Guidance Document

Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites

Produced by:

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America's Oil & Gas Producers

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Table of Contents

List of Attachments

List of Appendixes

List of Figures

PREFACE

Congress determined that it was appropriate to provide a limited exemption from stormwater permitting requirements for oil and natural gas exploration and production activities due to their unique nature (Clean Water Act (CWA) section 402(l)(2)). This exemption applies only in those specific situations where the stormwater runoff does not result in a reportable quantity discharge to waters under the jurisdiction of the CWA or contributes to a violation of a water quality standard. Thus, if the stormwater runoff from oil or natural gas production activities contacts CWA jurisdictional waters and is contaminated with materials such as oil, grease or hazardous substances, or contains sediment that violates applicable water quality standards, the operator is not exempt from the regulations under the CWA and must still obtain permit coverage from EPA or from the appropriate state permitting authority under the NPDES program.

To further clarify its intent, Congress included statutory modifications in the Energy Policy Act of 2005 to clarify section 502 of the Federal Water Pollution Control Act, defining the term "oil and gas exploration, production, processing, or treatment operations, or transmission facilities" to mean "all field activities or transmission facilities, including activities necessary to prepare a site for drilling and for the movement and placement of drilling equipment, whether or not such field activities or operations may be considered to be construction activities. This provision clarified that stormwater discharges from E&P construction activities would be subject to the same criteria as other E&P operations and therefore, would not be subject to other stormwater construction regulations.

Consistent with the Energy Policy Act of 2005, the U.S. Environmental Protection Agency (EPA) published a final rule in 2006 that exempts stormwater discharges of sediment from construction activities at oil and gas exploration and production operations from the requirement to obtain a NPDES stormwater permit as long as stormwater runoff to waters under the jurisdiction of the CWA are not contaminated with oil, grease, or hazardous substances.

With this exemption, EPA specifically encouraged the oil and natural gas industry to develop and implement Best Management Practices (BMPs) to minimize the discharges of pollutants, including sediment, in stormwater both during and after construction activities. In an effort to meet the expectations of EPA under this rulemaking -- to incorporate successful voluntary stormwater management practices into our day-to-day operations – the American Petroleum Institute (API) and the Independent Petroleum Association of America (IPAA), industry associations, and company representatives (referred to as the Stormwater Technical Workgroup (SWTW)), built upon the 2004 guidance document entitled *Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Natural Gas Construction Sites*. Through field validation of the RAPPS, gap identification, and concerted program improvements, the SWTW developed a voluntary guidance document that if implemented correctly will serve as a readily applicable tool for operators to use in order to efficiently and effectively maximize control of stormwater discharges at oil and natural gas exploration and production activities throughout the contiguous U.S.

The SWTW spent over two years developing a guidance document to aid oil and gas operators in selecting efficient, reasonable and prudent operating practices to control erosion and sedimentation associated with storm water runoff from oil and natural gas construction activities. The SWTW will continue to work to make the application of this valuable and robust information the standard to achieve in industry operations.

Many thanks for the incredible contributions of several SWTW participants who saw this effort through to the end.

ACKNOWLEDGEMENTS

The Stormwater Technical Workgroup (SWTW) would like to thank Terracon Consultants, Inc. for conducting the field validation and revising and improving the original RAPPS guidance document. The SWTW would also like to thank the three storm water experts, Dr. Daniel Yoder, a professor at The University of Tennessee, Dr. Dave Wachal, a senior consultant with ESRI and David T. Lightle, a conservation agronomist with the United State Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, who gave many valuable suggestions and reviewed and greatly improved this revised guidance document.

1.0 Introduction

The purpose of this document is to provide a quick reference guide (Attachment 1) to select efficient, reasonable and prudent operating practices for use by operators in the oil and gas industry to control erosion and sedimentation associated with storm water runoff from oil and gas construction sites. These construction site areas are disturbed by clearing, grading, and excavating activities related to site preparation associated with oil and gas exploration, production, processing, treatment, and transmission activities. Best Management Practices (BMPs) are generally presented as a broad menu of erosion control alternatives, sometimes with specific limitations as to their use, but rarely with specific direction as to which are best adapted to specific situations. Ideally, all operators would be able to use United States Department of Agriculture, Agricultural Research Service (USDA-ARS) Version 2.0 of Revised Universal Soil Loss Equation (RUSLE2) erosion control computer model, or some similar tool, allowing them to pick out the BMPs that are economical and provide optimum protection. The problem is that even RUSLE2 is not simple enough to use without substantial training and implementation effort. The guidance document provides a tool to help the operator make good planning decisions based on easily-available information and minimal effort. It does not provide a detailed examination of the RUSLE2 computer model, but will aid in the selection of practices that will be effective for a specific situation which we will call "Reasonable and Prudent Practices for Stabilization (RAPPS)".

This guidance document is divided into a quick reference guide for ease of use by field personnel followed by supporting technical information. The quick reference guide located in the following section is provided as a six-step tool to evaluate slope, erosivity and erodibility and subsequently use decision tree flow charts to select efficient RAPPS to meet management goals at a given construction site. Attachment 1 consists of a complete RAPPS quick reference guide including the decision trees, soil texture decision chart and photographs that may be detached from the document, copied and laminated for use in the field. The technical information supporting the quick reference guide including the RUSLE approach, sensitivity analyses, efficiency ratings, the decision tree process, final stabilization and references are documented in Sections 3.0 – 7.0.

This document anticipates that the user will exercise good judgment in evaluating site conditions and deciding which RAPPS or combination of RAPPS is to be used at a specific site. Subsequent to the installation of the suggested RAPPS, the RAPPS should be inspected, evaluated and modified to reduce soil loss from the site (i.e. sediment deposited off-site), if necessary. If the RAPPS selected are not effective at preventing discharges of potentially undesirable quantities of sediment, operators should use good engineering judgment, and select different or additional RAPPS. Site-specific conditions should be considered in conjunction with federal, state or local regulatory requirements to ensure that RAPPS are implemented, if necessary, to achieve regulatory compliance.

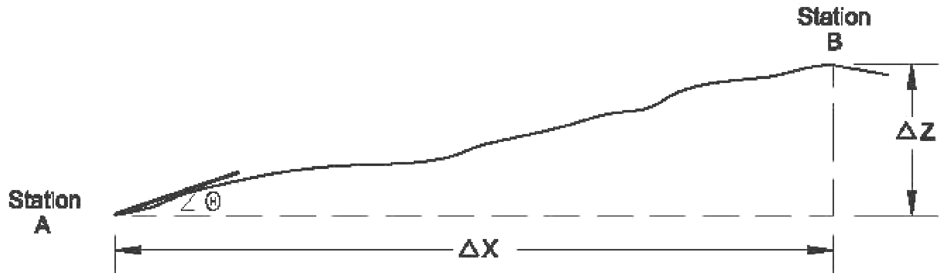
2.0 RAPPS Quick Reference Guide

The RAPPS site evaluation consists of six-steps which allow the user to objectively evaluate efficient erosion control(s) for a given set of site conditions. The RAPPS Quick Reference Guide (Attachment 1) is intended to help the user evaluate a proposed site's slope, erosivity and erodibility and use decision tree flow charts to select efficient RAPPS. The user guide may be detached, copied and laminated for use in the field. The RAPPS selection process consists of the following steps:

- Step 1) Define the slope of the area to be disturbed;
- Step 2) Determine the site average rainfall erosivity (R Value);
- Step 3) Determine soil type of area to be disturbed (K Value);
- Step 4) Select one of the nine RAPPS decision trees based on an evaluation of slope and erosivity;
- Step 5) Select the appropriate path of the decision tree based on soil type to evaluate the efficiency of RAPPS;
- Step 6) Choose one or more of the suggested RAPPS in the decision tree, based on the efficiency rating meeting a management goal.

Step 1) Determine The Slope Of The Area To Be Disturbed

$$Slope = \frac{Difference\ in\ Elevation}{Difference\ in\ Lateral\ Position}$$ **This is equivalent to:** $$\%Slope = \frac{Rise}{Run} x100 = \left(\frac{\Delta Z}{\Delta X}\right) x100$$



Percent Slope is not equivalent to slope angle. The following formula can be used to convert the slope in degrees to the slope in percent.

$$\text{Percent Slope} = \tan\theta * 100$$

The user may choose to evaluate the slope by their own method. However, several methods to determine the rise (ΔZ), run (ΔX) and slope angle (θ) are described in Section 6.2.1 (Page 18).

Step 2) Determine Site Average Rainfall Erosivity

The average annual erosivity factor (R-value) is an index of rainfall erosivity for a geographic location. The R-value is a rainfall and runoff factor that represents the effect of both rainfall intensity and rainfall amount.

The R-values for each county in the United States have been included in Appendix A. The county-specific R-values listed in Appendix A are to be used to select your construction site's R-value. In the example below, the R-value for Harding County in New Mexico is 69.94.

State Name	County	R Factor US
New Mexico	Harding	69.94
New Mexico	Hidalgo	99.81
New Mexico	Lea	87.71
New Mexico	Lincoln	110.20

Step 3) Site Erodibility - Determine Soil Type Of Area To Be Disturbed

A) Use existing soil surveys located at your local USDA/ Natural Resource Conservation Service (NRCS) office

OR

B) Look-up the soil type from the following online Soil Survey Geographic (SSURGO) database or the NRCS database links:

http://soildatamart.nrcs.usda.gov/
http://websoilsurvey.nrcs.usda.gov/app/

OR

C) Use the Soil Texture Decision Chart:

Use the Soil Texture Decision Chart in Attachment 1 and follow the steps to determine the predominate soil type to be disturbed at your site (i.e. clay, sand, or silt/loam).

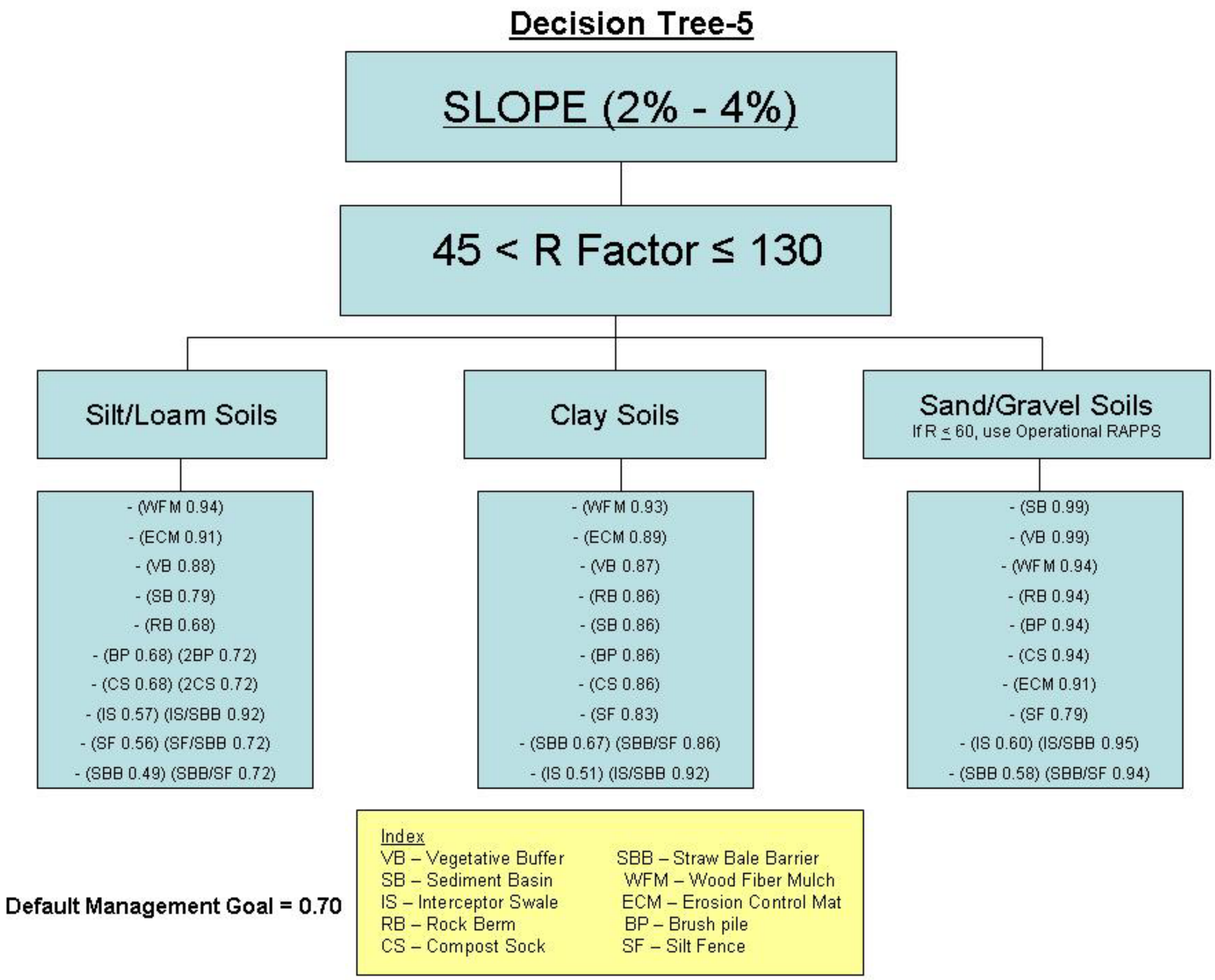
Step 4) Select one of the nine RAPPS decision trees based on an evaluation of slope and erosivity.

Step 5) Select the appropriate path of the decision tree based on soil type to evaluate the efficiency of RAPPS.

Each decision tree path includes a list of RAPPS (abbreviated) and its corresponding efficiency rating listed in order of highest to lowest efficiency. The efficiency rating (ER) represents the proportion of sediment kept on-site by the erosion control practice that would have otherwise been transported off-site. For example, an ER of 0.80 represents the percentage (80%) of sediment that would have been transported off-site had the erosion control practice not been in place.

Example Decision Tree-5 illustrates RAPPS nomenclature (CS 0.68) (2CS 0.72), which indicates that a compost sock exhibits an efficiency of 68%, and a combination of two compost socks exhibit an efficiency of 72%. Example Decision Tree-5 also illustrates RAPPS nomenclature (SF 0.56) (SF/SBB 0.72) which indicates that a silt fence exhibits an efficiency of 56% and a combination of a silt fence with a straw bale barrier exhibits an efficiency of 72%. A detailed discussion of efficiency ratings is provided in Section 5.0 (Page 15).

Example of RAPPS Decision Tree



Step 6) Compare ER to Management Goal

Compare each RAPPS ER for the appropriate soil type path to management goals to evaluate if erosion control methods removed a sufficient amount of sediment for a particular site. The site management goal represents a measure of the acceptable amount of sediment removed by the erosion control method under site-specific conditions. A management goal of 0.60 indicates that an erosion control method must reduce the sediment yield by 60% compared to the sediment yield that would occur if no erosion control methods were in place. Sediment yield is the amount of eroded soil. In north central Texas, a management goal of 0.70 has been suggested as a minimum guideline to achieve adequate design of erosion and sediment control plans (NCTCOG ISWM Manual, 2003). For example, if selection of a specific RAPPS indicated a site-specific efficiency of 0.75 and the management goal was 0.70, then the goal has been met, and the RAPPS should be sufficient to prevent undesirable quantities of sediment from leaving the construction site assuming RAPPS are designed, constructed and maintained properly. If the RAPPS efficiency does not meet the default management goal of 70%, then additional combinations of RAPPS with corresponding efficiencies are listed in the decision tree.

Management goals may vary depending on the sensitivity of the site. Based on the literature, a general management goal of 0.70 is suggested for construction in non-sensitive areas. However, if the local agency suggests a region-specific management goal, the user should utilize that goal. The county USDA NRCS office or regional council of governments should be contacted to evaluate the region-specific management goal.

Based on soil loss modeling data, sites with silt/loam and clay soils and low (<2%) slopes exhibit special conditions using this method and it is appropriate to lower the management goal to 0.60 compared to a default management goal of 0.70 for the other decision tree paths. A detailed discussion of management goal selection is provided in Section 5.0 (Page 16).

In addition to RAPPS documented in the decision trees, other types of RAPPS including Supplemental RAPPS, Operational RAPPS and Specialty RAPPS are discussed below.

Supplemental RAPPS

Under certain circumstances, such as steep slopes or a region with high erosivity (R-values), alternate or additional RAPPS should be employed to prevent discharges of potentially undesirable quantities of sediment. In those cases, one or a combination of two RAPPS documented in the decision trees will not provide adequate protection above a specified slope, R-Value or combination of slope and R-value. This specific situation is noted in the soil type decision box in the decision tree paths. The RAPPS used for these situations are referred to as “Supplemental RAPPS” and are expected to achieve the intent of the efficiency goal as a combined system of RAPPS. Supplemental RAPPS are a combination of two or more listed RAPPS or Specialty RAPPS and are required if a site has high risk attributes that exceed the values prescribed in the decision trees (Appendix B – Decision trees 3, 6, 7, 8 & 9). A detailed discussion on Supplemental RAPPS is provided in Section 6.2.5 (Page 30).

- In the case of a site with a steep pre-construction slope (Decision Trees 7, 8 & 9), the user should employ Supplemental RAPPS that will:

    1) reduce the amount of stormwater reaching the site by redirecting the up-gradient run-on flow of stormwater around the construction site by means of a diversion structure (i.e., a diversion dike, interceptor swale, ditches, slope drains);

2) protect disturbed soil on the slope with a form of cover (i.e., mulch and/or erosion control mat); and
3) protect the base of the slope with a runoff-velocity barrier (i.e., rock berm, compost sock, brush piles, fiber rolls/logs). It should be noted that soil loss modeling data indicate that silt fences and straw hay bales should not be used at the bottom of steep slopes as they do not function well in high runoff-velocity conditions.

- In the case of a site with a high Erosivity (R value - Decision Trees 3, 6 or 9), the user should employ Supplemental RAPPS that will:

  1) protect disturbed soil on the slope with roughening and a form of cover (i.e., mulch, straw, compost and/or erosion control mat); and
  2) protect the base of the slope with runoff-velocity barriers (i.e., silt fence, straw bales, fiber rolls/logs, rock berms, vegetative barrier or brush piles).

- In the case of a construction site adjacent to a drainage feature or a water way, the use of sediment basins or other sediment capturing containment structures (i.e. silt trap, dewatering structure, filter bag) are recommended.

The above-referenced scenarios are not an exhaustive list of the site-specific situations that could be encountered during oil and gas construction activity. It should be noted that other combinations of RAPPS in site specific situations should be installed using good judgment, if required to prevent undesirable quantities of sediment being transported off the site. If these situations exist, operators may want to consider retaining a certified professional in erosion and sediment control (CPESC) to design RAPPS, inspect constructed RAPPS and provide periodic inspection of the site during operations.

Operational RAPPS

Under certain circumstances including low slopes and/or low erosivity, a minimal erosion control effort may be utilized. Operational RAPPS reflect a minimal effort of erosion control including installation of an inexpensive sediment barrier (i.e., compost sock, compost berm, vegetative barrier, brush pile, interceptor swale, soil berm, straw bale barriers or silt fence) near the downgradient boundary of the construction site along with the following practices that operators are commonly using as part of normal operations:

- Planning the site location to choose low-slope sites away from waterways;
- Minimizing the footprint of the disturbed area;
- Phasing/scheduling projects to minimize soil disturbance;
- Timing the project during dry weather periods of the year;
- Managing slopes to decrease steepness;
- Maintaining the maximum amount of vegetative cover as possible;
- Cutting vegetation above ground level and limiting removal of vegetation, root zones and stumps, where possible;

- Limiting site disturbance to only clear what is necessary;
- Practicing good housekeeping including proper material storage and
- Practicing operation and maintenance procedures to limit sediment yield (i.e. maintaining silt fence).

Specialty RAPPS

During construction of oil and gas sites, an operator may encounter special circumstances including crossing a regulated water body or construction near a roadway that requires Specialty RAPPS to divert or reduce the velocity of surface water flow. Specialty RAPPS near roadways are also constructed to limit the amount of sediment leaving the site via truck traffic. Site-specific conditions should be considered in conjunction with federal, state or local regulatory requirements to ensure that RAPPS are implemented to achieve regulatory compliance, if necessary. Specialty RAPPS are documented in Appendix D and include:

- Stabilized Construction Entrance (SCE);
- Road Surface Slope (RDSS);
- Drainage Dips (DIP);
- Road-Side Ditches (RDSD);
- Turnouts or Wing Ditches (TO);
- Cross-drain Culverts (CULV);
- Sediment Traps (ST);
- Construction Mats (CM);
- Filter Bags (FB);
- Trench Dewatering and Discharge (TDD);
- Dewatering Structure (DS);
- Stream Crossing Flume Pipe (SCFP);
- Stream Crossing Dam and Pump (SCDP);
- Stream Bank Stabilization (SBS);
- Dry Stream Crossing (DSC) and
- Temporary Equipment Crossing of Flowing Creek (TECFC).

Subsequent to selection of a RAPPS or a combination of RAPPS, the following sequential tasks should be employed until the construction site is re-vegetated or stabilized:

Step 7) Install RAPPS in appropriate locations before beginning clearing, grading and excavation activities.

- It should be noted that most of the RAPPS combinations were modeled with the RAPPS located near the base of the slope and 75% down the slope.

- It should be noted that a consensus of erosion control experts and regulatory agencies recommend preserving existing vegetation and re-establishing vegetation (i.e. seeding, sodding, or hydroseeding) on the disturbed slope as the preferred method of stabilization. Therefore, preserving and re-establishing vegetation should always be encouraged regardless of the particular RAPPS chosen.

Step 8) Begin site construction;

Step 9) Inspect RAPPS during or subsequent to a rainfall event and evaluate if sediment has been deposited off the site;

Step 10) Modify or add RAPPS to prevent off-site sediment yield, if necessary;

Step 11) Complete construction;

Step 12) Vegetate and/or stabilize disturbed areas following completion of construction.

3.0 RUSLE Approach

In the preparation of this document, emphasis was placed on the selection and practical application of RAPPS, given a set of physical parameters included in the Revised Universal Soil Loss Equation (RUSLE) soil erosion model. RUSLE was derived from the Universal Soil Loss Equation (USLE), and predicts the long term average annual rate of erosion based on rainfall pattern, soil type, topography, and management practices. The model is well validated, and its empirical equation is based on over 10,000 plot years of natural runoff data and 2,000 plot years of simulated runoff data (Foster et al., 2003). The erosion model was created for agricultural conservation planning, but is also applicable in non-agricultural settings including construction sites (Yoder, 2007). The United States Environmental Protection Agency (USEPA) uses the rainfall erosivity factor of RUSLE to evaluate the applicability of a waiver from the National Pollutant Discharge Elimination System (NPDES) Phase II construction storm water permit program, thereby providing additional rationale for using the RUSLE approach. The RUSLE method uses the following computation:

$$A = R * K * LS * C * P$$

where:

A represents the potential long term average annual soil loss per unit area (commonly expressed as tons/acre/year).

R is the rainfall-runoff erosivity factor that is a rainfall erosion index plus a factor for any significant runoff from snowmelt. R is based on geographic location and varies from approximately 10 to 700 in the United States.

K is the soil erodibility factor that represents the effect of soil properties on soil loss. K is a measure of the susceptibility of soil particles to erosion by rainfall and runoff and is primarily a function of soil type. K is defined under worst-case conditions of continuous bare soil, and does not account for soil-altering management practices such as the addition of organic matter.

LS is the slope length-steepness factor. Longer and steeper slopes typically result in higher erosion. Slope length (L) is defined as the horizontal distance from the origin of overland flow to the point where runoff becomes concentrated in a defined channel (USDA-ARS, 2008). In earlier versions of USLE and RUSLE (Wischmeier and Smith 1978; Renard et al., 1997) the slope length stopped when deposition occurred, but inclusion of process-based sediment transport code in later versions of RUSLE removed that restriction, thereby allowing for modeling of deposition caused by sediment control practices or by decreasing slope steepness. Slope steepness (S) reflects the influence of slope gradient on erosion.

C is the cover-management factor and represents the ratio of soil loss from land under the desired cover and management condition to the soil loss under nearly worst-case conditions of continuous bare and loosened soil. In other words, the C factor represents the fraction by which the current management practice reduces erosion. Cover-management (e.g., re-seeding bare soil) reduces erosion by reducing the impact of raindrops and runoff.

P is the supporting practice factor and represents practices (i.e. RAPPS) that reduce soil loss by diverting runoff or reducing its transport capacity. This factor is also expressed as a ratio of the sediment delivery with the current practice to the worst-case situation with no special practices in place.

This document uses the RUSLE2 computer model, which was developed by the USDA-ARS and is a hybrid of its empirical predecessors (USLE/RUSLE) and a number of process-based soil erosion equations. A comprehensive discussion of RUSLE2, which includes a variation of the USLE computation and deposition, transport capacity and sediment load equations, is provided in Foster et al. (2003) and in USDA-ARS (2008a, 2008b).

As explained in these documents, the erosion science has evolved from USLE through RUSLE1 and RUSLE2, with one of the main results being that the independence of the USLE factors has been diminished. For example, research has shown that the effectiveness of surface cover is greater for situations where small gullies are likely to form, as the residue tends to stop the small gully/rill formation. The conditions that lead to rill formation include highly erodible soils (high K), highly disturbed soils (high C values), and soils on steep slopes (high S value). This interdependence is also clearly evident in the transport relationships, where the soil type controls the size of the eroded aggregates (controlling the tendency to settle), and both soil and management properties control the relative runoff rates, which govern transport. This means that it is no longer possible to define a simple C factor for a practice, as it will now depend on the specifics of the situation.

The RUSLE2 computer program used for evaluating soil loss in this document is a version of RUSLE2 currently being developed for construction sites by the USDA-ARS and includes additional erosion control practices commonly used in the construction industry (Lightle, personal communication, 2008). This version of RUSLE2 for construction sites will be available to the public in 2009.

Based on sensitivity analyses, a stream-lined approach using three variables (R, K and S) and decision tree flow charts to select suggested RAPPS is described in Section 6.2.

It should be noted that erosion control experts recommend minimizing the window of bare, untreated soil, and treating the source of the erosion is preferred, rather than trapping the sediment after erosion has occurred. This is known as “source reduction” and is relatively easy to achieve when compared to capturing transportation soil off the site.

4.0 Sensitivity Analyses

A sensitivity analyses was conducted using a conservative soil-loss tolerance value to evaluate the relative importance of the parameters in RUSLE and to develop the decision tree process. The soil-loss tolerance (T) is the maximum annual amount of soil that can be removed before the long term natural soil productivity is adversely affected. Soil-loss tolerance values for agricultural settings do not necessarily apply to non-agricultural settings like construction sites because cropland productivity is commonly not a factor for construction sites, but they do provide at least a general reference value for good erosion-control management. The sensitivity analyses used to evaluate slope, erosivity and erodibility values are based on a conservative soil-loss tolerance of 5 tons/acre/year, which corresponds to an average soil loss over the area of less than 1 millimeter/year.

A default cover-management factor (C) of 0.45 for disturbed bare soil was used in the sensitivity analyses (D. Lightle, personal communication, 2008). This value was used because a construction site has typically been disturbed and compacted by a bull dozer allowing the roughening to cause deposition and infiltration of rainwater and the compaction to reduce erosion. The following default slope lengths derived from a table of values for slope steepness versus slope length were used in the sensitivity analyses (Lightle and Weesies, 1996).

Default Slope Length for each Increment of Slope Steepness
For use in all areas of the US except the "Palouse*"

Slope	Length
0.5	100
1.0	200
2.0	300
3.0	200
4.0	180
5.0	160
6.0	150
7.0	140
8.0	130
9.0	125
10.0	120
11.0	110
12.0	100
13.0	90
14.0	80
15.0	70
16.0	60
17.0	60
18.0	50
19.0	50
20.0	50

* "Palouse" refers to a large farming region in the Pacific Northwest and is primarily an area of very steep, silty soils. Erosion is caused by rainfall as well as by melting snow on frozen soils.

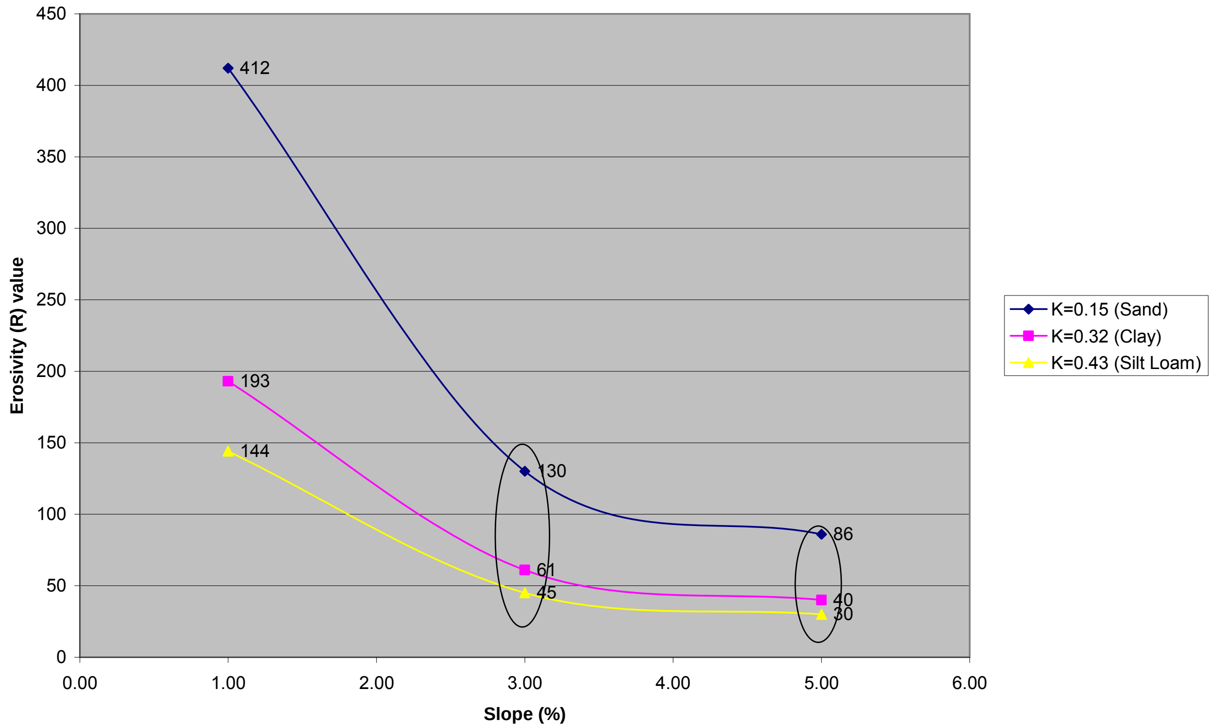
The length-slope (LS) factors were determined using a table developed by the USDA and documented in USDA Agricultural Handbook No. 703 (1997) that lists LS factors for a unique combination of length (ft.) and steepness (%) of the slope. The algorithm used in the table is the same as that used subsequently in RUSLE2.

Table 1- LS Values for Construction Sites (Source: USDA Agricultural Handbook No. 703)

Slope (%)	Slope Length (ft.)							
	50	75	100	150	200	250	300	400
0.2	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06
0.5	0.08	0.08	0.09	0.09	0.1	0.1	0.1	0.11
1	0.13	0.14	0.15	0.17	0.18	0.19	0.2	0.22
2	0.21	0.25	0.28	0.33	0.37	0.4	0.43	0.48
3	0.3	0.36	0.41	0.5	0.57	0.64	0.69	0.8
4	0.38	0.47	0.55	0.68	0.79	0.89	0.98	1.14
5	0.46	0.58	0.68	0.86	1.02	1.16	1.28	1.51
6	0.54	0.69	0.82	1.05	1.25	1.43	1.6	1.9
8	0.7	0.91	1.1	1.43	1.72	1.99	2.24	2.7
10	0.91	1.2	1.46	1.92	2.34	2.72	3.09	3.75
12	1.15	1.54	1.88	2.51	3.07	3.6	4.09	5.01
14	1.4	1.87	2.31	3.09	3.81	4.48	5.11	6.3
16	1.64	2.21	2.73	3.68	4.56	5.37	6.15	7.6
20	2.1	2.86	3.57	4.85	6.04	7.16	8.23	10.24
25	2.67	3.67	4.59	6.3	7.88	9.38	10.81	13.53
30	3.22	4.44	5.58	7.7	9.67	11.55	13.35	16.77
40	4.24	5.89	7.44	10.35	13.07	15.67	18.17	22.95
50	5.16	7.2	9.13	12.75	16.16	19.42	22.57	28.6
60	5.97	8.37	10.63	14.89	18.92	22.78	26.51	33.67

In the initial sensitivity analyses, the importance of slope in RUSLE was evaluated by plotting slope percent versus rainfall erosivity (R) for various soil types where tolerable soil loss equaled 5 tons/acre/year. The critical slopes were identified by examining the level of convergence between the trend lines.

Figure 1. R-value vs. Slope for various K values (assuming A = 5 tons/acre/yr)



As shown in Figure1, the R values that yield the target A = 5 tons/acre/yr for varying soil types and K values including sand (K=0.15), clay (K=0.32) and silt loam (K=0.43) tend to vary greatly at a slope of 1% and converge at a slope of approximately 3%. The R values further converge at a slope of approximately 5%. This analysis indicates that at sites with slopes steeper than 5%, the soil types begin to behave in a similar fashion.

The importance of the erosivity factor in RUSLE was evaluated by plotting erosivity versus soil loss with the above-referenced soil types at slopes of 1%, 3% and 5% (Figures 2, 3, and 4). The following graphs indicate that soil loss increases from sand to clay to silt loam for a given rainfall erosivity (R) value for the different slopes. Figures 2, 3 and 4 indicate the significant R values for each soil type where soil loss equals 5 tons/acre/year at 1%, 3% and 5% slopes used in the decision trees, except for steeper slopes. Steeper slopes (>5%) were also modeled to evaluate their effect on soil loss.

Figure 2. Soil Loss (A) vs. Erosivity factor (R-value) for 1% Slope

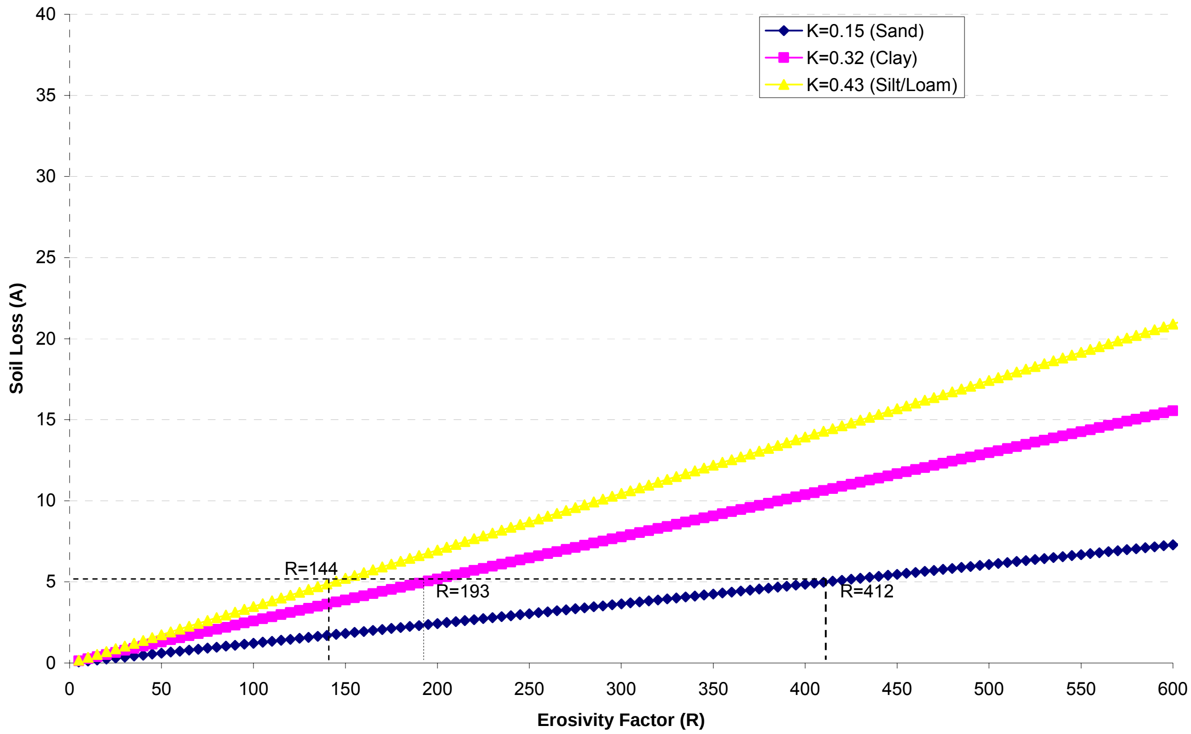


Figure 3. Soil Loss (A) vs. Erosivity factor (R-value) for 3% Slope

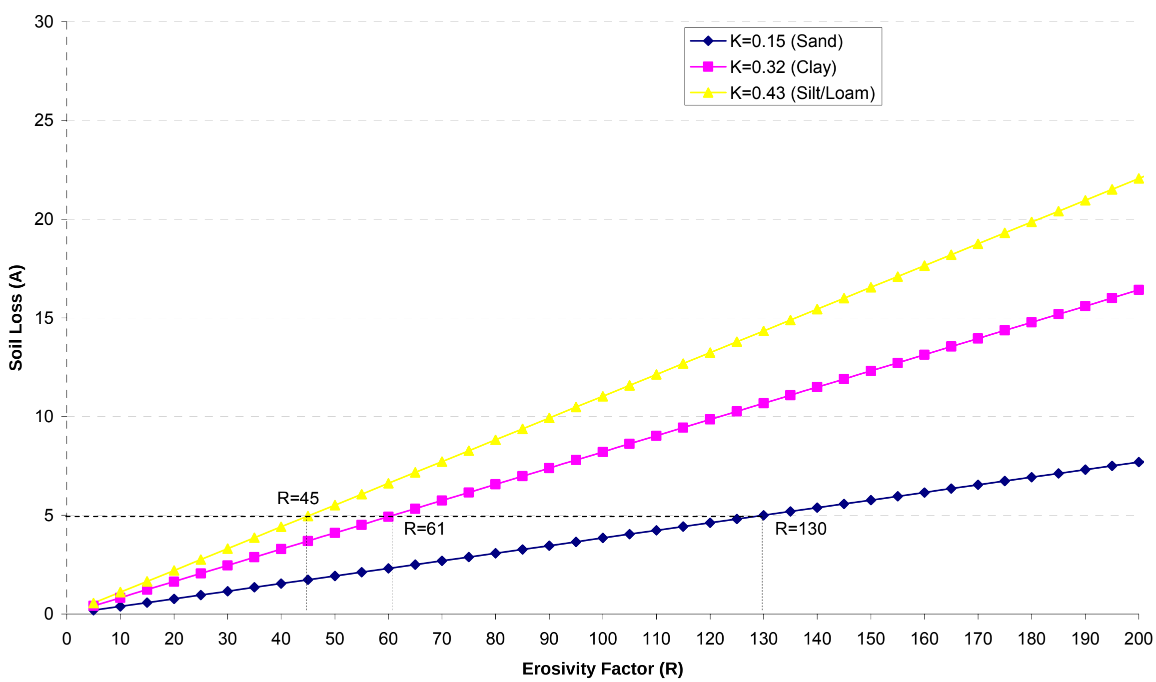
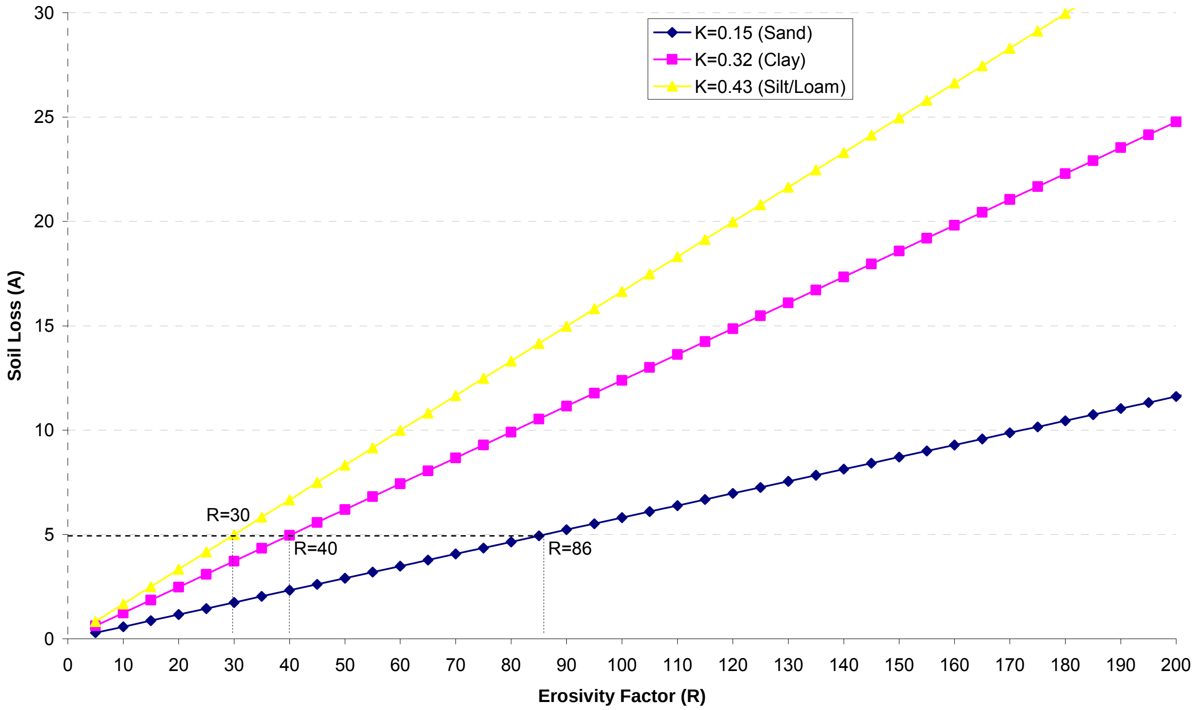


Figure 4. Soil Loss (A) vs. Erosivity factor (R-value) for 5% Slope



5.0 Efficiency Ratings

In order to evaluate the applicability of a specific RAPPS in variable site conditions, efficiency ratings were derived from RUSLE2 results. RUSLE2 has been utilized to determine sediment loss and derive efficiency ratings of erosion control practices for various slopes, soil erodibility, regional erosivity and site management goals (Wachal et al., 2008). A relative comparison of the efficiency of several RAPPS used in the construction industry is documented in the decision trees. Efficiency ratings for RAPPS identified in RUSLE2 were determined from modeled sediment yields according to the following equation:

$$ER = (SY_{\text{without RAPPS}} - SY_{\text{with RAPPS}})/SY_{\text{without RAPPS}}$$

where:

ER is the efficiency rating, $SY_{\text{without RAPPS}}$ is the modeled sediment yield without any erosion or sediment control protection, and $SY_{\text{with RAPPS}}$ is the modeled sediment yield with erosion or sediment control protection. The ER represents the proportion of sediment kept on-site by the erosion control practice that would have otherwise been transported off-site. For example, an ER of 0.80 represents the percentage (80%) of sediment that would have been transported off-site had the erosion control practice not been in place. Note that the ER thus represents the effectiveness of the practice at both keeping erosion from occurring in the first place, and in controlling sediment transport once the sediment has been detached.

