The Spartan Cap Athletic Field System

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High School Athletic Field

- Sports and community events
  - Football
  - Lacrosse
  - Soccer
  - Cheerleading
  - Marching band
  - Rugby
  - Track and field

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Native Soil Athletic Fields

- High in silt and clay
  - Advantage
    - Stable when dry
  - Disadvantage
    - Low infiltration rates

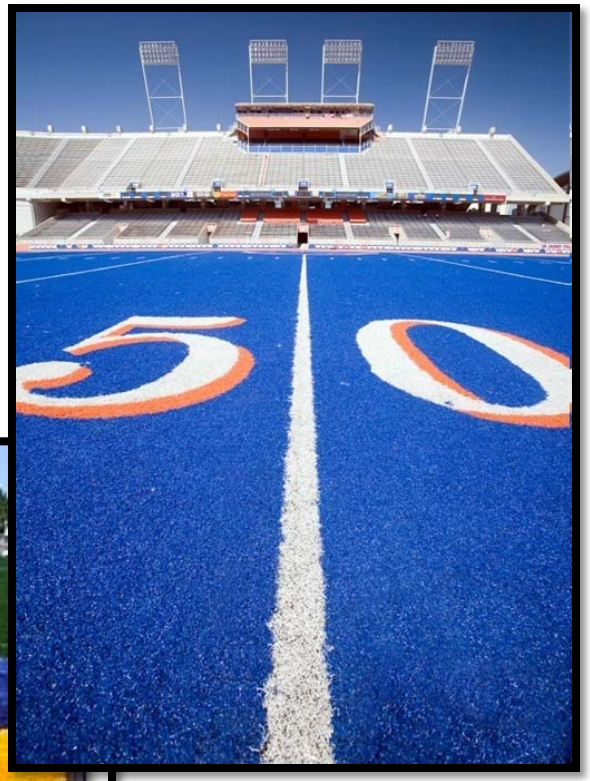
During Heavy Rainfall

- Saturated field conditions
  - Decrease soil stability


Haslett, Mich., Nov. 2006

Solutions

- Complete field renovation
  - Synthetic athletic field
    - $600,000 - 1,000,000

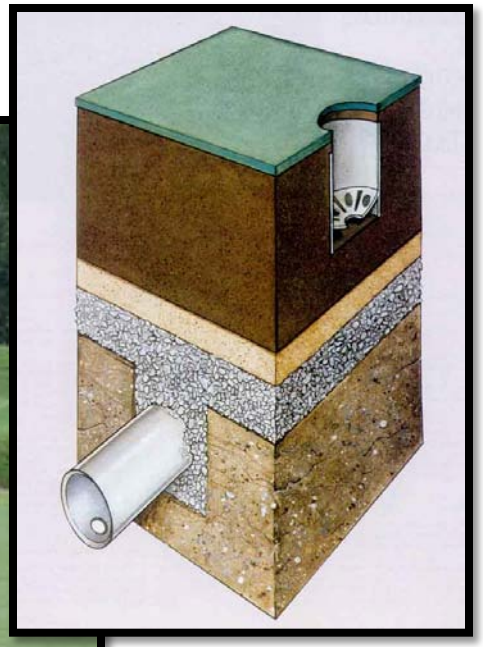


Complete Field Renovation

- Sand-based systems
  - Natural playing surface
  - Rapid infiltration rates
  - Maintain stability during periods of heavy use

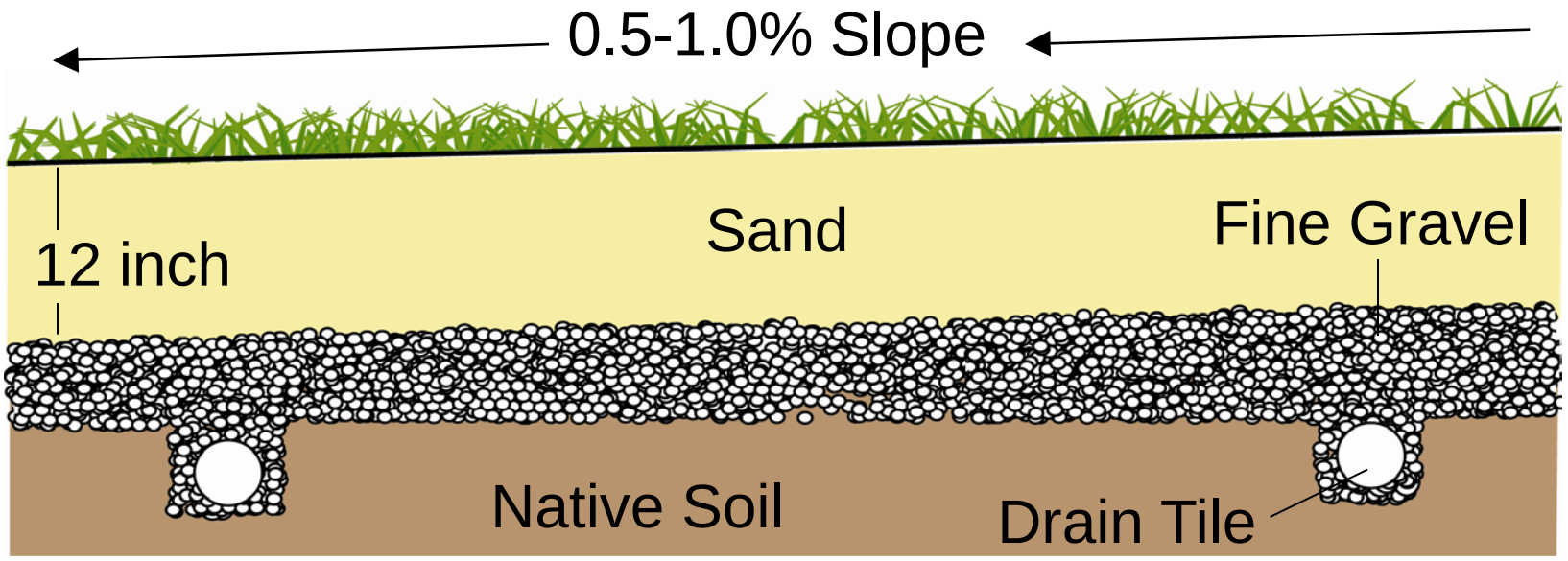
Sand-based Systems

- United States Golf Association (USGA)
  - USGA Green Section Staff, 1960



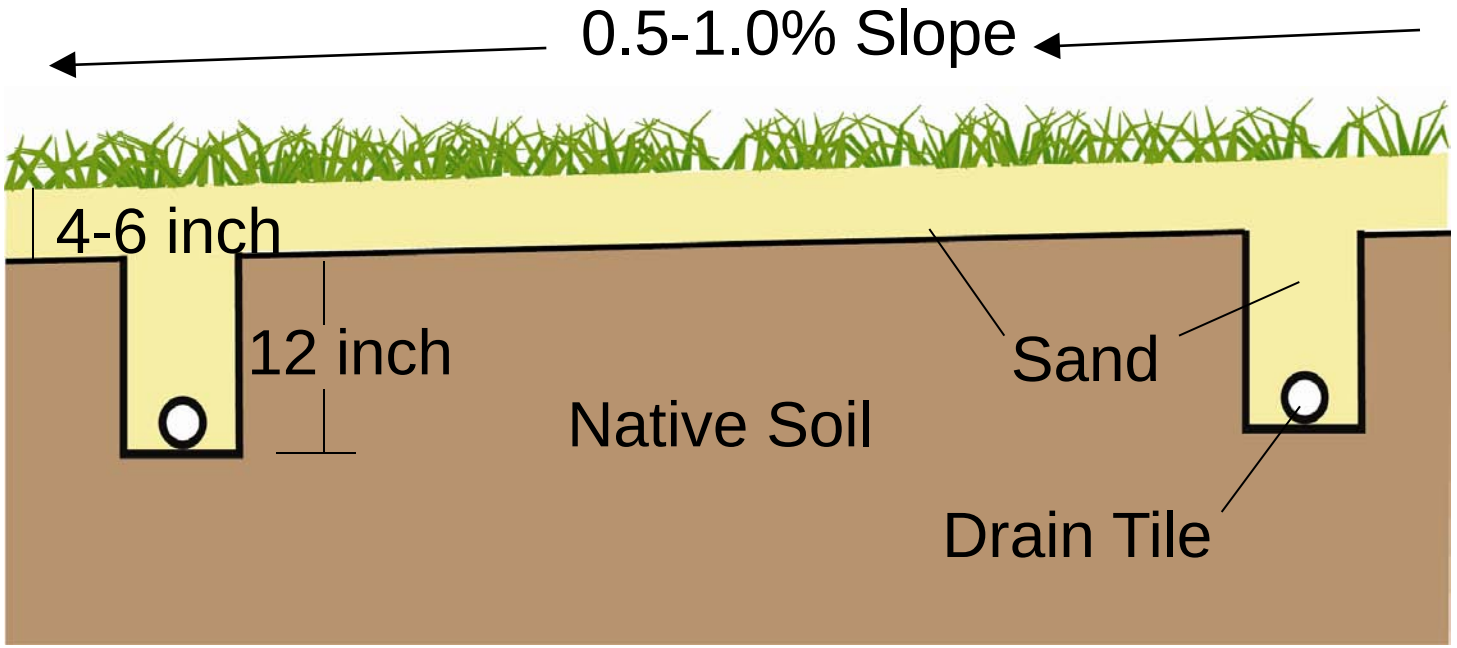
Sand-based Systems

- Conventional sand-based field
  - $400,000 - 600,000



Sand-based Systems

- Sand-capped system
  - $200,000 - 300,000



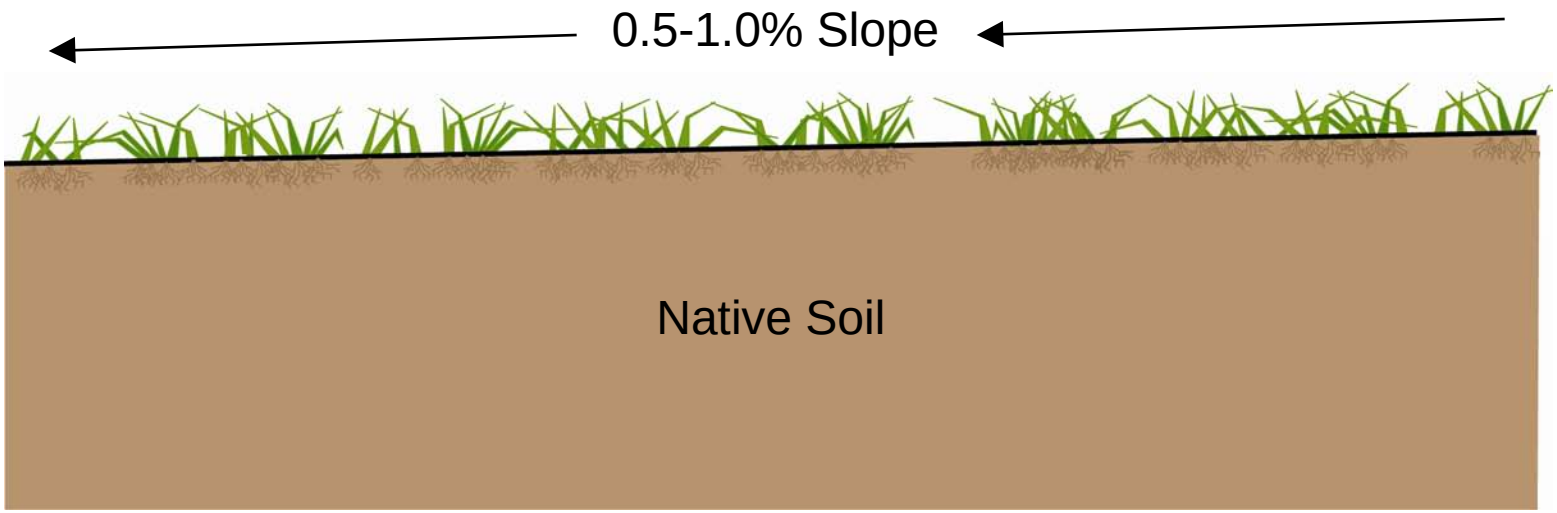
Complete Field Renovations

- Expensive
- Field temporarily useless

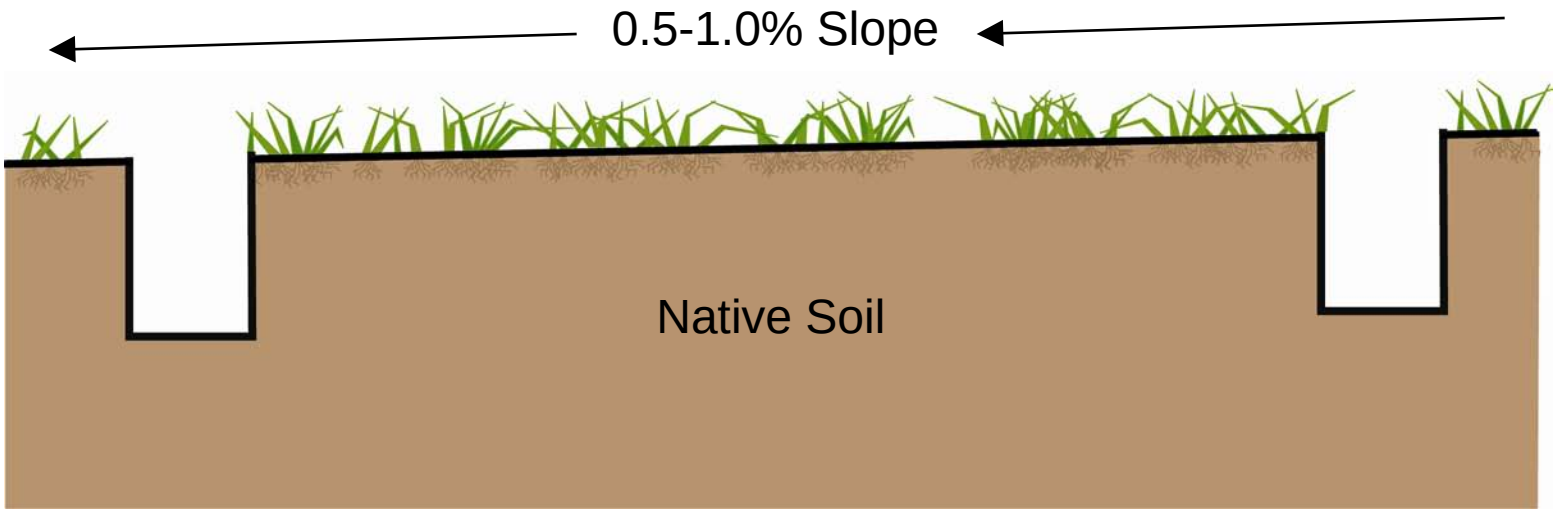
Alternative Renovation Process

- Intercept drain tile installation
- Cumulative topdressing
  - Built-up sand-capped system
    - Spartan Cap System

