Sanitary Sewer Design Computations

Project:________________________________

Design By:__________________Date:_________

Manhole #		Flow Determination				Flow Million Gallons Per Day				Pipe Run			Capacity of Pipe (Full)			Proportional			Elevations				
		By Area (Acres)		By Buildings						Mannings "N" Value _______													
From	To	Inc. Area	Flow/Acre	No. of Units	Flow/Unit	Incr.	Total Ave.	Peak Flow Factor	Peak Flow	Length, ft	Dia, in	Slope, %	MGD	CFS	Velocity FPS	Flow	Depth of Flow	Velocity	Upper (Out) Invert	Fall (Pipe run)	Lower (In) Invert	Drop in Structure	Top of Structure

Drawing: SD-1

Note: Multiply CFS by 0.6463139 to Obtain MGD.

ARTICLE 4-130.4A

The average daily demand figures for individual systems within the Town of Leesburg are as follows:

Establishment	Usage
Single-family, duplex	350 gpd/unit
Apartment and townhouse and condominiums	300 gpd/unit
Office/employment	0.1 gpd/gross s.f. or 700 gpd/acre
Shopping center/retail	0.3 gpd/gross s.f.
Hotel	130 gpd/room
Nursing home	200 gpd/bed
Schools without showers and cafeterias	10 gpd/student
School with showers and cafeterias	16 gpd/student
Light/medium industry/warehouse	1000 gpd/acre
Commercial	770 gpd/acre
Park, recreation	500 gpd/acre
Swimming pools	10 gpd/swimmer
Dentist office	60 gpd/operative

NOTES:

A. For uses other than those listed, refer to Commonwealth of Virginia Sewerage and Water Works Regulations.

ARTICLE 4-130.4B

Peaking factors for the sanitary sewer system shall be as follows:

1. **Pipes 8" and smaller: peak factor = 4.0.**
2. **Pipes 10" - 24": peak factor = 3.5.**
3. **Pipes 24" - 36": peak factor = 3.0.**

REVISIONS				PEAK FLOW FACTOR	DRAWING SD-3
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ARTICLE 4-130.6C.(2)

EXAMPLE - GREASE TRAP / INTERCEPTOR SIZING TABLE

Facility	Typical Sizing Requirements
1. Bakeries (no frying) 2. Coffee Shops 3. Deli (without grill)	Grease Trap / Interceptor not required
1. Salad, subs and small grill areas	Under sink grease removal system at wash sink and dishwasher or 500 to 1000 gallons
1. Schools and day cares that serve less than 400 total meals per day 2. Take out grilled foods 3. Grocery story or commissary (butcher/deli departments)	1000 to 1500 gallons
1. Schools and day cares that serve 400 to 600 total meals per day 2. Take out deep fried foods	1000 to 2000 gallons
1. Schools and day cares that serve more than 600 total meals per day 2. Sit down full menu restaurants that have fewer than 100 seats 3. Hospital cafeterias, dining facilities and full menu restaurants that serve less than 900 total meals per day	1500 to 2500 gallons
1. Hospital cafeterias, dining facilities and full menu restaurants that serve 900 to 1200 total meals per day	2500 to 3000 gallons
1. Hospital cafeterias, dining facilities and full menu restaurants that serve more than 1200 total meals per day	3000 to 5000 gallons

NOTE:

