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What You Will Learn in This Lesson

The at-grade absorption area is an alternate component listed in the DEP Alternate Systems Guidance Document (guidance). It provides another option for property owners who have a site with certain conditions.

To introduce you to the alternate at-grade absorption area, we will compare it to a conventional sand mound bed, which most of you are familiar with.

In this lesson, you will learn about three primary differences between an alternate at-grade absorption area and a conventional sand mound bed.

An alternate at-grade absorption area used as a repair.

Note: This course deals with an at-grade absorption area on a site with at least 20 inches of suitable soil. If you want to learn about a shallow limiting zone at-grade absorption area that can be placed on a site with less than 20 inches of suitable soil, go to course #342. Currently, this course is under development.

At-Grade vs Sand Mound

Let's start by looking at a photo of each of the components, both of which provide final treatment and distribution in an onlot sewage treatment system.

Sand Mound

At-Grade

Three Differences

The three primary differences between the conventional sand mound bed and the alternate at-grade absorption area are:

1) Different minimum suitable soil depths without the use of secondary treatment
2) Different materials used in the absorption area construction
3) An additional option for the absorption area design

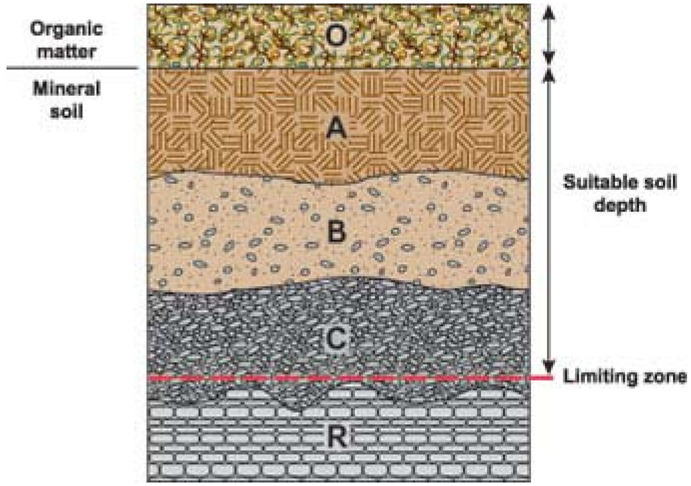
We will cover each one in detail.

#1 -- Minimum Suitable Soil Depth

The first difference between the alternate at-grade absorption area and the conventional sand mound is the minimum required suitable soil depth for a system that does not use secondary treatment.

The suitable soil depth must be **≥48** inches to use an alternate at-grade absorption area **without** any additional secondary treatment.

	At-Grade	Sand Mound
1) Suitable Soil Depth Without Secondary Treatment	**≥48"**	**≥20"**



#1 -- Minimum Suitable Soil Depth

PRIMARY TREATMENT OR PRIMARY AND SECONDARY TREATMENT

The 48-inch minimum suitable soil depth applies if primary treatment only is being provided.

If primary and secondary treatment are provided, the minimum suitable soil depth may be as shallow as 20 inches.

Note: If the suitable soil depth is less than 20 inches (as shallow as 10 inches to a seasonal high water table, or 16 inches to a rock limiting zone), then **advanced treatment** and a **shallow limiting zone at-grade absorption area** must be used. The shallow limiting zone at-grade absorption area is covered in course #342.

#1 -- Minimum Suitable Soil Depth

Which limiting zone(s) below would be acceptable for an alternate at-grade absorption area, assuming the proper primary or primary and secondary treatment options were used, and other testing was also acceptable?

- [ ] A) 18 inches to rock
- [ ] B) 58 inches to rock
- [ ] C) 9 inches to a seasonal high water table
- [ ] D) 20 inches to a seasonal high water table

Submit Reset

#1 -- Minimum Suitable Soil Depth

PRIMARY TREATMENT OR PRIMARY AND SECONDARY TREATMENT

Research Theory

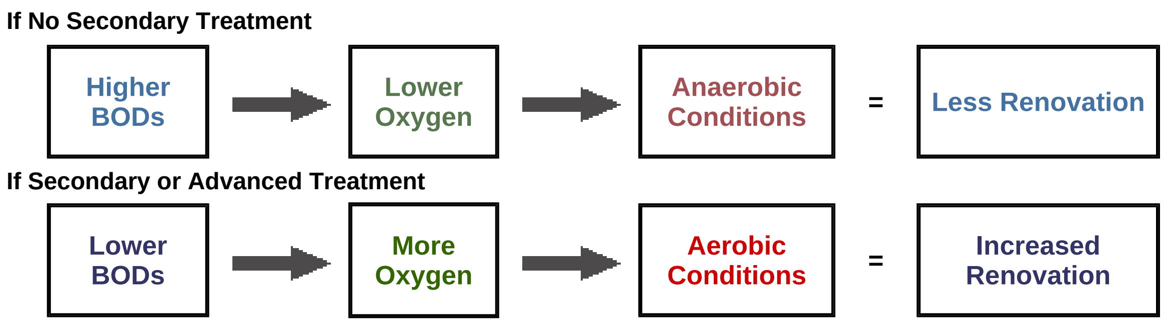
If no secondary treatment is provided, there must be at least 48 inches of suitable soil between the bottom of the absorption area aggregate and the limiting zone. If there is less than 48 inches of suitable soil, a minimum of secondary treatment must be provided to reduce the depth of suitable soil needed.

If the effluent goes through **secondary treatment** or **advanced treatment**, a cleaner effluent is being discharged to the soil, reducing the risk of contaminating a water source. The soil is a living filter for the onlot sewage treatment system. If the effluent is more highly treated, less suitable soil depth is necessary to achieve the same treatment results as with primary treated effluent.

PRIMARY AND SECONDARY TREATMENT

Research Theory

Effluent that has gone through secondary or advanced treatment has a lower **biological oxygen demand (BOD)** and lower suspended solids, which reduce the risk of clogging the soil. High BODs use more oxygen, making it harder for microbes to survive, which can reduce the renovative capacity of the soil. With lower BODs, the microbes have a better chance of surviving and renovation may be increased.



#2 -- Material Difference

The second difference between an alternate at-grade absorption area and a conventional sand mound bed is in the materials used to construct the absorption area.

No sand is used in the construction of an at-grade absorption area. The aggregate is placed directly on the surface, as shown in the picture to the left.

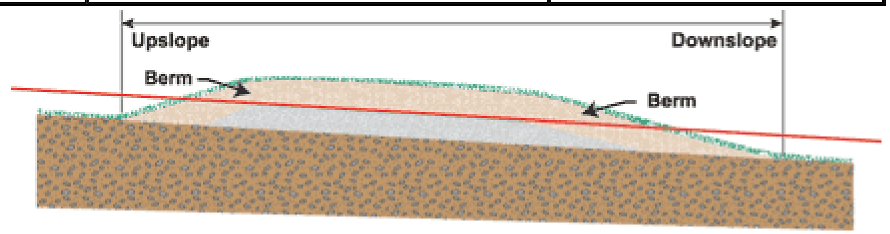
	At-Grade	Sand Mound
1) Suitable Soil Depth Without Secondary Treatment	**≥48"**	**≥20"**
2) Materials	**Aggregate**	**Aggregate and Sand**

#3 -- Absorption Area Design

The third difference between an alternate at-grade absorption area and a conventional sand mound bed is the design of the absorption area. The at-grade absorption area offers two design options. The aggregate may be level on top like the sand is on a conventional sand mound, or the top of the aggregate may follow the slope along contours with a constant depth as shown in the diagram below. Either way is acceptable according to the guidance.

	At-Grade	Sand Mound
1) Suitable Soil Depth Without Secondary Treatment	**≥48"**	**≥20"**
2) Materials	**Aggregate**	**Aggregate and sand**
3) Design	**1) Aggregate depth constant following the slope or 2) Aggregate is level on top**	**Aggregate is level on top**

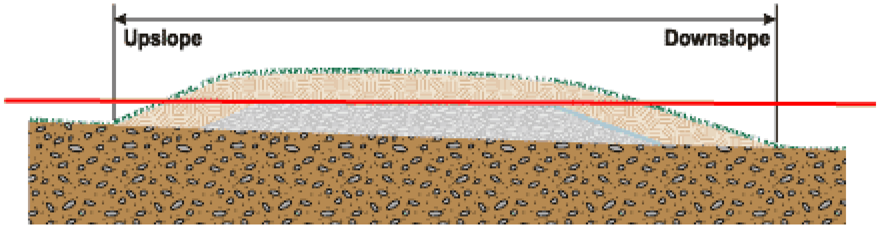
The top of the aggregate is parallel with the original slope, and it is the same depth on the upslope and downslope of the bed.



#3 -- Absorption Area Design

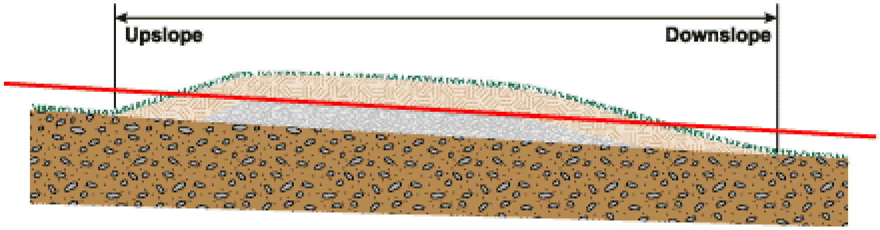
The diagrams below show the two design options available for an alternate at-grade absorption area.

LEVEL



The absorption area is constructed like a conventional sand mound, except aggregate is used in place of the sand.

SLOPED



The aggregate is placed at a constant depth from the upslope to the downslope of the absorption area and follows the original slope.

Review

What items listed below may be differences between the alternate at-grade absorption area and the conventional sand mound bed?

- [ ] A) Materials in the construction
- [ ] B) Materials in the piping system
- [ ] C) Minimum suitable soil depths without secondary treatment
- [ ] D) Material for the cover
- [ ] E) Absorption area design

Submit Reset

Lesson Review

To review the three differences between the alternate at-grade absorption area and the conventional sand mound bed, ***drag the items at left to the correct place on the chart.***

Word Bank

≥20"

≥48"

Aggregate

Along Slope or Level

Level

Aggregate and Sand

	At-Grade	Sand Mound
1) Suitable Soil Depth Without Secondary Treatment		
2) Materials		
3) Design		

Lesson Review

In this lesson, you have learned the differences between the alternate at-grade absorption area and the conventional sand mound bed.

At-Grade Absorption Area

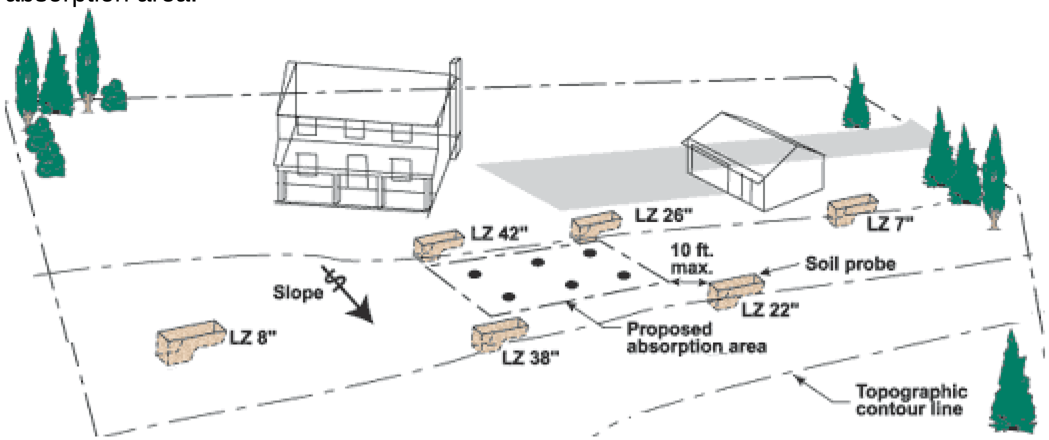
Sand Mound Bed

Note: If you have more questions about the at-grade absorption area after completing this lesson or course, refer to the DEP Alternate Systems Guidance document in the "job aids."

What You Will Learn in This Lesson

In this lesson, you will learn what site testing must be done to consider an alternate at-grade absorption area. **All of the criteria must be met before a permit may be issued for a system employing an alternate at-grade absorption area.**

After completing this lesson, you will be able to evaluate the test results for a proposed site and know if a permit may be issued for a system employing an alternate at-grade absorption area.



Site Testing for an Alternate At-Grade Absorption Area

The criteria listed below must be determined before a permit may be issued for a system employing an alternate at-grade absorption area.

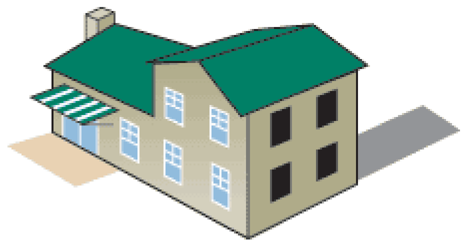
1) Wastewater characteristics
2) Isolation distances
3) Slope
4) Suitable soil depth
5) Percolation rate

The guidance outlines the criteria that must be met before a permit may be issued for a system employing an alternate at-grade absorption area. The following pages will explain what criteria will meet the guidance requirements.

1) Wastewater Characteristics

Section 9.B.1

The first criterion to consider is the **wastewater characteristics.** The alternate at-grade absorption area may only receive wastewater from a residential development or other facilities producing sewage effluent with chemical and biological characteristics typical of untreated domestic wastewater.



1) Wastewater Characteristics

DOMESTIC WASTEWATER CHARACTERISTICS

A single-family dwelling with typical domestic wastewater (gray and black water) should meet the domestic wastewater characteristics listed below.

- 12-50 mg/l ammonia as nitrogen
- 8-35 mg/l organic nitrogen (20-85 mg/l total Kjeldahl nitrogen)
- 350-1200 mg/l total solids
- 100-350 mg/l suspended solids
- 110-400 mg/l for five-day **BOD**

A structure that produces any other waste besides domestic wastewater must be tested to determine if it meets the criteria listed above.

Note: An EPA-approved (approved for chemical and biological testing) testing laboratory can determine if the existing structure has domestic wastewater characteristics, or samples may be taken from any structure with similar waste to determine if the proposed structure's wastewater would have domestic wastewater characteristics. It is recommended to use an EPA-approved lab. The results from an EPA lab should stand up in court. If for some reason the project ends up in court, it would be helpful to have information that is usable to defend your case.

1) Wastewater Characteristics

An alternate at-grade absorption area may be designed for a(n) __________ with domestic wastewater characteristics.
--Click any that apply.

- [ ] A) Commercial facility
- [ ] B) Institutional facility
- [ ] C) Single-family dwelling
- [ ] D) Recreational and seasonal facility

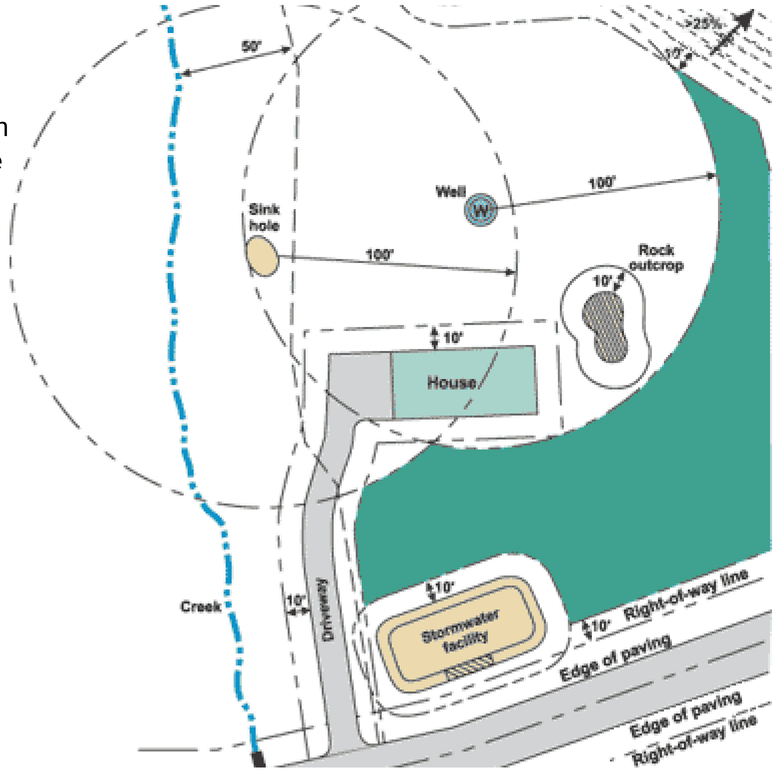
Submit Reset

2) Isolation Distances

Isolation distances are the second criterion to examine when considering an alternate at-grade absorption area.

