans

1. Show stationing in plan and profile.
2. Indicate flow line, banks, design water surface, and freeboard. Show hydraulic computations.
3. Indicate nature of banks such as rock, earth, etc.
4. Provide cross-sections with ties to property lines and easements.
5. Show side slopes of creek, channels, etc.
6. Specify compacted fill where fill is proposed.
7. Indicate any adjacent alley or street elevations on creek profile.
8. Show any temporary or permanent erosion controls.
9. Indicate existing and proposed velocities.
10. Show access and/or maintenance easements.
11. As necessary, show ground elevations parallel to the top of bank to show how runoff is prevented from overland flow into the creek or channel.

e. Detention and Retention Facilities

1. Show plan view of detention/retention area and outlet structure.
2. Delineate limits of conservation pool, sediment storage area, flood storage pool, and/or freeboard.
3. Indicate size, dimension, total capacity, design discharge and velocity of the outlet structure.
4. Show any erosion control features at the discharge point of the outlet structure.
5. Specify side slopes of basin and outlet structure.
6. Show existing or proposed structures or other facilities down stream of the outlet structure and emergency spillway, and provide information sufficient to show that the downstream facilities will not be inundated or otherwise affected by the discharge from the basin.
7. Indicate locations and quantities of all inflows to the basin.
8. State the design time to empty the basin.

f. Levees

1. Show location, extent, nature, dimensions, etc., of levee embankments and associated interior and exterior drainage facilities.

2. Provide engineering analysis addressing potential erosion of the levee embankments during flood events.

3. Provide engineering analysis of levee embankment stability and seepage through the levee during flood events.

4. Demonstrate that future settlement of the levee embankments will not result in freeboard dropping below the minimum requirements. Provide geotechnical reports showing anticipated levee consolidation.

5. Analyze interior drainage concerns. Identify sources of interior flooding, and extent and depth of such flooding, assuming a joint probability of interior and exterior flooding. Consider capacity of pumps and other drainage devices for evacuating interior waters.

6. Write an operations manual which discusses the flood warning system to trigger closures; closure operations, procedures, and personnel; operation plans for interior drainage facilities; at least an annual inspection program; and maintenance plans, procedures, and frequency.

7. Provide all other information required in Article 7, Section C, and any other information requested or required by the Manager of Engineering and/or the Federal Emergency Management Agency.

2. Floodplain Alteration Plans

The materials listed below shall be submitted as part of the application for a Development Permit. It is recommended that applicants coordinate the application materials listed below with those needed for other City of Mesquite permits and with the data requirements of the Federal Emergency Management Agency. Such coordination will facilitate staff review and drawings could be combined so as to save the applicant from multiple drawings.

a. An engineering report consisting of at least:

1. Project description.

2. Description of the hydrologic and/or hydraulic analyses used, including method used to determine historic rainfall and stream data, soils reports used to determine erosive velocity values, and discharges and water surface elevations for both the design and base floods.

3. Vicinity map.

4. Evaluation of the "natural floodway" and floodplain limits for the design flood. The "natural floodway" differs from the FEMA "regulatory floodway." The "natural floodway" is established to allow the City of Mesquite to effectively manage flood plain areas. FEMA requirements for the "regulatory floodway" must also be met by applicants.

5. If hydraulic analyses are being submitted, then a table of values for existing and proposed water surface elevations and velocities must be included.

6. Documentation that the principle of equal conveyance has been achieved.

7. Copies of computer input and output data for existing and proposed conditions for both the base flood and design flood discharges.

8. Evaluation of existing and proposed valley storage (see Article 8 for design requirements).

b. Engineering drawings consisting of at least:

1. Water surface profile, including channel flow line, existing and proposed water surface elevations, recorded high water marks, and location and number designation of cross-sections.

2. Plan view on 24" x 36" paper, including

a. Scale and north arrow.
b. Title block.
c. Boundary lines and nearest street intersections.
d. Existing and proposed contours.
e. Existing and proposed floodplain limits, and limits of the "natural floodway" and the "regulatory floodway."
f. Area to be removed from the floodplain or area to be altered.
g. Top and toe of fill and/or side slopes and the numerical slope of the fill and/or side slopes labeled.
h. Location of all other associated improvements or alterations to the creek and/or floodplain, such as check dams, swales, channel modifications, etc.
i. Location of cross-sections.
j. Location of all existing and proposed easements and dedications.
k. Site vicinity map.

3. Plots of cross-sections, including:

a. Scale.
b. Title block.
c. Existing and proposed ground elevations.
d. Cut and/or fill areas labeled.
e. Limits of and numerical values for existing and proposed "n" values.
f. Equal conveyance removed from both sides.

SECTION E. Appeals and Variance Procedure

1. Appeal

Any person aggrieved by a decision of the Manager of Engineering or City Manager may appeal from any order, requirement, decision or determination of the Manager of Engineering to the City Council. An appeal from a determination of the City Council may be made directly to the Court of Appeal.

2. Variances

The City Council as established by the City of Mesquite shall hear and decide requests for variances from the requirements of this ordinance.

Variances concerning Development Permits may be issued for the reconstruction, rehabilitation or restoration of structures listed on the National Register of Historic Places or the State Inventory of Historic Places, without regard to the procedures set forth in the remainder of this section.

Variances shall not be issued within any designated natural or regulatory floodway if any increase in flood elevations during the design flood discharge would result unless the increase will result in no negative impacts on adjacent properties and written approval is obtained from impacted property owners.

Variances shall be issued only upon a determination that the variance is the minimum necessary to afford relief considering the flood hazard, drainage problems, and soil loss.

Variance shall be issued only upon meeting all three of the following criteria:

1. A showing of good and sufficient cause.

2. A determination that failure to grant the variance would result in exceptional hardship to the applicant; and,

3. A determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, create nuisances, cause fraud on or victimization of the public, or conflict with existing local laws or ordinances.

   Any applicant to whom a variance for building or renovating in a floodplain is granted shall be given written notice that the structure will be permitted to be built with a lowest floor elevation below the design flood elevation and that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced lowest floor elevation.

   In considering variance requests, the City Council shall consider all technical evaluations, all relevant factors, standards specified in other sections of this ordinance, and the:

   - Danger that materials may be swept onto other lands to the injury of others;
   - Danger to life and property due to drainage, flooding, or erosion damage;
   - Susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner;
   - Importance of the services provided by the proposed facility to the community;
   - Necessity to the facility of a waterfront location, where applicable;
   - Availability of alternative locations for the proposed use which are not subject to flooding damage.
   - Compatibility of the proposed use with existing and anticipated development.
   - Relationship of the proposed use to the comprehensive plan and flood plain management program of that area.
   - Safety of access to the property in times of flood for ordinary and emergency vehicles;

- Expected heights, velocity, duration, rate of rise, and the effects of wave action, if applicable, expected at the site; and,

- Costs of providing governmental services during and after storm events, including maintenance and repair of public utilities and facilities such as sewer, gas, electrical, and water systems, and streets and bridges.

Upon consideration of the factors listed above and the purposes of this ordinance, the City Council may attach such conditions to the granting of variances as it deems necessary to further the purposes of this ordinance.

The City Manager shall maintain the records of all appeal actions, including technical information, and report any variances of the floodplain management portions of this ordinance to the Federal Emergency Management Agency upon request.

ARTICLE 5

RUNOFF CALCULATIONS

The selection of which method to use for calculating runoff depends upon the size of drainage area contributing runoff at a most downstream point of a project. The "Rational Method" is acceptable for situations in which the drainage area is less than 160 acres. A unit hydrograph method is required for situations with larger drainage areas.

Detention may be required by the Manager of Engineering Services if existing downstream facilities are undersized or downstream cities have detention requirements. If required the owner or developer shall assume full responsibility for maintenance of the lake or pond. This obligation shall run with the land and be a continuing obligation.

Runoff computations shall be based upon fully developed watershed conditions in accordance with the land use projections in the latest comprehensive land use plan for the City of Mesquite. The design engineer shall size drainage facilities by disregarding the detention effects of upstream property and calculating the runoff as if the off-site property was developed without any detention. If an approved regional detention/retention facility is in operation, the design engineer may size downstream drainage facilities based on consideration of the detention effects of the regional facility.

SECTION A. Procedure for Drainage Areas Less Than 160 Acres

1. Rational Method

Computation of Stormwater Runoff for drainage areas less than 160 acres shall be by the "Rational Method," which is based on the principle that the maximum rate of runoff from a given drainage area for an assumed rainfall intensity occurs when all parts of the area are contributing to the flow at the point of discharge. The formula for calculation of runoff by the "Rational Method" is:

(Equation 1)

$$Q = CIA$$

Where: Q = the maximum rate of discharge, expressed in cubic feet per second.

C = a runoff coefficient which varies with the topography, soil, land use and moisture content of the soil at the time the runoff producing rainfall occurs. This runoff coefficient shall be based on the ultimate use of the land as recommended by the Master Plan for the City of Mesquite and shall be selected from Table 1 herein on the basis of the use shown on land use and zoning map of the Comprehensive Zoning Ordinance for the City of Mesquite. If an area has had a change of Zoning to give the area land use for which the "C" in Table 1 is higher than use shown on land use and zoning maps, the higher "C" factor shall be used.

A = The drainage area, expressed in acres, contributing to the runoff at the point in question. Calculation of the drainage area shall be made from an accurate topographic map, a copy of which shall be submitted with the engineering plans for approval.

I = Rainfall intensity in inches per hour for the time period that it takes for flow from the farthest point of the drainage area to reach the point of design. The rainfall intensity is

found by referring to the applicable curves of Figure 1. Time of Concentration or Duration of Rainfall for use in Figure 1 shall be calculated by velocity data shown in Table 2.

Time of concentration is the longest time, without interruption of flow by detention devices, that a drop of water takes to flow from the farthest point of the drainage area to the point of concentration (i.e., the point of design). The time of concentration is composed of the "inlet time" and the flow time in a conduit or channel to the point of design. Equation 2 shows how to calculate the time of concentration.

(Equation 2)

$$T_c = \text{Inlet Time} + \frac{L}{V \times 60\ sec/min}$$

Where: T_c = Time of concentration in minutes.

Inlet time = 10 minutes for property zoned multiple family, churches, schools, local business, central business, commercial, or industrial

or

15 minutes for property zoned for parks, cemeteries, agricultural, and single family residential.

or

$$\frac{L}{V \times 60\ sec/min}$$

L = Length of conduit or channel, in feet.

V = Velocity of flow in conduit or channel, in feet per second.

When designing inlets and laterals, the time of concentration is simply equal to the inlet time. The design engineer will compare the above specified inlet times to the actual calculated inlet time by computing the flow time overland and along the gutter to the first inlet. The Manning equation, along with the velocity information in Table 2 (or other acceptable procedures such as the SCS method), shall be used to determine flow time to the inlet. The design engineer may use the actual calculated or specified inlet time. In no case shall a longer inlet time be used than 10 minutes for multiple family, commercial, churches, schools, industrial and business areas and 15 minutes for parks, cemeteries, agricultural, and single-family areas.

When sizing storm sewers and channels, the time of concentration shall be calculated by adding the actual calculated inlet time (but not greater than the specified inlet times) to the flow time in the conduit and/or channel. The design engineer may use the combined times, as described, or the specified inlet times for storm sewer sizing.

SECTION B. Procedure for Drainage Areas Greater than 160 Acres.

For drainage areas in excess of 160 acres where the use of the "Rational Method" does not provide reliable results, the use of a unit hydrograph method shall be made. The use of a unit hydrograph calculation will be based upon standard and accepted Engineering Principles normally used in the Profession subject to the approval of the Manager of Engineering. Use The Corps of Engineers HEC-1 models for drainage areas 160 acres or more.

The unit hydrograph method shall be based upon fully developed watershed conditions assuming no effects from the small on-site detention facilities for maintaining the rate of runoff as if the property was developed as single family residential uses. The detention effects of large regional detention facilities can be taken into account in unit hydrograph methods.

Circumstances that may require the use of a unit hydrograph method include sizing open channels, reclaiming floodplains, creating lakes, or building other types of drainage-related facilities on major drainage courses. Design engineers of these types of facilities should be aware that the requirement of designing for fully developed watershed conditions will mean that they will have to calculate these fully developed flows instead of using the flows calculated in the Federal Emergency Management Agency's (FEMA) flood insurance studies for Mesquite. FEMA's flows cannot be used because the flows are based upon existing watershed conditions (For more information, see Article 7 on the sizing of channels and other major drainage facilities and Article 8 for floodplain alteration procedures). Use of the rational method is allowed for design of storm sewers within the project area.

ARTICLE 6

DESIGN OF LOCAL DRAINAGE SYSTEMS

SECTION A. Design Storm Frequencies

The calculations of runoff quantities that must be accommodated in drainage facilities require the selection of the design storm frequency. The design storm frequencies for various drainage structures are given below.

DRAINAGE FACILITY	DESIGN RECURRENCE INTERVAL
Closed Storm Sewer Systems (Required for all drainage areas less than 70 acres unless approved by the Manager of Engineering.)	25-year with 100-year positive overflow for Inlets on Grade in streets such that the depth of flow in the street does not exceed the top of curb.
Closed Storm Sewer Systems and Inlets at Street Low Point or Sag	100-year with positive overflow for 100 yr.
Culverts and Bridges	100-year
Concrete-lined Channels	100-year
Earthen Channels	100-year
Levees	Standard Project Flood
Dams Above Natural Ground/Spillways	Spillway design flood varies with the class of structure (see Article 7, Section B).

The approved drainage system shall provide for positive overflow at all low points. The term "positive overflow" means that when the inlets do not function properly or when the design capacity of the conduit is exceeded, the excess flow can be conveyed overland along a grassed or paved course. Normally, this would mean along a street or alley, or shall require the dedications of special drainage easements on private property.

SECTION B. Street and Alley Capacities

Street capacities shall be designed for the 100-year design flood.

Minor Arterial and lower classifications - Maximum 6 inches or top of curb.

Principal Arterial - One lane open in each direction.

1. Streets

The depth of flow in the streets shall not exceed the top of curb. Figure 2 shows the capacity of streets with a straight cross slope that varies from 1/8 inch per foot to 1/2 inch per foot, which are the minimum and maximum allowable street cross slopes.

2. Alleys

The flows created by the 100-year storm shall be contained within the capacity of all paved alleys. Figure 3 shows the capacity of various alley sections.

Alley capacities shall be checked at all alley turns and "T" intersections to determine if curbing is needed or grades should be flattened. Alley sections shall be super-elevated as required at corners and curves to insure that flow remains in the alley through these changes in alignment.

Curbing shall be required for at least 10 feet on either side of an inlet in an alley and on the other side of the alley so that the top of the inlet is even with the high edge of the alley pavement.

3. Finished Floor Elevations in Relation to Alleys, Streets, and Positive Overflows

The first floor elevations of all residential and other structures shall be set at a minimum elevation of the higher of either 1.5 feet above the alley invert or one foot above the top of the street curb elevation, and with positive drainage provided away from the structure. Positive overflow sections shall provide a minimum of 2 feet of freeboard from the overflow invert adjacent to structures and the corresponding first floor elevation of all residential and other structures. Lot grading plans are required for all new subdivisions.

SECTION C. Placement of Inlets

Storm sewer inlets shall be built along paved streets at such intervals that the depth of flow, based upon the 100-year storm, does not exceed the top of curb. Inlets shall be located as necessary to remove the flow based on a 25-year storm. If in the opinion of the Manager of Engineering the flow in the gutters would be excessive using the above design criteria, the storm sewers or inlet locations could be altered to relieve adverse conditions.

Inlets shall be placed upstream from an intersection whenever possible. At any intersection, only one street shall be crossed with surface drainage and this street shall be the lower classified street. When an alley intersects a street, inlets shall be placed in the alley whenever flow down that alley would cause the capacity of the intersecting street to be exceeded.

SECTION D. Inlet Capacities and Sizes

Figure 4 shows the various types of inlets allowed for use along various kinds of streets. Other types of inlets may be used upon the approval of those inlets by the Manager of Engineering. The minimum inlet size shall be eight feet. Figures 5 through 18 show how to determine the capacity of inlets. No more than 20 feet of inlets shall be placed along one gutter at any given location. Grate or combination inlets shall not be used in City maintained streets unless approved by Manager of Engineering.

Minimum sizes of laterals shall be 18-inches for use with 8-foot inlets, and 21-inch laterals with 10-foot, 14-foot, and drop inlets, and 24-inch laterals for 20-foot inlets. Where laterals tie into trunk lines, place the laterals on a 60° angle with the trunk line and connect them so that the longitudinal centers intersect.

SECTION E. Pipe Design Standards

1. The Manning Equation

Storm sewer conduit shall be sized to flow full. Manning's Equation shall be used to determine the conduit size. Manning's equation is expressed as:

(Equation 3)

$$Q = \frac{1.486}{n}(A)(R)^{2/3}(S)^{1/2} \text{ or } V = \frac{1.486}{n}(R)^{2/3}(S)^{1/2}$$

Where: Q = Flow in cubic feet per second.

V = Velocity of flow in conduit in feet per second.

A = Cross-sectional area of the conduit in square feet.

R = Hydraulic radius of the conduit, which is the area of flow divided by the wetted perimeter (R = A/P).

S = Slope of the hydraulic gradient.

n = Roughness coefficient of the conduit.

P = Wetted perimeter.

Figure 19 is a graphical solution of Manning's Equation, which allows sizing of concrete pipe, assuming an "n" value of 0.013.

2. Minimum and Maximum Velocities in Pipes

The minimum velocities in conduit shall be 2.5 feet per second. The minimum slopes for various pipe sizes that will maintain this minimum velocity are given in Table 3. The recommended maximum velocities of flow in the conduit and channels are given in Table 4.

The maximum discharge velocities in the pipe shall also not exceed the permitted velocity of the receiving channel or conduit at the outfall to prevent erosive conditions, as shown in Table 4. The maximum outfall velocity of a conduit in partial flow shall be computed for partial depth and shall not exceed the maximum permissible velocity of the receiving channel unless controlled by an appropriate energy dissipater (e.g. stilling basins, impact basins, riprap protection).

3. Roughness Coefficients for Conduits

In general, stormwater shall be carried in concrete pipe conduit, but other types of conduit can be used to carry stormwater. However, prior permission to use metal conduit must be obtained from the Manager of Engineering. Table 5 shows recommended roughness coefficients for various types of conduits. If, in the opinion of the design engineer, other values for the roughness coefficient should be used, the different value can be used with the permission of the Manager of Engineering. Appropriate notes of the approved roughness coefficient shall then be shown on the engineering plans.

4. Hydraulic Gradient of Conduits

Conduits must be sized and slopes must be set such that runoff flows smoothly down the drainage system. To insure this smooth passage, the hydraulic gradient must be at the proper elevations.

The proper starting elevation of the hydraulic gradient shall be set according to the applicable criteria listed below:

1. When a proposed conduit is to connect to an existing storm sewer, the hydraulic gradient of the proposed storm sewer should start at the elevation of the hydraulic gradient of the existing storm sewer based on an evaluation of the existing storm sewer with respect to the requirements found in this ordinance. This criterion will be used for existing systems whether or not they are designed in accordance with this ordinance.

2. When a proposed conduit enters an open channel, creek, or flood control sumps, the hydraulic gradient of the proposed conduit should start at the 25-year water surface elevation of the channel or creek when the ratio of the drainage area of the receiving creek (at the development) to the development area is 15 or greater. For ratios of less than 15, the 100-year water surface will be used on the receiving creek.

Not only is it important to use the proper starting elevation for the hydraulic gradient, but proper hydraulic gradient elevations must be maintained for the length of the conduit. The inside top of the conduit should be at or below the hydraulic gradient. However, effort should be made to keep the top of the pipe as close to the hydraulic gradient as possible so that deep excavations to lay pipe are not required.

When the conduit is flowing partially full, the hydraulic gradient shall be shown at the inside crown of the conduit.

The hydraulic gradient shall be kept two feet below the top of curb. If this cannot be obtained, the hydraulic gradient shall be at least 1.5 $V_1^2/2g$ feet below the gutter line, where V_1 is the velocity in the lateral.

5. Minor Head Losses

When establishing the hydraulic gradient of a storm sewer, minor head losses at points of turbulence shall be calculated and included in the computation of the hydraulic gradient.

Entrance Losses

Entrance losses to a closed storm sewer system from an open channel or lake shall be calculated using Equation 4.

(Equation 4)

$$H_L = K_e \frac{V_1^2}{2g}$$

Where: H_L = Head loss in feet.

V_1 = Velocity in the downstream pipe in feet per second.

K_e = Head loss coefficient (see Table 6).

The resulting hydraulic gradeline shall be compared to inlet control conditions for the storm sewer as described in Section F. The higher of the two values will be used as the controlling upstream hydraulic grade line.

Expansion Losses

For pipe size expansions, head loss shall be calculated using the following equations:

(Equation 5)

$$H_L = \left(1 - \left(\frac{D_1}{D_2}\right)^2\right)^2 \frac{V_1^2}{2g}$$

Where: H_L = Head loss in feet.

V_1 = Upstream velocity in feet per second.

D_1 = Upstream pipe diameter.

D_2 = Downstream pipe diameter.

Manhole and Bend Losses

Head losses associated with manholes for pipe direction changes and bends in pipes of equal diameter shall be calculated using:

(Equation 6)

$$H_L = K_b \frac{V_2^2}{2g}$$

Where: H_L = Head loss in feet.

