Chapter 11

Sanitary Drainage Systems

11.1 MATERIALS
See Section 3.1.

11.2 BUILDING SEWERS AND BUILDING DRAINS

11.2.1 Sewer or Drain in Filled Ground
Building sewers or building drains that are installed in filled or unstable ground shall be installed in accordance with Section 2.6.

11.2.2 Existing Building Sewers and Building Drains
Existing building sewers and building drains may be used in connection with new building sewer and drainage systems only when found by examination to conform to the new system in quality of material prescribed by this Code.

11.2.3 Building Sewer and Building Drain Size
The size of the building sewer and the size of the building drain shall be determined by fixture unit loads connected in accordance with Table 11.5.1A.

11.3 DRAIN PIPING INSTALLATION

11.3.1 Slope of Horizontal Drain Piping
a. Horizontal drain piping shall be installed in uniform alignment at uniform slopes not less than 1/4 inch per foot for 2-inch size and smaller, and not less than 1/8 inch per foot for 3-inch size and larger.
   EXCEPTION: Horizontal drain piping for non-water urinals shall be sloped not less than 1/4 inch per foot to the point where it connects to piping with drainage for one or more water closets.

b. Where conditions do not permit building drains and sewers to be laid with slope as great as that specified, a lesser slope may be permitted by the Authority Having Jurisdiction. See Appendix K for approximate discharge rates and flow velocities in drains at various slopes.

11.4 FIXTURE UNITS

11.4.1 Load on Drain Piping
The load on drainage system piping shall be computed in terms of drainage fixture unit values in accordance with Table 11.4.1 and Section 11.4.2.

11.4.2 Conversion of Flow in GPM to DFU
Where the discharge rate of fixtures or equipment is expressed in gallons per minute (GPM), two (2) drainage fixture units (DFU) shall be allowed for each gallon per minute (GPM) of flow.
### Table 11.4.1
DRAINAGE FIXTURE UNIT (DFU) VALUES

<table>
<thead>
<tr>
<th>HEAVY-USE ASSEMBLY</th>
<th>OTHER THAN DWELLING UNITS</th>
<th>SERVING 3 OR MORE DWELLING UNITS</th>
<th>INDIVIDUAL DWELLING UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BATHROOM GROUPS HAVING 1.6 GPF GRAVITY-TANK WATER CLOSETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Half-Bath or Powder Room</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1 Bathroom Group</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1-1/2 Bathrooms</td>
<td>6</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>2 Bathrooms</td>
<td>7</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>2-1/2 Bathrooms</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>3 Bathrooms</td>
<td>9</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Each Additional Half-Bath</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Each Additional Bathroom Group</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>BATHROOM GROUPS HAVING 1.6 GPF PRESSURE-TANK WATER CLOSETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Half-Bath or Powder Room</td>
<td>3.5</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>1 Bathroom Group</td>
<td>5.5</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>1-1/2 Bathrooms</td>
<td>6.5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2 Bathrooms</td>
<td>7.5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2-1/2 Bathrooms</td>
<td>8.5</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>3 Bathrooms</td>
<td>9.5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Each Additional Half-Bath</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Each Additional Bathroom Group</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>BATHROOM GROUPS HAVING 3.5 GPF (or higher) GRAVITY TANK WATER CLOSETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Half-Bath or Powder Room</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1 Bathroom Group</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1-1/2 Bathrooms</td>
<td>8</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>2 Bathrooms</td>
<td>10</td>
<td>6.5</td>
<td></td>
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<td>2-1/2 Bathrooms</td>
<td>11</td>
<td>7.5</td>
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</tr>
<tr>
<td>3 Bathrooms</td>
<td>12</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Each Additional Half-Bath</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Each Additional Bathroom Group</td>
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</tr>
<tr>
<td>BATHROOM GROUP WITH 1.6 GPF FLUSHOMETER VALVE</td>
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<td>3</td>
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</tr>
<tr>
<td>BATHROOM GROUP WITH 3.5 GPF (or higher) FLUSHOMETER VALVE</td>
<td>6</td>
<td>4</td>
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### Table 11.4.1 (Continued)
**DRAINAGE FIXTURE UNIT (DFU) VALUES**