A. The grease trap / interceptor sizes are recommended and may be adjusted based on specifics for the proposed use.

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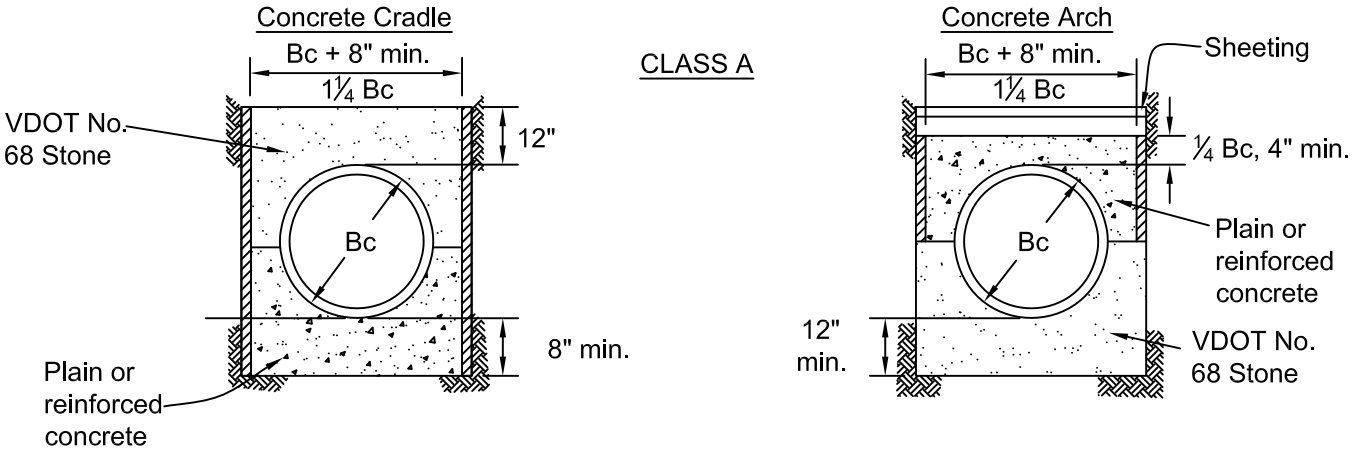
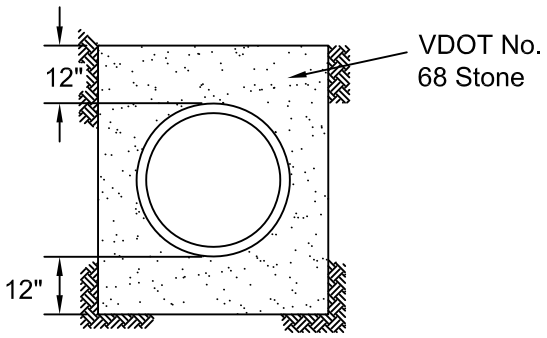
GREASE INTERCEPTOR SIZING TABLE

ARTICLE 4-140.2A

CLASS A



CLASS B



NOTES:

A. In rock trench, excavate at least 12" below the bell of the pipe except where concrete cradle is used.
B. Compacted granular material for PVC pipe is VDOT crushed stone No. 68.

Not To Scale

REVISIONS				**PIPE BEDDING SEWER**	DRAWING SD-5
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ARTICLE 4-130.8J

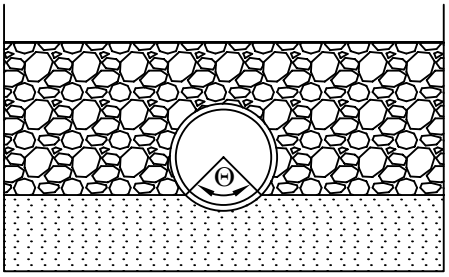
PVC PIPE DEFLECTION CALCULATIONS

Under most soil conditions, flexible PVC tends to deflect into a nearly elliptical shape and the horizontal and vertical deflection may be considered equal for small deflections. The equation for calculating deflection is:

$$\%\frac{\Delta Y}{D} = \frac{D_L K P(100)}{0.149\,\frac{F}{\Delta Y} + 0.061E'}$$

D_L = Deflection lag factor (1.5 or 1.0 when prism load is anticipated)

K = Bedding Constant (Depending on bedding angle).



Bedding Angle Θ	K
0	0.110
30	0.108
45	0.105
60	0.102
90	0.096
120	0.090
180	0.083

$\frac{F}{\Delta Y}$ = Pipe stiffness or outside diameter to thickness ratio (DR). For SDR 35 it equals 46 PSI (E = 400,000 PSI) and 56 PSI (E = 500,000 PSI) where E equals the modulus of elasticity.

E' = Modulus of soil reaction, PSI refer to Standard SD-8 in this Article.

P = Prism load (soil pressure), PSI refer to Standard SD-7 in this Article.

Liveloads = Liveloads have very little effect on pipe performance except at shallow depths.

The liveload on PVC pipe buried 10' or deeper under highway (H20) is negligible where a H20 loading equals a 20 ton truck.

If the sewer is crossing railroad or airport, the liveload shall be accounted for up to depth of 24' and greater.

Maximum Deflection = Recommended a maximum of 5% not to exceed manufacturer's maximum.

Note:

A. Source of computations is "Handbook of PVC Pipe Design and Construction", UNI-Bell PVC Pipe Association.

ARTICLE 4-130.8J

SUPERIMPOSED LOADS ON BURIED PIPE

PRISM LOAD SOIL PRESSURE (psi)
P = WH

Soil Unit Weight (lb/ft^3)

