Chapter 420-3-1-.67
MOUND COMPONENTS

- Treatment Tank
- Pump Chamber w/ Effluent Pump, Controls and Alarms
- Mound [ bed ] of Fill Material [ s, ls, sl ] w/gravel for effluent distribution lines
- Low Pressure, Small Diameter Distribution Piping [ edf ]
- Cap of Proper Material
- Prepared Layer of Original Soil
MOUND SYSTEMS
Slope/Surface Requirements [ Site ]

- Wisconsin Design: Dependent on Installer Accessibility [ Ala. Rules: =/< 40% ]
- UNC Design: =/< 10%
- Both Designs:
  - avoid depression/drainage area
  - divert/intercept surface/subsurface water
  - locate edf at elevation higher than pump chamber
MOUND SYSTEMS Construction

- Protect Site Integrity
- Prohibit:
  - site compaction
  - topsoil removal
  - working during wet conditions

- Prepare the Site
  - cut trees
  - clear brush
  - cover boulders
  - cut vegetation

.67(1)(b)10
MOUND SYSTEMS
Construction

- Scarify [break up] Original Soil
  - 6 – 8 inch depth
  - moisture range satisfactory
    - soil crumbles rather than beads
  - use proper equipment
    - chisel teeth attached to backhoe
    - chisel plow
    - bucket with short teeth

** rototillers are not recommended

.67(1)(b)10
MOUND SYSTEMS
Construction

- Placement of Fill Material – Basal Area
  - protect scarified area
  - fill placed on scarified area ASAP
  - fill placed in lifts
  - fill placed from “up slope” side
  - fill applied [off mound] w/backhoe
  - work on the mound by use of crawler tractor/tracked equipment
  - create a gradual boundary between the fill and original soil
<table>
<thead>
<tr>
<th>Design Factors</th>
<th>Wisconsin Mound</th>
<th>UNC Design Mound</th>
<th>CF Design</th>
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<td>Percolation Rate in top 12&quot; of original soil:</td>
<td>=/\ 120 min/in</td>
<td>=/\ 120 min/in</td>
<td>Required [by memo] 11/06/01 No perc limit</td>
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<td>Depth to Restrictive Layer</td>
<td>=/\ 12”</td>
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<td>Depth to Seasonal Water Table</td>
<td>=/\ 10”</td>
<td>=/\ 12”</td>
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TYPICAL DISPOSAL AREA IN CONTROLLED FILL

- Crown finished surface from center at 3% grade
- 4" diameter perforated distribution line equally spaced
- Clean fill in 8" lifts and compacted as placed
- Uniform grade to meet original soil with a maximum slope of 25%
- Remove vegetation and scarify original soil under disposal area
- Bottom of bed level with maximum grade tolerance of 1 inch/100 feet
- Maintain 18" separation
- Seed to prevent erosion

NOTE: Provide surface drainage to prevent surface water flow across disposal field

FIG. H-2
TYPICAL DISPOSAL AREA IN CONTROLLED FILL

- clean fill in 8" lifts and compacted as placed
- uniform grade to meet original soil with a maximum slope of 25%
- 4" diameter perforated distribution line equally spaced
- crown finished surface from center at 3% grade
- remove vegetation and scarify original soil under disposal area
- original grade
- bottom of bed level with maximum grade tolerance of 1 inch/100 feet
- LIMITING FACTOR
- maintain 18" min separation
- seed to prevent erosion
- NOTE: provide surface drainage to prevent surface water flow across disposal field
TYPICAL LFP DISPOSAL AREA IN CONTROLLED FILL

- Crown finished surface from center at 3% grade
- Small Diameter Low Pressure Pipe (LPP)
  - Clean fill in 6" to 8" lifts and compacted as placed
- Uniform grade to meet original soil with a maximum slope of 1:3
- Original grade
- Remove vegetation and scalped original soil under disposal area
- Bottom of bed level with maximum grade tolerance of 1"/100 ft

NOTE: Provide surface drainage to prevent surface water flow across disposal field.

- Seed to prevent erosion
CONTROLLED FILL REQUIREMENTS FOR NEW RULES

- Design Calculations Established/Defined
  - Terms defined
  - Perc table expanded for sizing EDFs with 4” pipe/gravel
  - Loading rates and correction factors established use with LPP designs [soil loading rates, linear loading rates for site conditions, slope correction factors]
  - Minimum standards for side/end slopes, separation distances from sidewalls to side/end slopes, etc.
  - Minimum standards for high certain high shrink/swell soils

- Fill Placement / Bed Construction Standards

- Allowable Reductions Established

- Five Basic Design Modes for Approval by LHD
3 DESIGN “AREAS” of CF
Distribution Area (DA), Absorption Area (AA), and Basal Area (BA) – End View