<table>
<thead>
<tr>
<th>HEAVY-USE ASSEMBLY</th>
<th>OTHER THAN DWELLING UNITS</th>
<th>SERVING 3 OR MORE DWELLING UNITS</th>
<th>INDIVIDUAL DWELLING UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INDIVIDUAL FIXTURES</strong></td>
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</tr>
<tr>
<td>Bathtub or Combination Bath/Shower, 1-1/2” Trap</td>
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<tr>
<td>Bidet, 1-1/4” Trap</td>
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<td></td>
</tr>
<tr>
<td>Clothes Washer, Domestic, 2” Standpipe</td>
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<td></td>
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<tr>
<td>Dishwasher, Domestic, with Independent Drain, 1-1/2” minimum trap</td>
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<tr>
<td>Drinking Fountain or Watercooler</td>
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<tr>
<td>Food Waste Disposer, Commercial, 2” Min Trap</td>
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<td>Floor Drain, Auxiliary</td>
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<tr>
<td>Kitchen Sink, Domestic, with One 1-1/2” Trap</td>
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<td></td>
</tr>
<tr>
<td>Kitchen Sink, Domestic, with Food Waste Disposer</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Kitchen Sink, Domestic, with Dishwasher</td>
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<td></td>
</tr>
<tr>
<td>Kitchen Sink, Domestic, with Disposer and Dishwasher</td>
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<td></td>
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<tr>
<td>Laundry Sink, One or Two Compartments, 1-1/2” Waste</td>
<td>2  2  2</td>
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<td></td>
</tr>
<tr>
<td>Laundry Sink, with Discharge from Clothes Washer</td>
<td>2  2  2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lavatory, 1-1/4” Waste</td>
<td>1  1  1  1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mop Basin, 3” Trap</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Service Sink, 3” Trap</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Shower Stall, 1-1/2” Trap</td>
<td>2  2  2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shower Stall, 2” Trap</td>
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<td></td>
</tr>
<tr>
<td>Showers, Group, per Head (Continuous Use)</td>
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<td>5</td>
<td></td>
</tr>
<tr>
<td>Sink, 1-1/2” Trap</td>
<td>2  2  2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sink, 2” Trap</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sink, 3” Trap</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trap Size, 1-1/4” (Other)</td>
<td>1  1  1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trap Size, 1-1/2” (Other)</td>
<td>2  2  2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trap Size, 2” (Other)</td>
<td>3  3  3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trap Size, 3” (Other)</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Trap Size, 4” (Other)</td>
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<td>6</td>
<td></td>
</tr>
<tr>
<td>Urinal, 1.0 GPF</td>
<td></td>
<td>4  5</td>
<td></td>
</tr>
<tr>
<td>Urinal, Greater Than 1.0 GPF</td>
<td></td>
<td>5  6</td>
<td></td>
</tr>
<tr>
<td>Wash Fountain, 1-1/2” Trap</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Wash Fountain, 2” Trap</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Wash Sink, 1-1/2” Trap</td>
<td></td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Table 11.4.1 (Continued)
DRAINAGE FIXTURE UNIT (DFU) VALUES

<table>
<thead>
<tr>
<th>HEAVY-USE ASSEMBLY</th>
<th>OTHER THAN DWELLING UNITS</th>
<th>SERVING 3 OR MORE DWELLING UNITS</th>
<th>INDIVIDUAL DWELLING UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Closet, 1.6 GPF Gravity or Pressure Tank</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Water Closet, 1.6 GPF Flushometer Valve</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Water Closet, 3.5 GPF Gravity Tank</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Water Closet, 3.5 GPF Flushometer Valve</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Whirlpool Bath or Combination Bath/Shower, 1-1/2” Trap</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

