RULE NO.: **R161-17.12**

POSTING DATE: **April 5, 2017**

NOTICE OF PROPOSED RULE

The Director of Watershed Protection Department proposes to adopt the following rule after May 6, 2017.

Comments on the proposed rule are requested from the public. Comments should be submitted to Dana McGehee, 505 Barton Springs Road, Suite 1200, Austin Texas, 78704, 974-2634, or via email at dana.mcgehee@austintexas.gov. To be considered, comments must be submitted before May 7, 2017, the 32nd day after the date this notice is posted. A summary of the written comments received will be included in the notice of rule adoption that must be posted for the rule to become effective.

An affordability impact statement regarding the proposed rule has been obtained and is available for inspection or copying at the address noted in the preceding paragraph.

EFFECTIVE DATE OF PROPOSED RULE

A rule proposed in this notice may not become effective before the effective date established by a separate notice of rule adoption. A notice of rule adoption may not be posted before May 7, 2017 (the 32nd day after the date of this notice) or not after June 14, 2017 (the 70th day after the date of this notice).

If a proposed rule is not adopted on or before June 14, 2017 it is automatically withdrawn and cannot be adopted without first posting a new notice of a proposed rule.

TEXT OF PROPOSED RULE

A copy of the complete text of the proposed rule is available for public inspection and copying at the following locations. Copies may be purchased at the locations at a cost of ten cents per page:

Watershed Protection Department, located at 505 Barton Springs Road, Suite 1200, Austin, TX, 78704; and

Office of the City Clerk, City Hall, located at 301 West 2nd Street, Austin, Texas.

BRIEF EXPLANATION OF PROPOSED RULE

R161-17.12: Revises the Environmental Criteria Manual as follows:

Section 1.4.1 Introduction – Updated department name to DSD.

Section 1.4.2 City of Austin Erosion and Sedimentation Control

B. Policy - Updated department name to DSD.

C. Plans and Computations - Updated department name to DSD and removed outdated web reference for CPESC.org.

D. Updated department name to DSD.

Section 1.4.4 Plan Development and Implementation

B. Construction Phase Controls

1. General Concepts - Updated department name to DSD.

2, Design Guidelines –Removed reference to Appendix V. Standard detail is the correct reference.

3. Submittal Requirements – Reformatted and added Demolition Plan and Tree Preservation to list.

Section 5

I. Site Management

b. Temporary Stabilization – Removed construction sequence item requiring length of time that each phase will remain disturbed. Removed Flexible Growth Medium and replaced with Fiber Reinforced Matrix (FBM).

IV. Choosing the Control Device – Added Appendix V reference 1-1.1 through 1-1.5.

C. Plan Review Procedures - Updated department name to DSD.

D. Procedures During Construction

5. Project Release or Acceptance by the City - Updated department name to DSD.

Section 1.4.5 Temporary Structural Practices

H. Triangle Sediment Filter Dikes – Removed word "specifications" and replaced with "Standards".

I. Hay Bale Dikes – Removed word "specifications" and replaced with "Standards".

Q. Dust Control - New Section: Relocated this section from 1.4.8, Special Practices and updated. Removed Table 1-5, Spray on Adhesives. Removed redundant requirements under Permanent Methods.

Appendix V – Removed Figures 1-35, Rock Types, Soils, Topography and Characteristic Vegetation, 1-42, Rock Types, Soils, Topography Correlations, 1-43, Woody Species Planting Information

AUTHORITY FOR ADOPTION OF PROPOSED RULE

The authority and procedure for the adoption of a rule to assist in the implementation, administration, or enforcement of a provision of the City Code is established in Chapter 1-2 of the City Code. The authority to regulate water quality is established in Chapter 25-8 of the City Code.

CERTIFICATION BY CITY ATTORNEY

By signing this Notice of Proposed Rule (R161-17.12), the City Attorney certifies the City Attorney has reviewed the rule and finds that adoption of the rule is a valid exercise of the Director's administrative authority.

REVIEW AND APPROVED

Joseph G. Pantalion, P.E., Director
Watershed Protection Department

Date: 3/16/17

Anne Morgan
City Attorney

Date: 3/22/17

This Notice of Proposed Rule was posted on a central bulletin board at City Hall by the City Clerk. Date and time stamp is on the front of the notice.

1.4.0 - EROSION AND SEDIMENTATION CONTROL CRITERIA

1.4.1 - Introduction

The purpose of this section is to provide a resource document and policy for the protection of land and water resources, so as to minimize the adverse effects of erosion and sedimentation per the City of Austin's Land Development Code. Additionally, the criteria have been fashioned to complement the language of the Texas Pollution Discharge Elimination System (TPDES) Construction General Permit.

The conversion of land from its natural state or agricultural use to urban use accelerates the processes of erosion and sedimentation. These negatively impact the city's drinking water supply, aquatic life and the recreational resource provided by them.

Construction related sediment can be a significant pollutant of streams, lakes, ponds and reservoirs. Not only does sediment reduce the quality of water for boating, fishing, swimming and other water-oriented recreation, it also creates maintenance problems due to excessive wear on pumps and due to the reduced capacity of streams, lakes and other waterways. Another problem associated with sediment is the affinity of pesticides, phosphates and many other chemical pollutants for soil particles. These pollutants are carried to the waterway on the sediment and further reduce the quality of the water.

Mankind accelerates the erosion process by modifying the topography, soil conditions, vegetative cover and drainage patterns during construction to suit its needs. The clearing and grading of land to convert it from a natural state to cultivated row crops greatly increases the potential for erosion. The magnitude of this increase can be as much as 200 times. In addition, earth moving and construction to convert agricultural land to urban uses such as roads, houses, shopping centers, schools and airports increases the erosion potential another ten (10) times (Erosion and Sedimentation Control Guidelines for Developing Areas in Texas, U.S.D.A., S.C.S., Temple, Texas, 1976). After full urbanization takes place in a watershed, however, erosion usually decreases several fold from that experienced during the period of construction (Virginia Erosion and Sedimentation Control Handbook, Second Edition, 1980) and may decrease from that occurring before construction.

As additional development and urban growth takes place in Austin, the value of all land and water resources increases. The conservation of these resources is easier and less expensive than their restoration.

On most development projects, the major period for erosion potential exists between the time when the existing vegetation is removed to begin site work and the completion of construction and revegetation. There are numerous activities associated with construction and land development that accelerate the rate of erosion. Virtually all of these actions involve the removal of vegetation and/or the movement of the native geologic structure to provide a construction site. The adverse impact upon the site and the environment in general can be reduced if these actions are taken with some thought to the resultant erosion.

The control criteria included in this manual provide several methods to address the dual problems of erosion and sedimentation, but are in no way a complete outline of the possible actions to provide adequate reductions. We therefore encourage innovation and suggestions to improve or expand on these concepts. Any questions concerning the criteria or the use of measures not included in the manual should be directed to the Watershed Protection and Development Review Department.

The Erosion and Sedimentation Control Criteria are established and reviewed by the Environmental Resource Management Division of the Watershed Protection ~~and Development Review~~ Department. ~~Site plan~~Development permit review is conducted by the ~~Land Use Review Division~~ Development Services Department and construction inspection oversight by the Environmental Inspection Section of the Site and Subdivision Inspection Division.

1.4.2 - City of Austin Erosion and Sedimentation Control Policy

B. **Policy.**

It shall be the policy of the City of Austin that erosion and sedimentation controls are required for all construction and development, conducted with or without a permit, including without limitation commercial, multi-family, single-family, and duplex construction, the construction of all roads, utilities, parks, golf courses, water quality basins, detention basins, and all other activities utilizing clearing, trenching, grading or other construction techniques. It is the intent of City of Austin policy to closely parallel the requirements set forth in the Texas Pollution Discharge Elimination System (TPDES) Construction General Permit, the City of Austin's MS4 permit and any applicable updates to NPDES or TPDES.

The objectives of this policy are to:

- Minimize the erosion and transport of soil resulting from development activities.

- Prevent sedimentation in streams, creeks, lakes, waterways, storm drains, etc by ensuring no off-site transport of disturbed sediment for the 2-year 24-hour storm during construction and through establishment of permanent controls.

- Protect and improve the quality of surface water in the Austin environment and maintain and improve the quality and quantity of recharge to groundwater supplies, especially the Edwards aquifer.

- Minimize flooding hazards and silt removal cost associated with excessive sediment accumulation in storm drains and waterways.

- Preserve and protect existing vegetation to the greatest extent possible, particularly native plant and wildlife habitats.

The following sections present the minimum requirements for the planning, design, construction, operation and maintenance of erosion and sedimentation control facilities and should be used as a resource document to help developers and engineers plan and implement their projects to provide protection from erosion or sedimentation. The adequacy of the plan to meet the letter and intent of this section will be determined by the ~~Watershed Protection and~~ Development ~~Review~~ Services Department. Please note that projects that require a building permit, but not a site plan permit, are required to complete the TPDES Construction Site Notice (Small or large depending on size. See Appendix V, Figures 1-2, 1-3, 1-4, 1-5. Or click on TCEQ link at:

http://www.tceq.state.tx.us/assets/public/permitting/waterquality/attachments/stormwater/txr150000.pdf

Figure 1-1.1 (Appendix V) outlines the general sequence of events that take place in the planning, review, approval, construction and inspection of an Erosion and Sedimentation Control Plan. See Section 1.4.4(B)3 for the E&S control plan submittal requirements. The City of Austin and the Watershed Protection and Development Review Department shall not be responsible to anyone for the use or reliance on any portion of this manual and shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation, or reliance on any specification or guidelines contained herein.

