Vegetative Barriers

a new upland buffer tool

- This is a new practice for which there is not currently a National Practice Standard. This module was developed from a draft standard developed by Bob Glennon and the Mississippi standard Vegetative Barrier (Interim) Code 205.
- This technology has been widely used in various parts of the tropics. An interagency U.S. work group has been involved in evaluating it since 1989. Further evaluation under more state interim practice standards is needed. This chapter provides the best guidance available at this time.
- For more information on international applications see: www.vetiver.org

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Definition - Vegetative Barriers (also referred to as grass hedges)

- narrow, parallel strips of stiff, erect, dense grass planted close to the contour
- cross concentrated flow areas at convenient angles for farming
- managed in such a way that any soil berms that develop are not smoothed out during maintenance operations

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Purposes - Vegetative Barriers

- 1. Control erosion, trap sediment, and facilitate benching of sloping cropland
- 2. Control ephemeral gully erosion and trap sediment in concentrated flow areas
- 3. Trap sediment at the bottom of fields and at the end of furrows
- 4. Improve the efficiency of other conservation practices

- Four purposes are included in the national practice standard being drafted. They are discussed sequentially in this presentation, with emphasis on the first two.

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Additional Benefits - Vegetative Barriers

- Retard and reduce surface runoff by promoting detention and infiltration
- Divert Runoff to a stable outlet
- Entrap and transform sediment-borne and soluble contaminants
- Provide wildlife habitat

- In addition to the 4 purposes, a number of additional benefits can be recognized.

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Parallel barriers divide field into short tilled strips, making tillage impact greater

- This view of the Southland Farm was taken in the fall of 1992, the first full year after switchgrass barrier establishment. Vertical interval between barriers is 4 to 5 ft in this field. Maximum recommended vertical interval is 6 ft, 4 ft in concentrated flow areas. Periodic surveys have documented changes in slopes over time.
- Note that switchgrass will not grow in shade of tree.

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- Narrow barriers with stiff woody stems carried over from the previous year are the most resistant to concentrated flow. Switchgrass has particularly strong stems.
- In controlled flume studies, backwaters as great as 15 inches deep (0.4 m) have not caused 1-ft wide barriers to fall over.

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Sediment deposits upslope of barriers

- Sediment is not deposited in the barrier but upslope. Only residues are trapped, by filtration, on the vegetation.
- Research has shown that most sediment larger than 125 microns is trapped, while trapping of sediment between 32 and 125 microns is trapped at low flows.

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- On USLE scale plots, 70% of sediment was trapped by barriers with up-and-down slope tillage. RUSLE would predict lower erosion from tillage parallel to contour barriers.

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Physical Effects
(How Vegetative Barriers Function)

- Coarse, stiff, hedge-forming grasses can withstand high water flows and sediment
- Concentrated flows are slowed and spread, scouring and head cuts are replaced by sediment deposition
- Vegetative barriers disperse flows before runoff enters other conservation buffers.

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Sediment deposited upslope of barriers and soil moved from shoulders by tillage gradually level flow areas

- Tillage moves soil from shoulders into swales, causing most rapid leveling in swale areas. Runoff is dispersed over a much wider area than when concentrated in an ephemeral. Sediment trapped is derived primarily from ephemeral below upslope barrier.

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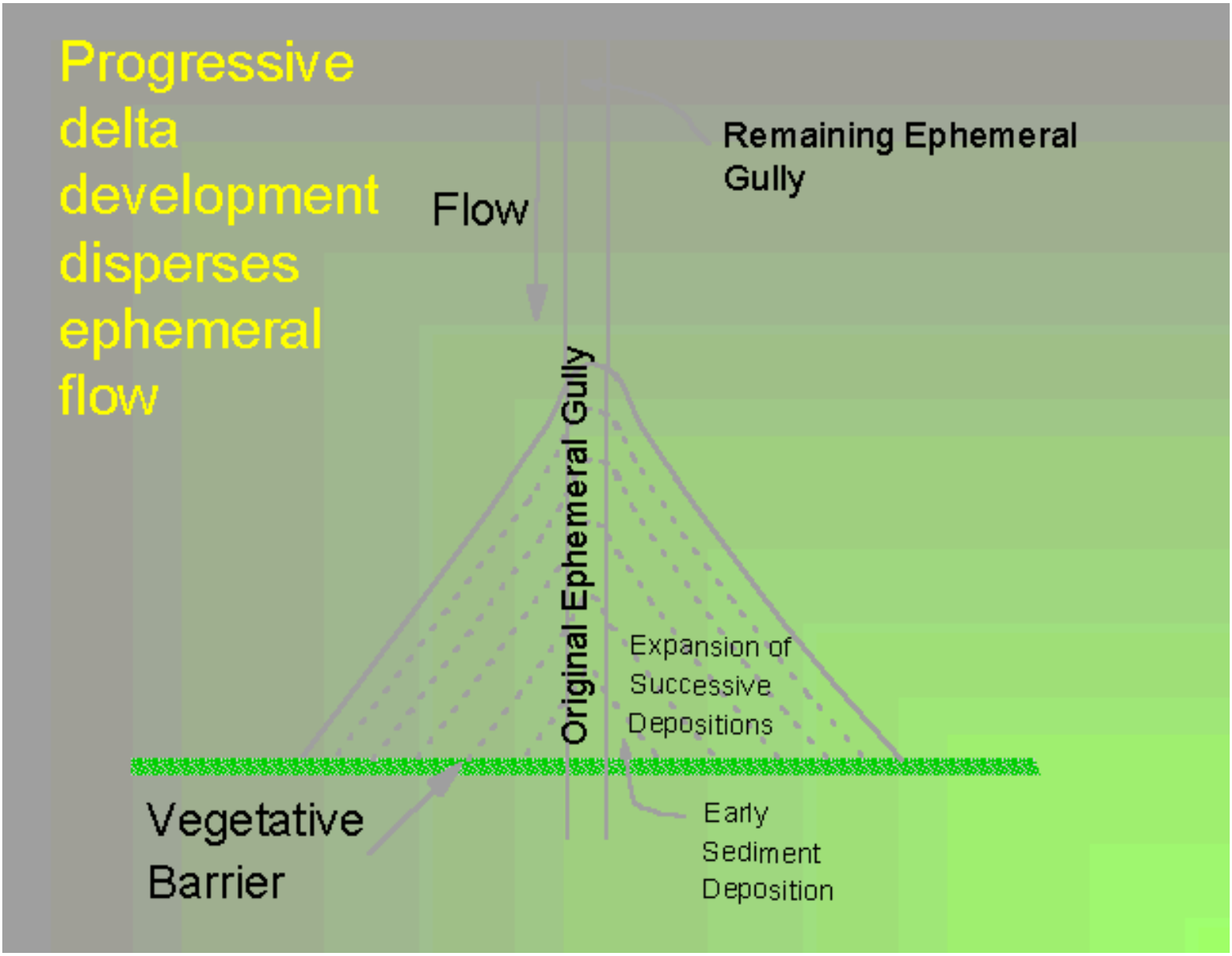

- Swale areas are gradually filled over time, both by tillage translocation and erosion/deposition. As swales are leveled, future runoff is further and further dispersed making the system more and more stable over time.

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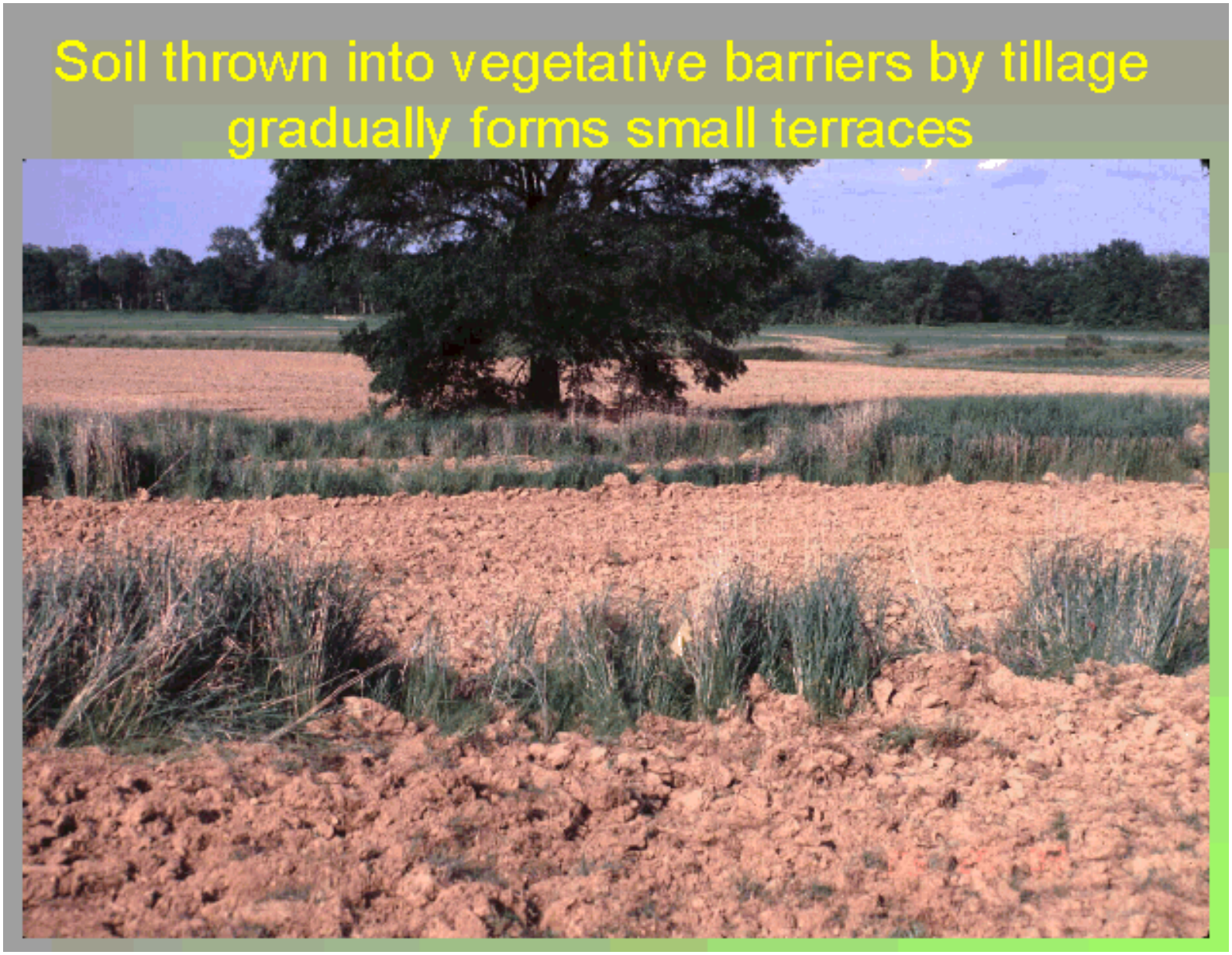

- Tillage moves soil down slope and into vegetative barriers. Over time, clods coalesce to form continuous berms that redirect runoff if barriers are not exactly on the contour.

