Darrell Fussell, PE **Civil and Structural Engineering** **237 Natchez Trace, Covington, LA 70433**		**PAGE:** **1 of 4**
JOB: Proposed Storage Facility **Dunbar Ave.** **Bay St. Louis, MS.**	DARRELL FUSSELL LICENSED PROFESSIONAL ENGINEER 11185 STATE OF MISSISSIPPI 4.17.26	**DATE:** **4/17/26**
		BY: **DRF**

HYDROLOGICAL CALCULATIONS

Scope:
Provide drainage calculations for the proposed storage facility on Ruella Ave. at Dunbar Ave. in Bay St. Louis Mississippi.

The drainage calculations are based on the Rational Method for computing quantities of storm water runoff. The Rational method is based on the following:

Q = CIA
Q = peak runoff rate, cfs
C = runoff coefficient
I = average rainfall intensity
A= drainage area, acres

1. Existing Conditions:

The existing 3.26-acre site was previously developed with a large commercial building, paved parking areas, and paved drive areas for a total existing impervious area of 1.70 acres. The existing site drains from south to north across the property toward Ruella Avenue. There is no defined drainage on Ruella Avenue. It appears that rainfall runoff ultimately flows into the Highway 90 drainage system. The existing site drains as a single basin. (see sheet C1 for basin area details). (Note- The total area of the site is 4.09 acres. The proposed storage facility will be constructed on a 3.26 acre portion of the site. See sheet C1.1)

The existing drainage calculations are as follows:

Determination of "Tc"
Area = 3.26

Darrell Fussell, PE
Civil and Structural Engineering
237 Natchez Trace, Covington, LA 70433

JOB: Proposed Storage Facility
Dunbar Ave.
Bay St. Louis, MS.

DATE: 4/17/26

BY: DRF

Determination of "C"
Area Total = 3.26 acres
Area of Grass = 1.42 acres
Area of Building Foundation and Paving = 1.84 acres

$C = 0.25\ (1.42/3.26) + 0.95(1.84/3.26) = 0.65$

$T_c = 5$ min (Min. allowable value.)

2. Developed Conditions:

The proposed plans call for the construction of seven storage buildings along with paved parking and drive areas for a total developed impervious area of 1.26 acres and total limestone paving area of 1.53 acres. The developed site will continue to drain as the existing, into the Highway 90 drainage system.
(see sheet C1 for developed site drainage details).

The developed drainage calculations are as follows:

Determination of "Tc"
Area = 3.26

Determination of "C"
Area Total = 3.26 acres
Area of Grass = 0.47 acres
Area of Building and Concrete Paving = 1.01 acres
Area of Limestone = 1.53 acres

$C = 0.25\ (0.47/3.26) + 0.5(1.53/3.26) + .95(1.53/3.26) = 0.72$

$T_c = 13$ min

(See TR55 Worksheet and sheet C1 for Tc calculation information.)

Darrell Fussell, PE **Civil and Structural Engineering** **237 Natchez Trace, Covington, LA 70433**		**PAGE:** **3 of 4**
JOB: Proposed Storage Facility **Dunbar Ave.** **Bay St. Louis, MS.**		**DATE:** **4/17/26**
		BY: **DRF**

HYDRAFLOW COMPUTER ANALYSIS

The pre-developed and developed areas, "C" values, and "Tc" values were input into the program along with the rainfall intensity data producing the following data for a 25-year storm (NOAA for Bay St. Louis attached).

Design Storm	10 Year Storm	25 Year Storm	100 Year Storm
Existing Flow	24.96 cfs	26.00 cfs	35.75 cfs
Developed Flow	18.38 cfs	19.97 cfs	26.09 cfs

Conclusion:
The developed flow is less than the existing flow because of the increased runoff length, paving type, and channel flow in the developed condition. In the existing condition, the runoff length is small because the the flow is across the site. The "C" value of the existing condition is high because of the existing concrete and asphalt.

The developed flow will drain from the proposed buildings, across the proposed drive area, through the proposed pipes / swale, and out to the existing ditch along Dunbar Ave.. (See sheet C1 for drainage details).

North Property Line to Center of Limestone Paving Area (Area A) :
The runoff from the roofs of the North buildings will be carried from roof drains to a swale 1' deep 6' wide with a capacity of 10.0 cfs., then to 2-18" HDPE pipes sloped at .002 ft./ft., with a capacity of 11.76 cfs. The flow from the 1.42 Acre area will be will be 7.2 cfs. (Developed flow based on 10 Year Storm Rational Method, L = 800', S = 21.25-17.70 / 800' = 0.0044 ft/ft, Pipe Flow Capacity based on Manning Equation Pipe Flowing Full, Channel Flow based on Mannings Equation flowing full.)

Darrell Fussell, PE **Civil and Structural Engineering** **237 Natchez Trace, Covington, LA 70433**		**PAGE:** **4 of 4**
JOB: Proposed Storage Facility **Dunbar Ave.** **Bay St. Louis, MS.**		**DATE:** **4/17/26**
		BY: **DRF**

South Property Line to Center of Limestone Paving Area (Area B):
The runoff from the roofs of the South and East buildings will be carried from roof drains to a 1' deep, 6' wide swale with a capacity of 10 cfs, then to 2-12" HDPE pipes sloped at 002 ft./ft., with a capacity of 3.78 cfs, then to 2-18" HDPE pipes sloped at .002 ft./ft., with a capacity of 11.76 cfs. The maximum flow from the 1.53 Acre area will be will be 10.79 cfs. (Developed flow based on 10 Year Storm Rational Method, L = 640', S = 21.15-17.70 / 640' = 0.0055 ft/ft, Pipe Flow Capacity based on Manning Equation Pipe Flowing Full. Channel Flow based on Mannings Equation flowing full.)

Entrance Concrete Drive Area (Area C) :
The runoff from the concrete drive will be drained to 24" Catch Basins along the south property line. 2-18" HDPE pipes sloped at .002 ft./ft., with a capacity of 11.76 cfs will meter the 19.97 cfs developed flow of the site to 11.76 cfs. Storm events causing flow volumes greater than 11.76 cfs. will be accounted for by the additional storage volume capacity of the developed site swales, drain pipes, and limestone paving area. (Developed flow based on Rational Method, Pipe Flow Capacity based on Manning Equation Pipe Flowing Full.)

TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve

Hyd. No. 1

Dunbar Existing

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.011	0.011	0.011	
Flow length (ft)	= 100.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 5.42	0.00	0.00	
Land slope (%)	= 0.54	0.00	0.00	
Travel Time (min)	**= 1.57** +	**0.00** +	**0.00** =	**1.57**
Shallow Concentrated Flow				
Flow length (ft)	= 85.00	0.00	0.00	
Watercourse slope (%)	= 0.54	0.00	0.00	
Surface description	= Paved	Paved	Paved	
Average velocity (ft/s)	= 1.49	0.00	0.00	
Travel Time (min)	**= 0.95** +	**0.00** +	**0.00** =	**0.95**
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	= 0.00	0.00	0.00	
Flow length (ft)	= 0.0	0.0	0.0	
Travel Time (min)	**= 0.00** +	**0.00** +	**0.00** =	**0.00**

Total Travel Time, Tc ..... **2.52 min**

Hydrograph Plot

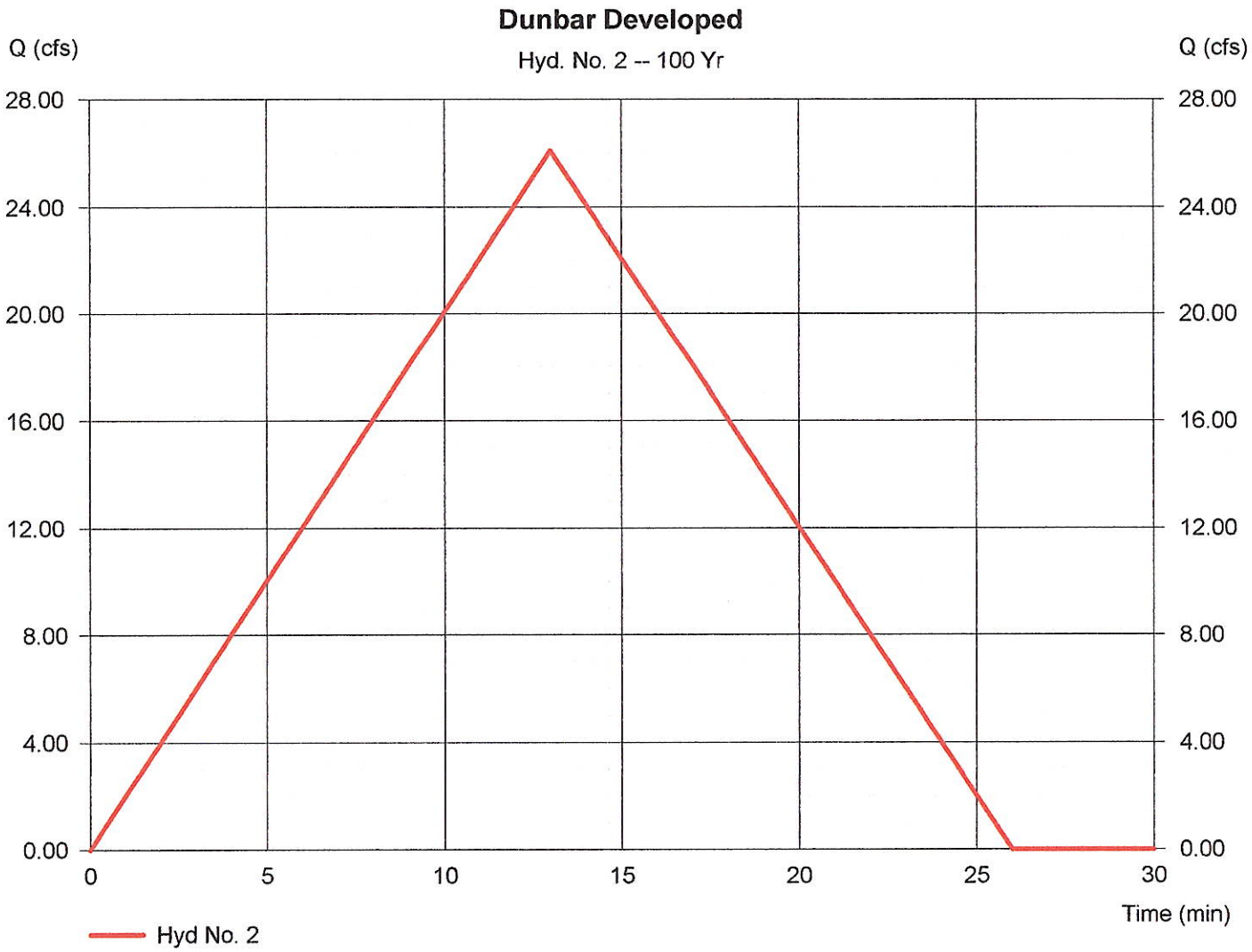
Hydraflow Hydrographs by Intelisolve | Friday, Apr 17 2026, 12:26 PM

Hyd. No. 2

Dunbar Developed

Hydrograph type	= Rational	Peak discharge	= 26.09 cfs
Storm frequency	= 100 yrs	Time interval	= 1 min
Drainage area	= 3.260 ac	Runoff coeff.	= 0.72
Intensity	= 11.114 in/hr	Tc by TR55	= 13.00 min
IDF Curve	= bay st louis.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 20,347 cuft



TR55 Tc Worksheet

Hyd. No. 2

Dunbar Developed

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.025	0.011	0.011	
Flow length (ft)	= 100.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 5.42	0.00	0.00	
Land slope (%)	= 1.00	0.00	0.00	
Travel Time (min)	**= 2.37**	**+ 0.00**	**+ 0.00**	**= 2.37**
Shallow Concentrated Flow				
Flow length (ft)	= 60.00	0.00	0.00	
Watercourse slope (%)	= 2.00	0.00	0.00	
Surface description	= Paved	Paved	Paved	
Average velocity (ft/s)	= 2.87	0.00	0.00	
Travel Time (min)	**= 0.35**	**+ 0.00**	**+ 0.00**	**= 0.35**
Channel Flow				
X sectional flow area (sqft)	= 3.00	3.54	0.00	
Wetted perimeter (ft)	= 6.32	9.42	0.00	
Channel slope (%)	= 0.12	0.15	0.00	
Manning's n-value	= 0.026	0.012	0.015	
Velocity (ft/s)	= 1.21	2.50	0.00	
Flow length (ft)	= 520.0	460.0	0.0	
Travel Time (min)	**= 7.19**	**+ 3.07**	**+ 0.00**	**= 10.26**

