TIJERAS ARROYO/SOUTH EUBANK LANDFILL EVALUATION

SUMMARY REPORT

Prepared for

NEW MEXICO STATE LAND OFFICE

December 1993

LH 93043.11

LEEDSHILL-HERKENHOFF, INC.
Copper Square, 500 Copper Avenue, NW
P.O. Box 1217 - Phone (505) 247-0294
Albuquerque, New Mexico 87103

ENGINEERS ARCHITECTS

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I. INTRODUCTION

A. PURPOSE

The Tijeras Arroyo/South Eubank Landfill evaluation has been performed to analyze and develop options for protection of the closed South Eubank Landfill against erosion from the Tijeras Arroyo. Project analysis includes hydrologic, hydraulic and sediment/scour evaluation to determine viable options for detailed analysis. Project cost estimate budgets are prepared for each of the feasible options, along with identification of advantages and disadvantages of each option.

The study reach includes that portion of the Tijeras Arroyo which directly impacts the closed South Eubank Landfill, which lies east of the extension of Eubank Boulevard and west of the extension of Juan Tabo Boulevard (see Figure 1).

B. AUTHORITY

Authority for this study is provided in the A/E Services Agreement between the Commissioner of Public Lands for the State of New Mexico and Leedshill-Herkenhoff, Inc. dated December 6, 1993.

C. PROJECT SCOPE

The scope of work for the Tijeras Arroyo/South Eubank Landfill evaluation specifically includes the following tasks:

1. Phase One

Phase one consists of an analysis of the current situation and development of options for consideration by the Land Commissioner. The principle objective is to protect the closed South Eubank Landfill against erosion from the Tijeras Arroyo. This phase shall culminate with a written report. It should include, but not be limited to, the following elements of work:

a. A brief review of completed hydrologic studies to determine the appropriate design flows in the arroyo.

b. Hydraulic analysis sufficient to analyze existing flow patterns upstream, adjacent to, and downstream of the site.



TIJERAS ARROYO

PROJECT AREA
LOCATION MAP

FIGURE 1

c. Coordination with other affected agencies to determine policies and requirements.

d. Appropriate sediment/scour analysis.

e. Limited geotechnical investigation as appropriate.

f. Development of options to protect the landfill, with an assessment of impacts for each option. Each option will include, as a minimum, a hydraulic analysis to predict flow patterns upstream, adjacent to, and downstream of the site. Cost estimates will be developed for each option.

g. Written recommendation as to preferred option(s).

2. Phase Two

Upon selection of a preferred option by the Land Commissioner, the engineer will develop detailed design documents. This phase shall include, but not be limited to, the following elements of work:

a. Design drawings and specifications including details for the EPA stormwater pollution prevention plan.

b. Coordination with affected agencies to approve drawings and specifications.

c. Coordination with outside agencies which may have jurisdiction, and the filing of necessary permit applications or notifications.

d. Detailed cost estimate.

Upon completion of Phases One and Two, a request shall be made to the 1994 session of the New Mexico Legislature to fund the recommended project. The request for funding will be a joint request involving the City of Albuquerque, Bernalillo County, Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) and the State Land Office.

Should funding be made available, the following additional tasks will be included in the project scope.

3. Phase Three

Phase Three will consist of the preparation of contract documents, final project cost estimates, advertising for competitive sealed bids, pre-bid meeting and site visits for respective bidders, preparation of addenda, if required, evaluating bids and assisting the State Land Office in opening bids and in the awarding of a contract.

4. Phase Four

Phase Four work will consist of construction contract administration services and shall include but not be limited to, the following elements of work:

a. Pre-construction conference.

b. Assistance to the Land Office in acquiring necessary permits.

c. Construction monitoring of the project, including surveys and geotechnical testing.

d. Submission of necessary reports.

e. Preparation of monthly pay estimates.

f. All other construction contract administration services, such as preparation of change orders, review of shop drawings, etc.

g. Submittal of "record" drawings, construction completion report and other necessary final reports and closeout documents.

h. Eleven month warranty inspection.

D. AGENCY REVIEW/APPROVAL

Due to the fast-track schedule of this project, AMAFCA agreed to take the lead on technical review, comment, and approval for each review stage of the project, which includes the evaluation summary report and final design plans and specifications. The City/County Floodplain Administration representative, the Land Commissioner of the State Land Office and City Hydrology will provide review comments as well, but will defer final recommendations for the determination of AMAFCA.

Environmental concerns relative to the landfill shall be coordinated with and reviewed by both the Surface Water Quality Bureau and the Solid Waste Bureau of the New Mexico Environment Department (NMED).

The County of Bernalillo, Kirtland Air Force Base and City Open Space and Solid Waste will receive courtesy copies of the report and design plans for informational purposes only.

E. PROCUREMENT OF INFORMATION

To the extent possible, mapping, hydrologic data, and hydraulic data were acquired from previous studies. In particular, the Tijeras Arroyo Drainage Master Plan, Phase I and II reports dated October 1987 and August 1990, respectively, were heavily relied upon and are frequently excerpted in this report. A summary list of the other reports and studies reviewed for this project is provided in the references section of this report.

Orthophotobase-topographic mapping of the project area was obtained from the Federal Emergency Management Agency (FEMA) Flood Insurance Mapping Project, dated 1982. This mapping was utilized for hydraulic analyses. Supplemented data was obtained through a land survey of the project site, performed by Albuquerque Surveying Company. In early December, 1993, cross sections were measured at 50 foot spacing through the project reach limits and topographic mapping was developed at a scale of 1" = 50' with a 1-foot contour interval for use as the base mapping for final design drawings.

II. GENERAL DESCRIPTION

A. PHYSICAL CHARACTERISTICS OF PROJECT AREA

The Tijeras Arroyo is an ephemeral stream typical of those which exist in semi-arid climates in the southwest United States. The headwaters begin in the Sandia Mountains and drain to the Rio Grande. The Tijeras Arroyo is the largest arroyo located in Bernalillo County, with a watershed area of approximately 133 square miles. The lower ten miles of the arroyo are generally located along the southern edge of the southeast metropolitan area of Albuquerque (see Figure 2).

B. TIJERAS ARROYO STUDY LIMITS

The study area for this project is limited to that portion of the arroyo which directly impacts the closed South Eubank Landfill. A map of this area is presented on Figure 1.

The flood plain along this reach of the arroyo is characterized by a wide flood plain valley with a well defined low flow channel. Sediment transport analyses performed as part of the Tijeras Arroyo Drainage Management Plan, Phase II report indicate that the project area lies within the only arroyo reach west of Four Hills Road which is in a degradating mode. (For details, reference Chapter VIII of the Phase II Report.)

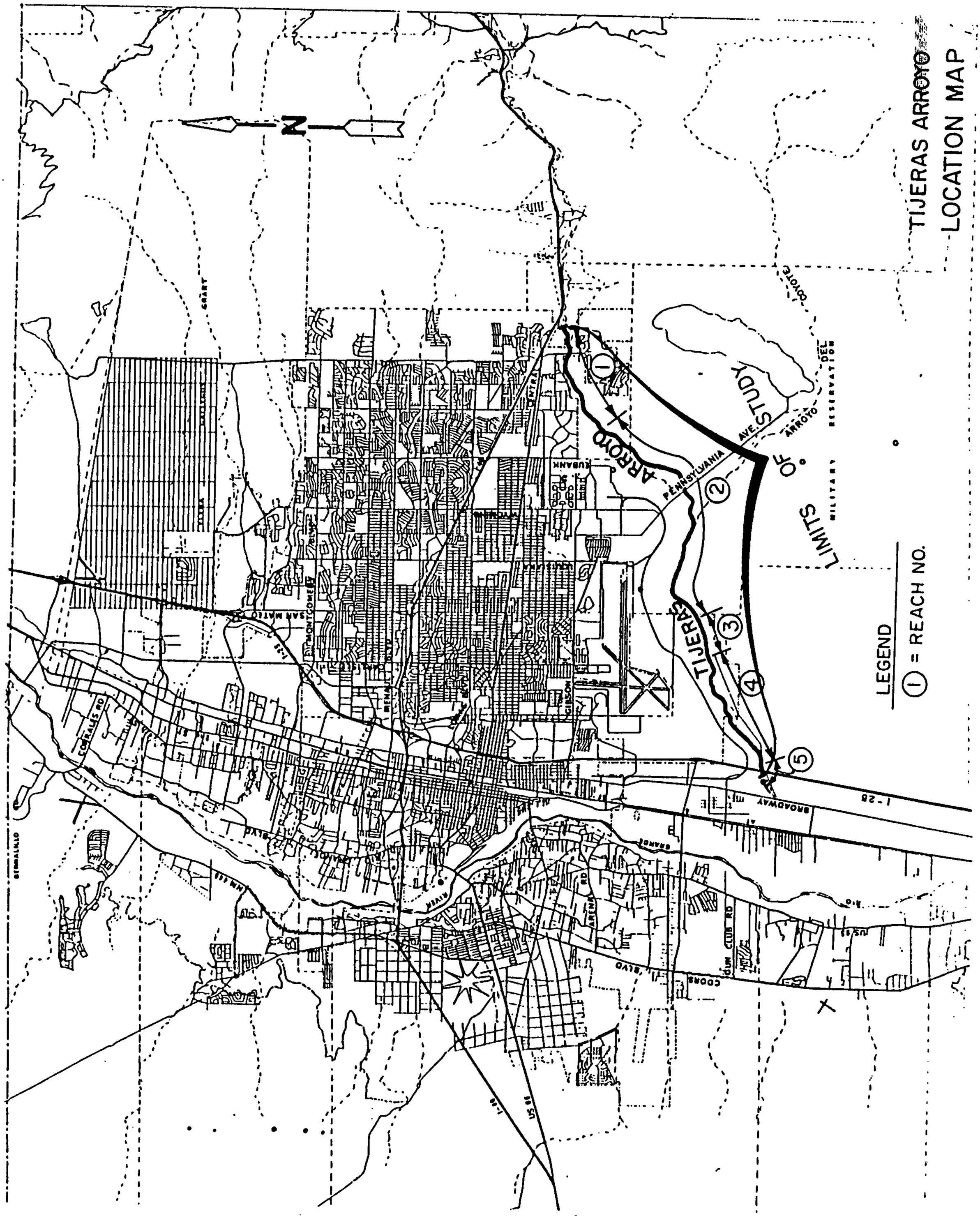
C. SOUTH EUBANK LANDFILL

The City of Albuquerque began operating a landfill on property owned by the New Mexico State Land Office in 1966 at the north edge of the arroyo bottom in an area just east of Eubank Boulevard and continued its use until around the summer of 1977. The landfill was closed in 1977, in accordance with the 1974 Solid Waste Management Regulations.

Closure requirements under the '74 regulations required only that the landfill be entirely covered with two feet of clean earth. This was accomplished. Following the City's closure of the landfill, however, an individual contracted with the New Mexico State Land Office to lease the property for further dumping of construction waste. For several years the area was subjected to the dumping of curb stone, etc.

New Solid Waste Regulations were promulgated by the State of New Mexico in 1992. Several meetings and discussions have been held with personnel in the Solid Waste Bureau and Surface Water Bureau of the NMED to discuss this project. It was concluded that for the present, the South Eubank Landfill can be grandfathered under the '92

TIJERAS ARROYO
LOCATION MAP



LEEDSHILL - HERKENHOFF, INC.

FIGURE 2

regulations, providing permanent bank stabilization treatments constructed along the Tijeras Arroyo address environmental aspects of the landfill to the satisfaction of NMED.

Interaction between the Tijeras Arroyo and the South Eubank Landfill has significantly altered the path of the natural low flow channel and has resulted in a blighted area that extends for hundreds of feet along the arroyo. The placement of the landfill material inadvertently changed the path of the arroyo to a more southerly alignment. The resulting channel has cut a new low flow channel path nearly thirty feet wide, ten feet deep and more than 2200 feet long during the past twenty-five to thirty years.

Along the eastern portion of the landfill, near the southeast corner, the arroyo has, over-time, eroded the landfill embankment resulting in a vertical cut adjacent to the arroyo bed for approximately 200 linear feet along the channel (see Figure 3). Debris has been carried away from the landfill and deposited downstream (see Figure 4). There is no record of large flows being conveyed in the arroyo since 1967. It is concluded that exposure of the landfill has been accelerated as a result of more frequent runoff generated from development occurring along the north and south watershed area, west of Four Hills Road.

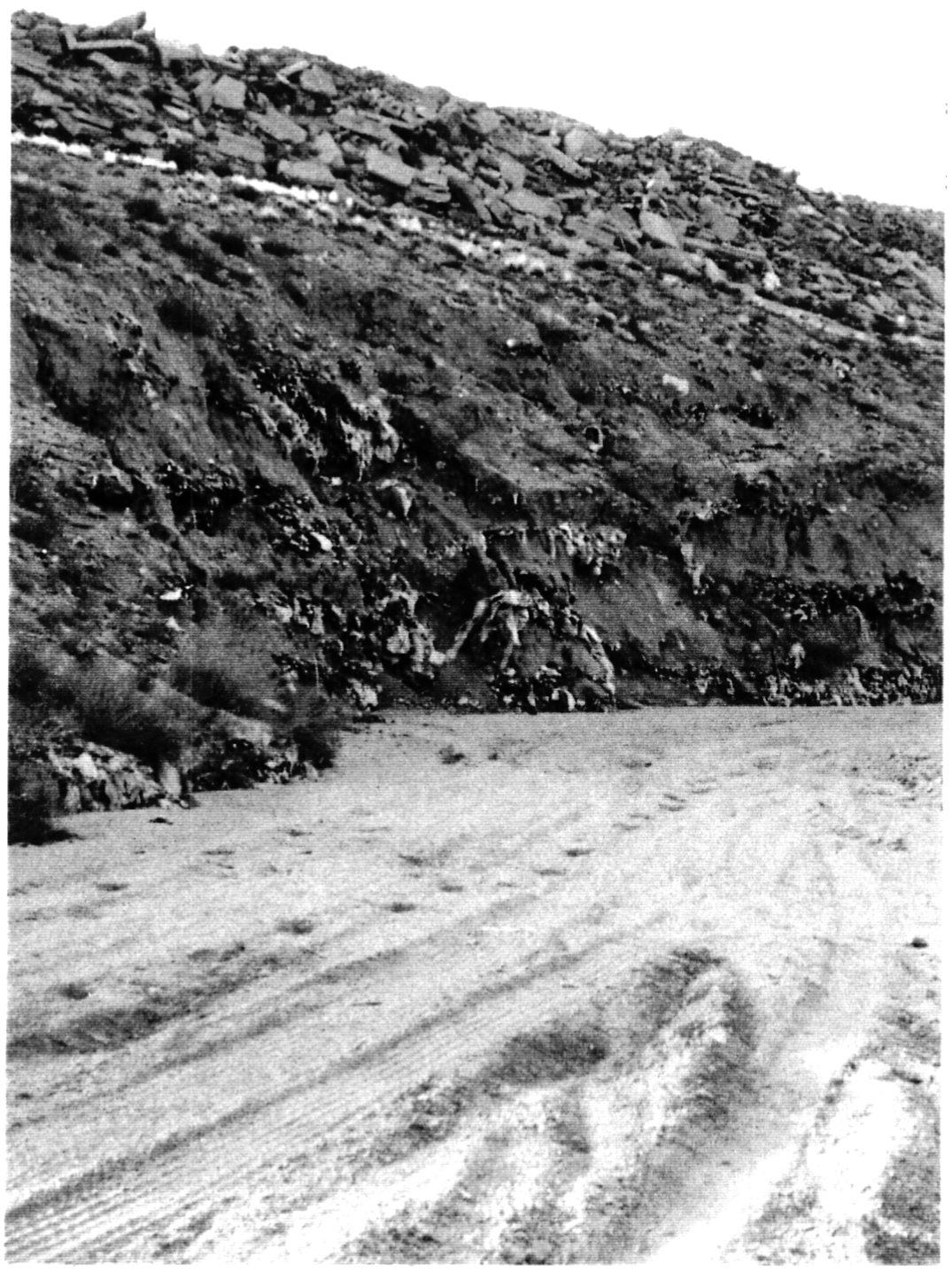


FIGURE 3
Existing Erosion at South Eubank Landfill
(October 1993)



FIGURE 4
Trash and Debris Carried Downstream f South Eubank Landfill Erosion
(October 1993)

III. HYDROLOGIC ANALYSIS

A. GENERAL

Several hydrologic studies have previously been prepared for the Tijeras Arroyo. The most recent and well known studies include the:

(1) Corps of Engineering (COE) Hydrologic Report for Kirtland Air Force Base (KAFB), 1979.

(2) FEMA Flood Insurance Study, 1983, and

(3) Tijeras Arroyo Drainage Master Plan Phase I, October 1987 (TADMP, Phase I) and Phase II, November 1990 (TADMP, Phase II).

No hydrologic studies were discovered to have been prepared in this reach of the Tijeras Arroyo since 1987. Table 1 summarizes the comparison of hydrologic results from the above mentioned studies. The project site is located upstream of the junction of Tijeras Arroyo with the Arroyo del Coyote.

B. RUNOFF

The Phase I TADMP report recommended that design flows for the TADMP be based on a 100-year peak discharge east of Arroyo del Coyote of 22,600 cfs. (Q 10-year = 6,400 cfs). In general, the 100-year peak flow rate compared well to the COE results (1979), which were based upon USGS gage data, collected at a station about three miles east of KAFB.

These design flows were subsequently used to develop concepts of alternative improvements to Tijeras Arroyo in Phase II of the Tijeras Arroyo Drainage Master Plan analysis. As well, the Four Hills Bridge structure was designed based on a peak 100-year discharge of 22,600 cfs.

The methodology, assumptions and results for the TADMP hydrologic evaluation were reviewed as part of this study to determine the appropriateness of using the same design flows. It was concluded that no significant events or development has occurred since 1987 which would materially change the hydrologic conditions previously analyzed. Therefore, the same peak design flows are adopted for use in the hydraulic analysis for the present study.

TABLE 1

COMPARISON OF CALCULATED PEAK DISCHARGE FOR TIJERAS ARROYO

LOCATION	Q PEAK 10-YEAR (cfs)	Q PEAK 100-YEAR (cfs)
Tijeras Arroyo at Four Hills Road		
LH (Existing/Future Development Conditions)	5,700/6,300	16,700/17,900
COE (1979 Report)	5,200	18,050
FEMA FIS		14,300
Tijeras Arroyo After Junction with Arroyo del Coyote		
LH (Existing/Future)	6,500/7,100	21,000/22,200
COE (1979 Report)	6,500	23,850
FEMA FIS		14,700
Tijeras Arroyo at Junction with South Diversion Channel		
LH (Existing/Future)	6,000/6,500	19,800/20,800
COE (1979 Report)	6,200	22,700
FEMA FIS		14,700

Note: Extracted from Table 2 "Tijeras Arroyo Drainage Management Plan, Phase I" report dated October 1987.

New regulations promulgated by FEMA for areas with a potential high sediment load in the waterways require an incremental increase in calculated design flow rates by a percentage equal to the estimated sediment load. This percentage increase is typically referred to as a "bulking factor" and ranges from zero to 20 percent, depending upon local conditions. Based on available data and meetings with AMAFCA, a bulking factor of 10 percent was included for this reach of Tijeras Arroyo, which resulted in the bulked design flow rates shown in Table 2 below.

TABLE 2

PROJECT DESIGN FLOW RATES

DESIGN STORM	UNBULKED	BULKED
100-year storm event	22,600 cfs	24,860
10-year storm event	6,400 cfs	7,040

For a detailed discussion of watershed characteristics, rainfall, soil types, and runoff computations, see Chapter III of the Tijeras Arroyo Drainage Master Plan, Phase I report dated October, 1987.

IV. HYDRAULIC ANALYSIS

A. GENERAL

Water surface profiles for existing channel conditions and for various slope stabilization treatment options were calculated using the U.S. Army Corps of Engineer's HEC-2 computer program. Channel cross-sections used in the analysis were based on cross-sections determined for the City of Albuquerque, FEMA FIS equivalent to Sections AK (or 221) to AM (or 225). The data base was supplemented with additional sections defined from the 1982 FEMA FIS orthophotobase-topographic mapping to more accurately reflect conditions in the project area (cross-sections numbers with an extension number represent the supplemental sections). Cross section locations and identification numbers are shown on Figure 5.

B. HYDRAULIC CHARACTERISTICS

Channel roughness coefficients were determined based on field inspection, a review of those values listed in the FEMA study, and from recommendations in the City of Albuquerque Design Process Manual (DPM), 1993.

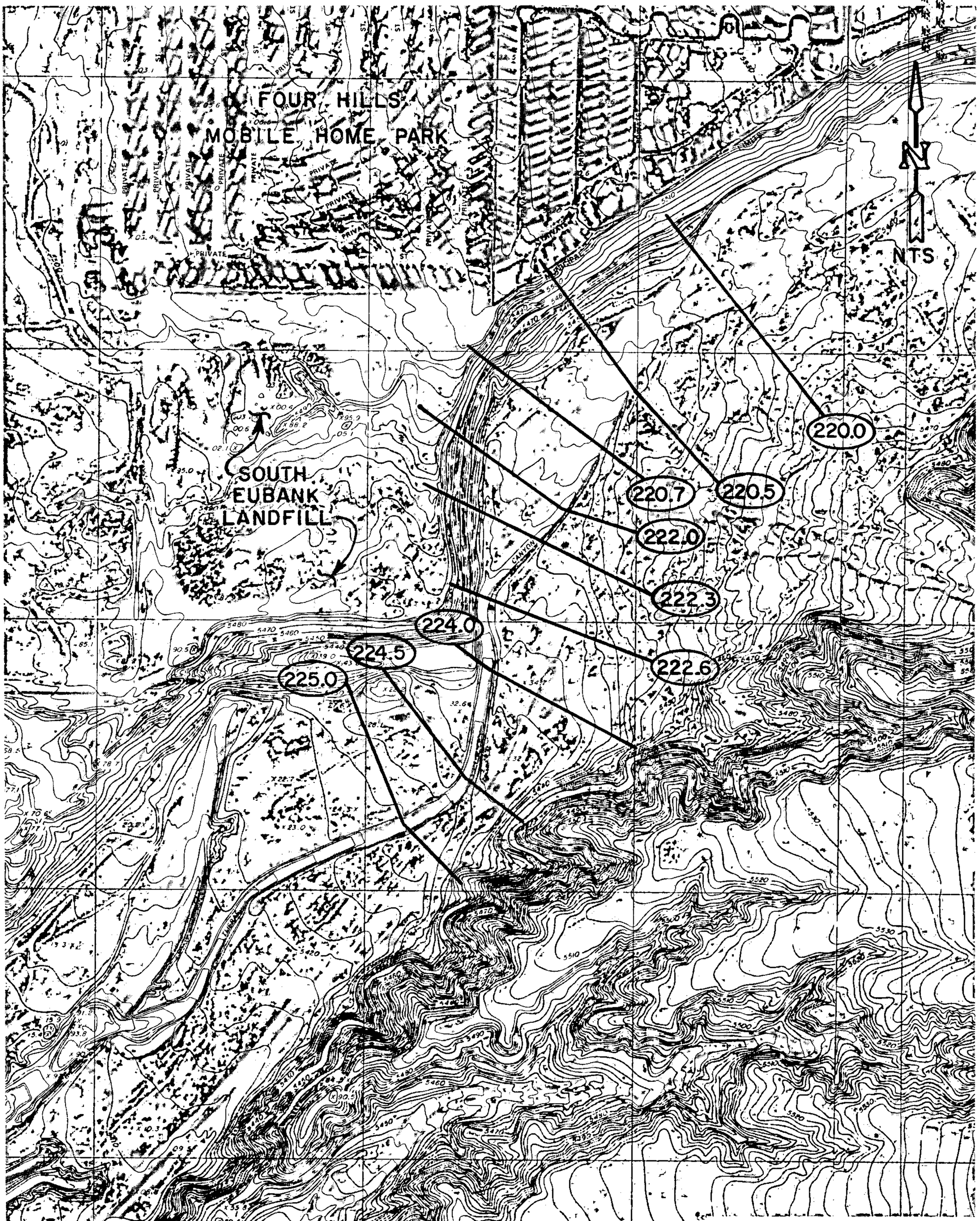
In general the following Mannings "n" values were assigned for characteristic arroyo conditions and slope stabilization options:

Main Channel (Unimproved, Sandy bed)	"n" = .030
Channel Banks (Unimproved, Vegetated)	"n" = .040
Riprap Lining	"n" = .050
Gabion Lining	"n" = .040
Soil Cement Lining (Stepped)	"n" = .035

Water surface profile calculations for existing conditions show that the flow is typically in a critical state throughout the study reach. Calculated supercritical flow velocities during the 10-year storm event range from 9 to 12 feet per second with 100-year storm event velocities in the range of 14 to 17 feet per second.

C. FLOODPLAIN IMPACTS

This portion of the Tijeras Arroyo is included as part of the FEMA FIS and therefore, falls under the jurisdiction of the local flood plain administration to insure that the floodplain is not determentally impacted by any development or modification of the arroyo.



TIJERAS ARROYO

CROSS SECTION
LOCATION MAP

FIGURE 5

As shown in Table 1, the 100-year peak design discharge rate of 22,600 cfs and 24,860 cfs when a 10 percent bulking factor is included (see Section III, B) actually exceeds the FEMA 100-year peak flow rate of 14,300 cfs. However the HEC-2 data base for the FEMA FIS was utilized along with the greater design flow rate for evaluating improvement options in this study. Therefore, the following methodology was implemented to insure that the floodplain and thus, property owners, along this reach, as well as upstream and downstream reaches, are not detrimentally impacted.

First, the 10-year and 100-year water surface profiles with bulking were calculated for the arroyo as it exists. These were identified as baseline conditions. Subsequent, for each analysis of an optional slope stabilization treatment, water surface elevations were compared to the baseline conditions water surface profile for both the 10-year and 100-year storm events. The HEC-2 water surface profile output files for subcritical and supercritical "baseline" conditions are included in Appendix A at the back of this report.

Excavation of the slope opposite the stabilized embankment was quantified and cross-sections were adjusted accordingly, in an iterative process, until a comparison indicated that the resulting water surface elevations associated with improved channel conditions were equal to or less than baseline water surface elevations at each of the HEC-2 coded cross-sections. This analysis was extended for approximately 2,000 feet upstream and 4,000 feet downstream of the project limits to define potential off-site impacts.

In this manner, the 100-year design peak flow rate used in this analysis is higher than the FEMA 100-year peak discharge rate. However, the relative comparison of water surface profiles, as described above, demonstrates that predicted water surface elevations and flow velocities would generally be the same as under existing conditions for the properties located upstream and downstream of the project site, for any flow rates equal to or less than 24,860 cfs (Q 100+ 10% bulking), assuming stable channel conditions.

V. EVALUATION OF ALTERNATIVES

A. GENERAL

In accordance with the contract scope, options were evaluated to determine the most cost-effective stabilization measure to be utilized to protect the landfill slope. The fact that this portion of the arroyo was designated as a Major Open Space Arroyo in the Facility Plan for Arroyos, adopted by the City of Albuquerque in February 1986, was of particular importance in the evaluation.

The Facility Plan states that "Major Open Space Arroyos are to remain in a natural or semi-natural condition with native vegetation and channel stabilization consisting primarily of naturalistic treatments such as ungrouted riprap, gabions, gabion weirs, and geotextile mats. Any arroyo treatment which utilizes concrete should be limited, and if above ground, must be tinted concrete." Additional statements are made that the natural flood plain should be retained and other appropriate stabilization treatments may include soil cement.

Another constraint on project options includes consideration of regulations pursuant to Section 404 of the Clean Water Act. If discharges of dredged or fill materials into the headwaters and isolated waters of the United States (U.S.) do not result in the loss of more than one acre of waters of the U.S., then the project qualifies under Nationwide Permit No. 26. For discharges which cause a loss of one to ten acres of such waters, notification is required in accordance with General Condition No. 13 of the regulations. Only discharges resulting in the loss of more than ten acres of these waters would require an individual Section 404 permit. The acreage of loss of waters of the U.S. includes the filled area plus waters of the U.S. that are adversely affected by flood, excavation or drainage as a result of the project.

A third consideration in all options is the impact and specific protection of the South Eubank Landfill. Any solution must result in an impermeable protection layer (to a factor of 1 x 10^{-6} cm/sec) between the surface flows and the landfill.

B. OPTIONAL SLOPE STABILIZATION TREATMENTS

The objective of the present study is to evaluate optional stabilization treatments which (1) are consistent with the criteria outlined in the Facility Plan for Arroyos, (2) least impact the waters of the U.S., (3) satisfy environmental concerns for both the protection of the surface flow from leachates through the landfill and the protection of the landfill from saturation due to local runoff, and (4) are most cost-effective in stabilizing the channel bank.

The following channel stabilization treatments are consistent with criteria outlined in the Facility Plan for Arroyo:

- Riprap slope protection
- Gabion Slope protection
- Soil cement slope protection
- Geotextile mats slope protection
- Channelization
- Gabion drop structures

Geotextile mats would not be appropriate for the high velocity range expected to be experienced in this reach. As a result, a geotextile treatment was eliminated as a viable option. Channelization would result in the greatest disturbance to the natural setting of the arroyo. Therefore, channelization was eliminated from further consideration. Drop structures would essentially be ineffective unless designed to control the entire 100-year peak discharge. Due to the extremely wide 100-year floodplain, the technical feasibility is questionable and the expense associated with this option would likely be disproportionate to the benefit. So drop structures were not evaluated further. Thus, three treatments were determined to be worthy of a detailed evaluation: riprap, gabion and soil-cement slope protection.

"Riprap slope stabilization is based on the theory that stones placed on a natural embankment will protect the slope by resisting the erosive forces of channel flow. The ability of riprap to provide slope protection depends on the interrelation of stone shape, size, weight, durability; riprap gradation, and layer thickness; and channel alignment, cross-section, gradient and velocity distribution. The bed material and local scour characteristics determine the design of toe protection necessary for riprap revetment stability. The bank material and groundwater conditions affect the need for filters between the riprap and underlying material. Design should be based on the expectation that damage resulting from any storm occurring during the service life of the channel would not cause damage exceeding minimal maintenance or replacement." (7) Section IV, F presents a design summary for riprap slope stabilization for this project.

Gabion slope stabilization utilizes another flexible lining material to protect channel banks from erosion. This consists of rectangular baskets, with lids, made of a steel wire mesh. The gabions are subdivided into cells of equal size, by diaphragms, and are filled with stone. Dimensions of rocks to be used in gabions are typically significantly less than for riprap rock. Failure is defined as when some of the rock fill within the individual compartments is displaced downstream. A filter placed under the gabion is often necessary to prevent erosion of the face material. (5) Section IV, G discusses the applicability of gabion slope stabilization for this project.

Soil-cement is defined as "a material formed by blending, mixing, compacting, and curing a mixture of soil/aggregate, portland cement, possibly flyash, and water, and allowed to harden in-place. The main advantage of soil-cement slope stabilization is that it can be produced with on-site materials and can achieve the design compressive strengths and durability required for flow velocities up to 35 feet per second." (8) Figure 6 is a reproduction of Figure I from the AMAFCA Interim Soil Cement Guide, May 1993, which illustrates a typical cross-section for soil-cement slope protection. Section IV, H, discusses the soil-cement option for this project.

C. GEOTECHNICAL EVALUATION

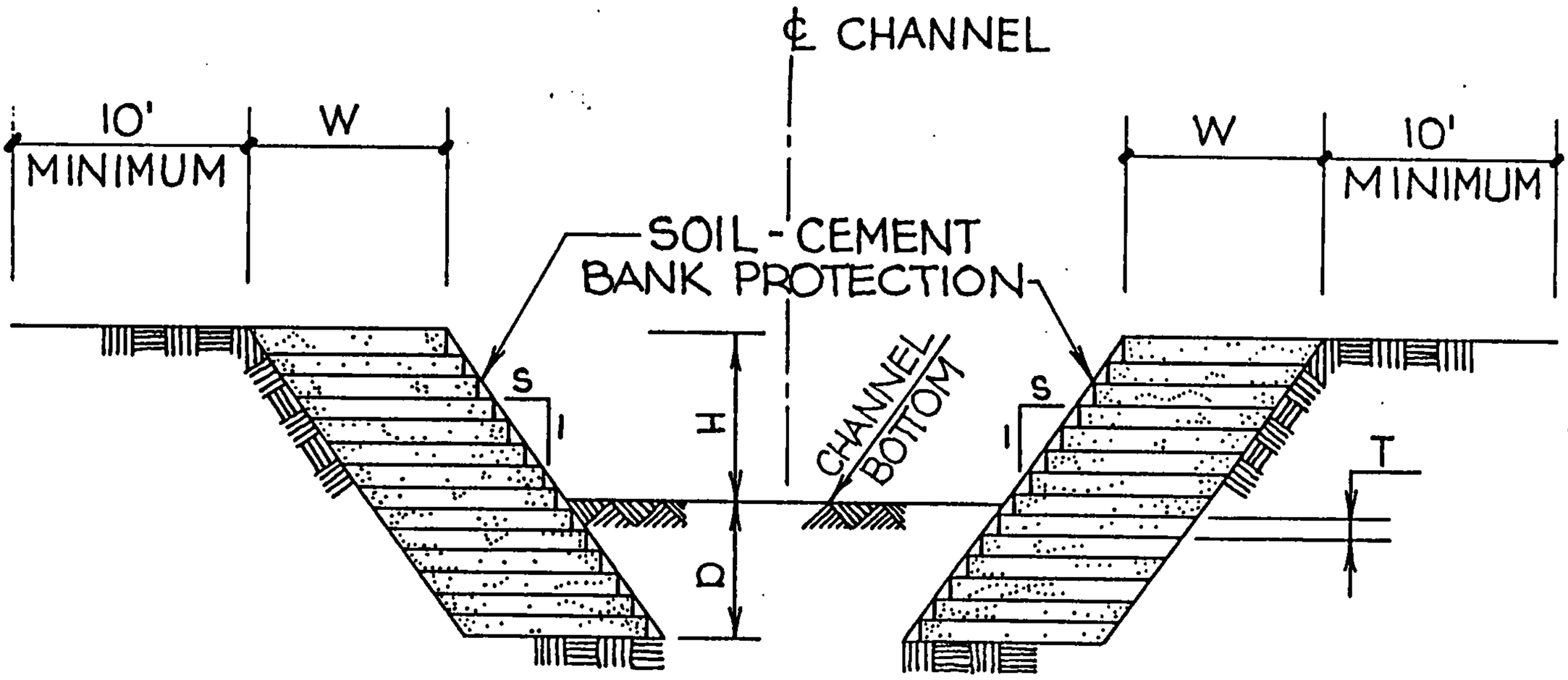
Martin Vinyard and Associates was contracted by Leedshill-Herkenhoff, Inc. to perform field investigations in the project area. The investigation will include two borings along the channel bed as illustrated in Figure 7. The borings will be to a depth of 25 feet to determine the angle of repose for the in-situ material to be excavated during the construction for scour protection. Two pits will be dug with a backhoe along the toe of slope to determine slope stability measures specifically related to the landfill slope.

A copy of the geotechnical report will be available in early January, 1994 to be referenced during final design.

D. SCOUR ANALYSIS

For each optional improvement concept, an estimation of scour was evaluated to quantify the bury depth required below the present low flow channel bed to protect the slope stabilization treatment from being undermined. Two main factors comprise the scour calculation: (1) local scour and (2) contraction scour. Both values are calculated based on hydraulic depth (area/top width) of representative geometric channel sections for the full 100-year flow area, assuming the landfill bank responds like a spur dike. Often, antidune scour is also considered. However, due to the significant depths calculated for local scour, it was concluded that adding antidune scour depth would be extremely conservative. Thus, antidune scour was eliminated from the analysis.

When an obstruction projects into flood flows, such as the landfill embankment which encroaches the Tijeras Arroyo, scour will be experienced at the toe of the slope "due to an increased boundary shear stress produced by locally increased velocity gradients that result from the reduced roughness of the floodwall as compared to the natural channel. It is reasonable to conclude that scour will continue until the local flow area has increased enough to reduce the local velocity, and hence the local boundary shear stress, to values typical of the rest of the channel cross-section." (11). The scour depth is calculated for each viable option based on equations and theory outlined for "Flow Impinging on the Wall at an Angle" in the draft form of the "Sediment and Erosion Design Guide" dated September, 1993, provided to LH by AMAFCA.



W= WIDTH - MINIMUM OF 9' OR AS DETAILED ON CONSTRUCTION PLANS.

D= DEPTH - MINIMUM OF 4' OR AS DETAILED ON CONSTRUCTION PLANS.

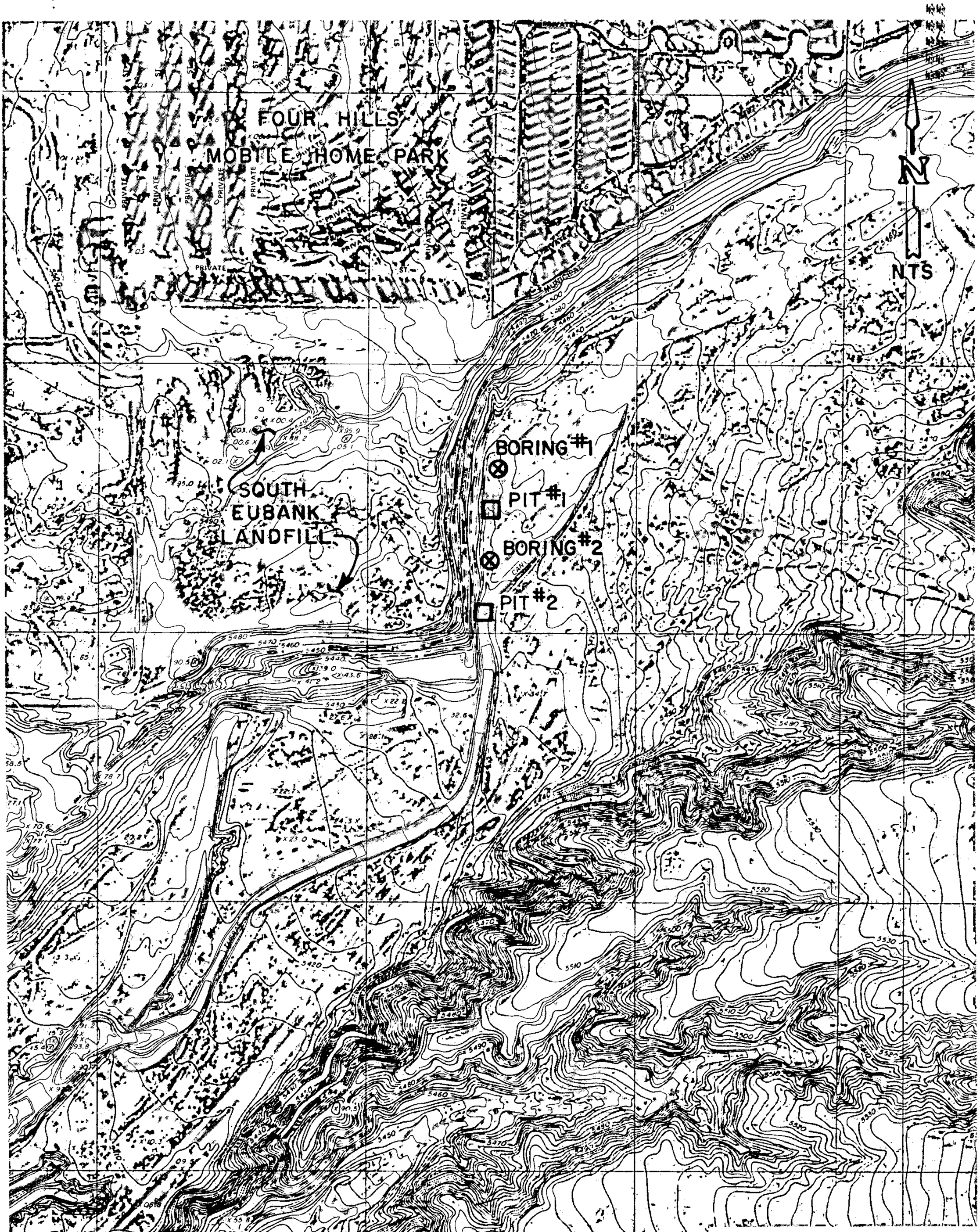
T= LIFT THICKNESS - MAXIMUM OF 12" UNCOMPACTED OR AS DETAILED ON CONSTRUCTION PLANS.

S= SLOPE - MAXIMUM SLOPE 2:1, IF TRIMMED. 1:1 IF STEPPED. MAY BE STEEPER IF ACCESS IS RESTRICTED

H = HEIGHT - ADEQUATE TO PROVIDE FOR DESIGN FLOWS AND FREEBOARD.

TYPICAL SOIL CEMENT BANK PROTECTION

FIGURE I



TIJERAS ARROYO

GEOTECHNICAL ANALYSIS
TESTING LOCATION MAP

FIGURE 7

Contraction scour is that which is experienced along a channel bed due to the contraction of the bottom width of the flow area. This scour is additive to local scour quantities. Contraction scour depth is calculated based on theory and equations outlined in Hydraulic Engineering Circular No 18, Federal Highway Administration, dated February, 1991. Scour calculations specific to each option are referenced in the technical appendix for the respective option.

E. LANDFILL PROTECTION

Main channel velocities along the existing landfill embankment are from supercritical flow conditions and range from 12 to 15 feet per second. Erosive velocities are defined as those which exceed four (4) feet per second. Thus, the entire bank along the east side of the landfill would potentially experience erosion during a 100-year storm event, if not protected. Consequently, any slope protection treatment must extend along the embankment length for approximately 800 feet, and continue south and westerly around the corner for approximately an additional 125 feet. Figure 8 identifies the northern and southern limits for which slope stabilization must be implemented.

Similarly, for all stabilization options, an impermeable boundary must be placed along the same embankment to isolate the landfill material from surface flows in the Tijeras Arroyo and from any local runoff generated along the slope itself. The soil-cement option would inherently provide an impermeable separation up to 1×10^{-6} cm/sec providing no cracks fully penetrate the structure. The riprap and gabion stabilization treatments would require an impermeable membrane of some type along the extent of the slope stabilization treatment. In all cases, an impermeable boundary must be placed in the upper 30 to 40 feet of the landfill embankment above the slope stabilization treatment, up to the landfill cap. This will protect the slope from local erosion, and more importantly, minimizes potential problems from local runoff.

Based on consultation with Professor Val Green at New Mexico Tech, Socorro, New Mexico, and with the Solid Waste Bureau and Surface Water Bureau of the NMED, a system featuring an impermeable membrane comprised of bentonite sandwiched between two layers of felt type geotextile material is recommended. Commercially available products such as Bentofix, or Claymax, come prefabricated and can provide impermeable separation up to 1×10^{-3} cm/sec. This type of material can be placed directly on the slope, requiring little on no compaction, adheres well to the slope (because of the fabric), and is cost-competitive with other liner systems such as HDPE or PVC. Because the "smooth" liners many times require additional felt to prevent slippage, and require seaming, the bentonite-type system is considered a better, more cost-effective solution for this application. In order to protect the integrity of this liner system, it is recommended that one foot of pervious material be placed upon the liner, covered by growth medium or an erosion protection system. The use of native vegetation and/or wildflowers will also allow a more aesthetic slope protection solution.

Because field investigations have indicated a potential slope failure plane along the existing face of the landfill, construction activities along this face with traditional earth moving equipment may not be feasible. Therefore, it is recommended that limited material be removed in these areas until a stable slope is attained.


FOUR HILLS
MOBILE HOME PARK
PRIVATE
ST
N
NTS
*≤3(H):1(V)
3(H):1(V)
SOUTH
EUBANK
LANDFILL
*3(H):1(V)
TO
2.5(H):1(V)
CANYON
* EXISTING
SIDE SLOPE
TIJERAS ARROYO
SLOPE
STABILIZATION
LIMITS

FIGURE 8

In addition, as garbage and other materials are presently exposed, a sand layer beneath the impermeable membrane system is recommended in order to allow filling of potential voids around this material, and the placement of the membrane along a smooth surface.

Other considerations included in the landfill protection system relate to surface drainage along this slope. A backslope drain along the top of this slope is recommended to avoid local erosion from runoff from the landfill running down the slope. These drains will convey runoff to designated run-down channels located along the slope. In addition, as the landfill slope extends approximately 30-40 feet above the channel slope protection, it is possible to get sill-type erosion along the face of the slope.

Therefore, two optional slope treatments were invested: gravel mulch, and a terraced slope.

- Vegetated gravel mulch - as shown in Figure 9, the vegetation gravel mulch allows a 3:1 side slope, and is placed directly over the liner system. AMAFCA has had very positive results with using this type of system on embankments of similar height.

- Terraced slope - as shown in Figure 10, a terraced slope consists of a terraced section with interim channels to intercept local runoff along the face of the slope. This system does not require gravel mulch, but features flatter slopes (4:1) and would require addition embankment and plant materials.

Because of this, the associated additional costs for terracing do not merit its use for this application. Cost estimates for both treatments have been included in Appendix E; however, the cost for the gravel mulch system, illustrated in Figure 9, was included in the total cost estimate for each of the options discussed in the later sections.

It should be noted that the sections presented herein for the landfill slope protection, are in general compliance with the 1992 NM Solid Waste Regulations. In addition, the liner configuration along the top of the slope has been designed to allow for future connection with a possible landfill cap replacement.

F. OPTION 1: RIPRAP SLOPE STABILIZATION

The first slope stabilization option evaluated for the project was based on using a riprap bank protection system. The COE publication EM1110-2-1601, dated July, 1991, was referenced for calculating required riprap size, thickness, and gradation.

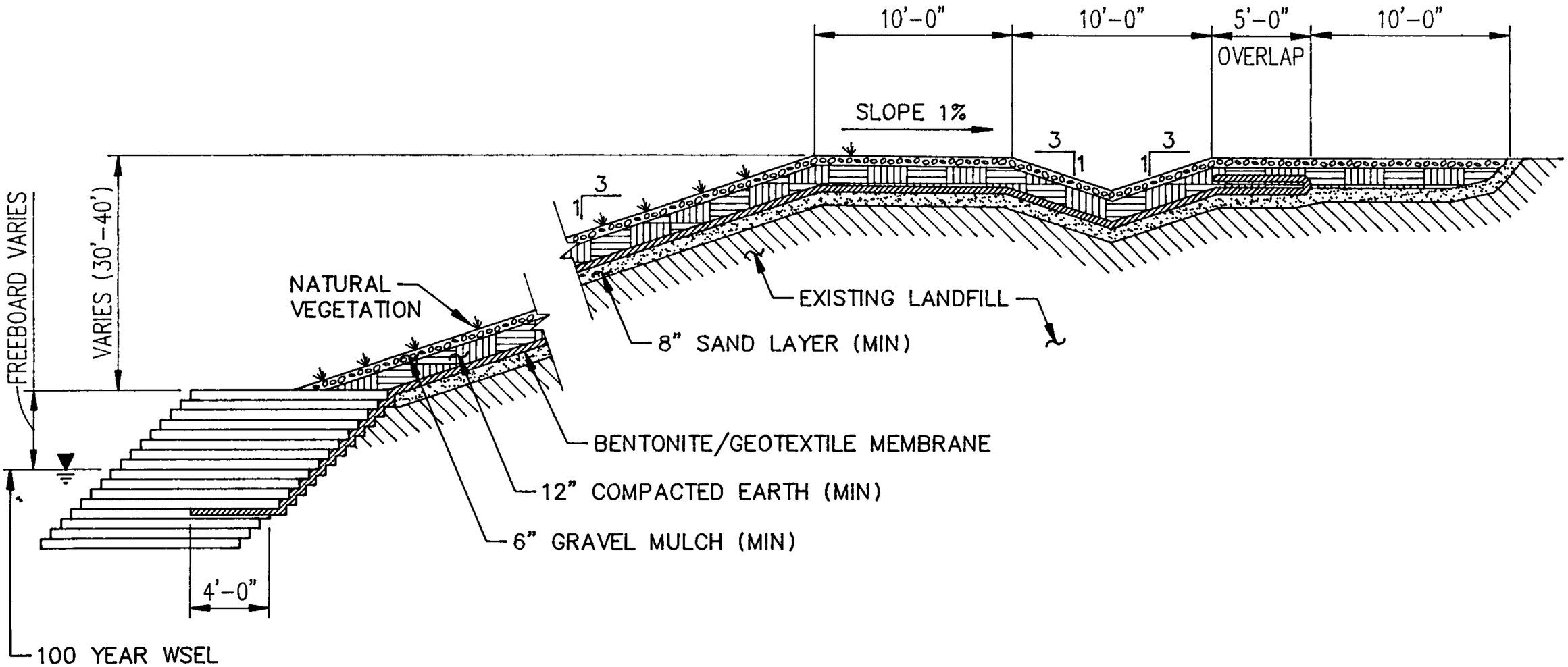


FIGURE 9

TIJERAS ARROYO
LANDFILL TREATMENTS
VEGETATED GRAVEL MULCH

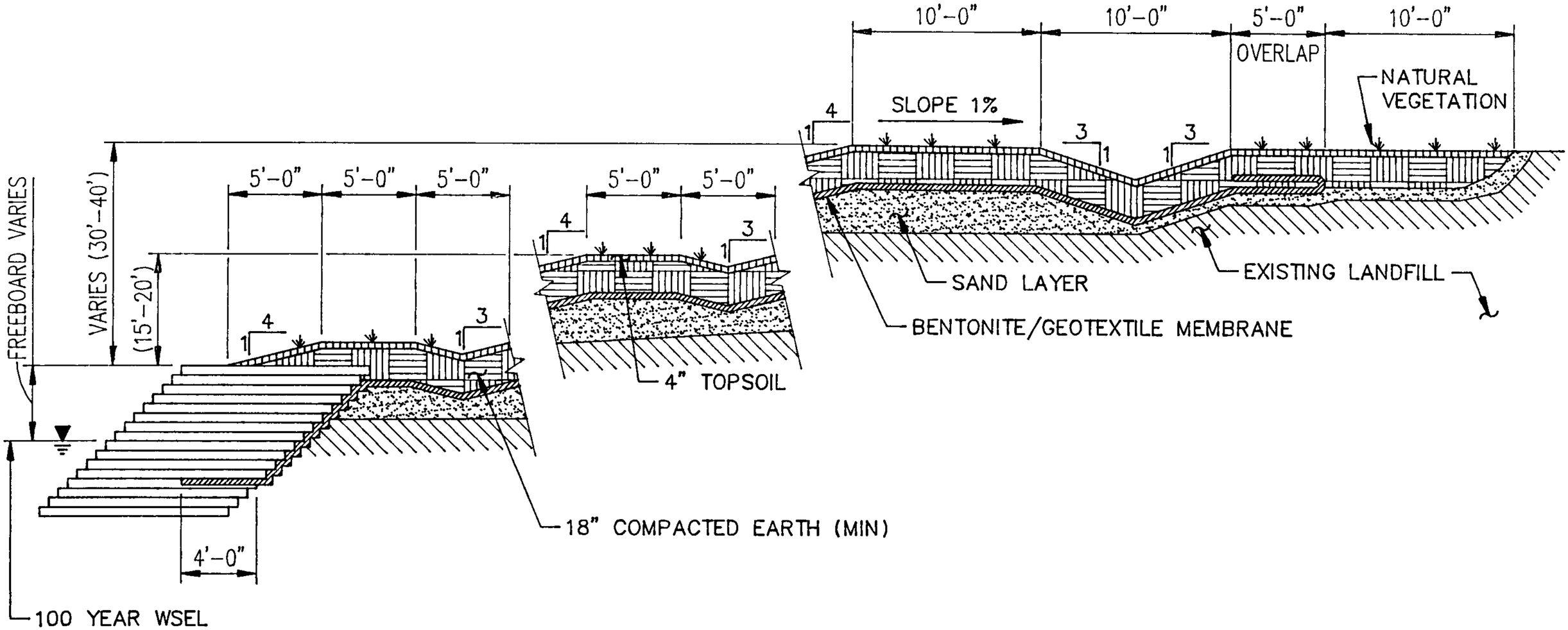


FIGURE 10

TIJERAS ARROYO
LANDFILL TREATMENTS
TERRACED SLOPE

Flow characteristics for this option vacillate around critical flow conditions. Consequently the supercritical model for water surface profile calculations was utilized to identify design velocities (which represent the worst case scenario). Riprap placement was assumed to be on a minimum 2.5 H:1V sideslope or at existing slopes, whichever is less steep. A typical section is illustrated in Figure 11.

Average design velocities range from 12 to 16 fps. These are adjusted to estimate the depth - averaged local velocity over the slope at a point 20 percent of the slope length from the toe of slope, which range from 17 to 20 fps. Following the COE design procedure, and assuming a unit weight of 165 pounds per cubic foot (pcf), 30 percent of the total weight of the riprap material must contain a minimum rock size of 30-inches be able to withstand the design velocities. This translates to a maximum stone diameter of 54-inches and a placement depth of over six feet (see Appendix B). This rock size is extraordinarily large compared to more typical applications of riprap slope stabilization in the Albuquerque area. Gradation of stones is critical to the riprap's resistance to erosion (7). This results in the need to test a quarry's ability to produce a particular size of stone. Testing riprap at these sizes will be very difficult, at best.

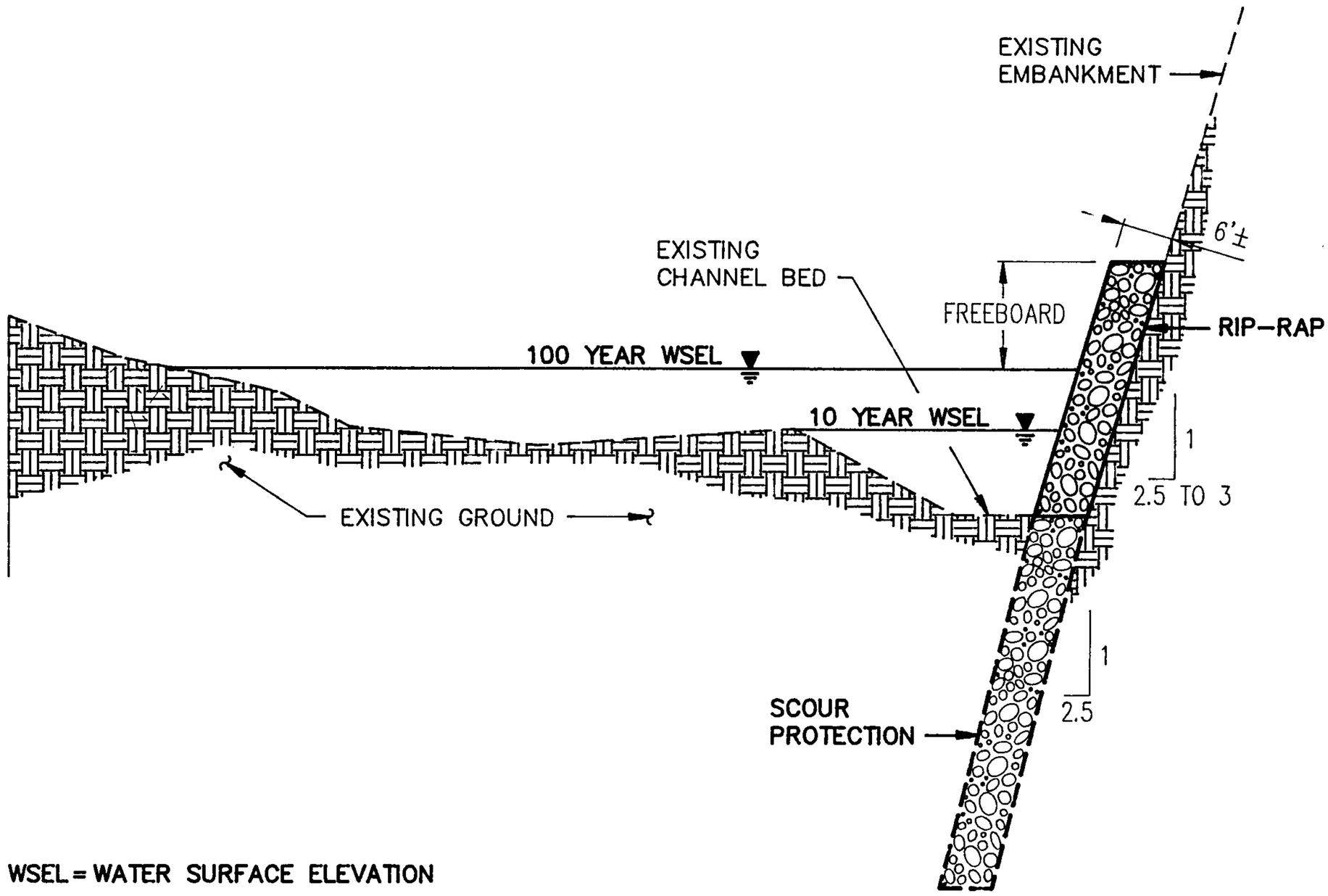
Local contractors and suppliers were contacted to determine the availability of riprap in dimensions of this proportion. Although available from the limestone quarry located east of the City, costs to provide and deliver to the site would be in the range of $40 to $50 cy. This includes the cost for hauling to the site. Western Mobile estimated that it would take approximately six months to produce the quantity of riprap needed. A preliminary cost estimate of this option resulted in a total cost of $2,092,700, which exceeds that of Option 3 (see Appendix D).

Much concern has been expressed by City officials and AMAFCA over the use of a large expanse of riprap for slope stabilization due to the creation of an attractive habitat for rodents and, as a result, increasing the risk of spreading disease. Due to the complications in producing riprap of this size, the limitations in testing proper gradation, the high total estimated cost, and the associated public health issues, the riprap option was eliminated from further consideration.

G. OPTION 2: GABION SLOPE STABILIZATION

The gabion slope stabilization option was evaluated based on current manufacturer's referenced materials published by Maccafferri Gabion.

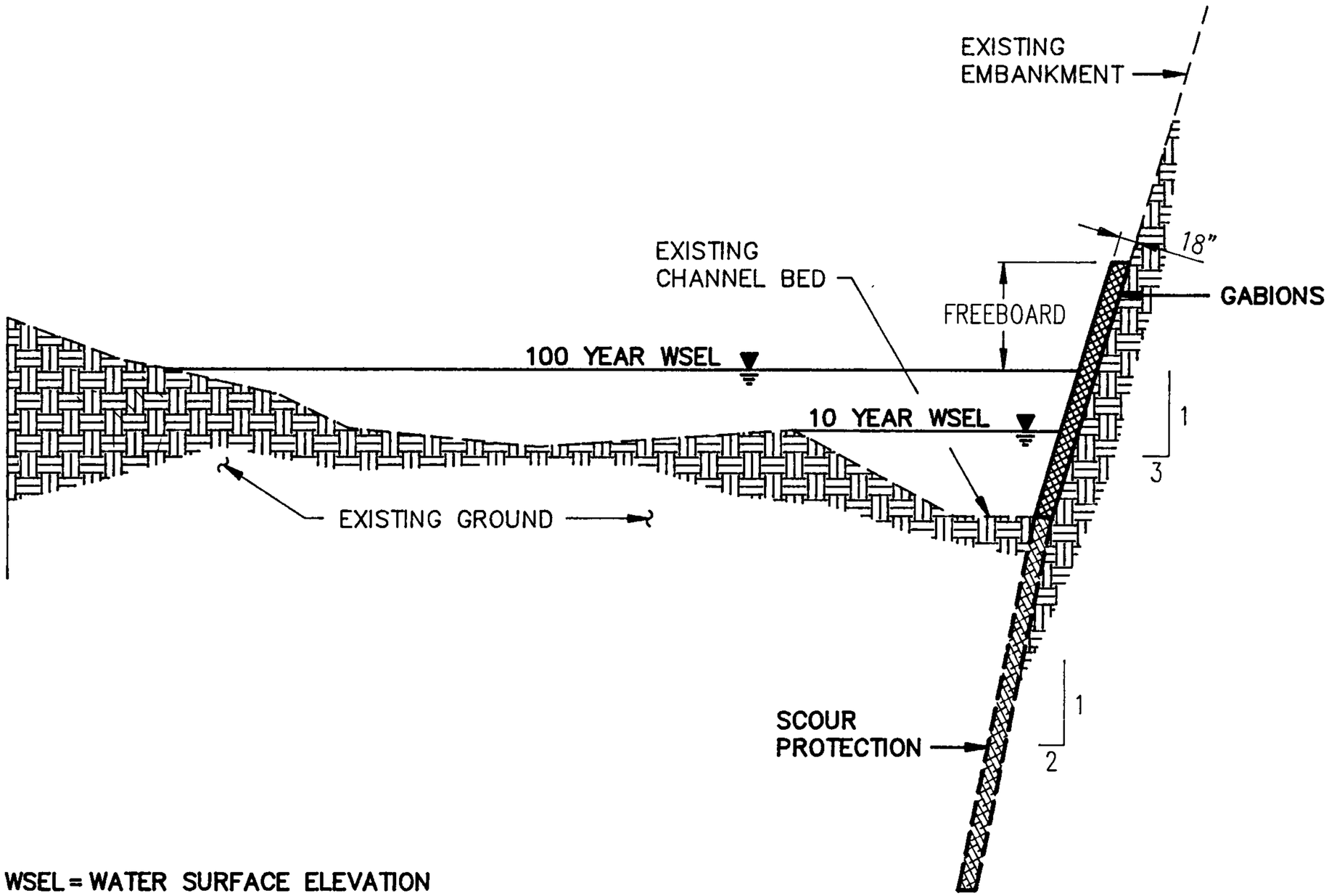
As was true for the riprap analysis, flow characteristics for this option vacillate around critical flow conditions. Based on the supercritical water surface profile design velocities range from 12 to 16 fps were identified, which represent the worst case scenario. A typical section is illustrated on Figure 12.



WSEL = WATER SURFACE ELEVATION

TIJERAS ARROYO
TYPICAL SECTION
OPTION 1: RIP-RAP
SLOPE STABILIZATION

FIGURE 11



WSEL = WATER SURFACE ELEVATION

FIGURE 12

TIJERAS ARROYO
TYPICAL SECTION
OPTION 2: GABION
SLOPE STABILIZATION

The reference guide, along with conversations with the Maccafferri-West Coast manufacturer representative, indicate that gabion slope stabilization is effective for channel velocities up to 21 fps. Design velocities for this project result in a gabion thickness of 18-inches with the diameter of rock fill ranging from 4-inches to 10-inches, and the need for a 6-inch granular material and filter fabric between the gabions and slope face (see Appendix B). (The impermeable membrane for landfill treatment is an acceptable substitute for the filter fabric).

