TECHNICAL REPORT COVERSHEET

DRAFT LOCATION HYDRAULICS REPORT

Florida Department of Transportation

District 5

S.R. 60 Project Development and Environment (PD&E) Study

Limits of Project: Prairie Lake Road to Florida's Turnpike

Osceola County, Florida

Financial Management Number: 452574-1

ETDM Number: 14563

Date: June 2025

The environmental review, consultation, and other actions required by applicable federal environmental laws for this project are being, or have been, carried out by the Florida Department of Transportation (FDOT) pursuant to 23 U.S.C. § 327 and a Memorandum of Understanding dated May 26, 2022 and executed by the Federal Highway Administration and FDOT.

| Authorized Signature | | | | |
|-----------------------------------|--|--|--|--|
| Daniel P. Shull, P.E. | | | | |
| Print/Type Name | | | | |
| Drainage Engineer | | | | |
| Title | | | | |
| 220 West Garden Street, Suite 700 | | | | |
| Address | | | | |
| Pensacola, FL 32502 | | | | |
| Address | | | | |

Issue and revision record

| Revision | Date | Originator | Checker | Approver | Description | |
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Document reference: 452574-1-22-01

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The above named Professional Engineer shall be responsible for the following sheets in accordance with Rule 61G15-23.004, F.A.C.

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1 Introduction

1.1 Purpose

Mott MacDonald (MM) has been authorized by Volkert, Inc. on behalf of the FDOT to prepare planning documents for the SR 60 improvements in Osceola County. This project begins at Prairie Lake Road on the east side of Lake Kissimmee and ends just west of the bridge crossing over SR 91 (Florida's Turnpike).

The development of a Location Hydraulics Report is essential in the preparation of the SR 60 design improvements. The primary goal of the report is to identify and evaluate floodplain impacts created by the project.

1.2 Project Description

This project involves the improvement of SR 60 from Prairie Lake Road to SR 91 in Osceola County, approximately 20 miles in total mainline length. A project location map is provided in **Figure 1**.

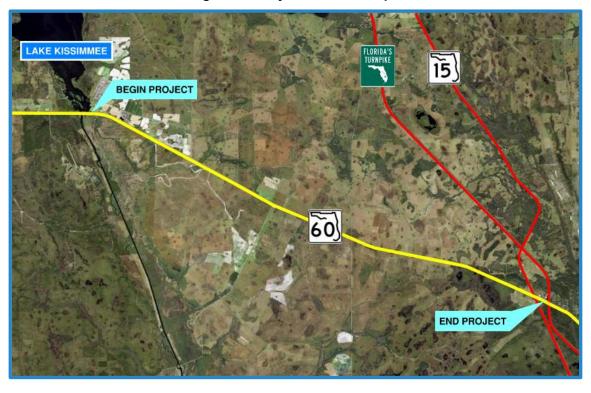


Figure 1 - Project Location Map

The existing roadway is classified as a rural principal arterial and is a two-lane, undivided roadway consisting of two 12-foot travel lanes with 4-foot outside paved shoulders in each direction.

The proposed improvements include widening to four, 12-foot travel lanes with 5-foot paved outside shoulders and 4-foot paved inside shoulders on both sides of the roadway. A median will be constructed to provide division between the opposing travel lanes. The purpose of the proposed roadway is to improve safety with considerations to the Target Zero Initiative. The project further aims to improve regional mobility by adding capacity to the mainline, which also

increases safety for motorists and bicyclists, as well as increasing emergency evacuation accessibility in the surrounding areas.

This project was evaluated through FDOT's Efficient Transportation Decision Making (ETDM) process. It is designated as project #14563. Feedback from the Environmental Technical Advisory Team (ETAT) was compiled in the Preliminary Programming Screen that was published on November 26, 2024. The impact of the proposed project was evaluated in this screen for many factors such as natural, physical, social resources, etc.

This project is located in Sections 1, 2, 11, and 12, Township 31 South, Range 31 East, Sections 1, 7, 8, 12, 15, 16, 17, 18, 22, 23, 25, 26, 29, 30 31, 32, 33, and 34, Township 31 South, Range 33 East, and Sections 5, 6, 8, 9, 10, 14, and 15, Township 32 South, Range 34 East. Elevations in this report are based on the 1988 North American Vertical Datum (NAVD).

2 Existing Conditions

2.1 Roadway

The existing typical section from the begin project to SR 15 (US 441) is a two-lane, undivided roadway consisting of two 12-foot travel lanes, as well as 4-foot outside paved shoulders in each direction. Within these limits, there are four sections of roadway that widen out to provide a passing lane. There are two passing lanes for both eastbound and westbound directions. These passing lanes are typically about 1 mile in length and provide an additional 12-foot wide lane.

Between US 441 and SR 91, the existing roadway uses a three-lane section with a two-way left turn lane separating the eastbound and westbound travel lanes. East of the SR 91 on and off-ramps, the roadway transitions to a four-lane, divided roadway prior to the overpass bridges over SR 91.

2.2 Drainage

Existing drainage infrastructure and patterns were evaluated by review of the project location through existing as-built plans and other available FDOT construction plans, Straight Line Diagrams (SLD) of Road Inventory, Geographic Information System (GIS) maps, and Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs). Further existing permit information was obtained from the St. Johns River Water Management District (SJRWMD) and the South Florida Water Management District (SFWMD).

The project limits span over six primary drainage basins and discharge into two Hydrologic Unit Code (HUC) Basins. Lake Kissimmee, Blanket Bay Slough and Skeeter Slough drain into the Kissimmee River (HUC 03090101). Lokosee ditches, unnamed ditch near Yeehaw Junction, and unnamed tributary to Cow Log Branch drain into the Upper St. Johns (HUC 03080101).

The land use is primarily agriculture with commercial and mixed use near US 441 and SR 91. The existing drainage for SR 60 from Prairie Lake Road to SR 91 consists predominantly of flat, open ditches that convey runoff to existing cross drain locations. Runoff generally leaves the right-of-way at these cross drain locations to either an existing channel or a man-made ditch. Much of the surrounding area is used for agricultural purposes and irrigation ditches or canals are present just outside the existing right-of-way in many locations on the project. Most of these irrigation canals are located on the north side of the roadway and many do not receive any flow from the Department's right-of-way unless under an extreme event. These locations are generally assumed to be isolated basins that contain runoff from offsite areas. However, there are some locations where runoff does leave the R/W and drain into these man-made canals. Refer to **Appendix D** for Drainage Maps of the project area.

2.2.1 Basin Divides and Outfalls

The existing drainage divides were determined using one-foot contours generated from LiDAR data from NOAA Coastal Service Center's Digital Coast Data Access Viewer and the USGS topographic quad maps.

Overall, the project was delineated into 27 mainline subbasins as shown in the Drainage Maps. All basins are considered open basins. **Table 1** below lists the limits of the existing drainage basins and the associated cross drains.

Table 1 - Basin Limits and Cross Drains

| Basin | Existing Ba | sin Limits | Waterbody | | | Out | all |
|-------|--------------|------------|-----------|---------------------------------------|--------|----------------------|---------|
| No. | From Station | To Station | ID ´ | Watershed | WMD | Type | Station |
| 1 | 14+10.00 | 72+50.00 | 3183E2 | Lake Kissimmee | SFWMD | Ditch | 20+00 |
| 2 | 72+50.00 | 158+75.00 | 3186G | Blanket Bay Slough | SFWMD | 30" CD | 134+63 |
| 3 | 158+75.00 | 188+45.00 | 3186G | Blanket Bay Slough | SFWMD | 30" CD | 179+38 |
| 4 | 188+45.00 | 214+45.00 | 3186G | Blanket Bay Slough | SFWMD | 36" CD | 197+93 |
| 5 | 214+45.00 | 257+00.00 | 3186G | Blanket Bay Slough | SFWMD | 30" CD | 231+91 |
| 6 | 257+00.00 | 290+75.00 | 3186G | Blanket Bay Slough | SFWMD | Bridge | 290+75 |
| 7 | 290+75.00 | 324+90.00 | 3186G | Blanket Bay Slough | SFWMD | Bridge | 290+75 |
| 8 | 324+90.00 | 357+30.00 | 3186G | Blanket Bay Slough | SFWMD | 24" CD | 326+17 |
| 9 | 357+30.00 | 386+80.00 | 3186G | Blanket Bay Slough | SFWMD | 24" CD | 359+88 |
| 10 | 386+80.00 | 402+50.00 | 3186G | Blanket Bay Slough | SFWMD | 30" CD | 391+46 |
| 11 | 402+50.00 | 477+55.00 | 3186F | Skeeter Slough | SFWMD | 36" CD | 415+23 |
| 12 | 477+55.00 | 487+00.00 | 3186F | Skeeter Slough | SFWMD | 24" CD | 481+92 |
| 13 | 487+00.00 | 551+95.00 | 3186F | Skeeter Slough | SFWMD | 8'X3' CBC | 540+56 |
| 14 | 551+95.00 | 570+30.00 | 3186F | Skeeter Slough | SFWMD | 24" CD | 562+90 |
| 15 | 570+30.00 | 611+70.00 | 3186F | Skeeter Slough | SFWMD | 8'X3' CBC | 584+20 |
| 16 | 611+70.00 | 632+75.00 | 3186F | Skeeter Slough | SFWMD | 30" CD | 626+59 |
| 17 | 632+75.00 | 670+60.00 | 3186F | Skeeter Slough | SJRWMD | 30" CD | 638+99 |
| 18 | 670+60.00 | 695+10.00 | 3186F | Skeeter Slough | SJRWMD | 30" CD | 684+77 |
| 19 | 695+10.00 | 757+40.00 | 3186F | Skeeter Slough | SJRWMD | 30" CD | 705+90 |
| 20 | 757+40.00 | 812+90.00 | 3186F | Skeeter Slough | SJRWMD | 24" CD | 782+44 |
| 21 | 812+90.00 | 869+55.00 | 3148 | Unnamed Ditch Near Yeehaw Junction | SJRWMD | 6'X3' CBC | 860+86 |
| 22 | 869+55.00 | 889+65.00 | 3143 | Lokosee Ditches | SJRWMD | 6'X3' CBC | 872+89 |
| 23 | 889+65.00 | 915+80.00 | 3148 | Unnamed Ditch Near Yeehaw Junction | SJRWMD | 36" CD | 912+04 |
| 24 | 915+80.00 | 937+90.00 | 3148 | Unnamed Ditch Near Yeehaw Junction | SJRWMD | 36" CD | 929+65 |
| 25 | 937+90.00 | 999+20.00 | 3148 | Unnamed Ditch Near Yeehaw Junction | SJRWMD | 8'X5' CBC | 959+64 |
| 26 | 999+20.00 | 1046+35.00 | 3148 | I S IRWWID I | | CD – Size Unknown | 1039+29 |
| 27 | 1046+35.00 | 1079+70.00 | 3148 | Unnamed Ditch Near Yeehaw Junction | SFWMD | 19"x30" CD | 1068+00 |

3 Proposed Conditions

3.1 Proposed Roadway Configuration

The proposed roadway improvements strive to improve safety by accounting for the Target Zero Initiative. The capacity and operations for this roadway will be improved by utilizing both rural and urban typical sections.

For much of the project, the existing roadway will be reconstructed to use a rural typical. This will include two 12-foot lanes, a 5-foot paved outside shoulder, and 4-foot paved inside shoulder in each direction. A 40-foot median will be constructed to divide the eastbound and westbound lanes. Most of the project will utilize a 15-foot wide ditch to provide linear retention for stormwater requirements. This ditch is proposed to be constructed 3-feet above the seasonal high water level to provide sufficient separation from the water table and improve recovery performance. A modified version of this typical section is proposed to be used at the beginning of the project to reduce the footprint and impacts of the roadway. This modified rural typical section will have the same roadway characteristics, but will not use linear retention for stormwater requirements. Instead, a minimal ditch will be constructed on either side of the roadway to collect runoff. A closed drainage system will be used to collect runoff from this ditch and convey it to an offsite stormwater pond.

As the roadway nears US 441, the typical section will transition to an urban typical section to minimize impacts. This typical section will consist of two 12-foot lanes and a 7-foot bike lane on each side of the roadway separated by a 22-foot median. Type E curb will be used along the median and Type F curb constructed along the outside of the roadway. 6-foot sidewalks will be constructed on either side directly behind the curb and gutter. Figures 2, 3 and 4 illustrate the proposed typical sections for the roadway.

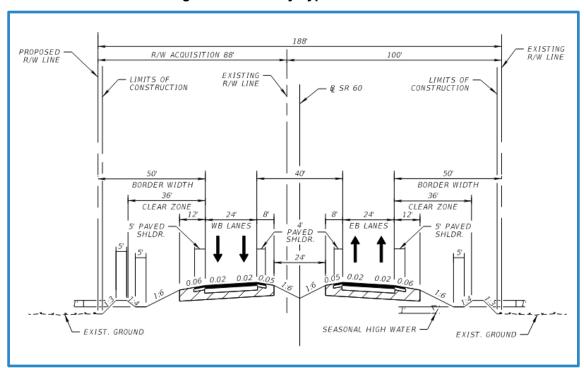


Figure 2 - Roadway Typical Section 1

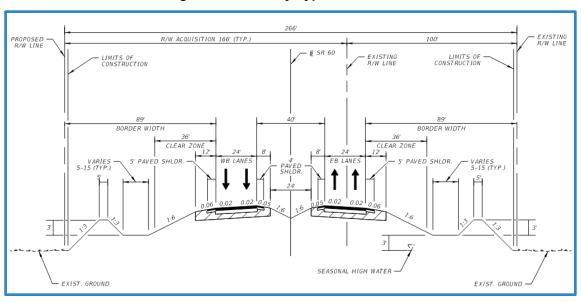
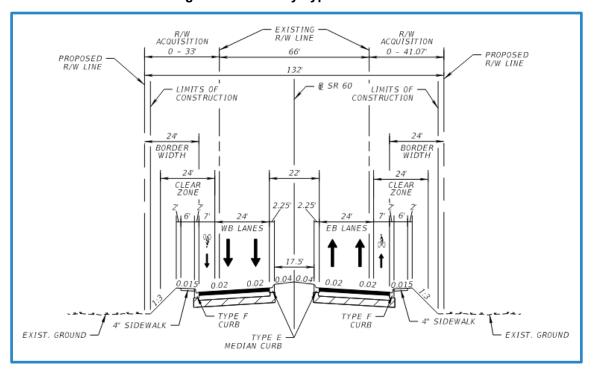


Figure 3 - Roadway Typical Section 2

Figure 4 - Roadway Typical Section 3



3.2 Proposed Drainage

Most of the project will utilize linear retention on either side of the roadway for stormwater requirements. Runoff from the median will be conveyed in a ditch and collected in ditch bottom inlets and piped under the roadway to the linear retention pond on either side of the roadway. The linear retention systems will be sized to provide sufficient treatment and attenuation volume for the basins. Outfall systems will discharge runoff from the linear treatment systems to the existing outfall location, which is typically near the existing cross drains.

As mentioned in the previous section, the beginning portion of the project will have a rural typical section but will not use linear retention for stormwater. This section of roadway will instead have minimal roadside ditches with an inlet system within the ditch to collect and convey runoff to an offsite stormwater pond. Similarly, the end of the project will use an urban typical section that will have a closed system to collect runoff along the curb and gutter and this system will be piped to an offsite stormwater pond.

Offsite drainage conditions for all basins will be maintained and routed to existing cross drains and outfalls. Unless unavoidable, these offsite basins will not be co-mingled with the onsite runoff from SR 60.

4 Cross Drain Evaluation

There are currently 24 cross drains within the project limits. These cross drains were summarized in Section 2 of this report in Table 1. FDOT straight line diagrams were used to identify the location and size of the existing crossings. Refer to **Appendix E** for these diagrams.

FDOT Maintenance was contacted during the pre-advertisement and did not note any specific drainage or flooding concerns within the limits. Per the *FDOT Drainage Design Guide* Section 4.7.1, Method 1 was chosen for conducting hydrologic and hydraulic analysis since there are no known historical problems in the area. Method 1 estimates the 25-year discharge using the culvert area and an assumed velocity of 6 feet per second. The 100-year flow was estimated as being 40% larger than the 25-year discharge and the 500-year flow was estimated as being 70% larger than the 100-year discharge. The 50-year discharge was then determined reading from a best fit curve of flow vs. frequency of the 25, 100, and 500-year events. A hydraulic analysis was then conducted to estimate stages for these various frequency events using FHWA HDS 5 techniques. All charts listed below are within the FHWA Hydraulic Design of Highway Culverts – Hydraulic Design Series Number 5 (HDS 5).

Headwaters were calculated for both inlet and outlet control conditions. For inlet control, headwater depths were determined using data from Chart 1B for pipes and from Chart 8B for box culverts. For outlet control, entrance loss coefficients (Ke) were selected based on the type of end treatments for the pipe or box culvert. Factors for pipes were then determined using Charts 5B and 4B. Factors for box culverts were determined using Chart 15B and 14B.

The controlling headwater condition, either inlet or outlet control, was determined for each cross drain based on the higher computed stage. Refer to **Appendix C** for the cross drain calculations. These results gave preliminary recommendations for replacement, resizing, or rehabilitation of existing structures to ensure compliance with FDOT hydraulic performance criteria. Based on the methodology used, many of the cross drains show headwaters for the design event that are higher than the existing shoulder point. During the design phase, a full hydrologic and hydraulic analysis should be performed that would account for the characteristics of the contributing basin. The proposed roadway will likely be raised significantly above existing at most cross drain locations. Therefore, meeting headwater requirements for the design storm is likely not a concern, but raising the stages of areas outside of the right-of-way should be evaluated.

There is one existing bridge within the project limits. SR 60 currently crosses over Blanket Bay Slough with an approximately 120-foot bridge (#920172) that was constructed in 1999. A separate Bridge Hydraulics Report has not been prepared as part of this PD&E Study.

5 Floodplain Evaluation

Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA) were reviewed to assess potential floodplain involvement within the project limits (see **Table 2**). The current effective FIRMs for Osceola County, dated 2013, indicate multiple areas of encroachment into Special Flood Hazard Zone A, and one area of encroachment into Zone AE. Refer to **Appendix A** for the FEMA FIRM panels within the project limits.

| Map No. | Effective Date |
|-------------|----------------|
| 12097C0725G | 6/18/2013 |
| 12097C0750G | 6/18/2013 |
| 12097C0850G | 6/18/2013 |
| 12097C0875G | 6/18/2013 |

Table 2 - FEMA FIRMs

As required by the applicable water management districts, the project must avoid any net loss of flood storage volume within the 100-year floodplain. Given the proposed roadway improvements and the ultimate typical section, all designated floodplain areas located within the project right-of-way are anticipated to be impacted. Consequently, floodplain compensation will be necessary to offset the loss of storage volume.

Fifteen locations have been identified that will impact the FEMA floodplain. These locations are identified on the FEMA FIRM panels in **Appendix A** and summarized in Table 3. Most of these encroachments are considered transverse, however there are some locations of longitudinal encroachments. These longitudinal impacts are due to impacts to existing irrigation ditches and low areas that run parallel to SR 60. As discussed in the Conceptual Drainage Design Report, many of these irrigation ditches are to be impacted due to the widening of the roadway. It is anticipated that many of these would be reconstructed by the property owner outside of the proposed right-of-way to maintain patterns of their existing agricultural facilities. Most of the surrounding project area is used for agriculture or is undeveloped. Some of the undeveloped areas are conservation areas. Due to the characteristics of the surrounding area, the floodplain encroachments are considered minimal. There is floodplain involvement, but these encroachments will not impact human life or transportation facilities. Mitigation to these impacts can be resolved with minimal efforts.

Floodplain A is the only location that is within Zone AE. All other floodplain areas are within Zone A and therefore do not have a base flood elevation identified. To estimate impacts to the floodplain, preliminary cross sections were created using available LiDAR data and an approximate proposed typical section. These sections were drawn at each end of a floodplain area and every 500-feet in between. A floodplain elevation was then drawn in the cross section, using either the base flood elevation provided for Zone AE or an approximate elevation of the Zone A floodplain areas using the LiDAR data. Fill impacts were then drawn within each cross section for areas of proposed fill below the approximated floodplain elevation. Volumes of impacts for each floodplain area were calculated using the average end-area method. Refer to **Appendix B** for the floodplain impact calculations.

The floodplain impacts shown will need to be mitigated for using floodplain compensation sites. Floodplain compensation sites have not been identified as part of this PD&E Study, as only the estimated volume of floodplain compensation has been quantified. Compensation sites will

need to ensure that there is sufficient fill below the floodplain elevation and above seasonal high water table that can be excavated out to provide an offset to fill added as part of this project.

Table 3 – Estimated Floodplain Impacts Areas for North Shift Alternative

| Floodplain | Flood Zone | Base Flood Elevation (ft) | Floodplain Encroachment Volume (acre-feet) |
|------------|------------|------------------------------------|---|
| А | AE | 54 | 11.14 |
| В | Α | - | 2.47 |
| С | Α | - | 5.93 |
| D | Α | - | 12.34 |
| Е | Α | - | 10.57 |
| F | Α | - | 2.04 |
| G | Α | - | 15.65 |
| Н | Α | - | 0.10 |
| I | А | - | 28.23 |
| J | А | - | 7.66 |
| K | Α | - | 2.76 |
| L | Α | - | 6.98 |
| М | Α | - | 10.10 |
| N | Α | - | 6.77 |
| 0 | Α | - | 0.05 |
| | | TOTAL | 122.78 |

6 Conclusion

The roadway widening of SR 60 from Prairie Lake Road to SR 91 will impact numerous floodplains with the project limits. An estimation of these impacts has been quantified. Mitigation to offset these impacts will be needed and specific compensation sites will be identified during the design phase of the project. Existing cross drains have also been evaluated for estimation of flow rates and headwaters at each crossing location. This report is preliminary and should be used as a tool for evaluation of potential impacts to the floodplains and performance of cross drains within the project. Any assumptions made within this report will be verified and updated through the design process.

APPENDIX A – FEMA Flood Insurance Rate Maps

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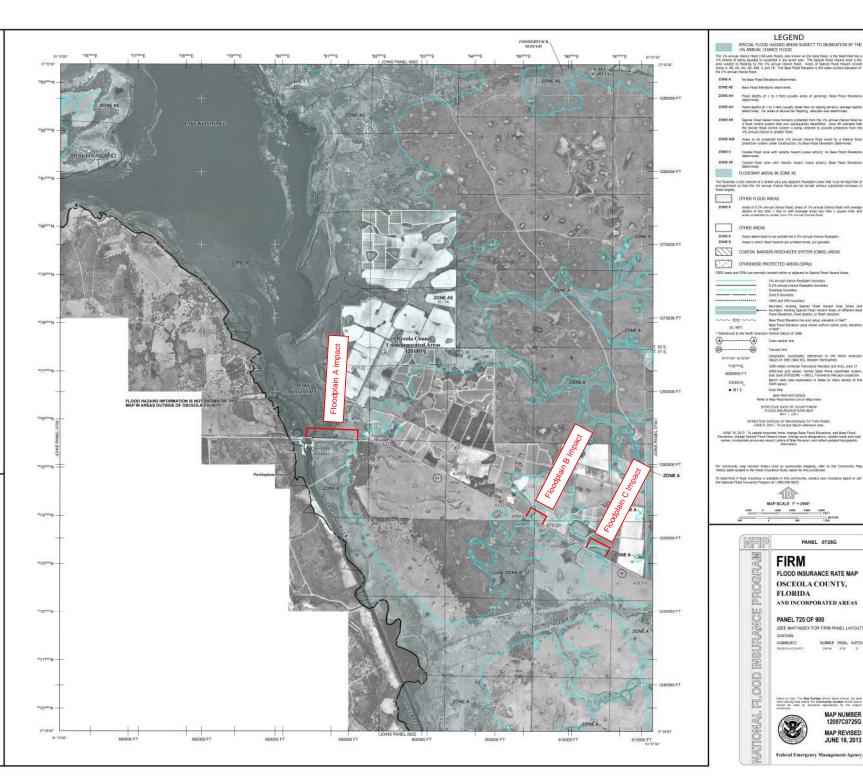
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ember to the apparability printed Map Rodes for an overview map of the county, ing the layout of map parels; community map repository addresses; and a of Communities table containing National Food insurance Program dates for community as well as a listing of the panels on which each community is

For information and questions about this map, available products associated with the IRBM market present or the IRBM market present of the IRBM market prese

The "graftle base lines" depicted on this map represent the hydrautic modeling baselines that match the flood profiles in the FIS report. As a result of improved topograptic data, the "profile base line;" in second cases, may deviate significantly from the channel centerline or appear outside the SFHA.



LEGEND

Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Sevations distanced. Flood depths of 1 to 3 feet (usually sheet flow on xloping terrain); seerage depths determined. For areas of alluvial fan flooding, velocities also determined.

Coercial flood zone with velocity hazard (verve action); no Sene Flood Severices Coesal flood zone with velocity hazard (wave action); Base Flood Sevictors

Ares of IV.Th annual chance floor; areas of 1% annual chance flood with average depths of less than 1, floor or with disprage areas less than 1 square miles and assess majorated to leveau floor 1% areas chance floor.

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Hood Elevations, flood depths, or flood velocities

See Flood Devision fee and value; elevation in feet.*
See Flood Elevation value where uniform within core; elevation
in feet.*

Geographic coordinates referenced to the North American Datum of 1983 (NAC 83), Western Hemisphere

1006-metric Universal Transverse Percator grid Sicks, zone 17 9006-foot grid values: Floods State Plante coordinate system, 5xx Zone (FFFSCOME = 6981), Tonneverse Mercator projection Banch mark (see explanation in Notes to Users section of the ISSM parks).

PANEL 0725G

FLOOD INSURANCE RATE MAP OSCEOLA COUNTY, FLORIDA AND INCORPORATED AREAS

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

Federal Emergency Management Agency

MAP NUMBER

MAP REVISED

JUNE 18, 2013

MAP REPOSITORIES Refer to Map Repositories List on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE NATE MAP MAY 7, 2001 EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL.
JUNE 6, 2001 - To ported deturn reference note.

1 MAP SCALE 1" = 2000" 1,008 8 1,000 1,000 1,000 1,000 FEE 484

FIRM

PANEL 725 OF 900

CONTAINS:

INSURANCE

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ATTONAL

This map is for use in adminishering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage excitors of small stee. The community map repository should be consulted for possible updated or additional flood fazzard information.

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Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The foodways were based on hydraulic considerations with regard to requirements of the hadronal Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report

Certain areas not in Special Flood Hearrd Aveas may be protected by flood control structures. Refer to Section 2.4 "Flood Protection Measures" of the Floo-Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was Timeravanes Marcator State Paraira Florida East FIRS 9091. The herizonate ideath mass NADSS AHARI, GRESTIES spheroid. Differences in datum, spheroid, projection or State Flore cores used in the production of FIRMs for adjacent plantations may result in slight positional differences in map features across jurisdiction boundaries. These differences do not effect the accuracy of the FIRMs.

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NGS Information Services NGAA, NINGS12 National Geodelic Survey SSMC-3, #9202 1315 East-West Highway SNW Spring, Maryland 20940-3282 (201) 713-3242

To obtain current elevation, description, and/or location information for bench marks store on this map, please confact the Information Services Branch of the National Geodetic Servey at (391) 713-3282 or win its settled

Base map information shown on this FIRM was provided in digital format by the Discola County Planning Office. Orthophotography was collected in tale 2007 early 2008.

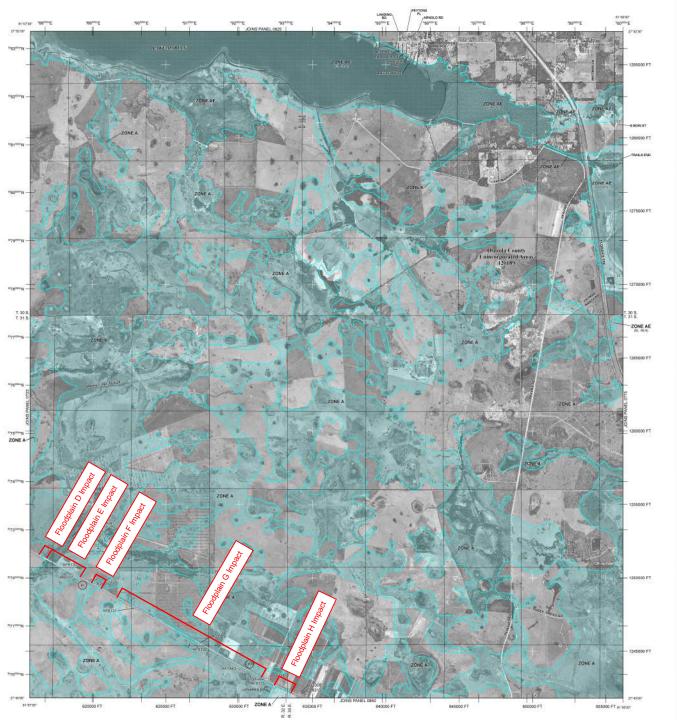
This map refects more detailed and up-to-date steam channel configurations has have shown on the previous FISII for the justication. The footblass and footblass part footb

Corporate iterits shown on this map are based on the best data available at the time of pusication. Secause changes due to annexations or de-annexations may have occurred other this map was published, map users should context appropriate community officials to world cannot corporate limit locations.

Please refer to the separately printed Map lindax for an overview map of the countyshowing the layout of map panels; community map repository addresses; and in Lating of Communities table containing National Plood Insurance Program dates for each continuity as well as a listing of the parests on which each community is

For information and questions about this area, weaking products associated with the FIRM estation behavior eventure of the FIRM. Two for other residues of the National Flood instance Program is general, private cell in FIRM. Mapping information for the program is general, private cell in FIRM. Mapping information weeking all https://www.mchemagaid...html product previous section of the product product product product previous section of the major product previous sections of the major product product product from the exhibit. Uses may determine the current raisp size for each FIRM parel by from the exhibit. Uses may determine the current raisp size for each FIRM parel by formation and the product of the product of the product for the product of the product of the product for the product of the product of the product for the product of the product of the product for the prod

The "grafile base lines" depicted on this map represent the hydrausic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the "profile base line", in some cases, may deviate algorithmic from the channel confidering on appear outside the SFHA.





MAP NUMBER 12097C0750G MAP REVISED

JUNE 18, 2013

Federal Emergency Management Agency

LEGEND

This map is for use in administering the National Flood Insurance Program. It does not recessarily identity at areas subject to flooding, particularly from food challege sources of small size. The community map repository should be consulted for

To dolar more delabel elimination in erasis where Base Flood Elevations (DFE) for the property of the property

Coastal Base Flood Elevelanes (BFEs) shows on this map apply only landward of 0.7 Morth American Medical Claims of 1988 (Mol. 201). Uses a create 1998 shall be 1999 (Mol. 201). Uses a create 1999 of 1999 (Mol. 201). Uses a create 1999 of 1999 of 1999 (Mol. 201). Elevelanes table in the Flood Inscriptors (Mol. 1999 of 1999

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The Scodways were based on hydrautic considerations with regard to registrement of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 2.4 "Flood Protection Measures" of the Flood. Insurance Study report for information on flood control structures for this jurisdiction.

The projection used in the preparation of this map was Transverse Microsofte State Plane Prints East PIPS 0001. The horizontal statem was NADIS 14494, CRS1190 period. Deferrors in data, special, projection of State Pieter cores used in period. The core of the PIPS of the PIPS of the PIPS of the cores used in differences in map hadrons across prindiction boundaries. These differences do not show the accuracy of the PIPS.

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NISS Information Services NOAA, NINGS12, National Canadesic Survey SSMC-3, #9202 1315 East-West Highway Silver Spring, Maryland 20910-3282 (201) 713-3242

To obtain commit elevation, description, and/or location information for bench marks shown on this map, please contact the information Services Branch of the Nationa Geodetic Survey at (201) 713-2242 or wisk its verbolin of http://www.ncs.ncea.goad

Base map information shown on this FIRM was provided in digital format by the Oscaria County Manning Office. Onthophotography was collected in late 2007 early 2009.

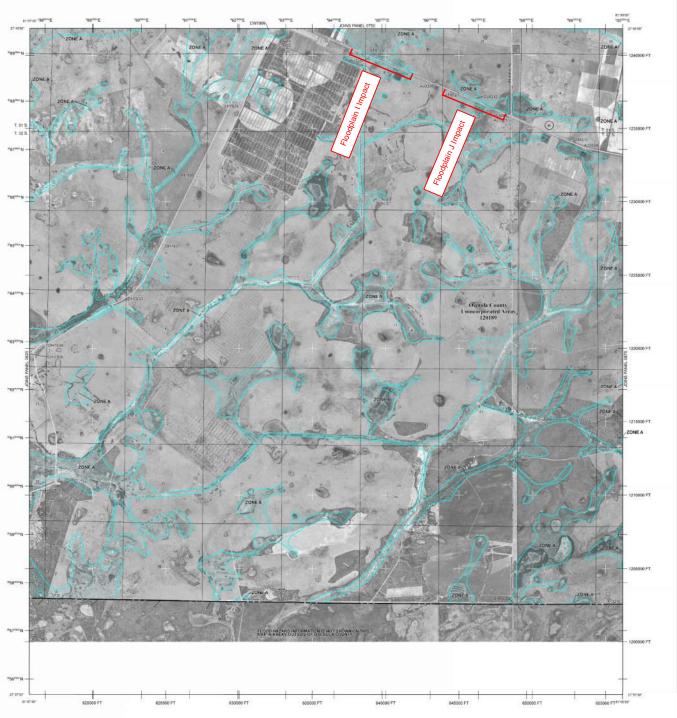
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Corporate limits shown on this map are based on the best data available at the time of publication. Recurse changes the to accessorates or de amenations may have occurred when this map was published, may such such studied appropriate consequently officials to worky current corporate intel locations.

Please refer to the separately printed Mag leides for an overview map of the country showing the liquid of neg sensis, community may repositiny addresses, and a Listing of Communities table containing National Robot Hearston Program dates the each convexity as well as a Bellag of the penels on which each convexity is located.

For information and questions should from mac, available products associated with this FIRM collader position, coverage of the FIRM. The to set the products of the FIRM that the set of the FIRM collader position of the FIRM that the FIRM th

The "profile base lines" depicted on this map represent the hydraulic modeling beseines that meant the flood profiles in the FIS report. As a result of improved bacquartic data, the "profile base line", in serior cases, may deviate significantly from the character certains or appear outside the STHA.