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Tillage moves soil both in the direction of travel and sideways

- Tillage not only creates conditions conducive to water erosion, but directly moves soil down slope
- Gradients between and along barriers will become flatter and more uniform over time
- Berms formed in vegetative barriers divert runoff along the barriers in the same way that terraces redirect water.

- Tillage erosion rates are calculated by dividing the amount of soil moving downslope across a contour line by the up-and-down field length. Barriers divide a hillslope into a number of short tilled fields and so amplify the impact of tillage translocation and resulting in the gradual formation of bench terraces.
- Tillage moves soil into vegetative barriers. Clods eventually coalese into berms that can act as mini-gradient terraces if barriers are not strictly on the contour.

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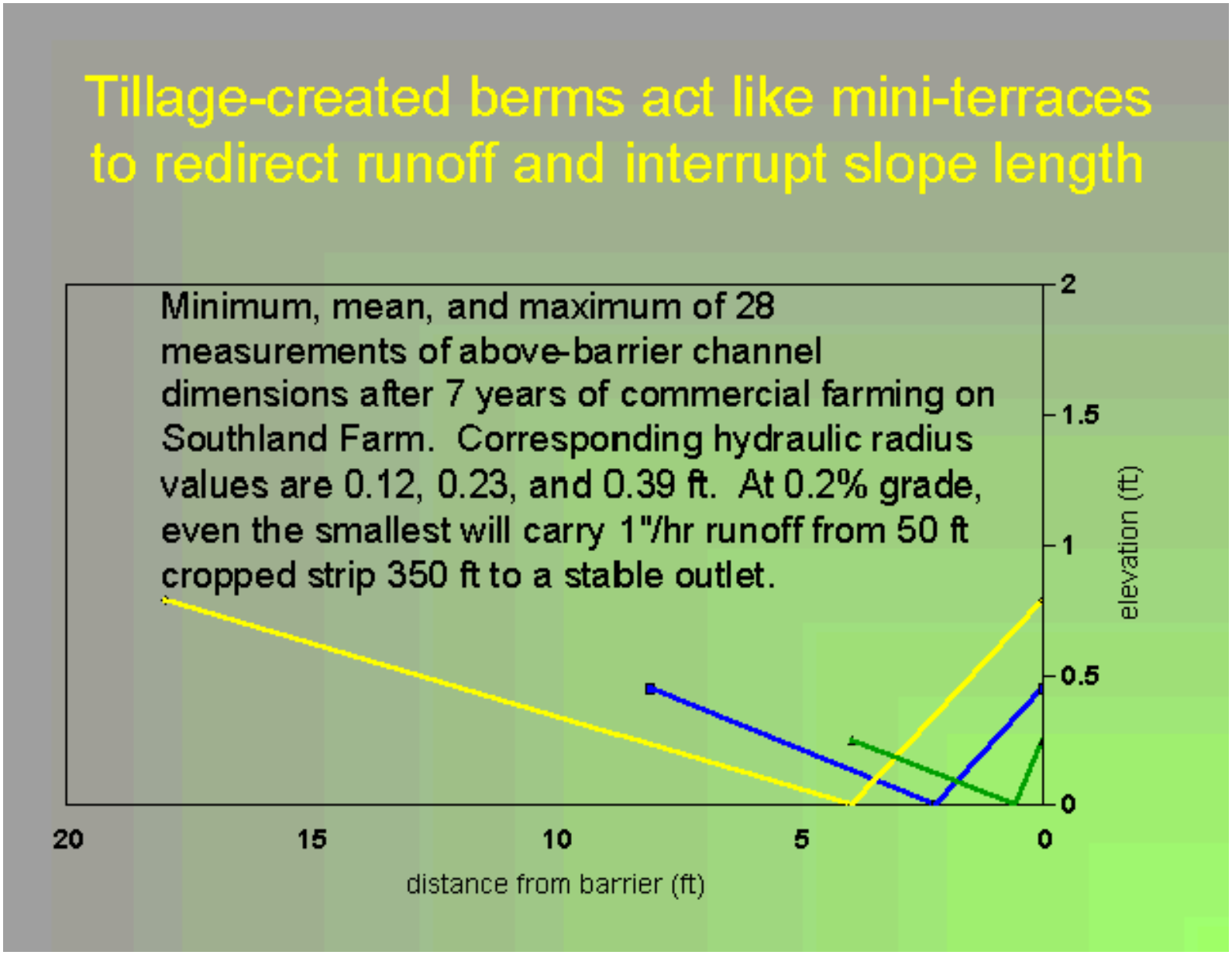

- When barriers deviate from the contour, berms created over time by tillage can divert runoff to a stable outlet. This slide shows the minimum, mean and maximun dimensions of channels created on one field over seven years. Calculations indicate the berms are large enough to divert most of the runoff that occurs on this field.
- By diverting runoff, barriers shorten slope length and reduce downslope erosion. The stable outlet may be a series of concentrated flow barriers or, in larger fields, a grassed waterway or a tile-outlet terrace.

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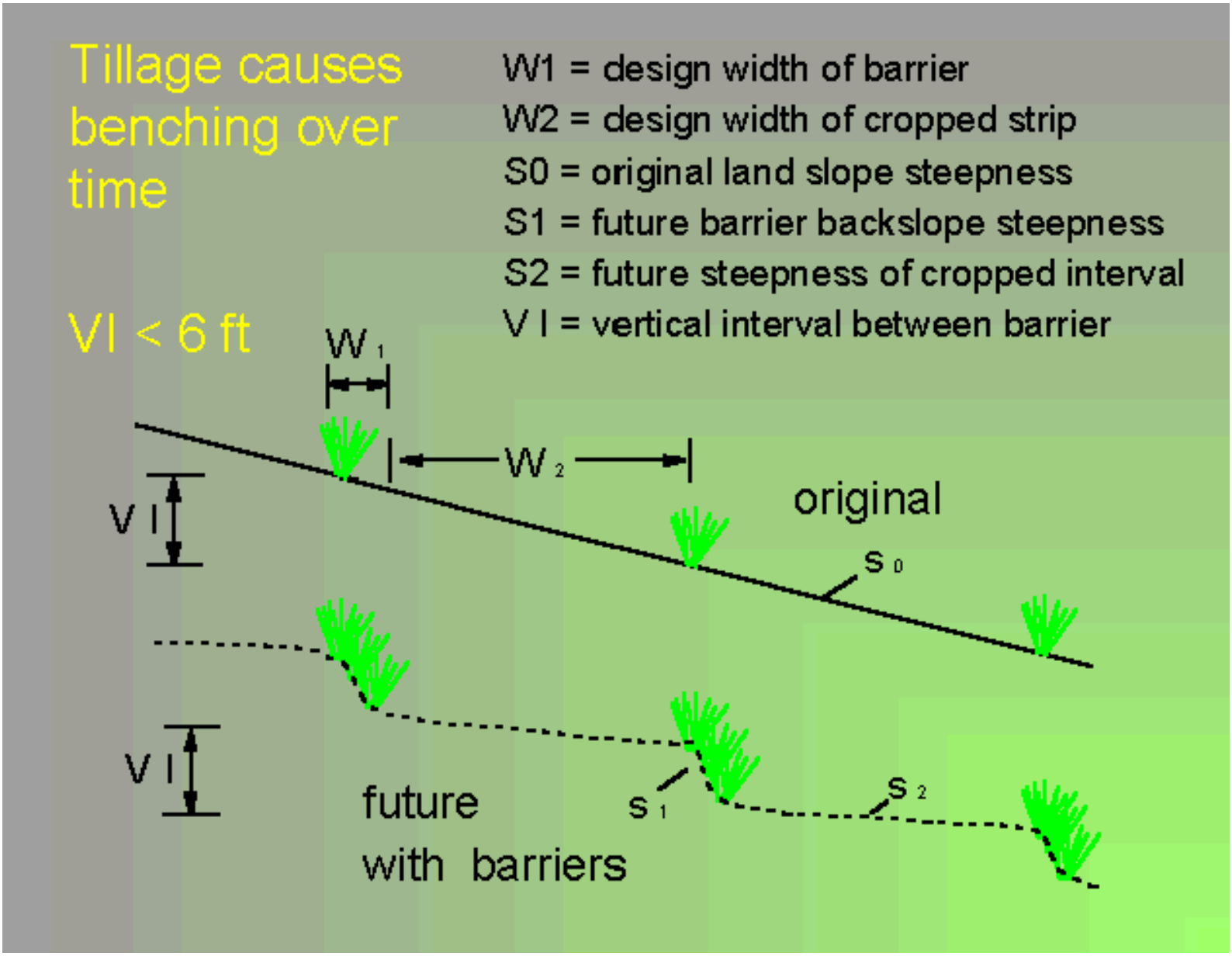

- Tillage causes benching. Benching reduces slope steepness, which in turn reduces future erosion and runoff.
- Whether or not the productivity of subsoils exposed downslope of barriers can be increased by amendments or deep tillage should be considered in planning barrier systems.
- To limit the size of the benching, the maximum allowed vertical interval is 6 ft. This is reduced to 4 ft in concentrated flow areas.

