9-16-2021

sdw
Engineering Progress

August 24, 2021

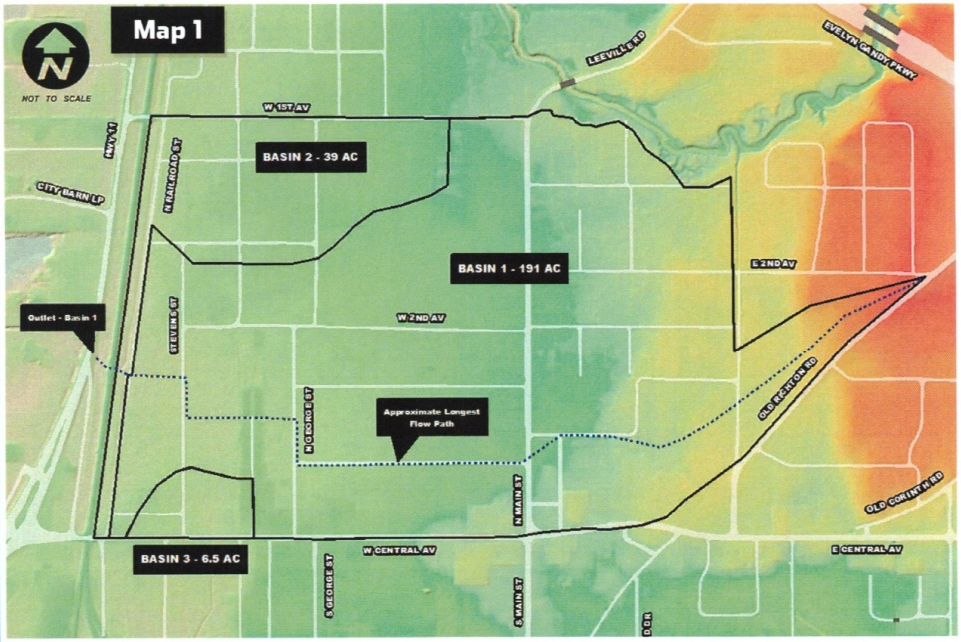
City of Petal
119 W 8th Ave
Petal, MS 39465

**Re: Project 11484 – E Hattiesburg & Bradshaw Heirs Drainage Investigation**

Dear Mayor Ducker:

Per your request, we have reviewed the drainage issues in the East Hattiesburg & Bradshaw Heirs area, specifically the culverts near the drainage area's outlet near the railroad. The Attachments for this report are listed as follows:

**Attachment A** – Base Investigation Map
**Attachment B** – 25-Year Storm Culvert Needs Map
**Attachment C** – Supporting Calculations
**Attachment D** - Flood Map




**Abbreviations**

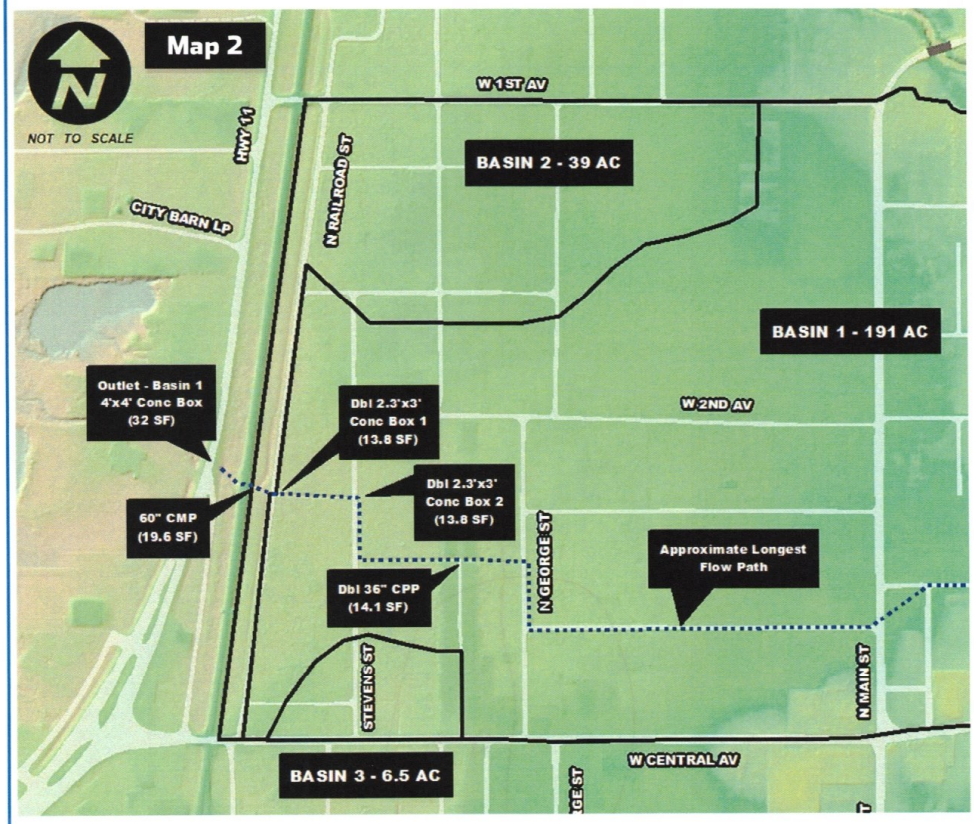
| | | |
|---|---|---|
| **CPP** - Corrugated Plastic Pipe | **RCP** - Reinforced Concrete Pipe | **AC** - Acres |
| **RACP** - Reinforced Arch Concrete Pipe | **LIDAR** - Light Detection & Ranging | **SF** - Square Feet |

301 Second Ave. | Hattiesburg, MS 39401 | (p) 601.544.1821 | (f) 601.544.0501 | sd-w.com

## Existing Conditions

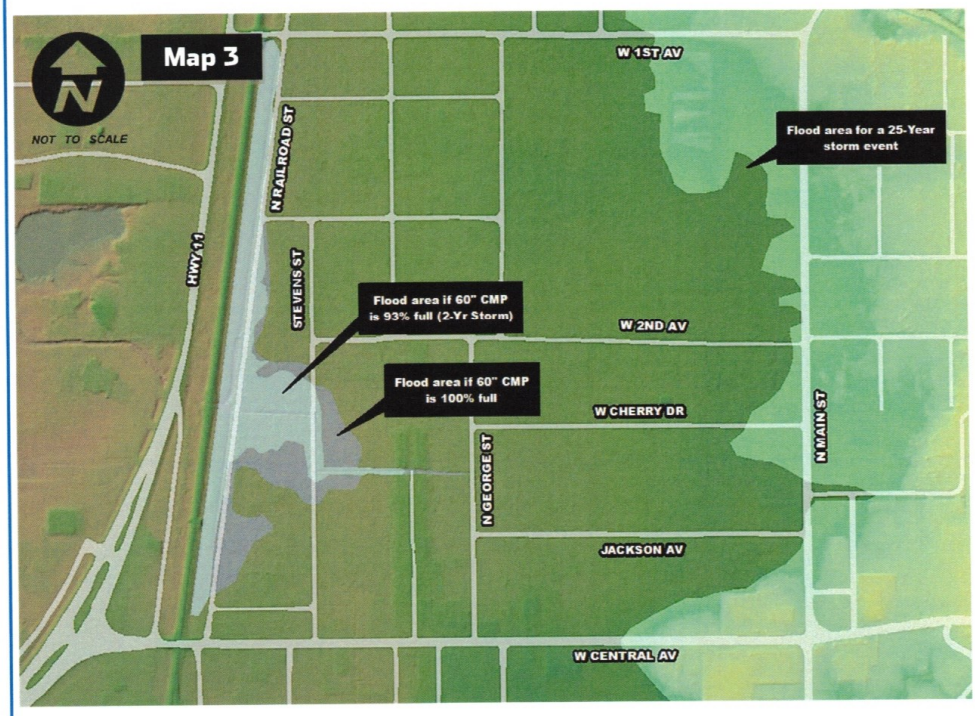
The natural channels and drainage basins in this area have been modified by urban development. The area is extremely flat and overgrown with foliage in many places. Water from the east side of the area generally sheet flows (water spreads out over a large area and flows in a "sheet") west until it is collected by small ditches and manmade channels. These ditches convey the water through a series of approx. 250 pipes and culverts until it finally reaches the outlet under Hwy 11. The outlet is a double 4'x4' concrete box in good condition (32 SF Opening) which appears to be adequately sized for a 2-year storm event but not a 25-Year storm event.

There are also several other major pipes water must travel through before it reaches this point. See the map below:

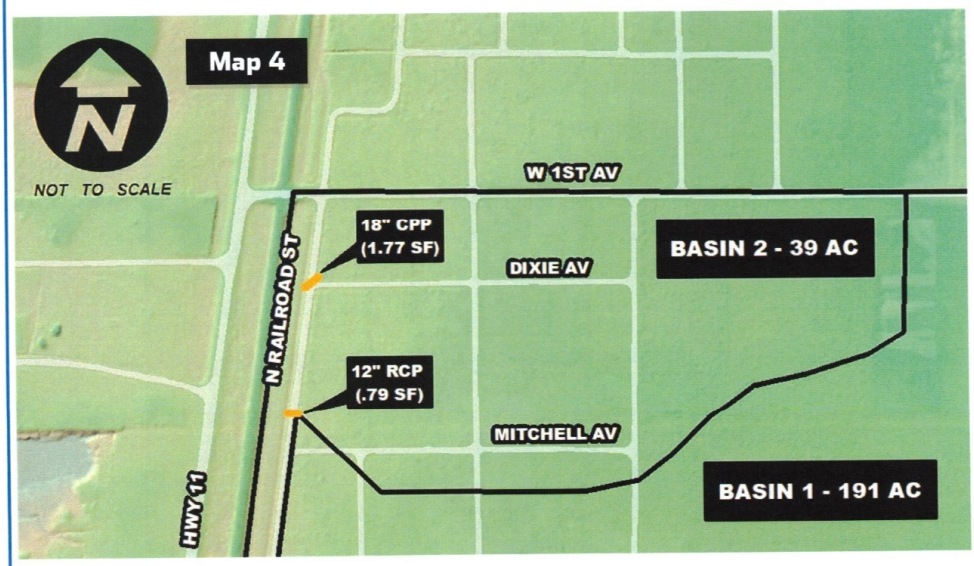



All of these pipes (except the double 4'x4' Conc Box) are undersized for a 2-Year storm event. According to our calculations, the 60" CMP under the railroad is approximately 93% full during a 2-year storm event. Although this is technically acceptable, the inundation (flooding) area associated with that elevation of flow may cause problems upstream. To evaluate this scenario, we utilized LIDAR imagery to estimate where the backups may occur in the event of 93% flow and 100% flow in the 60" CMP. We also evaluated the inundation area for a 25-Year flood which is also included on **Map 3**.