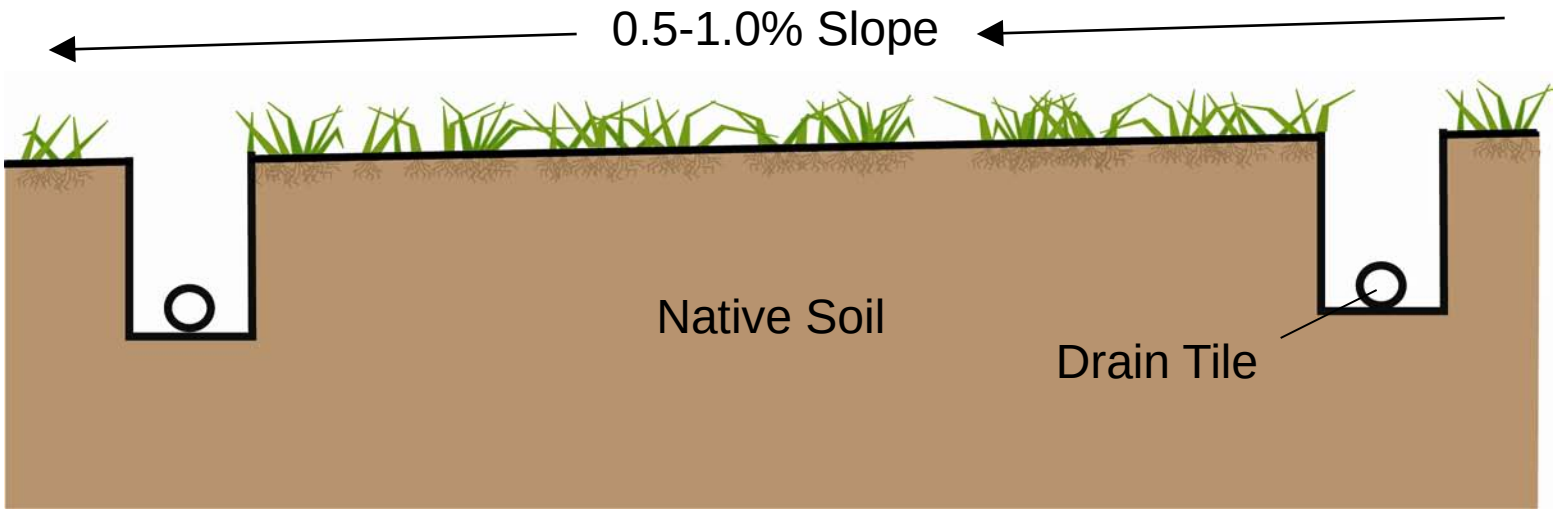
Native Soil Athletic Fields



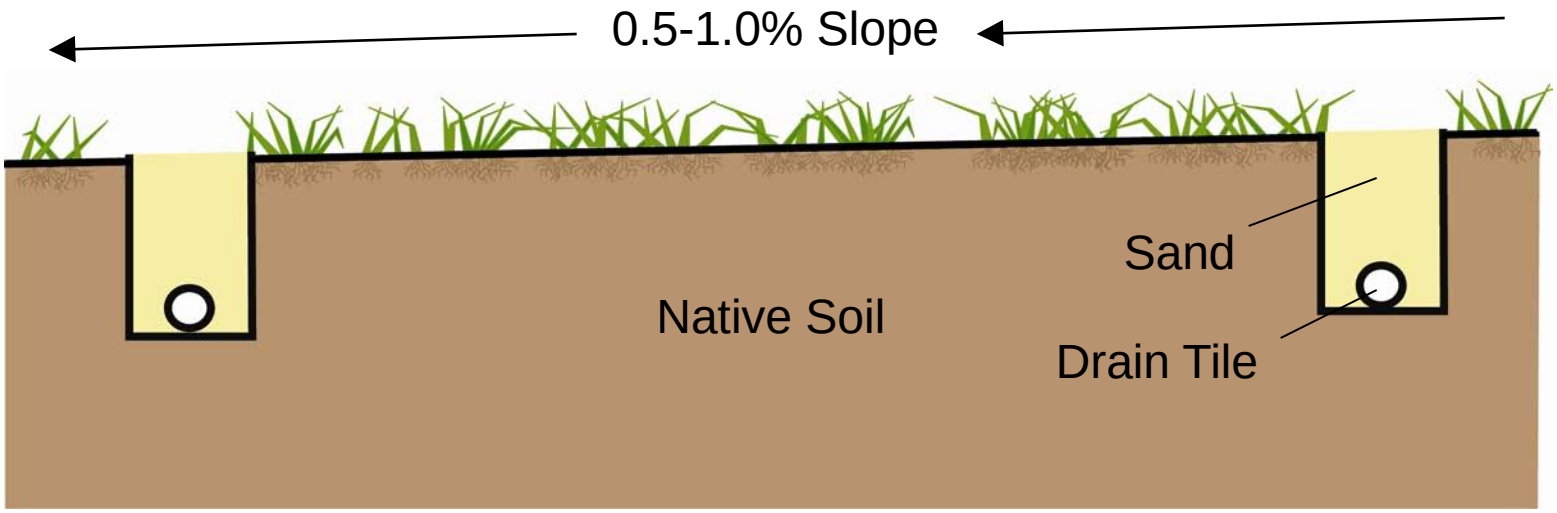
Cut Drain Lines



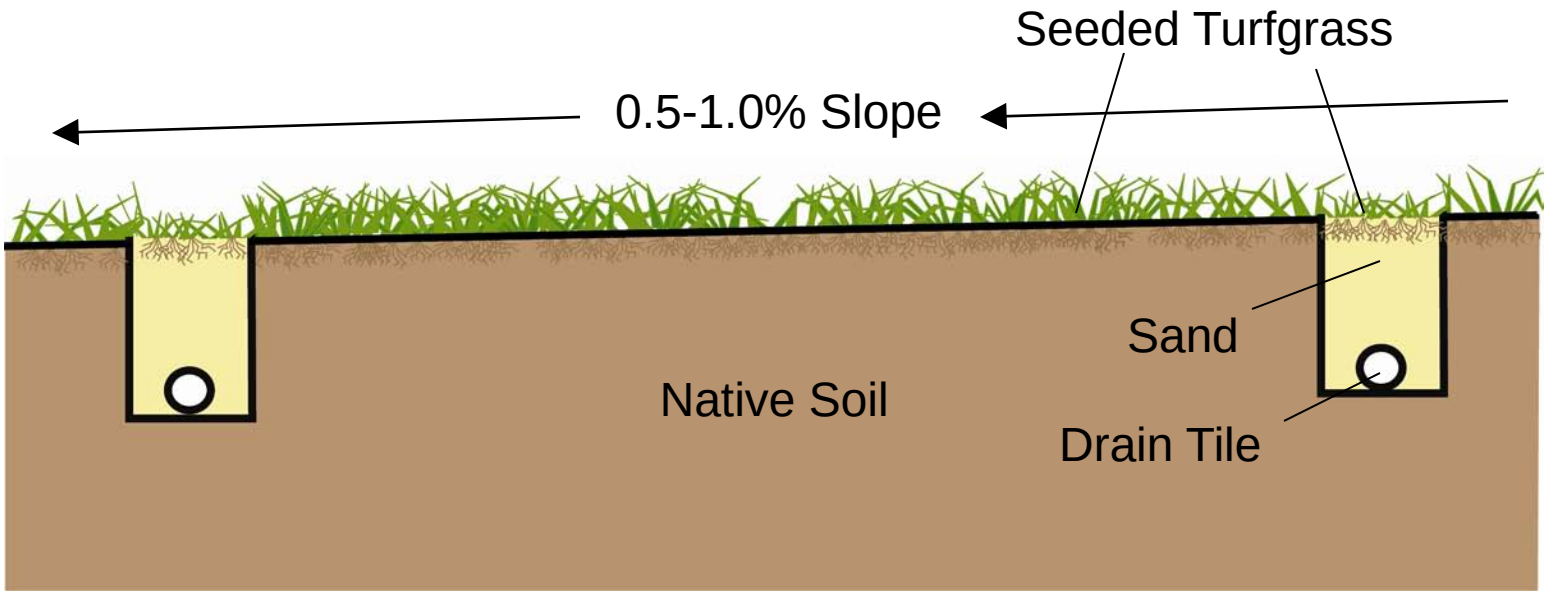
Install Drain Tiles



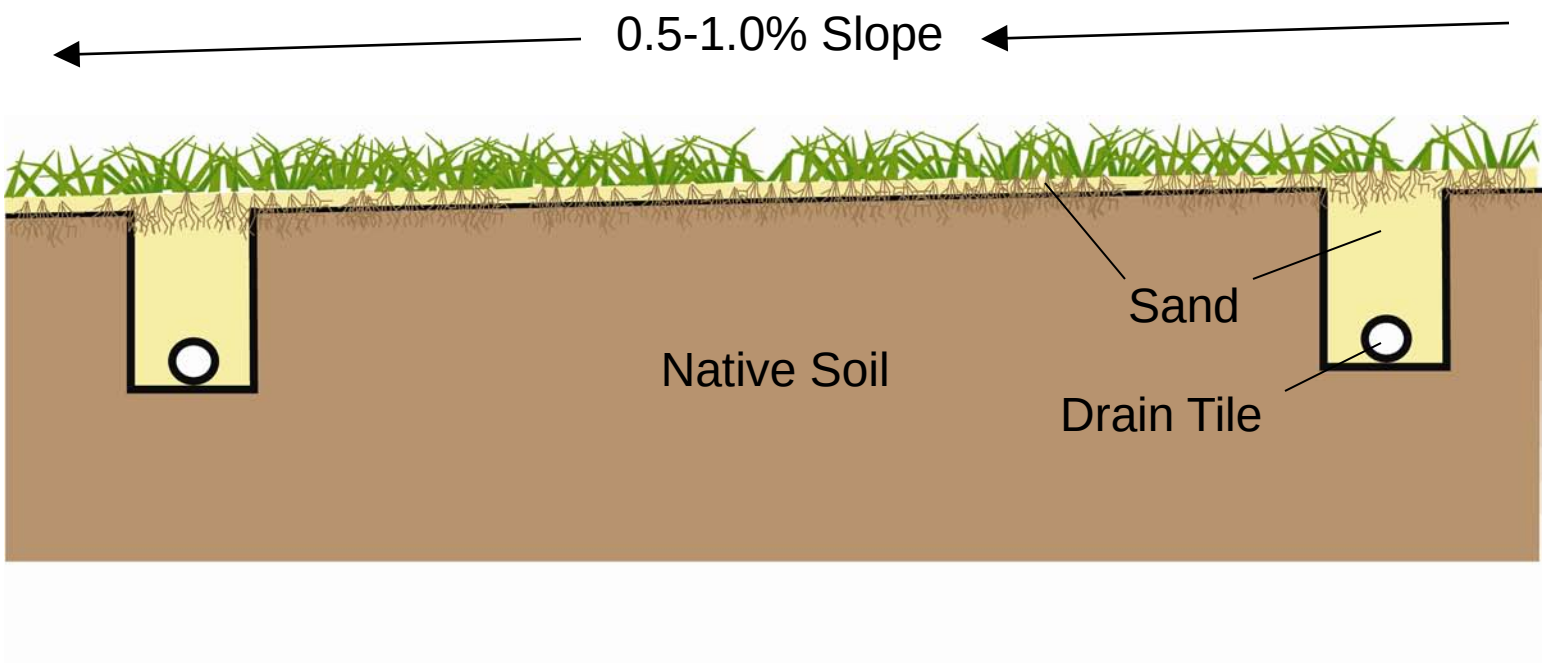
Fill Drain Lines with Sand



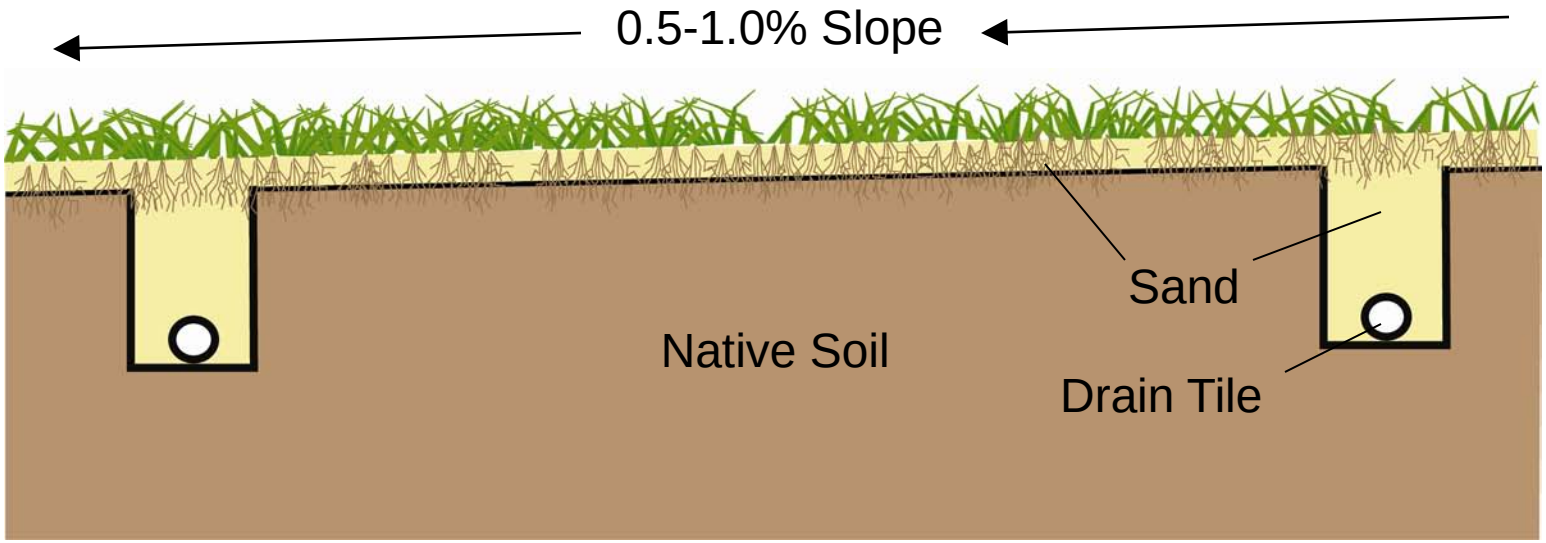
Inter-seed



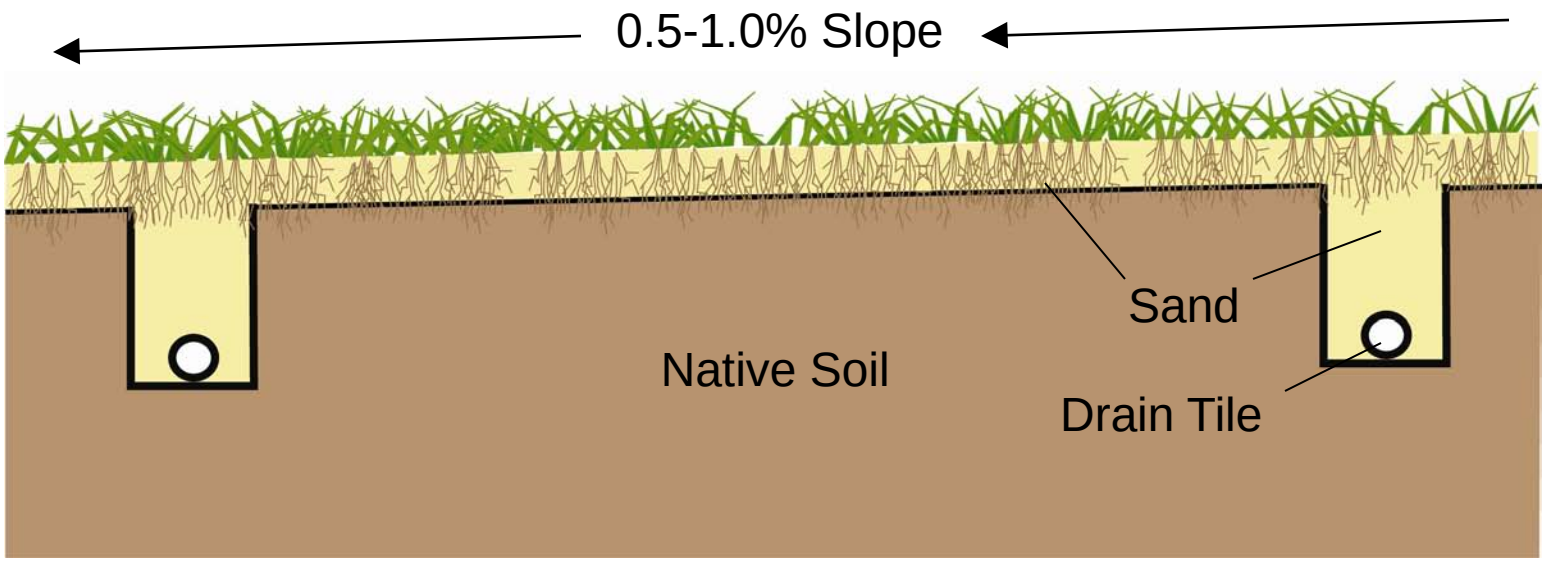
Sand Topdressing #1



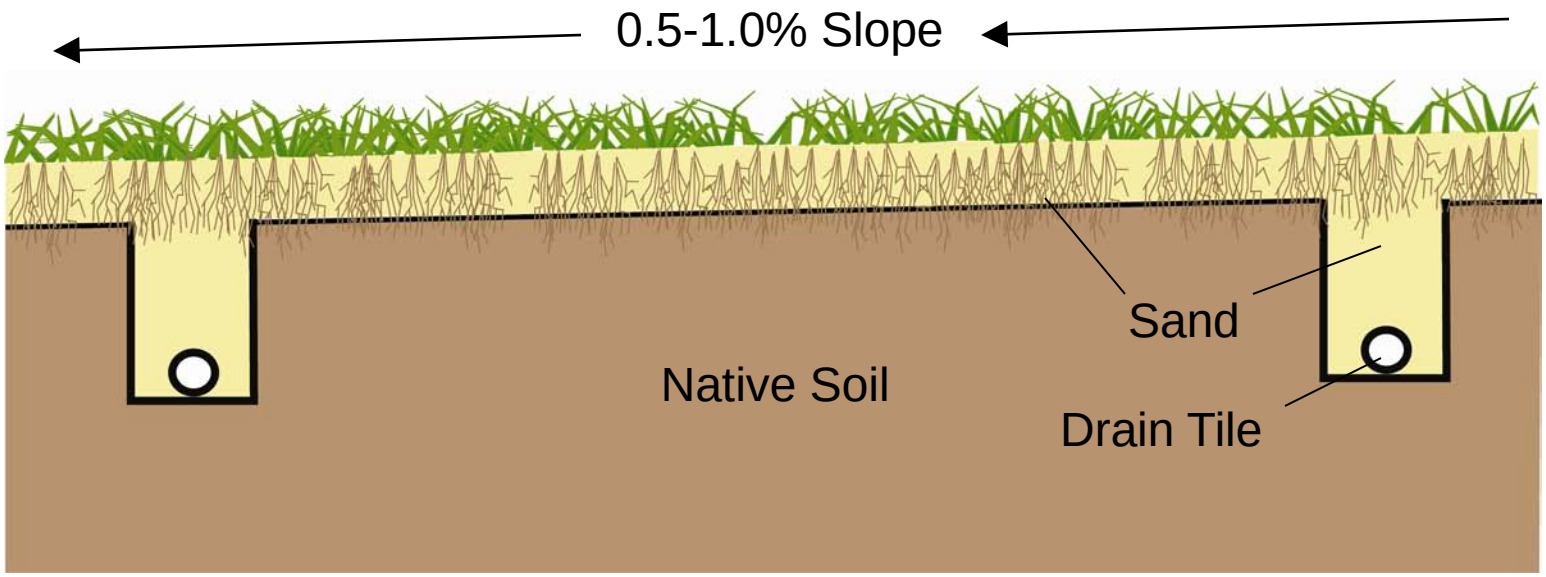
Sand Topdressing #2



Sand Topdressing #3



Sand Topdressing #4



Spartan Cap System

- Benefits
  - Field is never totally out of play
  - Reduced installation cost

Spartan Cap System

- Synthetic field
  - $600,000 - 1,000,000
- Conventional sand-based system
  - $400,000 - 600,000
- Sand-capped system
  - $200,000 - 300,000
- Spartan Cap System
  - $144,800 – 156,000

Spartan Cap System

- Irrigation system
  - $15,000
- 6.5 ft drain tile spacing
  - $44,800-56,000
- 6 inch sand topdressing
  - $85,000

- Local professionals
  - Country Club Turf, Jackson, MI
  - Water Management Co., Mason, MI
  - J.W. Surge Inc., Muskegon, MI

Questions

- How many annual topdressing applications can be made?


Walnut Hills Country Club
rivate
3 inch in 30 yrs

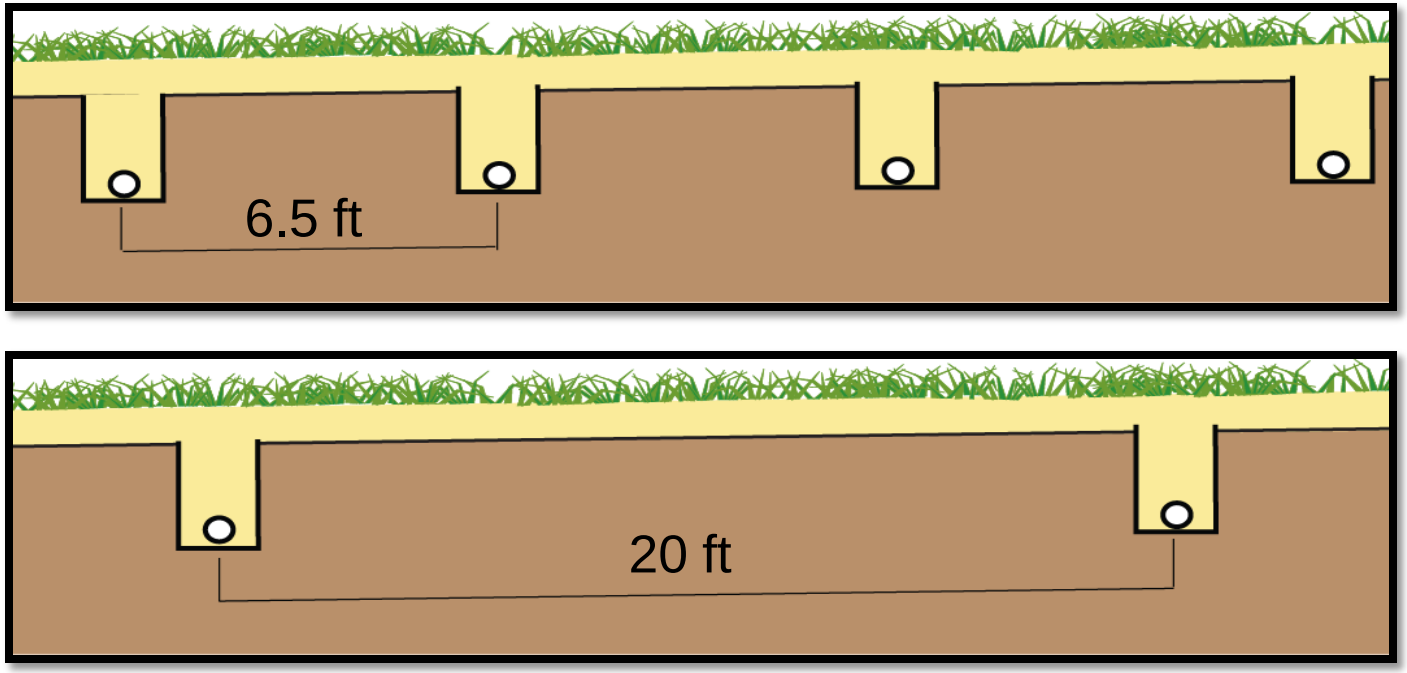

3 inch in 3 yrs

Questions

- How many annual topdressing applications can be made?
- When sand topdressing is included, what drain tile spacing is necessary to provide a dry and stable playing surface?

Current Recommendations

- Increase drain tile spacing
- Reduced sand topdressing depth
  - Further reduction in renovation cost



Questions

- Experiment 1
  - How many annual topdressing applications can be made?
- Experiment 2
  - When sand topdressing is included, what drain tile spacing is necessary to provide a dry and stable playing surface?

Experiment 1

Objective

- Evaluate the effects of cumulative sand topdressing rates on the fall wear tolerance and surface stability of a cool-season turfgrass stand.

Materials and Methods

- Research initiated Apr. 10, 2007
- Hancock Turfgrass Research Center
  - East Lansing, MI
- Sandy loam

- Seeded (May 29, 2007)
  - 90% *Poa pratensis* L. (Kentucky bluegrass)
  - 10% *Lolium perenne* L.(perennial ryegrass)

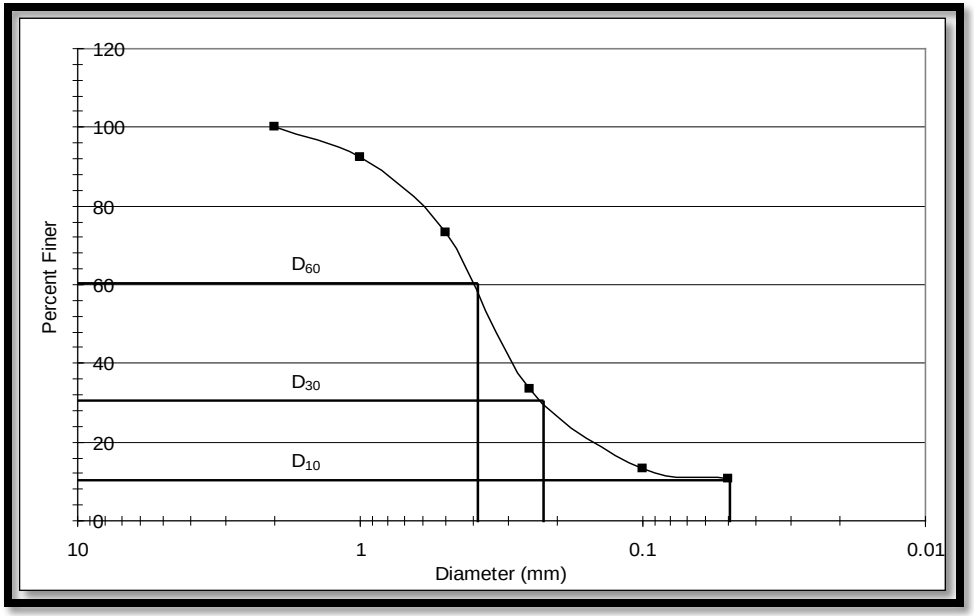
Materials and Methods

- Treatments
  - Topdressing depth (inch)
    - 0.0 (0 applications)
    - 0.5 (2 applications)
    - 1.0 (4 applications)
    - 1.5 (6 applications)
    - 2.0 (8 applications)

Eight topdressing applications at 9.8 kg m^{-2} (0.25 inch) provided a 2 inch sand layer, Aug. 23, 2007.

Materials and Methods

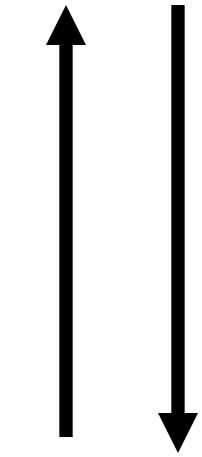
- July 11 – Aug. 15, 2007
- Topdressing material
  - Well-graded sand (90% sand - 10% silt/clay)



Materials and Methods

- Henderson et al., 2005
  - 98% sand – 2% silt/clay
  - 95% sand – 5% silt/clay
  - 93% sand – 7% silt/clay
  - 92% sand – 8% silt/clay
  - 90% sand – 10% silt/clay
  - 88% sand – 12% silt/clay
  - 85% sand – 15% silt/clay
  - 81% sand – 19% silt/clay

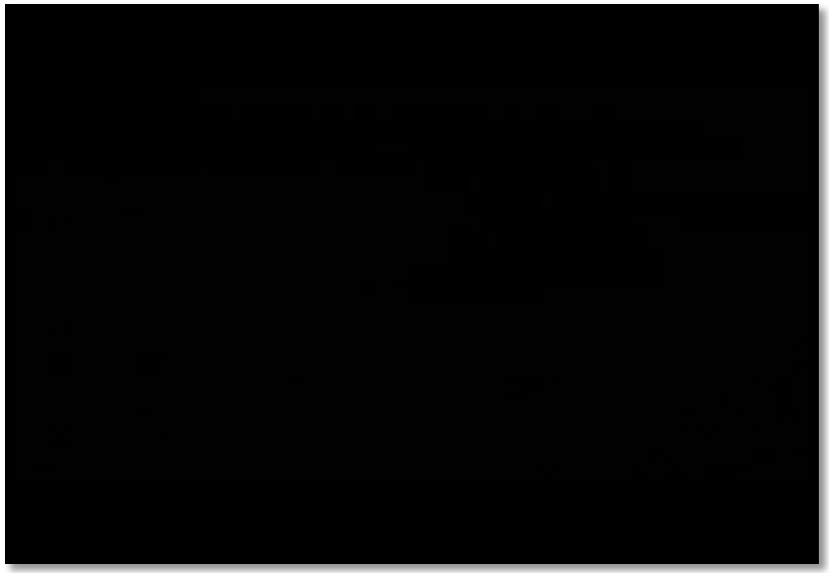
Drainage



Stability

Materials and Methods

- Fall traffic
  - Oct. 10 – Nov. 3, 2007
- Cady traffic simulator
  - 4 passes/week
    - 2 pass backward
    - 2 passes forward



Materials and Methods

- Data collected after the fall traffic period
  - Nov. 10, 2007

Materials and Methods

- Response variables
  - Shoot density (shoots•13.4 inch^{-2})
  - Clegg turf shear tester strength (Nm)

Results

- How many annual topdressing applications can be made?