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Vegetation Guidelines

- 50 stems/ft^2 in all barriers
- M x D^4 >0.1 to resist concentrated runoff
  - example:

    70 stems/ft^2
    stem diameter = 0.2 in

    70 x 0.2^4 = 0.112
- Mowing decreases average stem diameter

- Vegetion specifications are more stringent in concentrated flow areas.
- While stem density is the same as for other grass buffers at 50 stems/ft2, where flow is concentrated stem diameter is an additional criteria.
- Because stem stiffness is proportional to the 4th power of the diameter, this is a critical pamameter. A formula is given to assess adequacy for concentrated flow areas.
- It is best not to mow vegetation in concentrated flow areas since this decreases average stem diameter to an extent that cannot be compensated for by increased stem numbers.

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Grass species of adequate character include:

- Grasses Native to the Contiguous U.S.
- switchgrass (*Panicum virgatum*)
- coastal panicgrass (*Panicum amarum* var. amarulum)
- eastern gamagrass (*Tripsacum dactyloides*)
- basin wildrye (*Leymus cinerus*)
- big sacaton (*Sporobolus wrightii*)

- Exotic Grasses
- tall wheatgrass (*Elytrigia elongata*)
- Altai wildrye (*Leymus cinerus*)
- mammoth wildrye (*Leymus racemosus*)
- Chinese silver grass (*Miscanthus sinensis*)
- vetivergrass (*Vetiver zizanioides*)

- A number of grasses possess the desired vegetative characteristics.
- Grasses should be selected that are adapted to the local climate. Native grasses are preferred.

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Vegetation Guidelines

- Barrier should be at least 3 feet wide
  - Tall-growing barriers may be made wider to accommodate available mowing equipment
  - Stable backslope steepness (S1, Fig. 1) may also require wider barriers
- Barriers may be established from seed, but transplants are faster in critical areas

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- Barriers may be as narrow as one row (3 ft).
- They may need to be wider to accomodate mowing equipment or to create a stable backslope.

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'Alamo' switchgrass has large stem diameter but grows so tall that yield of adjacent crops is reduced. Such barriers need to be wide enough for available mowing equipment.

- Tall-growing switchgrass cultivars can compete with and reduce yields of adjacent rows of short-growing crops.

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- More compact, shorter-statured varieties are more desirable, if stem density and stem diameter are not sacrificed.
- Short-statured varieties allow barriers to be planted that do not have to be mowed and so permit barriers narrower than the width of mowing equipment.

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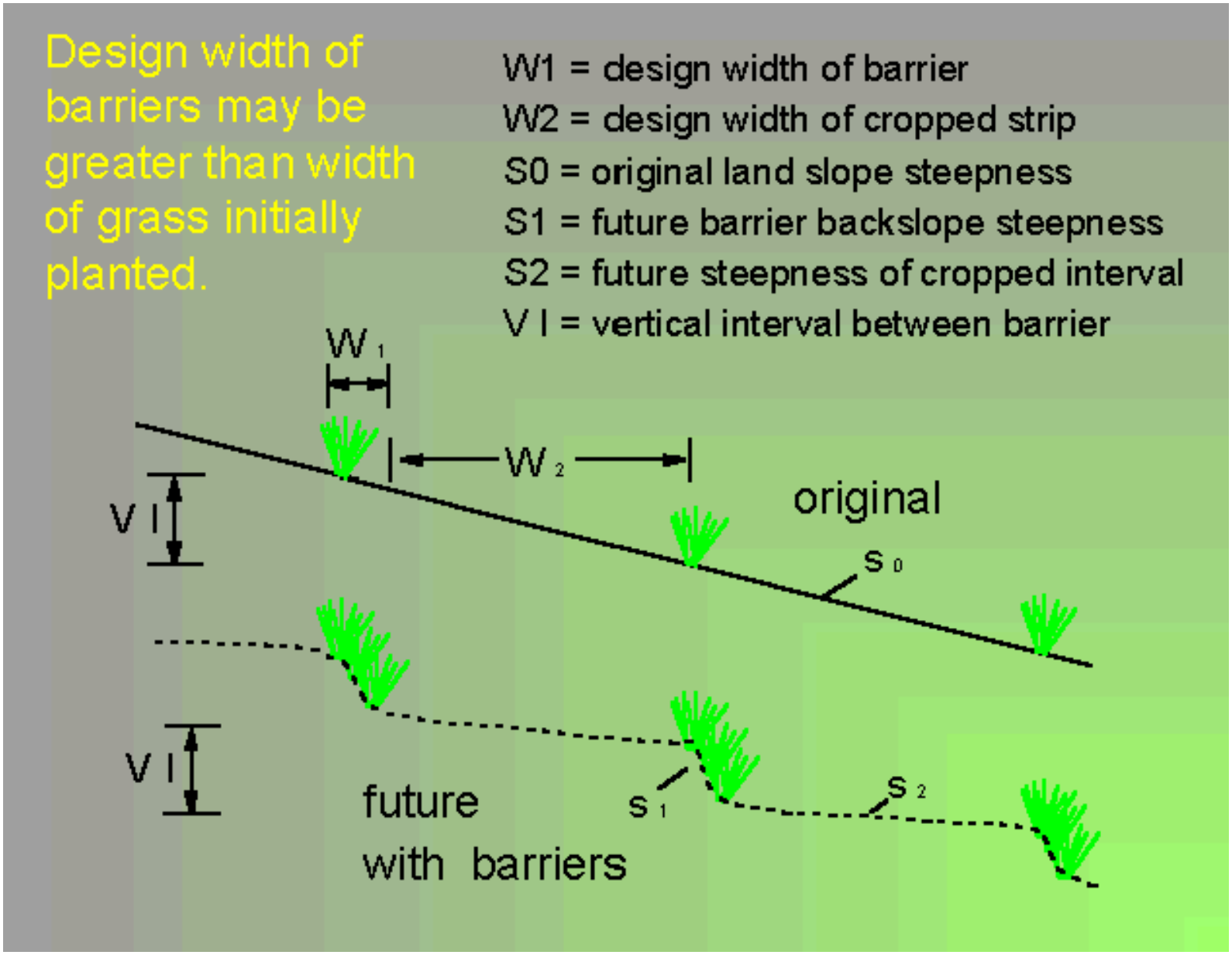

- Minimum barrier width may depend on the stable backslope steepness, that is a function of site-specific soil, flow, and vegetation conditions.
- The design width of barrier may need to be wider than the amount of grass initially planted.

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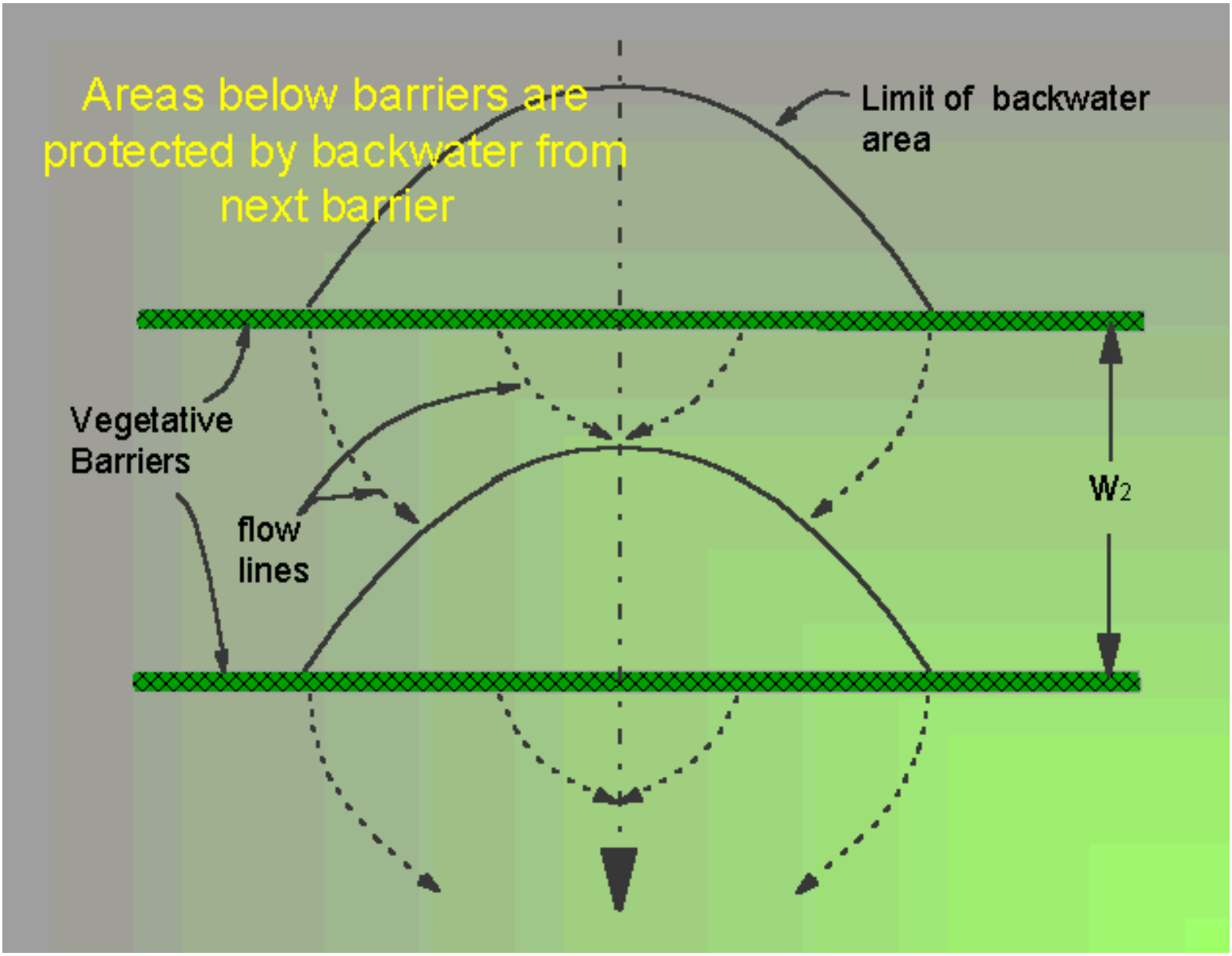

- The most downslope barrier should be located on footslope below which exiting flow velocities do not exceed critical velocities for ambient land use.
- In concentrated flow areas, barrier backslopes are protected by the backwater extending from the next downslope barrier.