SPECIAL FLOOD HAZARD AREAS SUBJECT TO INLINDATION BY THE 1% ANNUAL CHARGE FLOOD ZONE AE Rase Flood Elevations determined. ZONEAH Rood depths of 1 to 3 first (usually areas of ponding); liese Flood Desistons determined. Ploof depths of 1 to 5 feet (usually sheet flow on sloping terrain); average depths ofermines. His areas of allusial fan flooding, velocities also determines. Coestal Road zone with velocity healed (wave action); no Base Road Elevations interviewed. ZONEVE Cantal food zone with velocity faulant (were action); Salar Food Develores PLOODWAY AREAS IN ZONE AE The floodway is the channel of a streen plus any adjacent floodplain areas that must be large line of exchangement so that the 1% annual channel floot can be canned without substantial increases in flood keeping. OTHER PLOOD AREAS Areas of 0.2% annual chance flood, wreas of 1% annual chance flood with average depths of less than 1 floot or with challenge areas, less than 1 square mile, and areas projected to levies from 1% annual chance flood. OTHER AREAS ZONE X Areas determined to be outside the 0.3% annual chance flootplain.
ZONE D Areas in which floot hazards are undetermined, but possible. COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS OTHERWISE PROTECTED AREAS (OPAs) I'lls simual chance floodplain boundary 0.2% simual chance floodplain boundary Floodway boundary Zone D boundary CBRS and CPA bouncery Roundary cividing Special Flood Hazerd Area Zones and boundary dividing Special Flood Hazerd Areas of different base Flood Developin, flood depths, or flood velocities --- 513 ---Base Flood Develop line and value: elevation in feet* base Flood Cleviston value where uniform within zone; in feet* in Westkist Dietum of 1986 leferment to the North Geographic coordinates referenced to the North American Delum of UNIX (NAD BI), Western Herrughere NT STATE \$2.2230" 1000 meter Linkvisul Transvisie Mercular gelt taks, zone 17 1000-hot gelt valuts: Handa State Plane socidente system, East Zone (FPSCOME = 9001), Transvisie Mercular projection Resolt noise (see explanation in Notes to Users section of this FIRM gares) 0000000 FT DX5510_ MAP REPOSITORIES

Refer to Map Repositories Link on Map Index EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP MAY 7, 2001 EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL.
JUNE 6, 2001 - To correct datum reference role. JUNE 16, 2010 - To update corporate limits, change Base Flood Exhadians, and Base Flood Elevations, strange Spoolal Flood House Annes, sharpy zone strangarious, update reads and re-traines, incorporate previously lieused Letters of May Revision, and reflect updated topographic for community map revision finitory given to countywide mapping, refer to the Community Plap History latels located in the Flood Insurance Study report for this particulation. To determine if food incurance is available in this community, contact your insurance agent or call the balance from Insurance Document is 1,800,630 (620). 1 MAP SCALE 1" = 2000" 1,002 8 1,000 2,000 2,000 4,000 11,000 1,000 1,000 PANEL 0850G **FIRM** FLOOD INSURANCE RATE MAP OSCEOLA COUNTY. FLORIDA AND INCORPORATED AREAS PANEL 850 OF 900 INSURANC (SEE MAP INDEX FOR FIRM PANEL LAYOUT) CONTAINS. 000 T. MAP NUMBER

12097C0850G MAP REVISED

JUNE 18, 2013

Federal Emergency Management Agency

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To come more detabled information in cross whore Stee Phond Elevations (SFE) and/or Studenty's three the elevations of the steep of the cross of the Phond control of the steep of the cross of the Phond control of the steep of the cross of the Phond control of the cross of the cross of the Phond control of the cross of the cross of the Phond control of the cross of th

Netional Geodetic Survey SSNC-3, #3202 1316 East-West Highway Silver Spring, Monyland 20910-3282 (301) 713-3242

To obtain current elevation, description, and/or location information for bench marks shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at https://www.nas.nase.gov/

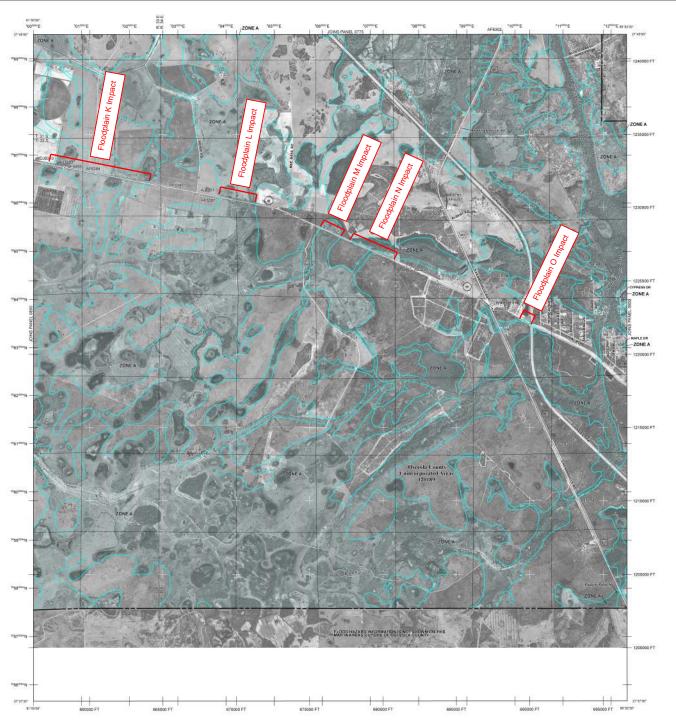
This map which more soluted and up-to-date stream channel configurations than those shown on the previour FMR for the introduction. The foodbased solutions are foodbase that were considered from the previour FMR may have been objected on confirm to these was stream channel configurations. As a result, the Proof Professional Configuration is an excell, the Proof Professional Configuration is an excell the Proof Professional Configuration in the security of the the

Corporate limits shown on this rarg are based on the best date available of the lime of publication. Business through our to emissations or de-emiscations rary have occurred after this map year, published, map issees, should connect appropriate community officials to welly current corporate into locations.

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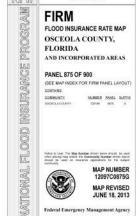
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The "graftle base lines" depicted on this map represent the hydrautic modeling baselines that match the flood profiles in the FIS report. As a result of improved topograptic data, the "profile base line;" in second cases, may deviate significantly from the channel centerline or appear outside the SFHA.





LEGEND



APPENDIX B – Floodplain Impact Calculations

| | | Floodpla | ain A Impacts | 3 | | |
|---------|----------------------|----------------|---------------|---------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1006+00 | 750 | 375 | | | | |
| | | | 700 | 226,399 | 8,385 | 5.197 |
| 1013+00 | 543.71 | 271.855 | | | | |
| | | | 200 | 57,438 | 2,127 | 1.319 |
| 1015+00 | 605.04 | 302.52 | | | | |
| | | | 500 | 95,233 | 3,527 | 2.186 |
| 1020+00 | 156.82 | 78.41 | | | | |
| | | | 500 | 50,195 | 1,859 | 1.152 |
| 1025+00 | 244.74 | 122.37 | | | | |
| | | | 500 | 41,608 | 1,541 | 0.955 |
| 1030+00 | 88.12 | 44.06 | | | | |
| | | | 500 | 12,790 | 474 | 0.294 |
| 1035+00 | 14.2 | 7.1 | | | | |
| | | | 400 | 1,420 | 53 | 0.033 |
| 1039+00 | 0 | 0 | | | | |

17,966 CY

11.136 acre-ft

| | | Floodpl | ain B Impacts | | | |
|---------|----------------------|----------------|---------------|--------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1165+00 | 0 | 0 | | | | |
| | | | 500 | 34,060 | 1,261 | 0.782 |
| 1170+00 | 272.48 | 136.24 | | | | |
| | | | 500 | 53,810 | 1,993 | 1.235 |
| 1175+00 | 158 | 79 | | | | |
| | | | 300 | 19,516 | 723 | 0.448 |
| 1178+00 | 102.21 | 51.105 | | | | |
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| | | | | | | |

3,977 CY

2.465 acre-ft

| | Floodplain C Impacts | | | | | | | |
|---------|----------------------|----------------|--------|--------|--------|-----------|--|--|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume | | |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) | | |
| 1210+00 | 290.86 | 145.43 | | | | | | |
| | | | 500 | 85,850 | 3,180 | 1.971 | | |
| 1215+00 | 395.94 | 197.97 | | | | | | |
| | | | 500 | 98,711 | 3,656 | 2.266 | | |
| 1220+00 | 393.75 | 196.875 | | | | | | |
| | | | 500 | 73,663 | 2,728 | 1.691 | | |
| 1225+00 | 195.55 | 97.775 | | | | | | |
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| | | | | | | | | |

9,564

CY

5.928

acre-ft

| | | Floodpl | ain D Impacts | } | | |
|---------|----------------------|----------------|---------------|---------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1265+00 | 86.44 | 43.22 | | | | |
| | | | 500 | 68,600 | 2,541 | 1.575 |
| 1270+00 | 462.36 | 231.18 | | | | |
| | | | 500 | 161,788 | 5,992 | 3.714 |
| 1275+00 | 831.94 | 415.97 | | | | |
| | | | 500 | 307,100 | 11,374 | 7.050 |
| 1280+00 | 1624.86 | 812.43 | | | | |
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19,907 CY

12.339 acre-ft

| | | Floodpl | ain E Impacts | | | |
|---------|----------------------|----------------|---------------|---------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1280+00 | 1624.86 | 812.43 | | | | |
| | | | 500 | 279,289 | 10,344 | 6.412 |
| 1285+00 | 609.45 | 304.725 | | | | |
| | | | 500 | 123,839 | 4,587 | 2.843 |
| 1290+00 | 381.26 | 190.63 | | | | |
| | | | 500 | 52,529 | 1,946 | 1.206 |
| 1295+00 | 38.97 | 19.485 | | | | |
| | | | 500 | 4,871 | 180 | 0.112 |
| 1300+00 | 0 | 0 | | | | |
| | | | 500 | 0 | 0 | 0.000 |
| 1305+00 | 0 | 0 | | | | |
| | | | | | | |
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| | | | | | | |

17,057 CY

10.572 acre-ft

| | | Floodpl | ain F Impacts | | | |
|---------|----------------------|----------------|---------------|--------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1310+00 | 263.04 | 131.52 | | | | |
| | | | 500 | 53,539 | 1,983 | 1.229 |
| 1315+00 | 165.27 | 82.635 | | | | |
| | | | 500 | 28,014 | 1,038 | 0.643 |
| 1320+00 | 58.84 | 29.42 | | | | |
| | | | 500 | 7,355 | 272 | 0.169 |
| 1325+00 | 0 | 0 | | | | |
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| | | | | | | |

3,293 CY

2.041 acre-ft

| | | Floodpl | ain G Impacts | | | |
|---------|----------------------|----------------|---------------|---------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1330+00 | 537.71 | 268.855 | | | | |
| | | | 500 | 121,918 | 4,515 | 2.799 |
| 1335+00 | 437.63 | 218.815 | | | | |
| | | | 500 | 111,591 | 4,133 | 2.562 |
| 1340+00 | 455.1 | 227.55 | | | | |
| | | | 500 | 113,655 | 4,209 | 2.609 |
| 1345+00 | 454.14 | 227.07 | | | | |
| | | | 500 | 111,729 | 4,138 | 2.565 |
| 1350+00 | 439.69 | 219.845 | | | | |
| | | | 500 | 88,683 | 3,285 | 2.036 |
| 1355+00 | 269.77 | 134.885 | | | | |
| | | | 500 | 59,925 | 2,219 | 1.376 |
| 1360+00 | 209.63 | 104.815 | | | | |
| | | | 500 | 74,081 | 2,744 | 1.701 |
| 1365+00 | 383.02 | 191.51 | | | | |
| | | | 500 | 90,294 | 3,344 | 2.073 |
| 1370+00 | 339.33 | 169.665 | | | | |
| | | | 500 | 68,940 | 2,553 | 1.583 |
| 1375+00 | 212.19 | 106.095 | | | | |
| | | | 500 | 71,319 | 2,641 | 1.637 |
| 1380+00 | 358.36 | 179.18 | | | | |
| | | | 500 | 69,124 | 2,560 | 1.587 |
| 1385+00 | 194.63 | 97.315 | | | | |
| | | | 500 | 30,411 | 1,126 | 0.698 |
| 1390+00 | 48.66 | 24.33 | | | | |
| | | | 500 | 11,476 | 425 | 0.263 |
| 1395+00 | 43.15 | 21.575 | | | | |
| | | | 500 | 37,519 | 1,390 | 0.861 |
| 1400+00 | 257 | 128.5 | | | | |
| | | | 500 | 125,324 | 4,642 | 2.877 |
| 1405+00 | 745.59 | 372.795 | | | | |
| | | | 500 | 115,283 | 4,270 | 2.647 |
| 1410+00 | 176.67 | 88.335 | | | | |
| | | | 500 | 75,476 | 2,795 | 1.733 |
| 1415+00 | 427.14 | 213.57 | | | | |
| | | | 500 | 86,981 | 3,222 | 1.997 |
| 1420+00 | 268.71 | 134.355 | | | | |
| | | | 500 | 76,421 | 2,830 | 1.754 |
| 1425+00 | 342.66 | 171.33 | | | | |
| | | | 500 | 86,236 | 3,194 | 1.980 |
| 1430+00 | 347.23 | 173.615 | | | | |
| | | | 500 | 64,975 | 2,406 | 1.492 |
| 1435+00 | 172.57 | 86.285 | | | | |
| | | | 500 | 30,180 | 1,118 | 0.693 |
| 1440+00 | 68.87 | 34.435 | | | | |
| | | | 500 | 8,609 | 319 | 0.198 |
| 1445+00 | 0 | 0 | | * | | |

| TOTAL | 25,244 CY | 15.647 | acre-ft |
|-------|-----------|--------|---------|

| | | Floodpl | ain H Impacts | } | | |
|---------|----------------------|----------------|---------------|--------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1455+00 | 0 | 0 | | | | |
| | | | 500 | 2,151 | 80 | 0.049 |
| 1460+00 | 17.21 | 8.605 | | | | |
| | | | 500 | 2,151 | 80 | 0.049 |
| 1465+00 | 0 | 0 | | | | |
| | | | | | | |
| | | | | | | |

| _ | | | | |
|-------|-----|----|-------|---------|
| TOTAL | 159 | CY | 0.099 | acre-ft |
| | | | | |

| Station ORD Measured XS Area (SF) Actual XS Area (SF) Length (FT) Volume (CF) Volume (CY) 1510+00 427.98 213.99 500 106,043 3,928 1515+00 420.36 210.18 500 132,101 4,893 1520+00 636.45 318.225 500 179,165 6,636 1525+00 796.87 398.435 500 195,686 7,248 1530+00 768.62 384.31 500 208,519 7,723 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 400 2704 2704 | | | | ain I Impacts | Floodpl | | |
|---|-----------|--------|----------|---------------|----------------|----------------------|-----------|
| (SF) (SF) (FT) (CF) (CY) 1510+00 427.98 213.99 500 106,043 3,928 1515+00 420.36 210.18 500 132,101 4,893 1520+00 636.45 318.225 500 179,165 6,636 1525+00 796.87 398.435 500 195,686 7,248 1530+00 768.62 384.31 500 208,519 7,723 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 400 189,109 7,004 | Volume | Volume | Volume | Length | Actual XS Area | ORD Measured XS Area | Station |
| 1515+00 420.36 210.18 500 106,043 3,928 1520+00 636.45 318.225 500 179,165 6,636 1525+00 796.87 398.435 500 195,686 7,248 1530+00 768.62 384.31 500 208,519 7,723 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 400 7,004 7,004 | (acre-ft) | (CY) | (CF) | (FT) | (SF) | (SF) | Station |
| 1515+00 420.36 210.18 500 132,101 4,893 1520+00 636.45 318.225 500 179,165 6,636 1525+00 796.87 398.435 500 195,686 7,248 1530+00 768.62 384.31 500 208,519 7,723 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 | | | | | 213.99 | 427.98 | 1510+00 |
| 1520+00 636.45 318.225 500 132,101 4,893 1525+00 796.87 398.435 500 179,165 6,636 1530+00 768.62 384.31 500 208,519 7,723 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 400 400 400 | 2.434 | 3,928 | 106,043 | 500 | | | |
| 1520+00 636.45 318.225 6,636 1525+00 796.87 398.435 500 195,686 7,248 1530+00 768.62 384.31 500 208,519 7,723 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 400 400 6,636 6,636 | | | | | 210.18 | 420.36 | 1515+00 |
| 1525+00 796.87 398.435 500 179,165 6,636 1530+00 768.62 384.31 500 195,686 7,248 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 | 3.033 | 4,893 | 132,101 | 500 | | | |
| 1525+00 796.87 398.435 1530+00 768.62 384.31 500 208,519 7,248 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 | | | | | 318.225 | 636.45 | 1520+00 |
| 1530+00 768.62 384.31 500 195,686 7,248 1535+00 899.53 449.765 7,723 1540+00 826.76 413.38 7,992 1545+00 712.87 356.435 7,128 1550+00 800 400 7,004 | 4.113 | 6,636 | 179,165 | 500 | | | |
| 1530+00 768.62 384.31 500 208,519 7,723 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 | | | | | 398.435 | 796.87 | 1525+00 |
| 1535+00 899.53 449.765 7,723 1540+00 826.76 413.38 7,992 1545+00 712.87 356.435 7,128 1550+00 800 400 7,004 | 4.492 | 7,248 | 195,686 | 500 | | | |
| 1535+00 899.53 449.765 500 215,786 7,992 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 | | | | | 384.31 | 768.62 | 1530+00 |
| 1540+00 826.76 413.38 500 215,786 7,992 1545+00 712.87 356.435 500 192,454 7,128 1550+00 800 400 500 189,109 7,004 | 4.787 | 7,723 | 208,519 | 500 | | | |
| 1540+00 826.76 413.38 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 | | | | | 449.765 | 899.53 | 1535+00 |
| 500 192,454 7,128 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 | 4.954 | 7,992 | 215,786 | 500 | 440.00 | | 4.7.40.00 |
| 1545+00 712.87 356.435 500 189,109 7,004 1550+00 800 400 | 4.440 | 7.400 | 100 45 4 | 500 | 413.38 | 826.76 | 1540+00 |
| 500 189,109 7,004 1550+00 800 400 | 4.418 | 7,128 | 192,454 | 500 | 050 405 | 740.07 | 4545.00 |
| 1550+00 800 400 | 4 0 4 1 | 7.004 | 100 100 | F00 | 356.435 | /12.8/ | 1545+00 |
| | 4.341 | 7,004 | 109,109 | 500 | 400 | 900 | 1550±00 |
| | 2.296 | 3,704 | 100.000 | 500 | 400 | 000 | 1990+00 |
| 1555+00 0 | 2.290 | 3,704 | 100,000 | 500 | 0 | | 1555±00 |
| 1333700 | | | | | U | | 1999+00 |

| | TOTAL | 45,546 | CY | 28.231 | acre-ft |
|--|-------|--------|----|--------|---------|
|--|-------|--------|----|--------|---------|

| | Floodpl | lain J Impacts | | | |
|----------------------|--------------------------|---|--|---|--|
| ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 463.58 | 231.79 | | | | |
| | | 500 | 80,955 | 2,998 | 1.858 |
| 184.06 | 92.03 | | | | |
| | | 500 | 31,936 | 1,183 | 0.733 |
| 71.43 | 35.715 | | | | |
| | | 500 | 13,118 | 486 | 0.301 |
| 33.51 | 16.755 | | | | |
| | | 500 | 10,114 | 375 | 0.232 |
| 47.4 | 23.7 | | | | |
| | | 500 | 33,195 | 1,229 | 0.762 |
| 218.16 | 109.08 | | | | |
| 202.50 | 404.005 | 500 | 75,094 | 2,/81 | 1.724 |
| 382.59 | 191.295 | 500 | 00.440 | 0.014 | 0.050 |
| 220.00 | 100 045 | 500 | 89,410 | 3,311 | 2.053 |
| 332.69 | 100.345 | E00 | 67.005 | 2.405 | 1.540 |
| 204.07 | 102 025 | 500 | 67,095 | 2,400 | 1.540 |
| 204.07 | 102.035 | | | | |
| | | | | | |
| | | | | | |
| | (SF) 463.58 184.06 | ORD Measured XS Area (SF) (SF) 463.58 231.79 184.06 92.03 71.43 35.715 33.51 16.755 47.4 23.7 218.16 109.08 382.59 191.295 332.69 166.345 | ORD Measured XS Area (SF) (SF) (FT) 463.58 231.79 500 184.06 92.03 500 71.43 35.715 500 33.51 16.755 500 47.4 23.7 500 218.16 109.08 500 382.59 191.295 500 332.69 166.345 500 | ORD Measured XS Area (SF) (SF) (FT) (CF) 463.58 231.79 500 80,955 184.06 92.03 500 31,936 71.43 35.715 500 13,118 33.51 16.755 500 10,114 47.4 23.7 500 33,195 218.16 109.08 500 75,094 382.59 191.295 500 89,410 332.69 166.345 500 67,095 | ORD Measured XS Area (SF) (SF) (FT) (CF) (CY) 463.58 231.79 500 80,955 2,998 184.06 92.03 500 31,936 1,183 71.43 35.715 500 13,118 486 33.51 16.755 500 10,114 375 47.4 23.7 500 33,195 1,229 218.16 109.08 500 75,094 2,781 382.59 191.295 500 89,410 3,311 332.69 166.345 500 67,095 2,485 |

12,364 CY

7.663 acre-ft

| | | Floodpl | ain K Impacts | | | |
|-----------|----------------------|----------------|---------------|---------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1720+00 | 77.9 | 38.95 | | | | |
| | | | 500 | 22,909 | 848 | 0.526 |
| 1725+00 | 105.37 | 52.685 | | | | |
| | | | 500 | 44,210 | 1,637 | 1.015 |
| 1730+00 | 248.31 | 124.155 | | | | |
| 4705 : 00 | 45.70 | 7.005 | 500 | 33,005 | 1,222 | 0.758 |
| 1735+00 | 15.73 | 7.865 | 500 | 3,089 | 114 | 0.071 |
| 1740+00 | 8.98 | 4.49 | 500 | 3,009 | 114 | 0.071 |
| 1740.00 | 0.50 | 4.40 | 500 | 2,996 | 111 | 0.069 |
| 1745+00 | 14.99 | 7.495 | | 2,000 | | 0.000 |
| | | | 500 | 2,893 | 107 | 0.066 |
| 1750+00 | 8.15 | 4.075 | | | | |
| | | | 500 | 11,134 | 412 | 0.256 |
| 1755+00 | 80.92 | 40.46 | | | | |
| | | | 500 | 34,631 | 1,283 | 0.795 |
| 1760+00 | 196.13 | 98.065 | | | | |
| 4705 : 00 | 077.04 | 222 525 | 500 | 109,143 | 4,042 | 2.506 |
| 1765+00 | 677.01 | 338.505 | 500 | 156,483 | 5,796 | 3.592 |
| 1770+00 | 574.85 | 287.425 | 300 | 130,463 | 3,790 | 3.392 |
| 1770.00 | 074.00 | 207.420 | 500 | 179,580 | 6,651 | 4.123 |
| 1775+00 | 861.79 | 430.895 | | 270,000 | 3,002 | 25 |
| | | | 500 | 182,686 | 6,766 | 4.194 |
| 1780+00 | 599.7 | 299.85 | | | | |
| | | | 500 | 134,019 | 4,964 | 3.077 |
| 1785+00 | 472.45 | 236.225 | | | | |
| | | | 500 | 79,604 | 2,948 | 1.827 |
| 1790+00 | 164.38 | 82.19 | | | | |
| | | | | | | |
| | | | | | | |

| | | |] |
|-------|----------|-------|---------|
| TOTAL | 4,453 CY | 2.760 | acre-ft |
| | | | |

| | | Floodpl | ain L Impacts | | | |
|---------|----------------------|----------------|---------------|--------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1835+00 | 0 | 0 | | | | |
| | | | 500 | 42,265 | 1,565 | 0.970 |
| 1840+00 | 338.12 | 169.06 | | | | |
| | | | 500 | 70,228 | 2,601 | 1.612 |
| 1845+00 | 223.7 | 111.85 | | | | |
| | | | 500 | 49,899 | 1,848 | 1.146 |
| 1850+00 | 175.49 | 87.745 | | | | |
| | | | 500 | 41,050 | 1,520 | 0.942 |
| 1855+00 | 152.91 | 76.455 | | | | |
| | | | 500 | 59,881 | 2,218 | 1.375 |
| 1860+00 | 326.14 | 163.07 | | | | |
| | | | 500 | 40,768 | 1,510 | 0.936 |
| 1865+00 | 0 | 0 | | | | |
| | | | | | | |
| | | | | | | |

11,263 CY

6.981 acre-ft

| | | Floodpla | ain M Impacts | S | | |
|---------|----------------------|----------------|---------------|---------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1910+00 | 0 | 0 | | | | |
| | | | 500 | 70,934 | 2,627 | 1.628 |
| 1915+00 | 567.47 | 283.735 | | | | |
| | | | 500 | 147,805 | 5,474 | 3.393 |
| 1920+00 | 614.97 | 307.485 | | | | |
| | | | 500 | 148,988 | 5,518 | 3.420 |
| 1925+00 | 576.93 | 288.465 | | | | |
| | | | 500 | 72,116 | 2,671 | 1.656 |
| 1930+00 | 0 | 0 | | | | |
| | | | | | | |
| | | | | | | |

16,290 CY

10.097 acre-ft

| | | Floodpl | ain N Impacts | | | |
|---------|----------------------|----------------|---------------|---------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 1930+00 | 0 | 0 | | | | |
| | | | 500 | 32,900 | 1,219 | 0.755 |
| 1935+00 | 263.2 | 131.6 | | | | |
| | | | 500 | 41,769 | 1,547 | 0.959 |
| 1940+00 | 70.95 | 35.475 | | | | |
| | | | 500 | 34,861 | 1,291 | 0.800 |
| 1945+00 | 207.94 | 103.97 | | | | |
| | | | 500 | 105,690 | 3,914 | 2.426 |
| 1950+00 | 637.58 | 318.79 | | | | |
| | | | 500 | 79,698 | 2,952 | 1.830 |
| 1955+00 | 0 | 0 | | | | |
| | | | 500 | 0 | 0 | 0.000 |
| 1960+00 | 0 | 0 | | | | |
| | | | | | | |
| | | | | | | |

10,923 CY

6.770 acre-ft

| | | Floodpl | ain O Impacts | | | |
|---------|----------------------|----------------|---------------|--------|--------|-----------|
| Station | ORD Measured XS Area | Actual XS Area | Length | Volume | Volume | Volume |
| Station | (SF) | (SF) | (FT) | (CF) | (CY) | (acre-ft) |
| 2060+00 | 39.37 | 19.685 | | | | |
| | | | 100 | 1,490 | 55 | 0.034 |
| 2061+00 | 20.24 | 10.12 | | | | |
| | | | 100 | 506 | 19 | 0.012 |
| 2062+00 | 0 | 0 | | | | |
| | | | | | | |
| | | | | | | |

| TOTAL | 74 | CY | 0.046 | acre-ft |
|-------|----|----|-------|---------|

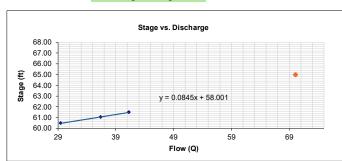
APPENDIX C – Cross Drain Calculations

Insert Values

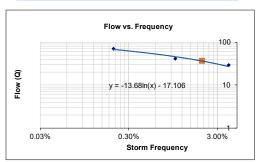
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 29 | 60.5 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 41 | 61.5 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 70 | 65.0 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 36 | 61.1 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge







Given Information

| FL (US) = | 57.3 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 57 | Downstream invert |
| Edge of Travel Lane (ETL) = | 60.1 | Upstream elevation |
| Length (L)= | 71.3 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge Q25= (Velocity) x (Area)

Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1. Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-1 | 1 | 30 | 4.91 | 6 | 29 | 41 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 30 | 2.5 |
| Width (B) | - | - |
| | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.2 | 1.5 | 1.65 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.00 | 3.75 | 4.13 | HW = (HW/D) * Diameter |
| HW Elev. | 60.30 | 61.05 | 61.43 | HW Elev. = HW + FL (US) |

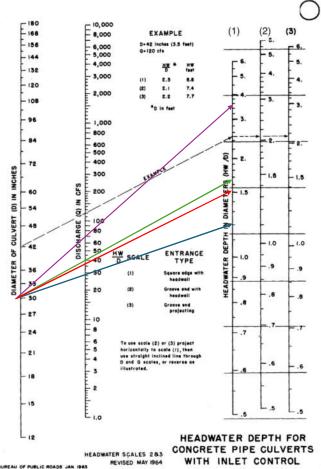
C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2.5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr, storm) |

| | | 25-yr | 50-yr | 100-yr | Notes: |
|---|--------------|-------|-------|--------|--|
| | н | 1 | 1.50 | 2.00 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| ſ | dc | 1.70 | 1.90 | 2.20 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ſ | ho | 2.1 | 2.2 | 2.35 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| ſ | DTW | 2.5 | 2.5 | 2.5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| ſ | HW Depth | 3.2 | 3.70 | 4.20 | Headwater Depth (HW) = H + DTW - LSo |
| ſ | HW Elevation | 60.5 | 61.00 | 61.50 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|----------------|----------------|---------------|----------------|---|
| Controling HW | 60.5 | 61.05 | 61.50 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Outlet Control | Inlet Control | Outlet Control | |





| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 29 | 1.20 |
| 100 | 41 | 1.65 |
| 500 | 70 | 3.60 |
| 50 | 36 | 1.50 |

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A (see page F-3 for notes)

| Standard | Descri | Spition | 10 | Applicate | 94 | | net End | |
|---------------|--------------------------------------|------------------------------------|----------------|----------------|---------|-------------|---------------------------|--------------------------|
| Plan Index | Year. | Parties | Cross Crass | Side Street | Median | Application | Hydraulic Perlimitance | * |
| 430.010 | U Type Concrete With Cross | Single 12" from SE" | Limited | Limited | Yes | Yes | TW | 07. |
| 430.011 | 1/ Type Conomie | Single 15" five 36" | Crystell | 760 | Vec | Limite | Good | 881x0.1 |
| 430.012 | Concess Everyo Disequier | Single Siff this TIT | Groted | No | the : | No. | BK: | 164 |
| 499-029 | Fixed End Section Discussion | Single stress tir | Yes | 766 | See | 799 | Deed | 0.8 |
| 630 CCT | Ones Dram Millsred End Section | Single & Multiple 15" Serv. 72" | Yes | *** | Yee | Yes | Fee | 117 |
| ein-mi | Side Drain Milered Ent Section | Single & Multiple 10" Pers 00" | *** | 514 | ter | Yes | rar. | GF w/n 13 w/ grate |
| 130 000 | Straight Convents | Single EMuliple 15" Box 34" | jel Yes | No | Limited | Ywy | Doslant | 01 |
| 430-031 | Straight Consiste | linge & Goulee 80° | Pec | 100 | United | Yes | Souther | 82 |
| 4m-000 | Braght Concrete | Impo A Double SE | Yes | 700 | circles | Yes | Existen | 347 |
| 630-003 | Straight Concrete | Strige & Double 72" | Yes | * | Limited | Yes | Examel | 0.2 |
| 430.034 | Dissipit Constite | Segate | Yes | Ne | Detect | Vas | Some | 0.2 |
| 436-040 | Ringed Commis | Single 12" thro 48" | Van | No | Ven. | Yes | Vary Gost | 0.3 |

Headwater (H) found using Chart 5, FHWA HDS 5: Flow (cfs)

Flow (cfs)
25 29
100 41
50 36

| | 25-yr | 50-yr | 100-yr |
|---|-------|-------|--------|
| н | 1.0 | 1.5 | 2.0 |

Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).

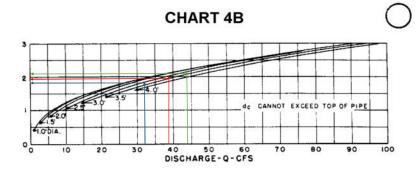
CHART 5B

> HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

Critical Depth (dc) Found using Chart 4, FHWA HDS 5

Flow (cfs) dc 25 29 1.7 100 41 2.2 50 36 1.9 DIA (FT) 2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)

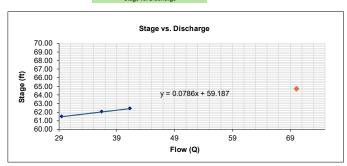


Insert Values

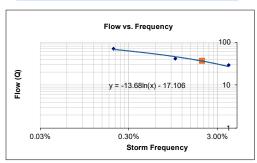
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 29 | 61.5 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 41 | 62.4 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 70 | 64.7 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 36 | 62.1 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

| FL (US) = | 58.3 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 58.0 | Downstream invert |
| Edge of Travel Lane (ETL) = | 61.5 | Upstream elevation |
| Length (L)= | 65.7 | (Existing) |
| Slope (So) = | 0.005 | |

A. Calculate Discharge Q25= (Velocity) x (Area)

Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1. Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-03 | 1 | 30 | 4.91 | 6 | 29 | 41 |

| - | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 30 | 2.5 |
| Width (B) | - | - |
| | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

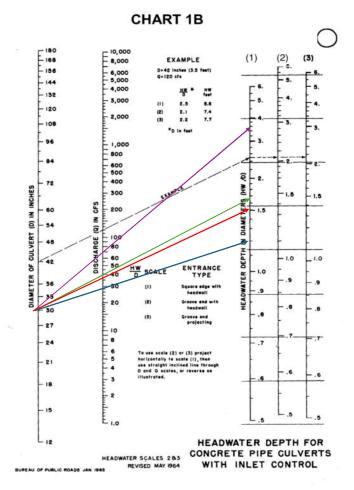
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|--|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.2 | 1.5 | 1.65 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached |
| HW | 3.00 | 3.75 | 4.13 | HW = (HW/D) * Diameter |
| HW Elev. | 61.30 | 62.05 | 62.43 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2.5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo 0.3 L | | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm) |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1 | 1.50 | 1.90 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.70 | 1.90 | 2.20 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.1 | 2.2 | 2.35 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2.5 | 2.5 | 2.5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.2 | 3.70 | 4.10 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 61.5 | 62.00 | 62.40 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|----------------|---------------|---------------|---|
| Controling HW | 61.5 | 62.05 | 62.43 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling riv | Outlet Control | Inlet Control | Inlet Control | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 29 | 1.20 |
| 100 | 41 | 1.65 |
| 500 | 70 | 3.60 |
| 50 | 36 | 1.50 |

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A (see page F-3 for notes)

| Blundard | Descri | Epitore | Application | | | toner Band | | |
|----------|--|------------------------------------|----------------|----------------|---------|-------------|--------------------------|-----------------------------|
| Indee. | Type | Parties | Cross Drain | State Orain | Median | Application | Hydraulic Performance | * |
| 430-010 | UType Concrete Web Sinds | Striple 117 Was 307 | Lincon | (miles | THE | Yes | Fire | - 67 |
| 430-011 | U Type Convelo | Things 19" this 30" | Certified | 100 | 781 | Leminol | Seed | 859-02 |
| 430-012 | Coverete Erwege Greequiter | Single 30" time 10" | Limited | 160 | - 500 | Me | 166 | 164 |
| 430 ccc | Filtred Engl Section Concerns | Strain Strain Str | Yee | 161 | Tee | 766 | Good | 61. |
| 430 GD1 | Exces Draw Billhood Street Section | Strige & Multiple 15' Strik 72' | Yes | ne. | Yes | Teri | rw | 10 |
| 430-017 | Gille Crars Millered Erel Section | Strigte & Multiple 15" Hero 10" | He | Yes | 460 | THE | fer | 1.7 w/s, 1.8 w/ grate |
| 430-000 | Stranger Conscions | Single &Multiple 10" See 54" | 16) 780 | No. | Keelnel | Yes | Ecotors | 11 |
| 430-001 | Straight Corents | Single & Outside 807 | Yes | - | Livinoi | Yes | Esselve | 0.2 |
| 450-002 | Straight Coverable | Single & Coulde 80" | Yes | 100 | Cretus | Yes | Country | 12 |
| 430-005 | Straight Coronto | Single & Dealine 72" | Ver | No. | Limited | Yes | Ecolory | 0.0 |
| 100-004 | Straight Constate | Smjetir | Yes | Ho | Cretisi | 766 | Doder | 112 |
| 430-040 | Wingood Concrede | Tingle 17 time 47 | Ven | No | .Ter | Yes | Very Good | 0.3 |

0.0786 59.187

Headwater (H) found using Chart 5, FHWA HDS 5:

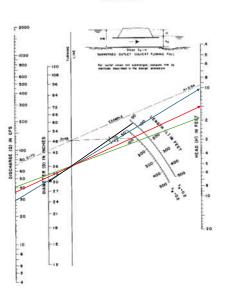
| | Flow (cfs) | | | |
|-----|------------|--|--|--|
| 25 | 29 | | | |
| 100 | 41 | | | |
| 50 | 36 | | | |

| | 25-yr | 50-yr | 100-yr |
|---|-------|-------|--------|
| Н | 1.0 | 1.5 | 1.9 |

Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).