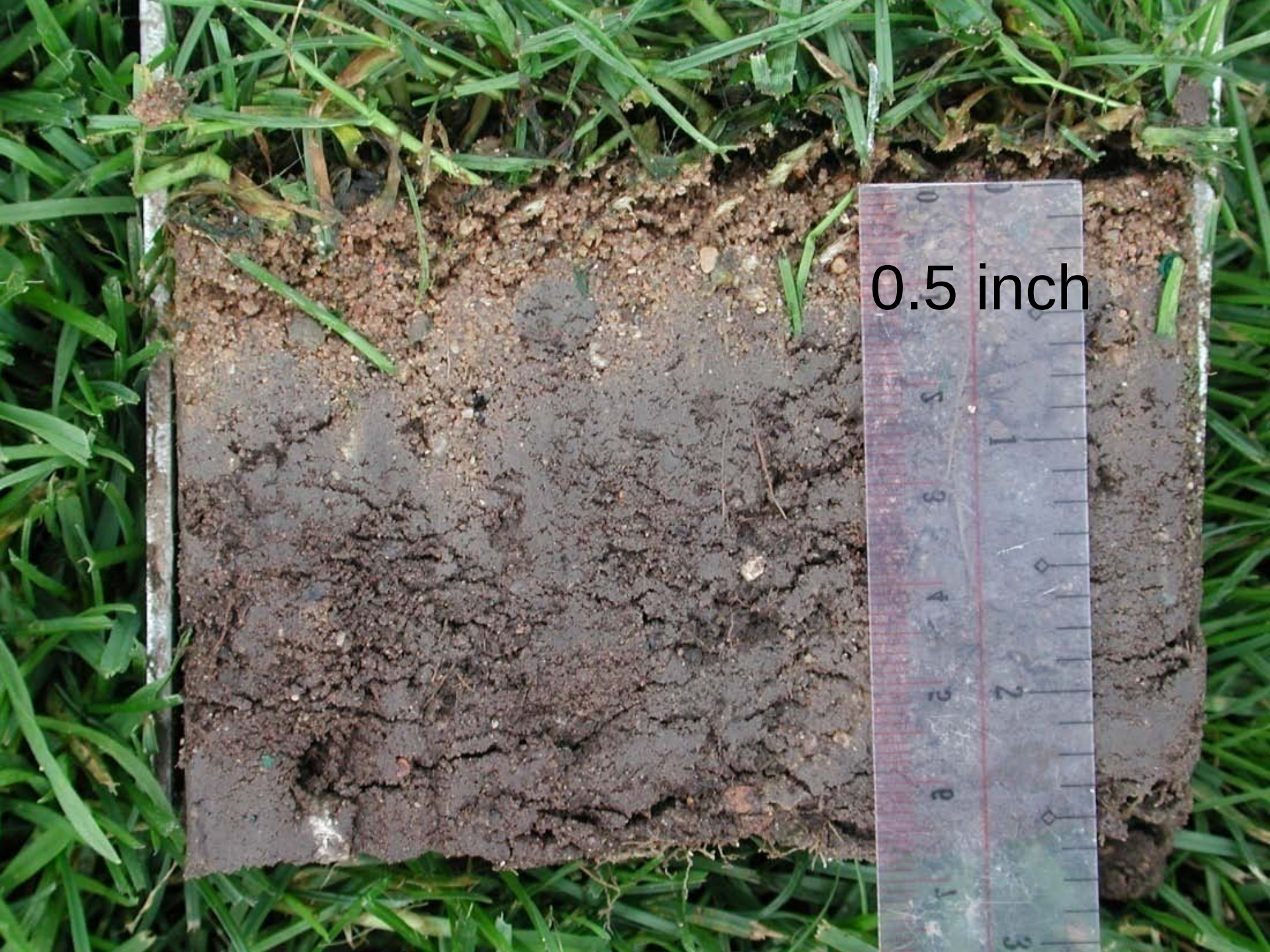
2007 Results

- Shoot density
- Turf shear tester strength

Effects of topdressing depth (inch) on turf shear tester strength (Nm) following fall traffic simulator applications, East Lansing, Mich., Nov. 10, 2007.

Topdressing Depth (in)	2007 Mean Shear Tester Strength (Nm)
0.0	55.8 b†
0.5	101.8 a
1.0	87.7 ab
1.5	56.5 b
2.0	53.2 b

† Means followed by the same letter are not significantly different according to LSD (0.05).


0.5 inch

2008 Results

- July 14 – Aug. 22, 2008
  - Cumulative topdressing applications
    - Applied to the same experimental treatments

- Topdressing depth (inch)
  - 0.0 (0 applications)
  - 1.0 (4 applications)
  - 2.0 (8 applications)
  - 3.0 (12 applications)
  - 4.0 (16 applications)

4.0 inches of sand topdressing applied over a two year period, Sep. 18, 2008.

Materials and Methods

- Fall traffic (Oct. 14 – Nov. 12, 2008)
  - 4 passes/week

2008 Results

- Shoot density
- Turf shear tester strength

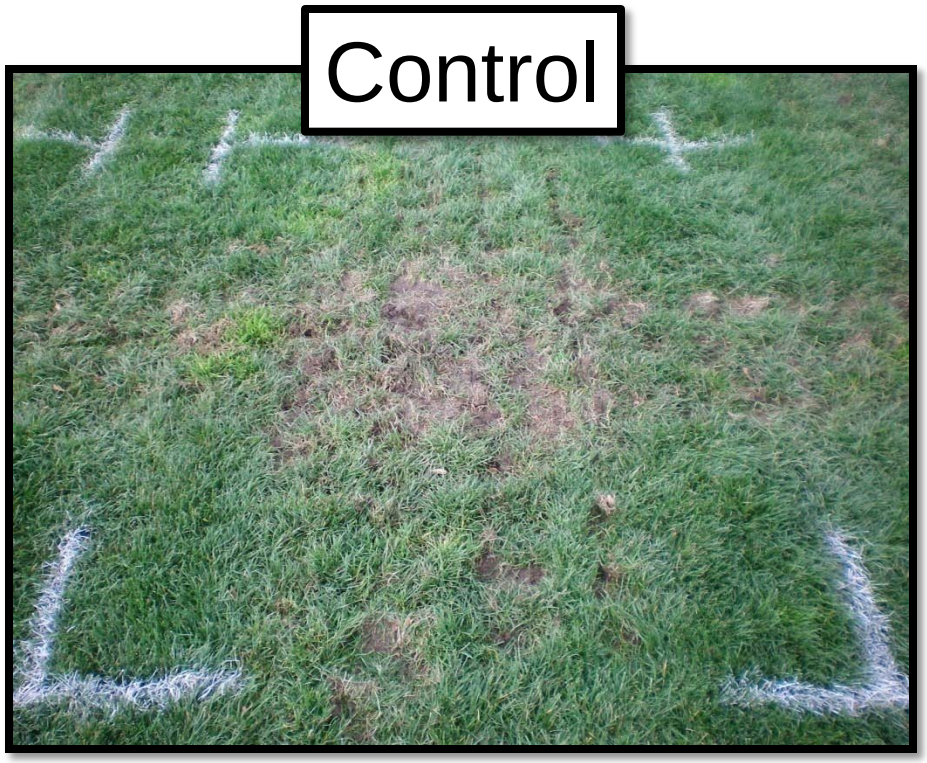
Effects of topdressing depth (inch) on turfgrass shoot density (shoots•13.4 inch^{-2}) following fall traffic simulator applications, East Lansing, Mich., Nov. 14, 2008.

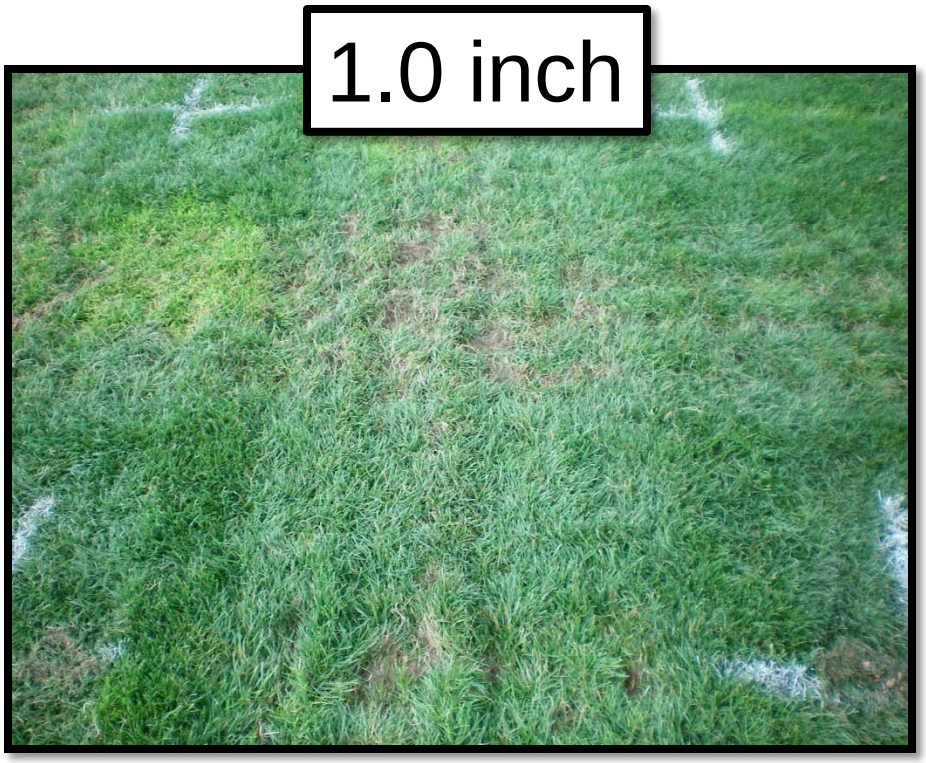
Topdressing Depth (in)	2008 Mean Shoot Density (Shoots/13.4 inch^2)
0.0	25.3 c†
1.0	49.7 b
2.0	53.0 b
3.0	62.3 a
4.0	54.7 ab

† Means followed by the same letter are not significantly different according to LSD (0.05).

2008 Results

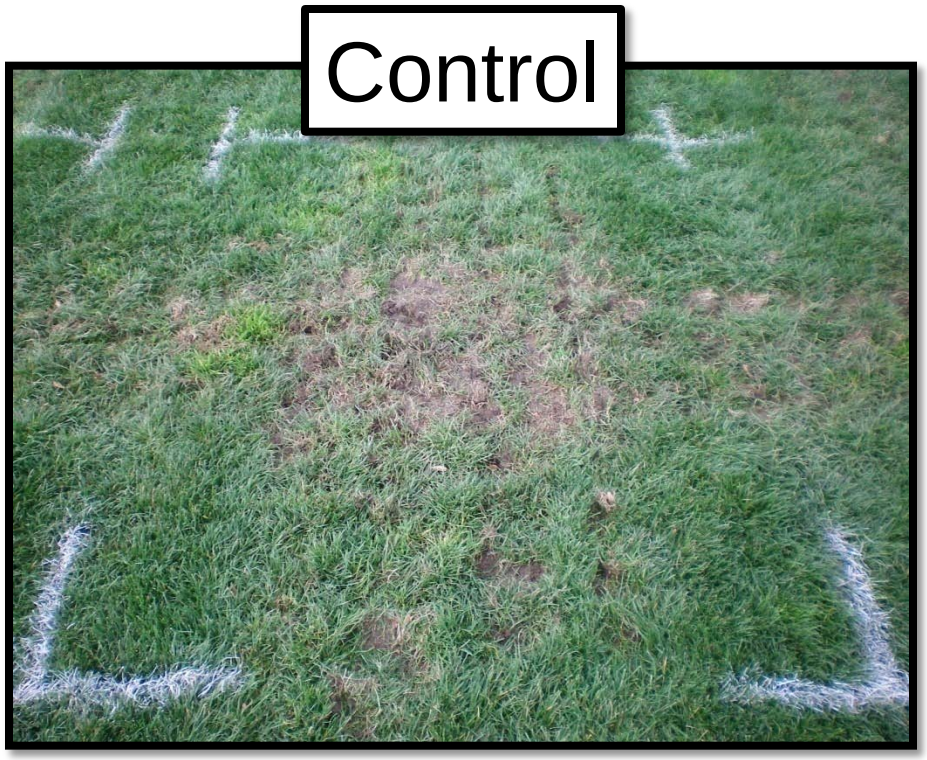
- Effects of topdressing depth (inch) on turfgrass cover following fall traffic simulator applications, East Lansing, Mich., Nov. 7, 2008.

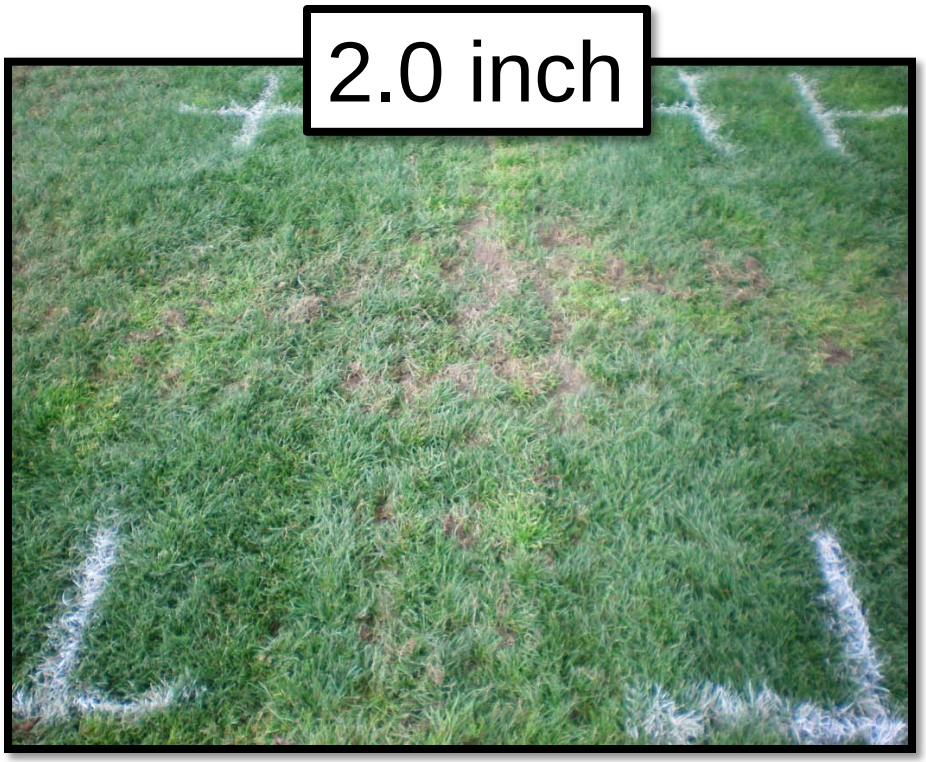




2008 Results

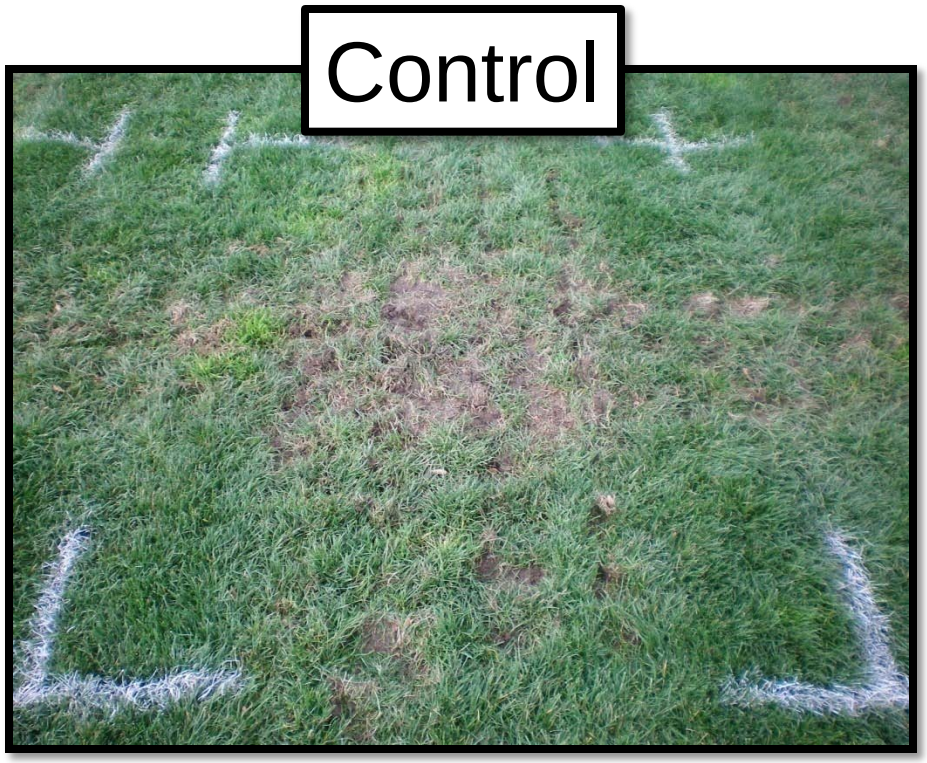
- Effects of topdressing depth (inch) on turfgrass cover following fall traffic simulator applications, East Lansing, Mich., Nov. 7, 2008.

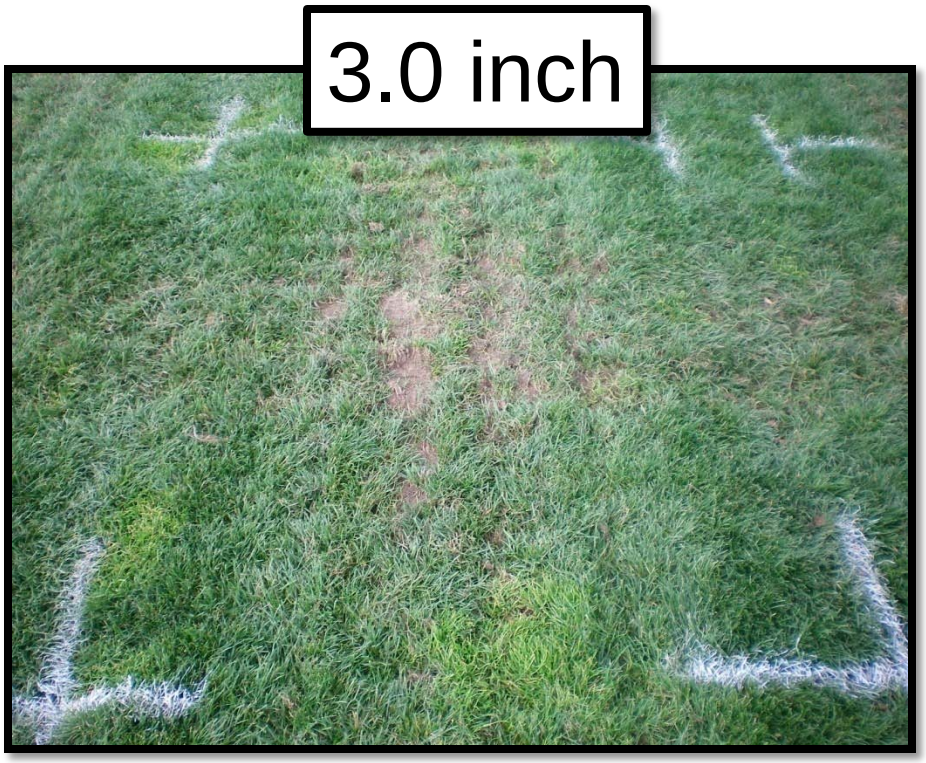




2008 Results

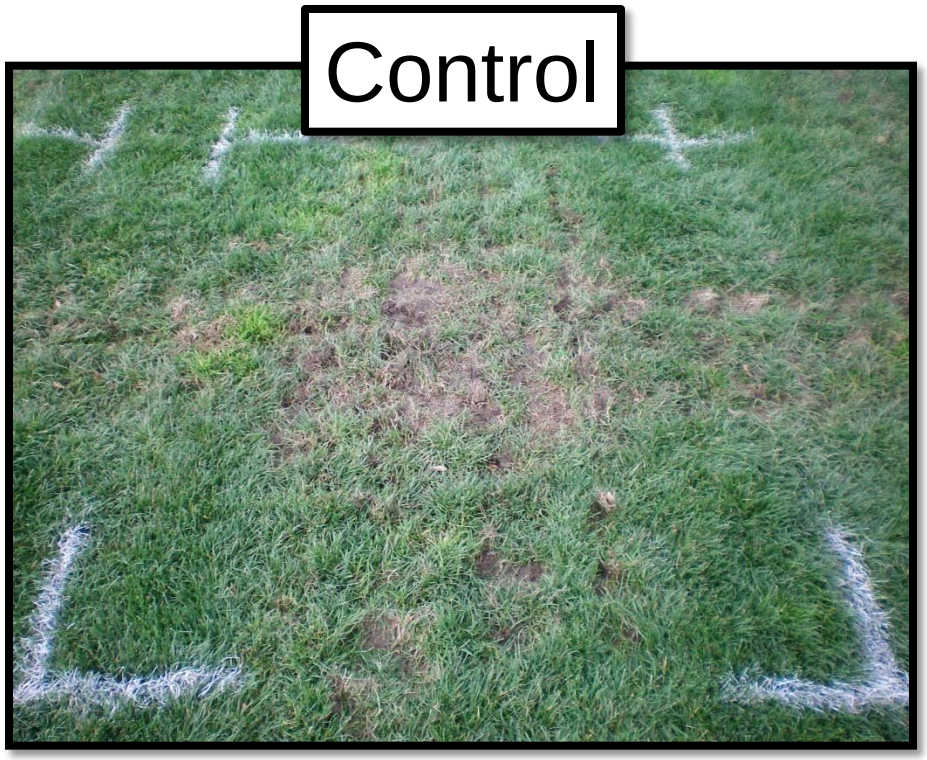
- Effects of topdressing depth (inch) on turfgrass cover following fall traffic simulator applications, East Lansing, Mich., Nov. 7, 2008.