C. **Plans and Computations.**

Plans and computations to support all erosion and sedimentation control designs shall be submitted to the ~~Watershed Protection and~~ Development Services ~~Review~~ Department for review. Plans and computations shall be in such form as to allow for timely and consistent review and to be made a part of the permanent record for future reference. Computations shall be required for BMPs that rely on detention, sedimentation, filtration, diversion and velocity control. The reviewer may deny an application if the applicant cannot support Erosion and Sedimentation control designs with appropriate calculations. All engineering computations shall

be certified by a Licensed Professional Engineer with competence in this area as required by Texas Engineering Practice Act, Section 137. All ESCPs shall be signed by a Licensed Professional Engineer (TX) or a Certified Professional in Erosion and Sedimentation Control {(CPESC)(http://cpesc.org/)} If the ESCP itself contains engineering calculations, then a Licensed Professional Engineer must seal and sign the ESCP. All drainage calculations shall be done in accordance with the guidelines in the Drainage Criteria Manual.

D. **Ordinance Authority.**

The information in the following sections is intended to define the technical design criteria needed to achieve the policy goals identified in the Land Development Code relating to erosion and sedimentation control. A brief summary of specific code sections relating to the requirements for erosion and sedimentation control is included below:

Title 6-5-51: Discharges into Storm Sewers or Watercourses.

25-1-441: Cease and desist order ("Red Tag").

25-1-288: Requirements for a pre-construction inspection; owner's demonstration of compliance; modifications to controls and plans.

25-7-61 and 25-7-65: Adequate temporary and permanent erosion and sedimentation control plans required for final plat, subdivision construction plan, or site plan approval; estimated cost of fiscal security; fiscal security insures no cost to the city.

25-8-181 to 25-8-184: Erosion and sedimentation control required for all construction; restoration required for a complete project; modifications to plans allowed.

25-8-321 to 25-8-323: Topsoil to be protected against erosion; existing vegetation to be left in place where possible; limitation of time between rough cutting and final surfacing of roadways.

25-8-341 and 25-8-342: Cuts and fills to be restored and stabilized.

25-8-343: Restoration and revegetation of spoil disposal sites required.

25-8-281 and 25-8-282: Special erosion controls required to protect critical environmental features.

Work done under this policy is subject to all provisions of the Land Development Code. No work shall be done by the contractor until all required permits have been obtained. To find out exactly what permits are required, an inquiry should be made to the ~~Watershed Protection and~~ Development Services ~~Review~~ Department~~.~~

1.4.4 - Plan Development and Implementation

B. **Construction Phase Controls.**

1. General Concepts.

The goal of erosion and sedimentation control is to limit as much as possible the detachment and transport of sediment from construction sites and the finished projects they eventually become. Sediment is transported off-site through one of four means:

- Stormwater runoff,

- Water discharges (e.g. pumping of water out of trenches, open channels (creeks, rivers, ditches) or foundation and basement excavations),

- Vehicles, and
- Wind.

Stormwater runoff and water discharges are the primary means by which sediment is transported from construction sites.

Sediment becomes suspended in runoff as it flows over or out of disturbed areas seeking the lowest path of least resistance. It is very important to realize that in order to control this suspended sediment, the means by which it is transported, water, and must first be successfully controlled. The principal tasks are to keep the sediment from entering the runoff or, once in it, to separate and trap the suspended sediment before it can leave the site. The techniques to accomplish this consist of two basic types: site management practices and structural controls.

Site management practices focus on the prevention of erosion and include methods such as minimizing the area of the site that is disturbed at any one time during construction, preserving the existing natural vegetation to the greatest extent feasible, covering exposed soils with temporary stabilization soon after disturbance and restoring vegetation as rapidly as possible in disturbed areas. A related method would be to revegetate between phases of a project, when there will be a delay between these phases. Additional site management techniques include keeping the velocity of stormwater below the erosive level, promoting sheet flow rather than concentrated flow, and protecting and maintaining stable slopes.

Structural controls utilize engineered devices (such as channels, berms, silt fences, ponds, etc.) to keep sediment on-site. This is accomplished in a two-stage process consisting of drainage control followed by sediment removal.

Drainage Control.

The control of on-site drainage is essential to the process, as this must be accomplished first in order to successfully separate and trap suspended sediment. Drainage control is accomplished by strategically placing structural controls at locations where they will intercept stormwater runoff as it flows towards the lower portions of a site. These control devices must be substantial enough to withstand the anticipated runoff velocity and either must direct the flow to another control device or must be shaped to temporarily pool the runoff behind the structure. At this point in the process, trapping of sediment can occur. If the drainage control stage is unsuccessful or only partially successful, it will correspondingly limit the amount of sediment that will be trapped. Reviewers shall require calculations to demonstrate that drainage controls have the capacity to withstand the velocity of the 10 year 24 hour storm and all detention sedimentation controls shall be shown to have capture volume for the 2 year 24 hour storm as well as the volume of sediment generated from a two year 24 hour storm. Drainage controls shall have a drawdown time of 72 hours.

Sediment Control.

Sediment trapping, i.e. the separation of the sediment from the runoff, occurs primarily by sedimentation: when suspended materials settle out as runoff velocity is decreased, and the sediment is trapped and left behind to be removed later, while the runoff is released to drain off-site.

The other methods by which sediment leaves a site, vehicles and wind, can be controlled in a manner similar to runoff. The first step is to control the mechanism that moves the sediment and the second step is to capture the sediment. For vehicles this entails directing them to a limited number of stabilized exits where most of the attached soil or mud can fall or be washed off. Wind-blown dust, although generally not a major problem, can be

controlled with barriers that slow velocity and prevent transport. In addition, excessive dust can be controlled with regular wetting of the dust source. Special additives to the water used for dust control (i.e. dust palliatives) will assist in preventing the resuspension of dust when the moisture has evaporated. Article V, Chapter 4-3 of the City Code of 1981, however, does not allow the use of oil, diesel fuel or other pollutants which may wash into streams and watercourses for the control of dust.

The previous paragraphs describe the basic process that occurs in implementing successful structural erosion and sedimentation controls. Variations of this process can be employed, depending on the type, number, and location of structural control devices used. However, the basic concepts and engineering functions involved in successful erosion and sedimentation control applications remain the same regardless of which specific structural devices or techniques are employed. Whether or not a plan is judged to be able to adequately meet the letter and intent of the policy in 1.4.2 (B) will be determined by the ~~Watershed Protection and~~ Development Services Department ~~Review~~ Staff. Because each site is unique, this volume cannot prescribe an upfront pre-approved recipe that will ensure site plan approval. However, following the submittal requirements in section 3 will demonstrate to the reviewer that a thoughtful, rigorous analysis of the potential pollutants, runoff pathways, and methods for control have been considered.

In the following sections, design of temporary and permanent controls for sites will be more fully examined.

2. Design Guidelines

There are several methods available to reduce erosion and sedimentation problems at construction sites. Site management methods are one of the most economical ways to accomplish this control. This section introduces several new or underutilized methods that will be required as part of the Plan Submittals. Phasing, limiting the extent of existing vegetation that is disturbed, planning the necessary locations of the disturbance, restricting construction traffic to those locations, and revegetating or otherwise stabilizing any disturbed area are examples of this type of planning, hereafter referred to as Prevention.

More common methods, however, use structural controls to take advantage of the reduced ability of water to carry sediment when its velocity is reduced. Temporary structural control devices can be grouped into one or more functional categories, defined by its particular application on a site. Recognition of the function of each control at the point where it is to be used is critical in choosing the most effective measure for each location. Three functional categories have been identified and are described below:

• Diversion - A control device used for diversion is strategically placed on a site to intercept runoff and divert it to another location. A diversion may be installed to keep clean water from crossing and eroding a disturbed area or to move runoff with silt to a location where it can be treated more effectively. (see COA Standards ~~Detail~~ 621S-1 and 622 S-1~~, also included in Appendix V~~) All sites that receive off-site runoff must install flow diversion devices designed to handle the concentrated flow and divert it around the disturbed area in a non-erosive manner to the receiving drainage system downstream of the site. Diversion capacity shall be the runoff volume of the 10-year, 24-hour storm. All diversions shall be designed to withstand erosion from the velocity of the 10-year, 24-hour storm.

• Flow Spreading/Velocity Reduction - This category of control applies to smaller flow amounts which may be diverted onto undisturbed ground while at the same time allowing a small amount of flow to pass over and through the device. The control device can also function as a grade control to reduce the length and steepness of a slope to prevent rills and gullies. These controls are normally situated at a right angle to the flow path and are spaced to ensure not erosive velocities. This form of control attempts to restore a sheet

flow condition such that the velocity and depth of flow are so low that sediment cannot be effectively carried by the runoff. (See Figure 1.6.7 B.~~1~~3 level spreader or rock berm)

• Detention/Sedimentation - Runoff is ponded behind a structure allowing the sediment to drop out of suspension and be trapped in the detention pool because of the reduction in runoff velocity.

Previously, silt fences were classified as detention/filtration devices. Recent research by the University of Texas and Texas Department of Transportation demonstrated that silt fences function primarily as detention/sedimentation due to clogging of the pores. They were found often to be undersized and improperly installed as detention/sedimentation devices. Therefore, silt fence criteria in section 1.4 have been updated to reflect the actual function of silt fences under field conditions.

Detention/sedimentation structures must be designed to withstand the force and velocity from a 10-year frequency storm without failing. Larger storms shall be bypassed via stabilized conveyances. Those devices that employ sedimentation must provide the storage volume for the runoff from a 2-year, 24-hour storm under compacted site conditions. The sedimentation basins must be designed such that drawdown time is 72 hours via surface skimmers. The design must include considerations for overflows to ensure that the device and its detention pool remain intact. Detention/sedimentation structures shall not be sited in natural drainage channels, draws or ravines that are directly connected to off-site drainage features like creeks, rivers, ponds or recharge features. In particular, this means that silt fences shall not be used to control concentrated or channelized flow and sedimentation basins shall not be constructed in natural draws because failures of the earthen retaining system are often catastrophic to the downstream receiving waters.