Total Travel Time, Tc ..... 12.98 min

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

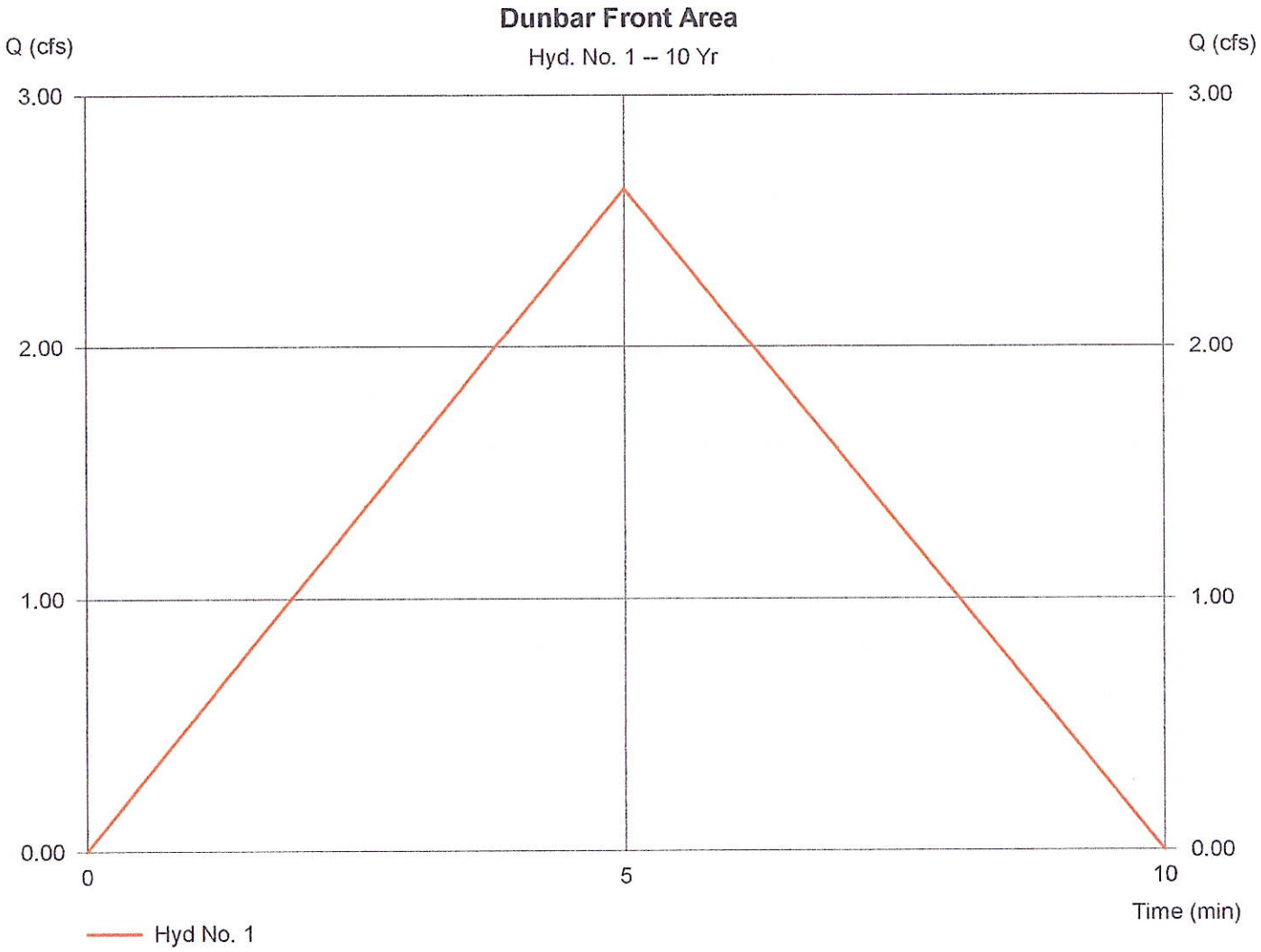
Thursday, Apr 16 2026, 4:19 PM

Hyd. No. 1

Dunbar Front Area

Hydrograph type	= Rational	Peak discharge	= 2.63 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 0.310 ac	Runoff coeff.	= 0.72
Intensity	= 11.778 in/hr	Tc by User	= 5.00 min
IDF Curve	= bay st louis.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 789 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