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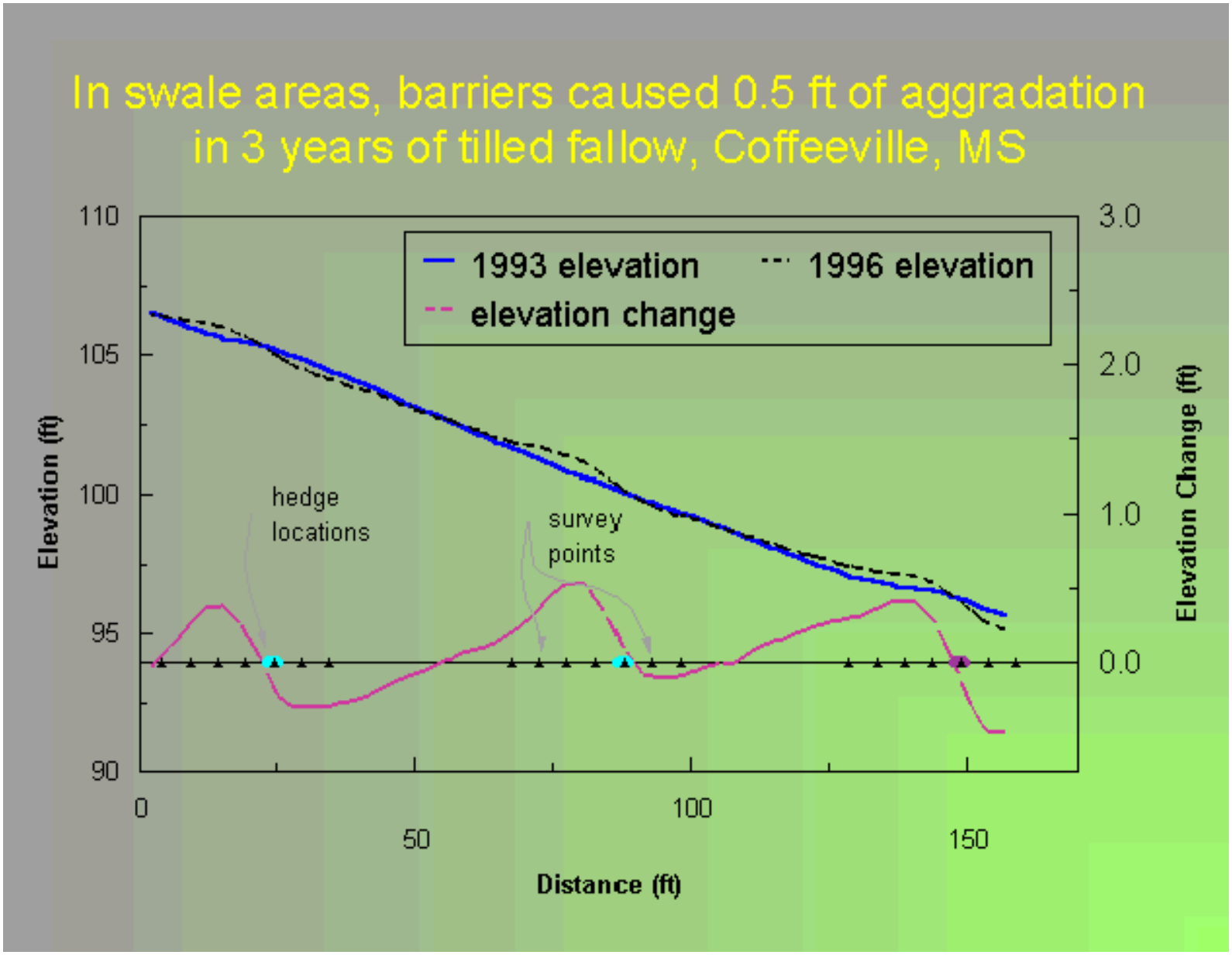

- Slope changes can occur in a relatively short time, particularly in swale areas. In a study at the Coffeeville, MS, NRCS Jamie Whitten Plant Materials Center, 0.5 ft of aggradation above barriers occurred in 3 years of tilled fallow. Tillage translocation could account for about 50% of this soil movement.

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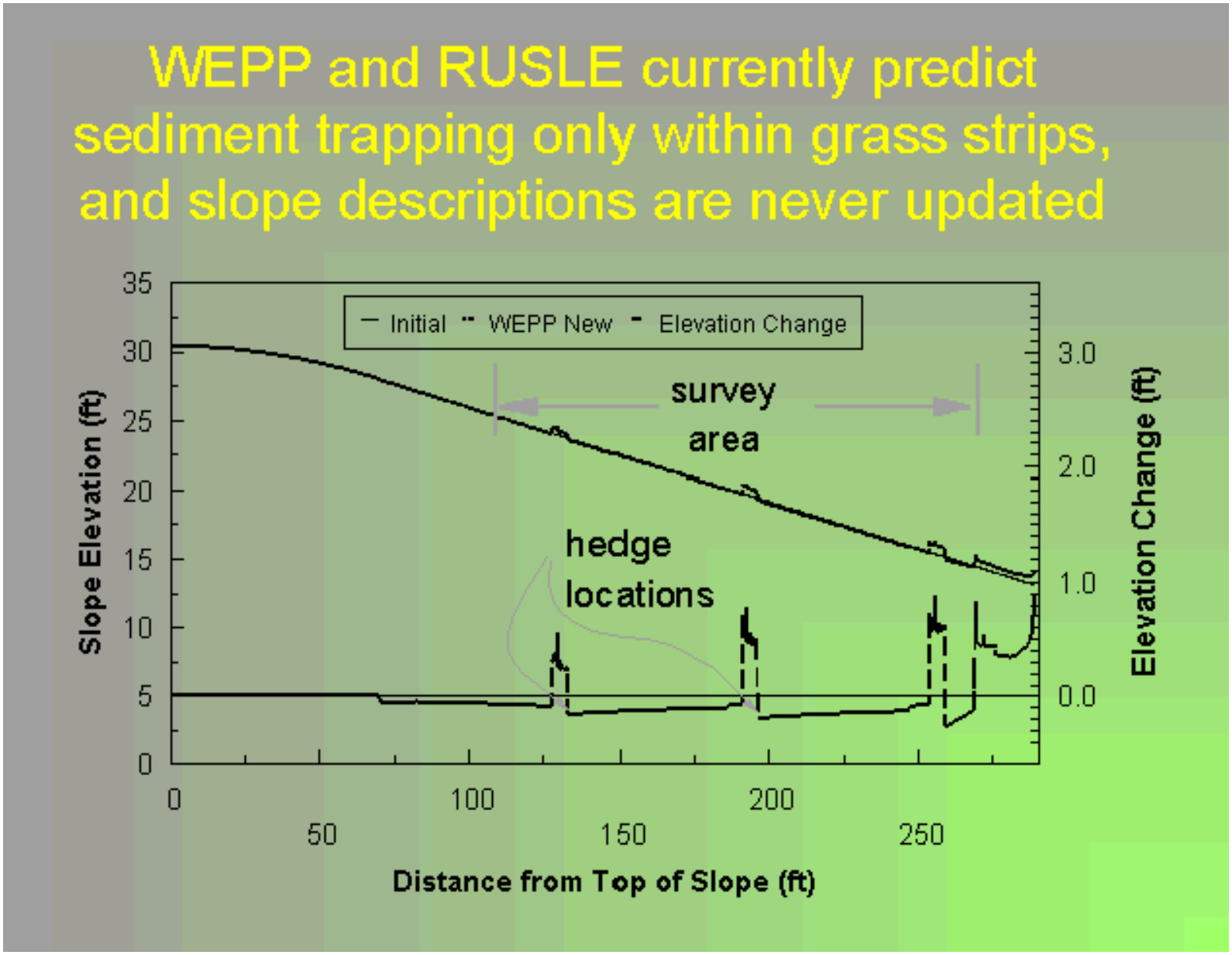

- Because WEPP and RUSLE do not update slope description based on erosion and deposition, and do not account for tillage translocation, long term evaluation of vegetative barrier conservation credit is difficult.

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Conservation Credit - RUSLE
varies with time barriers are in place

- contouring and strip cropping P subfactors
- effective width after well established
  - 0.12 L for < 5%
  - 0.08 L for 5 - 10%
  - 0.05 L for 10-15%
- if terraces are seen to develop, L reduction may be appropriate

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- Based on consultation with Glen Weesies and George Foster, there are three appropriate ways to calculate conservation credit for vegetative barriers using RUSLE. Which one is appropriate depends on how the barrier is functioning.
- When first established, credit is based on barrier width through the RUSLE P-factor. When well established, effective barrier width can be increased to account for backwater effects with guidelines recommended by Toy and Foster (1998). Finally, if the conservationist sees that berms have developed and that runoff is being redirected, treating barriers like terraces and reducing L may be appropriate.

