FLAP GATE SPECIFICATION

Manufactured by: **Agri Drain CORPORATION**

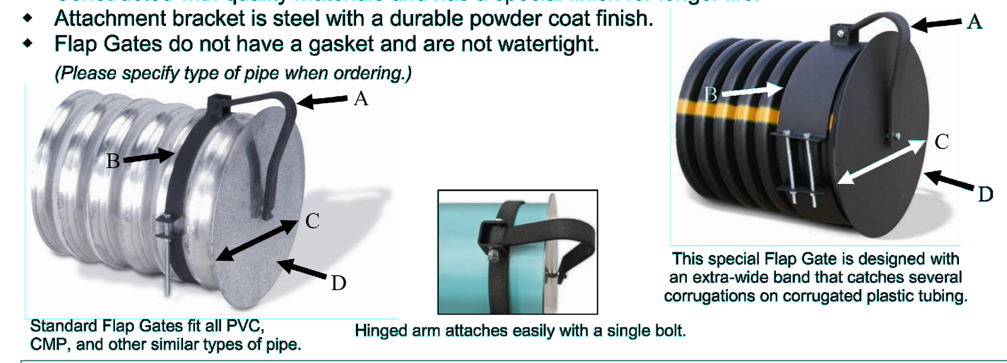
PO Box 458 · 1462 340th Street · Adair, Iowa 50002
Phone: 1-800-232-4742 · Fax: 1-800-282-3353
www.agridrain.com · email: info@agridrain.com

Standard Flap Gates

Keep damaging water out of drainage systems.

- Constructed with quality materials and has a special finish for longer life.
- Attachment bracket is steel with a durable powder coat finish.
- Flap Gates do not have a gasket and are not watertight.

(Please specify type of pipe when ordering.)



Standard Flap Gates fit all PVC, CMP, and other similar types of pipe.

Hinged arm attaches easily with a single bolt.

This special Flap Gate is designed with an extra-wide band that catches several corrugations on corrugated plastic tubing.

Standard Flap Gates for PVC, CMP, and Similar Types of Pipe

Size	Flap Gate Dimensions A	B	C	Flap Description (D)	Range of Measurements for OD of PVC, CMP, Etc., Pipe
4"*	1/4" x 1"	1/8" x 1"	6 3/8"	Galvanized, 12 Ga. Mild Steel	3.85" to 5.1"
6"*	1/4" x 1"	1/8" x 1"	8 3/8"	Galvanized, 12 Ga. Mild Steel	5.75" to 7"
8"	1/4" x 1"	1/8" x 1"	10 3/8"	Galvanized, 12 Ga. Mild Steel	7.75" to 9"
10"	1/4" x 1"	1/8" x 1"	12 3/8"	Galvanized, 12 Ga. Mild Steel	9.75" to 11"
12"	3/8" x 1"	1/8" x 1 1/4"	14 3/8"	Galvanized, 12 Ga. Mild Steel	12" to 14"
15"	3/8" x 1"	1/8" x 1 1/4"	17 3/8"	Galvanized, 12 Ga. Mild Steel	15" to 17"
18"	1/2" x 2"	3/16" x 2"	21"	Powder Coated 3/16" Mild Steel	18" to 20"
21"	1/2" x 2"	3/16" x 2"	24"	Powder Coated 3/16" Mild Steel	21" to 23"
24"	1/2" x 2"	3/16" x 2"	28 1/2"	Powder Coated 3/16" Mild Steel	24" to 26"
30"	1/2" x 2"	3/16" x 2"	35"	Powder Coated 3/16" Mild Steel	30" to 32"
36"	1/2" x 2"	1/4" x 2"	42"	Powder Coated 1/4" Mild Steel	36" to 38"