The procedure for developing an effective erosion and sedimentation control plan (henceforth adopting the NPDES nomenclature of Erosion and Sedimentation Control Plan (ESCP)) for a construction project involves several required steps, as indicated below. During plan review, the City of Austin Plan reviewer shall have final authority regarding the proper implementation of the ESCP. The submittals must demonstrate to the satisfaction of the reviewer that all potential sources of sediment and other construction related pollution have been identified and minimized. The plan shall not move forward until the reviewer has been satisfied that the letter and intent of this section have been satisfied.

3. Submittal Requirements

Submittals to satisfy the requirements for Erosion & Sedimentation control plans consist of two parts:

a. Completed Erosion and Sedimentation Control Plan template.

b. ~~Site~~ Plan sheets that include the graphics necessary to illustrate, review and construct the systems outlined in the ESCP (specific submittal requirements enumerated and explained below~~, but at least one sheet showing existing conditions, one sheet showing site prep and grading operation, one sheet showing BMP layout, sequence of construction/phasing, one sheet showing final grades and permanent stabilization measures, one sheet with details and notes~~). Plan sheets shall clearly show the following:

- Existing conditions
- Demolition plan, as required
- Site preparation and grading operation

- Tree Preservation, as required
- BMP layout
- Sequence of construction/phasing
- Final grades
- Permanent stabilization
- Details and notes

The ESCP must be signed and certified by a Licensed Professional Engineer (TX) or a Certified Professional in Erosion and Sedimentation Control (CPESC). If the ESCP includes engineering calculations, then ESCP must be sealed and signed by Licensed Professional Engineer.

Section 1 - Existing Conditions Site Evaluation, Assessment and Planning

- Project Site Information (e.g. name, location)

- Contact Information/Responsible Parties (Owner, ESCP designer, Construction Phase ESCP contact)

- Representative photograph of site that shows the designer on-site.

- Description of Soils- Use NRCS Soil Survey, USGS or Bureau of Economic Geology Geologic maps. Geotechnical reports are acceptable to define subsurface soil properties.

- Delineation of existing topography and drainage patterns, including overland and concentrated flow; contributing drainage area for flow paths that drain at least 1 acre, presence or absence of baseflow, USGS stream type (ephemeral, intermittent or perennial)

- Slope steepness

- List the receiving water to which the site drains; if receiving water is impaired or subject to Total Maximum Daily Loads, list pollutants causing impairment and requirements in TMDL applicable to construction sites. State how ESCP prevents discharge of these pollutants

- Description and location of Critical Environmental Features

- Photos and description of predominant vegetation

Section 2 - Construction Activities and Site Management Practices (see http://www.epa.gov/npdes/pubs/exampleswppp_residential.pdf for examples)

- Nature of Construction Activity (e.g. residential, commercial, utility, etc.)

- Phasing and construction sequence plan- maps and schedules of disturbances, phasing, temporary and permanent stabilization. Phasing is a preventive measure defined as: One portion of the site is disturbed at any one time to construct the infrastructure necessary to complete that phase. Subsequent phases are not started until earlier phases are substantially complete and exposed soils are stabilized. In the case of subdivision construction, it is defined that the activities associated with ROW construction (including utilities) are distinct phases from the activities associated with mass clearing and grading for subdivisions, which are also distinct from the activities associated with individual lot construction. If the permit allows for all three activities, then the ESCP must address the

sequence, timing, appropriate BMPs, installation and maintenance for all three phases. In addition, ROW construction must be accepted prior to beginning the phase of clearing and grading or individual lot construction. If the application for subdivision development anticipates clearing and grading of individual lots, then the ESCP must show the interior and perimeter controls that will be in place and maintained until final stabilization of individual lots. ROW and utility construction will not be accepted by the City of Austin if any mass grading on lots has occurred without an approved ESCP that anticipates construction through permanent stabilization of individual lots. Stormwater ponds are accepted separate from other utilities and ROW.

- For site plan review purposes, the construction sequence must show the duration of each activity, as opposed to specific start and end dates. Prior to the start of construction, though, the ESCP must be updated with actual dates of start/finish for each activity outlined in the sequence. The ESCP must be kept updated to reflect any changes, or the inspector may red tag the site. Environmental Inspection will make the determination regarding the level of submittal needed for ESCP updates. The determination will follow these general guidelines: 1) if the changes do not require a site plan revision or correction (certain changes like changes to LOC require revisions) and the EV Inspector, PE and/or CPESC all agree on a revision to planned E&S controls, then the ESCP update log can be used to document the updates. Any graphics that are necessary for documentation shall be physically added to the ESCP file. The construction sequence shall include at a minimum, the following:

a. Length of time to install construction phase E&S controls

b. Length of time for each identified phase of construction from initial groundbreaking to final grade and any intermediate steps that would require modification of E&S controls (temporary and permanent storm water ponds, clearing and grubbing, rough grade, final grade, utilities, roads, etc.)

c. Identification of areas within the LOC that will require temporary stabilization and the times of installation, modification, removal. Sequencing of grading and cut and fill activities will be required to show how disturbed and stockpiled sediment is accounted for each time it is transported from initial disturbance to permanent stabilization. For subdivisions, the sequence must show when construction of utilities and ROW construction ends, when grading of lots begins and ends, and when the individual lot construction phase begins.

d. Identify schedule for permanent stabilization

e. Identify schedule for converting temporary controls to permanent functions (e.g. basins)

f. Identify schedule for removal of E&S controls

- Maintenance schedule for Construction Phase BMPs

- Calculations of cut/fill volumes per phase; include description of how spoils will be handled during construction (e.g. kept on site, hauled off; if on-site how will spoils be protected from erosion?)

- Identify all potential sources of pollution during construction (not just sediment); describe pollution control procedures and devices.

Section 3 - Grading & Erosion/Sediment Control BMPs

- Plan sheets that show:

a. Direction of flow during grading operations

b. Location, description and calculations for off-site flow diversion structures

c. Areas that will not be disturbed; natural features to be preserved

d. Delineation of and contributing drainage area to each proposed BMP (e.g. silt fence, sediment basin, etc.)

e. Location and type of E&S BMPs for each phase of disturbance

f. Calculations for BMPs as required

g. Location and description of temporary stabilization measures

h. Location of on-site spoils; description of handling and disposal of borrow materials; On-site permanent spoils disposal areas, including size, depth of fill and revegetation procedures. (Off-site disposal requires a separate site development permit. A note shall be made on the plan to specify that "the contractor shall notify the city's inspector about the location and permit number of the disposal site 48 hours prior to the removal.")

i. Location of vehicle entrance, description of stabilization measures and procedures for removing accumulated sediment to prevent off-site transport

Section 4 - Permanent Stabilization

It is required that submittals for permanent stabilization contain the same level of detail as that stated above for temporary controls. Permanent stabilization should occur within seven (7) days after completion of construction activities or each phase of construction. It is given that some of the language is only applicable to temporary controls, but when it is appropriate for the word "permanent" to be substituted for the word "temporary" in sections 1-3 above, it is the reviewer's prerogative to require such submittals without them being individually itemized again in section 4.

Additional requirements for permanent stabilization submittals include, but are not limited to:

a. Location and type of permanent stabilization (e.g. vegetation, slope stabilization, sodding, seed/soil retention blanket, Fiber Reinforced Matrix, Bonded Fiber Matrix, or rock rip rap)

b. Establishment irrigation and maintenance plan for permanent vegetation. Revegetation plans for all disturbed areas on the site in accordance with the vegetative practices section of this manual. Information provided by the engineer should include any of the following which are applicable:

- Topsoil requirements,(see Standard Specification 601S.3.A, Salvaging and Placing Topsoil, as well as ECM 1.4.7
- Seed, sod, and mulch type and rate of application (see 1.4. 7),
- If seed is used to revegetate, include the soil retention blanket, FRM or BFM to be used until establishment
- Irrigation schedule for permanent vegetative establishment,(see Special Specification for 609S)
- Application technique,
- Maintenance requirements for each specific area,
- If vegetation is to be temporary,
- If vegetation is to be permanent,

• A clear definition of criteria to be utilized in determining when acceptable revegetation has taken place (minimum requirements are 95 percent coverage with no bare areas exceeding ~~16~~10 square feet with a 1½ inch stand of grass).

Landscape installation and natural area restoration requirements may be applicable to certain developments. To find out what regulations may apply, an inquiry should be made to the ~~Watershed Protection~~Development Services Department.

c. Specific locations shall be noted for the following:

• Where special slope stabilization techniques are to be utilized and the extent of stabilization to be achieved.

• Location and type of permanent Stormwater management facilities (e.g. detention ponds, water quality ponds, outlet protection/velocity dissipaters)

• A schematic representation of each control measure for each phase of construction, with adequate specifications for the measure, such as dimensions and length (or size) and references to the City of Austin Standards and Standard Specifications, so that the feature can be built and maintained as intended.

• For detention/diversion/sedimentation control devices, a summary of calculations for runoff from the ten (10) year, 24 hour storm ~~(see section 1.4.2. of this manual)~~. Calculations shall include velocity for each of the drainage sub basins to a control in the pre-disturbance, under construction, and permanently stabilized conditions.