V_2 = Velocity in the downstream pipe in feet per second.

K_b = Head loss coefficient from Table 7.

Junction Losses

Head losses associated with wye connections or manholes with branch laterals entering the main line can be calculated by using Equation 7.

(Equation 7)

$$H_L = \frac{V_2^2}{2g} - K_j \frac{V_1^2}{2g}$$

Where: H_L = Head loss in feet.

V_1 = Velocity in the upstream pipe in feet per second.

V_2 = Velocity in the downstream pipe in feet per second.

K_j = Head loss coefficient from Table 7.

6. Storm Sewer Laterals

Laterals for storm sewer systems shall be sized to control the flooding depth at the inlets. The depth shall not exceed the limits previously established for storm sewer systems. Calculation of the flooding depth shall be determined based on the addition of the velocity head of the lateral to the computed HGL:

$$ELEV = HGL + \frac{V_L^2}{2g}$$

This calculated elevation shall be compared to the elevation determined based on inlet control nomographs as developed by the Department of Transportation. The highest of the two elevations shall be used to establish the capacity of laterals and the corresponding depth of flooding.

7. Outfalls to Open Channels and Lakes

The flow lines of storm sewer conduits that discharge into open channels shall match the flow line of the channel. One exception to this requirement of matching the flow line is when a storm sewer discharges into a concrete-lined channel, or when the outfall is submerged below the normal water surface of a lake. In the case of a pipe discharging to a lined channel, the outlet must be below the top of the channel lining. The second exception pertains to storm sewer discharge that must cross wide floodplain areas. Under this condition, the storm sewer could discharge into a lined ditch which would convey runoff to the flow line of the channel without creating an erosive condition. Permissible velocities within the ditch will be based on the type of lining used and the velocities provided in Table 4. Flumes to bring the discharge down to the flow line of earthen creeks shall not be permitted. Drop structures shall be allowed upon written approval of the Manager of Engineering.

The velocity at the discharge end of the conduit shall be computed based on partial flow depth and shall be sufficiently low so as to not cause downstream erosion problems. Table 4 shows the maximum velocities allowed in various types of channels, which are then the maximum discharge velocities at storm sewer outfalls.

In some circumstances, the configuration of the storm sewer in relation to the flow line of the creek may cause excessive velocities to be reached unless provisions are made to slow the

velocity. One recommended method of slowing the velocity is to have the last length of pipe (a length of at least ten times the diameter) be on a slope that will reduce the partial flow outlet velocity to the values shown in Table 4 for the receiving stream. Stilling basins shall also be allowed to reduce discharge velocities.

The discharge pipe shall also intersect minor creeks at an angle not to exceed 60 degrees. Minor creeks are defined as those creeks, channels, or drainageways where the distance from the pipe outlet to the opposite creek bank at the bottom of the channel is twenty (20) feet or less. Pipes may intersect major creeks (greater than 20 feet to opposite bank) at a 90-degree angle. The Manager of Engineering may require that pipes intersect major creeks at an angle not to exceed 60 degrees, when a 90-degree angle would result in an erosive condition.

Figure 20 shows how a storm sewer should be configured to discharge into a creek.

8. Easements for Enclosed Storm Sewers and Positive Overflow Areas

All storm sewer conduits to be dedicated to the City of Mesquite shall be located in an easement dedicated to the City of Mesquite at the time of final platting of the property. The easement shall be at least 15 feet wide for storm sewers or wider if the Manager of Engineering requires it for maintenance or other purposes. Special drainage easements on private property shall be a minimum of 15 feet wide or wider if the Manager of Engineering requires it for maintenance or other purposes. Maintenance responsibility shall be as required in Article 7.A.5. No fences, buildings or other structures and improvements shall be placed within these dedicated easements.

SECTION F. Culvert Design Standards

Culverts shall be designed in accordance with the Texas Highway Department Hydraulic Manual, Chapter 4 - Culverts. The calculation of hydraulic grade lines will consider both inlet and outlet control for the culvert. Starting water surface elevations for gradeline calculation will be the same as required for storm sewers; see Section E.

ARTICLE 7

SPECIAL DRAINAGE FACILITIES

SECTION A. Channels

1. Channel Design

Open channels may be used instead of enclosed systems when the drainage area of contributing flow to the channel is greater than 160 acres. Open channels shall not be permitted when the drainage area is less than 160 acres. Table 4 shows the maximum velocities allowed for certain types of channels. Roughness coefficients for the design of open channels are provided in Table 8. The following criteria shall be used in determining the nature of the open channel.

- For channels with a contributing drainage area of 160 acres or greater:

a. Channels may be left in their natural state provided that the channel velocities are 6.0 feet per second or less, if approved by Manager of Engineering. Otherwise, all channels shall be in accordance with A.I.d. or fully lined.

b. If the natural channel is to be replaced by an improved channel, the flow from the 100-year design flood must be contained within the improved channel while allowing for one foot of freeboard. An improved channel shall meet the floodplain alteration regulations presented in Article 8.

c. Improved channels shall include a lined section if the design velocity is greater than six feet per second. Lining types such as concrete and rock walls may be used upon approval of the Manager of Engineering. Improved channels with design velocities of less than the permissible velocities shown in Table 11 may be earthen if the channels are revegetated properly.

d. For lined channels, all of the channel bottom and at least the first three feet (vertical height) of the side slopes up from the channel bottom shall be lined, unless approved by the Manager of Engineering.

e. Earthen sides above the lined section or totally earthen channels shall be on at least a four horizontal to one vertical slopes and shall have approved ground cover to prevent erosion.

f. Unless shown to be feasible in a soils report sealed by a registered professional engineer in the State of Texas, and approved by the Manager of Engineering, improved channels shall have minimum side slopes of:

- 4 feet horizontal to 1 foot vertical for earthen grassed side slopes.
- 2 feet horizontal to 1 foot vertical for side slopes in rock.

g. The developer or owner shall use low maintenance vegetation for vegetative cover, as approved by the Manager of Engineering prior to planting. The selection of materials shall comply with either the current ground cover listing for North Central

Texas furnished through the Texas Agricultural Extension Service or Table 9 in this ordinance.

h. The developer/owner shall provide a drainage easement and a required maintenance easement (see paragraph 4 below) which shall be dedicated to the City of Mesquite as a permanent drainage right-of-way and open space corridor.

i. Channel improvement shall not include concrete pilot channels which do not meet the requirements of item A.1.d., unless approved by the Manager of Engineering.

2. Erosion Prevention

All channel sections must consider and account for channel stabilization in their design. This requirement pertains to all sections whether they are left in their natural condition or are modified in any manner. Three sets of requirements are provided depending upon the relationship of the existing channel to the limits of the developer/owner's property boundaries. The Manager of Engineering shall have the discretion to require the implementation of the portion of these requirements as deemed necessary, depending on the specifics of the property being developed or improved or to allow the escrow of funds sufficient to provide for the construction of a proportionate amount of channel improvements in lieu of actual construction. This discretion may be exercised when a small section of improvements is not deemed by the Manager of Engineering to be economically practicable.

a. In cases where the entire channel section is contained within the limits of the developer/owner property boundaries. The developer/owner shall:

1. Provide for an improved stabilized channel cross-section which reduces all velocities to 6.0 fps or below for vegetated channels. The channel improvements must meet all requirements of this ordinance.

2. For vegetated channel sections with channel velocities ranging from 6 to 8 fps, construct grade control structures within the channel and overbank areas to prevent erosion. Grade control structures shall have a minimum effective depth of 3.0 feet below existing or proposed grades with an adequate number of structures to prevent less than 1 foot of degradation.

b. In cases where the property boundary follows the centerline of the channel or incorporates only a portion of the channel cross-section, the developer/owner shall:

1. Determine the design section required to provide for an improved stabilized channel cross-section which reduces all velocities to 6.0 fps or below for vegetated channels. The design channel section must meet all requirements of this ordinance.

2. The design section may include vegetated channel sections with channel velocities ranging from 6 to 8 fps, provided that grade control structures are included within the channel and overbank areas to prevent erosion. Grade control structures shall have a minimum effective depth of 3.0 feet below existing or proposed grades with an adequate number of structures to prevent less than 1 foot of degradation.

3. The developer/owner shall construct or escrow funds for construction of the portion of the design improvements required on their property for the ultimate channel design. The Manager of Engineering shall have the

discretion to determine the portion of the design improvements to be constructed/ escrowed by the developer/owner. In most instances, the developer/owner shall construct one-half of the improvements on their property.

4. If grade control structures are incorporated into the design, the developer/owner shall coordinate with adjacent owners in order to construct these features in their entirety at the time of the initial portion of the channel improvements.

5. The developer/owner shall provide for a drainage easement and access/maintenance easement consistent with the portion of the improvements provided.

c. In cases where the developer/owner owns property adjacent to channel or floodplain areas but does not own a portion of the channel or floodplain area, the developer/owner shall (at the discretion of the Manager of Engineering):

1. Determine the channel improvement configuration necessary to meet the requirements of item (2a) above and

2. Shall provide a dedicated easement to the city for the portion of this future improvement configuration, including necessary maintenance and access easement, which will include the developer/owner property.

3. Starting Water Surface Condition

When performing hydraulic analyses for channel or drainageway design, the starting water surface shall be based on the following criteria.

a. When the ratio of the drainage area of the receiving creek (at the confluence location) to the drainage area of the channel or drainageway being designed is 15 or greater, the 10-year water surface of the receiving creek shall be used as the starting water surface for hydraulic design calculations. For creeks where the 10-year water surface is not available, the slope-area method will be used for starting design calculations.

b. When the ratio of the drainage area is less than 15, the 100-year elevation on the receiving creek shall be used as the starting water surface for design calculations.

4. Easements Required for Open Channels

Drainage and/or floodway easements for all open channels, creeks and flumes shall be dedicated to the City of Mesquite. Easements shall encompass all areas having a ground elevation below the higher of one foot above the water surface elevation associated with the design flood or the top of the high bank or channel edge. No fences, buildings, or other structures which could impede flow shall be placed within this dedicated drainage easement. In all cases, the easement shall also include at least a 15-foot wide maintenance strip along both sides of the channel or, if the Manager of Engineering so allows, at least a 20- foot wide maintenance strip along one side of the channel. Streets, alleys, bike paths, etc., alongside the channel can serve as all or part of the maintenance easement.

Drainage easements for flumes shall be located with sufficient width to permit future maintenance accessibility, and in no case shall be less than 15 feet wide.

5. Maintenance of Facilities and Easements

All drainage easements shall be dedicated to the City of Mesquite. The maintenance responsibility of the easements will vary based on the situation. The following outlines the maintenance responsibility for various conditions.

a. Drainage improvements constructed by the City of Mesquite shall be the maintenance responsibility of the City.

b. Drainage improvements constructed in single family residential areas, where no homeowner's association or other similar association has been formed, shall be the maintenance responsibility of the City of Mesquite.

c. Drainage improvements shall not be the maintenance responsibility of the City of Mesquite when constructed in:

1. residential areas where a homeowner's association or other similar association is formed,
2. areas of commercial or industrial zoning.

The maintenance activities in these areas shall be the responsibility of private ownership including associations. If such improvement deteriorates in condition, the city manager or his designated representative shall notify such property owner or association of required corrections and/or maintenance to bring drainage facility up to the standards as originally approved by the city and according to the original improvement. If such maintenance is not accomplished within a reasonable time, then the city may contract for such work and levy an assessment to the property owner or association for such cost.

Perpetual maintenance must be assured by either a homeowner's association (single family only), trust fund, or other private entity as specified by the City Council.

SECTION B. Lakes and Dams

In the event that a property owner or developer desires to modify an existing pond or lake or desires to impound stormwater by filling or constructing an above-ground dam, thereby creating a lake, pond, lagoon or basin as part of the planned development of that property, the criteria listed below shall be met before City approval of the impoundment can be given. Ponds or lakes created by excavation of a channel area without erecting a dam above natural ground elevation or instream, low water checkdams are also subject to the criteria listed below, with the exception of spillway capacity requirements. The Manager of Engineering has the final authority to determine the design criteria for a proposed dam, check dam or excavated lake. The requirements of the State of Texas must also be met for the construction of dams, lakes, and other impoundments.

The design criteria for a dam is dependent on the size and hazard classification of the dam. The size and hazard classification will be based on Chapter 12 of the Texas Water Code and will be determined by the Manager of Engineering based on information furnished by the owner. The following criteria will be used to classify a dam:

1. Size

The classification for size is based on the height of the dam and storage capacity, whichever gives the larger size category. Height is defined as the distance between the top of the dam

(minus the freeboard) and the existing streambed at the downstream toe. Storage is defined as the maximum water volume impounded at the top of the dam (minus the freeboard).

Size Classification

Impoundment

Category	Storage (acre-feet)	Height (feet)
Minor	<100	<10
Small	≥100 and < 1,000	≥10 and < 40
Intermediate	≥1,000 and < 50,000	≥40 and < 100
Large	≥50,000	≥100

2. Hazard Potential

The hazard potential for a dam is based on the potential for loss of human life and property damage downstream from a dam in the event of failure. The following categories will be used:

Hazard Potential Classification

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Develop.)
Low	None expected (No permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Possible, but not expected (No urban developments and no more than a small number of inhabitable structure	Appreciable (notable agricultural, industry,or commercial development)
High	Expected (Urban developm ent or large number of inhabitable structures)	Excessive (Extensive public, industrial,or agricultural development)

3. Spillway Design Flood

The classification of a dam based on the above criteria will be used to determine the Spillway Design Flood (SDF). The total capacity of a dam structure, including principal and emergency spillways, shall be adequate to pass the SDF without exceeding the top dam elevation at a minimum. The SDFs for various dam classifications are as follows:

Spillway Design Flood

Hazard	Size	SDF
Low	Minor	100-year
	Small	1/4 PMF
	Intermediate	1/4 PMF to 1/2 PMF
	Large	PMF
Significant	Small	1/4 PMF to 1/2 PMF
	Intermediate	1/2 PMF to PMF
	Large	PMF
High	Small	PMF
	Intermediate	PMF
	Large	PMF

In all cases, the minimum principal spillway design capacity is the 100-year design flood. In certain cases, a dam breach analysis may be required to determine the proper classification of the structure. For all structures requiring a spillway design flood equal to the PMF, a dam breach analysis is required to determine the downstream consequences of a failure. All dams designed for a SDF of 1/2 PMF or less shall be constructed with a minimum freeboard of two feet above the SDF elevation.

4. Additional Design Requirements

a. An engineering plan for such construction, accompanied by complete drainage design information and sealed by a registered professional engineer, shall have been approved by the City of Mesquite;

b. The spillway and any emergency overflow areas shall be located so that flood waters will not inundate any buildings, roadways, or other structures.

c. All Federal, State and County laws pertaining to impoundment of surface water shall have been complied with, including the design construction and safety of the impounding structure. Copies of any Federal, State, and County permits issued for the proposed impoundments shall be submitted to the Manager of Engineering.

d. Any existing structure, which is included in the project area shall be improved to comply with the applicable Federal, State, County and City safety requirements for structures.

e. Before removing, enlarging, or altering any existing lake, the Owner will furnish a study of the effects of the alteration upon flooding conditions both upstream and downstream. The study shall be prepared by a professional Engineer and submitted

to the City for approval prior to making the proposed alteration. Compensatory storage shall be provided in some manner such that equal or comparable flood retention capacity is maintained.

f. Any improvements to existing dams or lakes or construction of new impoundments shall be made at the expense of the developer, prior to acceptance of the adjacent street, utilities and drainage improvements as provided for under the Subdivision Ordinance.

5. Maintenance and Liability Criteria

a. The owner or developer shall have agreed to retain private ownership of the lake, pond, or lagoon or basin constructed and to assume full responsibility for the protection of the general public from any health or safety hazards related to the lake, pond, or lagoon constructed.

b. The owner or developer shall have agreed to assume full responsibility for the maintenance of the lake, pond, or lagoon or basin constructed. The owner or developer shall keep the Manager of Field Services advised of the current responsible agent for this maintenance.

SECTION C. Levees

In the event that developers or owners wish to build levees to protect an area from flooding, applicable FEMA and State of Texas guidelines and the following criteria apply:

1. Levees shall be designed to have four feet of freeboard above the Standard Project Flood for the fully developed watershed flows.

2. Levees shall be designed according to the Corps of Engineers design criteria whether or not they are federally authorized levees.

3. Levee systems shall be designed with interior drainage systems to prevent flooding from local runoff contained within the system for the 100-year design flood.

4. Levee systems shall have written operation procedures that address gate closure conditions and emergency warning plan. A copy of these procedures shall be furnished to the Manager of Engineering and the Manager of Field Services.

5. Automated gate closure systems shall have power from two independent sources and shall be capable of being operated manually.

6. Ring levees protecting individual structures proposed for construction after the enactment date of this ordinance shall not be permitted.

7. All new levee systems shall have permanent positive closures to the required design elevation. Temporary closures involving sandbagging or other procedures requiring manual operations shall not be permitted.

8. Provisions shall be made for ensuring the permanent maintenance of levees either by a flood control district or similar governmental organization or by the existing property owner and all future owners, heirs, or assigns.

9. Additional plan requirements include water surface profiles for the design flood and SPF; top of levee profile, definition of interior drainage facilities, including pump station and ponding areas; location of gravity outlets, gatewells and closure structures; and elevation-duration data on the receiving system.

SECTION D. Detention and Retention Facilities.

As previously described in Article 5 of this ordinance, the Manager of Engineering may require that runoff rates for all land uses be limited to the rates that would be produced from single family residential areas. This requirement may also apply to the development of sites as churches, schools, and other institutional uses. Detention/retention facilities to reduce runoff rates will be provided within approved levee districts unless the District can demonstrate, with technical data, that adequate detention/retention storage is provided in dedicated sumps and storage areas to offset the impacts of developments to runoff rates equal to a single-family residential rate. Detention/retention facilities shall be designed for the 100-year design flood according to the following criteria.

1. The minimum amount of storage volume of the detention basin shall be that volume required to reduce runoff rate to a single-family rate. Dedicated detention/retention basins shall also include an additional one foot of freeboard and two feet of sediment storage. The volume of runoff storage for drainage areas greater than 160 acres shall be computed using unit hydrograph procedures. Snyder's Unit Hydrograph will be utilized for all computations. Manual methods or use of the computer program HEC-1 are allowed for runoff hydrograph computation and flood routings.

   For drainage areas less than 160 acres, the above methods are recommended; however, an approximate routing method based on the rational formula is allowable, as outlined in Figure 21.

2. Detention areas in parking lots shall not be:

   - In required parking spaces but in extra spaces.
   - Behind speed bumps unless the speed bumps are made with reinforced concrete.
   - Deeper than six inches unless warning signs are posted.

3. Drainage easements shall be provided for all regional detention/retention facilities and for other detention/retention facilities where two or more owners are involved.

4. Detention/retention facilities shall be designed to empty in less than 24 hours, unless it is also serving as an erosion control facility.

5. Detention/retention facilities shall not be counted as an erosion control technique unless (1) the basins are designed to empty a minimum of 24 hours from the storm event and (2) adequate sediment storage areas in the basin have been set aside and are maintained. Other municipal ordinances give additional details as to how to design multi-purpose detention/retention facilities.

6. Detention/retention facilities shall be maintained by the owner unless the facilities are dedicated to and accepted by the City of Mesquite.

SECTION E. Flumes

The use of flumes is not recommended for widespread use. Flumes shall not be permitted when the purpose of a permanent flume is to carry runoff down the sides of earthen channels. A flume may be used to direct overflow runoff along property lines until the runoff can be intercepted by streets or conduit flows. Flumes crossing sidewalks shall be covered or bridged such as to minimize danger to pedestrians.

SECTION F. Connections from Buildings to Storm Sewers

Drainage from residential areas, such as roof tops, should be allowed to flow overland before joining the storm sewer system.

Seepage into basements or sub-surface structures that is pumped to ground level, seepage from springs, and runoff from roof drains on non-residential buildings that would flow onto or across driveways, sidewalks, or other areas commonly crossed by pedestrians can create hazards or nuisances to pedestrians. Thus, if hazards or nuisances would be created, the basement and rooftop drains shall be tied directly to the nearest storm sewer, provided that pumped lines from basements have back flow preventers and the water is uncontaminated.

ARTICLE 8

FLOODPLAIN GUIDELINES

SECTION A. Lands to Which This Article Applies

A person shall comply with the requirements of this article for floodplain areas before making substantial improvements to or increasing the outside dimensions of an existing structure or developing land within the design flood line of a creek or stream having a contributing drainage area of 160 acres or more, whether or not the land has been formally designated as a floodplain. Floodplain areas shall also include all areas inundated by the design flood and shown as Areas of Special Flood Hazard on the Flood Insurance Study's maps.

SECTION B. General Floodplain Regulations

1. Permitted Uses of Floodplain Areas

To minimize possible losses of life and property, the following uses are permitted in a floodplain area provided they are also permitted in the underlying zoning district:

- Farm or ranch;
- Local utilities, electrical substation, water reservoir or pumping station, and water treatment plant;
- Public park or playground, private recreation club or area, private community center, and golf course;
- Outside commercial amusement approved by a specific use permit;
- Helistop approved by a specific use permit; and
- Radio, television, or microwave tower, and amateur communications tower with a special use permit.