NOTES FOR TABLE 11.4.1:
1. A Bathroom Group, for the purposes of this Table, consists of not more than one water closet, up to two lavatories, and either one bathtub, one bath/shower combination, or one shower stall. Other fixtures within the bathing facility shall be counted separately to determine the total drainage fixture unit load.
2. A Half-Bath or Powder Room, for the purposes of this Table, consists of one water closet and one lavatory.
3. For unlisted fixtures, refer to a listed fixture having a similar flow and frequency of use.
4. When drainage fixture unit (DFU) values are added to determine the load on the drainage system or portions thereof, round the sum to the nearest whole number before referring to Tables 11.5.1A, 11.5.1B, or 12.16.6A for sizing the drainage and vent piping. Values of 0.5 or more should be rounded up to the next higher whole number (9.5 = 10 DFU). Values of 0.4 or less should be rounded down to the next lower whole number (9.4 = 9 DFU).
5. “Other Than Dwelling Units” applies to business, commercial, industrial, and assembly occupancies other than those defined under “Heavy-Use Assembly.” Included are the public and common areas in hotels, motels, and multi-dwelling buildings.
6. “Heavy-Use Assembly” applies to toilet facilities in occupancies that place heavy, but intermittent, time-based loads on the drainage system, such as; schools, auditoriums, stadiums, race courses, transportation terminals, theaters, and similar occupancies where queuing is likely to occur during periods of peak use.
7. Where other than water-supplied fixtures discharge into the drainage system, allow 2 DFU for each gallon per minute (gpm) of flow. (See Section 11.4.2.)

11.4.3 Diversity Factors
In certain structures such as hospitals, laboratory buildings, and other special use or special occupancy buildings where the ratio of the number of plumbing fixtures to the number of occupants is proportionally more than required by Table 7.21.1 for Business Occupancy and in excess of 1,000 drainage fixture units, the Authority Having Jurisdiction may permit the use of a diversity factor for sizing drain branches, drain stacks, building drains, and building sewers.

**Comment**: The Authority Having Jurisdiction may permit the use of a diversity factor in systems where the number of fixtures per person is higher than normal. A hospital is such an example where toilet facilities are provided in each patient room for the convenience of the patients. The load on the drainage system is created by the number of persons served, not by the number of plumbing fixtures that are installed.

11.5 DETERMINING DRAIN PIPE SIZES

11.5.1 Selecting the Size of Drain Piping
Pipe sizes shall be determined from Table 11.5.1A and 11.5.1B on the basis of the drainage fixture unit load (DFU) computed from Table 11.4.1 and Section 11.4.1. Sanitary drain pipe sizes shall not be reduced in the direction of flow.

**EXCEPTION**: Drain pipe sizes for individual fixtures shall be not less than the minimum trap size required in Section 5.2.
### Table 11.5.1A
BUILDING DRAINS AND SEWERS

Maximum Number of Drainage Fixture Units (DFU) That May Be Connected to Any Portion of the Building Drain or the Building Sewer.

<table>
<thead>
<tr>
<th>Pipe Size- Inches</th>
<th>Slope Per Foot 1/16-Inch</th>
<th>Slope Per Foot 1/8-Inch</th>
<th>Slope Per Foot 1/4-Inch</th>
<th>Slope Per Foot 1/2-Inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>21</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>36&lt;sup&gt;2&lt;/sup&gt;</td>
<td>42&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>180</td>
<td>216</td>
<td>250</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>390</td>
<td>480</td>
<td>575</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>700</td>
<td>840</td>
<td>1,000</td>
</tr>
<tr>
<td>8</td>
<td>1,400</td>
<td>1,600</td>
<td>1,920</td>
<td>2,300</td>
</tr>
<tr>
<td>10</td>
<td>2,500</td>
<td>2,900</td>
<td>3,500</td>
<td>4,200</td>
</tr>
<tr>
<td>12</td>
<td>3,900</td>
<td>4,600</td>
<td>5,600</td>
<td>6,700</td>
</tr>
<tr>
<td>15</td>
<td>7,000</td>
<td>8,300</td>
<td>10,000</td>
<td>12,000</td>
</tr>
</tbody>
</table>

NOTES FOR TABLE 11.5.1A:
1. On-site sewers that serve more than one building may be sized according to the current standards and specifications of the Authority Having Jurisdiction for public sewers.
2. See Section 11.5.6.c & d for the restrictions on the number of water closets installed on 3" building drains and sewers.