CHART 5B





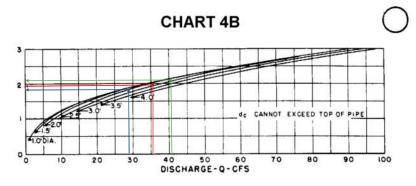
HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

Critical Depth (dc) Found using Chart 4, FHWA HDS 5

| _ | | | |
|---|-----|------------|-----|
| Γ | | Flow (cfs) | dc |
| ı | 25 | 29 | 1.7 |
| ı | 100 | 41 | 2.2 |
| П | 50 | 26 | 1.0 |

DIA (FT) 2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)



Insert Values

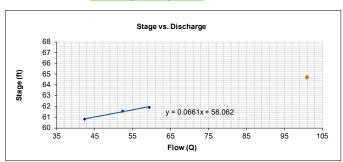
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | |
|--------------|-------|---------------|------------|------------|---------------------------------|
| | 25 | 4.00% | 42 | 60.8 | 25-yr, 100-yr, and 500-yr flow |
| Base Flood | 100 | 1.00% | 59 | 62.0 | 25-yr, 50-yr and 100-yr stages |
| Greatest | 500 | 0.20% | 101 | 64.7 | 500-yr stage calculated using |
| Design Flood | 50 | 2.00% | 52 | 61.6 | 50-vr flow rate calculated usin |

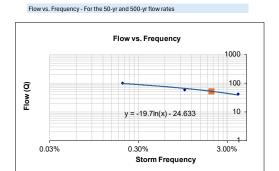
Notes w rates calculated per Drainage Design Guide (see below, Section A). es found using Chart 18, FHWA HDS 5 (see below, Section B).

g Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
ing Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge





Given Information

| FL (US) = | 57.3 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 57 | Downstream invert |
| Edge of Travel Lane (ETL) = | 61.2 | Upstream elevation |
| Length (L)= | 69.5 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge Q25= (Velocity) x (Area)

Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1. Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-3 | 1 | 36 | 7.07 | 6 | 42 | 59 |

| Pipe | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 36 | 3 |
| Width (B) | 1 | - |
| | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

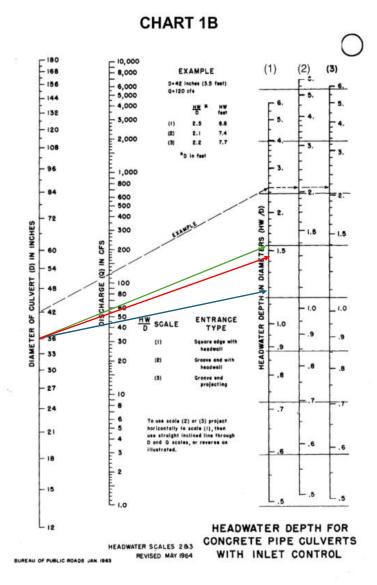
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.18 | 1.43 | 1.55 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.54 | 4.29 | 4.65 | HW = (HW/D) * Diameter |
| HW Elev. | 60.84 | 61.59 | 61.95 | HW Flev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 3 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlot Valacity (f/s) = 6 ft/s (Sama as inlet valacity used to calculate discharges for the 25 yr. storm) |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.8 | 1.40 | 1.80 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 2.10 | 2.60 | 2.90 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.55 | 2.8 | 2.95 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 3 | 3 | 3 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.5 | 4.10 | 4.50 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 60.8 | 61.40 | 61.80 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|---------------|---------------|---------------|---|
| Controling HW | 60.84 | 61.59 | 61.95 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controding rive | Inlot Control | Inlot Control | Inlot Control | 1 |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 42.41 | 1.18 |
| 100 | 59.38 | 1.55 |
| 50 | 52.43 | 1.43 |

Entrance Loss Coeficient (Ke) found using Apilication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Stendard Fine | 9666 | Typican (| 19 | Agerica de | | | met their | |
|------------------|---------------------------------------|------------------------------------|----------------|----------------|----------|-------------|--------------------------|----------------------------|
| Pion Notes | Tow | Pipe Size | Cross Drain | State Evans | Median | Application | Hydraulic Portomanica | 15 |
| 600.019 | O Type Concrete With Challe | Single 10" Fire 30" | Limited | Limited | Yes | Yes: | TW. | 41 |
| 490.011 | Li Type Coresen | Single 16" See 26" | - | 70- | Yes | LHRIS | Dest | 0.0 m it |
| 810-012 | Greent Every Despute: | Steph SIT See 17" | - | 160 | 160 | - | 160 | 16. |
| 410-007 | Flored Envi Section Concrete | 17.004.57 | Yes | No. | Tee | Ten | Geef | 9.9 |
| 60-01 | Cross Drein Misrad Cost Section | Straple & Multiple 19' 90's 12" | 700 | 10- | Yes | Yes | Fee | 9.7 |
| 410-522 | Sale Crem Mitered End Section | Single & Mydlyne 15" Hely 60" | No | je. | No | Yes | 7se | 07 m/s. 1,0 ml green |
| 430-liter | Straight Committee | Tingle Attuitule 10" Tinu 94" | (M) Yes | 10- | Limited | Yes | Enabet | 0.2 |
| 410-231 | Streets Concrete | Single & Strake (6" | Yee | 100 | Lember | Yes | Dates | 4.6 |
| 400-017 | Strapt Concess | Strape & Donate SE [*] | Yes | 40- | Lenker | THY | Street | 42 |
| 690-0111 | Shage Corone | Simple & Shuden 12" | Yes | * | Limit | Yes | Excellent | 93 |
| 430-334 | Straight Conceile | Singletin | View | ter | (protect | Yes | brateri | 48 |
| 630-040 | Worged Concrete | Sign 12 700 FF | Yes | 160 | Yes | : Van: | Ting Good | 43- |

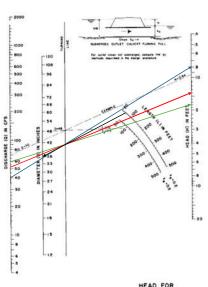
Headwater (H) found using Chart 5, FHWA HDS 5: Flow (cfs)

| | Flow (cfs) | |
|-----|------------|--|
| 25 | 42 | |
| 100 | 59 | |
| 50 | 52 | |

| н | 25-yr | 50-yr | 100-yr |
|---------------|-------------|-------------|---------------|
| | 0.8 | 1.4 | 1.8 |
| Headwater (H) | found using | Chart 5, Fi | HWA HDS 5. |

CHART 5B



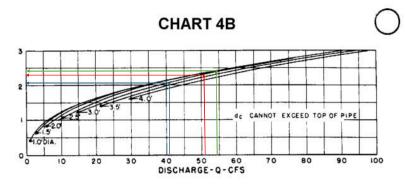


HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

Critical Depth (dc) Found using Chart 4, FHWA HDS 5

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 42 | 2.1 |
| 100 | 59 | 2.9 |
| 50 | 52 | 2.6 |

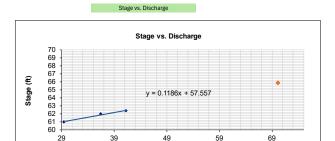
DIA (FT)



Insert Values

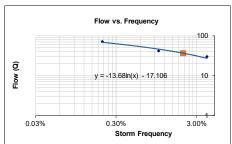
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 29 | 61.0 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 41 | 62.4 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 70 | 65.9 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 36 | 62.0 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:



Flow (Q)





Given Information

| FL (US) = | 58 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 57.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 61.15 | Upstream elevation |
| Length (L)= | 77.51 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 Tiksec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-4 | 1 | 30 | 4.91 | 6 | 29 | 41 |

| Pipe | in. | ft. | |
|--------------|-----|-----|--|
| Diameter (D) | 30 | 2.5 | |
| Width (B) | | - | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

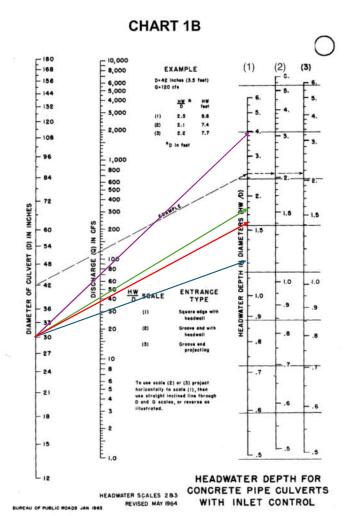
| | 25-уг | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.2 | 1.6 | 1.75 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.00 | 4.00 | 4.38 | HW = (HW/D) * Diameter |
| HW Elev. | 61.00 | 62.00 | 62.38 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|--|
| TW | 2.5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.45 | 0.70 | 0.90 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.80 | 2.10 | 2.30 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.15 | 2.3 | 2.4 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2.5 | 2.5 | 2.5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.65 | 2.90 | 3.10 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 60.65 | 60.90 | 61.10 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|------------------|---------------|---------------|---------------|---|
| Controling HW | 61 | 62.00 | 62.38 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling rive | Inlet Control | Inlet Control | Inlet Control | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 29 | 1.20 |
| 100 | 41 | 1.75 |
| 500 | 70 | 3.80 |
| 50 | 36 | 1.60 |

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Electori | Descri | Epitore | | Applicate | | | inst find | |
|------------|---|------------------------------------|----------------|----------------|---------|-------------|--------------------------|-----------------------|
| Indee | Yype | Parties | Cross Drain | State Orane | Median | Application | Hydraulic Performance | 16 |
| 430-010 | UType Concrete With Sinite | Single 10" No. 30" | Lincon | (miles | THE | 761 | Fire | . 67 |
| 430-011 | U Type Conceile | Tingle 197 tins 307 | Carding | 1941 | Yes | London's | Seed | 8510-02 |
| 430-012 | Coverete Erwege Glesquater | Single 30" (fire 10" | Cimiled | Ho | No. | No | 166 | 166 |
| 430 cor | Flored Engl Section Concerns | Single 12" thru 72" | Vee | 101 | Ter. | 766 | Good | 61. |
| 430-021 | Exces Draw Milhored Error - Section | Strope & Multiple 15" Box 72" | Yes | ni. | Yes | Yes | rwc | 10 |
| 436-027 | Claim Crains Millered Ered Section | Strigte & Multiple 15" (for HS" | 160 | Yes | No | 746 | fer | STWN 13 w grate |
| 4 III -000 | Straight Conumitie | Single MAJORE 107 See 547 | 10 | No | Letted | Yes | Ecotori | Ü |
| 430-001 | Straight Coronto | Single & Dualite 80° | Yes | 10. | Livinoi | Yes | Esselve | 0.0 |
| 430-002 | Straight Coverates | Single & Coulde 86" | Yes | 160 | Centuci | Yes | Douber | 12 |
| 430-003 | Straight Corondo | Single & Decisio 77* | Ver | No | Limited | Yes | Emailer | 0.0 |
| 400-004 | Straight Corento | Simple 64" | Yes | No | Cretisi | 96 | Doder | 62 |
| 430-040 | Minged Convento | Traje 17 time 47 | Ven | Fee: | - Yes | Yes | Very Good | 8.3 |

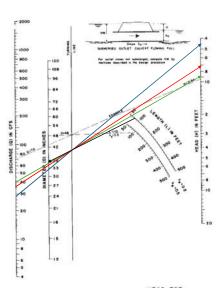
Headwater (H) found using Chart 5, FHWA HDS 5:

| | Flow (cfs) | |
|-----|------------|--|
| 25 | 29 | |
| 100 | 41 | |
| 50 | 36 | |

| | 25-yr | 50-yr | 100-yr |
|---------------|-------------|-------------|------------|
| н | 0.45 | 0.70 | 0.90 |
| Headwater (H) | found using | Chart 5, FH | IWA HDS 5. |

CHART 5B





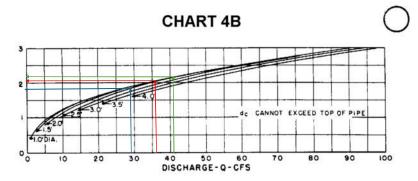
HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

Critical Depth (dc) Found using Chart 4, FHWA HDS 5

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 29 | 1.8 |
| 100 | 41 | 2.3 |
| 50 | 36 | 2.1 |

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DIA (FT) 2.5



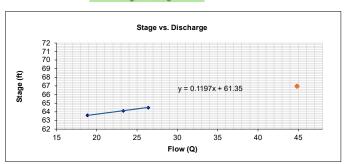
Insert Values

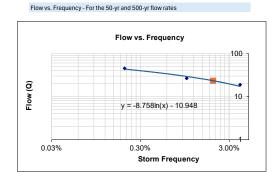
| | | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | |
|---|--------------|-------|---------------|------------|------------|-------------------------------|
| | | 25 | 4.00% | 19 | 63.6 | 25-yr, 100-yr, and 500-yr flo |
| | Base Flood | 100 | 1.00% | 26 | 64.5 | 25-yr, 50-yr and 100-yr stag |
| | Greatest | 500 | 0.20% | 45 | 67.0 | 500-yr stage calculated usi |
| Γ | Design Flood | 50 | 2.00% | 23 | 64.2 | 50-yr flow rate calculated u |

flow rates calculated per Drainage Design Guide (see below, Section A).
tages found using Chart 18, FHWA HDS 5 (see below, Section B).
using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge





Notes

Given Information

| FL (US) = | 60.8 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 60.5 | Downstream invert |
| Edge of Travel Lane (ETL) = | 63.5 | Upstream elevation |
| Length (L)= | 68.48 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge Q25= (Velocity) x (Area)

Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1. Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-5 | 1 | 24 | 3.14 | 6 | 19 | 26 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 24 | 2 |
| Width (B) | 1 | - |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.35 | 1.65 | 1.8 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 2.70 | 3.30 | 3.60 | HW = (HW/D) * Diameter |
| HW Elev. | 63.50 | 64.10 | 64.40 | HW Fley. = HW + FL (US) |

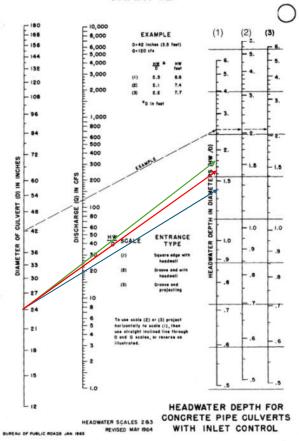
C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm) |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.1 | 1.65 | 2.00 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.55 | 1.70 | 1.75 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 1.775 | 1.85 | 1.875 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2 | 2 | 2 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.8 | 3.35 | 3.70 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 63.6 | 64.15 | 64.50 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|----------------|----------------|----------------|---|
| Controling HW | 63.6 | 64.15 | 64.50 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controding rive | Outlet Control | Outlet Centrel | Outlet Control | 1 |

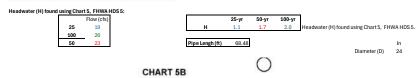


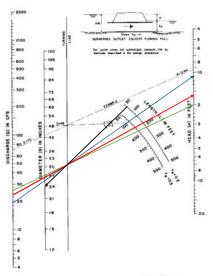


| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 19 | 1.35 |
| 100 | 26 | 1.80 |
| 50 | 23 | 1.65 |
| | | |

| Table F-1: Applicat | on Guidelines | for Pipe En | d Treatments | - Part A |
|---------------------|---------------|-------------|--------------|----------|
| | | | | |

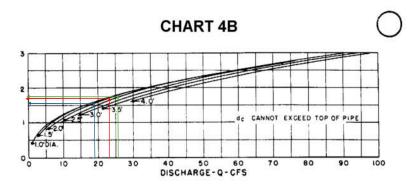
| Stendard Fign (Irdex | 2000 | Parties . | | Application | ** | | met bed | |
|----------------------------|--|-----------------------------------|----------------|---------------|-----------|-------------|--------------------------|----------------------------|
| | Tops | Parlie | Cross Drain | Side Drain | Martino | Application | Hydroutic Performance | 15. |
| 400.013 | O Types Concrete With Challe | Single 10' thru 30' | (Jerme) | Similard | Yes | Yes | Fee | 0.7 |
| 430-211 | Si Type Coveres | Straph 10" Stray 20" | Lorenza | 100 | Yes | Control | Geed | 0.000 |
| 430-912 | Covered Energy (Designator) | Straje SE See SE | - | ten | No | - | 160 | NA. |
| 410-DIT | Fland End Section Concrete | Single 17:314.12 | Yes | No. | Yes | Ten | Geed | 0.0 |
| 60-01 | Cross Grein Misered Cont Section | Strape & Multiple 19" See, 72" | Ten | 16- | Yes | Yes | Fair | 47 |
| 410-027 | Sale Drain Mitered End Section | Single & Multiple 15' Hosp 65" | No | Yes | No | V= | Yes | 07 n/s. 1,0/ar (peta |
| 40.00 | Straigh Coveres | Timps Attuituse 13" time Self | (III) Yes | 16- | Sinteri | Yes | Emakeri | 42 |
| 490-211 | Straight Concrete | Single & Souther 60" | Yes | 100 | Levisori | Yes | Donter | 0.2 |
| 410.017 | Straight Concerns | Strage & Double 50° | Yes | - | Carried | TW. | Streeters | 93 |
| 430-033 | Straight Constree | Simple & Divable 12" | Yes | 100 | Series | Yes | Excelent | 93 |
| 430-034 | Stranger Concerns | Single 64" | Ven | 160 | (antique) | Yes | Example | ar |
| 630-040 | Wright Concrete | Single 12" Mile MC | Yes | 160 | Yes | Yes | TRO GOOD | 43 |





HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

| | Flow (cfs) | dc | DIA (FT) |
|-----|------------|------|---|
| 25 | 19 | 1.55 | 2 |
| 100 | 26 | 1.75 | |
| | 00 | 4.70 | Critical Death (de) Ferral critical Object A FUNAL LIDG |

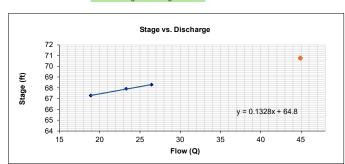


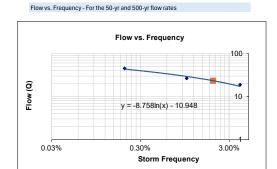
Insert Values

| | Storm | Francis man (0/) | Flow (cfs) | Chara (ft) | 7 |
|--------------|-------|------------------|------------|------------|--|
| | Storm | Frequency (%) | Flow (CIS) | Stage (ft) | Notes |
| | 25 | 4.00% | 19 | 67.3 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 26 | 68.3 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 45 | 70.8 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 23 | 67.9 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge





Given Information

| FL (US) = | 64.5 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 64.2 | Downstream invert |
| Edge of Travel Lane (ETL) = | 67 | Upstream elevation |
| Length (L)= | 64.25 | (Existing) |
| Slope (So) = | 0.005 | |

A. Calculate Discharge Q25= (Velocity) x (Area)

Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1. Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-6 | 1 | 24 | 3.14 | 6 | 19 | 26 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 24 | 2 |
| Width (B) | - | - |
| | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

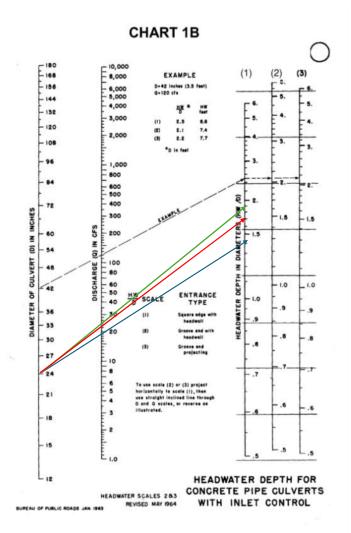
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.4 | 1.7 | 1.85 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 2.80 | 3.40 | 3.70 | HW = (HW/D) * Diameter |
| HW Elev. | 67.30 | 67.90 | 68.20 | HW Fley. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|--|
| TW | 2 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr, storm) |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.09 | 1.55 | 2.10 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.55 | 1.75 | 1.85 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 1.775 | 1.875 | 1.925 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2 | 2 | 2 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.79 | 3.25 | 3.80 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 67.29 | 67.75 | 68.30 | US Pipe inv. + HW depth |

| | | 25-yr | 50-yr | 100-yr | Notes: |
|---|-----------------|---------------|---------------|----------------|---|
| | Controling HW | 67.3 | 67.90 | 68.30 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| ı | Controding rive | Inlet Control | Inlet Control | Outlet Control | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 19 | 1.40 |
| 100 | 26 | 1.85 |
| 50 | 23 | 1.70 |

Entrance Loss Coeficient (Ke) found using Apilication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Stendard Etec | 2000 | the contract of | 139 | Age/Isseli | ** | | met bed | |
|------------------|--|-----------------------------------|----------------|---------------|-----------|-------------|--------------------------|---------------------------|
| riche | Tops | Planting | Cross Drain | Side Drain | Martino | Application | Hydroutic Performance | |
| 400.013 | O Types Concrete With Challe | Single 10' fire 30' | Detect | Limited | Yes | Yes | Fee | 0.7 |
| 430-211 | Si Type Coveres | Straph 10" Stray 20" | Lorenza | 100 | Yes | Control | Geed | dites: |
| 430-912 | Covered Energy (Designator) | Straje SE Sea SE | - | 160 | No | - | 160 | NA. |
| 410-DIT | Fland End Section Concrete | Single ST 2014 ST | Yes | No. | Yes | Ten | Geed | 0.0 |
| 60-01 | Cross Grein Misered Cont Section | Strayle & Multiple 19" New 72" | Ten | No. | Yes | Yes | Fair | 9.7 |
| 410-027 | Sale Drain Mitered End Section | Single & Multiple 15" Hez 65" | No | Yes | No | V= | Yes | 07 sys. 1,0 at gene |
| 40.00 | Straight Commiss | Timps Attorns 15" time Se" | (W) Yes | 10- | Sinteri | Yes | Emakeri | 02 |
| 490-011 | Straight Concrete | Simple & Smaller 60° | Yes | 10- | Leminol | Yes | Donter | 0.0 |
| 410.017 | Straight Concerns | Strape & Double 95° | Yun | 4 | (amind | Time . | Seater | 45 |
| 430-033 | Straight Constrain | Strape & Divarie 12" | Yes | * | Series | Yes | Excelen | 93 |
| 430-034 | Stranger Concerns | Supple* | Vien | ta: | (antique) | Yes | Example | 48 |
| 630-040 | Wright Concrete | Single 12" 2514 66". | Yes | 140 | Yes | Yes | Yang Good | 43 |

eadwater (H) found using Chart 5, FHWA HDS

Flow (cfs)

25 19

100 26

50 23

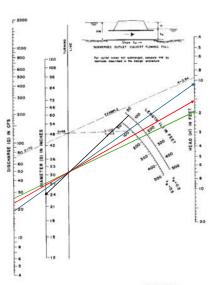
 25-yr
 50-yr
 100-yr

 H
 1.1
 1.6
 2.1

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

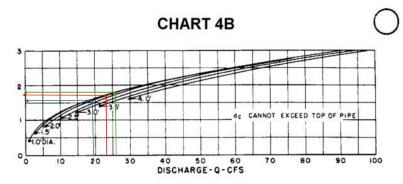
0



HEAD FOR
CONCRETE PIPE GULVERTS
FLOWING FULL
0 PAIL NICE OF THE NI

| | Flow (cfs) | dc |
|-----|------------|------|
| 25 | 19 | 1.55 |
| 100 | 26 | 1.85 |
| 50 | 23 | 1.75 |

DIA (FT)

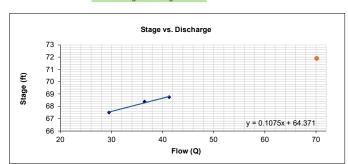


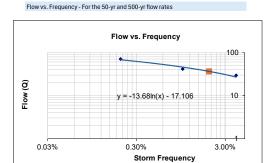
Insert Values

| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 29 | 67.5 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 41 | 68.8 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 70 | 71.9 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 36 | 68.4 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge





Given Information

| FL (US) = | 64.5 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 64 | Downstream invert |
| Edge of Travel Lane (ETL) = | 68.08 | Upstream elevation |
| Length (L)= | 68.2 | (Existing) |
| Slope (So) = | 0.007 | |

A. Calculate Discharge Q25= (Velocity) x (Area)

Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1. Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-7 | 1 | 30 | 4.91 | 6 | 29 | 41 |

| in. | ft. |
|-----|-----------|
| 30 | 2.5 |
| - | - |
| | in. 30 |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

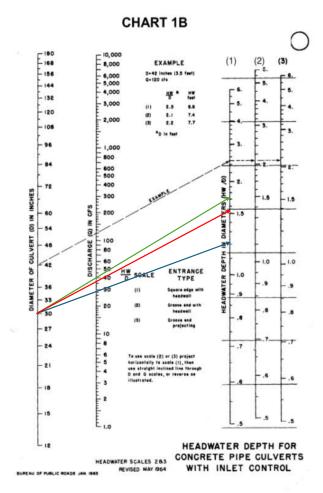
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.2 | 1.55 | 1.7 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.00 | 3.88 | 4.25 | HW = (HW/D) * Diameter |
| HW Elev. | 67.50 | 68.38 | 68.75 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|--|
| TW | 2.5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.5 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ff/s (Same as injet velocity used to calculate discharges for the 25-yr, storm) |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.9 | 1.45 | 1.80 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.80 | 2.00 | 2.20 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.15 | 2.25 | 2.35 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2.5 | 2.5 | 2.5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.9 | 3.45 | 3.80 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 67.4 | 67.95 | 68.30 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|---------------|---------------|---------------|---|
| Controling HW | 67.5 | 68.38 | 68.75 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controding rive | Inlet Control | Inlot Control | Inlot Control | 1 |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 29 | 1.20 |
| 100 | 41 | 1.70 |
| 50 | 36 | 1.55 |

Outlet Control

Entrance Loss Coeficient (Ke) found using Apillication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

| Stendard Fine | 9666 | Typican (| | Application | | | met their | |
|------------------|---------------------------------------|------------------------------------|----------------|--------------|----------|-------------|--------------------------|----------------------------|
| Pion Notes | Tow | Pipe Size | Cross Drain | Side Evan | Median | Application | Hydraulic Portomanica | * |
| 600.019 | O Type Concrete With Challe | Single 10" Fire 30" | Limited | Similard | Yes | Yes: | TW. | 41 |
| 490.011 | Li Type Coresen | Single 16" See 26" | - | Ter. | Yes | LHRIS | Dest | 0.000.0 |
| 810-012 | Greent Every Despute: | Steph SIT See 17" | - | ter | 160 | - | 160 | 16. |
| 410-007 | Flored Envi Section Concrete | 17.004.57 | Yes | No. | Tee | Ten | Geef | 9.9 |
| 60-01 | Cross Drein Misrad Cost Section | Strayle & Multiple 19' 90's 12" | 700 | * | Yes | Yes | Fee | 97 |
| 410-422 | Sale Dram Mitered End Section | Single & Mydlyne 15' Hely 65" | No. | Ven | 360 | Yes | Ne | 07 m/s. 1,0 pt green |
| 436-207 | Straight Companie | Timple Attribute 10" time (of | Yes | 10- | Linted | Yes | Enales | 92 |
| 400-031 | Straight Concrete | Single & Studies 60° | Yes | in. | Limited | Yes | Doder | u |
| 60.017 | Strapt Concess | Strape & Double SE [*] | Yes | 100 | Lamber | Ten | Souther | 42 |
| 690-033 | Shage Carries | Simple & Shudde 12" | Yes | - | Limit | Yes | Excellent | 93 |
| 430-334 | Straight Conceile | Singletin | Ven | 100 | (protect | Yes | brateri | 48 |
| 630-040 | World Concess | Sign 12" 710 HF | Yes | 160 | Yes | : Yes: | Yang Good | 43 |

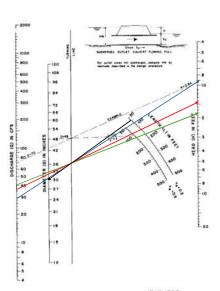
| leadwater (H) found | using Chart 5, | FHWA | IDS 5 |
|---------------------|----------------|-------------|-------|
| | Flo | ow (cfs) | |

| | Flow (cfs) |
|-----|------------|
| 25 | 29 |
| 100 | 41 |
| 50 | 36 |

| | 25-yr | 50-yr | 100-yr |
|---------------|-------------|----------|------------|
| н | 0.9 | 1.5 | 1.8 |
| Headwater (H) | found using | Chart 5, | FHWA HDS 5 |

CHART 5B

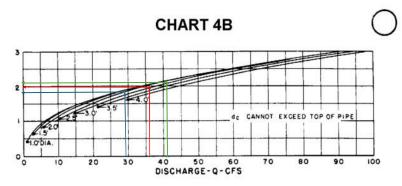




HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 29 | 1.8 |
| 100 | 41 | 2.2 |
| 50 | 36 | 2.0 |

DIA (FT) 2.5

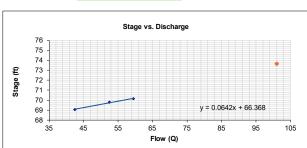


Insert Values

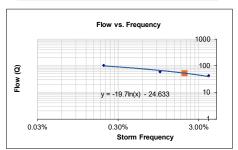
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 42 | 69.1 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 59 | 70.2 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 101 | 73.6 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 52 | 69.8 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:





Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

| FL (US) = | 65.5 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 65.2 | Downstream invert |
| Edge of Travel Lane (ETL) = | 69.22 | Upstream elevation |
| Length (L)= | 70.76 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-8 | 1 | 36 | 7.07 | 6 | 42 | 59 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 36 | 3 |
| Width (B) | | - |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

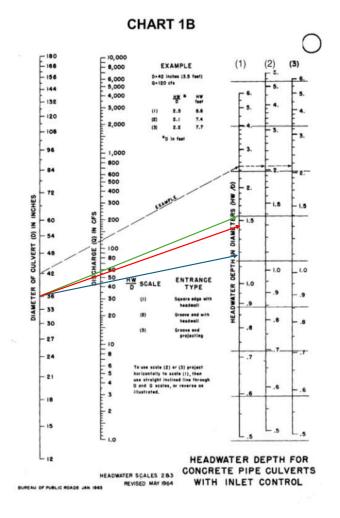
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.18 | 1.43 | 1.55 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.54 | 4.29 | 4.65 | HW = (HW/D) * Diameter |
| HW Elev. | 69.04 | 69.79 | 70.15 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|--|
| TW | 3 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.87 | 1.40 | 1.80 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 2.10 | 2.60 | 2.90 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.55 | 2.8 | 2.95 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 3 | 3 | 3 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.57 | 4.10 | 4.50 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 69.07 | 69.60 | 70.00 | US Pipe inv. + HW depth |

| | 25-уг | 50-yr | 100-yr | Notes: |
|---------------|----------------|---------------|---------------|---|
| Controling HW | 69.07 | 69.79 | 70.15 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| ontroung nw | Outlot Control | Inlet Central | Inlot Control | 1 |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 42 | 1.18 |
| 100 | 59 | 1.55 |
| 50 | 52 | 1.43 |

Outlet Control

Entrance Loss Coeficient (Ke) found using Apillication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

| Stendard Floor | Desir | Typican . | 19 | Age/kath | | | meter. | |
|-------------------|---------------------------------------|------------------------------------|----------------|----------------|----------|-------------|--------------------------|-----------------------------|
| Piges Notice | Tow | Pipe Size | Cross Drain | State Evans | Median | Application | Hydraulic Portomanica | 15 |
| 600.019 | O Type Concrete With Challe | Single 10" Fire 30" | Limited | Limited | Yes | Yes: | TW. | 41 |
| 490.011 | Li Type Covered | Single 16" See 26" | - | 70- | Yes | LHRIS | Dest | 0.0 m it |
| 810-012 | Greent Every Despute: | Steph SIT See 17" | - | 160 | 160 | - | 160 | 16. |
| 410-007 | Flored Envi Section Concrete | 17.004.57 | Yes | No. | Tee | Ten | Geef | 9.9 |
| 60-01 | Cross Drein Misrad Cost Section | Strayle & Multiple 19' 90's 12" | 700 | 10- | Yes | Yes | Fee | 9.7 |
| 410-422 | Sale Dram Mitered End Section | Single & Mydlyne 15' Hely 65" | No | Yes | 360 | Yes | Ne | 07-w/s. 1,0 yr. green |
| 430-liter | Straight Committee | Tingle Attuitule 10" Tinu 94" | (M) Yes | 10- | Limited | Yes | Enabet | 0.2 |
| 410-231 | Streets Concrete | Single & Strades (6)* | Yee | in. | Lember | Yes | Dates | 4.6 |
| 400-017 | Strapt Concess | Strape & Donate SE [*] | Yes | 40- | Lenker | THY | Street | 42 |
| 690-003 | Shage Corone | Simple & Shuden 12" | Yes | * | Limit | Yes | Excellent | 93 |
| 430-334 | Straight Conceile | Singletin | View | ter | (protect | Yes | brateri | 48 |
| 630-040 | World Concern | Sign S2700.8F | Yes | 160 | Yes | : Yes: | Yen Good | 43: |