Standard Flap Gates for Corrugated Plastic Tubing

Size	Flap Gate Dimensions A	B	C	Flap Description (D)	Range of Measurements for OD of Corr. Plastic Tubing
4"*	1/4" x 1"	1/8" x 1"	6 3/8"	Galvanized, 12 Ga. Mild Steel	3.85" to 5.1"
6"*	1/4" x 1"	1/8" x 1"	8 3/8"	Galvanized, 12 Ga. Mild Steel	5.75" to 7"
8"	1/4" x 1"	1/8" x 6"	12 3/8"	Galvanized, 12 Ga. Mild Steel	8.75" to 10"
10"	3/8" x 1"	1/8" x 6"	14 3/8"	Galvanized, 12 Ga. Mild Steel	11.25" to 12.5"
12"	3/8" x 1"	1/8" x 6"	17 3/8"	Galvanized, 12 Ga. Mild Steel	13.2" to 14.7"
15"	1/2" x 2"	1/8" x 6"	21"	Powder Coated 3/16" Mild Steel	16.7" to 18.2"
18"	1/2" x 2"	1/8" x 6"	24"	Powder Coated 3/16" Mild Steel	20.5" to 22"
21"	N/A	N/A	N/A	N/A	N/A
24"	1/2" x 2"	1/8" x 6"	30"	Powder Coated 3/16" Mild Steel	27.4" to 28.9"
30"	1/2" x 2"	1/8" x 6"	38"	Powder Coated 3/16" Mild Steel	35" to 36.5"
36"	1/2" x 2"	1/8" x 6"	45"	Powder Coated 1/4" Mild Steel	41" to 42.5"

*4" and 6" not available with a wide band. Item #FG04 and #FG06 can be used for PVC, CMP, and corrugated plastic tubing.

APPROVED: ____________________
Development Coordinator

DATE: ____________________

SWALE "A1" – 100-YR PEAK RUNOFF

C (RUNOFF COEFFICIENT) = 0.35 GRASS
TOTAL DRAINAGE AREA TO SWALE "A" (A) = 0.048 AC.
Q = C x C(f) x I x A
I (100-yr) = 7.51 In/Hr
Q(100-YR) = 0.35 x 1.25 X7.51 x 0.048 = 0.157 < 0.185 CFS ... OK!

Open Channel "A1" Flow Calculation
Manning Formula 9/5/2018

$Q = (1.49 / n) AR_h^{2/3} * S^{1/2}$ and $R = A / P$

Q = Channel Conveyance (cfs); n = Manning's roughness coefficient; A = Cross Sectional Area
V = Channel Velocity (ft/sec); P = Wetted perimeter; S = Slope of Channel; R = Hydraulic Radius (ft)

Width B (ft) Top	Bottom	Length L (ft)	Depth (ft) Initial	End	H	Slope Side (to 1)	Channel	n	A (sf)	P (ft)	R (ft)	Q (cfs)	V (fps)
5.00	-	95.00	-	0.30	0.15	16.67	0.32%	0.030	0.38	5.01	0.07	**0.185**	**0.494**

SWALE "A2" – 100-YR PEAK RUNOFF

C (RUNOFF COEFFICIENT) = 0.35 GRASS
TOTAL DRAINAGE AREA TO SWALE "A" (A) = 0.036 AC.
Q = C X C(F) x I x A
I (100-yr) = 7.55 In/Hr
Q(100-YR) = 0.35 x 1.25 X 7.55 x 0.036 = 0.118 < 0.238 CFS ... OK!

Open Channel "A2" Flow Calculation
Manning Formula 9/5/2018

$Q = (1.49 / n) AR_h^{2/3} * S^{1/2}$ and $R = A / P$

Q = Channel Conveyance (cfs); n = Manning's roughness coefficient; A = Cross Sectional Area
V = Channel Velocity (ft/sec); P = Wetted perimeter; S = Slope of Channel; R = Hydraulic Radius (ft)

Width B (ft) Top	Bottom	Length L (ft)	Depth (ft) Initial	End	H	Slope Side (to 1)	Channel	n	A (sf)	P (ft)	R (ft)	Q (cfs)	V (fps)
5.00	-	100.00	0.10	0.30	0.20	12.50	0.20%	0.030	0.50	5.02	0.10	**0.238**	**0.476**

SWALE "B1" – 100-YR PEAK RUNOFF :

C (RUNOFF COEFFICIENT) = 0.35 GRASS
TOTAL DRAINAGE AREA TO SWALE "A" (A) = 0.051 AC.
Q = C X C(F) x I x A
I (100-yr) = 7.50 In/Hr
Q(100-YR) = 0.35 X 1.25 X 7.50 x 0.051 = 0.167 < 0.185 CFS ... OK!