Section 73.13

The isolation distance requirements
for the alternate at-grade absorption area are the **same** as for a conventional system.



2) Isolation Distances

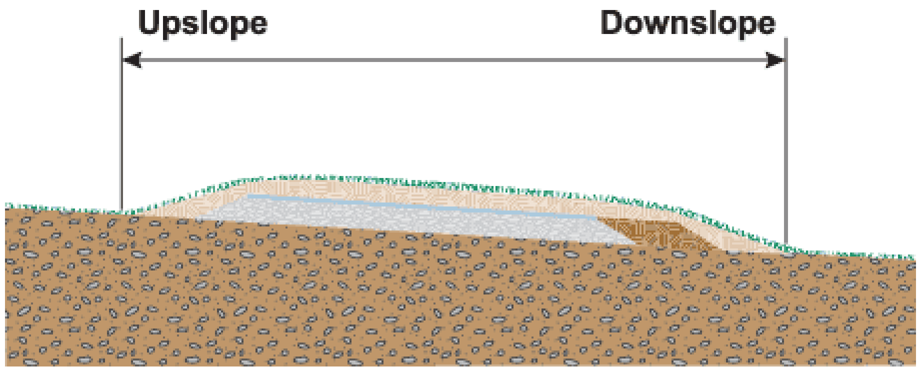
Which isolation distance from the absorption area aggregate to the items listed below would not allow a permit to be issued for an alternate at-grade absorption area on a new site?

- A) 22 feet -- Water supply line under pressure
- B) 12 feet -- Property line
- C) 88 feet -- Swimming pools
- D) 18 feet -- A cistern used as a water supply
- E) 27 feet -- Driveways

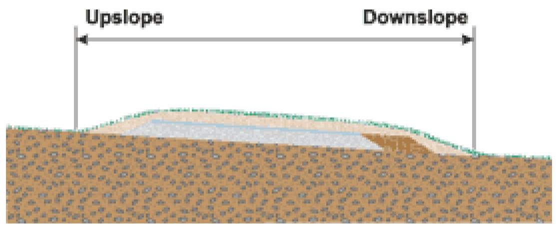
Submit

3) Slope

The **slope** of the proposed absorption area is the third criterion to consider when siting an alternate at-grade absorption area. The slope must be measured from the extremity of the berm on the upslope side to the extremity of the berm on the downslope side of the proposed absorption area.



3) Slope



Section 9.A.3

What is the maximum slope allowed to permit an alternate at-grade absorption area?

Use the Alternate Systems Guidance in the "job aids" and refer to the section reference above to find the answer. Type your answer in the box below.

%

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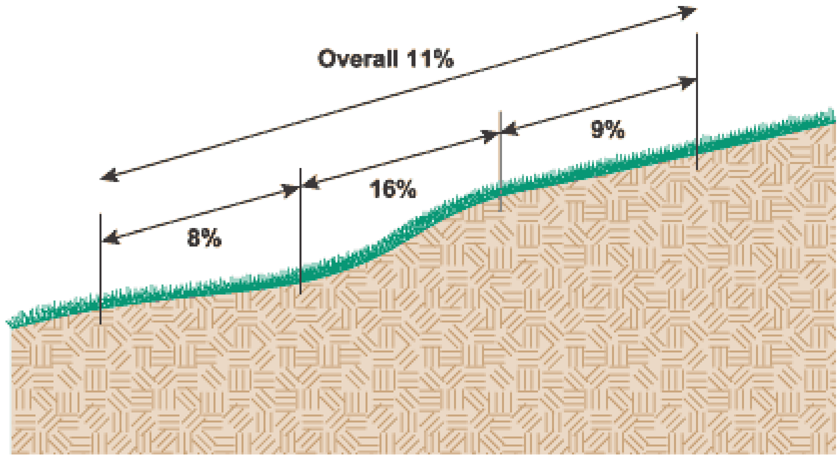
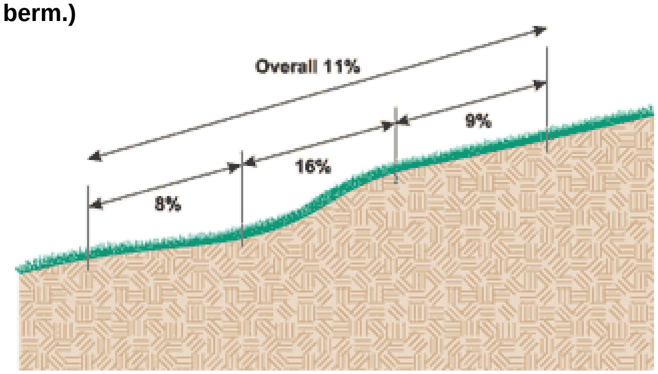
3) Slope

If the slope varies, differs, or changes over a large portion of the area being measured, then the **steepest**, or **maximum**, slope must be measured.



3) Slope

Which slope from the diagram below must be used when testing for an alternate at-grade absorption area? (The overall slope of 11% was measured from toe of berm to toe of berm.)

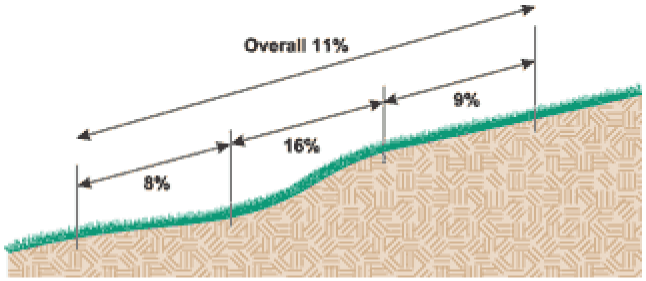


- ○ A) 8%
- ○ B) 9%
- ○ C) 11%
- ○ D) 16%

Submit

3) Slope

Could an alternate at-grade absorption area be considered for this site?



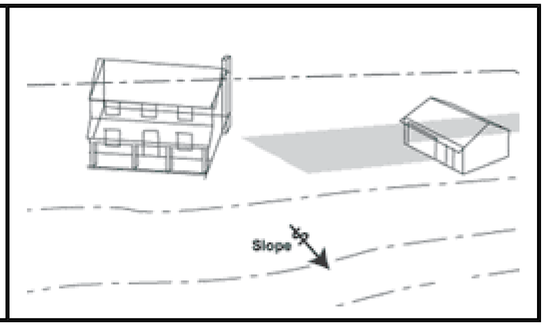
○ Yes ○ No

Submit

Review

Based on the criteria we have covered so far (domestic wastewater characteristics, isolation distances, and slope), which of the following proposed sites could usually be considered for an alternate at-grade absorption area?

- [ ] A) 4-bedroom single-family dwelling with a maximum slope of 10%
- [ ] B) Office with four employees with a maximum slope of 12%
- [ ] C) Restaurant with 120 patrons with a maximum slope of 7%



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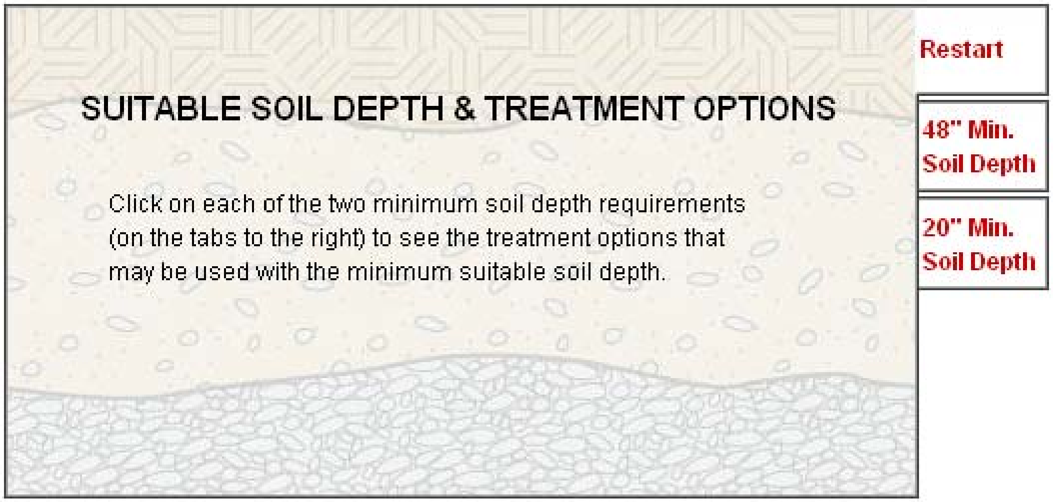
4) Minimum Suitable Soil Depth

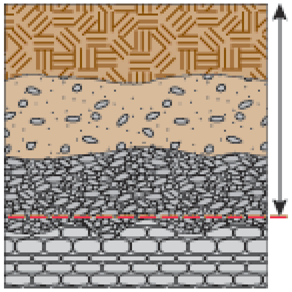
Suitable soil depth is the fourth criterion to consider for an alternate at-grade absorption area. There are two specified minimum suitable soil depth requirements. The suitable soil depth will determine the minimum primary or primary and secondary treatment options that may be used with an alternate at-grade absorption area.



4) Minimum Suitable Soil Depth

#1 -- If the minimum suitable soil depth for an alternate at-grade absorption area is ≥48 inches, then either a septic treatment tank(s) or an aerobic treatment tank may be used without any additional secondary treatment.

Section 9.A.1



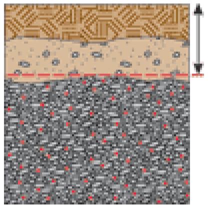
48" minimum suitable soil depth

- Septic treatment tank(s) or
- Aerobic treatment tank for primary treatment
- Secondary treatment is not required

Note: When an aerobic treatment tank is proposed for a conventional system, the regulations sometimes allow an absorption area size reduction. However, no size reduction is permitted with an alternate at-grade absorption area.

4) Minimum Suitable Soil Depth

#2 --If the requirement for a minimum 48 inches of suitable soil cannot be met, secondary treatment may be used with an alternate at-grade absorption area on sites with a suitable soil depth of at least 20 inches.



20" minimum **suitable** soil depth

- Secondary treatment option must be used

Secondary Treatment Options

A) Alternate Peat Filter

Sections 3.B and 9.A.1

Note: With the peat filter, the designer can take up to a 40 percent reduction in the absorption area size if the percolation rate falls in the range of 3 to 60 minutes per inch. However, for a new dwelling, percolation testing must document that a sufficient area exists for installation of a full-sized absorption area prior to taking any reduction.

4) Minimum Suitable Soil Depth

Secondary Treatment Options (continued)

B) Alternate Free Access Gravity Media Filter

Sections 4.A.2 and 9.A.1

C) Alternate CO-OP RFS III Filter

Sections 5.A.2 and 9.A.1

D) Alternate Recirculating Subsurface Media Filter

Sections 14 and 9.A.1

Note: Refer to the Alternate Guidance in the "job aids" for more information on these secondary treatment components listed above.

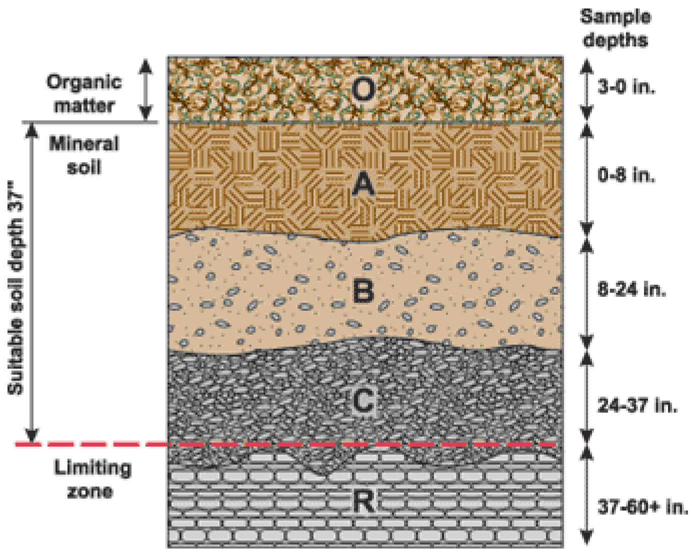
4) Minimum Suitable Soil Depth

True or False?

This soil probe will meet the alternate at-grade absorption area criteria if primary treatment is provided by two septic tanks for a commercial facility with domestic wastewater characteristics without any additional treatment.

- True
- False

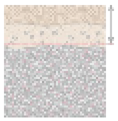
Submit

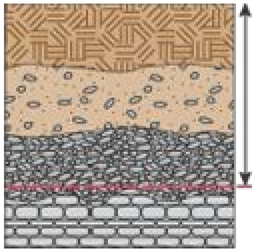


4) Minimum Suitable Soil Depth

Treatment Options Depending on Suitable Soil Available:

1. Check the primary treatment options that could be used with a minimum suitable soil depth of 48 inches.

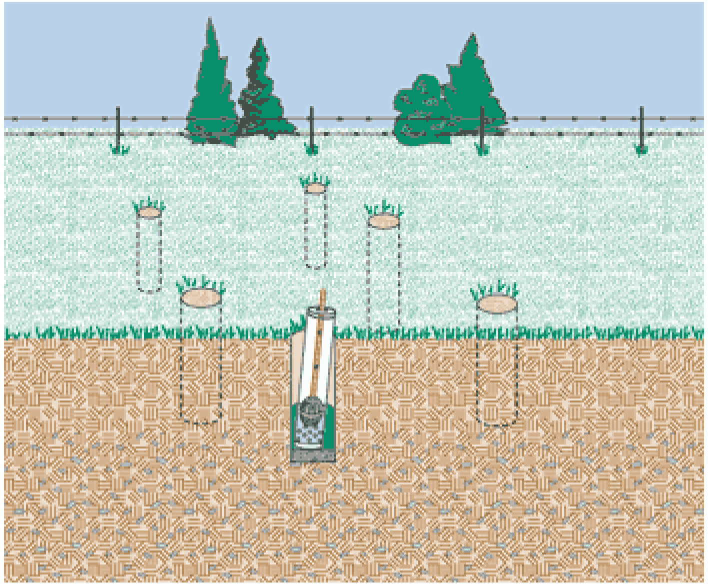




- ☐ Septic Treatment Tank(s)
- ☐ Aerobic Treatment Tank
- ☐ Alternate Peat Filter
- ☐ Alternate Free Access Gravity Media Filter
- ☐ Alternate CO-OP RFS III Filter
- ☐ Alternate Recirculating Subsurface Media Filter

5) Percolation Rate

The **percolation rate** is the fifth criterion to consider for an alternate at-grade absorption area.



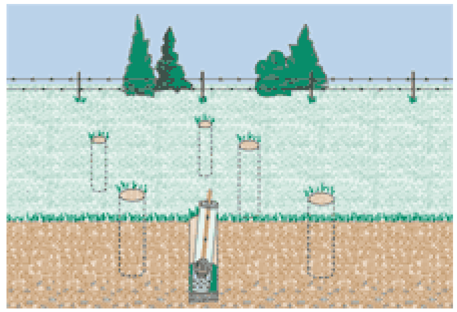
5) Percolation Rate

Section 9.A.2

At what rate must the water move through the soil to meet the alternate at-grade absorption area criteria? ***Use the Alternate Systems Guidance in the "job aids" and refer to the section reference below to find the answer.***

The percolation rate must be on or between ____ and 180 minutes per inch.

Note: When laying out the percolation test holes, remember the alternate at-grade absorption area length-to-width ratio must be a minimum of 4-to-1.



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5) Percolation Rate

SYSTEM SIZING

To size the alternate at-grade absorption area, use the "Subsurface Sand Filters and Elevated Sand Mounds" column in Table A from Section 73.16(c) of the regulations.

Section 73.16(c) Table A

Note: The minimum amount of absorption area aggregate needed for an at-grade absorption area is calculated the same way it is when a conventional sand mound bed is sized.

Lesson Review

What treatment option or options could be used to permit an alternate at-grade absorption area with the test results listed below?