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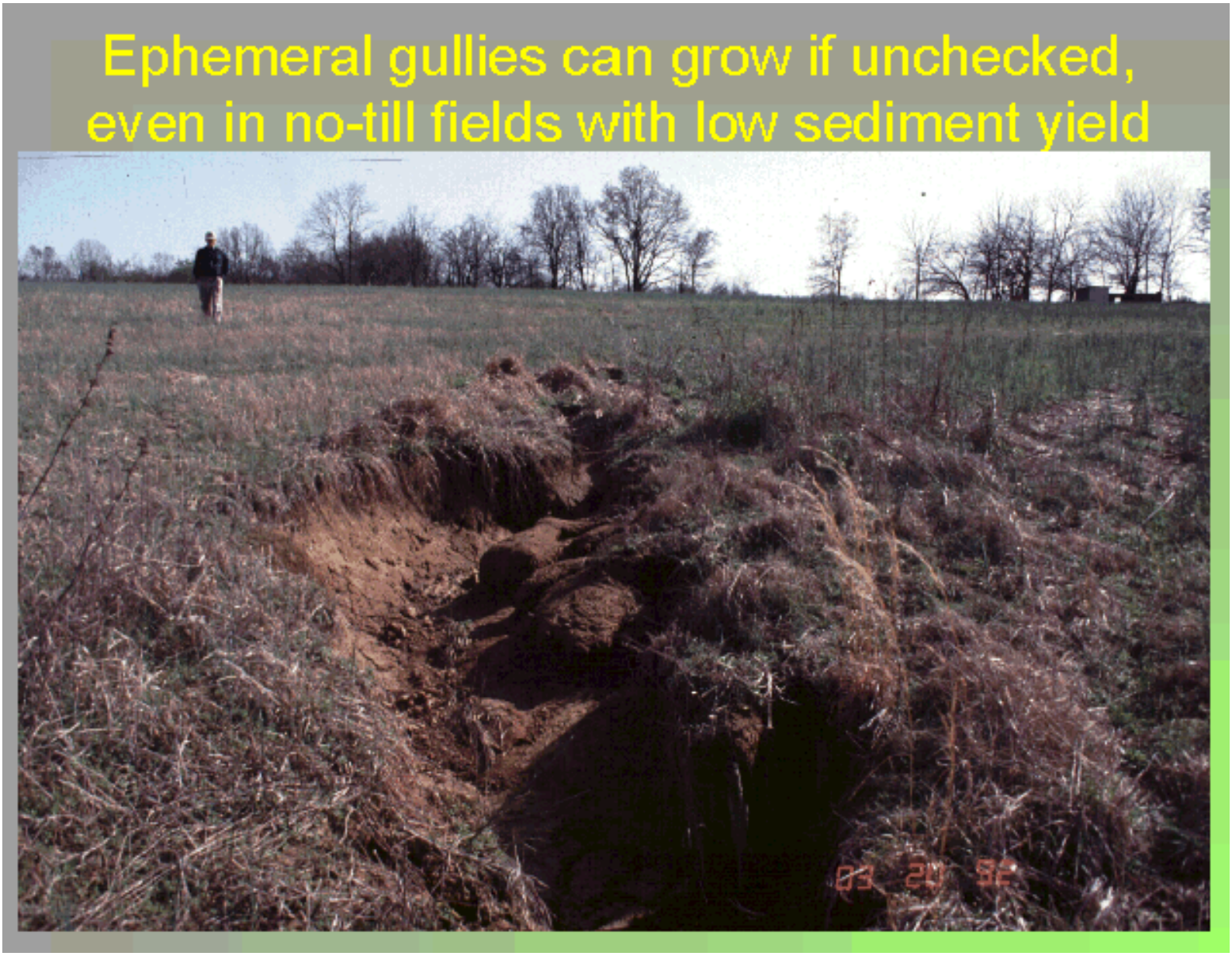

- Once headcuts are initiated, no-till cannot solve concentrated flow erosion problems.
- Over a five year field, this gully grew in a no-till soybean field in Mississippi from which sediment yield was less than 1 t/a/y. Instead of fixing this site with a terrace to intercept concentrated runoff, a series of vegetative barriers was established.

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Temporary burlap checkdams prevent switchgrass transplanted or seeded upslope from washing.

- First, the gully was filled with soil borrowed from the footslope.
- Next, switchgrass was transplanted as well as seeded and burlap checkdams were established downslope of the grass to slow runoff and keep the seedling from washing away and to trap moisture for them.
- Burlap is more effective than silt fence because it allows more water to pass through it instead of finding a way around or over it; and it only needs to remain functional a short time.

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- Discrete vegetative barriers have stabilized a concentrated flow area after a gully was filled. No-till farming can now be conducted straight across what was a 3-ft deep gully.

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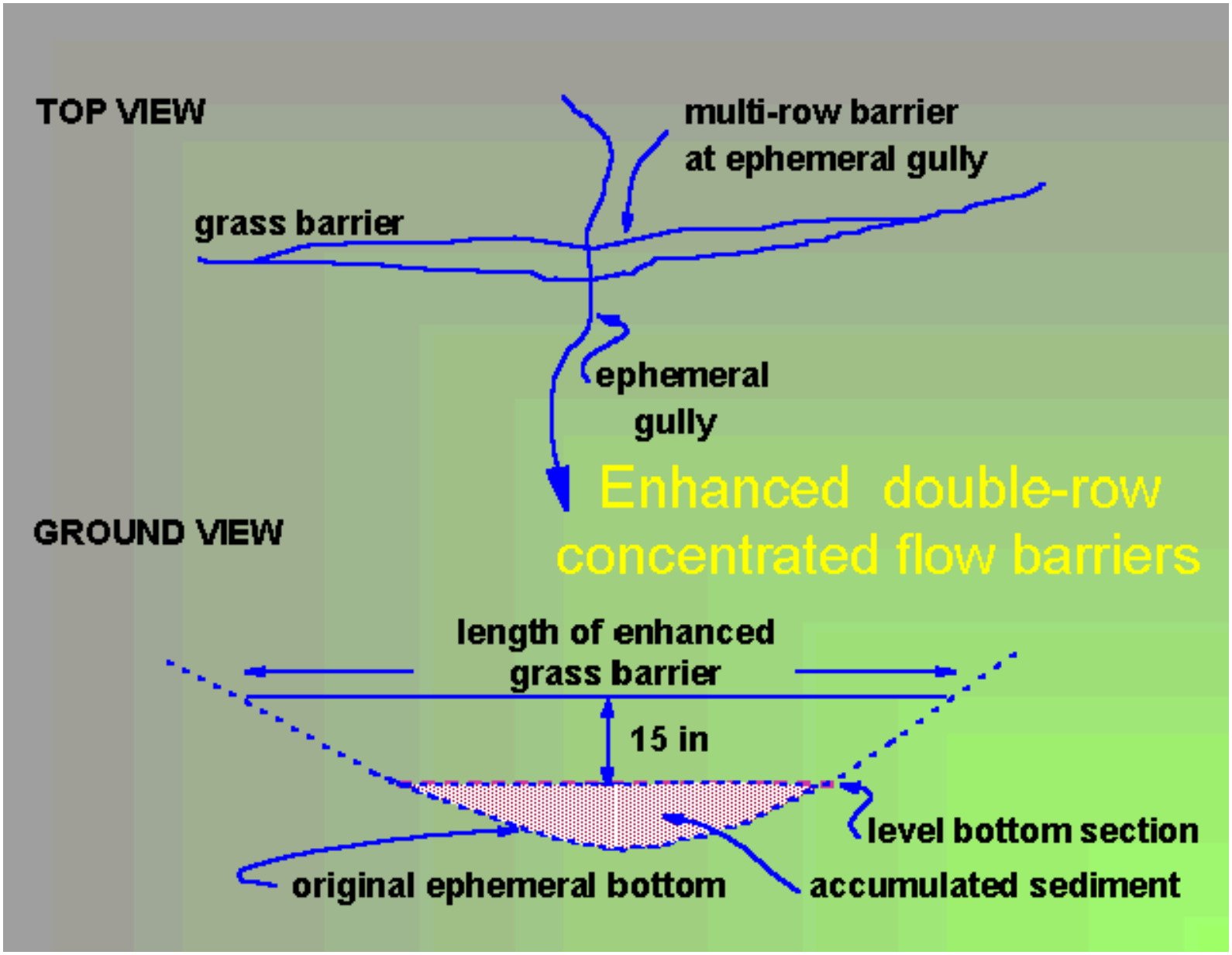

- In concentrated flow areas, discrete barriers should be two rows wide and should extend long enough to prevent bypass flow around the barrier ends.