- **DA** - The area formed by the EDF footprint
- **AA** – The area formed by the DA plus the required setbacks from the side and end slopes
  - 5’ for large diameter pipe
  - 2’ for small diameter pipe
- **BA** – The entire “footprint” of the Controlled Fill bed over the natural ground surface
  - For small diameter pipe and drip, it is calculated on the original ground soil loading rate
  - For other pipe, it is calculated on the soil test results and the amount of pipe required, with no reductions given for the type of pipe used
Distribution Area (DA), Absorption Area (AA), and Basal Area (BA) – Side View

- **DA** - The area formed by the EDF footprint
- **AA** – The area formed by the DA plus the required setbacks from the side and end slopes
  - 5’ for large diameter pipe
  - 2’ for small diameter pipe
- **BA** – The entire “footprint” of the Controlled Fill bed over the natural ground surface
  - For small diameter pipe and drip, it is calculated on the original ground soil loading rate
  - For other pipe, it is calculated on the soil test results and the amount of pipe required, with no reductions given for the type of pipe used
CF Designs for LHD Approval

- **Five Basic Design Concepts**
  - 4 inch pipe [other large diameter], in trenches, with 12” gravel; primary treatment
  - 4 inch pipe [other large diameter], in trenches, with 12” gravel; secondary treatment
  - Small diameter pipe [LPP system], in a bed, with 9” gravel; primary treatment
  - Small diameter pipe [LPP system], in a bed, with 9” gravel; secondary treatment
  - Drip tube, 6” into fill; secondary treatment
CONTROLLED FILL CALCULATIONS FOR DESIGNS USING LARGE DIAMETER PIPE

- Determine Height of Fill Material
  - Bottom of trench located as required above restrictive layer
  - Minimum of 12” from b.o.t. to top of gravel
  - Minimum of 12” of cover over pipe

- Determine Perc Rate of Original Soil at 12”

- Determine Amount of EDF Required
  - Table 3 or 3a

- Determine Layout of EDF [Rectangular] - DA
  - 3’ wide trenches
  - 5’ between trench sidewalls

- Allow for Setbacks from Side/End Slopes – AA
  - 5’ for large diameter pipe
  - 2’ for small diameter pipe

- Determine Side/End Slopes Length
  - Maximum 3:1 ratio
DA for CF Using Large Diameter Pipe
Perc Tables

- **Review of Current Tables**
  - Rules: 1 – 60 min/inch
  - Mound Manuals: up to 120 min/inch
  - Alternating Field Formula: up to 120 min/inch
  - Drip Charts: >120 min/inch

- **New Rules**
  - Table 3: up to 120 min/inch
    - Conventional OSS
  - Table 3a: 121 – 240 min/inch
    - High Shrink-Swell Soils and Poorly Structured Soils
    - Minimum Design Rate of 180 min/inch in Vertisols & vertic soils
CONTROLLED FILL CALCULATIONS
Large Diameter Pipe

- Determine Height of Fill
  - Depth of trench bottom above restrictive layer
    - 12”, 18”, 24”
  - Minimum of 12” from B.O.T. to top of gravel
  - Minimum of 12” of cover over pipe

- Determine Side/End Slopes Length
  - Maximum 3:1 Slope

- Determine Perc Rate of Original Soil at 12”

- Determine Amount of EDF Required
  - Table 3 or 3a

- Determine Layout of EDF [Rectangular]
  - This is the CF Bed Distribution Area [DA]
  - 3’ wide trenches are standard
  - 5’ minimum between trench sidewalls

- Allow for Setbacks from Side/End Slopes
  - This, added to the DA is Absorption Area [AA]
  - 2’ for small diameter pipe
  - 5’ for all others

- Basal Area = Total Length x Total Width
CONTROLLED FILL CALCULATIONS
Large Diameter Pipe

- **Determine Height of Fill**
  - Depth of trench bottom above restrictive layer
  - Minimum of 12” from B.O.T. to top of gravel
  - Minimum of 12” of cover over pipe
- **Determine Perc Rate of Original Soil at 12”**
- **Determine Amount of EDF Required**
  - Table 3 or 3a
- **Determine Layout of EDF [Rectangular]**
  - This is the CF Bed Distribution Area [DA]
  - 3’ wide trenches are standard
  - 5’ minimum between trench sidewalls
- **Allow for Setbacks from Side/End Slopes**
  - This, added to the DA is Absorption Area [AA]
- **Determine Side/End Slopes Length**
  - Maximum 3:1 Slope
- **Basal Area = Total Length x Total Width**
Layout Configurations Using 4 inch Pipe with Gravel
3 bdrm dwelling; flat lot; ASHES @ 12”; perc of 90 @ 12”
450 LF of EDF

- Boxed Ends as part of EDF
  - DA = 2807 ft²; AA = 4059 ft²; BA = 6312 ft²

- Header as part of EDF
  - DA = 2978.5 ft²; AA = 4279.5 ft²; BA = 6606 ft²

- Center manifold as part of EDF
  - DA = 3010 ft²; AA = 4320 ft²; BA = 6660 ft²

- Center manifold; not part of EDF
  - DA = 3150 ft²; AA = 4500 ft²; BA = 6900 ft²