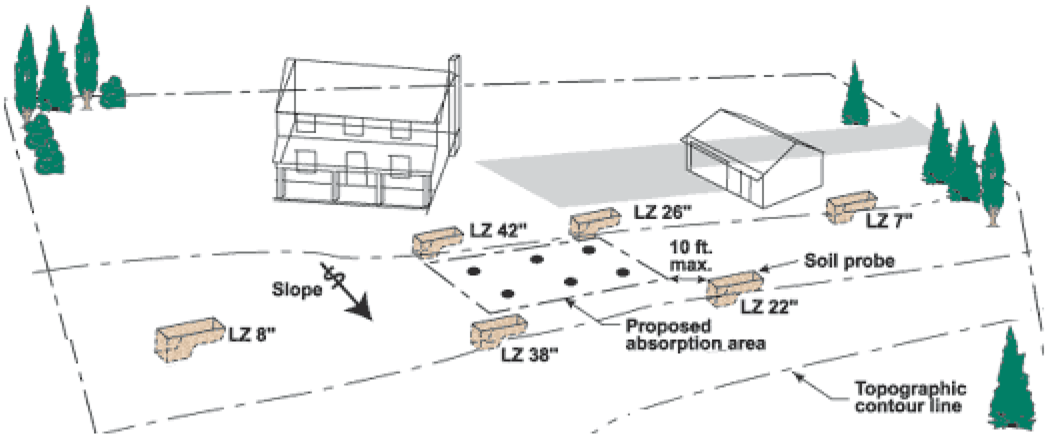
- A single-family dwelling with domestic wastewater characteristics
- Slope -- 25%
- Suitable soil -- 77 inches to rock
- Percolation rate -- 36 minutes/inch

- A) Septic treatment with no secondary treatment
- B) Alternate recirculating subsurface media filter for secondary treatment
- C) Alternate free access gravity media filter for secondary treatment
- D) Alternate CO-OP RFS III filter for secondary treatment
- E) Alternate peat filter for secondary treatment
- F) One of the test results eliminates the site for an at-grade absorption area

Submit

Lesson Summary

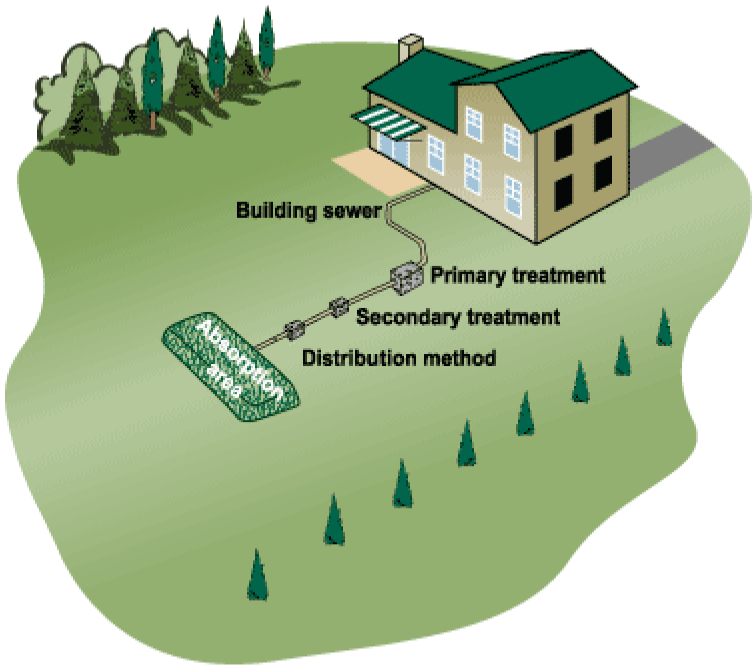
In this lesson, you have learned the criteria in the DEP Alternate Systems Guidance document for the alternate at-grade absorption area. **All of the criteria must be met before a permit may be issued for the alternate at-grade absorption area.** If you have more questions after completing this lesson or course, refer to the DEP Alternate Systems Guidance document in the "job aids."



What You Will Learn in This Lesson

In this lesson, you will review the general design criteria for components used with the alternate at-grade absorption area. The components listed below will be covered in this lesson.

- Building sewer
- Primary treatment
- Secondary treatment options
- Distribution method



Building Sewer

Section 73.21

The building sewer must meet all the requirements listed in the regulations.

Building sewer

Primary Treatment Tanks

SEPTIC TANKS

Section 73.31 If a septic tank is used as the primary treatment with the alternate at-grade absorption area, the tanks must meet all the regulations regarding septic treatment tanks.

Section 9.B.2 The guidance further requires the septic treatment tanks to be either **multiple-compartmented rectangular tanks** or **two rectangular tanks in a series.**

Round tanks cannot be used with the alternate at-grade absorption area.

Primary Treatment Tanks

AEROBIC TANKS

Section 73.32

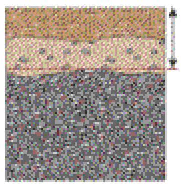
If an **aerobic tank** is used as the primary treatment tank, the aerobic tank must comply with the regulations.

Section 9.A.5

Note: When an aerobic treatment tank is proposed for a conventional system, the regulations sometimes allow a reduction in the absorption area size. However, the Alternate Systems Guidance (guidance) specifies that **no** size reduction is permitted for an aerobic tank used with an alternate at-grade absorption area.

Options for Secondary Treatment Depending on Limiting Zone

On sites where the minimum suitable soil depth is at least 20 inches but less than 48 inches, secondary treatment must be employed with an alternate at-grade absorption area.



Secondary Treatment Options

- Alternate Peat Filter
- Alternate Free Access Gravity Media Filter
- Alternate CO-OP RFS III Filter
- Alternate Recirculating Subsurface Media Filter

Note: SEOs must successfully complete this course and the DEP-approved training on a secondary treatment option before they can issue a permit for an alternate at-grade absorption area using that secondary treatment option.

Distribution Method

Sections 73.43 and 73.44

The alternate at-grade absorption area, like a conventional sand mound, must be **pressure dosed.** The regulations have requirements for the pressure distribution design that the SEO must verify before issuing a permit. Refer to the sections listed above for more information on pressure distribution.

Alternate at-grade absorption area with the distribution pipes installed.

Distribution Methods

Sections 73.44, 73.45, and 73.46

Also, like the conventional sand mound, the alternate at-grade absorption area must be pressure dosed with a **pump** or a **siphon**. The pump or siphon is sized by calculating the flow and the total dynamic head, just like you would do for a conventional elevated sand mound.

Bell Siphon

Pump

Distribution Methods

After pressure dosing the alternate at-grade absorption area with a pump or siphon, there must be at least____ feet of head at the terminal end of each lateral.

Section 73.44(b)(11)

- A) 1
- B) 2
- C) 3
- D) 4

Submit

Demand Dosed vs. Timed Dosed

A) DEMAND DOSED

In a demand-dosed system, the absorption area is dosed when there is enough effluent in the dosing tank to tip up the dosing float. When the float is tipped to the "on" position, the absorption area is dosed. This dosing method may dose the absorption area multiple times in a short period of time.

Demand Dosed vs. Timed Dosed

B) TIMED DOSED

Unlike the demand-dosed system, a timed-dosed system doses the absorption area at specific, predetermined times throughout the day. When the float in the tank is tipped to "on," the control panel is alerted that enough effluent is available to dose the absorption area. Then only when the timer signals the pump that it is time to dose and that enough effluent is available will the absorption area be dosed. This method will prevent the absorption area from being dosed multiple times in a short period of time.

The timed-dosed system is useful when water usage is high at certain times of the day and low at others. It equalizes the hydraulic loading on the absorption area and gives the soil time to rest between doses.

Lesson Review

You are reviewing a permit for an alternate at-grade absorption area design on a site with the following characteristics:

- A single-family dwelling with domestic wastewater characteristics
- Slope -- 10%
- Suitable soil -- 77 inches to rock
- Percolation rate -- 36 minutes/inch

The items listed below were taken from the alternate at-grade design. What design specification would need to be corrected before a system employing an alternate at-grade absorption area could be issued a permit for the site described above?

- A) Building sewer - Pipe 3 inches in diameter
- B) Primary treatment - Rectangular compartmented septic tank
- C) Secondary treatment - None
- D) Distribution method - Pressure distribution using a pump
- E) All items listed above meet the regulations and Alternate Systems Guidance requirements

Submit

Lesson Review

A) Building sewer

- Must meet the requirements of the regulations.

B) Primary treatment

- Rectangular compartmented septic tank, or
- Two rectangular tanks in a series must be used.

C) Secondary treatment options

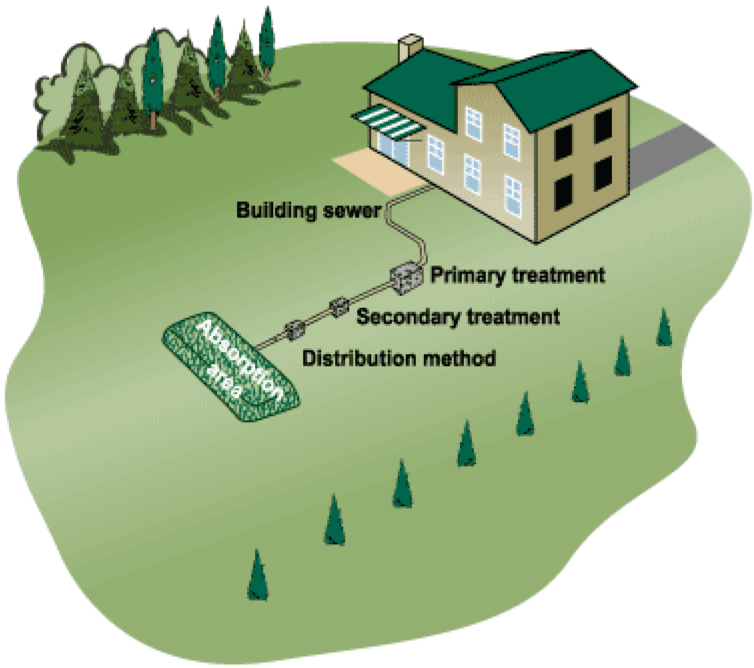
- The suitable soil depth will determine whether secondary treatment is necessary.

D) Distribution method

- Pressure distribution must be provided by a pump or a siphon.

Lesson Summary

In this lesson, you reviewed the design criteria for the building sewer, primary treatment, secondary treatment options, and the distribution method for the alternate at-grade absorption area.



What You Will Learn in This Lesson

In this lesson, you will learn about the general design requirements listed in the Alternate Systems Guidance (guidance) for the alternate at-grade absorption area. The guidance includes requirements on the items listed below.

1) Absorption area

2) Aggregate

3) Laterals

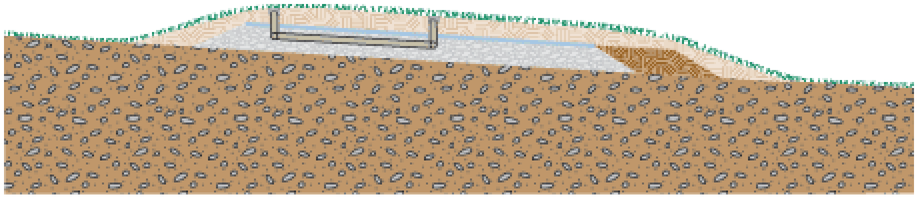
4) Berm

5) Cover material

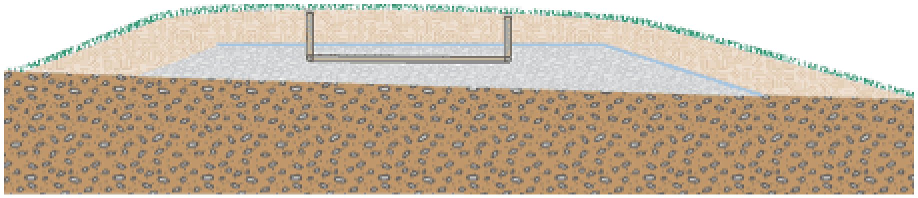
Review of Design Options

There are two design options for the alternate at-grade absorption area, **Option A** and **Option B.**

OPTION A
(Sloped)



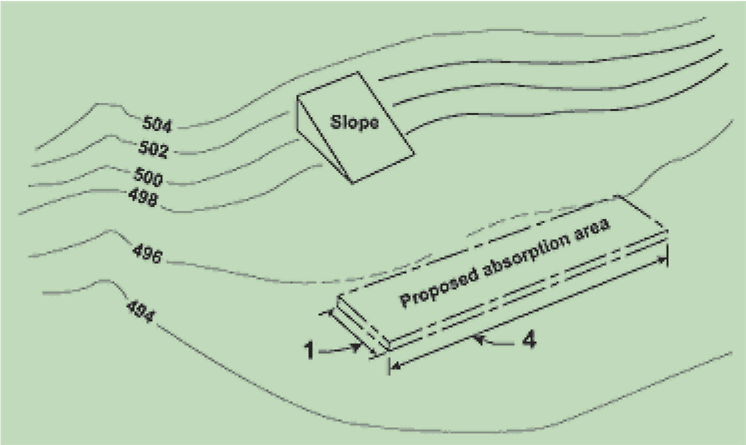
OPTION B
(Level)



The criteria covered in this lesson will apply to **both** design options. Criteria specific to Option A will be covered in the next lesson. Option B follows the same basic design criteria as a conventional sand mound bed on a slope of greater than 8 percent without the sand.

1) Absorption Area

One of the at-grade absorption area requirements is the length-to-width ratio of the absorption area. The guidance requires the absorption area to have a **minimum 4-to-1** length-to-width ratio.



1) Absorption Area

The 4-to-1 length-to-width ratio means for every foot across, the absorption area must be at least four times that long to achieve the **minimum** 4-to-1 length-to-width ratio. An absorption area with a length-to-width ratio greater than 4-to-1 is also acceptable. The absorption area cannot have a length-to-width ratio of less than 4-to-1.

1) Absorption Area

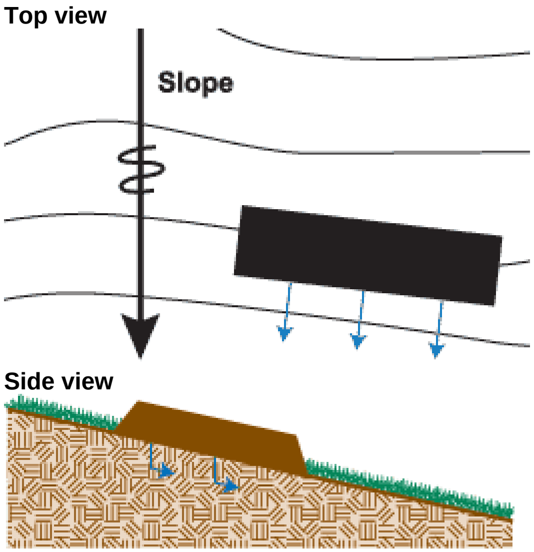
Research Theory

Keeping the absorption area long and narrow helps reduce the **horizontal linear loading rate**, giving the soil a better chance of maintaining an aerobic condition. This helps to preserve the renovative capacity of the soil. A long narrow absorption area distributes effluent along the slope, so less effluent per square foot is moving downslope. This results in a lower horizontal linear loading rate.

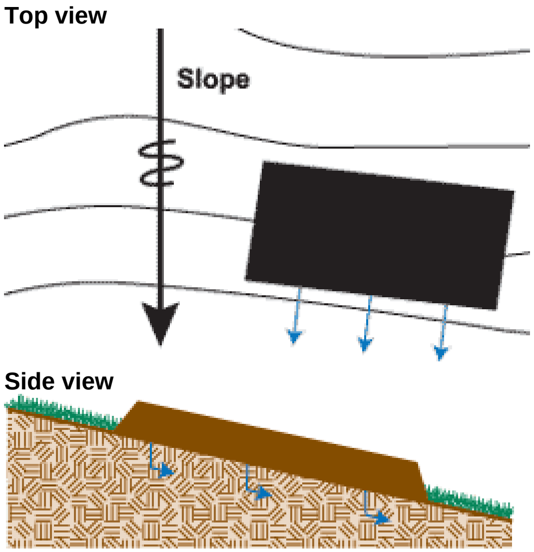
1) Absorption Area

Click on the image of each absorption area type for more information about its design in relation to the loading rate and renovation.

LONG AND NARROW ABSORPTION AREA



WIDE ABSORPTION AREA



1) Absorption Area Review

The alternate at-grade absorption area must have a minimum ___ -to-1 length-to-width ratio.

- A) 1
- B) 2
- C) 3
- D) 4

Submit

1) Absorption Area

MULTIPLE ABSORPTION AREAS **Section 9.B.1**

In some instances when the design flow is high or the percolation rate is slow, a designer may propose multiple absorption areas. However, this is not a common occurrence. The guidance prohibits "stacking" the multiple absorption areas, which means placing two absorption areas hydraulically upgradient or downgradient from each other. The absorption areas must be placed so the hydraulic loading from one does not affect the hydraulic loading of the other.

