STORMWATER DRAINAGE DESIGN MANUAL

CITY OF JONESBORO
CRAIGHEAD COUNTY
ARKANSAS

September 2008

STORMWATER MANAGEMENT REGULATIONS

REGULATIONS DESIGNED TO LESSEN AND AVOID HAZARDS TO PERSONS AND PROPERTY CAUSED BY OBSTRUCTION TO DRAINAGE, AND TO OTHERWISE PROMOTE THE PUBLIC HEALTH, SAFETY AND GENERAL WELFARE.

ARTICLE 1

1.1 Title – These regulations shall hereafter be known, cited and referred to as the "Stormwater Management Regulations" of the City of Jonesboro, Arkansas.

1.2 Authority – These regulations are adopted pursuant to the power and authority vested through the applicable laws and statutes of the State of Arkansas.

1.3 Applicability – The provisions of this regulation are applicable to all persons, firms, corporations, business, or other legal entity proposing to develop land in the City of Jonesboro Planning jurisdiction.

1.4 Purpose – In order to promote the public health, safety, and general welfare of the citizens of Jonesboro, the provisions of these regulations are intended to: (1) reduce property damage and human suffering, (2) minimize the hazards of personal injury and loss of life due to flooding, and (3) protect water quality and the environment.

1.5 Definitions – For the purpose of these regulations, certain terms and words shall be used, interpreted, and defined as set forth in this section. Unless the context clearly indicates to the contrary, words used in the present tense include the future tense; words used in the singular shall include the plural, and vice-versa; and the word, "shall," is always mandatory.

A. Base Flood – The flood that has a one (1) percent chance of being equaled or exceeded in any given year, i.e., the 100-Year Flood.

B. Bond – The form of security for the completion or maintenance of drainage improvements.

C. Building – Any structure built for the support, shelter, or enclosures of persons, animals, chattels, or movable property of any kind.

D. Channel – Course of perceptible extent which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water, and which has a definite bed and banks.

E. Compliance Letter – An acceptance letter issued by the City Engineer based upon the review of the Stormwater Management plan or construction plans as prepared and certified by the Engineer of Record for a project.

F. Conduit – Any open or closed device for conveying flowing water.

G. Critical Facilities – Include: Governmental facilities that are considered essential for the delivery of critical services and crisis management (such as data and

communication centers and key governmental complexes); facilities that are essential for the health and welfare of the whole population (such as hospitals, prisons, police and fire stations, emergency operations centers, evacuation shelters and schools); mass transportation facilities (such as airports, bus terminals, train terminals); lifeline utility systems (including potable water, wastewater, oil, natural gas, electric power and communications systems); high potential loss facilities (such as nuclear power plants or military installations); hazardous material facilities (such as industrial facilities housing or manufacturing or disposing or corrosives, explosives, flammable materials, radioactive materials and toxins).

H. Detention – The temporary detaining or storage of floodwater in reservoirs, on parking lots, on rooftops, and other areas under predetermined and controlled conditions accompanied by controlled release of the stored water.

I. Detention Basins – Any man-made area which serves as a means of controlling and temporarily storing stormwater runoff. The facility normally drains completely between spaced runoff events, e.g., parking lots, rooftops, athletic fields, dry wells, oversized storm drain pipes.

J. Developer – A person, legal entity, or its representative that improves unimproved land or rehabilitates or adds improvements to an existing improvement on previously improved land.

K. 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, or drilling operations or storage of equipment or materials.

L. Differential Runoff – The volume and rate of flow of stormwater runoff discharged from a parcel of land or drainage area which is or will be greater than the volume and rate which existed prior to the development.

M. Drainage Easement – Authorization by a property owner for use by another party or parties for all or any portion of his, her, or its land for drainage purposes.

N. Engineer of Record – A professional engineer registered in the State of Arkansas who is responsible for the design and construction administration, observation, and inspection of the stormwater facilities proposed for specific development or redevelopment projects of all facilities to be dedicated to the City of Jonesboro.

O. Flooding – An overflowing of water resulting in the inundation or submergence of normally dry land.

P. Floodplain – A land area adjoining a watercourse which is likely to be flooded.

Q. Floodway – The channel of a watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without a cumulative increase of the water surface elevation more than a designated height.

R. Freeboard – A factor of safety expressed as the difference in elevation between the top of the detention basin dam, levees, culvert entrances and other hydraulic structures, and the design flow elevation.

S. Grading Permit – A permit issued by the City Engineer which allows land disturbance activities (e.g., clearing, grading, excavation, etc.) on a specific development.

T. Lowest Floor – Refers to the lowest floor of the lowest enclosed area (including basement). For a typical **slab-on-grade construction**, the elevation of the lowest floor is the top of the first floor of the house. For a typical **basement foundation construction**, the elevation of the lowest floor is the top of the basement floor. For a typical **crawlspace foundation construction**, the elevation of the lowest floor is the top of the first floor of the house. For typical **split-level constructions**, the elevation of the lowest floor is the top of the first living floor – the **garage floor** is not the lowest floor as long as there are no living areas in the garage and it is used solely for storage, parking vehicles and entry to the house. The elevation of the lowest floor of **a manufactured home**, however, is the bottom surface of the lowest floor joist.

U. Maintenance:

Short-term Maintenance – General upkeep of the site and facilities, specifically the mowing or trimming of grasses or other vegetative cover and the removal of litter and other minor debris that could impact the functionality of the facilities or that would otherwise be considered unsightly or a nuisance.

Long-term Maintenance – Removal of sediment deposits, re-grading or shaping of embankments, drainage channels, and detention areas, and repair or replacement of piping networks, and other drainage structures.

V. NRCS (SCS) Method – A methodology developed by the Natural Resources Conservation Service (formerly the Soil Conservation Service) for obtaining a design hydrograph to simulate the discharge from a watercourse over a specific time period.

W. On-site Detention – Temporary storage of runoff on the same land or development site where the runoff is generated.

X. Peak Flow – The peak rate of flow of water at a given point in a watercourse or conduit.

Y. Plat – A legally recorded plat of a parcel of land subdivided into lots with streets, alleys, easements, and other land lines drawn to scale.

Z. Project – Any development involving the construction, reconstruction, or improvement of structures or grounds, or both.

AA. Retention Basin – A stormwater detention facility which maintains a fixed minimum water elevation between runoff events except for the lowering resulting from losses of water to infiltration or evaporation.

BB. Special Flood Hazard Area (SFHA) – The land area covered by the floodwaters of the base flood.

CC. Stormwater Drainage Design Manual – The set of drainage policies, analysis methods, design charts, stormwater runoff methods, and design standards used by the City of Jonesboro as the official design guidelines for drainage improvements consistent with the regulations.

DD. Stormwater Management System – The collection of open channels, drainage swales, detention facilities, retention facilities, and enclosed conduits that comprise the overall drainage system for an area or region.

EE. Stormwater Runoff – Water that results from precipitation which is not absorbed by the soil, evaporated into the atmosphere, or entrapped by ground surface depressions and vegetation, which flows over the ground surface.

FF. Stormwater Runoff Management Facility – Any facility constructed to manage or otherwise control the flow of stormwater runoff from a site including but not limited to open channels, drainage swales, detention facilities, retention facilities, or enclosed stormwater conveyance systems.

GG. Structure – Any object constructed above or below ground. Pipes, manholes, and certain other utility structures which exist underground may be excluded from the definition.

HH. Sub-basin – The area that contributes stormwater runoff to a given point in the overall stormwater management system.

II. Substantial Damage – Damage of any origin where the cost to restore a structure to its original undamaged state would equal or exceed 50% of the market value of the structure before any damage occurred. In determining whether substantial damage has occurred, estimators must use standard contractor and materials costs. There are no exceptions for homeowners who make their own repairs or for discounted or free raw materials.

JJ. Substantial Improvement – Any reconstruction, remodeling, addition or improvement to a structure with a cost equaling or exceeding 50% of the market value of the structure before any improvement. Improvements to correct indentified violations of local health, sanitary or safety Codes are not substantial improvements, regardless of the cost, as long as they are the minimum improvement necessary to bring the structure up to Code. Alterations to historical structures are also exempted, as long as the improvement does not affect the structure's official status of "historical structure."

KK. Swale – A ditch or depression that is cut into the soil that allows the flow of water to pass.

LL. Watercourse – Any surface stream, creek, brook, branch, depression, reservoir, lake, pond, river, ditch, wetland, swamp area, or drainage way in or into which stormwater runoff flows.

ARTICLE 2
STANDARD PROVISIONS

2.1 General This article establishes the standard provisions of the City of Jonesboro Stormwater Management Regulations.

2.2 Stormwater Management Plan (SWMP) Required - Any person, firm, corporation, business, or legal entity proposing to develop land within the City of Jonesboro Planning jurisdiction shall prepare and submit a SWMP to the City Engineer for review and be issued a Compliance Letter prior to commencement of construction of the improvements, except for the following:

- One new or existing single-family structure;
- One new or existing duplex family structure;
- One existing commercial or industrial structure where additional structural and site improvements are less than 2000 square feet.

2.3 Stormwater Pollution Prevention Plan (SWPPP) Required – Any person, firm, corporation, business, or legal entity proposing to disturb for construction purposes (e.g., clear, grade, excavate, etc.) one (1) acre or more of total land area, or less than one (1) acre of total land area that is part of a larger common development or sale if the larger common plan will ultimately disturb one (1) acre or more, shall prepare and submit a SWPPP to the City Engineer for review and be issued a Grading Permit prior to commencement of the proposed land disturbance activities.

2.4 Drainage Alterations or Modifications Permit Required - No person, firm, corporation or business shall alter or modify any open channel, drainage swale, detention facility, enclosed stormwater conveyance system, or other watercourse either natural or artificial where any of said facility is part of the City of Jonesboro Stormwater Management System, without first submitting construction plans and supporting documentation to the City Engineer for review and being issued a Compliance Letter.

2.5 Floodplain Development Permit Required – A permit is required for all structural development, placement of manufactured structures, clearing, grading, mining, drilling, dredging, placement of fill, excavating, watercourse alteration, drainage improvements, roadway or bridge construction, individual water or sewer installation or any other development in a Special Flood Hazard Area.

2.6 Public and Private Responsibilities

A. Public Responsibilities:

1. Administration – Administration of these regulations shall be the responsibility of the City Engineer.

2. Operation and Maintenance of Publicly Owned Facilities – The City of Jonesboro Public Works Department shall be responsible, after construction, for the operation and long-term maintenance of all drainage

structures and improved watercourses which are part of the City of Jonesboro Stormwater Management System and which are not constructed and maintained by or under the jurisdiction of any State or Federal agency.

B. Private Responsibilities:

1. Each developer of land has responsibility to provide on the developer's property Stormwater Runoff Management Facilities to ensure proper drainage and control of stormwater on and from the developer's property;

2. Each developer of land has a responsibility to properly maintain any on-site Stormwater Runoff Management Facility. Such responsibility is to be transmitted to subsequent owners through appropriate covenants to be recorded with or in the deed, and;

3. Each developer of land has a responsibility both during and after construction to provide, install, and maintain appropriate erosion control measures and other stormwater Best Management Practices (BMPs) as needed to minimize any adverse impact to water quality or the local environment.

ARTICLE 3
APPLICATION FOR PERMITS

3.1 General - This article establishes plan preparation and submittal requirements for development projects within the Jonesboro Planning jurisdiction.

3.2 Stormwater Management Plans (SWMP)

3.2.1 Preparation – The SWMP shall be prepared in accordance with the provisions set forth in these regulations and shall be sealed by the Engineer of Record for the project.

3.2.2 Submission – The Developer shall submit two (2) copies of the SWMP and all supporting documentation to the City Planning Office along with the review fee as established by the City Council. Upon receipt, the Planning Office will forward the submittals to the City Engineer for review.

3.2.3 Plan Review – The City Engineer or his designated representative shall review the submittals for conformance to the City of Jonesboro minimum design standards as established in these regulations and in the Stormwater Drainage Design Manual.

The City Engineer will review and comment or approve the project submittals within fifteen (15) business days upon receipt. Failure of the City Engineer to meet this timeline shall not be considered approval of the proposed work.

3.2.4 Rejection – If it is determined that the proposed development will not control stormwater runoff in accordance with these regulations, a comment letter listing the deficiencies shall be issued to the Developer for response. Re-submittals shall be made to the City Planning Office.

If needed, an informal meeting between the Developer and the City Engineer or his designee may be scheduled by either party to review the overall concepts included in the plan. The purpose of this meeting may vary, but generally shall be to jointly agree upon an overall stormwater management concept for the proposed development and to review criteria and design parameters which shall apply to the project.

3.2.5 Acceptance – If it is determined that the proposed development will control stormwater runoff in accordance with these regulations, a Compliance Letter shall be issued to the Developer stipulating the conditions of approval which are:

1. The Engineering Department relied upon statements and representations made in the engineer's report, plans, and specification. In case any statement or representation in the aforementioned documents is found to be incorrect, then the approval may be revoked;

2. There shall be no deviations from the approved plans and specifications unless revised plans and specifications have been first submitted for review and written consent given amending the Compliance Letter;

3. The review of the plans and specifications are for conformance to City of Jonesboro minimum design standards and in no way constitute an analysis of the hydraulic or structural design;

4. If construction of this project is not started within one-year from the date of approval, then the approval is terminated, and;

5. Construction inspection for the work related to the Stormwater Management plan shall be the responsibility of the Engineer of Record.

Other conditions of approval may be added by the City Engineer as needed, as long as the added conditions are consistent with these regulations.

Should the original Engineer of Record be prevented from completing the project, the Developer shall employ another qualified engineer and immediately notify the City Engineer. The Developer shall also provide the name, address and telephone number of the new Engineer of Record.

3.3 Stormwater Pollution Prevention Plan (SWPPP)

3.3.1 Preparation – The SWPPP shall be prepared in accordance with the provisions set forth in these regulations. All SWPPPs shall be prepared and sealed by the Engineer of Record for the project except those for:

- One new or existing single-family structure that is part of a larger common development;

- One new or existing duplex family structure that is part of a larger common development, or;
- One existing commercial or industrial structure where additional structural or site improvements are less than 2000 square feet and that is part of a larger common development.

SWPPPs for the above exempt sites can be prepared by the Developer, provided that the Developer is knowledgeable with the applicable local, state, and federal requirements for SWPPP preparation.

3.3.2 Submission – The Developer shall submit two (2) signed copies of the SWPPP to the City Planning Office along with the review fee as established by the City Council. Upon receipt, the Planning Office will forward the submittals to the City Engineer for review.

3.3.3 Plan Review – The City Engineer or his designated representative shall review the submittals for conformance to the City of Jonesboro minimum design standards as established herein.

The City Engineer will review and comment or approve the project submittals within fifteen (15) business days upon receipt. Failure of the City Engineer to meet this timeline shall not be considered approval of the proposed work.

3.3.4 Rejection – If it is determined that the proposed development will not control stormwater runoff in accordance with these regulations, a comment letter listing the deficiencies shall be issued to the Developer for response. Re-submittals shall be made to the City Planning Office.

If needed, an informal meeting between the Developer and the City Engineer or his designee may be scheduled by either party to review the overall concepts included in the plan. The purpose of this meeting may vary, but generally shall be to jointly agree upon an overall stormwater management concept for the proposed development and to review criteria and design parameters which shall apply to the project.

3.3.5 Acceptance – If it is determined that the proposed development will control stormwater runoff in accordance with these regulations, a Grading Permit shall be issued to the Developer.

3.4 Drainage Alterations/Modifications

3.4.1 Preparation – Construction plans for alterations or modifications to the City of Jonesboro Stormwater Management System shall be prepared in accordance with the provisions set forth in these regulations and shall be sealed by the Engineer of Record for the project.

3.4.2 Submission – The Developer shall submit two (2) copies of the construction plans and all supporting documentation to the City Planning Office along with the review fee as established by City Council. Upon receipt, the Planning Office will forward the submittals to the City Engineer for review.

3.4.3 Plan Review – The City Engineer or his designated representative shall review the submittals for conformance to the City of Jonesboro minimum design standards as established by these regulations and the Stormwater Drainage Design Manual.

The City Engineer will review and comment or approve the project submittals within fifteen (15) business days upon receipt. Failure of the City Engineer to meet this timeline shall not be considered approval of the proposed work.

3.4.4 Rejection – If it is determined that the construction plans do not comply with these regulations, a comment letter listing the deficiencies shall be issued to the Developer for response. Re-submittals shall be made to the City Planning Office.

If needed, an informal meeting between the Developer and the City Engineer or his designee may be scheduled by either party to review the overall concepts included in the plan. The purpose of this meeting may vary, but generally shall be to jointly agree upon an overall stormwater management concept for the proposed development and to review criteria and design parameters which shall apply to the project.

3.4.5 Acceptance – If it is determined that the proposal complies with these regulations, a Compliance Letter shall be issued to the Engineer of Record stipulating the conditions of approval which are:

1. The Engineering Department relied upon statements and representations made in the engineer's report, plans, and specification. In case any statement or representation in the aforementioned documents is found to be incorrect, then this approval may be revoked;

2. There shall be no deviations from the approved plans and specifications unless revised plans and specifications have been first submitted for review and written consent given amending the Compliance Letter;

3. The review of the plans and specifications are for conformance to City of Jonesboro minimum design standards and in no way constitute an analysis of the hydraulic or structural design;

4. If construction of this project is not started within one-year from the date of approval, then the approval is terminated, and;

5. Construction inspection for the work related to the alterations or modifications to the City of Jonesboro Stormwater Management System is the responsibility of the Engineer of Record.

Other conditions of approval may be added by the City Engineer as needed, as long as the added conditions are consistent with these regulations.

Should the original Engineer of Record be prevented from completing the project, the Developer shall employ another qualified engineer, and immediately notify the City Engineer. The Developer shall also provide the name, address and telephone number of the new Engineer of Record.

3.5 Floodplain Development Permit

3.5.1 Preparation – Application for a Floodplain Development Permit shall be made by the Developer on forms prescribed by the City Engineer and made available through the City Planning Office.

3.5.2 Submission – The Developer shall submit two (2) copies of the application and all supporting documentation to the City Planning Office along with the review fee as established by the City Council. Upon receipt, the Planning Office will forward the submittals to the City Engineer for review.

3.5.3 Plan Review – The City Engineer or his designated representative shall review the submittals for conformance to the City of Jonesboro minimum design standards as established in these regulations and in the Stormwater Drainage Design Manual.

The City Engineer will review and comment or approve the project submittals within fifteen (15) business days upon receipt. Failure of the City Engineer to meet this timeline shall not be considered approval of the proposed work.

3.5.4 Rejection – If it is determined that the proposed development is not in accordance with these regulations, a comment letter listing the deficiencies shall be issued to the Developer for response. Re-submittals shall be made to the City Planning Office.

If needed, an informal meeting between the Developer and the City Engineer or his designee may be scheduled by either party to review the overall concepts included in the plan. The purpose of this meeting may vary, but generally shall be to jointly agree upon an overall stormwater management concept for the proposed development and to review criteria and design parameters which shall apply to the project.

3.5.5 Acceptance – If it is determined that the proposed development is in accordance with these regulations, a Compliance Letter shall be issued to the Developer stipulating the conditions of approval which are:

1. The Engineering Department relied upon statements and representations made in the Floodplain Development Application. In case any statement or representation in the aforementioned documents is found to be incorrect, then the approval may be revoked;

2. There shall be no deviations from the approved plans and specifications unless revised plans and specifications have been first submitted for review and written consent given amending the Compliance Letter;

3. The review of the plans and specifications are for conformance to City of Jonesboro minimum design standards and in no way constitute an analysis of the hydraulic or structural design, and;

4. If construction of this project is not started within one-year from the date of approval, then the approval is terminated.

Other conditions of approval may be added by the City Engineer as needed, as long as the added conditions are consistent with these regulations.

ARTICLE 4
DESIGN CRITERIA AND PERFORMANCE STANDARDS

4.1 Design Criteria – The City of Jonesboro's Stormwater Drainage Design Manual (Drainage Manual) latest version shall be the accepted design document. It is the responsibility of the Developer and the Engineer of Record to verify that they are using the latest version of the Drainage Manual in the design of their proposed development. Unless otherwise provided, the following rules shall govern the design and improvements with respect to managing stormwater runoff:

A. Method of Determining Stormwater Runoff – Developments where the upstream drainage area contributing runoff is less than 100 acres should be designed using the SCS, Type II 24-hour distribution, TR-55 Hydrograph Method for calculating runoff. Developments where the area contributing runoff is greater than 100 acres shall use the City of Jonesboro basin analysis for calculating runoff. If not available, the FEMA Data shall be used for calculating runoff. If neither the basin analysis nor the FEMA Data is available, the SCS TR-55 Hydrograph Method for calculating runoff shall be used.

B. Differential Runoff – The total volume, peak flow rate, and velocity of stormwater runoff from a site, post-development, should to the extent practicable approximate that of the site prior to the development.

C. Development Design – Developments shall be located and laid out in such a manner as to minimize the velocity of overland flow, allow maximum opportunity for infiltration of stormwater into the ground, preserve and utilize existing and planned streams, channels, detention basins, retention basins, and include wherever possible, streams and floodplains within parks and other public grounds.

Streets, curbs and gutters, parking areas, enclosed conveyance systems, detention basins, retention basins, and other generally accepted practices and methods for stormwater control may be a part of the overall stormwater runoff management systems for a particular site. To the maximum extent possible, these facilities shall be concurrently designed to effectively manage stormwater runoff in accordance with these regulations.

D. Enclosed Systems and Open Channels – Enclosed systems and open channels shall be designed in accordance with the Drainage Manual.

E. Evaluation of Downstream Flooding – The Engineer of Record shall evaluate whether the proposed plan will cause or increase downstream flooding conditions within the drainage sub-basin in which the project is located or if it will otherwise increase peak flows from the drainage sub-basin. This evaluation shall be made on the basis of existing downstream development and an analysis of stormwater runoff with and without the proposed development. When it is determined that the proposed development will cause or increase downstream flooding conditions, provisions to correct such cause or increase shall be included in the overall design of the stormwater management system improvements. Such

provisions may include downstream improvements or detention of stormwater runoff and its regulated discharge to the downstream storm drainage system, or both.

When it is determined that a localized flooding condition exist downstream of a proposed development, the Engineer of Record for the project shall notify the City Engineer of this discovery and include sufficient documentation in the project submittals to assist in the delineation of the identified Special Flood Hazard Area (SFHA).

F. Detention – The following design criteria shall govern the design of detention facilities:

1. Release Rate – The release rate from any detention facility shall be equal to or less than that of the site prior to the proposed development.

2. Freeboard – Detention storage areas shall have adequate capacity to contain the storage volume of tributary stormwater runoff with freeboard in accordance with the Drainage Manual.

3. Outlet Control Works

(a.) Outlet works shall not include any mechanical components or devices and shall function without requiring attendance or control during operation.

(b.) Size and hydraulic characteristics shall be such that all water and detention storage is released to the downstream stormwater conveyance systems within 24 hours after the end of the design rainfall. Normal time for discharge ranges from 3 to 24 hours.

4. Spillway – Emergency spillways shall be provided in accordance with the Drainage Manual.

5. Design Data Submittal – In addition to complete plans, all design data shall be submitted as required in the detention design data submittal section of the Drainage Manual.

6. Detention Methods – Depending upon the detention alternative or alternatives selected by the Engineer of Record, the design criteria for detention shall follow those given in the Drainage Manual.

G. Alternatives to On-site Detention

1. Alternative Methods – Where on-site detention is deemed inappropriate, alternatives to on-site detention shall be permitted. The methods may include off-site detention or improvements.

   Determinations regarding the appropriateness of on-site detention shall be made by the City Engineer based upon the impact of the proposed development on existing drainage networks and the location of the project in relation to existing floodplains, regional detention facilities, and other planned drainage or channel improvements. Disputes, if any, shall be resolved by the Stormwater Management Board.

   Determinations regarding the appropriateness of off-site detention or comparable improvements shall be made by the City Engineer based upon the impact of the proposed development on existing drainage networks and the location of the project in relation to existing floodplains, regional detention facilities, and other planned drainage or channel improvements. Disputes, if any, shall be resolved by the Stormwater Management Board.

2. Excess Stormwater Storage Credit – A Developer may receive credit for excess stormwater storage (in acre-ft) created on one site that may be applied to another site within the same watershed. The transfer of storage volume credit (in acre-ft) shall not be allowed when the site where credited storage is proposed to be transferred has an existing flooding condition downstream or the proposed development will cause downstream flooding.

4.2 Performance Standards

A. Stormwater Channel Location – Generally acceptable locations of stormwater runoff channels may include but not be limited to the following:

   1. In a depressed median of a double roadway, street or parkway provided the median is wide enough to permit maximum three (3) to one (1) side slopes;

   2. Along the roadway, street, or parking; or,

   3. Located along lot lines within the rear yards of lots or parcels. Stormwater runoff channels located along front and side lot lines shall be enclosed with conduits sized in accordance with the Drainage Manual. Channels along rear lot lines can be open ditch. In all cases, provisions (site grading, berms, dikes, swales, etc.) shall be provided for the safe containment or conveyance of the base flood along these routes.

B. Easements – Drainage easements for access, maintenance, detention or retention, and conveyance of stormwater shall be provided and shown on the final plat. Easements shall be required for all drainage ways serving two or more lots or parcels and shall be designated for drainage only. Minimum required dimensions for drainage easements are included in the Drainage Manual, but in

no case shall the prescribed easements be less than the floodway. All drainage easements shall have a maintenance agreement approved before final acceptance of the improvements.

C. Storm Sewer Outfall – The storm sewer outfall shall be designed in accordance with the Drainage Manual so as to provide adequate protection against downstream erosion and scouring.

D. Lot Lines – Whenever the plans call for the passage or storage of floodwater, surface runoff, or stormwater along lot lines, grading of all such lots shall be prescribed and established for the safe passage or storage of the waters, and no structures including fences may be erected, shrubbery or trees planted, or changes made to the prescribed grades and contours of the specified floodways which will obstruct the flow of stormwater.

E. Manholes – All sanitary sewer manholes constructed in a floodplain or in an area designed for the storage or passage of flood or stormwater, shall be provided with either a watertight manhole cover or be constructed with a rim elevation of a minimum one (1) foot above the high water elevation of the base flood, whichever is applicable to the specific area. The Engineer of Record shall identify which sanitary sewer manholes within the project limits are subject to this requirement, and coordinate with City Water and Light regarding the appropriate remedy.

F. Floor Elevations – The lowest floor of any occupied residence or commercial building in a local or FEMA designated Special Flood Hazard Area (SFHA) shall be established by a licensed Professional Engineer registered in the State of Arkansas, using good engineering practices. Any proposed lot or lots located in a local or FEMA Special Flood Hazard Area (SFHA) shall be identified and the Finished Floor Elevation (FFE) shown on the record plat. Finished Floor Elevations shall be referenced to the applicable engineering study.

ARTICLE 5
BONDS, MAINTENACE ASSURANCE, CERTIFICATIONS, NOTIFICATIONS AND FINAL ACCEPTANCE

5.0 Maintenance Agreement – A maintenance agreement assuring perpetual maintenance of stormwater management improvements and drainage easements to be dedicated to the City shall be agreed upon by the City and the Developer prior to final acceptance of the improvements. The maintenance agreement shall be the responsibility of the Developer and shall be in a form acceptable to the City Engineer and the City Attorney.

5.1 Performance Bond – The Developer shall, before the sale of any lot or lots, either complete the improvements or provide a Performance Bond to guarantee the completion of the improvements in a timely manner. The bond shall be in a form and in an amount acceptable to the City Engineer and the City Attorney, and shall assure that the prescribed work will be well and truly performed and complete in good, sufficient, and workmanlike manner within an agreed time period, not to exceed six (6) months, and shall indemnify and hold harmless the City of Jonesboro from and against all claims, loss, damages, injury or death, court costs, litigation

expense, reasonable attorneys' fees, and expenses whatsoever which may arise because of or resulting from the Developer's operation.

All companies furnishing bonds shall be on the U.S. Treasury Department's most current list of approved surety companies (Circular 570, as amended) and be authorized to transact business in the State of Arkansas.

5.2 Maintenance Bond – A one-year maintenance bond against defects in workmanship shall be required for any portions of the stormwater management improvements proposed to be dedicated to the City of Jonesboro. The maintenance bond shall be in a form acceptable to the City Engineer and the City Attorney, and shall indemnify and hold harmless the City from and against all claims, loss, costs, damages, injury or death, court costs, litigation expense, reasonable attorneys' fees, and expenses whatsoever which it may suffer or be compelled to suffer to pay by reason of failure of the Developer to keep said work in repair or against any and all defects of workmanship or materials. No maintenance bond shall be required for improvements located on private property which is not to be dedicated to the City.

All companies furnishing bonds shall be on the U.S. Treasury Department's most current list of approved surety companies (Circular 570, as amended) and be authorized to transact business in the State of Arkansas.

5.3 Certifications – Prior to issuance of any occupancy permit or entrance into the one-year probationary period for subdivision acceptance, the Engineer of Record shall submit to the City Engineer certification that the stormwater management system is complete and functional in accordance with the plans approved by the City Engineer. Any deviations from the approved plans shall be noted. To insure the adequacy of stormwater quantity detention facilities and stormwater management practices, this certification shall, at a minimum include "record drawings" showing final topographic features of all facilities and updated hydrologic and hydraulic computations for the as-built conditions. To ensure that floodplain cut and fill balances have been achieved, record plans, cross-sections, and related calculations must be submitted for all floodplain manipulations.

Prior to the issuance of any occupancy permit subject to minimum floor elevation requirements, a registered engineer or registered land surveyor, shall submit to the City Engineer certification of the elevation of the lowest floor (including basement); or if the structure has been flood proofed, the elevation to which the structure is flood proofed. This information must be provided on a FEMA Elevation Certificate.

5.4 Notifications – Developers having been issued a Grading Permit shall notify the City Engineer upon final stabilization of the disturbed lands and request that the grading permit be terminated.

5.5 Final Acceptance – Upon expiration of the approved one-year maintenance bond and correction of all deficiencies noted in the eleventh month anniversary inspection report prepared by the City Engineer or his designated representative and presented to the Developer, the City Engineer shall issue or cause to be issued a letter to the Engineer of Record for the project accepting the improvements into the City's long-term maintenance program.

As-builts of the project shall be provided to the City of Jonesboro in ESRI shapefile and PDF formats in conformance with provisions of this manual.

For all shapefiles, a separate spatial data file should be used for each structure and specific attributes should be recorded on site at the time of collection. The fields that should be used for recording these attributes along with all feature attribute input criteria are located in Appendix 6-"GIS Database Submittals" of the *Stormwater Drainage Design Manual*.

Final Acceptance by the City of Jonesboro will not be given until as-builts are provided to the City.

ARTICLE 6
ENFORCEMENT

6.1 General – It shall be the duty of the City Engineer to bring to the attention of the City Attorney any violation or lack of compliance of these regulations.

6.2 Violations and Penalties – Any person, firm, corporation, or other legal entity who fails to comply with or violates these regulations shall be guilty of a misdemeanor and upon conviction thereof shall be fined not less than $100 per day and not more than $500 per day for so long as the violation or violations exist. Each day shall constitute a separate offense.

6.3 Inspection – The City Engineer may make or cause to be made the inspection of any tract of land for each of the following:

A. Permit – Before a Compliance Letter or Grading Permit is issued, the City Engineer may examine or cause to examine any tract of land for which an application has been received.

B. Construction – The City Engineer may inspect or cause to be inspected at various intervals during the course of construction including but not limited to:

1. Prior to the initiation of the project after temporary or permanent erosion prevention and sediment control practices have been installed;

2. After the completion of rough grading and installation of stormwater management structures, and;

3. Upon completion of the project.

The City Engineer shall issue or cause to be issued a Notice of Violation (NOV) to the Developer of the project where the violations are observed. The NOV shall identify the violation or violations found and request that a Corrective Action Plan (CAP) with timeline be developed, submitted to the City Engineer for approval, and implemented to ensure future compliance with these regulations. Failure to respond to the NOV within 30 calendar days from the date shown shall result in the NOV and all supporting documents being forwarded to the City Attorney for appropriate enforcement action and may result in the issuance of a Stop Work Order.

6.4 Revocation; Stop Work Orders – The City Engineer may revoke any permit issued under the provisions of these regulations when informed of any false statement misrepresentation of facts in the application or plans. Any non-permitted stormwater management system, or

construction, or fill located within a floodplain shall, upon written notice, be removed at the expense of the Developer.

When it is found that any provisions of these regulations are being violated, the City Engineer may issue a stop work order. The stop work order shall be served upon the Developer and the Engineer of Record for the project, and by posting of the stop work order at the site of the violation.

A hearing to appeal the stop work order may be requested by the Developer upon whom an order has been served. An appeal must be requested in writing to the Secretary of the Stormwater Management Board or his or her designee within 30 days after service of the stop work order. The Stormwater Management Board shall hold an appeal hearing within 31 days after receipt of appeal. If no appeal is requested within 30 days after service of the stop work order, the stop work order shall remain in effect until compliance with the appropriate regulations can be demonstrated to the reasonable satisfaction of the City Engineer.

ARTICLE 7
GENERAL PROVISIONS

7.1 Interpretation, Conflict and Severability Interpretations

A. Interpretation – In their interpretation and application, the provisions of these regulations shall be held to be the minimum requirements for the promotion of the public health, safety and general welfare.

B. Conflict with Public and Private Provisions – These regulations are not intended to interfere with, abrogate, or annul any other ordinance, rule or regulation statute or other provision of law. Where any provision of these regulations imposes restrictions different from those imposed by any other provision of any other ordinance, rule or regulation, or other provision or law, whichever provisions are more restrictive or impose higher standards, shall control.

C. Private Provisions – These regulations are not intended to abrogate any easement, covenant or any other private agreement or restriction, provided that where the provision of these regulations are more restrictive or impose highest standards or regulations that such easement, covenant or other private agreement or restriction, the requirements of these regulations shall govern. Where the provisions of easement, covenant or private agreement or restriction imposed duties and obligations more restrictive, or higher standards than the requirements of these regulations, and regulations or determinations there under, then such private provisions shall be operative and supplemental to these regulations and determinations made hereunder.

D. Severability – If any part of provision of these regulations or application thereof to any person of circumstances is adjudged invalid by any court or competent jurisdiction, such judgment shall be confined in its operation to that part, provision, or application directly involved in the controversy in which such judgment shall have rendered and shall not affect or impair the validity of the remainder of these regulations or the application to other persons or

circumstances. The governing body hereby declares that it would be enacted the remainder of these regulations even without any such part, provision or application found to be unlawful or invalid.

7.2 Saving Provision – These regulations shall not be construed as abating any action now pending under, or by virtue of, prior existing regulations, or as discontinuing, abating, modifying, or altering any penalty accruing or about to accrue, or as effecting the liability of any person, firm or corporation, or as waiving any right to the City of Jonesboro under any section or provision existing at the time of adoption of these regulations, or as vacating or annulling any rights obtained by any person, firm, or corporation by lawful action of the City, except as shall be expressly provided for in these regulations.

7.3 Amendments – For the purpose of providing for the public health, safety and general welfare, the governing body may, from time to time, amend the provisions of these regulations. The Public Works Department has the responsibility for updating, on a continuing basis, the Stormwater Drainage Manual.

7.4 Appeals

Only the Developer may appeal an adverse decision of the City of Jonesboro regarding stormwater development issues, including, but not limited to, stormwater runoff quantity and quality, floodplain impact, stop work orders, and impact to neighboring properties, to the Stormwater Management Board.

All appeals and variance requests must be complete and filed on the form provided by the Secretary of the Board and shall include:

1. The name of the Developer;

2. The name of the Developer's representative, if any;

3. The case number, map number, and parcel number, if any;

4. The interpretation that is claimed;

5. The decision of the City Engineer or his agent;

6. The location of the property;

7. The stormwater drainage plans which were accepted, and the deviation from the stormwater drainage plan that is being requested;

8. The specific action requested of the Board, and;

9. The reasons justifying such action.

All appeals and variance requests must be filed within thirty (30) days after an adverse decision of the office of the City Engineer for the City of Jonesboro regarding stormwater development issues, including, but not limited to, stormwater runoff quantity or quality, or both, floodplain impact, stop work orders and impact to neighboring properties. The required items must be submitted ten (10) business days prior to the regular monthly Stormwater Management

Board meeting for the appeal or variance to be heard at that meeting. A filing fee as established by the City Council shall be charged to each appellant and shall be payable to the City of Jonesboro. Appellant shall also be responsible for any and all publication fees.

All appeals and variance requests will be filed with the Secretary of the Board. The Secretary of the Board shall:

1. Accept all appeals and variance requests on behalf of the Board;

2. Assign each appeal or variance request a number;

3. Number each appeal or variance request consecutively in order of receipt (beginning on January 1 of each year), preceded by a hyphen and the year of filing;

4. Ensure that appeals or variance requests are heard in the order that they appear on the calendar;

5. Prepare an agenda and distribute it to each Board member at least five (5) business days before each meeting;

6. Send a copy of the agenda to the City of Jonesboro Public Works Committee, the Metropolitan Area Planning Commission, the Mayor, the City Clerk, the City Attorney, the Public Works Director, the City Engineer, and the City Floodplain Administrator, and;

7. Include on the agenda each appeal or variance request to be heard.

Variance Considerations

1. In passing variances for applications, the Stormwater Management Board shall consider all technical evaluations, all relevant factors, all applicable local ordinances and regulations, and:

   a. The danger that materials may be swept onto other lands to the injury of others;

   b. The danger to life and property due to flooding or erosion damage;
   c. The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner;

   d. The importance of the services provided by the proposed facility to the community;

   e. The necessity of the ancillary facility;

   f. The availability of alternative locations that is for the proposed facility, not subject to flooding or erosion damage;

   g. The relationship of the proposed development or improvement plan to the master drainage plans for that area;

h. The safety of access to the property in times of flood for ordinary and emergency vehicles;

i. The expected heights, velocity, duration, rate of rise, and sediment transport of the floodwaters expected at the site;

j. The costs of providing governmental services during and after flood conditions including maintenance and repair of public utilities and facilities such as sewer, gas, electrical, water systems, streets, and bridges, and;

k. Any other relevant facts that pertain to compliance with City Ordinances and Regulations or are mandated by Federal or State laws, rules, or regulations.

2. Upon consideration of the factors listed above, and the objectives of these regulations, the Stormwater Management Board may attach such conditions to the granting of variances as it deems necessary to further the objectives of these regulations.

3. Conditions for variances:

a. Variances shall only be issued upon a determination that the variance is the minimum necessary, considering the flood hazard, to afford relief; and in the instance of a historical building, a determination that the variance is the minimum necessary so as not to destroy the historic character and design of the building;

b. Variances shall only be issued upon (i) a showing of good and sufficient cause, (ii) a determination that failure to grant the variance would result in exceptional hardship, and (iii) a determination that the granting of a variance will not result in any of the following: (a) increased flood heights; (b) additional threats to public safety or extraordinary public expense; (c) create a public or private nuisance; (d) cause fraud on or victimization of the public; (e) or conflict with existing Federal or State laws, rules, regulations;

c. The Secretary of the Stormwater Management Board shall maintain the records of all appeal actions, and;

d. The City Floodplain Administrator shall report any variances to the Federal Emergency Management Agency upon request.

4. Variances 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 this section, except for Items 3a, 3c, and 3d above, and provided the proposed reconstruction, rehabilitation, or restoration will not result in the structure losing its historical designation.

Open Meetings

All meetings of the Board shall be open to the public. The Board shall meet at regular monthly intervals with the day and time to be determined by the chairman.

Notice of such regular or special meetings shall be provided to the media as required by the Arkansas Freedom of Information Act by the Secretary of the Board who shall notify the City

Clerk and all notices of meetings shall be posted on the City of Jonesboro web site.

The Board shall provide fifteen (15) minutes at the conclusion of each regular Board meeting for public comment on non-agenda items. Each individual is required to limit his or her comments to five (5) minutes. The Board reserves the right to suspend the rules and allow additional time if necessary.

Hearing Procedure

1. Members and alternates of the Board shall receive applicant's documents from the Secretary no less than five (5) business days before the appeal hearing date;

2. Following the introduction of the case, the Board will be given two (2) minutes to review documents pertinent to the appeal hearing;

3. The Developer or Developer's agent will be allowed ten (10) minutes to present the case to the Board;

4. City of Jonesboro technical staff shall be given ten (10) minutes for questions and comments. Technical staff shall include, but not be limited to, the City Engineer, the Assistant City Engineer, the City Floodplain Administrator, the City Public Works Director, or any designated city staff with pertinent technical information related to the appeal;

5. The Mayor or City Council member(s), or both, shall be given two (2) minutes to speak if he or she requests time to comment;

6. A public representative, for or against the requested variance, may have two (2) minutes to comment, with a maximum of three persons representing each side. Persons wishing to address the Board shall register with the Secretary of the Board or his/her designee, including their name, address and a brief description of their concern, prior to the beginning of the appeal hearing;

7. Rebuttal will be limited to five (5) minutes per each public representative;

8. The Developer, City of Jonesboro technical staff, or others present will then respond to questions from the Board;

9. Upon a motion by any Board member specifically stating the amount of additional time requested and approval by five (5) members of the Board, additional time may be granted to a speaker, and;

10. Once a motion and a second to the motion are made, further discussion is limited to members of the Board unless they have additional questions for the applicant or others. In the absence of procedures included in the Board's enabling legislation or this document, the most recent edition of the Robert's Rules of Order shall apply.

Conduct During Appeal Hearing

Any person other than a Board member shall only address their comments to the Board,

shall respond to the questions asked, and shall accord the utmost courtesy to the Board and the other participants. The chairman reserves the right to remove any participant from the hearing upon repeated rude or derogatory remarks, abusive comments and unsubstantiated statements as to motives or personalities, or both.

Decision of the Board

At the conclusion of all of the evidence in all cases heard at that hearing session, the Board shall discuss the cases and render decisions on that date or defer decisions for no longer than thirty-one (31) days thereafter. The Board shall have the authority to table, approve or deny a variance or appeal.

The Developer may withdraw his/her appeal one time. The appeal shall be heard at the next regularly scheduled Board meeting. If applicant withdraws an appeal a second time, the Developer must wait 180 days before requesting that the appeal be heard by the Board.

Any action taken by the Board shall be by motion which shall state the reason or reasons for the action taken with particularity. All the decisions of the Board shall be in writing and must indicate the vote of the Board upon the decision.

A quorum of the Board must be present to render any decisions. Five (5) Board members are considered a quorum and there must be five (5) votes to take any affirmative action.

The vote of an alternate member of the Board shall be counted in the tabulation of the result only if she or he is substituting for a regular member. If the alternate member is not substituting for a regular member, the vote shall be recorded but not counted in the decision of the Board.

The decision of the Board on each appeal shall be promptly entered on the minutes of the meeting of the Board by the Secretary and filed in the City Clerk's office.

Re-hearings

No re-hearing of a decision by the Board shall be held except on motion to reconsider that vote by a member of the majority of the Board on the preceding vote, or on a motion or written request to reconsider a prior decision receiving five (5) votes of a quorum of the Board.

If the request for a re-hearing is granted, the case shall be put on the calendar for a re-hearing. In all cases, the request for a re-hearing shall be by the Developer in writing, reciting the reasons for the request, and shall be duly verified and accompanied by the necessary data and diagrams. The Developer requesting the re-hearing shall be notified to appear before the Board on a date to be set by the Board. The notification shall be by the secretary.

7.5 Conflict of Interest

No member of the Board shall act on any case in which he/she has a personal interest, whether it is a direct or indirect financial interest in the property itself, or by virtue of family relationship with the Developer pursuant to the City of Jonesboro's Code of Ethics (Code Section 2.20.14).

Any person who has a conflict shall notify the chairman or secretary immediately upon realizing a conflict may exist. A Board member who has a conflict may not participate as a Board member on the item in which he or she has a conflict of interest.

An alternate member shall replace any member who has a conflict of interest or who is unable to attend due to an illness or an extended absence from the metropolitan area. The Secretary of the Board shall be responsible for contacting the Board members prior to the meeting to determine the need for alternate members. If an alternate member is needed, the secretary shall be responsible for contacting the alternate member.

7.6 Special Meetings

The Chairman or Vice-Chairman may call special meetings at a time and place of their choosing. Whenever such a special meeting is called, the public shall be notified by appropriate means in accordance with the Arkansas Freedom of Information Act.

7.7 Board Announcements

Public announcements including, but not limited to, Board decisions, Board recommendations or other Board actions shall be released to the public upon approval by the Board or in the interim upon approval by the Chair, or in his absence, the Vice-Chair.

7.8 Appeals from Decisions of the Board

Any aggrieved party may appeal any decision of the Board to the Craighead County Circuit Court as provided in ARK. CODE ANN. §14-56-425.

ARTICLE 8
LIABILITY

8.1 Disclaimer of Liability – The performance standards and design criteria set forth herein and in the Drainage Manual establish minimum requirements which must be implemented with good engineering practice and workmanship. Use of the requirements contained herein shall not constitute a representation, guarantee, or warranty of any kind by the City of Jonesboro, or its officers and employees of the adequacy or safety of any Stormwater Management plan imply that the land uses permitted will be free from damages caused by stormwater runoff. The degree of protection required by these regulations is considered reasonable for regulatory purposes and is based on historical records, engineering and scientific methods of study. Larger storms may occur or stormwater runoff heights may be increased by man-made or natural causes. These regulations, therefore, shall not create liability on the part of the City of Jonesboro or any officer or employee with respect to any legislative or administrative decision lawfully made hereunder.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this manual is to establish standard principles and practices for the design and construction of storm water drainage facilities within Jonesboro, Arkansas. In addition floodplain compliance guidelines will be presented to insure base flood elevations will not rise because of the construction or modification of structures or land alteration within the floodplain. The design factors, formula, graphs, and procedures are intended for use as engineering guides in the solution of drainage problems involving determination of the quantity, rate of flow, and conveyance of storm water. The procedures defined herein shall be applied by experienced professional engineers licensed to practice in the State of Arkansas. Also, ultimate responsibility for the design of storm drainage structures lies with the engineer of record. As such, prudent engineering judgment should be used in the design of any facility within Jonesboro.

Methods of design other than those indicated herein may be considered in difficult cases where experience clearly indicates they are preferable. However, there should be no extensive variations from the practices established herein without express approval from the City of Jonesboro.

1.2 Scope

This manual presents various applications of accepted principles of surface drainage engineering and is a working supplement to the information obtained from standard drainage handbooks and other publications on drainage. It is presented in a format that gives logical development of solutions to problems of storm water drainage design and floodplain management.

This manual is intended to be used by the City of Jonesboro, consulting engineers contracted with the City, and for private development within the planning jurisdiction of the City. This manual applies to storm drainage conditions, which are generally relative to the City of Jonesboro and the immediate geographical area. Accepted engineering principles, applied to the City of Jonesboro's storm drainage requirements, are detailed within this manual.

1.3 Drainage Policy

The basic objective of the City of Jonesboro is to construct and maintain facilities intended to minimize the threat of flooding to all areas of the City and comply with the requirements of the National Flood Insurance Program. Drainage facilities are defined as all channels, pipes or other structures which handle public water. Additionally, it is the City's intent to insure that adequate facilities are constructed to accommodate new development such that existing property will not be subjected to additional flooding and so as not to increase the limits of the floodplains as shown on the flood insurance rate maps (FIRM's) for the City of Jonesboro and other entities (County, Levee Improvement Districts, and Municipal Utility Districts).

It is not economically feasible to construct storm sewer facilities, which are large enough to keep the street systems from becoming inundated during severe storm events. City policies as defined in the governing drainage ordinance and standards in this manual are

designed to minimize the impacts (depth and duration) of storm events and insure that the lowest floor elevation of any structures not used exclusively for storage, access, or parking are, at a minimum, twelve (12) inches above the 100-year flood elevation. The intent of this policy is that there should not be any street ponding for minor storm events, minor street ponding for larger events, and major ponding for the 100-year event storms but without water inundating building structures. Every attempt will be made to design major thoroughfares so that they are passable during severe storm events.

The City of Jonesboro has included in this manual criteria covering the design of storm water systems to serve both existing and new developments.

The criterion is considered a minimum for the City of Jonesboro. Approval from other applicable agencies may be required. Ultimate approval for any variance of the criteria contained in this manual must be given by the City of Jonesboro.

2.0 CONSTRUCTION PLAN PREPARATION

2.1 General

This section covers the preparation of drainage construction plans for the City of Jonesboro.

2.2 Design Phase

Plans shall be submitted in accordance with the City of Jonesboro's Checklist for Storm Drainage Plans. The first engineering plan set submission shall be complete, and in sufficient detail to allow review by the City of Jonesboro. All topographic surveys should be furnished to allow establishment of alignment, grades, and rights-of-way requirements.

The hydraulic design of the proposed facilities shall be accomplished based on the procedures and criteria outlined in this manual. Calculations shall be submitted as part of the plan set. These plans shall show the alignment, drainage areas, size of facilities, and grades.

Storm drainage plans shall include at a minimum, a drainage area map, plan-profile sheets, and channel cross-sections, if applicable.

Survey control performed for the project shall reference two reference marks established by the City of Jonesboro. A copy of the reference marks can be obtained from the City Engineer.

Survey control for the project shall conform to the following requirements:

- Vertical control will be NAVD 88, Third Order Vertical
- Horizontal control will be NAD 83, Third Order Class 1, Arkansas State Plane North Zone

2.3 Miscellaneous

All drawings shall be prepared on bond paper with a minimum sheet size of 24" x 36" , to a standard engineering scale, and shall be clearly legible when sheets are reduced to half scale. All drawings shall be signed and sealed by a Professional Engineer registered in the State of Arkansas. After each review, all review comments shall be addressed, additional data incorporated, and drafting of plans completed. Each plan-profile sheet shall have a benchmark shown.

2.4 Design Guidelines and Checklists for Storm Drainage Plans

2.4.1 Drainage Area Map

The drainage area map shall be to a standard engineering scale, and show the street rights-of-way. Scale shall be selected to adequately depict drainage areas, flow paths, etc.

When calculating runoff, the drainage area map shall show the boundary of the drainage area contributing runoff into the proposed system. The area shall be further divided into sub-areas, sequentially numbered, to determine flow concentration points or inlet locations. The centerline of all streets will normally be a boundary of a drainage area, to insure that inlets are sized and positioned to fill the need without depending on storm water crossing over the street crown for proper drainage.

Direction of flow within streets, alleys, natural and man-made drainage ways, and at all system intersections, shall be clearly shown on the drainage area map and/or paving plans. Existing and proposed drainage inlets, storm sewer pipe systems, and drainage channels shall also be clearly shown and identified.

The following items/information shall be included:

(1) Use design criteria as outlined in drainage regulations and prescribed in this manual;

(2) Standard Engineering Scale. Show match lines between any two (2) or more maps. Show graphic bar scale;

(3) Show drainage areas including acres, land use description, hydrologic soil group, and inlet time for each area;

(4) Show existing sub-areas for alley, street, and off-site areas;

(5) Indicate contours on map for on- and off-site, not to exceed two (2) foot contour. For large drainage areas show contours at intervals appropriate to indicate drainage patterns;

(6) Location of all existing and proposed drainage structures on the project site;

(7) Show local and FEMA designated SFHA and floodways if they exist. If not, note that none exists;

(8) Indicate city zoning on drainage area. Identify land use for adjacent properties;

(9) Show points of concentration and their designations;

(10) Inlets, their size and location, the bypass flow for each, the direction of flow as indicated by flow arrows, the station for the centerline;

(11) Indicate runoff at all inlets, dead-end streets and alleys, or to and from adjacent additions or acreage;

(12) For cumulative runoff, show calculations;

(13) Show north arrow. Orient sheet such that the direction of north is to top page or to the left;

(14) Location of existing and proposed drainage structures;

(15) A table depicting runoff computations;

(16) Flow arrows to indicate all crests, sags, and street and alley intersections; and,

(17) Street names shall be indicated.

2.4.2 Storm Sewer Design Guidelines

General guidelines for the design of closed conduit systems, storm sewers, are outlined below.

(1) Diversion of flow from one natural drainage area to another will not be allowed;

(2) Show plan and profile of all storm sewers;

(3) Pipe Material in City rights-of-way or easements shall conform to the following minimum requirements:

- Roadway Crossings
  - RCP Class III or Class IV
    - ASTM C-76
    - ASTM C-506
    - ASTM C-507
  - Box Culverts and Small Bridges
    - ASTM C-1433
    - ASTM C-507
- Mains and Laterals
  - Aluminized Steel Type 2 Corrugated Steel Pipe
    - ASTM A-929
    - ASTM A-760
  - RCP Class III or Class IV
    - ASTM C-76
    - ASTM C-506
    - ASTM C-507
  - Box Culverts and Small Bridges
    - ASTM C-1433
    - ASTM C-507

Alternative pipe materials for use outside City rights-of-way or easements shall be approved by the City Engineer.

(4) In areas where pipes cross beneath railroads, areas of deep fill and areas subjected to heavy loads the engineer shall select the pipe material that is adequate for the design load and provide documentation of such analysis;

(5) The minimum allowable concrete strength for concrete pipe is 3,500 psi. Specify concrete strength for all structures;

(6) Provide inlets where street capacity is exceeded. Provide inlets where addition of alley runoff to street exceeds intersecting street capacity;

(7) Storm water flow from streets into alleys is to be avoided. The City Engineer may approve this type of drainage flow when it is not possible to direct flow anywhere else;

(8) Maximum discharge velocity of eight (8) feet per second (fps) is allowed at the pipe outfall. Velocities that exceed 8 fps must be approved by the City Engineer and must include adequate provisions for erosion control considering the soil conditions at the outfall;

(9) As it relates to erosion control, discharge flow lines of storm sewers shall be a maximum of two (2) feet above the natural flow line of the channel, unless channel lining is present. Energy dissipation shall be provided when specified by the City Engineer;

(10) Where fill is proposed for trench cuts in creeks or outfall ditches, compaction shall be 95% of the maximum density as determined by ASTM D 698; and,

(11) Any off-site drainage work or discharge to downstream property will require an easement. Easement shall be sized such that the developed flows can be conveyed within the easement.

2.4.3 Laterals

Laterals are defined as minor storm sewer lines that serve the purpose of connecting a single inlet to a larger storm sewer main line. The following is a list of requirements that apply to laterals.

(1) Show laterals on trunk profile with stations;

(2) Provide lateral profiles for laterals exceeding thirty (30) feet in length. Potential conflicts with existing utilities (i.e. sanitary sewer, etc.) should be shown in profile;

(3) Laterals shall be placed in profile such that the hydraulic grade line is not less than one foot from the curb flow line, unless utilities or storm sewer depth requires otherwise;

(4) Laterals shall not enter the corners or bottoms of inlets;

(5) In general, the angle of confluence between main line and lateral shall not exceed ninety (90) degrees. Situations where angles exceed this requirement must be supported by calculations that show that the connection will not create adverse flow conditions in the connecting pipe;

(6) Longitudinal centers should intersect;

(7) At junction structures, downstream pipe crown elevations should not be above upstream pipe crown elevations; and,

(8) Minimum pipe diameter within City rights-of-way or easements shall be eighteen (18) inches unless otherwise approved by the City Engineer.

2.4.4 Inlets and Intakes

Inlets shall be provided at the following locations as a minimum:

- At locations on grade where the design flows exceeds the depth and spread criteria;
- At all low points (sag points) in gutters;
- Immediately upgrade of median breaks and street intersections;
- Immediately upgrade of roadway cross slope reversals;
- Upstream and downstream of bridge locations where applicable; and,
- Behind curbs and sidewalks as necessary to drain low areas

Inlets shall be given the same number designation as the area or sub-area contributing runoff to the inlet. The inlet number designation shall be shown opposite the inlet. At intersections, where possible, the end of the inlet shall be ten (10) feet from the curb return or Point of Tangency, and the inlet location shall also provide minimum interference with the use of adjacent property. Inlets in residential areas should be located in streets and alleys so that driveway access is not prohibited to the lots. Drainage from abutting properties shall not be impaired, and shall be designed into the storm drainage system.

Data opposite each inlet shall include paving or storm sewer stationing at centerline of inlet, size and type of inlet, number or designation, top of curb elevation and flow line of inlet as shown on the construction plans.

(1) Indicate direction of flow and the design flow (Q) entering the inlet. Identify capacity of inlet and any bypass flow that may result;

(2) On plan view, indicate inlet designation number, location of inlet (station and offset), size of inlet, sizes of pipes entering and exiting the inlet with associated flow lines, and top-of-curb elevations; and,

(3) Use standard curb inlets in City rights-of-way or easements as presented in the City of Jonesboro Street Improvement Program Manual, latest edition.

2.4.5 Plan and Profile Sheets

In the plan view, the storm sewer designation, size of pipe, and length of each size pipe shall be shown adjacent to the storm sewer. The main line sewer plan shall be stationed at one hundred (100) feet intervals.

This data shall consist of pipe diameter in inches, the design storm discharge in cubic feet per second, slope of hydraulic gradient in percent, Manning capacity of the pipe flowing full in cubic feet per second, velocity in feet per second, and $V^2/2g$. Also, the head loss at each interception point shall be shown.

Stationing and flow line elevations shall also be shown at all pipe grade changes, pipe size changes, lateral connections, manholes, and wye connections. Crown elevations should conform to 2.4.3(7).

(1) The recommended scale for storm sewer plan and profile sheets is 1"= 50' minimum and 1"= 100' maximum;

(2) Indicate property lines and lot lines along storm sewers, and show easements with dimensions;

(3) Provide separate plan and profile of storm sewers. The storm drain lines should also be shown on paving plans with a dashed line. Full pipe sections should be shown on sanitary sewer profiles at crossings;

(4) Show pipe sizes in plan and profile;

(5) Show hydraulics on each segment of pipe profile to include: Q (Design Flow), C (Manning full flow capacity); S (Slope), V (Velocity), $V^2/2g$ (Velocity Head);

(6) Show all existing utilities in plan and profile. Show sanitary sewer profiles at all crossings of storm drain profiles;

(7) Indicate existing and proposed ground line on all street, alley, and storm sewer profiles;

(8) Show future streets and grades where applicable;

(9) When connections are made to existing systems, computations must be provided to show the capacity of the existing system to accept flows. Hydrologic Grade Line (HGL) will be calculated from the outfall to the connection point including the designed flows of the added system;

(10) Indicate flow line elevations of storm sewers on profile, show pipe slope (percent grade). Match pipe soffits at all junction boxes or inlets;

(11) In general, the angle of confluence between main line and lateral shall not exceed ninety (90) degrees;

(12) Show details of all non-standard structures such as junction boxes, headwalls, storm sewers, flumes, and manholes;

(13) Pipe deflections for directional changes shall be placed at the manufacturers recommendations. Deflections exceeding the manufacturer's recommendation will not be tolerated;

(14) Bends in pipes may be used in unusual circumstances with approval by the City. No bend at one location may exceed thirty (30) degrees;

(15) Show water surface elevation of the outfall for design year event (i.e. Q_{25});

(16) On all dead-end streets and alleys where water exits at the dead-end, show grade out to "daylight" for drainage on the profiles and provide erosion control when necessary. Show typical section and slope of "daylight" drainage;

(17) At sags in pavement, provide a positive overflow (swale) to act as a safety path for failure of the storm drain system. Also, provide minimum lowest floor elevations along this overflow rout; and,

(18) Provide sections for road, railroad, and other ditches with profiles. Show design water surface on profile.

The profile portion of the storm sewer plan-profile sheet shall include:

(1) The existing and proposed ground profile along the centerline of the proposed sewer;

(2) The hydraulic gradient of the sewer;

(3) The profile of the proposed storm sewer line;

(4) Profile view of utilities that cross the proposed sewer alignment;

(5) Locations where laterals intersect the main line;

(6) Text identifying the pipe size, elevations at 50' intervals, physical grade in percent, stations where laterals intersect main line; and,

(7) Hydraulic data for each length of storm sewer between interception points shall be shown on the profile.

2.4.6 Detention

(1) Provide drainage area map and show all computations for runoff affecting the detention basin;

(2) Provide a plot plan with existing and proposed contours for the detention basin and plan for structural measures;

(3) Where earth embankment is proposed for impoundment, furnish a typical embankment section and specifications for fill including profile for the structural outflow structure and Geotechnical report;

(4) Provide structural details and calculations for any item that is not a standard detail;

(5) Provide detention basin volume calculations and elevation versus storage curve;

(6) Provide detention calculations for volume by elevation-area, outflow using orifice and/or weir, and reservoir routing; and,

(7) Provide SCS, Type II 24-hour distribution, determination of storage requirements, (permitted for areas of 100 acres or less). Areas greater than 100 acres shall use City of Jonesboro FEMA data (if available).

2.4.7 Bridges

(1) Show Geotechnical soil boring information on plans;

(2) Provide channel cross sections of the water surface elevations for the design storm immediately upstream and downstream of the structure;

(3) Provide hydraulic calculations on all sections;

(4) Provide structural/standard details and calculations;

(5) Provide vertical and horizontal alignment;

(6) Show soil erosion protection measures;

(7) The pre- and post- construction SFHA and regulatory floodway if defined shall be delineated on the plans; and,

(8) Additional requirements for Bridges may be found in Section 7.0 and Section 9.0.

2.4.8 Open Channels

(1) Plan view of channel showing existing and proposed alignment including creek centerline stationing, north arrow, and scale;

(2) Profile of existing and proposed creek centerline;

(3) Profile of the 25-year and 100-year water surface elevation;

(4) Typical cross sections showing dimensions, and the station limits for which they apply;

(5) Velocities and discharges for the 25-year and 100-year storms;

(6) Limits of temporary erosion protection associated with the construction of the channel needs to be indicated in plan view;

(7) Indicate property lines and lot lines along with existing utilities and show easements with dimensions; and,

(8) Include on the construction plans or as in a separate report, the computations performed in developing the water surface profile.

3.0 HYDROLOGY

3.1 General

The planning, design, and construction of drainage facilities are based on the determination of one or more aspects of storm runoff.

Continuous long-term records of rainfall and resulting storm runoff in an area provide the best data source from which to base the design of storm drainage and flood control systems in that area. However, it is not possible to obtain such records in sufficient quantities for all locations requiring storm runoff computations. Therefore, the accepted practice is to relate storm runoff to rainfall, thereby providing a means of estimating the rates, timing and volume of runoff expected within local watersheds at various recurrence intervals.

It is generally accepted that urban development has a pronounced effect on the rate and volume of runoff from a given rainfall. Urbanization generally alters the hydrology of a watershed by improving its hydraulic efficiency, reducing its surface infiltration, and reducing its storage capacity.

For certain small drainage areas (generally less than 100 acres in size), the widely used NRCS (formerly SCS) graphical peak discharge (TR55) provides a useful means of determining peak discharges. If the engineer wishes to use an alternative design technique, it is recommended that the City Engineer be consulted prior to design. If the area is larger than 100 acres and has FEMA hydrology determined for it, the FEMA hydrology model shall be used.

3.2 (Intentionally Deleted)

3.3 SCS, Type II 24-hour Distribution, TR-55 Hydrograph Method

The Soil Conservation Service (SCS now Natural Resources Conservation Service – NRCS) hydrologic method has been widely used by engineers and hydrologists for analyses of small urban watersheds.

This method results from extensive analytical work using a wide range of statistical data concerning storm patterns, rainfall-runoff characteristics and many hydrologic observations in the United States. The SCS method can be applied to urban drainage areas of any size. Major parameters required to calculate the hydrograph include the rainfall distribution, runoff curve numbers, time of concentration, and drainage area.