### Table 11.5.1B
HORIZONTAL FIXTURE BRANCHES AND STACKS

Maximum Number of Drainage Fixture Units (DFU) That May Be Connected to Any Horizontal Fixture Branch, a Stack of Three Branch Intervals or Less, or Stacks of more than Three Branch Intervals

<table>
<thead>
<tr>
<th>Pipe Size- Inches</th>
<th>Any Horizontal Fixture Branch&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Stacks with Three Branch Intervals or Less</th>
<th>Total for Stack</th>
<th>Discharged Into One Branch Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1-1/2</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>2</td>
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<tr>
<td>2</td>
<td>6</td>
<td>10</td>
<td>24</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>20&lt;sup&gt;2&lt;/sup&gt;</td>
<td>48&lt;sup&gt;2&lt;/sup&gt;</td>
<td>72&lt;sup&gt;2&lt;/sup&gt;</td>
<td>20&lt;sup&gt;2&lt;/sup&gt;</td>
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<tr>
<td>4</td>
<td>160</td>
<td>240</td>
<td>500</td>
<td>90</td>
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<tr>
<td>5</td>
<td>360</td>
<td>540</td>
<td>1,100</td>
<td>200</td>
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<tr>
<td>6</td>
<td>620</td>
<td>960</td>
<td>1,900</td>
<td>350</td>
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<tr>
<td>8</td>
<td>1,400</td>
<td>2,200</td>
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<td>10</td>
<td>2,500</td>
<td>3,800</td>
<td>5,600</td>
<td>1,000</td>
</tr>
<tr>
<td>12</td>
<td>3,900</td>
<td>6,000</td>
<td>8,400</td>
<td>1,500</td>
</tr>
<tr>
<td>15</td>
<td>7,000</td>
<td>10,500</td>
<td>13,000</td>
<td>2,300</td>
</tr>
</tbody>
</table>

NOTES FOR TABLE 11.5.1B:
1. Does not include branches of the building drain.
2. See Section 11.5.6.a & d for the restrictions on the number of water closets installed on 3" horizontal fixture branches.
3. See Section 11.5.6.b & d for the restrictions on the number of water closets on 3" stacks and discharged into any branch interval of a 3" stack.
11.5.2 Size of Soil and Waste Stacks

The sizing of sanitary drain stacks shall be based on the maximum vertical height from their base to their highest branch drain connection and the total number of their branch intervals in accordance with either Section 11.5.2.1 or Section 11.5.2.2.

11.5.2.1 Less than Five Branch Intervals and Forty (40) Feet Maximum Total Stack Height

a. Sanitary drain stacks with 40 feet or less height shall be sized according to Table 11.5.1B based on less than five branch intervals and the number of connected drainage fixture units (DFU).

b. Sections of drain stacks shall be sized according to the total accumulated drainage fixture unit load (DFU) within each branch interval.

EXCEPTION: Sections of drain stacks shall not be smaller than their largest branch connection. Lower sections of the drain stack shall be increased to that size if necessary.

c. No portion of the drain stack shall be less than one-half of the pipe size of the drain stack at its base.

d. The top of the drain stack shall be connected to a stack vent that is not less than the size of the drain stack at that point.

11.5.2.2 Five or More Branch Intervals with No Limit on Total Stack Height

a. The entire drain stack shall be sized according to Table 11.5.1B based on the total drainage fixture unit (DFU) load at the base of the drain stack.

EXCEPTION: The drain stack size shall be not less than its largest branch connection.

b. The top of the drain stack shall be connected to a stack vent that is not less than the size of the drain stack.

c. A vent stack shall be provided in accordance with Section 12.3.1.

11.5.3 Size of Branch Drains and the Building Drain

a. Horizontal fixture branches, which connect to drain stacks, shall be sized in accordance with Table 11.5.1B.

b. Horizontal branch drains, which do not connect to drain stacks, shall be sized as branches of the building drain in accordance with Table 11.5.1A.

c. The building drain, branches of the building drain, and branch connections to the building drain shall be sized in accordance with Table 11.5.1A.

11.5.4 Provision for Future Fixtures

When provision is made for the future installation of fixtures, those provided for shall be considered in determining the required sizes of drain and vent pipes. Construction to provide for such future installation shall be terminated with a plugged fitting or fittings.

11.5.5 Minimum Size of Underground Drain Piping

No portion of the drainage system installed underground shall be less than two inch pipe size.

EXCEPTION: Condensate waste, tub and shower traps and trap arms, and piping that receives the discharge from relief valves after an air gap.

11.5.6 Restrictions on the Number of Water Closets on 3" Drains

a. 3" Horizontal Fixture Branches

No more than four water closets or bathroom groups shall be installed on a 3" horizontal fixture branch.