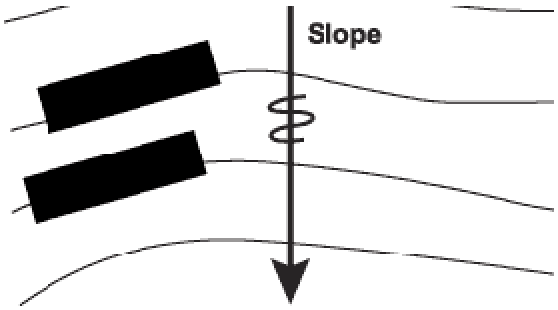
Section 73.13(c)(6)

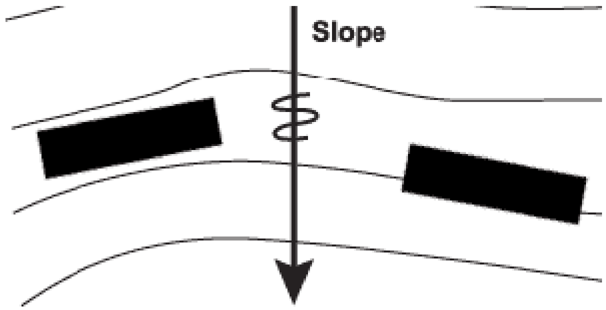
One long narrow absorption area reduces the soil linear loading rate, but if two absorption areas were placed upslope and downslope from each other, then the soil linear loading rate would increase. The absorption areas must be placed side by side along contours with at least 5 feet between the perimeter of the aggregate of the absorption areas.

1) Absorption Area

MULTIPLE AREAS REVIEW

Which configuration below would meet the guidance requirements for the alternate at-grade absorption area when two areas are being proposed?





- ◯ Configuration A
- ◯ Configuration B

Submit

2) Aggregate

Now we are going to cover the requirements for the aggregate. Three items must meet the aggregate requirements of the regulations and the guidance. These items are:

A) Specifications or type

B) Depth

C) Slope

2) Aggregate

A) SPECIFICATIONS

Section 73.51(a)

Section 7

In Section 7 of the guidance, you will find some alternate aggregate that may be used in any onlot sewage disposal system. If you are not using an alternate aggregate, you must follow the guidelines for aggregate in the regulations for a conventional onlot system.

This is a sample of aggregate that meets the regulation's guidelines.

2) Aggregate

B) DEPTH

Section 73.52

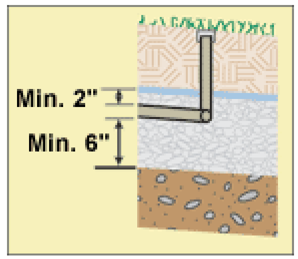
Section 9.B.3.a and b

The guidance requires the overall depth of the aggregate in an alternate at-grade absorption area to be a minimum of **10 inches**.

2 Inches - Aggregate Over Lateral
The aggregate placed over the laterals must be to a uniform minimum depth of **2 inches.**

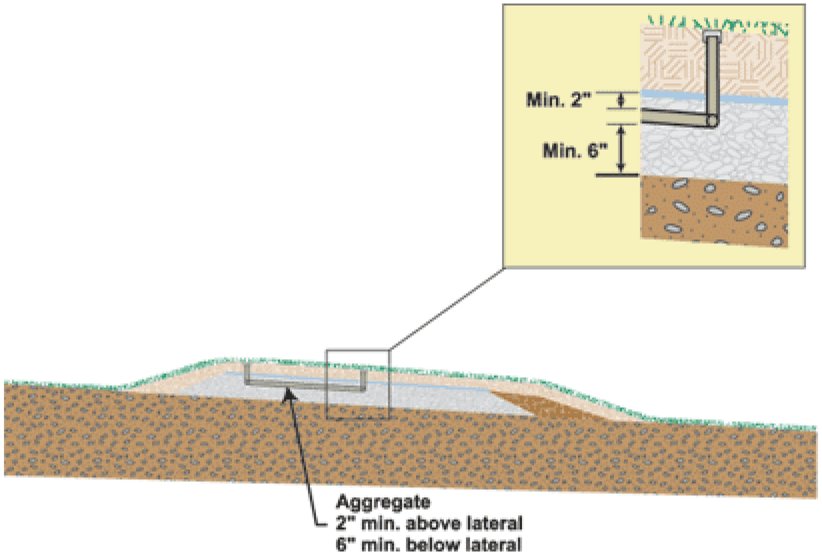
6 Inches - Aggregate Beneath Lateral
The aggregate placed under the laterals must be a minimum depth of **6 inches.**

2 Inches - Pipe Diameter
In an area that is ≤ 2,500 square feet, 2 inches of the aggregate depth will be the outside diameter of the pipe. If the area is > 2,500 square feet, the depth of the aggregate around the lateral pipe will equal the outside diameter of the pipe.



2) Aggregate

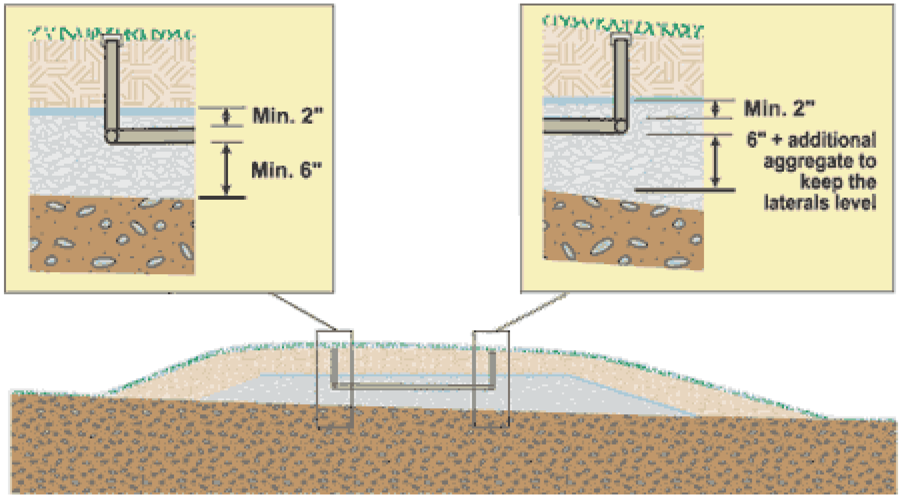
B) DEPTH FOR OPTION A (Sloped)



For Option A, there must be a minimum of 6 inches of aggregate on contour throughout the absorption area bed below the lateral pipe. The top of the aggregate will follow the contour from upslope to downslope with a constant aggregate depth of 6 inches below the lateral pipe and 2 inches above the lateral pipe.

2) Aggregate

B) DEPTH FOR OPTION B (Level)



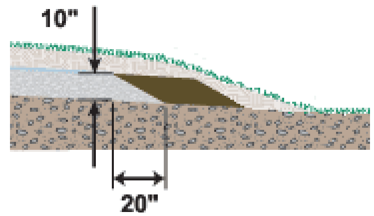
For Option B, the minimum 6 inches of aggregate is on the upslope side of the area, and additional aggregate is added below the lateral pipe to the downslope side of the area to keep the laterals level. The overall depth of the aggregate on the downslope side will depend on the slope. The aggregate is kept level on top of the area like it is in a conventional sand mound.

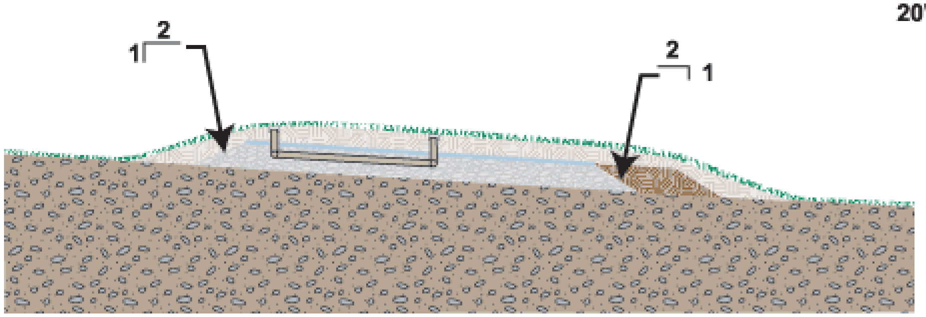
2) Aggregate

C) SLOPE

Section 9.B.4

The guidance requires the slope on all sides of the aggregate to be 2-to-1. This means, for an alternate at-grade absorption area where the aggregate is 10 inches deep, the aggregate must extend out two times that distance horizontally.





Absorption Area Option A (Sloped)

3) Laterals

Section 73.44 **Section 9.B.8**

Now let's cover the design requirements for the laterals. The guidance requires a minimum of two pairs of laterals and lateral-end cleanouts placed on the ends of the laterals. The rest of the lateral configuration must be designed in accordance with the regulations. Note that the alternate at-grade absorption area must be pressure dosed and follow the requirements in the regulations for pressure distribution.

Absorption Area Option B (Level)

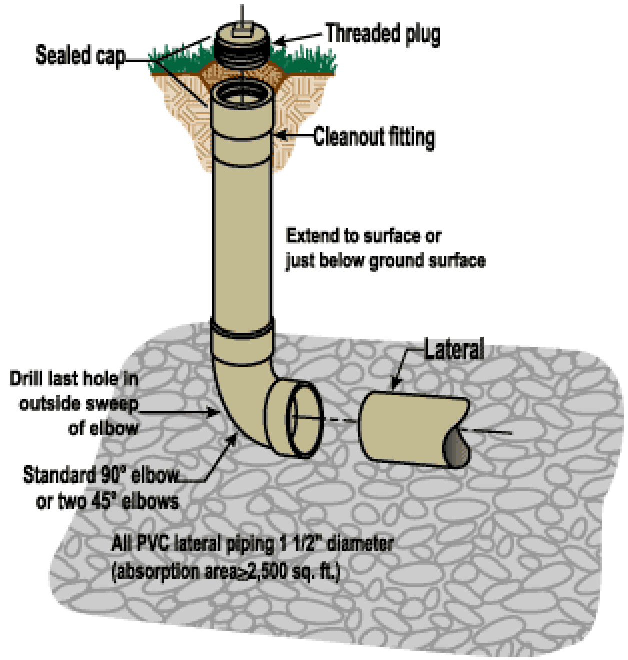
3) Laterals

CLEANOUTS

Section 9.B.8

In case of a system malfunction, the lateral-end cleanouts may be used to help determine if the cause of the malfunction is in the absorption area. The cleanouts also provide an inspection port into the absorption area.

This diagram shows a typical lateral-end cleanout.



3) Laterals

CLEANOUTS

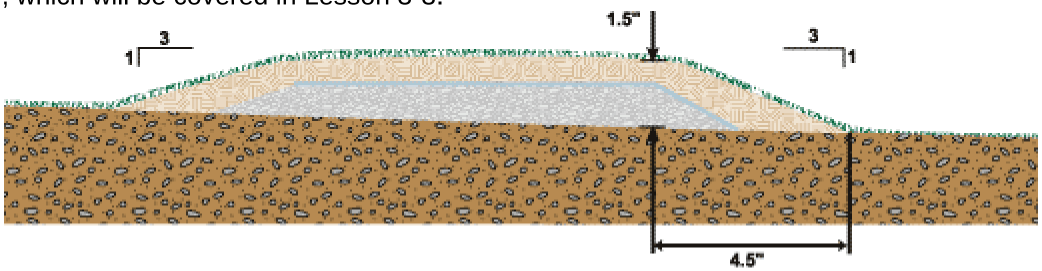
This picture shows a lateral cleanout at the terminal end of a lateral in an alternate at-grade absorption area.

4) Berm

Once the aggregate and laterals are in place, the berm material is placed around the aggregate. This material holds the absorption area in place and provides a buffer to the ground surface.

SLOPES **Sections 73.55(b)(7) and 73.55(d)(3)** **Section 9.B.5**

The guidance requires the outside slope of the berm to be no greater than 33.3%. This means for every foot deep the berm is, it must extend at least 3 feet horizontally. This outside berm slope requirement applies to both Option A and Option B. Option A requires an additional 3-foot subsoil berm, which will be covered in Lesson 3-3.



Absorption Area Option A (Sloped)

5) Cover Material

Section 73.52(b)(13)

Once the berm material is in place, the cover material is placed over the aggregate to protect the absorption area. A barrier material is also placed between the aggregate and the cover to keep the fine soil particles out of the aggregate.

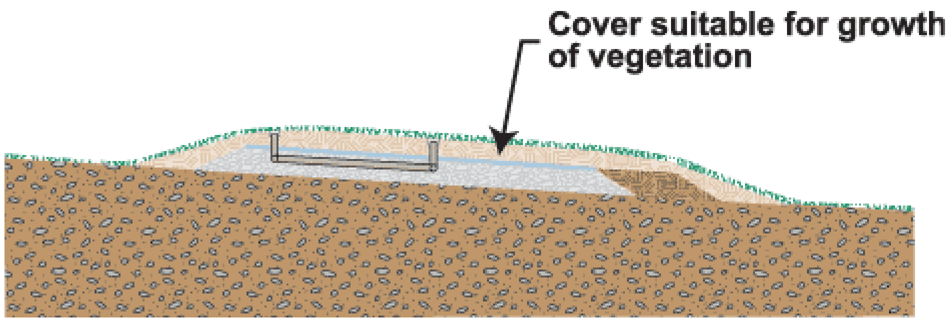
Absorption Area Option B (Level)

5) Cover Material

COVER MATERIAL CRITERIA

Section 73.52(b)(15) **Section 9.B.5**

The regulations and the guidance require the cover material to be suitable for the growth of vegetation. The berm and cover must be seeded after installation to ensure stability and protect the absorption area.



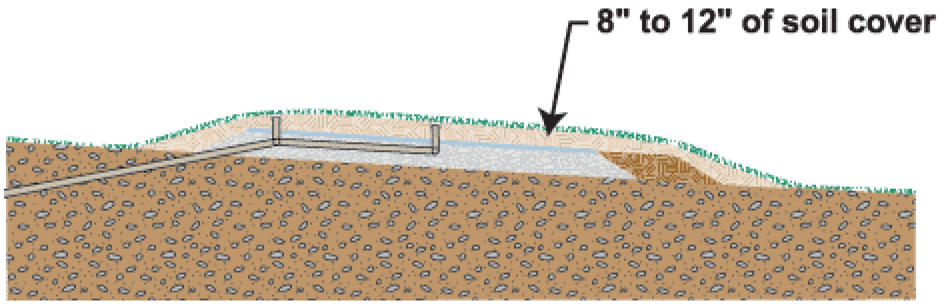
Absorption Area Option A (Sloped)

5) Cover Material

DEPTH

Section 9.B.5

The guidance requires the soil cover to be **8** to **12** inches deep over the aggregate for both Option A and Option B.



This is a diagram of Option A (Sloped).

5) Cover Material

DEPTH

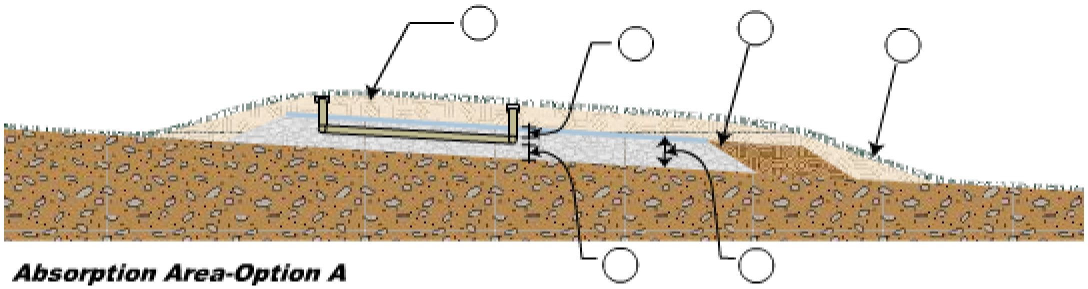
Research Theory

Research has indicated that the cover material should be deep enough to protect the absorption area but shallow enough to provide oxygen to the area. The absorption area needs plenty of oxygen to properly function and renovate the effluent.

Lesson Review

Drag the letters associated with the design numbers listed below to the correct blank on the diagram.