Structures customarily associated with the above uses may be constructed within a floodplain area only if the proposed structure meets the same engineering requirements applicable to filling in a floodplain (See Article 8.C).

Open private recreation clubs or areas and private community centers, without exterior walls which would incur structural damage during flood conditions, are permitted in floodplain areas. Private facilities listed above, with enclosed walls that would incur damage, are not permitted in floodplain areas.

Uses and structures other than those mentioned above shall not be permitted in floodplain areas.

Notwithstanding the previous provisions of this section, the city will seek to preserve the 100-year floodplain for the following stream and creek segments:

a. Stream 2B7 south of Town East Boulevard to its confluence with South Mesquite Creek.

b. The West Fork of South Mesquite Creek south of U.S. 80 to its confluence with South Mesquite Creek.

c. South Mesquite Creek from North Mesquite Drive to the East Fork of the Trinity River.

d. North Mesquite Creek from U.S. 80 to its confluence with the East Fork of the Trinity River.

e. The East Fork of the Trinity River within the city.

Plans for encroachment and/or improvement of the floodplain in the five (5) stream and creek segments identified above shall be submitted for review to the city engineer, the city planner and the director of parks and recreation. The engineer will comment on the effects of the proposed encroachments and/or improvements on floodwater elevations and on the hydraulic adequacy of the channel. The city planner may comment on the advisability of the zoning and land use. The Director of Parks and Recreation will comment on the use of the land for parks and open space as well as bird and wildlife habitat. The 100-year floodplain may not be developed in the stream and creek segments identified above without staff and city council review of the ramifications of such development.

2. Residential Construction

New construction in reclaimed floodplain areas and "substantial improvements" of any existing residential structure in floodplain areas shall have the lowest floor, including basements or fully enclosed areas of any new or "substantial improvement" construction, elevated to at least two feet above the design flood elevation. Fill elevations shall be one foot above the elevation of the design flood. Incremental improvements, either at one time or over a period of time, the cumulative cost of which equals or exceeds 50 percent of the market value at the time of the first improvement, shall be considered as a "substantial improvement." New residential structures or "substantial improvements" on stilts or behind ring levees serving individual lots shall not be permitted.

Improvements to an existing structure that increase the outside dimensions, but do not result in a "substantial improvement," must meet the requirements of Article 8.C.

Table 10 presents a synopsis of the requirements for residential construction in floodplain areas.

3. Non-residential Construction

New construction in reclaimed floodplain areas and "substantial improvement" of any existing commercial, industrial, or other non-residential structure in floodplain areas shall either have the lowest floor, including basements of any new or "substantial improvement" construction, elevated to at least two feet above the design flood elevation; or, together with attendant utility and sanitary facilities, shall:

- Be floodproofed so that below two feet above the design flood elevation the structure is watertight, with walls substantially impermeable to the passage of water;

- Have structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy; and

- Be certified by a registered professional engineer or architect that the standards of this subsection are satisfied. Such certifications shall be provided to the official set forth in Article 4, Section A.1.

Incremental improvements, either at one time or over a period of time, the cumulative cost of which equals or exceeds 50 percent of the market value at the time of the first improvement, shall be considered as a "substantial improvement." *Improvements* to an existing commercial, industrial or other non-residential structure that increase the outside dimensions, but do not result in a "substantial improvement," must meet the requirements of Article 8.C.

Table 10 presents a synopsis of the requirements for nonresidential structures in floodplain areas.

4. Manufactured Homes

a. All manufactured homes shall be anchored to resist flotation, collapse, or lateral movement by providing over-the-top and frame ties to ground anchors. Special requirements shall be that:

- Over-the-top ties be provided at each of the four corners of the manufactured home, with two additional ties per side at intermediate locations, with manufactured homes less than 50 feet long requiring one additional tie per side;
- Frame ties be provided at each corner of the home with five additional ties per side at intermediate points, with manufactured homes less than 50 feet long requiring four additional ties per side;
- All components of the anchoring system be capable of carrying a force of 4,800 pounds; and,
- Any additions to the manufactured home be similarly anchored.

b. For all new manufactured homes, new manufactured home parks and manufactured home subdivisions; for expansions to existing manufactured home parks and manufactured home subdivisions; for existing manufactured home parks and manufactured home subdivisions where the repair, reconstruction or improvement of the streets, utilities and pads is planned; and for manufactured homes not placed in a manufactured home park or manufactured home subdivision; for new manufactured homes moved into an old site in an existing manufactured home park; and for substantial improvements to a manufactured home, require that:

- Stands or lots are elevated on compacted fill so that the lowest floor of the manufactured home will be at least two feet above the design flood elevation;
- Adequate surface drainage and access for a hauler are provided; and,
- No new manufactured homes shall be placed in a floodplain, except on a pad site created by compacted fill in an existing manufactured home park, in which the new fill pad site is elevated to the design flood elevation.

Manufactured homes may be supported to the required 2 feet above the design flood elevation by stands or foundation features as accepted by FEMA.

Table 10 overviews the requirements for placing manufactured homes in flood hazard areas.

5. Recreation Vehicles

Recreational vehicles located on a site within a designated floodplain area shall (i) be on the site for fewer than 180 consecutive days and (ii) be fully licensed and ready for highway use, or (iii) meet the elevation and anchoring requirements for "manufactured homes" outlined in this section. A recreational vehicle is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick disconnect type utilities and security devices, and has no permanently attached additions.

6. Streets, Parking Lots, and Bridges

The top of curb of all new streets to be built in reclaimed floodplain areas shall be at least two feet above the design flood elevation. The low beam of all new bridges to be constructed across floodplains shall be a minimum of two feet above the design flood elevation. All new private bridges to individual homes shall have their low beams at two feet above the design flood elevation. Parking lots associated with residential, commercial and industrial uses in reclaimed floodplain areas shall be at least at the design flood elevation. Parking lots for public parks or playgrounds, private recreation club or area, private community center and golf courses may be located below the design flood elevation.

7. Utilities

All new and replacement water supply systems, sanitary sewer facilities, and other public utilities shall be designed to minimize or eliminate flood damage and infiltration of flood waters into the system.

8. Fences

Fences (Private and Public Screening) shall be constructed such that blockage of surface water flow does not occur. Fences shall not be allowed in floodplain area or within dedicated easements. This includes the requirement that erosive conditions shall not be created around, under or near a fence structure.

9. Additional Construction Standards for Structures

All improvements and construction permitted in a floodplain area must comply with the following requirements:

a. Structures must be securely anchored to the foundation to prevent flotation and collapse during inundation and designed to prevent damage to nonstructural elements during inundation.

b. Thermal insulation used below the first floor elevation must be of a type that does not absorb water.

c. Adhesives must have a bonding strength that is unaffected by inundation.

d. Doors and all wood trim must be sealed with a waterproof paint or similar product.

e. Mechanical, electrical, and utility equipment shall be located above the design flood elevation. Water heaters, furnaces, electrical distribution panels, and other critical mechanical or electrical installations must not be placed in basements. Electrical circuits for basements shall be separate from circuits serving floors above the basement, and circuits for basements shall be installed lowered from above.

f. Basements are permitted for non-residential structures only if they are designed to preclude inundation by the design flood elevation, either by:

1. The elimination of exterior openings below the design flood elevation; or

2. The use of water-tight closures, such as bulkheads and flood shields. However, no basements are permitted in soils whose permeability meets or exceeds the minimum local standards of permeability established for the installation of individual sewage disposal systems.

g. Plywood used at or below the lowest floor elevation must be of an "exterior" or "marine" grade and of a water-resistant or waterproof variety.

h. Wood flooring used at or below the lowest floor elevation must be installed to accommodate a lateral expansion of the flooring, perpendicular to the flooring grain, without incurring structural damage to the building.

I. Basement ceilings for non-residential structures must be of sufficient wet strength and be so installed as to survive inundation.

j. Paints or other finishes used at or below the lowest floor elevation must be capable of surviving inundation.

k. All air ducts, large pipes and storage tanks located at or below the lowest floor elevation must be firmly anchored to prevent flotation.

l. Tanks must be vented at a location above the design flood elevation.

SECTION C. Floodplain Alterations

As stated previously in Article 8, Section B, no new construction is allowed in floodplain areas, but construction is allowed in those areas that can be reclaimed from the floodplain. The City of Mesquite has adopted a "natural floodway" that differs from the "regulatory floodway" established by FEMA. The "natural floodway" consists of the natural channel and floodplain that is effective in conveying the design flood. Areas of ineffective flow around bridges, topographic constrictions, and other constrictions are excluded from the "natural floodway." The effective flow area and limits of the "natural floodway" are determined using 4:1 flow expansions downstream of constrictions and 1:1 flow expansions upstream of constrictions. Figure 22 displays an example of effective flow areas at a typical bridge location.

A Development Permit for floodplain reclamation or other types of alterations shall be allowed only if all of the following criteria are met:

1. Alterations of the floodplain and "natural floodway" shall not increase the water surface elevation of the design flood of the creek.

2. Alterations shall be in compliance with FEMA guidelines. All projects shall receive a Conditional Letter of Map Revision prior to issuance of a Development Permit.

3. Alterations of the floodplain shall not create an erosive water velocity on or off-site.

4. Alterations of the floodplain shall not significantly increase downstream discharges. Acceptable values are listed:

Minor Tributaries	15% maximum storage loss
Major Streams	0% maximum storage loss
East Fork Trinity River	
North Mesquite Creek	
South Mesquite Creek	

5. The effects of existing improvements or public and private improvements for which a future commitment has been made by the City of Mesquite or county, state, or federal agencies, shall be used in determining water surface elevations and velocities.

6. Any alteration of floodplain areas shall not cause any additional expense in any current or projected public improvements.

7. The floodplain shall be altered only to the extent permitted by equal conveyance on both sides of the natural channel. The right of equal conveyance applies to all owners and uses, including greenbelt, park areas, and recreational usages. Owners may relinquish their right to equal conveyance by providing a written agreement to the City of Mesquite.

8. Maximum slopes of filled areas shall not exceed three to one. Slopes of any excavated areas not in rock shall not exceed four to one.

   Fill slopes, vertical walls, terracing, and other slope treatments may be considered provided no unbalancing of stream flow results and only as a part of a grading permit application.

9. A grading permit shall be required so that proper provisions for protecting against erosion losses will be made.

These criteria shall be met before a Development Permit can be issued for a proposed project. Typical projects requiring a Development Permit include placing fill whether or not it actually raises the property out of the floodplain, constructing a dam, straightening channel sections, making improvements, substantial or otherwise, to existing structures in a floodplain in which the existing outside dimensions of the structure are increased, and temporary storage of fill materials, supplies, and equipment.

The required submittals for a Development Permit are listed in Article 4, Section D.2. In general, the information needed for the application can be obtained by running a backwater model, such as HEC-2, and a flood routing model, such as HEC-1. Both models shall be run by permit applicants. The backwater information shall be used to determine that upstream water surface elevations and erosive velocities have not increased. Starting water surface conditions for backwater calculations are outlined in Article 7, Section A.3. Flood routing information shall be used to insure that the cumulative effects of the reduction in floodplain storage of flood waters will not cause downstream increases in water surface elevations and erosive velocities.

The Manager of Engineering shall keep the models current with modifications to the floodplain.

SECTION D. Verification of Floodplain Alterations.

Prior to final acceptance by the City of utilities and street construction for projects involving floodplain alterations or adjacent to defined floodplains, creeks, channels and drainageways, a certified statement shall be prepared by a Registered Public Surveyor showing that all lot elevations, as developed within the subject project, meet or exceed

the required minimum finished floor elevations shown on the final plat of the subdivision. This certification shall be filed with the Manager of Engineering.

In addition, at any time in the future when a building permit is desired for existing platted property which is subject to flooding or carries a specified or recorded minimum finished floor elevation, a Registered Public Surveyor shall survey the property prior to obtaining a building permit. The certified survey data showing the property to be at or above the specified elevation shall be furnished to the Manager of Engineering for approval. Certificate of compliance with the provisions of this ordinance pertaining to specified finished floor elevations shall be required.

The owner/developer shall furnish, at his expense, to the Manager of Engineering sufficient engineering information to confirm that the minimum floor elevations proposed are as required by this paragraph. Construction permits will not be issued until (1) a conditional letter of map revision or amendment has been issued by FEMA, and (2) lots and/or sites are certified by a Registered Public Surveyor and are elevated from the floodplain according to the FEMA-approved revisions to the floodplain and the requirements of this ordinance.

TABLE 1

MINIMUM RUNOFF COEFFICIENTS

Zone	Zoning District Name	*Runoff* Coefficient "C"	*Max.* Inlet Time
AG	Agricultural, 1 Ac., 2,000 sq. ft. home	Variable	15 min.
R-1	Single Family, 11,000 sq. ft. lot; 2,000 sq. ft. home	0.60	15 min.
R-1A	Single Family, 8,250 sq. ft. lot; 2,000 sq. ft. home	0.60	15 min.
R-2	Single Family, 8,250 sq. ft. lot; 1,700 sq. ft. home	0.60	15 min.
R-2A	Single Family, 7,200 sq. ft. lot; 1,700 sq. ft. home	0.60	15 min.
R-3	Single Family, 7,200 sq. ft. lot; 1,500 sq. ft. home	0.60	15 min.
D	Duplex, 12,500 sq. ft. lot; 2,200 sq. ft. home	0.60	15 min.
A-1	Multifamily, 12 units/acre	0.80	10 min.
A-2	Multifamily, 18 units/acre	0.85	10 min.
A-3	Multifamily, 25 units/acre	0.90	10 min.
PD	Planned Development	Variable	10 min.
O	Office	0.85	10 min.
GR	General Retail	0.85	10 min.
SS	Service Station	0.95	10 min.
MU	Mixed Use	Variable	10 min.
CBD	Central Business District	0.90	10 min.
LC	Light Commercial	0.90	10 min.
C	Commercial	0.90	10 min.
I	Industrial	0.90	10 min.
FP	Flood Plain	1.00	10 min.
H	Historic Landmark	0.40	15 min.
R/PC	Restaurant/Private Club	0.90	10 min.
*	Parking Lots	1.00	10 min.
*	Church	0.90 Varies	10 min.
*	School	0.75 Varies	15 min.
*	Park	0.40 Varies	15 min.
*	Road & Interstate Hwy.	0.90	10 min.
(*)	Indicates non-zoned use		

TABLE 2

AVERAGE VELOCITY FOR USE IN DETERMINING TIME OF CONCENTRATION

Description of Water Course	0% to 3% V. in f.p.s.	4% to 7% V. in f.p.s.	8% to 11% V. in f.p.s.	Over 12% V. in f.p.s.
Surface Drainage	5	9	13	15
Channels	Determine V. by Manning's Equation			
Storm Sewers	Determine V. by Manning's Equation			

TABLE 3

MINIMUM SLOPES FOR CONCRETE PIPES

(to produce a velocity of 2.5 f.p.s. or greater)

(n = .013)

Pipe Diameter (inches)	Slope (Feet/100 Feet)	Pipe Diameter (inches)	Slope (Feet/100 Feet)
18	.180	51	.045
21	.150	54	.041
24	.120	60	.036
27	.110	66	.032
30	.090	72	.028
33	.080	78	.025
36	.070	84	.023
39	.062	90	.021
42	.056	96	.019
45	.052	102	.018
48	.048	108	.016

TABLE 4

MAXIMUM VELOCITIES IN CONDUITS FLOWING FULL AND CHANNELS

Flow Through:	Maximum Velocity (fps)
Culverts	10
Inlet Laterals	10
Storm Sewers	10
Earthen Channels	See Table 11
Concrete Channels	6
Shale	6
Rock	6 - 10*

* Depends upon exact type of vegetative cover, soil, or rock for the location in question.

TABLE 5

ROUGHNESS COEFFICIENTS FOR CLOSED CONDUITS

Materials of Construction	Recommended Roughness Coefficient "n"
Concrete Pipe Storm Sewer	
Good Alignment, Smooth Joints	.013
Fair Alignment, Ordinary Joints	.015
Poor Alignment, Poor Joints	.017
Concrete Pipe Culverts	.012
Monolithic Concrete Culverts & Conduit	.012
Corrugated Metal Pipe	.024
Corrugated Metal Pipe (Smooth Lined)	.013

TABLE 6

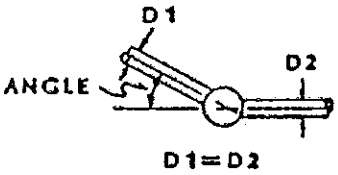
ENTRANCE LOSS COEFFICIENTS

Entrance head loss $H_L = K_e \cdot \frac{V_1^2}{2g}$

Type of Structure and Design of Entrance	Coefficient K_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, square cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
End-section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
End-section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension dimension, or bevele d top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwall parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

TABLE 7

VELOCITY HEAD LOSS COEFFICIENTS FOR CLOSED CONDUITS

MANHOLE AT CHANGE IN PIPE DIRECTION		
DESCRIPTION	ANGLE	HEAD LOSS COEFFICIENT Kj
	90°	0.55
	60°	0.48
	45°	0.42
	30°	0.30
	0°	0.05

BENDS IN PIPES		
DESCRIPTION	ANGLE	HEAD LOSS COEFFICIENT Kj
	90°	0.50
	60°	0.43
	45°	0.37
	30°	0.25

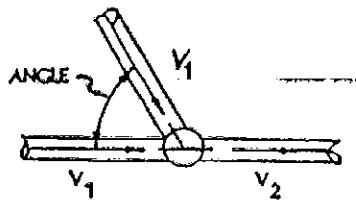
JUNCTION		
DESCRIPTION	ANGLE	HEAD LOSS COEFFICIENT Kj
	0°	1.00
	22 1/2°	0.75
	45°	0.50
	60°	0.35
	90°	0.25

TABLE 8

ROUGHNESS COEFFICIENTS FOR OPEN CHANNELS FLOW AREAS

Channel Description	Roughness Coefficient Minimum	Normal	Maximum
MINOR NATURAL STREAMS (Top Width at Flood Stage Less Than 100 Feet)			
Moderately Well-Defined Channel			
Grass and Weeds, Little Brush	0.025	0.030	0.033
Dense Weeds, Little Brush	0.030	0.035	0.040
Weeds, Light Brush on Banks	0.030	0.035	0.040
Weeds, Heavy Brush on Banks	0.035	0.050	0.060
Weeds, Dense Willows on Banks	0.040	0.060	0.080
Irregular Channel with Pools and Meanders			
Grass and Weeds, Little Brush	0.030	0.036	0.042
Dense Weeds, Little Brush	0.036	0.042	0.048
Weeds, Light Brush on Banks	0.036	0.042	0.048
Weeds, Heavy Brush on Banks	0.042	0.060	0.072
Weeds, Dense Willows on Banks	0.048	0.072	0.096
Floodplain, Pasture			
Short Grass, No Brush	0.020	0.030	0.035
Tall Grass, No Brush	0.025	0.035	0.050
Floodplain, Cultivated			
No Crops	0.025	0.030	0.035
Mature Crops	0.030	0.040	0.050
Floodplain, Uncleared			
Heavy Weeds, Light Brush	0.035	0.050	0.070
Medium to Dense Brush	0.070	0.100	0.160
Trees with Flood Stage Below Branches	0.080	0.100	0.120
MAJOR NATURAL STREAMS (Top Width at Flood Stage Greater Than 100 Feet)			
The roughness coefficient is less than that for minor streams of similar description because banks offer less effective resistance.			
Moderately Well Defined Channel	0.025	---	0.060
Irregular Channe'	0.035	---	0.100

TABLE 8, continued

Channel Description	Roughness Coefficient Minimum	Normal	Maximum
MANMADE VEGETATED CHANNELS			
Mowed Grass, Clay Soil	0.025	0.030	0.035
Mowed Grass, Sandy Soil, or Easily Erodible Soils	0.025	0.030	0.035
MANMADE NON-VEGETATED CHANNELS			
Clean Gravel Section	0.022	0.025	0.030
Shale	0.025	0.030	0.035
Smooth Rock	0.025	0.030	0.035
LINED CHANNELS			
Smooth Finished Concrete	0.013	0.015	0.020
Riprap (Larger Pieces)	0.030	0.040	0.050

TABLE 9.A

TEMPORARY VEGETATION

Temporary Vegetation - The following plants are commonly used for temporary cover in Texas. For optimum planting dates and adaptations for a specific soil or site, contact your local field office of the USDA, Soil Conservation Service.

Species	Planting Rate/Materials [1]	Planting Date [2]	Source [3]
Cane, Redtop	30#/Ac /S	8/15-9/30	C
Millet, German	40#/Ac /S	4/1-5/15	C
Oats	3 bu/Ac /S	8/15-9/30	C
Panicum, Texas	25#/Ac /S	3/15-5/15	C
Prosomillet	40#/Ac /S	4/1-5/15	C
Rye, Elbon	1-1/2 bu/Ac /S	8/15-9/30	C
Ryegrass, Annual	30#/Ac /S	8/15-9/30	C
Sprangletop, Green	3.4#PLS/Ac /S	2/1-5/15	C
Sudangrass	40#/Ac /S	4/1-5/15	C

1 Planting Rate - # Commercial Seed/AC, bu - bushels/AC, #PLS - Pure Live Seed/AC
Materials - S - Seed

2 Planting Date: This represents a statewide spread in planting dates. Refer to local guides for specific dates.

3 Source: C - Commercial

TABLE 9.B

PERMANENT VEGETATION - LOW AREAS

Permanent Vegetation - Because of wide variations in growing conditions within a planned area, permanent vegetation has been selected for the following conditions. For optimum planting dates and adaptations for a specific soil or site, contact your local field office of the USDA, Soil Conservation Service.