Open Channel "B1" Flow Calculation
Manning Formula 9/5/2018

$Q = (1.49 / n) AR_h^{2/3} * S^{1/2}$ and $R = A / P$

Q = Channel Conveyance (cfs); n = Manning's roughness coefficient; A = Cross Sectional Area
V = Channel Velocity (ft/sec); P = Wetted perimeter; S = Slope of Channel; R = Hydraulic Radius (ft)

Width B (ft) Top	Bottom	Length L (ft)	Depth (ft) Initial	End	H	Slope Side (to 1)	Channel	n	A (sf)	P (ft)	R (ft)	Q (cfs)	V (fps)
5.00	-	95.00	-	0.30	0.15	16.67	0.32%	0.030	0.38	5.01	0.07	**0.185**	**0.494**

SWALE "B2" – 100-YR PEAK RUNOFF :

C (RUNOFF COEFFICIENT) = 0.35 GRASS
TOTAL DRAINAGE AREA TO SWALE "A" (A) = 0.020 AC.
Q = C X C(F) x I x A
I (100-yr) = 7.62 In/Hr
Q(100-YR) = 0.35 X 1.25 x 7.62 x 0.020 = 0.066 < 3.13 CFS ... OK!

Open Channel "B2" Flow Calculation
Manning Formula 9/5/2018

$Q = (1.49 / n) AR_h^{2/3} * S^{1/2}$ and $R = A / P$

Q = Channel Conveyance (cfs); n = Manning's roughness coefficient; A = Cross Sectional Area
V = Channel Velocity (ft/sec); P = Wetted perimeter; S = Slope of Channel; R = Hydraulic Radius (ft)

Width B (ft) Top	Bottom	Length L (ft)	Depth (ft) Initial	End	H	Slope Side (to 1)	Channel	n	A (sf)	P (ft)	R (ft)	Q (cfs)	V (fps)
5.00	-	60.00	-	1.00	0.50	5.00	1.67%	0.030	1.25	5.10	0.25	**3.131**	**2.505**

SWALE "B3" – 100-YR PEAK RUNOFF :