The runoff equation used by the SCS is a relationship between accumulated rainfall and accumulated runoff derived from experimental plots for numerous soils and vegetation. The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is:

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad (3.2)$$

Where

Q = accumulated direct runoff, (in)
P = accumulated rainfall (potential maximum runoff), (in)
S = potential maximum retention after runoff begins, (in)
I_a = initial abstraction (including surface storage, interception, and infiltration prior to runoff), (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \tag{3.3}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of S and P to produce a unique runoff amount. Substituting equation (3.3) into equation (3.2) gives:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \tag{3.4}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \tag{3.5}$$

Graphical peak discharge was developed from TR-20. The peak discharge equation is

$$q_p = q_u A_m Q F_p \tag{3.6}$$

q_p = peak discharge, (cfs)
q_u = unit peak discharge, (cfs/sq mi/in)
A_m = drainage area, (mi^2)
Q = runoff, (in)
F_p = pond and swamp adjustment factor (necessary if spread throughout the watershed and not considered in Tc computation)

The following are the steps necessary to use the SCS Method for peak discharge computations:

1. Determine the drainage area;
2. Determine the soil classification based on runoff potential (Group A, B, C, or D). See Section 3.3.3 for detailed information. One approach for a general classification is to determine the soil name and type from SCS (NRCS) soils map or report for Craighead County;
3. Determine the antecedent soil moisture conditions (AMC). For design purposes, the AMC will be “average” or II;
4. Classify cover type and hydrologic condition of the soil-cover complex as good, fair, or poor. For additional information see Tables 2-2a, b, and c in Appendix 1;

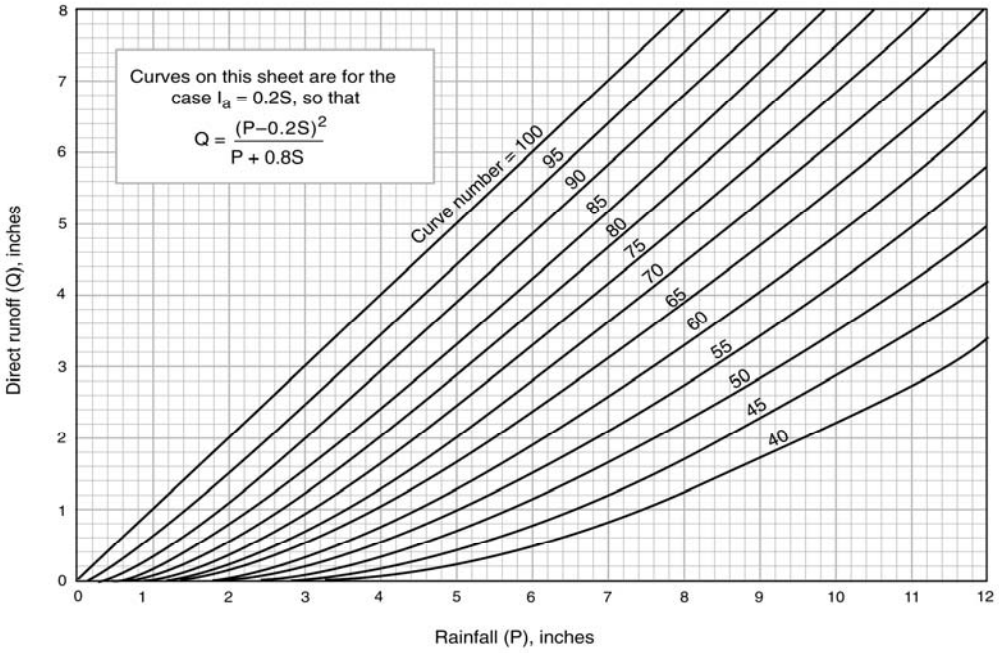
5. Determine the Curve Number (CN) for the AMC II soil classification. If necessary, determine a weighted value by dividing the sum of the products of the subarea sizes and CNs by the total area. (See Section 3.3.2 for details about CN);
6. Estimate the watershed time of concentration in hours (Tc) using TR-55 with max sheet flow of 100 ft.;
7. Determine the potential maximum storage (S). Use Equation 3.5 to calculate the potential maximum storage;
8. Determine the initial abstraction (I_a). Use CN to determine I_a using Table 4-1 from TR-55, as shown below. See if I_a is greater than P;

Table 4-1. I_a values for runoff curve numbers

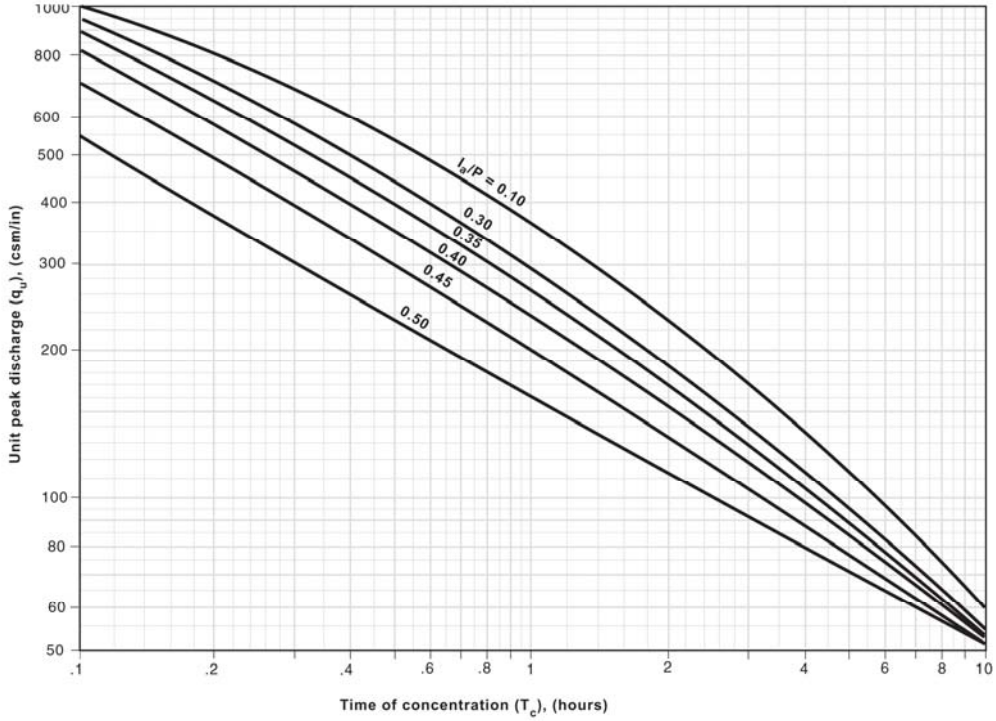
Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

9. Use information in Section 3.3.1 to determine the total rainfall for watershed for the design frequency;

10. Determine the accumulated direct runoff (Q) using equation 3.4 (or solution of runoff equation TR-55 Figure 3.1);



11. Determine I_a /P ratio;
12. Using I_a /P ratio and Tc determine unit peak discharge (qu).
    Use TR-55 Exhibit 4-II Unit peak discharge (q_u) for NRCS (SCS) type II rainfall distribution;



13. Determine the unit peak discharge using graphical methods of the Ia/P ratio and the Tc (hours) and using Worksheet 4 in Appendix 1;
14. Determine the pond and swamp adjustment factor (Fp); and,
15. Compute peak discharge using equation 3.6

Appendix 1 has worksheets from the TR-55 manual to determine peak discharge.

3.3.1 Accumulated Rainfall (P) and Rainfall Distribution

Jonesboro is located in the SCS Type II hypothetical storm area. The design storm duration for drainage work is the 24-hour duration at the relevant frequency. The rainfall depth vs. frequency is shown in Table 3-1.

Table 3-1. Rainfall Depth vs. Frequency for Jonesboro, AR from TP-40 and HYDRO-35

Frequency	24-hour
2-Year	3.88
10-Year	5.58
25-Year	6.35
50-Year	6.99
100-Year	7.70
500-Year	9.25

3.3.2 Curve Number (CN) Factors

The major factors affecting CN determination are hydrologic soil groups (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). The CN varies according to the factors below. Tables 2-2a, b and c in Appendix 1 provide details for CN selection. If a watershed subarea has multiple land uses, the CN can be weighted for the subarea.

3.3.3 Hydrologic Soil Groups

Soil properties influence the relationship between rainfall and runoff by affecting the rate of infiltration. NRCS divides soils into four hydrologic soil groups based on infiltration rates (Groups A-D). Urbanization also impacts soil groups as well.

Group A - Group A soils have low runoff potential due to high infiltration rates even when saturated. These soils primarily consist of deep sands, deep loess, and aggregated silts.

Group B - Group B soils have moderate infiltration rates when saturated. These soils primarily consist of moderately deep to deep, moderately well-drained to well-drained soils with moderately fine to moderately coarse textures (shallow loess, sandy loam).

Group C - Group C soils have slow infiltration rates and a moderately high runoff potential. These soils when saturated usually have a layer near the surface that impedes downward movement of water. These soils are moderately fine to fine in texture and examples include clay loams, shallow sandy loams, soils low in organic content, and soils usually high in clay.

Group D - Group D soils have high runoff potential (very slow infiltration rates) when saturated. These soils are predominantly clay soils with a high swelling potential, soils

with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material.

The SCS has published a county soil survey book for Craighead County. Use of the soil survey book and TR-55 table of soils and their hydrologic soil group is necessary to determine the Curve Number (CN).

3.3.4 Cover Type

Cover types can include vegetation, bare soil, and impervious surfaces. Cover type can be determined by reconnaissance, aerial photography, and land use maps. Tables 2-2a, b and c in Appendix 1, addresses most cover types.

3.3.5 Treatment

Treatment is a cover modifier that describes management of cultivated agricultural lands. Table 2-2b in Appendix 1 is used with agricultural areas that are cultivated.

3.3.6 Hydrologic Condition

Hydrologic condition is generally estimated from plant density and residue cover to account for the effects of cover and treatment in infiltration and runoff. Hydrologic condition only is a factor in CN for agricultural lands. Details about good, fair, and poor conditions are found in Table 2-2b and Table 2-2c in Appendix 1.

3.3.7 Antecedent Runoff Condition (ARC)

For design purposes, the antecedent runoff conditions (ARC) will be average, or Type II. The CN values assume medium ARC (or Type II) conditions.

3.3.8 Ponding and Swamp Adjustment Factor (F_p)

If ponds and swamp areas are spread throughout the watershed and not considered in the Tc computation, an adjustment is needed. Table 4-2 includes the adjustment factor for percent of area of the subbasin that is pond or swamp.

TR55-Table 4.2. Adjustment factor (Fp) for pond and swamp areas that are spread throughout the watershed

Percentage of pond and swamp areas	F_p
0	1.00
0.2	0.97
1.0	0.87
3.0	0.75
5.0	0.72

3.4 Computer Hydrograph Methods

The Corps of Engineers have developed HEC-HMS for determining hydrology. For large areas, HEC-HMS provides flow estimates that can account for valley storage and routing which SCS methods do not. HEC-HMS can be obtained from the Corps of Engineers. It can be downloaded from their website at http://www.hec.usace.army.mil/. For a Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR), a FEMA approved hydrology model must be used. Currently (May 2006), HEC-HMS is approved by FEMA.

NRCS has also developed a computer version of TR-55. It can be downloaded from their website at http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-tr55.html or http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-wintr55.html.

4.0 STORM DRAIN AND DRAINAGE APPURTENANCES

4.1 General

This section contains storm drainage design criteria and demonstrates the design procedures to be employed on drainage projects within the City of Jonesboro. All drainage design calculations and assumptions shall submitted with permit applications.

4.2 Design Frequencies

Table 7 in Appendix 1 shows the appropriate design frequencies to be used for storm drain designs in the City of Jonesboro.

4.3 Runoff Calculations

To begin design of a storm drainage system, it is necessary to compute the amount of runoff that accumulates upstream of the intake structures. For basins less than 100 acres, the SCS Method should be used for computing runoff. The equation is:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \tag{4.1}$$

where

Q = runoff, (in)
P = rainfall, (in)
S = potential maximum retention after runoff begins, (in)

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \frac{1000}{CN} - 10 \tag{4.2}$$

4.4 Street Flow

The next step in the design of the storm drain system is to calculate the flow within the streets.

4.4.1 Definitions

The following street classifications will provide clarity in discussing the requirements and methodology to calculate the flow in streets:

Principal Arterials: Serve the major centers of activity
Minor Arterials: Intended to provide land access
Collectors: Connect local streets in residential neighborhoods

Locals: Provide access to various public and private properties

The following descriptions relate to the shape of the cross section of the roadway:

Straight Crown - A constant slope from one gutter flow line across the street to the other gutter flow line.

Parabolic Crown - A pavement surface shaped in a parabolic from one gutter flow line to the other.

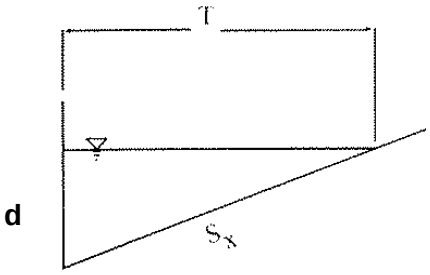
Vertical Displacement Between Gutter Flow Line - Due to topography, it will be necessary at times that the curbs on a street be placed at different elevations.

4.4.2 Calculation of Flow in Streets

The calculation of flow in streets is dependent on street width and shape. Generally, there are two shapes for streets: straight crown and parabolic crown. The straight crowned street can be further subdivided into two types of gutters: uniform and composite. The following discussion covers the methodology used to compute the flow in the street.

Table 7 in Appendix 1 shows the requirements for the design of the roadway drainage.

4.4.3 Uniform Gutter Sections



Uniform Road Section

The runoff in the gutter is generally treated as open channel flow. Therefore, Manning's Equation can be used to calculate the flow or spread in the road section. The following formula is a modified version of the Manning's Equation. It incorporates the geometry of the uniform roadway section.

$$Q = \frac{K_C}{n} S_X^{1.67} S_L^{0.5} T^{2.67} \quad (4.3)$$

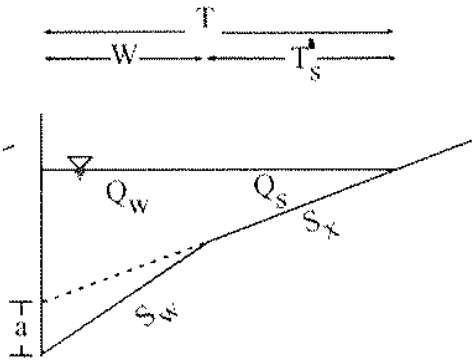
Where:

K_C = 0.56
n = Manning's roughness coefficient (0.013 for concrete)
S_L = Longitudinal slope of road, (ft/ft)
S_X = Pavement (road) cross-slope, (ft/ft) = d/T
T = Total width of flow or spread
Q = Total discharge, (cfs)
S_L = Longitudinal slope of road

This equation assumes that the depth of flow, d, is small when compared to the overall spread and therefore the spread is assumed to be equal to the wetted perimeter. Also, the friction along the curb height is assumed to be negligible when compared to the friction along the spread.

The roadway should be designed such that the spread will be maximized just upstream of the inlet. See design spread criteria in Table 7 in Appendix 1.

4.4.4 Composite Gutter Sections



Composite Road Section

Where:

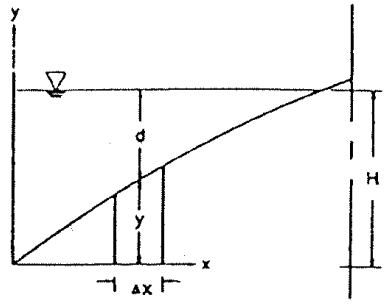
Q_W = Flow in depressed section, (ft^3/s)
Q_S = Side flow, (cfs)
S_W = Gutter Cross Slope, (ft/ft)
S_X = Pavement (road) cross-slope, (ft/ft)
W = Width of depressed gutter, (ft)
T_S = Width of side flow, (ft)
T = Total width of flow, (ft)
a = Continuous gutter depression, (in)

In order to calculate the flow in a composite section the ratio of frontal flow to total gutter flow, E_o, can be calculated using Formula (4.4) in conjunction with Formula (4.3).

$$E_O = \frac{1}{\left\{1+\frac{S_W}{S_X}\left[\left(1+\frac{S_W/S_X}{(T/W)-1}\right)^{2.67}-1\right]^{-1}\right\}} = \frac{Q_W}{QTOTAL} \quad (4.4)$$

\

4.4.5 Parabolic Street Sections



c. Parabolic

For residential streets, parabolic sections are often used because they provide a flatter driving surface than uniform sections. However, the flow capacity is less for the parabolic section than the uniform section. The following formulas can be used to calculate the flows and associated spread in a parabolic section.

$$y = ((Q/S^{0.5})^{C2}) /C1 \quad (4.5)$$

$$Q = (y*C1)^{(1/C2)}*S^{0.5} \quad (4.6)$$

$$T = B – (C3-C4y)^{0.5} \quad (4.7)$$

$$A = (T \times y) / 3 \quad (4.8)$$

$$V = Q/A \quad (4.9)$$

Where:

y = Flow depth in gutter for one side of street, (ft)
Q = Gutter discharge for one side of the street, (cfs)
T = Spread for one side of the street, (ft)
A = Cross sectional area of flow, (ft^2)
V = Velocity of flow, ($ft/_S$)
B = 1/2 of the street width

Table 4.1: Parabolic Roadway Coefficients

	CROWN	C1	C2	C3	C4
	6”	9.2180	0.3405	169	338
26’	* 5”	9.9714	0.3404	169	405.6
	4”	10.9821	0.3404	169	507
	7”	9.1145	0.3418	225	385.7143
31’	6”	9.7396	0.3418	225	450
	* 5”	10.5346	0.3418	225	540
	8”	9.1888	0.3421	324	486
36’	7”	9.7317	0.3421	324	555.4286
	* 6”	10.4020	0.3422	324	648
44’	* 8”	9.9146	0.3433	484	726
	7”	10.4975	0.3433	484	829.7143
	6”	11.2173	0.3433	484	968
* These crown heights shall be used for new developments					
Note: These constants were derived for a Manning’s n of 0.016.					

Alternatively, the nomographs included in Appendix 4 can be used as aids in designing parabolic roadway drainage.

4.5 Drainage Inlet Design

The hydraulic capacity of a storm drain inlet depends upon its geometry as well as the characteristics of the gutter flow. Inlet capacity governs both the rate of water removal from the gutter and the amount of water that can enter the storm drainage system. Inadequate inlet capacity or poor inlet location may cause flooding on the roadway resulting in a hazard to the traveling public.

In general inlets should be placed to meet the spread requirements summarized in Table 7 in Appendix 1. In addition, inlets should be spaced at a maximum distance of 600 feet apart or before intersecting street.

4.5.1 Inlet Types

Storm drain inlets are used to collect runoff and discharge it to an underground storm drainage system. Inlets are typically located in gutter sections, paved medians, and roadside and median ditches. Inlets used for the drainage of highway surfaces can be divided into the following three classes:

1. Grate inlets;
2. Curb-opening inlets; and,
3. Combination inlets

Grate inlets consist of an opening in the gutter or ditch covered by a grate. Curb-opening inlets are vertical openings in the curb covered by a top slab. Combination inlets consist of both a curb-opening inlet and a grate inlet placed in a side-by-side configuration, but the curb opening may be located in part upstream of the grate.

4.5.2 Interception Capacity of Inlets on Grade

Inlet interception capacity, Q_j, is the flow intercepted by an inlet under a given set of conditions. The efficiency of an inlet, E, is the percent of total flow that the inlet will intercept for those conditions. The efficiency of an inlet changes with changes in cross slope, longitudinal slope, total gutter flow, and, to a lesser extent, pavement roughness. In mathematical form, efficiency, E, is defined by the following equation:

$$E = \frac{Q_j}{Q} \qquad (4.10)$$

Where:

E = Inlet Efficiency (ft^3/s)
Q = Total Gutter Flow
Q_j = Intercepted F=low, (ft^3/s)

Flow that is not intercepted by an inlet is termed carryover or bypass and is defined as follows:

$$Q_b = Q - Q_j \qquad (4.11)$$

Where:

Q_b = bypass flow, (ft^3/s)

In Appendix 4, design charts for inlets on grade and procedures for using the charts are presented for the various inlet configurations. Remember that for locally depressed inlets, the quantity of flow reaching the inlet would be dependent on the upstream gutter section geometry and not the depressed section geometry.

Charts for grate inlet interception have been made and are applicable to all grate inlets tested for the Federal Highway Administration. The chart for frontal flow interception is based on test results which show that grates intercept all of the frontal flow until a velocity is reached at which water begins to splash over the grate. At velocities greater than “Splash-over” velocity, grate efficiency in intercepting frontal flow is diminished. Grates also intercept a portion of the flow along the length of the grate, or the side flow. A chart in Appendix 4 is provided to determine side-flow interception. Chart 5B in Appendix 4 determines the “splash-over” velocity.

A procedure for determining the interception capacity of combination inlets is also presented.

4.5.2.1 Grate Inlets

Grate inlets perform satisfactory over a wide range of gutter grades. The capacity of an inlet depends on its geometry and the cross slope, longitudinal slope, total gutter flow, depth of flow and pavement roughness. The depth of water next to the curb is a major factor in the interception capacity of both gutter inlets and grate inlets. At low velocities all the water flowing in the gutter adjacent to a grate is intercepted. On steep slopes only a portion of the frontal flow will be intercepted if the velocity is high or the grate is short and splash over occurs. For grates less than two (2) feet long intercepted flow is small.

A parallel bar grate inlet is the most efficient type of curb inlet; however when crossbars are added for bicycle safety the efficiency is greatly reduced. Where bicycle traffic is a design consideration, the curved vane grate and tilt bar grate are recommended for both hydraulic features and safety.

Where debris is a problem, consideration should be given to debris handling efficiency rankings. Table 4-2 presents the results of tests for debris handling efficiency. This table should be used for relative comparisons only.

Table 4-2. Average Debris Handling Efficiencies of Grates Tested

Rank	Grate	Longitudinal Slope	
		0.005	0.04
1	Curved Vane	46	61
2	30º - 85 Tilt Bar	44	55
3	45º - 85 Tilt Bar	43	48
4	P – 50	32	32
5	P – 50x100	18	28
6	45º - 60 Tilt Bar	16	23
7	Reticuline	12	16
8	P-30	9	20

When the velocity approaching the grate is less than the “splash-over” velocity, the grate will intercept essentially all of the frontal flow. Conversely, when the gutter flow velocity exceeds the “splash-over” velocity for the grate, only part of the flow will be intercepted. A part of the flow along the side of the grate will be intercepted, dependent on the cross slope of the pavement, the length of the grate, and flow velocity.

The ratio of frontal flow to total gutter flow, E_o for a uniform cross slope is expressed by equation 4.12:

$$E_o = \frac{Q_w}{Q} = 1 - \left(1 - \frac{W}{T}\right)^{2.67} \quad (4.12)$$

Where:

Q= total gutter flow, (ft^3/s)
Q_w= flow in width W, (ft^3/s)
W= width of depressed gutter or grate, (ft)
T= total spread of water, (ft)

Chart 2B in Appendix 4 provides solutions of E_o for either uniform cross slopes or composite gutter sections.

The ratio of side flow, Q_s, to total gutter flow is:

$$\frac{Q_s}{Q} = 1 - \frac{Q_w}{Q} = 1 - E_o \quad (4.13)$$

The ratio of frontal flow intercepted to total frontal flow, R_f, is expressed by equation 4.14:

$$R_f = 1 - K_u (V - V_o) \quad (4.14)$$

Where:

K_u= 0.09 in English Units
V= velocity of flow in the gutter, (ft/s)
V_o= gutter velocity where "splash-over" first occurs, (ft/s)
(Note: R_f cannot exceed 1.0)

This ratio is equivalent to frontal flow interception efficiency. Chart 5B in Appendix 4 provides a solution for equation 4.14 which takes into account grate length, bar configuration, and gutter velocity at which splash-over occurs. The average gutter velocity (total gutter flow divided by the area of flow) is needed to use Chart 5B in Appendix 4. This velocity can also be obtained from Chart 4B in Appendix 4.

The ratio of side flow intercepted to total side flow, R_s, is side flow interception efficiency, is expressed by equation 4.15. Chart 6B in Appendix 4 provides a solution to equation 4.15.

$$R_s = 1 / \left(1 + \frac{K_u V^{1.8}}{S_x L^{2.3}} \right) \quad (4.15)$$

Where:

K_u = 0.15 in English Units
L = length of grate along gutter, (ft)
S_x = roadway cross slope
V = velocity, (ft/s)

The efficiency, E, of a grate is expressed as provided in equation 4.16:

$$E = R_f E_o + R_s (1 - E_o) \quad (4.16)$$

The first term on the right side of equation 4.16 is the ratio of intercepted frontal flow to total gutter flow, and the second term is the ratio of intercepted side flow to total side flow. The second term is insignificant with high velocities and short grates.
The interception capacity of a grate inlet on grade is equal to the efficiency of the grate multiplied by the total gutter flow as represented in equation 4.17.

$$Q_j = E\,Q = Q\,[R_f E_o + R_s (1 - E_o)] \quad (4.17)$$

4.5.2.2. Curb-opening Inlets

Curb-opening inlets are most effective on flatter slopes, in sags, and with flows which typically carry significant amounts of floating debris. The interception capacity of curb-opening inlets decreases as the gutter grade increases. Consequently, the use of curb-opening inlets is recommended in sags and on grades less than 3%.

Curb-opening inlets are effective in the drainage of pavements where flow depth at the curb is sufficient for the inlet to perform efficiently. Curb openings are less susceptible to clogging and offer little interference to traffic operation. They are a viable alternative to grates on flatter grades where grates would be in traffic lanes or would be hazardous for pedestrians or bicyclists.

Curb opening heights vary in dimension; however, a typical maximum height is approximately 4 to 6 inches. The length of the curb-opening inlet required for total interception of gutter flow on a pavement section with a uniform cross slope is expressed by equation 4.18:

$$L_T = K_u\, Q^{0.42}\, S_L^{0.3} \left(\frac{1}{n S_x}\right)^{0.6} \quad (4.18)$$

Where:

K_u= 0.6 in English Units
n = Manning's Coefficient
S_x = roadway cross slope
L_T= curb opening length required to intercept 100 percent of the gutter flow, (ft)
S_L= longitudinal slope
Q= gutter flow, (ft^3/s)

The efficiency of curb-opening inlets shorter than the length required for total interception is expressed by equation 4.19:

$$E = 1 - \left(1 - \frac{L}{L_T}\right)^{1.8} \quad (4.19)$$

Where:

L = curb-opening length, (ft);
L_t = curb opening length at 100% efficiency, (ft)

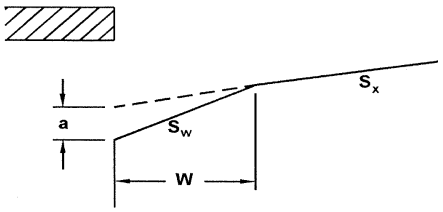
Chart 7B in Appendix 4 is a nomograph for the solution of equation 4.18 and Chart 8B In Appendix 4 provides a solution of equation 4.19.
The length of inlet required for total interception by depressed curb-opening inlets or curb-openings in depressed gutter sections can be found by the use of an equivalent cross slope, S_e, in equation 4.18 in place of S_x. S_e can be computed using equation 4.20.

$$S_e = S_x + S'_w E_o \quad (4.20)$$

Where:

S_x= roadway cross slope, (ft/ft);
S'_w= cross slope of the gutter measured from the cross slope of the pavement, S_x, (ft/ft) , (S'_w = (a/[12 W], for W in ft) or = S_w - S_x);
a= gutter depression, (in);
E_o= ratio of flow in the depressed section to total gutter flow determined by the gutter configuration upstream of the inlet.

The following diagram shows the depressed curb inlet for equation 4.26, E_o is the same ratio as used to compute the frontal flow interception of a grate inlet.



As seen from Chart 7B in Appendix 4, the length of curb opening required for total interception can be significantly reduced by increasing the cross slope or the equivalent cross slope. The equivalent cross slope can be increased by use of a continuously depressed gutter section or a locally depressed gutter section.

Using the equivalent cross slope, S_e, equation 4.18 becomes:

$$L_T = K_T\, Q^{0.42}\, S_L^{0.3} \left(\frac{1}{nS_e}\right)^{0.6} \quad (4.21)$$

Where:

K_T = 0.6 in English Units
n = Manning's Coefficient
S_e = eqivalent cross slope
L_T= curb opening length required to intercept 100 percent of the gutter flow, (ft)
S_L= longitudinal slope
Q= gutter flow, (ft^3/s)

Equation 4.19 is applicable with either straight cross slopes or composite cross slopes. Charts 7B and 8B in Appendix 4 are applicable to depressed curb-opening inlets using S_e.

4.5.2.3. Combination Inlets

Combination inlets provide the advantages of both curb opening and grate inlets. This combination results in a high capacity inlet which offers the advantages of both grate and curb-opening inlets. When the curb opening extends upstream of the grate in a "sweeper" configuration, the interception capacity can be computed as the sum of the capacity of the curb opening upstream of the grate and the grate capacity. Used in a sag configuration, the "sweeper" inlet can have a curb opening on both sides of the grate.

The interception capacity of a combination inlet consisting of a curb opening and grate placed side-by-side is no greater than that of the grate alone. Capacity is computed by neglecting the curb opening. A combination inlet is sometimes used with a part of the curb opening placed upstream of the grate. The curb opening in such an installation intercepts debris which might otherwise clog the grate and is called a "sweeper" inlet. A sweeper combination inlet has an interception capacity equal to the sum of the curb opening upstream of the grate plus the grate capacity, except that the frontal flow and thus the interception capacity of the grate is reduced by interception by the curb opening.

4.5.3 Interception Capacity of Inlets in Sag Locations

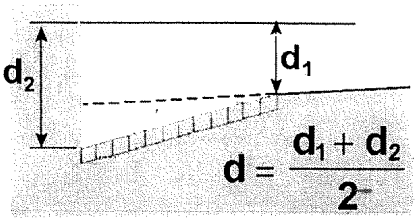
Inlets in sag locations operate as weirs under low head conditions and as orifices at greater depths. Orifice flow begins at depths dependent on the grate size, the curb opening height, or the slot width of the inlet. At depths between those at which weir flow definitely prevails and those at which orifice flow prevails, flow is in a transition stage. At

these depths, control is ill-defined and flow may fluctuate between weir and orifice control. Design procedures presented here are based on a conservation approach to estimating the capacity of inlets in sump locations.

The efficiency of inlets in passing debris is critical in sag locations because all runoff which enters the sag must be passed through the inlet. Total or partial clogging of inlets in these locations can result in hazardous ponded conditions. Grate inlets alone are not recommended for use in sag locations because of the tendencies of grates to become clogged. Combination inlets or curb-opening inlets are recommended for use in these locations.

4.5.3.1 Grate Inlets in Sags

A grate inlet in a sag location operates as a weir to depths dependent on the size of the grate and as an orifice at greater depths. Grates of larger dimension will operate as weirs to greater depths than smaller grates.



The capacity of grate inlets operating as weirs is:

$$Q_j = C_w P d^{1.5} \quad (4.22)$$

Where:

P= perimeter of the grate in (ft) disregarding the side against the curb
C_w= 3.0 in English Units
d= average depth across the grate; 0.5 (d_1 + d_2), (ft)

The capacity of a grate inlet operating as an orifice is:

$$Q_j = C_o A_g (2 g d)^{0.5} \quad (4.23)$$

Where:

C_o= orifice coefficient = 0.67
A_g=clear opening area of the grate, (ft^2)
g= 32.2 ft/s^2

Use of equation 4.23 required the clear area of opening of the grate. Opening ratios for the grates are given on Chart 9B in Appendix 4.

Chart 9B in Appendix 4 is a plot of equation 4.22 and 4.23 for various grate sizes. The chart indicates the effect of the grate size on the depth at which it operates as an orifice. The transition from weir to orifice flow results in an interception capacity less than that computed by either the weir or the orifice equation. This capacity can be approximated by drawing in a curve between the lines representing the perimeter and net area of the grate to be used.

4.5.3.2 Curb-Opening Inlets

The capacity of a curb-opening inlet in a sag depends on water depth at the curb, the curb opening length, and the height of the curb opening. The inlet operates as a weir to depths equal to the curb opening height and as an orifice at depths greater than 1.4 times the opening height. At depths between 1.0 and 1.4 times the opening height, flow is in a transition stage.

Spread on the pavement is the usual criterion for judging the adequacy of a pavement drainage inlet design. It is also convenient and practical in the laboratory to measure depth at the curb upstream of the inlet at the point of maximum spread on the pavement. Therefore, depths at the curb measurements from experiments coincide with the depth at curb of interest to designers. The weir coefficient for a curb-opening inlet is less than the usual weir coefficient for several reasons. The most obvious of which is that depth measurements from experimental tests were not taken at the weir, and drawdown occurs between the point where measurements were made and the weir.

The weir location for a depressed curb-opening inlet is at the edge of the gutter, and the effective weir length is dependent on the width of the depressed gutter and the length of the curb opening. The weir location for a curb-opening inlet that is not depressed is at the lip of the curb opening, and its length is equal to that of the inlet, as shown in Chart 10B in Appendix 4.

The equation for the interception capacity of a depressed curb-opening inlet operating as a weir as:

$$Q_j = (L + 1.8\ W)d^{0.5} \qquad (4.24)$$

Where:

C_w= 2.3
L= length of curb opening, (ft)
W= lateral width of depression, (ft)
d= depth at curb measured from the normal cross slop, (ft), i.e., d = T S_x

The weir equation is applicable to depths at the curb approximately equal to the height of the opening plus the depth of the depression. Thus, the limitation on the use of equation 4.24 for a depressed curb-opening inlet is:

$$d \le h + a/12, \text{ in English Units} \qquad (4.25)$$

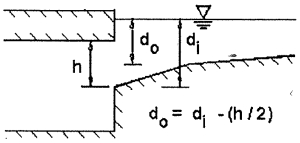
Where:

h= height of curb-opening inlet, (ft)
a= depth of depression, (in)

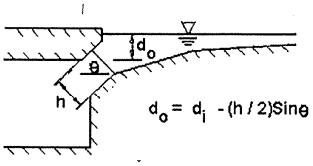
The weir equation for curb-opening inlets without depression becomes:

$$Q_j = C_w L d^{1.5} \quad (4.26)$$

Without depression of the gutter section, the weir coefficient, C_w, becomes 3.0, English system. The depth limitation for operation as a weir becomes d ≤ h.



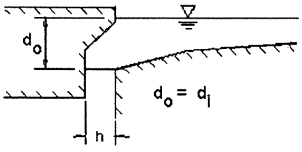
a. Horizontal Throat



b. Inclined Throat

At curb-opening lengths greater than 12 feet, equation 4.26 for non-depressed inlet produces intercepted flows which exceed the values for depressed inlets computed using equation 4.25. Since depressed inlets will perform at least as well as non-depressed inlets of the same length, equation 4.26 should be used for all curb-opening inlets having lengths greater than 12 feet.

Curb-opening inlets operate as orifices at depths greater than approximately 1.4 times the opening height. The interception capacity can be computed by equation 4.27a and equation 4.27b. These equations are applicable to depressed and undepressed curb-opening inlets. The depth at the inlet includes any gutter depression.



$$Q_j = C_o h L (2 g d_o)^{0.5} \quad (4.27a)$$

Or

$$Q_j = C_o A_g \left[2g\left(d_i - \frac{h}{2}\right)\right]^{0.5} \quad (4.27b)$$

Where:

C_o= orifice coefficient (0.67)
d_o= effective head on the center of the orifice throat, (ft)
L= length of orifice opening, (ft)
A_g= clear area of opening, (ft^2)
d_i= depth at lip of curb-opening, (ft)
h= height of curb-opening orifice, (ft)
g= gravitational constant (32.2 ft/s^2)

The height of the orifice in equations 4.27a and 4.27b assumes a vertical orifice opening. As illustrated in the adjacent figure, other orifice throat locations can change the effective depth on the orifice and the dimension (d_j – h/2). A limited throat width could reduce the capacity of the curb-opening inlet by causing the inlet to go into orifice flow at depths less than the height of the opening.

For curb-opening inlets with other than vertical faces, equation 4.27a can be used with:

h= orifice throat width, (ft)
d_o= effective head on the center of the orifice throat, (ft)

Chart 10B in Appendix 4 provides solutions for equations 4.24 and 4.27 for depressed curb-opening inlets, and Chart 11B in Appendix 4 provides solutions for equations 4.26 and 4.27 for curb-opening inlets without depression. Chart 12B in Appendix 4 is provided for use for curb-openings with other than vertical orifice openings.

4.5.3.3 Combination Inlets

Combination inlets consisting of a grate and a curb opening are considered advisable for use in sags where hazardous ponding can occur. Equal length inlets refer to a grate inlet placed along side a curb-opening inlet, both of which have the same length. A "sweeper" inlet refers to a grate inlet placed at the downstream end of a curb-opening inlet. The curb-opening inlet is longer than the grate inlet and intercepts the flow before the flow reaches the grate. The "sweeper" inlet is more efficient than the equal length combination inlet and the curb-opening has the ability to intercept any debris which may clog the grate inlet. The interception capacity of the equal length combination inlet is essentially equal to that of a grate alone in weir flow. In orifice flow, the capacity of the equal combination inlet is equal to the capacity of the grate plus the capacity of the curb-opening.

Equation 4.22 and Chart 9B in Appendix 4 can be used for grates in weir flow or combination inlets in sag locations. Equations 4.24, 4.25, and 4.26 as well as Charts 10B, 11B, and 12B in Appendix 4 for curb-opening inlets are applicable assuming that the grate is completely clogged.

Where depth at the curb is such that orifice flow occurs, the interception capacity of the inlet is computed by adding equations 4.23 and 4.27 are as follows:

$$Q_j = 0.67\ A_g\ (2\ g\ d)^{0.5} + 0.67\ h\ L\ (2\ g\ d_o)^{0.5} \qquad (4.28)$$

Where:

A_g= clear area of the grate, (ft^2)
g= gravitational constant (ft/s^2)
d= average depth over the grate, (ft)
h= height of curb-opening orifice (ft)
L= length of curb-opening, (ft)
d_o= effective depth at the center of the curb opening orifice, (ft)

Trial and error solutions are necessary for determining the depth at the curb for a given flow rate using Charts 9B, 10B, and 11B in Appendix 4 for orifice flow. Different assumptions for clogging of the grate can also be examined using these charts.

4.5.4 Inlet Locations

4.5.4.1 Geometric Controls

There are a number of locations where inlets may be necessary with little regard to contributing drainage area. These locations should be marked on the plans prior to any computations regarding discharge, water spread, inlet capacity, or flow bypass. Examples of such locations as follows:

- At locations on grade where the design flows exceeds the depth and spread criteria;
- At all low points (sag points) in gutters;
- Immediately upgrade of median breaks and street intersections;
- Immediately upgrade of roadway cross slope reversals;
- Upstream and downstream of bridge locations, where applicable;
- Behind curbs and sidewalks as necessary to drain low areas; and,
- At the end of channels in cut sections.

In addition to the areas identified above, runoff from areas draining towards the highway pavement should be intercepted by roadside channels or inlets before it reaches the roadway. This applies to drainage from cut slopes, side streets, and other areas alongside the pavement. Curbed pavement sections and pavement drainage inlets are inefficient means for handling extraneous drainage.

4.5.4.2 Inlet Spacing on Continuous Grades

Design spread is the criterion used for locating storm drain inlets between those required by geometric or other controls. Design spread criteria is presented in Table 7 in Appendix 1. The interception capacity of the upstream inlet will define the initial spread. As flow is contributed to the gutter section in the downstream direction, spread increases. The next downstream inlet is located at the point where the spread in the gutter reaches the design spread. Therefore, the spacing of inlets on a continuous grade is a function of the amount of upstream bypass flow, the tributary drainage area, and the gutter geometry. However, the inlets shall not be spaced any more than 600 feet apart.

For a continuous slope, the designer may establish the uniform design spacing between inlets of a given design if the drainage area consists of pavement only or has reasonably uniform runoff characteristics and is rectangular in shape. In this case, the time of concentration is assumed to be the same for all inlets.

4.6 HYDRAULIC DESIGN OF CLOSED CONDUITS

All closed conduits shall be hydraulically designed through the application of Manning's Equation, (non critical flows) expressed as follows:

$$Q = A\,V \tag{4.29}$$

$$Q = \frac{1.486}{n}\ AR^{2/3}\ \ S_f^{1/2} \tag{4.30}$$

$$R = \frac{A}{P} \tag{4.31}$$

Where:

Q = flow (ft^3/s)
A = cross sectional area, (ft^2)
V = velocity of flow in the conduit, (ft/s)
n = roughness coefficient of the conduit
R = hydraulic radius which is the area of flow divided by the wetted perimeter, (ft)
S_f = channel slope of the conduit in (ft/ft)
P = wetted perimeter, (ft)

4.6.1 Velocity in Closed Conduits

Storm sewers should operate within certain velocity limits to prevent excessive deposition of solids due to low velocities, and to prevent invert erosion and undesirable and hazardous outlet conditions due to excessively high velocity. Minimum and maximum velocities for closed conduits are provided in Table 6 in Appendix 1. In extreme conditions where the maximum velocity must be exceeded, prior approval must be obtained from the City Engineer.

4.6.2 Roughness Coefficients for Closed Conduits

Roughness coefficients are directly related to construction procedures. When alignment is poor and joints have not been properly assembled, extreme head losses will occur. Coefficients used in this matter are related to construction procedures, and assume that the pipe will be manufactured with a consistently smooth surface. Recommended roughness coefficients are provided in Table 2 in Appendix 1.

4.6.3 Minor Head Losses in Closed Conduits

Head losses at structures shall be determined for manholes, junction boxes, wye branches, bends, curves, and changes in pipe sizes in the design of closed conduits. Minimum head loss used at any structure shall be 0.10 feet. Properly designed curves may have zero losses.

A. Head losses and gains for wyes and pipe size changes will be calculated by the following formulas:

Where $V_1 < V_2$: Where $V_1 > V_2$:

$$\frac{V_2^2}{2g} - \frac{V_1^2}{2g} = HL \qquad \frac{V_2^2}{4g} - \frac{V_1^2}{4g} = HL \qquad (4.32)$$

and V_1 is upstream velocity and V_2 is downstream velocity. It should be noted that new storm sewer design shall be designed where the receiving pipe velocity increases going downstream. Otherwise, a hydraulic jump may occur. Deviations to this requirement shall be handled on a case by case basis by the City Engineer.

B. Head losses and gains for manholes, bends, curves and junction boxes will be calculated as shown in Table 5A and Table 5B in Appendix 1.

1) The basic equation for most cases where there is both upstream and downstream velocity, takes the form as set forth below with the various conditions of the coefficient "Kj" shown in Table 5A in Appendix 1.

$$hj = \frac{V_2^2}{2g} - Kj \frac{V_1^2}{2g} \qquad (4.33)$$

Where:

Hj = junction or structure head loss, (ft)
V_1 = velocity in upstream pipe, (ft/s)
V_2 = velocity in downstream pipe, (ft/s)
K = junction or structure coefficient of loss

2) In the case where the inlet is at the very beginning of a line, or the line is laid with bends or obstructions, the equation is revised as follows, without any approach velocity.

$$hj = Kj \frac{V_2^2}{2g} \qquad (4.34)$$

5.0 OPEN CHANNELS

5.1 General

This section describes the criteria for the design of drainage channels. The minimum slope for all proposed channels shall be 0.25%, unless otherwise approved by the City Engineer.

The hydraulic characteristics of improved channels are to be determined through the application of Manning's Equation. In lieu of Manning's Equation, HEC-RAS can be used to determine the water surface profile. According the complexity of the system, the City Engineer may require the use of the HEC-RAS Computer Program.

5.2 Cross Sections

Figure 2 in Appendix 2, contains typical sections that are to be used in the design of open channels.

All improved channels shall be designed to carry the 25-year flow plus one foot of freeboard. Adjacent building structures finish floor elevations shall be at least one foot above the 100-year water surface elevation.

A dedicated drainage easement shall be provided to the City of Jonesboro for open channels. The easement width shall be no less than the minimum width required to convey the 100-year frequency runoff or 15 feet, whichever the greater.

Unlined improved channels that contain bends shall be designed such that erosion at the bends is minimized. Erosion protection at bends shall be determined based on the velocity along the outside of the channel bend. Unlined improved channels shall have side slopes no steeper than 3:1 and lined channels shall have side slopes no steeper than 2:1, unless authorized by the City Engineer. A soil analysis shall be performed to determine the maximum slope that the soil, at the channel improvement site, can sustain without failure.

5.3 Roughness Coefficients

The roughness coefficients that are to be used are shown in Table 4 in Appendix 1. Variations from that which is shown must be approved by the City Engineer.

5.4 Velocity Requirements

The velocity limits for open-channel flow are given in Table 4 in Appendix 1. The channels for which the velocity exceeds these limits shall be protected by appropriate erosion protection or energy dissipater or both.

5.5 Channel Drop Structures

The function of a drop structure is to reduce channel velocities by allowing flatter upstream and downstream channel slopes. Sloping channel drops and vertical channel drops are two commonly used drop structures.

The flow velocities in the channel upstream and downstream of the drop structure need to satisfy the permissible velocities allowed for channels in Table 4 in Appendix 1. The velocities shall be checked for flows produced by the 10-, 50- and 100-year frequency events.

An apron shall be constructed immediately upstream of the chute to protect against the increasing velocities and turbulence which result as the water approaches the drop structure. The apron shall extend at least five (5) feet upstream of the point where flow becomes supercritical. In no case shall the length of the upstream apron be less than ten (10) feet.

An apron shall be constructed immediately downstream of the chute or stilling basin to protect against erosion due to the occurrence of the hydraulic jump. The apron shall extend a minimum of ten (10) feet beyond the anticipated location of the hydraulic jump.

The design of drop structures is based on the height of the drop, the normal depths upstream and downstream of the drop structure and discharge.

5.5.1 Vertical Drop Structures

The approximate height of the drop required to stabilize the hydraulic jump should be determined.

The drop length and the hydraulic jump length of the drop structure should be calculated to determine the length of the downstream apron required to prevent erosion.

5.5.2 Sloping Drop Structures

The location of the hydraulic jump should be determined based on the upstream and downstream flow depths and channel slopes.

The length of the hydraulic jump should be calculated to determine the length of the downstream apron required to prevent erosion.

6.0 CULVERTS

6.1 General

The design theory outlined herein is a modification of the method used in the hydraulic design of concrete box and pipe culverts, as discussed in the Federal Highway Administration's Hydraulic Design Series Number 5 entitled "*Hydraulic Design of Highway Culverts*".

The hydraulic capacity of culverts is computed using various factors and formulas. Laboratory tests and field observations indicate that culvert flow may be controlled either at the inlet or outlet. Inlet control involves the culvert cross-sectional area, the ponding of headwater at the entrance, and the inlet geometry. Outlet control involves the tailwater elevation in the outlet channel, the slope of the culvert, the roughness of the surface and length of the culvert barrel.

6.2 Culverts Flowing with Inlet Control

Inlet control means that the discharge capacity of a culvert is controlled at the culvert entrance by the depth of the headwater and entrance geometry, including the barrel shape and cross-sectional area, and the type of inlet edge.

Nomographs for determining culvert capacity for inlet control are shown in Appendix 5. These nomographs were developed by the Division of Hydraulic Research, Bureau of Public Roads, from analysis of laboratory research reported in the National Bureau of Standards Report No. 444, entitled "*Hydraulic Characteristics of Commonly Used Pipe Entrances",* by John L. French, and "*Hydraulics of Conventional Highway Culverts*" by H. G. Bossy. Experimental data for box culverts with headwalls and wingwalls were obtained from an unpublished report of the U.S. Geological Survey.

6.3 Culverts Flowing with Outlet Control

The culvert is designed so that the depth of headwater, which is the vertical distance from the upstream culvert flow line to the elevation of the ponded water surface, does not encroach on the allowable freeboard during the design storm.

Headwater depth, HW, can be expressed by a common equation for all outlet control conditions:

$$HW = H + h_O - L\,(S_O) \qquad (6.1)$$

HW = headwater depth in feet from the flow line of the culvert, (ft)
H = head or energy required to pass a given discharge through a culvert, (ft)
h_O = vertical distance from the downstream culvert flow line to the elevation from which H is measured, (ft)
L = length of culvert, (ft)
S_O = culvert barrel slope, (ft)

The head, H, is made up of three parts: including the velocity head, exist loss (H_V) and entrance loss (H_e), and a friction loss (H_f). This energy is obtained from the ponding of water at the entrance and is expressed as:

$$H = H_V + H_e + H_f \quad (6.2)$$

H = head or energy in feet of water

$H_V = \frac{V^2}{2g}$ where V is average velocity in culvert or $\frac{Q}{A}$

$H_e = K_e \frac{V^2}{2g}$ where K_e is the entrance loss coefficient Table 8 in Appendix 1

H_f = the energy required to overcome the friction of the culvert barrel and expressed as:

$$H_f = \left[\frac{29.2n^2L}{R^{1.33}}\right]\frac{V^2}{2g} \quad (6.3)$$

Where:

n = coefficient of roughness
L = length of culvert barrel, (ft)
V = average velocity in the culvert, (ft/s)
g = gravitational acceleration (32.2 ft/s^2)
R = hydraulic radius (Area / Wetted Perimter, ft)

Substituting into the previous equation:

$$H = \frac{V^2}{2g} + K_e \frac{V^2}{2g} + \left[\frac{29.2n^2L}{R^{1.33}}\right]\frac{V^2}{2g} \quad (6.4)$$

and simplifying:

$$H - \left[1+K_e+\frac{29.2n^2L}{R^{1.33}}\right]\left[\frac{V^2}{2g}\right] \text{ for full flow} \quad (6.5)$$

For various conditions of outlet control flow, h_O is calculated differently. When the elevation of the water surface in the outlet channel is equal to or above the elevation of the top of the culvert opening at the outlet, h_O is equal to the tailwater depth or:

h_O re = TW

If the tailwater elevation is below the top of the culvert opening at the outlet, h_O is the greater of two values: (1) Tailwater, TW, as defined above, or (2) (d_C + D) /2, where d_C = critical depth. The critical depth, d_C, for box culverts may be obtained from Appendix 5 or may be calculated from the formula:

$$d_C = 0.315\left[\frac{Q}{B}\right]^{2/3} \quad (6.6)$$

Where:

dc=critical depth for box culvert, (ft)
Q=discharge, (ft^3/s)
B =bottom width of box culvert, (ft)

The critical depth for circular pipes may be obtained from Appendix 5, or may be calculated by trial and error. Charts developed by the Bureau of Public Roads may be used for determining the critical depth. Utilize values of D, A and d_C, which will satisfy the equation:

$$\frac{Q^2}{g} = \frac{A^3}{D} \qquad (6.7)$$

Where:

d_C = critical depth for culvert, (ft)
Q = discharge, (ft^3/s)
g = gravitational constant (32.2 ft/s^2)
A = cross-sectional area, (ft^2)

The equation is also applicable for trapezoidal or irregular channels, in which instances "D" becomes the channel top width in feet.

7.0 BRIDGES

Once a design discharge and depth of flow have been established, the size of the bridge opening may be determined. The bridge opening shall be designed so that it is in compliance with Section 5.0 and Section 9.0 of this manual and meets all FEMA requirements.

The bridge opening shall be designed utilizing the latest version of HEC-RAS computer software.

Input and output data from the software shall be included within the storm drainage calculations as required by Section 2.0 of this manual.

8.0 DETENTION POND DESIGN

8.1 General

The purpose of stormwater detention is to protect downstream properties from flood increases due to upstream development. Stormwater detention is required to control peak flow at the outlet of a site such that post-development peak flows are equal to or less than pre-development peak flows for the 2-year through 100-year design storms.

8.2 No Adverse Impact Policy

The City of Jonesboro has adopted the policy that runoff from new development will not adversely affect downstream properties.

The City of Jonesboro retains the right to require detention in areas of known flooding when detention will not exacerbate downstream flooding. Detention systems must be constructed during the first phase of major developments to eliminate damage to adjacent properties during construction. In this regard, the detention systems shall be designed to function as sediment traps and cleaned out to proper volumes before completion. If siltation has occurred, detention systems must be restored to their design dimensions after construction is complete and certified as part of the as-built submittal.

8.3 Detention Reservoir Routing

The peak flow reduction obtained by a stormwater detention system can be evaluated by performing reservoir routing calculations, usually as a trial and error process. The use of the Storage Indication Method relationship is as follows:

a. Inflow Hydrograph
b. Stage-storage curve
c. Stage-discharge curve

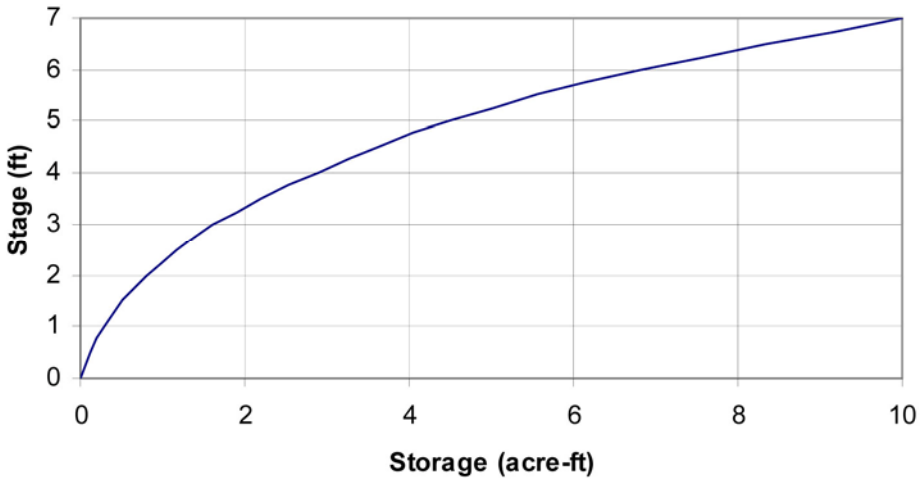
Development of each of these relationships should be based on site-specific data.

8.3.1 Inflow Hydrograph

Fundamentals for the development of an inflow hydrograph for design flood conditions presented in Section 3.

8.3.2 Stage-Storage Curve

A stage-storage curve defines the relationship between the depth of water and storage volume in a reservoir. An example of a stage-storage curve is shown below.



8.3.2.1 Stage-Storage Calculations

Bottom Area

The volume is computed by treating it as a trapezoidal basin where:

$$V = LWD + (L+W)Z\,D^2 + \frac{4}{3}Z^2\,D^3 \qquad (8.1)$$

Where:

V = Storage at stage D (cu-ft)
D = Stage or depth (ft)
L = Bottom length (ft)
W = Bottom width (ft)
Z = Side slope, (Z:1) (H:V)

Pipe Storage

$$V = \frac{L}{6}(A_1 + 4M + A_2) \qquad (8.2)$$

Where:

V = Storage (cu-ft)
L = Pipe length (ft)
A_1 = Cross-sectional area of depth at downstream end
A_2 = Cross-sectional area of depth at upstream end
M = Cross-sectional area of depth at midsection

When the pipe slope is zero, Volume = LA_1

Contours

The average-end-area method may be applied vertically or the Conic method. The conic method uses the following equation:

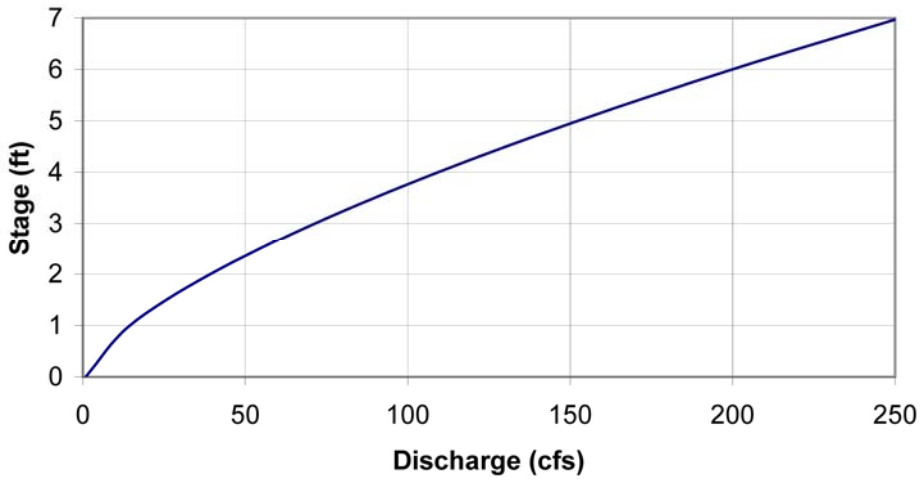
$$V = d\left(\frac{A_1 + \sqrt{A_1 A_2} + A_2}{3}\right) \quad (8.3)$$

Where:

V = Storage (cu-ft)
d = Change in elevation between points 1 and 2
A_1 = Surface area at elevation 1 (sq-ft)
A_2 = Surface area at elevation 2 (sq-ft)

8.3.3 Stage-Discharge Curve

A stage-discharge curve defines the relationship between the depth of water and the discharge or outflow from a storage basin. An example of a stage-discharge curve is shown below.



A typical stormwater storage basin has two spillways: principal and emergency. The principal spillway is usually designed with a capacity sufficient to convey the design storm without allowing flow to enter the emergency spillway. The emergency spillway is sized to provide a bypass for stormwater during a storm that exceeds the design capacity of the principal spillway.

8.3.3.1 Stage-Discharge Calculations

Culverts/Orifices

The equation used for culvert/orifice structures is:

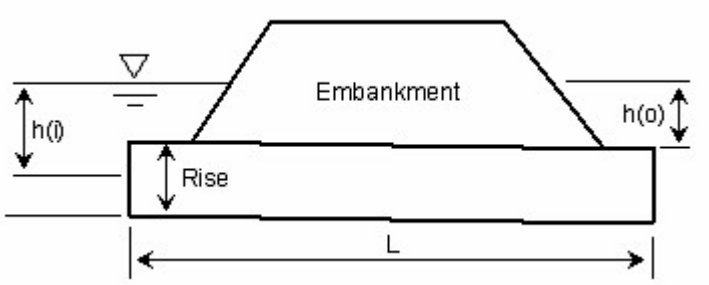
$$Q = C_o A \sqrt{\frac{2gh}{k}} \times Nb \qquad (8.4)$$

Under Inlet Control

Q = Discharge, (cfs)
A = Culvert area, (sq-ft)
h = Distance between the water surface and the centroid of the culvert barrel (1/2 flow depth during partial flow), (ft)
N_b = Number of barrels
C_o = Orifice coefficient
k = 1

Under Outlet Control

Q = Discharge, (cfs)
A = Culvert area, (sq-ft)
h = Distance between the upstream and downstream water surface
N_b = Number of barrels
C_o = 1
$k = 1.5 + [(20n^2L)/R^{1.33}]$
n = Manning's n-value
L = Culvert length, (ft)
R = Area/wetted perimeter, (ft)



Profile of typical culvert
h(i) is the head under inlet control. H(o)under outlet control.

Weirs

The basic equations used to calculate weir flow are:

Rectangular, Cipoletti, Broad Crested & Riser

$$Q = C_W L H^{1.5} \tag{8.5}$$

Where:

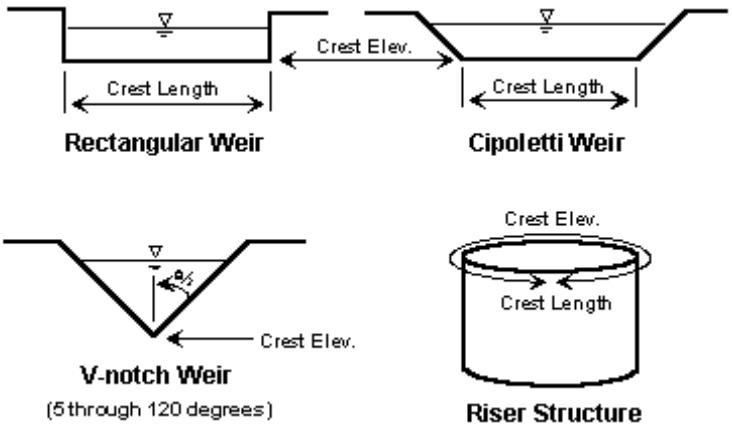
Q = Discharge over weir, (cfs)
L = Length of the weir crest, (ft)
H = Distance between water surface and the crest, (ft)
C_w = Weir coefficient, typically 3.33

V-notch

$$Q = 1.38 Tan\left(\frac{\theta}{2}\right) H^{2.5} \tag{8.6}$$

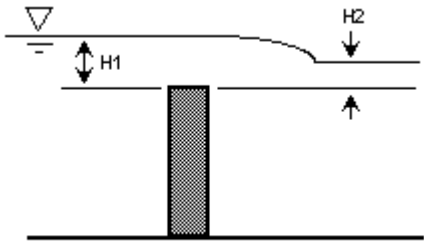
Where:

Q = Discharge over weir, (cfs)
Θ = Angle of v-notch, (deg)
H = Head on apex of v-notch, (ft)



Adjustment for Submerged Weirs

Rectangular, V-notch, and Cipoletti weirs are affected by submergence when the tailwater rises above the crest, as shown below. The result will be that the discharge over the weir will be reduced.



Submerged Weir

The equation for the reduction in flow is:

$$Qs = Qr\left(1-\left(\frac{H2}{H1}\right)^{1.5}\right)^{0.385} \quad (8.7)$$

Where:

Q_s = Submerged flow, (cfs)
Q_r = Unsubmerged flow from standard weir equations
H_1 = Upstream head above crest, (ft)
H_2 = Downstream head above crest, (ft)

Routing fundamentals

Reservoir routing is the process of passing a flood hydrograph through a storage reservoir or detention pond. This process changes the pattern of flow with respect to time but conserves volume. The purpose of reservoir routing is usually to reduce the peak flow to a predetermined level or to delay the peak. The routing procedure is known as the Storage Indication Method and begins with a stage/storage/discharge relationship, an inflow hydrograph and is based entirely on the continuity equation.

$$I - O = \frac{ds}{dt} \quad (8.8)$$

Where:

I = Inflow;
O = Outflow;
ds/dt = change in storage

Limitations

The most common type of detention routing problem requires knowing the design storm period or inflow hydrograph and peak outflow or allowable discharge from the detention basin. A trial and error procedure is used to calculate the storage volume required.

A less common routing problem involves preventing storage basin overflow during the design for a given basin size and return period. In such a case, the magnitude of the peak flow reduction is fixed. A trial and error procedure will be required to find a solution, as only the stage-storage curve is known explicitly.

8.3.4 Dry Reservoirs (Ponds)

Wet weather ponds or dry reservoirs shall be designed with proper safety, stability, and ease of maintenance. Maximum side slopes for grass reservoirs shall not exceed one (1) foot vertical for three (3) feet horizontal (3:1) unless adequate measures are included to provide for the above noted features. In no case shall the limits of the maximum water surface elevation be less than one (1) foot vertically below the lowest floor elevation of any adjacent structure.

The entire reservoir area shall be seeded, fertilized, mulched, sodded or paved as required for acceptance by the City Engineer. Overflow areas shall be protected against erosive velocities.

8.3.5 Open Channels

Normally permitted open channels may be used as detention areas provided that the limits of the maximum design water surface elevation are not less than one (1) foot below the lowest floor elevation of any adjacent structure. No detention will be permitted within public road rights-of-way unless approval is given by the City of Jonesboro.

8.3.6 Wet Reservoirs (Ponds)

Permanent lakes with fluctuating volume controls may be used as retention areas provided that the limits of the maximum water surface elevation are not less than one (1) foot below the lowest floor elevation of any adjacent structure.

Maximum side slopes for the fluctuating area of permanent lakes shall be one (1) foot vertical to three (3) feet horizontal (3:1) unless provisions are included for safety, stability, and ease of maintenance.

Special consideration shall be given to safety and accessibility in design of permanent lakes in residential areas. Typical items to be considered are: tops with grate openings on riser structures, 6’ to 10’ wide safety ledges at no greater than 2’-3’ below normal pool elevation, trash and/or safety racks on pipe inlets and outlets, danger/warning signs, fencing, etc.

An analysis shall be furnished of any proposed earthen dam construction soil. A boring of the foundation for the earthen dam may be requested by the City Engineer. Earthen dam structures shall be designed by a licensed Professional Engineer in the State of Arkansas.

