UNIFORM RULES,

REGULATIONS AND STANDARDS

FOR THE DESIGN AND CONSTRUCTION OF

SEWERAGE IMPROVEMENTS

MAY 1978

CITY OF CLEVELAND
CLEVELAND REGIONAL SEWER DISTRICT
CUYAHOGA COUNTY SANITARY ENGINEER
CUYAHOGA COUNTY MUNICIPAL ENGINEERS ASSOCIATION

We, the regular members of the Committee on Uniform Standards for Sewerage Improvements have prepared these Standards and recommend their adoption and use by all governmental entities, agencies, and consulting engineers in Cuyahoga County.

Stephen J. Sebesta, Chairman — Cuyahoga County Sanitary Engineering Department

MEMBERS	AGENCY
Stuart Blydenburgh, P.E.	Ohio Environmental Protection Agency - Public Wastewater Branch
John Januska, P.E.	Ohio Environmental Protection Agency - Northeast District Office
Anthony S. Jordan, R.S.	Cleveland Regional Sewer District
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Riley Westmoreland	Cuyahoga County Sanitary Engineering Department
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GENERAL OUTLINE OF THE RULES, REGULATIONS, AND STANDARDS FOR INSTALLATION OF SEWERAGE IMPROVEMENTS

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PURPOSE

These Standards are intended for use as a guide in the design and construction of sewerage facilities. They represent minimum requirements. Adherence to these Standards does not guarantee proper design and/or construction. Design must use engineering judgement in the application of these Standards and are ultimately responsible for a design which will result in satisfactory performance of all structures and systems.

Although every effort was made to prevent conflict with Federal, and State regulations, adherence to these Standards does not necessarily guarantee compliance with such regulations. In cases where these Standards conflict with Federal and/or state standards or regulations, the more restrictive shall apply.

DEFINITIONS

Definition of terms and their use in these Standards are in accordance with GLOSSARY - WATER AND WASTEWATER CONTROL ENGINEERING, published by APHA, ASCE, AWWA and WPCF. The units of expression used are in accordance with those recommended in Manual of Practice Number 6, Units of Expression for Wastewater Treatment, published by the Water Pollution Control Federation.

AUTHORITY

Approvals pursuant to these standards shall be obtained from those agencies exercising jurisdiction or responsibility for any or all of the following functions:

1. Construction, operation and maintenance of the storm or drainage system;
2. Construction, operation and maintenance of the sanitary sewage collection system;
3. Construction, operation and maintenance of storm or wastewater pumping stations;
4. Construction, operation and maintenance of the stormwater or wastewater treatment facilities.

It should be recognized that approvals may be required by more than one local, County, regional and/or special purpose agencies.

Following is a list of responsible agencies with authority in the various municipalities and townships who can be contacted for information or required approvals. This list can be used as a guide in identifying agencies with potential review, approval or permit authority.

Ohio Environmental Protection Agency approval is required on all sanitary sewers, combined sewers, wastewater pumping stations, wastewater treatment plants, and wastewater sludge handling and disposal facilities.

Additional approval requirements will be identified by any responsible agency upon receipt of plans and/or specifications for review.

AGENCIES EXERCISING JURISDICTION OR RESPONSIBILITY

FOR REVIEW AND/OR APPROVAL

Incorporated Municipalities

Cleveland Regional Sewer District
801 Rockwell Avenue
Cleveland, Ohio 44111

Telephone: 781-6000

Cuyahoga County Sanitary Engineer
75 Public Square
Cleveland, Ohio 44113

Telephone: 623-7600

Ohio Environmental Protection Agency
Northeast Ohio District Office
2110 East Aurora Road
Twinsburg, Ohio 44087

Telephone: 425-9171

REVIEW AGENCIES AND PERMIT AUTHORITIES

CITIES

CITIES	PLAN REVIEW AND APPROVAL				ISSUE STM. SWR. PERMIT	ISSUE SAN. SWR. PERMIT
	SAN. SWRS.	STM. SWRS.	W.W.T.P.	PUMP. STA.		
Bay Village						
Beachwood						
Bedford						
Bedford Heights						
Berea						
Brecksville						
Broadview Heights						
Brooklyn						
Brook Park						
Cleveland						
Cleveland Heights						
East Cleveland						
Euclid						
Fairview Park						
Garfield Heights						
Highland Heights						
Independence						
Lakewood						
Lyndhurst						
Maple Heights						
Mayfield Heights						
Middleburg Heights						
North Olmsted						
North Royalton						
Olmsted Falls						
Parma						
Parma Heights						
Pepper Pike						
Richmond Heights						
Rocky River						
Seven Hills						
Shaker Heights						
Solon						
South Euclid						
Strongsville						
University Heights						
Warrensville Hts.						
Westlake						

1. Muncipality
2. Cuyahoga County Sanitary Engineer
3. Cleveland Regional Sewer District
4. Ohio Environmental Protection Agency

REVIEW AGENCIES AND PERMIT AUTHORITIES

VILLAGES

VILLAGES	PLAN REVIEW AND APPROVAL				ISSUE STM. SWR. PERMIT	ISSUE SAN. SWR. PERMIT
	SAN. SWRS.	STM. SWRS.	W.W.T.P.	PUMP. STA.		
Bentleyville						
Bratenahl						
Brooklyn Heights						
Chagrin Falls						
Cuyahoga Heights						
Gates Mills						
Glenwillow						
Hunting Valley						
Linndale						
Mayfield						
Moreland Hills						
Newburgh Heights						
North Randall						
Oakwood						
Orange						
Valley View						
Walton Hills						
Woodmere						

TOWNSHIPS

TOWNSHIPS	PLAN REVIEW AND APPROVAL				ISSUE STM. SWR. PERMIT	ISSUE SAN. SWR. PERMIT
	SAN. SWRS.	STM. SWRS.	W.W.T.P.	PUMP. STA.		
Chagrin Falls						
Olmsted						
Riveredge						
Warrensville						

1. Municipality
2. Cuyahoga County Sanitary Engineer
3. Cleveland Regional Sewer District
4. Ohio Environmental Protection Agency

PART 2 - PERMIT REQUIREMENTS

2.1 PROCEDURE

Approval of plans and specifications for storm and/or sanitary sewers by the responsible agency within the public right-of-way will serve as authority to construct those facilities. Storm and sanitary service connection permits are required for any and all connections to any public sewer and the issuing authorities are listed in Section 1.3 of these Specifications.

In addition to the required plan approvals and service connection permits, Contractors will be responsible for obtaining any required local permits and/or utility company approvals.

2.2 PERMIT APPLICATIONS

Service connection permit forms can be obtained from the issuing municipal authority or the Cuyahoga County Sanitary Engineer. A summary of the issuing authorities are listed in Section 1.3 of these Specifications.

PART 3 - STANDARDS FOR SEWERAGE FACILITIES

3.1 - ENGINEERING

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- B. Designer's Reports

3.102 Plans
- A. General Information
- B. Detail Plans

3.103 Plans of Sewers
- A. General Information
- B. Boring Location Plans
- C. Detailed Plans and Profiles
- D. Special Detail Drawings

3.104 Plans of Sewage Pumping Stations
- A. Location Plan
- B. General Layout

3.105 Plans of Sewage Treatment Plants
- A. Location Plan
- B. General Layout
- C. Detail Plans

3.106 Specifications
- A. General Information
- B. Construction Requirements

3.107 Revisions to Approved Plans

3.108 Operation During Construction

3.101 PREPARATION OF DRAWINGS, SPECIFICATIONS, AND DESIGNER'S REPORTS

A. General Information

All drawings, specifications, and designer's reports submitted for approval shall be prepared by or under the supervision of a Registered Professional Engineer legally qualified to practice in Ohio. The front cover or fly leaf of each set of such drawings, of each copy of the designer's reports and of the specifications submitted shall bear the imprint of the seal of the Registered Engineer by or under whom prepared. In addition, each drawing submitted shall bear an imprint or a legible facsimile of such seal.

B. Designer's Reports

The purpose of the report is to record in form for convenient and permanent reference the controlling assumptions made and factors used in the functional design of the sewerage works as a whole and of each of the component units. Data on structural, mechanical, and electrical designs may be excluded except to the extent that reference to such elements is necessary in checking the functional operation. Six (6) copies of a report consisting of the appropriate required information shall be submitted with each application.

3.102 PLANS

A. General Information

All plans for sewerage facilities shall bear a suitable title showing the name of the municipality, sewer district, or

institution, and show the scale in feet and meters, a graphical scale, original lot number and tract, the north point, date and the name of the engineer and imprint of his registration seal; these plans shall be clear and legible.

They shall be drawn to a scale which will permit all necessary information to be plainly shown. To facilitiate the microfilming of all approved plans by our Department, the maximum plan size shall be no larger than 36 inches by 50 inches. Datum used shall be USGS only.

B. Detail Plans

Detail plans shall consist of plan views, elevations, sections and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the works. Include dimensions and relative elevations of structures, the location and outline of form of equipment, location and size of piping, water levels, ground elevations, and any other pertinent data.

3.103 PLANS OF SEWERS

A. General Information

A comprehensive plan of the existing and/or proposed sewers shall be submitted for projects involving new sewer systems or substantial additions to existing systems. This plan shall show the following:

1. Topography and Elevations

Existing or proposed streets and all streams, water courses, or water surfaces shall be clearly shown.

2. Contour Lines

General contour lines of not more than two (2) feet intervals should be included.

3. Streams

The direction of flow in all streams, and high and low water elevations of all water surfaces at sewer outlets and overflows should be shown.

4. Boundaries

The boundary lines of the municipality or township and the sewer district or area to be sewered shall be shown.

5. Sewers

The plan shall show the location, size, and direction of flow of all existing and proposed sanitary, storm, and combined sewers associated with the proposed project.

B. Boring Location Plans

Boring location plan and cross section (with boring log sheets) shall be supplied for major sewer projects.

C. Detailed Plans and Profiles

Detailed plans and profiles must be submitted for sewer construction projects. Projects should have a horizontal scale of not more than one hundred (100) feet to the inch and an appropriate vertical scale of not more than ten (10) feet to the inch, and plans should be drawn to a corresponding horizontal scale. Such plans and profiles shall show:

1. Location of streets and sewers.

2. Line of ground surface, size, material and type of pipe, length between manholes, invert and surface elevation at each manhole, and grade of sewer between each two adjacent manholes. All manholes shall be numbered on the plan and correspondingly numbered on the profile.

3. Where there is any question of the sewer being sufficiently deep to serve any existing residence, the elevation and location of the basement floor shall be plotted on the profile of the sewer which is to serve the house in question. The engineer shall state that all sewers are sufficiently deep to serve existing adjacent basements and future normal depth basements except where otherwise noted on the plans.

4. Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, etc.

5. All known existing structures both above and below ground which might interfere with the proposed construction, particularly water mains, gas mains, underground utilities, etc.

D. Special Detail Drawings

Special detail drawings, made to a scale to clearly show the nature of the design, shall be furnished to show the following particulars:

1. All stream crossings and sewer outlets, with elevations of the stream bed and extreme high and low water levels.

2. Details of all special sewer joints and cross-sections.

3. Details of all sewer appurtenances such as, but not limited to, manholes, catch basins, inlets, inspection chambers, inverted siphons, regulators, tide gates and elevated sewers.

3.104 PLANS OF SEWAGE PUMPING STATIONS

A. Location Plan

A plan shall be submitted for projects involving construction or revision of pumping stations. This plan shall show the following:

1. The location and extent of the tributary area.

2. Any municipal or township boundaries within the tributary area.

3. The location of the pumping station and force main.

4. The general topography using a minimum contour interval of ten (10) feet and pertinent elevations.

B. Detail Plan

Detail plans shall be submitted showing the following, where applicable:

1. A contour map of the property to be used. Contour intervals shall be not more than two (2) feet.

2. Existing pumping station.

3. Proposed pumping station, including provisions for installation of future pumps or ejectors.

4. Elevation of high water at the site, and maximum elevation of sewage in the collection system upon occasion of power failure.

5. Test borings and ground water elevations.

3.105 PLANS OF SEWAGE TREATMENT PLANTS

A. Location Plan

A plan shall be submitted showing the sewage treatment plant in relation to the remainder of the system. A USGS Topographic Map

(7.5 minute series where available) shall be included to indicate its location with relation to streams and the point of discharge of treated effluent.

B. General Layout

Layouts of the proposed sewage treatment plant shall be submitted showing:

1. Topography of the site.
2. Size and location of plant structures.
3. Schematic flow diagram showing the flow through various plant units.
4. Piping, including any arrangements for bypassing individual units.
5. Materials handled and direction of flow through pipes shall be shown.
6. Hydraulic profiles showing the flow of sewage, supernatant liquor and sludge, including hydraulic and energy gradients.
7. Test borings and ground water elevations.

C. Detail Plans

Detail plans shall show the following:

1. Location, dimensions and elevations of all existing and proposed plant facilities.

2. Elevations of high and low water level of the body of water to which the plant effluent is to be discharged.

3. Type, size, pertinent features, and manufacturer's rated capacity of all pumps, blowers, motors and other mechanical devices.

4. Adequate description of any features not otherwise covered by specifications.

3.106 SPECIFICATIONS

A. General Information

Complete technical specifications for the material and construction of sewers, sewage pumping stations, sewage treatment plants, and all appurtenances, shall accompany the detailed plans.

The specifications shall include, but not be limited to, all construction information not shown on the drawings which is necessary to inform the builder in detail of the construction requirements as follows.

B. Construction Requirements

1. Quality of materials, workmanship, fabrication, and the type, size, strength, operating characteristics, requirements and rating of all mechanical and electrical equipment.

2. Allowable infiltration.

3. Valves, piping and jointing of pipe.

4. Wiring.

5. Meters.

6. Laboratory fixtures and equipment.

7. Operating tools.

8. Construction materials.

9. Special filter materials such as stone, sand, gravel, or slag.

10. Miscellaneous appurtenances.

11. Chemicals when used.

12. Instructions for testing materials and equipment as necessary to meet design standards.

13. Operating tests for the complete works and component units.

3.107 REVISIONS TO APPROVED PLANS

The facilities shall be constructed under supervision of a Professional Engineer in accordance with the approved plans, reports, and specifications. Any deviations from approved plans or specifications affecting capacity, flow or operation of units shall be approved in writing before such changes are made. Plans or specifications so revised should therefore be submitted well in advance of any construction work which will be affected by

such changes to permit sufficient time for review and approval. Structural revisions or other minor changes not affecting capacities, flows, or operation may be permitted during construction without prior written approval; "As built" plans clearly showing such alterations shall be placed on file with the responsible agency at the completion of the work.

3.108 OPERATION DURING CONSTRUCTION

Specifications shall contain a program for keeping existing sewers, pumping stations and/or treatment plants units in operation during construction of the improvements.

PART 3 - STANDARDS FOR SEWERAGE FACILITIES

3.2 - DESIGN OF SANITARY SEWERS

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- B. Information Required
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- D. Special Projects

3.202 Quantity of Sanitary Sewage
- A. General Information
- B. Design Basis
- C. Infiltration
- D. Additional Design Factors

3.203 Design Criteria for Sanitary Sewers
- A. Energy Concept
- B. Flow Formulas
- C. Mannings Formula Flow Tables
- D. Hydraulic Properties of Circular Sewers
- E. Minimum Size

3.204 Sewer Materials
- A. General Information
- B. Types of Sewer Pipe
- C. Sanitary Sewer Joints

3.205 Layout of Sewers
- A. General Information
- B. Curved Sewers
- C. Lateral Connections
- D. Test Tee
- E. Ventilation
- F. Depth of Sanitary Sewers
- G. Velocities

3.206 Organization of Computations

3.201 INVESTIGATIONS AND SURVEYS

A. General Information

In general, 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 and so that the estimated ultimate tributary population and area is served.

B. Information Required

Each project shall be identified by name, municipality within which it is to be constructed, and original lot number and tract. A general description of the project shall be included indicating 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 should list the capacity of the receiving sewer and the sewage treatment facility to accept the predicted hydraulic load. Potential overall development of tributary area and how such future development will affect the design of the project under consideration and any existing on side facilities that will be eliminated, incorporated within or modified by the contemplated project shall be considered. Special analysis will be required for known flooding areas.

D. Special Projects

Variation from a separate gravity sanitary sewerage system of normal depth shall be considered a special project and 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 and other variations not included in these Specifications.

3.202 QUANTITY OF SANITARY SEWAGE

A. General Information

Sanitary sewers shall be designed on a peak flow plus infiltration allowance basis.

B. Design Basis

1. Ultimate Population Density is based on existing zoning.

2. Sewage Flow Guide is based on one hundred (100) gallons per person per day average daily flow.

3. Sewage Flow Guide (OEPA).

Place:	Estimated Sewage Flow, Gal. p/day:
1, 2, and 3 family Apartments	400 per living Unit
	250 one bedroom
	300 two bedroom
	350 three bedroom
Assembly Halls	2 per seat
Bowling Alleys (no food service)	75 per lane
Churches (small)	3-5 per sanctuary seat
Churches (large, with kitchen) Note(a)	5-7 per sanctuary seat
Country Clubs	50 per member
Dance Halls	2 per person
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 hr.) Note (b)	35 per seat
24-hour Restaurant Note (b)	50 per seat
Banquet Rooms Note (c)	5 per seat
Restaurant along Freeway Note (b)	100 per seat
Tavern (very little food service.) Note (b)	35 per seat
Curb Service (drive-in) Note (b)	50 per car
Vending Machine Restaurants	100 per seat
Hospitals (No Resident Personnel) Note (a)	300 per bed
Institutions (Residents) Note (a)	100 per person
Laundries (Coin-operated)	400 per machine (stand. sz. mach.)
Laundry wastes require special consideration	Consult approving authority
Motels	100 per unit
Nursing and Rest Homes Note (a)	150 per patient
	100 per resident employee
	50 per non-resident emp.
Office Buildings	20 per employee
Schools - Elementary Note (a)	15 per pupil
High & Junior High Note (a)	20 per pupil
Service Stations Note (c)	1000 first bay
	500 each add. bay
Shopping Centers (without food service or laundries)	0.2 per square foot of floor space
Swimming Pool (average)	3-5 per swimmer (design load)
With hot water shower	5-7 per swimmer (design load)
Trailer Parks	200 per trailer space
Travel Trailer Dumping Stations at Service Stations	Consult approving authority
Travel Trailer Parks and Camps	125 per trailer or tent space
Vacation Cottages	50 per person
Youth and Recreation Camps Note (a)	50 per person

Note (a) Food service waste included but without garbage grinders.
Note (b) Garbage grinders not permitted.
Note (c) Truck parking areas will require consideration for treatment of runoff at large truck stops.

Ratio of Average to Peak Flows

Aver. 24 hour Flow in M. G. D.	Conversion Factor	Peak Flow in M. G. D.
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

Allowance shall be 375 gallons per acre day over the tributary upstream acreage.

D. Additional Design Factors

These include additional maximum sewage or waste flow from industrial plants, pumping requirements, others.

3.203 DESIGN CRITERIA FOR SANITARY SEWERS

In general, all sewers shall be designed using the following criteria, with variation 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 $h_f = V^2/ 2 g$.

B. Flow Formulas

Mannings Formula $V = \frac{1.486}{n} (r)^{2/3}(s)^{1/2}$ where s is slope in feet per foot; r is hydraulic 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. Charts included. Quantity of flow Q = Av where A is the cross sectional area of the conduit developed by the nominal conduit diameter. Where other than circular pipe is proposed, the actual cross-sectional area developed may be used. Hydraulic Radius r = A/p where p is the wetted perimeter developed by the nominal pipe diameter. Where other than circular pipe is proposed the actual wetted perimeter developed may be used.

C. Mannings Formula Flow Tables

$Q = Av$ $\qquad V = \frac{1.486}{n}(r)^{2/3}(s)^{1/2}$

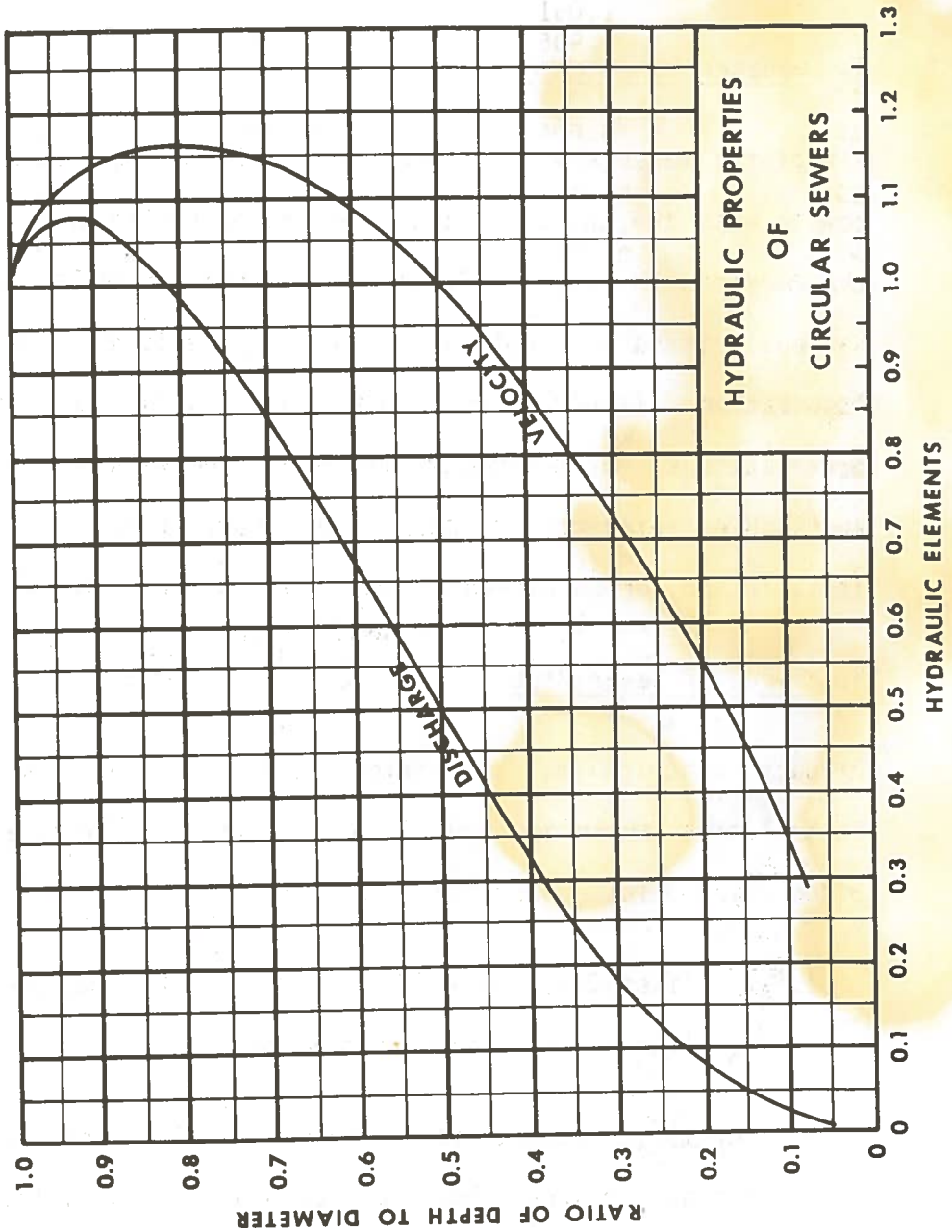
	SIZE	CAP. @ 1% (cfs)	AREA	CAP. @ 1% (MGD)
n = 0.015	5	0.321	0.139	0.207
	6	0.485	0.196	0.313
	8	1.061	0.349	0.686
	10	1.906	0.545	1.232
	12	3.087	0.785	1.995
	15	5.567	1.227	3.598
	16	6.604	1.389	4.266
	18	9.105	1.767	5.827
	21	14.20	2.405	9.179
	24	19.61	3.142	12.67
	27	26.75	3.977	17.29
n = 0.013	30	40.79	4.909	26.37
	33	53.03	5.940	34.28
	36	66.67	7.069	43.09
	39	82.41	8.296	53.26
	42	100.2	9.621	64.76
	48	143.6	12.57	92.84
	54	196.0	15.90	126.7
	60	260.4	19.64	168.3
	66	334.8	23.76	216.4
	72	423.4	28.27	273.7
	78	523.1	33.18	338.1
	84	638.8	38.49	412.9
n = 0.011	90	906.0	44.18	585.6
	96	1077.7	50.27	696.5
	102	1264.9	56.75	817.5
	108	1475.6	63.62	953.7
	120	1954.4	78.54	1263.2
	132	2520.2	95.03	1628.8
	144	3177.9	113.10	2053.9

TO FIND CAPACITY AT ANY SLOPE

MULTIPLY; CAPACITY LISTED @ 1% BY $(s)^{1/2}$ IN %.