- **A 3-to-1 ratio**
- **B 2-to-1 ratio**
- **C 8 to 10 inches**
- **D Minimum 2 inches**
- **E Minimum 6 inches**
- **F Minimum 10 inches**



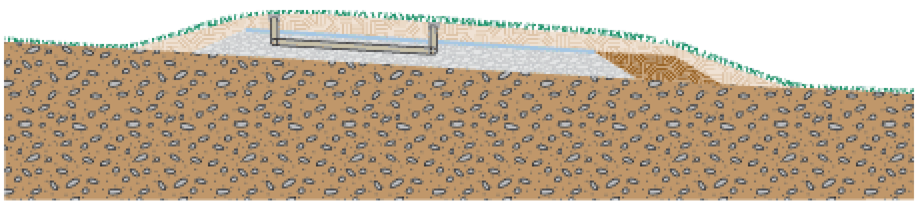
Absorption Area-Option A

Lesson Review

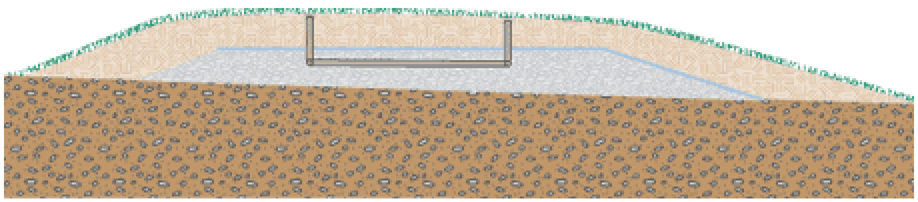
In this lesson, you learned about the general design criteria for the Option A and Option B alternate at-grade absorption area.

Criteria specific to Option A will be covered in the next lesson. Criteria not covered in this lesson for Option B should follow the same specifications, without the sand, as a conventional sand mound bed on a slope of greater than 8 percent.

Option A (Sloped)



Option B (Level)

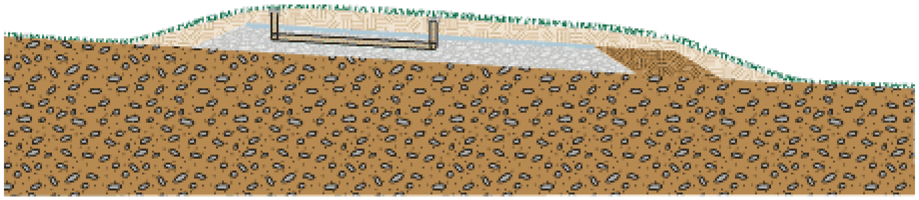


What You Will Learn in This Lesson

In this lesson, you will learn about the design criteria for the alternate at-grade **Option A** absorption area.

Advantages of Option A (Sloped) :

- Design blends easily into the landscape.
- May use less aggregate, causing the construction cost to be less than Option B.



Absorption Area Option A (Sloped)

Option A: At-Grade Absorption Area

This alternate at-grade absorption area has been seeded with grass. The absorption area blends into the landscape quite well, and if the owner wanted to put more soil around the berm, the mound could be almost hidden altogether.

.

This picture shows an Option A at-grade absorption area that has been seeded. The inspection ports and lysimeters are for research purposes.

Option A At-Grade Absorption Area vs. Elevated Sand Mound Bed

OPTION A AT-GRADE ABSORPTION AREA
A site with a 20-inch limiting zone that uses the Option A alternate at-grade absorption area will have a final minimum bed height of 18 inches.

10 inches of aggregate + 8 inches of cover = **min. 18 in. total bed height**

ELEVATED SAND MOUND BED
A site with a 20-inch limiting zone that uses the conventional sand mound bed will have a final minimum bed height of 50 inches on the upslope side of the bed. The downslope side will be greater than or equal to 50 inches, depending on the slope.

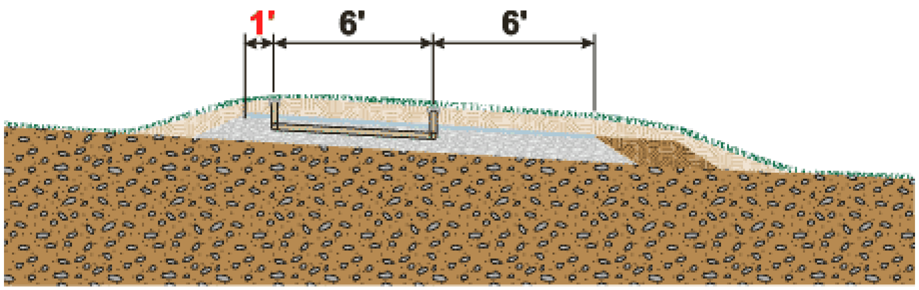
28 inches of sand + 10 inches of aggregate + 12 inches of cover = **min. 50 in. total bed height**

Option A's total absorption area height is lower, making it easy to blend into the landscape.

Laterals

UPSLOPE **Section 9.B.3.a**

The guidance requires the upslope lateral to be placed **1** foot from the upper edge of the aggregate.

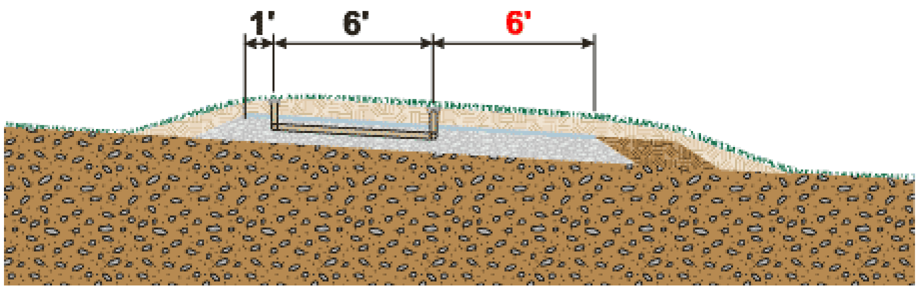


The discharged effluent will move with gravity into the soil and downslope, so there is no reason to have extra aggregate on the upslope side of the absorption area.

Laterals

DOWNSLOPE **Section 9.B.3.a**

The guidance requires the downslope lateral to be placed **6** feet from the downslope edge of the aggregate.



Gravity will push the effluent into the soil and downslope, so the extra aggregate on the downslope side of the bed provides an extra buffer to the ground surface.

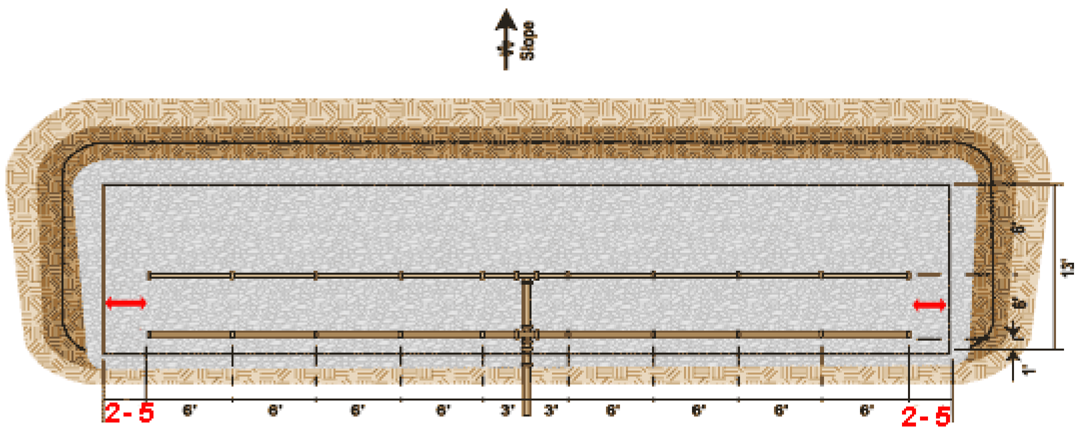
Note: The distance between the laterals may be up to 6 feet, the same as other conventional pressure dosed absorption areas.

Where Laterals Terminate

Section 9.B.3.a.

Section 73.52(b)(9)

The guidance and the regulations require all the laterals to terminate **2 to 5** feet from the ends of the aggregate.



Laterals

BALANCED APPLICATION RATE **Section 73.44(d)(3)**

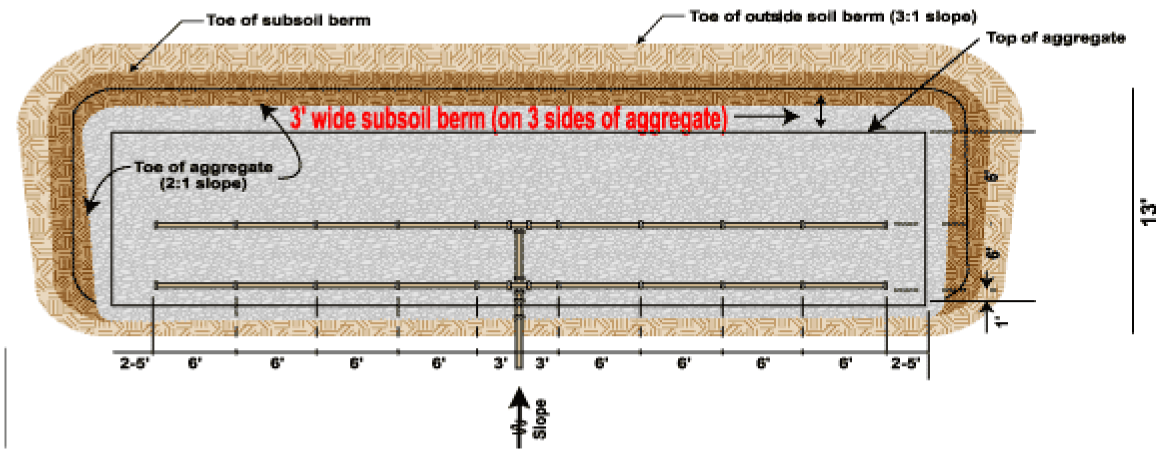
The laterals in an Option A alternate at-grade absorption area may be at different elevations due to slope. When the laterals are at different elevations, the application rate or flow from the laterals may vary. The regulations only allow the application rate to vary up to 10 percent. If the flow variation between the laterals is greater than 10 percent, the laterals must be balanced to keep the flow variation at or below 10 percent.

In the next lesson, you will learn how to determine if the flow from the laterals varies more than 10 percent. The designer is responsible for making sure the flow variation is not more than 10 percent, and the SEO is responsible for checking the design.

Subsoil Berm

Section 9.B.3.a

The design must include a **3-foot** subsoil berm around the ends and on the downslope side of the aggregate area in addition to the outside berm. A **2-to-1** slope must be maintained on the subsoil berm.

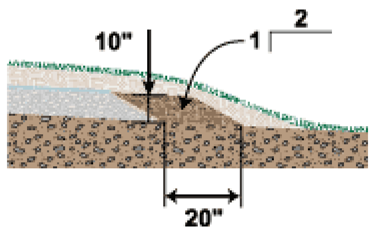


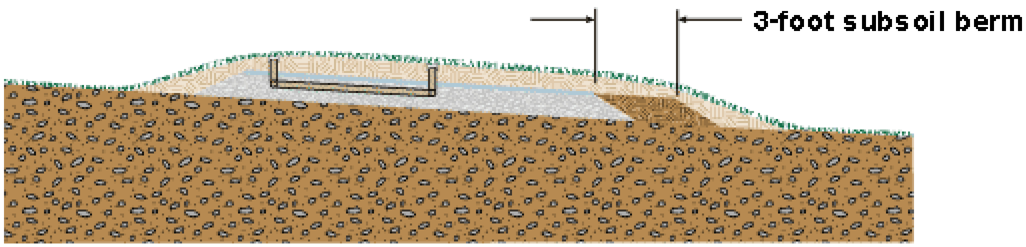
Subsoil Berm

Section 9.B.3.a

A **2-to-1** slope must be maintained on the subsoil berm.

Close-up of the subsoil berm.





Subsoil Berm

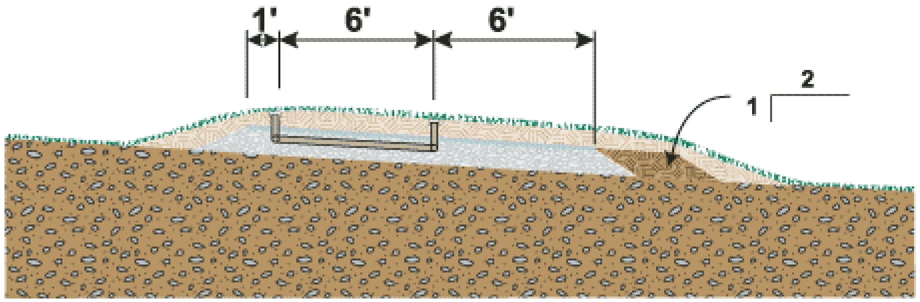
SOIL REQUIREMENTS

Section 73.55(b)(7)

The subsoil berm material must meet the regulatory requirements for berm material specified in Section 73.55(b)(7) of the regulation. The section states the material must contain less than 20 percent coarse fragments with no coarse fragments greater than 4 inches in diameter.

Lesson Summary

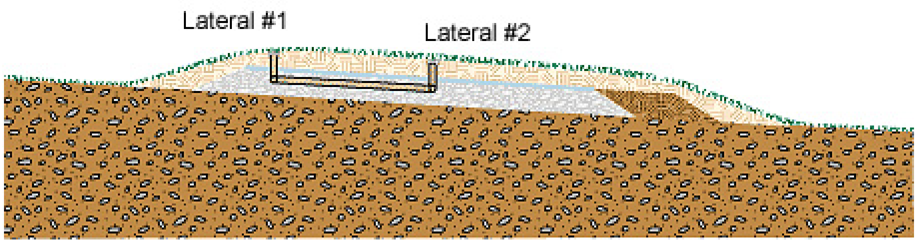
In this lesson, you learned about the design criteria for the alternate at-grade **Option A** absorption area design.



What You Will Learn in this Lesson

In this lesson, you will learn how to check the flows from alternate at-grade **Option A** absorption area laterals to see if the difference in flow between the laterals meets the requirements for this type of area.

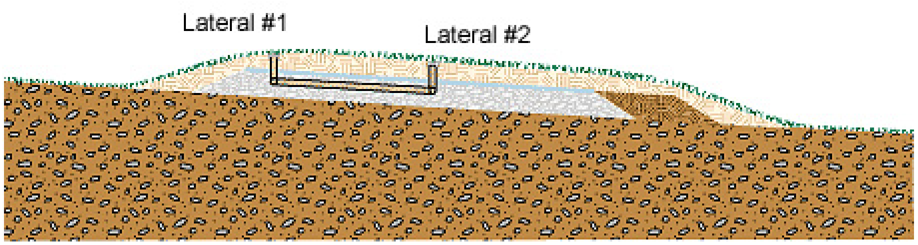
Option A (sloped)



Option A (Sloped) At-Grade Absorption Area

The Option A alternate at-grade absorption area is constructed on contour with a constant aggregate depth. This places the laterals at different elevations.

When the laterals are on different elevations, the flow may differ between the laterals. For an alternate at-grade Option A absorption area, the difference in flow between the laterals must be less than or equal to 10 percent.



Option A (Sloped) At-Grade Absorption Area

Section 73.44(d)

The flow variation between the laterals in the absorption area needs to be less than or equal to 10 percent to make sure the whole area is being used for distribution. The absorption area is sized assuming the effluent will be equally distributed over the whole area.

If the lower lateral receives more flow than the upper lateral, then the upper part of the absorption area may be underused and the lower part of the absorption area may be hydraulically overloaded.

Flow between the laterals may be equalized by adjusting the hole size or the number of holes.

SEO Responsibility

As an SEO, you will need to run through the calculations to determine if the absorption area was properly designed. If the flow variation between the laterals is greater than 10 percent, the designer must change the design so the variation is less than or equal to 10 percent before you can issue a permit.

Two things influence the difference in flow between the laterals:

1) elevation change between the laterals and

2) friction loss in the manifold.

The calculations covered in this lesson will show you how to determine the percent difference in flow using elevation change and friction loss.

Calculating Difference in Flow Between Laterals

To help you step through this lesson, we have developed worksheets to help you follow along with the math.

At this time, print out two worksheets:
1) "Worksheet-34134" will help you follow along with the example presented in this lesson and
2) "Worksheet-Lateral Flow Variation" is a blank worksheet that you can use to work through the quiz questions.

Note: Both of these worksheets are also available under the "job aids" through any of the SEO Web-based courses. You are welcome to print and use the worksheets at any time.

You will also find it helpful to have a calculator available.

Calculating Difference in Flow Between Laterals

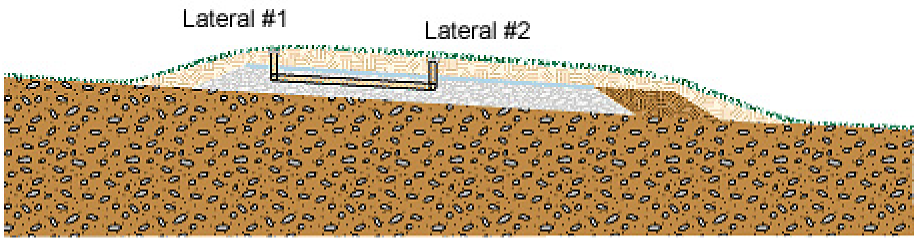
We are going to go through several steps to determine if a sample design results in a flow variation of less than or equal to 10 percent between the laterals.