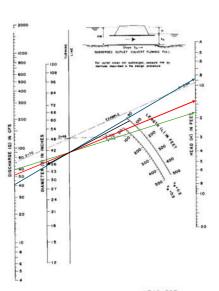
| leadwater (H) found | using Chart 5, | FHWA HDS | 5 |
|---------------------|----------------|----------|---|
| | Flo | ow (cfs) | |
| | 0.5 | 40 | |

| | Flow (cfs) | |
|-----|------------|--|
| 25 | 42 | |
| 100 | 59 | |
| 50 | 52 | |

| | 25-yr | 50-yr | 100-yr |
|---------------|-------------|-------------|------------|
| н | 0.9 | 1.4 | 1.8 |
| Headwater (H) | found using | Chart 5, Fl | HWA HDS 5. |

CHART 5B

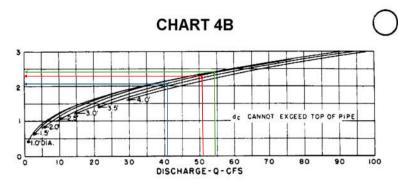




HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 42 | 2.1 |
| 100 | 59 | 2.9 |
| 50 | 52 | 2.6 |

DIA (FT)



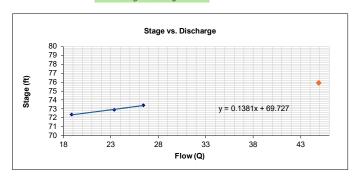
Insert Values

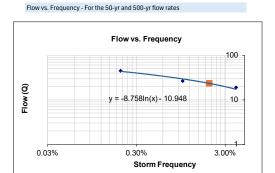
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | 7 |
|--------------|-------|---------------|------------|------------|-------|
| | 25 | 4.00% | 19 | 72.4 | 25-yı |
| Base Flood | 100 | 1.00% | 26 | 73.4 | 25-yı |
| Greatest | 500 | 0.20% | 45 | 75.9 | 500- |
| Design Flood | 50 | 2.00% | 23 | 72.9 | 50-yı |

Notes
25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
25-yr, 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:







Given Information

| FL (US) = | 69.5 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 69.2 | Downstream invert |
| Edge of Travel Lane (ETL) = | 72 | Upstream elevation |
| Length (L)= | 86.88 | (Existing) |
| Slope (So) = | 0.003 | |

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-9 | 1 | 24 | 3.14 | 6 | 19 | 26 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 24 | 2 |
| Width (B) | - | - |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

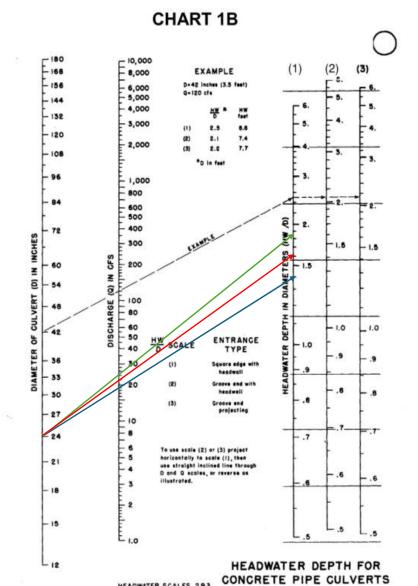
| | 25-yr | 50-yr | 100-yr | Notes |
|---------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.4 | 1.6 | 1.8 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 2.80 | 3.20 | 3.60 | HW = (HW/D) * Diameter |
| HW Flev | 72.30 | 72 70 | 73 10 | HW Flev = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| | | <u> </u> |
|-----------------|-----|--|
| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
| TW | 2 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.15 | 1.70 | 2.20 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.50 | 1.70 | 1.80 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 1.75 | 1.85 | 1.9 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2 | 2 | 2 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.85 | 3.40 | 3.90 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 72.35 | 72.90 | 73.40 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|----------------|----------------|----------------|---|
| Controling HW | 72.35 | 72.90 | 73.40 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling riv | Outlet Control | Outlet Control | Outlet Control | |



HEADWATER SCALES 283

REVISED MAY 1964

WITH INLET CONTROL

| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 19 | 1.40 |
| 100 | 26 | 1.80 |
| 50 | 23 | 1.60 |

Entrance Loss Coeficient (Ke) found using Apilication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

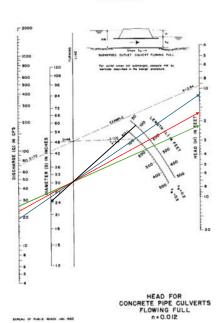
| Steedard Etec | Desc | Parties (| 19 | Age/Ace/A | | met their | | | |
|------------------|--|-----------------------------------|----------------|---------------------------------------|-----------|-------------|--------------------------|---------------------------|--|
| richt. | Tom | Parties | Cross Drain | Cross Side States Dram Dram States | | Application | Hydroutic Performance | | |
| 430-013 | O'Type Concrete Will Challe | Single NE You SE | (immed | Limited | Sec | Yes | Fee. | 0.7 | |
| 430-211 | ti Tyen Coveres | Straph 10" Stray 20" | Lorente | 100 | Yes | Control | Geed | dites: | |
| 430-912 | Coveredo E transpo (Steampertor) | Straje SE See SE | - | 160 | No | - | 160 | NA. | |
| 410-DIT | Fluid End Section Concrete | Single 17:314.12 | Yes | No. | Yes | Ten | Geed | 0.0 | |
| 60-EP1 | Cross Grein Misered Enri Section | Strape & Multiple 19" See, 72" | Ten | No. | Yes | Yes | Fair | 9.7 | |
| 410-027 | Sale Drain Mitered End Section | Single & Multiple 15' Hosp 65" | No | Yes | No | V= | Yes | 07 sys. 1,0 at gene | |
| 40.00 | Straigh Coversio | Timps Attuituse 13" time Self | (N) Yes | 10- | Sinteri | Yes | Emakeri | 42 | |
| 494211 | Straight Conclain | Single & Souther 60" | Yes | ш | Levisori | Yes | Donter | 0.0 | |
| 410.017 | Straight Concerns | Strage & Double 50° | Yes | 4 | Carried | TW. | Number | 45 | |
| 410-011 | Straight Consister | Simple & Double 72" | Yes | * | Series | Yes | Excelen | 93 | |
| 430-334 | Stranger Concession | Single 64" | Vien | ter | (antique) | Yes | Example | 48 | |
| 630-040 | Wright Concrete | Single 12" Mile MC | Yes | 160 | Yes | Yes | TRO GOOD | 43 | |

| eadwater (H) found | using Cha | rt 5, FHWA I | IDS |
|--------------------|-----------|--------------|-----|
| | | Flow (cfs) | |
| | 25 | 19 | |
| | 100 | 26 | |
| | 50 | 23 | |

| н | 25-yr | 50-yr | 100-yr | | | |
|--|-------|-------|--------|--|--|--|
| | 1.2 | 1.7 | 2.2 | | | |
| Headwater (H) found using Chart 5, FHWA HDS 5. | | | | | | |

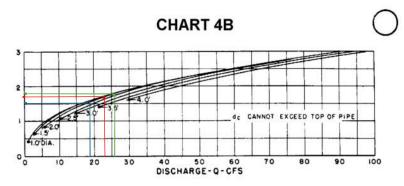
CHART 5B





Flow(cfs) dc
25 19 1.5
100 26 1.8
50 23 1.7

DIA (FT)



SR-60 LHR FPID

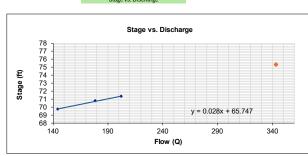
Cross Drain Flow/Stage Calulations CD-10

Insert Values

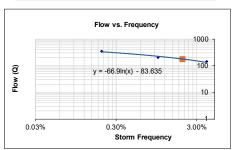
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 144 | 69.8 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 202 | 71.4 | 25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 343 | 75.3 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 178 | 70.8 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

| FL (US) = | 66 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 65.5 | Downstream invert |
| Edge of Travel Lane (ETL) = | 70.3 | Upstream elevation |
| Length (L)= | 85.16 | (Existing) |
| Slope (So) = | 0.006 | |

A. Calculate Discharge Q25= (Velocity) x (Area) Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1. Q100-Q25-1.4

| CDNa | me | Barrels | Culvert Size | Culvert Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|------|----|---------|--------------|-----------------------|-----------------|--------------------|---------------------|
| CD-: | 10 | 1 | 8x3' | 24.00 | 6 | 144 | 202 |

| | in. | ft. |
|------------|-----|-----|
| Height (D) | 36 | 3 |
| Width (B) | 96 | 8 |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

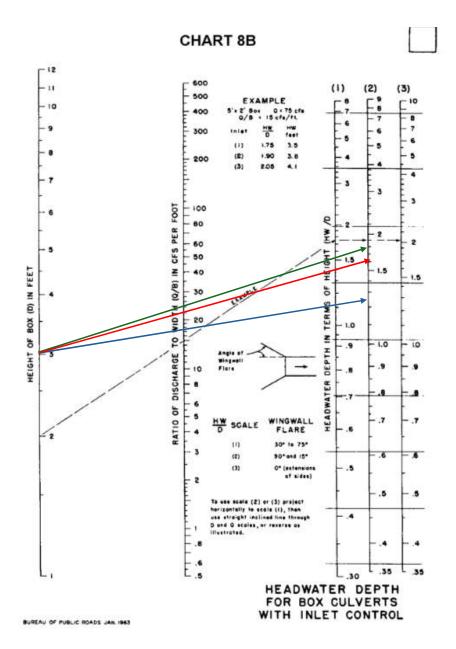
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | 18.0 | 22.3 | 25.2 | Box Culverts |
| HW/D | 1.25 | 1.60 | 1.75 | Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached) |
| HW | 3.75 | 4.80 | 5.25 | HW = (HW/D) * Diameter |
| HW Elev. | 69.75 | 70.80 | 71.25 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.5 | Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert |
|-----------------|-----|---|
| TW | 3 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.5 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

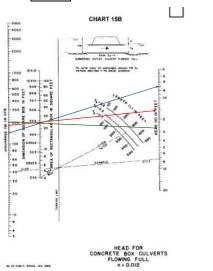
| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|---|
| н | 0.7 | 1.50 | 2.85 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 2.25 | 2.50 | 2.75 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached |
| ho | 2.625 | 2.75 | 2.875 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 3 | 3 | 3 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.2 | 4.00 | 5.35 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 69.2 | 70.00 | 71.35 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|----------------|---------------|---------------|----------------|---|
| Controling HW | 69.75 | 70.80 | 71.35 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Inlot Control | Inlet Central | Outlet Central | |

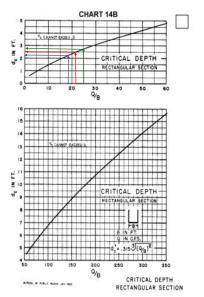


| | Q/B (cfs) | HW/D |
|-----|-----------|------|
| 25 | 18 | 1.25 |
| 50 | 22 | 1.60 |
| 100 | 25 | 1.75 |

water (H) found using Chart 158, FHWA HDS 5: Q/B (cfs) 25 18 50 22 100 25



Critical Depth (dc) Found using Chart 148, FHWA HDS 5

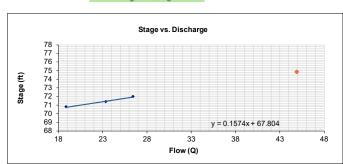


Insert Values

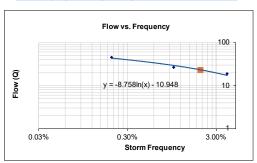
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 19 | 70.8 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 26 | 72.0 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 45 | 74.9 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 23 | 71.4 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

| FL (US) = | 68 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 67.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 70.5 | Upstream elevation |
| Length (L)= | 81.86 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 tr/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25 1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-11 | 1 | 24 | 3.14 | 6 | 19 | 26 |

| Diameter (D) 24 2 Width (B) | | in. | ft. |
|--------------------------------|--------------|-----|-----|
| Width (B) | Diameter (D) | 24 | 2 |
| | Width (B) | - | - |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

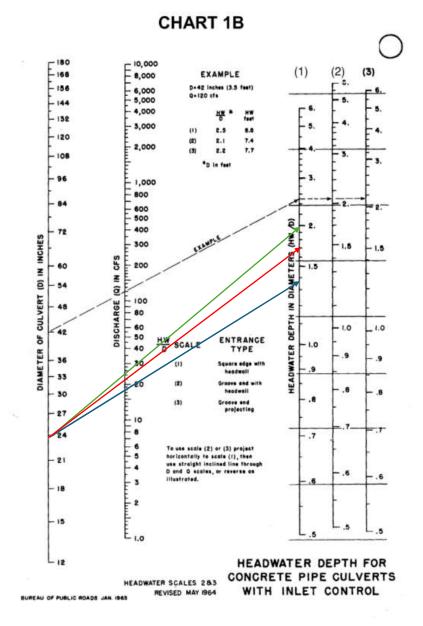
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.37 | 1.7 | 2 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 2.74 | 3.40 | 4.00 | HW = (HW/D) * Diameter |
| HW Elev. | 70.74 | 71.40 | 72.00 | HW Flev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm) |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.1 | 1.60 | 2.20 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.55 | 1.70 | 1.80 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 1.775 | 1.85 | 1.9 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2 | 2 | 2 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.8 | 3.30 | 3.90 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 70.8 | 71.30 | 71.90 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|----------------|---------------|---------------|---|
| Controling HW | 70.8 | 71.40 | 72.00 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controding rive | Outlet Control | Inlot Control | Inlot Control | 1 |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 19 | 1.37 |
| 100 | 26 | 2.00 |
| 50 | 23 | 1.70 |

Entrance Loss Coeficient (Ke) found using Apilication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Steedard Etec | Peri | lighters (| 19 | Application | | | methet. | |
|------------------|--|-----------------------------------|----------------|---------------|-----------|-------------|--------------------------|---------------------------|
| riche. | Ton | Pipe Size | Cross Drain | Side Drain | Martin | Application | Hydroutic Performance | |
| 400.013 | O Types Concrete With Challe | Single 10' fire 30' | Detect | Similard | Yes | Yes | Fee | 0.7: |
| 430-211 | Si Type Coveres | Straph 10" Stray 20" | Lorente | 100 | Yes | Control | Geed | 0.0-2.1 |
| 430-912 | Covered Energy (Designator) | Straje SE Sea SE | - | ten | No | - | 160 | NA. |
| 410-DIT | Fland End Section Concrete | Single ST 2014 ST | Yes | No. | Yes | Ten | Geed | 0.0 |
| 60-01 | Cross Grein Misered Cont Section | Strayle & Multiple 19" New 72" | Ten | 16- | Yes | Yes | Fair | 4.7 |
| 410-022 | Sele Drain Mitered End Section | Single & Multiple 15 Hes 657 | No | Yes | No | V= | Yes | 07 n/s. 1.0 sr gree |
| 40.00 | Straight Commiss | Timps Attorns 15" time Se" | (W) Yes | 10- | Sinteri | Yes | Emakeri | 02 |
| 490-011 | Straight Concrete | Simple & Smaller 60° | Yes | 100 | Leminol | Yes | Donter | 0.0 |
| 410.017 | Straight Concerns | Strape & Double 95° | Yun | 46- | (amind | Time . | Seater | 45 |
| 430-033 | Straight Constrain | Strape & Divaries 12" | Yes | - | Series | Yes | Excelen | 93 |
| 430-034 | Stranger Concerns | Supple* | Vien | 160 | (antique) | Yes | Example | 417 |
| 630-040 | Wright Concrete | Single 12" Mile 66". | Yes | 160 | Yes | Yes | TRO Good | 43 |

eadwater (H) found using Chart 5, FHWA HDS 5

Flow (cfs)

25

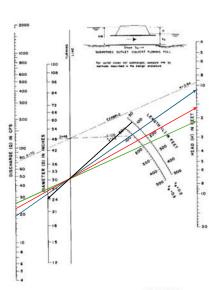
19

| | Flow (cfs) | |
|-----|------------|--|
| 25 | 19 | |
| 100 | 26 | |
| 50 | 23 | |

| н | 25-yr | 50-yr | 100-yr | |
|--|-------|-------|--------|--|
| | 1.1 | 1.6 | 2.2 | |
| Headwater (H) found using Chart 5, FHWA HDS 5. | | | | |

CHART 5B

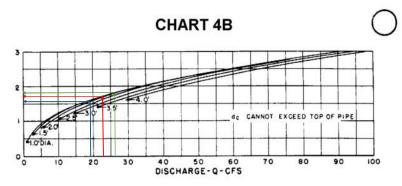




HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

| | Flow (cfs) | dc |
|-----|------------|------|
| 25 | 19 | 1.55 |
| 100 | 26 | 1.80 |
| 50 | 23 | 1.70 |

DIA (FT)



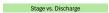
SR-60 LHR FPID

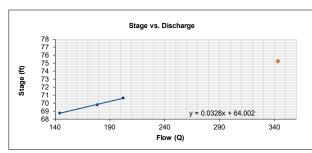
Cross Drain Flow/Stage Calulations CD-12

Insert Values

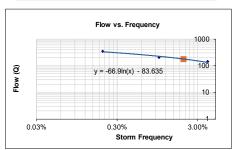
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 144 | 68.8 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 202 | 70.7 | 25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 343 | 75.2 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 178 | 69.8 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:









Given Information

| FL (US) = | 65 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 64.8 | Downstream invert |
| Edge of Travel Lane (ETL) = | 70 | Upstream elevation |
| Length (L)= | 83.41 | (Existing) |
| Slope (So) = | 0.002 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Culvert Size | Culvert Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|--------------|-----------------------|-----------------|--------------------|---------------------|
| CD-10 | 1 | 8x3' | 24.00 | 6 | 144 | 202 |

| | in. | ft. |
|------------|-----|-----|
| Height (D) | 36 | 3 |
| Width (B) | 96 | 8 |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

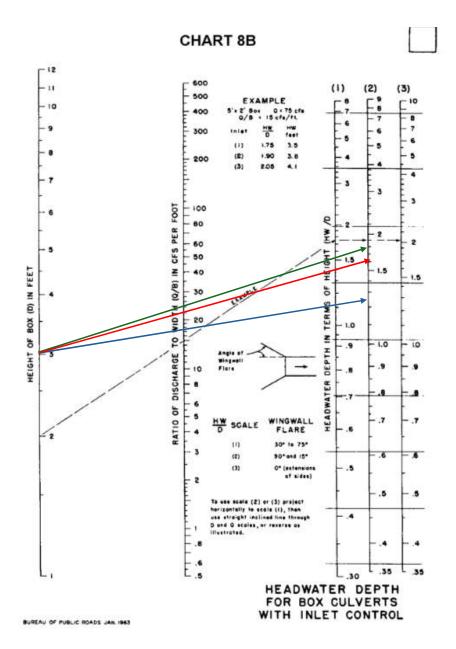
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | 18.0 | 22.3 | 25.2 | Box Culverts |
| HW/D | 1.25 | 1.60 | 1.75 | Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached) |
| HW | 3.75 | 4.80 | 5.25 | HW = (HW/D) * Diameter |
| HW Elev. | 68.75 | 69.80 | 70.25 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.5 | Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert |
|-----------------|-----|---|
| TW | 3 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.2 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.7 | 1.50 | 2.85 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 2.25 | 2.50 | 2.75 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.625 | 2.75 | 2.875 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 3 | 3 | 3 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.5 | 4.30 | 5.65 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 68.5 | 69.30 | 70.65 | US Pipe inv. + HW depth |

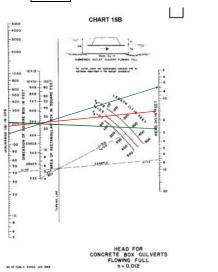
| | | 25-уг | 50-yr | 100-yr | Notes: |
|---|------------------|---------------|---------------|----------------|---|
| Γ | Controling HW | 68.75 | 69.80 | 70.65 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Ш | Controlling rivi | Inlet Central | Inlet Central | Outlet Centrel | 1 |



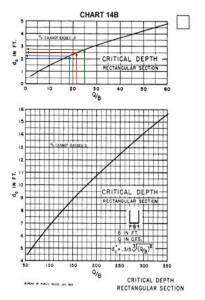
| | Q/B (cfs) | HW/D |
|-----|-----------|------|
| 25 | 18 | 1.25 |
| 50 | 22 | 1.60 |
| 100 | 25 | 1.75 |

Outlet Control $\begin{array}{c} \text{Note the desirent laws Confliction}, \\ \text{Outlet Content, Fail or Fixing Fail Entrops Fail Fixing Fail Entrops Fail Contents Fail Co$ 05 02 84 02 88 03 03







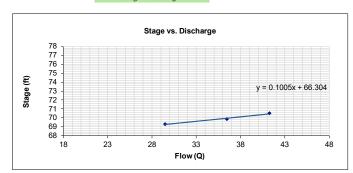


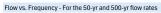
Insert Values

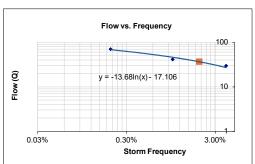
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 29 | 69.3 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 41 | 70.5 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 70 | 73.3 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 36 | 69.9 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:









Given Information

| FL (US) = | 66 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 65.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 69.5 | Upstream elevation |
| Length (L)= | 82.16 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge

Q25= (Velocity) x (Area) Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1. Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-13 | 1 | 30 | 4.91 | 6 | 29 | 41 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 30 | 2.5 |
| Width (B) | - | ú |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

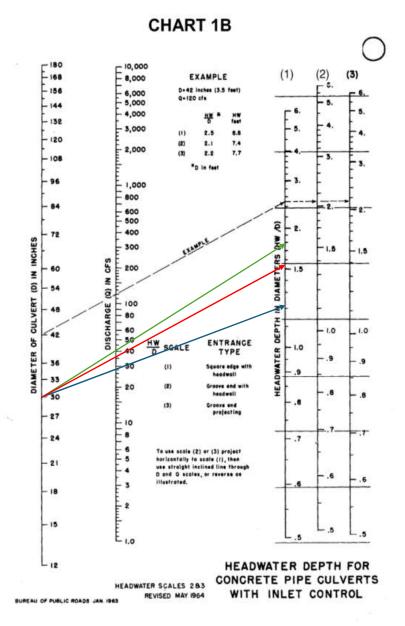
| | 25-yr | 50-yr | 100-yr | Notes |
|---------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.2 | 1.55 | 1.8 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.00 | 3.88 | 4.50 | HW = (HW/D) * Diameter |
| HW Flev | 69.00 | 69.88 | 70.50 | HW Fley = HW + FL (LIS) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2.5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr, storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.1 | 1.65 | 2.20 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.80 | 2.10 | 2.30 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.15 | 2.3 | 2.4 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2.5 | 2.5 | 2.5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.3 | 3.85 | 4.40 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 69.3 | 69.85 | 70.40 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|----------------|----------------|---------------|---------------|---|
| Controling HW | 69.3 | 69.88 | 70.50 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Outlet Control | Inlet Control | Inlet Control | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 29.45 | 1.20 |
| 100 | 41.23 | 1.80 |
| 50 | 36.41 | 1.55 |

Entrance Loss Coeficient (Ke) found using Apilication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Stendard Etec | 2000 | the contract of | 13 | Age/Isseli | * | | met bed | |
|------------------|--|-----------------------------------|----------------|---------------|-----------|-------------|--------------------------|---------------------------|
| richt. | Tops | Planting | Cross Drain | Side Drain | Martino | Application | Hydroutic Performance | |
| 400.013 | O Types Concrete With Challe | Single 10' fire 30' | Detect | Limited | Yes | Yes | Fee | 0.7 |
| 430-211 | Si Type Coveres | Straph 10" Stray 20" | Lorente | 100 | Yes | Control | Geed | dites: |
| 430-912 | Cororein Energy (Designator | Straph SE Stra TE | - | 160 | No | - | 160 | NA. |
| 410-DIT | Fland End Section Concrete | Single ST 2014 ST | Yes | No. | Yes | Ten | Geed | 0.0 |
| 60-01 | Cross Grein Misered Cont Section | Strayle & Multiple 19" New 72" | Ten | No. | Yes | Yes | Fair | 4.7 |
| 410-027 | Sale Drain Mitered End Section | Single & Multiple 15" Hez 65" | No | Yes | No | V= | Yes | 07 sys. 1,0 at geom |
| 40.00 | Straight Commiss | Timps Attorns 15" time Se" | (W) Yes | 10- | Sinteri | Yes | Emakeri | 02 |
| 490-011 | Straight Concrete | Simple & Smaller 60° | Yes | ш | Leminol | Yes | Donter | 0.0 |
| 410.007 | Straight Concerns | Strape & Double 95° | Yun | 4 | (amind | Time . | Seater | 45 |
| 430-033 | Straight Constrain | Strape & Divaries 12" | Yes | * | Series | Yes | Excelen | 93 |
| 430-034 | Stranger Concerns | Supple* | Vien | ta: | (antique) | Yes | Example | 48 |
| 630-040 | Wright Concrete | Single 12" 2514 66". | Yes | 140 | Yes | Yes | Yang Good | 43 |

Headwater (H) found using Chart 5, FHWA HDS 5:

Flow (cfs)
25
29

| | Flow (cfs) | |
|-----|------------|--|
| 25 | 29 | |
| 100 | 41 | |
| 50 | 36 | |

| н | 25-yr | 50-yr | 100-yr |
|---------------|-------------|-------------|-----------|
| | 1.1 | 1.7 | 2.2 |
| Headwater (H) | found using | Chart 5, Fi | HWA HDS 5 |

CHART 5B

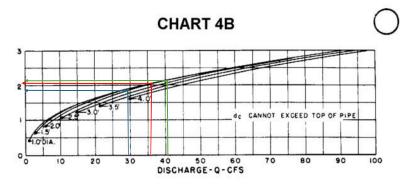


| 2000 | | |
|---------|--|--|
| | | In |
| 1000 | 9 | SHAMENED COLUMN CONTENT ADDRESS AND |
| 800 | L120 | for putel occur on extension, compute the by maileds described in the design procedure |
| - 600 | - 108 | L. |
| 500 | - 96 | المحوي |
| 400 | - 84 | |
| 300 | - 72 | |
| 7 | - 66 | me of the file |
| - 200 | -60 | The state of the s |
| | -54 | 100 2 |
| | 48 048 | |
| 100 | 48 3-48 3-48 3-48 42 8 (0) -36 | 800 800 E |
| BO 9179 | 2 | 100 100 |
| -60 | 9 - 36 | 000 |
| - 10 | | T T T T T T T T T T T T T T T T T T T |
| 20 | 30 24 0 - 27 | **** |
| 80 | -24 | 8,7 |
| | (esse) | E |
| 20 | - 21 | 1 |
| | -10 | E |
| | 1 | 1000 |
| -10 | -15 | |
| | | |
| - | -12 | 1 |
| -5 | | |

HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n=0.012

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 29 | 1.8 |
| 100 | 41 | 2.3 |
| 50 | 36 | 2.1 |

DIA (FT) 2.5

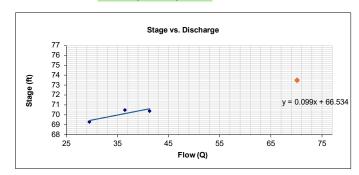


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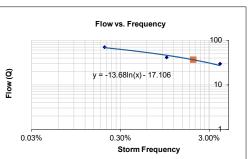
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 29 | 69.3 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 41 | 70.4 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 70 | 73.5 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 36 | 70.5 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:









Given Information

| FL (US) = | 66 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 65.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 70.3 | Upstream elevation |
| Length (L)= | 87.85 | (Existing) |
| Slope (So) = | 0.003 | |

A. Calculate Discharge

Q25= (Velocity) x (Area)

Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.

Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-14 | 1 | 30 | 4.91 | 6 | 29 | 41 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 30 | 2.5 |
| Width (B) | - | - |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

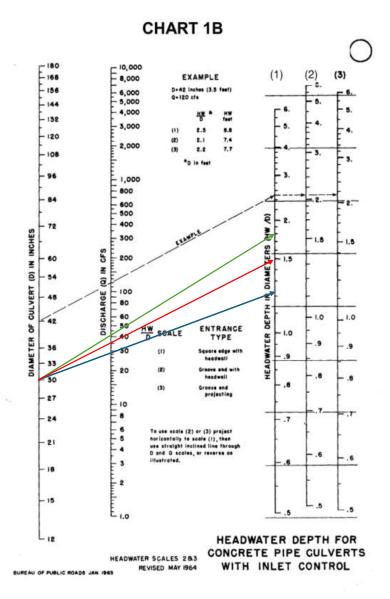
| | 25-yr | 50-yr | 100-yr | Notes |
|---------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.25 | 1.8 | 1.55 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.13 | 4.50 | 3.88 | HW = (HW/D) * Diameter |
| HW Flev | 69 13 | 70.50 | 69.88 | HW Fley = HW + FL (LIS) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| | | _ |
|-----------------|-----|--|
| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
| TW | 2.5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.1 | 1.60 | 2.20 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.80 | 2.00 | 2.20 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.15 | 2.25 | 2.35 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2.5 | 2.5 | 2.5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.3 | 3.80 | 4.40 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 69.3 | 69.80 | 70.40 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|----------------|----------------|---------------|----------------|---|
| Controling HW | 69.3 | 70.50 | 70.40 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Outlet Control | Inlet Control | Outlet Control | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 29.45 | 1.25 |
| 100 | 41.23 | 1.55 |
| 50 | 36.41 | 1.80 |

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Standard Plan | Desig | Description | | | 44. | Annal Street | | |
|------------------|---------------------------------------|-----------------------------------|-----------------|---------------|---------|--------------|------------------------|------------------------------|
| tirdex. | Type | Pipe Size | Cress Sirain | Side Drain | Median | Application | Hydrauki Pertemance | к, |
| 436.012 | U Type Committe With Grate | Single ST tire ST | Limited | Living | Yee | Yee | Fair | 0.7 |
| 430-011 | ti Yjipe Constete | Single 10" for 30" | Limited | 161 | Yee | Liveled | Goet | 1500 |
| 436-013 | Concrete Energy Designator | Single 30" tiny 17" | Limited | 361 | No | Mo | NA. | NA. |
| 436-020 | Flend Ent. Section Concrete | Single 12" thru 72" | Yes | No | Yes | Yes | Georgi | 0.0 |
| 435/01 | Crees Drain Milered End Section | Single & Multiple 15" Sinu 72" | Yes | No | Yes | 766 | Far | 0.7 |
| 436-022 | Side Drain Witered End Section | Single & Multiple 15' Dou 60" | Nex | Ven | Ne | Vee | Fee | 0.7 m/o, 1.8 m/c grade |
| 436-030 | Bragis Consens | Simple SMultiple 15" thru SM | IX Yes | *** | Limited | 700 | Excellent | -0.2 |
| 435-031 | Straight Constelle | Single & Double 60" | Yes | No | Limited | Yes | Excellent | 0.0 |
| 430-002 | Braight Conveile | Single & Double 60" | Yes | No | Limited | Yes | Excelent | 0.8 |
| 436-033 | Straight Concrete | Single & Ocadie 7/F | Yes | 161 | Limited | 786 | bother | 0.3 |
| 400-034 | Straight Concrate | Single 64" | -yes | 190 | Limited | 200 | Dooles | 0.2 |
| 430-040 | Winged Doccrete | Ringle 12" flow 46" | Yes | No | Yes | Yes | Very Good | 0.8 |

Headwater (H) found using Chart 5, FHWA HDS 5: Flow (cfs) 25 29 100 41 50 36

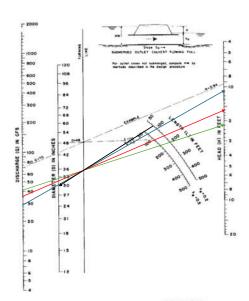
 25-yr
 50-yr
 100-yr

 H
 1.1
 1.6
 2.2

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

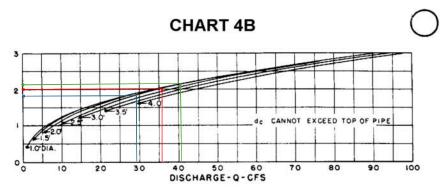
0



HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 29 | 1.8 |
| 100 | 41 | 2.2 |
| | | |

DIA (FT) 2.5

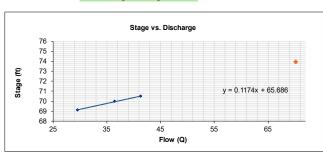


Insert Values

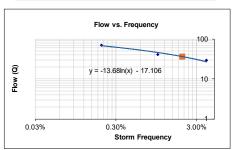
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 29 | 69.1 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 41 | 70.5 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 70 | 73.9 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 36 | 70.0 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge







Given Information

| FL (US) = | 66 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 65.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 70 | Upstream elevation |
| Length (L)= | 68.61 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-15 | 1 | 30 | 4.91 | 6 | 29 | 41 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 30 | 2.5 |
| Width (B) | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

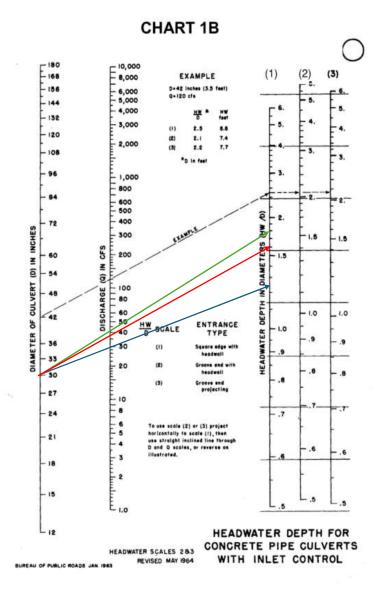
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.25 | 1.6 | 1.8 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.13 | 4.00 | 4.50 | HW = (HW/D) * Diameter |
| HW Elev. | 69.13 | 70.00 | 70.50 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2.5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|----------------|-------|--------|--|
| н | 0.9 | 1.50 | 1.90 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.80 | 2.10 | 2.45 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.15 2.3 2.475 | | 2.475 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2.5 2.5 2.5 | | 2.5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.1 | 3.70 | 4.10 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 69.1 | 69.70 | 70.10 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|----------------|---------------|---------------|---------------|---|
| Controling HW | 69.125 | 70.00 | 70.50 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Inlet Central | Inlet Central | Inlot Control | 1 |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 29.45 | 1.25 |
| 100 | 41.23 | 1.80 |
| 50 | 36.41 | 1.60 |

Entrance Loss Coeficient (Ke) found using Apilication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Stendard Etec | Peri | lighters (| 19 | Age/Ace/A | | | methet. | |
|------------------|--|-----------------------------------|----------------|---------------|-----------|-------------|--------------------------|---------------------------|
| riche. | Tops | Pipe Size | Cross Drain | Side Drain | Martin | Application | Hydroutic Performance | п. |
| 400.013 | O Types Concrete With Challe | Single 10' fire 30' | Detect | Limited | Yes | Yes | Fee | 0.7 |
| 430-211 | Si Type Coveres | Straph 10" Stray 20" | Lorente | 100 | Yes | Control | Geed | dites: |
| 430-912 | Cororein Energy (Designator | Straph SE Stra TE | - | 160 | No | - | 160 | NA. |
| 410-DIT | Fland End Section Concrete | Single ST 2014 ST | Yes | No. | Yes | Ten | Geed | 0.0 |
| 60-01 | Cross Grein Misered Cont Section | Strayle & Multiple 19" New 72" | Ten | No. | Yes | Yes | Fair | 9.7 |
| 410-027 | Sale Drain Mitered End Section | Single & Multiple 15" Hez 65" | No | Yes | No | V= | Yes | 07 sys. 1,0 at gene |
| 40.00 | Straigh Coveres | Timps Attubus 15" thuy 54" | (N) Yes | 10- | Sinteri | Yes | Emakeri | 42 |
| 490-211 | Straight Concrete | Single & Strake 60° | Yes | ш | Levisori | Yes | Donley | 0.0 |
| 410.017 | Straight Concerns | Strage & Double 90° | Ten | - | (amind | TW. | Seater | 45 |
| 430-033 | Straight Constrain | Strape & Divaries 12" | Yes | * | Series | Yes | Excelen | 93 |
| 430-334 | Stranger Concerns | Supple* | Vien | ta: | (antique) | Yes | Example | 48 |
| 630-040 | Wright Concrete | Single 12" Mile 66" | Yes | 940 | Yes | Yes | TRO Good | 43 |

Headwater (H) found using Chart 5, FHWA HDS 5:

Flow (cfs)
25
29

| | Flow (cfs) | |
|-----|------------|--|
| 25 | 29 | |
| 100 | 41 | |
| 50 | 36 | |

| н | 25-yr | 50-yr | 100-yr |
|---------------|-------------|-------------|---------------|
| | 0.9 | 1.5 | 1.9 |
| Headwater (H) | found using | Chart 5, Fi | HWA HDS 5 |

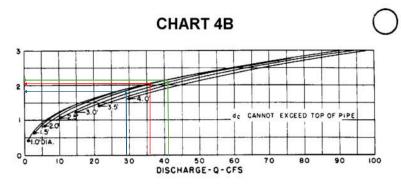
CHART 5B



| 2000 | | |
|---------|----------------------------------|--|
| | | |
| 1000 | 9 | SHARARED CALLEL CONTENT ATTACHED LOCK |
| 800 | L120 | for outset occur not submerged, compute MW by mailteds described in the design procedure |
| - 600 | -108 | |
| 500 | - 96 | |
| 400 | - 84 | |
| 300 | - 72 | |
| 77 | - 66 | mer of the line |
| - 200 | -60 | X8. 34 |
| - | -54 | The state of the s |
| | 48 048 | 3 |
| 100 | SH 48 3448 42 42 8 (0) -36 | 100 E 34 |
| BO 9:19 | ž. | 100 100 |
| -60 | 2 - 36 | 000 |
| -10 | 30 | 1 |
| - 90 | 27 | *** |
| 50 | -24 | 9,4 |
| | (esc) | į. |
| 20 | - 21 | 1 |
| | -10 | į į |
| | | |
| -10 | -15 | |
| | | |
| - 6 | -18 | J. |
| -5 | | |

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 29 | 1.8 |
| 100 | 41 | 2.5 |
| 50 | 36 | 2.1 |

DIA (FT) 2.5



Insert Values

| | | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | |
|---|--------------|-------|---------------|------------|------------|------------------------|
| | | 25 | 4.00% | 29 | 69.1 | 25-yr, 100-yr, and 50 |
| | Base Flood | 100 | 1.00% | 41 | 70.5 | 25-yr , 50-yr and 100 |
| | Greatest | 500 | 0.20% | 70 | 73.9 | 500-yr stage calculat |
| Ī | Design Flood | 50 | 2.00% | 36 | 70.0 | 50-vr flow rate calcul |

Notes

Styr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).