A preliminary cost estimate of Option 2 resulted in a cost of $1,472,100, which exceeds that of Option 3. So, the gabion option was also eliminated from further consideration (see Appendix D).

H. OPTION 3: SOIL-CEMENT SLOPE STABILIZATION

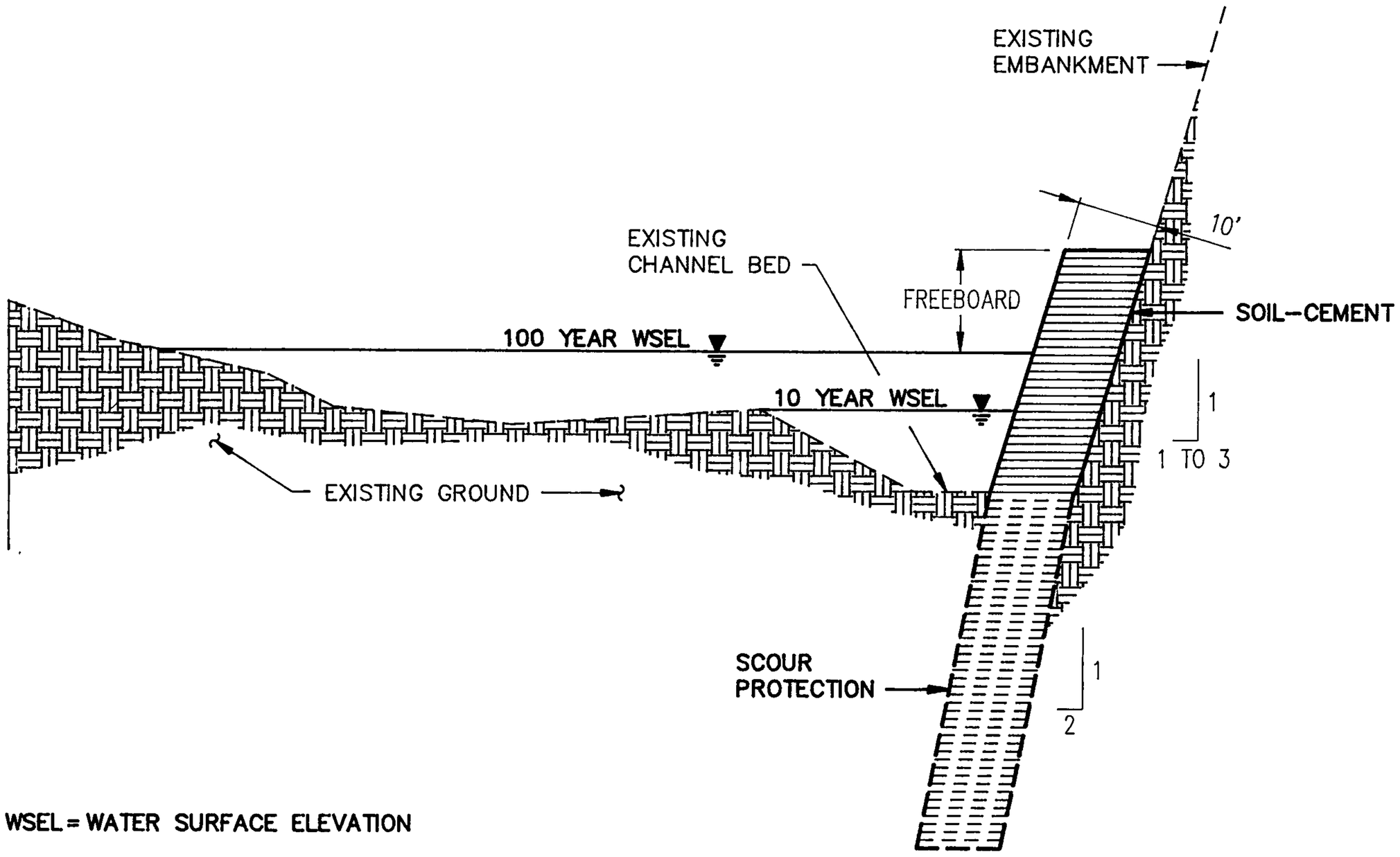
Evaluation of Option 3 - soil-cement slope stabilization was in accordance with the following references: Soil-Cement and Roller Compacted Concrete for Water Control, 1986, Portland Cement Assoc. and the draft copy of AMAFCA's Soil Cement Guide, 1993. Based on the recommendation of AMAFCA, a placement slope of 1H:1V or the existing bank slope, whichever is less steep, is used. Placement was assumed at 6-inch lifts, 10 feet wide, which allows construction using standard roadway construction equipment. A typical section is illustrated in Figure 13.

Flow characteristics for the soil-cement option reflect a supercritical flow regime. Supercritical average flow velocities range from 12 to 16 fps, which are within the recommended values for soil-cement applications.

Excavation of approximately 1,450 cy of material from the opposite bank is needed to maintain flow depths, both upstream and downstream of the site, the same as those depths for existing "baseline" conditions. Excavation of some material from the opposite bank is needed for all three options, but Option 3 requires the least amount of excavation necessary to yield flow characteristics similar to "baseline" conditions. Table 3 summarizes the comparison of water surface elevations associated with Option 3 to those for "baseline" conditions.

1. Design Height

The required height of slope stabilization needed to protect the landfill from a 100-year storm event was calculated based on the depth of flow, plus freeboard, above the existing channel bed invert elevation. Freeboard is defined as the sum of the velocity head and one-half of the antidune wave action height or three feet, whichever is greater. This calculation was made for both subcritical and supercritical flow conditions at each defined cross-section. Freeboard depths were calculated ranging from 3.2 to 6.0 feet (see Appendix C).



WSEL = WATER SURFACE ELEVATION

TIJERAS ARROYO
TYPICAL SECTION
OPTION 3: SOIL-CEMENT
SLOPE STABILIZATION

FIGURE 13

TABLE 3
COMPARISON OF OPTION 3 SUBCRITICAL WATER SURFACE ELEVATIONS TO BASELINE CONDITIONS

SEC NO.	WATER SURFACE ELEVATION	
	BASELINE	OPTIONS
220.7	5446.7	5446.6
222.0	5445.7	5444.4
222.3	5443.4	5442.3
222.6	5441.7	5440.8
224.0	5439.8	5439.3

The supercritical flow conditions resulted in the greatest total design height for slope stabilization above the channel bed, ranging from a height of 10.6 feet at Section 220.7 to 14.9 feet at Section 224.0. A comparison of design depths for subcritical and supercritical flow velocities is summarized on Sheet 5 of 8 in Appendix C.

2. Scour

The 1992 New Mexico Solid Waste regulations are not expected to be imposed on this project. Yet, compliance with providing a level of protection for up to the 100-year event is considered to be a reasonable design approach. Local scour and contraction scour were calculated and summed for each of the defined cross-sections based on 100-year supercritical water surface profile and shear velocity calculations for Option 3 (see Appendix C). Table 4 summarizes the scour depths calculated at each design cross-section. As seen on Table 4, total scour depths range from 17.4 to 22.2 feet. Although it is feasible to excavate, below grade, a sufficient area to construct the soil-cement section to the full depth of potential scour (Option 3A), it was surmised that other materials or methods are available that will provide the same level of protection possibly at a lower cost. Alternatives considered for providing this scour protection include:

Option B: Sheet piles driven to the total depth of scour.

Option C: Placing a stockpile of riprap in the low flow channel at a volume sufficient to fill the void created by scour.

Option D: Intrusion grouting to total depth of scour.

Option E: Concrete trench wall, either reinforced or unreinforced, constructed to below total depth of scour.

Although the soils investigation is not yet complete, existing subgrade conditions are expected to be conducive to any of the alternative scour protection measures considered. The impermeable membrane required by NMED along the landfill embankment is not necessary below grade, as part of the scour protection solution. In all of the options, the soil-cement slope would be extended below grade to approximately one-third (1/3) of the total scour depth, which ranges from about six to eight feet. Whatever material is used to protect the lower two-thirds of scour depth (ranging from 6 feet to 14 feet), would be tied into the base of the soil-cement slope.

TABLE 4
SCOUR DEPTH CALCULATION
OPTION 3: SOIL-CEMENT SLOPE STABILIZATION

SECTION NUMBER	LOCAL SCOUR						CONTRACTION SCOUR				TOTAL SCOUR DEPTH
	FLOW AREA	TOP WIDTH	BOTTOM WIDTH	HYDRAULIC DEPTH	FROUDE NUMBER	SCOUR DEPTH	ENERGY SLOPE	SHEAR VELOCITY	K1	SCOUR DEPTH	
220.7	1996.6	525.3	380.0	3.80	0.95	17.4	0.012560	1.91	0.64	0.0	17.4
222.0	2045.0	520.5	357.5	3.93	1.06	18.6	0.008836	1.32	0.64	0.2	18.8
222.3	2066.7	460.1	236.5	4.49	0.88	20.2	0.005401	1.10	0.64	1.4	21.5
222.6	2071.0	474.3	150.0	4.37	0.98	20.2	0.006677	1.21	0.64	1.5	21.7
224.0	2532.3	558.2	90.0	4.54	0.89	20.4	0.005851	1.16	0.64	1.8	22.2

SCOUR.WK1

Similar to Option 1, Option 3C (stockpile of riprap) is dependent upon the availability of large diameter riprap. Based on the limitations previously discussed of this material, and the high unit cost for the size needed, Option 3C was eliminated from further consideration.

Structural stability, integrity, and feasibility of the four remaining alternatives were also investigated. Since the success of intrusion grouting is not certain until the grouted soil is exposed, this option is risky. In addition, until the soils investigation is complete, it is unknown whether soil grouting is viable. For these reasons, Option 3D was also eliminated from further consideration. Options 3B and 3E would require less excavation than Option 3A but at a greater wall construction cost. Option 3B would be subject to corrosion although it could be oversized to increase its design life.

Options 3A, 3B, and 3E appeared to be equally feasible from a constructability and technical vantage, so project cost estimates were evaluated for each to select the best option (see Appendix D). The estimates are based on preliminary designs, design assumptions, and costs, however, the same assumptions were used for each Option for cost comparison. Options 3B and 3E were evaluated only for wall construction costs. The more economical section, Option 3B, was then compared to Option 3A to evaluate the trade off between excavation costs and wall construction costs (see Appendix D). As additional soils information becomes available and design is finalized, the estimated cost can be refined if necessary.

Preliminary costs estimates resulted in a cost of $1,059,200 for Option 3A, and $1,206,300 for Option 3B. The two cost estimates are within $150,000 of each other. It is important to note, however, that Option 3B - soil-cement slope stabilization combined with sheet piling scour protection is somewhat of a less reliable solution for scour protection. Even though excavation costs are saved by not placing soil-cement to the full scour depth, the sheet piling alternative may not provide as solid of a barrier as the soil-cement structure. Spacing between sheet piles could occur if boulders obstruct the placing of the piles, which is a likely possibility.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. RECOMMENDED ALTERNATE IMPROVEMENT: OPTION 3B

Several slope stabilization and scour protection treatments were investigated for this project. Of those evaluated in detail, soil-cement slope stabilization and soil-cement scour protection offers the best protection for the least cost, and complies with Open Space Arroyo criterion. Consequently, Option 3A is recommended as the most cost-effective to satisfy project objectives. (This recommendation is dependent upon verifying assumptions used, once the geotechnical evaluation is complete).

A typical section of Option 3A is shown on Figure 14. The ranges of slope heights and scour depths are summarized on the figure. Also, as shown, a gravel mulch landfill treatment in combination with the soil-cement is recommended to satisfy environment concerns associated with the South Eubank Landfill.

B. PERMIT REQUIREMENTS

Permit requirements for construction of the recommended channel improvements are discussed below:

1. COE Nationwide Permit No. 26 pursuant to Section 404 of the Clean Water Act: The recommended improvement, Option 3A, impacts the U.S. waters by an amount of 0.21 ac. Since this value is less than one acre, the project satisfies the existing COE determination that the project qualifies for a Nationwide Permit No. 26, which is valid until November, 1995.

2. EPA Stormwater Pollution Prevention Plan: As a part of the EPA Stormwater Quality permitting, a Stormwater Pollution Prevention Plan (SP3) is required for construction projects disturbing more than five acres of contiguous land. This plan consists of temporary erosion control details and construction sequencing and other measures designed to mitigate the potential for sediment and other pollutants from entering stormwater runoff. To allow the State a more competitive bid process, the temporary erosion control details to be used on this project will be developed and included in the plans. However, as the construction sequencing directly impacts how the Contractor does the job, it is recommended that the Contractor be responsible for incorporating the erosion protection details into the SP3 and subsequent submittal of this plan.

3. City Environmental Health - Depending upon final design details, the City of Albuquerque Environmental Health will subject the Contractor to certain air pollution and noise control, and other environmental ordinances.

4. City Traffic Control - Depending on the details of how a Contractor chooses to haul landfill waste away from the site and on whether fill will be transported to the site on public roads, the Contractor will need to present a traffic control plan to the City of Albuquerque for review and approval.

5. City Solid Waste - The City of Albuquerque Solid Waste will require review and approval of the hauling and relocation of materials from the South Eubank Landfill.

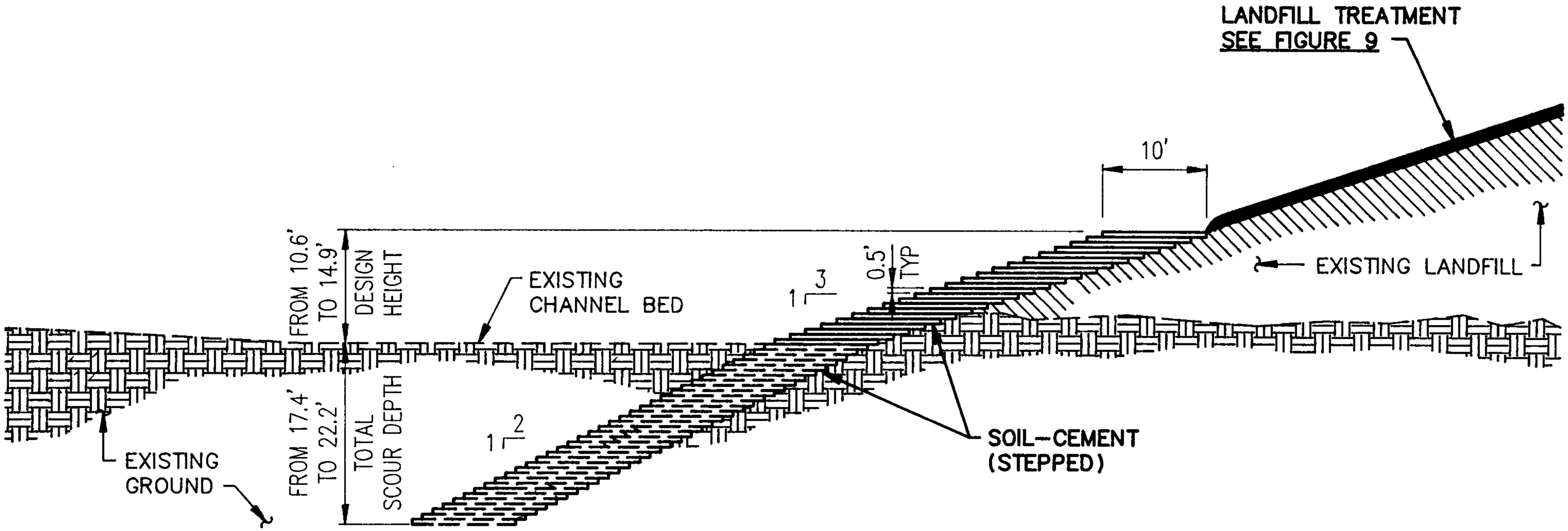
C. CONSTRUCTION EASEMENTS

Construction activities will require access from the top of the landfill down to the bottom of the arroyo, and construction of slope stabilization and scour protection measures along the east slope of the South Eubank Landfill.

The most practical approach to access the arroyo bottom would be to construct a ramp along a southerly extension of Eubank Boulevard. Travel to the east along the arroyo from this location would then provide a direct route to the immediate construction site.

Figure 15 illustrates property owners in and adjacent to the construction site. As can be seen, the property owned by St. John's Cathedral Church, AMAFCA, and Mary Johnson, et. al. (cross-hatched on the figure) would be trespassed upon, in addition to the property owned by the NM State Land office.

The Land Commissioner has already obtained formal authorization from St. John's Cathedral Church and AMAFCA to trespass and construct upon their respective properties, as necessary. The NMSLO is pursuing owners of the remaining property that is impacted, to obtain similar authorization to trespass during construction.



TIJERAS ARROYO
TYPICAL SECTION
OPTION 3A: SOIL-CEMENT
SLOPE STABILIZATION
AND SCOUR PROTECTION

FIGURE 14

D. CONSTRUCTION COST ESTIMATE

Table 5 summarizes cost items, quantities, unit costs, and total costs for Option 3A. Unit costs were derived from several sources. For those items common to channel stabilization projects in the Albuquerque area, unit costs were taken from the City of Albuquerque Spring, 1992 City Engineer's Estimated Unit Prices for Construction Items. Other unit costs were obtained through estimates by Means, suppliers, manufacturers and local contractors, or bid tabulations from recent projects of a similar nature. Quantity take-offs and cost estimate details are included in Appendix D. A twenty percent contingency factor is included to provide an appropriate estimate of cost for budgeting purposes.

E. CONSTRUCTION SCHEDULE

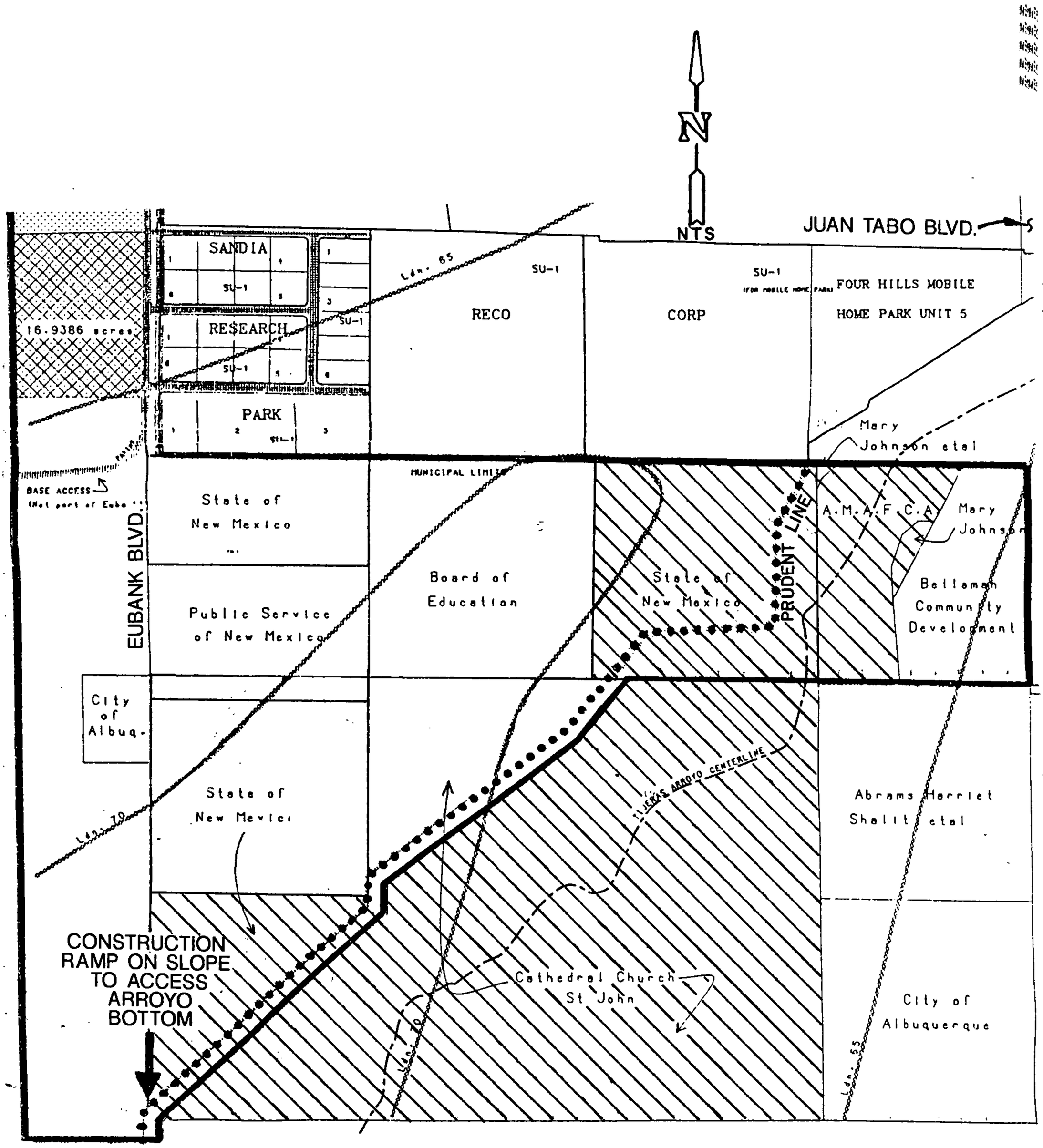
If construction funds are approved by the 1994 NM Legislative Session, actual money will likely not be available for use until June 1994. The advertisement, bid, and award process requires a minimum of six weeks. AMAFCA has prohibited any construction to occur between May 15 and October 15, 1994. Therefore, a feasible construction start date is October 15, 1994.

In reality, there are no constraints to performing construction efforts during the time period anywhere from October 15, 1994 to May 15, 1995. Actual project construction may take only three or four months. However, if the contractor is given a start date of October 15, 1994, and a completion date of May 15, 1995, with the freedom to perform the work any time during that period, bid prices may be more competitive. Therefore, it is recommended that the advertisement for bids be scheduled to begin on September 1, 1994, with award of contract on or before October 15, 1994, and a firm completion date of May 15, 1995.

F. MAINTENANCE

The project area lies within a reach, from the east boundary of KAFB east to the Tramway Diversion Channel, for which no entity has official responsibility for maintaining the arroyo channel or its floodplain and banks.

To insure the long-term integrity of construction improvements which are recommended to protect the closed South Eubank Landfill against erosion from the Tijeras Arroyo, a resolution should be made regarding what entity is responsible for maintenance. Further, an inspection schedule should be established so that any maintenance needs can be identified early-on.



TIJERAS ARROYO
PROPERTY OWNERSHIP

FIGURE 15.

TABLE 5

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY PROJECT COST ESTIMATE
OPTION 3A

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$8,500.00	$8,500
DEMOBILIZATION	1	LS	8,500.00	8,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	20,000.00	20,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,450	CY	4.00	5,800
EXC, BKFLL, COMPCT SCOUR PROT	57,150	CY	4.00	228,600
GRADE LANDFILL SIDE–SLOPES	300	CY	5.00	1,500
INSTALL IMPERM. MEMBRANE	1	LS	272,000.00	272,000
INSTALL SOIL–CEMENT SLOPE IN	11,420	CY	28.00	319,760
0.5' x 10' WIDE LIFTS				
SUBTOTAL				882,660
CONTINGENCES	20.00	%		176,532
ESTIMATED PROJECT COST				**1,059,192**

TJOPT3A.WK1

VII. REFERENCES

1. City Engineer's Estimated Unit Prices for Contract Items - Spring 1992, City of Albuquerque, NM.

2. Development Process Manual; Jan, 93; Chapter 22 Section 2 - Hydraulics, City of Albuquerque.

3. Evaluating Scour At Bridges; Feb, 1991; Publication FHWA-1D-90-017 (AKA HEC-18) pg 13-9, 13-7, Case 1a.

4. Facility Plan for Arroyos, Multiple Use of Albuquerque's Arroyos and Their Floodplains, City of Albuquerque, NM, Draft, August 1985.

5. Flexible Reno Mattress and Gabion Linings for Channels and Canalized Water Courses, Maccaferri Gabions West Coast Inc.

6. HEC-2 Water Surface Profile Users Manual, US Army Corps f Engineers, September 1990.

7. Hydraulic Design of Flood Control Channels, 1 July 1991, US Army Corps of Engineers, Publication EM 1110-2-1601.

8. Interim Soil Cement Guide, May 1993, AMAFCA.

9. Letter Report by Corps of Engineers to Mr. Richard Leonard, Executive Engineer, AMAFCA, covering the floodplains along Tijeras Arroyo between Four Hills Road and KAFB, December 7, 1979.

10. Means Building Construction Cost Data, 1993, R.S. Means Company, Inc.

11. Sediment & Erosion Design Guide (Draft) Sept 93; AMAFCA.

12. Stream Stability at Highway Structures; Feb, 1991; Publication # FHWA-1P-90-014 (AKA. HEC-20). Pg 35-40, Sec 3.2.

13. Tijeras Arroyo Drainage Master Plan Phase I, October 1987, prepared for City of Albuq, NM, (Appendix D - August 1987) Leedshill-Herkenhoff, Inc.

14. Tijeras Arroyo Drainage Management Plan, Phase II, August, 1990. Prepared for City of Albuquerque, NM, Leedshill-Herkenhoff, Inc.

APPENDIX A

SUBCRITICAL/SUPERCRITICAL HEC-2 OUTPUT FILES: BASELINE CONDITIONS

HEC2 S/N: 1126260289 HMVersion: 6.20 Data File: TJSUB.hc2

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*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.6.0;  February 1991          *
*                                           *
*  RUN DATE    21DEC93    TIME    18:22:41  *
*********************************************
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*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  HYDROLOGIC ENGINEERING CENTER        *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616-4687         *
*        (916) 756-1104                 *
*****************************************
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X     X  X        X     X           X     X
X     X  X        X                       X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                 X
X     X  X        X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
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:::::::::::::::::::::::::::::::::::::::::::::
:::                                       :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION   :::
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============================
H A E S T A D   M E T H O D S
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

NOTE: - THIS RUN CONTAINS THE BASELINE CONDITIONS FOR COMPARING SUBCRITICAL RUNS FROM ALTERNATIVES 1, 2, & 3

- ALL Q'S ARE BULKED 10%
- Q_{100} = 22,600 CFS PRIOR TO BULKING

THIS RUN EXECUTED 21DEC93 18:22:41

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

T1 TIJERAS ARROYO GRADE AND BANK STABILIZATION 93043.11
T2 SUBCRITICAL RUN FOR EXISTING 10-YEAR FLOW FILE NAME: TJSUB.HC2
T3 ORGINAL SUBCRITICAL RUN TIJERAS ARROYO EDIT DATE: (12-07-93)

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2						5399.97		

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	0	-1				-1			

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

38	1	2	68	26	16	17	18	42	0
38	43	13	14	15	55	26	56	8	25
0	38	43	8	22	53	54	4	0	150

J5 LPRNT NUMSEC ********REQUESTED SECTION NUMBERS********

-10 -10

J6	IHLEQ	ICOPY	SUBDIV	STRTDS	RMILE
	1.0				

THE FLOW INCLUDES 10% BULKING, 10-YEAR (6400 cfs) & 100-YEAR (22600 cfs)

QT	2	7040	24860							
NC	.040	.040	.030	.1	.3					
X1	227	26	1580	1740	0	0	0			
GR	5420	950	5410	1000	5408	1200	5406	1205	5404	1240
GR	5406	1250	5408	1265	5408	1430	5406	1560	5404	1575
GR	5402	1580	5400	1595	5396	1605	5394	1630	5394	1680
GR	5398	1700	5402	1740	5404	1750	5406	1770	5408	1850
GR	5408	1940	5406	2040	5408	2065	5408	2100	5410	2115
GR	5420	2175								

X1	226.	17	1500.00	1600.00	1010.00	1010.00	1010.00	0.00	0.00	0.00
GR	5430.0	990.0	5418.00	1110.0	5418.00	1305.0	5419.00	1450.0	5418.00	1500.0
GR	5412.5	1525.0	5412.50	1555.0	5416.00	1565.0	5419.00	1600.0	5416.00	1660.0
GR	5410.0	1685.0	5408.00	1700.0	5410.00	1740.0	5414.00	1925.0	5418.00	1945.0
GR	5420.0	2020.0	5430.00	2180.0						

X1	225.0	12	1245.00	1375.00	720.00	900.00	800.00	0.00	0.00	0.00
GR	5440.0	1000.0	5430.00	1045.0	5428.00	1110.0	5426.00	1245.0	5424.00	1265.0
GR	5424.0	1320.0	5426.00	1375.0	5428.00	1650.0	5428.00	1755.0	5427.60	1790.0
GR	5430.0	1840.0	5440.00	1920.0						

SECTION 224.5 IS A NEW SECTION

X1	224.5	12	1190	1330	260	260	300			
GR	5440	1000	5432	1050	5430	1190	5426.5	1220	5426.5	1280
GR	5430	1300	5431.5	1330	5430	1650	5432	1690	5430	1740
GR	5440	1810	5450	1880						

X1	224.	9	1465.00	1560.00	460.00	260.00	385.00	0.00	0.00	0.00
GR	5450.0	905.0	5440.00	1000.0	5436.00	1160.0	5434.00	1465.0	5430.00	1490.0
GR	5429.5	1525.0	5430.00	1535.0	5440.00	1560.0	5450.00	1750.0		

SECTION 222.6 IS A NEW SECTION

X1	222.6	11	1460	1630	200	300	250			
GR	5444	1000	5442	1070	5440	1160	5438	1200	5437	1310
GR	5438	1460	5436	1540	5432	1560	5432	1610	5440	1630
GR	5460	1680								

SECTION 222.3 IS A NEW SECTION

X1	222.3	11	1400	1570	250	250	250			
GR	5450	1000	5448	1040	5444	1150	5442	1210	5440	1400
GR	5435	1440	5436	1470	5437	1570	5435	1610	5440	1660
GR	5450	1690								

X1	222.	11	1360.00	1600.00	200	300	200			
GR	5450.0	1000.0	5448.00	1060.0	5440.00	1360.0	5438.00	1370.0	5437.00	1380.0
GR	5438.0	1395.0	5440.00	1600.0	5438.00	1670.0	5438.00	1720.0	5440.00	1735.0
GR	5450.0	1790.0								

X1	220.7	12	1200	1350	200	300	225			
GR	5450	1000	5448	1080	5442	1200	5440	1220	5442	1300
GR	5442.5	1350	5442	1440	5442	1600	5444	1620	5446	1640
GR	5450	1680	5460	1720						

SECTION 220.5 IS A NEW SECTION

X1	220.5	9	1560	1700	250	300	275			
GR	5460	1000	5448	1300	5446	1560	5444	1600	5446	1700
GR	5446	1880	5448	1900	5450	1910	5460	1970		

X1	220.	7	1520.00	1820.00	560	460	555			
GR	5468.0	1000.0	5460.00	1225.0	5452.00	1520.0	5451.50	1700.0	5452.00	1820.0
GR	5460.0	1855.0	5470.00	1920.0						

X1	218.	7	1445.00	1855.00	1490.00	1580.00	1445.00	0.00	0.00	0.00
GR	5488.0	1000.0	5470.00	1445.0	5468.00	1600.0	5470.00	1660.0	5468.00	1800.0
GR	5470.0	1855.0	5490.00	1970.0						

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

T1 TIJERAS ARROYO GRADE AND BANK STABILIZATION 93043.11
T2 SUBCRITICAL RUN FOR EXISTING 100-YEAR FLOW FILE NAME: TJSUB.HC2
T3 ORGINAL SUBCRITICAL RUN TIJERAS ARROYO EDIT DATE: (12-07-93)

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		3							5405.52	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2	0	-1				-1			

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

THIS RUN EXECUTED 21DEC93 18:22:44

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ORGINAL SUBCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	CWSEL	CRIWS	FRCH	VCH	K*XNL	K*XNCH	K*XNR	ELMIN
*	227.000	5400.29	5400.29	1.01	12.08	.00	30.00	.00	5394.00
*	227.000	5406.55	5406.55	.87	15.46	40.00	30.00	40.00	5394.00
*	226.000	5414.21	5414.21	1.41	6.96	.00	30.00	40.00	5408.00
*	226.000	5417.56	5417.56	1.22	11.25	.00	30.00	40.00	5408.00
*	225.000	5428.63	5428.63	.75	8.52	40.00	30.00	40.00	5424.00
*	225.000	5430.72	5430.72	.95	13.37	40.00	30.00	40.00	5424.00
*	224.500	5432.08	5432.08	.77	8.77	40.00	30.00	40.00	5426.50
*	224.500	5434.21	5434.21	.97	13.68	40.00	30.00	40.00	5426.50
*	224.000	5436.78	5436.78	.76	10.29	40.00	30.00	.00	5429.50
*	224.000	5439.79	5439.79	.94	15.22	40.00	30.00	.00	5429.50
*	222.600	5438.88	5438.88	.80	8.94	40.00	30.00	.00	5432.00
*	222.600	5441.68	5441.68	.95	13.93	40.00	30.00	40.00	5432.00
	222.300	5440.30	5439.47	.74	8.15	40.00	30.00	40.00	5435.00
*	222.300	5443.42	5443.42	.94	13.93	40.00	30.00	40.00	5435.00
	222.000	5441.68	5440.99	.72	6.84	40.00	30.00	40.00	5437.00
*	222.000	5445.74	5443.86	.62	9.25	40.00	30.00	40.00	5437.00
*	220.700	5444.06	5444.06	1.05	9.70	40.00	30.00	40.00	5440.00
*	220.700	5446.73	5446.73	1.09	14.24	40.00	30.00	40.00	5440.00
*	220.500	5448.13	5448.13	.90	9.03	40.00	30.00	40.00	5444.00
*	220.500	5450.34	5450.34	1.06	13.87	40.00	30.00	40.00	5444.00
*	220.000	5454.26	5454.26	.98	8.82	40.00	30.00	40.00	5451.50
*	220.000	5457.28	5457.28	.97	12.94	40.00	30.00	40.00	5451.50

	SECNO	CWSEL	CRIWS	FRCH	VCH	K*XNL	K*XNCH	K*XNR	ELMIN
*	218.000	5471.10	5471.10	.99	8.13	40.00	30.00	40.00	5468.00
*	218.000	5473.79	5473.79	.98	12.12	40.00	30.00	40.00	5468.00

ORGINAL SUBCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	Q	QLOB	QCH	QROB	VLOB	VCH	VROB	DEPTH	AREA
*	227.000	7040.00	.00	7040.00	.00	.00	12.08	.00	6.29	582.56
*	227.000	24860.00	431.66	24096.07	332.26	3.53	15.46	4.04	12.55	1763.23
*	226.000	7040.00	.00	433.54	6606.46	.00	6.96	9.01	6.21	795.58
*	226.000	24860.00	.00	2890.14	21969.86	.00	11.25	13.17	9.56	1925.19
*	225.000	7040.00	776.19	4491.95	1771.86	3.42	8.52	3.19	4.63	1310.28
*	225.000	24860.00	4091.16	10679.06	10089.78	6.65	13.37	6.68	6.72	2924.38
*	224.500	7040.00	416.26	4971.62	1652.11	2.74	8.77	3.06	5.58	1258.86
*	224.500	24860.00	3042.94	11831.88	9985.18	6.54	13.68	6.84	7.71	2790.03
*	224.000	7040.00	1968.08	5071.92	.00	3.55	10.29	.00	7.28	1046.84
*	224.000	24860.00	13192.67	11667.33	.00	7.54	15.22	.00	10.29	2515.69
*	222.600	7040.00	1221.93	5818.06	.00	3.34	8.94	.00	6.88	1016.57
*	222.600	24860.00	9187.89	15663.25	8.86	7.32	13.93	2.53	9.68	2384.04
	222.300	7040.00	3.01	5180.04	1856.95	.71	8.15	5.95	5.30	951.79
*	222.300	24860.00	2473.25	16249.99	6136.75	5.04	13.93	10.05	8.42	2267.73
	222.000	7040.00	120.37	4654.19	2265.44	2.28	6.84	5.40	4.68	1152.17
*	222.000	24860.00	2390.95	15308.37	7160.68	3.87	9.25	6.81	8.74	3324.43
*	220.700	7040.00	164.27	3843.15	3032.59	3.88	9.70	5.91	4.06	951.55
*	220.700	24860.00	1390.28	11343.33	12126.40	6.23	14.24	9.54	6.73	2290.20
*	220.500	7040.00	1005.12	3952.21	2082.66	3.43	9.03	5.14	4.13	1136.41
*	220.500	24860.00	6861.11	10363.08	7635.80	7.33	13.87	8.86	6.34	2545.10
*	220.000	7040.00	364.74	6632.70	42.56	3.88	8.82	3.82	2.76	857.10
*	220.000	24860.00	3045.04	21459.68	355.28	5.92	12.94	5.83	5.78	2233.88
*	218.000	7040.00	37.17	6994.26	8.57	2.49	8.13	2.47	3.10	878.61
*	218.000	24860.00	868.44	23791.47	200.10	4.90	12.12	4.85	5.79	2181.75

ORGINAL SUBCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	Q	DEPTH	STCHR	SSTA	ENDST	TOPWID
*	227.000	7040.00	6.29	1740.00	1592.79	1722.94	130.15
*	227.000	24860.00	12.55	1740.00	1203.62	2046.92	353.20
*	226.000	7040.00	6.21	1600.00	1517.21	1926.07	301.31
*	226.000	24860.00	9.56	1600.00	1502.02	1942.78	395.04
*	225.000	7040.00	4.63	1375.00	1089.42	1811.53	722.11
*	225.000	24860.00	6.72	1375.00	1041.75	1845.78	804.03
*	224.500	7040.00	5.58	1330.00	1049.47	1754.59	705.13
*	224.500	24860.00	7.71	1330.00	1036.16	1769.50	733.33
*	224.000	7040.00	7.28	1560.00	1128.95	1551.94	423.00
*	224.000	24860.00	10.29	1560.00	1008.32	1559.48	551.16
*	222.600	7040.00	6.88	1630.00	1182.45	1627.19	444.74
*	222.600	24860.00	9.68	1630.00	1084.61	1634.19	549.58
	222.300	7040.00	5.30	1570.00	1371.70	1660.89	289.19
*	222.300	24860.00	8.42	1570.00	1167.34	1670.27	502.92
	222.000	7040.00	4.68	1600.00	1297.08	1744.23	447.14
*	222.000	24860.00	8.74	1600.00	1144.69	1766.58	621.89
*	220.700	7040.00	4.06	1350.00	1158.85	1620.58	461.73
*	220.700	24860.00	6.73	1350.00	1105.49	1647.26	541.77
*	220.500	7040.00	4.13	1700.00	1296.83	1900.63	603.81
*	220.500	24860.00	6.34	1700.00	1241.54	1912.03	670.49
*	220.000	7040.00	2.76	1820.00	1436.78	1829.87	393.09
*	220.000	24860.00	5.78	1820.00	1325.31	1843.10	517.79
*	218.000	7040.00	3.10	1855.00	1417.85	1861.31	443.46
*	218.000	24860.00	5.79	1855.00	1351.35	1876.78	525.43

ORGINAL SUBCRITICAL RUN

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	227.000	.00	.00	.00	5394.00	7040.00	5400.29	5400.29	5402.56	81.82	12.08	582.56	778.28
*	227.000	.00	.00	.00	5394.00	24860.00	5406.55	5406.55	5410.16	47.44	15.46	1763.23	3609.23
*	226.000	1010.00	.00	.00	5408.00	7040.00	5414.21	5414.21	5415.44	121.20	6.96	795.58	639.46
*	226.000	1010.00	.00	.00	5408.00	24860.00	5417.56	5417.56	5420.16	113.05	11.25	1925.19	2338.16
*	225.000	800.00	.00	.00	5424.00	7040.00	5428.63	5428.63	5429.41	45.77	8.52	1310.28	1040.54
*	225.000	800.00	.00	.00	5424.00	24860.00	5430.72	5430.72	5432.31	64.78	13.37	2924.38	3088.62
*	224.500	300.00	.00	.00	5426.50	7040.00	5432.08	5432.08	5432.97	48.82	8.77	1258.86	1007.60
*	224.500	300.00	.00	.00	5426.50	24860.00	5434.21	5434.21	5435.97	67.62	13.68	2790.03	3023.24
*	224.000	385.00	.00	.00	5429.50	7040.00	5436.78	5436.78	5438.02	43.73	10.29	1046.84	1064.56
*	224.000	385.00	.00	.00	5429.50	24860.00	5439.79	5439.79	5441.95	59.73	15.22	2515.69	3216.63
*	222.600	250.00	.00	.00	5432.00	7040.00	5438.88	5438.88	5439.93	53.95	8.94	1016.57	958.45
*	222.600	250.00	.00	.00	5432.00	24860.00	5441.68	5441.68	5443.88	64.60	13.93	2384.04	3093.01
	222.300	250.00	.00	.00	5435.00	7040.00	5440.30	5439.47	5441.20	46.76	8.15	951.79	1029.52
*	222.300	250.00	.00	.00	5435.00	24860.00	5443.42	5443.42	5445.82	60.77	13.93	2267.73	3188.98
	222.000	200.00	.00	.00	5437.00	7040.00	5441.68	5440.99	5442.31	47.66	6.84	1152.17	1019.76
*	222.000	200.00	.00	.00	5437.00	24860.00	5445.74	5443.86	5446.79	26.58	9.25	3324.43	4821.97
*	220.700	225.00	.00	.00	5440.00	7040.00	5444.06	5444.06	5445.09	105.19	9.70	951.55	686.40
*	220.700	225.00	.00	.00	5440.00	24860.00	5446.73	5446.73	5448.89	89.38	14.24	2290.20	2629.49
*	220.500	275.00	.00	.00	5444.00	7040.00	5448.13	5448.13	5448.98	72.69	9.03	1136.41	825.72
*	220.500	275.00	.00	.00	5444.00	24860.00	5450.34	5450.34	5452.19	84.04	13.87	2545.10	2711.85
*	220.000	555.00	.00	.00	5451.50	7040.00	5454.26	5454.26	5455.41	93.09	8.82	857.10	729.66
*	220.000	555.00	.00	.00	5451.50	24860.00	5457.28	5457.28	5459.60	69.74	12.94	2233.88	2976.92
*	218.000	1445.00	.00	.00	5468.00	7040.00	5471.10	5471.10	5472.12	100.33	8.13	878.61	702.82
*	218.000	1445.00	.00	.00	5468.00	24860.00	5473.79	5473.79	5475.99	74.19	12.12	2181.75	2886.15

ORGINAL SUBCRITICAL RUN

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	227.000	7040.00	5400.29	.00	.00	.32	130.15	.00
*	227.000	24860.00	5406.55	6.26	.00	1.03	353.20	.00
*	226.000	7040.00	5414.21	.00	13.92	.00	301.31	1010.00
*	226.000	24860.00	5417.56	3.34	11.00	.00	395.04	1010.00
*	225.000	7040.00	5428.63	.00	14.42	.00	722.11	800.00
*	225.000	24860.00	5430.72	2.09	13.17	.00	804.03	800.00
*	224.500	7040.00	5432.08	.00	3.45	.00	705.13	300.00
*	224.500	24860.00	5434.21	2.13	3.49	.00	733.33	300.00
*	224.000	7040.00	5436.78	.00	4.69	.00	423.00	385.00
*	224.000	24860.00	5439.79	3.02	5.58	.00	551.16	385.00
*	222.600	7040.00	5438.88	.00	2.10	.00	444.74	250.00
*	222.600	24860.00	5441.68	2.80	1.88	.00	549.58	250.00
	222.300	7040.00	5440.30	.00	1.42	.00	289.19	250.00
*	222.300	24860.00	5443.42	3.13	1.75	.00	502.92	250.00
	222.000	7040.00	5441.68	.00	1.39	.00	447.14	200.00
*	222.000	24860.00	5445.74	4.06	2.32	.00	621.89	200.00
*	220.700	7040.00	5444.06	.00	2.38	.00	461.73	225.00
*	220.700	24860.00	5446.73	2.67	.98	.00	541.77	225.00
*	220.500	7040.00	5448.13	.00	4.07	.00	603.81	275.00
*	220.500	24860.00	5450.34	2.21	3.61	.00	670.49	275.00
*	220.000	7040.00	5454.26	.00	6.13	.00	393.09	555.00
*	220.000	24860.00	5457.28	3.02	6.94	.00	517.79	555.00
*	218.000	7040.00	5471.10	.00	16.84	.00	443.46	1445.00
*	218.000	24860.00	5473.79	2.69	16.51	.00	525.43	1445.00

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO= 227.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 227.000 PROFILE= 2 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 226.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 226.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 226.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 226.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 225.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 225.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 225.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 225.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 224.500 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 224.500 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 224.500 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 224.500 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 224.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 224.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 224.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 224.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 222.600 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 222.600 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 222.600 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 222.600 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 222.300 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 222.300 PROFILE= 2 MINIMUM SPECIFIC ENERGY

WARNING SECNO= 222.000 PROFILE= 2 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO= 220.700 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.700 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 220.700 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.700 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 220.500 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.500 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 220.500 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.500 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 220.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 220.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 218.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 218.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 218.000 PROFILE= 2 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 218.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

Normal program termination

HEC2 S/N: 1126260289 HMVersion: 6.20 Data File: TJSUPER.hc2

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*********************************************
*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.6.0;  February 1991          *
*                                           *
*  RUN DATE    21DEC93    TIME    18:22:57  *
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*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  HYDROLOGIC ENGINEERING CENTER        *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616-4687         *
*         (916) 756-1104                *
*****************************************
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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X           X     X
X     X  X        X                       X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX            XXXXXXX
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::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION   :::
:::                                      :::
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H A E S T A D   M E T H O D S
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

NOTE: - THIS RUN CONTAINS BASELINE CONDITIONS

FOR COMPARING SUPERCRITICAL RUNS

FROM ALTERNATIVES 1 2 & 3

- ALL Q's ARE BULKED 10%
- Q_{100} = 22,600 CFS PRIOR TO BULKING

THIS RUN EXECUTED 21DEC93 18:22:57

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

T1 TIJERAS ARROYO GRADE AND BANK STABILIZATION 93043.11
T2 SUPERCRITICAL RUN FOR 10-YEAR FLOWS FILE NAME: TJSUPER.HC2
T3 ORGINAL SUPER. RUN TIJERAS ARROYO EDIT DATE: (12-07-93)

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		2		1	-1					
J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1		-1				-1			

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

38	1	2	68	26	16	17	18	42	
38	43	13	14	15	55	26	56	8	25
	38	43	8	22	53	54	4		150

J5 LPRNT NUMSEC ********REQUESTED SECTION NUMBERS********

-10 -10

J6 IHLEQ ICOPY SUBDIV STRTDS RMILE

1.0

NC	.040	.040	.030	.1	.3

THE FLOW INCLUDES 10% BULKING, 10-YEAR (6400 cfs) & 100-YEAR (22600 cfs)

QT	2	7040	24860

X1	218.	7	1445.00	1855.00	1490.00	1580.00	1445.00			
GR	5488.0	1000.0	5470.00	1445.0	5468.00	1600.0	5470.00	1660.0	5468.00	1800.0
GR	5470.0	1855.0	5490.00	1970.0						

X1	220.	7	1520.00	1820.00	560	460	555			
GR	5468.0	1000.0	5460.00	1225.0	5452.00	1520.0	5451.50	1700.0	5452.00	1820.0
GR	5460.0	1855.0	5470.00	1920.0						

SECTION 220.5 IS A NEW SECTION

X1	220.5	9	1560	1700	250	300	275			
GR	5460	1000	5448	1300	5446	1560	5444	1600	5446	1700
GR	5446	1880	5448	1900	5450	1910	5460	1970		

SECTION 220.7 IS A NEW SECTION

X1	220.7	12	1200	1350	200	300	225			
GR	5450	1000	5448	1080	5442	1200	5440	1220	5442	1300
GR	5442.5	1350	5442	1440	5442	1600	5444	1620	5446	1640
GR	5450	1680	5460	1720						

X1	222.	11	1360.00	1600.00	200	300	200			
GR	5450.0	1000.0	5448.00	1060.0	5440.00	1360.0	5438.00	1370.0	5437.00	1380.0
GR	5438.0	1395.0	5440.00	1600.0	5438.00	1670.0	5438.00	1720.0	5440.00	1735.0
GR	5450.0	1790.0								

SECTION 222.3 IS A NEW SECTION

X1	222.3	11	1400	1570	250	250	250			
GR	5450	1000	5448	1040	5444	1150	5442	1210	5440	1400
GR	5435	1440	5436	1470	5437	1570	5435	1610	5440	1660
GR	5450	1690								

SECTION 222.6 IS A NEW SECTION

X1	222.6	11	1460	1630	200	300	250			
GR	5444	1000	5442	1070	5440	1160	5438	1200	5437	1310
GR	5438	1460	5436	1540	5432	1560	5432	1610	5440	1630
GR	5460	1680								

X1	224.	9	1465.00	1560.00	460.00	260.00	385.00			
GR	5450.0	905.0	5440.00	1000.0	5436.00	1160.0	5434.00	1465.0	5430.00	1490.0
GR	5429.5	1525.0	5430.00	1535.0	5440.00	1560.0	5450.00	1750.0		

SECTION 224.5 IS A NEW SECTION

X1	224.5	12	1190	1330	260	260	300			
GR	5440	1000	5432	1050	5430	1190	5426.5	1220	5426.5	1280
GR	5430	1300	5431.5	1330	5430	1650	5432	1690	5430	1740
GR	5440	1810	5450	1880						
X1	225.0	12	1245.00	1375.00	720.00	900.00	800.00			
GR	5440.0	1000.0	5430.00	1045.0	5428.00	1110.0	5426.00	1245.0	5424.00	1265.0
GR	5424.0	1320.0	5426.00	1375.0	5428.00	1650.0	5428.00	1755.0	5427.60	1790.0
GR	5430.0	1840.0	5440.00	1920.0						
X1	226.	17	1500.00	1600.00	1010.00	1010.00	1010.00			
GR	5430.0	990.0	5418.00	1110.0	5418.00	1305.0	5419.00	1450.0	5418.00	1500.0
GR	5412.5	1525.0	5412.50	1555.0	5416.00	1565.0	5419.00	1600.0	5416.00	1660.0
GR	5410.0	1685.0	5408.00	1700.0	5410.00	1740.0	5414.00	1925.0	5418.00	1945.0
GR	5420.0	2020.0	5430.00	2180.0						
X1	227	26	1580	1740						
GR	5420	950	5410	1000	5408	1200	5406	1205	5404	1240
GR	5406	1250	5408	1265	5408	1430	5406	1560	5404	1575
GR	5402	1580	5400	1595	5396	1605	5394	1630	5394	1680
GR	5398	1700	5402	1740	5404	1750	5406	1770	5408	1850
GR	5408	1940	5406	2040	5408	2065	5408	2100	5410	2115
GR	5420	2175								

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

T1 TIJERAS ARROYO GRADE AND BANK STABILIZATION 93043.11
T2 SUPERCRITICAL RUN FOR 100-YEAR FLOWS FILE NAME: TJSUPER.HC2
T3 ORGINAL SUPER. RUN TIJERAS ARROYO EDIT DATE: (12-07-93)

	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
J1		3		1	-1					

	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
J2	2	0	-1				-1			

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

THIS RUN EXECUTED 21DEC93 18:23:00

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ORGINAL SUPER. RUN

SUMMARY PRINTOUT

	SECNO	CWSEL	CRIWS	FRCH	VCH	K*XNL	K*XNCH	K*XNR	ELMIN
*	218.000	5471.08	5471.08	1.00	8.19	40.00	30.00	40.00	5468.00
*	218.000	5473.81	5473.81	.97	12.06	40.00	30.00	40.00	5468.00
	220.000	5454.05	5454.26	1.13	9.71	40.00	30.00	40.00	5451.50
*	220.000	5456.27	5457.28	1.35	16.30	40.00	30.00	40.00	5451.50
	220.500	5447.87	5448.09	1.08	10.38	40.00	30.00	40.00	5444.00
	220.500	5449.85	5450.37	1.28	15.96	40.00	30.00	40.00	5444.00
	220.700	5443.78	5444.06	1.29	11.24	40.00	30.00	40.00	5440.00
	220.700	5446.39	5446.76	1.22	15.43	40.00	30.00	40.00	5440.00
*	222.000	5440.99	5440.99	1.09	9.02	40.00	30.00	40.00	5437.00
	222.000	5443.53	5443.87	1.16	14.27	40.00	30.00	40.00	5437.00
*	222.300	5439.48	5439.48	1.06	10.45	.00	30.00	40.00	5435.00
*	222.300	5443.42	5443.42	.94	13.93	40.00	30.00	40.00	5435.00
*	222.600	5438.83	5438.83	.82	9.11	40.00	30.00	.00	5432.00
	222.600	5441.27	5441.68	1.08	15.28	40.00	30.00	40.00	5432.00
	224.000	5436.24	5436.79	.97	12.64	40.00	30.00	.00	5429.50
	224.000	5439.31	5439.85	1.08	17.08	40.00	30.00	.00	5429.50
*	224.500	5431.25	5432.17	1.34	13.68	40.00	30.00	40.00	5426.50
*	224.500	5433.12	5434.22	1.53	19.58	40.00	30.00	40.00	5426.50
	225.000	5428.04	5428.55	1.13	11.87	40.00	30.00	40.00	5424.00
	225.000	5430.08	5430.71	1.23	16.39	40.00	30.00	40.00	5424.00
*	226.000	5413.66	5414.11	1.87	7.49	.00	30.00	40.00	5408.00
	226.000	5416.89	5417.47	1.56	13.08	.00	30.00	40.00	5408.00

	SECNO	CWSEL	CRIWS	FRCH	VCH	K*XNL	K*XNCH	K*XNR	ELMIN
*	227.000	5400.31	5400.31	1.00	12.04	.00	30.00	.00	5394.00
*	227.000	5406.00	5406.55	.96	16.57	40.00	30.00	40.00	5394.00

ORGINAL SUPER. RUN

SUMMARY PRINTOUT

	SECNO	Q	QLOB	QCH	QROB	VLOB	VCH	VROB	DEPTH	AREA
*	218.000	7040.00	36.29	6995.34	8.36	2.50	8.19	2.48	3.08	872.12
*	218.000	24860.00	874.50	23784.01	201.49	4.88	12.06	4.83	5.81	2192.53
	220.000	7040.00	326.33	6675.59	38.08	4.25	9.71	4.18	2.55	773.41
*	220.000	24860.00	2487.71	22082.04	290.25	7.41	16.30	7.29	4.77	1730.67
	220.500	7040.00	837.20	4169.58	2033.22	3.69	10.38	5.74	3.87	982.68
	220.500	24860.00	6396.93	10836.99	7626.09	8.16	15.96	10.05	5.85	2222.36
	220.700	7040.00	138.74	3980.06	2921.20	4.39	11.24	6.68	3.78	823.10
	220.700	24860.00	1293.78	11514.40	12051.82	6.71	15.43	10.28	6.39	2111.45
*	222.000	7040.00	46.51	4639.51	2353.98	2.54	9.02	7.33	3.99	853.90
	222.000	24860.00	1302.55	16038.69	7518.75	5.58	14.27	10.81	6.53	2052.76
*	222.300	7040.00	.00	5192.46	1847.54	.00	10.45	7.73	4.48	736.01
*	222.300	24860.00	2472.74	16250.40	6136.86	5.04	13.93	10.05	8.42	2267.49
*	222.600	7040.00	1183.19	5856.81	.00	3.35	9.11	.00	6.83	995.75
	222.600	24860.00	8728.50	16126.70	4.80	7.90	15.28	2.40	9.27	2162.63
	224.000	7040.00	1393.64	5646.36	.00	3.67	12.64	.00	6.74	826.36
	224.000	24860.00	12555.08	12304.93	.00	8.21	17.08	.00	9.81	2250.08
*	224.500	7040.00	183.53	6160.95	695.51	3.36	13.68	3.36	4.75	711.79
*	224.500	24860.00	2446.08	13925.76	8488.15	8.15	19.58	8.65	6.62	1993.42
	225.000	7040.00	555.97	5335.15	1148.88	3.98	11.87	3.86	4.04	886.89
	225.000	24860.00	3775.04	11736.83	9348.13	7.75	16.39	7.71	6.08	2414.97
*	226.000	7040.00	.00	299.11	6740.89	.00	7.49	11.33	5.66	634.89
	226.000	24860.00	.00	2697.31	22162.68	.00	13.08	15.14	8.89	1669.79
*	227.000	7040.00	.00	7040.00	.00	.00	12.04	.00	6.31	584.60
*	227.000	24860.00	256.00	24370.96	233.04	3.40	16.57	4.65	12.00	1595.75

ORGINAL SUPER. RUN

SUMMARY PRINTOUT

	SECNO	Q	DEPTH	STCHR	SSTA	ENDST	TOPWID
*	218.000	7040.00	3.08	1855.00	1418.21	1861.23	443.02
*	218.000	24860.00	5.81	1855.00	1350.84	1876.90	526.06
	220.000	7040.00	2.55	1820.00	1444.72	1828.93	384.21
*	220.000	24860.00	4.77	1820.00	1362.65	1838.67	476.02
	220.500	7040.00	3.87	1700.00	1317.01	1898.69	581.68
	220.500	24860.00	5.85	1700.00	1253.71	1909.26	655.55
	220.700	7040.00	3.78	1350.00	1164.46	1617.77	453.31
	220.700	24860.00	6.39	1350.00	1112.15	1643.93	531.78
*	222.000	7040.00	3.99	1600.00	1322.96	1740.43	417.48
	222.000	24860.00	6.53	1600.00	1227.72	1754.40	526.68
*	222.300	7040.00	4.48	1570.00	1404.20	1654.75	250.55
*	222.300	24860.00	8.42	1570.00	1167.36	1670.26	502.91
*	222.600	7040.00	6.83	1630.00	1183.39	1627.08	443.69
	222.600	24860.00	9.27	1630.00	1103.07	1633.16	530.09
	224.000	7040.00	6.74	1560.00	1150.37	1550.60	400.23
	224.000	24860.00	9.81	1560.00	1027.97	1558.25	530.28
*	224.500	7040.00	4.75	1330.00	1102.60	1748.74	553.65
*	224.500	24860.00	6.62	1330.00	1043.02	1761.82	718.80
	225.000	7040.00	4.04	1375.00	1108.91	1799.03	690.13
	225.000	24860.00	6.08	1375.00	1044.62	1840.68	796.07
*	226.000	7040.00	5.66	1600.00	1519.71	1909.46	278.35
	226.000	24860.00	8.89	1600.00	1505.06	1939.43	367.43
*	227.000	7040.00	6.31	1740.00	1592.67	1723.10	130.43
*	227.000	24860.00	12.00	1740.00	1204.99	2040.04	255.52

ORGINAL SUPER. RUN

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	218.000	.00	.00	.00	5468.00	7040.00	5471.08	5471.08	5472.12	102.74	8.19	872.12	694.56
*	218.000	.00	.00	.00	5468.00	24860.00	5473.81	5473.81	5475.99	73.10	12.06	2192.53	2907.69
	220.000	1445.00	.00	.00	5451.50	7040.00	5454.05	5454.26	5455.45	127.21	9.71	773.41	624.18
*	220.000	1445.00	.00	.00	5451.50	24860.00	5456.27	5457.28	5460.03	144.92	16.30	1730.67	2065.06
	220.500	555.00	.00	.00	5444.00	7040.00	5447.87	5448.09	5449.04	107.78	10.38	982.68	678.10
	220.500	555.00	.00	.00	5444.00	24860.00	5449.85	5450.37	5452.32	126.40	15.96	2222.36	2211.22
	220.700	275.00	.00	.00	5440.00	7040.00	5443.78	5444.06	5445.18	164.10	11.24	823.10	549.56
	220.700	275.00	.00	.00	5440.00	24860.00	5446.39	5446.76	5448.94	114.30	15.43	2111.45	2325.31
*	222.000	225.00	.00	.00	5437.00	7040.00	5440.99	5440.99	5442.10	120.03	9.02	853.90	642.58
	222.000	225.00	.00	.00	5437.00	24860.00	5443.53	5443.87	5446.14	106.05	14.27	2052.76	2414.04
*	222.300	200.00	.00	.00	5435.00	7040.00	5439.48	5439.48	5440.97	103.26	10.45	736.01	692.79
*	222.300	200.00	.00	.00	5435.00	24860.00	5443.42	5443.42	5445.82	60.79	13.93	2267.49	3188.52
*	222.600	250.00	.00	.00	5432.00	7040.00	5438.83	5438.83	5439.93	56.87	9.11	995.75	933.55
	222.600	250.00	.00	.00	5432.00	24860.00	5441.27	5441.68	5443.97	84.76	15.28	2162.63	2700.20
	224.000	250.00	.00	.00	5429.50	7040.00	5436.24	5436.79	5438.27	73.62	12.64	826.36	820.51
	224.000	250.00	.00	.00	5429.50	24860.00	5439.31	5439.85	5442.08	80.21	17.08	2250.08	2775.73
*	224.500	385.00	.00	.00	5426.50	7040.00	5431.25	5432.17	5433.81	153.70	13.68	711.79	567.85
*	224.500	385.00	.00	.00	5426.50	24860.00	5433.12	5434.22	5436.95	179.73	19.58	1993.42	1854.33
	225.000	300.00	.00	.00	5424.00	7040.00	5428.04	5428.55	5429.75	110.06	11.87	886.89	671.07
	225.000	300.00	.00	.00	5424.00	24860.00	5430.08	5430.71	5432.54	112.68	16.39	2414.97	2341.92
*	226.000	800.00	.00	.00	5408.00	7040.00	5413.66	5414.11	5415.61	221.05	7.49	634.89	473.51
	226.000	800.00	.00	.00	5408.00	24860.00	5416.89	5417.47	5420.35	169.37	13.08	1669.79	1910.22
*	227.000	1010.00	.00	.00	5394.00	7040.00	5400.31	5400.31	5402.56	81.10	12.04	584.60	781.72
*	227.000	1010.00	.00	.00	5394.00	24860.00	5406.00	5406.55	5410.19	58.91	16.57	1595.75	3238.88

ORGINAL SUPER. RUN

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	218.000	7040.00	5471.08	.00	.00	.00	443.02	.00
*	218.000	24860.00	5473.81	2.73	.00	.00	526.06	.00
	220.000	7040.00	5454.05	.00	-17.04	.00	384.21	1445.00
*	220.000	24860.00	5456.27	2.22	-17.54	.00	476.02	1445.00
	220.500	7040.00	5447.87	.00	-6.17	.00	581.68	555.00
	220.500	24860.00	5449.85	1.98	-6.42	.00	655.55	555.00
	220.700	7040.00	5443.78	.00	-4.10	.00	453.31	275.00
	220.700	24860.00	5446.39	2.62	-3.46	.00	531.78	275.00
*	222.000	7040.00	5440.99	.00	-2.79	.00	417.48	225.00
	222.000	24860.00	5443.53	2.54	-2.86	.00	526.68	225.00
*	222.300	7040.00	5439.48	.00	-1.51	.00	250.55	200.00
*	222.300	24860.00	5443.42	3.95	-.11	.00	502.91	200.00
*	222.600	7040.00	5438.83	.00	-.64	.00	443.69	250.00
	222.600	24860.00	5441.27	2.44	-2.15	.00	530.09	250.00
	224.000	7040.00	5436.24	.00	-2.59	.00	400.23	250.00
	224.000	24860.00	5439.31	3.07	-1.97	.00	530.28	250.00
*	224.500	7040.00	5431.25	.00	-4.99	.00	553.65	385.00
*	224.500	24860.00	5433.12	1.87	-6.19	.00	718.80	385.00
	225.000	7040.00	5428.04	.00	-3.21	.00	690.13	300.00
	225.000	24860.00	5430.08	2.05	-3.03	.00	796.07	300.00
*	226.000	7040.00	5413.66	.00	-14.37	.00	278.35	800.00
	226.000	24860.00	5416.89	3.23	-13.19	.00	367.43	800.00
*	227.000	7040.00	5400.31	.00	-13.35	.00	130.43	1010.00
*	227.000	24860.00	5406.00	5.69	-10.89	.00	255.52	1010.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
CAUTION SECNO=    218.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    218.000  PROFILE=  2  CRITICAL DEPTH ASSUMED

WARNING SECNO=    220.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=    222.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    222.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    222.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    222.300  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    222.300  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    222.300  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO=    222.300  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    222.300  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    222.300  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    222.600  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    222.600  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    222.600  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=    224.500  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    224.500  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=    226.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=    227.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    227.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    227.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=    227.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
```

Normal program termination

APPENDIX B

DESIGN CALCULATIONS: OPTIONS 1 AND 2

LEEDSHILL · HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT TIJERAS ARROYO			SHEET NUMBER 1 OF 3
	COMPUTED BY: RAS	CHECKED BY: MMD	JOB NUMBER	DATE: 12/20/93

ALTERNATIVES 1 & 2

DETERMINE RIPRAP SIZE PER CORPS OF ENGRS.

MANUAL EM-1110-2-1601 REV 1-JULY-1991 &

HEC-2 RUN: SUP_01, HC2

I SOLVE FOR V_{AVE} & V_{SS}

SEC #	$V_{AVE} = V_{CH}$	WIDTH	R/W *	V_{SS} **
220.7	11.85	525.60	4.28	16.73
222.0	12.48	533.59	4.22	17.66
222.3	13.22	462.40	4.87	18.28
222.6	14.17	509.02	4.42	19.90

* RADIUS (R) = 2250' (SEE SHEET 3 OF 3)

** $\frac{V_{SS}}{V_{AVE}} = 1.74 - 0.52 LOG(R/W)$ (REF. PLATE B-33)

II DETERMINE D_{30} & DEPTH WITH CORRECTION FACTORS

$\gamma = 165$ pcf

SEC #	V_{SS}	D_{30}	DEPTH	C_2 *	C_V **	D_{30} CORRECTED (MIN)
220.7	16.73	1.8'	5'	1.0	1.15	1.8(1.15) = 2.07
222.0	17.66	1.8'	7'	1.0	1.15	1.8(1.15) = 2.07
222.3	18.28	2.0	7'	1.0	1.15	2.0(1.15) = 2.30
222.6	19.90	2.2	10'	1.0	1.15	2.2(1.15) = 2.53

* PLATE B-39

** PLATE B-40

III FIND D_{100} (MAX) PER TABLE 3-1

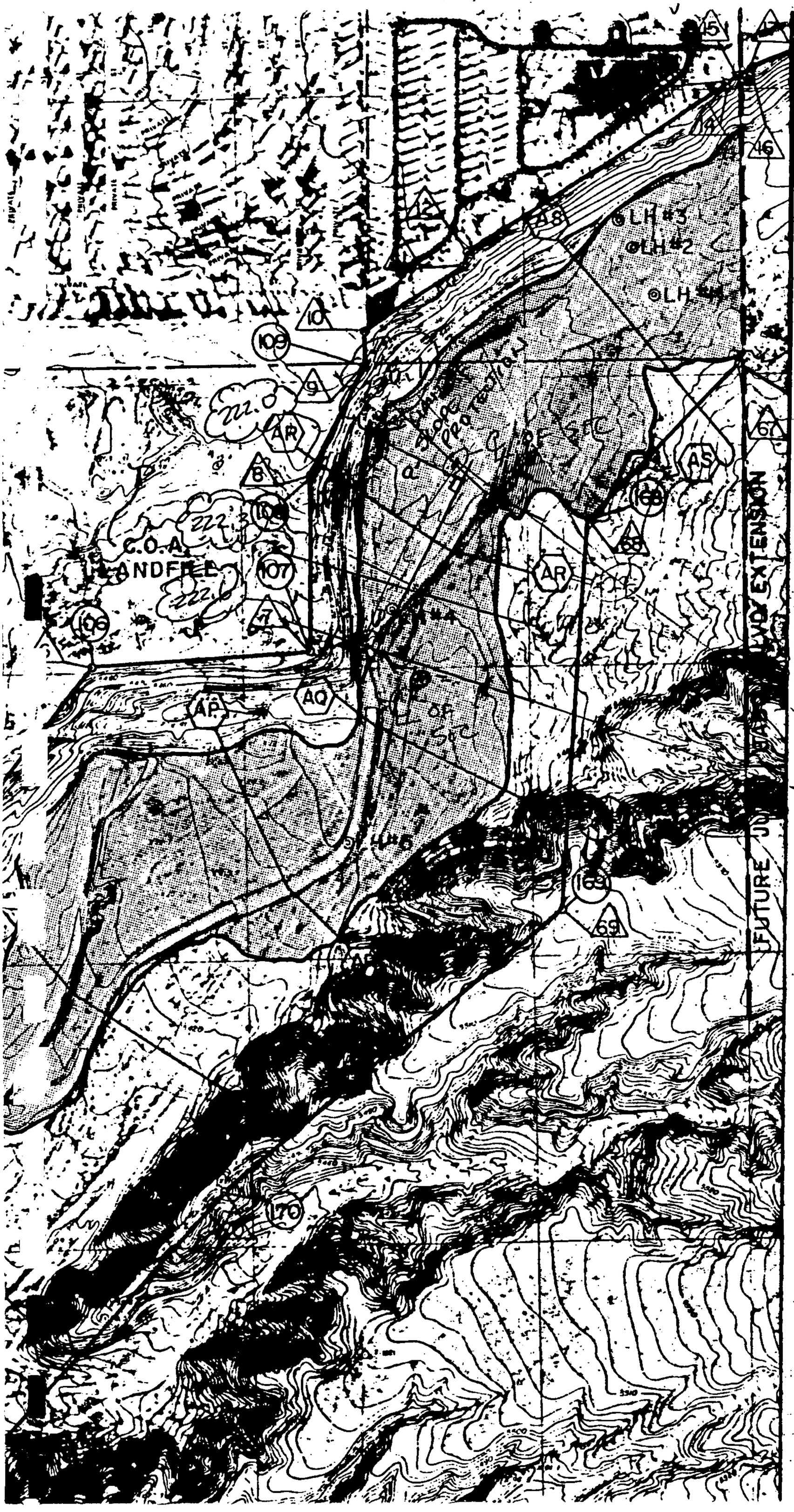
SEC #	D_{30} MIN	D_{100} (MAX)	D_{50}
220.7	2.07	54"	30"
222.0	2.07	54"	30"
222.3	2.30	—	
222.6	2.53	— TOO LARGE —	

IV COMPARISON OF ALT-1 & ALT-2

VELOCITY PROFILES FOR BOTH ALTERNATIVES ARE SIMULAR. ACCOLDING TO MACCAFERRI GABIONS, WHEN DESIGN VELOCITIES EXCEED 20 FPS, ...

V REFERENCES

- HYDRAULIC DESIGN OF FLOOD CONTROL CHANNELS; JUL 91; CORPS OF ENGINEERS (SEE ATTACHED



FIND RADIUS OF BEND

$L_1 \doteq 2260$

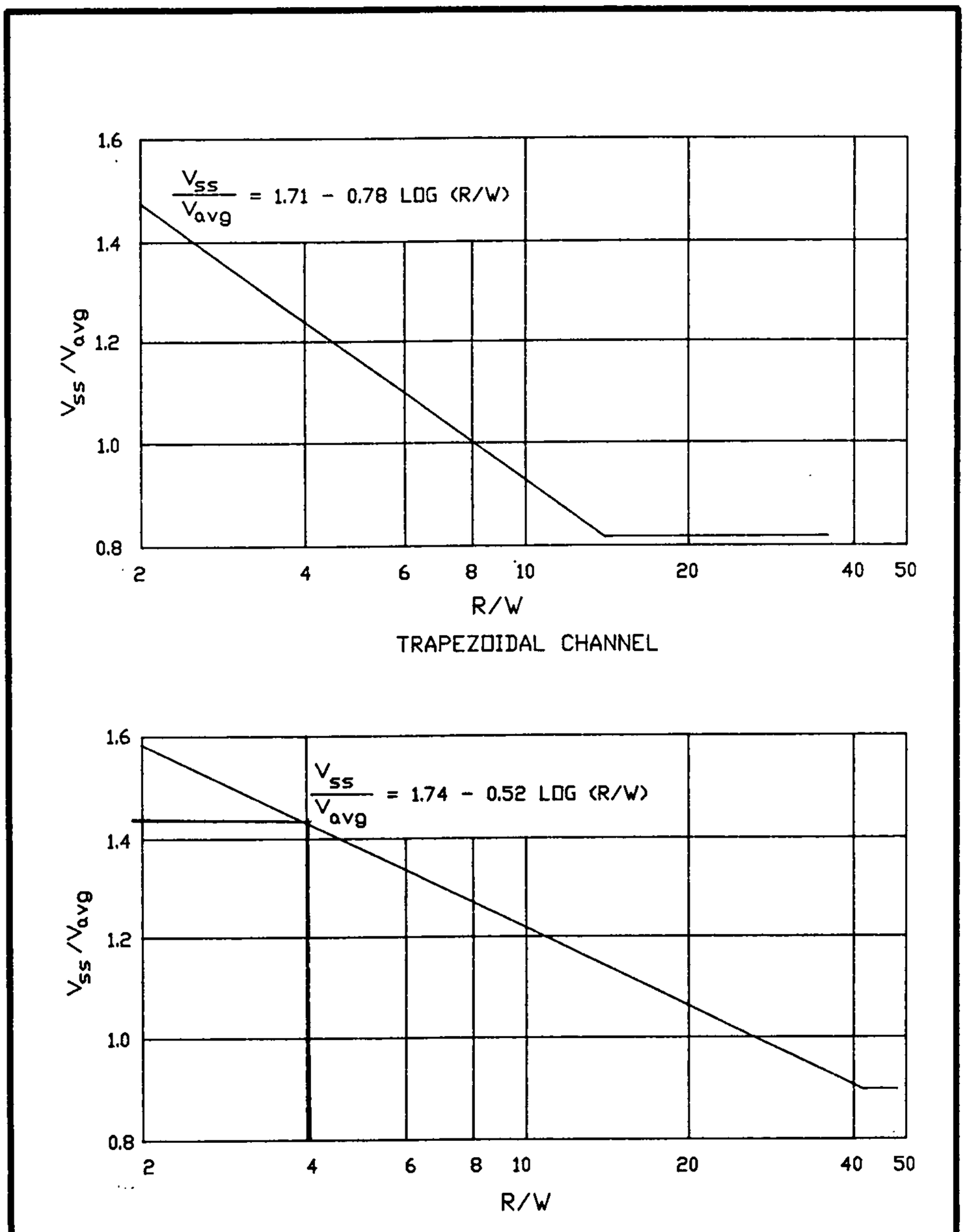
$L_2 \doteq 2250$

PI

$\therefore$ SAY $R = 2250'$

REFERENCE FOR APPENDIX C

1 OF 6



NOTE: V_{ss} IS DEPTH-AVERAGED VELOCITY AT 20 PERCENT OF SLOPE LENGTH UP FROM TOE

RIPRAP DESIGN VELOCITIES

PLATE B-33

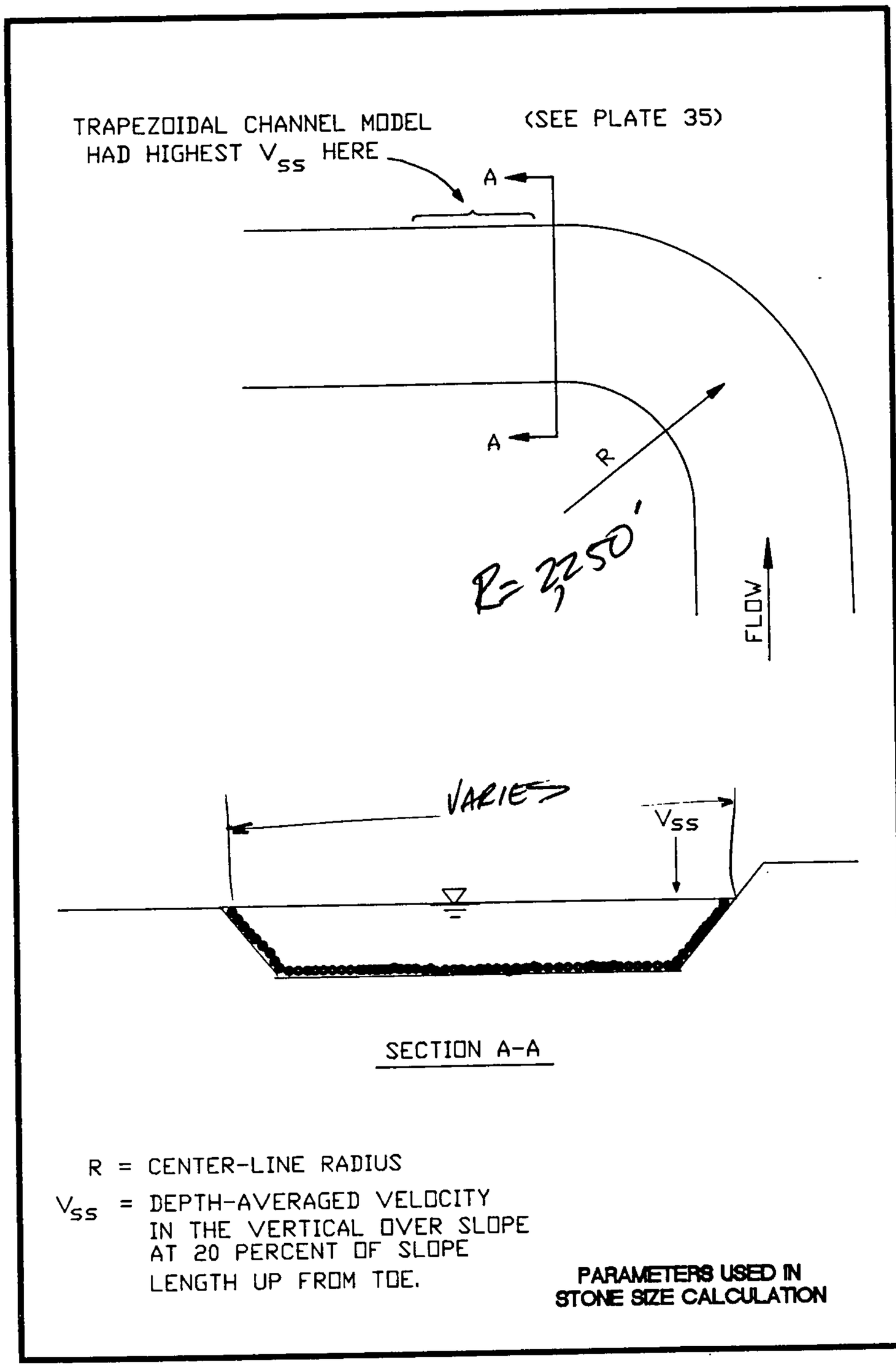
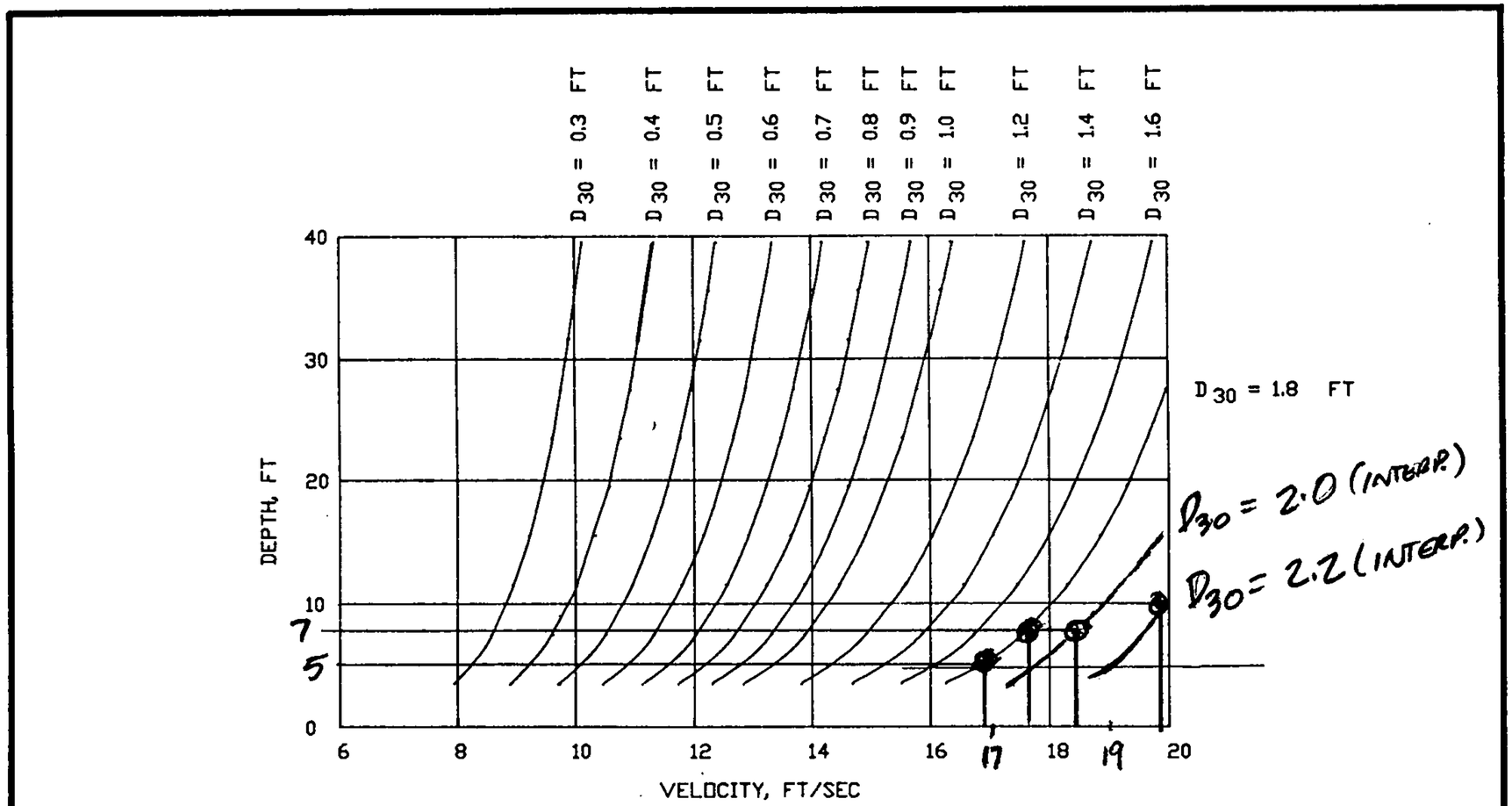

TRAPEZOIDAL CHANNEL MODEL
HAD HIGHEST V_{ss} HERE
(SEE PLATE 35)
A
A
R
R= 2250'
FLOW
VARIES
V_{ss}
SECTION A-A
R = CENTER-LINE RADIUS
V_{ss} = DEPTH-AVERAGED VELOCITY IN THE VERTICAL OVER SLOPE AT 20 PERCENT OF SLOPE LENGTH UP FROM TOE.
PARAMETERS USED IN STONE SIZE CALCULATION

PLATE B-34



NOTE: APPLICABLE TO THICKNESS $1D_{100}$ (max) AND CHANNEL BOTTOMS OR SIDE SLOPES FLATTER THAN OR EQUAL TO 1V ON 4H. STONE WEIGHT 165 pcf, C_S = 0.30, C_V = C_T = 1.0 S_f = 1.1 BASED ON EQUATION 3-3.

DEPTH-AVERAGED VELOCITY VS D30 AND DEPTH

PLATE B-37

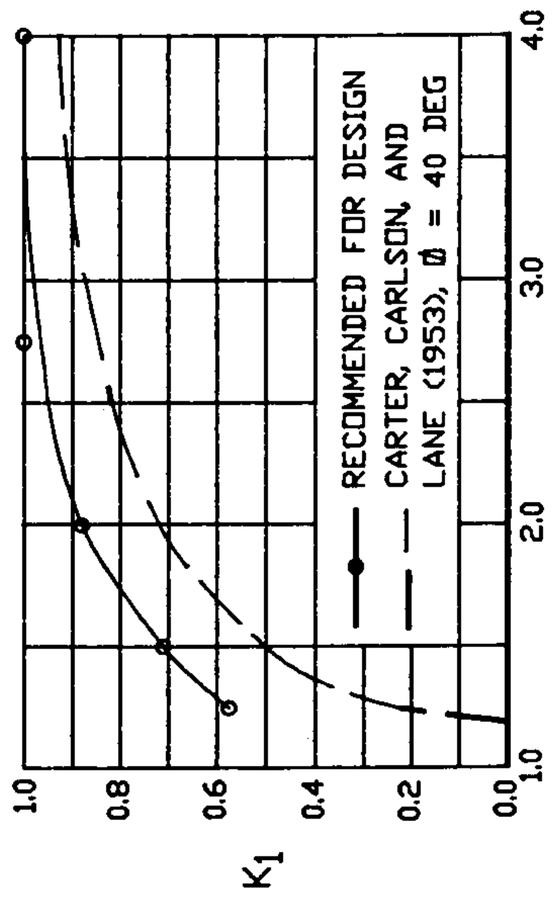
3 of 6

CORRECTION FOR SIDE SLOPE ANGLE

$D_{30} = C_2 * (D_{30}$ FROM PLATE 37)

WHERE C_2 = CORRECTION FOR SIDE SLOPE ANGLE

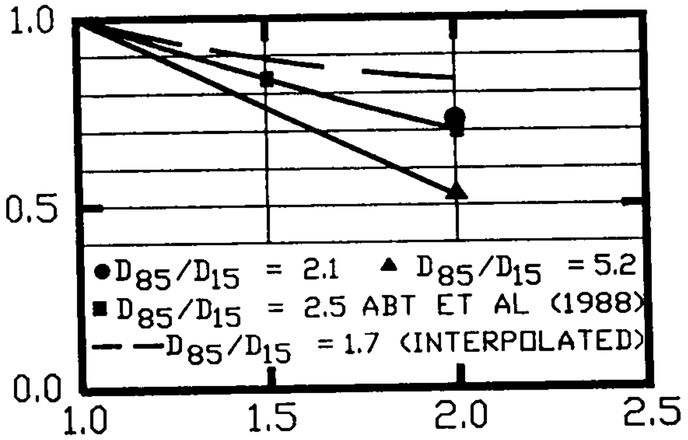
NOTE 1 DO NOT MAKE THIS CORRECTION IF D_{30} COMPUTED FROM EQUATION 3-3.



K_1 = SIDE SLOPE CORRECTION COEFFICIENT FOR USE IN EQUATION 3-3 ONLY.

PLATE B-39

PLATE B-40

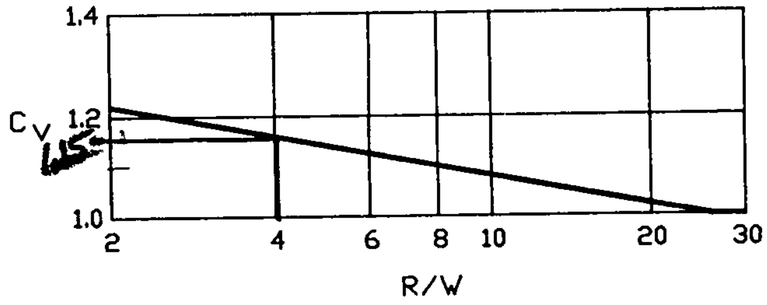


$$N = \frac{\text{THICKNESS}}{T^*}$$

WHERE C_T = CORRECTION FOR THICKNESS

$$= \frac{D_{30} \text{ FOR THICKNESS OF NT*}}{D_{30} \text{ FOR THICKNESS OF T*}}$$

$T^* = 1D_{100}$ OR $1.5D_{50}$, WHICHEVER IS GREATER



$D_{30} = C_V * (D_{30}$ FROM PLATE 37)

WHERE C_V = CORRECTION FOR VERTICAL VELOCITY DISTRIBUTION

CORRECTION FOR VERTICAL VELOCITY DISTRIBUTION IN BEND AND RIPRAP THICKNESS

Table 3-1
Gradations for Riprap Placement in the Dry, Low-Turbulence Zones

D_{100}(max) in.	Limits of Stone Weight, lb[1], for Percent Lighter by Weight						D_{30}(min) ft	D_{90}(min) ft
	100		50		15			
	Max	Min	Max[2]	Min	Max[2]	Min		
Specific Weight = 155 pcf								
12	81	32	24	16	12	5	0.48	0.70
15	159	63	47	32	23	10	0.61	0.88
18	274	110	81	55	41	17	0.73	1.06
21	435	174	129	87	64	27	0.85	1.23
24	649	260	192	130	96	41	0.97	1.40
27	924	370	274	185	137	58	1.10	1.59
30	1,268	507	376	254	188	79	1.22	1.77
33	1,688	675	500	338	250	105	1.34	1.94
36	2,191	877	649	438	325	137	1.46	2.11
42	3,480	1,392	1,031	696	516	217	1.70	2.47
48	5,194	2,078	1,539	1,039	769	325	1.95	2.82
54	7,396	2,958	2,191	1,479	1,096	462	2.19	3.17
Specific Weight = 165 pcf								
12	86	35	26	17	13	5	0.48	0.70
15	169	67	50	34	25	11	0.61	0.88
18	292	117	86	58	43	18	0.73	1.06
21	463	185	137	93	69	29	0.85	1.23
24	691	276	205	138	102	43	0.97	1.40
27	984	394	292	197	146	62	1.10	1.59
30	1,350	540	400	270	200	84	1.22	1.77
33	1,797	719	532	359	266	112	1.34	1.96
36	2,331	933	691	467	346	146	1.46	2.11
42	3,704	1,482	1,098	741	549	232	1.70	2.47
48	5,529	2,212	1,638	1,106	819	346	1.95	2.82
54	7,873	3,149	2,335	1,575	1,168	492	2.19	3.17
Specific Weight = 175 pcf								
12	92	37	27	18	14	5	0.48	0.70
15	179	72	53	36	27	11	0.61	0.88
18	309	124	92	62	46	19	0.73	1.06
21	491	196	146	98	73	31	0.85	1.23
24	733	293	217	147	109	46	0.97	1.40
27	1,044	417	309	209	155	65	1.10	1.59
30	1,432	573	424	286	212	89	1.22	1.77
33	1,906	762	565	381	282	119	1.34	1.94
36	2,474	990	733	495	367	155	1.46	2.11
42	3,929	1,571	1,164	786	582	246	1.70	2.47
48	5,864	2,346	1,738	1,173	869	367	1.95	2.82
54	8,350	3,340	2,474	1,670	1,237	522	2.19	3.17

Notes:
1. Stone weight limit data from ETL 1110-2-120 (HQUSACE, 1971 (14 May), "Additional Guidance for Riprap Channel Protection, Ch 1," US Government Printing Office, Washington, DC). Relationship between diameter and weight is based on the shape of a sphere.
2. The maximum limits at the W_{50} and W_{15} sizes can be increased as in the Lower Mississippi Valley Division Standardized Gradations shown in Appendix F.

APPENDIX C

OPTION 3
SOIL-CEMENT DESIGN CALCULATIONS

1. Calculations
2. HEC-2 - Subcritical Flow Output File
3. HEC-2 - Supercritical Flow Output File

LEEDSHILL - HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT: TIJERAS ARROYO			SHEET NUMBER: 1 OF 8
	COMPUTED BY: RAS	CHECKED BY: PWA	JOB NUMBER: 93043.11	DATE: 12/21/93

OPTION 3: SOIL-CEMENT SLOPE STABILIZATION

(#) = reference identified on Sheet 8 of 8

I DETERMINE FREEBOARD REQUIREMENTS FOR SUBCRITICAL AND SUPERCRITICAL FLOWS.

(SEE APPENDIX D FOR HEC-2 RUNS)

SUB CRITICAL — 100-YEAR EVENT

- DATA TAKEN FROM HEC-2 RUNS WILL BE USED IN THE FOLLOWING CALC's.
- FREEBOARD IS THE SUM OF THE VELOCITY HEAD, (4) & (5) AND 0.5 ANTI-DUNE HEIGTH FOR A GIVEN SECTION
- STANDING WAVE HEIGHT IS ANALIZED AT POINTS OF CONFLUENCE. ANTI-DUNE ACCOUNTS FOR STANDING WAVE IN OPEN CHANNEL. (1)
- FLOWS USED TO ANALIZE THE HYDRAULIC CONDITION OF THE CHANNEL WERE BULKED BY 10%
- MINIMUM FREEBOARD = 3' (5)

SEC #	ELMIN	CWSEL	EGL	VCH	½hA *	REQ'D FREEB.
220.7	5440.0	5446.55	5448.69	10.70	1.56	3.70
222.0	5437.0	5444.42	5446.07	10.53	1.57	3.16
222.3	5435.0	5442.25	5444.69	13.23	2.39	5.03
222.6	5432.0	5440.78	5443.19	13.67	2.55	4.96
224.0	5430.0	5439.30	5441.47	14.18	2.75	4.92

* - ANTIDUNE HEIGTH (2) $h_A = 0.14 (2\pi)\left(\frac{V^2}{g}\right)$

SUPERCRITICAL —

— DATA TAKEN FROM HEC-2 RUN

— FLOWS ARE BULKED 10%

— FREEBOARD METHOD SAME AS IN SUBCRITICAL ANALYSIS

SEC #	ELMIN	CWSEL	EGL	VCH	1/2 HA	REQ'D FREE B.
220.7	5440.00	5446.18	5448.75	11.77	1.89	4.46
222.0	5437.00	5443.45	5445.99	12.88	2.27	4.81
222.3	5435.00	5442.26	5444.89	13.21	2.38	5.01
222.6	5432.00	5440.19	5443.33	15.35	3.22	6.36
224.0	5430.00	5438.86	5441.56	15.66	3.35	6.05

SEE SPREADSHEET FOR CAL'ES

(SHT 5 OF 8)

III DETERMINE SCOUR DEPTHS FOR LOCAL AND CONTRACTION SCOUR

NOTE: SEE SPREAD SHEET FOR CALC'S (SHT 6 OF 8)

EQUATIONS USED:

(2) LOCAL SCOUR – $\frac{y_s}{y_1} = (.73 + 0.14\,\pi\, F_r^2)\cos\theta + 4\,F_r^{0.33}\sin\theta$

WHERE: y_s = DEPTH OF SCOUR

y_1 = HYDRAULIC DEPTH

F_r = FROUDE NO.

θ = ANGLE OF FLOW MASS TO EMBANKMENT

(3) CONTRACTION SCOUR – $\frac{y_s}{y_1} = \left[\frac{Q_{MC2}}{Q_{MC1}}\right]^{6/7}\left[\frac{W_{C1}}{W_{C2}}\right]^{K_1}$

WHERE: y_s = DEPTH OF SCOUR

y_1 = HYDRAULIC DEPTH

Q_{MC2} = FLOW IN MAIN CHANNEL AT POINT 2 (DOWN STREAM)

Q_{MC1} = " " " " " " 1

W_{C2} = BOTTOM WIDTH " " " " 2

W_{C1} = " " " " " 1

K_1 = BED TRANSPORT COEFFICIENT

WHERE K_1 IS BASED ON V_{*c} (SHEAR VELOCITY)

AND $\frac{V_{*c}}{w} = (g y_1 S_1)^{0.5}$

WHERE! g = GRAVITY 32.2 fps

y_1 = HYDRAULIC DEPTH

S_1 = ENERGY SLOPE

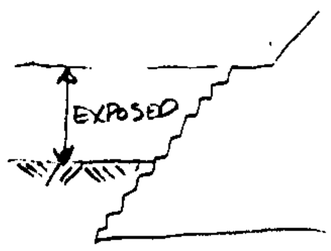
w = FALL VELOCITY OF D_{30} BED MAT'L
(10° WAS USED)

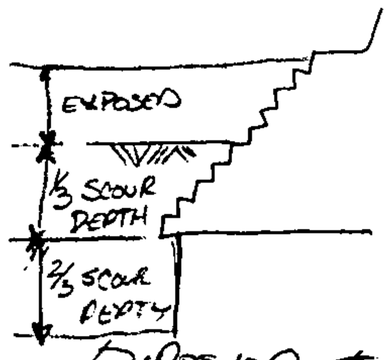
D_{30} = 1.7 MM (4)

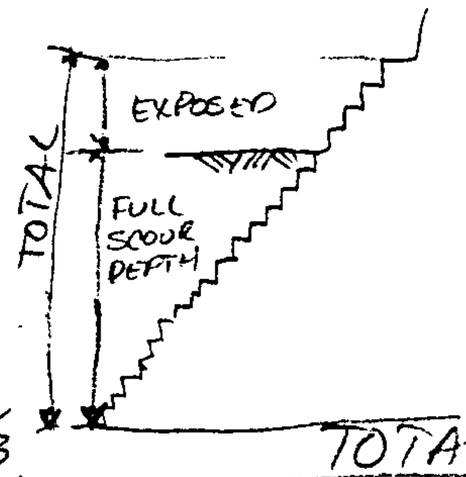
III DETERMINE TOTAL EMBANKMENT HEIGHT

SEE SPREADSHEET FOR DATA MANIPULATION

(SHT 7 OF 8)







SEC #	EXPOSED	EXPOSED + 1/3 SCOUR DEPTH	TOTAL
220.7	10.64	16.45	28.09
222.0	11.74	17.98	30.49
222.3	13.21	20.38	34.75
222.6	14.55	21.77	36.25
224.0	14.91	22.30	37.11

FREEBOARD CALCULATIONS FOR SUBCRITICAL FLOW
ALTERNATIVE 3

SEC NO.	ELMIN	CWSEL	EG	VCH	0.5 Ha	FREEBOARD	
						HEIGTH	ELEV.
220.7	5440.0	5446.6	5448.7	10.7	1.6	3.7	5450.3
222.0	5437.0	5444.4	5446.1	10.5	1.5	3.2	5447.4
222.3	5435.0	5442.3	5444.9	13.2	2.4	5.0	5447.3
222.6	5432.0	5440.8	5443.2	13.7	2.6	5.0	5445.7
224.0	5430.0	5439.3	5441.5	14.2	2.7	4.9	5444.2

FREEBORD.WK1

FREEBOARD CALCULATIONS FOR SUPERCRITICAL FLOW
ALTERNATIVE 3

SEC NO.	ELMIN	CWSEL	EG	VCH	0.5 Ha	FREEBOARD	
						HEIGTH	ELEV.
220.7	5440.0	5446.2	5448.8	11.8	1.9	4.5	**5450.6**
222.0	5437.0	5443.5	5446.0	12.9	2.3	4.8	**5448.3**
222.3	5435.0	5442.3	5444.9	13.2	2.4	5.0	**5447.3**
222.6	5432.0	5440.2	5443.3	15.4	3.2	6.4	**5446.5**
224.0	5430.0	5438.9	5441.6	15.7	3.3	6.0	**5444.9**

ELEVATIONS IN BOLD DENOTE CONTROLING FREEBOARD HEIGTH

SHT 5 OF 8

PRELIMINARY
SCOUR DEPTH CALCULATION
ALTERNATIVE 3

SECTION NUMBER	LOCAL						CONTRACTION				TOTAL SCOUR DEPTH
	FLOW AREA	TOP WIDTH	BOTTOM WIDTH	HYDRAULIC DEPTH	FROUDE NUMBER	SCOUR DEPTH	ENERGY SLOPE	SHEAR VELOCITY	K1	SCOUR DEPTH	
220.7	1996.6	525.3	380.0	3.80	0.95	17.4	0.012560	1.91	0.64	0.0	17.4
222.0	2045.0	520.5	357.5	3.93	1.06	18.6	0.008836	1.32	0.64	0.2	18.8
222.3	2066.7	460.1	236.5	4.49	0.88	20.2	0.005401	1.10	0.64	1.4	21.5
222.6	2071.0	474.3	150.0	4.37	0.98	20.2	0.006677	1.21	0.64	1.5	21.7
224.0	2532.3	558.2	90.0	4.54	0.89	20.4	0.005851	1.16	0.64	1.8	22.2

SHT 6 of 8

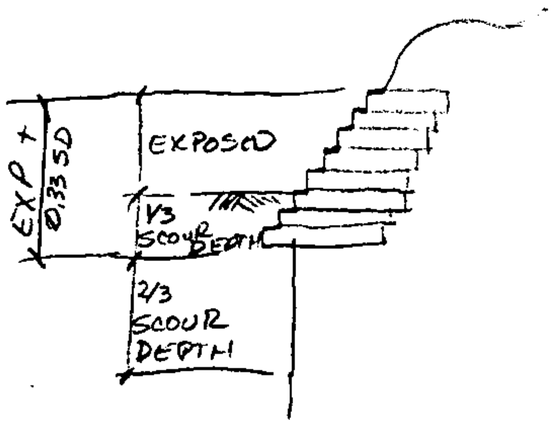
EMBANKMENT HEIGTHS
ALTERNATIVE 3

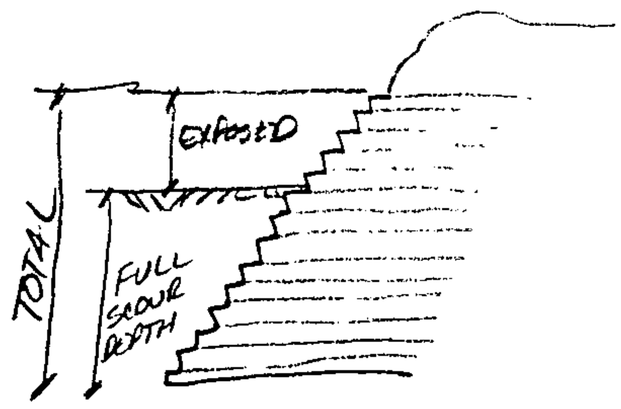
SEC NO.	SCOUR DEPTH	ELMIN	FREEBOARD ELEV.	HEIGTH OF EMBANKMENT		
				EXPOSED	EXP+0.33SD	TOTAL
220.7	17.5	5440.0	5450.6	10.6	16.5	28.1
222.0	18.8	5437.0	5448.3	11.3	17.5	30.0
222.3	21.5	5435.0	5447.3	12.3	19.4	33.8
222.6	21.7	5432.0	5446.5	14.5	21.8	36.2
224.0	22.2	5430.0	5444.9	14.9	22.3	37.1

FREEBORD.WK1

COMPARISON OF SUBCRITICAL
WATER SURFACE ELEVATIONS

SEC NO.	WATER SURFACE ELEVATION			
	BASELINE	ALT-1	ALT-2	ALT-3
220.7	5446.7	5446.5	5446.2	5446.6
222.0	5445.7	5445.0	5443.9	5444.4
222.3	5443.4	5442.5	5442.5	5442.3
222.6	5441.7	5441.3	5441.1	5440.8
224.0	5439.8	5439.3	5438.7	5439.3





LEEDSHILL · HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER 8 OF 8
	COMPUTED BY: RAS	CHECKED BY:	JOB NUMBER	DATE:

REFERENCES

(1) STREAM STABILITY AT HIGHWAY STRUCTURES; FEB, 1991; PUBLICATION # FHWA-IP-90-014 (A.K.A. HEC-20). Pg 35 – 40, SEC 3.2

(2) SEDIMENT & EROSION DESIGN GUIDE; SEPT 93; AMAFCA

(3) EVALUATING SCOUR AT BRIDGES; FEB, 1991; PUBLICATION FHWA-IP-90-017 (AKA HEC-18) Pg 13-9, 13-7, CASE 1a

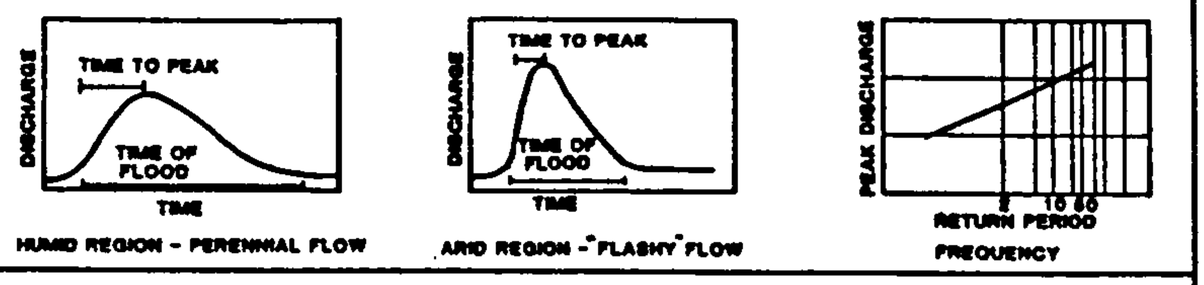
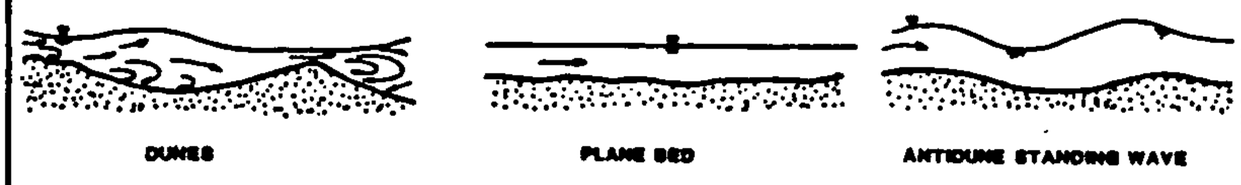
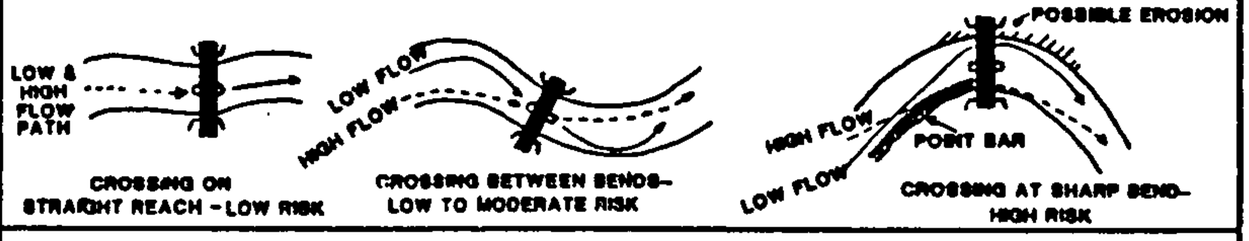
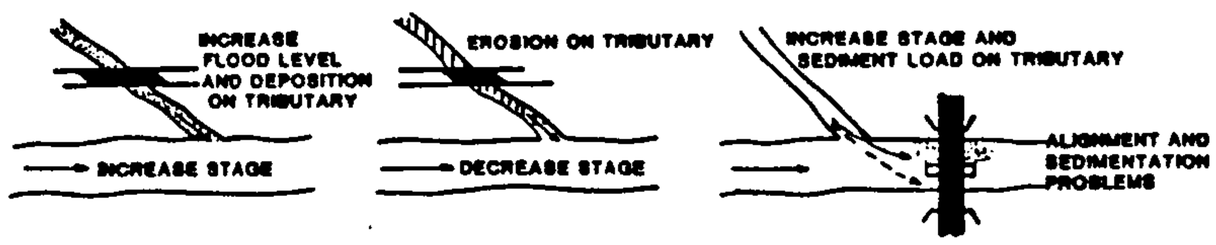
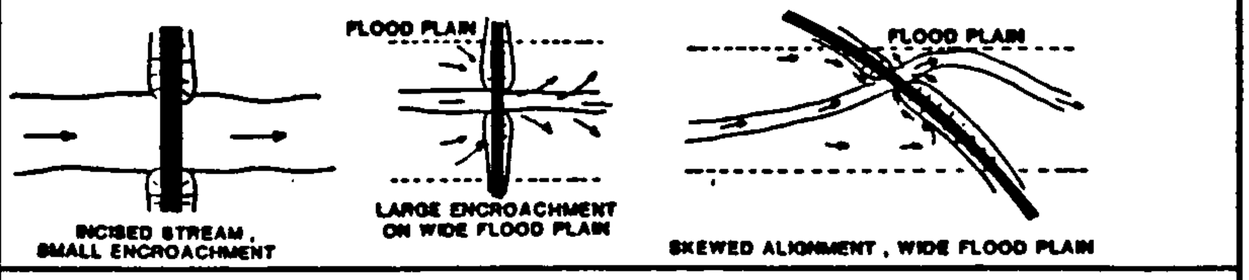
(4) TIJERAS ARROYO DRAINAGE MASTER PLAN PHASE II, MARCH 1987, APPENDIX D

(5) DEVELOPMENT PROCESS MANUAL; JAN, 93; CHAPTER 22 SECTION 2 - HYDRAULICS, CITY OF ALBUQUERQUE

REFERENCE #1 HEC-20 1 OF 3

Pg's 36-38

Figure 12. Hydraulic and location factors that affect stream stability.

MAGNITUDE and FREQUENCY of FLOODS (SECT 3.2.1)	
BED CONFIGURATION IN SAND BED STREAMS (SECT 3.2.2)	
RESISTANCE to FLOW (SECT 3.2.3)	LOWER REGIME n=.014 - .040 TRANSITION n=.010 - .013 UPPER REGIME n=.012 - .020
WATER SURFACE PROFILES (SECT 3.2.4)	
PROBLEMS at BENDS (SECT. 3.3.1)	
PROBLEMS at CONFLUENCES (SECT. 3.3.2)	
BACKWATER EFFECTS of ALIGNMENT and LOCATION (SECT. 3.3.3)	
EFFECTS of HIGHWAY PROFILE (SECT. 3.3.4)	
BRIDGE DESIGN (SECT. 3.4)	SCOUR ABUTMENTS PIERS FOUNDATIONS SUPERSTRUCTURES

Hydrologic analysis establishes the probability of occurrence of a flood of given magnitude in any one year period. It also is the first step in establishing the probability of occurrence of the flood event which will pass through bridge waterways in the highway-stream crossing system without overtopping the highway. The FHWA HEC-19 document (Hydrology)[14] should be referred to for more detailed information and guidelines on hydrologic analysis. The second step is the determination of the stage-discharge relationship, flow and velocity distributions, backwater, scour, etc., (i.e., the hydraulics of the crossing system, as discussed in the remainder of this section).

3.2.2 Bed Configurations in Sand Bed Streams

In sand bed streams, sand material is easily eroded and is continually being moved and shaped by the flow. The interaction between the flow of the water-sediment mixture and the sand bed creates different bed configurations which change the resistance to flow, velocity, water surface elevation and sediment transport. Consequently, an understanding of the different types of bed forms that may occur and a knowledge of the resistance to flow and sediment transport associated with each bed form can help in analyzing flow in an alluvial channel. More specific to this discussion, it is necessary to understand what bed forms will be present so that the resistance to flow can be estimated and flood stages and water surface profiles can be computed.

Flow Regime. Flow in alluvial channels is divided into two regimes separated by a transition zone.[4] Forms of bed roughness in sand channels are shown in Figure 13a, while Figure 13b shows the relationships between water surface and bed configuration. The flow regimes are:

- The lower flow regime, where resistance to flow is large and sediment transport is small. The bed form is either ripples or dunes or some combination of the two. Water-surface undulations are out of phase with the bed surface, and there is a relatively large separation zone downstream from the crest of each ripple or dune. The velocity of the downstream movement of the ripples or dunes depends on their height and the velocity of the grains moving up their backs.

- The transition zone, where the bed configuration may range from that typical of the lower flow regime to that typical of the upper flow regime, depending mainly on antecedent conditions. If the antecedent bed configuration is dunes, the depth or slope can be increased to values more consistent with those of the upper flow regime without changing the bed form; or, conversely, if the antecedent bed is plane, depth and slope can be decreased to values more consistent with those of the lower flow regime without changing the bed form.

REF #1

3 of 3

* Resistance to flow and sediment transport also have the same variability as the bed configuration in the transition. This phenomenon can be explained by the changes in resistance to flow and, consequently, the changes in depth and slope as the bed form changes.

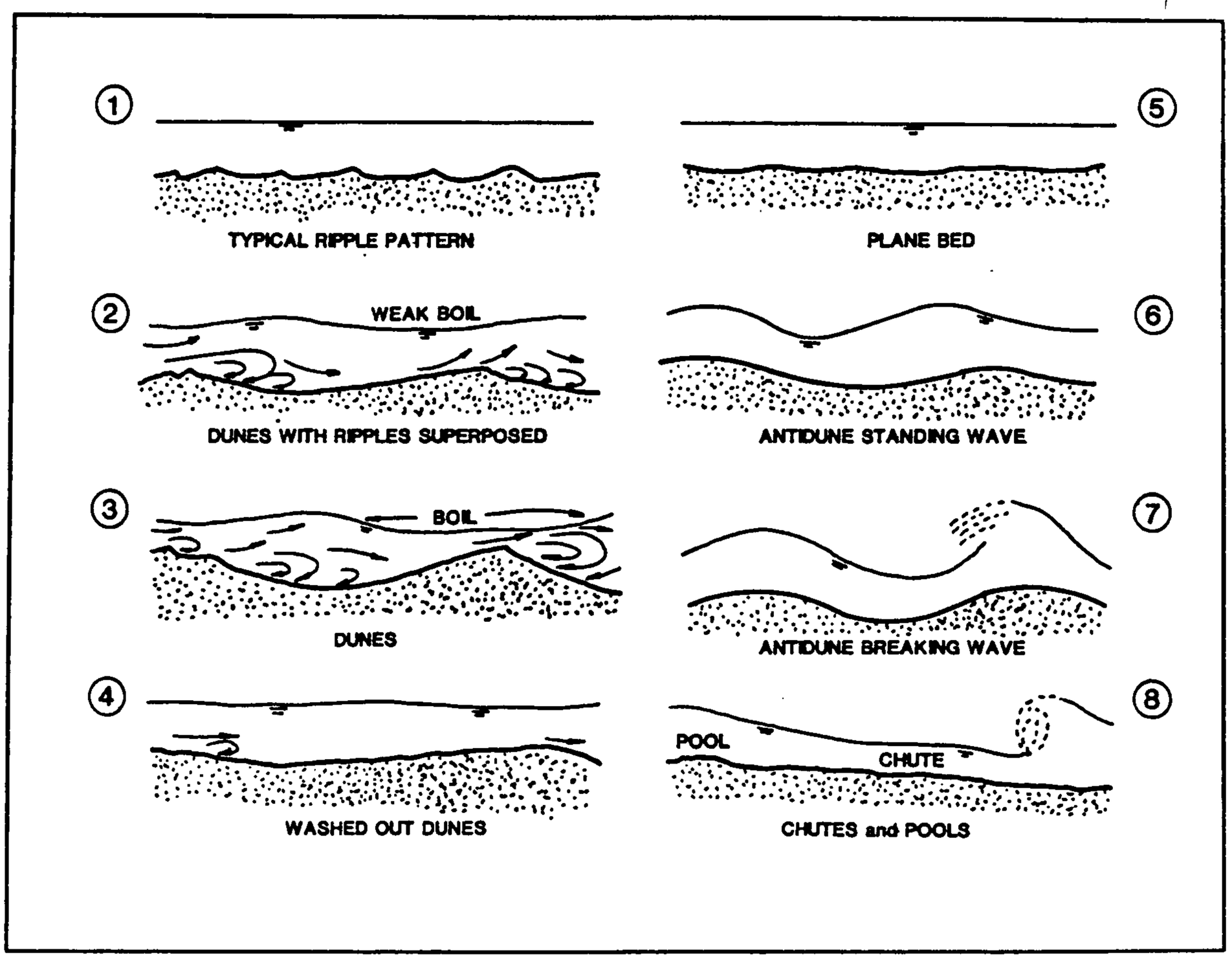


Figure 13(a). Forms of bed roughness in sand channels (After [4]).

* The upper flow regime, in which resistance to flow is small and sediment transport is large. The usual bed forms are plane bed or antidunes. The water surface is in phase with the bed surface except when an antidune breaks, and normally the fluid does not separate from the boundary.

Effects of Bedforms at Stream Crossings. At high flows, most sand bed stream channels shift from a dune bed to a transition or a plane bed configuration. The resistance to flow is then decreased to one-half to one-third of that preceding the shift in bed form. The increase in velocity and corresponding decrease in depth may increase scour around bridge

REFERENCE #2

For a vertical floodwall, this calculation simplifies to a unit width basis and the scour depth is a multiplier of the flow depth (0.73*Y).

It is important to understand that this provides a first approximation of the potential scour along a floodwall due to flow parallel to the wall. Using this relation, the total scour along the wall due to parallel flow can be approximated as the sum of the above relation which results from a differential in shear stress plus scour associated with the passage of antidunes (see Equation 3.65) which results in the following relationship:

$$\frac{Y_s}{Y_o} = 0.73 + 0.07\pi Fr^2$$

$$\hookrightarrow h_a = 0.14(2\pi)\left(\frac{V^2}{g}\right) \qquad (3.80)$$

Applies only to bank protection on both sides with narrow confined channel.

Flow Impinging on the Wall at an Angle

As discussed in the previous section, when an obstruction such as an abutment projects into the flow, the depth of scour at the nose of the obstruction can be estimated from Equation 3.78. Considering the physical configuration of the channels for which the data on which this relation is based, this can reasonably be assumed to be the upper limit of the scour that could be expected for flow along a flood wall when the flow impinges on the wall at an approximately 90° angle. The total scour along a flood wall, thus, will vary as a proportion of that given by Equation 3.78 and Equation 3.79. If it is assumed that the relative significance of the two scour mechanisms is related to the change in momentum associated with the change in flow direction from some angle to the wall to a direction parallel to the wall (see Figure 3.30), the two relations can be combined using a weighting factor based on the sine or cosine of the angle, respectively. The resulting relationship is given by:

$$\frac{Y_s}{Y} = (0.73 + 0.14\pi Fr^2)\cos\theta + 4Fr^{0.33}\sin\theta \qquad (3.81)$$

where θ is the angle between the flow direction and the flood wall.

Case 1a.

Case 1a involves contraction scour of the channel and overbank flow. For this case Laursen's general live bed equation reduces to:

$$\frac{y_2}{y_1} = \left(\frac{Q_{mc2}}{Q_{mc1}}\right)^{6/7} \left(\frac{W_{c1}}{W_{c2}}\right)^{K_1}$$

Where:

Q_{mc1} = Flow in the main channel upstream of the bridge.

Q_{mc2} = Flow through the bridge opening.

W_{c1} = Bottom width of the main channel upstream of the bridge.

W_{c2} = Bottom width of the bridge opening less the total width of the piers.

For this case:

* $Q_{mc1} < Q_{mc2}$ $Q_{MC1} = Q_{MC2}$

  Q_{mc2} = the total flow passing through the bridge opening. This quantity is the sum of the unobstructed main channel flow upstream of the bridge, Q_{mc1}, and the overbank flow, Q_{ob} less any flow passing over the roadway, or through any relief bridges or culverts, or otherwise bypassing the bridge crossing.

* $W_{c1} > W_{c2}$

* $n_1 = n_2$

The simplified Laursen's equation for live bed (Case 1a) can be used to evaluate the effect of piers on contraction scour when there is overbank flow.

NOTES:

REF #3

2 OF 2

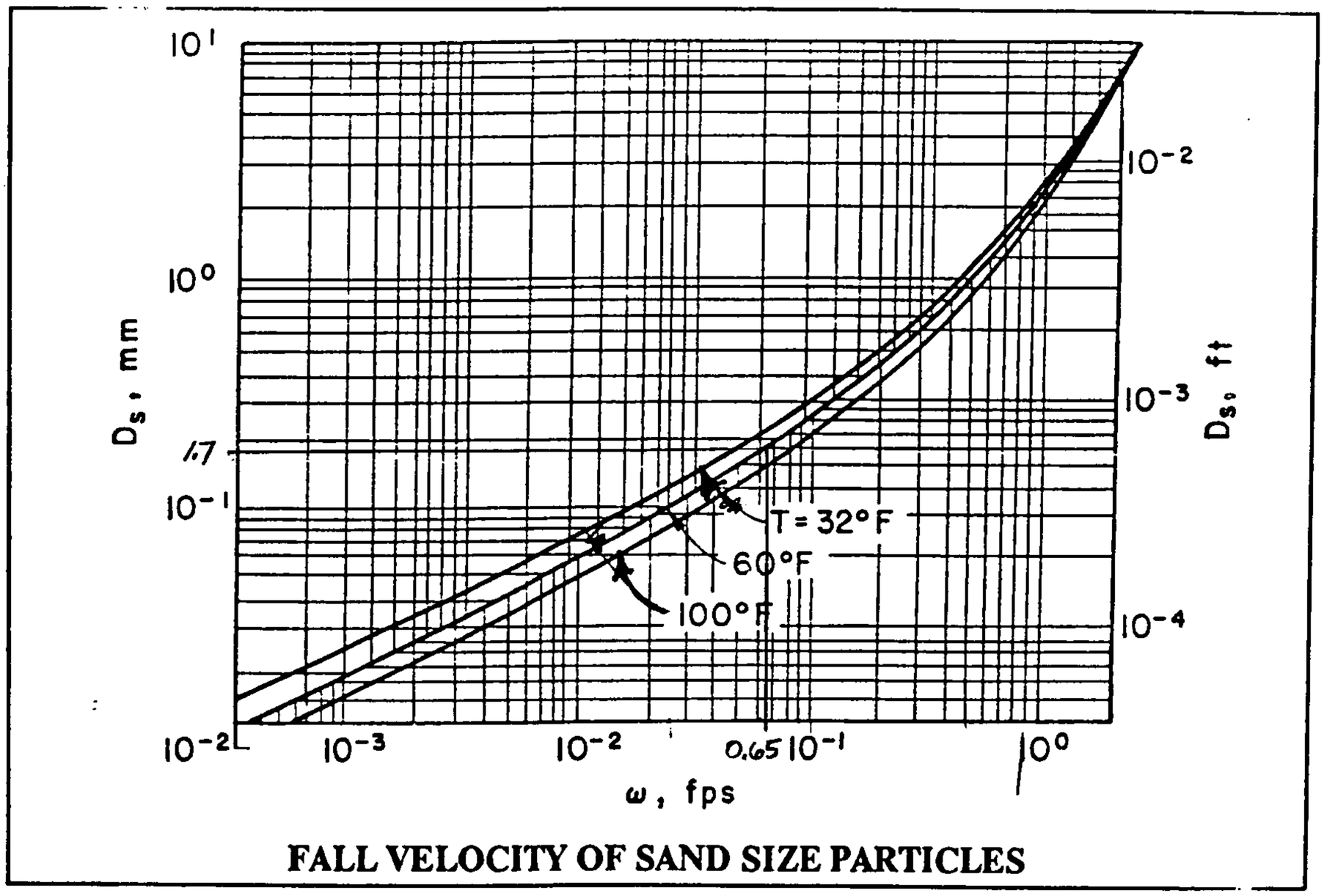
V_{*c}/w	e	K_1	K_2	Mode of Bed Material Transport
<0.5	0.25	0.59	0.066	mostly contact bed material
0.5 to 2.0	1.0	0.64	0.21	some suspended bed material
>2.0	2.25	0.69	0.37	mostly suspended bed material

Where:

$V_{*c} = (g y_1 S_1)^{0.5}$, shear velocity
w = fall velocity of D_{50} of bed material (see figure below)
g = gravity constant, 32.2 ft/sec^2
S_1 = slope, energy grade line main channel

$$K_1 = \frac{6(2+e)}{7(3+e)}$$

$$K_2 = \frac{6e}{7(3+e)}$$



FALL VELOCITY OF SAND SIZE PARTICLES

REFERENCE #4

APPENDIX D

1 of 1

SOIL SAMPLES - IDENTIFICATION & LOCATION

EASTERN STUDY AREA

LOCATION	SOIL SAMPLE ID		D50 (mm)	SOIL CLASSIFICATION AT D50
3/4 mi. downstream of USFS channel	UNM #9	Bed	0.51	Medium Sand
	UNM #10	Bank	0.14	Fine Sand
	UNM #11	Floodplain	0.22	Medium Sand
1/2 mi. downstream of Pennsylvania St. Bridge	UNM #7	Bed	4.0	Gravel
	UNM #8	Bank	0.17	Fine Sand
300' upstream of the east KAFB Boundary	UNM #2	Bed	7.0	Gravel
	UNM #3	Bank	0.23	Medium Sand
	UNM #4	Floodplain	3.0	Gravel
Adjacent to COA Landfill	L-H #4	Bed	1.7	Coarse Sand
	L-H #5	South Bank	.07	Fine Sand
700' downstream of Juan Tabo	L-H #1	Bed	4.0	Gravel
	L-H #2	Floodplain	2.0	Coarse Sand
	L-H #3	North Bank	2.0	Coarse Sand
1300' upstream of Juan Tabo	UNM #5	Bed	8.0	Gravel
	UNM #6	Bank	0.6	Medium Sand
350'downstream Four Hills Rd.	L-H #6	Floodplain	1.3	Coarse Sand
East of Four Hills Rd.	UNM #1	Bed	1.7	Coarse Sand

Note: UNM sample ID denotes those collected by Gerbrandt.
L-H sample ID denotes those collected by Leedshill-Herkenhoff.

REFERENCE #5

F. BERMS AND LEVEES

All levees and berms constructed for drainage or flood control purposes and which are required to contain or convey 50 cfs or more in the event of the 100 year design discharge must conform to the following guidelines:

1. Cross Section

   a. Unarmored faces of berms and levees must have side slopes not steeper than 3:1 (horizontal to vertical).
   b. Rock rip rapped faces of berms and levees must have side slopes not steeper than 2:1 (horizontal to vertical)
   c. Concrete faced berms and levees may have side slopes of 2:1 (horizontal to vertical)
   d. Berms and levees less than 4 feet in height must have a minimum top width of 8.0 feet.
   e. Berms and levees 4.0 feet high and greater must have a minimum top width of 12 feet.
   f. All berms and levees must be provided with a structural keyway with bottom width equal to the top width and depth equal to at least one half the height, but not less than 3.0 feet and side slopes not steeper than 2:1 (horizontal to vertical)

2. Certification

   All levees and berms with heights greater than 5.0 feet shall be inspected during construction and certified by a New Mexico Professional Engineer as to their substantial compliance to the plans and specifications. Certified as-built drawings, accompanied by daily inspection reports, shall also be provided.

3. Any berm or levee whose purpose is to divert or convey runoff in a major arroyo shall be specially designed on a case by case basis and shall meet or exceed the guidelines listed herein.

4. Freeboard

   Berms and levees must be provided with freeboard for the 100-year design flow based on the following guidelines:

   a. For flow depths less than 3.0 feet and not involving a major arroyo; minimum freeboard is 2.0 feet.
   b. For flow depths 3.0 feet and greater and involving a major arroyo; minimum freeboard is 3.0 feet.

5. Bank Protection

   All berms and levees expected to convey or divert 50 cfs or more in the event of the 100-year design discharge must be provided with bank protection according to the following guidelines:

KEEP "S

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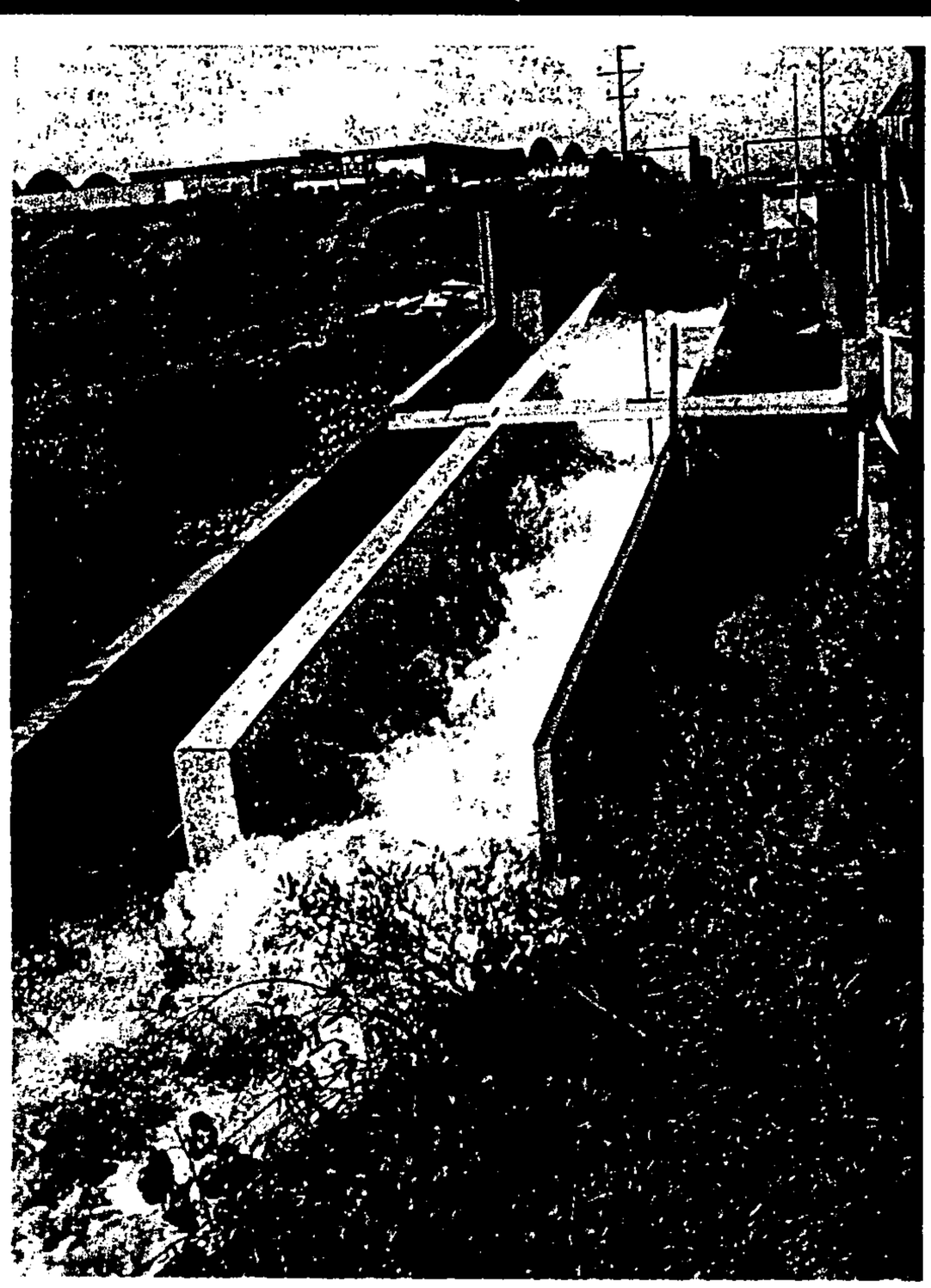
a. Bank protection must be provided wherever design velocities exceed 8 feet/sec.
b. Bank protection must be provided on the outside of curves from the beginning of curvature, through the curve and for a distance equal to 5 times the flow velocity in feet downstream from the point of tangency.
c. When required, bank protection must be provided to two feet above the design flow depth plus additional depth as required (e.g. superelevation, waves at confluences, hydraulic jumps, etc.).
d. Bank protection must extend downward on a projection of the bank slope, to a minimum depth equal to 1.5 times the design flow depth but never less than 3.0 feet. Bank protection for major arroyos shall be accompanied by a City Engineer approved sediment transport analysis.

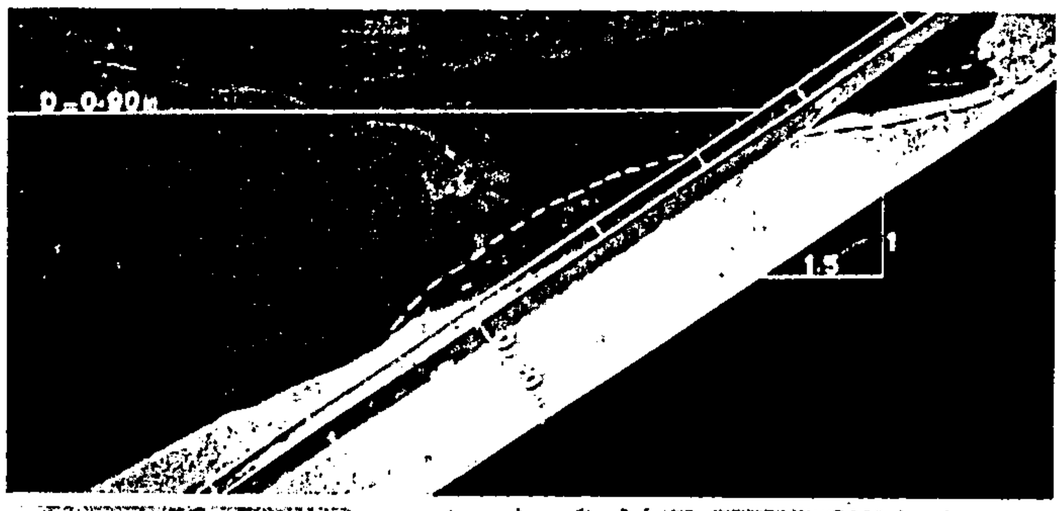
NOTE: BERMS, DAMS, LEVEES, AND DIVERSIONS OF CERTAIN MAGNITUDES AND NATURE MAY FALL WITHIN THE JURISDICTION OF THE STATE ENGINEER OF THE STATE OF NEW MEXICO. THE DESIGN PROFESSIONAL IS EXPECTED TO BE AWARE OF AND COMPLY WITH REGULATIONS PROMULGATED BY THAT JURISDICTION.

Flexible Reno mattress and gabion linings
for channels and canalized water courses

Revêtements souples en matelas Reno et gabions
dans les canaux et les cours d'eau canalisés

Revestimientos flexibles en colchones Reno y gaviones
en los canales y en los cursos de agua canalizados







Laboratory tests and experiments carried out on Reno mattresses and gabions.

Essais en laboratoire et directement effectués sur les matelas Reno et les gabions.

Pruebas de laboratorio y experimentos efectuados sobre colchones Reno y gaviones

MACCAFERRI

linings for channels and canalized water courses

Much can be achieved by lining the banks and bed of a canalized water course, such as:

a) reducing water losses by seepage;
b) improving the stability of the banks;
c) protecting the banks and bed from erosion;
d) providing of a pre-determined roughness, and reducing maintenance costs.

The engineer has a difficult task in choosing from many different types the most reliable method with the required characteristics of permeability or impermeability, strength, flexibility, roughness, durability and economy.

Without doubt flexible linings have a number of advantages which make them preferable in most cases to rigid or semirigid linings.

Gabions and Reno mattress rank among the best flexible linings; the dimensions and unit weights of the various types are shown in table 1 and fig. 3.

des revêtements dans les canaux et dans les cours d'eau canalisés

La réalisation du revêtement des berges et du fond d'un cours d'eau canalisé permet d'obtenir de nombreux résultats comme:

a) la réduction des fuites d'eau vers la campagne et, parfois de l'infiltration dans le sens contraire;
b) l'amélioration de la stabilité des berges;
c) la protection des berges et du fond contre l'érosion;
d) la réalisation de parois ayant une rugosité prédéterminée et la diminution des frais d'entretien.

Mais la tâche du technicien qui doit effectuer un choix entre les nombreux types de revêtements est difficile: à chaque fois qu'un cas se présente, il faut enquêter sur le type de revêtement ayant les caractéristiques requises de perméabilité ou étanchéité, de robustesse, de flexibilité, rugosité, de durée, d'économie, puis, effectuer son choix pour adopter la solution qui offre les meilleures garanties.

Sans aucun doute, les revêtements souples offrent une série d'avantages qui, dans la plupart des cas, les rendent préférables aux revêtements rigides ou semirigides.

Et c'est justement dans cette catégorie que se placent les gabions et les «matelas Reno» au sujet desquels la table 1 et la fig. 3 illustrent les caractéristiques de construction.

los revestimientos en los canales y en los cursos de agua canalizados.

Múltiples son las metas que se pueden alcanzar con la realización de un revestimiento de las orillas y del fondo de un curso de agua canalizado, entre estas:

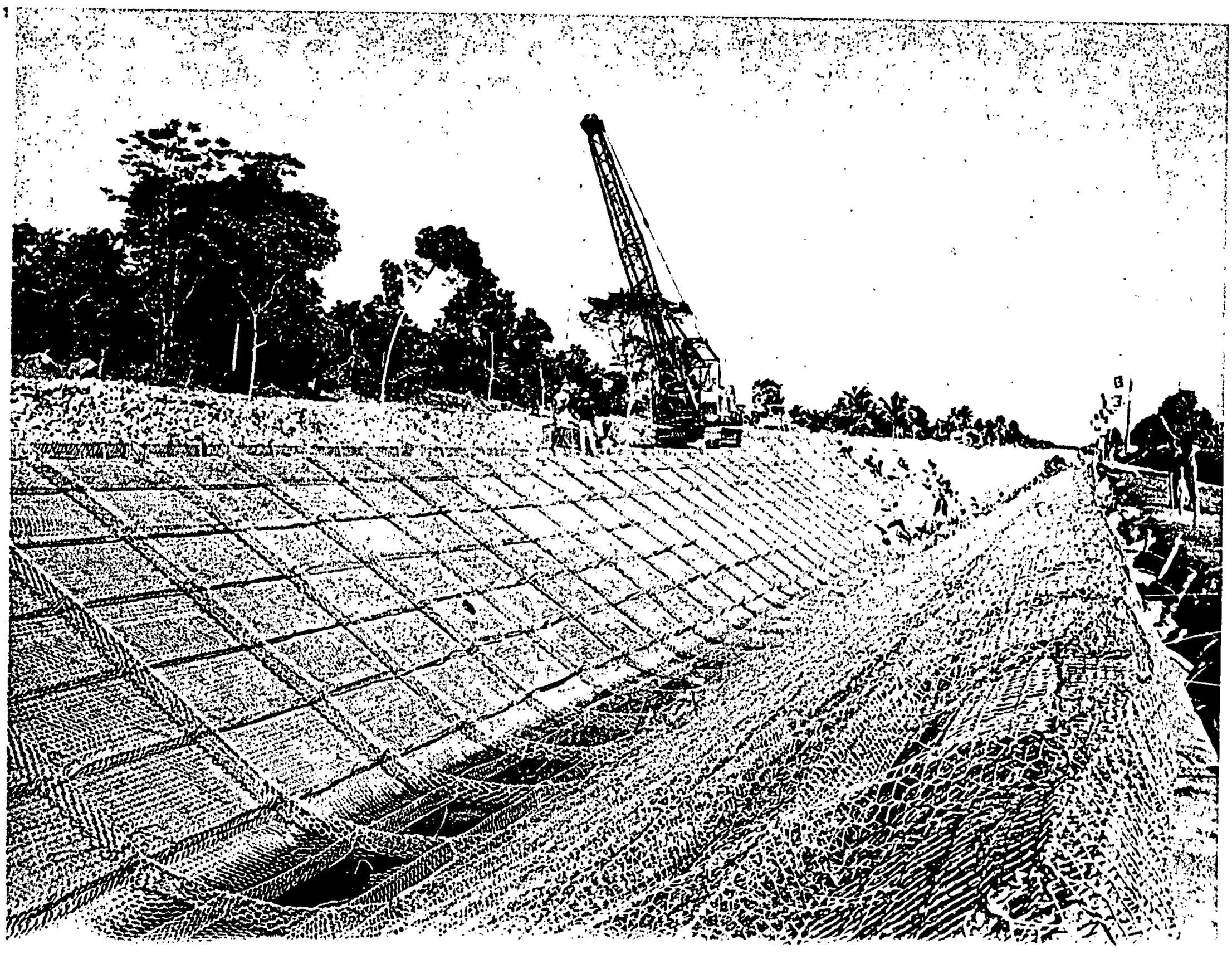
a) la reducción de las fugas de agua del canal hacia el campo, o a veces, la infiltración en el sentido opuesto;
b) la mejora de la estabilidad de los margenes;
c) la defensa de las orillas y del fondo contra la erosión;
d) la realización de paredes con rugosidad prefijada y la reducción de los gastos de mantenimiento.

Es difícil, a veces, para el técnico elegir entre los numerosos tipos de revestimientos: a menudo es necesario comparar los revestimientos que poseen las características requeridas de permeabilidad o impermeabilidad, de robustez, de flexibilidad, de rugosidad, de durabilidad, de economicidad, y entre ellos, adoptar el tipo que dé la máxima seguridad.

Las grandes ventajas de los revestimiento flexibles los hacen preferibles, en muchos casos, a los rígidos y semirígidos.

Los gaviones y los colchones Reno ocupan un puesto muy importante entre los revestimientos flexibles; en la tabla 1 y en la figura 3 se describen sus características constructivas.

1



Reno mattress - Zinc coated
Matelas Reno galvanisés
Colchones Reno galvanizados

Mesh type Maille type Malla tipo	Wire Fil Alambre ø mm	Thickness Epaisseur Espesor m
6 x 8	2.00 2.20	0.17 0.23 0.30
5 x 7	2.00	0.15 0.20 0.25

Reno mattress - Zinc coated with PVC sleeve
Matelas Reno galvanisés et plastifiés
Colchones Reno galvanizados y plastificados

Mesh type Maille type Malla tipo	Wire / Fil / Alambre		Thickness Epaisseur Espesor m
	Inner Intérieur Interior ø mm	Outer Extérieur Exterior ø mm	
6 x 8	2.00 2.20	3.00 3.20	0.17 0.23 0.30

Width / Largeur / Ancho: 2.00 - 3.00 m — Length / Longueur / Largo: 3.00 - 4.00 - 5.00 - 6.00 m

Gabions - Zinc coated
Gabions galvanisés
Gaviones galvanizados

Mesh type Maille type Malla tipo	Wire Fil Alambre ø mm	Thickness Epaisseur Espesor m
10 x 12	2.70 3.00	0.50
8 x 10	2.70 3.00	
6 x 8	2.20 2.70	1.00
5 x 7	2.00 2.40	

Gabions - Zinc coated with PVC sleeve
Gabions galvanisés et plastifiés
Gaviones galvanizados y plastificados

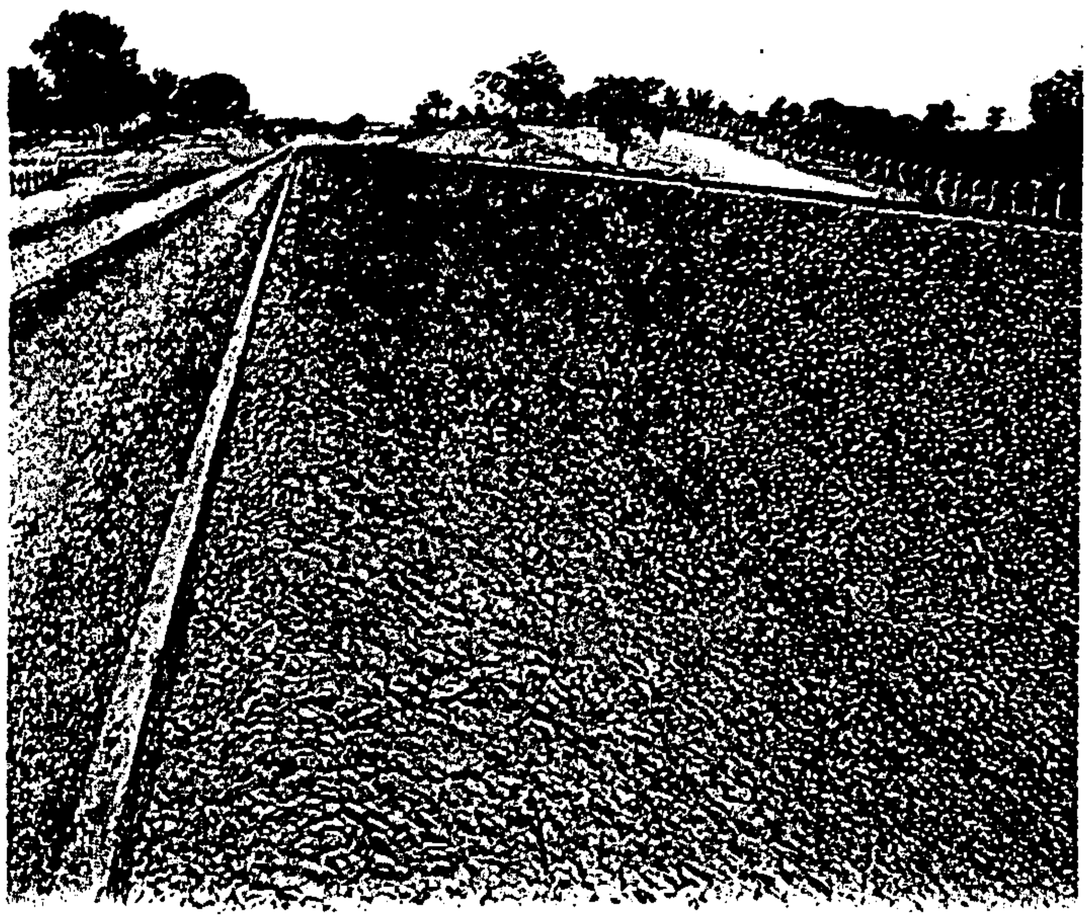
Mesh type Maille type Malla tipo	Wire / Fil / Alambre		Thickness Epaisseur Espesor m
	Inner Intérieur Interior ø mm	Outer Extérieur Exterior ø mm	
10 x 12	2.40 2.70	3.40 3.70	0.50
8 x 10	2.40 2.70	3.40 3.70	1.00

Width: 1.0 - 2.0 m — Length: 2.0 - 3.0 - 4.0 m for gabions 1.0 m wide; 3.0 - 4.0 - 5.0 m for gabions 2.0 m wide.
Largeur: 1.00 - 2.00 m — Longueur: 2.00 - 3.00 - 4.00 m pour gabions larges 1.00 m; 3.00 - 4.00 - 5.00 m pour gabions larges 2.00 m.
Ancho: 1.00 - 2.00 m — Largo: 2.00 - 3.00 - 4.00 para gaviones anchos 1.00 m; 3.00 - 4.00 - 5.00 m para gaviones anchos 2.00 m.

Reno mattress and gabions are manufactured with double-twisted hexagonal mesh made with annealed mild steel wire, zinc coated according to Circ. Cons. Sup. LL. PP. No. 2078 dd. 27.8.1962, to BS 443-1982 and to U.S. Federal Specification QQ-W-461 H finish 5-class 3.
PVC-coated mattress are made with wire coated by extrusion with a special, highly corrosion resistant PVC.
The types indicated in the table are standards; for more detailed information, see general catalogue.

Les matelas Reno et les gabions sont en maille hexagonale à double torsion et en fil d'acier doux avec une galvanisation conforme aux normes de la circulaire du Cons. Sup. LL. PP. n. 2078 du 27/8/1962. De la British standard 443/1982 et de U.S. - Federal Specification QQ-W-461. H. Finish 5-class 3. Le fil plastifié est revêtu par extrusion avec un matériel spécial en P.V.C. ayant haute résistance à la corrosion. Les types indiqués à la table sont ceux standards. Pour informations plus détaillées voir catalogue général.

Los colchones Reno y los gaviones son de malla exagonal a doble torsión, en alambre de acero dulce, galvanización conforme con las normas indicadas en la Circ. del Cons. Sup. LL. PP. n. 2078 del 27/8/1962, en las British Standard 443-1982 y en las US Federal Specification QQ-W-461 H finish 5-class 3. El alambre plastificado es revestido por extrusión con un material especial PVC de elevada resistencia a la corrosión. Los tipos indicados en las tablas son estandard: para informaciones más detalladas ver el catálogo general.



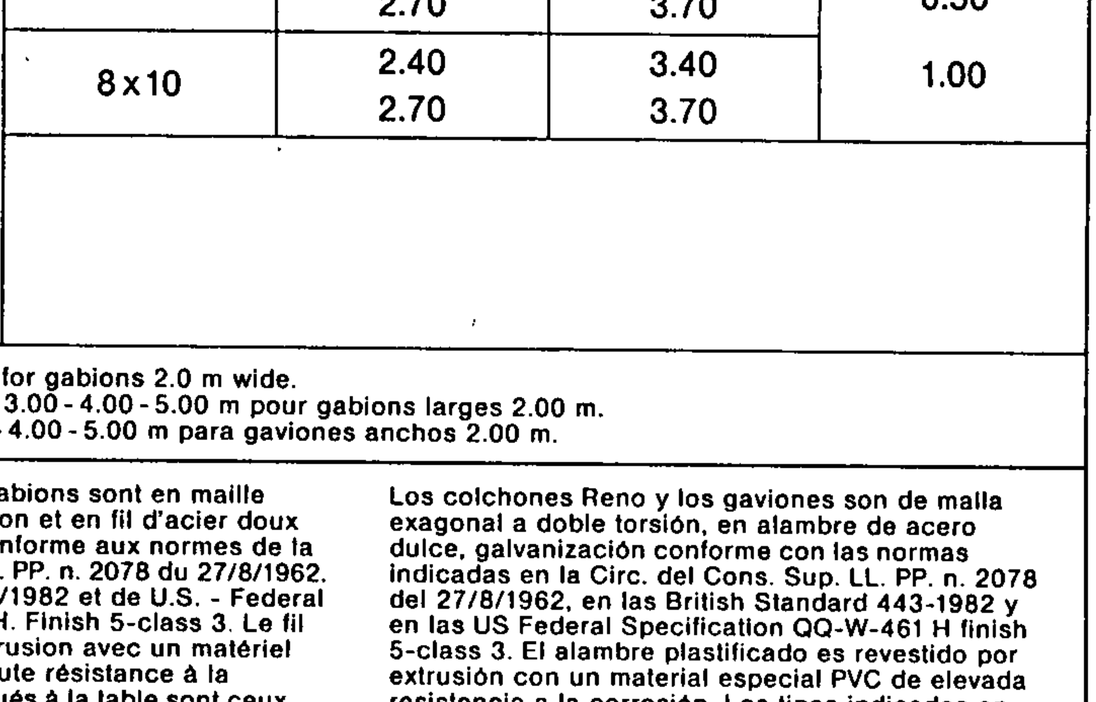


Fig. 1 and 2 - BRAZIL - Bahia - Reno mattress lining to the Pedra do Cavalo canal, during construction and on completion.

Figg. 1 et 2 - BRÉSIL - Bahia - Revêtement en matelas Reno du Canal Pedra do Cavalo; phase de pose et mise en œuvre terminée.

Figg. 1 y 2 - BRASIL - Bahia - Revestimiento en colchones Reno del canal Pedra do Cavalo durante la fase de colocación en obra y la obra terminada.

Fig. 3 - Weights and dimensions of Reno mattress.

Fig. 3 - Caractéristiques de construction du matelas

The assembly and filling operations for Reno mattress can be summarized as follows:

a) preparing the individual units before laying;
b) laying the units and wiring them together;
c) filling the units with stone;
d) closing up the units by wiring down the lids.

Reno

Les opérations de ligature et de remplissage des matelas Reno peuvent être ainsi résumées:

a) montage des éléments du grillage hors des lieux;
b) mise en place et assemblage des éléments;
c) remplissage des éléments avec des galets ou des enrochements;
d) fermeture des éléments en ligaturant les couvercles.

Reno

Las varias etapas de costura y de relleno de los colchones Reno se pueden brevemente resumir como sigue:

a) preparación fuera de obra de cada uno de los colchones;
b) colocación y unión de los colchones entre sí;
c) relleno de los elementos con guijarros y/o pedrisco;
d) colocación y amarre de las tapas.

Fig. 4 and 5 - Assembling a Reno mattress unit and wiring units together.

Fig. 6, 7, 8 and 9 - Filling mattress units using different types of equipment.

Figg. 4 et 5 - Mise en œuvre d'un matelas Reno et ligature de plusieurs éléments.

Figg. 6, 7, 8 et 9 - Remplissage des éléments à l'aide de différents équipements.

Figg. 4 y 5 - Preparación de un colchón Reno y unión de elementos entre sí.

Figg. 6, 7, 8 y 9 - Relleno de los elementos con equipos especiales.

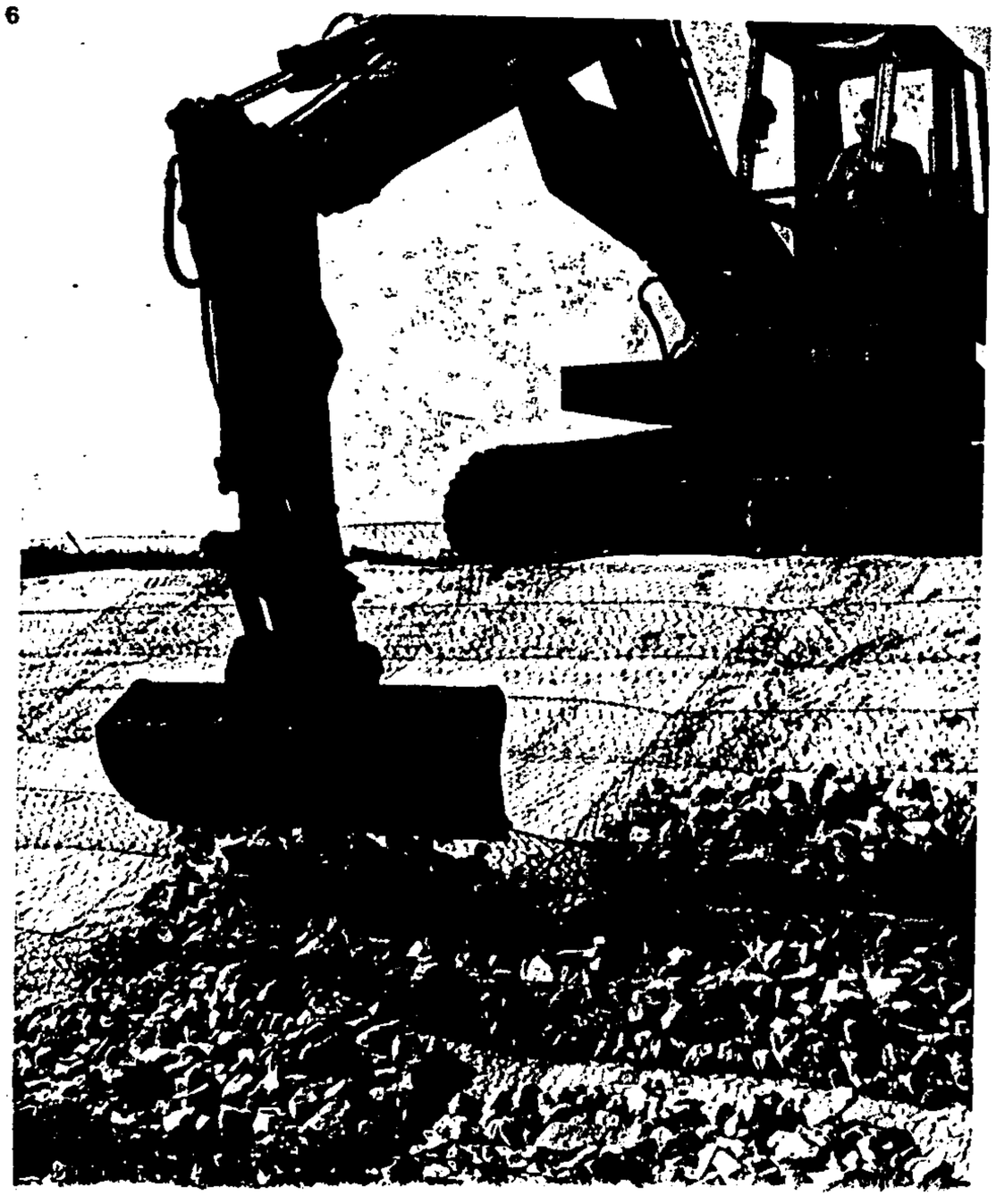
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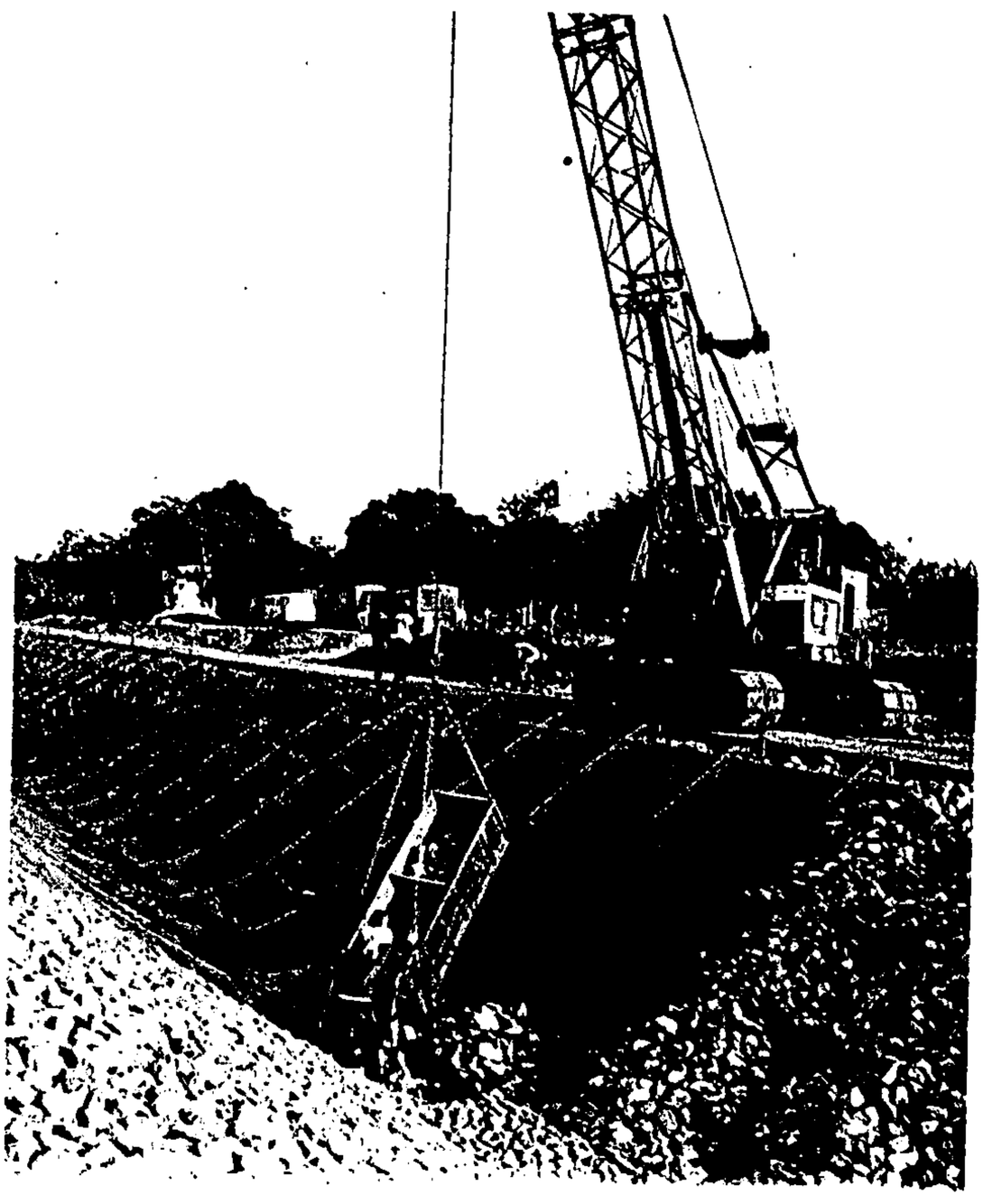
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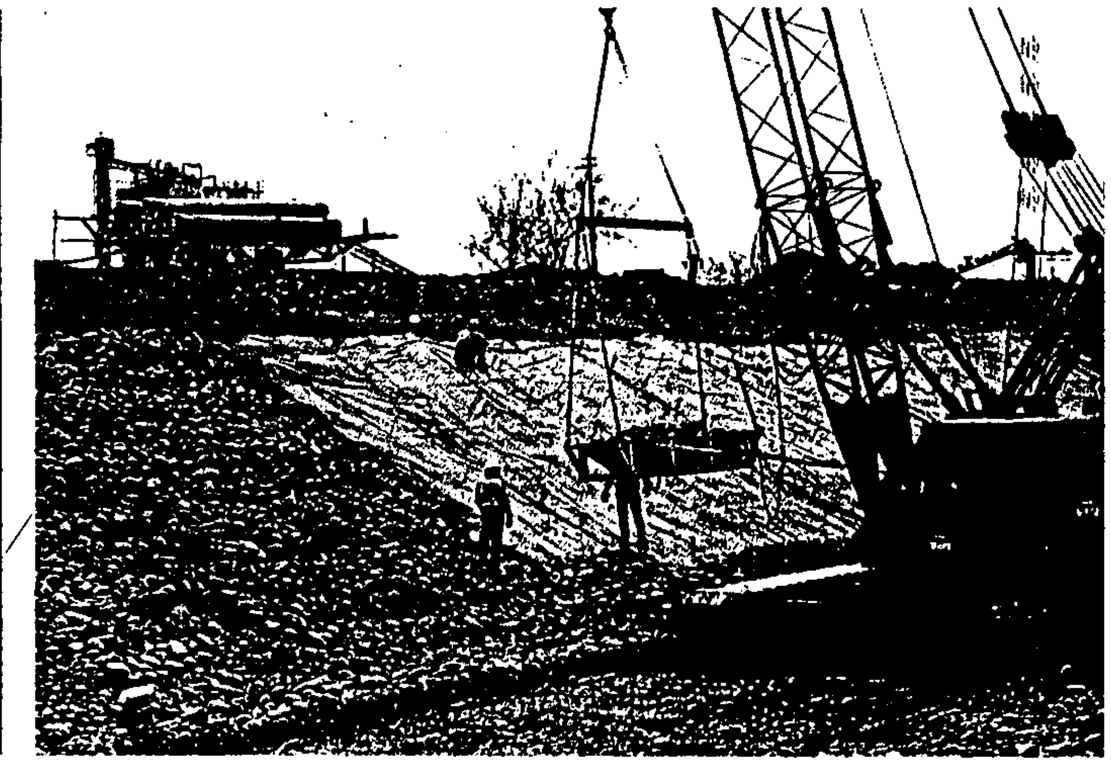




Fig. 10 - Closing the mattress with individual lids (fig. 3) and with rolls of mesh.

Fig. 10 - Fermeture des éléments à l'aide de leurs couvercles (fig. 3) et à l'aide de grillage.

Fig. 10 - Cierre de los elementos con tapas separadas (fig. 3) y con rollos de red.

Types of lining

The use and possible applications of Reno mattress and gabions for protecting and lining canals and canalized water courses, for the sake of simplicity, are divided into the following types of work:

a) linings laid in the dry;
b) linings laid under water;
c) linings consolidated and/or made impermeable with sand asphalt mastic;
d) linings consolidated and/or made impermeable with sand asphalt mastic, prepared on pontoons and laid using special equipment.

a) Linings laid in dry conditions

Reno mattress and gabions are laid directly into the ground to be protected; so the slope must be stable itself, and must not be so steep to cause the revetment to slide.
However, unlike rigid linings, Reno mattress and gabion linings can adapt to considerable movements of the bank.
Lining with Reno mattress is one of the

Catégories de revêtements

En ce qui concerne l'emploi des matelas Reno et des gabions pour la protection et le revêtement des canaux et des cours d'eau canalisés, et les diverses applications possibles, nous avons considéré, pour simplifier, les catégories de travail suivantes:

a) revêtements réalisés à sec;
b) revêtements réalisés en présence d'eau;
c) revêtements consolidés et/ou imperméabilisés au mastic de bitume;
d) revêtements consolidés et/ou imperméabilisés au mastic de bitume et exécutés sur ponton, puis mis à l'eau en utilisant des equipements particuliers.

a) Revêtements effectués à sec

Les revêtements en matelas Reno et en gabions se posent directement sur le terrain qu'ils doivent protéger; par conséquent, le terrain doit être suffisamment stable et ne doit pas être trop incliné afin d'éliminer tout risque de glissement de l'ouvrage.
Ces deux conditions ne sont cependant pas

Categorías de revestimientos

Con respecto al empleo de los colchones Reno y de los gaviones para la defensa y el revestimiento de los canales y cursos de agua canalizados y sus posibles aplicaciones, por simplicidad se consideran las siguientes categorias de obras:

a) revestimientos realizados en seco;
b) revestimientos realizados en presencia de agua;
c) revestimientos consolidados y/o impermeabilizados con almáciga bituminosa hidráulica ejecutados en seco;
d) revestimientos consolidados y/o impermeabilizados con almáciga bitumosa hidráulica preparados sobre pontones y varados con equipos especiales.

a) Revestimientos ejecutados en seco

Los revestimientos en colchones Reno y en gaviones se apoyan directamente sobre el terreno que tendrán que proteger; es necesario por lo tanto que el terreno sea suficientemente estable y su inclinación adecuada para prevenir el deslizamiento de la obra.
Ambas condiciones no son estrictamente

this procedure: at times it may be appropriate to lay the units longitudinally in relation to the water flow, as for example for linings on the bed, and in the case of fast flowing rivers, also for the banks.
Ease of laying or other technical reasons determine which of the two systems above should be chosen.
The banks are usually built with a 1 in 1.5 and 1 in 2 slope depending on the nature of the ground, adopting the maximum slope for normal soils of medium consistency, and the minimum for non-cohesive fine sands.
The stability of Reno mattress revetments depends on the thickness of the lining, and the grading of the gravel fill, as well as on the strength of the mesh.
Assuming that the stress to which the revetment is subjected is proportional to the "average velocity", parameters may be chosen by reference to table 2 which is valid for bed protection and gives good

en mesure de s'adapter aux mouvements de la berge.
Du point de vue économique, le matelas Reno est l'un des revêtements les plus avantageux; il se pose généralement sur la berge, transversalement par rapport au cours d'eau et donc, suivant l'inclinaison maximum de la berge.
Cette disposition n'est cependant pas obligatoire. En effet, parfois il convient de disposer les éléments longitudinalement dans la direction du courant, c'est, par exemple, le cas des revêtements pour le fond des cours d'eau et celui du revêtement des berges quand le courant est très fort.
Pour choisir l'un des deux systèmes, on peut également envisager le problème de la facilité de mise en place ou d'autres problèmes de construction de nature diverse.
Normalement, les pentes à revêtir se réalisent avec une inclinaison de 1:2 et 1:1,5 en fonction de la nature du terrain; on adopte l'inclinaison maximum dans le cas de terrains végétaux de consistance moyenne, et l'inclinaison minimum dans le cas de terrains sablonneux et finement inconsistants.
La résistance des revêtements en matelas Reno qui dépend de la solidité du grillage dépend aussi de l'épaisseur de la structure

revestimiento en colchones Reno y en gaviones puede adaptarse a notables movimientos de la orilla.
Desde el punto de vista económico, el colchón Reno es, entre los diferentes tipos de revestimiento, uno de los más convenientes. En los taludes es colocado generalmente en sentido transversal al curso de agua, o sea según la máxima inclinación de las orillas y perpendicularmente al sentido de la corriente. Esta disposición sin embargo no es obligatoria; a veces, es más conveniente colocar los elementos longitudinalmente a la corriente sobre el fondo y, en el caso de cursos de agua con fuerte velocidad sobre toda la sección.
La mayor facilidad de colocación u otros juicios constructivos pueden influir también en la elección entre ambos sistemas.
Normalmente, los taludes de apoyo son perfilados con pendiente de 1:1,5 y 1:2 según el tipo de terreno; la pendiente máxima en el caso de terrenos vegetales de mediana consistencia y la mínima en el caso de aquellos arenosos finos incoherentes.
La resistencia de los revestimientos en colchones Reno depende, además de la robustez de la red metálica, del espesor de la estructura y del tamaño del pedrisco de relleno.

Fig. 11 - ITALY - Sicily - Reno mattress revetment to a double trapezoidal section on a stretch of the river Flascio.

Fig. 12 - IRAQ - Protection of the banks of Tajat Island on the river Tigris with PVC Reno mattress.

Fig. 13 - ITALY - Puglia - Canalization, using PVC Reno mattress, of the river Cervaro near its mouth.

Fig. 14 - FRANCE - R. Largue - 0.5 m deep gabion lining.

Fig. 11 - ITALIE - Sicile - Revêtement en matelas Reno d'une section à double trapèze du Flascio.

Fig. 12 - IRAQ - Protection des berges de l'île Tajiat du Tigri à l'aide de matelas Reno galvanisés et plastifiés.

Fig. 13 - ITALIE - Pouilles - Canalisation en matelas Reno galvanisés et plastifiés du Cervaro, près de son embouchure.

Fig. 14 - FRANCE - Revêtement en gabions de 0,50 m - Rivière du Largue.

Fig. 11 - ITALIA - Sicilia - Revestimiento en colchones Reno de una sección trapecial compuesta de un tramo del río Flascio.

Fig. 12 - IRAQ - Protección de las orillas de la isla Tajiat en el río Tigris realizada en colchones Reno galvanizados y plastificados.

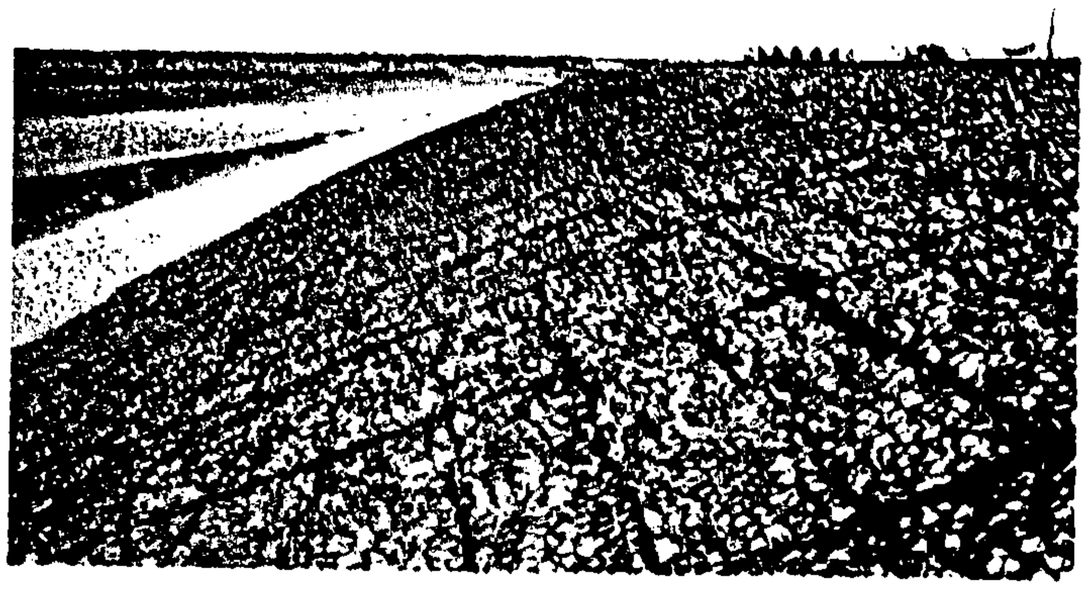
Fig. 13 - ITALIA - Puglia - Canalización en colchones Reno galvanizados y plastificados del Río Cervaro cerca de la desembocadura.

Fig. 14 - FRANCIA - Revestimiento del Rivière du Largue realizado en gaviones altos 0,50 m.

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approximations for bank protection also.
In this figure, "critical velocity" means that velocity at which the revetment will remain stable without movement of the gravel fill. "Limit velocity" is that velocity which is still acceptable even though there is some deformation to the Reno mattress due to fill movement. The values in table 2 are derived from model tests conducted in 1982/83 (Hydraulics Laboratory Engineering Research Center, Colorado State University - Fort Collins - U.S.A.) which are described later. This research has also quantified the advantages that derive from containment of the fill material by mesh when compared with loose rip rap protection.
It has been shown that Reno mattress linings have double the stability of rip rap of the same stone grading against bed tractions. Furthermore, it was verified that, for a given velocity of flow, the Reno mattress needs only be 1/3 to 1/4 as thick as a rip rap lining.

et de la taille de la pierre de remplissage.
Etant donné que les sollicitations auxquelles sera soumis le revêtement dépendent aussi de la vitesse moyenne du courant, la fixation des paramètres sera facilitée par l'examen des données du fond et, approximativement, du revêtement des berges.
La vitesse critique, élément de cette table, est égale à la vitesse que le revêtement peut supporter en toute sécurité sans mouvement de la pierre à l'intérieur du matelas Reno; la vitesse limite correspond à la vitesse acceptable mais entraînant de légères déformations du matelas Reno dues au tassement de la pierre.
Les données de la table 2 découlent des essais sur maquette datant de 1982-1983 et exécutés par Hydraulics Laboratory Engineering Research Center Colorado State University - Fort Collins - U.S.A.
Ces essais seront décrits par la suite.
L'étude que nous venons de citer a entre autre permis de quantifier les avantages de l'action de rétention du matériau de remplissage exercée par le grillage, par rapport aux revêtements en enrochements.
Il a été démontré que le revêtement en matelas Reno est stable en présence de charriage de fond dont les tensions sont

tomando como representativa de las solicitaciones a las cuales será sometido el revestimiento la «velocidad media» de la corriente, la elección de estos parámetros está facilitada por los valores que aparecen en la tabla 2, válida para los revestimientos de fondo pero con buena aproximación también para aquellos de las orillas.
En esta tabla por «velocidad crítica» se entiende la que puede soportar el revestimiento con seguridad sin movimientos de piedras en el interior del colchón Reno; por «velocidad límite» se entiende la que puede ser aceptada admitiendo modestas deformaciones del colchón Reno causadas por el movimiento de la piedra.
Los valores de la tabla 2 derivan de pruebas efectuadas sobre modelo en 1982/1983 (Hydraulics Laboratory Engineering Research Center Colorado State University - Fort Collins - USA) que serán descriptas más adelante.
Esta búsqueda ha cuantificado además, las ventajas que derivan de la acción de contención ejercitada por la red metálica sobre el material de relleno con respecto a los revestimientos en material suelto (rip-rap). Se ha demostrado que el revestimiento en colchones Reno es estable para fuerzas

Tab. 2 - Indicative Reno Mattress and gabion thicknesses in relation to water velocities

Tab. 2 - Epaisseurs approximatives des revêtements en matelas Reno et en gabions en fonction de la vitesse du courant

Tab. 2 - Espesores indicativos de los revestimientos en colchones Reno y en gaviones en función de la velocidad de la corriente

Type Type Tipo	Thickness Epaisseur Espesor m	Filling stones Pierraille de remplissage Pedrisco de relleno		Critical velocity Vitesse critique Velocidad crítica m/s	Limit velocity Vitesse limite Velocidad limite m/s
		Stone size Granulométrie Dimensiones mm	d_{50}		
Reno mattress Matelas Reno Colchones Reno	0.15 - 0.17	70 - 100	0.085	3.5	4.2
		70 - 150	0.110	4.2	4.5
	0.23 - 0.25	70 - 100	0.085	3.6	5.5
		70 - 150	0.120	4.5	6.1
	0.30	70 - 120	0.100	4.2	5.5
		100 - 150	0.125	5.0	6.4
Gabions Gabions Gaviones	0.50	100 - 200	0.150	5.8	7.6
		120 - 250	0.190	6.4	8.0

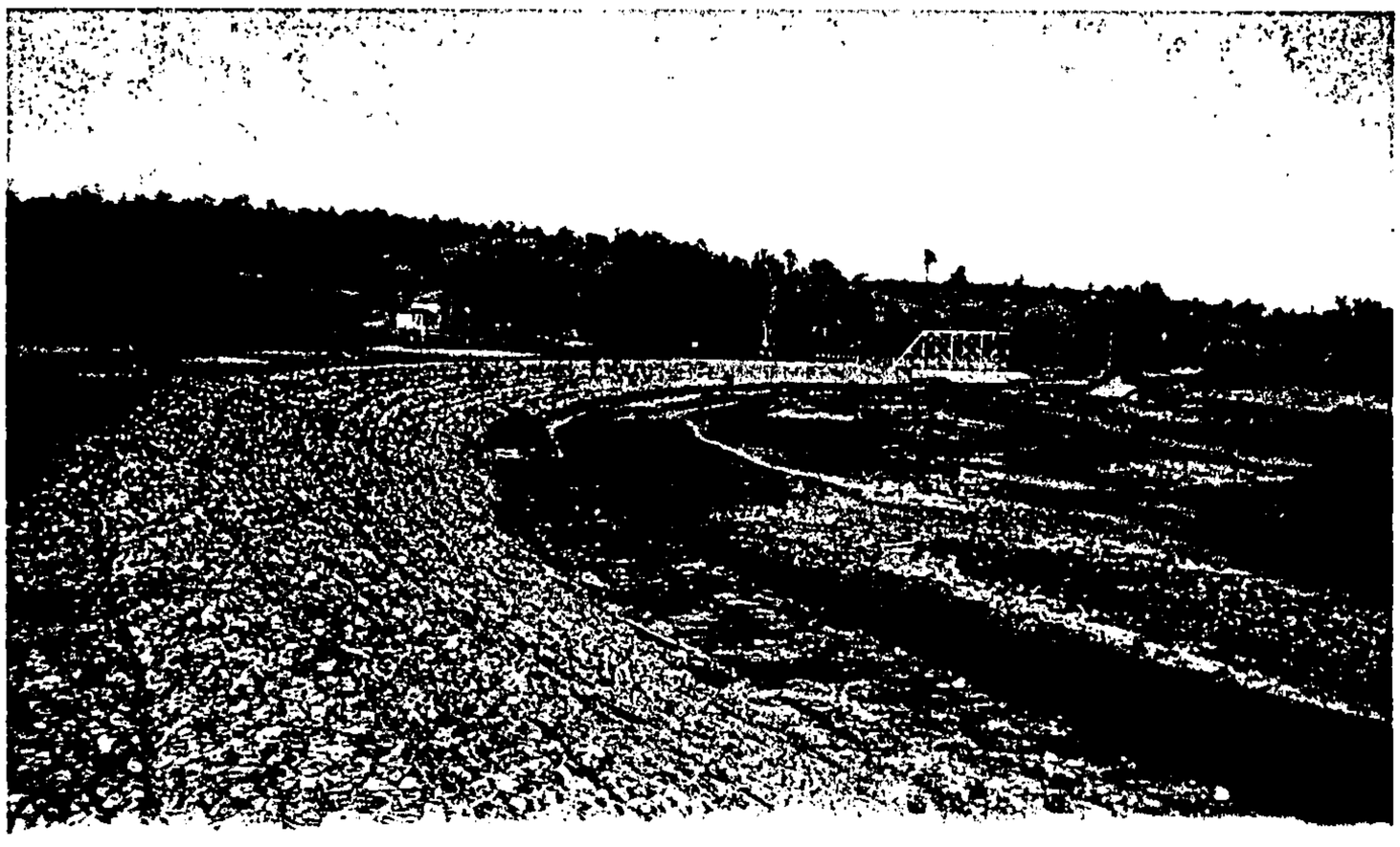


Fig. 15 - U.S.A. - New York - Bank protection near Buffalo.

Fig. 15 - U.S.A. - New York - Revêtement de berges réalisé en proximité de la ville de Buffalo.

Fig. 15 - U.S.A. - New York - Defensa de un dique en las cercanias de Buffalo.

be intuitively comprehended when we consider that the resistance of the rip rap depends on the stability of individual stones, while the mesh of the Reno mattress enables it to act as a coherent whole. The big reduction in the revetment thickness, which is achieved using Reno mattress instead of rip rap, is of economic significance in the protections of large rivers given the area of the work and, therefore, the quantity of material required.
With banks affected by landslips, it may be better to use a stronger and heavier lining with box gabions, 0.50 to 1.00 m thick.If, however, the sliding movement is of a deeper nature and it is necessary to consolidate the bank, this may be done by using stepped Reno mattress and box gabions.
When particularly corrosive industrial or salt waters are present, it is preferable to use P.V.C. coated gabions or Reno mattress.

doubles par rapport aux tensions acceptables pour un revêtement en enrochement de mêmes dimensions.
Il a aussi été démontré qu'à vitesse du courant égale, le matelas Reno — stable — a une épaisseur de 3 à 4 fois inférieure à l'épaisseur nécessaire dans les mêmes conditions en adoptant le revêtement en enrochement.
Ces avantages du matelas Reno sont facilement compréhensibles quand on pense que la résistance d'un revêtement en enrochement est fonction de chacun des éléments lithiques: la présence du grillage permet au matelas Reno d'exercer un effort vraiment solidaire.
La réduction de l'épaisseur du revêtement que l'on obtient grâce à la mise en œuvre des matelas Reno acquiert toute son importance économique pour les travaux concernant les grands fleuves, car ces travaux ont de grande envergure et la quantité de matériau à mettre en œuvre est proportionnelle.
Si les berges ont tendance à s'ébouler, il peut être suffisant d'adopter, pour les parties éboulées, un revêtement plus robuste et plus lourd en gabions-boîtes de 0,50 ou 1,00 mètre d'épaisseur, et si, au contraire, la nature ébouleuse du terrain est profonde et s'il faut procéder à une véritable consolidation de la berge, on choisira un revêtement de matelas Reno et de gabions-boîtes.
En présence d'eaux industrielles ou saumâtres, particulièrement corrosives, il est préférable adopter des matelas Reno et des gabions galvanisés et plastifiés.

tractivas sobre el fondo del doble de magnitud de las admisibles para un revestimiento en piedra suelta del mismo tamaño. Se ha averiguado además que, para una determinada velocidad de la corriente, el colchon Reno (estable) tiene un espesor 3-4 veces inferior al de un revestimiento en piedra suelta.
Estas ventajas del revestimiento en colchones Reno son de fácil intuición cuando se piensa que la resistencia de un revestimiento en materiales sueltos es ofrecida por cada elemento litoide mientras que la red metálica permite al colchón Reno funcionar como un conjunto.
La evidente reducción del espesor del revestimiento que se obtiene empleando colchones Reno en lugar del rip-rap, asume una particular importancia económica en el caso de la regulación de grandes ríos, en consideración de las dimensiones de las obras y las cantidades de materiales a emplear.
En caso de posibilidad de desmoronamientos puede ser suficiente adoptar, en los trechos inestables de las orillas, un revestimiento más grueso y pesado en gaviones en forma de caja del espesor de 0,50 o 1,00 m. Si el movimiento de desprendimiento es profundo y debe procederse a una consolidación de las orillas, esta podrá ser realizada con obras escalonadas en colchones Reno y gaviones en forma de caja. En presencia de aguas industriales o salobres y por lo tanto particularmente corrosivas se prefiere la adopción de colchones Reno o gaviones galvanizados y plastificados.

Fig. 16 - ITALY - Tuscany - Canalization on a bend in the river Greve, using Reno mattress and gabions.

Fig. 16 - ITALIE - Toscane - Canalisation d'un coude du Greve en gabions et matelas Reno.

Fig. 16 - ITALIA - Toscana - Canalización realizada en gaviones y colchones Reno de un tramo en curva del rio Greve.



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Fig. 17 - DOMINICAN REPUBLIC - La Vega, River Camu' - River training to protect housing.

Fig. 17 - REP. DOMINICAINE - Canalisation d'un tronçon du Rio Camù pour la protection de la ville de La Vega.

Fig. 17 - REPUBLICA DOMINICANA - Canalización de un tramo del rio Camú para la defensa del poblado de La Vega.

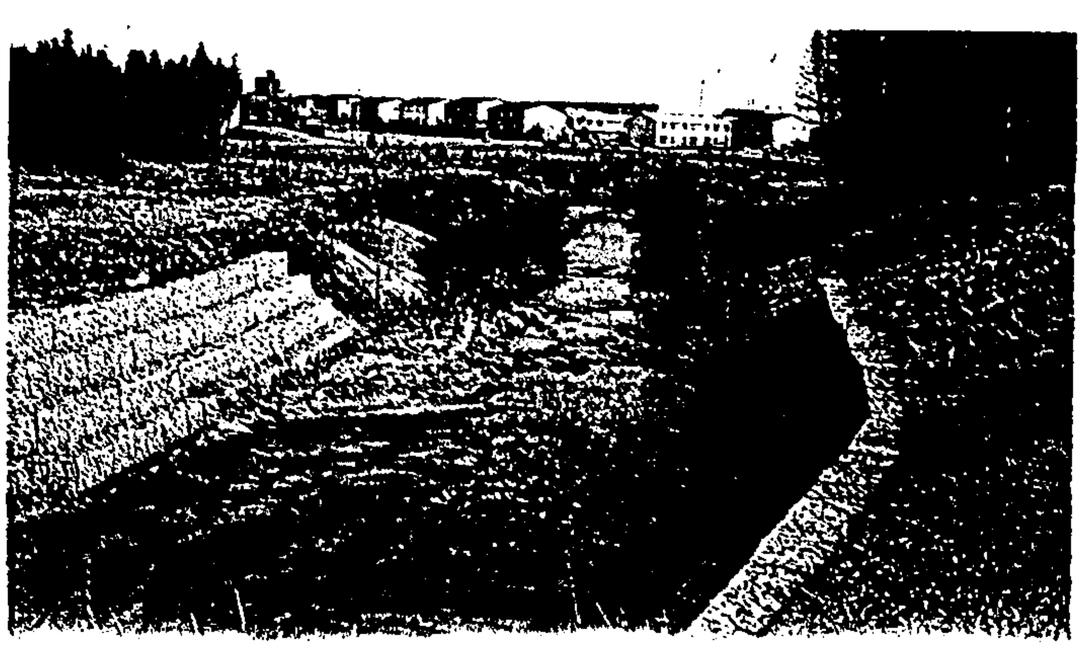


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Fig. 18 - CANADA - Ontario - Canalization of Malvern Creek, part rectangular section using gabions, and part trapezoidal using Reno mattress.

Fig. 18 - CANADA - Ontario - Canalisation du Mulvern Creek dans le tronçon passant de la section rectangulaire en gabions à la section trapézoidale en matelas Reno.

Fig. 18 - CANADA - Ontario - Canalización del Mulvern Creek en el tramo de pasaje de la sección rectangular en gaviones a la trapecial en colchones Reno.



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$$S = \frac{d_v}{f}\left[1 - \left(\frac{v_e}{v_b}\right)^2\right] \qquad (20)$$

where f is the Darcy-Weisbach coefficient (it may be assumed that $f = 0.05$) and d_v is the equivalent void diameter. This latter may be assumed to equal 1/5 of the gravel filter's average particle size

$$d_v = \frac{d_{50}^{(\text{filter})}}{5} \qquad (21)$$

The grading of the filter is determined from the following:

$$\frac{d_{50}^{(\text{filter})}}{d_{50}^{(\text{soil})}} \leqslant 40;\ 5 \leqslant \frac{d_{15}^{(\text{filter})}}{d_{15}^{(\text{soil})}} \leqslant 40;$$

$$\frac{d_{15}^{(\text{filter})}}{d_{85}^{(\text{soil})}} \leqslant 5 \qquad (22)$$

Resistance of sand asphalt mastic grouted Reno mattress and gabion linings

Grouting with sand asphalt mastic, whether for consolidation only or for the complete filling of the voids, gives the lining monolithicity, and also a greater total weight; therefore the resistance to the flow is improved. In particular, the mastic keeps the rocks from moving inside the mattress and so the condition of "initial movement" cannot be used to define stability. The mode and cause of deformation is completely different to that of ungrouted Reno mattresses and gabions. Therefore, grouted linings can be used for much more severe conditions. In table 5 the values of the average flow velocities that different depths of grouted mattress and gabions may withstand are shown.

Differences between Reno mattress and rip rap revetments

Linings of rip rap and of Reno mattress and gabions have in common the fact that the mass of the lining is made up of rocks and, consequently, stability calculations are based on the tractive force theory. However, while a lining in rip rap is made up of individual rocks only, Reno mattress and gabion linings have mesh in addition; therefore:

a) Shields co-efficient for the Reno mattress and the gabions is twice the value of that for rip rap. This means that with the same hydraulic conditions, the average dimension of the rocks to be used in the Reno mattress or in the gabions is half that of rip rap rock. Vice versa, when the same size rocks are used the allowable velocity for the Reno mattress and gabions is more than twice, even as much as 3 or 4 times that for rip rap.
b) The condition of "initial movement" for the rip rap is a limit condition beyond which the lining is progressively destroyed as the separate elements are

supérieure à la quantité.

$$S = \frac{d_v}{f}\left[1 - \left(\frac{v_e}{v_b}\right)^2\right] \qquad (20)$$

où f est le coefficient de Darcy-Weisbach (ici $f = 0{,}05$) et d_v le diamètre équivalent des interstices (on peut le poser égal à 1/5 de la dimension moyenne du gravier qui constitue le filtre:

$$d_v = \frac{d_{50}^{(\text{filtre})}}{5} \qquad (21)$$

On détermine la granulométrie du filtre grâce aux inéquations suivantes:

$$\frac{d_{50}^{(\text{filtre})}}{d_{50}^{(\text{sol})}} \leqslant 40;\quad 5 \leqslant \frac{d_{15}^{(\text{filtre})}}{d_{15}^{(\text{sol})}} \leqslant 40;$$

$$\frac{d_{15}^{(\text{filtre})}}{d_{85}^{(\text{sol})}} \leqslant 5 \qquad (22)$$

Résistance des revêtements en matelas Reno et en gabions traités au mastic de bitume

Les revêtements traités au mastic de bitume (renforcement et joints) acquièrent un caractère monolithique ainsi qu'un poids total plus élevé, ce qui augmente la résistance au mouvement de l'eau.
De même, le mastic prévient les mouvements des pierres à l'intérieur de la structure, donc on ne parlera plus de «premier mouvement» en terme de paramètre de stabilité.
Pour ce type de revêtement, les déformations se produisent de façons différentes et dans des conditions beaucoup plus difficiles que pour les revêtements non traités au mastic de bitume.
La table 5 donne les valeurs de la vitesse moyenne du courant à laquelle les matelas Reno et les gabions bitumés peuvent résister, en fonction de leur épaisseur.

Comparaison entre les revêtements Reno et les revêtements en enrochements (rip-rap)

Les revêtements en enrochements (rip-rap) et les revêtements en matelas Reno et en gabions, se ressemblent par quelques caractéristiques et se différencient par d'autres.
Du fait que la masse du revêtement composée de pierres est un point commun, les calculs de la stabilité se baseront sur la théorie de la force d'entrainement. Le revêtement en rip-rap n'est constitué que d'enrochements, alors que les matelas Reno et les gabions ont en plus, un grillage métallique, d'où:

a) le coefficient de Shields des matelas Reno et des gabions sera le double de celui du rip-rap: ainsi, à conditions hydrauliques égales, on utilisera pour les matelas Reno et les gabions, de la pierre de dimensions inférieures (1/2) à celles du rip-rap. Vice versa, la vitesse supportable par les matelas Reno et les gabions est plus que double par rapport au rip-rap (même 3 à 4 fois supérieure si la pierre utilisée est équivalente).
b) Le «premier mouvement» de la pierre pour le revêtement en rip-rap détermine la condition limite de résistance du

maneras, superior a la cantidad.

$$S = \frac{d_v}{f}\left[1 - \left(\frac{v_e}{v_b}\right)^2\right] \qquad (20)$$

donde f es el coeficiente de Darcy-Weisbach (se puede asumir aquí $f = 0{,}05$) y d_v es el diámetro equivalente a los vacios, que se puede asumir igual a 1/5 de la dimensión media de la grava que constituye el filtro:

$$d_v = \frac{d_{50}^{(\text{filtro})}}{5} \qquad (21)$$

La granulometría del filtro se determina con las siguientes relaciones:

$$\frac{d_{50}^{(\text{filtro})}}{d_{50}^{(\text{suelo})}} \leqslant 40;\quad 5 \leqslant \frac{d_{15}^{(\text{filtro})}}{d_{15}^{(\text{suelo})}} \leqslant 40;$$

$$\frac{d_{15}^{(\text{filtro})}}{d_{85}^{(\text{suelo})}} \leqslant 5 \qquad (22)$$

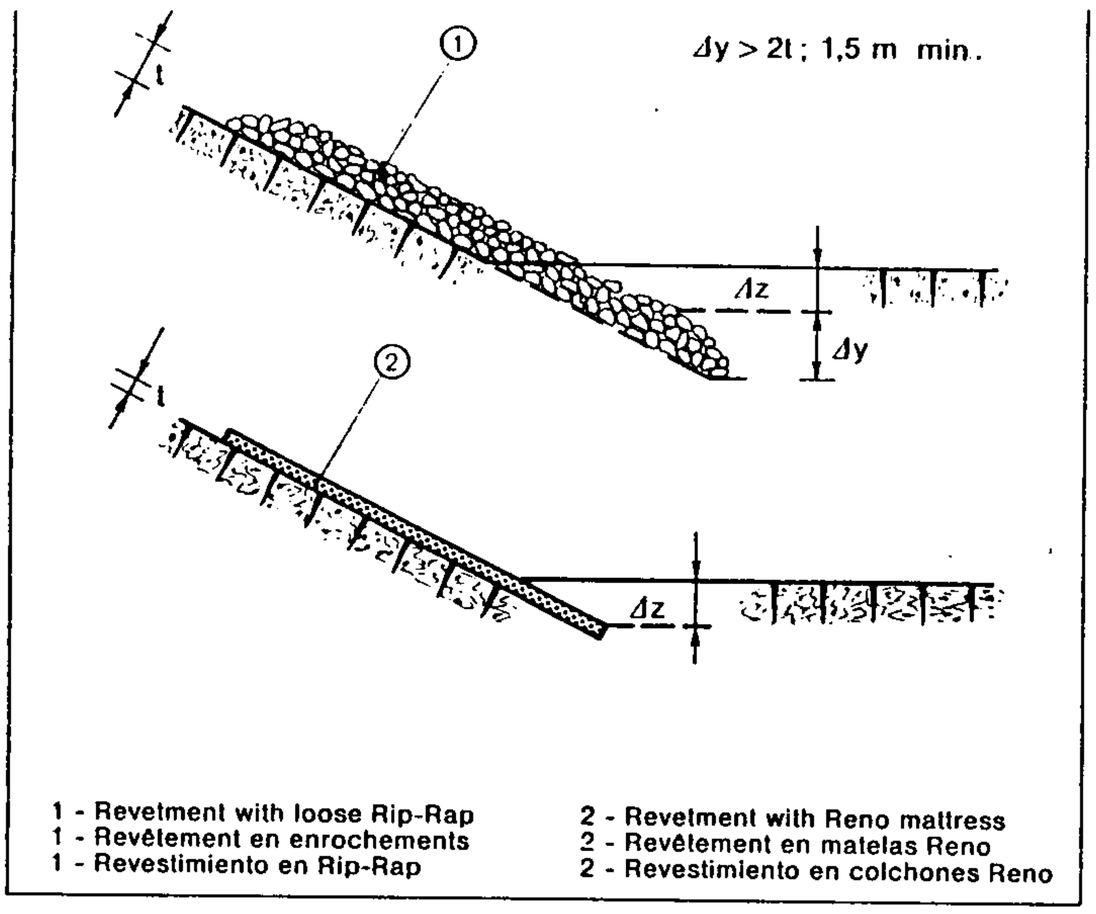
Resistencia de los revestimientos en colchones Reno y en gaviones tratados con almáciga bituminosa

El tratamiento con almáciga bituminosa (consolidación o selladura) confiere al revestimiento un aspecto monolítico y un mayor peso total aumentando así su resistencia al movimiento del agua. En particular, la acción de la almáciga impide los movimientos de las piedras en el interior de la estructura; por lo tanto no se define más una condición de «primer movimiento» como parámetro de estabilidad.
Las deformaciones se verifican de manera diferente de las de los colchones Reno y gaviones no bitumados y con condiciones mucho más gravosas que aquellas que los colchones soportarian sin emplear la almáciga.
En la tabla 5 se reportan los valores de la velocidad media de la corriente que los colchones y los gaviones bitumados pueden soportar en función de su espesor.

Comparación entre revestimientos en colchones Reno y revestimientos en piedra suelta (rip-rap)

Los revestimientos en piedras sueltas tienen algunas características en común con los revestimientos en colchones Reno y en gaviones mientras difieren en otras.
El material básico del revestimiento está formado por pedrisco y consecuentemente los cálculos de estabilidad se fundamentan sobre la teoría de la fuerza de arrastre. Mientras el revestimiento en rip-rap está constituido solamente por pedrisco, los colchones Reno y los gaviones están constituidos también por red metálica, en tonces:

a) el coeficiente de Shields para los colchones Reno y los gaviones es el doble que el del rip-rap; la consecuencia es que en identicas condiciones hidráulicas la dimensión média del pedrisco a emplear en los colchones Reno y en los gaviones es la mitad de la de los revestimientos en rip-rap. Al contrario la velocidad soportable por los colchones Reno y gaviones es más que el doble, hasta 3-4 veces, de aquella soportable por el rip-rap.
b) La condición de inicio del movimiento del pedrisco [illegible] al rip-rap es la condición



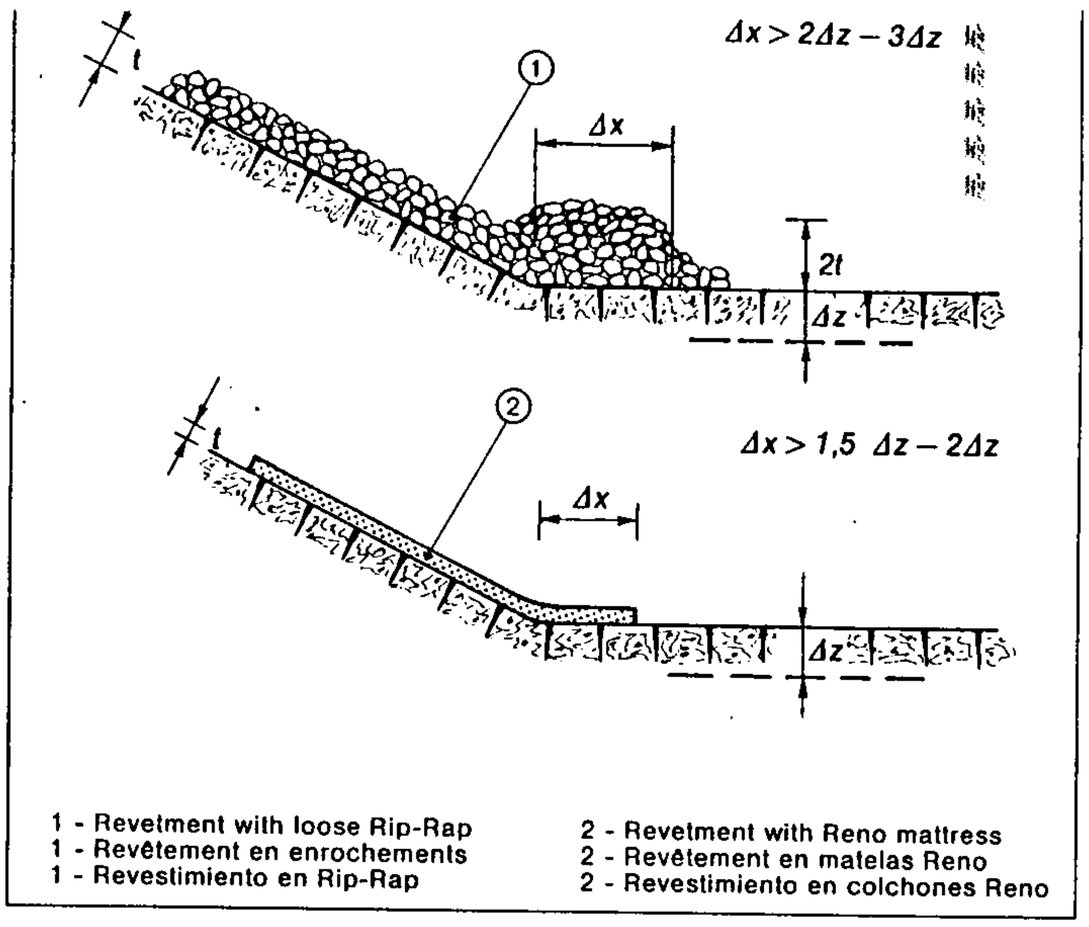


Fig. 50 - Vertical extension of the revetment referred to the expected erosion.

Fig. 51 - Horizontal extension of the revetment referred to the exptected erosion.

Fig. 50 - Approfondissement du revêtement vu la profondeur d'érosion prévue.

Fig. 51 - Extension horizontale du revêtement vu la profondeur d'érosion prévue.

Fig. 50 - Profundización del revestimiento para la profundidad de erosión prevista.

Fig. 51 - Extensión horizontal del revestimiento para la profundidad de erosión prevista.

removed by the flow. In the case of the Reno mattress and gabions however, after the "initial movement" the containment offered by the mesh remains. A new situation of equilibrium with a deformed Reno mattress is obtained, allowing it to withstand more severe conditions without compromising the resistance and without further deformation.

c) With the small dimension of the rock used in the Reno mattress and gabions, the residual velocity of the flow which impinges on the underlying soil is small, giving additional security. Moreover, it is possible to reduce the necessity for filters of either gravel or geotextiles.

d) The reduction in the size of stone for filling decreases, even if only by a little, the roughness of the lining thereby increasing the capacity of the channel.

e) The regulations governing the design of rip rap provide for a minimum depth of 0.30 m and, in general, the relationship between this depth and the average dimension of the rocks is 1.5 to 2. For works under water the depth must be increased by 50% and the slope of the banks must not be more than 1:2.

Rip rap protection for canal banks requires a considerable increase in material at the toe and/or careful design and execution. The Reno mattress and gabions on the contrary do not present these difficulties; they can be very thin (0.15 m); the method of placing a Reno mattress lining under water, together with the ability to accurately ensure the required thickness means there is no need to increase the depth or to reduce the slope of the banks, (permissible slope 1:1.5). Nor is it necessary to increase the revetment thickness at the toe. The stability at the toe of a revetment in Reno mattress or rip rap may be guaranteed either with an increase in depth of the lining, (fig. 50), or with extension horizontally, Δx, (fig. 51). It can be seen that in the first case, using rip rap, a level, Δz, lower than the depth of the expected erosion must be obtained, while with Reno mattress it is sufficient

Après les premiers mouvements des pierres, les matelas Reno et les gabions offrent, eux, une meilleure retention, grâce au grillage; on atteint une nouvelle position d'équilibre, le matelas Reno est déformé mais peut supporter des conditions encore plus difficiles sans compromettre sa résistance, et sans autres déformations.

c) Les pierres des matelas Reno et des gabions sont de dimensions inférieures à celles du rip-rap; la vitesse résiduelle au fond est donc inférieure, ce qui augmente la sécurité et donc la possibilité de réduire les filtres en gravier ou en géotextile.

d) La réduction des dimensions des pierres entraîne une légère diminution de la rugosité du revêtement, et une augmentation du débit des cours d'eau.

e) Les règles pour le dimensionnement du rip-rap prévoient une épaisseur de revêtement minimum de 0,30 m, avec un rapport entre l'épaisseur et la dimension moyenne de la pierre variant de 1,5 à 2. Il faut augmenter l'épaisseur de 50% lorsqu'on effectue les travaux sous l'eau et il convient que l'inclinaison maximum des berges soit de 1:2.

Les revêtements des berges en enrochements (rip-rap) nécessitent d'une augmentation considérable au pied, ainsi que de précautions lors du projet et de la mise en œuvre.

Les matelas Reno et les gabions, qui ne présentent pas ces inconvénients peuvent avoir une épaisseur réduite (0,15 m); la mise en œuvre et le plongement en présence d'eau ne nécessitent ni d'une augmentation de l'épaisseur, ni d'une réduction de l'inclinaison des berges (inclinaison admissible 1:1,5), ni même d'une augmentation d'épaisseur au pied des berges. On garantit la stabilité au pied d'un revêtement en matelas Reno ou en enrochement par approfondissement de la pose du revêtement (fig. 50) ou par étalement horizontal Δx (fig. 51).

Si on utilise des enrochements, il faut pousser la pose du revêtement jusqu'à un niveau inférieur à la profondité

elementos son arrastrados por la corriente. En el caso de colchones Reno y gaviones, al contrario, después de los primeros movimientos entra en acción la contención ofrecida por la red metálica hasta obtener una nueva situación de equilibrio con el colchón Reno deformado pero aún capaz de soportar condiciones más gravosas sin sensibles deformaciones ulteriores.

c) Por la menor dimensión del pedrisco utilizado en los colchones Reno y en los gaviones, la velocidad del agua que afecta efectivamente el material del fondo es menor, por lo tanto aumenta la seguridad y es posible reducir la necesidad de los filtros en grava o geotéxtiles.

d) La reducción de las dimensiones del pedrisco disminuye, aunque levemente, la rugosidad del revestimiento aumentando el caudal de los cursos de agua.

e) Las reglas de dimensionamiento del rip-rap preven un espesor mínimo de 0,30 m y en general una relación entre el espesor del revestimiento y la dimensión media del pedrisco de 1,5-2; para obras ejecutadas bajo agua el espesor tiene que ser aumentado el 50% y la pendiente de las orillas no debe superar la 1:2.

Los revestimientos en rip-rap sobre orilla necesitan un notable refuerzo al pié y/o precauciones en el diseño y puesta en obra. Los colchones Reno y los gaviones al contrario, no presentan ninguna de estas difucultades; pueden ser muy finos (0,15 m); no necesitan el refuerzo al pié de las orillas; ya que la estabilidad al pié de un revestimiento en colchones Reno o en rip-rap puede ser garantizada o con una profundización del revestimiento (fig. 50) o con una extensión horizontal Δx (fig. 51). Se nota que en el primer caso la profundización con empleo de rip-rap tiene que alcanzar una cota más baja que la profundidad de erosión prevista Δz, mientras empleando colchones Reno es suficiente alcanzar la cota de erosión; en el segundo caso es necesario un refuerzo

HEC2 S/N: 1126260289 HMVersion: 6.20 Data File: SUB_03.hc2

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**********************************************
*  HEC-2 WATER SURFACE PROFILES              *
*                                            *
*  Version   4.6.0;  February 1991           *
*                                            *
*  RUN DATE    21DEC93    TIME    19:17:06   *
**********************************************
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****************************************
*  U.S. ARMY CORPS OF ENGINEERS        *
*  HYDROLOGIC ENGINEERING CENTER       *
*  609 SECOND STREET, SUITE D          *
*  DAVIS, CALIFORNIA 95616-4687        *
*          (916) 756-1104              *
****************************************
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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X                 X     X
X     X  X        X                       X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
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:::                                      :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION   :::
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============================
H A E S T A D   M E T H O D S
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

NOTE: - THIS SUBCRITICAL RUN HAS A TRANSITIONING SIDE SLOPE FROM 3:1 TO 1:1 AND IS CONSTRUCTED WITH SOIL-CEMENT.

- ALL Q_S ARE BULKED 10%
- Q_{100} = 22,600 cfs UNBULKED

THIS RUN EXECUTED 21DEC93 19:17:06

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

T1 TIJERAS ARROYO GRADE AND BANK STABILIZATION 93043.11
T2SUBCRITICAL RUN WITH SOIL-CEMENT SLOPES, 10-YEAR FLOW FILE NAME: SUB_03.HC2
T3 ALT-3 SUBCRITICAL RUN TIJERAS ARROYO EDIT DATE: (12-13-93)

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2						5399.97		

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	0	-1				-1			

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

38	1	2	68	26	16	17	18	42	0
38	43	13	14	15	55	26	56	8	25
0	38	43	8	22	53	54	4	0	150

J5 LPRNT NUMSEC ********REQUESTED SECTION NUMBERS********

-10 -10

J6 IHLEQ ICOPY SUBDIV STRTDS RMILE

1.0

QT	2	7040	24860							
NC	.040	.040	.030	.1	.3					
X1	227	26	1580	1740	0	0	0			
GR	5420	950	5410	1000	5408	1200	5406	1205	5404	1240
GR	5406	1250	5408	1265	5408	1430	5406	1560	5404	1575
GR	5402	1580	5400	1595	5396	1605	5394	1630	5394	1680
GR	5398	1700	5402	1740	5404	1750	5406	1770	5408	1850
GR	5408	1940	5406	2040	5408	2065	5408	2100	5410	2115
GR	5420	2175								

X1	226.	17	1500.00	1600.00	1010.00	1010.00	1010.00	0.00	0.00	0.00
GR	5430.0	990.0	5418.00	1110.0	5418.00	1305.0	5419.00	1450.0	5418.00	1500.0
GR	5412.5	1525.0	5412.50	1555.0	5416.00	1565.0	5419.00	1600.0	5416.00	1660.0
GR	5410.0	1685.0	5408.00	1700.0	5410.00	1740.0	5414.00	1925.0	5418.00	1945.0
GR	5420.0	2020.0	5430.00	2180.0						

X1	225.0	12	1245.00	1375.00	720.00	900.00	800.00	0.00	0.00	0.00
GR	5440.0	1000.0	5430.00	1045.0	5428.00	1110.0	5426.00	1245.0	5424.00	1265.0
GR	5424.0	1320.0	5426.00	1375.0	5428.00	1650.0	5428.00	1755.0	5427.60	1790.0
GR	5430.0	1840.0	5440.00	1920.0						

X1	224.5	12	1190	1330	260	260	300			
GR	5440	1000	5432	1050	5430	1190	5426.5	1220	5426.5	1280
GR	5430	1300	5431.5	1330	5430	1650	5432	1690	5430	1740
GR	5440	1810	5450	1880						

SEC 224, EXISTING 3:1 SIDESLOPE

NH	3	.04	1448	.03	1550	.035	1750			
X1	224.	9	1448.00	1580.00	460.00	260.00	385.00	0.00	0.00	0.00
GR	5440.0	1000.0	5436.00	1160.0	5434.00	1448.0	5430.00	1460.0	5430.0	1550.0
GR	5440.0	1580.0	5442.5	1587.5	5442.5	1597.5	5450	1750		

SEC 222.6, 1:1 SIDESLOPE

NH	3	.04	1450	.03	1618	.035	1680			
X1	222.6	13	1450	1626	200	300	250			
GR	5444	1000	5442	1070	5440	1160	5438	1200	5437	1310
GR	5438	1450	5432	1468	5432	1618	5440	1626	5444	1631
GR	5444	1641	5450	1655	5460	1680				

SEC 222.3, 1.5:1 SIDESLOPE

NH	3	.04	1400	.03	1651.5	.035	1690			
X1	222.3	11	1400	1659	250	250	250			
GR	5450	1000	5448	1040	5444	1150	5442	1210	5440	1400
GR	5435	1415	5435	1651.5	5440	1659	5446	1668	5446	1678
GR	5450	1690								

SEC 222, 2.5:1 SIDESLOPE

NH	3	.04	1360	.03	1737.5	.035	1790			
X1	222.	12	1360.00	1600.00	200	300	200			
GR	5450.0	1000.0	5448.00	1060.0	5440.00	1360.0	5438.00	1370.0	5437.00	1380.0
GR	5438.0	1395.0	5440.00	1600.0	5438.00	1670.0	5438	1737.5	5449	1765
GR	5449	1775	5450.0	1790.0						

SEC 220.7, EXISTING SIDESLOPE

NH	3	.04	1360	.03	1600	.035	1720				
X1	220.7	12	1200	1350	200	300	225				
GR	5450	1000	5448	1080	5442	1200	5440	1220	5442	1300	
GR	5442.5	1350	5442	1440	5442	1600	5444	1620	5446	1640	
GR	5450	1680	5460	1720							
NC	.04	.04	.03	.1	.3						
X1	220.5	9	1560	1700	250	300	275				
GR	5460	1000	5448	1300	5446	1560	5444	1600	5446	1700	
GR	5446	1880	5448	1900	5450	1910	5460	1970			
X1	220.	7	1520.00	1820.00	560	460	555				
GR	5468.0	1000.0	5460.00	1225.0	5452.00	1520.0	5451.50	1700.0	5452.00	1820.0	
GR	5460.0	1855.0	5470.00	1920.0							
X1	218.	7	1445.00	1855.00	1490.00	1580.00	1445.00	0.00	0.00	0.00	
GR	5488.0	1000.0	5470.00	1445.0	5468.00	1600.0	5470.00	1660.0	5468.00	1800.0	
GR	5470.0	1855.0	5490.00	1970.0							

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

T1 TIJERAS ARROYO GRADE AND BANK STABILIZATION 93043.11
T2SUBCRITICAL RUN WITH SOIL-CEMENT SLOPES, 10-YEAR FLOW FILE NAME: SUB_03.HC2
T3 ALT-3 SUBCRITICAL RUN TIJERAS ARROYO EDIT DATE: (12-13-93)

	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
J1		3							5405.52	

	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
J2	2	0	-1				-1			

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

THIS RUN EXECUTED 21DEC93 19:17:09

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HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ALT-3 SUBCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	CWSEL	CRIWS	FRCH	VCH	K*XNL	K*XNCH	K*XNR	ELMIN
*	227.000	5400.29	5400.29	1.01	12.08	.00	30.00	.00	5394.00
*	227.000	5406.55	5406.55	.87	15.46	40.00	30.00	40.00	5394.00
*	226.000	5414.21	5414.21	1.41	6.96	.00	30.00	40.00	5408.00
*	226.000	5417.56	5417.56	1.22	11.25	.00	30.00	40.00	5408.00
*	225.000	5428.63	5428.63	.75	8.52	40.00	30.00	40.00	5424.00
*	225.000	5430.72	5430.72	.95	13.37	40.00	30.00	40.00	5424.00
*	224.500	5432.08	5432.08	.77	8.77	40.00	30.00	40.00	5426.50
*	224.500	5434.21	5434.21	.97	13.68	40.00	30.00	40.00	5426.50
*	224.000	5436.03	5436.03	.74	9.74	40.00	30.81	.00	5430.00
*	224.000	5439.30	5439.30	.88	14.18	40.00	31.15	.00	5430.00
	222.600	5437.27	5436.00	.66	8.31	40.00	30.22	.00	5432.00
*	222.600	5440.78	5440.78	.84	13.67	40.00	30.33	35.00	5432.00
	222.300	5438.43	5437.98	.81	8.42	.00	30.13	.00	5435.00
*	222.300	5442.25	5442.25	.88	13.23	40.00	30.18	35.00	5435.00
*	222.000	5440.95	5440.95	.95	7.85	40.00	30.00	30.09	5437.00
	222.000	5444.42	5443.73	.79	10.53	40.00	30.00	30.17	5437.00
	220.700	5443.93	5443.89	.87	7.80	40.00	40.00	30.11	5440.00
*	220.700	5446.55	5446.55	.83	10.70	40.00	40.00	30.28	5440.00
*	220.500	5448.10	5448.10	.92	9.15	40.00	30.00	40.00	5444.00
*	220.500	5450.38	5450.38	1.04	13.72	40.00	30.00	40.00	5444.00
*	220.000	5454.26	5454.26	.98	8.80	40.00	30.00	40.00	5451.50
*	220.000	5457.28	5457.28	.97	12.92	40.00	30.00	40.00	5451.50

	SECNO	CWSEL	CRIWS	FRCH	VCH	K*XNL	K*XNCH	K*XNR	ELMIN
*	218.000	5471.10	5471.10	.99	8.14	40.00	30.00	40.00	5468.00
*	218.000	5473.79	5473.79	.98	12.11	40.00	30.00	40.00	5468.00

ALT-3 SUBCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	Q	QLOB	QCH	QROB	VLOB	VCH	VROB	DEPTH	AREA
*	227.000	7040.00	.00	7040.00	.00	.00	12.08	.00	6.29	582.56
*	227.000	24860.00	431.66	24096.07	332.26	3.53	15.46	4.04	12.55	1763.23
*	226.000	7040.00	.00	433.54	6606.46	.00	6.96	9.01	6.21	795.58
*	226.000	24860.00	.00	2890.14	21969.86	.00	11.25	13.17	9.56	1925.19
*	225.000	7040.00	776.19	4491.95	1771.86	3.42	8.52	3.19	4.63	1310.28
*	225.000	24860.00	4091.16	10679.06	10089.78	6.65	13.37	6.68	6.72	2924.38
*	224.500	7040.00	416.26	4971.62	1652.11	2.74	8.77	3.06	5.58	1258.86
*	224.500	24860.00	3042.94	11831.88	9985.18	6.54	13.68	6.84	7.71	2790.03
*	224.000	7040.00	748.78	6291.22	.00	2.52	9.74	.00	6.03	943.17
*	224.000	24860.00	9901.37	14958.63	.00	6.80	14.18	.00	9.30	2511.50
	222.600	7040.00	5.42	7034.57	.00	.58	8.31	.00	5.27	855.98
*	222.600	24860.00	4928.66	19930.85	.50	5.46	13.67	1.32	8.78	2362.24
	222.300	7040.00	.00	7040.00	.00	.00	8.42	.00	3.43	836.48
*	222.300	24860.00	754.33	24094.32	11.36	3.16	13.23	2.99	7.25	2063.73
*	222.000	7040.00	36.93	3969.91	3033.17	2.18	7.85	8.75	3.95	868.80
	222.000	24860.00	1556.56	14071.18	9232.26	4.26	10.53	10.69	7.42	2565.56
	220.700	7040.00	151.73	2929.09	3959.18	4.12	7.80	8.32	3.93	888.26
*	220.700	24860.00	1285.43	8236.10	15338.47	6.22	10.70	12.60	6.55	2193.34
*	220.500	7040.00	985.96	3974.64	2079.41	3.44	9.15	5.20	4.10	1120.80
*	220.500	24860.00	6895.18	10328.63	7636.19	7.27	13.72	8.78	6.38	2571.65
*	220.000	7040.00	365.52	6631.83	42.65	3.88	8.80	3.81	2.76	858.83
*	220.000	24860.00	3047.65	21456.76	355.59	5.92	12.92	5.82	5.78	2236.41
*	218.000	7040.00	37.00	6994.48	8.52	2.50	8.14	2.47	3.10	877.31
*	218.000	24860.00	869.30	23790.40	200.30	4.89	12.11	4.85	5.79	2183.29

ALT-3 SUBCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	Q	DEPTH	STCHR	SSTA	ENDST	TOPWID
*	227.000	7040.00	6.29	1740.00	1592.79	1722.94	130.15
*	227.000	24860.00	12.55	1740.00	1203.62	2046.92	353.20
*	226.000	7040.00	6.21	1600.00	1517.21	1926.07	301.31
*	226.000	24860.00	9.56	1600.00	1502.02	1942.78	395.04
*	225.000	7040.00	4.63	1375.00	1089.42	1811.53	722.11
*	225.000	24860.00	6.72	1375.00	1041.75	1845.78	804.03
*	224.500	7040.00	5.58	1330.00	1049.47	1754.59	705.13
*	224.500	24860.00	7.71	1330.00	1036.16	1769.50	733.33
*	224.000	7040.00	6.03	1580.00	1158.71	1568.10	409.39
*	224.000	24860.00	9.30	1580.00	1027.93	1577.91	549.98
	222.600	7040.00	5.27	1626.00	1279.92	1623.27	239.45
*	222.600	24860.00	8.78	1626.00	1125.11	1626.97	501.86
	222.300	7040.00	3.43	1659.00	1404.72	1656.64	251.91
*	222.300	24860.00	7.25	1659.00	1202.50	1662.38	459.88
*	222.000	7040.00	3.95	1600.00	1324.39	1744.87	420.49
	222.000	24860.00	7.42	1600.00	1194.47	1753.54	559.06
	220.700	7040.00	3.93	1350.00	1161.60	1619.20	457.60
*	220.700	24860.00	6.55	1350.00	1109.08	1645.46	536.38
*	220.500	7040.00	4.10	1700.00	1297.47	1900.51	603.03
*	220.500	24860.00	6.38	1700.00	1240.55	1912.27	671.72
*	220.000	7040.00	2.76	1820.00	1436.62	1829.89	393.28
*	220.000	24860.00	5.78	1820.00	1325.13	1843.12	517.99
*	218.000	7040.00	3.10	1855.00	1417.92	1861.30	443.37
*	218.000	24860.00	5.79	1855.00	1351.28	1876.80	525.52

ALT-3 SUBCRITICAL RUN

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	227.000	.00	.00	.00	5394.00	7040.00	5400.29	5400.29	5402.56	81.82	12.08	582.56	778.28
*	227.000	.00	.00	.00	5394.00	24860.00	5406.55	5406.55	5410.16	47.44	15.46	1763.23	3609.23
*	226.000	1010.00	.00	.00	5408.00	7040.00	5414.21	5414.21	5415.44	121.20	6.96	795.58	639.46
*	226.000	1010.00	.00	.00	5408.00	24860.00	5417.56	5417.56	5420.16	113.05	11.25	1925.19	2338.16
*	225.000	800.00	.00	.00	5424.00	7040.00	5428.63	5428.63	5429.41	45.77	8.52	1310.28	1040.54
*	225.000	800.00	.00	.00	5424.00	24860.00	5430.72	5430.72	5432.31	64.78	13.37	2924.38	3088.62
*	224.500	300.00	.00	.00	5426.50	7040.00	5432.08	5432.08	5432.97	48.82	8.77	1258.86	1007.60
*	224.500	300.00	.00	.00	5426.50	24860.00	5434.21	5434.21	5435.97	67.62	13.68	2790.03	3023.24
*	224.000	385.00	.00	.00	5430.00	7040.00	5436.03	5436.03	5437.36	44.07	9.74	943.17	1060.52
*	224.000	385.00	.00	.00	5430.00	24860.00	5439.30	5439.30	5441.47	55.38	14.18	2511.50	3340.68
	222.600	250.00	.00	.00	5432.00	7040.00	5437.27	5436.00	5438.34	34.67	8.31	855.98	1195.71
*	222.600	250.00	.00	.00	5432.00	24860.00	5440.78	5440.78	5443.19	47.88	13.67	2362.24	3592.59
	222.300	250.00	.00	.00	5435.00	7040.00	5438.43	5437.98	5439.53	59.26	8.42	836.48	914.52
*	222.300	250.00	.00	.00	5435.00	24860.00	5442.25	5442.25	5444.89	54.19	13.23	2063.73	3376.97
*	222.000	200.00	.00	.00	5437.00	7040.00	5440.95	5440.95	5442.00	93.29	7.85	868.80	728.86
	222.000	200.00	.00	.00	5437.00	24860.00	5444.42	5443.73	5446.07	45.80	10.53	2565.56	3673.55
	220.700	225.00	.00	.00	5440.00	7040.00	5443.93	5443.89	5444.93	129.86	7.80	888.26	617.78
*	220.700	225.00	.00	.00	5440.00	24860.00	5446.55	5446.55	5448.69	93.96	10.70	2193.34	2564.65
*	220.500	275.00	.00	.00	5444.00	7040.00	5448.10	5448.10	5448.99	75.58	9.15	1120.80	809.77
*	220.500	275.00	.00	.00	5444.00	24860.00	5450.38	5450.38	5452.19	81.45	13.72	2571.65	2754.58
*	220.000	555.00	.00	.00	5451.50	7040.00	5454.26	5454.26	5455.41	92.52	8.80	858.83	731.89
*	220.000	555.00	.00	.00	5451.50	24860.00	5457.28	5457.28	5459.60	69.51	12.92	2236.41	2981.71
*	218.000	1445.00	.00	.00	5468.00	7040.00	5471.10	5471.10	5472.12	100.81	8.14	877.31	701.17
*	218.000	1445.00	.00	.00	5468.00	24860.00	5473.79	5473.79	5475.99	74.04	12.11	2183.29	2889.22

ALT-3 SUBCRITICAL RUN

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	227.000	7040.00	5400.29	.00	.00	.32	130.15	.00
*	227.000	24860.00	5406.55	6.26	.00	1.03	353.20	.00
*	226.000	7040.00	5414.21	.00	13.92	.00	301.31	1010.00
*	226.000	24860.00	5417.56	3.34	11.00	.00	395.04	1010.00
*	225.000	7040.00	5428.63	.00	14.42	.00	722.11	800.00
*	225.000	24860.00	5430.72	2.09	13.17	.00	804.03	800.00
*	224.500	7040.00	5432.08	.00	3.45	.00	705.13	300.00
*	224.500	24860.00	5434.21	2.13	3.49	.00	733.33	300.00
*	224.000	7040.00	5436.03	.00	3.95	.00	409.39	385.00
*	224.000	24860.00	5439.30	3.27	5.09	.00	549.98	385.00
	222.600	7040.00	5437.27	.00	1.24	.00	239.45	250.00
*	222.600	24860.00	5440.78	3.50	1.47	.00	501.86	250.00
	222.300	7040.00	5438.43	.00	1.15	.00	251.91	250.00
*	222.300	24860.00	5442.25	3.82	1.47	.00	459.88	250.00
*	222.000	7040.00	5440.95	.00	2.52	.00	420.49	200.00
	222.000	24860.00	5444.42	3.47	2.17	.00	559.06	200.00
	220.700	7040.00	5443.93	.00	2.98	.00	457.60	225.00
*	220.700	24860.00	5446.55	2.62	2.12	.00	536.38	225.00
*	220.500	7040.00	5448.10	.00	4.17	.00	603.03	275.00
*	220.500	24860.00	5450.38	2.28	3.83	.00	671.72	275.00
*	220.000	7040.00	5454.26	.00	6.16	.00	393.28	555.00
*	220.000	24860.00	5457.28	3.02	6.91	.00	517.99	555.00
*	218.000	7040.00	5471.10	.00	16.83	.00	443.37	1445.00
*	218.000	24860.00	5473.79	2.70	16.51	.00	525.52	1445.00

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO= 227.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 227.000 PROFILE= 2 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 226.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 226.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 226.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 226.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 225.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 225.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 225.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 225.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 224.500 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 224.500 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 224.500 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 224.500 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 224.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 224.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 224.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 224.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 222.600 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 222.600 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 222.300 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 222.300 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 222.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 222.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 220.700 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.700 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 220.500 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.500 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 220.500 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.500 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 220.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 220.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 220.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 218.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 218.000 PROFILE= 1 MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 218.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 218.000 PROFILE= 2 MINIMUM SPECIFIC ENERGY

Normal program termination

HEC2 S/N: 1126260289 HMVersion: 6.20 Data File: SUP_03.hc2

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*********************************************
*  HEC-2 WATER SURFACE PROFILES             *
*                                           *
*  Version   4.6.0;  February 1991          *
*                                           *
*  RUN DATE    21DEC93    TIME   19:16:03   *
*********************************************
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*****************************************
*  U.S. ARMY CORPS OF ENGINEERS         *
*  HYDROLOGIC ENGINEERING CENTER        *
*  609 SECOND STREET, SUITE D           *
*  DAVIS, CALIFORNIA 95616-4687         *
*          (916) 756-1104               *
*****************************************
```