D. Hydraulic Properties of Circular Sewers

The hydraulic properties of partically full circular sections may be derived from the following chart.



E. Minimum Size

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

3.204 SEWER MATERIALS

A. General Information

All piping materials furnished for public sanitary sewers shall comply with the current applicable national standards, such as the American Society for Testing and Materials (ASTM), American National Standard 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 C700 ES, may be used up to fifteen (15) inches in diameter.

2. Acrylonitrile-Butadiene-Styrene (ABS) Composite Sewer Piping, ASTM D 2680, may be used up to fifteen (15) inches in diameter.

3. Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings, ASTM D 2751, may be used up to six (6) inches in diameter.

4. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, ASTM D 3034, may be used up to six (6) inches in diameter.

5. Reinforced Concrete Pipe, ASTM C-76 or C-597, may be used for fifteen (15) inch diameter or larger.

6. Cast Iron Pipe, ANSI A-21.6.

7. Ductile Iron Pipe, ANSI A-21.51.

03-12-80 Added

8. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, ASTM-D3034 SDR 35 may be used up to fifteen (15) inches diameter

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.

C. Sanitary Sewer Joints

All sanitary sewers shall be installed with premium joints to insure maximum durability, flexibility, strength and watertightness. All sewer materials listed above provide for joint watertightness tests in their specifications. All sanitary sewer joints in the public right of way shall conform to ASTM C-425, C-443 or other premium type joint compatible with pipe materials other than vitrified clay and reinforced concrete pipe. Joints for PVC pipe shall be of O-Ring. 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.

3.205 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. Where this condition cannot be met, all portions of both the storm and sanitary sewers shall be constructed using a premium jointed conduit throughout such full manhole to manhole increments. Necessary minor crossings of such sewers will not require premium joint construction in the storm sewer. In sewer sizes 36 inches in diameter and less, manholes shall be spaced at not over 400 feet. In sewer sizes 42 inches through 60 inches in diameter, manholes shall be spaced at not over 600 feet. In sewer sizes larger than 60 inches diameter, manhole spacing up to 1000 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.

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 so long as the joint deflection is limited to a degree as to stay within that allowable 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 the building sites shall be a minimum of five (5) inches in diameter and of Virtrified Clay ASTM C-700 ES, Cast Iron ANSI A-21.6 (Class 22), Ductile Iron ANSI A-21.51 (Class 2), ABS Solid Wall D-2751 (SDR35), ABS Composite ASTM D2680, or Polyvinyl Chloride ASTM D 3034 (SDR 35) Pipe. (All lateral connections to the main public sewer shall be made through use of manufactured fittings or neatly cored holes fitted with specials as recommended by the Manufacturers Trade Association of the piping material involved. In no case will the connections for other than five (5) or six (6) inch lateral connections exceed 2/5 the diameter of the main sewer.)

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. The tee fitting at the bottom of the risers shall be encased in concrete.

E. Ventilation

Manholes which may be subject to flooding shall have solid lid castings and, where such conditions occur in excess of 1000 feet of sewer, special non-flooding venting shall be provided.

F. Depth of Sanitary Sewers

In general, the top of pipe of sanitary sewers shall be at least ten (10) feet below the average finished grade at the building line in residential districts and twelve (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 so 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.

Sewer Size (inch)	Min. Slope in %
5	1.00
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

3.205 ORGANIZATION OF COMPUTATIONS

The Standard Computation Sheet, contained in the Appendix, 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.

3.3 - DESIGN OF STORM SEWERS

3.301 Design of Storm Sewers
- A. General Information
- B. Investigations and Surveys
- C. Special Projects

3.302 Design Criteria for Storm Sewers
- A. Design Storm Frequency
- B. Rainfall Intensity-Duration
- C. Runoff Coefficient
- D. Concentration Times
- E. Standard Rainfall Intensity-Duration Tables

3.303 Design of Storm Sewers
- A. General Information
- B. Flow Formulas

3.304 Layout of Sewers
- A. General Information
- B. Minimum Size
- C. Types of Conduits
- D. Lateral Connections
- E. Storm Sewer Joints
- F. Depths of Sewers
- G. Velocity
- H. Open Channel and Culvert Design

3.305 Storage Basins

3.306 Organization of Computations

3.301 DESIGN OF STORM SEWERS

A. General Information

In general, storm drainage shall be designed for conveyance in a separate gravity system at such depths that all structures within the tributary area may be served to full foundation footer drain depths and so that no violations of a natural drainage area are generated.

B. Investigations and Surveys

1. Information required

Each project shall be identified by name, municipality within which it is to be constructed and original lot number and tract. A general description of the project shall be included indicating approximate project size, zoning, general description of discharge points, off site tributary area and any special factors to be considered in the design.

2. Investigations

Information on all existing conditions shall be listed. This shall include capacity of receiving sewers or culverts, ability of receiving waterways to provide an adequate outlet with respect to both depth and capacity in vicinity of storm outlet. Special analysis will be required for known flooding areas.

C. Special Projects

Variation from a separate gravity storm sewerage system of normal depth shall be considered a special project and shall require that the approving governmental agency review and approve the variation in concept prior to final design. Variations will include shallow depth, materials of construction, methods of construction, combined sewers, controlled discharge systems, combination conduit-overland flow systems, others.

3.302 DESIGN CRITERIA FOR STORM SEWERS

A. Design Storm Frequency

Residential Multi-family Schools	5 Year Frequency
Industrial/Commercial	10 Year Frequency
Downtown or Major Urban Business Area	25 Year Frequency

Additional Minimum Criteria

Flow between 0 - 150 cfs	5 Year Frequency
150 cfs - 500 cfs	10 Year Frequency
500 cfs - 1500 cfs	25 Year Frequency
1500 cfs - and over	50 Year Frequency

B. Rainfall Intensity - Duration

5 - Year Storm	i = 1.50 Inches/Hr.
10 - Year Storm	i = 1.80 Inches/Hr.
25 - Year Storm	i = 2.00 Inches/Hr.
50 - Year Storm	i = 2.25 Inches/Hr.
100 - Year Storm	i = 2.50 Inches/Hr.

C. Runoff Coefficient

Zoning	Lot Area (ft^2)	c =
Residential	0 - 5000	0.7
	5,000 - 10,000	0.6
	10,000 - 25,000	0.5
	25,000 - and over	0.4
Multi-family		0.75
Schools		
Industrial/Commercial		0.90
Shopping Centers		0.90
Major Urban Business Areas		0.90

The above runoff coefficients assume typical ground cover and average slope.

D. Concentration Times

1. Residential Areas

The concentration times to the critical inlet varies between 12 and 20 minutes with 15 minutes to be used as the general case based upon full development of the land.

2. Industrial - Multi-family - School Areas

The concentration time to the critical inlet varies between 10 and 15 minutes with 12.5 minutes to be used as the general case based upon full development of the land.

3. Major Urban Business Areas and Shopping Centers

The concentration time to the critical inlet varies between 5 and 12 minutes with 10 minutes used as the general case based upon full development of the land.

E. Standard Rainfall Intensity-Duration Tables

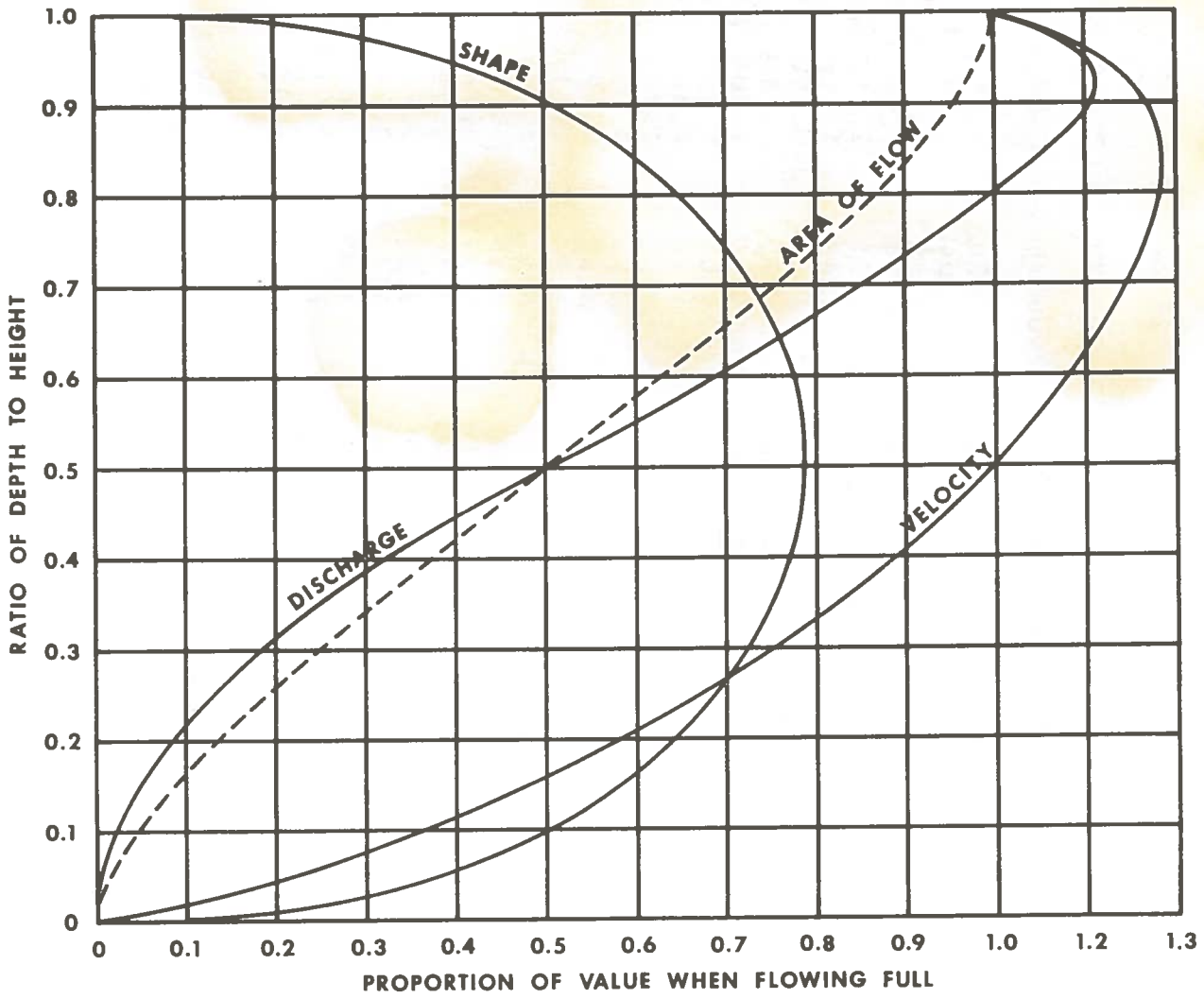
The Standard Rainfall Intensity-Duration Tables shall be used to determine the rainfall intensity occuring at the time of concentration to the inlet under consideration.

STANDARD RAINFALL INTENSITY-DURATION TABLES

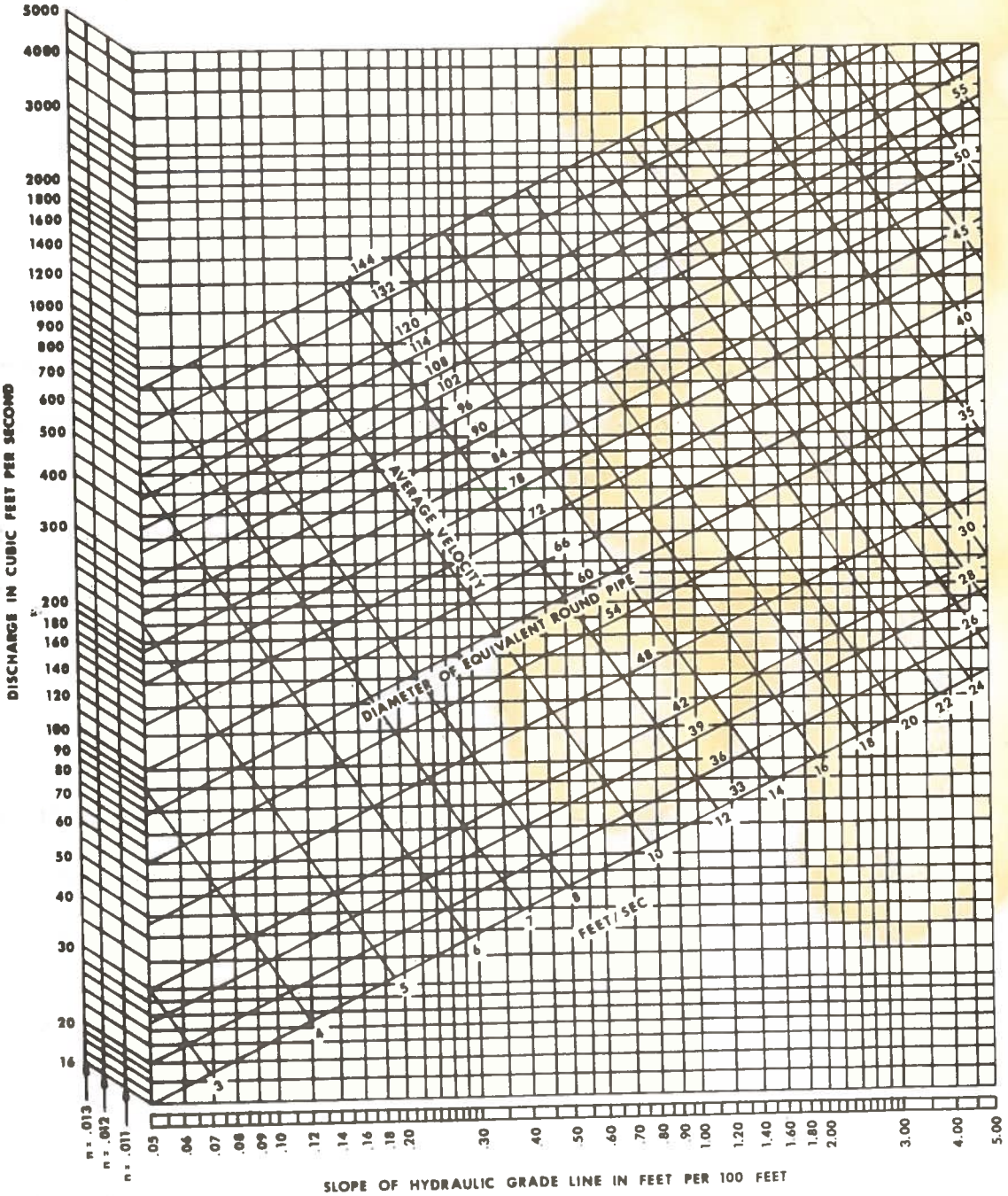
Rainfall Intensity in Inches Per Hour

Time of Concentration in Minutes	5 Yr. 1.50"/Hr.	10 Yr. Design 1.80"/Hr.	25 Yr. Storm 2.00"/Hr.	50 Yr. Frequency 2.25"/Hr.	100 Yr. Frequency 2.50"/Hr.
10	4.30	4.95	5.20	5.75	6.15
11	4.14	4.78	5.04	5.58	5.98
12	4.00	4.63	4.89	5.41	5.81
13	3.87	4.48	4.74	5.26	5.65
14	3.74	4.34	4.61	5.11	5.51
15	3.62	4.21	4.48	4.98	5.37
16	3.51	4.09	4.36	4.85	5.23
17	3.41	3.98	4.25	4.72	5.11
18	3.31	3.87	4.14	4.60	4.99
19	3.22	3.76	4.04	4.49	4.87
20	3.13	3.67	3.94	4.39	4.76
21	3.05	3.57	3.85	4.28	4.65
22	2.97	3.49	3.76	4.19	4.55
23	2.89	3.40	3.67	4.09	4.46
24	2.82	3.32	3.59	4.01	4.37
25	2.76	3.25	3.51	3.92	4.28
26	2.69	3.17	3.44	3.84	4.19
27	2.63	3.10	3.37	3.76	4.11
28	2.57	3.04	3.30	3.69	4.03
29	2.52	2.97	3.23	3.61	3.96
30	2.46	2.91	3.17	3.54	3.88
35	2.22	2.64	2.89	3.23	3.28
40	2.03	2.41	2.65	2.97	3.28
45	1.86	2.22	2.45	2.75	3.04
50	1.72	2.06	2.28	2.56	2.84
55	1.60	1.92	2.13	2.40	2.66
60	1.50	1.80	2.00	2.25	2.50
70	1.33	1.60	1.78	2.01	2.23
80	1.19	1.43	1.60	1.81	2.02
90	1.08	1.30	1.46	1.65	1.84
100	0.99	1.19	1.34	1.51	1.70
110	0.91	1.10	1.24	1.40	1.57
120	0.84	1.02	1.15	1.30	1.46

HYDRAULIC PROPERTIES OF HORIZONTAL ELLIPTICAL CONCRETE PIPE



HORIZONTAL ELLIPTICAL REINFORCED CONCRETE PIPE FLOWING FULL



3.303 DESIGN OF STORM SEWERS

A. General Information

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

B. Flow Formulas

1. Quantity of Runoff by Rational Method

a) Areas up to 500 acres

Q = CIA in cubic feet per second where A is the area to be drained in acres, C is the runoff coefficient for the area under consideration and I is the rainfall intensity derived from the Standard Rainfall Intensity-Duration Tables for the concentration time to the inlet under consideration.

b) Areas greater than 500 acres

Ohio Department of Natural Resources Bulletin No. 45 with urbanization correction in accordance with the following table shall be used as a guideline for computing runoff quantities.

URBANIZATION MULTIPLYING FACTOR

PERCENT URBANIZATION	10 YEAR STORM	25 YEAR STORM	50 YEAR STORM	100 YEAR STORM
10	1.25	1.25	1.25	1.25
20	1.39	1.36	1.34	1.33
30	1.52	1.47	1.44	1.42
40	1.67	1.58	1.53	1.50
50	1.81	1.69	1.63	1.58
60	1.94	1.81	1.72	1.67
70	2.08	1.92	1.82	1.75
80	2.22	2.03	1.91	1.83
90	2.36	2.14	2.01	1.92
100	2.50	2.25	2.10	2.00

2. Mannings Formula

$V = \frac{1.486}{n} (r)^{2/3} (s)^{1/2}$ where s is slope in feet per foot; r is hydraulic 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 and larger. Charts included. Quantity of flow Q = Av where A is the cross-sectional area of the conduit developed by the nominal conduit diameter. Where other than circular pipe is proposed, the actual cross-sectional area developed may be used.

3. Hydraulic Radius

r = A/p where p is the wetted perimeter developed by the nominal pipe diameter. Where other than circular pipe is proposed, the actual wetted perimeter developed may be used.

3.304 LAYOUT OF SEWERS

A. General Information

The layout of the storm system shall be such that the storm and sanitary sewers shall be on opposite sides of roadways and within the tree lawn areas where practical. Where opposite side constuction is not practical, every effort shall be made to separate the storm and sanitary sewers by 6 feet barrel to barrel. Where the above condition cannot be met, all portions of the storm and sanitary sewers shall be constructed using a premium jointed conduit throughout such full manhole to manhole increments. Necessary minor crossings of such sewers will not require premium joint construction in the storm sewer. Vertical and horizontal alignment of storm sewers shall be in general conformance with Section 3.205.

B. Minimum Size

The minimum size of all storm sewers, excluding connections and yard drains, shall be twelve (12) inches in diameter.

C. Types of Conduits

1. Conduits for public storm sewers up to fifteen (15) inches in diameter may be Vitrified Clay ASTM C-700ES, A.B.S. - Composite ASTM D2680 or Polyvinyl Chloride ASTM D-3034 (SDR-35). Conduits for public storm sewers over fifteen (15) inches in diameter may be Reinforced Concrete Pipe ASTM C-76, or Reinforced Concrete Arch Culvert ASTM C-507, Reinforced Concrete Elliptical Pipe

ASTM C-597, or Reinforced Concrete Box Culvert ASTM C-789.