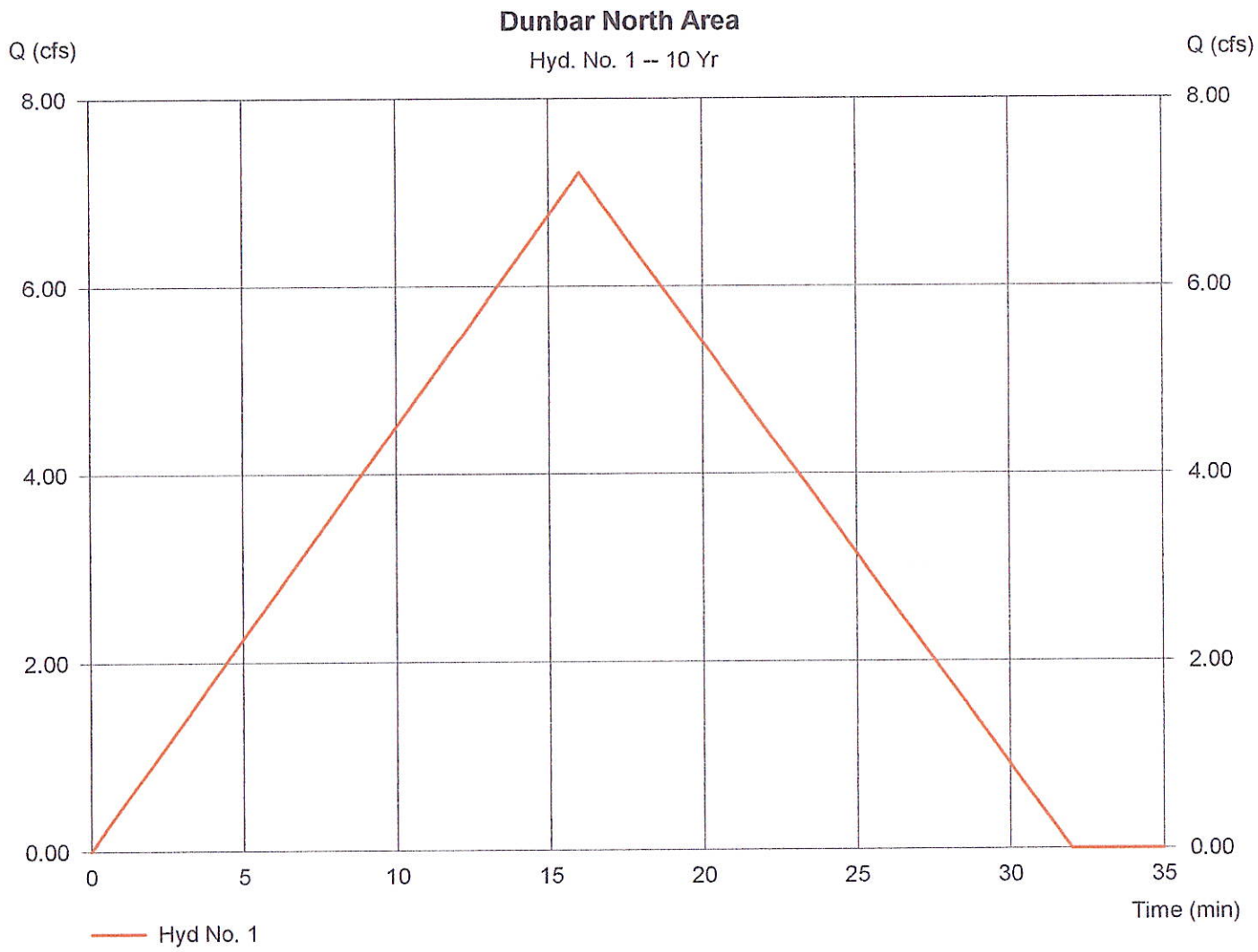
Thursday, Apr 16 2026, 3:46 PM

Hyd. No. 1

Dunbar North Area

Hydrograph type	= Rational	Peak discharge	= 7.20 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 1.420 ac	Runoff coeff.	= 0.72
Intensity	= 7.047 in/hr	Tc by User	= 16.00 min
IDF Curve	= bay st louis.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 6,917 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

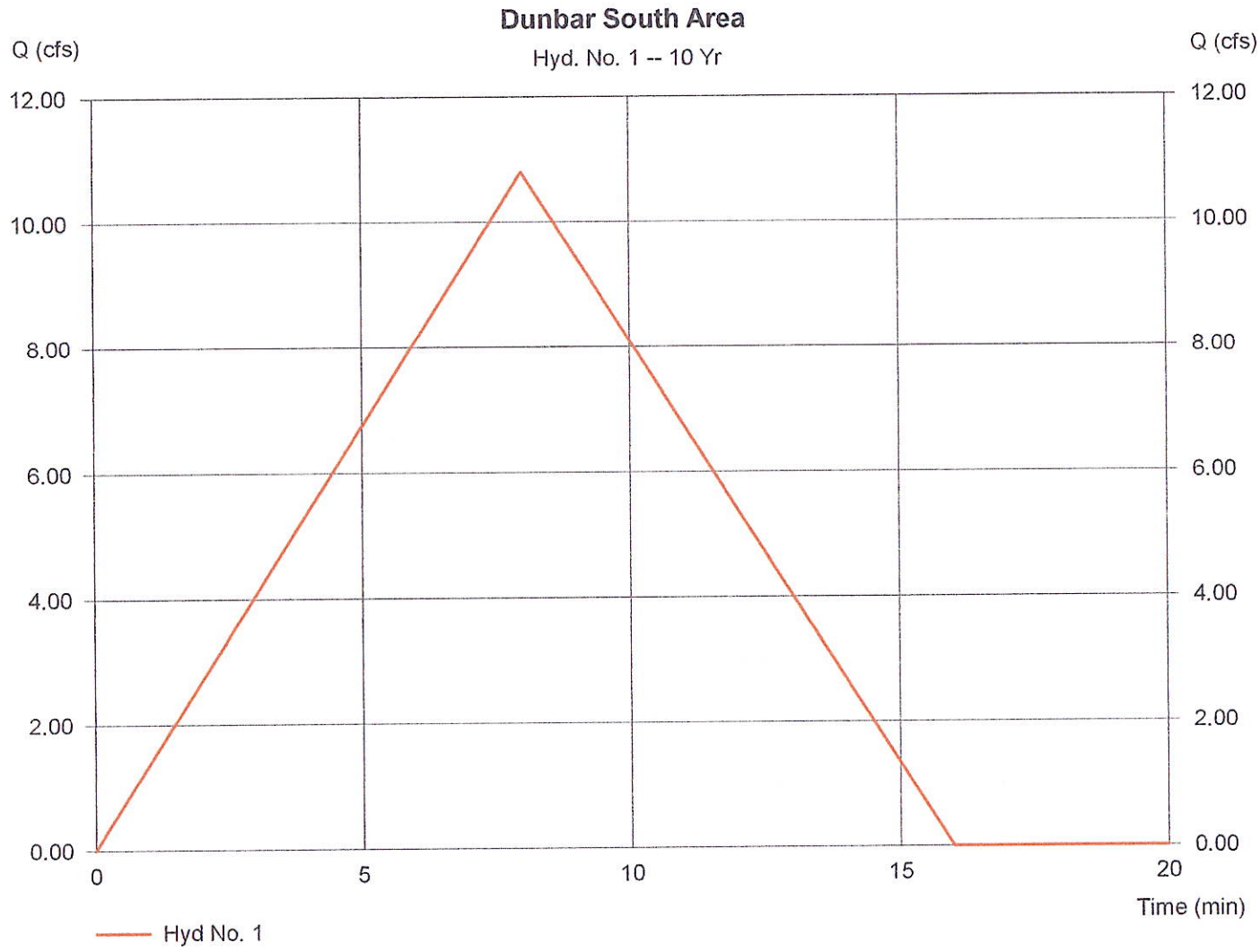
Thursday, Apr 16 2026, 4:10 PM

Hyd. No. 1

Dunbar South Area

Hydrograph type	= Rational	Peak discharge	= 10.79 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 1.530 ac	Runoff coeff.	= 0.72
Intensity	= 9.799 in/hr	Tc by User	= 8.00 min
IDF Curve	= bay st louis.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 5,181 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

