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3.201 INVESTIGATIONS AND SURVEYS

A. General Information

Sanitary sewers shall be designed for conveyance in a separate gravity system at such depths that all structures within the tributary area may be served at full basement depths so that the estimated ultimate tributary population and area is served. Type II cement must be utilized for the fabrication of concrete sanitary sewer pipe.

B. Information Required

Each project shall be identified by name, municipality within which it is to be constructed, original lot number and tract. A general description of the project shall be provided. The description shall indicate the approximate site size, zoning, probable upstream tributary area of future system expansion and any special factors to be considered in the system design.

C. Investigations

Information on all existing conditions shall be listed. The designer shall list the capacity and capacity available of the receiving sewer and the sewage treatment facility which will ultimately accept the predicted hydraulic load. Consideration shall be given to potential overall development of tributary area, how such future development will affect the design of the project under consideration, and any existing on site facilities that will be eliminated, incorporated within or modified by the proposed project. Special analysis shall be required for known areas with high inflow and infiltration.

D. Special Projects

Variation from a separate gravity sanitary sewerage system or from the normal depth required to serve the entire tributary area shall be considered a special project. Special projects shall require that the approving governmental agency review and approve the variation in concept prior to final design. Variations shall include shallow depth, materials of construction, methods of construction, pressure sewer systems, quantity of sewage generated, alternative collection systems and other variations not included in the Specifications.

E. MANHOLE ACCESS

When designing new sewers, the engineer will insure that access for service vehicles is provided to at least every other manhole along the alignment of the sewer line. If difficulty in insuring access is encountered, the design engineer will bring the potential problem to the attention of the reviewing authority prior to finalizing the design.

If a road is constructed for the access, it shall be a minimum of 15 feet wide with an aggregate rock or cinder base of 8 inches minimum thickness.

3.202 QUANTITY OF SANITARY SEWAGE

A. General Information

Sanitary sewers shall be designed for peak flow plus infiltration allowance basis. See Table 3.2 RATIO OF AVERAGE TO PEAK FLOWS.

B. Design Basis

1. Ultimate Population Density is based on existing zoning.
2. Sewage Flow Guide (OEPA) Table 3.1.
3. For undeveloped commercial property, use fifteen hundred (1,500) gallons per acre per day average daily flow.

SEWAGE FLOW GUIDE

TABLE 3.1

PLACE		ESTIMATED SEWAGE FLOW GALLONS PER DAY	
Apartments and Condominiums		250	one bedroom
		300	two bedroom
		350	three bedroom
Assembly Halls	Note a	2	per seat
Beauty Shop, Styling Salon		200	per basin
Bowling Alleys (no food service)	Note a	75	per lane
Churches (small)	Note a	3-5	per sanctuary seat
Churches (large with kitchen)	Note b	5-7	per sanctuary seat
Country Clubs		50	per member
Dance Halls	Note a	2	per person
Doctors/Dentists		75	per doctor
		20	per employee
		10	per patient
Drive-In Theaters		5	per car space
Factories (no showers)		25	per employee
Factories (with showers)		35	per employee
Food Service Operations			
Ordinary Restaurant (not 24-hour)	Note c	35	per seat at 400 ppm BOD ₅
24-Hour Restaurant	Note c	50	per seat at 400 ppm BOD ₅
Banquet Rooms	Note c	5	per seat at 400 ppm BOD ₅
Restaurant Along Freeway	Note c	100	per seat at 400 ppm BOD ₅
Tavern (very little food service)	Note c	35	per seat at 400 ppm BOD ₅
Curb Service (drive-in)	Note c	50	per car space at 400 ppm BOD ₅
Vending Machine Restaurants	Note c	100	per seat at 200 ppm BOD ₅
Homes in Subdivision		400	per dwelling
Hospitals (no resident personnel)	Note b	300	per bed
Institutions (residents)	Note b	100	per person
Laundries (coin-operated)	Note e	400	per standard size machine
Laundry wastes require special consideration		Consult district office	
Marinas (restrooms and showers only)		15	per boat mooring/slip/dock
Migrant Labor Camps	Note g	50	per person
Mobile Home Parks		300	per mobile home space
Motels		100	per unit