Please see **Map 3,** shown on the next page, for inundation maps associated with the flow regimes in the 60" CMP.




Water from Basin 2 also drains to the 60" CMP (and the outlet box culvert). There are two pipes conveying water from Basin 2 to the ditch along the railroad that drains to the 60" CMP and double 4'x4' box culvert. That water bypasses the smaller box culverts on Stevens St and Railroad St. See **Map 4** below:



Assuming flow is split between each culvert, both are undersized for a 2-Yr Storm.
Flooding in the area is due to a variety of factors such as:

- Large number of pipes (some functioning and some not)
- Flat terrain
- Undersized outlet culverts
- Flood Zone presence (see Map 5)
- Poor ditch/pipe maintenance (Photo 1, 2, 3, 4, 5, 6, 7)

See Below:

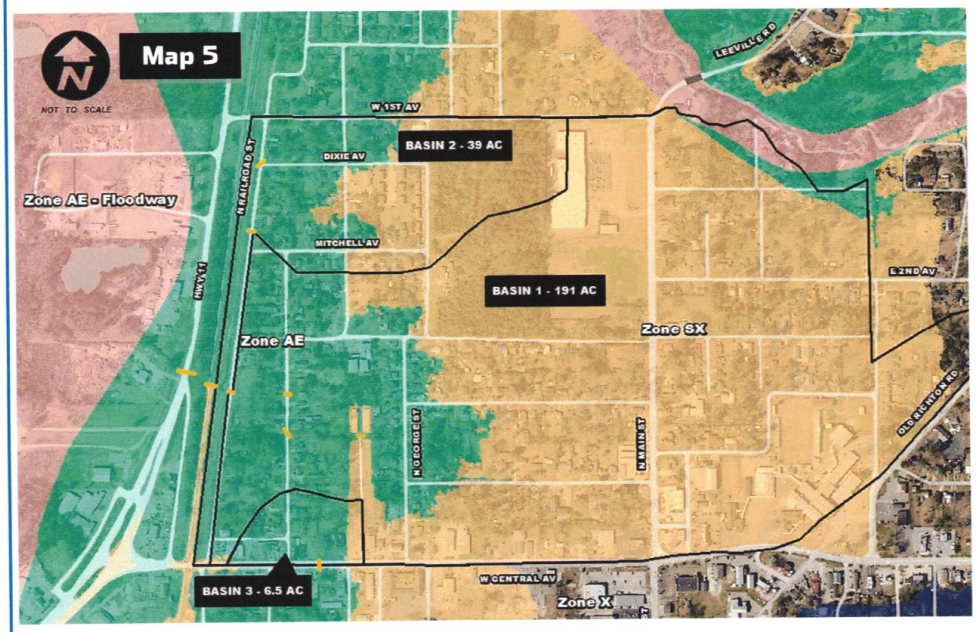




Photo 1 shows the downstream channel for the Box Culvert on Stevens St. Photo 2 shows a crushed pipe on Stevens St.



Photo 3 shows the channel downstream of the double 36" CPP near the abandoned storage facility. Photo 4 shows evidence of flooding at the same location.



Photo 5 shows a typical example of an overgrown ditch in the area. Photo 6 shows the condition of the 12" RCP shown in **Map 4**. Photo 7, shown below, shows a ditch on Railroad St holding water after a minor rain event (due to a flat channel or reversed pipe grade).

## Conclusion & Recommendations

Stormwater runoff upgrades are typically the most difficult and expensive projects to retrofit into an existing community. It is also important to note that drainage improvements within flood zone areas are exponentially more difficult to produce appreciable results.

In order to reduce the frequency of stormwater accumulation, water would need to exit the area faster (upgrade downstream infrastructure), be retained in an acceptable location (inline stormwater retention), or water would need to be diverted to Basin 3 (shown in report maps – Drains into a 44"x27" RCAP – 7.1 SF opening).

**Option 1** – Upgrade Downstream Infrastructure

Upsizing the culverts under the railroad and Hwy 11 will be very expensive and will not necessarily cure the problem due to the presence of a flood zone. It will also be extremely time consuming since the railroad and MDOT (MS Dept of Transportation) would have to be involved.

Please see **Attachment 3** for a map depicting culvert sizes needed to pass a 25-Year storm event.

**Option 2** – Store water via Inline Detention

This option includes cleaning the ditches of vegetative debris (and other debris) and widening where possible. It may also be advantageous to grade an area near the 60" CMP where water can pool without backing up the upstream drainage path. We recommend this option withholding further field research and survey data.

Identification of a "primary" channel in the area is difficult although it appears the most obvious one is shown along the drainage path depicted in **Map 1**. The primary channel would be between the outlet box culvert under Hwy 11 and N Main St.

This option would not fix the problem but would definitely provide some relief for the area.

**Option 3** – Divert Water to a Different Basin

The pipes downstream of the 44"x27" RCAP were observed to be surcharged during dry weather. This indicates issues with the grade of the ditches/pipes. Upgrades would be required downstream in the event water is rerouted. There is also a flood zone located there as well.

Judging from LIDAR elevations, it also does not appear possible to divert water to Basin 3. Survey data is required to make this determination.

## Conclusion

Additional field investigation and surveying would be required to make an ideal recommendation. We are also not sure as to where the existing drainage structures on W 1st Ave, Central Ave, and N Main St flow exactly. However, it is obvious from the existing information that the following points are true:

- All pipes mentioned in the report are undersized for a 25-Year storm event (most are undersized for a 2-Year storm). This justifies upgrades.
- Nearly the entire area is in a flood zone so upgrades will only prevent flooding to some degree.
- Ditches and channels in the area need maintenance and cleaning (some work was done on Railroad St recently).
- Broken and reversed pipes need to be replaced.

Withholding further investigation, we recommend routine maintenance of pipes and channels. This includes fixing broken drainage structures, removing debris and vegetation from existing ditches, and widening existing ditches where possible.

Please see **Attachments A, B, and C** for the **Base Analysis Map, 25-Year Storm Culvert Needs Map, and Supporting Calculations.**

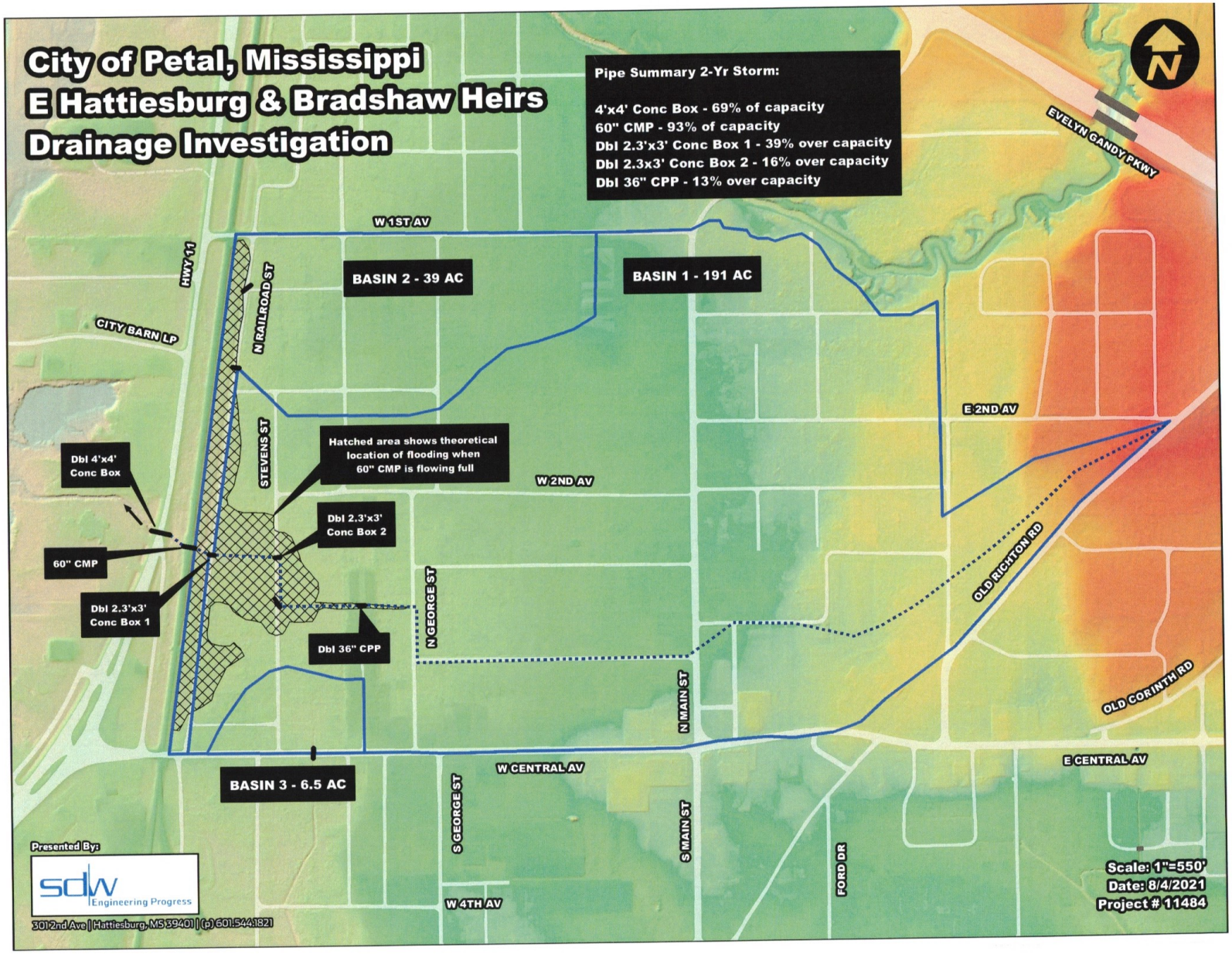
Should you have any questions or comments, please do not hesitate to call. With kindest regards, I remain.