To do this, we are going to determine the:
1) Operating head in the lower lateral due to elevation change
2) Total friction loss in the manifold pipe
3) Operating head of the lower lateral including elevation change and friction loss
4) Total flow for each lateral
5) Difference in flow between laterals

Please refer to Worksheet 34134 as we work through the calculations. The worksheet contains all the information you need to follow the five steps listed above.

Calculating Difference in Flow Between Laterals

So you always know which lateral is which, we will refer to the upslope lateral as lateral #1 and the downslope lateral as lateral #2. The diagram below has the laterals labeled.

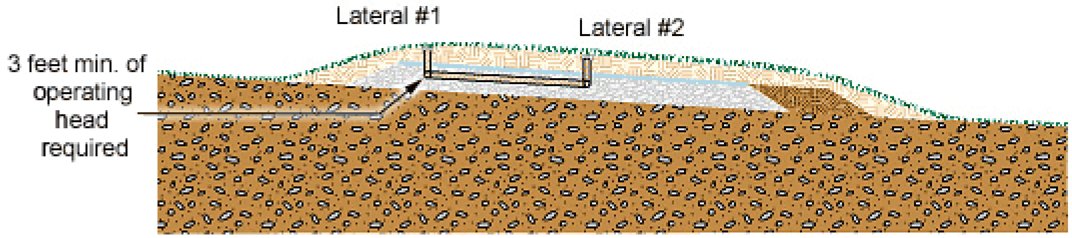


Calculating Difference in Flow Between Laterals

OPERATING HEAD

Throughout the calculations, we will be referring to operating head. When people say the system needs 3 feet of head, they are referring to the force behind the water.

The regulations state that a pressure dosed onlot sewage system requires a minimum of 3 feet of head at the terminal end of the lateral. The pump must exert enough pressure to push the effluent through the piping system and still have 3 feet of head at the terminal end of the lateral.



Designer Information

When a designer submits a design with a permit application, he or she will give you all the calculations. Your job is to make sure the calculations are correct. However, there are some given numbers assigned by the designer. The given numbers are listed below.

- % slope
- Distance between laterals
- Assigned operating head for lateral #1 (min. 3 feet by regulation)
- Hole size for lateral #1
- Hole size for lateral #2
- Number of holes for lateral #1
- Number of holes for lateral #2
- Diameter of the manifold
- Fittings in the manifold
- Length of manifold

For our sample problem, the given numbers are listed at the top of Worksheet 34134 under "Information Given by the Designer." On the worksheet, these numbers are referenced as lines G1 through G10. The "G" indicates that the numbers are "Given" by the designer.

Example and Quiz Format

The example and each quiz question will include all of the "Information Given by the Designer." We will take these numbers and run them through a set of calculations to determine if the design follows the guidance criteria or if the design must be sent back to the designer for modifications.

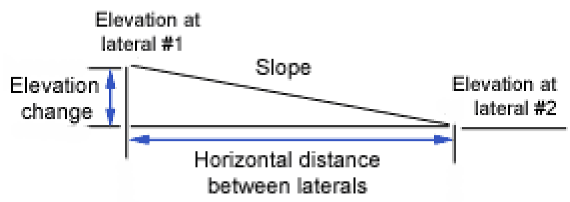
The rest of the lesson will go through the calculations step-by-step. You will be prompted to take the answers we calculate and write them on your printed copy of Worksheet 34134. This will help you follow along with the whole calculation from beginning to end.

Later when you take the quiz, the questions will be in the same format as the example. You can print additional copies of the blank worksheet to help you work through the quiz questions.

1) Operating Head in the Lower Lateral Due to Elevation Change

To calculate whether the flow between the laterals varies more than 10 percent, the first step is to determine the operating head for lateral #2 due to elevation.

Begin by calculating the elevation change between the upslope and downslope laterals. The formula to calculate the change in elevation is:

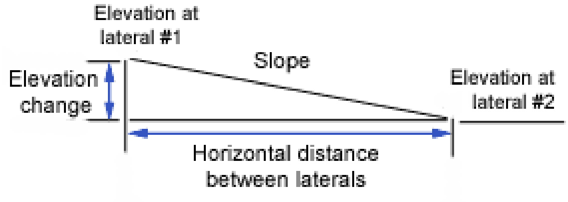


$$\text{Elevation change between upslope and downslope laterals} = \text{Slope} \times \text{Horizontal distance between laterals}$$

The slope is expressed as a decimal. For example, if the slope were 10%, you would use .10 in the formula.

The elevation change is expressed in feet.

1) Operating Head in the Lower Lateral Due to Elevation Change



Note: The designer may give you the actual field elevations for both laterals. To calculate the elevation change using actual field elevations, you would simply subtract the elevation for lateral #1 from the elevation for lateral #2.

1) Operating Head in the Lower Lateral Due to Elevation Change

EX **EXAMPLE**

Now we will begin to work through the example. Refer to the "Information Given by the Designer" on Worksheet 34134. The first three pieces of information show that the design calls for:

G1	**5%**	% slope
G2	**6 ft.**	Distance between upslope and downslope laterals
G3	**3 ft.**	Assigned operating head for lateral #1 Please copy this number to line ***1a*** of the worksheet.

We can use the slope and distance between the laterals to determine the elevation change between the laterals.

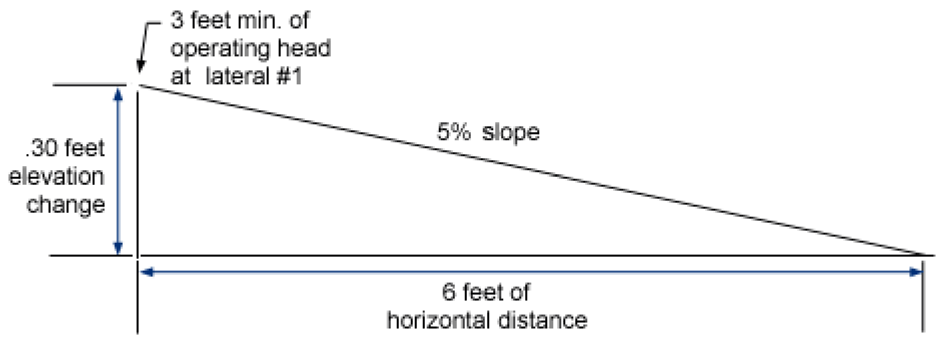
Elevation change between upslope and downslope laterals	=	.05 Slope	x	6 feet Horizontal distance between laterals	=	.30 feet Elevation change

1b	**.30 ft.**	Elevation change - Please place the elevation change on line ***1b*** of the worksheet.

1) Operating Head in the Lower Lateral Due to Elevation Change

EX **EXAMPLE**

The diagram below shows how these numbers relate to the absorption area design.



1) Operating Head in the Lower Lateral Due to Elevation Change

Next, we will calculate the operating head for lateral #2 due to the elevation change. The elevation change causes the downslope lateral to gain head.

To calculate the operating head for lateral #2 due to elevation change:

Operating head for lateral #2 due to elevation change	=	Lateral #1 operating head	+	Elevation change from lateral #1 to lateral #2

1) Operating Head in the Lower Lateral Due to Elevation Change

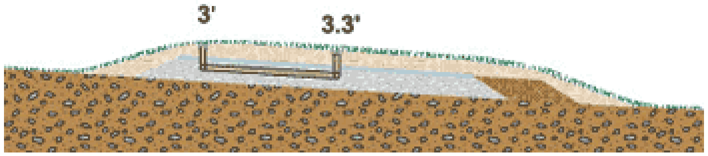
EX **EXAMPLE**

Continuing with our example, so far we know we have 3.00 feet of operating head at lateral #1 and .30 feet of elevation change between lateral #1 and lateral #2.

Using these numbers in the formula:

Operating head for lateral #2 due to elevation change	=	3.00 Lateral #1 operating head	+	0.30 feet Elevation change from lateral #1 to lateral #2	=	**3.30 feet** Operating head due to elevation change

The upslope lateral was assigned 3.00 feet of operating head, and the downslope lateral gains .30 feet of head because of gravity. This results in 3.30 feet of operating head at the downslope lateral due to elevation change.



1c **3.30 ft.** Operating head for lateral #2 due to elevation change.
Please place 3.30 feet on line ***1c*** of the worksheet.

2) Total Friction Loss in the Manifold Pipe

The second step of the calculation provides the total friction loss in the manifold. To do this, you will need to determine:

A) the flow going through the manifold pipe, and
B) the total friction loss in the manifold pipe.

We will start with the flow going through the manifold pipe.

Section 73.44(a)(3)

The flow going through the manifold pipe is the same as the flow for lateral #1. This is because the pump must be placed on the downslope side of the bed to facilitate drainage from the system back into the pump tank.

To determine the flow going through the manifold pipe, we will calculate the flow for lateral #1.

2) Total Friction Loss in the Manifold Pipe

HOW TO CALCULATE FLOW

Section 73.44(c)(3)

The regulations cite this formula to use when calculating flow:

$$\text{Gallons per minute per hole} = 11.82 \times d^2 \times \sqrt{h}$$

Parts of the formula:

11.82	a constant specified by the regulations
d	diameter of the hole in inches
h	operating head at the terminal end of the lateral in feet

The formula gives you the flow for one hole. Take the answer from the formula, and multiply it by the number of holes in the lateral to calculate the total flow in the lateral.

$$\text{Total flow in lateral} = \text{Gallons per minute per hole} \times \text{Number of holes in lateral}$$

2) Total Friction Loss in the Manifold Pipe

A) THE FLOW GOING THROUGH THE MANIFOLD PIPE

Gallons per minute per hole	=	11.82	x	d^2	x	$\sqrt{h}$

To calculate the flow through the manifold section, you will need:

a) d^2 the diameter of the hole in inches squared

b) $\sqrt{h}$ the square root of the operating head of the lateral in feet

2) Total Friction Loss in the Manifold Pipe

A) THE FLOW GOING THROUGH THE MANIFOLD PIPE

EX **EXAMPLE**

Let's try the numbers for our example problem.

G4 **1/4** Hole size for lateral #1 as given by the designer

To square ¼ inch, first change the fraction to a decimal by dividing the numerator (top number) by the denominator (bottom number):

¼ = **.25**

To square the number, multiply it by itself:

d^2 = .25 x .25 = **.0625**

Using the result in the formula for flow:

Gallons per minute per hole for lateral #1	=	11.82	x	**.0625**	x	$\sqrt{h}$

2) Total Friction Loss in the Manifold Pipe

A) THE FLOW GOING THROUGH THE MANIFOLD PIPE

EX **EXAMPLE**

The next part of the calculation requires taking the square root of the assigned operating head for lateral #1 ($\sqrt{h}$).

G3 **3 ft.** Assigned operating head for lateral #1

To calculate the square root of 3, type 3 in your calculator and press the square root button ($\sqrt{\ }$). The square root of 3 is **1.7320508.**

Gallons per minute per hole for lateral #1	=	11.82	X	.0625	X	**1.7320508**	=	**1.28 gpm per hole**

2) Total Friction Loss in the Manifold Pipe

A) THE FLOW GOING THROUGH THE MANIFOLD PIPE

EX **EXAMPLE**

Since the calculation provides you with the gpm per hole, now you need to multiply it by the number of holes to get the flow for lateral #1.

Total flow in lateral	=	Gallons per minute per hole	X	Number of holes in lateral

From the Worksheet, you can see the designer has specified 8 holes:

G6 **8** Number of holes for lateral #1

Using this information in the formula:

Total flow in lateral #1	=	1.28 gpm per hole	X	8 holes	=	10.24 gpm for lateral #1

You can round the result to two decimal places.

2a **10.24 gpm** Flow for lateral #1
Please place the answer on line ***2a*** of the worksheet.

2) Total Friction Loss in the Manifold Pipe

B) THE TOTAL FRICTION LOSS IN THE MANIFOLD PIPE

In our example, the flow needed to lateral #1 will also be the flow through the manifold. Now that you know the flow through the manifold, you have to calculate the friction loss through the manifold. The formula for friction loss is:

$$\text{Total friction loss in the manifold} = \text{Total feet of length} \times \text{Value from Head Loss Chart} \div 100$$

To help you determine the values to use in the friction loss formula, you will need to use two job aids: "Head Loss Chart" and "Fitting Equivalents." You can access these by clicking on their names on the screens in this lesson. Later, you can access them at any time by clicking on the "job aids" button and making the appropriate selection.

To use the Head Loss Chart and the Fitting Equivalents job aids, you will need two figures supplied by the designer:

G8	**2 in.**	Diameter of the manifold
G9	**1 tee**	Fittings in the manifold

2) Total Friction Loss in the Manifold Pipe

B) THE TOTAL FRICTION LOSS IN THE MANIFOLD PIPE

EX **EXAMPLE**

Total friction loss in the manifold	=	Total feet of length	X	Value from Head Loss Chart	÷	100

The Head Loss Chart gives you the head loss per 100 feet of pipe. To use the Head Loss Chart, you need to know:

2a **10.24 gpm** Flow for lateral #1 (flow through the manifold without friction loss)
When looking up values in the Head Loss Chart, always round the flow **up** to the nearest whole number. In this case, we will use a flow of **11.**

G8 **2 in.** Diameter of the manifold

G9 **1 tee** Fittings in the manifold

Using the Head Loss Chart and applying the above numbers from our example, you will see there is **.24** feet of head loss per 100 feet of pipe.

2b **.24 ft.** Friction loss in 100 feet of manifold pipe.
Please place the number on line ***2b*** on the worksheet.

2) Total Friction Loss in the Manifold Pipe

B) THE TOTAL FRICTION LOSS IN THE MANIFOLD PIPE

EX **EXAMPLE**

Next you need to determine the total feet of length that apply in your situation.

Total feet of length	=	Length of manifold pipe in feet	+	Equivalent feet of pipe for the fittings

The length of the manifold pipe is in the information given by the designer, line ***G10***. The Fitting Equivalents job aid gives you the equivalent feet for the type of fitting specified. For this example, the designer specified one "T" equivalent and a 2" pipe. From the job aid, a "T" equivalent = 11.1 feet.

2c **6.00 ft.** Length of manifold pipe - from line ***G10***

2d **11.10 ft.** Fitting equivalent. Please place this number on Line ***2d*** of the Worksheet

Total feet of length	=	6.00 ft. Length of manifold pipe in feet	+	11.10 ft. Equivalent feet of pipe for the fittings	= **17.10 ft.**

2e **17.10 ft.** Total feet of length. Please place this number on Line ***2e*** of the Worksheet

2) Total Friction Loss in the Manifold Pipe

B) THE TOTAL FRICTION LOSS IN THE MANIFOLD PIPE

EX **EXAMPLE**

You now have the information you need to solve the formula for friction loss in the manifold.

Total friction loss in the manifold	=	Total feet of length	X	Value from Head Loss Chart	÷	100

2b **.24 ft.** Friction loss in 100 feet of manifold pipe (from Head Loss Chart)

2e **17.10 ft.** Total feet of length

The head loss chart gives you the head loss per 100 feet of pipe. To get the head loss per foot, you must divide by 100. To get the total friction loss, multiply the head loss per foot by the total feet of length that apply in your situation.

Total friction loss in the manifold	=	17.10 Total feet of length	X	.24 ft. Value from Head Loss Chart	÷	100	=	**.04** feet of total friction loss

2f **.04 ft.** Total friction loss in the manifold
Please place this number on Line ***2f*** of the Worksheet

3) Operating Head of the Lower Lateral Including the Elevation Change and the Friction Loss

So far we have calculated:

✓ 1) Operating head due to elevation change
✓ 2) Total friction loss in the manifold pipe

The third step in determining if the flow between the laterals varies more than 10 percent is to calculate the operating head of lateral #2 including elevation change and friction loss.

The delivery line enters from the downslope side of the bed, so the friction loss is added to the elevation change to obtain the lower lateral operating head.

Section 73.44(a)(3)

The delivery line must enter from the downslope side of the mound to facilitate drainage of the distribution piping back to the dosing tank between doses.

3) Operating Head of the Lower Lateral Including the Elevation Change and the Friction Loss

To do this calculation, simply take the operating head for lateral #2 with elevation change (this was calculated in step #1) and add the friction loss through the manifold.

$$\text{Total operating head for lateral \#2} = \text{Operating head for lateral \#2 with elevation change} + \text{Friction loss in the manifold}$$

The head loss due to friction will operate in the opposite direction of the flow. Assuming the flow is moving upslope from lateral #2 to lateral #1, to calculate the total operating head, add the total friction loss from the manifold to the elevation change head gain (elevation change + friction loss from the manifold).