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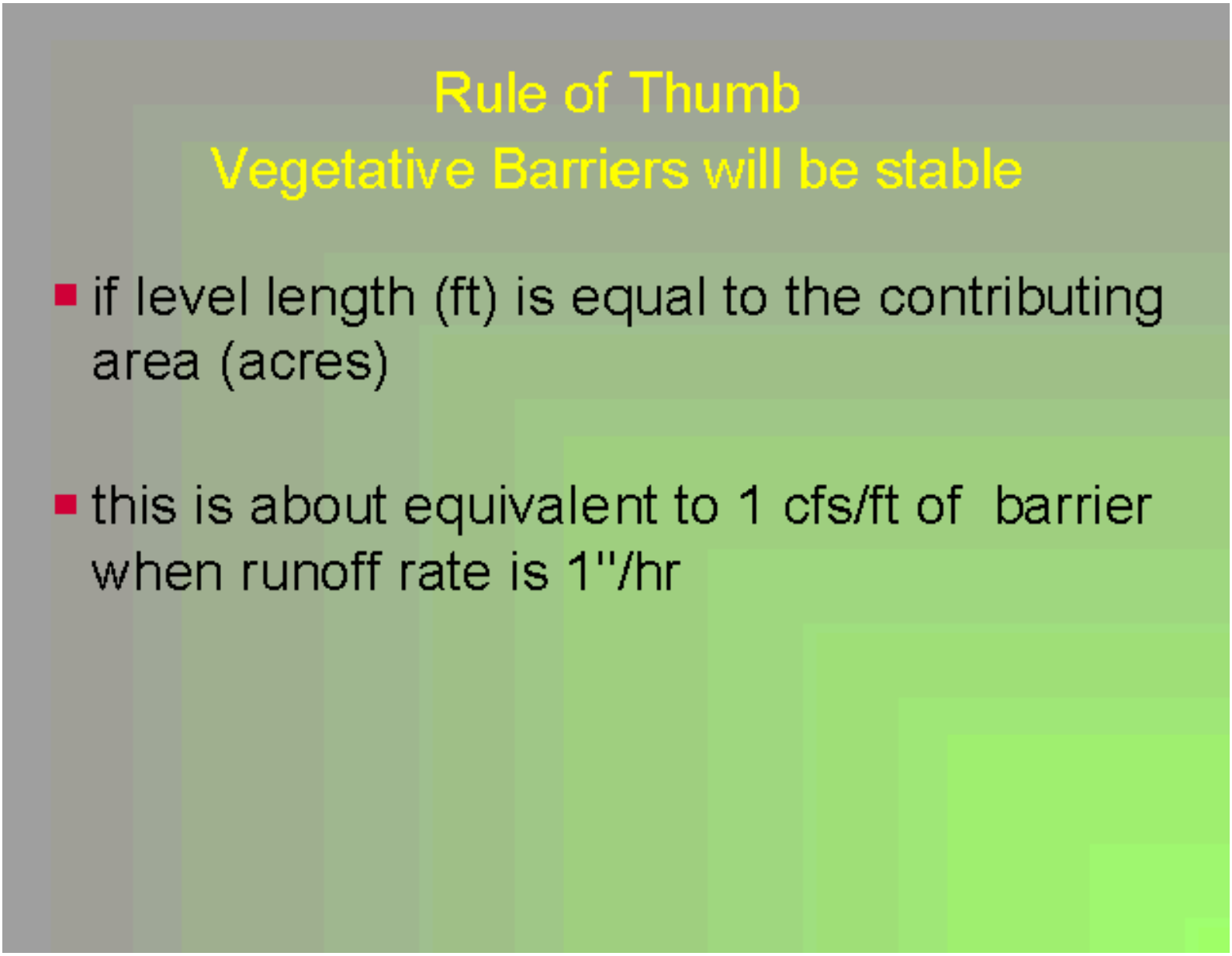

- As a rule of thumb, a concentrated flow barrier with stem size meeting the stated criteria will be stable if the length of the level bottom section, measured in feet, is greater than the contributing area, measured in acres.
- 1 cfs/ft is the specific flow rate (eg. the product of VR in waterway design computations).

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Edge of Field Treatment

- Reduce sediment delivery off site
- Do not reduce in-field sheet and rill erosion and factors used in erosion models should not be altered
- A series of barriers spaced at 2-ft VI may serve as an inexpensive alternative to small drop pipe structures where shading by woody vegetation will not restrict vegetative barrier growth

- The third purpose for Vegetative Barriers is to reduce sediment leaving a field. For this purpose, no conservation credit is given since erosion within the field is not changed. The practice is effective in improving water quality and may be able to stop headcuts from working up into fields.

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Increasing the efficiency of other conservation practices

- contour buffer strips
  - disperse concentrated flow
- filter strips - increase strip longevity by depositing sediment upslope
- field borders
- riparian forest buffers
- grassed waterways - help establishment and prevent flows outside waterway
- diversions and terraces - keep sediment our of channel, stabilize during extreme events

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- The fourth purpose of Vegetative Barriers is to increase the efficiency and longevity of other conservation practices.
- This can be done by preventing sediment from depositing within buffers and channels, by dispersing flow entering other buffers, and by traing flows into waterways.

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Planning consideration: subsurface tiles can avoid wet areas that cause farmers to want to cut water a furrow

- When off-contour barriers divert runoff to swale areas where it is retarded and sediment accumulates, wet areas can develop.
- Farmers may want to cut "water furrows" to alleviate the wetness.
- To avoid this problem, bury a porous drainage tile when barriers are established.

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Vegetative Barrier impacts on cotton IPM are being assessed by Arkansas entomologists, and should be considered

- Permanent strips of vegetation create extra field edge and can influence populations of pest and beneficial arthropods. Species composition and management alter these effects.

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Vegetative Barriers - Summary

- Inexpensive - appropriate to large and limited-resource farmers
- Practice needs to be raised on radar screen
- If CRP is converted to cropland, enhanced remnant strips may serve as barriers
- Need interim state practice standards and more evaluation
- Need long-term planning tools

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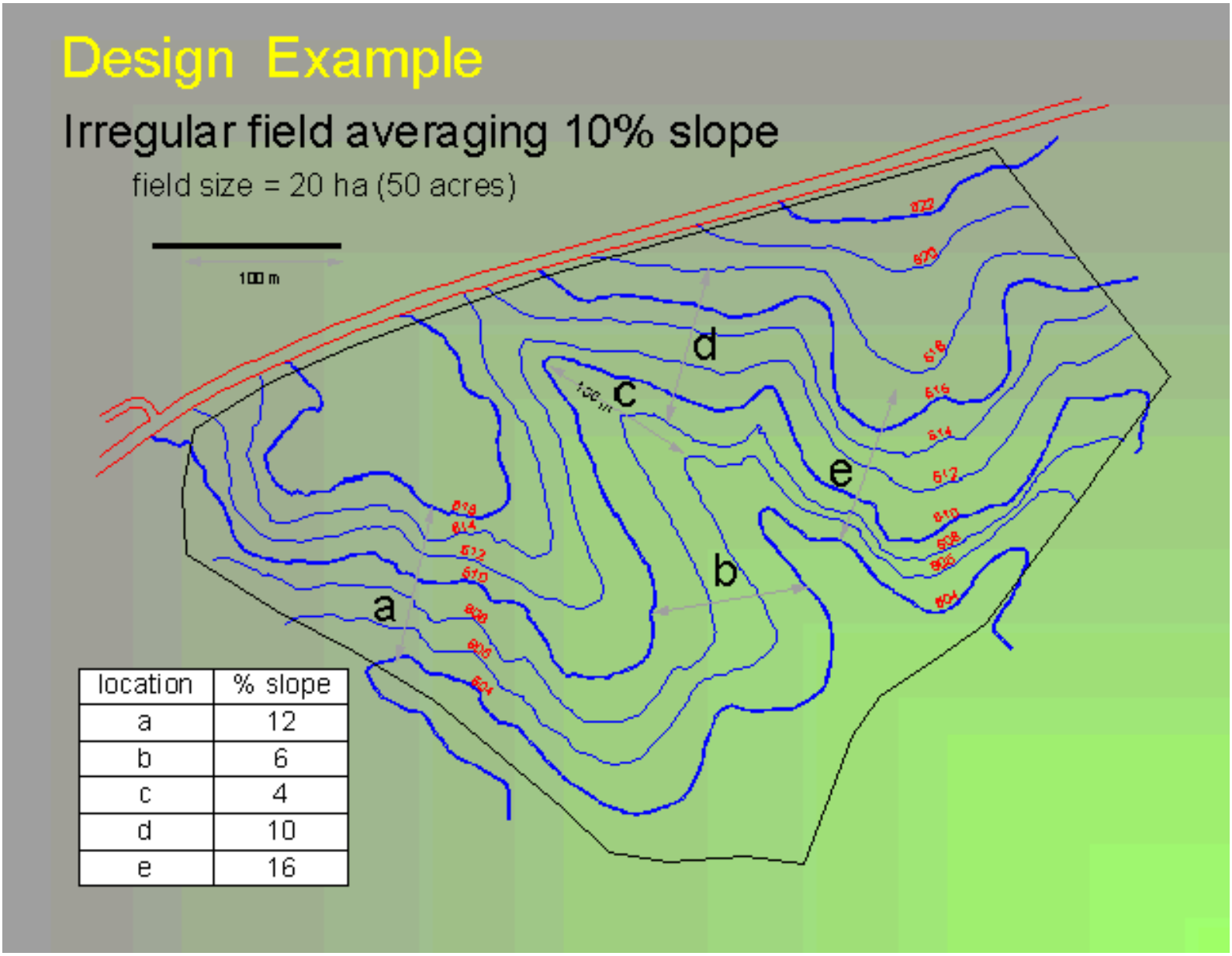

- This case study is based on an irregular field that Dillaha and Hayes used in an analysis of filter strip design.
- In different parts of the field, slopes vary from 6% to 16%, making it a challenge to keep buffers close to the contour.
- Several alternative buffer practice designs, including a hybrid combination, are compared and contrasted as part of a more comprehensive conservation plan including conservation tillage.