8.3.7 Parking Lots

Detention in parking lots is not permitted except in those instances where the parking serves lot serves as overflow storage for those storms above the 10-year storm event. In this instance detention is permitted to a maximum depth of six (6) inches. In no case should the maximum limits or storage be designed closer than ten (10) feet from a building unless waterproofing of the building and pedestrian accessibility are properly documented and approved. The maximum design water surface elevation should be no less than one (1) foot below the lowest floor of any adjacent structure.

8.3.8 Control Structures

The 100-year frequency storm is to be used to determine the volume of detention storage required. In addition, the outlet structure shall be designed such that peak discharges for the fully urbanized development are not increased for the pre-developed storm frequencies of the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events.

Detention facilities shall be provided with obvious and effective control structures. Plan view and sections of the structure with adequate details shall be included in plans.

The maximum discharge shall be designed to take place under total anticipated design-head conditions.

Sizing of the low-flow pipe shall be by inlet control, hydrologic control, and hydrologic gradient requirements. Low-flow pipes shall not be smaller than twelve (12) inches in diameter to minimize maintenance and operating problems except in parking lot and roof retention where minimum size of openings shall be designed specifically for each condition. A bar-screen on a minimum (3:1) slope to reduce blockage by debris is suggested on the flow-pipe.

Where the outflow structure conveys flow through the embankment in a conduit, the conduit shall be reinforced concrete or an approved alternate designed to withstand external loads. The conduit is to withstand the internal hydraulic pressure without leakage under full external load or settlement, and must convey water at the design velocity without damage to the interior surface of the conduit.

The outflow structure shall discharge flows into the natural stream or unlined channels at a non-erosive rate in accordance with the requirements of this design manual.

Earth embankments used to impound required detention volume shall be constructed according to specifications for fill based on a Geotechnical Investigation of the site. The Geotechnical investigation shall be performed by a registered Professional Engineer in the State of Arkansas, who has an emphasis in geotechnical analysis and shall include, as a minimum, the type of material to be used, water content, liquid limit, plasticity index, and desired compaction.

8.3.9 Emergency Spillways

An emergency spillway or overflow area shall be provided at the maximum 100-year pool level. Spillways shall be designed for the 500-year design storm. This design criteria shall apply to all dams with normal storage greater than or equal to one (1) acre-ft or have a dam height of five (5) feet of greater, that are exempt from Title VII "*Rules Governing Design and Operation of Dams" that are regulated by the Arkansas Natural Resource Commission.*

9.0 FLOODPLAIN GUIDELINES

9.1 General Standards

The following standards apply to all developments in Special Flood Hazard Areas, regardless of the type of proposed development or the Risk Zone of the proposed site:

(1) All new and substantial construction or substantial improvements shall be designed (or modified) and adequately anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy;

(2) All new construction or substantial improvements shall be constructed by methods and practices that minimize flood damage;

(3) All new construction or substantial improvements shall be constructed with materials resistant to flood damage;

(4) All critical facilities constructed or substantially improved in Special Flood Hazard Areas (SFHA) must be constructed or modified to exceed 500-year flood protection standards or located outside the SFHA;

(5) The placement or construction of all new structures must be in full compliance with the provisions of this Code;

(6) For the purposes of this Code, all mixed-use structures are subject to the more stringent requirements of residential structures;

(7) A substantial improvement or substantial damage to an existing structure triggers a requirement to bring the entire structure into full compliance with the provisions of this Code. The existing structure, as well as any reconstruction, rehabilitation, addition, or other improvement, must meet the standards of new construction in this Code;

(8) Any improvement to an existing structure that is less than a substantial improvement requires the improvement, but not the existing structure, to be in full compliance with the provisions of this Code;

(9) All manufactured homes to be placed within a Special Flood Hazard Area on a community's FIRM shall be installed using methods and practices which minimize flood damage. For the purposes of this requirement, manufactured homes must be elevated and anchored to resist flotation, collapse, or lateral movement. Methods of anchoring may include, but are not limited to, use of over-the-top or frame ties to ground anchors. This requirement is in addition to applicable State and local anchoring requirements for resisting wind forces. Screw augers or expanding anchors will not satisfy the requirement of this provision;

(10) The design or location of electrical, heating, ventilation, plumbing, and air conditioning equipment for new structures, or for any improvements to an

existing structure, must prevent water from entering or accumulating within the components during base flood events;

(11) The design of all new and replacement water supply systems must minimize or eliminate infiltration of floodwaters into the system during base flood events;

(12) The design of all new and replacement sanitary sewage systems must minimize or eliminate infiltration of floodwaters into the system during flooding events, and must prevent sewage discharge from the systems into floodwaters;

(13) The placement of on-site waste disposal systems must avoid impairment to, or contamination from, the disposal system during base flood events;

(14) Construction of basement foundations in any Special Flood Hazard Area is prohibited;

(15) New construction and substantial improvements, with fully enclosed areas (such as garages and crawlspaces) below the lowest floor that are usable solely for parking of vehicles, building access or storage in an area other than a basement and which are below the base flood elevation shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a registered professional engineer or architect or meet or exceed the following minimum criteria:

(a) A minimum of two (2) openings on separate walls having a total net area of not less than one (1) square inch for every square foot of enclosed area subject to flooding shall be provided;

(b) The bottom of all openings shall be no higher than one (1) foot above grade;

(c) Openings may be equipped with screens, louvers, valves, or other coverings or devices provided that they permit the automatic entry and exit of floodwaters.

(16) The placement of recreational vehicles (RV) in Special Flood Hazard Areas must either:

(a) Be temporary, as demonstrated by the RV being fully licensed, being on wheels or a jacking system, attached to the site only by quick disconnect type utilities and security devices, having no permanently attached additions, and being immobile for no more than 180 consecutive days; or else

(b) Meet all provisions of this Code applicable to manufactured home structures.

(17) All proposals for the development of a residential subdivision, commercial business park or manufactured home park/subdivision must have public utilities

and facilities such as sewer, gas, electrical and water systems located and constructed to minimize or eliminate flood damage;

(18) All proposals for the development of a residential subdivision, commercial business park or a manufactured home park/subdivision must include an adequate drainage plan to reduce exposure to flood hazards; and,

(19) All proposals for the development of a commercial business park or a manufactured home park/subdivision must include an adequate evacuation plan for the escape of citizens from affected nonresidential structures during flooding events.

(20) A minimum of a ten (10) foot buffer shall be placed between any structure and the floodway.

9.2 RISK ZONE SPECIFIC STANDARDS

In addition to the General Standards, the following standards apply to specific development types in specific Risk Zones. Risk Zones listed in this Code that do not appear on the current FIRM are not applicable.

(1) **In AE Risk Zones:** Special Flood Hazard Areas with base floods determined

(a) For Residential Structures in Zone AE:

1. For all new residential structures, the top surface of the lowest floor must have an elevation (1 feet or more) above the published BFE. This elevation must be documented on an Elevation Certificate properly completed by a Professional Engineer, Surveyor, or Architect licensed to practice in the State of Arkansas.

2. For all substantial improvements or substantial damage to existing residential structures, the entire structure becomes subject to the requirements of a new residential structure.

3. For any reconstruction, rehabilitation, addition, or other improvement to an existing residential structure that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new residential structure.

(b) For Nonresidential Structures in Zone AE:

1. All new commercial, industrial or other nonresidential structures must either:

a. have the lowest floor (including basement) elevated (1 feet or more) above the base flood level or

b. Be floodproofed such that, together with attendant utility and sanitary facilities, be designed so that below (an elevation of 3 feet above) the base flood level the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

c. A registered professional engineer or architect shall develop and/or review structural design, specifications, and plans for the construction, and shall certify on a Floodproofing Certificate that the design and methods of construction are in accordance with accepted standards of practice as outlined in this subsection. A record of such certification which includes the specific elevation (in relation to mean sea level) to which such structures are floodproofed shall be maintained by the Floodplain Administrator.

2. For all substantial improvements or substantial damage to existing commercial, industrial or other nonresidential structures the entire structure becomes subject to the requirements of a new nonresidential structure.

3. For any reconstruction, rehabilitation, addition, or other improvement to an existing nonresidential structure that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new nonresidential structure.

(c) For Manufactured Homes in Zone AE:

1. All manufactured homes that are placed or substantially improved on sites:

a. outside of a manufactured home park or subdivision,

b. in a new manufactured home park or subdivision,

c. in an expansion to an existing manufactured home park or subdivision, or

d. in an existing manufactured home park or subdivision on which a manufactured home has incurred "substantial damage" as a result of a flood, be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated (1 feet or more) above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

2. Require that manufactured homes be placed or substantially improved on sites in an existing manufactured home park or subdivision on the community's FIRM that are not subject to the provisions of paragraph (1.) of this section be elevated so that either:

   a. the lowest floor of the manufactured home is (1 feet or more) above the base flood elevation, or
   b. the manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above grade and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

3. For all substantial improvements or substantial damage to existing manufactured home, the entire structure becomes subject to the requirements of a new manufactured home.

4. For any reconstruction, rehabilitation, addition, or other improvement to an existing manufactured home that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new manufactured home.

(d) Where FEMA has not established a regulatory floodway in Zone AE, no Floodplain Development Permit may be issued unless a detailed engineering analysis is submitted along with the application that demonstrates the increase in base floodwater elevation due to the proposed development and all cumulative developments since the publication of the current FIRM will be less than 1 foot.

(2) **Floodways** - High risk areas of stream channel and adjacent floodplain

a) Developments in regulatory floodways are prohibited, unless:

1. A No-Rise Certificate, signed and stamped by a Professional Engineer licensed to practice in the State of Arkansas, is submitted to demonstrate through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed development would not result in any increase in flood levels within the community during the occurrence of a base flood event; or

2. All requirements of 44 CFR §65.12 are first met.

b) No Manufactured Home may be placed in a regulatory floodway, regardless of elevation height, anchoring methods, or No-Rise Certification.

(3) **In AH or AO Risk Zones:** Special Flood Hazard Areas of shallow flooding

(a) For Residential Structures in Zones AH or AO:

1. All new residential structures must be constructed with the top surface of the lowest floor elevated (1 feet or more) above the published BFE, or (2 feet or more) above the highest adjacent grade in addition to the depth number specified (at least 2 feet if no depth number is specified) on the community's FIRM. This elevation must be documented on an Elevation Certificate properly completed by a Professional Engineer, Surveyor or Architect licensed to practice in the State of Arkansas.

2. For all substantial improvements or substantial damage to existing residential structures the entire structure becomes subject to the requirements of a new residential structure.

3. For any reconstruction, rehabilitation, addition, or other improvement to an existing residential structure that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new residential structure

(b) For Nonresidential Structures in Zones AH or AO:

1. All new commercial, industrial or other nonresidential structure must either:

a. have the top surface of the lowest floor elevated (1 feet or more) above the published BFE, or (2 feet or more) above the highest adjacent grade in addition to the depth number specified (at least 2 feet if no depth number is specified) on the community's FIRM, with documentation on an Elevation Certificate properly completed by a Professional Engineer, Surveyor or Architect licensed to practice in the State of Arkansas; or

b. be floodproofed such that the structure, together with attendant utility and sanitary facilities be designed so that below (3 feet or more) above the published BFE in Zone AH, or (3 feet or more) above the base specified flood depth in an AO Zone, the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads of effects of buoyancy.

2. For all substantial improvements or substantial damage to existing commercial, industrial or other nonresidential structures the entire structure becomes subject to the requirements of a new nonresidential structure.

3. For any reconstruction, rehabilitation, addition, or other improvement to an existing nonresidential structure that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new nonresidential structure.

(c) For Manufactured Homes in Zones AH or AO:

1. All manufactured homes that are placed or substantially improved on sites:

   a. outside of a manufactured home park or subdivision,
   b. in a new manufactured home park or subdivision,
   c. in an expansion to an existing manufactured home park or subdivision, or
   d. in an existing manufactured home park or subdivision on which a manufactured home has incurred "substantial damage" as a result of a flood, be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated (1 feet or more) above the published BFE, or (2 feet or more) above the highest adjacent grade in addition to the depth number specified (at least 2 feet if no depth number is specified) on the community's FIRM, and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

2. Require that manufactured homes be placed or substantially improved on sites in an existing manufactured home park or subdivision on the community's FIRM that are not subject to the provisions of paragraph 1. of this section be elevated so that either:

   a. the lowest floor of the manufactured home meets the elevation standard of paragraph 1., or
   b. the manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above grade and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

3. For all substantial improvements or substantial damage to existing manufactured home, the entire structure becomes subject to the requirements of a new manufactured home.

4. For any reconstruction, rehabilitation, addition, or other improvement to an existing manufactured home that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new manufactured home.

(d) Where FEMA has not established a regulatory floodway in Zone in Zones AH or AO, no Floodplain Development Permit may be issued unless a detailed engineering analysis is submitted along with the application that demonstrates the increase in base floodwater elevation due to the proposed development and all cumulative developments since the publication of the current FIRM will be less than 1 foot.

(e) Require adequate drainage paths around structures on slopes, to guide flood waters around and away from proposed structures.

(4) **In "A" Risk Zones:** Special Flood Hazard Areas with no base flood elevations determined

(a) In Zone A, The applicant or the applicant's agent must determine a base flood elevation prior to construction. The BFE will be based on a source or method approved by the local Floodplain Administrator.

(b) For Residential Structures in Zone A:

1. For all new residential structures, the top surface of the lowest floor must have an elevation (1 feet or more) above the BFE. This elevation must be documented on an Elevation Certificate properly completed by a Professional Engineer, Surveyor or Architect licensed to practice in the State of Arkansas.

2. For all substantial improvements or substantial damage to existing residential structures, the entire structure becomes subject to the requirements of a new residential structure.

3. For any reconstruction, rehabilitation, addition, or other improvement to an existing residential structure that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new residential structure.

(c) For Nonresidential Structures in Zone A:

1. All new commercial, industrial or other nonresidential structures must either:

   a. have the lowest floor (including basement) elevated (1 feet or more) above the base flood level or
   b. be floodproofed such that, together with attendant utility and sanitary facilities, be designed so that below (an elevation of 3 feet above)the base flood level the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

c. A registered professional engineer or architect shall develop and/or review structural design, specifications, and plans for the construction, and shall certify on a Floodproofing Certificate that the design and methods of construction are in accordance with accepted standards of practice as outlined in this subsection. A record of such certification which includes the specific elevation (in relation to mean sea level) to which such structures are floodproofed shall be maintained by the Floodplain Administrator.

2. For all substantial improvements or substantial damage to existing commercial, industrial or other nonresidential structures the entire structure becomes subject to the requirements of a new nonresidential structure.

3. For any reconstruction, rehabilitation, addition, or other improvement to an existing nonresidential structure that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new nonresidential structure.

(d) For Manufactured Homes in Zone A:

1. All manufactured homes that are placed or substantially improved on sites:

a. outside of a manufactured home park or subdivision,
b. in a new manufactured home park or subdivision,
c. in an expansion to an existing manufactured home park or subdivision, or
d. in an existing manufactured home park or subdivision on which a manufactured home has incurred "substantial damage" as a result of a flood, be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated (1 feet or more) above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

2. Require that manufactured homes be placed or substantially improved on sites in an existing manufactured home park or subdivision on the community's FIRM that are not subject to the provisions of paragraph (1.) of this section be elevated so that either:

a. the lowest floor of the manufactured home is (1 feet or more) above the base flood elevation, or
b. the manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than 36 inches in height above

grade and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

3. For all substantial improvements or substantial damage to existing manufactured home, the entire structure becomes subject to the requirements of a new manufactured home.

4. For any reconstruction, rehabilitation, addition, or other improvement to an existing manufactured home that is less than a substantial improvement, only the improved area, but not the entire structure, becomes subject to the requirements of a new manufactured home.

(e) Base flood elevation data and a regulatory floodway, utilizing accepted engineering practices, shall be generated for subdivision proposals and other proposed development including the placement of manufactured home parks and subdivisions which is greater than 50 lots or 5 acres, whichever is lesser, if not otherwise provided.

9.3 Hydrology

Any hydrologic study performed within the City of Jonesboro must comply with the guidelines set forth in this manual. This includes submitting a hydrologic work map that includes watershed boundaries, and all other hydrologic parameters. If the Design Engineer wishes to use an alternative hydrologic analysis methodology, the City Engineer shall be consulted prior to the start of the analysis. In locations where FEMA hydrology exists, the FEMA hydrology model shall be used. FEMA models shall be updated, as deemed necessary, by the City Engineer to simulate current development within the drainage basin.

9.4 Hydraulics

Any modification to a floodway or floodplain where no floodway has been determined within the City of Jonesboro requires a hydraulic study, performed by a Professional Engineer licensed in the State of Arkansas. All hydraulic studies along water courses must comply with FEMA's guidelines.

The Corps of Engineers HEC-RAS computer program shall be used to compute the water surface elevation. To do so, cross sections along the watercourse must be no greater than 400 ft. apart for tangent sections of channel and no greater than 200 ft. apart for curvilinear sections of channel unless otherwise approved by the City Engineer. Roughness values shall be determined based on values in Table 4 in Appendix 1. A printout of the computer model as well as an electronic copy of the HEC-RAS files shall be submitted with the Hydraulic Report for any work proposed in the floodplain. All hydraulic models shall conform to survey control requirement of Section 2.2.

Table 4 in Appendix 1, shows the maximum permissible velocities that are to be allowed in the channel. Velocities above that which are shown in this table, must be reduced or approved by the City Engineer.

9.5 SFHA Submittals

(1) Elevation Certificates

(a) Minimum requirements for all elevation certificate submittals are as follows:

1. Submit two original copies of all elevation certificates with permit applications;

2. The basis for all base flood elevations in Zone AE areas shall be determined using the FIS Profiles, not scaled off the FIRM;

3. Provide at least two site pictures and a vicinity map with all submittals (includes pre-construction elevation certificates). The vicinity map shall depict, at a minimum, the following:

a. Location of floodplain and floodway (where floodway is applicable);
b. Property Lines (Plat of Survey);
c. Spot elevation for all pertinent data to include all utilities servicing the building;
d. Adjacent waterway name;
e. Surrounding street names;
f. Location of utilized benchmark;
g. Dimensioned location of building on property;
h. North arrow; and,
i. Scale

(2) Letter of Map Change

(a) For letters of map change, submit all FEMA requirements and forms requested included in the MT-1, MT-2, and MT-EZ standard application packs;

(b) As-built or topographic surveys are required for all LOMR-F submittals. These surveys shall depict, at a minimum, the following:

1. Location of floodplain and floodway (where floodway is applicable),
2. Adjacent waterway name;
3. Surrounding street names;
4. Location of utilized benchmark;
5. Location of property and buildings;
6. Spot elevations;
7. Natural ground contours (maximum one foot contour interval);
8. North arrow; and,
9. Scale

All SFHA submittals must comply with all guidelines set forth in this manual and all utilized survey control must be based on state or federal published benchmarks.

10.0 EROSION CONTROL

10.1 General

Any development within the City of Jonesboro Planning jurisdiction must comply with the Arkansas Water and Air Pollution Control Act (Act 472 of 1949, as amended, Ark. Code Ann. 8-4-101 et seq.) and the Clean Water Act (33 U.S,C. 1251 et seq.), and shall obtain authorization to discharge storm water associated with construction activity under the National Pollutant Discharge Elimination System (NPDES) permit program administered by the Arkansas Department of Environmental Quality (ADEQ). Eligibility and permit requirements for this program are provided in Appendix 7.

In addition to the Federal and State requirements, any development within the City of Jonesboro Planning jurisdiction shall comply with the provisions of Section 2.3, 2.6 (B)(3), and Section 3.3 of the Stormwater Management Regulations.

10.2 Environmental Protection Agency BMP's

In 1996, under a cooperative agreement between the American Society of Civil Engineers (ASCE) and the U.S. Environmental Protection Agency (USEPA) the International Stormwater Best Management Practices (BMP) Database was developed monitoring the performance of BMP techniques. All BMP studies, performance analysis results, tools for use in BMP performance studies, monitoring guidance and other study-related publications can be found at www.bmpdatabase.org. This website provides scientifically sound information to improve the design, selection and performance of BMPs. Designers shall utilize appropriate BMP's as they relate to each specific project.

APPENDIX 1
LIST OF TABLES

Appendix 1

Table of Contents

TABLE 1
(Intentionally Deleted)

TABLE 2
Roughness Coefficients for Closed Conduits*

Material of New Construction	Recommended Roughness Coefficient, n
Concrete Pipe Storm Sewer	0.013
Corru`gated Metal Pipe Culverts	0.024

Material of Existing Systems	Recommended Roughness Coefficient, n
Concrete Pipe Storm Sewer	
Fair Alignment, Ordinary Joints	0.015
Poor Alignment, Poor Joints	0.017
Concrete Pipe Culverts	0.012
Corrugated Metal Pipe Culverts	0.030

Note: For materials other then those listed here, use manufacturer's suggestion and/or City Engineers recommendations.

Table 2-1 Runoff depth for selected CN's and rainfall amounts [1/]

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

[1/] Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1/]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Worksheet 2: Runoff curve number and runoff

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Runoff curve number

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	CN [1/] Figure 2-3	CN [1/] Figure 2-4	Area ☐ acres ☐ mi^2 ☐ %	Product of CN x area
	Totals ➡					

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____ = _____ ; **Use CN** ➡ ☐

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr			
Rainfall, P (24-hour)	in			
Runoff, Q	in			

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

Worksheet 4: Graphical Peak Discharge method

Project	By	Date
Location	Checked	Date

Check one: ☐ Present ☐ Developed

1. Data

Drainage area ..... A_m = _____ mi^2 (acres/640)

Runoff curve number .....CN = _____ (From worksheet 2)

Time of concentration ..... T_c = _____ hr (From worksheet 3)

Rainfall distribution ..... = _____ (I, IA, II III)

Pond and swamp areas sprea
throughout watershed ..... = _____ percent of A_m (_____ acres or mi^2 covered)

	Storm #1	Storm #2	Storm #3
2. Frequency ..... yr			
3. Rainfall, P (24-hour) ..... in			
4. Initial abstraction, I_a ..... in (Use CN with table 4-1)			
5. Compute I_a / P			
6. Unit peak discharge, q_u ..... csm/in (Use T_c and I_a / P with exhibit 4– _____)			
7. Runoff, Q ..... in (From worksheet 2) Figure 2-6			
8. Pond and swamp adjustment factor, F_p ..... (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.)			
9. Peak discharge, q_p ..... ft^3/s			

(Where $q_p = q_u A_m Q F_p$)

TABLE 4
Roughness Coefficients for Open Channels*

Channel Description	Recommended Roughness Coefficients			Maximum Velocity (ft/s)
	Minimum	Normal	Maximum	
Minor Natural Streams				
Moderately Well Defined Channel				
Grass and Weeds, Little Brush	0.025	0.030	0.033	8
Dense Weeds, Little Brush	0.030	0.035	0.040	8
Weeds, Light Brush on Banks	0.030	0.035	0.040	8
Weeds, Heavy Brush on Banks	0.035	0.050	0.060	8
Weeds, Dense Willow on Banks	0.040	0.060	0.080	8
Irregular Channel With Pools and Meanders				
Grass and Weeds, Little Brush	0.030	0.036	0.042	8
Dense Weeds, Little Brush	0.036	0.042	0.048	8
Weeds, Light Brush on Banks	0.036	0.042	0.048	8
Weeds, Heavy Brush on Banks	0.042	0.060	0.072	8
Weeds, Dense Willow on Banks	0.048	0.072	0.096	8
Floodplain, Pasture				
Short Grass, No Brush	0.030	0.035	0.040	8
Tall Grass, No Brush	0.035	0.040	0.050	8
Floodplain, Cultivated				
No Crops	0.030	0.035	0.040	8
Mature Crops	0.035	0.045	0.050	8
Floodplain, Uncleared				
Heavy Weeds, Light Brush	0.050	0.060	0.070	8
Medium to Dense Brush	0.070	0.100	0.160	8
Trees with Flood Stage below Branches	0.080	0.100	0.120	8

TABLE 4
Roughness Coefficients for Open Channels*

Channel Description	Recommended Roughness Coefficients			Maximum Velocity (ft/s)
	Minimum	Normal	Maximum	
Major Natural Streams				
The roughness coefficient is less than that for minor streams of similar description becase banks offer less effective resistance.				
Moderately Well Defined Channel	0.025		0.060	8
Irregular Channel	0.035		0.100	8
Unlined Vegetated Channels				
Mowed Grass, Clay Soil	0.025	0.030	0.035	8
Mowed Grass, Sandy Soil	0.025	0.030	0.035	6
Unlined Non-Vegetated Channels				
Clean Gravel Section	0.022	0.025	0.030	8
Shale	0.025	0.030	0.035	10
Smooth Rock	0.025	0.030	0.035	15
Earth Lined, Sandy	0.028	0.035	0.040	6
Earth Lined, Clay	0.028	0.035	0.040	8
Lined Channels				
Smooth Finished Concrete	0.013	0.015	0.020	15
Riprap (rubble)	0.030	0.040	0.050	12
Gabion	0.028	0.032	0.035	15
Pavement				
Concrete	-	0.015	-	-
Asphalt	-	0.017	-	-

Note: Deviations from these values must be approved by the City Engineer for Jonesboro.

TABLE 5A
Velocity Head Loss Coefficients for Closed Conduits

Description of Conditions	Kj
Inlet on Main Line	0.5
Inlet on Main Line with Branch Lateral	0.25
Manhole on Main Line with bend at:	
90 degrees	0.25
60 degrees	0.35
45 degrees	0.5
22.5 degrees	0.95
Wye Connection or Cut In	
60 degrees	0.6
45 degrees	0.75
22.5 degrees	0.95
Inlet or Manhole at the Beginning of Line	1.25
Conduit Curves for 90 degrees*	
Curve Radius	
2 to 8 times the diameter **	0.4
8 to 20 times the diameter	0.25
Greater than 20 times the diameter	0
Bends where the radius is equal to the Diameter	
90 degree bend	0.05
60 degree bend	0.43
45 degree bend	0.35
22.5 degree bend	0.2

The values of the coefficient "Kj" for determining the loss of head due to obstructions in pipes are shown in Table 6-B and the coefficients are used in the following equation to calculate the head loss at the obstruction:

$Hj = Kj \ (V2^2/2*g)$

* Where deflection other than 90 degrees are used, the 90 degree deflection coefficeient can be used with the following percentage factors:
60 degree bend = 0.85
45 degree bend = 0.70
22.5 degree bend = 0.40

**The diameter is the inside diameter of the pipe.

TABLE 5B
Head Loss Coefficients Due to Sudden Enlargements and Contractions

D2/D1*	Sudden Enlargements, Kj	Sudden Contractions, Kj
1.2	0.1	0.08
1.4	0.23	0.18
1.6	0.35	0.25
1.8	0.44	0.33
2	0.52	0.36
2.5	0.65	0.4
3	0.72	0.42
4	0.8	0.44
5	0.84	0.45
10	0.89	0.46
> then 10	0.91	0.47

D2/D1 = Ratio of larger to smaller diameter

TABLE 6
Velocity Requirements for Closed Conduits*

	Velocity	
Material of New Construction	**Minimum**	**Maximum**
Storm Sewers	2.000	8
Inlet Laterals	2.000	8
Culverts	2.000	8

Note: Velocities that exceed 8 fps must be approved by the City Engineer.

For velocity requirements in Open Channels see Table 4. Storm Sewers shall discharge into open channels at a maximum velocity of 8 feet per second.

TABLE 7
Design Criteria for the Design of Roads, Culverts, and Channels*

Road Classification	Design Return Period	Design Spreads
Major Thoroughfare		
6 Lane Divided	10-Year	Two Lanes Open Ea. Direction
	100-Year	Top of Curb
4 Lane Divided	10-Year	One Lane Open Ea. Direction
	100-Year	Top of Curb
4 Lane Undivided	10-Year	One Lane Open Ea. Direction
	100-Year	Top of Curb
Collector	10-Year	Allow 1 Lane Open
	100-Year	Top of Curb
Residential Streets	10-Year	Top of Curb
	100-Year	Contained within the Right of Way
Rural Road w/ Bar Ditches	10-Year	One Foot Below Pavement
	100-Year	Contained within the Right of Way

Other Drainage Structures***	Design Return Period
Enclosed Storm Sewer System	10-Year
Culvert or Bridge Along a Creek, River, or other Watercourse	25-Year
Culvert or Bridge not Located on a Creek River or other Watercourse	10-Year
Channel Improvements	25-Year**

Note: The City Engineer may reserve the right to require more stringent requirements depending on the location of a specific project. All deviations from what is shown must be approved by the City Engineer.

****Note: For Channel Improvements the 25-year storm should be contained within the channel. Adjacent structures and lots must be a minimum of one foot above the 100-year water surface elevation.***

*****Note: All improvements in SFMA shall meet requirements of Section 9 in this manual***

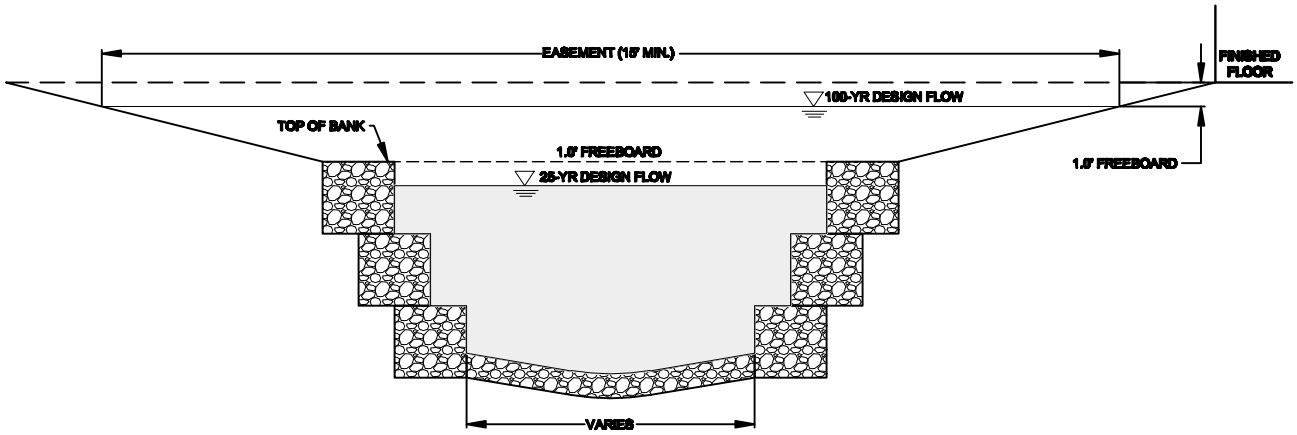
APPENDIX 2
FIGURES

Appendix 2

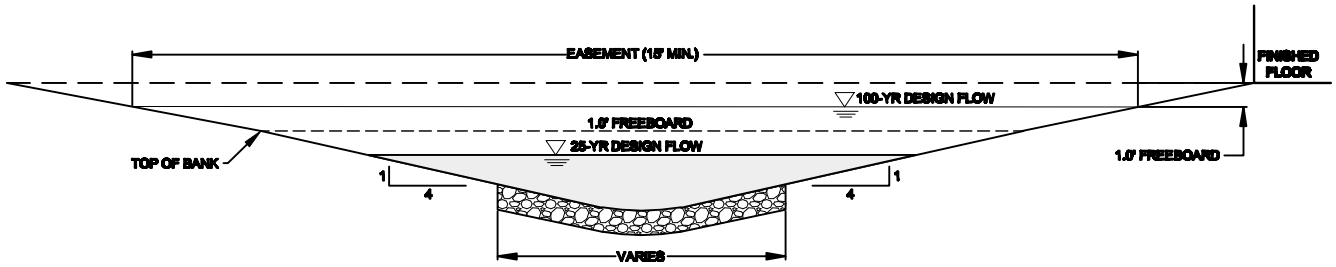
Table of Contents

FIGURE 1
(Intentionally Deleted)

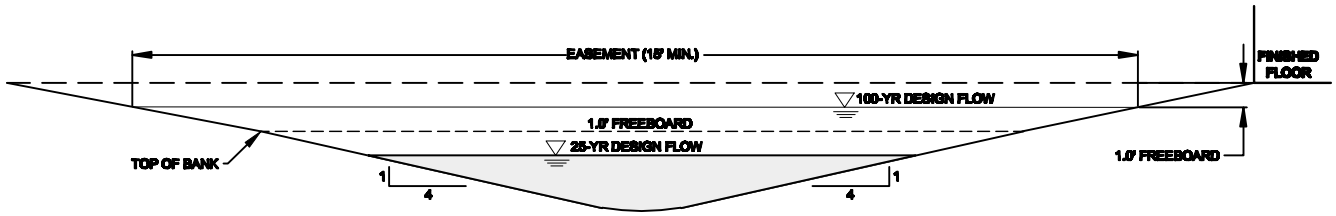
Figure 2. Open Channel Types



TYPICAL CHANNEL IMPROVEMENT
W/ GABION LINING



TYPICAL IMPROVED CHANNEL IMPROVEMENT
W/ ROCK CHANNEL LINING



TYPICAL IMPROVED UNLINED CHANNEL SECTION

APPENDIX 3
INTENTIALLY DELETED

APPENDIX 4
STREET CAPACITY NOMOGRAPHS

Appendix 4

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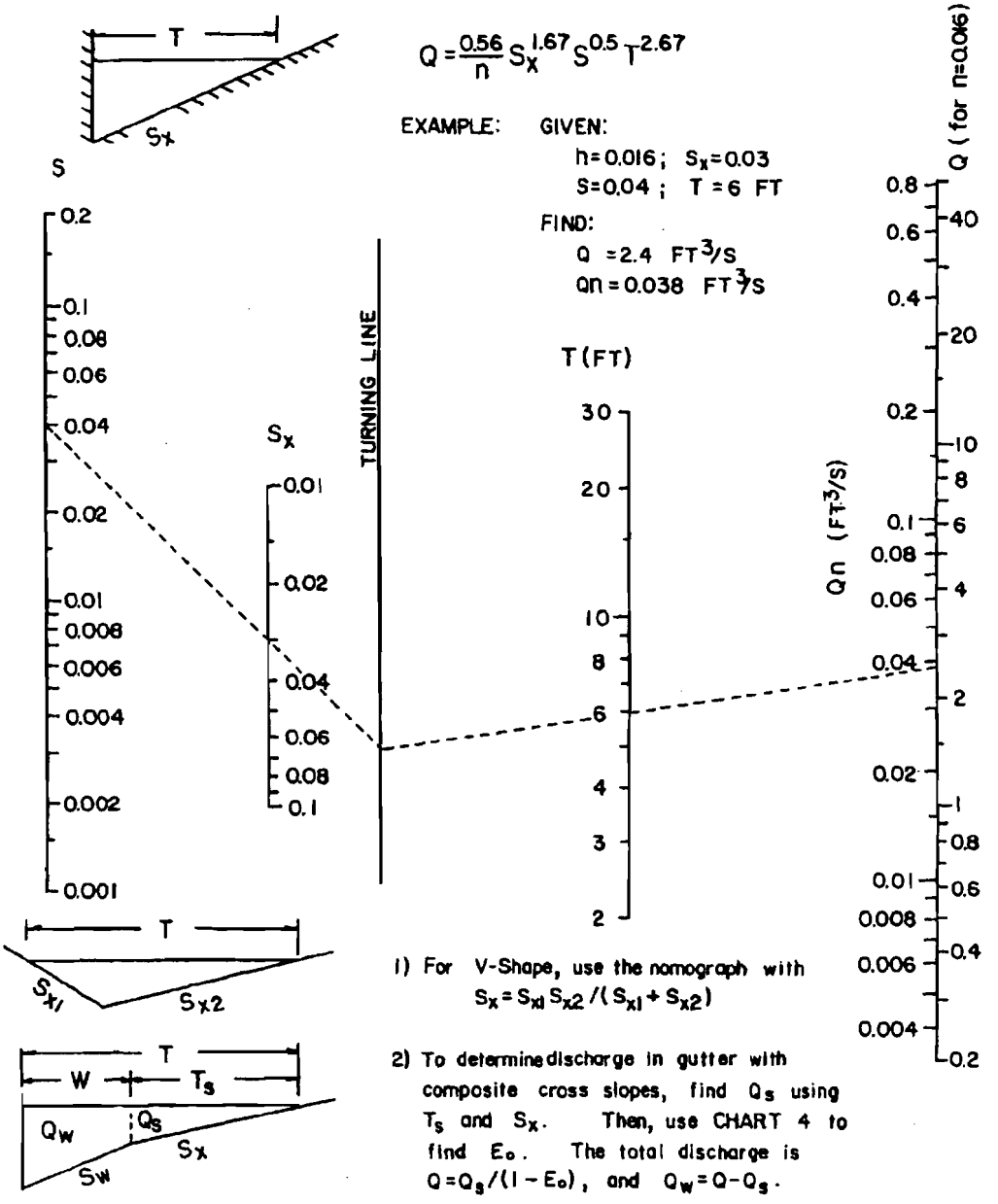
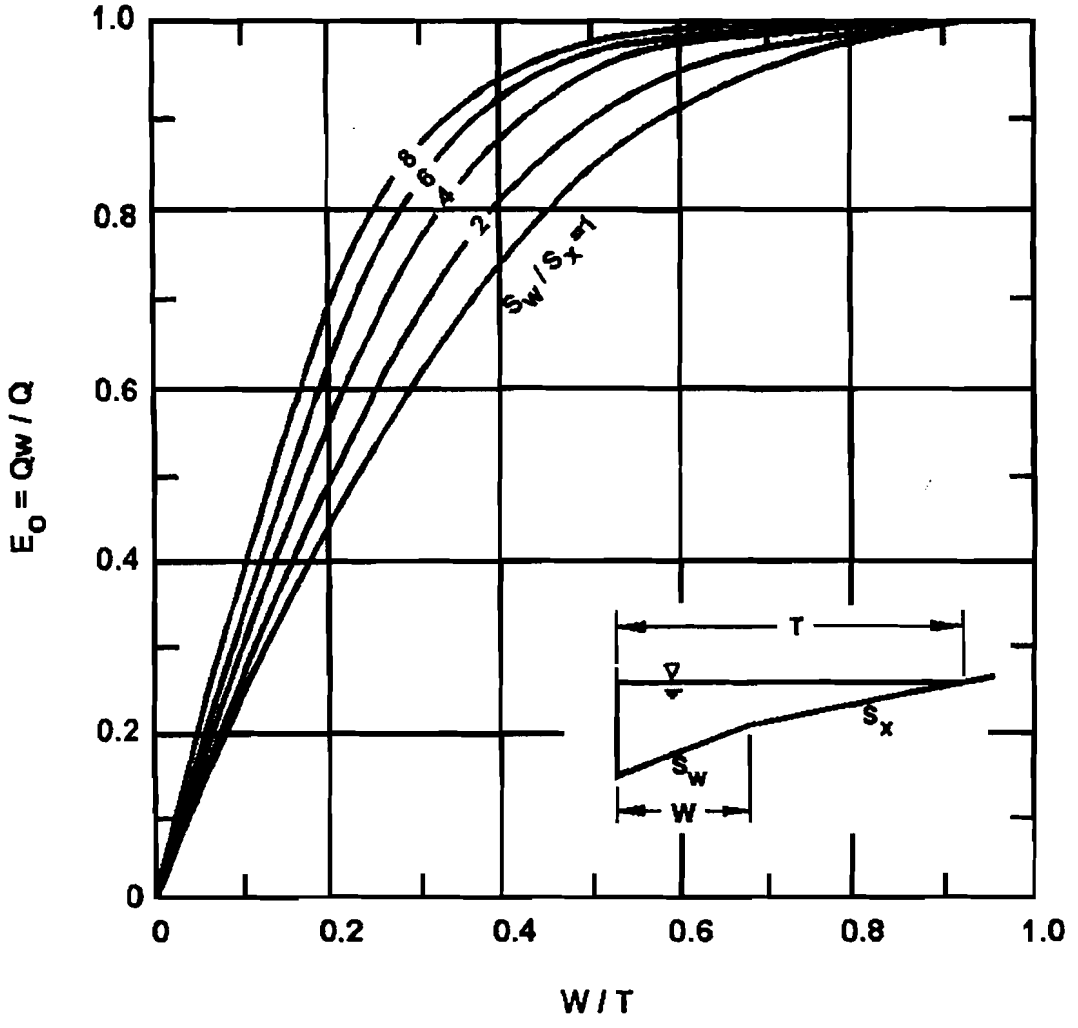
CHART 1B



Flow in Triangular Gutter Sections - English Units

CHART 2B



Ratio of Frontal Flow to Total Gutter Flow

CHART 3B

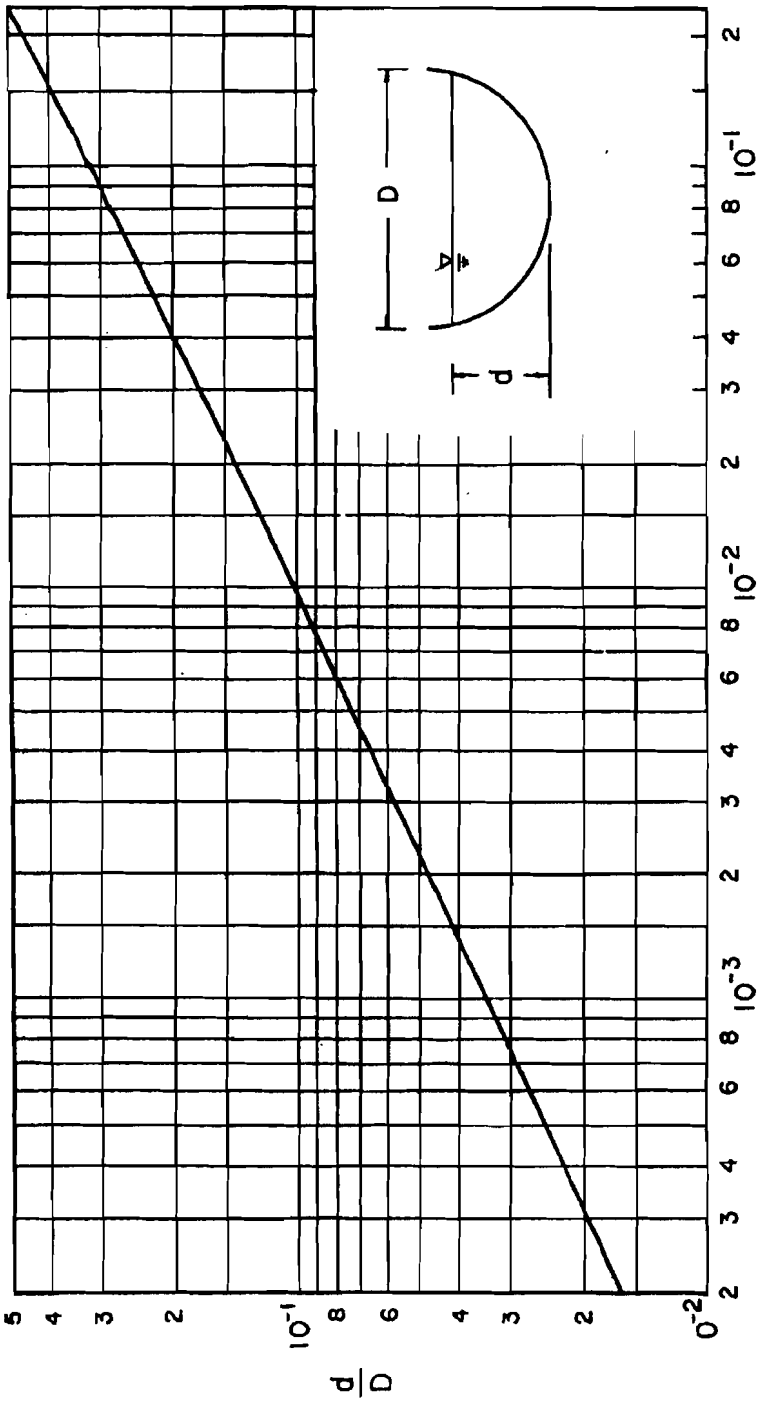
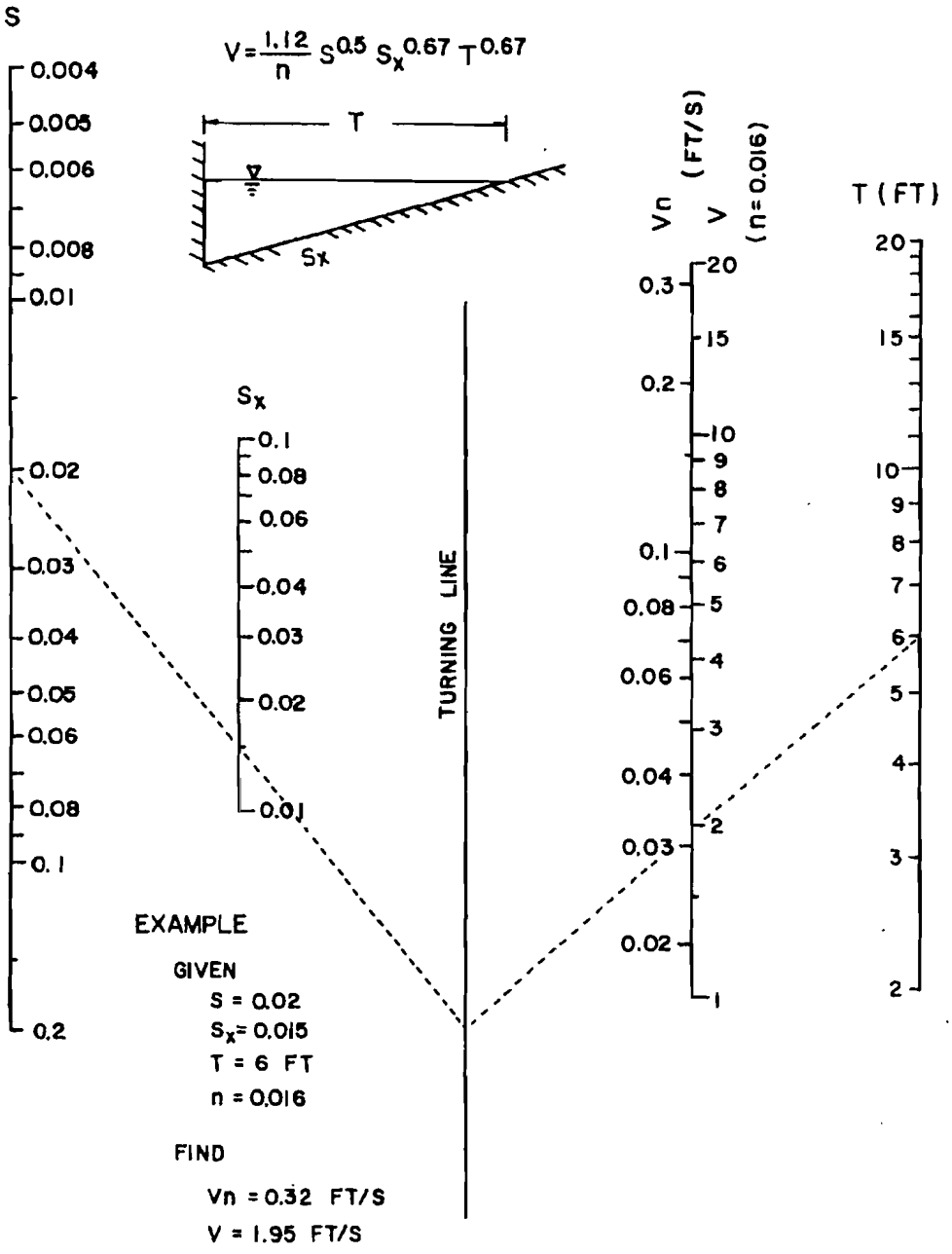


Chart 3B
Appendix 4

CHART 4B



Velocity in Triangular Gutter Sections - English Units

CHART 5B

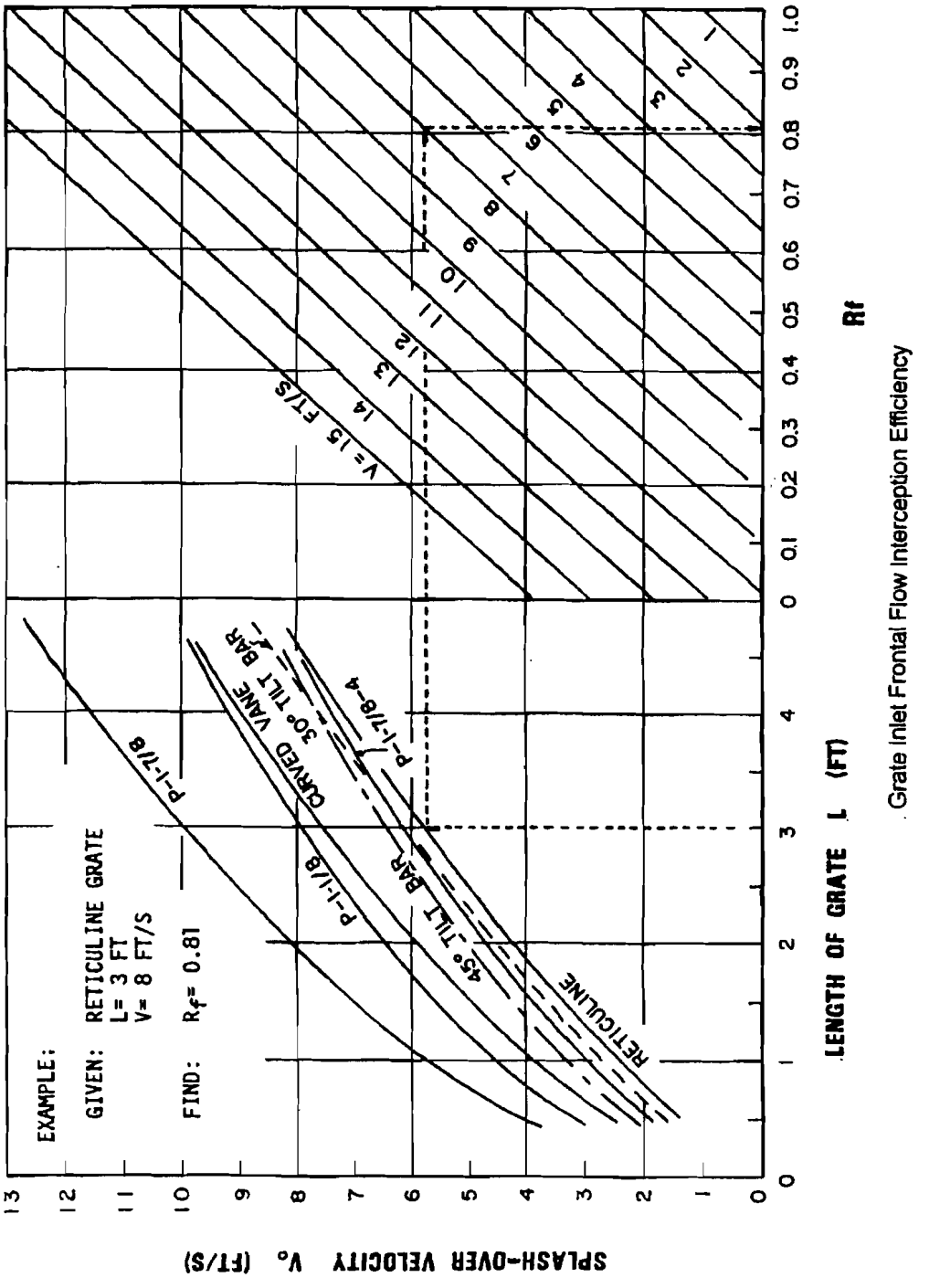
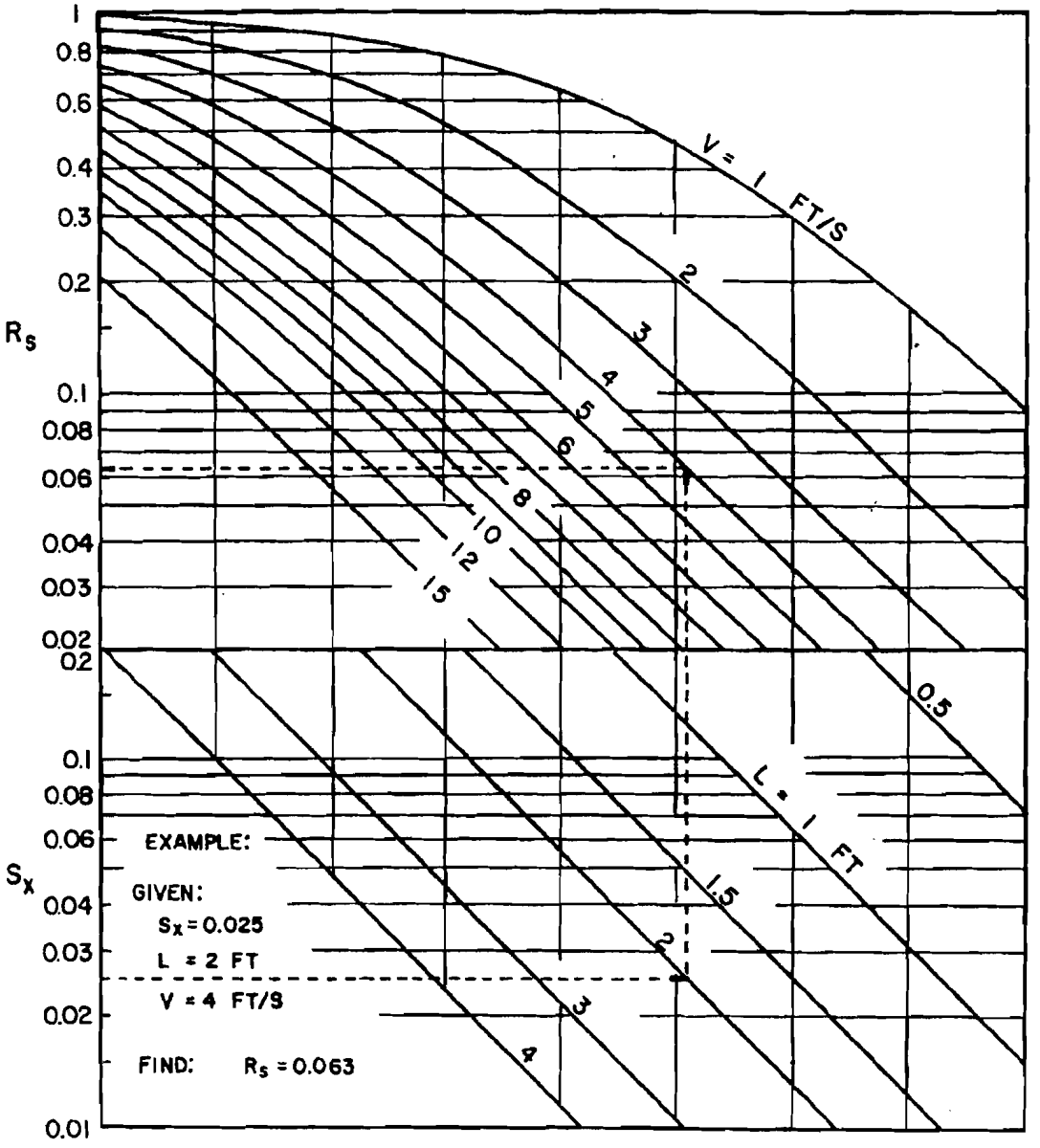
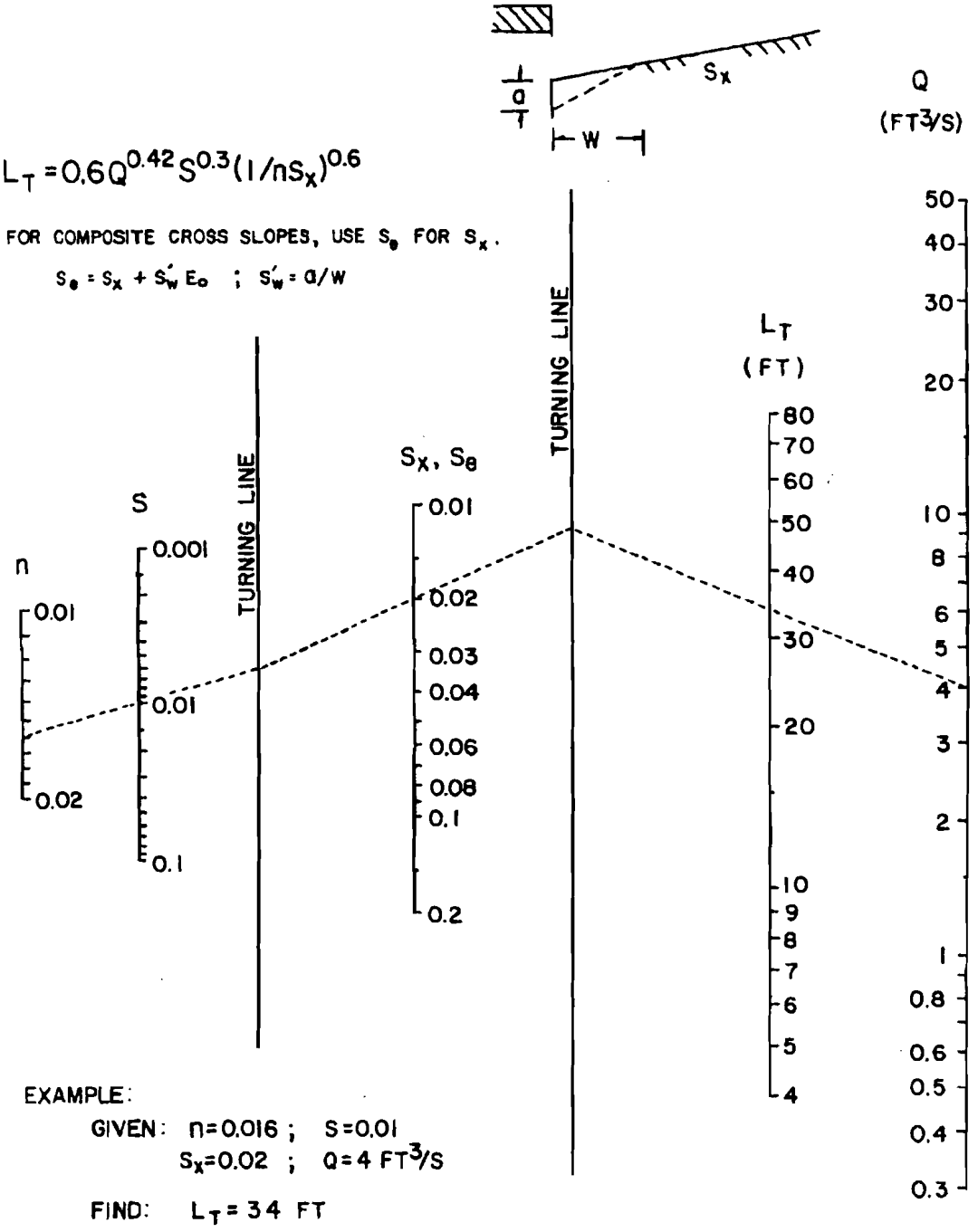

EXAMPLE:
GIVEN: RETICULINE GRATE
L= 3 FT
V= 8 FT/S
FIND: R_f= 0.81
P-1-7/8
P-1-1/8
CURVED VANE
30° TILT BAR
45° TILT BAR
RETICULINE
P-1-7/8-4
V= 15 FT/S
SPLASH-OVER VELOCITY V_o (FT/S)
LENGTH OF GRATE L (FT)
Rf
Grate Inlet Frontal Flow Interception Efficiency

CHART 6B



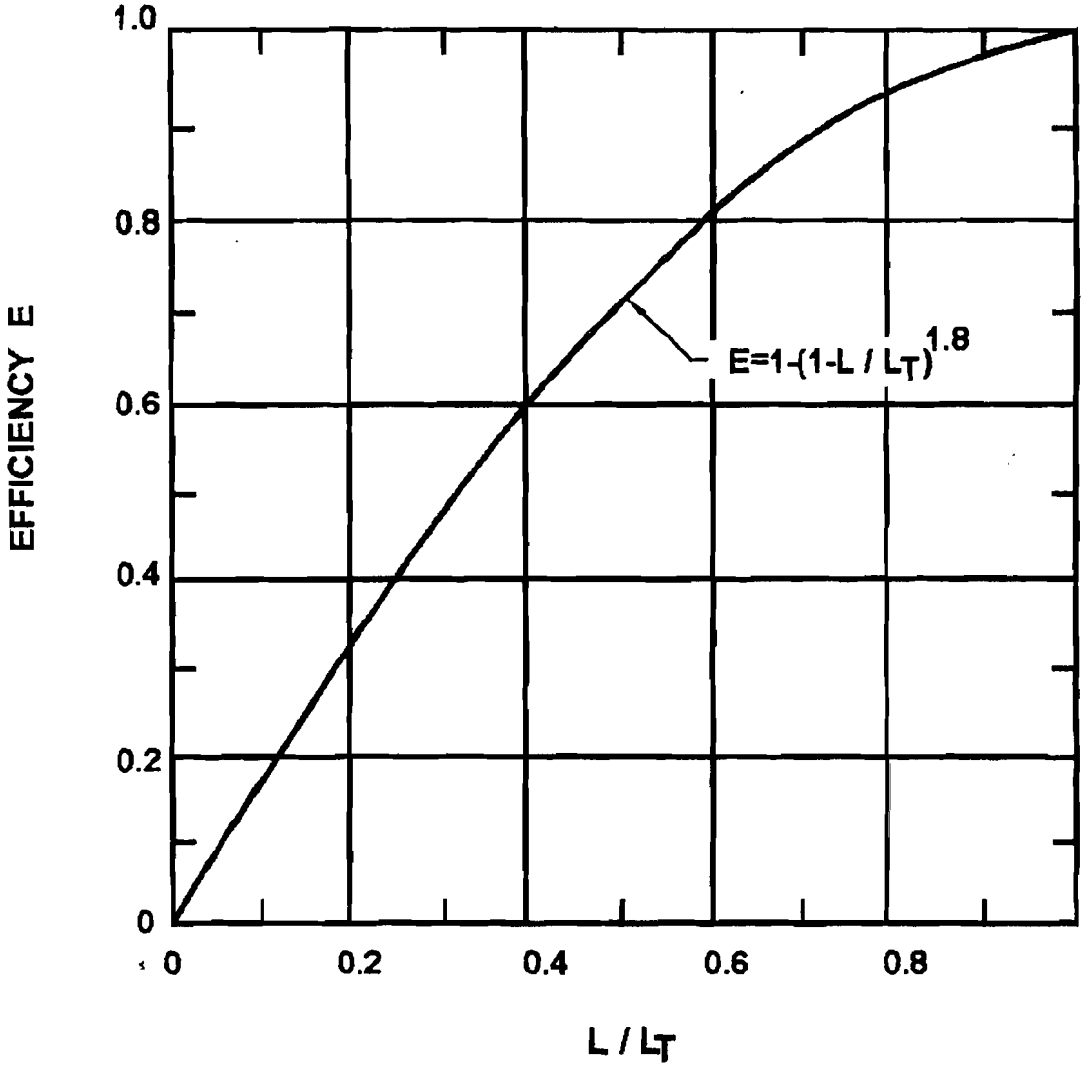
Grate Inlet Side Flow Intercept Efficiency

CHART 7B



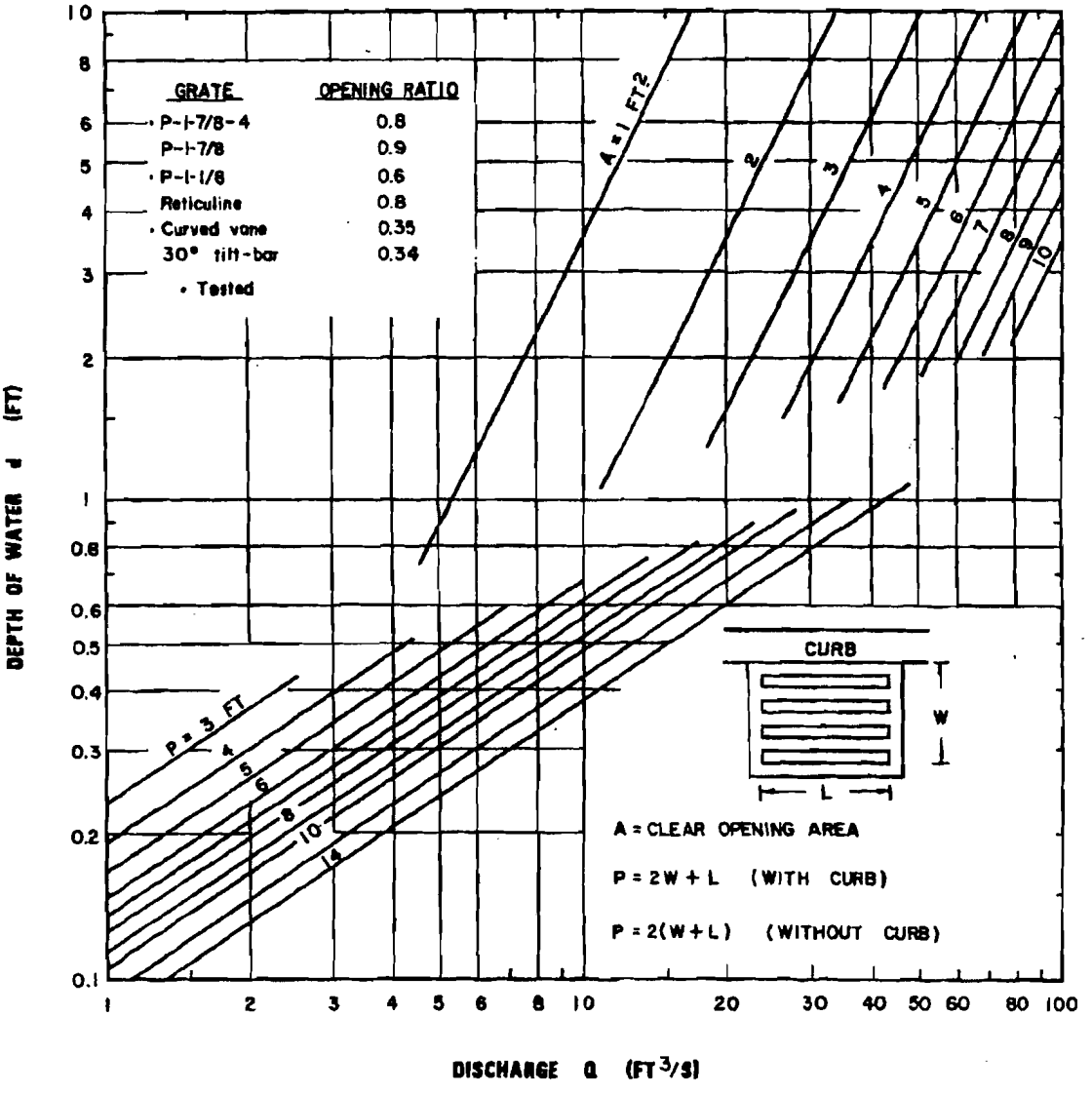
Curb-opening & Slotted Drain Inlet Length for Total Interception - English Units

CHART 8B



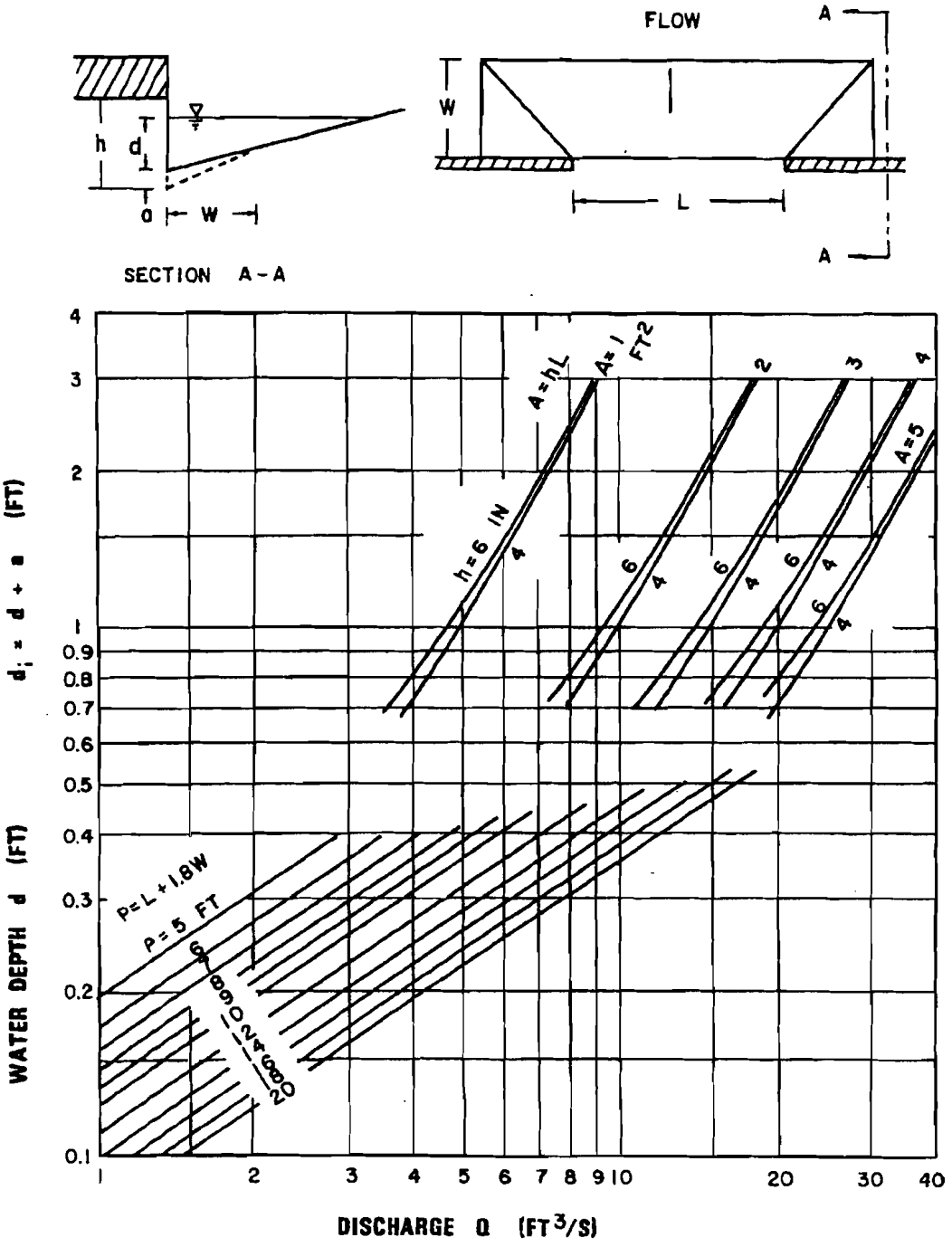
Curb-opening and Slotted Drain Inlet Interception Efficiency.

