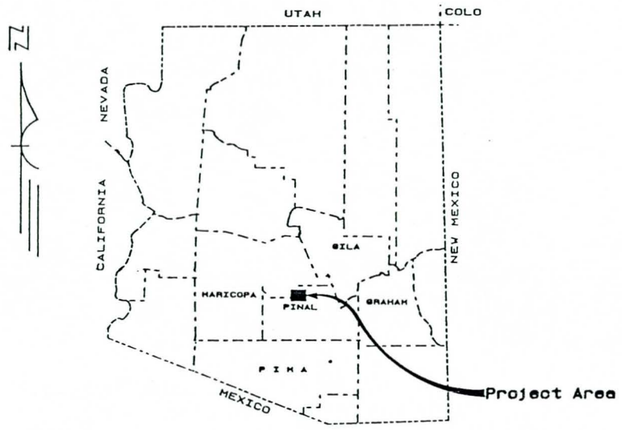
East Maricopa Floodway

Reach 3 Bank Erosion Study Sites



ARIZONA

WILLIAMS-CHANDLER WATERSHED PROTECTION AND FLOOD PREVENTION PROJECT

MARICOPA COUNTY, ARIZONA

PLANS FOR THE CONSTRUCTION OF EAST MARICOPA FLOODWAY BANK EROSION STUDY SITES

PREPARED FOR THE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
EAST MARICOPA NATURAL RESOURCE CONSERVATION DISTRICT
BY
SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

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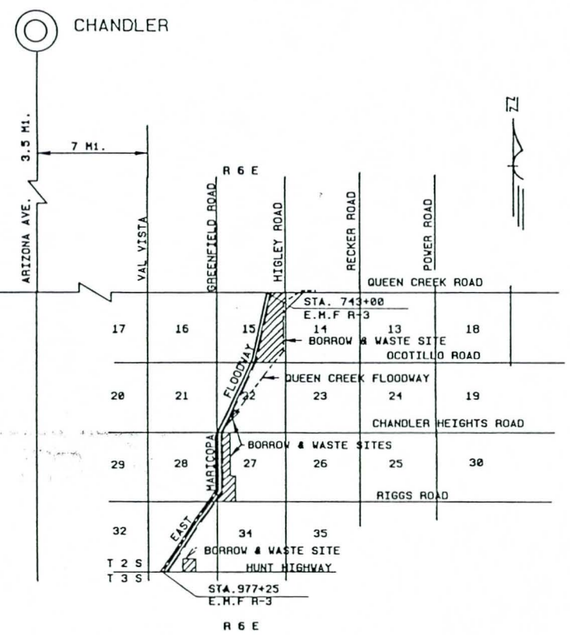
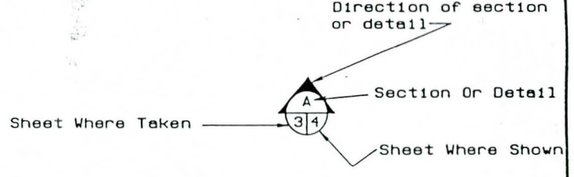
2801 W. Durango
Phoenix, AZ 85009

AS BUILT
CONTRACT NO.
50-9457-9-564
CONTRACTOR:
CONSTRUCTION CONSULTANTS
4420 N. HIGHWAY DR.
TUCSON, AZ 85705
CONTRACT OFFICER
CAROL HARRIS
GOV. REPRESENTATIVE
& CONST. INSPECTOR
JOHN HARRINGTON
DATE COMPLETED
OCT-24-1989



PROJECT LOCATION

Direction of section or detail



INDEX OF DRAWINGS

SHT. NO.	TITLE
1.	INDEX OF DRAWINGS & LOCATION MAP
2.	LOCATION OF STUDY SITES
3.	LOCATION OF STUDY SITES
4.	SECTION DETAILS-STUDY SITES NO.1, NO.2, NO.3 AND NO.4
5.	SECTION DETAILS-STUDY SITES NO.5, NO.6 AND NO.7

STUDY SITES AND RELATED WORK

SITE NO.	GENERAL DESCRIPTION OF WORK
1.	Improve slope, seed, and install erosion control blankets.
2.	Improve slope only.
3.	Improve slope, seed, and apply tackifier.
4.	Fill rills with 3-inch minus gravel.
5.	Seed and place gravel material 3-inches deep on slope.
6.	Place a sand filter 3-inches thick and cover with 3-inches of gravel on slope.
7.	Seed and place cobbles (6-inch minus) 6-inches deep on slope

GENERAL NOTES

1. All cross sections are shown looking downstream.
2. East Maricopa Floodway subsidence monument locations and elevations.

Monument	Station	Offset from fldwy C/L	Elevation
R3-6	790+00	170' East	1309.94
R3-9	830+00	170' East	1305.15
R3-17	910+00	195' East	1298.97
R3-22	960+00	170' East	1298.36
R3-19	930+00	195' East	1299.04

Note: Monuments damaged by the contractor which are outside the work limits will be replaced by the Government at the contractors expense.

EAST MARICOPA NATURAL RESOURCE CONSERVATION DISTRICT	FLOOD CONTROL DISTRICT OF MARICOPA COUNTY	REVISIONS
APPROVED DATE: 6/5/89 CHAIRMAN BOARD OF SUPERVISORS	APPROVED DATE: 5-31-89 CHIEF ENGINEER	

INDEX OF DRAWINGS &
PROJECT LOCATION MAP
EMF BANK EROSION STUDY SITES
WILLIAMS-CHANDLER WPP
MARICOPA & PINAL COUNTIES, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed	D. Paulus 1-89	Approved By	Ralph M Campbell
Drawn	B. Lloyd 1-89	Title	STATE CONSERVATION ENGINEER
Traced		Title	ASST. STATE ENGR.
Checked	D. Paulus 1-89	Sheet No. 1 of 5	Drawing No. AZ-89003 -Ch

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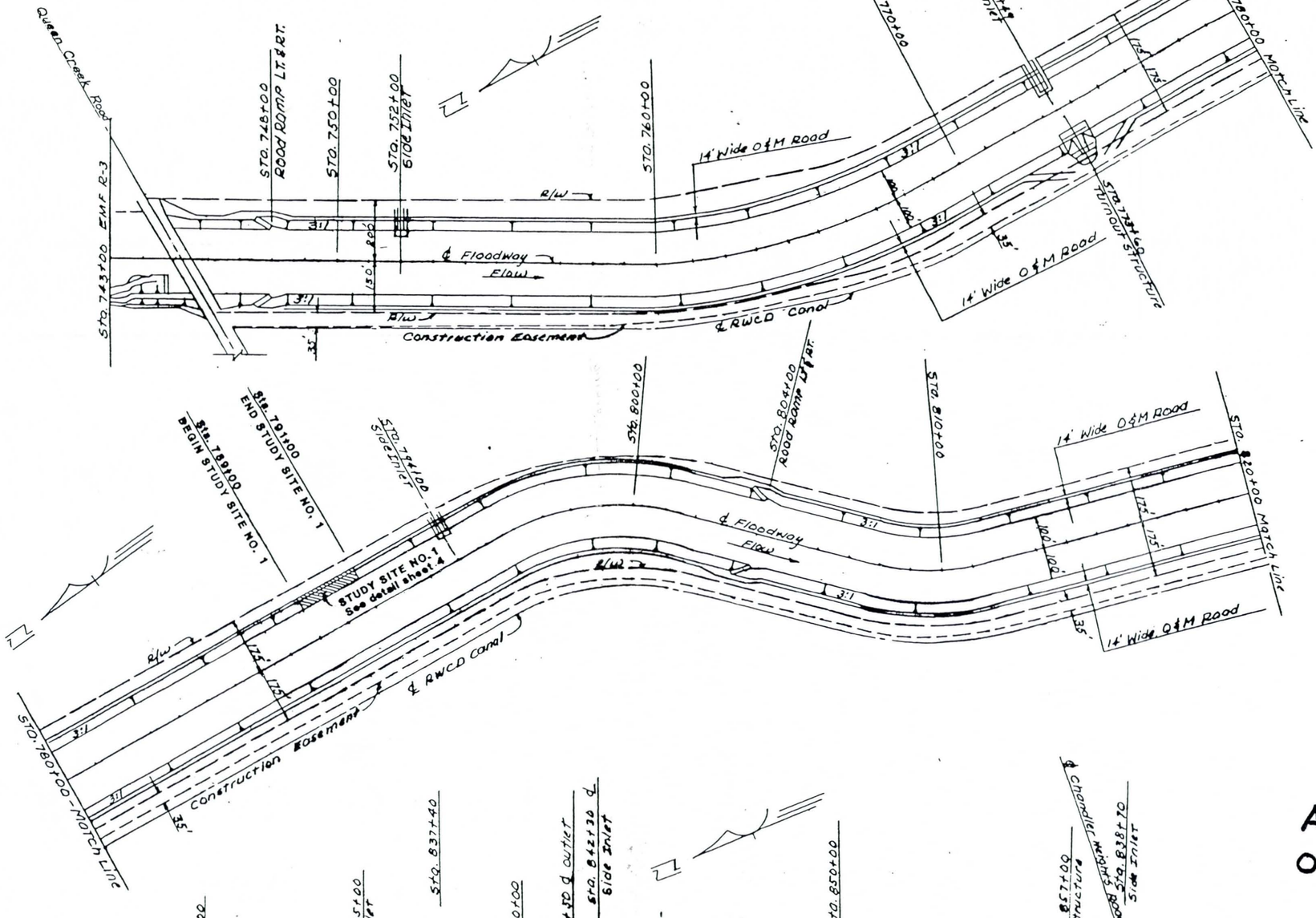


AS BUILT
OCT. 24-1989

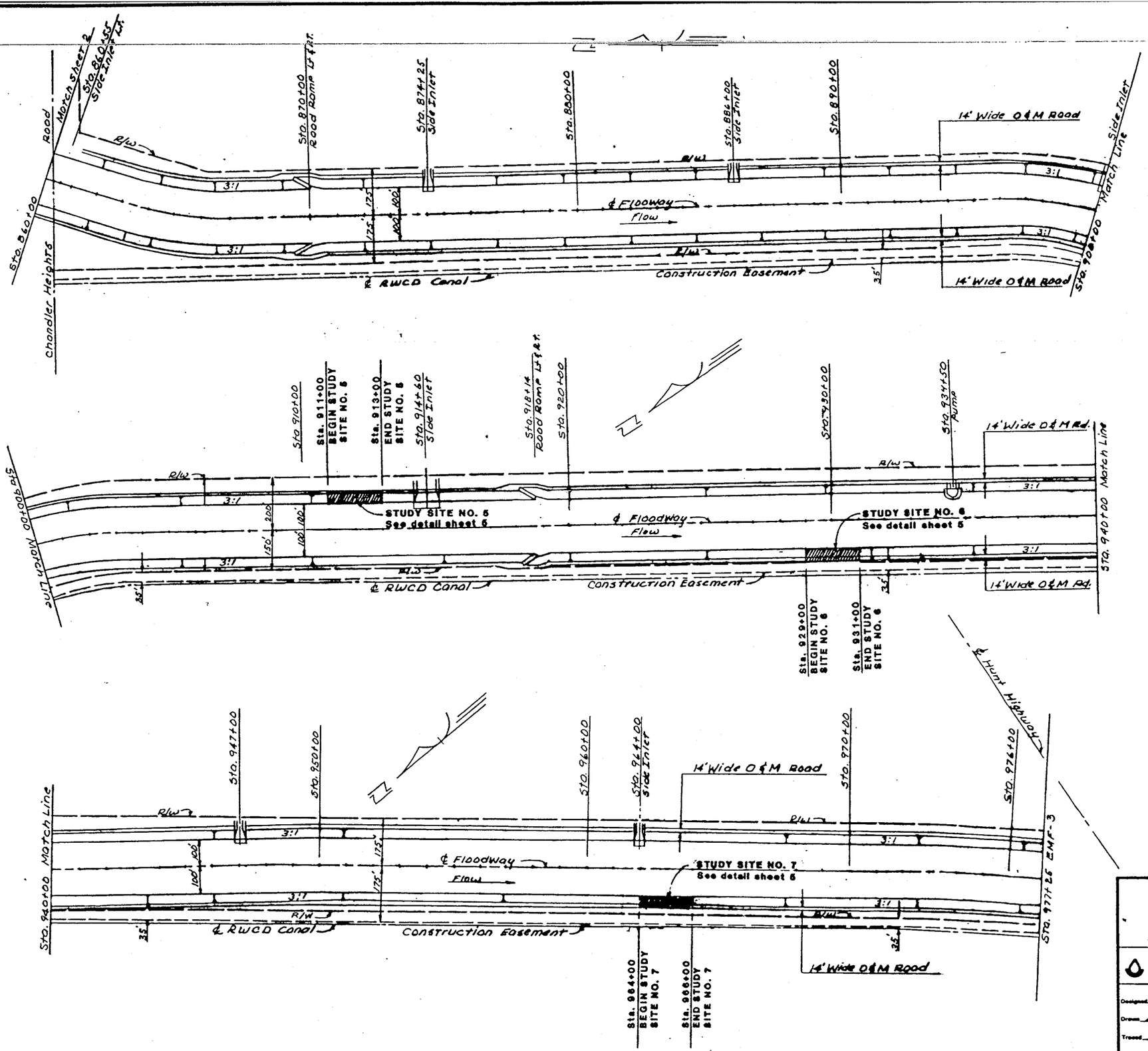
SCALE

LOCATION OF STUDY SITES
E.M.F. BANK EROSION STUDY SITES
WILLIAMS - CHANDLER W.P.P.
MARICOPA & PINAL COUNTIES ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed D. Rawlins	2-89	Approved by	
Drawn B. Lloyd	2-89	Title	
Traced		Title	
Checked		Sheet No. 4 of 5	Drawing No. AZ-89003-Ch

SCS-ENG-313C (REV. 6-71)



AS BUILT
OCT. 24 - 1989

200 100 0 200 400

SCALE

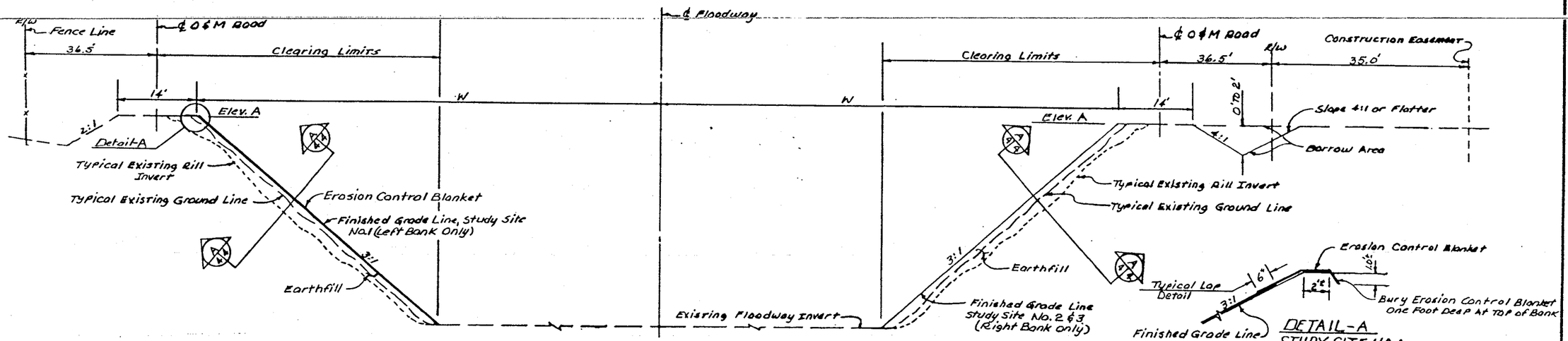
LOCATION OF STUDY SITES

E,M,F. BANK EROSION STUDY SITES
WILLIAMS - CHANDLER W.P.P.
MARICOPA & PINAL COUNTIES ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed D. Bourke	3-89	Approved by	
Drawn A. Lloyd	3-89	Title	
Traced		Title	
Checked		Sheet No. 3 of 5	Drawing No. AZ-89003-Ch

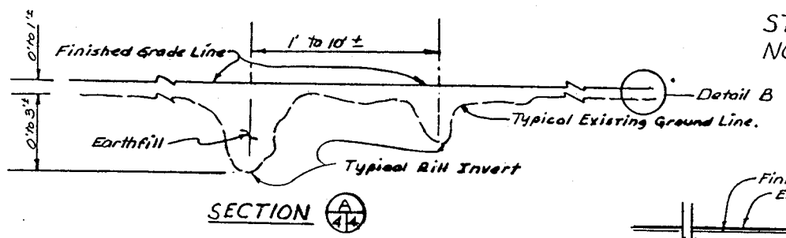
SCS-Eng-31C (REV. 6-78)



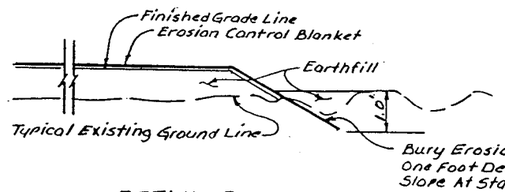
TYPICAL SECTION

STUDY SITES
NO.1, NO.2 & NO.3

DETAIL-A
STUDY SITE NO.1



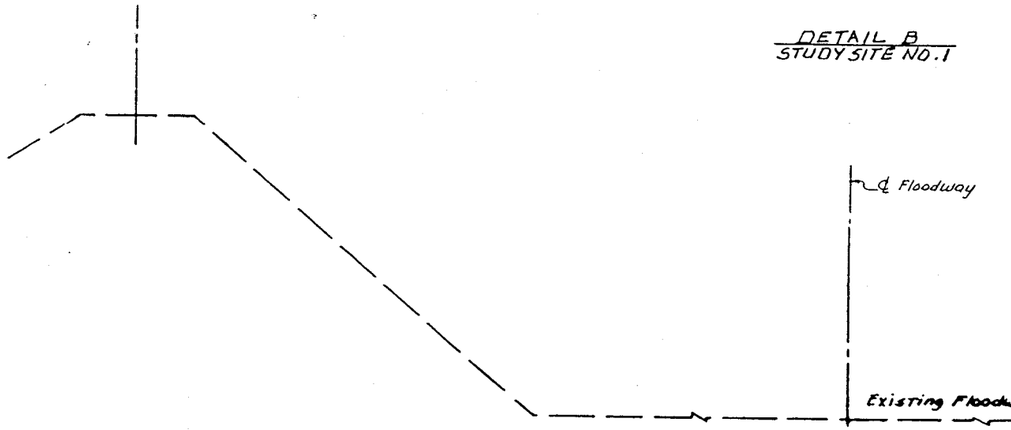
SECTION (A 4/4)



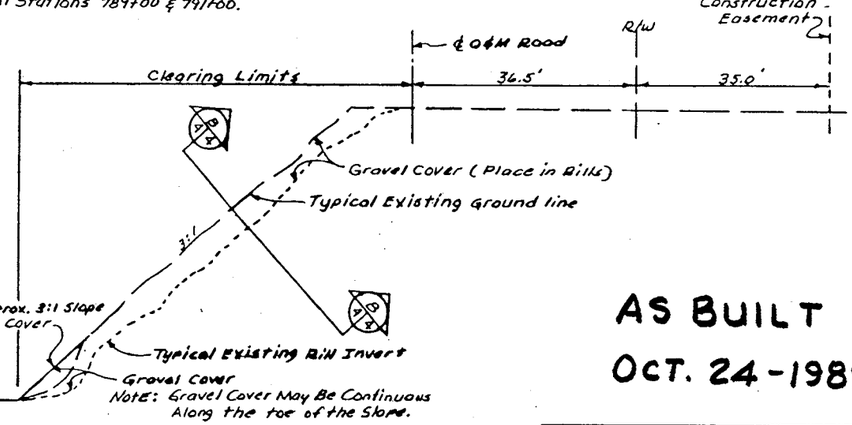
DETAIL B
STUDY SITE NO.1

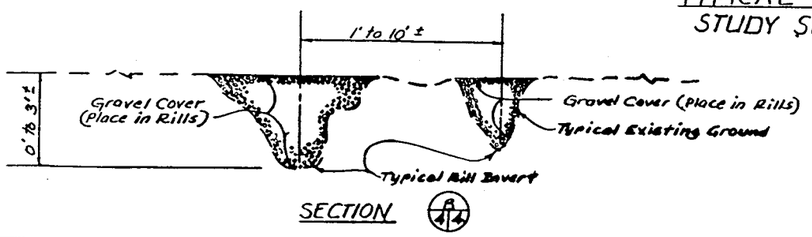
Site No.	Station To Station	W	Elev. A	Left or Right Bank	*Gravel Cover	Seed Operation
1	789+00 TO 791+00	131.5	1308.7	Left	——	A
2	824+00 TO 828+00	131.5	1307.6	Right	——	—
3	828+00 TO 830+00	131.5	1307.5	Right	——	B
4	830+00 TO 832+00	——	——	Right	50 C.Y. 70 TONS	—

* Excess Gravel Material Shall Be Stockpiled Near The Study Site, As Approved by The Engineer.



TYPICAL SECTION
STUDY SITE NO.4





SECTION (A 4/4)

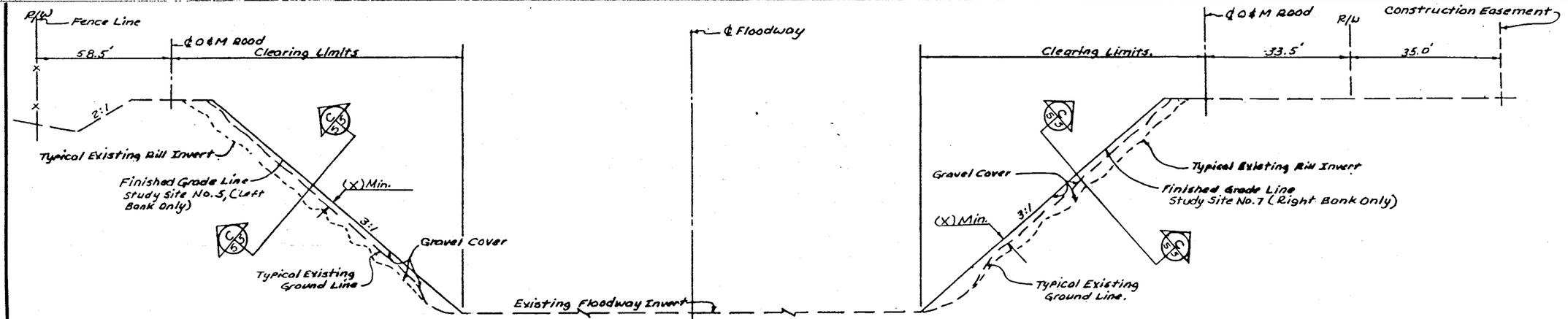
AS BUILT
OCT. 24-1989

SECTION DETAILS
STUDY SITES No.1, No.2, No.3, & No.4
E.M.F. BANK EROSION STUDY SITES
WILLIAMS - CHANDLER W.P.P.
MARICOPA & PINAL COUNTIES ARIZONA

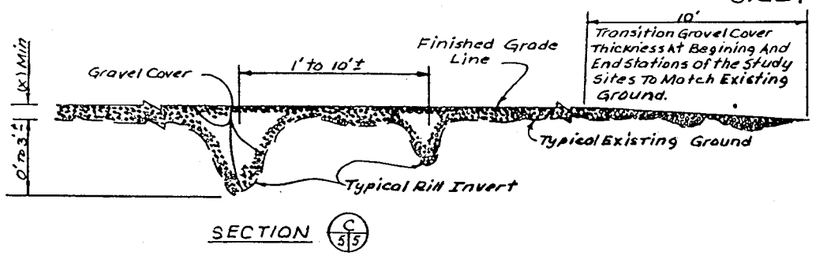
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed D. Pouliot	3-89	Approved by:
Drawn A. Lloyd	3-89	Title:
Traced		Title:
Checked		Sheet No. 4 of 5

Drawing No. AZ-89083-Ch

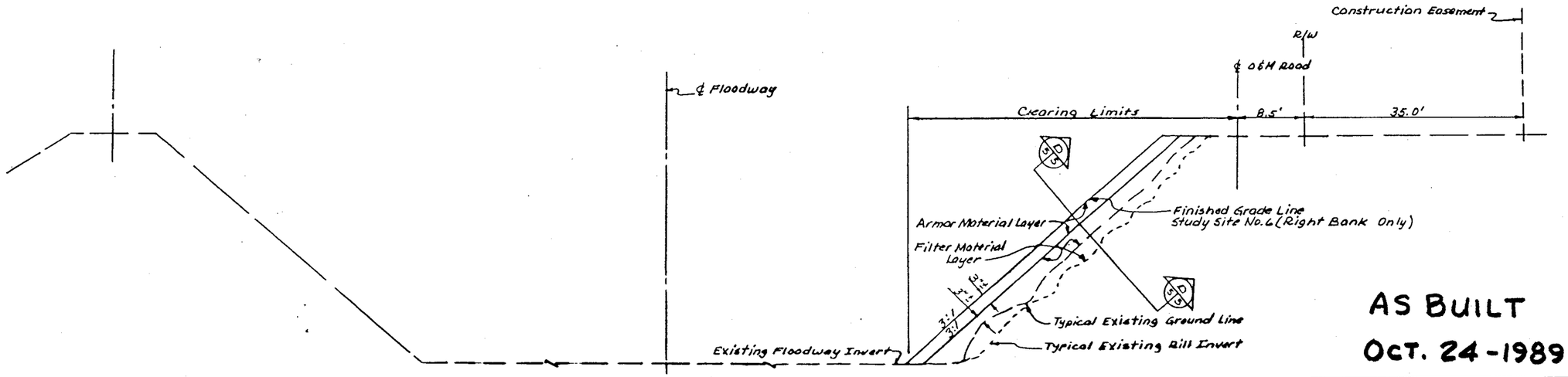


TYPICAL SECTION
STUDY SITES NO. 5 & 7

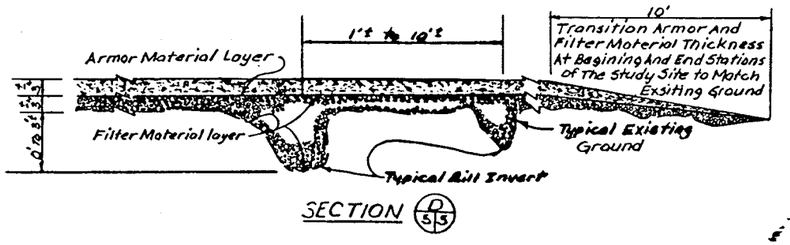


SECTION (C 5|5)

SITE NO.	Station to Station	Left or Right Bank	(X)	Gravel Cover	Filter Material	Armor Material	Seed Operation
5	911+00 to 913+00	Left	3"	185 C.Y. 225.6 TONS	—	—	C
6	929+00 to 931+00	Right	—	—	140 C.Y. 164.2 TONS	70 C.Y. 96.4 TONS	—
7	964+00 to 966+00	Right	6"	200 C.Y. 243.2 TONS	—	—	C



TYPICAL SECTION
STUDY SITE NO. 6



SECTION (D 5|5)

AS BUILT
OCT. 24-1989

SECTION DETAILS
STUDY SITES No.5, No.6, & No.7
E.M.F. BANK EROSION STUDY SITES
WILLIAMS ⌐ CHANDLER W.P.P.
MARICOPA & PINAL COUNTIES ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	Approved by:	
Designed D. Meacham	3-89	Title	
Drawn A. L. Loyd	3-89	Title	
Traced		Sheet No. 5 of 5	Drawing No. AZ-89003-Ch
Checked			

SCS-ENG-313C (REV. 6-75)

EMF Reach 3
Bank Erosion Study Sites

DESIGN FOLDER

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ARIZONA STATE OFFICE
ENGINEERING STAFF
PHOENIX, ARIZONA
March 3,1989

DESIGN REPORT

Job : Williams-Chandler WPP
Project : EMF Reach-3 Bank Erosion Study Sites
Location : Maricopa and Pinal Counties, Arizona
Authority : PL-566
Phase : Final Design

SUMMARY

Rainfall and local runoff has caused extensive and severe rilling of the floodway banks. The Flood Control District of Maricopa County, the Soil Conservation Service Arizona State Office and WNTC have determined that there is a need to evaluate alternative methods for controlling the bank erosion and determine the cost effectiveness of each method.

A preliminary review has been made on proposed erosion treatments and contracting approach. Comments have been discussed and incorporated into the final design.

DESCRIPTION OF JOB

The job consists of constructing seven study sites of alternative erosion control treatments. Treatments consist of a soil stabilizing solution, an erosion control blanket, and various gravel covers. A control site will also be constructed.

DESIGN OBJECTIVE

The design objective is to determine the most economical method to control rill erosion on the floodway banks.

BASIS FOR DESIGN

1. Soil Stabilization Products Company
2. North American Green
3. Exxon Chemical Company
4. Trip Report, to Donald E. Wallin from Clifton Deal, dated 12/22/86.
5. Trip Report, to W.R. Evans from Leland Saele, dated 10/12/88.
6. Bank Erosion Study, notes by LMS, 11/88
7. Review letter, to Ralph Arrington from W.R. Evans, dated 2/16/89.
8. Soil Mechanics Note 1
9. TR-25

LOCATION AND LAYOUT

A site investigation was made by Don Paulus, State Design Engineer, and Aubrey Sanders, State Geologist, on October 8, 1987. The plans for the construction of Reach-3 were reviewed for locations of compacted earth lining and locations of the floodway in natural cut. Within these locations seven areas were identified, visually, as having typical to extreme bank erosion. The study sites are located in these areas.

GRAVEL COVER DESIGN

A filter and armor gravel material were designed using SM-1 and TR-25. This is an ideal design which would prevent bank rill erosion due to dispersive soils, local runoff, and floodway flows. However, the base soils do not show consistent dispersive values with the amount and type of bank erosion visually observed. In addition, there is no ground water table to cause seepage problems and the permeability of the base soil is very low so that saturation will not occur during flood flows to cause a seepage problem during drawdown. Limited experience on this same floodway with pit-run sand and gravel has produced excellent results. Therefore, an armor material which includes fine grain sizes, placed in a single layer, will be used as an alternative treatment. The filter and armor design will be used as a treatment to serve a purpose similar to the control section.

Slope stability was analyzed using the Infinite Slope Method assuming a well graded, cohesionless sand and gravel mixture.

STUDY SITE DESIGN

Study site no.1: This site consists of re-establishing the floodway banks and applying an erosion control blanket, consisting of straw and coconut fibers, and seed mixture. Although establishing vegetation on channel slopes has not been very successful, it will be included for evaluation purposes.

Study site no.2: This is a control site consisting of re-establishing the floodway bank to the original design section.

Study site no.3: This site consists of re-establishing the floodway banks and applying a soil stabilizing solution. The solution will form a cohesive bond between low PI soil particles. A seed mixture has been added to be evaluated as a secondary erosion control measure.

NOTE: Borrow may be taken along the west rights-of-way. The excavated section will form a "V" which will retain local runoff water. This is not a concern, however, since berms at the slope juncture already exist and hold runoff water from flowing over the floodway banks

Study sites no.s 4,5,6 and 7: These study sites consist of applying different treatments of gravel covers. A seed mixture has been added to sites 5 and 7 which will be evaluated as a secondary erosion control measure.

NOTE: All seed will be purchased by the Government and supplied to the contractor.

SPECIFICATIONS

Interim specification 210, Construction Surveys, has been used because of the minimal staking and control required to layout the work.

Lump sum bid items have been used for each study site and are placed in both the earthfill and gravel cover specifications. In order to facilitate bidding for the unknown gravel material quantities, a required quantity has been established and is shown on the drawings. Excess material, if any, can be stockpilled and used by the FCD on the O&M roads or other maintenance applications.

COST ESTIMATE

The cost estimate includes all equipment and labor to be compensated for during the installation of all seven study sites.

This cost should be in the range of the highest bid. However, if contractor interest and competition is unfavorable to install the project, the estimate should be about average.

CONSTRUCTION SCHEDULE

Because vegetation is a secondary item to the evaluation of erosion control treatments there will not be specified seed dates. However, the project is scheduled to be awarded in September and the seed mixture was developed using this assumption.

CONSTRUCTION REVIEW

A study plan will be completed in May 1989 to establish the evaluation period, process, possible irrigation of seed, etc..

AUTHORITY

Donald J. Paulus — 3/9/89

Submitted (Head of Design) — Date

Ralph W. Armagh — 3-9-89

Approved (State Conservation Engineer) — Date

CONSTRUCTION SPECIFICATION

SPECIFICATION NO.	NAME OF SPECIFICATION	PAGES
1	Clearing	1 to 2
5	Pollution Control	1 to 3
6	Seeding, Sprigging and Mulching for Protective Cover	1 to 7
8	Mobilization	1 to 2
23	Earthfill	1 to 8
202	Gravel Cover	1 to 5

CONSTRUCTION SPECIFICATION

1. CLEARING

1. SCOPE

The work shall consist of the clearing and disposal of trees, snags, logs, brush, shrubs, stumps, and rubbish from the designated areas.

