GALVESTON COUNTY

DRAINAGE DISTRICT NUMBER ONE

3722 Ave J—P.O. Box 591—Santa Fe, TX 77517-0591—Office (409) 925-5402—Fax (409) 927-2493
office@gcdd1.us—Galvestoncountydd1.org

DENNIS WAGNER SR. – CHAIRMAN * D. W. WOSTAL, JR.–SECRETARY * KEITH AUSTIN - COMMISSIONER

DRAINAGE CRITERIA MANUAL

October 2023

GALVESTON COUNTY
DRAINAGE DISTRICT NUMBER ONE

SCHEDULE OF FEES

The following fees will be collected by the DISTRICT prior to review and acceptance of any submittals. All review fees must be submitted at the time the plan and/or plats are submitted for review. Failure to submit the fee will result in the plat and/or plans not being considered by the District. This schedule of fees is subject to review and update by the DISTRICT Commissioners.

Residential Single Lot
$750.00

Developments with Master Drainage Plan (2 submittals)*

Residential……$850.00

Commercial…….……..…$1,000

Master Drainage Plan ……..$3,000

Development Plans with Drainage/Detention Calculations (2 submittals)*

Residential (<10 acres)…….……$1,000

Residential (>10 acres)…….……$1,500 + $500 per detention basin

Commercial (<5 acres)…….……$1,250

Commercial (>5 acres)…….……$1,500 + $500 per detention basin

* Re-submittal……. ½ original Fee

District Consultant Performing Small Watershed Detention Analysis (Projects < 200 acres)

$2,000.00 + $500 per detention basin (in addition to Plan Review Fees)

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I. INTRODUCTION

Purpose

This DRAINAGE CRITERIA MANUAL (the Manual) provides a design guidance for use by developers and engineers in preparation of drainage plans for development within GALVESTON COUNTY DRAINAGE DISTRICT NUMBER 1 (the DISTRICT). It establishes rules and regulations that must be consistently followed and will be enforced throughout the DISTRICT'S jurisdiction including the portions of the Dickinson Bayou, Highland Bayou, Willow Bayou, Cloud Bayou and Halls Bayou watersheds lying within the DISTRICT'S boundaries. The design methods presented in this manual are intended to provide guidance for determination of runoff rates; methods of storm water collection, conveyance, and detention; and design standards for facilities (ditches, ponds, detention basins, etc.).

Methods of design and analysis other than those included in this Manual may be considered in certain cases where there may be inherent problems with the traditional methods. However, any deviation from this Manual will require consideration and acceptance by the DISTRICT before approval will be granted for any work based on these alternatives.

The creation of this Manual was authorized and funded by the Galveston County Drainage District Number 1.

Policy

Due to the nature of the watershed hydraulics within the DISTRICT'S boundaries and the prevalent existence of flood plains that exceed the banks of the creeks, it shall be the policy of the DISTRICT to maintain zero net increase in storm water runoff rates and to insure no negative impacts attributable to new development. Although it is the DISTRICT'S long-term goal to construct and maintain facilities (i.e., channels and regional detention facilities) that will contain 100-year storm flows within drainage rights-of-way, it is recognized that further impacts to the existing system cannot be tolerated. Therefore, the current DISTRICT policy is based upon an "on-site detention" storm water management policy. Strict adherence to this policy will insure that existing runoff rates will not increase as a by-product of development, and therefore no off-site impacts will be developed. It is further recognized that impacts to other land owners and jurisdictions outside of the DISTRICT'S boundaries are unacceptable, and the DISTRICT believes that this policy will effectively eliminate any such out-of-district impacts.

It is the goal of the DISTRICT to complete channel improvements of the major Creeks within its jurisdiction in general conformance with the adopted Master Plan. Further studies have been completed or are on-going within certain reaches of other creeks which will expand, update and revise this original plan upon review and acceptance by the DISTRICT Commissioners. The DISTRICT will also support and cooperate with the

other governmental entities including City of Dickinson, City of League City, City of Santa Fe, City of Texas City, Galveston County, Galveston County Consolidated Drainage District, Galveston County Drainage District No. 2 and Brazoria County Conservation and Reclamation District No. 3 to improve local drainage.

Individual developers must provide infrastructure required to meet the DISTRICT'S stated objective of zero net increase in runoff rates and no negative impacts. Practically, this will mean that developers will provide adequate on-site detention volume to off-set increased runoff rates and must provide compensating storage volume for all fill placed in the floodplain. The DISTRICT will require separate "off-line" detention facilities, and no "in-line" detention scenarios will be approved. Additionally, development in the delineated 100-year floodway will be restricted by the DISTRICT.

All Developers shall provide the District with a drainage plan prepared by a licensed engineer showing the overall approach for the collection, conveyance and storm water detention required by the District's "Drainage Criteria Manual" to assure a "no impact" development.

Individuals constructing a Homestead Development for their personal use shall be required to provide a grading and/or drainage plan which may not need to be prepared by a licensed engineer as determined by the District's Commissioners or District Superintendent (if so authorized), which will eliminate negative impacts to the adjacent properties.

This Manual also establishes minimum right-of-way requirements for certain ditches, channels and bayous within the DISTRICT'S jurisdiction. These minimum right-of-way requirements are based upon results from the current Master Plan as adopted by the DISTRICT, and generally allow for conveyance of the projected 100-year flow in a ditch section that can readily be accessed and maintained by the DISTRICT.

Jurisdiction

The area within the GALVESTON COUNTY DRAINAGE DISTRICT No. 1 boundary is drained entirely by five major drainage arteries: Dickinson Bayou, Highland Bayou, Willow Bayou, Cloud Bayou and Halls Bayou (Willow Bayou and Cloud Bayou are tributaries to Halls Bayou). **Figure 1** shows the extent of the existing DISTRICT boundary and the location of the identified drainage arteries. Subdivisions and other developments in the area that are not located directly on one of these major drainage arteries are generally drained by man-improved or man- made ditches and storm sewers which convey the rainfall runoff to the major drainage artery. Responsibility for provision and maintenance of drainage facilities is uniquely divided between the other jurisdictional entities and the DISTRICT in the following manner:

> GALVESTON COUNTY DRAINAGE DISTRICT No. 1 has jurisdiction for all creeks, streams, ditches, and outfalls into such drainage arteries within the DISTRICT'S boundaries as shown on the current version of the DISTRICT BOUNDARY MAP. There are certain ditches draining portions of the

DISTRICT'S service area that the DISTRICT has not accepted for maintenance because of structural problems, utility encroachments, access restrictions or other deficiencies. These ditches are not included in the DISTRICT'S inventory and are not delineated on the DISTRICT BOUNDARY MAP as being the responsibility of the DISTRICT.

The City of Dickinson is responsible for the maintenance of those drainage ways that drain City road rights-of-way (such as storm sewers or roadside ditches, whether or not they are within the right-of-way) within its City Limits.

The City of League City is responsible for the maintenance of those drainage ways that drain City road rights-of-way (such as storm sewers or roadside ditches, whether or not they are within the right-of-way) within its City Limits.

The City of Santa Fe is responsible for the maintenance of those drainage ways that drain City road rights-of-way (such as storm sewers or roadside ditches, whether or not they are within the right-of-way) within its City Limits.

The City of Texas City is responsible for the maintenance of those drainage ways that drain City road rights-of-way (such as storm sewers or roadside ditches, whether or not they are within the right-of-way) within its City Limits.

Galveston County is responsible for the maintenance of those drainage ways that drain County road rights-of-way (such as storm sewers or roadside ditches, whether or not they are within the right-of-way) within unincorporated Galveston County.

The Texas Department of Transportation (TxDOT) is responsible for the maintenance of those drainage ways that drain State road rights-of-way (such as storm sewers or roadside ditches, whether or not they are within the right-of-way).

Regardless of maintenance responsibility for local drainage facilities within City, County or State rights-of-way, the DISTRICT shall have jurisdiction over stormwater runoff from proposed developments.

GALVESTON COUNTY DRAINAGE DISTRICT No. 1 is chartered by the State of Texas to manage the above-named drainage arteries. The DISTRICT Commissioners are charged with the responsibility of developing policy and enacting resolutions to implement the intent. The DISTRICT relies upon laws of the State Legislature and the DISTRICT Master Drainage Plan as updated and revised from time to time.