3) Operating Head of the Lower Lateral Including the Elevation Change and the Friction Loss

EX **EXAMPLE**

From our worksheet, we know:

1c **3.30 ft.** Operating head for lateral #2 due to elevation change

2f **.04 ft.** Total friction loss in the manifold

Using the formula to add the results:

Total operating head for lateral #2	=	3.30 ft. Operating head for lateral #2 with elevation change	+	.04 ft. Friction loss in the manifold	=	3.34 ft. Total operating head for lateral #2

3a **3.34 ft.** Total operating head for lateral #2
Please place the total operating head for lateral #2 on line ***3a*** of the worksheet.

4) Total Flow for Each Lateral

So far we have calculated:

✓ 1) Operating head due to elevation change
✓ 2) Total friction loss in the manifold pipe
✓ 3) Operating head of the lower lateral including elevation change and friction loss

The fourth step in determining if the flow between the laterals is greater than 10 percent is to calculate the total flow for lateral #2 using the total operating head for lateral #2.

We will use the same process and formula as we used to calculate operating head for lateral #1 in step two. Now we will determine the flow for lateral #2, allowing for the effect of elevation change and friction loss on lateral #2.

Recall that the formula for calculating flow is:

$$\text{Gallons per minute per hole for lateral \#2} = 11.82 \times d^2 \times \sqrt{h}$$

4) Total Flow for Each Lateral

EXAMPLE

Now let's run the numbers for our example.

You already know from previous work:
$d^2 = (1/4)^2 = .0625$ diameter of the holes, squared

h = 3.34 operating head at lateral #2

You need to calculate:

$$\text{Gallons per minute per hole for lateral \#2} = 11.82 \times .0625 \times \sqrt{3.34}$$

$$\text{Gallons per minute per hole for lateral \#2} = 11.82 \times .0625 \times 1.8275666 = \underline{\mathbf{1.35}} \text{ gpm per hole}$$

4) Total Flow for Each Lateral

EX **EXAMPLE**

Next, we need to multiply the flow per hole of 1.35 by the number of holes for lateral #2.

Total flow in lateral	=	Gallons per minute per hole	X	Number of holes in lateral

G7 **8** Number of holes for lateral #2 (from Worksheet)

Total flow in lateral	=	1.35 gpm per hole	X	8 holes	=	**10.80** gpm for lateral #2

4a **10.24 gpm** Total flow for lateral #1
Please copy this number from line ***2a*** to line ***4a*** of the Worksheet.

4b **10.80 gpm** Total flow for lateral #2
Please place the results of the calculation above on line ***4b*** of the Worksheet.

5) Difference in Flow Between Laterals

So far we have calculated:

✓ 1) Operating head due to elevation change
✓ 2) Total friction loss in the manifold pipe
✓ 3) Operating head of the lower lateral including elevation change and friction loss
✓ 4) Total flow for each lateral

The last step to determine if the flow between the laterals varies more than 10 percent is to actually calculate the percent difference between the flows.

The formula for percent difference between flows is:

$$\text{Percent difference between flows} = (\text{Higher flow} - \text{Lower flow}) \div \text{Lower flow} \times 100$$

5) Difference in Flow Between Laterals

EX **EXAMPLE**

From our worksheet, we know:

4b **10.24 gpm** Total flow for lateral #1

4c **10.80 gpm** Total flow for lateral #2

Using these numbers in our formula:

Percent difference between flows	=	(	10.80	-	10.24	)	÷	10.24	x	100	= **5.5 %**

You verified that the designer's 5.5% difference in flow between lateral #1 and lateral #2 is correct.

5a **5.5 %** Percent difference in flow between lateral #1 and lateral #2
Please place this number on Line ***5a*** of the Worksheet

This concludes the calculation of percent change in flow between the laterals.

5) Difference in Flow Between Laterals

For our design example, you have determined that the flow between the laterals is 5.5 percent. What should you do?

A) Continue to review the permit application.

B) Send the design back to the designer. The designer needs to balance the flow between the laterals.

Submit

Designer Tips

If you have to send the design back to the designer, listed below are some tips on how to balance the flow between the laterals:

1) Keep laterals to a minimum. Two laterals are best.
2) A larger diameter manifold pipe will influence friction loss less than a smaller one. A 2-inch diameter is generally good.
3) Smaller holes will give you smaller flows, which will influence friction loss less. 1/4 inch is the smallest hole size for a system using a pump, and 5/16 is the smallest hole size for a system using a siphon.
4) More holes will give you larger flows, which will influence a greater friction loss.

Note: Sometimes a designer may want a higher friction loss between the laterals to help achieve the 10 percent or less maximum loading variation. A pressure distribution design with different elevations will be as individual as there are people designing them.

Lesson Summary

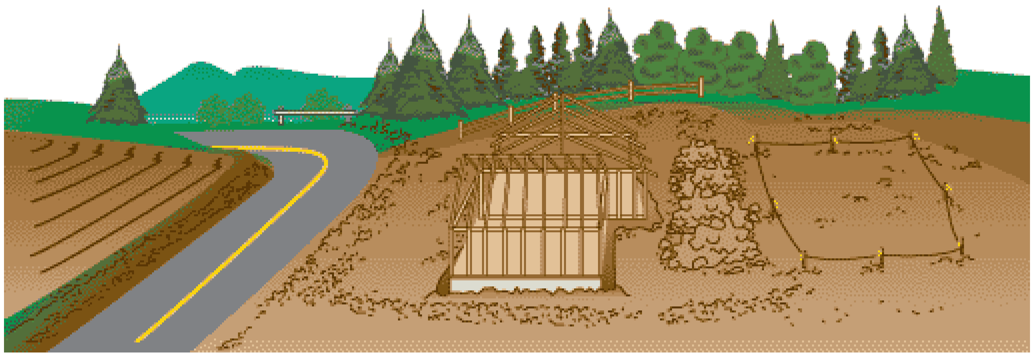
In this lesson, you learned how to determine if the flow between two laterals in an alternate at-grade absorption area is more than 10 percent.

The blank worksheet under "Worksheets, At-Grade Lateral Flow Variation" in the "job aids" is for your use in reviewing designs that have laterals at different levels.

Note: The calculations we ran through are the same type of calculations you would use to balance the flow between pressure dosed trenches.

What You Will Learn in This Lesson

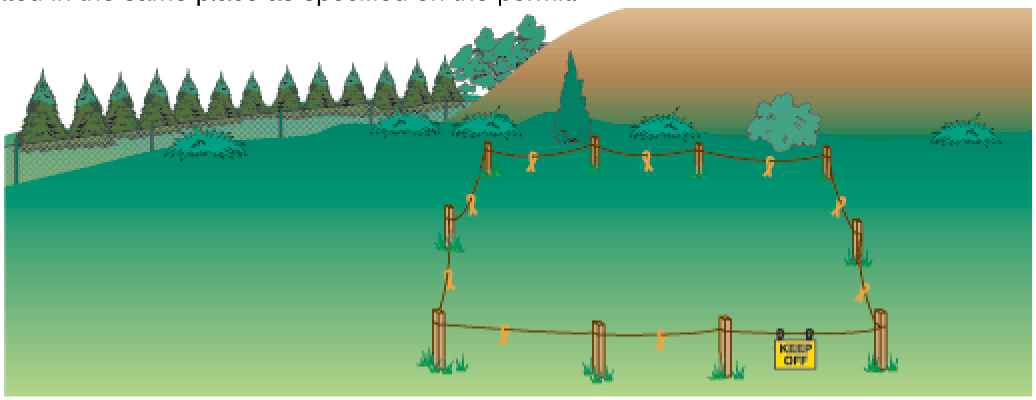
In this lesson, you will learn how to prepare the site to install an alternate at-grade absorption area. The site preparation is the same as the conventional sand mound absorption area.



Site Conditions

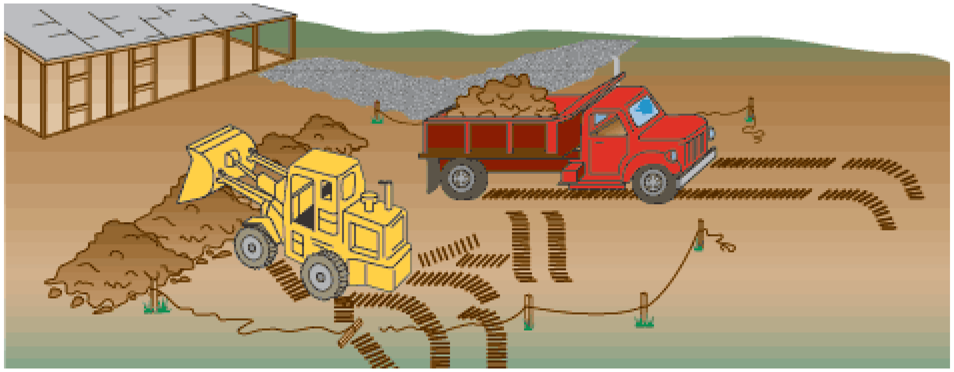
Section 72.28

As the SEO, you should check to see if the site was preserved. This means the site is in the same state as it was during testing. If anything was done to damage the site after testing, such as removing soil, driving or parking heavy equipment on the site, or stacking heavy construction materials over the area, the permit must be revoked. Also make sure the absorption area is located in the same place as specified on the permit.



Site Conditions

May an alternate at-grade absorption area be constructed on a site that had heavy equipment driven over it during the construction of the building and had top soil removed from the site?

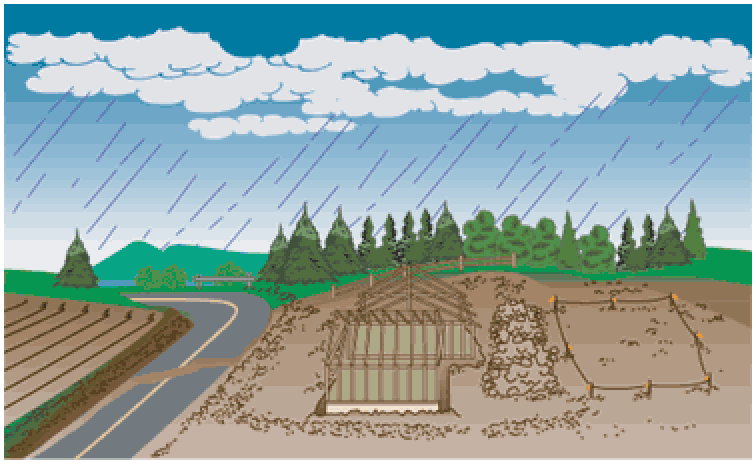


○ **Yes** ○ **No**

Submit

Site Conditions

May an alternate at-grade absorption area be constructed in wet soil conditions?



- Yes
- No

Submit

Site Conditions

SOIL CONDITIONS

Before construction is started, a test should be done to determine if the soil is dry enough to install an absorption area without compacting the soil. If the installation is done in wet soil, the absorption area may malfunction due to compaction of the soil.

The soil moisture level should be below **field capacity** at the time of construction. This is the point at which gravity can no longer pull the water out of the soil. The water left in the soil, after this point, is available for plants to use.

SOIL MOISTURE TEST

Section 73.51(c)

To determine if the soil is dry enough to install an absorption area and minimize compaction, do a simple soil moisture test to see if the soil is below field capacity.

Soil Moisture Field Test Procedures

1) Squeeze a handful of soil in one hand.

2) Open your hand.

3) Bounce the sample once lightly in your hand, or tap the soil lightly with your finger.

   a. If the sample of soil crumbles or breaks up immediately when bounced or tapped, the soil moisture should be acceptable.

   b. If the sample sticks together, construction must be postponed.

Site Conditions

SOIL MOISTURE TEST - Perform the following procedure to determine if the soil is dry enough to install an absorption area.

1) Grab a handful of soil.

2) Squeeze the soil in your hand.

3) After squeezing the soil, bounce the soil in your hand. If it breaks apart as shown in the photo above, the soil moisture level should be low enough to install an absorption area.

Site Conditions

SUMMARY

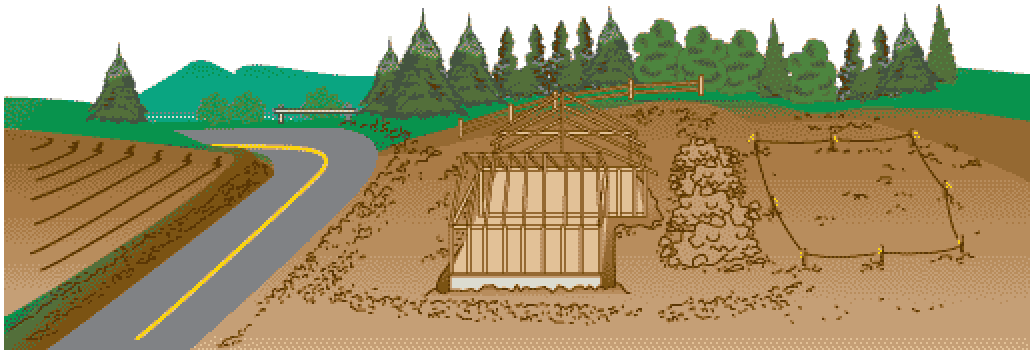
- An absorption area installed in soil that is too wet may compact the soil and cause problems down the road.
- Your job as an SEO is to make sure the absorption area is installed when the soil moisture level is below field capacity.
- The drier the soil, the better. Less moisture in the soil means less chance of compaction.

Chisel Plowing

After you determine that the moisture content of the soil is appropriate to begin, prepare the surface of the ground. The surface of the area must be chisel plowed. We will cover the importance of chisel plowing in Lesson 4-2.

Lesson Summary

In this lesson, you learned about preparing the site for an alternate at-grade absorption area installation. Remember that preparing the area by chisel plowing when the soil moisture content is below field capacity is the first key to a well-functioning absorption area for any onlot sewage treatment system.



What You Will Learn in This Lesson

In this lesson, you will learn:

- Why chisel plowing is an important construction step to help the alternate at-grade absorption area function properly.
- Why defined furrows are preferred.
- Which tool works best for chisel plowing.

An alternate at-grade absorption area being chisel plowed.

Reasons for Chisel Plowing

There are three reasons why chisel plowing is an important construction step to help any onlot sewage disposal system function properly.

1) To reduce surface compaction

2) To increase surface area

3) To help water movement

We will cover each of the reasons for chisel plowing listed above in detail on the pages to follow.

Reasons for Chisel Plowing

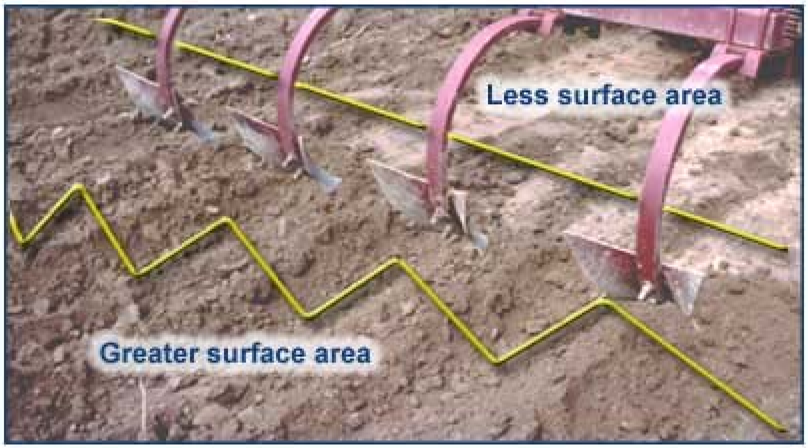
1) TO REDUCE SURFACE COMPACTION

The chisel plow breaks up the surface of the soil, which also breaks up the surface compaction. This makes it easier for the effluent to be absorbed into the soil for renovation.

Reasons for Chisel Plowing

2) TO INCREASE SURFACE AREA

The chisel plow creates furrows that provide increased surface area for the effluent to come in contact with and infiltrate the soil.



Reasons for Chisel Plowing

3) TO HELP WATER MOVEMENT

Chisel plowing increases the surface area of the soil, providing the effluent with more opportunity to move into a loosened soil interface. This results in unsaturated flow in an aerobic condition causing increased renovation.

Reasons for Chisel Plowing Review

Click on the phrase in each pair that best describes what chisel plowing does.

- [ ] Loosens the soil

or

- [ ] Compacts the soil

- [ ] Decreases surface area

or

- [ ] Increases surface area

- [ ] Inhibits water infiltration

or

- [ ] Provides better water infiltration

Submit Reset

Regulatory Chisel Plow Requirements

Section 73.55(b)(2)

Section 9.B.9

The regulations and the guidance state that the proposed absorption area must be **roughed or plowed** parallel with the **contours** of the absorption area to a maximum depth of **6** inches, using a multiple share chisel plow or similar implement attached to lightweight equipment.