Height Cover (ft)	100	110	120	125	130
2	1.39	1.53	1.67	1.74	1.81
3	2.08	2.29	2.50	2.60	2.71
4	2.78	3.06	3.33	3.47	3.61
5	3.47	3.82	4.17	4.34	4.51
6	4.17	4.58	5.00	5.21	5.42
7	4.86	5.35	5.83	6.08	6.32
8	5.56	6.11	6.67	6.94	7.22
10	6.94	7.64	8.33	8.68	9.03
12	8.33	9.17	10.00	10.42	10.33
14	9.72	10.69	11.67	12.15	12.64
16	11.11	12.22	13.22	13.89	14.44
18	12.50	13.75	15.00	15.63	16.25
20	13.89	15.28	16.67	17.36	18.06
22	15.28	16.81	18.33	19.10	19.86
24	16.67	18.33	20.00	20.83	21.67
26	18.06	19.86	21.67	22.57	23.47
28	19.44	21.39	23.33	24.31	25.28
30	20.83	22.92	25.00	26.04	27.08
35	24.31	26.74	29.17	30.38	31.06
40	27.78	30.56	33.33	34.72	36.11

ARTICLE 4-130.8J

Soil type-pipe bedding material (Unified Classification System[a]) (1)	E' for Degree of Compaction of Bedding in pounds per square inch			
	Dumped (2)	Slight <85% Proctor <40% relative density (3)	Moderate 85%-95% Proctor 40%-70% relative density (4)	High >95% Proctor >70% relative density (5)
Fine-grained Soils (LL>50[b]) Soils with medium to high plasticity CH, MH, CH-MH	No data available, consult a competent soils engineer. See Note Below.			
Fine-grained Soils (LL<50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
Fine-grained Soils (LL<50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles Coarse-grained Soils with Fines GM, GC, SM, SC - contains more than 12% fines	100	400	1,000	2,000
Coarse-grained Soils with little or no fines GW, GP, SW, SP[c] - contains less than 12% fines	200	1,000	2,000	3,000
Crushed Rock	1,000	3,000	3,000	3,000
Accuracy in Terms of Percentage Deflection[d]	±2	±2	±1	±0.5

[a] ASTM Designation D-2487. USBR Designation E-3.

[b] LL = Liquid Limit.

[c] Or any borderline soil beginning with one of these symbols

[d] For = 1% accuracy and predicted deflection of 3% actual deflection would be between 2% and 4%.

NOTES: A. Values applicable only for fills less than 50 ft. (50 m). Table does not include any safety factor. For use in predicting initial deflections only, appropriate Deflection Lag Factor must be applied for long-term deflections. If bedding falls on the borderline between two compaction categories, select lower E value or average the two values. Percentage Proctor based on laboratory maximum dry density from test standards using about 12,500 ft-lb/ft^3 (598.000 l/m) (ASTM D-698, AASHTO T-99. USBR Designation E-11). 1 psi = 6.9 kN/m^2.

B. An accepted conservative design value based on ASCE Manual 37 is 700 psi without additional soils information.

"Soil Reaction for Buried Flexible Pipe" by Amster K. Howard. U.S. Bureau of Reclamation, Denver, Colorado. Reprinted with permission from American Society of Civil Engineers Journal of Geotechnical Engineering Division. January 1977. pp. 33-42.

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MODULUS OF SOIL REACTION "E"