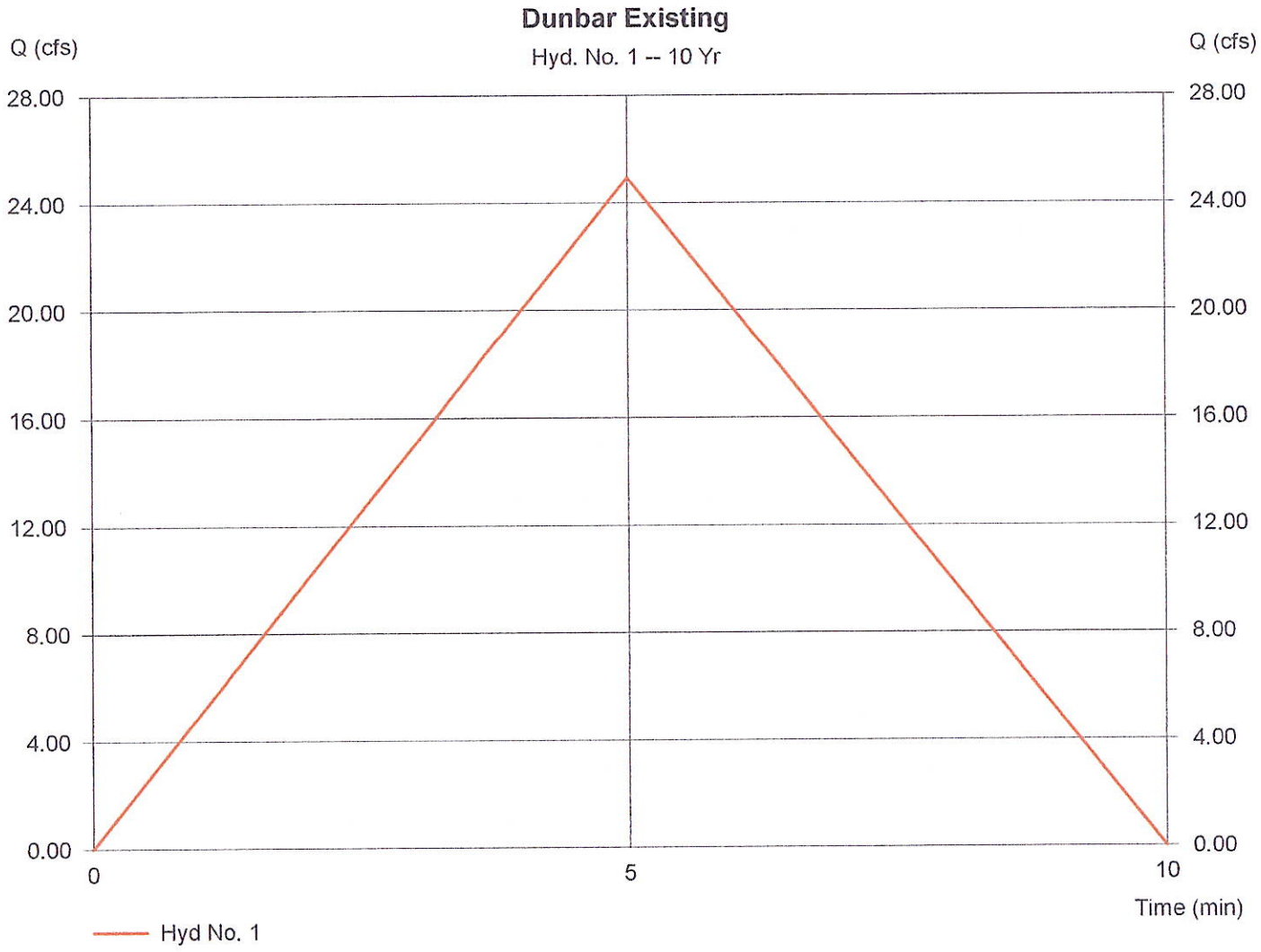
Thursday, Apr 16 2026, 5:0 PM

Hyd. No. 1

Dunbar Existing

Hydrograph type	= Rational	Peak discharge	= 24.96 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 3.260 ac	Runoff coeff.	= 0.65
Intensity	= 11.778 in/hr	Tc by User	= 5.00 min
IDF Curve	= bay st louis.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 7,487 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