CHART 9B



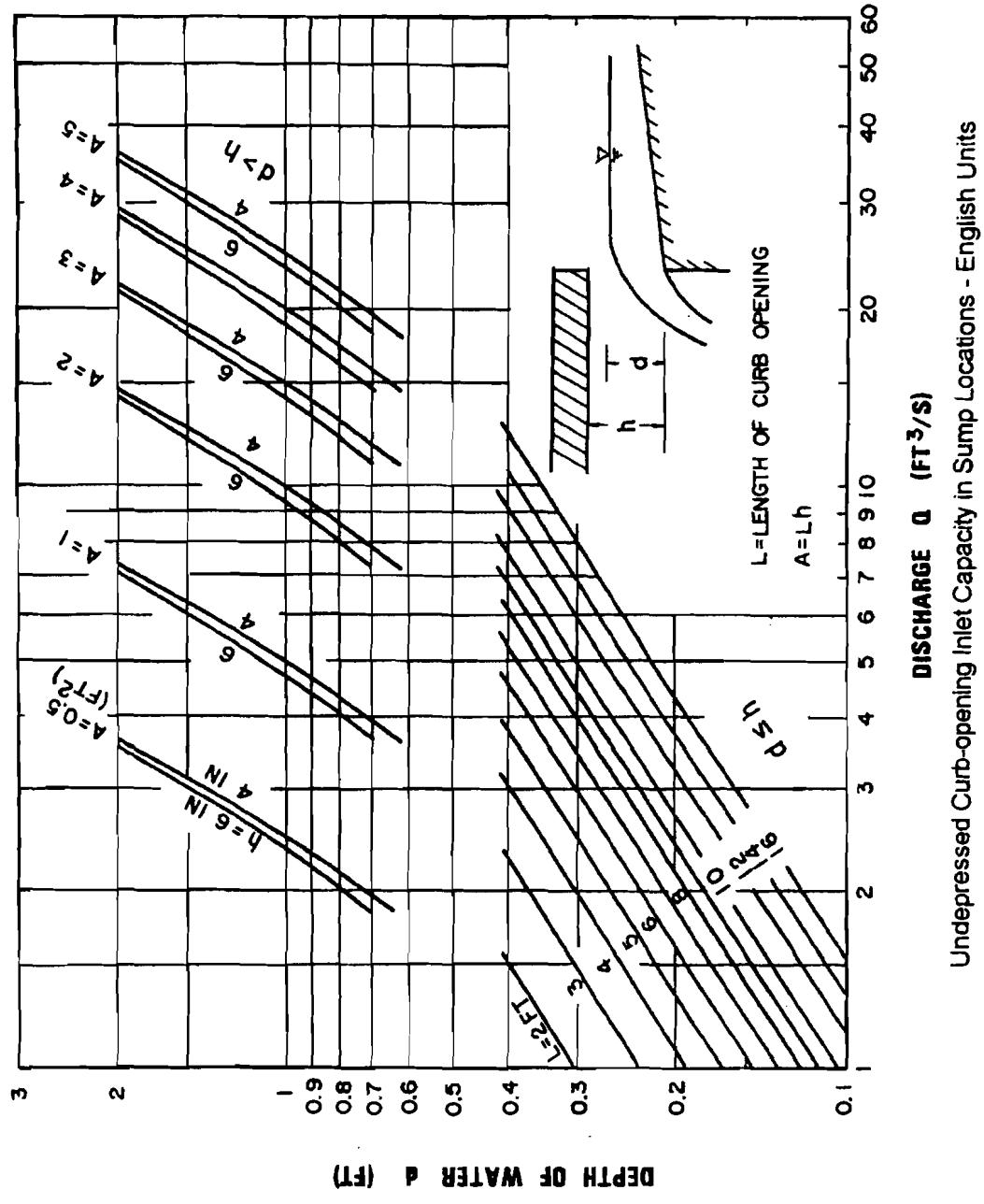
Grate Inlet Capacity in Sump Conditions - English Units

CHART 10B



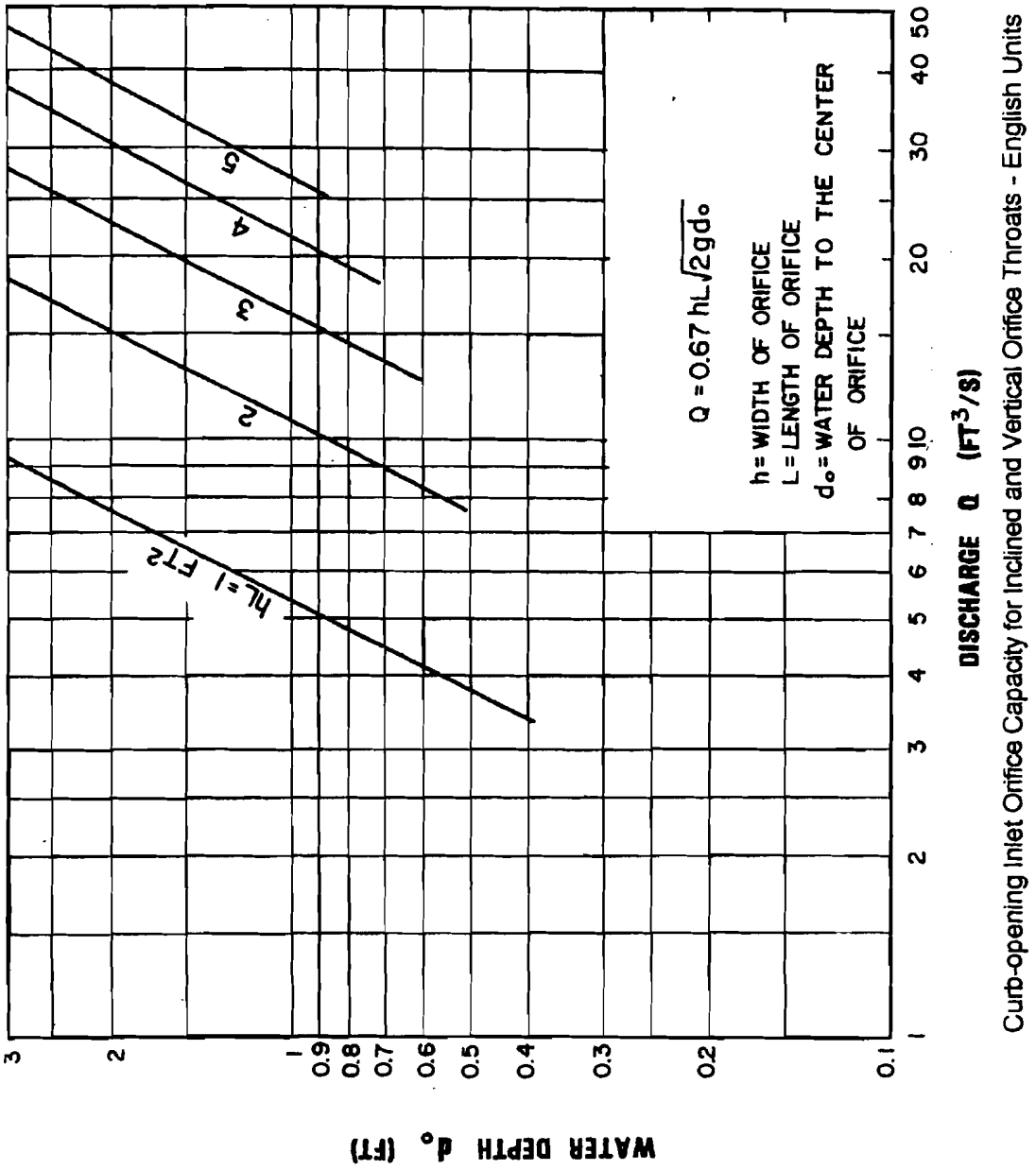
Depressed Curb-opening Inlet Capacity in Sump Locations - English Units

CHART 11B



Undepressed Curb-opening Inlet Capacity in Sump Locations - English Units

CHART 12B



Curb-opening Inlet Orifice Capacity for Inclined and Vertical Orifice Throats - English Units

APPENDIX 5
CULVERT NOMOGRAPHS

Appendix 5

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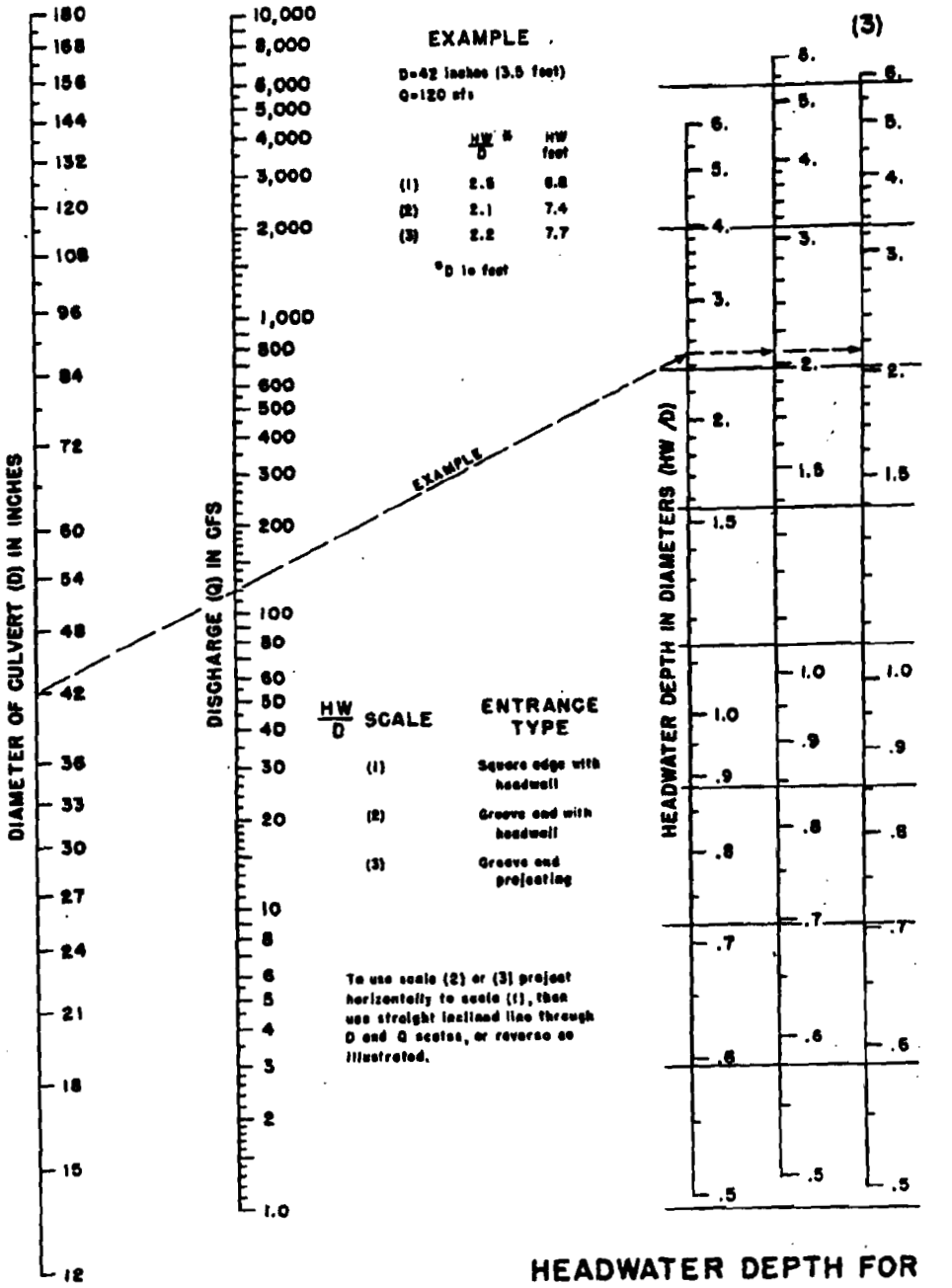
CHART 1B

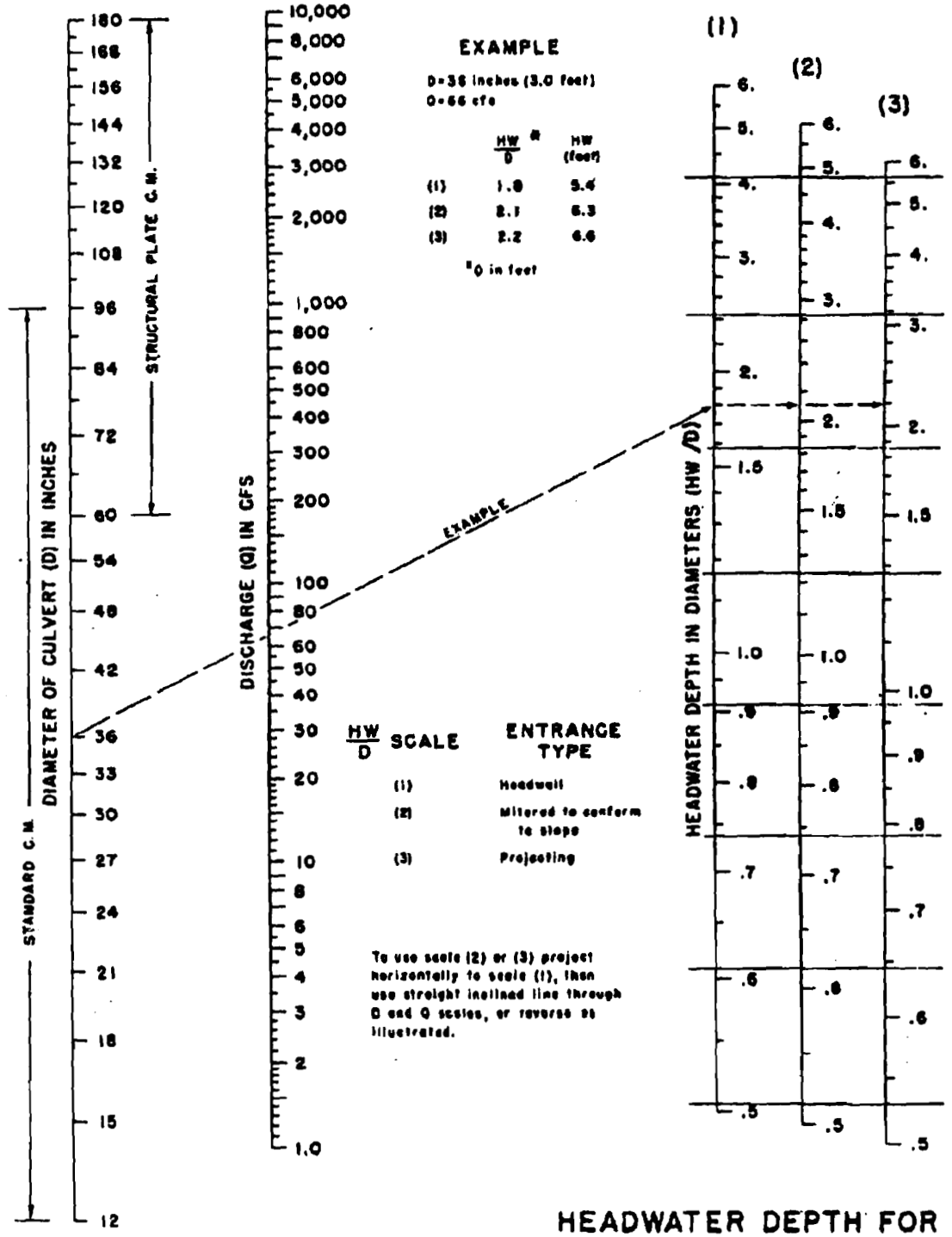


HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

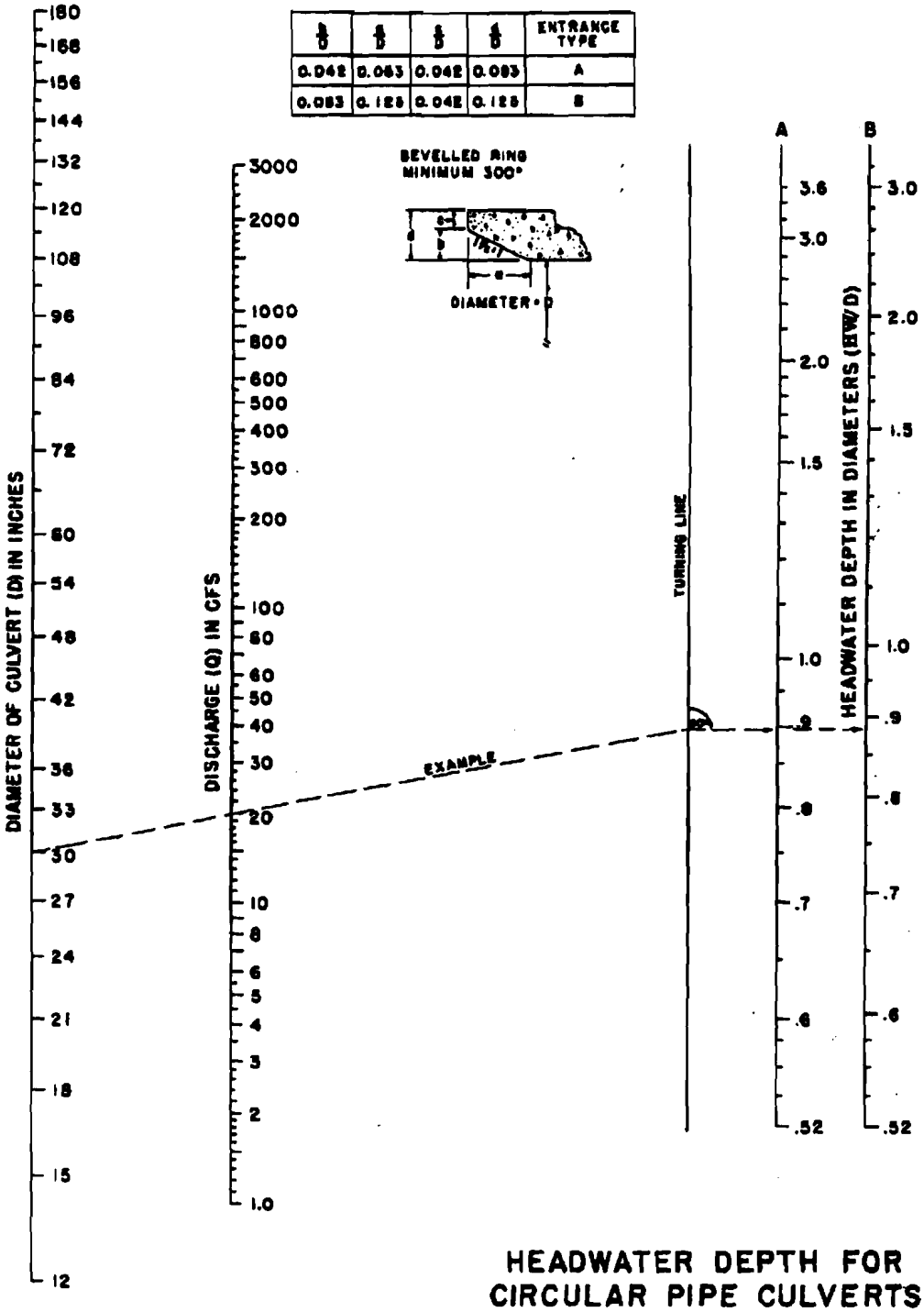
CHART 2B



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

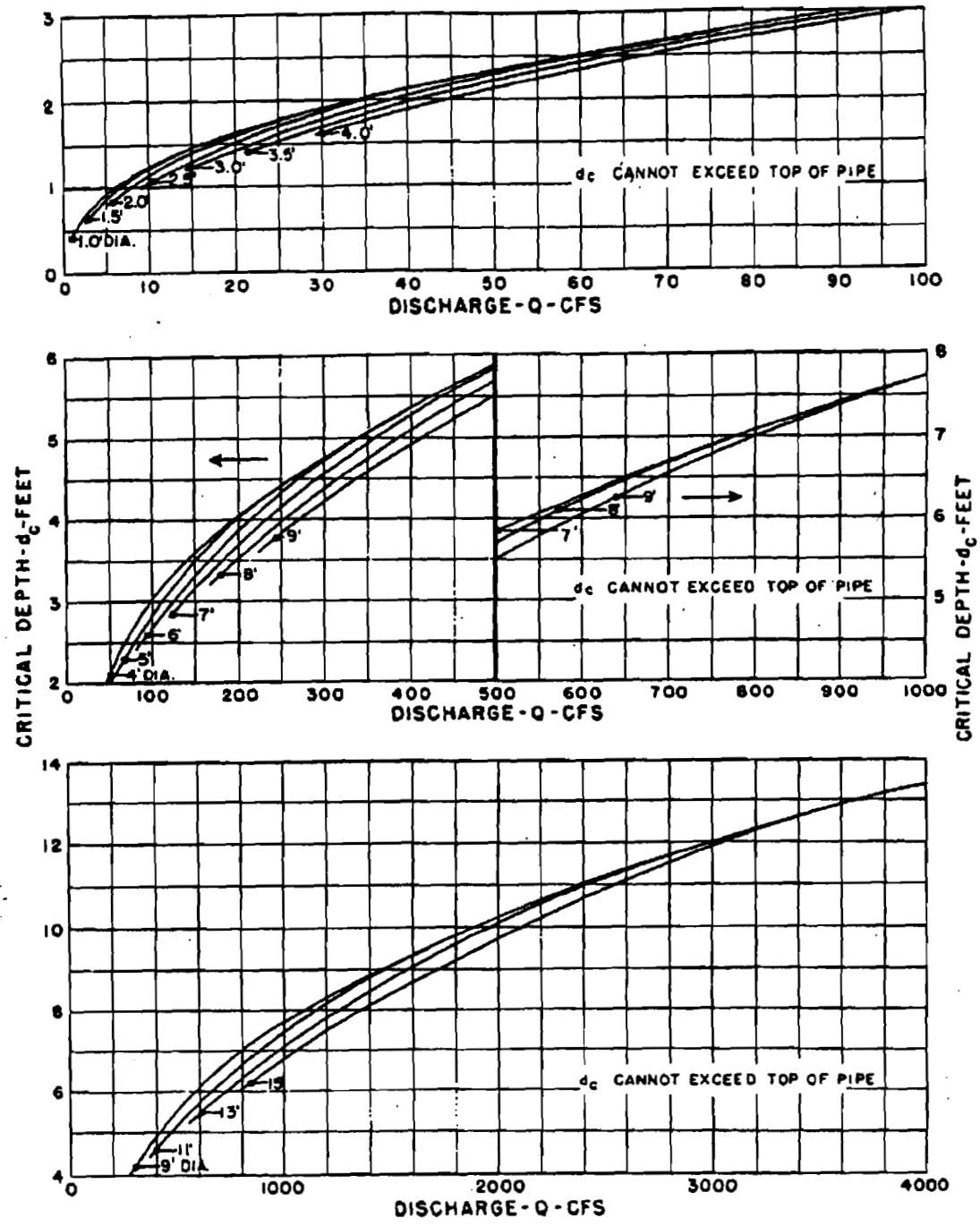
CHART 3B



FEDERAL HIGHWAY ADMINISTRATION
MAY 1973

HEADWATER DEPTH FOR CIRCULAR PIPE CULVERTS WITH BEVELED RING INLET CONTROL

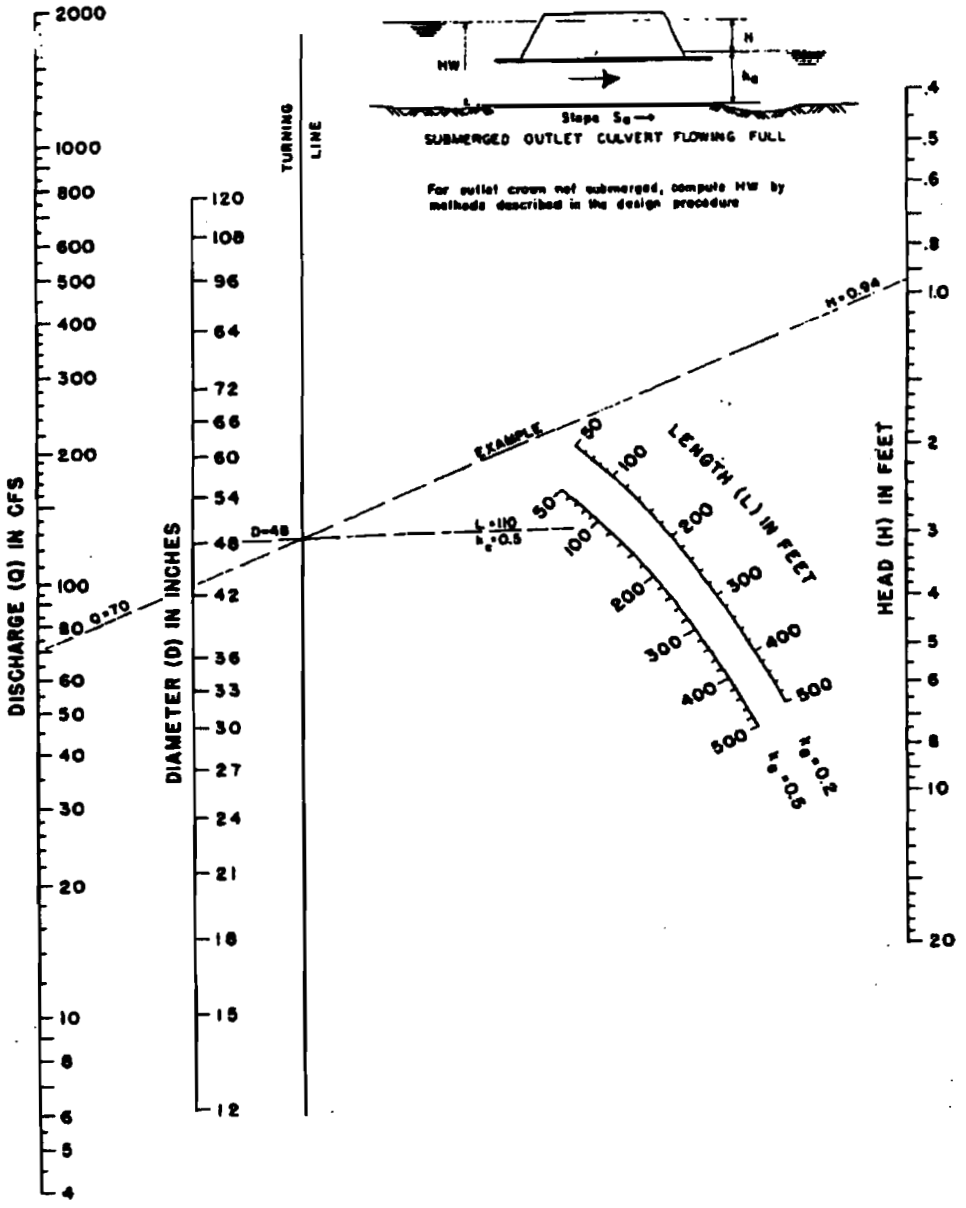
CHART 4B



BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

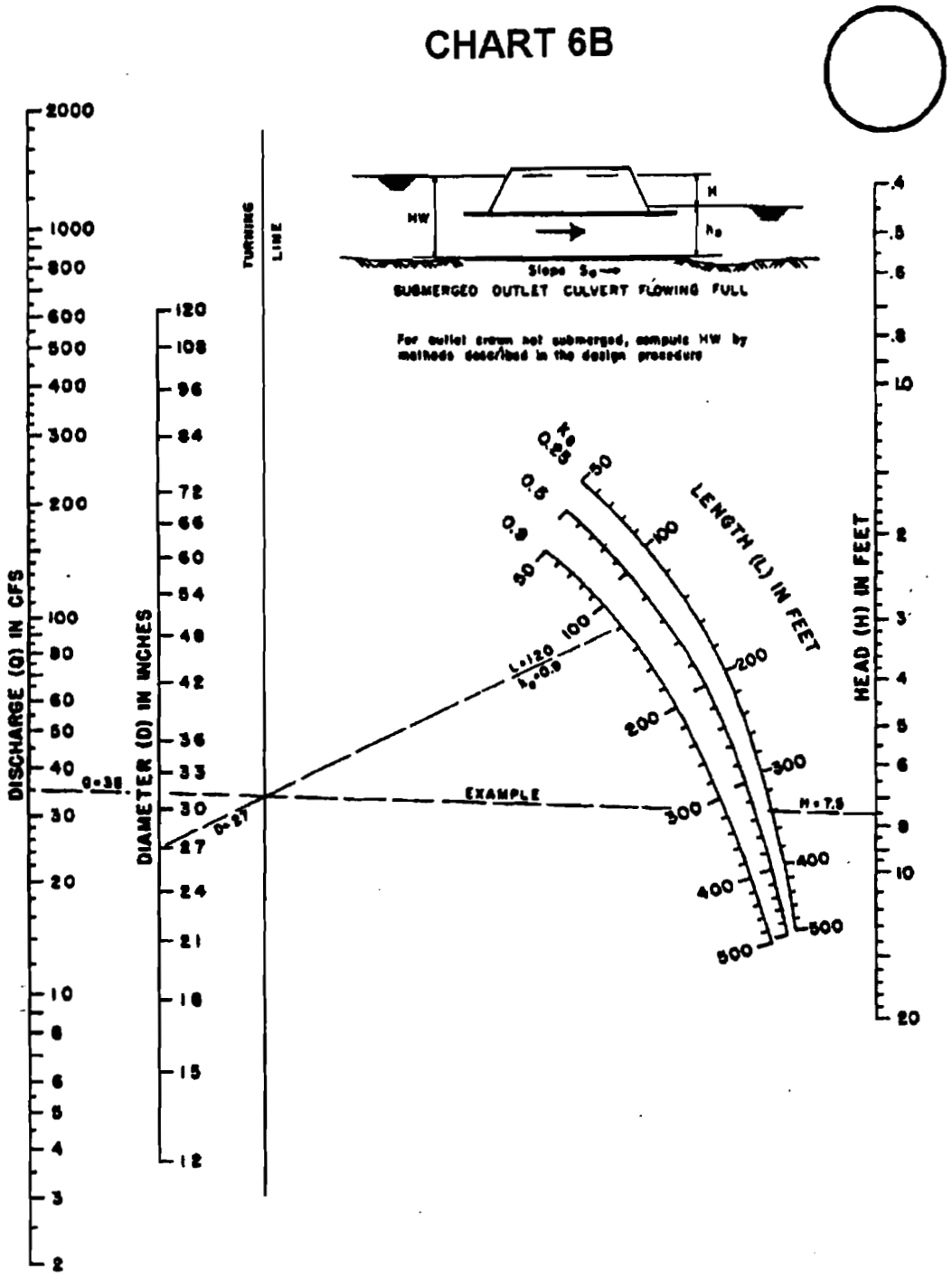
CHART 5B



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

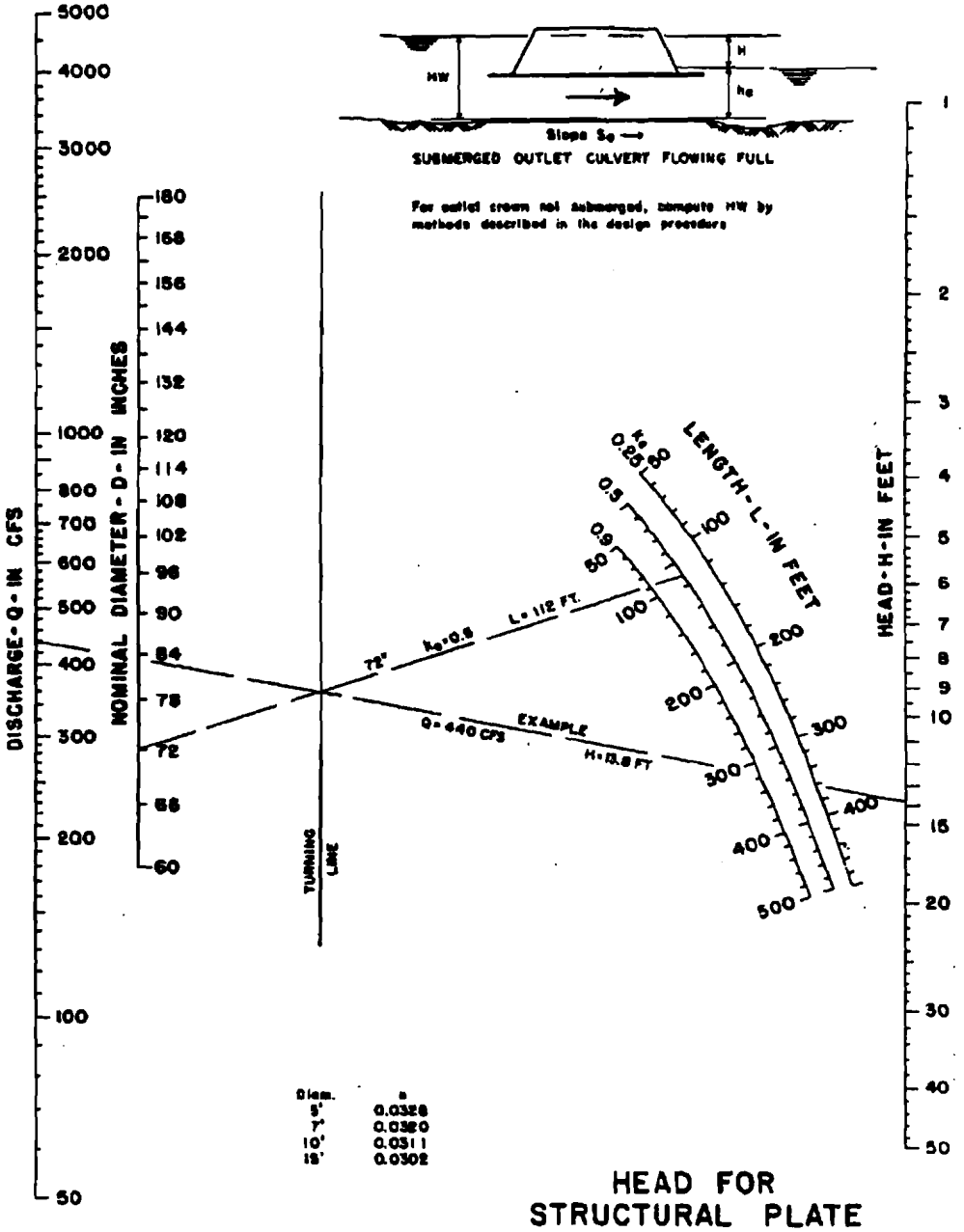
CHART 6B



HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

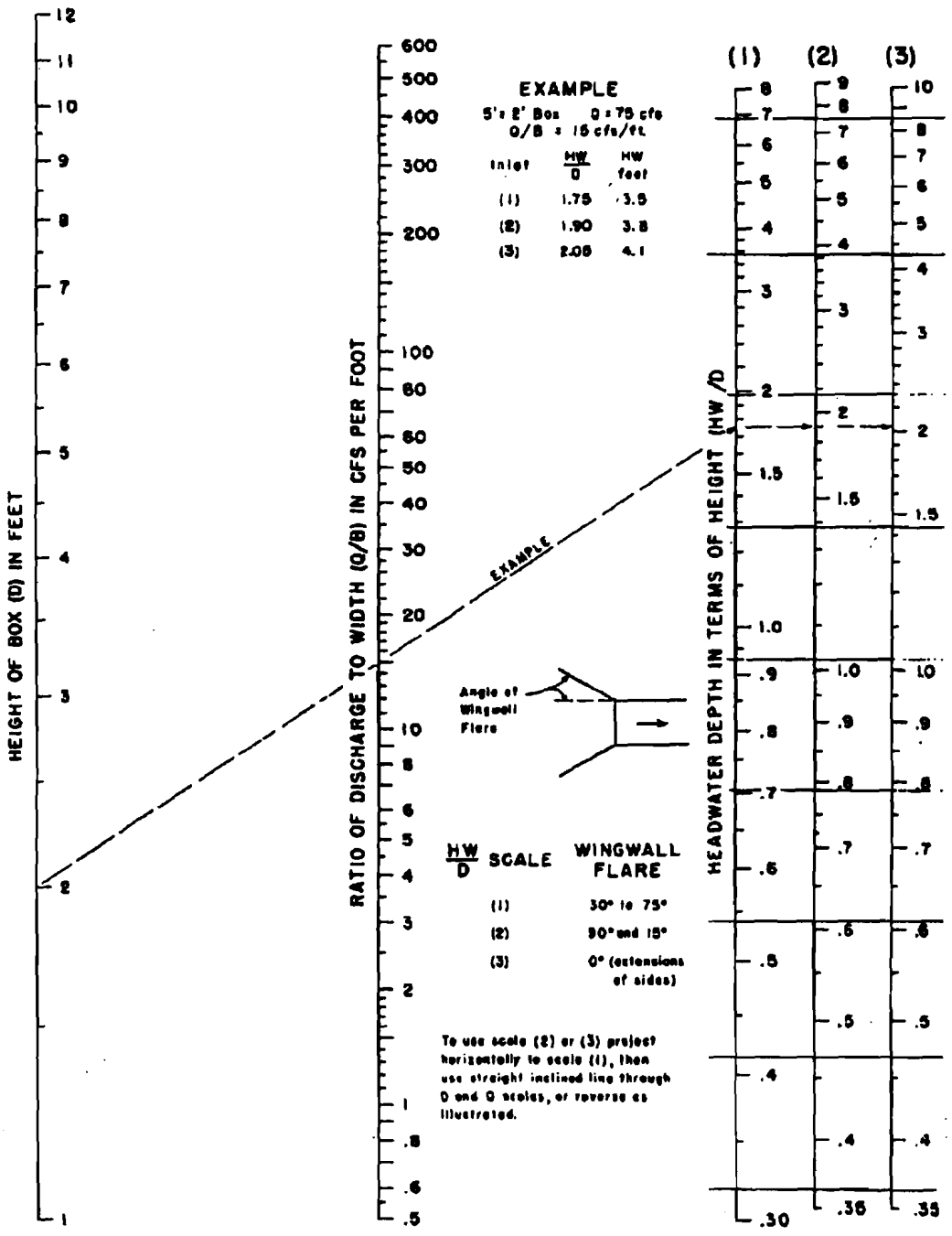
CHART 7B



HEAD FOR STRUCTURAL PLATE CORR. METAL PIPE CULVERTS FLOWING FULL n = 0.0328 TO 0.0302

BUREAU OF PUBLIC ROADS JAN. 1963

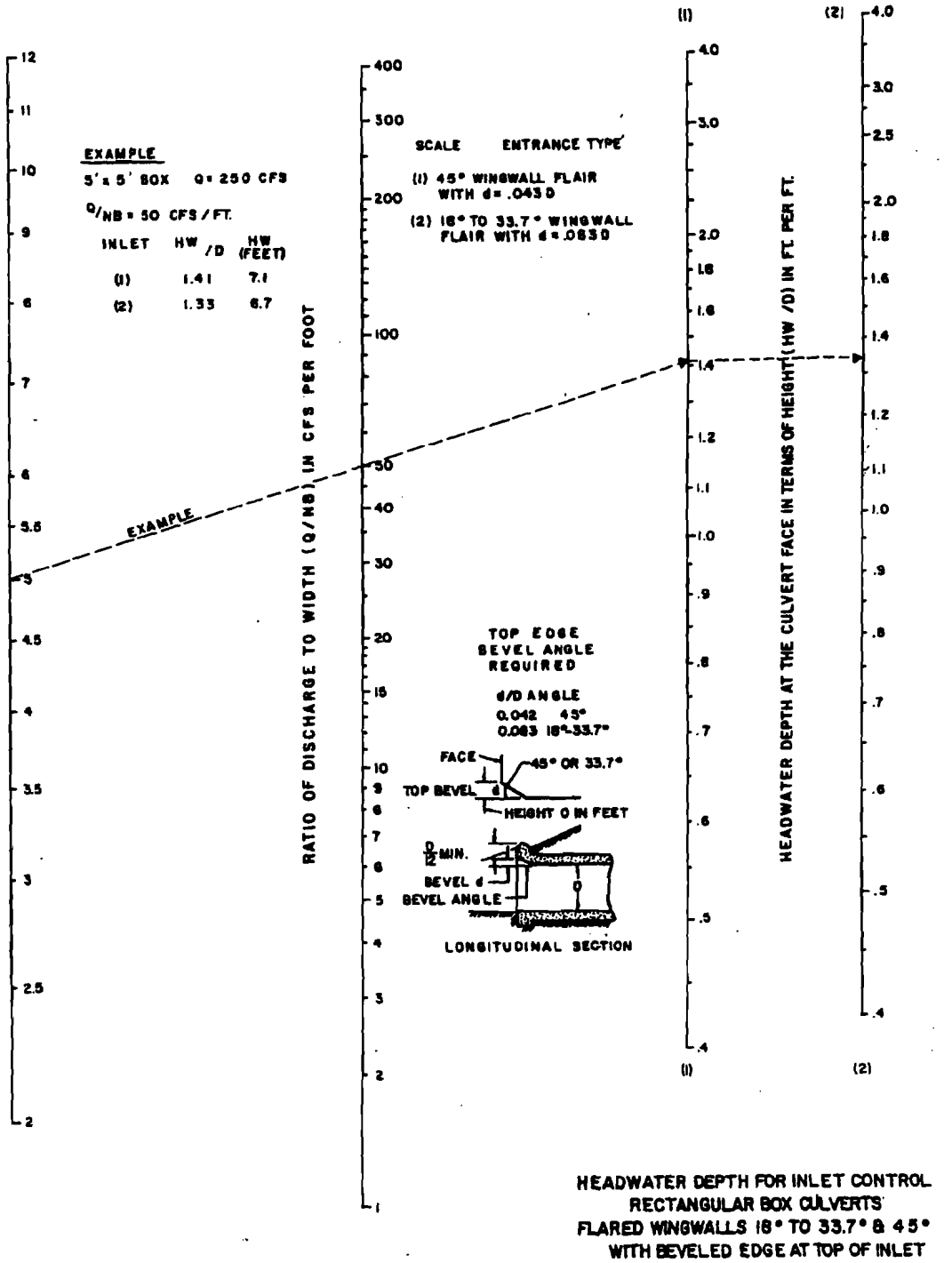
CHART 8B



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

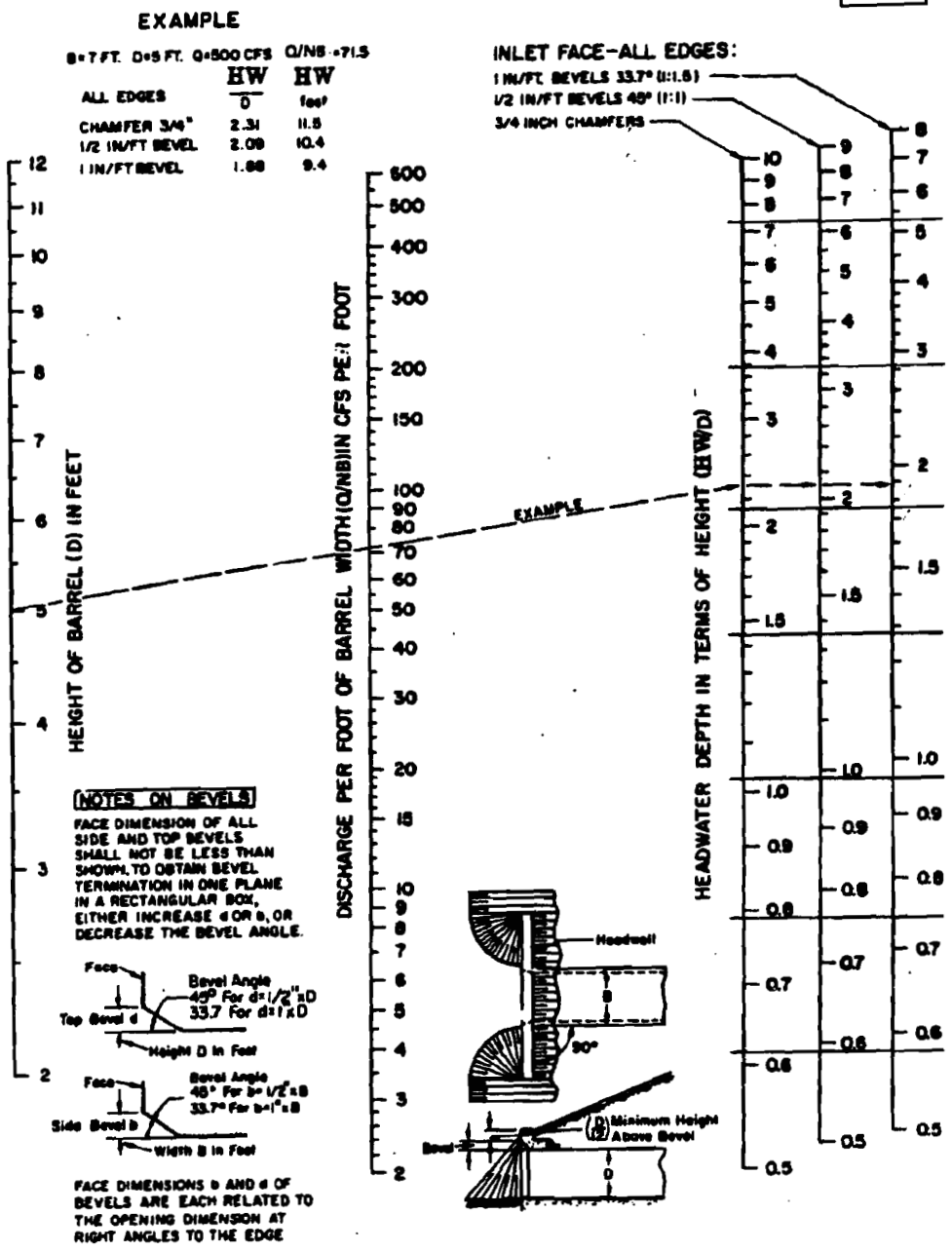
BUREAU OF PUBLIC ROADS JAN. 1963

CHART 9B



HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS 18° TO 33.7° & 45°
WITH BEVELED EDGE AT TOP OF INLET

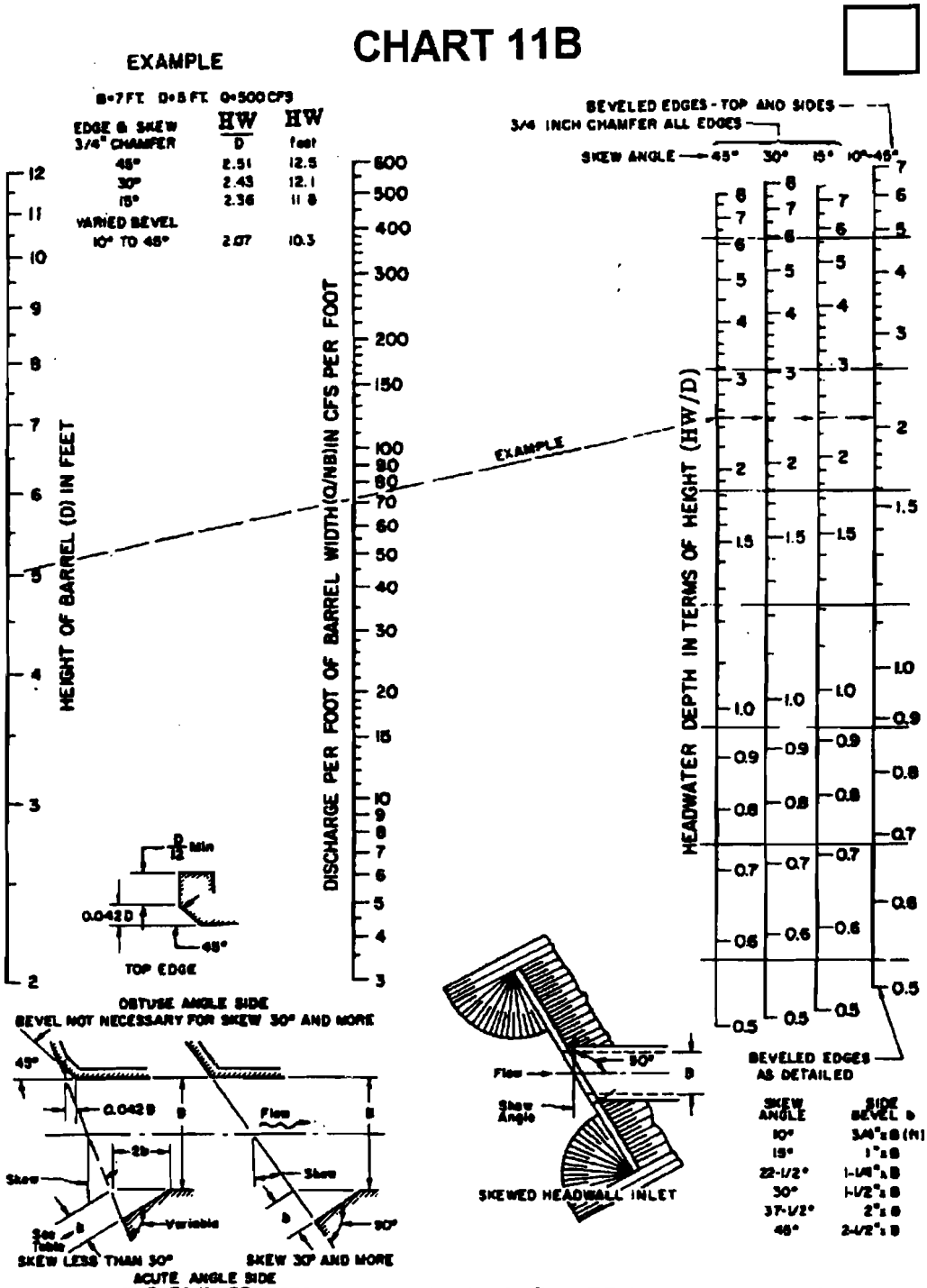
CHART 10B



HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
90° HEADWALL
CHAMFERED OR BEVELED INLET EDGES

FEDERAL HIGHWAY ADMINISTRATION
MAY 1973

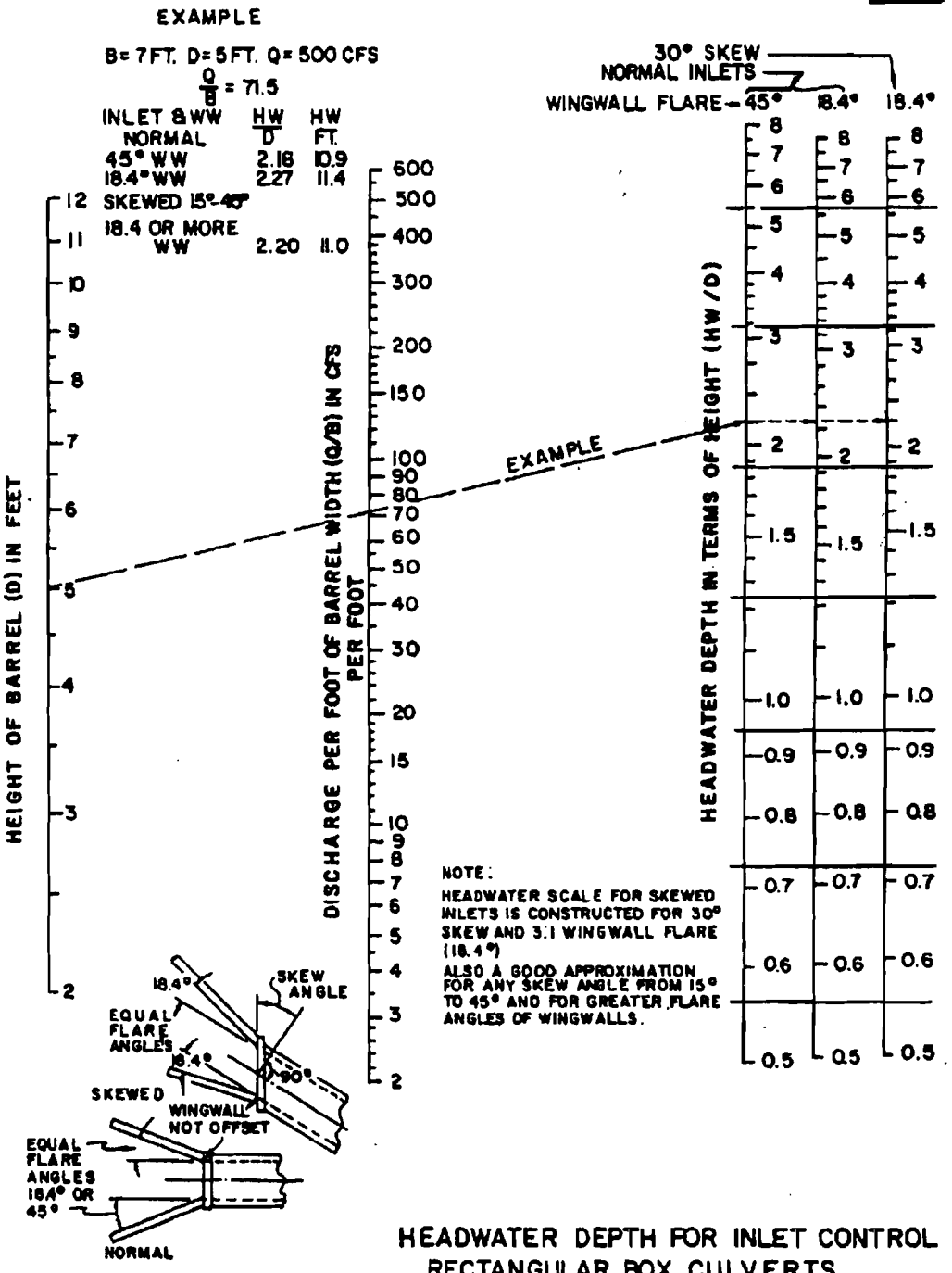
CHART 11B



FEDERAL HIGHWAY ADMINISTRATION
MAY 1973

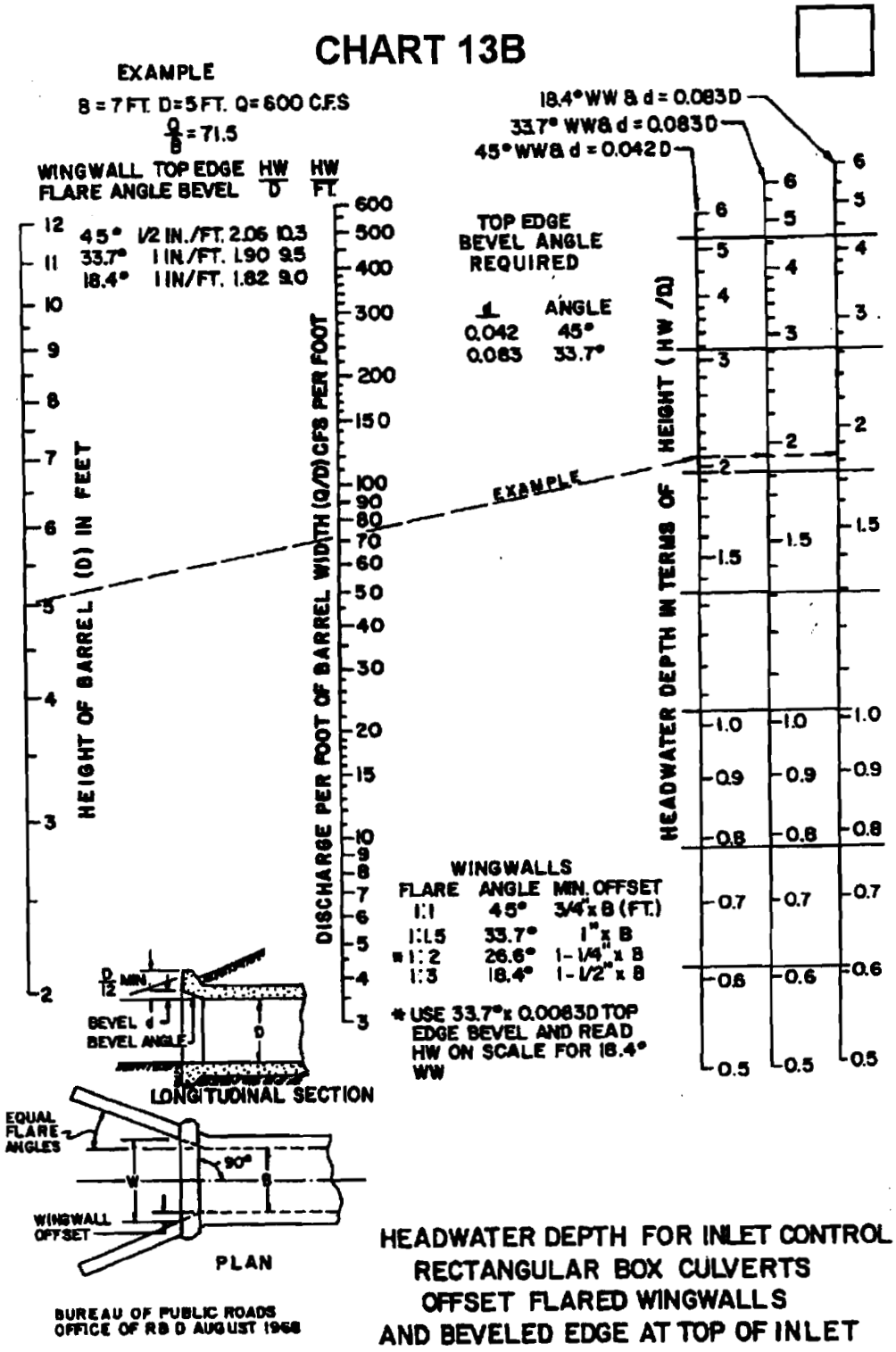
HEADWATER DEPTH FOR INLET CONTROL
SINGLE BARREL BOX CULVERTS
SKEWED HEADWALLS
CHAMFERED OR BEVELED INLET EDGES