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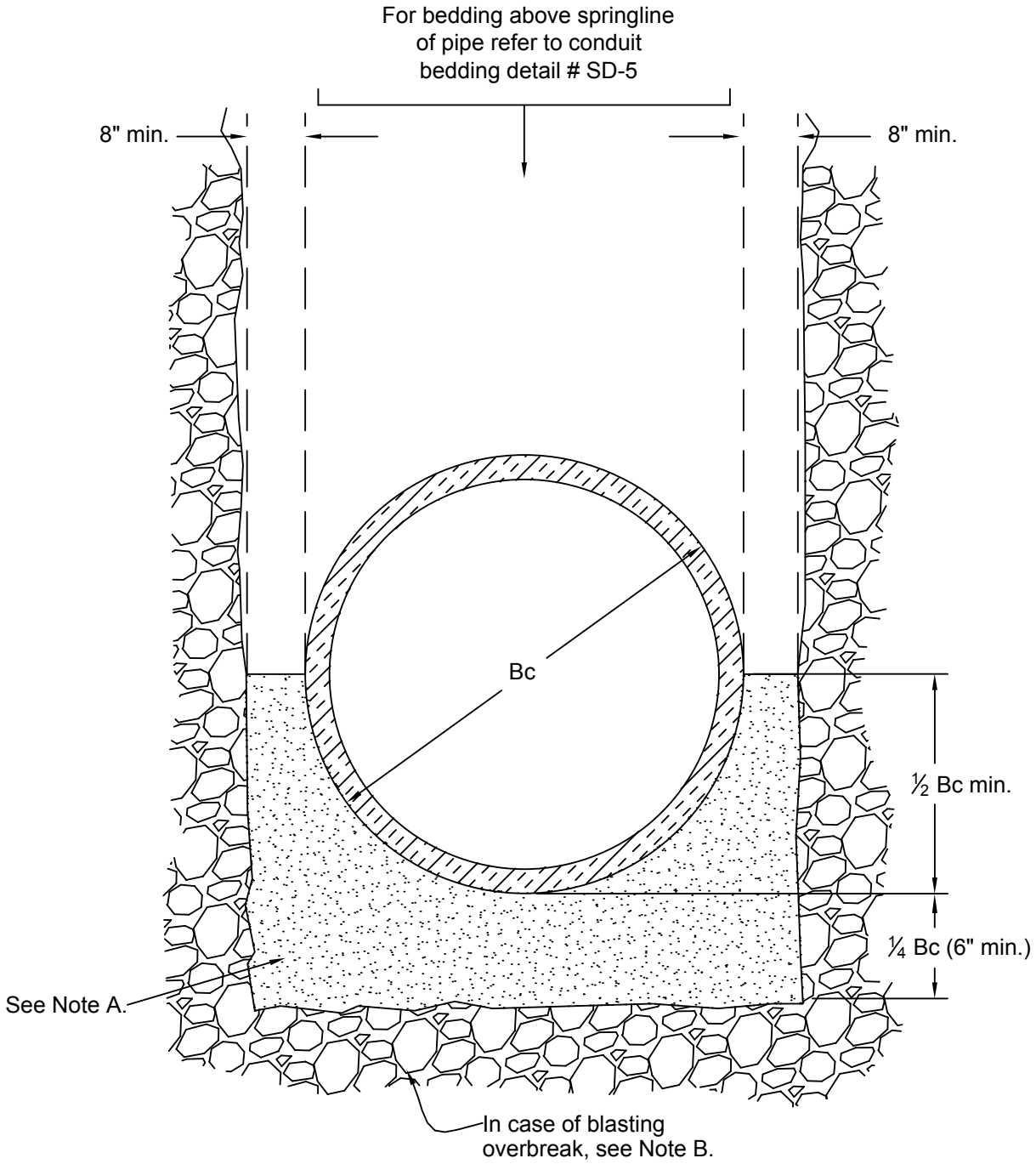
ARTICLE 4-140.2A



NOTES:

A. Crushed stone VDOT size No. 68 or 78 in accordance with VDOT specifications.
B. Blasting overbreak to be removed and replaced with compacted crushed stone.

Not To Scale

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TYPICAL SEWER MAIN TRENCH IN ROCK

DRAWING
SD-9

ARTICLE 4-130.6C.(1).b

RECOMMENDED GREASE TRAP / INTERCEPTOR CLEANING FREQUENCY

Unit	Suggested Inspection Frequency	Suggested Cleaning Frequency
Exterior underground grease interceptors	Visual Inspection: Weekly Kitchen managers or delegates should visually inspect the unit (without opening) at least weekly to ensure that it is not surcharging. Internal Inspection: During each cleaning Cleaning personnel should inspect the interior of grease interceptor to identify any cracks, broken pipes, or other problems.	Monthly to semiannual Grease should not be allowed to accumulate to more than 50% of the grease interceptor's capacity. Cleaning frequency depends on loading.
Interior, under the sink grease traps (larger units that require vacuum truck cleaning)	Visual Inspection: Weekly Kitchen managers or delegates should visually inspect the unit (without opening) at least weekly to ensure that it is not surcharging. Internal Inspection: During each cleaning Cleaning personnel should inspect the interior of each grease trap to identify any cracks, broken pipes, or other problems.	2 weeks to 6 times per year Grease should not be allowed to accumulate to more than 50% of the grease trap's capacity. Capacity varies. Cleaning frequency depends on loading. Given the small capacity of these units, the frequency should not be longer than every 2 months.
Under sink grease trap or automatic grease removal unit	Observe grease and soilds depth: Daily Kitchen staff must inspect units at least daily to ensure proper operation. Internal Inspection: Once per year Plumbing or grease trap cleaning personnel should internally inspect units to identify any problems.	Daily Grease and solids in under sink traps should be removed at least once per day. If grease trap appears to be more than 50% full of grease at the end of the day, it should be cleaned twice per day or replaced by a larger unit. Grease-removal systems will need the grease container emptied once or twice per day.
Solid strainer or interceptor	Observe solids depth: After each meal Kitchen staff should inspect unit to ensure proper operation.	After each meal to daily Solids should be removed and put into the trash can when needed so flow through the strainer is not affected. Remove solids after each meal or once per day.