Note: Low areas are subject to ephemeral and intermittent flows.

Species	Moisture Tolerance[1]	Planting Rate/Materials[2]	Planting Date[3]	Source[4]
Bermudagrass,				
Coastal or				
Selection 3	A/2	50 cu.ft/Ac/Sp	12/1-5/30	C
Common	A/2	4.6#/Ac/S	3/1-5/30	C
Buffalograss	A/3	32#/Ac/S	1/1-4/30	C or PMC
Bushy Beard Grass	C/3	---	Spring	-
Cordgrass, Prairie	B/2	1/sq.ft/R	1/1-5/30	L
Eastern Gammagrass	C/3	---	Spring	-
Knotgrass	A/2	1/sq.ft/R&St	2/1-5/30	L
Marshmillet	B/1	1/sq.ft/R	4/1-5/30	L
Reedgrass, Common	A/2	1/sq.ft/R	2/1-5/30	L or PMC
Vine-mesquite	A/2	1/sq.ft/St	2/1-1/30	L

[1] Moisture Tolerance:

Total Submergence	Soil Saturation
A - 20 days or more	1 - Require a saturated soil
B - 10 - 20 days	2 - Will tolerate prolonged saturation and frequent drought.
C - Less than 10 days	3 - Will not tolerate a constantly saturated soil.

[2] Planting: Rate - #PLS/AC, Plant Parts/sq.ft.
Materials - S - Seed, R - Rhizomes, Sp - Sprigs, St - Stolons

[3] Planting Date: This represents a statewide spread in planting dates. Refer to local guides for specific dates.

[4] Source: C - Commercial, L - Locally Collected, PMC - Plant Material Center (as available)

TABLE 9.C

PERMANENT VEGETATION - SIDE SLOPES

Species	Soils[2]	Planting Rate/Materials[3]	Planting Date[4]	Source[5]
Grasses				
Bermudagrass, Common	All	4.6#/Ac/S	3/1-5/30	C
Selection 3 or Coastal	All	50 cu.ft/Ac/Sp	12/1-5/30	C
Bluestem, K.R.*	M-F	4#/Ac/S	12/1-5/30	C
Old World*	M-F	2.4#/Ac/S	2/1-5/30	PMC
Buffalograss*	M-F	32#/Ac/S	1/1-5/15	C or PMC
Dallisgrass	M-F	7#/Ac/S	2/1-5/30	C
Knotgrass[1]	All	1/sq.ft/R&St	2/1-5/30	L
Vine-mesquite	All	1/sq.ft/St	2/1-4/30	L
Wildrye	All	25#/Ac/S	9/1-10/1	L
Forbs:				
Bushsunflower*	All	10#/Ac/S	4/1-5/20	L or PMC
Englemandaisy*[1]	All	30#/Ac/S	9/1-2/30	L or PMC
Legumes:				
Trailing wildbean*	C-M	25#/Ac/S	2/15-5/15	L or PMC
Vetch*	All	20#/Ac/S	9/1-10/1	C

*Mixtures only: Reduce rates according to percentage of mixture desired.

1 Lower portion of slope only, frequently inundated.

2 Soils: C - Coarse, M - Medium, F - Fine

3 Planting: Rate - #PLS/AC, Plant Parts/sq.ft.
Materials - S - Seed, R - Rhizomes, Sp - Sprigs, St - Stolons

4 Planting Date: This represents a statewide spread in planting dates. Refer to local guides for specific dates.

5 Source: C - Commercial, L - Locally Collected, PMC - Plant Material Center (as available)

TABLE 9.D

PERMANENT VEGETATION

BERMS, SPOIL BANKS, AND SIMILAR AREAS

Species	Soils[1]	Planting Rate/Materials[2]	Planting Date[3]	Source[4]
Grasses				
Bermudagrass, Common	All	4.6#/Ac/S	3/1-5/30	C
Selection 3 or Coastal	All	50 cu.ft/Sp	12/1-5/30	C
Bluestem, Caucasian*	M-F	4#/Ac/S	12/1-5/30	C
K.R.*	M-F	4#/Ac/S	12/1-5/30	C
Little*	All	6.8#/Ac/S	2/1-5/15	C
Buffalograss*	All	6#/Ac/S	2/1-5/15	C
Fescue	M-F	20#/Ac/S	9/1-10/30	C
Hardinggrass "Wintergreen"	M-F	6#/Ac/S	9/1-10/30	C
Indiangrass*	All	9#/Ac/S	2/1-5/30	C
Kleingrass, "Selection 75"*	M-F	4#/Ac/S	1/1-5/30	C
Wildrye*	All	30#/Ac/S	9/1-10/1	L
Wintergrass, Texas*	M-F	30#/Ac/S	9/1-10/30	C
Forbs:				
Bushsunflower*	All	10#/Ac/S	4/1-5/30	L or PMC
Englemandaisy*	All	30#/Ac/S	9/1-2/30	L or PMC
Partridgepea*	C-M	10#/Ac/S	2/15-5/15	C or PMC
Sunflower, Maximilian*	All	16#/Ac/S	4/1-5/30	L or PMC

TABLE 9.D, continued

Species	Soils[1]	Planting Rate/Materials[2]	Planting Date[3]	Source[4]
Legumes:				
Clover,				
Crimson*	M	20#/Ac/S	9/1-10/30	C
White*	M-F	3#/Ac/S		C
Trailing wildbean*	C-M	10#/Ac/S	2/15-5/15	PMC
Vetch*	All	20#/Ac/S	9/1-10/1	C

*Mixtures only: Reduce rates according to percentage of mixture desired.

1 Soils: C - Coarse, M - Medium, F - Fine

2 Planting: Rate - #PLS/AC, Plant Parts/sq.ft.
Materials - S - Seed, R - Rhizomes, Sp - Sprigs, St - Stolons

3 Planting Date: This represents a statewide spread in planting dates. Refer to local guides for specific dates.

4 Source: C - Commercial, L - Locally Collected, PMC - Plant Material Center (as available)

TABLE 10

SYNOPSIS OF REQUIREMENTS

TO PROTECT STRUCTURES FROM FLOODING

	Is a Develpoment Permit Required?	Is Lowest Floor Req'd To Be 2 Feet Above Design Flood Elev.?	Is Floodproofing Allowed as an Alternative to Lowest Floor Requirement?
RESIDENTIAL			
New Structure	Yes, if new structures are being placed in a proposed floodplain reclamation area.	Yes	No
Substantial improvement (i.e., value of renovation of existing structure is greater than 50% of the structure).	Yes, if structure is subject to flooding.	Yes, of improve-ment	No
Renovation valued at less than 50% of the structure's value, with no expansion of outside dimensions.	No	No	Floodproofing is allowed, but not required.
Renovation valued at less than 50% of the structure's value, but including expansion of outside dimensions.	Yes, if structure is subject to flooding.	No	Floodproofing is allowed, but not required.

TABLE 10, continued

	Is a Development Permit Required?	Is Lowest Floor Req'd To Be 2 Feet Above Design Flood Elev.?	Is Floodproofing Allowed as an Alternative to Lowest Floor Requirement?
NON-RESIDENTIAL			
New Structure	Yes, if new structures are being placed in a proposed floodplain reclamation area.	Yes	No
Substantial improvement (i.e., value of renovation of existing structure is greater than 50% of the structure).	Yes, if structure is subject to flooding.	Yes, of improve-ment	Yes
Renovation valued at less than 50% of the structure's value, with no expansion of outside dimensions.	No	No	Floodproofing is allowed, but not required.
Renovation valued at less than 50% of the structure's value, but including expansion of outside dimensions.	Yes, if structure is subject to flooding.	No	Floodproofing is allowed, but not required.

TABLE 10, continued

	Is a Development Permit Required?	Is Lowest Floor Req'd To Be 2 Feet Above Design Flood Elev.?	Is Floodproofing Allowed as an Alternative to Lowest Floor Requirement?
MANUFACTURED HOMES			
New home placed at any pad site	Yes, if new structures are being placed in a proposed floodplain reclamation area.	Yes	No
Expansion of an existing home park	Yes, if the park is in a floodplain area.	Yes	No
New home park	Yes, if the new park is being located in a proposed floodplain area.	Yes	No
Substantial improvements to an existing manufactured home	Yes, if the pad site for the home is in a flood hazard area and the pad is being raised or expanded.	Yes	No
Renovation valued at less than 50% of the manufactured home's value, with no expansion of the home's or pad's outside dimensions.	No	No	No
Renovation valued at less than 50% of the manufactured home's value, but including expansion of its outside dimensions.	Yes, if structure is subject to flooding.	No	No

TABLE 10, continued

	Is a Development Permit Required?	Is Lowest Floor Req'd To Be 2 Feet Above Design Flood Elev.?	Is Floodproofing Allowed as an Alternative to Lowest Floor Requirement?
RECREATIONAL VEHICLES			
Recreational Vehicle which is: 1. on a site less than 180 consecutive days, 2. fully licensed and ready for highway use, 3. has quick disconnect utilities and devices, and 4. has no permanently attached additions.	No	No	No
Vehicle at any pad site which does not meet all recreational requirements	Yes, if vehicle is being placed in a proposed floodplain reclamation area.	Yes	No
Vehicles which do not meet all recreational requirements at an expansion of an existing home park	Yes, if the park is in a floodplain area.	Yes	No
New home park for vehicles which do not meet all recreational requirements	Yes, if the new park is being located in a proposed floodplain area.	Yes	No

TABLE 11

MAXIMUM PERMISSIBLE VELOCITIES FOR CHANNELS LINED WITH GRASS

COVER	SLOPE, RANGE,*	PERMISSIBLE VELOCITY, FPS
Bermuda Grass	0-5	6
	5-10	5
	>10	4
Buffalo grass, Kentucky bluegrass smooth brome, blue grama	0-5	5
	5-10	4
	>10	3
Grass mixture	0-5	4
	4	3
	5-10	
	Do not use on slopes steeper than 10%	
Lespedeza sericea, weeping love grass, ischaemum (yellow blue-stem), kudzu, alfalfa, crabgrass	0-5	2.5
	Do not use on slopes steeper than 5% except for side slopes in a combination channel.	
Annuals - used on mild slopes or as temporary protection until permanent covers are established, common lespedeza, Sudan grass	0-5	2.5
	Use on slopes steeper than 5% is not recommended.	

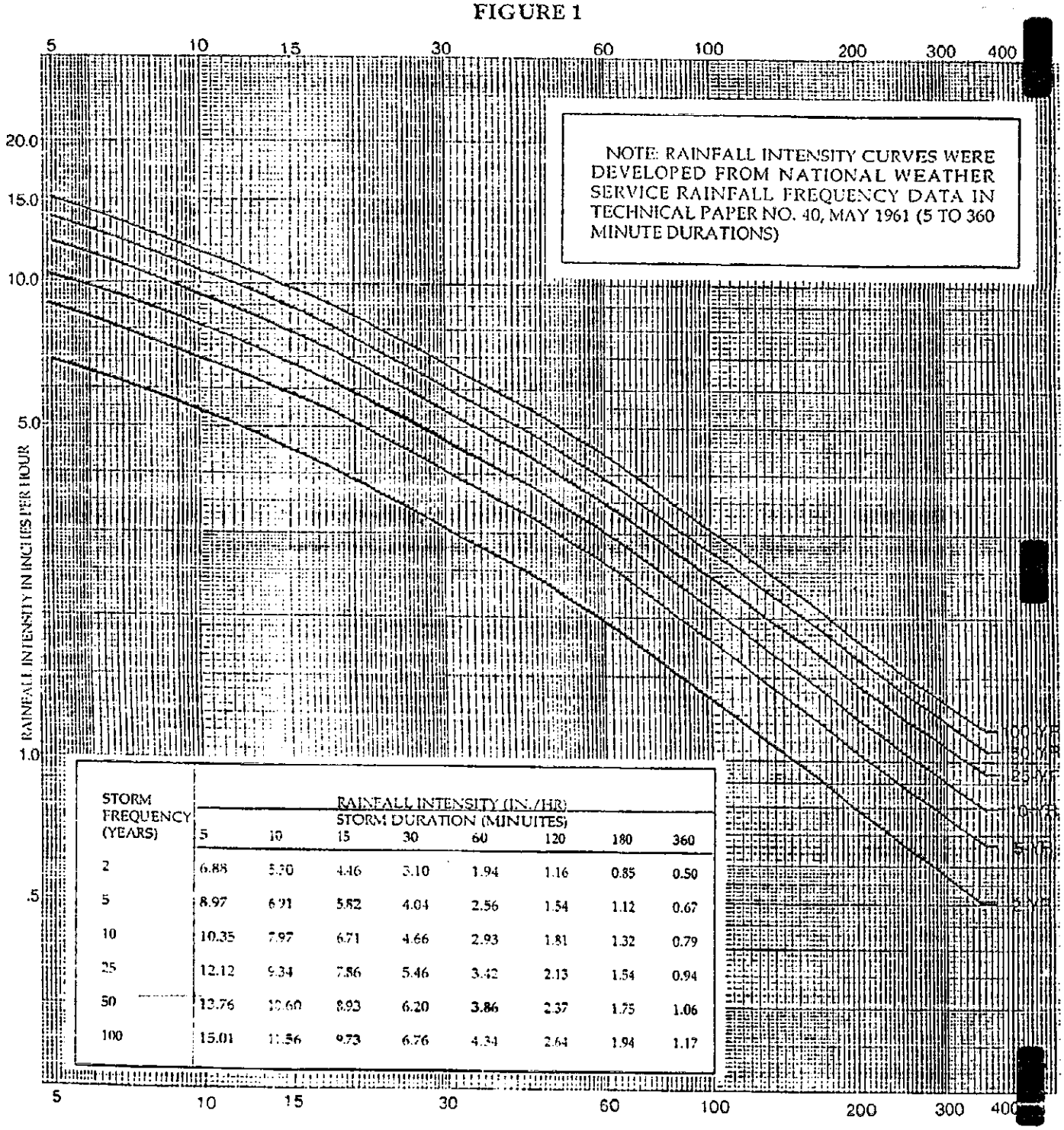
Remarks: The values apply to average, uniform stands of each type of cover. Use velocities exceeding 5 fps only where good covers and proper maintenance can be obtained. Based on past experience, all soils within the City of Mesquite have been found to be easily eroded soils.

* Longitudinal bed slope of the channel bottom.

00154

CITY OF MESQUITE RAINFALL INTENSITY VALUES

FIGURE 1



STORM FREQUENCY (YEARS)	RAINFALL INTENSITY (IN./HR) STORM DURATION (MINUITES) 5	10	15	30	60	120	180	360
2	6.88	5.30	4.46	3.10	1.94	1.16	0.85	0.50
5	8.97	6.91	5.82	4.04	2.56	1.54	1.12	0.67
10	10.35	7.97	6.71	4.66	2.93	1.81	1.32	0.79
25	12.12	9.34	7.86	5.46	3.42	2.13	1.54	0.94
50	13.76	10.60	8.93	6.20	3.86	2.37	1.75	1.06
100	15.01	11.56	9.73	6.76	4.34	2.64	1.94	1.17

CAPACITY OF TRIANGULAR GUTTERS

00155

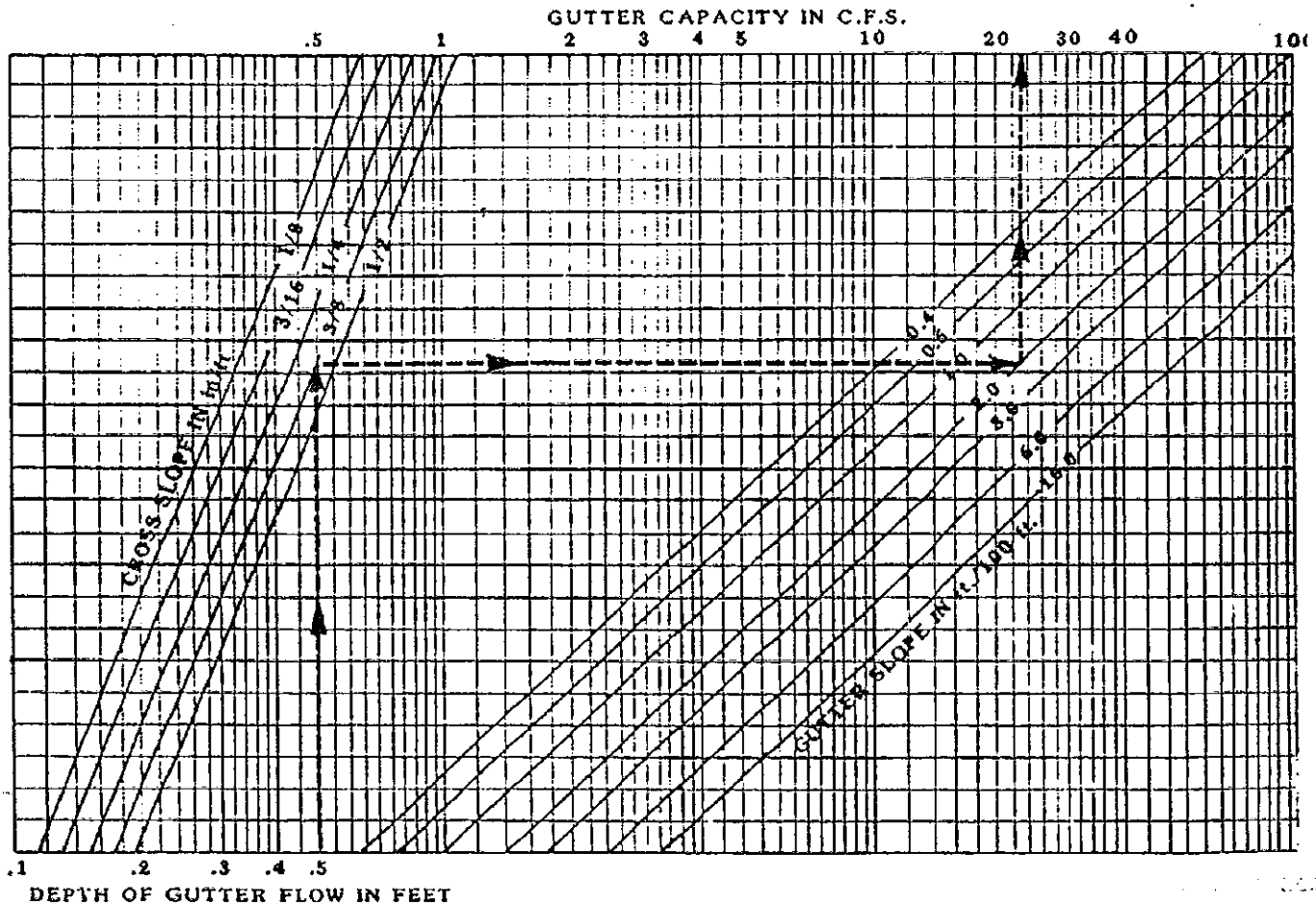
FIGURE 2

EXAMPLE

KNOWN :
MAJOR THOROUGHFARE, TYPE M6D
PAVEMENT WIDTH : 33'
GUTTER SLOPE : 2.0%
PAVEMENT CROSS SLOPE : 3/8"/1'
DEPTH OF GUTTER FLOW : .5'

FIND:
GUTTER CAPACITY

SOLUTION:
ENTER GRAPH AT .5'
INTERSECT CROSS SLOPE : 3/8"/1'
INTERSECT GUTTER SLOPE : 2.0%
READ GUTTER CAPACITY : 23.5 c.f.s.