EXCEPTION: Where the water closets are rated 3.5 gallons or more per flush, no more than two water closets or bathroom groups shall be permitted.

b. 3" Stacks

No more than four water closets or bathroom groups shall be installed within any branch interval of a 3" stack, and no more than a total of twelve on the stack.
EXCEPTION: Where the water closets are rated 3.5 gallons or more per flush, no more than two water closets or bathroom groups shall be permitted in any branch interval, and no more than a total of six on the stack.

c. 3" Building Drains and Sewers
   1. In single dwelling units, no more than six water closets or bathroom groups shall be installed on a 3" building drain or building sewer, or branches thereof.

   EXCEPTION: Where the water closets are rated 3.5 gallons or more per flush, no more than three water closets or bathroom groups shall be permitted.

   2. In other than single dwelling units, no more than four water closets or bathroom groups shall be installed on a 3" building drain or building sewer, or branches thereof.

   EXCEPTION: Where the water closets are rated 3.5 gallons or more per flush, no more than two water closets or bathroom groups shall be permitted.

d. Mixed Water Closets on 3" Drains
Where 3" drain piping serves a mixture of 1.6 GPF water closets and 3.5 (or higher) GPF water closets, the 3.5 (or higher) GPF water closets shall be counted as two water closets for the purpose of determining the total number of water closets on the 3" drain piping. The drainage fixture unit (DFU) load for each 3.5 (or higher) GPF water closet shall be as indicated in Table 11.4.1.

### 11.6 EFFECT OF OFFSETS IN SANITARY DRAIN STACKS

#### 11.6.1 Vertical Offsets
An offset in a drain stack that is 45 degrees or more from horizontal shall be sized as a straight vertical stack in accordance with Table 11.5.1B.

#### 11.6.2 Horizontal Offsets
Horizontal offsets in sanitary drain stacks shall be sized according to Table 11.5.1A for building drains and sewers. Drain piping downstream from a horizontal offset shall be not less than the pipe size of the offset.

#### 11.6.3 Sanitary Drain Stacks with Horizontal Offsets
   a. Where a sanitary drain stack includes a horizontal offset, the upper and lower portions of the drain stack shall be sized and vented based on their individual number of branch intervals.

   b. Where a vertical portion of a drain stack has less than five branch intervals, it shall be sized according to Section 11.5.2.1 and vented by a stack vent in accordance with Section 12.3.1.

   c. Where a vertical portion of a drain stack has five or more branch intervals, it shall be sized according to Section 11.5.2.2 and vented by a stack vent and vent stack in accordance with Section 12.3.1.

   d. Where a drain stack with horizontal offsets is designed as a single drain stack and any vertical portion requires a vent stack, the size of all drain stack piping, including horizontal offsets, shall be not less than the pipe size at the base of the drain stack. The drain stack shall be vented according to Section 12.3.1.

   See Figure 11.6.3

#### 11.6.4 Offsets Above the Highest Branch
An offset in a drain stack above the highest horizontal branch drain connection shall not affect the size of the drain stack or stack vent.
NOTES:
1. The drain stack contains five or more branch intervals in its upper portion and five or more branch intervals in its lower portion. It must be sized according to Section 11.5.2.
2. The upper portion of the stack (A-B) must be sized based on its total DFU load at its base, using Table 11.5.1B.
3. The offset (B-C) is horizontal and must be sized as a building drain, using Table 11.5.1A.
4. The lower portion of the stack (C-D) must be sized based on the total DFU at its base, using Table 11.5.1B, or the size of the offset, whichever is larger.
5. The size of the entire drain stack must not be smaller than (1) the base of the upper portion (A-B), (2) the horizontal offset (B-C), (3) the base of the lower portion (C-D), or (4) its largest branch connection.
6. The upper and lower portions of the drain stack must have vent stacks and stack vents in accordance with Section 12.3.1.
7. If either the upper portion or the lower portion of the drain stack has ten or more branch intervals, relief vents must be provided for that portion in accordance with Section 12.3.2 and Figure 12.3.2.
8. If one stack is provided for both the upper and lower portions of the drain stack, it should be arranged as indicated in Figure 12.3.3A.
9. If separated stacks are provided for the upper and lower portions of the drain stack, they should be arranged as indicated in Figure 12.3.3B.