2. Uncased bored sewer conduit under fourteen (14) inches shall be Ductile Iron Pipe ANSI A-21.51 Class 2 or Cast Iron Pipe Class 22. Pipe over 14 inches thru 24 inches shall be Ductile Iron Culvert Pipe ANSI A-716, and pipe 30 inches and over may be Ductile Iron Culvert Pipe ANSI A-716 or Reinforced Concrete Pipe ASTM C-76.

3. The types of conduits shall be in general conformance with Section 3.204.

D. Lateral Connections

Lateral connections to building sites shall be a minimum of five (5) inches in diameter and of Vitrified Clay ASTM C-700 ES, Cast Iron ANSI A-21.6 (Class 22), Ductile Iron ANSI A-21.51 Class 2, ABS Solid Wall ASTM D2680 (SDR 35) or Polyvinyl Chloride ASTM D-3034 (SDR35) Pipe.

E. Storm Sewer Joints

Storm sewer joints may be rubber gaskets, bitumastic, cement or material in conformance with Section 5.204 of these Specifications. Storm sewer joints in concrete sewers over 48 inches shall be cement mortar in conformance with Section 5.112C.

F. Depths of Sewers

In general, the storm sewer crown shall be at least 8 1/2 fe below the finished grade at the building line in residen

districts and 10 1/2 feet below the finished grade at the building line in all other areas, measured to the crown of the conduit. Conduits shallower than this requirement shall be considered a special project.

G. Velocities

Storm sewers should have a minimum flowing full velocity of two (2) feet per second and a maximum velocity of 15 feet per second.

H. Open Channel and Culvert Design

Open channels shall be designed using the energy concept and Mannings Formula using care in selection of the proper roughness coefficient "n". Following are suggested "n" factors for several typical open channel materials:

n = 0.014 for concrete lined

n = 0.017 for smooth rock bottoms with rock or concrete sides

n = 0.023 for well constructed waterways in firm earth.

Other channel materials may be considered as special projects. Other suitable "n" factors and velocities can be obtained from the Bureau of Public Roads Publication, Hydraulic Engineering Circular No. 5.

3.305 STORAGE BASINS

In general, storage basins shall be considered to be special projects with the design criteria to be that of the State of

Ohio, Department of Natural Resources, Division of Water, where applicable.

3.306 ORGANIZATION OF COMPUTATIONS

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

Any special treatment, such as stilling basins, energy dissipator, downstream channel improvements, erosion control or other treatment shall be taken into consideration by the design engineer.

Maximum storm discharge from any project may be established by the responsible agency for the purpose of minimizing downstream flooding, erosion control or protection of downstream structures.

3.4 - DESIGN OF WASTEWATER AND STORMWATER PUMPING STATIONS

Section 3.4 is in review pending inclusion of additional data from the latest revisions of the Ten State Standards and will subsequently be incorporated in these Standards.

3.5 - WASTEWATER TREATMENT PLANT

Section 3.5 is in review pending inclusion of additional data from the latest revisions of the Ten State Standards and will subsequently be incorporated in these Standards.

PART 4 - SEWER USE REGULATIONS

4.101 General Limitations

4.102 Discharge Quality Standards
- A. Toxic Materials
- B. Solids or Viscous Materials
- C. Other Harmful Wastes

4.103 Owner's Responsibilities

4.101 GENERAL LIMITATIONS

It shall be unlawful to discharge to any natural outlet within the area under the jurisdiction of the responsible agency, any sewage, industrial waste or other polluted waters, except where suitable treatment has been provided in accordance with the provisions of these regulations.

No person shall discharge or cause to be discharged any sewage, industrial waste or other polluted waters to any sanitary sewer or wastewater treatment plant, except where suitable treatment has been provided in accordance with these regulations. In addition, discharges to treatment plants or trunk sewers operated by the Cleveland Regional Sewer District shall conform to the Cleveland Regional Sewer District Use Code.

No person shall discharge or cause to be discharged any stormwater, surface water, groundwater, swimming pool water (except backwash), or unpolluted industrial process waters to any sanitary sewer.

Stormwater and all other unpolluted drainage shall be discharged to such sewers as are specifically designed as combined sewers or storm sewers, or to a natural outlet approved by the responsible agency. Industrial cooling water or unpolluted process waters may be discharged, on approval of the responsible agency, to a storm sewer or natural outlet.

4.102 DISCHARGE QUALITY STANDARDS

A. Toxic Materials

No person shall discharge or cause to be discharged any of the following described wastes or waters to any public sewers: Any gasoline, benzene, naptha, fuel oil, or other flammable or explosive liquid, solid or gas.

B. Solids or Viscous Materials

Any waters or wastes containing toxic solids, liquids, or gases in sufficient quantity, either single or by interaction with other wastes, to injure or interfere with any sewage teatment process, constitute a hazard to humans or animals or create any hazard in the receiving waters or wastewater treatment plant sewerage system including, but not limited to, the following materials:

Solid or viscous substances in quantities or of such size capable of causing obstruction to the flow in sewers, or other interference with the proper operation of the sewage works such as, but not limited to: ashes, cinders, sand, mud, structural materials, straw, shavings, metal, glass, sludge, feathers, grease and fats, tar, plastics, wood, unground garbage, whole blood, paunch manure, hair and fleshings, entrails, and paper dishes, cups, milk containers, chemical residues, paint residues, lime slurry, lime residue, cannery waste bulk, etc., either whole or ground by garbage grinders.

C. Other Harmful Wastes

No person shall discharge or cause to be discharged the following described substances, materials, waters, or wastes if it appears likely in the opinion of the responsible agency that such wastes can harm either the sewers, sewer system or equipment, sewage treatment process or equipment, or have an adverse effect on the receiving stream, or can otherwise endanger life, limb, public property, or constitute a nuisance. In forming their opinion as to the acceptability of these wastes, the responsible agency will give consideration to such factors as the quantities of subject wastes in relation to flows and velocities in the sewers, materials or construction of the sewers, nature of the sewage treatment process, capacity of the sewage treatment plant, and other pertinent factors. The substances prohibited are:

1. Any liquid or vapor having a temperature higher than one hundred forty degrees (140°) F., sixty degrees (60°) C.

2. Any water or waste containing fats, wax, grease, or oils, petroleum base, whether emulsified or not, in excess of eighty (80) mg/l or one hundred (100) mg/l containing substances which may solidify or become viscous at temperatures between thirty-two (32) and one hundred forty (140) degrees F. or zero degrees (0°) C. or sixty degrees (60°) C.

3. Any garbage that has not been properly shredded. The installation and operation of any garbage grinder equipped

with a motor of three-fourth (3/4) horsepower or greater shall be subject to the review and approval of the responsible agency.

4. Maximum cyanide to be accepted into the sewer system will be one (1) milligram per liter with no dilution and five (5) milligrams per liter with high dilution. Both stated figures shall be regulated at the discretion of the responsible agency, using such data as it is provided by the laboratory of the responsible agency.

5. Any radioactive wastes or isotopes of such a concentration as may exceed limits established by the applicable State or Federal regulations.

6. Any water or wastes, acid or alkaline in reaction, and having corrosive properties capable of causing damage or hazard to structures, equipment or personnel. Any waters or wastes having a pH lower than 6.0. Any waters or wastes having a pH higher than 9.0. Free acids and alkalis of such waste must be neutralized at all times.

7. Materials which exert or cause:

   a) Unusual concentrations of inert suspended solids (such as, but not limited to, fullers earth, lime slurries, and lime residue) or of inert dissolved solids (such as, but not limited to, sodium chloride, calcium chloride and sodium sulfate), from ion exchange softeners.

b) Excessive discoloration (such as, but not limited to, dye wastes and vegetable tanning solutions).

c) Discharge rate and servicing not to exceed the hydraulic capacity of the sewer, viz, unusual volume of flow or concentration of wastes constituting "slugs" as defined herein.

8. Any waters or wastes which waters contain the substances or possess characteristics which may be injurious to the sewers or which may be hazardous and which in the judgment of the responsible agency may have a deleterious effect upon the sewage works, processes, equipment, or receiving waters, or which otherise might create a hazard to life or constitute a public nuisance.

4.103 OWNER'S RESPONSIBILITIES

Where preliminary treatment of flow-equalizing facilities are provided for any waters or wastes, they shall be maintained continuously in satisfactory and effective operation by the owner at his expense.

Any wastes prohibited by these regulations which are discharged to the sewer system shall be brought to the attention of the responsible agency at the time it occurs. For failure to report discharges at the time they occur, a charge of $250.00 shall be made for each violation.

It shall be understood that the above shall in no way relieve any individual, company, or industry of any liabilities for

damage to any facilities, which damage can be shown to have been caused by the wastes discharged by said individual, company or industry. All measurements, tests and analyses of the characteristics of waters and wastes to which reference is made in these regulations shall be determined in accordance with latest edition of "Standard Methods for the Examination of Water and Wastewater", published by the American Public Health Association; or Ohio Department of Health, Division of Laboratories, or the Robert A. Taft Sanitary Engineering Center, United States Department of Interior, or ASTM, whichever method is applicable. Any measurements, tests, or analyses not covered in the tests must be described.

Where such facilities are provided for the treatment, pre-treatment, control or neutralization of waters or wastes, they shall be maintained continuously in satisfactory and effective operation by the owner at his expense and shall be subject to periodic inspection by the responsible agency. The owner shall maintain operating records and shall submit to the responsible agency, in a form prescribed by the responsible agency, a monthly summary report, of the character of the influent and effluent to show the performance of the treatment facilities as determined.

An approval by the responsible agency of facilities does not, in any way, guarantee that these facilities will function in the manner described by a person or company; nor shall it relieve a person or a company of the responsibility of revamping.

enlarging or otherwise modifying such facilities to accomplish the intended purpose.

No statement contained in these regulations shall be construed as preventing any special agreement or arrangement between the responsible agency and any person whereby an industrial waste of unusual strength or character may be accepted by the responsible agency for treatment.

PART 5 - STANDARD SPECIFICATIONS

5.1 - MATERIALS

5.101 General Information

5.102 Inspection Necessary

5.103 Mill, Factory and Field Testing Materials
- A. Laboratory Testing
- B. Certified Mill Tests
- C. Visual Inspection

5.104 Clay Pipe

5.105 Concrete Pipe (Circular and Elliptical)
- A. Non-reinforced Concrete
- B. Reinforced Circular Concrete
- C. Reinforced Elliptical Concrete

5.106 Cast Iron Pipe
- A. Form and Conditions
- B. Weight of Special Castings
- C. Application of Coating

5.107 Ductile Iron Pipe
- A. Form and Conditions
- B. Application of Coating

5.108 Corrugated Pipe

5.109 ABS Solid Wall Pipe

5.110 ABS Composite Wall Pipe

5.111 Polyvinyl Chloride (PVC) Pipe

5.112 Jointing Materials
- A. For Clay Pipe
- B. For Concrete Pipe
- C. ABS Solid Wall Pipe
- D. ABS Composite Pipe
- E. Polyvinyl Chloride (PVC) Pipe
- F. For Cast Iron and Ductile Iron Pipe

5.113 Castings

5.114 Manhole Steps
- A. General Information
- B. Ductile Iron Steps
- C. Plastic-Steel Manhole Steps

5.115 Concrete and Masonry
- A. Precast Manholes
- B. Portland Cement

5.116 Water

5.117 Fine Aggregates

5.118 Mortar Sand

5.119 Coarse Aggregates

5.120 Brick
- A. Shale Sewer Brick
- B. Concrete Brick

5.121 Reinforcing Steel

5.122 Structural Steel

5.123 Steel Electrodes

5.124 Lumber
- A. Grillage
- B. Timber Piles

5.101 GENERAL INFORMATION

Unless otherwise specified, all materials used in the work under these regulations shall conform to the requirements of the latest revision of the applicable specifications of the American Society for Testing and Materials (ASTM), and shall be tested in accordance with the latest specifications or methods of testing of the ASTM, where specifications and methods of testing have been adopted, revised or proposed for such materials. It is further understood and agreed that wherever reference is made to the specifications and/or methods of testing adopted by the American Society for Testing and Materials, American Concrete Institute, American National Standards Institute, American Water Works Association, American Welding Society, Ohio Department of Transportation, American Association of State Highway and Transportation Officials, City of Cleveland Water Department, or other organization or department, it shall refer to the standard or tentative standard of that society or organization, bearing the latest date.

5.102 INSPECTION NECESSARY

No material shall be used in the work until it has been inspected and approved on the site of the work. When required by the responsible agency, any or all materials entering into the construction of any work under this contract shall be tested by a reputable local testing laboratory at the responsible agency's expense. Such inspection shall not relieve the contractor of any of his obligations in this respect, and any defective material or workmanship shall be at all times liable to rejection when

discovered, until the final completion and adjustment of the contract.

5.103 MILL, FACTORY AND FIELD TESTING MATERIALS

All materials to be incorporated in the work of this contract shall be tested or inspected in accordance with the following schedule. Sampling, testing and inspection shall be made in accordance with the latest applicable ASTM standards.

A. Laboratory Testing

The following materials shall be inspected and tested at the expense of the responsible agency, by a local bureau, laboratory or other agency selected by the Engineer, and the Contractor shall furnish all such samples of materials as may be required, and such materials shall be approved before permission is given to incorporate same in the work. It is the responsibility of the Contractor to arrange for laboratory testing and the cost of such samples shall be included in the unit prices bid for the various items of work. The requirements for each item to be tested shall be as follows:

1. Cement

a) Containers shall bear the name of the manufacturer.

b) The testing laboratories shall provide certificates of tests of samples for 7 day and 28 day tensile strength, soundness, time of setting and fineness, for each carload shipped.

2. Sand

a) Color test for organic matter.

b) Decantation test for silt.

c) Sieve analysis.

3. Brick

a) Shale sewer brick shall be tested for the requirements of Section 5.120A of these Specifications.

b) Concrete sewer brick shall be tested according to Section 5.120B of these Specifications.

4. Concrete Masonry Units

a) Compressive Strength Test.

b) Absorption Test.

5. Stone and Slag

a) Sieve Analysis and Visual Inspection

b) Abrasion.

c) Absorption.

6. All Concrete

For each separate pour:

a) Slump Test.

b) Three compression (cylinder) tests made at two

different times.

7. Sanitary and Storm Sewer Pipe

Furnish one pipe section for each diameter of a given strength class for each 2000 feet or fraction thereof to be supplied on each individual project.

a) Clay, plain concrete and reinforced concrete pipe - 3 Edge Bearing Test

1) Clay pipe strength as required by ASTM C-700ES

2) Plain concrete pipe strength as required by C-14.

3) Reinforced concrete strength as required by C-76.

Test loading for reinforced concrete pipe shall be increased to a magnitude of 115% of that which the pipe must support without developing a 0.01 inch crack as defined in ASTM Specification C 497, "Determining Physical Properties of Concrete Pipe or Tile." If a 0.01 inch crack has not been developed by this increased loading, the crushing load shall be removed and the test terminated and the test section plus all the pipe it represents shall be considered to have passed the 3 Edge Bearing Test requirements. Should a 0.01 inch crack develop in the pipe surface at or prior to the

attainment of the 115% load, the pipe shall be tested to ultimate strength.

b) Concrete Pipe - Core sample testing

1) When concrete pipe manufactured at a plant that has been previously approved by a responsible agency has once been tested and approved for a specific size and design in accordance with the above procedure any responsible agency may accept similar concrete pipe on the basis of cores. Such cores can be used to verify wall thickness, steel areas, absorption and concrete compressive strength. A minimum of one core per 20 sections of pipe will be required.

c) Flexible pipe - Strength, flattening, stiffness and deflection in accordance with ASTM D2412.

1) ABS Solid Wall Pipe as required by ASTM D2751, (SDR 35) to acceptance values given therein.

2) ABS Composite Wall Pipe as required by ASTM D2680 to acceptance values given therein.

3) Polyvinyl Chloride Pipe (PVC) as required by ASTM D3034 (SDR 35) to acceptance values given therein.

d) Acceptance tests for iron pipe.

1) Cast-iron pipe modules of rupture and secant modules of elasticity tested as required in ANSI A21.6 or A21.8 to acceptance values listed therein.

2) Ductile Iron pipe tensile and impact tested as required in ANSI A 21.51 to accceptance values listed therein.

8. Welding

Shop and field tests shall be made on the work of welding operations according to the American Welding Society's "Standard Qualification Procedure".

9. Miscellaneous

All other material and testing procedures which the responsible agency may determine to be necessary.

B. Certified Mill Tests

Certificates of tests at mill by manufacturer shall be furnished for the following materials:

1. Cast Iron Pipe, Fittings and other Castings:

Furnish certificates of tests by foundry under ANSI, AWWA, or Federal Specifications. Make, weight, and year to be stenciled or cast on all pipe, fittings and castings.

2. Structural Steel, Reinforcing Steel and Genuine Ductile Iron and Corrugated Metal:

   Furnish certified mill tests of steels and ductile irons.

3. All other material which the responsible agency may determine to be necessary.

C. Visual Inspection

All material and all equipment shall be subject to visual inspection and acceptance or rejection after delivery to the site of the work. All rejected materials shall immediately be removed from the site.

5.104 CLAY PIPE

All clay sewer pipe shall conform to the requirements stipulated in the "Standard Specifications for Clay Sewer Pipe," ASTM Designation C-700 ES, as may be specifically identified on the plans or further specified. All clay pipe services shall conform to ASTM Designation C-700 ES.

5.105 CONCRETE PIPE (Circular and Elliptical)

A. Non-reinforced Concrete

All non-reinforced concrete sewer pipe furnished under these Specifications shall conform to all the requirements of Class 3 pipe in "Concrete Sewer, Storm Drain, and Culvet Pipe", ASTM Designation C-14.

B. Reinforced Circular Concrete

All reinforced circular concrete sewer pipe furnished under these Specifications shall conform to all the requirements of "Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe", ASTM Designation C-76. Where designs for a given size and strength class of pipe are provided for under the provisions of the ODOT Specifications, such designs shall be permitted subject to the testing requirements of Section 5.103 as it applies to circular reinforced concrete pipe.

C. Reinforced Elliptical Concrete

All reinforced elliptical concrete sewer pipe furnished under these Specifications shall conform to all the requirements of "Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe", ASTM Designation C-507. Where designs for a given size and strength class of pipe are provided for under provisions of the ODOT Specifications, such designs shall be permitted subject to the test requirements of Section 5.103 as it applies to reinforced elliptical concrete pipe.

5.106 CAST IRON PIPE

A. Form and Conditions

All cast iron pipe and special castings shall be of superior quality of iron, tough and even grain, free from cracks, sand, holes or defects of any nature.

Cast iron pipe shown on the plans and bid blanks as Thickness Class "22", cement lined, shall conform to the "Specifications

for Cast Iron Pipe, for Water and Other Liquids," ANSI A-21.6 or A-21.8.

Every length of pipe delivered to the site shall have been previously tested and withstood the minimum hydraulic pressure required by the specifications under which it is furnished. All cast iron pipe and special castings used in pipe extensions must be numbered and inspected, said inspection to be made by an inspector from the responsible agency.

B. Weight of Special Castings

No special castings shall be accepted, the weight of which shall be less than American Water Works Association, Class "D", standard weight, by more than ten percent (10%).

C. Application of Coating

All pipe and special castings shall be thoroughly cleaned and, except for cement-mortar lined pipe, shall be coated inside and outside with an approved asphaltum or other approved impervious preparation in accordance with ANSI A-21.4 applied at a temperature of 300°F. Pipe shall be handled in such a manner that a minimum amount of damage to the coating will result. All cast iron pipe or fittings, the coating of which has been damaged in shipping or handling, shall have the damaged portion well cleaned and coated as above specified before being placed in the work. The Contractor shall thoroughly coat all exposed parts of nuts and bolts, as above specified, after the pipe has been placed and before backfilling has been placed. All field coating shall be furnished by the Contractor and approved by the

responsible agency. All cement-mortar lining for cast iron and ductile iron pipe and fittings shall be installed in conformance with ANSI-21.4.

5.107 DUCTILE IRON PIPE

A. Form and Conditions

All ductile iron pipe and special castings shall be of superior quality of iron, tough and even grain, free from cracks, sand, holes or defects of any nature.

Ductile iron pipe shown on the plans and bid blanks as cement lined Thickness Class "2" shall conform to the Specifications for Ductile Iron Pipe, for Water and Other Liquids, ANSI A-21.51. Every length of pipe delivered to the site shall have been previously tested and withstood the minimum hydraulic pressure required by the specifications under which it is furnished. All ductile iron pipe and special castings used in pipe extensions must be numbered and inspected, said inspection to be made by an inspector from the responsible agency.

G. Application of Coating

All pipe and special castings shall be thoroughly cleaned, and except for cement-mortar lined pipe, shall be coated inside and outside with an approved asphaltum or other approved impervious preparation applied at a temperature of 300°F. Pipe shall be handled in such a manner that a minimum amount of damage to the coating will result. All ductile iron pipe or fittings, the coating of which has been damaged in shipping or handling, shall

have the damaged portion well cleaned and recoated as above specified before being placed in the work. The Contractor shall thoroughly coat all exposed parts of nuts and bolts, as above specified, after the pipe has been placed and before backfilling has been placed. All field coating shall be furnished and applied by the Contractor and approved by the responsible agency.

5.108 CORRUGATED METAL PIPE

All corrugated metal pipe shall be galvanized, and shall conform to the requirements of the latest specifications for corrugated metal pipe, adopted in the ODOT Specifications. The thickness of the base metal shall be shown on the plans. When specified or called for on the plans, a bituminous paved invert and/or bituminous coating or a smooth bituminous lining applied centrifugally shall be applied to the pipe after fabrication.

5.109 ABS SOLID WALL PIPE (6" diameter or less)

All ABS solid wall pipe shall conform to the requirements specified in the latest Standard Specifications for ABS Solid Wall Pipe and Fittings, ASTM Designation D-2751 (SDR 35). All pipe and fittings shall be marked or stenciled with the appropriate classification.

5.110 ABS COMPOSITE WALL PIPE

All ABS composite pipe shall conform to the requirements specified in the latest Standard Specifications for ABS Composite Sewer Piping, ASTM Designation D-2680. Exposed ends of all pipe and fittings shall be sealed with a thick application of solvent

cement. All pipe and fittings shall be marked or stenciled with the appropriate classification.

5.111 POLYVINYL CHLORIDE PIPE (PVC)

All polyvinyl chloride pipe shall conform to the requirements specified in the latest Standard Specifications for Polyvinyl Chloride Pipes, ASTM Designation D-3034 (SDR 35). All pipe and fittings shall be marked or stenciled with the appropriate classification.