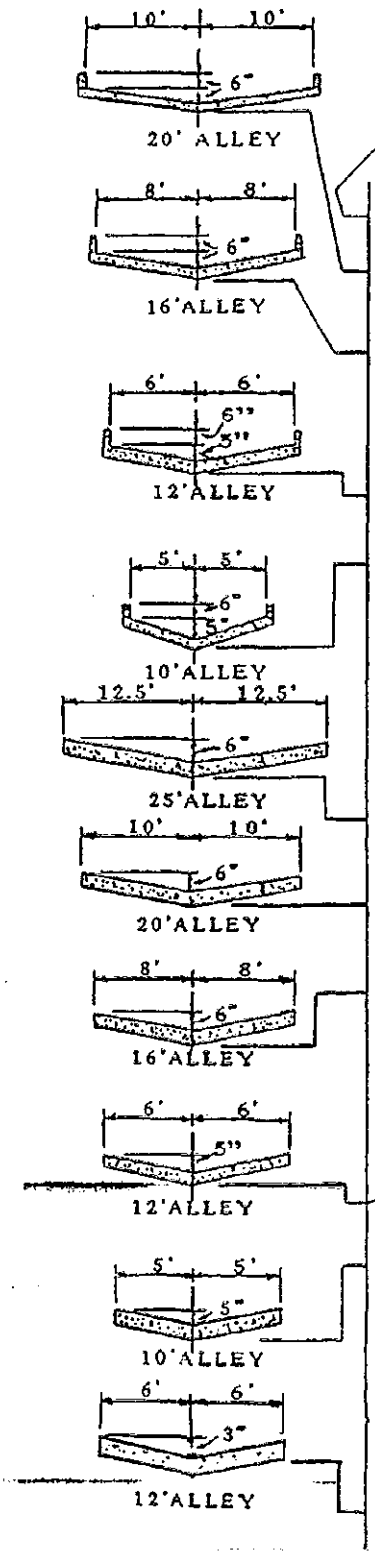
(ROUGHNESS COEFFICIENT n : .0175)

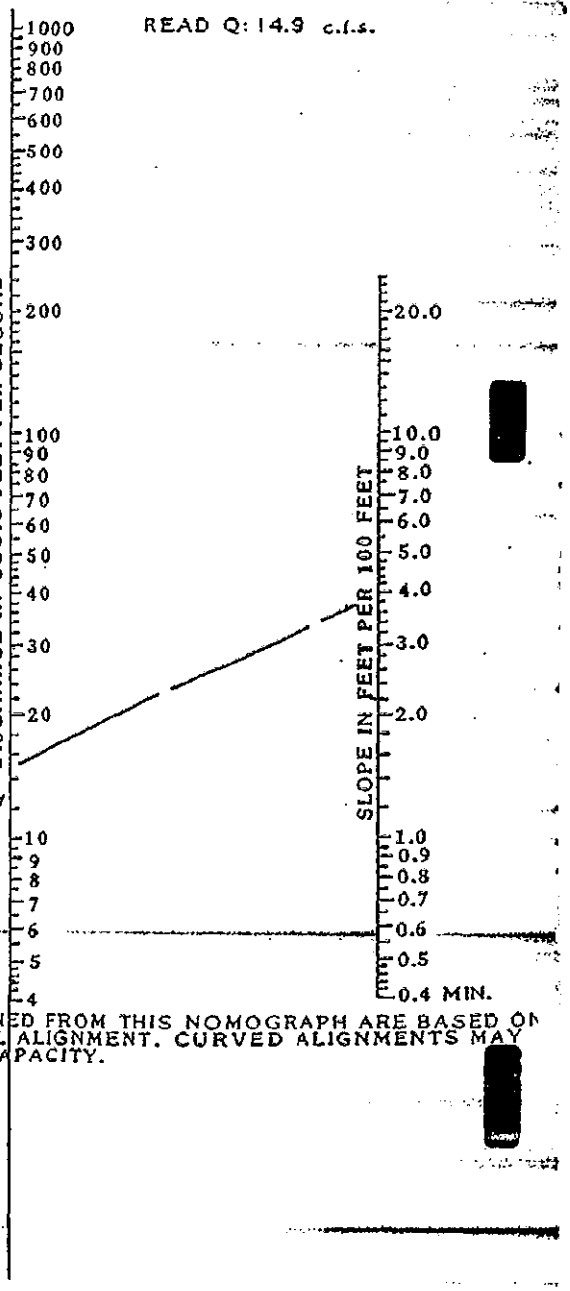
00156

CAPACITY OF ALLEY SECTIONS

n:0.0175

FIGURE 3





EXAMPLE :

KNOWN:
ALLEY WIDTH: 12'
ALLEY DEPRESSION: 5"
GUTTER SLOPE: 4.0%

FIND:
GUTTER FLOW (Q)

SOLUTION:
CONNECT THE 12' ALLEY SECTION WITH SLOPE: 4.0%
READ Q: 14.9 c.f.s.

NOTE:
THE CAPACITIES OBTAINED FROM THIS NOMOGRAPH ARE BASED ON A STRAIGHT HORIZONAL ALIGNMENT. CURVED ALIGNMENTS MAY RESULT IN REDUCED CAPACITY.

FIGURE 4

STORM DRAIN INLETS

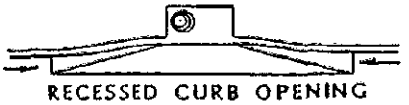
INLET DESCRIPTION	AVAIL. INLET SIZES	WHERE USED	DESIGN CURVES
 STANDARD CURB OPENING INLET ON GRADE	8' 10' 12' 14'	Residential Street, Collector Street - Types C2UA and C2UB; Alley	Figures 5 Through 8
 STANDARD CURB OPENING INLET AT LOW POINT	8' 10' 12' 14'	Residential Street, Collector Street - Types C2UA and C2UB; Alley	Figure 9
 RECESSED CURB OPENING INLET ON GRADE	8' 10' 12' 14'	Collector Street, Type C4U Major Streets - Types M4U, M4D, M6D, Principal Streets (P6D)	Figures 5 Through 8
 RECESSED CURB OPENING INLET AT LOW POINT	8' 10' 12' 14'	Collector Street, Type C4U Major Streets - Types M4U, M4D, M6D, Principal Streets (P6D)	Figure 9

FIGURE 4 CONTINUED

INLET DESCRIPTION	AVAIL. INLET SIZES	WHERE USED	DESIGN CURVES
 COMBINATION INLET ON GRADE	8'	Combination Inlets to be Used Where Space Behind Curb Prohibits Other Inlet Types	Figures 10 Through 12
 COMBINATION INLET AT LOW POINT Must Be Approved By The City Engineer	8'	Combination Inlets to be Used Where Space Behind Curb Prohibits Other Inlet Types	Figure 13
 GRATE INLETS Must Be Approved By The City Engineer	2 GRATE 3 GRATE 4 GRATE 6 GRATE	Grate Inlets to be Used Where Space Restrictions Prohibit Other Inlet Types or At Locations with No Curb.	Figures 14 THROU[redacted] 17
 DROP INLET	2' x 2' 3' x 3' 4' x 4'	Open Channels	Figure 18

NOTE: Combination inlets can be used on public streets only if approved by Manager of Engineering.

RECESSED AND STANDARD CURB OPENING INLET CAPACITY CURVES ON GRADE

FIGURE 5

EXAMPLE

KNOWN:

PAVEMENT WIDTH : 36'

GUTTER SLOPE: 3.0%

1/2"/ft CROSS SLOPE

GUTTER FLOW: 5.2 c.f.s.

FIND:

LENGTH OF INLET REQUIRED

SOLUTION:

ENTER GRAPH AT 5.2 c.f.s.

INTERSECT SLOPE: 3.0%

READ L_i: 8.8'

DECISION:

1. USE 10' INLET

NO FLOW REMAINS IN GUTTER

2. USE 8' INLET

INTERCEPT ONLY PART OF FLOW

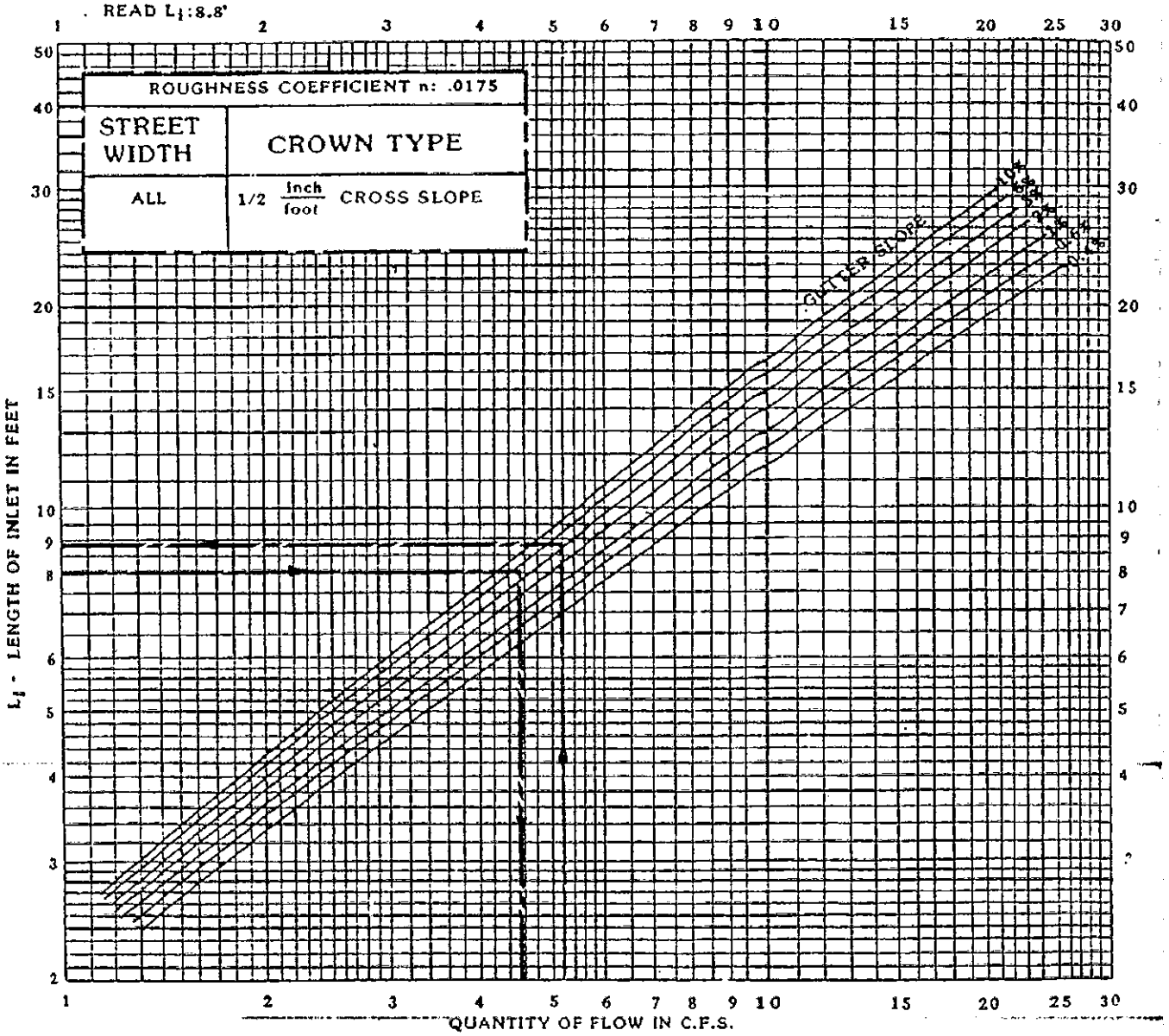
USE 8' INLET

ENTER GRAPH AT L_i: 8'

INTERSECT SLOPE: 3.0%

READ Q: 4.6 c.f.s.

REMAINING GUTTER FLOW: 5.2 c.f.s. - 4.6 c.f.s. = 0.6 c.f.s.



00130

RECESSED AND STANDARD CURB OPENING INLET CAPACITY CURVES ON GRADE

FIGURE 6

EXAMPLE

KNOWN:

PAVEMENT WIDTH: 30'

GUTTER SLOPE: 3.0%

PAVEMENT CROSS SLOPE: 1/4"/1'

GUTTER FLOW: 4.8 c.f.s.

FIND:

LENGTH OF INLET REQUIRED

SOLUTION:

ENTER GRAPH AT 4.8 c.f.s.

INTERSECT SLOPE: 3.0%

READ L_I: 9.5'

DECISION:

1. USE 10' INLET
   NO FLOW REMAINS IN GUTTER
2. USE 8' INLET
   INTERCEPT ONLY PART OF FLOW

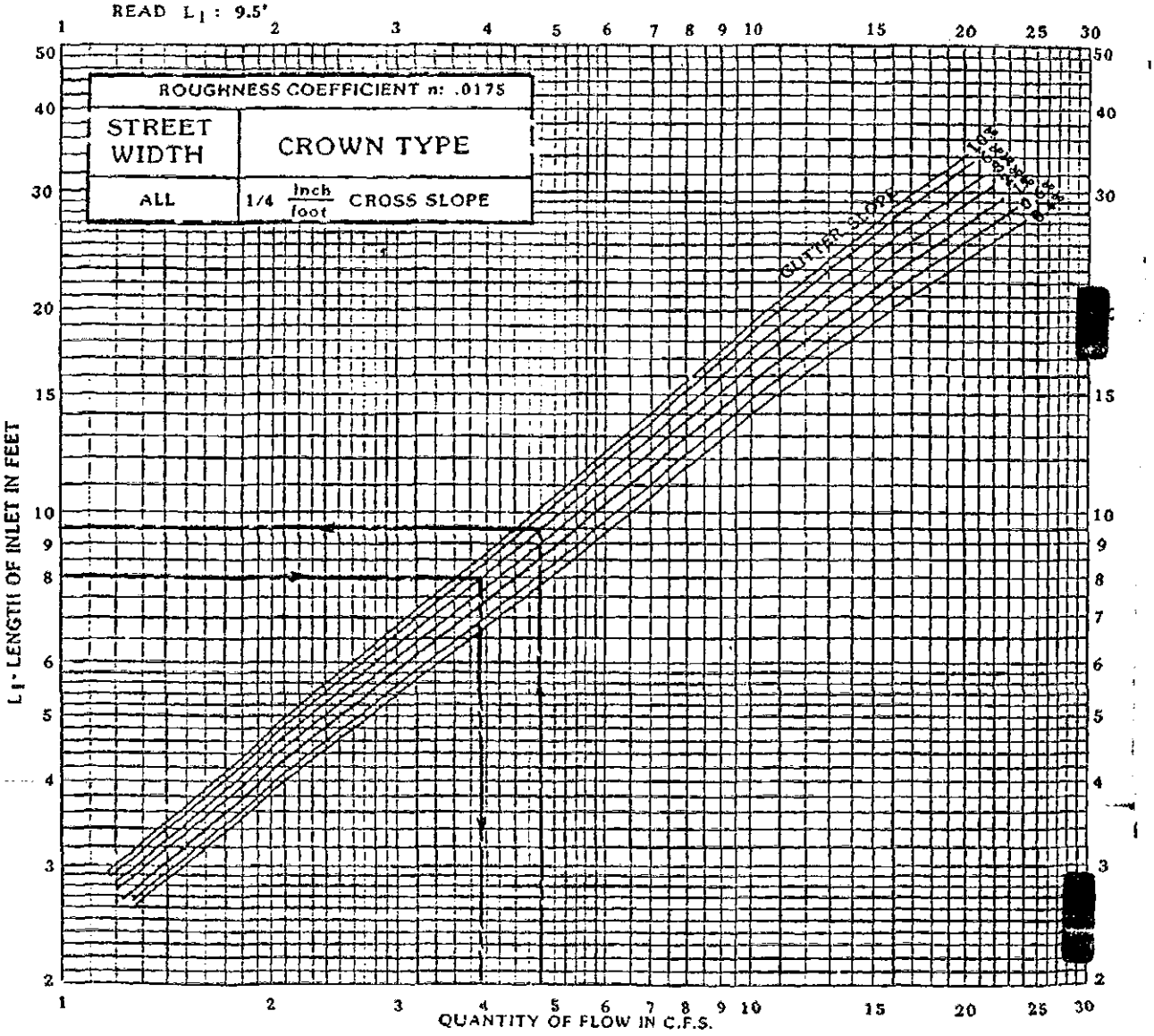
USE 8' INLET

ENTER GRAPH AT L_I: 8'

INTERSECT SLOPE: 3.0%

READ Q: 3.9 c.f.s.

REMAINING GUTTER FLOW: 4.8 c.f.s.-3.9 c.f.s.=0.9 c.



RECESSED AND STANDARD CURB OPENING INLET CAPACITY CURVES ON GRADE

FIGURE 7

EXAMPLE

KNOWN:

PAVEMENT WIDTH : 40'

GUTTER SLOPE: 1.0%

6" PARABOLIC CROWN

GUTTER FLOW: 6.5 c.f.s.

FIND:

LENGTH OF INLET REQUIRED

SOLUTION:

ENTER GRAPH AT 6.5 c.f.s.

INTERSECT SLOPE: 1.0 %

READ L_i : 10'

DECISION:

1. USE 10' INLET

NO FLOW REMAINS IN GUTTER

2. USE 8' INLET

INTERCEPT ONLY PART OF FLOW

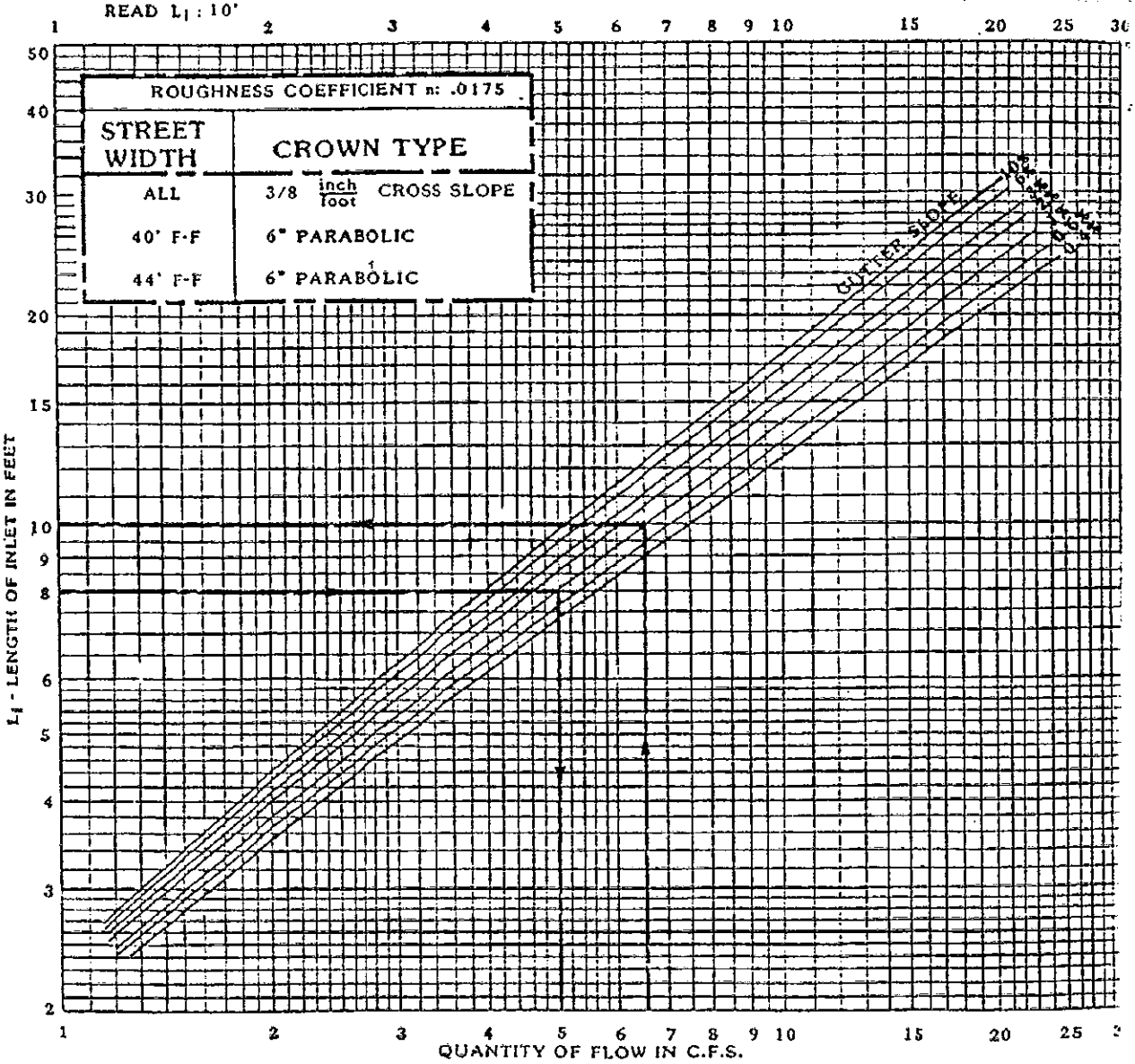
USE 8' INLET

ENTER GRAPH AT L_i : 8'

INTERSECT SLOPE: 1.0%

READ Q: 5.0 c.f.s.

REMAINING GUTTER FLOW: 6.5 c.f.s. - 5.0 cfs : 1.5



00162

RECESSED AND STANDARD CURB OPENING INLET CAPACITY CURVES ON GRADE

FIGURE 8

EXAMPLE

KNOWN:

PAVEMENT WIDTH : 12'

ALLEY SLOPE: 0.4%

QUANTITY OF FLOW: 10.5 c.f.s.

FIND:

LENGTH OF INLET REQUIRED

SOLUTION:

ENTER GRAPH AT 10.5 c.f.s.

INTERSECT SLOPE: 0.4%

READ L_1 : 13.0 ft.