Figure 11.6.3
HORIZONTAL OFFSETS IN DRAIN STACKS
11.7 Sewage Pumping

11.7.1 General

a. Equipment for pumping or lifting sewage shall be in accordance with the following:
   11.7.2 Building subdrains.
   11.7.3 Sewage pumps and ejectors.
   11.7.4 Pneumatic sewage ejectors.
   11.7.5 Grinder pumps.
   11.7.6 Macerating toilet systems.
   11.7.7 Sump pits, basins, and receptors.
   11.7.8 Discharge piping.
   11.7.9 Controls.
   11.7.10 High level alarm.
   11.7.11 Individual fixture pumps and ejectors.

b. Pumping equipment shall be installed in accordance with the manufacturer’s instructions and this Code.

11.7.2 Building Subdrains

a. Sanitary drainage below the elevation of the building drain that cannot flow to the building drain by gravity shall be connected to a subdrain from which the contents shall be pumped up to a point in the building drainage system that will flow to the building drain by gravity.

b. Only drainage that must be lifted for gravity flow to the building drain shall be connected to building subdrains. All other drainage shall flow to the building drain by gravity.

EXCEPTION: Renovations and additions to an existing system.

c. Building subdrain piping shall comply with the applicable requirements of Chapter 11.

d. Building subdrain piping shall be vented in accordance with Chapter 12. Vents from subdrain piping may be combined with vents from building gravity drain piping or may be vented separately to outdoors.

See Figure 11.7.2

![Diagram of Building Subdrain and Sewage Pump](image-url)

**NOTES:**

1. Sewage pumps and ejectors must have audible, visual, or combination high level alarms per Section 11.7.10.

**Figure 11.7.2**

BUILDING SUBDRAIN AND SEWAGE PUMP
11.7.3 Sewage Pumps and Ejectors

a. Sewage pumps and ejectors shall:
   1. be installed in a sump pit, basin, or receptor in accordance with Section 11.7.7.
   2. in single dwelling units, be capable of passing a solid at least 1-1/2 inches in diameter and have a 2" minimum discharge pipe size.
   3. in other than single dwelling units, be capable of passing a solid at least 2 inches in diameter and have a 3" minimum discharge pipe size.
   4. have a minimum capacity of 20 gallons per minute if they receive drainage from a water closet or urinal.

b. Discharge piping shall comply with Section 11.7.8.

EXCEPTION: Individual fixture pumps and ejectors shall comply with Section 11.7.11.

11.7.4 Pneumatic Sewage Ejectors

a. Discharge piping shall comply with Section 11.7.8.

b. If water closets, urinals, or other fixtures are close enough to a pneumatic sewage ejector that they will overflow if flushed or discharged while the ejector is discharging under pressure, a surge tank shall be provided to provide temporary holding capacity and gravity flow to the ejector. Surge tanks shall be vented in accordance with Section 12.14.3.a.

c. Pressure release vents for pneumatic sewage ejectors shall not be connected to vent piping for drain piping. Pneumatic ejectors shall be vented separately to the outdoors in accordance with Section 12.14.3.b.

11.7.5 Grinder Pumps

a. Grinder pumps that discharge to a low pressure sewer system shall:
   1. be approved by the authority for the sewer system.
   2. be installed outdoors underground or indoors in a vented sump pit, basin, or receptor.
   3. have discharge pressure that is coordinated with the pressure in the sewer system.
   4. have discharge piping that complies with Section 11.7.8.
   5. include materials for the underground discharge piping that are approved by the sewage authority.

b. Discharge pipe sizes shall be as follows:
   1-1/4" size for up to 25 gallons per minute
   1-1/2" size for 15 to 35 gallons per minute
   2" size for 25 to 65 gallons per minute

11.7.6 Macerating Toilet Systems

a. Macerating toilet systems shall comply with ASME A112.3.4/CSA B45.9.

b. Units shall:
   1. be either self-contained within a water closet or be an external unit.
   2. be permitted to drain bathroom groups, kitchen groups, or individual fixtures.
   3. have clothes washers drained indirectly through a laundry sink if necessary.
   4. be complete including receptor, macerating pump, and automatic controls.
   5. be suitable for the application and be installed in accordance with the manufacturer’s instructions and this Code.
   6. include connections for drain inlets, pumped discharge and vent.
   7. be installed within the manufacturer’s distance limits for vertical lift and horizontal discharge.

c. Discharge piping shall comply with the applicable requirements of Section 11.7.8 with 3/4" minimum pipe size. Horizontal piping beyond the vertical rise from the pump shall be sloped in accordance with the unit manufacturer’s installation instructions.