Section 5 - Additional Considerations and Further Discussion on Submittal Requirements and Design Guidelines

This section describes in more detail practices and BMPs noted above to guide the applicant in developing appropriate ESCP submittals. The reviewers may require demonstration that the following have been considered:

I. **Site Management**

a. Phasing - Phasing is a preventive measure defined as: One portion of the site is disturbed at any one time to construct the infrastructure necessary to complete that phase. Subsequent phases are not started until earlier phases are substantially complete and exposed soils are stabilized. The plan reviewers will not allow a site plan to proceed without the applicant demonstrating that all feasible opportunities for phasing have been implemented. Construction sites greater than 25 acres are required to show phasing of disturbance tailored to the specific site conditions. Items that shall be considered to determine the effectiveness in phasing include: size of disturbed area, compatibility with construction sequence (e.g. Stormwater controls, then utilities, then roads, then pads), proximity to CEFs or waterways, slope steepness. Sites less than 25 acres must demonstrate on the grading plan the areas to be disturbed and how it was minimized.

b. Temporary Stabilization - ~~The construction sequence must indicate the length of time that phases will remain disturbed.~~ The designer must anticipate the construction process and identify times when disturbed areas will be dormant (i.e. not making progress toward a benchmark phase) for 14 days or longer. These areas must be identified on the ESCP and the temporary stabilization practices described. Inspectors will make note of length of time of dormant disturbed areas and require coverage on Day 15. Approved practices include: rock rip rap for concentrated flow areas and vehicle access; ~~Flexible Growth Medium,~~ Fiber Reinforced Matrix (FRM), Bonded Fiber Matrix (BFM), Turf Reinforcement Mat or Rolled Erosion Control Product for

Slopes steeper than 4:1, and bark or wood chip mulch or sod for areas flatter than 2:1 slopes. Spoil piles will require daily cover or demonstration of adequate perimeter containment to prevent the migration of spoils outside of the defined spoil pile footprint. Unacceptable practices include broadcasting seed, paper based hydromulch, and wood fiber based hydromulch without a tackifier. Inspectors will require invoice from applicator showing certification of mix as FRM or BFM. Inspectors have authority to require additional application of temporary stabilizer if visual inspection shows inadequate coverage.

c. No offsite flow can flow onto the Limits of Construction of the disturbed phase. ESCP must show locations where pass-through flows may be safely diverted around disturbed areas and routed at a properly stabilized discharge point to downstream drainage conveyance. Proper stabilization shall be determined by the Environmental Inspector.

d. ESCP must show all designated construction access points and equipment travel paths. In particular, if there are any CEFs, protected water ways or trees, the ESCP must demonstrate that construction access is diverted at least 25 feet from such features. In addition to temporary stabilization measures for construction access, plans must demonstrate methods for ensuring that construction vehicles do not track sediment onto roadways.

e. Spoils may not be located in the 100 year flood plain, Critical Water Quality Zone, within 150 feet of a CEF or within 25 ft. of a concentrated flow path with more than 5 acres contributing drainage area.

II. **Drainage Control Points and Sediment Control BMPs**

Using the information gathered in the above analysis, the designer must determine the most practical and effective locations for controls to be installed. These controls should be located:

- As close to the source of sediment as possible, but sufficiently distant from areas under construction or from site traffic in order to avoid constant disturbance,

- In areas that permit access for maintenance to remove sediment build-up,

- Where they will not cause flooding of adjacent properties due to diversion or ponding of stormwater, and

- In areas where they will not be removed and replaced frequently.

III. **Determining the Function of the Control**

The designer must determine which functional category of control (diversion, flow spreading, detention/filtration, or detention/ sedimentation see 1.4.4 B.2. Design Guidelines) will be appropriate at each location. In addition, the designer should be able to recognize which controls must be removed or relocated and which ones can remain in place throughout the entire construction period.

Using the base information developed previously, the designer can identify the location and function of controls and where phasing in the installation of controls is to occur. Phasing of the temporary controls is particularly important for construction projects that take significant periods of time to complete or where the construction work itself is divided into distinct phases. Such projects include major utility installations, large sites, and street and drainage improvements and subdivisions.

Perimeter controls are placed at the edge of a project's disturbed area prior to the beginning of construction. All perimeters downslope from the construction site and any existing channels draining the site should be protected by temporary erosion and sedimentation controls. These

control measures generally remain in place throughout the construction period since they are located outside the construction zone and should need only small adjustments. It should not be assumed that perimeter controls by themselves are adequate to control erosion and sedimentation. In all cases, perimeter controls shall be the secondary failsafe controls installed in conjunction with interior controls. For example, silt fence along the contours of the Limits of Construction (LOC) may be used as perimeter control in conjunction with interior controls such as site management practices, rock berms, mulch berms and sedimentation controls around spoils.

Interior controls are added inside the project perimeters during and after clearing, rough cut and fill operations when the site topography is rapidly changing. They are dynamic controls that, generally, must be modified to accommodate the changing conditions on the site in order to achieve optimum results. Examples of these types of controls would be temporary stabilization measures as outlined in previous sections, silt fence located below roadway fill sections, mulch berms on contour, protection of detention pond outlets and controls across backfilled utility trenches.

In addition, work in a channel that drains more than five acres shall employ a dewatering system that bypasses channel base flow around the site. At no time shall construction be permitted in any channel that does not have an approved bypass system. The most common and effective system consists of a temporary dam (not earthen) upstream of the construction site with a sump pump with the capacity to handle the flow rate of the baseflow. Plans will need to show details of the berm/pump system to ensure pump/pipe capacity and that discharge is in a non-erosive manner downstream of the construction activity.

Where temporary channel crossings are required, compacted earth is not allowed. The designer must demonstrate that the proposed crossing is capable of withstanding a 25 year storm and that failure would not result in a discharge of construction materials.

IV. **Choosing the Control Device**

At this point the designer must determine which specific structural device will be effective at each location where control is needed. Choice of the specific control device for each location is dependent on the function to be accomplished (i.e. diversion, flow/spreading, or detention /sedimentation), the amount of flow, and the type of flow (i.e. sheet or concentrated flow) to be controlled. The designer may use any of the approved practices shown in this manual which are appropriate (see Figure 1-1 in Appendix V). Figure 1-1.1 through 1-1.5 in Appendix V of this manual shows the example site plan with specific control devices, anticipated phasing, and associated runoff flow direction.

Sedimentation basins shall not be allowed as stand-alone BMPs. Applicant must demonstrate appropriate site management practices, temporary stabilization measures, perimeter and internal controls instead of just relying on a sediment basin at the outlet of the project. Temporary sediment basins and traps are not allowed to be constructed where concentrated flow paths, draws, creeks or other drainage features exist that have contributing drainage areas greater than 10 acres.

Each control device must be able to function as designed when controlling the peak runoff resulting from the two (2) year, 24-hour storm. Flow calculations must be provided to reviewer and they should be based upon the methods presented in the City of Austin Drainage Criteria Manual. Calculations must assume a precondition of maximum allowable sediment accumulation. Therefore, the control devices must be designed for capacity of both the water flowing through as well as the sediment that could accumulate over normal operations. The designer must demonstrate that each device will be able to detain the water, and contain the volume of sediment that may be mobilized during the 10 year storm (use Modified Universal Soil Loss Equation to quantify soil loss for 10 year storm). Mobilization includes sheet, rill and gully erosion as well as mass failures of cuts and stockpiles. Care must be taken to determine the

location of any low points in control devices when assessing the flow capacity of the barrier. Table 1-1 summarizes the characteristics of several typical temporary controls, including recommended maximum drainage area and maximum flow-through rate.

Summary Check List

Upon completing the design of the temporary controls the engineer should check the design for compliance with the following list of guidelines:

- Control devices shall be located as close as possible to the source of sediment.
- They shall be situated to catch runoff prior to its entering drainage ways.
- Controls shall be located approximately perpendicular to the direction of runoff flow for effective interception.
- Controls shall be used within their drainage acreage limits.
- Controls shaped to create detention areas shall have adequate space behind them for ponding of water and sediment accumulation including the volume of soil that can be transported by the 10-year, 24-hour storm (using MUSLE procedures).
- Perimeter controls shall be installed along the contour, if possible, to evenly spread the detained runoff. When their function is to divert water to another location, the control should gently slope downhill and the design shall include additional controls to slow velocity and prevent erosion along the flow path of the diversion.
- Detention controls that cannot be installed along the contour shall have reinforced low points to protect against washouts from concentrated flow.
- Controls shall be located in areas that allow access for removal of sediment accumulations.
- Controls shall not be located in areas where they will be frequently disturbed during construction.
- Controls shall not be located where they will cause a flooding problem to adjacent property or rights-of-way.
- When controls must be removed to accommodate equipment, they shall be restored at the end of each working day.

It is recommended that the designer also review site management practices (as stated in 1.4.4 B) in conjunction with the final temporary erosion and sedimentation control design.

C. **Plan Review Procedures.**

According to the Land Development Code, designs for erosion and sedimentation controls included with subdivision, site plan or site development permit applications will be reviewed by the ~~Watershed Protection and~~ Development Services ~~Review~~ Department. General criteria for review of plans are provided below. Reviewers shall not approve plans unless satisfied that the specific and general criteria provided in ECM 1.4 have been demonstrated and certified by a Licensed Professional Engineer (TX) or a Certified Professional in Erosion and Sedimentation Control (CPESC).

In addition, for all plans, the applicant must post fiscal surety, consisting of a letter-of-credit, cash, or a bond, for the cost of the erosion and sedimentation controls proposed for the site and the anticipated cost of clean-up of a sediment discharge as outlined in Appendix S. This money may be used by the city to provide controls, if the contractor does not properly install or maintain the temporary controls; it may be used to complete the revegetation of a site if the owner refuses or is unable to do so; it may be used to clean-up any on-site or off-site sediment spills that degrade public or private property if the contractor refuses to abide by the clean-up plan specified by the ~~Watershed Protection and~~ Development Services ~~Review~~ Department. This fiscal surety must be approved and accepted by the Watershed Protection and Development Review Department prior to final approval of the plans

D. **Procedures During Construction.**

5. Project Release or Acceptance by the City.

Upon completion of the site construction and revegetation of a project site, the design engineer shall submit an engineer's letter of concurrence to the ~~Watershed Protection and~~ Development Services ~~Review~~ Department indicating that construction, including revegetation, is complete and in substantial conformity with the approved plans. After receiving this letter, a final inspection will be scheduled by the appropriate city inspector.

As part of the final inspection, the city will inspect for the following environmental requirements:

- Determine that grass coverage and revegetation, including type of grasses, topsoil, temporary and permanent stabilization, are complete and in accordance with the plan requirements,

- Determine that all drainage facilities, including water quality facilities and permanent structural controls, are installed in accordance with the plans. Any water quality facilities with sediment deposits will not be accepted until the contractor cleans the facilities and re-installs the appropriate media such that it is per specifications of ECM 1.6.7.

- Note any unauthorized disturbance of the site or vegetation and ensure that all disturbed areas, including haul roads and spoil sites are revegetated.

- Determine that all special environmentally related requirements, such as replacement trees and buffer zone restoration, are complete.

- Note all temporary erosion and sedimentation control measures that will still be required due to incomplete revegetation. All controls and sediment must be removed upon the completion of revegetation and before the full fiscal deposit for erosion and sedimentation controls is released through the ~~Watershed Protection and~~ Development Services ~~Review~~ Department

When all revegetation is completed as required by the plans and specifications the project can be certified for acceptance.

Developer's Contracts

Section 25-8-181 of the Land Development Code requires that a separate and enforceable agreement to ensure revegetation be signed by the city and the developer of a project if maintenance responsibility for constructed facilities is accepted, or a temporary certificate of occupancy is issued, by the city before the required revegetation coverage is complete.

This agreement is in the form of a standard Developer's Contract in which the developer agrees to complete the required revegetation within a specified period of time, normally a 4-month period. The contract is tied to a fiscal surety in the form of a letter of credit, a cash deposit, or a bond. The amount of this fiscal surety is determined by the amount of disturbed area that will be required to be revegetated for the project. All areas disturbed as part of the project and any adjacent areas that were disturbed by the construction of the project will be required to be revegetated. The Contract states that if the required revegetation is not completed within the specified period of time, the city will use the deposited funds to ensure revegetation is completed.

The city can consider longer Developer's Contract periods for projects accomplishing revegetation with native grasses. The factors that will be considered for approval of longer revegetation periods than four months will be: (a) the erosion and sedimentation potential of a particular project area which will be exposed to erosion for a longer period of time (temporary erosion and sedimentation measures must be constantly maintained until completion), (b) the use of only minimum amounts of topsoil to reduce erosion potential, (c) postponement of initial seeding until a more suitable seasonal time, (d) the good faith effort on the part of the developer/owner to accomplish project completion and revegetation as soon as practically possible.

Upon satisfactory completion of any outstanding items identified by the inspector, final release or acceptance of the project can occur.

1.4.5 - Temporary Structural Practices

H. **Triangular Sediment Filter Dikes.** (See Standard Specifications manual item 648S and ~~Specifications~~ Standards manual item 648S for detail)

1. Description.

   A temporary barrier constructed of wire mesh and geotextile fabric, installed along a flat area.

2. Purpose.

   The purpose of a triangular sediment filter dike is to intercept and detain water-borne sediment from a stabilized construction entrance, roadway utility work, small utility repairs, underground storage tank removals, or minor redevelopment projects.

3. Conditions Where Practice Applies.

   The triangle sediment filter dike is used where:

   • There is no concentration of water in a channel or other drainage way above the barrier, and

   • If concentrated flow occurs after installation, corrective action must be taken such as placing rock berms in the areas of concentrated flow.

   • Contributing drainage area is limited to sheetflow from the stabilized construction entrance. Additionally, the triangle sediment filter dike should be placed across the construction entrance(s) at the end of the day to form a continuous perimeter sedimentation control in conjunction with other approved perimeter controls.

- There is work within a parking lot covered with asphalt, the dike should be placed on the asphalt and the skirt weighed down with rock or a continuous wood strip nailed to the asphalt.

- There is roadway or small utility work. The dike should be placed to intercept stormwater prior to entering the inlet.

- There is underground storage tank removal or installation.

- There is minor redevelopment on a site and no other types of sediment control are feasible.

4. Design Criteria.

   - See City of Austin Standard Specification 628S.

I. **Hay Bale Dikes.** (See Standard Specifications manual item 628S and ~~Specifications~~ Standards manual item 628S-1 for detail)

1. Description.

   A temporary barrier constructed with hay bales with a life expectancy of two (2) months or less.

2. Purpose.

   The purpose of a hay bale dike is to intercept and detain small amounts of sediment from unprotected areas of limited extent. The use of this type of sediment control is only acceptable for above ground and underground storage tank construction or removal projects.

3. Conditions Where Practice Applies.

   The hay bale dike is used where:

   - No other practice is feasible, and

   - There is no concentration of water in a channel or other drainage way above the barrier and

   - If concentrated flow occurs after installation, corrective action must be taken such as placing rock berms in the areas of concentrated flow.

   - Construction activities and revegetation will be completed in three (3) months or less.

   - Contributing drainage area is less than 2,500 square feet.

4. Design Criteria.

   A design is not required. The following criteria shall be observed:

   All bale dikes shall be placed on the contour. Bales shall be embedded a minimum of four (4) inches and securely anchored using 3/8 inch diameter rebar stakes driven through the bales. Bales that are not able to be imbedded and are place on impervious cover should be placed level with the concrete and have all bales butted end to end with no voids or gaps between them. Bales shall be bound by either wire or nylon string. Jute or cotton binding is unacceptable. Bales shall be replaced every two (2) months or more often during wet weather when loss of structural integrity is accelerated.

Q. **Dust Control.**

1. Description.

Controlling dust movement on construction sites and roads.

2. Purpose.

To prevent blowing and movement of dust from exposed soil surfaces, reduce on and off-site damage, health hazards and improve traffic safety.

3. Conditions Where Practice Applies.

This practice is applicable to areas subject to dust blowing and movement where on and off-site damage is likely without treatment.

4. Procedures

a. Temporary Methods.

i. Mulching - See Section 1.4.5.A.

ii. Vegetative Stabilization - See Section 1.4.7.

iii. Tillage - To roughen surface and bring clods to the surface. This is an emergency measure which should be used before soil blowing starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, spring-toothed harrows and similar plows are examples of equipment which may produce the desired effect.

iv. Irrigation - Site is sprinkled with water until the surface is moist. Repeat as needed.

v. Barriers - Solid board fences, snow fences, burlap fences, crate walls, bales of hay, and similar materials can be used to control air currents and soil blowing. Barriers placed at right angles to prevailing currents at intervals of about 15 times their height are effective in controlling soil blowing.

vi. Alternative dust control methods must be approved by the Environmental Inspector prior to use.

1.4.8 - Special Practices

~~B. **Protection of Trees in Construction Areas.**~~

~~1. Description.~~

~~Protection of desirable trees from mechanical and other injury while the land is being converted to urban use.~~

~~2. Purpose.~~

~~To employ the necessary protective measures to insure the survival of desirable trees for shade, beautification and vegetative cover.~~

~~3. Conditions Where Practice Applies.~~

~~On areas now occupied by single specimen trees or groups of trees.~~

~~• Criteria for deciding upon the trees to leave:~~

- Aesthetic values: Consideration should be given to autumn foliage, flowering habits, bark and crown characteristics and type of fruit.

- Freedom from disease and rot.

- Life span of trees: Some are considered short-lived trees.

- Wildlife values: Oaks, hickories, dogwoods, etc., have a high food value.

- Comfort index: Summer temperatures are generally ten (10) degrees cooler under stands of hardwoods than cedars.

- Sudden exposure: To direct sunlight and ability to withstand radiated heat from proposed buildings and pavement.

- Space needed: For future growth and relationship to structures, electric and telephone lines, water and sewer lines, driveways and streets. Mark trees with bright paint or ribbon so there is no doubt as to which trees are to be left and protected from damage during construction.

C. **Dust Control.**

1. Description.

Controlling dust movement on construction sites and roads.

2. Purpose.

To prevent blowing and movement of dust from exposed soil surfaces, reduce on and off-site damage, health hazards and improve traffic safety.

3. Conditions Where Practice Applies.

This practice is applicable to areas subject to dust blowing and movement where on and off-site damage is likely without treatment.

4. Procedures

• Temporary Methods.

- Mulches - See Section 1.4.5.

- Vegetative Cover - See Section 1.4.7.

- Spray-on Adhesives - On mineral soils (not effective on muck soils). Keep traffic off these areas.

TABLE 1-5
SPRAY-ON ADHESIVES

	Water Dilution	Type of Nozzle	Apply-Gallons/Acre
Anionic asphalt emulsion	7:1	Fine Spray	1,200

Latex emulsion	12½ :1	Fine Spray	235
Resin-in-water emulsion	4:1	Fine Spray	300
Source: City of Austin			

- Tillage - To roughen surface and bring clods to the surface. This is an emergency measure which should be used before soil blowing starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, spring-toothed harrows and similar plows are examples of equipment which may produce the desired effect.

- Irrigation - This is generally done as an emergency treatment. Site is sprinkled with water until the surface is moist. Repeat as needed.

- Barriers - Solid board fences, snow fences, burlap fences, crate walls, bales of hay and similar materials can be used to control air currents and soil blowing. Barriers placed at right angles to prevailing currents at intervals of about 15 times their height are effective in controlling soil blowing.

Other methods must be approved

- Permanent Methods.

  - Permanent Vegetation - See Section 1.4.7.

  - Stone - Cover surface with crushed stone or coarse gravel.