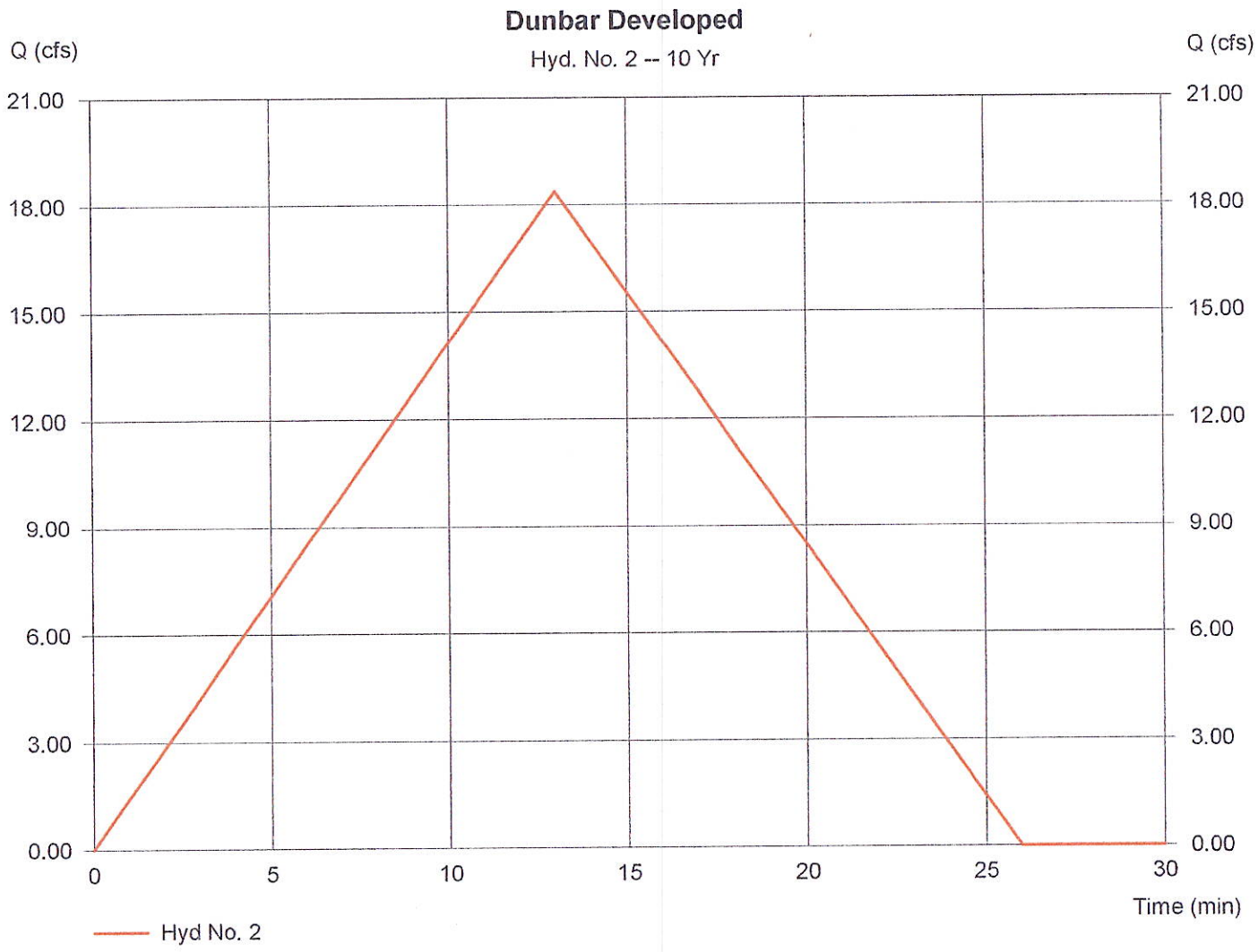
Thursday, Apr 16 2026, 5:1 PM

Hyd. No. 2

Dunbar Developed

Hydrograph type	= Rational	Peak discharge	= 18.38 cfs
Storm frequency	= 10 yrs	Time interval	= 1 min
Drainage area	= 3.260 ac	Runoff coeff.	= 0.72
Intensity	= 7.829 in/hr	Tc by TR55	= 13.00 min
IDF Curve	= bay st louis.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 14,333 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

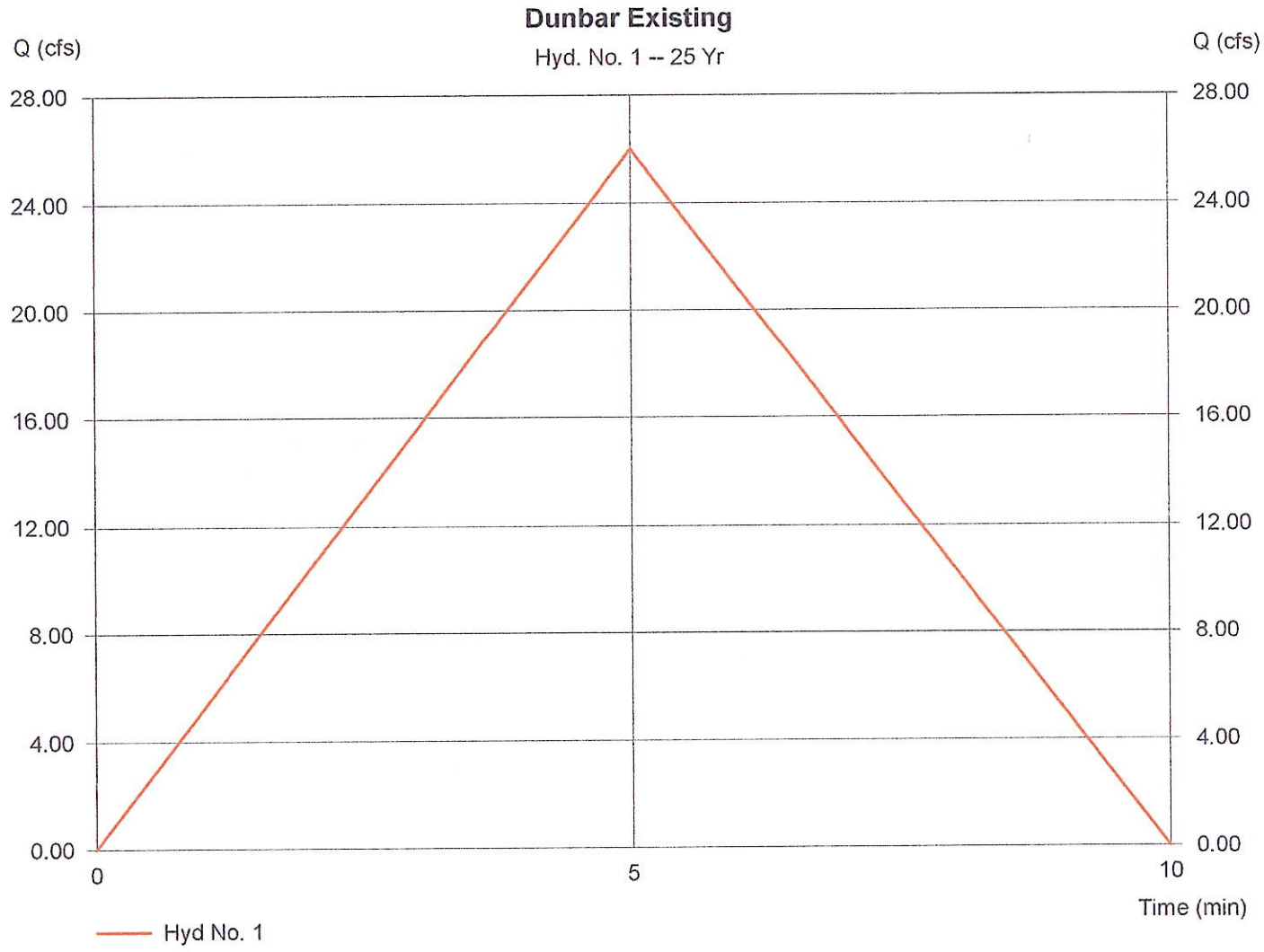
Thursday, Apr 16 2026, 5:2 PM

Hyd. No. 1

Dunbar Existing

Hydrograph type	= Rational	Peak discharge	= 26.00 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 3.260 ac	Runoff coeff.	= 0.65
Intensity	= 12.270 in/hr	Tc by User	= 5.00 min
IDF Curve	= bay st louis.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 7,800 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