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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X           X     X
X     X  X        X                       X
XXXXXXX  XXXX     X          XXXXX    XXXXX
X     X  X        X                 X
X     X  X        X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
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:::::::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::::::
:::                                       :::
:::   FULL MICRO-COMPUTER IMPLEMENTATION   :::
:::                                       :::
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:::::::::::::::::::::::::::::::::::::::::::::
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============================
H A E S T A D   M E T H O D S
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37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

NOTE:- THIS SUPERCRITICAL RUN HAS A TRANSITION IN SIDE SLOPE FROM 3:1 TO 1:1 AND IS CONSTRUCTED WITH SOIL-CEMENT

- ALL Q'S ARE BULKED 10%
- Q_{100} = 22,600 CFS UNBULKED

THIS RUN EXECUTED 21DEC93 19:16:03

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

T1 TIJERAS ARROYO GRADE AND BANK STABILIZATION 93043.11
T2SUPERCRITICAL RUN WITH SOIL-CEMENT SLOPES, 10-YEAR FLOW FILE NAME: SUP_03.HC2
T3 ALT-3 SUPERCRITICAL RUN TIJERAS ARROYO EDIT DATE: (12-13-93)

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		2		1	-1					

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1		-1				-1			

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

	38	1	2	68	26	16	17	18	42	
	38	43	13	14	15	55	26	56	8	25
		38	43	8	22	53	54	4		150

J5 LPRNT NUMSEC ********REQUESTED SECTION NUMBERS********

-10 -10

J6 IHLEQ ICOPY SUBDIV STRTDS RMILE

1.0

THESE FLOWS HAVE BEEN BULKED BY 10%, 10-YEAR (6400 cfs) & 100-YEAR (22600 cfs)

NC	.04	.04	.03	.1	.3					
QT	2	7040	24860							
X1	218.	7	1445.00	1855.00	1490.00	1580.00	1445.00			
GR	5488.0	1000.0	5470.00	1445.0	5468.00	1600.0	5470.00	1660.0	5468.00	1800.0
GR	5470.0	1855.0	5490.00	1970.0						

```
X1     220.        7    1520.00    1820.00     560     460     555
GR    5468.0    1000.0  5460.00    1225.0   5452.00  1520.0  5451.50  1700.0  5452.00  1820.0
GR    5460.0    1855.0  5470.00    1920.0

X1     220.5       9       1560       1700      250     300     275
GR      5460    1000      5448       1300     5446    1560    5444  1600      5446  1700
GR      5446    1880      5448       1900     5450    1910    5460  1970

  SEC 220.7, EXISTING SIDESLOPE

NH         3     .04       1360        .03     1600    .035    1720
X1     220.7      12       1200       1350      200     300     225
GR      5450    1000      5448       1080     5442    1200    5440  1220      5442  1300
GR    5442.5    1350      5442       1440     5442    1600    5444  1620      5446  1640
GR      5450    1680      5460       1720

  SEC 222, 2.5:1 SIDESLOPE

NH         3     .04       1360        .03   1737.5    .035    1790
X1      222.      12    1360.00    1600.00      200     300     200
GR    5450.0  1000.0    5448.00     1060.0  5440.00  1360.0  5438.00  1370.0  5437.00  1380.0
GR    5438.0  1395.0    5440.00     1600.0  5438.00  1670.0  5438     1737.5  5449     1765
GR      5449    1775      5450.0     1790.0

  SEC 222.3, 1.5:1 SIDESLOPE

NH         3     .04       1400        .03   1651.5    .035    1690
X1     222.3      11       1400       1659      250     250     250
GR      5450    1000      5448       1040     5444    1150    5442  1210      5440  1400
GR      5435    1415      5435     1651.5     5440    1659    5446  1668      5446  1678
GR      5450    1690

  SEC 222.6, 1:1 SIDESLOPE

NH         3     .04       1450        .03     1618    .035    1680
X1     222.6      13       1450       1626      200     300     250
GR      5444    1000      5442       1070     5440    1160    5438  1200      5437  1310
GR      5438    1450      5432       1468     5432    1618    5440  1626      5444  1631
GR      5444    1641      5450       1655     5460    1680

  SEC 224, EXISTING 3:1 SIDESLOPE

NH         3     .04       1448        .03     1550    .035    1750
X1      224.       9    1448.00    1580.00    460.00  260.00  385.00
GR    5440.0  1000.0    5436.00     1160.0  5434.00  1448.0  5430.00  1460.0  5430.0   1550.0
GR    5440.0  1580.0     5442.5     1587.5   5442.5  1597.5     5450  1750
```

NC	.040	.040	.030	.1	.3					
X1	224.5	12	1190	1330	260	260	300			
GR	5440	1000	5432	1050	5430	1190	5426.5	1220	5426.5	1280
GR	5430	1300	5431.5	1330	5430	1650	5432	1690	5430	1740
GR	5440	1810	5450	1880						
X1	225.0	12	1245.00	1375.00	720.00	900.00	800.00			
GR	5440.0	1000.0	5430.00	1045.0	5428.00	1110.0	5426.00	1245.0	5424.00	1265.0
GR	5424.0	1320.0	5426.00	1375.0	5428.00	1650.0	5428.00	1755.0	5427.60	1790.0
GR	5430.0	1840.0	5440.00	1920.0						
X1	226.	17	1500.00	1600.00	1010.00	1010.00	1010.00			
GR	5430.0	990.0	5418.00	1110.0	5418.00	1305.0	5419.00	1450.0	5418.00	1500.0
GR	5412.5	1525.0	5412.50	1555.0	5416.00	1565.0	5419.00	1600.0	5416.00	1660.0
GR	5410.0	1685.0	5408.00	1700.0	5410.00	1740.0	5414.00	1925.0	5418.00	1945.0
GR	5420.0	2020.0	5430.00	2180.0						
X1	227	26	1580	1740						
GR	5420	950	5410	1000	5408	1200	5406	1205	5404	1240
GR	5406	1250	5408	1265	5408	1430	5406	1560	5404	1575
GR	5402	1580	5400	1595	5396	1605	5394	1630	5394	1680
GR	5398	1700	5402	1740	5404	1750	5406	1770	5408	1850
GR	5408	1940	5406	2040	5408	2065	5408	2100	5410	2115
GR	5420	2175								

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

T1 TIJERAS ARROYO GRADE AND BANK STABILIZATION 93043.11
T2SUPERCRITICAL RUN WITH SOIL-CEMENT SLOPES, 100-YEAR FLOW FILE NAME: SUP_03.HC2
T3 ALT-3 SUPERCRITICAL RUN TIJERAS ARROYO EDIT DATE: (12-13-93)

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		3		1	-1					

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2	0	-1				-1			

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

THIS RUN EXECUTED 21DEC93 19:16:06

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.0; February 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ALT-3 SUPERCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	CWSEL	CRIWS	FRCH	VCH	K*XNL	K*XNCH	K*XNR	ELMIN
*	218.000	5471.08	5471.08	1.00	8.19	40.00	30.00	40.00	5468.00
*	218.000	5473.81	5473.81	.97	12.06	40.00	30.00	40.00	5468.00
	220.000	5454.05	5454.26	1.13	9.71	40.00	30.00	40.00	5451.50
*	220.000	5456.27	5457.28	1.35	16.30	40.00	30.00	40.00	5451.50
	220.500	5447.87	5448.09	1.08	10.38	40.00	30.00	40.00	5444.00
	220.500	5449.85	5450.37	1.28	15.96	40.00	30.00	40.00	5444.00
	220.700	5443.73	5443.92	1.01	8.70	40.00	40.00	30.10	5440.00
	220.700	5446.18	5446.56	.95	11.77	40.00	40.00	30.25	5440.00
*	222.000	5440.92	5440.92	.98	7.97	40.00	30.00	30.09	5437.00
	222.000	5443.45	5443.74	1.06	12.88	40.00	30.00	30.14	5437.00
	222.300	5437.75	5437.98	1.14	10.56	.00	30.10	.00	5435.00
*	222.300	5442.26	5442.26	.88	13.21	40.00	30.18	35.00	5435.00
*	222.600	5436.01	5436.01	1.00	11.12	.00	30.17	.00	5432.00
	222.600	5440.19	5440.77	.98	15.35	40.00	30.33	35.00	5432.00
*	224.000	5435.98	5435.98	.76	9.92	40.00	30.80	.00	5430.00
	224.000	5438.86	5439.36	.99	15.66	40.00	31.10	.00	5430.00
*	224.500	5431.32	5432.17	1.28	13.20	40.00	30.00	40.00	5426.50
*	224.500	5433.16	5434.39	1.50	19.22	40.00	30.00	40.00	5426.50
	225.000	5428.01	5428.63	1.14	12.04	40.00	30.00	40.00	5424.00
	225.000	5430.07	5430.70	1.24	16.47	40.00	30.00	40.00	5424.00
	226.000	5413.69	5414.11	1.86	7.49	.00	30.00	40.00	5408.00
	226.000	5416.90	5417.50	1.56	13.05	.00	30.00	40.00	5408.00

	SECNO	CWSEL	CRIWS	FRCH	VCH	K*XNL	K*XNCH	K*XNR	ELMIN
*	227.000	5400.30	5400.30	1.00	12.06	.00	30.00	.00	5394.00
*	227.000	5405.99	5406.56	.97	16.60	40.00	30.00	40.00	5394.00

ALT-3 SUPERCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	Q	QLOB	QCH	QROB	VLOB	VCH	VROB	DEPTH	AREA
*	218.000	7040.00	36.29	6995.34	8.36	2.50	8.19	2.48	3.08	872.12
*	218.000	24860.00	874.50	23784.01	201.49	4.88	12.06	4.83	5.81	2192.53
	220.000	7040.00	326.33	6675.59	38.08	4.25	9.71	4.18	2.55	773.41
*	220.000	24860.00	2487.71	22082.04	290.25	7.41	16.30	7.29	4.77	1730.67
	220.500	7040.00	837.20	4169.58	2033.22	3.69	10.38	5.74	3.87	982.68
	220.500	24860.00	6396.93	10836.99	7626.09	8.16	15.96	10.05	5.85	2222.36
	220.700	7040.00	135.59	3023.69	3880.72	4.52	8.70	9.12	3.73	802.99
	220.700	24860.00	1184.65	8403.59	15271.77	6.80	11.77	13.78	6.18	1996.61
*	222.000	7040.00	34.36	3964.01	3041.63	2.19	7.97	8.91	3.92	854.45
	222.000	24860.00	1120.43	14237.50	9502.06	5.02	12.88	13.26	6.45	2045.02
	222.300	7040.00	.00	7040.00	.00	.00	10.56	.00	2.75	666.66
*	222.300	24860.00	759.45	24089.13	11.42	3.17	13.21	2.99	7.26	2066.65
*	222.600	7040.00	.00	7040.00	.00	.00	11.12	.00	4.01	633.38
	222.600	24860.00	4081.01	20778.99	.00	5.69	15.35	.03	8.19	2071.02
*	224.000	7040.00	703.41	6336.58	.00	2.50	9.92	.00	5.98	919.89
	224.000	24860.00	9242.94	15617.06	.00	7.25	15.66	.00	8.86	2272.93
*	224.500	7040.00	202.79	6068.70	768.51	3.34	13.20	3.34	4.82	750.47
*	224.500	24860.00	2479.57	13805.52	8574.90	8.07	19.22	8.55	6.66	2028.18
	225.000	7040.00	544.96	5371.94	1123.10	4.00	12.04	3.90	4.01	870.73
	225.000	24860.00	3766.72	11765.33	9327.94	7.78	16.47	7.74	6.07	2403.31
	226.000	7040.00	.00	302.63	6737.37	.00	7.49	11.27	5.69	638.43
	226.000	24860.00	.00	2699.95	22160.05	.00	13.05	15.11	8.90	1673.38
*	227.000	7040.00	.00	7040.00	.00	.00	12.06	.00	6.30	583.58
*	227.000	24860.00	253.22	24375.30	231.48	3.40	16.60	4.65	11.99	1592.76

ALT-3 SUPERCRITICAL RUN

SUMMARY PRINTOUT

	SECNO	Q	DEPTH	STCHR	SSTA	ENDST	TOPWID
*	218.000	7040.00	3.08	1855.00	1418.21	1861.23	443.02
*	218.000	24860.00	5.81	1855.00	1350.84	1876.90	526.06
	220.000	7040.00	2.55	1820.00	1444.72	1828.93	384.21
*	220.000	24860.00	4.77	1820.00	1362.65	1838.67	476.02
	220.500	7040.00	3.87	1700.00	1317.01	1898.69	581.68
	220.500	24860.00	5.85	1700.00	1253.71	1909.26	655.55
	220.700	7040.00	3.73	1350.00	1165.35	1617.32	451.97
	220.700	24860.00	6.18	1350.00	1116.49	1641.75	525.26
*	222.000	7040.00	3.92	1600.00	1325.67	1744.79	419.12
	222.000	24860.00	6.45	1600.00	1230.64	1751.12	520.49
	222.300	7040.00	2.75	1659.00	1406.76	1655.62	248.86
*	222.300	24860.00	7.26	1659.00	1202.31	1662.38	460.07
*	222.600	7040.00	4.01	1626.00	1455.98	1622.01	166.03
	222.600	24860.00	8.19	1626.00	1151.96	1626.22	474.27
*	224.000	7040.00	5.98	1580.00	1163.59	1567.93	404.34
	224.000	24860.00	8.86	1580.00	1045.59	1576.58	531.00
*	224.500	7040.00	4.82	1330.00	1097.82	1749.22	577.94
*	224.500	24860.00	6.66	1330.00	1042.72	1762.16	719.44
	225.000	7040.00	4.01	1375.00	1109.67	1798.55	688.88
	225.000	24860.00	6.07	1375.00	1044.68	1840.57	795.89
	226.000	7040.00	5.69	1600.00	1519.65	1910.05	279.08
	226.000	24860.00	8.90	1600.00	1505.02	1939.48	367.83
*	227.000	7040.00	6.30	1740.00	1592.73	1723.02	130.29
*	227.000	24860.00	11.99	1740.00	1205.15	1769.91	254.65

ALT-3 SUPERCRITICAL RUN

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
*	218.000	.00	.00	.00	5468.00	7040.00	5471.08	5471.08	5472.12	102.74	8.19	872.12	694.56
*	218.000	.00	.00	.00	5468.00	24860.00	5473.81	5473.81	5475.99	73.10	12.06	2192.53	2907.69
	220.000	1445.00	.00	.00	5451.50	7040.00	5454.05	5454.26	5455.45	127.21	9.71	773.41	624.18
*	220.000	1445.00	.00	.00	5451.50	24860.00	5456.27	5457.28	5460.03	144.92	16.30	1730.67	2065.06
	220.500	555.00	.00	.00	5444.00	7040.00	5447.87	5448.09	5449.04	107.78	10.38	982.68	678.10
	220.500	555.00	.00	.00	5444.00	24860.00	5449.85	5450.37	5452.32	126.40	15.96	2222.36	2211.22
	220.700	275.00	.00	.00	5440.00	7040.00	5443.73	5443.92	5444.96	179.39	8.70	802.99	525.62
	220.700	275.00	.00	.00	5440.00	24860.00	5446.18	5446.56	5448.75	125.60	11.77	1996.61	2218.19
*	222.000	225.00	.00	.00	5437.00	7040.00	5440.92	5440.92	5442.00	98.23	7.97	854.45	710.30
	222.000	225.00	.00	.00	5437.00	24860.00	5443.45	5443.74	5445.99	88.36	12.88	2045.02	2644.72
	222.300	200.00	.00	.00	5435.00	7040.00	5437.75	5437.98	5439.48	123.83	10.56	666.66	632.63
*	222.300	200.00	.00	.00	5435.00	24860.00	5442.26	5442.26	5444.89	54.01	13.21	2066.65	3382.78
*	222.600	250.00	.00	.00	5432.00	7040.00	5436.01	5436.01	5437.93	87.04	11.12	633.38	754.58
	222.600	250.00	.00	.00	5432.00	24860.00	5440.19	5440.77	5443.33	66.77	15.35	2071.02	3042.41
*	224.000	250.00	.00	.00	5430.00	7040.00	5435.98	5435.98	5437.36	46.21	9.92	919.89	1035.61
	224.000	250.00	.00	.00	5430.00	24860.00	5438.86	5439.36	5441.56	71.44	15.66	2272.93	2941.30
*	224.500	385.00	.00	.00	5426.50	7040.00	5431.32	5432.17	5433.67	141.22	13.20	750.47	592.42
*	224.500	385.00	.00	.00	5426.50	24860.00	5433.16	5434.39	5436.84	171.15	19.22	2028.18	1900.23
	225.000	300.00	.00	.00	5424.00	7040.00	5428.01	5428.63	5429.78	114.14	12.04	870.73	658.96
	225.000	300.00	.00	.00	5424.00	24860.00	5430.07	5430.70	5432.56	114.24	16.47	2403.31	2325.90
	226.000	800.00	.00	.00	5408.00	7040.00	5413.69	5414.11	5415.61	217.98	7.49	638.43	476.83
	226.000	800.00	.00	.00	5408.00	24860.00	5416.90	5417.50	5420.35	168.33	13.05	1673.38	1916.10
*	227.000	1010.00	.00	.00	5394.00	7040.00	5400.30	5400.30	5402.56	81.46	12.06	583.58	780.00
*	227.000	1010.00	.00	.00	5394.00	24860.00	5405.99	5406.56	5410.19	59.19	16.60	1592.76	3231.43

ALT-3 SUPERCRITICAL RUN

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	218.000	7040.00	5471.08	.00	.00	.00	443.02	.00
*	218.000	24860.00	5473.81	2.73	.00	.00	526.06	.00
	220.000	7040.00	5454.05	.00	-17.04	.00	384.21	1445.00
*	220.000	24860.00	5456.27	2.22	-17.54	.00	476.02	1445.00
	220.500	7040.00	5447.87	.00	-6.17	.00	581.68	555.00
	220.500	24860.00	5449.85	1.98	-6.42	.00	655.55	555.00
	220.700	7040.00	5443.73	.00	-4.14	.00	451.97	275.00
	220.700	24860.00	5446.18	2.44	-3.67	.00	525.26	275.00
*	222.000	7040.00	5440.92	.00	-2.82	.00	419.12	225.00
	222.000	24860.00	5443.45	2.54	-2.73	.00	520.49	225.00
	222.300	7040.00	5437.75	.00	-3.17	.00	248.86	200.00
*	222.300	24860.00	5442.26	4.51	-1.20	.00	460.07	200.00
*	222.600	7040.00	5436.01	.00	-1.74	.00	166.03	250.00
	222.600	24860.00	5440.19	4.18	-2.07	.00	474.27	250.00
*	224.000	7040.00	5435.98	.00	-.03	.00	404.34	250.00
	224.000	24860.00	5438.86	2.89	-1.32	.00	531.00	250.00
*	224.500	7040.00	5431.32	.00	-4.66	.00	577.94	385.00
*	224.500	24860.00	5433.16	1.84	-5.71	.00	719.44	385.00
	225.000	7040.00	5428.01	.00	-3.31	.00	688.88	300.00
	225.000	24860.00	5430.07	2.06	-3.09	.00	795.89	300.00
	226.000	7040.00	5413.69	.00	-14.33	.00	279.08	800.00
	226.000	24860.00	5416.90	3.22	-13.17	.00	367.83	800.00
*	227.000	7040.00	5400.30	.00	-13.38	.00	130.29	1010.00
*	227.000	24860.00	5405.99	5.69	-10.91	.00	254.65	1010.00

SUMMARY OF ERRORS AND SPECIAL NOTES

```
CAUTION SECNO=    218.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    218.000  PROFILE=  2  CRITICAL DEPTH ASSUMED

WARNING SECNO=    220.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=    222.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    222.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    222.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    222.300  PROFILE=  2  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    222.300  PROFILE=  2  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    222.300  PROFILE=  2  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    222.600  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    222.600  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    222.600  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=    224.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    224.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    224.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=    224.500  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO=    224.500  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=    227.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=    227.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=    227.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL
WARNING SECNO=    227.000  PROFILE=  2  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

Normal program termination
```

APPENDIX D

COST ESTIMATES

1. Impermeable Membrane Cost Estimates
2. Option 1: Riprap Slope Stabilization
3. Option 2: Gabion Slope Stabilization
4. Option 3A: Soil-Cement Slope Stabilization and Scour Protection
5. Option 3B: Soil-Cement Slope Stabilization and Sheet Pile Scour Protection

LEEDSHILL - HERKENHOFF, INC.