2. CLASSIFICATION

Unless otherwise specified in Section 7, clearing will be classified according to the following definitions:

Class A clearing requires that trees and other woody vegetation be cut off so that the remaining stumps extend no higher than 4 inches above the ground surface.

Class B clearing requires that trees and other woody vegetation be cut off so that the remaining stumps extend no higher than 12 inches above the ground surface.

Class C clearing requires that trees and other woody vegetation be cut off as near the ground surface as conventional tools or field conditions will permit, or as specified in Section 7 of this specification.

3. MARKING

The limits of the areas to be cleared will be marked by means of stakes, flags, tree markings or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed on the trunks at a height of about 6 feet above the ground surface.

4. CLEARING

All trees not marked for preservation and all snags, logs, brush, and rubbish shall be cleared from within the limits of the marked areas.

5. DISPOSAL

All materials cleared from the designated areas shall be disposed of in the locations and in the manner shown on the drawings, or as specified in Section 7 of this specification.

6. MEASUREMENT AND PAYMENT

Compensation for any item of work desribed in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specifiction and the construction details are:

a. Subsidiary Item, Clearing

(1) This item shall consist of clearing all areas shown on the drawings and staked in the field.

(2) Section 2, Classification, Class C shall apply.

(3) Any materials resulting from clearing operations that are to be burned shall be carried out in accordance with state, county, and local regulations. Burning shall take place in the waste areas shown on the drawings.

(4) If materials resulting from the clearing operations are disposed of by burying, they shall be buried a minimum of 24 inches below the existing ground surface in the waste areas shown on the drawings. When disposal is complete, the waste areas shall be smoothed and graded to blend with the surrounding terrain.

(5) Section 6, Measurement and Payment, no separate payment will be made for Clearing. Compensation for this work will be included in the payment for Study Site Bid Items 2, 3, 4, 5, 6, 7 and 8.

CONSTRUCTION SPECIFICATION

5. POLLUTION CONTROL

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air during construction operations in accordance with these specifications.

2. MATERIALS

All materials furnished shall meet the requirements of the Material Specifications listed in Section 8 of this specification.

3. EROSION AND SEDIMENT CONTROL MEASURES AND WORKS

The work and measures shall include but not be limited to the following, as shown on the drawings or as specified in Section 8 of this specification.

Staging of Earthwork Activities - The excavation and moving of soil materials shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.

Seeding - Seedings to protect disturbed areas shall be done as specified on the drawings or in Section 8 of this specification.

Mulching - Mulching shall be used to provide temporary protection to soil surfaces from erosion.

Diversions - Diversions shall be used to divert water away from work areas and/or to collect runoff from work areas for treatment and safe disposition.

Stream Crossings - Stream crossings shall be used where fording of streams by equipment is necessary.

Sediment Basins - Sediment basins shall be used to settle and filter out sediment from eroding areas to protect properties and streams below the construction site.

Straw Bale Filters - Straw bale filters shall be used to trap sediment from areas of limited runoff. Bales are temporary and shall be removed when permanent measures are installed.

Waterways - Waterways shall be used for the safe disposal of runoff from fields, diversions and other structures or measures.

4. CHEMICAL POLLUTION

The Contractor shall provide watertight tanks or barrels or construct a sump sealed with plastic sheets to be used to dispose of chemical pollutants (such as drained lubricating or transmission oils, greases, soaps, asphalt, etc.) produced as a by-product of the project's work. At the completion of the construction work, sumps shall be voided without causing pollution as specified in Section 8 of this specification.

Sanitary facilities such as pit toilets, chemical toilets, or septic tanks shall not be placed adjacent to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water sources. At the completion of construction work, facilities shall be disposed of without causing pollution as specified in Section 8 of this specification.

5. AIR POLLUTION

Local and state regulations concerning the burning of brush or slash or disposal of other materials shall be adhered to.

Fire prevention measures shall be taken to prevent the start or the spreading of fires which result from project work. Fire breaks or guards shall be constructed at locations shown on the drawings.

All public access or haul roads used by the contractor during construction of the project shall be sprinkled or otherwise treated fully suppress dust.

6. MAINTENANCE, REMOVAL ,AND RESTORATION

All pollution control measures and works shall be adequately maintained in a functional condition as long as needed during the construction operation. All temporary measures shall be removed and the site restored to as nearly to original conditions as practicable.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items, and the items to which they are made subsidiary, are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Pollution Control

(1) This item shall consist of all work and materials required to control or reduce pollution.

(2) Section 3, Erosion and Sediment Control Measures and Works, the Contactor may locate an equipment yard on site at an approved location that will minimize contamination of storm runoff water.

(3) Section 4, Chemical Pollution, the Contractor shall remove sanitary facilities and dispose all chemical pollutants at approved sites as required by local, State and Federal laws and regulations.

(4) Section 7, Measurement and Payment, no separate payment will be made for Pollution Control. Compensation for this work will be included in the payment for Study Site Bid Items 2, 3, 4, 5, 6, 7 and 8.

CONSTRUCTION SPECIFICATION

6. SEEDING, SPRIGGING AND MULCHING FOR PROTECTIVE COVER

1. SCOPE

The work shall consist of preparing the area for treatment, furnishing and placing seed, sprigs, mulch, fertilizer, inoculant, soil amendments, and asphalt emulsion in the designated areas as specified.

2. MATERIALS

Seed - All seed shall conform to the current rules and regulations of the state where it is being used and from the latest crop available. It shall meet or exceed the standards for purity and germination listed in Section 7.

Seed shall be labeled in accordance with the state laws and the U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act in effect on the date of invitations for bids. Bag tag figures will be evidence of purity and germination. No seed will be accepted with a date of test of more than 9 months prior to the date of delivery to the site.

Seed that has become wet, moldy, or otherwise damaged in transit or storage will not be accepted. The percent of noxious weed seed allowable shall be as defined in the current state laws relating to agricultural seeds. Each type of seed shall be delivered in separate sealed containers and fully tagged unless exception is granted in writing by the Contracting Officer.

Fertilizer - Unless otherwise specified, the fertilizer shall be a commercial grade fertilizer. The fertilizer shall meet the standard for grade and quality specified by state law. Where fertilizer is furnished from bulk storage, the Contractor shall furnish a supplier's certification of analysis and weight. When required by the contract, a representative sample of the fertilizer shall be furnished the Contracting Officer for chemical analysis.

Inoculants - The inoculant for treating legume seeds shall be a pure culture of nitrogen-fixing bacteria prepared specifically for the species and shall not be used later than the date indicated on the container or as otherwise specified. A mixing medium, as recommended by the manufacturer, shall be used to bond the inoculant to the seed. Two times the amount of the inoculant recommended by the manufacturer shall be used when seed is applied by use of a hydraulic seeder. Seed shall be sown within 24 hours of treatment and shall not remain in the hydraulic seeder longer than 4 hours.

Soil Amendments - Lime shall consist of Standard Ground Agricultural Limestone, or approved equivalent. Standard Ground Agricultural Limestone is defined as ground limestone meeting current requirements of the State Department of Agriculture.

Mulch Tackifiers - Asphalt emulsion tackifiers shall conform to the requirements of ASTM D-977, Specification For Emulsified Asphalt. The emulsified asphalt may be rapid setting, medium setting, or slow setting. Nonasphaltic tackifiers required because of environmental considerations shall be as specified in Section 7.

Straw Mulch Materials shall consist of wheat, oat, or rye straw, hay, grass cut from native grasses or other plants approved by the Contracting Officer. The mulch material shall be air dry, reasonably light in color, and shall not be musty, moldy, caked, or otherwise of low quality. The use of mulch that contains noxious weeds will not be permitted. The Contractor shall provide a method satisfactory to the Contracting Officer for determining weight of mulch furnished.

Other Mulch Materials - Mulching materials, such as wood cellulose fiber mulch, mulch tackifiers, synthetic fiber mulch, netting, and mesh are other mulching materials that may be required for specialized locations and conditions. These materials, when specified, must be accompanied by the manufacaturers' recommendations for methods of application.

3. SEEDING MIXTURES, SOD, SPRIGS AND DATES OF PLANTING

The per acre rate for seed mixtures, sprigs, or sod and date of seeding or planting shall be as shown on the vegetating plan or as specified in Section 7.

4. SEED BED PREPARATION AND TREATMENT

Areas to be treated shall be dressed to a smooth, firm surface.

On sites where equipment can safely operate, (generally slopes 2:1 or flatter), the seedbed shall be adequately loosened (4 to 6 inches deep) and smoothed. Disking or cultipacking or both may be necessary.

On sites where equipment cannot operate, the seedbed shall be prepared by hand by scarifying to provide a roughened surface so that broadcast seed will stay in place.

If seeding is to be done immediately following construction, seedbed preparation may not be required except on compacted, polished, or freshly cut area.

Rocks larger than 6 inches in diameter, trash, weeds, and other debris that will interfere with seeding or maintenance shall be removed or disposed of as directed by the Government Representative.

Seedbed preparation shall be discontinued when soil moisture conditions are not suitable for the preparation of a satisfactory seedbed as determined by the Government Representative.

5. SEEDING, SPRIGGING, FERTILIZING, MULCHING, AND STABILIZING

All seeding or sprigging operations shall be performed in such a manner that the seed or sprigs are applied in the specified quantities uniformly on the designated areas. The method and rate of seed application shall be as specified in Section 7. Unless othewise specified, seeding or sprigging shall be done within 2 days after final grading is complete.

Fertilizer and soil amendments shall be applied as specified in Section 7. When specified the fertilizer and soil amendments shall be thoroughly incorporated into the soil as soon as possible after being applied.

The rate, amount, and kind of mulching or mesh shall be as specified in Section 7. Mulches shall be applied uniformly to the designated areas, and shall be applied to the seeded areas not later than 2 work days after seeding has been performed. Straw mulch materials shall be stabilized by the use of a disk or by a suitable tackifier. A disk harrow weighing as specified in Section 7 shall have the disks set straight and the harrow shall be used to anchor the straw mulch into the soil as specified in Section 7.

The tackifier shall be applied uniformly over the mulch material at the specified rate, or by injecting it into the mulch material as it is being applied. The mesh or netting stabilizing materials shall be applied smoothly but loosely on the designated areas, and the edges shall be buried or securely anchored by means of spikes or staples as specified in Section 7.

The Contractor shall maintain the mesh or netting areas until all work on the entire contract has been completed and accepted. Maintenance shall consist of the repair of areas damaged by erosion, wind, fire, or other causes. Such areas shall be repaired to reestablish the condition and grade of the soil and shall be refertilized, reseeded, and remulched prior to the new application of the mesh or netting.

6. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsididary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Seed Operation A

(1) This item shall consist of placing the seed furnished by the government and furnishing and placing mulching material at Study Site No. 1 as specified.

(2) Section 2, materials, only seed and other mulch materials shall apply.

SEED

The seed mixture will contain the following grasses:

(a) Common Bermudagrass (Cynodon dactylon, var. dactylon)

(b) Mediterranean Ricegrass (Oryzopsis coerulescens)

(c) Threeawn (Aristida spp.)

(d) Plains Bristlegrass (Setaria macrostachya)

All seed will be furnished by the government. The contractor shall allow 20 days for delivery after the notice to proceed is issued.

The application rate of the seed listed shall be on an adjusted basis to 100% pure live seed (PLS).

MULCH

The mulch material shall be an erosion control blanket that is machine - produced and shall consist of 70% agricultural straw (0.35 lb/sq. yd). and 30% coconut fiber (0.15 lb/sq, yd).

The straw and coconut fiber shall be uniformly distributed over the entire area of the mat. The blanket shall be covered on the top and bottom with polypropylene netting having an approximate 1/2" x 1/2" mesh having a minimum weight of 1.6 lb per 1000 square feet. The blanket shall be sewn together with cotton thread.

(3) Section 3, only seeding mixtures shall apply. The per acre rate for the seed mixture shall be as follows:

SPECIES	RATES/AC (PLS)
Cynodon dactylon var. dactylon	2.2 lbs.
Oryzopsis coerulescens	6.0 lbs.
Aristida spp.	5.0 lbs.
Setaria macrostachya	12.0 lbs.

(4) Section 4, Seed Bed Preparation, the compacted finished bank slopes shall be scarified 1 to 2 inches to provide a roughened surface to ensure that broadcast seed will remain in place.

(5) Section 5, only seeding and mulching shall apply. Seed shall be placed by broadcasting. The Contractor shall submit his proposed broadcasting method to the Contracting Officer for approval 10 calendar days prior to beginning seeding operations.

The erosion control blanket installation shall proceed from the toe to the top of the bank, parallel to the direction of the floodway flow, and stapled in place using one (1), 6 inch wire staple per square yard. The blanket shall be overlapped six (6) inches at the edges and will not be stretched but allowed to lay loosely on the soil surface to achieve maximum soil contact.

(6) Section 6, Measurement and Payment, no separate payment will be made for Seed Operation A. Compensation for this work will be included in the payment for Bid Item 3, Study Site No. 1.

b. Subsidiary Item, Seed Operation B

(1) This item shall consist of placing the seed furnished by the government and furnishing and placing mulching material at Study Site No. 3 as specified.

(2) Section 2, Materials, only seed and mulch tackifier shall apply.

SEED.

The seed mixture shall conform to the requirements of Section 7.a.(2) Seed.

MULCH

The mulch shall be a soil stabilizing compound, readily miscible in water, and capable of creating a crust through the cohesive bonding of the surface soil particles. The solution shall be environmentally safe, non-injurious to seed, animal or human life, non-offensive in oder, non-flammable, non-toxic and non-corresive, and have the characteristic of being transparent after drying.

The Contractor shall submit the soil stabilizing compound material specifications to the Contracting Officer for approval 10 days prior to beginning seeding operations.

(3) Section 3, shall conform to the requirements of Section 7.a.(3).

(4) Section 4, seedbed preparation shall only consist of the operations required for Bid Item 4, Study Site No. 3.

(5) Section 5, only Seeding and Other Mulch Materials shall apply. Seed shall be placed by broadcasting. The contractor shall submit a proposed broadcasting method to the Contracting Officer for approval 10 days prior to beginning seeding operations.

The Contrator shall submit the proposed dilution ratio and application rate for the tackifier (soil stabilization solution) to the Contrating Officer for approval at least 10 days prior to beginning seeding operations. The dilution ratio and application rate shall be in accordance with the manufactures recommendations for using the soil stabilization solution as the sole treatment for combating soil erosion due to the effects of water on exposed cut and fill slopes. The soil stabilization solution shall be applied evenly such that the in place seed is not dislodged.

(6) Section 6, Measurement and Payment, no separate payment will be made for Seed Operation B. Compensation for this work will be included in the payment for Bid Item 4, Study Site No. 3.

c. Subsidiary Item, Seed Operation C

(1) This item shall consist of placing the seed furnished by the government at Study Sites No. 5 and No. 7 as specified.

(2) Section 2, shall conform to the requirements of Section 7.a.(2) Seed.

(3) Section 3, shall conform to the requirements of Section 7.a.(3).

(4) Section 4, seedbed preparation shall only consist of the operations required for Subgrade Preparation in Bid Items No. 6 and No. 7.

(5) Section 5, only seeding shall apply. Seed shall be placed on the prepared seedbed by broadcasting. The Contractor shall submit a proposed broadcasting method to the Contracting Officer for approval 10 days prior to beginning seeding operations.

(6) Section 6, Measurement and Payment, no separate payment will be made for Seed Operation C. Compensation for this work will be included in the payment for Bid Item No. 6, Study Site No. 5, and Bid Item No. 7, Study Site No. 7.

CONSTRUCTION SPECIFICATION

8. MOBILIZATION

1. SCOPE

The work shall consist of the mobilization of the Contractor's forces and equipment necessary for performing the work required under the contract. Mobilization will not be considered as work in fulfilling the contract requirement for commencement of work.

Mobilization shall include the cost for transportation of personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary facilities as the site not covered in specific bid items, and other pereparatory work at the site. The cost of the entire amount of premiums paid for performance and payment bonds, including coinsurance and reinsurance agreements as applicable shall be paid upon request when evidence of full payment to the surety has been provided to the Contracting Officer.

Work done under this specification shall not include mobilization for any specific item of work for which payment for mobilization is provided elsewhere in the contract.

The specification covers mobilization for work required by the contract at the time of award. If additional mobilization costs are incurred during performance of the contract as a result of changed or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

2. PAYMENT

Payment will be made as the work proceeds, after presentation of invoices by the Contractor showing his own mobilization costs and evidence of the charges of suppliers, subcontractos, and others for mobilization work performed by them. If the total of such payments is less than the contract lump sum for mobilization, the unpaid balance will be included in the price final contract payment. Total payment will be the lump sum contract price for mobilization, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

Payment of the lump sum contract price for mobilization will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.

3. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 1, Mobilization

(1) This item consists of the mobilization of the Contractor's equipment and forces to perform the work required under this contract.

CONSTRUCTION SPECIFICATION

23. EARTHFILL

1. SCOPE

The work shall consist of the construction of earth embankments and other earthfills required by the drawings and specifications.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Engineer.

Fill materials shall contain no sod, brush, roots or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

3. FOUNDATION PREPARATION

Foundations for earthfill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, eath foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to effect a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shll be not steeper than 1 horizontal to 1 vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. PLACEMENT

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Engineer. Fill shall not be placed upon a frozen surface, nor shall now, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exeed the maximum thickness specified. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of fill compacted by manually directed power tampers.

Adjacent to structures, fill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earthfill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.

b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.

c. The top surfaces of embankments shall be maintained approximately 8evel during construction, except that a crown or cross-slope of approximately 2 percent shall be maintained to insure effective drainage, and except as otherwise specified for drainfill or sectional zones.

d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized in the contract.

e. Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than 3 feet horizontal to 1 foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification, and shall moisture content and density at the contact of the in place and new fills."

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of fill, the moisture content of the Materials being placed shall be maintained within the specified range.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the fill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the fill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacated fill or a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall be scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

6. COMPACTION

Earthfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of fill shall be compacted as necessary to make the density of the fill matrix not less than the minimum density specified. The fill matrix is defined as the protion of the fill material finer than the maximum particle size used in the compaction test method specified.

Class B comapction. Each layer of fill shall be compacted to a mass density not less than the minimum density specified.

Class C compaction. Each layer of fill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified, or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Fill adjacent to structures shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping, or manually directed power tampers or plate vibrators. Unless otherwise specified, heavy equipment including backhoe mounted power tampers, or vibrating compactors and manually directed vibrating rollers, shall not be operated within 2 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed: (1) over cast-in-place conduits prior to 14 days after placement of the concrete; (2) over cradled or bedded precast conduits prior to 7 days after placement of the concrete cradle or bedding; or (3) over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 2 feet, whichever is greater.

Compacting of fill adjacent to structures shall not be started until the concrete has attained the strength specified in Section 10 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determing when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of fill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

Structure	Time Interval
Retaining walls and counterforts (Impact basins)	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast-in-place (with inside forms in place)	7 days
Conduits and spillway risers, cast-in-place (inside forms removed)	14 days
Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Cantilever outlet bents (Backfilled both sides simultaneously)	3 days

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE FILL

Fill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

8. TESTING

During the course of the work, the Engineer will perform such tests as are required to identify materials, to determine compaction characteristics, to determine moisture content, and to determine density of fill in place. These tests performed by the Engineer will be used to verify that the fills conform to the requirements of the specifications. Such tests are not intended to provide the Contractor with the information required by him for the proper execution of the work and their performance shall not relieve the Contractor of the necessity to perform tests for that purpose.

Densities of fill requiring Class A compaction will be determined by the Engineer in accordance with ASTM Method D 1556, 2167, 2922 or 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density or if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent compostion for comparision. The density so computed will be used to determine the percent compaction of the fill matrix. Moisture content will be determined by one of the following methods: ASTM Method D-2216, D-3017 unless otherwise specified.

9. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 2, Study Site No.2

(1) This item shall consist of ripping, borrow excavation, and the placement and compaction of earthfill to the finished grade line for the O&M road and floodway bank surfaces as shown on the drawings.

(2) The bank slope and O&M road surface shall be ripped a minimum of two (2) inches below the inverts of the rills prior to placement of earthfill.

(3) Section 2, materials, earthfill shall be obtained from the borrow areas shown on the drawings. All earth material in these areas is surplus excavated material resulting from the construction of the floodway.

(4) The borrow area along the right O&M road shall conform to the depth and slopes of the section shown on the drawings. All slopes shall be 4:1 or flatter.

Borrow taken from the borrow areas shown on the east side of the floodway shall be completed such that the final surface elevation does not vary more than 0.5 foot from the undisturbed area. All slopes resulting from borrow excavations shall be 4:1 or flatter.

(5) The maximum size rock fragment incorported in the fill shall be six (6) inches.

(6) The moisture content of the fill material shall be maintained within the limits required to: (a) prevent bulking or dilatance of the material under the action of the hauling or compacting equipment, (b) prevent the adherence of the fill material to the treads and tracks of the equipment, (c) insure the crushing and blending of the soil and aggregates into a homogeneous mass, and (d) remain intact when a small portion is taken in the hand and squeezed and released.

(7) Section 4, Placement, loose fill up to 12 inches thick may be placed in one layer on a 3:1 slope.

(8) Section 6, Compaction, Class C shall apply. The fill shall be compacted with a minimum of four (4) passes of a Caterpiller 12G motor grader or other equipment that will exert an equivalent compactive effort.

(9) Water for earthfill may be purchased from the Roosevelt Water Conservation District, Higley, Arizona (Mike Leonard - Telephone 963-3414).

(10) Section 9, Measurement and Payment, the following method shall apply. Payment for Study Site No 2 will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, and include compensation for subsidiary items; Clearing, and Pollution Control.

b. Bid Item 3, Study Site No. 1

(1) This item shall consist of ripping, borrow excavation, and the placement and compaction of earthfill to the finished grade line for the O&M road and floodway bank surfaces as shown on the drawings.

(2) Earthfill operations shall meet the requirements specified in Section 10.a. paragraphs (2) thru (9).

(3) Section 9, Measurement and Payment, the following method shall apply. Payment for Study Site No. 1 will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work and include compensation for subsidiary items; Clearing, Pollution Control, and Seed Operation A.

c. Bid Item 4, Study Site No. 3

(1) This item shall consist of ripping, borrow excavation, placement and compaction of earthfill to the finished grade line for the O&M road and floodway bank surfaces as shown on the drawings.

(2) Earthfill operations shall meet the requirements specified in Section 10.a. paragraphs (2) thru (9).

(3) Section 9, Measurement and Payment, the following method shall apply. Payment for Study Site No. 3 will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work and include compensation for subsidiary items; Clearing, Pollution Control, and Seed Operation B.

CONSTRUCTION SPECIFICATION 202
GRAVEL COVER

1. SCOPE

The work shall consist of the construction of gravel cover over slopes or on other areas that are subject to erosion.

2. MATERIALS

Gravel shall meet the requirements of Section 8 of this specifiction or be obtained from designated sources as shown on the drawings. Gravel from designated sources shall be excavated, selected, handled, and processed as necessary to meet the quality and grading requirements specified.

3. SUBGRADE PREPARATION

The subgrade surfaces shall be the neat lines and grades shown on the drawings.

Gravel cover shall not be placed until the subgrade surfaces have been inspected and approved by the Engineer.

4. PLACEMENT

The gravel cover shall be placed by equipment on the surfaces and to the depths specified in Section 8 of this specification. The cover shall be constructed to the full coarse thickness in one operation and in such a manner as to avoid serious displacement of the underlying materials. The gravel shall be delivered and placed in a manner that will ensure that the cover in-place shall be reasonably homogeneous and the fractions well distributed.

Hand placing of gravel cover shall be required to the extent necessary to prevent damage to the permanent works.

The gravel cover may be placed in sequence with the placement of earth fill zones of the embankment or after completion of the embankment. If sequential placement is used, it is emphasized that the Contractor shall complete the earthwork to the required cross-sectional line and grade prior to gravel cover placement. Contamination of earth fill zones by gravel cover placement operations will not be allowed. Surfaces of the completed gravel cover shall be finished reasonably free of mounds, dips or windrows to the lines and grades specified.

5. COMPACTION AND MOISTURE REQUIREMENTS

No compaction will be required beyond that resulting from the placing and spreading operations unless otherwise specified in Section 8 of this specification. Moisture control shall be that necessary to control dust during borrow and placing operations.

6. TESTING AND MEASUREMENTS

The Engineer will perform such tests and measurements as are required to verify that the gravel material and work meet the requirements of this specification. These tests are not intended to provide the Contractor with the information he needs to assure that the materials and workmanship meet the requirements of this specification, and their performance will not relieve the Contractor of the responsibility of performing his own tests for the purpose.

7. MEASUREMENT AND PAYMENT

Compensation for any items of work described in the contract but not listed in the Bid Schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 5, Study Site No. 4

(1) This item shall consist of furnishing and placing gravel cover to the finished grade lines for the O&M road and floodway bank surfaces as shown on the drawings.

(2) The gravel cover material shall be a GW or GW-GM as defined by the Unified Soil Classification System with a maximum size of three (3) inches. At least 10 days prior to delivery of materials to the site the Contractor shall inform the Contracting Officer of the intended source and shall allow the engineer access for inspection and sampling of materials.

(3) Section 7, Measurement and Payment, the following method shall apply. Payment for Study Site No. 4 will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, and include compensation for subsidiary items, Clearing and Pollution Control.

b. Bid Item 6, Study Site No. 5

(1) This item shall consist of furnishing and placing gravel cover to the finished grade lines for the O&M road and floodway banks surfaces as shown on the drawings.

(2) The gravel cover material shall be a GW or GW-GM as defined by the Unified Soil Classification System with a maximum size of three (3) inches. At least 10 days prior to delivery of materials to the site the Contactor shall inform the Contracting Officer of the intended source and shall allow the engineer access for inspection and sampling of materials.

(3) The finished grade line of the gravel cover on the floodway bank shall be 3:1 with a minimum gravel cover thickness of three (3) inches.

(4) Section 3, Subgrade Preparation, the subgrade surfaces shall be scarified to a minimum depth of two (2) inches. The moisture of the loosened material shall meet the specified moisture for Bid Item 2, Specification 23, Section 10.a.(6).

(5) Section 7, Measurement and Payment, the following method shall apply. Payment for Study Site No. 5 will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, and include compensation for subsidiary items; Clearing, Pollution Control, and Seed Operation C.

c. Bid Item 7, Study Site No.7

(1) This item shall consist of furnishing and placing gravel cover to the finished grade lines for the O&M road and floodway banks surfaces as shown on the drawings.

(2) The gravel cover material shall be a well graded sand, gravel, and cobble mixture with a maximum size of six (6) inches.

(3) The finished grade line of the gravel cover on the floodway bank shall be 3:1 with a cover thickness of six (6) inches.

(4) Section 3, Subgrade Preparation, the subgrade surfaces shall be scarified to a minimum depth of two (2) inches. The moisture of the loosened material shall meet the specified moisture for Bid Item 2, Specifiction 23, Section 10.a.(6).

(5) Section 7, Measurement and Payment, the following method shall apply. Payment for Study Site No. 7 will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, and include compensation for subsidiary items; Clearing, Pollution Control, and Seed Operation C.

d. Bid Item 8, Study Site No. 6

(1) This item whall consist of furnishing and placing the filter and armor material to the finished grade lines for the O&M road and floodway bank surfaces as shown on the drawings.

(2) The filter material shall meet the following gradation:

Sieve Size	% Passing
1"	100
#4	90 - 100
#10	55 - 100
#20	25 - 85
#40	10 - 60
#100	0 - 20
#200	0 - 5

ASTM C-33 fine aggregate will meet the above gradation requirement.

(3) The armor material shall meet the following gradation:

Sieve Size	% Passing
3"	100
1-1/2"	90 -100
3/4"	64 -100
3/8"	40 - 90
#4	10 - 65
#8	0- 40
#16	0 - 15
#200	0 - 5

(4) Section 3, Subgrade Preparation, the subgrade surface of the filter layer shall be scarified to a minimum depth of two (2) inches. The moisture of the loosened material shall meet the specified moisture for Bid Item 2, Specification 23, Section 10.a.(6).

(5) Section 7, Measurement and Payment, the following method shall apply. Payment for Study Site No. 6 will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, and include compensation for subsidiary items; Clearing and Pollution Control.

Summary of treatments as of 1/23/89: by DSP

Existing:

1. EMF K-5 2" minus — need pictures
2. EMF L-4 3" minus
3. WAFB Seeding (Winter Rye) — need pictures
4. EMF R-5 ~1 mile on O&M Rd (westbank) " "

Considering:

1. Soil Stab w/ veg. > Re-work bank
2. " " w/o "
3. Gravel to fill in rills — (no reworking of bank)
4. Flyash
5. Lime > or combination
6. Re-work bank only w/o treatment (For control @ each section

AZ
JMH 1-18-89

EMF - EROSION STUDY
DRP 11/20/89

1 1

Economics

DETERMINE REASONABLE QUANTITIES AND COSTS FOR ENTIRE EAST MARICOPA FLOODWAY.

REACH	AVG. CH. DEPTH	SIDE SLOPE	LENGTH	APPROX. SLOPE AREA S.Y.
1	8?	3:1?	~20,000×2 SIDES	113,000
2	11.0	3:1	20,000×2	156,000
3	11.5	3:1	23,100×2 SIDES	186,000
4	10.5	3:1	18,800×2	139,000
5	11.5	3:1	16,300×2	132,000
				726,000 SY

SAY 750,000 SY surface area of slopes that require protection.

FOR EACH 12" OF depth

$$750{,}000 \times \frac{1\ Ft}{?\ Ft/yd} = 250{,}000\ CY \text{ of volume.}$$

- 6" Soil cement @ 35 × 125,000 = $4,375,000.
- 12" Pit run Gravel (2" minus) @ 15.00 = $3,750,000
- Soil Seal Concentrate 1¢ per S.F. .01 × 725,000 × 9 = $130,000
  5¢ " " w/seed etc = $650,000
- Seeding and mulching - 160 acres
  (1984 heavy Const Cost Guide)
  Seeding - Slope $650, mulching $385 = 2,035, DOUBLE IT 160 × 4000 = 640,000

ARIZONA East Maricopa Floodway Reach 3 - Erosion STUDY
JMH 12-9-88

1

Received notebook from State Design Engr. recently for the Bank Erosion Study of the East Maricopa Floodway. Notebook contains pictures of bank erosion at various stations, primarily along Reach 3, completed soil test background from the Soils Lab at Lincoln performed in 1987, (sieve analysis, atterburg, classification, soluble salts, Gs, resistivity, pH, T.D.S., dispersion data.), trip report from WNTC, Cliff Reed 12-22-86, possible alternatives for slope protection.

Discussed project w/ Don Paulus (SOD) this morning. We have $50,000 appropriated for installation of various measures to study each one's effectiveness for erosion control. Current design schedule shows going to Contract Admin. people by May 1, 1989.

At this time, there are very few parameters such as length of study. These must be developed by the study itself. The design alternatives ~~with~~ for the study will be reviewed by WNTC.

Apparently, some of the test data obtained thus far was for the purpose to see if a correlation between the erosion and test results exists. In other words, some of the test information may or may not be of influence on the design.

Briefly, alternatives in the notebook are

- Vegetation
- Grand
- Soil Stabalization chemicals
- Hydrated lime
- Fly ash
- Geotextiles
- Soil cement

United States Department of Agriculture
Soil Conservation Service
West National Technical Center
511 N. W. Broadway, Room 248
Portland, Oregon 97209-3489

Subject: MGT - Trip Report, Arizona
September 27-30, 1988

Date: October 12, 1988

To: W. R. Evans, Head, Engineering Staff, WNTC

File code: 330-

Purpose: The primary purpose of this trip was to provide assistance in the evaluation of joint preparation for the repair of joints on Reach 4, of the East Maricopa Floodway.

Participants: Don Paulus, State Design Engineer, SCS, Arizona
Elde Chevaz, Design Engineer, SCS, Arizona (part-time)
Noller Herbert, Project Engineer, SCS, Arizona (part-time)
Larry Moliter, Inspector, SCS, Arizona
Leland Saele, Design Engineer, SCS, WNTC

Background: A portion of Reach 4, of the East Maricopa Floodway (RWCD R4), consists of a concrete lined, trapezodial shaped channel, approximately 6700 feet long with expansion-contraction joints at 100 foot intervals. The sealant used to seal the joints failed shortly after installation. An investigation report attributed the failure to joint design. A construction contract has been awarded for repair of the joints. This will include an initial phase for testing and evaluation of three different joint widths. The contractor began preparing the test joints on September 26, with an estimated completion time of three days.