5.112 Jointing Materials

Joint materials for all classifications of pipe shall be the same between any consecutive manholes.

A. For Clay Pipe

Clay pipe for sanitary sewers and storm sewers installations shall be provided with compression joints meeting all performance requirements of ASTM Standard C-425.

B. For Circular Concrete Pipe

1. Sanitary Sewers

Concrete pipe joints for sanitary sewers shall conform to the requirements of ASTM C-443 as it pertains to the use of a confined gasket. All joints shall consist of confined approved gaskets placed in grooves in the spigots of the pipe such that the gaskets will be enclosed on all sides when the pipe is laid and the joints are completed.

2. Storm Sewers

Concrete pipes for storm sewers shall conform to one of the following:

Type A. Bituminous joints may be used for all concrete pipe installations under 48 inches except where the normal distance between storm and sanitary sewers is less than eight (8) feet center to center or five (5) feet between pipe barrels.

Type B. Concrete pipe joints for storm sewers where the distance between storm and sanitary sewers is less than eight (8) feet center to center or five (5) feet between pipe barrels shall conform to the requirements of ASTM C-443 as it pertains to the use of confined gaskets placed in grooves in the spigots of the pipe such that the gaskets will be enclosed on all sides when the pipe is laid and the joints are completed.

Type C. Mortar joints shall be used for storm sewers 48 inches in diameter and larger except where the normal distance between storm and sanitary sewers is less than eight (8) feet center to center or five (5) feet between pipe barrels. The groove end of the pipe laid to line and grade shall be carefully washed with a wet brush and the bottom half of the groove buttered with 1 to 2 Portland Cement mortar. The tongue of the next section of pipe shall be cleaned with a wet brush and a layer of 1 to 2 Portland Cement mortar shall be applied to the top

half of it. The tongue end of the second pipe shall be then fitted into the groove end of the first pipe until the mortar is squeezed out into the inner and outer surfaces. The inner surface of the pipe at the joint shall be then pointed up smooth.

Type D. All elliptical reinforced concrete pipe for sanitary and storm sewers shall have Type C joints unless otherwise specified.

C. ABS Solid Wall Pipe

All ABS Solid Wall Pipe joints shall be of the "O" ring or Solvent Cement type per ASTM 2680.

D. ABS Composite Wall Pipe

All ABS Composite Wall Pipe Joints shall be of the "O" ring or Solvent Cement type per ASTM 2680. If the joint is of the Solvent Cement type, it shall be installed per ASTM D2235 and the manufacturer's recommendations. Additionally, all exposed ends of the ABS Composite Pipe shall be fully sealed with a thick application of solvent cement.

E. All ABS joints shall be of the "O" ring or the Solvent Cement type per ASTM 2680. If the joint is of the Solvent Cement type, it shall be installed per ASTM D2235 and the manufacturer's recommendations. Additionally, all exposed ends of the ABS Composite Pipe shall be fully sealed with a thick application of solvent cement.

F. For Polyvinyl Chloride (PVC) Pipe

PVC pipe joints shall be integral with the body of the pipe and belled as illustrated in ASTM D3034 and shall utilize O-Ring gaskets. Gaskets shall conform to Section 3 of ASTM C 443.

G. For Cast Iron and Ductile Pipe

Joints shall be rubber slip joints, comparable to the following: "Tyton" Joint, as manufactured by the U.S. Pipe and Foundry Company; "Fastite" Joint as manufactured by American Cast Iron Pipe or "Bell-Tite" as manufactured by James B. Clow and Sons, Inc.

5.113 CASTINGS

Castings for manholes, inlets and catch basins furnished under these Specifications shall conform in design to the standard plans on file in the office of the responsible agency Engineer. All casting shall be true to pattern and free from cracks, gas holes, flaws and excessive shrinkage. Surfaces shall be free from burnt-on sand and shall be reasonably smooth. Runners fins, risers and other cast-on pieces shall be removed.

Cast iron manhole and catch basin frames and covers and for any other purpose under these Specifications, except as otherwise provided, shall conform to all the requirements of Class No. 25 for Gray Iron Castings of the ASTM Designation A-48.

All castings shall be commercially machineable and, in the case of manholes and catch basins, the frame and cover shall, if

necessary, be so machined that it will be impossible to rock the cover after it has been seated in the proper position in the frame.

5.114 MANHOLE STEPS

A. General Information

All steps shall be minimum of twelve (12) inches in width with safety side lugs to prevent slipping and shall conform to the latest OSHA requirements.

B. Ductile Iron Steps

They shall be true to pattern and surfaces shall be free from cracks, flaws, fins, and burnt-on sand, and shall be reasonably smooth. They shall be coated with an approved asphaltum or other impervious preparation. The ductile iron shall conform to all of the requirements of Grade 65-45-12, ASTM Designation A-536.

C. Plastic-Steel Manhole Steps

The plastic used shall be a Co-Polymer Polypropylene and shall conform to the requirements of ASTM D-2146, Type 2, Grade 16906. The steel used shall conform to ASTM A615, Grade 60. All steps shall be a minimum of twelve (12) inches in width with safety side lugs to prevent slipping and shall conform to the latest OSHA requirements.

5.115 CONCRETE AND MASONRY

A. Precast Manholes

All precast concrete manhole sections furnished under these Specifications shall conform to all the requirements of "Precast Reinforced Concrete Manhole Sections", ASTM Designation C-478.

Precast manhole "tee" sections where used on sewers 48 inches in diameter and larger shall conform in design to the Uniform Standard Sewer Details of the responsible agency.

B. Portland Cement

All cement used in the work shall be approved brand and shall meet the requirements of the following ASTM Designation:

Standard Portland Cement	C-150 Type I
*Standard Portland Cement w/air entraining admixture:	C-150 Type I
High Early Strength Portland Cement	C-150 Type III
*High Early Strength Portland Cement w/air entraining admixture:	C-150 Type III

*Air entraining admixture shall conform to AASHO, M-154 added at mixer.

Cement for job-mixed concrete shall be furnished in unbroken 94 pound bags marked with the brand of the manufacturer, showing no signs of damage from moisture such as the formation of cakes or lumps, or of damage of any other character.

5.116 WATER

All water required in the execution of the contract must be provided by the Contractor. It shall be free from organic matter, acids and strong alkalis and shall be of potable quality. Water may be obained from fire hydrants of the municipality wherever available, after obtaining a permit for such services. Cost of water shall be included in the unit prices bid for the various items of work unless otherwise designated by the responsible agency.

5.117 FINE AGGREGATES

The fine aggregates shall consist of natural or manufactured sand composed of clean, strong, hard, durable, uncoated particles of stone. It shall be well graded from coarse to fine and shall be free from lumps of clay, shale, loam, soft and flakey particles, and all organic matter. The sand shall conform to the following grading:

Sieve No. (U.S. Standard Sieve Series)	Total Percent by Weight Passing
3/8"	100
No. 4	95-100
No. 8	70-95
No. 16	45-80
No. 30	25-60
No. 50	10-30
No. 100	1-10
No. 200	0-4

In the event that the sand does not pass the minimum requirements for the No. 50 and/or the No. 100 sieves, the deficiency may be corrected by the addition of approved fine inorganic material.

The amount of such material to be added shall be determined by a laboratory designated by the responsible agency Engineer.

The gradation of the sand from any one source shall be reasonably uniform and not subject to extreme variations within the above specified limits. Sand from any one source exhibiting a variation in fineness modulus of more than 0.20 may be rejected.

In addition to the grading requirements, the fine aggregate shall pass the color test for organic matter, soundness test and the compressive tests of cement sand mortar, all as per latest ASTM specifications.

5.118 MORTAR SAND

With the exception of grading, the specifications for the Fine Aggregate shall govern.

Grading shall be as follows:

Sieve No. (U.S. Standard Sieve Series)	Total Percent by Weight Passing
No. 4	100
No. 8	90-100
No. 50	15-40
No. 100	0-10
No. 200	0-5

5.119 COARSE AGGREGATES

The coarse aggregate shall consist of clean, strong, hard, durable, uncoated particles of crushed limestone, crushed granite or crushed air-cooled blast furnace slag. It shall be reasonably

uniform in density and free from an excess of thin, elongated or laminated pieces and also free from organic material.

The amounts of deleterious substances contained in the aggregate shall not exceed the following limits:

	Percent by Weight
Dust (Passing No. 200 Sieve)	1.0
Shale	1.0
Coal	1.0
Clay Lumps	0.25
Soft Fragments	3.0
Miscellaneous Substances such as Chert	
Alkali, Friable or Laminated Pieces	1.0

If the material passing the No. 200 sieve consists of the dust of fracture, and is free from shale or clay particles, the allowable amount may be increased to 1.5%.

The coarse aggregate shall conform to the following grading: No. 4 size shall be used for all concrete work, the least dimension of which is six (6) inches or greater. No. 57 gradation may be used in all other cases.

Grading of the No. 57 (AASHO M-43)

Sieve Size (Square Openings)	Total Percent by Weight Passing
1 1/2	100
1	95 - 100
1/2	25 - 60
No. 4 Sieve	0 - 10
No. 8 Sieve	0 - 5

Light weight aggregates will not be permitted, and all coarse aggregates shall weigh at least 65 pounds per cubic foot.

All coarse aggregates shall meet the ASTM specifications in regard to soundness and abrasion losses.

5.120 BRICK

A. Shale Sewer Brick

All sewer brick shall be made from shale sewer brick and shall be smooth, sound, hard, tough, and thoroughly vitrified. They shall be true in form with straight sharp edges and flat surfaces, and shall be uniform in quality, cross section and dimensions. Shale sewer brick furnished or used under these Specifications shall comply with all the requirements for Grade S.S., ASTM C-32 so far as the same may apply and are not in conflict with these Specifications.

Sewer brick shall be one or more of the following designated sizes:

DEPTH	WIDTH	LENGTH
1 1/2"	4"	8 1/2"
3"	4"	8 1/2"
3 1/2"	4"	8 1/2"

Not more than two percent (2%) of the brick shall vary more than one-eighth inch (1/8") in depth or width, or one-quarter inch (1/4") in length from the specified dimensions.

Lugged brick, cored brick or brick having recessed or openings extending through or partially through the body of the brick in any direction will not be accepted under these Specifications.

All shale brick furnished or used under these Specifications shall comply with the following physical test requirements:

ABSORPTION LIMIT (5 Hour Boiling)

Mean of five (5) tests ----------Not to exceed 6%

Individual Maximum----------Not to exceed 9%

Minimum Compressive Strength (lbs. per sq. inch)

Mean of five (5) tests---------8000

Individual Minimum----------5000

B. Concrete Brick

Brick used in storm sewers, catch basins, inlet basins, storm manholes, storm junction chambers and for grade adjustment of

sanitary manholes may be concrete sewer brick conforming to ASTM Designation C-55, Type I, Grade S-1.

5.121 REINFORCING STEEL

Reinforcing steel shall conform to the "Standard Specifications for Billet Steel or Rail Steel Reinforcement Bars" of the American Society for Testing and Materials, ASTM A-615 or ASTM A-616. Bars shall be round as indicated on the drawings, and shall be of the deformed type. Bars shall be of new stock and free from scale, rust, oil, paint or coating of any kind. Deformations shall conform to ASTM Designation A-305. Welded wire fabric shall conform to the latest ASTM Specification A-185.

5.122 STRUCTURAL STEEL

All structural steel shall meet the requirements of the "Standard Specifications for Steel Bridges and Buildings", ASTM Designation A-36.

5.123 STEEL ELECTRODES

Steel electrodes shall conform to all requirements of the latest "Standard Specifications for Steel Electrodes", ASTM Designation A-233.

5.124 LUMBER

Lumber for sheeting, sheet piling, forms, bracing or bridging must be of good quality and of sizes and strength suitable for protecting the work and workmen from danger, and for securing the best possible conditions for construction. Any material deemed

unsuitable or unsafe by the responsible agency must be removed at once from the work.

A. Grillage

Lumber for grillage under the foundation of the sewer shall be of oak, southern yellow pine or douglas fir. Other species must be approved by the Engineer. The material for grillage shall conform to the following specifications and grades:

1. Oak: 1700# f grade for wales and bridge plank grade for flooring. Based on the specifications by the National Hardwood Lumber Association.

2. Southern Yellow Pine: Structural square edge and sound longleaf P. & T. or dense structural square edge and sound shortleaf P. & T. grades for wales, and No. 1 structural longleaf J. & P. or dense No. 1 structural shortleaf J. & P. grades for flooring. Based on the specifications by the Southern Pine Association.

3. Douglas Fir: Select structural B. & S. or dense construction B. & S. grades for wales, and select structural J. & P. or dense construction J. & P. grades for flooring. Based on the specifications by the West Coast Lumberman's Association.

B. Timber Piles

Piles shall be of red oak, white oak, cypress, southern yellow pine or douglas fir. Other species must be approved by the responsible agency Engineer. All piles shall be sound, solid and

contain no unsound knots. Sound knots will be permitted provided they do not exceed one-third (1/3) of the minimum diameter of the pile at that particular section and are not over four inches (4") in diameter. Any defects or combination of defects, which would be more injurious than the maximum allowable will not be permitted. Piles shall have a uniform taper, and be free from short kinks. A reasonable amount of ground swell will be permitted but shall not extend more than three feet from the butt or be considered in measuring diameters.

PART 5 - STANDARD SPECIFICATIONS

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5.201 SITE WORK

A. Maintaining Sewage Flow

The Contractor shall be required to by-pass and maintain the flow in all existing live sanitary and storm sewers during construction and the method employed shall be approved by the responsible agency. The full cost of by-passing and maintaining sewage flow shall be included in the prices bid for other items of work and no additional compensation will be allowed therefore.

B. Replacing, Moving and Repairing of Existing Structures

The Contractor shall be responsible for the replacement, movement or repair and maintenance of all sewers, drains, catch basins, manholes, culverts, water lines, steam lines, air or gas lines, wire conduit(s) and any other appurtenances or structures encountered in the performance of said work, together with all house connections whether or not they are shown on the plans. Written permission from the owner must be obtained prior to initiating any construction on privately owned lines, equipment or appurtenances or on private property.

The Contractor shall replace, move or repair and maintain all pipes for water, steam, air or gas, and all wire conduit(s), and all other structures encountered in the work and repair all damage done to any of the said structures through his acts or neglect and shall keep them in repair during the life of this contract. He shall in all cases leave them in as good condition as they were previous to the commencement of the work and to the full satisfaction of the responsible agency Engineer.

The full cost of replacing, moving or repairing all damage done to any of the said structures encountered in excavation, including continuously along the trench, shall be included in the unit prices bid for other items of work and no additional compensation will be allowed therefore, whether or not shown on the plans.

C. Removal of Existing Sewers and Appurtenances

Where required to clear the new construction, or when shown on the plans, existing sewers, manholes, catchbasins and other appurtenances shall be removed by the Contractor. All abandoned sewers shall be sand filled and bulkheaded with brick masonry bulkheads at all points where they are cut. Any materials removed in the progress of the work which are deemed to be salvageable shall be removed to storage points designated by the Engineer and shall remain the property of the responsible agency. The Contractor shall use reasonable care in removing such items to prevent their breakage, and shall include the entire cost of sandfilling, bulkheading and removal of existing sewers and appurtenances in the unit prices bid for sewers in place.

D. Restoration of Pavement, Curbing, Concrete Gutters, Driveways, Sidewalks, Retaining Walls, Headwalls, Piers and Abutments

All pavements, road surfaces, curbing, concrete gutters, driveways, driveway culvert pipes, sidewalks, retaining walls, piers, headwalls, abutments, fencing and mailboxes removed or damaged during the course of the work shall be replaced by the

Contractor. All such items shall be replaced in the same manner, and be at least of equal quality and dimensions as existed before the commencement of the work, except that the disturbed driveway culvert pipes shall be replaced with a new corrugated galvanized pipe in a minimum size of twelve (12) inches diameter and fourteen (14) guage. All such replacement shall be performed as soon as practicable. The full cost of such work shall be included in the unit prices bid for sewers in place. All replacement work done on County, Municipal or State roads shall be approved by the appropriate agency or agencies.

E. Removal of Trees

Only those trees which are directly in the line of excavation, or those which are designated for removal by the responsible agency, shall be removed to a depth of six (6) inches below the finished grade. The entire cost of removing all sizes of trees shall be included in the prices bid for other items of work and no additional compensation will be allowed therefore, unless otherwise specified.

F. Dust Control

The Contractor shall keep the entire construction site reasonably clean and clear of excessive dust. He shall immediately control the dust or apply dust control chemicals in the affected area to the full satisfaction of the responsible agency.

The full cost of this work shall be included in the unit prices bid for other items of work, and no additional compensation will be allowed therefore.

5.202 EXCAVATING

A. Test Pits

The Contractor shall dig such exploratory test pits as necessary, in advance of excavation operations, to determine the exact location of sub-surface pipe lines, conduits and structures which are likely to be encountered, and shall make acceptable provision for their protection, support and maintenance in operation. The cost of such work shall be included in the unit prices bid for sewers in place.

B. Alignment and Grade

Alignment and grade may be established by means of grade bars or a laser beam.

1. Laser Beam

When approved by the Engineer, a laser beam may be used. The contractor shall furnish all material and labor to establish line and grade of the generated laser beam from the benchmarks and control points indicated on the plans. The laser shall be securely anchored and checked at least twice daily to insure that OSHA regulations are met. Strict adherence to the manufacturer's operation procedure shall be observed. Only qualified and trained employees may be assigned to install, adjust, or operate laser equipment, and proof of qualifications of the equipment operator must be available at all times. Areas in which lasers are used must be posted with standard

laser warning placards, and the laser beam shall be turned off when not needed. During rain, snow, dust, excessive heat, or fog the operation of laser systems shall be prohibited where practicable because of beam scatter.

All horizontal and vertical control required for the complete layout and performance of the work under this contract shall be done by the Contractor at the Contractor's expense, and any approvals by the responsible agency of the Contractor's methods will not relieve the Contractor of his responsibility.

2. Open Cut

All sewers in open cut shall be laid and maintained to the required lines and grades.

Unless otherwise specified, the responsible agency shall establish all base lines for the location of the principal component parts of the work together with a suitable number of benchmarks adjacent to the work. Based upon the information provided, the Contractor shall employ and retain a Registered Surveyor to develop and make all detail surveys necessary for construction, including slope stake, cut stakes, batter boards, stakes for pile locations and other working points, lines and elevations. The Contractor shall have the responsibility to carefully preserve benchmarks, reference points and stakes, and, in case of the destruction thereof, the

Contractor shall be charged with the expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the loss or disturbance of such benchmarks, reference points and stakes. The Contractor shall notify the responsible agency at least 72 hours prior to starting survey work to establish line and grade.

3. Tunnel

In tunnel construction, the Contractor shall furnish all labor and equipment required to transfer line and grade from the benchmarks and control points at ground level indicated on the plans into the tunnel section at each shaft. The method employed by the Contractor shall be approved by the responsible agency. The control of vertical and horizontal alignment in the tunnel sections shall be accomplished by the use of a laser beam instrument, unless another method is approved in writing by the Engineer.

Prior to submitting his estimate for payment, the Contractor shall submit for review by the Engineer a plan and profile of all work performed during the preceding month. The plan and profile shall indicate thereon the survey indication of adherence to the design alignment and grade, as well as conformity to the requirements of these Specifications. The survey notes and drawings to be submitted shall be certified and stamped by a

Registered Surveyor, licensed to practice in the State of Ohio.

C. Excavation and Preparation of Trench

1. General

Unless otherwise provided, all excavation shall be unclassified and shall include the removal and disposal of all material encountered in excavation, including pavement surface, pavement base and other materials. It shall also include the placing and removal of the sheeting and bracing, and removing water encountered. All excavated materials shall be stored in convenient piles near the construction sites and removed from the site of the work unless otherwise specified.

2. Width

The maximum width of unsheeted trench shall not exceed 12 inches on each side of the pipe for pipe diameters or spans of 24 inches or less, and not exceed 15 inches on each side of the pipe for diameters or spans greater than 24 inches and less than 72 inches, and not exceed 24 inches on each side of the pipe for pipe diameters or spans 72 inches and larger. The minimum width of unsheeted trench shall be at least nine (9) inches wider on each side than the outside diameter of pipe at the spring line.

3. Bedding

Type I. All pipe shall have a bedding of AASHTO M-43 No. 6, 67, 68, 7, 78 or 8 aggregate extending the width of the trench excavation with depth in conformance with the construction drawings. When Type I bedding is used, the cost of all bedding as described above shall be included in the price bid for the various pipe items unless otherwise shown.

Type II. Where shown on the drawings, pipe shall be bedded in a monolithic cradle of plain concrete having a minimum thickness below the bottom of the pipe of one-fourth (1/4) the vertical inside pipe diameter or rise but not less than six (6) inches extending up the sides for a height equal to one-fourth (1/4) the vertical outside diameter or rise. The cradle shall have a width at least equal to that of the excavated trench.

3000 psi concrete shall be used for the above bedding purposes. Care shall be taken so that the concrete strength does not exceed 3000 psi, unless a positive method of breaking bond between the pipe and the concrete is provided for.

When Type II bedding is used, the cost of all bedding as described above shall be included in the price bid for the various pipe items.

All space within the width of the trench excavation, inside or outside the authorized limits, shall be filled

between the elevation limits with the same material as specified for the type of bedding to be used and as shown on the applicable standard drawings.

4. Pipe Cover

Only coarse aggregate shall be used for filling above the pipe bedding along the sides of the sewer and to a height of twelve (12) inches over the top of the sewers. The pipe cover material shall be brought up evenly on both sides of the sewers and shall be thoroughly compacted by tamping or ramming. Care shall be taken to spade the aggregate under the pipe haunch below the spring line.

5. Concrete Anchorage

Concrete anchorages will be used when sewer slopes fall within the following limits, unless otherwise specified:

20% to 35% slope - anchorage 36 feet center to center (maximum)

35% to 50% slope - anchorage 24 feet center to center (maximum)

Over 50% slope - anchorage 16 feet center to center (maximum).

The cost of concrete anchorage shall be included in the contract unit price for the sewer complete in place and no additional compensation will be allowed therefore.