DECISION:

1. USE 14' INLET

NO FLOW REMAINS IN GUTTER

2. USE 10' INLET

INTERCEPT ONLY PART OF FLOW

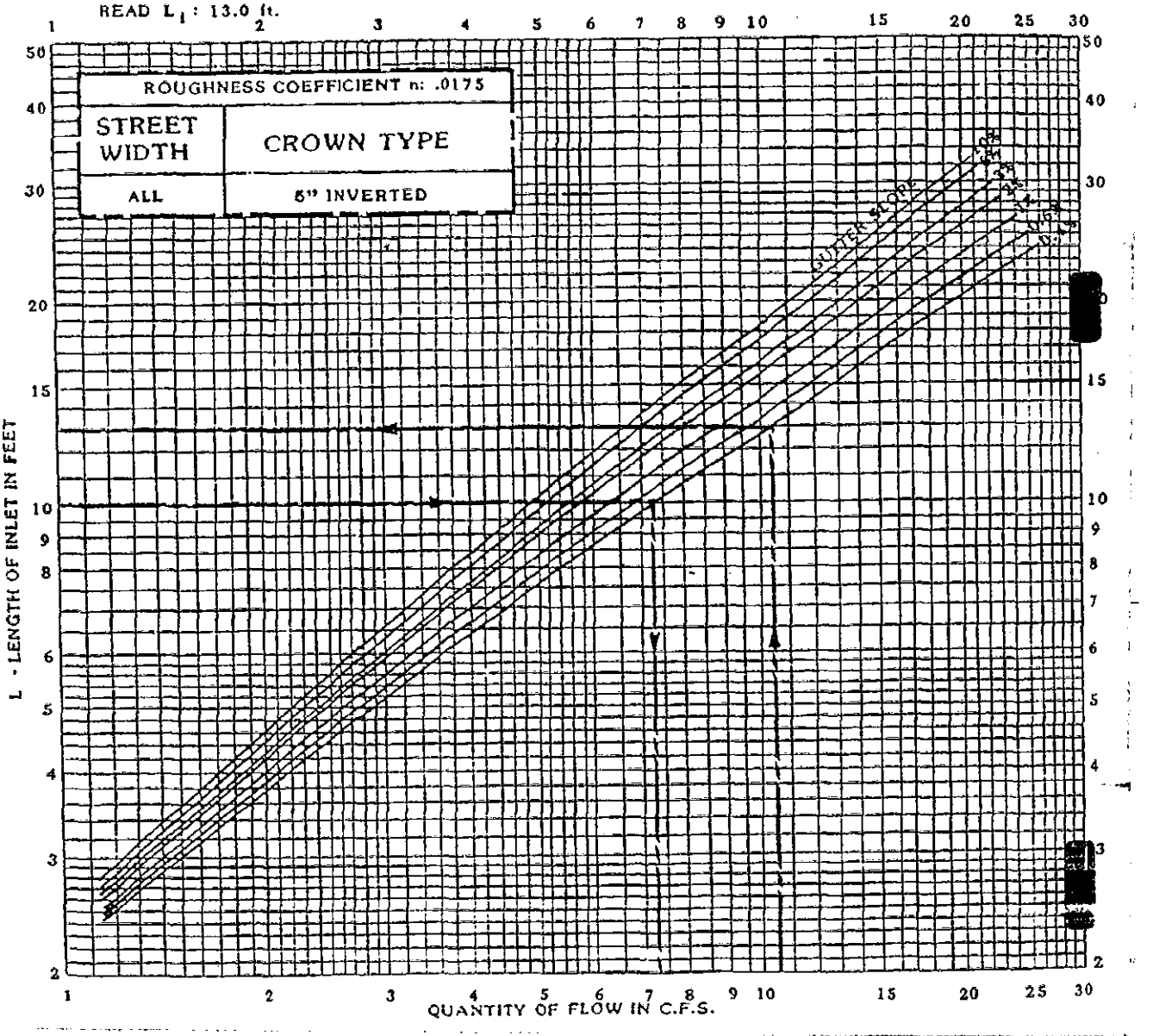
USE 10' INLET

ENTER GRAPH AT L_1 : 10'

INTERSECT SLOPE: 0.4%

READ Q: 7.3 c.f.s.

REMAINING FLOW IN ALLEY : 10.5 c.f.s. - 7.3 c.f.s. : 3.2 c.f.s.



RECESSED AND STANDARD CURB OPENING INLET CAPACITY CURVES AT LOW POINT

FIGURE 9

EXAMPLE

KNOWN:

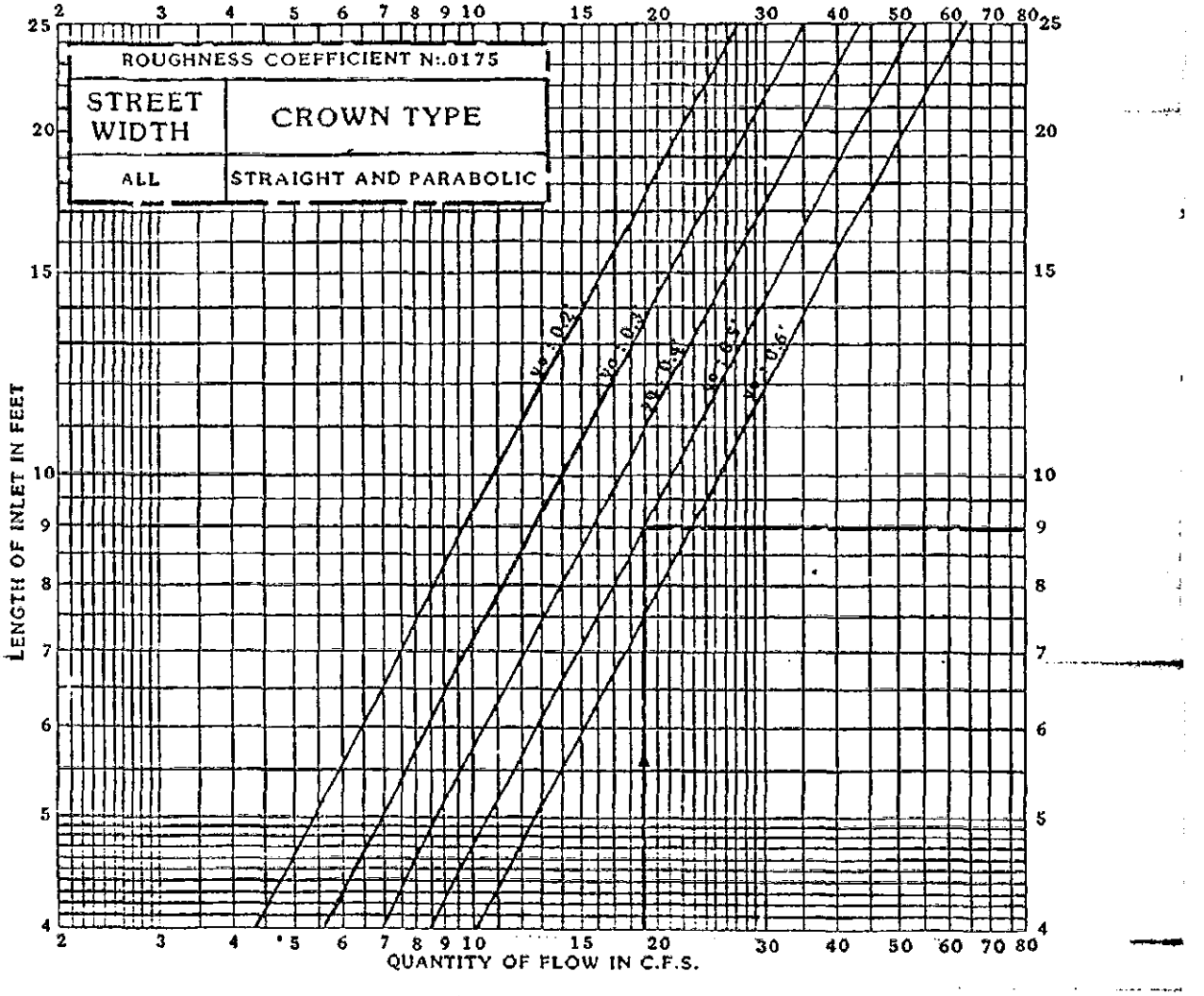
QUANITY OF FLOW: 19.0 c.f.s.
MAXIMUM DEPTH OF FLOW DESIRED IN GUTTER AT LOW POINT (yo): 0.5'

FIND:

LENGTH OF INLET REQUIRED (L_i)

SOLUTION:

ENTER GRAPH AT 19 c.f.s.
INTERSECT yo: 0.5'
READ L_i : 9.0'
USE 10' INLET



00164

TWO GRATE COMBINATION INLET CAPACITY CURVES ON GRADE

FIGURE 10

EXAMPLE

KNOWN:

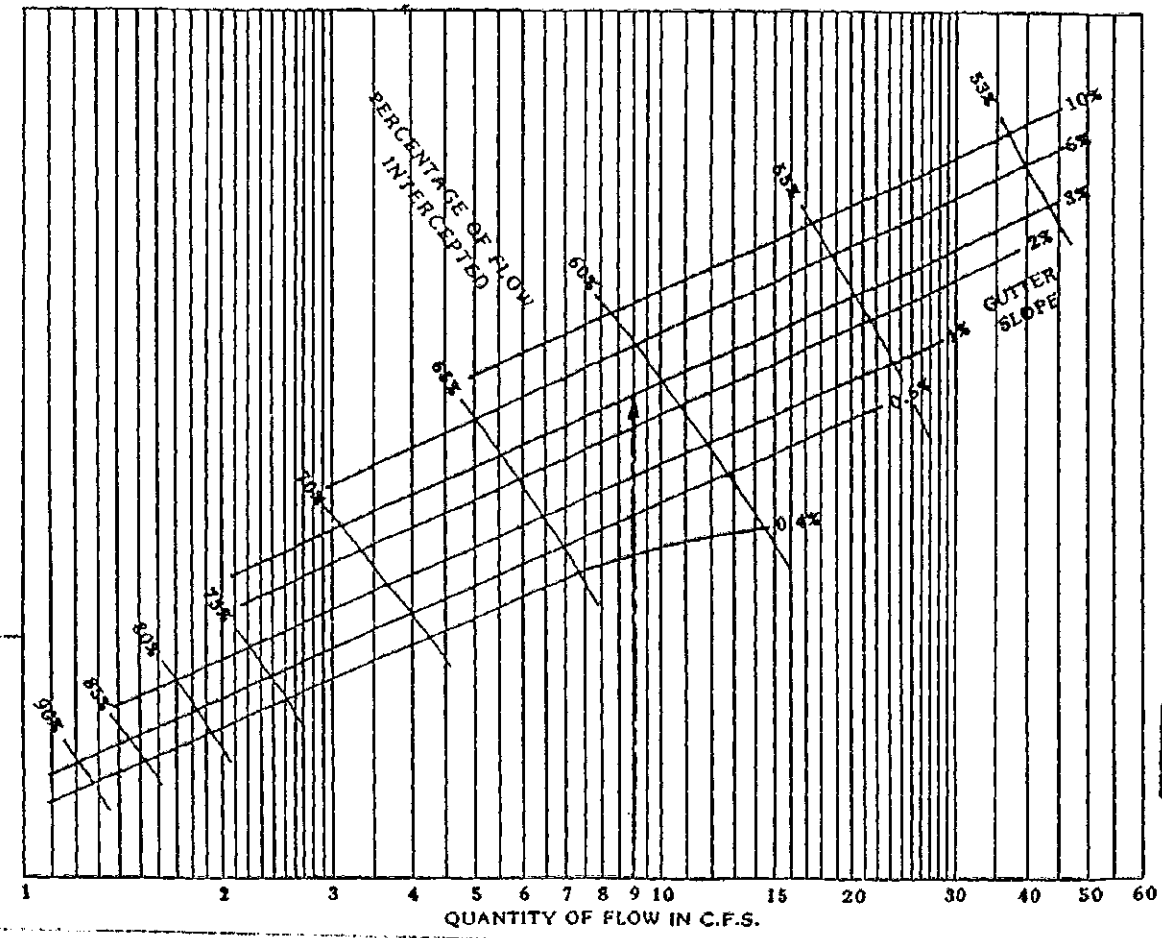
QUANITY OF FLOW: 9 c.f.s.
GUTTER SLOPE: 3.0%

FIND:

CAPACITY OF TWO GRATE COMBINATION INLET

SOLUTION:

ENTER GRAPH AT 9.0 c.f.s.
INTERSECT SLOPE: 3.0 %
READ PERCENT OF FLOW INTERCEPTED: 61%
61% OF 9.0 c.f.s. = 5.5 c.f.s.
AS CAPACITY OF TWO GRATE COMBINATION INLET
REMAINING GUTTER FLOW:
9.0 c.f.s. - 5.2 c.f.s. = 3.8 c.f.s.



THREE GRATE COMBINATION INLET
CAPACITY CURVES ON GRADE

FIGURE 11

EXAMPLE

KNOWN:

QUANTITY OF FLOW. 15 c.f.s.

GUTTER SLOPE: 2.0 %

FIND:

CAPACITY OF THREE GRATE INLET

SOLUTION:

ENTER GRAPH AT 15 c.f.s.

INTERSECT SLOPE: 2.0 %

READ PERCENT OF FLOW

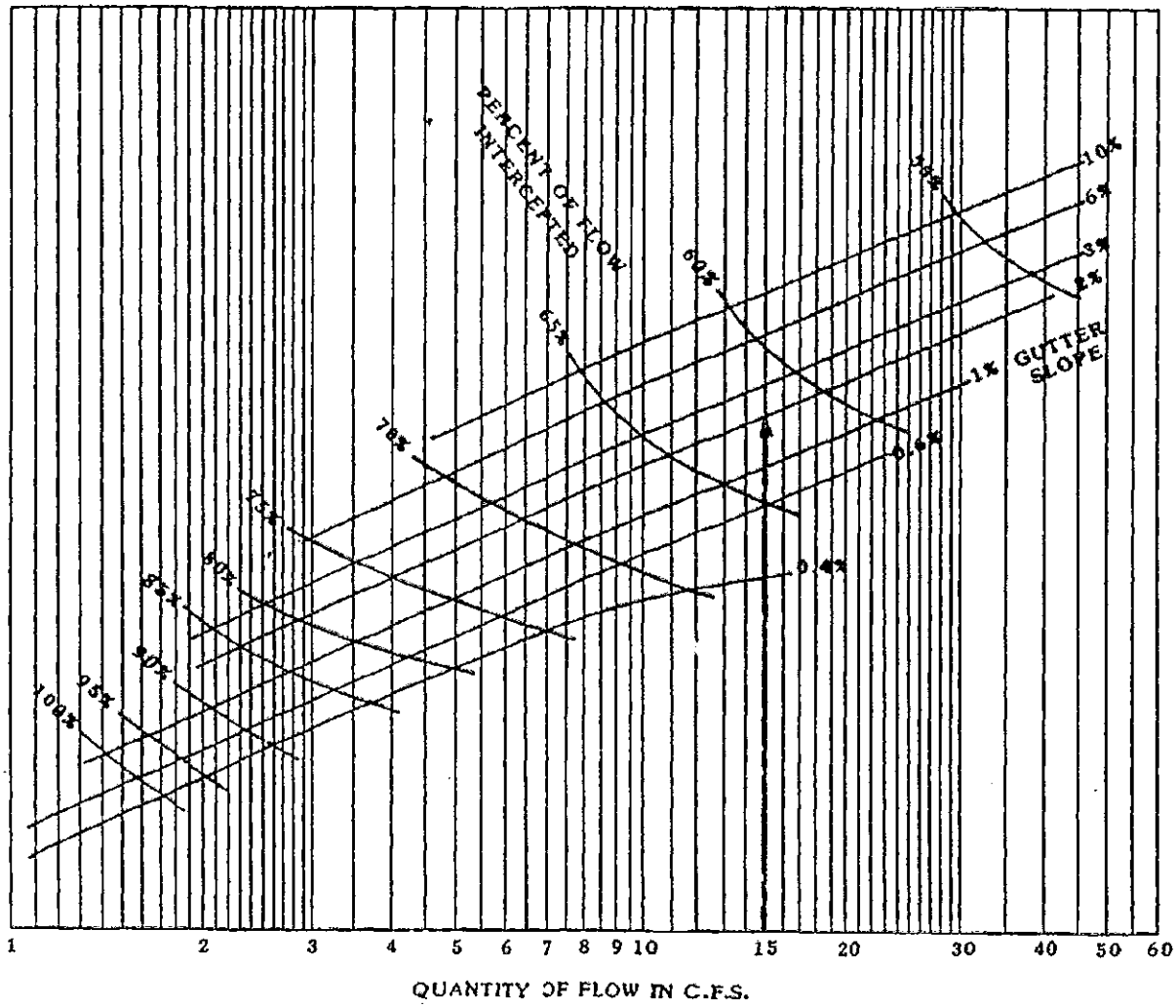
INTERCEPTED: 62%

62 % OF 15 c.f.s.: 9.3 c.f.s.

AS CAPACITY OF THREE GRATE INLET

REMAINING GUTTER FLOW:

15 c.f.s.-9.3 c.f.s. : 5.7 c.f.s.



00166

FOUR GRATE COMBINATION INLET CAPACITY CURVES ON GRADE

FIGURE 12

EXAMPLE

KNOWN:

QUANTITY OF FLOW: 12 c.f.s.

GUTTER SLOPE: 2.0 %

FIND:

CAPACITY OF FOUR GRATE COMBINATION INLET

SOLUTION:

ENTER GRAPH AT 12 c.f.s.

INTERSECT SLOPE: 2.0 %

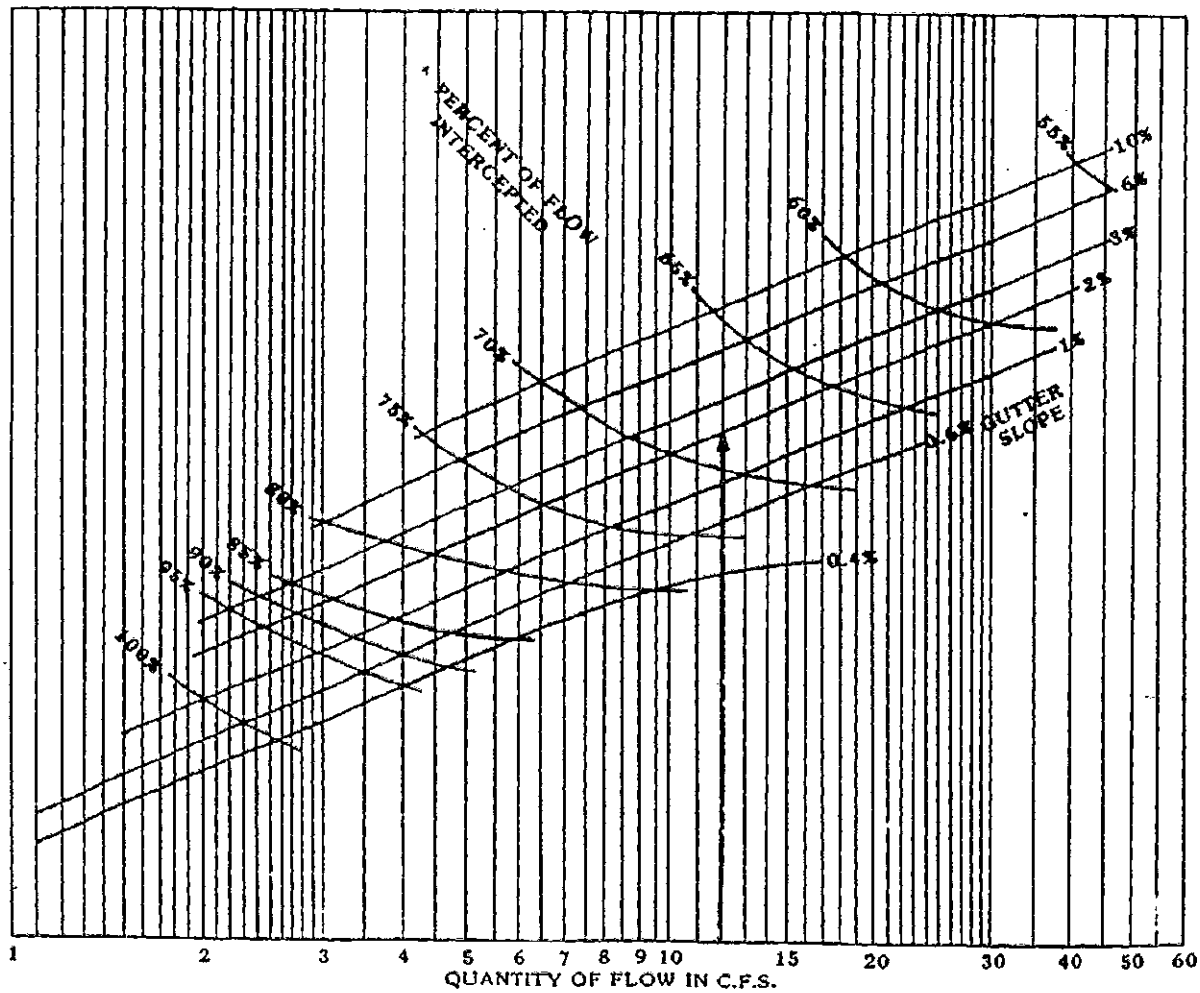
READ PERCENT OF FLOW INTERCEPTED: 68 %

68 % OF 12 c.f.s.: 8.2 c.f.s.

AS CAPACITY OF 4 GRATE COMBINATION INLET

REMAINING GUTTER FLOW:

12 c.f.s.-8.2 c.f.s. : 3.8 c.f.s.



COMBINATION INLET CAPACITY CURVES AT LOW POINT

FIGURE 13

EXAMPLE

KNOWN :

QUANTITY OF FLOW : 20.0 c.f.s.