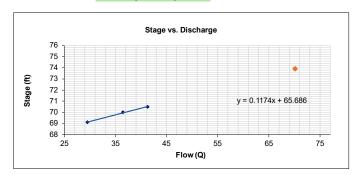
25-yr, 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).

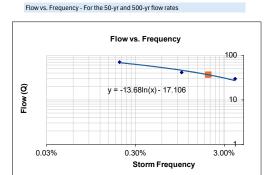
500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages

50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:







Given Information

| FL (US) = | 66 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 65.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 70 | Upstream elevation |
| Length (L)= | 90.15 | (Existing) |
| Slope (So) = | 0.003 | |

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-16 | 1 | 30 | 4.91 | 6 | 29 | 41 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 30 | 2.5 |
| Width (B) | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

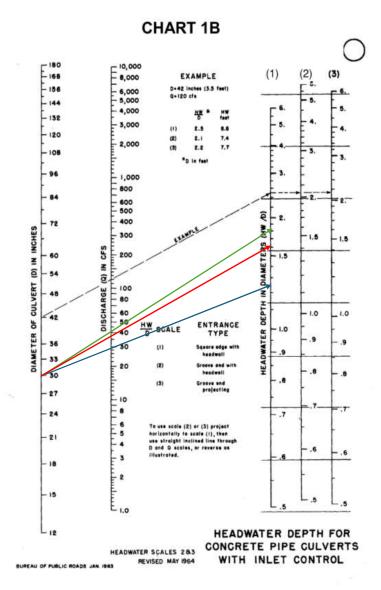
| | 25-yr | 50-yr | 100-yr | Notes |
|---------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.25 | 1.6 | 1.8 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.13 | 4.00 | 4.50 | HW = (HW/D) * Diameter |
| HW Flev | 69 13 | 70.00 | 70.50 | HW Fley = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2.5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.8 | 1.40 | 1.80 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.80 | 2.10 | 2.45 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.15 | 2.3 | 2.475 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2.5 | 2.5 | 2.5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3 | 3.60 | 4.00 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 69 | 69.60 | 70.00 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|----------------|---------------|---------------|---------------|---|
| Controling HW | 69.125 | 70.00 | 70.50 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Inlet Control | Inlet Control | Inlet Control | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 29 | 1.25 |
| 100 | 41 | 1.80 |
| 50 | 36 | 1.60 |

Entrance Loss Coeficient (Ke) found using Apilication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Steedard Etec | Peri | Parties . | 13 | Age/Isseli | * | | met bed | |
|------------------|--|-----------------------------------|----------------|---------------|-----------|-------------|--------------------------|---------------------------|
| Pign (Irdex | Tore | Parties | Cross Drain | Side Drain | Martin | Application | Hydroutic Performance | 15. |
| 400.013 | O Type Concrete WA Challe | Single 10' thru 30' | Detect | Limited | Yes | Yes | Fee | 0.7 |
| 430-211 | Si Type Covered | Straph 10" Stray 20" | Lorente | 100 | Yes | Control | Geed | 0.000 |
| 430-912 | Constant Strenge (Seeparter) | Straje SE See SE | - | 160 | No | - | 160 | NA. |
| 410-DIT | Fluid End Section Concrete | Single 17:314.12 | Yes | No. | Yes | Ten | Geed | 0.0 |
| 60-01 | Cross Grein Misered Cost Section | Strape & Multiple 19" See, 72" | Ten | No. | Yes | Yes | Fair | 47 |
| 410-027 | Sale Drain Mitered End Section | Single & Multiple 15' Hosp 65" | No | Yes | No | V= | Yes | 07 m/s. 1,0/ar gyen |
| 40.00 | Straigh Covered | Timps Attuituse 13" time Self | (N) Yes | 10- | Sinteri | Yes | Emakeri | 42 |
| 490-211 | Straight Concrese | Single & Souther 60" | Yes | ш | Levisori | Yes | Donter | 92 |
| 410.017 | Straight Concerns | Strage & Double 50° | Yes | 4 | Carried | TW. | Streeters | 45 |
| 430-033 | Straight Constree | Simple & Divable 12" | Yes | * | Series | Yes | Excelent | 93 |
| 430-034 | Stranger Concession | Single 64" | Vien | ta: | (antique) | Yes | Example | 48 |
| 630-040 | Winged Concrete | Single 12" 2514 66". | Yes | 140 | Yes | Yes | Ting Good | 03- |

Headwater (H) found using Chart 5, FHWA HDS 5:
Flow (cfs)

| | Flow (cfs) | |
|-----|------------|--|
| 25 | 29 | |
| 100 | 41 | |
| 50 | 36 | |

| н | 25-yr | 50-yr | 100-yr |
|---------------|-------------|-------------|---------------|
| | 0.8 | 1.4 | 1.8 |
| Headwater (H) | found using | Chart 5, FH | WA HDS 5. |

CHART 5B

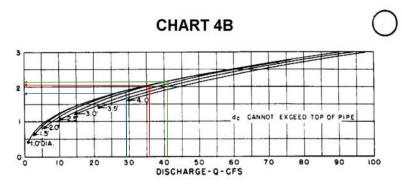


| L 3000 | | |
|---------|--------|---|
| 1 | | m |
| 1000 | 9 | Superior Current Courtes Formers Force -5 |
| 800 | L120 | for purel cross not submerged, compute the by maintake described in the design protestors |
| 600 | - 108 | -1 |
| 500 | - 96 | ,,990 10 |
| 400 | - 84 | |
| 300 | - 72 | |
| | - 66 | 20 C |
| - g00 | -60 | Charles of the same of |
| - | - 54 | 0.2 |
| -100 | 48 048 | 3 |
| 100 | 42 | 100 to 11 2 |
| 10.9°19 | -36 | 100 100 |
| -60 8 | | 000 / 000 -0 |
| -10 | 30 | 900 : |
| 30 | -27 | 1 |
| 80 | -24 | 9 # 10 |
| 20 | -21 | |
| | -10 | Ĺ, |
| -10 | -10 | |
| -• | 1 | |
| - | -18 | 1 |
| -5 | | |

HEAD FOR
CONCRETE PIPE GULVERTS
FLOWING FULL
n=0.012

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 29 | 1.8 |
| 100 | 41 | 2.5 |
| EO | 20 | 2.1 |

DIA (FT) 2.5

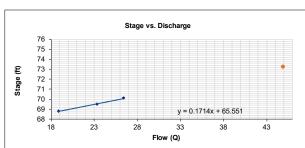


Insert Values

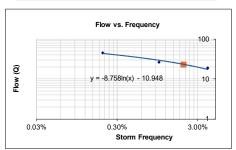
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 19 | 68.8 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 26 | 70.1 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 45 | 73.2 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 23 | 69.5 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:





Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

| FL (US) = | 66 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 65.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 69.25 | Upstream elevation |
| Length (L)= | 90.21 | (Existing) |
| Slope (So) = | 0.003 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-17 | 1 | 24 | 3.14 | 6 | 19 | 26 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 24 | 2 |
| Width (B) | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

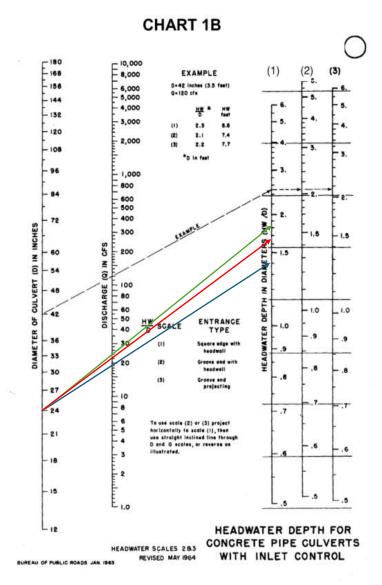
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.4 | 1.6 | 1.8 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 2.80 | 3.20 | 3.60 | HW = (HW/D) * Diameter |
| HW Elev. | 68.80 | 69.20 | 69.60 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.1 | 1.80 | 2.40 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.50 | 1.65 | 1.85 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 1.75 | 1.825 | 1.925 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2 | 2 | 2 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.8 | 3.50 | 4.10 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 68.8 | 69.50 | 70.10 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|----------------|----------------|----------------|----------------|---|
| Controling HW | 68.8 | 69.50 | 70.10 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Outlot Control | Outlet Central | Outlet Centrel | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 19 | 1.40 |
| 100 | 26 | 1.80 |
| 50 | 23 | 1.60 |

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Stendard Etec | 2000 | the contract of | 13 | Age/Isseli | * | | met bed | |
|------------------------------------|--|-----------------------------------|----------------|---------------|-----------|-------------|--------------------------|---------------------------|
| richt. | Tops | Planting | Cross Drain | Side Drain | Martino | Application | Hydroutic Performance | |
| 400.013 | O Types Concrete With Challe | Single 10' fire 30' | Detect | Limited | Yes | Yes | Fee | 0.7 |
| 430-211 | Si Type Coveres | Straph 10" Stray 20" | Lorente | 100 | Yes | Control | Geed | dites: |
| 430-012 Concrete Energy Strape SET | | Straph SE Stra TE | - | 160 | No | - | 160 | NA. |
| 410-DIT | Fland End Section Concrete | Single ST 2014 ST | Yes | No. | Yes | Ten | Geed | 0.0 |
| 60-01 | Cross Grein Misered Cont Section | Strayle & Multiple 19" New 72" | Ten | No. | Yes | Yes | Fair | 4.7 |
| 410-027 | Sale Drain Mitered End Section | Single & Multiple 15" Hez 65" | No | Yes | No | V= | Yes | 07 sys. 1,0 at gene |
| 40.00 | Straight Commiss | Timps Attorns 15" time Se" | (W) Yes | 10- | Sinteri | Yes | Emakeri | 02 |
| 490-011 | Straight Concrete | Simple & Smaller 60° | Yes | ш | Leminol | Yes | Donter | 0.0 |
| 410.017 | Straight Concerns | Strape & Double 95° | Yun | 4 | (amind | Time . | Seater | 45 |
| 430-033 | Straight Constrain | Strape & Divarie 12" | Yes | * | Series | Yes | Excelen | 93 |
| 430-034 | Stranger Concerns | Supple* | Vien | ta: | (antique) | Yes | Example | 48 |
| 630-040 | Wright Concrete | Single 12" 2514 66". | Yes | 140 | Yes | Yes | Yang Good | 43 |

eadwater (H) found using Chart 5, FHWA HDS 5

Flow (cfs)
25
19
100
26
50
23

| н | 25-yr | 50-yr | 100-yr | |
|--|-------|-------|---------------|--|
| | 1.1 | 1.8 | 2.4 | |
| Headwater (H) found using Chart 5, FHWA HDS 5. | | | | |

CHART 5B

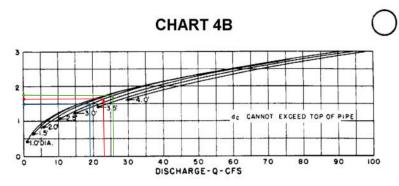


| 2000 | | - T. | |
|---------|--|--|----|
| | | in 1, = | |
| | 3 | managed Steps Square Principalities | Γ |
| 1000 | 1 | SHEMENDED GUTLET CHEVENT FLOWING FILL | 1 |
| 800 | L120 | for outsit cross not submerged, compute the by mailtage described in the design procedure | 1 |
| - 600 | - 10a | | F, |
| 500 | - 96 | 4.040- | Ł, |
| 400 | -84 | | 1 |
| 300 | - 72 | | E |
| | -66 | m # 6 / 5 | Ę |
| 200 | -60 | Commercial Services | F |
| - | -54 | WXX XX | E |
| 8 | 40 544 | The state of the s | 1 |
| 100 | Q 42 | 400 63 3 | Ē. |
| BO 9-19 | Z | | 1 |
| -60 | 9-36 | 1 | F. |
| -10 | - 53 | *00. | E' |
| -40 | 45 -42 40 -42 41 -42 42 -33 43 -30 | **** £ | þ |
| | | • • • | ŧ, |
| - 10 | -24 | | ŀ |
| 26 | - 21 | | F |
| | -10 | | Ē, |
| -10 | -10 | | |
| | | | |
| | -12 | | |
| - 5 | | | |

HEAD FOR
CONCRETE PIPE GULVERTS
FLOWING FULL
0 0.012

| | Flow (cfs) | dc |
|-----|------------|------|
| 25 | 19 | 1.50 |
| 100 | 26 | 1.85 |
| 50 | 23 | 1.65 |

DIA (FT)



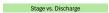
SR-60 LHR FPID

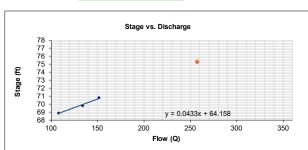
Cross Drain Flow/Stage Calulations CD-18

Insert Values

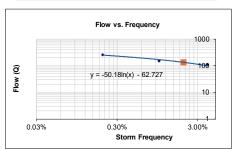
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 108 | 68.9 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 151 | 70.8 | 25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 257 | 75.3 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 134 | 69.8 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:









Given Information

| FL (US) = | 65 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 64.8 | Downstream invert |
| Edge of Travel Lane (ETL) = | 69 | Upstream elevation |
| Length (L)= | 89.5 | (Existing) |
| Slope (So) = | 0.002 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Culvert Size | Culvert Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|--------------|-----------------------|-----------------|--------------------|---------------------|
| CD-10 | 1 | 6x3' | 18.00 | 6 | 108 | 151 |

| | in. | ft. |
|------------|-----|-----|
| Height (D) | 36 | 3 |
| Width (B) | 72 | 6 |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

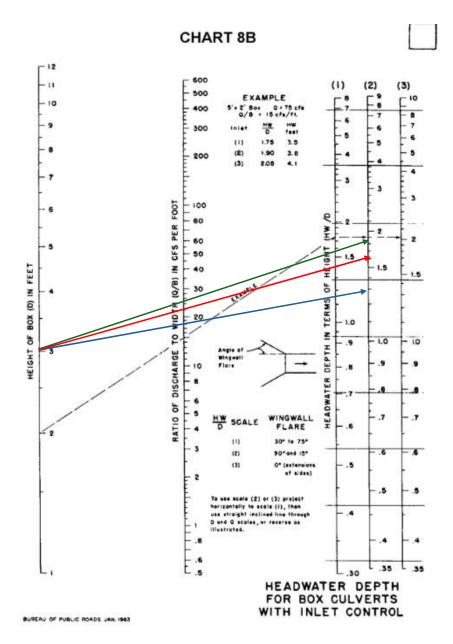
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | 18.0 | 22.3 | 25.2 | Box Culverts |
| HW/D | 1.30 | 1.60 | 1.85 | Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached) |
| HW | 3.90 | 4.80 | 5.55 | HW = (HW/D) * Diameter |
| HW Elev. | 68.90 | 69.80 | 70.55 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

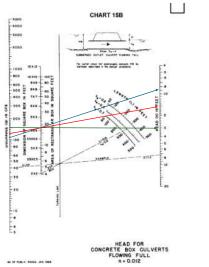
| Ke | 0.5 | Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert |
|-----------------|-----|---|
| TW | 3 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.2 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.85 | 1.50 | 3.00 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 2.25 | 2.50 | 2.75 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.625 | 2.75 | 2.875 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 3 | 3 | 3 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.65 | 4.30 | 5.80 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 68.65 | 69.30 | 70.80 | US Pipe inv. + HW depth |

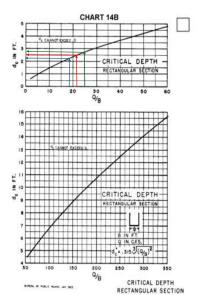
| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|---------------|---------------|----------------|---|
| Controling HW | 68.9 | 69.80 | 70.80 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling riv | Inlot Control | Inlet Control | Outlet Control | 1 |



| | Q/B (cfs) | HW/D |
|-----|-----------|------|
| 25 | 18 | 1.30 |
| 50 | 22 | 1.60 |
| 100 | 25 | 1.85 |







SR-60 LHR FPID

Cross Drain Flow/Stage Calulations CD-19

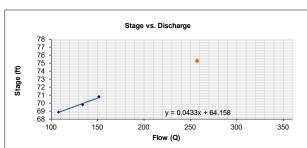
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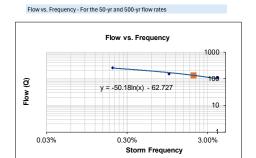
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) |
|--------------|-------|---------------|------------|------------|
| | 25 | 4.00% | 108 | 68.9 |
| Base Flood | 100 | 1.00% | 151 | 70.8 |
| Greatest | 500 | 0.20% | 257 | 75.3 |
| Design Flood | | 2.000/ | 124 | 60.0 |

| e (ft) | Notes |
|--------|--|
| .9 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| .8 | 25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B). |
| .3 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| .8 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:







Given Information

| FL (US) = | 65 | Upstream invert | |
|-----------------------------|-------|--------------------|--|
| FL (DS) = | 64.8 | Downstream invert | |
| Edge of Travel Lane (ETL) = | 69 | Upstream elevation | |
| Length (L)= | 87 | (Existing) | |
| Slope (So) = | 0.002 | | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Culvert Size | Culvert Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|--------------|-----------------------|-----------------|--------------------|---------------------|
| CD-10 | 1 | 6x3' | 18.00 | 6 | 108 | 151 |

| | in. | ft. |
|------------|-----|-----|
| Height (D) | 36 | 3 |
| Width (B) | 72 | 6 |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

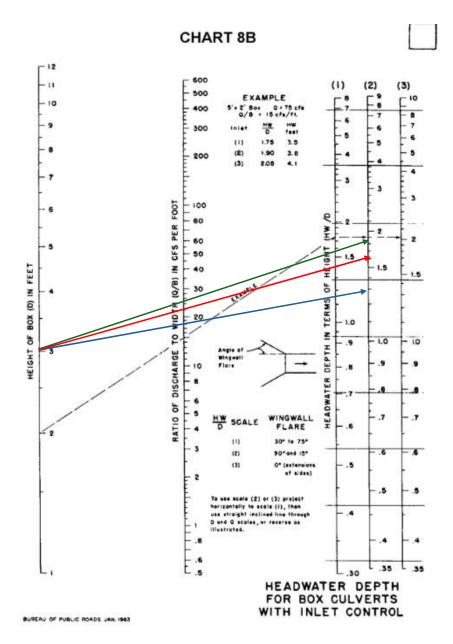
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | 18.0 | 22.3 | 25.2 | Box Culverts |
| HW/D | 1.30 | 1.60 | 1.85 | Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached) |
| HW | 3.90 | 4.80 | 5.55 | HW = (HW/D) * Diameter |
| HW Elev. | 68.90 | 69.80 | 70.55 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

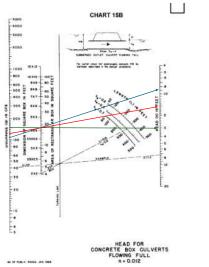
| Ke | 0.5 | Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert |
|-----------------|-----|---|
| TW | 3 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.2 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|---|
| н | 0.85 | 1.50 | 3.00 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 2.25 | 2.50 | 2.75 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached |
| ho | 2.625 | 2.75 | 2.875 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 3 | 3 | 3 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.65 | 4.30 | 5.80 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 68.65 | 69.30 | 70.80 | US Pipe inv. + HW depth |

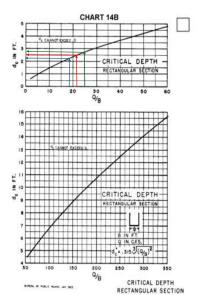
| | 25-уг | 50-yr | 100-yr | Notes: |
|----------------|---------------|---------------|----------------|---|
| Controling HW | 68.9 | 69.80 | 70.80 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Inlet Central | Inlet Central | Outlet Centrel | |



| | Q/B (cfs) | HW/D |
|-----|-----------|------|
| 25 | 18 | 1.30 |
| 50 | 22 | 1.60 |
| 100 | 25 | 1.85 |







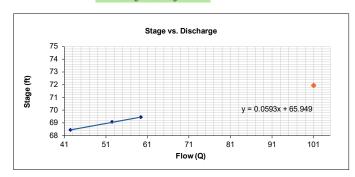
Insert Values

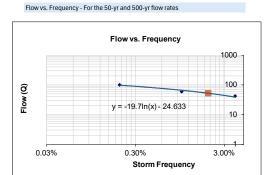
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | |
|--------------|-------|---------------|------------|------------|--------------------------------------|
| | 25 | 4.00% | 42 | 68.5 | 25-yr, 100-yr, and 500-yr flow rates |
| Base Flood | 100 | 1.00% | 59 | 69.5 | 25-yr, 50-yr and 100-yr stages four |
| Greatest | 500 | 0.20% | 101 | 71.9 | 500-yr stage calculated using Stage |
| Design Flood | 50 | 2 00% | 52 | 69 1 | 50-yr flow rate calculated using Flo |

Notes
25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
25-yr, 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:







Given Information

| FL (US) = | 64.8 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 64.5 | Downstream invert |
| Edge of Travel Lane (ETL) = | 68.5 | Upstream elevation |
| Length (L)= | 84.68 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-20 | 1 | 36 | 7.07 | 6 | 42 | 59 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 36 | 3 |
| Width (B) | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

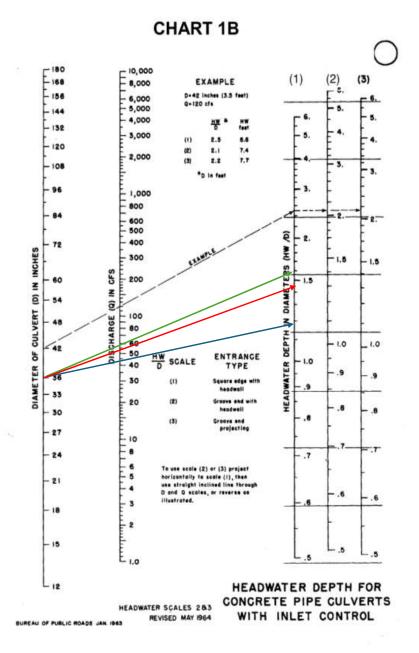
| | 25-yr | 50-yr | 100-yr | Notes |
|---------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.18 | 1.43 | 1.55 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.54 | 4.29 | 4.65 | HW = (HW/D) * Diameter |
| HW Flev | 68.34 | 69.09 | 69 45 | HW Fley = HW + FL (LIS) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 3 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr, storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.95 | 1.50 | 1.90 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 2.10 | 2.60 | 2.90 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.55 | 2.8 | 2.95 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 3 | 3 | 3 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.65 | 4.20 | 4.60 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 68.45 | 69.00 | 69.40 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|----------------|----------------|---------------|---------------|---|
| Controling HW | 68.45 | 69.09 | 69.45 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling HW | Outlet Control | Inlet Control | Inlet Control | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 42 | 1.18 |
| 100 | 59 | 1.55 |
| 50 | 52 | 1.43 |

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

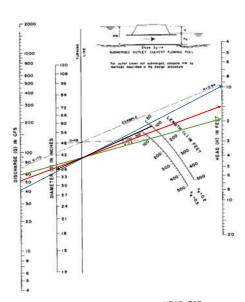
| Standard Flan Index | Desir | quitam | - 0 | Appleate | 4 | | ARREST NAME | |
|---------------------------|---------------------------------------|-----------------------------------|-----------------|---------------|---------|-------------|-------------------------|-------------------------------|
| | Type | Pipe Size | Cress Sirain | Side Drain | Median | Application | Hydrauki Perfernance | к, |
| 436010 | U Type Committe With Grate | Single ST Box 30" | Limited | Limited | Yes | Yes | Fair | 0.7 |
| 438-011 | U Yype Commete | Single 10" Eve. 30" | Liveted | 191 | Yee | Liveled | Goet | 15 to 2. |
| 438-013 | Concrete Energy Dissipator | Single 30" tiny 17" | Limited | 94 | No | Mo | NA. | NA. |
| 435-020 | Flend Ent Section Concrete | Single 12 May 72" | Yes | No | Yee | Yes | Gnot | 0.0 |
| 430-021 | Cross Drain Misered End Section | Single 8 Multiple 15' Seu 72' | Yes | No | Yes | 766 | Fee | 0.7 |
| 416-022 | Side Drain Witered End Seatter | Single & Multiple 18' Shiu 60" | Nex | Ven | Ne | Vie | Fac | 0.7 m/o. 1.8 m/c. grade |
| 436-030 | Straight Constants | Single &thittpse 15" this 34" | IX Yes | 100 | Limited | 700 | Excelue | -0.2 |
| 435-031 | Braight Constelle | Single & Double 67 | Yes | No | Limited | Yes | Excelled | 0.0 |
| 430-002 | Braight Conveile | Single & Drudie 60° | Yes | Mo | Limited | Yes | Exelect | 0.8 |
| 436-033 | Straight Concrete | Single & Octable 73" | Yes | 161 | Limited | 766 | Doorbert | 0.3 |
| 430-034 | Straight Concealer | Single 64" | -yes | 90.0 | Limited | 200 | Dooles | 0.2 |
| 430.040 | Winged Concrete | Ringle 12" through | Yes | No | Yes | Yes | Very Good | 0.8 |

25-yr 50-yr 100-yr H 1.0 1.5 1.9

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

0

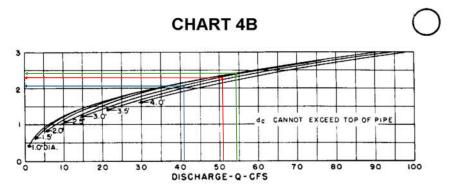


HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

Critical Depth (dc) Found using Chart 4, FHWA HDS 5

Flow (cfs) dc
25 42 2.1
100 59 2.9

DIA (FT)



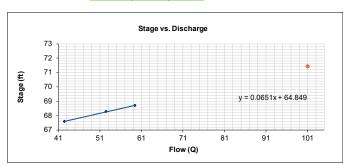
Insert Values

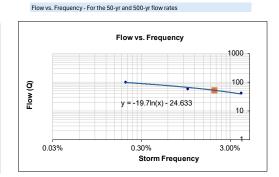
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | |
|--------------|-------|---------------|------------|------------|---|
| | 25 | 4.00% | 42 | 67.6 | 25-yr, 100-yr, and 500-yr flow rates calculated per Dra |
| Base Flood | 100 | 1.00% | 59 | 68.7 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, F |
| Greatest | 500 | 0.20% | 101 | 71.4 | 500-yr stage calculated using Stage vs. Discharge equ |
| Design Flood | 50 | 2.00% | 52 | 68.3 | 50-vr flow rate calculated using Flow vs. Frequency eq |

rainage Design Guide (see below, Section A). , FHWA HDS 5 (see below, Section B). quation (obtained from graphing 25-yr to 100-yr stages equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge





Notes

Given Information

| FL (US) = | 64 | Upstream invert |
|-----------------------------|--------|--------------------|
| FL (DS) = | 63.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 68 | Upstream elevation |
| Length (L)= | 91.12 | (Existing) |
| Slope (So) = | 0.0033 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 tr/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25 1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-21 | 1 | 36 | 7.07 | 6 | 42 | 59 |

| Diameter (D) 36 3 | | in. | ft. |
|-------------------|--------------|-----|-----|
| | Diameter (D) | 36 | 3 |
| Width (B) | Width (B) | - | - |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

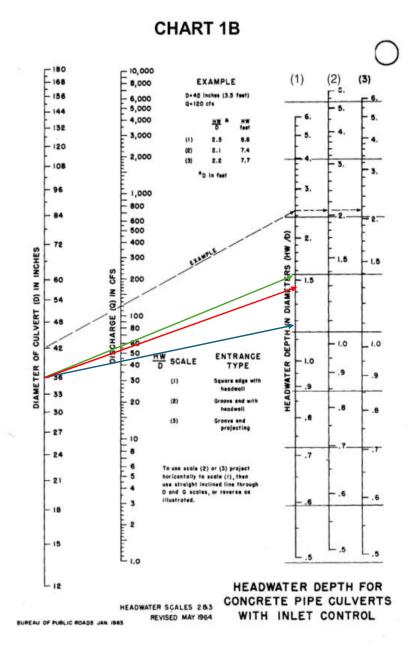
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.18 | 1.43 | 1.55 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 3.54 | 4.29 | 4.65 | HW = (HW/D) * Diameter |
| HW Elev. | 67.54 | 68.29 | 68.65 | HW Flev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 3 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr, storm) |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 0.9 | 1.50 | 2.00 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 2.10 | 2.60 | 2.90 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 2.55 | 2.8 | 2.95 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 3 | 3 | 3 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 3.6 | 4.20 | 4.70 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 67.6 | 68.20 | 68.70 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|----------------|---------------|----------------|---|
| Controling HW | 67.6 | 68.29 | 68.70 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controding rive | Outlet Control | Inlot Control | Outlet Control | 1 |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 42 | 1.18 |
| 100 | 59 | 1.55 |
| 50 | 52 | 1.43 |

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

| Stendard Etec | Descri | lighters (| | Age/Ace/A | | meter. | | |
|------------------|--|-----------------------------------|----------------|---------------|-----------|-------------|--------------------------|---------------------------|
| rides | Tore | Pipe Size | Cross Drain | Side Drain | Martin | Application | Hydroutic Performance | 15. |
| 400.013 | O Type Concrete WA Challe | Single 10' fire 30' | Detect | Limited | Yes | Yes | Fac. | 0.7 |
| 430-211 | Si Type Coveres | Straph 10" Stray 20" | Lorente | 100 | Yes | Control | Geof | 0.000 |
| 430-912 | Constant Strenge (Seeparter) | Straph SE Stra TE | - | 160 | No | - | 160 | NA. |
| 410-DIT | Fluid End Section Concrete | Single ST 2014 ST | Yes | No. | Yes | Ten | Gent | 0.0 |
| 60-01 | Cross Grein Misered Cost Section | Strayle & Multiple 19" New 72" | Ten | No. | Yes | Yes | Feb. | 47 |
| 410-027 | Sale Drain Mitered End Section | Single & Multiple 15" Hez 65" | No | Yes | No | V= | Yes | 07 m/s. 1,0/ar gyen |
| 40.00 | Straigh Covered | Timps Attubus 15" thuy 54" | (N) Yes | 10- | Sinteri | Yes | Emaker | 42 |
| 490-211 | Straight Concrese | Single & Strake 60° | Yes | ш | Levisori | Yes | Distant | 92 |
| 410.017 | Straight Concerns | Strage & Double 90° | Ten | - | (amind | TW. | Streeters | 0.2 |
| 430-033 | Straight Constrain | Strape & Divarie 12" | Yes | * | Series | Yes | Excellent | 93 |
| 430-034 | Stranger Concession | Supple* | Vien | ta: | (antique) | Yes | Exales | 48 |
| 630-040 | Wright Concrete | Single 12" Mile 66" | Yes | 940 | Yes | Yes | TRO Good | 43 |

Headwater (H) found using Chart 5, FHWA HDS 5: Flow (cfs)

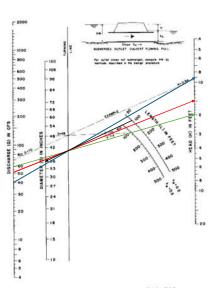
| | Flow (cfs) | |
|-----|------------|--|
| 25 | 42 | |
| 100 | 59 | |
| 50 | 52 | |

| | 25-yr | 50-yr | 100-yr | _ |
|---|-------|-------|--------|---|
| н | 0.9 | 1.5 | 2.0 | |
| | | | | |

 $Headwater \, (H) \, found \, using \, Chart \, 5, \, \, FHWA \, HDS \, 5.$

CHART 5B



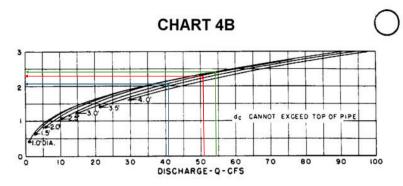


HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

Critical Depth (dc) Found using Chart 4, FHWA HDS 5

| | Flow (cfs) | dc |
|-----|------------|-----|
| 25 | 42 | 2.1 |
| 100 | 59 | 2.9 |
| 50 | 52 | 2.6 |

DIA (FT)

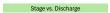


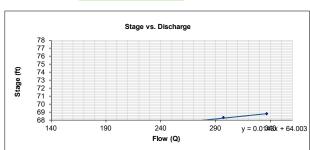
SR-60 LHR FPID Cross Drain Flow/Stage Calulations CD-22

Insert Values

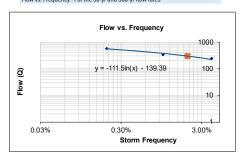
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 240 | 67.4 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 336 | 68.8 | 25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 571 | 77.4 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 297 | 68.3 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:





Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

| FL (US) = | 62.3 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 62 | Downstream invert |
| Edge of Travel Lane (ETL) = | 67.2 | Upstream elevation |
| Length (L)= | 83.41 | (Existing) |
| Slope (So) = | 0.004 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Culvert Size | Culvert Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|--------------|-----------------------|-----------------|--------------------|---------------------|
| CD-10 | 1 | 8x5' | 40.00 | 6 | 240 | 336 |

| | in. | ft. |
|------------|-----|-----|
| Height (D) | 60 | 5 |
| Width (B) | 96 | 8 |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

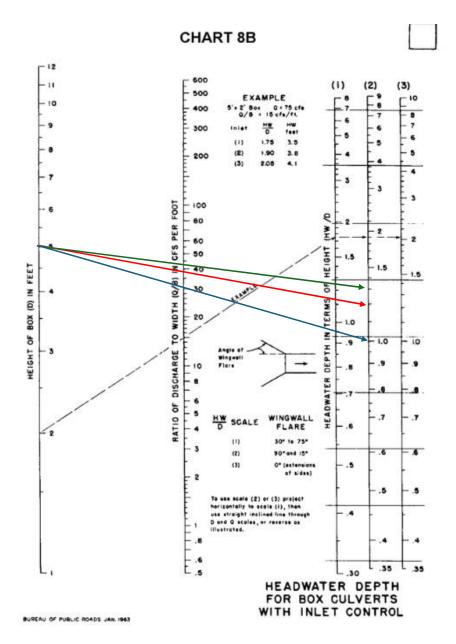
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | 30.0 | 37.1 | 42.0 | Box Culverts |
| HW/D | 1.00 | 1.20 | 1.30 | Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached) |
| HW | 5.00 | 6.00 | 6.50 | HW = (HW/D) * Diameter |
| HW Elev. | 67.30 | 68.30 | 68.80 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.5 | Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert |
|-----------------|-----|---|
| TW | 5 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| н | 0.43 | 1.05 | 1.70 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 3.00 | 3.50 | 3.80 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 4 | 4.25 | 4.4 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 5 | 5 | 5 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 5.13 | 5.75 | 6.40 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 67.43 | 68.05 | 68.70 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|----------------|---------------|---------------|---|
| Controling HW | 67.43 | 68.30 | 68.80 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling riv | Outlet Control | Inlot Control | Inlot Control | 1 |



| | Q/B (cfs) | HW/D |
|-----|-----------|------|
| 25 | 30 | 1.00 |
| 50 | 37 | 1.20 |
| 100 | 42 | 1.30 |

Outlet Control

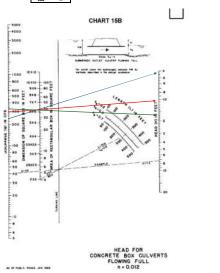
Take 13-defined less Confinence

Outlet Control, Fed or Fedy Fed Edinason for

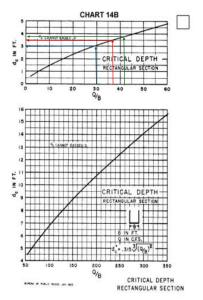
No. 66 (20)

"Gaugest 05 02 84 02 88 03 03









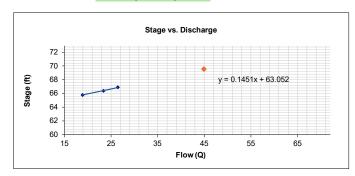
SR-60 LHR FPID: 452574-1-22-01 Cross Drain Flow/Stage Calulations CD-23 (Assuming pipe size of 24")

Insert Values

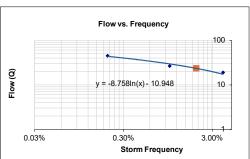
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 19 | 65.8 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 26 | 66.9 | 25-yr, 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 45 | 69.6 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 23 | 66.4 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge







Given Information

| FL (US) = | 63 | Upstream invert |
|-----------------------------|--------|--------------------|
| FL (DS) = | 62.7 | Downstream invert |
| Edge of Travel Lane (ETL) = | 65.1 | Upstream elevation |
| Length (L)= | 75 | (Existing) |
| Slope (So) = | 0.0040 | |

A. Calculate Discharge

Q25= (Velocity) x (Area)

Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.