D. Blasting

Blasting will not be permitted under and near buildings, bridges, railroad tracks and underground structures and utilities. Elsewhere, blasting will be permitted, but only upon the written approval of the responsible agency and of the municipality in which work is being done. The Contractor shall use all possible precautions against accidents or damage due to explosions or in the use or storage of explosives, and he shall assume all risk and responsibility therefore and promptly settle all claims occasioned thereby thus saving the responsible agency harmless from any claims resulting from such actions. A licensed person in the use of explosives shall be employed to supervise the drilling and blasting operations. The Engineer shall fix the time during which the blasting operations may be carried on. Explosives shall be used, handled and stored as prescribed by the laws and regulations of OSHA and the State of Ohio and the legal municipality. All explosives shall be kept in a safe place, at a sufficient distance from the work, so that in case of accident, no damage will occur to any part of the work or adjacent property.

Explosives shall be so stored and secured that they are not accessible to unauthorized persons.

Blasting shall be conducted so as not to endanger persons or property and, whenever required, the blast shall be covered with mats or otherwise satisfactorily confined. The Contractor shall be held responsible for and shall make good any damage caused by blasting or accidental discharge. Blasting in tunnel section and

elsewhere, when permitted, shall be done in accordance with the provisions of all applicable local, State and Federal Laws.

E. Tunnel

All excavation shall be open cut from the surface and no tunneling will be allowed except when written permission has been previously obtained from the Engineer or it is specifically called for on the contract documents. In case tunneling is permitted under pavements, or specifically called for on the plans, the work shall be done in accordance with the supplemental specifications. The Contractor must take out the necessary permits and make the necessary deposits for the proper replacing of pavement support or the breaking down and repairing of the pavement.

F. Sewers Within Jacked or Bored Casing Pipe

At the locations shown on the plans, the sewer pipe shall be installed in a steel casing pipe with track for sewer pipe as per details shown on the contract plans. Material, equipment and construction procedure shall comply with the contract documents and shall be in accordance with the supplemental specifications.

G. Jacked or Bored or Tunneled Service Conections

At the locations shown on the contract documents, the sewer pipe shall be jacked into a bored hole as herein specified.

A sufficiently large boring pit shall be excavated to allow for proper alignment of the drilling equipment and to allow the pipe to be pushed through the drilled hole. The alignment of pipe

will not be allowed to vary more than two (2) feet at the upstream end of the house connections from a line drawn at right angles from the sanitary sewer at the wye or riser. The lateral connections shall be laid on a grade of not less than one percent (1%) but not more than three percent (3%), and the invert of the upstream end of the pipe shall be not less than nine (9) feet below the elevation of the center line of the street for residential areas and twelve (12) feet for commercial and industrial areas. The upstream end of the pipe shall be fitted with a stopper painted yellow and an increaser and adapter, if necessary.

In cases where local ordinances or governmental agencies prohibit the cutting of pavements, and the subsurface consists of rock or other hard material that does not lend itself to boring, the sewer shall, upon the order of the Engineer, be installed by tunneling under the pavement.

H. Bracing and Sheeting of Excavation

All trench and excavation bracing and sheeting shall be in conformance with the latest available OSHA requirements.

I. Drainage

The contractor shall, when ordered by the Engineer, construct tight bulkheads across trench and provide pumps suitable for the removal of any water which may be encountered or which may accumulate in the trenches. Unless otherwise provided for in the contract documents, drainage water will not be permitted to flood the trench or flow through the sewer.

1. Drainage of Trenches and Underdrains

The sewer trench shall be kept free from storm, surface, and subsoil water or sewage. No joints shall be made under water. If necessary, the Contractor shall install an underdrain, embedded on all sides in crushed slag or stone as shown on the plans or standard construction details. This work shall be done only upon the written order of the responsible agency and it will be paid for at the unit price bid for underdrains, unless otherwise specified.

2. Existing Water Courses

In open water courses, ditches or drains and drain pipes encountered during the progress of work, the Contractor shall provide for protection and securing of a continuous flow in such courses or drains and shall repair any damage that may be done by reason of them. The full cost of such shall be included in other items of work and no additional compensation will be provided therefore.

J. Paved Surfaces

The Contractor shall remove all pavements, road surfaces, curbing, driveways, and sidewalks within the lines of excavation. The Contractor shall clean saw cut the pavement and base without undue shattering. All concrete curbing, driveways or sidewalks within the lines of excavation shall be broken up and removed by Contractor. All such work shall be done in accordance with the rules and regulations of the municipality in which the work is

done. The use of pneumatic or hydraulic backhoe boom mounted pavement breakers or weights dropped on pavement for breaking will not be allowed except by written permission of the responsible agency. The full cost of such work shall be included in the unit prices bid for sewers in place unless otherwise specified.

K. Excavation by Machine or by Hand

The use of excavation machinery will be permitted, except in places where hand excavation is called for in the contract documents. The full cost of such work shall be included in the unit prices bid for sewers in place, unless otherwise specified.

L. Barricades, Guards and Safety Provisions

Temporary traffic control devices and facilities shall be furnished, erected and maintained in accordance with the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways prepared by the National Joint Committee on Uniform Traffic Control Devices. The work shall be conducted so that the least interference with traffic will result. Suitable steel plate bridges of a minimum of 0.75" thickness and recessed and anchored shall be provided over open trenches in pavements and driveways. The full cost of such shall be included in the unit price for sewers in place unless otherwise specified.

5.203 PIPE INSTALLATION

A. General Information

All pipe for use in sanitary or storm sewers shall conform to the specifications for pipe in Sections 5.104, 5.105, 5.106, 5.107, 5.108, 5.109, 5.110, 5.111.

Only one type and strength of pipe shall be used between any two consecutive manholes, unless otherwise shown on the contract drawings and specifications.

Where ASTM, ANSI or other national organizations have published recommended practices for installation, such recommendations shall be followed. Clay pipe shall be installed in full compliance with ASTM C 12, "Standard Recommended Practice for Installing Vitrified Clay Pipe." Plastic pipe, ABS Solid Wall pipe, ABS Composite Wall pipe, and PVC pipe, shall be installed in full compliance with ASTM D2321, "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe."

B. Construction

After the trench has been excavated and the pipe bedded as specified in Section 5.202-C-3, the pipe shall be laid to the line and grade as specified. All joints shall be made as hereinafter specified. In no case shall material except bedding material be placed under the bell of the pipe to secure proper grade.

Previous to being lowered into the trench, each pipe shall be carefully inspected and those not meeting the specified requirements shall be rejected and clearly marked and immediately removed from the site of the work. Satisfactory means shall be used to hold the pipe in line while the pipe is being jointed, and due precautions shall be taken to insure that the spigot end of the pipe being laid is pushed the proper depth into the socket of the preceeding pipe.

Pipe shall be laid with the socket end upstream.

No pipe shall be laid within ten feet of the machine excavating the trench nor within forty feet of any place where blasting is being done. In no case shall more than 200 feet of trench be opened in advance of the pipe laying operations.

In sanitary sewer construction, no drainage shall run through the newly laid pipe. All sewers shall be tightly sealed at open ends at the completion of each day's work and no drainage water shall be permitted to flow through the sewer.

All trenches and excavations shall, in general, be backfilled as hereinafter specified, as soon as possible after the pipe is laid and jointed. Where concrete encasement or cradle is used, pipe shall not be backfilled for at least 24 hours after placing concrete except that pipe may be covered to a depth of not to exceed sixteen (16) inches over the top of the pipe. The method employed in depositing the backfill shall be such as to prevent damage to the sewer or other structures.

5.204 PIPE JOINTS

A. General Information

The pipes shall be very carefully stored and handled to prevent any damage and no pipes shall be connected if the jointing rings have been deformed or damaged from any cause. Unless otherwise specified by the Engineer, directed or indicated on the plans, the following types of joints shall be used.

B. Joints for Clay Pipe

The joints for clay pipe shall conform to the provisions of Section 5.112A of these Standards.

When jointing pipe using a compression type joint, a lubricant as furnished or recommended by the pipe manufacturer shall be applied in the manner prescribed by the pipe manufacturer. No jute or other caulking will be permitted. The spigot shall then be entered into the socket and the pipe shoved home in an approved manner to fully complete the particular type of joint which is being used. The socket and spigot shall be free of any foreign matter which may prevent proper jointing of the pipe. When laying the pipe in concrete bedding, care shall be exercised to prevent the joint materials from coming in contact with the fresh concrete until after the joint has been completed.

C. Joints for Concrete Pipe

The joints for concrete pipe shall conform to the provisions of Section 5.112 B of these Specifications.

When jointing pipe using a compression type joint, a lubricant as furnished or recommended by the pipe manufacturer shall be applied in the manner prescribed by the pipe manufacturer. No jute or other caulking will be permitted. The spigot shall then be entered into the socket and the pipe shoved home in an approved manner to fully complete the particular type of joint which is being used. The socket and spigot shall be free of any foreign matter which may prevent proper jointing of the pipe. When laying the pipe, care shall be exercised to prevent the gasket from coming in contact with the fresh concrete until after the joint has been completed.

D. Joints for ABS Solid Wall Pipe

The joints for ABS Solid Wall Pipe shall conform to the provisions of Section 5.112C.

When jointing pipe for lateral sewers, ABS solvent cement joints shall be installed in accordance with ASTM D 2235. Pipe shall be cleaned of dust or moisture. Remove grease and oil with an approved cleaning solvent. Brush cement solvent uniformly on mating surfaces of inner socket and outer pipe. Insert the pipe immediately after applying cement, using a slight twisting motion, and hold in position for a few seconds to prevent the pipe from backing out. Avoid rough handling for one hour. For more complete instructions and cautionary notes, refer to Appendix A1 of ASTM D 2235.

E. Joints for Composite Wall Pipe

The joints for ABS Composite Wall Pipe shall conform to the provisions of Section 5.112 D.

When jointing pipe using the required O ring compression type joint, a lubricant recommended by the gasket manufacturer shall be used. The gasket shall be lubricated by drawing it through lubricant held in the hand of the workman, thus coating the entire surface of the gasket and allowing free rotation as the spigot is pushed into the socket.

The socket and spigot shall be free of any foreign matter such as twigs, sand particles, or other material that might prevent closure of the joint.

F. Joints for Polyvinyl Chloride (PVC) Pipe

The joints for PVC pipe shall conform to the provisions of Section 5.112 E.

When jointing pipe using the required O ring compression type joint, a lubricant recommended by the gasket manufacturer shall be used. The gasket shall be lubricated by drawing it through lubricant held in the hand of the workman, thus coating the entire surface of the gasket and allowing free rotation as the spigot is pushed into the socket.

The socket and spigot shall be free of any foreign matter such as twigs, sand particles, or other material that might prevent closure of the joint.

G. Joints for Cast Iron Pipe

1. Lead Joints

When lead joints are used for joining cast iron pipe sewers, the joints shall be made as specified below, using materials as specified under Section 5.112 F. All dirt and foreign matter shall be removed from the pipe before lowering into the trench or placing in tunnel and pipe ends must be kept clean and dry until the joint is properly made.

The spigot shall be centered in the bell, the pipe shoved into position and brought into true alignment, secured there with earth tamped around the pipe except at the bell holes. A strand of yarning material, either braided hemp or untarred twisted jute, shall be firmly pressed into the joint. Whenever it is necessary to cut pipe, this shall be done with a power cutter in a neat and workmanlike manner without damage to the pipe, leaving the end smooth and at right angles to the axis of pipe.

Before laying the pipe, all lumps, blisters and excess coating material shall be removed from both bell and spigot ends by wire brushing and wiped clean and dry. Yarning material as specified above shall be applied dry and firmly pressed into the joint end and shall be long enough to reach entirely around the pipe with ends overlapping not less than two (2) inches. The ends shall meet on opposite sides of pipe and not on top or bottom.

If necessary, successive strands of yarning material shall be driven home separately, thoroughly packed and hammered into the joint.

For lead joints, a space of not less than two and one-half inches (2 1/2") in depth shall be left in the bell in pipe twenty inches (20") or less. Lead joints in sleeves shall be cast solid to the full length of sleeve. Lead shall be heated in a melting pot kept near the joint to be poured, brought to a proper temperature such that, when stirred, it will show a rapid change of color and that, when poured into the joint space, it will insure a perfect joint. Before pouring the lead, all scum shall be removed. The joint runner shall fit snugly against the face of the bell and the outside of the pipe and shall be dammed with clay at the pouring gate to provide for filling the joint even with the top of bell.

Each joint shall be made with one pour filling the joint space. After cooling to the temperature of the pipe, lead joints shall be caulked by means of pneumatic or hand tools, by competent workmen, until thoroughly compacted, making watertight joints without overstraining the bells.

2. Rubber Slip Joints

All cast iron and ductile iron pipe for which lead joints are not applicable, shall be laid with rubber slip joints, comparable to one of the following:

"Tyton" joint, as manufactured by the U.S. Pipe and Foundry Company.

"Fastite" joint, as manufactured by the American Cast Iron Pipe Company.

"Bell-Tite" joint, as manufactured by James B. Clow & Sons, Inc.

3. Bolted Joints

Where specified or called for on the plans, bolted or special type mechanical joints shall be used for cast iron, ductile iron or steel pipe. Such joints shall be made in a manner satisfactory to the responsible agency and in accordance with the manufacturer's instructions.

5.205 BACKFILLING

A. Extent of Backfill

The backfill includes all backfilling, ramming, puddling or rolling as required, the regarding of adjacent disturbed areas, the replacing of drains and other surface and sub-surface structures, the placing and maintaining of temporary sidewalks and driveways, furnishing of suitable backfill material and all appurtenant work incidental thereto.

B. Backfill Material

If approved by the responsible agency, material excavated from the trench shall be suitable for backfill. The Contractor shall secure suitable material from other sources if required. The

backfill material shall be brought up evenly and must be laid in twelve (12") inch horizontal layers or to the specified depth and thoroughly compacted by methods satisfactory to the responsible agency. Puddling may be allowed except in heavy clay soils or during freezing weather. In general, the additional water shall be limited to achieving optimum moisture content for tamping procedures.

No backfilling shall be made during freezing weather except by written permission of the responsible agency, and no fill shall be made when the material already in the trench is frozen, nor shall frozen material be used in backfilling.

C. Premium Backfill

At all places where pavement, driveways, concrete gutters, and sidewalks are removed in the sewer construction and/or proposed in new construction, all backfilling of the sewer trench shall be made with slag or limestone screenings or coarse aggregate as specified on the plans.

Excavated material shall be removed from the site of the work and the premium material containing not more than ten percent (10%) by weight of loam or clay and free from all deleterious or objectionable material shall be used for backfilling. If required, this backfill shall be thoroughly compacted to a minimum of 95% compaction by tamping in layers of not more than twelve inches (12") or by puddling.

D. Additional Premium Backfill

Where ordered by the responsible agency, sections of the trench other than those specified above or called for on the plans may also be backfilled with premium material. All such additional backfilling ordered by the responsible agency will be paid for at the contract unit price bid for "Additional Premium Backfill Material" unless otherwise specified.

5.206 DISPOSAL OF SURPLUS EXCAVATED MATERIAL

All surplus excavated material shall be removed and disposed of by the Contractor. The cost of this work shall be included in the contract unit price bid for sewers and no additional compensation will be allowed, therefore, unless otherwise specified.

5.207 BRANCH CONNECTIONS AND RISERS

Branches, "Y"s or "T"s of the size specified, shall be installed at the locations shown on the plans and shall be standard fittings. Openings at the outer ends of the branches shall be closed and sealed with approved stoppers. When required on account of depth of the sewer, branches shall be built up vertically with riser pipes to a point nine (9) feet below the top of the building line ground elevation as shown on the drawings, using bends whenever necessary. Branch connections and risers shall be included in the contract unit price unless otherwise specified. All pipe joints shall be carefully made and shall conform to the requirements in these specifications for the type of pipe used.

5.208 LATERAL CONNECTIONS

Sewer service street connections shall be constructed as shown on the plans, and shall be laid in accordance with Section 5.203 from the lateral sewer or risers to a point designated on the plans.

All street connections shall be closed and sealed at the outer end with approved stoppers.

A. Cast Iron or Ductile Iron Lateral Connections

All lateral connections crossing under existing pavements shall be constructed of cast iron or ductile iron and be installed by boring and pushing the ductile iron pipe through the excavated hole unless written permission is granted by the responsible agency to use the open trench method.

5.209 MANHOLES

All manholes shall be built in accordance with the plans and Uniform Standard Sewer details. Sanitary manholes shall be constructed of precast concrete manhole sections conforming to Section 5.115. Storm manholes shall be constructed of either precast concrete manhole sections conforming to Section 5.115, concrete conforming to Section 5.120B, or shale sewer brick conforming to Section 5.120A.

All brick used in manhole construction shall be laid in full mortar beds with no mortar joint appearing on the inner surface of the manhole exceeding three-eighths inches (3/8") thick.

When sewer brick is used for manhole construction, they shall be laid in 1 to 2 Portland Cement mortar with bricks arranged radially as headers, forming a wall nine inches (9") thick. In deep manholes, the wall shall be thirteen inches (13") below a point twelve feet (12') from the surface to a maximum depth of twenty-eight feet (28').

Two ring brick arches shall be incorporated in the manhole masonry walls around all sewer pipes passing through the walls. The entire outer surface of sewer brick manholes shall be plastered with a smooth coating of 1 to 2 Portland Cement mortar at least one-half inch (1/2") in thickness. The top of the walls of manholes shall be properly leveled off with mortar so as to form a flat surface upon which the cast iron manhole cover ring is to rest and the manhole shall be carried to proper height above sewer. In precast manholes, provisions shall be made for a minimum of eight inches (8") and a maximum of sixteen inches (16") of grade rings or brick between the uppermost precast section and the bottom of the cast iron manhole cover ring. The Contractor shall furnish and set in mortar, upon the top of each manhole, a cast iron manhole ring and cover, ventilated or solid as specified. Where the pipe passes through the outside face of manhole walls, there shall be a pipe joint such that slight flexing or motion can take place in the plane of the wall face without shearing the sewer pipe.

Manhole steps, as specified in Section 5.114, shall be built into each manhole in accordance with the Uniform Standard details and shall be continued downward along the interior side of the

manhole spaced not less than twelve inches (12") apart nor more than sixteen inches (16") apart.

Landing platforms shall be installed in manholes that are over 28 feet deep to the invert with a maximum vertical spacing of 20 feet.

A. Drop Manholes

Where shown on the plans, drop manholes shall be built in accordance with the Uniform Standard Sewer details. The drop pipe shall be one-half of the main sewer diameter with an eight inch (8") diameter and a 24" maximum diameter and shall be encased in reinforced concrete to the dimensions shown on the Standard details. The cost of the drop and such encasement shall be included in the contract unit price for the drop manhole, complete, in place, unless otherwise specified.

B. Inlets and Catch Basins

Inlets and catch basins shall be built in accordance with plans and the Uniform Standard Sewer details.

C. Bulkheads

The Contractor shall construct masonry bulkheads in all existing sewers which are cut and abandoned, in all stub sewers in new sewer construction, at all locations shown on the plans and at all other locations where so directed by the responsible agency. They shall be built nine inches (9") thick, unless otherwise specified, and with a one-half inch (1/2") coating of 1 to 2 Cement mortar. The cost of constructing bulkheads shall be

included in the contract price bid for various sewer items and no additional compensation will be allowed, therefore, unless otherwise specified.

5.210 CONCRETE AND MASONRY

A. Frost and Dampness Protection of Masonry

All masonry work shall be carried on under dry conditions and be properly protected from cold weather and dampness. Such work shall be protected from frost to the extent and equivalent to that required for concrete as specified under Section 5.210-D-6 of these Specifications.

All material and all work in progress shall be adequately covered during periods of precipitation.

The cost of frost and dampness protection of masonry shall be included in the contract price bid for various sewer items and no additional compensation will be allowed, therefore, unless otherwise specified.

B. Mortar

Mortar shall be composed of Portland Cement one part, and mortar sand, two parts by volume.

Mortar sand shall conform to Section 5.118 of these Specifications. All mortar shall be mixed in tight boxes or mixers furnished by the Contractor. In mixing the mortar, the Contractor shall accurately measure the sand and cement. Shovel measurements will not be permitted.

In no case shall mortar be used that has once begun to set; retempering will not be allowed.

No lime or other admixutres of any description shall be used unless so specified or permitted by the responsible agency.

C. Concrete

1. General Information

Concrete shall consist of a mixture of Portland Cement, fine aggregates, coarse aggregates and water, proportioned and mixed as provided in these Specifications and constructed as shown on the plans. In proportioning concrete materials, one (1) sack of cement shall be considered as being one (1) cubic foot volume and ninety-four (94) pounds weight. Total maximum water shall be considered as that including added water and surface water in the aggregates. Cement shall be weighed on a balance scale separate from those used to weigh the other ingredients. Aggregates shall be measured by weight. Batch weights shall be based on surface dried materials and shall be corrected to take into account the weight of surface water contained in the aggregate. Water shall be measured by volume or weight.

2. Unit Stresses

All structural concrete, both plain and reinforced, shall develop a minimum ultimate compressive stress of 4000 psi

at 28 days. Unless otherwise noted on plans, all concrete shall be taken to be 4000 psi.

Concrete for bedding, encasement of pipe and general fill purposes shall have a minimum strength of 3000 psi at 28 days. Admixtures shall not be used unless approved by the responsible agency.

3. Proportions of Aggregates

Before starting any concrete work, the Contractor shall inform the Engineer as to the source of his aggregates. A testing laboratory will then test representative samples of coarse and fine aggregates and establish the weights of each aggregate to be used in the concrete mixes.

The responsible agency may change the relative proportions of fine and coarse aggregate, at any time during construction, to conform to variations in the character of the material used, at the same time maintaining the water-cement ratio and the specified slumps.

4. Quality Control

It is the intent of these Specifications that all concrete construction shall be monitored by a testing laboratory approved by the responsible agency. This includes the testing of materials, establishment of batch

weights, inspection and testing, all as per the latest ASTM Specifications.

ASSUMED STRENGTH OF CONCRETE MIXTURES

Water Content U.S. Gal., per 94 Lb. Sack of Cement	Assumed Compressive Strength at 28 Days, Lb. per Sq. Inch
7 1/4	2500
6 1/2	3000
5 3/4	3500
5	4000

Note: In interpreting this table, surface water contained in the aggregate must be included as part of the mixture water in computing the water content.

In all cases, however, the materials used in concrete shall conform to their respective Sections of the Specifications.

No concrete exposed to the action of freezing weather shall have a water content exceeding six (6) gallons per sack of cement.

5. Storage of Materials

The Contractor shall provide suitable means of storing and protecting the cement against dampness. Different grades or brands of cement shall be stored separately. Sacks of cement, which for any reason have become partially set, or which contain lumps or caked cement shall not be used.