During the week we also visited Vineyard Road Dam, the nearly completed Apache Junction Dam and Bulldog Wash Floodway projects, and made a general inspection of [redacted] the recently completed [redacted] for rilling of the side slopes or other potential problems. The final design for the repair of Vineyard Road Dam will be prepared by the state design staff and forwarded to the WNTC for approval by the end of the year.

Findings/Recommendations:

RWCD R4, Joint Repair: Several visits were made to the site throughout the week to observe the contractor's operations and to discuss progress with the SCS inspector and project engineer. The concrete temperature sensors had been installed and were functioning well. The measured temperature of the concrete ranged from 72°F to 105°F between 7 a.m. and 4 p.m. The daily high ambient air temperature was near 100°F. Saw cutting of the test joints to the specified width was completed by Thursday afternoon and cleaning of the joint face was underway. The saw cutting and joint cleaning operation was progressing at a considerably slower pace than indicated by the contractors schedule.

☆ U.S. Government Printing Office: 1988—529-568/30577

Three joint widths, existing, 2-inch and 3-inch, are specified for the test section. The contractor is using a high pressure wash and is experiencing difficulty in removing all of the existing sealant from the "existing" and "2-inch" joint widths. Old sealant remains in pockets where stones apparently were dislodged during the original joint, saw cutting and sealant installation operation. A visual examination of the "2-inch" joints indicated approximately 5 to 10 percent of the effective joint surface for adhesion was still covered with old sealant. Considerably more sealant was evident on the "existing" joint faces. The contractor will have to put forth more effort to properly prepare these joints.

Existing sealant between the bridge piers and the channel lining is in excellent condition whth no sign of distress. Because of the difficulty involved in saw cutting at this location and the condition of existing sealant, it is recommended that joints around the bridge piers not be disturbed.

Larry (SCS inspector) is well versed on the contract requirements for this project and is doing an excellent job of inspection and documentation of the contractors work.

[redacted]5: Although the general appearance of Reach 5 is excellent, there is some evidence of side slope rilling in its early stages. The 2-inch minus, pit-run, gravel lining placed downstream of the Power Road Bridge shows no sign of rilling whereas the earth slope just downstream of this section has several rills forming. The gravel, with a small percentage of fines, appears to offer excellent resistance to rilling. Similar conditions were observed on Reach 4, downstream of Station 530+00, where gravel cover (3-inch minus) was placed on the upper right bank.

Nearly all of the 3-inch diameter drain outlets in the concrete lined channel on Reach 4 are plugged with sediment. Inspection at two locations found sediment completely filling the transverse drain outlet pipe to the "T" connection and possibly some extending into the longitudinal perforated drain pipe. Since the outlet pipe is 36+ inches long, it is speculated that there may be reverse flow carrying sediment laden flow into the drain pipe. We expect the situation to improve with the completion of Reach 6 and sediment due to construction minimized. It is recommended that the drains be cleaned to provide free outlets. Locating the drain outlets 12 inches or more above the invert would have helped prevent this problem.

Piping of foundation material and rilling along the side was noted at three grouted rock side inlets at the following locations:

left bank, just upstream of Sta. 570+00
left bank, Sta. 595+75
left bank, Sta. 625+00

Inspection of the exposed grouted rock section indicates that less than full grout penetration may have been a problem during construction. Expedient O&M is recommended to control the piping and prevent further damage. Damage should be treated by pumping or placing grout to fill voids under the structure and placement of 3-inch minus, well graded, pit-run, sand/gravel along the sides of the structures to control surface erosion. If, during repair, it becomes apparent that numerous voids exist under the grouted rock, the upstream cutoff should be exposed and treated to form a positive cut off acoss the inlet.

Future designs using grouted rock inlets need to consider a more open rock gradation, similar to what was used on Reach 5 for better grout penetration and a more positive cut off.

Occasional areas of light rilling and some isolated deeper rills exist randomly throughout Reach 4. Also, downstream of Sta. 605+00, in the vicinity of the gas pipeline relocation, erosion and settlement of the left bank has occured along a 3-foot wide strip, diagonally up the slope, to the approximate original ground line. This is apparently due to insufficient compaction of material replaced after relocation of the pipeline but prior to the construction of Reach 4. This damaged area, as well as any significant rilling that has developed in Reach 4 or Reach 5, should be repaired by filling with 3-inch minus, well-graded, pit-run, sand/gravel mixture.

Vineyard Road Dam: The design being prepared for this structure is to repair damage done by excavation into the embankment during the study and evaluation of flow through cracks that was conducted at this site several years ago. The repair also includes installing a transition filter along the centerline of the embankment where it was left out for testing. The test cells constructed for the test do not appear to interfere with the function of the dam and do not need to be removed from a design standpoint. Their easthetic value is less certain and may justify removal.

Serious erosion was noted in at least one location on the downstream slope. This was apparently due to localized concentration of runoff from the top of the dam. The eroded area should be filled with compacted material (per original specifications) and concentration of drainage alleviated to prevent further damage. A 12-inch thick section of sand/gravel, in areas of concentrated drainage, graded as noted above for the RWCD Floodway, may work well here, too.

Action Items:
State Responsibility

1. Notify the sponsors of need for maintainance to repair rilling on channel side slopes and side inlets on Reach 4 and 5 and to clean out drain outlets on Reach 4.

2. Notify the sponsors of need for maintenance to repair rills on the downstream slope of Vineyard Road Dam.

WNTC Responsibility

1. Assist state design staff by preparation of designs for control of rilling for evaluation by field trial.

I appreciated this opportunity to work with the Arizona design and construction personnel and to evaluate structural performance.

Leland M. Saele

LELAND M. SAELE
Design Engineer

cc:
Charles R. Adams, State Conservationist, SCS, Phoenix, Arizona
Stanley N. Hobson, Director, SCS, WNTC
Donald Basinger, Director, Engineering Division, SCS, Washington, D. C.
Ralph Arrington, State Conservation Engineer, SCS, Phoenix, Arizona

1-8-88

IK EROSION STUDY - As Built

Test Site: WAFB Side Inlet #4

Treatment: Winter Rye, 100 lbs./ac.

- watered once to force a wk. to get established
- used burlap cover, staked @ 5' centers. Burlap will not away by itself.
- Do not maintain; grass height does not become a problem (as their experience indicates).

Test Site: EMF C-4 gravel cover, Sta 536+00 westbank

Treatment: Same gradation as bedding used for EMF C-4.

Sieve Size	% passing
3"	100
1½"	70-100
¾"	60-90
⅜"	55-82
#4	45-65
#16	30-50
#100	0-30
#200	0-10
	0-5

9/22/87

[redacted] K EROSION STUDY — TREATMENT:

A. Soil Stab products Company - (209) 383-3296
   1. Soil Seal Concentrate — latex acrylic copolymer, applied with spray device. State of art for ease and low cost. Life/application only a few yrs?
      also Soil Seal Corp (213) 481-7185
   2. BIO CAT 300-1 — concentrated liquid catalyst, Recent tests by a Fed Agency showed it effective in treating dispersive clay soils

B. Gravel
   1. Thin & Thick sections 3" to 12" } for other than dispersive soils
      - pit run
      - d_{50} > for tractive stress reqm'ts
   2. Filter & Armor Sections } 1.5' — meet SMN #1 (for dispersive areas)
      (6") (12")

C. HYDRATED LIME } for EROSION & DISPERSION w/soils having 15% > 0.005
   1. Scarified 6" to 12", mixed, and recompacted to 95%

D. FLY ASH } treatment to be determined by SNTC

E. GEOTEXTILE
   1. - Anchored at toe of slope & top of bank.

F. Soil-Cement

[redacted]

G. it disk (1" to 2"), mulch, seed
   - Gravel deep gullies only

9/22/87

BANK EROSION STUDY

DATA — (existing design)

Side Slopes — 3:1

O&M Rd — R-2 crowned @ center

R-3 0.02 toward Fwy on west bank

0.036 away from Fwy on east bank

DESIGN:

test sections

1. 200 ft. Reach Lengths
2. Extended into O&M Rd. projected thickness

9/22/87

[redacted]

bank
east bank

[redacted]

United States Department of Agriculture

Soil Conservation Service

West National Technical Center
511 NW Broadway, Room 547
Portland, Oregon 97209-3489

Subject: MGT - Trip Report, RWCD Reaches 2-6, October 31, 1986, Arizona

Date: December 22, 1986

To: Donald E. Wallin, Head, Engineering Staff, WNTC

File code:

Purpose. This trip to Arizona was made to provide assistance in evaluating the probable dispersion on Reach 3 of RWCD.

Participants. Ralph Arrington, State Conservation Engineer, SCS, Phoenix, AZ
Clifton E. Deal, Soil Mechanics Engineer, WNTC

Background (Reach 3 RWCD). Reviewed in the field with Ralph Arrington the slope erosion occurring in Reach 3. Based on our limited review, part of the erosion is the result of dispersion as well as the low plastic nature of the fines. The dispersive condition of some of the materials was illustrated by a tunnel under the left roadway extending from the roadway ditch on the left to the floodway on the right. The tunnel exited nearly 1/3 the vertical distance above the bottom of the floodway channel. This point appeared to coincide with a zone of nondispersive materials.

There are areas of severe surface erosion interspersed with zones of limited to no surface erosion. This will make it difficult to develop an inexpense repair. It has been suggested that the Maricopa County Flood Control District (MCFCD) may be interested in installing several different trial sections to arrive at the best solution. This idea should be discussed with MCFCD. Data on the soils, specifically, dispersion amounts and grain size distribution should be obtained as soon as possible to aid in determining the most viable trials.

Based on the obervational data, controlling the dispersion will require at the very least a filter system between the soil and any armoring system used to prevent removal of the soil during channel and over slope flows. The attached sheets give suggested methods of providing the necessary repair.
During the review of Reach 2 it was noted that sand piles were developing below each of the weep holes through the concrete walls of the concrete section. It is suggested an evaluation be made by SCS representatives as to the source of this sand. This evaluation may require excavation to expose the wall drainage system to see if drainfill is being lost through the weep holes.

Action Items:

State Leadership.

1. Will contact MCFCD about installing trial sections.

2. Will obtain appropriate soils data.

WNTC Leadership.

1. Will assist the State Design Section in developing appropriate trials to be used should an arrangement be established with the MCFCD.

2. Attached is a suggested method of controlling the dispersive condition of the soils and provides the most appropriate combination repair (dispersion and surface erosion).

Appreciations. The opportunity to work with the Arizona Engineering staff on this problem proved very productive.

These items were discussed with Ralph Arrington during the review of RWCD Reach 3.

Clifton E. Deal

CLIFTON E. DEAL
Soil Mechanics Engineer

Attachment

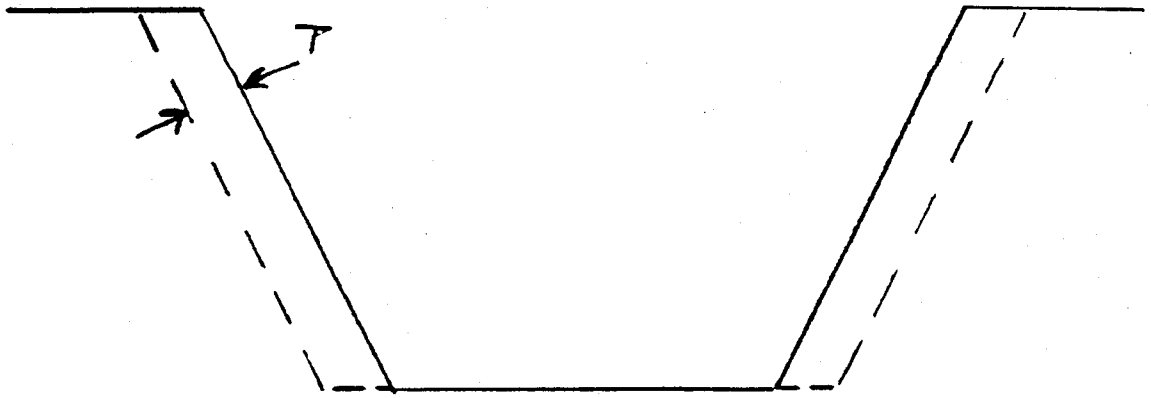
cc:
George C. Bluhm, Director, WNTC
Verne M. Bathurst, State Conservationist, SCS, Phoenix, Arizona
James R. Talbot, National Soil Mechanics Engineer, SCS, Washington D.C.
Ralph Arrington, State Conservation Engineer, SCS, Phoenix, Arizona

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE AZ		PROJECT RWCD -3		
BY	DATE 11/1/86	CHECKED BY	DATE	JOB NO.
SUBJECT Protection Against Dispersion				SHEET 1 OF 5

Example Solution



T = 1.5' (6" Filter and 12" of Armor layer)

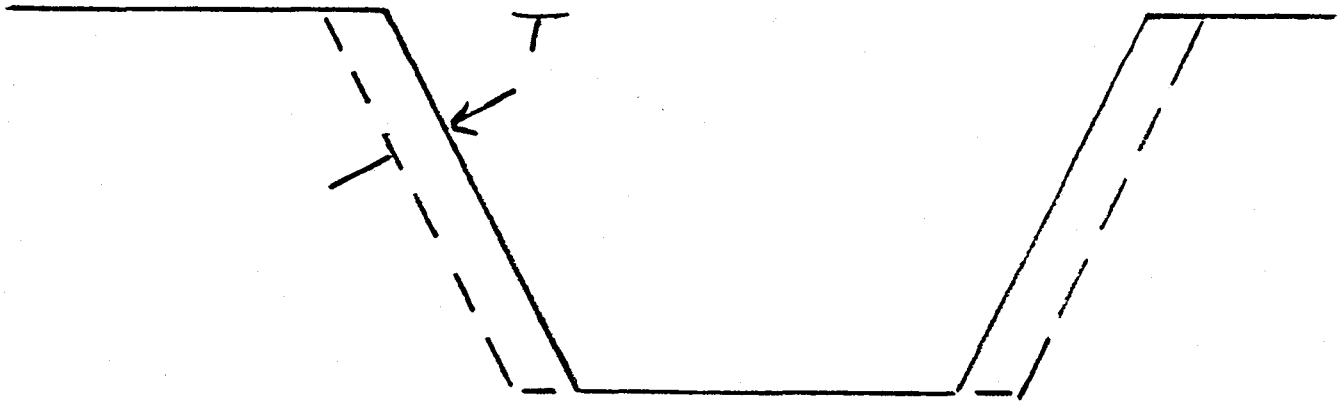
Filter must meet SN#1 requirements

Filter and Armor layer must meet SN#1 requirements for the D_{15}/d_{85} ratio

This example is for areas containing dispersire soils.

STATE AZ		PROJECT RWCD-3		
BY CRO	DATE 11/1/86	CHECKED BY	DATE	JOB NO.
SUBJECT Erosion Protection				SHEET 2 OF 5

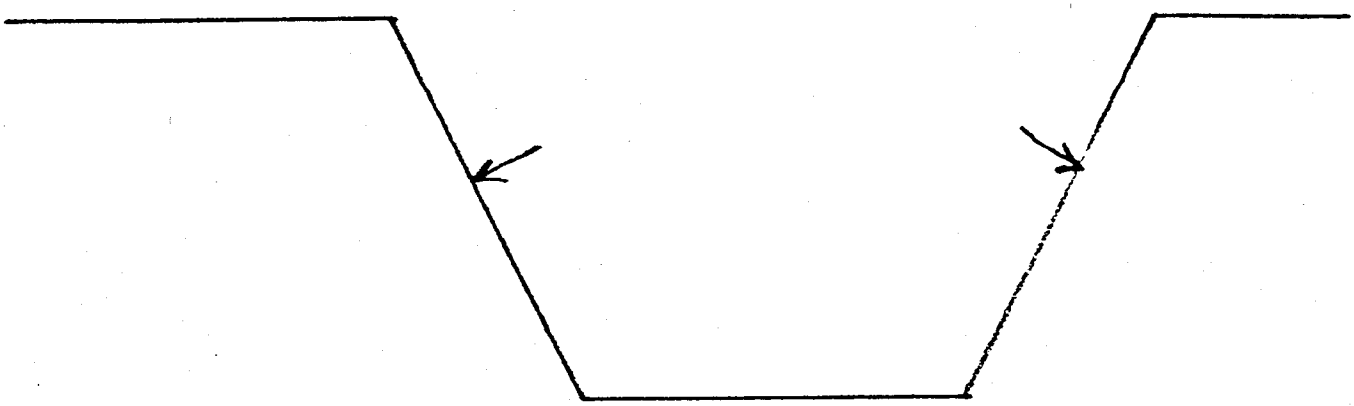
Example Solution



T = 6" to 12" of Armor layer.
This material is controlled according to particle size needed for erosion resistance against the water velocity during flows in the channel.
This method should not be used in areas containing dispersive materials.

STATE AZ		PROJECT RWCD-3		
BY	DATE 11/1/86	CHECKED BY	DATE	JOB NO.
SUBJECT Erosion Protection				SHEET 3 OF 5

Example Solution

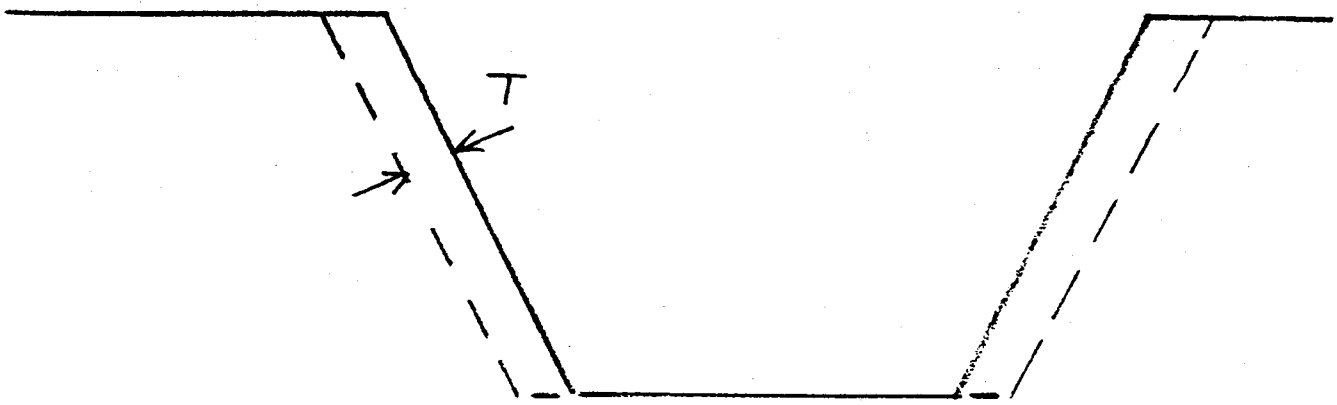


This consists of re-grading the slopes to fill in the rills. Over an extended time this will cause either flattening of the original slopes or encroach on the R/W. limits.

This method should not be used in areas containing dispersive materials.

STATE AZ		PROJECT RWCD-3		
BY	DATE 11/1/86	CHECKED BY	DATE	JOB NO.
SUBJECT Erosion and Dispersion Protection				SHEET 4 OF 5

Example Solution

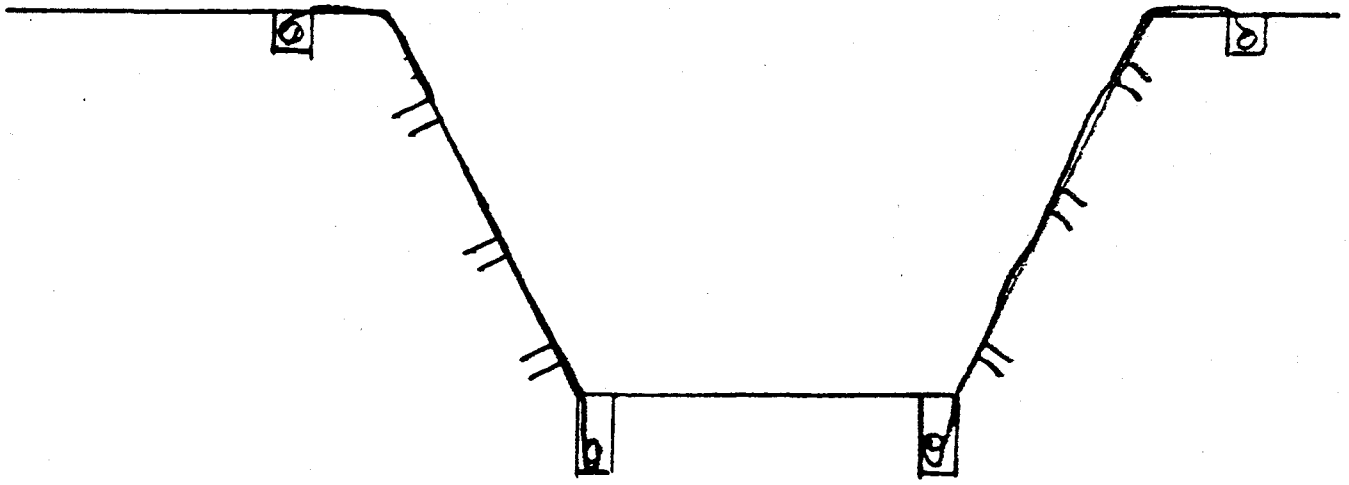


T = 6" or 12" scarified and mixed with an appropriate percentage of hydrated lime. Recompacted to 95% Std Proctor Density. This method may not be appropriate when the percent passing the 0.005mm sieve size is less than 15%.

This method appears to be the most costly of methods utilizing soils or aggregates.

STATE A2		PROJECT RWCD-3		
BY	DATE 7/1/86	CHECKED BY	DATE	JOB NO.
SUBJECT Erosion and Dispersion Protection				SHEET 5 OF 5

Example Solution



Place nonwoven filter cloth on the soil surface with erosion gride placed on top. Each panel to be pinned to the soil with noncorrosive pins at the 1/3 points up the slopes and roll overlapped to prevent movement of the panels as the result of flow in the channel.

This method may work but appears to be too expensive.

EXXON CHEMICAL COMPANY
Polymers Group

EXXON CHEMICALS

VIRGIL H. CARGLE, PhD
Manager - Soil Stabilization Products
Polymer Products, Americas

POLYBILT™ 4178 IN BRIEF

Exxon Chemical Research has recently developed **POLYBILT™ 4178**, a new polymeric composition which appears to significantly enhance the mechanical properties of soils. This product's effectiveness has been demonstrated in successful field applications involving both surface erosion control, as well as soil stabilization (via a mixed-in-place technique).

Additional data concerning the effects of **POLYBILT™ 4178** on a broad spectrum of soil types is being developed through our research programs conducted by a major university's geotechnical engineering facility. However, summarized below is a checklist of what <u>is known</u> about **POLYBILT™ 4178**:

I. General Properties

- Low toxicity
- Will support plant growth
- Resistant to leaching
- Easy to apply

  - Topical Applications

    : spray equipment
    : Conventional water spray truck

  - Mixed-in-Place Applications

    : Rotary mixes, e.g., Bomag, Bros or Raygo
    : Blading and compacting

- Decreased fines generation

II. Erosion and Dust Control

Polymer has been applied diluted in water, both as a topical spray and mixed-in-place on road embankments, soil conservation projects, and construction projects in Louisiana, Arizona and Colombia.

Observations:

- Improved wet aggregation properties
- Improved abrasion resistance
- Improved bearing capacity
- Improved compressive strength
- Improved shear strength
- Improved cohesive characteristics

III. Soil Stabilization

Mixed-in-place applications have been made in Arizona, Texas, Colombia and southern Africa. Laboratory studies have shown improved railroad sub-ballast and ballast properties.

Observations:

- Reduced moisture absorption
- Increased plastic limits
- Reduced plasticity
- Increased wet compressive strength
- Reduced pumpability of railroad sub-ballast
- Reduced settlement of railroad ballast

IV. Physical Properties

Density, lbs./Gallon @ 77°F	8.74
Flash Point, °F SETA CC	None - water based
Pour Point, °F	35
Odor	Mild
Color	Clear

2/87

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POLYBILT™ 4178 FOR WATER AND WIND EROSION

POLYBILT™ 4178 has been successfully used to control both wind and water erosion. The pictures on the opposite page show methods used to apply **POLYBILT™ 4178** diluted with water. Any method of spraying can be used from large hydroseeders to garden hoses.

POLYBILT™ 4178 is diluted with water before application. Application rates for the diluted mixture are usually between 0.25 and 0.50 gallons per square yard. Dilution rates vary depending on the severity of the erosion problem, soil type and the slope steepness. Typical dilutions rates are:

Wind erosion: 1 part **POLYBILT™ 4178** diluted with 20 parts water by volume. This would be 0.05 gallons of **POLYBILT™ 4178** per square yard.

Water erosion: 1 part **POLYBILT™ 4178** diluted with 10 - 20 parts water by volume. This would be 0.10 - 0.05 gallons of **POLYBILT™ 4178** per square yard.

EROSION CONTROL WITH EXXON CHEMICAL'S POLYBILT 4178

Problem: Water erosion of railroad embankment.

Background: The railroad embankment is located in a remote area of Colombia, South America and connects the Cerrejon Coal Mine with the port of Puerto Bolivar 100 miles away. The slope of the embankment averages about 1.5:1. The terrain varies from jungle at the mine to arid (near desert conditions) near the port. Water erosion of the railroad embankment is severe. This is especially true in the arid portion which lacks vegetation. While there is little rainfall, the amount that does fall comes in intense thunderstorms. Two inch rainfalls within an hour are not uncommon during the two rainy months of April and October. These conditions combine to create significant erosion problems that seriously increase the costs of maintenance.

Solution: POLYBILT™ 4178 was diluted with water and the dilute mixture was sprayed along the railroad embankment. The dilution ratio was one gallon POLYBILT™ 4178 to 20 parts water. The application equipment used was a water truck fitted with a hose and nozzle. The application rate of dilute POLYBILT™ 4178 was about 0.5 gallon per square yard.

Results: After 18 months the portion of the railroad embankment treated with POLYBILT™ 4178 has shown very little erosion. Untreated portions have serious erosion problems and are in need of repair.

For information regarding Exxon's POLYBILT™ 4178 soil stabilization chemical call Virgil Cargle at (713) 870-6771.

EXXON CHEMICALS

POLYBILT™

TYPICAL QUESTIONS ABOUT POLYBILT™ 4178 SOIL STABILIZER

APPLICATION METHODS

POLYBILT™ 4178 is diluted with water in normal applications. Dilution is easily accomplished since POLYBILT™ 4178 mixes in all proportions with water. Typical dilutions are 10 to 20 times with tap water.

Wind erosion - topical spray of 0.25 to 0.50 gallons diluted mixture (ie: 1:20) per square yard
Water erosion - topical spray of 0.25 to 0.50 gallons diluted mixture (ie: 1:10) per square yard

Any convenient spray equipment is ok for topical application.

Temporary road building - mixed in place with the soil to a depth of about 2 inches. Typically about 1 percent POLYBILT™ 4178 is mixed with soil. The amount of dilution water used is the amount required to yield the optimum moisture content for each soil.

Requires typical road building equipment such as:

Road grader
Rubber tire compactor
BOMAG or other rotary mixing equipment to mix POLYBILT™ 4178 with the soil.

COSTS

Wind erosion control - $0.10 to $0.20 per square yard.
Water erosion control - $0.20 to $0.30 per square yard.
Temporary road building - Typical chemical cost is $1.25 per square yard.

TOXICITY

POLYBILT™ 4178 contains no toxic materials. Normal care should still be used as with any chemical.

LEACHING

POLYBILT™ 4178 reacts with soil particles and does not leach from treated soil.

EXXON CHEMICALS

POLYBILT

FLAMMABILITY

POLYBILT™ 4178 is non-flammable and non-combustible.

PLANT GROWTH

POLYBILT™ 4178 will not inhibit the growth of plant life.

STORAGE

POLYBILT™ 4178 should be protected from freezing in winter. In summer POLYBILT™ 4178 should not be stored for long periods (measured in months) in direct sunlight. Excessive heat can cause the viscosity to increase. However, even when the viscosity has significantly increased, POLYBILT™ 4178 can still be easily diluted with water and used.

DUST CONTROL

POLYBILT™ 4178 is not sold as a traditional dust palliative. However, it does give added strength and abrasion resistance to treated soil. Therefore, a reduction in dust generation can be expected.

SOIL TYPES

POLYBILT™ 4178 can be used with all types of soil. However, best results are obtained with coarser grained, well graded soils.

WATER EVAPORATION

POLYBILT™ 4178 does not create a water impervious barrier. However, the evaporation and penetration of water is significantly reduced.

SOIL STABILIZATION WITH EXXON CHEMICAL'S POLYBILT™ 4178

Problem: Blowing dust on traffic and non-traffic areas.

Background

A southwest electric utility experienced severe blowing dust problems in a 20 acre storage yard used for transformers, poles, wire and associated equipment. Dust evolved from wind and vehicular traffic had resulted in health and safety problems severe enough to warrant issuance of dust masks to employees. Complaints from neighbors also were common.

The terrain at the storage yard is flat and the soil can be described as a "silty sand". Equipment is stored on the ground and is accessed mostly by dirt roads. Vehicular traffic on the roads consists of small fork lifts, pickup trucks, 18 wheel trucks and large fork lifts.

Two types of problems were identified, 1) Dust blowing between equipment stored on the ground and 2) the dust generated due to traffic on the roads.

Solution

Non-traffic areas: One gallon of POLYBILT™ 4178 was diluted with 20 gallons of water. About 0.50 gallons per square yard of this dilute mixture was sprayed onto the soil in the areas that were not subject to vehicular traffic. Equipment similar to that used to apply liquid fertilizer or pesticides was used. This treatment required 0.025 gallons POLYBILT 4178 per square yard.

Traffic areas (Roads): When POLYBILT™ 4178 is mixed with soil and compacted the result is a soil that is resistant to washboarding, rutting and the formation of pot holes. POLYBILT™ 4178 is not sold specifically as a dust supressant, however, because of the increased strength of the soil, an increased resistance to abrasion and dust generation can be expected. Therefore, POLYBILT™ 4178 was used to rebuild the "dirt" roads on this site.

Laboratory data indicated that the unconfined compressive strength of the native soil was about 128 psi. Treatment with POLYBILT™ 4178 at concentration of one percent basis dry soil weight resulted in an unconfined compressive strength of about 250 psi. A significant improvement. Therefore, one percent POLYBILT™ 4178 was chosen for this road application.

EXXON CHEMICALS

POLYBILT

The equipment used was a road grader, BOMAG MPH 100 rotary mixer, water truck and a rubber tire compactor.

Briefly, the procedure was:

(1) To properly grade the roads to provide good drainage. The road area was then scarified to a depth of two inches using the scarifier on the road grader.

(2) POLYBILT™ 4178 was diluted with enough water so that when the diluted POLYBILT™ 4178 was applied with the water truck onto the scarified road, the soil would have the optimum moisture necessary for good compaction and the content of POLYBILT™ 4178 in the soil would be one percent on a dry weight basis.

(3) Soil and POLYBILT™ 4178 were mixed using a BOMAG MPH 100 rotary mixer.

(4) The road was again graded to insure smoothness and drainage.

(5) The final operation was to compact the new road with a rubber tire compactor. This was done with the compactor loaded to 90 psi ground pressure.

The treatment rate of one percent POLYBILT™ 4178 and at depth of two inches required 0.20 gallons of POLYBILT™ 4178 per square yard. The total road area was 15,600 square yards and required 3337 gallons of POLYBILT™ 4178. The treated roads achieved cured hardness after the water evaporated in 24 hours. One week later a sprayed "top coat" of POLYBILT™ 4178 was applied to the road areas using a water truck. This consisted of 550 gallons of POLYBILT™ 4178 diluted with 4950 gallons of water.

Good civil engineering practices were used throughout the construction.

Results

The use of POLYBILT™ 4178 virtually eliminated the dust problem at this location. After six months the amount of dust (particles smaller than 200 mesh) on the roads was less than 9% of that found in untreated areas.

For information regarding Exxon's POLYBILT™ 4178 soil stabilization chemical call Virgil Cargle (713) 870-6771.

PCVCT004

POLYBILT 4178 CONTROLS EROSION

The need to control soil erosion by rain water is becoming more important both from an environmental and an economical point of view. In many states, laws are on the books that require project designers to plan for erosion control. It can't be just an afterthought anymore. And, it makes good sense economically too. Effective erosion control can save dollars in manpower and equipment time by not having to rebuild what mother nature keeps tearing down.

Exxon Chemical can help with **POLYBILT 4178** soil stabilization chemical. Topically applied with any convenient spray equipment, POLYBILT 4178 has been shown to be highly effective in controlling water erosion on many highly erodible soils. We all know that the growth of vegetation is the best solution to many erosion problems. **POLYBILT 4178** can help this process too. Spraying **POLYBILT 4178** over seeded areas will hold the seed in place during germination.