MAXIMUM DEPTH OF FLOW DESIRED AT LOW POINT (yo) : 0.5'

FIND :

LENGTH OF INLET REQUIRED (Li)

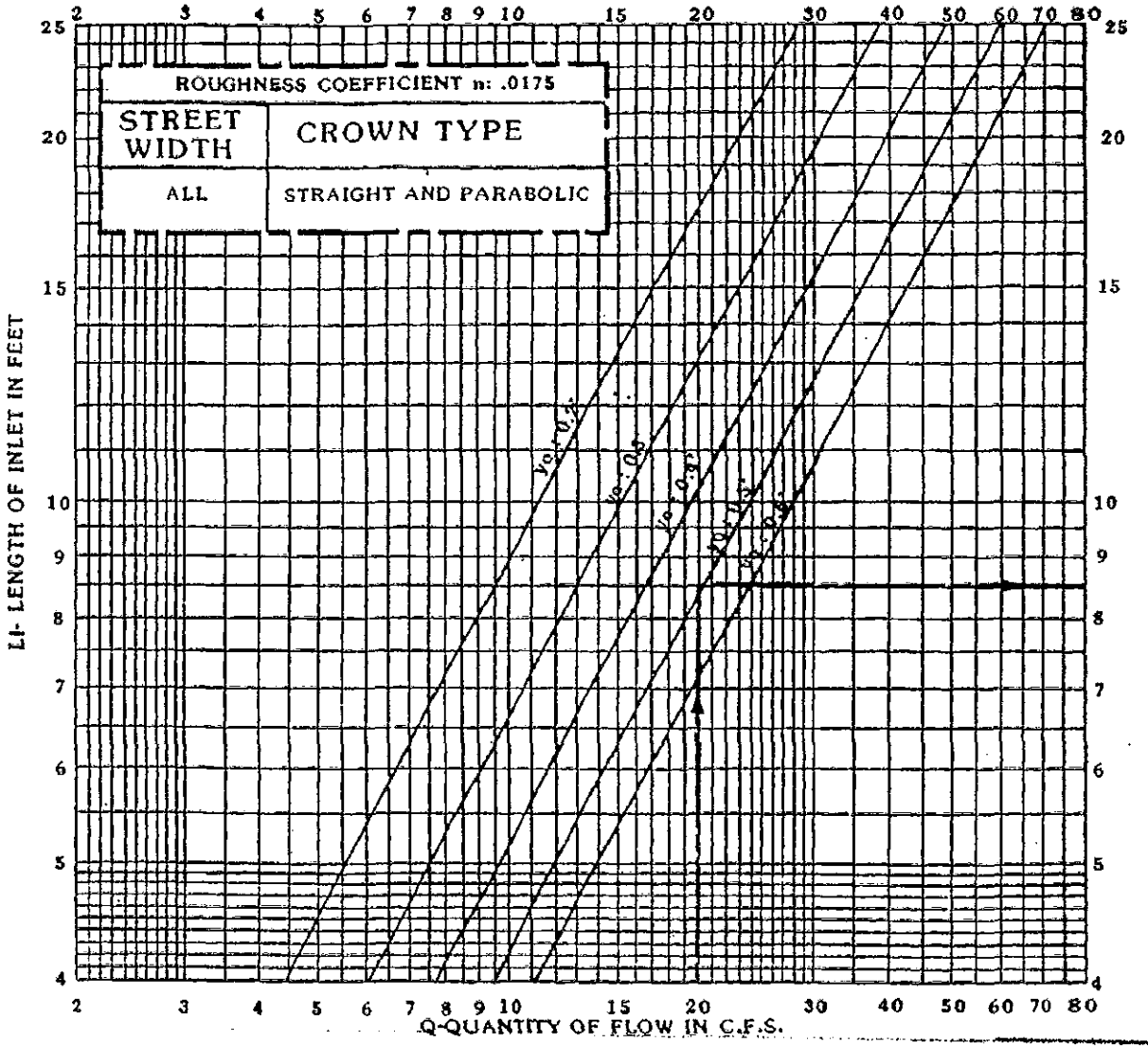
SOLUTION :

ENTER GRAPH AT 20.0 c.f.s.

INTERSECT yo : 0.5'

READ Li : 8.4

USE 10' INLET



TWO GRATE INLET CAPACITY CURVES ON GRADE

FIGURE 14

EXAMPLE

KNOWN:

QUANTITY OF FLOW: 5.0 c.f.s.

GUTTER SLOPE: 0.6 %

FIND:

CAPACITY OF TWO GRATE INLET

SOLUTION:

ENTER GRAPH AT 5.0 c.f.s.

INTERSECT SLOPE: 0.6 %

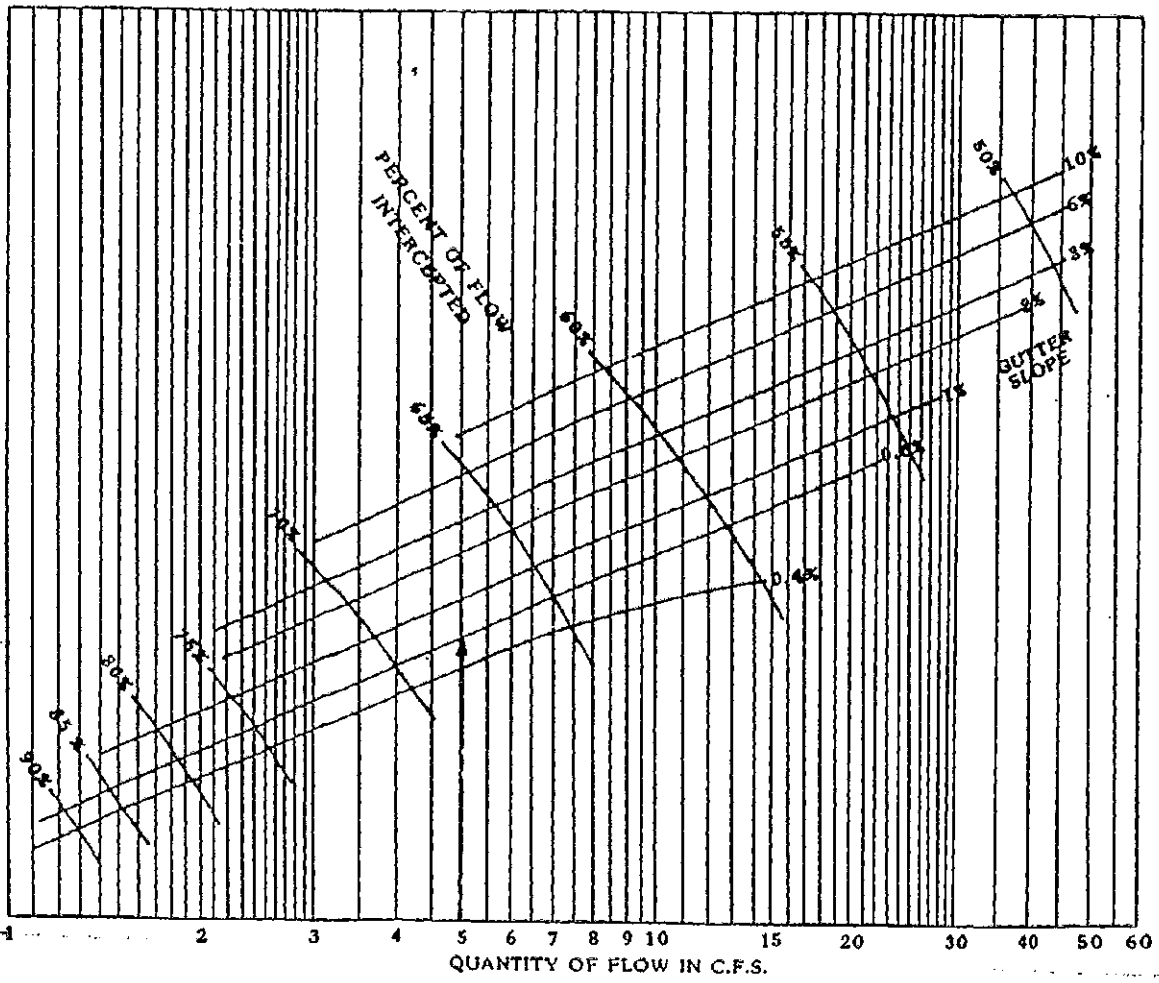
READ PERCENT OF FLOW INTERCEPTED: 63%

63 % OF 5.0 c.f.s. : 3.2 c.f.s.

AS CAPACITY OF TWO GRATE INLET

REMAINING GUTTER FLOW:

5.0 c.f.s. -3.2 c.f.s. : 1.8 c.f.s.



FOUR GRATE INLET CAPACITY CURVES ON GRADE

FIGURE 15

EXAMPLE

KNOWN:

QUANTITY OF FLOW: 20 c.f.s.

GUTTER SLOPE: 1.0 %

FIND:

CAPACITY OF FOUR GRATE INLET

SOLUTION:

ENTER GRAPH AT 20 c.f.s.

INTERSECT SLOPE: 1.0 %

READ PERCENT OF FLOW

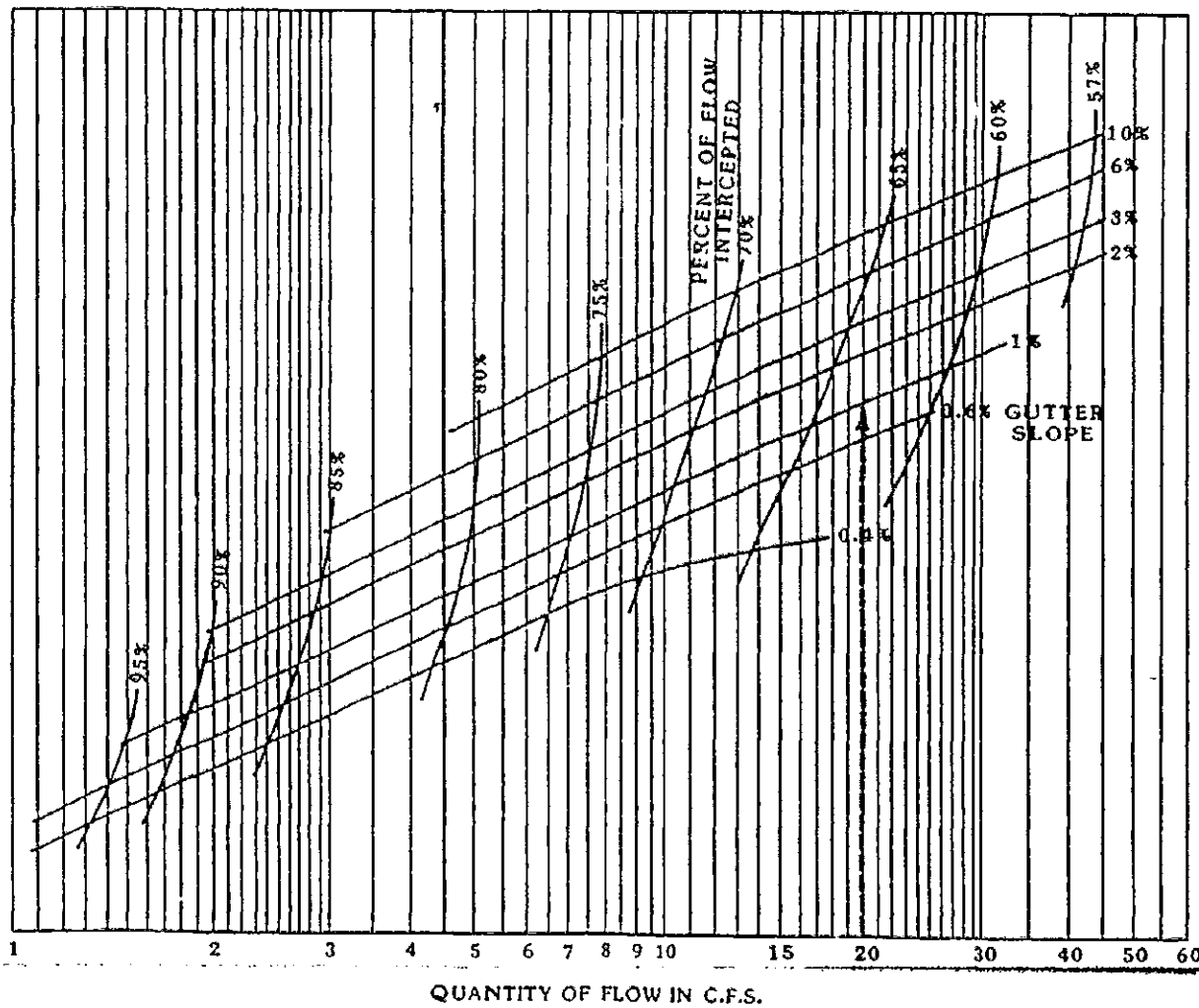
INTERCEPTED: 63 %

63 % OF 20 c.f.s.: 12.6 c.f.s.

AS CAPACITY OF FOUR GRATE INLET

REMAINING GUTTER FLOW:

20.0 c.f.s. − 12.6 c.f.s. = 7.4 c.f.s.



00170

SIX GRATE INLET CAPACITY CURVES ON GRADE

FIGURE 16

EXAMPLE

KNOWN:

QUANTITY OF FLOW: 4.0 c.f.s.

GUTTER SLOPE: 3.0 %

FIND:

CAPACITY OF SIX GRATE INLET

SOLUTION:

ENTER GRAPH AT 4.0 c.f.s.

INTERSECT SLOPE: 3.0 %

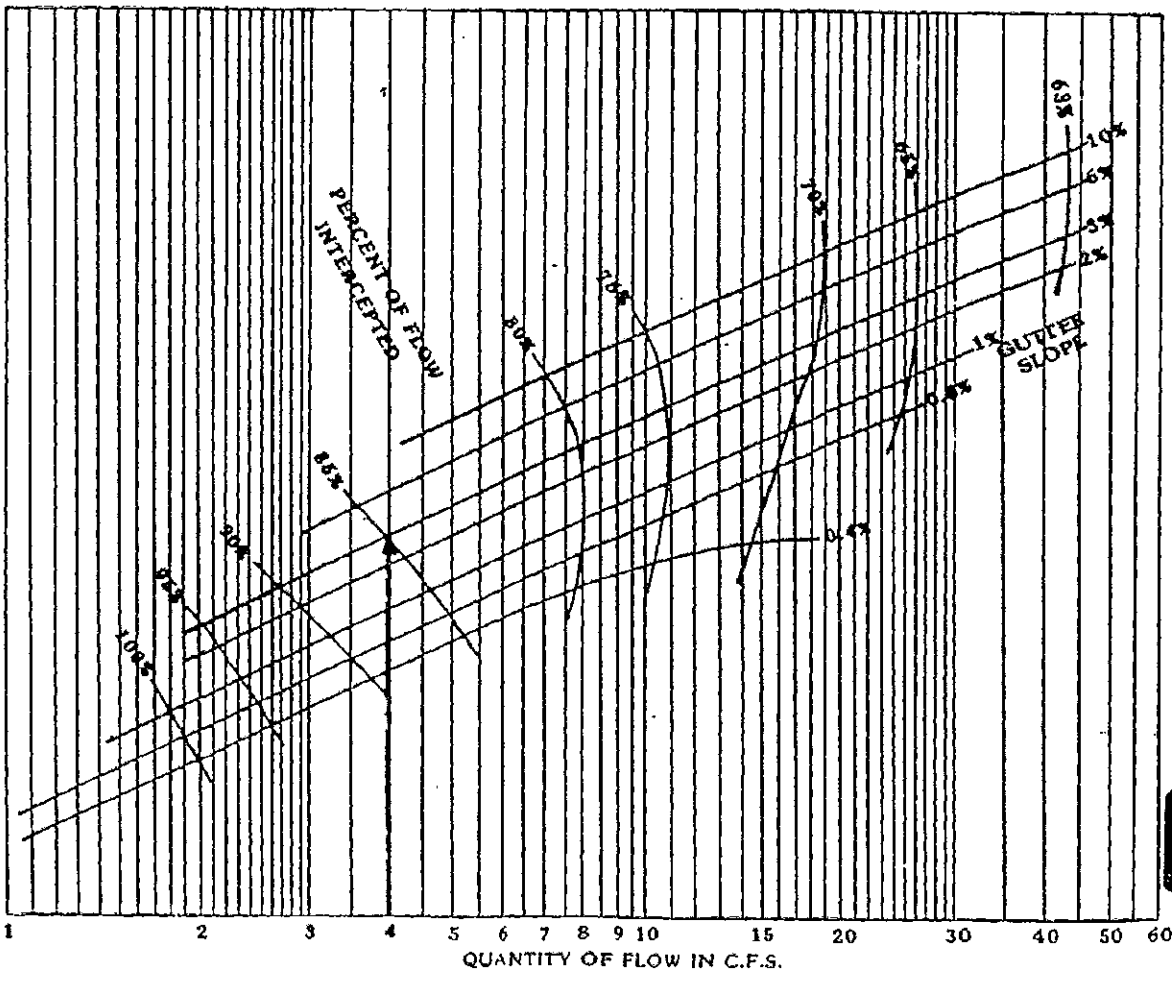
READ PERCENT OF FLOW INTERCEPTED: 85%

85% OF 4.0 c.f.s.: 3.4 c.f.s.

AS CAPACITY OF SIX GRATE INLET

REMAINING GUTTER FLOW:

4.0 c.f.s. - 3.4 c.f.s. : 0.6 c.f.s.



GRATE INLET
CAPACITY CURVES AT LOW POINT

00171

FIGURE 17

EXAMPLE

KNOWN:

QUANTITY OF FLOW: 4.8 c.f.s.

MAXIMUM DEPTH OF FLOW DESIRED AT LOW POINT: 0.4'

FIND:

INLET REQUIRED

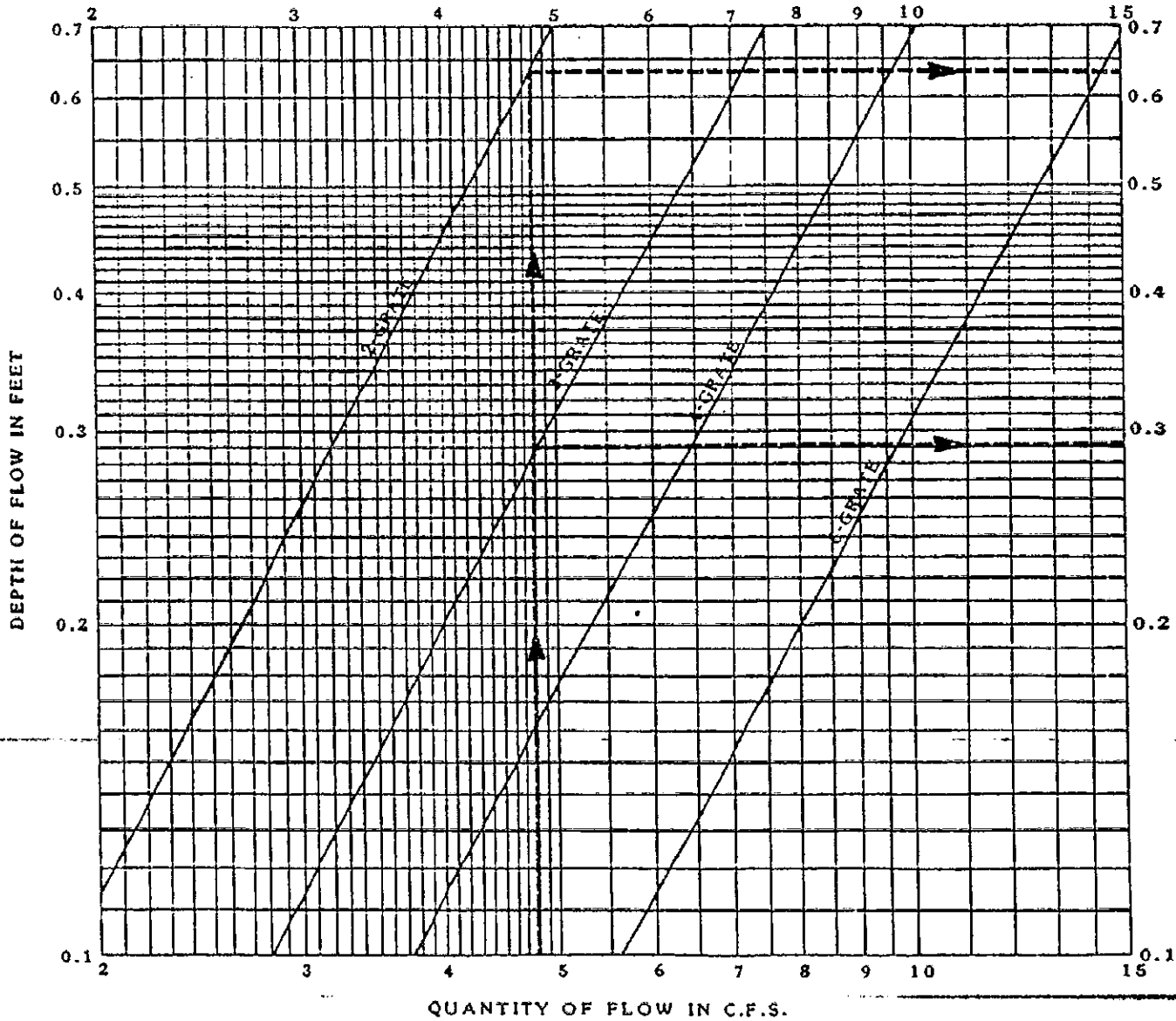
SOLUTION:

ENTER GRAPH AT 4.8 c.f.s.

INTERSECT 3 - GRATE AT 0.28'

INTERSECT 2 - GRATE AT 0.63'

USE 3 - GRATE



00172

DROP INLET
CAPACITY CURVES AT LOW POINT

FIGURE 18

EXAMPLE

KNOWN:

QUANTITY OF FLOW: 12 c.f.s.