Each size and type of aggregate shall be stored separately and kept in such a manner as to avoid the inclusion of all foreign matter. Aggregates containing lumps of frozen or partially cemented material shall not be used in the concrete.

Coarse aggregates shall be stored in such a manner as to avoid segregation of particles and to maintain a reasonably uniform moisture content.

6. Consistency of Concrete

The proportions of aggregate to cement shall be such as to produce concrete that can be worked readily into the corners and angles of the forms and around the reinforcement without excessive spading and without segregation or accumulation of water on the surface. In no case shall concrete be placed which shows a slump outside the following limits:

TYPE OF CONSTRUCTION	SLUMP IN INCHES Maximum	Minimum
Reinforced Footings and Headwalls	4	2
Reinforced Beams, Columns, Slabs & Walls	5	3
Pipe Cradling, Encasement & Fill	5	3

7. Water-Cement Ratio

Inasmuch as the strength of concrete is a function of water-cement ratio, it is imperative that this ratio, as established by the testing laboratory approved by the responsible agency, not be exceeded under any circumstances.

In the event that the given water-cement ratio does not produce the proper consistency and workability of the concrete mixes, the testing laboratory will change the relative proportions of the aggregates with the written approval and permission of the responsible agency.

Free moisture held by the aggregates must be included in determining the water-cement ratio.

8. Tests on Concrete

a) During the progress of the work compression test specimens shall be made and cured in accordance with the "Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field", ASTM Designation C-31. Not less than three (3) specimens shall be made for each test, nor less than one (1) test for each 250 cu. yd. of concrete of each class. Specimens shall be cured under laboratory conditions except that when there is a possibility of the surrounding air temperature falling below 40°F. Additional specimens may be required to be cured under job conditions unless otherwise specified.

b) Specimens shall be tested in accordance with the "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders", ASTM Designation C-39.

c) The standard age of test shall be 28 days. 7 day tests shall be made to provide the relationship between the 7

and 28 day strengths of the concrete as established by test for the materials and proportions used.

d) All concrete that does not meet the specified strength requirements as indicated by compression test cylinders, shall be retested by taking cores from the completed structures and testing them. If the concrete fails to meet the minimum strength requirements on this second test, the responsible agency shall order its removal in writing. Any such removal and replacement shall be done at the Contractor's expense.

D. Mixing and Placing Concrete

1. Preparation of Equipment and Place of Deposit

a) Before placing concrete, all equipment for mixing and transporting the concrete shall be cleaned, all debris and ice shall be removed from the places to be occupied by the concrete, forms shall be thoroughly wetted (except in freezing weather) or oiled, and masonry filler units that will be in contact with concrete shall be well drenched (except in freezing weather), and the reinforcement shall be thoroughly cleaned of ice and other coatings.

b) Water shall be removed from place of deposit before concrete is placed unless otherwise permitted by the responsible agency.

2. Mixing of Concrete

a) The concrete shall be mixed until there is a uniform distribution of the materials and shall be discharged completely before the mixer is recharged.

b) For job-mixed concrete, the mixer shall be rotated at a speed recommended by the manufacturer and mixing shall be continued for at least one (1) minute after all materials are in the mixer.

c) Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in the "Standard Specifications for Ready-Mixed Concrete", ASTM Designation C-94.

d) Mixing concrete by hand will not be permitted except when approved by the responsible agency.

3. Conveying

a) Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent the separation or loss of the materials.

b) Equipment for chuting, pumping and pneumatically conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at the delivery end without separation of the materials.

4. Depositing

a) Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. The concreting shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the space between the bars. No concrete that has partially hardened or been contaminated by foreign material shall be deposited on the work, nor shall retempered concrete be used.

b) When concreting is once started, it shall be carried on as a continuous operation until the placing of the panel or section is completed. The top surface shall be generally level.

When construction joints are necessary, they shall be made in accordance with Section 5.210-E-7.

c) All concrete shall be thoroughly compacted by suitable means during the operation of placing and shall be thoroughly worked around reinforcement and embedded fixtures and into the corners of the forms.

5. Curing

Provision shall be made for maintaining concrete in a moist condition for at least seven (7) days after the placement of the concrete, except that, for

high-early-strength concretes, moist curing shall be provided for at least the first 72 hours.

6. Cold Weather Requirements

a) Adequate equipment shall be provided for heating the concrete materials and protecting the concrete when the atmosphere temperature is 40°F or less. No frozen materials containing ice shall be used.

b) All concrete materials and all reinforcment, forms, fillers and ground with which the concrete is to come in contact shall be free from frost. Whenever the temperature of the surrounding air is below 40°F., all concrete in the forms shall have temperatures of between 50°F and 80°F., and adequate means shall be provided for maintaining a temperature of not less than 50°F for 5 days, except, when high-early-strength concrete is used, the temperature shall be maintained at not less than 50°F for 72 hours or for as much more time as is necessary to insure proper curing of the concrete. The housing, covering or other protection used in connection with curing shall remain in place and intact at least 24 hours after the artificial heating is discontinued. No dependence shall be placed on salt or other chemicals for the prevention of freezing. No concrete exposed to the action of freezing weather shall have a water content exceeding six (6) gallons per sack of cement.

E. Concrete Forms and Construction Details

1. Design of Forms

Forms shall conform to the shape, lines and dimensions of the members as called for on the plans, and shall be substantial and sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied together so as to maintain position and shape.

2. Removal of Forms

Forms shall be removed in such a manner as to insure the complete safety of the structure. Where the structure as a whole is supported on shores, the removable floor forms, beams and girder sides, column and similar vertical forms may be removed after 72 hours or with written approval from the responsible agency, providing the concrete is sufficiently hard not to be injured thereby. In no case shall the supporting forms or shoring be removed until the members have acquired sufficient strength to support safely their weight and the load thereon.

3. Cleaning and Bending Reinforcement

Steel reinforcement, at the time concrete is placed, shall be free from rust, scale or other coatings that will destroy or reduce the bond. All bending shall be done in accordance with current ACI requirements.

4. Placing Reinforcement

Steel reinforcement shall be accurately placed in accordance with the plans and shall be adequately secured in postion by concrete or metal chairs and spacers.

5. Splices and Offsets in Reinforcement

a) In slabs, beams and girders, splices of reinforcement at points of maximum stress shall be avoided. Splices shall provide sufficient lap to transfer the stress between bars by bond and shear.

b) Where changes in the cross section of a column occur, the longitudinal bars shall be offset in a region where lateral support is afforded. Where offset, the slope of the inclined portion shall not be more than one (1) to six (6), and in case of tied columns the ties shall be spaced not more than three inches (3") on center for a distance of one foot (1') below the actual point of offset.

6. Concrete Protection for Reinforcement

a) The steel reinforcement shall be protected by the thickness of concrete indicated on the plans. Where not otherwise shown, the thickness of concrete over the reinforcement shall be as follows:

Where concrete is deposited against the ground without the use of forms, not less than three inches (3").

Where concrete is exposed to the weather, or exposed to the ground but placed in forms, not less than two inches (2") for bars more than five-eighths inch (5/8") in diameter and one and one-half inches (1 1/2") for bars five-eighths inch (5/8") or less in diameter.

In slabs and walls not exposed to the ground or to the weather, not less than three-fourths inch (3/4").

In beams, girders, and columns not exposed to the ground or to the weather, not less than one and one-half inches (1 1/2").

In all cases, the thickness of concrete over the reinforcement shall be at least equal to the diameter of round bars.

b) Exposed reinforcement bars intended for bonding with future extensions shall be protected from corrosion by concrete or other adequate covering.

7. Construction Joints

Joints not indicated on the plans shall be so made and located as to least impair the strength of the structure. Where a joint is to be made, the surface of the concrete shall be thoroughly cleaned and all laitance removed. In addition, vertical joints shall be thoroughly wetted and slushed with a coat of neat cement grout immediately before the placing of new concrete.

5.211 INSPECTION AND TESTING

A. Service Markings

Whenever a stone or concrete sidewalk or curb exists, service connections shall be indicated by witness signs cut into the sidewalk or curb. Each riser, slant or "Y" connection, left plugged at the sewer shall be evidenced by a triangle and each sewer curb connection, plugged at the curb shall be evidenced by an arrow.

B. Line Acceptance Tests for Sewers

1. All sewers 33 inches in diameter and under shall be tested for leakage in the following manner:

As soon after completing a reasonable section of sewer, and the manholes have been completed, the Contractor shall furnish all equipment, material and personnel to conduct a "line acceptance" test using low pressure air. The equipment to be used shall have prior approval and the test shall be conducted under the supervision of the responsible agency. The line acceptance test shall be conducted after backfilling has been completed.

All wyes, tees or end of lateral stubs shall be suitably capped to withstand the internal test pressures. Such caps shall be a type which is easily removable for future lateral connections or extensions.

After a manhole-to-manhole section of the line has been cleaned, it shall be plugged at each manhole with pneumatic

plugs inflated to 35 psig internal pressure. The design of the plugs shall be such that they will hold against the line test pressure without requiring external blocking or bracing. Each pneumatic plug shall have a sealing length equal to or greater than the diameter of the pipe in which it is to be used so that effective sealing will always take place around any nodule or lump that may be on the inner surface of the pipe. Before actual line testing starts, the pneumatic plugs shall pass the following qualifying test in the presence of the responsible agency: one length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked; air shall be introduced into the pipe until the pipe pressure reaches 15 psig. The pneumatic plugs being checked shall hold against this pressure without bracing being needed, and without movement of the plugs out of the pipe. All pneumatic plugs shall pass the aforementioned qualifications before being used to test the actual installation.

One pneumatic plug used in this testing procedure shall have two factory equipped hose connections in addition to that hose connection used only for the inflation of the pneumatic plug. One of the additional hose connections shall be used for continuously reading the air pressure rise in the sealed line. The second additional hose connection shall be used only for introducing low pressure air into the sealed line.

There shall be a minimum three inch (3") diameter, 0-30 psig guage supplied for reading the internal pressure of the line being tested.

Calibrations from the 0-10 psig range shall be in tenths of pounds (not ounces) and this 0-10 portion shall cover 90% of the complete dial range.

Low pressure air shall be introduced into the sealed line until the internal pressure reaches 4.0 psig greater than the average back pressure of any ground water pressure that may be over the pipe. At least two (2) minutes shall be allowed for the air pressure to stabilize. After the stabilization period, the hose for introducing low pressure air into the sealed line shall be disconnected from the air source in such a manner as to retain the pressure in the sealed line.

The portion of line being tested shall be accepted if the portion under test does not lose air at a rate greater than 0.003 cfm per square foot of internal pipe surface when tested at an average pressure of 3.0 psig greater than any pressure exerted by ground water that may be over the pipe at the time of the test.

The above requirement shall be accomplished by performing the test as follows: the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig greater than the average back pressure of any ground water that may be over the pipe shall not be less than the time shown for the given diameter in the following table:

Pipe Diameter in Inches	Minutes
8	4.0
10	5.0
12	5.5
15	7.5
18	8.5
21	10.0
24	12.5
27	15.0
30	18.0
33	21.0

Where high ground water is known to exist, the height in feet of ground water above the invert of the sewer shall be divided by 2.3 to establish the pounds of pressure that will be added to the internal air pressure used for the line acceptance test in determining the time in minutes for the air pressure to decrease 1.0 psig.

If the installation fails to meet the requirements of this test, the Contractor shall determine at his own expense the source of leakage. He shall repair or replace all defective materials and/or workmanship and then re-test the installation for compliance with these Specifications for the line acceptance test.

2. Deflection Test

All plastic pipe shall be tested for proper installation by means of deflection attainment. In addition to material tests,

construction compaction and leakage tests required elsewhere in these Regulations, the contractor is required to install the pipe in such a manner that the diametric deflection shall not exceed five percent (5%). To attain this requirement, the backfill materials surrounding the pipe shall be compacted to the required Standard Densities called out in ASTM D 2321. The sectors requiring compaction shall include the bed and side fill material, as well as the material placed above the pipe for a distance of twelve (12") inches.

Deflection tests shall be performed no sooner than 28 days following completion of backfill. Final deflection tests shall be performed by the responsible agency or by an accredited, independent testing laboratory that shall submit verification records of results and dates tested. Maximum ring deflection of the pipe under load shall be limited to 5% of the average inside diameter listed in ASTM D 2751 for ABS Solid Wall Pipe and ASTM D 2680 for ABS Composite Wall Pipe. ASTM D 3034 for Polyvinyl chloride (PVC) Pipe lists outside dimensions and minimum wall thicknesses which may be used to calculate applicable base diameters. The following table may be used for reference for all plastic pipe permitted for use in sanitary sewers by these Regulations.

DEFLECTION LIMITS TABLE

Nominal Diameter, Inches	Average Inside Diameter, Inches			Minimum Inside Diameter, Inches*		
	ABS Solid Wall D-2751	ABS Composite D-2680	PVC SDR 35 D-3034	ABS Solid Wall D-2751	ABS Composite D-2680	PVC SDR 35 D-3034
6	5.875	N.A.**	5.915	5.581	N.A.**	5.619
8	7.875	7.750	7.920	7.481	7.462	7.524
10	9.875	9.750	9.900	9.381	9.262	9.405
12	11.875	11.750	11.780	11.281	11.162	11.191
15	N.A.**	14.750	N.A.**	N.A.**	14.012	N.A.**

* Based on 95% of average inside diameters.

** Not available in specification cited.

All pipe failing to maintain the minimum deflection diameter or larger listed for the applicable type of pipe shall be considered to have been improperly installed and shall be relaid or replaced by the contractor at no cost to the responsible agency.

Deflection testing shall be accomplished by using an electronic deflectometer which produces a continuous record of diameter readings or by pulling a go no-go gage through the pipe. G - no go gages may be mandrels, spheres, pin-sleds, or other device approved by the responsible agency prior to testing. The diameter or minimum dimension of the go - no go gage shall be as listed in the DEFLECTION LIMITS TABLE for the type and nominal diameter of the pipe being tested.

3. Weir-Test

   Weir test shall be performed on all sewers in pipe sizes 36 inches in diameter and larger as specified herein. The maximum permissable leakage shall be 200 gallons/per inch of diameter/per mile/per day when field tested by actual infiltration conditions.

4. All sewers constructed under these Specifications shall be subjected to visual inspection and, if required by the responsible agency, internal 16mm color photography or TV inspection. Costs will be paid for by the Contractor unless otherwise provided for in the specifications. The responsible agency shall retain ownership of all inspection records. Following any repairs and/or cleaning, the lines shall be resubmitted to the low pressure air "Line

Acceptance" test prior to photographic or television inspection.

C. Leakage Tests for Water Mains

Whenever sewer work is adjacent to a water main, tests of the main may be required upon completion of the sewer work along each section of water main between line valves to determine if any leakage has been caused by the Contractor's operations. In case leakage is shown by the test, the Contractor shall be responsible for any repairs. After completion of the contract, a final test of the entire main shall be made and approved by the responsible Water Authority.

D. Leakage Tests for Force Mains

1. Methodology

All pipes, valves, fittings, etc., shall be laid in such a manner as to leave all joints watertight. After the pipe is laid and before backfill is placed around the joints, such lengths of the force main as determined by the responsible agency shall be tested under a hydrostatic pressure of 75 pounds per square inch above the maximum pump head, but, in no case, shall such force mains be tested at less than 100 pounds per square inch. The test shall be conducted under the direction of the responsible agency or his appointed agent. The Contractor may obtain water for testing by observing the rules and regulations enforced in the municipality or

township in whch the work is being done. The Contractor shall furnish pressure gauges, suitable pump or pumps, pipes, test heads, and all appliances, labor, fuel, and other appurtenances necessary to make the test.

The test pressure shall be maintained for a length of time determined by the responsible agency to allow for a thorough examination of joints and elimination of leaks if any should be discovered. The pipe lines shall be made absolutely tight under the test pressure.

After the test has been completed, the Contractor shall drain all pipes and surrounding areas. The Contractor shall open all valves, air cocks, by-passes, and drains in the section of the installation tested immediately after the test to prevent damage to the force main and appurtenances due to freezing weather.

2. Alternate Method

The force main shall be tested under the same hydrostatic pressure as above. The test pressure shall be maintained for a period of two (2) hours by pumping additional water into the main, if necessary. The quantity of water thus pumped into the main multiplied by twelve (12) shall be taken as the leakage per twenty-four (24) hours.

The permitted leakage shall not exceed a rate of 75 gallons per 24 hours per mile of pipe per inch of nominal diameter.

In using this method of testing, the Contractor may backfill the pipe except at joints immediately following the laying and before the actual test has been made. In case the leakage is in excess of the permissible 75 gallons/mile/inch of diameter/day, the Contractor shall locate and repair the leak. The Contractor shall furnish suitable means for determining the quantity of water lost by leakage during the test.

The method of testing any force mains shall be approved by the responsible agency. Additional testing and/or different test conditions may be specified in the contract specifications or contract drawings. All testing and repairs shall be included in the unit price bid for sewers and force mains in place and no additional compensation will be provided, therefore, unless otherwise specified.

5.212 FABRICATION AND ERECTION OF STEEL

A. Structural Steel

In general, the fabrication of steel and the erection thereof shall be in accordance with the latest "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" and the "Code of Standard Practice for Steel Buildings and Bridges" of the American Institute of Steel Construction.

In the event that work is done on land under the jurisdiction of railroads, highway departments or other similar agencies, the specifications will be subject to the approval of such agencies.

B. Reinforcing Steel

Fabrication and erection of reinforcing steel shall conform to the current edition of the "Specifications for Placing Reinforcement" and the "Code of Standard Practice" of the Concrete Reinforcing Steel Institute.

5.213 WELDING

Welding of iron and steel shall be done by operators who have been previously qualified by tests as prescribed in the American Welding Society's "Standard Qualification Procedure" to perform the type of work required. All equipment shall be of a type which will produce proper current so that the operator may produce satisfactory welds. The welding machine shall be 200-400 ampere, 25-40 volt capacity.

Electrodes shall be of classification numbers E-6011, E-6012, E-6013, or E-6020, and shall be suitable for positions and other conditions of intended use in accordance with the instructions with each container.

Field welding shall be done by direct current.

The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work, shall conform to the current edition of Welding Society "Code for Arc Welding in Building Construction", Section 4, Worksmanship.

Surfaces to be welded shall be free from loose scale, rust, grease, paint and other foreign material, except that mill scale which withstands vigorous wire brushing may remain. A light film

of linseed oil may likewise be disregarded. Joint surfaces shall be free from fins and tears.

No welding shall be done when the base metal temperature is lower than 0° F. At temperatures between 32° F. and 0° F., the surface of all areas within three inches (3") of a point where a weld is started shall be heated until they are too hot to touch before welding is started.

Finished members shall be true to line and free from twists, bends and open joints.

5.214 MISCELLANEOUS

A. Clean-up, Repairs, Seeding and Sodding

1. Clean-up

As the work progresses, the Contractor shall keep the site reasonably free of debris, discarded materials and equipment. He shall maintain streets in a safe and convenient condition for travel as well as providing vehicular access to the abutting properties. Upon completion of the work, the Contractor shall remove all surplus excavated materials, tools, equipment and temporary buildings from the site and restore all pavements, road surfaces, curbing, gutters, driveways, driveway culvert pipes, sidewalks, retaining walls, guard rails, utility and service lines, mail boxes, and other items affected by the construction operations. All such work shall be of a quality and dimensions approved by the

responsible agency, including all disturbed driveway culvert pipes which shall be replaced with new pipe in a minimum of fourteen (14) gauge and twelve (12) inch diameter. The Contractor shall perform such replacements as soon as practicable after completion of the sewer and shall save the responsible agency free and harmless from all suits for damages to persons or property arising from or caused by this construction.

Before final acceptance for the work, the Contractor shall, as directed by the responsible agency, clear the sewers of any mortar, dirt or other refuse that may have been left or accumulated in the sewers. All manholes, inlets, catch basins and other structures shall be cleared of all forms, scaffolding, bulkheads, centering, surplus mortar, rubbish or dirt and left in a clean and proper condition.

2. Seeding and Sodding

The Contractor shall restore to original grade and seed and/or sod all lawn and grass areas disturbed by construction. All areas adjacent to residences shall be sodded. Areas in easements away from residences shall be seeded. The Contractor, at his option and with prior approval of the responsible agency, may substitute sod for the areas specified for seed, all at no change in contract price.

a) Material

1) Sod shall be 100% Merion Blue grass strongly rooted and free of pernicious weeds and bent grasses. It shall be mowed to a height not to exceed 2 inches before cutting and lifting and shall be of uniform thickness; not over one and one-half inches (1 1/2") or less than one inch (1") of soil. Sod shall be delivered within 24 hours after being cut and shall be installed within 36 hours after cutting.

2) Grass seed shall be vendor-mixed and delivered to the site in sealed bags and guaranteed by the dealer. Mix shall be as follows:

35% - Kentucky Bluegrass

55% - Creeping Red Fescue

5% - Red Top

5% - White Dutch Clover

b) Method of Installation

1) Sodding

The subgrade material shall be loosened and mixed to a depth of two (2) to four (4) inches. All sticks, stone over two (2) inches and rubbish shall be removed and the whole area compacted so that it will be parallel to the

finished grade. A commercial fertilizer formula 10-6-4 shall be applied to the upper two inches (2") of soil at the rate of ten (10) pounds per 1000 square feet and thoroughly raked in. Sod shall be laid so that no voids occur and shall be tamped and rolled. Screened topsoil shall be brushed or raked over the area to be sodded and the sod shall be thoroughly watered. The complete surface should be true to finished grades.

Sod on slopes steeper than two to one (2:1) shall be held in place by six inch (6") long wooden pins driven flush with the top of the sod at two foot (2') intervals or by other methods approved by the responsible agency.

2) Seeding

Before any seed is sown, the ground shall be raked until surface is smooth, friable and of uniform fine texture, then lightly compacted. Low spots shall be brought up to finished grade. A 10-6-4 formula commercial fertilizer shall be evenly applied at the rate of fifteen (15) pounds per 1000 square feet. Seed shall be applied evenly at a rate of four (4) pounds per 100 square feet with a mechanical spreader, lightly raked, then watered with a fine spray.

c) Maintenance

All seeded and sodded areas shall be protected and maintained by watering, mowing and replanting until an even dense growth is started. Dead sod or non-growing seeded areas shall be repaired at the direction of the responsible agency Engineer. The full cost of all clean-up, repairs, seeding, sodding, reseeding and resodding shall be included in the unit prices bid for other items of work, unless otherwise specified.

d) Replacement of Trees and Shrubs

The Contractor shall be responsible for replacing all sizes of trees, shrubbery and sprinkler systems damaged during and all appurtenant work incidental thereto, unless otherwise provided in the plans and specifications. The full cost of this shall be included in the unit prices for sewers in place.

