A to Z
Soil Treatment Systems

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2019 Northeast Onsite Wastewater Short Course

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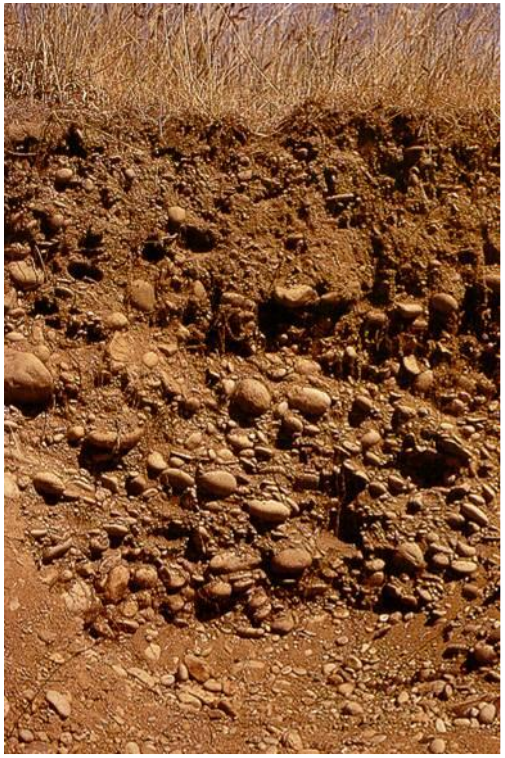
Soil Treatment & Dispersal Options

- Purpose
  - Provide further treatment
  - Assimilate treated effluent into the *receiving environment* so neither public health nor environmental quality are adversely impacted.



Soil Treatment & Dispersal Options

- Subsurface dispersal
  - Discharge effluent ***into*** soil
  - Most cases – original, undisturbed, unsaturated soil
  - As effluent quality increases, focus is more on dispersal
  - Point of application – top 2-3 feet of soil

Subsurface Dispersal

- Treatment provided by soil
  - Certain depth of unsaturated soil needed
    - Measured from point of application into soil
    - Measured to water table, excessively coarse or impermeable soils
  - Typical *minimum* vertical distance is 12-36”
    - Function of soil and site conditions
    - Function of degree of effluent treatment

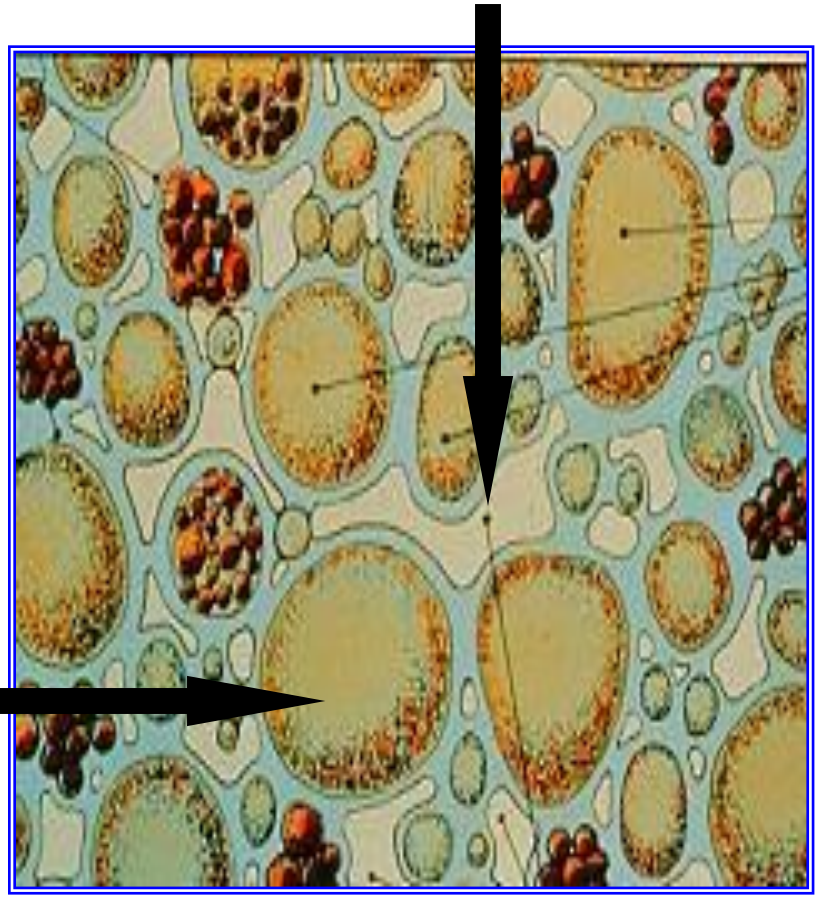
To Use Soil for Treatment

- You need

Unsaturated flow

Aerobic environment

Aerobic bacteria



Onsite Wastewater System Design Options

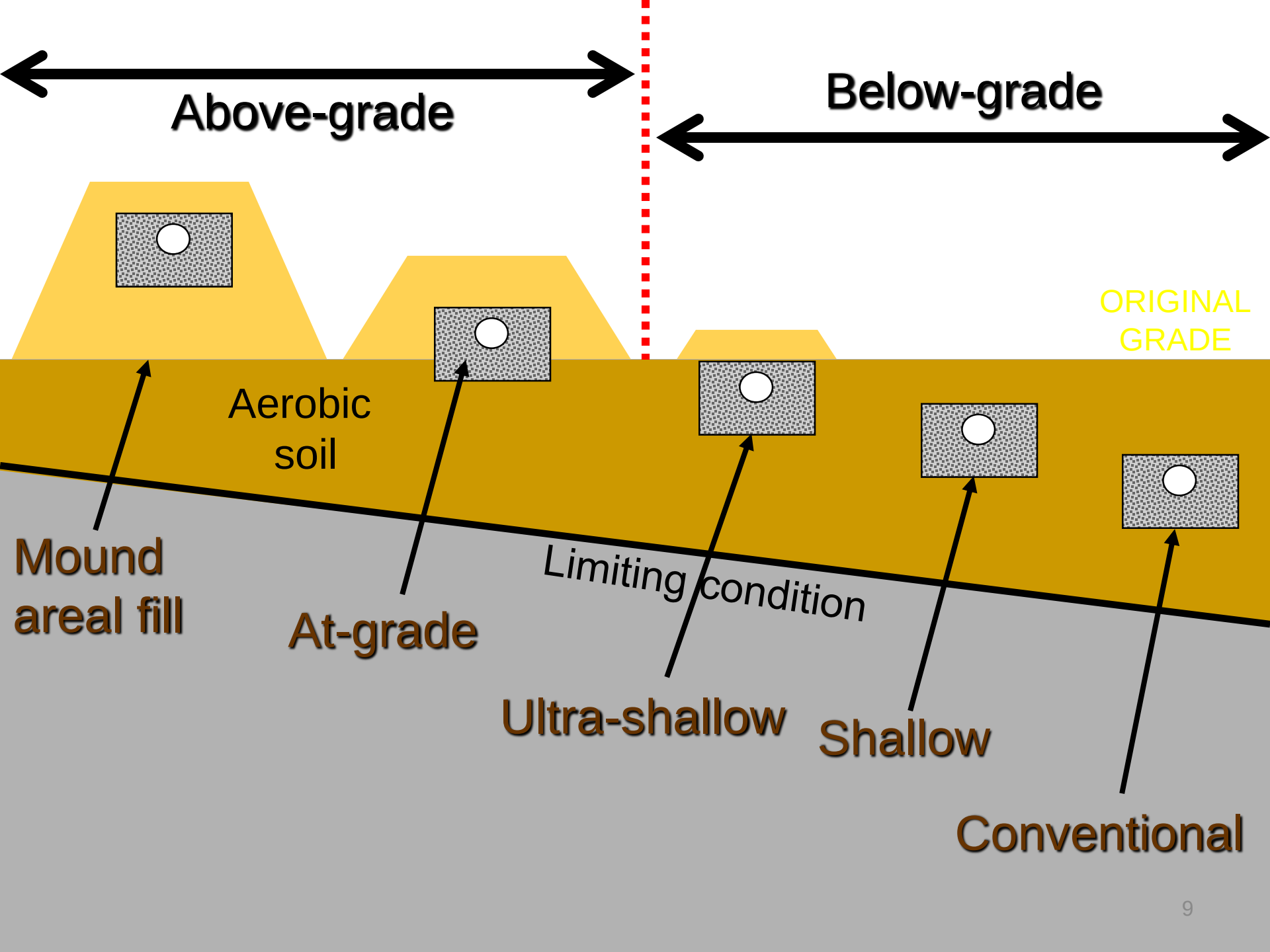
- Major design options include:
  - Depth of trench bottom
  - Loading rates
    - At infiltrative surface
    - For most restrictive horizon
    - Account for horizontal flow
  - Distribution system
  - Pretreatment options

Principles for Applying Effluent to Soil

- To achieve best treatment
  - Distribute over large enough area to ensure unsaturated flow
  - Small doses help maintain aerated conditions
  - Apply at shallow depths

System definitions

- Terminology of soil treatment areas is very regional and regulatory driven
- Our terminology is based on national glossary
  - Online: www.onsiteconsortium.org/
- Long term goal - use the same language
- *Don't* get caught up in terminology & definitions
- STA = Soil treatment area


Above-grade
Below-grade
ORIGINAL GRADE
Aerobic soil
Limiting condition
Mound areal fill
At-grade
Ultra-shallow
Shallow
Conventional

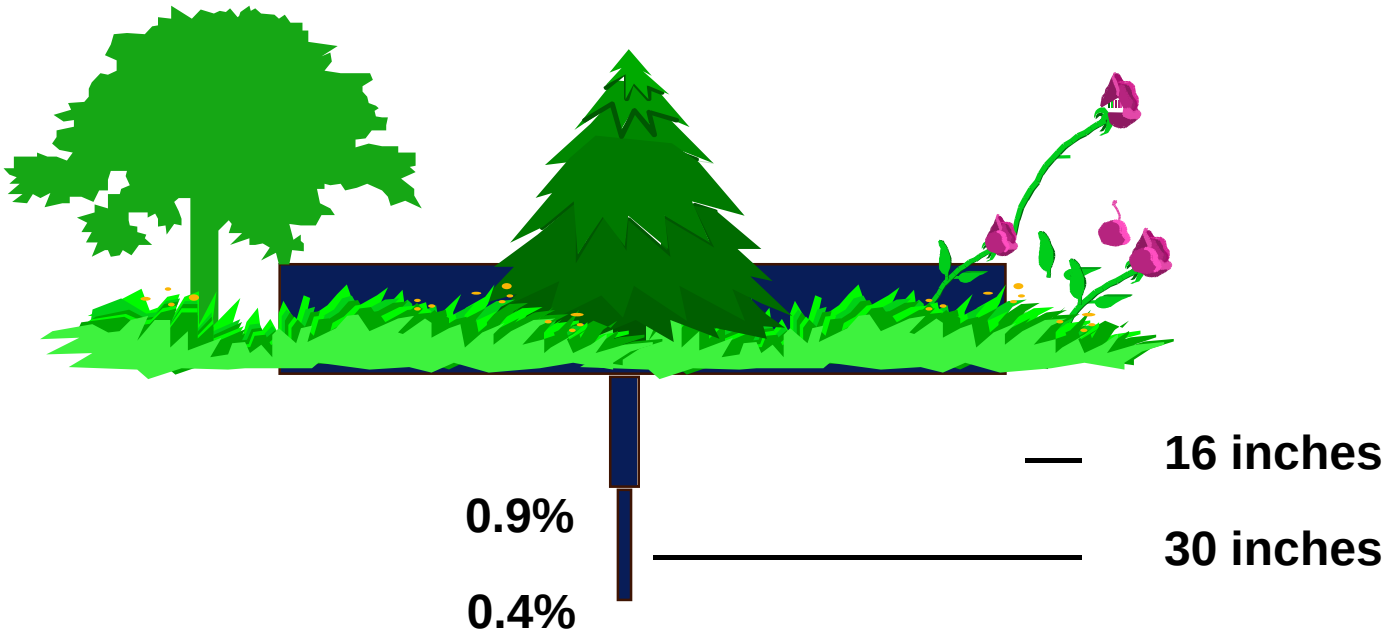
Benefits of Shallow Depth

- Easier to maintain vertical separation from limiting condition
  - Seasonal high water table
  - Claypan
  - Bedrock, etc.
- Proper separation distance allows for interactions with particles and bacteria