PLACE		ESTIMATED SEWAGE FLOW GALLONS PER DAY
Nursing and Rest Homes	Note b	200 per patient at 300 ppm BOD ₅ 100 per resident employee 50 per non-resident employee
Office Buildings		20 per employee
Recreational Vehicle Dumping Stations		Consult district office
Recreational Vehicle Parks and Camps		See DWPC Policy 2.07
Retail Store		20 per employee
Schools - Elementary - High and Junior High	Note b Note b	15 per pupil 20 per pupil
Service Stations	Note d	1000 first bay or pump island 500 additional bay or pump island
Shopping Centers (No food service or laundries)	Note f	0.2 per sq. ft. of floor space
Swimming Pool (average) With hot water shower		3-5 per swimmer (design load) 5-7 per swimmer (design load)
Vacation Cottages		50 per person
Veterinarians and Animal Hospitals	Note h Note h	10 per run 10 per cage 20 per employee
Youth and Recreation Camps	Note b	50 per person

Note a - Food Service waste not included.

Note b - Food Service waste included but without garbage grinders.

Note c - Aeration tanks for these require 48 hour detention period. Garbage grinders not permitted.

Note d - Truck parking areas will require consideration for treatment of runoff at large truck stops.

Note e - Laundry (coin operated); Temperatures may be critical if not diluted with other sewage. Laundry flow shall not be more than 20 percent of the additional bay or pump island flow of a treatment plant. Commercial laundries will not be permitted for treatment plants designed for less than 30,000 gpd.

Note f- Add laundries or other high flow or high strength uses.

Note g - 20 gpd if vault latrine is used for toilet wastes.

Note h - Assumes manual removal of solids, food, droppings, etc. prior to hosing.

RATIO OF AVERAGE TO PEAK FLOWS

TABLE 3.2

<u>AVER. 24 HOUR FLOW IN M.G.D.</u>	<u>CONVERSION FACTOR</u>	<u>PEAK FLOW IN M.G.D.</u>
0.1	3.70	0.37
0.2	3.66	0.73
0.3	3.63	1.09
0.4	3.59	1.44
0.5	3.55	1.78
0.6	3.52	2.11
0.7	3.48	2.44
0.8	3.45	2.76
0.9	3.42	3.08
1.0	3.38	3.38
1.5	3.23	4.85
2.0	3.09	6.18
2.5	2.97	7.43
3.0	2.86	8.56
3.5	2.76	9.66
4.0	2.66	10.64
4.5	2.58	11.61
5.0	2.51	12.55
5.5	2.44	13.42
6.0	2.38	14.28
6.5	2.32	15.08
7.0	2.27	15.89
7.5	2.23	16.73
8.0	2.19	17.52
8.5	2.15	18.28
9.0	2.11	18.99
9.5	2.08	19.76
10.0	2.06	20.60
11.0	2.00	22.00

For flows in excess of eleven (11) mgd, a conversion factor of 2.00 shall be used.

C. Infiltration

For new systems, allowance shall be 375 gallons per acre day for the upstream tributary acreage.

D. Additional Design Factors

These include additional requirements such as maximum sewage or waste flow from industrial plants, pumping requirements, and other situations that may exist but are not included in these Standards.

3.203 DESIGN CRITERIA FOR SANITARY SEWERS

In general, all sewers shall be designed using the following criteria, with variations from such to create a special project.

A. Energy Concept

The energy concept of hydraulic design shall be used on all projects, with the energy line occurring above the free water surface by an amount equal to the velocity head of $h_f = V^2 / 2g$.

B. Flow Formulas

Mannings Formula $V = \frac{1.486}{\text{hydraulic } n} (R)^{2/3} (S)^{1/2}$ where S is slope in feet per foot; R is radius; and n is roughness coefficient. The roughness coefficient shall be n = 0.015 for sizes up to and including 27 inches; n = 0.013 for sizes including 30 inches through 84 inches and n = 0.011 for 90 inches or larger. Mannings Formula and Tables are provided in Table 3.3. The quantity of flow, $Q = AV$, where A is the cross sectional area of the conduit developed by the nominal conduit diameter is included in the Table. Where other than circular pipe is proposed, the actual cross-sectional area developed may be used. The formula for the Hydraulic Radius is $R = A/p$ where p is the wetted perimeter developed by the nominal pipe diameter and/or the actual wetted perimeter developed may be used.