B. Measurement for Payment

1. General

The contract price per unit of storm sewer, sanitary sewer, manholes, catch basins, inlets, curb connections and other items, is for the work complete in place as shown on the plans and specifications regardless of the character of the material encountered in the excavation or contingencies of any other nature, unless otherwise specified. Unit and lump sum prices for such work

complete in place shall include the furnishing of all labor, materials, tools and equipment necessary for its proper performance, unless otherwise specified. All costs such as excavation, backfill, relocation, repair or replacement of existing structures, sheeting and bracing of excavations, clean-up and repairs and all other operations required in the construction shall be included in the contract unit or lump sum prices, and no additional compensation will be allowed thereof unless otherwise specified.

It is the intent of these specifications that the cost of the work which does not have pay items provided for, shall be included in the contract unit or lump sum prices for items shown on the bid blanks.

2. Sewers

The number of linear feet of sewers to be paid for under their respective items, shall be the actual number of lineal feet of each class and size, measured continuously along the center line of the sewer through manholes, "T"s and "Y" branches.

Such payment shall include the furnishing, laying, connecting and testing of the sewer; the excavation, sheeting, concrete encasement or cradling of the pipe, backfilling, including premium backfill; the replacement of all structures and pavements and the furnishing of all labor, materials, tools and equipment to complete the

work as specified in the contract document or ordered by the responsible agency. Such payment shall include all items of expense except such items as are stated in the specifications to have separate payments.

When a sewer begins or ends at a manhole, measurement shall be made to the center of the manhole. At all points where sewers change size, the measurement for each size shall be made to the center of the manhole where the change is made. Sewers will not be paid for through special structures.

3. Manholes

The number of manholes of each type to be paid for under their respective items shall be the actual number of manholes of each type installed in the work, including excavation, backfill, masonry, stubs, cast iron and ductile iron frames, covers, steps, pipe drops, concrete, and all other required appurtenances.

4. Catch Basins and Inlets

The number of catch basins and inlets to be paid for at the respective contract prices shall be the actual number of each installed in the work, including excavation, backfill, masonry or reinforced concrete, cast iron and ductile iron frames, grates, steps, traps, stubs and all other required appurtenances.

5. Y-Branches, "T"s, Y-Connections and Slants

The number of branches, connections of each type and size to be paid for under their respective items shall be the actual number of such connections installed in the work. When Y-branches, "T"s, or slants require extensions to clear the sides of the concrete bedding and encasement, but no risers are necessary, the cost of such extensions shall be included in the price bid for each Y-branch, "T" or slant. There will be no deduction for these specials from the length of pipe they are connected to.

6. Risers

The number of lineal feet of pipe riser to be paid for at the contract price, shall be the actual number of lineal feet of each size of vertical risers furnished, laid and connected, measured from the bell end of the branch or slant at the sewer, along the center line of the riser pipe, including any intermediate bends. The cost of concrete or masonry encasements and excavation and backfill shall be included in the contract unit price per lineal foot of riser.

7. Lateral Connections

Clay, cast iron, ABS solid wall, ABS composite wall, Polyvinyl Chloride (PVC) and ductile iron pipe lateral connections will be paid for at their respective contract unit prices per lineal foot of each size of connections or risers to the end of the lateral connections installed

from the branch connections or risers to the end of the lateral connection, regardless of kind of pipe or excavation procedure used, unless otherwise specified.

The prices bid shall include furnishing, laying and connecting pipe; the excavation by boring and/or tunneling or jacking for the cast iron and ductile iron and open cut for clay or plastic pipe, concrete encasement where specified, sheeting, backfilling, replacement of all structures, utilities and paved surfaces and the furnishing of all labor, materials, tools and equipment to complete the work as shown on the contract documents or ordered by the responsible agency. Lateral connections shown on the plans and details to be installed as six inch (6") clay pipe, six inch (6") ductile iron pipe, ABS solid wall pipe, ABS composite pipe and PVC pipe all of which will be paid for at the same contract unit price bid per lineal foot of lateral connection pipe whether installed by the open cut, boring, jacking or tunneling methods. Bends, increasers, and adapters will be included in the contract unit price bid.

Any additional cost of installing the lateral connections above their respective contract unit prices bid per lineal foot of each size shall be included in the contract price bid for various sewer items and no additional compensation will be allowed therefore.

8. Catch Basin and Inlet Connections

The number of lineal feet of each class and size of catch basin or inlet pipe connections to be paid for at the contract unit price shall be the actual number of lineal feet of such pipe connections installed, measured from the center of the manhole to the center of catch basin or inlet, including concrete cradling or bedding for all catch basins and inlet connection pipe.

The contract unit price shall include all costs as described under other parts of Section 5.214B of these Specifications including the cost of concrete cradling or bedding for all catch basins and inlet connections pipe.

9. Sheeting Ordered Left in Place

The amount of sheeting in thousand feet board measure to be paid for at the contract unit price, shall be the amount actually left in place by the Contractor upon written order of the responsible agency. In no case will capping, bracing or sheeting used in tunnel construction be paid for as sheeting.

10. Timber Grillage

The amount of timber grillage in thousand feet board measure to be paid for at the contract unit price, shall be the amount actually installed in trench by the Contractor upon written order of the responsible agency. The contract unit price shall include all cost of

furnishing, treating and placing of such timber grillage. In no case will capping, bracing or sheeting used in tunnel construction be paid for as grillage.

11. Tile Underdrain

The number of lineal feet of tile underdrain to be paid for at the contract unit price, shall be the number of lineal feet of such underdrain actually installed in the work upon written order of the responsible agency. The cost of additional excavation, furnishing and placing of slag or stone screening and tile shall be included in the contract unit price.

12. Additional Excavation

The number of cubic yards of additional excavation to be paid for at the contract unit price shall be the amount of additional excavation required by reason of increase in depths of the excavation, over and above that shown on the plans or excavation made necessary that is not shown in the contract documents.

The number of cubic yards of excavation to be paid for at the contract unit price shall be established by computing the actual volume of material excavated unless otherwise specified.

13. Additional Premium Backfill

The number of cubic yards of additional premium backfill to be paid for at the contract prices shall be the actual

amount of the respective materials installed in the work upon written order of the responsible agency, over and above that called for in the contract documents.

14. Additional Structural Concrete

The number of cubic yards of additional concrete to be paid for at the contract unit prices for plain and reinforced concrete respectively shall be the actual number of cubic yards installed in the work upon written order of the responsible agency, over and above that called for in the contract documents.

The contract unit price shall include all cost of furnishing and placing of concrete and the form work. Reinforced concrete shall include the cost of steel in place.

15. Additional Concrete Bedding, Cradling or Fill

The number of cubic yards of additional concrete bedding, cradling or fill to be paid for at the contract unit price shall be the actual number of cubic yards of such concrete installed in the work upon written order of the responsible agency, exclusive of quantities which are specified to be paid for under other items of the work. The contract unit price shall include all cost of furnishing and placing of such concrete.

16. Sewers in Tunnel Construction

The number of lineal feet of sewers in tunnel construction to be paid for under their respective items shall be the actual number of lineal feet of each class and size, measured continuously along the center line of the sewer to the inside face of manholes, in shafts at the invert but not through them, and to the end of the tunnel construction wherever it is terminated.

Such payment shall include the proper construction of sewers in tunnel, including excavation, its disposal, sheeting, bracing and lining of the tunnel excavation, cement grouting, crane rails or channels, sewer pipe, concrete backfill, plain or reinforced, or encasements, connecting and testing of the sewer, the replacement of all structures and pavements and the furnishing of all labor, materials, tools and equipment to complete the work, as shown in the contract documents or ordered in writing by the responsible agency. Such payment shall include all items of expense except such items as are stated in the contract documents to have separate payments.

When sewer in tunnel construction ends at a manhole in a shaft, measurement shall be made to the nearest inside face of the wall of the manhole at the invert. At all points where sewers in tunnel construction change size, the measurement for each size shall be made to the

nearest inside face of the wall of the manhole where the change is made.

17. Manholes in Shaft Construction

The number of manholes constructed in shafts of each type to be paid for under their respective items shall be the actual number of manholes in shafts of each type installed in the work, including the entire cost of the shafts, excavation, its disposal, sheeting, bracing ribs and lining of the shaft excavation, cement grouting, masonry, concrete, reinforced and plain, or encasements, backfill, connecting of the sewer, steps and/or elevator for the full depth of the shaft, stubs, cast iron or ductile iron frames, covers, steps, pipe drops, replacement of all structures and pavements and the furnishing of all labor, materials, tools and equipment to complete the work as specified and as shown in the contract documents. Such payment shall include all items of expense except such items as are stated in the contract documents to have separate payments.

18. Sewers in Jacked or Bored Casing Pipe

The number of lineal feet of sewers in jacked or bored casing pipe construction to be paid for under their respective items shall be the actual number of lineal feet of each class and size, measured continuously along the center line of the sewer to manholes in shafts, but not through them, and to the end of the jacked or bored

casing pipe construction wherever it is terminated. Such payment shall include the proper construction of sewers in jacked or bored casing pipe, including excavation, its disposal, sheeting, bracing and casing of the excavation, cement grouting, crane rails or channels, sewer pipe, concrete backfill, plain or reinforced or encasements, connecting and testing of the sewer, the replacement of all structures and pavements and the furnishing of all labor, materials, tools and equipment to complete the work as specified and as shown in the contract documents or ordered in writing by the responsible agency. Such payment shall include all items of expense except such items as are stated in the contract documents to have separate payments.

When a sewer in jacked or bored casing pipe construction ends at a manhole in a shaft, measurement shall be made to the nearest inside face of the wall of the manhole at the invert and will not be paid through the manhole inside diameter dimensions as it is a special structure. At all points where sewers in jacked or bored casing pipe construction change size, the measurement for each size shall be made to the nearest inside face of the wall of the manhole where the change is made.

19. Jacked or Bored Sewers

The number of lineal feet of jacked or bored sewer construction to be paid for under their respective items shall be the actual number of lineal feet of each class

and size, measured continuously along the centerline of the sewer to the inside face of manholes, but not through them, and to the end of the jacked or bored sewer construction wherever it is terminated. In the event that the ends of the construction of this section are not visible, the lineal feet of such construction shall be verified before the backfill covers the ends.

Such payment shall include the proper construction of jacked or bored sewers including excavation, its disposal, sheeting and bracing of the excavation, sewer pipe, connecting and testing of the sewer, the replacement of all structures and pavements and the furnishing of all labor, materials, tools and equipment to complete the work as shown in the contract documents or as ordered in writing by the responsible agency. Such payment shall include all items of expense except such items as are stated in the contract documents to have separate payments.

PART 6 - STANDARD DESIGN AND CALCULATION FORMS.

6.1 Sanitary Sewer Data Sheet
6.2 Sanitary Sewer Design Calculation Sheet
6.3 Storm Sewer Data Sheet
6.4 Storm Sewer Design Calculation Sheet
6.5 Pump Station Data Sheet
6.6 Pump Station Design Calculation Sheet
6.7 Wastewater Treatment Plant Data Sheet
6.8 Wastewater Treatment Plant Design Calculation Sheet

PART 6 - STANDARD DESIGN AND CALCULATION FORMS

6.1 SANITARY SEWER DATA SHEET.

Name of Municipality or Sewer District _____

Name of Project _____

Original Township and Lot Number _____

Name of Engineer or Firm Preparing Plans _____

Address _____ Telephone _____

Name and Address of Governmental Authority to whom plan approval should be sent

_____

Brief description of project. Include information as to (a) the location, size and development of the area to be served, (b) total length of sewer to be installed, (c) possibility of future extensions, (d) exact location of connections to existing sewers, (e) treatment plant receiving wastes, (f) and other data pertinent to the project. (Use attachment if necessary).

_____

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Pipe Material	Mat'l Spec.*	Joint Spec.*	Bedding Class.	Pipe Size	Pipe Length	Min. Slope	Max. Manhole Spacing	Type Manhole	M.H. Joint Spec.*

* List ASTM, AWWA, ANSI

** Or ODOT Specification Number.

a. Specify the type of leakage test (air, infiltration and/or exfiltration) and the limit to be used _____.

Air _____ time for 1 psi drop in pressure, infiltration, exfiltration _____ gallons per inch of pipe diameter.

Tested under supervision of an Engineer. Yes _____ No _____.

Name of Engineer _____.

b. Deflection limit specified _____% (Applies only for flexible pipe)

Tested under supervision of an Engineer. Yes _____ No _____.

Name of Engineer _____.

c. Specifications include provisions for inspection of all construction by an engineer or qualified inspector. Yes _____ No _____.

Name of Engineer of Inspector _____.

Capacity of existing system and/or plant to which connected.

Present Treatment Facility Loading _____ MGD (based on average daily flow previous year).

Present Capacity of Treatment Facility _____ MGD (average daily flow).

If proposed sewer is to be connected to an existing sanitary sewer, give the capacity of the existing sewer available for additional loading at point of connection _____ MGD. (Base calculations on basis of peak flows.)

Estimated hydraulic loading of proposed sewer at point of connection to plant or existing sewer:

initial: _____ Average daily flow: _____ peak flow
(based on existing homes to be served)

design: _____ Average daily flow: _____ peak flow
(based on immediate area served)

ultimate: _____ Average daily flow: _____ peak flow
(based on immediate area and extension)

If the flow figures for items four or five indicate a hydraulic loading over the design capacity of the sewer or treatment plant, explain what steps are being taken to eliminate or reduce the hydraulic loading to an acceptable value

Are the proposed sewers deep enough to serve all adjacent basements?

Yes _____ No _____ If No, explain: _____

_____

_____

a. Are the sewers at least 10 feet horizontally from water lines and/or at least 18 inches below the water line. Yes _____ No _____. If No, why? _____

_____

b. Are any water supply sources, public or private, located within 200 feet of the sewers? Yes _____ No _____ .

If Yes, specify plan sheet(s) on which sources are shown _____

_____

If Yes, will sewers be encased or watertight? Yes _____ No _____

c. Is there any connection between the sewer and a public or private potable water supply or appurtenances? Yes _____ No _____

d. Are sewers in streams constructed to remain watertight and in alignment? Yes _____ No _____ N/A _____

e. Are watertight covers used where manholes are subject to flooding by street runoff or high water? Yes _____ No _____

a. Are manholes provided at all changes in size, grade, alignment, and sewer intersections? Yes _____ No _____

b. Are drop manholes provided where the entrance sewer invert is 30 inches or more above manhole invert: Yes _____ No _____

a. Where small sewers join larger ones, have the inverts of the larger sewers been lowered sufficiently to maintain the same energy gradient? Yes _____ No _____ N/A _____

b. Have provisions been made to protect sewers at velocities of over 10 feet per second? Yes _____ No _____ N/A _____

c. Are sewers secured with concrete anchors (or equal) spaced as required? Yes _____ No _____ N/A _____

a. Are there any overflows or bypasses? Yes _____ No _____

b. If Yes, specify plan sheet(s) where shown _____

_____

a. Will this project include any pump stations? Yes _____ No _____
If Yes, please complete pump station data sheet.

b. Will there be a pump station involved in receiving sewage from the sewer extension? Yes _____ No _____ N/A _____

If Yes, specify present and design flows of pumping station. _____

_____

_____

Estimated Cost of Projects $_____

NOTE:

A statement that "Roof drains, foundation drains, and other clean water connections to the sanitary sewer system are prohibited", must be shown on the plans or sewer permit.

THE FOREGOING DATA IS A TRUE STATEMENT OF FACTS PERTAINING TO THIS PROPOSED SANITARY SEWER INSTALLATION.

DATE: _____ SIGNED: _____

Professional Engineer (preparing plans)

PART 6 - STANDARD DESIGN AND CALCULATION FORMS.

6.2 SANITARY SEWER DESIGN CALCULATION SHEET.

MUNICIPALITY OR SEWER DISTRICT

_____ DATE _____

PROJECT _____ ENGINEER _____ BY _____

h_v $\frac{V^2}{2g}$ (1)	(Street (2)	(From M.H. (3)	To M.H. (4)	(Length Feet (5)	Area Acres (Increment (6)	Accum. (Total (7)	Average Flow Per Acre (G.P.D.) (8)	Average Flow Flow (G.P.D.) (9)	Peak Factor (10)	Peak Flow (M.G.D) (11)	Infilt/(M.G.D.) at 375 G/A/D (12)	Infiltration (Accumulated) (G.P.D.) (13)	Total Peak Flow M.G.D. (14)	n = Pipe Dia. (inches) (15)	Slope % (16).	Capacity Full (M.G.D.) (17)	Velocity Full (F.P.S.) (18)	Velocity Actual (F.P.S.) (19)

Sewerage Design Map Also Required - See Section 3.014

PART 6 - STANDARD DESIGN AND CALCULATION FORMS.

6.3 STORM SEWER DATA SHEET.

Name of Municipality or Sewer District _____

Name of Project _____

Original Township Lot and Tract Number _____

Name of Engineer or Firm Preparing Plans _____

Address _____

Name and Address of Governmental Authority to whom plan approval should be sent

_____

Brief description ot project. Include information as to (a) the location, size and development of the area to be served, (b) total length of sewer to be installed, (c) possibility of future extensions, (d) exact location of connections to existing sewers (e) conditions affecting natural drainage, (f) type of ground cover and average slope, (g) and other data pertinent to the project.

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Pipe Material	Spec.*	Joint Spec.	Pipe Class. (1,2 or 3)**	Pipe Size	Pipe Length	Min. Slope	Max Manhole Spacing	Type Manhole	H.J Spect.*

* List ASTM, AWWA, ANSI

** Or ODOT Specification No.

Deflectionlimit specified _____% (Applies only for flexible pipe)

Tested under supervision of an Engineer. Yes _____ No _____

Name of Engineer _____

Specifications include provisions for inspection of all construction by an engineer or qualified inspector. Yes _____ No _____

Name of Engineer of Inspector _____

Estimated hydraulic loading of proposed sewer; flows full, no head.

Are manholes provided at all changes in size, grade, alignment, and sewer intersections? Yes _____ No _____

Where small sewers join larger ones, have the inverts of the larger sewers been lowered sufficiently to maintain the same energy gradient?

Yes _____ No _____ N/A _____

Have provisions been made to protect sewers at velocities of over 18 feet per second? Yes _____ No _____ N/A _____

Are sewers secured with concrete anchors (or equal) spaced as required?

Yes _____ No _____ N/A _____

Estimated Cost of Projects $_____

Building sewers shall be constructed in accordance with specifications equal to those indicated above. Yes _____ No _____

Plans for connection of a proposed installation to a county, village, or municipal sewer or other political entity, must be accompanied by written consent of both entities.

If applicable to this project written consent agreement is attached.

Yes _____ No _____

What is the minimum difference in elevation between the bottom of any existing or proposed footings and the crown of the storm sewer at the point of connection of the lateral. _____

What is the minimum difference in elevation between the lowest floor elevation of any existing or proposed structure and the crown of the sewer. _____

PART 6 - STANDARD DESIGN AND CALUCULATION FORMS.

6.4 STORM SEWER DESIGN CALCUATIONS.

MUNICIPALITY OR SEWER DISTRCT _____ DESIGN STORM FREQUENCY Date _____

PROJECT _____ ENGINEER _____ By _____

Street (1)	From M.H. (2)	To M.H. (3)	Area Acres		Time of Flow (Min.)			c (runoff coeffient) (9)	i (rainfall intensity) (10)	Q(c.f.s.) (11)	Design n				Profile				
			(Increment) (4)	Total Area (5)	To Inlet (6)	In Pipe (7)	Time of Conc. (8)				Pipe Size in. (12)	Slope % (13)	Capacity (full)c.f.s. (14)	Velocity ft./sec. (15)	Length ft. (16)	Fall ft. (17)	Other Losses & Fall in MH (18)	Invert Elev Upper End (19)	Invert Elev Lower End (20)

PART 6 - STANDARD DESIGN AND CALCULATION FORMS.

6.5 PUMP STATION DATA SHEET.

Name of Municipality or County Sewer District _____

Name of Project _____

Original Lot and Tract No. _____

Name of Engineer or Firm Preparing Plans _____

Address _____

Name and Address of Municipal or County Official to whom plan approval should be sent _____

Site	Yes	No
(a) Accessible at all times	_____	_____
(b) Graded around station so as to lead surface drainage away from the station	_____	_____
(c) Protected to prevent vandalism and entrance by unauthorized persons or animals	_____	_____
(d) Subject to flooding	_____	_____

(e) Distance to nearest dwelling _____

Estimated average flow tributary to this station _____ GPD

Estimated peak flow tributary to this station _____ GPD

Type Waste to be Pumped

_____ (a) Sanitary

_____ (b) Combined (Sanitary & Storm)

_____ (c) Industrial

Source of Industrial Waste _____

_____

Pneumatic Ejectors

(a) Make and Model Number _____

(b) Operating Conditions _____ GPM @ _____ T.D.H.

(c) Number of compressors _____

(d) Number of pots _____

(e) Capacity of pot _____

Pumps

(a) Number _____

(b) Make, Model # and Type (Suction lift, positive disp., centrifugal, horizontal centrifugal) Make _____

Model _____

Type _____

(c) Materials (Cast iron, stainless steel, etc.)

Casing _____

Impeller _____

(d) Operating conditions _____ GPM @ _____ T.D.H.

(e) Maximum allowable speed _____ RPM

	YES	NO
(f) Will pass 3 1/2" sphere	____	____
(g) Water seal unit air gapped	____	____

Dry Well

(a) Type of construction _____

(b) Corrosion protection _____

	YES	NO
(c) Stairway or access ladder with treads of nonslip material	____	____
Stairway or safety landings provided every 10'	____	____
(d) Ventilation-positive	____	____
Outside controls	____	____
Number of air changes per hour _____		
(e) Dehumidifier to insure a dry atmosphere for protection of motors and control system	____	____
(f) Lighting - explosion proof	____	____
- outside controls	____	____
(g) Sump pump to handle floor drainage	____	____
- discharge line air gapped above high water alarm elevation	____	____

Wet Well Type of Construction _____

(a) ASTM C-443 joints between precast concrete section Yes _____ No _____

(b) Effective Capacity _____Gal. Design Detention Time _____ at _____flow

(c) Elevations:

Inlet invert _____

Outlet invert _____

Bottom of wet well _____

Low shut off _____

No. 1 Start _____

No. 2 Start _____

No. 3 Start _____

High Water Alarm _____

By-pass or overflow Yes _____ No _____
If yes, is treatment provided? Yes _____ No _____
Explain.