Benefits of Shallow Depth

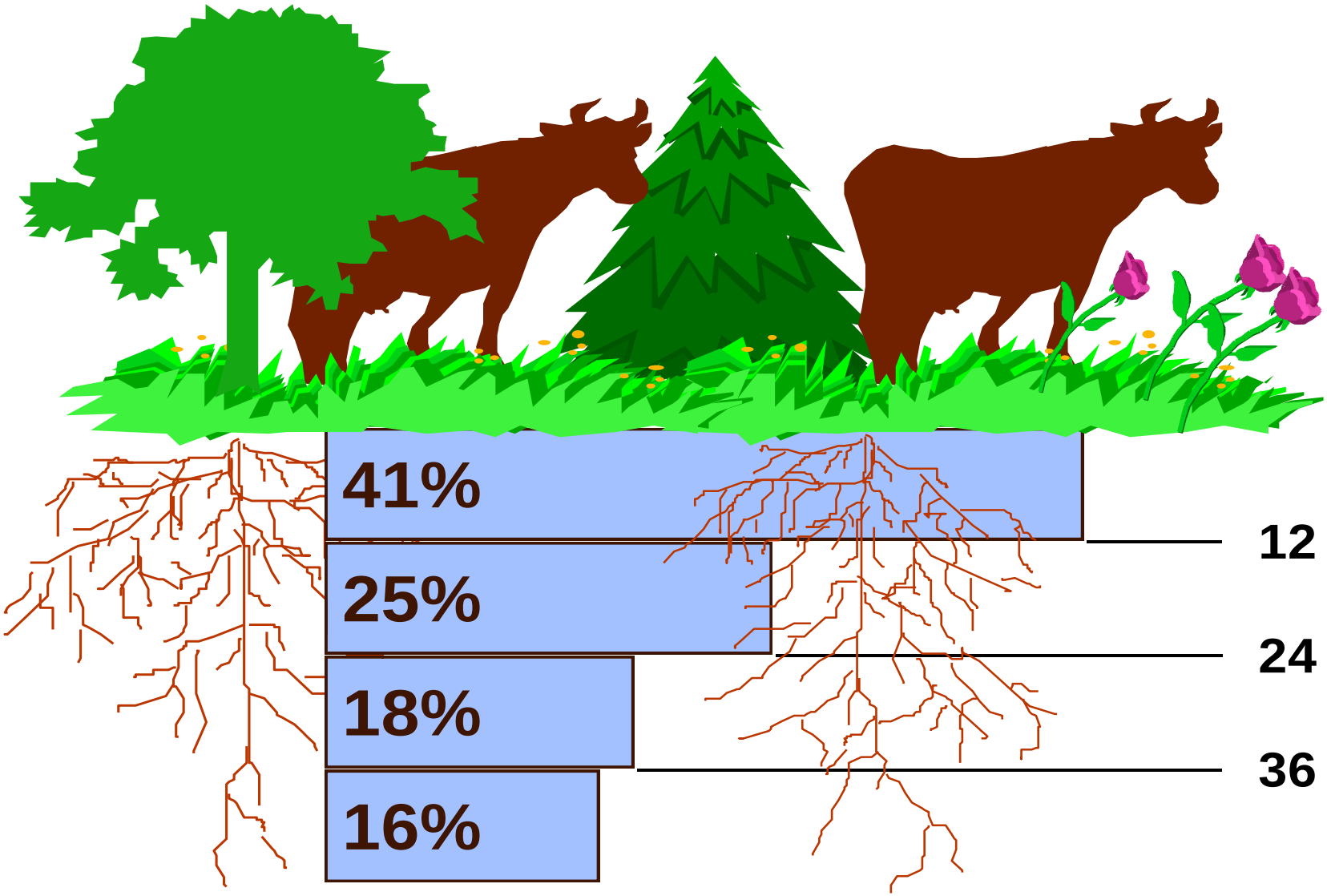
- Keeps effluent in biologically active portion of soil profile
  - More oxygen present
  - More soil microbes present
- Evapotranspiration

SOIL BIOTA POPULATION
vs
SOIL DEPTH



WATER USE

(WHERE ROOTS DRINK AND EAT)



System Selection - Consider

- Effluent quality
  - May need treatment beyond septic tank if
    - High strength waste or
    - Using smaller diameter perforations in distribution

System Selection - Consider

Slope

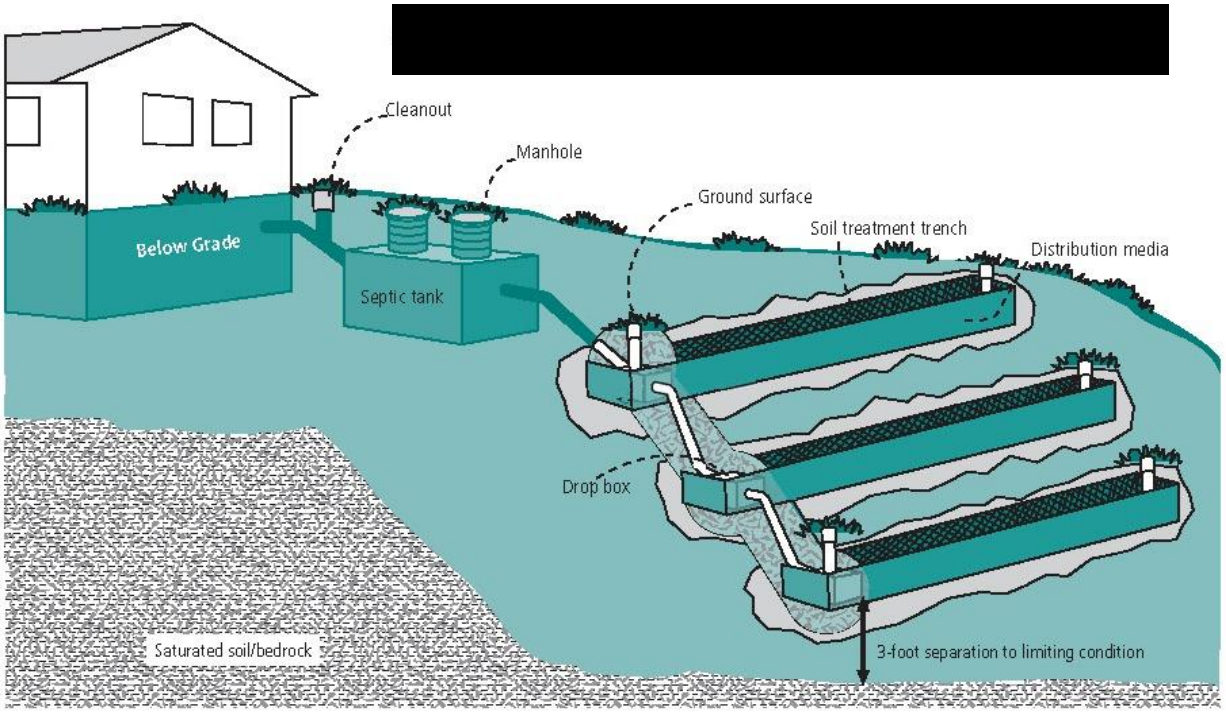
- Setbacks
- Other
  - Aesthetics
  - Maintenance
  - Cost

Types of Soil Treatment Units

- Trench
- Bed
- Low pressure
- At-grade
- Drip distribution

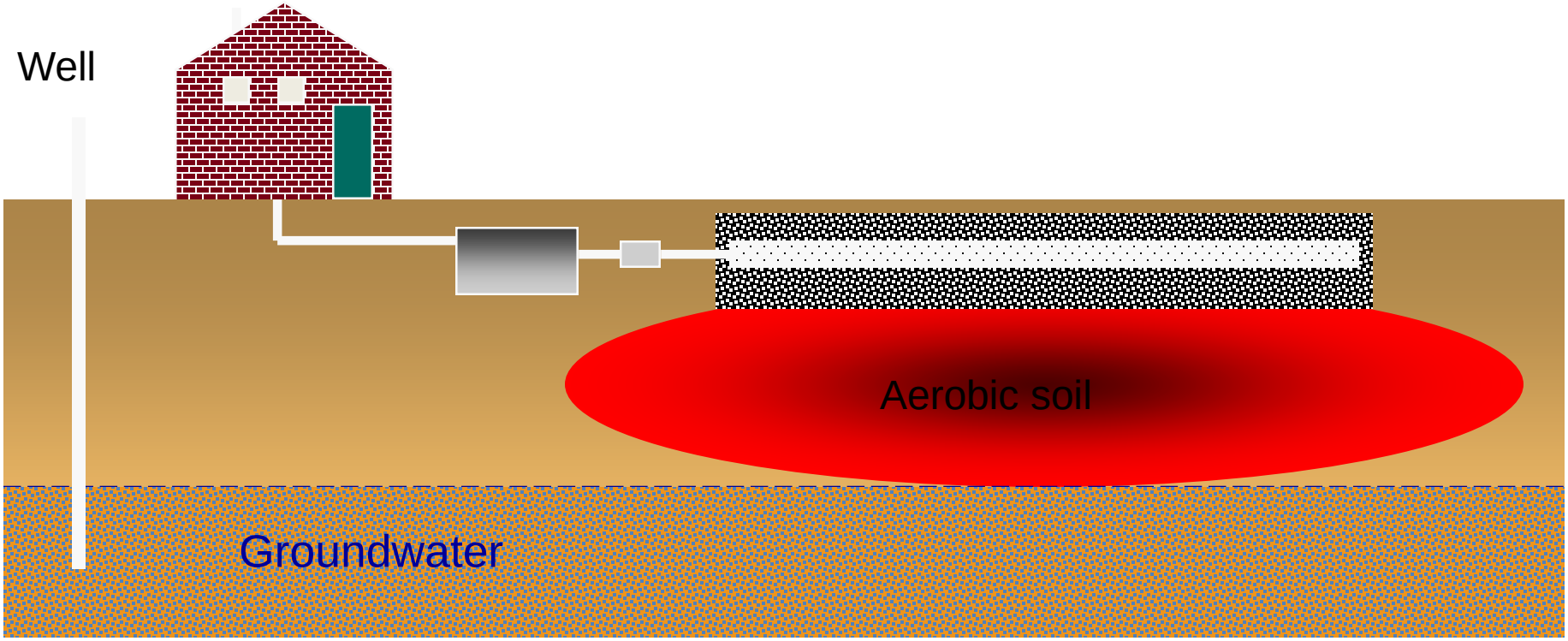
Trench System

- Definition - A trench containing media through which septic tank effluent is treated
- Many types of media
- Distribution
  - Gravity
  - Pump to gravity
  - Pressurized



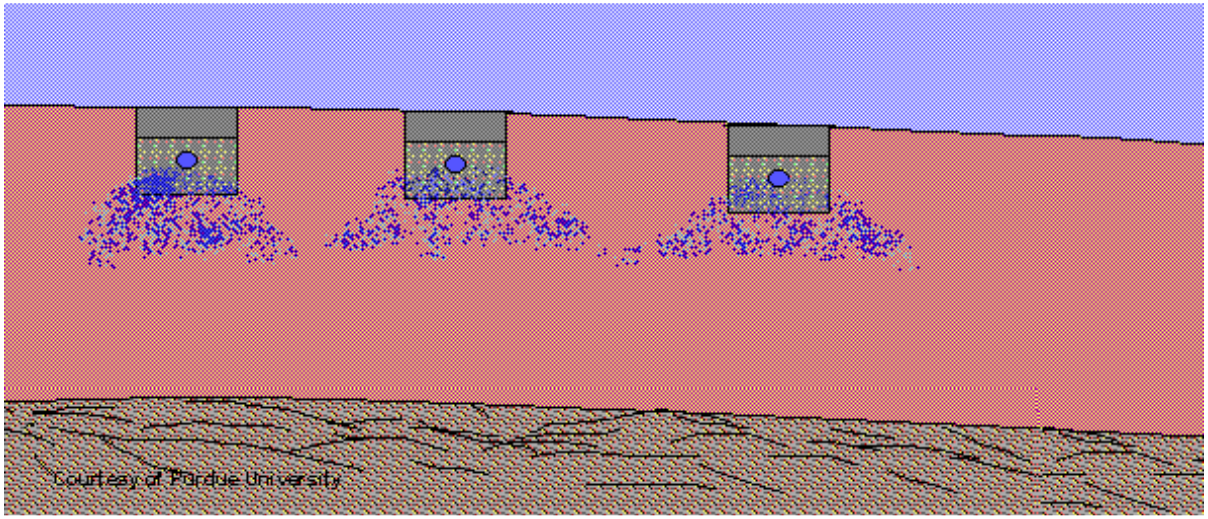
Septic System Design Options

- **Must allow for aerobic zone beneath field**



Subsurface Dispersal

- In ground: gravity drainfield
  - Why / Where used?
    - Where soil and site meet code requirements
    - Simplest and least expensive option



Subsurface Dispersal

- **In ground: Drainfield**
  - **Design considerations**
    - Sized by soil and design flow (gallons/ft^2/day)
      - Bottom: Is the design criteria
      - Sidewall: Is extra if it occurs
    - Need aerated soil below
    - Many configurations
    - Maximum slopes typically of 20% - 45%

Purpose of Media

- Provide void space
  - For effluent to enter
  - For effluent to contact soil infiltrative surface
- All have advantages and disadvantages
- Soil loading rates must be established for each media material
  - Hydraulic loading rates
  - Organic loading rates

Ideal Trench System

- Narrow trenches
- Shallow placement
- Oriented on contour
- Time dosed
  - Surge capacity (septic tank/pump chamber)
- Multi cells – for resting
- Monitor flow and ponding

In-ground trench

Soil Absorption System

- Rock size
  - Too small, more likely to plug, pore space too small;
  - Too large, hard to work with and level
- Rock must be clean and free of fines
  - Largest reason for trench plugging
- Purpose of rock is to hold the trench open and allow access by the waste to the soil base
  - There have been other materials developed to do that

Options for Distribution Media

- Gravel/Rock
  - Functions:
    - Supports distribution pipe
    - Transfers effluent from pipe to infiltrative surface
    - Provides storage of peak flows
    - Dissipates energy of surges
    - Supports sidewall and overlying soil