CHART 12B



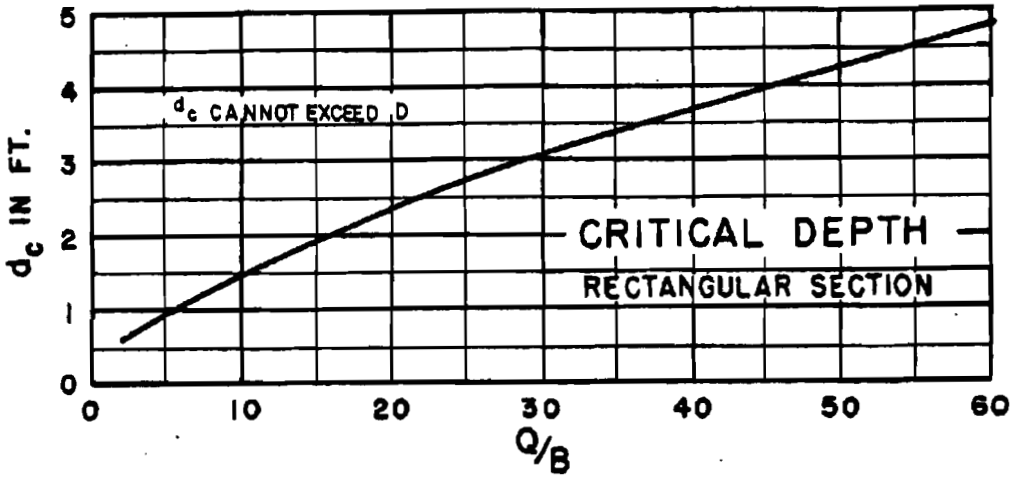
HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
FLARED WINGWALLS
NORMAL AND SKEWED INLETS
3/4" CHAMFER AT TOP OF OPENING

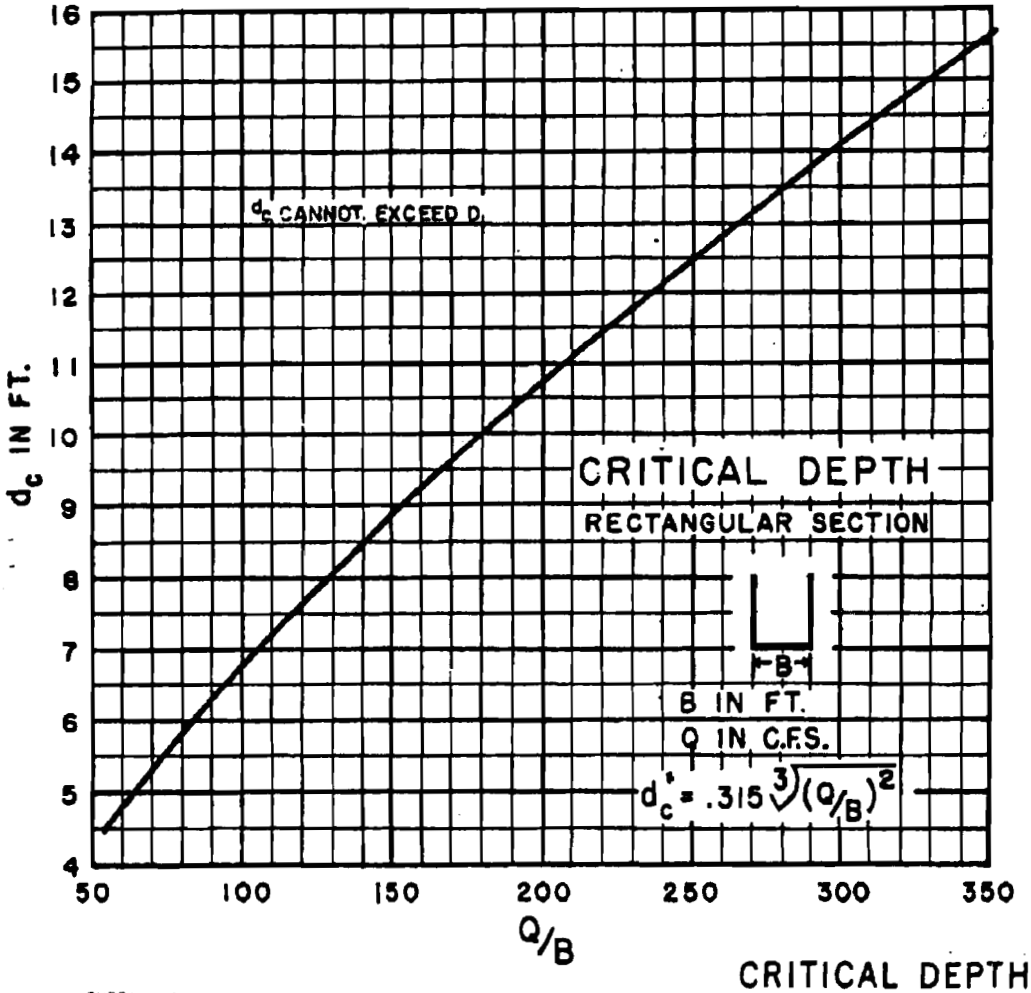
CHART 13B



HEADWATER DEPTH FOR INLET CONTROL
RECTANGULAR BOX CULVERTS
OFFSET FLARED WINGWALLS
AND BEVELED EDGE AT TOP OF INLET

CHART 14B

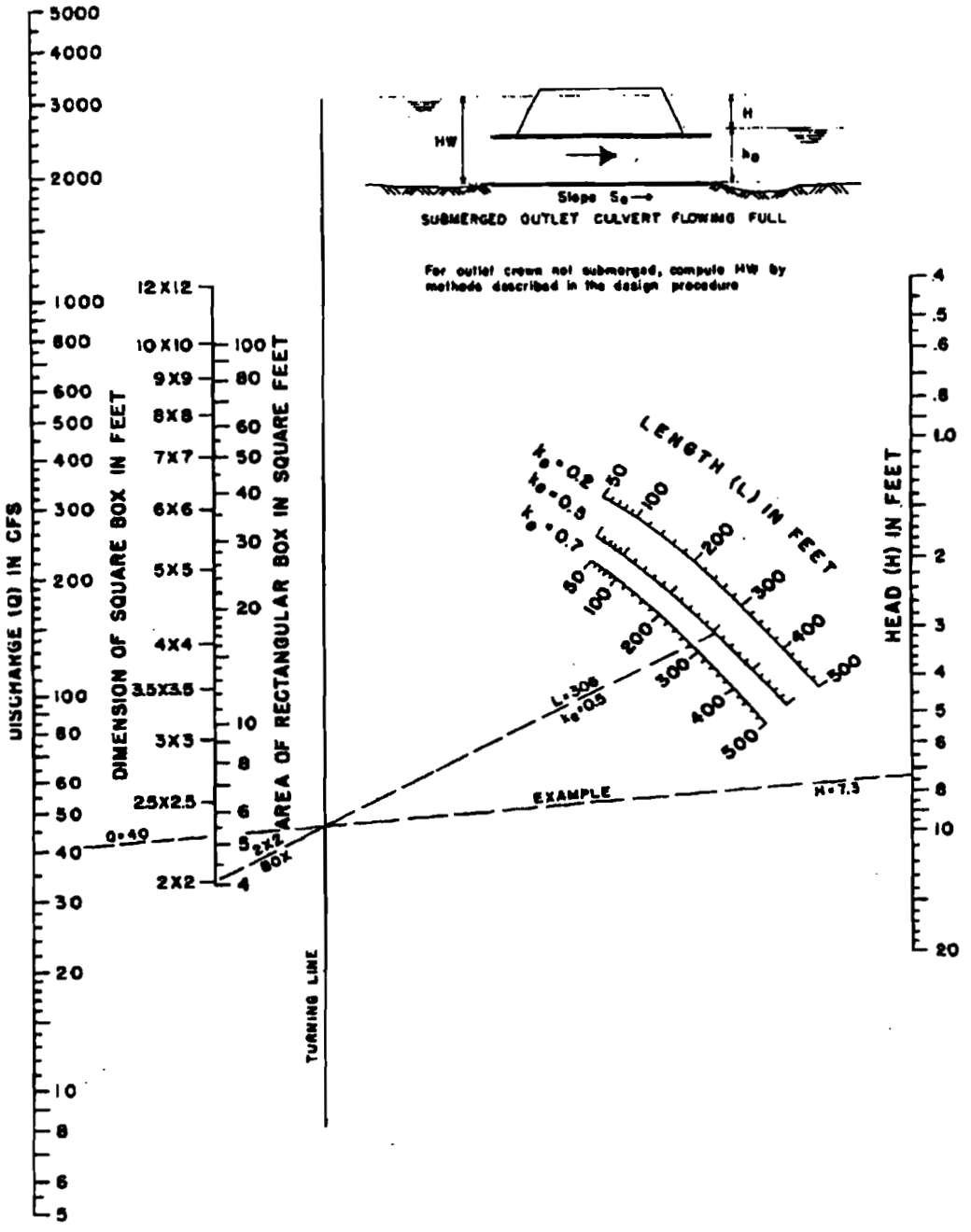




BUREAU OF PUBLIC ROADS JAN 1963

CRITICAL DEPTH
RECTANGULAR SECTION

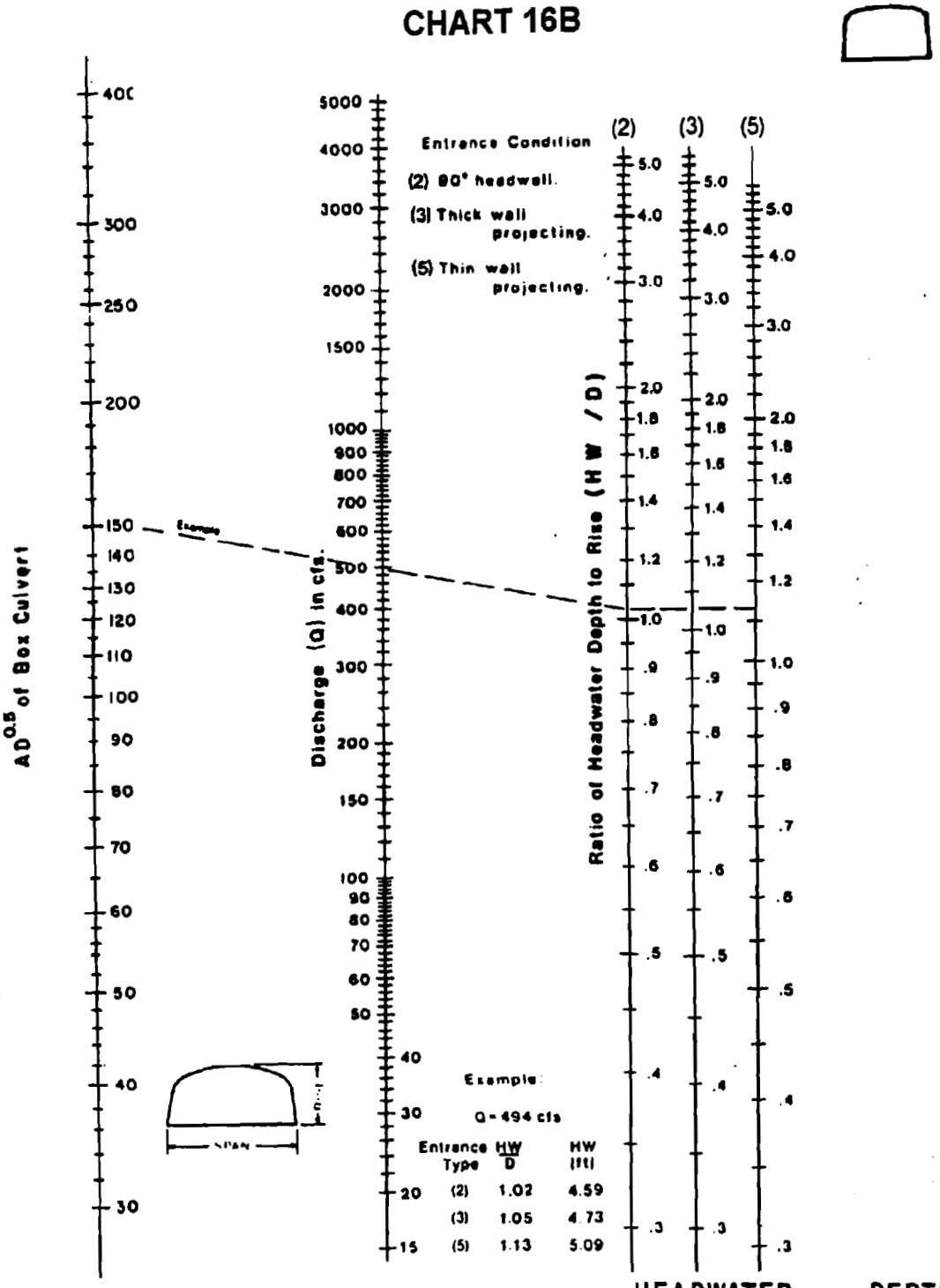
CHART 15B



HEAD FOR CONCRETE BOX CULVERTS FLOWING FULL n = 0.012

AU OF PUBLIC ROADS JAN. 1963

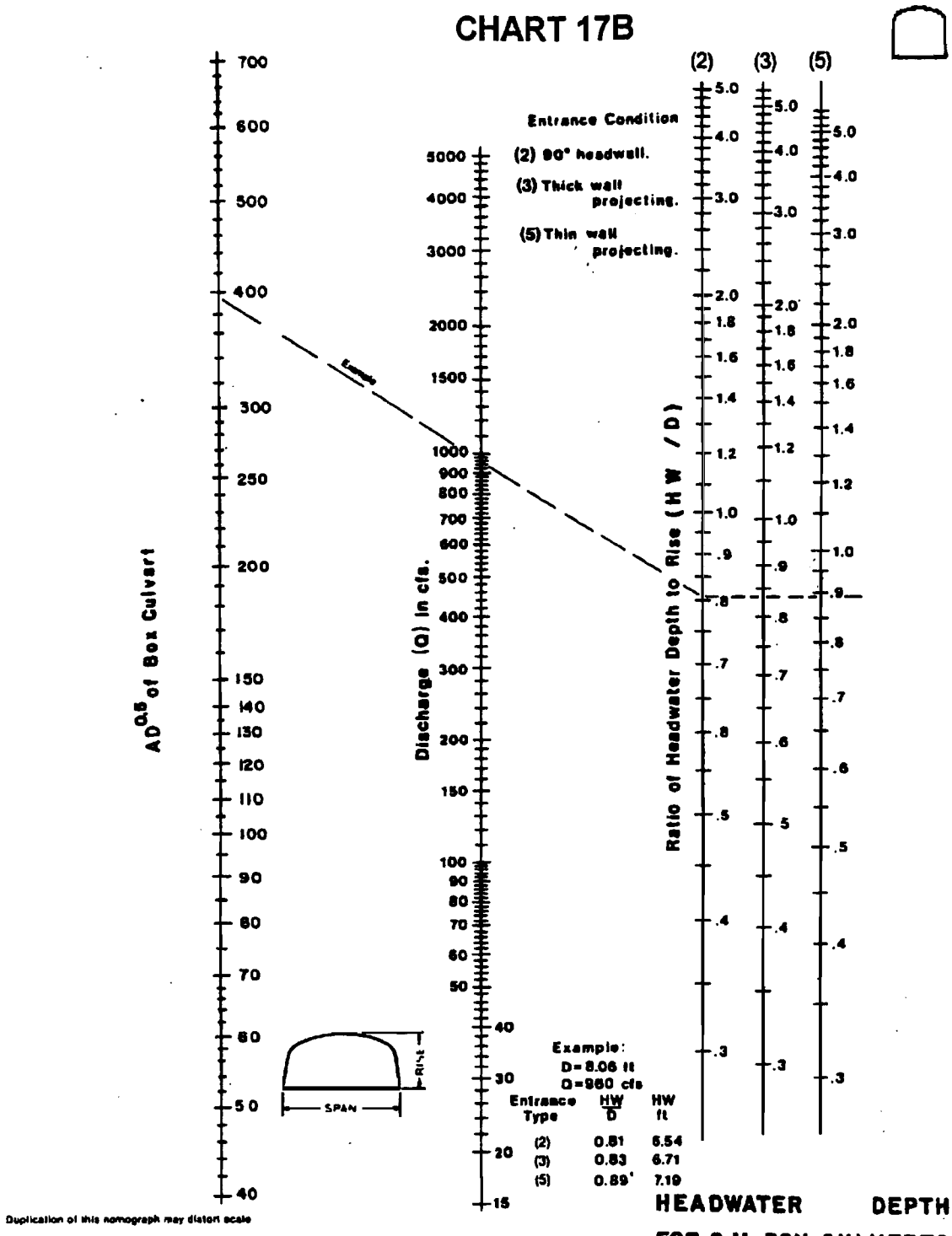
CHART 16B



Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

HEADWATER DEPTH FOR C.M. BOX CULVERTS RISE / SPAN ≤ 0.3 WITH INLET CONTROL

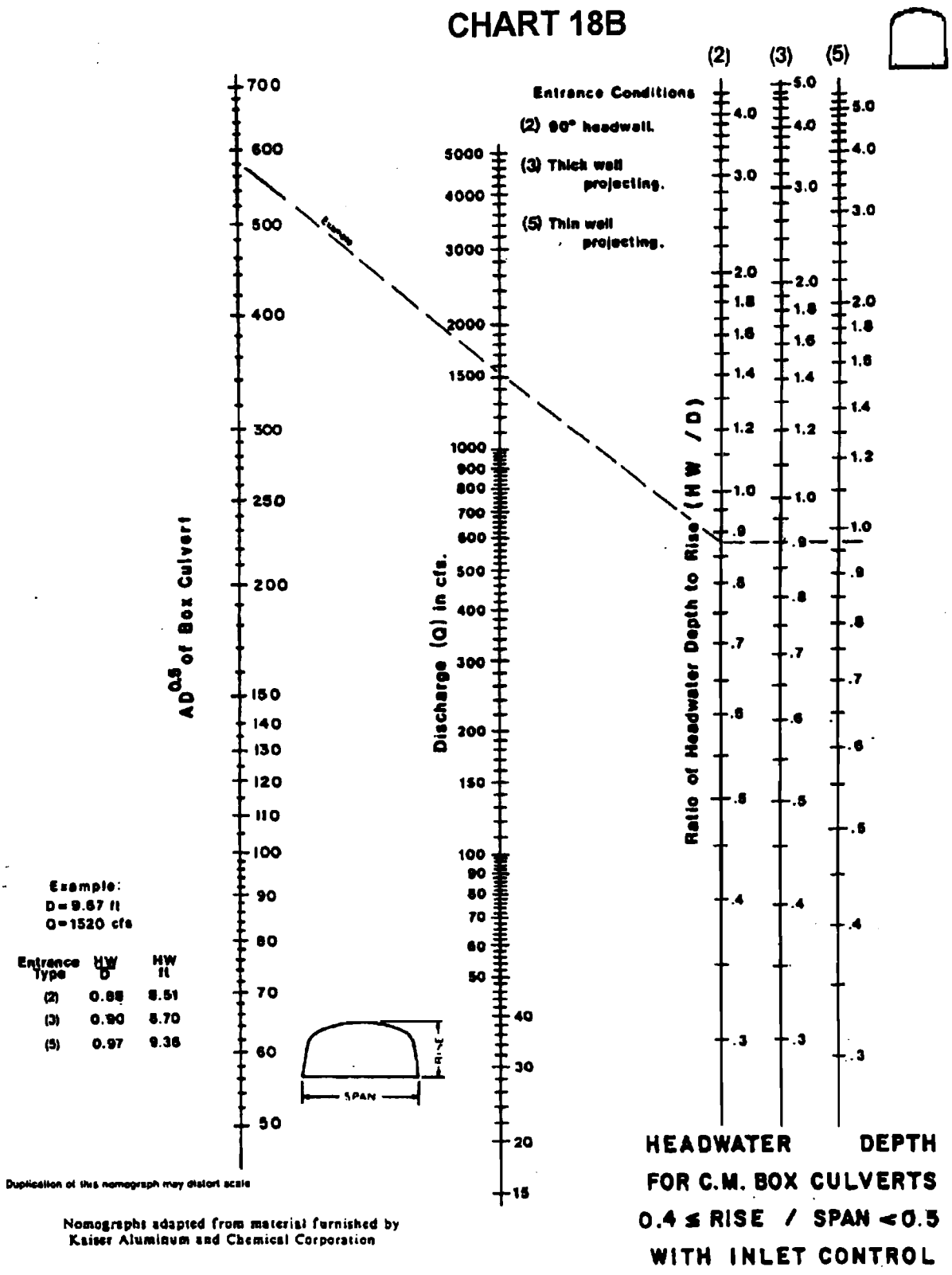
CHART 17B



Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

HEADWATER DEPTH FOR C.M. BOX CULVERTS
0.3 ≤ RISE / SPAN < 0.4
WITH INLET CONTROL

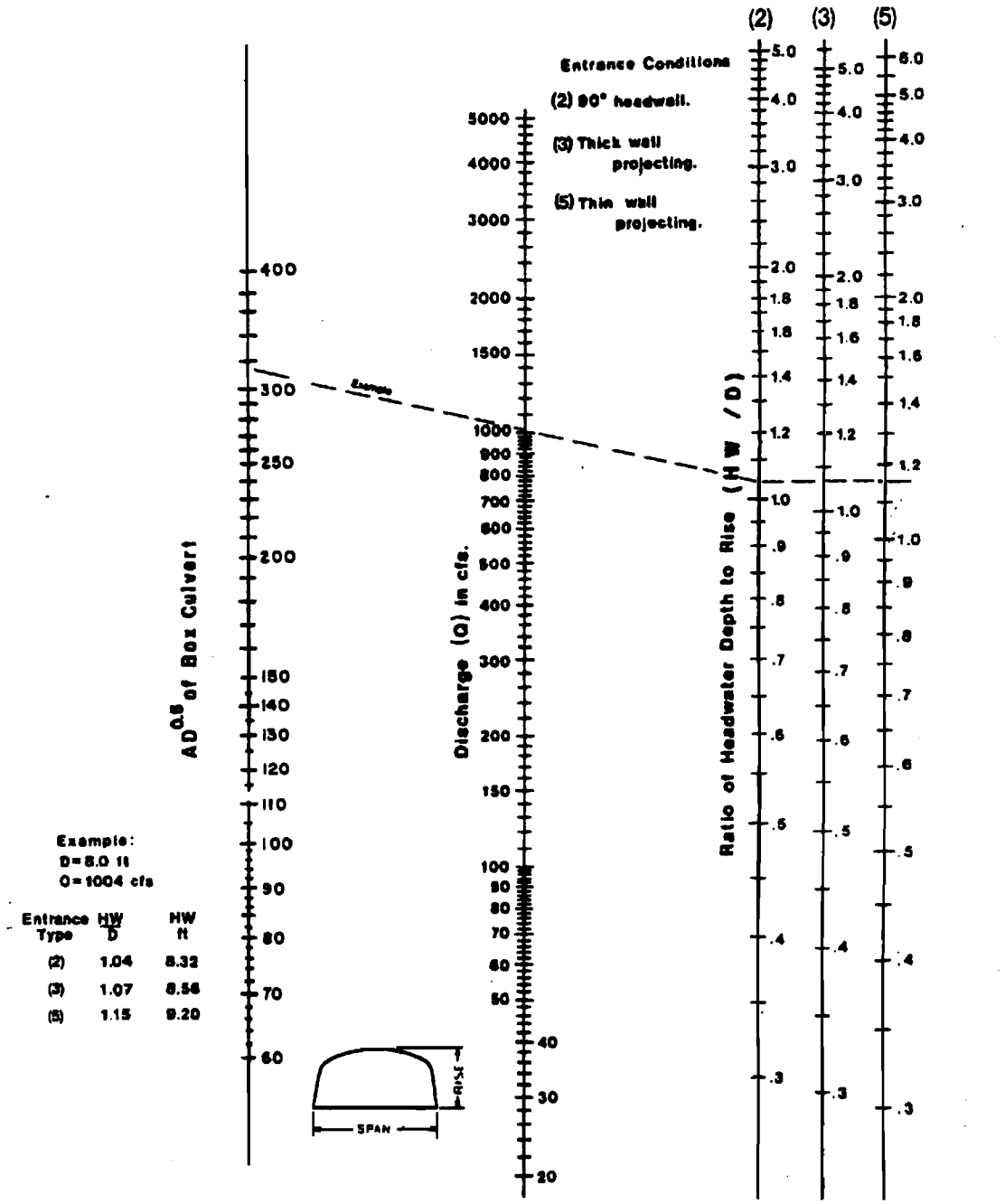
CHART 18B



Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

HEADWATER DEPTH FOR C.M. BOX CULVERTS
0.4 ≤ RISE / SPAN < 0.5
WITH INLET CONTROL

CHART 19B



Example:
D = 8.0 ft
Q = 1004 cfs

Entrance Type	HW/D	HW ft
(2)	1.04	8.32
(3)	1.07	8.56
(5)	1.15	9.20

Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

HEADWATER DEPTH FOR C.M. BOX CULVERTS
0.5 ≤ RISE / SPAN
WITH INLET CONTROL

CHART 20B

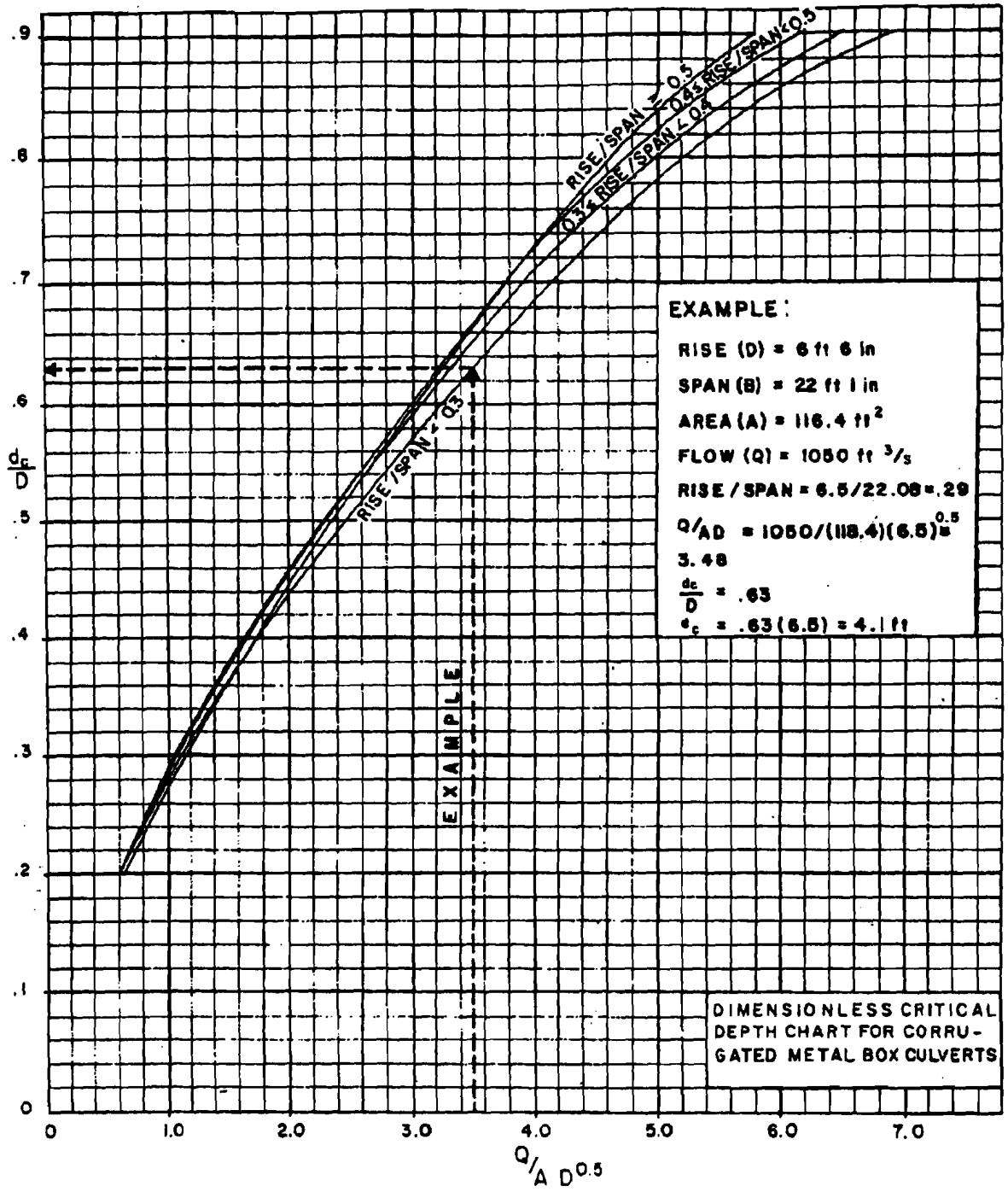
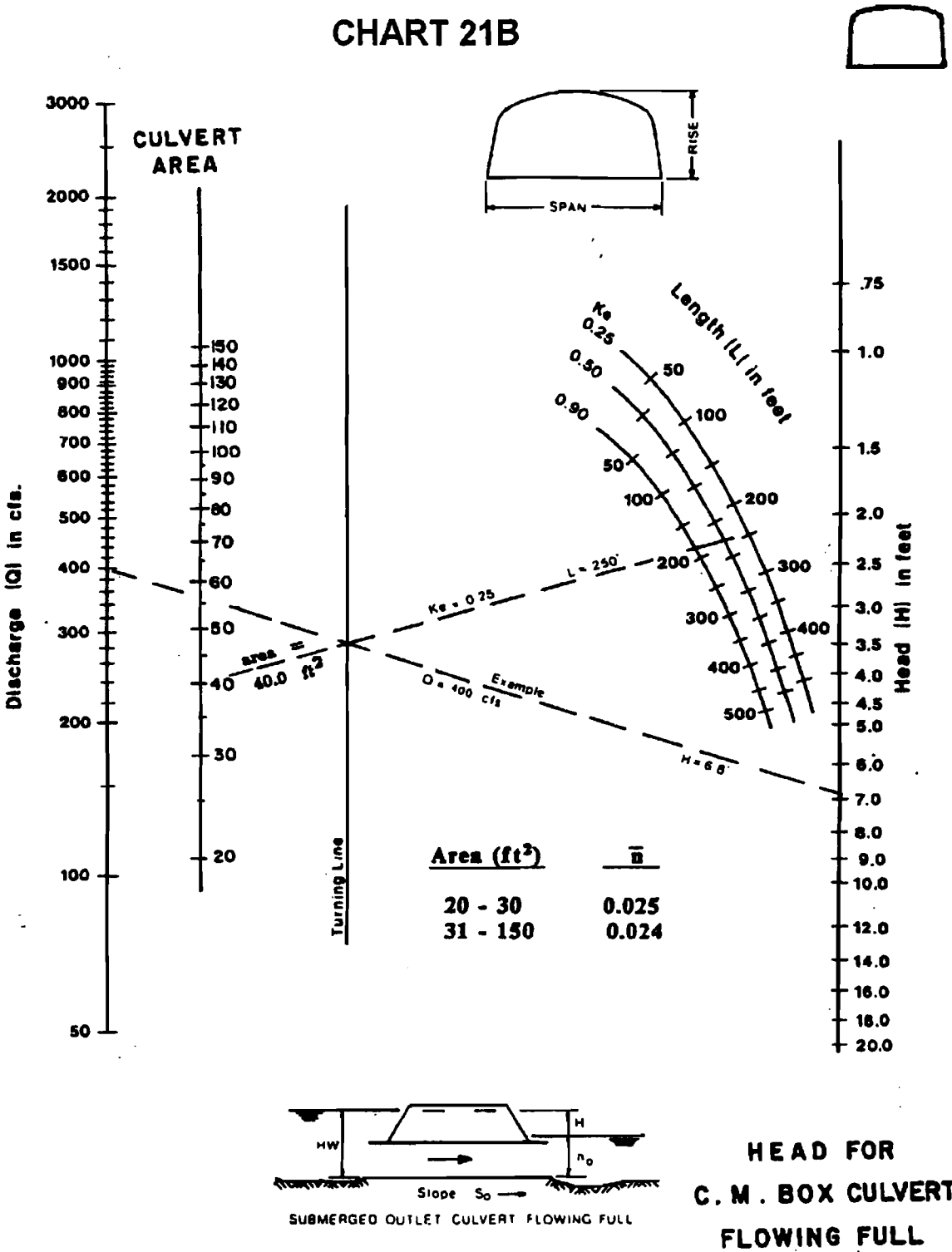

RISE/SPAN ≥ 0.5
0.33 ≤ RISE/SPAN < 0.5
RISE/SPAN < 0.33
RISE/SPAN = 0.3
EXAMPLE
EXAMPLE:
RISE (D) = 6 ft 6 in
SPAN (B) = 22 ft 1 in
AREA (A) = 116.4 ft²
FLOW (Q) = 1050 ft³/s
RISE / SPAN = 6.5/22.08 = .29
Q/AD^0.5 = 1050/(118.4)(6.5)^0.5 = 3.48
dc/D = .63
dc = .63(6.5) = 4.1 ft
DIMENSIONLESS CRITICAL DEPTH CHART FOR CORRUGATED METAL BOX CULVERTS
dc/D
Q/A D^0.5
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
2.0
3.0
4.0
5.0
6.0
7.0

CHART 21B



Area (ft^2)	$\bar{n}$
20 - 30	0.025
31 - 150	0.024

SUBMERGED OUTLET CULVERT FLOWING FULL

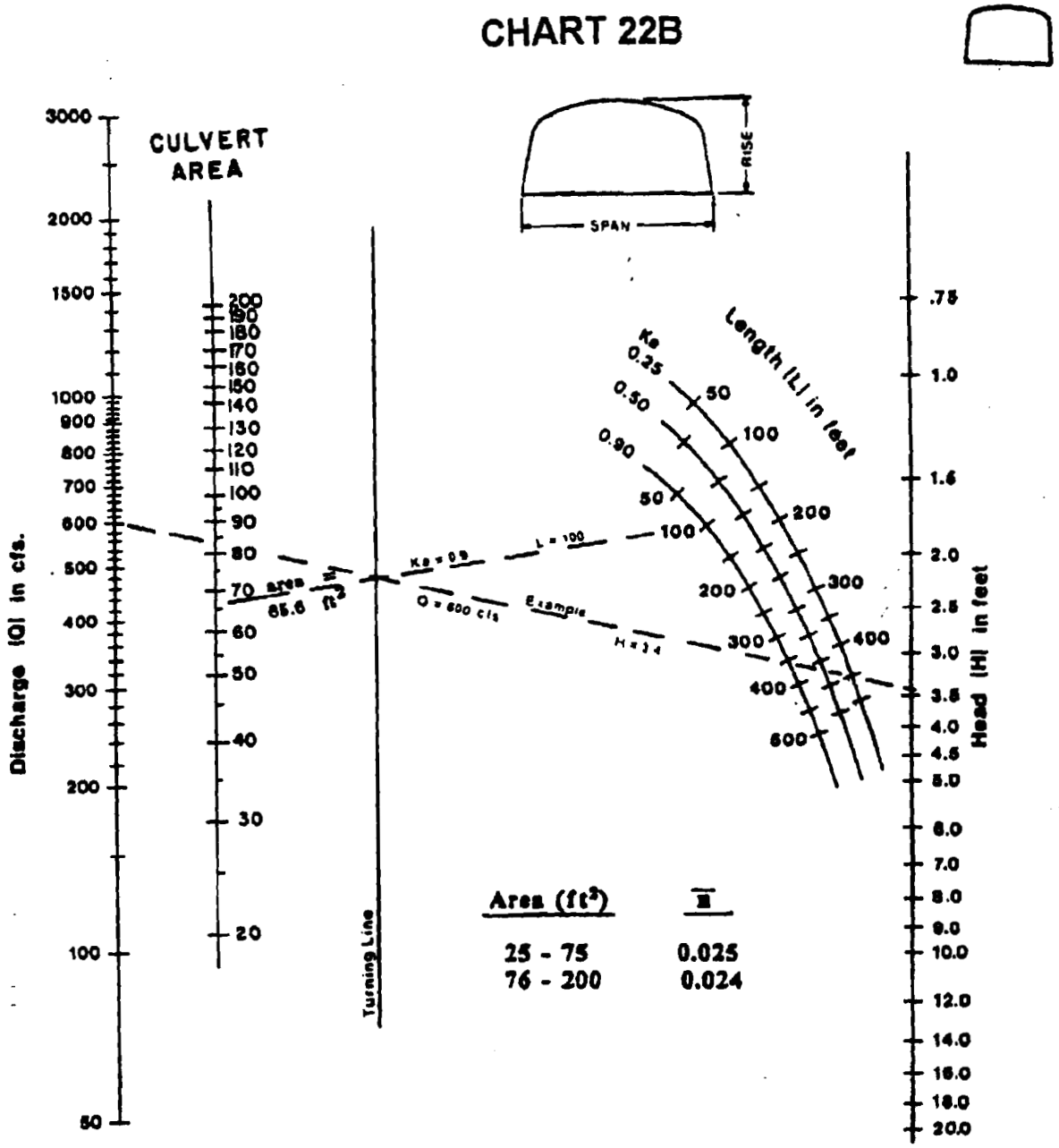
HEAD FOR C.M. BOX CULVERTS FLOWING FULL CONCRETE BOTTOM

RISE/SPAN ≤ 0.3

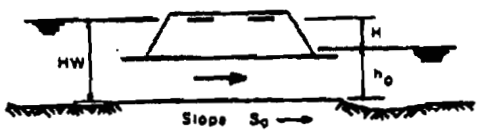
Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 22B



Area (ft^2)	$\bar{n}$
25 - 75	0.025
76 - 200	0.024



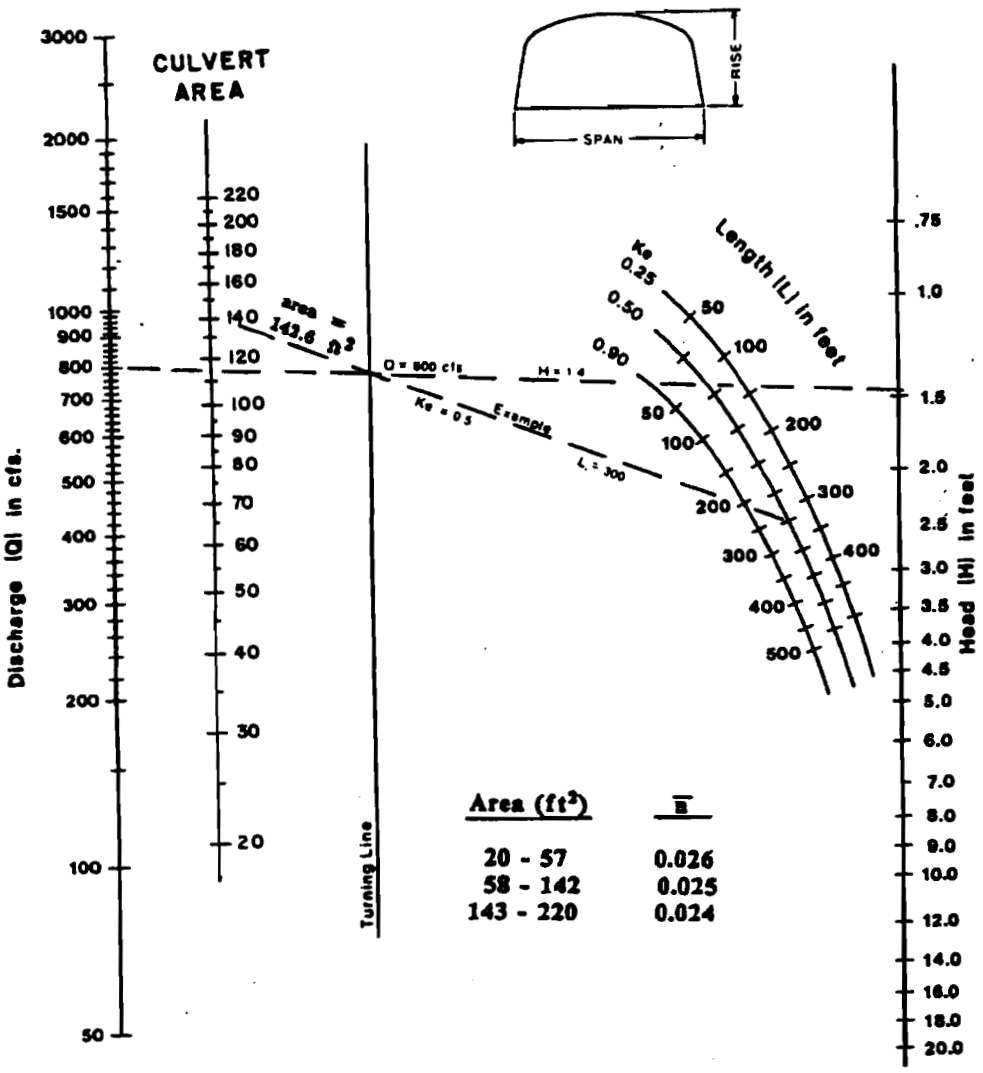
SUBMERGED OUTLET CULVERT FLOWING FULL

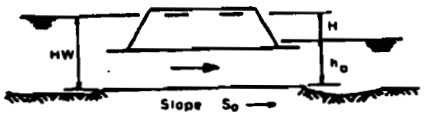
HEAD FOR
C. M. BOX CULVERTS
FLOWING FULL
CONCRETE BOTTOM
0.3 ≤ RISE/SPAN ≤ 0.4

Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 23B





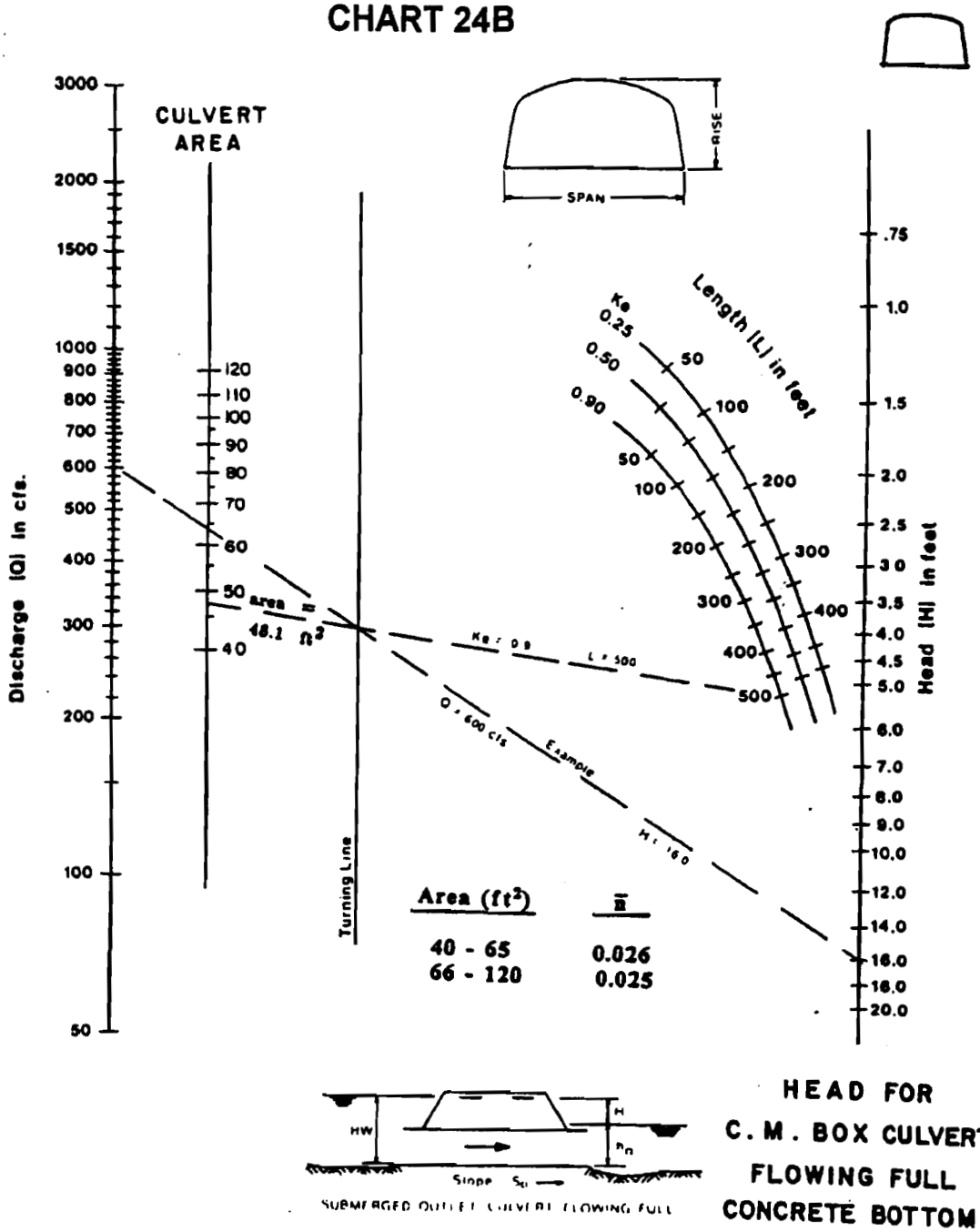
SUBMERGED OUTLET CULVERT FLOWING FULL

HEAD FOR
C. M. BOX CULVERTS
FLOWING FULL
CONCRETE BOTTOM
0.4 ≤ RISE/SPAN ≤0.5

Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 24B



SUBMERGED OUTLET CULVERT FLOWING FULL

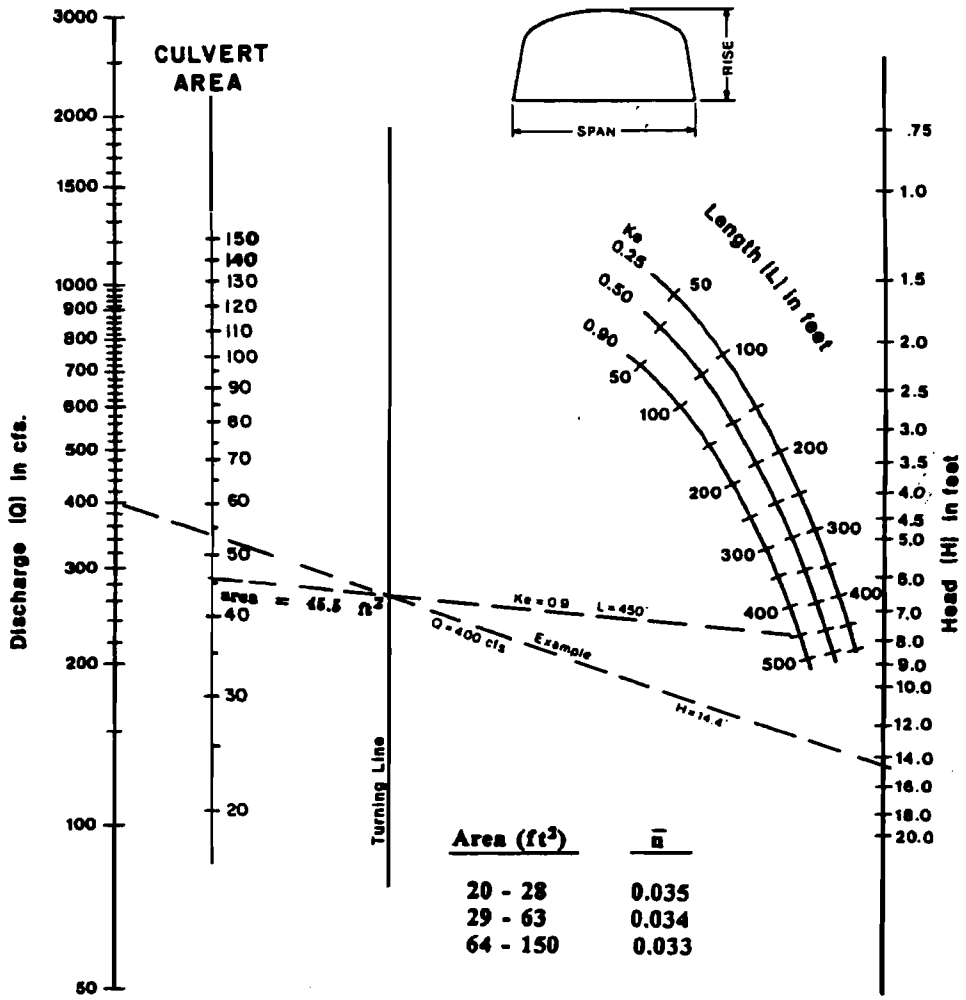
HEAD FOR C. M. BOX CULVERTS FLOWING FULL CONCRETE BOTTOM

0.5 ≤ RISE / SPAN

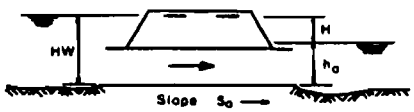
Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 25B



Area (ft^2)	$\bar{n}$
20 - 28	0.035
29 - 63	0.034
64 - 150	0.033



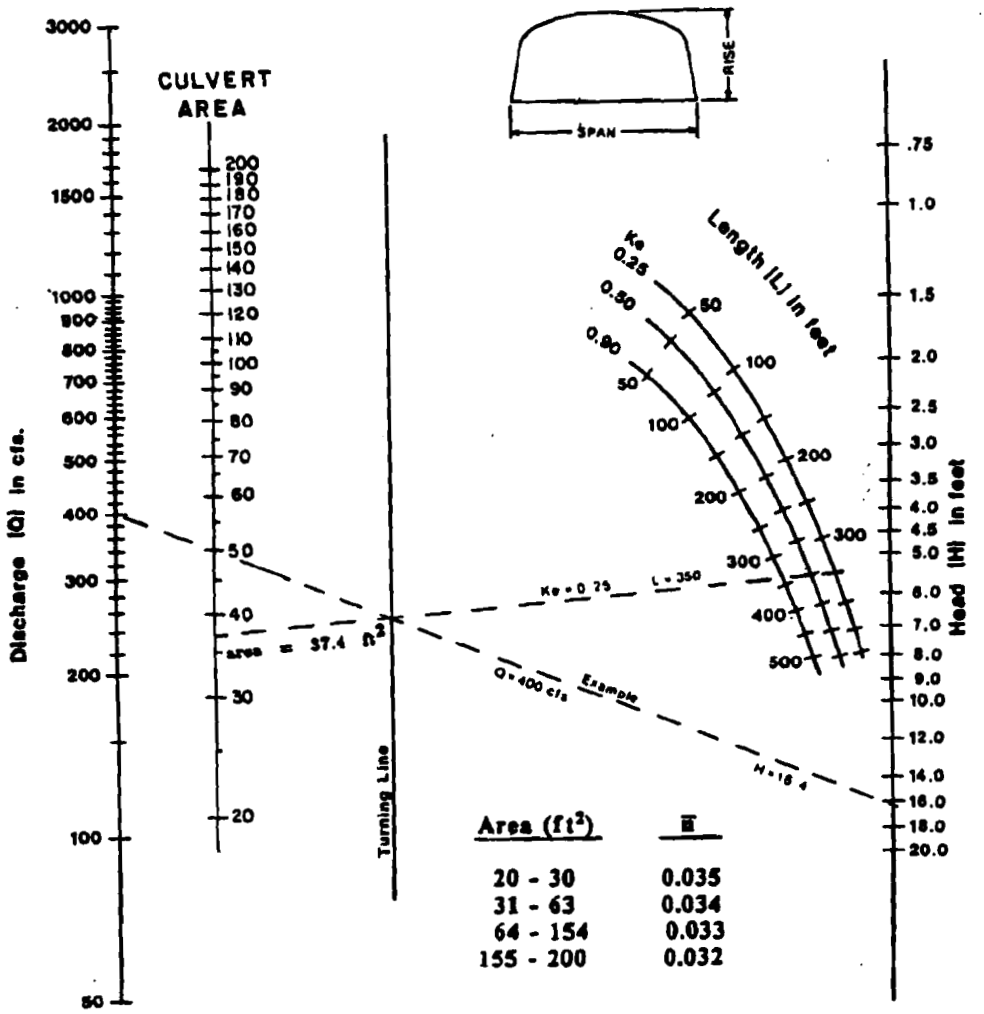
SUBMERGED OUTLET CULVERT FLOWING FULL

HEAD FOR
C. M. BOX CULVERTS
FLOWING FULL
CORRUGATED METAL BOTTOM
RISE / SPAN < 0.3

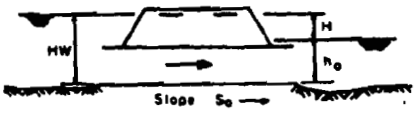
Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 26B



Area (ft^2)	$\overline{n}$
20 - 30	0.035
31 - 63	0.034
64 - 154	0.033
155 - 200	0.032



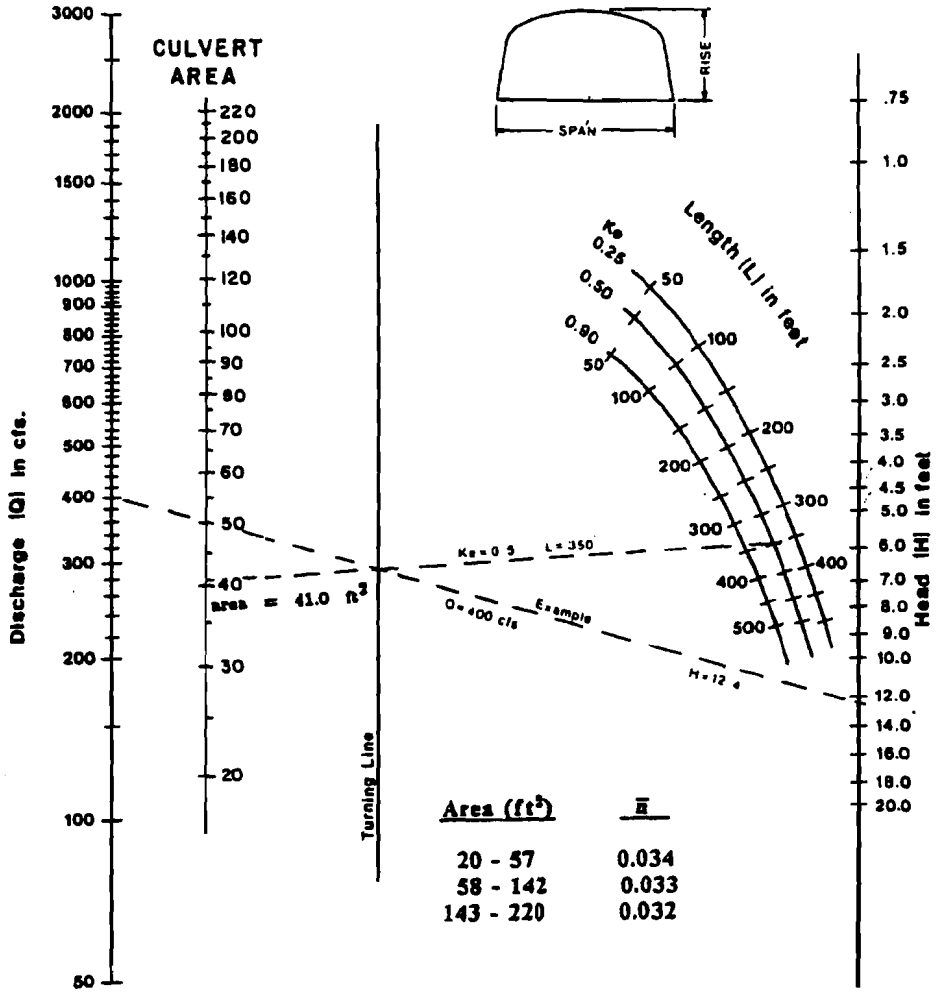
SUBMERGED OUTLET CULVERT FLOWING FULL

HEAD FOR
C. M. BOX CULVERTS
FLOWING FULL
CORRUGATED METAL BOTTOM
0.3 ≤ RISE/SPAN ≤ 0.4

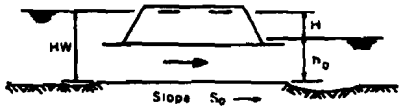
Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 27B



Area (ft^2)	$\bar{n}$
20 - 57	0.034
58 - 142	0.033
143 - 220	0.032



SUBMERGED OUTLET CULVERT FLOWING FULL

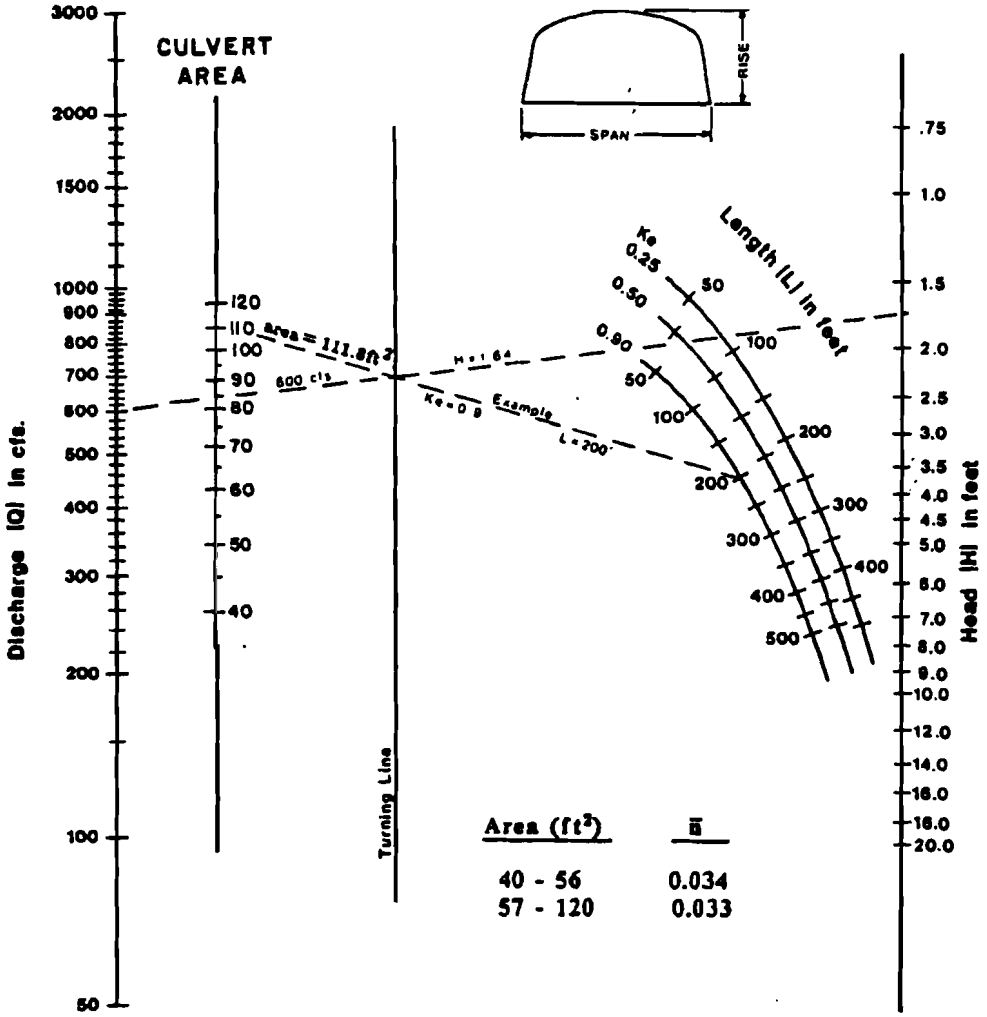
HEAD FOR C.M. BOX CULVERTS FLOWING FULL CORRUGATED METAL BOTTOM

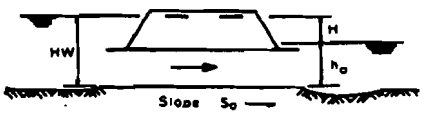
$0.4 \leq$ RISE/SPAN < 0.5

Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 28B





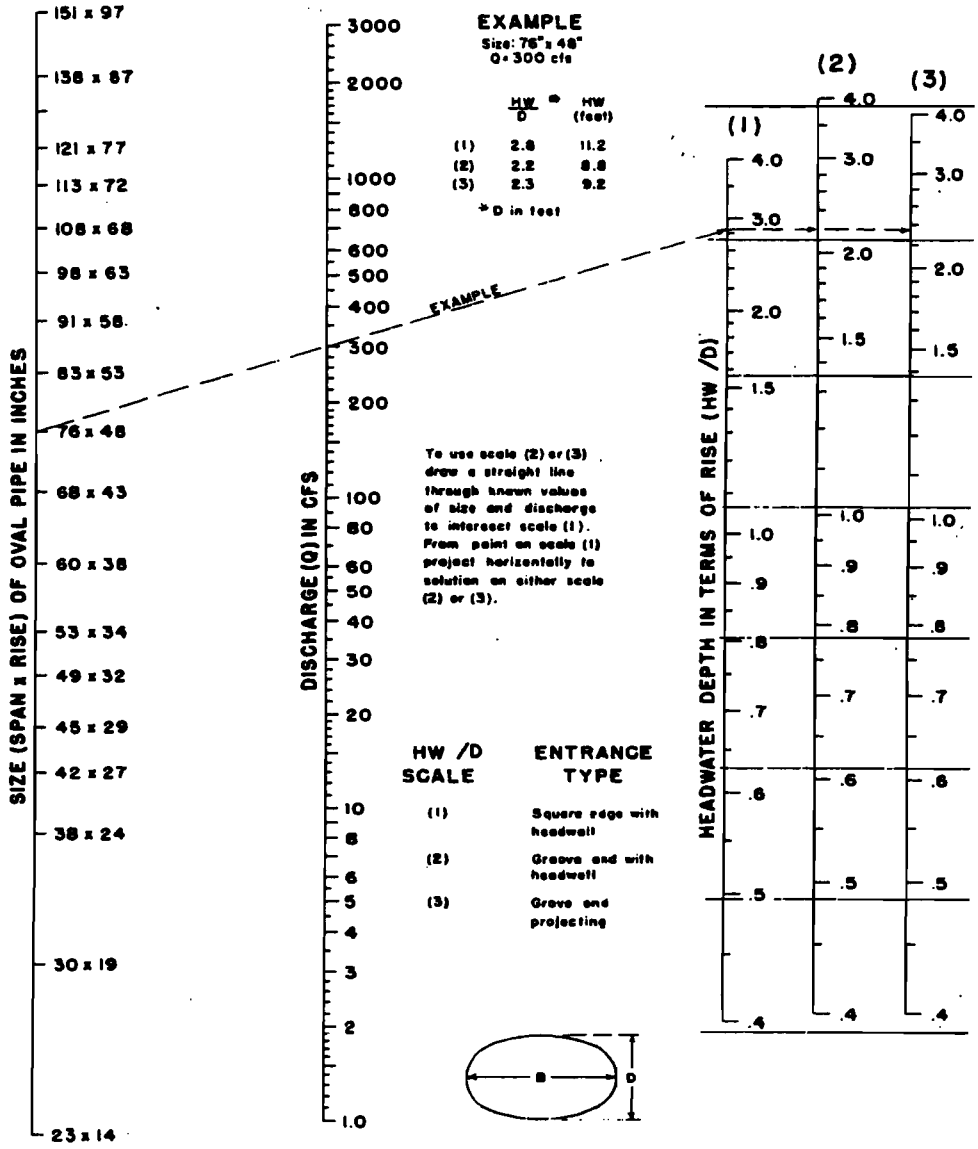
SUBMERGED OUTLET CULVERT FLOWING FULL

HEAD FOR
C. M. BOX CULVERTS
FLOWING FULL
CORRUGATED METAL BOTTOM
0.5 ≤ RISE/SPAN

Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

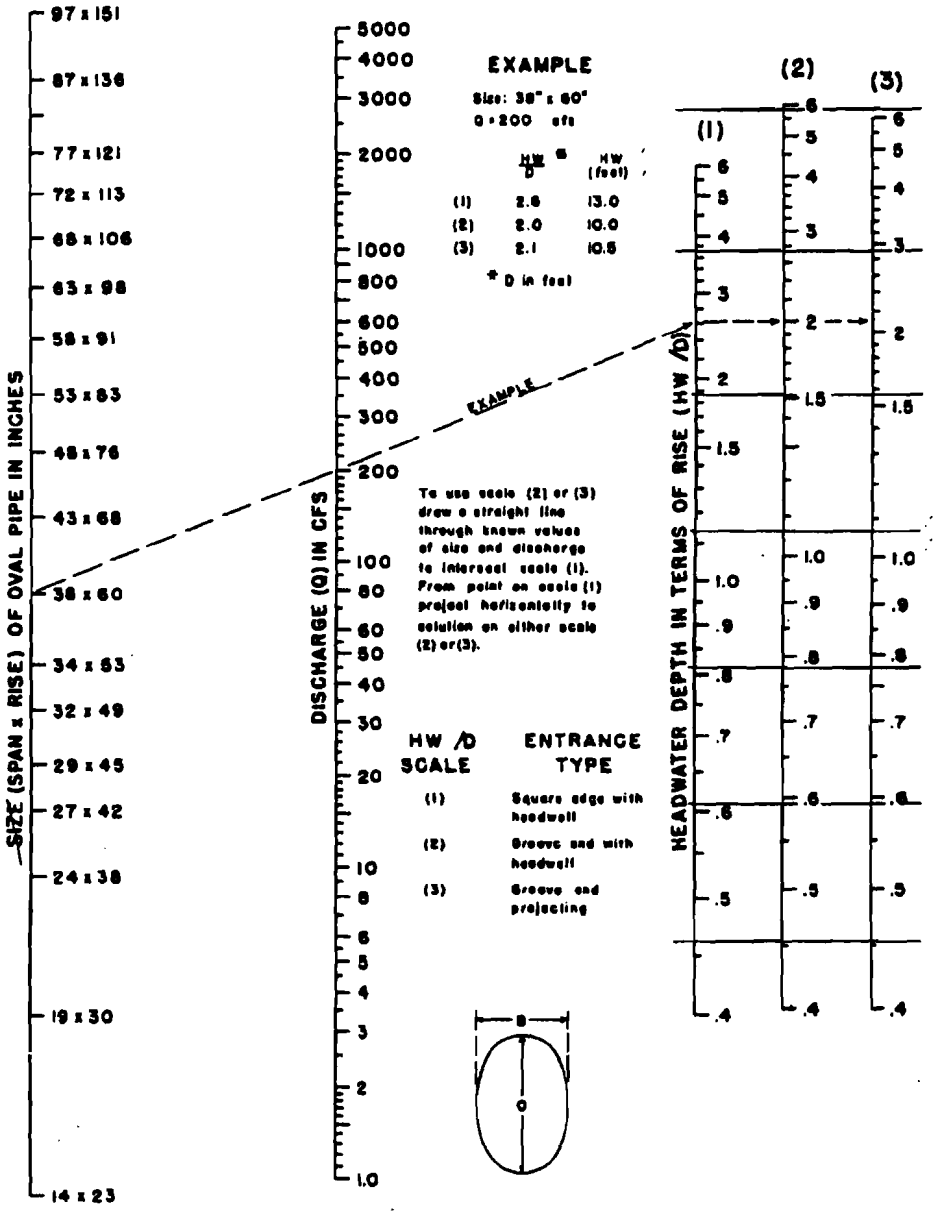
CHART 29B



HEADWATER DEPTH FOR OVAL CONCRETE PIPE CULVERTS LONG AXIS HORIZONTAL WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