FIGURES TO BE REMOVED

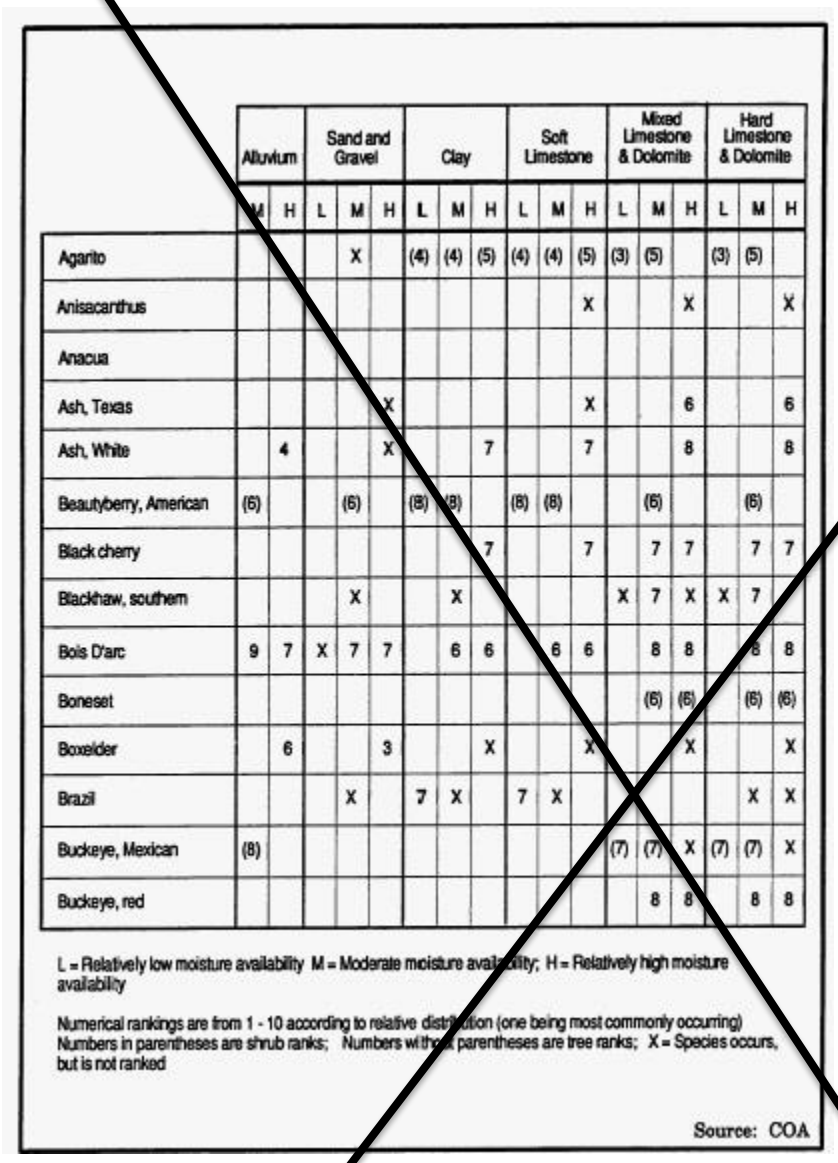
APPENDIX V - FIGURES AND DIAGRAMS

Figure 1-35 Rock Types, Soils, Topography and Characteristic Vegetation

ROCK UNIT	SOILS	CHARACTERISTIC VEGETATION	VEGETATION
Sandy Alluvium	Red-Brown to gray sandy loam and gravelly sand	Cottonwood sycamore, willow, ash, pecan	Broad, flat flood plain
Clayey alluvium	Gray clay and clay loam, calcareous	Cottonwood sycamore, ash, pecan	Broad, flat flood plain
Sand and gravel	Red-brown and brown sandy loam and gravelly sand less than 20 in deep	Post oak and blackjack oak, elm dominant on many tributary deposits	Broad, flat terraces, upper levels are dissected
Clay	Brown, dark-gray, and olive, calcareous clays and clay loams	Grasses and mesquite	Rolling prairies 12 to 36 in deep
Soft limestone	Dark-brown to gray-brown, calcareous silty loams, 7 to 65 in. deep	Live oak, juniper	Moderately dissected
Mixed limestone and dolomite	Dark-brown to gray-brown, calcareous silty clays; clay loams and stony clays less than 20 in. deep; locally absent	Juniper, live oak, cedar elm, hack-berry, persimmon	Moderately to deeply dissected, stairstep topography
Hard limestone and dolomite	Red-brown and brown, calcareous clays & stony clays, less than 20 in. deep; locally absent	Oak, juniper, cedar elm, hack-berry, persimmon	Moderately to deeply dissected
Basalt	Dark-brown, non-calcareous clay with basalt rock fragments	Grasses	Too local for characterization
Altered volcanic rocks	Dark-brown, non-calcareous clay, 12 to 30 in. deep	Grasses and mesquite	Too local for characterization

SOURCE: Adapted from Garner, 1973;1974

Figure 1-42 Vegetation, Rock Types and Topography Correlations



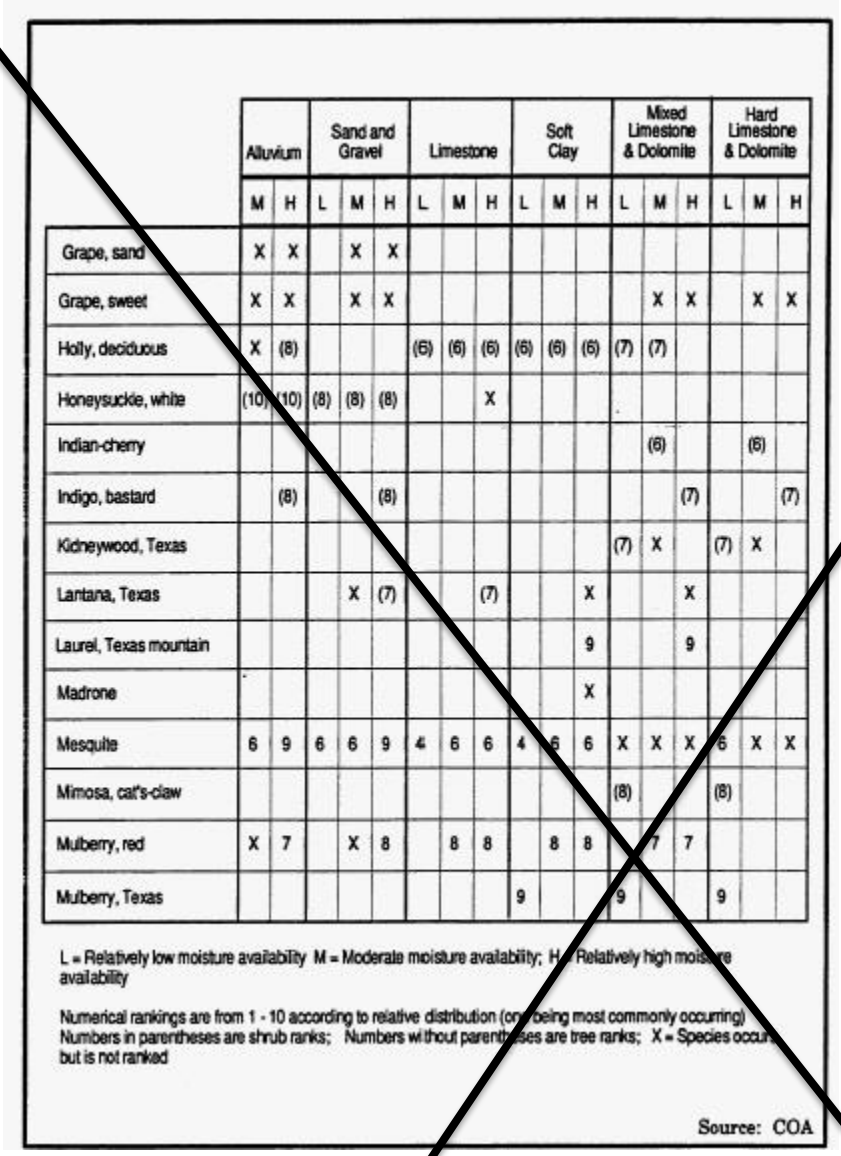
	Alluvium		Sand and Gravel			Clay			Soft Limestone			Mixed Limestone & Dolomite			Hard Limestone & Dolomite		
	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Agarito				X		(4)	(4)	(5)	(4)	(4)	(5)	(3)	(5)		(3)	(5)	
Anisacanthus											X			X			X
Anacua																	
Ash, Texas					X						X			6			6
Ash, White		4			X			7			7			8			8
Beautyberry, American	(6)			(6)		(8)	(8)		(8)	(8)			(6)			(6)	
Black cherry								7			7		7	7		7	7
Blackhaw, southern				X			X					X	7	X	X	7	
Bois D'arc	9	7	X	7	7		6	6		6	6		8	8		8	8
Boneset													(6)	(6)		(6)	(6)
Boxelder		6			3			X			X			X			X
Brazil				X		7	X		7	X						X	X
Buckeye, Mexican	(8)											(7)	(7)	X	(7)	(7)	X
Buckeye, red													8	8		8	8

L = Relatively low moisture availability M = Moderate moisture availability; H = Relatively high moisture availability

Numerical rankings are from 1 - 10 according to relative distribution (one being most commonly occurring) Numbers in parentheses are shrub ranks; Numbers without parentheses are tree ranks; X = Species occurs, but is not ranked

Source: COA

Figure 1-42 Vegetation, Rock Types and Topography Correlations (Continued)



	Alluvium		Sand and Gravel			Limestone			Soft Clay			Mixed Limestone & Dolomite			Hard Limestone & Dolomite		
	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Grape, sand	X	X		X	X												
Grape, sweet	X	X		X	X								X	X		X	X
Holly, deciduous	X	(8)				(6)	(6)	(6)	(6)	(6)	(6)	(7)	(7)				
Honeysuckle, white	(10)	(10)	(8)	(8)	(8)			X									
Indian-cherry													(6)			(6)	
Indigo, bastard		(8)			(8)									(7)			(7)
Kidneywood, Texas												(7)	X		(7)	X	
Lantana, Texas				X	(7)			(7)			X			X			
Laurel, Texas mountain											9			9			
Madrone											X						
Mesquite	6	9	6	6	9	4	6	6	4	6	6	X	X	X	6	X	X
Mimosa, cat's-claw												(8)			(8)		
Mulberry, red	X	7		X	8		8	8		8	8		7	7			
Mulberry, Texas									9			9			9		

L = Relatively low moisture availability M = Moderate moisture availability; H = Relatively high moisture availability

Numerical rankings are from 1 - 10 according to relative distribution (one being most commonly occurring) Numbers in parentheses are shrub ranks; Numbers without parentheses are tree ranks; X = Species occurs but is not ranked

Source: COA

Figure 1-42 Vegetation, Rock Types and Topography Correlations (Continued)