Options for Distribution Media

- Gravel
  - Typically ¾ to 2 ½ inches in diameter
  - Usually 6 inches below the pipe and 2 above
  - Concerns:
    - Amount of “fines” in gravel
    - Dropping it on infiltrative surface may compact soil
    - Machinery to place gravel may compact soil

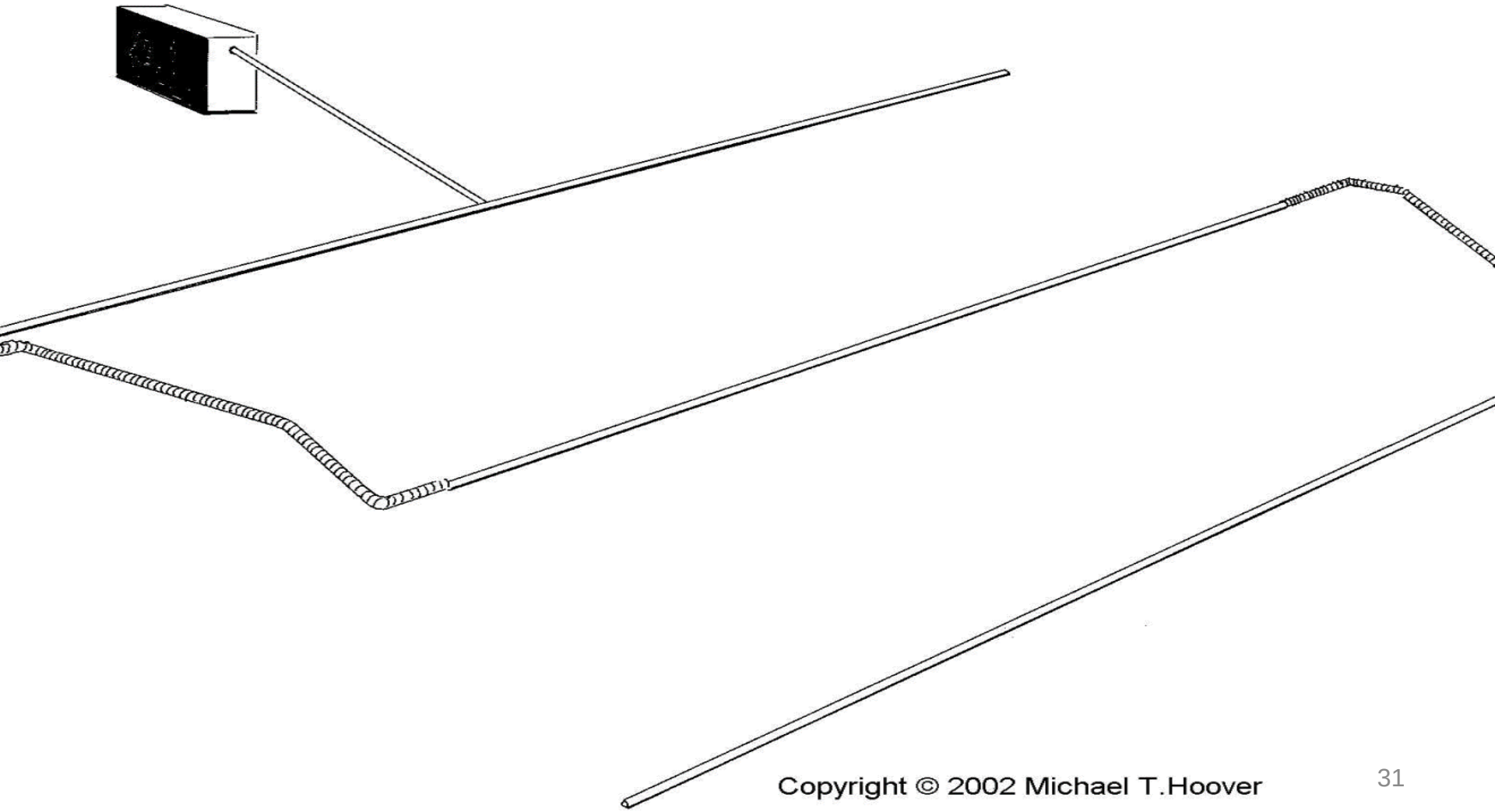
Placing Tire Chips in Conventional Trench

Gravity Distribution on the Contour

Distribution Box

Distribution Devices

Serial Distribution (Step-down)



Alternative Systems

- Gravelless drainfield systems
  - **Component:** part of a disposal component
  - **Function:** to take the place of gravel in drainfields, hopefully overcoming some of the limitations of gravel
  - **Considerations:**
    - Different types
    - Each type has different sizing criteria
    - Each type can be used with gravity or pressure distribution.

Options for Distribution Media

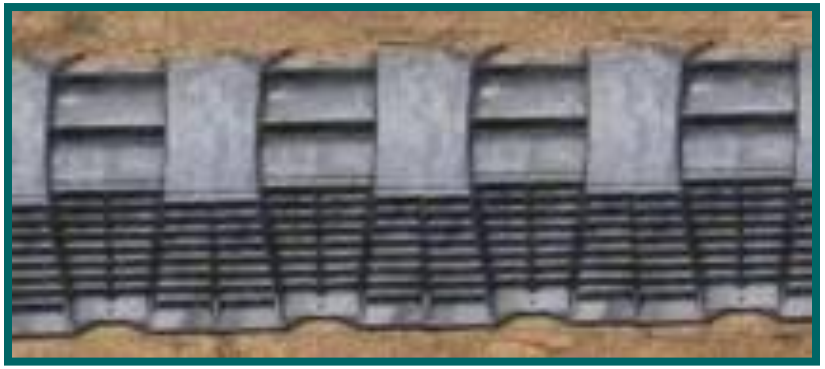
- Gravelless technologies
  - Can be used for gravity & dosed flow networks
  - Can be used where gravel is used
  - Avoids many of the installation problems of aggregate
  - Have unique sizing and installation requirements
  - Have their own unique precautions
  - Do NOT make the soil “work” better

Distribution Media

- What's the difference?
  - Choices
  - No 'Value Judgment'
- Rock
- Chamber
- Gravelless pipe
- Synthetic media
- Other

Gravelless Technologies

- Aggregate-free technologies - chambers



Chamber Technology

Polystyrene Wrapped Pipe

Gravelless Technologies

- Aggregate-free technologies – gravelless pipe

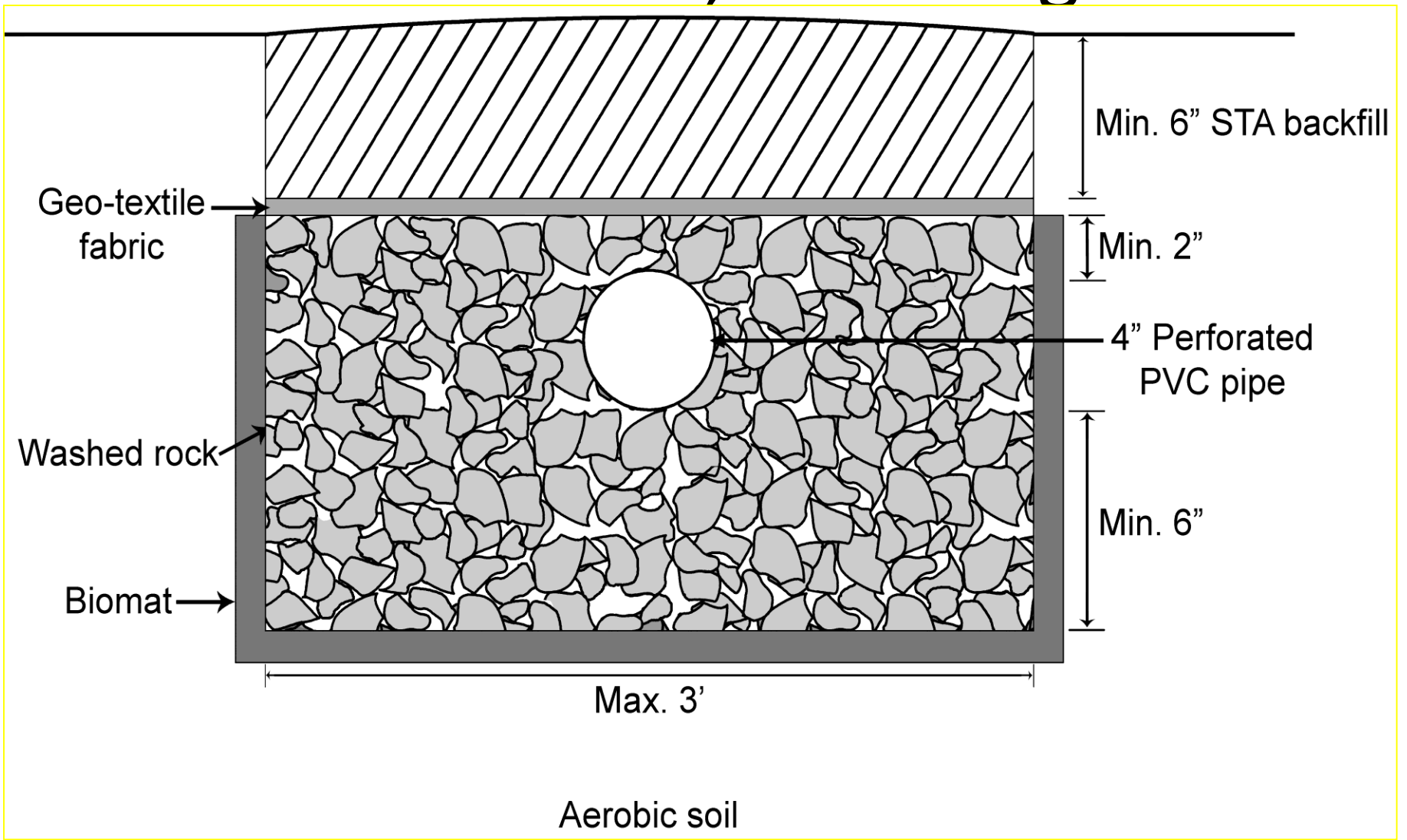
Geotextile Wrapped Pipe

Other Examples

Tire Chips

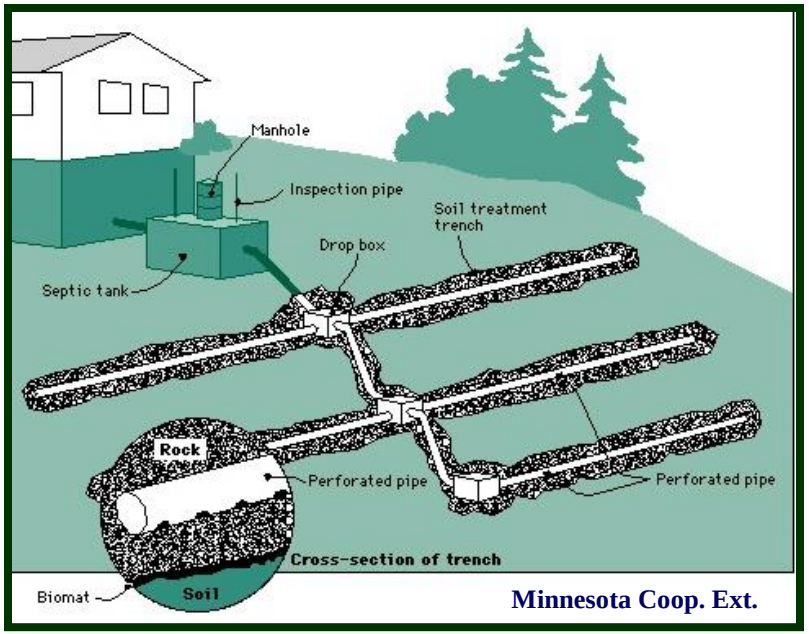
Eljin In-Drain

Trench cross-section example: Crowned backfill; shedding water



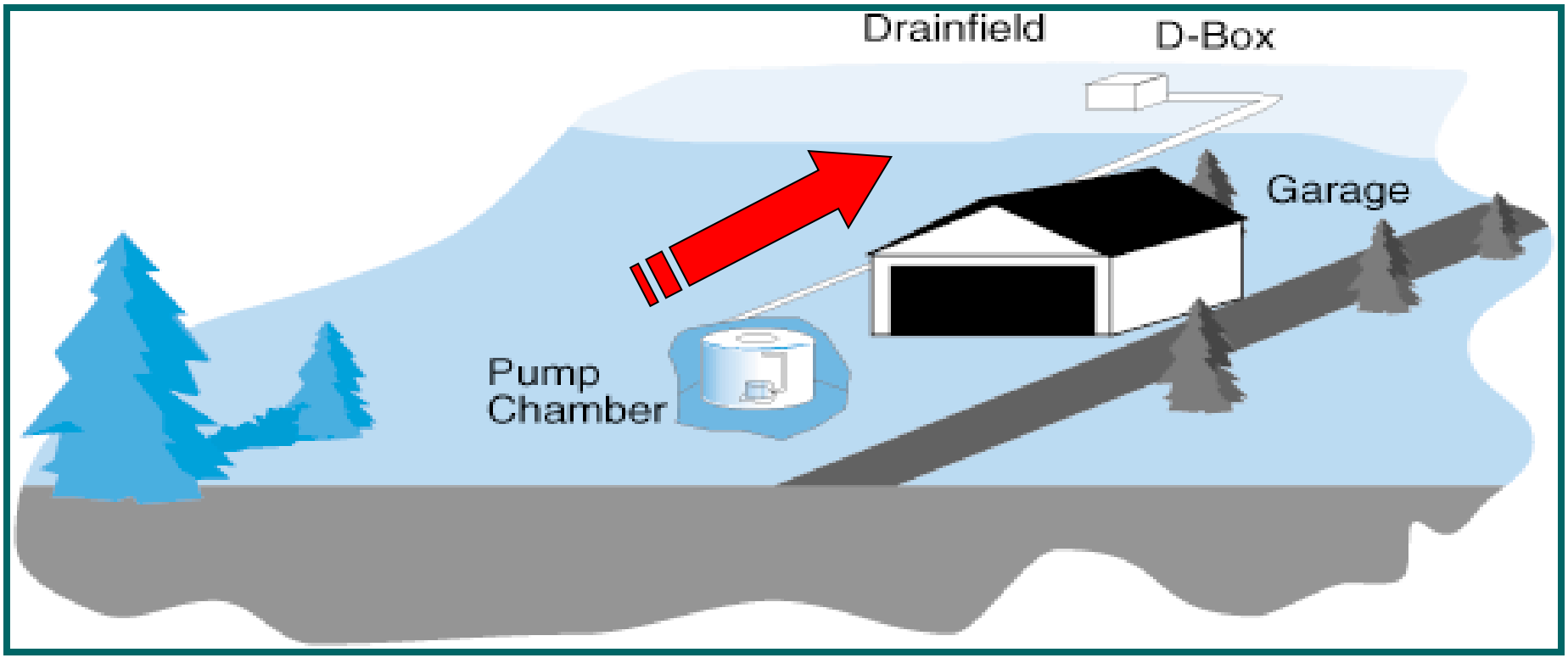
Subsurface Dispersal

- **In ground: <u>Drainfield</u>**
  - **Design considerations** – <u>parallel vs. serial</u>