Applications for POLYBILT 4178 in erosion control include:

- Landscaping
- Highway cuts
- Replacement for temporary seeding
- Adjunct in permanent seeding
- Erosion control in forestry operations

POLYBILT 4178 is a product of Exxon Chemical Research and has been tested throughout the world in numerous soil stabilization applications. **POLYBILT 4178** is a liquid material that is easily diluted with any available water. It is non-toxic, non-flammable and non-corrosive. **POLYBILT 4178** is environmentally safe to use.

Application Methods:

POLYBILT 4178 is a liquid that is easily diluted with any convenient water supply. It can be applied with all types of equipment designed to spray liquids, from hand-held sprayers to hydroseeders.

Treatment Parameters:

A number of variables will drastically influence the amount of erosion encountered in any given project. They include:

- Soil type and mineralogy
- Soil particle size gradation
- Slope of the area to be treated
- Rainfall

Favorable results have been obtained with POLYBILT 4178 diluted 10-20 times with water and sprayed at 0.3 - 0.5 gal. diluted mixture/square yard.

Rate of Application	Coverage of One 55 gallon Drum			
	10 Times Dilutions		20 Times Dilutions	
	Sq Yd	Acres	Sq Yd	Acres
0.3	1833	0.38	3666	0.76
0.4	1375	0.28	2750	0.56
0.5	1100	0.23	2200	0.46

Laboratory Data

POLYBILT 4178 has been shown to provide good protection against erosion on several highly erodible soils. Several examples are given here:

Sand:

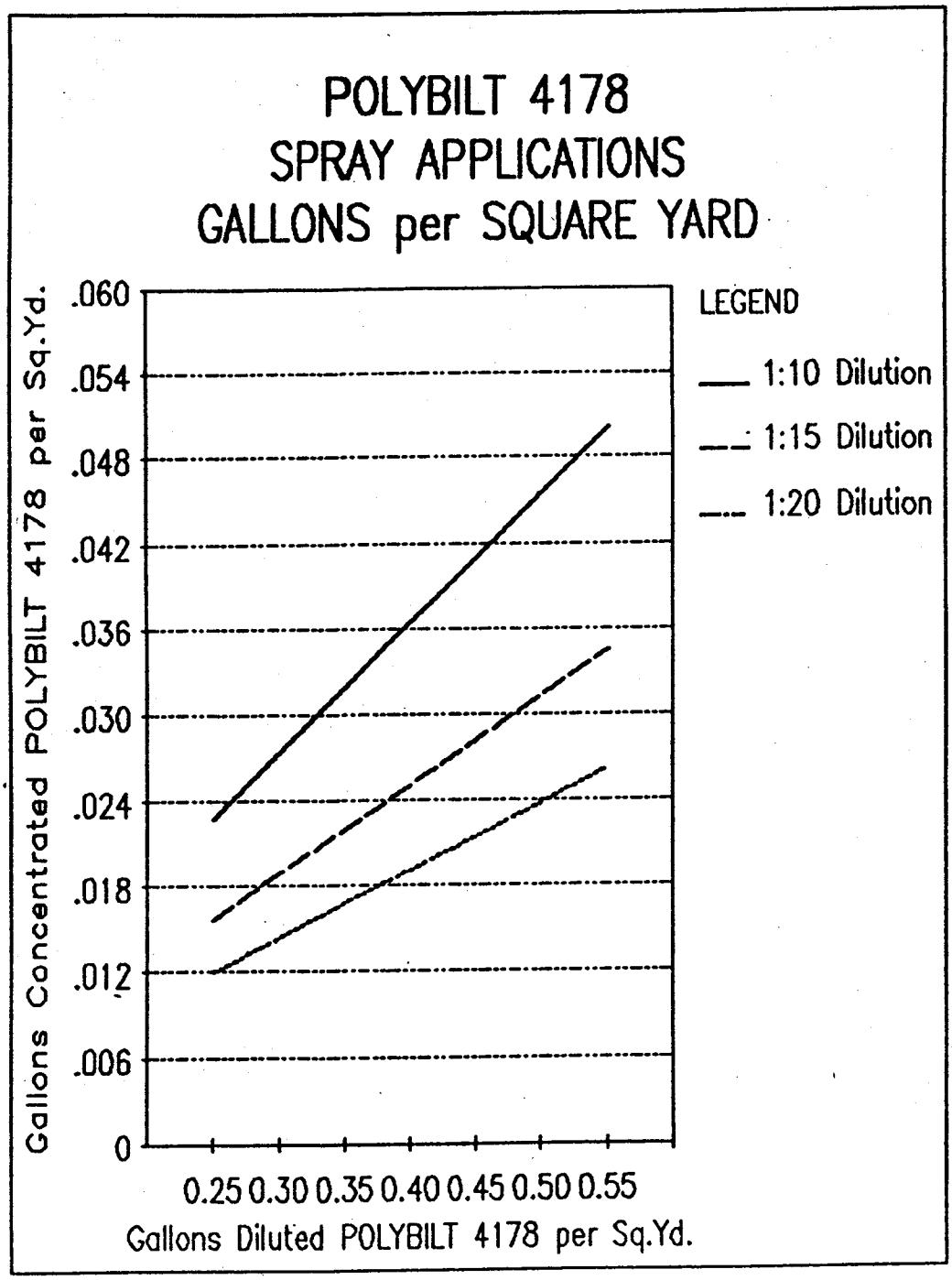
AASHTO: A-2-4(0); Unified: SM
Non-plastic
Poorly graded
87.5 % 10 to 200 mesh
12.5 % passing 200 mesh
Rainfall rate: 2 inches per hour
Rainfall duration: one hour
Dilution: 8.5 parts water to 1.0 part **POLYBILT 4178**

Treatment	Slope	Gal/Sq Yd	Tons Sediment per Acre
None	3:1	None	29.78
POLYBILT 4178	3:1	0.3	4.35

Loess:

AASHTO: A-4(1); Unified: ML
Poorly graded
96 % passing 200 mesh
Rainfall rate: 2 inches per hour
Rainfall duration: 30 minutes
Dilution: 8.5 parts water to 1.0 part **POLYBILT 4178**

Treatment	Slope	Gal/Sq Yd	Tons Sediment per Acre
None	3:1	None	2.15
POLYBILT 4178	3:1	0.3	0.34


POLYBILT 4178
SPRAY APPLICATIONS
GALLONS per SQUARE YARD
Gallons Concentrated POLYBILT 4178 per Sq.Yd.
.060
.054
.048
.042
.036
.030
.024
.018
.012
.006
0
LEGEND
1:10 Dilution
1:15 Dilution
1:20 Dilution
0.25 0.30 0.35 0.40 0.45 0.50 0.55
Gallons Diluted POLYBILT 4178 per Sq.Yd.

437-~~434~~
1311

193 W. CAMELBACK, SUITE 100 • PHOENIX, AZ 85013 • 602-~~279-4636~~

Western Tech-Sales
An ASI Company

Manufacturers' Representatives

F A X T R A N S

TO: Don Paulis - Soil Conservation Inc.

FAX # 241-5140

DATE: 2-2-89

REFERENCE:

NO. OF PAGES this plus 6 pgs

FROM Janelle F. Bell

ACTION REQUESTED

Dear Don:

We are still working on the specification for the Polyfelt 4178.
Enclosed are the specifications for the S75 and S150 Blankets.
There are definite variables to consider in regards to the following categories. Availability of water, easy access with regards to hydra mulching)

[redacted]

Please call me should you have questions.

Sincerely
Janelle & Bill

SC150
Vel. 7 fps
Slopes 2:1 Bottom with heavy runoff
Staple pattern tbd.

14649 Highway 41 North • Evansville, Indiana 47711

MATERIAL SPECIFICATIONS — CATEGORY I

S75 Erosion control blanket shall be a machine-produced mat of 100% agricultural straw.

The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with a polypropylene netting having an approximate ½" X ½" mesh and be sewn together with cotton thread.

Straw erosion control blanket shall be S75 as manufactured by North American Green, or equivalent. Erosion control blanket shall have the following properties:

Material Content

Straw	100% (.50 lb/sq. yd.) (.27 kg/m²)
Netting	One side only, photodegradable Weight approximately 1.64 lb/1000 sq. ft.
Thread	Cotton

Physical Specifications (Roll)

Width	6.5 feet (2m)
Length	83.5 feet (25.4m)
Weight	30 lbs ± 10% (13.6 kg)
Area	60 sq. yds. (50m²)

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MATERIAL SPECIFICATIONS — CATEGORY I

S150 Erosion control blanket shall be a machine-produced mat of 100% agricultural straw.

The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top and bottom sides with polypropylene netting having an approximate ½" X ½" mesh. The blanket shall be sewn together with cotton thread.

Straw erosion control blanket (or low velocity channel lining) shall be S150 as manufactured by North American Green, or equivalent. Erosion control blanket or channel lining shall have the following properties.

Material Content

Straw	100% (.5 lb/sq. yd.) (.27 kg/m²)
Netting	Top and bottom sides lightweight photodegradable (1.64 lb/1000 sq. ft. approx. wt.)
Thread	Cotton

Physical Specifications (Roll)

Width	6.5 feet (2m)
Length	83.5 feet (25.4m)
Weight	30 lbs ± 10% (13.6 kg)
Area	60 sq. yds. (50m²)

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MATERIAL SPECIFICATIONS — CATEGORY II

S75 Erosion control blanket shall be a machine-produced mat of 100% agricultural straw.

The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with a polypropylene netting having an approximate ½" X ½" mesh and be sewn together with cotton thread.

Straw erosion control blanket shall have the following properties:

Material Content

Straw	100% (.50lb/sq. yd.) (.27 kg/m²)
Netting	One side only, photodegradable Weight approximately 1.64 lb/1000 sq. ft.
Thread	Cotton

Physical Specifications (Roll)

Width	6.5 feet (2m)
Length	83.5 feet (25.4m)
Weight	30 lbs ± 10% (13.6 kg)
Area	60 sq. yds. (50m²)

14649 Highway 41 North • Evansville, Indiana 47711

MATERIAL SPECIFICATIONS — CATEGORY II

S150 Erosion control blanket shall be a machine-produced mat of 100% agricultural straw.

The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top and bottom sides with polypropylene netting having an approximate ½" X ½" mesh. The blanket shall be sewn together with cotton thread.

Straw erosion control blanket (or low velocity channel lining) shall have the following properties.

Material Content

Straw	100% (.50 lb/sq. yd.) (.27 kg/m²)
Netting	Top and bottom sides lightweight photodegradable (1.64 lb/1000 sq. ft. approx. wt.)
Thread	Cotton

Physical Specifications (Roll)

Width	6.5 feet (2m)
Length	83.5 feet (25.4m)
Weight	30 lbs ± 10% (13.6 kg)
Area	60 sq. yds. (50m²)

NORTH AMERICAN GREEN

14649 Highway 41 North • Evansville, Indiana 47711

MATERIAL SPECIFICATIONS — CATEGORY III

S75 Erosion control blanket shall be a machine-produced mat of 100% agricultural straw.

The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with a polypropylene netting having an approximate ½" X ½" mesh and be sewn together with cotton thread.

The blankets shall be 6.5 feet (2m) in width with a minimum length of 83.5 feet (25.4m) and a weight of 30 lbs ± 10% (13.6 kg) per roll. The weight of the straw material shall not be less than .50 lb/sq. yd. (.27 kg/m²).

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MATERIAL SPECIFICATIONS — CATEGORY III

S150 Erosion control blanket shall be a machine-produced mat of 100% agricultural straw.

The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top and bottom sides with polypropylene netting having an approximate ½" X ½" mesh. The blanket shall be sewn together with cotton thread.

The blanket shall be 6.5 feet (2m) in width with a minimum length of 83.5 feet (25.4m) and a weight of 30 lbs ± 10% (13.6 kg) per roll. The weight of the straw material shall not be less than .50 lb/sq. yd. (.27 kg/m²).

EMF - Bank Erosion Study, AZ notes by LMS, 11/88

Problem - Bank erosion from rainfall and local runoff has caused extensive and severe rilling of the channel slopes in all reaches of the floodway.

Assignment - Design alternative methods for controlling bank erosion. Short reaches using the different alternatives will be evaluated as to effectiveness and cost.

Budget - $50,000 has been allocated for Construction costs.

Location - Reach 3 and 4, RWCD Floodway. Soils data and samples taken from Reach 3 and 4. Actual test sections could be in either reach but probably will locate them in Reach 3.

References -

1. Letter, A.G. Sanders to Arrington 5/10/85
2. Stability and Erosion Analysis, R1 & R2, Fred Theurer, 5/23/85.
3. Letter, Stevenson to Arrington, Stability and Erosion Analysis R1 & R2, 6/21/85.
4. Engineering Report, RWCD Floodway - Reach 1, Nov. 8, 1985
5. Trip Report, RWCD Reach 2 to 6, 10/31/86 and Evaluation of Dispersion on Reach 3, Cliff Deal, 12/22/86.
6. Trip Report, Post Construction Conditions on Reach 1,2 and 3 of the RWCD Floodway, Saele and Thackeray, 3/20/87.
7. Trip Report, EMF Reach 4 joint repair, Saele, 10/12/88 (pictures and comments)

Causes of Rilling -

1. Cracking caused by dessication of plastic clays and silts. Rainfall or local runoff penetrating the cracks causing erosion of low plastic soils results in erosion patterns similar to what is termed juggeing in dispersive soils. (page 15 of reference 4.)

2. Isolated dispersive soils may exist but have not been proved out by testing on reach 3.

3. General rilling appears to be the result of rainfall on low to non-plastic fine grained soils.

Design approach - preventive measures

1. Prevent movement of flow on surface except at very low velocities. Protect slope from rainfall impact.
2. Prevent free flow of water in cracks.

Design The choices for design and evaluation appear very limited.

1. Concrete lining - too expensive
2. Soil Cement - too expensive
3. Asphalt layer - excessive cracking has been experienced and high cost.
4. Geogrids, straw matts etc. - These methods work well where a good stand of vegetation can be established. The climatic conditions in this area are not conducive to establishing vegetative cover. Burlap and seeding was not effective on a side channel on reach 4. Some locations along the floodway have a fair stand of vegetation and therefore it should not be ruled out.
5. Vegetative cover - same as geogrids, except less likely to be succesful.
6. Chemical treatments - need to check with different suppliers.
7. Sand/Gravel - This appears to be the most promising. Experience to date indicates that it works. No rilling has occurred on the banks where a sand-gravel layer has been installed along the RWCD floodway. Therefore the greatest design effort should be concentrated on this alternative.

The design analysis should consider the following:

- Material size and thickness for armoring versus channel flow velocity.
- size and thickness for raindrop impact
- minimum practical construction thickness
- filter requirements, sand or fabric
- slope stability
- pit run versus specific gradation limits
- cost of alternatives

Proposed design to include:

1. Sand-gravel cover
2. Vegetative seeding with and without mulch system
3. synethic materials

SAND - GRAVEL SLOPE PROTECTION

STATE	PROJECT		
AZ	Bank Erosion Study		
BY LMS	DATE 1/12/89	CHECKED BY DB	DATE 3/89
SUBJECT			JOB NO.
SAND - Gravel Cover			SHEET 1 OF 13

Sand - Gravel Cover:

Design must evaluate for stability for
1. slope failure from soil shear
2. erosion from channel flow
3. erosion from rainfall

Slope stability analysis - soil strength

The existing side slopes are stable for the constructed 3:1 slopes. However, a sand-gravel mixture placed on the slope may not be stable. The sand-gravel will be assumed to be cohesionless and will be analyzed using the "Infinite slope method"

Proposed Materials:

Well graded pit run sand-gravel mixture with 3 inch maximum size stone

Determine safety factor for stability for material with less than 10% fines (free draining) and for up to 20% fines.

STATE		PROJECT		
Az		Bank Erosion Study		
BY	DATE	CHECKED BY	DATE	JOB NO.
LMS	1/12/89	DP	3/89	

SUBJECT SAND-GRAVEL Cover SHEET 2 OF 13

Infinite slope analysis

SS = 3:1

Well graded gravel

$D_{100} = 3"$

$C_u = \frac{D_{60}}{D_{10}} > 4$ $\quad D_{60} = (4+) D_{10}$

$C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$

If $D_{10} = 4.76$ mm (#4)
$D_{60} \geq 25.4$ mm (1")

Well graded sand

$D_{100} = 4.76$ mm

$C_u = \frac{D_{60}}{D_{10}} > 6$

$C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$

If $D_{10} = 0.074$ mm (#200)
$D_{60} \geq (6)(0.074) \geq 0.44$ mm (Use 0.5 mm)

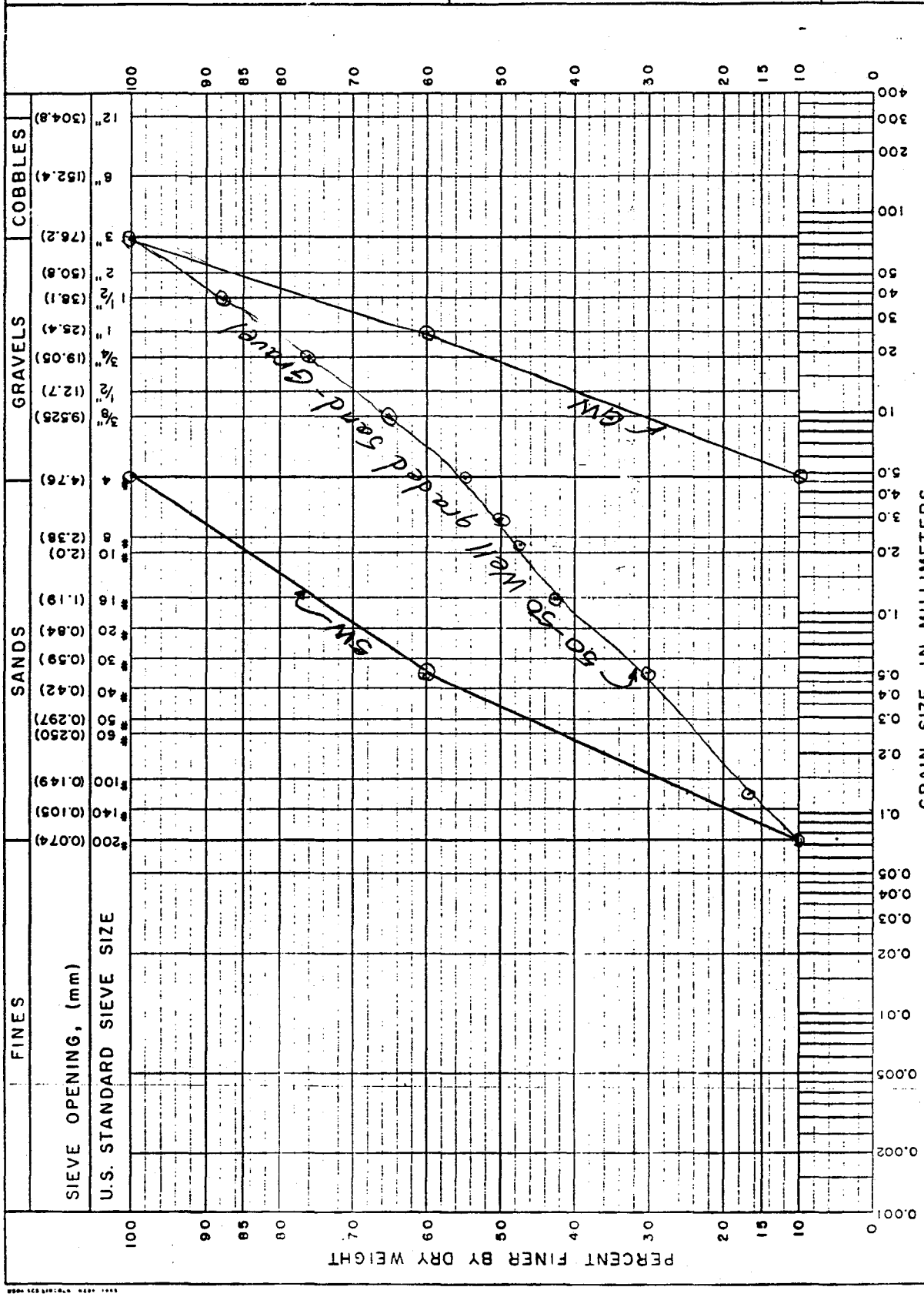
Assume a well graded sand-gravel mixture is represented by a 50% SW and 50 GW mix.

Form SCS 130
5-65

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	DRAIN MATERIALS

PROJECT and STATE: Bank Erosion Study, Az — Sheet 3 of 13

DESIGNED AT: WNTC — BY: LMS — DATE: 1/12/89



REMARKS

SAND-GRAVEL Mixture, 50% GW, 50% SW with 10% or less fines

Mix #4 and above = $1 - [C' - D_{GW}(.5)]$

Mix #4 and below = $(D_{SW} + 0.1)(0.5)$

STATE	AZ	PROJECT	Bank Erosion Study		
BY	LMS	DATE 1/12/89	CHECKED BY DSP	DATE 3/89	JOB NO.
SUBJECT	Sand-Gravel Cover				SHEET 4 OF 13

Assuming 70% relative density and GM, GP material the angle of internal friction is estimated. Reference attached chart developed from series of test at SML-Lincoln

$\phi = 38°$ for GM, GP @ 70% RD

$$F.S. = \frac{\gamma_b \tan\phi}{\gamma_s \tan\theta}$$ free draining material

$$F.S. = \frac{(\gamma_s \cot^2\theta - \gamma_w)\tan\phi}{\gamma_s \sin\theta \cos\theta}$$ non-free draining

$\gamma_s = 130$ #/ft³ saturated wt.

$\gamma_b = 67.6$ #/ft³ buoyant wt.

θ = slope angle 18.4° (3:1)

RAPID DRAWDOWN

Free draining

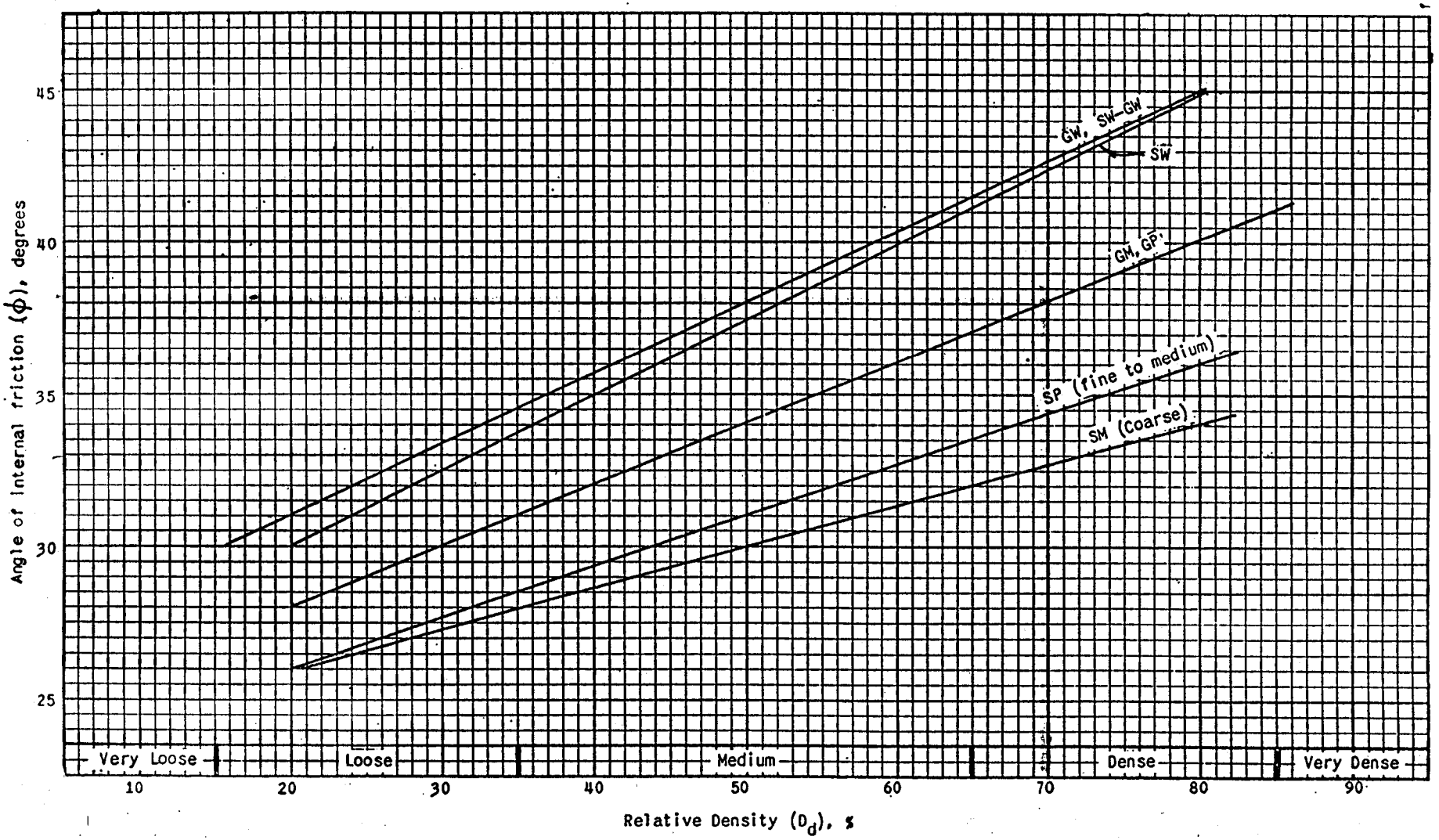
$$F.S. = \frac{(67.6)(\tan 38°)^{0.78}}{(130)(\tan 18.4°)^{0.333}} = 1.22 \checkmark$$

Non-Free draining

$$F.S. = \frac{[130(\cos^2 18.4°)^{0.9} - 62.4][\tan 38°]^{0.78}}{130(\sin 18.4°)(\cos 18.4°)} = \frac{42.7}{38.9} \checkmark$$

F.S. = 1.1 ✓

RELATIONSHIP OF RELATIVE DENSITY & ϕ FOR NON-COHESIVE SOILS



STATE		PROJECT		
Az.		Bank Erosion Study		
BY	DATE	CHECKED BY	DATE	JOB NO.
LMS	1/12/89		3/89	
SUBJECT				SHEET 6 OF 13
Sand-Gravel Cover				

For F.S. = 1.0 find minimum strength required.

Free draining

$$1.0 = \frac{(67.6)\tan\phi}{(130)(\tan\theta)} = \left(\frac{67.6}{43.2}\right)\tan\phi$$

$$\tan\phi = \frac{1}{1.56} = 0.639$$

$$\underline{\phi = 32.6^\circ} \checkmark$$

Note = Free Draining

$$1.0 = \frac{(\gamma_s \cos^2\theta - \gamma_w)\tan\phi}{\gamma_s \sin\theta \cos\theta}$$

$$1.0 = \frac{54.6\tan\phi}{38.9}$$

$$\tan\phi = \frac{38.9}{54.6} = 0.712$$

$$\underline{\phi = 35.4^\circ} \checkmark$$

Using 35° as the minimum value for ϕ and refering to sheet 5, the more sandy gravel could be prone to local slide failure when saturated if the material is not free draining. Well to Poorly graded gravel and silty gravel are satisfactory.

Therefore the sand-gravel mixture should have a minimum of 50% gravel (50% > the #4 sieve). At least 25% sand should be provided to fill the voids in gravel. The % of fines is somewhat arbitrary but believe that up to 15% is satisfactory.

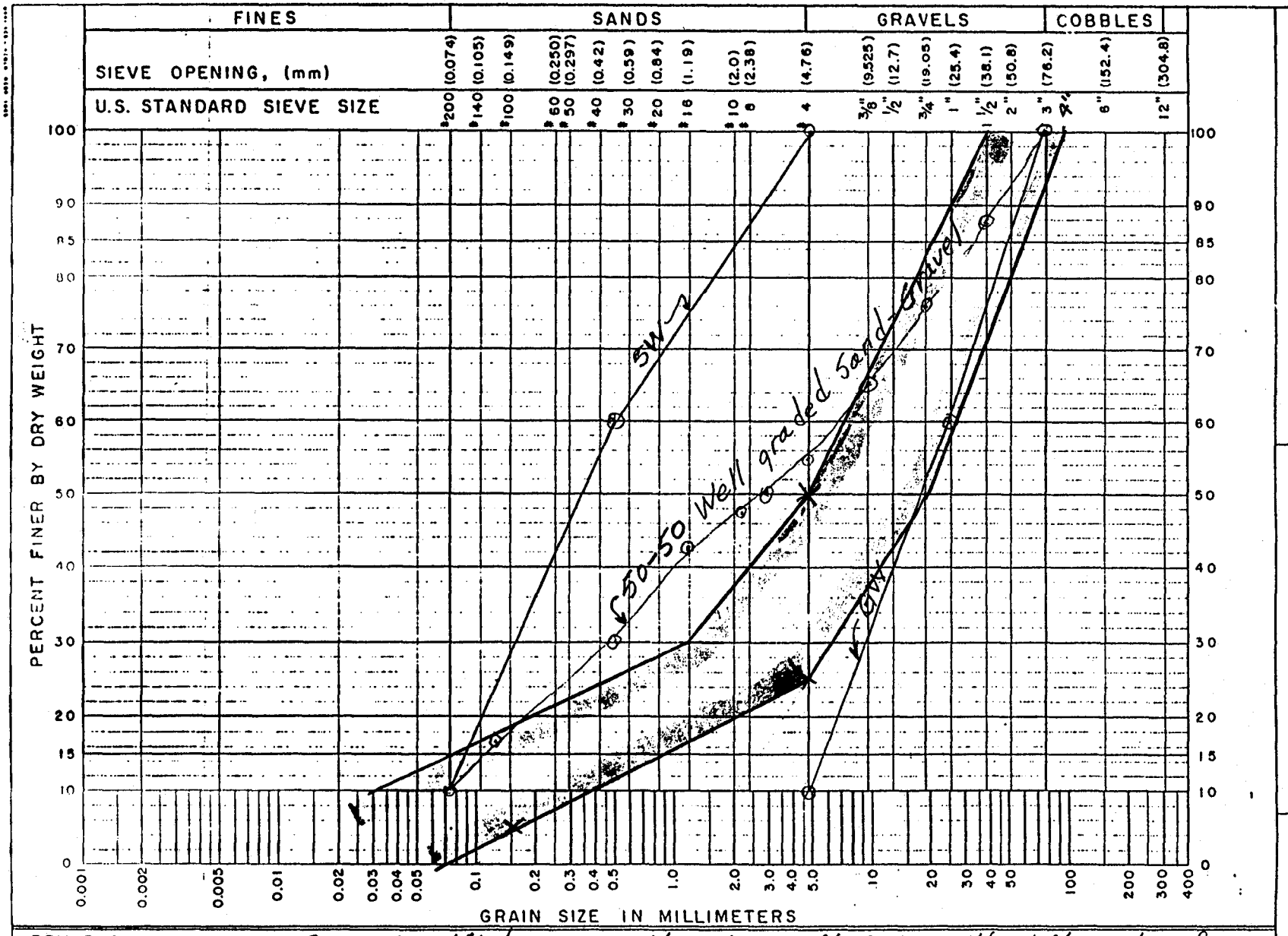
STATE	Az.	PROJECT	Bank Erosion Cover		
BY LMS	DATE 1/12/89	CHECKED BY	DATE 3/89	JOB NO.	
SUBJECT Sand-Gravel Cover				SHEET 7 OF 13	

- cont. from sheet 6

Material consisting of more than 50% gravel will provide good armoring characteristics. With 25 to 50 % sand the voids will be well filled to prevent sliding. A minimum of 5 % fines is desirable to prevent flow of water adjacent to the base material.

Gradation limits are shown on sheet 8 that meet the above requirements.

To satisfy assumptions used in stability analysis the above material should be placed at a minimum relative density of 50%. This should not be a problem for one layer thickness using a dumping and spreading operation.