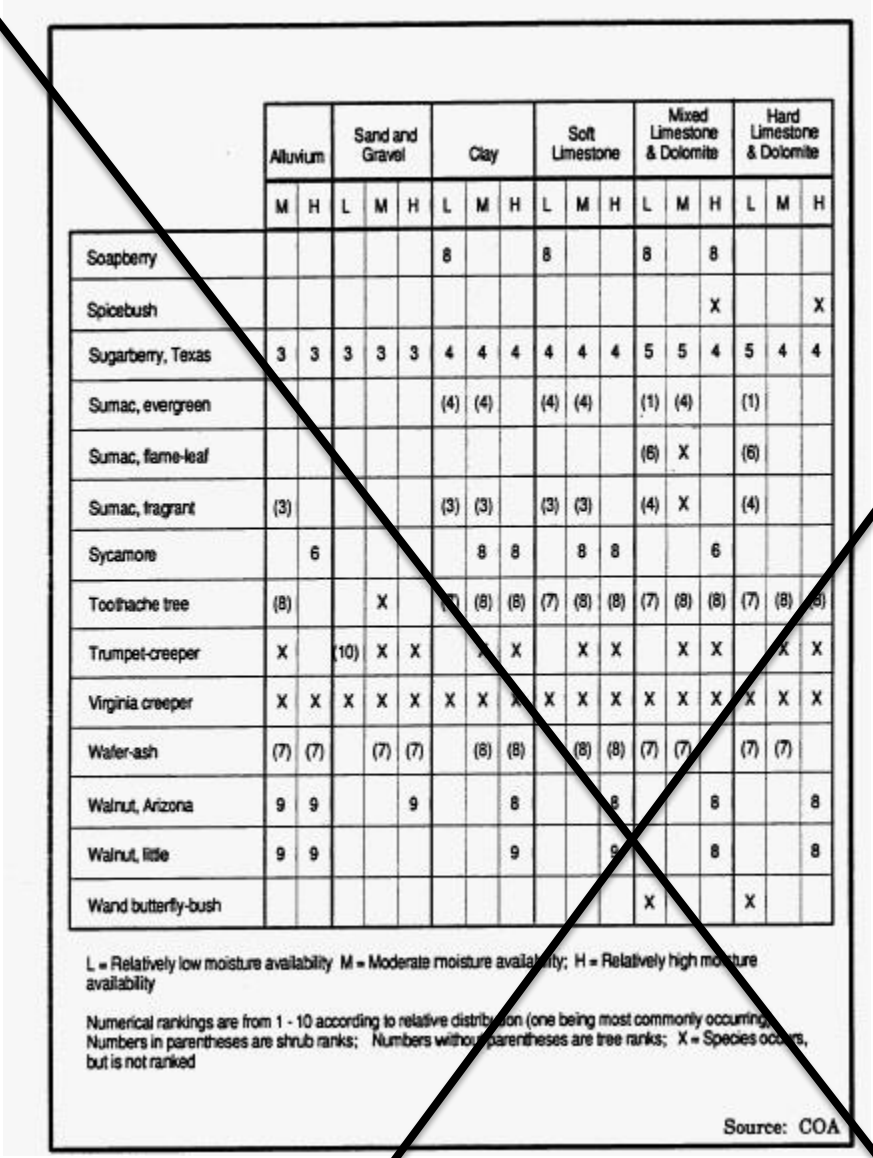
	Alluvium		Sand and Gravel			Limestone			Soft Clay			Mixed Limestone & Dolomite			Hard Limestone & Dolomite		
	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Oak, blackjack			2	2					7								
Oak, live	1	X	2	2	2	1	1	1	1	1	1	2	2	2	2	2	2
Oak, post			1	1	1	6			6						8	8	
Oak, shin	X											6	6		6	6	
Oak, mountain									X	X	X	4	4	1	4	4	1
Pecan	1	1						X			X			X			X
Pepper-vine		(8)			(8)			(8)			(8)			X			X
Persimmon, Texas				(1)		(2)	(3)		(2)	(3)		(7)	(7)	(7)	(7)	(7)	(7)
Plum, Mexican	(8)		X	X									(7)			(7)	
Poison Ivy	(3)	X	(3)	(3)	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-berried moon seed	X		X	X		X	X		X	X			X	X		X	X
Redbud	X	X	X	X	X	X	X	X		X	X	7	7	7		7	7
Silk tassel													(7)	X		(7)	X
Silverbell												X			X		

L = Relatively low moisture availability M = Moderate moisture availability; H = Relatively high moisture availability

Numerical rankings are from 1 - 10 according to relative distribution (one being most commonly occurring) Numbers in parentheses are shrub ranks; Numbers without parentheses are tree ranks; X = Species occurs, but is not ranked

Source: COA

Figure 1-42 Vegetation, Rock Types and Topography Correlations (Continued)



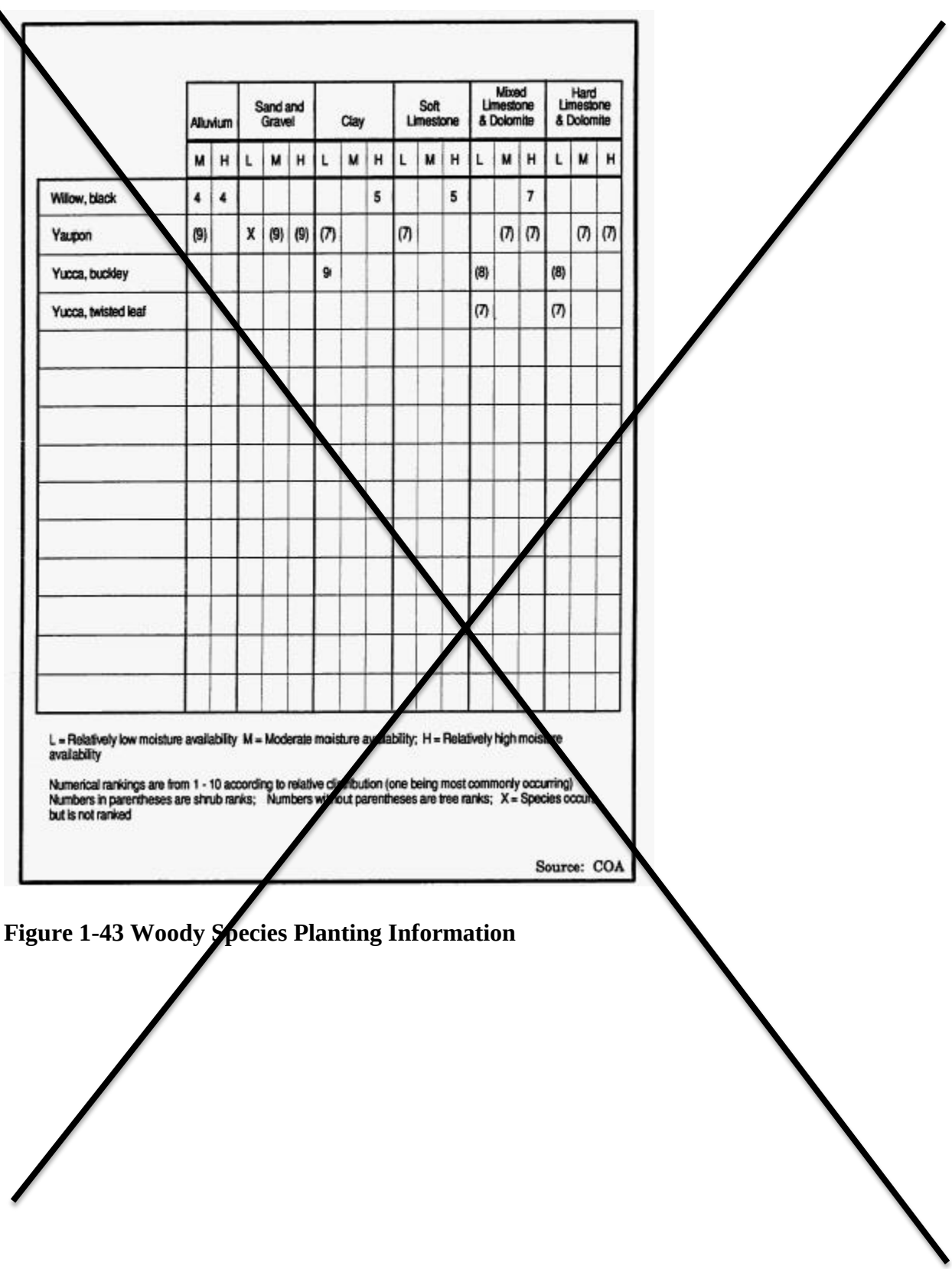
	Alluvium		Sand and Gravel			Clay			Soft Limestone			Mixed Limestone & Dolomite			Hard Limestone & Dolomite		
	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Soapberry						8			8			8		8			
Spicebush														X			X
Sugarberry, Texas	3	3	3	3	3	4	4	4	4	4	4	5	5	4	5	4	4
Sumac, evergreen						(4)	(4)		(4)	(4)		(1)	(4)		(1)		
Sumac, flame-leaf												(6)	X		(6)		
Sumac, fragrant	(3)					(3)	(3)		(3)	(3)		(4)	X		(4)		
Sycamore		6					8	8		8	8			6			
Toothache tree	(8)			X		(8)	(8)	(8)	(7)	(8)	(8)	(7)	(8)	(8)	(7)	(8)	(8)
Trumpet-creeper	X		(10)	X	X		X	X		X	X		X	X		X	X
Virginia creeper	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wafer-ash	(7)	(7)		(7)	(7)		(8)	(8)		(8)	(8)	(7)	(7)		(7)	(7)	
Walnut, Arizona	9	9			9			8			8			8			8
Walnut, little	9	9						9			9			8			8
Wand butterfly-bush												X			X		

L = Relatively low moisture availability M = Moderate moisture availability; H = Relatively high moisture availability