Type (cont.)

a. Method for dosing to field:
   - Pump-to-gravity



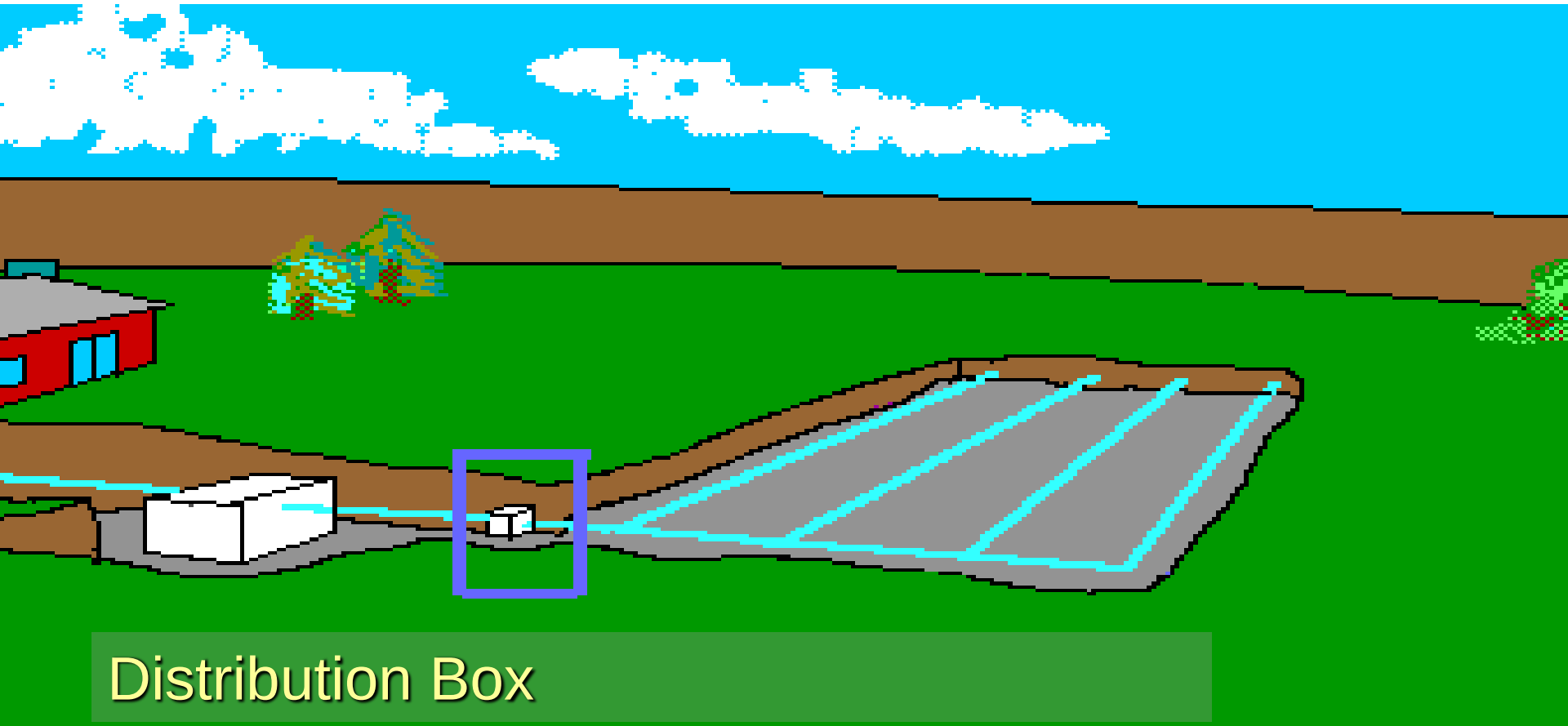
Subsurface Dispersal

- **In ground: <u>Drainfield</u>**
  - **Installation considerations**
    - Bottoms of each bed/trench must be level
    - Soils must be dry to install

What is a bed?

- Excavation greater than 3 feet in width
- Filled with distribution media
- Often with multiple pipes
- Gravity or pressure distribution

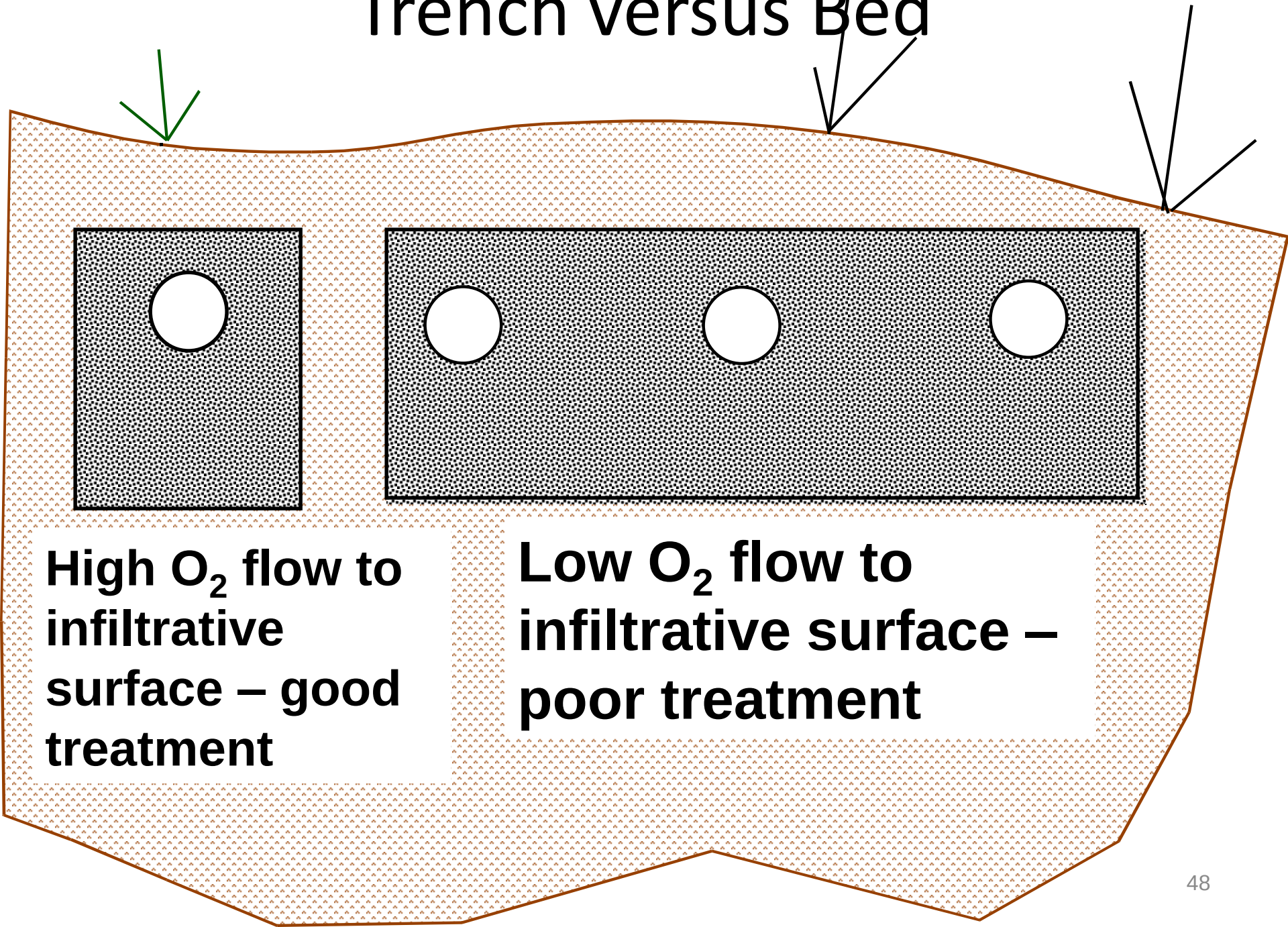
Distribution Device



Distribution Box

Bed System with Chambers

Trench versus Bed



High O_2 flow to infiltrative surface – good treatment

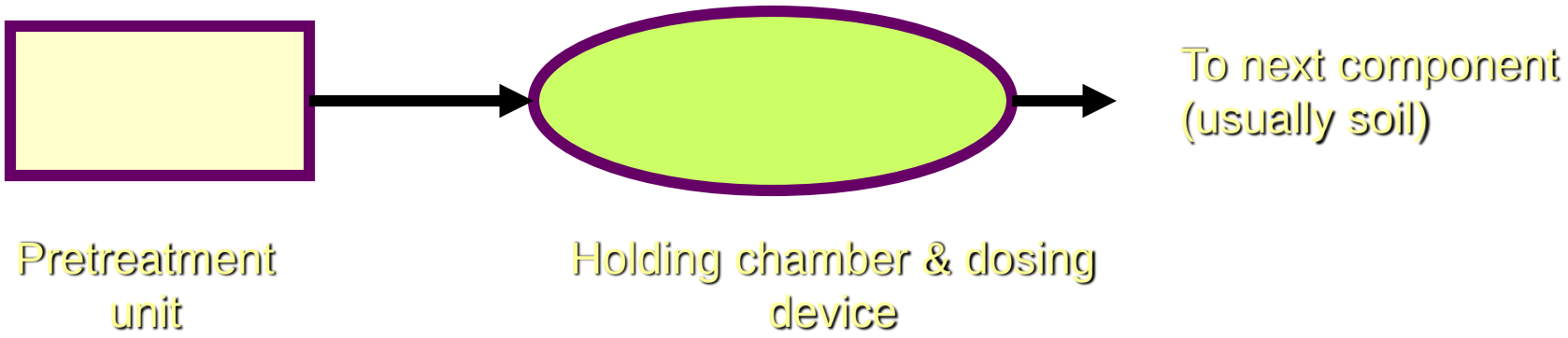
Low O_2 flow to infiltrative surface – poor treatment

Application/Distribution

- Two general options available:
  - Gravity-flow
  - Dosed-flow

Application/Distribution Options

- Dosed-flow distribution
  - Predetermined volume of effluent is held in chamber and dosed to next component.
  - Provides:
    - More uniform loading to next component
    - Resting times between doses



Dosed-flow Distribution

- Dosing methods - *Demand*
  - Dose occurs when sufficient, pre-determined volume of effluent has been collected.
  - Dosing frequency depends on how much wastewater generated.
  - No control on how much effluent is dosed daily (Socially controlled)

Dosed-flow Distribution

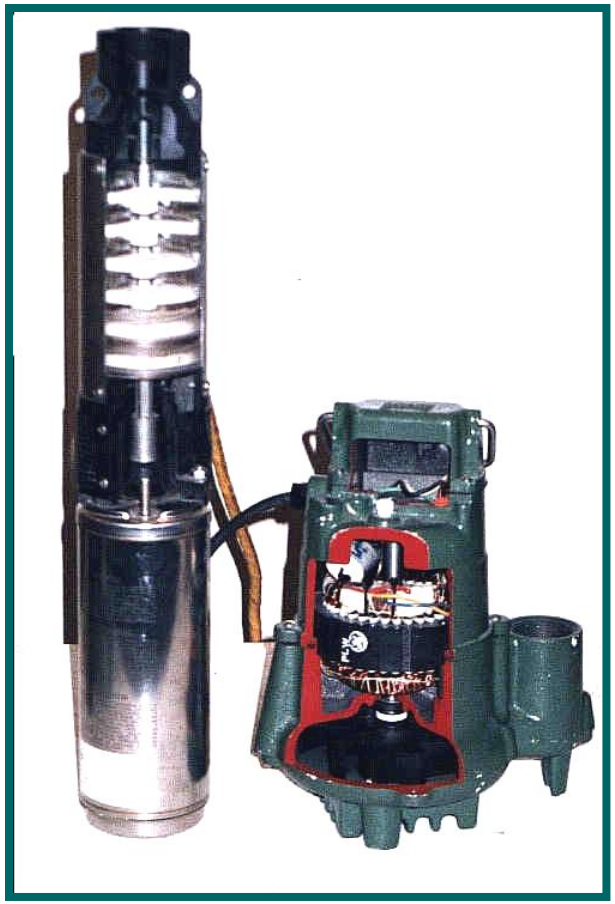
- Dosing methods - *Timed*
  - Timer controls number of doses per day & dose volume
  - Allows only a certain amount of effluent to be dosed daily (24-hour period)
  - Protects downstream components from being overloaded
  - Useful for controlling surges or big-flow days