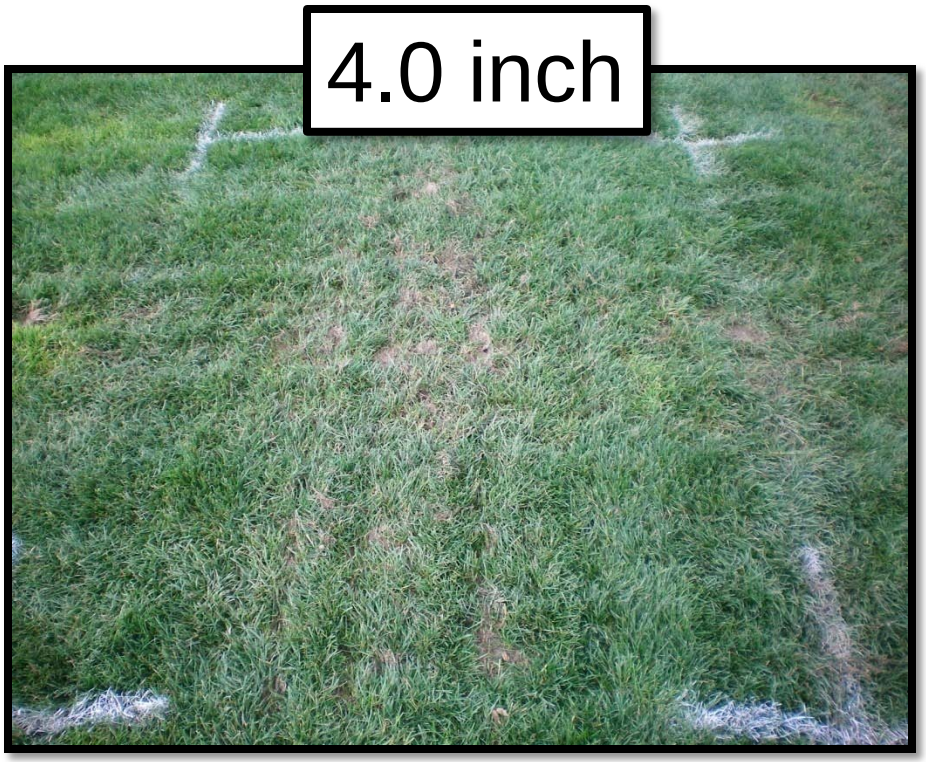




2008 Results

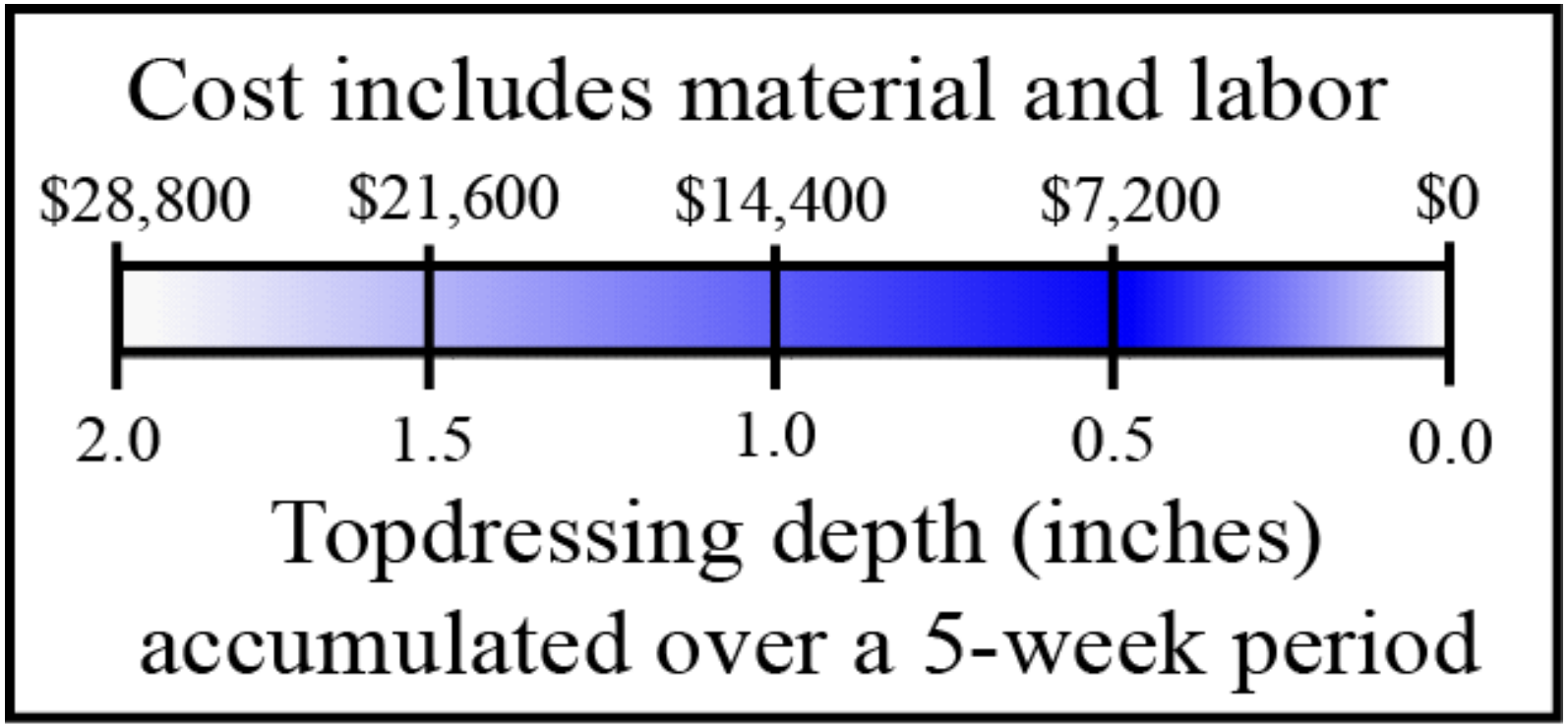
- Effects of topdressing depth (inch) on turfgrass cover following fall traffic simulator applications, East Lansing, Mich., Nov. 7, 2008.





Conclusions

- 0.5 inch of topdressing, applied over a 5-week period, provided the greatest turf shear tester strength in the fall of 2007 and 2008.
- All cumulative topdressing application rates improved turfgrass shoot density in the fall of 2008.
- Summer traffic was not detrimental to fall turfgrass shoot density or turf shear tester strength.



- Optimum turfgrass wear tolerance and surface stability characteristics
- Intermediate
- Minimal turfgrass wear tolerance and surface stability characteristics

Experiment 2

Objective

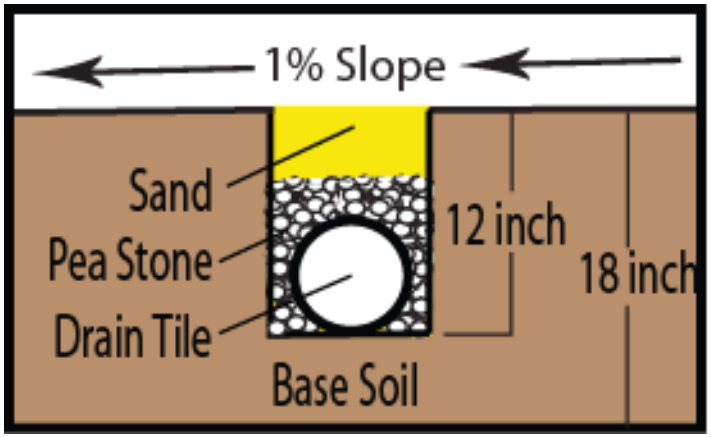
- Establish intercept drain tile spacing, in combination with sand topdressing, necessary to improve drainage characteristics and surface shear strength on a sandy loam soil.

Materials and Methods

- Research was initiated April 10, 2007
- Hancock Turfgrass Research Center
  - East Lansing, Mich.
- Sandy loam
- Seeded (May 29, 2007)
  - 90% Poa pratensis L. (Kentucky bluegrass)
    - 19.7% ‘Arcadia’, 19.7% ‘Odyssey’, 19.6% ‘America’, 19.6% ‘SR100’ and 19.6% ‘Mercury’
  - 10% Lolium perenne L. (perennial ryegrass)
    - 34.4% ‘Harrier’, 34.1% ‘Peregrine’, and 29.8% ‘SR 4600’

Materials and Methods

- Treatments
  - Intercept drain tile spacing
    - 6.5 ft
    - 10.0 ft
    - 13.0 ft
    - 20.0 ft
    - Control
      - 26.5 ft plot without drain tiles

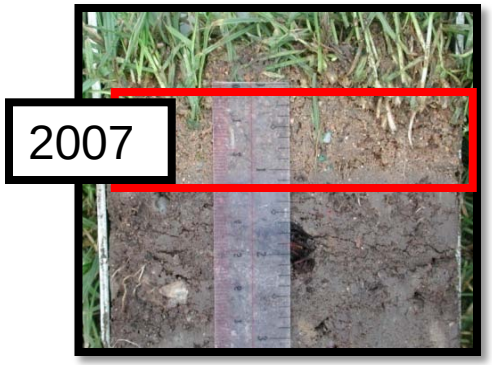


Materials and Methods

- Topdressing
  - July 11 – Aug. 15, 2007
    - 4 applications @ ¼ inch = 1.0 inch
      - Well-graded sand (90% sand-10% silt/clay)

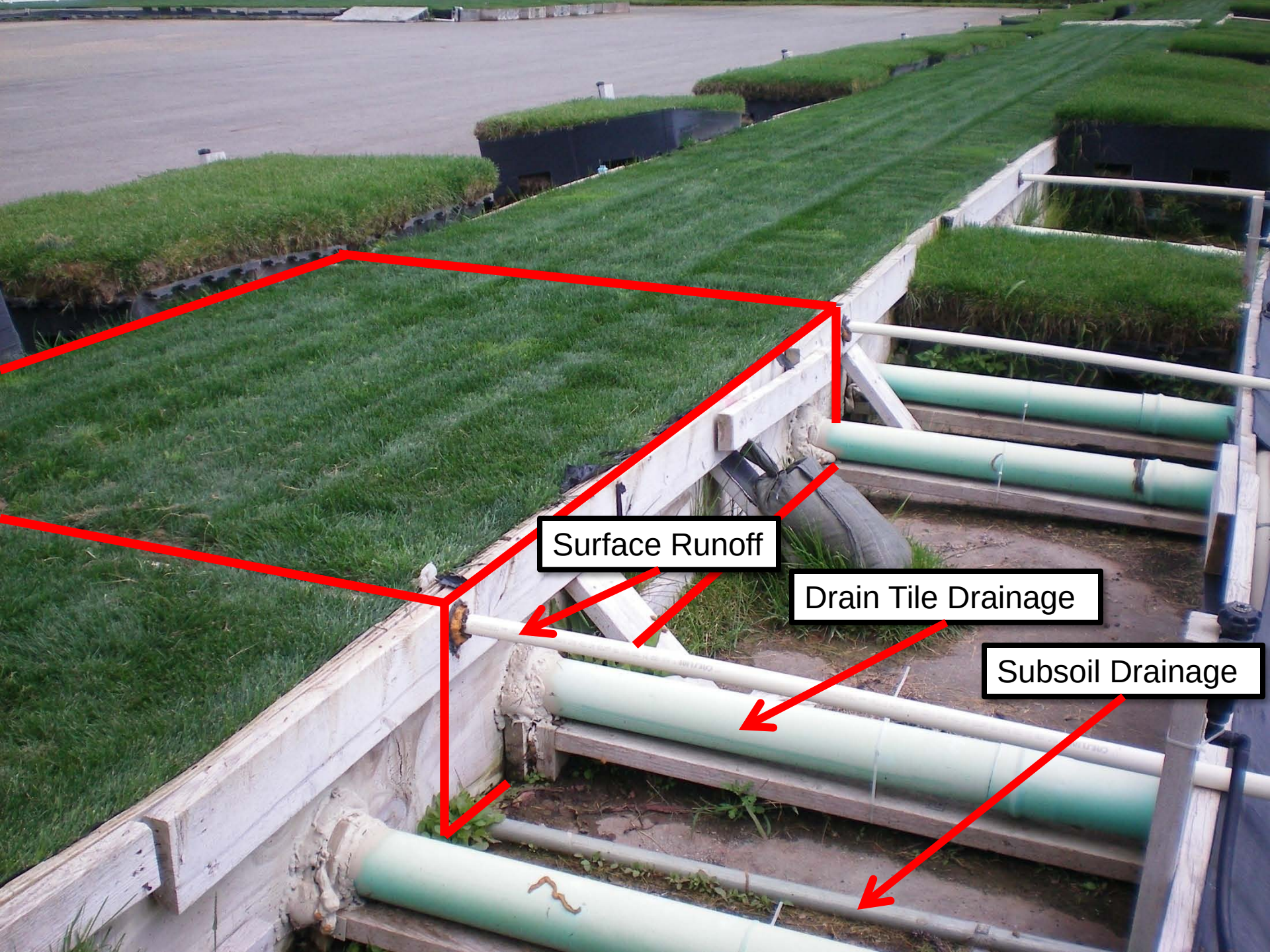
Materials and Methods

- Response variables
  - Drainage characteristic data
    - After the accumulation of 1.0 inch sand
      - Aug. 18, 2007



Surface soil water content

Subsurface soil water content


Surface Runoff
Drain Tile Drainage
Subsoil Drainage

Materials and Methods

- Fall traffic
  - Oct. 10 – Nov. 3, 2007
- Cady traffic simulator
  - 4 passes/week
    - 2 pass backward
    - 2 passes forward

Materials and Methods

- Response variables
  - Surface shear strength
    - Eijkelkamp shear vane (Nm)

Materials and Methods

- Surface shear strength
  - Collected after the fall traffic period
    - Nov. 10, 2007

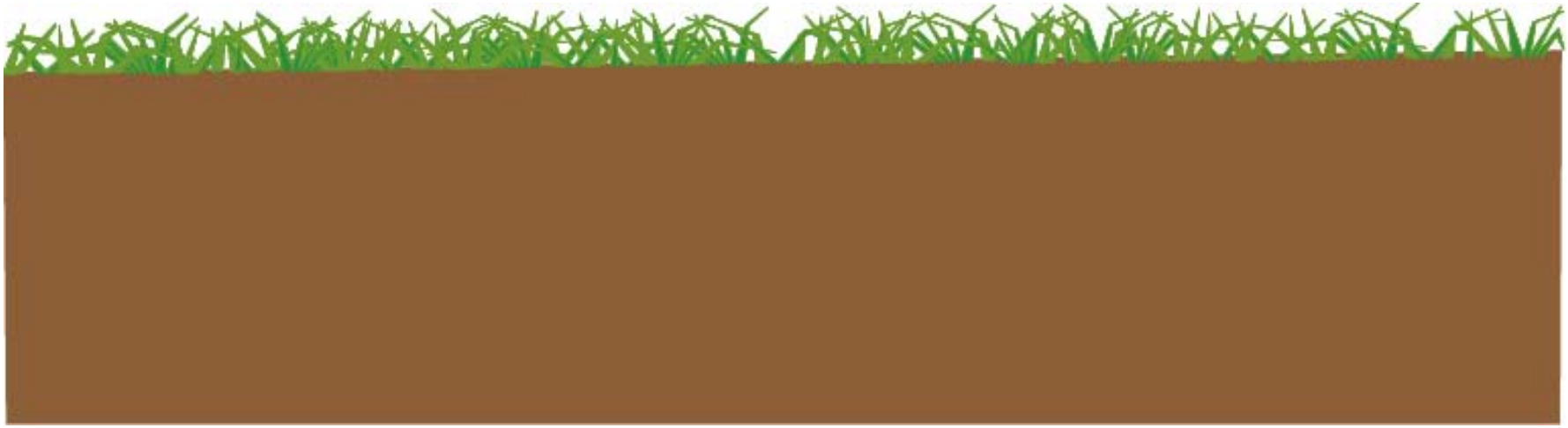
Results

- When sand topdressing is included, what drain tile spacing is necessary to provide a dry and stable playing surface?