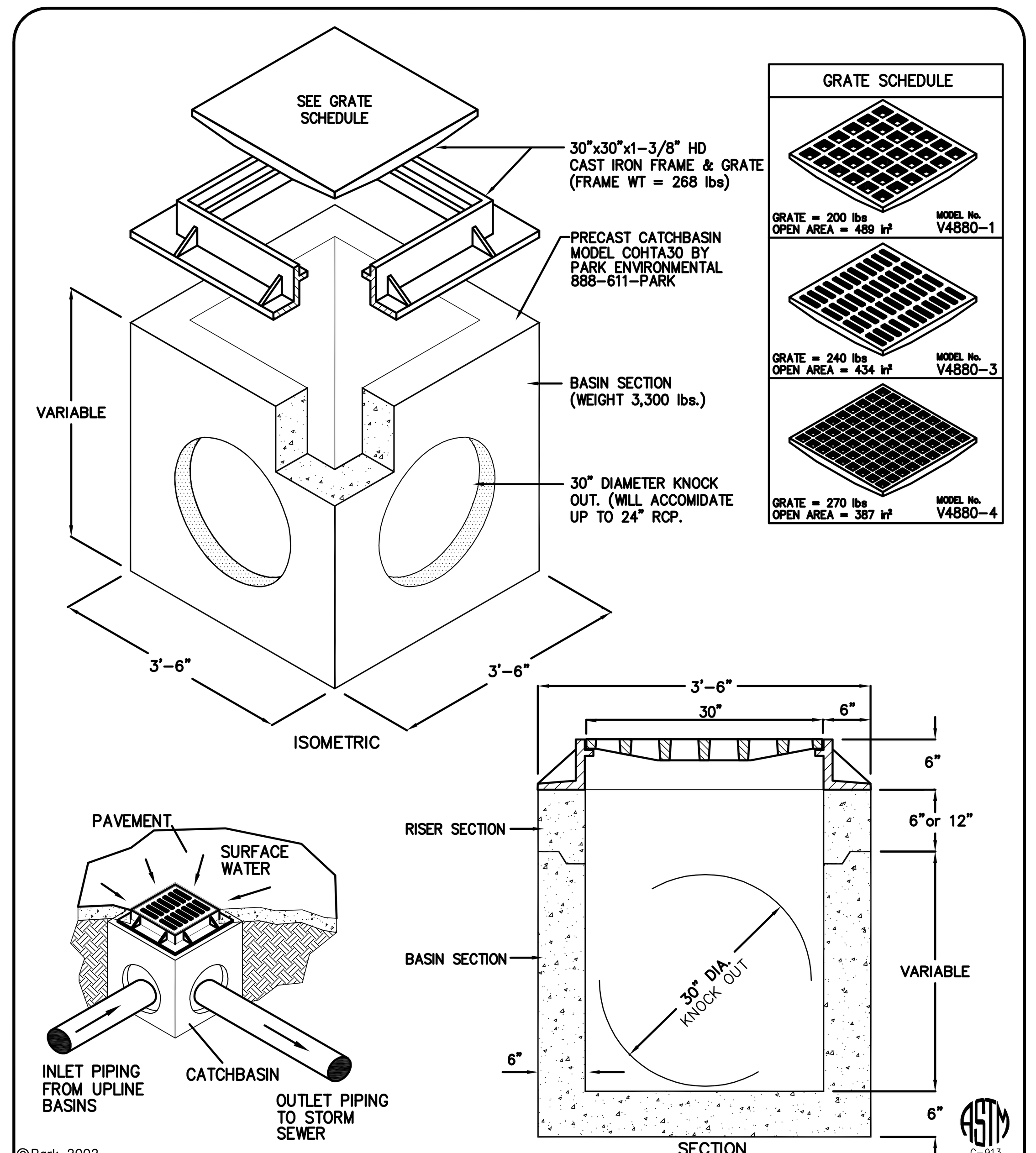
C (RUNOFF COEFFICIENT) = 0.35 GRASS
TOTAL DRAINAGE AREA TO SWALE "A" (A) = 0.012 AC.
Q = C X C(F) x I x A
I (100-yr) = 7.68 In/Hr
Q(100-YR) = 0.35 x 1.25 X 7.68 x 0.012 = 0.040 < 2.65 CFS ... OK!

Open Channel "B3" Flow Calculation
Manning Formula 9/5/2018

$Q = (1.49 / n) AR_h^{2/3} * S^{1/2}$ and $R = A / P$

Q = Channel Conveyance (cfs); n = Manning's roughness coefficient; A = Cross Sectional Area
V = Channel Velocity (ft/sec); P = Wetted perimeter; S = Slope of Channel; R = Hydraulic Radius (ft)

Width B (ft) Top	Bottom	Length L (ft)	Depth (ft) Initial	End	H	Slope Side (to 1)	Channel	n	A (sf)	P (ft)	R (ft)	Q (cfs)	V (fps)
5.00	-	40.00	0.60	0.20	0.40	6.25	2.50%	0.030	1.00	5.06	0.20	**2.656**	**2.656**



SPECIFICATIONS

CONCRETE: Class 1 concrete with of design strength of 4500 PSI at 28 days. Unit is of monolithic construction at floor and first stage of wall with sectional riser to required depth. Rated for H-20 Loading.

REINFORCEMENT: Grade 60 reinforced with steel rebar to conform to ASTM A615 on required centers or equal.

C.I. CASTINGS: Cast iron frames and grates are manufactured of gray cast iron conforming to ASTM A48-76 Class 30.