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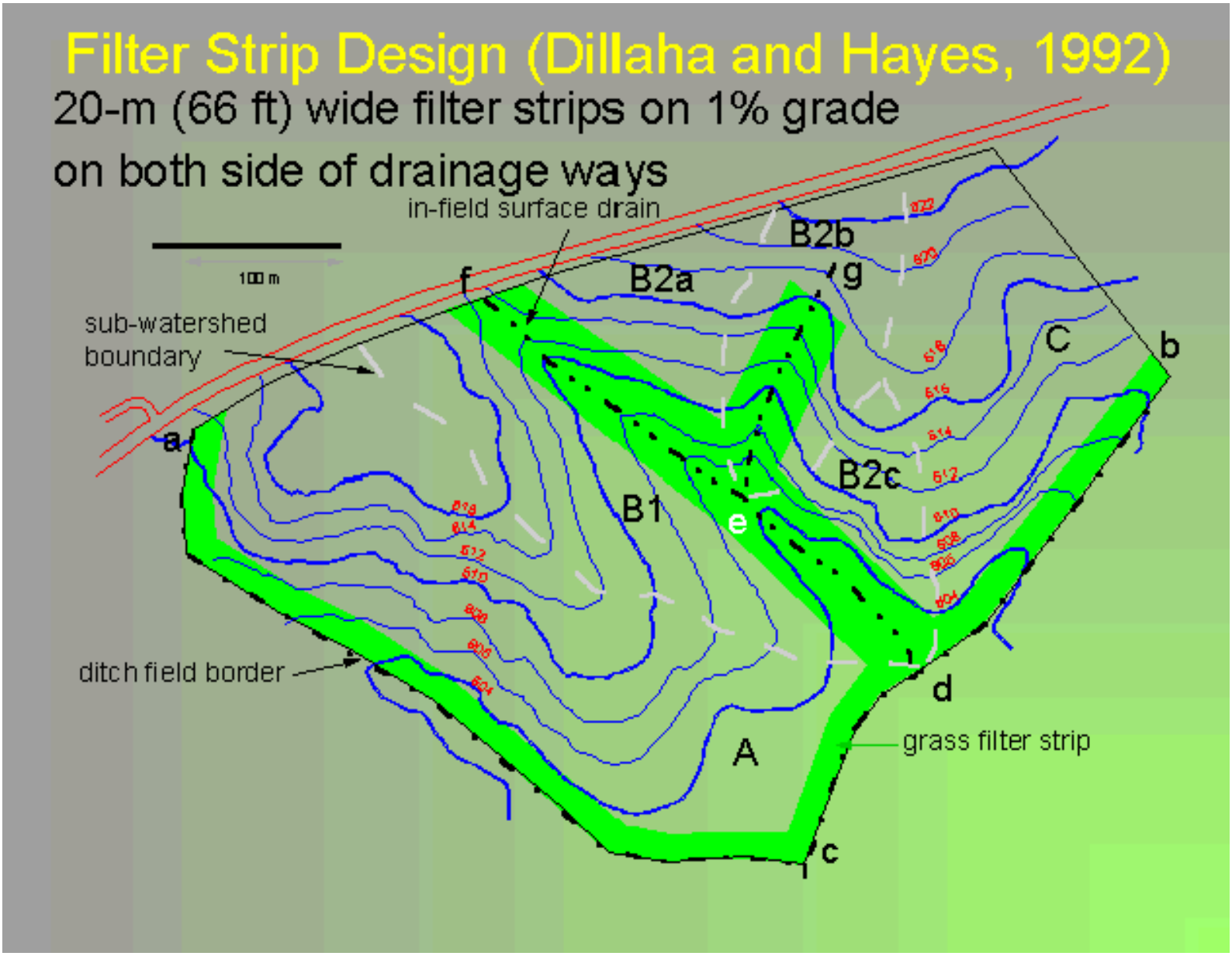

- While the original vegetative filter strip design does a good job of reducing sediment yield, it does nothing to reduce sheet and rill erosion within the cropped portion of the field and it removes the greatest amount of land from production.

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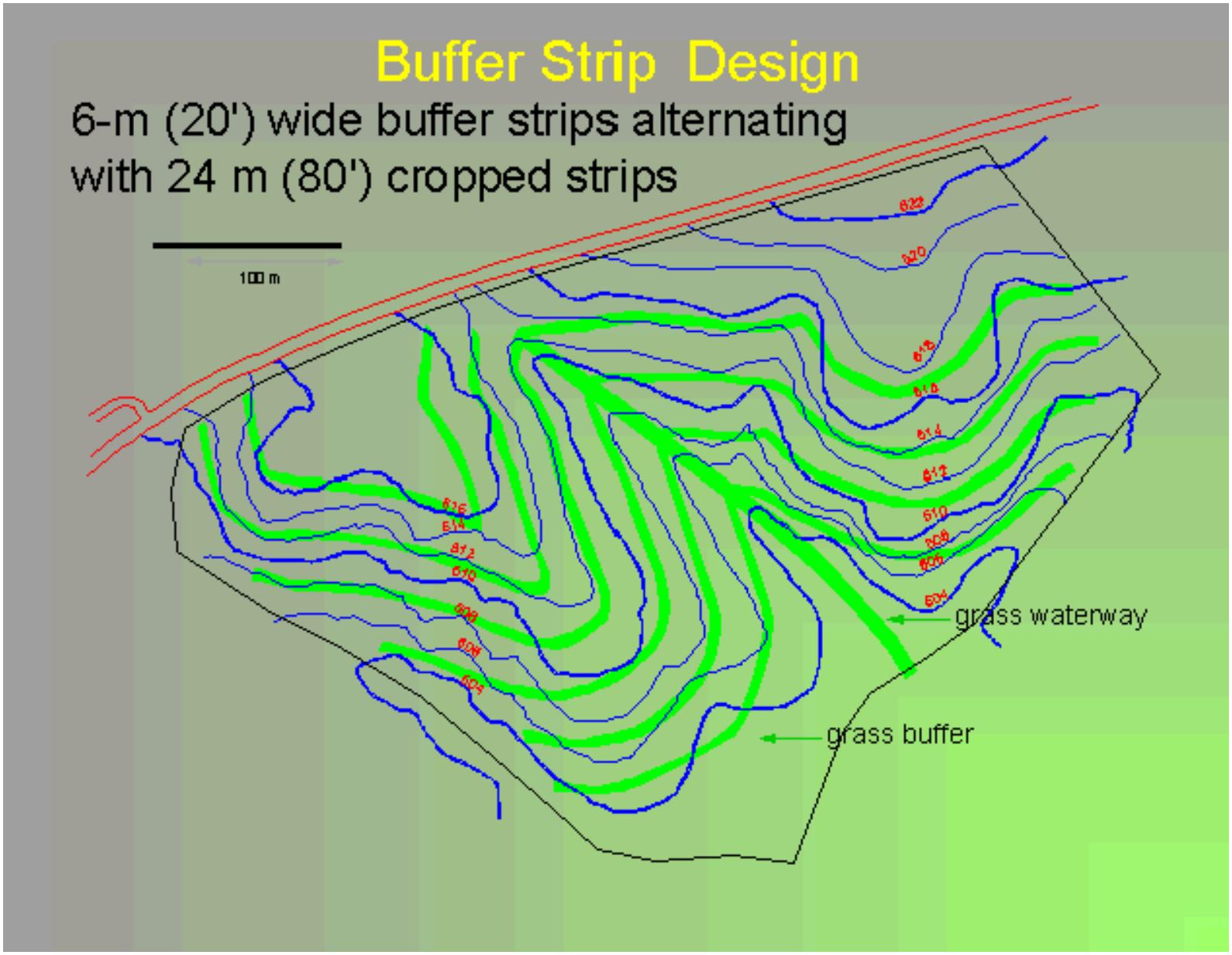

- Based on RUSLE calculations, the contour buffer strip design, reduced sheet and rill erosion in the field by about 25% but this is inadequate by itself as an erosion or sediment control system because of significant deviations of the strips from the contour at several points. This practice also removed a relatively large area of the field from crop production.