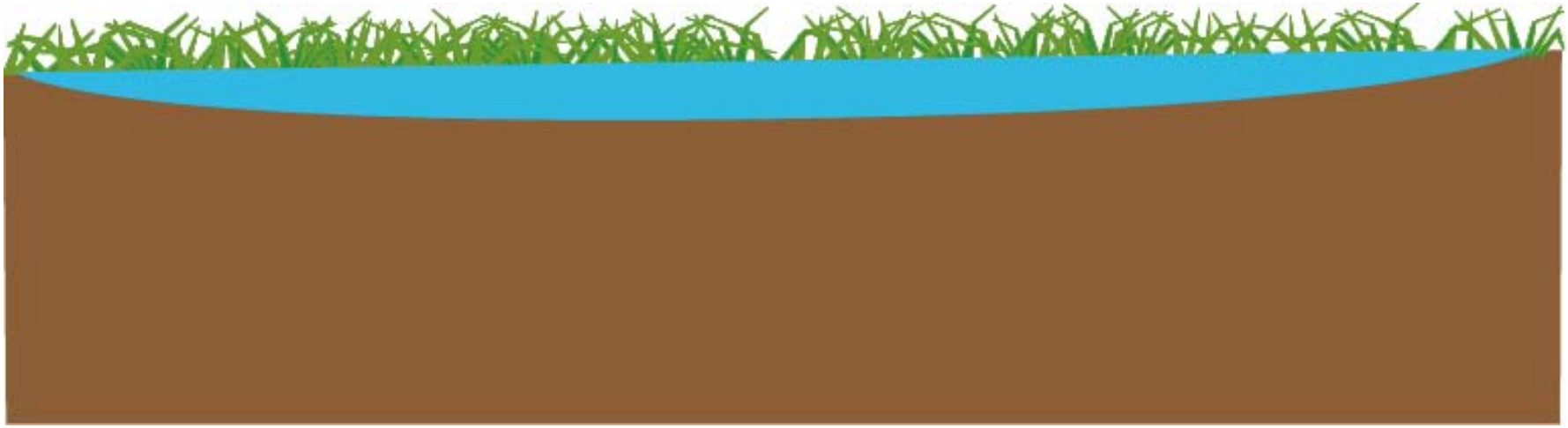
2007 Results

- Response variables
  - Drainage characteristics
  - Surface shear strength

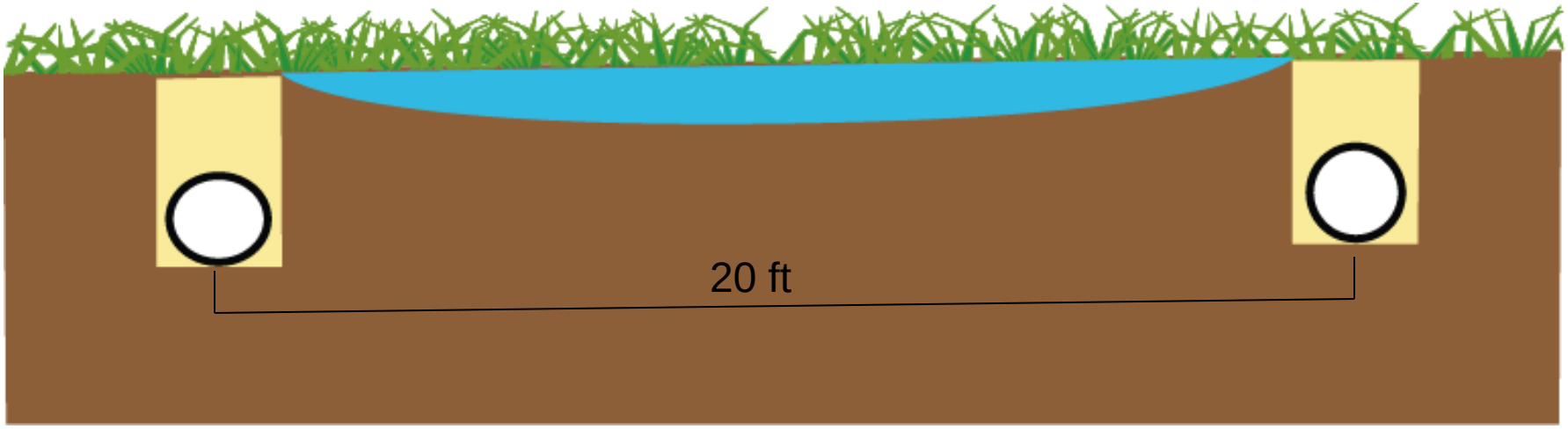
2007 Results



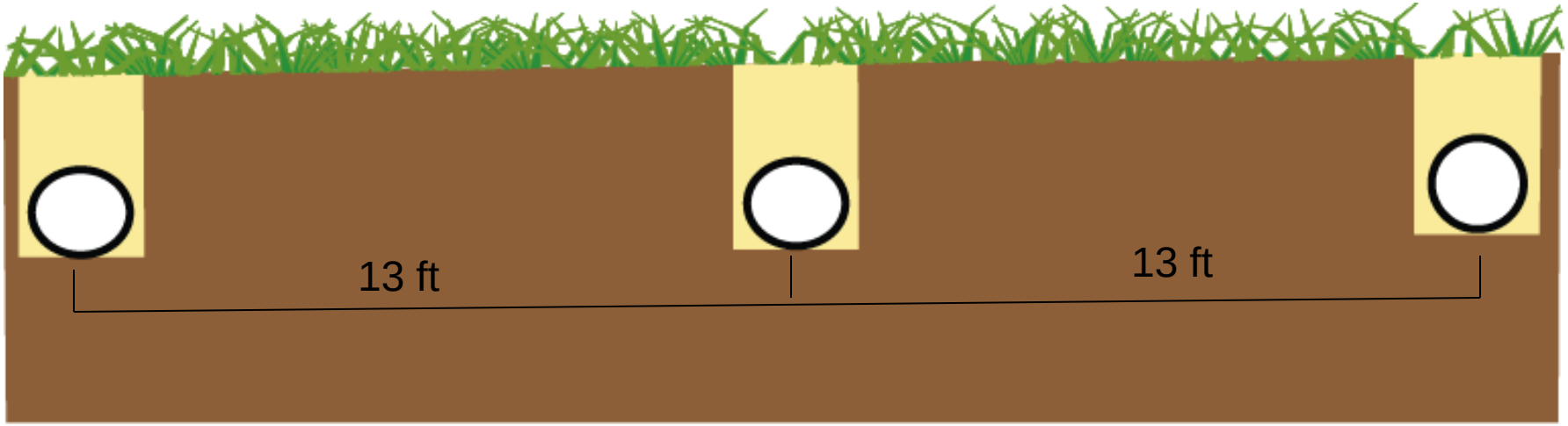
2007 Results



2007 Results



2007 Results

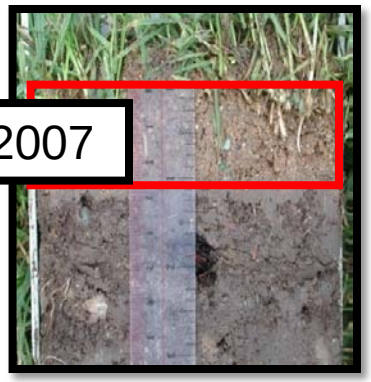


2007 Results

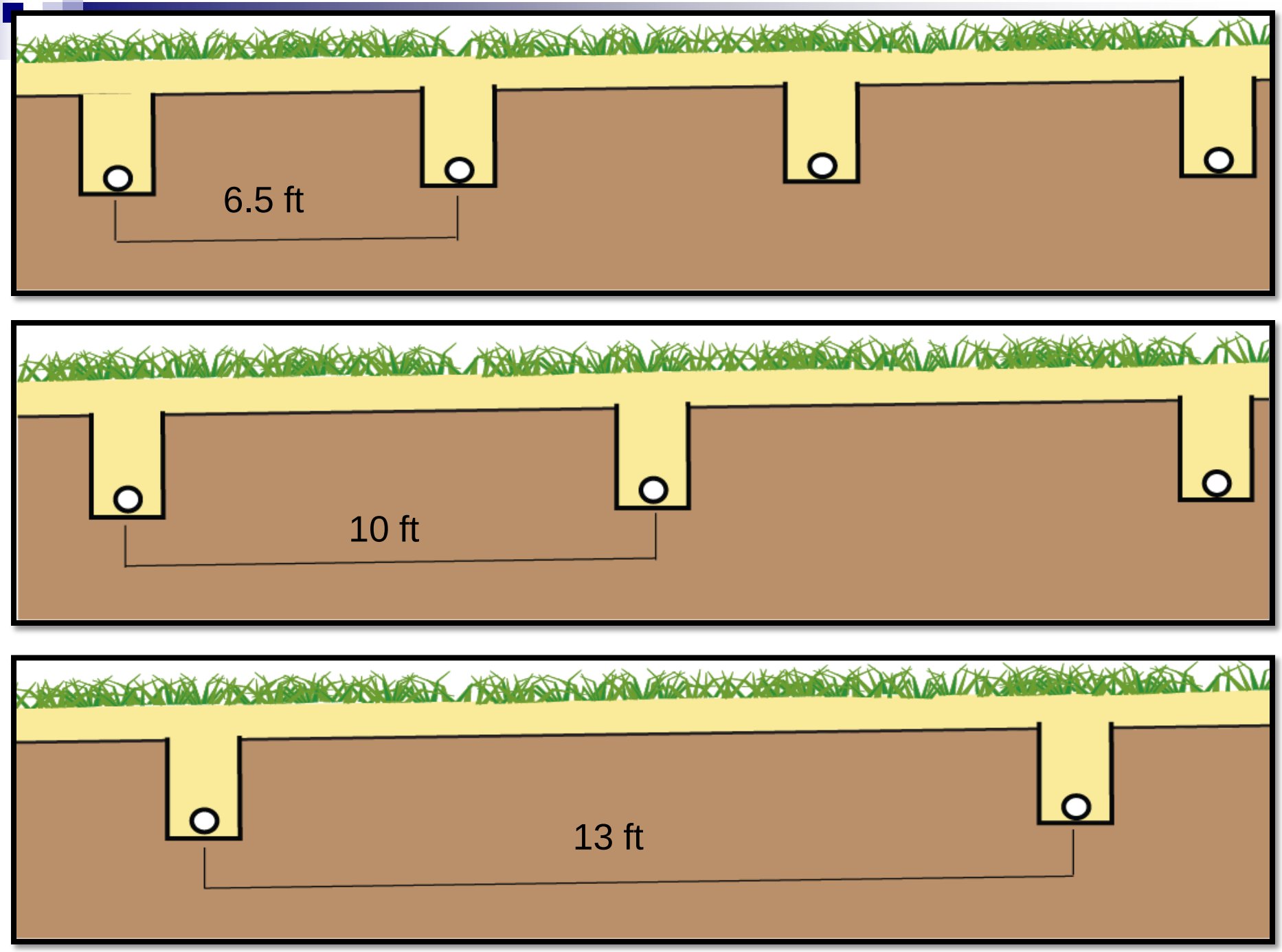
- Response variables
  - Drainage characteristics
  - Surface shear strength

Effects of drain spacing on surface shear strength following fall traffic simulator applications, East Lansing, Mich., Nov. 10, 2007 (1.0 inch topdressing depth).

Drain Spacing (ft)	2007 Mean Shear Vane Strength (Nm)
6.5	8.0a†
10.0	7.6a
13.0	8.6a
20.0	6.3b
control‡	4.8c



† Means followed by the same letter are not significantly different according to LSD (0.05); ‡Control = 26.5 ft long treatment, equivalent to the distance from the crown of a field to the hash makers, without drain tiles.


6.5 ft
10 ft
13 ft

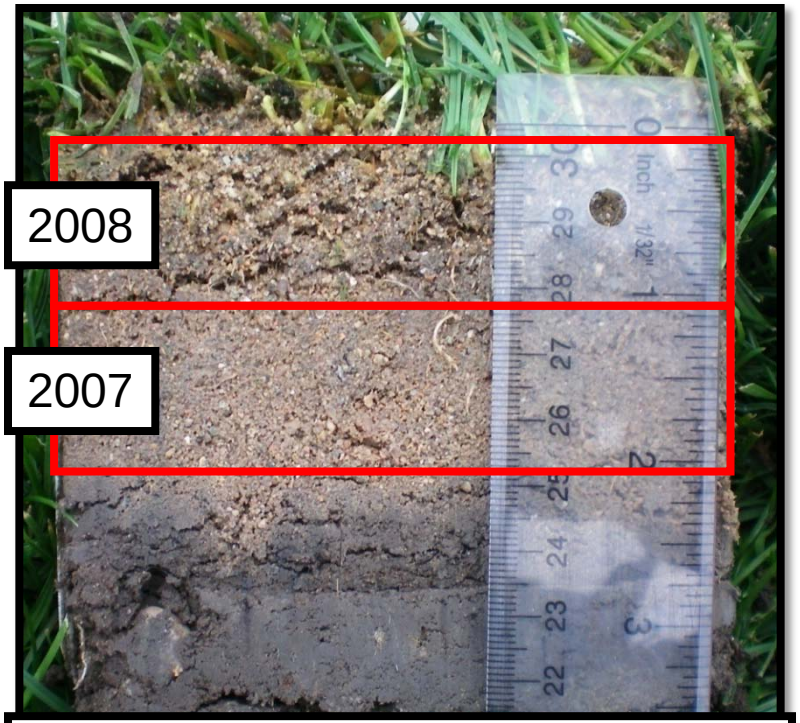
2008 Results

- Apr. 22, 2008
  - Core cultivated
  - Inter-seeded

- July 26 – Aug. 22, 2008
  - Cumulative topdressing applications
    - Applied to the existing experimental treatments

2008 Results

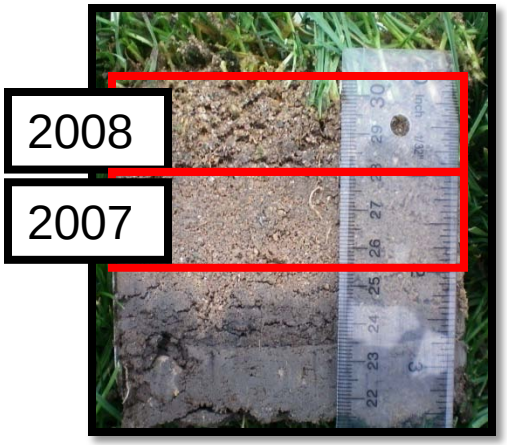
- Topdressing depth (inch)
  - 2.0 (Aug. 22, 2008)



2.0 inches of topdressing applied over a two years period, Sep. 4, 2008.

2008 Results

- Response variables
  - Drainage characteristic data
    - After the accumulation of 2.0 inch sand
      - Aug. 28, 2008



Materials and Methods

- Fall traffic (Oct. 14 – Nov. 12, 2008)
  - 4 passes/week

Materials and Methods

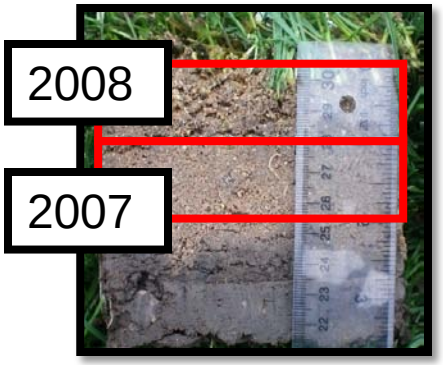
- Surface shear strength
  - Collected after the fall traffic period
    - Nov. 14, 2008

2008 Results

- Response variables
  - Drainage characteristics
  - Surface shear strength

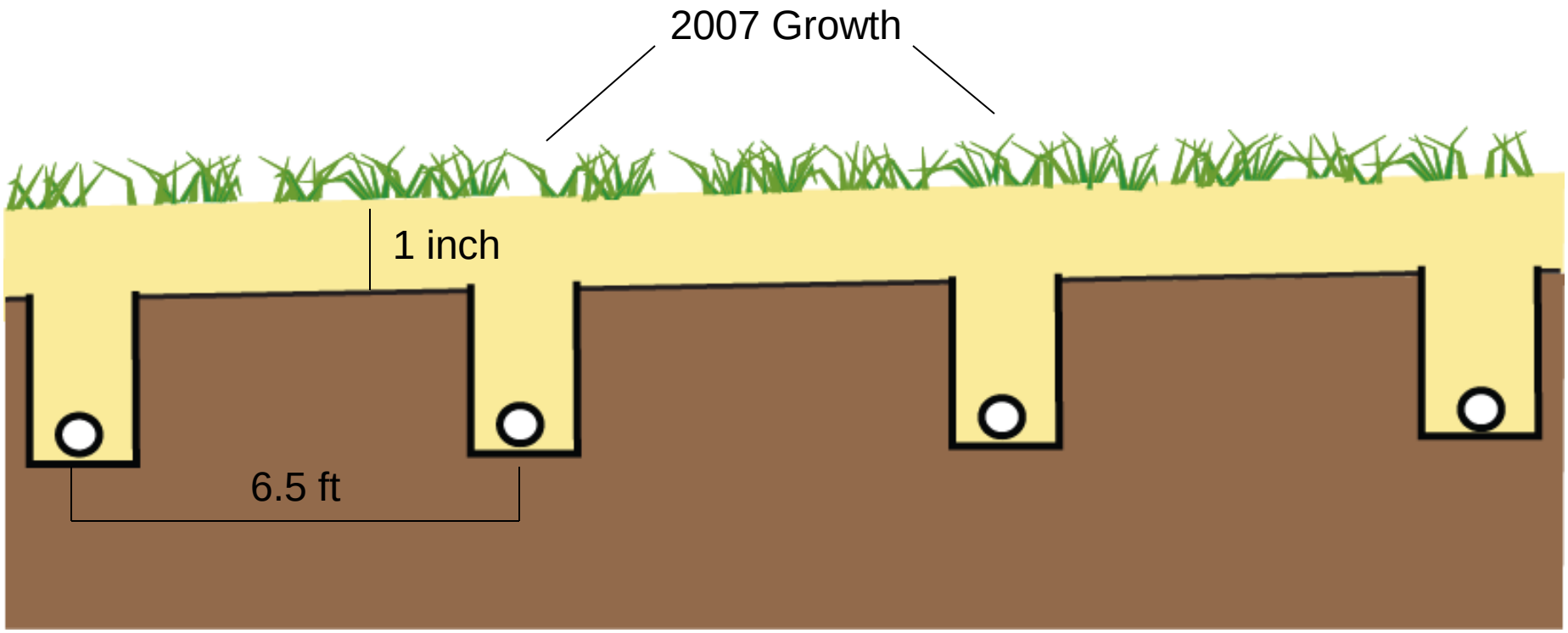
Effects of drain spacing on surface shear strength following fall traffic simulator applications, East Lansing, Mich., Nov. 14, 2008 (2.0 inch topdressing depth).

Drain Spacing (ft)	2008 Mean Shear Vane Strength (Nm)
6.5	7.5a†
10.0	8.5a
13.0	9.6a
20.0	8.9a
control‡	9.4a

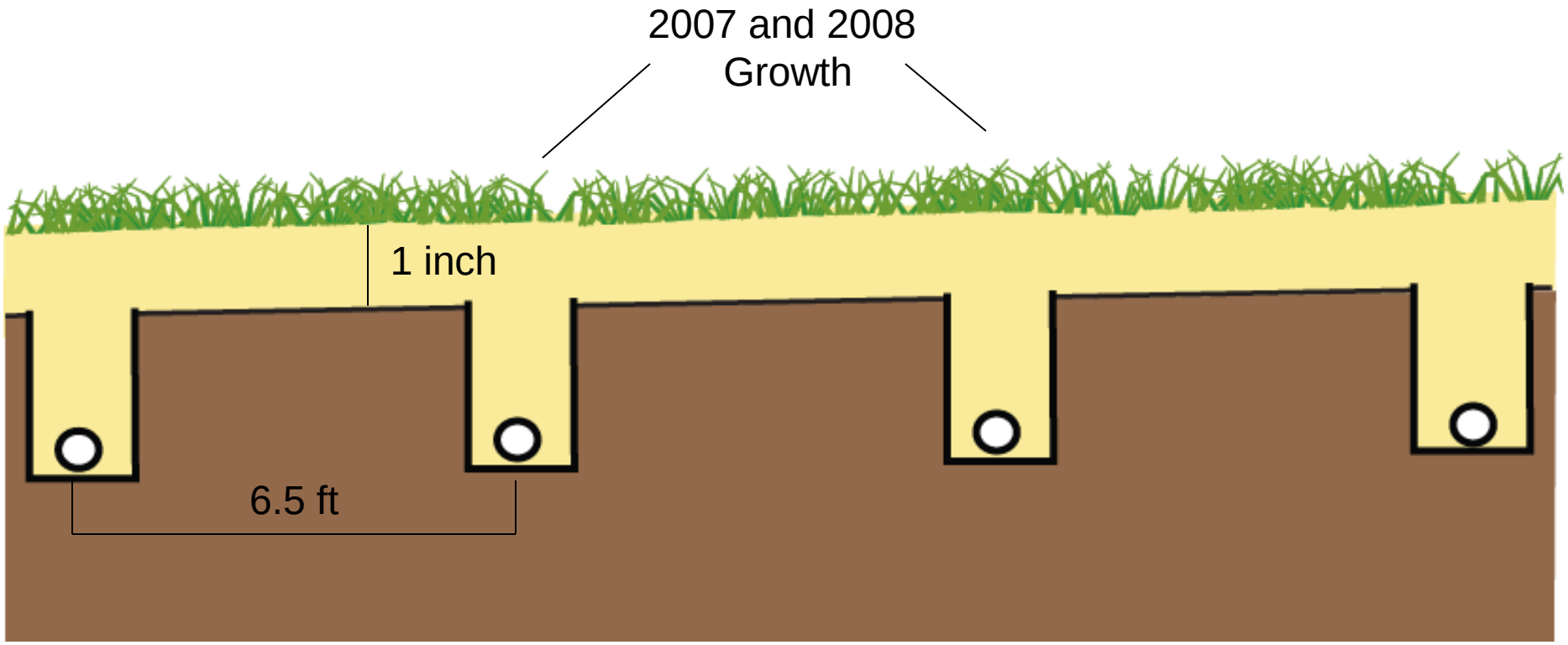


† Means followed by the same letter are not significantly different according to LSD (0.05); ‡Control = 26.5 ft long treatment, equivalent to the distance from the crown of a field to the hash makers, without drain tiles.