PARK ENVIRONMENTAL EQUIPMENT 888-611-PARK www.park-USA.com "Expect the Best"

TYPE-A GRATE INLET SIZE 30"

SCALE	DWG. NO.	REV.
NONE	COHTAI-2	A
DATE 01/02		

Grate Inlet Capacity Calculation — INLET # 1
9/5/2018

REQUIRED RUNOFF (Rational Method)

A = Drainage Area **A1** 0.3520 Acres
C = 0.40; C_f = 1.25 (100-yr); C_{used} = 0.50
$i_{100\text{-}yr}$ 11.63 In/Hr
Q_R = 100-year runoff to be captured by the inlet — **Q_R = 2.0469 CFS**

DESIGN INFO

Grate Model: V4880-4
L_1 = Grate Length 2.50 ft or 30 in
L_2 = Grate Width 2.50 ft or 30 in
t = Grate Thickness 0.12 ft or 1.38 in
A = Grate Opening 3.13 sf or 450 in²
TG = Design Top of Grate Elevation 100.30 ft
WSE = Design Water Surface Elevation 99.30 ft
MPE = Design Ponding Elevation 100.60 ft

INLET CAPACITY

- $Q_O = C_d A (2 g h)^{0.5}$ or $Q_W = C_w P h^{1.5}$

C_W = Weir Coefficient (increased by 10%) 3.30
C_d = Discharge Coefficient 0.60
g = Gravitational Factor 32.20
P = Perimeter of grate in feet 10.00 ft
h = Head above grate 0.30 ft
Q_O = **8.2415 CFS**
Q_W = **5.4225 CFS**

Minimum expected flow through a grate: Q_i = 5.4225 CFS

Grate Inlet Capacity Calculation — INLET #2
5/16/2018

REQUIRED RUNOFF (Rational Method)

A = Drainage Area : **A2** 0.1560 Acres
C = 0.85; C_f = 1.25 (100-yr); C_{used} = 1.00
$i_{100\text{-}yr}$ 11.63 In/Hr
Q_R = 100-year runoff to be captured by the inlet — **Q_R = 1.8143 CFS**

DESIGN INFO

Grate Model: V4880-4
L_1 = Grate Length 2.50 ft or 30 in
L_2 = Grate Width 2.50 ft or 30 in
t = Grate Thickness 0.12 ft or 1.38 in
A = Grate Opening 3.13 sf or 450 in²
TG = Design Top of Grate Elevation 101.25 ft
WSE = Design Water Surface Elevation 99.30 ft
MPE = Design Ponding Elevation 101.75 ft

INLET CAPACITY

- $Q_O = C_d A (2 g h)^{0.5}$ or $Q_W = C_w P h^{1.5}$

C_W = Weir Coefficient (increased by 10%) 3.30
C_d = Discharge Coefficient 0.60
g = Gravitational Factor 32.20
P = Perimeter of grate in feet 10.00 ft
h = Head above grate 0.50 ft
Q_O = **10.6397 CFS**
Q_W = **11.6673 CFS**

Minimum expected flow through a grate: Q_i = 10.6397 CFS

Grate Inlet Capacity Calculation — INLET #3
5/16/2018

REQUIRED RUNOFF (Rational Method)

A = Drainage Area : **A4** 0.2290 Acres
C = 0.85; C_f = 1.25 (100-yr); C_{used} = 1.00
$i_{100\text{-}yr}$ for Tc = 10 min 11.63 In/Hr
Q_R = 100-year runoff to be captured by the inlet — **Q_R = 2.6633 CFS**

DESIGN INFO

Grate Model: V4880-4
L_1 = Grate Length 2.50 ft or 30 in
L_2 = Grate Width 2.50 ft or 30 in
t = Grate Thickness 0.12 ft or 1.38 in
A = Grate Opening 3.13 sf or 450 in²
TG = Design Top of Grate Elevation 101.00 ft
WSE = Design Water Surface Elevation 99.30 ft
MPE = Design Ponding Elevation 101.75 ft

INLET CAPACITY

- $Q_O = C_d A (2 g h)^{0.5}$ or $Q_W = C_w P h^{1.5}$

C_W = Weir Coefficient (increased by 10%) 3.30
C_d = Discharge Coefficient 0.60
g = Gravitational Factor 32.20
P = Perimeter of grate in feet 10.00 ft
h = Head above grate 0.75 ft
Q_O = **13.0309 CFS**
Q_W = **21.4341 CFS**