Pump Systems

- Pump to gravity
- Low pressure pipe (LPP) system
- At-grade or mound system
- Drip irrigation

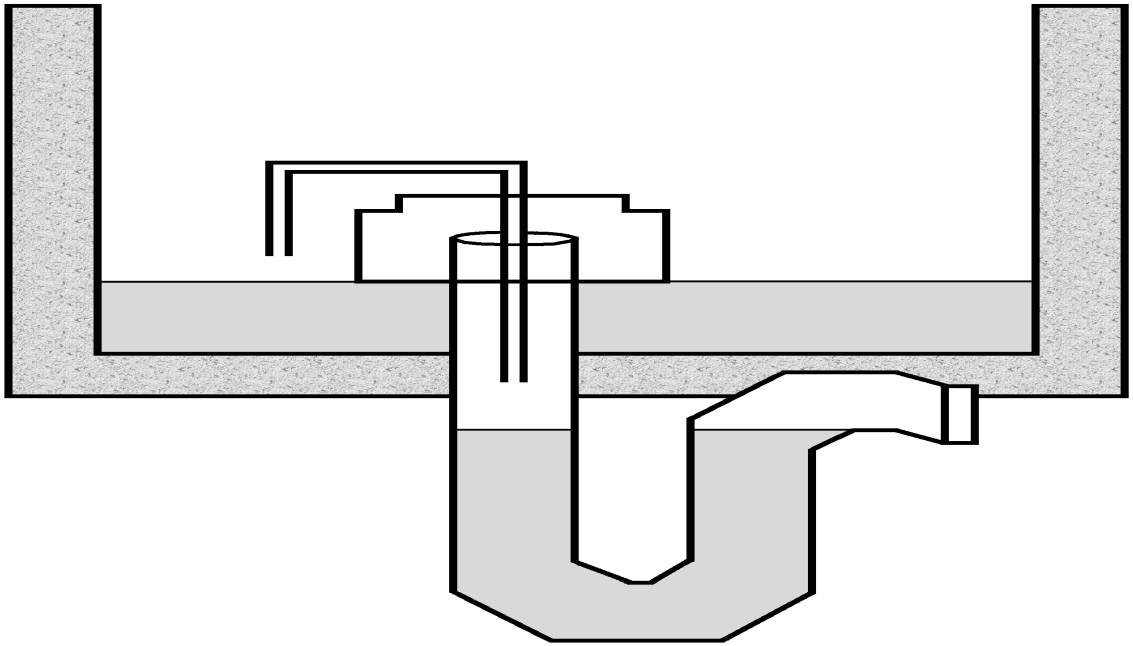
Dosed-flow Distribution

- **Dosing devices** - Pump



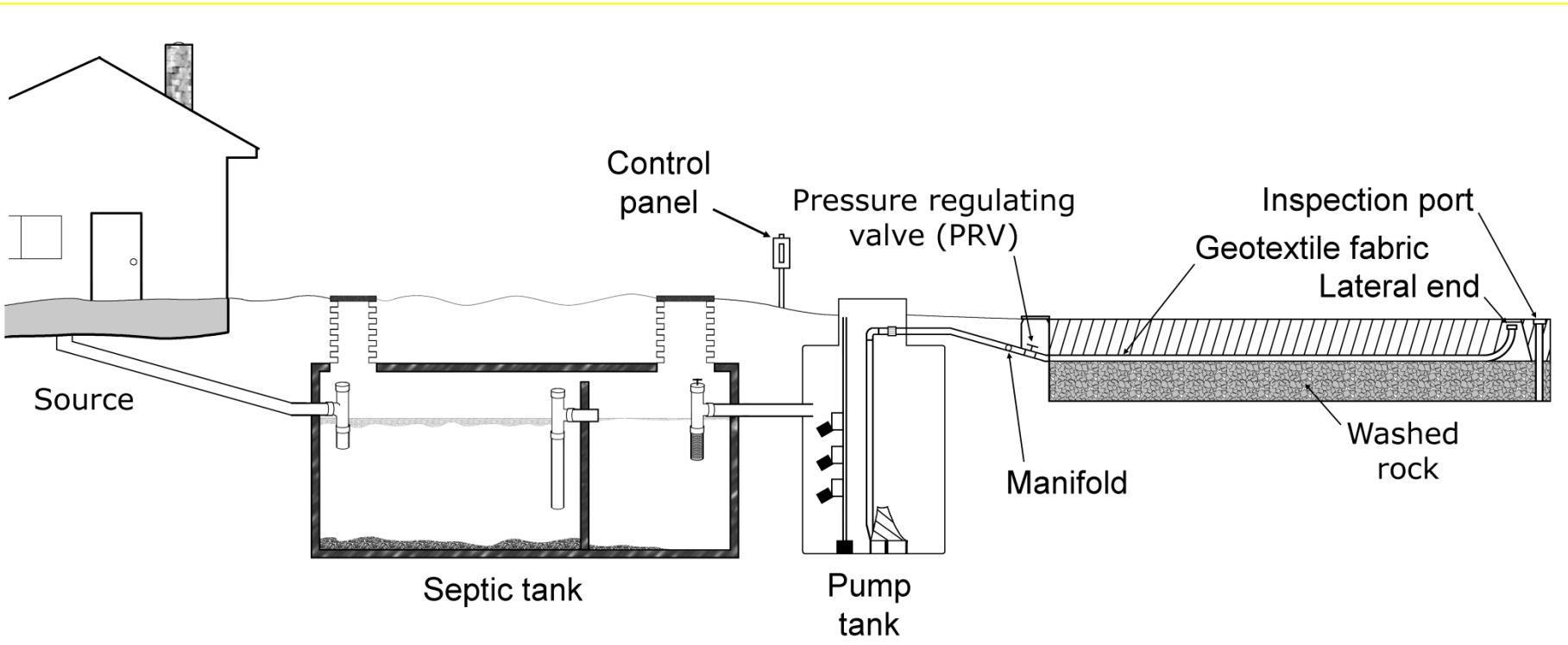
Type (cont.)

a. Method for dosing to field:
   - Siphon-to-gravity

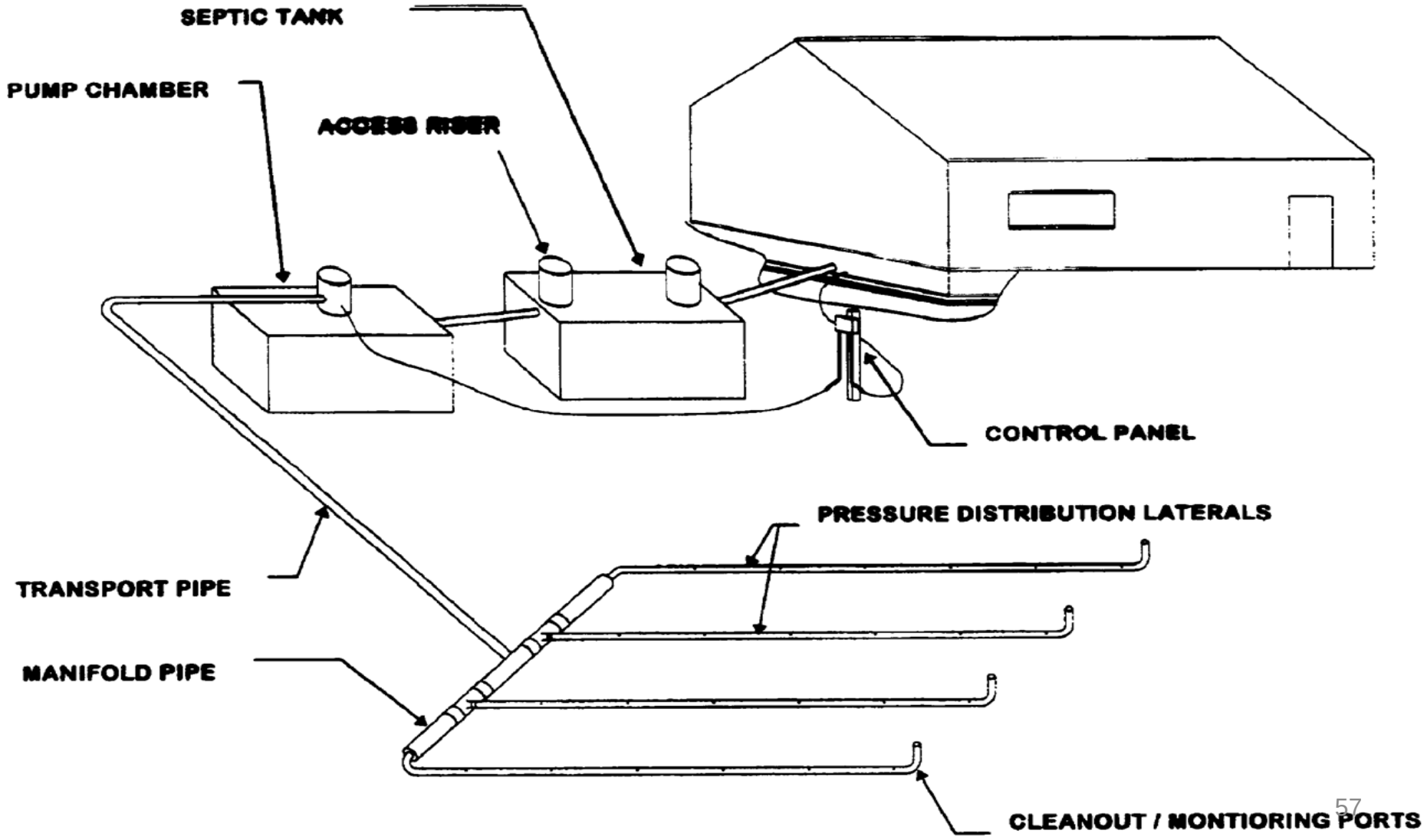


What is a low pressure distribution (LPD) system? AKA Low Pressure Pipe (LPP)