d. Except for water closets, fixtures connected to macerating toilet units shall be trapped and vented before connection to the pumping unit.
11.7.7 Sump Pits, Basins, and Receptors
a. Sump pits, basins, and receptors shall comply with the following:
   1. be concrete, steel, fiberglass, or other suitable material.
   2. be suitable for indoor or outdoor installation, as required.
   3. be liquid-tight and gas-tight with a sealed cover.
   4. be not less than the minimum size recommended by the pump manufacturer.
   5. include necessary pipe connections for drains, discharge, and vent.
   6. provide access to the pump, piping, and controls.
   7. have provisions for electrical power and control wiring.
   8. shall have a solid bottom adequate to support the pump.

11.7.8 Discharge Piping
a. Discharge piping from pumps and ejectors shall comply with the following unless specified otherwise for specific applications.
   b. The drainage load that sewage pumping units place on building gravity drain piping shall be based on two (2) drainage fixtures units (DFU) for each gallon per minute of pump discharge.
   c. The discharge piping from sewage pumping units shall consist of rigid pipe and fittings that are suitable for conveying sewage and pressure rated for the maximum discharge pressure of the pumping unit.
   d. Discharge pipe shall be:
      1. ASTM A53 galvanized steel
      2. ASTM B88 copper tube, Type L or K
      3. ASTM A377 ductile iron
      4. ASTM D1785 PVC, schedule 40 or 80
      5. ASTM F441 CPVC, schedule 40 or 80
      6. ASTM F442 CPVC, SDR
      7. ASTM D2846 CPVC, SDR 11, CTS
      8. ASTM F2389 PP, IPS schedule 80
   e. Piping shall be sized for a flow velocity of not less than 2 feet per second.
   f. The inside diameter of piping shall be not less than the solid passing capacity of the pump that it serves.
   g. Fittings shall not reduce the inside diameter of the pipe.
   h. Discharge piping from pumps shall include a check valve and full-way shutoff valve that are accessible.

11.7.9 Controls
Pump units shall have automatic liquid level controls. Units with multiple pumps shall include multi-stage lead-lag control.
11.7.10 High Level Alarm

Sewage pumping units shall include an audible, visual, or combination high liquid level alarm.

EXCEPTIONS:

(1) Existing sewage pumping units.
(2) Sewage ejectors and sewage pumps serving individual fixtures.
(3) Macerating toilet systems.

11.7.11 Individual Fixture Pumps and Ejectors

a. Individual fixtures other than water closets, urinals, and similar fixtures may discharge directly into an approved fixture-mounted pump or ejector, or into a receptor having a pump or ejector.

b. The discharge piping from a sewage pump or ejector for an individual fixture shall be sized to suit the discharge rate of the fixture and include a backwater valve and full-way shutoff valve.

c. Direct-mounted equipment may be manually or automatically controlled.

d. The installation of manually or automatically operated equipment shall not be subject to the venting requirements of this Code, but shall be vented only as required for proper operation of the equipment in accordance with the manufacturer’s instructions.

e. If the equipment provides a proper liquid trap for the fixture, additional traps are not required.

f. A vent on the fixture side of a trap may terminate locally in the area served.

11.8 RESERVED
11.9 BRANCH CONNECTIONS NEAR THE BASE OF DRAIN STACKS
   a. Branch drain connections near the base of drain stacks that do not have vent stacks shall be not less than 2 feet above the base of the stack and not less than 10 pipe diameters downstream from the base of the stack.
   b. Where drain stacks have vent stacks in accordance with Section 12.3.1, branch drain connections near the base of the drain stack shall be coordinated with the location of its pressure relief connection by the vent stack.
      1. If the pressure relief connection by the vent stack is above the base of the drain stack, there shall be no branch drain connections to the drain stack between its pressure relief connection and its base.
      2. If the pressure relief connection by the vent stack is to the building drain beyond the base of the drain stack, there shall be no branch drain connections to the building drain between its pressure relief connection and the base of the drain stack.
See Figures 11.9 and 12.3.1

11.10 BRANCH CONNECTIONS TO OFFSETS IN DRAIN STACKS
   a. Branch drains shall be permitted to connect to a horizontal stack offset, provided that the connection is not within 10 pipe diameters downstream from the upper portion of the stack.
   b. Where stacks have five or more branch intervals above a horizontal offset, there shall be no branch connections to the stack within 2 feet above or below the offset.
   c. Where stacks having five or more branch intervals above a vertical offset have branch connections to the stack within 2 feet above or below the offset, the offset shall be vented as required for a horizontal offset.