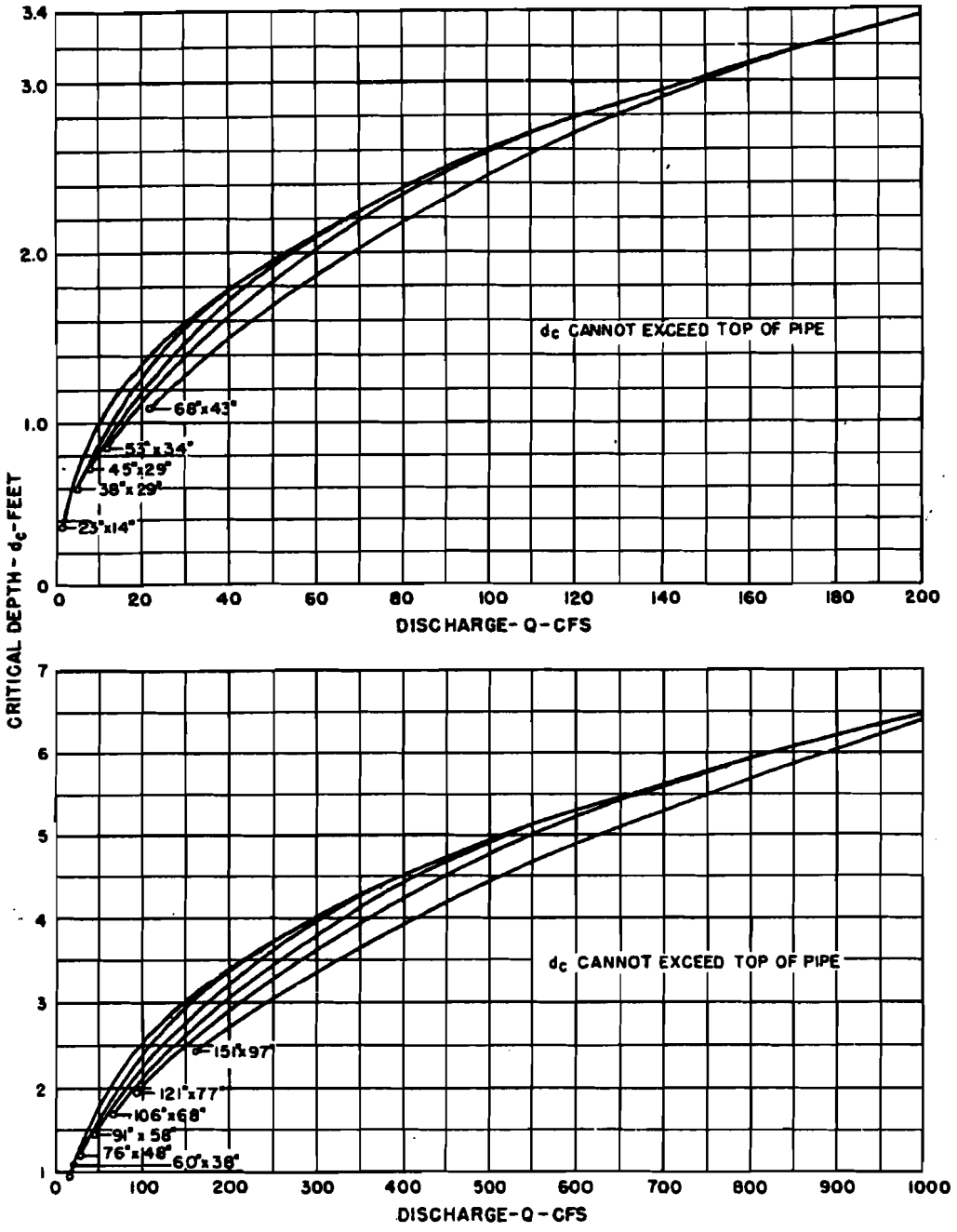
CHART 30B



HEADWATER DEPTH FOR OVAL CONCRETE PIPE CULVERTS LONG AXIS VERTICAL WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 31B

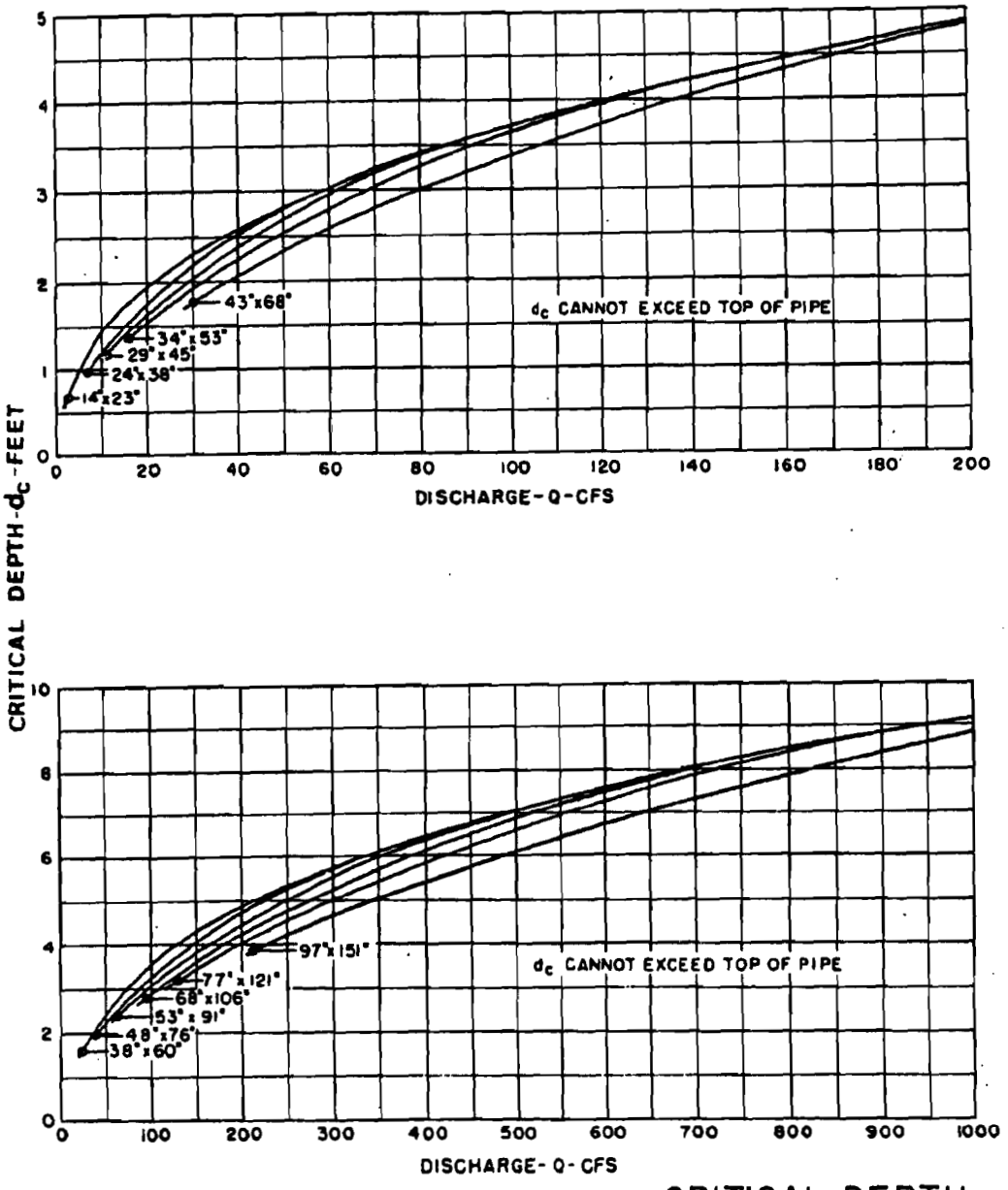


BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
OVAL CONCRETE PIPE
LONG AXIS HORIZONTAL

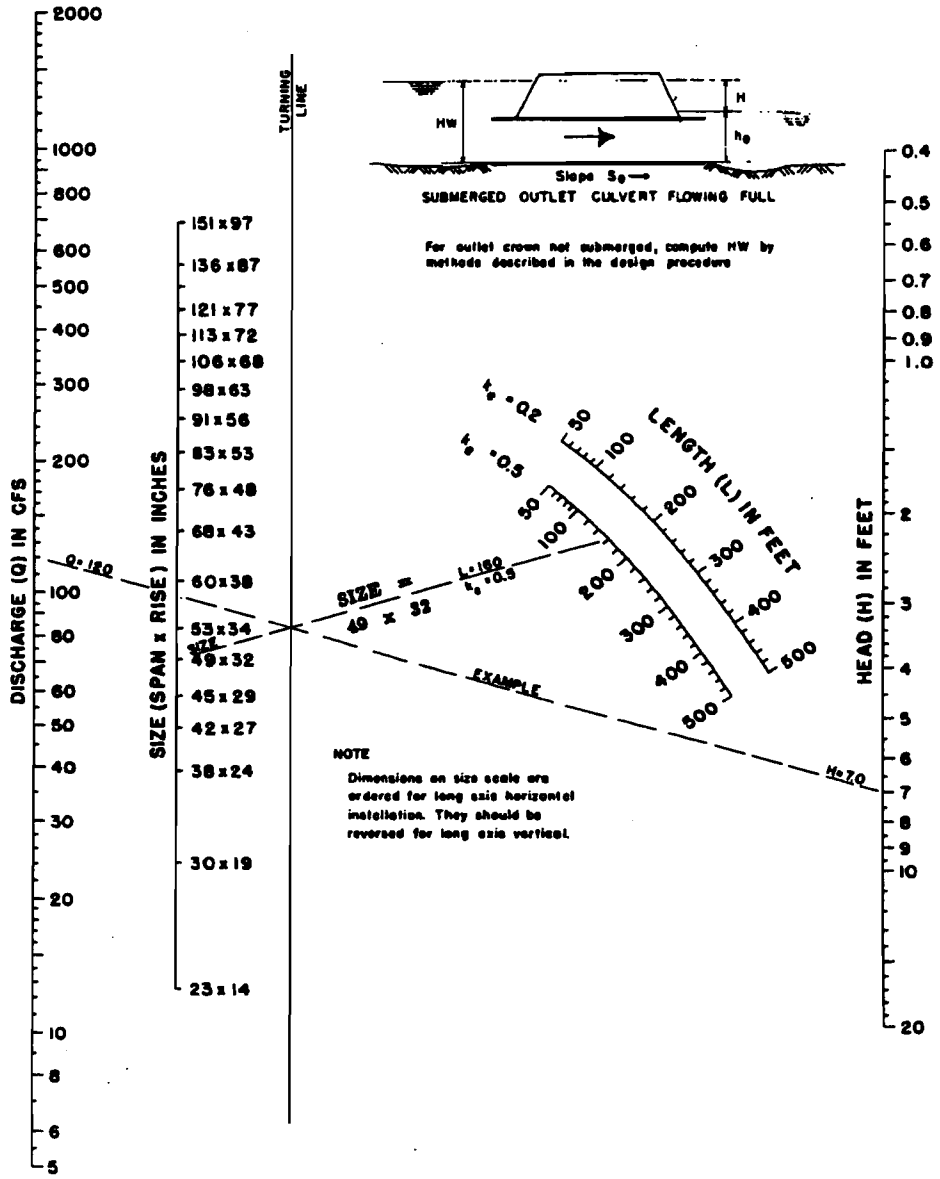
CHART 32B



BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
OVAL CONCRETE PIPE
LONG AXIS VERTICAL

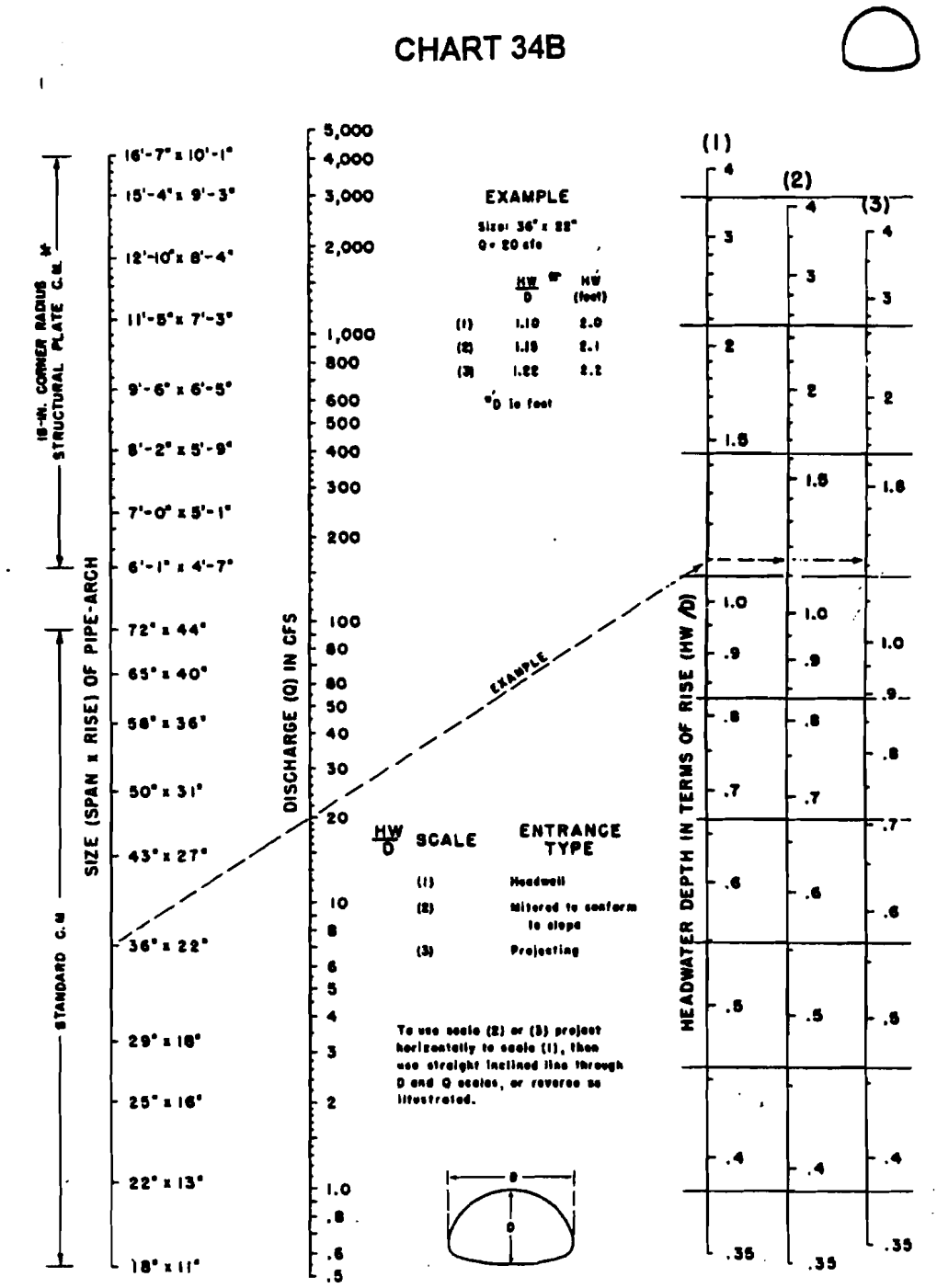
CHART 33B



HEAD FOR
OVAL CONCRETE PIPE CULVERTS
LONG AXIS HORIZONTAL OR VERTICAL
FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 34B

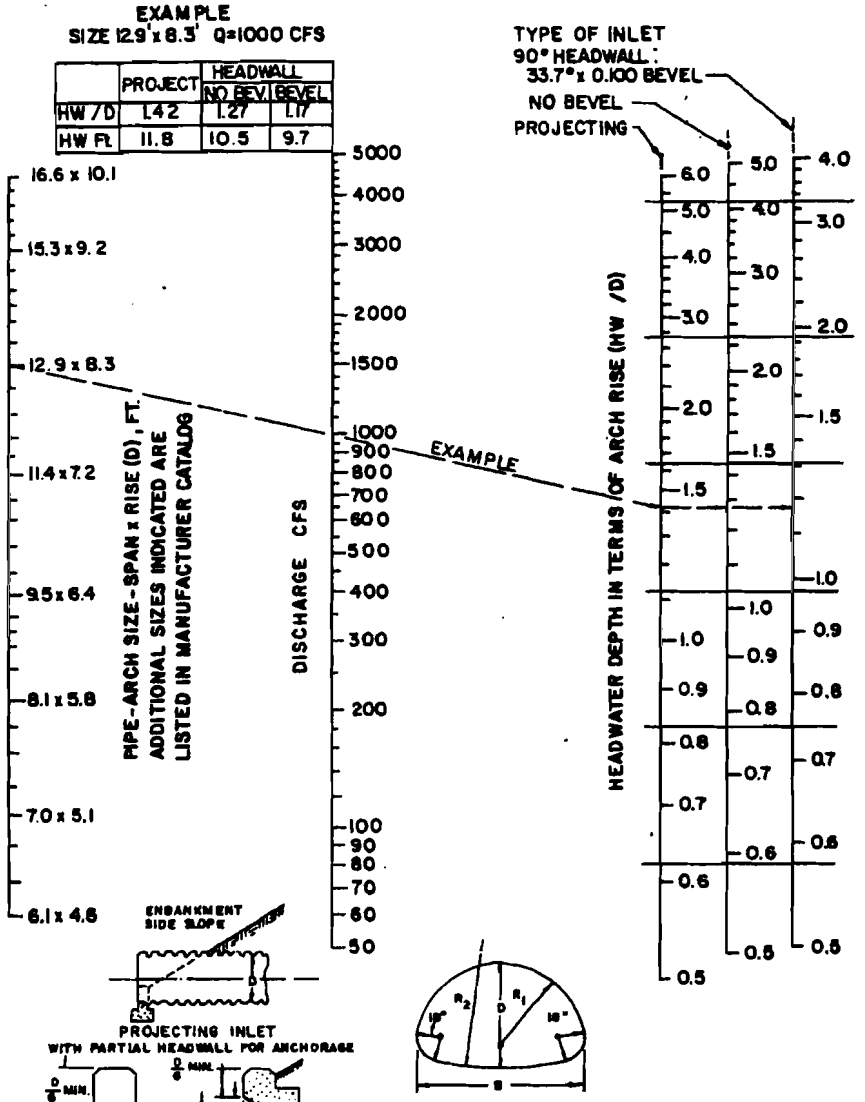


* ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

BUREAU OF PUBLIC ROADS JAN. 1963

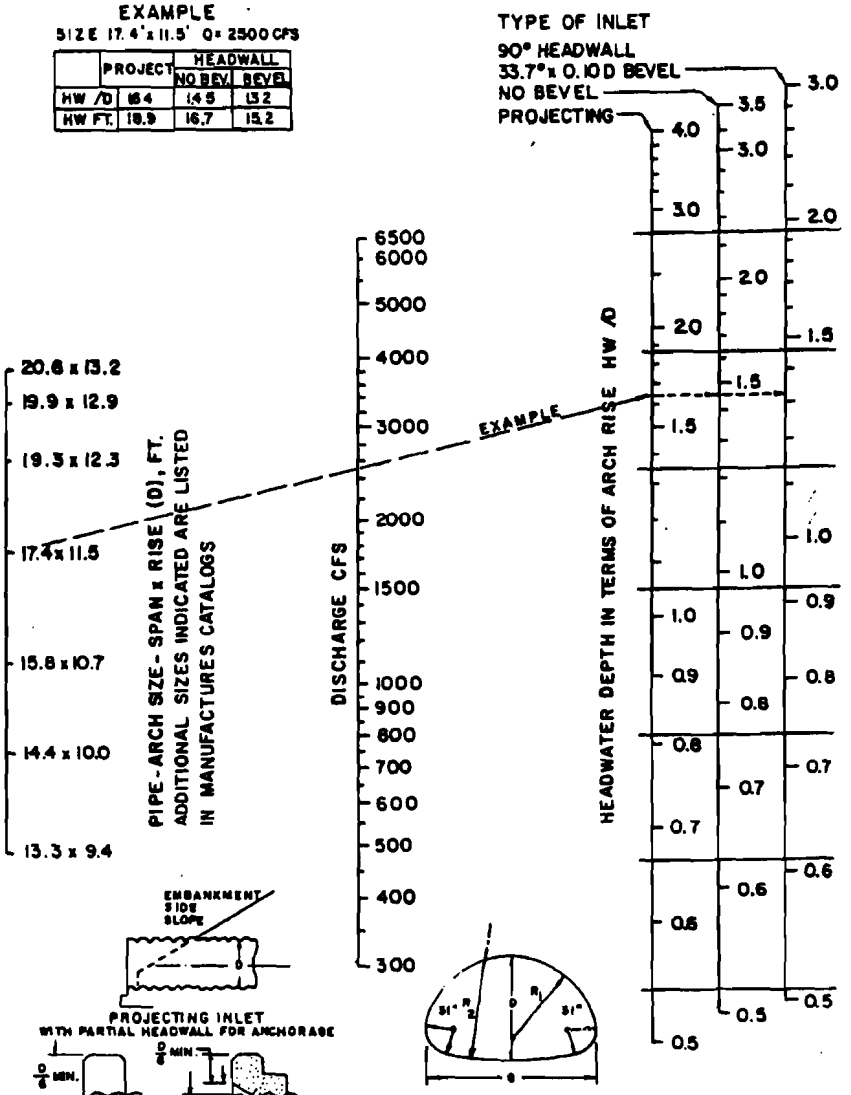
HEADWATER DEPTH FOR C. M. PIPE-ARCH CULVERTS WITH INLET CONTROL

CHART 35B



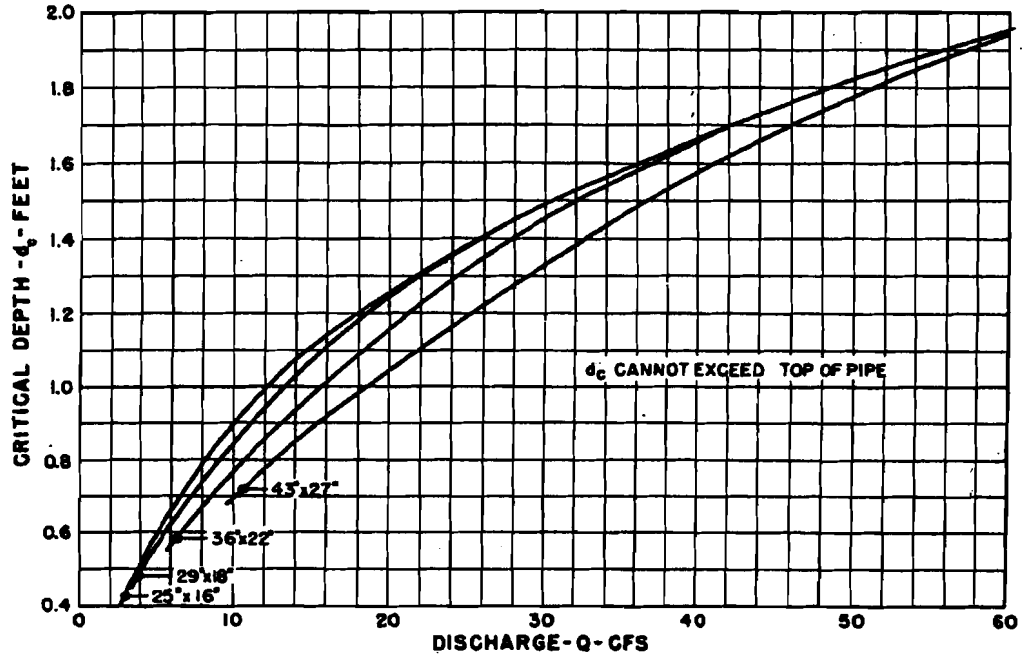
HEADWATER DEPTH FOR INLET CONTROL
STRUCTURAL PLATE PIPE-ARCH CULVERTS
18-IN. RADIUS CORNER PLATE
PROJECTING OR HEADWALL INLET
HEADWALL WITH OR WITHOUT EDGE BEVEL

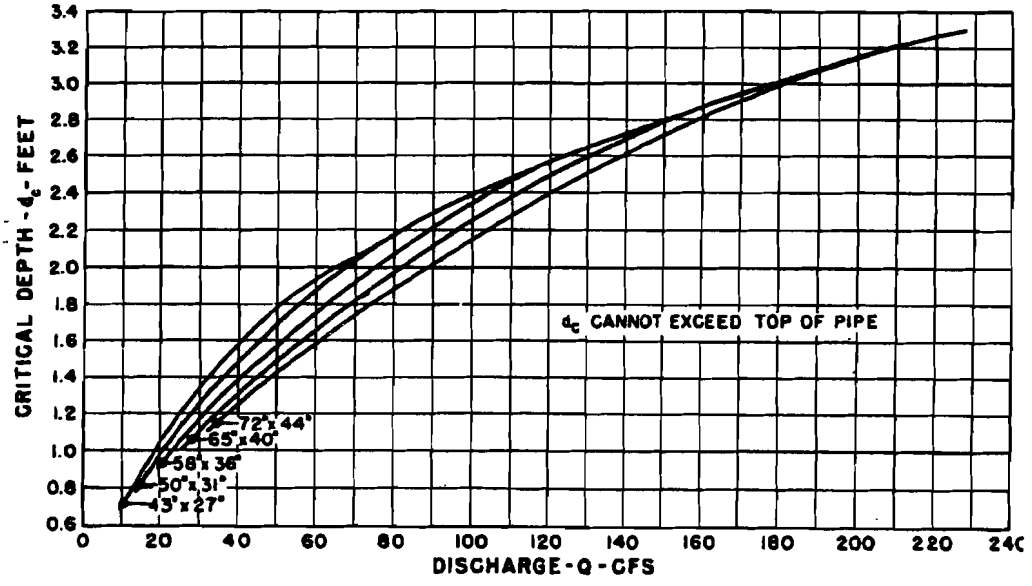
CHART 36B



HEADWATER DEPTH FOR INLET CONTROL
STRUCTURAL PLATE PIPE-ARCH CULVERTS
31-IN. RADIUS CORNER PLATE
PROJECTING OR HEADWALL INLET
HEADWALL WITH OR WITHOUT EDGE BEVEL

CHART 37B

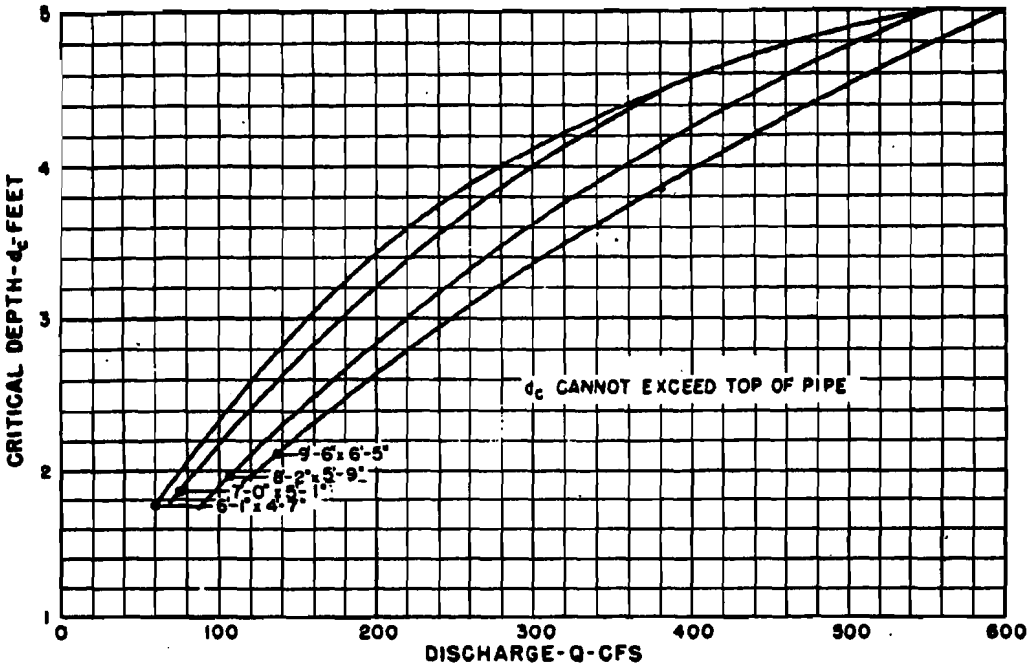


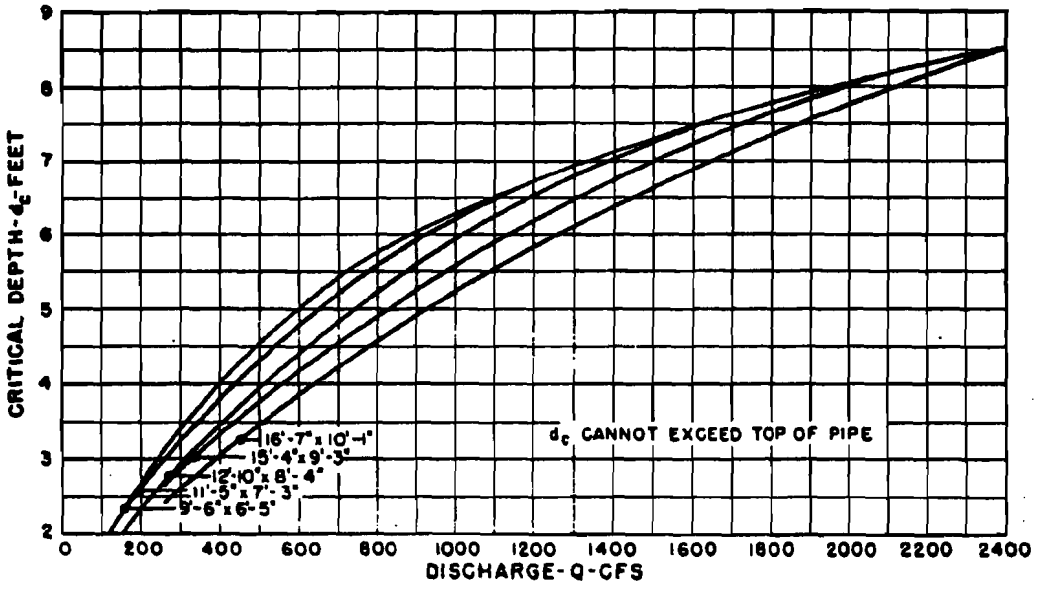


BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
STANDARD C.M. PIPE-ARCH

CHART 38B





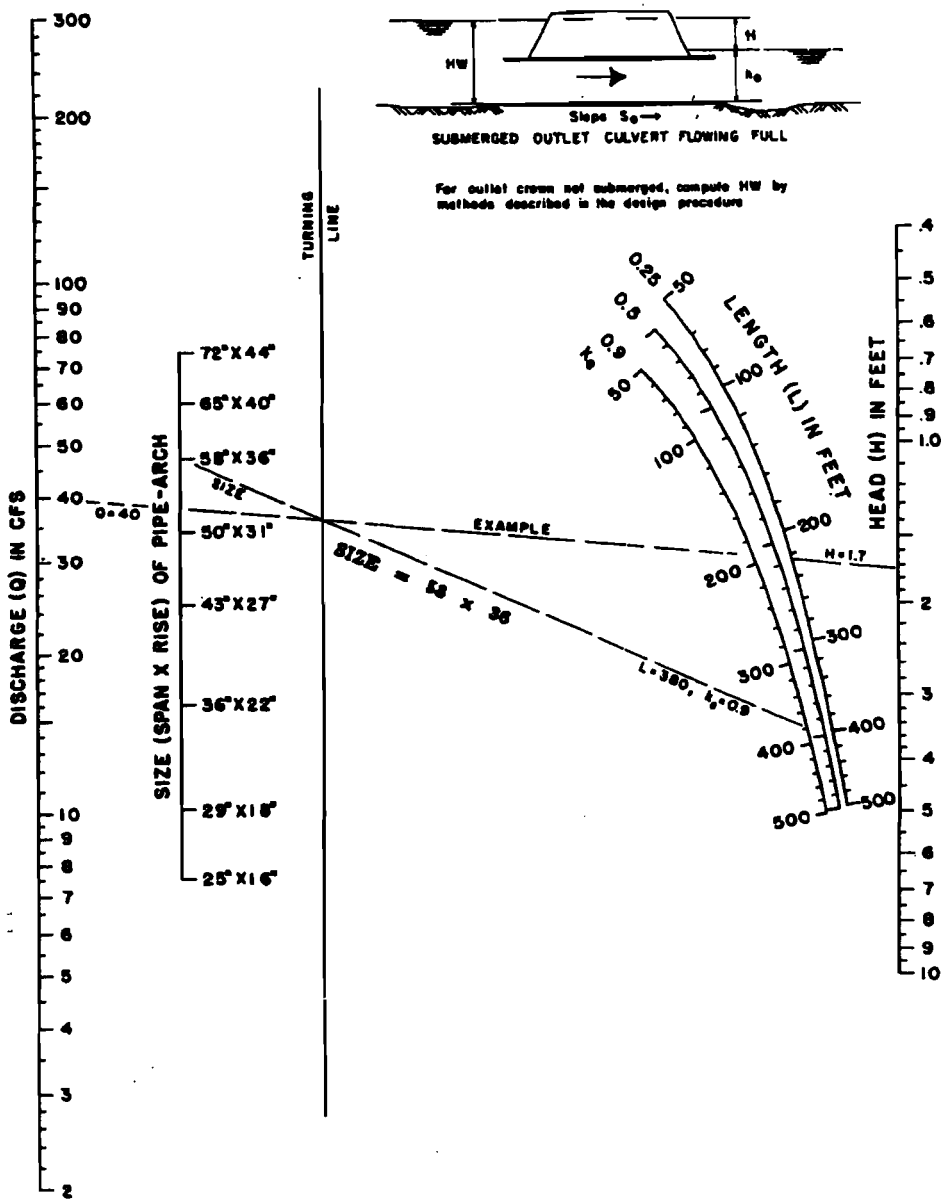
BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
STRUCTURAL PLATE
C. M. PIPE-ARCH

18 INCH CORNER RADIUS

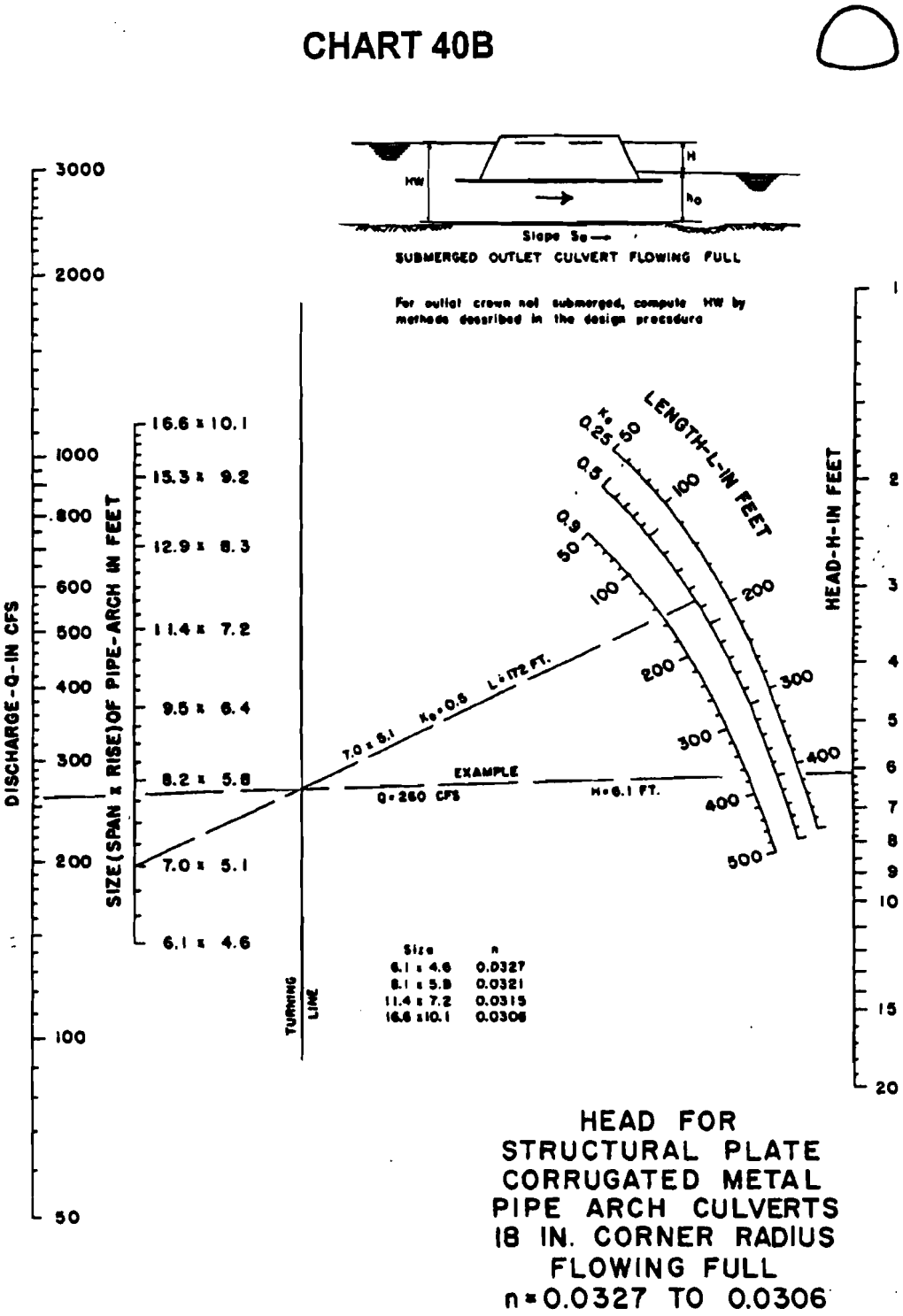
CHART 39B



HEAD FOR
STANDARD C. M. PIPE-ARCH CULVERTS
FLOWING FULL
n=0.024

BUREAU OF PUBLIC ROADS JAN. 1963

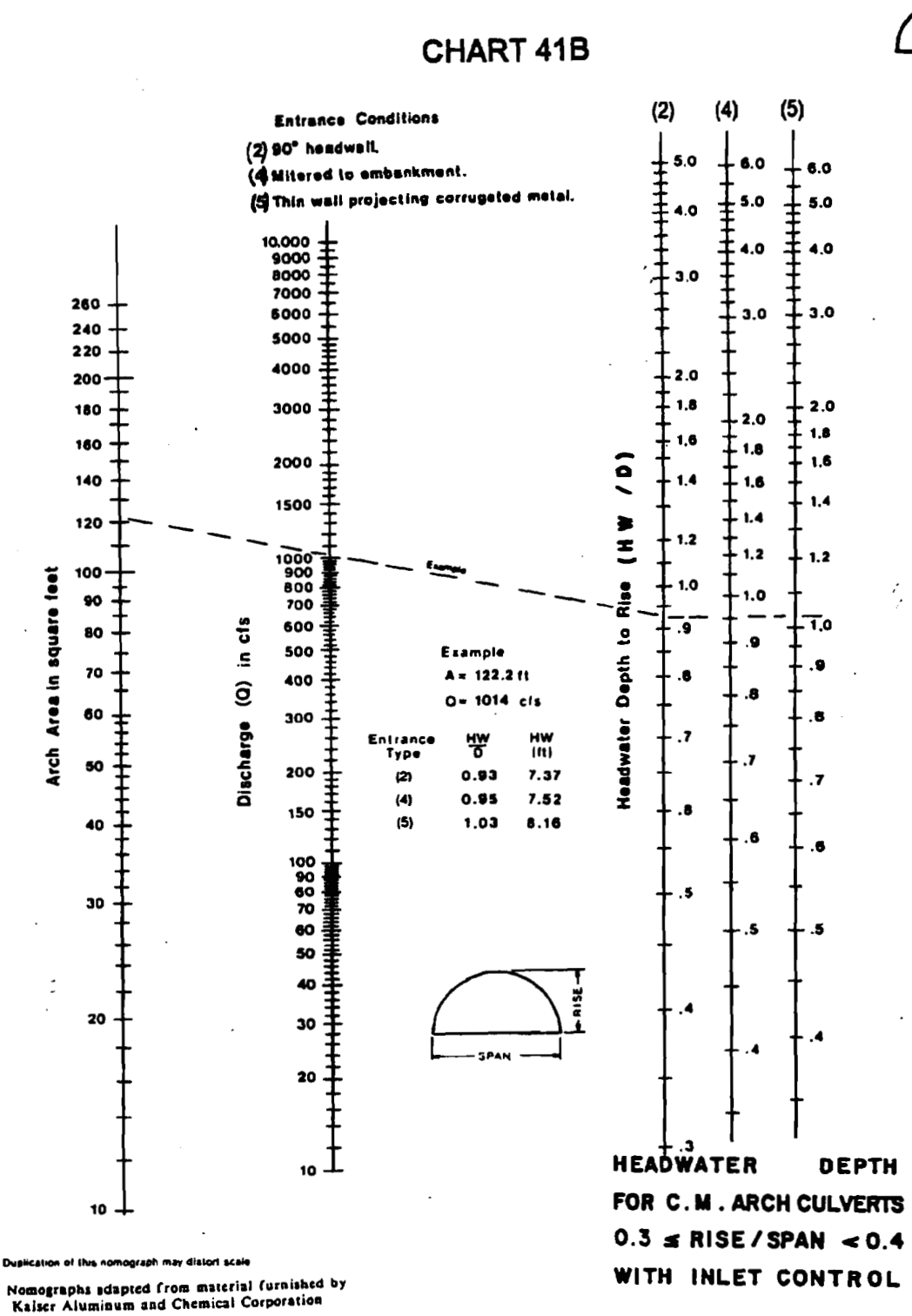
CHART 40B



HEAD FOR
STRUCTURAL PLATE
CORRUGATED METAL
PIPE ARCH CULVERTS
18 IN. CORNER RADIUS
FLOWING FULL
n=0.0327 TO 0.0306

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 41B



Duplication of this nomograph may distort scale

Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

CHART 42B

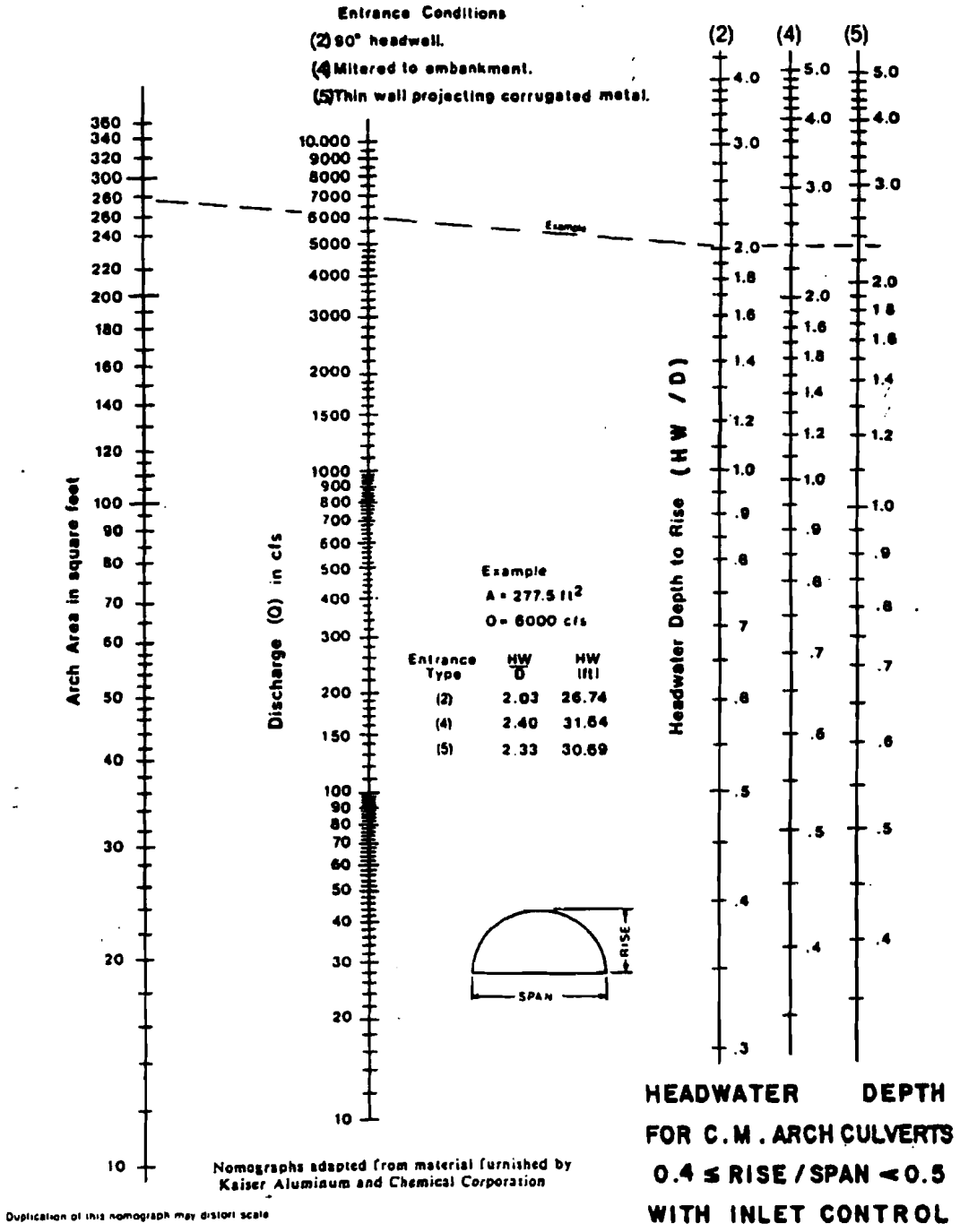

Entrance Conditions
(2) 90° headwall.
(4) Mitered to embankment.
(5) Thin wall projecting corrugated metal.
Arch Area in square feet
Discharge (Q) in cfs
Headwater Depth to Rise (HW / D)
(2)
(4)
(5)
Example
A = 277.5 ft²
Q = 6000 cfs
Entrance Type | HW/D | HW (ft)
(2) 2.03 26.74
(4) 2.40 31.64
(5) 2.33 30.69
RISE
SPAN
HEADWATER DEPTH
FOR C.M. ARCH CULVERTS
0.4 ≤ RISE / SPAN < 0.5
WITH INLET CONTROL
Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation
Duplication of this nomograph may distort scale

CHART 43B

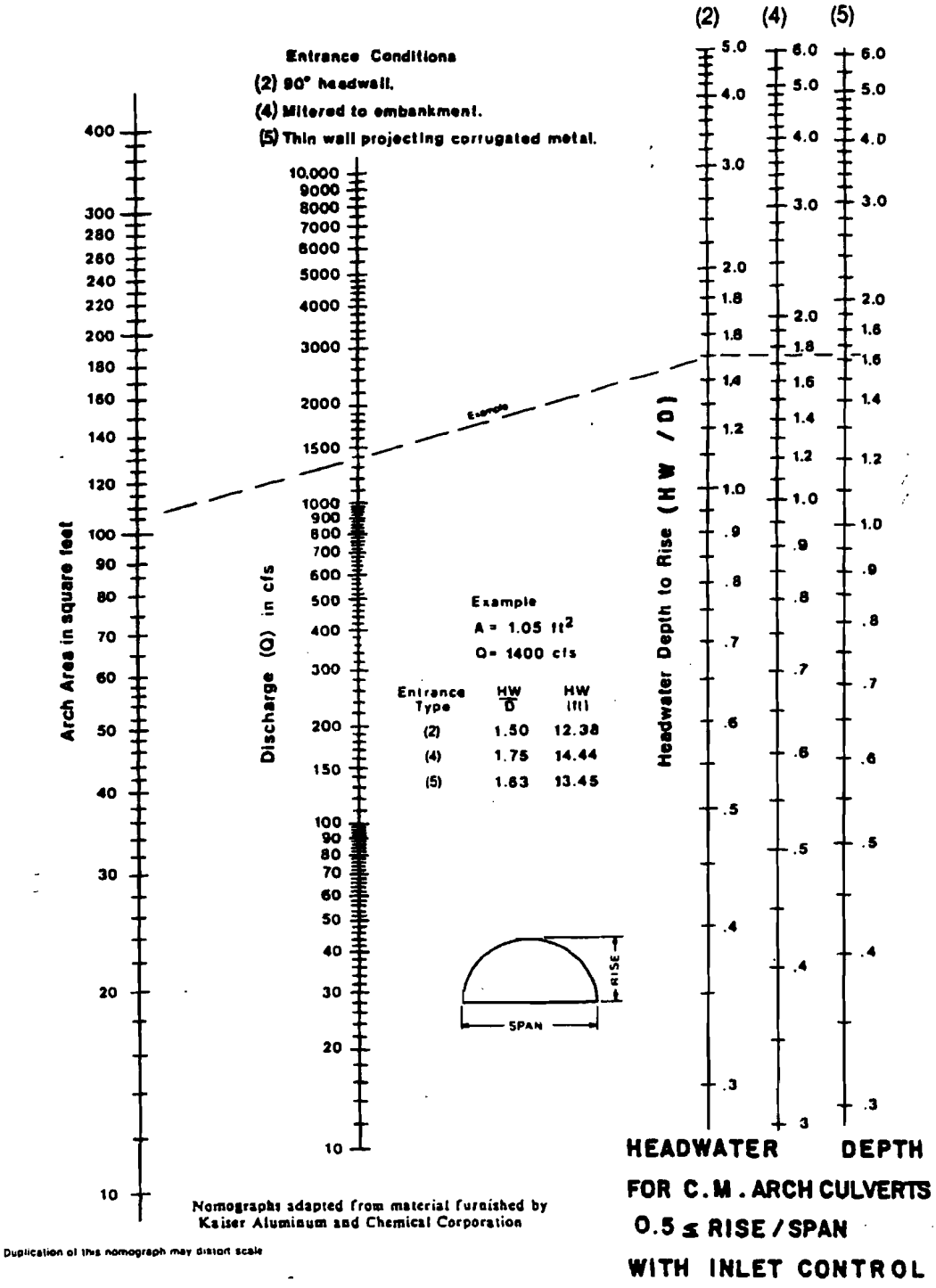

Entrance Conditions
(2) 90° headwall.
(4) Mitered to embankment.
(5) Thin wall projecting corrugated metal.
Arch Area in square feet
Discharge (Q) in cfs
Headwater Depth to Rise (HW / D)
(2)
(4)
(5)
Example
A = 1.05 ft²
Q = 1400 cfs
Entrance Type | HW/D | HW (ft)
(2) | 1.50 | 12.38
(4) | 1.75 | 14.44
(5) | 1.83 | 13.45
RISE
SPAN
HEADWATER DEPTH
FOR C.M. ARCH CULVERTS
0.5 ≤ RISE / SPAN
WITH INLET CONTROL
Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation
Duplication of this nomograph may distort scale

CHART 44B

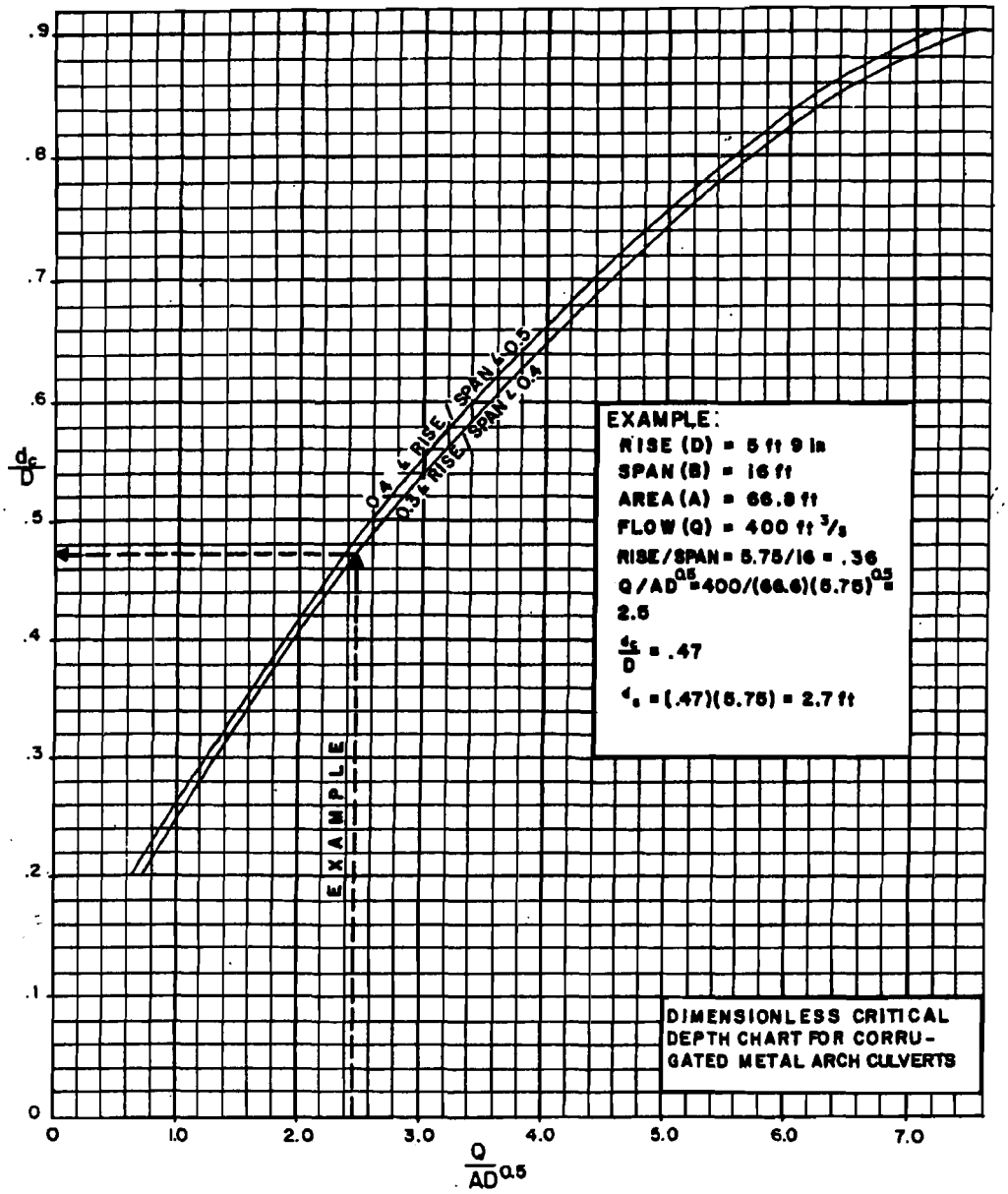
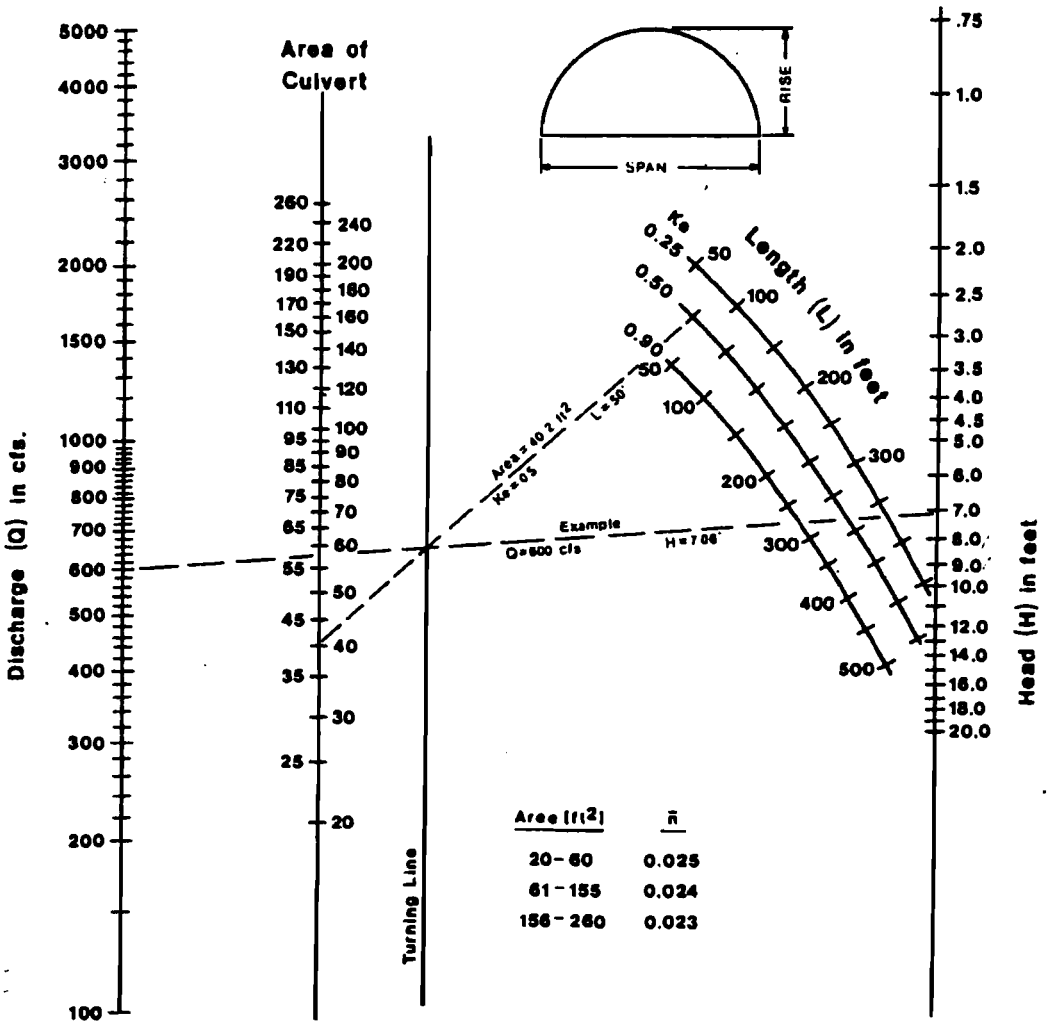
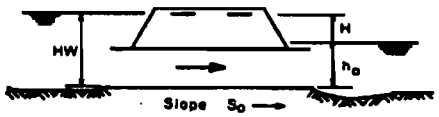

.9
.8
.7
.6
.5
.4
.3
.2
.1
0
$\frac{d_c}{D}$
0.4 < RISE / SPAN < 0.5
0.3 < RISE / SPAN < 0.4
EXAMPLE
EXAMPLE:
RISE (D) = 5 ft 9 in
SPAN (B) = 16 ft
AREA (A) = 66.8 ft
FLOW (Q) = 400 ft $^3/_s$
RISE/SPAN = 5.75/16 = .36
$Q/AD^{0.5} = 400/(66.6)(5.75)^{0.5} = 2.5$
$\frac{d_c}{D} = .47$
$d_c = (.47)(5.75) = 2.7$ ft
DIMENSIONLESS CRITICAL DEPTH CHART FOR CORRUGATED METAL ARCH CULVERTS
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
$\frac{Q}{AD^{0.5}}$

CHART 45B





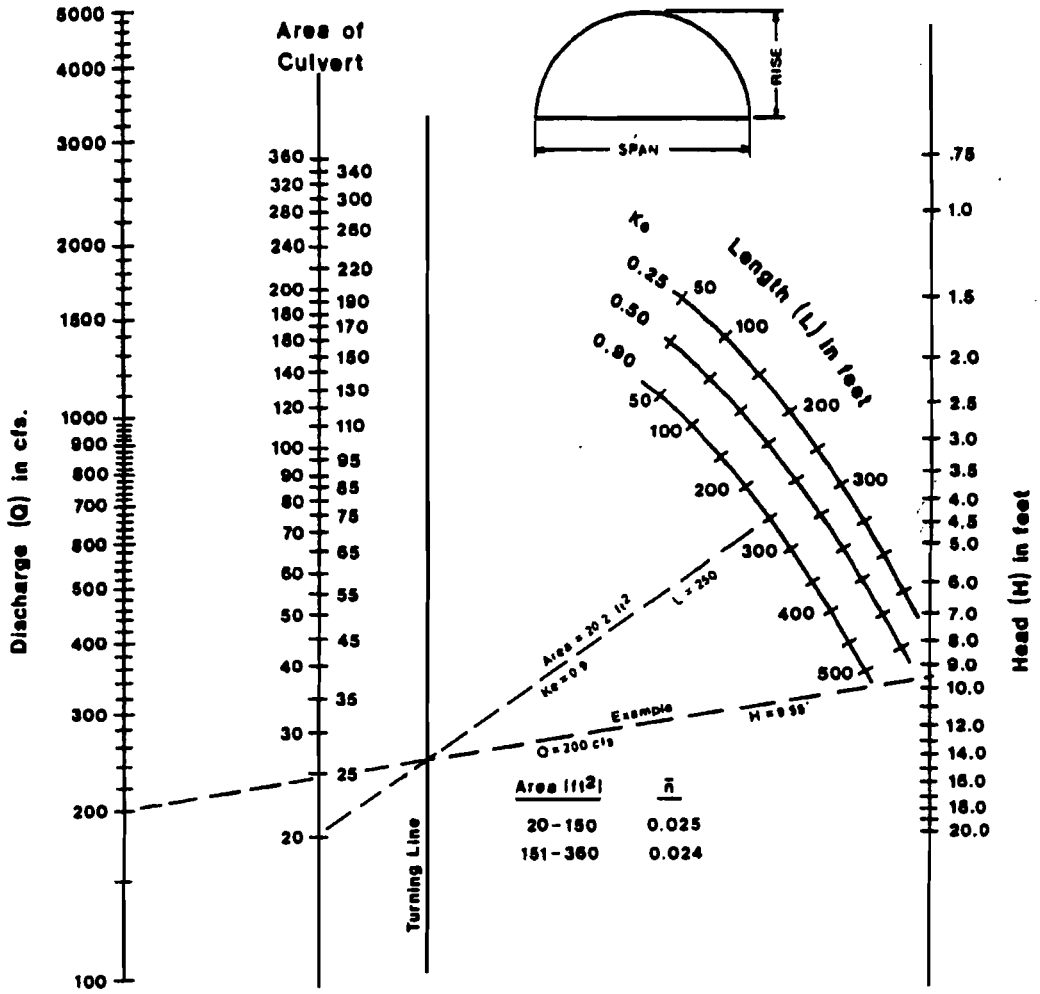
SUBMERGED OUTLET CULVERT FLOWING FULL

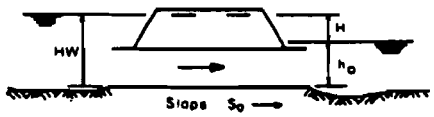
HEAD FOR
C.M. ARCH CULVERTS
FLOWING FULL
CONCRETE BOTTOM
0.3 ≤ RISE / SPAN < 0.4

Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 46B





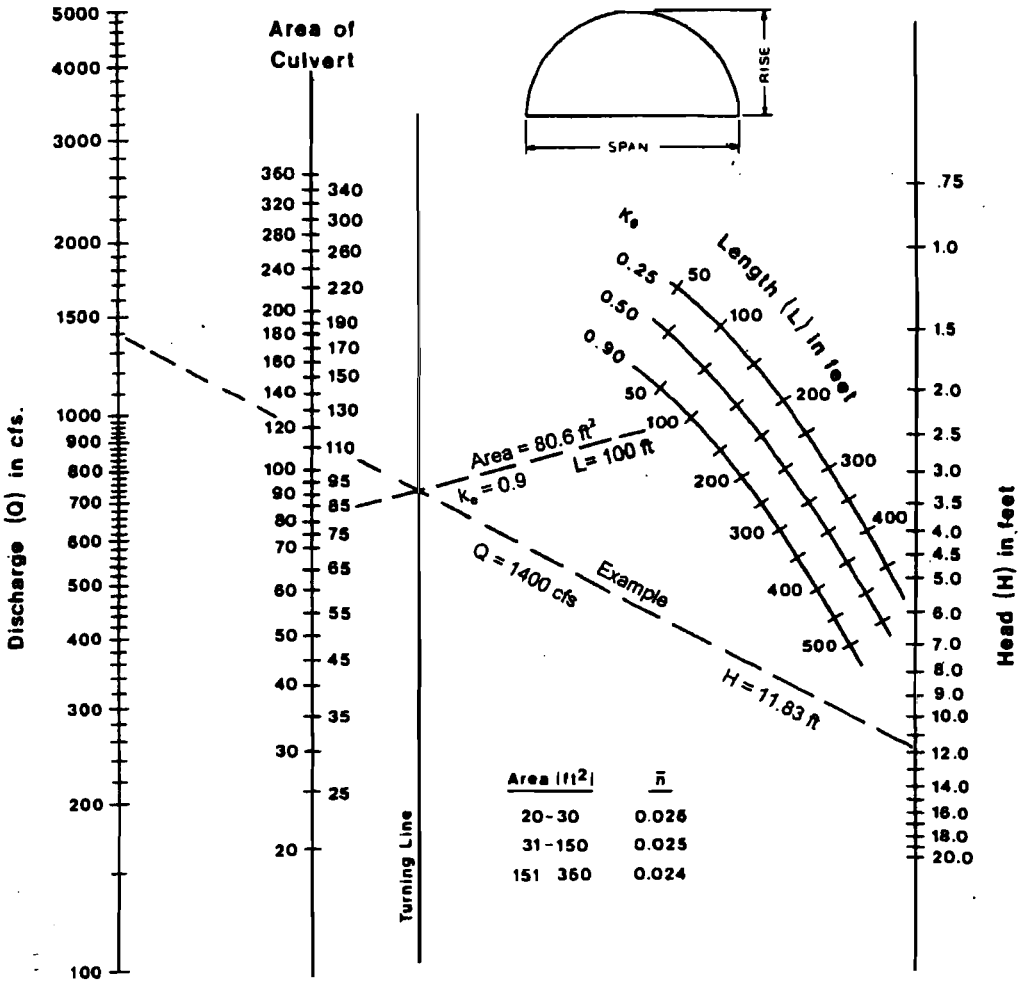
SUBMERGED OUTLET CULVERT FLOWING FULL

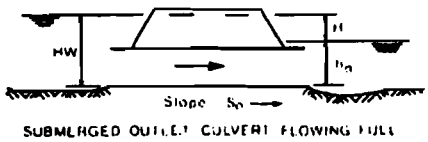
HEAD FOR
C.M. ARCH CULVERTS
FLOWING FULL
CONCRETE BOTTOM
0.4 ≤ RISE / SPAN < 0.5

Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 47B





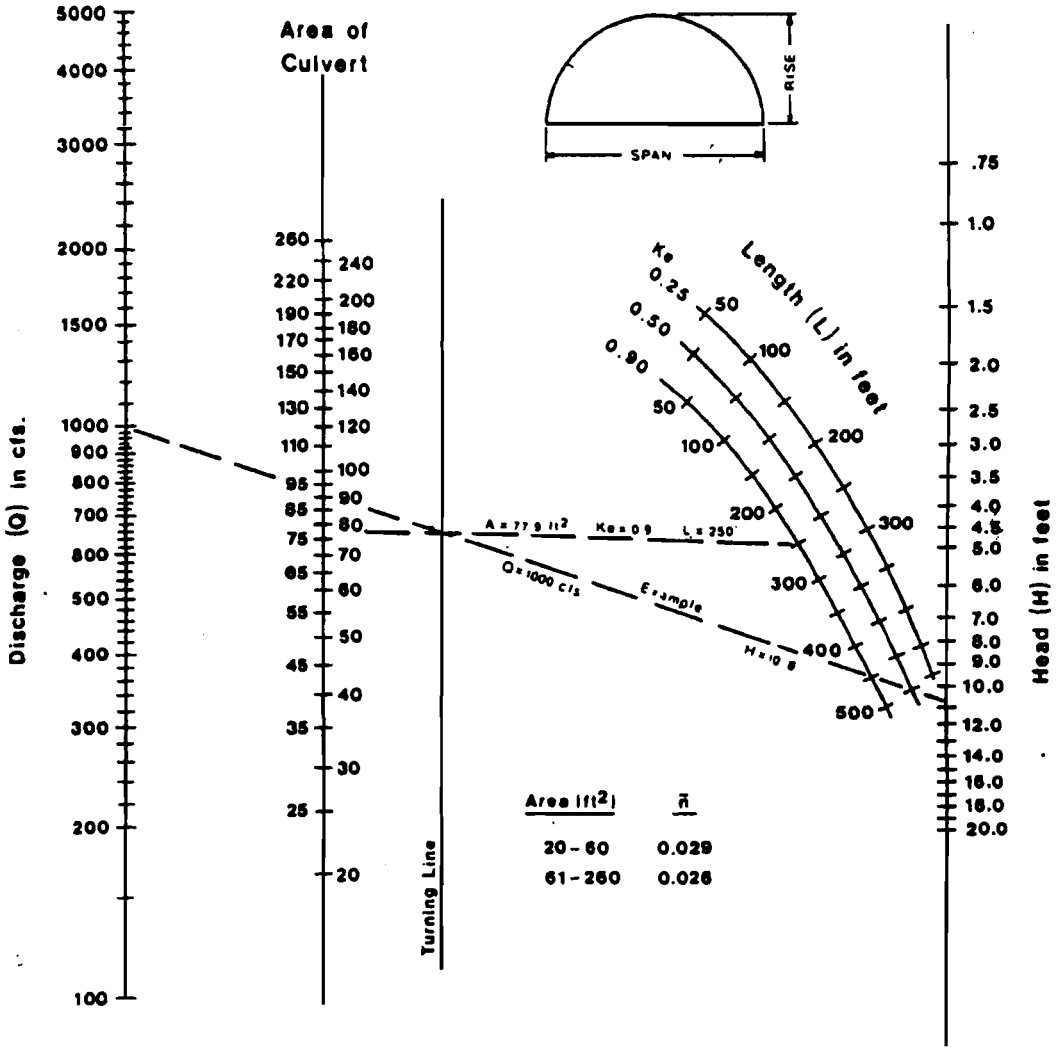
SUBMERGED OUTLET CULVERT FLOWING FULL

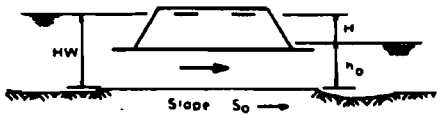
HEAD FOR
C.M. ARCH CULVERTS
FLOWING FULL
CONCRETE BOTTOM
0.5 ≤ RISE / SPAN

Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 48B





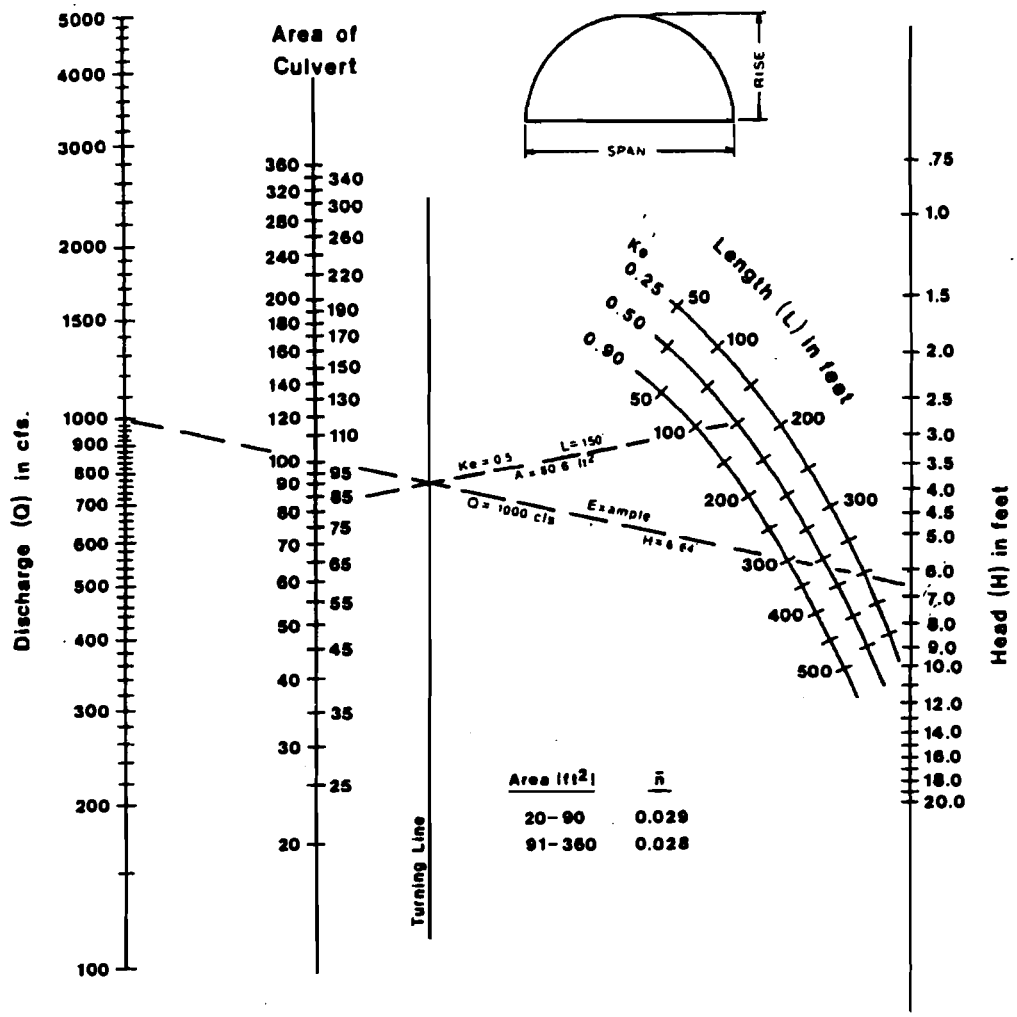
SUBMERGED OUTLET CULVERT FLOWING FULL

HEAD FOR
C.M. ARCH CULVERTS
FLOWING FULL
EARTH BOTTOM (n_b = 0.022)
0.3 ≤ RISE / SPAN < 0.4

Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 49B



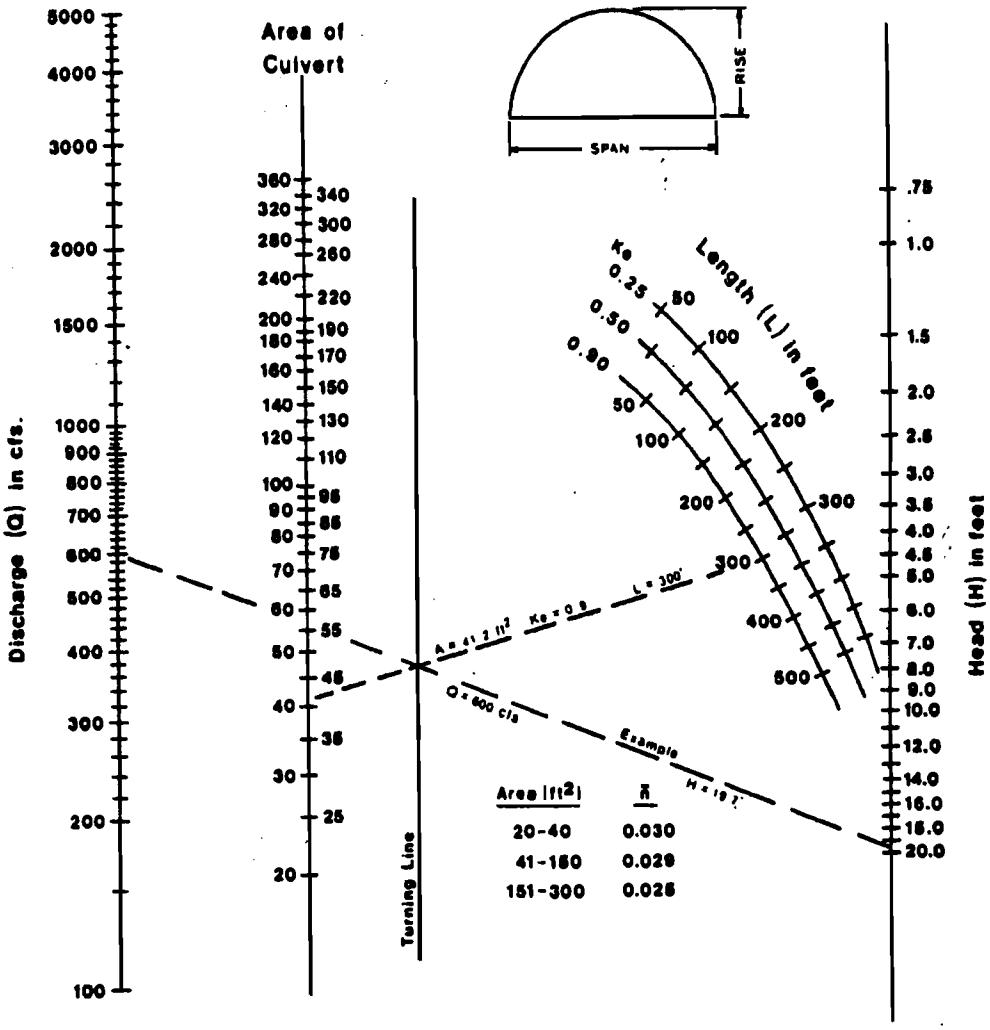
SUBMERGED OUTLET CULVERT FLOWING FULL

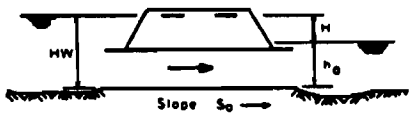
HEAD FOR
C.M. ARCH CULVERTS
FLOWING FULL
EARTH BOTTOM (n_b = 0.022)
0.4 ≤ RISE / SPAN < 0.5

Nomographs adapted from material furnished by
Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 50B





SUBMERGED OUTLET CULVERT FLOWING FULL

HEAD FOR
C.M. ARCH CULVERTS
FLOWING FULL
EARTH BOTTOM (n_b = 0.022)
0.5 ≤ RISE / SPAN

Nomographs adapted from material furnished by Kaiser Aluminum and Chemical Corporation

Duplication of this nomograph may distort scale

CHART 51B
(English Units)

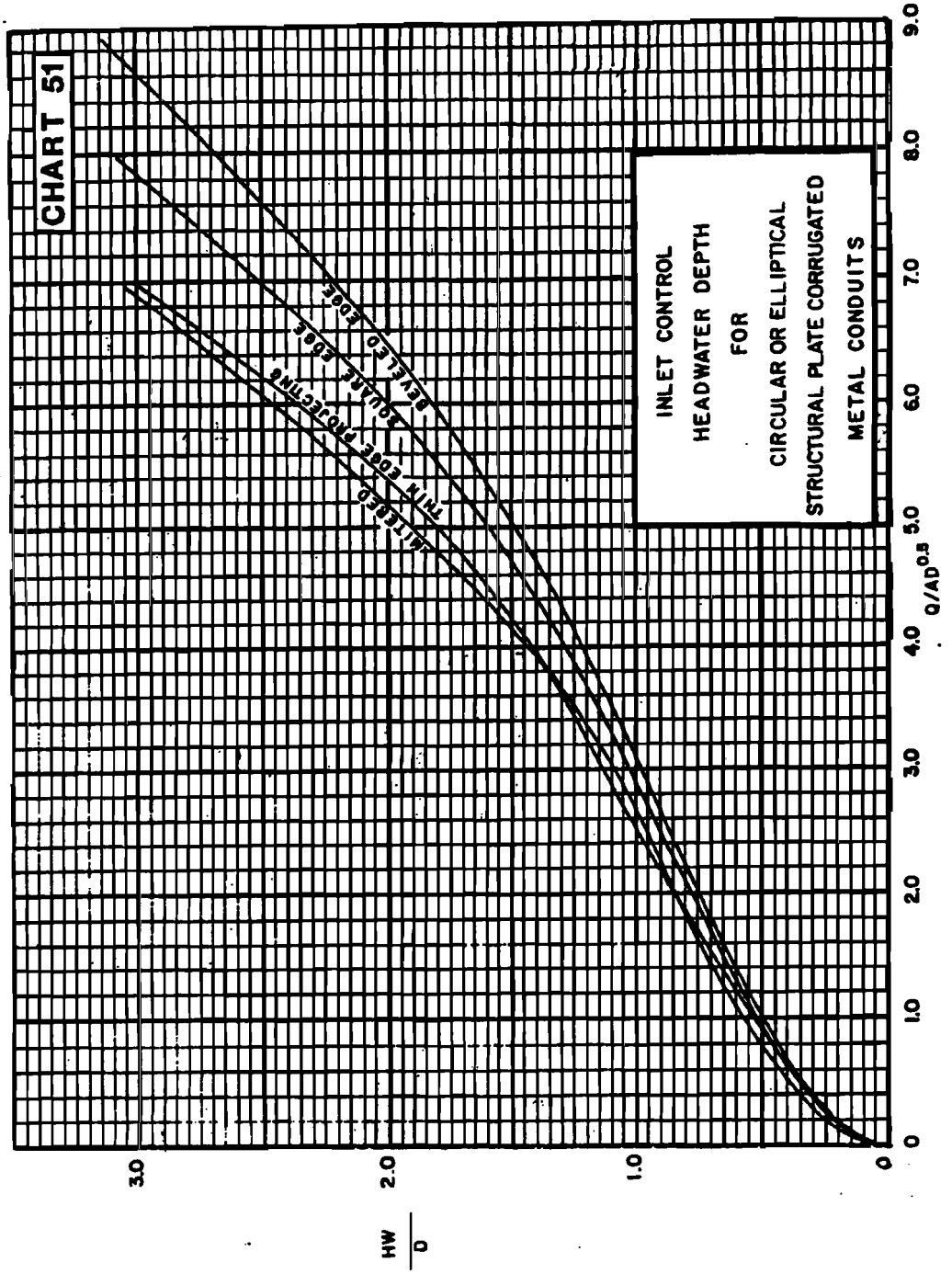


CHART 52B
(English Units)

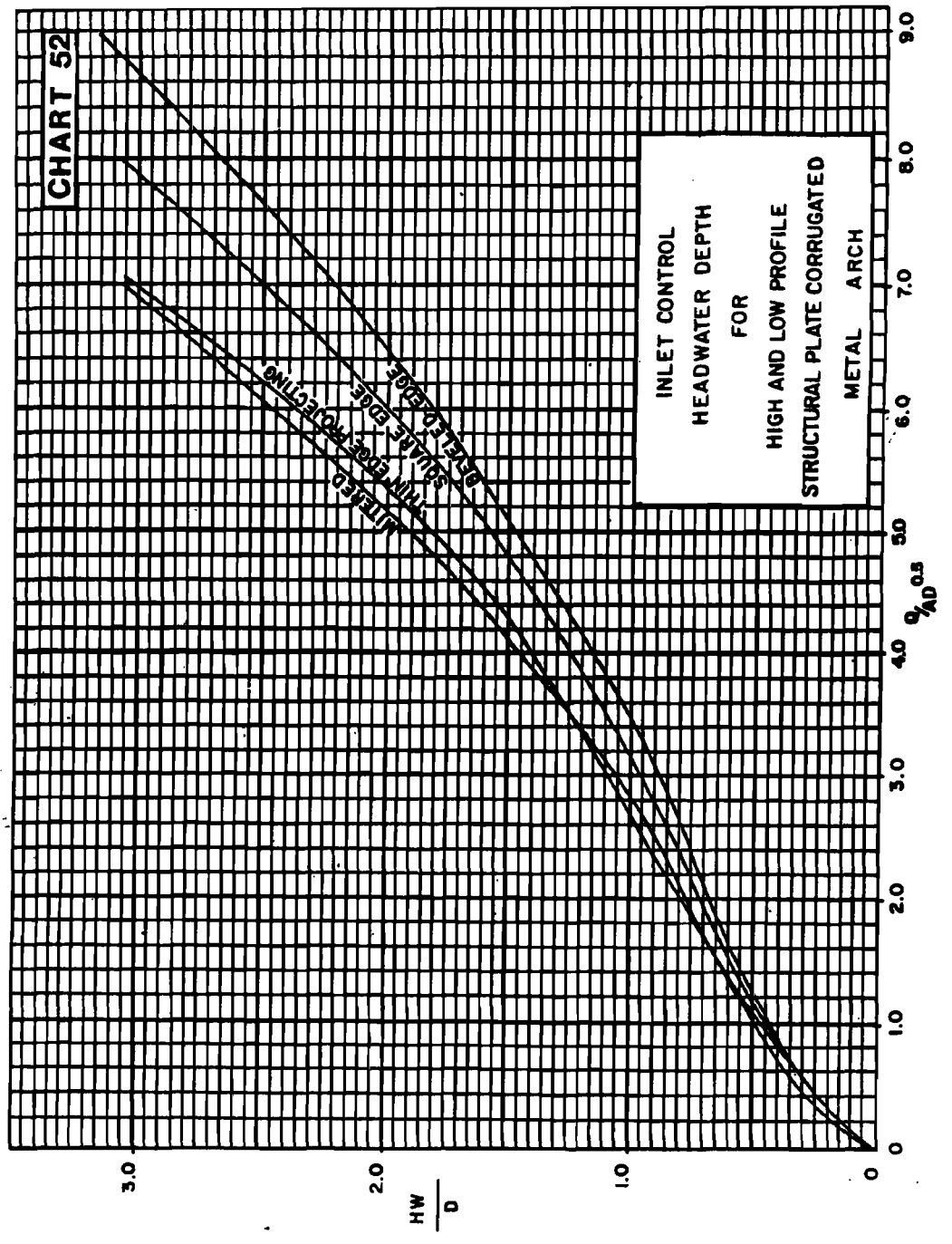
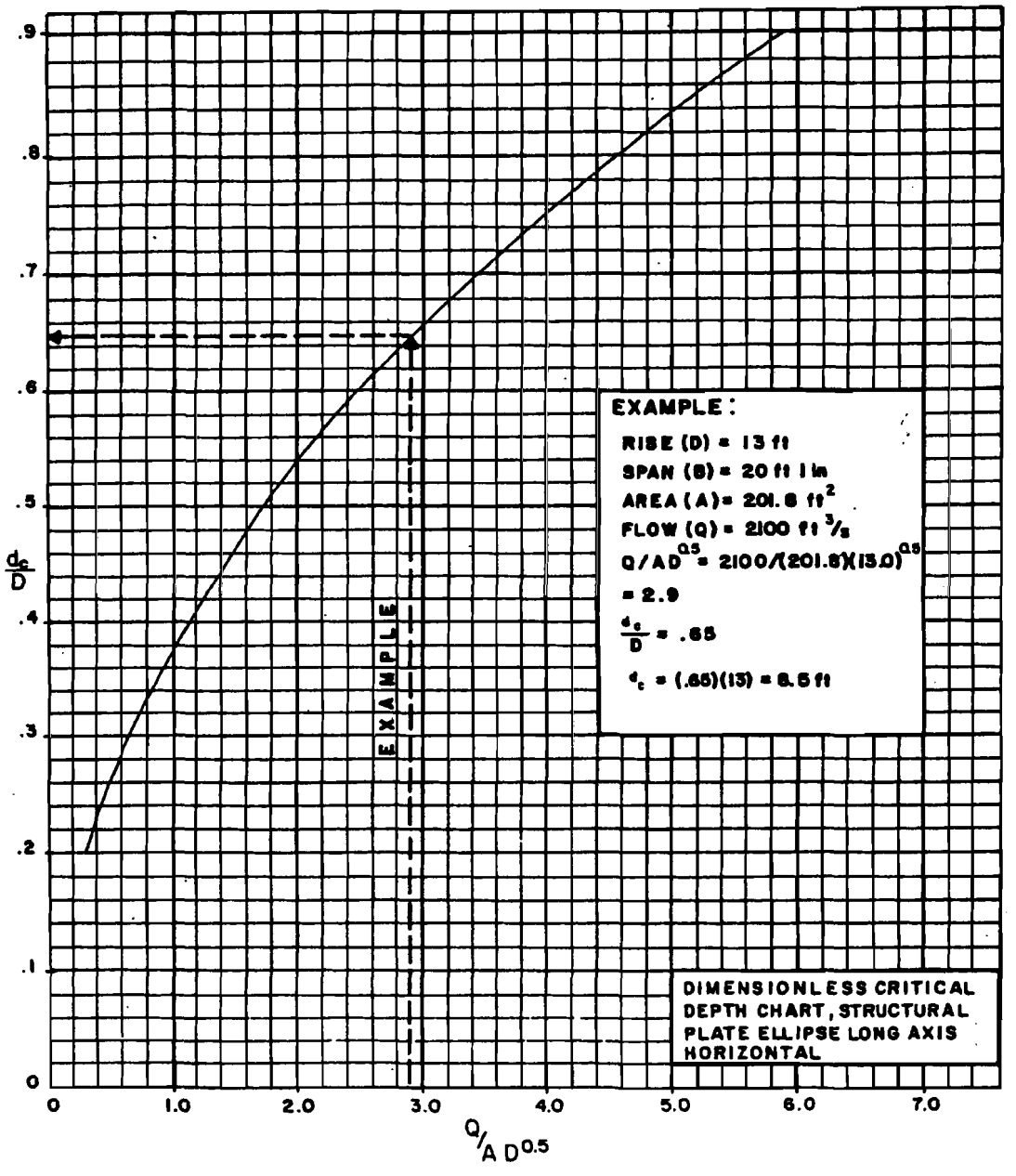


CHART 53B


.9
.8
.7
.6
.5
.4
.3
.2
.1
0
$\frac{d_c}{D}$
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
$Q/A\,D^{0.5}$
EXAMPLE
EXAMPLE:
RISE (D) = 13 ft
SPAN (B) = 20 ft 1 in
AREA (A) = 201.8 ft^2
FLOW (Q) = 2100 ft^3/s
$Q/AD^{0.5} = 2100/(201.8)(13.0)^{0.5}$
= 2.9
$\frac{d_c}{D}$ = .65
d_c = (.65)(13) = 8.5 ft
DIMENSIONLESS CRITICAL DEPTH CHART, STRUCTURAL PLATE ELLIPSE LONG AXIS HORIZONTAL

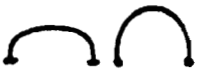


CHART 54B

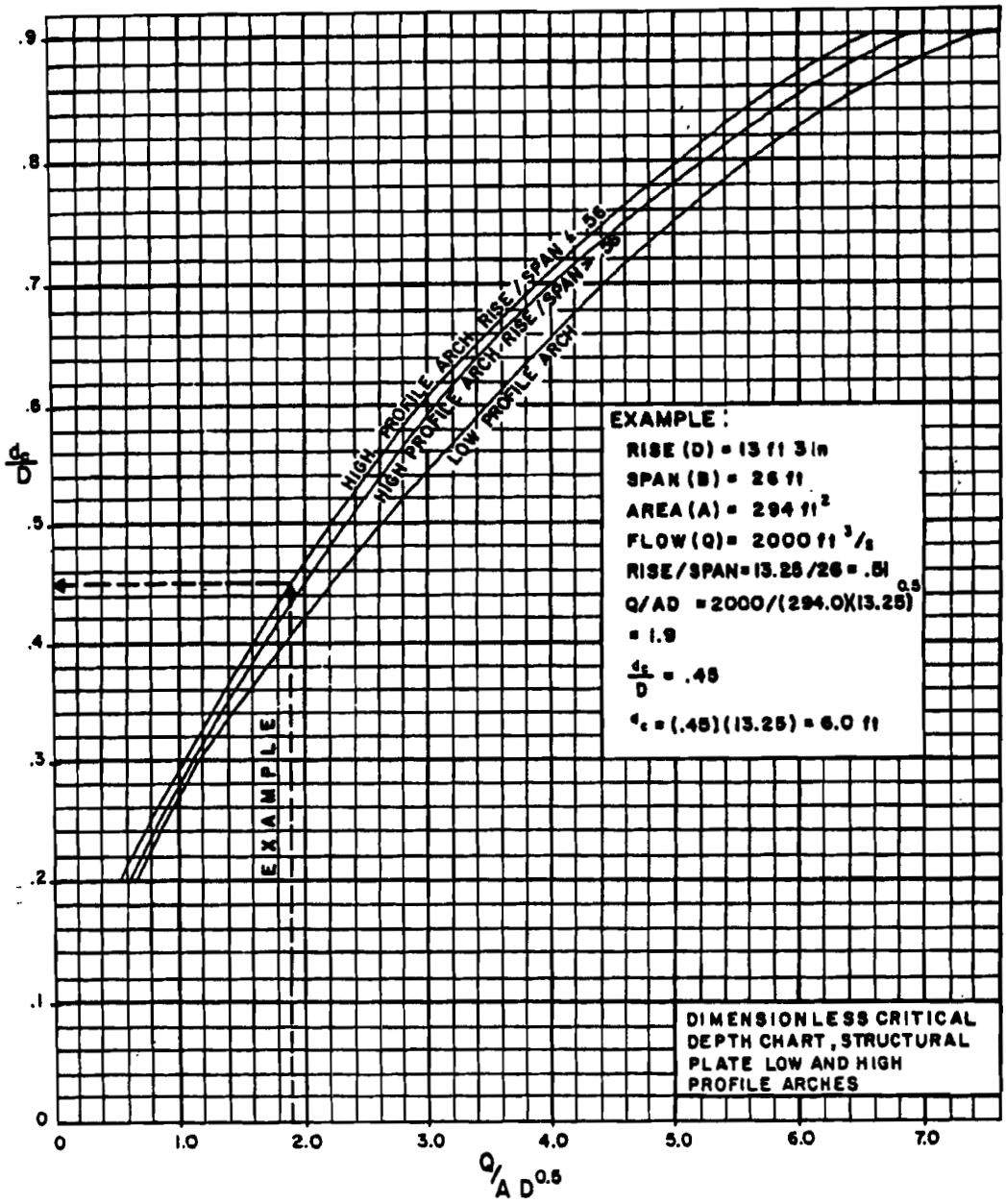
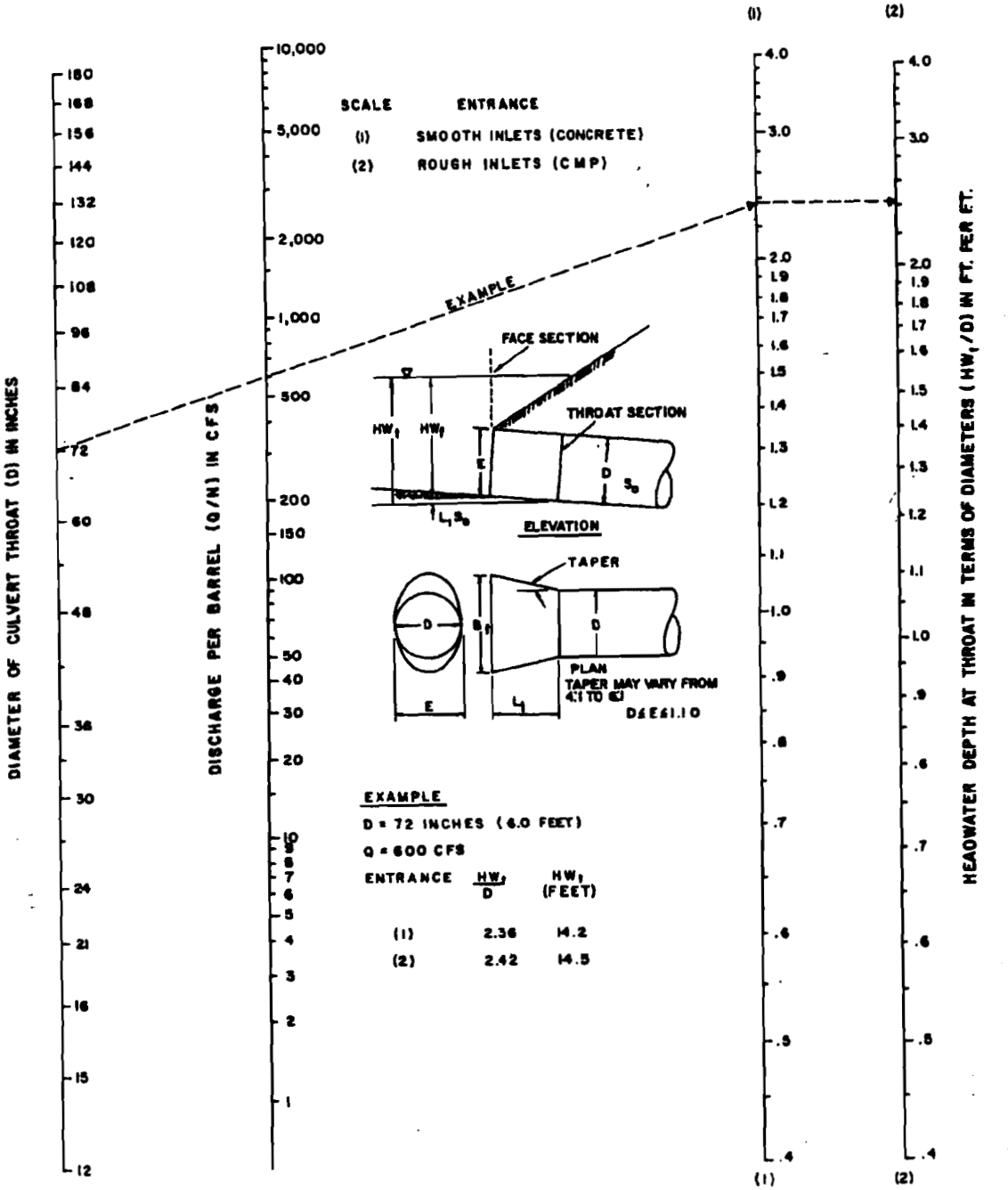
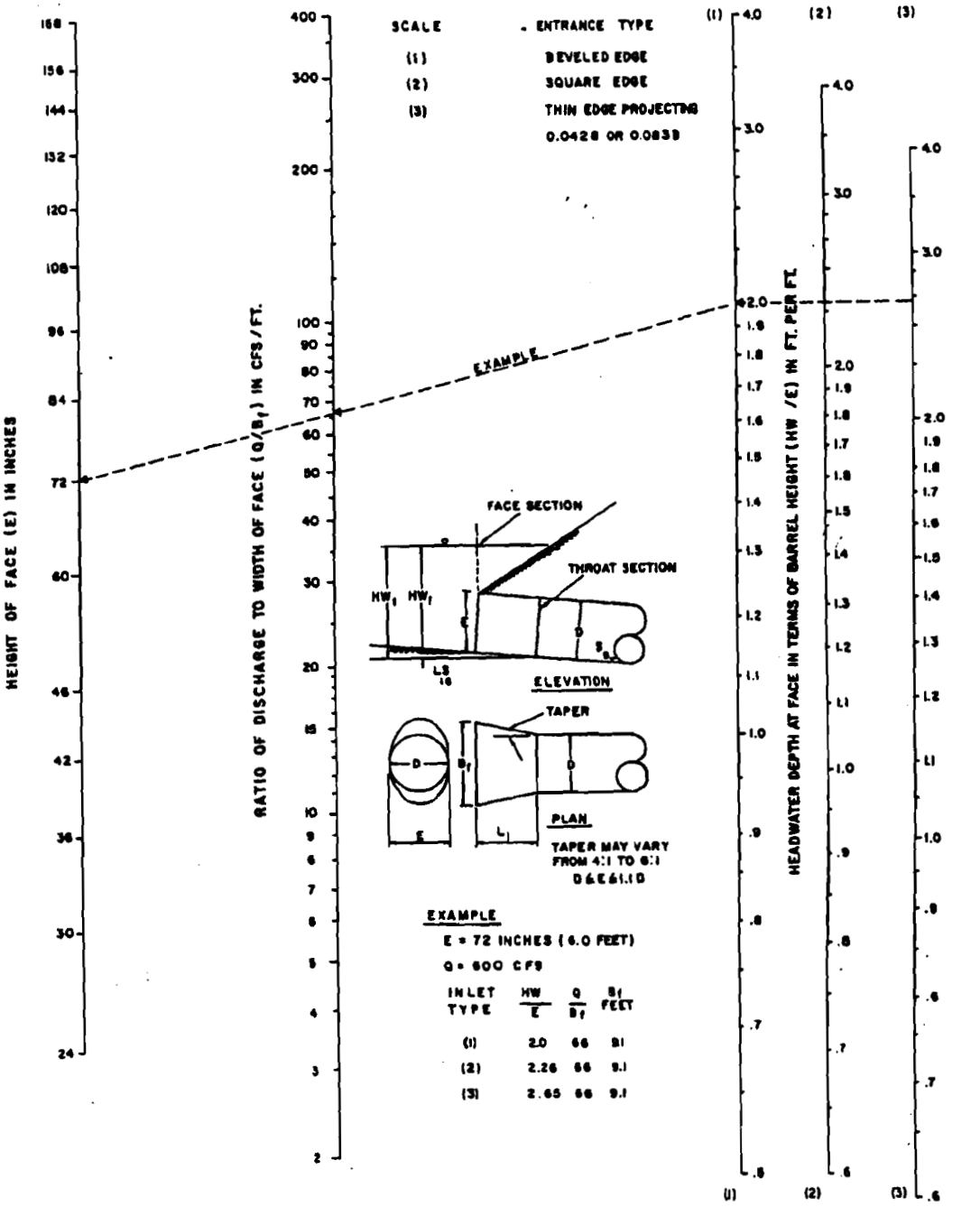

HIGH PROFILE ARCH, RISE/SPAN ≤ .56
HIGH PROFILE ARCH, RISE/SPAN > .56
LOW PROFILE ARCH
EXAMPLE
EXAMPLE:
RISE (D) = 13 ft 3 in
SPAN (B) = 26 ft
AREA (A) = 294 ft²
FLOW (Q) = 2000 ft³/s
RISE/SPAN = 13.25/26 = .51
Q/AD^0.5 = 2000/(294.0)(13.25)^0.5
= 1.9
dc/D = .45
dc = (.45)(13.25) = 6.0 ft
DIMENSIONLESS CRITICAL DEPTH CHART, STRUCTURAL PLATE LOW AND HIGH PROFILE ARCHES
dc/D
Q/A D^0.5
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
2.0
3.0
4.0
5.0
6.0
7.0

CHART 55B



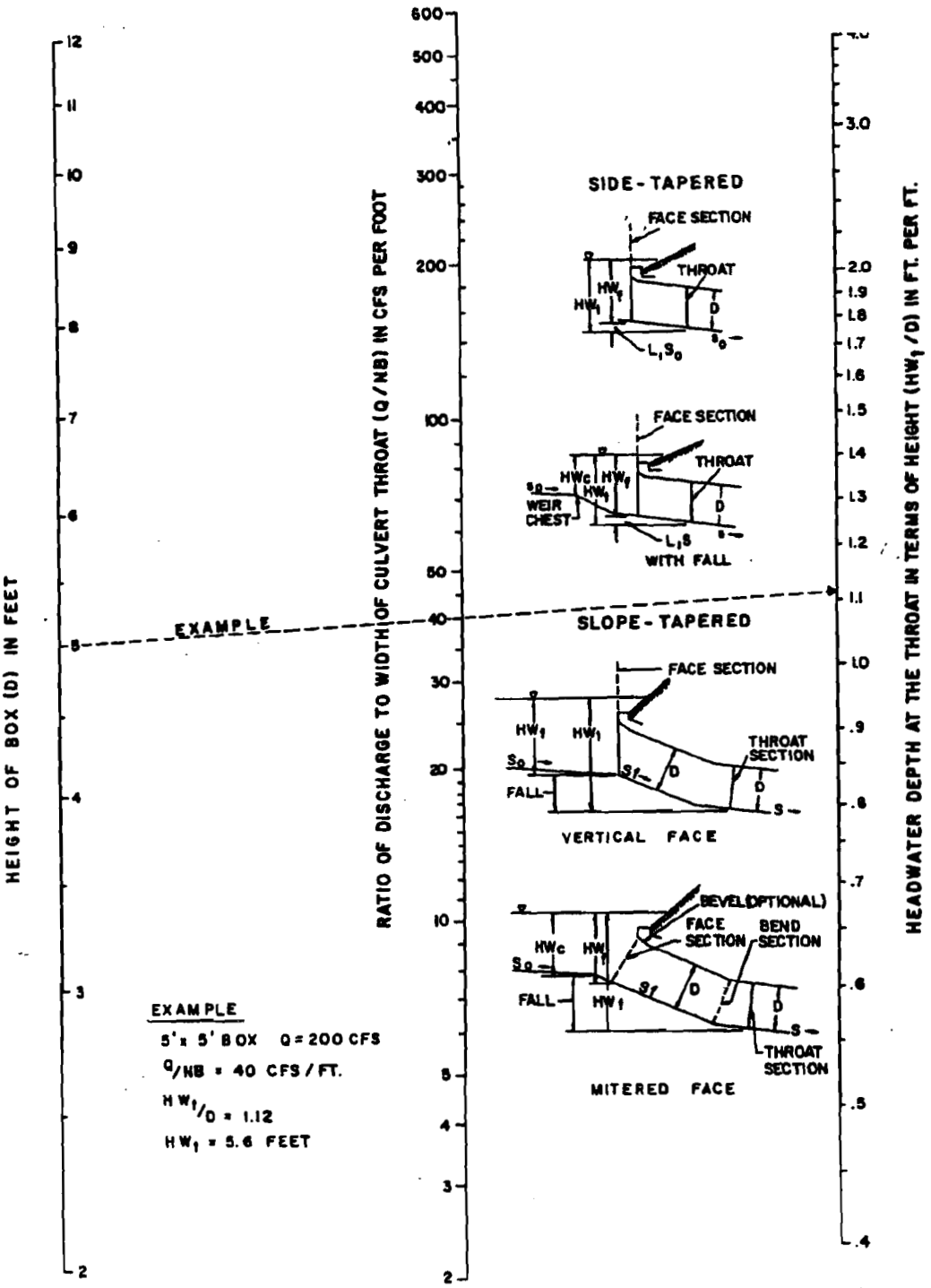
THROAT CONTROL
FOR SIDE-TAPERED INLETS TO PIPE CULVERT
(CIRCULAR SECTION ONLY)

CHART 56B



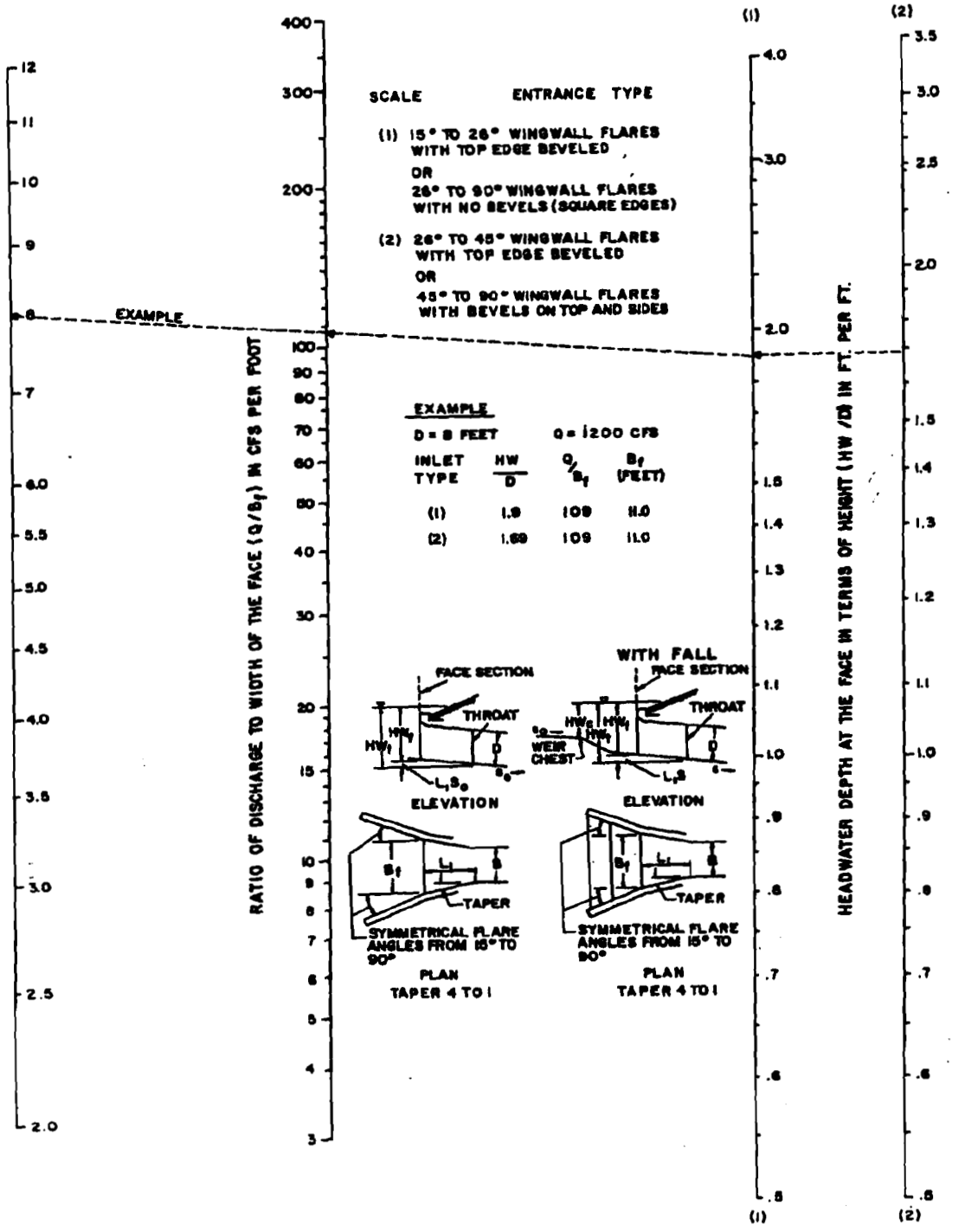
FACE CONTROL FOR SIDE-TAPERED INLETS TO PIPE CULVERTS (NON-RECTANGULAR SECTIONS ONLY)

CHART 57B



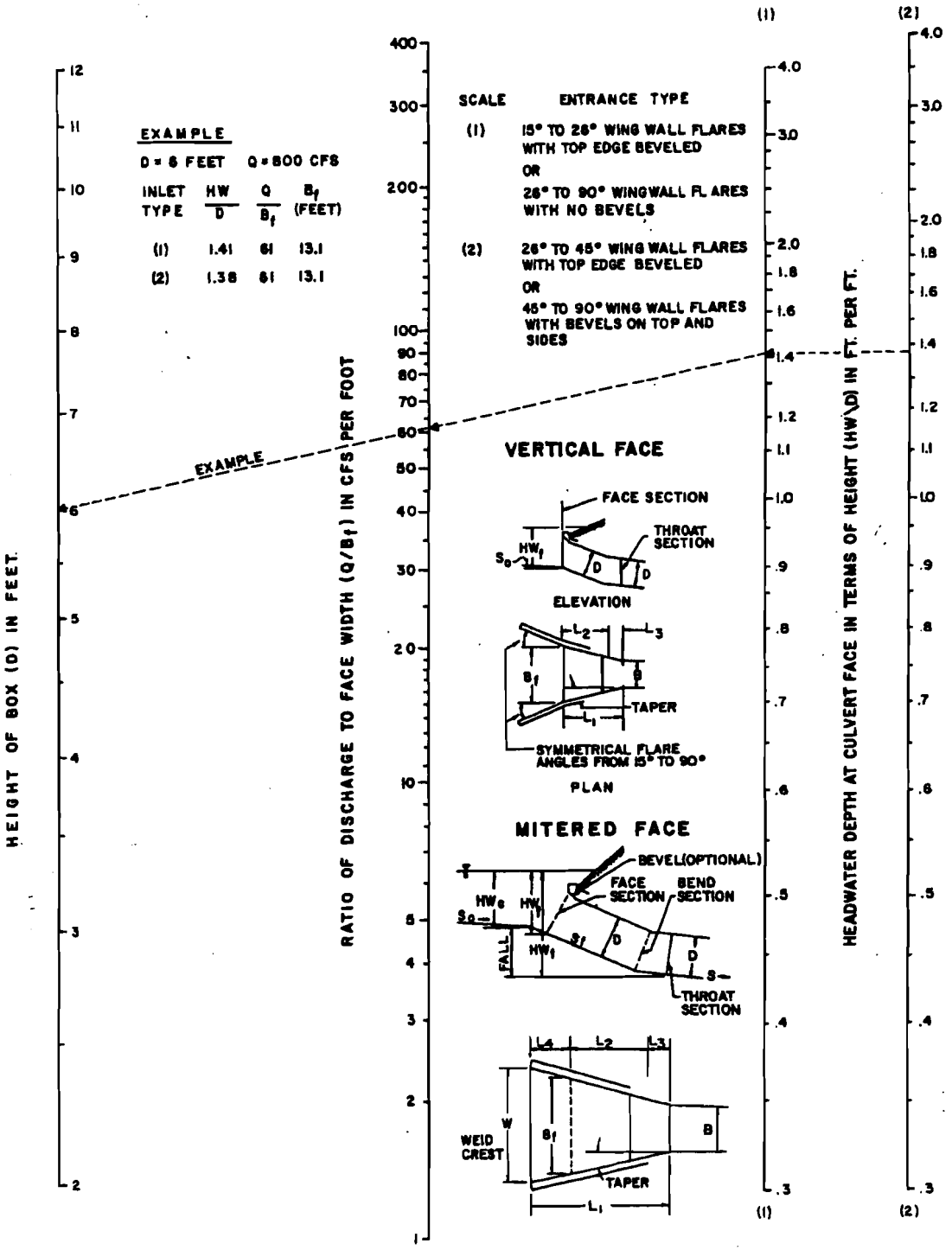
THROAT CONTROL FOR BOX CULVERTS WITH TAPERED INLETS

CHART 58B



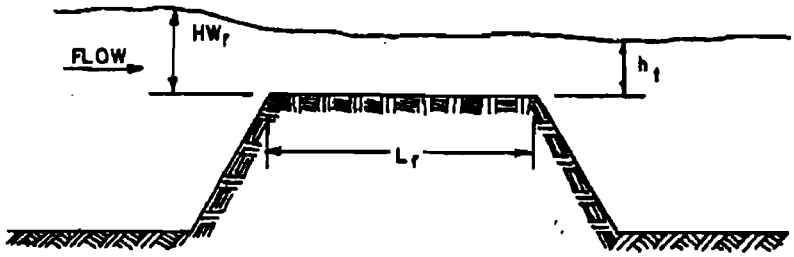
FACE CONTROL FOR BOX CULVERTS
WITH SIDE TAPERED INLETS

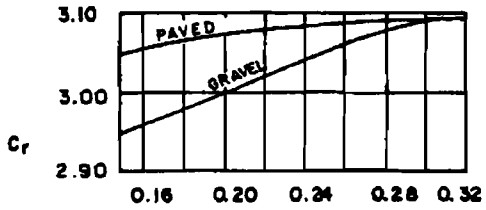
CHART 59B



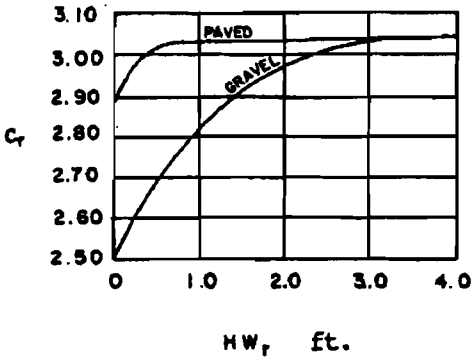
FACE CONTROL FOR BOX CULVERTS WITH SLOPE TAPERED INLETS

CHART 60B





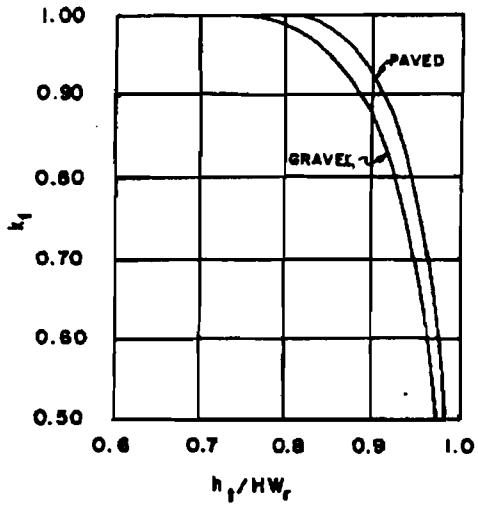
A) DISCHARGE COEFFICIENT FOR $HW_r / L_r > 0.15$



B) DISCHARGE COEFFICIENT FOR $HW_r / L_r \leq 0.15$

$C_d = k_t C_r$

$Q_r = C_d \, L \, H \, W_r^{1.5}$



C) SUBMERGENCE FACTOR

English Discharge Coefficients for Roadway Overtopping

APPENDIX 6
GIS DATABASE SUBMITTALS

Appendix 6

GIS Database Submittals

All storm drainage infrastructures in any dedicated easement or street rights of way shall be submitted in accordance with all provisions herein. This includes all vertical and horizontal alignments for all constructed street centerlines and detention/retention pond finished contours, outlet structures, and emergency spillways. Survey control shall conform to Section 2.2 of this manual.

All data shall be provided to the City of Jonesboro in ESRI shapefile and PDF formats.

For all shapefiles, a separate spatial data file should be used for each structure and specific attributes should be recorded on site at the time of collection. The following table should be used for recording these attributes along with all feature attribute input criteria.

Table 1. Attribute Fields

	Field Name	Data Type	Length	Precision	Scale
Inlet	DATE	Date			
	BASIN	Text	1		
	NUMBER	Long Integer		6	
	DEPTH	Double		12	1
	TYPE	Text	20		
	WIDTH	Short Integer	21	2	
	LENGTH	Short Integer	80	2	
	COMMENT	Text			
Circular Pipe	DATE	Date			
	BASIN	Text	1		
	NUMBER	Long Integer		6	
	SIZE	Short Integer	5	2	
	MATERIAL	Text	20		
	PROTECTION	Text	21		
	COMMENT	Text	80		
	INVERT	Float		6	2
Elliptical Pipe	DATE	Date			
	BASIN	Text	1		
	NUMBER	Long Integer		6	
	DIMENSION	Text	5		
	MATERIAL	Text	20		
	PROTECTION	Text	21		
	COMMENT	Text	80		
	INVERT	Float		6	2

	Field Name	Data Type	Length	Precision	Scale
Arch Pipe	DATE	Date			
	BASIN	Text	1		
	NUMBER	Long Integer		6	
	DIMENSION	Text	5		
	MATERIAL	Text	20		
	PROTECTION	Text	21		
	COMMENT	Text	80		
	INVERT	Float		6	2
Box Culvert	DATE	Date			
	BASIN	Text	1		
	NUMBER	Long Integer		6	
	WIDTH	Short Integer		2	
	HEIGHT	Short Integer		2	
	MATERIAL	Text	8		
	COMMENT	Text	80		
	INVERT	Float		6	2
Outfall	DATE	Date			
	BASIN	Text	1		
	NUMBER	Long Integer		6	
	SIZE	Short Integer		2	
	FLOWDIRECT	Text	1		
	ODOR	Short Integer		4	
	FLOWQUANT	Short Integer		3	
	COLOR	Text	11		2
	POLLUTANT	Text	10		
	COMMENT	Text	80		
	INVERT	Float		6	
Bridge	DATE	Date			
	BASIN	Text	1		
	NUMBER	Long Integer		6	
	DECK TO BEAM	Float		4	1
	PIERSHAPE	Text	8		
	PIERSIZE	Short Integer	80	2	
	COMMENT	Text			

ANY FEATURE WITH THESE ATTRIBUTES

BASIN: C = Cache
L = Languille
S = St Francis

MATERIAL: Concrete
Corrugated metal
Non corrugated metal
Plastic
Clay

PROTECTION: None
Flared end section
Headwall
Headwall and Wingwall

INVERT: 2 decimal places in the measurement

ARCH PIPE

DIMENSION: 11x18
14x22
18x29
23x36
27x44
31x51
36x59
40x65
45x73
54x88

BOX CULVERT

WIDTH & HEIGHT: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

BRIDGE

PIERSHAPE: Circular
Square

PIERSIZE: 12, 18, 24, 30, 36, 42, 48

DECKTOBEAM: one decimal place in the measurement

CIRCULAR PIPE

SIZE: 12, 15, 18, 24, 30, 36, 42, 48, 54, 60, 72

ELLIPTICAL PIPE

DIMENSION: 12x18
14x23
19x30
22x34
24x38
29x45
34x53
38x60
43x68
48x76
53x83

INLET

TYPE: Area
Combination
Curb
Grate
Junction box
Other

WIDTH & LENGTH: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

DEPTH: one decimal place in the measurement

OUTFALL

SIZE: 12, 15, 18, 24, 30, 36, 42, 48, 54, 60, 72

FLOWDIRECT: N, S, E, W

FLOWQUANT: 0, 25, 50, 75, 100

COLOR: Clear
Black
Dark brown
Light brown
Red
Other

POLLUTANT:	None
	Oil
	Oil sheen

For each structure, a digital photograph shall be taken and submitted, providing visual documentation of the structure's condition. Each image file shall be named to identify it based on drainage area, structure type, and number.

As a post processing step, all appropriate drainage structure location points shall be connected to create line work representing the storm drainage network. Care should be taken to tie the new drainage structures to the existing structures or to the appropriate drainage channel. At a minimum, structure diameter and length (in feet) should be added to the attribute table at the time of creation.

APPENDIX 7
ADEQ PERMIT NO. ARR150000

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM AND THE ARKANSAS WATER AND AIR POLLUTION CONTROL ACT

In accordance with the provisions of the Arkansas Water and Air Pollution Control Act (Act 472 of 1949, as amended, Ark. Code Ann. 8-4-101 et seq.), and the Clean Water Act (33 U.S.C. 1251 et seq.),

Owners or operators of Facilities Discharging Storm Water Associated With Construction Activity Located in the State of Arkansas

are authorized to discharge

to all receiving waters

in accordance with effluent limitations, monitoring requirements, and other conditions set forth in Parts I and II herein.

This permit shall become effective on November 1, 2003.

This permit and the authorization to discharge shall expire at midnight, October 31, 2008.

Signed this 30th day of September, 2003.

_____

Martin Maner, P.E.
Chief, Water Division
Arkansas Department of Environmental Quality

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PERMIT REQUIREMENTS

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Section A: Permit Requirements Summary Flowchart

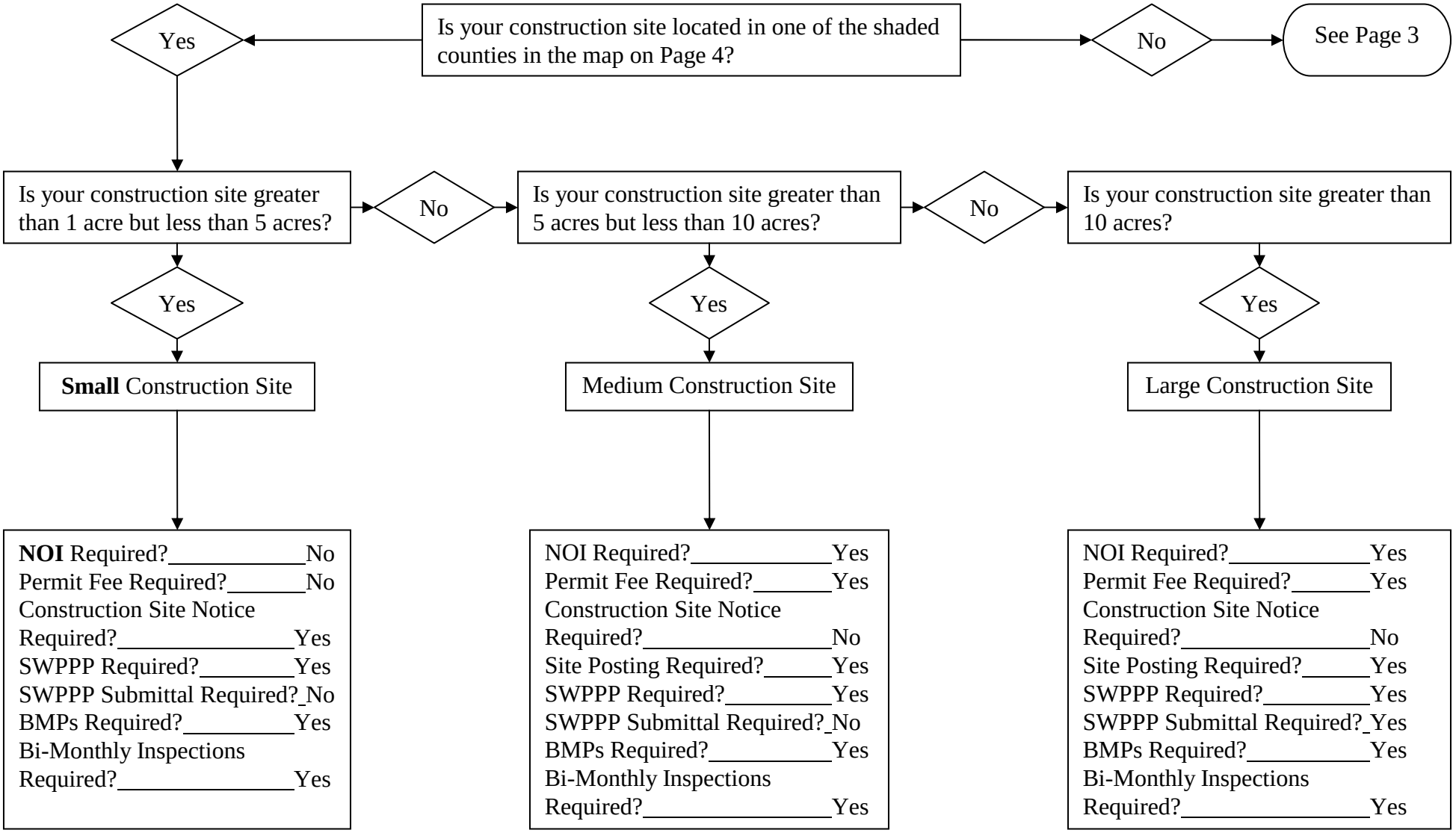
Section B: Coverage Under this Permit:

1. Permit Area
2. Eligibility
3. Limitations on Coverage
4. Requiring an Individual NPDES Permit or an Alternative General Permit
5. Waivers from Permit Coverage
6. Authorization
7. Notice of Intent Requirements
8. Notice of Termination Requirements

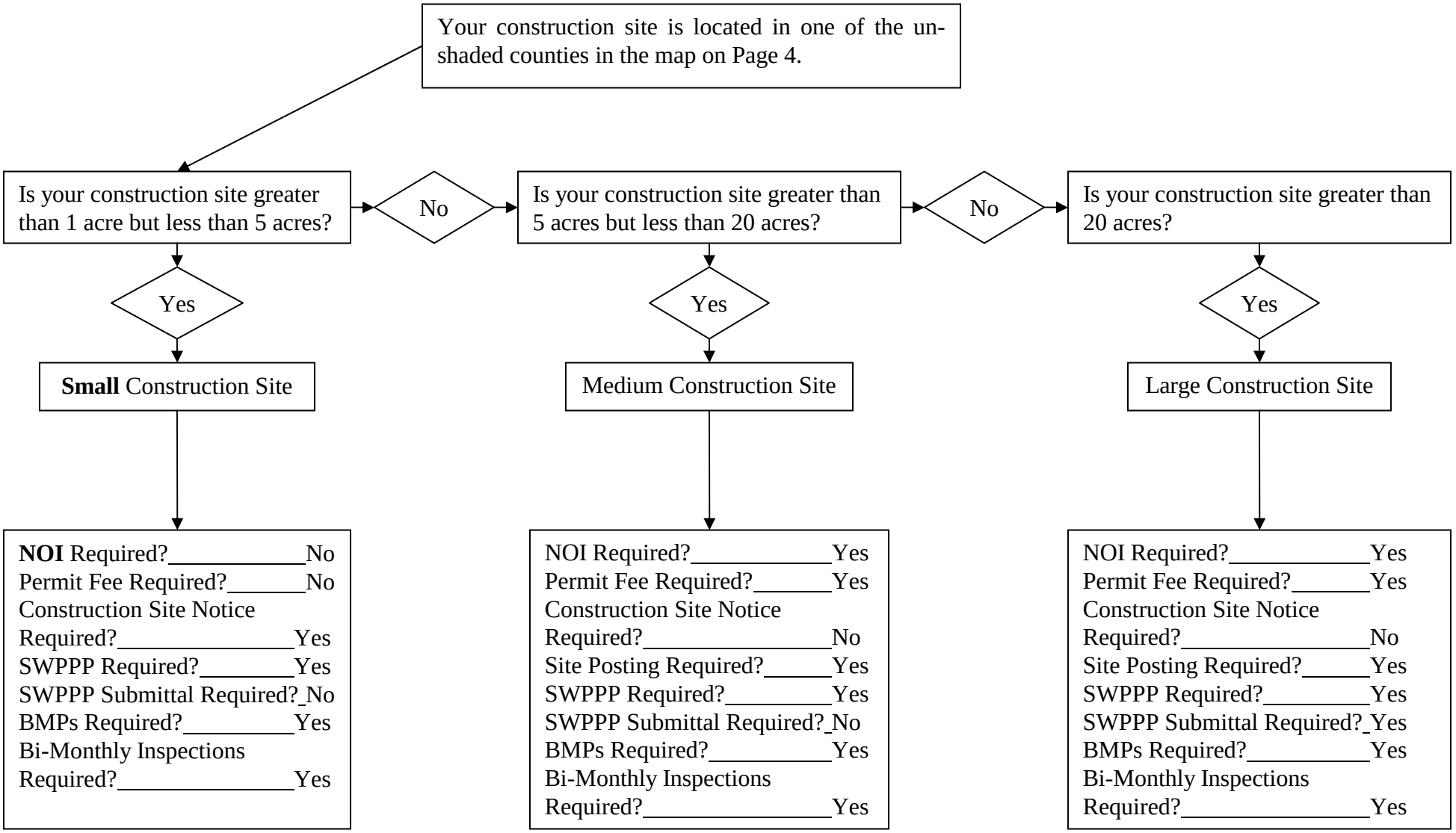
Section C: Other Requirements:

1. Prohibition of Non-Storm Water Discharges
2. Releases in Excess of Reportable Quantities
3. Responsibilities of Operators

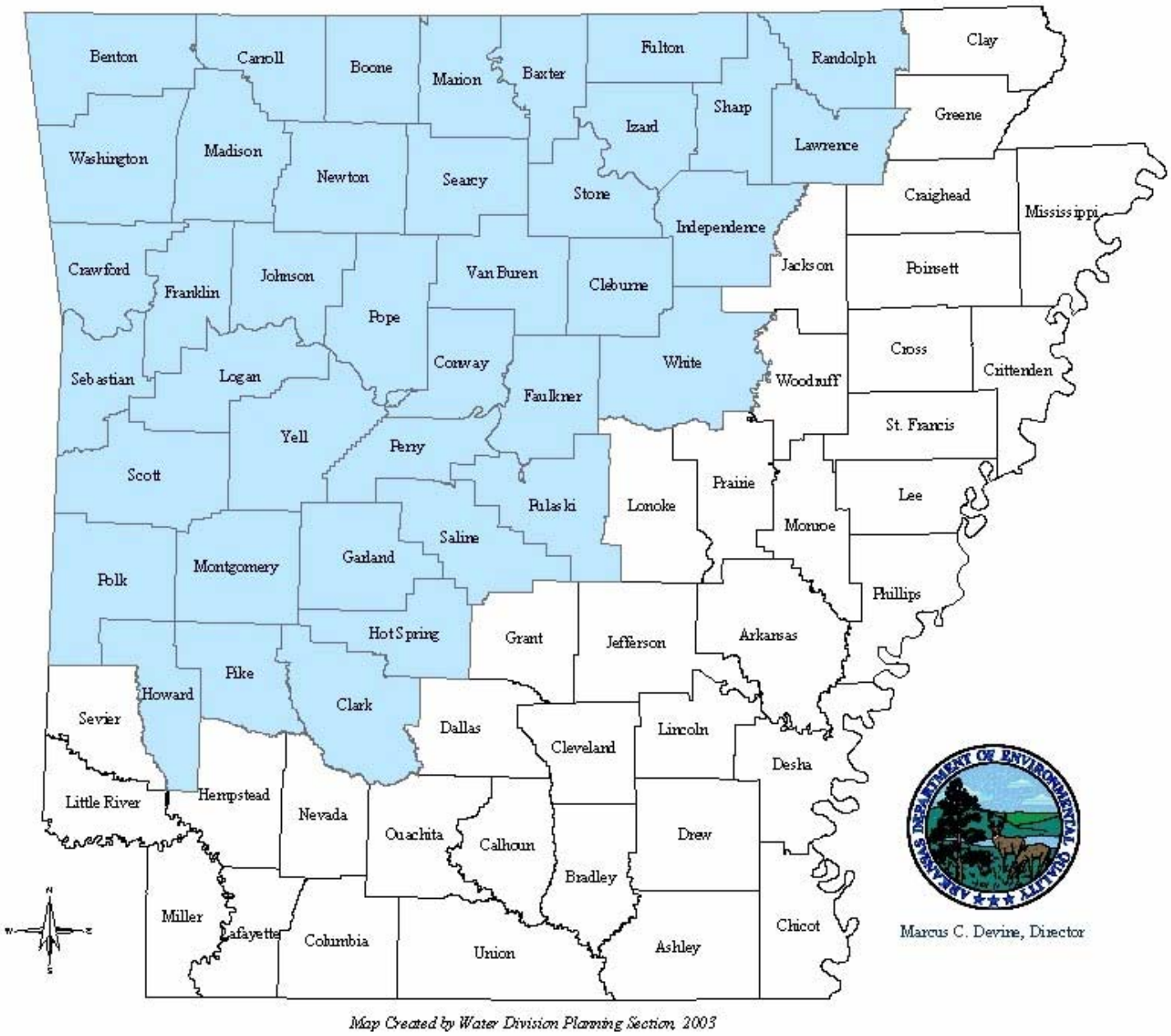
SECTION A: PERMIT REQUIREMENTS SUMMARY FLOWCHART



SECTION A: PERMIT REQUIREMENTS SUMMARY FLOWCHART (CONT.)



SECTION A: PERMIT REQUIREMENTS SUMMARY FLOWCHART (CONT.)



SECTION B: COVERAGE UNDER THIS PERMIT

1. **Permit Area**. This general permit includes all areas within the State of Arkansas.

2. **Eligibility.**

a. Except for storm water discharges identified under Part I.B.3 below, this permit shall authorize all discharges of storm water from the following construction sites (henceforth referred to as storm water discharges from construction activities) occurring after the effective date of this permit (including discharges occurring after the effective date where the construction activity commenced before the effective date):

i. **Large Construction Sites:** any construction activity that meets one of the following two definitions:

A. Construction sites that will result in the disturbance (e.g., clearing, grading, excavating, etc.) of **ten (10)** or more acres of total land area or less than **ten (10)** acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **ten (10)** acres or more located in the following counties:

Baxter	Garland	Newton	Sharp
Benton	Hot Spring	Perry	Stone
Boone	Howard	Pike	Van Buren
Carroll	Independence	Polk	Washington
Clark	Izard	Pope	White
Cleburne	Johnson	Pulaski	Yell
Conway	Lawrence	Randolph	
Crawford	Logan	Saline	
Faulkner	Madison	Scott	
Franklin	Marion	Searcy	
Fulton	Montgomery	Sebastian	

B. Construction sites that will result in the disturbance (e.g., clearing, grading, excavating, etc.) of **twenty (20)** or more acres of total land area or less than **twenty (20)** acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **twenty (20)** acres or more located in the following counties:

Arkansas	Crittenden	Jefferson	Nevada
Ashley	Cross	Lafayette	Ouachita
Bradley	Dallas	Lee	Phillips
Calhoun	Desha	Lincoln	Poinsett
Chicot	Drew	Little River	Prairie
Clay	Grant	Lonoke	Sevier
Cleveland	Greene	Miller	St. Francis
Columbia	Hempstead	Mississippi	Union
Craighead	Jackson	Monroe	Woodruff

ii. **Medium Construction Sites:** any construction activity that meets one of the following two definitions:

A. Construction sites that will result in the disturbance (e.g., clearing, grading, excavating, etc.) of greater than **five (5)** acres and less than **ten (10)** acres of total land area or less than **five (5)** acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **five (5)** acres or more, but less than ten (10) acres, located in one of the counties identified in Part I.B.2.a.i.A above.

B. Construction sites that will result in the disturbance (e.g., clearing, grading, excavating, etc.) of greater than **five (5)** acres and less than **twenty (20)** acres of total land area or less than **five (5)** acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **five (5)** acres or more, but less than twenty (20) acres, located in one of the counties identified in Part I.B.2.a.i.B above.

iii. **Small Construction Sites:** any construction activity that meets the following definition:

A. Construction sites that will result in the disturbance (e.g., clearing, grading, excavating, etc.) of greater than or equal to **one (1)** acre and less than **five (5)** acres of total land area or less than **one (1)** acre of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **one (1)** acre or more, but less than five (5) acres.

(1) Road, pipeline, and utility maintenance activities are not regulated under this permit unless one or more acres of underlying and/or surrounding soil are cleared, graded, or excavated as part of the operation.

b. This permit also authorizes storm water discharges from support activities (e.g., concrete or asphalt batch plants, equipment staging yards, materials storage areas, excavated material disposal areas, borrow areas) provided:

i. The support activity is directly related to a construction site that is required to have NPDES permit coverage for discharges of storm water associated with the construction activity;

ii. The support activity is not a commercial operation serving multiple unrelated construction projects by different operators, and does not operate beyond the completion of the construction activity at the last construction project it supports; and

iii. Appropriate controls and measures are identified in a storm water pollution prevention plan covering the discharges from the support activity areas.

3. **Limitations on Coverage.** The following storm water discharges associated with construction activity are not covered by this permit:

a. Storm water discharges associated with construction activity that originate from the site after construction activities have been completed and the site has undergone final stabilization.

b. Discharges that are **mixed with** sources of **non**-storm water. (See Part I.C.1.a on page 16)

c. Storm water discharges from facilities with an existing NPDES individual or general permit for storm water discharges or which are issued a permit in accordance with Part I.B.4 of this permit. Such discharges may be authorized by this permit after an existing permit expires provided the expired permit did not establish numeric effluent limitations for such discharges.

d. Storm water discharges from construction sites that the Director has determined to be or may reasonably be expected to be contributing to a violation of a water quality standard.

e. Discharges to waters for which there is a total maximum daily load (TMDL) allocation are not eligible for coverage under this permit unless you develop and certify a storm water pollution prevention plan (SWPPP) that is consistent with the assumptions and requirements in the approved TMDL. To be eligible for coverage under this general permit, operators must incorporate into their SWPPP any conditions applicable to their discharges necessary for consistency with the assumptions and requirements of the TMDL within any timeframes established in the TMDL. If a specific numeric wasteload allocation has been established that would apply to the project's discharges, the operator must incorporate that allocation into its SWPPP and implement necessary steps to meet that allocation.

f. Discharges that the Department, prior to authorization under this permit, determines will cause, have the reasonable potential to cause, or contribute to an excursion above any applicable water quality standard. Where such a determination is made prior to authorization, the Department may notify you that an individual permit application is necessary in accordance with Part I.B.4. However, the Department may authorize coverage under this permit after inclusion of appropriate controls and implementation procedures in the SWPPP designed to bring the discharge into compliance with water quality standards.

g. Storm water discharges from construction sites if the discharge or clearing activities are likely to adversely affect a **listed endangered or threatened species or its critical habitat***.

*For a **list of endangered or threatened species,** contact the Arkansas Natural Heritage Commission at (501) 324-9619or www.naturalheritage.com or the U.S. Fish and Wildlife Service at (501) 324-5643 www.fws.gov.

h. Discharges which are not in compliance with the Endangered Species Act (ESA). In order to obtain coverage, the applicant must certify to meeting one of the following criteria.

The criteria are as follows:

i. The storm water discharge(s), and the construction and implementation of Best Management Practices (BMPs) to control storm water runoff, are not likely to adversely affect species or critical habitat for a listed species; or

ii. The applicant's activity has received previous authorization under section 7 or section 10 of the Endangered Species Act and that authorization addressed storm water discharges and/or BMPs to control storm water runoff (e.g. developer included impact of the entire project in consultation over a wetlands dredge and fill permit under Section 7 of the Endangered Species Act); or

iii. The applicant's activity was considered as part of a larger, more comprehensive assessment of impacts on endangered and threatened species under section 7 or section 10 of The Endangers Species Act that which accounts for storm water discharges and BMPs to control storm water runoff (e.g., where an area wide habitat conservation plan and section 10 permit is issued which addresses impacts from construction activities including those from storm water, or a National Environmental Policy Act (NEPA) review is conducted which incorporates ESA section 7 procedures); or

iv. Consultation under section 7 of the Endangered Species Act is conducted for the applicant's activity which results in either a no jeopardy opinion or a written concurrence on a finding of a no likelihood of adverse effects: or

v. The applicant's activity was considered as part of a larger, more comprehensive site-specific assessment of impacts on endangered and threatened species by the owner or other operator of the site and that owner or operator certified eligibility under item (1), (2), (3), or (4) above (e.g., owner was able to certify no adverse impacts for the project as a whole under item (1), so the contractor can the certify under item (5).

The State of Arkansas notes that it is **requiring all** applicants to follow directions to ensure protection of the **listed species and critical habitat** when applying for permit coverage. Those directions require that applicants assess the impacts of their "storm water discharges" and "BMPs to control storm water run off" on listed species and critical habitat that are located in "proximity" to

those discharges and BMPs are planned or are to be constructed. This definition reflects the purpose of this permit which regulates storm water discharges and measures (i.e., BMPs) to control those discharges.

4. Requiring an *Individual* NPDES Permit.

a. The Director may require any person authorized by this permit to apply for and obtain an individual NPDES permit. Any interested person may petition the Director to take action under this paragraph.

b. The Director may require any owner or operator authorized to discharge under this permit to apply for an individual NPDES permit only if the owner or operator has been notified in writing that a permit application is required.

i. This notice shall include a brief statement of the reasons for this decision, an application form, a statement setting a deadline for the owner or operator to file the application, and a statement that on the effective date of the individual NPDES permit as it applies to the individual owner or operator, coverage under this general permit shall automatically terminate.

ii. The Director may grant additional time to submit the application upon request of the applicant.

iii. Coverage under this permit will be terminated if an owner or operator fails to submit the Individual NPDES permit application in a timely manner as required by the Director.

c. Any owner or operator authorized by this permit may request to be excluded from the coverage of this permit by applying for an individual permit. The owner or operator shall submit an individual application in accordance with the requirements of 40 CFR 122.26(c)(1)(ii), with reasons supporting the request to the Director. The request may be granted by issuance of any individual permit if the reasons cited by the owner or operator are adequate to support the request. However, the permittee **must comply with this permit until** an individual permit is issued.

d. When an individual NPDES permit is issued to a discharger otherwise subject to this permit, the applicability of this permit to the individual NPDES owner or operator is automatically terminated on the effective date of the individual permit. When an individual NPDES permit is denied to an owner or operator otherwise subject to this permit, the applicability of this permit to the individual NPDES owner or operator remains in effect, unless otherwise specified by the Director.

5. Waivers from Permit Coverage. The Director may waive the otherwise applicable requirements of this general permit for storm water discharges from some small construction activities (e.g., sites disturbing between one and five acres of total land area) under the terms and conditions described in this section.

a. Waiver Applicability and Coverage. Operators of small construction activities may apply for and receive a waiver from the requirements to obtain authorization under this general permit where:

i. The calculated **rainfall erosivity (R) factor** for the entire period of the construction project is less than five (5);

ii. The operator submits a signed waiver certification form, supplied by the Director, certifying that the construction activity will commence and be completed within a period when the value of the calculated rainfall erosivity (R) factor is less than five (5); and

iii. The waiver certification form is submitted to the Department **at least 48 hours before** construction activity begins.

b. Activities Extending Beyond the Waiver Period. If a construction activity extends beyond the approved waiver period due to circumstances beyond the control of the operator, the operator **must either**:

i. Recalculate the rainfall erosivity (R) factor using the original start date and the new projected ending date, and if the R factor is still under five (5), **submit a new** waiver certification form at least 48 hours before the end of the original waiver period; or

ii. **Develop and implement** a storm water pollution prevention plan in accordance with the requirements **of Part II** of this permit **at least 48 hours before** the end of the approved waiver period.

6. Authorization.

a. Large Construction Sites

i. An owner or operator of a large construction site must submit a Notice of Intent (NOI) and a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the requirements of Part I.B.7 of this permit in order for storm water discharges from large construction sites to be authorized to discharge under this general permit. **An initial permit fee of $200.00 must accompany the NOI under the provisions of ADEQ Regulation No.9. Subsequent annual fees of $200.00 per year will be billed by the Department.** Failure to remit the required permit fee may be grounds for the Director to deny coverage under this general permit.

ii. Where a new operator is selected after the submittal of an NOI under Part I.B.7, a new Notice of Intent **must** be submitted by the operator in accordance with Part I.B.7.a.iv.

iii. Unless notified by the Director to the contrary, dischargers who submit a Notice of Intent in accordance with the requirements of this permit are authorized to discharge storm water from construction sites under the terms and conditions of this permit **two weeks after** the date the NOI is postmarked. Upon review of the NOI and other available information, the Director may deny coverage under this permit and require submittal of an application for an individual NPDES permit.

b. Medium Construction Sites

i. An owner or operator of a medium construction site must submit a Notice of Intent (NOI) in accordance with the requirements of Part I.B.7 of this permit in order for storm water discharges from medium construction sites to be authorized to discharge under this general permit. **An initial permit fee of $200.00 must accompany the NOI under the provisions of ADEQ Regulation No.9. Subsequent annual fees of $200.00 per year will be billed by the Department.** Failure to remit the required permit fee may be grounds for the Director to deny coverage under this general permit.

ii. Where a new operator is selected after the submittal of an NOI under Part I.B.7, a new Notice of Intent **must** be submitted by the operator in accordance with Part I.B.7.a.iv.

iii. Unless notified by the Director to the contrary, dischargers who submit a Notice of Intent in accordance with the requirements of this permit are authorized to discharge storm water from construction sites under the terms and conditions of this permit **two weeks after** the date the NOI is postmarked. Upon review of the NOI and other available information, the Director may deny coverage under this permit and require submittal of an application for an individual NPDES permit.

c. Small Construction Sites

i. In accordance with 40 CFR 122.28(b)(2)(v), the owner or operator of a small construction site, that meets the eligibility criteria set forth in this general permit and in 40 CFR 122.28 (a) and (b), may discharge under this general permit without submitting a NOI.

ii. An owner or operator of a small construction site, as described in Part I.B.6.C.i above, is automatically authorized to discharge storm water related to construction activities under this general permit. **Submittal of an NOI or general permit fee is not required for coverage under this general permit.**

7. Notice of Intent Requirements

a. Deadlines for Notification.

i. Except as provided in Part I.B.7.a.iv and Part I.B.7.a.v individuals who intend to obtain coverage for storm water discharges from medium and large construction sites under this general permit, shall submit a Notice of Intent (NOI) in accordance with the requirements of this Part **at least two weeks prior** to the commencement of construction at any site that will result in the disturbance of **five (5)** or more acres of total land area.

ii. Large Construction

A. **Ongoing Projects:** Operators of ongoing large construction projects as of the effective date of this permit that received authorization to discharge for these projects under the 1998 construction general permit (ARR10A000 issued July 1, 1998) **must**:

(1) **For the first 90 days** from the effective date of this permit (i.e., grace period), comply with the terms and conditions of the **previous** construction general permit they were previously authorized under; and

(2) **Update** their storm water pollution prevention plan (SWPPP), **as necessary**, to **comply with** the requirements of Part II.A **within 90 days** of the effective date of this permit. (Submittal is not required.)

B. **New Projects:** Operators of large construction projects that commence construction after the effective date of this permit must:

(1) Submit an NOI and a SWPPP to comply with the requirements of Part II.A at least **two weeks prior to** commencement of construction activities (i.e., the initial disturbance of soils associated with clearing, grading, excavation activities, or other construction activities). The SWPPP may be submitted for "pre-approval" two weeks prior to submittal of the NOI.

iii. Medium Construction

A. **Ongoing Projects:** Operators of ongoing medium construction projects as of the effective date of this permit that received authorization to discharge for these projects under the 1998 construction general permit (ARR10A000 issued July 1, 1998) **must**:

(1) **For the first 90 days** from the effective date of this permit (i.e., grace period), comply with the terms and conditions of the **previous** construction general permit they were previously authorized under; and

(2) **Update** their storm water pollution prevention plan (SWPPP), **as necessary**, to **comply with** the requirements of Part II.A **within 90 days** of the effective date of this permit.

B. **New Projects:** Operators of medium construction projects that commence construction after the effective date of this permit must:

(1) Submit an NOI **two weeks prior to** commencement of construction activities (i.e., the initial disturbance of soils associated with clearing, grading, excavation activities, or other construction activities); and

(2) Develop a SWPPP to comply with the requirements of Part II.A **prior to commencement** of construction activities.

iv. Small Construction

A. **Ongoing Projects:** Operators of ongoing small construction projects as of March 10, 2003 are automatically authorized to discharge storm water related to construction activities under this general permit and **must**:

(1) Develop and implement a SWPPP to comply with the requirements of Part II.A within 90 days after the effective date of this permit (i.e., grace period). If the construction is completed and final stabilization achieved before the 90^{th} day, development of a SWPPP is not required.

(2) Complete a Construction Site Notice, located in Attachment A to this permit, within 90 days after the effective date of this permit. **The signed Construction Site Notice shall be posted at the construction site in a prominent place for public viewing (such as alongside a building permit).**

B. **New Projects:** Operators of small construction projects that commence construction after the effective date of this permit are automatically authorized to discharge storm water related to construction activities under this general permit and **must**:

(1) **Develop and implement** a SWPPP to comply with the requirements of Part II.A **prior to commencement** of construction activities (i.e., the initial disturbance of soils associated with clearing, grading, excavation activities, or other construction activities).

(2) Complete a Construction Site Notice, located in Attachment A to this permit, prior to commencement of construction activities. **The signed Construction Site Notice shall be posted at the construction site in a prominent place for public viewing (such as alongside a building permit).**

v. **Change in Operator:** For storm water discharges from **large** and **medium** construction sites where the owner/operator changes, (including projects where an operator is selected after an NOI has been submitted under Part I.B.7.a above), a new NOI shall be submitted **at least two weeks prior to** the operator beginning work at the site; and

vi. **Late Notifications:** A discharger is not precluded from submitting an NOI in accordance with the requirements of this part after the dates provided in Part I.B.7.a of this permit. In such instances, the Director **may** bring an **enforcement action** for failure to submit an NOI in **a timely manner** or for any unauthorized discharges of storm water associated with industrial activity that have occurred on or after the dates specified in Part I.B.7.a.

b. Failure to Notify. Owners or operators of **large** or **medium** construction sites who fail to notify the Director of their intent to be covered under this permit, and who discharge pollutants to waters of the State without an NPDES permit, **are in violation** of the Arkansas Water and Air Pollution Control Act (Act 472 of 1949, as amended)

c. Contents of the Notice of Intent.

i. The Notice of Intent form must be the form obtained from the ADEQ (www.adeq.state.ar.us) unless written approval is received for an optional form.

ii. All Notices of Intent for coverage under this general permit must be signed in accordance with the provisions of 40 CFR 122.22, as adopted by reference in ADEQ Regulation No. 6, and Part II.B.9 of this permit, and submitted to the Department by **certified** mail.

iii. Owners and operators shall notify the Director upon permanent termination of discharge from their facilities. (See Part I.B.8)

d. Where to Submit.

i. Facilities which discharge storm water from medium and large construction sites must submit a complete signed original of the Notice of Intent to the Department at the following address. In addition, facilities which discharge storm water from a large construction site must also submit a complete SWPPP to the Department at the following address:

NPDES Permits/Storm Water
Department of Environmental Quality
P.O. Box 8913
Little Rock, AR 72219-8913

e. **Construction Site Posting for Medium and Large Construction Sites. The Storm Water Construction General Permit Certificate, a copy of the NOI confirmation letter, or other indication that storm water discharges from the site are covered under an NPDES permit, and a brief description (shall include permit number) of the project shall be posted at the**

construction site in a prominent place for public viewing (such as alongside a building permit).

f. Additional Notification. Facilities which are operating under approved State or local sediment and erosion plans, grading plans, local storm water permits, or storm water management plans, **in addition to** filing copies of the Notice of Intent in accordance with Part I.B.7, **shall submit** signed copies of the Notice of Intent to the State or local agency approving such plans in accordance with the deadlines in Part I.B.7 of this permit (or sooner if required by State or local rules).

g. Reaffirmation of Permit Coverage. Upon re-issuance of a new general permit, the owner or operator must notify the Director of his/her intent to be covered by the new general permit in the following manner.

i. Submit an NOI consistent with the new general permit requirements **no later than 90 days** following the effective date of the new general permit.

8. Notice of Termination (NOT). Where a site has been finally stabilized and all storm water discharges from construction activities authorized by this permit are eliminated, the operator of the facility must submit a Notice of Termination to the Director at the address in Part I.B.7.d that is signed in accordance with Part II.B.9 of this permit. Final stabilization is not required if the land is returned to its pre-construction agriculture use. **If a Notice of Termination is not submitted when the project is completed, owners and contractors will be responsible for annual fees due.**

SECTION C: OTHER REQUIREMENTS

1. Prohibition of Non-storm Water Discharges.

a. All discharges covered by this permit shall be composed entirely of storm water except the following non-storm water discharges that are combined with storm water may be authorized by this permit:

i. Discharges from fire fighting activities; fire hydrant flushings; water used to wash vehicles (where detergents are not used) or control dust in accordance with Part II.A.4.b.iii.B; potable water sources including uncontaminated waterline flushings; irrigation drainage; routine external building wash down which does not use detergents; pavement washwaters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled materials have been removed) and where detergents are not used; uncontaminated air conditioning or compressor condensate; uncontaminated springs; uncontaminated ground water; foundation or footing drains where flows are not contaminated with process materials such as solvents; and uncontaminated excavation dewatering.

b. Except as provided in Part I.C.1.a above, discharges of material other than storm water must be in compliance with an individual NPDES permit issued for the discharge.

2. Releases in Excess of Reportable Quantities.

a. The discharge of hazardous substances or oil in the storm water discharge(s) from a facility shall be prevented or minimized in accordance with the applicable storm water pollution prevention plan for the facility. This permit does not relieve the owner or operator of the reporting requirements of 40 CFR Parts 110, 117 and 302. Where a release containing a hazardous substance or oil in an amount equal to or in excess of a reporting quantity established under either 40 CFR 110, 40 CFR 117, or 40 CFR 302, occurs during a 24-hour period, the following action shall be taken:

i. Any person in charge of the facility is **required** to notify the National Response Center (NRC) (800-424-8802) in accordance with the requirements of 40 CFR 110, 40 CFR 117, or 40 CFR 302 **as soon as** he/she **has knowledge** of the discharge;

ii. The Owner or operator **shall submit** within **5** calendar days of knowledge of the release a **written** description of the release (including the type and estimate of the amount of material released), the date that such release occurred, the circumstances leading to the release, and steps to be taken in accordance with Part I.C.10.a.iii of this permit to the ADEQ at the address provided in Part I.B.7.d of this permit.

iii. The storm water pollution prevention plan described in Part II.A of this permit **must** be modified **within 14 calendar days** of knowledge of the release to:

A. Provide a description of the release and the circumstances leading to the release; and

B. The date of the release;

iv. Additionally, the plan must be reviewed to identify measures to prevent the reoccurrence of such releases and to respond to such releases, and the plan must be modified where appropriate. The modified plan **must be sent to this Department** for review.

b. Spills. This permit does **not** authorize the discharge of hazardous substances or oil resulting from an on-site spill.

3. Responsibilities of operators.

a. **Permittees with operational control are responsible for compliance with all applicable terms and conditions of this permit as it relates to their activities on the construction site, including protection of endangered species and implementation of BMPs and other controls required by the SWPPP.**

PART II
STANDARD CONDITIONS

Information in **Part II** is organized as follows:

Section A: Storm Water Pollution Prevention Plans:

1. Deadlines for Plan Preparation and Compliance
2. Signature and Plan Review
3. Keeping Plans Current
4. Contents of Plan
5. Non-storm water discharges
6. Contractors

Section B: Standard Permit Conditions:

1. Retention of Records
2. Duty to Comply
3. Penalties for Violations of Permit Conditions
4. Continuance of Expired General Permit
5. Need to Halt or Reduce Activity Not a Defense
6. Duty to Mitigate
7. Duty to Provide Information
8. Other Information
9. Signatory Requirements
10. Certification
11. Penalties for Falsification of Reports
12. Penalties for Tampering
13. Oil and Hazardous Substance Liability
14. Property Rights
15. Severability
16. Transfers
17. Proper Operation and Maintenance
18. Inspection and Entry
19. Permit Actions
20. Re-Opener Clause

Section C: Definitions

SECTION A: STORM WATER POLLUTION PREVENTION PLANS (SWPPP).

A storm water pollution prevention plan (the plan) shall be developed for each construction site covered by this permit. The plan shall be prepared in accordance with good engineering practices. The plan shall identify potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges associated with industrial activity from the facility. In addition, the plan shall describe and ensure the implementation of practices which are to be used to reduce pollutants in storm water discharges associated with industrial activity at the facility and to assure compliance with the terms and conditions of this permit. Facilities must implement the provisions of the plan required under this part as a condition of this permit.

1. Deadlines for Plan Preparation and Compliance.

a. Large Construction Sites

i. The plan shall be completed and submitted for review along with an NOI to be covered under this permit and updated as appropriate. The plan may be submitted for "pre-approval" prior to submittal of an NOI. Submittals of updates to the plan during the construction process are required only if requested by the Director.

b. Medium Construction Sites

i. The plan shall be completed prior to the submittal of an NOI to be covered under this permit and updated as appropriate.

c. Small Construction Sites

i. The plan shall be completed prior to the commencement of construction activities and updated as appropriate.

2. Signature and Plan Review.

a. The plan shall be signed in accordance with Part II.B.9, and be retained on-site at the facility which generates the storm water discharge in accordance with Part II.B.7 (Retention of Records) of this permit.

b. The owner or operator shall make plans available, upon request, to the Director, the EPA, or a State or local agency approving sediment and erosion plans, grading plans, or storm water management plans, or, in the case of a storm water discharge associated with construction activity which discharges through a municipal separate storm sewer system with an NPDES permit, to the municipal operator of the system.

c. The Director, or authorized representative, may notify the owner or operator at any time that the plan does not meet one or more of the minimum requirements of this Part. Within 7 days of such

notification from the Director, (or as otherwise provided by the Director), or authorized representative, the owner or operator shall make the required changes to the plan and submit to the Director a written certification that the requested changes have been made.

3. **Keeping Plans Current.** The owner or operator shall amend the plan whenever there is a change in design, construction, operation, or maintenance which has a significant affect on the potential for the discharge of pollutants to the waters of the State and which has not otherwise been addressed in the plan or if the plan proves to be ineffective in eliminating or significantly minimizing pollutants from sources identified under Part II.A.4.b of this permit, or in otherwise achieving the general objectives of controlling pollutants in storm water discharges associated with construction activity. Amendments to the plan may be reviewed by ADEQ in the same manner as Part II.A.2 above.

4. **Contents of Plan.** The storm water pollution prevention plan shall include the following items:

a. Site Description. Each plan shall provide a description of the following:

i. A description of the nature of the construction activity;

ii. A description of the intended sequence of major activities which disturb soils for major portions of the site (e.g. grubbing, excavation, grading);

iii. Estimates of the total area of the site and the total area of the site that is expected to be disturbed by excavation, grading or other activities;

iv. An estimate of the runoff coefficient of the site after construction activities are completed and existing data describing the soil or the quality of any discharge from the site;

v. A site map indicating drainage patterns and approximate slopes anticipated after major grading activities, areas of soil disturbance, the location of major structural and nonstructural controls identified in the plan, the location where stabilization practices are expected to occur, surface waters (including wetlands), and locations where storm water is discharged to a surface water;

vi. The name of the receiving water(s), or if the discharge is to a municipal separate storm sewer, the name of the operator of the municipal system, the ultimate receiving water(s), and the extent of wetland acreage at the site.

vii. Endangered Species: Information on endangered and threatened species including whether any endangered species are in proximity of the storm water discharge and BMPs to be constructed to control storm water runoff.

b. Controls. Each plan **shall include** a description of appropriate controls and measures that will be implemented at the construction site. The plan will clearly describe for each major activity identified in Part II.A.4.a.ii appropriate control measures and the timing during the construction process that

the measures will be implemented. (For example, perimeter controls for one portion of the site **will be installed** after the clearing and grubbing necessary for installation of the measure, but **before the** clearing and grubbing for the remaining portions of the site. Perimeter controls will be **actively maintained** until final stabilization of those portions of the site upward of the perimeter control. Temporary perimeter controls will be removed after final stabilization). The description and implementation of controls shall address the following minimum components:

i. Erosion and Sediment Controls.

A. Stabilization practices. A description of interim and permanent stabilization practices, **including site-specific** scheduling of the implementation of the practices. Site plans should ensure that existing vegetation is preserved where attainable and that disturbed areas are stabilized. Stabilization practices may include: temporary seeding, permanent seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, protection of trees, and preservation of mature vegetation and other appropriate measures. A **record of the dates** when major grading activities occur, when construction activities temporarily or permanently cease on a portion of the site, and when stabilization measures are initiated shall be included in the plan. Except as provided in Parts II.A.4.b.i.A.(1) and (2) below, stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but **in no case more than 14 days** after the construction activity in that portion of the site has temporarily or permanently ceased.

(1) Where the initiation of stabilization measures by the 14th day after construction activity temporarily or permanently ceases is precluded by snow cover, stabilization measures shall be initiated as soon as practicable.

(2) Where construction activity will **resume on a portion** of the site within 21 days from when activities ceased, (e.g. the total time period that construction activity is temporarily ceased is less than 21 days) then stabilization measures do not have to be initiated **on that portion** of the site by the 14th day after construction activity temporarily ceased.

(3) In arid regions (areas with an average annual rainfall of 0-10 inches) and semi-arid regions (areas with an average annual rainfall of 10-20 inches), where the initiation of stabilization measures by the 14th day after construction activity has been temporarily or permanently ceased is precluded by seasonal arid conditions, stabilization measures shall be initiated as soon as practicable thereafter.

B. Structural practices.

(1) A description of structural practices to divert flows from exposed soils, store

flows or otherwise limit runoff and the discharge of pollutants from exposed areas of the site to the degree attainable. Such practices may include:

- silt fences (installed **and maintained**)
- earth dikes
- drainage swales
- check dams
- subsurface drains
- pipe slope drains
- level spreaders
- storm drain inlet protection
- rock outlet protection
- sediment traps
- reinforced soil retaining systems
- gabions
- temporary or permanent sediment basins.

Structural practices should be placed on upland soils to the degree attainable. The installation of these devices may be subject to Section 404 of the Clean Water Act.

(2) For **common drainage locations** that serve an area with **10 or more disturbed acres** at one time, a **temporary** or **permanent** detention basin based on either the smaller of **3600 cubic feet per acre**, or a size based on the runoff volume of a **10 year, 24 hour storm**, shall be provided where attainable until stabilization of the site. This does not apply to flows from offsite areas and flows from onsite areas and flows from onsite areas that are either undisturbed of have undergone final stabilization where such flows are diverted around the sediment basin. For drainage **locations** which serve **10 or more disturbed acres** at one time and where a temporary sediment basin based on either the smaller of 3600 cubic feet per acres, or a size based on the runoff volume of a 10 year storm, **is not attainable**, sediment traps, silt fences, or equivalent sediment controls **are required** for **all side** slope **and down** slope boundaries of the construction area.

(3) For drainage locations serving **less than 10 acres**, sediment traps, silt fences, or equivalent sediment controls are **required for all side** slope **and down** slope boundaries of the construction area **unless** a sediment basin providing storage based on either the smaller of 3600 cubic feet per acre, or a size based on the run off volume of a 10 year, 24 hour storm is provided.

ii. Storm Water Management. A description of measures that will be installed during the construction process to control pollutants in storm water discharges that will occur after construction operations have been completed. Structural measures should be placed on

upland soils to the degree attainable. The installation of these devices may be subject to Section 404 of the Clean Water Act. This permit only addresses the installation of storm water management measures, and not the ultimate operation and maintenance of such structures after the construction activities have been completed and the site has undergone final stabilization. Owners or operators are only **responsible for the installation and maintenance** of storm water management measures prior to final stabilization of the site, and are not responsible for maintenance after storm water discharges associated with industrial activity have been eliminated from the site.

A. Such practices may include:

- infiltration of runoff onsite
- flow attenuation by use of open vegetated swales and natural depressions
- storm water retention structures
- storm water detention structures (including wet ponds)
- sequential systems, which combine several practices

A goal of 80 percent removal of total suspended solids from these flows which exceed predevelopment levels should be used in designing and installing storm water management controls (where practicable). Where this goal is not met, the owner or operator shall provide justification for rejecting each practice listed above based on site conditions.

B. Velocity dissipation devices (e.g., rock check dam, hay bales, etc.) shall be placed at discharge locations and along the length of any outfall channel as necessary to provide a non-erosive velocity flow from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected.

iii. Other Controls.

A. Waste disposal. No solid materials, including building materials, shall be discharged to waters of the United States, except as authorized by a Section 404 permit.

B. Off-site vehicle tracking of sediments and the generation of dust shall be minimized.

C. The plan shall ensure and demonstrate compliance with applicable State or local waste disposal, sanitary sewer or septic system regulations.

c. Approved State or Local Plans.

i. Facilities which discharge storm water associated with industrial activity from construction activities must include in their storm water pollution prevention plan procedures and requirements specified in applicable sediment and erosion site plans, site permits or storm

water management plans approved by State or local officials. Requirements specified in sediment and erosion plans, site permits or storm water management plans approved by State or local officials that are applicable to protecting surface water are, upon submittal of an NOI for coverage under this permit, incorporated by reference and are enforceable under this permit even if they are not specifically included in a storm water pollution prevention plan required under this permit. This provision does not apply to provisions of master plans, comprehensive plans, non-enforceable guidelines or technical guidance documents that are not identified in a specific plan or permit that is issued for the construction site.

ii. Dischargers seeking alternative permit requirements shall submit an individual permit application in accordance with Part I.B.4 of this permit to the Director, along with a description of why requirements in approved State or local plans or permits should not be applicable as a condition of an NPDES permit.

d. Maintenance. A description of procedures to maintain in good and effective operating condition vegetation, erosion and sediment control measures and other protective measures identified in the site plan.

e. Inspections. Qualified personnel (**provided** by the **discharger**) **shall** inspect disturbed areas of the construction site, areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, and structural control measures and locations where vehicles enter or exit the site at least **once** every **fourteen (14) calendar days and within 24 hours of the end of a storm that is 0.5 inches or greater**. Where sites have been finally stabilized or during seasonal arid periods in arid areas (areas with an average rainfall of 0-10 inches) and semi-arid areas (areas with an average rainfall of 10-20 inches) such inspection shall be conducted at least once every month.

i. Disturbed areas and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the plan shall be observed to ensure that they are operating correctly. Where discharge locations or points are accessible, they shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles enter or exit the site shall be inspected for evidence of offsite sediment tracking.

ii. Based on the results of the inspection, the site description identified in the plan in accordance with Part II.A.4.a of this permit and pollution prevention measures identified in the plan in accordance with Part II.A.4.b of this permit shall be revised as appropriate, but in no case more than 7 calendar days following the inspection. Such modifications shall provide for timely implementation of any changes to the plan within 7 calendar days following the inspection.

iii. A report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the storm water pollution prevention plan, and actions taken in accordance

with paragraph II.A.4.e.ii of the permit shall be made and retained as part of the storm water pollution prevention plan for at least three (3) years from the date the site is finally stabilized. The report shall be signed in accordance with Part II.B.9 of this permit.

f. Documentation of Permit Eligibility Related to Total Maximum Daily Loads (TMDL). The SWPPP must include documentation supporting a determination of permit eligibility with regard to waters that have an established TMDL, including **either**:

i. Information on whether storm water discharges from the site enter a water body with an approved TMDL;

And

ii. A statement that the construction site's discharge is not identified in a TMDL applicable to that water body;

Or

iii. Information on whether storm water discharges from the site enter a water body with an approved TMDL;

iv. Identification of the pollutants that the TMDL addresses, specifically whether the TMDL addresses sediment or a parameter that addresses sediment (such as total suspended solids, turbidity, or siltation);

v. Identification of whether the operator's discharge is identified, either specifically or generally, in the TMDL and any associated assumptions and allocations identified for the discharge; and

vi. Measures taken by the operator to ensure that its discharge of pollutants from the site is consistent with the assumptions and allocations of the TMDL.

g. Attainment of Water Quality Standards After Authorization.

i. The permittee must select, install, implement and maintain BMPs at the construction site that minimize pollutants in the discharge as necessary to meet applicable water quality standards. In general, except in situations explained in Part II.A.4.g.ii below, the SWPPP developed, implemented, and updated consistent with Part II.A.4 is considered as stringent as necessary to ensure that the discharges do not cause or contribute to an excursion above any applicable water quality standard.

ii. At any time after authorization, the Department may determine that the storm water discharges may cause, have reasonable potential to cause, or contribute to an excursion above any applicable water quality standard. If such a determination is made, the Department will

require the permittee to:

A. Develop a supplemental BMP action plan describing SWPPP modifications to address adequately the identified water quality concerns;

B. Submit valid and verifiable data and information that are representative of ambient conditions and indicate that the receiving water is attaining water quality standards; or

C. Cease discharges of pollutants from construction activity and submit an individual permit application according to Part I.B.4.

iii. All written responses required under this part must include a signed certification consistent with Part II.B.9.

5. **Non-storm water discharges.** Except for flows from fire fighting activities, sources of non-storm water listed in Part I.C.1.a of this permit that are combined with storm water discharges associated with construction activity must be identified in the plan. The plan shall identify and ensure the implementation of appropriate pollution prevention measures for the non-storm water component(s) of the discharge.

6. **Contractors.**

a. The storm water pollution prevention plan **must clearly identify** for each measure identified in the plan, **the contractor(s) that will implement** the measure. **All contractors identified** in the plan **must sign a copy** of the certification statement required by Part II.A.6.b below in accordance with Part II.B.9 of this permit. All certifications must be included in the storm water pollution prevention plan.

b. Certification statement. All contractors identified in the storm water pollution prevention plan in accordance with Part II.A.6 of this permit shall sign a copy of the following certification statement before conducting any professional service at the site identified in the storm water pollution prevention plan:

"I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification."

The certification **must** include the name and title of the person providing the signature in accordance with Part II.B.9 of this permit; the **name**, **address**, and **telephone number** of the contracting firm; the address (or other identifying description) of the site; and the date the certification is made.

SECTION B: STANDARD PERMIT CONDITIONS

1. Retention of Records.

a. The owner or operator shall retain records of all storm water pollution prevention plans and all reports required by this permit, and records of all data used to complete the Notice of Intent to be covered by this permit, for a period of at least three years from the date the site is finally stabilized. This period may be extended by request of the Director at any time.

b. The owner or operator shall retain a copy of the storm water pollution prevention plan required by this permit at the construction site from the date of project initiation to the date of final stabilization.

2. Duty to Comply. The owner or operator **must** comply with **all** conditions of this permit. Any permit noncompliance constitutes a violation of the federal Clean Water Act and the Arkansas Water and Air Pollution Control Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

3. Penalties for Violations of Permit Conditions. The Arkansas Water and Air Pollution Control Act (Act 472 of 1949, as amended) provides that any person who violates any provisions of a permit issued under the Act shall be guilty of a misdemeanor and upon conviction thereof shall be subject to imprisonment for not more than one (1) year, or **a fine of** not more than **twenty five thousand dollars** ($25,000) **or by both** such fine and imprisonment **for each day of** such **violation**. Any person who violates any provision of a permit issued under the Act may **also** be subject to **civil penalty** in such amount as the court shall find appropriate, not to exceed **ten thousand dollars** ($10,000) **for each day** of such violation. The fact that any such violation may constitute a misdemeanor shall not be a bar to the maintenance of such civil action.

4. Continuance of the Expired General Permit. An expired general permit continues in force and effect until a new general permit is issued. If this permit is not re-issued or replaced prior to the expiration date, it will be administratively continued in accordance with the Administrative Procedure Act and remain in force and effect. If you were granted permit coverage prior to the expiration date, you will automatically remain covered by the continued permit until the earliest of:

a. Re-issuance or replacement of this permit, at which time you must comply with the conditions of the new permit to maintain authorization to discharge; or

b. Your submittal of a Notice of Termination; or

c. Issuance of an individual permit for the project's discharges; or

d. A formal permit decision by the ADEQ to not re-issue this general permit, at which time you must seek coverage under an individual permit.

5. Need to Halt or Reduce Activity Not a Defense. It shall not be a defense for a owner or operator in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to

maintain compliance with the conditions of this permit.

6. **Duty to Mitigate.** The owner or operator shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has reasonable likelihood of adversely affecting human health or the environment.

7. **Duty to Provide Information.** The owner or operator shall furnish to the Director, an authorized representative of the Director, the EPA, a State or local agency approving sediment and erosion plans, grading plans, or storm water management plans, or in the case of a storm water discharge associated with industrial activity which discharges through a municipal separate storm sewer system with an NPDES permit, to the municipal operator of the system, within a reasonable time, any information which is requested to determine compliance with this permit.

8. **Other Information.** When the owner or operator becomes aware that he or she failed to submit any relevant facts or submitted incorrect information in the Notice of Intent or in any other report to the Director, he or she shall promptly submit such facts or information.

9. **Signatory Requirements.** All Notices of Intent, reports, or information submitted to the Director or the operator of a regulated small, medium, or large municipal separate storm sewer system shall be signed and certified.

a. All Notices of Intent shall be signed as follows:

i. For a corporation: by a responsible corporate officer. For purposes of this section, a responsible corporate officer means:

A. A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or

B. The manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

ii. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

iii. For a municipality, State, Federal or other public agency: By either a principal executive or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes:

A. The chief executive officer of the agency; or

B. A senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency.

b. All reports required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

i. The authorization is made in writing by a person described above and submitted to the Director;

ii. The authorization specifies either an individual or a person having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a well field, superintendent, or position of equivalent responsibility, or position of equivalent responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position); and

iii. Changes to authorization. If an authorization under this Part is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the above requirements must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

10. Certification. Any person signing a document under this section shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

11. Penalties for Falsification of Reports. The Arkansas Water and Air Pollution Control Act provides that any person who knowingly makes any false statement, representation, or certification in any application, record, report, plan or other document filed or required to be maintained under this permit shall be subject to civil penalties specified in Part II.B.9 of this permit and/or criminal penalties under the authority of the Arkansas Water and Air Pollution Control Act (Act 472 of 1949, as amended).

12. Penalties for Tampering. The Arkansas Water and Air Pollution Control act provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under the Act shall be guilty of a misdemeanor and upon conviction thereof shall be subject to imprisonment for not more than one (1) year or a fine of not more than twenty five thousand dollars ($25,000) or by both such fine and imprisonment.

13. **Oil and Hazardous Substance Liability.** Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the owner or operator from any responsibilities, liabilities, or penalties to which the owner or operator is or may be subject under Section 311 of the Clean Water Act or Section 106 of CERCLA.

14. **Property Rights.** The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

15. **Severability.** The provisions of this permit are severable. If any provisions of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provisions to other circumstances, and the remainder of this permit, shall not be affected thereby.

16. **Transfers.** This permit is not transferable to any person except after notice to the Director. A new NOI must be submitted to the ADEQ as required in Part I.6.a.ii and Part I.6.b.ii of this permit.

17. **Proper Operation and Maintenance.** The owner or operator shall at all times:

a. Properly operate **and maintain all facilities and systems** of treatment and control (and related appurtenances) which are installed or used by the owner or operator to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems which are installed by a owner or operator only when the operation is necessary to achieve compliance with the conditions of the permit.

b. Provide an adequate operating staff which is duly qualified to carry out operation, maintenance and testing functions required to insure compliance with the conditions of this permit.

18. **Inspection and Entry.** The owner or operator shall allow the Director, the EPA, or an authorized representative, or, in the case of a construction site which discharges to a municipal separate storm sewer, an authorized representative of the municipal operator of the separate sewer system receiving the discharge, upon the presentation of credentials and other documents as may be required by law, to:

a. Enter upon the owner or operator's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

c. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment);

19. **Permit Actions.** This permit may be modified, revoked and reissued, or terminated for cause including, but not limited to, the following;

a. Violation of any terms or conditions of this permit; or

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. A change in any conditions that requires either a temporary or permanent reduction or elimination of the authorized discharge; or

d. A determination that the permitted activity endangers human health or the environment and can only be regulated to acceptable levels by permit modification or termination; or

e. Failure of the owner or operator to comply with the provisions of ADEQ Regulation No. 9 (Permit Fees). Failure to promptly remit all required fees shall be grounds for the Director to initiate action to terminate this permit under the provisions of 40 CFR 122.64 and 124.5(d), as adopted by reference in ADEQ Regulation No. 6, and the provisions of ADEQ Regulation No. 8.

20. **Re-Opener Clause.**

a. If there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with industrial activity covered by this permit, the owner or operator of such discharge may be required to obtain an individual permit or an alternative general permit in accordance with Part I.B.4 of this permit or the permit may be modified to include different limitations and/or requirements.

b. Permit modification or revocation will be conducted in accordance with the provisions of 40 CFR 122.62, 122.63, 122.64 and 124.5, as adopted by reference in ADEQ Regulation No. 6.

SECTION C: DEFINITIONS

"Arid Areas" means areas with an average rainfall of 0 to 10 inches.

"Best Management Practices (BMPs)" means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

"Control Measure" as used in this permit, refers to any Best Management Practice or other method used to prevent or reduce the discharge of pollutants to waters of the United States.

"Commencement of Construction" means the initial disturbance of soils associated with clearing, grading, or excavating activities or other construction activities.

"CWA" means the Clean Water Act or the Federal Water Pollution Control Act.

"Dedicated Portable Asphalt Plant" means a portable asphalt plant that is located on or contiguous to a construction site that provides asphalt only to the construction site on which the plant is located or adjacent to. The term does not include facilities that are subject to the asphalt emulsion effluent guideline limitations at 40 CFR Part 443.

"Dedicated Portable Concrete Plant" means a portable concrete plant that is located on or contiguous to a construction site and that provides concrete only to the construction site on which the plant is located on or adjacent to.

"Director" means the Director, Arkansas Department of Environmental Quality, or a designated representative.

"Discharge" when used without qualification means the "discharge of a pollutant".

"Discharge of Storm Water Associated with Construction Activity" as used in this permit, refers to a discharge of pollutants in storm water runoff from areas where soil disturbing activities (e.g., clearing, grading, or excavation), construction materials or equipment storage or maintenance (e.g., fill piles, borrow area, concrete truck washout, fueling), or other industrial storm water directly related to the construction process (e.g., concrete or asphalt batch plants) are located.

"Discharge-Related Activities" as used in this permit, include: activities that cause, contribute to, or result in storm water point source pollutant discharges, including but not limited to: excavation, site development, grading and other surface disturbance activities; and measures to control storm water including the siting, construction and operation of BMPs to control, reduce or prevent storm water pollution.

"Eligible" means qualified for authorization to discharge storm water under this general permit.

"Facility" or "Activity" means any NPDES "point source" or any other facility or activity (including land or appurtenances thereto) that is subject to regulation under the NPDES program.

"Final Stabilization" means that:

(i) All soil disturbing activities at the site have been completed and either of the two following criteria are met:

(1) A uniform (e.g., evenly distributed, without large bare areas) perennial vegetative cover with a density of 70% of the native background vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures, or

(2) Equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

(ii) When background native vegetation will cover less than 100% of the ground (e.g., arid areas, beaches), the 70% coverage criteria is adjusted as follows: if the native vegetation covers 50% of the ground, 70% of 50% (0.70 x 0.50 = 0.35) would require 35% total cover for final stabilization. On a beach with no natural vegetation, no stabilization is required.

(iii) In arid and semi-arid areas only, all soil disturbing activities at the site have been completed and both the following criteria have been met:

(1) Temporary erosion control measures (e.g., degradable rolled erosion control product) are selected, designed, and installed along with an appropriate seed base to provide erosion control for at least three years without active maintenance,

(2) The temporary erosion control measures are selected, designed, and installed to achieve 70% vegetative coverage within three years.

(iv) For individual lots in residential construction, final stabilization means that either:

(1) The homebuilder has completed final stabilization as specified above, or

(2) The homebuilder has established temporary stabilization including perimeter controls for an individual lot prior to occupation of the home by the homeowner and informing the homeowner of the need for, and benefits of, final stabilization.

(v) For construction projects on land used for agricultural purposes (e.g., pipelines across crop or range land, staging areas for highway construction, etc.), final stabilization may be accomplished by returning the disturbed land to its pre-construction agricultural use. Areas disturbed that were not previously used for agricultural activities, such as buffer strips immediately adjacent to "water of the United States", and areas which are not being returned to their pre-construction agricultural use must meet the final stabilization criteria in (i), (ii), or (iii) above.

"**Flow-Weighted Composite Sample**" means a composite sample consisting of a mixture of aliquot collected at a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge.

"**Large and Medium Municipal Separate Storm Sewer System**" means all municipal separate storm sewer systems that are either:

(i) Located in an incorporated place with a population of 100,000 or more as determined by the latest Decennial Census by the Bureau of Census: or

(ii) Located in the counties with unincorporated urbanized populations of 100,000 or more, except municipal, separate storm sewers that are located in the incorporated places, townships or towns within such counties; or

(iii) Owned or operated by a municipality other than those described in paragraphs (i) or (ii) and that are designated by the Director as part of the large or medium municipal separate storm sewer system.

"Large Construction Sites" mean any construction activity that meets one of the following two definitions:

(i) Construction sites that will result in the disturbance of **ten (10)** or more acres of total land area or less than **ten (10)** acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **ten (10)** acres or more located in the following counties:

Baxter	Garland	Newton	Sharp
Benton	Hot Spring	Perry	Stone
Boone	Howard	Pike	Van Buren
Carroll	Independence	Polk	Washington
Clark	Izard	Pope	White
Cleburne	Johnson	Pulaski	Yell
Conway	Lawrence	Randolph	
Crawford	Logan	Saline	
Faulkner	Madison	Scott	
Franklin	Marion	Searcy	
Fulton	Montgomery	Sebastian	

(ii) Construction sites that will result in the disturbance of **twenty (20)** or more acres of total land area or less than **twenty (20)** acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **twenty (20)** acres or more located in the following counties:

Arkansas	Crittenden	Jefferson	Nevada
Ashley	Cross	Lafayette	Ouachita
Bradley	Dallas	Lee	Phillips

Calhoun	Desha	Lincoln	Poinsett
Chicot	Drew	Little River	Prairie
Clay	Grant	Lonoke	Sevier
Cleveland	Greene	Miller	St. Francis
Columbia	Hempstead	Mississippi	Union
Craighead	Jackson	Monroe	Woodruff

"Medium Construction Sites" mean any construction activity that meets one of the following two definitions:

(i) Construction sites that will result in the disturbance of greater than **five (5)** acres and less than **ten (10)** acres of total land area or less than **five (5)** acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **five (5)** acres or more located in one of the counties identified in Part (i) of the Large Construction Site definition above.

(ii) Construction sites that will result in the disturbance of greater than **five (5)** acres and less than **twenty (20)** acres of total land area or less than **five (5)** acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **five (5)** acres or more located in one of the counties identified in Part (ii) of the Large Construction Site definition above.

"NOI" means Notice of Intent to be covered by this permit.

"NOT" means Notice of Termination.

"Operator" for the purpose of this permit and in the context of storm water associated with construction activity, means any party associated with a construction project that meets either of the following two criteria:

(i) The party has operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications; or

(ii) The party has day-to-day operational control of those activities at the project which are necessary to ensure compliance with a SWPPP for the site or other permit conditions (e.g., they are authorized to direct workers at a site to carry out activities required by the SWPPP or comply with other permit conditions).

"Owner or Operator" means the owner or operator of any "facility or activity" subject to regulation under the NPDES program.

"Physically Interconnected" means that one municipal separate storm sewer system is connected to a second municipal separate storm sewer system in such a way that it allows for direct discharges into the second system.

"Point Source" means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

"Regulated Small Municipal Separate Storm Sewer System" means all municipal separate storm sewer systems that are either:

(i) Located within the boundaries of an "urbanized area" with a population of 50,000 or more as determined by the latest Decennial Census by the Bureau of Census; or

(ii) Owned or operated by a municipality other than those described in paragraph (i) and that serve a jurisdiction with a population of at least 10,000 and a population density of at least 1,000 people per square mile; or

(iii) Owned or operated by a municipality other than those described in paragraphs (i) and (ii) and that contributes substantially to the pollutant loadings of a "physically interconnected" municipal separate storm sewer system.

"Runoff Coefficient" means the fraction of total rainfall that will appear at the conveyance as runoff.

"Semi-Arid Areas" means areas with an average rainfall of 10 to 20 inches.

"Small Construction Sites" mean any construction activity that meets the following definition:

(i) Construction sites that will result in the disturbance of greater than **one (1)** acre and less than **five (5)** acres of total land area or less than **one (1)** acre of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb **one (1)** acre or more.

"Storm Water" means storm water runoff, snow melt runoff, and surface runoff and drainage.

"Storm Water Associated with Construction Activity" means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to construction activity. Discharges of storm water from large construction sites, medium construction sites, and small construction sites, as defined in Part I.B.2, (henceforth referred to as storm water discharges from construction activities).

"Storm Water Pollution Prevention Plan" or "SWPPP" means a plan that includes site map(s), an identification of construction/contractor activities that could cause pollutants in the storm water, and a description of measures or practices to control these pollutants.

"Total Maximum Daily Load" or "TMDL" means the sum of the individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for non-point sources and natural background. If a receiving water has only one point source discharger, the TMDL is the sum of that point source WLA plus the LAs for any non-point sources of pollution and natural background sources, tributaries, or adjacent segments. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.

"Urbanized Area" means the areas of urban population density delineated by the Bureau of the Census for statistical purposes and generally consisting of the land area comprising one or more central place(s) and the adjacent densely settled surrounding area that together have a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile as determined by the latest Decennial Census by the Bureau of Census.

ATTACHMENT A

CONSTRUCTION SITE NOTICE

FOR THE
Arkansas Department of Environmental Quality (ADEQ)
Storm Water Program

NPDES GENERAL PERMIT NO. ARR150000

The following information is posted in compliance with **Part I.B.7.a.iii** of the ADEQ General Permit Number **ARR150000** for discharges of storm water runoff from construction sites. Additional information regarding the ADEQ storm water program may be found on the internet at:

www.adeq.state.ar.us/water/branch_npdes/stormwater

Permit Number	ARR150000
Contact Name and Phone Number:	
Project Description: (Including estimated start date and projected end date, or date that disturbed soils will be stabilized.)	
Location of Storm Water Pollution Prevention Plan:	

For Construction Sites Authorized under **Part I.B.6.b** (Small Construction Sites Authorization) the following certification must be completed:

I _____ (Typed or Printed Name of Person Completing this Certification) certify under penalty of law that I have read and understand the eligibility requirements for claiming an authorization under Part I.B.2.a.iii of the ADEQ General Permit Number ARR150000. A storm water pollution prevention plan has been developed and implemented according to the requirements contained in Part I.B.7.a.iii of the permit. A copy of this signed notice is supplied to the operator of the MS4 if discharges enter a regulated small, medium, or large MS4 system as defined in Part II.C of the ADEQ General Permit Number ARR150000. I am aware there are significant penalties for providing false information or for conducted unauthorized discharges, including the possibility of fine and imprisonment for knowing violations.

_____ _____

Signature and Title Date

APPENDIX 8
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Appendix 8

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