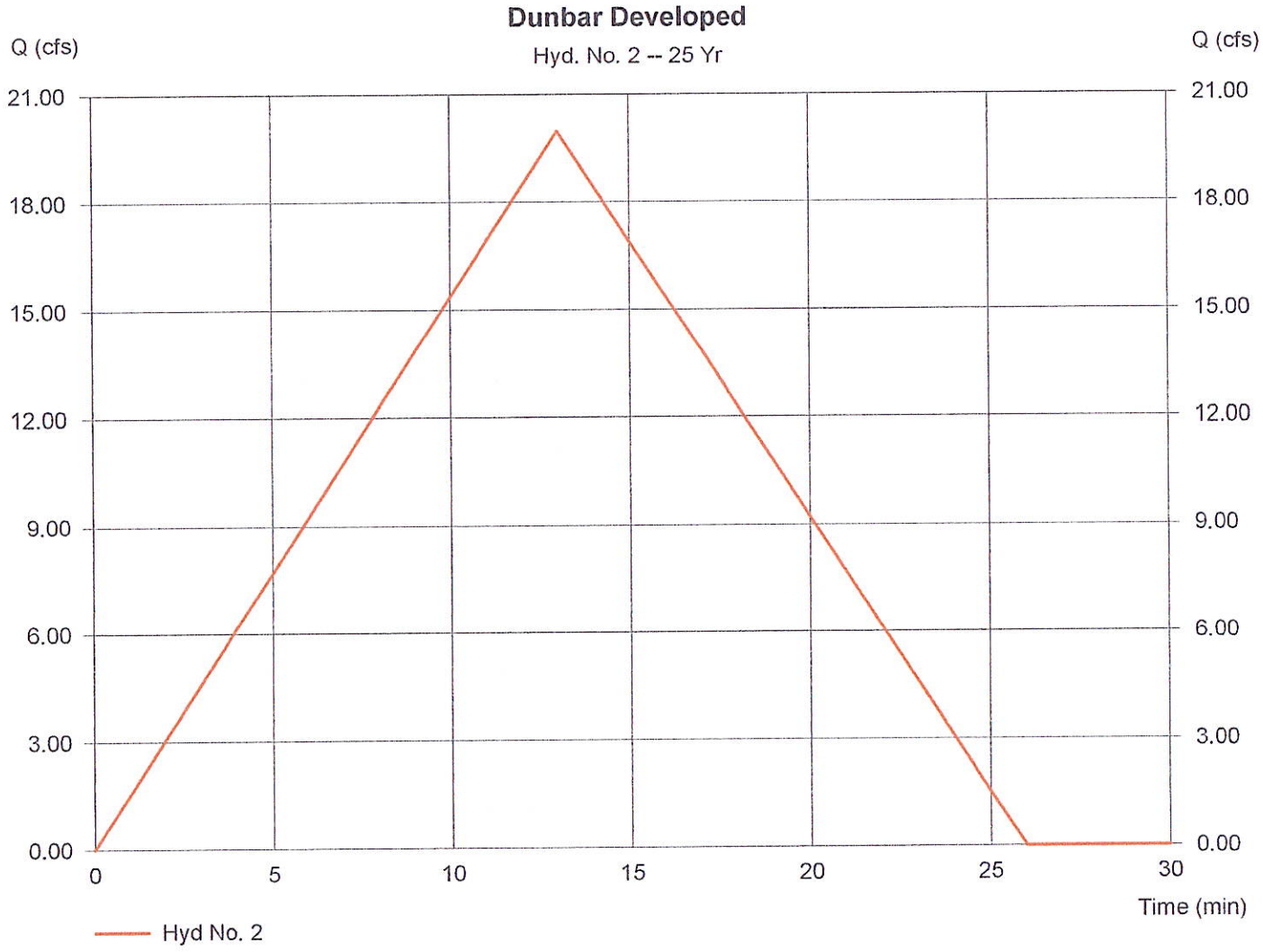
Thursday, Apr 16 2026, 5.3 PM

Hyd. No. 2

Dunbar Developed

Hydrograph type	= Rational	Peak discharge	= 19.97 cfs
Storm frequency	= 25 yrs	Time interval	= 1 min
Drainage area	= 3.260 ac	Runoff coeff.	= 0.72
Intensity	= 8.507 in/hr	Tc by TR55	= 13.00 min
IDF Curve	= bay st louis.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Volume = 15,575 cuft