Albuquerque • San Diego • Santa Fe

ENGINEERING COMPUTATIONS

NAME OF PROJECT: TIJERAS ARROYO - OPT 3 & 3A

SHEET NUMBER: 1 OF 2

COMPUTED BY: TRB

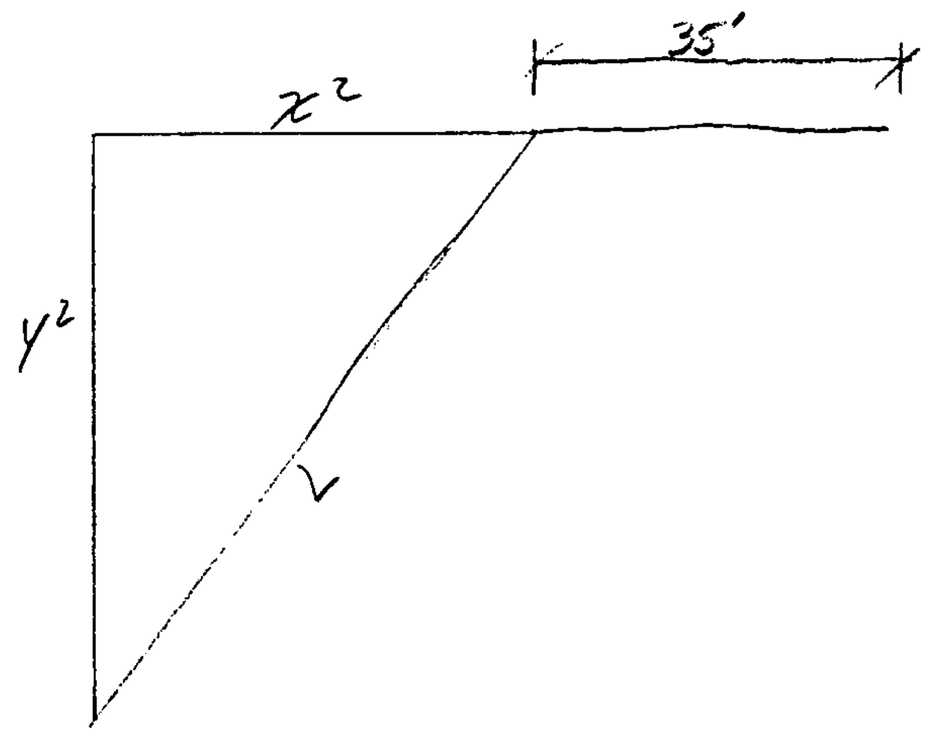
CHECKED BY: DWD

JOB NUMBER: 93043.11

DATE: 12.28.93

Sec. No.	Top Elev.	x^2	y^2	L + 35	= Leff
220.7	5500	130 16,900	3069	176.3	
				225	41.1 E3
222.0	5500	145 21,025	2673	188.9	
				225	43.75E3
222.3	5488	160 10,851	1,656	200	
				250	42.6E3
222.6	5482	100 8,789	1,260	141.1	
				225	38.3E3
224.0	5481	160 27,778	1303	199.0	
					165.7E3

Leff (ave) = 179.2'



Use L = 179

LEEDSHILL · HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT: TIJERAS ARROYO			SHEET NUMBER: 2 OF 2
	COMPUTED BY: TRB	CHECKED BY: DWP	JOB NUMBER: 93043.11	DATE: 12.28.93

Quantities

CITY ENGR. EST. UNIT PRICES SPRING, 1992

TOM

ITEM	UNIT	UNIT COST	QUANTITY	COST
Sand fill $(\frac{8}{12})(179)(925)/27$	CY	7.90	4,088	$32,300
Membrane $(179+5)(925)$	SF	0.75	170,200	$127,650
Earth fill $\frac{12}{12}(179)(925)/27$	CY	5.25	6,132	$32,200
6" gravel mulch $(179)(925)/9$	SY CY	19.75	18,400 3,066	$60,550
Vegetation $\frac{(179)(925)}{43560}$	Ac.	1,200	38.	$4,560
Soil Prep	SY	0.80	18,400	$14,720

$271,980

use $272,000

FREEBOARD CALCULATIONS FOR SUBCRITICAL FLOW
ALTERNATIVE 3

SEC NO.	ELMIN	CWSEL	EG	VCH	0.5 Ha	FREEBOARD	
						HEIGTH	ELEV.
220.7	5440.0	5446.6	5448.7	10.7	1.6	3.7	5450.3
222.0	5437.0	5444.4	5446.1	10.5	1.5	3.2	5447.4
222.3	5435.0	5442.3	5444.9	13.2	2.4	5.0	5447.3
222.6	5432.0	5440.8	5443.2	13.7	2.6	5.0	5445.7
224.0	5430.0	5439.3	5441.5	14.2	2.7	4.9	5444.2

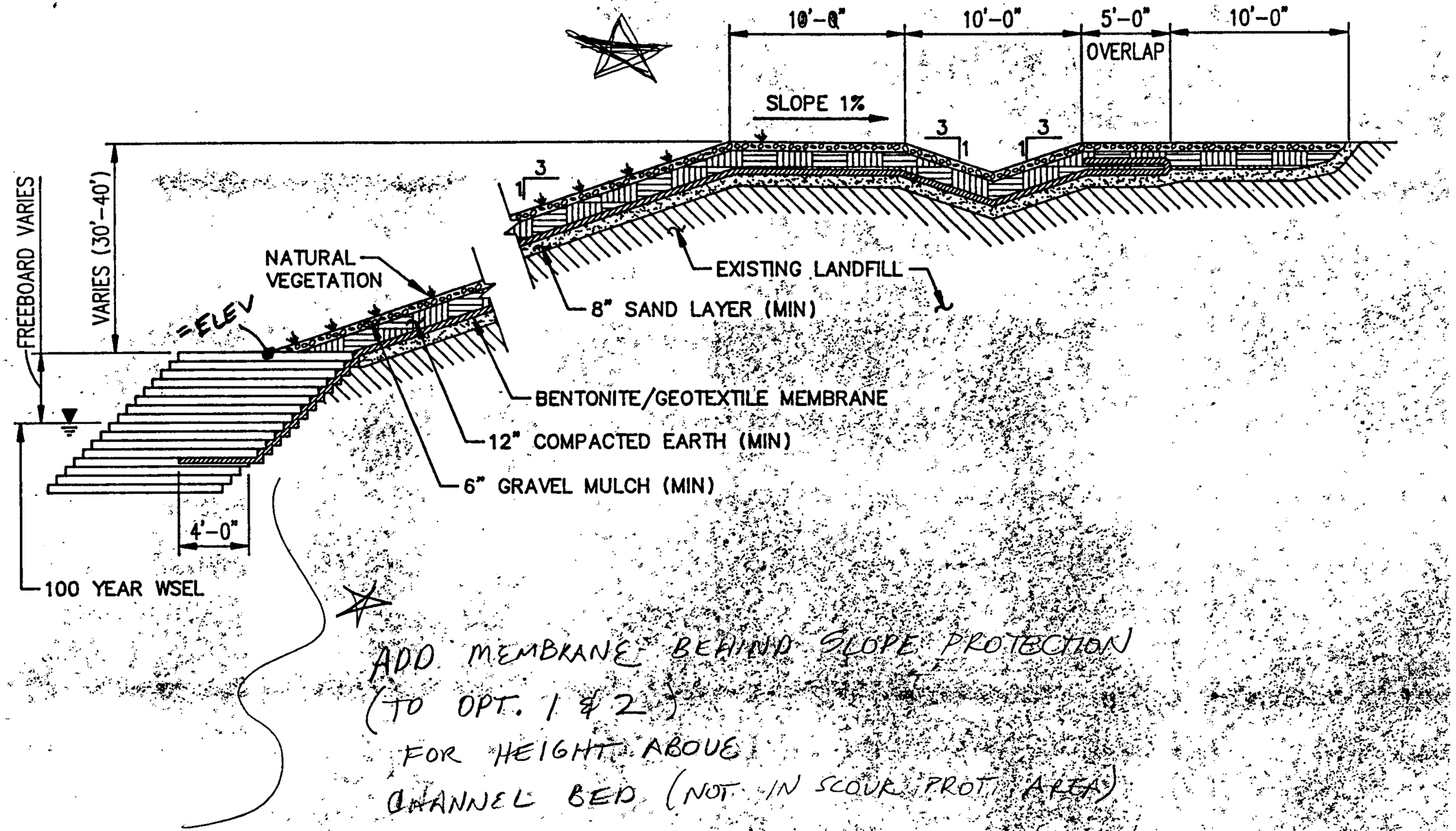
FREEBORD.WK1

FREEBOARD CALCULATIONS FOR SUPERCRITICAL FLOW
ALTERNATIVE 3

SEC NO.	ELMIN	CWSEL	EG	VCH	0.5 Ha	FREEBOARD	
						HEIGTH	ELEV.
220.7	5440.0	5446.2	5448.8	11.8	1.9	4.5	5450.6
222.0	5437.0	5443.5	5446.0	12.9	2.3	4.8	5448.3
222.3	5435.0	5442.3	5444.9	13.2	2.4	5.0	5447.3
222.6	5432.0	5440.2	5443.3	15.4	3.2	6.4	5446.5
224.0	5430.0	5438.9	5441.6	15.7	3.3	6.0	5444.9

ELEVATIONS IN BOLD DENOTE CONTROLING FREEBOARD HEIGTH

SHT 5 OF 8



ADD MEMBRANE BEHIND SLOPE PROTECTION (TO OPT. 1 & 2) FOR HEIGHT ABOVE CHANNEL BED (NOT IN SCOUR PROT. AREA)

FIGURE 9

TIJERAS ARROYO
LANDFILL TREATMENTS
VEGETATED GRAVEL MULCH

TIJERAS ARROYO

UNM 12/28/93

ESTIMATE QUANTITIES FOR:

OPTION 1 - RIPRAP (6' THICK)

$$\frac{28.1+30}{2} = \sqrt{[(29.05)\,3]^2 + 29.05^2}$$

$$= 91.9'\,(6)(225 = 124,065$$

$$+ \sqrt{3\left(\frac{30+33.8}{2}\right)^2 + 100.9^2}\;(6)(200)$$

$$= 121,080$$

$$+ \sqrt{3\cdot\left(\frac{33.8+36.2}{2}\right)^2 + 110.7^2}\;(6)(250)$$

$$= 166,050$$

$$+ \sqrt{3\left(\frac{36.2+37.1}{2}\right)^2 + 116^2}\;(6)(250)$$

$$= 174,000$$

TOTAL = $585,195/27 = 21,674$ CY

OPTION 2 GABIONS

$\left(\frac{1.5}{6}\right)$ 21,674 CY = 5,418.5 CY

6" FILTER

$\frac{.5}{1.5}(5420) = 1806$ CY

1 FT FILTER

$\frac{21,674}{6} = 3,612$ CY

FOR OPTIONS 1 & 2
TO GET IMPERMEABLE BEHIND RIPRAP OR GABION
ADDITIONAL MEMBRANE

calc actual slope

3H:1V @ Σ

16.5 − 17.5 * 225
17.5 − 19.4 * 200
19.4 − 21.8 * 250
21.8 − 22.3 * 250

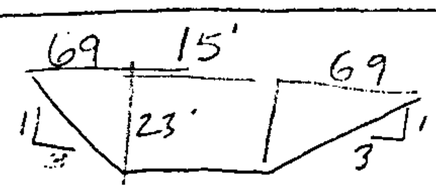
53.8 * 225 = 12,095
58.3 * 200 = 11669
65.1 * 250 = 16,286
69.7 * 250 = 17,432

57,482 SF
* .75/SF
membrane = $43,112

Sand $\frac{8}{12}\left(\frac{57482}{27}\right) = 1419$
* 7.90
= $ 1,427

TOTAL ADDITIONAL = $44,500

OPTIONS 1 & 2
EXCAVATION BELOW GRADE @ 3:1



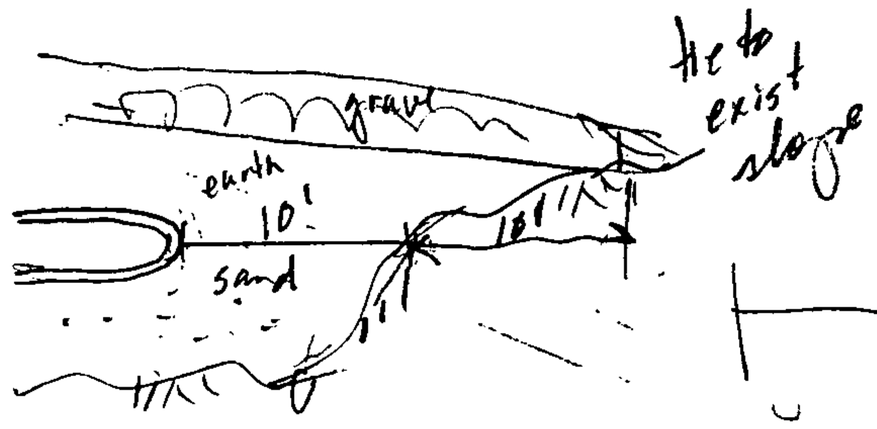
A = 69(23) + 15(23)
V = 925(1932) = 66,190 CY
27

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ENGINEERING COMPUTATIONS

NAME OF PROJECT			SHEET NUMBER OF
COMPUTED BY:	CHECKED BY:	JOB NUMBER	DATE:



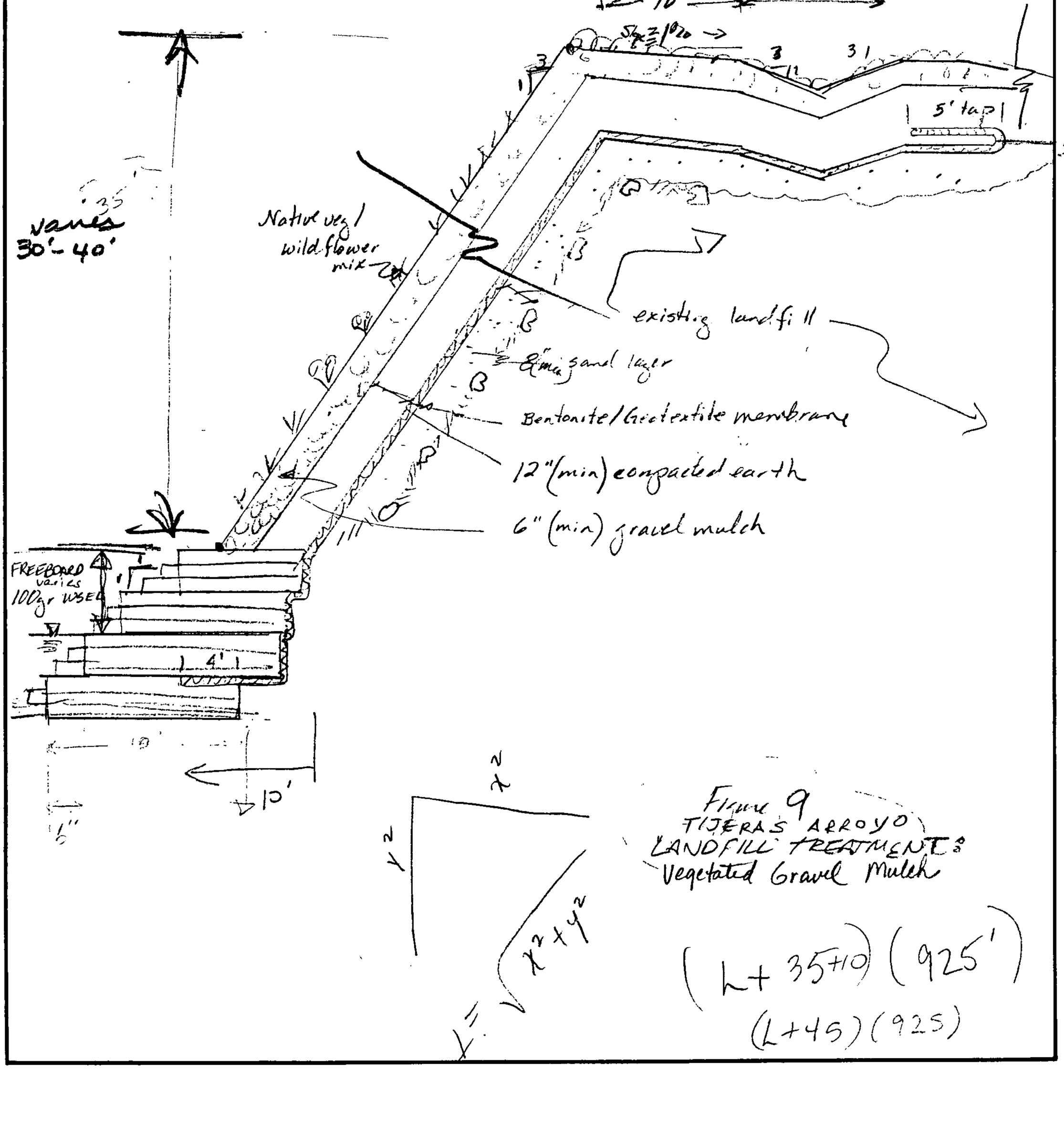


FIGURE 9
TIJERAS ARROYO
LANDFILL TREATMENT:
Vegetated Gravel Mulch

$(L+35+10)(925')$

$(L+45)(925)$

LEEDSHILL - HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER OF
	COMPUTED BY:	CHECKED BY:	JOB NUMBER	DATE:

Gravel Mulch Section ★

w/10" Sandfill – 6.00/LF =? /LF

Membrane – $0.50_{mat} + 0.25_{lab}$ /SF [0.75 x 0]/F

assume 35' slope + 3' FB +

$l = 50 + [(38)^2 + (38 \times 3)^2]^{1/2} =$

12' fill @ 4.00/CY /LF

6" gravel mulch @ $10.00 SY ? /LF

$l = 50 + [(35)^2 + (35 \times 3)^2]^{1/2}$

Veg – $1000/Acre conv /LF

l = same as gravel mulch

use Richards' removal =

Terrace Section

w 24" Sandfill – 6.00 CY /LF

Membrane

$l = 40 + 2 \times 5 + 2 \times 10 + [(38)^2 + (38 \times 4)^2]^{1/2} =$

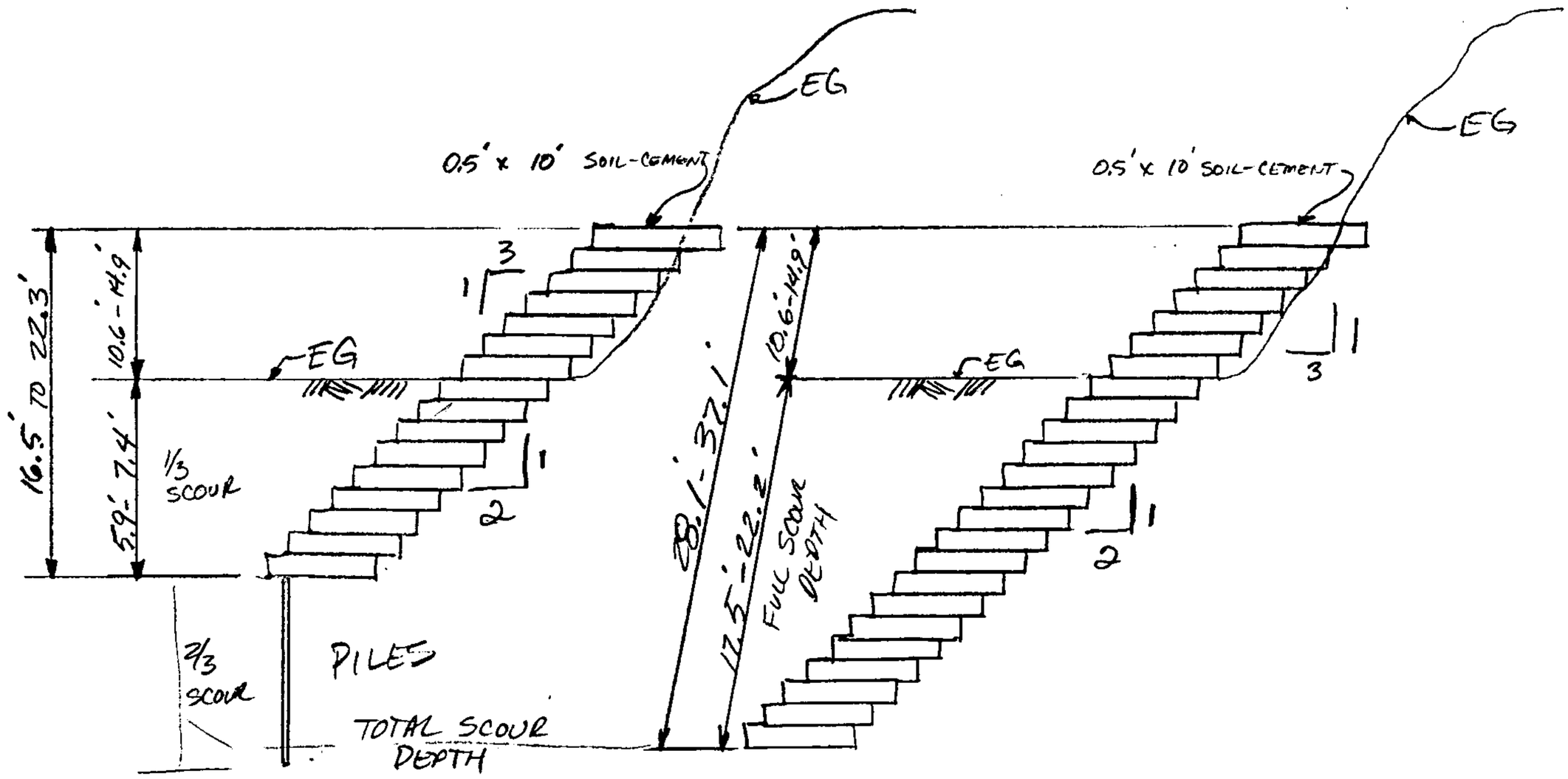
18" fill @ 4.00/CY /LF

6" topsoil @ 6.00/CY /LF

Veg $1000/Acre conv /LF

$l = 40 + 30 + [(35)^2 + (35 \times 4)^2]^{1/2}$

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	COMPUTED BY: RAS	CHECKED BY: Maturino	JOB NUMBER 93043.11	DATE: 12/23/93



ALT-3B -

- SOIL-CEMENT SLOPE PROTECTION TO A DEPTH OF 1/3 SCOUR DEPTH AND SHEET PILE SCOUR PROTECTION
- IMPERMIABLE MEMBRANE

ALT-3A

- FULL DEPTH SOIL-CEMENT
- IMPERMIABLE MEMBRANE

LEEDSHILL · HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT TIJERAS ARROYO			SHEET NUMBER 2 OF 11
	COMPUTED BY: RAS	CHECKED BY: Matumia	JOB NUMBER 93043.11	DATE: 12-22-93

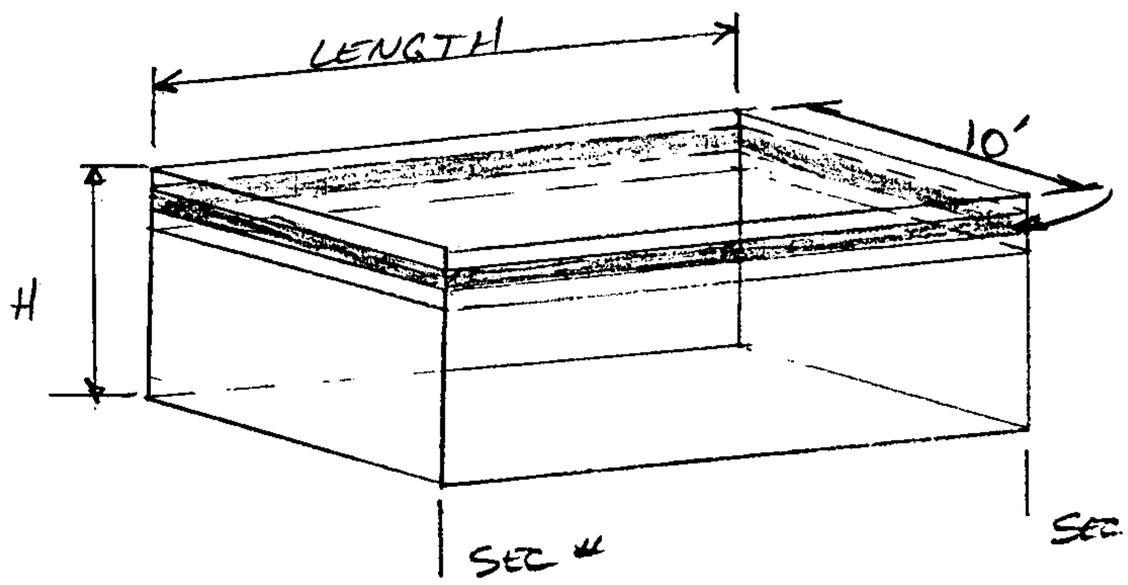
ABBREVIATIONS

E = EXPOSED + ⅓ SCOUR DEPTH

T = TOTAL HEIGHT

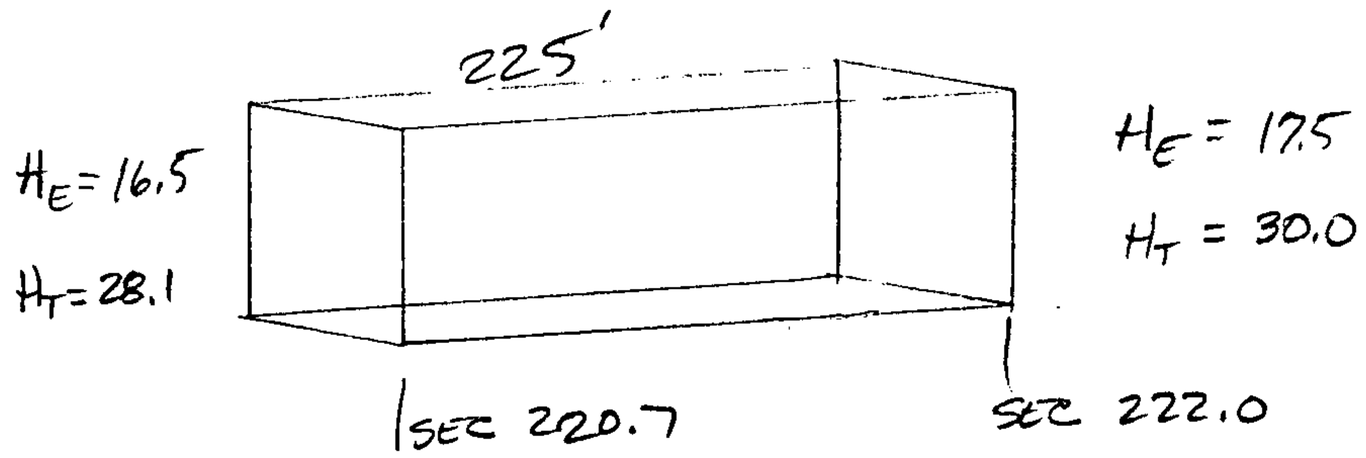
H = HEIGTH

V = VOLUME



TYPICAL VOLUMETRIC SECTION

NOTE! EVENTHOUGH SOIL-CEMENT SLOPE PROTECTION IS BUILT ON A SLOPE, THE 0.5' THICK SECTIONS ARE OFFSET TO CREATE A STAIR STEP SLOPE. I.E. A 1:1 SIDESLOPE WOULD BE OFFSET 0.5 PER LIFT, ETC.



ALT-3B

$$V = \frac{16.5 + 17.5}{2}(10)(225) = 38{,}250 \text{ ft}^3$$

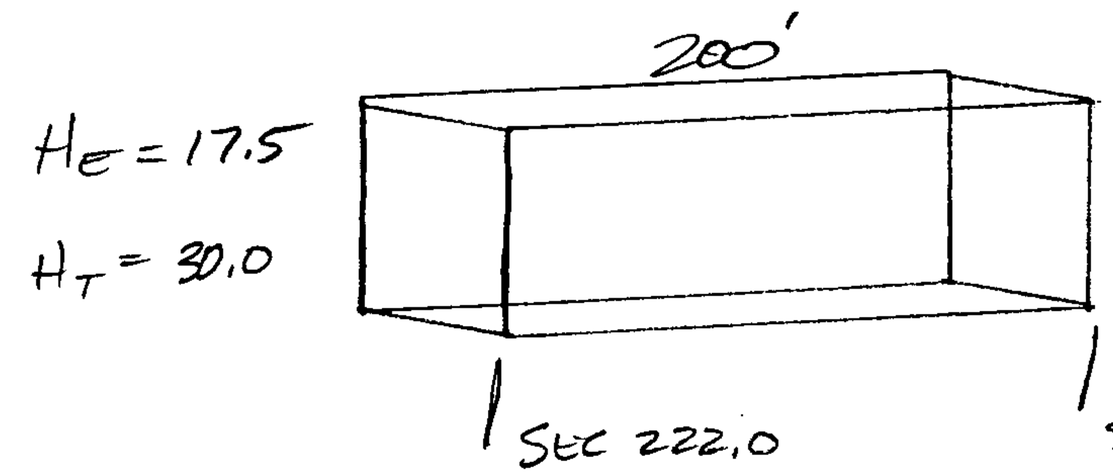
$$= \underline{1{,}417 \text{ cy}}$$

ALT-3A

$$V = \frac{28.1 + 30.0}{2}(10)(225) = 65{,}363 \text{ ft}^3$$

$$= \underline{2{,}421 \text{ cy}}$$

LEEDSHILL - HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT: TIJERAS ARROYO			SHEET NUMBER: 3 OF 11
	COMPUTED BY: RAS	CHECKED BY: Matunis	JOB NUMBER: 93043.11	DATE: 12-23-93



ALT-3B

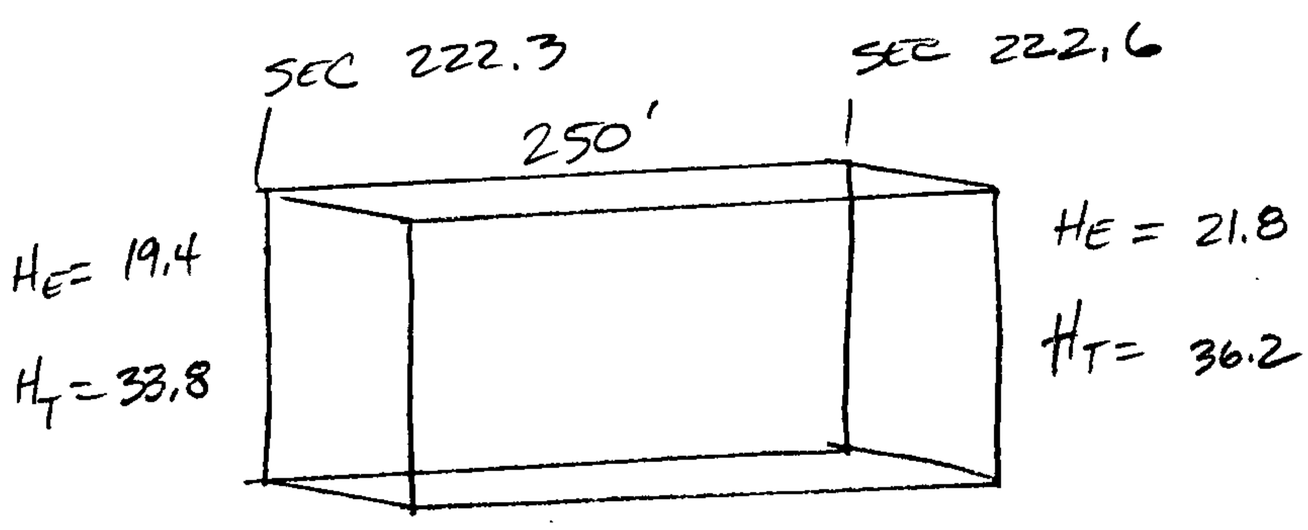
$$V = \frac{17.5 + 19.4}{2}(10)(200) = 36{,}900 \text{ ft}^3$$

$$= 1{,}367 \text{ cy}$$

ALT-3A

$$V = \frac{30.0 + 33.8}{2}(10)(200) = 63{,}800 \text{ ft}^3$$

$$= 2{,}363 \text{ cy}$$



ALT-3B

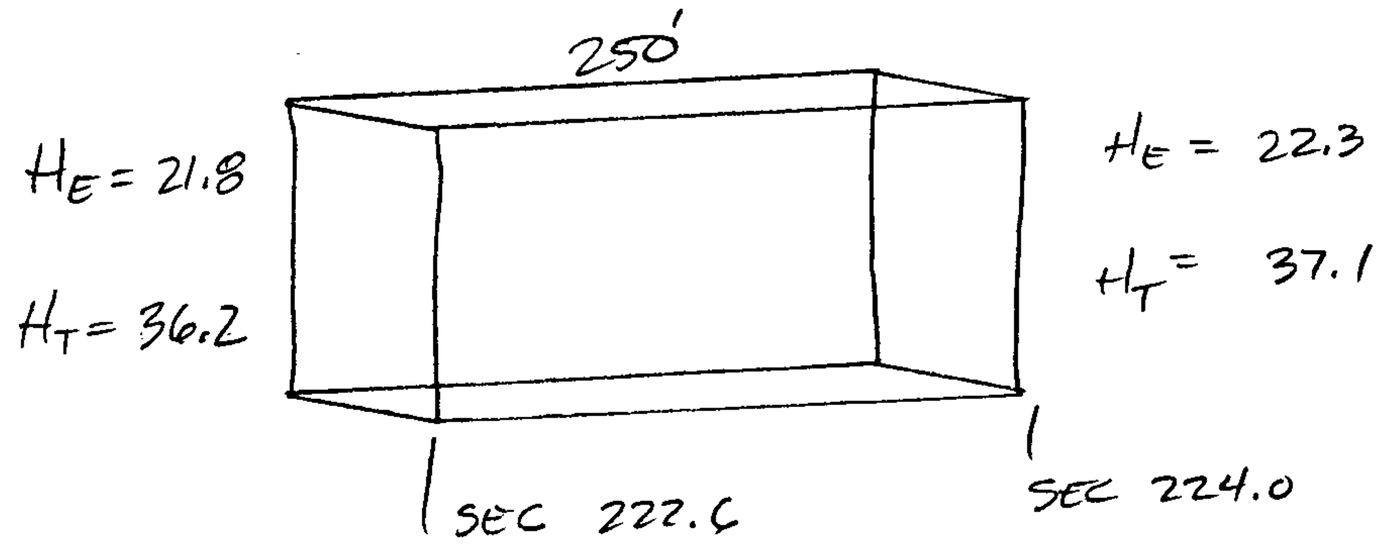
$$V = \frac{19.4 + 21.8}{2}(10)(250) = 51{,}500 \text{ ft}^3$$

$$= 1{,}907 \text{ cy}$$

ALT-3A

$$V = \frac{33.8 + 36.2}{2}(10)(250) = 87{,}500 \text{ ft}^3$$

$$= 3{,}241 \text{ cy}$$



ALT-3B-

$$V = \frac{21.8 + 22.3}{2}(10)(250) = 55{,}125\ ft^3$$

$$= 2{,}042\ cy$$

ALT-3A

$$V = \frac{36.2 + 37.1}{2}(10)(250) = 91{,}625\ ft^3$$

$$= 3{,}394\ cy$$

LEEDSHILL · HERKENHOFF, INC.
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ENGINEERING COMPUTATIONS

NAME OF PROJECT			SHEET NUMBER
TIJERAS ARROYO - TAKE OFF			5 OF 11
COMPUTED BY: (GN)/RS	CHECKED BY: Matuna	JOB NUMBER 93043	DATE: 12-22-93

TAKE-OFF SUMMARY

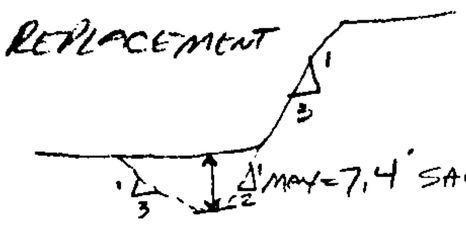
SEC. #	ALT-3B	ALT-3A
220.7		
	1,417	2,421
222.0		
	1,367	2,363
222.3		
	1,907	3,241
222.6		
	2,042	3394
224.0		
TOTALS	6,733 CY	11,419 CY

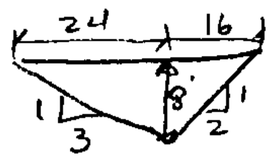
EARTHWORK QUANITIES — (RAS)

1) EXCAVATION FOR SLOPE PROTECTION AND REPLACEMENT

ALT-3B

$L = 925'$





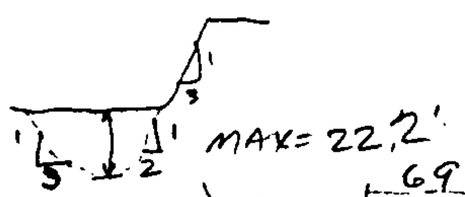
$A = \frac{1}{2}(24)(8) + \frac{1}{2}(16)(8) = 160\ \#'$

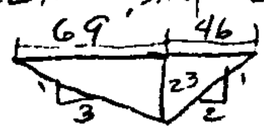
$V = 925(160) = 148{,}000\ \#' = 5{,}480$ CY $+ 4111 =$ 9600 CY

provide 15' flat width on bottom
8'(15')(925)
= 111000 CF
= 4111 CY

ALT-3A

$L = 925$





$A = \frac{1}{2}(69)(23) + \frac{1}{2}(46)(23) = 1323\ \#'$

$V = 925(1323) = 1{,}223{,}775\ \#' = 45{,}325\ \#' + 11819 =$ 57150 CY

23 (15')(925)
= 319 125 CF
= 11819 CY

2) GRADE CHANNEL FOR HYDRAULIC SOLUTIONS

V= DEPTH (LENGTH X WIDTH)

V= (6)(300)(22) = 39,600 #' = 1467 SAY 1470 CY

FOR BOTH ALT-3A & 3B

TOTAL EARTH WORK QUANTITIES

ALT-3B

9600
~~5,480~~
1,470
~~6,550~~ CY
11070

ALT-3A

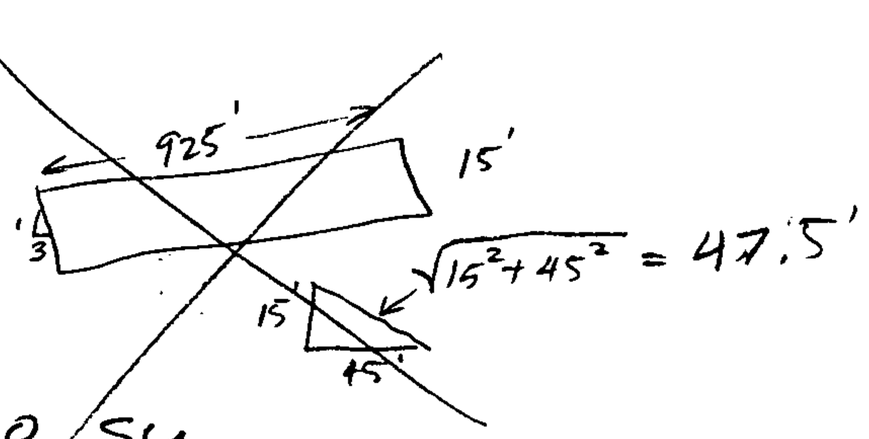
57150
~~45,325~~
1,470
~~46,795~~ SAY
58620
~~46,800 CY~~

IMPERMEABLE MEMBRANE

ALT-3B = ALT3A

$A = \frac{925\ (47.5')}{9} = 4875$

SAY 5,000 SY



LEEDSHILL - HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER 7 OF 11
	COMPUTED BY: RAS	CHECKED BY: Matsumi	JOB NUMBER	DATE:

DIVISION 1 COSTS

MOBILIZATION & DEMOBILIZATION

(LOCAL CONTRACTOR)
LESS THAN 50 MILES

ALT-3B — 2 SCRAPERS 2(1000) ~~2,000~~ 2000
2 D-9's W/VIB. ROLLERS 2(1500) ~~3,000~~ 3000
RCC PAVER & EQUIP. 2(1500 ~~5,500~~ 3000
MISC TRUCKS & EQUIP 500
PILE DRIVER W/JIB CRANE 5000 ~~8,000~~
~~#28,000~~ # 13500

ALT-3A — 2 SCRAPERS ~~4,000~~ 2000
2 D-9's W/VIB. ROLLERS ~~8,000~~ 3000
RCC PAVER & EQUIP ~~5,500~~ 3000
MISC TRUCKS & EQUIP 500
~~$18,000~~ $ 8500

CONSTRUCTION STAKING FOR WALL LAYOUT

ALT 3A & 3B

$925 (110 X 0.08^{\#}/SF) = 8,140$ SAY 8,000

MATERIAL TESTING FOR WALL & TOE

ALT 3A & 3B

$925 (110 X 0.12^{\#}/SF) = 12,210$ SAY ~~12,000~~ 20 000

LEEDSHILL - HERKENHOFF, INC.

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ENGINEERING COMPUTATIONS

NAME OF PROJECT			SHEET NUMBER OF
COMPUTED BY:	CHECKED BY:	JOB NUMBER	DATE:

Testing

11,000 y^3 soil Cement. - 17000 Tons

10 y³/ 5 min ≈ 10 days placement Time

Titrations?

Lab Tests (comp. str & wet wt) 2 */day = 20 sets

Field 10 days @ 10 hrs/day = 100 Tech Hours

100 Tech Hours @ 40.00/hr = 4,000.00

20 sets s/c tests @ 250.00 ea = 5000.00

P.E review, report, etc lump = 1,000.00

ST = $10 k

just for soil cement
double for subgrade,
backfill & channel
compaction testing

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY CONSTRUCTION COST ESTIMATE
OPTION 1

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$8,500.00	$8,500
DEMOBILIZATION	1	LS	8,500.00	8,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	15,000.00	15,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,525	CY	4.00	6,100
INSTALL IMPERM. MEMBRANE	1	LS	316,500.00	316,500
INSTALL 1' GRAVEL FILTER	3,615	CY	12.00	43,380
INSTALL 6' RIP–RAP	21,674	CY	46.00	997,004
EXC, BACKFLL, COMPCT SCOUR PROT	66,190	CY	5.00	330,950
SUBTOTAL				1,743,934
CONTINGENCES	20.00	%		348,787
TOTAL BASE BID				**$2,092,721**

TJOPT11.WK1

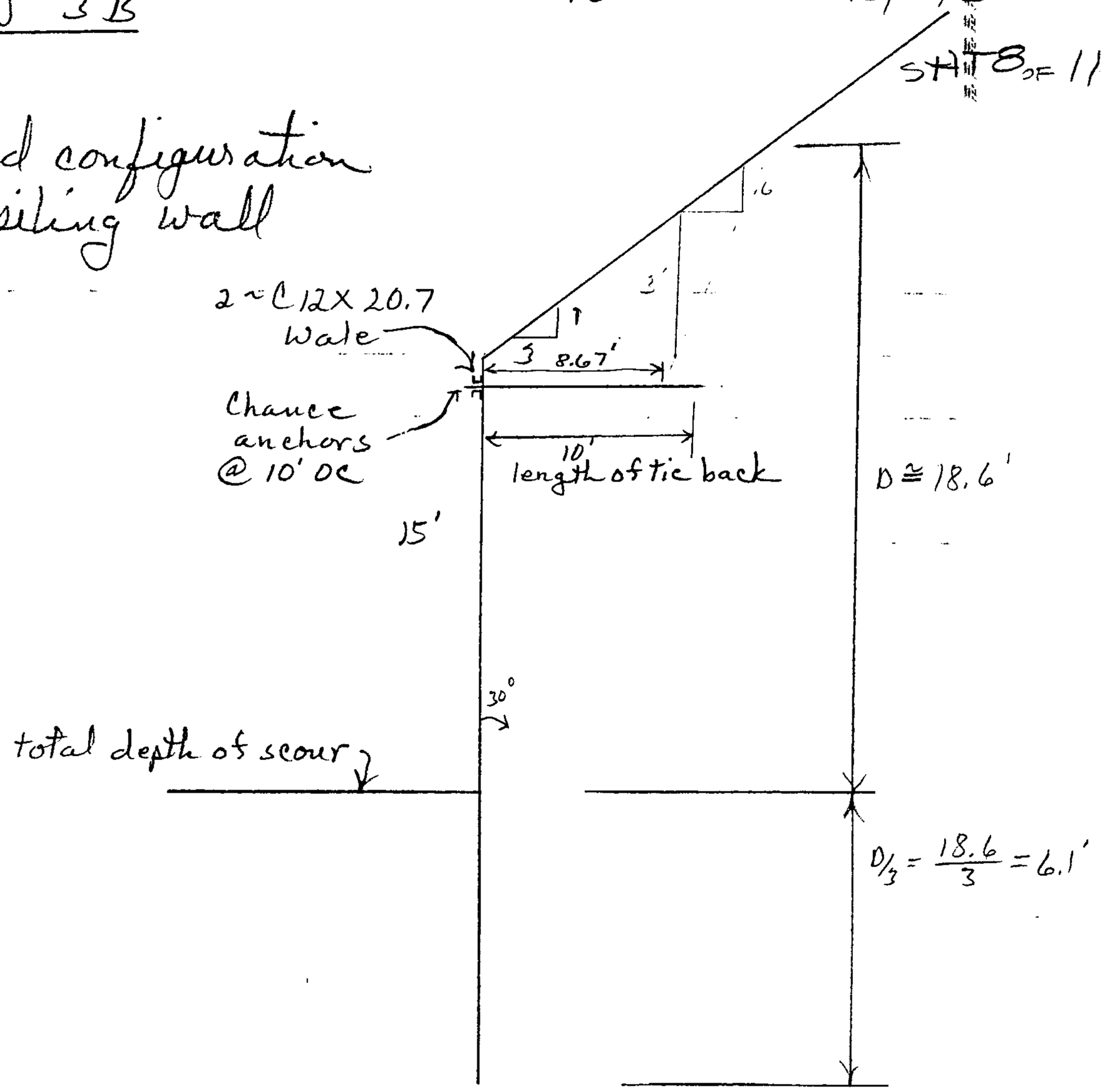
TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY CONSTRUCTION COST ESTIMATE
OPTION 2

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$8,500.00	$8,500
DEMOBILIZATION	1	LS	8,500.00	8,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	15,000.00	15,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,500	CY	4.00	6,000
6" GRANULAR FILL	1,806	CY	19.75	35;669
INSTALL IMPERM. MEMBRANE	1	LS	316,500.00	316,500
INSTALL 18" DEEP GABIONS	5,418	CY	90.00	487,620
EXC, BACKFLL, COMPCT SCOUR PROT.	66,190	CY	5.00	330,950
SUBTOTAL				1,226,739
CONTINGENCES	20.00	%		245,348
TOTAL BASE BID				**$1,472,086**

TJOPT2.WK1

OPTION 3B

Assumed configuration of sheetpiling wall



Sheet piling length = 15' + 6.1' ≅ 21' = tallest
Use 20' as average

length of wall = 925 ft.

LEEDSHILL · HERKENHOFF, INC. Albuquerque • San Diego • Santa Fe ENGINEERING COMPUTATIONS	NAME OF PROJECT Tijeras Arroyo			SHEET NUMBER 9 OF 11
	COMPUTED BY: Matunis	CHECKED BY: RER	JOB NUMBER 93043.11	DATE: 12/23/93

Quantities

Sheet piling 27 psf (assume) (20')(925' of wall) = 499500 lb = 250 Tons

Wales: 20.7 plf (2)(2)(925' of wall) = 76590 lb. = 38.3 Tons

Anchors: 925'/10' (10' length) = 925 ft.

Cost

Sheetpiling	250 T	($375/Ton)	= $268750	Means
Wales	38.3 T	($2000/Ton)	= 76600	Supplier
Anchors	925 ft	($65/ft)	= 60125	Contractor

$405475 fully loaded cost

TOTAL UNIT COST = $\frac{\$405,475}{925'} = 438.35$ /LF

SF cost = $\frac{438.35}{20'} = 21.92$ /SF

Reinforced slurry wall minimum cost = 25.50 /SF > sheet piling

Maximum cost = $72.00 /SF >> sheet piling

(cost from Means)

TABLE 5

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY PROJECT COST ESTIMATE
OPTION 3A

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$8,500.00	$8,500
DEMOBILIZATION	1	LS	8,500.00	8,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	20,000.00	20,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,450	CY	4.00	5,800
EXC, BKFLL, COMPCT SCOUR PROT	57,150	CY	4.00	228,600
GRADE LANDFILL SIDE–SLOPES	300	CY	5.00	1,500
INSTALL IMPERM. MEMBRANE	1	LS	272,000.00	272,000
INSTALL SOIL–CEMENT SLOPE IN	11,420	CY	28.00	319,760
0.5' x 10' WIDE LIFTS				
SUBTOTAL				882,660
CONTINGENCES	20.00	%		176,532
ESTIMATED PROJECT COST				**1,059,192**

TJOPT3A.WK1

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY PROJECT COST ESTIMATE
ALTERNATIVE 3B

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$13,500.00	$13,500
DEMOBILIZATION	1	LS	13,500.00	13,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	20,000.00	20,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,450	CY	4.00	5,800
EXC, BCKFLL, COMPCT SCOUR PROT	9,600	CY	4.00	38,400
GRADE LANDFILL SIDE-SLOPES	300	CY	5.00	1,500
INSTALL IMPERM. MEMBRANE	1	LS	272,000.00	272,000
INSTALL SHEET PILES	925	LF	440.00	407,000
INSTALL SOIL-CEMENT SLOPE IN	6,735	CY	32.00	215,520
0.5' x 10' WIDE LIFTS				
SUBTOTAL				1,005,220
CONTINGENCES	20.00	%		201,044
ESTIMATED PROJECT COST				**$1,206,264**

TJOPT3B.WK1

DANIEL W. COOK, CHAIRMAN
PAT D. HIGDON, VICE-CHAIRMAN
RONALD BROWN, SECRETARY-TREASURER
GENEIVA MEEKER, ASST. SECRETARY-TREASURER
MICHAEL MURPHY, DIRECTOR

LARRY A. BLAIR
EXECUTIVE ENGINEER

Albuquerque
Metropolitan
Arroyo
Flood
Control
Authority

2600 PROSPECT N.E. - ALBUQUERQUE, N.M. 87107
TELEPHONE (505) 884-2215

December 27, 1993

Dr. Richard Heggen, PE, Ph.D.
620 Ridgecrest, SE
Albuquerque, NM 87108

RE: Hydrology/Hydraulic Review of Drainage Plan for South Eubank Landfill adjacent to Tijeras Arroyo, by Leedshill-Herkenhoff, Inc. Ninth Supplement to Agreement for Engineering Services Hydrology/Hydraulic Review dated December 3, 1990

Dear Richard:

You are authorized to proceed with hydrology and hydraulics review for the above-referenced project. As we recently discussed, this report has not been submitted to AMAFCA, but will need to be reviewed promptly when it is available. Water surface, bank stability and scour will be critical drainage issues at this site. This work will be under the Agreement for Engineering Services dated December 3, 1990. Fees for this work will be on a unit price basis, with a maximum fee for the work not to exceed $2,000, plus applicable gross receipts tax.

AMAFCA's contact on this project will be Cliff Anderson.

Sincerely,
AMAFCA

Larry A. Blair, P.E.
Executive Engineer

LAB:ij

copy: Robert Foglesong, Bernalillo County Surface Water Hydrologist
Gilbert Aldaz, City-County Floodplain Administrator
Steve Metro, Wilson & Company

Gilbert Aldaz
City PWO

M21/Z1

BLVD

SANDIA

SU-1 IP USES

SU-1 IP USES

SU-1 IP USES

RESEARCH

SU-1 IP USES

PARK

EUBANK

SU-1 MH PARK

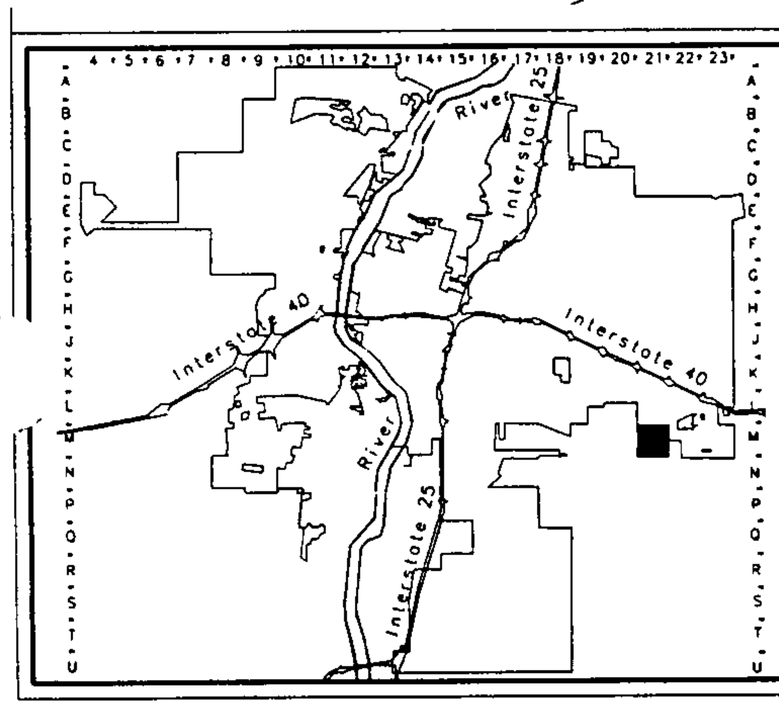
RECO CORP TRACTS

FOUR HILLS MOBILE HOME PARK

PROJECT LOCATION

(TIJERAS ARROYO STABILIZATION @ LANDFILL)

TIJERAS ARROYO



North

750 375 0 750

Scale: 1" = 750'

Albuquerque Geographic Information System

City of Albuquerque

© Planning Department July 04, 1993

LEGAL DESCRIPTION

T10N

R4E

SEC 33

UNIFORM PROPERTY CODE

1-021-C55

M-21-Z

To: Dolores

From: Gilbert

Please make a file

TIJERAS ARROYO GRADE AND BANK STABILIZATION

PRELIMINARY TECHNICAL REPORT



for

THE NEW MEXICO
STATE LAND OFFICE

December 15, 1993

Prepared by

LEEDSHILL-HERKENHOFF, INC.
500 Copper Avenue NW, Suite 500
Albuquerque, New Mexico 87102
505.247.0294

TIJERAS ARROYO GRADE AND BANK STABILIZATION

PRELIMINARY TECHNICAL REPORT

General

To eliminate further deterioration of the landfill embankment, and to establish a stable and hydraulically efficient channel section, three alternative concepts have been developed and evaluated. All of the alternatives include: repair of failed landfill embankment, reconstruction of landfill side slopes, regrading the existing low flow channel, and erosion control and protection of the landfill embankment against the 10-year and 100-year design flows. It is variation in the materials used for erosion protection that makes each alternative unique. Three types of erosion control: rip-rap on a 3:1 side slope, gabions on a 3:1 side slope, and soil-cement at a 1.5:1 side slope, were evaluated as alternatives 1, 2, and 3. These alternatives are shown on Plates 1, 2, and 3, respectively. For reference, the original section is shown on Plate 4.

Embankment Reconstruction

Initial field investigations have revealed evidence of slope erosion and slope failure at the landfills toe of slope adjacent to the low flow channel. The original 3:1 sloping embankment has eroded to nearly vertical cuts of 15 feet in height. Surface rupture lines along the slope face parallel to the toe, were found during the investigation. This indicates the existence of failure planes within the slope which will need to be addressed as part of our solution. Approximately 100 feet of the slope has failed, the remaining 600 feet has no physical evidence of failure and would not require reconstruction. Due mostly to the fact that the

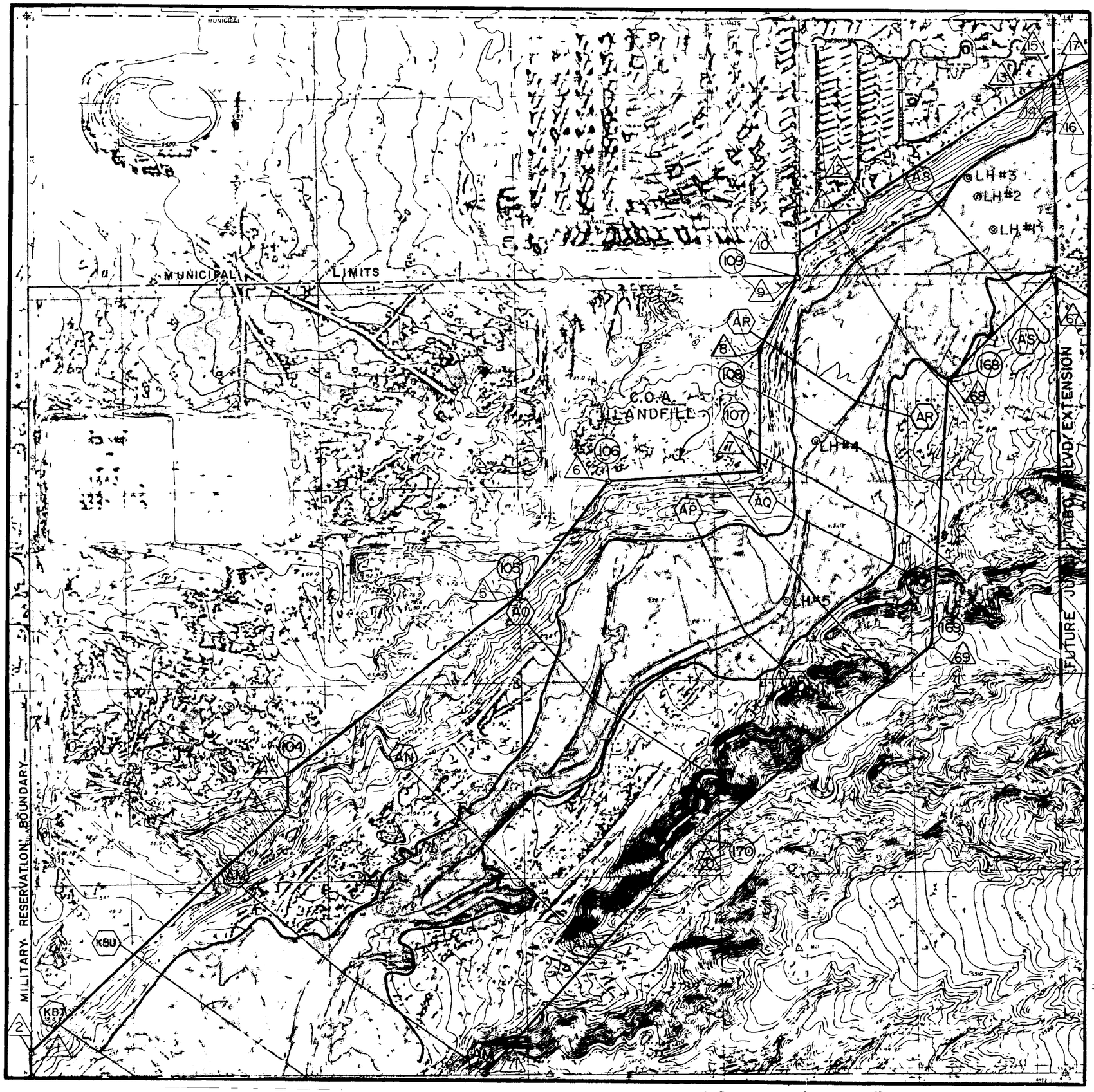
failed slope consists of landfill material which contains large amounts of debris, this type of soil may not be appropriate for use in embankment reconstruction. Disposal of this material is an issue which will need to be addressed with respect to federal, state and local agencies' regulations.

If suitable for embankment construction, potential on-site sources of fill would include cut from grading the low flow channel and a possible borrow site. Alternatives 1 and 2 use a 3:1 side slope and match the existing embankment slope. Alternative 3 uses a 1.5:1 side slope for soil-cement erosion control. The first two alternatives will require slightly larger amounts of fill than the third in the localized area of slope failure reconstruction. A geotechnical investigation is being performed to provide recommendations, concerning optimal slope stability and specific recommendations concerning the landfill.

Hydraulic Analyses

Preliminary hydraulic analyses were performed for each of the conceptual alternatives using the Corps of Engineers HEC-2 computer model. Design flows for the 10 year and 100 year design storms were obtained from the Tijeras Arroyo Drainage Management Plan Phase I as prepared by Leedshill-Herkenhoff, Inc. for the City of Albuquerque in August of 1987. The reach analyzed in this report uses cross-sections excerpted from the Phase I study with additional cross-sections obtained from 1"= 500' scale ortho-topo maps, to better define actual hydraulic conditions through the project reach. Results from this analysis were used as the bases of comparison for analyzing the improvement alternatives.

Based upon receipt of actual survey data through this reach of the channel, these preliminary analyses will be revised to more accurately reflect today's conditions. It should be noted that planned remedial work within the channel may alter the validity of our analysis. In addition, recommendations from our environmental division and NMED have not been incorporated into the design.



SCALE: 1" = 500'

KEY TO MAP

100-YEAR FLOOD BOUNDARY

CROSS SECTION LINE — A — A

OFFSET TANGENT LINES - DELINEATING BOUNDARIES BEYOND WHICH DEVELOPEMENT WOULD NOT BE PRUDENT.

DEFINITION 'A' 1 2

DEFINITION 'B' 101 102

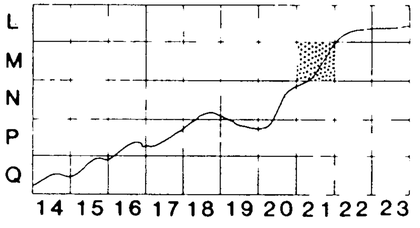
SOIL SAMPLE LOCATION ◎LH#2

NOTES TO USER

BOUNDARIES OF THE FLOODPLAINS WERE COMPUTED AT CROSS SECTIONS AND INTERPOLATED BETWEEN CROSS SECTIONS.

THIS MAP WAS PREPARED TO FACILITATE FLOODPLAIN MANAGEMENT ACTIVITIES ONLY: IT MAY NOT SHOW ALL SPECIAL FLOOD HAZARD AREAS IN THE COMMUNITY OR ALL PLANIMETRIC FEATURES OUTSIDE OF THE FLOODPLAIN. REFER TO THE LATEST OFFICIAL FLOOD INSURANCE RATE MAP FOR ANY ADDITIONAL AREAS OF SPECIAL FLOOD HAZARD.

THIS MAP WAS PRODUCED BY PHOTOGRAMMETRIC METHODS USING PREVIOUSLY PREPARED (BY OTHERS) MATERIALS OBTAINED FROM THE CITY OF ALBUQUERQUE. DATE OF PHOTOGRAPHY 1982. 2-FOOT CONTOUR INTERVAL ESTABLISHED ON NATIONAL GEODETIC DATUM OF 1929. COORDINATES SHOWN ARE NEW MEXICO STATE PLAIN COORDINATES, CENTRAL ZONE. SHEET INDEX GRID EQUALS CITY ZONE ATLAS.