11.11 SUDS PRESSURE ZONES

11.11.1 General
Where suds-producing fixtures on upper floors discharge into a sanitary drain stack, suds pressure zones shall exist as described in Section 11.11.2. Fixture or branch drain connections shall not be made to such stacks in the suds pressure zones except where relief vents complying with Section 12.15 are provided. Suds-producing fixtures include kitchen sinks, laundry sinks, automatic clothes washers, dishwashers, and other fixtures that could discharge sudsy detergents.

Comment #1: The most likely fixtures to create suds pressure problems in drain stacks are clothes washers, dishwashers, kitchen sinks, and laundry sinks. Where liquid wastes in tall buildings include high-sudsing detergents, the detergent is vigorously mixed with the liquid waste and air in the stack. The liquid waste is heavier than the suds and does not carry them along with the flow. The suds will settle in the lower portions of the drainage system, including any horizontal offsets. The air that is flowing with the liquid waste compresses the suds and builds up pressure in the stack that can blow trap seals if not relieved. Zones of the drainage and vent piping where suds pressure can exist are described in Section 11.11.2 and illustrated in Figure 11.11.2.

Comment #2: Suds pressure relief vents in Section 12.15 are larger than ordinary vents for drainage systems because the suds are heavier than air. Suds can weight from 2 to as much as 19 pounds per cubic foot.
11.11.2 Locations in Stacks Serving Suds-Producing Fixtures

a. Zone 1 - at offsets greater than 45 degrees from vertical. A suds pressure zone shall extend 40 pipe diameters up the stack above the offset, 10 pipe diameters downstream from the base of the upper portion of the stack, and in the horizontal offset, 40 pipe diameters upstream from the top of the lower portion of the stack.

b. Zone 2 - at the base of a sanitary drain stack. A suds pressure zone shall extend 40 pipe diameters up the stack above its base.

c. Zone 3 - in the horizontal drain beyond the base of a sanitary drain stack. A suds pressure zone shall extend 10 pipe diameters from the base of the stack. Also, if a turn greater than 45 degrees occurs in the horizontal drain less than 50 feet from the base of the stack, suds pressure zones shall exist 40 pipe diameters upstream and 10 pipe diameters downstream from the horizontal turn.

d. Zone 4 - in a vent stack at the base of a sanitary drain stack. Where a vent stack connects above or beyond the base of a sanitary drain stack, a suds pressure zone shall extend up the vent stack to a level equal to the level of the suds pressure zone in the sanitary drain stack.

See Figure 11.11.2

Figure 11.11.2
THE LOCATIONS OF SUDS PRESSURE ZONES IN DRAIN AND VENT PIPING
11.11.3 Separate Stacks
Where sanitary drain stacks serving suds-producing fixtures extend six or more floors above the base of the stack or above a horizontal offset in the stack, the lowest four floors above the base or horizontal offset shall be drained by a separate stack. In the case of a horizontal offset, the separate stack for the four floors above the offset may be reconnected to the main stack below the offset, provided that the point of connection is not a suds pressure zone in either stack.

See Figure 11.11.3

11.11.4 Exceptions
a. The requirements of Sections 11.11 and 12.15 shall not apply to the following:
   1. Stacks that are less than three stories in height.
   2. Stacks in individual dwellings having their own building sewer.
NOTES:
1. There should be no branch drain connections within 10 pipe diameters of the base of a drainage stack.
2. Portion D-1 of the upper floor offset between the 8th and 9th floors must be sized as a building drain, based on the DFU load for the upper floors above that portion of the offset.
3. Portion D-2 of the upper floor offset between the 8th and 9th floors must be sized as a building drain based on the DFU load for all floors above the offset.
4. Portion D-3 of the building drain must be sized based on the DFU load for the drainage stack above that portion of the building drain.
5. Portion D-4 of the building drain must be sized based on the DFU for the entire drainage stack.

Figure 11.11.3
SEPARATE DRAINAGE STACKS FOR LOWER FLOORS
WHERE THERE ARE SUDS PRODUCING FIXTURES ABOVE