Lowest Basement _____

(d) High Water Alarm Make _____

Model _____

Type _____

	YES	NO
Battery Operated Alarm	_____	_____
Telemetered Alarm	_____	_____
Provisions for retaining overflow waste on-site	_____	_____

Controls Make _____

Model _____

Type _____

Alternating Yes _____ No _____

Enclosure: Nema _____

PART 6 - STANDARD DESIGN AND CALCULATION FORMS.

6.6 PUMP STATION CALCULATION SHEET.

Name of Municipality or Sewer District _____

Original Lot, Township and Tract _____

For: _____ By: _____

Location: _____ Date: _____

Wet Well Calculations:

(a) Pumping Station No. _____.

(b) Average Daily Flow into Station incl. infiltration = _____GPD.

(c) Peak Factor = _____.

(d) Present Flow:

Peak Flow into Station = _____GPM.

Estimated ultimate Peak Flow into Station = _____GPM.

(e) Rated pump delivery = _____GPM.

(f) Storage volume between high and low levels = _____gallons.

(g) Wet well diameter = _____ft. & _____gal./ft.

(h) Total time between successive pump starts = _____min.

$$\text{Line } \frac{\text{Line (f)}}{\text{(e) - Line (d)}} + \frac{\text{Line (f)}}{\text{Line (d)}} = \text{Line (h)}$$

Total Dynamic Head Calculations:

External Loss (Dynamic)

(a) Force main size = _____inches.

(b) Friction loss = _____ft./]00 feet of pipe.

(c) Length of Force Main = _____feet.

(d) Equivalent length of pipe due to bends, etc. = _____feet.

(e) Total length of pipe (actual & equivalent) = _____feet.

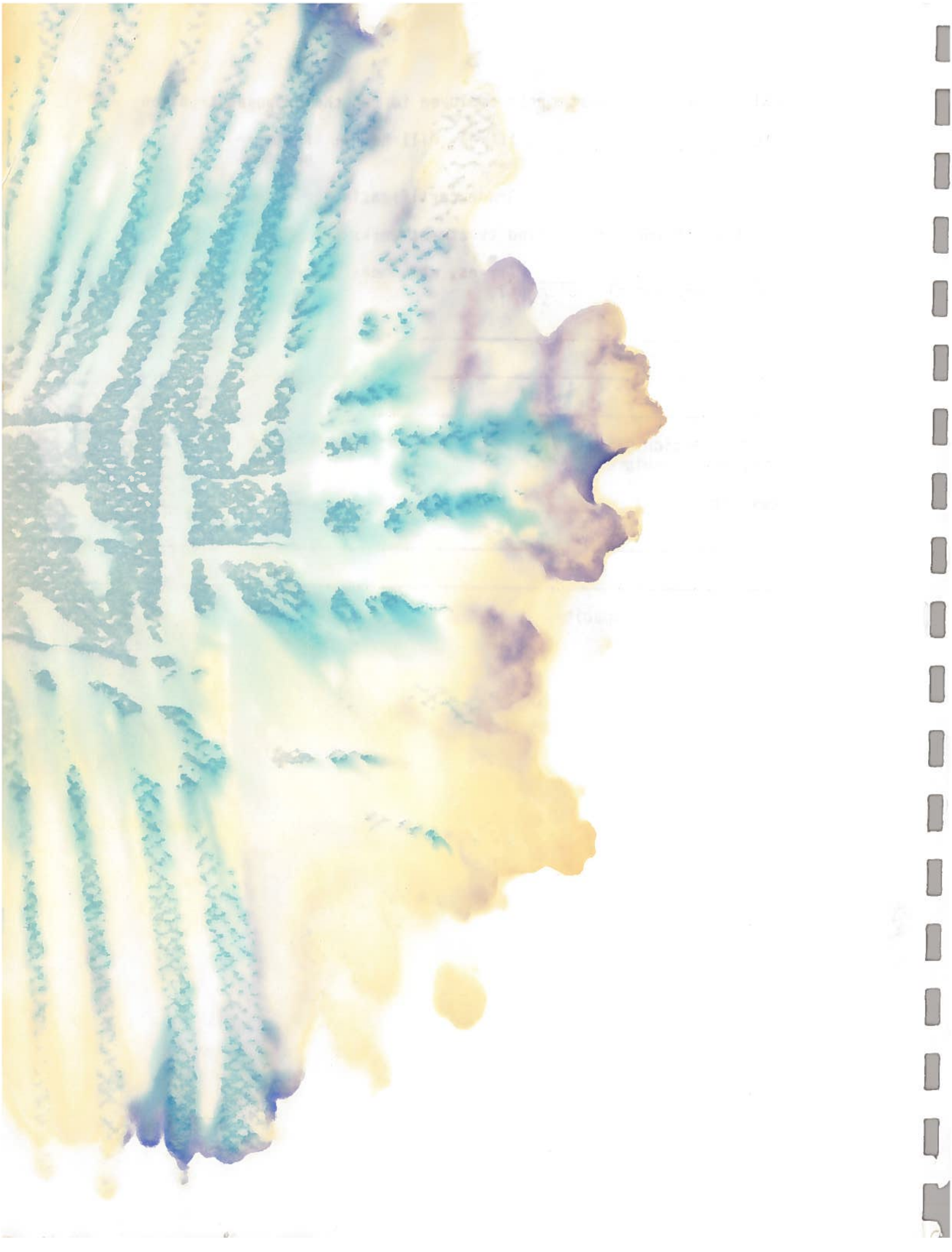
(f) Total friction loss = _____feet.

	YES	NO
Is flow measuring device provided	_____	_____
Is stand-by power supply available	_____	_____
Is emergency pumping facilities provided	_____	_____

The foregoing is a true statement of facts pertaining to this proposed pump station installation.

DATE: _____ SIGNED: _____
Sanitary Engineer (preparing plans)

REVISED: 1/6/77



Will a certified operator be employed to run the proposed treatment works?

Yes _____ No _____ If yes, will he be: fulltime _____
parttime _____

Grade certification level: _____

Is the site for the proposed treatment works subject to flooding?

Yes _____ No _____ If yes, what measures will be taken to protect mechanical equipment?

_____

_____

_____

What provisions, if any, will be made to provide standby power for electrical equipment:

Describe: _____

_____

_____

Should include capacity.

If chlorination is to be used in what form will it be?

Gas _____ Powder _____ Tablet _____

Volume of contact tank(s): (based on 15 minutes retention at the peak flow rate)

Peak flow rate* _____gal./min. x 15 min. = _____gal.

_____gallons supplied

*Note: The peak flow rate shall be equal to the maximum rate of the pumping facilities preceding the contact chamber.

Are the tank(s) baffled or so constructed as to reduce short circuiting of flow to a minimun? Yes _____ No _____

Describe provisions for cleaning tank(s) and for maintaining adequate desinfection during cleaning operations:

_____

_____

Chlorine dosage rate: _____ mgl (at peak flow rate)

Will duplicate chlorinators be provided? Yes _____ No _____

Will the chlorinator be housed? Yes _____ No _____

Describe: _____

_____

What type of flow measurement device, if any, will be installed? Describe: (indicating, recording, totalizing, etc.)

_____

_____

What laboratory facilities or other types of monitoring equipment will be provided? Describe:

_____

_____

_____

What is the estimated cost of the above proposed wastewater treatment facility? $_____

$$\frac{\text{Peak flow rate*} \_\_\_\_\_ \text{gal./min.}}{3.33 \text{ gpm/sq.ft.}} = \_\_\_\_\_ \text{sq. ft.}$$

_____ submerged square feet provided

_____ total square feet provided

_____ number of microstrainers

*Note: The peak flow rate shall be equal to the maximum rate of the pumping facilities preceding the microstrainers.

a. Continuous backwash rate: _____gal./min./ft. of microstrainer length.

b. Number of backwash pumps: _____ @ _____gal./min.

Note: Please refer to Part II of Ohio EPA's "Recommended Engineering Procedures and Design Guidelines Relative to Advanced Wastewater Treatment" in designing microstrainers.

If lagoons are to be utilized their total volume will be:
(based on five (5) days detention)

Design hydraulic flow _____gal./day x 5 = _____gal.

_____gallons supplied

Average design flow depth: _____feet

Number of cells: _____

Minimum freeboard of _____feet will be provided.

The embankments of the lagoons shall have a maximum slope of _____ vertical to _____horizontal.

Does the overflow structure provide flexible water depth control and operation of facilities? Yes _____ No _____

Note: Prior to designing tertiary lagoons contact the Division of Waste Management and Engineering in the appropriate District Office for information relative to the acceptability of the proposal.

What type of disinfection process will be employed?

Chlorination _____ Ozone _____ Other _____ .

Describe: _____

_____

_____

Check which of the following modes of advanced treatment or effluent disposal are to be installed:

_____ Surface slow sand filter
_____ Rapid sand gravity filter
_____ Microstrainers
_____ Lagoons
_____ Other: _____

If surface slow sand filters are to be installed, the area provided shall be: (based on 11.5 gallons per square foot per day)

$$\frac{\text{ADDF} \_\_\_\_\_ \text{gal./day}}{11.5 \text{ gal./sq.ft./day}} = \_\_\_\_\_ \text{sq. ft.}$$

_____square feet provided _____number of beds

a. Capacity of dosing chamber shall be: _____gallons

b. Size of dosing pumps: _____ gal./min. (with largest pump out of service)

Note: Dosing chamber and pumps must be sized to dose half of the total filter to a depth of three inches within 10 to 15 minutes.

c. Dosing siphon height above sand beds: _____ feet

If rapid sand gravity filters are to be installed, the area provided shall be: (based on 3.33 gpm/sq.ft. at the peak flow rate)

$$\frac{\text{Peak flow rate*} \_\_\_\_\_ \text{gal./min.}}{3.33 \text{ gpm/sq.ft.}} = \_\_\_\_\_ \text{sq. ft.}$$

_____square feet provided _____number of cells

*Note: The peak flow rate shall be equal to the maximum rate of the pumping facilities preceding filtering.

a. Clearwell capacity: _____gallons

b. Rate of backwash: _____gpm/sq.ft.

c. Duration of backwash: _____ minutes

d. Number of backwash pumps: _____ @ _____gal./min,

e. Mudwell capacity: _____ gallons

Note: Please refer to Part II of Ohio EPA's "Recommended Engineering Procedures and Design Guidelines Relative to Advanced Wastewater Treatment" in designing rapid sand gravity filters.

If microstrainers are to be installed, the net submerged effective area of the microstrainer fabric shall be: (based on 3.33 gpm/sq.ft. at the peak flow rate)

Describe method and frequency of sludge removal and method and location of sludge disposal:

_____

_____

_____

_____

Amount of sludge to be removed _____lbs./day.

If a sludge storage tank is to be installed, the volume of the tank(s) will be: (based on at least 10% of design loading).

$$\frac{\text{Design } BOD_5 \text{ loading}}{0.167 \text{ lbs. } BOD_5/\text{population equivalent}} \quad \text{lbs./day x 100 x 10\%} = \_\_\_\_\_ \text{gal. (minimum)}$$

Aeration tank vol. x 10% _____gallons supplied

a. Air supply: _____cu.ft./min. (with largest blower out of service)

Note: A minimum storage volume of 1000 gallons will be required for plants with a design flow of less than 10,000 gal. day

If aerobic digestion of sludge is to be utilitzed, the volume of the tank(s) will be: (based on three cubic feet per population equivalent)

$$\frac{\text{Design } BOD_5 \text{ loading}}{0.167 \text{ lbs. } BOD_5/\text{population equivalent}} \quad \text{lbs./day x 3 x 7.48} = \_\_\_\_\_ \text{gal. (minimum)}$$

_____gallons supplied

a. Air supply: (based on 20 cu. ft./min. per 100 cu. ft. of volume)

$$\frac{\text{gallons supplied x 20 cu.ft./min.}}{7.48 \text{ gal./cu.ft. x 1000 cu.ft.}} = \_\_\_\_\_ \text{cu. ft./min.}$$

Air supplied: _____cu.ft./min. (with largest blower out of service)

If anaerobic digestion of sludge is to be utilized, the volume of the tank(s) will be: _____gal.

Note: Basis of design and calculations must be submitted for the above volume.

If sludge drying beds are to be installed, the area provided shall be: (based on one square foot per population equivalent)

$$\frac{\text{Design } BOD_5 \text{ loading}}{0.167 \text{ lbs./population equivalent}} \quad \text{lbs./day} = \_\_\_\_\_ \text{sq. ft.}$$

_____square feet provided _____number of beds

Note: Where phosphate removal or other chemical treatment processes are to be utilized, design of sludge handling facilities must take into account possible increased sludge production.

Are the aeration plates, tubes, or jets used for the introduction of air to mixed liquor removable for inspection, maintenance, and replacement without de-watering the tank?

Yes _____ No _____ N/A _____

If mechanical aerators are to be used the oxygen required will be:

_____ lbs. BOD_5/day x 2 = _____ lbs. O_2/day

Oxygen supplied: _____ lbs. O_2/day

Note: Calculations and data should be included to verify the O_2 transfer rate used to compute the supplied amount of O_2/day.

Settling chamber volume: _____gallons

Settling chamber detention time:

$$\frac{\text{Chamber volume } \_\_\_\_ \text{ gal. x 24 hours}}{\text{ADDF } \_\_\_\_ \text{ gal./day}} = \_\_\_\_\_ \text{ hours}$$

Note: Non-mechanical hoppered tanks only may include the upper 1/3 (by height) of the hopper(s) in computing detention time.

Surface settling rate:

$$\frac{\text{ADDF } \_\_\_\_ \text{ gal./day}}{\text{Surface area } \_\_\_\_ \text{ sq.ft.}} = \_\_\_\_\_ \text{ GPD/sq.ft.}$$

At peak flow:

$$\frac{\text{PIR } \_\_\_\_ \text{ gal./min/ x 1400}}{\text{Surface area } \_\_\_\_ \text{ sq. ft.}} = \text{GPD/sq.ft.}$$

Note: If the influent pumping rate (IPR) exceeds the peak influent flow rate (PIR), then it should be substituted in the above equation for (PIR).

Weir overflow rate:

a. At peak flow:

$$\frac{\text{PIR } \_\_\_\_ \text{ gal./min. x 1440}}{\text{Total weir length } \_\_\_\_ \text{ feet}} = \text{GPD/lin.ft.}$$

Note: If the influent pumping rate (IPR) exceeds the peak influent flow rate (PIR), then it should be substituted in the above equation for (PIR).

b. Are the weirs adjustable: Yes _____ No _____

Describe method of scum removal and disposal: _____

_____

_____

Scum storage capacity _____

Pre-treatment devices:

Trash trap: yes _____ no _____ Capacity _____gal.

Comminutor with bar screen bypass: yes _____ no _____

Other _____

Design capacity of comminutor _____gal./min.

Method of flow division where parallel aeration unit arrangements are planned. Describe: _____

_____

Aeration chamber volume: (based on 80 cu. ft./lb. BOD_5)

_____lb. BOD_5/day x 80 cu.ft. x 7.48 gal./cu.ft. = _____gal.

_____gallons supplied

Aeration detention time:

$$\frac{\text{Chamber volume } \_\_\_\_\_ \text{ gal. x 24 hours}}{\text{ADDF } \_\_\_\_\_ \text{ gal./day}} = \_\_\_\_\_ \text{ hours}$$

Are the dimensions and proportions of the aeration tanks such as to maintain effective mixture and utilization of air, to prevent unaerated sections and noticeable channeling, and to maintain velocities sufficient to prevent deposition of solids?

yes _____ no _____

Are inlets and outlets for each aeration tank provided with valves, gates, stop-planks, weirs, or other devices to permit flexibility in controlling the flow to any unit to maintain a reasonable constant water level and to permit cleaning of individual units?

yes _____ no _____

Amount of air required: (based on 2600 cu.ft./lb. BOD_5/day)

$$\frac{\text{lbs. } BOD_5\text{/day x 2600 cu.ft.}}{\text{1440 min./day}} = \_\_\_\_\_ \text{cu.ft./min.}$$

Amount of air supplied: _____cu.ft./min. (with largest blower out of service)

Note: Additional capacity should be provided to operate airlifts and skimmers.

PART 6 - STANDARD DESIGN AND CALCULATION FORMS.

6.8 WASTEWATER TREATMENT PLAN DESIGN CALCULATION SHEET.

Municipality, County & Sewer District _____

Address of Treatment Facility _____

Original Lot & Tract No. _____

Engineer _____

Date _____

Name & Address of Governmental Agency for Approval _____

_____

Design period: _____ First phase _____
Ultimate _____

Number of persons to be served: _____ First phase _____
Ultimate _____

Average daily design hydraulic flow (ADDF): _____ gal./day

Design BOD_5 loading: _____ lbs. BOD_5/day

Significant runoff period (SRP): _____ hours

Peak Factor (PF): _____ unitless

Peak influent flow rate (PIR):

$$\frac{\text{ADDF}}{\text{SRP}} \quad \frac{\text{gal./day x PF}}{\text{hours x 60 min.}} = \text{_____ gal.min.}$$

If an equalization basin is to be used, its volume will be _____ gal.

Air to be supplied: _____ cu.ft./min. (with largest blower out of service)

Plant influent pumping station: Yes _____ No _____

Number of pumps _____ Type of pumps _____

Influent pumping rate (IPR): _____ gal./min. (with largest pump out of service)

NOTE: Influent pumping facilities shall be capable of pumping the peak influent flow rate (PIR) with the largest pump out of service, unless a flow equalization basin is installed. Include here the wet well calcs from pumping station - 7.601.

What is the estimated cost of the above proposed wastewater treatment facility? $_____

Will a certified operator be employed to use the proposed treatment works?

Yes _____ No _____ If yes, will he be:

fulltime _____ parttime _____ What grade level: _____

What provision if any, will be made to provide standby power for electrical equipment? Describe: _____

_____

_____

A mechanical sludge collecting device will be installed:

Yes _____ No _____ If yes, type _____.

Froth control equipment will be installed: Yes _____ No _____

Hosing facilities for routine flushing of walls and walkways will be installed:

Yes _____ No _____

Sludge handling facilities will be installed: Yes _____ No _____

What mode of advanced treatment or effluent disposal is to be installed?

_____

What type of disinfection process will be employed:

Chlorination _____ Ozone _____ Other _____

If other, describe: _____

If chlorination is to be used, in what form will it be?

gas _____ powder _____ tablet _____

Describe provision for cleaning tanks and for maintaining adequate disinfection during cleaning operations: _____

_____

_____

What type of flow measurement device, if any, will be installed?

Describe: _____

_____

_____

What laboratory facilities or other types of monitoring equipment will be provided: Describe: _____

_____

What type of high water alarms if any are provided? Describe: _____

_____

_____

Pretreatment Devices:

Trash trap: Yes _____ No _____ Capacity _____gal.

Comminutor with bar screen by-pass: Yes _____ No _____.

Other _____

Design capacity of comminutor _____gal/min.

Method of dlow division where parallel aeration unit arrangements are planned. Describe: _____

_____

Are inlet and outlets for each tank provided with valves, gates, stop-planks, weirs or other devices to permit flexibility in controlling the flow to any unit to maintain a reasonably constant water level and to permit cleaning of individual units? Yes _____ No _____ N/A _____

Describe method of scum removal and disposal:

_____

_____

_____

Describe method and frequency of sludge removal and method and location of sludge disposal: _____

_____

_____

Are baffles to be provided at the inlet and within six inches of the outlet to prevent turbulence and short circuiting: Yes _____ No _____

Does each sludge hopper have an individually valved withdrawal line?

Yes _____ No _____ N/A _____

(a) Minimum diameter of withdrawal line is _____inches.

(b) Head for sludge withdrawal is _____feet.

(c) The side walls of the hopper(s) will have a minimum slope of _____ vertical to _____horizontal. N/A _____

PART 6 - STANDARD DESIGN AND CALCULATION FORMS.

6.7 WASTEWATER TREATMENT PLANT DATA SHEET.

Name of Municipality or County Sewer District _____

Name of Project _____

Original Lot and Tract No. _____

Name of Engineer or Firm preparing plans _____

Address _____

Name and Address of Municipal or County Official to whom plan approval should be sent _____

Site

(a) Subject to flooding _____ If yes, what measures will be taken to protect mechanical equipment?

(b) Distance to nearest dwelling _____

Design period _____ First phase _____
Ultimate _____

Average daily design hydraulic flow (ADDF) _____ gpd

Design BOD_5 loading: _____ lbs. BOD_5/day _____

Type waste to be treated:

_____ (a) Sanitary

_____ (b) Combined (sanitary and storm)

_____ (c) Industrial

Source of industrial waste _____

Plant influent pumping station: Yes _____ No _____,

number of pumps _____, type of pumps _____, influent pumping rate (IPR) _____gal/min (with largest pump out of service).

Will pass 3 1/2" sphere: Yes _____ No _____.

Operating conditions _____ gpm @ _____TDH, maximum allowable speed _____ rpm.

Internal Loss (Dynamic)

(a) Pumping Station Losses = _____feet.

Static Head:

(a) Highes Elevation of Force Main = _____feet.

(b) Elevation of Suction = _____feet.

(c) Static Lift = _____feet.

Total Dynamic Head:

Lines 7.603 + 7.604 + 7.605 = _____feet.

Net Positive Suction Head Calculations: (when applicable)

(a) Atmospheric pressure & sea level = 33.90 feet.

(b) Atmospheric pressure & site = _____feet.

(c) Atmospheric pressure available at site = _____feet.

(d) Total dynamic suction lift = _____feet.

(e) Vapor pressure 74° liquid = _____feet.

(f) Safety Factor = _____feet.

(g) N.P.S.H. Available = _____feet.

(h) N.P.S.H. Required by Pump = _____feet.

(i) Excess N.P.S.H. Available = _____feet.

(j) Priming Lift (high liquid level to & pump) = _____feet.

Buoyancy Calculations:

(a) Weight of soil = _____lbs./cu. ft.

(b) Downward force of soil on top area of station = _____lbs.

(c) Watertable Eleveation = _____feet.

(d) Upward bouyant force at center of buoyancy = _____lbs.

(e) Weight of Station exerted at center of gravity = _____lbs.

(f) Resultant = Line (b) + Line (e) - Line (d) = _____lbs.

Pumps: - Rated Capacities

Make _____

Model _____