- Header; not part of EDF
  - DA = 3202.5 ft²; AA = 4567.5 ft²; BA = 6990 ft²
Example of “Connector” Trench at End of Lines
LARGE DIAMETER PIPE IN CONTROLLED FILL

Points to Remember

- BA reductions not given for type of pipe used
- Large diameter pipe to be used in trenches
- Designs utilizing large diameter pipe in gravel bed must be reviewed at State level
- Reductions in required separation from limiting zone may be GIVEN FOR ALL PIPES if effluent is pre-treated to secondary levels
CF Designs on Other Restrictive Sites

- **Minimum Above Ground Height of Trench Bottom**
  - 6”; trench bottoms not located at <6” [.67(1)(d)]

- **Pre-Treatment (Secondary Standards) Required**:
  - Sites with <6 inches to ASHES [.67(1)(e)]
    (Average Seasonal High Extended Saturation)
  - Sites with <6 inches to ASHES [.67(1)(e)]
    (Average Seasonal High Extended Saturation)
  - Sites with <12 inches to Rock [.67(1)(f)]
DESIGN EXAMPLE #1
3 bdrm. dwelling; flat lot; ASHES @12”; perc @ 12” = 90 min / inch

- **CALCULATE HEIGHT OF FILL**
  - B.O.T [Table 15]
  - B.O.T. + 12” [pipe/gravel] + 12” cover

- **DETERMINE SIDE/END SLOPES**
  - 33.3% maximum slope [3:1]

- **CALCULATE EDF AMOUNT**
  - Table 3

- **DETERMINE EDF LAYOUT**
  - Rectangular

- **DETERMINE DA**
- **DETERMINE AA**
  - 5’ setback on all sides

- **DETERMINE BASAL AREA**
  - L = AA(L) + ES
  - W = AA(W) + SS

- **HEIGHT = 30” above NGS**
  - [BOT] 6” + 12” + 12” = 30” above ngs

- **90” / 12” = 7.5’ per side / end**
  - 3 x 30” = 90”

- **150’ / 3’ per bedroom**
  - 450 LF of 3’ trench
  - 5 x 77.2’ lines + ends [2 x 32’]
  - 386’ + 64’ = 450 LF

- **DA = 80.2’ x 35’ = 2807 ft2**
  - Includes 1.5’ on each end
- **AA = 90.2’ x 45’ = 4059 ft2**
  - [80.2’+10’] x [35’ + 10’]
- **BA = 105.2’ x 60’ = 6312 ft2**
  - [90.2’+15’] x [35’ + 15’]
Examples: Five CF Designs with Minimum Standards for LHD Approval (Design Examples based on: 3 bdrm. dwelling; level lot; 450 gpd; restrictive layer at 12”; perc at 12” equal to 90 min/inch)

- **4 inch pipe**, in trenches, with **12” gravel**; primary treatment [all figures are minimum]
  - **EDF Pipe**: 450 lin.ft. in 3’ trenches
    - 5 lines: each 77.2’ long
    - connection trenches on each end; each 32’ long
  - **DA Size**: 2,807 ft² (Appr. 80.2’ x 35’)
  - **AA Size**: 4,059 ft² (Appr. 90.2’ x 45’) – 5’ setbacks
  - **BA Size**: 6,312 ft² (Appr. 105.2’ x 60’)
    - B.O.T. = 6” above natural ground, + 12” w/pipe and gravel; + 12” cover = 30” above NGS
    - 3:1 slope @ 30” (2.5’) height = Appr. 7.5’ length on each side/end
DESIGN EXERCISE #1a
3 bdrm. dwelling; flat lot; ASHES @12”; perc @ 12” = 90 min / inch;
Pre-treatment of effluent to Secondary Standards

- **CALCULATE HEIGHT OF FILL**
  - B.O.T [Table 13a & .67 (1) (d)]
  - B.O.T. + 12” [pipe/gravel] + 12” cover

- **DETERMINE SIDE/END SLOPES**
  - 33.3% [3:1] maximum slope

- **CALCULATE EDF AMOUNT**
  - Table 3
  - Apply allowed reduction

- **DETERMINE EDF LAYOUT**
  - Rectangular

- **DETERMINE DA**

- **DETERMINE AA**
  - 5' setback on all sides

- **DETERMINE BASAL AREA**
  - L = AA(L) + ES
  - W = AA(W) + SS

- **B.O.T. = 6” above NGS [.67(1)(d)]**
  - 6” + 12” + 12” = 30” above ngs

- **90” / 12” = 7.5’ per side slope**

- **150’ / 3’ per bedroom**
  - 450 LF of 3’ trench
  - 450 - 20% reduction = 360 LF

- **4 x 78’ lines + ends [2 x 24’]**
  - 312’ + 48’ = 360 LF

- **DA = 81’ x 27’ = 2187 ft2**
  - Includes 1.5’ on each end/side

- **AA = 91’ x 37’ = 3367 ft2**
  - [81’+10’] x [27’ + 10’]