Q100=Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-23 | 1 | 24 | 3.14 | 6 | 19 | 26 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 24 | 2 |
| Width (B) | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

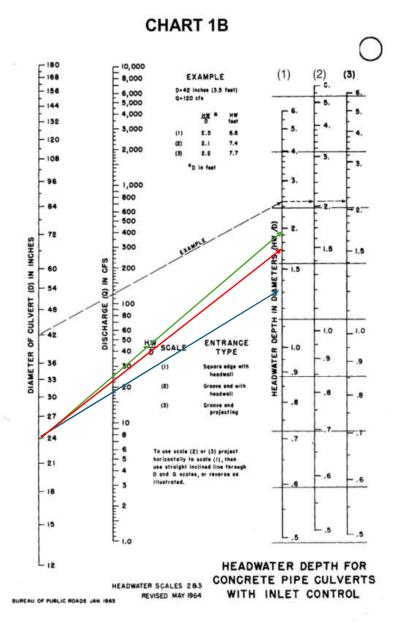
| | 25-yr | 50-yr | 100-yr | Notes |
|---------|-------|-------|--------|---|
| Q/B | - | - | - | Box Culverts |
| HW/D | 1.3 | 1.7 | 1.95 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 2.60 | 3.40 | 3.90 | HW = (HW/D) * Diameter |
| HW Flev | 65.60 | 66.40 | 66.90 | HW Fley = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). |
|-----------------|-----|---|
| TW | 2 | If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater |
| LSo | 0.3 | LSo = Pipe Lengh * Pipe Slope |
| Outlet Velocity | 6 | Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr, storm). |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.1 | 1.70 | 2.00 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.50 | 1.70 | 1.80 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 1.75 | 1.85 | 1.9 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2 | 2 | 2 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.8 | 3.40 | 3.70 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 65.8 | 66.40 | 66.70 | US Pipe inv. + HW depth |

| | 25-yr | 50-yr | 100-yr | Notes: |
|-----------------|----------------|----------------|---------------|---|
| Controling HW | 65.8 | 66.40 | 66.90 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling riv | Outlet Control | Outlet Control | Inlet Control | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 19 | 1.30 |
| 100 | 26 | 1.95 |
| 50 | 23 | 1.70 |

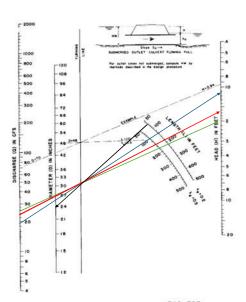
Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

| Standard | Desir | ription | | Applicati | | Mari Brief | | |
|---------------|---------------------------------------|-----------------------------------|----------------|---------------|----------|-------------|-------------------------|-----------------------------|
| Plan Index | Type | Pipe Size | Cress Grain | Side Drain | Madian | Application | Hydraulio Perference | к, |
| 400-010 | M Yype Comores With Grate | Single ST Tes. 30" | Limited | Liested | Yes | Yes | Far | 0.7 |
| 430-011 | U Type Compete | Single ST Tex. ST | Livre | 1911 | Yee | Lovened | Geet | 1500 |
| 436-013 | Concrete Energy Dissipation | Single 30" time 17" | Limited | 90 | Ne | Mo | NA. | NA. |
| 436-020 | Fliend Entil Section Concess | Single 12" thru 12" | Yes | 160 | Yes | Yes | Good | 0.0 |
| 430/01 | Greek Dram Miterac Dram Section | Single & Multiple 187 Stru 72" | Yes | No | Yes | Tee. | Fac | 87 |
| 436-022 | Side Dwn Wiered End Sestion | Single & Multiple 15' thru 60" | No | Ven. | Ne | Yes | Fac | 8.7 m/o. 1.8 m/ grate |
| 436-036 | Stranger Constraints | Single SMultiple 15" May 34" | Tes | 96 | Carrient | 700 | Excellent | -0.2 |
| 430-031 | Straight Constrain | Single & Double 60" | Yes | No | Limited | Yes | Excellent | 0.0 |
| 430-002 | Braight Donovelle | Single & Double 60" | Yes | No | Limited | Yes | Extellent | 0.8 |
| 436-033 | Straight Concess | Single & October 72" | Yes | 100 | Lessed | Yes | botes | 0.8 |
| 435-034 | Straight Concrate | Single 64° | Yes | 140 | Circles | Tea | Doolee | 0.0 |
| 430-040 | Wroged Concrete | Single 12" this 45" | Yes | No. | Yes | Yes | Very Good | 0.8 |

100-yr

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

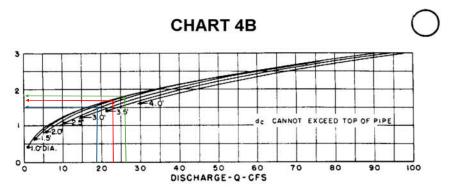


HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

Critical Depth (dc) Found using Chart 4, FHWA HDS 5

Flow (cfs) 19 26 dc 1.5 1.8 25 100

DIA (FT)

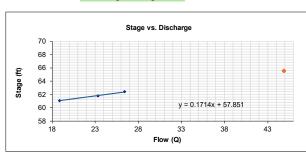


Insert Values

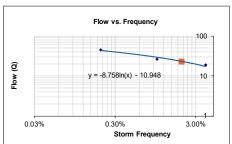
| | Storm | Frequency (%) | Flow (cfs) | Stage (ft) | Notes |
|--------------|-------|---------------|------------|------------|--|
| | 25 | 4.00% | 19 | 61.1 | 25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A). |
| Base Flood | 100 | 1.00% | 26 | 62.4 | 25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B). |
| Greatest | 500 | 0.20% | 45 | 65.5 | 500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages |
| Design Flood | 50 | 2.00% | 23 | 61.8 | 50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates). |

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge







Given Information

| FL (US) = | 58.3 | Upstream invert |
|-----------------------------|-------|--------------------|
| FL (DS) = | 58 | Downstream invert |
| Edge of Travel Lane (ETL) = | 61 | Upstream elevation |
| Length (L)= | 90.21 | (Existing) |
| Slope (So) = | 0.003 | |

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity - 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100-Q25*1.4

| CD Name | Barrels | Pipe Size (in) | Pipe Area (sq. ft) | Velocity (ft/s) | Flow (25-yr) (cfs) | Flow (100-yr) (cfs) |
|---------|---------|----------------|--------------------|-----------------|--------------------|---------------------|
| CD-17 | 1 | 24 | 3.14 | 6 | 19 | 26 |

| | in. | ft. |
|--------------|-----|-----|
| Diameter (D) | 24 | 2 |
| Width (B) | | |

B. Compute stages using FHWA HDS 5 assuming Inlet Control

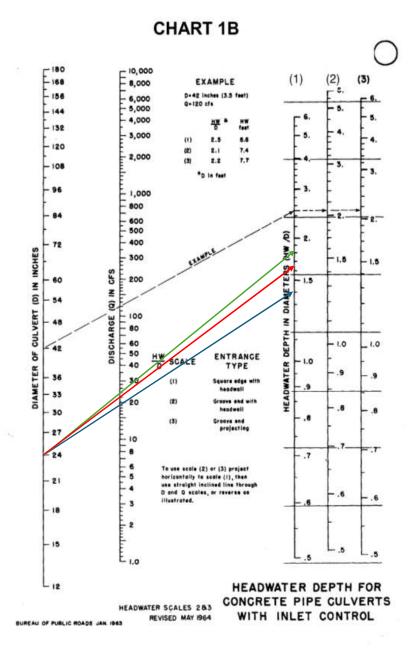
| | 25-yr | 50-yr | 100-yr | Notes |
|----------|-------|-------|--------|---|
| Q/B | - | | - | Box Culverts |
| HW/D | 1.4 | 1.6 | 1.8 | Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached) |
| HW | 2.80 | 3.20 | 3.60 | HW = (HW/D) * Diameter |
| HW Elev. | 61.10 | 61.50 | 61.90 | HW Elev. = HW + FL (US) |

C. Compute stages using FHWA HDS 5 assuming Outlet Control

| Ke | 0.2 | Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached). If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater LSo = Pipe Lengh * Pipe Slope Outlet Velocity (f/s) = 6 f/s (Same as inlet velocity used to calculate discharges for the 25-yr storm). | |
|-----------------|-----|--|--|
| TW | 2 | | |
| LSo | 0.3 | | |
| Outlet Velocity | 6 | | |

| | 25-yr | 50-yr | 100-yr | Notes: |
|--------------|-------|-------|--------|--|
| Н | 1.1 | 1.80 | 2.40 | Headwater (H) found using Chart 5, FHWA HDS 5 (see attached). |
| dc | 1.50 | 1.65 | 1.85 | Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached) |
| ho | 1.75 | 1.825 | 1.925 | Equivalent Hydraulic Elevation (ho) = (D+dc)/2 |
| DTW | 2 | 2 | 2 | Design Tail Water (DTW) = TW or ho, whichever is greater |
| HW Depth | 2.8 | 3.50 | 4.10 | Headwater Depth (HW) = H + DTW - LSo |
| HW Elevation | 61.1 | 61.80 | 62.40 | US Pipe inv. + HW depth |

| | | 25-уг | 50-yr | 100-yr | Notes: |
|-----------------|----------------|----------------|----------------|--------|---|
| | Controling HW | 61.1 | 61.80 | 62.40 | If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv. |
| Controlling riv | Outlot Control | Outlet Central | Outlet Central | 1 | |



| | Flow (cfs) | HW/D |
|-----|------------|------|
| 25 | 19 | 1.40 |
| 100 | 26 | 1.80 |
| 50 | 23 | 1.60 |

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

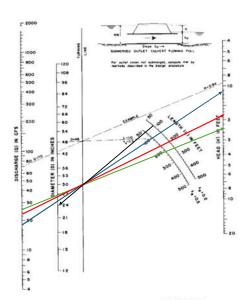
| Standard Flori Index | Desir | ephon | - 0 | Applicati | 4 | Asset Blood | | | | | |
|----------------------------|--|-----------------------------------|-----------------|---------------|---------|-------------|-------------------------|------------------------------|--|--|--|
| | Type | Pipe Size | Cress Sirain | Side Drain | Median | Application | Hydrauki Perternance | к, | | | |
| 436010 | U Type Committe With Grate | Single ST Res 30" | Limited | Limited | Yes | 700 | Fair | 0.7 | | | |
| 430-011 | U Type Commen | Single 10" for 30" | Livred | 191 | Yee | Liveled | Goet | 1500 | | | |
| 438-013 | Coxcets Energy Designator | Single 30" time 17" | Limited | 94 | No | Me | NA. | NA. | | | |
| 436-020 | Flend Ent. Section Concrete | Single 12" Minu 72" | Yes | No | Yee | Yes | Gnot | 0.0 | | | |
| 435/01 | Crees Onain Millered End Section | Sind Single & Multiple | | No | Yes | Tee . | re- | 0.7 | | | |
| 436-022 | Side Drain Witered End Section | Single & Multiple 16" Seu 60" | Nex | Ven | Ne | Vee | Fee | 0.7 m/o, 1.8 m/c grade | | | |
| 436-030 | Straight Constants | Single &thiltiple 15" this 34" | III. Yes | * | Limited | 700 | Excellent | 0.2 | | | |
| 435-031 | Straight Constelle | Single & Double 67 | Yes | No | Limited | Yes | Excellent | 0.0 | | | |
| 430-002 | Braight Donnelle | Single & Double 60" | Yea | No | Limited | Yes | Exelect | 0.8 | | | |
| 436-033 | Straight Concrete | Single & Ocadie 72" | Yes | 161 | Limited | 786 | bother | 0.3 | | | |
| 400-034 | Straight Concease | Single 64" | Yes. | 90.0 | Limited | 200 | Existent | 0.2 | | | |
| 430-040 | Winged Concrete | Regio 12" fire 48" | Yes | No | Yes | Yes | Very Good | 0.8 | | | |

| | 25-yr | 50-yr | 100-yr |
|---|-------|-------|--------|
| Н | 1.1 | 1.8 | 2.4 |
| Н | 1.1 | 1.8 | 2 |

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



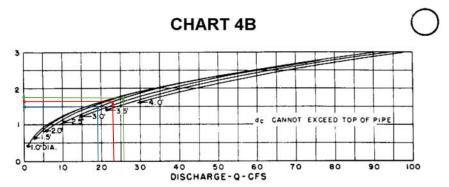


HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

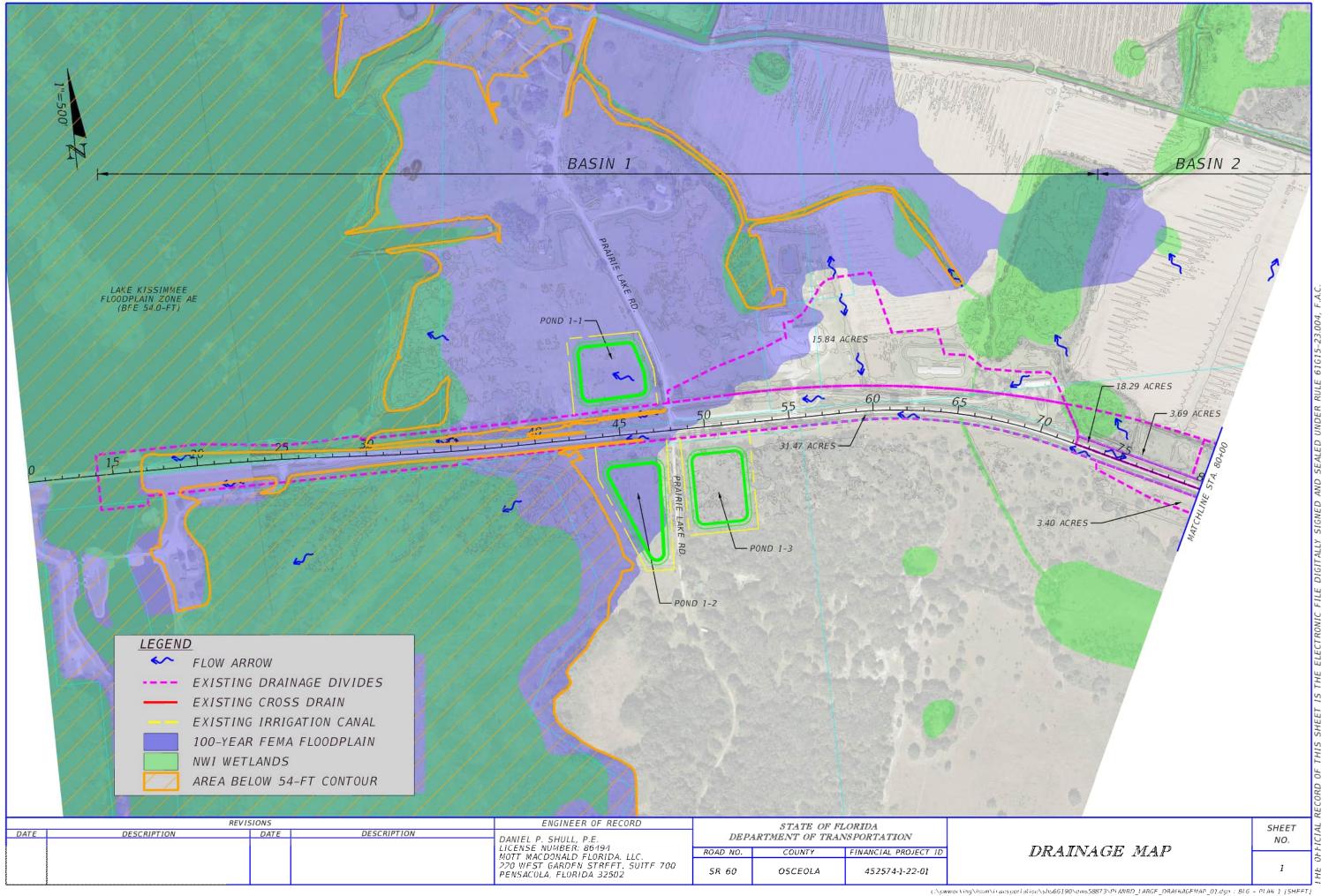
Flow (cfs) dc
25 19 1.50
100 26 1.85
50 23 1.65

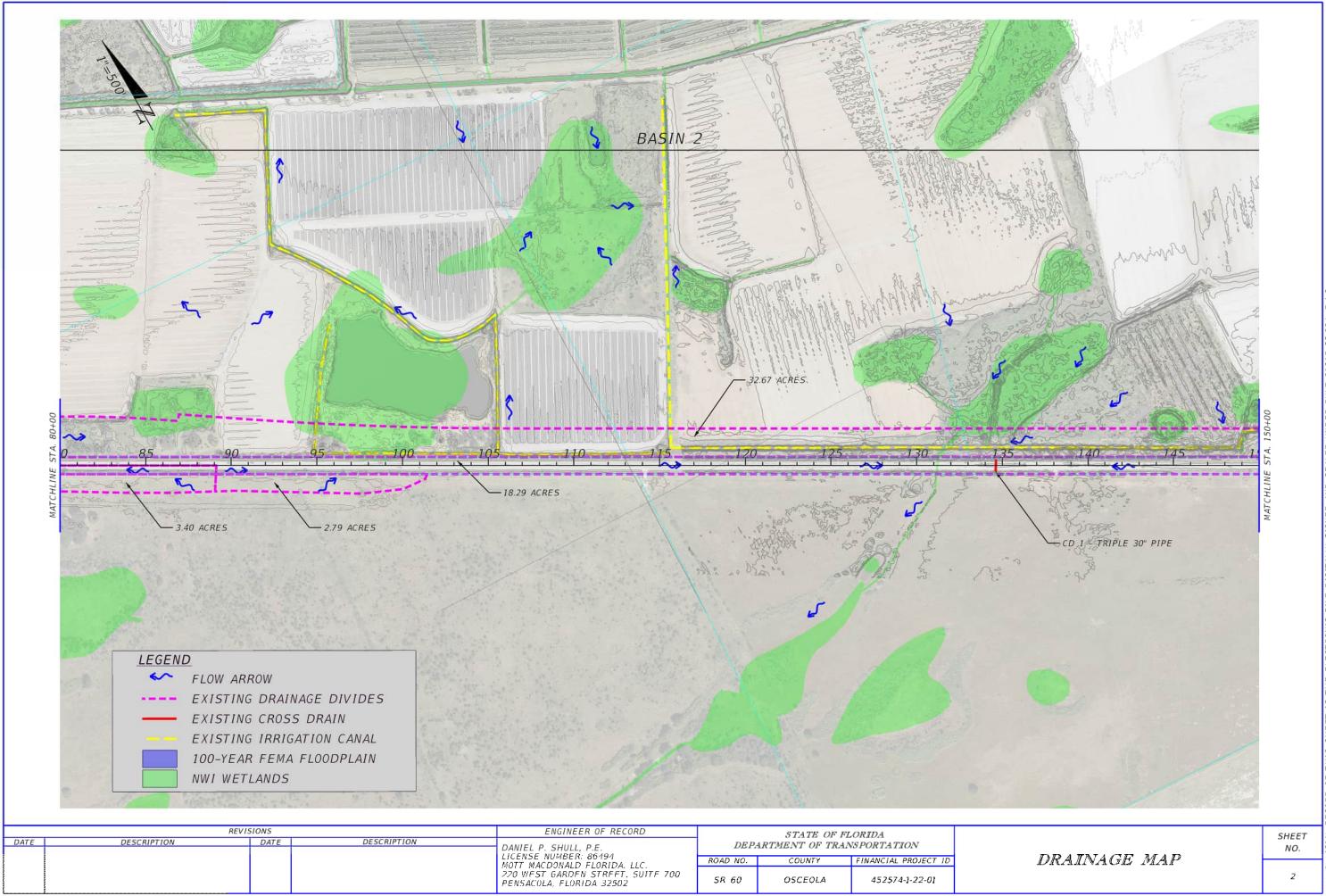
DIA (FT)

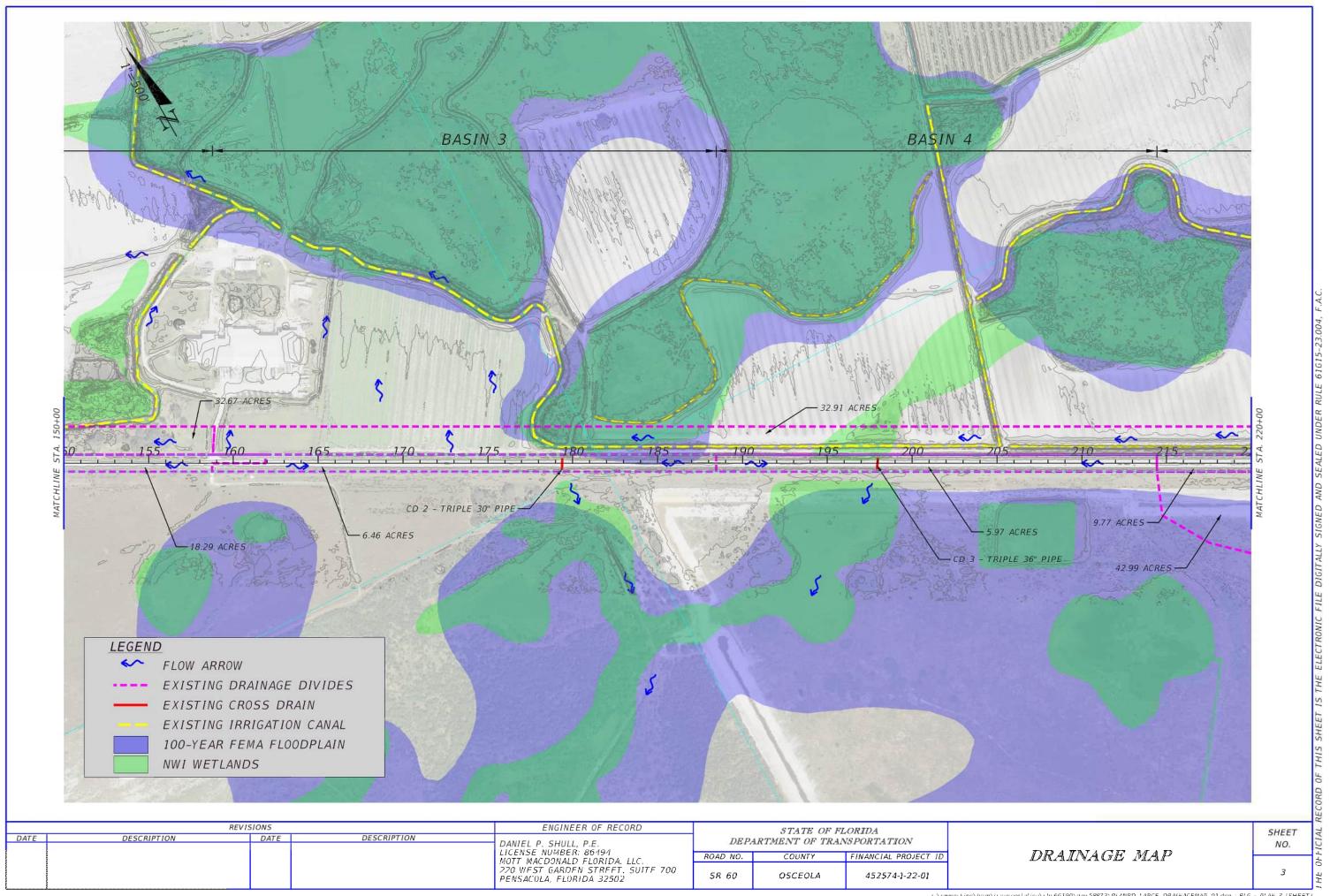
Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