TABLE 3.3

C. Mannings Formula Flow Tables

$$Q = AV \quad V = \frac{1.486}{n} (R)^{2/3} (S)^{1/2}$$

n=0.015

n=0.013

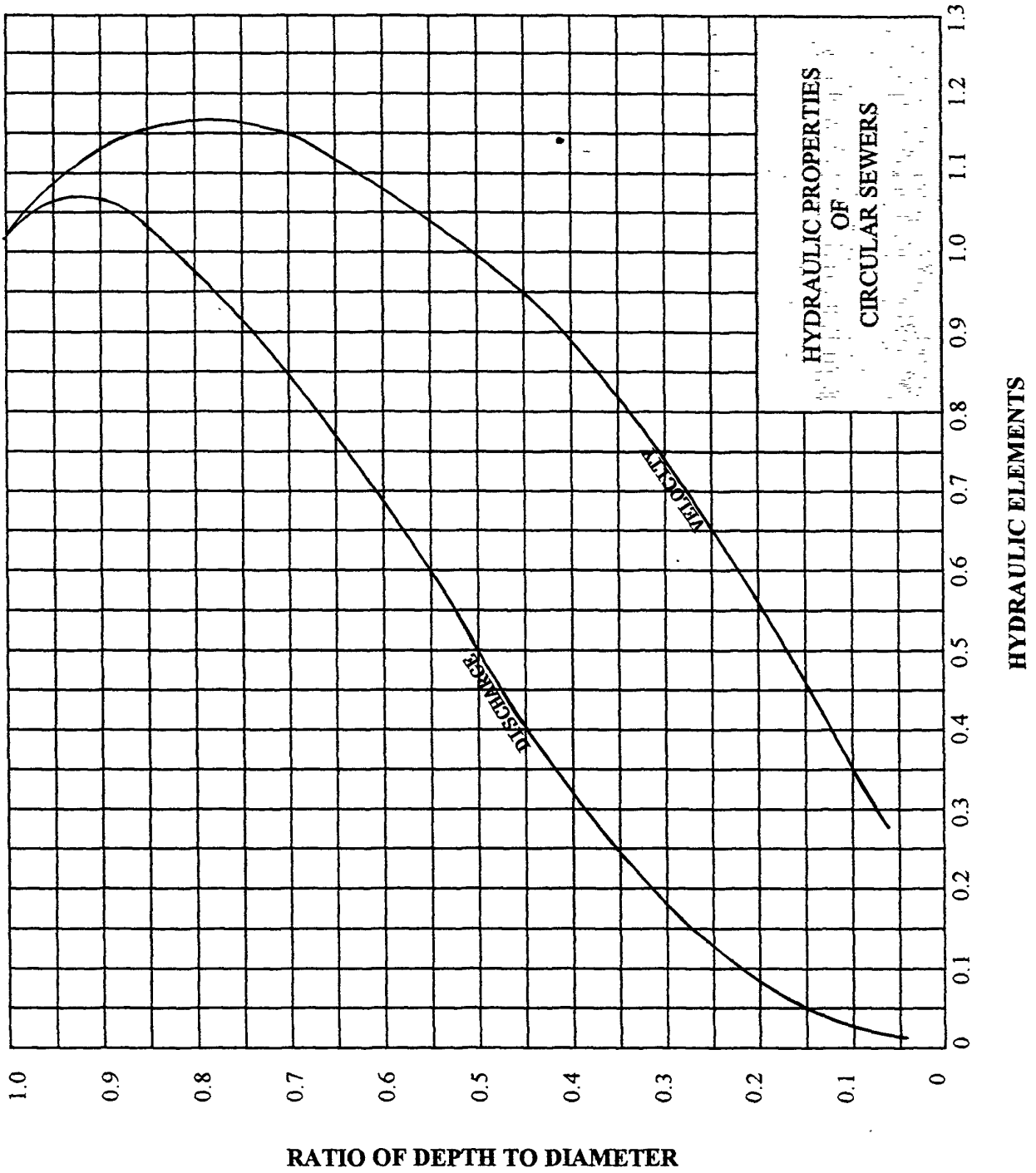
n=0.011

<u>DIAMETER</u>	<u>CAP. @ 1% (cfs)</u>	<u>AREA (ft.²)</u>	<u>CAP. @ 1% (MGD)</u>
<u>(IN)</u>			
5	0.321	0.139	0.207
6	0.485	0.196	0.313
8	1.061	0.349	0.686
10	1.906	0.545	1.232
12	3.087	0.785	1.995
15	5.567	1.227	3.598
16	6.604	1.389	4.266
18	9.105	1.767	5.827
21	13.730	2.405	8.870
24	19.610	3.142	12.670
27	26.750	3.977	17.290
30	40.790	4.909	26.370
33	53.030	5.940	34.280
36	66.670	7.069	43.090
39	82.410	8.296	53.260
42	100.200	9.621	64.760
48	143.600	12.570	92.840
54	196.000	15.900	126.700
60	260.400	19.640	168.300
66	334.800	23.760	216.400
72	423.400	28.270	273.700
78	523.100	33.180	338.100
84	638.800	38.490	412.900
90	906.000	44.180	585.600
96	1077.700	50.270	696.500
102	1264.900	56.750	817.500
108	1475.600	63.620	953.700
120	1954.400	78.540	1263.200
132	2520.200	95.030	1628.800
144	3177.900	113.100	2053.900

**TO FIND CAPACITY AT ANY SLOPE
MULTIPLY; CAPACITY LISTED @ 1% BY (S)^{1/2} in %.**

D. Hydraulic Properties of Circular Sewers

The hydraulic properties for partially full circular sections of pipe may be derived from the following graph:



E. Minimum Size

The minimum nominal size of all sanitary sewers, excluding lateral connections, shall be eight inches (8") in diameter.

3.204 SEWER MATERIALS

A. General Information

All piping materials, manholes, and appurtenances furnished for public sanitary sewers shall comply with the latest applicable national standards, such as the American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), American Water Works Association (AWWA), or other representative standards organizations. Some products are specified with more than one applicable reference standard for such items as testing, installation, or supplementary material specifications.

B. Types of Sewer Pipe

Product description, materials testing, field testing and installation techniques shall be governed by the documents cited below unless otherwise specified.