- **BA = 106’ x 52’ = 5512 ft2 NO**
  - Primary treatment = 6312 ft² [105.2x60]
  - 6312 / 106 = 59.55’; - 37’=22.55’
  - 22.55 / 2 = 11.275’ [135’] per side
  - 135’ / 30” = 4.5 Slope = 1:4.5 [<25%]

- **BA = 106 x 59.55 = 6312.3 ft² YES**
Examples: Five CF Designs with Minimum Standards for LHD Approval
(Design Examples based on: 3 bdrm. dwelling; level lot; 450 gpd; restrictive layer at 12”; perc at 12” equal to 90 min/inch)

- **4 inch pipe**, in trenches, with **12” gravel**; secondary treatment [all figures are minimum] – **Appr. 20% reduction in EDF**
  - **EDF Pipe**: 360 lin.ft. in 3’ trenches [minimum of 360’ req’d]
    - 4 lines: each 78’ long
    - connection lines on each end; each 24’ long
  - **DA Size**: 2,187 ft² (Appr. 81’x 27’)
  - **AA Size**: 3,367 ft² (Appr. 91’x 37’) – 5’ setbacks
  - **BA Size**: 6,312 ft² (Appr. 106’x 59.55’)
    - B.O.T.= 6”above natural ground, + 12” w/pipe and gravel; + 12” cover = 30” above NGS
    - 3:1 slope @ 30” (2.50’) height = Appr. 7.5’ length on each end
    - 4.5:1 slope @ 30’ height = Appr. 11.275’ length on each side
CF Designs for LHD Approval

- **Five Basic Designs**
  - 4 inch pipe [other large diameter], in trenches, with 12” gravel; primary treatment
  - 4 inch pipe [other large diameter], in trenches, with 12” gravel; secondary treatment
  - Small diameter pipe [LPP system], in a bed, with 9” gravel; primary treatment
  - Small diameter pipe [LPP system], in a bed, with 9” gravel; secondary treatment
  - Drip tube, 6” into fill; secondary treatment
Design Standards for CF Utilizing Low Pressure Pipe [LPP]

- **Linear Loading Rate [LLR]**
  - An estimation of the amount of effluent (gpd) that will be dispersed along each linear foot of LPP.
  - Dependent on:
    - direction of flow away from CF bed
      - underlying soils
      - surface slope
    - amount of flow away from CF bed

- **Slope Correction Factor**
  - Applied when CF installed on non-level sites
LOADING RATE CONCEPT OF LPP IN CONTROLLED FILL

[Subjective in Nature]

- Loading rate will be high [8-10 gpd per LF of pipe] when site has Slight Limitations
- Loading rate will be lower [6-8 gpd per LF of pipe] when site has Moderate Limitations
- Loading rate will be very low [3-4 gpd per LF of pipe] when site has Severe Limitations [slope, shallow depth to limiting factor (rock, water, restrictive soils), etc.], resulting in a long, narrow bed
For Controlled Fill bed using small diameter LPP only

Incorporates correction factors for up slope and down slope sizing

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<th>Slope %</th>
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Design Standards for CF Utilizing Low Pressure Pipe [LPP]

- Fill Material Loading Rate
  - Tables 11 and 13
  - Loading Rate by Fill Type

- Basal Area Loading Rate
  - Table 12
  - Loading Rate of Uppers Horizons of Original Ground under the CF Bed
OTHER DESIGN LOADING RATES FOR LPP [Low Pressure Pipe] in CONTROLLED FILL

- **Fill Material Loading Rates – Tables 11&13**
  - **Sand:** 1.0 gpd/ft² [primary effluent]; 2.0 [secondary effluent] for perc <20 min/inch
  - **Loamy Sand:** 0.8 gpd/ft² [primary effluent]; 1.5 [secondary effluent] for perc ≥20 min/inch
  - **Sandy Loam:** 0.6 gpd/ft² [primary effluent]; 1.0 [secondary effluent] for perc = 20-40 min/inch
  - **Sandy Clay Loam:** 0.4 gpd/ft² [primary effluent]; 0.6 [secondary effluent] for perc = 40-60 min/inch

- **Perc Rates [if required]**
  - 30 min/inch, maximum, except for high shrink/swell soils
  - 45 min/inch in high shrink/swell soils
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<th>Soil Group</th>
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<td>0.050 gpd/ft²</td>
<td>0.075 gpd/ft²</td>
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</table>