REMARKS

SAND-GRAVEL Mixture, 50% GW, 50% SW with 10% or less fines

Mix #4 and above = $1 - [(1 - D_{GW})(.5)]$

Mix #4 and below = $(D_{SW} + 0.1)(0.5)$

MATERIALS TESTING REPORT | U.S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE

PROJECT and STATE

DESIGNED AT | BY | DATE

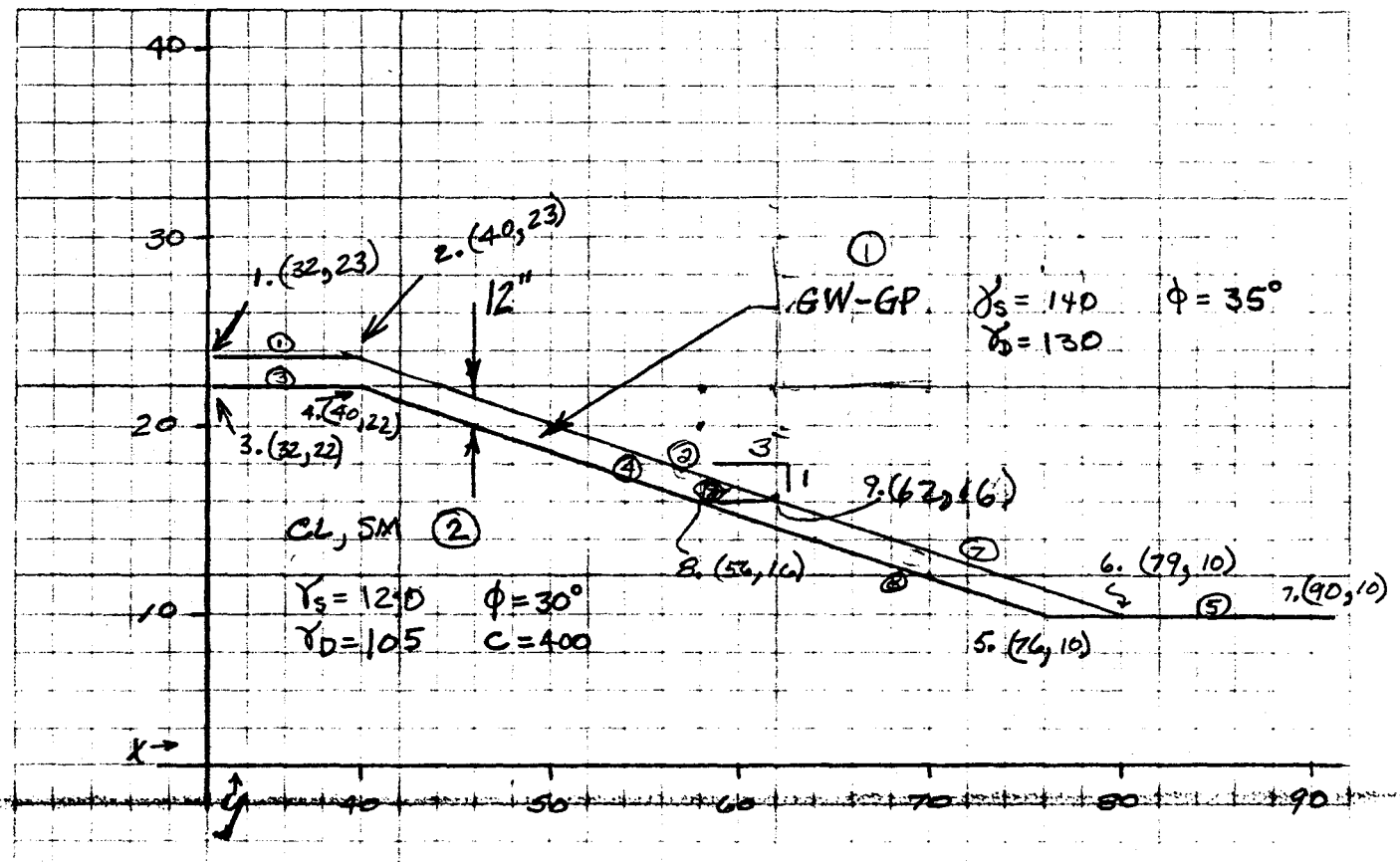
DRAIN MATERIALS

Sheet 8 of 13

COMPUTATION SHEET
SCS–ENG–523 Rev. 8–69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE		PROJECT		
AZ		Bank Erosion Study		
BY	DATE	CHECKED BY	DATE	JOB NO.
LMS	1/12/89			
SUBJECT				SHEET 9 OF 13
Sand - Gravel Cover				



1/12/89 LMS
sht 10 of 13

BKSTDY - Bank erosion study, slope stability
AUTOMATIC SEARCH ANALYSIS
Approximately 20 slices selected
First X= 73.0 X increment = 1.0
First Y= 24.0 Y increment = 1.0
Minimum radius= 10.0 radius increment = 0.5

Minimum FS found during automatic search = 0.99
Found at X= 74.0, Y= 25.0, R= 12.5

SB-SLOPE

PROJECT DATA
Project: RWCD BANK EROSION STUDY
Location: MARICOPA COUNTY AZ.
Filename: BKSTDY Description: Bank erosion study, slope stability

ANALYSIS DATA

Line No.	Left X	Left Y	Right X	Right Y	Density pcf	Cohesion psf	Phi Deg	Phreatic Line
1	32.0	23.0	40.0	23.0	138.0	0	38	N
2	40.0	23.0	62.0	16.0	138.0	0	38	N
3	32.0	22.0	40.0	22.0	120.0	400	30	N
4	40.0	22.0	56.0	16.0	120.0	400	30	N
5	76.0	10.0	90.0	10.0	120.0	400	30	N
6	56.0	16.0	62.0	16.0	140.0	0	35	Y
7	62.0	16.0	79.0	10.0	140.0	0	35	Y
8	56.0	16.0	76.0	10.0	120.0	400	30	Y
9	56.0	16.0	62.0	16.0	Free water line			

1/12/89 LMS
Sht 11 of 13

BKSTDY - Bank erosion study, slope stability
AUTOMATIC SEARCH ANALYSIS
Approximately 24 slices selected
First X= 73.0 X increment = 1.0
First Y= 24.0 Y increment = 1.0
Minimum radius= 10.0 radius increment = 0.5

Circle center at X= 73.0, Y= 24.0
Minimum FS for center = 1.018 at R= 11.5

Circle center at X= 74.0, Y= 24.0
Minimum FS for center = 1.033 at R= 12.0

Circle center at X= 74.0, Y= 23.0
Minimum FS for center = 1.030 at R= 11.0

Circle center at X= 73.0, Y= 23.0
Minimum FS for center = 1.015 at R= 10.5

Circle center at X= 72.0, Y= 23.0
Minimum FS for center = 0.998 at R= 10.0

Circle center at X= 72.0, Y= 24.0
Minimum FS for center = 1.002 at R= 11.0

Circle center at X= 72.0, Y= 25.0
Minimum FS for center = 1.007 at R= 12.0

Circle center at X= 73.0, Y= 25.0
Minimum FS for center = 1.021 at R= 12.5

Circle center at X= 74.0, Y= 25.0
Minimum FS for center = 0.992 at R= 12.5

Circle center at X= 75.0, Y= 25.0
Minimum FS for center = 1.006 at R= 13.0

Circle center at X= 75.0, Y= 24.0
Minimum FS for center = 1.002 at R= 12.0

Circle center at X= 73.0, Y= 26.0
Minimum FS for center = 1.023 at R= 13.5

Circle center at X= 74.0, Y= 26.0
Minimum FS for center = 0.996 at R= 13.5

Circle center at X= 75.0, Y= 26.0
Minimum FS for center = 1.009 at R= 14.0

Minimum FS found during automatic search = 0.99
Found at X= 74.0, Y= 25.0, R= 12.5

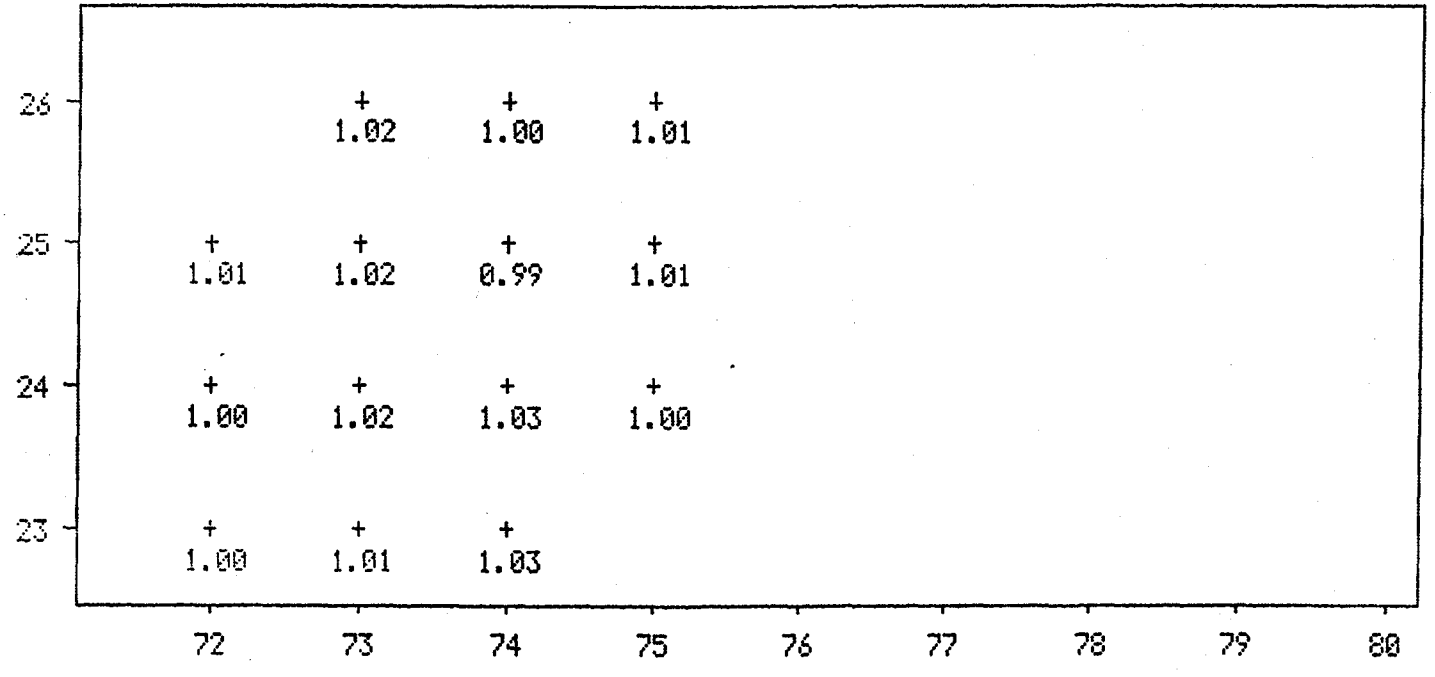
SB-SLOPE

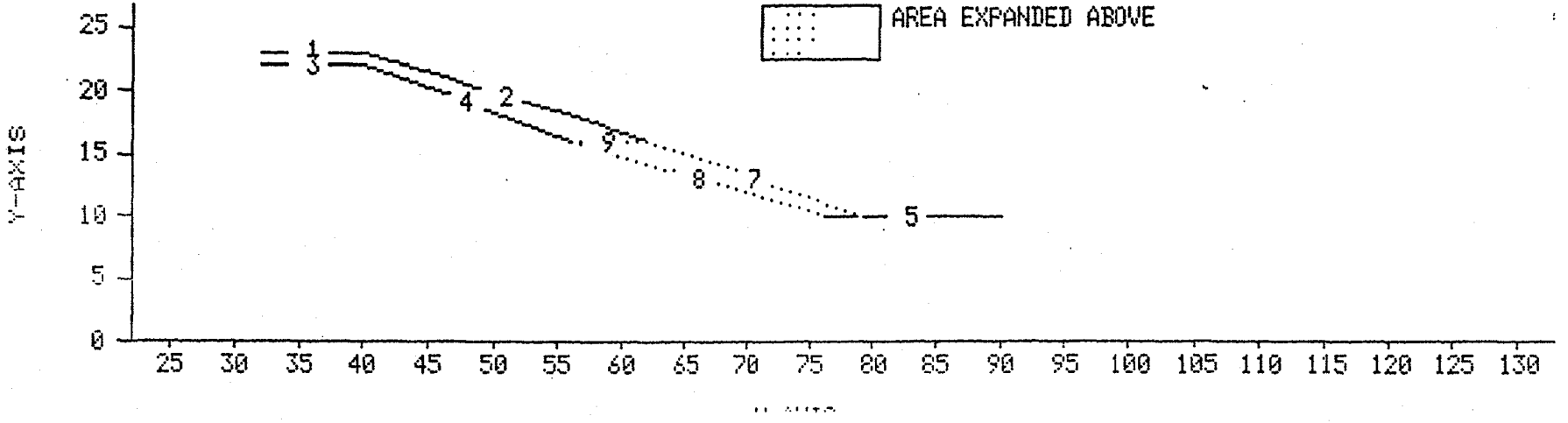
Simplified Bishop Slope Stability Analysis

PROJECT: RWCD BANK EROSION STUDY

LOCATION: MARICOPA COUNTY AZ.

FILE: BKSTDY





11/2/89 cms
544 12 of 13

SB-SLOPE

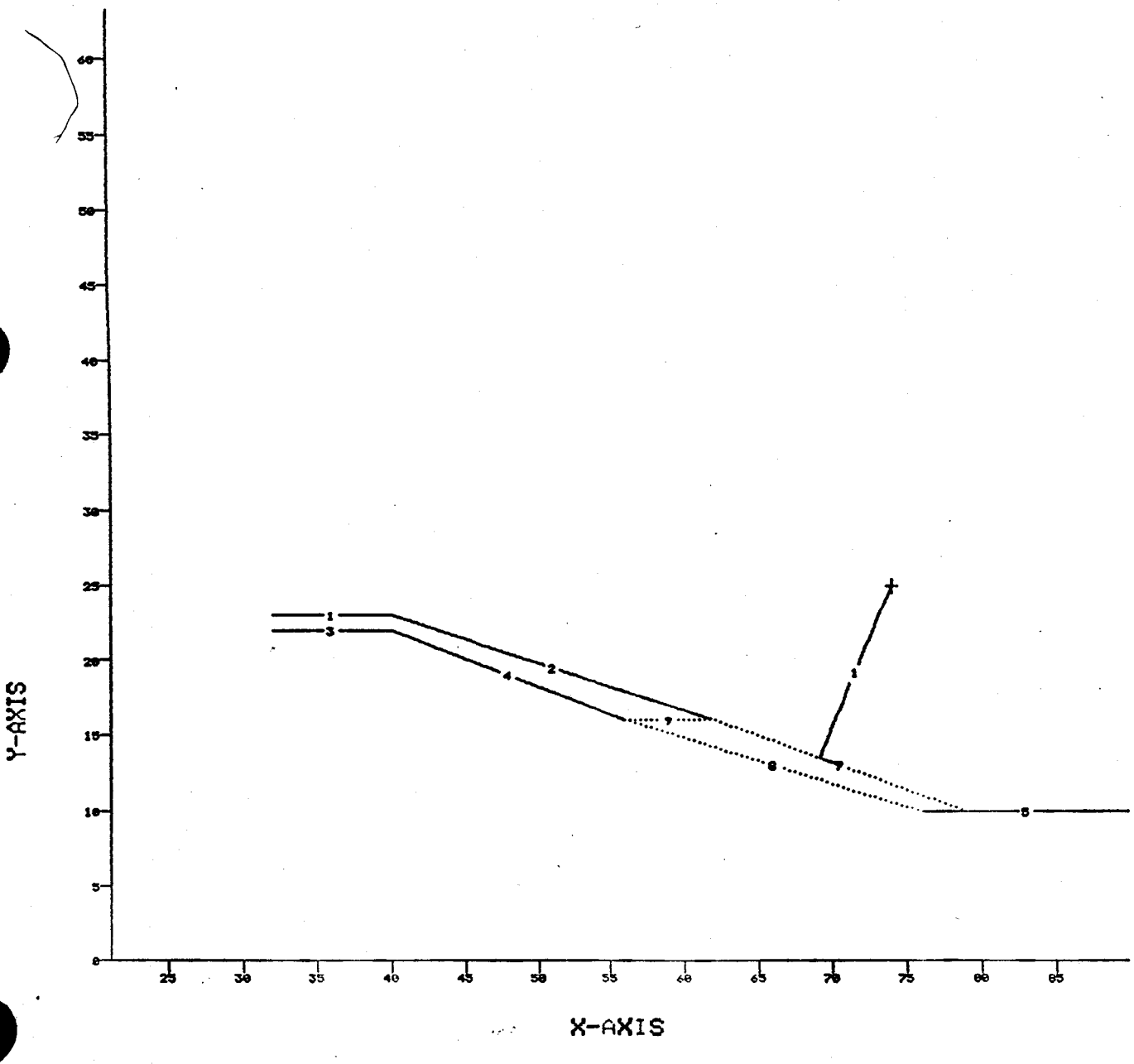
Simplified Bishop Slope Stability Analysis

PROJECT: RWCD BANK EROSION STUDY

LOCATION: MARICOPA COUNTY AZ.

FILE: BKSTDY COMPLETE SLOPE CROSS SECTION

CIRCLE	X	Y	RADIUS	FS
1	74.0	25.0	12.5	0.99



EMF - 83 EROSION STUDY

JMH 12-9-88 DP 1/20/89

Design Filter layer for base material. 1 6

SM NOTE #1 - 1986

From sieve analysis performed 10-87, tests at 9 stations from 705+00 to 965+00 had the following extremes.

SIEVE	790+00	829+50	ADJUST 829+50
1"	—	98	
3/4"	—	96	100/88 = 1.136
1/2"	—	93	
3/8"	—	91	
#4	—	88	100
#10	100	83	94
#20	99	78	89
#40	96	69	78
#60	91	57	65
#140	80	37	42
#200	75	30	34
.02	63	22	25
.05	49	11	12
.002	33	7	8

ARIZONA Bank Erosion Study

JMH 12-9-88 DGB 1/20/89

Filter Design

Design Filters for both and check if one envelope is acceptable.

	790+00	829+50
STEP 1	GIVEN CURVE	GIVEN CURVE
STEP 2	100% passing #4	88% passing #4
STEP 3	N/A	Adjust $\frac{88}{100} = 1.136$
STEP 4	CATEGORY 2, 75%	CATEG. 3, 34%
STEP 5	Max $D_{15} \leq 0.7$ mm	$D_{15} \leq \left[\frac{40-A}{40-15}\right](4 \times d_{85} - 0.7) + 0.7$ mm $A = 34$, $d_{85} = 0.6$ $D_{15\,MAX} = 1.1$ mm
STEP 6	$D_{15\,MIN} = 0.1$ mm	$D_{15\,MIN} = 4 \times d_{15}$ $= 4 \times 0.03 = 0.12$ mm
STEP 7	Max = 3 inches Max passing 2.00 = 5%	→
STEP 8	$D_{10\,MIN} = 0.089$ $D_{90\,MAX} = 20$ mm Choose D_{90} = #4 sieve $\frac{D_{90}}{D_{10}} = 47$	$D_{10\,MIN} = 0.1$ $D_{90\,MAX} = 20$mm Choose D_{90} = #4 sieve

Az BANK EROSION STUDY

JMH 12-9-88 DR 1/20/89

Filter Design 3 6

Reasonable limits, combining both extremes

SIEVE SIZE	% PASSING
1"	100
#4	90-100
#10	55-100
#20	25-85
#40	10-60
#100	0-20
#200	0-5

C-33 Fine Aggregate is right down the middle of this gradation. The envelope is about twice the size of the C-33 F/A envelope.

U.S. Department of Agriculture
Soil Conservation Service

GRAIN SIZE ANALYSIS FOR

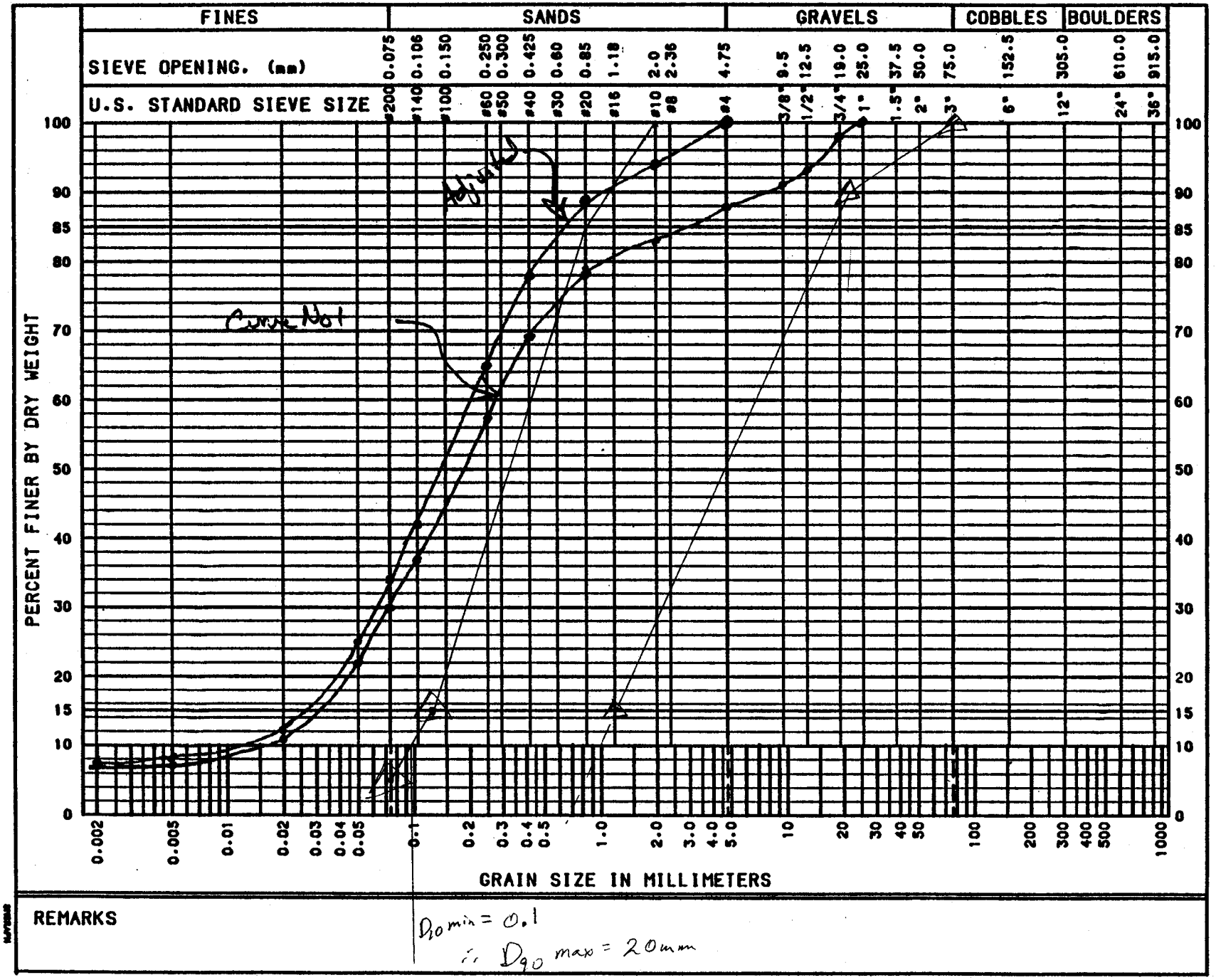
Project and state Bank Erosion Study - Arizona

Designed at S.O. By JMH Date 12-9-88

SCS-ENG-130
2-85

Sht 4 of 6

829+50



REMARKS

$D_{10\,min} = 0.1$

$\therefore D_{90\,max} = 20\,mm$

U.S. Department of Agriculture
Soil Conservation Service

SCS-ENG-130
2-85

GRAIN SIZE ANALYSIS FOR

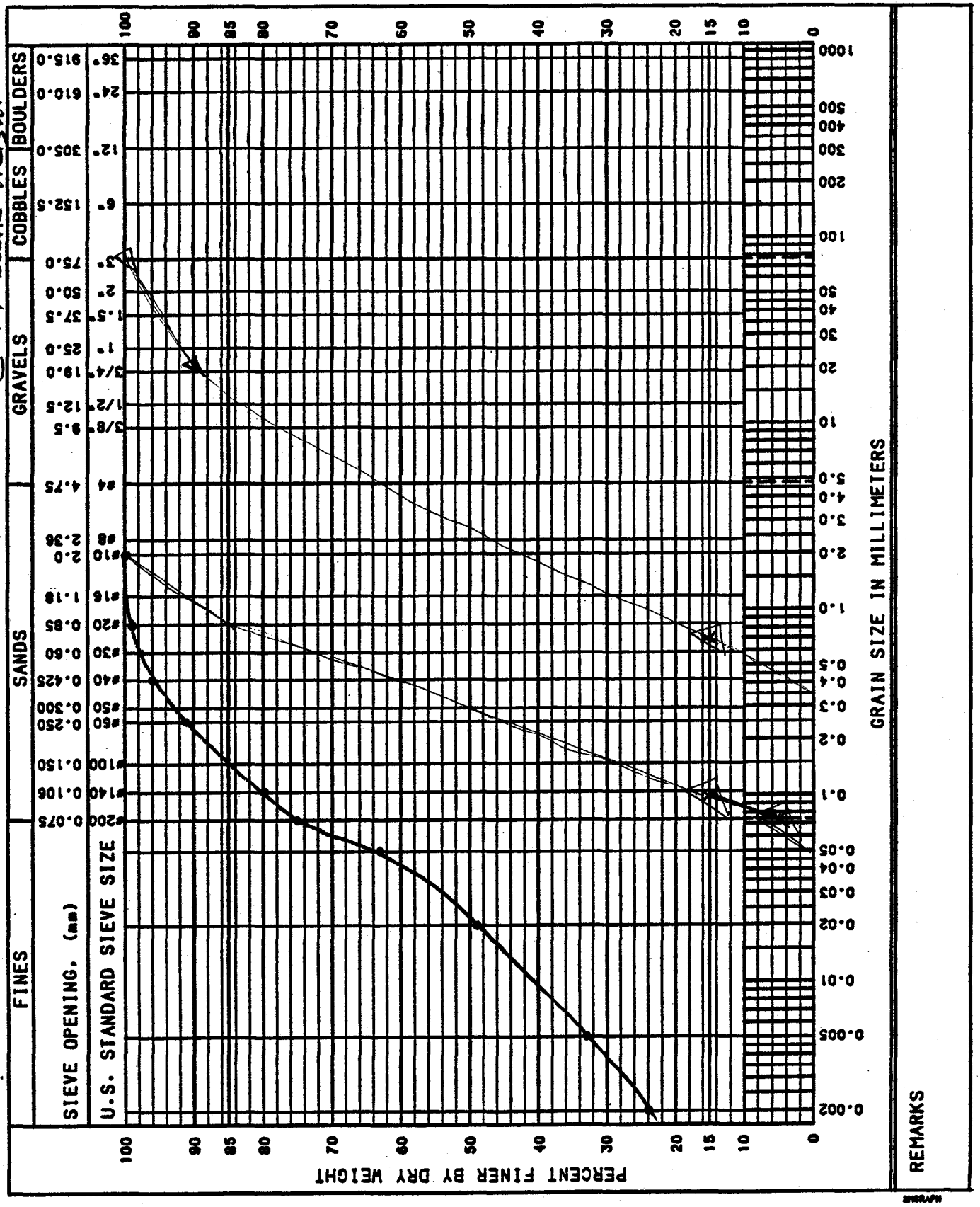
Base Curve No. 2
(Specify)

Sht 5 of 6

Project and state EMF R-3 Bank Erosion Study.

Designed at S.O. By JMH Date 12-9-88

.0700 @ ½ Bank Height



U.S. Department of Agriculture
Soil Conservation Service

SCS-ENG-130
2-85

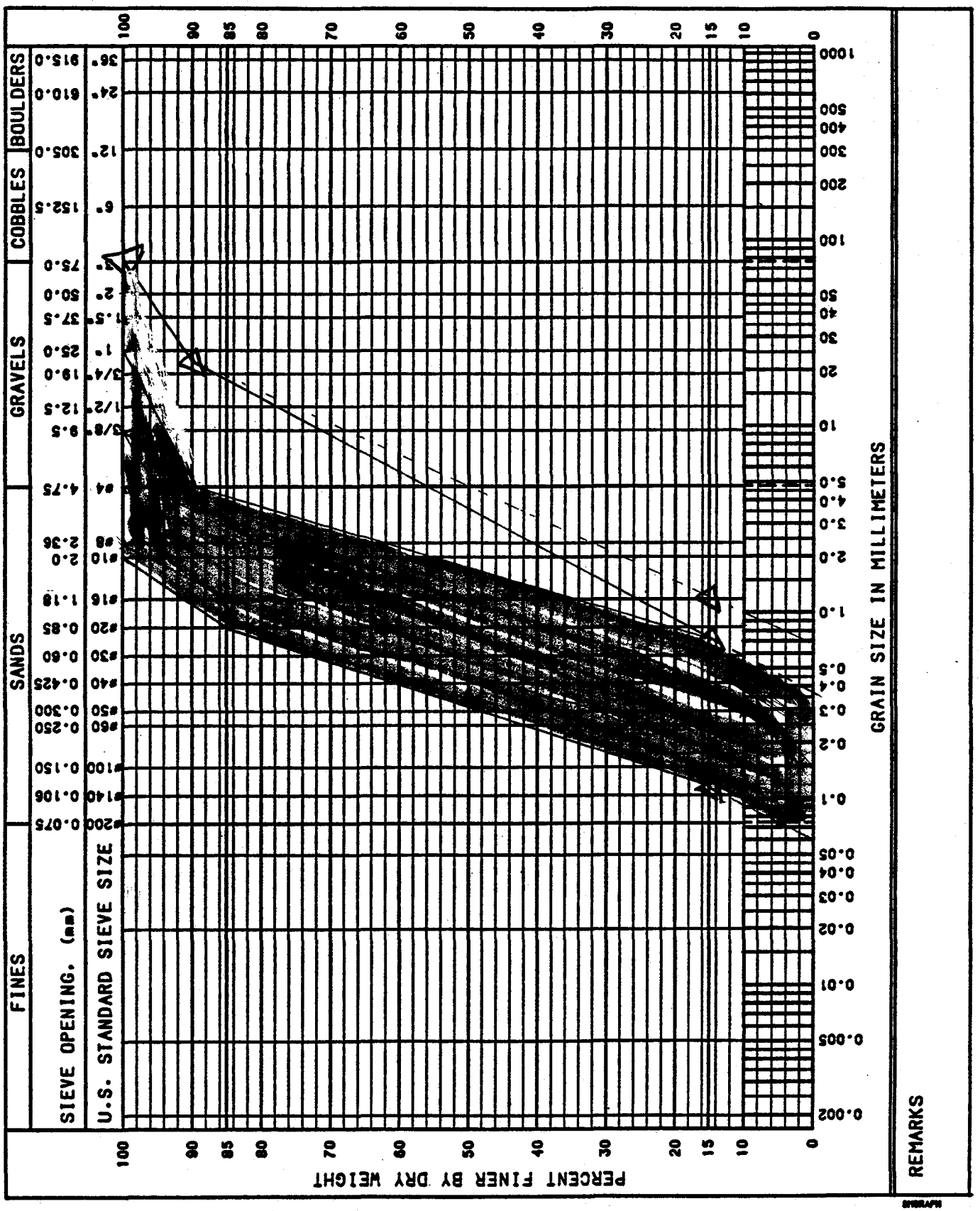
GRAIN SIZE ANALYSIS FOR

Combined
(Specify)

sht 6 of 6

Project and state Bank Erosion Study — Arizona

Designed at S.O. By JMH Date 12-9-88



Att. EMF BANK EROSION STUDY

JMH 12-14-88 DP 1/20/89

ARMOR LAYER DESIGN 1 3

Use SM Note 1 to develop an armor layer above the Filter. Use the two extremes of the Filter envelope and compare.

SIEVE	MINIMUM	ADJUSTED	MAXIMUM	ADJUSTED
1"	100	N/A	100	$\frac{100}{90} = 1.11$
#4	100		90	100
#10	100		55	61
#20	85		25	28
#40	60		10	11
#100	20		0	0
#200	5		—	—

AZ
JMH 12-14-88 EMF BANK EROSION STUDY
DSP 1/2d89

Armor Layer

2 3

	SMALLEST	LARGEST
STEP 1	Page 4	Page 4
2	100% passing #4	90% passing #4
3	N/A	$100/90 = 1.11$ Adjustment
4	CAT. 4	CAT. 4
5	Max $D_{15} \leq 4 \times d_{85}$ $4 \times 0.83 = 3.3$ mm	Max $D_{15} \leq 4 \times d_{85}$ $4 \times 4 = 16$ mm
6	Min $D_{15} \geq 4 \times d_{15}$ $4 \times 0.11 = 0.44$ mm > 0.1 ok	Min $D_{15} \geq 4 \times d_{15}$ $4 \times 0.7 = 2.8$ mm > 0.1 ok
7	Max. Size 3" 5% #200	Max Size 3"
8	$D_{10} = 0.17$ mm Max $D_{90} = 20$mm	$D_{10} = 0.5$ mm Max $D_{90} = 20$

for segregation - will not use as criteria

SIEVE	ENVELOPE	TYPICAL	Envelope revised
3"	100	100	100
1½"	95-100	100	90-100
¾"	90-100	94	64-100
⅜"	40-90	70	40-90
#4	10-65	40	10-65
#8	0-40	15	0-40
#16	0-15	7	0-15
#200	0-5	3	0-5

DSP 3/11/89

...rtment of Agriculture
...servation Service

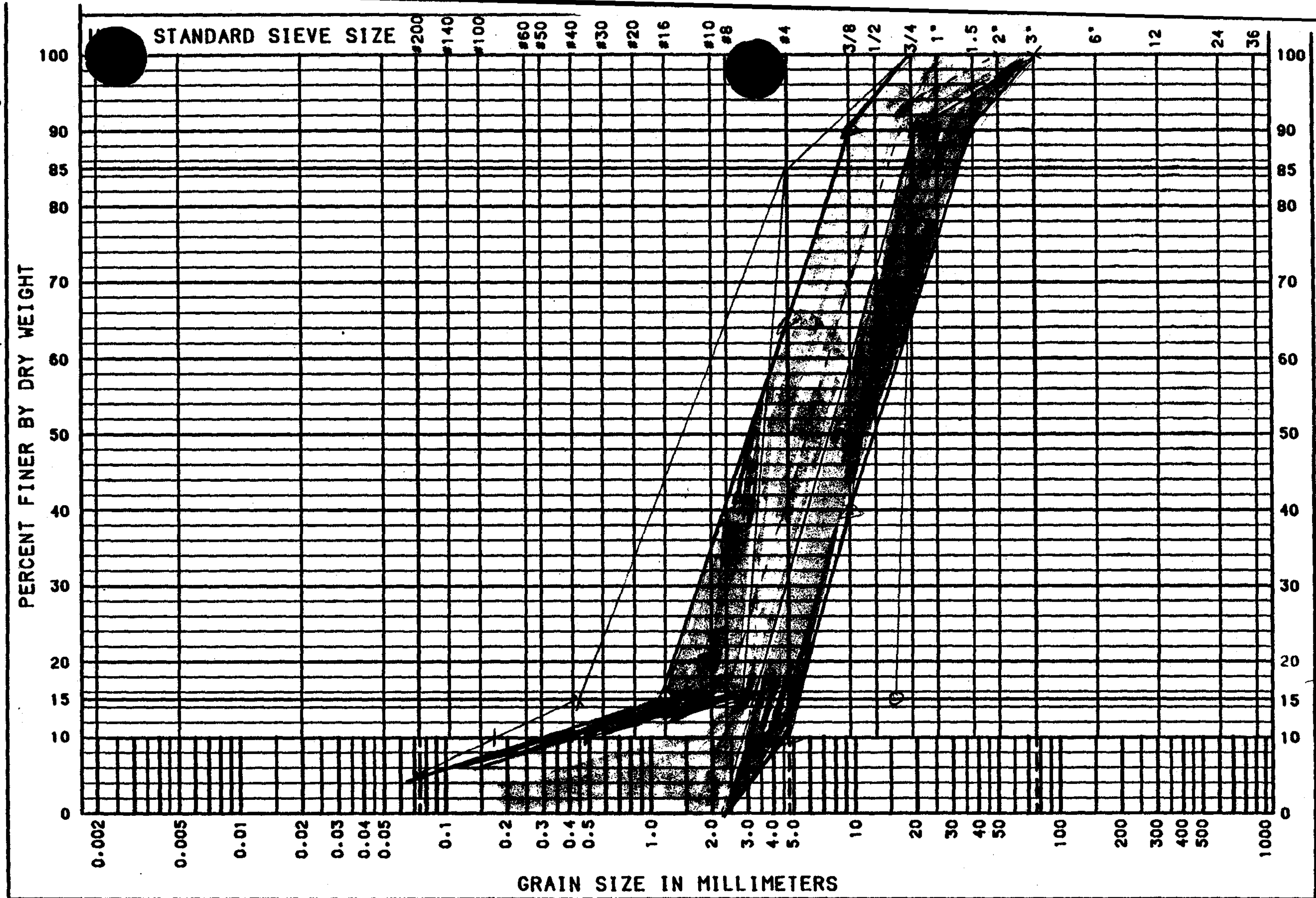
SCS-ENG-130
2-85

GRAIN SIZE ANALYSIS FOR *Filter Gradation (Armor)*
(Specify)

...ate *EME Bank Erosion Study – AZ*

By *JMH*   Date *12-14-88*

Sht 3 of 3



REMARKS

Common to both filter extremes

Design Envelope + Pink

STATE AZ		PROJECT EMF REACH-3 STUDY
BY JMH	DATE 12-15-88	8 9 89
SUBJECT TRACTIVE STRESS TR-25		SHEET 1 of 7

Check Armor layer design for bank stability.

$d_{75} > 1/4"$ Use $\tau_\infty = \gamma_w d S_t$

Q = 8,100 cfs
b = 200 ft
z = 3 :1
n = 0.027
d = 9.2 ft
V = 3.86 f/s

Se = 0.0003 f/f
Sample No. = _____
Station = General
d_{75} = 3/8" ≡ 10 MM
d_{65} = 8 MM
d_{50} = 6 MM

@ 4' Flow
@ 2' Flow

1. $S_t = \left(\frac{n_t}{n}\right)^2 S_e$

TRY 1/4"

$n_t = \frac{(d_{75})^{1/6}}{39}$ (inches) $= \frac{(0.85)}{39} =$ 0.022 ✓

$S_t = \left(\frac{0.022}{0.027}\right)^2 (0.0003) =$ 0.0002 ✓

$\tau_\infty = (62.4)(9.2)(0.0002) =$ 0.114 psf (÷2)

4' = .05
2' = .025

9.2' = 0.098
4' = 0.0425

2. $\tau_b = \tau_\infty \left(\tau_b/\tau_\infty\right)$

$b/d = \frac{200}{9.2} =$ 22.

$\tau_b/\tau_\infty =$ bottom N/A – Go to τ_s (Fig. 6-3)

$\tau_b = (\quad)(\quad) =$ _____ psf

STATE AZ	PROJECT
BY JMH DATE	
SUBJECT TRACTIVE STRESS TR-25	SHEET 2 of 7

CKd DP 3/87

3. $\tau_{bc} = \tau_b \left(\tau_{bc}/\tau_b\right)$

$R_{c/b} =$ ——— = _____

$\tau_{bc}/\tau_b =$ _____ (Fig. 6-5)

$\tau_{bc} =$ ( )( ) = _____ psf

4. $\tau_{bt} = \left(\frac{\tau_{bt} - \tau_b}{\tau_{bc} - \tau_b}\right)(\tau_{bc} - \tau_b) + \tau_b$

$L_{c/b} =$ ——— = _____

$\left(\frac{\tau_{bt} - \tau_b}{\tau_{bc} - \tau_b}\right) =$ _____ (Fig. 6-6)

$\tau_{bt} =$ ( )( )+( ) = _____ psf

5. $\tau_s = \tau_\infty \left(\tau_s/\tau_\infty\right)$

$b/d = \frac{200}{9.2} =$ 22

Exceeds graph - use limit value of 0.78

$\tau_s/\tau_\infty =$ 0.78 (Fig. 6-4)

$\tau_s =$ (0.78)(0.114) = 0.089 ✓ psf

4' = .039
2' = .019

3" = 1.74
6" = 2.~
9" = 2.52

9.2' = ¼" = 0.076
4' = .0332

STATE AZ		PROJECT
BY JMH	DATE	ckd DP 3/89
SUBJECT TRACTIVE STRESS TR-25		SHEET 3 of 7

6. $\tau_{sc} = \tau_s \left(\tau_{sc}/\tau_s\right)$

$R_c/_b = \frac{716}{200} = 3.6$.

$\tau_{sc}/\tau_s = 1.77$ (Fig. 6-5)

$\tau_{sc} = (1.77)(.089) = 0.16$ psf

7. $\tau_{st} = \left(\frac{\tau_{st} - \tau_s}{\tau_{sc} - \tau_s}\right)(\tau_{sc} - \tau_s) + \tau_s$

$L_c/_b = \_\_\_\_ = \_\_\_\_$.

$\left(\frac{\tau_{st} - \tau_s}{\tau_{sc} - \tau_s}\right) = \_\_\_\_$ (Fig. 6-6

$\tau_{st} = (\quad)(\quad)+(\quad) = \_\_\_\_$ psf

8. τ allow

$\tau_{Lb} = 0.4\ d_{75} = (0.4)(\quad) = N/A$ psf

$\tau_{Ls} = 0.4\ d_{75}\ K$

$d_{75} = 0.375$ ins.

$\phi_R = 26^\circ$ Fig. 6-7

$K = 0.7$ Fig. 6-8

$\tau_{Ls} = (0.4)(0.7)(0.375) = 0.10$ psf

9.2' = 0.07

3" = .

6" = 1.68

9" = 2.52

STATE AZ		PROJECT	
BY Jmh	DATE	CKd	DSP 3/89
SUBJECT TRACTIVE STRESS TR-25			SHEET 4 of 7

9. Check Stability

τ_b = _____

$\tau_{b\,c}$ = _____

τ_{bt} = _____

} τ_{Lb} = _____

τ_s = .009

τ_{sc} = _____

τ_{st} = _____

} τ_{Ls} = 0.10

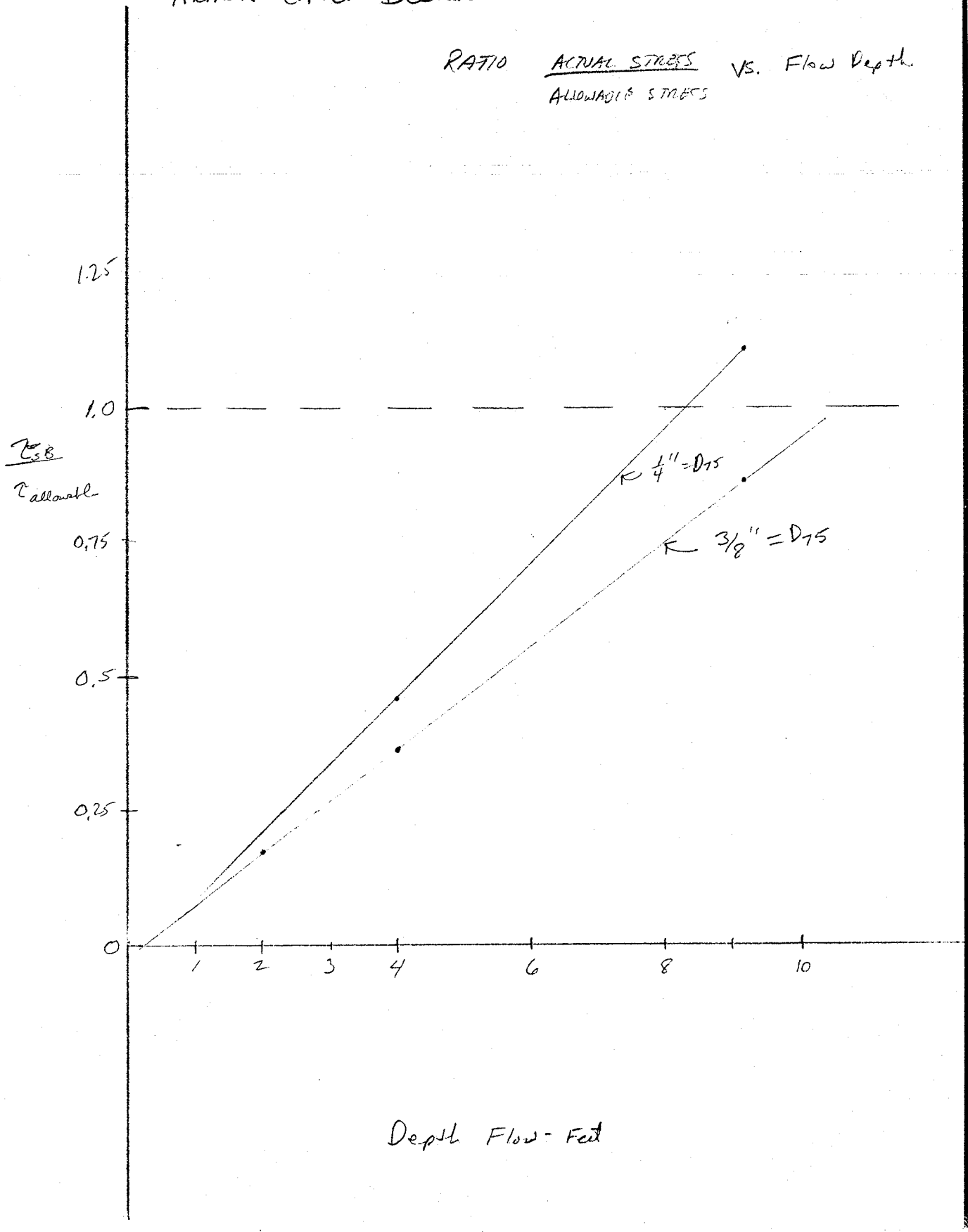
AZ
JMH 12-14-88

EMF BANK EROSION STUDY

ARMOR LAYER DESIGN

5 7

RATIO $\frac{\text{ACTUAL STRESS}}{\text{ALLOWABLE STRESS}}$ VS. Flow Depth



ARIZONA EMF BANK EROSION STUDY

JMH 12-14-88 DB 3/89

ARMOR LAYER DESIGN 6 7

D_{75} between 1/4" plus works with Tractive Stress

Check against allowable velocity.

Assume Flow Depth = 4 Feet

$n = .027$ $b = 200'$

$s = 0.0003$ $Z = 3:1$

$$V = \frac{1.486}{.027}(R)^{2/3}(.0003)^{1/2}$$

$$R = \frac{A}{WP} = \frac{4(212)}{200+2(12.4)} = 3.76$$

ACTUAL $V = 2.31$ Fps.

FROM FIG. 6.2, TR-25

basic velocity: Discrete particles, 1/4-inch 3/8

V_b sed. free = 3 Fps. 3.25

"D" = 1.07

"A" = No curve = 1.0

"B" = 0.83

$$V_{allowable} = V_b \times D \times A \times B$$

$$= 3(1.07) \times (.83)$$

STRAIGHT SECTION = 2.66 Fps OK (> 2.31 fps)

ROUGH CHECK CURVE (716' TIGHTEST RADIUS S-2.

$$\frac{\text{Radius}}{\text{SURFACE}} = \frac{716}{224} = 3.2$$

"A" = 0.7 $V_{all} = 2.66 \times 0.7 = 1.86$ 2.0

JMH AZ 12-14-88 EMF BANK EROSION STUDY DSP 3/89

ARMOR LAYER DESIGN 7 7

The gradation on page 5 meets allowable velocity and Tractive Stress requirements for straight sections only. The D_{75} of 3/8" is too small for curved sections of the channel. For purposes of this study, because the majority of the channel (Floodway) is aligned in straight sections and we are looking for economical slope protection, study will focus on straight portions of the channel.

EMF BANK EROSION STUDY – AZ. ①
by DEP

Evaluation: Soil test results vs. field erosion

Ranking of field Erosion (worst to least), visual
1. 911+80
2. 830+60
3. 829+50
4. 965+00
5. 930+00
6. 790+00

Ranking of Dispersion by total salts, (worst to least) / sm-10 (%)

1.	930+00 (DISP)	790+00	(33)
2.	829+50 (TRANS)	830+60	(7)
3.	965+00 (TRANS)	930+00	(5)
4.	911+80 (TRANS)	965+00	(5)
5.	830+60 (TRANS)	911+80	(TR)
6.	790+00 (NON-DISP)	829+50	(TR)

NOTE: CRUMB TEST – old rank #1

Ranking of Resistivity (HIGHEST to LOWEST)
1. 911+80 (4000)
2. 930+00 (3830)
3. 829+50 (2070)
4. 965+00 (1780)
5. 830+60 (1170)
6. 790+00 (720)

EMF BANK EROSION STUDY – A+
by DSP

GRADATION:

Except for sample 113 @ station 829+50 there is not much difference between the samples.

% passing (.002) range: 10 to 24
% passing (0.005) range: 10 to 33
% FINES (#200) range: 52 to 75

Plastic Index:

Range from Non-Plastic to 10. ~~No relationship~~

Ranking of PI. (Lowest to highest)

1. 829+50 (N.P.)
2. 911+80 (≈4)
3. 880+60 (≈4)
4. 965+00 (≈5)
5. 930+00 (≈6)
6. 790+00 (≈8)

Conclusions

The most revealing of all the test values are the Plastic Indexes With an average value of 5, there ~~seems~~ is not enough cohesiveness ~~in~~ the soil to resist the erosion caused by the forces of the direct rainfall.

Dispersion does not seem to have a direct correlation to the observed erosion. I would tend to believe the areas that seem to be failing from jugging & ~~wash~~ are the result of piping of the low P.I. material. Piping can be started by cracking of overcompacted (Pumping of material) earthfill. ~~Increasing the dispersion during construction~~

GUIDE FOR RATING SOILS FOR CORROSION TO UNCOATED METAL PIPE

Soil Property or Quality	Corrosivity Classes		
	Low (Slightly corrosive to non-corrosive)	Moderate (Moderately corrosive)	High (Severely to very severely corrosive)
Drainage class and texture	somewhat excessively OR excessively drained - coarse OR well drained moderately coarse or medium OR somewhat poorly drained - coarse	Well drained - moderately fine OR moderately well drained - medium OR somewhat poorly drained - moderately coarse OR very poorly drained peats and mucks with water table at surface throughout the year	moderately well or well drained - fine OR moderately well drained - moderately fine OR somewhat poorly drained - medium or moderately fine OR poorly drained - coarse to moderately fine OR somewhat poorly, poorly very poorly drained - fine OR very poorly drained with fluctuating water table within 1 foot of surface OR peats and mucks with fluctuating water table
Total acidity 1/ (meq. H+/100 g.)	less than 8	8 through 12	more than 12
Conductivity saturation extract (mmhos/cc @ 25°C.)	less than 0.2	0.2 - 0.4	more than 0.4
Electrical resistivity at moisture equivalent, (ohm-cc @ 60°F.)	more than 5000	2000 - 5000	less than 2000

1/ Roughly equal to extractable acidity as determined by Soil Survey Laboratories, or sodium acetate cation exchange capacity (CEC, NaOAc) minus sum of bases (Ca+Mg+Na+K)

United States Department of Agriculture
Soil Conservation Service
Midwest National Technical Center
Soil Mechanics Laboratory
512 South 7th Street
Lincoln, NE 68508-2919

WORKING COPY

Subject: ENG - Soil Mechanics - Arizona (WF-08) Date: January 7, 1988
Williams Chandler, Site: East
Maricopa Floodway Reach 3 and 4
Re: SML Report Dated December 21, 1987

To: File code:
Ralph M. Arrington 210-22
State Conservation Engineer
SCS, Phoenix, AZ

The pore water chemistry tests for samples from the subject site have been completed and the data are attached. The test results for resistivity, pH, TDS and percent sodium are recorded on the attached forms SCS-ENG-354. The percent sodium versus TDS are plotted on the attached graph which shows that two samples plot in the dispersive clay zone, eight plot in the transitional zone and ten plot in the non-dispersive clay zone.

The worksheets for the pore water chemistry tests are also included.

Also, attached is a note from NSSL that no gypsum was found in these samples. (NSSL lab numbers 88Q162 thru 88Q181, SML lab numbers 88W100 thru 88W119.

Edgar L. Steele Acting

LORN P. DUNNIGAN
Head, Soil Mechanics Laboratory

Attachments:
Form SCS-ENG-354, Soil Mechanics Laboratory Data, 4 sheets
Figure 1, Plot of Total Dissolved Salts Vs Percent Sodium, 1 sheet
Worksheets for Pore Water Chemistry Tests, 2 sheets
Note From NSSL Dated 12/15/87, 1 sheet

cc: w/atts.
Ralph M. Arrington (Original + 3 copies)
W. R. Evans, Head, Engineering Staff, West NTC, SCS, Portland, OR (ltr only)
Clifton E. Deal, Soil Mechanics Engineer, Engineering Staff, West NTC, SCS, Portland, OR

SCS-ENG-354
Rev. 3-70
File Code ENG-13-18

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 1 of 4

10/27/87 — ARIZONA

Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis — Grain Size Distribution Expressed as Percent Finer by Dry Weight: Fines 0.002 mm	0.005	0.02	0.05	#200 0.074	Sand #100 0.149	#60 0.250	#40 0.42	#20 0.84	#10 2.0	#4 4.76	Gravel 3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm	Atterberg Limits: L.L.	P.I.	Unified Classification	Soluble Salts %	Dispersion % Finer Than 5 Micron Size	Moisture-Density Relationships (☐ Standard ☐ Modified): Curve No.	Max. γd p.c.f.	Opt. %	Undisturbed Sample Data: γd g/cc	Opt. %	Gs	Special Tests: Resistivity Saturated-Ohm-cm	pH	T.D.S. MEQ/Liter	Ha % P/M Hole	Alum #
88W		Williams Chandler, Site: East Maricopa Floodway Reach 3 & 4																																			
100	1.1	Reach-4, East Bank L. Bag	0-3"	SM-SC	21	26	37	55	69	76	91	96	99	100								25	10	CL	0.3	12						2.68	600	7.30	152.9	8.1 No-1	1
		Sta 705+00																																			
		@ 1/2 bank ht.																																			
101	1.2	@ toe of slope L. Bag			15	18	25	46	58	66	85	93	98	100								21	4	CL-ML	0.3	Tr.						2.64	1720	7.52	12.9	41.6	1
102	2.1	R-4, West Bank L. Bag			16	20	31	45	56	62	81	92	98	100								22	6	CL-ML	0.4	10						2.71	430	7.30	85.9	43.5 No-1	1
		Sta 720+00																																			
		@ 1/2 bank Ht.																																			
103	2.2	@ toe of slope (sed.) L. Bag			14	19	25	39	51	59	80	91	97	100								20	4	CL-ML	0.4	Tr.						2.71	1490	7.49	16.4	41.0	1
104	3.1	R-4, East Bank L. Bag			13	16	22	36	50	55	69	75	82	89	94	97	99	99	100			21	4	CL-ML	0.3	6						2.67	730	7.40	483	30.6	1
		Sta 725+00																																			
105	4.1	R-3, West Bank L. Bag			16	19	25	40	54	62	77	84	92	100								22	5	CL-ML	0.4	5						2.70	650	7.34	53.8	30.8	1
		Sta 965+00																																			
		@ 2/3 bank ht.																																			

SCS-E... 4
Rev.
File Code ENG-13-18

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 2 of 4

10/27/87 ARIZONA

Williams Chandler, Site: East Maricopa Floodway Reach 3 & 4

Laboratory Sample Number 88W	Field Number	Location and Description	Depth	Field Classification	Fines .002 mm	Fines .005	Fines .02	Fines .05	Fines #200 0.074	Sand #140 0.105	Sand #60 0.250	Sand #40 0.42	Sand #20 0.84	Sand #10 2.0	Sand #4 4.76	Gravel 3/8" 9.525	Gravel 1/2" 12.7	Gravel 3/4" 19.05	Gravel 1" 25.4	Gravel 1 1/2" 38.1	Gravel 3" 76.2 mm	Atterberg Limits L.L.	Atterberg Limits P.I.	Unified Classification	Soluble Salts %	Dispersion % Moist Soil	Moisture-Density Curve No.	Max. γd p.c.f.	wo %	Undisturbed γd g/cc	Undisturbed wn %	Gs	Resistivity ohm-cm	pH	T.D.S. MEQ/Liter	Na %/ Pin Hole	Cl
106	4.2	Sta 965+00 @ 1/2 bank ht. L. Bag			14	19	25	39	54	61	77	83	92	100								22	6	CL-ML	0.3	Tr.						2.79	1410	7.45	19.9	48.0	1
107	4.3	@ toe of slope L. Bag			14	19	25	40	55	64	80	86	94	100								23	5	CL-ML	0.3	Tr.						2.71	1780	7.46	13.7	27.6	1
108	5.1	R-3, West Bank Sta. 930+00 @ 3/4 bank ht. M. Bag			18	20	26	42	59	67	82	88	95	100								22	6	CL-ML	0.4	Tr.						2.71	2580	7.70	8.1	74.4	1
109	5.2	@ 1/2 bank ht. L. Bag			17	20	27	44	62	70	85	90	95	100								23	7	CL-ML	0.4	5						2.77	745	7.50	43.8	63.8	1
110	5.3	@ 1/4 bank ht. L. Bag			10	10	14	30	44	58	92	97	99	100								NON PLASTIC		SM	0.4	Tr.						2.76	3290	7.22	7.0	36.6	1
111	6.1	East Bank C-3 Sta 911+80 @ 1/4 bank ht. L. Bag			14	17	23	40	63	72	89	94	99	100								20	4	CL-ML	0.4	Tr.						2.70	2120	7.32	10.8	43.3	1

get pin hole tests run.

SCS-ENG-354
Rev. 3-70
File Code ENG-13-18

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 3 of 4

10/27/87 — ARIZONA

Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis: Grain Size Distribution Expressed as Percent Finer by Dry Weight — Fines: .0002 mm; .005; .02; .05; #200 .074	Sand: #140 .105; #60 .250; #40 .42; #20 .84; #10 2.0; #4 4.76	Gravel: 3/8" 9.525; 1/2" 12.7; 3/4" 19.05; 1" 25.4; 1 1/2" 38.1; 3" 76.2 mm	Atterberg Limits: L.L.	Atterberg Limits: P.I.	Unified Classification	Soluble Salts %	Dispersion % Moist Soil	Moisture-Density Relationships: ☐ Standard ☐ Modified — Curve No.	Max. γ_d pcf	w_o %	Undisturbed Sample Data: γ_d g/cc	w_o %	G_s	Special Tests: Resistivity ohm-cm	pH	T.D.S. meq/Liter	Na % per Hole	Comments
88W																							
112	6.2	East Bank, R-3 M. Bag Sta 911+80, scd. @ toe & slope			10 11 15 36 58	71 89 93 97 100		NON PLASTIC		ML	0.4	Tr.						2.70	4000	7.42	4.6	30.2	1
113	7.1	R-3, West Bank L. Bag Sta. 829+50 @ 3/4 bank ht.			7 7 11 22 30	37 57 69 78 83 88	91 93 96 98 100	✓ NON PLASTIC		SM	0.4	Tr.						2.76	2070	7.20	13.9	46.8	1
114	7.2	@ toe of slope (scd.) L. Bag			11 12 20 38 52	60 80 91 97 100		19	✓1	ML	0.4	Tr.						2.73	✓2030	7.35	11.0	57.9	1
115	8.1	R-3, West Bank L. Bag Sta 830+60 @ 3/4 bank ht.			12 17 26 43 58	67 87 95 99 100		21	✓4	CL ML	0.4	6						2.75	1170	7.32	22.0	43.2	1
116	8.2	@ 1/2 bank ht. L. Bag			11 13 22 40 54	63 85 93 98 100		20	1	ML	0.4	8						2.74	770	7.25	46.8	28.7	1
117	8.3	@ 1/4 bank ht. L. Bag			12 16 27 46 63	72 90 96 99 100		22	3	ML	0.6	6						2.74	290	7.13	166.8	23.3	1

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 1 of 1

10/27/87

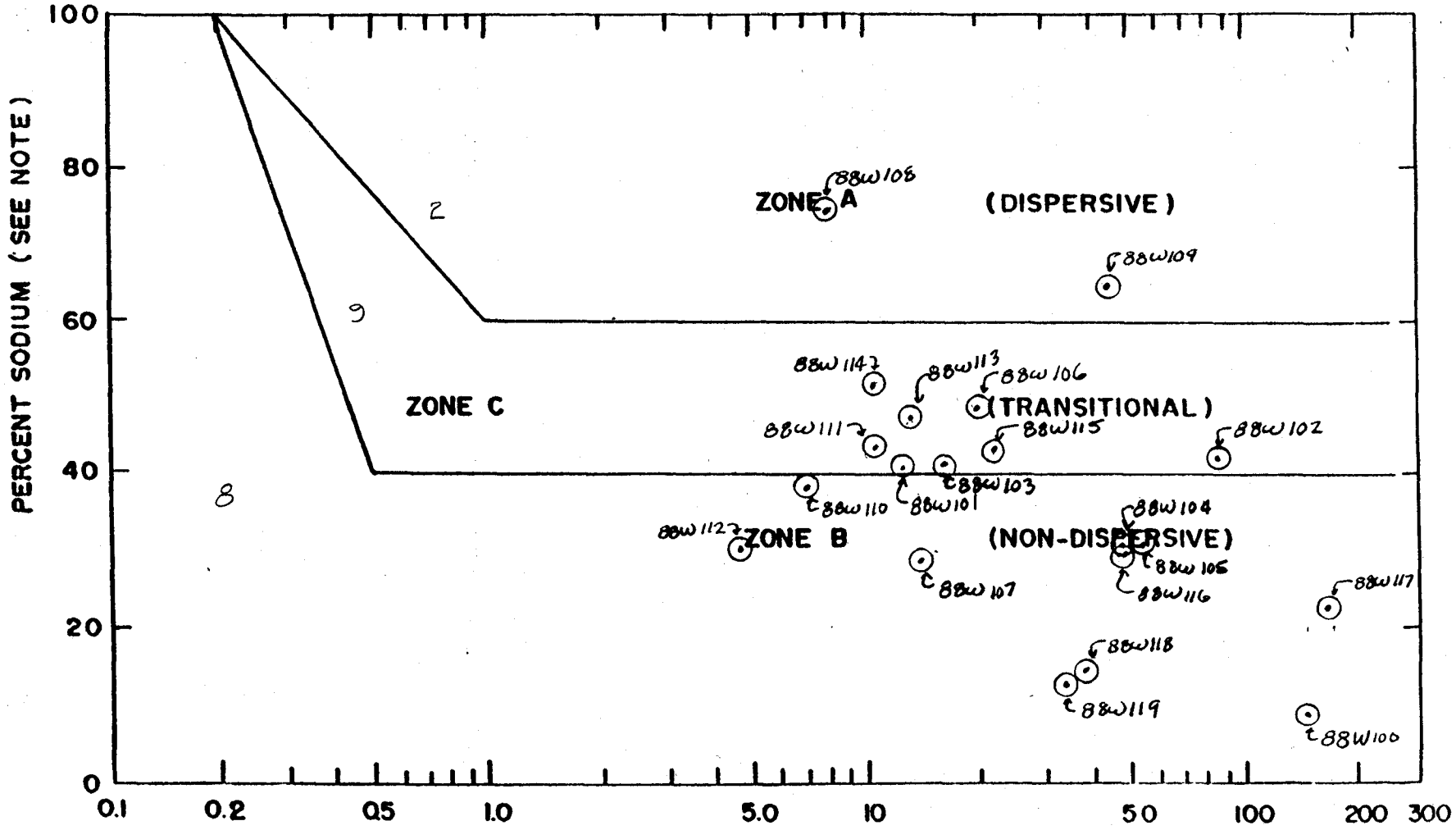
Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis: Grain Size Distribution Expressed as Percent Finer by Dry Weight — Fines: 0.002 mm	0.005	0.02	0.05	#200 0.074	Sand: #100 0.149	#60 0.250	#40 0.42	#20 0.84	#10 2.0	#4 4.76	Gravel: 3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2	Atterberg Limits: LL	PI	Unified Classification	Soluble Salts %	Dispersion % Moist Soil	Moisture-Density Relationships: ☐ Standard ☐ Modified — Curve No.	Max. γ_d pcf	Opt. %	Undisturbed Sample Data: γ_d g/cc	%	G_s	Special Tests: Resistivity Ohm-cm	pH	T.D.S. MEQ/LITER	Na Pit Hole	Comments
88W		Williams Chandler, Site: East Maricopa Floodway Reach 3 & 4																																				
118	9.1	R-3, East Bank L. Bag			18	25	44	60	73	78	90	96	99	100								24	7	CL-ML	0.4	32						2.73	720	7.40	36.9	15.3	1
		Sta. 790+00																																				
		@ 3/4 bank ht.																																				
119	9.2	@ 1/4 bank ht. L. Bag			24	33	49	63	75	80	91	96	99	100								26	9	CL	0.4	33						2.73	720	7.35	33.0	12.9	1

State: ARIZONA

Site: WILLIAMS CHANDLER EAST FLOODWAY REACH #3 & 4

FIGURE 1

NOTE: PERCENT SODIUM (MEQ./LITER) = $\frac{Na(100)}{Ca+Mg+Na+K}$



TOTAL DISSOLVED SALTS IN SATURATION EXTRACT IN MILLIEQUIVALENTS PER LITER

(TDS = Ca + Mg + Na + K)

LSL NO.	SIL	6A1A CRGN CARB	6B1A NITG	C/N	6C2A EXT FE	6S1A TOTL CA	6N2C MG	6O2C NA	K	6O2A SUM EXTR	6N1A BACL TEA	6C1C KCL EXT	5A3A EXTR ACTY	5A6A NHAC	8D1 NHAC TO CLAY	8D3 CA TO MG	SAT	EXTR ACTY	SCT NHAC
NO.		PCT	PCT		PCT	PCT	(- - - - - - - - - - - - MEQ / 100 G - - - - - - - - - - - -)										PCT	PCT	PCT

AZ WILLIAMS CHANDLER EMF REACH #3 & 4

LSL NO.	SIL	(SATURATED PASTE) 8E1 REST OHM-CM	8C1C PH	8A H2C PCT	NA SO2 ESP PCT	NA SE SAR	SALT 8D5 TOTL SOLU PPM	GYP 6F1A PCT	8A1A EC MMHOS/CM	SATURATION EXTRACT 6N1C CA	6O1C MG	6P1A NA	6Q1A K	6I1A CO3	TOTAL SOLUBLE SALTS	Na %	Results for Dy PSum % Will be furnished as soon as possible Hopefully before 12/30/82
80Q0162	88W-100	600	7.30	37.86		1.5	3700			132.85	7.04	12.41	.64		152.94	8.1	Computed OK
163	-101	1720	7.52	30.43		2.8	250			5.59	1.70	5.36	.23		12.88	41.6	OK Rich
164	-102	430	7.30	32.98		7.4	1800			37.60	11.30	36.55	.46		85.91	42.5	
165	-103	1490	7.49	29.34		3.1	310			7.40	2.00	6.73	.29		16.42	41.0	
166	-104	730	7.40	29.28		3.6	900			24.15	8.72	14.75	.63		48.25	30.6	
167	-105	650	7.34	28.72		3.9	990			25.90	10.42	16.55	.89		53.76	30.8	
168	-106	1410	7.45	27.52		4.3	380			7.03	2.75	9.53	.55		19.86	48.0	
169	-107	1780	7.46	22.63		4.7	260			7.17	2.37	3.79	.41		13.24	27.6	
170	-108	2580	7.70	29.96		6.4	160			1.16	.62	6.06	.30		8.14	74.4	
171	-109	750	7.45	32.93		10.1	900			9.15	6.05	27.95	.65		43.8	63.8	

LSL NO.	SIL	6A1A ORGN CARB PCT	6A1A NITG PCT	C/N	6C2A EXT FE PCT	6S1A TOTL PCT	6N2C CA	6O2D MG	6 NA	6O2A K	SUM EXTR	6H1A BACE TEA	6C1D KCL EXT	6A3A EXTR ACTY	6A6A NH4AC	8D1 NH4AC TO CLAY	8D3 CA TO MG	SAT NH4AC PCT	EXTR ACTY PCT	SCI NH4AC PCT
NO.							MEQ / 100 G													

AZ WILLIAMS CHANDLER EMF REACH #3 & 4

LSL NO.	SIL	(SATURATED PASTE) 8C1 REST OHM-CM	6C1D PH	8A H2O PCT	NA 5O2 ESP PCT	NA 5E SAR	SALT GYP 8D5 TOTL SOLU PPM	6F1A PCT	8A1A EC MMHOS/CM	6N1D CA	6O1B MG	SATURATION EXTRACT 6P1A NA	6Q1A K	6I1A CO3	TOTAL SOLUBLE SALTS	Na %	
88Q0172	884 -110	3290	7.22	31.72		1.8	140			3.26	.70	2.57	.50		7.03	36.6	
173	-111	2120	7.32	31.74		2.9	220			4.05	1.10	4.65	.95		10.25	43.3	
174	-112	4000	7.42	29.13		1.2	86			2.13	.58	1.40	.52		4.63	20.2	
175	-113	2070	7.28	24.58		3.4	220			6.32	.84	6.51	.23		13.90	46.8	
176	-114	2030	7.35	29.24		3.6	210			4.15	.90	5.69	.23		10.97	51.9	
177	-115	1170	7.32	34.09		3.9	480			10.55	1.65	9.53	.32		22.05	43.2	
178	-116	720	7.25	30.45		3.3	910			28.50	4.50	13.44	.39		46.83	28.7	
179	-117	290	7.13	32.68		4.5	3500			111.16	16.25	38.85	.52		166.78	23.3	
180	-118	720	7.40	36.97		1.4	980			26.35	4.16	5.65	.70		36.86	15.3	
181	-119	720	7.35	38.84		1.1	820			23.70	3.87	4.27	1.15		32.99	12.9	

computed by OK

10/15/87

RT88-SM050

Soil Mech. Lab - Lincoln, Ne.

Samples 88Q 162-181

No Gypsum Was Found in samples

Do You Want the samples returned ?

IEPA will need samples during PIC. 12-22-87

cc: Project Folder

USDA-SCS
SOIL MECHANICS
LABORATORY

DEC 17 1987

LINCOLN, NEBR. 68508

LPD
EFS
RFH
A JPP
MDK
DMY
BUL BD

United States Department of Agriculture
Soil Conservation Service
Midwest National Technical Center
Soil Mechanics Laboratory
512 South 7th Street
Lincoln, NE 68508-2919

WORKING COPY

Subject: ENG - Soil Mechanics - Arizona (WF-08)
Williams Chandler, Site: East
Maricopa Floodway Reach 3 and 4
Re: SML Report Dated December 21, 1987

Date: January 7, 1988

To: Ralph M. Arrington
State Conservation Engineer
SCS, Phoenix, AZ

File code: 210-22

The pore water chemistry tests for samples from the subject site have been completed and the data are attached. The test results for resistivity, pH, TDS and percent sodium are recorded on the attached forms SCS-ENG-354. The percent sodium versus TDS are plotted on the attached graph which shows that two samples plot in the dispersive clay zone, eight plot in the transitional zone and ten plot in the non-dispersive clay zone.

The worksheets for the pore water chemistry tests are also included.

Also, attached is a note from NSSL that no gypsum was found in these samples. (NSSL lab numbers 88Q162 thru 88Q181, SML lab numbers 88W100 thru 88W119.

Edgar J. Steele Acting

LORN P. DUNNIGAN
Head, Soil Mechanics Laboratory

Attachments:
Form SCS-ENG-354, Soil Mechanics Laboratory Data, 4 sheets
Figure 1, Plot of Total Dissolved Salts Vs Percent Sodium, 1 sheet
Worksheets for Pore Water Chemistry Tests, 2 sheets
Note From NSSL Dated 12/15/87, 1 sheet

cc: w/atts.
Ralph M. Arrington (Original + 3 copies)
W. R. Evans, Head, Engineering Staff, West NTC, SCS, Portland, OR (ltr only)
Clifton E. Deal, Soil Mechanics Engineer, Engineering Staff, West NTC, SCS, Portland, OR

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 1 of 4

10/27/87 — ARIZONA

Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis: Grain Size Distribution Expressed as Percent Finer by Dry Weight — Fines: 0.002 mm	0.005	0.02	0.05	#200 0.074	Sand: #140 0.105	#60 0.250	#40 0.42	#20 0.84	#10 2.0	#4 4.76	Gravel: 3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm	Atterberg Limits: L.L.	P.I.	Unified Classification	Soluble Salts %	Dispersion % Passing #10 Sieve	Moisture-Density Relationships: ☐ Standard ☐ Modified — Curve No.	Max. γ_d pcf.	Opt. %	Undisturbed Sample Data: γ_d g/cc	Opt. %	Gs	Special Tests: Resistivity Ohms-cm	pH	T.D.S. MEQ/Liter	Na % Ca + Mg Ratio	Remarks
88W					mm																																	
100	1.1	L. Bag			21	26	37	55	69	76	91	96	99	100								25	10	CL	0.3	12						2.68	600	7.30	152.9	8.7 NO-1	1
101	1.2	L. Bag			15	18	25	46	58	66	85	93	98	100								21	4	CL-ML	0.3	Tr.						2.64	1720	7.52	12.9	41.6	1
102	2.1	L. Bag			16	20	31	45	56	62	81	92	98	100								22	6	CL-ML	0.4	10						2.71	430	7.30	85.9	43.5 NO-1	1
103	2.2	L. Bag			14	19	25	39	51	59	80	91	97	100								20	4	CL-ML	0.4	Tr.						2.71	1490	7.49	16.4	41.0	1
104	3.1	L. Bag			13	16	22	36	50	55	69	75	82	89	94	97	99	99	100			21	4	CL-ML	0.3	6						2.67	730	7.40	48.3	30.6	1
105	4.1	L. Bag			16	19	25	40	54	62	77	84	92	100								22	5	CL-ML	0.4	5						2.70	650	7.34	53.8	30.8	1

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 2 of 4

10/27/87 ARIZONA

Location and Description: Williams Chandler, Site: East Maricopa Floodway Reach 3 & 4

Mechanical Analysis — Grain size distribution expressed as percent finer by dry weight

Laboratory Sample Number 88W	Field Number	Location and Description	Depth	Field Classification	Fines .002 mm	.005	.02	.05	#200 0.074	Sand #140 0.105	#60 0.250	#40 0.42	#20 0.84	#10 2.0	#4 4.76	Gravel 3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm	Atterberg Limits L.L.	P.I.	Unified Classification	Soluble Salts %	Dispersion % Moist Soil	Moisture-Density Curve No.	Max. γ_d pcf	w_o %	Undisturbed γ_d g/cc	w_n %	G_s	Resistivity ohms-cm	pH	T.D.S. MEQ/Liter	Na % / Pin Hole	Crumb
106	4.2	L. Bag			14	19	25	39	54	61	77	83	92	100								22	6	CL-ML	0.3	Tr.						2.79	1410	7.45	19.9	48.0	1
107	4.3	L. Bag			14	19	25	40	55	64	80	86	94	100								23	5	CL-ML	0.3	Tr.						2.71	1780	7.46	13.7	27.6	1
108	5.1	M. Bag			18	20	26	42	59	67	82	88	95	100								22	6	CL-ML	0.4	Tr.						2.71	2580	7.70	8.1	74.4	1
109	5.2	L. Bag			17	20	27	44	62	70	85	90	95	100								23	7	CL-ML	0.4	5						2.77	745	7.50	43.8	63.8	1
110	5.3	L. Bag			10	10	14	30	44	58	92	97	99	100								NON PLASTIC		SM	0.4	Tr.						2.76	3290	7.22	7.0	36.6	1
111	6.1	L. Bag			14	17	23	40	63	72	89	94	99	100								20	4	CL-ML	0.4	Tr.						2.70	2120	7.32	10.8	43.3	1

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SOIL MECHANICS LABORATORY DATA
Sheet 3 of 4

10/27/87 — ARIZONA

Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis: Grain Size Distribution Expressed as Percent Finer by Dry Weight — Fines: .002 mm	.005	.02	.05	#200 0.074	Sand: #140 0.105	#100 0.250	#60 0.42	#40 0.84	#20 2.00	#10 2.0	#4 4.76	Gravel: 3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm	Atterberg Limits: LL	PI	Unified Classification	Soluble Salts %	Dispersion % (Modified Soil)	Moisture-Density Relationships: Standard ☐ Modified ☐ — Curve No.	Max. γ_d pcf	Optimum %	Undisturbed Sample Data: γ_d g/cc	Optimum %	G_s	Special Tests: Resistivity ohm-cm	pH	T.D.S. MEQ/LITER	Na % (psi Hose)	Remarks
88W					mm																																	
112	6.2	M. Bag			10	11	15	36	58	71	89	93	97	100									NON PLASTIC		ML	0.4	Tr.						2.70	4000	7.42	4.6	30.2	1
113	7.1	L. Bag			7	7	11	22	30	37	57	69	78	83	88	91	93	96	98	100			NON PLASTIC		SM	0.4	Tr.						2.76	2070	7.20	13.9	46.8	1
114	7.2	L. Bag			11	12	20	38	52	60	80	91	97	100									19	1	ML	0.4	Tr.						2.73	2030	7.35	11.0	57.9	1
115	8.1	L. Bag			12	17	26	43	58	67	87	95	99	100									21	4	CL ML	0.4	6						2.75	1170	7.32	22.0	43.2	1
116	8.2	L. Bag			11	13	22	40	54	63	85	93	98	100									20	1	ML	0.4	8						2.74	770	7.25	46.8	28.7	1
117	8.3	L. Bag			12	16	27	46	63	72	90	96	99	100									22	3	ML	0.6	6						2.74	290	7.13	146.8	23.3	1

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SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 1 of 1

10/27/87 — ARIZONA

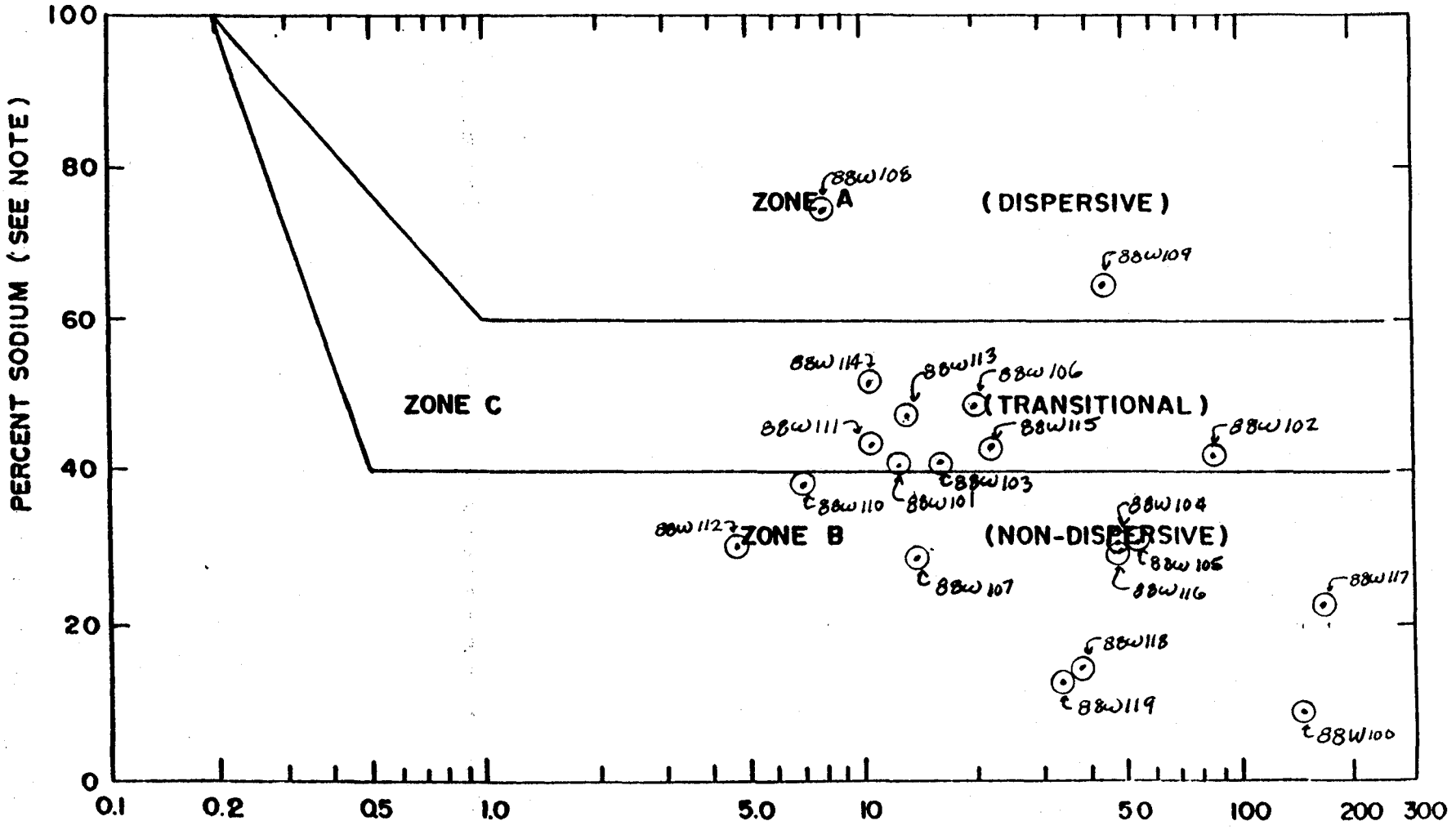
Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis — Grain Size Distribution Expressed as Percent Finer by Dry Weight: Fines (0.002 mm; 0.005; 0.02; 0.05; #200 0.074)	Sand (#140 0.105; #60 0.250; #40 0.42; #20 0.84; #10 2.0; #4 4.76)	Gravel (3/8" 9.525; 1/2" 12.7; 3/4" 19.05; 1" 25.4; 1 1/2" 38.1; 3" 76.2 mm)	Atterberg Limits: LL	PI	Unified Classification	Soluble Salts %	Dispersion % Most Soil	Moisture-Density Relationships: Curve No.	Max. γd pcf	Opt. %	Undisturbed Sample Data: γd g/cc	%	Gs	Special Tests: Resistivity Ohm-cm	pH	T.D.S. Meq/Liter	Na: P in Hole	Remarks
88W																						
118	9.1	L. Bag			18 25 44 60 73	78 90 96 99 100		24	7	CL-ML	0.4	32						2.73	720	7.40	36.9	15.3 / D-1	1
119	9.2	L. Bag			24 33 49 63 75	80 91 96 99 100		26	9	CL	0.4	33						2.73	720	7.35	33.0	12.9 / D-1	1

State: ARIZONA

Site: WILLIAMS CHANDLER EAST FLOODWAY REACH #3 & 4

FIGURE 1

NOTE: PERCENT SODIUM (MEQ./LITER) = $\frac{Na\,(100)}{Ca+Mg+Na+K}$



TOTAL DISSOLVED SALTS IN SATURATION EXTRACT IN MILLIEQUIVALENTS PER LITER

(TDS = Ca + Mg + Na + K)

LAB NO.	SOIL NO.	6A1A ORGN CARB PCT	6B1A NITG PCT	C/N	6C2A EXT FE PCT	6S1A TOTL PCT	6H2C CA	6J2C MG	6K2C NA	6K2A K	SUM CXTR MEQ/100G	6H1A BACL TEA	6C1D KCL EXTR ACTY	5A3A NH4AC EXT	5A6A NH4AC TO	8D1 CA TO CLAY	8D3 MG	SAT NH4AC PCT	EXTR ACTY PCT	SC1 PCT

AZ WILLIAMS CHANDLER EMF REACH #3&4

LAB NO.	SOIL NO.	(SATURATED PASTE) 8C1 REST OHM-CM	8C1B PH	8A H2C PCT	NA SO2 ESP PCT	NA SE SAR	SALT GYP (- - - - - - - - - SATURATION EXTRACT 8D5 TOTL SOLU PPM	6F1A PCT	8A1A EC MMHOS/CM	6N1B CA	6O1B MG	6P1A NA	6Q1A K	6I1A CO3	TOTAL SOLUBLE SALTS	Na %	Results for Dy PSum % Will be furnished as soon as possible Hopefully before 12/30/82
83Q0162	88W-100	600	7.30	37.86		1.5	3700			132.85	7.04	12.41	.64		152.94	8.1	J Computed OK
163	-101	1720	7.52	30.43		2.8	250			5.59	1.70	5.36	.23		12.88	41.6	J OK Rich
164	-102	430	7.30	32.98		7.4	1800			37.60	11.30	36.55	.46		85.91	42.5	J
165	-103	1490	7.49	29.34		3.1	310			7.40	2.00	6.73	.29		16.42	41.0	J
166	-104	730	7.40	29.28		3.6	900			24.15	8.72	14.75	.63		48.25	30.6	J
167	-105	650	7.34	28.72		3.9	990			25.90	10.42	16.55	.89		53.76	30.8	J
168	-106	1410	7.45	29.52		4.3	380			7.03	2.75	9.53	.55		19.86	48.0	J
169	-107	1780	7.46	29.63		6.7	260			7.17	2.37	3.79	.41		13.24	27.6	J
170	-108	2580	7.70	29.96		6.4	160			1.16	.62	6.06	.30		8.14	74.4	J
171	-109	750	7.45	32.03		10.1	900			9.15	6.05	27.95	.65		43.8	63.8	J

LSL NO.	SIL	6A1A ORGN CARB PCT	6A1A NITG PCT	C/N	6C2A EXT FE PCT	6S1A TOTL PCT	6A2C CA	6D2D MG	6 NA	6O2A K	SUM EXTR	6H1A BACL TEA	6C1D KCL EXTR ACTY	6A3A NH4AC EXT	6A6A NH4AC TO	8D1 CA TO CLAY	8D3 SAT MG PCT	EXTR ACTY PCT	NH4C PCT
NO.							MEQ / 100 G												

AZ WILLIAMS CHANDLER EMF REACH #3 & 4

LSL NO.	SIL	(SATURATED PASTE) 8E1 REST OHM-CM	8C1B PH	8A H2C PCT	NA SO2 ESP PCT	NA SE SAR	SALT GYP 8D5 TOTL SOLU PPM	6F1A PCT	SATURATION EXTRACT 8A1A EC MMHOS/CM	6N1B CA MEQ / LITER	6O1B MG	6P1A NA	6O1A K	6I1A CO3	TOTAL SOLUBLE SALTS	Na %	computed by DK
88Q0172	BW -110	32.90	7.22	31.72		1.8	140			3.26	.70	2.57	.50		7.03	36.6	
173	-111	2120	7.32	31.24		2.9	220			4.05	1.10	4.65	.95		10.25	43.3	
174	-112	4000	7.42	29.13		1.2	86			2.13	.58	1.40	.52		4.63	20.2	
175	-113	2070	7.28	24.58		3.4	220			6.32	.84	6.51	.23		13.90	46.8	
176	-114	2030	7.35	29.24		3.6	210			4.15	.90	5.69	.23		10.97	51.9	
177	-115	1170	7.32	34.02		3.9	480			10.55	1.65	9.53	.32		22.05	43.2	
178	-116	770	7.25	30.45		3.3	910			28.50	4.50	13.44	.39		46.83	28.7	
179	-117	290	7.13	32.68		4.5	3500			111.16	16.25	38.85	.52		166.28	23.3	
180	-118	720	7.40	36.97		1.4	980			26.35	4.16	5.65	.70		36.86	15.3	
181	-119	720	7.35	38.84		1.1	820			23.70	3.87	4.27	1.15		32.99	12.9	

10/15/87

RT88 - SM050

Soil Mech. Lab - Lincoln, Ne.

Samples 88Q 162 - 181

No Gypsum Was Found in samples

Do You Want the samples returned ?

Keith will throw samples away pk. 12-22-87

cc: Project Folder

USDA-SCS
SOIL MECHANICS
LABORATORY

DEC

LINCOLN, NEBR. 68508

LPD
EFS
RFH
JPH
MDK
DNY
BUL BD

United States Department of Agriculture
Soil Conservation Service
Midwest National Technical Center
Soil Mechanics Laboratory
512 South 7th Street
Lincoln, NE 68508-2919

WORKING COPY

Subject: ENG - Soil Mechanics - Arizona (WF-08)
Williams Chandler, Site: East
Maricopa Floodway Reach 3 and 4

Date: December 21, 1987

To: Ralph M. Arrington
State Conservation Engineer
SCS, Phoenix, AZ

File code: 210-22

The soil mechanics tests requested on form EWP-21 have been completed with the following exceptions.

The chem test and dispersion test data, unavailable at this time, will be forwarded to you when completed. Only four pinhole tests have been run at this time. The laboratory dispersion and crumb test data indicate that this should be an adequate number of pinhole tests for this group of samples. The need for more pinhole tests will be reviewed at the time the chem test data is computed.

Lorn P. Dunnigan

LORN P. DUNNIGAN
Head, Soil Mechanics Laboratory

Enclosures:
Form SCS-ENG-354, Soil Mechanics Laboratory Data, 4 sheets

cc: w/encls.
Ralph M. Arrington (Original + 3 copies)
W. R. Evans, Head, Engineering Staff, West NTC, SCS, Portland, OR (ltr only)
Clifton E. Deal, Soil Mechanics Engineer, Engineering Staff, West NTC, SCS, Portland, OR

☆ U.S. Government Printing Office: 1985—529-568/30577

SCS-ENG-354
Rev. 3-70
File Code ENG-13-18

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 1 of 4

10/27/87

ARIZONA

Williams Chandler, Site: East Maricopa Floodway Reach 3 & 4

LABORATORY SAMPLE NUMBER	FIELD NUMBER	LOCATION AND DESCRIPTION	DEPTH	FIELD CLASSIFICATION	MECHANICAL ANALYSIS — GRAIN SIZE DISTRIBUTION EXPRESSED AS PERCENT FINER BY DRY WEIGHT: FINES 0.002 mm	0.005	0.02	0.05	#200 0.074	SAND #140 0.105	#60 0.250	#40 0.42	#20 0.84	#10 2.0	#4 4.76	GRAVEL 3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm	ATTERBERG LIMITS L.L.	P.I.	UNIFIED CLASSIFICATION	SOLUBLE SALTS %	DISPERSION % Moist Soil	MOISTURE - DENSITY RELATIONSHIPS ☐ STANDARD ☐ MODIFIED CURVE NO.	MAX. γ_d pcf.	w_o %	UNDISTURBED SAMPLE DATA γ_d g/cc	w_o %	G_s	SPECIAL TESTS Resistivity ohms-cm	pH	T.D.S MEQ/Liter	HA % Pin Hole	Remarks
88W																																					
100	1.1	L. Bag			21	26	37	55	69	76	91	96	99	100								25	10	CL	0.3	12						2.68	600	7.30		NO-1	1
101	1.2	L. Bag			15	18	25	46	58	66	85	93	98	100								21	4	CL-ML	0.3	Tr.						2.64	1720	7.52			1
102	2.1	L. Bag			16	20	31	45	56	62	81	92	98	100								22	6	CL-ML	0.4	10						2.71	430	7.30		NO-1	1
103	2.2	L. Bag			14	19	25	39	51	59	80	91	97	100								20	4	CL-ML	0.4	Tr.						2.71	1490	7.49			1
104	3.1	L. Bag			13	16	22	36	50	55	69	75	82	89	94	97	99	99	100			21	4	CL-ML	0.3	6						2.67	730	7.40			1
105	4.1	L. Bag			16	19	25	40	54	62	77	84	92	100								22	5	CL-ML	0.4	5						2.70	650	7.34			1

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 2 of 4

10/27/87

ARIZONA

Williams Chandler, Site: East Maricopa Floodway Reach 3 & 4

Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis — Grain Size Distribution Expressed as Percent Finer by Dry Weight: Fines 0.002 mm	0.005	0.02	0.05	#200 0.074	Sand #140 0.105	#60 0.250	#40 0.42	#20 0.84	#10 2.0	#4 4.76	Gravel 3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm	Atterberg Limits: L.L.	P.I.	Unified Classification	Soluble Salts %	Dispersion % Moist Soil	Moisture-Density Relationships: Standard / Modified — Curve No.	Max. γ_d pcf.	w_o %	Undisturbed Sample Data: γ_d g/cc	w_o %	G_s	Special Tests: Resistivity ohms-cm	pH	T.D.S. MEQ/Liter	Na %	Cl me/l
88W																																					
106	4.2	L. Bag			14	19	25	39	54	61	77	83	92	100								22	6	CL-ML	0.3	Tr.						2.79	1410	7.45			1
107	4.3	L. Bag			14	19	25	40	55	64	80	86	94	100								23	5	CL-ML	0.3	Tr.						2.71	1780	7.46			1
108	5.1	M. Bag			18	20	26	42	59	67	82	88	95	100								22	6	CL-ML	0.4	Tr.						2.71	2580	7.70			1
109	5.2	L. Bag			17	20	27	44	62	70	85	90	95	100								23	7	CL-ML	0.4	5						2.77	7.45	7.50			1
110	5.3	L. Bag			10	10	14	30	44	58	92	97	99	100								NON PLASTIC		SM	0.4	Tr.						2.76	3290	7.22			1
111	6.1	L. Bag			14	17	23	40	63	72	89	94	99	100								20	4	CL-ML	0.4	Tr.						2.70	2120	7.32			1

SCS-ENG-354
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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 3 of 4

10/27/87

ARIZONA

Williams Chandler, Site: East Maricopa Floodway Reach 3 & 4

LABORATORY SAMPLE NUMBER	FIELD NUMBER	LOCATION AND DESCRIPTION	DEPTH	FIELD CLASSIFICATION	MECHANICAL ANALYSIS GRAIN SIZE DISTRIBUTION EXPRESSED AS PERCENT FINER BY DRY WEIGHT: FINES 0.002 mm	FINES 0.005	FINES 0.02	FINES 0.05	FINES #200 0.074	SAND #140 0.105	SAND #60 0.250	SAND #40 0.42	SAND #20 0.84	SAND #10 2.0	SAND #4 4.76	GRAVEL 3/8" 9.525	GRAVEL 1/2" 12.7	GRAVEL 3/4" 19.05	GRAVEL 1" 25.4	GRAVEL 1 1/2" 38.1	GRAVEL 3" 76.2 mm	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	UNIFIED CLASSIFICATION	SOLUBLE SALTS %	DISPERSION % MOIST SOIL	MOISTURE-DENSITY RELATIONSHIPS ☐ STANDARD ☐ MODIFIED CURVE NO.	MAX. γ_d p.c.f.	w_o %	UNDISTURBED SAMPLE DATA γ_d g/cc	UNDISTURBED SAMPLE DATA w_o %	G_s	SPECIAL TESTS RESISTIVITY ohm-cm	SPECIAL TESTS pH	SPECIAL TESTS T.D.S. MEQ/LITER	SPECIAL TESTS Na %	SPECIAL TESTS CR mg/g
88W																																					
112	6.2	M. Bag			10	11	15	36	58	71	89	93	97	100								NON PLASTIC		ML	0.4	Tr.						2.70	4000	7.42			1
113	7.1	L. Bag			7	7	11	22	30	37	57	69	78	83	88	91	93	96	98	100		NON PLASTIC		SM	0.4	Tr.						2.76	2070	7.20			1
114	7.2	L. Bag			11	12	20	38	52	60	80	91	97	100								19	1	ML	0.4	Tr.						2.73	2030	7.35			1
115	8.1	L. Bag			12	17	26	43	58	67	87	95	99	100								21	4	CL-ML	0.4	6						2.75	1170	7.32			1
116	8.2	L. Bag			11	13	22	40	54	63	85	93	98	100								20	1	ML	0.4	8						2.74	770	7.25			1
117	8.3	L. Bag			12	16	27	46	63	72	90	96	99	100								22	3	ML	0.6	6						2.74	290	7.13			1

SCS-ENG-354
Rev. 3-70
File Code ENG-13-18

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 1 of 4

10/27/87

ARIZONA

Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis: Grain Size Distribution Expressed as Percent Finer by Dry Weight — Fines: 0.042 mm	0.005	0.002	0.001	#200 0.074	Sand: #140 0.105	#60 0.250	#40 0.42	#20 1.84	#10 2.0	#4 4.76	Gravel: 3/8" 9.525	1/2" 12.7	3/4" 19.05	1" 25.4	1 1/2" 38.1	3" 76.2 mm	Atterberg Limits: L.L.	P.I.	Unified Classification	Soluble Salts %	Dispersion % Moist Soil	Moisture-Density Relationships: Curve No.	Standard / Modified: Max. γ_d pcf	Opt. w_o %	Undisturbed Sample Data: γ_d g/cc	w_o %	G_s	Special Tests: Resistivity Ohms-cm	pH	T.D.S. MEQ/LITER	N_a Pin Hole	Class B
88W		Williams Chandler, Site: East Maricopa Floodway Reach 3 & 4																																				
118	9.1	L. Bag			18	25	44	60	73	78	90	96	99	100								24	7	CL-ML	0.4	32						2.73	720	7.40		D-1	1
119	9.2	L. Bag			24	33	49	63	75	80	91	96	99	100								26	9	CL	0.4	33						2.73	720	7.35		D-1	1

GOVERNMENT INSPECTION PLAN
for the construction of
EMF R-3 BANK EROSION STUDY SITES

The work to be accomplished under this contract consists of installing six different test panels for bank protection and a control section at selected locations along Reach 3 of the East Maricopa Floodway (EMF). The project is located approximately 20 miles southeast of Phoenix, Arizona in the Williams-Chandler watershed. The purpose of this project is to install various test measures to prevent or reduce rill erosion occuring on the EMF banks. The banks will then be monitored under a separate study plan to determine the most effective and economical treatment.

1. ITEMS OF WORK TO BE INSPECTED

The work primarily consists of clearing, scarifying, and installing the following measures at seven different bank sites in test areas 200 feet long:

SITE	DESCRIPTION
1	Re-work slope, seed, and install erosion control blankets.
2	Re-work slope only, to be used as the control section.
3	Re-work slope, seed, and add tackifier (soil stabilization solution).
4	Fill rills with 3-inch minus material.
5	Seed and place 3-inch minus material 3" deep on slope.
6	Place a sand filter 3" deep and cover with a 3" gravel armor layer.
7	Seed and place 6" of a 6-inch minus material.

The filter and armor materials are the only materials requiring specific testing by the government. The re-worked slopes will be done according to a method specification. Inspection will consist of a qualitative approach to assure proper scarification, moisture application, wheel rolling, seeding and application of blankets or tackifier to sites 1, 2, and 3. Sites 4, 5, 6, and 7 will be inspected for proper scarification, moisture application, seeding and spreading of sand, gravel and cobbles to the minimum depths specified. Layout consists primarily of determining the beginning and ending stations for each test site.

2. TIMING OF INSPECTIONS

One person familiar with the design concepts can fully provide all inspection and government representative duties. The design provides 50 days of performance time of which the actual construction time should be approximately two weeks.

Mobilization	20 days
Clearing	1
Earthwork	1
Seeding, mulch	2
Place aggregate	4
Clean up	3
Weekends	8
Weather	3
TOTAL	42 days

3. SKILLS REQUIRED FOR INSPECTION

Project Engineer-Government Representative, GS-11

Skills Needed:

Knowledge of the design concept.
Ability to judge acceptable soil moisture for proper earthfill placement and compaction.
Ability to communicate effectively with the contractor and convey the construction requirements of the project.
Ability to exercise judgement interpreting specifications to determine acceptability of material placement.
Ability to exercise judgement applying engineering drawings to the actual field conditions.

Training and Experience Required:

SCS Contract Administration Training course or 1 year experience as GR.
SCS Soil Engineering for Structural Measures or 1 year experience as GR or Inspector on projects involving placement of earthfill.

4. STAFF HOURS REQUIRED DURING CONSTRUCTION

The project engineer should be on-site full time during construction. The total time estimated for preconstruction activities, material approvals, inspection, construction delays, and finalizing project paper work is 280 staff hours (seven weeks). No overtime is anticipated.

5. TESTING EQUIPMENT AND FACILITIES

Testing equipment required for this project consists of that required for sieve analysis of sands and gravels. Only one passing test for the filter and armor materials will be required. The Mesa Construction Office materials testing lab will provide this service.

6. NAMES AND QUALIFICATIONS OF INSPECTION STAFF

Either of the following people have the required contract administration technical skills for this contract:

John M. Harrington, Civil Engineer, GS-11

Employed by SCS for 6 years, the majority of which was as project engineer and GR. Assigned as GR on the following construction contracts:

Vanar Diversion Repair, $2 million.
EMF Reach 3, $3 million.
Signal Butte FRS/Pass Mountain Div., $3.5 million.
Apache FRS/Bulldog Floodway, $7.5 million.

Formal training courses:

Concrete, 1983
Contract Administration, 1984
Construction Inspection, 1984
Engineering NPEG, 1985
Claims Avoidance by Hill Int'l, 1985
Contract Administration Workshop, 1988

Tom Jayo, Design Engineer, GS-11

Employed by SCS for 30 years with experience as area engineer, design engineer, and project engineer. Assigned as project engineer and GR on the following construction contracts:

Buckeye FRS site 1, $4 million
Buckeye FRS site 2&3, $3 million
Sunset & Sunny Cove FRS, $1 million
Spookhill FRS & Floodway, $5 million
Saddleback FRS & Floodway, $4 million
Harquahala FRS & Floodway, $21 million
Signal Butte Floodway, $2 million

Formal training courses:

Contract Administration, 1972
SM Classification, 1975
Claims Avoidance by Hill Int'l, 1985
Contract Administration Workshop, 1985
Concrete, 1987

7. STATEMENT OF AVAILABILITY

The project is scheduled to begin construction during FY 89 late in the summer. The design schedules will be adjusted so that either of the afore mentioned individuals will be available for construction during that time frame. Either person will likely be available to act as alternate GR in the other's absence.

The Mesa Construction Office will provide the necessary vehicle, camera, and survey equipment as required.

APPROVAL OF CO-DETERMINERS

State Conservation Engineer Ralph M Arnold date 4-5-89

Contracting Officer _____ date _____

United States Department of Agriculture
Soil Conservation Service
201 E. Indianola Ave
Suite 200
Phoenix, Arizona 85012

Subject: ECS - Bank Erosion Study Seed Mix **Date:** June 28, 1989

To: John Harrington
Civil Engineer
Phoenix, AZ

File Code: 190-0

Regarding the purchase of seed for the proposed bank erosion control study, the following species and amounts should be obtained:

SEED MIX COMPONENTS	SOURCE	QUANTITY REQUIRED PLS *
1. Mediterranean ricegrass Oryzopsis coerulescens	PMC	8 lbs
2. Common Bermuda Cynodon dactylon	Western Seed	1 lb
3. Purple three awn Aristicla purpurea	"Wild Seed"	8 lbs
4. Buffelgrass Cenchrus ciliaris	Western Seed	8 lbs

* Quantity required is amount of seed needed for one acre based on broadcast seeding rate. Amounts are expressed in Pure Live Seed (PLS).

Bristlegrass has been dropped from the original recommendation and replaced with buffelgrass because of a better chance for successful establishment. The Mediterranean ricegrass will be ordered from the Tucson PMC and delivered to the State Office in July. Other species should be obtained from commercial vendors.

Steve Carmichael

Steve Carmichael
Plant Materials Specialist

STATE: ARIZONA | PROJECT: EAST MARICOPA FLOODWAY R-3 BANK EROSION

BY: JMH | DATE: 2-27-89 | CHECKED BY: DP | DATE: 3/89 | JOB NO.

SUBJECT: QUANTITIES

SHEET 1 OF 10

At this time, there are seven (7) study panels.

STUDY SITE	BEGIN STA	TREATMENT	CHANNEL DESIGN HEIGHT
1	789+00 LT	Re-grade, seed & N.A Greenmat	10.5'
2	828+00 RT	R-grade only	10.5'
3	830+00 RT	Re-grade, seed & tackifier	10.5'
4	832+00 RT	Fill rills only w/ gravel	10.5'
5	911+00 LT	Fill rills plus 3" surface gravel	11.5'
6	929+00 RT	Fill rills plus 3" C-33, Toplayer 3" gravel	11.5'
7	964+00 RT	Fill rills plus 6" surface gravel	11.5'

ASSUMPTIONS:

- Look at photos, estimate rill volume by viewing surface area and degree of erosion for each study site.
- Seed placed from top of slope to toe only.
- Even though very little borrow, if any, include in clearing area.
- Areas that have gravel added are not required to be overexcavated to allow for gravel volume. Gravel will be placed on existing slope surfaces.

Quantities will be calculated on a site by site basis rather than item. This will help for preparing each lump sum cost.

STATE AZ PROJECT EMF R-3 BANK EROSION STUDY
BY JMH DATE 2-27-89 CHECKED BY DATE JOB NO.
SUBJECT SUMMARY QUANTITIES SHEET 2 OF 10

STUDY SITE	STATION LIMITS	CLEARING ACRES	FILTER C-33 CY	GRAVEL CY	STRAW MAT SY	SEED MIXTURE LBS.	TACKIFIER / GALLONS
1	789 to 791	0.40	—	—	900 (15 rolls)	3.8	—
2	828 to 830	0.40	—	—	—	—	—
3	830 to 832	0.40	—	—	—	3.8	50
4	832 to 834	0.18	—	50	—	—	—
5	911 to 913	0.20	—	~~155~~ 185	—	4.3	—
6	929 to 931	0.20	~~100~~ 140	70	—	—	—
7	964 to 966	0.20	—	~~170~~ 200	—	4.3	—
	TOTALS	2.0 Ac.	~~100~~ 140 CY	~~445~~ ~~505~~ CY	900 SY	16. Lbs.	50 GAL

WATER Based primarily on performance time.

STATE A2 PROJECT EMF REACH 3 B.E. Study

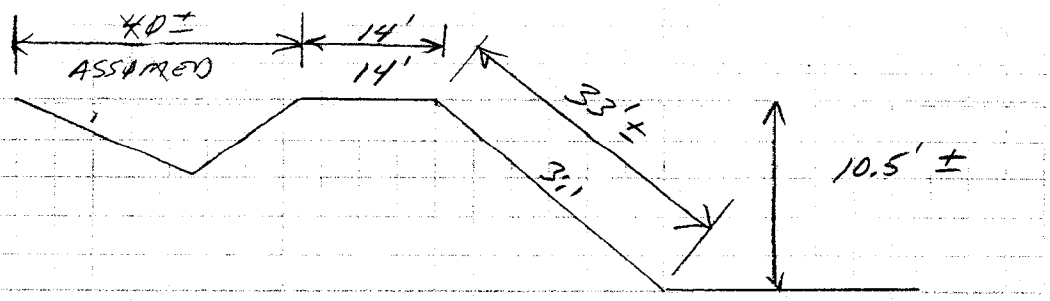
BY JMH DATE 2-27-89 CHECKED BY DB DATE 3/89 JOB NO

SUBJECT STUDY SITE #1 QUANTITIES SHEET 3 OF 10

789+00 to 791+00

CLEARING & GRUBBING

10.5' H/C H.
Plus borrow Area



Surface Area For SITE:

$200' \times (40 + 14 + 33) = 17,400$ S.F.

$= 1,933$ S.Y.

$= 0.40$ acres.

NOTE - Cleared areas are normally calculated on horizontal distances. For this project, the 3:1 slope will be slope distance.

SEED

$200' \times 33' = 6,600$ S.F.

Weight - per manufacturer and/or Steve Carmichael.

Understand the seed mixture developed 2-13-89, Steve Carmichael, lbs per acre $\Rightarrow (2.2 + 6.0 + 5.0 + 12.0) = 25.2$ lb/acre

$\frac{6,600}{43,560} (2.2 + 6.0 + 5.0 + 12.0) = 3.8$ pounds of Seed mixture. this site.

STATE AZ | PROJECT EMF - R-3 - BE. Study

BY JMH | DATE 2-27-89 | CHECKED BY DSB | DATE 3/89 | JOB NO.

SUBJECT Study Site #1 QUANTITIES | SHEET 4 OF 10

SURVEYS

Consists primarily of location beginning and ending stations. Calculate all sites together at end.

EARTHFILL

From picture, negligible soil loss, minor rilling.

No borrow source is req'd for this area. Scarifying, wetting, discing, and compacting will restore this area.

✓ This site will have North American Green mat layed on earth.

Surface area worked equals Seed area, 6,600 S.F.

WATER

Like surveys, figure as a whole at end of quantities.

North Am. Greenmat.

Surface to cover is 33' x 200'

Rolls come in 6.5 feet x 83.5 feet lengths and cover 60 SY.

$$\frac{7335Y}{60} = 12.2 \text{ Rolls.}$$

Add 2 rolls for waste, overlap, and carry over onto top of O&M. SAY 15 Rolls. ✓

STATE AZ PROJECT EMF R.3 B.E.S.
BY JMH DATE 2-27-89 CHECKED BY DR DATE 3/89 JOB NO.
SUBJECT STUDY SITE #2 - QUANTITIES SHEET 5 OF 10

Regrade only. - Control Section - 828+00

CLEARING -

IDENTICAL TO SITE #1 ~ 17,400 S.F.

= 0.40 acres

EARTHFILL

From photos, deeper rills than site 1, but not a significant volume.

IF rills are 6" wide x 8" deep x 33 Feet long = 11 C.F.
IF 1 rill every 3', Vol =

$$\frac{200'}{3'} \times 11' \frac{CF}{rill} = 733\ CF = 27\ CY. \checkmark$$

How much depth spread smoothly over area?

$$\frac{733\ CF}{200' \times 33'} = 0.11\ Feet$$

No additional fill required. We typically accept earthwork ± 0.1 foot, and slopes even more. Possibly borrow 40 or 50 CY.

Work area like Site 1

Rip, wet, mix, compact.

STATE Az PROJECT EMF R-3 B.E.S.
BY JMH DATE 2-27-89 CHECKED BY DB DATE 3/89 JOB NO.
SUBJECT STUDY SITE #3 QUANTITIES SHEET 6 OF 10

Re-grade, Seed, tackify 830+00

CLEARING

SAME AS #1 = 0.40 acres max.

EARTHWORK

SAME AS #1, possibly 40 or 50 CY borrowed.

SEED

SAME AS #1, 3.8 pounds of mixture
for 0.15 acres.

TACKIFIER

Polylit 4178.

Use lowest Dilution Ratio, 1:10.
Use high application Rate, 0.5 gall/SY.

Gallons of concentrate per SY ≡ 0.05 - From supplier Table.

$$\frac{200 \times (\overset{\text{slope}}{33} + \overset{\text{top}}{7})}{9} = 890 \text{ SY}$$

890 x 0.05 = 45 Gallons. ✓

STATE AZ PROJECT EMF R-3 B.E.S.

BY JMH DATE 2-27-89 CHECKED BY DP DATE 3/89 JOB NO.

SUBJECT STUDY SITE #4 QUANTITIES SHEET 7 OF 10

Fill rills only w/ GRAVEL, 832+00

CLEARING

$$\frac{200' \times (\overset{\text{STOPS}}{33} + \overset{\text{TOP}}{7})}{9} = 890 \text{ S.Y.}$$

$$= 0.18 \text{ acre}$$

GRAVEL

Rill volume estimated for site #2 & #3 (adjacent) was on the order of 25 to 30 CY. This translated to 0.11 feet of depth over a 200' x 33' area.

As a matter of practicality, and to handle possible large rills or toe erosion, double this quantity. WNTC suggested a table of estimated quantities for uniform beds. Home contractor provided 50 CY of gravel for this area, evidently during construction.

This translates to 0.25 CY per foot of floodway.

After study, when plans developed for major application, excess could be left on Ot M Road.

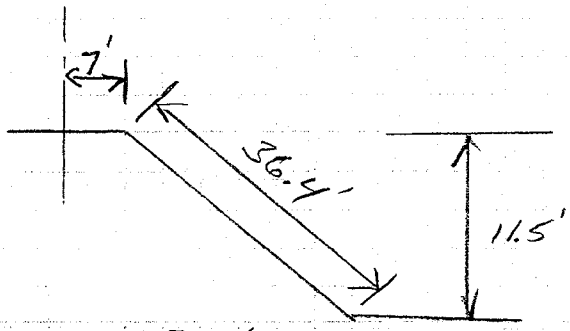
STATE AZ PROJECT EMF R-3 BES

BY JMH DATE 2-27-89 CHECKED BY DATE JOB NO.

SUBJECT STUDY SITE #5 QUANTITIES SHEET 8 OF 10

Fill Rills + 3" SURFACE GRAVEL 9/1+00

CLEARING



$(37+7) \times 200' = 8{,}800$ S.F. ✓

$= 980$ SY

$= 0.20$ acre ✓

GRAVEL

Locally severe toe erosion from pictures.

- From previous sites, estime

30 CY in rills. → 30 CY

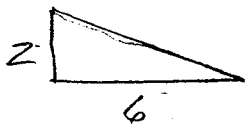
+30 c.y. unknown 30 CY.

- Total surface area

.025' x 200' x 44' ÷ 27 → 80 CY

- Toe erosion.

$\frac{1}{2}(2)(.6)$



× 200' ÷ 27 → 45 CY

155 CY.

+ 30?

185 (08

STATE Az PROJECT EMF R-3 BES

BY JMH DATE 2-27-89 CHECKED BY DP DATE 3/89 JOB NO.

SUBJECT SITE #6 - QUANTITIES SHEET 9 OF 10

929+00

Rills + 3" w/ C-33 SAND
Plus 3" Gravel

Clearing Same As 5

0.20 acres.

Filter Layer - C-33 SAND

Fairly mild rill section.

USE 30 CY C-33 for rills similar to other sections plus 3" layer, +30 c.y. unknown = 60 c.y.

$30\,CY + \left(0.25(200)\overset{44'}{\cancel{87}} \div 27\right) =$ ~~99 CY~~

80 +30 140 CY. ~~300~~

GRAVEL

$0.25(200)37 \div 27 =$ 69 CY.

COMPUTATION SHEET — U. S. DEPARTMENT OF AGRICULTURE

STATE: AZ | PROJECT: EMF R-3 BES

BY: JMH | DATE: 2-27-89 | CHECKED BY: DB | DATE: 3/89 | JOB NO.

SUBJECT: SITE #7 QUANTITIES | SHEET 10 OF 10

96400

Fill Rills + 6" SURFACE GRAVEL

Rills similar to other sections = 30 cy + 30 cy } DB

SURFACE

0.5(200) 37 ÷27 = 1370 4

~~167~~ use 200 c.y.

DB

COST ESTIMATE
East Maricopa Floodway
Bank Erosion Study Sites

ITEM NO	WORK OR MATERIAL	SPEC NO	QUANTITY	UNIT	AMOUNT
1	Mobilization	8	1	LS	$4,400.00
2	Study Site No. 2	23	1	LS	5,985.00
3	Study Site No. 1	23	1	LS	3,135.00
4	Study Site No. 3	23	1	LS	4,430.00
5	Study Site No. 4	202	1	LS	3,200.00
6	Study Site No. 5	202	1	LS	5,350.00
7	Study Site No. 7	202	1	LS	5,700.00
8	Study Site No. 6	202	1	LS	6,800.00
				TOTAL	$39,000.00

Approved: Ralph M Claypoole
State Conservation Engineer

4-5-89
Date

STATE ARIZ. PROJECT EMF Reach 3 Bank Erosion Study

BY JMH DATE 2-28-89 CHECKED BY JR DATE 3/89 JOB NO.

SUBJECT Cost Estimate SHEET 1 OF 11

Two cost estimates were generated, one approach based on reasonably actual times equipment is working on a particular phase or item, and a second approach of compensating the contractor for equipment and labor for the duration all are at the site.

For this very small project and short duration the construction equipment will actually be on site, the second approach is the most rational one to use. It will generate a cost that should be in the range of the highest bid.

Even so, there are variables that can impact the actual bid. If there is a reasonable amount of interest and competition in the project the government's cost estimate should not be exceeded.

If the best price exceeds the government cost estimate, alternate contracting methods should be considered such as using the sponsors forces, (FCO of MC).

Using the second method of calculating the construction cost:

$$\text{Cost} = 39{,}000^{00}$$

The estimate is based on a contractor using a CAT 12G, CAT 950 Loader, and a 4,000 gallon water truck at monthly blue book rates. A 50% labor burden was applied and 20% OH&P was used.

Minor costs such as ~~water~~, staples for Green Mat and so on were ignored

STATE AZ PROJECT EMF Reach 3 Bank Erosion Study
BY JMH DATE 2-28-89 CHECKED BY DATE JOB NO.
SUBJECT Cost Est. SHEET 2 OF 11

Sheet 5 of 10 gives lump sum costs per study site based on method 1 calculation.

Total For 7 study sites is 24,050.

Total For 7 study sites using second method on the spread sheet is
27,944 + 20% = 33,533

Distribute Difference evenly over 7 study sites for bid schedule:

33,533
- 24,050
9,480

$\frac{9480}{7} = 1354.^{00}$ additional

BID SCHEDULE

ITEM NO.	DESCRIP.	LUMP SUM	
1	MOB.	4,400.00	
2	SITE 1	5,700.00	$\frac{H_2O}{+285} = 5985$
3	SITE 2	2,850.00	+ 285 = 3135
4	SITE 3	4,150.00	+ 280 = 4430
5	SITE 4	3,200.00	
6	SITE 5	5,300.00	+ 50 = 5350
7	SITE 6	5,650.00	+ 50 = 5700
8	SITE 7	6,750.00	+ 50 = 6800
	TOTAL	$39,000.00	

STATE AZ PROJECT EMF R-3 BES
BY JMH DATE 2-28-89 CHECKED DSP DATE 3/89 JOB NO.
SUBJECT COST ESTMATE SHEET 3 OF 11

Called Salt River Sand Rock 833-8625

Talked with Denny.

Asked for cost, delivered, 10 miles South of Superstition Freeway on Greenfield Rd,

150 tons C-33 SAND = $8.00 per ton
400 tons 3" minus Rock = $9.50 per ton
300 tons 6" minus Rock = $10.50 per ton
3" to 8" - (for est. only DSP)
Semi End Dumps OK

Western Tech Sales - Tackifier Polybilt 4178
Janette Bell 437-1311

50 Gallon Cost - 12.50 per gallon
Soil Seal - 9.00 per gallon
} Available within 5 days ordered

SC-150
Overlap - 6" when placing
} She will call back for lead time

$80/roll

STATE AZ PROJECT EMF R-3 BANK STUDY

BY JMH DATE 2-27-89 CHECKED BY DP DATE 3/89 JOB NO

SUBJECT VERY ROUGH COST EST. SHEET 4 OF 11

To determine if reasonably within Budget before calculating a detailed estimate.

ASSUMPTIONS

- 30 calendar days per tree
- No irrigation of seeded areas
- No soils testing req'd.
- Use Full blue book rental rates due to very small project size.
- Costs for this very small project are very sensitive to equipment used. A scraper could be used but is not necessary, for example.

Clearing, scarifying, blading compacting, seeding, 3 weeks.

CAT 12-G	@ 50.00	For 120 =	6,000
WATER PULL	@ 100.00	For 120 =	12,000
P/U 1 2	@ 8.00	For 160 =	2,560
F/MAN	160 @ 20 x1.5	=	4,800
LABORERS	2@160 @ 12 x1.5	=	5,760
OPERATORS	2 @ 120@17x1.5	=	6,120

MATL:

	C-33	100 CY @ 15.00 =	1500
	GRAVEL	450 CY @ 10.00 =	4500
	SEED	25 lbs @ 10.00 =	250
15¢/SF	STRAW MAT	15 Rolls @ =	1200
10¢/SF	TACKIFIER	50 Gallons @ =	700
			45,390
	+20% OH&P		9,078
			$54,468.00

SHOULD BE QUITE HIGH.

COMPUTATION SHEET — U. S. DEPARTMENT OF AGRICULTURE

STATE AZ | PROJECT EMF R-6

BY JMH | DATE 2-27-89 | CHECKED BY DB | DATE 3/89 | JOB NO.

SUBJECT COSTS - SUMMARY | SHEET 5 OF 14

Deleted 3/24/89

STUDY SITE	CLEARING	C-33 FILTER	GRAVEL	STRAW MAT / TACKIFR	SURVEY	SEEDING	EARTH WORK	TOTAL
1	440	—	—	2670	200	175	850	4335
2*	440	—	—	—	200	—	850	1490
3	440	—	—	1130	200	175	850	2795
4	220	—	1420	—	200	—	—	1840
5	220	—	3310	—	200	175	—	3905
6	220	2080	1781	—	200	—	—	4281
7	220	—	4807	—	200	175	—	5402
					1400			24,048.00

* No Treatment - Control Section

+MOB 4,400.00

TOTAL 28,448.00

AVG. UNIT COSTS $1,100/ACRE | 23.20/CY | 16.67/CY | Apples & oranges | 2.85/SY

The cost estimate should be redone based on time at site rather than number of hours required for each item because of very low efficiency level on very small project.

This was done on 2-28-89, a spread sheet → $37,932.00

STATE AZ PROJECT EMF R-3 BANK STUDY
BY JMH DATE 2-27-89 CHECKED BY DP DATE 3/89 JOB NO.
SUBJECT Cost Est. SHEET 6 OF 11

MOBILIZATION

Assume 3 machines on Low Boy @ 500.00 = 1500.00
Bond - 1.3% of say 50,000 = 650.00
F/man - 40 hrs @ 20.00 x 1.5 burden = 1200.00
P/u - 40 hrs @ 8.00 = 320
SUBTOTAL 3670
20% OH&P 734
$4,400.00

SURVEYS

Performed by foreman and 2 laborers
1 DAY START, 1 DAY DURING

16 hours F/man @ 20.00 x 1.5 = 480
32 hours Labor @ 12.00 x 1.5 = 576
16 hours P/u @ 8.00 = 128
1,184
+20% OH&P = $1,420.00

Deleted 3/24/89

CLEARING

2 ACRES TOTAL divid among 7 sites.

1 DAY, BLADE & 950 LOADER

BLADE (0.93) 5515/176 + 12.95 = 42.00 + RIPPERS
950 DER (.93) 1245/176 + 14.70

BLADE- 8 hours @ 45.00 = 360
950- 8 hours @ 40.00 = 320
WATER - 8 hours @ 29.00 = 232
F/man 8 hours @ 20 x 1.5 = 240
P/u 8 hours @ 8.00 x 1 = 64
OPERATOR 24 hours @ 17 x 1.5 = 612
1828 +20% = 2200.00

2200/7 = 315

STATE AZ PROJECT EMF R-3
BY JMH DATE 2-27-89 CHECKED DA DATE 3/89 JOB NO.
SUBJECT COST EST. SHEET 7 OF 11

EARTHWORK

STUDY SITES 1, 2, & 3

RIP, WET, MIX, BORROW, BLADE, COMPACT

1 DAY

BLADE	8 × 45.00	= 360
950	8 × 40.00	= 320
WATER TRUCK	8 × 29.00	= 232
P/U	8 × 8.00	= 64

4,000 GAL

(.97) 2,900 / 176 + 12.25

LABOR

F/MAN	8 × 20 × 1.5	= 240
OPER	3 × 8 × 17 × 1.5	= 612
LABOR	2 × 8 × 12 × 1.5	= 288

2,116.00 +20% OH&P = $2540.00

SEEDING

4 areas, 2 separate occassions.

Sites 1 & 3 1 occassion

sites 5 & 7 1 occassion.

SAY LABORER AND F/MAN, ½ DAY each occassion

P/U	8 hours @ 8	= 64.00
F/MAN	8 @ 20 × 1.5	= 240.00
LABORER	8 @ 12 × 1.5	= 144
MAT'L ASSUME (SEED)		= 250

698.00

STATE AZ PROJECT EMF R-3
BY JMH DATE 2-27-89 CHECKED BY DP DATE 3/89 JOB NO.
SUBJECT Cost Estimate SHEET 8 OF 11

SITE 1
GREEN MAT

15 Rolls - 1 DAY

F/MAN	8 @ 20 × 1.5	=	240
LABORER	2 × 8 @ 12 × 1.5	=	288
OPER	1 × 8 @ 17 × 1.5	=	204

EQUIP

950	8 @ 40	=	320
P/U	8 @ 8	=	64

MAT'L

MAT 15 Rolls @ 73.80 = 1,107

Called Western Tech 2-27-89
$73.80 per Roll For SC 150

Janette Beck
3-1-89
Western Tech Sales
Says 2 week Lead time to order SC-150 GREENMATS

2223 + 20% = $2,670.00

SITE 3
TACKIFIER

½ DAY

WATER TRUCK	4 @ 29.00	=	116
P/U	4 @ 8.00	=	32
F/MAN	4 @ 20 × 1.5	=	120
OPER	4 @ 17 × 1.5	=	102
LABOR	4 @ 12 × 1.5	=	72
50 GALLONS @ 10.00		=	500

942 + 20% = $1130.00

STATE Az PROJECT EMF R-3
BY JMH DATE 2-27-89 CHECKED BY DEP DATE 3/89 JOB NO.
SUBJECT COST EST. SHEET 9 OF 11

SITE 4 GRAVEL

50 CY.

Approximately 3 Belly Dump Loads.

Early set up and spread ½ day

F/MAN	4 hrs @ 20 X 1.5 =	120
OPER	4 hrs @ 17 X 1.5 =	102
EQUIP R/U	4 x 8.00 =	32
BLADE	4 x 45 =	180
MAT'L	50 CY @ 15.00 =	750
	1184 +20% =	$1420.00

SITE 5 GRAVEL

155 CY.

≈ 10 LOADS

SAME AS SITE 4 EXCEPT FOR MORE MAT'L.

105 X 15.00 = 1575 +20% = 1890

1420 + 1890 = $3,310.00

STATE AZ PROJECT GMF R-6
BY JMH DATE 2-27-89 CHECKED BY DR DATE 3/89 JOB NO.
SUBJECT Cost Est. SHEET 10 OF 11

SITE 6 FILTER & GRAVEL

SAY 1 DAY Because Two MAT'L's

F/MAN	8 @ 20 x 1.5	= 240
OPER	8 @ 17 x 1.5	= 204
P/U	8 @ 8	= 64
BLADE	8 @ 45	= 360
C-33	100 @ 13	= 1300
GRAVEL	70 @ 15	= 1050

3,218 +20% = $3,862.00

SITE 7 Cobbles

MAT'L
170 CY ROCK @ 17.00 = 2890.00

EQUIP 950 LOADER TO PLACE

P/U	8 @ 8	= 64
8 hrs	@ 40	= 320.00

LABOR

F/MAN	8 @ 20 x 1.5	= 240
LABOR	2 x 8 @ 12 x 1.5	= 288
OPER	8 @ 17 x 1.5	= 204

4006 x 1.2 = 4807

STATE ARIZONA PROJECT EMF REACH 3 B.E.S.

BY JMH DATE 3-7-89 CHECKED BY DATE JOB NO.

SUBJECT WATER COSTS. SHEET 11 OF 11

Performance Time showed two weeks of construction time.

If a pump was available for the duration of the two weeks to pump water from the adjacent RWCD canal; Blue Book Rates

EQUIP: $\frac{\$1,000 \text{ month}}{176} = \$5.68$ per hour

$5.68 \times 80 = \$455$

OPERATING COST.

SAT RUNS 3 hrs / DAY (Very high)

$3 \times 7.65 \times 10 \text{ days} = \$230$

WATER COST.

SAT 6 lds per day $\times$ 10 days, $\times$ 4 Mi, $\frac{\$1}{\text{Mi}} = 240.00$

TOTAL COST 925.00

SAY $1,000.00

JMH - 2-28-89

EMF ~~EG~~ K-5 Bank Erosion Study

2nd Method Cost Estimate

Cost For Time On Site

EQUIPMENT:

Blade	8 days × 8 hrs/Day × $45.00/hr	=	$2,880.00
950	8 × 8 × 40.00	=	2,560.00
Water Truck 5	× 8 × 29.00	=	1,160.00
P/U	(9+13) × 8 × 8.00	=	1,408.00
			8,008.00 → $8,008

LABOR:

F/man	13 days × 8 hrs/day × 20.00	=	2,080.00
Operator	21 days × 8 × 17.00	=	2,856.00
Laborer	18 × 8 × 12.00	=	1,728.00
			6,664 × 1.5 BURDEN = $9,996.00

MATERIAL

Minimum 2 week lead time to order mats. →

MATS	15 rolls @ 75.00	=	1,125.00
TACKIFIER	50 GAL @ 10.00	=	500.00
C-33 Sand	100 CY @ 13.00	=	1,300.00
3" Minus Gravel	275 CY @ 15.00	=	4,125.00
6" Minus Cobbles	170 CY @ 17.00	=	2,890.00
Seed (by Owner)		=	-0-
			9,940.00 → 9,940

$18.00 per ton / 1.6 tons/CY = 12.80

$9.50 per ton / 1.6 = 15.20

3"/48" 10.50 × 1.6 = 16.80

	27,944
+ Mobi	3,667
	31,610
+ 20% OH&P	6,322
TOTAL	$37,932

×2 + 90 days P/U

+ P/U

EMF Reach 3 Bank Erosion Study

Performance Time & Cost Estimate

STATE Az PROJECT EMF R-3 Bank Erosion Study

BY JMH DATE 2-28-89 CHECKED BY DLP DATE 3/89 JOB NO.

SUBJECT Seed for contract SHEET 1 OF 3

4 different seeds will comprise the mix for the project. One of the seeds, Mediterranean Rice Grass is available only thru PMC at this time. Total seed reqd for project is under 20 lbs. Buy for one acre for waste etc.

Recommend SCS purchase seed prior to contracting and provide the desired blend to contractor because of Med. Rice Grass.

6.0	① Mediterranean Rice Grass (Oryzopsis coerulescens)	PMC
2.2	② Common Bermudagrass (Cynodon dactylon)	
5.0	③ Threeawn (Aristida spp.)	
12.0	④ Plains Bristlegrass (Setaria macrostachya)	
25.2	pounds per acre.	

① PMC – No Cost –

② 3 lbs →
Environ. Seed Producers – Cali – 213-442-3330 – OUT OF BUSI.

③ Get 5 lbs → @ 36 = $180.00
Gary Maskarinec – Tempe – 968-9751
Threeawn – 36.00 per pound.

④ Get 12 lbs → @ 16 = $192.00
Env. Seed. Prod. – Cali. – 213-442-3330 OUT OF BUSINESS
Gary Maskarinec – Wild Seed – Tempe – 968-9751
Bristlegrass – 16.00 pound

Seed cost approx. $400.00

Wild Seed of Tempe will work with govt. P.O. Normally has these 2 seeds in stock. Does not handle Bermuda grass.