Sincerely,

Louis Thomas, E.I.
Project Manager

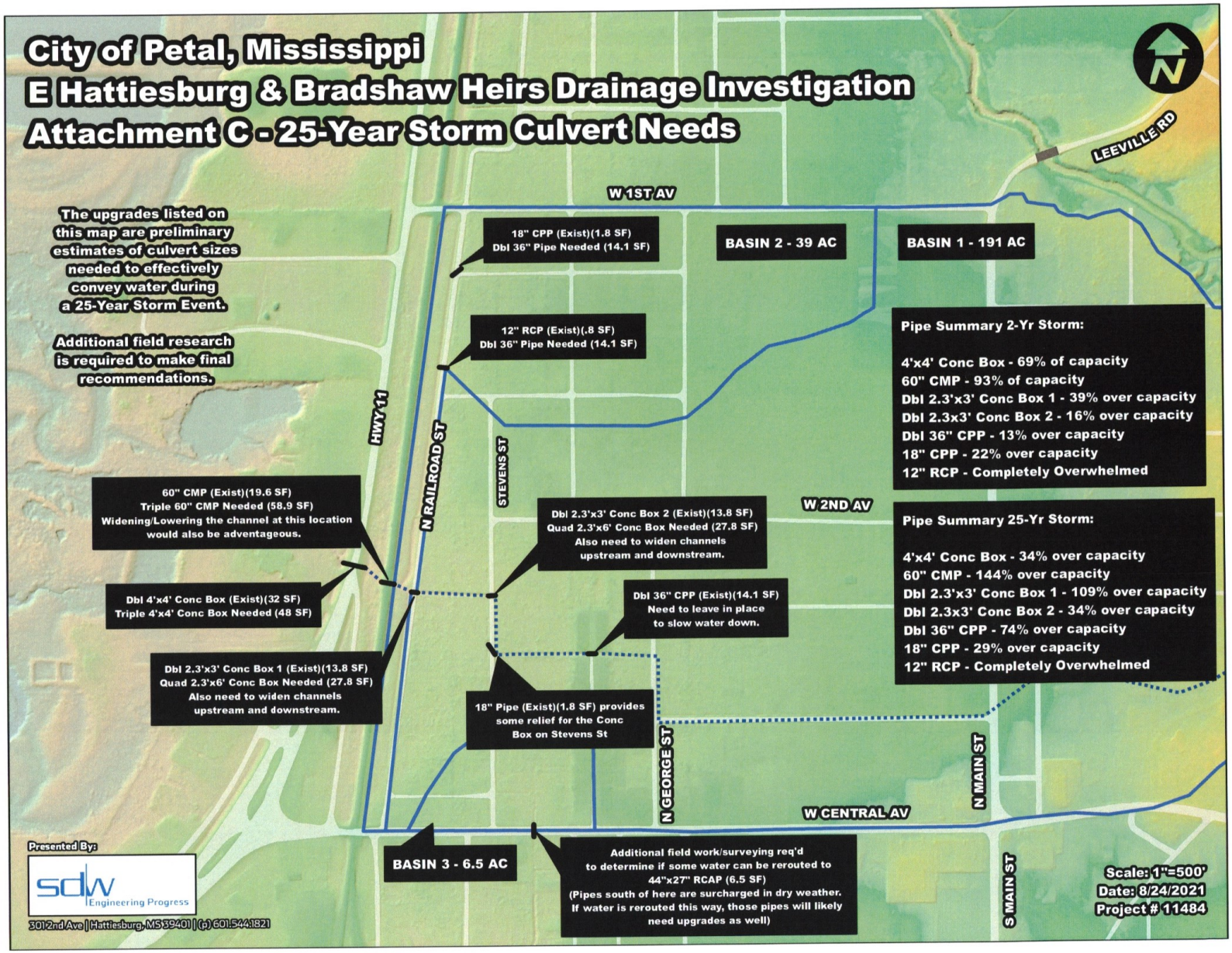
# ATTACHMENT A

## BASE INVESTIGATION MAP


City of Petal, Mississippi
E Hattiesburg & Bradshaw Heirs
Drainage Investigation
Pipe Summary 2-Yr Storm:
4'x4' Conc Box - 69% of capacity
60" CMP - 93% of capacity
Dbl 2.3'x3' Conc Box 1 - 39% over capacity
Dbl 2.3x3' Conc Box 2 - 16% over capacity
Dbl 36" CPP - 13% over capacity
N
EVELYN GANDY PKWY
W 1ST AV
HWY 11
N RAILROAD ST
BASIN 2 - 39 AC
BASIN 1 - 191 AC
CITY BARN LP
E 2ND AV
STEVENS ST
Hatched area shows theoretical location of flooding when 60" CMP is flowing full
Dbl 4'x4' Conc Box
W 2ND AV
Dbl 2.3'x3' Conc Box 2
60" CMP
OLD RICHTON RD
Dbl 2.3'x3' Conc Box 1
N GEORGE ST
Dbl 36" CPP
N MAIN ST
OLD CORINTH RD
W CENTRAL AV
E CENTRAL AV
BASIN 3 - 6.5 AC
S GEORGE ST
S MAIN ST
FORD DR
W 4TH AV
Presented By:
sdw Engineering Progress
301 2nd Ave | Hattiesburg, MS 39401 | (p) 601.544.1821
Scale: 1"=550'
Date: 8/4/2021
Project # 11484

## ATTACHMENT B

## 25-YEAR STORM CULVERT NEEDS MAP


City of Petal, Mississippi
E Hattiesburg & Bradshaw Heirs Drainage Investigation
Attachment C - 25-Year Storm Culvert Needs
The upgrades listed on this map are preliminary estimates of culvert sizes needed to effectively convey water during a 25-Year Storm Event.
Additional field research is required to make final recommendations.
W 1ST AV
LEEVILLE RD
18" CPP (Exist)(1.8 SF)
Dbl 36" Pipe Needed (14.1 SF)
BASIN 2 - 39 AC
BASIN 1 - 191 AC
12" RCP (Exist)(.8 SF)
Dbl 36" Pipe Needed (14.1 SF)
Pipe Summary 2-Yr Storm:
4'x4' Conc Box - 69% of capacity
60" CMP - 93% of capacity
Dbl 2.3'x3' Conc Box 1 - 39% over capacity
Dbl 2.3x3' Conc Box 2 - 16% over capacity
Dbl 36" CPP - 13% over capacity
18" CPP - 22% over capacity
12" RCP - Completely Overwhelmed
HWY 11
N RAILROAD ST
STEVENS ST
60" CMP (Exist)(19.6 SF)
Triple 60" CMP Needed (58.9 SF)
Widening/Lowering the channel at this location would also be adventageous.
Dbl 2.3'x3' Conc Box 2 (Exist)(13.8 SF)
Quad 2.3'x6' Conc Box Needed (27.8 SF)
Also need to widen channels upstream and downstream.
W 2ND AV
Pipe Summary 25-Yr Storm:
4'x4' Conc Box - 34% over capacity
60" CMP - 144% over capacity
Dbl 2.3'x3' Conc Box 1 - 109% over capacity
Dbl 2.3x3' Conc Box 2 - 34% over capacity
Dbl 36" CPP - 74% over capacity
18" CPP - 29% over capacity
12" RCP - Completely Overwhelmed
Dbl 4'x4' Conc Box (Exist)(32 SF)
Triple 4'x4' Conc Box Needed (48 SF)
Dbl 36" CPP (Exist)(14.1 SF)
Need to leave in place to slow water down.
Dbl 2.3'x3' Conc Box 1 (Exist)(13.8 SF)
Quad 2.3'x6' Conc Box Needed (27.8 SF)
Also need to widen channels upstream and downstream.
18" Pipe (Exist)(1.8 SF) provides some relief for the Conc Box on Stevens St
N GEORGE ST
N MAIN ST
W CENTRAL AV
BASIN 3 - 6.5 AC
Additional field work/surveying req'd to determine if some water can be rerouted to 44"x27" RCAP (6.5 SF)
(Pipes south of here are surcharged in dry weather. If water is rerouted this way, those pipes will likely need upgrades as well)
S MAIN ST
Scale: 1"=500'
Date: 8/24/2021
Project # 11484
Presented By:
sdw Engineering Progress
3012nd Ave | Hattiesburg, MS 39401 | (p) 601.544.1821

# ATTACHMENT C

## SUPPORTING CALCULATIONS

# Culvert Report - 2.3'x3' Concrete Box Under RR St - (Box 1)



## Box Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 142.50 |
| Pipe Length (ft) | = 30.00 |
| Slope (%) | = 1.67 |
| Invert Elev Up (ft) | = 143.00 |
| Rise (in) | = 27.6 |
| Shape | = Box |
| Span (in) | = 36.0 |
| No. Barrels | = 2 |
| n-Value | = 0.012 |
| Culvert Type | = Flared Wingwalls |
| Culvert Entrance | = 30D to 75D wingwall flares |
| Coeff. K,M,c,Y,k | = 0.026, 1, 0.0347, 0.81, 0.4 |