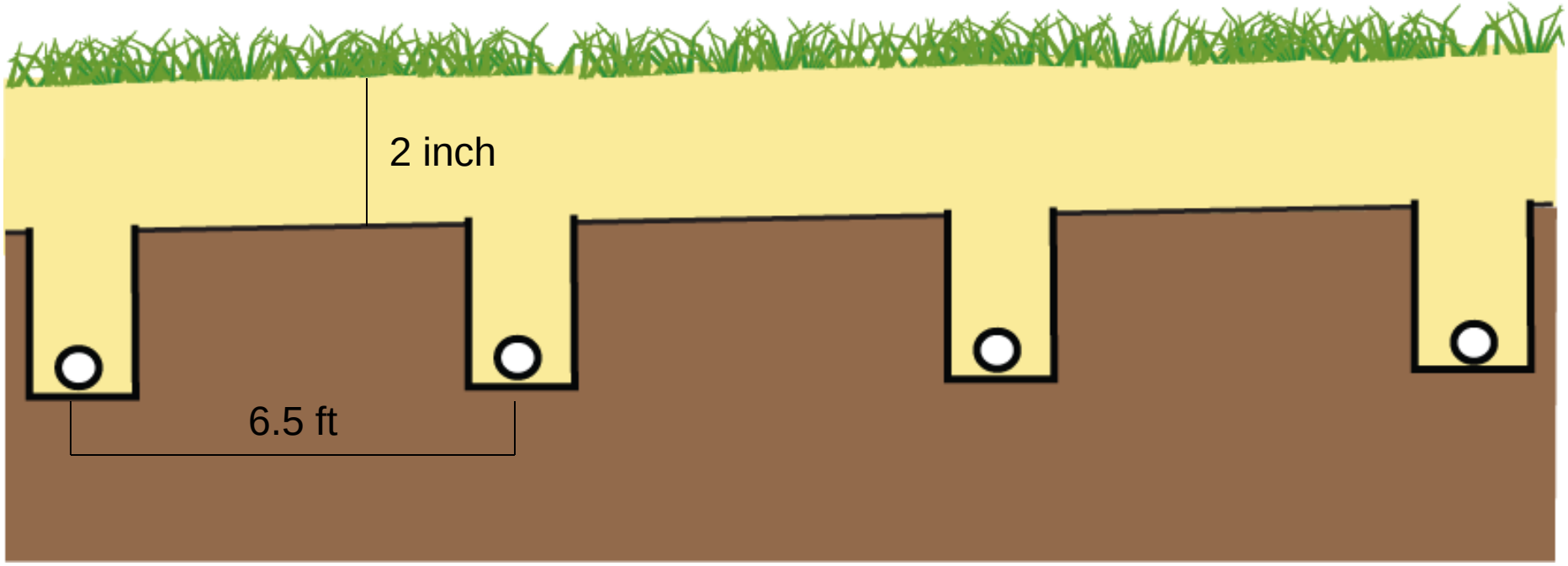
2008 Results



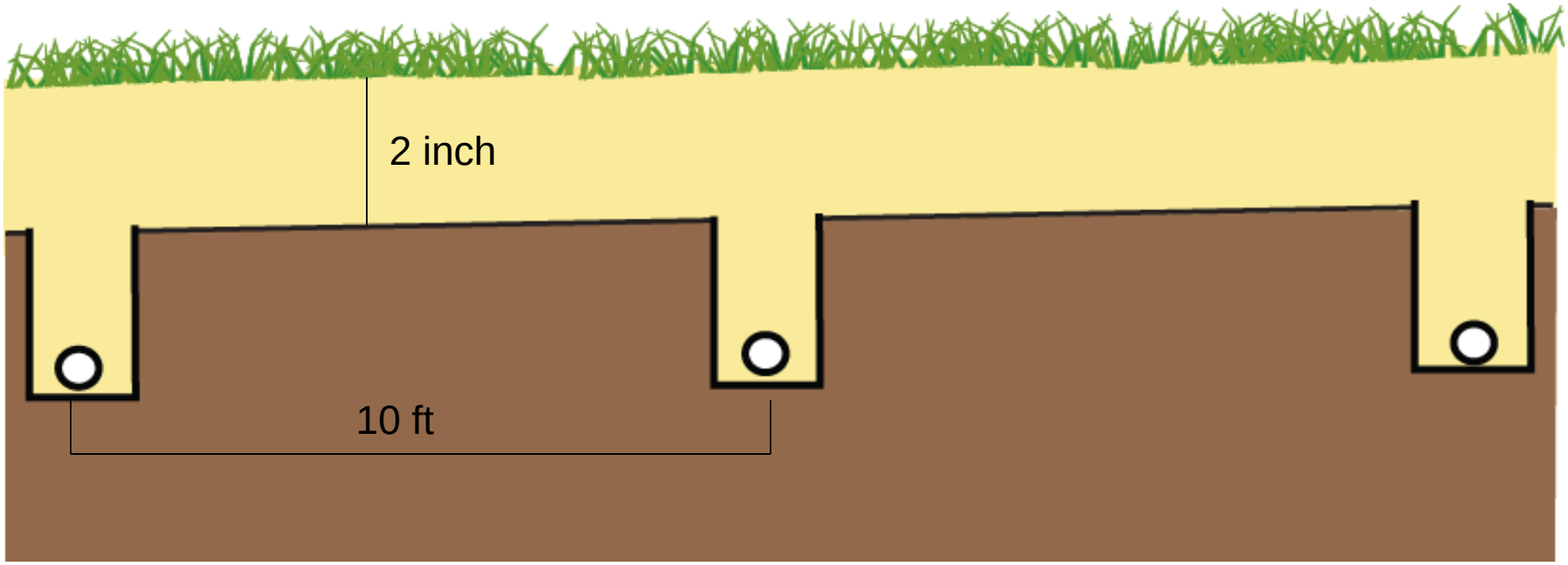
2008 Results



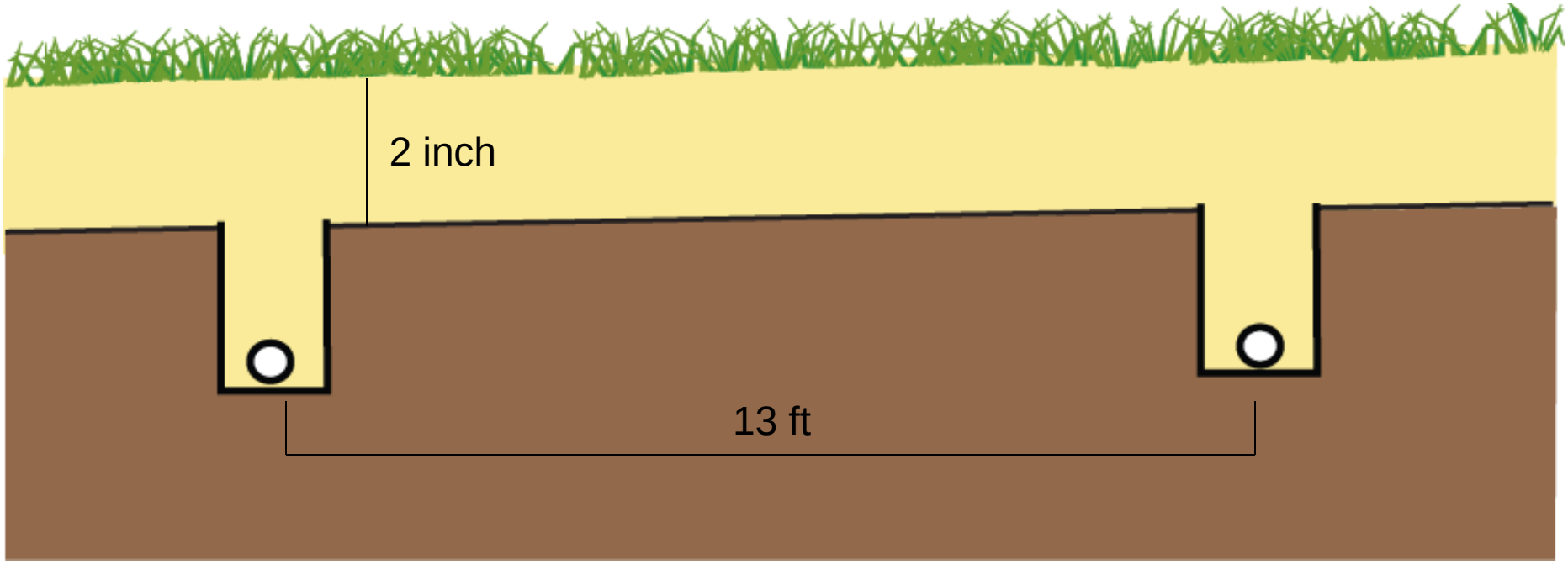
2008 Results



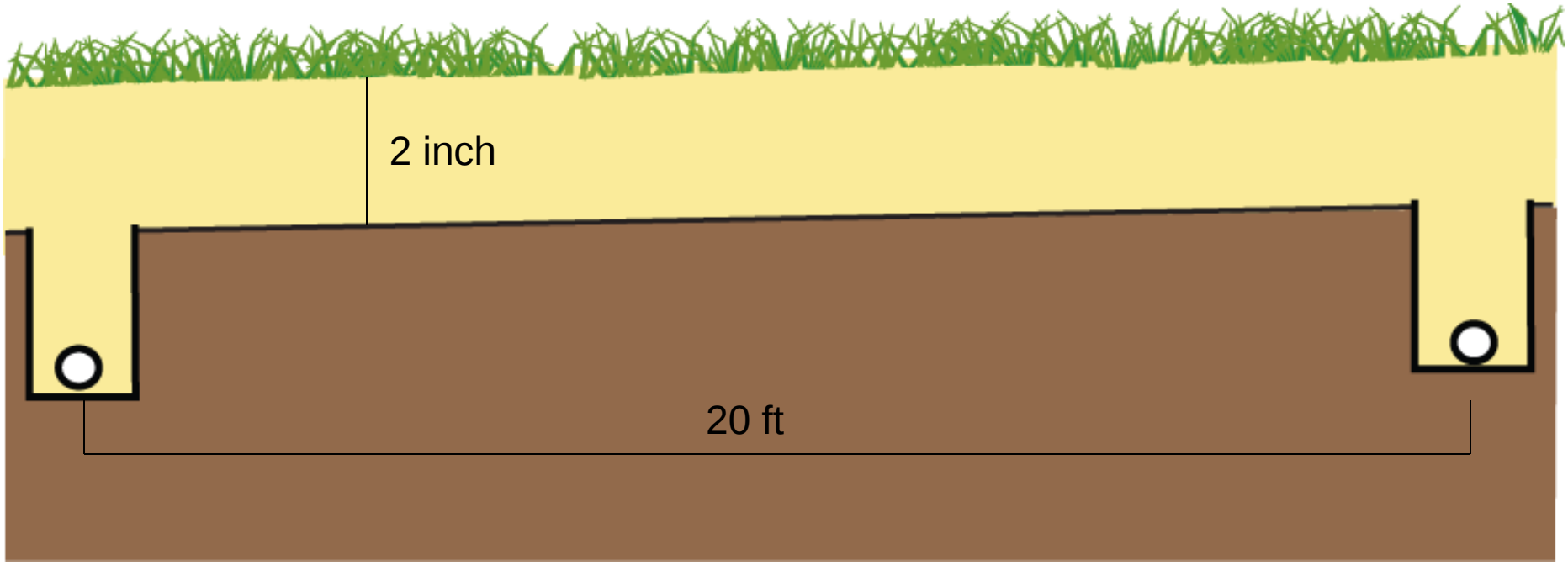
2008 Results



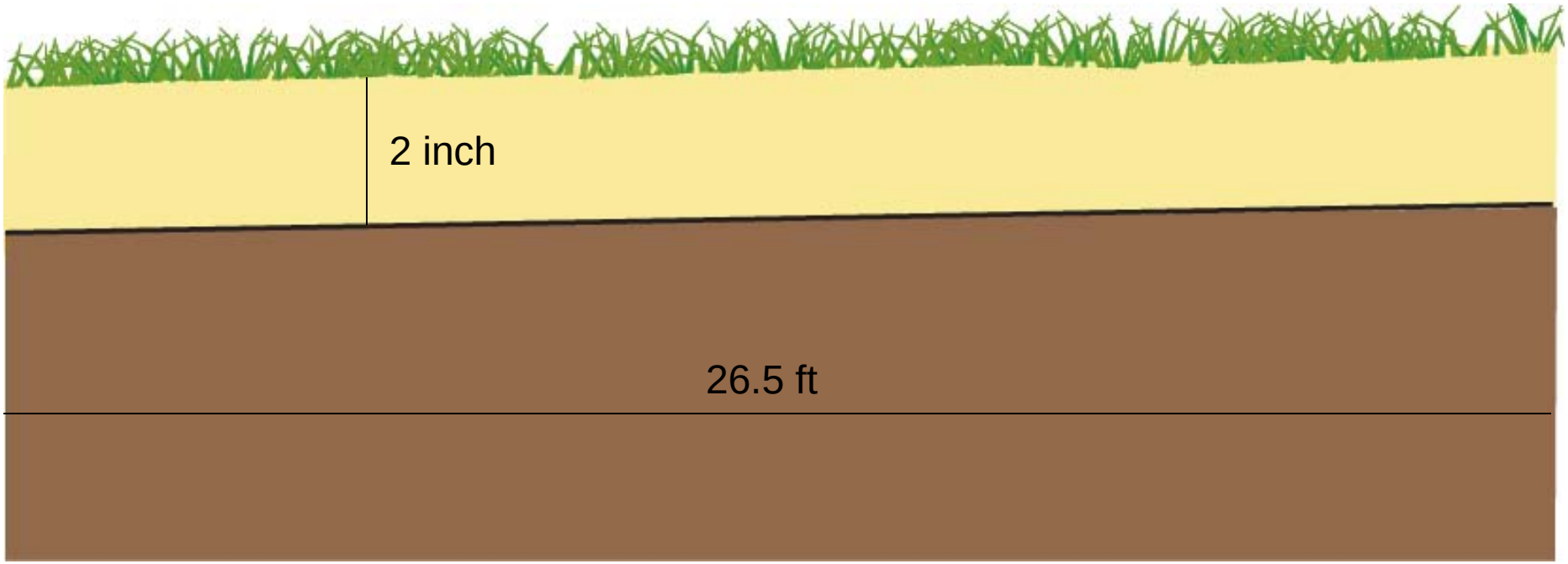
2008 Results



2008 Results

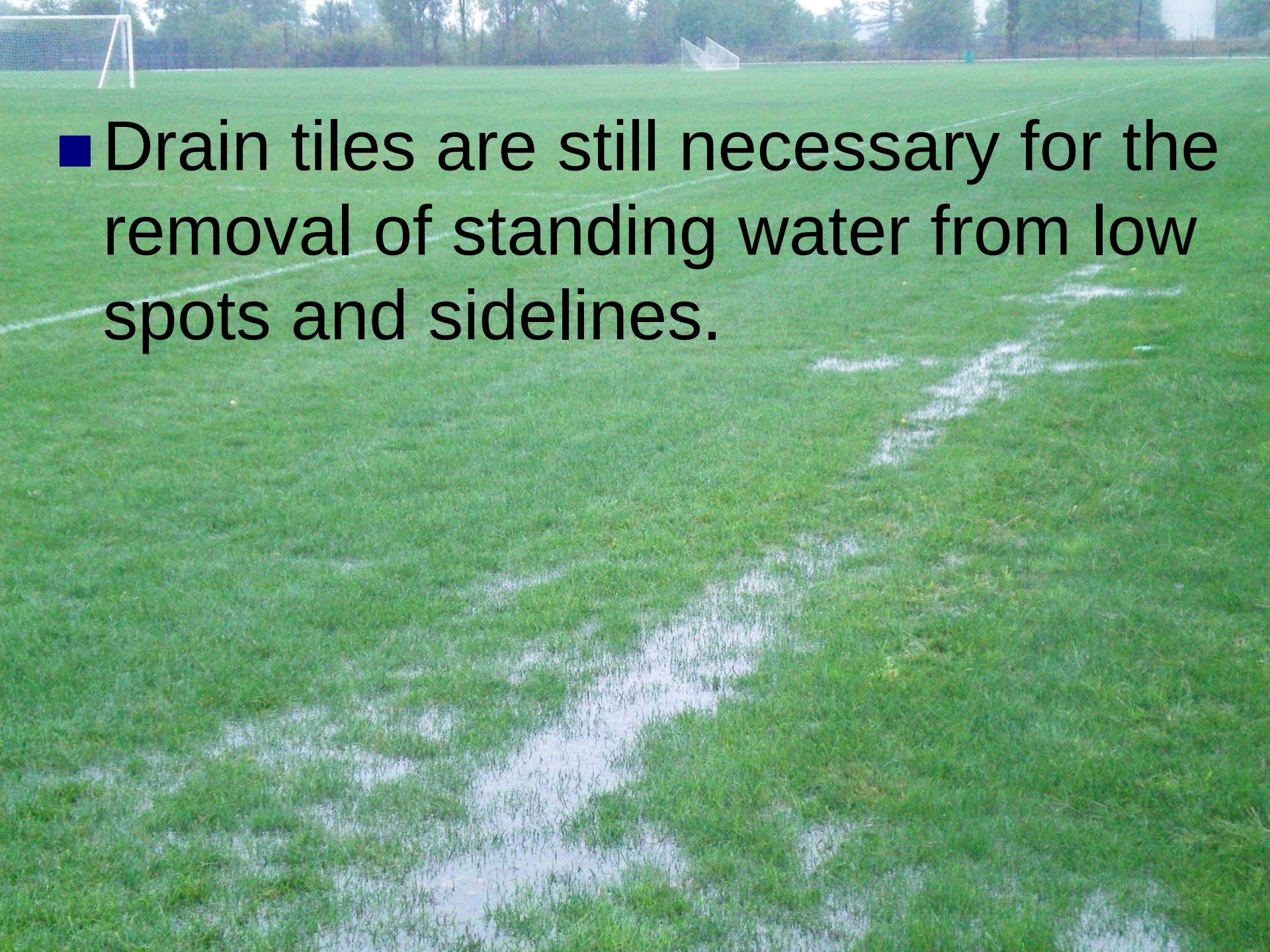


2008 Results



2008 Results

- Can topdressing alone provide an adequate playing surface without drain tile installation?

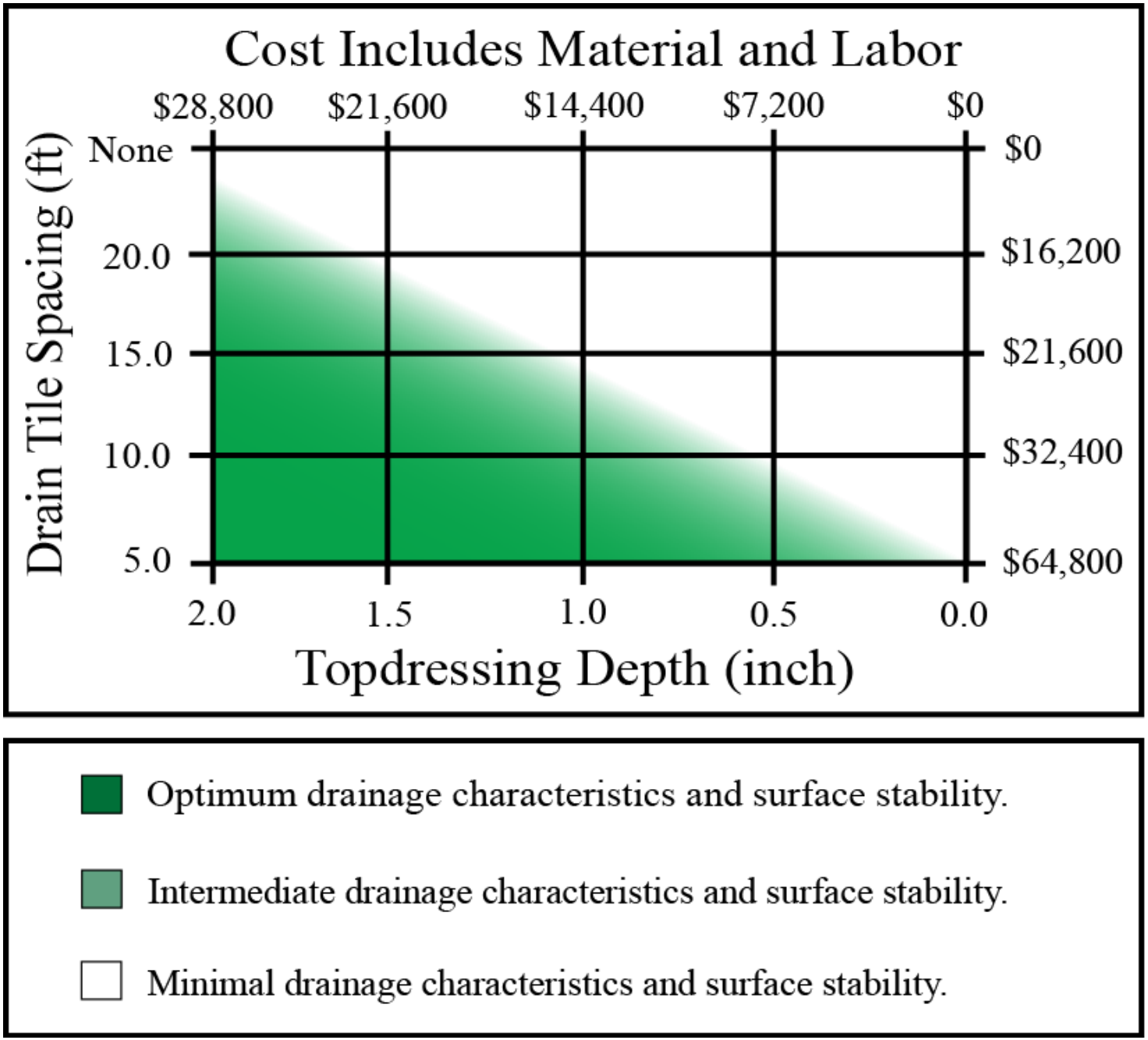


- Drain tiles are still necessary for the removal of standing water from low spots and sidelines.

Conclusions

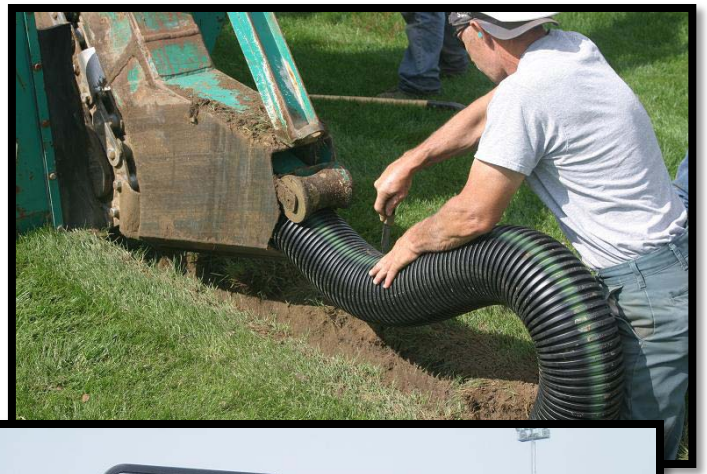
- A drain tile spacing of 13 ft apart will provide a dry and stable playing surface when 1.0 inch of topdressing has been accumulated.

- When 2.0 inches of sand topdressing is accumulated, and an adequate surface slope is available (≥1%), drain tile spacing can be increased to distances greater than 20 ft.

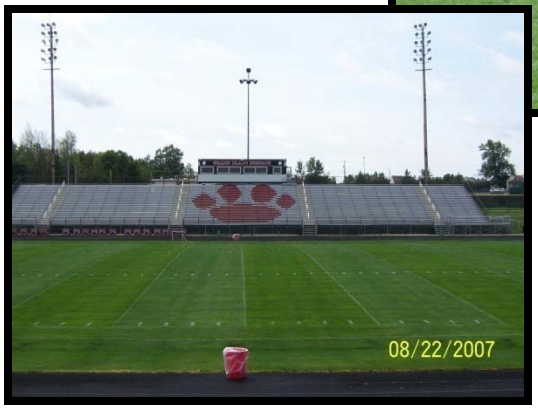

Cost Includes Material and Labor
$28,800
$21,600
$14,400
$7,200
$0
Drain Tile Spacing (ft)
None
20.0
15.0
10.0
5.0
$0
$16,200
$21,600
$32,400
$64,800
2.0
1.5
1.0
0.5
0.0
Topdressing Depth (inch)
Optimum drainage characteristics and surface stability.
Intermediate drainage characteristics and surface stability.
Minimal drainage characteristics and surface stability.

Overall Conclusions

- New recommendations
  - Irrigation system
    - $15,000
  - 13 ft drain tile spacing
    - $22,400-28,000
  - 2 inches sand topdressing
    - $28,800
  - Total
    - $66,200-71,800
- Old recommendations
  - $144,800-156,000