Numerical rankings are from 1 - 10 according to relative distribution (one being most commonly occurring). Numbers in parentheses are shrub ranks; Numbers without parentheses are tree ranks; X = Species occurs, but is not ranked

Source: COA

Figure 1-42 Vegetation, Rock Types and Topography Correlations (Continued)



	Alluvium		Sand and Gravel			Clay			Soft Limestone			Mixed Limestone & Dolomite			Hard Limestone & Dolomite		
	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Willow, black	4	4						5			5			7			
Yaupon	(9)		X	(9)	(9)	(7)			(7)				(7)	(7)		(7)	(7)
Yucca, buckley						9						(8)			(8)		
Yucca, twisted leaf												(7)			(7)		

L = Relatively low moisture availability M = Moderate moisture availability; H = Relatively high moisture availability

Numerical rankings are from 1 - 10 according to relative distribution (one being most commonly occurring) Numbers in parentheses are shrub ranks; Numbers without parentheses are tree ranks; X = Species occurs but is not ranked

Source: COA

Figure 1-43 Woody Species Planting Information

Common Name	Form	Transplanting			Spacing (Ft.)	Planting Option	Light		Soil	Habitat
		Ease	Method	Season			Sun	Shade		
Agarito	S	2	BB	W	20	1	P		Well drained	Wooded & open uplands
Anisacanthus	S	1	B	A	6	2	P		All	Floodplains & mesic slopes
Anacua	T	1	BB	W	40	2	P		Well drained	Wooded & open uplands
Ash, Texas	T	2	BB	W	20	2	P		Well drained neutral-acid	Wooded & open uplands, streams
Ash, white	T	2	BB	W	40	2	P		Moist	Streams & floodplains
Brazil	S	3	BB	W	10	1	P		Well drained	Wooded uplands
Beautyberry, American	S	1	B	W	4	2	P	T	All medium except wet	Mesic woodlands
Black-haw, southern	T	2	BB	W	6	1	P		Well drained	Streams & floodplains
Bois d'arc	T	2	BB	W	40	1	P		Well drained	Uplands & lowlands
Boneset	S	2	BB	W	3	1	P		Well drained	Streams & uplands
Box elder	T	1	B	W	40	3	P		Deep, wet	
Buckeye, Mexican	S	2	BB	W	15	1	P		Well drained	Streams & mesic slopes
Buckeye, red	S	2	BB	W	4	1	T	P	Well drained	Streams & mesic slopes
Button bush	S	2	B	W	3	1	P		Wet areas	
Cat-briar	V	4	B	A	3	3	P	T	All	Wooded & open uplands & lowlands

Form: T = tree; S = shrub; V = vine
Transplanting Ease: 1 = easy; 4 = difficult
Transplanting Method: B = bare root; BB = ball and burlap

Planting Option: 1 =plant; 2 = plant unless potential seed tree is already in the area; 3 = do not plant

Source: COA

Figure 1-43 Woody Species Planting Information (Continued)

Common Name	Form	Transplanting			Spacing (Ft.)	Planting Option	Light		Soil	Habitat
		Ease	Method	Season			Sun	Shade		
Cherry, black	T	2	B	W	40	1	P	T	Well drained & fertile	Streams, mesic uplands
Colubrina, Texas	S	2	BB	W	10	1	P		Well drained	Open uplands & slopes
Coma	T	2	BB	W	20	2	P		Well drained	Wooded & open uplands & lowlands
Cottonwood, eastern	T	1	B	W	25	3	P		Fertile soil	Streams & floodplains
Cypress, bald	T	2	BB	W	40	2	P		Deep Soils	Streams
Dogwood, roughleaf	S	2	B	W	20	1	T	P	Well drained	Streams & floodplains
Elbow bush	S	1	BB	W	10	1	P		Well drained	Open uplands
Elder, common	S	1	B	A	15	2	P		All except high lime	Streams & floodplains
Elm, American	T	1	B	W	30	3	P		All	Streams & floodplains
Elm, cedar	T	2	BB	W	30	3	P		All	Wooded & open uplands & lowlands
Eve's necklace	S	3	BB	W	10	1	P		Well drained	Open uplands
False-willow	S	4	BB	W	10	3	P		All	Streams, floodplains, mesic uplands
Grape, mustang	V	3	B	W	6	3	P		All except wet	Streams, floodplains
Grape, sand	V	3	B	W	6	3	P		All except wet	Mesic uplands
Grape, sweet	V	3	B	W	6	3	P		All except wet	Streams & mesic uplands
Holly, deciduous	S	2	BB	W	15	1	P	T	Acid soils	Streams & mesic uplands

Form: T = tree; S = shrub; V = vine
Transplanting Ease: 1 = easy; 4 = difficult
Transplanting Method: B = bare root; BB = ball and burlap

Planting Option: 1 =plant; 2 = plant unless potential seed tree is already in the area; 3 = do not plant

Source: COA

Figure 1-43 Woody Species Planting Information (Continued)

Common Name	Form	Transplanting			Spacing (Ft.)	Planting Option	Light		Soil	Habitat
		Ease	Method	Season			Sun	Shade		
Indian-cherry	T	2	B	W	10	2	P		Well drained	Streams & floodplains
Indigo, bastard	S	1	B	W	10	1	P		Well drained	Streams & floodplains
Kidneywood, Texas	S	2	BB	W	5	2	P	T	Well drained	Wooded & open uplands
Lantana, Texas	S	2	BB	A	3	2	P		Well drained	Open uplands & lowlands
Laurel, Texas mountain	S	4	BB	W	15	1	P		Well drained	Upland slopes
Madrone	T	4+	BB	W	40	1	P		Well drained	Wooded uplands & slopes
Mesquite	T	3	BB	W	20	3	P		Well drained deep soils	Streams, open uplands
Mimosa, cat's-claw	S	2	BB	A	4	2	P		Well drained	Open uplands
Mulberry, red	T	1	B	W	40	3	P		Well drained	Slopes & wooded uplands
Mulberry, Texas	T	1	B	W	40	3	P		Well drained	Slopes & wooded uplands
Oak, blackjack	T	4+	BB	W	40	2	P		Well drained coarse soils	Wooded & open uplands
Oak, live	T	3	BB	W	40	3	P		All	Streams, wooded & open uplands
Oak, post	T	4+	BB	W	40	2	P		Well drained coarse soils	Wooded & open uplands
Oak, shin	T	3	BB	W	40	2	P		Well drained	Wooded uplands & lowlands
Oak, mountain	T	3	BB	W	40	2	P		Well drained	Streams, wooded uplands
Pecan	T	4	BB	W	50	2	P		Well drained	Streams & floodplains

Form: T = tree; S = shrub; V = vine
Transplanting Ease: 1 = easy; 4 = difficult
Transplanting Method: B = bare root; BB = ball and burlap

Planting Option: 1 =plant; 2 = plant unless potential seed tree is already in the area; 3 = do not plant

Source: COA

Figure 1-43 Woody Species Planting Information (Continued)

Common Name	Form	Transplanting			Spacing (Ft.)	Planting Option	Light		Soil	Habitat
		Ease	Method	Season			Sun	Shade		
Persimmon, Texas	S	3	BB	W	30	2	P		Well drained	Wooded & open uplands
Plum, Mexican	S	2	B	W	30	1	P	T	Well drained	Streams & uplands
Poison ivy	S						T	P	All	Floodplains, wooded uplands
Rattlebush	S	?	BB	W	10	3	P		Wet sands	Wet areas
Red-berried moon seed	S	1	B	W	3	2	P		Well drained	Open uplands
Redbud	T	2	B	W	40	2	P		Well drained	Streams, wooded & open uplands
Silk tassel	S	2	BB	W	10	1	P	T	Well drained	Streams & mesic uplands
Silverbell	S		BB	W	10	1	T	P	Moist	Streams
Soapberry	T	2	BB	W	15	2	P		All except wet	Wooded & open uplands
Spicebush	S	2	BB	A	4	1		P	Sandy or rocky	Streams, mesic uplands
Sugarberry, Texas	T	2	BB	W	30	3	P		All	Floodplains, wooded & open uplands
Sumac, evergreen	S	2	BB	W	3	2	P		Lime soils	Wooded & open uplands
Sumac, flame-leaf	S	1	BB	W	6	2	P		Well drained	Wooded & open uplands
Sumac, fragrant	S	1	BB	W	3	2	P		Well drained	Wooded & open uplands
Sycamore	T	2	B	W	30	3	P		All neutral to acid	Streams & floodplains
Toothache tree	S	2	BB	W	20	2	P	T	Well drained	Streams, mesic uplands

Form: T = tree; S = shrub; V = vine
Transplanting Ease: 1 = easy; 4 = difficult
Transplanting Method: B = bare root; BB = ball and burlap

Planting Option: 1 =plant; 2 = plant unless potential seed tree is already in the area; 3 = do not plant

Source: COA

Figure 1-43 Woody Species Planting Information (Continued)

Common Name	Form	Transplanting			Spacing (Ft.)	Planting Option	Light		Soil	Habitat
		Ease	Method	Season			Sun	Shade		
Wafer-ash	S	2	BB	W	10	2	P		Well drained	Streams, wooded & open uplands
Walnut, Arizona	T	4	B	W	40	1	P		Well drained sands & loams	Streams and canyons
Walnut, little	T	4	B	W	20	1	P		Well drained sands & loams	Floodplains & streams
Wand butterfly-bush	S	2	BB	A	4	1	P		Well drained	Rocky ledges, slopes
Willow, black		1	B	W	20	3	P		Wet soils	Streams & floodplains
Yaupon	S	2	BB	W	6	2	P	T	Well drained	Streams, wooded & open uplands

Form: T = tree; S = shrub; V = vine
Transplanting Ease: 1 = easy; 4 = difficult
Transplanting Method: B = bare root; BB = ball and burlap

Planting Option: 1 =plant; 2 = plant unless potential seed tree is already in the area; 3 = do not plant

Source: COA