Minimum expected flow through a grate: Q_i = 13.0309 CFS

Grate Inlet Capacity Calculation — INLET #4
9/5/2018

REQUIRED RUNOFF (Rational Method)

A = Drainage Area : **A3** 0.2370 Acres
C = 0.40; C_f = 1.25 (100-yr); C_{used} = 0.50
$i_{100\text{-}yr}$ for Tc = 10 min 11.63 In/Hr
Q_R = 100-year runoff to be captured by the inlet — **Q_R = 1.3782 CFS**

DESIGN INFO

L_1 = Grate Length 2.50 ft or 30 in
L_2 = Grate Width 2.50 ft or 30 in
t = Grate Thickness 0.12 ft or 1.38 in
A = Grate Opening 3.13 sf or 450 in²
TG = Design Top of Grate Elevation 100.30 ft
WSE = Design Water Surface Elevation 99.30 ft
MPE = Design Ponding Elevation 101.00 ft

INLET CAPACITY

- $Q_O = C_d A (2 g h)^{0.5}$ or $Q_W = C_w P h^{1.5}$

C_W = Weir Coefficient (increased by 10%) 3.30
C_d = Discharge Coefficient 0.60
g = Gravitational Factor 32.20
P = Perimeter of grate in feet 10.00 ft
h = Head above grate 0.70 ft
Q_O = **12.5891 CFS**
Q_W = **19.3268 CFS**

Minimum expected flow through a grate: Q_i = 12.5891 CFS

STORM SEWER CALCULATIONS

HouTex Engineering, LLC

Project Title: DOJO LLC
Date Computed: 9/9/2017 by: SLP
Date Revised: 9/5/2018 by:
Storm Rainfall Frequency: 25-YR & 100-YR **Min Tc = 10** min

Rainfall Intensity Parameters for County:
FORTBEND County

	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
e	0.8111	0.8008	0.7893	0.7862	0.7866	0.7851
b (in)	62.62	78.89	89.26	106.05	125.49	146.18
d (min)	10.68	11.09	11.19	12.39	13.83	15.12

TW = 91.10 ft

	Drainage Area Designation	Flow Route Character.	Manhole or Inlet Number from	to	Elevations (ft) u/s	d/s	Hydr. Length (ft)	Grade S (%)	Accumulative Drainage Area (sf)	(ac)	Runoff Coef. C	Σ A x C	Time to Inlet (min)	Flow Time (min)	Comp. T_c (min)	Used T_c (min)	Intensity (In/hr) i 25-YR	100-YR	Frequency factor Cf 25-YR	100-YR	Sum of Flow Q_p (cfs) 25-YR	100-YR	Manning n
	A	B	C	D	E	F	G	H	I	J	K	L	O	P	Q	R	S	T			U	V	W
1	A0	Conduit	ROOF	1	98.70	97.40	140.0	0.93%	6,344.00	0.146	0.85	0.124	-	0.49	0.49	10.00	14.66	17.33	1.10	1.25	1.996	2.682	0.012
	A0+A1	Conduit	1	2	97.40	97.15	83.0	0.30%	15,340.50	0.352	0.85	0.299	-	0.32	0.32	10.00	14.66	17.33	1.10	1.25	4.827	6.485	0.012
2	A1+A2	Conduit	2	3	97.15	96.86	98.0	0.30%	22,114.40	0.508	0.85	0.432	-	0.38	0.88	10.88	14.66	17.33	1.10	1.25	6.959	9.348	0.012
3	A3	Conduit	4	3	97.50	96.69	68.0	1.20%	8,340.60	0.191	0.85	0.163	-	0.16	0.16	10.16	14.66	17.33	1.10	1.25	2.625	3.526	0.012
4	A1+A2+A3+A4	Conduit	3	OUT	94.80	89.10	130.0	4.38%	40,965.40	0.940	0.85	0.799	-	0.26	1.14	11.14	14.66	17.33	1.10	1.25	12.891	17.317	0.024