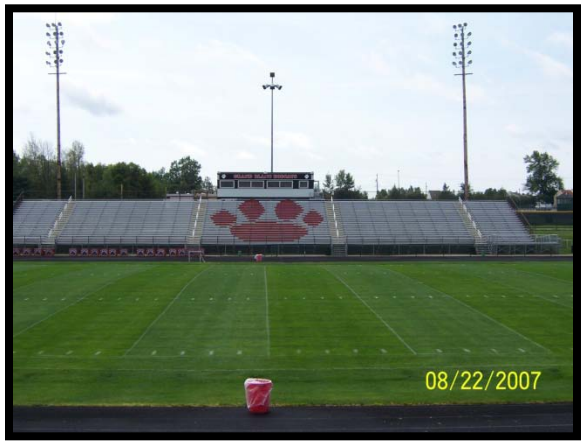


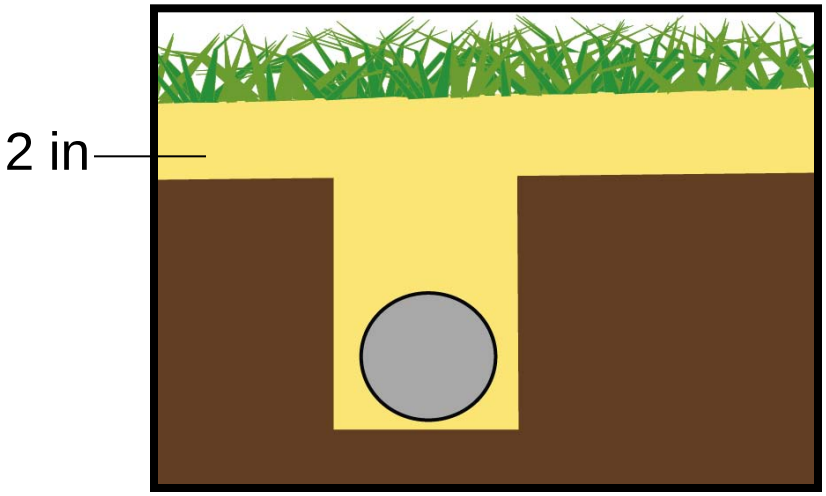
Case Studies

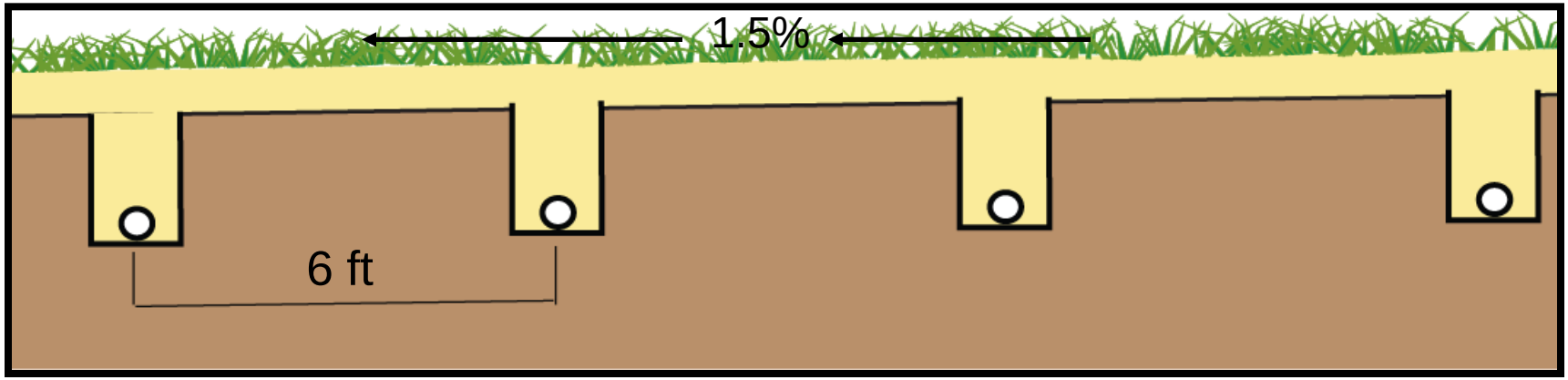


Grand Blanc High School

- May 2007





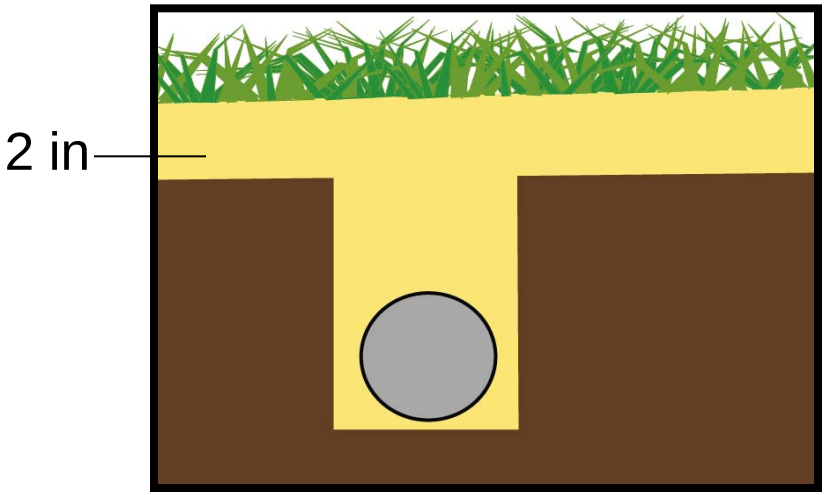


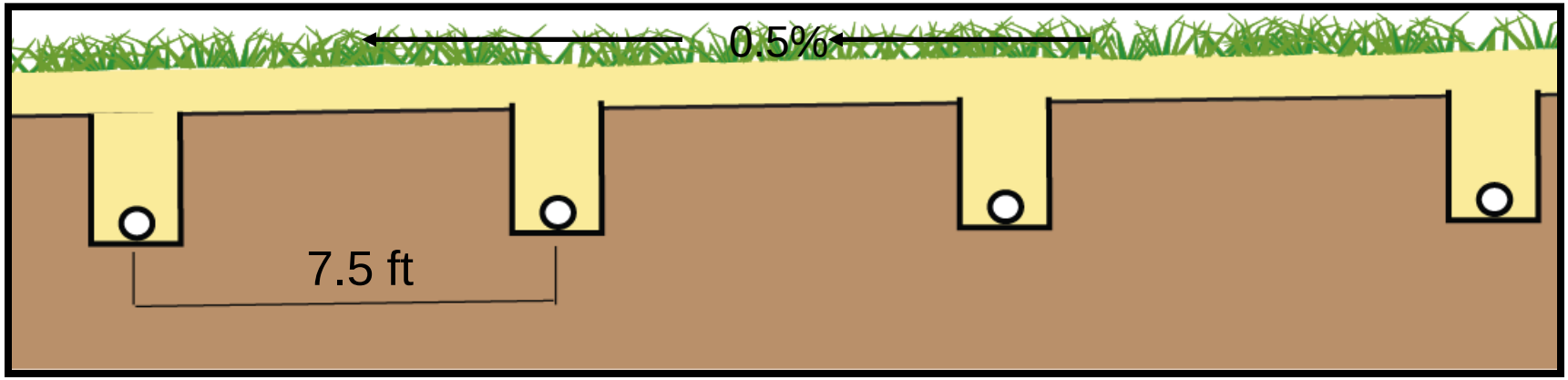
Grand Blanc HS – Dec. 2007

Grand Blanc HS – May 2009

Okemos High School

- Aug. 2007





Okemos Practice Field - Nov. 3, 2008

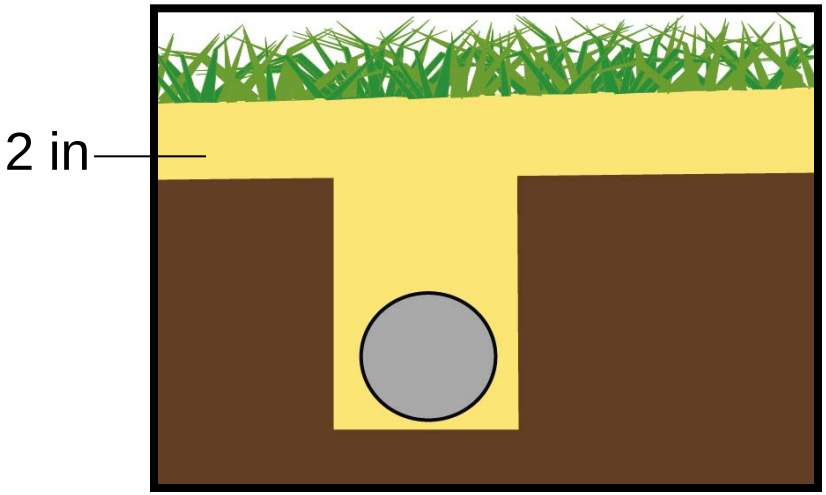
Okemos Practice Field – June 15, 2010

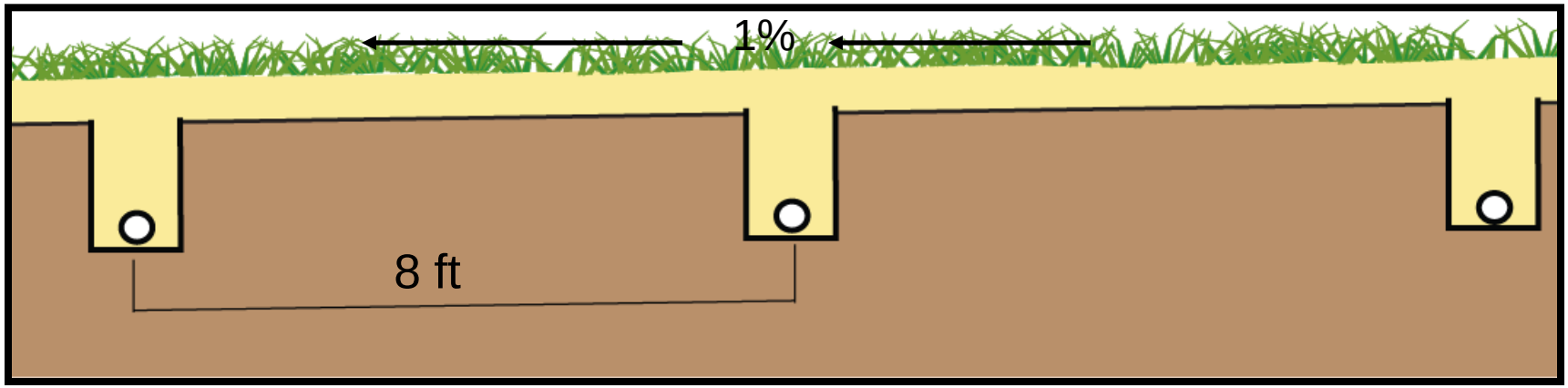
Maintenance

- Moles
  - Talpirid (bromethalin)
    - 20 worms/$35
  - Spring traps

Okemos High School

- May 2008





- Sep. 5, 2008
  - Rust (*Puccinia graminis*)
    - Urea 0.5 lbs 1000 ft^{-2}

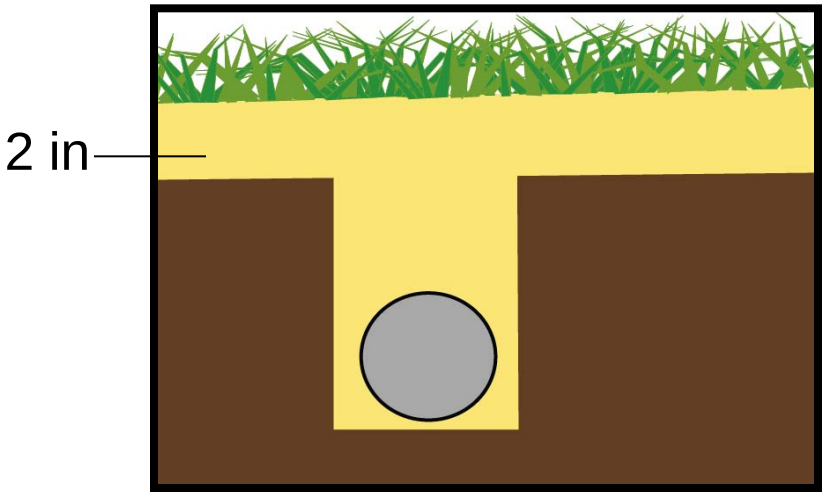
Maintenance

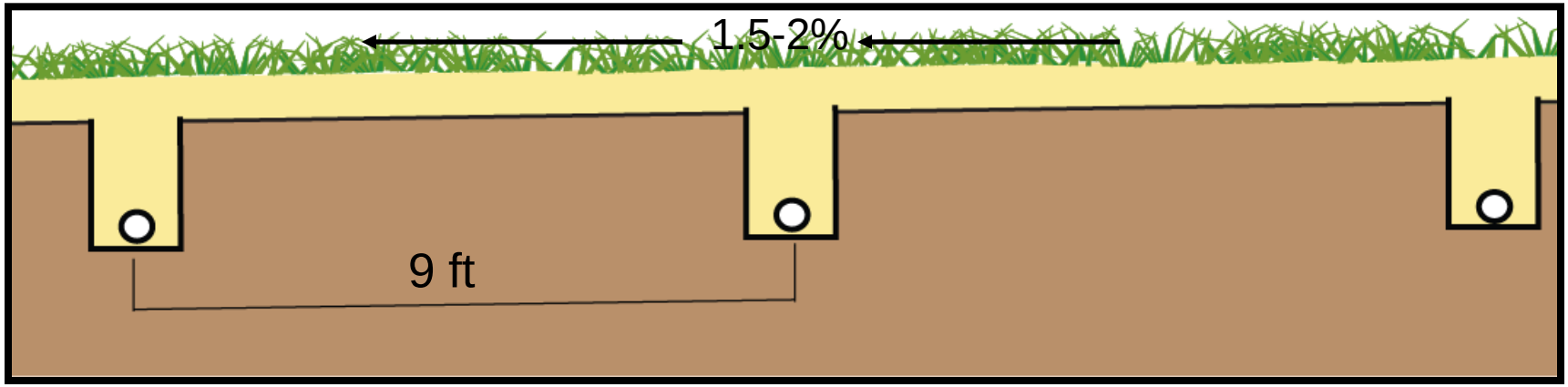
- 4 applications
  - May 25, July 4, Sep 5, Nov. 25
- Controlled release product
  - i.e. polyon (26-7-14)
    - 1 lbs 1000 ft^{-2} N
- Supplemental urea (46-0-0)
  - 0.5 lbs 1000 ft^{-2} N

Okemos Soccer Field – Oct. 27, 2009

Okemos High School

- May 2008





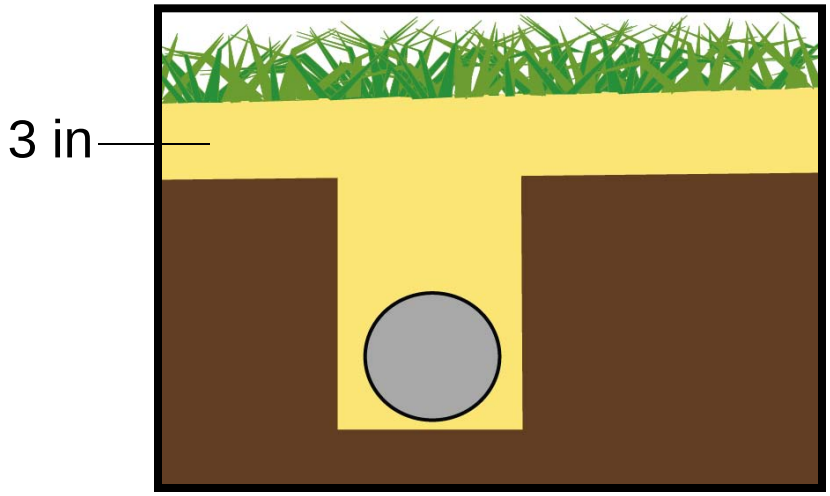
Okemos Football Field - 2010 Michigan Sports Turf Managers Association Field of the Year, Sep. 11, 2009.

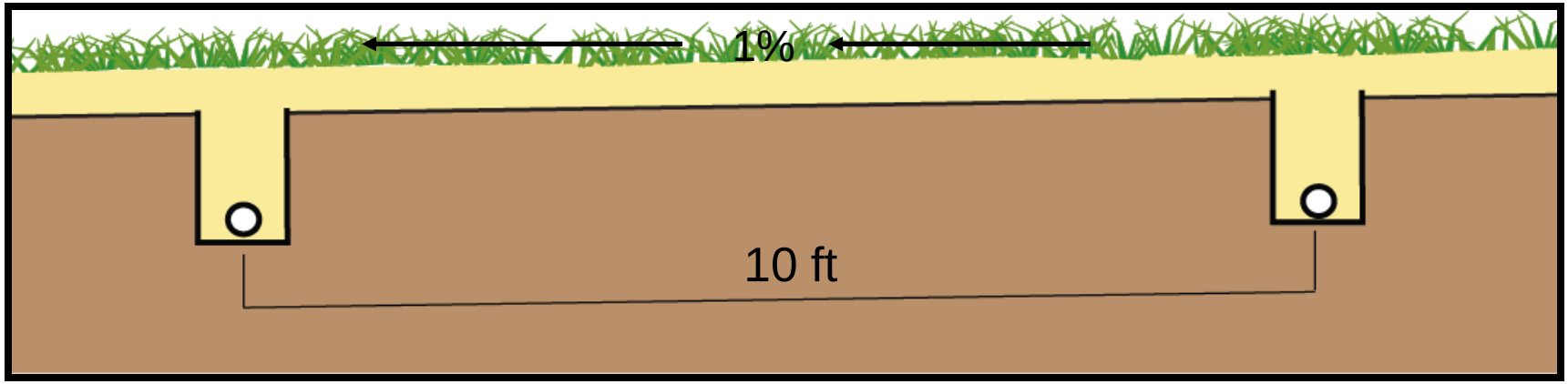
Okemos Football Field – Oct. 27, 2009

East Lansing Football Field – Oct. 27, 2009

MSU Intramural (IM)

- July 2008





MSU Intramural (IM)

- July 2008

MSU Intramural (IM)

- July 2008

MSU Intramural (IM)

- July 2008

MSU Intramural (IM)

- July 2008

MSU IM Field – Oct. 27, 2008

- Knotweed
  - Summer annual

MSU IM Field – June 16, 2009

Maintenance

- Cultivation
  - 20% affected surface area
- Topdressing
  - 0.25 inch annually

Maintenance

- Oct. 31, 2009

- Control
- 2 inches in 2 years
  - 0.25 inch maintenance

Maintenance

- Hollow tine core cultivation
  - Remove cores if native soil is excavated
- Solid tine core cultivation
  - No organic matter removal

Maintenance

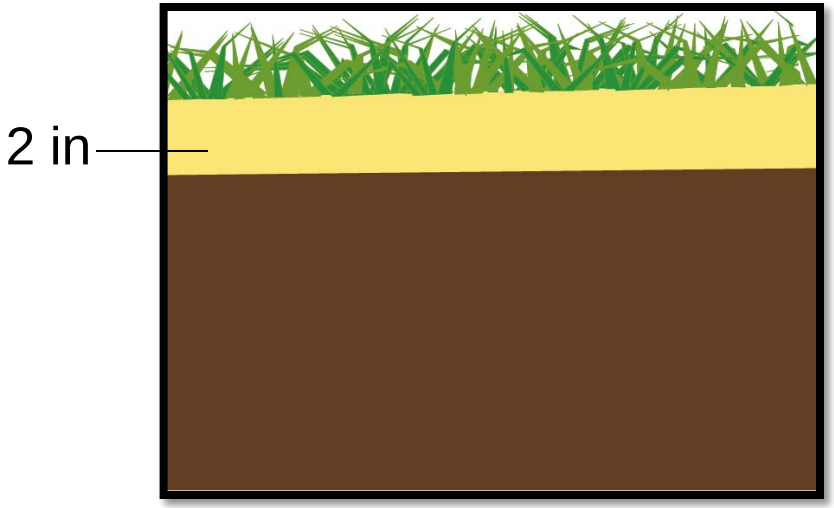
- Vertical mowing

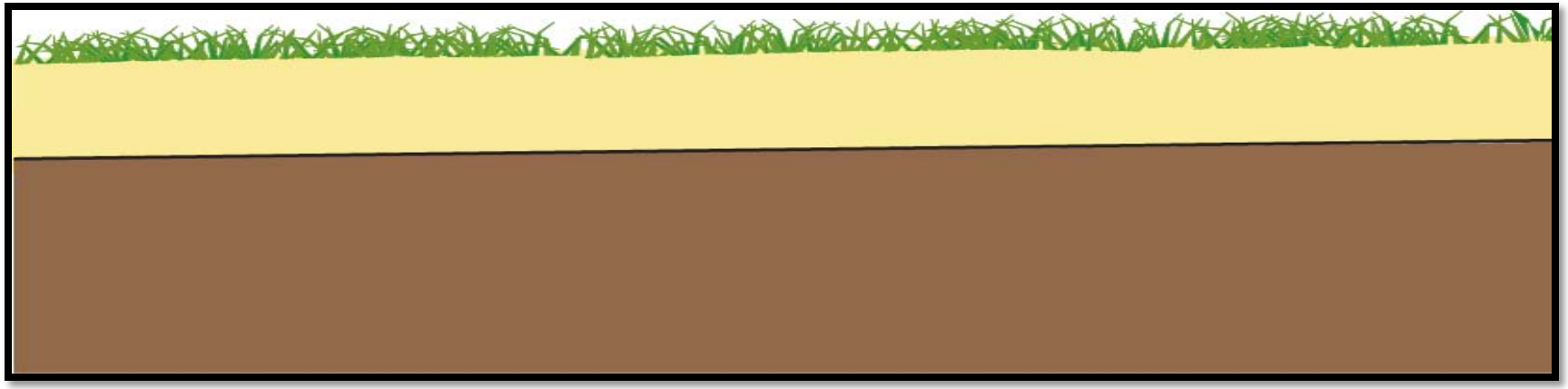
MSU IM Field – Oct. 21, 2009

Munn Field, MSU IM – Oct. 21, 2009

MSU IM Field 2

- July 2009





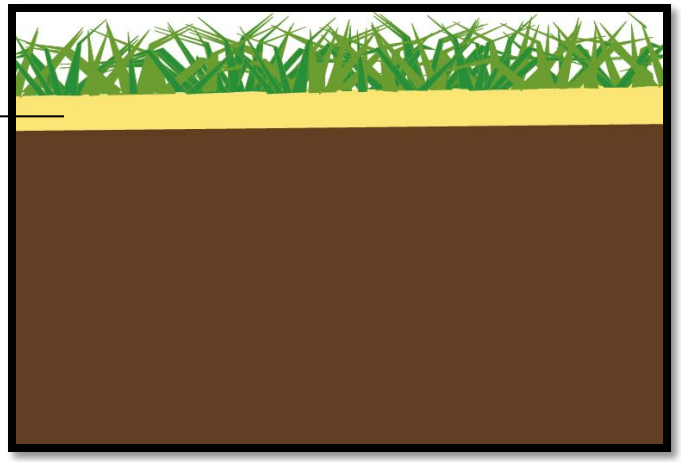
MSU IM Field 2 – Oct. 21, 2009

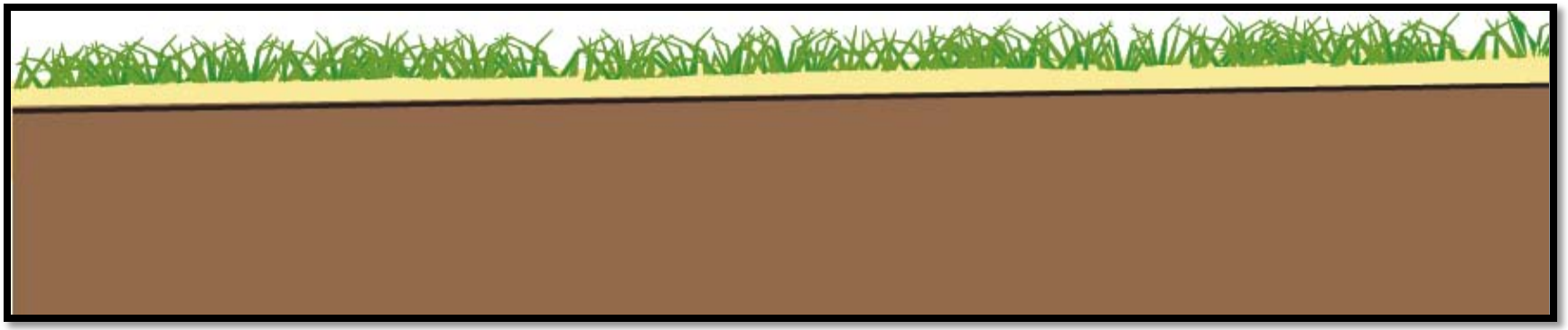
MSU IM Field 2 – Oct. 21, 2009

Haslett High School

- May 2009

1/10 in





Haslett Football Field – Oct. 27, 2009

Haslett Football Field – Oct. 27, 2009

East Lansing High School

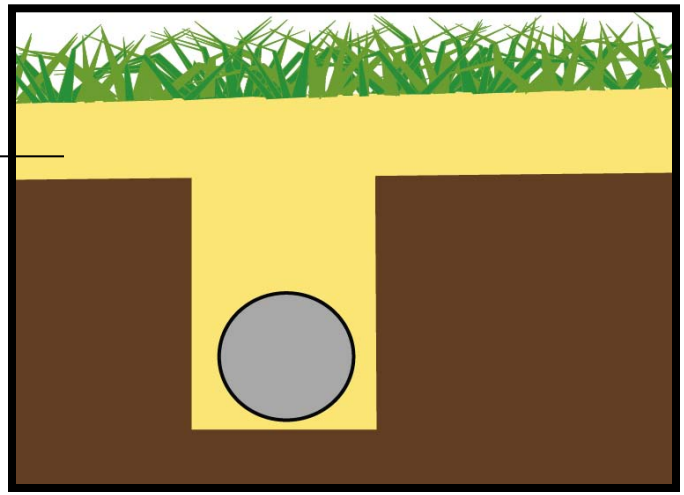
- Built-up sand-capped athletic field system 2010

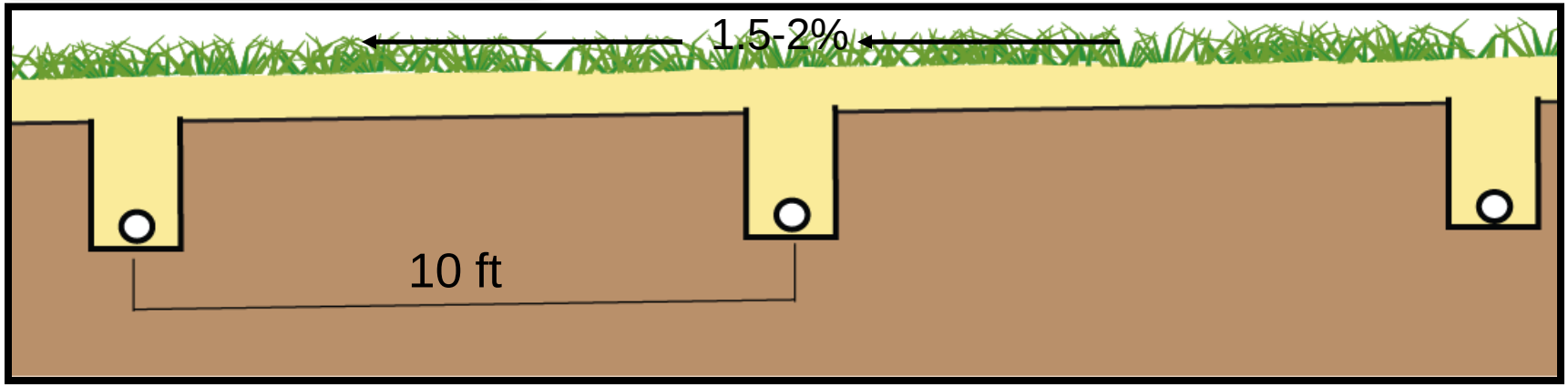
East Lansing High School

- Built-up sand-capped athletic field system 2010
  - 5 bids within 6%

East Lansing High School

- July 2010





East Lansing High School

Oct. 2009: Prior to drain tile installation and sand topdressing.