1. Vitrified Clay Sewer Pipe, ASTM C-700 ES, may be used up to 15 inches in diameter.
2. Acrylonitrile-Butadiene-Styrene (ABS) or Polyvinyl Chloride (PVC) Composite Sewer Pipe ASTM D-2680 may be used up to 15 inches in diameter.
3. Acrylonitrile-Butadiene-Styrene (ABS) Solid Wall Sewer Pipe ASTM D-2751, may be used up to 12 inches in diameter.
4. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings conforming to ASTM D-3034, SDR-35, SDR-23.5, SDR-26, ASTM F-949 up to 36 inches in diameter, ASTM F-794 up to 48 inches in diameter, ASTM F-679 up to 30 inches in diameter, ASTM F-789 up to 18 inches in diameter.
5. Reinforced Concrete Pipe ASTM C-76 or C-507 may be used for 12 inches in diameter or larger.
6. Reinforced plastic mortar sewer pipe ASTM D-3262.
7. Cast Iron Pipe ANSI A-21.6, (AWWA C-106) may be used for special projects approved by the municipal engineer and other appropriate agencies.
8. Ductile Iron Pipe, ANSI A-21.51, Class 52, (AWWA C-151).

For depths greater than 13 feet, when thermoplastic piping or PVC composite sewer pipe is used, it is recommended that minimum pipe stiffness of 115 PSI or SDR-26 be utilized. All plastic pipe for sanitary sewers and fittings shall have a minimum pipe stiffness of 46 PSI. In addition to the above for plastic pipes, the 5 percent diametric, in place deflection limits on the average inside diameter shall be adhered to. All sewer pipe within a manhole to manhole increment shall be one type and class. In the case of lateral connections, proper watertight transition connections of differing materials may be permitted. Lateral connections to building sites shall be a minimum of six (6) inches in diameter. Only wye branch fittings will be accepted for service connections for sewers up to and including 21" diameter. For sewers 24 inches and larger, tee connections are permitted. Deflection test is required on all plastic pipe with a pipe stiffness less than 200 PSI. Air testing required for all sanitary sewers.