- Small diameter laterals ~ 1 ¼ inch
- Small orifices ~ 1/8 to 3/16 inch



Pressure Distribution



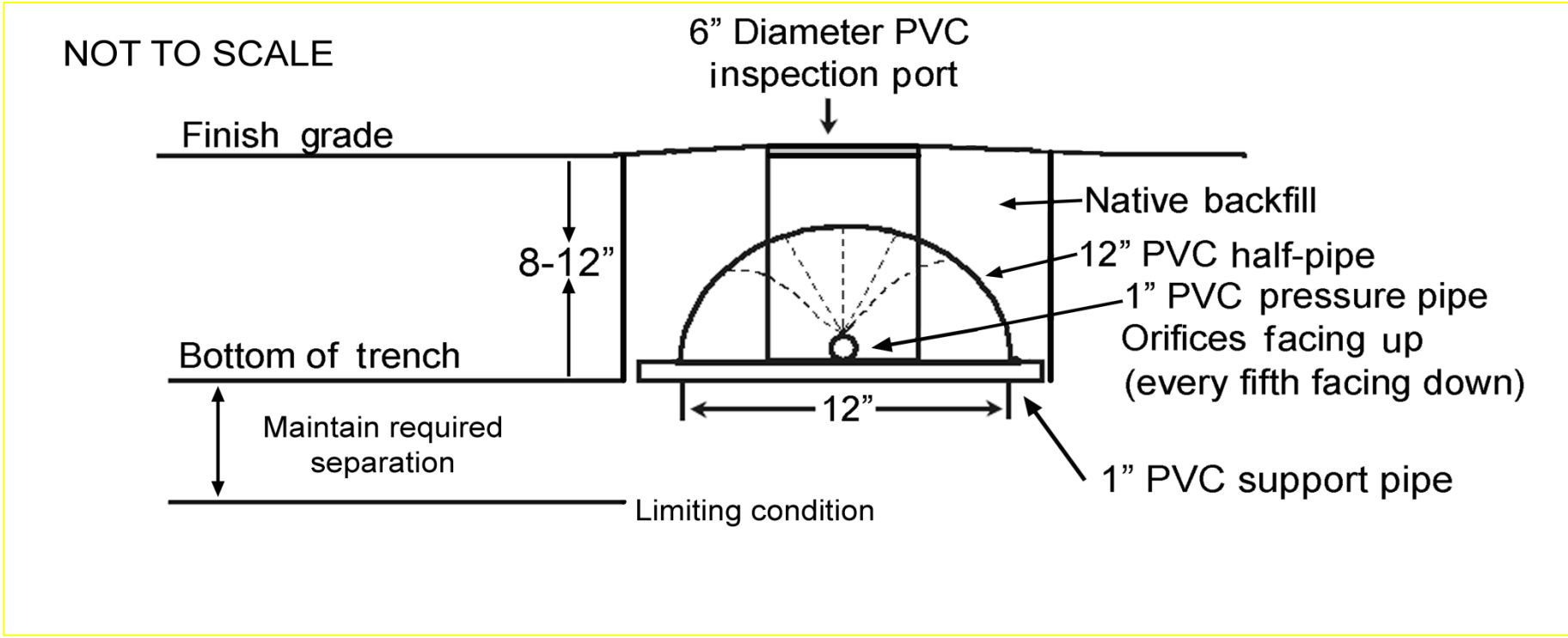
LPP: Spraying Upward and Distal Turn-up

Lateral turn up showing EZ FLOW option – sleeved line shown at rear

Low Pressure Pipe

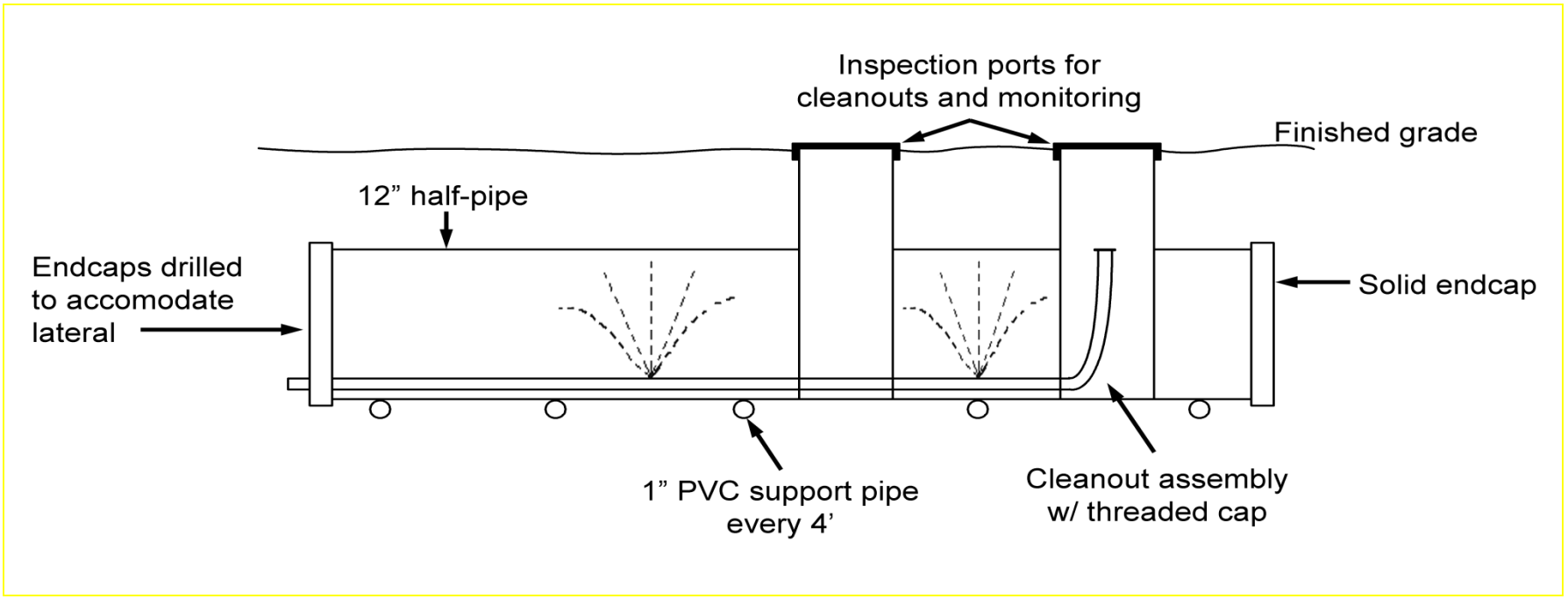
What is a shallow-narrow-pressurized trench?

- Type of LPD
- Dosed via 1/8″ orifices in low-pressure 1″ distribution laterals covered with 12″ diameter half pipe



What is a shallow-narrow-pressurized trench?

- Installed in upper portion (8 to 12”) of soil
- Highly-treated effluent applied

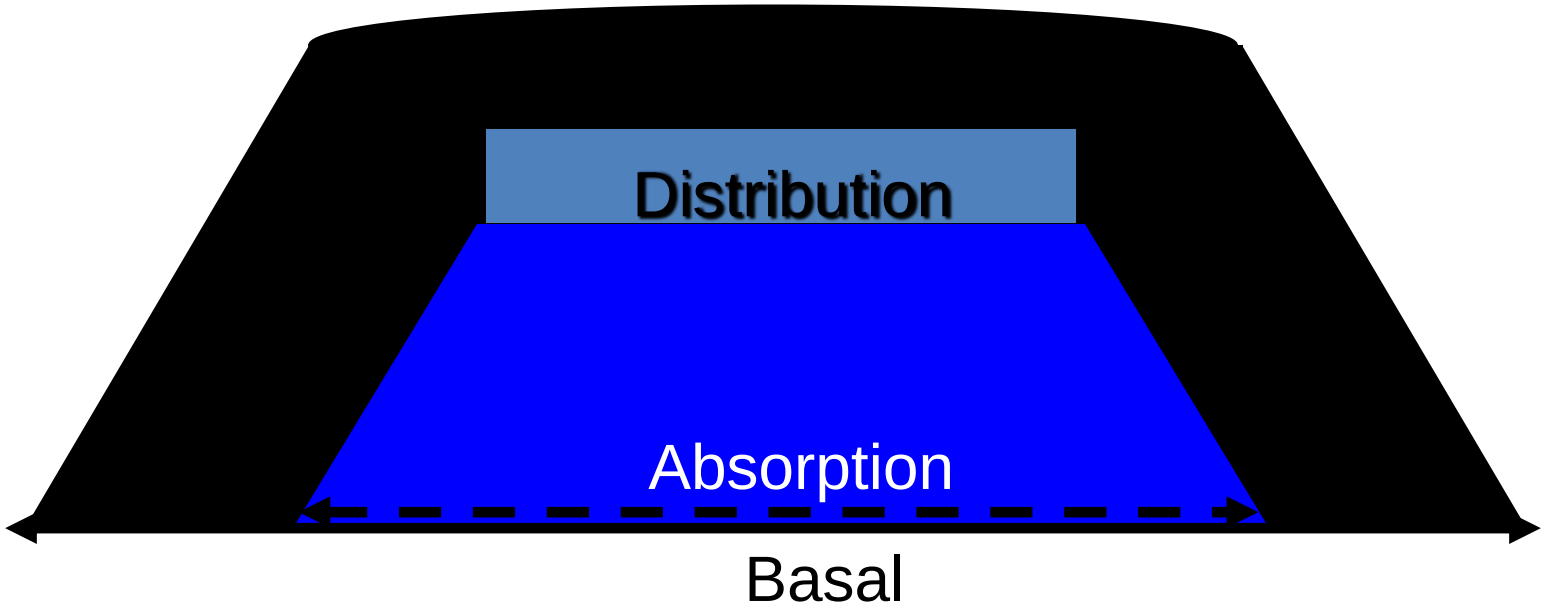


Above-grade system terms & options

- Terms referred to in above-grade systems
  - Absorption and basal area
- At-grade
- Mound
  - Modified mound
- Areal fill
- Bottomless media filter

Absorption versus basal area

- Absorption area is critical for acceptance
- Basal area is largely a function of landscaping

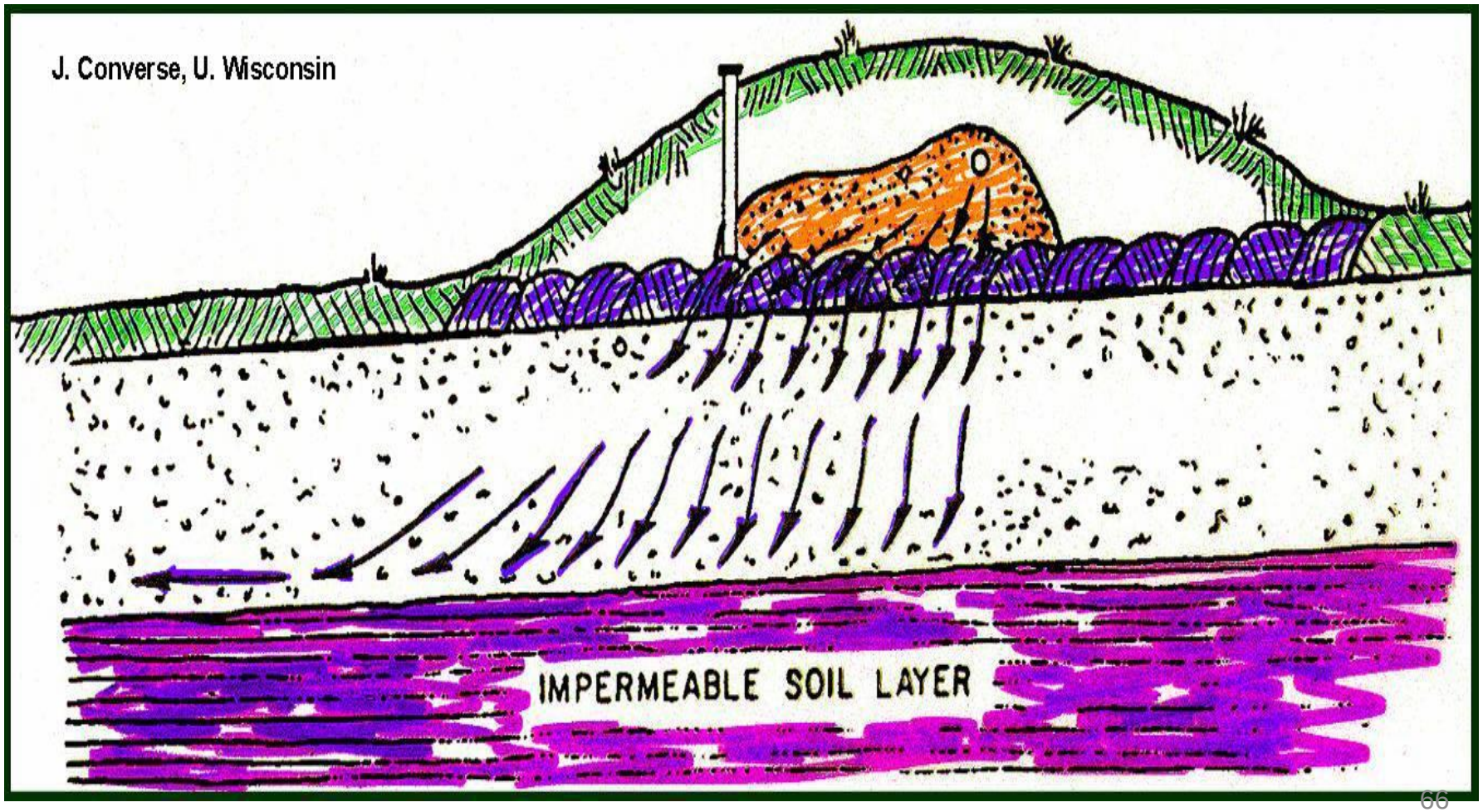


What is an at-grade?

- Above-grade STA installed with some part of the infiltrative surface located at the original ground elevation
  - Excavation 0 to 6 inches into native soil
  - Distribution media in contact with native soil
  - Pressure or gravity distribution
  - Orifices above the original ground elevation
  - Suitable cover

Subsurface Dispersal

- At-grade system



Subsurface Dispersal

- At-grade system
  - Uses native, original soils
  - Insufficient soil depth for typical subsurface system but enough so mound isn't required
  - Similar horizontal and vertical separations
  - Used with gravity or pressure distribution
    - Pressure distribution or drip recommended
  - Low linear loading rate – long & narrow
  - Usually max slope of 25%
  - Proper preparation of surface is critical

At-grade

- Similar installation techniques as mound and areal fill except distribution media is in direct contact with native soil