Oct. 2010: After drain tile installation and the application of 1 inch of sand topdressing.

Case Studies

- Grand Blanc football field
  - 2007
- Okemos practice field
  - 2007
- Novi soccer complex
  - 2007
- Okemos soccer field
  - 2008
- Okemos football field
  - 2008
- MSU Intramural
  - 2008
- Marshall soccer field
  - 2009
- Sheppard football field
  - 2009
- East Lansing football field
  - 2010
- Michigan Center football field
  - 2010

More Questions = More Research

- Topdressing material
  - 90% sand – 10% silt+clay
    - $14,400/1.0 inch (72,000 ft^2)
    - 1.0 inch x 72,000 ft^2 = 375 tons
    - $14,4000/375 tons = $38/ton
  - Alternative topdressing material
    - $10/ton




Objectives

- Evaluate the effects of various topdressing materials on the fall wear tolerance and surface stability of a well established turfgrass stand

Materials and Methods

- Research initiated Apr. 17, 2008
- Hancock Turfgrass Research Center
  - East Lansing, MI
- Kentucky bluegrass seeded in 2005
  - 24.7% ‘Showcase’
  - 24.6% ‘Rugby II’,
  - 24.5% ‘Midnight’
  - 24.5% ‘P 105’
- Native soil
  - Sandy loam

Materials and Methods

- Treatments
  - Topdressing
    - 8 applications @ ¼ inch
      - May 29 - Sep. 14, 08
  - Sand topdressing material
    - Sand #1
    - Sand #2
    - Sand #3
    - Sand #4

2.0 inch sand topdressing layer, accumulated over a 3.5 month period, 2008.

Materials and Methods

	Sand #1	Sand #2	Sand #3	Sand #4
Particel Size (mm)	Sieve fraction sand particle diameter (% retained)			
>2.0	0.1	0.3	0.0	23.7
1.0-2.0	3.7	9.1	0.1	17.2
0.5-1.0	24.0	19.9	2.6	20.4
0.25-0.5	45.8	39.3	69.2	23.7
0.1-0.25	23.1	18.7	27.3	11.6
0.05-0.1	0.9	2.7	0.2	1.0
0.002-0.05	0.4	7.0	0.0	0.5
<0.002	2.0	3.0	0.6	1.9
	dollars/ton			
Cost	$25	$35	$15	$10

Materials and Methods

- Crumb rubber
  - Particle size
    - 2.0-6.0 mm
  - 4 applications @ ¼ inch
    - May 29 - Sep. 14, 08

1.0 inch crumb rubber layer , accumulated over a 3.5 month period, 2008.

Materials and Methods

- Sand then crumb rubber
  - 4 applications @ ¼ inch
    - Sand #1
      - May 29 – July 10, 2008
  - 4 applications @ ¼ inch
    - Crumb rubber
      - July29 – Sept. 14, 2008

1.0 inch of crumb rubber over 1.0 inch of sand, accumulated over 3.5 months, 2008.

Materials and Methods

- Control
  - No topdressing

Materials and Methods

- Fall traffic (Oct. 15 – Nov. 14, 2008)
  - 2 passes/week
    - 1 pass forward
    - 1 pass backward

Materials and Methods

- Response variables
  - Turfgrass cover (0-100%)
  - Turf shear tester strength (Nm)
- Collected following fall traffic
  - Nov. 14, 2008

2008 Results

- Can alterative topdressing materials, other that 90% sand – 10% silt/clay, be used to improve fall wear tolerance and surface stability?

Mean values for turfgrass cover and turf shear tester strength following fall traffic simulator applications, East Lansing, MI, 14 Nov. 2008.

Topdressing material	Cover (0-100%)	Turf shear tester (Nm)
	2008 Mean values	
crumb rubber	85.0a†	120.8bc
sand #1 then crumb rubber	80.0a	143.2ab
sand #1	63.3b	139.2abc
sand #2	60.0bc	136.6abc
sand #3	60.0bc	109.7bc
sand #4	48.3bc	107.0c
control	46.7c	160.2a

† Means followed by the same letter are not significantly different according to LSD (0.05).

2008 Results

- Effects of the Cady traffic simulator on a Kentucky bluegrass stand without topdressing (left) and crumb rubber topdressing (right), Nov. 14, 2008.

Conclusions

- Crumb rubber, while being the most expensive topdressing material ($1,000/ton) produced the greatest turfgrass cover.
- The control, no topdressing, while producing TST strength raking in the greatest category, provided the lowest turfgrass cover
- Topdressing sand #1 and 2 produced TST values ranking in greatest category
- Topdressing sand #4, a poorly-graded sand, produced the lowest TST strength

Recommendations

- Crumb rubber
  - Sidelines
  - High traffic areas

Recommendations

- When selecting topdressing material
  - Sand #1 ($25/ton)
    - Well-graded sand
  - Sand #2 ($35/ton)
    - Well-graded sand
  - Sand #3 ($15/ton)
    - Well-graded sand
  - Sand #4 ($10/ton)
    - Poorly-graded sand

  - Maximum 10% silt/clay

More Questions = More Research

- What practices can be used to speed up turfgrass establishment over recently renovated drain lines?

Objective

- Evaluate the effects of seeding mulch on Kentucky bluegrass establishment from seed over a sand-filled intercept drain line.

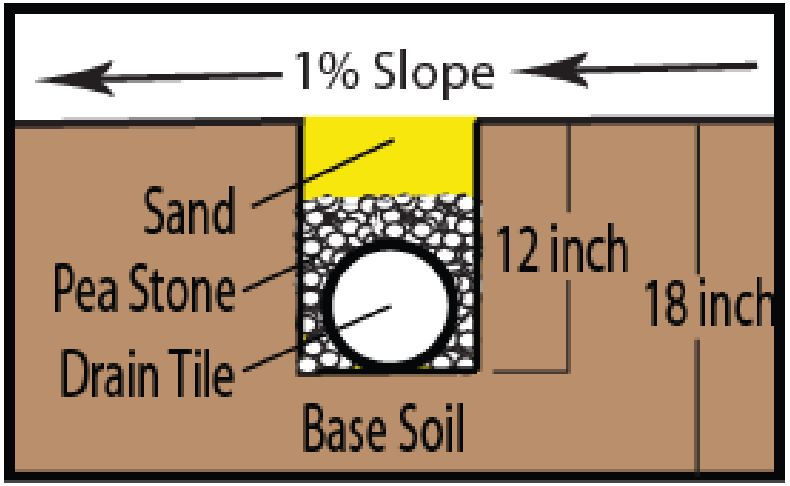
Materials and Methods

- Research initiated May 26, 2010
- Hancock Turfgrass Research Center
  - East Lansing, MI
- Native soil
  - Sandy loam

- Cool-season turfgrass stand seeded in 2007
  - 90% Kentucky bluegrass
  - 10% perennial ryegrass

Materials and Methods

- Existing intercept drain lines
  - Excavated
  - Filled with sand

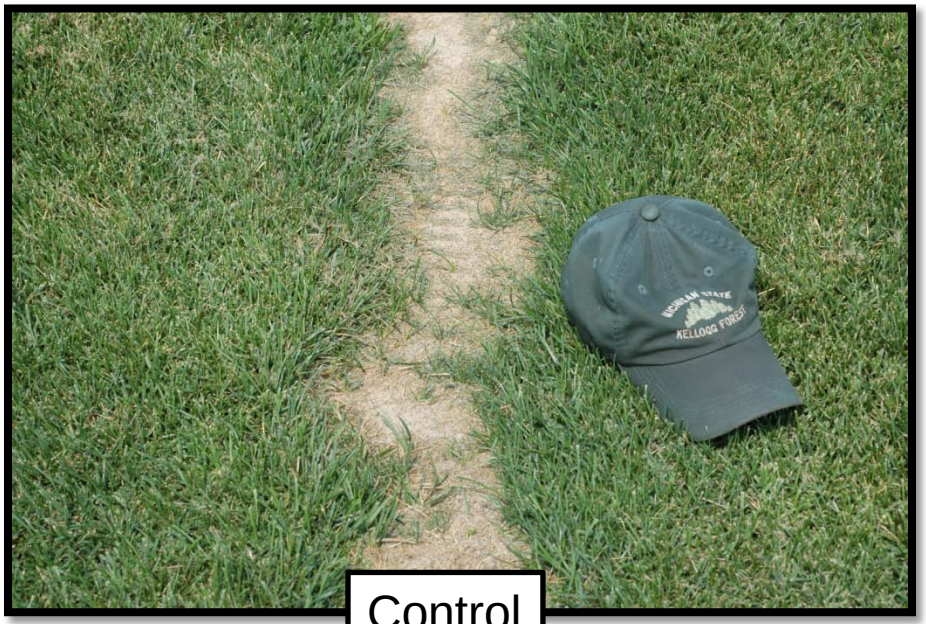


Materials and Methods

- Seeded
  - Kentucky bluegrass blend
    - 1.5 lbs/1,000 ft^2
- Treatments
  - Seeding mulch
    - 50 lbs/1,000 ft^2
  - Control

2010 Results

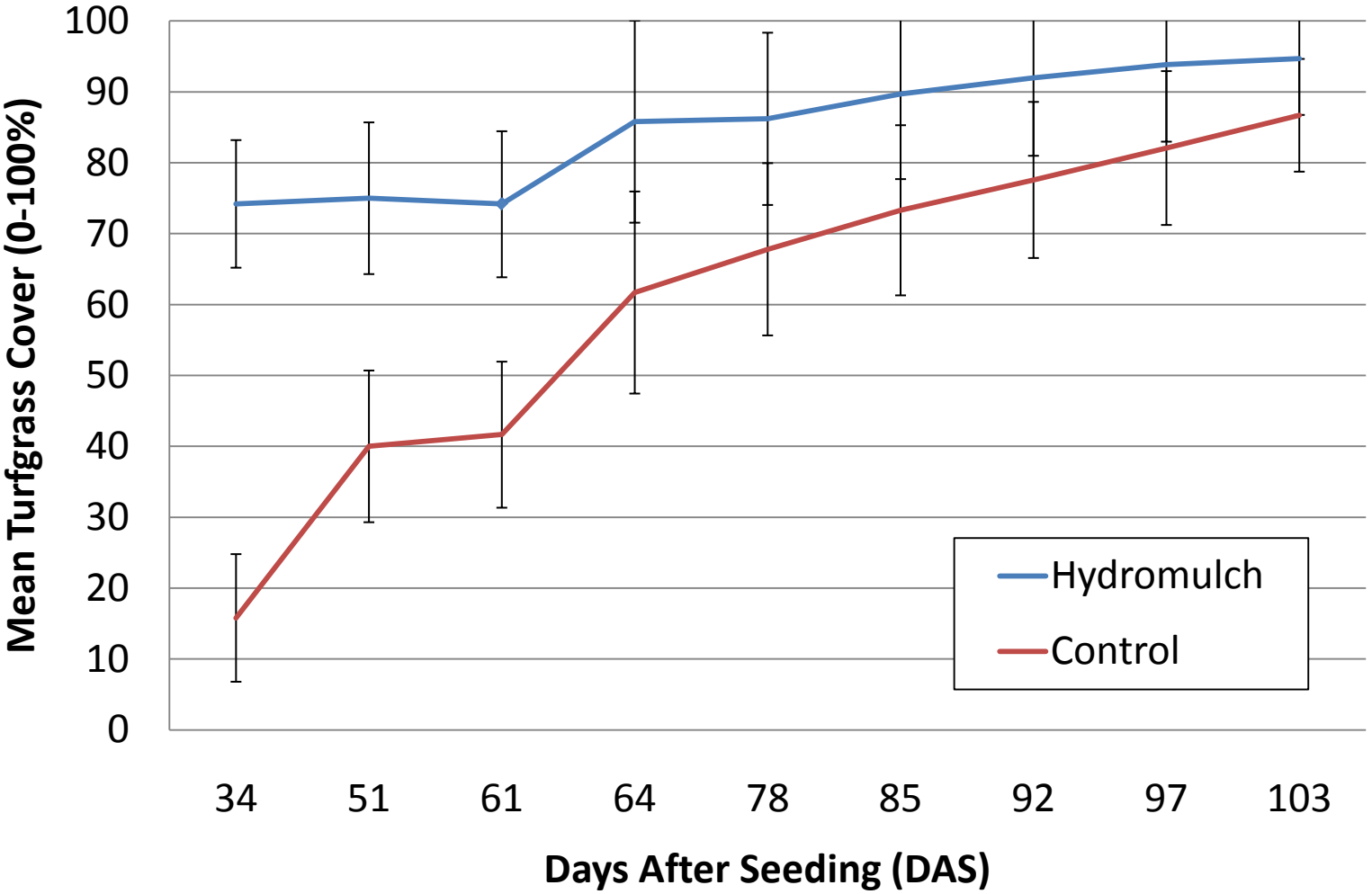
- Effects of seeding mulch on Kentucky bluegrass establishment from seed over a sand-filled intercept drain line, 51 DAS.



Control

Seeding mulch

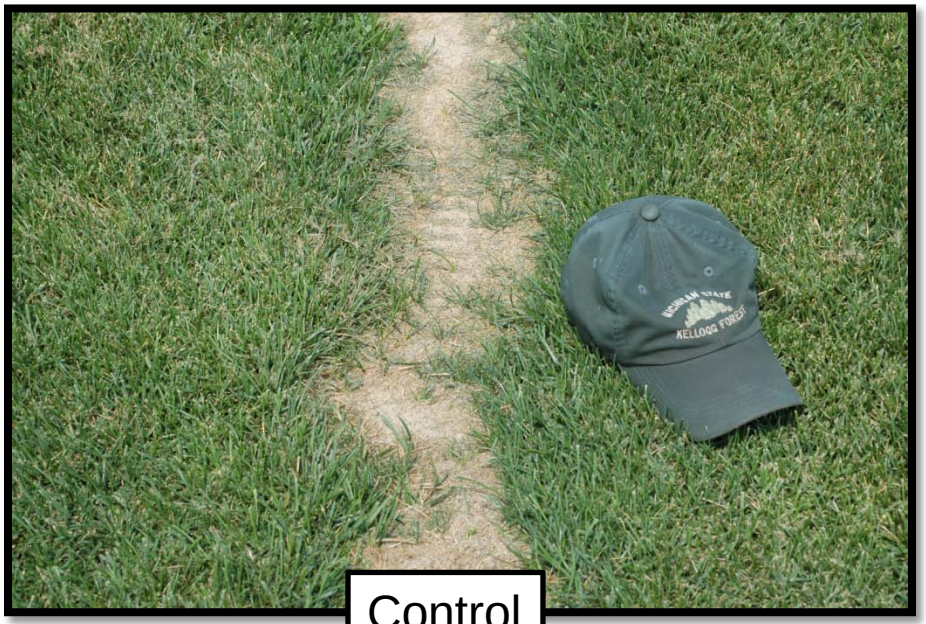
Effects of seeding mulch on Kentucky bluegrass establishment from seed over sand filled intercept drain lines, renovated May 26, 2010.



Means values with overlapping error bars are not significantly different according to LSD (0.05).

2010 Results

- Effects of seeding mulch on Kentucky bluegrass establishment from seed over a sand-filled intercept drain line, 51 DAS.



Control

Seeding mulch

2010 Results

- Effects of seeding mulch on Kentucky bluegrass establishment from seed over a sand-filled intercept drain line, 103 DAS.


Control

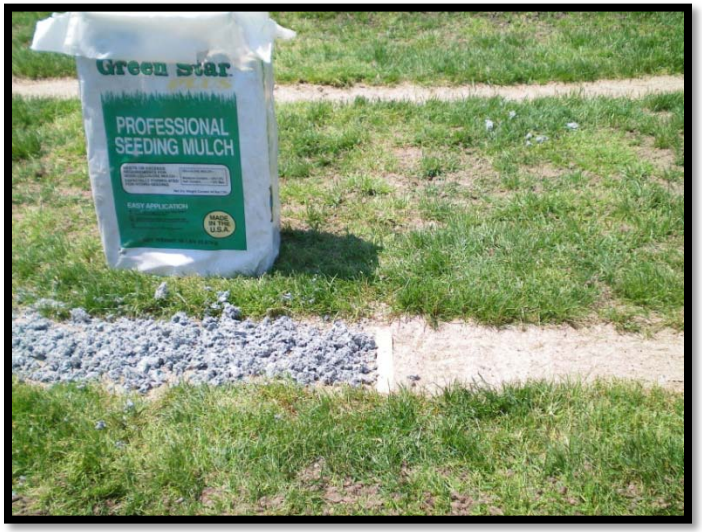

Seeding mulch

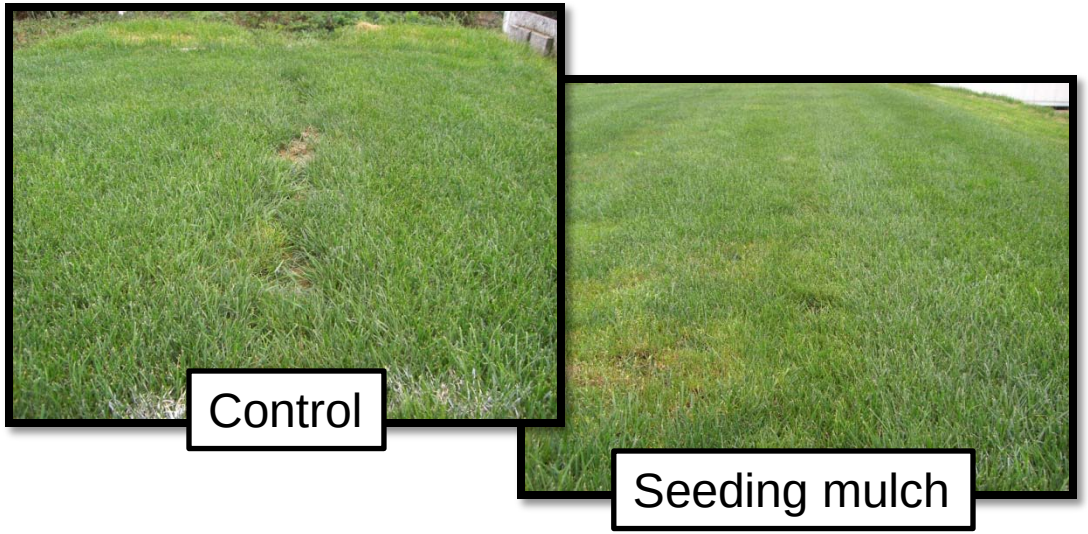
Conclusions

- If field use will begin sooner than 64 days following renovation then…
  - Seeding mulch can provide substantially greater turfgrass cover over recently renovated Intercept drain lines
  - Seeding mulch
    - $??/50 lbs
    - 50 lbs/1,000 ft^2
  - Intercept drain tile spacing
    - 13 ft/3,000 ft^2
      - $???

Conclusions

- If field use will begin 64 days after renovation or later…
  - Benefits of seeding mulch are no longer significant





Questions?

- Extension bulletin
  - Sand-capped build-up systems for Michigan high school fields.
    - http://www.turf.msu.edu/built-up-sand-capped-athletic-field-system
- Publications
  - Sand Topdressing Applications Improve Shear Strength and Turfgrass Density on Trafficked Athletic Fields
    - http://horttech.ashspublications.org/cgi/content/abstract/20/5/867
- Abraham Baldwin Agricultural College
  - http://www.abac.edu