The DISTRICT is not the agency designated to define or enforce floodplain management regulations but will work with the above jurisdictional entities to manage development within the floodplain.

Watersheds

The DISTRICT'S service area covers approximately 41,060 acres (64.2 square miles) and lies in northern Galveston County, as shown on **Figure 1**. Historically, this service area was primarily rural agricultural, but recent growth in the area is changing the land use to urban development at an increasing rate. The DISTRICT'S boundaries includes portions of five major watersheds including Dickinson Bayou, Highland Bayou, Willow Bayou, Cloud Bayou and Halls Bayou.

Dickinson Bayou

Dickinson Bayou makes up the largest share of the DISTRICT'S service area and covers approximately 18,090 acres (28.3 square miles) or 44% of the total DISTRICT'S service area. Dickinson Bayou drains surface water from Alvin, Friendswood, League City, Santa Fe, Dickinson and unincorporated Galveston County as it flows from its upstream end in Brazoria County to its outfall in Galveston Bay (approximately 22 miles in length).

The topography of the Dickinson Bayou basin is relatively flat, soils are typically low permeable clays, and land use includes agricultural, some light industrial/commercial and residential development. The main channel of Dickinson Bayou is generally unimproved, and while some individual land owners have cleared underbrush along the banks, there has been no major effort by any jurisdictional entity to realign, widen or otherwise change the natural channel.

Highland Bayou

Highland Bayou drains the eastern portions of the DISTRICT'S service area including eastern Santa Fe, western Texas City and portions of LaMarque and Hitchcock. This watershed covers approximately 8,175 acres (12.8 square miles) or 20% of the total DISTRICT'S service area. This watershed is largely developed with low and high density residential land uses. The main channel for Highland Bayou has been improved and can generally handle the larger event storms.

Willow Bayou

Willow Bayou drains the extreme southeastern portion of the DISTRICT'S service area and covers approximately 1,430 acres (2.2 square miles) or 3% of the total DISTRICT'S service area. This watershed contains some rural residential development, but remains mostly agricultural. Willow Bayou drains portions of south Santa Fe and unincorporated Galveston County as it flows from north to south to its confluence with Halls Bayou. The main channel has been improved in areas, but the flat terrain and fairly shallow depth make draining this portion of the service area a difficult task. The majority of Willow Bayou lies in unincorporated Galveston County and outside the DISTRICT'S boundary.

Cloud Bayou

Cloud Bayou serves the southern portion of the DISTRICT'S service area and covers approximately 4,875 acres (7.6 square miles) or 12% of the total DISTRICT'S service

area. Cloud Bayou drains the southern portions of Santa Fe as it flows from north to south to its discharge point in Halls Bayou. The majority of the main channel is within the DISTRICT'S service area, but the lower portions are in unincorporated Brazoria County and maintained by the Conservation and Reclamation District No. 3. Cloud Bayou main channel has been improved all the way to its tidal influence point just north of Halls Bayou, but the flat terrain and fairly shallow depth make draining portions of this service area difficult.

Halls Bayou
The upper reaches of Halls Bayou serve the western portions of the DISTRICT'S service area. Halls Bayou watershed covers approximately 8,100 acres (12.7 square miles) or 20% of the total DISTRICT'S service area. Halls Bayou drains water from Alvin and unincorporated Brazoria County from north to south to its outfall into Halls Lake adjacent to Chocolate Bay. Land use in this watershed includes some rural residential, but is mostly agricultural.

Definitions

Development: An activity that makes improvements to real property for the purpose of reselling the property or for new commercial use of the property, including subdivivision of land. The term includes new development and redevelopment

New Development – Development or subdivision of an undeveloped parcel of land.

Redevelopment – A change in land use that alters the impervious surface and/or alters the drainage pattern internally or externally to the Development.

Developer: An individual or entity that makes Development improvements to real property shall be considered a Developer by the District. An individual engaging in construction of a single Homestead Development shall not be considered a Developer by the District.

District: Galveston County Drainage District Number One.

District Commissioners: District Commissioners are those individuals duly elected by popular vote to serve the District in accordance with the District's State Charter. District Commissioners are responsible for the generation, implementation and enforcement of District policy to control and improve storm drainage within the District boundary as their resources permit.

District Superintendent: The District Superintendent is a full-time employee of the District with the primary responsibility of running the District's day-to-day operations. The District Commissioners may grant the District

Superintendent specific duties and responsibilities, including limited authority for approval of certain drainage plans; however, the District Superintendent shall have no authority to create policy for the District.

Drainage Plan: A plan prepared by a licensed engineer showing the overall approach for the collection, conveyance and storm water detention required by the District's "Drainage Criteria Manual" to assure a "no impact" development.

Floodplain Area delineated by the Federal Emergency Management Agency (FEMA) current Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) to be located within the Special Flood Hazard Area (SFHA), which is defined as area likely to be inundated in a 100-year (or 1% annual chance) flooding event.

The Floodway means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the 100-year flood without cumulatively increasing the water surface elevation more than a designated height (typically one foot).

The FEMA FIS and SFHA are used for floodplain regulation by jurisdictional entities (incorporated cities and unincorporated county). The District has adopted modeling and mapping developed in the 2021 "GALVESTON COUNTY MASTER DRAINAGE PLAN UPDATE" as the best available floodplain data.

Homestead Development: Construction of a single homestead to be used by that individual and his/her immediate family, including all reasonable associated improvements (i.e., driveways, garages, personal storage buildings and swimming pools) shall not be considered a Development by the District.

II. ADMINISTRATION

Submittal

The DISTRICT has authority for review and approval of plats and development plans for projects within its jurisdiction. Prior to commencing construction on proposed improvements, two (2) copies of plans, plats, reports, and calculations shall be submitted for review at least two weeks prior to the meeting at which the item will be considered. Proposed plats and plans shall be submitted for each development unless an overall master drainage plan for the development has been previously approved, in which case the applicant must demonstrate compliance with the approved master plan. For projects of 100 acres or more or out of tracts of 100 acres or more, approval of a preliminary engineering report and conceptual master plan shall be required, detailing design methodology and concepts for drainage of the project prior to preliminary plat approval. All plans and reports must be prepared and sealed by a Professional Engineer licensed to practice in the State of Texas.

Fees

Plats and plans submitted to the DISTRICT for approval must be accompanied by a check made payable to GALVESTON COUNTY DRAINAGE DISTRICT No. 1 for an amount specified in the Schedule of Fees as determined by the Board of Supervisors from time to time and on file at the DISTRICT'S Office. A schedule of fees will be provided upon request to the DISTRICT.

Site Visit

The DISTRICT may require a representative of the property owner or developer to meet with DISTRICT personnel at the project site prior to plat or drainage plan approval. This meeting shall be for the DISTRICT'S benefit and allow the DISTRICT to understand the developer's intentions.

Datum

All topographic information shown on plats and plans must be on the same vertical datum as the current FEMA FIRM Map showing the project area.

Plat Review

The plat shall show the applicant's overall layout for the proposed development, and it shall include the following (at a minimum):

1. Developer's name, address, phone number, and contact person.
2. Name, address, phone number and contact person of surveyor who prepared the plat.
3. Scale of drawing with a minimum scale of 1"=100'.

4. Benchmark and reference benchmark with year of adjustment.
5. A detailed location or vicinity map drawn to a scale. The project site shall be accurately located on the map.
6. Date on all submittals with date of all revisions, including month, day and year.
7. Signature lines for DISTRICT Supervisors in accordance with ATTACHMENT A.
8. DISTRICT notes in accordance with ATTACHMENT B.
9. Ownership of adjacent lots if unplatted or lot numbers and blocks if platted.
10. Drainage easements and dedicated Fee Simple Rights-of-Way along all creeks, bayous, streams, gullies, and ditches. See ATTACHMENT C.
11. True locations of existing creeks, bayous, streams, gullies, and ditches, as determined by actual ground survey, current within one year of approval of the plat.
12. A Floodplain Statement that specifies the site's position in relationship to the floodplain zones described on the appropriate FEMA FIRM map. This statement will specify the FIRM panel number, revision date, applicable zone(s), and the elevation of the 100-year floodplain (if applicable).

Plat Approval

The DISTRICT shall provide comments to the applicant as soon as possible after submittal. Revised plats addressing all comments of the DISTRICT must be submitted to the DISTRICT'S office and the DISTRICT'S engineer at least seven (7) days prior to the DISTRICT Commissioner's regularly scheduled meeting. If all comments have been addressed, the final plat will be placed on that agenda.

At the DISTRICT Commissioner's meeting at which final approval is being considered, the following shall be submitted:

1. Final plat mylars. The plat shall be prepared in accordance with requirements of the local jurisdiction involved (i.e., Dickinson, League City, Santa Fe, Texas City or Galveston County subdivision ordinances). All required signatures except those from the city or county jurisdiction involved must be on the plat.
2. Two copies of plat.

Drainage Plan Review

The drainage plan shall present the applicant's overall approach to collecting and conveying rainfall runoff to the appropriate drainage artery. It is recommended that prior to preparation of the plan a meeting be arranged between the applicant and DISTRICT Staff or designated representative to discuss the proposed concept for drainage of the project. The design submittal shall contain the following items:

1. Name, address, and phone number of engineer that prepared the plan including contact person.
2. Scale of drawing with a minimum scale of 1"=100'.

3. Benchmark and reference benchmark with datum and year of adjustment.
4. A detailed location or vicinity map drawn to a scale. The project site shall be accurately located on the map.
5. Date on all submittals with date of all revisions with month, day, and year.
6. Signature lines for DISTRICT Commissioners in accordance with ATTACHMENT A.
7. DISTRICT notes in accordance with ATTACHMENT B.
8. Contour lines at 0.5 foot where slopes do not exceed 1.0% and 1 foot intervals for slopes exceeding 1.0% intervals covering the entire development and extended beyond the development boundaries at least 200 feet on all sides for developments over 5 acres and 50 feet on developments under 5 acres. At least two contours are required for each project.
9. Scheme for the passage of sheet flow from adjacent properties.
10. Drainage area divides for project area, with peak run-off rates for each drainage area.
11. Locations of all planned drainage improvements proposed for moving run-off water from the development to the principle drainage artery, i.e., creek, stream, bayou, ditch etc., and their point(s) of entry into the drainage artery.
12. Points at which structures or pipelines will cross drainage ditches, streams etc., within the development.
13. Locations of structures or other physical features on the development area to provide orientation as required during field inspection of the site.
14. Location of all existing drainage structures, utility lines, pipelines, and other underground features on the property and adjacent rights-of-way.
15. Location and dimensions of all proposed drainage easements and rights-of-way. Requirements for rights-of-way and easements are listed in ATTACHMENT C.
16. Location of major drainage arteries adjacent to or crossing the development as determined through actual ground survey by the developer's surveyor. Survey shall have been completed within the past year and shall show stream alignment 200 feet upstream and downstream of development.
17. Cross-section of detention facility.
18. Detention calculations in accordance with SECTION VI including volumetric calculations of detention provided.
19. Drainage area map of receiving system, if discharging to existing storm sewer system. Drainage area of receiving channel if discharging to open ditch or stream. Include calculations to prove capacity is available.
20. Copy of approved permit from TxDOT if draining to or impacting their system.
21. Copies of documents and letters of request for permission to cross privately held easements or rights-of-way and their approvals to do so.
22. Limits of 100-year flood plain by a vertically controlled survey (not scaled from FEMA FIRM Maps).
23. A Floodplain Statement that specifies the site's position in relationship to the floodplain zones described on the appropriate FEMA FIRM map. This statement will specify the FIRM panel number, revision date, applicable zone(s), and the elevation of the 100-year floodplain (if applicable).

Drainage Plan Approval

The DISTRICT shall provide comments to the applicant as soon as possible after submittal. At least seven working days prior to the DISTRICT Commissioner's regularly scheduled meeting, revised plans addressing all comments of the DISTRICT must be submitted to the DISTRICT'S Office and the DISTRICT'S Engineer. If all comments have been addressed, the plan will be placed on that agenda.

At the DISTRICT Commissioner's meeting at which drainage plan approval is being considered, the original and one (1) copy of the plan must be submitted (the original will be returned for inclusion in the construction plans).

Project Acceptance

Upon completion of all construction improvements, the applicant shall contact the DISTRICT for an inspection of the project. Upon successful final inspection, the applicant must submit one copy of the as-built plans to the DISTRICT for their files.

The DISTRICT will require the developer to provide a one year maintenance period upon completion of the improvements. Correction of any deficiencies discovered on the final inspection will begin the maintenance period. After one year the DISTRICT will re-inspect the facility. A letter of final acceptance will be issued after correction of any deficiencies which will promptly be corrected before DISTRICT release.

Maintenance of Storm Water Storage Facilities

For the purpose of this section, a storm water storage facility shall mean an engineered system serving as a storm runoff collection and storage facility (not as a transmission system) for the benefit of a multi-parcel development, and not for a single lot or single parcel development.

In each case where an on-site storm water storage facility is provided pursuant to this Manual, the developer shall furnish evidence of acceptance for maintenance of such storage facility from the entity having authority to perform such service. On a case-by-case basis, the DISTRICT may consider assuming such maintenance responsibility for certain developments only under the following circumstances:

1. The developer dedicates to the DISTRICT an easement over and across such facility.
2. The developer dedicates an access easement to such facility.
3. The developer pays to the DISTRICT the estimated cost of maintaining such storage facility for a period of ten (10) years as determined by the Commissioners and on file in the DISTRICT'S Office.
4. The on-site storm water system facility is designed to be a "dry" facility and not an amenity or a private recreational facility. Amenity ponds shall be defined as

any pond whose land area has been deeded to the Homeowner/Landowners for the benefit of the Homeowner/Landowners Association. These facilities shall include "wet ponds" and detention areas used for recreational purposes.

Time Limits of Approvals

Plat and plan approvals shall expire within one (1) year if a construction has not commenced within that time. In cases where approval is given for a master plan and only certain sections are built immediately, the master plan approval will be valid for five (5) years. However, addenda to master plans may be required if watershed conditions and/or criteria change during the course of development.

Upon written request, the Board may grant extensions of approval for up to one (1) year for Drainage Plans and an additional two (2) years for Master Plans. All requests for extensions must be approved prior to the expiration of the original approval. No more than one (1) extension will be granted.

Revisions to Drainage Plans and Plats

All revisions to either the approved drainage plan or plat must be approved by the DISTRICT. The DISTRICT may require a re-submittal of a drainage plan or plat dependent upon the character and extent of the changes made as determined by the DISTRICT.

III. PRIVATE AND PUBLIC UTILITY CROSSINGS

Utility, Pipeline, and Cable Crossing

All utilities, pipelines, and cable crossings, either publicly or privately owned, shall obtain a permit from the DISTRICT prior to any construction to cross any drainage facility within the DISTRICT'S boundaries.

All utilities, pipelines, and cables shall cross DISTRICT facility within 20 degrees of perpendicular to that facility. No utility, pipeline, or cable shall be located within and parallel to a creek right-of-way without specific approval of the DISTRICT Commissioners.

Any and all utilities, pipelines, or cables to be buried within and/or across a drainage facility within the DISTRICT'S boundaries shall be installed a minimum of ten feet (10') below the lowest point of said drainage facility. In the event of an earthen drainage facility, the distance referenced to in this section shall be measured from the lowest point of the earthen drainage facility to the top of the utility line, pipe or cable to be installed or constructed. In the event of a pipe, culvert, or other manmade drainage facility, the distance referenced to in this section shall be measured from the lowest point of the pipe, culvert, or other manmade structure to the top of the utility line, pipe or cable to be installed or constructed. Variances to the depth requirements in this section may be granted by the DISTRICT on a case-by-case basis, and at the sole discretion of the District commissioners.

Submittal Procedures shall be the same as required for plats and plans.

Application fees are as stated in The Schedule of Fees located on file in the DISTRICT'S office. There will be no fees assessed to public entities seeking to cross DISTRICT facilities with extension of public utilities.

Review Procedure

Two copies of plans, plats, reports, and calculations shall be submitted for review at least two weeks prior to the meeting at which the item will be considered.

The DISTRICT and its Engineer shall review the submitted materials. The DISTRICT Commissioners may take action on the permit at the next regular Commissioner's Meeting and either approve, disapprove or specify changes to be made to comply with this rule for approval.

No processing fee is required for DISTRICT approval other than those required as part of the permit application (if any).

Submittal

Top of utility, pipeline, or cable shall be a minimum of five (5) feet below the existing flowline of the channel being crossed, or five (5) feet below the projected flowline of the channel as provided by the most recently adopted version of the DISTRICT'S Master Drainage Plan. Proposed utility, pipeline, or cable must stay at this depth for the entire width of existing easement, and then may be sloped towards the ground surface at a slope not to exceed 3:1.

All pipelines with a working pressure exceeding 200 pounds per square inch shall be constructed with a concrete pad over the line. Pads shall extend a minimum of one (1) foot on either side of edge of pipeline for the total length of the DISTRICT'S easement, and shall be six (6) inches thick. Top surface of pad shall be a minimum of five (5) feet below the existing flowline of the channel being crossed, or five (5) feet below the projected flowline of the channel as provided by the most recent available information. DISTRICT may release requirement for a concrete pad if pipeline is directionally drilled under easement and is at least ten (10) feet below the existing flowline of the channel being crossed, or ten (10) feet below the projected flowline of the channel as provided by the most recently available information.

Benchmark and survey requirements will comply with those listed for plats and plans. The drawings shall have the DISTRICT Commissioner's signature block as shown in ATTACHEMNT A and shall contain the DISTRICT design notes contained in ATTACHMENT B.

Notices

The Applicant shall provide the DISTRICT with forty-eight (48) hours' notice prior to the start of construction.

Upon completion of crossing, the Applicant shall install markers on either end of crossing, at the right-of-way limits of the DISTRICT'S easement. It shall be the Applicant's responsibility to maintain condition of markers.

IV. HYDROLOGY

Hydrology is the study of precipitation. Policy makers and engineers must study and understand hydrology because they are interested in designing and building structures and systems to safely convey and discharge precipitation runoff while minimizing the potential of flooding. They must determine how much water should be collected and conveyed or stored, how fast this process must take place, how much can be safely discharged without adversely impacting surrounding properties, and what are other effects of the development being considered. The following sections discuss specific parameters and methods to be used in analyzing proposed developments in the DISTRICT'S service area.

Storm Frequency

All drainage improvements shall, at the minimum, be designed for the following storm frequencies. The return intervals listed here are minimums, and the individual design engineer or the DISTRICT may choose to exceed these minimums given site specific requirements or constraints.

Type of Facility	**Return Interval Storm**
Closed Conduit Storm Sewers (for new development)[1]	2-year
DISTRICT Ditch Culverts (serving less than 100 acres)	10-year
DISTRICT Ditch Culverts (serving 100 to 250 acres)	25-year
DISTRICT Ditch Culverts (serving 250 acres or more)	50-year
Bridges crossing DISTRICT Ditches	100-year
Major Ditches and DISTRICT Channels	100-year
Detention Facilities	100-year
1) Provision must be made for conveyance of surface flows to receiving channel/detention	

Peak Storm Runoff Rates – Rational Method

The Rational Method can be used for determining peak runoff flow rate for both existing and proposed conditions. These peak runoff rates are used to estimate the impact of development and the conveyance requirements for drainage improvements. This method is applicable for small to medium drainage areas (generally less than 200 acres) where the flow domain is typically overland sheet flow or shallow surface ditch flow.

The Rational Method takes the following form:

$$Q = C_f * (C * I * A)$$

Where:

Q	=	Peak Runoff Flow Rate (cfs)
C	=	Runoff Coefficient, See table below
C_f	=	Frequency factor (the product of C_f and C should not exceed 1.0)
A	=	Area of drainage basin being studied (acres)
I	=	Rainfall Intensity of the design storm (inches/hour)

Runoff Coefficient (C)

The Rational Method runoff coefficient (C) is the dimensionless coefficient of runoff representing the ratio of peak discharge per acre to rainfall intensity. It reflects a ratio between rainfall and runoff, dependent on the land use and soil type.

Land Use or Land Cover	Rational Coefficient (C)	Impervious Cover (%)
Raw, undeveloped acreage	0.20	2
Improved, undeveloped acreage (i.e. mowed, filled graded, etc.)	0.25	2
Park land or cemetery	0.30	15
Residential – 1 acre lots or larger	0.35	25
Residential – ½ to 1 acre lots	0.45	35
Residential – ¼ to ½ acre lots	0.55	50
Residential – less than ¼ acre lots	0.60	60
Multi-Family – separate buildings w/ landscape	0.65	65
Multi-Family – high density	0.80	85
Light Commercial	0.65	65
Commercial/Industrial	0.80	85

Frequency Factor (C_f)

The Frequency Factor is used in the Rational Method to scale the magnitude of the peak runoff in relationship to the return interval of the storm consistent with observed runoff data. The Rational Method C coefficients were determined for more frequent storms. The C_f adjustment factor accounts for a greater ratio of rainfall to runoff with the less frequent storms. Appropriate values of C_f are presented in the following table.

Storm Frequency (years)	Frequency Factor (C_f)
10	1.0
25	1.1
100	1.25

The product of C_f and C used in the Rational Method should not exceed 1.0.

Basin Time of Concentration (T_c)

The storm rainfall Intensity used in Rational Method will be selected based upon the return interval of the storm to be used (specified in the Storm Frequency Table above), and the duration of the storm to be used (based on the study basin's time of concentration). Time of Concentration (T_c) is defined as the length of time it takes a drop of water to travel from the most hydraulically remote portion of the drainage basin to its outlet. T_c is calculated to represent the conditions in the drainage basin considering its area, shape, surface gradient, land use, land cover, and soil type. T_c (in minutes) may be estimated from the following equation:

$$T_c = \text{Length}/(\text{Velocity} * 60) + 10$$

Where:

Length = Flow distance (feet)
Velocity = Flow velocity (fps) [see following table]

Flow Condition	Representative Velocities
Shallow overland flow in undefined channels	0.25 to 0.50 fps
Flow in street curb & gutter or roadside ditches	0.75 to 1.25 fps
Flow in shallow DISTRICT ditches	1.5 to 3.0 fps
Flow in defined DISTRICT channels	2.0 to 4.0 fps
Flow in closed conduit storm sewers	3.0 to 5.0 fps

The constant value of 60 in this equation is used to convert seconds to minutes and 10 is used as an estimate of initial delay between the start of rainfall and development of actual surface runoff. This method can be applied fairly accurately to large and small basins with either undeveloped or developed surfaces. However, the designer must specify the flow condition and estimated flow velocities for each flow domain on the site (i.e., the first 100' is overland flow followed by 250' in a gutter followed by 400' in closed conduit, etc.) and estimate time of concentration as the sum of all these individual flow conditions. The flow path used as the basis of this calculation should be clearly denoted on the plans with the associated design calculations.

Another method that can be used to estimate time of concentration for developed areas (i.e., storm sewer projects) is in the following form:

$$T_c = 10*(A)^{0.1761} + 15$$

Where:

A = Drainage Basin area (acres)

This method accurately estimates T_c for developed projects with storm sewers, however it tends to underestimate actual T_c for basins with significant overland flow or open ditch flow, and therefore may overestimate peak runoff flow rates for these basins.

Alternative methods for estimating the time of concentration will be accepted for review by the DISTRICT, and may be allowed if the method is applicable to a specific situation.

Storm Intensity (I)

For small watersheds and individual developments, the storm intensity should be based upon the time of concentration of the basin being analyzed. For example, in the design of a detention facility serving a basin with a 2-hour time of concentration, an Intensity for a 100-year, 2-hour storm should be selected for use in the analysis.

The Intensity can be calculated from an intensity-duration-frequency (IDF) relationship equation developed to relate intensity with the Tc and design storm, using the following equation and coefficients:

$$I = \frac{b}{(t_c + d)^e}$$

Where:

I = Rainfall intensity (inches/hour)
Tc = Time of Concentration (minutes)
b, d, e = Coefficients (see table below)

Coefficient	2-year	5-year	10-year	25-year	50-year	100-year	500-year
e	0.7244	0.6900	0.6623	0.6294	0.6096	0.5797	0.5196
b (in)	48.35	52.32	54.68	57.79	61.00	60.66	62.17
d (min)	9.07	7.88	6.96	5.89	5.46	4.44	2.95
Reference: Harris County Atlas 14 IDF Curves for Region 3							

Storm Runoff Peak Discharge and Hydrograph

Other methods should be used to estimate peak runoff rates for larger areas or those served by well-defined channels where flow routing in defined channels may be significant.

For basins over 200 acres in size, the DISTRICT will require a hydrograph analysis covering the site and the adjacent parts of the watershed, using an approved computer model, preferably using a commonly available public software, such as HEC-HMS or EPA-SWMM. The District has adopted modeling and mapping developed in the 2021 "GALVESTON COUNTY MASTER DRAINAGE PLAN UPDATE" as the best available floodplain data, it may be advisable to utilize the hydrologic models developed for that study.

For these larger watersheds and regional studies, use a 24-hour duration storm for the analysis and design. Appropriate design storm rainfall depths are shown in the following table for various recurrence interval storms.

Duration	Rainfall Depth (inches)						
	Average recurrence interval						
	2-year	5-year	10-year	25-year	50-year	100-year	500-year
5-min	0.61	0.76	0.89	1.07	1.22	1.37	1.75
10-min	0.97	1.21	1.41	1.71	1.94	2.18	2.75
15-min	1.24	1.53	1.78	2.14	2.43	2.73	3.48
30-min	1.78	2.19	2.54	3.04	3.43	3.85	4.96
60-min	2.37	2.95	3.44	4.15	4.70	5.30	7.01
2-hr	2.97	3.81	4.57	5.70	6.62	7.66	10.60
3-hr	3.33	4.36	5.32	6.78	8.01	9.41	13.40
6-hr	3.97	5.33	6.64	8.65	10.40	12.40	18.20
12-hr	4.67	6.34	7.96	10.40	12.60	15.10	22.70
24-hr	**5.42**	**7.41**	**9.35**	**12.30**	**14.90**	**17.90**	**27.10**
2-day	6.20	8.52	10.80	14.40	17.70	21.40	31.40
Reference: NOAA Atlas 14 Precipitation Frequency Estimates Santa Fe, TX (Lat 29.38780, Long -95.08050)							

V. HYDRAULICS

Hydraulics is the study of fluid flow behavior. Policy makers and engineers must study and understand hydraulics because they are responsible for designing and constructing conveyance and storage facilities capable of managing storm water runoff in a safe and effective manner while reducing the potential for flooding. The following sections discuss specific methods and parameters to be used in analyzing proposed developments in the DISTRICT'S service area.

Open Channel Flow

The vast majority of conveyance capacity within the DISTRICT'S service area is located in the network of open channels that the DISTRICT builds and maintains. The Manning equation will be used to estimate a ditch's conveyance capacity. This equation is in the following form:

$$Q = 1.486/n * A * R^{2/3} * S^{1/2}$$

Where:

n = Manning's Roughness Coefficient (unitless)
A = Flow Cross-sectional area (sf)
R = Hydraulic Radius (ft)
S = Slope of the Hydraulic Grade Line (ft/ft)

Typical values for Manning's 'n' are included in the following table.

Channel / Pipe Material	**Manning's 'n'**
Plastic Pipe (PVC & HDPE)	0.011
Concrete Pipe (circular)	0.013
Concrete Pipe (box)	0.015
Corrugated Metal Pipe	0.024
Grass-lined Channel	0.040
Smooth Bare Earth Channel	0.020
Natural or Overgrown Channels	0.060 – 0.100

The flow area (A) is estimated from the ditch cross-section, and is the area that will be conveying water (also called the wet area). The hydraulic radius is calculated as the wetted area divided by the wetted perimeter. The wetted perimeter is defined as the length of water/surface interface around the perimeter of the wetted area (does not include the water/air interface length). For open channels, the slope of the hydraulic grade line is estimated to be the same as the ditch slope.

The District has adopted modeling and mapping developed in the 2021 "GALVESTON COUNTY MASTER DRAINAGE PLAN UPDATE" as the best available floodplain data, it may be advisable to utilize the hydraulic models developed for that study.

Closed Conduit (Pipe) Flow

The Manning equation presented earlier is also applicable for estimating flow capacity for closed conduits (i.e., pipes). There are some important distinctions to remember, including:

- Manning's 'n' for pipe materials are significantly different (i.e., smaller) than those for bare earth or vegetative surfaces. See the table above for appropriate 'n' values.
- The assumption of hydraulic grade line slope being approximately equal to the pipe slope is only valid under free flow conditions. Once the pipe is full and experiences surcharge conditions, the hydraulic grade line slope will increase as flow increases.

VI. DETENTION FACILITIES

To meet the DISTRICT'S requirements for zero net increase in runoff rates and no negative impacts due to new development, development projects will need to provide on-site detention facilities. Each detention facility should be designed based upon site specific parameters and constraints using accepted engineering methods. The DISTRICT will not allow in-line storage within DISTRICT ditches or channels. No approvals will be given by the DISTRICT for any proposed development until the Commissioners have been satisfied that the proposed design meet the DISTRICT'S requirements. The following paragraphs describe general design requirements and allowable methods for generating appropriate designs.

General Design Requirements

As shown in the storm frequency table earlier, detention facilities will be designed to provide enough storage to accommodate a 100-year event for the sub-area it is intended to serve. Detention facilities may be designed to be wet (constant level ponds) or may be designed to drain completely. They must be designed and constructed with stable slopes (4:1), they must provide adequate access and maintenance berms around the entire perimeter, provide freeboard, and have erosion control elements (i.e., backslope swales, drop pipes, slope pavement, etc.) as necessary to ensure a stable, low maintenance facility.

The minimum freeboard and maintenance berm width for all detention facilities is provided in the following table.

100-yr Storage Depth (ft)	Minimum Freeboard (ft)	Maintenance Berm Width (ft)
Less than 4	0.5	10
4 to 8	0.75	20
More than 8	1.0	30*
* Includes 10 ft backslope drain		

Outfall structures must be designed to restrict outflow from the detention facility at a rate not to exceed the pre- developed conditions, and must include a controlled release mechanism to safely discharge runoff from storm events in excess of the 100-year design storm.

With shallow outfall systems, the use of pumped detention may be considered under the following conditions.

- Discuss the potential use of pumped detention with the DISTRICT prior to submittal of a drainage study, with consideration of gravity drained alternatives.
- The pump station must be owned and maintained by a governmental entity (i.e., municipal utility district).

- A minimum of 25 percent of the volume must be drained by gravity.
- The pump discharge capacity should be no more than 25 percent of the allowable discharge, and must consider the low-flow capacity of the receiving system.

Underground storage may be considered under the following conditions:

- Discuss the potential use of underground detention with the DISTRICT prior to submittal of a drainage plans, with consideration of traditional above-ground alternatives.
- Storage within physical pipes or vaults will be accepted for use. Storage within bedding voids will not be accepted for use.
- Access must be designed to allow for simple inspection, maintenance and cleaning of the underground storage and outfall restrictor.

Detention storage may not be placed in road-side ditches or in curb-and-gutter streets in public or private easements and rights-of-way.

Volume Requirements

This Section discusses three methods to determine detention volume required for development. Detention is required for the portion of the site that is being developed, including the portions of the site that are disturbed, but result in impervious cover. Portions of a site that remain undisturbed will not require detention storage. For each method, the **minimum required volume is 0.75 acre-feet per acre**.

For example, on a 4 acre tract with 3 acres of building, parking, detention and landscape areas, the developer would be required to provide (3 acres)*(0.75 ac- ft/ac) = 2.25 ac-ft of detention storage at a minimum.

The following paragraphs describe allowable methods for use in determining storage volume requirements. This is not an exhaustive discussion of all methods, but will provide developers and engineers with a variety of tools for use in the DISTRICT.

Coefficient Method

For small developments (less than 5 acres for commercial or 10 acres for residential), the developer may choose to use this simplified method for detention volume estimation. Using this method, the developer would provide detention storage using the following equation:

$$\text{Storage} = 0.75 * A_{dev}$$

Where:

Storage = Detention volume required (ac-ft),
A_{dev} = The area of the site that will have modified cover (acres).

When using the Coefficient Method, the 100-year allowable discharge shall be no greater than 1.25 cfs/acre. When discharging to a roadside ditch, the allowable discharge shall be

the lesser of 1.25 cfs/acre and the proposed development's pro-rata share of the roadside ditch bank full capacity.

Using this method, storage is provided for the portion of the site that is being developed. This method will not be allowed where the total developed area (either proposed or in the future) will exceed 5 acres for commercial or 10 acres for residential developments. The outfall structures will be designed separately as discussed in later paragraphs.

Small Watershed Method

The storage requirements for detention ponds can be determined using the Small Watershed Method (also called Malcom's Method). This is a hydrograph routing method that utilizes an expected inflow hydrograph, routed to develop an outflow hydrograph to determine required storage volume. Using this method, the required volume of storage is determined through routing, and is the volume required to limit the discharge to less than pre-developed conditions with the selected outflow restricting structure.

DETENTION FACILITY INFLOW HYDROGRAPH
The inflow hydrograph is constructed by calculating instantaneous flow rates using the following equations:

$$Q_i = Q_p/2(1-\cos(\Pi * t_i/T_p)) \qquad \text{for } t_i \leq 1.25\ T_p$$

And

$$Q_i = 4.34 * Q_p * \exp(-1.3 * t_i/T_p) \qquad \text{for } t_i > 1.25\ T_p$$

Where:

Q_i = instantaneous flow rate at time "i" [cfs]
Q_p = peak flow rate (Rational Method) [cfs]
t_i = time interval "i" [minutes]
T_p = time to peak [minutes]

In the equations listed above, the time to peak (T_p) is calculated by:

$$\text{Time to peak } (T_p \text{ in minutes}) = V/(1.39*60*Q_p)$$

Where: V = volume of runoff [ft^3]

The total volume of runoff generated by the design storm event is the amount of rain that falls upon the watershed minus loses attributable to surface storage, soil infiltration, evaporation & transpiration, etc. For the purposes of projects within DISTRICT jurisdiction, designers shall use a cumulative depth of excess rainfall from the following table.

	Direct Runoff (inches)			
	2-year	**10-year**	**100-year**	**500-year**
Total Rainfall	5.4	9.35	17.9	27.1
0% impervious	3.2	6.8	15.9	24.0
40% impervious	4.0	7.7	16.6	25.1
85% impervious	4.9	8.8	17.4	26.3
Reference: HCFCD PCPM Small Watershed Hydrograph Method Region 3 Runoff depths adjusted by ratio for GCDD1 rainfall depth.				

DETENTION FACILITY OUTFLOW HYDROGRAPHS

To route the inflow hydrographs through the detention basin, a standard reservoir routing procedure is recommended. The Modified Puls method can be used, where outflow hydrographs are constructed by determining the capacity of the outfall structure under incremental surcharge conditions. A table is generated that contains the estimated outfall rate for the proposed structure given increasing depths of ponding in the detention facility. To determine appropriate detention design, the engineer will provide a mass-balance for water in the detention facility (i.e. change in storage of the system equals the volume of water flowing in minus the volume of water flowing out) for several incremental time steps covering the duration of the storm event. Alternatively, the detention routing can be evaluated using dynamic computer routing programs, such as EPA-SWMM.

The minimum storage requirement will equal the maximum cumulative storage determined in the time step analysis. The storage requirement may be in excess of the DISTRICT minimum volume rate of 0.75 acre-feet per developed area.

The Small Watershed Method should only be used for basins of less than 200 acres where there is no well defined channel and any flow routing can be considered negligible.

Computer Modeling

For basins over 200 acres in size, the DISTRICT will require a hydrograph analysis covering the site and the adjacent parts of the watershed, using an approved computer model, preferably using a commonly available public software, such as HEC-HMS or EPA-SWMM. Where multiple interconnected detention basins are proposed, a hydrodynamic model should be considered, such as EPA-SWMM or unsteady HEC-RAS (using storage areas).

This analysis should verify that the proposed improvements will not increase runoff rates anywhere in the system and therefore will have no negative impacts on adjacent properties. The engineer must submit a complete design report with sufficient detail (program input, program output and discussion of methods and assumptions used) for the DISTRICT staff to review. Before beginning this type of analysis, please check with the DISTRICT to receive the most current baseline model of the area for development (if one is available).

Outfall Restrictor Design

The outfall structure is an important design component of the detention facility. The design of the outfall structure can be as simple as a single pipe segment, and can be as complex as multiple pipes with differing diameters at staggered elevations with overflow weirs and flow orifices. The following paragraphs describe ways to estimate flow conveyance of several flow control structures.

Orifice

One of the most simple flow control structures is an orifice. An orifice is a two-dimensional flow structure (i.e., a drilled hole in a concrete wall, a hole in plate steel or a very short section of pipe) with an estimated conveyance capacity dependent upon the difference in water elevations from one side of the orifice to the other and the orifice opening area. The general equation for estimating flow through an orifice is as follows:

$$Q = C * A * (2 * g * H)^{1/2}$$

Where:

Q = Orifice flow capacity (cfs)
C = Orifice coefficient (unitless) [use 0.8]
A = Orifice opening area (sf)
g = Gravitational acceleration constant (32.2 ft/s^2)
H = Differential head across the orifice (ft)

For the design head differential (H) use the 100-year water surface elevation in the detention facility minus soffit of the outlet pipe at the receiving ditch (if known). The orifice should generally be greater than 6" diameter to reduce problems with clogging and blockage.

Outfall Pipe

The engineer may use one or more a pipe sections as flow control devices. The conveyance capacity of the pipe(s) can be estimated using the Manning equation discussed earlier. In using this method, the slope of the hydraulic grade line is equal to the head differential across the structure divided by the length of the pipe section. For the design head differential use the 100-year water surface elevation in the detention facility minus the soffit of the outlet pipe at the receiving ditch (if known). The restrictor pipe shall not be less than 6" in diameter.

Overflow Weir

An overflow weir can be used on an outfall structure to restrict and regulate outflow. One of the biggest advantages of this outfall structure is that they do not have a finite conveyance capacity, and can therefore be used for emergency overflows to control larger than 100-year flows.

There are many types of weir designs to chose from when designing an outfall structure, and each has a slightly different equation for estimating flow capacity. One of the simplest to design and construct is a weir consisting of a horizontal weir (of width B) with triangular weirs on either side (at 4:1 slopes) and a depth of flow of H feet. Capacity of a weir can be estimate by the following equation:

$$Q = C * L * H^{3/2}$$

Where:

Q = Weir capacity (cfs)
C = Weir coefficient (use 3.0)
L = Weir length (ft)
H = Depth of flow across weir (ft)

Erosion Control

High head differentials and erosive velocities for prolonged periods of time can occur at pipe inlets. Flow from the outflow structure can cause erosion in the outfall channel due to high velocities and turbulence. Use concrete lining around pipe inlets and outlets where erosive velocities and turbulence are expected. Use concrete lining for weirs. Design coverage, thickness, reinforcement, and toe walls for each structure.

Discuss the design of detention outlet and weir structure transitions to a grass-lined channels with the DISTRICT's Engineer.

Floodplain Fill

The volume of fill material placed in the DISTRICT 100-year floodplain must have a corresponding cut somewhere in the immediate vicinity of the fill (within the same watershed and preferably on-site). Fill shall be placed and lots graded so that there is no negative impact to adjacent properties.

VII. DISTRICT FACILITIES

The proper hydraulic design of channels is of primary importance to insuring that nuisance drainage conditions, flooding, sedimentation and erosion problems do not occur or the frequency of their occurrence is at an acceptably low rate. For facilities to be operated or maintained as DISTRICT facilities, the following minimum design standards shall be applied to construction of new or reconstruction of existing facilities.

Design Frequency

New DISTRICT facilities shall be designed and constructed to contain and safely convey runoff from the 100-year frequency storm when at all feasible to do so. Consideration must be made for the capacity of existing channels downstream, and no improvement shall be made that increase the frequency of downstream flooding.

Design Flow Velocities

Excessive flow velocity can cause erosion problems, may pose a threat to bank stability and may create safety problems. Additionally, velocities that are too low may allow sediment deposition resulting in loss of channel capacity. Generally, design flow velocities in unlined open channels (for 100-year flows) should be between 3 and 5 fps. Flow velocities in concrete lined channels may increase to be between 5 and 8 fps.

DISTRICT Ditch Width and Ditch Depth

Right-of-way or drainage easements provided for DISTRICT channels shall conform with the DISTRICT'S master plan for width and ultimate depth. In any case, the minimum width shall be adequate to provide maintenance areas, maintainable side slopes, and minimum bottom widths in accordance with DISTRICT criteria for the ultimate channel section. Ditch depth shall be what is required to provide the required capacity at a minimum.

DISTRICT Ditch Channel Slope

DISTRICT ditches shall have a minimum constructed channel slope of 0.05% to provide for the minimum velocities noted earlier. Excessive slopes may unnecessarily increase the potential for erosion of banks and undermining of bridge and culvert structures, therefore maximum slopes should generally not exceed 0.50%. In areas of steep topography, channel drop structures may be required to limit channel invert slopes.

DISTRICT Ditch Side Slopes

In grass lined channels, maximum side slopes shall be 4:1 (horizontal:vertical). Variance from this criteria may be granted by the DISTRICT to accommodate site specific issues. Side slopes for concrete lined channels shall be based on field conditions and shall be site specific.

DISTRICT Ditch Bottom Width

The bottom width for DISTRICT ditches should generally be no less than six feet. A larger bottom width may be required to meet other issues including ditch capacity, design velocity, etc.

DISTRICT Ditch Horizontal Curves

In general, centerline curves for grass channels should be as gradual as possible and should have a radius greater than three times the ultimate ditch top width. Smaller curvature radii can be allowed with adequate slope paving as approved by the DISTRICT.

DISTRICT Ditch Confluences

The angle of intersection between the tributary and main channel should be between 15º and 45º (with an optimal value of 30º). Angles in excess of 90º will not be permitted.

DISTRICT Ditch Transitions

Expansions and contractions should be designed to create minimal flow disturbance and thus minimal energy loss. Design consideration must be given to reducing erosion potential and turbulent flow characteristics at ditch transitions.

DISTRICT Ditch Drop Structures

When introducing flow into ditch main channel from shallow surface swales, the designer must include drop pipes to reduce the erosion potential at the confluence. Drop pipes shall be appropriately sized for the area being served. Drop pipe structures shall be HDPE pipe (or approved equal), properly bedded with a discharge elevation of 12” above the main channel flowline. These drop pipes shall provide for a continuous maintenance berm along the main channel and shall include erosion protection at upstream and downstream ends.

DISTRICT Concrete Lined Channels

As field conditions necessitate, concrete lined channels may be required to provide adequate capacity or erosion protection for less than optimum drainage easement widths. Design of concrete lined channels will be considered by the DISTRICT on a case-by-case basis.

Drop pipe and Crossing Policy

Drop pipe (Drain pipe in slope)

1. The Superintendent will confirm location of drop pipe and measure the length of pipe needed.
2. The Pipe will be installed when time permits and when pipe has been paid for by the landowner.
3. GCDD1 will call for line locates with a minimum of two days to locate any buried pipe lines or utilities.

Existing Drop pipe needing replaced

1. The superintendent will confirm the pipe needing replacing.
2. The district will decide who is responsible for purchasing new pipe.
3. Pipe will be installed when time permits.

Culvert Pipe Crossing

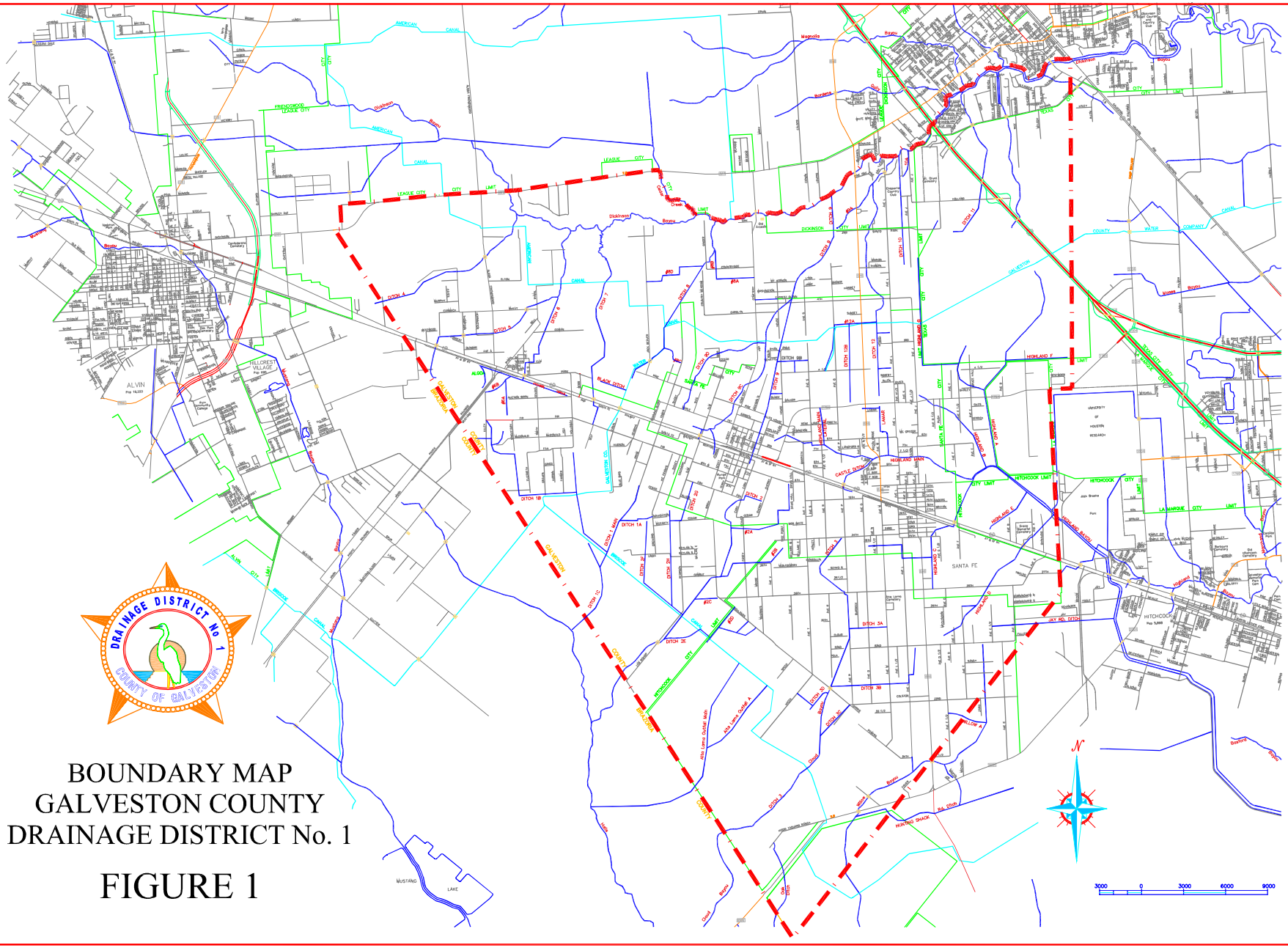
1. The superintendent will verify location of crossing and measure ditch for pipe size.
2. The District will estimate the amount of stabilized sand or fill dirt needed.
3. Once the pipe and fill material is paid for, the district will then call for line locates with a minimum of two days to locate pipelines or utilities.

If you are wanting a crossing to be put in, please contact the District at 409-925-5402. Existing pipe crossings that need replacement and causing the ditch to not drain correctly will be removed immediately to prevent any flooding upstream. The district will contact the landowner to inform them of the problem.
Note: The labor and machine costs for installing drop pipes and crossings are at no charge as a service to the taxpayers unless we need to use the larger equipment that requires us to hire a haul truck and that will be paid for by property owner and District cost.

VIII. REGIONAL AND SUB-REGIONAL DETENTION FACILITIES

The DISTRICT is pursuing development of regional and sub-regional detention facilities as its limited budget and manpower can allow. Capacity in these future facilities may be provided to the developer provided the DISTRICT determines capacity is available. For this to occur, the detention facility must be in the same watershed or sub-watershed as the developer's site, and the development must be less than or equal to 5 acres for any single-family residential development or less than or equal to 2 acres for any other type of development. Excess detention capacity may not be used for mitigation of fill in the flood plain.

The developer must provide for or prove existing conveyance capacity between the site and the detention facility without having a detrimental effect on any adjacent properties. The developer must pay the DISTRICT a fee as determined by the Commissioners and on file in the DISTRICT'S Office. If conveyance is directed through properties not directly owned by the developer, an executed contract or recorded deed between the parties agreeing to the said conveyance must be presented to the DISTRICT.



BOUNDARY MAP
GALVESTON COUNTY
DRAINAGE DISTRICT No. 1

FIGURE 1

JKC & Associates, Inc.
2920 F.M. 517 East
Dickinson, Texas 77539
(281) 309-9100

DISTRICT
BOUNDARY MAP

GALVESTON COUNTY
DRAINAGE DISTRICT No. 1

DRAWN BY: JKC
DATE: May 2, 2001
REVISED: July 7, 2003
SCALE: 1" = 4,000'
DRAWING NAME: DistrictMap.DWG

ATTACHMENT A

DISTRICT Signature Block

Approved by the GALVESTON COUNTY DRAINAGE DISTRICT No. 1

_____	_____
Commissioner	Date
_____	_____
Commissioner	Date
_____	_____
Commissioner	Date

The above signatures are valid for one year only. If construction has not commenced in that time, re-approval by the DISTRICT is required.

ATTACHMENT B

GCDD1 District Notes

Required Notes for Plats

1. Buildings, fences or other structures shall not be erected in DISTRICT rights-of-way or drainage easements.

2. The detention and drainage facilities are to be maintained by the property owner(s). *(Use this note for private systems only)*

3. The plat shall not be approved for any lot within this subdivision until a detention and drainage plan has been approved by GALVESTON CO. DRAINAGE DISTRICT No. 1.

4. Additional drainage easements may be required at the time a drainage plan is submitted to GALVESTON CO. DRAINAGE DISTRICT No. 1 for approval.

5. Plantings, flower beds, other landscaping, or fill materials are not permitted in side lot drainage or detention easements.

Required Notes for Drainage Plans

1. Contact GALVESTON CO. DRAINAGE DISTRICT No. 1 at least 48 hours prior to commencing construction and upon completion of improvements for the final inspection.

2. Buildings, fences or other structures shall not be erected in DISTRICT rights-of-way or drainage easements.

3. The detention and drainage facilities are to be maintained by the property owner(s). *(Use this note for private systems only)*

4. All drainage facilities shall have erosion control established upon completion. Contractor to provide the GALVESTON CO. DRAINAGE DISTRICT No. 1 with proposed grass type, application rate, and application method for approval prior to commencing work.

5. Plantings, flower beds, other landscaping, or fill materials are not permitted in side lot drainage or detention easements.

ATTACHMENT C

Ditch Right-of-way Width Requirements

DICKINSON BAYOU WATERSHED

Ditch	Segment	Required Width (ft)
Dickinson Bayou	District Boundary to District Boundary	*
Ditch 4 (Bushway Draw)	District Boundary to Dickinson Bayou	150
Ditch 5	District Boundary to Ditch 6	150
Ditch 6	Upstream of SH 6 SH 6 to Dickinson Bayou	100 150
Ditch 7 (Johnson Draw)	Upstream of SH 6 SH 6 to American Canal American Canal to Dickinson	100 120 140
Ditch 8 (Francis Bayou)	SH 6 to Pine Pine to American Canal American Canal to Dickinson Bayou	100 140 150
Ditch 9 (Runge Bayou)	SH 6 to Tributary N of Bunde Tributary N of Bunde to Ditch 9C Ditch 9C to Dickinson Bayou	130 150 160
Ditch 9A	Entire Length	100
Ditch 9B	Entire Length	100
Ditch 9C	Upstream 1st Street 1st Street to Ditch 9D	100 140
Ditch 9D	Maple to Williams ROW extension Williams ROW extension to Ditch 9C	100 130
Ditch 10	Entire Length	120
Ditch 11 (Metzler Gulley)	Upstream I-45 I-45 to Dickinson Bayou	130 140
Ditch 12 (Thaman Bayou)	FM 1764 to 4 ½ Street 4 ½ Street to 4th Street 4th Street to Thaman Rd Thaman Rd to Dickinson Bayou	120 130 140 160

* Minimum top of bank plus 50 feet. Encroachment on Dickinson Bayou floodplain must show no adverse impact.

Refer to GCDD1 District Superintendent for specification of ditch widths not shown on this table.

Continued, next page.

HIGHLAND BAYOU WATERSHED

Ditch	Segment	Required Width (ft)
Highland Bayou	District Boundary to Highland C	240
	Highland C to Avenue L	180
	Avenue L to FM 646	150
	646 to 7th Street	130
	7th Street to FM 1764	120
Highland A	Highland Bayou to FM 1764	110
	FM 1764 to Lago Mar	90
Highland A1	Highland A to Avenue E½	80
Highland B	Highland Bayou to Avenue J	120
Highland C	Highland Bayou to Highland C1	130
	Highland C1 to 28th Street	110
Highland C	Highland C to Avenue O	80
Highland D	Highland Bayou to 28th Street	120
	28th Street to McClendon	80
Highland E	Entire Length	160
Lamar Ditch	Highland Bayou to 6th Street	130
	6th Street to FM 1764	100
Castle Ditch	Entire Length	70
Highland Lateral	Entire Length	90

Continued, next page.

HALLS BAYOU WATERSHED

Ditch	Segment	Required Width (ft)
Ditch 1C	District Boundary to Briscoe Canal	150
Ditch 1 Main	Ditch 1C to Tower Rd.	150
Ditch 1	Briscoe Canal to Galveston Canal	140
	Galveston Canal to FAA Rd.	130
Ditch 1A	Ditch 1 to Ike Franks	90
Ditch 1B	Ditch 1 to Singletary	130
Ditch 2	District Boundary to Highlands Rd	150
	Highland Rd. to Ditch 2A	130
Ditch 2A	Entire Length	100
Ditch 2B	Entire Length	50
Ditch 2C	Entire Length	50
Ditch 2D	Ditch 2E to Highland Rd.	50
Ditch 2E	Ditch 2 to Highland Rd	100
	Highland Rd. to Avenue V	50
Ditch 2F	Ditch 2G to McCarty St (extended)	80
Ditch 2G	Ditch 2H to Ash St.	70
Ditch2H	Briscoe Canal to Linda	110
	Linda to Ditch 2G	80
Alta Loma Main	District Boundary to Alta Loma A	80
Alta Loma A1 (Shock Rd)	Alta Loma Main to end of Brigham Ln.	90
Alta Loma A2	Alta Loma A1 to Winding Trail	50
Cloud Bayou	District Boundary to Highland Rd	300
	Highland Rd. to Ditch 3A	240
	Ditch 3A 28th St.	220
	28th St. to 24th St	160
Ditch 3A	Cloud Bayou to Avenue O	90
	Avenue O to Avenue M (future extension)	70
Ditch 3B	Cloud Bayou to Avenue O	90
	Avenue O to Avenue L	70
Ditch 3C	Cloud Bayou to Highland Rd.	110
Ditch 3D	Cloud Bayou to channel split	120
	Ditch 3D north/south tributary	100
	Ditch 3D west/east tributaries	70
Ditch 3E (future)	Cloud Bayou to Vacek Rd.	100
Willow Bayou	District Boundary to FM 2004	300
	FM 2004 to FM 646	170
	FM 646 to Ditch Willow A	120
	Ditch Willow A to Sandy Ln.	80
Ditch Willow A	Willow Bayou to Avenue E ½	80