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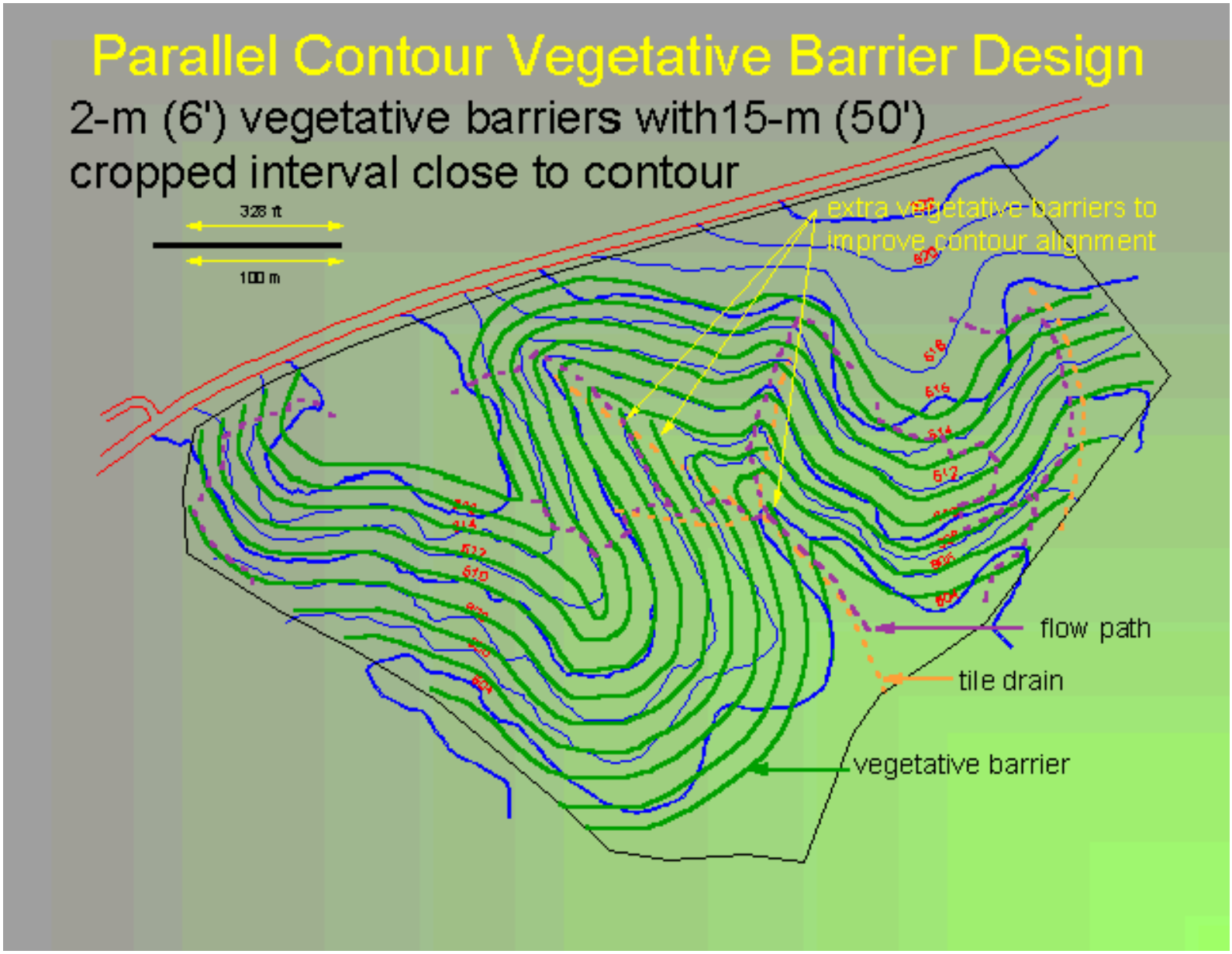
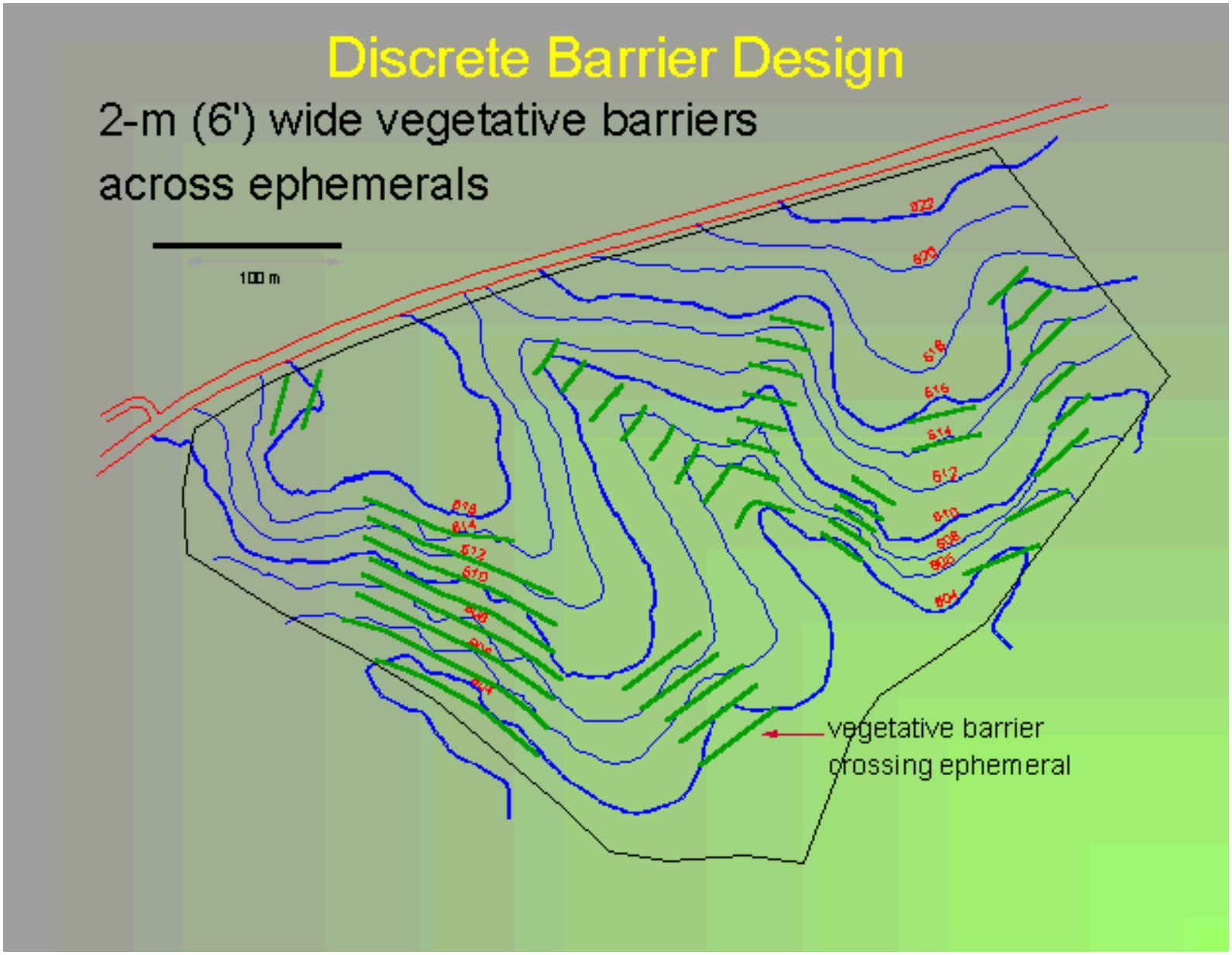


- The contour vegetative barrier design removes less cropland from production than the filter strips or buffer strips and affords the greatest degree of in-field erosion control of any of the alternative vegetative systems studied. However, it is also the most complex to design and establish and it provides less trapping of fine sediment than the filter strip design. The vegetative barriers provide a guide for contour tillage and tillage marks parallel to the barriers will intercept flow, thus reducing effective slope length. RUSLE calculations of this system indicate that with this reduction in slope length and contouring benefits, sheet and rill erosion may be reduced by about 75% compared to no treatment of this cropped field. Runoff diverted to local depressions is carried down slope through the barriers under controlled conditions that prevent ephemeral gully development. Tile drainage is provided to avoid wet spots within the field where barriers have directed runoff waters. Note that extra barriers are established on the southern, more gently slopping portion of the field in order to maintain contour alignment on the steeper portion to the north. In this arrangement, planting direction is reversed around the end of each extra barrier and no point rows will be created.



- The discrete vegetative barrier system can control ephemeral gullies within fields but, like filter strips, does not control sheet and rill erosion throughout the field. It removes the least amount of land from production of all the systems compared but could create problems with row alignment unless planting is done with a grain drill.

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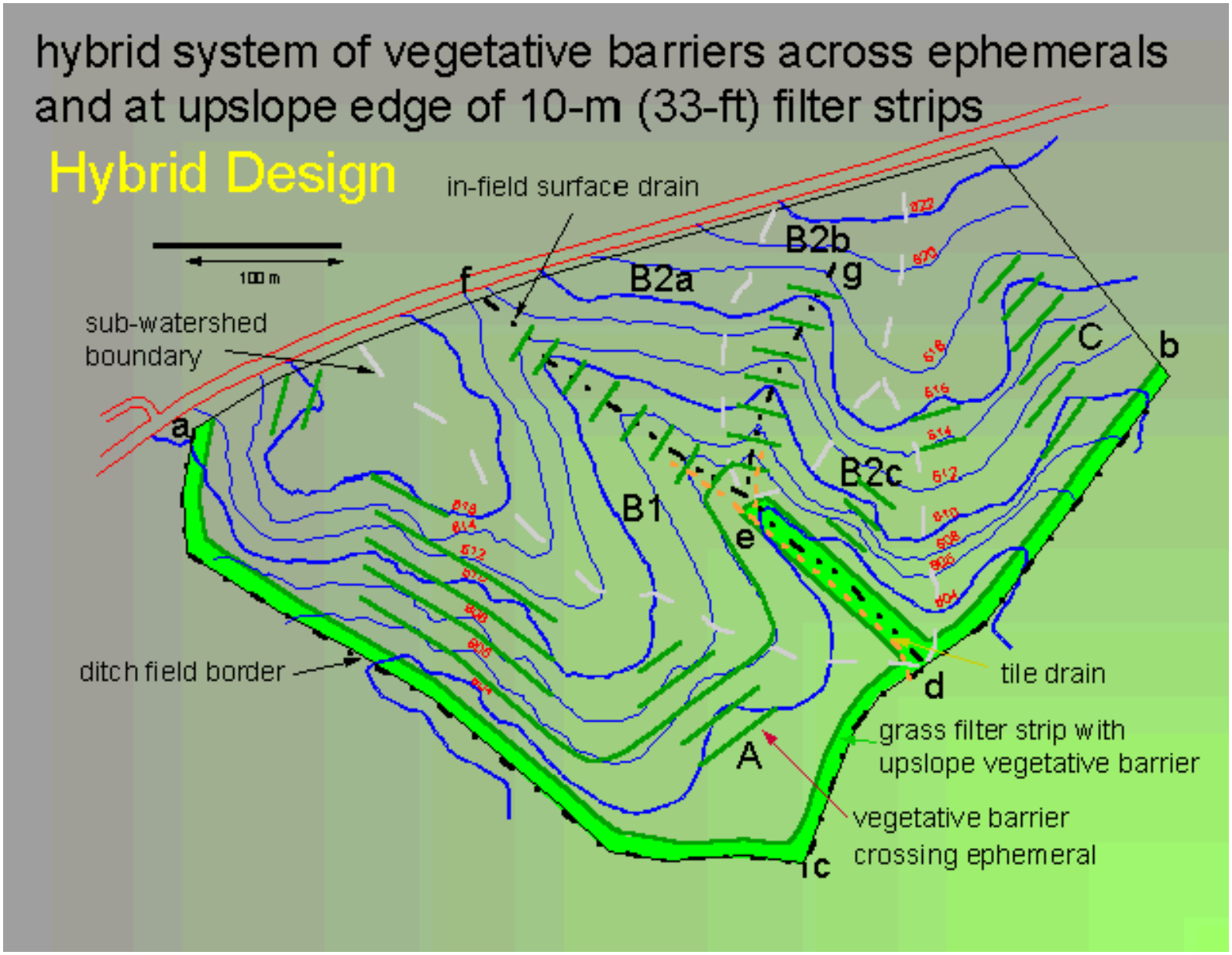

- The Hybrid System has several advantages.
  - 1) Sediment trapping of all but dispersed clay will be equal to that of the original filter strip design while taking less than one-half as much land out of production.
  - 2) Ephemeral gully erosion will be controlled within the field.
  - 3) The upslope of the filter strip includes a vegetative barrier which will protect the filter strip from inundation with concentrated flow during large storms.
  - 4) Deposition most sand and aggregated sediment will occur within the cropped portion of the field. This help to maintain field productivity and will extend the life of the filter strip.
- By combining the hybrid system with residue management to control sheet and rill erosion in the field a complete runoff and erosion control system is created.

Comparison of land use and impact of alternative vegetative erosion and sediment control systems in case study example

Vegetative System	Area in grass	Percent in grass	Sheet and rill control	Gully erosion control	Sediment yield control
	(ha)	(%)			
Filter Strip	3.6	18	no	waterway	yes
Buffer Strip	2.4	12	some	waterway	yes
Contour Barrier	1.4	7	yes	yes	yes
Discrete Barrier	0.5	2	no	yes	yes
Hybrid System	1.7	8	no	yes	yes

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