Wachal et al. (2003) compared efficiency ratings to management goals to evaluate if erosion control methods removed a sufficient amount of sediment for a particular site. The site management goal represents a measure of the acceptable amount of sediment removed by the erosion control method under site-specific conditions. A management goal of 0.60 indicates that an erosion control method must reduce the sediment yield by 60% compared to the sediment yield that would occur if no erosion control methods were in place. In north central Texas, a management goal of 0.70 has been suggested as a minimum guideline to achieve adequate design of erosion and sediment control plans (NCTCOG ISWM Manual, 2003). For example, if selection of a specific RAPPS indicated a site-specific efficiency of 0.75 and the management goal was 0.70, then the goal has been met, and the RAPPS should be sufficient to prevent undesirable quantities of sediment from leaving the construction site assuming RAPPS are designed, constructed and maintained properly.

Management goals may vary depending on the sensitivity of the site. For example, the management goal may be set higher for construction near a gold medal trout stream, whereas it may be set lower in an arid, upland, industrial setting. Based on the literature, a general management goal of 0.70 is suggested for construction in non-sensitive areas. Additionally, if the local agency suggests a region-specific management goal, the user should utilize that goal. The county USDA NRCS office or regional council of governments should be contacted to evaluate the region-specific management goal.

In low slope conditions (<2%), the efficiencies of practices are mathematically decreased because the sediment yield without RAPPS is lower, and the resultant numerator of the efficiency rating equation is lower. Based on soil loss modeling data, sites with silt/loam and clay soils and low (<2%) slopes exhibit special conditions using this method and it is appropriate to lower the management goal to 0.60 compared to a default management goal of 0.70 for the other decision tree paths. For example, a site with a silt loam soil, a 1% slope, an erosivity ≥ 145, and use of a silt fence results in 1.9 tons/acre/year of soil loss which equates to an efficiency rating of 0.67. However, a similar site with a silt loam, a 5% slope, an erosivity ≥120, utilizing a sediment basin results in 4.8 tons/acre/year of soil which equates to an efficiency rating of 0.80.

Location	Soil Type	Erodibility Value	R Value	Length of Slope (ft.)	Slope (%)	Supporting Practices	Sediment Yield (A,tons/acre/yr)	Efficiency Rating
Texas-Scurry	Silt Loam	0.43	145	200	1	Silt fence	1.9	0.67
Texas-Reagan	Silt Loam	0.43	120	200	5	Sediment Basin	4.8	0.80

Additionally, soil loss modeling data indicated soil loss tolerance levels below 5 tons/acre/year for an efficiency rating of 0.60 with low slopes and silt/loam and clay soils.

6.0 Using the RAPPS Process

6.1 RUSLE2 Process

This guidance document has been prepared to help operators select various RAPPS based on site specific conditions. The evaluation of RAPPS efficiency ratings is based on the RUSLE2 computer program output.

As previously stated the RUSLE 2 computer model was used to develop this guidance document. For more information on it or if a user would like to evaluate their proposed site using the RUSLE2 computer program, it may be downloaded from official RUSLE2 Internet Sites supported by the USDA-ARS at http://www.sedlab.olemiss.edu/RUSLE/, the USDA-Natural Resources Conservation Service (NRCS) at ftp://fargo.nserl.purdue.edu/pub/RUSLE2/ and the University of Tennessee at http://bioengr.ag.utk.edu/RUSLE2/. These internet sites also have supporting information for RUSLE2 including a tutorial, a sample database and a slide set that provides an overview. The RUSLE2 program may be used to evaluate soil loss by entering the site specific factors into the model. A discussion of the use of RUSLE2 is beyond the scope of this document, but more detail is provided in the RUSLE2 user guide, which can be found in its entirety and downloadable PDF at http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Technology.htm, and the supporting information in the above-referenced Internet Sites may be used to learn the basic operation of the RUSLE2 computer program. In spite of all this available information and attempts by its developers to make RUSLE2 user-friendly, it is also clear that RUSLE is intended to be used after some training in both the scientific model and user interface. There is currently a pronounced lack of such training besides that provided by USDA-NRCS for its personnel and Technical Support.

6.2 Decision Tree Process

The following RAPPS guidance is an alternative to using the RUSLE2 program and evaluating efficiency ratings from the model's output results. The RAPPS site evaluation consists of six steps which allow the user to objectively evaluate efficient erosion control(s) for a given set of site conditions. Attachment 1 is a quick reference user guide that is intended to help the user evaluate slope, erosivity and erodibility. The user guide may be copied and laminated for use in the field. Subsequent to the installation of the suggested RAPPS, the effectiveness of the employed RAPPS should be evaluated and modified to reduce soil loss from the site, if necessary. When used correctly, the result will guide the operator to select efficient RAPPS to meet management goals. The RAPPS selection process consists of the following steps:

Step 1) Define the slope of the area to be disturbed;
Step 2) Determine the site average rainfall erosivity (R Value);
Step 3) Determine soil type of area to be disturbed;
Step 4) Select one of the nine RAPPS decision trees based on an evaluation of slope and erosivity;

Step 5) Select the appropriate path of the decision tree based on soil type to evaluate the efficiency of RAPPS;
Step 6) Compare ER to Management Goal

Subsequent to selection of a RAPPS or a combination of RAPPS, the following sequential tasks should be employed until the construction site is re-vegetated or stabilized:

Step 7) Install RAPPS in appropriate locations before beginning clearing, grading and excavation activities.

- It should be noted that most of the RAPPS combinations were modeled with the RAPPS located near the base of the slope and 75% down the slope.

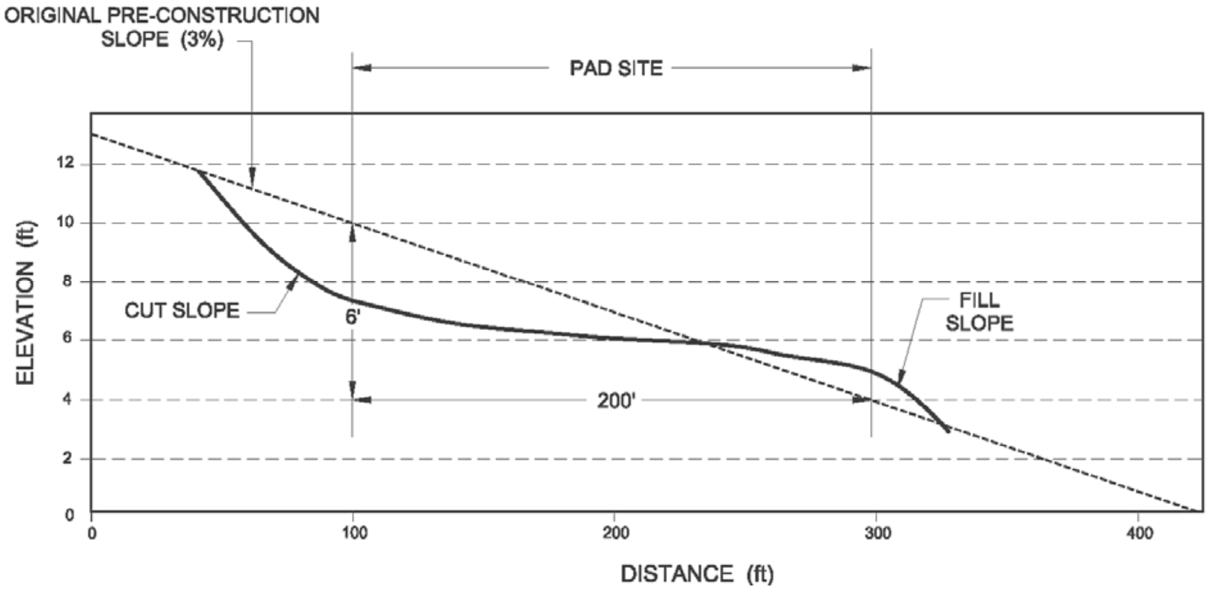
- It should be noted that a consensus of erosion control experts and regulatory agencies recommend preserving existing vegetation and re-establishing vegetation (i.e. seeding, sodding, or hydroseeding) on the disturbed slope as the preferred method of stabilization. Therefore, preserving and re-establishing vegetation should always be encouraged regardless of the particular RAPPS chosen.

Step 8) Begin site construction;
Step 9) Inspect RAPPS during or subsequent to a rainfall event and evaluate if sediment has been deposited off the site;
Step 10) Modify or add RAPPS to prevent off-site sediment yield, if necessary;
Step 11) Complete construction;
Step 12) Vegetate and/or stabilize disturbed areas following completion of construction.

6.2.1 DEFINE THE SLOPE OF THE AREA TO BE DISTURBED

RAPPS should be installed prior to the construction activity, so the predominant pre-construction slope of the area should be evaluated. If the construction area has more than one definable slope, then the predominant slope where the construction activity is intended should be used. RUSLE2 has the ability to compute sediment yield using a number of different slope profiles. For the purposes of this guidance, a uniform slope profile has been used to model soil loss and to develop the decision trees. The slope of an oil and gas well pad subsequent to construction activities is commonly modified to include a cut and fill slope. The cut slope and toe of the fill slope will typically be steeper than the original slope, and the well pad slope will typically be shallower than the original slope. The preconstruction slope was used because the resultant slope of the well pad is typically shallower, but takes into account the cut slope, the fill slope and slopes in up-gradient and down-gradient positions where water is flowing onto and leaving the construction site as illustrated in Figure 5.

Figure 5. Use of Pre-construction Slope for Construction Sites

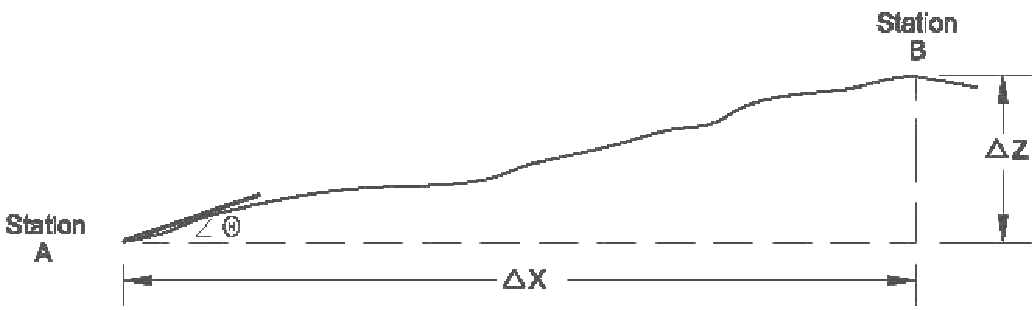


Slope is defined as the amount of elevation gain over a given distance (vertical rise to horizontal run). Slope is determined by measuring the elevation change over a linear distance. The slope percentage is calculated by dividing the elevation change by the linear distance. For example, Figure 5 illustrates a hill with 6 feet of elevation gain over a distance of 200 feet, which represents a 3% slope. A common engineering practice consists of evaluating slope on increments of 100 feet for the purpose of practicality. It should be noted that slope percent and slope angle are not the same, and a table has been included in this section to assist in the conversion from slope angle to percent slope.

The elevation change can be determined utilizing several methods including field methods, trigonometric methods, the use of aerial photographs or a site-specific topographic survey, if available. Field methods to determine elevation gain include the use of an altimeter commonly found on GPS units, surveyor's line-of-sight level, Abney level, a clinometer (also found on a Brunton compass), a digital level, or other surveying equipment (e.g., a total station).

The Slope Of The Area To Be Disturbed can be determined using the following equation:

$$Slope = \frac{Difference\ in\ Elevation}{Difference\ in\ Lateral\ Position}$$ **This is equivalent to:** $$\%Slope = \frac{Rise}{Run}x100 = \left(\frac{\Delta Z}{\Delta X}\right)x100$$



Percent Slope is not equivalent to slope angle. The following formula can be used to convert the slope in degrees to the slope in percent.

Percent Slope = Tan θ * 100

Several methods to determine the rise (ΔZ), run (ΔX) and slope angle (θ) are described below:

A) Use the Existing Topographic Survey:

- Read the plan view lateral distance "ΔX" from the survey plat.
- Read the change in elevation "ΔZ" from the contour lines on the survey.
- The slope (in percent) can be determined by using ΔZ and ΔX values in the slope formula $\left(\frac{\Delta Z}{\Delta X}\right)x100$

B) Evaluate Difference in Elevation using an Altimeter with an accuracy of ±1foot:

- Standing on Station A, hold the altimeter firmly in your hand and read the altitude of Station A.
- Similarly, standing on Station B, hold the altimeter firmly in your hand and read the altitude of Station B.
- The change in elevation "ΔZ" can be calculated by taking the difference in altitudes of Station A and Station B.
- Horizontal distance ΔX can be scaled from an aerial photograph or a survey map. ΔX can also be determined by using trigonometric methods or other acceptable methods.
- The slope (in percent) can be determined by using ΔZ and ΔX values in the slope formula $\left(\frac{\Delta Z}{\Delta X}\right)x100$

C) Use a GPS unit with elevation capabilities and a resolution of at least 1 sq. ft.:

- Set the unit to UTM coordinates.
- Record the coordinates (X_1, Y_1) and elevation (Z_1) at the base of the slope you wish to measure.
- Record the elevation (Z_2) and coordinates (X_2, Y_2) at the top of the slope you wish to measure.
- The Elevation Rise "ΔZ" = $Z_2 - Z_1$
- The Run Distance "ΔX" = $\sqrt{\left((X_2 - X_1)^2 + (Y_2 - Y_1)^2\right)}$
- The slope (in percent) can be determined by using ΔZ and ΔX values in the slope formula $\left(\frac{\Delta Z}{\Delta X}\right) x100$

D) Use a Digital Level

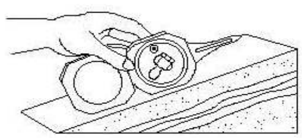
- Place the level directly on the surface of the slope.
- Read the percent slope directly from the instrument.
  - o It should be noted that this method should only be used for steep slopes.

E) Measure the slope in degrees (θ) and convert to percent slope:

- Use a Brunton compass (shown below) or Abney level to measure the slope angle "θ" in degrees.

- Use the following formula to convert the slope in degrees to the slope in percent:

Percent Slope = Tan θ * 100



Using a Brunton compass to measure slope angle

- It should be noted that this method should only be used for steep slopes.
- The Tan θ values can be determined using the tangent table as shown below.

Tangent Table

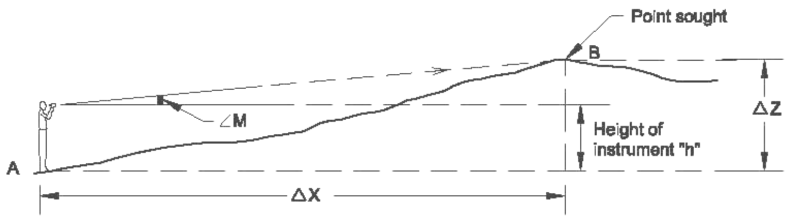
Angle	Tangent	Angle	Tangent	Angle	Tangent	Angle	Tangent
1	0.0175	11	0.1944	21	0.3838	31	0.6008
2	0.0349	12	0.2125	22	0.404	32	0.6248
3	0.0524	13	0.2309	23	0.4244	33	0.6493
4	0.0699	14	0.2493	24	0.4452	34	0.6744
5	0.0875	15	0.2679	25	0.4663	35	0.7001
6	0.1051	16	0.2867	26	0.4877	36	0.7265
7	0.1228	17	0.3057	27	0.5095	37	0.7535
8	0.1405	18	0.3249	28	0.5317	38	0.7812

Angle	Tangent	Angle	Tangent	Angle	Tangent	Angle	Tangent
9	0.1584	19	0.3443	29	0.5543	39	0.8097
10	0.1763	20	0.3639	30	0.5773	40	0.839

F) Measure the elevation difference (ΔZ) using a Brunton Compass or Abney Level:

- Start at the lower point (Station A) and sight the uphill point (Station B) using a Brunton compass.
- Record angle M on the Brunton compass or Abney level.
- Horizontal distance ΔX can be scaled from an aerial photograph or a survey map. ΔX can also be determined by using trigonometric methods or other acceptable methods.

$$\Delta Z = \{\Delta X \tan(\text{angle } M)\} + \text{Height of the instrument “h”}$$

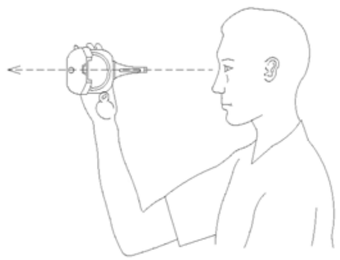


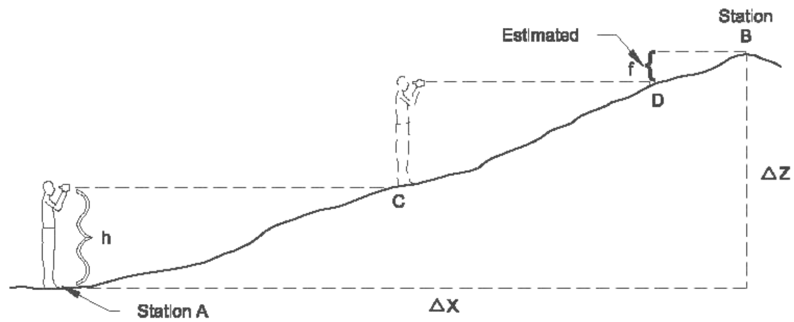
Using Brunton compass or Abney level to measure difference in elevation

G) Measure the elevation difference (ΔZ) using a Clinometer:

- A clinometer, Abney level or Brunton compass (shown below) can be used as a hand level to determine the difference in elevation between two points.
- Start the measurement by standing at the lower of the two points (Station A) and finding a point on the ground that is level with the eye (Point C). Mark Point C on the ground.
- Now standing at Point C, choose another point that is level with the eye further uphill (Point D).
- Repeat the procedure until the end point is reached (Station B). The last fractional reading can be estimated to the nearest foot.
- Horizontal distance ΔX can be scaled from an aerial photograph or a survey map. ΔX can also be determined by using trigonometric methods or other acceptable methods.

ΔZ = {Height of the surveyor's eye "h" x number of moves between Stations A & B} + last fractional reading "f"





Using the Brunton Compass as a Clinometer

Measuring the difference in elevation between two stations by using a hand level and counting eye-level increments

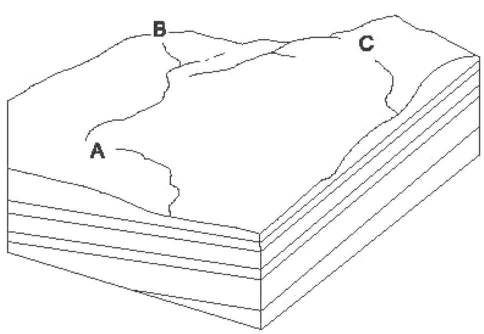
H) Determine the slope angle (θ) using the graphical three-point method:

- Mark three points (A, B, C) at different elevations on the surface of the preconstruction slope on a site topographic survey, as shown in figure (i) below.
- Locate Point D on the graph, which is at the same elevation as Point B, on the line joining Points A & C, as shown in figure (ii). Point D can be located by solving the relation:

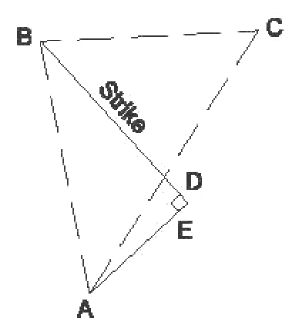
$$AD = AC \frac{\textit{Difference in Elevation Between Points A \& B}}{\textit{Difference in Elevation Between Points A \& C}}$$

- Level line BD is the direction perpendicular to the steepest slope of the preconstruction slope surface.
- The slope angle "θ" of the preconstruction slope can be determined by measuring the distance perpendicular to BD, i.e. AE.
- The slope angle "θ" can be determined from the following equation:

$$\text{Tan } \theta = \frac{\textit{Difference in Elevation Between Points A \& B}}{\textit{Distance AE}}$$



(i)



(ii)

- The following formula can be used to convert the slope in degrees to the slope in percent.

$$\text{Percent Slope} = \text{Tan } \theta * 100$$

Based on the sensitivity analyses, slope is an important factor in soil loss, and slopes steeper than 5 percent result in significant potential soil loss regardless of the other factors in RUSLE. Subsequent to the determination of the construction site's slope, a group of three decision trees are selected based on slopes representing <2%, 2-4% and >4%. Slope values of 1%, 3% and 5% were used as parameters in RUSLE2 as an evaluation of soil loss and preparation of the decision trees. Additionally, very steep slopes (>7 to 25%) were modeled to evaluate soil loss and are included in the decision trees where appropriate.

6.2.2 DETERMINE SITE AVERAGE RAINFALL EROSIVITY

The average annual erosivity factor (R-value) is an index of rainfall erosivity for a geographic location. The R-value is a rainfall and runoff factor that represents the effect of both rainfall intensity and rainfall amount. Soil losses from cultivated fields are directly proportional to a rain storm parameter consisting of the total storm energy (E) times the maximum 30-minute intensity (I_{30}) (Wischmeier, 1959; Wischmeier and Smith, 1958). The average annual total of the storm EI values for a particular geographic area is the rainfall erosion index (R) for that geographic location. R-values are available for each county in the United States and included in the RUSLE2 computer program database. The R-values for each county in the United States have been included in Appendix A. The county-specific R-values listed in Appendix A are to be used to select your construction site's R-value and appropriate decision tree. In the example below, the R-value for Harding County in New Mexico is 69.94.

State Name	County	R Factor US
New Mexico	Harding	69.94
New Mexico	Hidalgo	99.81
New Mexico	Lea	87.71
New Mexico	Lincoln	110.20
New Mexico	Luna	55.10

6.2.3 DETERMINE SOIL TYPE OF AREA TO BE DISTURBED

K is the soil erodibility factor and is an empirical measure of the susceptibility of soil particles to erosion by rainfall and runoff. Soil erodibility is primarily a function of soil texture, but other intrinsic soil properties including organic matter, permeability and structure also contribute to erodibility. Once the general textural class of the soil to be disturbed is evaluated, a conservative (higher) K factor for the general textural class (sand (K=0.15), clay (K=0.32) and silt loam (K=0.43)) was used in the RUSLE2 program to determine soil loss and efficiency ratings for different RAPPS. It should be noted that the K factor of 0.43 used for silt loam is one of the highest default K values that can be used in the current form of RUSLE2.

The deepest soil layer to be disturbed and predominantly exposed during the construction activity should be sampled with simple hand tools (i.e., hand trowel, shovel, hand auger, etc.) or mechanized equipment. For example, if only the topsoil will be disturbed when building a well pad, then this soil horizon should be sampled to evaluate the general textural class. However, if the well pad construction involves removing several feet of soil, then the topsoil or subsoil horizon that will have the most area of exposure subsequent to the construction activities should be evaluated.

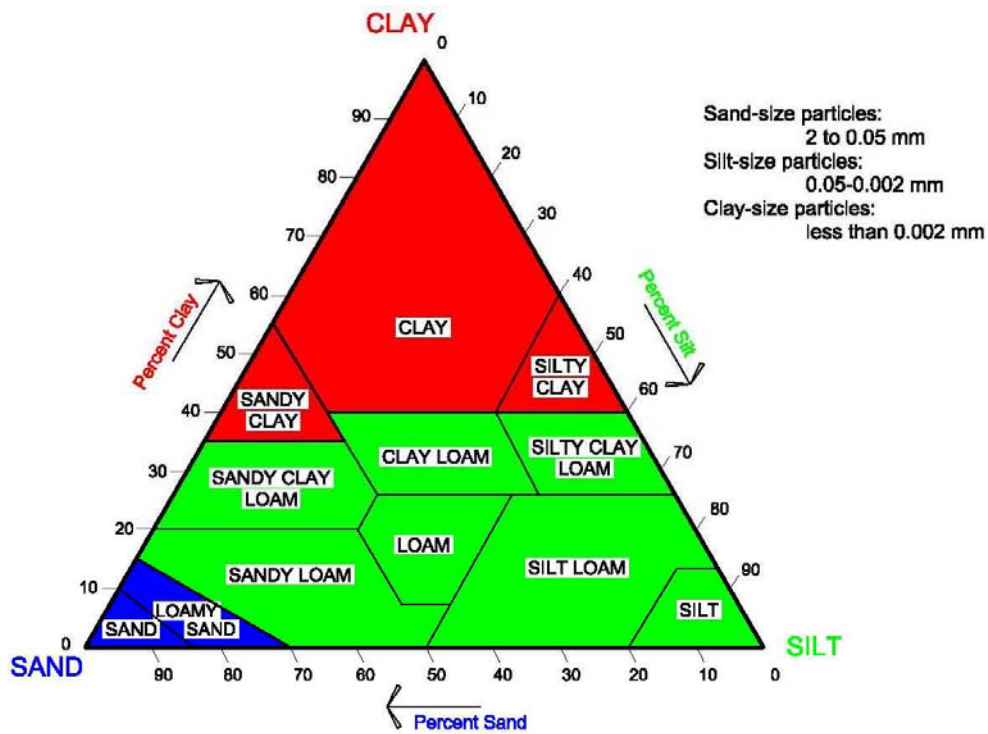
Soil texture represents the relative proportion of silt-, sand-, and clay-sized particles in a soil. This document uses the USDA soil texture classification system, and the USDA soil textural triangle is shown in Figure 6. The mineral particles in the soil are divided into the following size classes: gravel (greater than 2mm), sand (0.05 - 2mm), silt (0.002 - 0.05mm) and clay (smaller than 0.002 mm). The textural triangle specifies 12 different textural classes of soil based on particle-size distribution. The textural class may be determined by evaluating the percentages of any two particle size groupings. Figure 6 has been color coded to illustrate the three general soil textural classifications.

The texture of a soil and the associated K factor for a given site may be determined or estimated using several different methods. The K factors for most cropland soils and some rangelands and forestlands may be obtained from USDA-NRCS soil surveys, available at most county NRCS offices. K factors are also included in the Soil Survey Geographic (SSURGO) database (http://soildatamart.nrcs.usda.gov/) and the Web Soil Survey database (http://websoilsurvey.nrcs.usda.gov/app/). These databases allow the user to find their proposed construction site on aerial photographs and evaluate the soil series and associated K factor.

A field-method approach may also be used to evaluate the texture of a soil and the associated K factor. This document simplifies the determination of texture and groups the 12 textural classes into three general groups including sand, clay and silt/loam, which are designated by different color codes in the textural triangle (Figure 6). Percentages of clay, silt and sand are also included on Figure 6 for the 12 textural classes grouped into the three general textural classifications.

The field-method approach to evaluate soil texture is described in the Soil Texture Decision Chart illustrated in Figure 7. This method will help users classify the soil at their site into one of three general soil textural classes. It should be noted that silt has been grouped with the loams, and its occurrence is rare in nature compared to the other textural classes (Ponte, 2003). The RAPPS decision trees only require the user to determine if the soil is sand, clay or silt/loam. This field method approach to evaluate general soil texture is illustrated with photographs in Figure 8.

Figure 6. Soil Textural Triangle



SOIL DESCRIPTION

SAND GENERAL TEXTURAL CLASSIFICATION

Sand:	>85% Sand
Loamy Sand:	70 to 91% Sand

SILT/LOAM GENERAL TEXTURAL CLASSIFICATION

Sandy Loam:	7 to 20% Clay, >52% Sand, or <7% Clay, <50% Silt, and >43% Sand
Sandy Clay Loam:	20 to 35% Clay, <28% Silt, and 52% or less Sand
Loam:	7 to 27% Clay, 28 to 50% Silt, and 52% or less Sand
Silt Loam:	50% or more Silt and 12 to 27% Clay, or 50 to 80% Silt and <12% Silt
Silt:	80% or more Silt and <12% Clay
Silty Clay Loam:	27 to 40% Clay and 20% or less Sand
Clay Loam:	27 to 40% Clay and 20 to 46% Sand

CLAY GENERAL TEXTURAL CLASSIFICATION

Sandy Clay:	35% or more Clay and 45% or more Sand
Silty Clay:	40% or more Clay and 40% or more Silt
Clay:	40% or more Clay, 45% or less Sand, and <40% Silt

Figure 7. Soil Texture Decision Chart

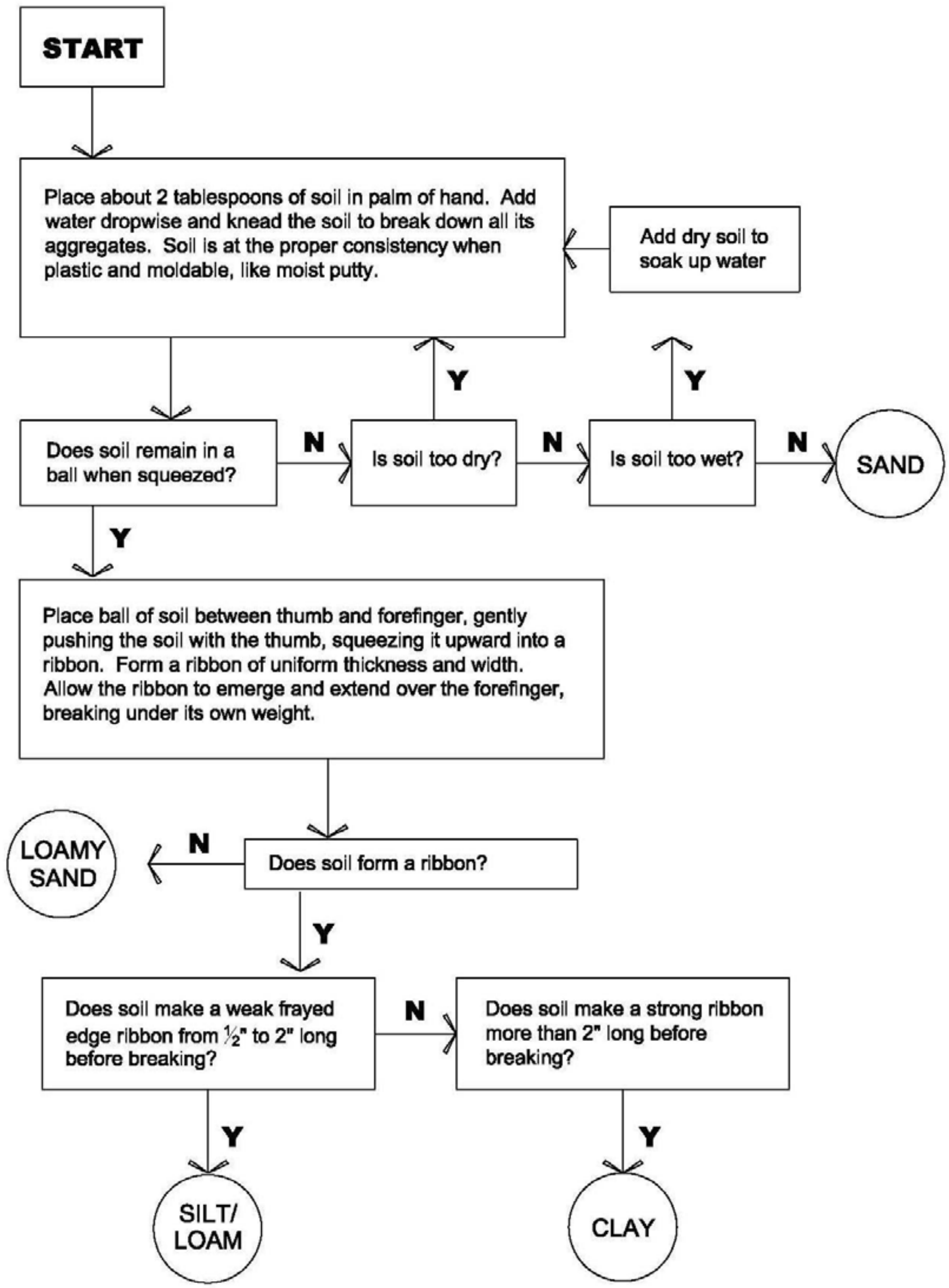
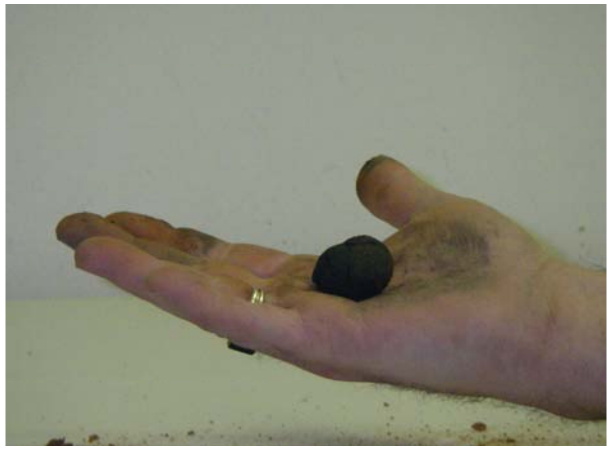


Figure 8. Field Tests to Evaluate Soil Texture

A – Sprinkle a few drops of water on the soil and knead the soil to break down its aggregates



B – Soil is formed into a ball for testing

C – Sand does not remain in a ball when squeezed

D – Loamy Sand does not form a ribbon

E – Less than 2-inch ribbon formed before breaking due to silt/loam content

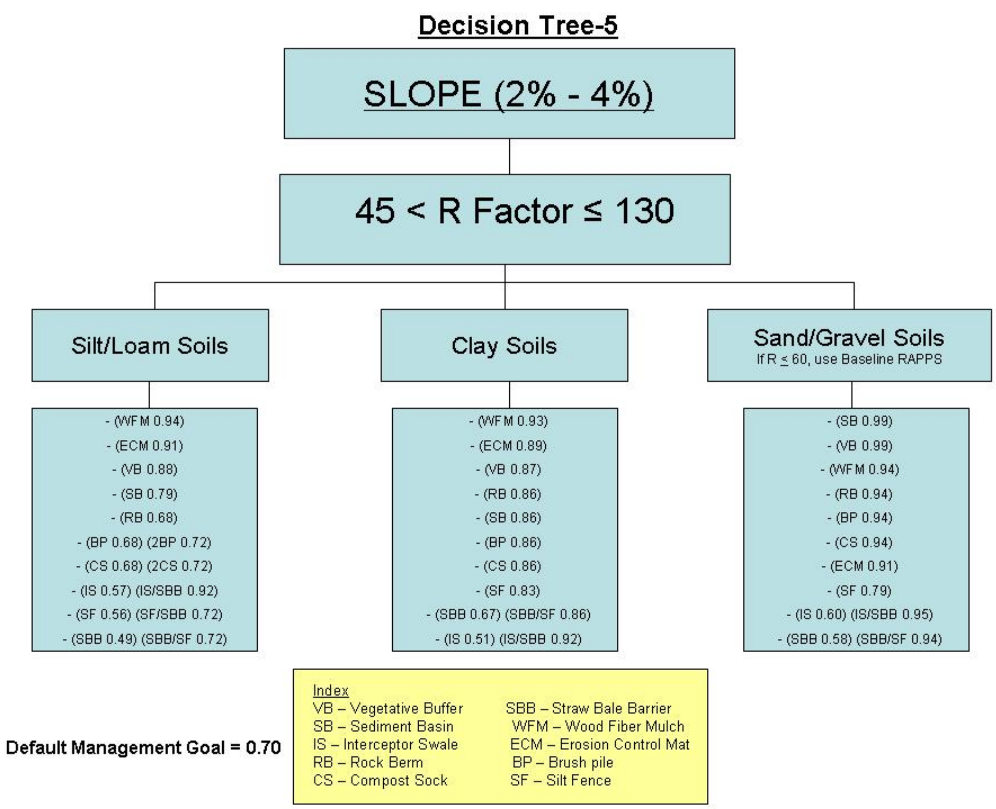
F – 2-inch ribbon formed due to higher clay content

6.2.4 SELECTION OF RAPPS USING DECISION TREES

Based on an evaluation of slope and erosivity, one of the nine RAPPS decision trees included in Appendix B is selected. Subsequent to evaluation of the soil type, the appropriate path of the decision tree is selected and resultant efficiencies of RAPPS are listed in order of highest to lowest efficiency as shown in Figure 9, which is an example of a RAPPS Decision Tree. If the efficiency of a specific RAPPS exceeds the management goal, then the RAPPS is effective in reducing sediment yield from the site, assuming the RAPPS are designed, operated and maintained properly.

The list of RAPPS provided in Appendix C and D are not exhaustive lists of available erosion control measures, rather they are presentations of the currently popular, cost-effective, efficient erosion control practices used in the U.S. construction market and documented in the construction version of RUSLE2. The examples of RAPPS presented in Appendix C and D are not engineering plans and specifications as defined by ASTM International or the American National Standards Institute (ANSI) and should only be used as a general guide for practices being used in the U.S. marketplace. In some situations, operators may want to consider retaining a certified professional in erosion and sediment control (CPESC) to design RAPPS, inspect constructed RAPPS and provide periodic inspection of the site during operations. A few RAPPS documented in Appendix C (e.g., surface roughening, RGHN) were not included in RUSLE2, and corresponding efficiency ratings were not calculated.

Figure 9. Example of RAPPS Decision Tree



The RAPPS listed in the decision trees represent the majority of the options in the RUSLE2 computer program for construction sites. A few erosion control methods in RUSLE2 have several variations, and this guidance document typically evaluates the most cost-effective and prevalent erosion control method currently available. For example, three variations of erosion control blankets including rolled material, rolled material with quick decay and rolled material with single net straw may be evaluated with RUSLE2 model; however, the generic erosion control blanket was used to model erosion control blankets because of its common use in the construction industry.

Each decision tree path includes a list of RAPPS (abbreviated) and its corresponding efficiency rating listed in order of highest to lowest efficiency. If the RAPPS efficiency does not meet the default management goal, then additional combinations of RAPPS with corresponding efficiencies are listed in the decision tree.

Figure 9 is an example Decision Tree that illustrates RAPPS nomenclature (CS 0.68) (2CS 0.72), which indicates that a compost sock exhibits an efficiency of 68%, and a combination of two compost socks exhibit an efficiency of 72%. Figure 9 also illustrates RAPPS nomenclature (SF 0.56) (SF/SBB 0.72) which indicates that a silt fence exhibits an efficiency of 56% and a combination of a silt fence with a straw bale barrier exhibits an efficiency of 72%. If a combination of specific RAPPS did not meet a management goal of 70%, then the RAPPS combination was not listed in the decision trees. The combinations of RAPPS that were selected are not an exhaustive list of RAPPS combinations, but represent a number of RAPPS that are efficient, economical, commonly used and/or relatively easy to install that meet the default management goal of at least 70%. It should be noted that most of the RAPPS combinations were modeled with the RAPPS located near the base of the slope and 75% down the slope.

6.2.5 SUPPLEMENTAL RAPPS

Under certain circumstances, such as steep slopes or a region with high erosivity (R-values), alternate or additional RAPPS should be employed to prevent discharges of potentially undesirable quantities of sediment. In those cases, one or a combination of two RAPPS documented in the decision trees will not provide adequate protection above a specified slope, R-Value or combination of slope and R-value. This specific situation is noted in the soil type decision box in the decision tree paths. The RAPPS used for these situations are referred to as “Supplemental RAPPS” and are expected to achieve the intent of the efficiency goal as a combined system of RAPPS. Supplemental RAPPS are a combination of two or more listed RAPPS or Specialty RAPPS and are required if a site has high risk attributes that exceed the values prescribed in the decision trees (Appendix B – Decision trees 3, 6, 7, 8 & 9). Supplemental RAPPS were employed in situations where soil loss modeling data consistently indicated that an efficiency rating of 70% could not be achieved with a combination of at least two RAPPS, or potential undesirable quantities of sediment may be transported off the site even while meeting the management goal. Installation and maintenance of these Supplemental RAPPS in accordance with accepted construction practices using good judgment should provide adequate erosion and sediment control. However, other combinations of RAPPS in site-specific conditions using good judgment should be employed, if necessary. It should be noted that a consensus of erosion control experts and regulatory agencies recommend preserving existing vegetation and re-establishing vegetation (i.e. seeding, sodding, or hydroseeding) on the disturbed slope as the preferred method of stabilization. Therefore, preserving and re-establishing vegetation should always be encouraged regardless of the particular RAPPS chosen.

In the case of a site with a steep pre-construction slope (Decision Trees 7, 8 & 9), the user should employ Supplemental RAPPS that will: 1) reduce the amount of stormwater reaching the site by redirecting the up-gradient run-on flow of stormwater around the construction site by means of a diversion structure (i.e., a diversion dike, interceptor swale, ditches, slope drains); 2) protect disturbed soil on the slope with a form of cover (i.e., mulch and/or erosion control mat); and 3) protect the base of the slope with a runoff-velocity barrier (i.e., rock berm, compost sock, brush piles, fiber rolls/logs). It should be noted that soil loss modeling data indicate that silt fences and straw hay bales should not be used at the bottom of steep slopes as they do not function well in high runoff-velocity conditions.

In the case of a site with a high Erosivity (R value - Decision Trees 3, 6 or 9), the user should employ Supplemental RAPPS that will: 1) protect disturbed soil on the slope with roughening and a form of cover (i.e., mulch, straw, compost and/or erosion control mat); and 2) protect the base of the slope with runoff-velocity barriers (i.e., silt fence, straw bales, fiber rolls/logs, rock berms, vegetative barrier or brush piles).

In the case of a construction site adjacent to a drainage feature or a water way, the use of sediment basins or other sediment capturing containment structures (i.e. silt trap, dewatering structure, filter bag) are recommended.

The above-referenced scenarios are not an exhaustive list of the site-specific situations that could be encountered during oil and gas construction activity. It should be noted that other combinations of RAPPS in site specific situations should be installed using good judgment, if required to prevent undesirable quantities of sediment being transported off the site. If these situations exist, operators may want to consider retaining a CPESC to design RAPPS, inspect constructed RAPPS and provide periodic inspection of the site during operations.

6.2.6 OPERATIONAL RAPPS

Under certain circumstances including a combination of low slopes, low R-values and/or low to moderate K-values, implementation of RAPPS beyond Operational RAPPS may not be required. Construction sites with modeled low soil loss (<5 tons/acre/year) using conservative input values including a C factor of 1.0 in the RUSLE2 program require Operational RAPPS. Operational RAPPS reflect a minimal effort of erosion control including installation of an inexpensive sediment barrier (i.e., compost sock, compost berm, vegetative barrier, brush pile, interceptor swale, soil berm, straw bale barriers or silt fence) near the downgradient boundary of the construction site along with the following practices that operators are commonly using as part of normal operations:

- Planning the site location to choose low-slope sites away from waterways;
- Minimizing the footprint of the disturbed area;
- Phasing/scheduling projects to minimize soil disturbance;
- Timing the project during dry weather periods of the year;
- Managing slopes to decrease steepness;
- Maintaining the maximum amount of vegetative cover as possible;
- Cutting vegetation above ground level and limiting removal of vegetation, root zones and stumps, where possible;
- Limiting site disturbance to only clear what is necessary;
- Practicing good housekeeping including proper material storage; and
- Practicing operation and maintenance procedures to limit sediment yield (i.e. maintaining silt fence).

6.2.7 SPECIALTY RAPPS

During construction of oil and gas sites, an operator may encounter special circumstances including crossing a regulated water body or construction near a roadway that require Specialty RAPPS to divert or reduce the velocity of surface water flow. Specialty RAPPS near roadways are also constructed to limit the amount of sediment leaving the site via truck traffic. Specialty RAPPS are not included in RUSLE2 because they are not considered general erosion control practices to reduce sediment yield and are used in special circumstances. Efficiency ratings for Specialty RAPPS were not calculated in this document because their corresponding P factors are not included in RUSLE2.

Specialty RAPPS are documented in Appendix D and include Stabilized Construction Entrance (SCE), Road Surface Slope (RDSS), Drainage Dips (DIP), Road-Side Ditches (RDSD), Turnouts or Wing Ditches (TO), Cross-drain Culverts (CULV), Sediment Traps (ST), Construction Mats (CM), Filter Bags (FB),Trench Dewatering and Discharge (TDD), Dewatering Structure (DS), Stream Crossing Flume Pipe (SCFP), Stream Crossing Dam and Pump (SCDP), Stream Bank Stabilization (SBS), Dry Stream Crossing (DSC) and the Temporary Equipment Crossing of Flowing Creek (TECFC). Information regarding installation, inspection and maintenance of Specialty RAPPS are included in Appendix D.

7.0 Final Stabilization

RAPPS should be maintained in good condition for the area disturbed during and after the period of active disturbance until final stabilization of the area. Final stabilization will limit and/or prevent potentially undesirable quantities of sediment from leaving the site in storm water runoff and entering a water body. Final stabilization can be achieved by several different methods including stabilization of the road, well pad, and equipment pad, as well as re-vegetation of the native background vegetative cover for the area.

After construction of roads and well/equipment pads are completed, the area covered by the road and/or equipment pad is considered stabilized by placing base material on these areas, such as asphalt, cement treated base, aggregate, crushed limestone or other types rock. Once the base material is sufficiently compacted for its intended use, it is considered stabilized.

Accepted erosion control guidance typically defines final stabilization as a uniform, (e.g. evenly distributed, without large bare areas) perennial vegetation cover with a density of 70% of the native background vegetation cover for the area has been established on all unpaved areas and areas not covered by permanent structures, or equivalent permanent stabilization measures (such as the use of stabilized construction entrances, rock berms, geotextiles) have been employed. Additionally, erosion control guidance typically requires that temporary erosion control measures are selected, designed, and installed to achieve 70 percent vegetative coverage within three years.

This document suggests a re-vegetation goal of 70% as a benchmark to allow oil and gas operators to remove or cease maintenance of erosion control practices. Although a re-vegetation goal of approximately 70% is suggested, federal, state or local regulations may require a specific stabilization goal, and these regulations or guidance documents should be evaluated prior to removal or cessation of maintenance of RAPPS.

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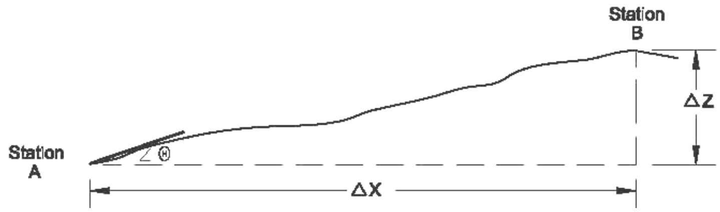
ATTACHMENT 1. RAPPS QUICK REFERENCE USER GUIDE

RAPPS QUICK REFERENCE GUIDE

Step 1) Determine The Slope Of The Area To Be Disturbed

$$Slope = \frac{Difference\ in\ Elevation}{Difference\ in\ Lateral\ Position}$$ **This is equivalent to:** $$\%Slope = \frac{Rise}{Run} x100 = \left(\frac{\Delta Z}{\Delta X}\right) x100$$



Percent Slope is not equivalent to slope angle. The following formula can be used to convert the slope in degrees to the slope in percent.

Percent Slope = Tan θ * 100

The user may choose to evaluate the slope by their own method. However, several methods to determine the rise (ΔZ), run (ΔX) and slope angle (θ) are described in the main text of the RAPPS document Section 6.2.1 (Page 18).

Step 2) Determine Site Average Rainfall Erosivity

The average annual erosivity factor (R-value) is an index of rainfall erosivity for a geographic location. The R-value is a rainfall and runoff factor that represents the effect of both rainfall intensity and rainfall amount.

The R-values for each county in the United States have been included in Appendix A. The county-specific R-values listed in Appendix A are to be used to select your construction site's R-value. In the example below, the R-value for Harding County in New Mexico is 69.94.

State Name	County	R Factor US
New Mexico	Harding	69.94
New Mexico	Hidalgo	99.81
New Mexico	Lea	87.71
New Mexico	Lincoln	110.20

Step 3) Site Erodibility - Determine Soil Type Of Area To Be Disturbed

A) Use existing soil surveys located at your local USDA/ Natural Resource Conservation Service (NRCS) office

OR

B) Look-up the soil type from the following online Soil Survey Geographic (SSURGO) database or the NRCS database links:

http://soildatamart.nrcs.usda.gov/
http://websoilsurvey.nrcs.usda.gov/app/

OR

C) Use the Soil Texture Decision Chart:

Use the Soil Texture Decision Chart, at the end of Attachment 1, and follow the steps below to determine the predominate soil type to be disturbed at your site (i.e. clay, sand, or silt/loam).

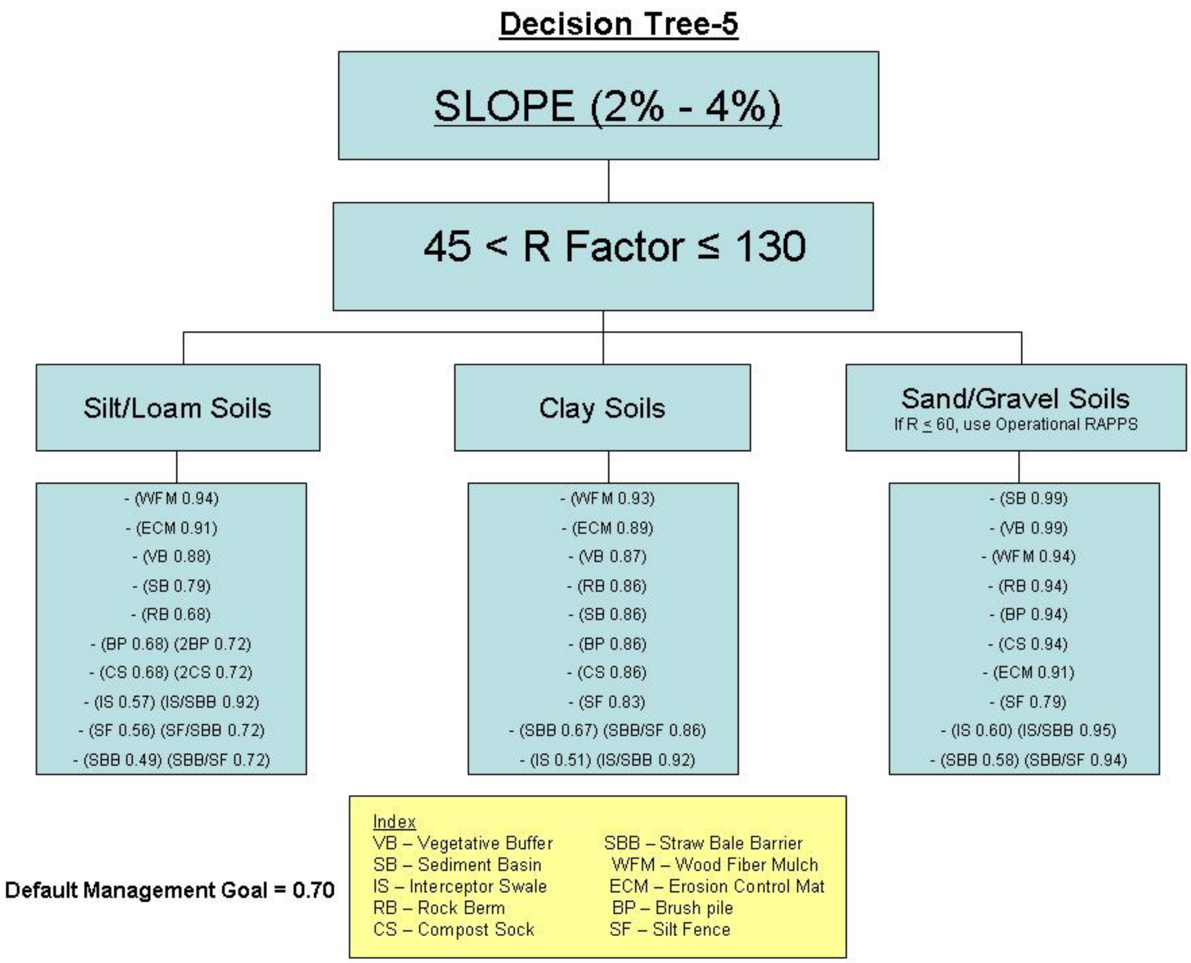
Step 4) Select one of the nine RAPPS decision trees based on an evaluation of slope and erosivity.

Step 5) Select the appropriate path of the decision tree based on soil type to evaluate the efficiency of RAPPS.

Each decision tree path includes a list of RAPPS (abbreviated) and its corresponding efficiency rating listed in order of highest to lowest efficiency. The efficiency rating (ER) represents the proportion of sediment kept on-site by the erosion control practice that would have otherwise been transported off-site. For example, an ER of 0.80 represents the percentage (80%) of sediment that would have been transported off-site had the erosion control practice not been in place.

Example Decision Tree-5 illustrates RAPPS nomenclature (CS 0.68) (2CS 0.72), which indicates that a compost sock exhibits an efficiency of 68%, and a combination of two compost socks exhibit an efficiency of 72%. Example Decision Tree-5 also illustrates RAPPS nomenclature (SF 0.56) (SF/SBB 0.72) which indicates that a silt fence exhibits an efficiency of 56% and a combination of a silt fence with a straw bale barrier exhibits an efficiency of 72%. A detailed discussion of efficiency ratings is provided in Section 5.0 (Page 15).

Example of RAPPS Decision Tree



Step 6) Compare ER to Management Goal

Compare each RAPPS ER for the appropriate soil type path to management goals to evaluate if erosion control methods removed a sufficient amount of sediment for a particular site. The site management goal represents a measure of the acceptable amount of sediment removed by the erosion control method under site-specific conditions. A management goal of 0.60 indicates that an erosion control method must reduce the sediment yield by 60% compared to the sediment yield that would occur if no erosion control methods were in place. Sediment yield is the amount of eroded soil. In north central Texas, a management goal of 0.70 has been suggested as a minimum guideline to achieve adequate design of erosion and sediment control plans (NCTCOG ISWM Manual, 2003). For example, if selection of a specific RAPPS indicated a site-specific efficiency of 0.75 and the management goal was 0.70, then the goal has been met, and the RAPPS should be sufficient to prevent undesirable quantities of sediment from leaving the construction site assuming RAPPS are designed, constructed and maintained properly. If the RAPPS efficiency does not meet the default management goal of 70%, then additional combinations of RAPPS with corresponding efficiencies are listed in the decision tree.

Management goals may vary depending on the sensitivity of the site. Based on the literature, a general management goal of 0.70 is suggested for construction in non-sensitive areas. However, if the local agency suggests a region-specific management goal, the user should utilize that goal. The county USDA NRCS office or regional council of governments should be contacted to evaluate the region-specific management goal.

Based on soil loss modeling data, sites with silt/loam and clay soils and low (<2%) slopes exhibit special conditions using this method and it is appropriate to lower the management goal to 0.60 compared to a default management goal of 0.70 for the other decision tree paths. A detailed discussion of management goal selection is provided in Section 5.0 (Page 16).

In addition to RAPPS documented in the decision trees, other types of RAPPS including Supplemental RAPPS, Operational RAPPS and Specialty RAPPS are discussed below.

Supplemental RAPPS

Under certain circumstances, such as steep slopes or a region with high erosivity (R-values), alternate or additional RAPPS should be employed to prevent discharges of potentially undesirable quantities of sediment. In those cases, one or a combination of two RAPPS documented in the decision trees will not provide adequate protection above a specified slope, R-Value or combination of slope and R-value. This specific situation is noted in the soil type decision box in the decision tree paths. The RAPPS used for these situations are referred to as “Supplemental RAPPS” and are expected to achieve the intent of the efficiency goal as a combined system of RAPPS. Supplemental RAPPS are a combination of two or more listed RAPPS or Specialty RAPPS and are required if a site has high risk attributes that exceed the values prescribed in the decision trees (Appendix B – Decision trees 3, 6, 7, 8 & 9). A detailed discussion on Supplemental RAPPS is provided in Section 6.2.5 (Page 30).

- In the case of a site with a steep pre-construction slope (Decision Trees 7, 8 & 9), the user should employ Supplemental RAPPS that will:

    1) reduce the amount of stormwater reaching the site by redirecting the up-gradient run-on flow of stormwater around the construction site by means of a diversion structure (i.e., a diversion dike, interceptor swale, ditches, slope drains);
    2) protect disturbed soil on the slope with a form of cover (i.e., mulch and/or erosion control mat); and
    3) protect the base of the slope with a runoff-velocity barrier (i.e., rock berm, compost sock, brush piles, fiber rolls/logs). It should be noted that soil loss modeling data indicate that silt fences and straw hay bales should not be used at the bottom of steep slopes as they do not function well in high runoff-velocity conditions.

- In the case of a site with a high Erosivity (R value - Decision Trees 3, 6 or 9), the user should employ Supplemental RAPPS that will:

    1) protect disturbed soil on the slope with roughening and a form of cover (i.e., mulch, straw, compost and/or erosion control mat); and
    2) protect the base of the slope with runoff-velocity barriers (i.e., silt fence, straw bales, fiber rolls/logs, rock berms, vegetative barrier or brush piles).

- In the case of a construction site adjacent to a drainage feature or a water way, the use of sediment basins or other sediment capturing containment structures (i.e. silt trap, dewatering structure, filter bag) are recommended.

The above-referenced scenarios are not an exhaustive list of the site-specific situations that could be encountered during oil and gas construction activity. It should be noted that other combinations of RAPPS in site specific situations should be installed using good judgment, if required to prevent undesirable quantities of sediment being transported off the site. If these situations exist, operators may want to consider retaining a certified professional in erosion and sediment control (CPESC) to design RAPPS, inspect constructed RAPPS and provide periodic inspection of the site during operations.

Operational RAPPS

Under certain circumstances including low slopes and/or low erosivity, a minimal erosion control effort may be utilized. Operational RAPPS reflect a minimal effort of erosion control including installation of an inexpensive sediment barrier (i.e., compost sock, compost berm, vegetative barrier, brush pile, interceptor swale, soil berm, straw bale barriers or silt fence) near the downgradient boundary of the construction site along with the following practices that operators are commonly using as part of normal operations:

- Planning the site location to choose low-slope sites away from waterways;
- Minimizing the footprint of the disturbed area;
- Phasing/scheduling projects to minimize soil disturbance;
- Timing the project during dry weather periods of the year;
- Managing slopes to decrease steepness;
- Maintaining the maximum amount of vegetative cover as possible;
- Cutting vegetation above ground level and limiting removal of vegetation, root zones and stumps, where possible;
- Limiting site disturbance to only clear what is necessary;
- Practicing good housekeeping including proper material storage and
- Practicing operation and maintenance procedures to limit sediment yield (i.e. maintaining silt fence).

Specialty RAPPS

During construction of oil and gas sites, an operator may encounter special circumstances including crossing a regulated water body or construction near a roadway that requires Specialty RAPPS to divert or reduce the velocity of surface water flow. Specialty RAPPS near roadways are also constructed to limit the amount of sediment leaving the site via truck traffic. Site-specific conditions should be considered in conjunction with federal, state or local regulatory requirements to ensure that RAPPS are implemented to achieve regulatory compliance, if necessary. Specialty RAPPS are documented in Appendix D and include:

- Stabilized Construction Entrance (SCE);
- Road Surface Slope (RDSS);
- Drainage Dips (DIP);
- Road-Side Ditches (RDSD);
- Turnouts or Wing Ditches (TO);
- Cross-drain Culverts (CULV);
- Sediment Traps (ST);
- Construction Mats (CM);
- Filter Bags (FB);
- Trench Dewatering and Discharge (TDD);
- Dewatering Structure (DS);
- Stream Crossing Flume Pipe (SCFP);
- Stream Crossing Dam and Pump (SCDP);
- Stream Bank Stabilization (SBS);
- Dry Stream Crossing (DSC) and
- Temporary Equipment Crossing of Flowing Creek (TECFC).

Subsequent to selection of a RAPPS or a combination of RAPPS, the following sequential tasks should be employed until the construction site is re-vegetated or stabilized:

Step 7) Install RAPPS in appropriate locations before beginning clearing, grading and excavation activities.

- It should be noted that most of the RAPPS combinations were modeled with the RAPPS located near the base of the slope and 75% down the slope.

- It should be noted that a consensus of erosion control experts and regulatory agencies recommend preserving existing vegetation and re-establishing vegetation (i.e. seeding, sodding, or hydroseeding) on the disturbed slope as the preferred method of stabilization. Therefore, preserving and re-establishing vegetation should always be encouraged regardless of the particular RAPPS chosen.

Step 8) **Begin site construction;**

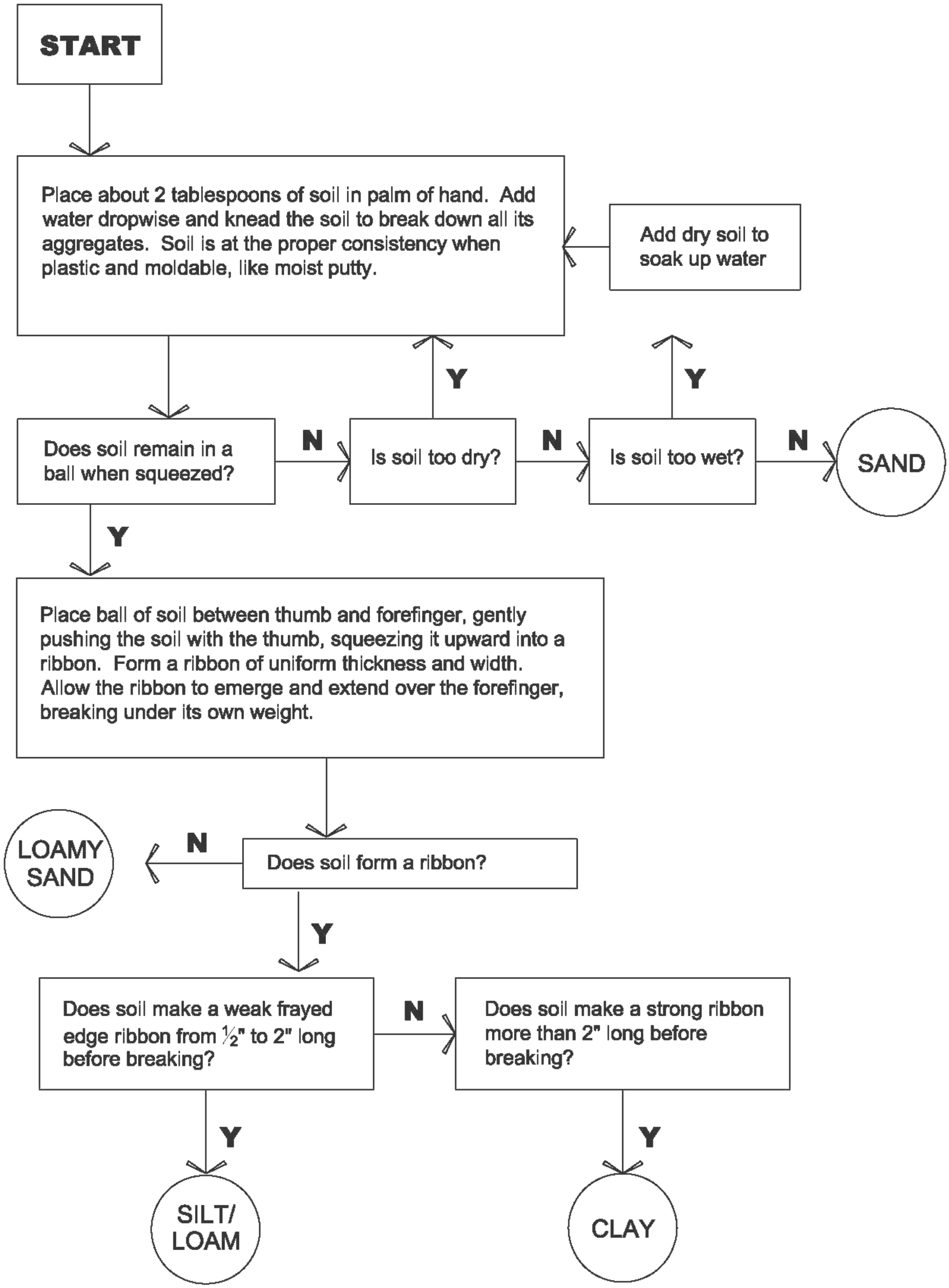
Step 9) **Inspect RAPPS during or subsequent to a rainfall event and evaluate if sediment has been deposited off the site;**

Step 10) **Modify or add RAPPS to prevent off-site sediment yield, if necessary;**

Step 11) **Complete construction;**

Step 12) **Vegetate and/or stabilize disturbed areas following completion of construction.**

Soil Texture Decision Chart



Field Tests to Evaluate Soil Texture

A – Sprinkle a few drops of water on the soil and knead the soil to break down its aggregates

B – Soil is formed into a ball for testing

C – Sand does not remain in a ball when squeezed

D – Loamy Sand does not form a ribbon

E – Less than 2-inch ribbon formed before breaking due to silt/loam content

F – 2-inch ribbon formed due to higher clay content

APPENDIX A. EROSIVITY (R-VALUE) TABLES

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County Name	R Factor US	State Name	County	R Factor US
ALABAMA			**ALABAMA**		
Alabama	Autauga	416.86	Alabama	Montgomery	435.61
Alabama	Baldwin	668.30	Alabama	Morgan	362.14
Alabama	Barbour	429.05	Alabama	Perry	430.07
Alabama	Bibb	423.50	Alabama	Pickens	418.79
Alabama	Blount	364.96	Alabama	Pike	453.94
Alabama	Bullock	422.21	Alabama	Randolph	362.40
Alabama	Butler	475.04	Alabama	Russell	388.24
Alabama	Calhoun	338.38	Alabama	St. Clair	370.15
Alabama	Chambers	392.93	Alabama	Shelby	390.83
Alabama	Cherokee	337.99	Alabama	Sumter	444.54
Alabama	Chilton	411.78	Alabama	Talladega	380.46
Alabama	Choctaw	503.55	Alabama	Tallapoosa	410.56
Alabama	Clarke	539.06	Alabama	Tuscaloosa	412.57
Alabama	Clay	394.00	Alabama	Walker	393.34
Alabama	Cleburne	354.70	Alabama	Washington	577.31
Alabama	Coffee	531.18	Alabama	Wilcox	480.62
Alabama	Colbert	373.57	Alabama	Winston	391.61
Alabama	Conecuh	567.69	**ARKANSAS**		
Alabama	Coosa	407.98	Arkansas	Arkansas	357.31
Alabama	Covington	547.34	Arkansas	Ashley	425.18
Alabama	Crenshaw	496.98	Arkansas	Baxter	264.44
Alabama	Cullman	372.27	Arkansas	Benton	284.49
Alabama	Dale	499.78	Arkansas	Boone	274.94
Alabama	Dallas	434.72	Arkansas	Bradley	413.00
Alabama	De Kalb	343.49	Arkansas	Calhoun	394.04
Alabama	Elmore	410.44	Arkansas	Carroll	263.87
Alabama	Escambia	613.36	Arkansas	Chicot	405.46
Alabama	Etowah	337.73	Arkansas	Clark	389.54
Alabama	Fayette	433.70	Arkansas	Clay	286.64
Alabama	Franklin	391.58	Arkansas	Cleburne	325.36
Alabama	Geneva	543.36	Arkansas	Cleveland	388.25
Alabama	Greene	411.99	Arkansas	Columbia	400.20
Alabama	Hale	419.53	Arkansas	Conway	319.22
Alabama	Henry	463.34	Arkansas	Craighead	300.37
Alabama	Houston	520.13	Arkansas	Crawford	312.32
Alabama	Jackson	332.18	Arkansas	Crittenden	337.70
Alabama	Jefferson	380.78	Arkansas	Cross	323.20
Alabama	Lamar	420.03	Arkansas	Dallas	384.01
Alabama	Lauderdale	363.18	Arkansas	Desha	382.09
Alabama	Lawrence	368.51	Arkansas	Drew	399.03
Alabama	Lee	402.79	Arkansas	Faulkner	331.63
Alabama	Limestone	347.76	Arkansas	Franklin	300.94
Alabama	Lowndes	442.41	Arkansas	Fulton	268.73
Alabama	Macon	416.53	Arkansas	Garland	392.70
Alabama	Madison	339.73	Arkansas	Grant	371.52
Alabama	Marengo	454.52	Arkansas	Greene	297.44
Alabama	Marion	417.90	Arkansas	Hempstead	397.31
Alabama	Marshall	337.60	Arkansas	Hot Spring	393.02
Arkansas	Izard	279.02	Arkansas	Howard	397.24
Arkansas	Jackson	311.26	Arkansas	Independence	308.53

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
ARKANSAS			**ARIZONA**		
Arkansas	Jefferson	361.80	Arizona	Mohave	38.01
Arkansas	Johnson	307.56	Arizona	Navajo	74.97
Arkansas	Lafayette	390.52	Arizona	Pima	118.70
Arkansas	Lawrence	289.27	Arizona	Pinal	122.43
Arkansas	Lee	351.47	Arizona	SantaCruz	153.64
Arkansas	Lincoln	380.84	Arizona	Yavapai	79.49
Arkansas	Little River	375.51	Arizona	Yuma	28.08
Arkansas	Logan	315.18	**CALIFORNIA**		
Arkansas	Lonoke	334.77	California	Alameda	78.90
Arkansas	Madison	296.57	California	Alpine	162.98
Arkansas	Marion	269.28	California	Amador	118.79
Arkansas	Miller	372.01	California	Butte	208.84
Arkansas	Mississippi	309.94	California	Calaveras	121.84
Arkansas	Monroe	347.85	California	Colusa	157.67
Arkansas	Montgomery	393.61	California	ContraCosta	66.73
Arkansas	Nevada	398.34	California	DelNorte	307.26
Arkansas	Newton	300.01	California	El dorado	153.53
Arkansas	Ouachita	391.35	California	Fresno	115.48
Arkansas	Perry	350.43	California	Glenn	183.66
Arkansas	Phillips	370.22	California	Humboldt	226.26
Arkansas	Pike	410.15	California	Imperial	50.86
Arkansas	Poinsett	311.13	California	Inyo	80.64
Arkansas	Polk	406.86	California	Kern	80.20
Arkansas	Pope	315.25	California	Kings	50.46
Arkansas	Prairie	339.11	California	Lake	146.38
Arkansas	Pulaski	343.04	California	Lassen	86.80
Arkansas	Randolph	284.47	California	LosAngeles	129.77
Arkansas	St. Francis	339.56	California	Madera	104.07
Arkansas	Saline	374.90	California	Marin	145.62
Arkansas	Scott	339.43	California	Mariposa	108.26
Arkansas	Searcy	288.90	California	Mendocino	266.31
Arkansas	Sebastian	302.45	California	Mendocino	237.86
Arkansas	Sevier	385.36	California	Merced	46.19
Arkansas	Sharp	283.30	California	Modoc	70.69
Arkansas	Stone	304.11	California	Mono	124.24
Arkansas	Union	410.17	California	Monterey	161.27
Arkansas	Van Buren	324.69	California	Napa	143.22
Arkansas	Washington	310.58	California	Nevada	159.45
Arkansas	White	334.39	California	Orange	91.06
Arkansas	Woodruff	332.92	California	Placer	158.82
Arkansas	Yell	331.06	California	Plumas	195.88
ARIZONA			California	Riverside	116.38
Arizona	Apache	85.81	California	Sacramento	62.75
Arizona	Cochise	153.64	California	SanBenito	61.23
Arizona	Coconino	80.75	California	SanBernardino	141.06
Arizona	Gila	87.30	California	SanDiego	86.95
Arizona	Graham	143.00	California	SanFrancisco	61.37
Arizona	Greenlee	90.08	California	SanJoaquin	58.54
Arizona	LaPaz	43.70	California	SanLuisObispo	132.56
Arizona	Maricopa	71.96	California	SanMateo	111.60

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
CALIFORNIA		
California	SantaBarbara	139.25
California	SantaClara	155.27
California	SantaCruz	156.20
California	Shasta	53.67
California	Sierra	177.20
California	Siskiyou	339.99
California	Solano	105.91
California	Sonoma	186.62
California	Stanislaus	46.27
California	Sutter	53.63
California	Tehama	229.72
California	Trinity	172.16
California	Tulare	100.39
California	Tuolumne	115.34
California	Ventura	117.00
California	Yolo	107.76
California	Yuba	156.82
COLORADO		
Colorado	Adams	31.79
Colorado	Alamosa	67.45
Colorado	Arapahoe	33.58
Colorado	Archuleta	51.98
Colorado	Baca	76.62
Colorado	Bent	61.72
Colorado	Boulder	47.08
Colorado	Chaffee	35.88
Colorado	Cheyenne	65.28
Colorado	ClearCreek	49.46
Colorado	Conejos	47.07
Colorado	Costilla	61.52
Colorado	Crowley	39.38
Colorado	Custer	56.82
Colorado	Delta	30.39
Colorado	Denver	35.26
Colorado	Dolores	47.15
Colorado	Douglas	47.90
Colorado	Eagle	29.33
Colorado	Elbert	42.48
Colorado	ElPaso	70.44
Colorado	Fremont	47.33
Colorado	Garfield	28.62
Colorado	Gilpin	32.50
Colorado	Grand	36.60
Colorado	Gunnison	36.51
Colorado	Hinsdale	46.46
Colorado	Huerfano	74.36
Colorado	Jackson	36.86
Colorado	Jefferson	35.16
Colorado	Kiowa	65.06
Colorado	KitCarson	59.68

State Name	County	R Factor US
COLORADO		
Colorado	Lake	35.16
Colorado	LaPlata	47.52
Colorado	Larimer	43.52
Colorado	LasAnimas	52.68
Colorado	Lincoln	52.60
Colorado	Logan	64.52
Colorado	Mesa	29.12
Colorado	Mineral	51.21
Colorado	Moffat	32.28
Colorado	Montezuma	42.40
Colorado	Montrose	25.75
Colorado	Morgan	49.06
Colorado	Otero	48.31
Colorado	Ouray	32.26
Colorado	Park	34.23
Colorado	Philips	65.51
Colorado	Pitkin	37.30
Colorado	Prowers	69.91
Colorado	Pueblo	79.86
Colorado	RioBlanco	27.82
Colorado	RioGrande	44.93
Colorado	Routt	38.88
Colorado	Saguache	57.84
Colorado	SanJuan	48.71
Colorado	SanMiguel	42.63
Colorado	Sedgwick	64.45
Colorado	Summit	29.12
Colorado	Teller	62.53
Colorado	Washington	54.72
Colorado	Weld	59.69
Colorado	Yuma	61.02
CONNECTICUT		
Connecticut	Fairfield	171.56
Connecticut	Hartford	157.40
Connecticut	Litchfield	153.89
Connecticut	Middlesex	177.59
Connecticut	New Haven	175.41
Connecticut	New London	179.48
Connecticut	Tolland	163.56
Connecticut	Windham	170.44
DELAWARE		
Delaware	Kent	185.32
Delaware	New Castle	172.62
Delaware	Sussex	204.26
DISTRICT OF COLUMBIA		
Dist. of Columbia	Washington	176.48
FLORIDA		
Florida	Alachua	509.89
Florida	Baker	504.91
Florida	Bay	649.74

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
FLORIDA			**FLORIDA**		
Florida	Bradford	507.57	Florida	Putnam	508.49
Florida	Brevard	541.11	Florida	St. Johns	482.85
Florida	Broward	640.73	Florida	St. Lucie	558.76
Florida	Calhoun	612.27	Florida	Santa Rosa	668.51
Florida	Charlotte	579.20	Florida	Sarasota	601.27
Florida	Citrus	553.56	Florida	Seminole	525.72
Florida	Clay	504.55	Florida	Sumter	533.04
Florida	Collier	603.33	Florida	Suwannee	510.08
Florida	Columbia	514.28	Florida	Taylor	558.09
Florida	Dade	660.25	Florida	Union	509.98
Florida	De Soto	573.74	Florida	Volusia	515.77
Florida	Dixie	567.77	Florida	Wakulla	588.98
Florida	Duval	477.28	Florida	Walton	637.23
Florida	Escambia	665.96	Florida	Washington	594.87
Florida	Flagler	498.63	**GEORGIA**		
Florida	Franklin	591.88	Georgia	Appling	391.87
Florida	Gadsden	540.95	Georgia	Atkinson	423.99
Florida	Gilchrist	543.56	Georgia	Bacon	398.31
Florida	Glades	554.40	Georgia	Baker	444.58
Florida	Gulf	648.82	Georgia	Baldwin	303.69
Florida	Hamilton	496.55	Georgia	Banks	308.59
Florida	Hardee	566.11	Georgia	Barrow	296.05
Florida	Hendry	576.49	Georgia	Bartow	304.11
Florida	Hernando	562.34	Georgia	Ben Hill	363.35
Florida	Highlands	549.00	Georgia	Berrien	414.04
Florida	Hillsborough	555.35	Georgia	Bibb	311.99
Florida	Holmes	576.25	Georgia	Bleckley	333.45
Florida	Indian River	584.00	Georgia	Brantley	451.26
Florida	Jackson	532.64	Georgia	Brooks	463.71
Florida	Jefferson	532.19	Georgia	Bryan	387.57
Florida	Lafayette	545.55	Georgia	Bulloch	359.21
Florida	Lake	512.66	Georgia	Burke	314.81
Florida	Lee	613.05	Georgia	Butts	310.51
Florida	Leon	581.80	Georgia	Calhoun	425.16
Florida	Levy	563.92	Georgia	Camden	452.13
Florida	Liberty	612.66	Georgia	Candler	358.44
Florida	Madison	502.15	Georgia	Carroll	342.47
Florida	Manatee	598.41	Georgia	Catoosa	299.22
Florida	Marion	524.80	Georgia	Charlton	467.11
Florida	Martin	576.29	Georgia	Chatham	410.53
Florida	Monroe	617.52	Georgia	Chattahoochee	377.45
Florida	Nassau	471.75	Georgia	Chattooga	319.13
Florida	Okaloosa	660.17	Georgia	Cherokee	318.92
Florida	Okeechobee	536.51	Georgia	Clarke	298.73
Florida	Orange	528.33	Georgia	Clay	439.72
Florida	Osceola	543.27	Georgia	Clayton	309.03
Florida	Palm Beach	613.12	Georgia	Clinch	463.78
Florida	Pasco	566.86	Georgia	Cobb	322.55
Florida	Pinellas	547.84	Georgia	Coffee	404.79
Florida	Polk	545.67	Georgia	Colquitt	437.18

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
GEORGIA			**GEORGIA**		
Georgia	Columbia	295.77	Georgia	Lanier	444.44
Georgia	Cook	432.25	Georgia	Laurens	335.57
Georgia	Coweta	336.05	Georgia	Lee	390.38
Georgia	Crawford	333.83	Georgia	Liberty	399.20
Georgia	Crisp	363.26	Georgia	Lincoln	290.59
Georgia	Dade	339.76	Georgia	Long	398.06
Georgia	Dawson	353.73	Georgia	Lowndes	462.80
Georgia	Decatur	501.72	Georgia	Lumpkin	366.80
Georgia	De Kalb	312.92	Georgia	McDuffie	308.30
Georgia	Dodge	349.36	Georgia	McIntosh	433.30
Georgia	Dooly	347.84	Georgia	Macon	340.43
Georgia	Dougherty	418.01	Georgia	Madison	292.25
Georgia	Douglas	334.10	Georgia	Marion	369.79
Georgia	Early	464.59	Georgia	Meriwether	343.23
Georgia	Echols	483.11	Georgia	Miller	471.58
Georgia	Effingham	378.69	Georgia	Mitchell	453.70
Georgia	Elbert	286.18	Georgia	Monroe	321.40
Georgia	Emanuel	334.55	Georgia	Montgomery	339.25
Georgia	Evans	383.30	Georgia	Morgan	296.11
Georgia	Fannin	349.75	Georgia	Murray	318.16
Georgia	Fayette	325.50	Georgia	Muscogee	371.25
Georgia	Floyd	309.73	Georgia	Newton	305.08
Georgia	Forsyth	328.84	Georgia	Oconee	296.85
Georgia	Franklin	298.76	Georgia	Oglethorpe	295.19
Georgia	Fulton	317.54	Georgia	Paulding	326.81
Georgia	Gilmer	359.46	Georgia	Peach	322.52
Georgia	Glascock	312.20	Georgia	Pickens	339.54
Georgia	Glynn	443.05	Georgia	Pierce	422.52
Georgia	Gordon	298.95	Georgia	Pike	336.56
Georgia	Grady	486.25	Georgia	Polk	315.48
Georgia	Greene	298.48	Georgia	Pulaski	342.92
Georgia	Gwinnett	320.05	Georgia	Putnam	302.25
Georgia	Habersham	358.24	Georgia	Quitman	416.52
Georgia	Hall	324.86	Georgia	Rabun	396.03
Georgia	Hancock	302.79	Georgia	Randolph	412.87
Georgia	Haralson	334.55	Georgia	Richmond	300.70
Georgia	Harris	376.51	Georgia	Rockdale	309.91
Georgia	Hart	291.50	Georgia	Schley	358.14
Georgia	Heard	349.44	Georgia	Screven	343.90
Georgia	Henry	319.83	Georgia	Seminole	504.36
Georgia	Houston	332.02	Georgia	Spalding	325.18
Georgia	Irwin	381.79	Georgia	Stephens	317.37
Georgia	Jackson	298.48	Georgia	Stewart	386.92
Georgia	Jasper	305.36	Georgia	Sumter	365.23
Georgia	Jeff Davis	365.54	Georgia	Talbot	369.79
Georgia	Jefferson	309.60	Georgia	Taliaferro	300.89
Georgia	Jenkins	329.24	Georgia	Tattnall	371.62
Georgia	Johnson	328.74	Georgia	Taylor	341.19
Georgia	Jones	311.75	Georgia	Telfair	359.62
Georgia	Lamar	326.46	Georgia	Terrell	394.75

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
GEORGIA		
Georgia	Thomas	471.26
Georgia	Tift	400.12
Georgia	Toombs	354.98
Georgia	Towns	366.62
Georgia	Treutlen	335.93
Georgia	Troup	358.99
Georgia	Turner	381.83
Georgia	Twiggs	321.72
Georgia	Union	349.03
Georgia	Upson	339.71
Georgia	Walker	322.16
Georgia	Walton	292.38
Georgia	Ware	444.47
Georgia	Warren	311.41
Georgia	Washington	319.28
Georgia	Wayne	424.02
Georgia	Webster	381.43
Georgia	Wheeler	335.74
Georgia	White	376.20
Georgia	Whitfield	305.61
Georgia	Wilcox	363.98
Georgia	Wilkes	294.42
Georgia	Wilkinson	316.66
Georgia	Worth	394.80
IDAHO		
Idaho	Ada	17.33
Idaho	Adams	29.44
Idaho	Bannock	29.09
Idaho	BearLake	36.99
Idaho	Benewah	35.55
Idaho	Bingham	23.99
Idaho	Blaine	28.93
Idaho	Boise	25.34
Idaho	Bonner	54.34
Idaho	Bonneville	21.75
Idaho	Boundary	40.46
Idaho	Butte	18.93
Idaho	Camas	29.98
Idaho	Canyon	6.59
Idaho	Caribou	27.59
Idaho	Cassia	21.15
Idaho	Clark	23.97
Idaho	Clearwater	48.38
Idaho	Custer	27.53
Idaho	Elmore	26.69
Idaho	Franklin	28.70
Idaho	Fremont	37.12
Idaho	Gem	27.31
Idaho	Gooding	10.76
Idaho	Idaho	39.70

State Name	County	R Factor US
IDAHO		
Idaho	Jefferson	11.40
Idaho	Jerome	5.97
Idaho	Kootenai	35.72
Idaho	Latah	34.64
Idaho	Lemhi	25.66
Idaho	Lewis	17.38
Idaho	Lincoln	8.66
Idaho	Madison	28.81
Idaho	Minidoka	7.65
Idaho	NezPerce	19.31
Idaho	Oneida	19.50
Idaho	Owyhee	33.21
Idaho	Payette	15.44
Idaho	Power	22.09
Idaho	Shoshone	48.34
Idaho	Teton	31.45
Idaho	TwinFalls	17.33
Idaho	Valley	31.87
Idaho	Washington	20.91
ILLINOIS		
Illinois	Adams	196.52
Illinois	Alexander	260.51
Illinois	Bond	192.40
Illinois	Boone	154.53
Illinois	Brown	194.09
Illinois	Bureau	172.02
Illinois	Calhoun	191.62
Illinois	Carroll	160.65
Illinois	Cass	188.97
Illinois	Champaign	183.07
Illinois	Christian	188.06
Illinois	Clark	194.83
Illinois	Clay	200.15
Illinois	Clinton	196.71
Illinois	Coles	189.23
Illinois	Cook	158.29
Illinois	Crawford	197.37
Illinois	Cumberland	188.07
Illinois	De Kalb	165.41
Illinois	De Witt	189.17
Illinois	Douglas	188.85
Illinois	Du Page	161.64
Illinois	Edgar	197.17
Illinois	Edwards	209.50
Illinois	Effingham	195.79
Illinois	Fayette	192.52
Illinois	Ford	171.04
Illinois	Franklin	219.23
Illinois	Fulton	185.24
Illinois	Gallatin	219.36

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
ILLINOIS			**ILLINOIS**		
Illinois	Greene	186.93	Illinois	Rock Island	176.24
Illinois	Grundy	165.10	Illinois	St. Clair	198.30
Illinois	Hamilton	211.57	Illinois	Saline	227.09
Illinois	Hancock	187.91	Illinois	Sangamon	179.93
Illinois	Hardin	239.26	Illinois	Schuyler	191.40
Illinois	Henderson	179.22	Illinois	Scott	190.20
Illinois	Henry	177.10	Illinois	Shelby	190.96
Illinois	Iroquois	176.71	Illinois	Stark	174.02
Illinois	Jackson	232.55	Illinois	Stephenson	152.07
Illinois	Jasper	195.92	Illinois	Tazewell	180.63
Illinois	Jefferson	207.24	Illinois	Union	254.15
Illinois	Jersey	189.80	Illinois	Vermilion	182.69
Illinois	Jo Daviess	157.00	Illinois	Wabash	210.52
Illinois	Johnson	248.19	Illinois	Warren	179.97
Illinois	Kane	164.42	Illinois	Washington	202.80
Illinois	Kankakee	181.23	Illinois	Wayne	207.73
Illinois	Kendall	165.89	Illinois	White	207.36
Illinois	Knox	178.99	Illinois	Whiteside	167.39
Illinois	Lake	146.13	Illinois	Will	168.14
Illinois	La Salle	170.25	Illinois	Williamson	233.89
Illinois	Lawrence	204.17	Illinois	Winnebago	152.38
Illinois	Lee	170.11	Illinois	Woodford	175.29
Illinois	Livingston	169.50	**INDIANA**		
Illinois	Logan	181.80	Indiana	Adams	137.47
Illinois	McDonough	183.29	Indiana	Allen	137.31
Illinois	McHenry	153.33	Indiana	Bartholomew	184.53
Illinois	McLean	178.28	Indiana	Benton	173.13
Illinois	Macon	191.86	Indiana	Blackford	157.01
Illinois	Macoupin	189.50	Indiana	Boone	175.45
Illinois	Madison	191.26	Indiana	Brown	189.83
Illinois	Marion	204.07	Indiana	Carroll	168.64
Illinois	Marshall	176.41	Indiana	Cass	164.90
Illinois	Mason	180.52	Indiana	Clark	203.98
Illinois	Massac	251.95	Indiana	Clay	198.32
Illinois	Menard	178.54	Indiana	Clinton	172.30
Illinois	Mercer	176.93	Indiana	Crawford	212.60
Illinois	Monroe	203.10	Indiana	Daviess	208.13
Illinois	Montgomery	192.79	Indiana	Dearborn	181.50
Illinois	Morgan	193.50	Indiana	Decatur	180.56
Illinois	Moultrie	188.85	Indiana	De Kalb	134.99
Illinois	Ogle	160.25	Indiana	Delaware	156.45
Illinois	Peoria	176.22	Indiana	Dubois	215.40
Illinois	Perry	214.08	Indiana	Elkhart	145.45
Illinois	Piatt	188.39	Indiana	Fayette	173.23
Illinois	Pike	197.84	Indiana	Floyd	202.47
Illinois	Pope	247.38	Indiana	Fountain	180.78
Illinois	Pulaski	260.41	Indiana	Franklin	178.07
Illinois	Putnam	174.89	Indiana	Fulton	160.07
Illinois	Randolph	214.71	Indiana	Gibson	216.63
Illinois	Richland	202.74	Indiana	Grant	158.15

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
INDIANA			**INDIANA**		
Indiana	Greene	201.59	Indiana	Switzerland	187.26
Indiana	Hamilton	172.53	Indiana	Tippecanoe	168.88
Indiana	Hancock	180.04	Indiana	Tipton	169.96
Indiana	Harrison	213.67	Indiana	Union	167.87
Indiana	Hendricks	184.83	Indiana	Vanderburgh	211.73
Indiana	Henry	170.32	Indiana	Vermillion	190.77
Indiana	Howard	168.96	Indiana	Vigo	196.25
Indiana	Huntington	149.25	Indiana	Wabash	158.83
Indiana	Jackson	195.18	Indiana	Warren	177.41
Indiana	Jasper	167.93	Indiana	Warrick	214.81
Indiana	Jay	146.04	Indiana	Washington	205.61
Indiana	Jefferson	192.00	Indiana	Wayne	165.54
Indiana	Jennings	192.48	Indiana	Wells	143.45
Indiana	Johnson	182.37	Indiana	White	167.68
Indiana	Knox	205.47	Indiana	Whitley	149.47
Indiana	Kosciusko	151.53	**IOWA**		
Indiana	Lagrange	140.50	Iowa	Adair	176.72
Indiana	Lake	169.41	Iowa	Adams	186.74
Indiana	La Porte	162.43	Iowa	Allamakee	144.58
Indiana	Lawrence	202.11	Iowa	Appanoose	192.56
Indiana	Madison	168.94	Iowa	Audubon	163.59
Indiana	Marion	175.13	Iowa	Benton	166.98
Indiana	Marshall	160.98	Iowa	Black Hawk	165.41
Indiana	Martin	209.80	Iowa	Boone	166.45
Indiana	Miami	162.58	Iowa	Bremer	165.00
Indiana	Monroe	198.80	Iowa	Buchanan	166.82
Indiana	Montgomery	178.65	Iowa	Buena Vista	149.91
Indiana	Morgan	187.57	Iowa	Butler	166.10
Indiana	Newton	173.26	Iowa	Calhoun	160.57
Indiana	Noble	145.24	Iowa	Carroll	160.45
Indiana	Ohio	184.57	Iowa	Cass	168.54
Indiana	Orange	212.18	Iowa	Cedar	175.02
Indiana	Owen	201.95	Iowa	Cerro Gordo	160.14
Indiana	Parke	194.70	Iowa	Cherokee	140.56
Indiana	Perry	219.28	Iowa	Chickasaw	159.49
Indiana	Pike	210.05	Iowa	Clarke	185.40
Indiana	Porter	168.25	Iowa	Clay	141.86
Indiana	Posey	211.06	Iowa	Clayton	152.09
Indiana	Pulaski	163.58	Iowa	Clinton	167.26
Indiana	Putnam	197.79	Iowa	Crawford	146.43
Indiana	Randolph	156.28	Iowa	Dallas	168.20
Indiana	Ripley	189.34	Iowa	Davis	192.64
Indiana	Rush	178.08	Iowa	Decatur	193.61
Indiana	St. Joseph	157.66	Iowa	Delaware	166.40
Indiana	Scott	199.62	Iowa	Des Moines	179.21
Indiana	Shelby	177.92	Iowa	Dickinson	136.88
Indiana	Spencer	215.94	Iowa	Dubuque	160.47
Indiana	Starke	163.86	Iowa	Emmet	137.22
Indiana	Steuben	132.89	Iowa	Fayette	162.20
Indiana	Sullivan	198.73	Iowa	Floyd	160.15

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
IOWA		
Iowa	Franklin	167.40
Iowa	Fremont	174.92
Iowa	Greene	160.26
Iowa	Grundy	165.86
Iowa	Guthrie	167.33
Iowa	Hamilton	164.54
Iowa	Hancock	151.90
Iowa	Hardin	167.99
Iowa	Harrison	147.31
Iowa	Henry	185.85
Iowa	Howard	154.95
Iowa	Humboldt	155.67
Iowa	Ida	149.39
Iowa	Iowa	180.60
Iowa	Jackson	164.08
Iowa	Jasper	174.03
Iowa	Jefferson	183.97
Iowa	Johnson	178.58
Iowa	Jones	166.58
Iowa	Keokuk	177.14
Iowa	Kossuth	146.81
Iowa	Lee	189.23
Iowa	Linn	172.81
Iowa	Louisa	177.43
Iowa	Lucas	190.27
Iowa	Lyon	122.30
Iowa	Madison	176.17
Iowa	Mahaska	179.66
Iowa	Marion	178.53
Iowa	Marshall	172.57
Iowa	Mills	165.71
Iowa	Mitchell	160.53
Iowa	Monona	139.07
Iowa	Monroe	187.37
Iowa	Montgomery	184.27
Iowa	Muscatine	175.11
Iowa	O'Brien	135.54
Iowa	Osceola	132.31
Iowa	Page	189.13
Iowa	Palo Alto	143.65
Iowa	Plymouth	127.59
Iowa	Pocahontas	152.87
Iowa	Polk	170.94
Iowa	Pottawattamie	155.95
Iowa	Poweshiek	177.91
Iowa	Ringgold	191.01
Iowa	Sac	153.23
Iowa	Scott	171.82
Iowa	Shelby	157.68
Iowa	Sioux	128.02

State Name	County	R Factor US
IOWA		
Iowa	Story	171.86
Iowa	Tama	171.79
Iowa	Taylor	194.58
Iowa	Union	183.18
Iowa	Van Buren	189.17
Iowa	Wapello	179.30
Iowa	Warren	175.59
Iowa	Washington	175.62
Iowa	Wayne	195.99
Iowa	Webster	164.68
Iowa	Winnebago	150.92
Iowa	Winneshiek	149.98
Iowa	Woodbury	131.06
Iowa	Worth	152.24
Iowa	Wright	158.62
KANSAS		
Kansas	Allen	254.05
Kansas	Anderson	240.97
Kansas	Atchison	210.55
Kansas	Barber	161.42
Kansas	Barton	144.84
Kansas	Bourbon	254.16
Kansas	Brown	202.32
Kansas	Butler	216.51
Kansas	Chase	207.89
Kansas	Chautauqua	236.75
Kansas	Cherokee	265.67
Kansas	Cheyenne	75.57
Kansas	Clark	134.58
Kansas	Clay	177.26
Kansas	Cloud	163.92
Kansas	Coffey	234.73
Kansas	Comanche	147.98
Kansas	Cowley	221.67
Kansas	Crawford	259.41
Kansas	Decatur	102.46
Kansas	Dickinson	189.14
Kansas	Doniphan	206.41
Kansas	Douglas	221.25
Kansas	Edwards	136.20
Kansas	Elk	234.31
Kansas	Ellis	124.13
Kansas	Ellsworth	157.97
Kansas	Finney	100.26
Kansas	Ford	129.82
Kansas	Franklin	228.85
Kansas	Geary	198.89
Kansas	Gove	105.09
Kansas	Graham	107.94
Kansas	Grant	85.49

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
KANSAS			**KANSAS**		
Kansas	Gray	118.81	Kansas	Saline	173.15
Kansas	Greeley	73.00	Kansas	Scott	95.38
Kansas	Greenwood	229.89	Kansas	Sedgwick	195.26
Kansas	Hamilton	74.34	Kansas	Seward	106.73
Kansas	Harper	182.21	Kansas	Shawnee	209.99
Kansas	Harvey	191.68	Kansas	Sheridan	100.24
Kansas	Haskell	101.68	Kansas	Sherman	76.35
Kansas	Hodgeman	116.76	Kansas	Smith	126.82
Kansas	Jackson	211.03	Kansas	Stafford	144.90
Kansas	Jefferson	222.08	Kansas	Stanton	76.25
Kansas	Jewell	143.35	Kansas	Stevens	96.30
Kansas	Johnson	227.64	Kansas	Sumner	203.59
Kansas	Kearny	85.50	Kansas	Thomas	85.28
Kansas	Kingman	174.94	Kansas	Trego	110.28
Kansas	Kiowa	141.72	Kansas	Wabaunsee	208.29
Kansas	Labette	263.35	Kansas	Wallace	75.98
Kansas	Lane	106.24	Kansas	Washington	169.80
Kansas	Leavenworth	223.08	Kansas	Wichita	82.12
Kansas	Lincoln	150.85	Kansas	Wilson	246.36
Kansas	Linn	246.34	Kansas	Woodson	249.88
Kansas	Logan	86.44	Kansas	Wyandotte	221.23
Kansas	Lyon	224.03	**KENTUCKY**		
Kansas	McPherson	179.36	Kentucky	Adair	260.11
Kansas	Marion	203.61	Kentucky	Allen	269.94
Kansas	Marshall	180.85	Kentucky	Anderson	210.16
Kansas	Meade	120.64	Kentucky	Ballard	264.36
Kansas	Miami	231.96	Kentucky	Barren	269.59
Kansas	Mitchell	143.62	Kentucky	Bath	203.55
Kansas	Montgomery	253.55	Kentucky	Bell	243.23
Kansas	Morris	203.52	Kentucky	Boone	182.44
Kansas	Morton	85.04	Kentucky	Bourbon	194.88
Kansas	Nemaha	191.35	Kentucky	Boyd	164.43
Kansas	Neosho	254.38	Kentucky	Boyle	227.48
Kansas	Ness	113.68	Kentucky	Bracken	186.69
Kansas	Norton	107.98	Kentucky	Breathitt	203.71
Kansas	Osage	217.86	Kentucky	Breckinridge	230.45
Kansas	Osborne	127.85	Kentucky	Bullitt	219.65
Kansas	Ottawa	164.92	Kentucky	Butler	251.50
Kansas	Pawnee	133.34	Kentucky	Caldwell	257.04
Kansas	Phillips	116.55	Kentucky	Calloway	295.79
Kansas	Pottawatomie	200.38	Kentucky	Campbell	179.51
Kansas	Pratt	153.74	Kentucky	Carlisle	277.59
Kansas	Rawlins	91.37	Kentucky	Carroll	195.31
Kansas	Reno	177.16	Kentucky	Carter	175.97
Kansas	Republic	158.54	Kentucky	Casey	248.34
Kansas	Rice	161.66	Kentucky	Christian	261.52
Kansas	Riley	187.86	Kentucky	Clark	207.83
Kansas	Rooks	117.36	Kentucky	Clay	219.93
Kansas	Rush	125.83	Kentucky	Clinton	262.15
Kansas	Russell	140.79	Kentucky	Crittenden	247.29

State Name	County	R Factor US	State Name	County	R Factor US
KENTUCKY			**KENTUCKY**		
Kentucky	Cumberland	258.22	Kentucky	Marshall	271.64
Kentucky	Daviess	223.15	Kentucky	Martin	184.17
Kentucky	Edmonson	255.70	Kentucky	Mason	187.62
Kentucky	Elliott	184.67	Kentucky	Meade	225.09
Kentucky	Estill	214.55	Kentucky	Menifee	213.32
Kentucky	Fayette	200.74	Kentucky	Mercer	218.50
Kentucky	Fleming	194.14	Kentucky	Metcalfe	266.37
Kentucky	Floyd	185.00	Kentucky	Monroe	272.64
Kentucky	Franklin	200.50	Kentucky	Montgomery	201.52
Kentucky	Fulton	292.97	Kentucky	Morgan	198.23
Kentucky	Gallatin	185.96	Kentucky	Muhlenberg	251.80
Kentucky	Garrard	224.15	Kentucky	Nelson	227.03
Kentucky	Grant	189.86	Kentucky	Nicholas	192.62
Kentucky	Graves	293.91	Kentucky	Ohio	241.80
Kentucky	Grayson	250.44	Kentucky	Oldham	205.27
Kentucky	Green	254.11	Kentucky	Owen	196.17
Kentucky	Greenup	162.88	Kentucky	Owsley	211.45
Kentucky	Hancock	227.03	Kentucky	Pendleton	188.17
Kentucky	Hardin	237.57	Kentucky	Perry	200.54
Kentucky	Harlan	224.61	Kentucky	Pike	182.53
Kentucky	Harrison	191.23	Kentucky	Powell	209.96
Kentucky	Hart	249.75	Kentucky	Pulaski	245.14
Kentucky	Henderson	218.69	Kentucky	Robertson	186.89
Kentucky	Henry	204.15	Kentucky	Rockcastle	234.69
Kentucky	Hickman	292.97	Kentucky	Rowan	198.66
Kentucky	Hopkins	241.76	Kentucky	Russell	256.61
Kentucky	Jackson	223.63	Kentucky	Scott	192.40
Kentucky	Jefferson	208.55	Kentucky	Shelby	210.29
Kentucky	Jessamine	214.42	Kentucky	Simpson	269.52
Kentucky	Johnson	186.34	Kentucky	Spencer	213.89
Kentucky	Kenton	181.98	Kentucky	Taylor	255.24
Kentucky	Knott	188.16	Kentucky	Todd	265.16
Kentucky	Knox	231.85	Kentucky	Trigg	266.06
Kentucky	Larue	240.23	Kentucky	Trimble	197.20
Kentucky	Laurel	218.80	Kentucky	Union	226.66
Kentucky	Lawrence	175.70	Kentucky	Warren	263.44
Kentucky	Lee	209.87	Kentucky	Washington	222.80
Kentucky	Leslie	214.02	Kentucky	Wayne	248.75
Kentucky	Letcher	186.38	Kentucky	Webster	229.84
Kentucky	Lewis	175.13	Kentucky	Whitley	234.58
Kentucky	Lincoln	237.61	Kentucky	Wolfe	207.29
Kentucky	Livingston	258.27	Kentucky	Woodford	206.31
Kentucky	Logan	265.28	**LOUISIANA**		
Kentucky	Lyon	260.38	Louisiana	Acadia	593.77
Kentucky	McCracken	255.23	Louisiana	Allen	602.71
Kentucky	McCreary	248.43	Louisiana	Ascension	640.85
Kentucky	McLean	225.98	Louisiana	Assumption	652.59
Kentucky	Madison	218.23	Louisiana	Avoyelles	575.41
Kentucky	Magoffin	193.27	Louisiana	Beauregard	552.20
Kentucky	Marion	240.11	Louisiana	Bienville	443.25

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
LOUISIANA		
Louisiana	Bossier	399.71
Louisiana	Caddo	386.15
Louisiana	Calcasieu	564.36
Louisiana	Caldwell	482.54
Louisiana	Cameron	587.64
Louisiana	Catahoula	532.31
Louisiana	Claiborne	419.39
Louisiana	Concordia	561.08
Louisiana	De Soto	414.12
Louisiana	East Baton Rouge	620.07
Louisiana	East Carroll	454.73
Louisiana	East Feliciana	618.32
Louisiana	Evangeline	596.75
Louisiana	Franklin	470.31
Louisiana	Grant	522.15
Louisiana	Iberia	640.26
Louisiana	Iberville	619.17
Louisiana	Jackson	458.44
Louisiana	Jefferson	675.29
Louisiana	Jefferson Davis	589.50
Louisiana	Lafayette	618.09
Louisiana	LaFourche	683.17
Louisiana	La Salle	537.41
Louisiana	Lincoln	432.37
Louisiana	Livingston	667.63
Louisiana	Madison	468.13
Louisiana	Morehouse	427.77
Louisiana	Natchitoches	484.61
Louisiana	Orleans	625.15
Louisiana	Ouachita	435.64
Louisiana	Plaquemines	685.02
Louisiana	Pointe Coupee	607.82
Louisiana	Rapides	562.41
Louisiana	Red River	425.06
Louisiana	Richland	447.83
Louisiana	Sabine	460.25
Louisiana	St. Bernard	659.09
Louisiana	St. Charles	665.48
Louisiana	St. Helena	656.10
Louisiana	St. James	648.17
Louisiana	St. John the Baptist	650.02
Louisiana	St. Landry	599.05
Louisiana	St. Martin	625.14
Louisiana	St. Mary	690.43
Louisiana	St. Tammany	637.24
Louisiana	Tangipahoa	652.17
Louisiana	Tensas	479.46
Louisiana	Terrebonne	693.78
Louisiana	Union	422.06
Louisiana	Vermilion	625.16

State Name	County	R Factor US
LOUISIANA		
Louisiana	Vernon	530.95
Louisiana	Washington	636.06
Louisiana	Webster	404.70
Louisiana	West Baton Rouge	621.48
Louisiana	West Carroll	435.59
Louisiana	West Feliciana	608.24
Louisiana	Winn	514.46
MAINE		
Maine	Androscoggin	108.52
Maine	Aroostook	71.98
Maine	Cumberland	109.89
Maine	Franklin	104.10
Maine	Hancock	105.40
Maine	Kennebec	101.79
Maine	Knox	115.56
Maine	Lincoln	107.89
Maine	Oxford	100.36
Maine	Penobscot	92.37
Maine	Piscataquis	84.10
Maine	Sagadahoc	110.26
Maine	Somerset	88.08
Maine	Waldo	106.59
Maine	Washington	99.55
Maine	York	120.64
MARYLAND		
Maryland	Allegany	120.80
Maryland	Anne Arundel	172.59
Maryland	Baltimore	176.31
Maryland	Calvert	192.56
Maryland	Caroline	188.49
Maryland	Carroll	154.43
Maryland	Cecil	174.75
Maryland	Charles	184.69
Maryland	Dorchester	200.70
Maryland	Frederick	155.92
Maryland	Garrett	137.28
Maryland	Harford	175.57
Maryland	Howard	176.29
Maryland	Kent	176.65
Maryland	Montgomery	166.89
Maryland	Prince Georges	179.74
Maryland	Queen Annes	180.01
Maryland	St. Marys	195.84
Maryland	Somerset	202.98
Maryland	Talbot	187.72
Maryland	Washington	134.95
Maryland	Wicomico	208.50
Maryland	Worcester	212.37
Maryland	Baltimore City	172.69

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
MASSACHUSETTS			**MICHIGAN**		
Massachusetts	Barnstable	161.98	Michigan	Iron	90.78
Massachusetts	Berkshire	140.74	Michigan	Isabella	94.25
Massachusetts	Bristol	163.11	Michigan	Jackson	106.24
Massachusetts	Dukes	177.67	Michigan	Kalamazoo	132.04
Massachusetts	Essex	133.84	Michigan	Kalkaska	87.17
Massachusetts	Franklin	126.19	Michigan	Kent	114.08
Massachusetts	Hampden	145.30	Michigan	Keweenaw	62.63
Massachusetts	Hampshire	134.44	Michigan	Lake	102.76
Massachusetts	Middlesex	137.18	Michigan	Lapeer	86.38
Massachusetts	Nantucket	167.90	Michigan	Leelanau	86.83
Massachusetts	Norfolk	154.87	Michigan	Lenawee	117.15
Massachusetts	Plymouth	168.85	Michigan	Livingston	93.90
Massachusetts	Suffolk	137.31	Michigan	Luce	65.61
Massachusetts	Worcester	135.22	Michigan	Mackinac	65.26
MICHIGAN			Michigan	Macomb	94.68
Michigan	Alcona	73.19	Michigan	Manistee	96.09
Michigan	Alger	73.14	Michigan	Marquette	81.12
Michigan	Allegan	129.98	Michigan	Mason	100.14
Michigan	Alpena	67.36	Michigan	Mecosta	100.54
Michigan	Antrim	80.61	Michigan	Menominee	89.28
Michigan	Arenac	79.30	Michigan	Midland	88.51
Michigan	Baraga	81.22	Michigan	Missaukee	85.87
Michigan	Barry	120.15	Michigan	Monroe	110.66
Michigan	Bay	85.52	Michigan	Montcalm	103.38
Michigan	Benzie	91.38	Michigan	Montmorency	71.14
Michigan	Berrien	146.86	Michigan	Muskegon	104.92
Michigan	Branch	130.38	Michigan	Newaygo	105.44
Michigan	Calhoun	122.34	Michigan	Oakland	93.55
Michigan	Cass	142.97	Michigan	Oceana	107.05
Michigan	Charlevoix	77.70	Michigan	Ogemaw	79.91
Michigan	Cheboygan	70.65	Michigan	Ontonagon	86.86
Michigan	Chippewa	61.95	Michigan	Osceola	95.57
Michigan	Clare	89.39	Michigan	Oscoda	76.43
Michigan	Clinton	102.10	Michigan	Otsego	79.19
Michigan	Crawford	86.24	Michigan	Ottawa	118.28
Michigan	Delta	79.61	Michigan	Presque Isle	67.48
Michigan	Dickinson	83.71	Michigan	Roscommon	81.78
Michigan	Eaton	110.86	Michigan	Saginaw	89.95
Michigan	Emmet	71.69	Michigan	St. Clair	86.70
Michigan	Genesee	89.95	Michigan	St. Joseph	136.14
Michigan	Gladwin	87.55	Michigan	Sanilac	82.76
Michigan	Gogebic	96.05	Michigan	Schoolcraft	71.59
Michigan	Grand Traverse	86.15	Michigan	Shiawassee	94.92
Michigan	Gratiot	94.63	Michigan	Tuscola	85.00
Michigan	Hillsdale	127.79	Michigan	Van Buren	137.60
Michigan	Houghton	73.36	Michigan	Washtenaw	101.40
Michigan	Huron	80.72	Michigan	Wayne	101.47
Michigan	Ingham	101.72	Michigan	Wexford	91.38
Michigan	Ionia	111.11	**MINNESOTA**		
Michigan	Iosco	76.16	Minnesota	Aitkin	103.79

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
MINNESOTA			**MINNESOTA**		
Minnesota	Anoka	121.14	Minnesota	Nicollet	128.31
Minnesota	Becker	90.18	Minnesota	Nobles	126.17
Minnesota	Beltrami	82.23	Minnesota	Norman	76.20
Minnesota	Benton	113.82	Minnesota	Olmsted	140.89
Minnesota	Big Stone	89.26	Minnesota	Otter Tail	93.67
Minnesota	Blue Earth	134.09	Minnesota	Pennington	72.95
Minnesota	Brown	122.46	Minnesota	Pine	112.45
Minnesota	Carlton	105.23	Minnesota	Pipestone	110.24
Minnesota	Carver	124.46	Minnesota	Polk	72.45
Minnesota	Cass	95.83	Minnesota	Pope	99.40
Minnesota	Chippewa	103.50	Minnesota	Ramsey	125.05
Minnesota	Chisago	119.20	Minnesota	Red Lake	77.54
Minnesota	Clay	79.49	Minnesota	Redwood	113.89
Minnesota	Clearwater	83.20	Minnesota	Renville	114.89
Minnesota	Cook	78.66	Minnesota	Rice	132.72
Minnesota	Cottonwood	121.34	Minnesota	Rock	118.09
Minnesota	Crow Wing	103.33	Minnesota	Roseau	66.10
Minnesota	Dakota	128.32	Minnesota	St. Louis	86.83
Minnesota	Dodge	138.91	Minnesota	Scott	126.74
Minnesota	Douglas	98.12	Minnesota	Sherburne	120.17
Minnesota	Faribault	145.99	Minnesota	Sibley	125.66
Minnesota	Fillmore	148.33	Minnesota	Stearns	109.39
Minnesota	Freeborn	146.49	Minnesota	Steele	137.76
Minnesota	Goodhue	134.63	Minnesota	Stevens	93.86
Minnesota	Grant	90.15	Minnesota	Swift	102.35
Minnesota	Hennepin	122.53	Minnesota	Todd	101.80
Minnesota	Houston	148.31	Minnesota	Traverse	85.37
Minnesota	Hubbard	91.80	Minnesota	Wabasha	139.64
Minnesota	Isanti	116.86	Minnesota	Wadena	96.89
Minnesota	Itasca	88.92	Minnesota	Waseca	138.36
Minnesota	Jackson	133.31	Minnesota	Washington	125.45
Minnesota	Kanabec	113.71	Minnesota	Watonwan	128.88
Minnesota	Kandiyohi	115.75	Minnesota	Wilkin	84.88
Minnesota	Kittson	58.22	Minnesota	Winona	147.23
Minnesota	Koochiching	81.54	Minnesota	Wright	119.80
Minnesota	Lac Qui Parle	97.33	Minnesota	Yellow Medicine	104.91
Minnesota	Lake	85.54	**MISSISSIPPI**		
Minnesota	Lake of the Woods	71.56	Mississippi	Adams	562.30
Minnesota	Le Sueur	131.66	Mississippi	Alcorn	374.04
Minnesota	Lincoln	105.50	Mississippi	Amite	595.35
Minnesota	Lyon	108.27	Mississippi	Attala	441.32
Minnesota	McLeod	118.79	Mississippi	Benton	388.09
Minnesota	Mahnomen	82.35	Mississippi	Bolivar	391.27
Minnesota	Marshall	66.32	Mississippi	Calhoun	415.75
Minnesota	Martin	137.95	Mississippi	Carroll	434.73
Minnesota	Meeker	117.23	Mississippi	Chickasaw	401.47
Minnesota	Mille Lacs	114.88	Mississippi	Choctaw	431.67
Minnesota	Morrison	104.07	Mississippi	Claiborne	504.51
Minnesota	Mower	147.46	Mississippi	Clarke	497.73
Minnesota	Murray	115.59	Mississippi	Clay	421.84

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
MISSISSIPPI		
Mississippi	Coahoma	383.25
Mississippi	Copiah	527.14
Mississippi	Covington	543.99
Mississippi	De Soto	350.87
Mississippi	Forrest	583.66
Mississippi	Franklin	568.24
Mississippi	George	650.89
Mississippi	Greene	613.58
Mississippi	Grenada	417.78
Mississippi	Hancock	660.11
Mississippi	Harrison	687.68
Mississippi	Hinds	466.33
Mississippi	Holmes	446.56
Mississippi	Humphreys	437.45
Mississippi	Issaquena	451.53
Mississippi	Itawamba	401.78
Mississippi	Jackson	683.10
Mississippi	Jasper	488.58
Mississippi	Jefferson	527.81
Mississippi	Jefferson Davis	542.34
Mississippi	Jones	531.09
Mississippi	Kemper	438.25
Mississippi	Lafayette	402.22
Mississippi	Lamar	588.81
Mississippi	Lauderdale	470.64
Mississippi	Lawrence	540.59
Mississippi	Leake	448.78
Mississippi	Lee	398.73
Mississippi	Leflore	418.89
Mississippi	Lincoln	540.79
Mississippi	Lowndes	425.73
Mississippi	Madison	447.21
Mississippi	Marion	596.90
Mississippi	Marshall	373.66
Mississippi	Monroe	407.72
Mississippi	Montgomery	433.12
Mississippi	Neshoba	451.83
Mississippi	Newton	470.84
Mississippi	Noxubee	426.88
Mississippi	Oktibbeha	424.91
Mississippi	Panola	397.95
Mississippi	Pearl River	618.65
Mississippi	Perry	597.63
Mississippi	Pike	605.05
Mississippi	Pontotoc	416.62
Mississippi	Prentiss	398.62
Mississippi	Quitman	385.16
Mississippi	Rankin	470.27
Mississippi	Scott	478.76
Mississippi	Sharkey	446.55

State Name	County	R Factor US
MISSISSIPPI		
Mississippi	Simpson	515.27
Mississippi	Smith	511.36
Mississippi	Stone	649.54
Mississippi	Sunflower	409.57
Mississippi	Tallahatchie	407.93
Mississippi	Tate	374.06
Mississippi	Tippah	383.01
Mississippi	Tishomingo	378.39
Mississippi	Tunica	366.51
Mississippi	Union	410.61
Mississippi	Walthall	607.25
Mississippi	Warren	464.28
Mississippi	Washington	402.11
Mississippi	Wayne	537.80
Mississippi	Webster	421.17
Mississippi	Wilkinson	603.82
Mississippi	Winston	449.19
Mississippi	Yalobusha	410.08
Mississippi	Yazoo	460.64
MISSOURI		
Missouri	Adair	201.67
Missouri	Andrew	201.81
Missouri	Atchison	181.85
Missouri	Audrain	208.96
Missouri	Barry	272.38
Missouri	Barton	261.31
Missouri	Bates	237.09
Missouri	Benton	233.25
Missouri	Bollinger	251.78
Missouri	Boone	210.72
Missouri	Buchanan	210.75
Missouri	Butler	272.42
Missouri	Caldwell	204.18
Missouri	Callaway	206.40
Missouri	Camden	231.89
Missouri	Cape Girardeau	252.47
Missouri	Carroll	212.52
Missouri	Carter	266.28
Missouri	Cass	232.42
Missouri	Cedar	249.75
Missouri	Chariton	213.71
Missouri	Christian	263.75
Missouri	Clark	195.79
Missouri	Clay	220.31
Missouri	Clinton	211.65
Missouri	Cole	209.48
Missouri	Cooper	217.01
Missouri	Crawford	223.07
Missouri	Dade	261.92
Missouri	Dallas	243.82

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
MISSOURI			**MISSOURI**		
Missouri	Daviess	198.28	Missouri	Phelps	229.28
Missouri	De Kalb	200.46	Missouri	Pike	196.91
Missouri	Dent	232.01	Missouri	Platte	218.80
Missouri	Douglas	252.22	Missouri	Polk	246.00
Missouri	Dunklin	290.41	Missouri	Pulaski	232.79
Missouri	Franklin	208.82	Missouri	Putnam	199.02
Missouri	Gasconade	213.95	Missouri	Ralls	202.44
Missouri	Gentry	197.44	Missouri	Randolph	213.01
Missouri	Greene	250.19	Missouri	Ray	216.27
Missouri	Grundy	196.13	Missouri	Reynolds	243.20
Missouri	Harrison	195.66	Missouri	Ripley	278.25
Missouri	Henry	241.29	Missouri	St. Charles	193.08
Missouri	Hickory	236.16	Missouri	St. Clair	240.48
Missouri	Holt	194.96	Missouri	Ste. Genevieve	218.51
Missouri	Howard	215.06	Missouri	St. Francois	221.02
Missouri	Howell	252.35	Missouri	St. Louis	197.01
Missouri	Iron	238.55	Missouri	Saline	212.11
Missouri	Jackson	226.32	Missouri	Schuyler	196.03
Missouri	Jasper	267.03	Missouri	Scotland	193.30
Missouri	Jefferson	201.49	Missouri	Scott	261.26
Missouri	Johnson	233.98	Missouri	Shannon	250.80
Missouri	Knox	194.65	Missouri	Shelby	199.00
Missouri	Laclede	237.54	Missouri	Stoddard	270.46
Missouri	Lafayette	221.90	Missouri	Stone	269.38
Missouri	Lawrence	263.69	Missouri	Sullivan	201.71
Missouri	Lewis	193.98	Missouri	Taney	261.48
Missouri	Lincoln	194.05	Missouri	Texas	241.23
Missouri	Linn	205.33	Missouri	Vernon	259.13
Missouri	Livingston	198.16	Missouri	Warren	198.33
Missouri	McDonald	274.47	Missouri	Washington	223.33
Missouri	Macon	203.54	Missouri	Wayne	256.73
Missouri	Madison	244.48	Missouri	Webster	248.95
Missouri	Maries	223.76	Missouri	Worth	191.59
Missouri	Marion	197.54	Missouri	Wright	245.50
Missouri	Mercer	197.49	Missouri	St. Louis City	194.04
Missouri	Miller	225.37	**MONTANA**		
Missouri	Mississippi	275.47	Montana	Beaverhead	37.29
Missouri	Moniteau	216.85	Montana	BigHorn	25.82
Missouri	Monroe	208.93	Montana	Blaine	28.43
Missouri	Montgomery	206.10	Montana	Broadwater	28.01
Missouri	Morgan	227.29	Montana	Carbon	30.01
Missouri	New Madrid	279.12	Montana	Carter	36.30
Missouri	Newton	268.81	Montana	Cascade	27.82
Missouri	Nodaway	190.68	Montana	Chouteau	27.06
Missouri	Oregon	265.83	Montana	Custer	27.01
Missouri	Osage	213.00	Montana	Daniels	26.84
Missouri	Ozark	253.59	Montana	Dawson	32.75
Missouri	Pemiscot	301.12	Montana	DeerLodge	33.49
Missouri	Perry	233.55	Montana	Fallon	35.85
Missouri	Pettis	227.44	Montana	Fergus	51.92

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
MONTANA			**NEBRASKA**		
Montana	Flathead	53.67	Nebraska	Box Butte	53.66
Montana	Gallatin	32.15	Nebraska	Boyd	99.05
Montana	Garfield	24.54	Nebraska	Brown	98.74
Montana	Glacier	61.77	Nebraska	Buffalo	118.81
Montana	GoldenValley	50.17	Nebraska	Burt	136.53
Montana	Granite	24.64	Nebraska	Butler	138.60
Montana	Hill	28.30	Nebraska	Cass	157.09
Montana	Jefferson	23.40	Nebraska	Cedar	113.28
Montana	JudithBasin	27.16	Nebraska	Chase	76.06
Montana	Lake	45.22	Nebraska	Cherry	80.23
Montana	LewisandClark	33.32	Nebraska	Cheyenne	60.24
Montana	Liberty	26.50	Nebraska	Clay	136.11
Montana	Lincoln	45.83	Nebraska	Colfax	134.99
Montana	McCone	30.03	Nebraska	Cuming	131.62
Montana	Madison	32.77	Nebraska	Custer	110.52
Montana	Meagher	26.29	Nebraska	Dakota	124.85
Montana	Mineral	56.04	Nebraska	Dawes	52.84
Montana	Missoula	40.25	Nebraska	Dawson	106.26
Montana	MusselShell	21.96	Nebraska	Deuel	63.60
Montana	Park	33.64	Nebraska	Dixon	121.76
Montana	Petroleum	19.85	Nebraska	Dodge	138.87
Montana	Phillips	28.36	Nebraska	Douglas	142.64
Montana	Pondera	39.84	Nebraska	Dundy	77.15
Montana	PowderRiver	26.43	Nebraska	Fillmore	137.97
Montana	Powell	35.92	Nebraska	Franklin	125.81
Montana	Prairie	31.56	Nebraska	Frontier	98.60
Montana	Ravalli	39.70	Nebraska	Furnas	109.80
Montana	Richland	32.81	Nebraska	Gage	164.29
Montana	Roosevelt	33.65	Nebraska	Garden	62.72
Montana	Rosebud	26.55	Nebraska	Garfield	109.14
Montana	Sanders	46.61	Nebraska	Gosper	109.07
Montana	Sheridan	35.27	Nebraska	Grant	74.92
Montana	SilverBow	23.74	Nebraska	Greeley	118.81
Montana	Stillwater	30.04	Nebraska	Hall	127.09
Montana	Sweetgrass	27.75	Nebraska	Hamilton	131.86
Montana	Teton	45.45	Nebraska	Harlan	116.57
Montana	Toole	21.16	Nebraska	Hayes	87.85
Montana	Treasure	21.34	Nebraska	Hitchcock	92.73
Montana	Valley	24.61	Nebraska	Holt	104.55
Montana	Wheatland	26.93	Nebraska	Hooker	85.60
Montana	Wibaux	36.30	Nebraska	Howard	119.91
Montana	Yellowstone	17.70	Nebraska	Jefferson	161.20
Montana	YellowstonePark	30.19	Nebraska	Johnson	168.63
NEBRASKA			Nebraska	Kearney	124.52
Nebraska	Adams	132.65	Nebraska	Keith	72.00
Nebraska	Antelope	113.23	Nebraska	Keya Paha	92.11
Nebraska	Arthur	74.59	Nebraska	Kimball	50.70
Nebraska	Banner	45.74	Nebraska	Knox	108.29
Nebraska	Blaine	101.67	Nebraska	Lancaster	149.21
Nebraska	Boone	129.32	Nebraska	Lincoln	88.62

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
NEBRASKA			**NEVADA**		
Nebraska	Logan	94.55	Nevada	Pershing	20.88
Nebraska	Loup	106.35	Nevada	Storey	29.83
Nebraska	McPherson	84.05	Nevada	Washoe	89.75
Nebraska	Madison	123.50	Nevada	WhitePine	35.15
Nebraska	Merrick	128.60	Nevada	CarsonCity	52.41
Nebraska	Morrill	55.81	**NEW HAMPSHIRE**		
Nebraska	Nance	128.65	New Hampshire	Belknap	103.88
Nebraska	Nemaha	173.80	New Hampshire	Carroll	115.03
Nebraska	Nuckolls	141.29	New Hampshire	Cheshire	112.94
Nebraska	Otoe	162.26	New Hampshire	Coos	108.19
Nebraska	Pawnee	176.44	New Hampshire	Grafton	110.32
Nebraska	Perkins	74.62	New Hampshire	Hillsborough	117.32
Nebraska	Phelps	115.76	New Hampshire	Merrimack	107.46
Nebraska	Pierce	116.21	New Hampshire	Rockingham	123.53
Nebraska	Platte	131.57	New Hampshire	Strafford	117.30
Nebraska	Polk	135.39	New Hampshire	Sullivan	103.72
Nebraska	Red Willow	100.79	**NEW JERSEY**		
Nebraska	Richardson	186.58	New Jersey	Atlantic	184.83
Nebraska	Rock	101.54	New Jersey	Bergen	180.31
Nebraska	Saline	145.88	New Jersey	Burlington	190.42
Nebraska	Sarpy	148.06	New Jersey	Camden	185.52
Nebraska	Saunders	142.74	New Jersey	Cape May	181.31
Nebraska	Scotts Bluff	42.43	New Jersey	Cumberland	179.14
Nebraska	Seward	139.17	New Jersey	Essex	189.80
Nebraska	Sheridan	65.28	New Jersey	Gloucester	182.54
Nebraska	Sherman	118.97	New Jersey	Hudson	174.32
Nebraska	Sioux	42.21	New Jersey	Hunterdon	177.05
Nebraska	Stanton	127.53	New Jersey	Mercer	183.52
Nebraska	Thayer	151.03	New Jersey	Middlesex	187.54
Nebraska	Thomas	93.55	New Jersey	Monmouth	189.46
Nebraska	Thurston	129.08	New Jersey	Morris	185.24
Nebraska	Valley	111.65	New Jersey	Ocean	193.84
Nebraska	Washington	141.98	New Jersey	Passaic	177.96
Nebraska	Wayne	123.18	New Jersey	Salem	177.00
Nebraska	Webster	136.02	New Jersey	Somerset	182.20
Nebraska	Wheeler	113.32	New Jersey	Sussex	164.73
Nebraska	York	137.08	New Jersey	Union	187.64
NEVADA			New Jersey	Warren	173.89
Nevada	Churchill	21.48	**NEW MEXICO**		
Nevada	Clark	43.51	New Mexico	Bernalillo	58.35
Nevada	Douglas	61.17	New Mexico	Catron	110.09
Nevada	Elko	28.05	New Mexico	Chaves	82.57
Nevada	Esmeralda	21.76	New Mexico	Cibola	67.00
Nevada	Eureka	29.33	New Mexico	Colfax	82.57
Nevada	Humboldt	25.39	New Mexico	Curry	88.89
Nevada	Lander	20.84	New Mexico	DeBaca	79.11
Nevada	Lincoln	27.56	New Mexico	DonaAna	85.35
Nevada	Lyon	32.36	New Mexico	Eddy	99.49
Nevada	Mineral	33.70	New Mexico	Grant	117.02
Nevada	Nye	29.52	New Mexico	Guadalupe	77.05

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
NEW MEXICO			**NEW YORK**		
New Mexico	Harding	69.94	New York	Monroe	73.66
New Mexico	Hidalgo	99.81	New York	Montgomery	100.92
New Mexico	Lea	87.71	New York	Nassau	173.07
New Mexico	Lincoln	110.20	New York	New York	178.04
New Mexico	LosAlamos	61.14	New York	Niagara	81.04
New Mexico	Luna	55.10	New York	Oneida	112.00
New Mexico	McKinley	34.75	New York	Onondaga	95.48
New Mexico	Mora	105.27	New York	Ontario	81.11
New Mexico	Otero	130.78	New York	Orange	154.55
New Mexico	Quay	90.48	New York	Orleans	75.56
New Mexico	RioArriba	78.39	New York	Oswego	98.24
New Mexico	Roosevelt	89.21	New York	Otsego	104.90
New Mexico	Sandoval	66.73	New York	Putnam	169.71
New Mexico	SanJuan	25.53	New York	Queens	167.01
New Mexico	San Miguel	102.34	New York	Rensselaer	114.16
New Mexico	SantaFe	80.11	New York	Richmond	182.53
New Mexico	Sierra	78.98	New York	Rockland	177.26
New Mexico	Socorro	66.79	New York	St. Lawrence	86.80
New Mexico	Taos	84.45	New York	Saratoga	103.06
New Mexico	Torrance	68.82	New York	Schenectady	101.85
New Mexico	Union	69.76	New York	Schoharie	104.82
New Mexico	Valencia	56.86	New York	Schuyler	91.10
NEW YORK			New York	Seneca	82.81
New York	Albany	105.30	New York	Steuben	86.19
New York	Allegany	96.05	New York	Suffolk	177.28
New York	Bronx	174.37	New York	Sullivan	143.29
New York	Broome	104.12	New York	Tioga	99.06
New York	Cattaraugus	108.55	New York	Tompkins	96.18
New York	Cayuga	89.97	New York	Ulster	146.07
New York	Chautauqua	118.92	New York	Warren	99.09
New York	Chemung	93.98	New York	Washington	97.62
New York	Chenango	106.60	New York	Wayne	84.12
New York	Clinton	78.27	New York	Westchester	172.76
New York	Columbia	130.58	New York	Wyoming	95.10
New York	Cortland	99.69	New York	Yates	83.49
New York	Delaware	121.90	**NORTH CAROLINA**		
New York	Dutchess	140.51	North Carolina	Alamance	248.21
New York	Erie	94.03	North Carolina	Alexander	246.42
New York	Essex	92.04	North Carolina	Alleghany	220.92
New York	Franklin	90.17	North Carolina	Anson	290.39
New York	Fulton	110.54	North Carolina	Ashe	232.41
New York	Genesee	82.49	North Carolina	Avery	259.52
New York	Greene	115.73	North Carolina	Beaufort	333.24
New York	Hamilton	113.76	North Carolina	Bertie	285.33
New York	Herkimer	112.32	North Carolina	Bladen	321.84
New York	Jefferson	83.97	North Carolina	Brunswick	394.61
New York	Kings	174.51	North Carolina	Buncombe	234.35
New York	Lewis	105.26	North Carolina	Burke	266.89
New York	Livingston	82.37	North Carolina	Cabarrus	257.05
New York	Madison	96.89	North Carolina	Caldwell	245.90

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
NORTH CAROLINA			**NORTH CAROLINA**		
North Carolina	Camden	288.68	North Carolina	New Hanover	413.13
North Carolina	Carteret	386.25	North Carolina	Northampton	254.14
North Carolina	Caswell	226.20	North Carolina	Onslow	388.68
North Carolina	Catawba	250.77	North Carolina	Orange	246.76
North Carolina	Chatham	263.78	North Carolina	Pamlico	368.13
North Carolina	Cherokee	326.02	North Carolina	Pasquotank	285.81
North Carolina	Chowan	294.49	North Carolina	Pender	382.17
North Carolina	Clay	350.22	North Carolina	Perquimans	297.44
North Carolina	Cleveland	260.80	North Carolina	Person	232.86
North Carolina	Columbus	341.04	North Carolina	Pitt	299.53
North Carolina	Craven	361.11	North Carolina	Polk	303.93
North Carolina	Cumberland	297.00	North Carolina	Randolph	258.00
North Carolina	Currituck	286.95	North Carolina	Richmond	289.27
North Carolina	Dare	333.80	North Carolina	Robeson	310.41
North Carolina	Davidson	239.03	North Carolina	Rockingham	219.20
North Carolina	Davie	229.64	North Carolina	Rowan	239.82
North Carolina	Duplin	353.26	North Carolina	Rutherford	275.48
North Carolina	Durham	246.52	North Carolina	Sampson	323.61
North Carolina	Edgecombe	270.45	North Carolina	Scotland	300.11
North Carolina	Forsyth	226.93	North Carolina	Stanly	270.61
North Carolina	Franklin	249.67	North Carolina	Stokes	229.82
North Carolina	Gaston	251.01	North Carolina	Surry	224.88
North Carolina	Gates	280.87	North Carolina	Swain	321.36
North Carolina	Graham	351.47	North Carolina	Transylvania	411.56
North Carolina	Granville	233.83	North Carolina	Tyrrell	323.06
North Carolina	Greene	310.73	North Carolina	Union	280.13
North Carolina	Guilford	231.99	North Carolina	Vance	233.90
North Carolina	Halifax	250.53	North Carolina	Wake	254.62
North Carolina	Harnett	286.33	North Carolina	Warren	237.25
North Carolina	Haywood	293.21	North Carolina	Washington	314.96
North Carolina	Henderson	300.40	North Carolina	Watauga	261.66
North Carolina	Hertford	270.81	North Carolina	Wayne	307.71
North Carolina	Hoke	293.64	North Carolina	Wilkes	237.84
North Carolina	Hyde	342.17	North Carolina	Wilson	277.47
North Carolina	Iredell	234.02	North Carolina	Yadkin	229.25
North Carolina	Jackson	375.85	North Carolina	Yancey	255.91
North Carolina	Johnston	278.37	**NORTH DAKOTA**		
North Carolina	Jones	360.55	North Dakota	Adams	50.68
North Carolina	Lee	279.88	North Dakota	Barnes	68.52
North Carolina	Lenoir	340.28	North Dakota	Benson	56.86
North Carolina	Lincoln	256.81	North Dakota	Billings	40.43
North Carolina	McDowell	258.19	North Dakota	Bottineau	50.28
North Carolina	Macon	367.15	North Dakota	Bowman	41.71
North Carolina	Madison	218.64	North Dakota	Burke	43.70
North Carolina	Martin	293.31	North Dakota	Burleigh	58.17
North Carolina	Mecklenburg	252.32	North Dakota	Cass	71.54
North Carolina	Mitchell	246.98	North Dakota	Cavalier	57.44
North Carolina	Montgomery	273.19	North Dakota	Dickey	71.67
North Carolina	Moore	280.42	North Dakota	Divide	37.24
North Carolina	Nash	257.65	North Dakota	Dunn	47.06

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
NORTH DAKOTA		
North Dakota	Eddy	62.29
North Dakota	Emmons	57.82
North Dakota	Foster	63.99
North Dakota	Golden Valley	36.34
North Dakota	Grand Forks	64.30
North Dakota	Grant	55.96
North Dakota	Griggs	68.61
North Dakota	Hettinger	50.24
North Dakota	Kidder	60.77
North Dakota	La Moure	71.11
North Dakota	Logan	64.97
North Dakota	McHenry	52.19
North Dakota	McIntosh	65.37
North Dakota	McKenzie	39.32
North Dakota	McLean	53.28
North Dakota	Mercer	52.12
North Dakota	Morton	55.92
North Dakota	Mountrial	46.72
North Dakota	Nelson	63.59
North Dakota	Oliver	55.50
North Dakota	Pembina	59.00
North Dakota	Pierce	53.93
North Dakota	Ramsey	57.81
North Dakota	Ransom	73.45
North Dakota	Renville	47.57
North Dakota	Richland	78.99
North Dakota	Rolette	54.92
North Dakota	Sargent	74.21
North Dakota	Sheridan	56.04
North Dakota	Sioux	54.95
North Dakota	Slope	42.97
North Dakota	Stark	49.12
North Dakota	Steele	68.32
North Dakota	Stutsman	64.75
North Dakota	Towner	55.89
North Dakota	Traill	69.03
North Dakota	Walsh	59.27
North Dakota	Ward	50.07
North Dakota	Wells	58.68
North Dakota	Williams	36.67
OHIO		
Ohio	Adams	171.14
Ohio	Allen	132.20
Ohio	Ashland	135.73
Ohio	Ashtabula	123.70
Ohio	Athens	141.32
Ohio	Auglaize	132.87
Ohio	Belmont	132.06
Ohio	Brown	181.41
Ohio	Butler	168.11

State Name	County	R Factor US
OHIO		
Ohio	Carroll	127.57
Ohio	Champaign	148.11
Ohio	Clark	153.17
Ohio	Clermont	176.67
Ohio	Clinton	165.42
Ohio	Columbiana	120.53
Ohio	Coshocton	135.63
Ohio	Crawford	137.05
Ohio	Cuyahoga	119.40
Ohio	Darke	147.96
Ohio	Defiance	128.35
Ohio	Delaware	143.66
Ohio	Erie	121.37
Ohio	Fairfield	145.56
Ohio	Fayette	152.07
Ohio	Franklin	148.30
Ohio	Fulton	121.45
Ohio	Gallia	157.80
Ohio	Geauga	130.67
Ohio	Greene	155.73
Ohio	Guernsey	127.79
Ohio	Hamilton	176.52
Ohio	Hancock	131.31
Ohio	Hardin	134.63
Ohio	Harrison	129.97
Ohio	Henry	126.28
Ohio	Highland	169.25
Ohio	Hocking	147.62
Ohio	Holmes	132.79
Ohio	Huron	128.62
Ohio	Jackson	154.57
Ohio	Jefferson	127.81
Ohio	Knox	143.17
Ohio	Lake	116.48
Ohio	Lawrence	166.01
Ohio	Licking	145.11
Ohio	Logan	138.40
Ohio	Lorain	117.42
Ohio	Lucas	115.14
Ohio	Madison	145.31
Ohio	Mahoning	118.33
Ohio	Marion	135.84
Ohio	Medina	122.18
Ohio	Meigs	146.16
Ohio	Mercer	136.74
Ohio	Miami	145.30
Ohio	Monroe	137.83
Ohio	Montgomery	152.75
Ohio	Morgan	143.14
Ohio	Morrow	142.78

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
OHIO			**OKLAHOMA**		
Ohio	Muskingum	139.92	Oklahoma	Delaware	285.82
Ohio	Noble	131.53	Oklahoma	Dewey	170.09
Ohio	Ottawa	115.54	Oklahoma	Ellis	141.11
Ohio	Paulding	129.04	Oklahoma	Garfield	208.92
Ohio	Perry	145.85	Oklahoma	Garvin	257.36
Ohio	Pickaway	151.18	Oklahoma	Grady	235.40
Ohio	Pike	156.55	Oklahoma	Grant	196.24
Ohio	Portage	123.73	Oklahoma	Greer	168.20
Ohio	Preble	160.54	Oklahoma	Harmon	154.22
Ohio	Putnam	129.62	Oklahoma	Harper	145.57
Ohio	Richland	138.31	Oklahoma	Haskell	313.90
Ohio	Ross	154.08	Oklahoma	Hughes	283.96
Ohio	Sandusky	121.24	Oklahoma	Jackson	171.06
Ohio	Scioto	156.87	Oklahoma	Jefferson	231.08
Ohio	Seneca	128.79	Oklahoma	Johnston	290.62
Ohio	Shelby	139.36	Oklahoma	Kay	219.30
Ohio	Stark	123.94	Oklahoma	Kingfisher	209.17
Ohio	Summit	123.63	Oklahoma	Kiowa	188.11
Ohio	Trumbull	116.92	Oklahoma	Latimer	343.88
Ohio	Tuscarawas	130.09	Oklahoma	Le Flore	342.52
Ohio	Union	138.65	Oklahoma	Lincoln	251.32
Ohio	Van Wert	134.73	Oklahoma	Logan	223.05
Ohio	Vinton	152.10	Oklahoma	Love	267.74
Ohio	Warren	165.99	Oklahoma	McClain	249.96
Ohio	Washington	138.56	Oklahoma	McCurtain	367.27
Ohio	Wayne	126.51	Oklahoma	McIntosh	290.74
Ohio	Williams	125.53	Oklahoma	Major	175.27
Ohio	Wood	121.12	Oklahoma	Marshall	289.66
Ohio	Wyandot	132.39	Oklahoma	Mayes	281.95
OKLAHOMA			Oklahoma	Murray	274.08
Oklahoma	Adair	304.06	Oklahoma	Muskogee	282.70
Oklahoma	Alfalfa	180.02	Oklahoma	Noble	227.55
Oklahoma	Atoka	309.52	Oklahoma	Nowata	252.73
Oklahoma	Beaver	124.27	Oklahoma	Okfuskee	270.93
Oklahoma	Beckham	163.60	Oklahoma	Oklahoma	236.05
Oklahoma	Blaine	191.24	Oklahoma	Okmulgee	274.40
Oklahoma	Bryan	309.81	Oklahoma	Osage	233.26
Oklahoma	Caddo	203.56	Oklahoma	Ottawa	274.43
Oklahoma	Canadian	218.26	Oklahoma	Pawnee	239.80
Oklahoma	Carter	256.99	Oklahoma	Payne	235.28
Oklahoma	Cherokee	296.70	Oklahoma	Pittsburg	311.67
Oklahoma	Choctaw	331.29	Oklahoma	Pontotoc	283.55
Oklahoma	Cimarron	79.84	Oklahoma	Pottawatomie	262.40
Oklahoma	Cleveland	249.15	Oklahoma	Pushmataha	353.19
Oklahoma	Coal	292.60	Oklahoma	Roger Mills	155.71
Oklahoma	Comanche	211.07	Oklahoma	Rogers	263.31
Oklahoma	Cotton	218.02	Oklahoma	Seminole	265.57
Oklahoma	Craig	265.96	Oklahoma	Sequoyah	299.24
Oklahoma	Creek	253.93	Oklahoma	Stephens	237.78
Oklahoma	Custer	188.19	Oklahoma	Texas	100.36

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
OKLAHOMA		
Oklahoma	Tillman	194.35
Oklahoma	Tulsa	259.69
Oklahoma	Wagoner	278.30
Oklahoma	Washington	243.44
Oklahoma	Washita	188.58
Oklahoma	Woods	157.01
Oklahoma	Woodward	151.38
OREGON		
Oregon	Baker	32.50
Oregon	Benton	291.07
Oregon	Clackamas	160.83
Oregon	Clatsop	327.37
Oregon	Columbia	118.05
Oregon	Coos	267.10
Oregon	Crook	22.65
Oregon	Curry	403.82
Oregon	Deschutes	114.79
Oregon	Douglas	236.53
Oregon	Gilliam	11.88
Oregon	Grant	28.16
Oregon	Harney	30.23
Oregon	HoodRiver	155.11
Oregon	Jackson	74.73
Oregon	Jefferson	110.45
Oregon	Josephine	365.36
Oregon	Klamath	83.32
Oregon	Lake	43.58
Oregon	Lane	267.15
Oregon	Lincoln	363.60
Oregon	Linn	120.50
Oregon	Linn	121.07
Oregon	Malheur	15.29
Oregon	Marion	140.88
Oregon	Morrow	21.77
Oregon	Multnomah	185.42
Oregon	Polk	361.34
Oregon	Sherman	14.14
Oregon	Tillamook	405.23
Oregon	Umatilla	31.43
Oregon	Union	48.54
Oregon	Wallowa	44.79
Oregon	Wasco	97.14
Oregon	Washington	219.17
Oregon	Wheeler	22.74
Oregon	Yamhill	321.43
PENNSYLVANIA		
Pennsylvania	Adams	145.86
Pennsylvania	Allegheny	118.53
Pennsylvania	Armstrong	123.47
Pennsylvania	Beaver	118.01

State Name	County	R Factor US
PENNSYLVANIA		
Pennsylvania	Bedford	121.80
Pennsylvania	Berks	165.88
Pennsylvania	Blair	124.55
Pennsylvania	Bradford	100.62
Pennsylvania	Bucks	176.63
Pennsylvania	Butler	125.41
Pennsylvania	Cambria	139.40
Pennsylvania	Cameron	122.32
Pennsylvania	Carbon	166.20
Pennsylvania	Centre	125.31
Pennsylvania	Chester	175.02
Pennsylvania	Clarion	128.99
Pennsylvania	Clearfield	123.46
Pennsylvania	Clinton	127.77
Pennsylvania	Columbia	138.16
Pennsylvania	Crawford	126.62
Pennsylvania	Cumberland	137.65
Pennsylvania	Dauphin	146.23
Pennsylvania	Delaware	176.28
Pennsylvania	Elk	125.13
Pennsylvania	Erie	124.30
Pennsylvania	Fayette	135.72
Pennsylvania	Forest	122.67
Pennsylvania	Franklin	142.02
Pennsylvania	Fulton	127.49
Pennsylvania	Greene	130.10
Pennsylvania	Huntingdon	125.06
Pennsylvania	Indiana	136.39
Pennsylvania	Jefferson	125.37
Pennsylvania	Juniata	134.21
Pennsylvania	Lackawanna	137.02
Pennsylvania	Lancaster	155.75
Pennsylvania	Lawrence	120.16
Pennsylvania	Lebanon	157.15
Pennsylvania	Lehigh	163.18
Pennsylvania	Luzerne	144.18
Pennsylvania	Lycoming	122.18
Pennsylvania	McKean	117.37
Pennsylvania	Mercer	125.16
Pennsylvania	Mifflin	129.19
Pennsylvania	Monroe	162.55
Pennsylvania	Montgomery	173.47
Pennsylvania	Montour	134.26
Pennsylvania	Northampton	165.37
Pennsylvania	Northumberland	140.06
Pennsylvania	Perry	136.28
Pennsylvania	Philadelphia	178.26
Pennsylvania	Pike	141.33
Pennsylvania	Potter	113.05
Pennsylvania	Schuylkill	168.51

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
PENNSYLVANIA		
Pennsylvania	Snyder	138.62
Pennsylvania	Somerset	132.25
Pennsylvania	Sullivan	127.12
Pennsylvania	Susquehanna	117.92
Pennsylvania	Tioga	95.78
Pennsylvania	Union	139.49
Pennsylvania	Venango	128.94
Pennsylvania	Warren	123.74
Pennsylvania	Washington	124.59
Pennsylvania	Wayne	130.22
Pennsylvania	Westmoreland	128.56
Pennsylvania	Wyoming	117.29
Pennsylvania	York	148.92
RHODE ISLAND		
Rhode Island	Bristol	163.63
Rhode Island	Kent	173.47
Rhode Island	Newport	166.73
Rhode Island	Providence	162.65
Rhode Island	Washington	179.01
SOUTH CAROLINA		
South Carolina	Abbeville	284.59
South Carolina	Aiken	318.68
South Carolina	Allendale	350.80
South Carolina	Anderson	278.76
South Carolina	Bamberg	342.75
South Carolina	Barnwell	325.33
South Carolina	Beaufort	411.07
South Carolina	Berkeley	385.99
South Carolina	Calhoun	318.89
South Carolina	Charleston	399.73
South Carolina	Cherokee	270.30
South Carolina	Chester	282.24
South Carolina	Chesterfield	296.66
South Carolina	Clarendon	330.08
South Carolina	Colleton	386.58
South Carolina	Darlington	304.44
South Carolina	Dillon	309.97
South Carolina	Dorchester	373.99
South Carolina	Edgefield	298.15
South Carolina	Fairfield	296.21
South Carolina	Florence	318.20
South Carolina	Georgetown	396.18
South Carolina	Greenville	317.09
South Carolina	Greenwood	284.06
South Carolina	Hampton	370.18
South Carolina	Horry	359.81
South Carolina	Jasper	397.23
South Carolina	Kershaw	287.03
South Carolina	Lancaster	286.27
South Carolina	Laurens	282.14

State Name	County	R Factor US
SOUTH CAROLINA		
South Carolina	Lee	301.43
South Carolina	Lexington	316.46
South Carolina	McCormick	292.44
South Carolina	Marion	334.13
South Carolina	Marlboro	299.34
South Carolina	Newberry	285.85
South Carolina	Oconee	331.91
South Carolina	Orangeburg	334.99
South Carolina	Pickens	332.14
South Carolina	Richland	306.14
South Carolina	Saluda	295.71
South Carolina	Spartanburg	284.33
South Carolina	Sumter	318.82
South Carolina	Union	285.19
South Carolina	Williamsburg	352.05
South Carolina	York	274.83
SOUTH DAKOTA		
South Dakota	Aurora	87.00
South Dakota	Beadle	78.13
South Dakota	Bennett	68.93
South Dakota	Bon Homme	105.77
South Dakota	Brookings	100.68
South Dakota	Brown	73.26
South Dakota	Brule	83.45
South Dakota	Buffalo	73.18
South Dakota	Butte	43.84
South Dakota	Campbell	61.34
South Dakota	Charles Mix	96.93
South Dakota	Clark	83.54
South Dakota	Clay	113.86
South Dakota	Codington	89.93
South Dakota	Corson	57.78
South Dakota	Custer	57.02
South Dakota	Davison	90.62
South Dakota	Day	81.17
South Dakota	Deuel	98.22
South Dakota	Dewey	60.83
South Dakota	Douglas	95.27
South Dakota	Edmunds	68.56
South Dakota	Fall River	48.73
South Dakota	Faulk	68.48
South Dakota	Grant	87.85
South Dakota	Gregory	97.98
South Dakota	Haakon	59.30
South Dakota	Hamlin	95.05
South Dakota	Hand	71.19
South Dakota	Hanson	93.34
South Dakota	Harding	43.55
South Dakota	Hughes	67.74
South Dakota	Hutchinson	100.30

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
SOUTH DAKOTA			**TENNESSEE**		
South Dakota	Hyde	70.92	Tennessee	Crockett	327.54
South Dakota	Jackson	61.93	Tennessee	Cumberland	297.03
South Dakota	Jerauld	80.70	Tennessee	Davidson	278.71
South Dakota	Jones	66.22	Tennessee	Decatur	340.05
South Dakota	Kingsbury	93.20	Tennessee	De Kalb	304.15
South Dakota	Lake	98.17	Tennessee	Dickson	303.16
South Dakota	Lawrence	62.72	Tennessee	Dyer	309.61
South Dakota	Lincoln	111.58	Tennessee	Fayette	353.77
South Dakota	Lyman	72.49	Tennessee	Fentress	272.77
South Dakota	McCook	100.07	Tennessee	Franklin	333.47
South Dakota	McPherson	66.66	Tennessee	Gibson	324.44
South Dakota	Marshall	77.10	Tennessee	Giles	343.93
South Dakota	Meade	52.86	Tennessee	Grainger	225.07
South Dakota	Mellette	70.20	Tennessee	Greene	203.46
South Dakota	Miner	90.48	Tennessee	Grundy	338.89
South Dakota	Minnehaha	105.51	Tennessee	Hamblen	201.39
South Dakota	Moody	103.13	Tennessee	Hamilton	303.40
South Dakota	Pennington	59.70	Tennessee	Hancock	210.90
South Dakota	Perkins	52.63	Tennessee	Hardeman	355.08
South Dakota	Potter	65.62	Tennessee	Hardin	362.07
South Dakota	Roberts	82.66	Tennessee	Hawkins	196.41
South Dakota	Sanborn	83.19	Tennessee	Haywood	329.21
South Dakota	Shannon	57.78	Tennessee	Henderson	334.05
South Dakota	Spink	76.08	Tennessee	Henry	308.13
South Dakota	Stanley	62.98	Tennessee	Hickman	319.97
South Dakota	Sully	66.57	Tennessee	Houston	299.72
South Dakota	Todd	75.42	Tennessee	Humphreys	318.60
South Dakota	Tripp	86.68	Tennessee	Jackson	281.77
South Dakota	Turner	106.42	Tennessee	Jefferson	203.66
South Dakota	Union	119.62	Tennessee	Johnson	212.72
South Dakota	Walworth	63.27	Tennessee	Knox	246.81
South Dakota	Yankton	106.65	Tennessee	Lake	298.79
South Dakota	Ziebach	57.51	Tennessee	Lauderdale	315.86
TENNESSEE			Tennessee	Lawrence	351.50
Tennessee	Anderson	271.01	Tennessee	Lewis	335.29
Tennessee	Bedford	315.69	Tennessee	Lincoln	327.62
Tennessee	Benton	319.99	Tennessee	Loudon	272.38
Tennessee	Bledsoe	304.06	Tennessee	McMinn	294.21
Tennessee	Blount	271.68	Tennessee	McNairy	365.20
Tennessee	Bradley	301.08	Tennessee	Macon	284.51
Tennessee	Campbell	257.65	Tennessee	Madison	336.10
Tennessee	Cannon	316.51	Tennessee	Marion	328.87
Tennessee	Carroll	329.35	Tennessee	Marshall	333.65
Tennessee	Carter	215.39	Tennessee	Maury	323.53
Tennessee	Cheatham	285.81	Tennessee	Meigs	285.01
Tennessee	Chester	346.56	Tennessee	Monroe	297.84
Tennessee	Claiborne	235.05	Tennessee	Montgomery	275.29
Tennessee	Clay	271.48	Tennessee	Moore	324.68
Tennessee	Cocke	225.64	Tennessee	Morgan	282.69
Tennessee	Coffee	325.37	Tennessee	Obion	316.60

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
TENNESSEE			**TEXAS**		
Tennessee	Overton	281.68	Texas	Brazos	326.09
Tennessee	Perry	341.86	Texas	Brewster	89.33
Tennessee	Pickett	264.13	Texas	Briscoe	129.51
Tennessee	Polk	315.81	Texas	Brooks	246.46
Tennessee	Putnam	296.32	Texas	Brown	200.72
Tennessee	Rhea	297.30	Texas	Burleson	311.64
Tennessee	Roane	272.70	Texas	Burnet	229.37
Tennessee	Robertson	268.70	Texas	Caldwell	280.12
Tennessee	Rutherford	311.11	Texas	Calhoun	380.63
Tennessee	Scott	265.47	Texas	Callahan	183.40
Tennessee	Sequatchie	323.16	Texas	Cameron	270.67
Tennessee	Sevier	261.01	Texas	Camp	342.89
Tennessee	Shelby	345.53	Texas	Carson	123.81
Tennessee	Smith	281.86	Texas	Cass	361.37
Tennessee	Stewart	286.63	Texas	Castro	100.51
Tennessee	Sullivan	183.74	Texas	Chambers	498.24
Tennessee	Sumner	276.10	Texas	Cherokee	355.39
Tennessee	Tipton	326.46	Texas	Childress	138.76
Tennessee	Trousdale	283.40	Texas	Clay	218.98
Tennessee	Unicoi	231.02	Texas	Cochran	99.77
Tennessee	Union	243.22	Texas	Coke	153.27
Tennessee	Van Buren	308.94	Texas	Coleman	191.85
Tennessee	Warren	307.04	Texas	Collin	297.26
Tennessee	Washington	199.69	Texas	Collingsworth	140.30
Tennessee	Wayne	366.44	Texas	Colorado	353.06
Tennessee	Weakley	312.77	Texas	Comal	267.22
Tennessee	White	298.67	Texas	Comanche	212.41
Tennessee	Williamson	303.01	Texas	Concho	176.38
Tennessee	Wilson	294.26	Texas	Cooke	267.43
TEXAS			Texas	Coryell	242.95
Texas	Anderson	335.10	Texas	Cottle	142.10
Texas	Andrews	88.75	Texas	Crane	77.89
Texas	Angelina	388.00	Texas	Crockett	126.48
Texas	Aransas	346.87	Texas	Crosby	129.39
Texas	Archer	198.99	Texas	Culberson	64.44
Texas	Armstrong	127.97	Texas	Dallam	80.29
Texas	Atascosa	227.91	Texas	Dallas	272.76
Texas	Austin	352.96	Texas	Dawson	112.90
Texas	Bailey	94.37	Texas	Deaf Smith	95.14
Texas	Bandera	224.32	Texas	Delta	332.01
Texas	Bastrop	289.31	Texas	Denton	275.78
Texas	Baylor	184.28	Texas	De Witt	303.08
Texas	Bee	299.18	Texas	Dickens	138.30
Texas	Bell	263.11	Texas	Dimmit	180.61
Texas	Bexar	245.42	Texas	Donley	135.52
Texas	Blanco	244.31	Texas	Duval	232.03
Texas	Borden	126.79	Texas	Eastland	200.52
Texas	Bosque	247.96	Texas	Ector	79.12
Texas	Bowie	365.61	Texas	Edwards	186.68
Texas	Brazoria	478.11	Texas	Ellis	273.05

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
TEXAS			**TEXAS**		
Texas	El Paso	39.01	Texas	Jasper	495.30
Texas	Erath	224.34	Texas	Jeff Davis	86.81
Texas	Falls	276.20	Texas	Jefferson	541.24
Texas	Fannin	323.35	Texas	Jim Hogg	219.69
Texas	Fayette	319.75	Texas	Jim Wells	263.93
Texas	Fisher	158.98	Texas	Johnson	250.76
Texas	Floyd	126.95	Texas	Jones	170.45
Texas	Foard	158.62	Texas	Karnes	258.09
Texas	Fort Bend	401.81	Texas	Kaufman	295.60
Texas	Franklin	338.41	Texas	Kendall	258.51
Texas	Freestone	314.84	Texas	Kenedy	261.02
Texas	Frio	209.27	Texas	Kent	139.41
Texas	Gaines	97.99	Texas	Kerr	218.13
Texas	Galveston	463.53	Texas	Kimble	188.68
Texas	Garza	129.45	Texas	King	150.46
Texas	Gillespie	227.57	Texas	Kinney	173.96
Texas	Glasscock	115.78	Texas	Kleberg	273.62
Texas	Goliad	312.40	Texas	Knox	168.80
Texas	Gonzales	296.39	Texas	Lamar	339.18
Texas	Gray	134.88	Texas	Lamb	104.18
Texas	Grayson	296.43	Texas	Lampasas	223.77
Texas	Gregg	365.74	Texas	La Salle	196.35
Texas	Grimes	359.62	Texas	Lavaca	334.29
Texas	Guadalupe	275.71	Texas	Lee	296.49
Texas	Hale	114.42	Texas	Leon	324.24
Texas	Hall	129.95	Texas	Liberty	479.33
Texas	Hamilton	222.37	Texas	Limestone	294.05
Texas	Hansford	105.23	Texas	Lipscomb	129.91
Texas	Hardeman	161.46	Texas	Live Oak	250.26
Texas	Hardin	511.52	Texas	Llano	212.70
Texas	Harris	435.78	Texas	Loving	57.51
Texas	Harrison	375.43	Texas	Lubbock	115.88
Texas	Hartley	87.21	Texas	Lynn	118.39
Texas	Haskell	174.40	Texas	McCulloch	188.44
Texas	Hays	266.09	Texas	McLennan	259.20
Texas	Hemphill	134.14	Texas	McMullen	215.41
Texas	Henderson	313.31	Texas	Madison	344.50
Texas	Hidalgo	240.42	Texas	Marion	364.09
Texas	Hill	264.80	Texas	Martin	105.31
Texas	Hockley	108.70	Texas	Mason	202.09
Texas	Hood	229.97	Texas	Matagorda	425.47
Texas	Hopkins	344.01	Texas	Maverick	178.17
Texas	Houston	350.89	Texas	Medina	218.96
Texas	Howard	123.53	Texas	Menard	180.25
Texas	Hudspeth	51.61	Texas	Midland	92.58
Texas	Hunt	316.01	Texas	Milam	279.91
Texas	Hutchinson	114.01	Texas	Mills	201.56
Texas	Irion	138.40	Texas	Mitchell	138.63
Texas	Jack	224.06	Texas	Montague	241.29
Texas	Jackson	383.17	Texas	Montgomery	408.72

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
TEXAS			**TEXAS**		
Texas	Moore	99.71	Texas	Taylor	175.50
Texas	Morris	353.68	Texas	Terrell	96.42
Texas	Motley	132.89	Texas	Terry	106.85
Texas	Nacogdoches	387.37	Texas	Throckmorton	189.60
Texas	Navarro	288.63	Texas	Titus	355.62
Texas	Newton	513.71	Texas	Tom Green	150.71
Texas	Nolan	162.89	Texas	Travis	257.26
Texas	Nueces	291.16	Texas	Trinity	374.95
Texas	Ochiltree	116.75	Texas	Tyler	467.31
Texas	Oldham	92.03	Texas	Upshur	346.36
Texas	Orange	559.83	Texas	Upton	93.12
Texas	Palo Pinto	221.81	Texas	Uvalde	197.83
Texas	Panola	392.80	Texas	Val Verde	142.70
Texas	Parker	234.33	Texas	Van Zandt	316.71
Texas	Parmer	91.03	Texas	Victoria	348.25
Texas	Pecos	87.25	Texas	Walker	380.49
Texas	Polk	422.57	Texas	Waller	367.80
Texas	Potter	110.75	Texas	Ward	64.78
Texas	Presidio	81.26	Texas	Washington	339.04
Texas	Rains	323.27	Texas	Webb	198.22
Texas	Randall	112.16	Texas	Wharton	388.36
Texas	Reagan	119.74	Texas	Wheeler	142.10
Texas	Real	209.80	Texas	Wichita	196.57
Texas	Red River	348.12	Texas	Wilbarger	177.49
Texas	Reeves	62.64	Texas	Willacy	270.86
Texas	Refugio	351.63	Texas	Williamson	261.80
Texas	Roberts	123.36	Texas	Wilson	245.82
Texas	Robertson	293.73	Texas	Winkler	70.26
Texas	Rockwall	298.82	Texas	Wise	249.55
Texas	Runnels	174.98	Texas	Wood	323.99
Texas	Rusk	368.45	Texas	Yoakum	98.58
Texas	Sabine	458.16	Texas	Young	209.68
Texas	San Augustine	431.00	Texas	Zapata	200.82
Texas	San Jacinto	425.26	Texas	Zavala	177.40
Texas	San Patricio	318.52	**UTAH**		
Texas	San Saba	200.94	Utah	Beaver	42.55
Texas	Schleicher	157.30	Utah	BoxElder	46.28
Texas	Scurry	144.22	Utah	Cache	32.87
Texas	Shackelford	187.83	Utah	Carbon	18.23
Texas	Shelby	416.50	Utah	Daggett	24.75
Texas	Sherman	94.34	Utah	Davis	37.24
Texas	Smith	336.82	Utah	Duchesne	28.45
Texas	Somervell	235.79	Utah	Emery	25.38
Texas	Starr	221.89	Utah	Garfield	32.79
Texas	Stephens	200.13	Utah	Grand	26.75
Texas	Sterling	131.84	Utah	Iron	37.64
Texas	Stonewall	151.69	Utah	Juab	27.78
Texas	Sutton	163.39	Utah	Kane	36.49
Texas	Swisher	116.82	Utah	Millard	26.66
Texas	Tarrant	252.95	Utah	Morgan	40.93

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US	State Name	County	R Factor US
UTAH			**VIRGINIA**		
Utah	Piute	42.55	Virginia	Chesterfield	208.96
Utah	Rich	26.75	Virginia	Clarke	145.41
Utah	SaltLake	50.29	Virginia	Craig	156.54
Utah	SanJuan	34.09	Virginia	Culpeper	179.01
Utah	Sanpete	30.36	Virginia	Cumberland	185.48
Utah	Sevier	34.96	Virginia	Dickenson	186.19
Utah	Summit	37.56	Virginia	Dinwiddie	219.80
Utah	Tooele	45.99	Virginia	Essex	204.28
Utah	Uintah	28.02	Virginia	Fairfax	168.12
Utah	Utah	42.11	Virginia	Fauquier	164.51
Utah	Wasatch	37.37	Virginia	Floyd	195.63
Utah	Washington	40.70	Virginia	Fluvanna	180.24
Utah	Wayne	26.79	Virginia	Franklin	203.31
Utah	Weber	46.28	Virginia	Frederick	135.55
VERMONT			Virginia	Giles	150.31
Vermont	Addison	93.46	Virginia	Gloucester	220.34
Vermont	Bennington	131.23	Virginia	Goochland	195.01
Vermont	Caledonia	98.81	Virginia	Grayson	190.46
Vermont	Chittenden	90.99	Virginia	Greene	186.90
Vermont	Essex	100.77	Virginia	Greensville	235.45
Vermont	Franklin	95.97	Virginia	Halifax	209.27
Vermont	Grand Isle	72.13	Virginia	Hanover	197.19
Vermont	Lamoille	105.65	Virginia	Henrico	206.66
Vermont	Orange	91.71	Virginia	Henry	221.25
Vermont	Orleans	97.62	Virginia	Highland	138.78
Vermont	Rutland	108.38	Virginia	Isle of Wight	258.17
Vermont	Washington	99.42	Virginia	James City	231.64
Vermont	Windham	126.56	Virginia	King and Queen	212.59
Vermont	Windsor	103.12	Virginia	King George	185.08
VIRGINIA			Virginia	King William	210.25
Virginia	Accomack	205.76	Virginia	Lancaster	208.33
Virginia	Albemarle	189.88	Virginia	Lee	224.99
Virginia	Alleghany	145.02	Virginia	Loudoun	157.35
Virginia	Amelia	202.67	Virginia	Louisa	191.89
Virginia	Amherst	178.84	Virginia	Lunenburg	215.60
Virginia	Appomattox	189.90	Virginia	Madison	178.60
Virginia	Arlington	177.60	Virginia	Mathews	226.68
Virginia	Augusta	151.24	Virginia	Mecklenburg	219.46
Virginia	Bath	151.25	Virginia	Middlesex	215.65
Virginia	Bedford	177.86	Virginia	Montgomery	158.62
Virginia	Bland	148.06	Virginia	Nelson	190.35
Virginia	Botetourt	160.76	Virginia	New Kent	214.39
Virginia	Brunswick	224.15	Virginia	Northampton	209.81
Virginia	Buchanan	174.53	Virginia	Northumberland	202.31
Virginia	Buckingham	185.34	Virginia	Nottoway	208.94
Virginia	Campbell	193.77	Virginia	Orange	187.86
Virginia	Caroline	189.79	Virginia	Page	151.42
Virginia	Carroll	194.45	Virginia	Patrick	229.82
Virginia	Charles City	220.14	Virginia	Pittsylvania	203.01
Virginia	Charlotte	202.68	Virginia	Powhatan	193.85

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
VIRGINIA		
Virginia	Prince Edward	204.82
Virginia	Prince George	226.45
Virginia	Prince William	166.61
Virginia	Pulaski	145.28
Virginia	Rappahannock	170.69
Virginia	Richmond	206.85
Virginia	Roanoke	161.81
Virginia	Rockbridge	160.38
Virginia	Rockingham	135.19
Virginia	Russell	185.25
Virginia	Scott	197.80
Virginia	Shenandoah	131.14
Virginia	Smyth	179.73
Virginia	Southampton	252.83
Virginia	Spotsylvania	184.50
Virginia	Stafford	175.55
Virginia	Surry	236.73
Virginia	Sussex	237.17
Virginia	Tazewell	166.07
Virginia	Warren	151.86
Virginia	Washington	184.37
Virginia	Westmoreland	195.57
Virginia	Wise	195.48
Virginia	Wythe	140.08
Virginia	York	243.55
WASHINGTON		
Washington	Adams	9.08
Washington	Asiton	25.47
Washington	Benton	8.60
Washington	Chelan	212.16
Washington	Clallam	409.46
Washington	Clallam	177.33
Washington	Clark	191.25
Washington	Columbia	38.55
Washington	Cowlitz	211.27
Washington	Douglas	21.36
Washington	Ferry	24.36
Washington	Franklin	7.26
Washington	Garfield	32.70
Washington	Grant	9.22
Washington	GraysHarbor	414.51
Washington	Island	47.12
Washington	Jefferson	495.03
Washington	Jefferson	157.52
Washington	King	237.15
Washington	Kitsap	97.63
Washington	Kittitas	199.35
Washington	Klickitat	74.38
Washington	Lewis	208.04
Washington	Lincoln	10.67

State Name	County	R Factor US
WASHINGTON		
Washington	Mason	382.51
Washington	Okanogan	85.82
Washington	Pacific	257.76
Washington	Pacific	170.72
Washington	PendOreille	39.69
Washington	Pierce	244.01
Washington	Skagit	184.67
Washington	Skamania	191.51
Washington	Snohomish	232.10
Washington	Spokane	24.25
Washington	Stevens	39.56
Washington	Thurston	150.81
Washington	Wahkiakum	209.41
Washington	Wahkiakum	151.79
Washington	WallaWalla	27.75
Washington	Whatcom	156.02
Washington	Whitman	19.39
Washington	Yakima	121.15
WEST VIRGINIA		
West Virginia	Barbour	150.34
West Virginia	Berkeley	134.54
West Virginia	Boone	167.61
West Virginia	Braxton	157.15
West Virginia	Brooke	126.77
West Virginia	Cabell	158.31
West Virginia	Calhoun	148.53
West Virginia	Clay	160.47
West Virginia	Doddridge	143.69
West Virginia	Fayette	162.60
West Virginia	Gilmer	149.65
West Virginia	Grant	124.74
West Virginia	Greenbrier	162.46
West Virginia	Hampshire	121.57
West Virginia	Hancock	121.87
West Virginia	Hardy	125.02
West Virginia	Harrison	137.89
West Virginia	Jackson	146.08
West Virginia	Jefferson	137.22
West Virginia	Kanawha	157.83
West Virginia	Lewis	150.91
West Virginia	Lincoln	166.87
West Virginia	Logan	174.65
West Virginia	McDowell	159.93
West Virginia	Marion	138.35
West Virginia	Marshall	134.22
West Virginia	Mason	150.73
West Virginia	Mercer	139.80
West Virginia	Mineral	115.69
West Virginia	Mingo	177.88
West Virginia	Monongalia	136.09

APPENDIX A. EROSIVITY (R-VALUE TABLES)

State Name	County	R Factor US
WEST VIRGINIA		
West Virginia	Monroe	139.72
West Virginia	Morgan	123.07
West Virginia	Nicholas	171.17
West Virginia	Ohio	126.77
West Virginia	Pendleton	125.13
West Virginia	Pleasants	140.60
West Virginia	Pocahontas	165.35
West Virginia	Preston	156.70
West Virginia	Putnam	152.96
West Virginia	Raleigh	153.32
West Virginia	Randolph	170.41
West Virginia	Ritchie	141.78
West Virginia	Roane	150.99
West Virginia	Summers	138.97
West Virginia	Taylor	137.83
West Virginia	Tucker	161.11
West Virginia	Tyler	143.03
West Virginia	Upshur	158.77
West Virginia	Wayne	170.35
West Virginia	Webster	178.98
West Virginia	Wetzel	144.56
West Virginia	Wirt	145.88
West Virginia	Wood	138.77
West Virginia	Wyoming	164.89
WISCONSIN		
Wisconsin	Adams	129.91
Wisconsin	Ashland	103.75
Wisconsin	Barron	128.37
Wisconsin	Bayfield	103.36
Wisconsin	Brown	102.54
Wisconsin	Buffalo	141.45
Wisconsin	Burnett	117.05
Wisconsin	Calumet	110.93
Wisconsin	Chippewa	129.00
Wisconsin	Clark	133.01
Wisconsin	Columbia	130.01
Wisconsin	Crawford	142.85
Wisconsin	Dane	134.57
Wisconsin	Dodge	125.21
Wisconsin	Door	93.91
Wisconsin	Douglas	108.51
Wisconsin	Dunn	130.11
Wisconsin	Eau Claire	133.51
Wisconsin	Florence	91.13
Wisconsin	Fond Du Lac	116.61
Wisconsin	Forest	100.33
Wisconsin	Grant	150.88
Wisconsin	Green	148.94
Wisconsin	Green Lake	120.80
Wisconsin	Iowa	143.96

State Name	County	R Factor US
WISCONSIN		
Wisconsin	Iron	101.54
Wisconsin	Jackson	140.00
Wisconsin	Jefferson	133.42
Wisconsin	Juneau	134.71
Wisconsin	Kenosha	142.89
Wisconsin	Kewaunee	97.73
Wisconsin	La Crosse	143.23
Wisconsin	Lafayette	154.26
Wisconsin	Langlade	108.23
Wisconsin	Lincoln	111.42
Wisconsin	Manitowoc	105.54
Wisconsin	Marathon	122.51
Wisconsin	Marinette	94.10
Wisconsin	Marquette	124.69
Wisconsin	Menominee	105.86
Wisconsin	Milwaukee	123.97
Wisconsin	Monroe	140.99
Wisconsin	Oconto	100.80
Wisconsin	Oneida	106.05
Wisconsin	Outagamie	108.40
Wisconsin	Ozaukee	119.27
Wisconsin	Pepin	134.41
Wisconsin	Pierce	133.63
Wisconsin	Polk	125.39
Wisconsin	Portage	122.90
Wisconsin	Price	113.87
Wisconsin	Racine	139.91
Wisconsin	Richland	140.06
Wisconsin	Rock	145.01
Wisconsin	Rusk	124.97
Wisconsin	St. Croix	128.77
Wisconsin	Sauk	134.85
Wisconsin	Sawyer	118.25
Wisconsin	Shawano	110.21
Wisconsin	Sheboygan	122.09
Wisconsin	Taylor	122.83
Wisconsin	Trempealeau	139.48
Wisconsin	Vernon	141.60
Wisconsin	Vilas	99.88
Wisconsin	Walworth	145.43
Wisconsin	Washburn	117.62
Wisconsin	Washington	124.80
Wisconsin	Waukesha	128.43
Wisconsin	Waupaca	117.16
Wisconsin	Waushara	120.08
Wisconsin	Winnebago	113.77
Wisconsin	Wood	129.88
WYOMING		
Wyoming	BigHorn	37.76
Wyoming	Campbell	32.70

State Name	County	R Factor US
WYOMING		
Wyoming	Carbon	38.18
Wyoming	Converse	30.29
Wyoming	Crook	63.55
Wyoming	Fremont	21.72
Wyoming	Goshen	40.31
Wyoming	HotSprings	21.03
Wyoming	Johnson	39.83
Wyoming	Laramie	32.40
Wyoming	Lincoln	27.50
Wyoming	Natrona	39.98
Wyoming	Niobrara	37.43
Wyoming	Park	35.13
Wyoming	Platte	38.18
Wyoming	Sheridan	28.70
Wyoming	Sublette	28.62
Wyoming	Sweetwater	14.83
Wyoming	Teton	33.84
Wyoming	Uinta	20.48
Wyoming	Washakie	31.08
Wyoming	Weston	69.62

APPENDIX B.   RAPPS DECISION TREES

Decision Tree-1

SLOPE < 2%

R Factor ≤ 145

Silt/Loam Soils
If R ≤ 65, use Operational RAPPS

- (WFM 0.91)
- (ECM 0.85)
- (VB 0.80)
- (BP 0.73)
- (CS 0.73)
- (RB 0.73)
- (SB 0.72)
- (SF0.67)
- (SBB 0.59) (SBB/SF 0.73)
- (IS 0.47) (IS/SBB 0.87)

Clay Soils
If R ≤ 85, use Operational RAPPS

- (WFM 0.90)
- (ECM 0.83)
- (VB 0.75)
- (RB 0.73)
- (SB 0.73)
- (BP 0.73)
- (CS 0.73)
- (SF 0.72)
- (SBB 0.69) (SBB/SF 0.78)
- (IS 0.39) (IS/SBB 0.82)

Sand/Gravel Soils
If R ≤ 145, use Operational RAPPS

- (VB 0.99)
- (SB 0.98)
- (BP 0.95)
- (CS 0.95)
- (RB 0.95)
- (WFM 0.93)
- (ECM 0.86)
- (SF 0.82)
- (SBB 0.65) (SBB/SF 0.95)
- (IS 0.52) (IS/SBB 0.88)

Modified Management Goal = 0.60

Index

VB – Vegetative Buffer
SB – Sediment Basin
IS – Interceptor Swale
RB – Rock Berm
CS – Compost Sock
SBB – Straw Bale Barrier
WFM – Wood Fiber Mulch
ECM – Erosion Control Mat
BP – Brush pile
SF – Silt Fence

Decision Tree-2

SLOPE < 2%

145 ≤ R Factor ≤ 300

Silt/Loam Soils*

- (WFM 0.90)
- (ECM 0.81)
- (VB 0.77)
- (SB 0.69)
- (RB 0.69)
- (BP 0.69) (2BP 0.76)
- (CS 0.69) (2CS 0.76)
- (SF 0.63) (2SF 0.71)
- (SBB 0.61) (SBB/SF 0.69)
- (IS 0.46) (IS/SBB 0.87)

Clay Soils*

- (WFM 0.88)
- (ECM 0.80)
- (VB 0.71)
- (SB 0.68)
- (RB 0.68)
- (SF 0.68) (2SF 0.81)
- (BP 0.68) (2BP 0.73)
- (CS 0.68) (2CS 0.73)
- (SBB 0.68) (SBB/SF 0.68)
- (IS 0.38) (IS/SBB 0.85)

Sand/Gravel Soils

If R ≤ 185, use Operational RAPPS

- (SB 0.98)
- (VB 0.98)
- (BP 0.96)
- (CS 0.96)
- (RB 0.96)
- (WFM 0.90)
- (SF 0.84)
- (ECM 0.82)
- (SBB 0.69) (SBB/SF 0.96)
- (IS 0.53) (IS/SBB 0.91)

***Modified Management Goal = 0.60**

Index

VB – Vegetative Buffer	SBB – Straw Bale Barrier
SB – Sediment Basin	WFM – Wood Fiber Mulch
IS – Interceptor Swale	ECM – Erosion Control Mat
RB – Rock Berm	BP – Brush pile
CS – Compost Sock	SF – Silt Fence

Decision Tree-3

SLOPE < 2%

R Factor > 300

Silt/Loam Soils*

If R > 325, use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.88)
- (ECM 0.79)
- (VB 0.72) (VB/SF 0.82)
- (SB 0.67) (SB/SF 0.77)
- (BP 0.66) (2BP 0.79)
- (CS 0.66) (2CS 0.79)
- (RB 0.66)
- (SF 0.61) (2SF 0.69)
- (SBB 0.51) (SBB/SF 0.66)
- (IS 0.43) (IS/SBB 0.87)

Clay Soils*

If R > 350, use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.87)
- (ECM 0.78)
- (RB 0.63)
- (VB 0.65) (VB/SF 0.81)
- (SF 0.62) (2SF 0.80)
- (SB 0.63) (SB/SF 0.80)
- (BP 0.63) (2BP 0.80)
- (CS 0.63) (2CS 0.80)
- (SBB 0. 62) (SBB/SF 0.63)
- (IS 0.35) (IS/SBB 0.85)

Sand/Gravel Soils

If R > 550, use Supplemental RAPPS in addition to Operational RAPPS

- (VB 0.97)
- (SB 0.97)
- (BP 0.96)
- (CS 0.96)
- (RB 0.96)
- (WFM 0.85)
- (SF 0.84)
- (ECM 0.73)
- (SBB 0.69) (SBB/SF 0.96)
- (IS 0.53) (IS/SBB 0.92)

***Modified Management Goal = 0.60**

Index

VB – Vegetative Buffer	SBB – Straw Bale Barrier
SB – Sediment Basin	WFM – Wood Fiber Mulch
IS – Interceptor Swale	ECM – Erosion Control Mat
RB – Rock Berm	BP – Brush pile
CS – Compost Sock	SF – Silt Fence

Decision Tree-4

SLOPE (2% - 4%)

R Factor ≤ 45

Silt/Loam Soils
If R ≤ 20, use Operational RAPPS

- (WFM 0.94)
- (ECM 0.93)
- (VB 0.90)
- (SB 0.80)
- (BP 0.70)
- (CS 0.70)
- (RB 0.70)
- (SF 0.59) (2SF 0.70)
- (IS 0.58) (IS/SBB 0.92)
- (SBB 0.51) (SBB/SF 0.71)

Clay Soils
If R ≤ 25, use Operational RAPPS

- (WFM 0.93)
- (ECM 0.92)
- (VB 0.87)
- (RB 0.86)
- (SB 0.86)
- (BP 0.86)
- (CS 0.86)
- (SF 0.77)
- (SBB 0.56) (SBB/SF 0.86)
- (IS 0.50) (IS/SBB 0.91)

Sand/Gravel Soils
If R ≤ 45, use Operational RAPPS

- (VB 0.99)
- (SB 0.99)
- (WFM 0.95)
- (ECM 0.94)
- (RB 0.92)
- (BP 0.92)
- (CS 0.92)
- (SF 0.71)
- (IS 0.59) (IS/SBB 0.92)
- SBB (0.43) (SBB/SF 0.92)

Default Management Goal = 0.70

Index

VB – Vegetative Buffer
SB – Sediment Basin
IS – Interceptor Swale
RB – Rock Berm
CS – Compost Sock
SBB – Straw Bale Barrier
WFM – Wood Fiber Mulch
ECM – Erosion Control Mat
BP – Brush pile
SF – Silt Fence

Decision Tree-5

SLOPE (2% - 4%)

$45 < R$ Factor ≤ 130

Silt/Loam Soils

- (WFM 0.94)
- (ECM 0.91)
- (VB 0.88)
- (SB 0.79)
- (RB 0.68)
- (BP 0.68) (2BP 0.72)
- (CS 0.68) (2CS 0.72)
- (IS 0.57) (IS/SBB 0.92)
- (SF 0.56) (SF/SBB 0.72)
- (SBB 0.49) (SBB/SF 0.72)

Clay Soils

- (WFM 0.93)
- (ECM 0.89)
- (VB 0.87)
- (RB 0.86)
- (SB 0.86)
- (BP 0.86)
- (CS 0.86)
- (SF 0.83)
- (SBB 0.67) (SBB/SF 0.86)
- (IS 0.51) (IS/SBB 0.92)

Sand/Gravel Soils

If $R \le 60$, use Operational RAPPS

- (SB 0.99)
- (VB 0.99)
- (WFM 0.94)
- (RB 0.94)
- (BP 0.94)
- (CS 0.94)
- (ECM 0.91)
- (SF 0.79)
- (IS 0.60) (IS/SBB 0.95)
- (SBB 0.58) (SBB/SF 0.94)

Default Management Goal = 0.70

Index

VB – Vegetative Buffer	SBB – Straw Bale Barrier
SB – Sediment Basin	WFM – Wood Fiber Mulch
IS – Interceptor Swale	ECM – Erosion Control Mat
RB – Rock Berm	BP – Brush pile
CS – Compost Sock	SF – Silt Fence

Decision Tree-6

SLOPE (2% - 4%)

R Factor > 130

Silt/Loam Soils

If R > 175, use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.92)
- (ECM 0.87)
- (VB 0.84)
- (SB 0.79)
- (RB 0.62)
- (BP 0.62) (2BP 0.70)
- (CS 0.62) (2CS 0.70)
- IS (0.58) (IS/SBB 0.91)
- (SF 0.52) (SF/SBB 0.62)
- (SBB 0.46) (SBB/SF 0.62)

Clay Soils

If R > 400, use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.87)
- (VB 0.81)
- (SB 0.80)
- (RB 0.79)
- (BP 0.79)
- (CS 0.79)
- (SF 0.79)
- (ECM 0.76)
- (SBB 0.69) (SBB/SF 0.91)
- (IS 0.49) (IS/SBB 0.79)

Sand/Gravel Soils

If R > 500, use Supplemental RAPPS in addition to Operational RAPPS

- (VB 0.99)
- (SB 0.99)
- (BP 0.96)
- (CS 0.96)
- (RB 0.96)
- (WFM 0.87)
- (SF 0.84)
- (ECM 0.77)
- (SBB 0.69) (SBB/SF 0.96)
- (IS 0.62) (IS/SBB 0.97)

Default Management Goal = 0.70

Index

VB – Vegetative Buffer
SB – Sediment Basin
IS – Interceptor Swale
RB – Rock Berm
CS – Compost Sock
SBB – Straw Bale Barrier
WFM – Wood Fiber Mulch
ECM – Erosion Control Mat
BP – Brush pile
SF – Silt Fence

Decision Tree-7

SLOPE > 4%

R Factor ≤ 30

Silt/Loam Soils

If Slope > 25%, use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.95)
- (ECM 0.94)
- (VB 0.90)
- (SB 0.81)
- (RB 0.64)
- (BP 0.64) (2BP 0.71)
- (CS 0.64) (2CS 0.71)
- (IS 0.61) (IS/SBB 0.93)
- (SF 0.51)
- (SBB 0.38)

Clay Soils

If Slope >30% , use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.94)
- (ECM 0.93)
- (VB 0.87)
- (SB 0.86)
- (RB 0.84)
- (BP 0.84)
- (CS 0.84)
- (IS 0.53) (IS/SBB 0.91)
- (SF 0. 51)
- (SBB 0.19) (SBB/SF 0.84)

Sand/Gravel Soils

If R ≤ 30, use Operational RAPPS

- (SB 0.99)
- (VB 0.98)
- (WFM 0.95)
- (ECM 0.94)
- (RB 0.82)
- (BP 0.82)
- (CS 0.82)
- (IS 0.62) (IS/SBB 0.91)
- SF (0.38) (SF/SBB 0.82)
- (SBB 0.10) (SBB/SF 0.82)

Default Management Goal = 0.70

Index

VB – Vegetative Buffer	SBB – Straw Bale Barrier
SB – Sediment Basin	WFM – Wood Fiber Mulch
IS – Interceptor Swale	ECM – Erosion Control Mat
RB – Rock Berm	BP – Brush pile
CS – Compost Sock	SF – Silt Fence

Decision Tree-8

SLOPE > 4%

30 < R Factor ≤ 90

Silt/Loam Soils

If Slope ≥ 10%, use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.95)
- (ECM 0.93)
- (VB 0.89)
- (SB 0.80)
- (RB 0.63)
- (BP 0.63) (2BP 0.69)
- (CS 0.63) (2CS 0.69)
- (IS 0.61) (IS/SBB 0.93)
- (SF 0.54)
- (SBB 0.67) (SBB/SF 0.71)

Clay Soils

If Slope ≥12% , use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.93)
- (ECM 0.92)
- (VB 0.87)
- (RB 0.86)
- (SB 0.86)
- (BP 0.86)
- (CS 0.86)
- (SF 0.80)
- (SBB 0.63) (SBB/SF 0.86)
- (IS 0.53) (IS/SBB 0.93)

Sand/Gravel Soils

If R ≤ 40, use Operational RAPPS

- (VB 0.99)
- (SB 0.99)
- (WFM 0.95)
- (ECM 0.94)
- (RB 0.93)
- (BP 0.93)
- (CS 0.93)
- (SF 0.73)
- (IS 0.62) (IS/SBB 0.94)
- (SBB 0.46) (SBB/SF 0.93)

Default Management Goal = 0.70

Index

VB – Vegetative Buffer	SBB – Straw Bale Barrier
SB – Sediment Basin	WFM – Wood Fiber Mulch
IS – Interceptor Swale	ECM – Erosion Control Mat
RB – Rock Berm	BP – Brush pile
CS – Compost Sock	SF – Silt Fence

Decision Tree-9

SLOPE > 4%

R Factor > 90

Silt/Loam Soils

If R > 120 **OR** If R ≥ 90 AND Slope ≥7%, use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.94)
- (ECM 0.90)
- (VB 0.87)
- (SB 0.80)
- (IS 0.61) (IS/SBB 0.93)
- (RB 0.60)
- (BP 0.60)
- (CS 0.60)
- (SF 0.52) (SF/SBB 0.71)
- (SBB 0.46) (SBB/SF 0.71)

Clay Soils

If R > 300, **OR** If R ≥ 100 AND Slope ≥10%, use Supplemental RAPPS in addition to Operational RAPPS

- (WFM 0.89)
- (VB 0.86)
- (RB 0.85)
- (SB 0.85)
- (BP 0.85)
- (CS 0.85)
- (SF 0.84)
- (ECM 0.81)
- (SBB/SF 0.93)
- (IS 0.54) (IS/SBB 0.85)

Sand/Gravel Soils

If R > 375, **OR** if R ≥ 200 AND Slope ≥10%, use Supplemental RAPPS in addition to Operational RAPPS

- (VB 0.99)
- (SB 0.99)
- (RB 0.96)
- (BP 0.96)
- (CS 0.96)
- (WFM 0.9)
- (SF 0.84)
- (ECM 0.83)
- (SBB/SF 0.96)
- (IS 0.64) (IS/SBB 0.98)

Default Management Goal = 0.70

Index

VB – Vegetative Buffer	SBB – Straw Bale Barrier
SB – Sediment Basin	WFM – Wood Fiber Mulch
IS – Interceptor Swale	ECM – Erosion Control Mat
RB – Rock Berm	BP – Brush pile
CS – Compost Sock	SF – Silt Fence

APPENDIX C. EXAMPLES OF RAPPS

1) Vegetative Buffer (VB)

Description:

A vegetative buffer is a zone of established vegetation that is conserved or promoted to guard the quality of stormwater runoff. The barrier reduces the velocity of the stormwater allowing water to infiltrate the subsurface and deposit sediment from stormwater runoff. The most effective vegetative cover consists of a low-growing, herbaceous species with a high percentage of ground coverage. Due to the “umbrella effect”, shrubs and trees can provide some means of preventing erosion by shielding the underlying soil from the impact of raindrops. However, their filtering ability is much lower than that of native grasses. Therefore, vegetation should be preserved or disturbed areas should be re-vegetated.

Installation:

It is recommended that at least a 20-foot wide vegetative buffer strip in a down-gradient position from the disturbed area be used prior to and during the disturbance phase of the excavation/construction. If sodding or seeding is required, adequate lead time prior to beginning soil disturbance should be planned to establish a healthy stand of grass. This may require the installation of an irrigation system. Existing vegetation should be used wherever possible.

Limitations:

- Adequate land must be available for a vegetated buffer to prevent the loss of sediment from the site;
- Adequate vegetative cover must be maintained in the buffer to keep it effective;
- Vegetated buffers work well with sheet flow, but they are not appropriate for controlling concentrated flows of stormwater;
- When used in areas that may have concentrated flows, additional RAPPS should be used to disperse the flow and reduce velocity prior to the buffer;
- Re-establishing vegetation on compacted soils is difficult without the use of geotextiles;
- In order to remain effective, buffer widths must increase as slope steepness increases.

Maintenance Considerations:

Routine maintenance is necessary to keep the vegetation in good condition. Maintenance may include: mowing, fertilizing, and irrigating. During the establishment phase, inspection and maintenance are most important. Once established, vegetated buffers do not require maintenance beyond routine procedures and periodic inspections. Vegetative buffers should be inspected after heavy rainfall and at least once a year. Operators should focus on headward erosion, gully erosion, the density of the vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. If more than 6 inches of sediment has accumulated on the upgraded edge of the vegetative buffer, the sediment should be removed.

A 20-foot wide vegetated buffer strip between a creek and disturbed bare land.
Source: Carleton College Seven-Mile Creek Watershed Project

2) Wood Fiber Mulch (WFM)

Description:

Wood fiber mulch provides protection of the slope and encourages vegetation. Mulch comes in a variety of types and in general, is an erosion control method that utilizes local materials such as wood chips, wood fibers, hay, grass, straw, bark or a mixture of composted materials to stabilize disturbed areas. An organic binder is also available to provide extra protection from extreme rain events. Regardless, with or without an organic binder, the use of mulch will likely reduce the effects of raindrop impact and reduce suspended solids in stormwater runoff. In addition, mulch can significantly reduce wind erosion of disturbed soils especially when used in conjunction with an organic-biodegradable binder. Mulch also assists in the re-vegetation effort by adding seeds and fertilizers to the mulch binder mixture. This will prevent birds from eating the seeds, as well as providing insulation for plant roots and retaining moisture, all of which provide favorable conditions for growth of vegetation. Mulch is commonly used in locations where vegetation cannot be established quickly. Mulch is a very efficient RAPPS and is considered an immediate, readily-available and cost-effective form of erosion control.

Installation:

Numerous methods exist to place mulch on a construction site. The method of placement depends upon the type of material being used as described in Table 1.

Table 1 - Typical Mulching Materials and Application Rates

Material	Rate per acre	Requirements	Notes
Straw	1 - 2 tons	Dry, unchopped, unweathered; avoid weeds	Spread by hand or machine; must be tacked or tied down
Wood fiber or wood cellulose	½ - 1 ton	Source of water may be necessary	Use with hydroseeder; may be used to tack straw; do not use in hot, dry weather
Wood chips	5 - 6 tons	Air dry; add fertilizer "N", 12 lb/ton	Apply with blower, chip handler, or by hand; not for fine turf areas
Bark	35 yd^3	Air dry, shredded, or hammermilled, or chips	Apply with mulch blower, chip handler, or by hand; do not use asphalt tack

(Source: "EPA Stormwater Menu of BMPs" – Web-Based Guide")

Limitations: (Source: "EPA Stormwater Menu of BMPs" – Web-Based Guide")

- When used near sensitive areas (i.e. near water bodies, drainage features, etc.) mulch matting or mulch with some form of binder or netting should be used;
- Mulch must be placed at a sufficient application rate to completely cover the disturbed area but not in excess. Refer to Table 1 for the suggested application rates for appropriate coverage;
- Mulch is susceptible to erosion over time as well as in large, intense storms.

Maintenance:

Occasional maintenance is necessary to prevent erosion or deterioration of mulch. The mulches themselves are subject to erosion and may be washed away in larger storm events. Therefore, bi-weekly inspection and maintenance is suggested to ensure that mulches provide effective erosion control.

3) Roughening (RGHN)

Description:

Soil roughening is a temporary erosion control measure often used during grading/excavation activity. Tracked construction vehicles drive up and down the slope parallel to the flow of water leaving tracks or grooves that are perpendicular to the flow of water down the slope. These horizontal grooves created along the disturbed slope will reduce the runoff flow velocity. In addition, the compaction of the soil provides resistance to erosion. Slopes that are not fine-graded and left in a roughened condition can also reduce erosion. Soil roughening reduces runoff velocity, increases infiltration, reduces erosion and traps sediment.

Installation:

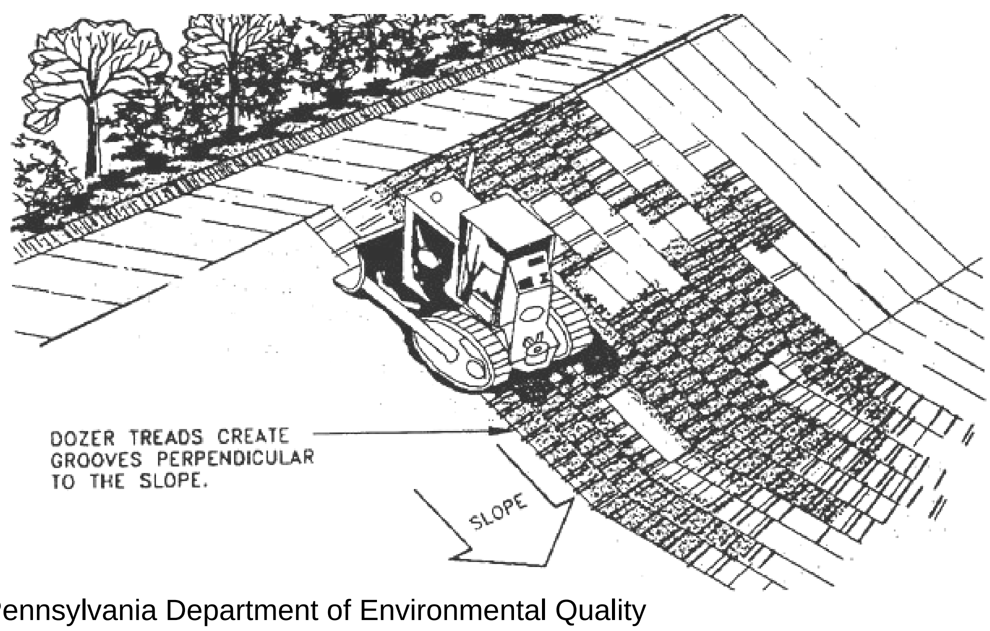
Use a tracked vehicle to drive up and down the slope with the goal of creating tracks that are parallel to the flow of runoff stormwater. The result should be “treads” that look like mini-diversion berms. Attempt to overlap the edges of each pass so as not to create ruts or channels between the tracks. Seeding often accompanies roughening as a means of establishing a more erosion resistant surface when vegetation is established. If roughening is washed away in a heavy storm event, the surface should be re-roughened and reseeded, if necessary.

Limitations:

- Soil roughening is not appropriate for rocky or sandy slopes.
- Sufficient clay content is necessary to form a hard surface under compaction.
- Tracked machinery can excessively compact the soil, creating less than favorable conditions for re-establishing vegetation.
- Typically, soil roughening is effective only for gentle or shallow depth rains.
- Since there are limits to the percent slope that can be safely navigated, strictly adhere to the safety documentation for your particular tracked vehicle.

Maintenance:

Inspect roughened areas after storm events to assess if re-roughening is needed. Regular inspections should indicate where additional erosion and sediment control measures are needed. If small gulliesrills and channels with steep sides appear, fill, re-grade, and re-seed the affected areas.



Source: Pennsylvania Department of Environmental Quality

4) Brush Piles (BP)

Description:
A brush pile is a linear structure made up of left-over material from the clearing and grubbing of a construction site. It can consist of shrubs, tree branches, cut grass, tree roots and stumps bound together by straps or netting that is tethered to the ground. The anchor provides structural integrity against the force of sediment-laden runoff water. Brush piles can be covered with jute mat, filter cloth, burlap, or geotextiles to further stabilize the structure, collect sediment, as well as, improve the filtration efficiency.

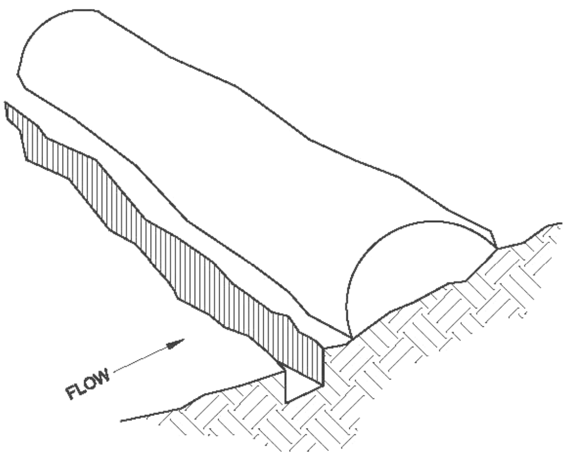
Installation:
Place the brush pile at the appropriate contour line near the base of the slope. The materials generated by clearing and grubbing activity should be placed in a linear pile along the downhill edge of the trench. The pile should be a minimum of 18 inches wide and 12 inches tall. Dig a 4-inch deep, 4-inch wide trench (minimum) along the uphill edge of the brush pile. Roll out an appropriate length of filter fabric, geotextile, coit fiber, burlap or other sturdy appropriate material. Drape the filter fabric over the brush barrier with one edge in the trench and stake it into the trench at approximately 36" spacings (on-center). Drive stakes along the downhill edge of the brush pile approximately 12 to 18 inches from the edge. Anchor the fabric by tying heavy twine from the trench stakes to the downhill stakes. Wood or steel stakes may be used, but please note, some local agencies or states specify the use of wood stakes. Therefore, inquire about the use of wood stakes with the appropriate local agency.

Limitations:
- Brush piles are not appropriate for high-velocity flow areas;
- A large amount of material is needed to construct a useful brush barrier, therefore, alternative perimeter controls such as a compost sock or silt fence may be more appropriate for sites with little material from clearing;
- Brush piles provide temporary storage for large amounts of cleared material from a site;
- Brush should be removed from the site after construction activities have ceased and the area is finally stabilized.

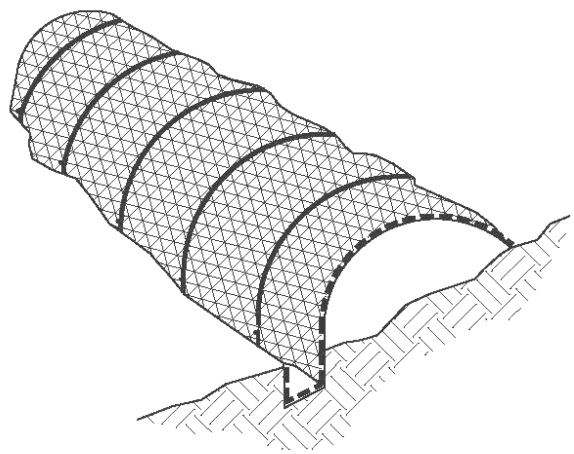
Maintenance:
Brush piles should be inspected after each significant rainfall event to ensure their continued structural integrity and collection effectiveness. If gullies or channels have formed through the void spaces, the barrier should be re-worked to eliminate the channeling. Collected sediment should be removed from the uphill side of the barrier when sediment height reaches approximately one-third of the height of the barrier. When the disturbed portion of the site has reached the final stabilization stage, the brush barrier should be removed and disposed of properly.

CONSTRUCTION OF A BRUSH BARRIER COVERED BY FILTER FABRIC

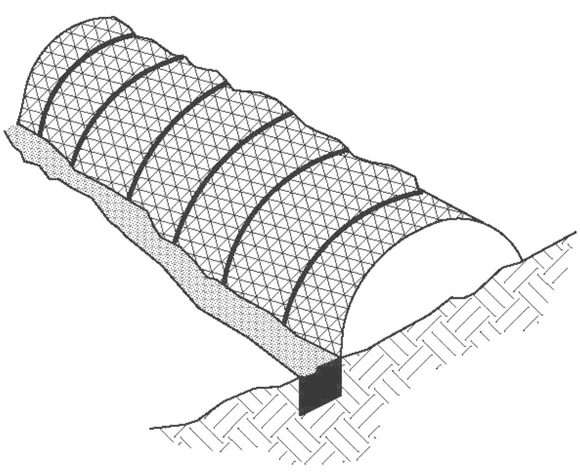
(TREE/RESIDUAL MATERIAL WITH DIAMETER >6")



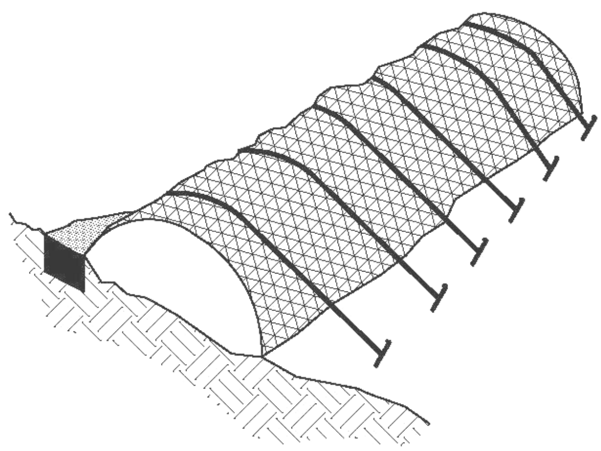
1. EXCAVATE A 4"x4" TRENCH ALONG THE UPHILL EDGE OF THE BRUSH BARRIER.



2. DRAPE FILTER FABRIC OVER THE BRUSH BARRIER AND INTO THE TRENCH WITH STAKES SET APPROXIMATELY 36" O.D.



3. BACKFILL AND COMPACT THE EXCVATED SOIL.



4. SET STAKES ALONG THE DOWN-HILL EDGE OF THE BRUSH BARRIER, AND ANCHOR BY TYING TWINE FROM THE FABRIC TO THE STAKES.

Source: Virginia Erosion and Sediment Control Handbook, 3rd Edition, 1992

5) Straw Bale Barrier (SBB)

Description:

Straw or hay bales have been used on construction sites for erosion and sediment control for many years. They are often used as check dams, inlet protection, outlet protection, and perimeter control. Many applications of straw bales for erosion and sediment control are proving ineffective due to the nature of straw bales, inappropriate placement, inadequate installation, or a combination of all three factors (Fifield, 2005). In addition, straw bales are maintenance-intensive and can be expensive to purchase. Because many applications of straw and hay bales have been ineffective, EPA and other agencies recommend that other RAPPS be carefully considered before considering the use of straw bales.

Installation:

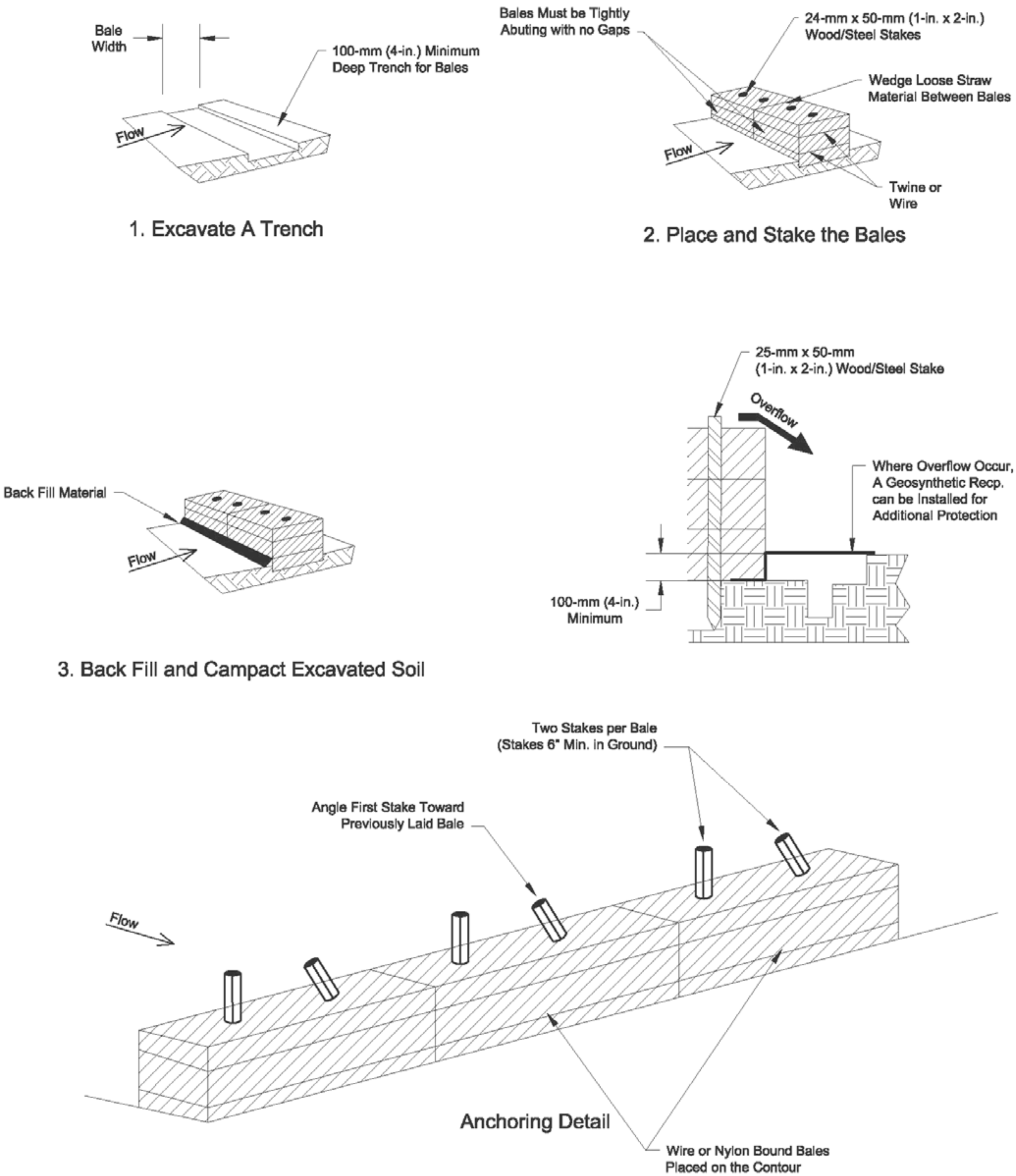
A shallow (minimum 4-inch deep) bale-sized trench should be excavated and the bales placed in them, end-to-end. The bales should be anchored with stakes (see diagram for placement). Wood or steel stakes may be used, but please note, some local agencies or states specify the use of wood stakes. Therefore, inquire about the use of wood stakes with the appropriate local agency.

Limitations:

- Straw bale installations have a high failure rate;
- Straw bale installations are seldom designed, installed, and maintained properly;
- Straw bales are difficult to transport and to carry around on-site, especially when attempting to dispose of them when they are waterlogged;
- The bindings break and the straw can wash into storm drains, causing clogging;
- Straw bales will rot and fall apart over time, especially in areas of high rainfall, and therefore require intensive maintenance; they commonly last for approximately three months;
- Straw bales will float and therefore must be properly staked even in low flow conditions;
- In high flow conditions, the water will flow around a straw bale barrier or undercut spaces between the bales;
- Straw bales may introduce undesirable non-native plants to the area if there are seeds in the bales.

Maintenance:

Straw bales degrade, and rotting bales will need to be replaced on a regular basis (as often as every 3 months depending on local conditions). Erosion from washouts around the bales will need to be repaired. Sediment that settles in ponded areas around correctly installed bales will need to be cleaned out when the sediment accumulation reaches one-third of the bale height. Straw bales will also have to be removed when they burst open or are no longer needed.



Source: NCTCOG Construction BMP Manual, 1998

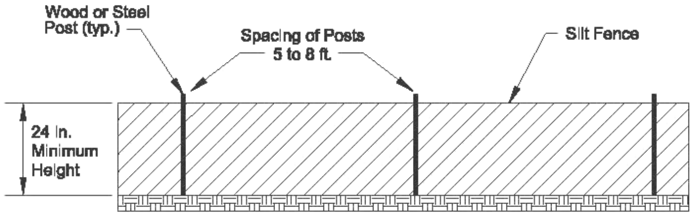
6) Silt Fence (SF)

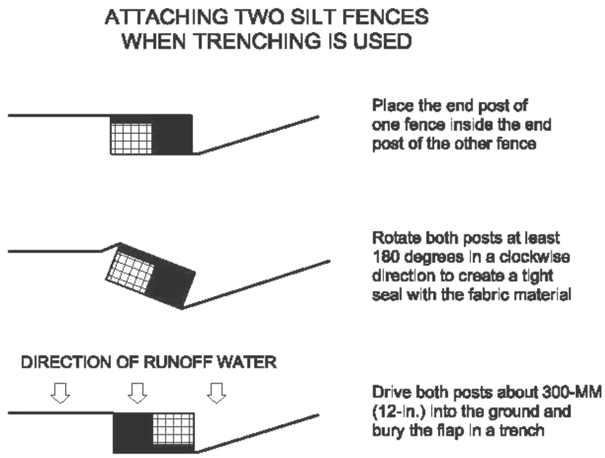
Description:
Silt fences are meant to reduce the velocity of runoff water, thereby allowing the deposition of eroded soil in an up-gradient position from the silt fence. The fence itself consists of a length of silt fence fabric mounted between anchor posts (steel posts are recommended). There are two varieties of fence including: 1) with steel wire reinforcement and 2) without reinforcement.

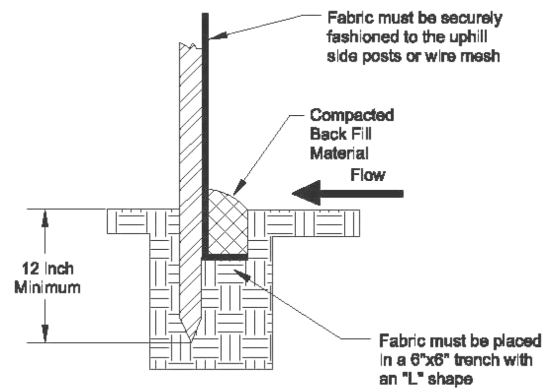
Installation:
Installation is initiated by creating a six-inch deep trench along the length of the contour line where the fence is to be placed. The posts are placed at regular intervals, which vary based upon whether or not it is reinforced fence. The generally accepted practice for each variety consists of no more than 6-foot spacing for silt fence without reinforcement and no more than 10-foot spacing for extra strength wire reinforced fencing. The fence post should be driven to 16 to 24 inches above the ground surface and the length of the post varies with the strength of the post material used. Steel stakes should be at least one pound per linear foot of length, and driven at least one third their height into the ground. When hard wood stakes (like oak) are used, they should be a minimum of 2-inch diameter. When soft wooden stakes are used, a larger diameter should be specified (some documents recommend minimum 4-inch diameter and 5 foot length). Drive the stakes along, but just downhill of, the 6-inch deep trench. Stretch the silt fence across the posts leaving no gaps between new portions of fence. When a new roll must be started or ended, secure both ends to the same post. Bury the bottom tail of the fence in the 6-inch deep trench and backfill the trench with the material excavated from the trench.

Limitations:
- Installing silt fences along rocky areas or other hard surfaces will prevent uniform anchoring of the fence posts and entrenching the silt fence fabric;
- Silt fences are not suitable for areas where large amounts of concentrated runoff are likely;
- The fence can be overloaded and bend under the pressure created by concentrated stormwater flows;
- Open, windy areas present a problem because high winds can rapidly deteriorate the silt fence.

Maintenance:
Inspect silt fences regularly and frequently, no less than every two weeks and after each rainfall event to make sure that they are intact and that there are no gaps where the fence meets the ground or tears along the length of the fence. If you find gaps or tears, repair or replace that section of fabric immediately. Remove the collected sediment from the base of the silt fence when the sediment reaches one-third the height of the fence. Remove sediment more frequently if the collected sediment is creating obvious strain on the fabric and the fence might fail from an intense storm event. When the silt fence is removed, the collected sediment should be removed as well.







Source: NCTCOG Integrated Storm Water Managment (iSWM) manual, 2003

Properly installed silt fence along a disturbed slope. Note the use of vegetated buffer and the tight spacing of posts.

Source: EPA Storm Water - Menu of BMPs, 2004

7) Rock Berm (RB)

Description:

Rock berms are meant to reduce the velocity of runoff water, thereby allowing the deposition of eroded soil. The berm itself consists of a length of large diameter rocks placed in a linear pile either held in place by gravity or by gabion/chain link fencing. Therefore, there are two varieties of rock berm including: 1) rock berms without wire reinforcement, and 2) rock berms with wire reinforcement. Either variety can be wrapped in filter fabric to add to the filtration capacity of the berm.

Installation:

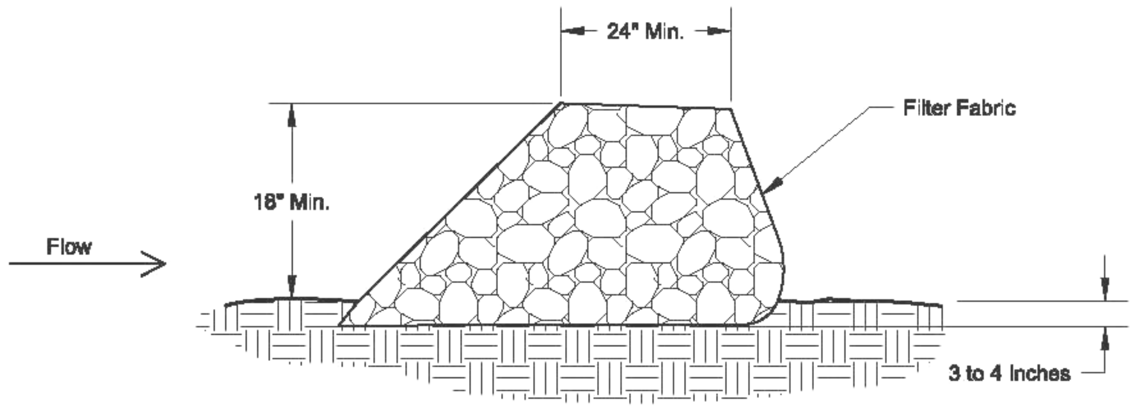
Installation is initiated by creating a three to four-inch deep trench along the length of the contour line where the fence is to be placed. The generally accepted minimum rock diameter is four-inches. The minimum width of the berm top (peak) dimension is 24 inches, the minimum width of the base must be wider than the peak but is limited by the natural slope the rock forms when piled up. Therefore, the minimum width of the trench is 36 inches. If fabric is to be used, line the trench with the filter fabric, leaving enough of the fabric out of the trench to cover or wrap the berm's uphill side. If enough fabric was used to wrap the entire circumference of the berm, then secure the loose end directly to the ground by staking it to the ground. If only the front side was covered, then pull the fabric tight and tether the edges to stakes. The stakes should be placed on the downhill side of the berm and stake spacing should be a maximum of one every 6 to 8 feet.

Limitations:

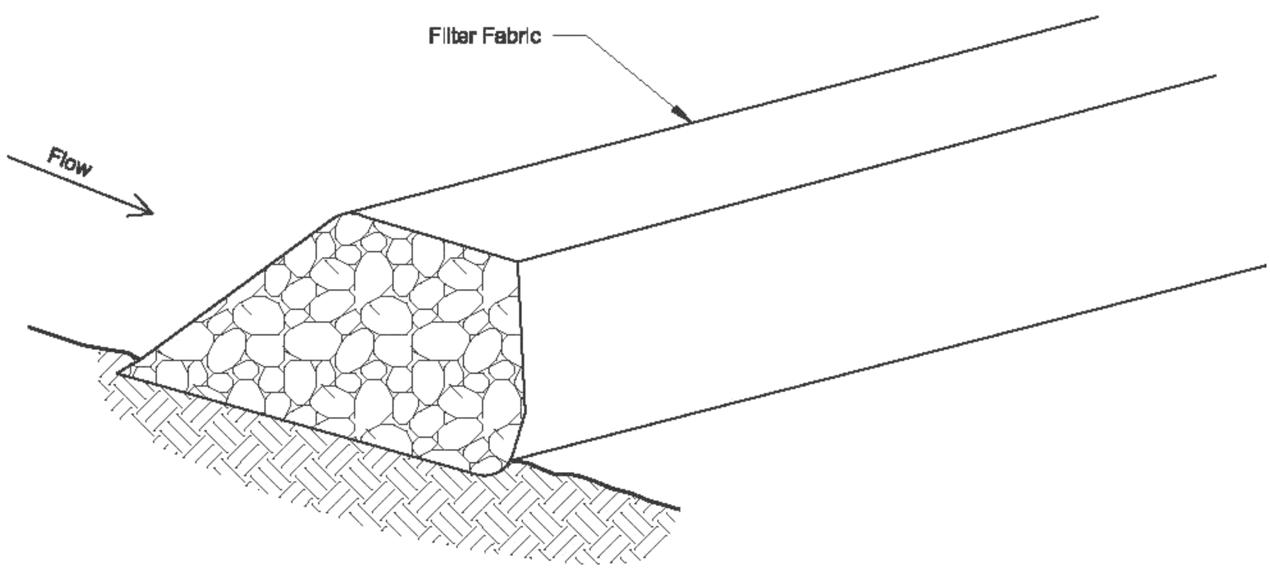
- Installing rock berms along rocky areas or other hard, uneven surfaces will prevent uniform "seating" of the rock berm base and it becomes difficult to tether the fabric;
- Rock berms are not suitable for areas where large amounts of concentrated runoff are likely, due to the high probability of under-cutting or over-topping of the berm;
- The berm can be overloaded and re-direct stormwater flows around the structure.

Maintenance:

Inspect rock berms regularly and frequently, no less than every month, as well as after each rainfall event, to make sure that berm has not been breached or undercut. If you find erosion or break-throughs, repair or replace that section of the berm or the base under the berm immediately. Remove the collected sediment from the base of the rock berm when the sediment reaches one-third the height of the berm. Remove sediment more frequently if the collected sediment is creating a ramp of silt and the runoff can over-top the berm. When the rock berm is removed (the fabric, posts & stone) the collected sediment should be removed as well.



Cross Section



Isometric Plan View

Source: NCTCOG Construction BMP Manual, 1998

8) Diversion Dikes: (DD)

Description:

A diversion dike is a berm usually consisting of a compacted earth or base material dike constructed along the perimeter or prior to a disturbed area of a construction site. It is often accompanied by a vegetated ditch or swale, at the top or base of a sloping disturbed area. Depending on its location and the topography of the landscape, a diversion dike can achieve significant re-direction of stormwater. When installed on the up-gradient side of a site, diversion dikes help to prevent stormwater runoff from entering the disturbed portion of a construction site. It can reduce the total amount of sheet flow runoff traveling across the disturbed area and thereby lessen erosion on the site. Diversion dikes can also be located on the down-gradient side of a site. In this case they would be used to divert sediment-laden runoff generated from the disturbed area to onsite sediment-trapping devices, preventing soil loss from the disturbed area.

Installation:

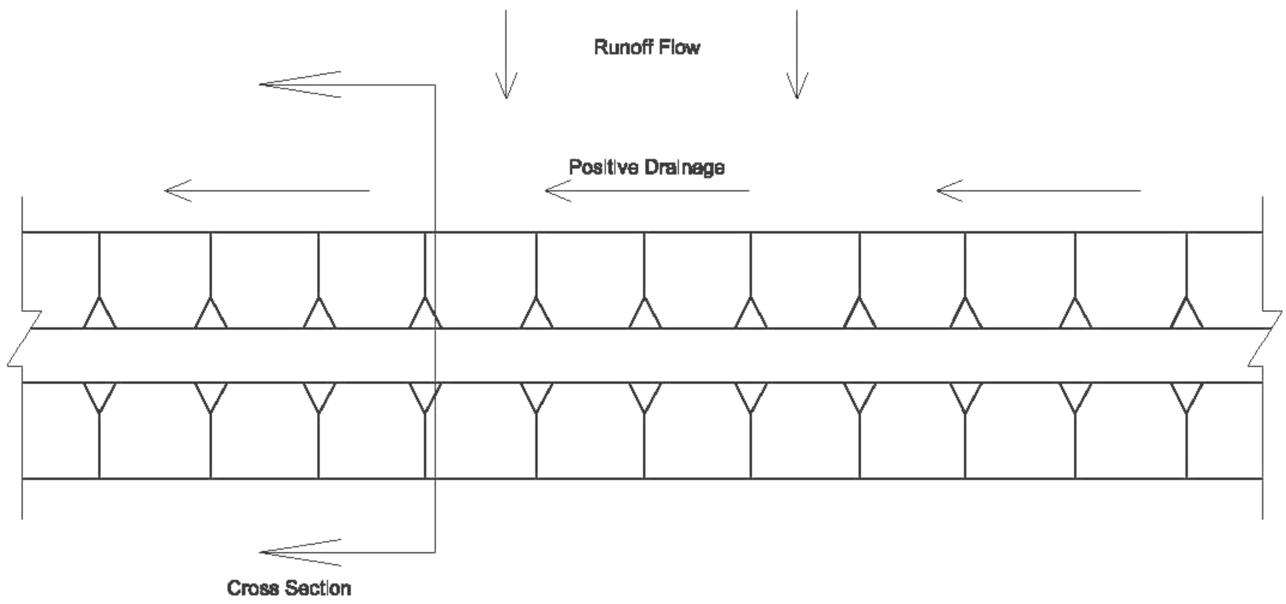
Determine the appropriate contour line for the berm to follow so as not to deflect the water more than 30 degrees at a time. Then place and compact some of the excavated native material along the contour line forming a minimum two-foot wide base berm. Placement of silt fences or small stone check dams approximately ten feet prior to deflecting water may help conserve the structural integrity of the dike. Direct diversion dike runoff to sediment-trapping devices, where sediment can settle out of the runoff before it is discharged. Sediment-trapping devices that work with temporary diversion structures include sediment basins, sediment chambers/filters, filter bags, traps, swales and any other structures designed to allow sediment to be collected for proper disposal.

Limitations:

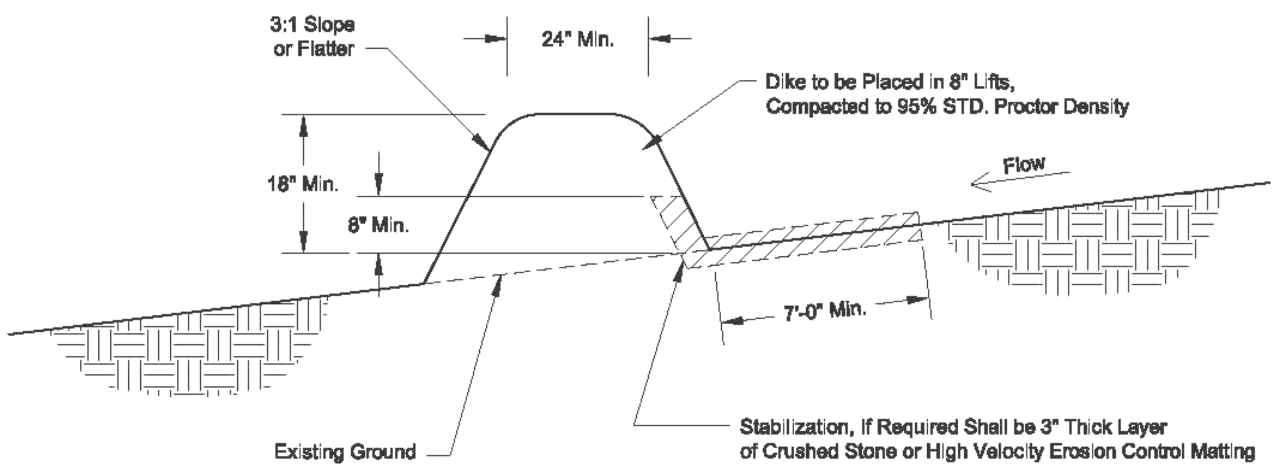
- Transforms sheet flow runoff into concentrated flow, which has a higher erosion potential than sheet flow.

Maintenance:

Inspect earthen diversion dikes after each rainfall to ensure continued effectiveness. Maintain dikes at their original height. Repair any decrease in height due to settling or erosion immediately. To remain effective, earth dikes must be compacted at all times. Regardless of rainfall frequency, inspect dikes at least once every 2 weeks for evidence of erosion or deterioration.



Plan View



Cross Section

Source: NCTCOG Integrated Storm Water Management (iSWM) Manual, 2003

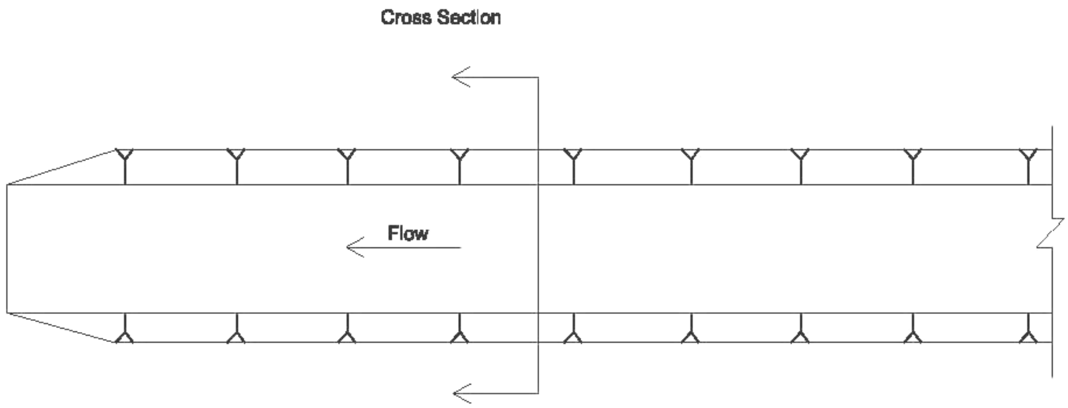
9) Interceptor Swale (IS)

Description:
An interceptor swale is typically a v-shaped water collection channel that controls the direction of runoff. This control measure can be used to divert "clean" runoff away from a disturbed area or it can capture sediment laden runoff to a sediment pond or other sediment filtration measure or sediment-removing RAPPS. These swales are typically lined with native grasses, erosion control matting or compacted base.

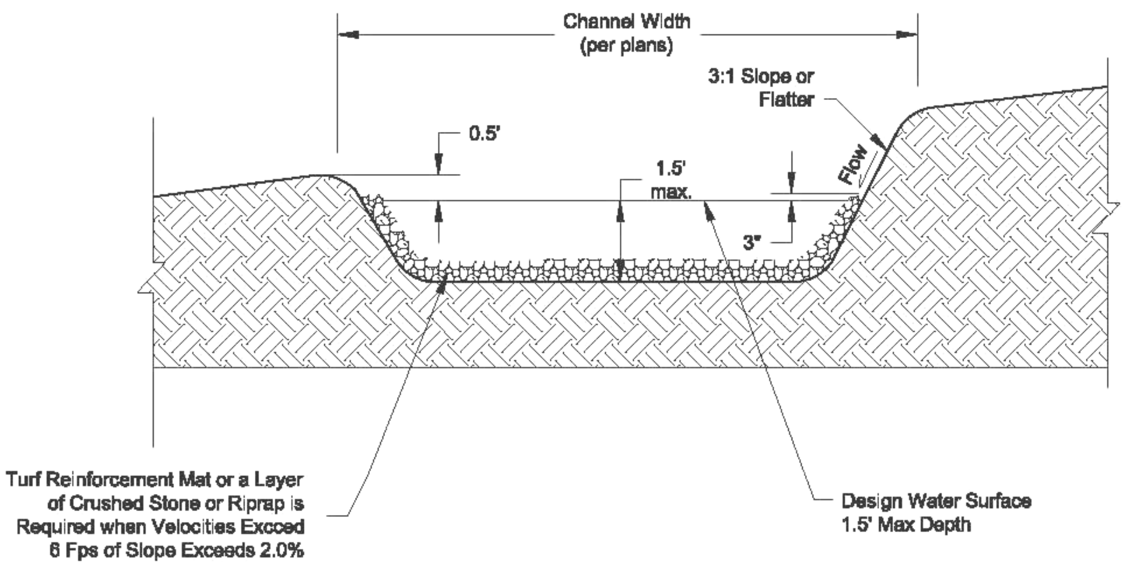
Installation:
The swale can be excavated by tilting the blade of the excavator to a sharp angle and dragging the angled blade through the path designed for the swale. The excavator should plan ahead to insure the appropriate (shallow) elevation change from start of the swale to the end of the swale. Please see the drawing below and adjust for site conditions.

Limitations:
- Transforms sheet flow runoff into concentrated flow;
- May not be suitable for site conditions on the slope (either too steep or too shallow);
- Must be stabilized quickly or the swale will contribute to erosion, by shedding it's soil lining;
- May not be suitable for slopes greater than 5%.

Maintenance:
It is recommended that the swale be inspected at least every two weeks or after every rainfall event of 0.5 inches or more. Locate and repair erosion or other damage to the channel. Clear collected sediment and debris to prevent diminished capacity and to prevent discharge of collected material.



Plan View



Cross Section

Source: NCTCOG Integrated Storm Water Management (iSWM) Manual, 2003

10) Erosion Control Mat/Geotextiles (ECM)

Description:

Erosion control mats and geotextiles are porous fabrics also known as filter fabrics, jute yarn, synthetic fabrics, construction fabrics, or simply fabrics. Mulch mattings are jute or other wood fibers that have been formed into sheets and are more stable than normal mulch. Netting is typically made from jute, wood fiber, plastic, paper, or cotton and can be used to hold the mulching and seeds to the ground. Netting can also be used alone to stabilize soils while the plants are growing; however, it does not retain moisture or temperature well. Mulch binders (either asphalt or synthetic) are sometimes used instead of netting to hold loose mulches together. Geotextiles can aid in plant growth by holding seeds, fertilizers, and topsoil in place.

Installation:

Generally, erosion control mats will come with a set of manufacturer specific instructions, and the general principals of installation are listed below. Bury the top of the ECM in a six-inch deep trench and roll the ECM down the slope, instead of across the slope. Overlap the edges of each roll of ECM and staple or anchor the edges of the ECM. Seed and fertilize the ECM itself or the disturbed area prior to covering the slope.

Limitations:

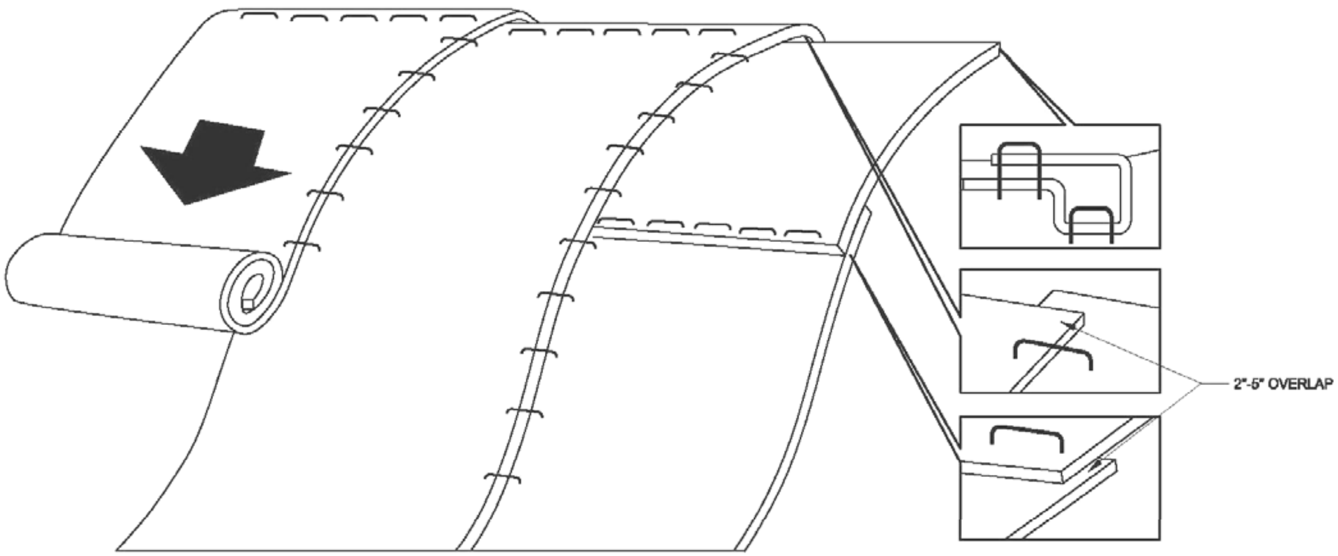
- Geotextiles (primarily synthetic types) have the potential disadvantage of disintegrating when exposed to light;
- Some geotextiles might increase runoff or blow away if not firmly anchored;
- Depending on the type of material used, geotextiles might need to be disposed of in a landfill, making them less desirable than vegetative stabilization;
- If the geotextile fabric is not properly selected, designed, or installed, its effectiveness may be reduced drastically;
- More expensive than most non-chemical forms of erosion control.

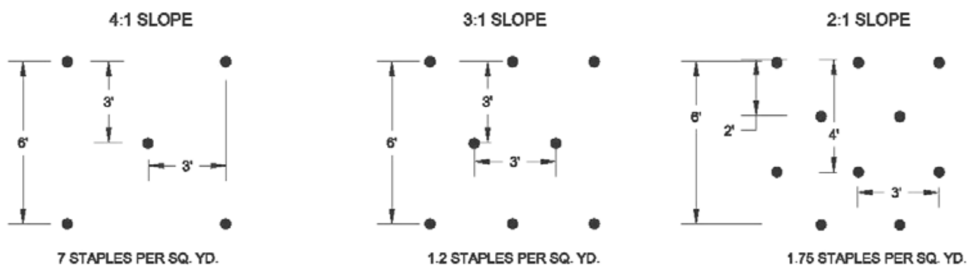
Maintenance

Inspect geotextiles at least monthly to determine if cracks, tears, or breaches have formed in the fabric; if so, repair or replace the damaged portion of fabric immediately. It is necessary to maintain contact between the ground and the mat at all times. Remove trapped sediment as it is discovered.

NOTES:
HERE ARE A FEW BRIEF BASICS COMMON TO ALL SUCESSFUL BLANKET AND MAT INSTALLATIONS:

1. PREPARE THE SEEDBED BY RAKING, SEEDING AND FERTILIZING.
2. USE TRENCHING AND ANCHORING PROCEDURES TO SECURE ANY EXPOSED MATERIAL ENDS.
3. KEEP MATERIAL IN SOLID CONTACT WITH THE GROUND.
4. USE THE REQUIRED NUMBER OF STAPLES.
5. SECURE ALL PRODUCT OVERLAPS.
6. IN SLOPE AND CHANNEL APPLICATIONS, OVERLAP MATERIAL IN THE DIRECTION OF WATER FLOW.





Source: North American Green Erosion Control, 2006

10) Fiber Rolls/Logs (FR)

Description:

Fiber rolls (also called Excelsior logs, fiber logs or straw wattles) are tube-shaped erosion-control devices filled with straw, flax, rice, coconut fiber material, or composted material. Each roll is wrapped with a UV-degradable polypropylene netting for longevity or with 100 percent biodegradable materials like burlap, jute, or coir. Fiber rolls complement permanent best management practices used for source control and re-vegetation. Fiber rolls also help to slow, filter, and spread overland flows.

Installation:

On slopes, install fiber rolls along the contour with a slight downward angle at the end of each row to prevent ponding at the midsection (California Straw Works, 2005). Turn the ends of each fiber roll up-gradient to prevent runoff from flowing around the roll. Install fiber rolls in shallow trenches dug 3 to 5 inches deep for soft, loamy soils and 2 to 3 inches deep for hard, rocky soils. Determine the vertical spacing for slope installations on the basis of the slope gradient and soil type. According to a manufacturer of this type of erosion control measure, a good rule of thumb is as follows:

1:1 slopes = 10 feet apart

2:1 slopes = 20 feet apart

3:1 slopes = 30 feet apart

4:1 slopes = 40 feet apart

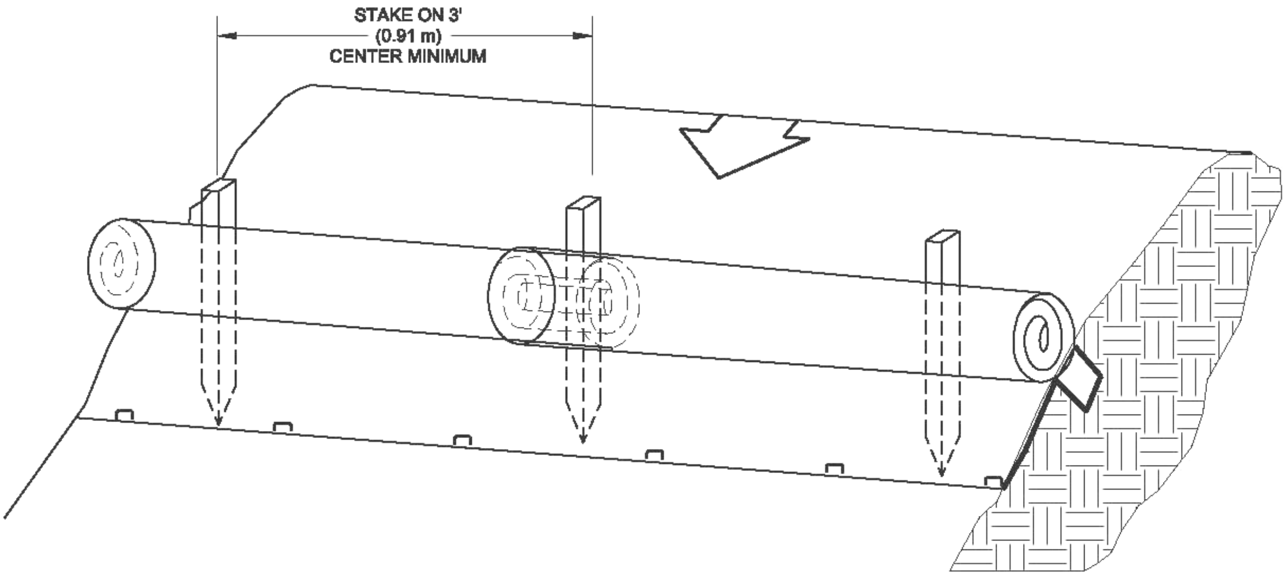
For soft, loamy soils, place the rows closer together. For hard, rocky soils, place the rows farther apart. Stake fiber rolls securely into the ground and orient them perpendicular to the slope. Biodegradable wood stakes or willow cuttings are recommended. Drive the stakes through the middle of the fiber roll and deep enough into the ground to anchor the roll in place. About 3 to 5 inches of the stake should stick out above the roll, and the stakes should be spaced 3 to 4 feet apart. A 24-inch stake is recommended for use on soft, loamy soils. An 18-inch stake is recommended for use on hard, rocky soils.

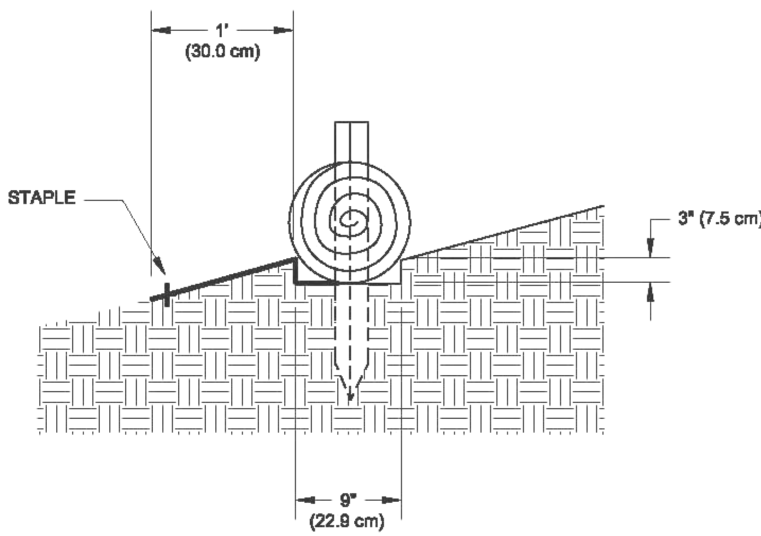
Limitations:

- Fiber rolls are not effective unless entrenched and properly staked, because fiber rolls can be transported by high flows;
- Fiber rolls can be difficult to move once saturated;
- To be effective, fiber rolls at the toe of slopes greater than 5:1 must be at least 20 inches in diameter;
- Fiber rolls have a limited sediment capture zone;
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.

Maintenance:

Bi-weekly inspection is recommended to ensure that the rolls remain firmly anchored in place and are not crushed or damaged by traffic. Monitor fiber rolls daily during prolonged rain events. Repair or replace split, torn, unraveled, or slumping fiber rolls. Fiber rolls are typically left in place on slopes. If they are removed, collect and dispose of the accumulated sediment.





Source: North American Green Erosion Control, 2006

Fiber rolls along a newly-vegetated hillside. Note the disturbed slope at the top of the hill
Source: EPA Storm Water.Menu of BMPs, 2004

11) Compost Sock (CS)

Description:
A compost sock is a type of compost filter berm that is enclosed in a netting or filter fabric tube, so as to prevent the loss of compost filling and collected sediment. It is a mesh tube filled with composted material that is anchored to the ground perpendicular to the direction of runoff to retain sediment from disturbed areas. The filter sock can be used in place of a traditional erosion control barrier such as a silt fence or straw bale barrier. They should be placed either at the edge of downhill slopes or at intervals along the slope to reduce the velocity and retain sediment. Composts in the sock are generally composed of various organic materials including: manure, yard wastes, wood wastes, and even other bio-degradable wastes.

Installation:
Compost socks are typically assembled in-the-field by tying a knot in one end of the sock and filling the sock with the composted material. Longer socks are usually filled by using a pneumatic blower. The other end of the sock is knotted shut after the appropriate length is reached. A filter sock the length of the slope is normally used to ensure that runoff does not pass through at the intersection of socks placed end-to-end. If this is not possible, the socks are placed end-to-end along a slope and the ends are anchored together. Wooden stakes may be used to anchor the sock at a post spacing at a maximum of ten feet, and driven into the ground at least six inches. Stakes should have a minimum diameter of 2 inches and the sock should be tied to the stakes rather than driving the stake through the sock itself.

Limitations:

- If punctured, the compost can “leak out”, thereby, contributing to the transportation of sediment;
- The sock will act as a filter and actually collect soil from the runoff. If not regularly cleaned, it can clog or deposit a “ramp” of soil causing runoff to go over the top of or around the sock.

Maintenance:
Regular inspections are required to insure that the socks are anchored firmly and that there is no “breakthrough” of stormwater under or between socks. Inspections should occur at a minimum of every two weeks and after each rainfall event of over 0.1 inches.

Compost Socks staked in place along a storm water swale.
Source: Ohio Department of Transportation, 2008

12) Sediment Basin (SB)

Description:

Sediement basins (also known as a rock dam or rock dam pond) can be used to capture sediment from stormwater runoff before it leaves a construction site. They allow a pool to form in an excavated or natural depression, where sediment can settle. The pool is dewatered through a single riser and drainage hole leading to a suitable outlet on the downstream side of the embankment or through the gravel of the rock dam. The water is released by the pipe more slowly than it would be without a control structure.

Installation:

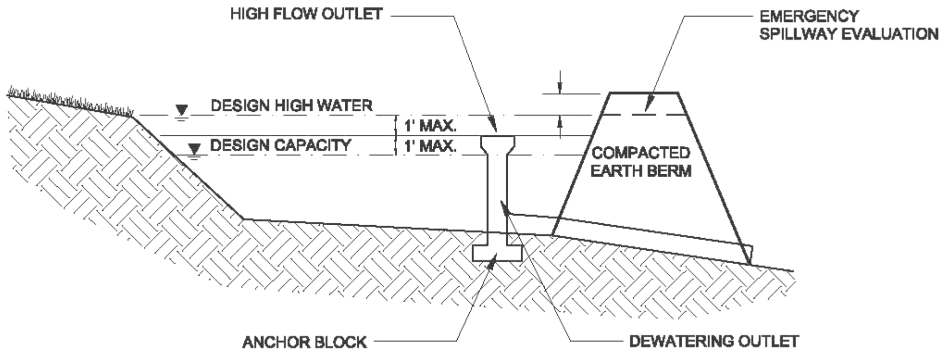
It is impossible to provide a one-size fits all design approach in this manual. Preferably a civil engineer or a certified erosion and sediment control professional should be retained to design the basin. In general, a sediment basin is constructed by excavation or by erecting an earthen embankment across a low area or drainage swale. The basin can be temporary or permanent. Some sediment basins are designed to drain completely during dry periods. Others are constructed so that a shallow pool of water remains between storm events.

Limitations:

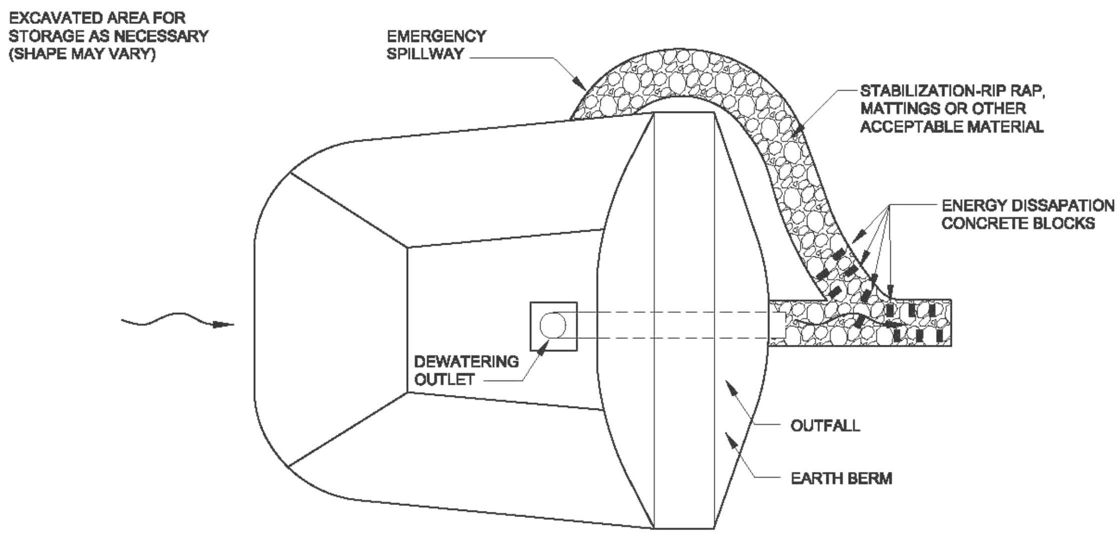
- A sediment basin with an earthen embankment or a rock dam should not be used in an area of continuously running water (live streams);
- A sediment basin is not recommended in an area where failure of the earthen or rock dam will result in loss of life or damage to homes, buildings, utilities or roads;
- The expense related to the design and construction of a sediment basin may be high compared to other erosion control measures.

Maintenance:

Routine inspection and maintenance of sediment basins is essential to their continued effectiveness. Inspect basins after each storm event and bi-weekly to ensure proper drainage from the collection pool and the need for structural repairs. Replace material eroded from earthen embankments or stones moved from rock dams as soon as discovered. Locate sediment basins in an area that is easily accessible to maintenance crews for the removal of accumulated sediment. Dewater and remove sediment from the basin when the storage capacity has reached approximately 50 percent. Remove collected trash and large debris from around dewatering devices promptly after rainfall events.



CROSS SECTION



PLAN VIEW

Source: NCTCOG Integrated Storm Water Managment (iSWM) Manual, 2003

APPENDIX D. EXAMPLES OF SPECIALTY RAPPS

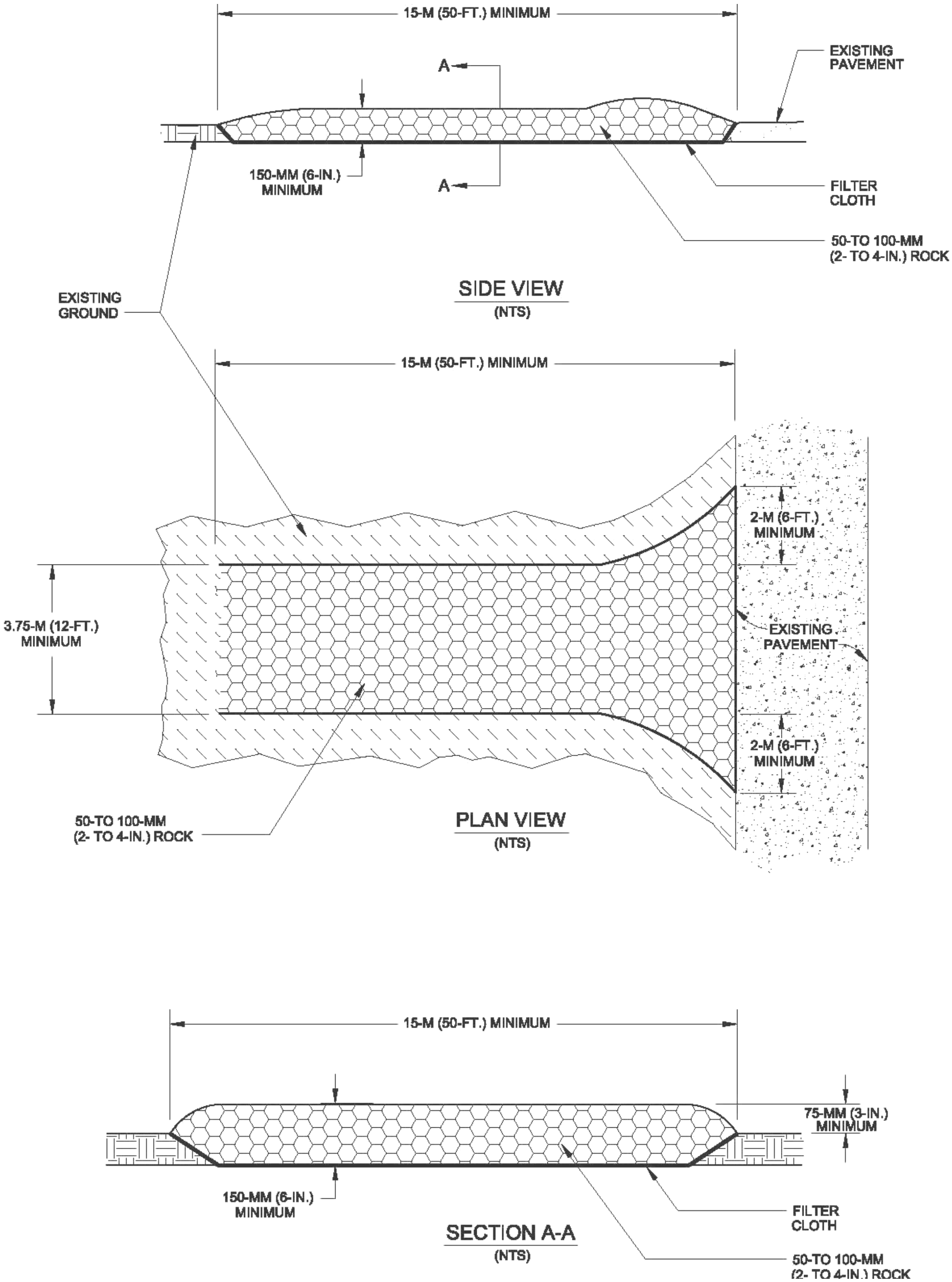
1) Stabilized Construction Entrance: (SCE)

Description:
Stabilized construction entrances limit the amount of tracked materials (mud and dust) from leaving the construction site. Mud and sediment are removed from vehicle tires when leaving the site as tires pass over rock pad. A “cattle-guard” grate or similar structure may be added to further remove mud from the tires. In addition, a wheel wash area may be added to clean tires and drain runoff to a dewatering pit or a filter bag.

Installation:
Install SCE at entrances/exits to paved roads and place geotextile filter fabric under medium to large diameter crushed rock. The length and width of the entrance should be adequate to allow large vehicles to access site. See drawing below and adjust to site conditions.

Limitations:
- Less effective with increased rain and mud;
- Additional sweeping of paved road will be necessary;
- Removal necessary after completion of construction;
- Availability of rock.

Maintenance:
A stone construction entrance must be regularly inspected after each 0.5-inch rainfall event to determine if the mud and silt collected has covered the stone surface of entrance. When the aggregate is clogged with sediment, the SCE should be replaced or washed down into a sediment collecting structure. If ponding occurs in low areas of the pad, the stone should be replaced.



Source: Best Management Practices for Contractors and Inspectors, Fifield, 2005

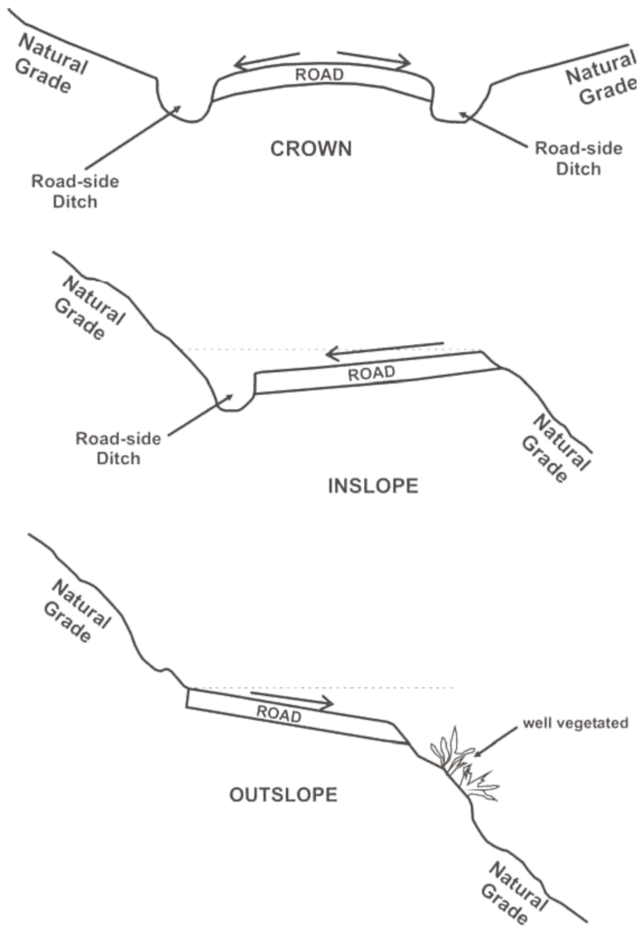
2) Road Surface Slope (RDSS):

Description:
This technique requires sloping the road surfaces toward constructed channels parallel to the roads. The ditches convey concentrated runoff of surface water from roads and surrounding areas to a stabilized area.

Installation:
Slope the road toward channels parallel to the road. Excavate channel along the roadside to a width and depth that can convey expected flows. Slope the ditches so that water velocities do not cause excessive erosion. Shape and level ditches removing excess spoil so water can flow. Vegetate or line ditches with material to prevent erosion

Limitations:
- Erosion occurs from the road surface or road side ditch, causing potholes;
- Road surface slopes do not necessarily filter sediment from runoff

Maintenance:
Monthly inspections should be conducted to prevent depressions or erosion of the crown or slope. If the road base has collapsed or washed-out, the surface will form potholes and depressions. Repair the road and base in the affected section as soon as practicable after discovery.



Source: Modified from RAPPS Version 1.0, IPAA, 2004

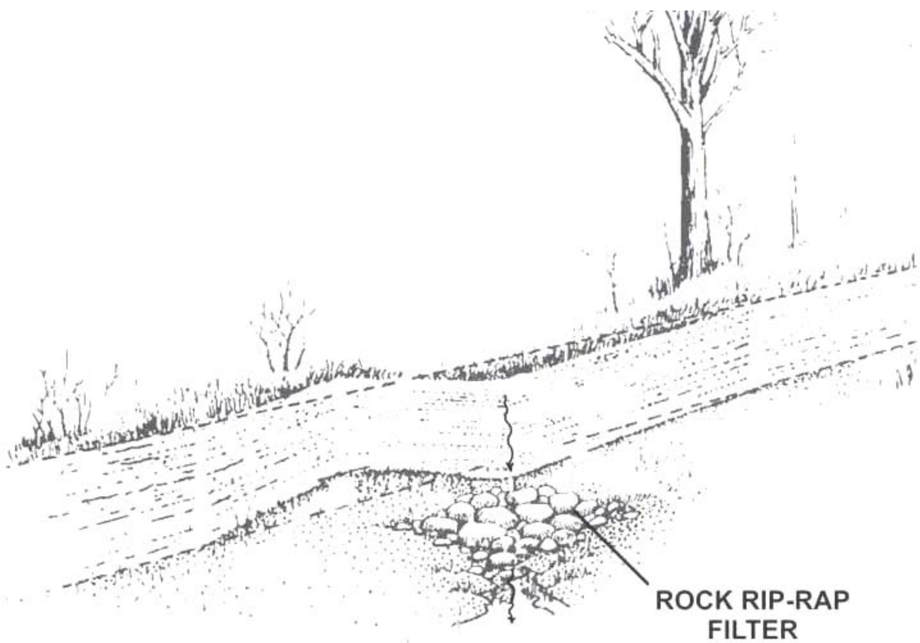
3) Drainage Dips: (DIP)

<u>Description:</u>
A drainage dip is an intentional depression in the roadway, usually consisting of a compacted earth or base material "swale" that drains water from the roadway instead of allowing it to puddle and erode the surface of the road. It will typically drain to a roadside ditch.

<u>Installation:</u>
During road grading provide a small grade change over a 10-foot stretch of roadway and then grade the next 10-foot section of roadway back to the original elevation, causing a dip over 20 linear feet. The dip should be angled to one or both edges of the road, but with medium-sized rip-rap placed at the edge of the road, thereby providing some erosion protection for the road's base.

<u>Limitations:</u>
- Generates point source of runoff water from the road surface.

<u>Maintenance:</u>
Inspect after each rainfall and re-compact the roadbase as needed.



PLAN VIEW
N.T.S.

Source: Modified from RAPPS Version 1.0, IPAA, 2004

4) Road-Side Ditches: (RDSD)

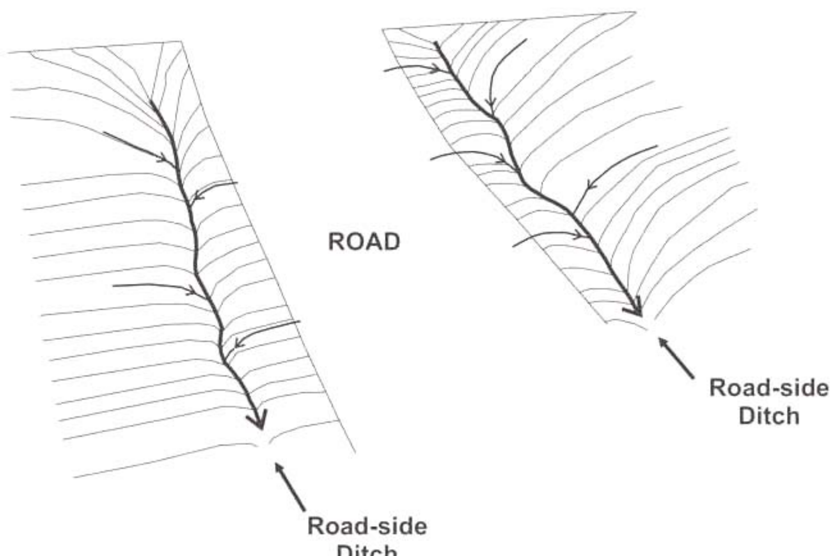
Description:
This technique requires constructing channels parallel to roads. The ditches convey concentrated runoff of surface water from roads and surrounding areas to a stabilized area.

Installation:
Excavate a channel along the roadside to a width and depth that can handle expected flows. Slope channels so that water velocities do not cause excessive erosion. Shape, level and line the channel, with rip-rap, erosion control mat or vegetation to prevent erosion.

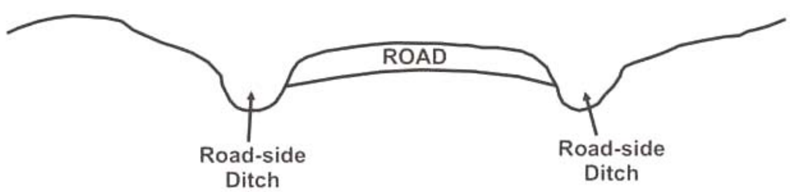
Limitations:

- Erosion occurs within channel;
- Channel does not necessarily filter sediment from runoff.

Maintenance:
Inspect after each rainfall greater than 0.5 inches in order to assure the stability of the roadbase.



PLAN VIEW
N.T.S.



CROSS-SECTION
N.T.S.

Source: Modified from RAPPS Version 1.0, IPAA, 2004

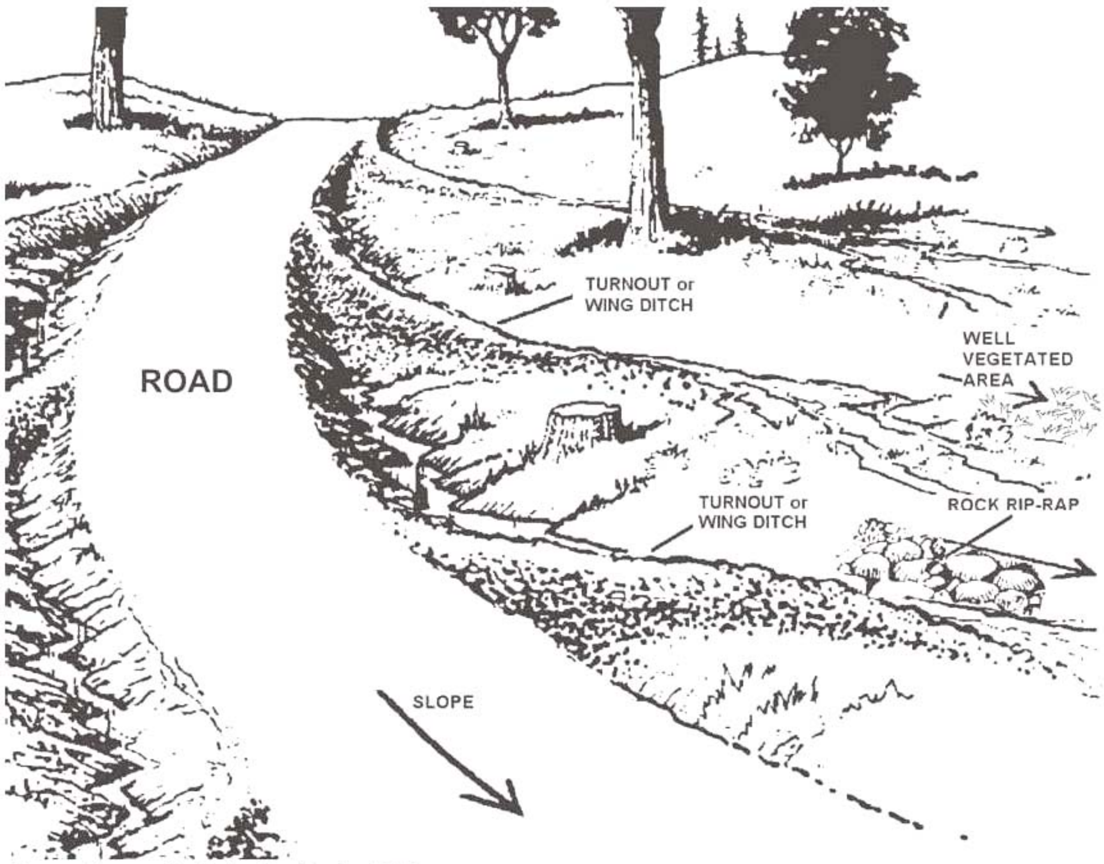
5) Turnouts or Wing Ditches: (TO)

Description:
These structures are extensions of road-side ditches and will effectively remove run-off water from the ditch into well-stabilized areas.

Installation:
Slope the turnout gradually down from the bottom of the road ditch and angle the turnout at approximately 30° to the road ditch. Discharge the turnout into a well-vegetated area or install a form of secondary control such as rock filter or straw bales. Space the turnouts according to slope.

Limitations:
- Gradual slopes only;
- Require vegetative cover or other filter at discharge point.

Maintenance:
Inspect after each rainfall greater than 0.5 inches in order to assure the stability of the turnout.



Source: Cooperative Extension Service, 2002.

6) Cross Drain Culverts: (CULV)

Description:

This technique can be used to direct road-side ditch flow across a road or may be used to direct stream flow under a road or construction area. Culverts passing construction sites will allow for continued flow of stream with minimal siltation.

Installation:

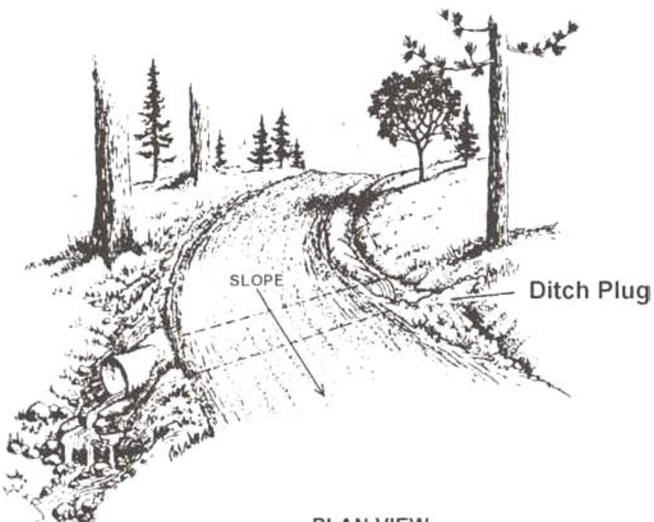
Culverts may be steel, aluminum, or concrete and should be placed at surface grades to allow normal low-flow water to be conveyed. Soil or road base should be compacted over culverts to a minimum of 12 inches. Culvert size should be adequate to convey anticipated flow. A ditch plug will be required within the road-side ditch to direct water into the culvert. The culvert grade change should be adequate to convey expected flow rates. Increase the frequency of culverts with increased slope. Rock rip-rap is commonly required at the outlet of the culvert.

Limitations:

- Culverts may become clogged;
- Culverts are not a sediment filters and will likely transport silt;
- Some silt may collect at the entrance of the culvert only to be transported subsequent rain events.

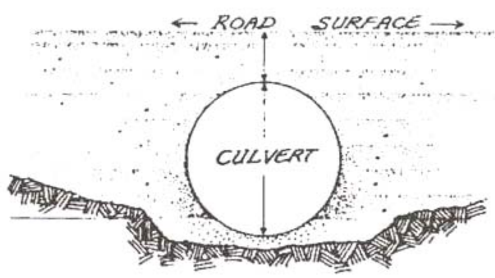
Maintenance:

Inspect the road base after each rainfall event greater than 0.5 inches to insure that it has not been eroded. Replace the eroded material as soon as practical.



PLAN VIEW
N.T.S.

Source: Cooperative Extension Service, 2002.



CROSS SECTION
N.T.S.

Source: Cooperative Extension Service, 2002.

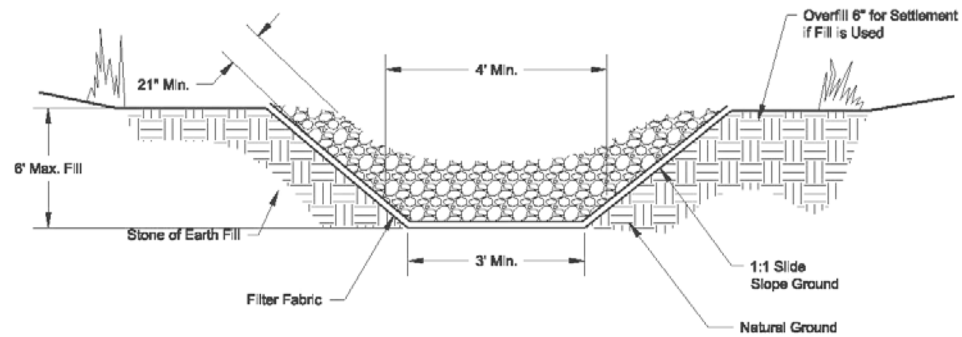
7) Sediment Traps: (ST)

Description:
This technique uses a basin or pond to hold sediment-laden water so that sediment can settle and water is absorbed into the soil. Sediment traps are useful for construction sites where excessive runoff will need to be captured and filtered and other RAPPS are insufficient.

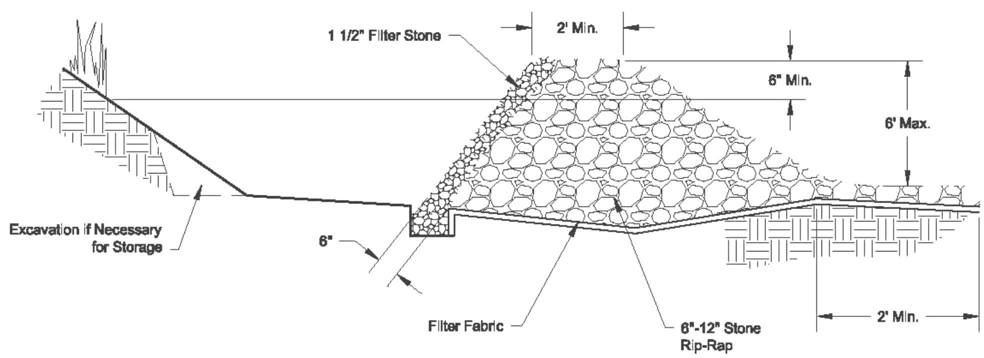
Installation:
Excavate the sediment trap or basin within an area where runoff may be easily directed. The side slopes should be 2:1 or flatter and machine compacted. The volume of the sediment trap should have a minimum 2-year storm event capacity and allow for water infiltration. Construct a spillway or outfall structure with rock rip-rap at the outlet.

Limitations:
- Not for use in rocky situations;
- Overflow can result during large rainfall events;
- Water will remain in the sediment trap for extended periods.

Maintenance:
Inspect bi-weekly or after each rainfall event of 0.5 inches or more. Remove sediment when it reaches 50% capacity.



View Looking Upstream



Section

Source: NCTCOG Integrated Storm Water Management (iSWM) Manual, 2003

8) Construction Mats: (CM)

Description:
This technique spreads the weight of construction equipment over a broad area to help prevent soil compaction and soil exposure.

Installation:
Mats are constructed of large timber fitted, tied or bolted together. Mats are placed ahead of, or under operating equipment to provide a stable work area.

Limitations:
- Useful on wet, soggy, and/or inundated soils;
- Mats are bulky and difficult to move;
- Does not filter sediment from runoff.

Maintenance:
Damage to the mat may occur due to heavy traffic and should be inspected once per month for damage.

Source: Carolina Mat Incorporated, 2008

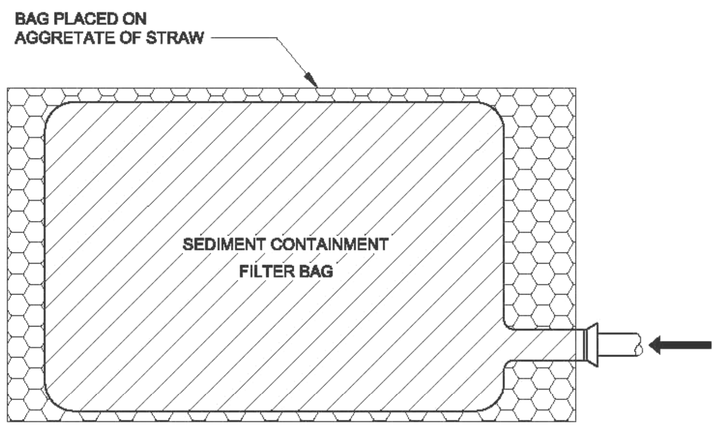
9) Filter Bags: (FB)

Description:
A filter bag is an outlet structure from a sediment laden pond or trap, usually connected to a floating pump or as an exit to a drain.

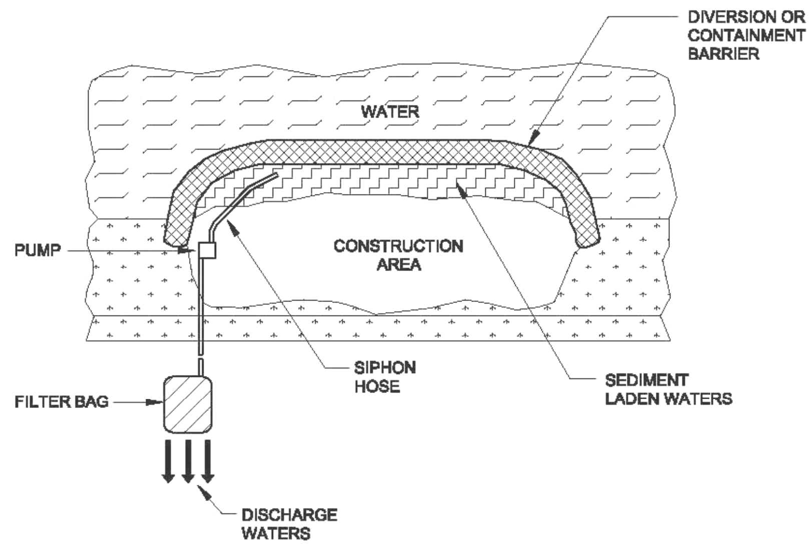
Installation:
Follow the bag's manufacturer's directions for sealing the bag and loading it with the appropriate volumetric flow rate (CFM).

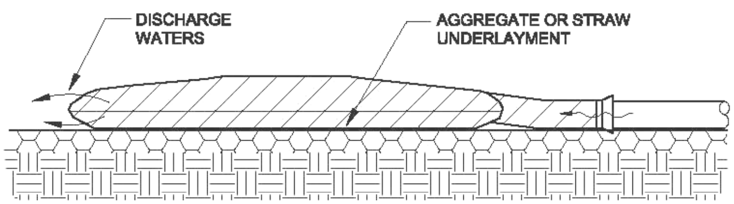
Limitations:
- It must be replaced regularly;
- It is part of a system of controls and not a stand-alone device;
- It must be monitored regularly for overloading.

Maintenance:
Inspect after every rain event or at least every two weeks for overloading. Replace the bag, as needed.

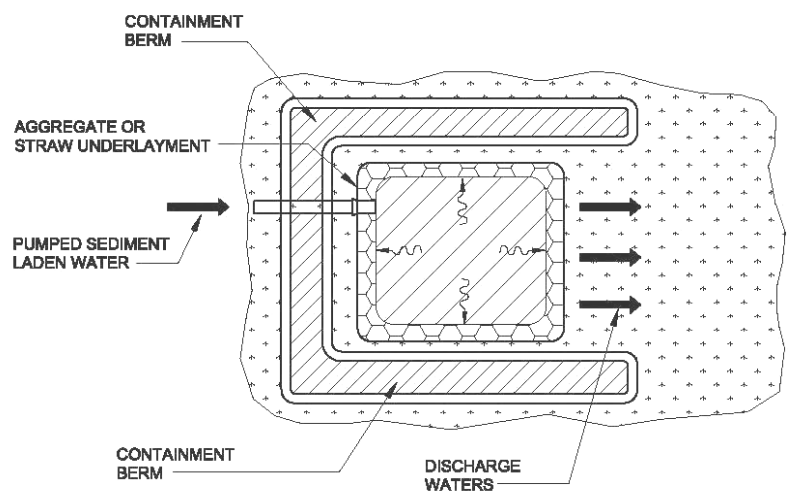


TOP VIEW
(NTS)





SIDE VIEW
(NTS)



NOTES:

1. DISCHARGE WATER ONTO A GRASS LINE SWALE, GRASS FIELD, OR INTO A SECONDARY SEDIMENT CONTAINMENT SYSTEM.
2. DISCHARGE WATER MUST FLOW AWAY FROM THE CONSTRUCTION AREA.
3. SEDIMENT CAPTURED BY THE FILTER BAG MUST BE REMOVED AND STABILIZED.

Source: Best Management Practices for Contractors and Inspectors, Fifield, 2005

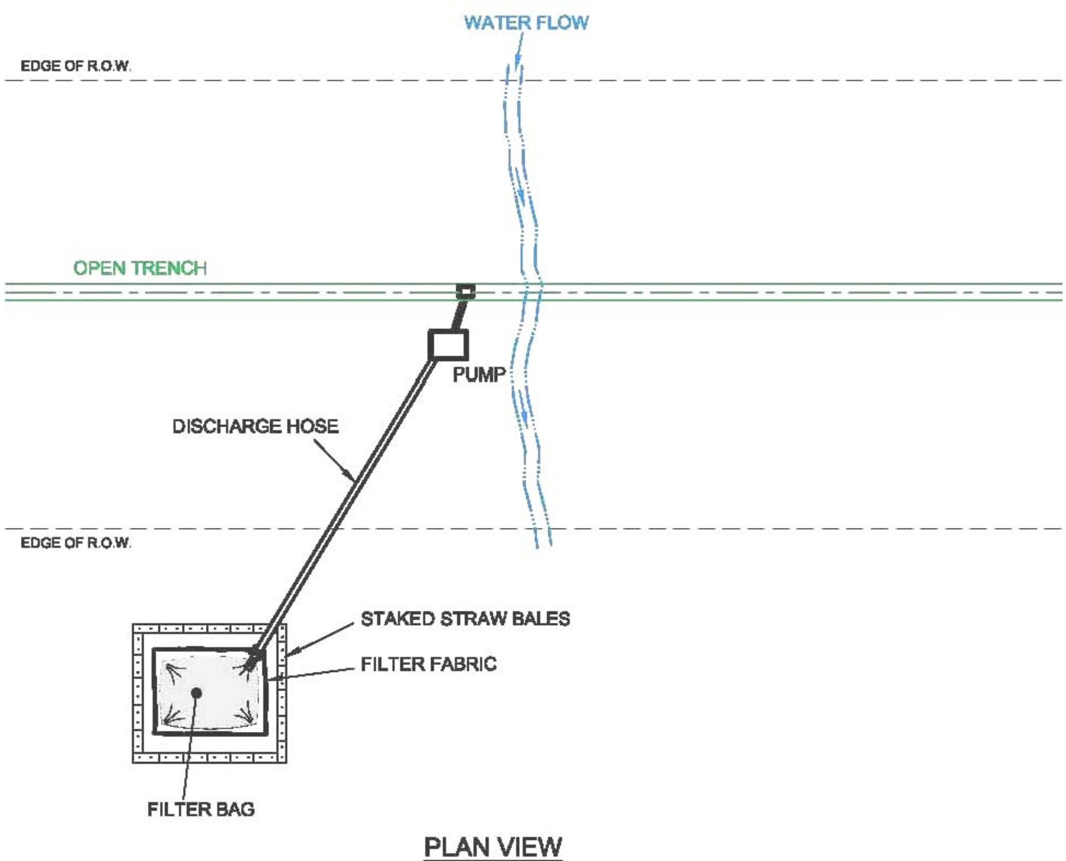
10) Trench Dewatering and Discharge: (TDD)

Description:
Trench dewatering and discharge is a method more than a structure and usually consists of draining a diked area or trench with a pump and filter bag surrounded by a straw bale berm (or better) containment that provides additional filtration for the discharged water.

Installation:
See drawing and adjust for site conditions.

Limitations:
- It must be maintained very regularly;
- It is a temporary solution for removing water from a trench.

Maintenance:
Inspect after each use and replace the berm or bag as capacity is diminished, or as needed.



PLAN VIEW
N.T.S.

CONSTRUCTION NOTES:

1. DISCHARGE ONTO STABILIZED AREA (i.e. HEAVILY VEGETATED)
2. DISCHARGE LOCATION MUST BE A MINIMUM OF 25' FROM OPEN WATER BODY OR INTO DISCHARGE STRUCTURE.

Source: Modified from RAPPS Version 1.0, IPAA, 2004

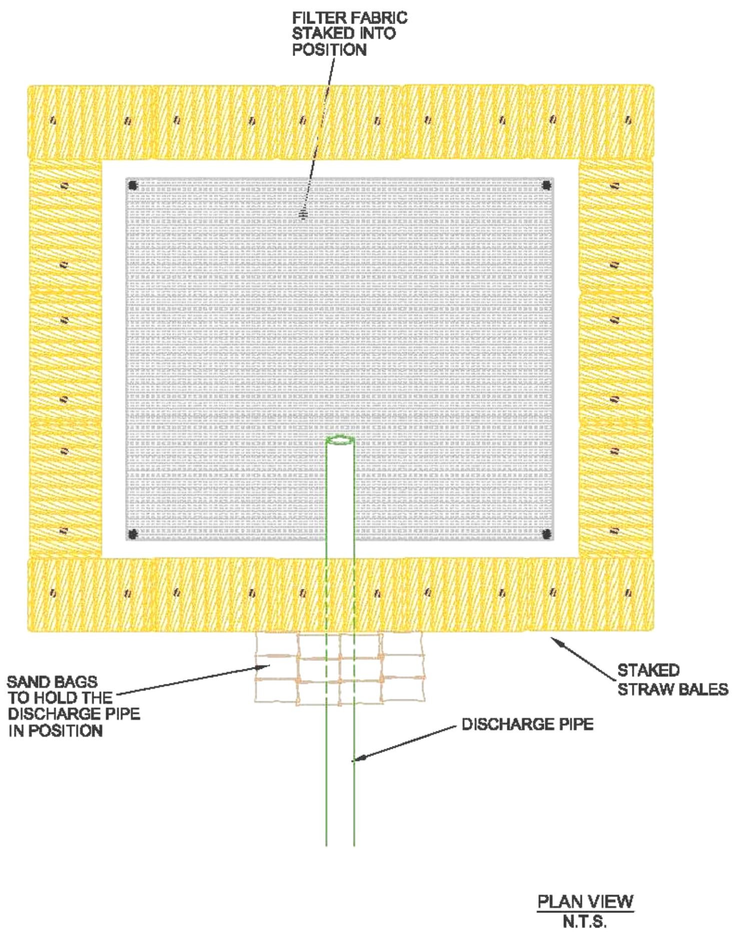
11) Dewatering Structure: (DS)

Description:
A dewatering structure is a berm usually consisting of a straw bale or compost filter dike surrounding an open pipe from a pond or other silt containment structure. It is meant as a final filtration step and not as a stop-gap last line-of-defense measure. Large amounts of silt should not be sent to this structure.

Installation:
See figure and adjust for site conditions.

Limitations:
- Not effective for large flows or heavy silt-laden water ;
- Straw bales will clog eventually causing ponding and submerged discharge pipe;
- Straw bales must be replaced very regularly to prevent rotting or clogging.

Maintenance:
Inspect weekly or after each discharge event.



CONSTRUCTION NOTES:

1. THIS DESIGN FOR FLAT OR RELATIVELY FLAT GROUND.
2. THIS DESIGN FOR SMALL DISCHARGES.

Source: Modified from RAPPS Version 1.0, IPAA, 2004

12) Typical Open Cut Flowing Stream Crossing Flume Pipe: (SCFP)

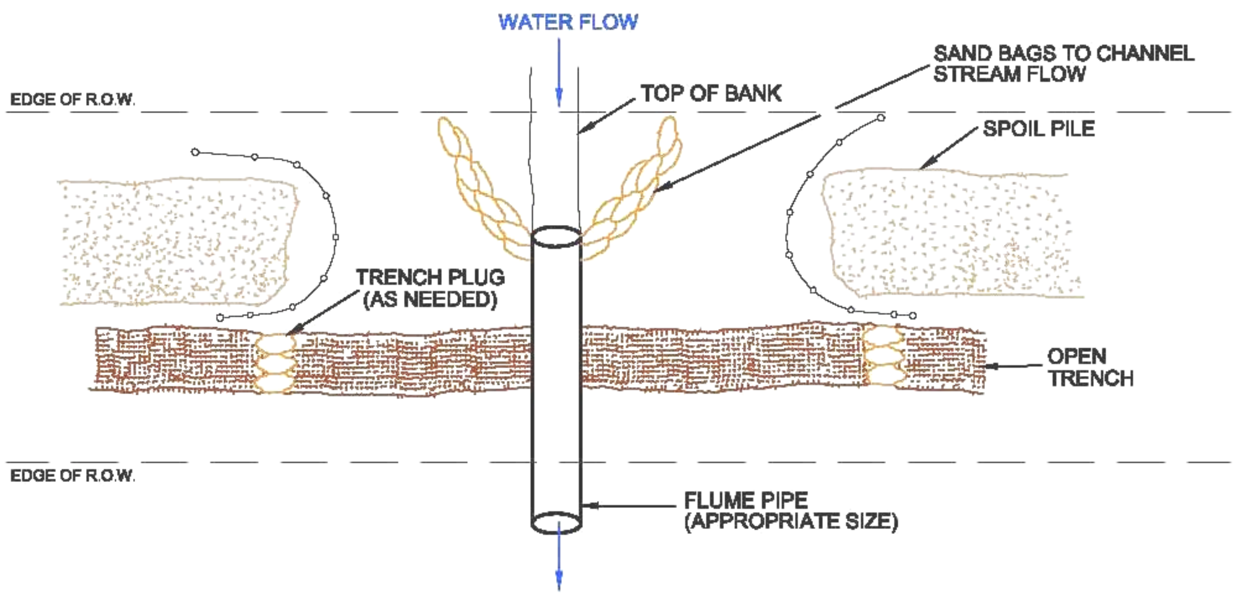
Description:
Usually consisting of a flume pipe that drains moving water over an open trench. It is meant as a temporary measure and is dangerous to the life of personnel if they are to be working in the trench. Take extreme precaution in the use of this measure to prevent cave-ins and the escape of the flumed water.

Installation:
See drawing and adjust to site conditions

Limitations:

- Temporary;
- Dangerous to personnel working in the trench, especially if rain events increase the water flow above the capacity of the flume.

Maintenance:
Inspect daily and after rain events.



PLAN VIEW
N.T.S.

CONSTRUCTION NOTES:

1. TRENCH SPOIL SHOULD BE PLACED APPROXIMATELY 10' FROM THE TOP OF THE BANK.
2. RAPPS NEEDED BETWEEN SPOIL AND WATERBODY.
3. FLUME PIPE SHOULD ADEQUATELY CONVEY NORMAL STREAM FLOWS.

Source: Modified from RAPPS Version 1.0, IPAA, 2004

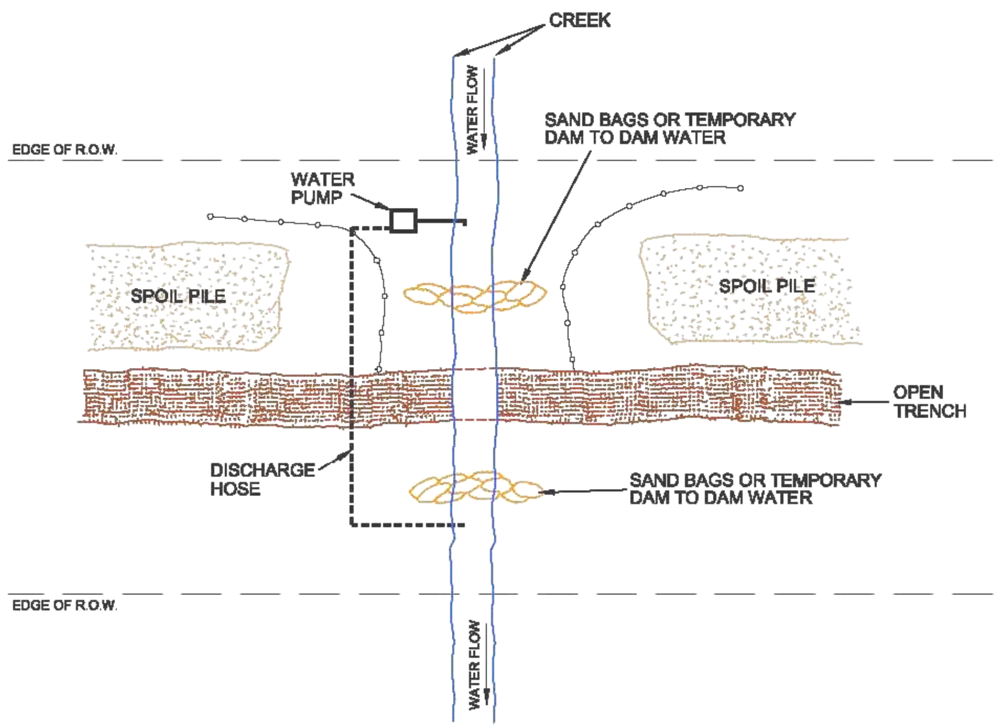
13) Typical Open Cut Minor Flowing Stream Crossing Dam and Pump: (SCDP)

Description:
A method usually consisting of a diversion dike or berm made up of: sand bags, compacted earth or base material dike. A pump and discharge hose are used to convey water downstream.

Installation:
See drawing and adjust to site conditions

Limitations:
- Temporary;
- Personnel must be protected from overflows.

Maintenance:
Inspect daily and after each rain event.



CONSTRUCTION NOTES:

1. REROUTE WATER VIA DAM AND PUMP.
2. EXCAVATE TRENCH.
3. TRENCH SPOIL SHOULD BE PLACED APPROXIMATELY 10' FROM THE TOP OF BANK.
4. RAPPS NEEDED BETWEEN SPOIL AND WATERBODY.
5. MONITOR PUMP(S) - REFUELING IN SPILL CONTAINMENT DEVICE.

Source: Modified from RAPPS Version 1.0, IPAA, 2004

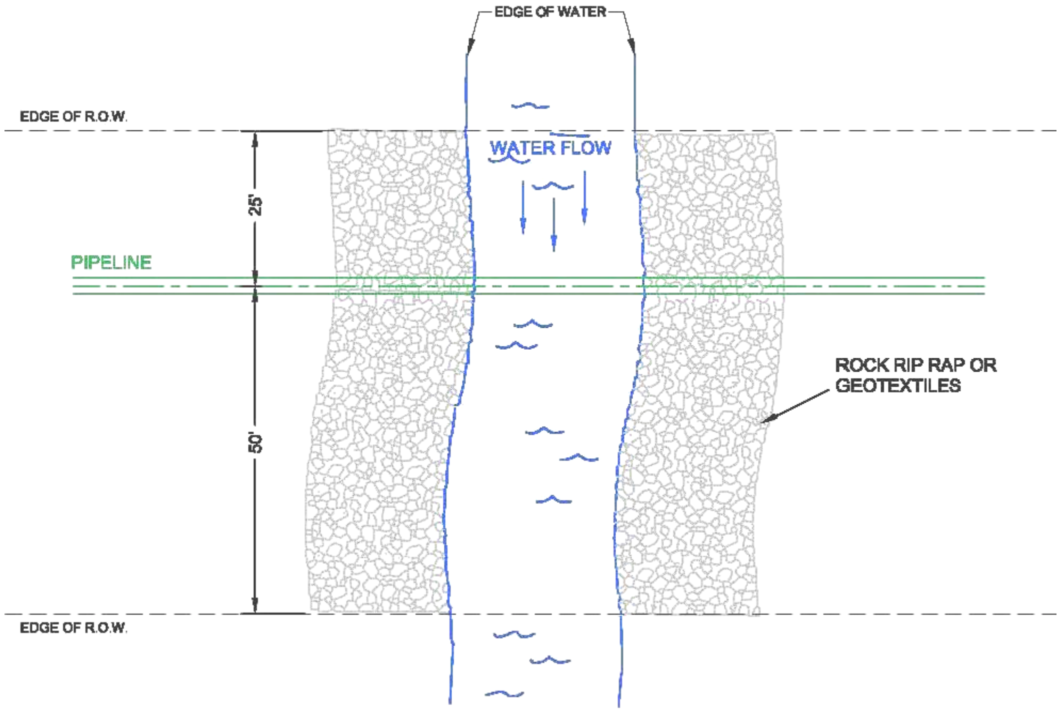
14) Post Construction Stream Bank Stabilization: (SBS)

Description:
Stabilization usually consisting of a compacted earth or rip-rap material over geotextiles.

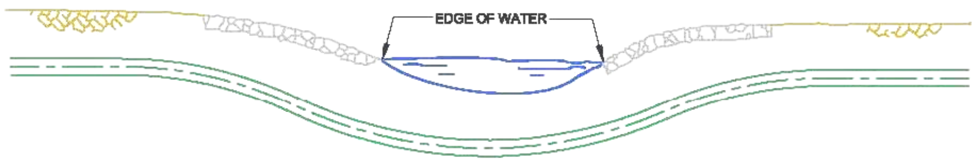
Installation:
See drawing and adjust to site conditions

Limitations:
• Vegetative stabilization is preferred and is considered more permanent

Maintenance:
Inspect after each rainfall event larger than 0.5 inches



PLAN VIEW
N.T.S.



CROSS-SECTION
N.T.S.

NOTES:

1. GEOTEXTILES MUST BE SECURED.

Source: Modified from RAPPS Version 1.0, IPAA, 2004

15) Typical Open Cut Dry Stream Crossing: (DSC)

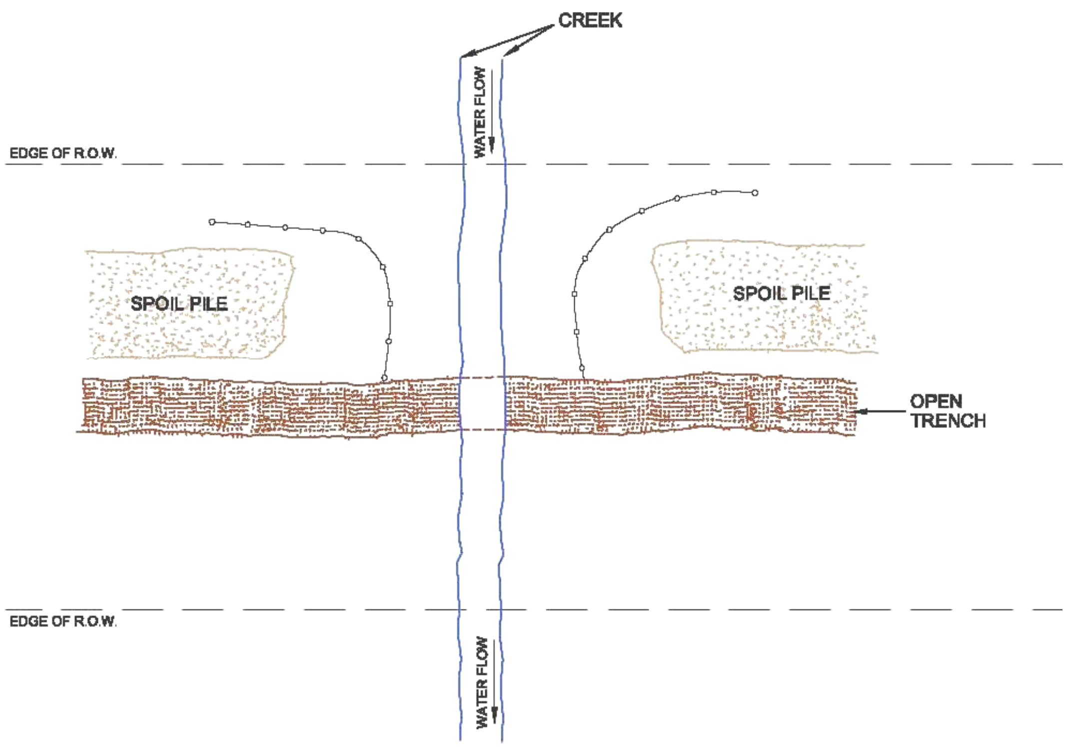
Description:
A diversion dike is used to separate the spoil pile from the open trench and waterway (creek).

Installation:
See drawing and adjust to site conditions

Limitations:

- Water bodies should be treated with extreme care so as not to pollute with spoil.

Maintenance:
Inspect after each rainfall event larger than 0.5 inches



CONSTRUCTION NOTES:

1. EXCAVATE TRENCH.
2. TRENCH SPOIL SHOULD BE PLACED APPROXIMATELY 10' FROM THE TOP OF BANK.
3. RAPPS NEEDED BETWEEN SPOIL AND WATERBODY.
4. INSTALL FLUME PIPE TO CONVEY WATER FLOW, IF STREAM BEGINS TO FLOW DURING CONSTRUCTION.

Source: Modified from RAPPS Version 1.0, IPAA, 2004

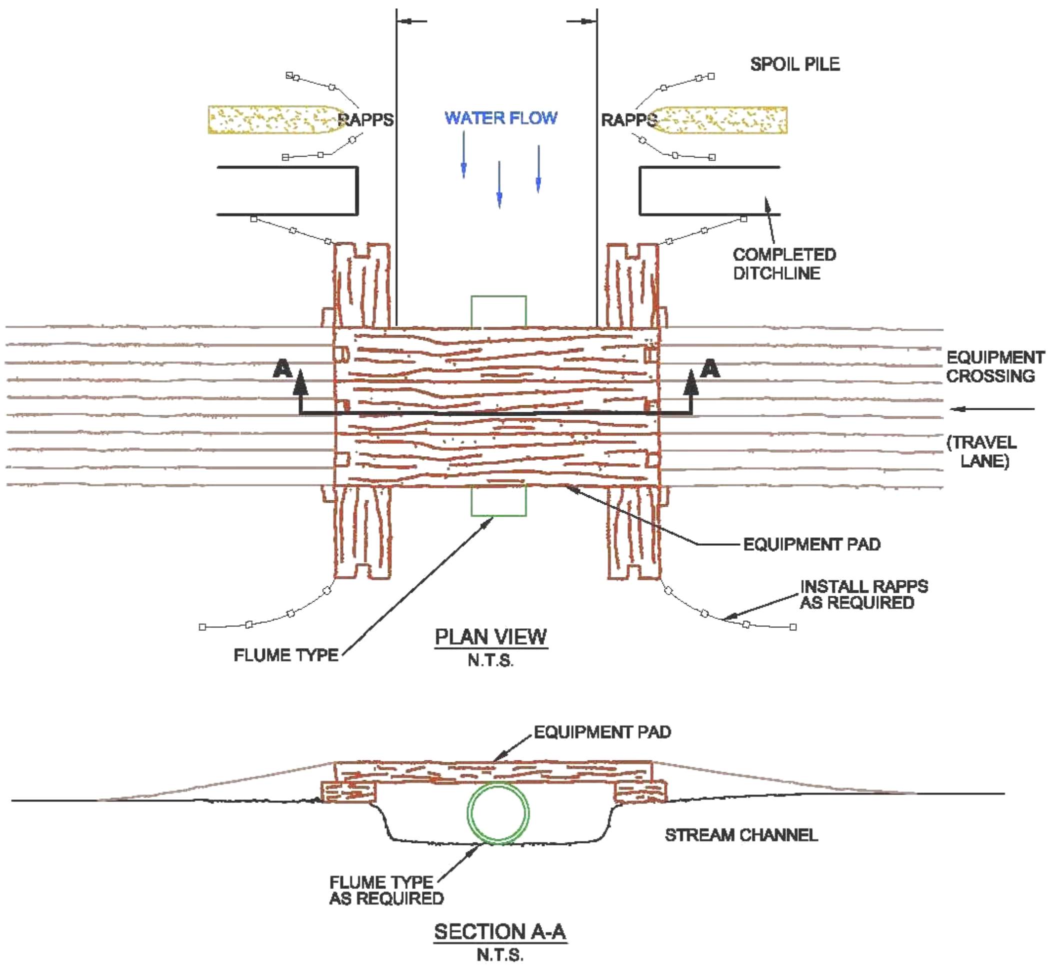
16) Temporary Equipment Crossing of Flowing Creek (Bridged) (TECFC)

Description:
Bridged crossing of a creek.

Installation:
See drawing and adjust to site conditions

Limitations:
- Structural integrity of foundation and bridge is the greatest concern and should be evaluated by an experienced P.E. or construction manager.

Maintenance:
Inspect after each rainfall event larger than 0.5 inches.



CONSTRUCTION NOTES:

1. UTILIZE CULVERT PIPE(S) IF ADDITIONAL SUPPORT IS NEEDED.
2. ADDITIONAL EQUIPMENT PADS CAN BE PUT SIDE BY SIDE IF EXTRA WIDTH IS NEEDED.
3. EQUIPMENT PAD TYPICALLY CONSTRUCTED OF HARDWOOD. SHOULD ACCOMMODATE THE LARGEST EQUIPMENT USED.

Source: Modified from RAPPS Version 1.0, IPAA, 2004