SHEET INDEX

TIJERAS ARROYO DRAINAGE MANAGEMENT PLAN PHASE II PRUDENT LIMITS

FEBRUARY, 1988

LEEDSHILL-HERKENHOFF, INC.
ENGINEERS ARCHITECTS

SHEET M-21

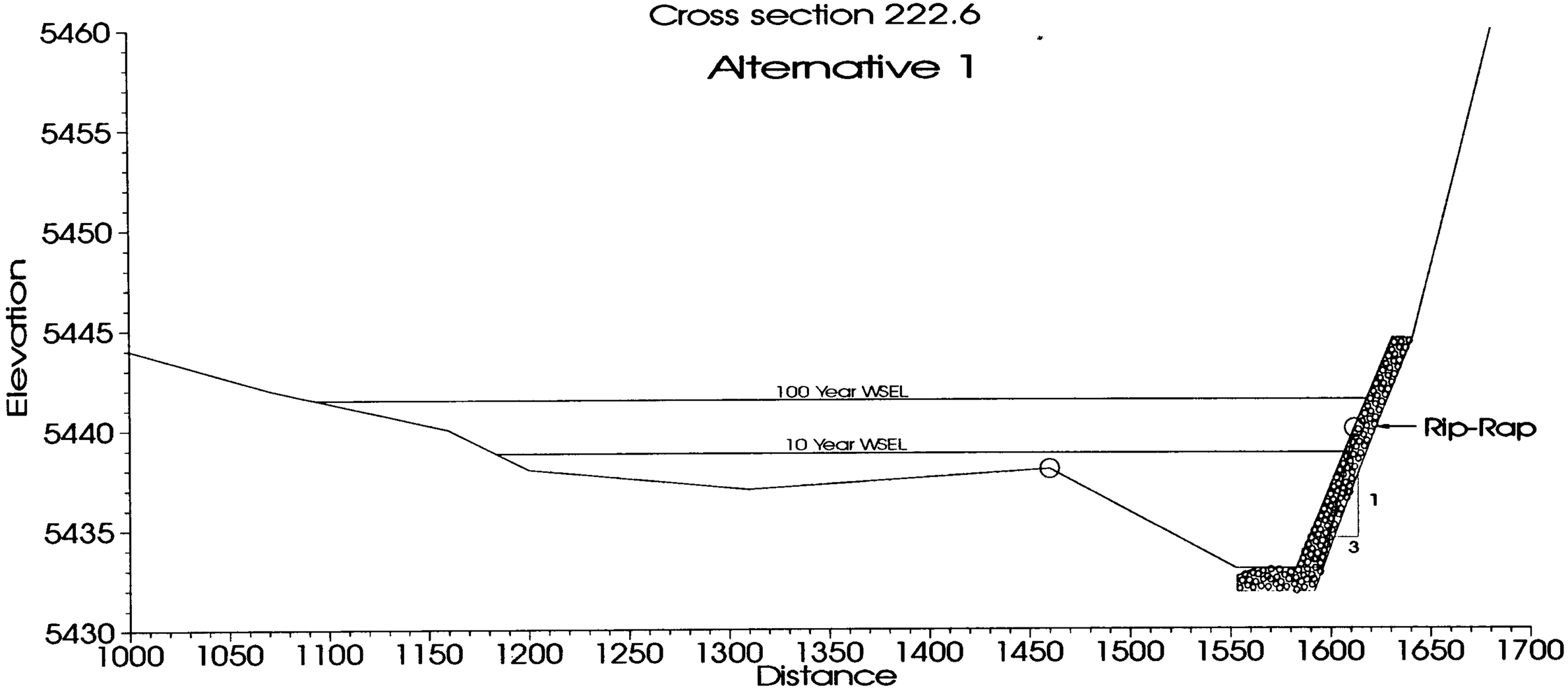

Cross section 222.6
Alternative 1
Elevation
5460
5455
5450
5445
5440
5435
5430
1000
1050
1100
1150
1200
1250
1300
1350
1400
1450
1500
1550
1600
1650
1700
Distance
100 Year WSEL
10 Year WSEL
Rip-Rap
1
3

PLATE 1

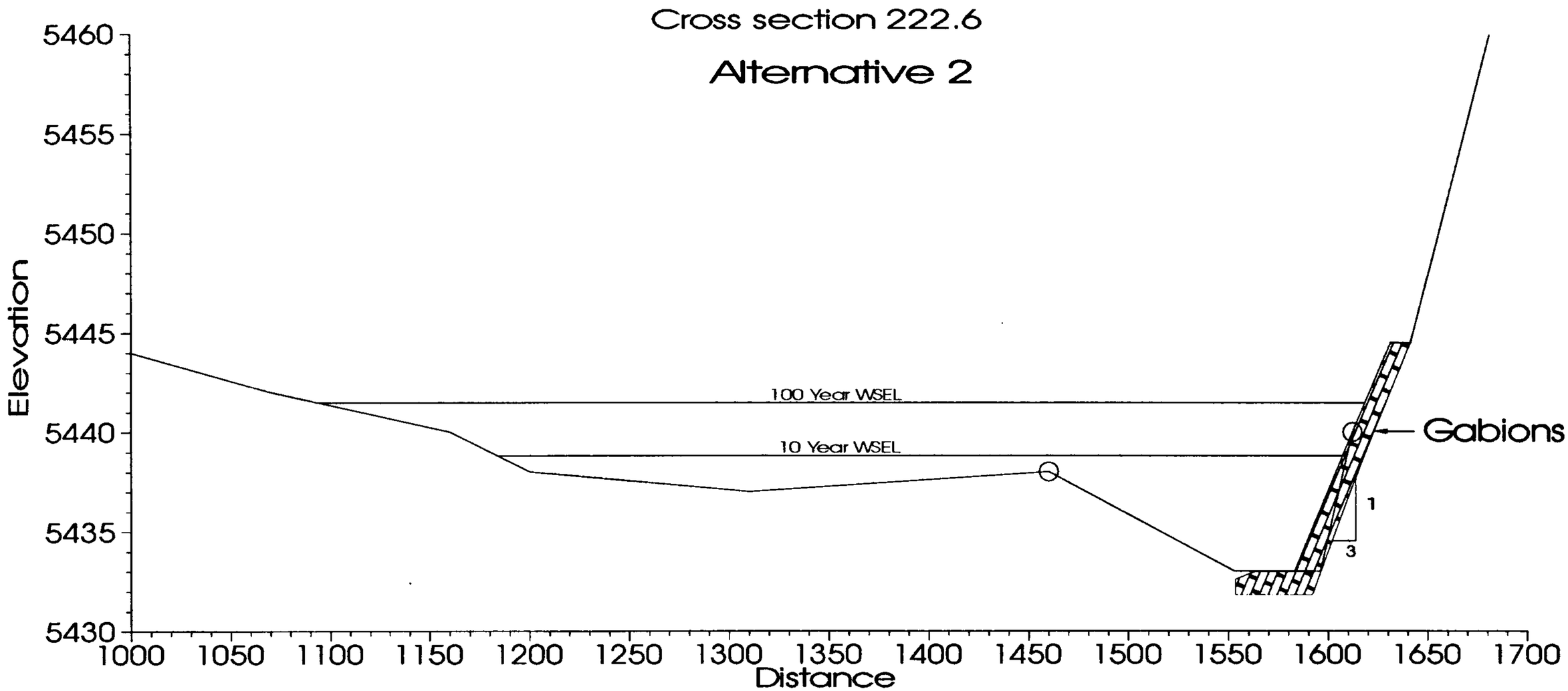

Cross section 222.6
Alternative 2
Elevation
5460
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1250
1300
1350
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1500
1550
1600
1650
1700
Distance
100 Year WSEL
10 Year WSEL
Gabions
1
3

PLATE 2

Tom Bruce Beach, COE
April '93

SYLLABUS

HYDROLOGY

FOR

John- Fx in OMI
Cliff Fx where appropriate

SOUTH DIVERSION AND TIJERAS ARROYO

Drainage area

SDC at upstream end is 1.15
downstream end is 7.1

Tijeras arroyo u/s of confluence is 130.3
d/s 137.4

1956 DM-1:

Design hydrology for SDC. SPF for SDC was 6700 at mouth. SPF for Tijeras Arroyo is 37,000 both u/s and d/s of confluence.

SPS is 1941 storm, 5.74" with max hour 1.33, 0.5 init, .16 and .5 "/hr const.

1978 Interior Drainage Study for Bernalillo to Belen:

SPF for Tijeras at mouth is 31,000. (value is labeled superceded by HMR-55)

SPS is 40% of PMP, 7.6", max hour = 1.69, 0 initial, .36 const

---

1979 Kirtland AFB Flood Plain Information Report:

LOCATION	100-YR	SPF
Tijeras above Coyote 81.3 sqmi	17,300	57,500
Tijeras below Coyote 115.3	23,850	80,980

SPS is 40% of PMP, '67 special study, 6.2" with max 15 minute = 1.93. Losses were .3 init and .25"/hr const.

1989 AMAFCA Tijeras Arroyo Drainage Management Plan:

100-yr Q (from Corps) = 22,600 east of Base, 22,700 west of Base.

Conclusion: SDC is OK for 100 yr

TIJERAS ARROYO
KICK-OFF MEETING
DECEMBER 15, 1993

AGENDA

I. SCHEDULE

II. AGENCY REVIEW

III. HYDROLOGY

IV. HYDRAULICS/ALTERNATIVE DESIGN

V. SEDIMENTATION

VI. LANDFILL TREATMENT

VII. ACCESS TO SITE/CONSTRUCTION EASEMENTS

VIII. CONSTRUCTION SCHEDULE

IX. ACTION ITEMS

December 1993

CALENDAR OF EVENTS

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1	2	3	4
5	6 ***START*** Review Data	7 1. Develop HEC-2 Files/ Run 10 Yr.-100Yr. 2. Coord. Kick-Off Mtg. 3. Brainstorm	8 Start Surveyor 404 Permit HEC-2 Invest. Impacts of Various Stabiliz. Measure	9 ***Hanukah*** Develop Alternatives	10 Cost Comparisons	11
12	13 Develop ALT 8 Cost Est. QA Calcs	14 Investigate Treatment of Landfill QA Revisions	15 KICK-OFF MEETING	16 Sedimnt/Scour Analysis Meet w/NMED	17 Investigate Ingress/Egress Const. Easements Prep.Const.Cost Est.&Maint. Cost Est.(3 or 1 Opt)	18
19	20 Finalize Cost Estimates Prepare Report	21 1:30 Meeting [~~Progress Meeting~~] Identify Permit Requirements	22 Recommend Best Option	23 QA Report QA Revisions Receive Survey Data	24 ***LH OFFICE CLOSED***	25 ***Christmas***
26	27 ***LH OFFICE CLOSED***	28 1:30 Meeting [Progress Meeting] Disseminate Report- Verbal Direction Begin Final Design Reduce Survey	29	30	31 ***LH OFFICE CLOSED***	

LH will submit report.

November 1993

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

January 1994

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

January 1994

CALENDAR OF EVENTS

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
						1 *New Year's Day*
2	**3** Prepare Outline Specs	**4** *Formal Direction State Land Office < Plans 35% >	**5** Plan Dev/Const. Cost Est./Specifications	**6** [Progress Meeting]	**7**	**8**
9	**10** Quality Assurance Review	**11** QA Revisions	**12** Review/Conditional Approval Final Revisions	**13** Plans 95% , Specs, Cost Estimate	**14** Printing Submittal	**15**
16	**17** *Martin Luther King, Jr.*	**18**	**19**	**20**	**21**	**22**
23	**24**	**25**	**26**	**27**	**28**	**29**
30	**31**					

Approval of Report Required

December 1993

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

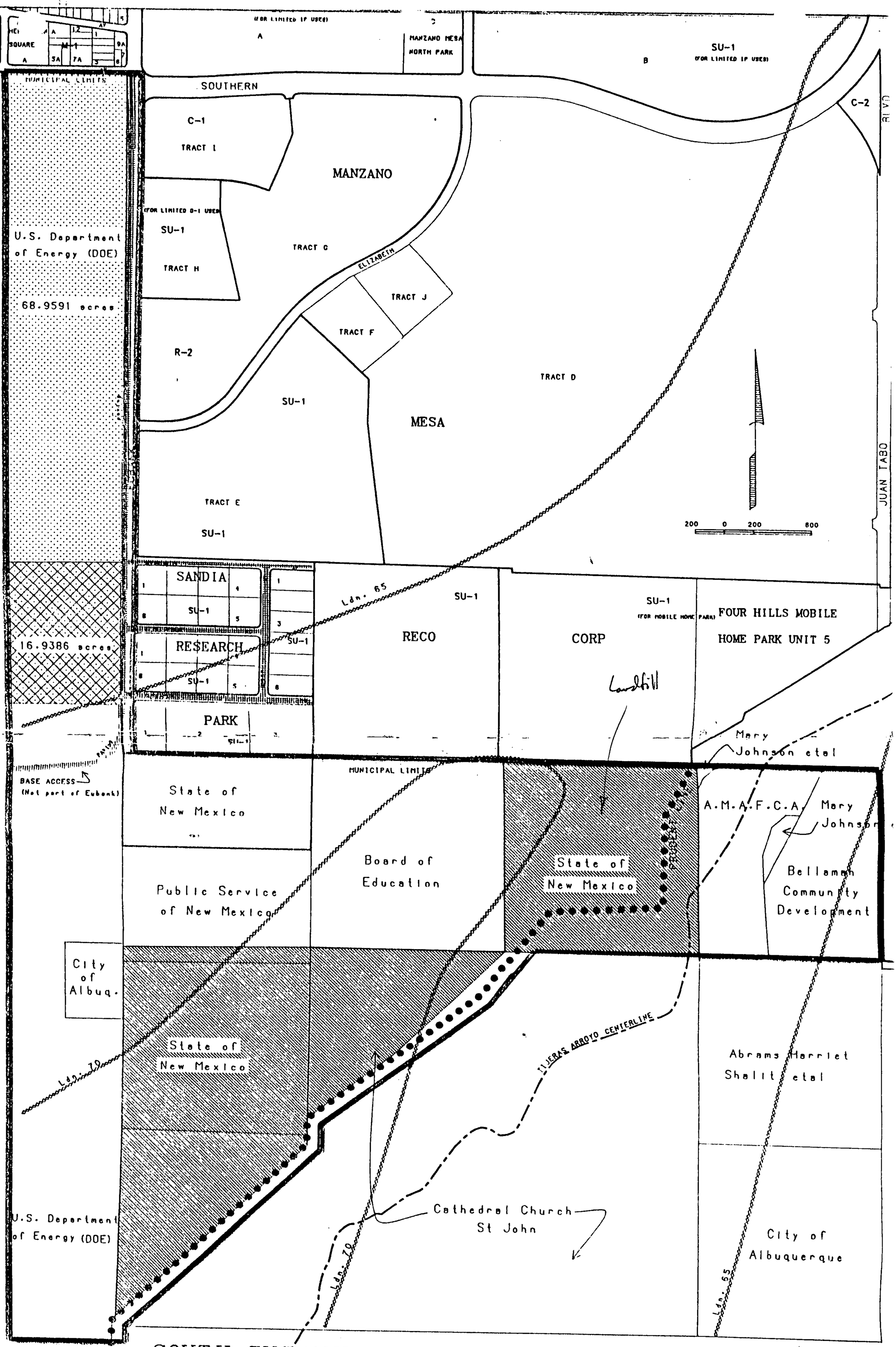
February 1994

S	M	T	W	T	F	S
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20	21	22	23	24	25	26
27	28					

93043.11

12/15/1993

SOUTH EUBANK SECTOR DEVELOPMENT PLAN



PLAN BOUNDARY

NORTH PRUDENT LINE (Tijeras Arroyo)

OLD LANDFILL SITE (within plan boundary as determined by AGIS)

INSPECTION CTR. (access from the Base)

SUBJECT 86 ACRE SITE

PLAN AREA = 417.77

NOTE: This map is for planning purposes only.

D5 ES File - Eubank Landfill

JPA GJ-221

JOINT POWERS AGREEMENT

CITY OF ALBUQUERQUE - COMMISSIONER OF PUBLIC LANDS FOR THE STATE OF NEW MEXICO - COUNTY OF BERNALILLO - ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

THIS JOINT POWERS AGREEMENT is entered into pursuant to the Joint Powers Agreement Act, Section 11-1-1 et seq. N.M.S.A. 1978 Comp., between the County of Bernalillo, New Mexico, a political subdivision ("County"); the City of Albuquerque, New Mexico, a municipal corporation ("City"), the Commissioner of Public Lands for the State of New Mexico ("Commissioner"); and the Albuquerque Metropolitan Arroyo Flood Control Authority ("AMAFCA").

WHEREAS, the parties are public agencies as defined in Section 11-1-2 N.M.S.A. 1978; and

WHEREAS, the Commissioner owns certain property commonly referred to as the "South Eubank Landfill" (the property) which is approximately forty-four (44) acres in size (more particularly described in Exhibit A); and which is located within the confines of the County, adjacent to the City; and which is adjacent to property owned by and other property subject to the jurisdiction of AMAFCA; and

WHEREAS, the City leased the property from the Commissioner pursuant to a lease for purposes of operating a sanitary solid waste landfill. Said lease term was from 1963 to 1973; and

WHEREAS, the City is no longer leasing the property and is no longer utilizing the property as a landfill; and

WHEREAS, it is the parties' intent to stabilize the property (prevent erosion) and to comply with the lawful requirements of the Environment Department of the State of New Mexico; and

WHEREAS, the cost of the stabilization is estimated at this time to be at least in the hundreds of thousands of dollars; and

WHEREAS, it is not the intent of the parties that this Joint Powers Agreement ascribe, assign or impute fault and/or responsibility for any and all (if any) problems and/or liability caused by the landfill on the property.

NOW, THEREFORE, it is agreed that:

1. This Agreement includes both short term remedial action such as movement of earth to correct the direction of the flow of water through the Arroyo and permanent remedial action through appropriate methods such as

soil stabilization using gabion, soil cement, or other appropriate methods to prevent the contents of the landfill being exposed to water flowing through Tijeras Arroyo.

2. The Commissioner shall permit all access necessary to effectuate the intent of this Joint Powers Agreement and contribute the sum of four thousand ($4,000) dollars to assist in the engineering and design study necessary to determine the appropriate remediation.

3. The Commissioner shall seek bids through a "Request for Proposal" process for engineering design and study for the remediation effort. The Commissioner shall act as the lead agency in administrating the engineering design and study project for the remediation effort as well as the actual remediation effort, if any.

4. The County shall pay to the Commissioner an amount equal to the price of the accepted bid (as referenced in paragraph 3 of this Joint Powers Agreement), not to exceed Two Hundred Thousand ($200,000) dollars.

5. AMAFCA agrees to provide technical staff assistance in hydrology, hydraulics, design, and such other support as the AMAFCA Board of Directors may authorize.

6. The City shall provide in kind services of labor and equipment valued at not more than Ten Thousand ($10,000) dollars for the short term remediation.

7. Strict accountability: It is understood by the parties that there shall be strict accountability for all receipts and disbursements made under this Agreement.

8. Disposal of property, materials or equipment: If, upon termination of this Agreement, there remains any property, materials, or equipment belonging to the State of New Mexico, the

City, AMAFCA, or the County, such property, materials or equipment, as well as any funds generated by that particular entity, shall be returned to that entity.

9. To the extent possible, all parties shall be credited with any expenditures made when application is made to the New Mexico State Legislature for appropriate legislation to fund the remediation project.

10. All parties agree to jointly seek state legislation in the 1994 legislative session to seek the necessary additional financing of the permanent remediation (pursuant to the above referenced design and study project) of the property.

11. All parties shall participate and cooperate to the fullest extent possible to effectuate the intent of this Joint Powers Agreement.

12. The parties shall collectively present the Joint Powers Agreement to the State of New Mexico Environment Department and seek its advice and assistance in carrying out the intent of this Joint Powers Agreement.

13. This Joint Powers Agreement is not an admission by any party of any liability relating in any manner whatsoever to the property and/or the landfill thereon.

14. Appropriate permits and other enforceable approvals will be obtained prior to commencement of work at the site. The parties agree to cooperate in obtaining such permits and approvals.

15. Major changes in the scope of the project must first be mutually agreed upon. Any alterations or revisions of this agreement must be in writing and approved by all parties.

16. The terms of this agreement are lawful; that performance of all duties and obligations hereunder shall conform with and not contravene any City, County, State or Federal Constitutions, Statutes, Ordinances and/or Regulations.

17. Each party shall indemnify and hold harmless the other parties, their officers and employees, against liability, claims, damages, losses or expenses arising out of bodily injury to persons or damage to property caused by, or resulting from, each party's and/or its employees or agents, contractors or subcontractors' own negligent and/or intentional acts or omissions while the party and/or its employees performs or fails to perform its obligations and duties under the terms and conditions of this Agreement. The parties are not required to indemnify the other parties for the negligence or intentional acts, errors or omissions of the other parties or their employees or agents. The parties' indemnification obligation to the other parties shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for each party, pursuant to laws, regulations, or policies of insurance, provided, however, that this save harmless and indemnification clause is subject to the immunities, provisions, and limitations of the Tort Claims Act (Section 41-4-1, et seq., N.M.S.A. 1978 Comp.) and any amendments thereto.

18. This Joint Powers Agreement in no way waives any defenses of the parties to any claims made or ever to be made by any person and/or entity (governmental or private) which in any manner whatsoever are related to the property and/or landfill thereon.

19. This Joint Powers Agreement in no way waives nor releases any claims nor defenses (present or future) of any party hereto against another party hereto which in any manner whatsoever are related to the property and/or landfill thereon.

20. This Joint Powers Agreement does not in any manner whatsoever allocate environmental liability (if any) among the parties as to any claims now or ever to be made by the parties hereto and/or by any person and/or entity (governmental or private) which in any manner whatsoever are related to the property and/or landfill thereon.

21. The effective date of this Agreement is the date it is signed by the Department of Fiannce and Administration.

CITY OF ALBUQUERQUE

By: _____
Arthur Blumenfeld,
Chief Administrative Officer

COMMISSIONER OF PUBLIC LANDS FOR THE STATE OF NEW MEXICO

By: _____
Ray Powell, Commissioner

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

By: _____
Larry Blair,
Executive Engineer
as authorized by the Board of Directors 26 August 1993

BOARD OF COUNTY COMMISSIONERS:

_____
PATRICK J. BACA, Chairman

_____
JACQUELYN SCHAEFER, Vice Chair

_____
EUGENE GILBERT, Member

_____
BARBARA J. SEWARD, Member

EXCUSED

_____
ALBERT "AL" VALDEZ, Member

Judy D. Woodward / county clerk

APPROVED AS TO FORM:

COUNTY ATTORNEY

CITY ATTORNEY

STATE LAND OFFICE LEGAL COUNSEL

AMAFCA ATTORNEY

VF David Bloom
DEPARTMENT OF FINANCE &
ADMINISTRATION

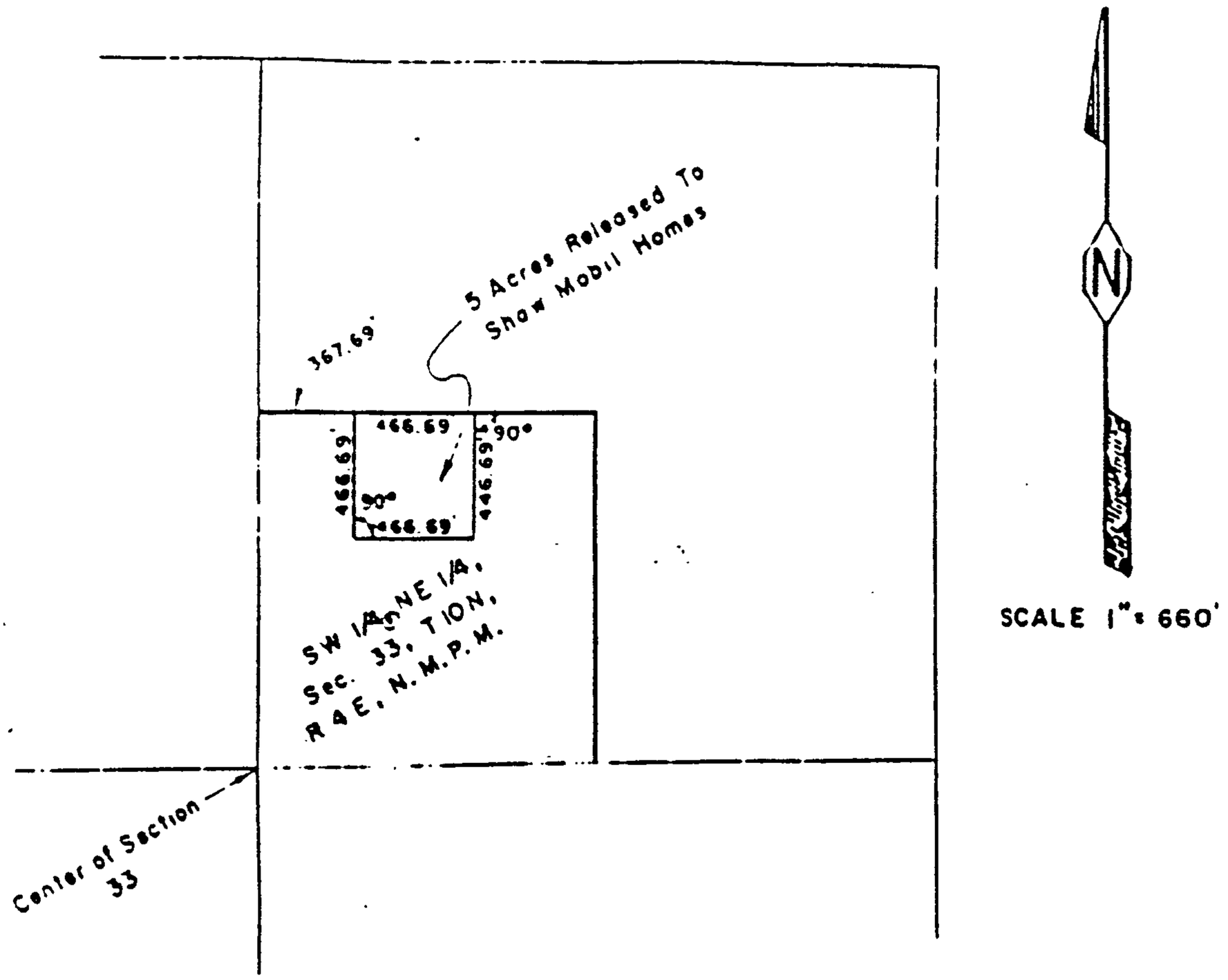
Reviewed by: Phil Roybal
Date: 9-16-93
DFA-Local Government Division

PUBLIC WORKS DEPARTMENT

CITY ENGINEERING DIVISION

RECEIVED
OCT 4 10 41 AM '68
SANTA FE, N. M.

SANITARY LAND FILL AND HEADQUARTERS BUILDING



A sketch showing the SW 1/4 NE 1/4, Section 33, T 10 N, R 4 E, N.M.P.M., Bernalillo County, New Mexico. Prepared by the office of the City Engineer, Albuquerque, New Mexico, by LaMonte Urban on September 26, 1968.

EXHIBIT A

TO: DAN 12-17-93

FROM: GILBERT

FOR YOU INFO. ON

TIJERAS EROSION PROTECTION,

PLEASE RETURN FOR

MY FILES

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY CONSTRUCTION COST ESTIMATE
OPTION 1

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$8,500.00	$8,500
DEMOBILIZATION	1	LS	8,500.00	8,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	15,000.00	15,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,525	CY	4.00	6,100
INSTALL IMPERM. MEMBRANE	1	LS	316,500.00	316,500
INSTALL 1' GRAVEL FILTER	3,615	CY	12.00	43,380
INSTALL 6' RIP–RAP	21,674	CY	46.00	997,004
EXC, BACKFLL, COMPCT SCOUR PROT	66,190	CY	5.00	330,950
SUBTOTAL				1,743,934
CONTINGENCES	20.00	%		348,787
TOTAL BASE BID				**$2,092,721**

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY CONSTRUCTION COST ESTIMATE
OPTION 2

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$8,500.00	$8,500
DEMOBILIZATION	1	LS	8,500.00	8,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	15,000.00	15,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,500	CY	4.00	6,000
6" GRANULAR FILL	1,806	CY	19.75	35,669
INSTALL IMPERM. MEMBRANE	1	LS	316,500.00	316,500
INSTALL 18" DEEP GABIONS	5,418	CY	90.00	487,620
EXC, BACKFLL, COMPCT SCOUR PROT.	66,190	CY	5.00	330,950
SUBTOTAL				1,226,739
CONTINGENCES	20.00	%		245,348
TOTAL BASE BID				**$1,472,086**

TABLE 5

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY PROJECT COST ESTIMATE
OPTION 3A

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$8,500.00	$8,500
DEMOBILIZATION	1	LS	8,500.00	8,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	20,000.00	20,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,450	CY	4.00	5,800
EXC, BKFLL, COMPCT SCOUR PROT	57,150	CY	4.00	228,600
GRADE LANDFILL SIDE–SLOPES	300	CY	5.00	1,500
INSTALL IMPERM. MEMBRANE	1	LS	272,000.00	272,000
INSTALL SOIL–CEMENT SLOPE IN	11,420	CY	28.00	319,760
0.5' x 10' WIDE LIFTS				
SUBTOTAL				882,660
CONTINGENCES	20.00	%		176,532
ESTIMATED PROJECT COST				**1,059,192**

TJOPT3A.WK1

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY PROJECT COST ESTIMATE
ALTERNATIVE 3B

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$13,500.00	$13,500
DEMOBILIZATION	1	LS	13,500.00	13,500
CONSTRUCTION STAKING	1	LS	8,000.00	8,000
MATERIALS TESTING	1	LS	20,000.00	20,000
CONSTRUCTION ACCESS ROAD	1	LS	5,000.00	5,000
DIVISION 2				
CLEAR AND GRUB	1	LS	2,000.00	2,000
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
CHANNEL EXCAVATION	1,450	CY	4.00	5,800
EXC, BCKFLL, COMPCT SCOUR PROT	9,600	CY	4.00	38,400
GRADE LANDFILL SIDE–SLOPES	300	CY	5.00	1,500
INSTALL IMPERM. MEMBRANE	1	LS	272,000.00	272,000
INSTALL SHEET PILES	925	LF	440.00	407,000
INSTALL SOIL–CEMENT SLOPE IN	6,735	CY	32.00	215,520
0.5' x 10' WIDE LIFTS				
SUBTOTAL				1,005,220
CONTINGENCES	20.00	%		201,044
ESTIMATED PROJECT COST				**$1,206,264**

TJOPT3B.WK1

Cross section 222.6

Alternative 3

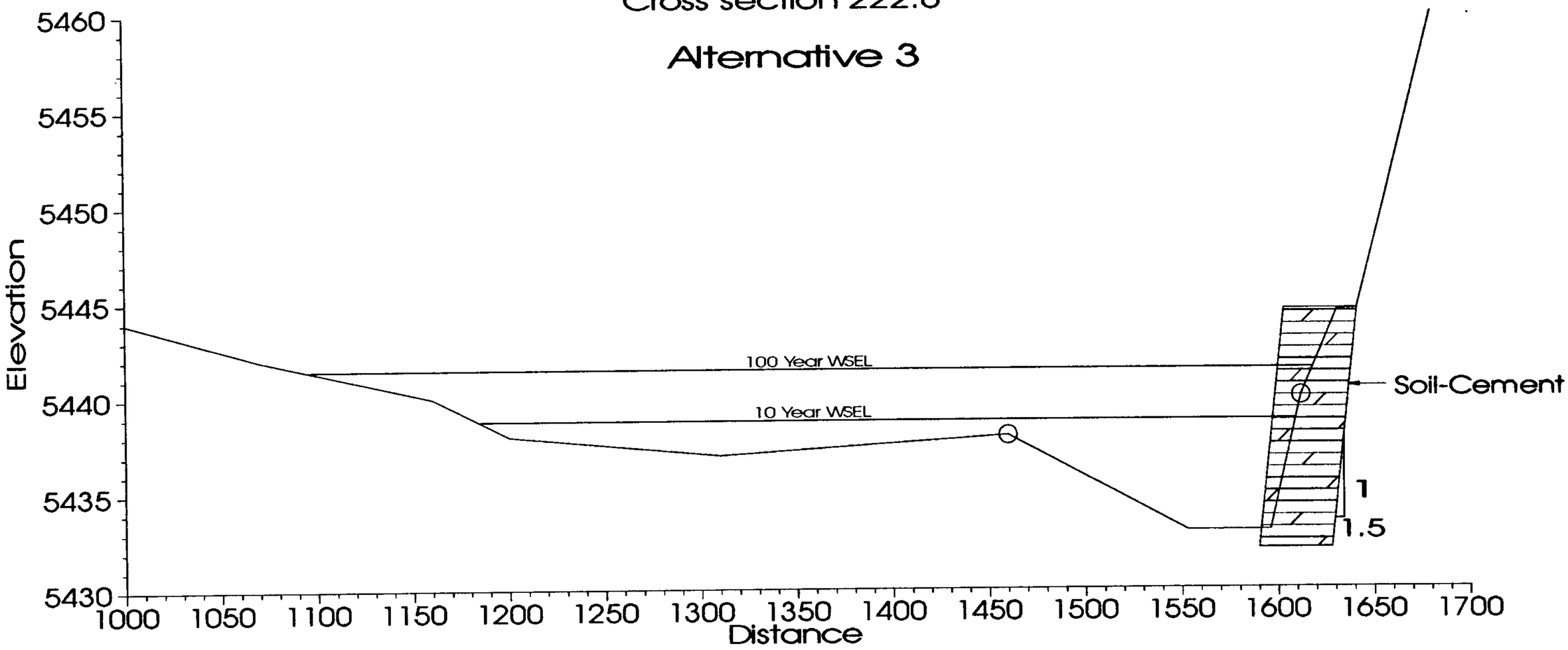


PLATE 3

ORGINAL SECTION
Cross section 222.6

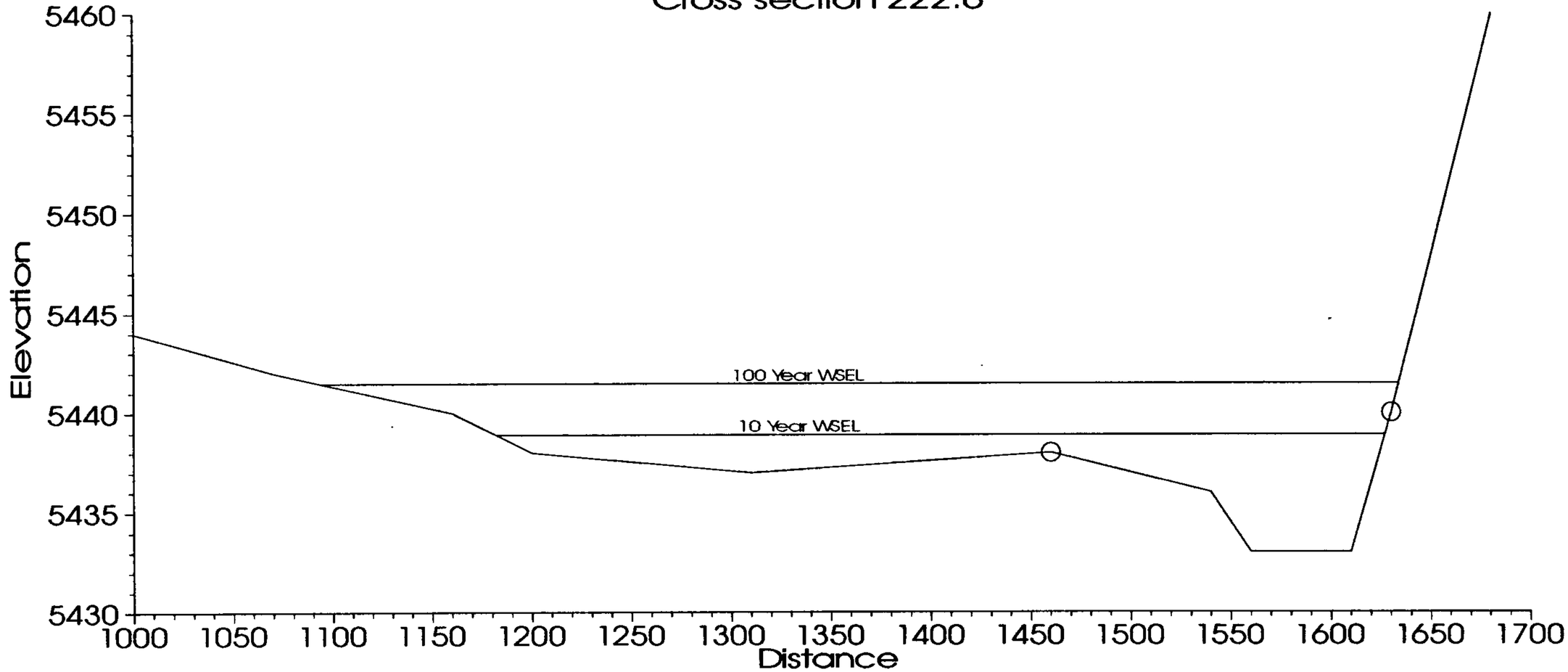


PLATE 4

PLATE 5

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY CONSTRUCTION COST ESTIMATE
ALTERNATIVE 1

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$3,800.00	$3,800
DEMOBILIZATION	1	LS	3,800.00	3,800
CONSTRUCTION STAKING	1	LS	2,200.00	2,200
MATERIALS TESTING	1	LS	2,400.00	2,400
DIVISION 2				
CLEAR AND GRUB	1	LS	600.00	600
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
GRADE CHANNEL	1,388	CY	5.00	6,940
CONSTRUCT LANDFILL SIDE-SLOPES	4,200	CY	5.00	21,000
INSTALL IMPERM. MEMBRANE	10,500	SF	4.50	47,250
INSTALL 1' GRAVEL FILTER	388	CY	20.00	7,760
INSTALL 3' RIP-RAP	1,167	CY	43.00	50,181
SUBTOTAL				148,931
CONTINGENCES	20.00	%		29,786
TOTAL BASE BID				**$178,717**

TJALT1.WK1

PLATE 6

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY CONSTRUCTION COST ESTIMATE
ALTERNATIVE 2

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$2,000.00	$2,000
DEMOBILIZATION	1	LS	2,000.00	2,000
CONSTRUCTION STAKING	1	LS	1,600.00	1,600
MATERIALS TESTING	1	LS	1,800.00	1,800
DIVISION 2				
CLEAR AND GRUB	1	LS	600.00	600
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
GRADE CHANNEL	1,388	CY	5.00	6,940
CONSTRUCT LANDFILL SIDE–SLOPES	4,200	CY	5.00	21,000
INSTALL IMPERM. MEMBRANE	10,500	SF	4.50	47,250
INSTALL 3' DEEP GABIONS	1,167	CY	135.00	157,545
SUBTOTAL				243,735
CONTINGENCES	20.00	%		48,747
TOTAL BASE BID				**$292,482**

TJAL2.WK1

PLATE 7

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY CONSTRUCTION COST ESTIMATE
ALTERNATIVE 3

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION	1	LS	$4,000.00	$4,000
DEMOBILIZATION	1	LS	4,000.00	4,000
CONSTRUCTION STAKING	1	LS	3,000.00	3,000
MATERIALS TESTING	1	LS	5,500.00	5,500
DIVISION 2				
CLEAR AND GRUB	1	LS	600.00	600
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
GRADE CHANNEL	1,450	CY	5.00	7,250
CONSTRUCT LANDFILL SIDE-SLOPES	300	CY	5.00	1,500
INSTALL IMPERM. MEMBRANE	10,500	SF	4.50	47,250
INSTALL SOIL-CEMENT SLOPE IN	3,500	CY	28.00	98,000
0.5' x 8' WIDE LIFTS				
SUBTOTAL				174,100
CONTINGENCES	20.00	%		34,820
TOTAL BASE BID				**$208,920**

TJALT3.WK1

Preliminary Cost Analysis

Hydraulicly, the three different types of erosion control gave virtually the same results. Therefore, the decision on material selection becomes a matter of economics or aesthetic preference. Preliminary construction cost estimates have been calculated for the three alternatives in order to assess relative magnitude in costs for the improvements. All costs have been based upon recent local bid tabulations, construction staking and materials testing, as well as a 20 percent contingency factor have been included. Again, these costs will be verified, and the estimates finalized based on final survey, geotechnical and landfill information.

As seen in the attached preliminary construction cost estimates, Plates 5, 6, and 7, respectively, Alternative 1 is the most economical solution. However, as the costs for Alternative 1 and 3 are similar, Alternative 3 maybe the preferred solution.

RAY POWELL, M.S., D.V.M.
COMMISSIONER

State of New Mexico
Commissioner of Public Lands
310 OLD SANTA FE TRAIL P.O. BOX 1148
SANTA FE, NEW MEXICO 87504-1148

(505) 827-5760
FAX (505) 827-5766

January 4, 1994

Susan Alvarez, P.E.
Leedshill-Herkenhoff, Inc.
P.O. Box 1217
Albuquerque, NM 87103

RE: Tijeras Arroyo/South Eubank Landfill Project - Phase 2 Services
State Land Office Contract No. 82-08-1

Thank you for the opportunity to review the draft copy of the Summary Report for Phase 1 of the above referenced project. I have provided my comments concerning this document via telephone conversation on January 3, 1994. Based upon our review of this document, and the comments received during the agency coordination meeting held in your offices on December 29, 1993, we generally concur with the findings and recommendations of this report.

With this letter we are providing formal notice to proceed with Phase 2 Design Services for Option 3A as described in this Summary Report, with the following alterations as discussed on December 29, 1993 and January 3, 1994:

- o Provide a soil-cement channel protection section;
- o Provide slope protection above the channel protection system consisting of 12-inches of earth fill, overlain with a 3-inch vegetated gravel mulch system;
- o Provide soil-cement scour protection;

It is our understanding that the Summary Report will be finalized to include changes in the cross section (and subsequent costs) resulting from agency review of the draft report, as well as our comments concerning this document.

RECEIVED
JAN - 6 1994
HYDROLOGY

If there are any significant changes to the basic design or estimated construction costs as presented in this document that become apparent during your development of the construction documents, please notify our office as soon as possible.

Sincerely,

Ray Powell, M.S., D.V.M.
Commissioner of Public Lands

RP/PMG/db

bcc: Larry Blair
Cliff Anderson
Gilbert Aldaz
David Duran
Dan Hogan
Rich Powell

TIJERAS ARROYO
MEETING MINUTES

A kick-off meeting was held on December 15, 1993 at 2:30 pm in the 4th floor conference room at Leedshill-Herkenhoff, Inc (LH). The purpose of the meeting was to discuss the Tijeras Arroyo project contracted by the New Mexico State Land Office with LH. Those in attendance included:

NAME	AGENCY	PHONE NUMBER
Susan Alvarez	Leedshill-Herkenhoff, Inc.	247-0294
Clint Dodge	Leedshill-Herkenhoff, Inc.	247-0294
Deborah Dixon BHD	Leedshill-Herkenhoff, Inc.	247-0294
Richard Stockton	Leedshill-Herkenhoff, Inc.	247-0294
Pleas M. Glenn	NM State Land Office	1-827-5768
Larry Blair	AMAFCA	884-2215
Cliff Anderson	AMAFCA	884-2215
Dan Hogan	City/PWD Hydrology	768-2778
~~Gilbert-Aldaz~~	City/PWD Hydrology Floodplains	768-2650

SCHEDULE - A schedule identifying tasks, progress meeting dates, submittal dates and review periods was disseminated. In summary, progress meeting dates were confirmed for December 21 and 28, 1993 and January 6, 1994. A draft analysis report will be submitted to reviewers on December 28, 1993, with verbal final design direction provided on December 28 and formal direction given by the NMSLO on January 4, 1994. Final design plans (95% complete), technical specifications and a construction cost estimate will be submitted by January 14, 1993. Albuquerque Survey Co.has been contracted by LH to land survey the study reach and to provide data by December 23, 1993. Vinyard & Assoc. has been contracted by LH to investigate slope stabilization at the landfill.

AGENCY REVIEW - Deborah Dixon confirmed that David Stoliker, of Bernalillo County, stated that Bernalillo County will not participate in the design process of this project. Mr. Richardson at Kirtland AFB is only interested in a courtesy copy of the report. The project presently qualifies under a Nationwide Permit No. 26 to satisfy Section 404 of the Clean Water Act. Consequently, unless this changes, the COE is not interested in actively participating in the design phase of the project. Randy Reed, City Open Space, should be informed of the project but will not be allowed to alter the schedule. Dan Hogan stated that in the interest of expediting the review of this project, the City is willing to defer to AMAFCA and will simply review the one copy which must be sent to the City/County Floodplain Administration, represented by Gilbert Aldaz. Therefore, AMAFCA agreed to serve as the lead agency in review of the analysis and final design on this project. Due to AMAFCA's heavy workload, Dr. Richard Heggen may be brought on board as AMAFCA's consultant to review the project. It was agreed by all in attendance that weekly progress meetings are necessary to meet the proposed schedule. NMSLO will receive copies of all comments, etc. from LH.

HYDROLOGY - Previous hydrologic studies for the Tijeras Arroyo were identified and discussed. Deborah Dixon confirmed that Frank Jaramillo at the Corps of Engineers (COE) is not aware of any further evaluations by the COE since 1979. It was agreed by all in attendance that the most appropriate peak design discharge to use in the present study should be based on recommendations of the **Tijeras Arroyo Drainage Master Plan, Phase I** dated August, 1987. The Plan is based on a Q100-yr = 23,600 cfs and Q10-year = 6,400 cfs, east of the Arroyo del Coyote confluence.

HYDRAULICS/ALTERNATIVE DESIGN - It was explained that LH will use the HEC-2 data-base file generated as part of the **Tijeras Arroyo Drainage Master Plan, Phase I.** Alternative slope treatments to analyze in detail include riprap, gabions, and soil-cement. Preliminary analysis results were presented which illustrated these design concepts and the associated preliminary cost estimates for each. It was emphasized that the cost estimates presented should be compared on a relative basis only, that they were incomplete relative to expected total costs. Suggestions were made by AMAFCA regarding several design issues including:

- o Riprap sizes needed to satisfy the design velocities would not be available locally and therefore would likely be cost-prohibitive if hauled in. As well, riprap is highly undesirable because of the attraction of rodents and associated diseases. Evaluation of this option should be included, yet limited.

- o Primary emphasis should be placed on the soil-cement stabilization option due to its positive performance in recent flooding in Arizona, its cost-effectiveness, and aesthetic compatibility with the City's Open Space ordinance. A slope of 1:1 or less will be evaluated. Design width should be 9' to 10'. A composite section using riprap to protect the toe of the soil-cement slope will be investigated. Dan Hogan said that in the past the City has received less competitive bids by specifying the source of soil for the soil-cement mixture. He suggested that it be left up to the contractor to find a source.

- o Several reference manuals are available at AMAFCA's library which LH can and will investigate. AMAFCA will assist in developing a matrix which qualifies the benefits vs. disadvantages of each treatment.

- o Hydraulic evaluations should include an analysis of both subcritical and supercritical flow conditions plus an evaluation of sequent depth (if applicable) to determine the worst case for depth of slope protection.

- o It is recognized that maintenance responsibility is an issue that needs to be resolved.

SEDIMENTATION/SCOUR - Design criteria for scour protection was discussed. AMAFCA will recommend certain reference manuals which include methodologies for estimating scour potential which are acceptable to AMAFCA. In addition:

- o Scour calculations should include local scour, antidune scour, and contraction scour based on main channel supercritical flow velocities. The embankment should be analyzed as a spur dike.

- o Bulking will be included in the calculations.

LANDFILL TREATMENT - A meeting will be held on December 16, 1993 with the Solid Waste Bureau and Surface Water Bureau of the NM Environmental Department to discuss their requirements for treatment of the landfill. Val Green, from NM Tech in Socorro, has been contracted by LH to provide expertise in this area.

SITE ACCESS - If access to the site is along Eubank, south to the arroyo bottom and easterly, the St. John Cathedral Church property must be crossed. In addition, construction efforts will likely impact property owned by Mary Johnson, et. al. AMAFCA stated that Roger is most informed about property owners and he could be contacted for further information. Public Service Co. easements will also be investigated as possible access routes.

CONSTRUCTION SCHEDULE - It is expected that construction funding will not be available until early summer. It would not be prudent to construct during the typical rainy season of July through September. All agreed that the window of time open for construction falls between October 15 through the winter and spring, up through May 15. AMAFCA has been successful in awarding a contract early and providing a period of time for construction which exceeds the amount needed along with a completion date, with the contractor selecting when actual work is performed. It was agreed that we will handle this project the same way. Advertisement for the project should begin in early September.

It may be prudent to require a pre-construction video be photographed of the arroyo prior to construction.

ACTION ITEMS - The following items should be accomplished prior to the next progress meeting:

1. Contact Randy Reed, City Open Space, and Gene Romo, City Solid Waste. - LH

2. Meet with NM Env. Dept. to formulate plan for treatment of landfill slope. - LH, NMSLO

3. Research library at AMAFCA to obtain pertinent reference materials for riprap, soil-cement, gabion, and scour analysis. - LH

4. Determine availability of Dr. Richard Heggen to review report and final design plans and specifications. - AMAFCA

5. Investigate existing easements and impact of construction on other property owners. - LH

TIJERAS ARROYO
MEETING MINUTES

A progress meeting was held on December 21, 1993 at 1:30 pm in the 5th floor conference room at Leedshill-Herkenhoff, Inc (LH). The purpose of the meeting was to discuss technical design issues on the Tijeras Arroyo project contracted by the New Mexico State Land Office with LH. Those in attendance included:

NAME	AGENCY	PHONE NUMBER
Pleas M. Glenn	NM State Land Office	1-827-5768
Cliff Anderson	AMAFCA	884-2215
Susan Alvarez	Leedshill-Herkenhoff, Inc.	247-0294
Deborah Dixon	Leedshill-Herkenhoff, Inc.	247-0294
Richard Stockton	Leedshill-Herkenhoff, Inc.	247-0294

BASIS FOR DESIGN - LH explained that subsequent to the kick-off meeting last week, AMAFCA assisted LH in identifying the most current reference publications which will satisfy their expectations for design criteria. In addition, the meeting was held with the NM Env. Dept. After preliminary review of this material and investigation of landfill treatments which satisfy NMED, it became apparent that cost estimates presented on December 15 were significantly underestimated. Therefore, they should be disregarded altogether.

Discussion at this meeting regarding technical analysis, references and methodology included the following:

1. Bulking will be calculated based on an assumed 10% bulking factor.

2. Velocities for the supercritical flow conditions were used to evaluate riprap (velocities range from 14 to 18 fps). Calculations for the riprap slope protection option result in the need for rock size of 30" for D50. This translates to at least a 6 ft. thickness and two to three filter layers to transition gradations. Due to the expectation that the local availability of riprap in this size range is limited (if existent) and the associated problems of rodent habitats in riprap, this option will be cost estimated but will not be pursued further.

3. Gabions have not been invested in detail, but manufacturer's literature indicates that gabions are reaching their limits of effectiveness in this high velocity range. This option will be cost estimated to determine whether it should be looked at in detail.

4. Soil-cement stabilization of the north channel bank appears to be the most feasible treatment for protecting the landfill. Not only does this treatment withstand the high velocities, it also satisfies the NM Environmental Department interest to provide an impermeable layer without the need to place a parallel impermeable membrane. In

the interest of time, further evaluation efforts will focus on using soil-cement slope protection in combination with alternate material treatments for scour protection.

5. Preliminary scour analyses include local scour, contraction scour and antidune scour - all based on the projected flow area which is normal to the embankment. Cliff Anderson determined that instead of using only the flow area which projects perpendicular to the embankment, that the entire flow area and entire topwidth at each section be used to calculate both local scour and contraction scour. Because of the significant local scour depths, he approved that antidune scour could be ignored for this particular flow condition. This should reduce the calculated scour depths to a range of 20' to 25' in the worst case location.

   Consideration was given to protect the landfill from scour for a lesser storm event than the 100-year storm. It was concluded, however, that the '92 Solid Waste regulations are based on a 100-year storm event and that design criteria should comply when practical.

6. Several composite sections appear to be feasible for scour protection. The following scour protection treatments will be investigated in combination with a soil-cement slope stabilization treatment placed to a depth of 6' to 8' below grade:

   - o riprap stock piled in sufficient volume in the low flow channel and below grade to fill in resulting void if full scour depth occurred
   - o auger-cast soil cement piles to full depth of scour
   - o sheet piling to full depth of scour
   - o concrete trench wall to full depth of scour
   - o soil-cement to full depth of scour

7. Excavation of the low-flow channel will be evaluated to create the most effective channel section geometry for the 10-year design storm.

<u>OPEN SPACE</u> - Deborah reported that Randy Reed had been contacted. The Rank III plan for Tijeras Arroyo is on the shelf. Randy speculated that the only impact of the project may be on the proposed trail system. Randy will meet with LH at 2 pm, Thursday (12/23/93) to discuss the project. Pleas stated that NM SLO will grant right-of-way for a trail anywhere along the SLO 40 acres.

On December 23, 1993, Randy contacted LH about the draft Rank III plan. After refreshing himself on the details of the draft report, he discovered that the proposed trail along Tijeras Arroyo going west from Four Hills Road ends at Juan Tabo and does not start again until west of KAFB. Consequently, this project should have no impact on the Rank III plan.

LANDFILL TREATMENT - The following summary was given by Susan Alvarez regarding the December 16 meeting with the NMED:

1. It is acceptable to disturb the landfill and remove waste from the site, as needed to accomplish subgrade preparation for slope stabilization.

2. The recommended impermeable membrane along the landfill slope will be comprised of bentonite sandwiched between two layers of felt.

3. Two options are being considered for vegetating over the bentonite layer:

   a) a 12" min. layer of compacted earth covered with 6" min. layer of gravel mulch at 3H to 1V slope, or

   b) terracing at a 4H to 1V slope over 18" min compacted earth plus topsoil.

OTHER DISCUSSION - Additional discussion included:

1. AMAFCA has made arrangements for Dr. Richard Heggen to review the summary report. Dr. Heggen is available any time for a telephone conference.

2. Pleas Glenn reported that St. Johns Cathedral Church and Mrs. Glazebrook (joint property owners impacted by construction) have provided written authorization to allow a contractor to pass through their property during construction. He will continue to attempt a similar agreement with Mary Johnson, et. al. property owners.

3. Meeting minutes from the December 15, 1993 kickoff meeting were approved.

cc: Dan Hogan, COA/PWD Hydrology
Gilbert Aldaz, COA/PWD Hydrology
Harry Relkin, NMSLO
Larry Blair, AMAFCA
Gene Romo, COA Solid Waste

RECEIVED
DEC 30 1993
GEOLOGY DIVISION

TIJERAS ARROYO
PROGRESS MEETING
DECEMBER 29, 1993

Offices of Leedshill-Herkenhoff, 2:00 pm

SIGN-IN SHEET

NAME	REPRESENTING	PHONE NUMBER
Susan Alvarez	L H	247-0291
Terry Nelson	NMED-Solid Waste	841-9469
TRY Hegger	AMAFCA	277-5777
Cliff Anderson	AMAFCA	884-2215
Harry Relkin	NMSLO	827-5713
Gilbert Aldaz	City of Alb	768-2650
Deborah Dixon	LH	247-0294
Rich Stafford	NMED	827-2866
David Duran	NMED	827-2950

COA, DPW: BOB GURULE/
DAN HOGAN

TIJERAS ARROYO
BANK STABILIZATION AT
SOUTH EUBANK LANDFILL

TECHNICAL SPECIFICATIONS

Prepared for

COMMISSIONER OF PUBLIC LANDS
FOR THE
STATE OF NEW MEXICO

JANUARY 1994

LH 93043.11

LEEDSHILL-HERKENHOFF, INC.
Copper Square, 500 Copper Avenue, NW
P.O. Box 1217 - Phone (505) 247-0294
Albuquerque, New Mexico 87103

ENGINEERS ARCHITECTS

TIJERAS ARROYO
BANK STABILIZATION AT
SOUTH EUBANK LANDFILL

TECHNICAL SPECIFICATIONS

Prepared for

COMMISSIONER OF PUBLIC LANDS
FOR THE
STATE OF NEW MEXICO

JANUARY 1994

LH 93043.11

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Copper Square, 500 Copper Avenue, NW
P.O. Box 1217 - Phone (505) 247-0294
Albuquerque, New Mexico 87103

ENGINEERS **ARCHITECTS**

SUPPLEMENTAL TECHNICAL SPECIFICATIONS

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SECTION 180

CONSTRUCTION SURVEYING BY CONTRACTOR

180.1 DESCRIPTION

180.1.1 This work shall consist of construction surveying for lines, grades, structures, layouts and finished as-constructed conditions by the Contractor in accordance with the plans and specifications and as directed by the Engineer.

All work shall be performed under the supervision of a New Mexico licensed land surveyor.

Failure to properly implement a comprehensive and complete construction surveying program shall constitute a basis for suspension of work and/or withholding of project progress payments.

180.2 MATERIALS

180.2.1 The Contractor shall furnish all stakes, templates, straightedges, benchmarks, surveying equipment, data collection equipment, hardware and software, and other devices necessary for establishing, checking, marking and maintaining points, lines, grades and layouts. As directed by the Engineer, points shall be referenced so that they may later be re-established.

180.3 CONSTRUCTION REQUIREMENTS (Construction Surveying by the Contractor)

180.3.1 Construction surveying by the Contractor shall include use of vertical and horizontal survey control points to establish construction survey points and construction centerlines; establish additional bench marks as necessary; setting stakes for fence, culverts, slopes, subgrade, subbase, base course, pavement courses, and any other points or elevations deemed necessary for proper control of the work; and for staking all lighting elements, visual aids and incidentals associated with airfield lighting. The Contractor shall establish stationing for the project at least every 100 linear feet consistent with stationing shown on the drawings. Survey control points have been established by the Owner. The Contractor shall protect these monuments from disturbance. Temporary benchmarks - control points shall be referenced and made available to Engineer. Any damage or disturbed control points must be replaced by the Contractor at his own expense.

180.3.2.1 Field notes shall be kept in standard field notebooks furnished by the Contractor. Field notes shall be kept in a clear, orderly and neat manner consistent with standard surveying practices.

The standard field notebooks shall become the property of the Engineer upon completion of the work. The standard field notebooks or copies of, shall be made available to the Engineer upon request at any time during the prosecution of the work.

180.3.2.2 The Contractor shall submit final as-constructed plan sheets, profiles, cross sections, structure placement sections, utility locations, and details with accurate information updated based on the finished work.

As-constructed cross sections shall be submitted in an AUTOCAD compatible format (.DWG or .DXF) drawn to the same scale as shown on the contract drawings. In addition, digitized cross section information shall be submitted in an ASCII format identifying stations with offset distances and elevations for all grade breaks, connections, and catch points. Stations shall be the same as the contract drawings unless otherwise approved by the Engineer.

The as-constructed earthwork quantity computations shall be submitted to the Engineer for verification. The Engineer reserves the right to reject any or all final survey data that is not in compliance with the specifications or is questionable. All survey notes, ASCII files, and cross sections shall be submitted to the Engineer no later than 15 days after the final inspection.

180.3.3 The Contractor shall profile all structure locations and underground utilities and lines as directed by the Project Engineer to verify accuracy of structure sections shown on the plans. The profiles shall be submitted to the Engineer for his use in preparing a revised structure and underground utilities and line profile list.

180.3.4 Any discrepancies in grade, alignment, locations, and/or dimensions detected by the Contractor shall immediately be brought to the attention of the Engineer for resolution.

180.3.5 The Contractor shall employ sufficient qualified personnel experienced in surveying and layout to complete the work accurately and timely. The supervision of the Contractor's surveying and layout personnel shall be the responsibility of the Contractor's surveyor and any errors resulting from the operations of such personnel shall be corrected at no additional cost to the Owner. Any overruns resulting from Contractor's errors will be at the expense of the Contractor.

180.3.6 The Contractor shall cross-section all cut and fill and borrow areas for periodic quantity estimates and as directed by the Engineer. The Engineer may verify the accuracy of same. The Engineer reserves the right to check and verify all measurements that involve determination of final quantities.

180.3.7 The Engineer may check the accuracy of the construction stakes, lines, grades and layouts but will assume no responsibility for the accuracy or the final result of the construction stakes, lines, grades and layouts.

180.3.8 The Contractor shall provide final "as-constructed" field surveying, including both vertical and horizontal data based on the finished work. The as-constructed survey shall be made upon completion of finish earthwork operations and prior to topsoil placement if used.

Final as-constructed surveys shall be certified true and correct by a New Mexico licensed surveyor.

180.3.9 All quantity determinations including those for monthly progress estimates shall be calculated by the Contractor's surveyor. All data used for such computations shall be provided to the Engineer for verification before project progress payment will be authorized. All such computations shall be certified true and correct.

180.4 METHOD OF MEASUREMENT

180.4.1 Measurement will be made per lump sum for construction surveying.

180.5 BASIS OF PAYMENT

180.5.1 Payment shall be made at the contract unit price per lump sum. This price shall be full compensation for furnishing all crews, licensed surveyors, equipment, hardware and software, plots and drawings and for all labor, equipment, field supplies and incidentals necessary to complete the item.

SECTION 185

COMPLIANCE TESTING

185.1 DESCRIPTION

185.1.1 This section consists of laboratories, personnel, equipment and procedures to be used for construction compliance testing, materials testing, and acceptance. The laboratory shall be selected by the Engineer.

185.1.2 The Contractor shall either arrange for or provide for its own routine quality control testing at no cost to the Owner. The Contractor may not employ the services of the Engineer selected laboratory, but may employ another agency or utilize appropriately qualified internal personnel. The laboratory selected by the Engineer shall be considered the laboratory of record. Should a conflict or difference of data arise, the laboratory of record shall be considered the final authority.

185.1.3 The laboratory shall submit to the Engineer for approval a fee schedule detailing personnel classifications and hourly rates and unit costs for applicable tests.

185.2 REFERENCED STANDARDS

185.2.1 American Society For Testing and Materials (ASTM)

C 1077 Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

D 3665-82(1987) Practice for Random Sampling of Construction Materials.

D 3740 Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

E 329 Practice for Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

185.3 LABORATORIES

185.3.1 Laboratories shall meet the minimum requirements of ASTM C1077 E329, D3666, D3740 or D4561. They shall be under the direct and general supervision of an Arizona Registered Professional Engineer having a minimum of five (5) years experience in materials engineering and testing. National accreditation of the laboratory is preferred.

185.3.2 Qualification Statements and Certifications of Compliance will be required. The laboratory shall make available, to the Engineer, records on all personnel employed on this project that adequately show competence in the required methods and procedures and shall submit a written guideline for maintaining internal quality control and review.

185.3.3 The laboratory shall cooperate with the Engineer and make their equipment, facilities and records available for inspection as may be required by the Engineer.

185.3.4 The laboratory shall provide all necessary insurance as may be required.

185.4 TECHNICAL STAFF

185.4.1 The resident supervising technician shall have a minimum of five (5) years experience in construction compliance testing. He or she shall be familiar with all aspects of earthwork, materials producing operations and bituminous pavement/materials productions and testing, and shall have at least Level II certification through the N.I.C.E.T. program in the appropriate field of experience. Supplemental staff shall be able to demonstrate competence in the various procedures and methods appropriate to test or function being performed. Adequate qualified personnel, equipment and support must be maintained at all times during construction and materials production.

185.5 PROCEDURES

185.5.1 Test locations and frequencies shall be determined by the Laboratory and approved by the Engineer.

185.5.2 Test data, including statistical evaluations, shall be promptly submitted to the Engineer as provided in other sections and items of these specifications. Hand written copies are acceptable prior to monthly review, final drafting, and signature by the organizations Materials Engineer.

185.5.3 The laboratory shall adopt and keep current a valid statistical program for interpretation of test data. The laboratory shall prepare a sample plan including proposed numerical evaluation methods, control charts and procedures for review and approval by the Project Engineer. All sampling shall be accomplished using methods presented by ASTM D3665. All charts, graphs and data shall be tabulated and submitted to the Engineer weekly. If significant trends or deviations from the allowable tolerances become apparent, the Project Engineer and Contractor shall be immediately notified so appropriate corrective measures can be taken with a minimum amount of lost time or material.

185.5.4 All material samples shall be sampled in accordance with ASTM D75, D140, D979, D3665, E122, E105 and other appropriate methods.

185.5.5 The laboratory shall provide a project testing summary at the end of construction containing a tabulation of all required testing required by each technical specification item. This summary shall clearly identify failing tests and retests or deviations allowed from the specifications. The summary shall include a narrative summary statement and shall be certified true and correct by the laboratory's P.E.

185.6 MEASUREMENT

185.6.1 Compliance testing will be measured as follows: Technician time will be measured per hour per technician level for time on-site including portal to portal travel. No additional measurement shall be made for clerical and professional review of reports of field test data.

185.6.2 Laboratory tests will be measured per each in accordance with the appropriate standard test procedure and in accordance with the approved fee schedule. This shall include laboratory time and equipment, all clerical and professional review of laboratory test data and all supplies or expendable materials associated with testing.

185.6.3 Professional Consultation will be measured per hour. This shall not include normal review of test data or supervision/management of technicians.

185.7 PAYMENT

185.7.1 Payment shall be made on a monthly basis from the approved fee schedule. No retention will be made on this item or withheld from the laboratory. The prime Contractor shall submit detailed invoices from the laboratory for services performed, said invoices to be in a format approved by the Engineer. Payment will be made only for tests ordered by the Engineer and will be made for invoices approved by the Engineer for the amount of actual services performed. The cost of retests necessary for compliance shall be deducted from payments due the Contractor. Administrative costs incurred by the Prime Contractor for this item shall be considered incidental to this item.