NOAA Atlas 14, Volume 9, Version 2
Location name: Stennis Space Center, Mississippi, USA*
Latitude: 30.3942°, Longitude: -89.5825°
Elevation: 33 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	6.67 (5.45-8.15)	7.63 (6.22-9.32)	9.20 (7.48-11.3)	10.5 (8.48-12.9)	12.3 (9.65-15.3)	13.6 (10.5-17.2)	15.0 (11.3-19.2)	16.4 (11.9-21.3)	18.2 (12.8-24.0)	19.6 (13.5-26.1)
10-min	4.89 (3.98-5.96)	5.59 (4.55-6.83)	6.74 (5.47-8.24)	7.69 (6.22-9.43)	8.99 (7.06-11.2)	9.99 (7.70-12.6)	11.0 (8.24-14.0)	12.0 (8.70-15.6)	13.3 (9.36-17.6)	14.3 (9.86-19.1)
15-min	3.97 (3.24-4.85)	4.54 (3.70-5.55)	5.48 (4.45-6.70)	6.25 (5.05-7.66)	7.31 (5.74-9.12)	8.12 (6.26-10.2)	8.93 (6.70-11.4)	9.75 (7.07-12.7)	10.8 (7.61-14.3)	11.6 (8.02-15.6)
30-min	3.03 (2.47-3.70)	3.49 (2.84-4.26)	4.23 (3.44-5.18)	4.85 (3.92-5.94)	5.68 (4.46-7.08)	6.32 (4.87-7.94)	6.95 (5.21-8.87)	7.58 (5.50-9.84)	8.42 (5.91-11.1)	9.04 (6.22-12.1)
60-min	2.02 (1.65-2.47)	2.33 (1.90-2.84)	2.84 (2.31-3.47)	3.28 (2.65-4.02)	3.92 (3.10-4.93)	4.43 (3.43-5.61)	4.96 (3.74-6.38)	5.52 (4.02-7.21)	6.29 (4.43-8.35)	6.89 (4.74-9.21)
2-hr	1.27 (1.04-1.53)	1.45 (1.19-1.76)	1.78 (1.46-2.16)	2.07 (1.69-2.52)	2.50 (2.00-3.13)	2.85 (2.23-3.59)	3.23 (2.45-4.13)	3.63 (2.66-4.71)	4.19 (2.97-5.53)	4.63 (3.21-6.15)
3-hr	0.941 (0.777-1.13)	1.08 (0.891-1.30)	1.33 (1.09-1.60)	1.56 (1.28-1.89)	1.91 (1.54-2.39)	2.20 (1.73-2.77)	2.52 (1.93-3.22)	2.86 (2.11-3.72)	3.35 (2.40-4.42)	3.75 (2.61-4.96)
6-hr	0.559 (0.466-0.668)	0.647 (0.538-0.772)	0.807 (0.669-0.965)	0.956 (0.789-1.15)	1.18 (0.964-1.48)	1.38 (1.10-1.73)	1.59 (1.23-2.02)	1.83 (1.36-2.36)	2.16 (1.55-2.83)	2.43 (1.70-3.19)
12-hr	0.326 (0.273-0.385)	0.382 (0.321-0.453)	0.484 (0.404-0.574)	0.576 (0.479-0.685)	0.715 (0.584-0.882)	0.832 (0.664-1.03)	0.957 (0.742-1.20)	1.09 (0.817-1.40)	1.28 (0.929-1.67)	1.44 (1.01-1.88)
24-hr	0.190 (0.161-0.223)	0.226 (0.191-0.265)	0.287 (0.242-0.337)	0.341 (0.286-0.402)	0.422 (0.346-0.514)	0.488 (0.392-0.598)	0.558 (0.435-0.694)	0.632 (0.476-0.801)	0.737 (0.536-0.951)	0.820 (0.582-1.06)
2-day	0.110	0.130	0.164	0.195	0.239	0.276	0.314	0.354	0.411	0.455

	(0.093-0.127)	(0.110-0.151)	(0.140-0.192)	(0.165-0.228)	(0.198-0.289)	(0.223-0.335)	(0.246-0.387)	(0.268-0.445)	(0.300-0.525)	(0.325-0.586)
3-day	**0.078** (0.067-0.091)	**0.093** (0.079-0.107)	**0.118** (0.100-0.136)	**0.139** (0.118-0.162)	**0.171** (0.142-0.205)	**0.197** (0.160-0.237)	**0.223** (0.176-0.274)	**0.252** (0.191-0.315)	**0.291** (0.214-0.371)	**0.322** (0.231-0.413)
4-day	**0.062** (0.053-0.072)	**0.073** (0.063-0.085)	**0.093** (0.079-0.107)	**0.110** (0.094-0.127)	**0.134** (0.112-0.160)	**0.154** (0.126-0.186)	**0.175** (0.138-0.214)	**0.197** (0.150-0.246)	**0.228** (0.168-0.289)	**0.252** (0.181-0.322)
7-day	**0.041** (0.036-0.047)	**0.048** (0.041-0.055)	**0.059** (0.051-0.068)	**0.069** (0.059-0.080)	**0.084** (0.070-0.100)	**0.096** (0.079-0.115)	**0.109** (0.087-0.132)	**0.122** (0.094-0.152)	**0.141** (0.105-0.179)	**0.156** (0.113-0.199)
10-day	**0.033** (0.028-0.037)	**0.037** (0.032-0.043)	**0.046** (0.039-0.052)	**0.053** (0.045-0.060)	**0.063** (0.053-0.075)	**0.072** (0.059-0.086)	**0.081** (0.065-0.099)	**0.091** (0.070-0.113)	**0.105** (0.078-0.132)	**0.116** (0.084-0.147)
20-day	**0.022** (0.019-0.025)	**0.025** (0.022-0.028)	**0.029** (0.026-0.033)	**0.034** (0.029-0.038)	**0.039** (0.033-0.046)	**0.044** (0.036-0.052)	**0.049** (0.039-0.058)	**0.054** (0.041-0.066)	**0.060** (0.045-0.076)	**0.066** (0.048-0.083)
30-day	**0.018** (0.016-0.020)	**0.020** (0.017-0.022)	**0.024** (0.021-0.026)	**0.027** (0.023-0.030)	**0.031** (0.026-0.035)	**0.034** (0.028-0.040)	**0.037** (0.030-0.044)	**0.041** (0.031-0.049)	**0.045** (0.034-0.056)	**0.048** (0.035-0.061)
45-day	**0.014** (0.013-0.016)	**0.016** (0.014-0.018)	**0.019** (0.017-0.021)	**0.021** (0.019-0.024)	**0.024** (0.021-0.028)	**0.027** (0.022-0.031)	**0.029** (0.023-0.034)	**0.031** (0.024-0.038)	**0.034** (0.026-0.042)	**0.036** (0.027-0.045)
60-day	**0.012** (0.011-0.014)	**0.014** (0.012-0.015)	**0.016** (0.014-0.018)	**0.018** (0.016-0.020)	**0.021** (0.018-0.024)	**0.023** (0.019-0.026)	**0.024** (0.020-0.029)	**0.026** (0.020-0.032)	**0.028** (0.021-0.035)	**0.030** (0.022-0.037)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical