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- CS100 OBJECTIVE
- The objective of these Minimum Design Standards is to provide each living unit with a water-carried sewerage system adequate to collect, treat and dispose of wastewater in a manner which will not create nuisances or endanger the public health or the environment.
- CS200 GENERAL ACCEPTABILITY
- CS201 LOCAL CODES AND REGULATIONS
- CS201-1 The minimum standards set forth herein have been established to accomplish certain basic HUD-FHA objectives and shall not be construed as relieving developers or builders of responsibility for compliance with local ordinances, codes and regulations, including established requirements of the U.S. Environmental Protection Agency or its delegated regulatory agency. To the extent that local, state, or Federal requirements exist which are more stringent than these Minimum Design Standards, the more stringent standard shall apply for insuring purposes.
- CS201-2 HUD-FHA does not assume the responsibility for enforcing or determining compliance with local codes or regulations or making interpretations regarding their application in any specific instance.
- CS201-3 HUD-FHA approval of all wastewater systems is contingent upon approval from the U.S. Environmental Protection Agency or its delegated regulatory agency for the system, including discharge permit where applicable. (See Section CS302.)
- CS201-4 Where the local codes, regulations or permits provide for less stringent standards than are required herein, these Minimum Design Standards shall apply. In the event the local codes, regulations or other requirements preclude compliance with these standards, the property will be ineligible unless the
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CS202 REVISIONS TO APPROVED PLANS

Any deviations from the approved plans or specifications must be approved in writing by the appropriate Field Office before such changes are undertaken. A request for such approval shall be accompanied by written evidence that the proposed changes are acceptable to the U.S. Environmental Protection Agency or their delegated regulatory agency, and any other state or local authority having jurisdiction. The request shall also be accompanied by a supplementary engineer's report describing the changes and the reasons for them.

CS203 DESIGN PERIOD

Sewerage systems shall be designed to provide adequate service for the economic life of all the residences to be served.

CS204 AREA TO BE SERVED

The initial plans and specifications shall provide for a sewerage system adequate to serve all prospective connections where all the properties proposed for development are to be completed on a continuous construction schedule.

CS205 STAGED CONSTRUCTION

Construction of sewerage systems in stages will be considered where the entire development is to be completed as a series of individual sections or groups of properties according to a development plan but not necessarily on a continuous schedule. Where staged construction is proposed, the original design plans and specifications shall provide for collection and treatment facilities adequate to serve the properties to be included in each development stage. The sub-trunk and trunk sewers shall be adequately

designed to handle the flow from sewer lines to serve the properties to be developed in all future stages of residential construction. A proposal for staged development shall be described in detail in the engineer's design development report (DDR).

CS300 SUBMISSION OF EXHIBITS

CS301 FEASIBILITY STAGE

Prior to the preparation of detailed engineering plans and specifications or any engineering reports, it is recommended that the project be discussed with the appropriate Field Office and the HUD-FHA Environmental Engineer or Construction Analyst. During this initial feasibility-stage, the field office representative and/or the HUD-FHA Environmental Engineer will offer an informal opinion as to the general feasibility of the project. The purpose of this informal opinion is to avoid unnecessary expense associated with the planning and design requirements contained in subsequent stages for projects which are clearly not feasible. However, importantly, a favorable opinion during this stage DOES NOT indicate or imply in any way approval of the project. Formal and final project approval will be provided as set forth in subsequent stages below. Note: A general location map of the area (a printed topographic quadrangle or United States Army map where available) with the location of the development shown thereon should be provided during this feasibility stage.

CS302 PRELIMINARY PLANNING STAGE

Prior to the preparation of detailed engineering plans and specifications, the submission of an engineering Design Development Report (DDR) giving the basic data on which the design of the system is to be developed is required. This report shall include information on the proposed size of the sewer pipes in the collection system; the type and capacity of the sewage treatment plant proposed; the point of final disposal of the sewage treatment plant effluent; and approval

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of the DDR from the U.S. Environmental Protection Agency, its delegated regulatory agency and/or other authority having jurisdiction over such matters, indicating that the degree of treatment and point of final disposal for the effluent will be suitable as to location and will be acceptable for the development under consideration.

Information concerning the structure of the organization which will own and operate the system and the means by which continuous satisfactory operation and maintenance of the system at reasonable cost is also required during the

preliminary planning stage. It is essential during this stage to demonstrate that the proposed organizational structure will provide for continuous satisfactory operation and maintenance of the system at reasonable rates. In those instances where this assurance cannot be clearly demonstrated, HUD-FHA may require a trust indenture from a responsible public entity to operate the system in the event of default, or, HUD-FHA may refuse approval of the project. Please refer to HUD Handbook 4075.12 REV. All facility planning and preliminary designs must be in accordance with all Federal, state and local National Environmental Policy Act requirements.

CS303 FINAL PLANNING AND DESIGN STAGE

CS303-1 Once the DDR required in the preliminary planning stage has been approved by HUD, the final planning and design stage may be commenced. Not less than the following exhibits are required during this stage for submission:

- A. A final engineering report containing detailed and specific information from which the design of the system was developed, where such data varies from or was not included in the original DDR.
- B. Detailed engineering plans bearing the seal of a professional engineer registered in the state where the improvements are proposed.
- C. Detailed specifications.

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CS303-2 The following specific data shall be included in the exhibits described above:

- A. Volume and strength of domestic sewage flow used in the design. (See CS603). Estimates will be acceptable for new systems. For extensions to existing systems actual flow and strength determinations shall be required. Details of the method used to determine ground water infiltration shall be included where it is appropriate. Actual measurements of flow are required where feasible and practical for extensions to existing systems to determine minimum, average, and maximum flow conditions. Strength determinations of sewage for existing systems should be based on reports of laboratory analyses of composite samples

taken over a continuous 24-hour period.

- B. An indication as to whether garbage disposals ("grinders") are being or will be used in the residential units being served.
- C. Existing Sewers - A discussion of the nature, location, extent and construction features of existing sewers that would be used to accommodate the proposed work. Submit technical data as evidence that existing sub-trunk, trunk or outfall sewers are adequate in capacity and structural quality to handle the proposed sewage flows.
- D. Geotechnical Report - Unless it can be shown through prior studies, soil maps or common knowledge that soil and groundwater conditions are not adverse or unusual, every project shall have an accompanying geotechnical report. The project geotechnical report shall address all the issues for which such information is necessary or desirable in order to make sound engineering decisions. Soil bearing pressures shall be provided for heavy structures. Depth to rock and groundwater shall be provided for construction beneath the surface in areas which rock or groundwater may be an issue during construction. Soil permeabilities shall

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be identified for holding pond projects which employ earthen liners. Swampy areas and expansive clay areas shall be delineated. Additionally, for each geotechnical issue identified as being unusual or requiring special attention, the geotechnical report shall provide recommended geotechnical solutions.

- E. Water Supply - Where adverse impact on local water supplies is possible as a result of the project, the following information shall be provided: A discussion of the location of wells or surface water supply intakes, treatment plants, reservoirs, or other structures of public health significance with relation to various parts of the sewerage system. Report the minimum, maximum, and average annual daily consumption of all existing water systems within close proximity of the project area.
- F. Receiving Stream - Where final disposal of sewage is

to a receiving stream, indicate the stream and point of discharge on a map of the area. Describe the characteristics of the stream and give the recorded or, if necessary, the estimated minimum and average annual daily flow. Give the highest known highwater marks, in relation to the elevation of the trunk sewer outfall and the flow line of various components of the sewage treatment plant. Any unusual flow characteristics or use of the stream (e.g., "trout stream") should also be discussed. If a lake is used for this purpose, include such pertinent information as the surface area, location, depth near the outlet, average rate of inflow and state any other purposes for which the lake is used (e.g., water supply, recreation, fishing, etc.).

- G. Design Data - Include all design criteria and assumptions used to determine the total flow for which each line in the collection system and the outfall sewer is designed. The computations for determining the diameter and related flow characteristics should be included. Likewise, the criteria and computations used

in developing the design of all sewage treatment plant units and pumping stations should be shown. Also, discuss the reasons for using the type of treatment proposed and the degree of treatment that can be expected from the processes to be utilized.

The use of "packaged" and "proprietary" (Brand name) pumping, transport and/or wastewater treatment equipment is acceptable. Packaged and proprietary systems shall conform to all the applicable requirements contained in this Handbook. In all instances where "packaged" or "proprietary" systems are proposed, the following shall be demonstrated:

1. The existence of a unit of similar type which has been in successful operation for twenty years or more, or
2. The existence of two units of similar type which have been in successful operation for two years or more.

In considering whether a particular unit has been in

"successful operation", the following factors shall be considered:

1. Operating performance
2. Reliability
3. Maintenance requirements.
4. Operating efficiency
5. General durability of all components including coatings and corrosion protection

If staged construction is contemplated, the design exhibits and computations should cover the complete system clearly indicating each stage of construction and the properties to be served during each stage.

- H. A topographic location map of the land on which the system is to be constructed including the treatment plant site shall be provided. A USGS "Quad" map

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(1" = 200'; 20' contour interval) is adequate for this purpose.

- I. Complete working drawings of the system including: plans, profiles, and details of the sewage collection system and appurtenances.
- J. Details of pumping stations including pump installation, electrical and piping details. Include force main details when used. It is recommended that all pumping station submittals include the following information:
1. TDH, NPSH Calculations
 2. Static Head
 3. Pump Curves from Manufacturer
 4. System Curve(s)
 5. Head Curve(s)
 6. Wet Well Volume
 7. Cycle Time
 8. Pump Station Friction Losses
 9. Buoyancy Calculations
 10. Force Main Friction Losses
 11. Force Main Diameter and Length
 12. Force Main Material Type
 13. Elevation and Plan View of Force Main/Pump Station

- K. Details of the treatment plant construction showing the location and dimension of all inlet and outlet structures, weirs, orifices, etc., including a complete hydraulic profile showing liquid surface elevations at average and peak daily flows.
- L. Details of the structural design of all structures included in the system as follows:
 - 1. Live and dead loads for floors and roofs.
 - 2. Elevation of the overflow or liquid level of all tank structures.

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- 3. A description of the sub-soil at the site of all major structures as determined by test borings and exploration pits. The data should include the type and nature of the soil from the original ground surface to a depth below foundation level equal to the diameter or width of the structure. It should also include the "N" values or number of blows per foot in the standard penetration test (ASTM D 1586). The Unified Soils Classification System is recommended for use in describing the soil. Actual as well as recommended maximum soil-bearing values shall be provided for all major structures.
- 4. The steel stress for ring tension in reinforcing used in the design of cylindrical tank structures.
- 5. The compressive strength of concrete used in the design.
- 6. Structural design assumptions and computations used in the design of the major structures.
- 7. Gross weight of machinery - or equipment supported by all major structures.
- 8. The maximum elevation of seasonal and average ground water table.
- 9. The thickness of concrete covering for reinforcing steel.

- M. A plan showing the location of treatment facilities with particular reference to the location of existing or proposed residences. A minimum scale of 1" = 200' shall be used. A 100 foot buffer area shall be shown as required in Section CS601. Additionally, the plan shall show the closest distance between any residential structure and any wastewater treatment system units. (See Section CS601.)

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- N. Specifications covering quality, kind and grade of all materials, equipment, construction, workmanship, and methods of assembly and installation.
- O. Approval from the U.S. Environmental Protection Agency or its delegated regulatory agency of the design of the system and land disturbing activities as described by these exhibits. Where local laws or regulations require approval prior to construction by an organization other than those noted, (such as local governmental agencies, etc.,) such approvals shall also be submitted. The EPA or its delegated regulatory agency may require pollution prevention plans and storm water discharge permit under the National Pollutant Discharge Elimination Permit System (NPDES) for all construction activities that disturb five acres or more in total land area.
- P. Complete details of the organizational structure for ownership and operation of the system including final drafts of all legal documents required.
- Q. Proof that all necessary property rights for the project have been obtained or are readily obtainable.

CS304

CONSTRUCTION STAGE

Prior to the commencement of any construction on the project, the approval by HUD shall be obtained with regard to all the items contained in Section CS303, above. Prior to HUD's acceptance of any properties associated with the project, it shall be determined that the completed construction is acceptable. Not less than the following exhibits are required for this determination:

- A. Written evidence that the system as constructed has been approved by the authorities having jurisdiction, if

such approval is customary or required.

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- B. A written statement from the design engineer that the system has been constructed in accordance with the approved plans and specifications.
- C. Evidence that an acceptable organization for assuring continuity of satisfactory service has been established and is functioning or completely prepared to commence operations.
- D. Documentation showing that all property deeds, easements, encroachments, etc., necessary for the project have been obtained.

CS400 SEWAGE COLLECTION SYSTEMS

CS401 GENERAL

New collection systems and extensions to existing systems shall not be designed for a combined stormwater/sanitary system. Except under unusual circumstances, the use of the sewers will be limited to the collection of sanitary (domestic) sewage, ground water infiltration (within allowable limits) and wastes from commercial establishments provided for the convenience of the property owners to be served by the system.

CS402 MATERIALS

All materials to be used shall be described in the specifications. Materials and appurtenances shall be of first quality, free of defects and suitable to accomplish the stated objectives for community sewerage systems.

CS402-1 Sewer Pipe

Concrete, ductile iron; high density polyethylene (HDPE) and polyvinyl chloride (PVC) are acceptable materials. Sewer pipe and fittings shall conform to currently dated standards of the American Society for Testing Materials (ASTM); American Standards Association (ASA); American Water

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Works Association (AWWA); American National Standards Institute (ANSI); or General Services Administration (Federal Specifications), for the type of pipe suitable for the use intended.

CS402-1.1 The applicable specifications include:

A. Concrete

ASTM C76 - Reinforced Concrete Culvert,
Storm Drain and Sewer Pipe.

ASTM C361 - Reinforced Concrete Low-Head
Pressure Pipe.

Federal Specification SS-P-375 - Pipe, Concrete,
Reinforced Sewer

Reinforced Concrete Federal Specification - SS-P-381
- Pipe, Pressure Reinforced Concrete, Pretensioned
Reinforcement (Steel Cylinder Type).

AWWA C300 - Standard Specifications for
Reinforced Concrete Water Pipe
Steel Cylinder Type, Not
Prestressed.

AWWA C301 - Standard Specifications for
Reinforced Concrete Water Pipe
Steel Cylinder Type, Prestressed.

AWWA C302 - Standard Specifications for
Reinforced Concrete Water Pipe
Non-Cylinder Type, Not
Prestressed.

B. Ductile Iron

AWWA C151/ - Ductile Iron Centrifugally Cast In
ANSI A21.51 Metal Molds or Sand-Lined Molds
for Water or Other Liquids.

AWWA C110/ - Gray and Ductile Iron Fittings, 3 in.
ANSI A1.10 through 48 in., for Water and
Other Liquids.

C. High Density Polyethylene

ASTM D-1248 - Polyethylene Plastics Molding and
Extrusion Materials.

D. PVC (Polyvinyl Chloride)

ASTM D1784 - Rigid (PVC) Compounds.

ASTM D3034 - Type PSM PolyVinyl Chloride
(PVC) Sewer Pipe and Fittings.

CS402-2 Corrosion Protection

CS402-2.1 The applicable specifications include:

A. Ductile Iron

AWWA C104/ - Cement Mortar Lining for Ductile
ANSI A21.4 Iron Pipe and Fittings.

AWWA C110, - Asphaltic Coatings and Linings.
C151/ANSI A21.10,
A21.51

Individual Manufacturer's Standards - Epoxy and
Polyethylene Linings.

B. Concrete

Individual Manufacturer's Standards - Sacrificial Wall,
Asphaltic, Epoxy and Polyethylene Linings.

CS402-3 Pipe Joints

The method of making joints and the material used shall be
included in the specifications. Pipe joints not described by

currently dated Federal Specifications, American National Standards Institute (ANSI), American WaterWorks Association (AWWA) or American Society for Testing Materials (ASTM) specifications shall comply with the manufacturer's specifications. Compression type joints are required for all below ground piping systems.

CS402-3.1 The applicable specifications include:

A. Concrete

ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Flexible, Watertight Rubber-Type Gaskets. (Alternate joints using steel plates and rings for bell and spigot connections with rubber gaskets are preferred.)

B. Ductile Iron

AWWA C111/
ANSI A21.11 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.

C. High Density Polyethylene (HDPE)

ASTM D3212 - Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

D. Polyvinyl Chloride (PVC)

ASTM D3139 - Joints for Plastic Pressure pipes Using Flexible Elastomeric Seals.

ASTM D3212 - Joints for Drain and Sewer Plastic pipes Using Flexible Elastomeric Seals.

ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

CS402-4 Bedding

CS402-4.1 Bedding for rigid pipe shall be provided in three classes, Class A, Class B, and Class C, as described herein and directed by the Engineer to fit the depth of trench, type and size of pipe, width of trench, and bearing value of subgrade.

A. Class A Bedding

The pipe shall be bedded in a monolithic cradle of 2,500 psi concrete having a minimum thickness of one-fourth the outside pipe diameter or a minimum of 4 inches under the barrel and extending up the sides for a height equal to one-fourth the outside diameter. The cradle shall have a width equal to or greater than the outside diameter of the pipe barrel plus 8 inches. The side fills and to a minimum height of 12 inches over the top of the pipe shall be filled with carefully compacted select backfill material.

B. Class B Bedding

The pipe shall be bedded in compacted granular material placed on a flat trench bottom. The granular bedding shall have a minimum thickness of one-fourth the outside pipe diameter and shall extend halfway up the pipe barrel of the sides. The remainder of the side fills and a minimum height of 12 inches over the top of the pipe shall be filled with carefully compacted select backfill material.

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C. Class C Bedding

The pipe shall be bedded in compacted granular material placed on a flat trench bottom. The granular bedding shall have a minimum thickness of 4 inches under the barrel and shall extend one-sixth of the outside diameter up the pipe barrel of the sides. The remainder of the side fills and to a minimum height of 12 inches over the top of the pipe shall be filled with carefully compacted select backfill material.

D. Granular material for bedding shall consist of ASTM C-33 #67 crushed stone, clean and graded, 95 to 100 percent of which shall pass a 1/2-inch sieve with 95 to 100 percent retained on a No. 4 sieve.

- E. Bell holes shall be provided in all classes of bedding so as to relieve pipe bells of all load. Bell holes are not required for plain end pipe.

CS402-4.2 Bedding and Backfill Materials Classifications

- A. The following backfill materials classifications shall apply. Refer to ASTM D 2487.

Class I: Angular, 1/4 to 1-1/2 inches (6 to 40 mm) graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed shells, and crushed stone.

Class II: Coarse sands and gravels with maximum particle size of 1-1/2 in. (40 mm), including variously graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW and SP are included in this class.

Class III: Fine sand and clayey (clay filled) gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class.

- B. Bedding and Backfill Terminology:
 - o Foundation is the backfill material beneath the bedding upon which the bedding rests. Foundations are usually not required in stable, non-expansive, unsaturated soils.
 - o Bedding is the material (usually four to six inches in thickness) upon which the pipe rests.
 - o Haunching is the backfill that is placed upon the bedding usually up to the pipe springline (midpoint). It is essential to have compacted haunching material under the pipe haunches (lower curved portions of the pipe).
 - o Initial backfill is placed upon the haunching usually covering the top half of the pipe. Initial backfill is usually placed six to twelve inches

above the crown of the pipe.

- o Final backfill is placed upon the initial backfill up to grade.

CS402-4.3 Bedding and Backfill for P.V.C. and High Density Polyethylene Pipe

- A. Backfill for P.V.C. and high density polyethylene pipe shall be in accordance with the general guidelines presented in ASTM D-2321.
- B. Only Class I materials shall be used for bedding, haunching and initial backfill for high density polyethylene pipe.
- C. For P.V.C. pipe, bedding materials shall be Class I except that Class II and Class III may be used with the specific approval of the HUD-FHA engineer and where the contractor has demonstrated his ability to obtain proper compaction within the pipe zones.

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- D. In stable soils, the bedding shall consist of a 6-inch layer of well leveled bedding material, compacted mechanically to 90% Modified Proctor Density. (ASTM D 1557)
- E. If the pipe is being installed above the normal water table, the haunching backfill zone shall extend to 50% of the pipe diameter, minimum. If the pipe is being installed below the normal water table, the haunching backfill shall extend 2 feet above the entire pipe. Haunching material must be thoroughly tamped under the pipe haunches. Haunching shall be compacted mechanically to 90% Modified Proctor Density. (ASTM D 1557)
- F. Pipes laid in expansive clay soils shall have Class I materials used for bedding, haunching and initial backfill.

CS402-4.4 General Bedding and Backfill Sewer Pipes

- A. The pipe shall be bedded only in a dry or dewatered trench. A foundation shall be installed where there is unstable subgrade material in the immediate transition

areas between concrete manholes and where the trench bottom has been over-excavated. The foundation shall consist of initial backfill type material compacted to 95% Modified Proctor Density (ASTM D 1557) for P.V.C. and high density polyethylene pipe.

- B. The final backfill may be native soil without large rocks or clumps which may cause point loading on the crown of the pipe.
- C. In all cases where structural loads are anticipated above the pipe (e.g., road crossings), the initial and final backfill must be compacted to 90% Modified Proctor Density. (ASTM D 1557)

CS402-5 Allowable Sewer Pipe Infiltration

Sewer pipe joints shall be tested for infiltration upon completion of construction. The maximum allowable infiltration for sewer pipe shall be as follows:

- CS402-5.1 Ductile Iron (Per AWWA C111/ANSI A21.11)
Infiltration - 50 gal/inch diameter/mile/day.
- CS402-5.2 Concrete (ASTM C443):
50 gal/inch diameter/mile/day.
- CS402-5.3 High Density Polyethylene (HDPE)
50 gal/inch diameter/mile/day.
- CS402-5.4 Polyvinyl Chloride (PVC)
50 gal/inch diameter/mile/day.

CS402-6 Measuring Infiltration

CS402-6.1 Infiltration Test

Infiltration may be measured by determining the quantity of groundwater flowing into the sewer pipe. However, this method of measuring infiltration is only applicable if the water table level is above the top of the pipe. This method may not be used during low groundwater table conditions.

CS402-6.2 Exfiltration Test

Exfiltration may be measured by determining the quantity of water exfiltrating from the sewer by surcharging the sewer pipe. This method is general used for pipes installed above the groundwater table.

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CS402-6.3 Low Pressure Air Test

The low pressure air test is the preferred method of infiltration testing. The minimum time duration permitted for a prescribed low pressure exfiltration pressure drop between two consecutive manholes should not be less than that shown in the table below. The prescribed drop should not exceed 0.5 psi from 3.5 to 3.0 psi in excess of the ground water pressure above the top of the sewer.

MINIMUM DURATION FOR AIR TEST PRESSURE DROP

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CS403 DESIGN

CS403-1 Size

Other than for individual unit service connections, 8-inch diameter sewer pipe will be the minimum acceptable size.

CS403-2 Depth

In general, all sewers must be designed deep enough to drain

basements or be 6 feet beneath the surface, whichever is deeper. Where for specific reasons shallower depths are necessary and can be justified, the sewer must be protected to prevent its being damaged. All sewers shall be designed and bedded or encased to prevent cracking or excessive deflection due to superimposed loads and weight of backfill material. Proper allowance for loads on the sewer shall be made, taking into account the width and depth of trench.

Note: The above sewer depth requirements do not apply to service sewers (i.e., sewers which carry wastewater from the residential unit to a collector or trunk sewer). Service sewers shall be no less than two feet beneath the surface.

CS403-3 Capacity

Sewer systems shall be designed for sanitary sewage flow using an average daily per capita flow of not less than 100 gallons per capita per day unless otherwise justified by sound engineering data. On this basis lateral and submain sewers should be designed with capacities, when running full, of not less than 4 times the average daily sewage flow. In similar manner, outfall sewers should be designed for 2.5 times the average daily sewage flow. Additional allowance should be made for significant waste contributions such as shopping centers and industries, and infiltration, taking into account soil and groundwater conditions, and for the possibilities of future expansion or extension.

CS403-4 Velocity of Flow

All sewers shall be designed and constructed with hydraulic slopes sufficient to give mean velocities, when flowing full, of not less than 2.0 feet per second based on Kutter's or Manning's formula using an "n" value relative to the pipe material used. The following table provides the minimum slopes which may be utilized for a given diameter sewer pipe:

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* GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED *
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CS403-5 Increasing Size and Junctions

When sewers are increased in size, or when a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient at the junction. An approximate method for securing this result is to place the 0.8 depth point of both sewers at the same elevation.

CS403-6 Alignment

Sewers, up to and including those with a 24 inch diameter, must be laid with uniform slope and alignment between manholes.

CS403-7 High Velocity Protection

In the case of sewers where the slope and volume are such that velocities of 15 ft. per second or greater may be realized, special provisions shall be made to protect against erosion and thrust.

CS404 MANHOLES

CS404-1 Location

Manholes shall be installed at the end of each line; at all changes in grade, size or alignment; at all intersections and at distances not greater than 400' for sewers 15" or less and 500' for sewers 18" to 30". Greater spacing may be permitted in larger lines and those carrying a settled effluent.

CS404-2 Materials of Construction

Manholes shall be of the precast concrete with gasketed joints (ASTM C 478) or concrete poured-in-place type.

- CS404-3 Diameter
- The minimum diameter of manholes shall be 48" with larger diameters being preferable for sewer pipes greater than 18" in diameter.
- CS404-4 Drop Type Pipe
- A drop pipe should be provided for a sewer entering a manhole at an elevation of 24" or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24" the invert should be filleted to prevent solids deposition.
- CS404-5 Flow Channel
- The flow channel through manholes should be made to conform in shape and slope to that of the sewer pipe.
- CS404-6 Watertightness
- Solid, watertight, bolt-down manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water.
- CS404-7 Joints to Pipes
- Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or other such watertight connection which provides for differential settlement between the pipe and manhole wall.
- CS405 INVERTED SIPHONS
- Inverted siphons shall have not less than two barrels with a minimum pipe size of not less than 6" and shall be provided with the necessary appurtenances for convenient flushing and maintenance; the associated manholes shall have adequate clearances for rodding; and in general sufficient head should be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second for average flows.

The inlet and outlet connections must be designed so that the normal flow can be diverted to one barrel allowing either barrel to be cut out of service for cleaning.

CS406 PROTECTION OF WATER SUPPLIES

CS406-1 Water Supply Interconnections

There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto, which would permit the passage of any sewage or polluted water into the potable water supply.

CS406-2 Relation to Water Works Structures

While no general statement can be made to cover all conditions, it is generally recognized that sewers shall be kept remote from public water supply, wells, or other water supply sources and structures.

CS406-3 Relation to Water Mains

CS406-3.1 Horizontal Separation: Whenever possible, sewers should be laid at least 10 feet, horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main so long as the elevation of the top (crown) of the sewer is at least 18" below the bottom (invert) of the water main, and the sewer pipe is:

- A. Laid in a separate trench, or
- B. Laid in the same trench with the water main(s) located at one side on a bench of undisturbed earth.

CS406-3.2 Vertical Separation: Whenever sewers must cross under water mains, the water main and/or sewer shall be laid at such an elevation that the top of the sewer is at least 18" below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirement, the water main shall be relocated to provide this separation.

Where relocation is not possible, the water main shall be constructed so that one full length of water main pipe will be centered over the sewer so that both joints will be as far from the sewer as possible.

CS500 SEWAGE PUMPING STATIONS

CS501 GENERAL

Sewage pumping stations shall be located and constructed so that the station and electrical control panel will not be subject to flooding. A suitable structure, preferably located off the right-of-way of streets and alleys, shall be provided. It is important that the station be readily accessible by road.

CS502 DESIGN

CS502-1 Type

Sewage pumping stations may be of the wet-well mounted, wet-well installed (using submersible pumps), or dry pit with wet well (using flooded suction pumps). Pneumatic ejector stations shall not be permitted.

CS502-2 Structures

CS502-2.1 Entrances: Where dry pit type installations are used, wet wells and dry pits should be completely separated with a separate entrance to each.

CS502-2.2 Pump Removal: Provisions should be made to facilitate removing pumps and motors.

CS502-2.3 Access: Suitable and safe means of access shall be provided to dry pits and wet wells of pump stations. Stairways are preferred for pump stations which incorporate bar screens or other mechanical equipment requiring frequent inspection or maintenance.

CS503 PUMPS

CS503-1 Duplicate Units

At least two pumps shall be provided for each pumping station. If only two pumps are provided, the pumps should have the same capacity with each unit being capable of handling the expected maximum flow at the required head. Where three or more pumps are provided, the pumps should be designed to fit actual flow conditions and of such capacity that with any one pump out of service the remaining pumps will have capacity to handle maximum sewage flows at the required head.

CS503-2 Protection Against Clogging

Pumps handling raw sewage shall be preceded by readily accessible bar racks with clear openings not exceeding 2 inches unless the pumping equipment is of a special solids handling type. Where screens are located below ground, convenient facilities must be provided for handling screenings. For the larger or deeper pump stations, duplicate screens are preferred. For large pump stations mechanically cleaned bar-screens should be considered.

CS503-3 Priming

The pump should be so placed that under normal operating conditions it will operate under a positive suction head unless the pump is designed for suction lift.

CS503-4 Electrical Equipment

Electrical equipment in enclosed places where gas may accumulate shall comply with the American Insurance Association specifications for hazardous conditions (AIA Type 7), and NFPA-70, National Electrical Code, for Class 1, Group D, Division 1 locations. All electrical equipment shall conform to NFPA 820.

CS503-5 Intake

Each pump should have an individual intake. Wet well design should be such as to avoid turbulence and vortexing near the intake.

CS503-6 Dry Pit Dewatering

A separate sump pump shall be provided in dry pits to remove leakage or drainage with the discharge above the high level of the wet well. Water ejectors connected to a potable water supply are not acceptable. All floor and walkway surfaces shall have adequate slope to the point of drainage.

CS504 CONTROLS

In stations with duplicate units, provision should be made to automatically alternate the pumps and provide for lead-lag operation.

CS505 VALVES

Suitable shutoff valves shall be placed on suction and discharge lines for each pump. A check valve shall be placed on each discharge line, between the shutoff valve and the pump. Where pressures dictate, check valves should be designed to eliminate the possibility of water hammer using hydraulic, pneumatic or electronically cushioned check valves.

CS506 WET WELLS

CS506-1 Size

The wet well shall be sized so that with any combination of inflow and pumping, no single pump will start in excess of five (5) times per hour or run less than five (5) minutes during any cycle. In general, detention periods should be kept to the minimum compatible with proper operation of the

pumping equipment so as to prevent sewage from becoming septic.

CS506-2 Floor Slope

The wet well floor shall have a minimum slope of 1 to 1.75 to the hopper bottom. The level bottom area shall be kept to an absolute minimum. Where it may be necessary to pump sewage prior to grit removal, the design of the wet well should receive special attention so that grit buildup is avoided, and the discharge piping shall be designed to prevent grit settling in the pump discharge lines.

CS506-3 Overflows/Bypasses

Wetwell overflows and bypasses will not be permitted.

CS507 VENTILATION

Adequate positive ventilation shall be provided for all pump stations. Where the pump it is below the ground surface, mechanical ventilation is required. Ventilation shall be arranged so as to independently ventilate the dry pit and the wet well if screens or mechanical equipment requiring maintenance or inspection are located in the wet well. There shall be no interconnection between the wet well and dry pit

ventilation systems. Dampers should not be used on exhaust or fresh air ducts and fine screens or other obstructions in the air ducts should be avoided to prevent clogging. Switches for operation of ventilation equipment should be marked and located conveniently near the entrance. Consideration should be given to automatic controls where intermittent operation is used. In climates where excessive moisture or low temperatures may be encountered, consideration should be given to installation of dehumidification and/or heating equipment.

In dry pits, ventilation may be either continuous or intermittent. For continuous operation at least six complete air changes per hour should be provided. For intermittent operation at least thirty air changes per hour should be

provided. Similar venting shall be used for wet wells except that 12 changes per hour should be provided for continuous operation.

CS508 FLOW MEASUREMENT

At larger pumping stations, consideration should be given to installation of suitable devices for measuring sewage flow and power consumption.

CS509 WATER SUPPLY

There shall be no physical connection between any potable water supply and a sewage pumping station which under any conditions might cause contamination of the potable water supply.

CS510 FORCE MAINS

CS510-1 Materials

Pressure piping shall consist of either Ductile Iron or any pressure pipe classes of polyvinyl chloride which meet requirements of pump pressure, depth of cover and installation conditions.

CS510-1.1 Applicable Specifications include:

A. Ductile Iron

AWWA C151 - Ductile Iron Centrifugally Cast
ANSI A21.51 in Metal Molds or Sand Lined
Molds for Water or Other
Liquids.

AWWA C110/ - Gray and Ductile Iron Fittings,
ANSI A21.10 3 in. through 48 in., for Water
and Other Liquids.

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B. Polyvinyl Chloride (PVC)

AWWA C900 - Polyvinyl Chloride (PVC)
Pressure Pipe 4 in. through 12
in., for Water.

ASTM D2241 - Poly Vinyl Chloride (PVC)
Plastic Pipe (SDR-PR).

ASTM D1784 - Rigid Poly Vinyl Chloride and
Chlorinated Poly Vinyl Chloride
Compounds.

CS510-2 Velocity

A design average flow velocity in excess of two feet per second shall be maintained; maximum velocity should be limited to eight feet per second.

CS510-3 Sewage Air Relief Valves

Automatic sewage air relief valves shall be placed at high points in the force main to prevent air locking. Where possible the force main shall pitch continuously upward to avoid any high points in the line.

CS510-4 Termination

Force mains should enter the gravity sewer system at a manhole with a 90 deg upturn of the force main within the manhole, or the forcemain should discharge within a partitioned segment of a manhole with the partition being as high as the crown of the force main.

CS511 POWER SUPPLY

Power supply should be available from at least two

independent generating sources, or emergency power equipment shall be provided. The installation of an emergency electrical receptacle shall be acceptable as a secondary emergency power source as set forth in CS605-3.

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CS600 SEWAGE TREATMENT WORKS

CS601 PLANT LOCATION

In general to avoid local objections and for sound engineering and environmental reasons, a sewage treatment plant site should be located as far as practicable from any presently inhabited area, any area which will probably be inhabited within a reasonable future period, any wetlands, or any site with poor soils. If an undesirable location must be used, special consideration must be given to the design and type of plant provided. Treatment plants shall be located at an elevation which is not subject to flooding or else be adequately protected against flood damage. The plant should be readily accessible at all times. A 100 foot buffer area shall be provided between all treatment facilities (including ponds) and property lines; however, this buffer requirement may be waived by HUD-FHA in situations for which it can be conclusively shown that such a buffer is not reasonably possible to provide. No portion of any residential structure shall be closer than 300 feet to any wastewater treatment unit (including ponds).

CS602 QUALITY OF EFFLUENT

Degree of treatment and desired quality of effluent for sewage treatment plants shall be based on the requirements of the U.S. Environmental Protection Agency or the properly delegated state regulatory environmental agency.

CS603 BASIS FOR DESIGN LOADING

The design of sewage treatment units shall be based on organic loading, hydraulic loading and solids loading at a minimum. A biochemical oxygen demand (BOD5) loading of 0.17 lb. per person served per 24 hours is required except that the loading shall be increased to 0.25 lb. BOD/person/day if the installation of mechanical household garbage grinders is proposed. The engineer's report (DDR) should clearly justify the computed total daily average flows and loads to include the number of persons contributing per

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property served and the estimated volume and load contributed by each occupant. (See CS403.) Commercial and industrial flow and infiltration, when appropriate, shall also be given due consideration.

CS604 CONSTRUCTION MATERIALS

Due consideration should be given to the selection of materials which are to be used in sewage treatment works because of the possible presence of hydrogen sulfide and other corrosive gases, greases, oils, and similar constituents frequently present in sewage. The selection of materials is particularly important in the selection of metals and coatings. The protective coating to be applied to the interior and exterior surfaces of metal treatment tanks shall be identified and described in detail in the project specifications.

CS605 ESSENTIAL FACILITIES

CS605-1 Internal By-Passes

Properly located and arranged by-pass capabilities to other process units shall be provided so that each unit of the plant can be removed from service without disturbing the operation of the treatment plant.

CS605-2 Grading, Landscaping, and Fencing

Upon completion of the plant, the ground shall be properly graded, finished, and landscaped. Concrete or gravel walkways should be provided for access to all units. Where possible, steep slopes should be avoided. Surface water should not be permitted to drain into any treatment unit. Provision should be made for landscaping, particularly when a plant must be located close to a residential area. The entire treatment plant area shall be enclosed by a fence of suitable quality and height to preclude entrance by unauthorized persons.

CS605-3 Emergency Power Facilities

Where two independent electrical feed sources are not available, a standby power source capable of running essential process units shall be provided. An emergency power receptacle compatible with owner's emergency power generation equipment will be acceptable as a standby power source; however, in this instance, the assurance of the availability of an adequately sized and functional mobile auxiliary power generator on an ongoing basis is required.

CS605-4 Water Supply

An adequate supply of safe potable water should be provided for use in the laboratory and for general cleanliness around the plant. No piping or other connections shall exist in any part of the treatment works which under any condition might cause the contamination of a potable water supply. Adequate backflow prevention shall be provided.

CS605-5 Sanitary Facilities

Sanitary facilities such as toilet, shower, and lavatory are recommended for all wastewater treatment facilities and shall be required for wastewater treatment facilities with 0.1 MGD design capacity and larger.

CS605-6 Laboratory Equipment

The treatment works should include a properly equipped laboratory for making the necessary analytical determinations and operating control tests; however, laboratories are optional for wastewater treatment systems smaller than 0.1 MGD.

CS605-7 Sewage Flow Measurement

Facilities for measuring and recording the volume of raw sewage entering and treated effluent leaving the plant shall be provided at the treatment works. However, for treatment

plants smaller than 1 MGD, measurement of either influent flow or effluent flow shall be sufficient.

CS605-8 Safety

Adequate provision should be made to protect the operator and any visitors from unnecessary hazards. All OSHA regulations apply to all phases of plant design.

CS605-8.1 All units or structures which may endanger human life shall be enclosed by a suitable fence or have keyed lock doors.

CS605-8.2 Hand rails shall be provided where walkways exceed two feet above grade and around the interior of all basins. Elevated walkways shall have handrails with kickplates.

CS605-8.3 First aid equipment shall be provided.

CS605-8.4 Proper fire extinguishing equipment shall be provided at convenient locations throughout the plant.

CS605-8.5 Proper safety and personal protective equipment shall be provided for the handling of all chemicals.

CS606 OTHER TREATMENT PROCESSES

Treatment processes other than those described in the following sections are eligible for consideration on the basis of their proven and documented record of performance and operating experience. All treatment processes and equipment shall be approved by the U.S. Environmental Protection Agency or its delegated regulatory agency. Where other treatment processes are proposed, a detailed description of each process and design data shall be submitted.

CS700 PRIMARY TREATMENT

CS701 SCREENING DEVICES

CS701-1 Use

All sewage treatment plants shall provide coarse and/or fine screening for protection of pumps and downstream processes. Screens may be used in conjunction with mechanical shredders. All equipment should be readily

accessible for maintenance.

CS701-2 Access

Hand-cleaned screens located in deep pits shall be provided with stairway access, adequate lighting and ventilation. A convenient and adequate means for removing screenings shall be provided.

Screening devices installed in a building where other equipment or offices are located should be separated from the rest of the building, provided with separate outside entrances, and provided with a separate means of ventilation.

CS701-3 Spacing of Bars

CS701-3.1 Non-Mechanical Screens: Clear openings between bars should be from one to six inches depending upon downstream equipment requirements. Construction of bar screens should be such that they can be conveniently raked.

CS701-3.2 Mechanical Screens: Clear openings for mechanically cleaned screens may be as small as five-eighths of an inch.

CS701-3.3 Velocities: For hand-raked bar screens the screen chamber should be designed to provide an approach velocity of approximately 2.0 feet per second at average rate of flow. Maximum velocities during wet weather periods shall not exceed 3.0 feet per second for mechanically cleaned screens.

CS701-3.4 Invert: The screen channel invert shall be located 3" to 6" below the invert of the incoming sewer.

CS701-3.5 Slope: Hand-cleaned screens, except those for emergency use, shall be placed on a slope between 30 to 45 degrees with the horizontal.

CS701-4 Channels

The channel preceding and following the screen shall be filleted to prevent stranding and sedimentation of solids.

CS701-5 Safety Devices

CS701-5.1 Auxiliary Control: All mechanical units which are operated by timing devices should be provided with auxiliary float controls

which will set the cleaning mechanism in operation at predetermined high water marks. These auxiliary controls should operate independent of the regular controls.

CS701-5.2 Electrical Fixtures and Controls: Electrical fixtures and controls in enclosed places where gas may accumulate shall comply with the American Insurance Association specifications for hazardous conditions and the National Electric Code for Class 1, Group D, Division 1 locations.

CS701-6 Screenings

Ample sanitary facilities must be provided for the removal, handling, storage and disposal of screenings. Hand-cleaned screening facilities should include an accessible platform from which the operator may rake screenings easily and safely. Suitable drainage facilities should be provided back to the head of the plant both for the platform and for storage areas. Removal of screenings and proper disposal in a sanitary landfill is the preferred method of disposal.

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CS702 COMMINUTING DEVICES

CS702-1 Restrictions On Use

Comminuting devices may not be utilized in wastewater treatment plants where primary clarifiers are not provided. The use of comminuting devices is generally discouraged in all wastewater treatment plants and pumping stations in favor of screening devices. Where comminuting devices are used, the following requirements must be met.

CS702-2 Channels

Design of approach channels should provide for gates or similar devices to bypass the flow from any one or more comminutors to a bypass channel with a bar screen. Drains should be provided in each comminator trap to allow for dewatering.

CS702-3 Auxiliary Screens

Where mechanically operated screening devices or shredding-screening devices are employed, auxiliary units should be provided, such units being either of the mechanical or hand-cleaned type and arranged in such a manner as to

provide for automatic diversion of the sewage flow should the regular units fail.

CS703 GRIT CHAMBERS

Grit chambers are recommended for plants treating sewage from sanitary sewers where the accumulation of grit is anticipated. The Engineer's report (DDR) should include full justification if grit chambers are not included in the design for treatment plants greater than 50,000 gpd in size.

CS703-1 Location

It is recommended that grit chambers be located ahead of pumps and comminuting devices. In such cases, coarse bar

racks should be placed ahead of mechanically cleaned grit chambers.

CS703-2 Number of Units

Duplicate hand-cleaned units or a single mechanically cleaned unit with an automatic by-pass to a hand-cleaned unit shall be provided. Mechanically cleaned grit chambers are recommended for larger treatment plants. Single, hand-cleaned channels with by-pass are acceptable for sewage treatment plants serving small sanitary sewerage systems. Treatment plants 50,000 gpd or smaller may omit grit collection.

CS703-3 Design Factors

CS703-3.1 Inlet: Inlet turbulence shall be minimized.

CS703-3.2 Velocity and Detention: Channels should be designed to provide controlled velocities to allow settlement of grit. The detention period and velocities shall be based on the size of particle to be removed.

CS703-3.3 Grit Washing: All chambers not providing positive velocity control should include means for grit washing to further separate organic and inorganic materials.

CS703-3.4 Drain: Provisions should be made for draining each unit.

CS703-4 Grit Removal

Grit chambers located in deep pits should be provided with facilities for hoisting grit to ground level, access by stairway, adequate ventilation, and adequate lighting.

CS703-5 Grit Disposal

Suitable means for grit storage and disposal shall be provided.

CS704 CLARIFIERS

CS704-1 General Considerations

CS704-1.1 Mechanical Systems: All clarifiers shall have mechanical mechanisms for sludge concentration and removal. Non-mechanical settling tanks and Imhoff tanks shall not be allowed.

CS704-1.2 Multiple Units: Multiple, parallel clarifiers shall be provided for each clarification installation such that the removal of any single parallel clarifier from service will not result in a significant reduction in treatment efficiency, overflows or equipment damage. However, single unit primary clarifiers may be utilized for treatment plants less than 1 MGD in capacity.

CS704-2 Design Characteristics

CS704-2.1 Inlets: Inlets shall be designed to dissipate the inlet velocity, diffuse the flow equally across the entire cross section of the clarifier to prevent shortcircuiting. Channels should be designed to maintain a velocity of at least 1 foot per second at 0.5 design flow. Corner pockets and dead ends shall be eliminated and corner fillets or channeling used where necessary. Provisions shall be made for elimination or removal of floating materials in inlet structures having submerged ports.

CS704-2.2 Scum Baffles: Scum baffles shall be provided ahead of outlet weirs on all primary and final clarifiers.

CS704-2.3 Weirs: Overflow weirs shall be adjustable. On circular tanks the weir should extend around the entire periphery of the tank. Weir loadings shall not exceed 10,000 gallons per day per linear foot for plants designed for average flows of 1.0

MGD or less. Weir loadings for plants designed for flows in excess of 1.0 MGD shall not exceed 15,000 gallons per day per linear foot.

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CS704-2.4 Submerged Surfaces: The tops of troughs, beams, and similar construction features which are submerged shall have a minimum slope of 1.4 vertical to 1 horizontal. The underside of such features should have a slope of 1 to 1 to prevent the accumulation of scum and septic solids.

CS704-2.5 Protection: All settling basins shall be adequately equipped to provide easy access for maintenance and for protection to operators. Such features shall include stairways, walkways, handrails, and lighting.

CS704-2.6 Surface Settling Rates

Unless otherwise approved by the HUD-FHA engineer, the following maximum surface settling rates shall be used:

A. Primary Clarifiers:

1. Surface settling rates for primary clarifiers shall not exceed 800 gallons per day per square foot for plants having a design flow of 1.0 M.G.D. or less. Higher surface settling rates may be permitted for larger plants.
2. The allowable estimate of BOD removal by primary clarifiers treating normal sewage shall not be greater than 35%. Allowable BOD removal by sedimentation of industrial wastes will be dependent upon the type of wastes contributed.

B. Intermediate Clarifiers: Surface settling rates for intermediate clarifiers should not exceed 600 gallons per square foot per day based on the design flow rate.

C. Final Clarifiers: Surface settling rates for final clarifiers shall not exceed 450 gallons per day per square foot based on the design flow rate.

CS704-2.7 Scum Removal: Scum removal equipment shall be provided ahead of the outlet weirs on all primary and final clarifiers.

The design should provide for the scum to be collected in a scum well for pumping to a digester or decanting unit.

- CS704-2.8 Sludge Removal: Provision for continuous sludge removal from clarifiers is recommended. Where sludge is removed from a clarifier to a digester, a sludge well or other appropriate device should be installed for viewing and sampling the sludge. Each sludge hopper shall have an individually valved sludge withdrawal line not less than 6" in diameter.
- CS704-2.9 Depth: The side water depth for all clarifiers shall not be less than 12 feet unless otherwise approved by the HUD-FHA engineer.
- CS704-2.10 Sludge Hoppers: Hoppers shall be accessible for maintenance from the operating level. The minimum slope of the side walls of sludge hoppers shall be 1.7 vertical to 1 horizontal.
- CS800 SLUDGE DIGESTION AND DISPOSAL
- CS801 GENERAL
- CS801-1 Classification: Separate sludge digestion tanks will be classified as either "aerobic or "anaerobic". Generally, aerobic tanks shall be those providing for digestion, supernatant separation and sludge concentration and storage in tanks open to the atmosphere, with mechanical aeration provided. Anaerobic tanks shall be those where the digestion process is accomplished within an enclosed unit devoid of oxygen.
- CS801-2 Multiple Units: Multiple tanks are recommended for larger sewage treatment plants. Where a single digestion tank is used, it is desirable to have a lagoon or storage tank for emergency use so that the tank may be taken out of service without unduly interrupting plant operations.

CS802 AEROBIC DIGESTION TANKS

CS802-1 Mixing and Air Requirements: Mechanical aeration shall be provided in sufficient amount to keep the solids in suspensions and to maintain a dissolved oxygen (DO) level of 2 mg/l or more. A minimum mixing and oxygen requirement of 30 cfm per 1,000 cubic feet of tank volume shall be provided with the largest blower out of service.

CS802-2 Capacity

CS802-2.1 Volatile Solids Loading: Volatile solids loading rates shall not exceed 100 pounds per day per 1,000 cubic feet of volume.

CS802-2.2 Solids Retention Time (SRT): Minimum SRT values shall be provided, as follows:

- A. 15 days for waste activated sludge.
- B. 20 days for combined primary and waste activated sludge.

Additional time should be considered where local conditions dictate such as in cold weather climates.

CS802-2.3 Supernatant Removal: Aerobic digesters shall be provided with supernatant removal facilities. Supernatant shall be returned to the head of the plant.

CS803 ANAEROBIC DIGESTION TANKS

CS803-1 Depth: The proportion of depth to a diameter should be such as to allow for the formation of two feet or greater of supernatant liquor and also to maintain the minimum surface area so as to minimize heat loss.

CS803-2 Maintenance Provisions: To facilitate emptying, cleaning, and maintenance, the following features are desirable:

CS803-2.1 Slope: The tank bottom should slope to drain toward the withdrawal pipe at a minimum slope of 3 vertically to 12 horizontally.

- CS803-2.2 Access Manholes: At least two access manholes should be provided in the top of the gas dome. One opening should be large enough to permit the use of mechanical equipment to remove grit and sand.
- CS803-3 Capacity
- CS803-3.1 Solids Basis: Where the composition of the sewage and solids production has been established, tank capacity shall be computed from the volume and character of sludge to be digested. Due allowance shall be provided for sludge storage and supernatant holding.
- CS803-3.2 Population Basis: Where solids production data are not available, the unit capacities shown below shall be used for plants treating domestic sewage. The below shown capacities shall be increased for any industrial wastes in the sewage. Additional capacity shall be provided where garbage solids are to be digested. The capacities shown below apply where digested sludge is dewatered on sand drying beds. The below shown values may be reduced if the sludge is dewatered mechanically. Required digester volumes should be calculated on the basis of the digester bottom having planes sloping thirty degrees from the horizontal upward from the end of the withdrawal pipe unless sludge mixing equipment is installed.

 * GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED *

For small installations (population 5,000 or less) consideration should be given to using the larger values. Unit capacities required for separate unheated tanks shall be increased in accordance with local climatic conditions.

- CS803-4 Anaerobic Tank Gas Collection, Piping and Appurtenances
- CS803-4.1 General: All portions of the gas system including the space above the tank liquor, storage facilities and piping shall be so designed that under all normal operating conditions, including sludge withdrawal, the gas, where any gas leakage might occur, should be adequately ventilated.

- CS803-4.2 Safety Equipment: All necessary safety facilities shall be included where gas is produced. Pressure and vacuum relief valves and flame traps together with automatic safety shut off valves shall be provided. Water seal equipment shall not be installed.
- CS803-4.3 Digester Gas Piping and Condensate: Gas piping shall be of adequate diameter and shall slope to condensation traps at low points. The use of float controlled condensate traps is not permitted.
- CS803-4.4 Digester Gas Utilization Equipment: Gas burning boilers, engines, and other equipment shall be located at ground level and in well ventilated rooms. Gas lines to these units shall be provided with suitable flame traps.
- CS803-4.5 Electrical Fixtures: Electrical fixtures in enclosed places where digester gas may accumulate shall comply with the American Insurance Association specifications for hazardous conditions and the NEC for Class 1, Group D, Division 1 locations.
- CS803-4.6 Waste Gas: All waste gas shall be burned or otherwise beneficially used. Waste gas burners shall be located at least 25 feet away from any plant structure if placed at ground level, or located at roof level if sufficiently removed from the digester tanks.
- CS803-4.7 Ventilation: All underground enclosures connecting with digestion tanks or containing sludge or digester gas piping or equipment shall be provided with forced ventilation.
- CS803-4.8 Meter: A gas meter with by-pass shall be provided.

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- CS803-4.9 Sludge Inlets: Provision should be made for the recirculation of sludge. One inlet should discharge above the liquid level and be located at approximately the center of the tank unless mechanical scum breakers are employed. The raw sludge inlet line should discharge at a point at least equal to the radius of the tank from the supernatant drawoffs.
- CS803-5 Digestion Tank Heating
- CS803-5.1 Insulation: Wherever possible digestion tanks should be constructed above the ground-water level and should be suitably insulated by earth embankments or by other means.

- CS803-5.2 Heating Facilities: If heat exchangers are used, hot water coils shall be at least two inches in diameter, and the coils as well as the support brackets shall be of ductile iron. The use of dissimilar materials shall be avoided to minimize galvanic action. The high point in the coils shall be vented to avoid air lock.
- CS803-5.3 Heating Capacity for Anaerobic Tanks: If tank heaters are utilized, sufficient heating capacity shall be provided to maintain the sludge at 85 degrees F. to 95 degrees F. or more at all times. Where digestion tank gas is used for heating, an auxiliary fuel may be required.
- CS803-5.4 Heating Coil Operating Controls
- A. Mixing Valves: A suitable automatic mixing valve shall be provided to temper the boiler water with return coil water so that the inlet water to the coils can be held to a temperature of 140 degrees F. or less. Manual control should also be provided by suitable by-pass valves.
 - B. Boiler Controls: The boiler should be provided with suitable automatic controls to maintain the boiler temperature at 180 degrees F. or more to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure.

- C. Thermometers: Thermometers should be provided to show temperatures of the sludge, hot water feed, hot water return, and boiler water.
- CS803-5.5 External Heater Operating Controls: All controls necessary to insure effective and safe operation are required.
- CS803-6 Supernatant Withdrawal
- CS803-6.1 Piping Size: Supernatant piping should not be less than six inches in diameter.
- CS803-6.2 Withdrawal Arrangements: Piping should be arranged so that withdrawal can be made from multiple levels in the tank. Telescoping valves are recommended.
- CS803-6.3 Sampling: Provision should be made for sampling at each

supernatant draw-off level. Sampling pipes should be at least 1-1/2 inches in diameter.

CS803-6.4 Supernatant Disposal: Digester supernatant shall be returned to the head of the plant.

CS804 SLUDGE PUMPS AND PIPING

CS804-1 Sludge Pumps

CS804-1.1 Capacity: Pump capacities should be adequate but not excessive. Provision for varying pump capacity for multiple pumps is recommended.

CS804-1.2 Duplicate Units: Duplicate pumping units are required as failure of one unit would seriously impair plant operation.

CS804-1.3 Type: Plunger pumps, progressive cavity, diaphragm, or centrifugal (solids handling) pumps should be provided for handling raw sludge.

CS804-1.4 Minimum Head: A minimum positive suction head of 24 inches shall be provided at the suction side of centrifugal type pumps. Suction lifts should be avoided where possible.

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CS804-1.5 Sampling Facilities: Unless sludge sampling facilities are otherwise provided, quick closing sampling valves shall be installed at the sludge pumps. The size of valve and piping should be at least 1-1/2 inches.

CS804-2 Sludge Piping

CS804-2.1 Size and Head: Sludge withdrawal piping should have a minimum diameter of eight inches for gravity withdrawal and six inches for suction. Sludge pump discharge piping shall be at least four inches in diameter. Where withdrawal is by gravity, adequate head and clean-outs shall be provided.

CS804-2.2 Slope: Gravity piping shall be laid on uniform grade and alignment. Slope of gravity discharge piping shall not be less than 3 percent. Arrangements for draining and flushing discharge lines shall be provided.

CS805 SLUDGE DRYING BEDS

CS805-1 Area

recommended. The top layer, consisting of gravel 1/8 inch to 1/4 inch in size shall be placed to a minimum depth of 3 inches.

CS805-3.2 Sand: The top course shall consist of clean coarse sand to a thickness of 12 to 15 inches. The finished sand surface should be level.

CS805-4 Underdrains

Polyvinyl chloride, vitrified clay tile and precast blocks of vitrified tile or concrete are acceptable materials for use as underdrains. Vitrified clay blocks shall comply with ASTM Specification C159. Other materials or methods for underdraining of filters will be considered subject to the submission of complete details and the description included in the engineer's report (DDR). All materials used shall be

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capable of supporting the loads imposed. The minimum diameter of underdrains shall be 4 inches, and the lateral spacing shall not exceed 20 feet.

CS805-5 Walls

Walls shall be watertight and extend 15 to 18 inches above and at least 6 inches below the sand surface, and be structurally adequate to the internal and external loads imposed.

CS805-6 Sludge Influent

The sludge pipe to the beds shall be installed so as to drain effectively. Concrete splash plates shall be provided at sludge discharge points.

CS805-7 Drainage Disposal

Drainage from beds shall be returned to the head of the plant.

CS806 MECHANICAL SLUDGE DEWATERING FACILITIES

If it is proposed to dewater or dispose of sludge by mechanical methods such as belt or plate and frame filter press, a detailed description of the unit and design data shall accompany the plans. Suitable evidence of the satisfactory performance of the units will be required.

CS807 SLUDGE DISPOSAL

Dried sludge may be composted, landfilled, spread over or cut into fields or in some cases sold to fertilizer manufacturers. Whichever method is proposed, approval by the local health and environmental permitting agencies will be required.

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CS900 SECONDARY TREATMENT

CS901 PACKED TOWERS OR TRICKLING FILTERS
("TRICKLING FILTERS")

CS901-1 Applicability

Trickling filters may be used for treatment of sewage and industrial wastes of a type amenable to purification by biological processes. Trickling filters shall be preceded by primary clarification.

CS901-2 Design Basis

The trickling filters shall be designed to provide a reduction in biochemical oxygen demand as necessary to properly condition the sewage for subsequent treatment processes.

CS901-3 Dosing Equipment

CS901-3.2 Dosing: The distribution devices may be actuated by siphons or pumps or by gravity discharge from preceding treatment plant units when suitable flow characteristics have been developed. Application of the sewage to the trickling filter media shall be continuous. Consideration shall be given to a piping system which will permit recirculation during periods of low flow.

CS901-3.3 Hydraulics: All hydraulic factors involving proper distribution of sewage on the trickling filters shall be carefully calculated. For reaction type distributors, a minimum head of 24 inches between the low water level in siphon chamber and the center of the distribution arms is generally desirable.

CS901-3.4 Clearance: A minimum clearance of six inches between media and distributor arms shall be provided. Greater

clearance will be necessary in climates where icing occurs.

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- CS901-4 Media
- CS901-4.1 Quality: The media shall consist of plastic materials which are durable, resistant to spalling or flaking, and insoluble in sewage.
- CS901-4.2 Media Physical Properties: Media dry specific surface area shall be 25 to 35 sq.ft./cu.ft. Void space shall be 95 to 97 percent.
- CS901-5 Underdrainage System
- CS901-5.1 Arrangement: Underdrains with semi-circular inverts or equivalent should be provided and the underdrainage system shall cover the entire floor of the trickling filter.
- CS901-5.2 Slope: The underdrains shall have a minimum slope of one percent. Effluent channels shall be designed to produce a minimum velocity of two feet per second at average daily rate of application to the trickling filter.
- CS901-5.3 Flushing: Provision should be made for flushing the underdrains. In small trickling filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities should be provided.
- CS901-5.4 Ventilation: The underdrain system, effluent channels, and effluent pipe should be designed to permit free passage of air. The size of drains, channels, and pipe should be such that not more than 50 percent of their cross-sectional area will be submerged under the design hydraulic loading. Blowers may be necessary to ensure adequate ventilation.
- CS901-6 Special Features
- CS901-6.1 Recirculation: Design of the recirculation process shall be such that it occurs automatically at a predetermined low flow.
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CS901-6.2 Maintenance: All distribution devices, underdrains, channels, and pipes shall be described with the necessary provisions to be properly maintained, flushed, or drained.

CS901-6.3 Flow Measurement: Devices shall be provided to permit measurement of flow to trickling filter whenever recirculation is used.

CS901-7 Two-Stage Towers

The foregoing standards shall also apply to second stage towers.

CS902 ACTIVATED SLUDGE

CS902-1 Applicability

The activated sludge process may be used where the sewage entering the aeration tanks is amenable to biological treatment. The processes may be one of the following types; conventional, extended aeration, step aeration, or contact stabilization.

CS902-2 Unusual Installations

Design data outlined herein are presumed to achieve a removal of 90% or more of BOD and suspended solids. Lesser removals are not acceptable. Plans for treatment plants contemplating abnormal concentrations of sewage constituents, unusual aeration periods or special equipment or arrangements of equipment will be reviewed on the merits of the proposed system and will be considered upon presentation of appropriate supporting data demonstrating the efficiency of the design for the specific project.

CS902-3 Primary Treatment

Primary treatment shall be provided for activated sludge processes as set forth in section CS700. Re-aeration of the return sludge shall be provided for all contact stabilization processes.

CS902-5.4 Inlets and Outlets

- A. Controls: Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, adjustable weirs or other devices to permit controlling the flow to any unit and to maintain a reasonably constant water level. The hydraulic properties of the system shall be such as to permit the maximum instantaneous hydraulic load to be carried with any single unit out of service.
- B. Ports: The velocity through ports or other inlets shall be as low as practicable to prevent hydraulic short circuiting.
- C. Channels: Channels and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleansing velocities or shall be agitated to keep such solids in suspension at all rates of flow within the design limits.

CS902-6 Measuring Devices

Devices for indicating rates of flow of return-sludge shall be installed. These devices shall also totalize and record as well as indicate flows.

CS901-7 Air Supply

CS902-7.1 Application: The design shall provide for the introduction of air in sufficient volume and in such manner as to:

- A. Maintain at least two ppm of dissolved oxygen under all conditions of loading in all parts of the aeration tanks except immediately beyond the inlets.
- B. Maintain sufficient velocity of movement or turbulence to bring sludge particles into intimate contact with all portions of the sewage.

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- C. Prevent deposition of solids in any part of the aeration basin.

CS902-7.2 Air Diffusion and Piping Capacity: The air diffusion and piping system shall be designed as to be capable of delivering 150% of normal air requirements. Normal air requirements

shall not be less than 1500 cubic feet per pound of applied primary effluent BOD per day for conventional, step aeration and contact stabilization processes, nor less than 2000 cubic feet per pound for extended aeration.

- CS902-7.3 Blowers: Nominal blower capacity shall be provided to deliver air equal to the aeration basin requirements plus whatever air may be required to supply channels, sludge pumps, or other air-use demands. Blowers shall be provided in multiple units so arranged and in such capacities as will meet the maximum air demand with the single largest unit out of service. The design should provide for variation in the volume of air to be delivered, in at least three steps, and, as near as practicable, following the load demand of the plant.
- CS902-7.4 Air Cleaners: Air filters shall be provided on all blower intake pipes.
- CS902-7.5 Sound Attenuation Measures: All compressors or blowers shall be provided with sound attenuation measures. Such compressors or blowers shall be located away from residential construction in a sound attenuating structure such as a concrete block walled area (4'-6' high with cores filled) or building.
- CS902-8 Air Diffusers
- CS902-8.1 Removal of Diffusers: Aeration diffusers or other equipment used for introduction of air to mixed liquor shall preferably be so designed as to permit removal for inspection, maintenance and replacement without necessity for dewatering the tank. In installations having one aeration unit, such provision shall be mandatory.

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- CS902-8.2 Air Control Valves: Individual assembly units of diffusers shall be equipped with control valves preferably with indicator markings for throttling and for complete shutoff. Diffusers in any single assembly shall have a substantially uniform pressure loss.
- CS902-9 Mechanical Aerators
- CS902-9.1 Other Aeration Facilities: Where designs provide mechanical apparatus other than, or supplementary to, compressed air as a means of flocculating; oxidizing and aerating the mixed liquor, the same objectives as specified under "Air Supply"

(CS902-7) shall be provided for. Such devices shall maintain these objectives when operating under all load conditions.

CS902-9.2 Spare Mechanism: A uninstalled spare aeration mechanism shall be furnished for single unit installations.

CS902-10 Drains

Aeration tank drains shall be provided for all units. Such drainage shall be discharged to the head of the plant.

CS902-11 Sludge Handling Equipment

CS902-11.1 Pump Capacities: For installations proposing to treat sewage of normal characteristics, return activated sludge pumps shall be provided with variable combined capacity ranging from 10% to 100% of the design flow. In addition, a standby unit equal in capacity to the largest single pump shall be provided.

CS902-11.2 Installation Detail: A positive head should be provided on the pump suction. Pumps should have at least a three inch and preferably a four inch suction and discharge. Piping shall not be less than four inches in diameter.

CS902-11.3 Waste Sludge Facilities: Waste Sludge control equipment and piping should be designed for an adjustable capacity of 0-500% of the design waste sludge volume. Devices for indicating rate of waste sludge discharge shall be provided.

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Indicating, recording, and totalizing devices are desirable and should be included.

CS902-11.4 Return Sludge Facilities: Suitable devices for readily observing, sampling, controlling, and apportioning return activated sludge shall be provided.

CS902-11.5 Disposal of Waste Sludge: Waste activated sludge may be returned either to the primary tanks, thickening tanks, digestion tanks or other sludge handling units.

CS903 FILTRATION

CS903-1 Use

Slow sand filters shall be provided following all waste stabilization ponds when necessary to meet required water

quality objectives. The use of subsurface or covered sand filters is not recommended. The use of filters for raw or settled sewage is not allowed.

- CS903-2 Filter Loading: Filter loading shall not exceed 10 gpd/sq.ft.
- CS903-3 Number of Units: Two or more filter units shall be provided for all installations.
- CS903-4 Media
- CS903-4.1 Gravel Base: Clean graded gravel, preferably placed in a least three layers, should be placed around the underdrains and to a depth of at least six inches over the top of the underdrains. Suggested gradings for the three layers bottom-to-top are 1-1/2" to 3/4", 3/4" to 1/4", and 1/4" to 1/8".
- CS903-4.2 Sand: At least 24 inches of clean sand should be provided. For open filters dosed by flooding, the effective size shall be 0.3 to 0.6 mm; for filters dosed by rotary distributors, the effective size shall be 0.4 to 1.0 mm. The uniformity coefficient shall not be greater than 3.5.

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- CS903-5 Dosing
- CS903-5.1 Duplicate Units: Two or more dosing siphons (or dosing pumps) shall be provided.
- CS903-5.2 Volume: The dosing tank volume shall be such that any filter bed will be covered to a depth of 2 to 4 inches by each dose.
- CS903-5.3 Siphons or Pumps: Siphons or pumps shall have a discharge capacity at minimum head at least 100% in excess of the maximum rate of inflow to the dosing tank and at average head, at least 90 gallons per minute per 1000 square feet of filter area.
- CS903-5.4 Discharge Lines: The discharge lines to the beds shall have sufficient capacity to permit the full rated discharge of the siphons or pumps.
- CS903-6 Distribution
- CS903-6.1 Arrangement: Troughs or piping may be used for distribution of the treated sewage over the filter surface and should be

so located that the maximum lateral travel is not more than 20 feet.

CS903-6.2 Splash Slabs: Splash slabs shall be provided at each point of discharge.

CS903-6.3 Drain: A drain opening from troughs or discharge piping shall be provided.

CS903-7 Underdrains

Perforated PVC or vitrified clay underdrains may be used. The underdrains should be sloped to the outlet and spaced not to exceed 10 feet centers.

CS903-8 Earth Base

The earth base of the filters should be sloped to the trenches in which the underdrains are laid. Sand filters in highly

permeable soils shall have clay or plastic liners installed to prevent excessive infiltration into the groundwater system.

CS1000 DISINFECTION

CS1001 GENERAL

Disinfection of the effluent shall be provided where required by the U.S. Environmental Protection Agency or their delegated regulatory agency. The use of chlorine gas or hypochlorites shall be utilized if other methods of disinfection such as ultra violet light (UV) or ozonation are not feasible. Whichever method is selected, consideration should be given to back-up or redundant equipment.

CS1002 ULTRAVIOLET LIGHT (UV)

CS1002-1 Applicability: The use of UV disinfection systems are desirable since no chemical residuals remain as by-products of the disinfection process. UV systems may be utilized only when effluent clarity is sufficient to allow adequate light penetration. UV systems are typically limited to wastewater treatment systems which utilize sand filtration.

CS1002-2 Design Criteria: The values for design parameters will vary between manufacturers. However, all designs should

account for the following factors:

- A. Reduction of UV transmissivity with increasing turbidity.
- B. Decline of UV output of lamps with time.
- C. Increased flow rate results in decreased UV contact time.
- D. Level of Total Suspended Solids.
- E. Effluent Limits.

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- CS1002-3 Duplicate Systems: Duplicate systems shall provide standby capacity of 100%.
 - CS1003 OZONATION
 - CS1003-1 Applicability: Ozone may be produced from either air or oxygen gas sources. Ozonation devices shall be automatically controlled to adjust ozone production to meet demand.
 - CS1003-2 Design Criteria: The values for design parameters will vary between manufacturers. However, all designs should account for the following factors:
 - A. Flow rate.
 - B. Nature and concentration of influent contaminants.
 - C. Ozone contact time.
 - D. Effluent limits.
 - CS1003-3 Duplicate Systems: Duplicate systems shall provide standby capacity of 100%.
 - CS1004 CHLORINATION
 - CS1004-1 Equipment: The use of equipment designed to feed chlorine gas in solution is recommended.
 - CS1004-2 Housing: The chlorinator building or room shall have ample forced air ventilation with heating facilities. If gas

chlorination equipment and chlorine containers are to be placed in a building used for other purposes, a gas-tight partition should separate the chlorine room from any other portion of the building. Doors should open only to the outside of the building.

CS1004-3 Capacity of Chlorinator: Chlorinator capacities required will vary depending on the use and point of application of the

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chlorine. For disinfection, the capacity should be adequate to produce a residual of 5.0 ppm in the final effluent.

CS1004-4 Contract Period: After thorough mixing, a minimum contact period of not less than 30 minutes at average daily flow or maximum rate of pumpage shall be provided for disinfection. The chlorine contact tank should be constructed to reduce short circuiting of flow.

CS1005 DECHLORINATION

To achieve the required chlorine reduction, the preferred method of dechlorination is aeration. If effluent aeration is not feasible, dechlorination equipment and chemicals may be required. Chemical addition of sulfur dioxide, sodium metabisulfite or other acceptable reducing agent or activated carbon may be used.

CS1005-1 A final chlorine residual of 0.1 mg/l or less in the treatment plant effluent must be achieved.

CS1100 WASTE STABILIZATION PONDS

CS1101 EXHIBITS

All of the exhibits required for the various states of processing as described in "Submission of Exhibits" shall be submitted when applicable. In addition the following exhibits will be required during the Preliminary Planning Stage:

- A. The results of at least 3 soil borings per acre of basin floor area.
- B. A detailed discussion of the soils where the basin floor will be constructed and of the embankment materials.
- C. The soil borings are required to determine if the soil is

sufficiently impermeable to preclude excessive liquid loss by percolation and is suitable for embankment construction. Soil borings should extend to a depth of

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at least one foot below the proposed finish basin floor elevation and samples should also be taken where significant soil changes are noted. Soil samples should be analyzed and the soil groups reported in accordance with the Unified Soil Classification System. Additional soil borings should be made where the original boring data indicates that the suitability of the soil is questionable. Should existing soils be incapable of reducing percolation rates to 1/8-inch per day or less, membrane liners or off-site clay must be used.

CS1102 AREA REQUIRED

CS1102-1 Clear Area

The site should be large enough to maintain a clear unobstructed, undeveloped area that will extend a minimum distance of 300 feet in all directions from the nearest edge of the basin embankments. Consideration should be given to any proposed basin expansion or the future addition of cells when laying out this distance.

CS1102-2 Expansion Possibilities

The site should include sufficient area for expansion of the original pond basin or for the construction of additional cells where the complete treatment facilities are to be built in stages or where land is available for future development.

CS1103 LOCATION

CS1103-1 Distance from Habitation

The site selected should be suitable for sewage stabilization basin operation without adversely affecting existing or proposed residential properties from an aesthetic standpoint or by reason of possible odors.

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CS1103-2 Prevailing Winds

Wherever practical, stabilization basins should be located so that the local prevailing wind will direct sewage odors away from residential developments.

The design should provide a water surface elevation that will utilize the maximum wind action for mixing and dispersing the sewage solids from the inlet toward the basin periphery.

CS1104 BASIS OF DESIGN

CS1104-1 Surface Area and Loadings

The maximum stabilization basin loading should be approximately 50 properties per acre of liquid surface. The average loading should be approximately 35 properties per acre of liquid surface.

Note: Ideal climate conditions in some sections of the nation may be conducive to higher loadings than 50 properties per acre. In these cases the higher loadings may be justified if experience has shown that satisfactory treatment has been demonstrated with existing stabilization basin installations. Care should be exercised in determining if the higher loadings should be used. The HUD-FHA field environmental engineer should be consulted in this matter.

CS1104-2 Industrial Wastes

Where commercial or industrial wastewater is to be combined with residential sewage, the maximum of 50 residencies per acre of liquid surface in the stabilization basin should be decreased according to the strength of the commercial or industrial wastes. To arrive at the maximum loading under these circumstances, the strength (BOD) of the commercial or industrial sewage can be determined, or estimated if necessary, and converted to the equivalent number of residences using a minimum of 4 persons per

residence and a daily loading of 0.17 pounds BOD per person. (0.7 lbs./dwelling.)

CS1104-3 Multiple Units

The initial construction of stabilization basins may include multiple cells in series where a greater degree of treatment is necessary or is required by state or local authorities. For this type of construction, the first cell should be designed on the basis of 50 residential connections per acre of liquid surface. The maximum number of residential connections per acre of liquid surface should be decreased if commercial or industrial wastes will be combined with residential sewage. The maximum loading should be computed in accordance with the preceding paragraphs.

CS1104-4 Polishing

Where it is necessary to use stabilization ponds for further treatment of effluent from other type sewage treatment works the surface area of the basin (acres of liquid surface required) should be based on a determination of the BOD removal of the pretreatment works. The actual BOD loading for further treatment can be determined from a review of the detailed plans and specifications for proposed pretreatment sewage works construction and from a review of operating records and/or design plans and specifications for existing pretreatment works of the type proposed.

CS1104-5 Pond Shape

To the extent possible, all stabilization basins should be oval, rectangular, square or circular in shape. Islands within embankment boundaries and coves or peninsulas along the embankments are not allowed.

CS1105 POND CONSTRUCTION DETAILS

CS1105-1 Basin Floors

CS1105-1.1 Uniformity: The basin floors shall be level.

CS1105-1.2 Vegetation: All existing vegetation should be completely

removed from the soils to be used for pond bottoms or dikes.

CS1105-1.3 Soils: Soils conforming to the following Unified Soil Classification groups are suitable materials for the basin floor when combined with adequate amounts of suitable clay material:

GC, SC, CL, and CH

All other soil groups shall require membrane liners or adequate clay blankets.

For further reference to the Unified Soil Classification System see FHA Publication No. 373, Engineering Soil Classification for Residential Developments or ASTM D 2487. Classification of soils for engineering purposes.

CS1105-1.4 Where sealing of the basin floor is required, the specifications should state the thickness of clay cover, and should provide for soil compaction, to achieve the percolation rates shown in CS1101.C. The specifications should also describe the manner in which the seal materials are to be placed, the depth of sealing material and the type of compaction equipment to be used.

CS1105-2 Embankments

CS1105-2.1 Foundations: The natural or undisturbed soil underlying a proposed embankment location should be impervious to the extent shown in CS1110.C. If the natural soil does not meet these requirements, membrane liners or adequate clay material shall be used.

CS1105-2.2 Cores: Where it is determined that the construction of a core is necessary, the specifications should provide for soil compaction to conform, insofar as practicable, with significant groups in the Unified Soil Classification System. The manner in which the soil is to be placed in the core and the type of compaction equipment to be used should also be described.

CS1105-2.3 Embankment Materials: Soil groups GM, GC, SM, and SC are good materials for constructing the embankments. The ML, CL, MH, and CH groups should be used in combination with the above groups. It should be emphasized that the GW, GP, SW and SP groups are not satisfactory materials

when used alone. Specifications for embankment construction should include information on method of placing and compacting fill and on the equipment to be used as well as the need for a membrane liner or clay blanket.

- CS1105-2.4 Top Width: A minimum top width of 8 feet should be provided.
- CS1105-2.5 Slopes: The maximum slope of the embankments should not exceed 3 horizontal to 1 vertical.
- CS1105-2.6 Freeboard: The minimum recommended freeboard is 2 feet.
- CS1105-2.7 Liquid Depth
- A. The minimum normal liquid depth should be 2-1/2 feet.
 - B. The maximum normal liquid depth should be 4 feet.
- CS1105-2.8 Protection of Embankments: Embankments should be seeded above the water level. Only shallow root crops will be effective for this purpose as the use of long root grasses may cause sewage to seep through the embankment. Concrete or asphalt splash protection shall be provided completely around the pond extending at a minimum from two feet above the high water line to two feet below the low water line.
- CS1105-3 Influent and Effluent Lines
- CS1105-3.1 Materials: Ductile iron pipe shall be used for the influent and effluent piping.
- CS1105-3.2 Line and Grade: The influent and effluent line design with respect to grade and diameter should conform to generally

accepted engineering practice. A minimum velocity of 2 feet per second shall be provided.

- CS1105-3.3 Point of Discharge: The influent line and the outlet should be located so as to minimize short-circuiting of the incoming sewage flowing through the pond.

Where practical the discharge end of the influent line for rectangular and oval basins should terminate approximately one-third the distance between the influent end and the

outlet structure and at the center of circular or square basins. Variances in this requirement may be satisfactory where modification in the shape of the basin is considered necessary.

- CS1105-3.4 Discharge Apron: The discharge end of the influent line should be laid on an adequately designed concrete slab. A 30 inch square minimum area is recommended.
- CS1105-3.5 Interconnecting Piping: Where multiple cells are used, ductile iron inlet piping to successive cells may be installed through the separating embankments.
- CS1105-4 Outlet Structure
- CS1105-4.1 Outlet Geometry: The outlet structure design should provide for operating the stabilization basin at depths between 2-1/2 and 4 feet. The effluent should be removed at a depth between 6 and 12 inches below the operating water level. Various appurtenances may be used to accomplish this depending on the outlet structure design. These appurtenances may include weirs and baffles or pipe fittings such as tees, ells and pipe extension rings.
- CS1105-5 Miscellaneous
- CS1105-5.1 Fencing: The entire basin area shall be fenced with eight foot (min.) fence. Warning signs to clearly indicate the type of utility shall be posted.

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- CS1105-5.2 Access Road: An all-weather road to the basin site should be provided and should extend to the toe of the embankment at one or more points. Ingress and egress rights should be required if the site is not contiguous with public property.
- CS1105-5.3 Limiting Use: Stabilization basins should not be used for the treatment of storm drainage system wastes.
- CS1105-5.4 Polishing Filters: Were required by the U.S. Environmental Protection Agency or their delegated state regulatory agency, all ponds shall be followed by slow sand filters as provided in CS903.
- CS1106 AERATED PONDS
- CS1106-1 Basin of Design

Aerated ponds shall be designed with a minimum hydraulic retention time of 5 days. Longer times may be required in colder climates.

CS1106-2 Mixing

Aerated ponds shall be adequately mixed to evenly diffuse oxygen throughout the pond. A mixing power input range of 0.5 - 1.0 hp per 1000 cu. ft. of pond volume is recommended.

CS1106-3 Dissolved Oxygen

Aerated ponds shall be maintained at dissolved oxygen levels above 2 mg/l. This oxygen may be supplied by diffused air or mechanical aerators.

CS1106-4 Velocity Gradient

A minimum velocity gradient of one foot per second shall be maintained throughout the aerated pond.

CS1106-5 Supplemental Treatment Processes

Aerated ponds may be followed by non-aerated polishing ponds, clarifiers, filters and/or other such processes.

CS1106-6 Construction

Construction of aerated ponds shall be in accordance with Section CS1105, Pond Construction Details.

CS1106-7 Operation and Maintenance

Pond design shall allow for expected operation and maintenance activities, including: pond access, influent structure access, effluent structure access, and aeration system access.

CS1200 LAND APPLICATION SYSTEMS

CS1201 GENERAL

CS1201-1 Feasibility

The feasibility assessment of land application systems shall be based on soil permeability, wastewater quality, and discharge quality criteria. For any proposed site, the soil permeability must be determined and feasibility judged based on the operating requirements and performance of each land treatment option.

CS1201-2 Approved Methods

The following methods of land application are approved for consideration: spray irrigation, overland flow, rapid infiltration, and constructed wetlands. These systems are approved only for municipal wastewater.

CS1201-3 Holding Ponds

CS1201-3.1 Construction: The methods of construction shall be the same as that required for waste stabilization ponds (see Section CS1100).

CS1201-3.2 Size: Holding ponds shall be sized such that with any combination of equipment outages or inclement weather which prohibits spraying, adequate storage will be available for the treated effluent from the treatment works. Water balance storage calculations over a 12-month period shall have been addressed in the Engineer's Report (DDR). Not less than two weeks storage shall be provided.

CS1201-4 Pumping

CS1201-4.1 The requirements of Section CS500 sewage pumping stations shall also apply to this section.

CS1201-4.2 Pumping Station: The pumping station shall contain:

- A. An in-line meter to measure the amount of effluent pumped.
- B. Pressure instruments with high and low signaling devices to close system valving or shutdown pumps due to line failures or over pressurization on any portion of the system.

CS1201-5 Land Rights

Proof of a recorded fee simple deed or easement for the land

dedicated to wastewater disposal by land application must be provided. Additionally, the holder of the fee simple title or easement to the land shall provide adequate assurances to HUD-FHA that the land or easement will not be conveyed or divested so long as the land is needed for wastewater disposal, unless such conveyance or divestiture is to a new owner who shall assume full responsibility for wastewater treatment as provided in this Handbook.

CS1202 SPRAY IRRIGATION

CS1202-1 Description: Spray irrigation consists of spray irrigating land with treated wastewater effluent. The spray application zones must have live vegetation capable of assimilating the moisture and nutrients.

CS1202-1.1 Design Criteria: In-depth soils testing shall be accomplished in order to:

- A. Ensure that soils are not excessively permeable so as to allow sprayed effluent to reach shallow groundwater tables before vegetative root systems can accomplish their biological uptake, and
- B. Ensure that soils will be adequately permeable so as to prevent effluent runoff or ponding.

CS1202-1.2 Irrigation Frequency: Spray distribution zones shall be irrigated no more than once per week. Five days spraying per week, is recommended. Buffer areas shall be included.

CS1202-1.3 Spray Application Loading: Dependent on soils and vegetation, loadings may vary from 0.25 inches to 6.0 inches per week over the entire application area. Rates of 0.1 to 1.0 inches per hour may be used. Generally an eight hour or less spraying time should be considered to take advantage of evaporation and daylight.

CS1202-1.4 Slopes: Slopes should not exceed 15 percent although in forested areas and for some crops up to 30 percent slopes may be acceptable.

CS1202-1.5 Crops: Where crops are grown to provide the biological uptake from the treated wastewater, rotation of both fields and crops must be considered due to crop growing and harvesting seasons where for a time, fields may be out of

service for spraying. Disposition of the harvested crop shall be considered.

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CS1202-1.6 Trees and Golf Courses: Both trees and golf courses are approvable for spray fields. Golf courses may also require a potable water or surface water (pond or lake) system in addition to the treated effluent system.

CS1202-1.7 Buffers: The following minimum buffers shall be provided:

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* GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED *
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CS1202-2 Spray Field Equipment

CS1202-2.1 Piping: Portable, center pivot and solid set buried piping systems are the most common. For all climates and conditions the solid set buried system is recommended herein. Risers generally should be no more than 4 feet in height with adequate post support and bracketry up to the nozzle.

Ductile iron or pressure class PVC is recommended for spray irrigation piping systems. Velocities in the pipe network should be between 2 and 8 feet per second. Valving for field or segment isolation shall be manual.

The piping grids should be designed for optimum sprinkler location and equal pressure distribution. A pressure differential of less than 20% in any field is desired.
Pressure

differentials which exceed 20% shall be justified by showing that the necessary site grading to achieve a 20% differential is not practical and that spray patterns have been adjusted to take into account the pressure differentials. However, in no case shall pressure differentials exceed 40% in any field.

CS1202-2.2 Nozzles: Nozzle orifice, pressure and flow shall be determined by application rate, size of field, sprinkler overlap, type of vegetation and wind velocity and consistency.

CS1203 OVERLAND FLOW

CS1203-1 Description: This system consists of applying wastewater to gently sloped terraces and allowing it to flow over vegetated surfaces to collection ditches.

CS1203-2 Design Criteria: Application shall be either by direct surface application or by sprinkler system. The area shall be sufficiently sized to allow 16 to 110 acres per MGD. Wastewater application shall not exceed 6 inches per week for screened wastewater or 16 inches per week for secondary effluent. Special care shall be exercised in design to ensure uniform sheet flow over the flow area.

CS1203-3 Preapplication Treatment: Minimum preapplication treatment shall consist of solids removal.

CS1203-4 Construction: During construction special care shall be exercised to ensure uniform sheet flow in accordance with system design.

CS1204 RAPID INFILTRATION

CS1204-1 Description: Rapid Infiltration (RI) consists typically of earthen basins which allow wastewater infiltration into the soil followed by percolation, either vertically or laterally, away from the application point.

CS1204-2 Design Criteria: The minimum land area requirement for a RI system shall be determined by:

$$A = \frac{(0.0365) Q}{L}$$

Where:

- A = treatment area
- Q = design daily flow, m³/d
- L = annual percolation rate, m/yr

Typically, land area should be 2 to 56 acres per MGD. Where RI percolate does not satisfy state groundwater quality requirements, the percolate shall be collected by underdrains for re-use or surface discharge.

Wastewater application shall be by direct surface application.

CS1204-3 Site Selection: The following parameters must be defined prior to determining a site to be suitable for a RI system: general hydrological setting, soil descriptions and water table locations, proposed soil layer for RI basin, groundwater flow characteristics, and necessary site modifications (underdrains, fill, etc.).

CS1205 CONSTRUCTED WETLANDS

CS1205-1 Description: Constructed wetlands consist of flooded meadows and marshes, and usually include a pond.

CS1205-2 Design Criteria: Required land area for constructed wetlands shall be between 11 and 280 acres per 1 MGD. Wastewater shall be applied by either sprinklers or direct surface application. Application shall not exceed 25 inches per week. Finished grade shall not exceed 5%.

CS1300 ONSITE WASTEWATER TREATMENT AND DISPOSAL SYSTEMS

CS1301 GENERAL

Where connection to a public sewer system is not feasible, the following types of onsite treatment shall be allowed:

septic tank with leaching system, sand filters or mounds, and evapotranspiration ponds.

CS301-2 Leaching Systems shall be installed in accordance with local requirements.

CS1302 SEPTIC TANKS

CS1302-1 Septic tanks shall be buried and watertight. All septic tank systems shall be located and installed in accordance with local health and environmental regulations.

CS1302-2 Septic tanks shall have a minimum 8 hour retention time. Tanks shall have inlet and outlet devices which prevent the discharge of sludge and scum with the effluent. Septic tanks shall be vented to permit the escape of gases.

CS1302-3 Septic tanks for residential units shall have the following minimum size:

1 - 2 bedrooms	750 gal
3 bedrooms	900 gal
4 bedrooms	1000 gal
5 bedrooms	1200 gal
each additional	250 gal

Where local codes require larger sizes, the local code shall prevail.

CS1302-4 Where septic tanks are to be installed for multiple homes, they shall be sized based on total flow. For flows between 750-1,500 gpd, the tank capacity shall be 1.5 times daily volume flow. For flows between 1,500-15,000 gpd, minimum tank capacity shall be equal to 1,125 gallons plus 75% of dally flow.

CS1302-5 Septic tank systems shall include one of the following subsurface wastewater disposal systems: leaching fields, sand filters or mounds.

CS1303 INTERMITTENT SAND FILTERS

CS1303-1 Intermittent sand filters may be used for polishing of septic

tank effluent prior to discharge.

- CS1303-2 Media shall be sized to obtain the desired flow rate. However, not more than 1 % of the media shall be smaller than 0.13mm. Typical media range from 0.25mm to 1.5mm, with a uniformity coefficient not more than 4.0. Allowable media materials are: sand, anthracite, garnet, ilmenite and activated carbon.
- CS1303-3 Filters shall be sized to allow 0.75 to 2.0 gpd per square foot of filter area. Wastewater should be applied to flood the surface of the filter to a minimum depth of 3 inches.
- CS1303-4 Intermittent Sand Filter Systems shall be followed by a leaching system or mounds.
- CS1304 MOUNDS
- CS1304-1 Mounds shall be installed in conjunction with septic tank systems only in well drained areas with the following maximum slopes:
- | Percolation Rate | Maximum Slope |
|------------------|---------------|
| < 60 min/in | 6% |
| > 60 min/in | 12% |
- CS1304-2 Mounds shall be located in accordance with local health and environmental codes.
- CS1304-3 Mound system influent shall be anaerobically treated wastewater free of settable solids and greases.
- CS1304-4 Mounds shall be of the following minimum dimensions:

Mound Height	Dimension
Fill Depth	1 ft (minimum)
Absorption Bed Depth	1 ft (minimum)
Cap at Edge of Bed	1 ft
Cap at Center of Bed	1.5 ft
Side Slope	< 3:1

- CS1305 EVAPOTRANSPIRATION PONDS
- CS1305-1 Evapotranspiration ponds shall be designed for zero discharge

in 10 years.

- CS1305-2 All evapotranspiration ponds shall be provided with an impervious liner.
- CS1305-3 All ponds shall be designed using local weather data for pan evaporation and precipitation. All pond designs shall account for wastewater flow and precipitation.
- CS1305-4 Synthetic pond liners shall be minimum 10 mil, with 2 inch sand cushion on both sides.
- CS1305-5 Surface runoff from adjacent areas shall be diverted around the pond.
- CS1400 ALTERNATIVE OR INNOVATING TECHNOLOGY
- CS1401 GENERAL

Wastewater transport or treatment involving alternative and/or innovative technology will be considered by HUD-FHA on a case-by-case basis. All the relevant requirements of this Handbook shall be met. Additionally, not less than one successful installation of the proposed technology shall be documented and demonstrated. Technology which may be considered under this paragraph include aquaculture

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treatment systems, recycling, curved sewers, and pressure sewer systems.

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