C. Sanitary Sewer Joints

All sanitary sewers shall be installed with premium water tight joints of the bell and spigot type to insure maximum durability, flexibility, strength and water-tightness. All sewer materials listed above provide for joint water-tightness tests in their specifications.

All sanitary sewer joints in the public right-of-way shall conform to ASTM C-425 for Clay pipe, ASTM C-361 for concrete pipe, ASTM D-3212 for plastic pipe, AWWA C-111 for Cast iron pipe, AWWA C-111 for Ductile Iron Pipe.

Joints for PVC pipe shall be of shall be elastomeric O-ring. Solvent cement joints for pipes six (6) inches or under is acceptable. All ABS joints shall be of the O-ring or the solvent cement type. If the joint is of the solvent cement type, it shall be installed per ASTM D-2235 and the manufacturer's recommendations. Additionally, all exposed ends of the ABS composite pipe shall be fully sealed with solvent cement. Elastomeric qualities of joint gaskets or O-rings shall meet ASTM F-477. Solvent cement for PVC piping and fittings shall conform to ASTM D-2564. Welded joints shall be air tested 24 hours after installation.

3.205 FORCE MAINS

A. General Information

All materials for the force main shall comply with the latest applicable national organizations standards such as Section 3.204A. Minimum cover of four (4) feet shall be used on force mains. All force mains crossing a stream shall have 6 inches of concrete (3000 PSI) encasement.

B. Material

The force main material shall be polyvinyl chloride (PVC) pipe SDR-26 ASTM D 2241, Push-on-Joints ASTM D-3139; SDR-21 ASTM D-2241, Push-on-Joints ASTM D-3139; AWWA C-900 series; Class 150 meeting requirements of DR-18 with rubber gaskets or O-Rings conforming to the requirements of ASTM D-3139; Push on Joints or Mechanical Joints Ductile Iron Pipe ANSI A21.51 Class 52 (AWWA C-151); Cast Iron Pipe ANSI A 21.6, (AWWA C-106). Other materials which are rated as pressure piping by national standards organizations such as ASTM, AWWA or ANSI are acceptable.

C. Fittings

For force mains 4" or larger, only ductile iron and gray iron (special projects) fittings are allowed. ANSI/AWWA A21.53/C-153 fittings shall be cast from ductile iron grade 70-50-05 or gray iron (special projects) with minimum tensile strength of 25,000 PSI in accordance with ANSI/AWWA A21.10/C-110. Fittings and accessories shall be mechanical joints in accordance with ANSI/AWWA A21.10/C-110 and ANSI/AWWA A21.11/C-111, with the exception of the manufacturer's proprietary design dimensions and weights. The wall thickness of ductile iron fittings shall be the equivalent of ductile iron Class 54. The working pressure rating shall be 350 PSI for ductile iron fittings and 250 PSI for gray iron fittings. Fittings shall have a bituminous outside coating in accordance with ANSI/AWWA A21.10/C-110. Fittings shall be cement lined and seal coated with bituminous material in accordance with ANSI/AWWA A21.4/C-104.

D. Thrust Blocks

All thrust blocks can be either 4,000 PSI concrete or of the pipe restrain type such as the ones manufactured by Uni-flange, such as melalugs, or retaining glands. The concrete

blocking must have its entire face bearing against undisturbed soil. Blocking design shall be based on combined working pressures plus water hammer of 240 PSI minimum and bearing capacity values of 1,000 psf for sand and gravel; 3,000 psf, shale; 5,000 psf, rock. No welding of bends will be permitted on the force main. Pipe bedding and trench details shall conform to the contract drawings.