- **Perc rates**:
  - **Group 1 Soils**: 5-20 min/inch
  - **Group 2 Soils**: 21-40 min/inch
  - **Group 3 Soils**: 41-60 min/inch
  - **Group 4 Soils** – 2 divisions
    - Perc rates: 61-90 min/inch
    - Perc rates: 91-120 min/inch
  - **Group 5 Soils** – 2 divisions
    - Perc rates: 121-180 min/inch
    - Perc rates: >180 min/inch
DESIGN EXERCISE #2
3 bdrm. dwelling; flat lot; ASHES @12”; perc @ 12” = 120 min / inch
Abbreviations: LLR = Linear Loading Rate; FMLR = Fill Material Loading Rate; FR = Flow Rate; BALR = Basal Area Loading Rate; ES = End Slope; SS = Side Slope

- **CALCULATE HEIGHT OF FILL**
  - B.O.T. + 9” [pipe/gravel] + 12” cover
    - B.O.T [Table 15]
- **CALCULATE SIDE & END SLOPES**
  - 3:1 Slope
- **CALCULATE DISTRIBUTION AREA [DA]**
  - \( W = \frac{\text{LLR} \times 3.0}{\text{FMLR} \times [\text{sand}] 1.0} \)
  - \( L = \frac{\text{FR}}{\text{LLR}} \)
  - Minimum DA (W): 420-3-1-.67(1)(b) 6 (ii) (IV)
- **DETERMINE EDF AMOUNT**
  - AA (L) minus 1’ at each end
  - 1 line for every 3’ of DA(W)
- **CALCULATE ABSORPTION AREA [AA]**
  - \([\text{DA} (L) + \text{setbacks}] \times [\text{DA} (W) + \text{setbacks}]
    - 420-3-1-.67(1)(b)7
- **DETERMINE BASAL AREA**
  - Loading Rate Method
    - \( \frac{\text{FR}}{\text{BALR}} \) [Table 12]
  - Geometry Method
    - \([\text{AA} (L) + (2 \times \text{ES}] \times [\text{AA}(W) + (2 \times \text{SS})]
  - LARGER OF THE TWO APPLIES

- **HEIGHT = 27” above NGS**
  - [BOT] 6” + 9” + 12” = 27” above ngs
- **SIDE & END SLOPES** =
  - 27” x 3 = 81” / 12 = 6.75’
- **DA = 450 ft^2 [3’ x 150’]**
  - \( W = 3 / 1.0 = 3’ \)
  - \( L = 450 / 3 = 150’ \)
- **EDF = 148’ [1 line]**
  - 150’ – 2’
- **AA = 1078 ft^2**
  - 154 x 7
- **BA = 4500 ft^2 [Appr 180’ X 25’]**
  - SLOPES: Ends = 1:5.8  Sides = 1:4
  - Loading Rate Method = 4500 ft^2
    - \( 450 / .1 = 4500 \text{ ft}^2 \)
  - Geometry Method = 3434 ft^2
    - \([154 + 13.5’] \times [7’ + 13.5’] =
      - 167.5’ x 20.5’ = 3433.75 \text{ ft}^2\)
DESIGN EXERCISE #2a
3 bdrm. dwelling; flat lot; ASHES @ 12”; perc @ 12” = 120 min / inch;
Pre-treatment of effluent to Secondary Standards

Abbreviations: LLR = Linear Loading Rate; FMLR = Fill Material Loading Rate; FR = Flow Rate; BALR = Basal Area Loading Rate; ES = End Slope; SS = Side Slope

- **CALCULATE HEIGHT OF FILL**
  - B.O.T. + 9” [pipe/gravel] + 12” cover
    - B.O.T. [Tables 15,13 & .67(1) (d)]
- **CALCULATE SIDE & END SLOPES**
  - 3:1 Slope
- **CALCULATE DISTRIBUTION AREA [DA]**
  - \( W = \frac{LLR \times 3.0}{FMLR [sand] \times 2.0} \)
    - Table 13
  - \( L = \frac{FR}{LLR} \)
    - Minimum DA (W): 420-3-1-.67(1) (b) 6 (ii) (IV)
- **DETERMINE EDF AMOUNT**
  - AA (L) minus 1’ at each end
  - 1 line for every 3’ of DA(W)
- **CALCULATE ABSORPTION AREA [AA]**
  - \([DA (L) + \text{setbacks}] \times [DA (W) + \text{setbacks}] \)
    - 420-3-1-.67(1)(b)7
- **DETERMINE BASAL AREA**
  - Loading Rate Method
    - \( FR \) divided by \( BALR [Table 12] \)
  - Geometry Method
    - \([ AA (L) + (2x ES) \times [AA(W) + (2xSS) ] \)
    - LARGER OF THE TWO APPLIES
  - \( HEIGHT = 27" \) above NGS
    - \([BOT] \ 6" + 9" + 12" = 27" \) above ng's
  - SIDE & END SLOPES =
    - 27” x 3 = 81” / 12 = 6.75’
  - DA = 450 ft² [ 3’ x 150’]
    - \( W = \frac{3}{2.0} = 1.5’ \) [3’mimum]
    - \( L = \frac{450}{3} = 150’ \)
  - EDF = 148’ [ 1 line ]
    - 150’ – 2’
  - AA = 1078 ft²
    - 154 x 7
  - BA = 3434 ft² [Appr 167.5’ X 20.5’]
    - SLOPES: Ends = 3:1  Sides = 3:1
    - Loading Rate Method = 3000 ft²
      - \( 450 / .15 = 3000 \) ft²
    - Geometry Method = 3434 ft²
      - \([154 + 13.5’] \times [7’ + 13.5’] = \)
      - 167.5’ x 20.5’ = 3433.75 ft²
Fill Material and Construction of Bed