Initial Site Preparation for At-Grade System

Coarse Aggregate and Pipe for At-Grade System

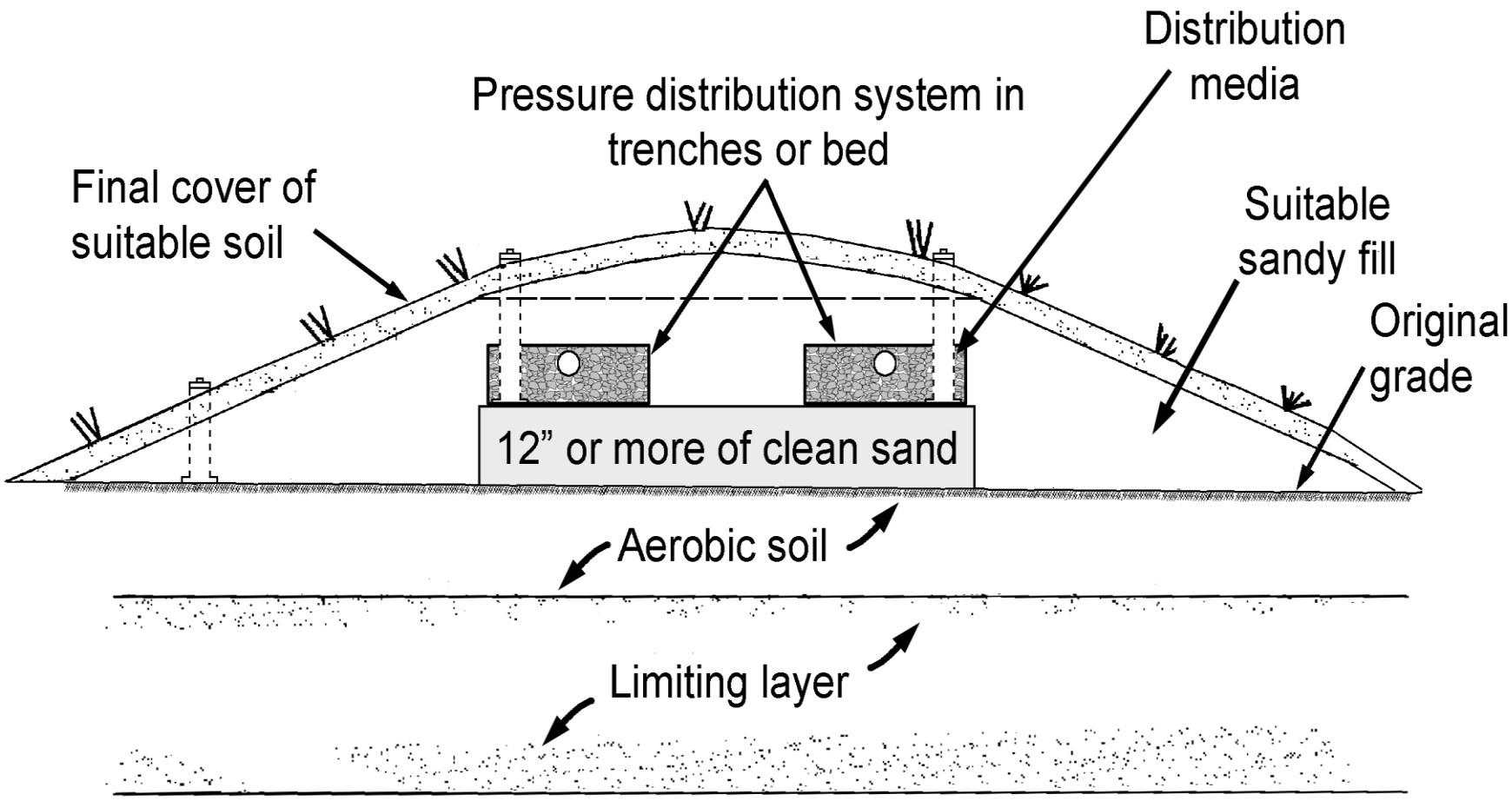
Soil and Geotextile for At-Grade System

What is a mound and a modified mound?

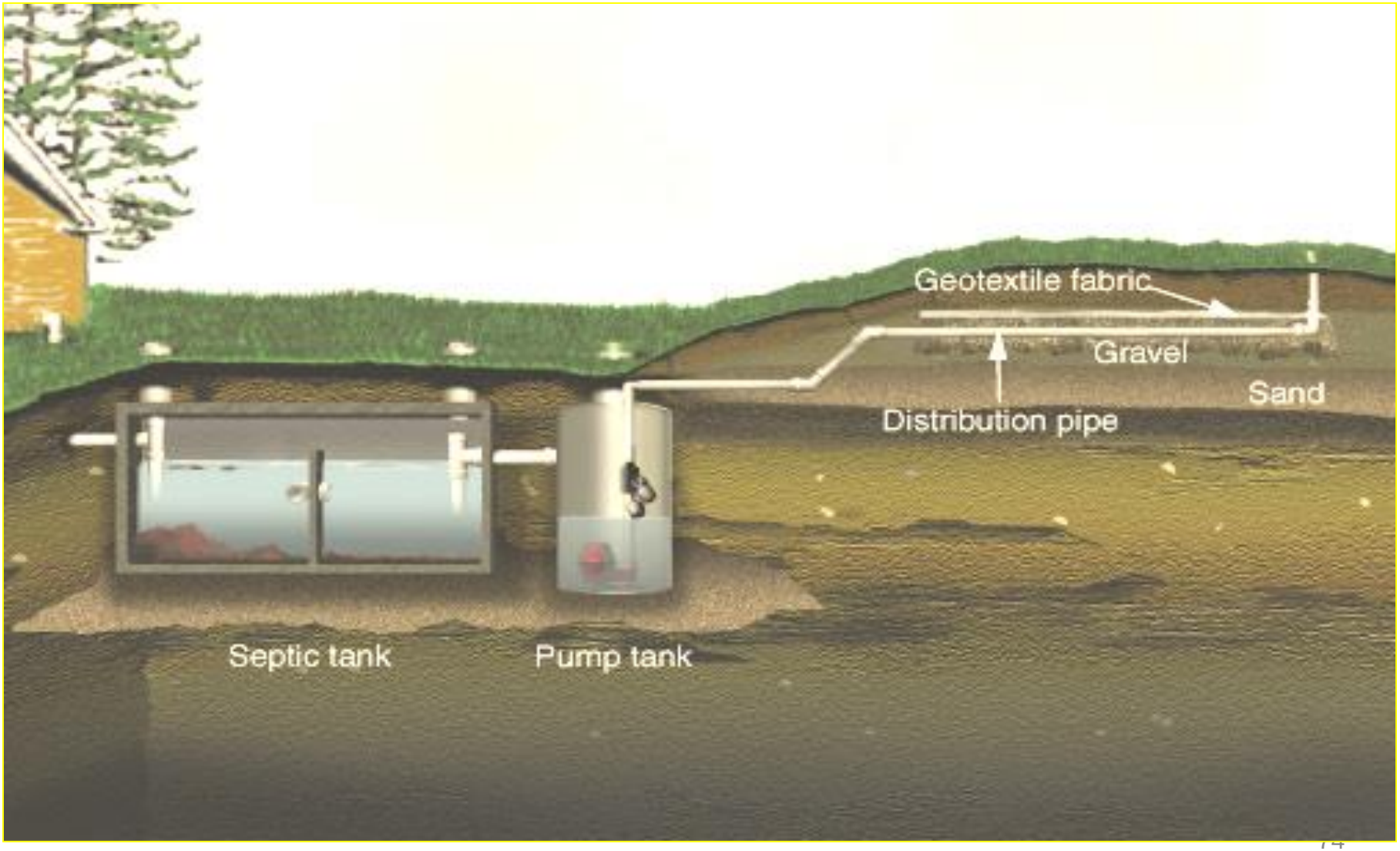
- Mound: above-grade STA with
  - At least 12 inches of clean sand treatment media between bottom of infiltrative surface and original ground elevation
  - Pressure distribution

- Modified mound: has < 12 inches of sand, but a minimum of 6 inches

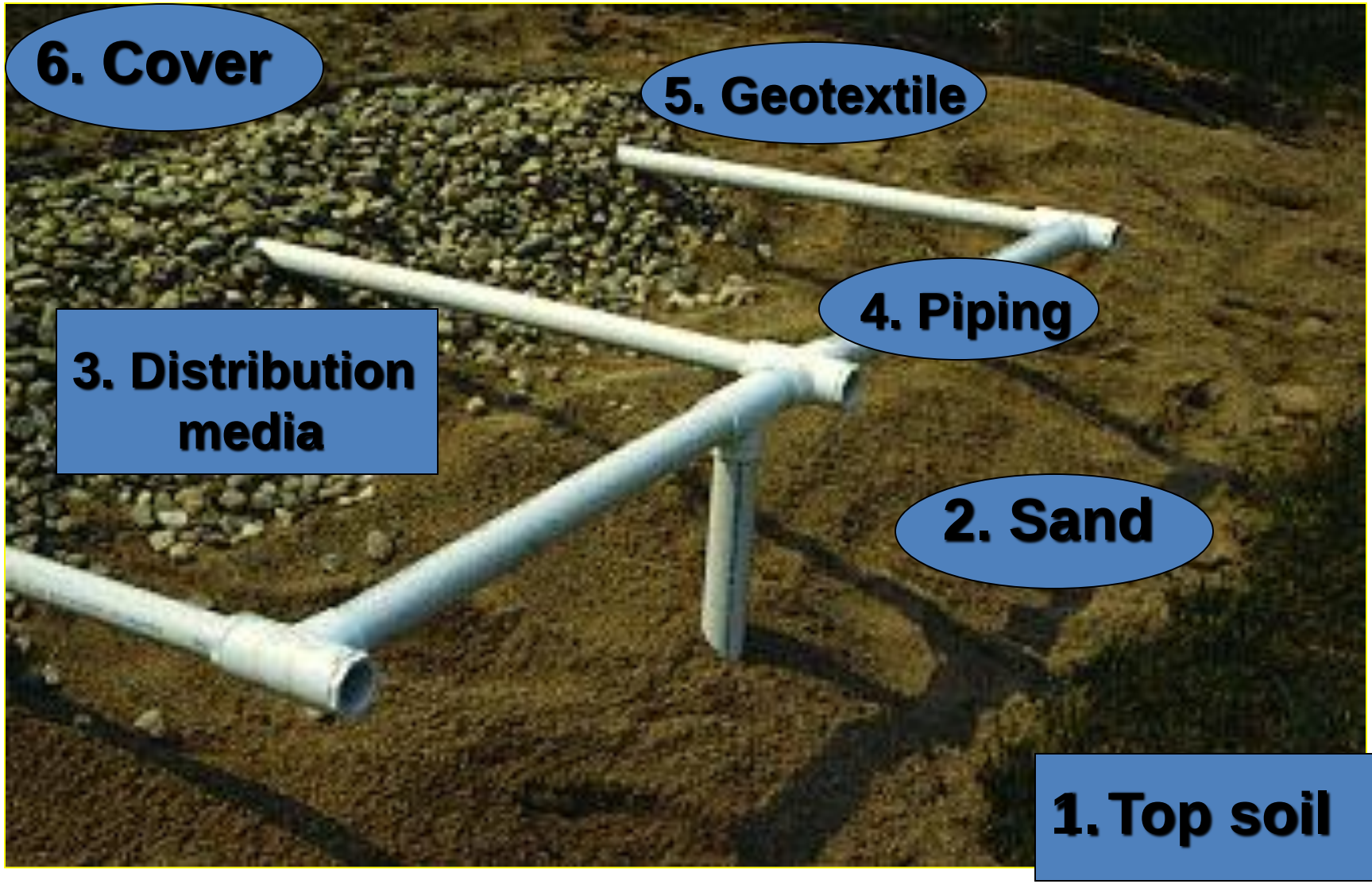
Mound system



Mound system



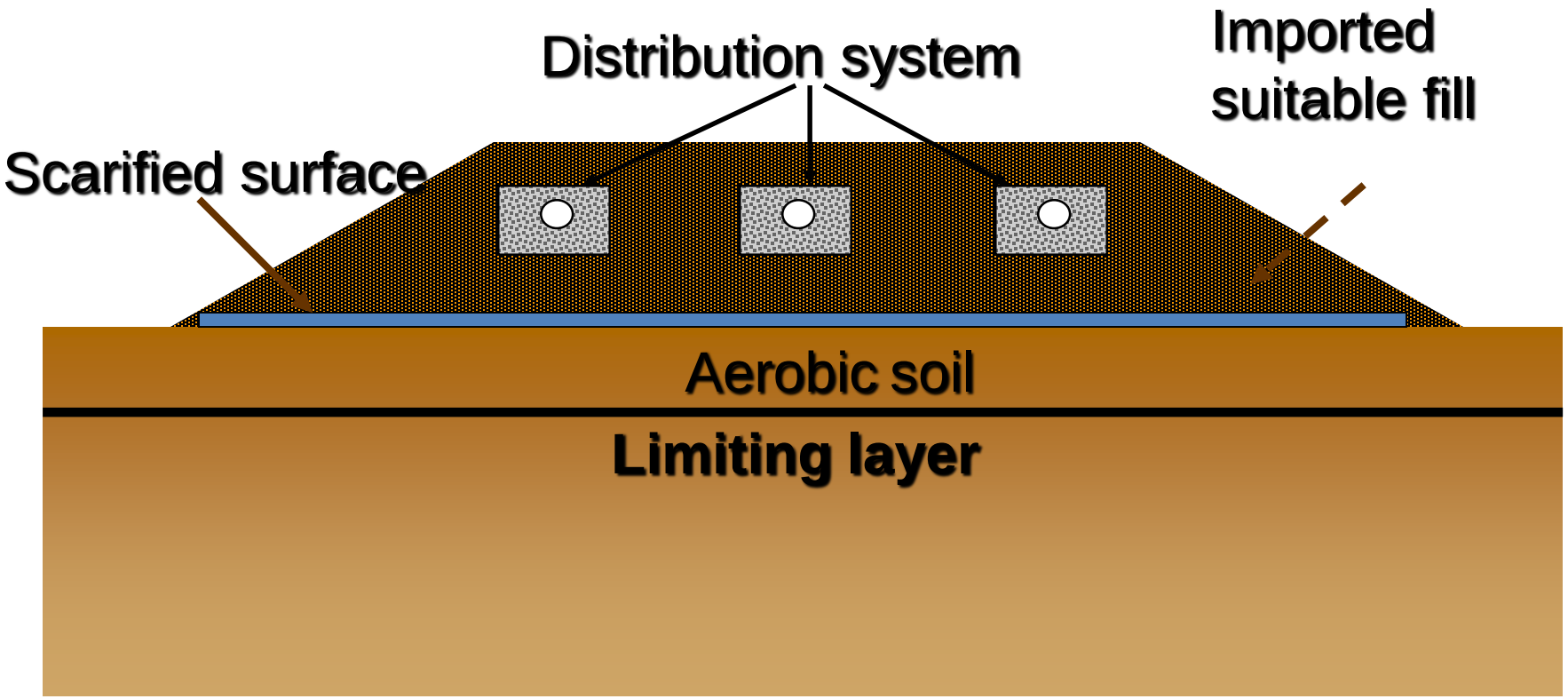
Mound components



What is an areal fill system?

