

Section 12 – Design Criteria: Higher Level Treatment

1. General

- a. Higher level treatment systems may be public domain technology systems or proprietary systems.
 - i. Public domain technology systems must be designed, installed and maintained according to established criteria and additional criteria established by the Clear Creek Environmental Health Department. When design criteria are not specifically provided in this regulation, the criteria used in the design must be from a reference commonly used as an industry standard and the criteria must be cited in the design.
 - ii. Proprietary systems must be designed, installed, and maintained according to manufacturer's instructions and additional criteria identified by the Colorado Department of Public Health and Environment in the Technology Review and Acceptance process, section 43.13 of Regulation #43.
- b. Reductions to soil treatment area or separation distances based on higher level treatment only apply when the requirements of Section 16 are met. The owner of a property that utilizes higher level treatment must obtain and maintain an Operating Permit issued by the Clear Creek Environmental Health Department.
- c. Soil treatment areas for higher level treatment systems must be pressure dosed.
- d. Systems must be capable of accommodating all anticipated flows and organic loads.
- e. Mechanical components must be installed in a properly vented location and all vents, air intakes, and air hoses must be protected from snow, ice, or water vapor accumulations.
- f. Covers, barriers, or other protection: All systems must be installed to include protection of openings against entry of insects, rodents, other vectors and unauthorized people.

2. Treatment Levels for Higher Level Treatment Systems

- a. The treatment levels identified in Table 7-3 are specified in this section for public domain technology, and proprietary treatment systems will be assigned a treatment level by the technology review and acceptance process in section 43.13 of Regulation #43. Adequate maintenance for each must be required and documented as required by Section 16.

3. Sand Filters

- a. A lined or unlined intermittent sand filter, or recirculating sand filter, may be used as a higher level treatment system prior to dispersing the effluent into a soil treatment area.
- b. Intermittent (Single Pass) Sand Filters; General Requirements
 - i. The treatment level for intermittent sand filters is considered TL3.

ii. Not all combinations of the variables noted below will result in a proper distribution system design. The design engineer must justify through calculations or design software that the selected values will concur with industry standards.

1. Distribution pipe size: 3/4 inch – 1.5 inches (PVC Class 200, min.)
2. 2 inch distribution pipe may only be used where other design modifications cannot overcome a greater than 10% variation in the pressure head between the initial and distal orifices.
3. Distribution pipe spacing: 18 inches – 48 inches
4. Orifice size: 1/8 inches – 3/8 inches (Also see 12.3.b.ii.5 below)
5. Orifice spacing: 18 inches – 48 inches
6. Operating head at the distal end of distribution pipes: 30 inches – 72 inches (60 inches typ.). Larger orifices allow for an operating head at the lower end of this range, while smaller orifices will necessitate an operating head at the higher end of this range.

iii. Dosing

1. Pressure distribution is required. The design of the distribution system must also comply with the requirements of Section 11.4.c.i.
2. Number of cycles/day: Will vary with design (Short, frequent doses are preferred.)
3. Proposed dose volume: Will vary with design (0.25 – 1.0) gallons/orifice/dose, or 3-5 times distribution pipe volume
4. Timed dosing is recommended where design considerations allow.

iv. Sand Filter Treatment Media

1. The depth of the sand media below the distribution system must be at least 24 inches unless otherwise noted in Table 11-1A for type “R” soils.
2. “Preferred” sand media requirements:
 - a. Effective size: 0.25-0.60 mm
 - b. (Uniformity coefficient: ≤ 4.0)
 - c. (Percent fines passing #200 sieve: ≤ 3.0)
3. “Secondary” sand media requirements:
 - a. Effective size: 0.15-0.60 mm
 - b. (Uniformity coefficient: ≤ 7.0)

c. Percent fines passing #200 sieve: ≤ 3.0

4. A gradation of the sand media used must be provided. The gradation must be dated no more than one month prior to the installation date. However, a gradation of the actual material placed in the excavation is recommended.

v. Gravel Requirements

1. Clean, graded gravel, or rock, must range in size from 1/2 inch to 2 1/2 inches. AASHTO M 43-05 (2005 version) size No.3 coarse aggregate meets this specification.
2. The gravel must surround the distribution pipes used to disperse the effluent and must be at least 6 inches below and 2 inches above the pipes.
3. Division accepted manufactured media may be used as an alternative to specified gravel.

vi. Filter Fabric Requirements

1. The top layer of gravel must be covered with a non-woven permeable geotextile fabric meeting a maximum thickness rating of 2.0 ounces per square yard or equivalent pervious material.

vii. Final Cover Material

1. 8 inches – 10 inches of Type 1 or 2 soil with an additional 2 inches top soil
2. Size adjustment factors provided in Tables 11-2 and 11-3 are not applicable for sand filters.