Five Cs of Controlled Fill

- **Consistency of Fill**
  - Uniform; free of trash and debris; consist with respect to texture and compaction

- **Compatibility of Fill**
  - Compatible (if possible) with in-situ soil

- **Compaction of Fill**
  - Stabilized; approximating “in-situ” condition

- **Construction of Fill Bed**
  - Natural ground surface preparation
    - scarification, removal of vegetative cover, trees cut flat with ground surface
  - Placement of Fill
    - dry conditions (ground and fill)
    - in 6 – 12 inch lifts; working from upside, on placed fill
    - track type equipment

- **Certification of CF Bed and Installation**
  - By design engineer
  - Fill material and bed construction inspected prior to EDF installation [.67(c)]

Tables 11 and 14; .67(b)10
SUMMARY OF DESIGN FACTORS CONTROLLED FILL USING SMALL DIAMETER LPP

- **Small Diameter, Low Pressure Pipe [LPP]**
  - **Design Factors:**
    - **Fill Material Loading Rate [FMLR]**
      - 1.0, 0.8, 0.6, 0.4 gpd / ft²
      - sand, loamy sand, sandy loam, sandy clay loam
    - **Linear Loading Rate [LLR]**
      - 3 to 10 gpd / L.F. of LPP
      - Use 3 gpd / linear foot of LPP in HShSw soils
    - **Basal Area Loading Rate [BALR]**
      - **Ranges:** 0.1 to 0.05 for primary effluent; 0.2 to 0.75 for secondary effluent
      - Use 0.05 gpd / ft² for LPP discharging primary effluent into vertic clay
    - **Slope Correction Factor**
DESIGN EXERCISE #3 - LPP
3 bdrm. dwelling; 10% sloped lot; ASHES @12”; perc @ 12” = 50 min / inch
Abbreviations: LLR = Linear Loading Rate; FMLR = Fill Material Loading Rate; FR = Flow Rate; BALR = Basal Area Loading Rate; ES = End Slope; SS = Side Slope; NGS = Natural Ground Surface

- **CALCULATE DISTRIBUTION AREA [DA]**
  - \( W = \frac{LLR}{FMLR} \)
  - \( L = \frac{FR}{LLR} \)

- **DETERMINE B.O.T. HEIGHTS**
  - Upslope [Us BOT] height = Required Distance above ASHES
    - BOT [Table 15]
  - Downslope [Ds BOT] height = [Us BOT] + [slope% \times DA(W)]

- **CALCULATE FILL HEIGHTS**
  - Upslope= UsBOT + gravel/pipe + cover
  - Downslope= DsBOT + gravel/pipe + cover

- **DA = 450 ft² [6’ x 75’]**
  - \( W = 6 / 1.0 = 6’ \)
  - \( L = 450 / 6 = 75’ \)

- **UPSLOPE [Us BOT] HT. = 12” over NGS**
  - 24” above ASHES = 12” over NGS
  - 12” below NGS + 24” = 12” over NGS

- **DOWNSLOPE [Ds BOT] HT. = 19” over NGS**
  - 12” + [.10 \times 72”] = 12” + 7” = 19” over NGS

- **FILL HEIGHTS = 33” & 40”**
  - U.s. Ht. = 12” + 9” + 12” = 33”
  - D.s. Ht. = 19” + 9” + 12” = 40”
CALCULATE END SLOPES LENGTH
- Avg. of fill height x 3
- 3:1 ratio

CALCULATE SIDE SLOPES LENGTH
- Upslope [Us] = 3 x [Us Ht] x SCF
- Downslope [Ds] = 3 x [Ds Ht] x SCF

CALCULATE EDF AMOUNT
- DA(L) minus 1’ at each end
- 1 line for every 3’ of DA(W)

CALCULATE ABSORPTION AREA [AA]
- [DA (L) + setbacks] x [DA (W) + setbacks]

DETERMINE BASAL AREA [BA]
- Loading Rate Method =
  - FR / BALR [Table 12]
- Geometry Method =
  - [AA(L) + 2(ES)] x [AA(W) + (Us+DS)]

LARGER OF THE TWO APPLIES

END SLOPES LENGTH = 9.25’ per end
- Fill avg. = [33” + 40”] / 2 = 73 / 2 = 37”
- 37” x 3 = 111” / 12 = 9.25’ per end

SIDE SLOPES LENGTH = 6’ and 14’
- Us = [3 x 33”] x .77 = 99” x .77 = 76”; 6.33’
- Ds = [3 x 40”] x 1.44 = 120” x 1.44 = 173”; 14.4’