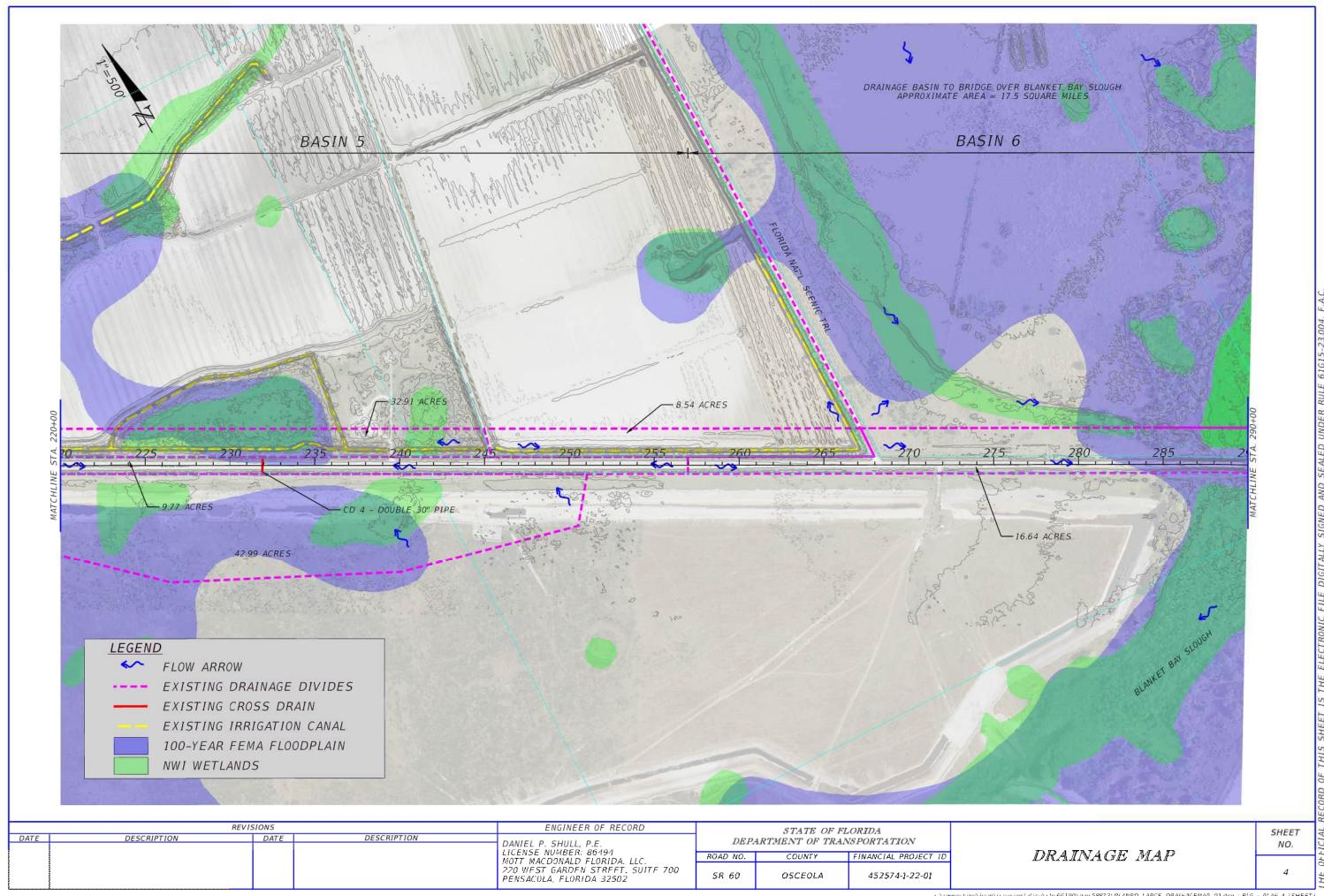


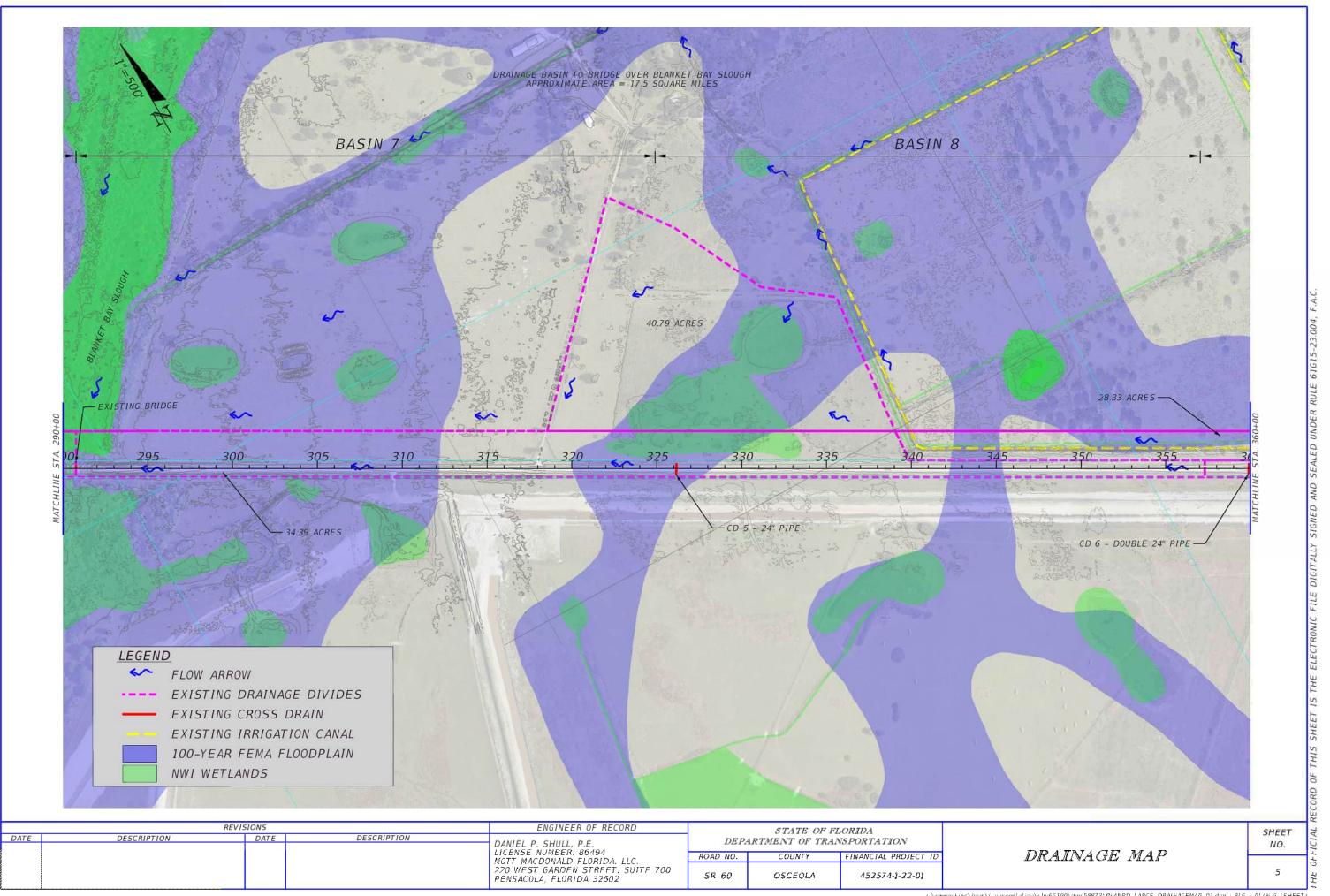
APPENDIX D – Drainage Maps

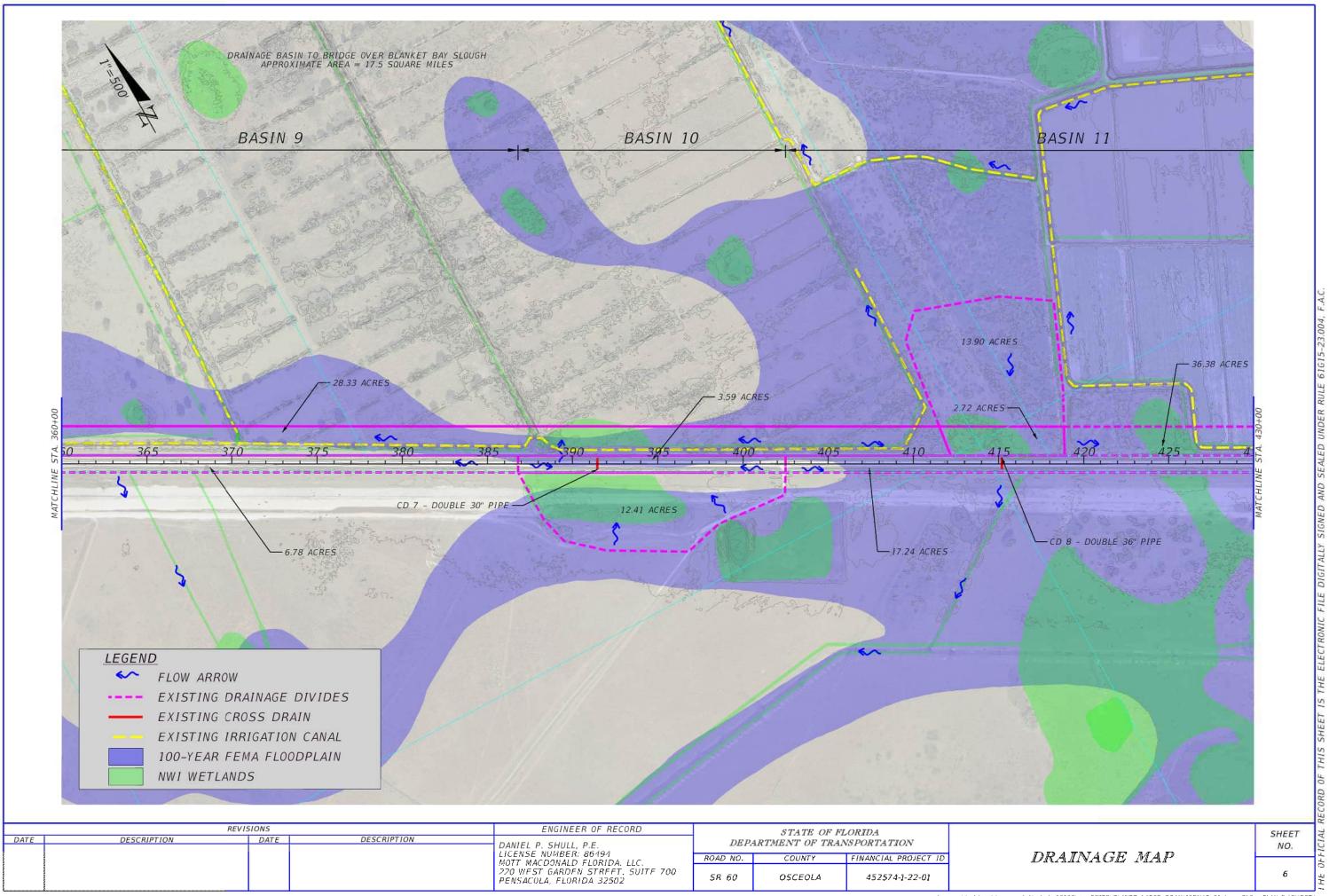


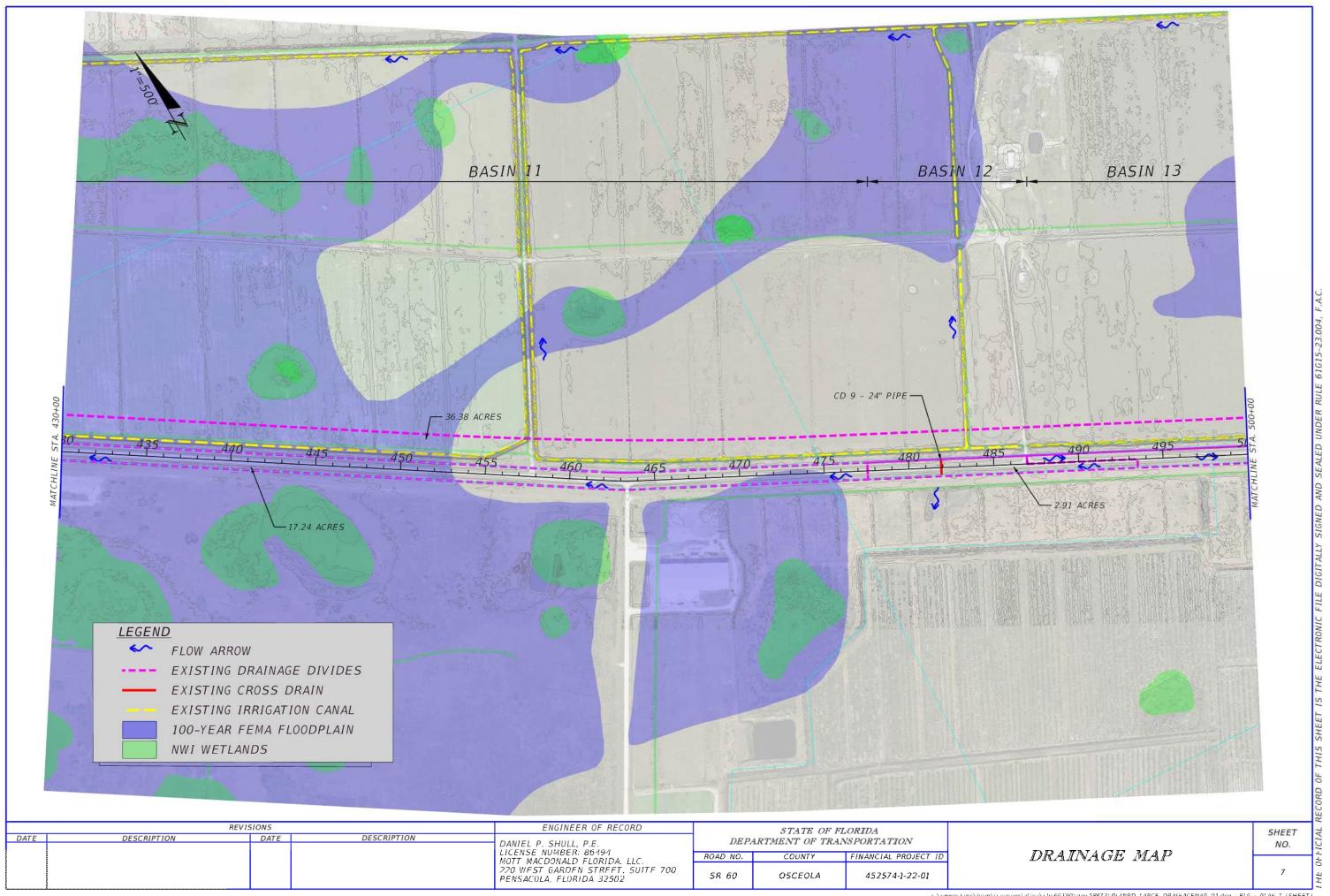


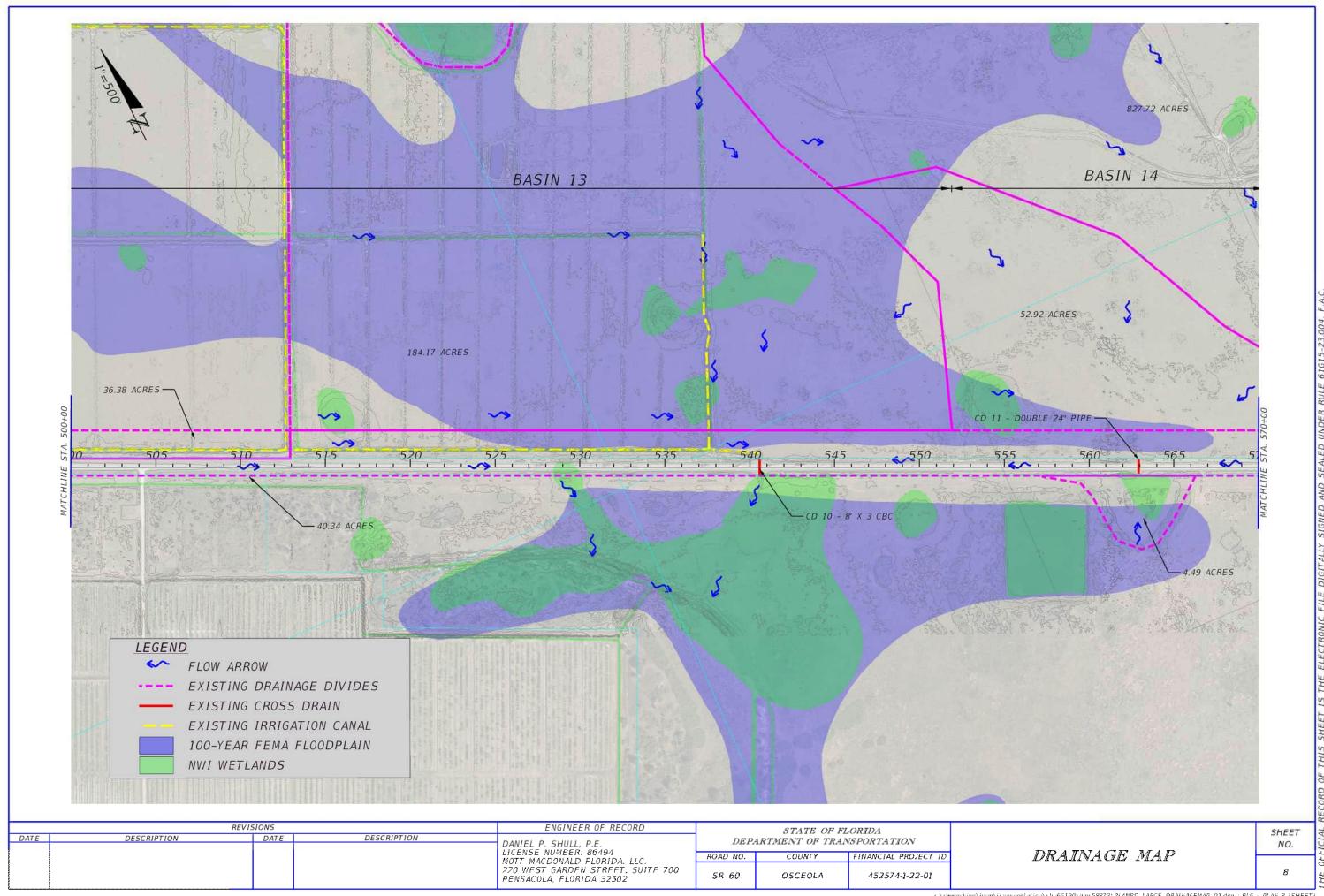


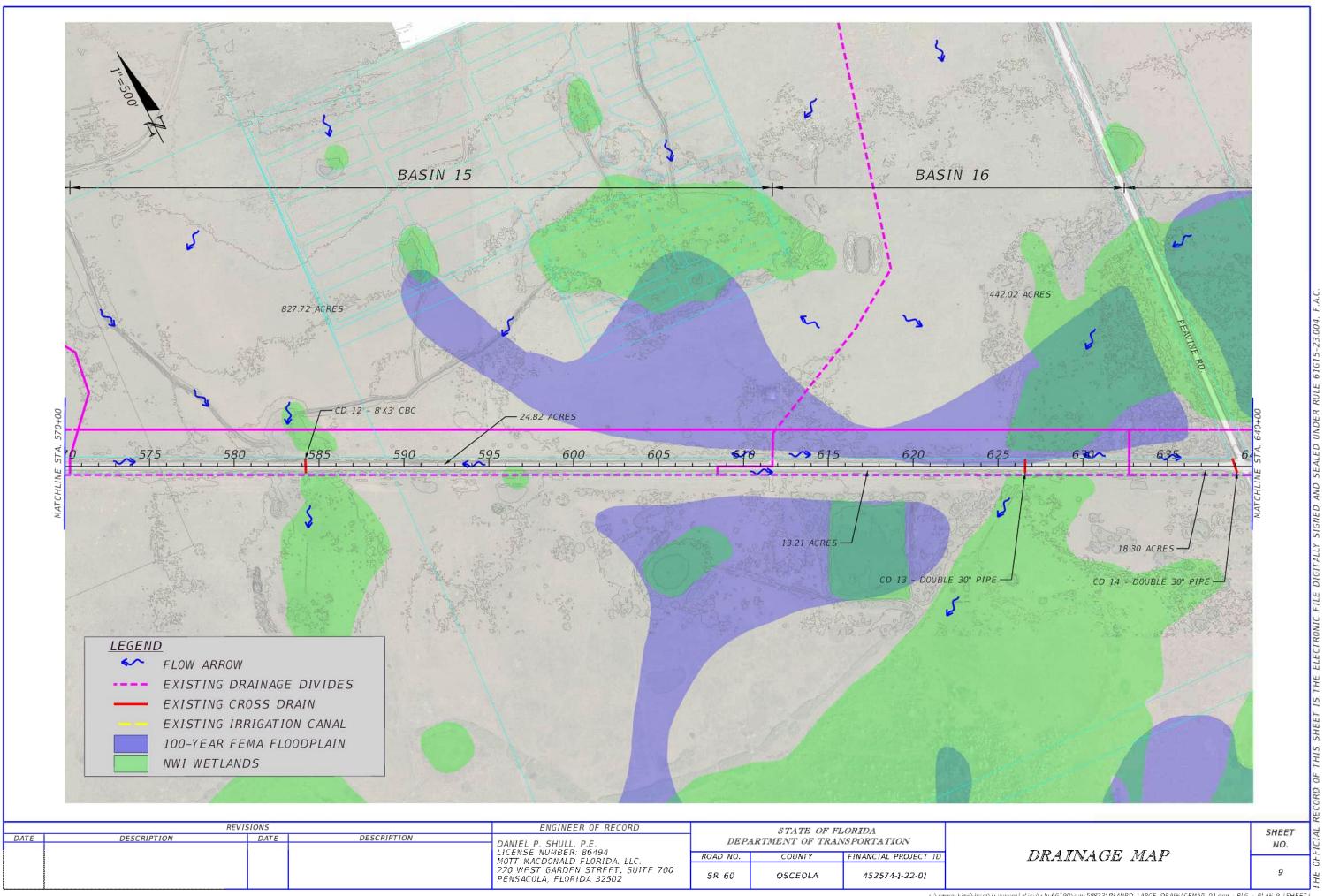


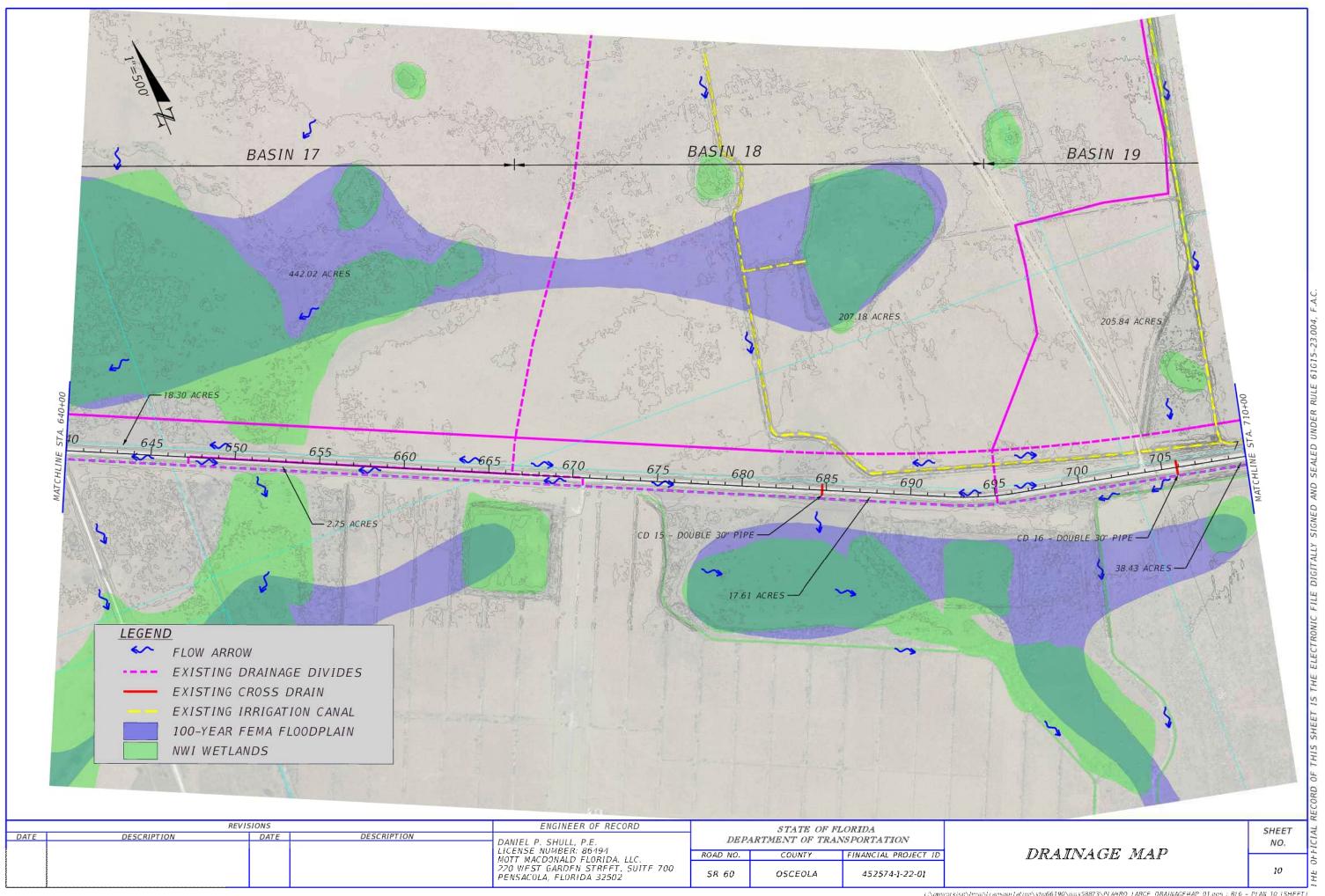


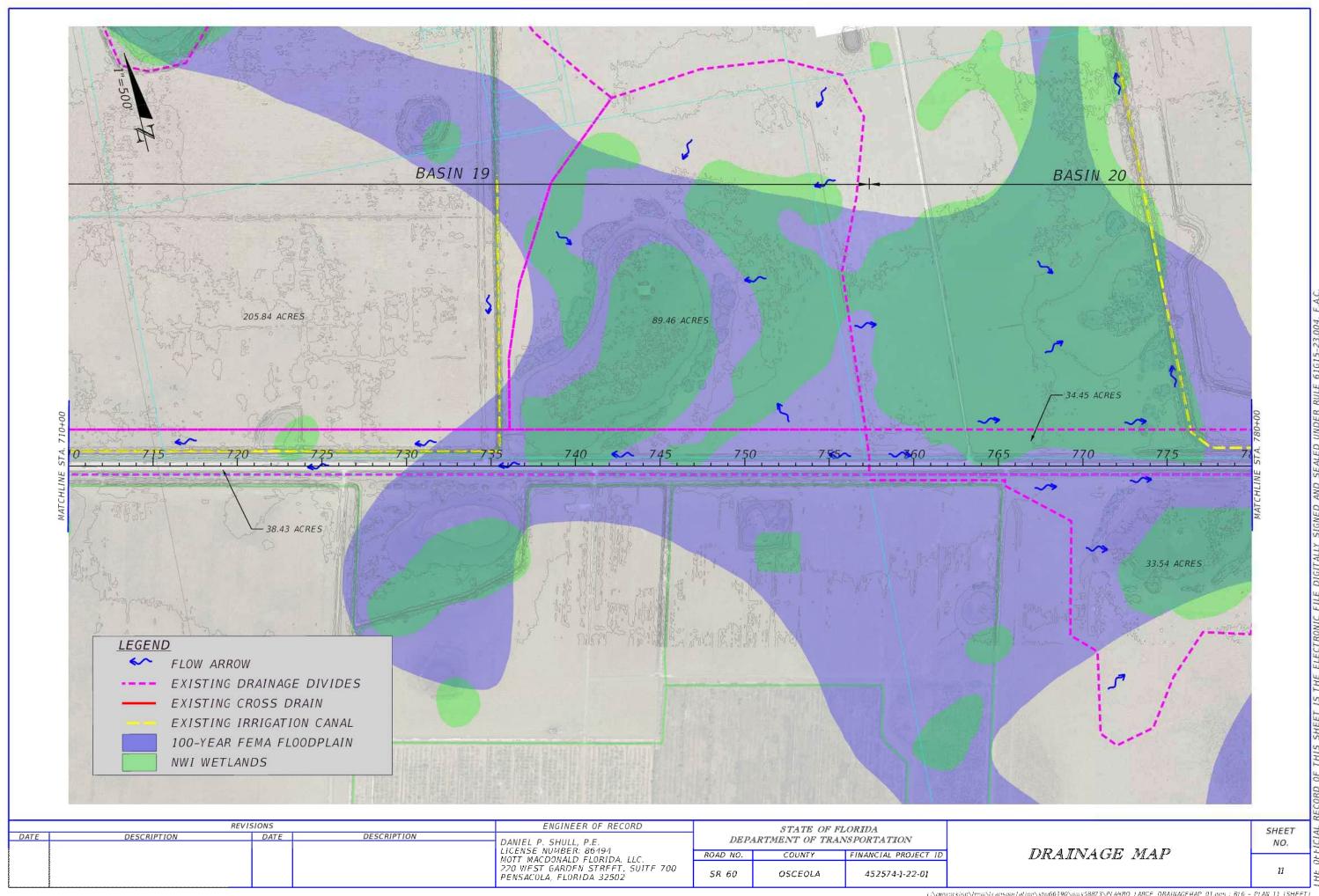


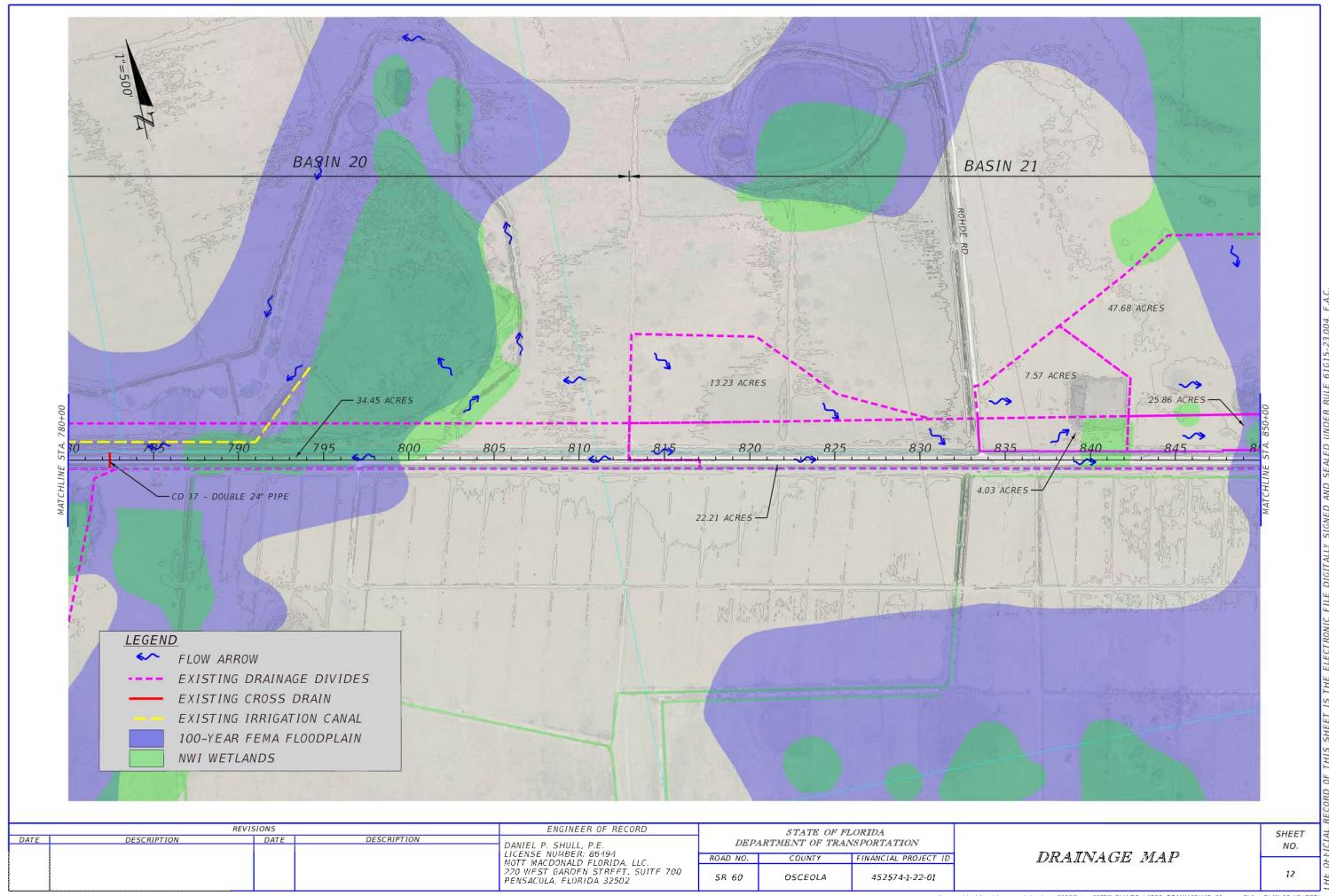


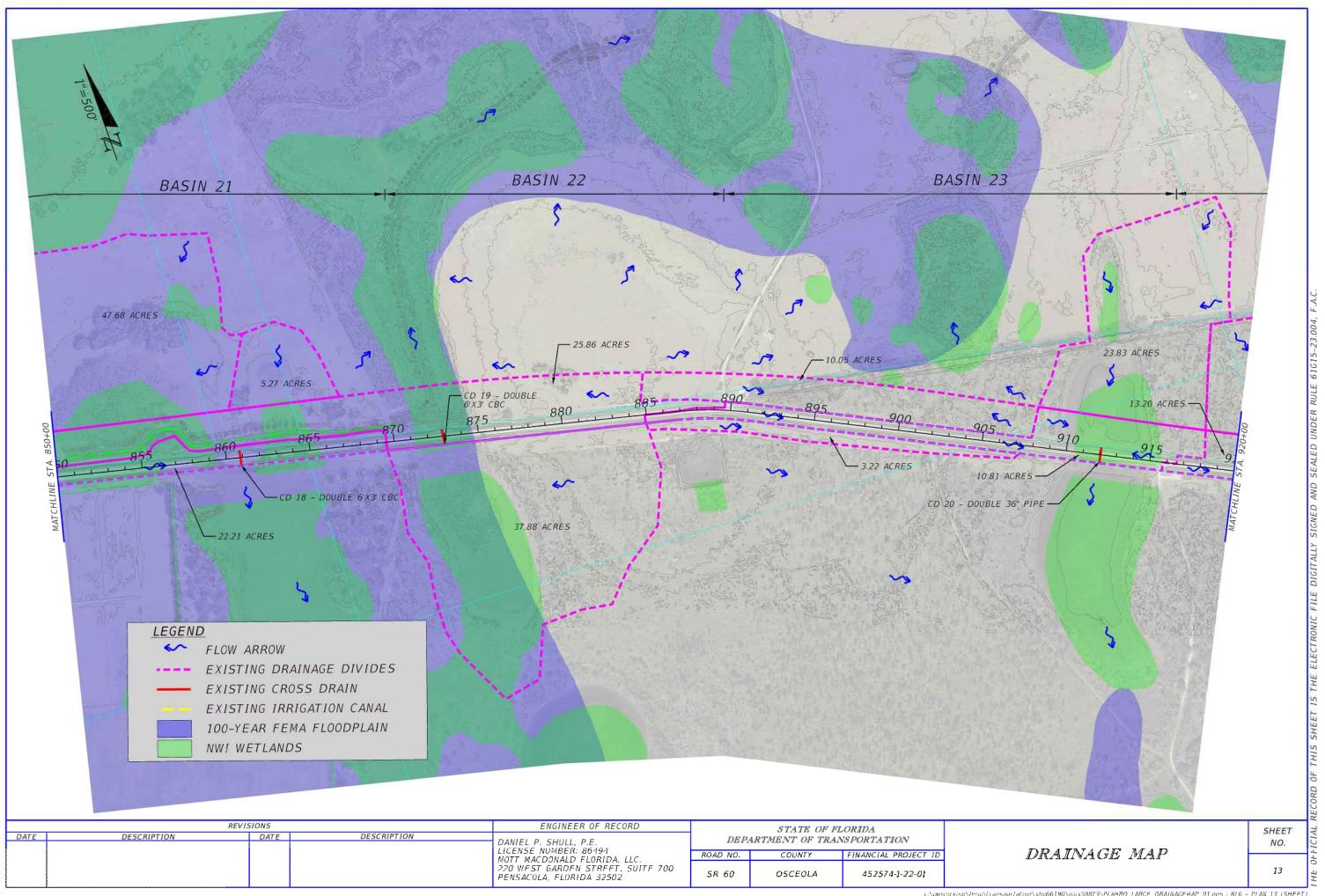


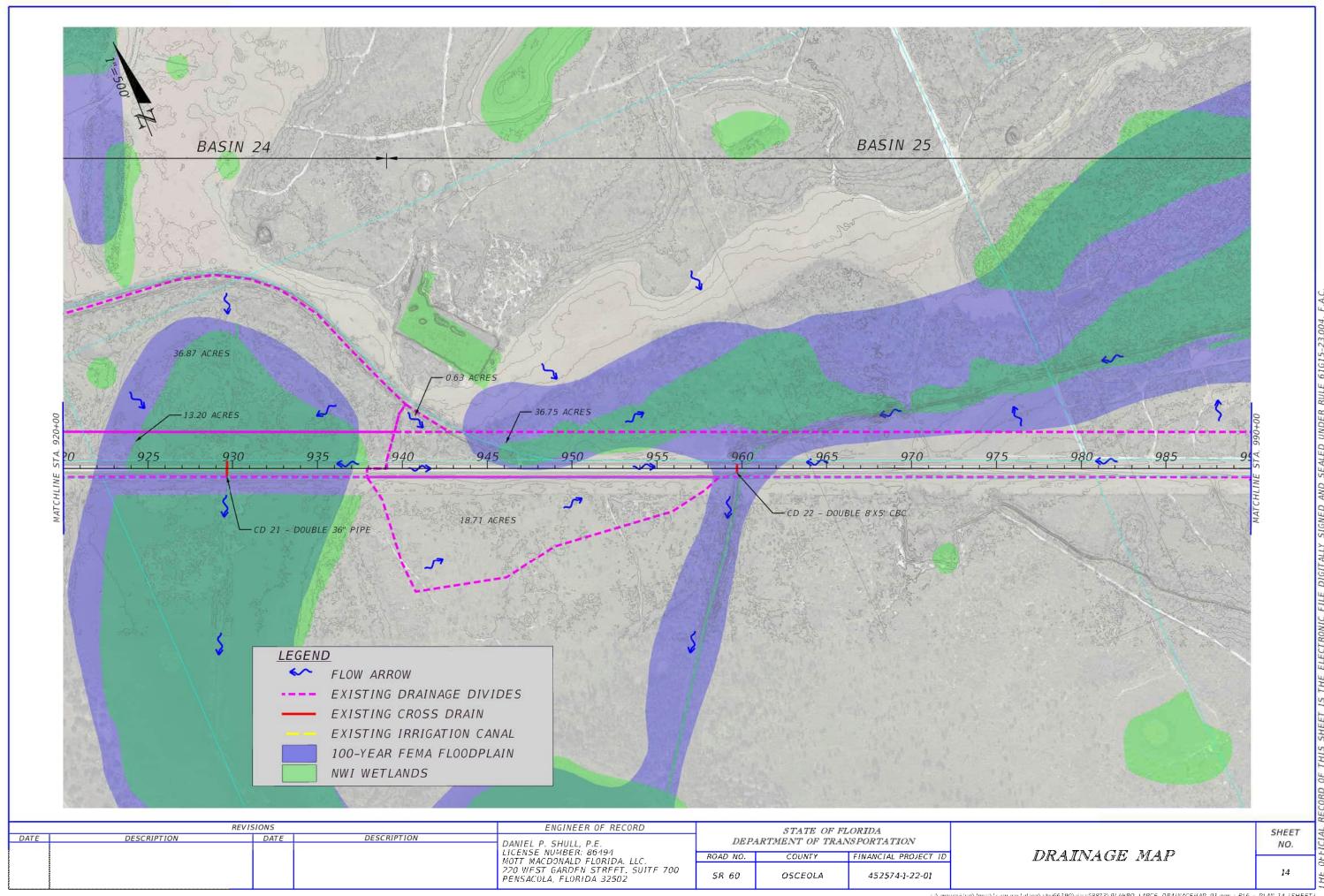


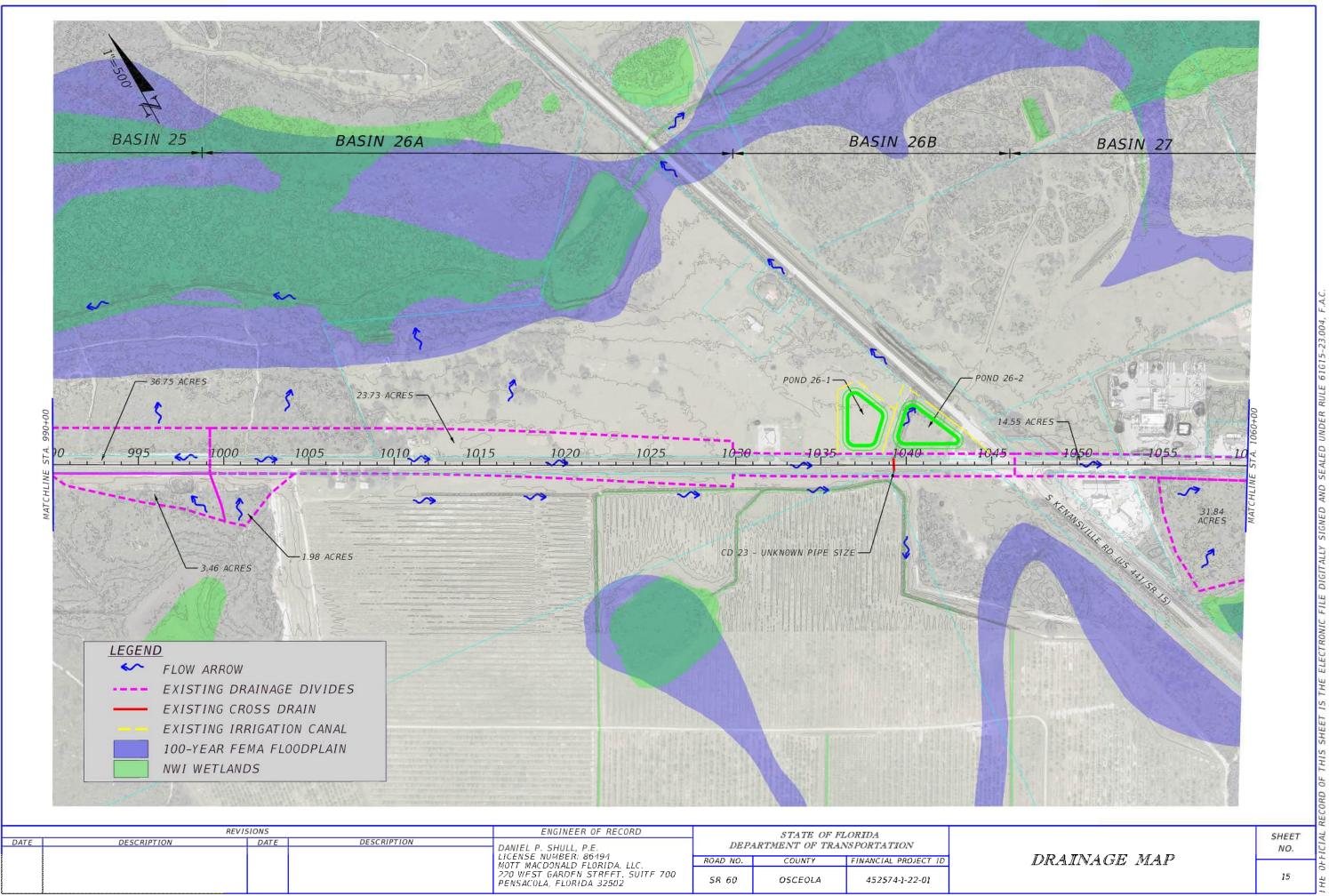


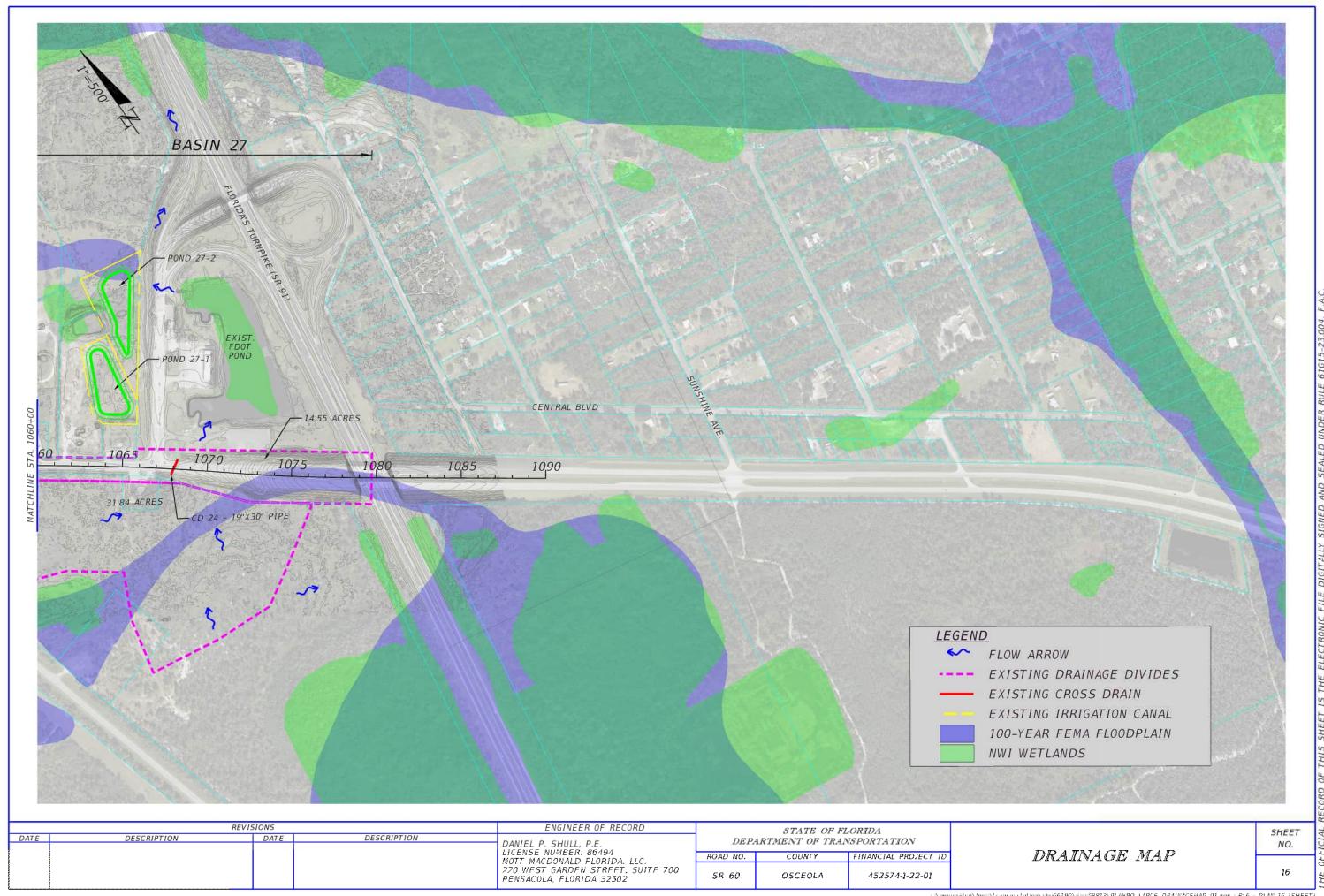








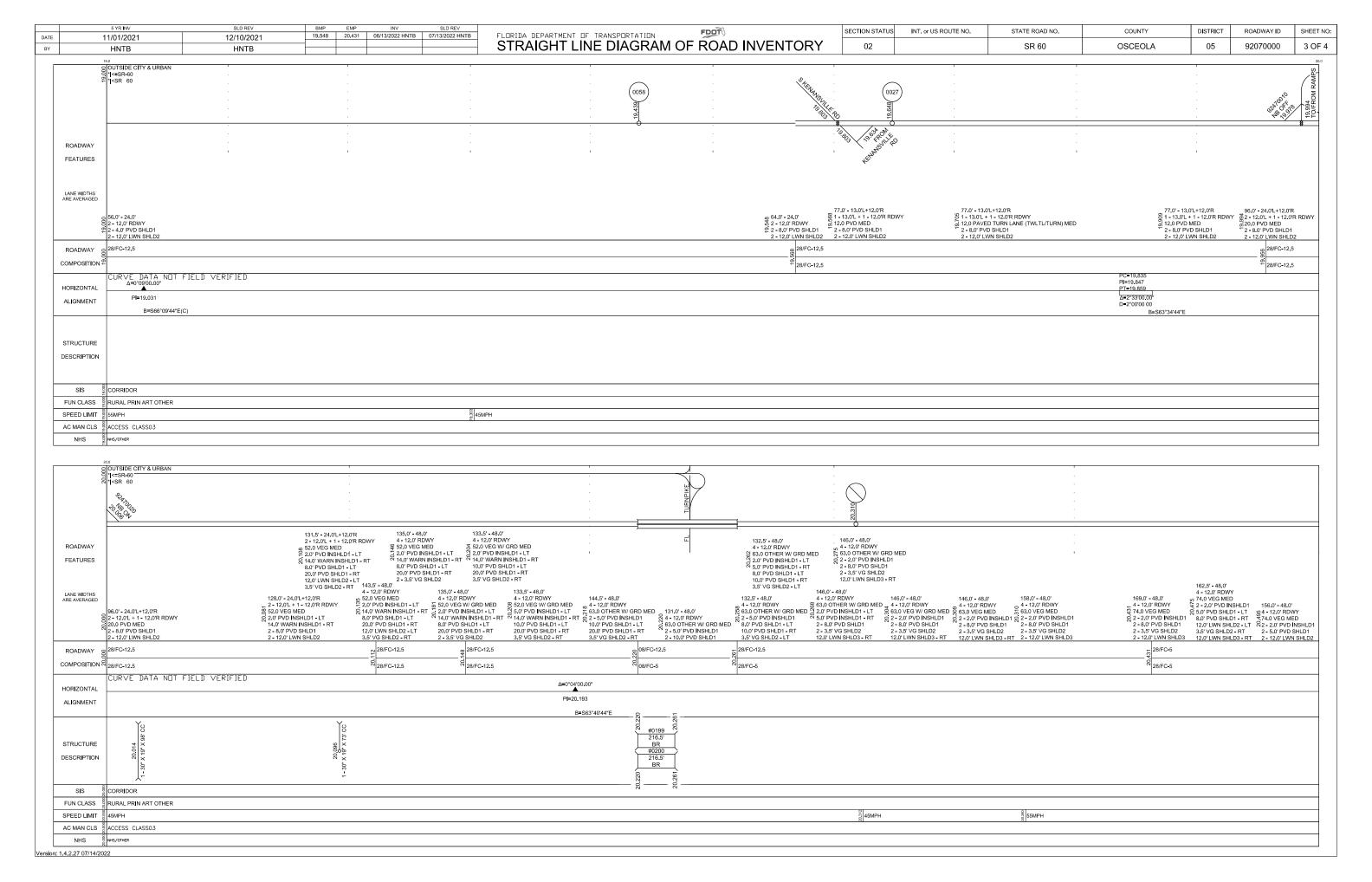




APPENDIX E – FDOT Straight Line Diagrams

| DATE | 5 YR INV 11/01/2021 | SLD REV BM 12/10/2021 19.5 | | INV 3/2022 HNTB 0 | SLD REV 7/13/2022 HNTB | FLORIDA DEPARTMEN | IT DE TRANSPORTA | ATION | FDOT | | SECTION STATUS | INT. or US ROUTE NO. | STATE ROAD NO. | COUNTY | DISTRICT | ROADWAY ID | SHEET NO: |
|--------------------------------|---|---|-----------------|---|---|-------------------|------------------|---|-----------------------------------|-------|-----------------|---|---------------------------------------|----------------|--|-------------------------|------------------|
| BY | HNTB | HNTB | | | | STRAIGHT I | LINE DIAC | RAM OF | ROAD INVE | NTORY | 02 | | SR 60 | OSCEOLA | 05 | 92070000 | 1 OF 4 |
| | © OUTSIDE CITY & URBAN | 1 1 1 | 1.0 | Г Г | 1 1 | | 2.0 | T I | T T T | 3.0 | 1 1 | I I I | 4.0 | 1 1 1 | 1 1 | 1 1 | 5.0 |
| | 1<=SR-60 1<=SR-60 | | | | | | | | | | | | | | | | |
| | 60216 | | | | | | | | | | | | | | | | : |
| | F BR1 | | | | | | | · · · | <u> </u> | | | · · · · <u>· · · · · · · · · · · · · · · </u> | · · · · · · · · · · · · · · · · · · · | | | · · · | |
| | O | | | | | | | | | | | | | | | | |
| ROADWAY | <u> </u> | 1 1 1 | 1 1 | 1 1 | 1 1 | 1 1 | 1 1 | 1 1 | 1 1 1 | 1 1 | 1 1 | | 1 1 1 1 | 1 1 1 | 1 1 | 1 1 | |
| FEATURES | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| LANE WIDTHS ARE AVERAGE | 50.5' - 24.0' | | | | | | | | | | | 20.01.01.01 | | | | | |
| | ± 2 - 12.0' RDWY ± 45.0' - 24.0' | 56.0' - 24.0' 9 2 - 12.0' RDWY | 2 | 68.0' - 24.0' 2 2 - 12.0' RDWY 12.0 PVD MED | 68.0' - 36.0' 68.0' - 36.0' | | 90 | 68.0' - 24.0' 2 - 12.0' RDWY 12.0 PVD MED | 56.0' - 24.0' G 2 - 12.0' RDWY | | | 68.0' - 24.0' ♀ 2 - 12.0' RDWY 9 12.0 PVD MED | 68.0' - 36.0' 7 3 - 12.0' RDWY | | 68.0' - 24.0' 66.2 - 12.0' RDWY 9.12.0 PVD MED | 56.0' - 24.0' | wy |
| | 45.0' - 24.0' \$\tilde{5} 7.0' PVD SHLD1 - LT \\ 2 - 12.0' RDWY \$\tilde{9} 4.0' PVD SHLD1 - RT \\ 2 - 7.0' PVD SHLD1 3.5' VG SHLD2 - LT \\ 2 - 3.5' VG SHLD2 12.0' LWN SHLD2 - R | Ö 2 - 4.0' PVD SHLD1 T 2 - 12.0' LWN SHLD2 | , | 2 - 4.0' PVD SHLE | 01 - 2 - 4.0' PVD SHLE _D2 2 - 12.0' LWN SHL | 01 _D2 | , | 2 - 4.0' PVD SHLD1 2 - 12.0' LWN SHLD2 | ~ 2 - 4.0' PVD SHLD1 | | | 2 - 4.0' WARN SHL | D1 | | 2 - 4.0' WARN SI 2 - 12.0' LWN SI | HLD1 | SHLD1 N SHLD2 |
| ROADWAY | 4 | .5 | | 28/FC-5 2 | 8/FC-5 | | | 28/FC-5 | 28/FC-12.5 | | | 28/FC-12.5 0 28/FC- | 12.5 28/FC-12.5 | | | 28/FC-12.5 & 28/F | C-9.5 |
| COMPOSITIO | N° ° ° ° ° ° ° ° ° ° | /FRIFIFN PC=0.89 | 99 | 28/FC-5 | | | | 28/FC-5 | 5 | | | ຶ່ 28/FC- | 12.5 | | | 28/FC-12.5 ⁴ | |
| HORIZONTA | | PI=1.02; PT=1.14 | 2 2 2 | | | | | | | | | | | | | | |
| ALIGNMENT | B=S88°52'35"E | Δ=25°4² D=2°00¹ | 00 00 | 02'00"E(C)AH° | | | | | | | | | | | | | |
| | _ 500 00 to to | | | 5 - F* | | | | Y. | | | Y | Y | | Y | | | |
| STRUCTURE | : | | | | | | g | 76' CC | | | 34 64' CC | 74 66' CC | | 76' CC | | | |
| DESCRIPTIO | N | | | | | | 6 | -30" × | | | 3.18 - 30" X | 3.5£ | | 4.14 -30" X | | | |
| | | | | | | | | <u>τ</u> ω | | | ζ., | \ | | _\c^{\c} | | | |
| SIS | CORRIDOR | | | | | | | | | | | | | | | | |
| FUN CLASS SPEED LIMI | 0 | | | | | | | | | | | | | | | | |
| | ACCESS CLASSO3 | | | | | | | | | | | | | | | | |
| NHS | NHS/OTHER | | | | | | | | | | | | | | | | |
| | 00UTSIDE CITY & URBAN | 1 1 1 | 6.0 | 1 1 | 1 1 | 1 1 1 | 7.0 | | 1 1 1 | 1 1 | 8.0 | | 9.0 | 1 1 1 | 1 1 | т т | 10.0 |
| | 8 * <=SR-60 | | | | | | | | | | | | | | | | |
| | OOUGH. | | | | | | | | | | | | | | | | |
| | . 필입 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CCESS RD - 8-566 . | | | | | |
| ROADWAY | | | | 1 1 | | 1 1 1 | | 1 1 1 | | 1 1 | 1 1 | CCES! | 1 1 1 | 1 1 1 | | 1 1 | 1 1 |
| FEATURES | | | | | | | | | | | | S 65/A | | | | | |
| LANE WIDTHS | | | | | | | | | | | | | | | | | |
| ARE AVERAGE | 9 40.0' - 24.0' 2 - 12.0' RDWY 9 2 - 8.0' PVD SHLD1 | | | | | | | | | | | | | | | | |
| | 56.0' - 24.0' 2 - 12.0' RDWY | 56.0' - 24.0' 2 - 12.0' RDWY | | | | | | | | | | | | | | | |
| | 2 - 12.0' LWN SHLD2 | 6 2 - 4.0' PVD SHLD1 2 - 12.0' LWN SHLD2 | | | | | | | | | | | | | | | |
| ROADWAY | 8 8 8 | | | | | | | | | £. | 28/FC-12.5 | | | | | | |
| COMPOSITIO | | A NOT FIELD VERIFIED | | | | | | | | | | Δ=5°30 | 0'00.00" | | | | |
| HORIZONTA | - PT=5.373 | | | | | | | | | | | D=3°00 PC=8.5 PI=8.5 | 544 | | | | |
| ALIGNMENT | D=2°00' | °47'00"E(C) | | | | | | | | | | PT=8.5 | 51 179 666°17'00"E | | | | |
| | 281 | | Y., | | | | | | | | | | | | | | |
| STRUCTURE | 121.4 | , | 962 X 65' CI | | y S | 0 × (85) × | | × 66' Ci | 350 × 66' C(| | | | 310 x 85° C(| | | | |
| DESCRIPTIO | N BR | | 5.5 | | ď | 2 - 24"." | | 7.2 - 30".) | 7.6 | | | | 8.5 | | | | |
| | | | Ţ | | | Ϊ | | Ϊ. | | | | | | | | | |
| SIS FUN CLASS | CORRIDOR RURAL PRIN ART OTHER | | | | | | | | | | | | | | | | |
| SPEED LIMI | 9 | | | | | | | | | | | | | | | | |
| | ACCESS CLASSO3 | | | | | | | | | | | | | | | | |
| NHS Version: 1.4.2.27 07/14 | 8 NHS/OTHER /2022 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

| DATE | 5 YR INV 11/01/2021 | SLD REV 12/10/202 | | EMP INV 20.431 06/13/2022 HNT | SLD REV B 07/13/2022 HNTB | FLORIDA I | DEPARTMENT OF | TRANSPORT | ATION | FOOAD IN | | SECTION | STATUS INT | or US ROUTE NO. | STATE RO | AD NO. | COU | NTY | DISTRICT | ROADWAY ID | SHEET NO: |
|-----------------------------|---|---|---------------------------------------|---|---|-----------------------|---------------|-------------------------------------|-----------|--------------------|-----------------|---|--|-------------------|--------------------|--------|------------------------------------|--|---------------------------------------|--|-----------|
| BY | HNTB | HNTB | | | | STRA | | | SRAM OF | F ROAD IN | VENTORY | | 2 | | SR 6 | | OSCE | OLA | 05 | 92070000 | 2 OF 4 |
| | OUTSIDE CITY & URBAN | 1 1 1 | | 11.0 | | | | 12.0 | | | | 13.0 | | | | 14.0 | | | | 1 1 | 15.0 |
| | ₽ <mark>* </mark> <sr 60<="" th=""><th></th><th>• • • • • • • • • • • • • • • • • • •</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>2 2</th><th></th><th>• •</th><th></th><th></th></sr> | | • • • • • • • • • • • • • • • • • • • | | | | | | | | | | | | | | 2 2 | | • • | | |
| | | | | | | | W. 77 | | | | | | | | | | USTIN | | | | |
| | | | | | | | 18 185 | | | | | | <u> </u> | | | | . 3.e 1 | = | | · · · | |
| ROADWAY | | | | | | | 1 1 | ; ; | | | | : | | | | | | | • • | | |
| FEATURES | 1 1 | 1 1 | 1 1 | 1 1 | 1 1 | 1 1 | 1 1 | ' | 1 1 1 | 1 1 | 1 1 | ' | 1 1 | 1 1 1 | 1 1 | ' | 1 1 | 1 1 | 1 1 | 1 1 | 1 |
| | | | | | | | | | | | | | | | | | | | | | |
| LANE WIDTHS ARE AVERAGED | | | | | | | | | | | | | | | | | | | | | |
| | - 56 0' - 24 0' | | | | | | | | | | | 68.0' - 24.0 |)' DWY 68.0' - 3 | 6.0' | | 2 | 68.0' - 24.0' 2 - 12.0' RDWY | - 56 0' - 24 0' | | 68.0' - 24. 2 - 12.0' R 4 12.0 PVD | .0' |
| | 56.0' - 24.0' 8 2 - 12.0' RDWY 2 - 4.0' PVD SHLD1 | | | | | | | | | | | 8 2 - 12.0' RI 12.0 PVD I 2 - 4.0' PV | OWY 68.0' - 3 MED 8 3 - 12.0 D SHLD1 2 2 - 4.0' VN SHLD2 2 - 12.0 | RDWY PVD SHLD1 | | 0.47 | 12.0 PVD MED 2 - 4.0' PVD SHLD1 | 56.0' - 24.0' 8 2 - 12.0' RDWY ₹ 2 - 4.0' PVD SHLE | 01 | 2 4 U PV | /D SHLDT |
| ROADWAY | 2 - 12.0' LWN SHLD2 28/FC-12.5 | | | | | | | | | | | 2 - 12.0' LV | VN SHLD2 2 - 12.0 Ω 28/FC-5 | LWN SHLD2 | | | 2 - 12.0' LWN SHLD2 B/FC-5 | 2 - 12.0' LWN SHI | LD2 | 2 - 12.0° L 28/FC-5 | WN SHLD2 |
| COMPOSITION | 10.0 | | | | | | | | | | | 28/FC-5 | 13.20 | | | | B/FC-5 | 14.30 | | 28/FC-5 | |
| HORIZONTAL | CURVE DATA NOT F | FIELD VERIFIED | | | | | | | | | Δ=12° D=3°0 | 00'00 00 00'00 00 | | | | | | I | | | |