- Above-grade STA with entire infiltrative surface located above original ground elevation
  - Uses imported soil fill treatment material
    - Typically Group I or II (sandy or loamy) soils
  - Pressure or gravity distribution
  - Difference from a mound
    - Uses media other than clean sand
    - May use gravity distribution

Areal fill



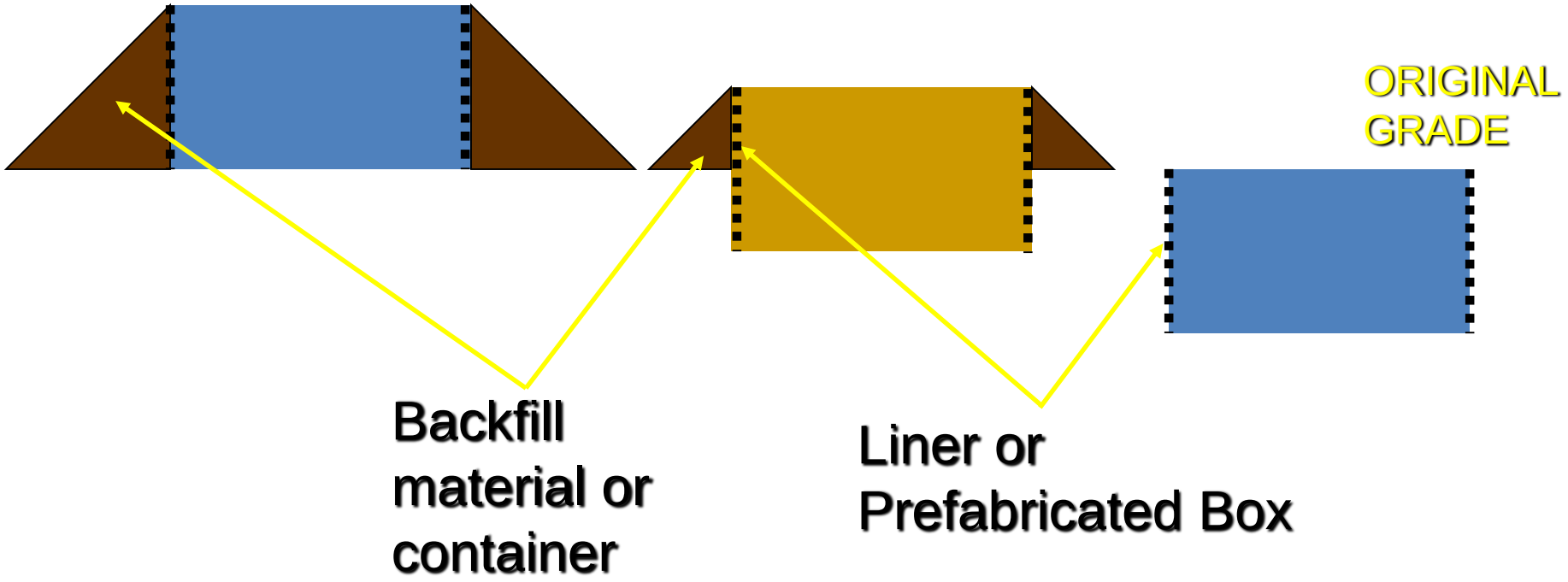
- Similar construction techniques
- Varying media specifications
- Gravity distribution is sometimes used

What is a bottomless media filter?

- Bed of specified media, typically with pressurized distribution
- Wastewater trickles down through media & disperses into soil directly under filter
- Constructed sand and modular peat are most common, but others exist
- Typically aggregate or soil cover or modular lid/container

Bottomless media filter (BMF)

- Can be above or below original grade



Pressure Distribution

- **Objectives:**
  - Quickly pressurize network
  - Be fully pressurized for most of dose
  - Minimize draining into lower laterals
  - Have about the same amount of effluent reach each square foot of infiltrative surface

Pressure Distribution

- **How it works**
  - Predetermined quantity of effluent collected
  - At predetermined volume or time, dosing device discharges effluent to distribution network
  - Because of small pipe and orifices, distribution network pressurizes quickly
  - Current design objectives want equal amounts of effluent from each orifice

Pressure Distribution

- **Why/Where used?**
  - Where uniformity of distribution is vital to achieve unsaturated flow in soil or media
    - Coarse or shallow soils
    - Many pretreatment components
    - Larger soil dispersal systems
  - Helps provide predictable level of treatment in soil or media by minimizing hydraulic overloading

Pressure Distribution

- **Design considerations**
  - The smaller the orifice diameter: the greater the potential for plugging
  - The smaller the orifices and the greater their spacing:
    - The faster the network will pressurize
    - The smaller the pump must be (gpm)
  - Orifices at 12 o'clock will help network pressurize faster but are more subject to:
    - Plugging
    - Freezing in cold weather areas

Supply Lines

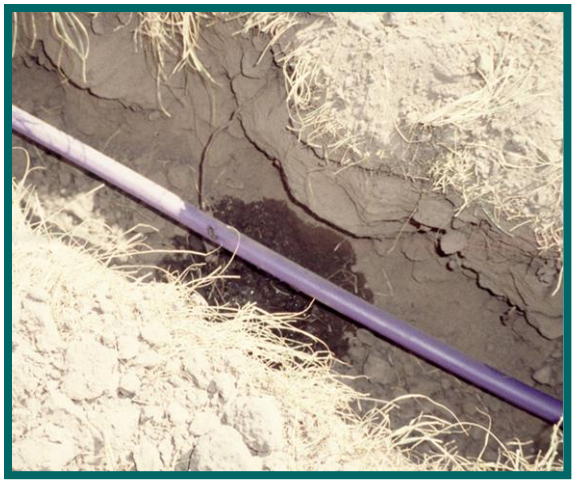
- Free drainback to either the pump basin or drainfield, minimizes freezing in cold weather
- If drainback is directed towards the pump basin do not use a check valve
- Check valves must be used when using duplex pumps and a common discharge assembly

Types of alternating or switching valves

- Bull run valves
- Gate valves
- Ball valves
- Sequencing valves (also called hydraulic switching valves)

Dosed-flow Distribution

- **Options** – **<u>Drip distribution</u>**
  - A small diameter pressurized distribution network that delivers small, precise volumes of pretreated effluent at slow controlled rates.



Drip Distribution

- **Why/where used?**
  - Where most efficient uniform distribution is desired or required
  - May be used anywhere where gravity- or dosed-flow distribution is used
  - Some locations allow use on soils shallower or finer-textured than allowed for other technologies
  - Can be placed on more difficult sites – slopes, trees, etc.
  - Causes less site disruption than other options

The Benefits of Drip Irrigation

Controlled & Uniform Dosing

- *Even dosing over <u>area</u>*
- *Even dosing over <u>time</u>*
- *Minimizes soil saturation: encourages unsaturated flow*

Subsurface Drip Dispersal: Wastewater Treatment Approach

- Small doses of wastewater into the soil.
- Uniform distribution over the entire area.
- Wastewater moves through soil under unsaturated flow conditions, thus effectively treating the wastewater.
- Wastewater can be dosed into the active surface layer of the soil.
- Facilitates reuse of nutrients and water.

Gravelless technologies

- Can be used for both gravity & pressure
- Can be used where washed rock is used
- Avoids the concerns of rock
- Have unique sizing & installation requirements
- Have their own unique precautions
- Check with manufacturer & local regulations

Final cover

a. Depth - 6” minimum recommended

b. Loamy topsoil material ideal, import if needed

- Appropriate for vegetative growth/landscaping

c. Crowned to allow for settling and shedding of surface wate

d. Vegetation planted

e. Description of landscaping

Backfilling

- Store topsoil separately so it can be used as final cover

- If site conditions (and inspector) allow, topsoil from one trench can be used to cover adjacent trench

Covering as you go

Landscaping importance

- Erosion protection
  - Plants help hold topsoil in place
- Protect the system from freezing
  - Plants trap snow
  - Provide insulation
- Soften “look” of system so more aesthetically pleasing

For Most Effective Wastewater Treatment in Soil

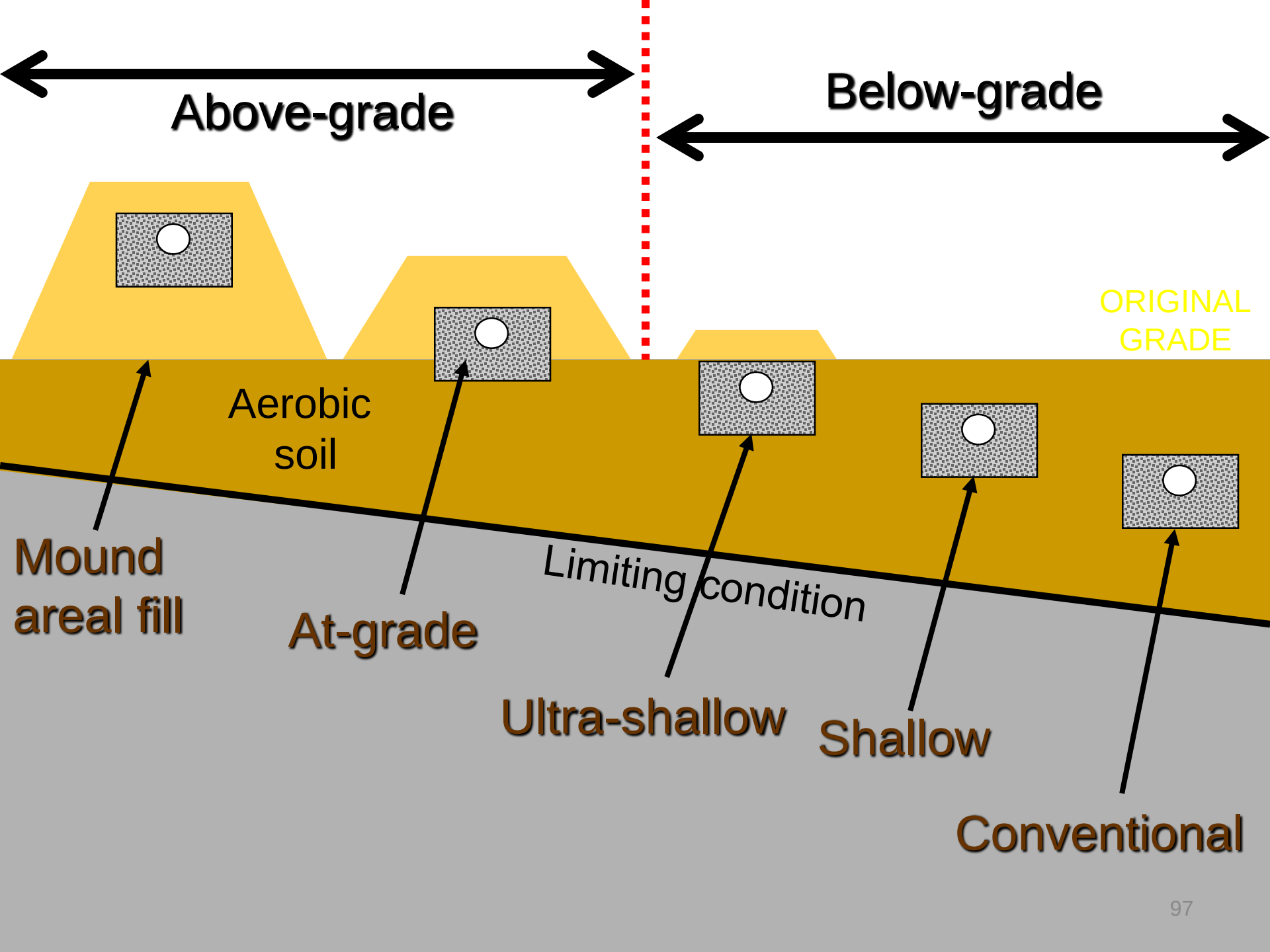
- Utilize aerobic soil conditions
- Encourage unsaturated flow
- Distribute evenly over soil infiltrative surface
- Place effluent shallow in soil profile to
  - Increase evapotranspiration
  - Use more biologically active portion of soil

What controls LTAR?

- Infiltrative surface – biomat/soil interface
- Least permeable layer in profile
- Horizontal hydraulic conductivity above the least permeable layer

Assessment of treatment potential

- Aerobic (unsaturated) soil conditions are required
- Aerobic (unsaturated) conditions results in greater contact time, thus greater treatment


Above-grade
Below-grade
ORIGINAL GRADE
Aerobic soil
Mound areal fill
At-grade
Limiting condition
Ultra-shallow
Shallow
Conventional

Thank You!

Questions?