MAXIMUM DEPTH OF FLOW DESIRED (yo): 0.5'

FIND:

LENGTH OF INLET OPENING REQUIRED (L_i)

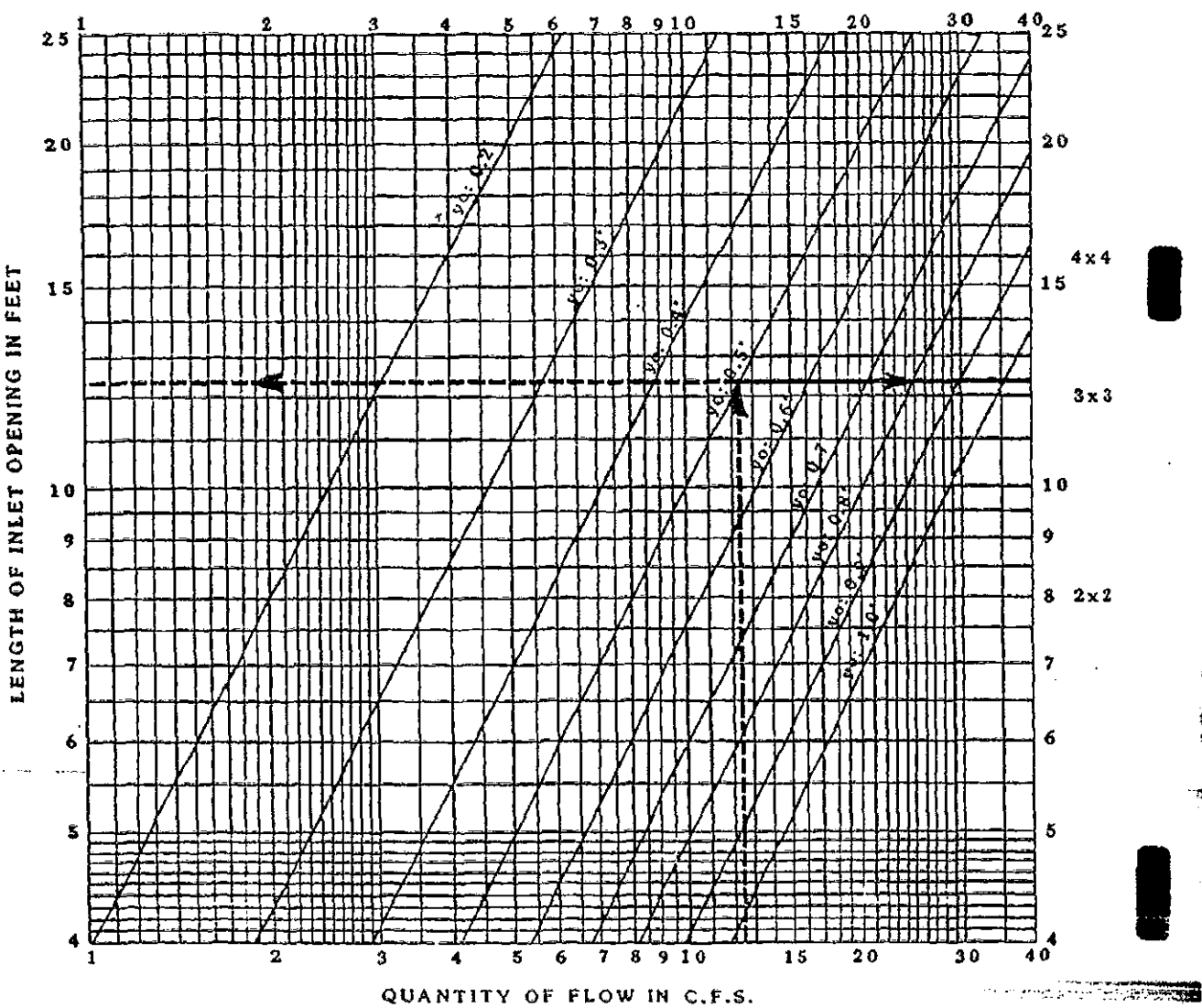
SOLUTION:

ENTER GRAPH AT 12 c.f.s.

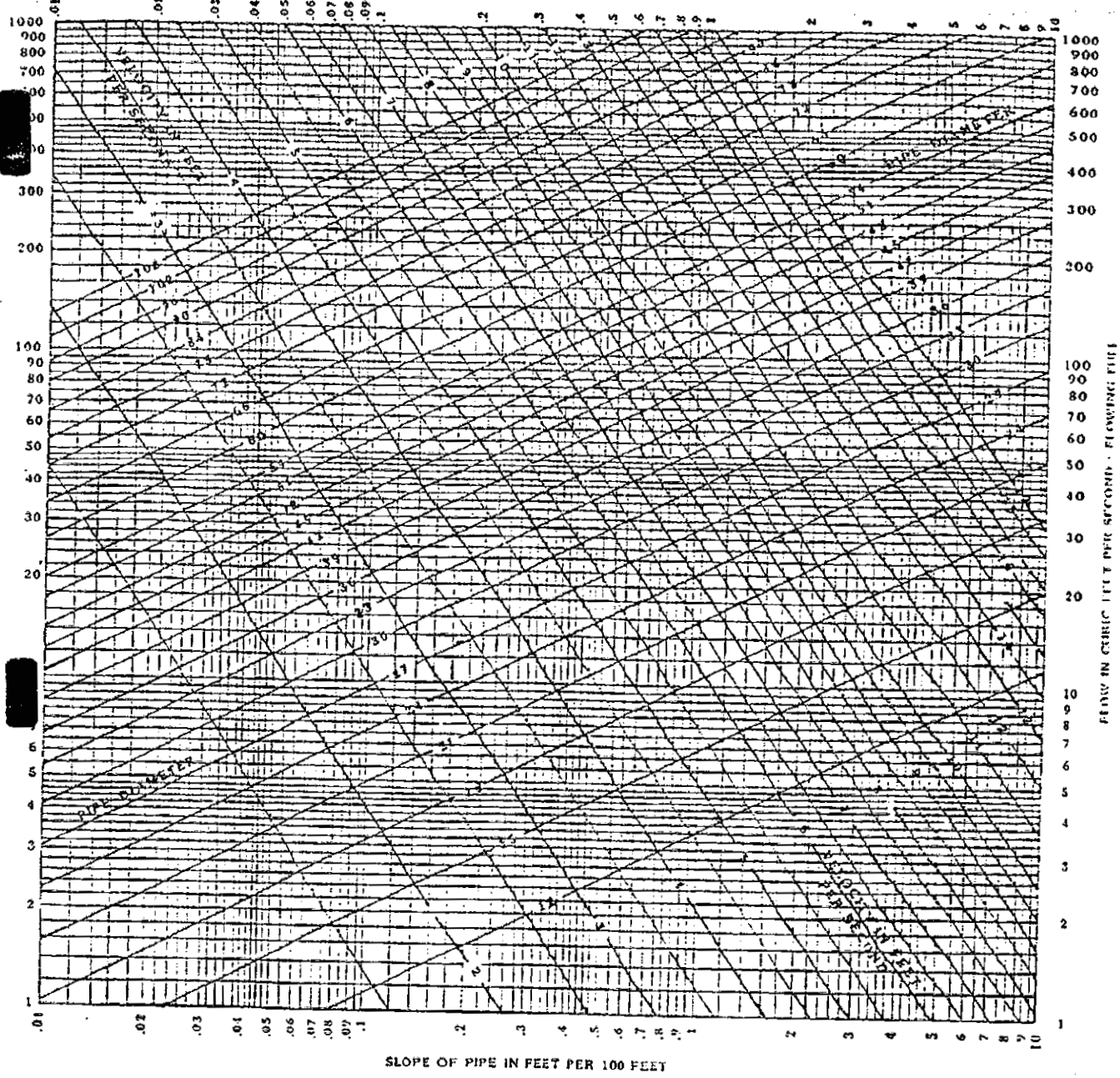
INTERSECT yo: 0.5'

READ L_i: 12.3

USE 12.3 OF INLET 4x4



STANDARD DROP INLET SIZES: 2'x 2', Li:8' 3'x 3', Li:12' 4'x 4', Li:16'



CAPACITY OF CIRCULAR
PIPES FLOWING FULL

FIGURE 19

A GRAPHICAL SOLUTION
OF
MANNING'S EQUATION

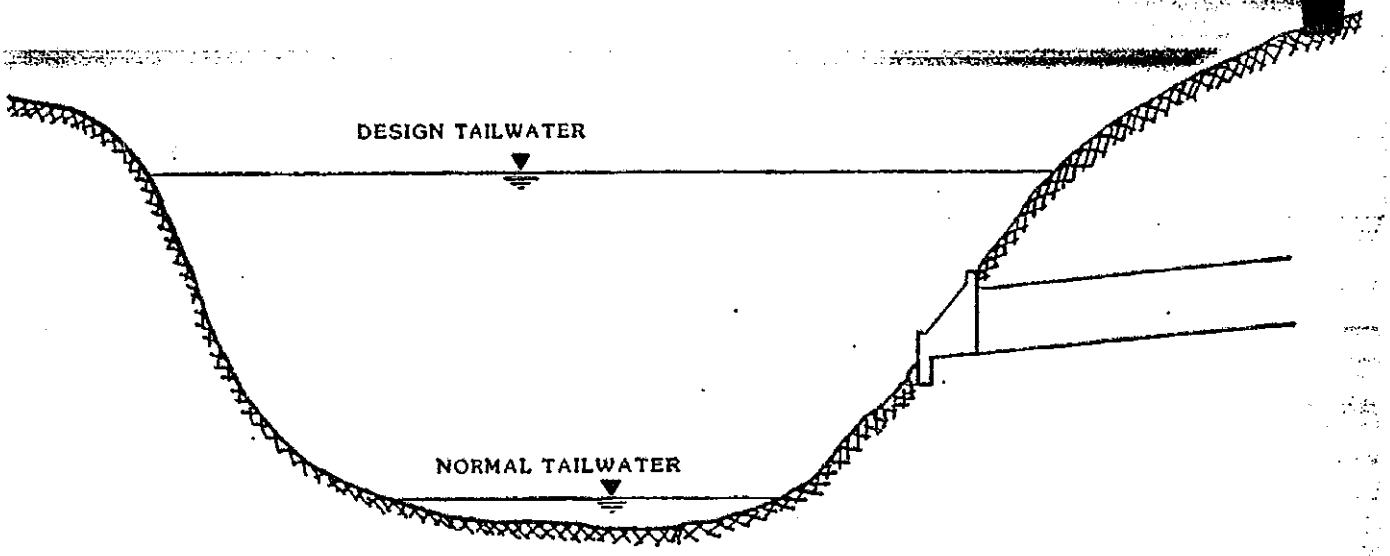
$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

$n = 0.013$

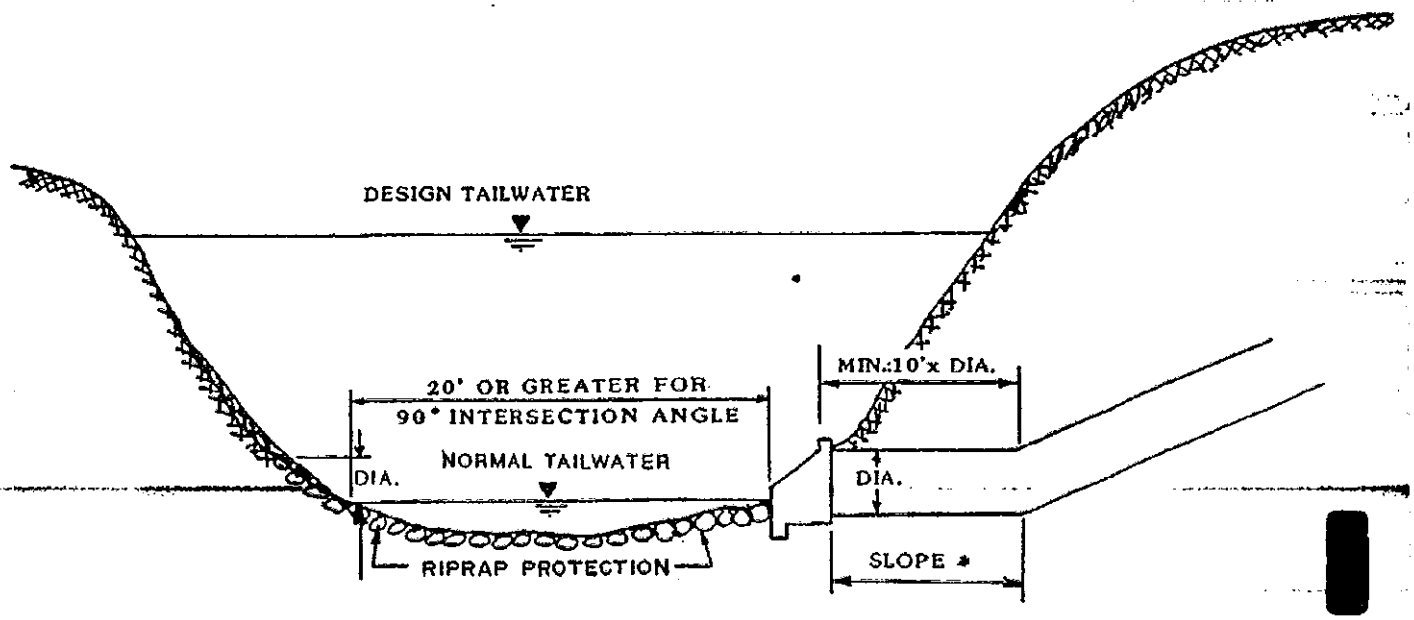
00174

OUTFALL OF A STORM SEWER INTO A CHANNEL

FIGURE 20



(NOT ALLOWED)

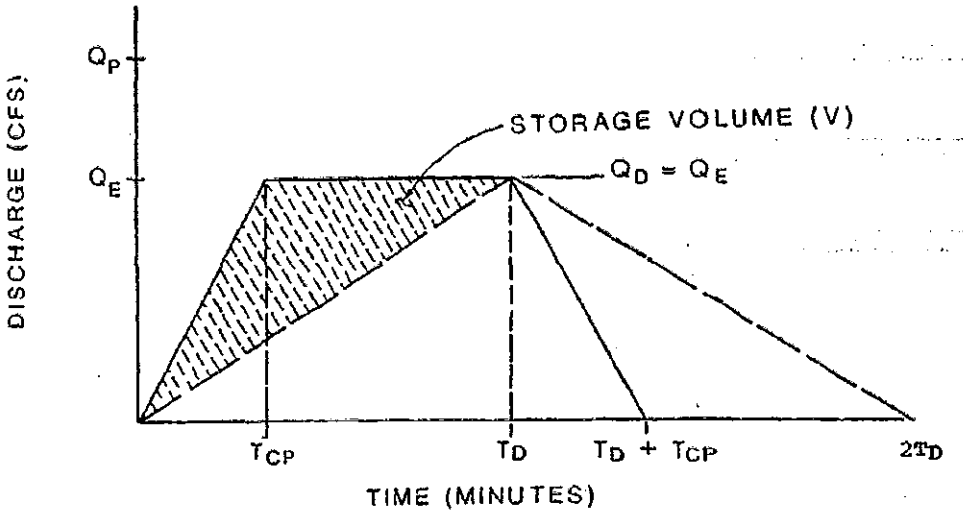


(ALLOWED)

* OUTFALL SLOPE SUCH THAT NONEROSIVE EXIT VELOCITIES WILL OCCUR.

FIGURE 21

Approximate Routing Method for Watersheds < 160 Acres



$$V = (60)\,[(Q_D[(T_D - T_{CP}) + (T_D + T_{CP})]/2) - (Q_E[T_{CP} + T_D]/2)]$$

in cubic feet.

or

$$V = 60\ (Q_{E/2})\ (T_D - T_{CP})$$

Where: Q_P = Peak discharge in cfs for developed watershed using storm duration equal to T_{CP}.

Q_E = Peak discharge in cfs for existing watershed, assuming full residential development and corresponding T_C.

Q_D = Peak discharge in cfs for developed watershed, based on a storm duration that yields the existing discharge for C_P and A.

T_{CP} = Time of concentration in minutes for proposed development.

T_D = Storm duration in minutes corresponding to I_D.

I_D = Rainfall intensity (inches/hour) for a storm duration that produces Q_D and is calculated using the following formula:

$$I_D = \frac{Q_D}{(C_P A)}$$

Where:

C_P = Rational "C" for developed condition.

A = Drainage area in acres.

FIGURE 21, *continued*

Detention Basin Example:

Development Data:

Drainage Area = 160 acres
Residential C = 0.60
Residential T_{CR} = 15 minutes
Developed C_P = 0.80
Developed T_{CP} = 10 minutes

For the 100-year storm:

I_{RES} = 9.73 in/hour (from Figure 1)
I_P = 11.56 in/hour.

$Q_E = Q_D = (0.60)\ (9.73)\ (160) = 934$ cfs

$Q_P = (0.80)\ (11.56)\ (160) = 1480$ cfs

$$I_D = \frac{Q_D}{(C_P A)} = \frac{934}{(.8)(160)} = 7.30 \text{ in/hour}$$

From Figure 1, for $I_D = 7.30$ in/hour,

T_D = 26.5 minutes

$$V = 60 \left(\frac{934}{2}\right) (26.5\text{-}10)$$

$$= 28{,}020\ (16.5) = 462{,}330 \text{ cubic feet}$$

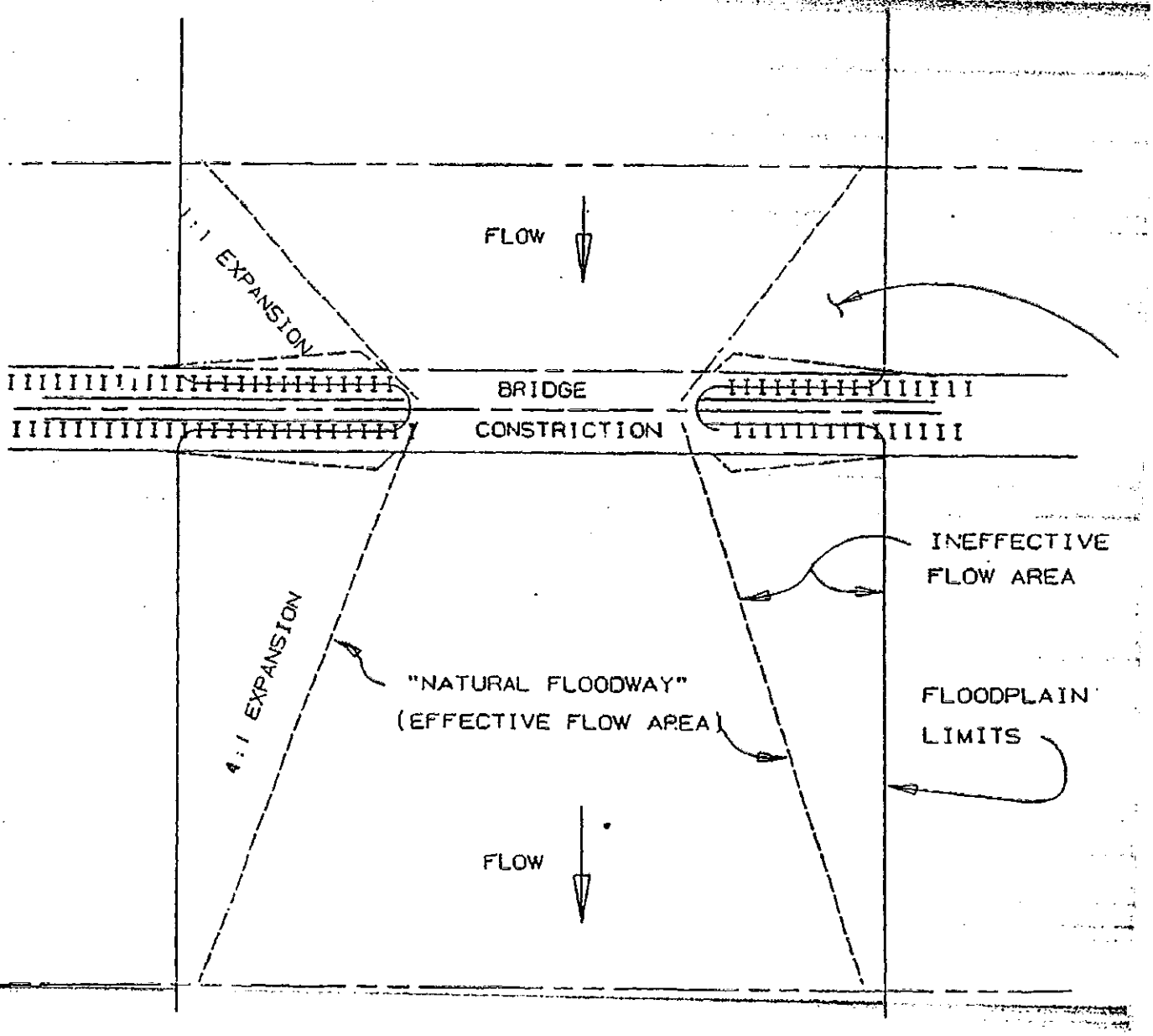


FIGURE 22. "Natural Floodway" Example