| HORIZONTAL ALIGNMENT | | | | | | | | | | | PC=12 PI=12. | 2.894 .932 | | | | | | | | | |
| | | | ~ | | | | | | | | PI=12 | 2.970 B=S78°58'44"E(0 | C)AH° | | | | | | · · · · · · · · · · · · · · · · · · · | | |
| | , cBC | 8 | CBC | | | 8 | 8 | | | | 8 | | 8 | | | | | | 8 | | |
| STRUCTURE | 3' X 85 | 10.449 1" X 85' | 10.853 × 3' × 65 | | | 11.665 7" X 85' | 11.885 | | | | 12.723 | 2. A. | | | | | | | 14.602 1" X 86' | | |
| BEOGRA HOW | X | 2-2 | . X | | | 2 -3 | 2-3 | | | | 2 - 30 | | 2-3 | | | | | | 2 - 22 | | |
| SIS | CORRIDOR | | | | | | | | | | Λ | | <u> </u> | | | | | | | | |
| FUN CLASS | RURAL PRIN ART OTHER | | | | | | | | | | | | | | | | | | | | |
| SPEED LIMIT | 60MPH B ACCESS CLASS03 | | | | | | | | | | | | | | | | | | | | |
| NHS | NHS/OTHER | | | | | | | | | | | | | | | | | | | | |
| | 15.0 | | | 16.1 | n | | | | | 17.0 | | | | | 18.0 | | | | | | 19.0 |
| | O OUTSIDE CITY & URBAN | | | | | | | | | | | | | | | | | | | | |
| | ^[2] * <sr 60<="" th=""><th></th><th>요 </th><th></th><th></th><th></th><th></th><th>SS RD</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></sr> | | 요 | | | | | SS RD | | | | | | | | | | | | | |
| | | | OHDE 5.575 | | | | • | IAE BA | | | | | | | | | | • | • | • | |
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| ROADWAY | | | | | | | | | | | | | | | | | | | | | |
| FEATURES | | 1 1 | l l | 1 | 1 1 | ' ' | 1 | ' ' | ' ' | ' | 1 1 | | ' | 1 1 | ' | 1 | ' ' | 1 | 1 | T. | ' |
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| LANE WIDTHS ARE AVERAGED | | | | | | | | | | | | | | | | | | | | | |
| | 68.0' - 24.0' 2 - 12.0' RDWY \$\to 68.0' - | · 36.0' | | 68.0' - 24.0' & 2 - 12.0' RDWY | 0 56.0' - 24.0' 청 2 - 12.0' RDWY | | | | | | | | | | | | | | | | |
| | 2 - 12.0' RDWY 68.0' - 6 12.0 PVD MED 5 3 - 12. 2 - 4.0' PVD SHLD1 5 2 - 4.0 2 - 12.0' LWN SHLD2 2 - 12. | .0' RDWY)' PVD SHLD1 .0' LWN SHLD2 | | 2 - 4.0' PVD MED 2 - 4.0' PVD SHLD1 2 - 12.0' LWN SHLD2 | S 2 - 12.0' RDWY © 2 - 4.0' PVD SHLD1 2 - 12.0' LWN SHLD2 | | | | | | | | | | | | | | | | |
| | 28/FC-5 28/FC- | | | 28/FC-5 | 28/FC-12.5 | | | | | • | | | | | • | | | | | | |
| COMPOSITION | | | | 28/FC-5 | 16.0 | | | | | | | | | | | | | | | | |
| HORIZONTAL | CURVE DATA NOT FIELD VERIFIED | PI=15.356 | | | | | | PC=16.582 PI=16.623 PT=16.664 | | | | | | | | | | | | | |
| ALIGNMENT | | Δ=0°03'00.00" | | | | | | Δ=12°55'00.00" D=3°00'00 00 | | | | | | | | | | | | | |
| | | B=S78°55'44"E(C | C) | | | Y | | B=S66°00 | 0'44"E(C) | Y | | Y | | | | | | | | | |
| atructure. | | | | | 6' CBC | e, cBC | | | | 20 25 | | 90 | | | 5' CBC | | | | | | |
| STRUCTURE DESCRIPTION | | | | | 16.090 (3' X 8I | 16.320 ' X 3' X 86 | | | | 17.059 16" × 86 | | 6" X 92 | | | 17.964 (5' X 6E | | | | | | |
| | | | | | 2-6. | 2-6'X | | | | 2-3 | | L | | | 2-8. | | | | | | |
| SIS | CORRIDOR | | | | ^ | ^ | | | | ^ | | ^ | | | ^ | | | | | | |
| FUN CLASS | RURAL PRIN ART OTHER | | | | | | | | | | | | | | | | | | | | |
| SPEED LIMIT AC MAN CLS | 60MPH ACCESS CLASS03 | | | | | | | | | | | | | | | | | | | | |
| NHS | NHS/OTHER | | | | | | | | | | | | | | | | | | | | |
| Version: 1.4.2.27 07/14/20 | 022 | | | | | | | | | | | | | | | | | | | • | |



| DATE 1 | 5 YR INV 11/01/2021 | 12/10/2021 | BMP | FLORIDA DEPARTMENT DE TRANSPORTATION FOOT | SECTION STATUS | INT. or US ROUTE NO. | STATE ROAD NO. | COUNTY | DISTRICT | ROADWAY ID | SHEET NO |
|-----------------------------|---|-----------------------------------|--|--|-----------------|---|--|---|---|--------------------------|-------------------|
| BY | HNTB | HNTB | | STRAIGHT LINE DIAGRAM OF ROAD INVENTORY | 02 | | SR 60 | OSCEOLA | 05 | 92070000 | 4 OF 4 |
| ы | ПИТО | HINTE | | OTTO GOTT EINE BIJ COTO GOT OT TOO AB HAVE AT OTA | | | | | | | |
| S | OUTSIDE CITY & URBAN | | | 21.0 | 1 | 1 | | 1 | 1 | | |
| 25.0 | ମ୍ * <=SR-60 ବ୍ୟ' <sr 60<="" th=""><th>·</th><th></th><th>•</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></sr> | · | | • | | | | | | | |
| , , | 1 1-21/ 00 | · | | · | • | • | LOG LOG | | , H | | |
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| FEATURES | | | | | | | | | | | |
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| LANE WIDTHS | | | | | | | | | | | |
| LANE WIDTHS ARE AVERAGED | 156.0' - 48.0' 144.0 | ' - 48.0' | | | | 139.0' - 48.0' 4 - 12.0' RDWY | 133 0' - 48 0' | 140.0' - 48.0' 140.0' _ 4 - 12.0' RDWY _ 4 - 12. | - 48.0' 0' RDWY 146.0' - 48 | .0' | |
| 99 | 4 - 12.0' RDWY 9 4 - 12 | ' - 48.0' 2.0' RDWY VEG MED | | | | 139.0' - 48.0' 4 - 12.0' RDWY 8 64.0 OTHER W GRD MED 64.0 OTHER W GRD MED 5.0' PVD SHLD1 - LT 10.0' PVD SHLD1 - RT 12.0' LWN SHLD2 - LT | 4 - 12.0' RDWY | 4 - 12.0' RDWY 4 - 12.0' RDWY 8 64.0 V | 0' RDWY 146.0' - 48 EG MED 24 - 12.0' R ' PVD INSHLD1 64.0 VEG PVD SHLD1 - LT 52 - 2.0' PV | DWY | |
| | √ 2 - 2.0' PVD NSHLD1 ~ 2 - 2.0 | 0' PVD INSHLD1 | | | | 5.0' PVD SHLD1 - LT | N 64.0 OTHER W/ GRD MED 2 - 2.0' PVD INSHLD1 | 11.0' PVD SHLD1 - LT 11.0' F | PVD SHLD1 - LT - 7: 64.0 VEG | MED D I NSHLD1 | |
| | 2 - 5.0' PVD SHLD1 2 - 5.0 2 - 12.0' LWN SHLD2 2 - 12 | 0' PVD SHLD1 | | | | 10.0' PVD SHLD1 - RT | N 2 - 2.0' PVD INSHLD1 11.0' PVD SHLD1 - LT 10.0' PVD SHLD1 - RT | 5.0 PVD SHLD1 - RT - 5.0 PV | /D SHLD1 - RT 2 - 5.0' P\ WN SHLD2 - RT 2 - 12.0' L | D SHLD1 | |
| | | LO EVIN GIEBZ | | | | 12.0 EWIN GITED2 - ET | 10.0 FVD 3HED1 • K1 | 12.0 EVVIV GHEDZ - IVI 12.0 E | WW GREDZ - RT - 2 - 12.0 E | WIN GITEBE | |
| 5 | 28/FC-5 | | | | | | | | | | |
| COMPOSITION S | 28/FC-5 | | | | | | | | | | |
| | CURVE DATA NOT F | TELD VERIFIED | | PC=20.968 PI=21.109 | | | | | | | - |
| HORIZONTAL | | | Δ=0°08'00.00" | PI=21.109 PT=21.248 | | | | | | | |
| ALIGNMENT | | | PI=20.706 | ∆=15°39′08.00° | | | | | | | |
| ALIGNMENT | | | | D=0°37'42" | | | B=S48°48'25"E | | | | |
| | | | B=\$63°48'44"E | V | | | — 22 — 22 — | | | | |
| | | Y8 | | You have the second of the sec | Y <u>s</u> | | YO 2 #0173 5 | Y8 | | Ϋ́ | |
| STRUCTURE | | (74, | | 138 | 141 | | 75 × 211.2' SR #0198 × 211.2' × 211.2' | 146 | | 21.470 X 19" X 138' 0 | |
| | | X 19" X 19" X | | 978.C | 11.132 19" X | | 55 × #0198 | 21.324 × 19" × 1 | | 1.470 X | |
| DESCRIPTION | | × × | | 8 × | , × | | 211.2' BR | , | | , × | |
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| FUN CLASS | RURAL PRIN ART OTHER | | | | | | | | | | |
| SPEED LIMIT | 55MPH | | 8 65MPH | | | | | | | | |
| AC MAN CLS | ACCESS CLASSO3 | | 81 | | | | | | | | |
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| 8 | OUTSIDE CITY & URBAN | 1 | ı | | | | | | | | |
| 2 | P!* <=SR-60 * <sr 60<="" th=""><th></th><th>•</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></sr> | | • | | | | | | | | |
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| ROADWAY | | • | · · · · · · · · · · · · · · · · · · · | 4 | | | | | | | |
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| FEATURES | | | | | | | | | | | |
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| LANE WIDTHS ARE AVERAGED | | | | | | | | | | | |
| | 146.0' - 48.0' 2 4 - 12.0' RDWY | | | END ND 004 000 | | | | | | | |
| Ĭ. | 64.0 VEG MED | | | END MP: 021.820 NET ROADWAY ID LENGTH: 21.707 | | | | | | | |
| | 2 - 2.0' PVD INSHLD1 2 - 5.0' PVD SHLD1 2 - 12.0' LWN SHLD2 | | | STATE MAINTAINED LENGTH: 21.707 | | | | | | | |
| | | | | | | | | | | | - |
| ROADWAY S | 28/FC-5 | | | | | | | | | | |
| COMPOSITION 5 | 28/FC-5 | | | 1 | | | | | | | |
| | CURVE DATA NOT F | TELD VEDICIED A-4004 | 10/03" | | | | | | | | |
| HODIZONITAL | COKAE DATA MAT F | D=3°45 | X34" | | | | | | | | |
| HORIZONTAL | | PC=21. | 639 | - | | | | | | | |
| ALIGNMENT | | PI=21.8 PT=21.8 | 820 820 | | | | | | | | |
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| STRUCTURE | | 54 | × | | | | | | | | |
| DESCRIPTION | | 24. 19. | 19 × 19 × 19 × × 19 × × × 19 × × × × × × | | | | | | | | |
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| 800 | CODDIDOS | | , | | | | | | | | |
| SIS | CORRIDOR | | CORRIDO | <u>v</u> | | | | | | | \longrightarrow |
| 20 | RURAL PRIN ART OTHER | | | | | | | | | | |
| SPEED LIMIT | 65MPH | | | | | | | | | | |
| AC MAN CLS | ACCESS CLASSO3 | | ACCESS CLASSO | 23 82 | | | | | | | |
| NHS 9 | NHS/OTHER | | NHS/OTHE | 028 | | | | | | | $\overline{}$ |
| ersion: 1.4.2.27 07/14/20 | N. | | <u> </u> | la l | | | | | | | |