3.206 LAYOUT OF SEWERS

A. General Information

In general, the layout of the sewerage systems shall be such that the storm and sanitary sewers shall be on opposite sides of the roadways and within the tree lawn areas where practical. Where opposite side construction is not practical, every effort shall be made to separate the storm and sanitary sewers by six (6) feet barrel to barrel. Both the storm and sanitary sewers shall be constructed using a premium jointed conduit throughout.

For sewers size 36 inches in diameter and less, manholes shall be spaced at not over 400 feet. For sewers 42 inches through 60 inches in diameter and larger, manholes shall be spaced at not over 600 feet. In sewer sizes larger than 60 inches in diameter, manhole spacing up to 1,000 feet will be considered. Tunnels shall be considered special projects. Manholes shall be placed at the end of all sewer runs which are 100 feet or more in length, and at any change of line, grade or size of sewer. A full size clean-out may be provided in lieu of a manhole at the end of sewer runs less than 150 feet.

All sewers (storm and sanitary) crossing a creek shall have six (6) inches of concrete (3000 PSI) encasement. All pipes (storm and sanitary) shall be encased in six (6) inches of concrete (3000 PSI) if ground cover is less than three (3) feet. Variations to be approved by appropriate agencies.

B. Curved Sewers

In general, all sanitary sewers shall be constructed to straight lines and grades. Curved sanitary sewers less than 36 inches in diameter shall be considered a special project. Sanitary sewers over 36 inches may be laid in horizontal curves as long as the joint deflection is limited to a

degree within that allowable joint deflection under the specification for the premium type

joint used. Sewers curved vertically or in combination with horizontal curves shall be considered a special project.

C. Lateral Connections

Lateral connections to building sites shall be a minimum of six inches (6") in diameter and constructed of Vitrified Clay ASTM C-700 ES, Cast Iron ANSI A-21.6 (Class 22), Ductile Iron ANSI A-21.51 (Class 52), ABS Solid Wall D-2751 (SDR35), ABS Composite ASTM D-2680, Polyvinyl Chloride (PVC) ASTM F-679, ASTM F-789, ASTM F-794, ASTM F-949, ASTM D-3034 (SDR35) Pipe. For new works, when flexible pipe is utilized, all lateral connections to the main public sanitary sewer (up to, and including 21 inch in size) shall be made through use of manufactured fittings. Neatly cored holes with core bore seals and special fittings as recommended by the Manufacturer Trade Association of the flexible piping material involved is acceptable for repair works, or for sewer larger than 21 inch in size. In no case will the connections for other than six (6) inch lateral connections exceed $\frac{2}{5}$ the diameter of the main sewer. Lateral connections shall be installed utilizing a laser or grade bar devices.

D. Test-Tee

Each lateral connection to building sites shall have a test-tee of full size constructed one foot outside of the right-of-way line or public easement line where such are encountered (Sheet 14/27). Test-tee caps shall be cast or Ductile iron. Plastic caps with metallic element imbedded are acceptable in non-paved areas (Sheet 15/27).

E. Manholes Frames and Castings

Standard manholes frames and castings are as indicated in the General Notes, Sheets 2/27 and 3/27. Manholes in residential and non-residential areas which may be subject to flooding shall have solid lid castings and, where such conditions occur in excess of 1,000 feet of sewer, special non-flooding venting shall be provided.

F. Depth of Sanitary Sewers

In general, the top of the pipe of sanitary sewers shall be at least 10 feet below the average finished grade at the building line in residential districts and 12 feet below the

building line elevation in all other areas. Conduits shallower than this requirement shall be considered a special project.

G. Velocities

All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second. The following are the minimum slopes which should be provided; however, slopes greater than these are desirable, with maximum velocity of 15.0 feet per second. Velocities greater or less shall be considered special projects.

<u>SEWER SIZE (INCH)</u>	<u>MIN. SLOPE IN %</u>
6	1.00
8	0.44
10	0.33
12	0.26
15	0.20
16	0.18
18	0.15
21	0.12
24	0.10
27	0.09
30	0.058
33	0.050
36	0.046

3.207 ORGANIZATION OF COMPUTATIONS

The Standard Computation Sheet, contained in Part 6, shall be filled out for each project and submitted to the approving governmental agency, along with a sewerage design map of such scale as to reasonably relate both on and off site areas incorporated within the design.