Drainage Area Designation	Computed Pipe Size D 25-YR ft	in	in	100-YR ft	in	in	Pipe Size Used (in)	Design A (sf)	P (ft)	R (ft)	Capacity Full Q_f (cfs)	25-YR Q (cfs)	100-YR Q (cfs)	Runoff Flow	Velocity Full V_f (fps)	25-YR V (fps)	100-YR V (fps)	Velocity Head $V^2/2g$	Friction Slope (%)	Friction Loss H_f (ft)	Exit Loss Coeff	Struct. Losses (ft)	EGL u/s (ft)	d/s (ft)	HGL u/s (ft)	d/s (ft)	Soffit u/s (ft)	d/s (ft)	Surface u/s (ft)	d/s (ft)
	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ		AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ
A0	0.79	9.50	10.00	0.88	10.62	12.00	**12**	0.79	3.14	0.25	3.694	3.795	4.056	-	4.74	4.83	5.17	0.349	1.154%	1.616	0.200	0.140	101.65	99.89	101.30	99.54	99.70	98.40	100.30	100.30
A0+A1	1.36	16.35	18.00	1.52	18.26	24.00	**24**	3.14	6.28	0.50	13.389	12.393	13.471	-	4.29	3.95	4.29	0.286	0.335%	0.278	0.200	0.114	99.83	99.44	99.54	99.15	99.40	99.15	100.30	101.25
A1+A2	1.57	18.81	24.00	1.75	21.01	24.00	**24**	3.14	6.28	0.50	13.271	13.510	14.447	-	4.26	4.30	4.60	0.282	0.329%	0.323	0.200	0.113	99.43	98.14	99.15	97.86	99.15	98.86	101.25	101.00
A3	0.84	10.04	12.00	0.93	11.21	12.00	**18**	1.77	4.71	0.38	12.390	9.976	10.724	-	7.06	5.65	6.07	0.774	1.396%	0.949	0.200	0.310	99.89	98.63	99.12	97.86	99.00	98.19	101.00	101.00
A1+A2+A3+A4	1.55	18.54	24.00	1.73	20.71	24.00	**24**	3.14	6.28	0.50	25.542	25.717	27.774	-	8.19	8.19	8.85	1.042	4.877%	6.340	0.200	0.417	98.90	92.14	97.86	91.10	96.80	91.10	101.00	93.10

- This spreadsheet has been developed using Fort Bend County Drainage Criteria Manual, Revised 2011.
- The Rational Method has been used to calculate flows; and Manning's Formula for pipes flowing full has been used to calculate velocities. Overland flow time is computed using equation: Tc = D / 60V and Average velocities for estimating travel time for overland flow is calculated from these eqations: V (Unpaved) = 16.1345 (S)^0.5, V (Paved) = 20.3282 (S)^0.5
- Rainfall Intensity-Duration-Frequency coefficients are based on United States Geological Survey (USGS) scientific investigations report 2004-5041 "Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas".

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Civil Engineering and consultant
FIRM NAME: HOUTEX ENGINEERING
FIRM REGISTRATION NUMBER: F-12522

STATE OF TEXAS — ZIAEDDIN MOHAMMADI — 67639 — REGISTERED PROFESSIONAL ENGINEER
9/5/2018

#	DATE	REVISION
1	6/26/2018	Revised for MUD Comments
2	7/05/2018	Revised for LID 12 Comments
3	8/16/2018	Revised for FBC Eng. & Drainage District comments
4	9/5/2018	Revised for Drainage District comments

PROP. OFFICE WAREHOUSE
NORTH PARK WAREHOUSE (PHASE 1)
7123 NORTH PARK DRIVE
HOUSTON, TX 77407

DRAINAGE CALCULATION

SCALE: N.T.S.
CONTROL:
DWG BY: SLP 15-May-18
RVS'D BY: 5-Sep-18
CK'D BY: SLP APRV'D BY: ZM
PROJECT NO. HT1713901

C.003
SHEET 6 OF 9