EDF = 146 LF; 2 x 73’ lines
- L = 75’ – 2’ = 73’
- # lines = 6’ / 3 = 2 lines

AA = 790 ft2 [79 x 10]
- [75’ + 4’] x [6’ + 4’] = 79’ x 10’ = 790 ft2

BA = 2340 ft2
- LRM = 450 / 0.5 = 900 ft2
- GM = [79’ + (2x9.25’)] x [10’ + 14’]
  - [79’ + 18.5’] x [10’ + 14’]
  - 97.5’ x 24’ = 2340 ft2
CF Designs on Other Restrictive Sites

- **Minimum Above Ground Height of Trench Bottom**
  - 6”; trench bottoms not located at <6” [.67(1)(d)]

- **Pre-Treatment (Secondary Standards) Required:**
  - Sites with <6 inches to ASHES [.67(1)(e)]
    (Average Seasonal High Extended Saturation)
  - Sites with <12 inches to Rock [.67(1)(f)]
Minimum OSS Requirements for CF Systems in Very High Shrink-Swell Soils

- **Minimum Size OSS Required**
  - 180 min/inch or greater [design rate for LDP]
  - BA loading rate of 0.75 gpd/ft² of LPP
  - Regardless of perc test results
  - Can be approved at LHD level

- **If Another OSS Designed**
  - Perc rate must be supported by PSC
    - rate is indicative of saturated condition
  - Design will be submitted to State thru LHD
Minimum OSS Sizing for CF in High and Very High Shrink-Swell Soils

- **Design Factors to Note**
  - Minimum Basal Area required
    - No “breaks” given for pipe types
    - “Breaks” given based on treatment only
  - Minimum Distribution Area required
    - Reduction can be given for type of pipe
  - Minimum Absorption Area required
  - Minimum EDF Amounts required
    - Reduction can be given for type of pipe
Concern: High and Very High Shrink-Swell Soils

- **Vertisols**
  - High Clay Content [50 to 70 percent]
  - Soil Periodically Opens [forms cracks], Closes
    - Shrinks When Soils Become Dry
      - Cracks = or >.2” form thru layer 10+” thick, and within 19+” of the mineral soil surface
      - Cracks remain open for a period of 60+ consecutive days between Jun 21st & Sept 21st
    - Expands When Soils Become Wet [saturated]
      - Cracks normally closed for period of 60+ consecutive days between Dec 21st & Mar 21st
  - Occurs in the **Black Belt** and **Southern Coastal Plain**

- **Other Soils**
  - Vertic [Shrink-Swell] Characteristics
    - Occur **Black Belt** and the **Upland Ridge and Valley Areas**
Vertisols are high in expanding clays that shrink when the soils become dry and swell when they become moist. Vertisols commonly have slickensides and develop deep, wide cracks when dry.
Soil Series Examples

- **Vertisols: Uderts** (Black Belt & Southern Coastal Plain)
  - **Faunsdale**: slightly poor drainage; slow permeability; occurs in B.Belt on concave side slopes, toeslopes; grayish brown, olive brown [mottles: yellow, gray; black concretions]
  - **Hannon**: moderately well drained; very slow permeability; occurs in B.Belt & S. Coastal Plain on side slopes; brown, olive brown, yellowish red [mottles: red, gray; mica]
  - **Hollywood**: moderately well drained; very slow permeability; occurs along footslopes and upland depressions of B.Belt; dark gray, olive brown, black; [brown, gray & black mottles]
  - **Houston**: moderately well drained; slow permeability; occurs in B.Belt; olive gray; [dark gray]
  - **Maytag**: well drained; slow permeability; occurs along slopes in B.Belt; olive brown, olive yellow; [mottles: yellowish brown, olive yellow; soft calcium carbonate deposits]
  - **Oktibbeha**: moderately well drained; very slow permeability; occurs in B.Belt on convex ridges & S. Coastal Plain along ridges; yellowish red, yellowish brown [mottles: red, gray, brown; calcium carbonate deposits @ 3’ depth or greater]
  - **Suggsville**: well drained; very slow permeability; occurs along convex ridges and side slopes of B.Belt and S. Coastal Plain; brown, red, reddish gray, yellowish red; [yellowish red, black concretions]
  - **Vaiden**: poorly drained; very slow permeability; occurs along upper slopes and stream terraces in B.Belt & S. coastal Plain; grayish and yellowish brown, olive brown [mottles: brown, gray, brownish gray, red; black concretions; calcium carbonate deposits 4’ to 5’]
  - **Watsonia**: well drained; very slow permeability; occurs along convex ridgetops and side slopes of B.Belt; yellowish & olive brown, yellowish red, gray [mottles: yellowish red/brown; chalk @ 2’ or <]
  - **Wilcox**: slightly poor drainage; very slow permeability; occurs along uplands of S. Coastal Plain; dark brown, yellowish brown, yellowish red, red, brownish gray [brown, red, yellow & gray mottles]
Soil Series Examples