Note: Rotary tilling is prohibited. Rotary tilling destroys the structure of the soil and the macropores, which reduces the soil's capacity to absorb effluent. The macropores in the soil allow liquid to quickly infiltrate into the soil. When the macropores are destroyed, the infiltration process slows, causing the effluent to move laterally.

Regulatory Chisel Plow Requirements

DEPTH OF FURROW

What is the maximum allowable depth of a furrow?

- A) 3 inches
- B) 6 inches
- C) 12 inches
- D) 24 inches

Submit

Regulatory Chisel Plow Requirements

DEPTH OF FURROW

Research Theory

The theory is that defined furrows on contour hold the effluent in place for a short period of time. This allows more time for **capillary action** to move the effluent upward, causing increased renovation. If there is no furrow, some effluent may move downslope, rather than infiltrating into the soil.

Regulatory Chisel Plow Requirements

SOIL TEXTURE

Soil texture has some influence on how chisel plowing will affect water movement. A sandy soil may have less risk of compaction, but the same procedures for chisel plowing should be followed for all soil textures.

Regulatory Chisel Plow Requirements

EQUIPMENT

The regulations specify a chisel plow or similar implement attached to lightweight equipment must be used.

The wide chisel plow blade, shown at the right, extends approximately 6 inches across and has a fine point at the tip of the plow. A plow with this type of blade minimizes compaction and **smearing**. This blade provides optimal ground surface preparation.

Note: Both compaction and smearing may reduce permeability and may reduce the renovative capacity of the soil.

Wide chisel plow blade

Comparing Equipment

CHISEL PLOW

A few chisel plow blades can easily be attached to a backhoe. The plow does not have to go on the back of a tractor. When you are trying to work around rocks and trees, this setup works well.

These two narrow chisel plow blades are attached to a backhoe.

Comparing Equipment

BACKHOE TEETH

Backhoe teeth are wide and tend to smear the soil, which can reduce the infiltration capacity of the soil.

On some sites with trees and rocks, a backhoe may be the only piece of equipment that can plow through and around the rocks and roots. If this is the case, the operator has to make short numerous bucket flips to roughen the surface. This process takes much longer, but it can do a satisfactory job with a limiting site.

If a backhoe must be used, tiger teeth are recommended.

Flat teeth

Tiger teeth

Comparing Equipment

Which piece of equipment shown below would do the best job of increasing surface area, reducing compaction, and preventing smearing? ***Rank the equipment shown below from best to worst by dragging each photo and dropping it into the appropriate spot.***

Comparing Equipment

Research Theory

It is best to use equipment that minimizes compaction and smearing of the soil. The chisel plow with the wide blade and fine point does the best job of minimizing compaction and smearing. It also creates a defined furrow to hold effluent for a short period of time.

When compaction is minimized, the effluent has a greater chance of moving down through the soil profile rather than downslope and causing a surface discharge.

Comparing Equipment

WATER MOVEMENT WHEN A CHISEL PLOW IS USED

Research Theory

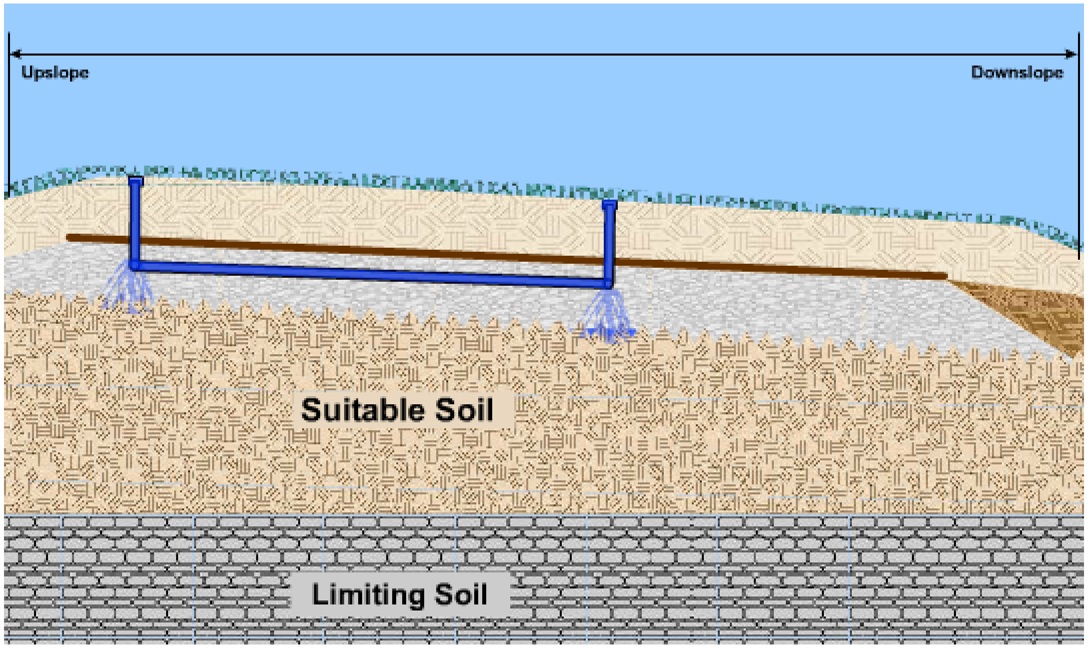
The theory is:

- Furrows will temporarily hold the effluent on contour, and
- Capillary action will pull the effluent upward and laterally through the furrow.

This gives the effluent a better chance of being in unsaturated flow, thus increasing the renovative capacity of the soil.

Comparing Equipment

WATER MOVEMENT WHEN A CHISEL PLOW IS USED



Comparing Equipment

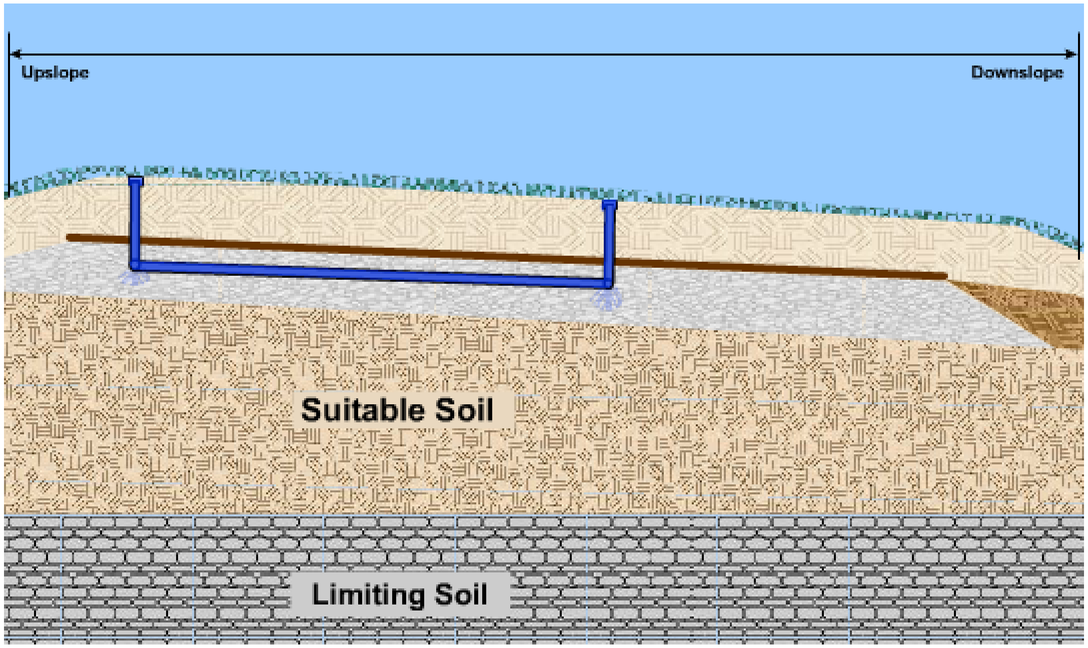
WATER MOVEMENT WHEN THE SITE IS PROPERLY CHISEL PLOWED

Research Theory

The backhoe teeth may smear the soil, and the teeth are not designed to make defined furrows to hold the effluent for a short period of time. The smearing may reduce the permeability of the soil, causing the effluent to move downslope rather than infiltrating into the soil.

Comparing Equipment

WATER MOVEMENT WHEN THE SITE IS NOT PROPERLY CHISEL PLOWED



Lesson Summary

In this lesson, you learned why chisel plowing is an important construction step to help the alternate at-grade absorption area function properly and what tools work best for chisel plowing. You also learned the regulatory requirements for chisel plowing.

What You Will Learn in This Lesson

In this lesson, you will learn about the items to check when inspecting an alternate at-grade absorption area. Remember all parts of the absorption area must be installed according to the specifications in the regulations and the Alternate Systems Guidance (guidance). As the SEO, you must inspect the entire onlot sewage treatment system to make sure it was installed according to the permit issued.

Inspections

Items are checked during the final inspection, although some items would need to be checked during an interim inspection. The **local agency** must decide what interim inspections will be required and either make them part of the application process or adopt them by ordinance.

We are now going to review a few important items to check when inspecting an alternate at-grade absorption area.

1) Chisel plow (optional interim inspection)
2) Aggregate type (final inspection) and aggregate placement (optional interim inspection)
3) Pipes (final inspection)
4) Grading and seeding (should be inspected after the approval to cover)

1) Chisel Plow

During the optional chisel plow interim inspection, check to see if the chisel plowing is:

A) On contour
B) A maximum of 6 inches deep
C) Covering the area under the absorption area and berm

2) Aggregate

A) TYPE

Section 73.51(a)

Section 7

When you are conducting your final inspection, make sure the correct aggregate was used. If the design specified an alternate aggregate, review Section 7 of the guidance for the requirements of these alternate materials. The regulations require the aggregate to meet AASHTO No. 57 requirements and be from a PADOT-certified stockpile of Type B quality.

2) Aggregate

A) PLACEMENT OF THE AGGREGATE ON THE ABSORPTION AREA

Section 73.51(b)

Prior to construction you should make sure the installer understands that it is best to not drive on the downslope side of the absorption area to prevent compaction of this area. Also explain that equipment cannot drive over the actual absorption area, and that it is best to place the aggregate from the upslope side to avoid disturbing and compacting the area downslope of the absorption area.

3) Pipes

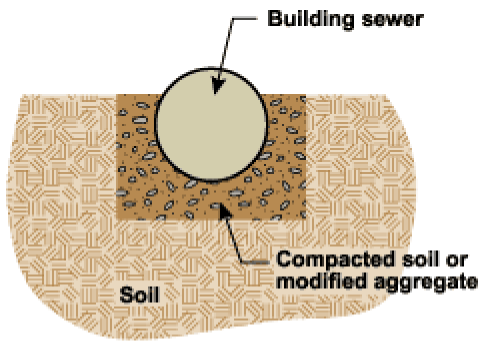
Make sure all joints are made watertight with either a mechanical seal or by gluing the pipes. When you are checking for the regulatory 3 feet of head at the terminal end of the lateral, make sure the lateral pipes and the pipes from the tank to the absorption area are watertight.

Pipes being glued

3) Pipes

During the final inspection, check to see if the building sewer pipe and other pipes are properly supported in compacted soil or modified aggregate.

Properly supported building sewer



4) Grading and seeding

After you have given approval to cover, the absorption area must be covered before the structure can be occupied. A grading and seeding inspection should be part of the permit inspection process.

An Option A absorption area that has been graded and seeded.

Lesson Summary

In this lesson, you learned a few important items to check when inspecting an alternate at-grade absorption area. Remember all parts of the system must be installed according to the specifications in the regulations and the Alternate Systems Guidance. As the SEO, you must inspect the entire onlot sewage treatment system to make sure it was installed according to the permit issued.

What You Will Learn in This Lesson

In this lesson, you will learn about how the homeowner can employ basic maintenance practices to help the at-grade absorption area properly function.

Maintaining the Absorption Area

To maintain the life of an at-grade absorption area, the homeowner should undertake two basic maintenance steps. These steps are:

1) Check the entire system for leaks and broken components once a month, and

2) Have the tank(s) pumped at least every three years.

Maintaining the Absorption Area

1) CHECK FOR LEAKS AND BROKEN COMPONENTS

The homeowner should inspect his or her onlot sewage disposal system on a regular basis. This means walking around the system and checking the ground surface over the

- Building sewer
- Treatment tank(s)
- Distribution system
- Absorption area

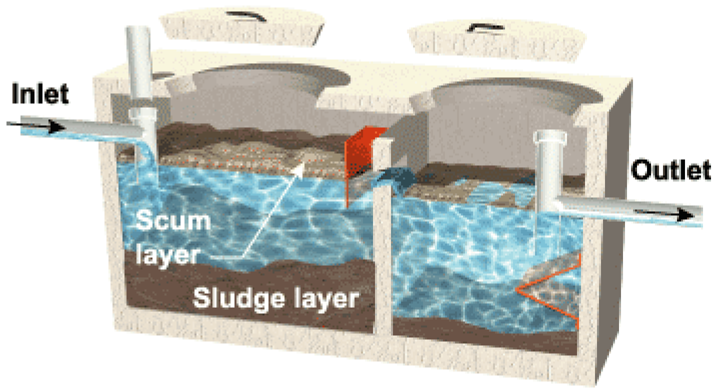
The homeowner should be looking for broken parts and wet areas. Reinforce to the homeowner that it is much easier to fix a problem in the earlier stages than later when it becomes a malfunction.

As the SEO, you should encourage homeowners to pick a day each month to do this inspection.

Maintaining the Absorption Area

2) HAVE THE TANKS PUMPED

The treatment tanks should be pumped on a regular basis. After a certain period of time, the scum and sludge layers become too thick and may allow solids to leave the tank. Solids that leave the tank may clog the absorption area. Pumping the tanks will remove these layers and prevent the solids from easily leaving the tank. Baffles and solids retainers should also be checked when the septic tank(s) is opened for pumping.



It is also recommended to have the dosing tank inspected and pumped, if needed, when the septic tank(s) are pumped.

Maintaining the Absorption Area

2) HAVE THE TANKS PUMPED

Section 71.73(b)(2)(i)

When the local agency has a maintenance program in place, the regulations require that the septage or other solids be removed from the treatment tank(s) once every three years or whenever an inspection program reveals that the **treatment tanks are filled with solids in excess of 1/3 of the liquid depth of the tank or with scum in excess of 1/3 of the liquid depth of the tank.**

Even if the system is not part of a local sewage management program, the DEP recommends that the tanks be pumped every three years.

Protecting the Absorption Area

Two important practices the homeowner can undertake every day will better help the onlot system to function properly.

1) Conserve water
2) Don't introduce hazards to the system

The system has a better chance of functioning and renovating the **effluent** if the homeowner conserves water and is careful about what is put into the system.

The next pages will explain these two items in more detail.

Protecting the Absorption Area

1) CONSERVE WATER

Conserving water is a great way to help the onlot septic system perform better. By using less water, the homeowner can avoid hydraulically overloading the system. The homeowner can conserve water by:

- Checking for and repairing leaky fixtures.
- Installing low-flow toilets and low-flow shower heads.
- Using a low-flow washing machine.
- Turning off running water (while brushing teeth, washing dishes, etc.).

These are just a few items that could help reduce waste flow from the structure. The more water conserved, the better.

Protecting the Absorption Area

2) DON'T INTRODUCE HAZARDS TO THE SYSTEM

Because onlot septic systems are "alive," a **biological mat** in the absorption area is constantly decomposing and treating raw sewage. This mat is extremely sensitive to pollutants that it is not able to treat. The septic tank also contains microbes that are sensitive to pollutants. Therefore, the homeowner should avoid placing any hazards down the drain that may disrupt the natural breakdown of sewage.

These hazards are listed on the next page and are in the "job aids" under "Hazards to a Septic System." You can print out copies of the handout in the "job aids" and share it with homeowners.

Protecting the Absorption Area

HAZARDS TO ONLOT SEWAGE TREATMENT SYSTEMS

This list contains just some hazards to onlot septic systems; many other hazards are not listed here.

- Oils and grease
- Harsh drain cleaners
- Pesticides
- Paints and thinners
- Disposable products, including sanitary napkins and diapers
- Paper towels
- Plastic products (children's toys, product wrappers)
- Septic tank additives/cleaners (These items are not needed and may harm the system's plumbing and/or biological mat.)
- Bones, eggshells, or coffee grounds
- Laundry detergents with high-sudsing elements

Note: Eliminating these items from the waste stream may help to increase the life of the onlot sewage treatment system.

Lesson Summary

In this lesson, you learned how maintaining the entire onlot sewage system will help an at-grade absorption area to function properly and last longer.