- viii. Sand filters must not be used to treat wastewater that does not conform to TL1 treatment level or better.

c. Unlined (Open Bottom) Sand Filters

- i. All requirements of Section 12.3.b.i-vii will apply to unlined sand filters.
- ii. Application rates:
 1. Maximum hydraulic loading rate for TL1 effluent applied to “Preferred Sand Media” in an unlined sand filter is 1.0 gal./sq.ft./day, or the long-term acceptance rate of the receiving soil for TL3 (Table 11-1) whichever results in the larger area.
 2. Maximum hydraulic loading rate for TL1 effluent applied to “Secondary Sand Media” in an unlined sand filter is 0.8 gal./sq.ft./day, or the long term acceptance rate of the receiving soil for TL3 (Table 11-1) whichever results in the larger area.

3. Maximum hydraulic loading rate for TL2, TL2N, TL3, or TL3N effluent applied to "Preferred" or "Secondary" Sand Media in an unlined sand filter must be the long-term acceptance rate of the receiving soil for TL3, (Table 11-1).
- iii. The upper infiltrative surface of an unlined sand filter receiving TL1 – TL2 effluent must be at least three feet above a limiting layer.
 - iv. The upper infiltrative surface of an unlined sand filter receiving TL2N-TL3 effluent must be at least two and one-half feet above a limiting layer.
 - v. The upper infiltrative surface of an unlined sand filter receiving TL3N effluent must be at least two feet above a limiting layer.
- d. Lined Sand Filters
- i. All requirements of Section 12.3.b.i-vii will apply to unlined sand filters.
 1. Application rates:
 - a. Hydraulic loading rate for TL1 effluent applied to "Preferred Sand Media" in a lined sand filter is 1.0 gal./sq.ft./day.
 - b. Hydraulic loading rate for TL1 effluent applied to "Secondary Sand Media" in a lined sand filter is 0.8 gal./sq.ft./day.
 2. The minimum depth of the sand media in a lined sand filter must be two feet.
 3. An intermediate layer of pea gravel, two inches in thickness, must be placed between the sand filter media and the course under-drain media to prevent the migration of sand into the lower layer of under-drain gravel. ASTM C 33-16 (2016 version), No. 8, coarse aggregate meets this specification.
 4. A minimum four-inch diameter slotted SCH40 PVC [ASTM Standard D 2729-17 (2017 version)] under-drain pipe must be used to collect the treated effluent. The under-drain pipe must be installed in the center of a 5 inches thick bed of washed, graded gravel, or rock ranging in size from 1/2 inch to 2 1/2 inches. AASHTO M 43-05 (2005 version), No.3 coarse aggregate meets this specification.
 5. Lined sand filters must have an impervious liner on the sides and bottom of the filter. The liner must consist of a minimum 30 mil thick PVC material or equivalent.
 6. Effluent collected by the under-drain must be dispersed to a soil treatment area. The soil treatment area may be sized with a maximum long-term acceptance rate of the receiving soil for TL3 effluent.

e. Recirculating Sand Filter

i. Treatment level:

1. Treatment level provided within recirculating sand filters is TL3.

ii. Not all combinations of the variables noted below will result in a proper distribution system design. Engineer must justify through calculations or design software that the selected values will concur with industry standards.

1. Distribution pipe size: 3/4 inch – 2 inches (PVC Class 200, min.)

2. Distribution pipe spacing: 18 inches – 36 inches (24 inches typ.)

3. Orifice size: 1/8 inch – ¼ inch

4. Orifice spacing: 18 inches – 36 inches (24 inches typ.)

5. Pressure head at end of distribution pipe: 24 inches – 72 inches (60 inches typ.)

iii. Dosing

1. Timed dosed, pressure distribution is required. The design of the distribution system must comply with the requirements of Section 11.4.c.i.

a. Recirculation ratio: 3:1 – 5:1

b. Gallons/orifice/dose: 1 – 3 (2.0 typ.)

c. Hydraulic loading: 3 - 5 gal./sq.ft./day (4 – 5 typ.)

d. Dosing time "ON"; <2.5 min. (<2.0 typ.)

e. Number of cycles/day: 48 – 120

iv. Top gravel requirements:

1. Washed, graded gravel, or rock, must range in size from 1/2 inch to 2 1/2 inches. AASHTO M 43-05 (2005 version), No.3 coarse aggregate meets this specification.

2. The gravel must surround the distribution pipes used to disperse the effluent and must be at least 6 inches below and 2 inches above the pipes.