- **Vertisols: Aquerts** (Black Belt and Southern Coastal Plain)
  - **Consul**: poorly drained; very slow permeability; occurs in uplands of B.Belt and S. Coastal Plain; grayish brown and brownish gray; [mottles of gray, yellowish brown and olive brown; black concretions around 4’]
  - **Sucarnoochee**: slightly poor drainage; very slow permeability; flood plain area of B.Belt; gray, dark gray and brownish gray; [mottles: brown and yellowish brown; black concretions @ 3’]
  - **Eutaw**: poorly drained; very slow permeability; occurs B.Belt and S. Coastal Plain, mainly in flat/level areas; dark gray, gray; [yellowish brown, brownish yellow mottles]

- **Other Soils: Vertic** (Shrink-Swell Tendencies; B. Belt & Upland Ridge/Valleys)
  - **Chisca**: well drained; very slow permeability; occurs along the Upland Ridge and Valley areas, along hillsides; gray, yellowish brown, yellowish red, red [heavily mottled reds, grays and browns; shale increasing at 40”]
  - **Colbert**: moderately well drained; very slow permeability; occurs along Upland Ridges and Valleys, hillsides; mostly brown; [gray, yellowish brown, yellowish red]
  - **Iredell**: moderately well drained; slow permeability; occurs along Piedmont Uplands; brown, grayish brown, olive; [black brown, grayish brown and greenish gray mottles with black concretions]
  - **Leeper**: slightly poor drainage; very slow permeability; occurs along flood plains and streams of B.Belt; brown and grayish brown; [gray, black and yellowish brown mottles; brown and black concretions]
  - **Tuscumbia**: poorly drained; very slow permeability; along flood plains and terraces of B.Belt; gray; [brown and yellowish brown mottles; black concretions]
DESIGN EXERCISE #4
3 bdrm. dwelling; flat lot located in a Vertisol soil; ASHES @10”; reported perc @ 12” = 90 min / inch

- **CALCULATE HEIGHT OF FILL**
  - B.O.T. + 12” [pipe/gravel] + 12?” cover
  - B.O.T [ Table 15 ]

- **CALCULATE EDF AMOUNT**
  - Table 3a

- **DETERMINE EDF LAYOUT**
  - Rectangular

- **DETERMINE DA**
  - 5’ setback on all sides

- **DETERMINE AA**
  - 5’ setback on all sides

- **DETERMINE SIDE/END SLOPES**
  - 3:1 maximum slope

- **DETERMINE BASAL AREA**
  - L = AA(L) + ES
  - W = AA(W) + SS

- **HEIGHT = 30” above NGS**
  - [BOT] 8” + 12” + 12” = 32” above ngs

- **MINIMUM EDF = 1010 LF of 3’ trench**
  - Basis: 180 min/in per =1010 ft2 / bedroom

- **DESIGN LAYOUT AMT. : 1010 LF**

- **9 x 98’ lines + ends [ 2 x 64’]**
  - 882’ + 128’ = 1010 LF

- **DA = 101’ x 67’ = 6767 ft2**
  - Includes 1.5’ on each end

- **AA = 111’ x 77’ = 8547 ft2**
  - [101'+10'] x [67’ + 10’]

- **SIDE & END SLOPES = 8’**
  - 3 x 32” = 96” /12 = 8’ per side/end

- **BA = 11,811 ft2 [127’ x 93’]**
  - [111’+16”] x [77’ + 16’]
LOT MODIFICATIONS
420-3-1-.67(2)

Flow Charts

- Non-wetland, Non-hydric, No ASHES <6”
- Wetland, Hydric Soils, ASHES <6”
- Cuts within 25’ of EDF (c)
- Cuts with fill below NGS (d)
- Cuts with fill above new GS (e)
- Bench Cuts (f)
Fill on Non-Wet Sites OR Fill on Wetland, Hydric, Wet Sites

- Amount of time fill in place
- Corp Approval [if applicable]
- Monitored weekly thru 1 wet season
- Site evaluated by PSC
  - If fill in place <3 yrs on non-hydric site
  - <5 years on hydric, wetland site or
  - A site with <6” to ASHES
Cuts Near EDF

- Depth of Cut
- Proximity to EDF
- Discretionary Actions for LHD
  - Geologist Report
  - Soils Classifier Report
Cut With Fill Below NGS

- Use Conventional OSS if possible
- No High Shrink/Swell Soils
- Underlying Soil Characteristics
- Soil Thickness Requirements & Depth to ASHES in Soil Layer
- Certain Provision Included in Design
Cut With Fill Above New GS

- No High Shrink/Swell Soils
- LHD Options
  - Geologist Report
  - PSC High Intensity Map
Bench Cuts

- Type of Rock
  - Hard Rock? Prohibited
  - Other Rock? Design Stipulations
- Required Reports
  - Geologist
  - PSC