**Embankment**

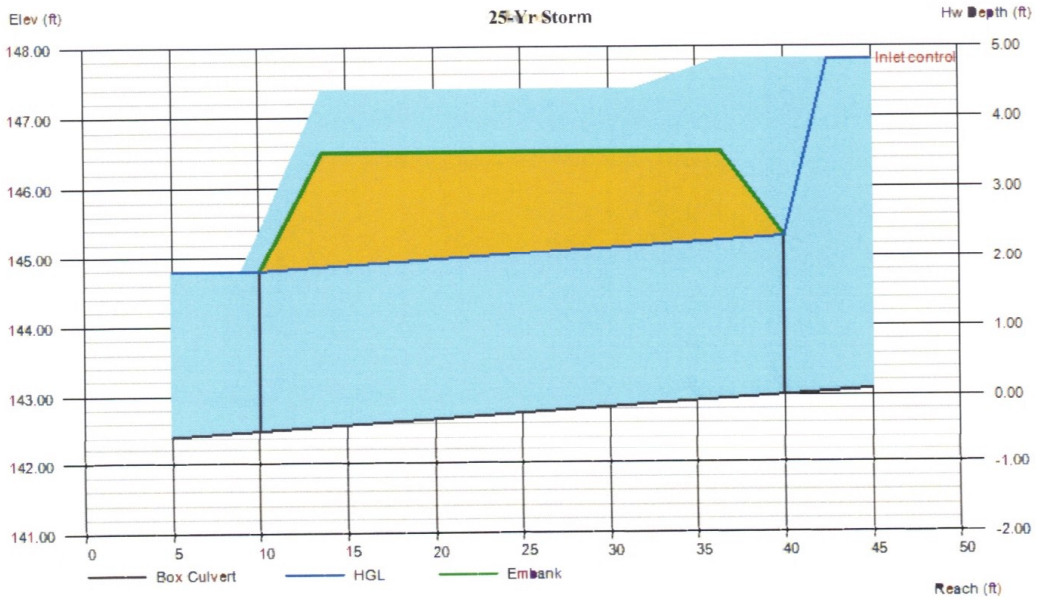
| | |
|---|---|
| Top Elevation (ft) | = 146.50 |
| Top Width (ft) | = 22.80 |
| Crest Width (ft) | = 20.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 219.50 |
| Qmax (cfs) | = 219.50 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 219.50 |
| Qpipe (cfs) | = 127.64 |
| Qovertop (cfs) | = 91.86 |
| Veloc Dn (ft/s) | = 9.25 |
| Veloc Up (ft/s) | = 9.25 |
| HGL Dn (ft) | = 144.80 |
| HGL Up (ft) | = 145.30 |
| Hw Elev (ft) | = 147.81 |
| Hw/D (ft) | = 2.09 |
| Flow Regime | = Inlet Control |



# Culvert Report - 2.3'x3' Concrete Box Under RR St - (Box 1)



## Box Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 142.50 |
| Pipe Length (ft) | = 30.00 |
| Slope (%) | = 1.67 |
| Invert Elev Up (ft) | = 143.00 |
| Rise (in) | = 27.6 |
| Shape | = Box |
| Span (in) | = 36.0 |
| No. Barrels | = 2 |
| n-Value | = 0.012 |
| Culvert Type | = Flared Wingwalls |
| Culvert Entrance | = 30D to 75D wingwall flares |
| Coeff. K,M,c,Y,k | = 0.026, 1, 0.0347, 0.81, 0.4 |

**Embankment**

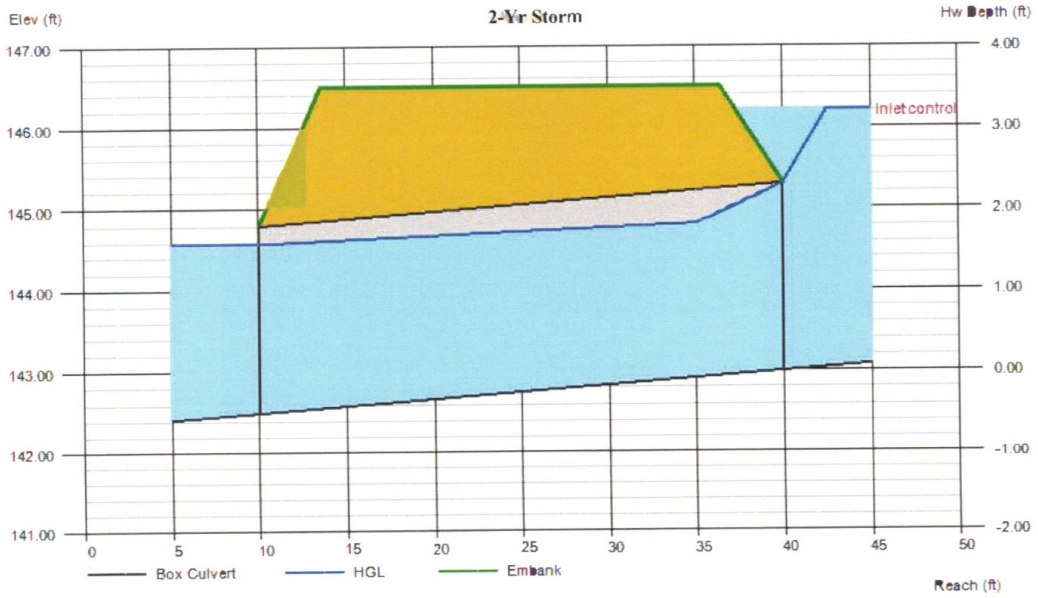
| | |
|---|---|
| Top Elevation (ft) | = 146.50 |
| Top Width (ft) | = 22.80 |
| Crest Width (ft) | = 20.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 86.50 |
| Qmax (cfs) | = 86.50 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 86.50 |
| Qpipe (cfs) | = 86.50 |
| Qovertop (cfs) | = 0.00 |
| Veloc Dn (ft/s) | = 6.93 |
| Veloc Up (ft/s) | = 7.74 |
| HGL Dn (ft) | = 144.58 |
| HGL Up (ft) | = 144.86 |
| Hw Elev (ft) | = 146.21 |
| Hw/D (ft) | = 1.39 |
| Flow Regime | = Inlet Control |



# Culvert Report - 2.3'x3' Concrete Box Under Stevens St - (Box 2)



## Box Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 144.20 |
| Pipe Length (ft) | = 30.00 |
| Slope (%) | = 1.67 |
| Invert Elev Up (ft) | = 144.70 |
| Rise (in) | = 27.6 |
| Shape | = Box |
| Span (in) | = 36.0 |
| No. Barrels | = 2 |
| n-Value | = 0.012 |
| Culvert Type | = Flared Wingwalls |
| Culvert Entrance | = 30D to 75D wingwall flares |
| Coeff. K,M,c,Y,k | = 0.026, 1, 0.0347, 0.81, 0.4 |

### Embankment

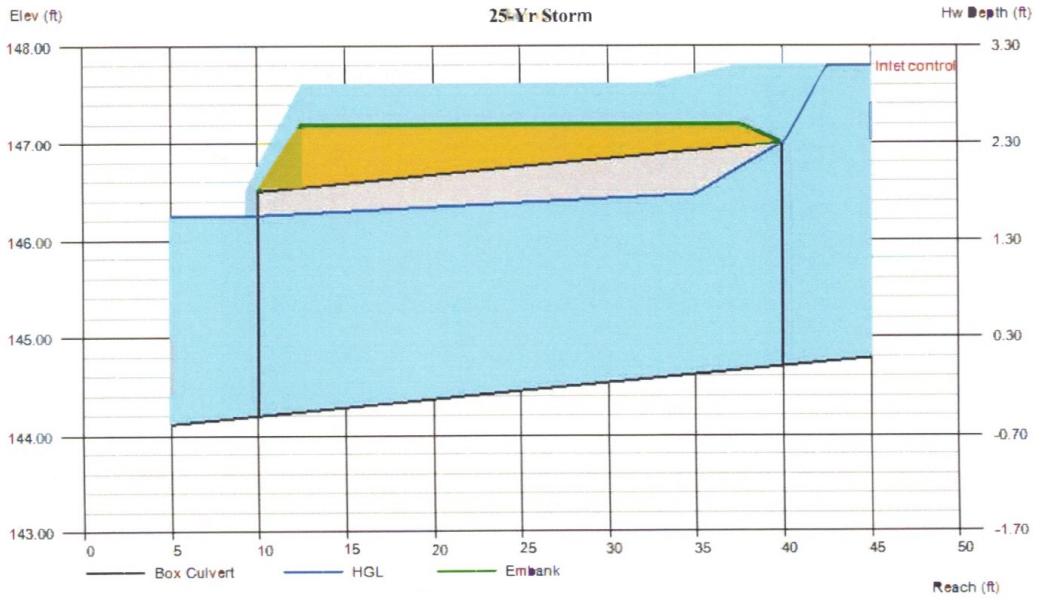
| | |
|---|---|
| Top Elevation (ft) | = 147.20 |
| Top Width (ft) | = 25.00 |
| Crest Width (ft) | = 100.00 |

### Calculations

| | |
|---|---|
| Qmin (cfs) | = 220.14 |
| Qmax (cfs) | = 220.14 |
| Tailwater Elev (ft) | = (dc+D)/2 |

### Highlighted

| | |
|---|---|
| Qtotal (cfs) | = 220.14 |
| Qpipe (cfs) | = 82.75 |
| Qovertop (cfs) | = 137.39 |
| Veloc Dn (ft/s) | = 6.72 |
| Veloc Up (ft/s) | = 7.63 |
| HGL Dn (ft) | = 146.25 |
| HGL Up (ft) | = 146.51 |
| Hw Elev (ft) | = 147.79 |
| Hw/D (ft) | = 1.34 |
| Flow Regime | = Inlet Control |



# Culvert Report - 2.3'x3' Concrete Box Under Stevens St - (Box 2)



## Box Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 144.20 |
| Pipe Length (ft) | = 30.00 |
| Slope (%) | = 1.67 |
| Invert Elev Up (ft) | = 144.70 |
| Rise (in) | = 27.6 |
| Shape | = Box |
| Span (in) | = 36.0 |
| No. Barrels | = 2 |
| n-Value | = 0.012 |
| Culvert Type | = Flared Wingwalls |
| Culvert Entrance | = 30D to 75D wingwall flares |
| Coeff. K,M,c,Y,k | = 0.026, 1, 0.0347, 0.81, 0.4 |

**Embankment**

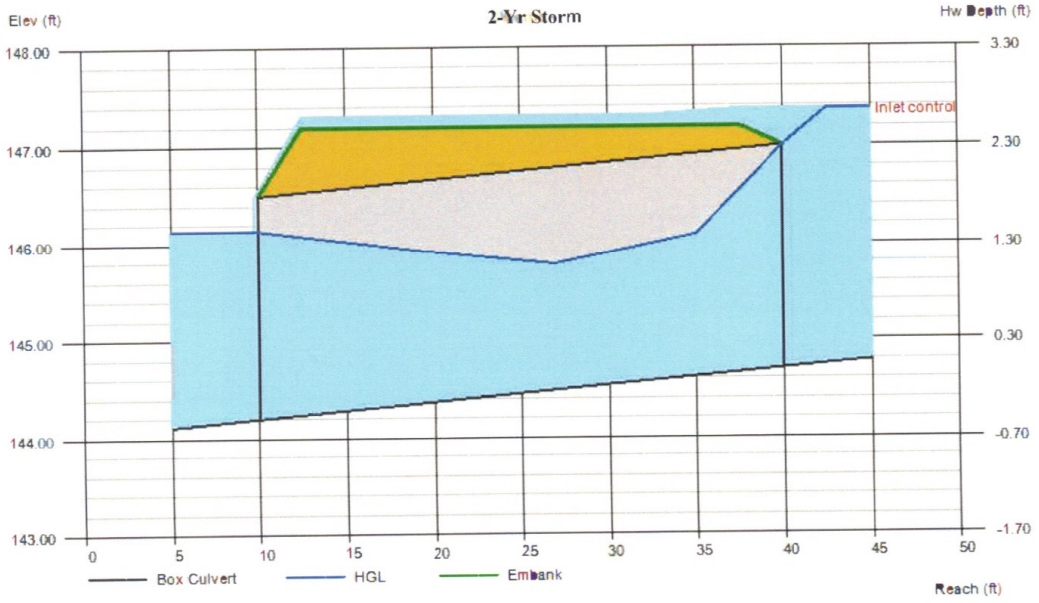
| | |
|---|---|
| Top Elevation (ft) | = 147.20 |
| Top Width (ft) | = 25.00 |
| Crest Width (ft) | = 100.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 86.30 |
| Qmax (cfs) | = 86.30 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 86.30 |
| Qpipe (cfs) | = 67.17 |
| Qovertop (cfs) | = 19.13 |
| Veloc Dn (ft/s) | = 5.78 |
| Veloc Up (ft/s) | = 7.12 |
| HGL Dn (ft) | = 146.14 |
| HGL Up (ft) | = 146.27 |
| Hw Elev (ft) | = 147.37 |
| Hw/D (ft) | = 1.16 |
| Flow Regime | = Inlet Control |



# Culvert Report - Dbl 4'x4' Conc Box Culvert Under Hwy 11



## Box Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 139.90 |
| Pipe Length (ft) | = 96.00 |
| Slope (%) | = 1.67 |
| Invert Elev Up (ft) | = 141.50 |
| Rise (in) | = 48.0 |
| Shape | = Box |
| Span (in) | = 48.0 |
| No. Barrels | = 2 |
| n-Value | = 0.012 |
| Culvert Type | = Flared Wingwalls |
| Culvert Entrance | = 30D to 75D wingwall flares |
| Coeff. K,M,c,Y,k | = 0.026, 1, 0.0347, 0.81, 0.4 |

**Embankment**

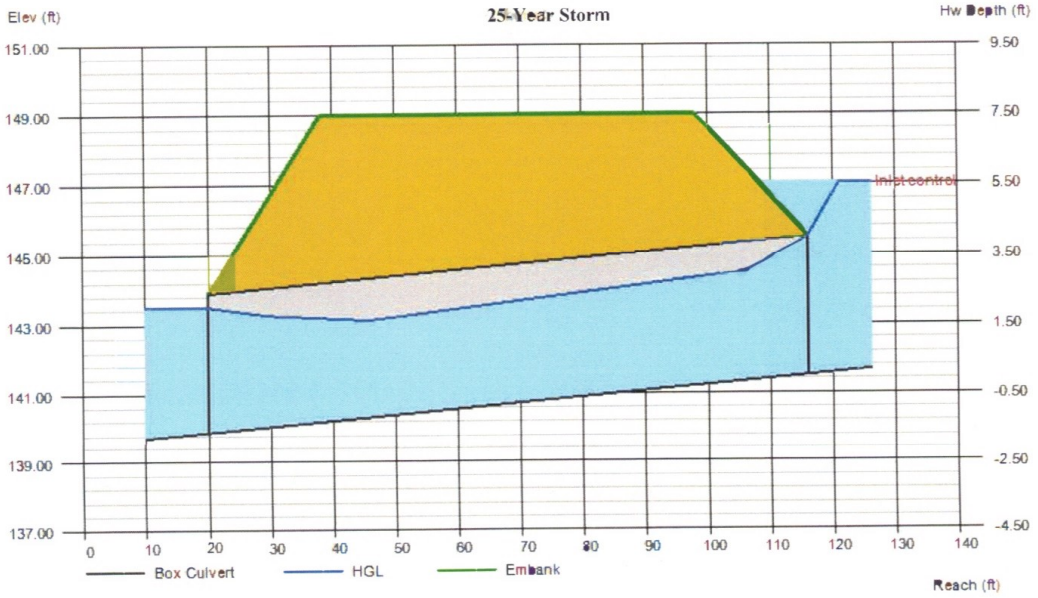
| | |
|---|---|
| Top Elevation (ft) | = 149.00 |
| Top Width (ft) | = 60.00 |
| Crest Width (ft) | = 200.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 262.00 |
| Qmax (cfs) | = 262.00 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 262.00 |
| Qpipe (cfs) | = 262.00 |
| Qovertop (cfs) | = 0.00 |
| Veloc Dn (ft/s) | = 9.08 |
| Veloc Up (ft/s) | = 10.19 |
| HGL Dn (ft) | = 143.51 |
| HGL Up (ft) | = 144.72 |
| Hw Elev (ft) | = 147.03 |
| Hw/D (ft) | = 1.38 |
| Flow Regime | = Inlet Control |



# Culvert Report - Dbl 4'x4' Conc Box Culvert Under Hwy 11



## Box Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 139.90 |
| Pipe Length (ft) | = 96.00 |
| Slope (%) | = 1.67 |
| Invert Elev Up (ft) | = 141.50 |
| Rise (in) | = 48.0 |
| Shape | = Box |
| Span (in) | = 48.0 |
| No. Barrels | = 2 |
| n-Value | = 0.012 |
| Culvert Type | = Flared Wingwalls |
| Culvert Entrance | = 30D to 75D wingwall flares |
| Coeff. K,M,c,Y,k | = 0.026, 1, 0.0347, 0.81, 0.4 |

**Embankment**

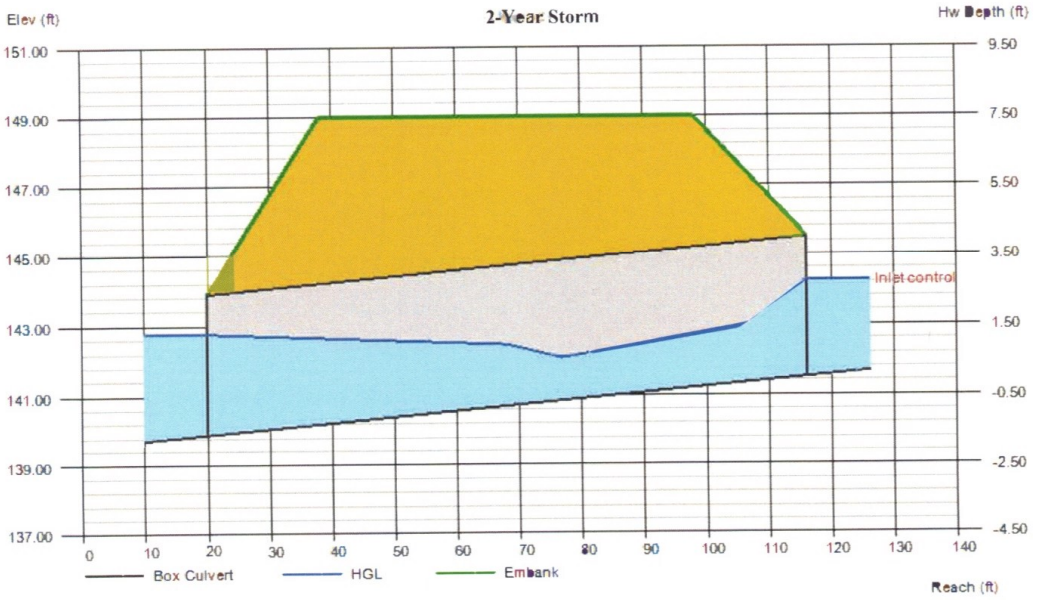
| | |
|---|---|
| Top Elevation (ft) | = 149.00 |
| Top Width (ft) | = 60.00 |
| Crest Width (ft) | = 200.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 105.00 |
| Qmax (cfs) | = 105.00 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 105.00 |
| Qpipe (cfs) | = 105.00 |
| Qovertop (cfs) | = 0.00 |
| Veloc Dn (ft/s) | = 4.57 |
| Veloc Up (ft/s) | = 7.51 |
| HGL Dn (ft) | = 142.77 |
| HGL Up (ft) | = 143.25 |
| Hw Elev (ft) | = 144.26 |
| Hw/D (ft) | = 0.69 |
| Flow Regime | = Inlet Control |



# Culvert Report - 12" RCP Under Railroad St

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Aug 23 2021

## Circular Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 144.40 |
| Pipe Length (ft) | = 27.00 |
| Slope (%) | = 2.22 |
| Invert Elev Up (ft) | = 145.00 |
| Rise (in) | = 12.0 |
| Shape | = Circular |
| Span (in) | = 12.0 |
| No. Barrels | = 1 |
| n-Value | = 0.012 |
| Culvert Type | = Circular Concrete |
| Culvert Entrance | = Square edge w/headwall (C) |
| Coeff. K,M,c,Y,k | = 0.0098, 2, 0.0398, 0.67, 0.5 |

**Embankment**

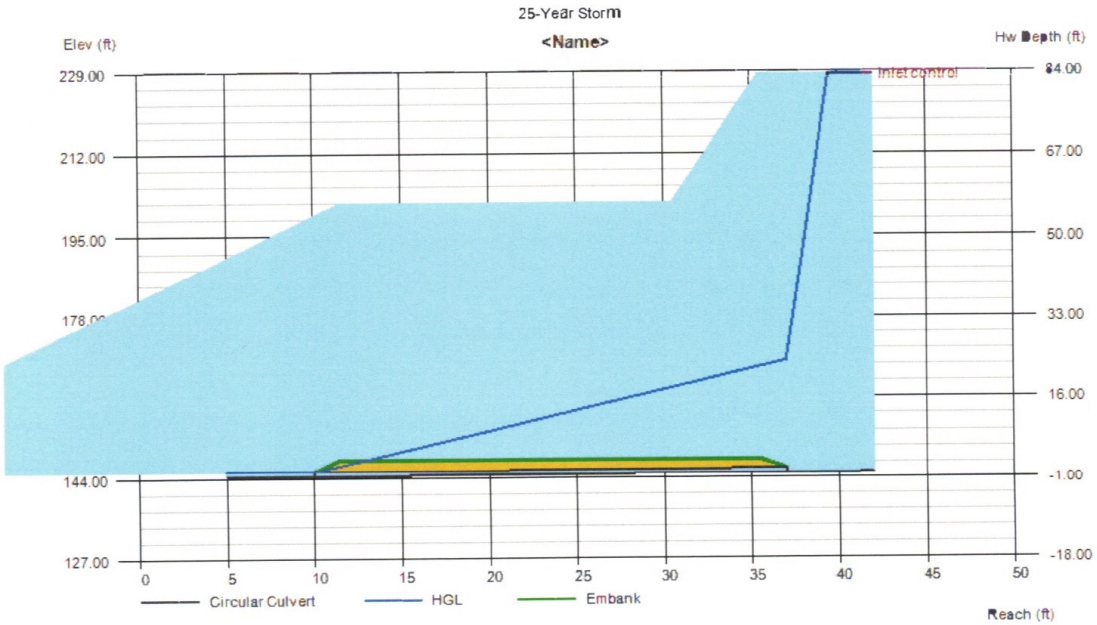
| | |
|---|---|
| Top Elevation (ft) | = 148.00 |
| Top Width (ft) | = 24.00 |
| Crest Width (ft) | = 50.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 36.40 |
| Qmax (cfs) | = 36.40 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 36.40 |
| Qpipe (cfs) | = 35.79 |
| Qovertop (cfs) | = 0.61 |
| Veloc Dn (ft/s) | = 45.56 |
| Veloc Up (ft/s) | = 45.56 |
| HGL Dn (ft) | = 145.40 |
| HGL Up (ft) | = 168.59 |
| Hw Elev (ft) | = 228.29 |
| Hw/D (ft) | = 83.29 |
| Flow Regime | = Inlet Control |



# Culvert Report - 12" RCP Under Railroad St

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Aug 23 2021

## Circular Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 144.40 |
| Pipe Length (ft) | = 27.00 |
| Slope (%) | = 2.22 |
| Invert Elev Up (ft) | = 145.00 |
| Rise (in) | = 12.0 |
| Shape | = Circular |
| Span (in) | = 12.0 |
| No. Barrels | = 1 |
| n-Value | = 0.012 |
| Culvert Type | = Circular Concrete |
| Culvert Entrance | = Square edge w/headwall (C) |
| Coeff. K,M,c,Y,k | = 0.0098, 2, 0.0398, 0.67, 0.5 |

**Embankment**

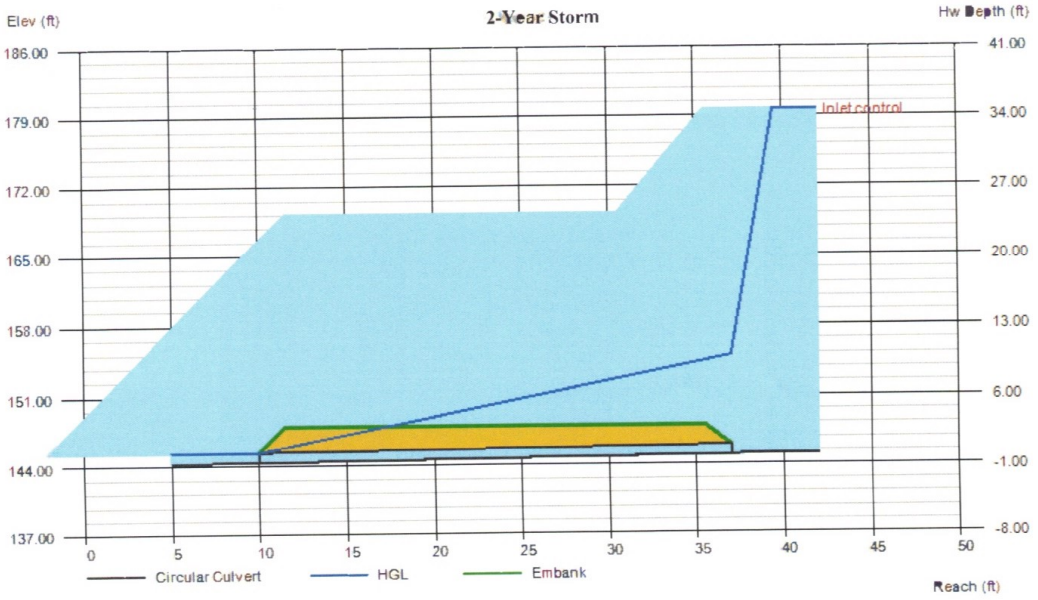
| | |
|---|---|
| Top Elevation (ft) | = 148.00 |
| Top Width (ft) | = 24.00 |
| Crest Width (ft) | = 50.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 23.00 |
| Qmax (cfs) | = 23.00 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 23.00 |
| Qpipe (cfs) | = 22.95 |
| Qovertop (cfs) | = 0.05 |
| Veloc Dn (ft/s) | = 29.22 |
| Veloc Up (ft/s) | = 29.22 |
| HGL Dn (ft) | = 145.40 |
| HGL Up (ft) | = 154.91 |
| Hw Elev (ft) | = 179.65 |
| Hw/D (ft) | = 34.65 |
| Flow Regime | = Inlet Control |



# Culvert Report - 18" CPP Under Railroad St



## Circular Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 145.10 |
| Pipe Length (ft) | = 40.00 |
| Slope (%) | = 4.00 |
| Invert Elev Up (ft) | = 146.70 |
| Rise (in) | = 18.0 |
| Shape | = Circular |
| Span (in) | = 18.0 |
| No. Barrels | = 1 |
| n-Value | = 0.009 |
| Culvert Type | = Circular Culvert |
| Culvert Entrance | = Smooth tapered inlet throat |
| Coeff. K,M,c,Y,k | = 0.534, 0.555, 0.0196, 0.9, 0.2 |

**Embankment**

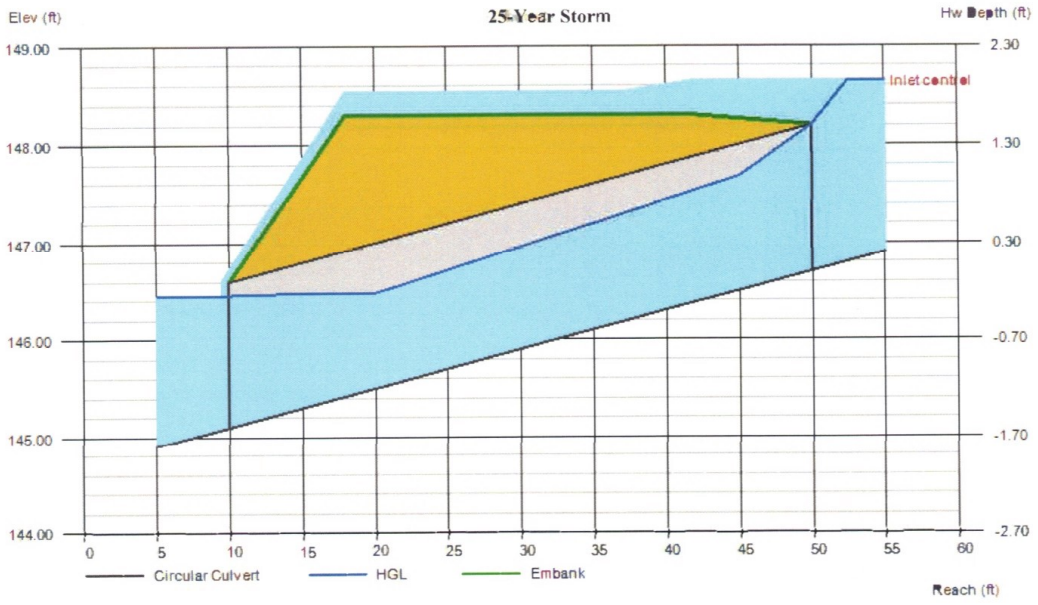
| | |
|---|---|
| Top Elevation (ft) | = 148.30 |
| Top Width (ft) | = 24.00 |
| Crest Width (ft) | = 45.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 36.40 |
| Qmax (cfs) | = 36.40 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 36.40 |
| Qpipe (cfs) | = 9.94 |
| Qovertop (cfs) | = 26.46 |
| Veloc Dn (ft/s) | = 5.91 |
| Veloc Up (ft/s) | = 6.49 |
| HGL Dn (ft) | = 146.46 |
| HGL Up (ft) | = 147.91 |
| Hw Elev (ft) | = 148.64 |
| Hw/D (ft) | = 1.29 |
| Flow Regime | = Inlet Control |



# Culvert Report - 18" CPP Under Railroad St



## Circular Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 145.10 |
| Pipe Length (ft) | = 40.00 |
| Slope (%) | = 4.00 |
| Invert Elev Up (ft) | = 146.70 |
| Rise (in) | = 18.0 |
| Shape | = Circular |
| Span (in) | = 18.0 |
| No. Barrels | = 1 |
| n-Value | = 0.009 |
| Culvert Type | = Circular Culvert |
| Culvert Entrance | = Smooth tapered inlet throat |
| Coeff. K,M,c,Y,k | = 0.534, 0.555, 0.0196, 0.9, 0.2 |

**Embankment**

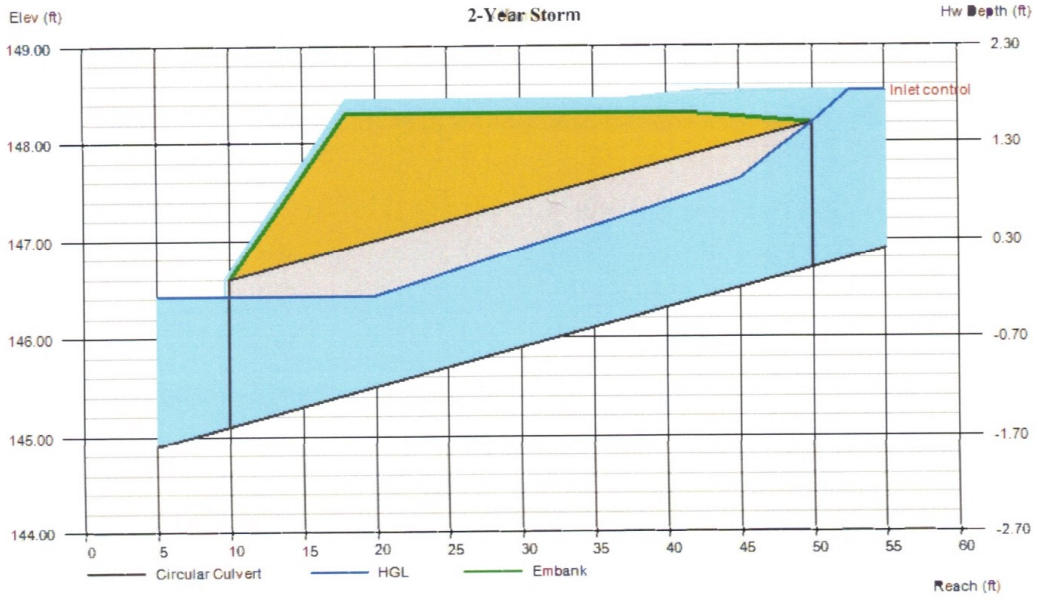
| | |
|---|---|
| Top Elevation (ft) | = 148.30 |
| Top Width (ft) | = 24.00 |
| Crest Width (ft) | = 45.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 23.00 |
| Qmax (cfs) | = 23.00 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 23.00 |
| Qpipe (cfs) | = 8.98 |
| Qovertop (cfs) | = 14.02 |
| Veloc Dn (ft/s) | = 5.42 |
| Veloc Up (ft/s) | = 6.13 |
| HGL Dn (ft) | = 146.43 |
| HGL Up (ft) | = 147.86 |
| Hw Elev (ft) | = 148.53 |
| Hw/D (ft) | = 1.22 |
| Flow Regime | = Inlet Control |



# Culvert Report - 60" CMP Under Rail Road

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Aug 23 2021

## Circular Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 141.30 |
| Pipe Length (ft) | = 60.00 |
| Slope (%) | = 0.35 |
| Invert Elev Up (ft) | = 141.51 |
| Rise (in) | = 60.0 |
| Shape | = Circular |
| Span (in) | = 60.0 |
| No. Barrels | = 1 |
| n-Value | = 0.022 |
| Culvert Type | = Circular Corrugate Metal Pipe |
| Culvert Entrance | = Projecting |
| Coeff. K,M,c,Y,k | = 0.034, 1.5, 0.0553, 0.54, 0.9 |

**Embankment**

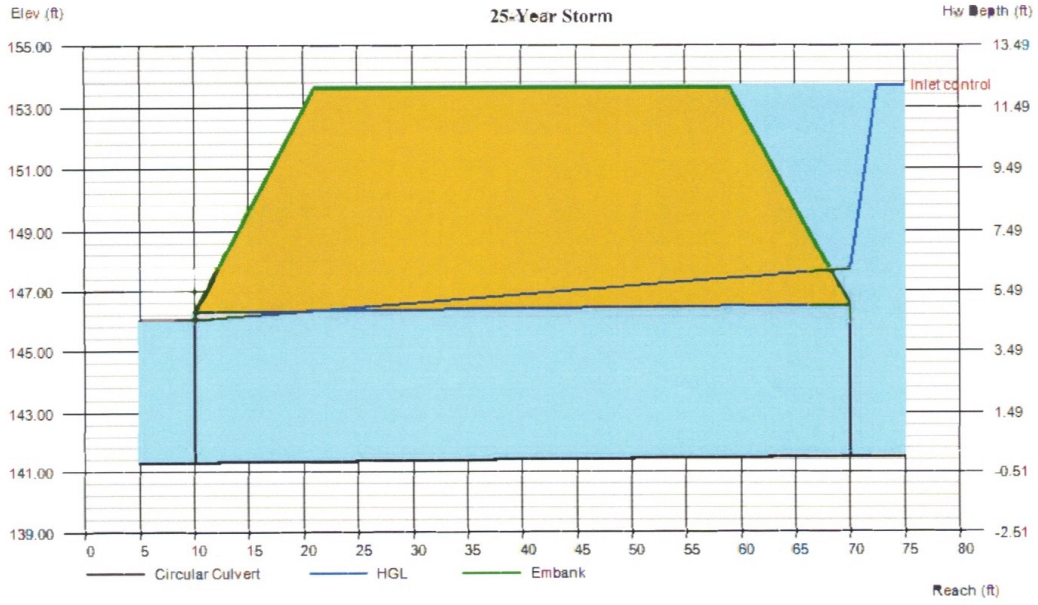
| | |
|---|---|
| Top Elevation (ft) | = 153.60 |
| Top Width (ft) | = 38.00 |
| Crest Width (ft) | = 30.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 259.50 |
| Qmax (cfs) | = 259.50 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 259.50 |
| Qpipe (cfs) | = 257.25 |
| Qovertop (cfs) | = 2.25 |
| Veloc Dn (ft/s) | = 13.38 |
| Veloc Up (ft/s) | = 13.10 |
| HGL Dn (ft) | = 146.03 |
| HGL Up (ft) | = 147.71 |
| Hw Elev (ft) | = 153.69 |
| Hw/D (ft) | = 2.44 |
| Flow Regime | = Inlet Control |



# Culvert Report - 60" CMP Under Rail Road

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Aug 4 2021

## Circular Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 141.30 |
| Pipe Length (ft) | = 60.00 |
| Slope (%) | = 0.35 |
| Invert Elev Up (ft) | = 141.51 |
| Rise (in) | = 60.0 |
| Shape | = Circular |
| Span (in) | = 60.0 |
| No. Barrels | = 1 |
| n-Value | = 0.022 |
| Culvert Type | = Circular Corrugate Metal Pipe |
| Culvert Entrance | = Projecting |
| Coeff. K,M,c,Y,k | = 0.034, 1.5, 0.0553, 0.54, 0.9 |

**Embankment**

| | |
|---|---|
| Top Elevation (ft) | = 153.60 |
| Top Width (ft) | = 38.00 |
| Crest Width (ft) | = 30.00 |

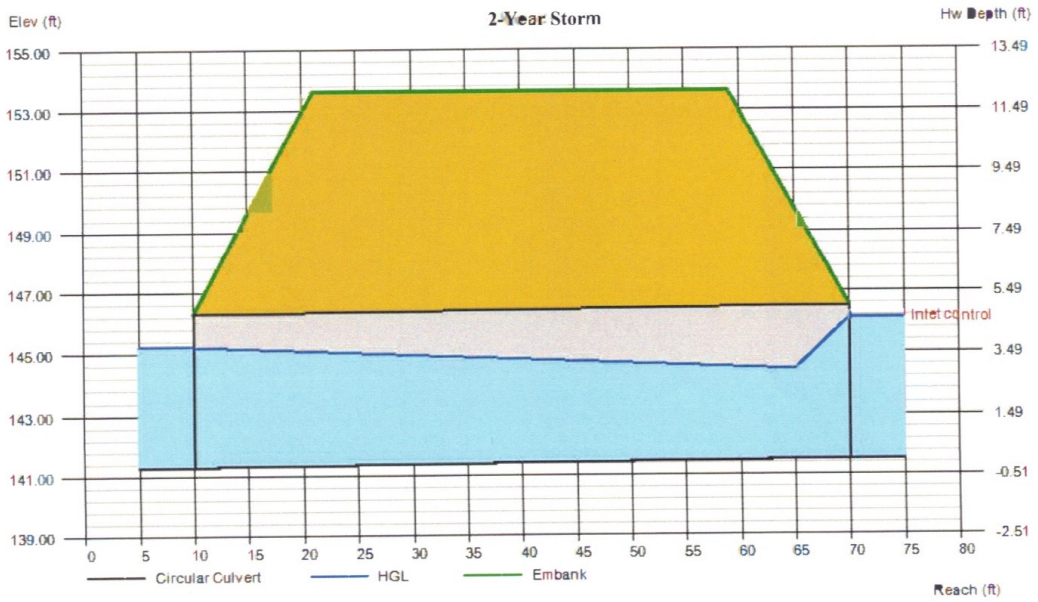
**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 101.50 |
| Qmax (cfs) | = 101.50 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 101.50 |
| Qpipe (cfs) | = 101.50 |
| Qovertop (cfs) | = 0.00 |
| Veloc Dn (ft/s) | = 6.13 |
| Veloc Up (ft/s) | = 8.72 |
| HGL Dn (ft) | = 145.23 |
| HGL Up (ft) | = 144.38 |
| Hw Elev (ft) | = 146.15 |
| Hw/D (ft) | = 0.93 |
| Flow Regime | = Inlet Control |

Note: All elevations were obtained from LIDAR imagery.



# Culvert Report - Dbl 36" CPP Near Abandoned Storage Facility



## Circular Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 146.20 |
| Pipe Length (ft) | = 20.00 |
| Slope (%) | = 1.00 |
| Invert Elev Up (ft) | = 146.40 |
| Rise (in) | = 36.0 |
| Shape | = Circular |
| Span (in) | = 36.0 |
| No. Barrels | = 2 |
| n-Value | = 0.009 |
| Culvert Type | = Circular Culvert |
| Culvert Entrance | = Smooth tapered inlet throat |
| Coeff. K,M,c,Y,k | = 0.534, 0.555, 0.0196, 0.9, 0.2 |

**Embankment**

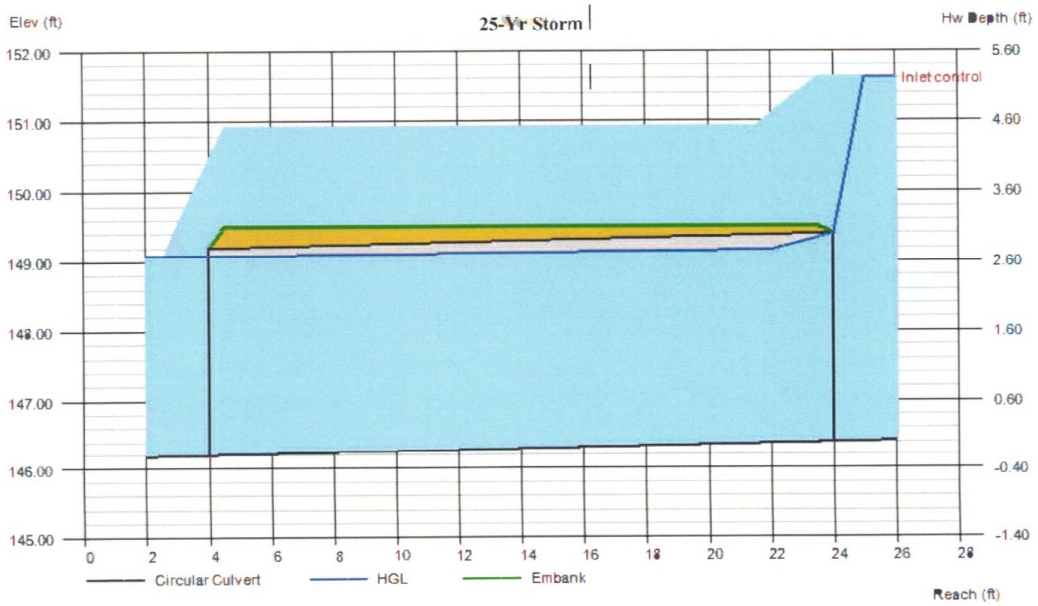
| | |
|---|---|
| Top Elevation (ft) | = 149.50 |
| Top Width (ft) | = 19.00 |
| Crest Width (ft) | = 7.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 226.00 |
| Qmax (cfs) | = 226.00 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 226.00 |
| Qpipe (cfs) | = 160.34 |
| Qovertop (cfs) | = 65.66 |
| Veloc Dn (ft/s) | = 11.49 |
| Veloc Up (ft/s) | = 11.75 |
| HGL Dn (ft) | = 149.09 |
| HGL Up (ft) | = 149.17 |
| Hw Elev (ft) | = 151.61 |
| Hw/D (ft) | = 1.74 |
| Flow Regime | = Inlet Control |



# Culvert Report - Dbl 36" CPP Near Abandoned Storage Facility



## Circular Culvert

| | |
|---|---|
| Invert Elev Dn (ft) | = 146.20 |
| Pipe Length (ft) | = 20.00 |
| Slope (%) | = 1.00 |
| Invert Elev Up (ft) | = 146.40 |
| Rise (in) | = 36.0 |
| Shape | = Circular |
| Span (in) | = 36.0 |
| No. Barrels | = 2 |
| n-Value | = 0.009 |
| Culvert Type | = Circular Culvert |
| Culvert Entrance | = Smooth tapered inlet throat |
| Coeff. K,M,c,Y,k | = 0.534, 0.555, 0.0196, 0.9, 0.2 |

**Embankment**

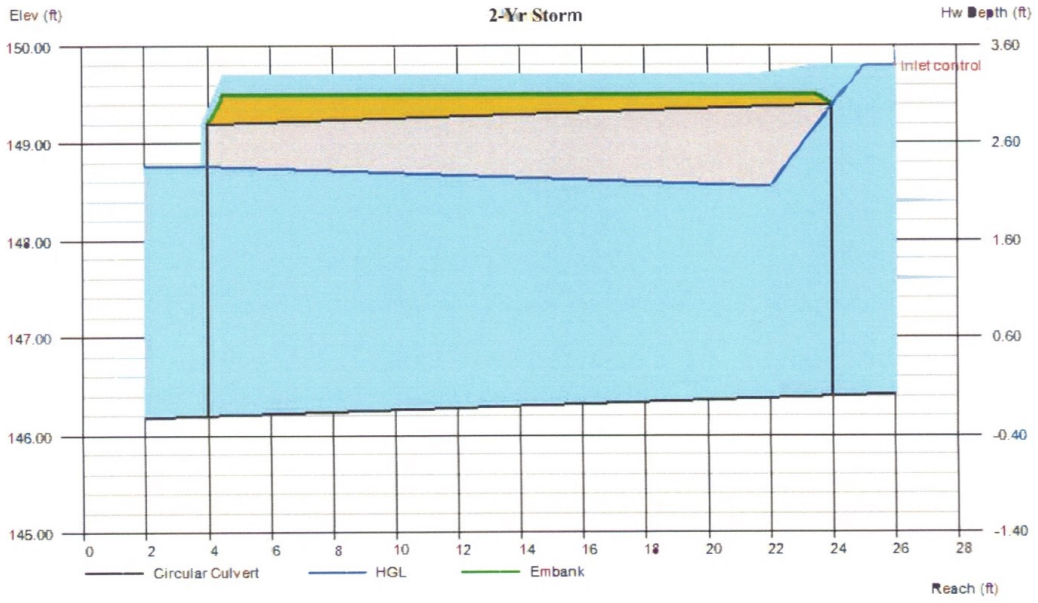
| | |
|---|---|
| Top Elevation (ft) | = 149.50 |
| Top Width (ft) | = 19.00 |
| Crest Width (ft) | = 7.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 87.80 |
| Qmax (cfs) | = 87.80 |
| Tailwater Elev (ft) | = (dc+D)/2 |

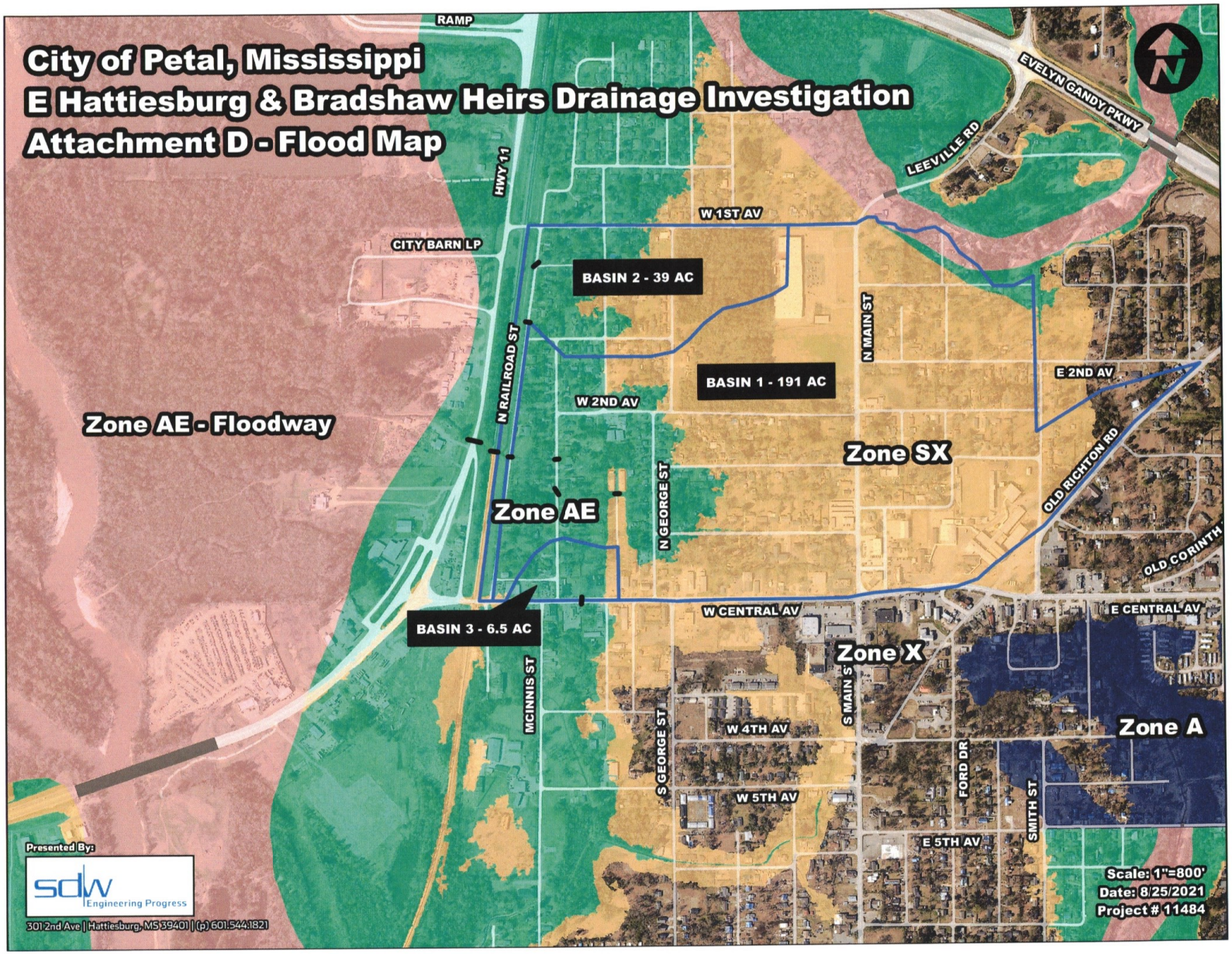
**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 87.80 |
| Qpipe (cfs) | = 84.64 |
| Qovertop (cfs) | = 3.16 |
| Veloc Dn (ft/s) | = 6.59 |
| Veloc Up (ft/s) | = 7.91 |
| HGL Dn (ft) | = 148.76 |
| HGL Up (ft) | = 148.52 |
| Hw Elev (ft) | = 149.79 |
| Hw/D (ft) | = 1.13 |
| Flow Regime | = Inlet Control |



## ATTACHMENT D

## FLOOD MAP


City of Petal, Mississippi
E Hattiesburg & Bradshaw Heirs Drainage Investigation
Attachment D - Flood Map
RAMP
HWY 11
EVELYN GANDY PKWY
LEEVILLE RD
W 1ST AV
CITY BARN LP
BASIN 2 - 39 AC
N RAILROAD ST
N MAIN ST
BASIN 1 - 191 AC
E 2ND AV
W 2ND AV
Zone AE - Floodway
Zone SX
OLD RICHTON RD
N GEORGE ST
Zone AE
OLD CORINTH
W CENTRAL AV
E CENTRAL AV
BASIN 3 - 6.5 AC
Zone X
MCINNIS ST
S MAIN ST
W 4TH AV
Zone A
S GEORGE ST
FORD DR
W 5TH AV
SMITH ST
E 5TH AV
Presented By:
sdw
Engineering Progress
301 2nd Ave | Hattiesburg, MS 39401 | (p) 601.544.1821
Scale: 1"=800'
Date: 8/25/2021
Project # 11484