3. State accepted manufactured media may be used as an alternative to specified gravel.

4. Soil cover is prohibited. The upper gravel layer must be open to the atmosphere.

- v. Filter media requirements:
 1. Effective size: 1.5 – 2.5 mm
 2. Uniformity coefficient: ≤ 3
 3. Fines passing #200 sieve: ≤ 1.0
 4. Media depth (min.): ≥ 24 inches
- vi. Intermediate gravel layer:
 1. An intermediate layer of pea gravel, two inches in thickness, must be placed between the coarse underdrain media and the sand filter media to prevent the migration of sand into the lower layer of under-drain gravel (ASTM C 33-16 (2016 version), No. 8, coarse aggregate).
- vii. Under-drain requirements:
 1. A minimum four-inch diameter slotted SCH40 [ASTM Standard D 2729-17 (2017 version)]. PVC under-drain pipe must be used to collect the treated effluent. The under-drain pipe must be installed in the center of a 5 inches thick bed of washed, graded gravel, or rock ranging in size from 1/2 inch to 2 1/2 inches. AASHTO M 43-05 (2005 version), No.3 coarse aggregate meets this specification.
- i. PVC liner requirements:
 1. Lined sand filters must have an impervious liner on the sides and bottom of the filter. The liner must consist of a 30 mil thickness PVC material or equivalent.
- ii. Effluent collected from the recirculating sand filter must be discharged to a soil treatment area. The soil treatment area may be sized with a maximum long-term acceptance rate of the receiving soil for TL3N effluent.

4. Mound Systems

- a. When the infiltrative surface area of the media receiving wastewater effluent is at or above the natural ground surface at any point, it shall be considered a mound system.
- b. Mound systems that provide a minimum of 24 inches of sand treatment media may use the application rates for the in-situ receiving soil for TL3 effluent (Table 11-1). Size adjustment factors within Table 11-3 must not be applied to mound designs where TL3 application rates are used. However they may be applied if TL1 application rates are used.
- c. Mound systems must conform to the design requirements of Section 12.3.c.i-v for unlined (open bottom) sand filters, with the following exceptions.
 - i. A mound system may include less than 24 inches of imported sand media on a site where a lesser depth of sand media is sufficient to meet vertical separation

- requirements above a limiting layer. Application rates for the in-situ receiving soil for TL1 effluent must be used when less than 24 inches of sand media is used, unless higher level treatment is provided prior to dispersal into the mound system.
- ii. For the design of a mound system where less than 24 inches of sand media is proposed, and application rates for TL1 are used, the size adjustment factors within Table 10-3 may be used.
- d. The basal area must be determined using the LTAR from Table 11-1 for the in-situ receiving soil under the mound.
- e. Linear loading rates must be determined. The evaluation of many factors is required for an accurate determination of the linear loading rate. While application rates for the in-situ receiving soil under the mound is a main component, placement on the slope, and percent of slope must also be addressed when defining the linear loading rate. If the movement of the effluent is primarily vertical, then the linear loading rate is not as critical. However, if the movement of the effluent will be primarily horizontal, as would be expected in soil types 3A through 5 (Table 11-1), then the linear loading rate is extremely important and long narrow mounds are strongly recommended.
- i. When TL1 effluent is applied to the distribution media of a mound system installed above in-situ soil types 1 through 3 (Table 11-1) and R-0 through R-2 (Table 11-1A), the suggested linear loading rate is between 6 gpd/lin.ft. and 12 gpd/lin.ft. The maximum width of the distribution media in a mound system installed above these soil types is 12 feet when TL1 effluent is applied to the distribution media of a mound system.
 - ii. When TL2 through 3N effluent is applied to the distribution media of a mound system installed above in-situ soil types 1 through 3 (Table 11-1) and R-0 through R-2 (Table 11-1A), the linear loading rate may exceed 12 gpd/lin.ft.; subsequently the mound may be wider than 12 feet.
 - iii. When TL1 through TL3N effluent is applied to mound systems installed above in-situ soil types 3A through 5 (Table 11-1), the suggested linear loading rate is between 3 gpd/lin.ft. and 5 gpd/lin.ft. The maximum width of the distribution media in a mound system placed above these soil types is 12 feet.
- f. The final cover over a mound system must extend at least twelve inches horizontally beyond the perimeter of the distribution media prior to sloping down to existing grade. The final slope of the mound must be no greater than three feet horizontal to one foot vertical.
- g. The surface of the mounded area must be planted with a suitable vegetative cover.
- h. A suggested reference for the design and installation of mound systems is, "*The Wisconsin Mound Soil Absorption System: Siting, Design, and Construction Manual, January 2000*". Note that this is suggested guidance, and where the requirements of this regulation differ from those in the referenced mound document, the requirements of this regulation will govern in those cases.

5. Rock Plant Filter (Constructed Wetland) Treatment Before a Soil Treatment Area

- a. The design must be site specific and include specifications for: loading, capacity, dimensions, liner material, filter media, effluent depth and depth control mechanism, density and species of plant material, and other site specific information.
- b. The treated effluent from a rock plant filter must be distributed to a soil treatment area.
- c. Although producing higher level treatment, rock plant filters must not be assigned a treatment level higher than TL1 because of system and seasonal variability.