END OF SECTION

SECTION 201

CLEARING AND GRUBBING

All clearing and grubbing shall conform to Section 201 of the Standard Specifications except as noted in paragraphs 201.2 and 201.7.

201.2 REFERENCES

Add the following reference to the paragraph:

201.2.1 Supplemental Technical Specification Section 214.

201.7 REMOVAL AND DISPOSAL OF DEBRIS

Delete this section in its entirety and replace with the following:

201.7.1 Section 214 provides specifications for the removal and disposal of unsuitable materials.

SECTION 203

UNCLASSIFIED EXCAVATION AND BACKFILL

203.1 GENERAL

203.1.1 Unclassified Excavation shall consist of excavating, removing, and satisfactorily disposing of all materials within the limits of the work required to construct the soil-cement section and other areas for drainage, or other purposes in accordance with these specifications and in conformity with the dimensions and typical sections shown on the plans and with the lines and grades established by the Engineer.

203.1.2 All suitable material taken from excavation shall be used in the formation of fill, subgrade, and for backfilling as indicated on the plans or as directed by the Engineer.

203.1.3 When the volume of the excavation exceeds that required to construct the fill, subgrade, and/or backfill to the grades indicated, the excess shall be used to grade the areas of ultimate development or disposal of as directed by the Engineer. When the volume of excavation is not sufficient for constructing the fill to the grades indicated, the deficiency shall be supplied from borrow sources.

203.1.4 Haul roads shall be located as shown on the plans and as approved by the Engineer. All haul routes shall be subject to the approval of the Engineer. They shall be designed to maintain the intended traffic, to be free draining, and shall be maintained in good condition throughout the contract period, unless otherwise directed by the Engineer. Dust control will be required.

203.1.5 Due to the alignment of the recommended access route partially following existing high-voltage power lines, the Contractor shall not place any fill material on the existing road such that the clearance between existing ground surface and the power lines is reduced in any way.

203.1.6 "Unclassified Excavation" shall include all excavation performed under this item regardless of the material encountered, unless otherwise defined.

203.2 REFERENCES

203.2.1 Supplemental Technical Specification Section 214 and Section 624

203.2.2 American Society for Testing and Materials (ASTM) -

C 117 and C 136
D 4318

D 1556
D 1557
D 2216
D 2922
D 3017

203.3 BACKFILL

203.3.1 Backfill shall consist of the placing and compacting of approved material to the line and grade shown on the drawings in areas where over excavation was necessary to construct the soil-cement section below the existing arroyo bed and bank.

203.3.2 Suitable materials for backfill include material that is free of debris, roots, organic matter, frozen matter, and which is free of stones with any dimension greater than one half of the specified loose layer thickness.

203.3.3 Unsuitable materials include all material that contains debris, roots, organic matter, frozen matter, stones with any dimension greater than one half of the specified loose layer thickness, or other materials that are determined by the Engineer as unsuitable. Otherwise suitable materials, which are unsuitable due to excess moisture content, will not be classified as unsuitable material unless they cannot be dried by manipulation, aeration, or blending with other materials satisfactorily, as determined by the Engineer.

203.3.4 Backfill includes all compacted fill, deposited in layers and compacted by rolling or tamping, which is placed at the depth below the existing arroyo bed and bank.

203.4 EXCAVATION

203.4.1 GENERAL

203.4.1.1 The rough excavation shall be carried to the necessary depth as shown on the plans. Should the contractor, through negligence or other fault, excavate below the designated lines, he shall replace the excavation with approved materials, in an approved manner and condition, at his own expense. All material determined unsuitable shall be disposed of in waste areas or as directed by the Engineer.

203.4.1.2 The contractor shall inform and satisfy himself as to the character, quantity, and distribution of all material to be excavated. No payment will be made for any excavated material which is used for purposes other than those designated. All spoil areas shall be leveled to a uniform line and section as shown on the plans and shall present a neat appearance before project acceptance.

203.4.1.3 If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, or parts thereof, the contractor shall be responsible for and shall take all necessary precautions to protect and preserve or provide temporary services. The contractor shall, at his own expense, satisfactorily repair all damage to such facilities or structures which may result from any of his operations during the period of the contract.

203.4.1.4 If boulder fields are encountered at a depth of one-half to two-thirds or more of the total excavation depth shown on the drawings, the Engineer may direct the Contractor to limit excavation to less than that shown on the drawings. Should the Contractor be directed to excavate less than the pay lines shown on the drawings, said pay lines will be reduced accordingly.

203.4.2 OPERATIONS

203.4.2.1 Excavation shall be performed as indicated on the contract plans to the lines, grades, and elevation shown or as directed by the Engineer. No excavation or stripping shall be started until the Contractor has staked out the proposed work. All unsuitable material encountered within the excavation limits indicated shall be removed and disposed of as directed in Supplemental Technical Specification Section 214. During the process of excavation, the grade shall be maintained so that the excavation will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the work. All fills and backfills shall be constructed of suitable earth material from required excavation.

203.4.2.2 When selective grading is specified or required as indicated on the plans, the excavated material shall be handled to allow the selected material to be properly placed in the fill as determined from the soil profile and soil characteristics. This material shall be deposited within the designated areas as shown on the plans or as directed by the Engineer.

203.4.2.3 If, at the time of excavation, it is not possible to place any material in its proper section of the permanent construction, it shall be stockpiled in approved areas for later use.

203.4.2.4 Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for embankments, subgrades, and intermediate areas, shall be excavated to a minimum depth of 3 feet, or to the depth specified by the Engineer, below the contemplated surface of the subgrade or the designated grades. Unsatisfactory materials shall be disposed of. All material so excavated shall be paid for at the contract unit price

per cubic yard for "Unclassified Excavation". The portion so excavated shall be refilled with suitable selected material as specified, obtained from the grading operations or borrow area and thoroughly compacted by rolling.

203.4.2.5 Overbreak, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the Engineer. The Engineer shall determine if the displacement of such material was unavoidable and his decision shall be final. All overbreak shall be removed by the contractor and disposed of as directed; however, payment will not be made for the removal and disposal of overbreak which the engineer determines as avoidable. Unavoidable overbreak will be classified as "Unclassified Excavation".

203.4.2.6 No payment or measurement for payment will be made for suitable materials removed, manipulated, and replaced in order to obtain density. Any removal, manipulation, aeration, replacement, and recompaction of suitable materials necessary to obtain the required density shall be considered as incidental to the excavation and fill operations, and shall be performed by the contractor at no additional cost to the project.

203.4.2.7 In cuts, all loose or protruding rocks on the back slopes shall be barred loose or otherwise remove to line or finished grade of slope. All cut-and-fill slopes shall be uniformly dressed to the slope, cross section, and alignment shown on the plans or as directed by the Engineer.

203.4.2.8 Stockpiling From Required Excavation Areas. When the excavation from required common excavations progresses at a faster rate than placement in the fill is being accomplished, such excavated material shall be stockpiled. No payment will be made for such stockpiling nor for the reloading and hauling of this material to its final position in the embankment.

203.4.2.9 Blasting, when necessary, will be permitted only with the Owner's prior approval and when proper precautions are taken for the protection and safety of all persons, the work, and the property. All damage done to the work or property shall be repaired at the contractor's expense. All operations of the contractor in connection with the transportation, storage, and use of explosives shall be approved by the Engineer. Any approval given will not relieve the contractor of his responsibility in blasting operations.

203.4.2.10 Trench stabilization or shoring protection may be necessary during excavation to satisfy fasety and OSHA requirements.

203.5 FIELD DENSITY AND LABORATORY COMPACTION TESTS

203.5.1 SAMPLING AND TESTING: Sampling and testing of each principal type of material shall be the responsibility of the Engineer or his representative.

203.5.2 MOISTURE-DENSITY DETERMINATION: Tests for the determination of maximum density and optimum moisture shall be performed in accordance with the requirements of ASTM D 1557. The above testing shall include Atterberg Limits, Mechanical Analysis and Specific Gravity, if requested by the Engineer. A moisture-density determination test will be performed for each principal type of material, or combination of materials encountered or utilized.

203.5.3 DENSITY CONTROL: Density shall be controlled in the field in accordance with ASTM D 1556,, or by approved nuclear devices in accordance with ASTM D 2922 and D 3017. A minimum of one test shall be made for each 1,000 square yards, or less, for each layer. Deficiencies in construction shall be corrected by the Contractor at no additional cost to the Owner. The cost of retests necessary to assure compliance with the specifications shall be paid for by the Contractor.

203.6 MEASUREMENT AND PAYMENT

203.6.1 MEASUREMENT

203.6.1.1 All unclassified excavation will be measured in its original position, such measurements will include slides not attributable to carelessness of the Contractor and authorized excavation of rock, shale, muck or other unsuitable material. Volumes will be computed from the measurements by the average end-area method. Measurements may be made by field cross- section surveys or by aerial photography methods.

203.6.1.2 All backfill and compaction associated with construction of soil-cement below the existing arroyo bed and bank will be measured by the cubic yard based on as-constructed final field cross-sections.

203.6.1.3 Where it is impractical to measure and compute material by the average end-area method due to the erratic location of isolated deposits, acceptable methods involving three-dimensional measurements may be used.

203.6.1.4 Measurement shall not include the volume of material excavated without authorization beyond normal slope lines, or the volume of material used for purposes other than those directed.

203.6.2 PAYMENT

203.6.2.1 No payment will be made separately or directly for haul or water on any part of the work. All hauling and water will be considered a necessary and incidental part of the work and its cost shall be considered by the contractor and included in the contract unit price for the pay items of the work involved.

203.6.2.2 No payment will be made separately or directly for trench stabilization required during excavation. Any shoring will be considered a necessary and incidental part of the work and its cost shall be considered by the Contractor and included in the contract unit price for the pay items of work involved.

203.6.2.3 The accepted quantities of unclassified excavation, excavation for disposal and foundation preparation will be paid for at the contract unit price per unit of measurement for each of the pay items listed below that is included in the bid schedule.

203.6.2.4 Payment will be made under:

Unclassified Excavation	Cubic Yard
Backfill	Cubic Yard

SECTION 204

FILL CONSTRUCTION

All fill shall conform to Section 204 of the Standard Specifications except as modified below in paragraphs 204.1, 204.3 and 204.5.

204.1 GENERAL

Delete the word "roadway embankments" in the second line and substitute with the following words "embankment foundations for soil-cement construction above the existing arroyo bed and for compacted earth fills and gravel mulching above the soil-cement and below the rubble."

204.3 PLACING

Insert the following words at the end of paragraph 204.3.1:

"In areas where the original ground is characterized by "soft or spongy" conditions due to the presence of landfill material, as approved by the Engineer, subgrade shall be prepared and compacted to a minimum depth of six (6) inches with a minimum of eighty-five (85%) percent of the maximum density as determined by ASTM D-1557".

204.5 MEASUREMENT AND PAYMENT

Delete this section in its entirety and replace with:

204.5.1 Fill construction shall include all fill constructed after clearing and grubbing operations. The work shall consist of haul, placement, compaction, watering, and all related work and shall be measured in place, after compaction. Cross-sections shall be obtained of the fill area prior to fill placement and after completion of fill construction. Payment will be made on the unit price per cubic yard.

SECTION 214

REMOVALS AND DISPOSALS

214.1 GENERAL

Removals and disposals shall consist of the removal of debris from the construction site and legal disposal of the materials.

214.2 REFERENCES

214.2.1 Supplemental Technical Specifications Section 201 and Section 203.

214.3 MATERIAL TO BE DISPOSED

214.3.1 Debris consisting of surface boulders, concrete rubble, and vegetable growth as defined in Supplemental Technical Specifications Section 201.4.1 and 203.3.3, shall be removed and legally disposed of at a location in accordance with local regulations.

214.3.2 Debris comprised of landfill refuse shall not be handled or removed until the Contractor has notified, coordinated with and obtained approval from the New Mexico Environmental Department (NMED), Solid Waste Bureau for safe removal and disposal of the refuse. The approval process is expected to include:

214.3.2.1 Four weeks in advance of performing any clearing and grubbing or excavation within the construction limits, the Contractor shall develop a plan for safe excavation, removal and final disposition of the refuse, in accordance with OSHA requirements and in compliance with current NMED Solid Waste Regulations, which must be approved by the NMED Solid Waste Bureau before beginning work. The contact for NMED Solid Waste Bureau is David Duran, ph. 827-2950 (Santa Fe).

214.3.2.2 The Plan is to include arrangements for boring and testing the landfill refuse material to be handled to determine if it contains any hazardous constituents. The Contractor shall notify Pleas Glenn, phone 827-5768 (Santa Fe), representative for the Commissioner of Public Lands for the State of New Mexico to coordinate this work.

214.4 MEASUREMENT AND PAYMENT

214.4.1 Compensation for the removal of debris, as described in Section 214.3.1 above, shall be considered as included in the unit price per acre paid for clearing and grubbing and no additional compensation will be made.

214.4.2 Compensation for the excavation, handling and removal of the landfill refuse will be measured by the cubic yard and paid for under one of two pay items listed below. Compensation for coordination efforts required with the NMED Solid Waste Bureau will be considered as included in the unit price per cubic yard for refuse removal and bury or disposal. Boring and testing of the landfill refuse will be coordinated by the Contractor but performed and paid for by the New Mexico State Land Office.

214.4.2.1 A pay item is included for refuse which is approved by NMED Solid Waste Bureau to be buried within the construction site.

214.4.2.2 A pay item is included for refuse which is directed by NMED Solid Waste Bureau to be legally disposed of in an approved solid waste or hazardous waste (if applicable) disposal site, in accordance with local regulations. Tipping fees, if required, shall be included in the unit price indicated on the Bid Proposal.

SECTION 624

SOIL-CEMENT

624.1 GENERAL

624.1.1 DESCRIPTION: This work shall consist of furnishing, transporting, placing, compacting, and curing of soil-cement for dams, bank protection, scour protection, grade control structures, dikes, spillways, rundowns, maintenance roads, channel linings, and grade slabs in substantial compliance with the lines, grades, and dimensions shown on the plans or the lines, grades, and dimensions established by the Engineer.

624.1.2 REFERENCES

Supplemental Technical Specifications - Section 203 and Section 204

624.2 MATERIALS

624.2.1 SOIL AGGREGATE: Soil-Aggregate for soil-cement shall conform the following gradation requirements.

GRADATION A	
SIEVE SIZE	**PERCENT PASSING**
1-1/2"	100
3/4"	80 - 90
#4	50 - 70
#200	5 - 20

The soil-aggregate for Gradation A shall have a plasticity index no greater than 3, a Los Angeles abrasion loss no greater than 45 on the aggregate retained on the #4 sieve, a bulk specific gravity (SSD) no less than 2.45, and will be free of any deleterious material.

Soil-aggregate suitable for soil-cement shall be obtained on site from excavated materials and from the designated project borrow site. Soil-aggregate for soil-cement shall be stockpiled or as specified in Section 624.3.2 or as approved by the Engineer.

624.2.2 PORTLAND CEMENT: Portland cement shall conform to Portland Cement Type II (ASTM C150).

624.2.3 FLYASH: If required, flyash shall conform to Class F or Class C (ASTM C618).

624.2.4 WATER: Water for mixing and curing soil-cement shall conform to the requirements of ASTM C94.

624.2.5 PROPORTIONING: The Mix Design shall be established by the Contractor's Quality Control Laboratory for the soil-aggregate, flyash (if required) and cement approved for use on this project. The Contractor's Quality Control Laboratory shall obtain samples from the proposed source for testing and development of mix design. Gradation shall be determined on the soil-aggregate alone and with the incorporated cement. The design mix shall be based on the compressive strength of specimens molded in accordance with AASHTO T134, cured seven (7) days at 100% relative humidity at 73.4° F±3°, soaked in water for four (4) hours, then tested in compression in accordance with ASTM D1633. A minimum of three different cement contents shall be tested to determine the cement content necessary to develop an average seven (7) day compressive strength of 1,000 psi for Gradation A. The design cement content shall be two percent more than the percentage required to attain the required compressive strengths. Based on the desired permeability factor, the cement content shall not be less than ten (10%) percent of the dry weight of the soil-aggregate unless otherwise approved by the Engineer. If flyash is required the content shall not be more than two (2%) percent by dry weight of the soil-aggregate. The contractor shall use the proportions of soil-aggregate, cement, and flyash (if required) and the moisture content determined by the Contractor's Quality Control Laboratory results. The contractor shall allow a minimum of ten (10) days for development of the mix design.

624.3 CONSTRUCTION REQUIREMENTS

624.3.1 REQUIRED CONTRACTOR SUBMITTALS: Prior to the start of construction, the contractor shall submit in writing for approval the following:

a. The location, size, equipment to be use, plant/equipment settings for construction of the test section.

b. The type of compaction equipment to be used on the project.

c. The method of curing to be used on permanently/temporarily exposed surfaces.

d. Calibration and certification of project scales.

e. The equipment, plant, machines and tools to be used in construction of the soil cement.

f. The method and schedule of plant calibration that shall be employed by the contractor.

g. Certification of proposed portland cement, flyash, and water for use in construction of soil-cement.

Approvals of the above items shall not relieve the contractor of his responsibility for producing the required soil-cement.

624.3.2 STOCKPILE OF AGGREGATE: Soil-Aggregate shall be constructed on level, firm ground free of brush, trees, stumps, roots, rubbish, debris or other deleterious materials. The stockpile shall be located to maintain a minimum of twenty (20') feet from the processing plant or another stockpile. The stockpile shall be constructed in layers which will not exceed three (3') feet in thickness. Ramps formed in the stockpile shall be constructed of the stockpile material and shall be considered a part of the stockpile. Stockpiled material shall be thoroughly mixed throughout its depth, width, and length before utilization. The stockpile material shall be monogenous and uniform in color, gradation and moisture throughout. After approval of the stockpile no material will be added without the approval of the Engineer.

624.3.3 TEST SECTION: Prior to the placement of any soil-cement the contractor shall construct a test section. The purpose of the test section is to demonstrate the suitability of the contractor's equipment, methods and personnel. The test section shall be a minimum of two (2) lifts in height and of thickness as specified on plans, fifty (50') in length and a minimum of ten (10') feet in width. The site of the test section shall be approved by the Engineer. The test section shall also demonstrate the lift edge treatment to be used. The Engineer shall approve all equipment, methods and personnel after completion of the test section.

624.3.4 SUBGRADE PREPARATION: The subgrade upon which the soil-cement is to be placed shall be graded and shaped to the lines and grades as shown on the plans or as directed by the Engineer. The subgrade shall be prepared and compacted to a minimum depth of six (6") inches with a minimum of ninety-five (95%) percent of the maximum density as determined by AASHTO T180 or ASTM D4253 with a moisture content of not less than optimum minus one (1%) percent nor more than optimum plus three (3%) percent. In areas where the existing landfill material creates soft or "spongy" conditions, at the ground surface as approved by the Engineer, subgrade shall be prepared and compacted to a minimum depth of six (6") inches with a minimum of eighty-five (85%) percent of the maximum density as determined by ASTM D-1557. Subgrade preparation does not apply to mix-in-place construction.

624.3.5 MIXING: Plant mixed soil-cement shall be mixed in an approved continuous-flow or batch-type central plant pugmil. The plant shall be equipped with metering and feeding devices that will add the soil-aggregate, cement, flyash (if required) and water into the mixer in the specified quantities. The plant shall also be equipped with a hydraulically or mechanically operated discharge holding bin having a minimum capacity of five (5) tons of soil-cement. Soil and cement shall be mixed sufficiently to prevent cement balls from forming when water is added. The mixing time shall be that time which is required to secure a homogenous, intimate, uniform mixture of soil-aggregate, cement, flyash (if required) and water.

Access shall be provided at all times to all parts of the plant for the purposes of checking the adequacy of the equipment in use, sampling of the soil-cement mixture and its components, and inspecting the operation of the plant.

Water shall be added to the soil-cement mix to produce a moisture content of the material at the point of placement of not less than optimum minus one (1%) percent nor more than optimum plus two (2%) percent as determined by the Owner's Testing Laboratory.

If the actual proportions of the mix vary more than two (2%) percent from the proportions established in the mix design, the Engineer will require changes in the plant operation or equipment as necessary to produce the specified soil-cement mix.

The contractor shall furnish and install a set of truck scales unless the plant is equipped with suitable scales for measuring the cement and soil-aggregate feeds. The scales shall be located at the plant to monitor/calibrate the soil-cement mix production. The scales shall be calibrated to an accuracy of two (2%) percent. The plant will be calibrated daily at the start of operation, or as otherwise directed by the Engineer.

624.3.6 HANDLING: The plant mixed soil-cement mixture shall be transported from the mixing plant to the site of placement in vehicles having tight, clean, and smooth beds. Haul time shall not exceed 30 minutes from the addition of cement to the mixture unless otherwise approved by the Engineer

624.3.7 PLACING: Plant mixed soil-cement shall be placed on the subgrade, moistened embankment, or previously completed soil-cement with spreading equipment that will produce layers of such widths and thickness as are necessary for compaction to the required dimensions. The soil-cement shall have a moisture content of not less than optimum minus one (1%) percent nor more than optimum plus two (2%) percent. The contractor shall complete the layer in one lift and will not be allowed to use multiple lifts for construction. Lifts before compaction shall be no greater than twelve (12") inches thick, and no less than eight (8") inches thick. Each successive layer shall be placed as soon as practicable after the preceding layer is completed and accepted. If stepped finish is indicated on the drawings it may be necessary to form the exposed edge or to use another method proposed by the contractor which will require approval by the Engineer prior to the construction of this item. Forms if used for step construction shall stay in place for a minimum of one (1) day. Spreading shall be completed within one (1) hour from the addition of cement to the mixture unless otherwise approved by the Engineer. No section shall be left undisturbed for longer than thirty (30) minutes during placing operations.

All necessary precautions shall be taken to prevent damage to completed soil-cement by the equipment and to avoid deposition of raw earth or foreign material between layers of soil-cement. Earth ramps crossing completed soil-cement shall have a compacted thickness of at least two (2') feet.

Mixing shall not proceed when the soil aggregate or the area on which the soil-cement is to be placed is frozen. Soil-cement shall not be mixed or placed where the air temperature

is below 45° F, unless the air temperature is at least 40° F and rising. The soil-cement shall not be mixed or placed when the air temperature is above 95° F. Also, the soil-cement shall not be mixed or placed if weather conditions are such that the materials being processed cannot be completely compacted or protected before the advent of damaging weather. Compacted soil-cement shall be protected from freezing by a method approved by the Engineer a minimum of seven (7) days. Areas damaged by freezing shall be removed and replaced at no cost to the Owner.

624.3.8 COMPACTION: Soil-cement shall be uniformly compacted to a density not less than ninety-eight (98%) percent of maximum laboratory density for Gradation A soil-cement. Maximum laboratory density and optimum moisture shall be as determined in accordance with AASHTO T134.

At the start of compaction, the mixture shall be in a uniform loose condition throughout its full depth. Its moisture content shall be not less than optimum minus one (1%) percent nor more than optimum plus two (2%) percent. No section shall be left undisturbed for longer than 30 minutes during compaction operations.

Compaction shall be completed within one and one-half (1.5) hours from the time the cement is added to the mixture.

624.3.9 FINISHING: After compaction of layered soil-cement, the individual layer shall be further shaped, if necessary to the required line, grades, and cross section, and rolled to a reasonably smooth surface. For layered construction, the top surface of the compacted and finished layer shall be scarified to a depth of at least one-half (1/2") inch with a spike tooth instrument, or by means acceptable to the Engineer prior to placement of the next layer. The spacing of the striations, produced by scarifying, shall not exceed six (6") inches measured perpendicular to the length of the soil-cement being placed. The surface of each lift shall be swept using a power broom to completely remove from the surface all loose material prior to placement of the next layer of soil-cement. The requirement for scarifying may be waived by the Engineer if the compaction equipment utilized produces a surface of sufficient roughness that will develop an adequate bond between soil-cement layers. Surface compaction and finishing of each layer shall be done in such a manner as to produce a dense surface free from compaction planes or loose material at a time no longer than two (2) hours from the time cement is added to the mixture.

Roads/Paths, grade slab, or other exposed soil-cement surfaces shall have a surface finish or treatment as indicated on the plans or directed by the Engineer.

For layered construction the successive layer shall be placed within three (3) hours from finishing of the previous layer. Sprinkle the top of each completed layer with dry cement, about 1 to 1-1/2 pounds per square yard. The cement should be applied to a moistened surface immediately prior to placement of the next layer. If placement will occur in a time period greater than three (3) hours the surface of the finished layer shall be treated/coated with a bonding agent in lieu of the dry cement. The bonding agent shall be vigorously broomed into the exposed surface to displace all air films and cover all

surfaces, to a uniform thickness of one-eighth (1/8") to one-quarter (1/4") inch. The agent shall consist of one (1) part portland cement, one (1) part concrete sand, and about one-half (1/2) part water to give a thick paint-like consistency, or shall be another bonding agent approved by the Engineer. The agent shall not be applied to an extremely wet surface or when hollow and rough areas contain free water. Excess water can be removed with compressed air. In no case should the agent be allowed to dry before the soil-cement is placed.

640.3.10 CURING: Finished surfaces of soil-cement shall be kept moist for seven (7) days or until a succeeding layer or surface treatment is applied. Moisture shall be retained by continuous wetting or by a method approved by the Engineer. Curing compounds will not be allowed. Care must be exercised to ensure that no curing material other than water is applied to surfaces that will be in contact with succeeding layers.

640.3.11 CONSTRUCTION JOINTS: Wherever construction operations are such that an adjacent layer will not be placed within three (3) hours of finishing the previous layer a transverse construction joint shall be formed by cutting into the compacted work to form a full depth vertical face. The joints shall be staggered from layer to layer by an eight (8') foot horizontal distance. The cutting of the soil-cement shall be performed within three (3) hours after finishing.

624.3.12 MAINTENANCE: The contractor shall be required to maintain the soil-cement in good condition during construction and until all work is completed and accepted. Maintenance shall include immediate repairs of any defects or damage that may occur, and maintenance of curing covers. Faulty or damaged work shall be replaced for the full depth of the layer.

624.3.13 INSPECTION: The Engineer, with the assistance and cooperation of the contractor, shall make such observations as he deems necessary to verify that the contractor's work is in conformance with specifications. These observations may include, but shall not be limited to the complete soil-cement construction operation.

624.4 TESTING: All testing of the soil-cement or its individual components, unless otherwise provided specifically in the contract documents, shall be in accordance with the latest applicable NMSHTD, ASTM, or AASHTO Specifications in effect at the date of advertisement for this project.

624.4.1 SAMPLING: Samples of soil-cement material for moisture content and laboratory compaction tests shall be taken directly from the area being constructed before compaction begins, as scheduled or periodic intervals during construction. Samples shall be placed in sealed containers and delivered to the Contractor's Quality Control Laboratory for testing. The samples shall be representative of the soil-cement being placed and compacted. Frequency for sampling shall be as determined in Section 624.4.1, 624.4.2, and 624.4.3 or as directed by the Engineer.

624.4.2 LABORATORY COMPACTION TESTS: The optimum moisture content - maximum density relationship shall be as determined in accordance with AASHTO T134.

Gradation tests shall be performed on each laboratory compaction test sample in accordance with AASHTO T88. A minimum of two (2) laboratory compaction tests shall be run for every ten (10) nuclear tests. The laboratory compaction test shall be defined as a single specimen molded from the soil-cement as received from the field following the molding procedures of AASHTO T134. The results of the laboratory compaction tests shall be compared to the optimum moisture-maximum density relationship curve. If the dry density from the laboratory compaction tests vary more than two (2%) percent from the curve, a new optimum moisture content-maximum density relationship shall be determined. The material for the one-point compaction test shall be obtained from the locution of the nuclear gauge test. Frequency of laboratory compaction tests shall be not less than one (1) test for each 1,500 cubic yards of compacted soil-cement. Testing shall take place before soil-cement begins to harden.

624.4.3 NUCLEAR DENSITY TEST: Nuclear Density Tests shall be performed in accordance with AASHTO T238, Method B. The frequency of nuclear tests shall not be less than 5 tests for each 1,000 cubic yards of soil-cement placed or as determined by the Engineer.

624.4.4 COMPRESSIVE STRENGTH TESTING: Compressive strength specimens shall be molded and tested in the same manner as described in Section 624.2.5. Frequency shall be two (2) specimens for every laboratory compaction test. The samples shall be obtained from the locution of the nuclear density test. Specimens shall be tested at seven (7) days.

624.5 METHOD OF MEASUREMENT: The work shall be measured: 1) in cubic yards of soil-cement as determined by the specified lines, grades, and cross sections shown on the plans; 2) tons of cementitious material (i.e., portland cement, flyash) incorporated into the soil-cement. Any waste of soil-cement or cementitious material by the Contractor during handling, mixing, placing, finishing operations shall not be included in measurement, unless otherwise specified in the Project Contract Documents.

624.6 BASIS OF PAYMENT: The accepted quantities of soil-cement, measured as provided above, will be paid for at the contract unit price per cubic yards of soil-cement and at the contract unit price per ton of cement in the soil-cement, or as otherwise specified in the Project Contract Documents. Such payment shall constitute full reimbursement for all work necessary to complete the soil-cement. This work shall include, but not be limited to: subgrade preparation, providing and stockpiling aggregate, watering, mixing, placing, compacting, shaping, finishing, and curing.

SECTION 1012
NATIVE GRASS SEEDING

1012.1 GENERAL:

Work under this section consists of preparing all area indicated on the plans for native grass seeding, furnishing and installing all seed, fertilizer and soil amendments as specified herein and on the plans, or as authorized by the ENGINEER.

1012.2 REFERENCES:

1012.2.1 This Publication:

Section 1011 Turf Grass Seeding

1012.3 WORK AREA/TIMING:

1012.3.1 Areas that are disturbed by the CONTRACTOR that are outside the construction limits shown on the plans or authorized by the ENGINEER shall be seeded with native grasses as specified herein at no cost to the OWNER.

1012.3.2 The seeding of disturbed areas shall commence upon completion of the other work in the area.

1012.4 MATERIALS:

1012.4.1 Native Seed: The native seed species and rate of application shall be as shown below and shall be used based on the type of soil or as specified on the plans or in the Supplemental Technical Specification.

1012.4.1.1 Sandy Soils: (mainly west side areas). Seed rate is given in pounds of pure live seed (P.L.S.) per acre.

Variety/ Common Name	Genus/ Species	P.L.S/Acre
"Paloma" Indian rice grass	Oryzopsis hymenoides	5.0
"Viva" Galleta grass	Hilaria jamesii	1.0
"Niner" Side oats grama	Bouteloua curtipendula	3.0
"Hatchita" Blue grama	Bouteloua gracilis	1.0
Sand dropseed (NM Region)	Sporobolus cryptandrus	1.0
Fourwing saltbush (NM Region)	Atriplex canescens (de-winged)	1.0
Total rate		12.0 lbs/ acre

1012.4.1.2 Clay, Clay Loam, and Sandy gravelly clay loam soils: (mainly valley and east side areas). Seed rate is given in pounds of pure live seed (P.L.S.) per acre.

Common Name	Genus-species	PLS/acre
"Paloma" Indian rice grass	Oryzopsis hymenoides	2.0
"Viva" Galleta grass	Hilaria jamesii	2.0
"Niner" Sideoats grama	Bouteloua curti pendula	2.0
"Hatchita" Blue grama	Bouteloua gracilis	3.0
Sand dropseed (NM Region)	Sporobolus cryptandrus	1.0
Four-wing saltbush (NM Region)	Atriplex canescens (de-winged)	1.0
Total rate		11.0 lbs/ac

NOTE: If the area to be seeded is along a recreational trail of any type the seed mixes for either type of soil listed above shall exclude the one (1) pound per acre of Four-wing saltbush. The seeding rate shall be lowered by one (1) pound per acre.

1012.4.1.3 Seeds may be pre-mixed by a seed dealer. Each bag of seed shall be sealed and labeled by the seed dealer in accordance with Federal Seed Laws and New Mexico Department of Agriculture Labeling Laws. This includes: variety, kind of seed, lot number, purity, germination, percent crop, percent inert, percent weed (including noxious weeds), origin, test data and net weight. Federal Seed Laws require that analysis shall be no older than 5 months for seed shipped interstate and no older than 9 months for seed shipped intra-state. The ENGINEER shall receive all labels from all bags of seed used for verification.

1012.4.2 Fertilizer and Soil Amendments: Unless otherwise specified on the plans or in the Supplemental Technical Specification, no fertilizer or other soil amendments are required on areas specified to receive native seeding. If fertilizer and/or other soil amendments are required they shall be in accordance with Section 1011 of these specifications.

1012.4.3 MULCH:

1012.4.3.1 Hay Mulch: Perennial native or introduced grasses of fine-stemmed varieties shall be used unless otherwise specified on the plans. At least 65 percent of the herbage by weight of each bale of hay shall be 10 inches in length or longer. Hay with noxious seed or plants will not be acceptable. Rotted, brittle, or moldy hay will not be acceptable. Marsh grass or prairie hay composed of native grass of species to be seeded will be acceptable. Tall wheat grass, intermediate wheat grass, switch grass, or orchard hay will be acceptable if cut prior to seed formation. Marsh grass hay shall be composed of mid and tall native, usually tough and wiry grass and grass-like plants found in the lowland areas within the Rocky Mountain region. Hay shall be properly cured prior to use. Hay which is brittle, short fibered or improperly cured is not acceptable.

1012.5.2 Straw Mulch: Small grain such as wheat, barley, rye, or oats will not be allowed except by prior approval of the ENGINEER and with the concurrence of the Air Division, Environmental Health Department. Alfalfa or the stalks of corn, maize or sorghum is not acceptable. Material which is brittle, shorter than 10 inches or which breaks or fragments during the crimping operation will not be acceptable.

1012.4.3.3 Gravel Mulch: Gravel mulch shall be crushed or screened gravel 3/4" to 1" maximum size with a minimum of one angular face unless otherwise specified.

1012.4.3.4 Erosion Control Matts, Fabric or Blankets: The type of erosion control mats, fabric or blankets used shall be as specified or allowed on the plans or in the Supplemental Technical Specifications.

1012.5 SEED BED PREPARATION:

1012.5.1 General:

1012.5.1.1 Prior to the starting of any seed bed preparation the final grades of all earth work shall be inspected and approved by the ENGINEER.

1012.5.1.2 No preparation shall be performed when the surface is wet or muddy or when the soil moisture content is such that the soil is not fully loosened by the discing operation.

1012.5.1.3 The extent of seed bed preparation shall not exceed the area on which seeding, mulching and crimping operations can be completed prior to crusting or wind or water erosion of the prepared surface - if erosion, crusting or re-compaction occurs, the affected area shall be re-worked beginning with seed bed preparation. Depth of preparation must be approved by the ENGINEER prior to the seeding and mulching operations.

1012.5.2 Mechanical Preparation: The seed bed shall be loosened to a minimum depth of 6" (six inches) by means of disc or harrow. Area of heavy or compacted soil may require additional preparation such as chiseling or ripping if discing alone does not result in preparation to the full minimum depth of 6". The soil shall be worked to a smooth surface free of clods, stones 4" and larger or any other debris or foreign material that could interfere with seeding or crimping equipment operations.

1012.5.3 Hand Preparation: Areas which cannot be prepared with mechanized equipment because of small size irregular shape or slope angle may be prepared to a minimum depth of 2" using hand tools or a rototiller. Any such areas will be specified on the plans.

1012.6 SEEDING:

1012.6.1 General:

1012.6.1.1 Seeding shall not start until the seed bed preparation has been inspected and approved by the ENGINEER.

1012.6.1.2 No more area may be seeded than can be covered with mulch and crimped, or covered with gravel mulch or erosion control mats by the end of the work day. No seeding operations may be conducted when steady wind speed exceeds 10 miles per hour. If winds exceed 10 mph while seeding is underway, seeding operations will be halted and any areas seeded to that point completed.

1012.6.2 Seed Application:

1012.6.2.1 Drill Seeding: Drill seeding is required unless otherwise specified on the plans or in the Supplemental Technical Specifications. Seed shall be applied with a "rangeland" type seed drill equipped with packer wheels. Seed shall be drilled to a maximum depth of 1/2" unless otherwise specified. Direction of seeding shall be across slopes and on the contour whenever possible.

1012.6.2.2 Broadcast Seeding: Seed may be applied using the broadcast method when size, irregular shape or slope angle exceeding 3.1 prevents the use of a seed drill. Seed may be broadcast by hand or by means of a mechanical seeder provided that the seed is evenly distributed over the seeding area. Areas of broadcast seeding will be hand raked to cover seed. Areas which are broadcast seeded shall be seeded at rate which is double that used for drill seeding.

1012.6.2.3 Seeding With Gravel Mulch: Areas to receive gravel mulch will be seeded at the broadcast seed rate with 1/2 the seed applied prior to application of gravel and 1/2 the seed applied on the surface of the gravel. Water shall be applied in quantity sufficient to wash seed from the surface and into the gravel.

1012.6.2.4 Hydro Seeding: Hydro seeding will not be allowed on areas of non-irrigated native grass seeding unless specified on the plans or in the Supplemental Technical Specifications or authorized by the ENGINEER.

1012.7 MULCHING:

1012.7.1 General:

1012.7.1.1 All seeded areas shall be mulched unless otherwise specified on the plans or in the Supplemental Technical Specifications.

1012.7.1.2 On seeded areas that are level or have slopes 3:1 or less, any of the four (4) types of mulching or erosion control specified herein may be used. On seeded areas that have slopes steeper than 3:1 only gravel mulch or erosion control materials may be used as specified on the plans and in the Supplemental Technical Specifications.

1012.7.2 Hay Mulch: Hay mulch shall be applied at a minimum rate of 1.5 tons per acre of air dry hay.

1012.7.3 Straw Mulch: Straw mulch shall be applied at a minimum rate of 2.5 tons per acre of air dry straw.

1012.7.4 Crimping: Hay and/or Straw mulch shall be crimped into the soil. The mulch shall be spread uniformly over the area either by hand or with a mechanical mulch spreader. When spread by hand, the bales of mulch shall be torn apart and fluffed before spreading. Mulching will not be permitted when wind velocity exceeds 15 miles per hour. The mulch shall be wetted down and allowed to soften for 15 to 20 minutes prior to crimping. A heavy disc such as a mulch-tiller, with flat serrated discs at least 1/4 inch in thickness, having dull edges and the disc spaced 6 inches to 8 inches apart shall be used to crimp (or anchor) the mulch into the soil to a minimum depth of 2 inches or as specified on the plans or the Supplemental Technical Specifications. The discs shall be of sufficient diameter to prevent the frame of the equipment from dragging the mulch.

The crimping operations shall be across the slope where practical but not be parallel to prevailing Westerly winds (270 degrees magnetic). Crimping shall be in a general north-south direction or by tight interlocking "S" curves to avoid straight east-west crimp lines.

If small grain straw mulch is used it shall be crimped in two (2) directions in a cross-hatch pattern.

1012.7.5 Gravel Mulch: Gravel mulch shall be placed by hand or by mechanized equipment that provides full coverage at a uniform thickness of 2 inches in depth.

1012.7.6 Erosion Control Matts, Fabric or Blankets: the type of erosion control mats, fabric or blankets used shall be as specified on the plans or the Supplemental Technical Specifications or as approved by the ENGINEER. The anchoring of the erosion control items shall be as per the manufacturer's recommendations.

1012.8 PROTECTION OF NATIVE GRASS SEEDED AREA:

1012.8.1 GENERAL: The CONTRACTOR shall be responsible for protecting and caring for seeded areas until final acceptance of the work and shall repair at his expense any damage to seeded areas caused by pedestrian or vehicular traffic or vandalism.

1012.9 INSPECTION FOR NATIVE GRASS AREA:

1012.9.1 The following inspection shall be the minimum required inspections to native grass during the course of construction. Additional inspections shall be made at any time at the discretion of the ENGINEER.

1012.9.2 It shall be the responsibility of the CONTRACTOR to notify the ENGINEER, in writing, 48 hours in advance of each required inspection.

1012.9.3 The sequence of required inspections shall not be changed from the sequence listed below. The CONTRACTOR shall not proceed with work of the next sequence without written approval of the work of the previous sequence. Payment will not be approved for items which have not been inspected and approved in writing.

1012.9.3.1 Each phase of soil preparation shall be inspected in process.

1012.9.3.2 Finish grade shall be inspected.

1012.9.3.3 Seed shall be inspected prior to seeding.

1012.9.3.4 Seeded area shall be inspected after completion.

1012.9.3.5 Final inspection of the project and acceptance.

1012.10 MEASUREMENT AND PAYMENT

1012.10.1 MEASUREMENT: The measurement of native grass seeding shall be by the acre.

1012.10.2 Payment: Payment shall be made at the contract unit price per acre of native grass seeding complete in place, which shall include the seed, fertilizer, (if required) area preparation, seeding, soil amendments, (if required) and mulching.

SECTION 2120

TEMPORARY WATER POLLUTION AND SOIL EROSION CONTROL

2120.1 DESCRIPTION

2120.1.1 This work shall consist of temporary measures to control water pollution, and soil erosion.

2120.2 REFERENCES

2120.2.1 Supplemental Technical Specification - Section 1012

2120.3 DEFINITIONS

2120.3.1 Structural control measures used to prevent water from crossing disturbed areas where sediment may be removed include earth dikes, swales, or diversions. Structural control measures used to remove sediment from site runoff before the runoff leaves the site include silt fences, check dams, or attenuation basins.

2120.3.2 Stabilization control measures used to cover or maintain an existing cover over soils, include seeding, grasses, and mulching.

2120.4 COORDINATION

2120.4.1 Coordinate temporary erosion control measures such as silt fencing with the permanent erosion control measures to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.

2120.4.2 Temporary control may include work outside the construction limits, such as borrow pit operations, equipment and material storage sites, waste areas, and temporary plant sites.

2120.5 STORMWATER DISCHARGE PERMIT REQUIREMENTS (NPDES)

2120.5.1 A Stormwater Discharge Permit for Construction under the National Pollutant Discharge Elimination System (NPDES) is required for this project.

2120.5.2 The Contractor is responsible for the development (with assistance from the Engineer) and submittal of a comprehensive Storm Water Pollution Prevention Plan (SP3), in accordance with National Pollutant Discharge Elimination System (NPDES) regulations for storm water discharges associated with construction activities [40 CFR 122.26 (b)(14)(x)]. The SP3 identifies sources of potential pollution to stormwater discharges associated with the site, and

identifies appropriate measures to reduce pollutants in storm water discharges to ensure compliance with the terms of the NPDES permit.

2120.5.3 The SP3 includes the following information related to the site Permit requirements: site description, erosion and sediment controls, storm water controls, housekeeping and maintenance, construction site inspections, and non-storm water discharges.

2120.5.4 Maintain a copy of the SP3 on the project job site at all times.

2120.5.5 The Contractor shall submit a Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity under the NPDES General Permit at least two weeks before construction begins.

2120.5.6 Provide a signed certificate acknowledging the terms and conditions of the NPDES General Permit for construction activities. File the certification of compliance on the construction site along with the SP3.

2120.5.7 The Contractor will submit a Notice of Termination (NOT) to the EPA which certifies that specific activities in the SP3 have ended and that either final stabilization is complete and temporary erosion and sediment controls have been removed or all discharges from the construction area have been eliminated.

2120.6 SUBMITTALS/PROJECT RECORD DOCUMENTS

2120.6.1 Submit a Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity Under the NPDES General Permit to the Environmental Protection Agency (EPA) at least two weeks before construction is to commence. Provide the Engineer a copy of the submitted NOI.

2120.6.2 Submit a comprehensive Storm Water Pollution Prevention Plan (SP3), in accordance with National Pollutant Discharge Elimination System (NPDES) regulations for storm water discharges associated with construction activities [40 CFR 122.26 (b)(14)(x)]. The SP3 identifies sources of potential pollution to stormwater discharges associated with the site, and identifies appropriate measures to reduce pollutants in storm water discharges to ensure compliance with the terms of the NPDES permit. The SP3 includes the following information related to the site Permit requirements: site description, erosion and sediment controls, storm water controls, housekeeping and maintenance, construction site inspections, and non-storm water discharges.

2120.6.3 Provide a signed certificate acknowledging the terms and conditions of the NPDES general permit for construction activities. File the certification of compliance on the construction site along with the SP3.

2120.6.4 Submit copies of inspection reports documenting inspections provided under compliance with the terms of the construction permit.

2120.6.5 Submit manufacturer's data on materials to be utilized for temporary erosion control measures to the Engineer for approval.

2120.6.6 Submit schedules for accomplishment of temporary erosion and pollution control work.

2120.6.7 Submit all methods proposed for erosion and sediment control in areas outside the construction limits (haul roads, borrow pits or storage sites), plans for disposal of waste materials, and/or erosion control details for other potential sources of pollution.

2120.6.8 Submit qualifications of the person or persons assigned to perform inspections on the SP3.

2120.6.9 Submit manufacturers data sheets for silt fences and mulches.

2120.7 SILT FENCES

2120.7.1 Provide 2 foot prefabricated geotextile silt fence with posts. Provide a reinforcing cord with the fence for future tensioning. Provide 36" (minimum) by 1-1/2" square solid wood fence stakes on an 6 foot minimum spacing. The Engineer, at his option, may require steel posts be used in areas where wood posts cannot be driven far enough into the ground to adequately support the silt fence.

2120.7.2 Provide geotextile fabrics with a Grab Tensile Strength of 100 Lbs when tested under ASTM D-4632 - Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).

2120.7.3 Provide geotextile fabrics with a minimum grab elongation of 20 percent when tested in accordance with ASTM D-4632.

2120.7.4 Provide geotextile fabrics with a minimum Trapezoidal Tear Strength of 50 pounds when measured in accordance with ASTM D-4533 - Test Method for Trapezoid Tearing Strength of Geotextiles.

2120.7.5 Provide geotextile fabrics with a minimum vertical water flow rate of 10 gallons per minute per square foot (GPM/ft^2) when measured in accordance with ASTM D-4491-85 - Test Methods for Water Permeability of Geotextiles by Permittivity, (Falling Head Method).

2120.7.6 Provide geotextile fabrics with a minimum 90 per cent Ultraviolet Stability when measured in accordance with ASTM D-4355 - Test Method for Deterio-

ration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

2120.8 SEEDING

2120.8.1 Provide seeding meeting the requirements of Supplemental Technical Specification, Section 1012, Native Grass Seeding.

2120.9 EXECUTION

2120.9.1 GENERAL

2120.9.1.1 Implement temporary pollution control measures to minimize soil erosion and to comply with NPDES storm water discharge permit requirements for construction activities. Provide temporary control measures as indicated in the SP3 filed on-site and as indicated on the Drawings.

2120.9.1.2 Implement all applicable features of the SP3 prior beginning construction. Complete all temporary pollution control features at the earliest practicable time and use such measures to comply with NPDES permit terms and conditions, to correct unforeseen conditions that occur during construction or to correct conditions that are needed prior to completion of permanent soil erosion and sediment control measures.

2120.9.1.3 Limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, or borrow and fill operations. Do not exceed 200,000 square feet, the maximum amount of surface area of exposed unprotected erodible earth at any one time during the construction process. The Engineer may require additional pollutant control measures or alternate exposed surface area dimensions for situations not foreseen by the plans and specifications.

2120.9.1.4 Maintain erosion control features that are installed in an acceptable manner during the construction period.

2120.9.1.5 Provide temporary control structures whenever construction equipment must cross watercourses at frequent intervals, and such crossings will adversely affect the sediment levels.

2120.9.1.6 Remove accumulated sediment when 50 percent of the storage volume has been utilized. The Engineer may direct the removal and disposal of accumulated sediment from temporary erosion control facilities as necessary to maintain sediment control functions. All sediment disposal activities will be on-site.

2120.9.2 TEMPORARY SEDIMENT FILTER TRAPS

2120.9.2.1 Construct temporary sediment traps using straw bales or rock cobbles to remove sediment from runoff before the runoff leaves the site. Place sediment traps in drainage ways, at storm drain inlets and at other points of discharge from the disturbed area. Remove excess sediment from sediment traps or replace sediment traps to maintain structural stability and erosion control.

2120.9.3 SILT FENCES

2120.9.3.1 Construct silt fencing along the perimeter of the designated disturbed areas of the site. Install silt fences in accordance with the Manufacturer's instructions.

2120.9.3.2 Place silt fences in drainageways and at points of discharge from the disturbed area.

2120.9.3.3 Maintain fencing materials and remove excess sediment from silt fences to maintain structural stability.

2120.9.3.4 Remove silt fence and accumulated silt after establishment of vegetation as directed by the Engineer. Dispose of silt fence materials on-site. The Engineer may, at his option, allow the silt fence to remain in place.

2120.9.4 SEEDING AND MULCHING

2120.9.4.1 Maintain existing vegetation where practicable.

2120.9.4.2 Provide seeding as in accordance with the provisions of Supplemental Technical Specification, Section 1012, Native Grass Seeding and as indicated on the Drawings. All seeding operations for erosion control include gravel mulching as necessary to provide and maintain plant growth.

2120.9.4.3 Initiate seeding to disturbed areas as soon as practicable, but no later than 14 days after construction activity on a particular portion of the site has temporarily or permanently ceased.

2120.9.4.4 If snow cover or other weather conditions preclude initiation of seeding activities within 14 days, provide seeding as soon as practicable thereafter.

2120.9.4.5 If construction on a disturbed area is to resume within a period of time specified by the Engineer, seeding on this portion of the project is not required.

2120.9.4.6 Maintain healthy vegetative growth on all seeded areas throughout the construction period.

2120.9.5 OTHER WATER POLLUTION CONTROLS

2120.9.5.1 Promptly clear all waterways of falsework, piling, debris, or other obstruction placed during construction work and not a part of the finished work.

2120.9.5.2 Locate aggregate washing, equipment washdown areas or other operations containing sediment so that runoff from these areas is directed to regularly maintained sediment control devices designed to accommodate these discharges.

2120.9.5.3 Do not discharge pollutants such as fuels, lubricants, bitumen, herbicides, raw sewage, wash water from concrete mixing operations, and other harmful materials into or near rivers, streams, and impoundments or into natural or manmade channels leading thereto.

2120.9.5.4 Designate areas for equipment maintenance and repair which include appropriate waste receptacles for spent oils, gasoline, grease and other solvents, and regular collection and disposal schedules.

2120.9.5.5 Provide regular site housekeeping activities designed to minimize the non- sediment related pollutants from entering storm water runoff.

2120.9.6 INSPECTION

2120.9.6.1 Provide qualified personnel to conduct inspection of the temporary water pollution, erosion and sediment control features of the SP3 at least once every seven days and within 24 hours of each 0.5-inch storm event. The person conducting these inspections must have sufficient technical abilities to conduct the inspection, must be cognizant of potential pollutant sources and knowledgeable of construction related requirements of the SP3.

2120.9.6.2 Provide a visual observation of the disturbed areas, areas used for storage of materials that are exposed to precipitation, structural control measures, and locations where vehicles enter or exit the site. Portions of the site that have been temporarily, or finally stabilized can be inspected on a monthly basis. Provide other Inspections as requested by the Engineer. Observations can be made during wet day weather conditions.

2120.9.6.3 Inspect disturbed areas and exposed storage areas for evidence of or potential for pollutants entering the drainage system. Observe the erosion and sediment control measures identified in the SP3 to verify that they are operating correctly. Inspect accessible discharge locations to ascertain whether erosion control measure are effective in preventing significant impacts to receiving waters; look for signs of erosion or sediment at

the discharge locations. Inspect vehicular site access locations for evidence of off-site sediment tracking.

2120.9.6.4 Document each inspection with a written report. File the inspection reports along with the certification of compliance and the SP3 on the construction site. Provide copy of inspection report to Engineer for information.

2120.9.6.5 If an inspection reveals inadequacies, revise the site description and pollution prevention measures identified in the SP3, as soon as possible after this inspection. The Engineer will coordinate and direct any necessary changes in the SP3.

2120.9.6.6 Implement changes to the SP3 within 7 calendar days following the inspection revealing inadequacies.

2120.10 MEASUREMENT

2120.10.1 Measurement shall be made per lump sum for the work required by this section except for native grass seeding and gravel mulching which shall be made on a per acre basis.

2120.11 PAYMENT

2120.11.1 Payment for all work required in this section shall be included in the applicable bid item.

Stormwater Pollution Prevention Plan . . . . . Lump sum
Native Grass Seeding with Gravel Mulch . . . . . per acre

END OF SECTION

TIJERAS ARROYO BANK STABILIZATION
AT
SOUTH EUBANK LANDFILL

FINAL SUMMARY REPORT



Prepared for

COMMISSIONER OF PUBLIC LANDS
for the
STATE OF NEW MEXICO

January 1994

Prepared by

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I. INTRODUCTION

A. PURPOSE

The Tijeras Arroyo Bank Stabilization at South Eubank Landfill evaluation has been performed to analyze and develop options for protection of the closed South Eubank Landfill against erosion from the Tijeras Arroyo. Project analysis includes hydrologic, hydraulic and sediment/scour evaluation to determine viable options for detailed analysis. Project cost estimate budgets are prepared for each of the feasible options, along with identification of advantages and disadvantages of each option.

The study reach includes that portion of the Tijeras Arroyo which directly impacts the closed South Eubank Landfill, which lies east of the extension of Eubank Boulevard and west of the extension of Juan Tabo Boulevard (see Figure 1).

B. AUTHORITY

Authority for this study is provided in the A/E Services Agreement between the Commissioner of Public Lands for the State of New Mexico and Leedshill-Herkenhoff, Inc. dated December 6, 1993.

C. PROJECT SCOPE

The scope of work for the Tijeras Arroyo/South Eubank Landfill evaluation specifically includes the following tasks:

1. Phase One

Phase One consists of an analysis of the current situation and development of project options for consideration by the Land Commissioner. The principle objective is to protect the closed South Eubank Landfill against erosion from the Tijeras Arroyo. This phase shall culminate with a written report. It should include, but not be limited to, the following elements of work:

a. A brief review of completed hydrologic studies to determine the appropriate design flows in the arroyo.

b. Hydraulic analysis sufficient to analyze existing flow patterns upstream, adjacent to, and downstream of the site.



TIJERAS ARROYO

PROJECT AREA
LOCATION MAP

FIGURE 1

c. Coordination with other affected agencies to determine policies and requirements.

d. Appropriate sediment/scour analysis.

e. Limited geotechnical investigation as appropriate.

f. Development of options to protect the landfill, with an assessment of impacts for each option. Each option will include, as a minimum, a hydraulic analysis to predict flow patterns upstream, adjacent to, and downstream of the site. Cost estimates will be developed for each option.

g. Written recommendation as to preferred option(s).

2. Phase Two

Upon selection of a preferred option by the Land Commissioner, the engineer will develop detailed design documents. This phase shall include, but not be limited to, the following elements of work:

a. Design drawings and specifications including details for the EPA stormwater pollution prevention plan.

b. Coordination with affected agencies to approve drawings and specifications.

c. Coordination with outside agencies which may have jurisdiction, and the filing of necessary permit applications or notifications.

d. Detailed cost estimate.

Upon completion of Phases One and Two, a request shall be made to the 1994 session of the New Mexico Legislature to fund the recommended project. The request for funding will be a joint request involving the City of Albuquerque, Bernalillo County, Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) and the State Land Office.

Should funding be made available, the following additional tasks will be included in the project scope.

3. Phase Three

Phase Three will consist of the preparation of contract documents, final project cost estimates, advertising for competitive sealed bids, pre-bid meeting and site visits for respective bidders, preparation of addenda, if required, evaluating bids and assisting the State Land Office in opening bids and in the awarding of a contract.

4. Phase Four

Phase Four work will consist of construction contract administration services and shall include but not be limited to, the following elements of work:

a. Pre-construction conference.

b. Assistance to the Land Office in acquiring necessary permits.

c. Construction monitoring of the project, including surveys and geotechnical testing.

d. Submission of necessary reports.

e. Preparation of monthly pay estimates.

f. All other construction contract administration services, such as preparation of change orders, review of shop drawings, etc.

g. Submittal of "record" drawings, construction completion report and other necessary final reports and closeout documents.

h. Eleven month warranty inspection.

D. AGENCY REVIEW/APPROVAL

Due to the fast-track schedule of this project, AMAFCA agreed to take the lead on technical review, comment, and approval for each review stage of the project, which includes the evaluation summary report and final design plans and specifications. The City/County Floodplain Administration representative, the Land Commissioner of the State Land Office and City Hydrology will provide review comments as well, but will defer final recommendations for the determination of AMAFCA.

Environmental concerns relative to the landfill shall be coordinated with and reviewed by both the Surface Water Quality Bureau and the Solid Waste Bureau of the New Mexico Environment Department (NMED).

The County of Bernalillo, Kirtland Air Force Base and City Open Space and Solid Waste will receive courtesy copies of the report and design plans for informational purposes only.

E. PROCUREMENT OF INFORMATION

To the extent possible, mapping, hydrologic data, and hydraulic data were acquired from previous studies. In particular, the Tijeras Arroyo Drainage Master Plan, Phase I and II reports dated October 1987 and August 1990, respectively, were heavily relied upon and are frequently excerpted in this report. A summary list of the other reports and studies reviewed for this project is provided in the references section of this report.

Orthophotobase-topographic mapping of the project area was obtained from the Federal Emergency Management Agency (FEMA) Flood Insurance Mapping Project, dated 1982. This mapping was utilized for hydraulic analyses. Supplemental data was obtained through a land survey of the project site, performed by Albuquerque Surveying Company. In early December, 1993, cross sections were measured at 50 foot spacing through the project reach limits and topographic mapping was developed at a scale of 1" = 50' with a 1-foot contour interval for use as the base mapping for final design drawings.

II. GENERAL DESCRIPTION

A. PHYSICAL CHARACTERISTICS OF PROJECT AREA

The Tijeras Arroyo is an ephemeral stream typical of those which exist in semi-arid climates in the southwest United States. The headwaters begin in the Sandia Mountains and drain to the Rio Grande. The Tijeras Arroyo is the largest arroyo located in Bernalillo County, with a watershed area of approximately 133 square miles. The lower ten miles of the arroyo are generally located along the southern edge of the southeast metropolitan area of Albuquerque (see Figure 2).

B. TIJERAS ARROYO STUDY LIMITS

The study area for this project is limited to that portion of the arroyo which directly impacts the closed South Eubank Landfill. A map of this area is presented on Figure 1.

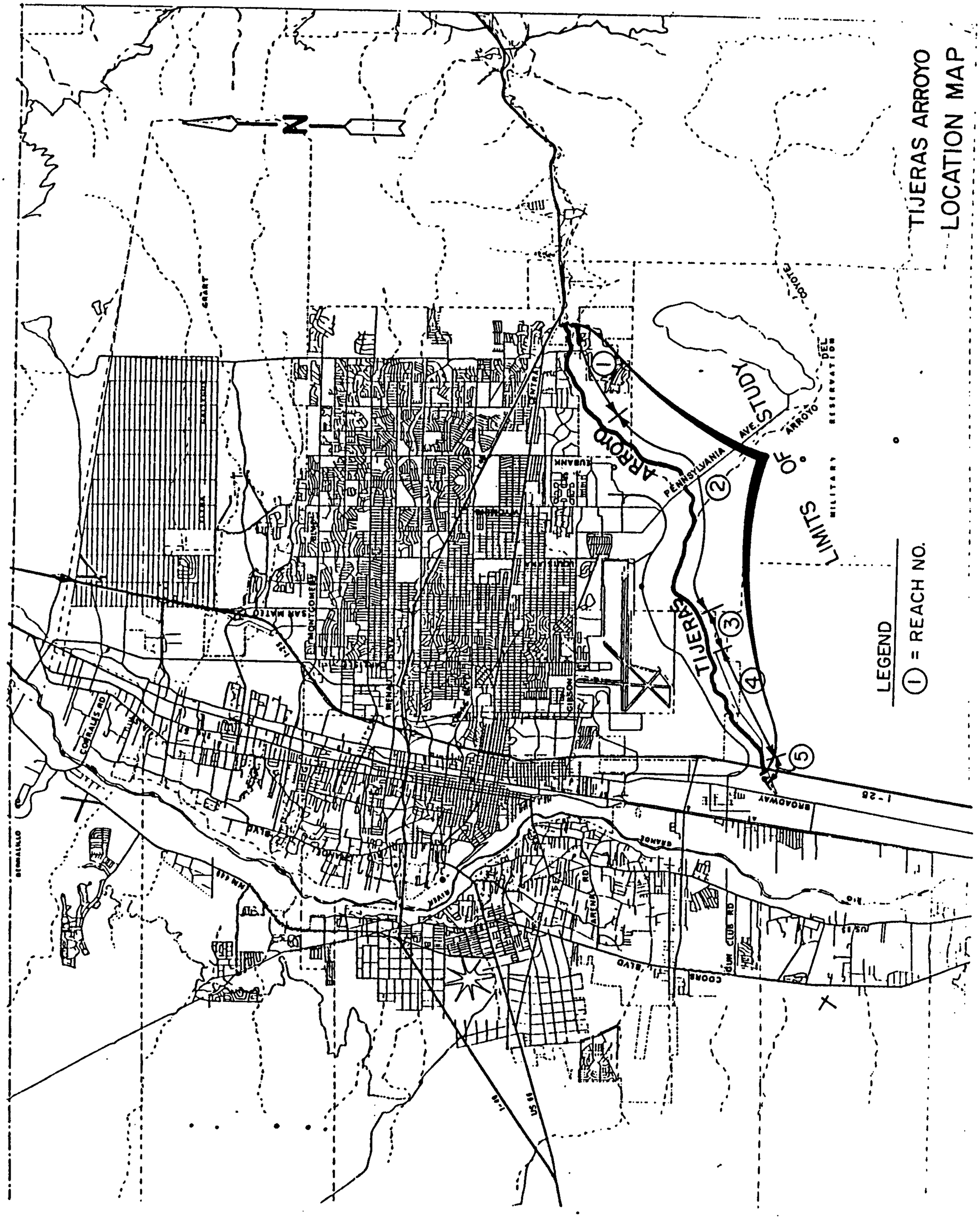
The flood plain along this reach of the arroyo is characterized by a wide flood plain valley with a well defined low flow channel. Sediment transport analyses performed as part of the Tijeras Arroyo Drainage Management Plan, Phase II report indicate that the project area lies within the only arroyo reach west of Four Hills Road which is in a degradating mode. (For details, reference Chapter VIII of the Phase II Report.)

C. SOUTH EUBANK LANDFILL

The City of Albuquerque began operating the South Eubank Landfill on property owned by the New Mexico State Land Office in 1966 at the north edge of the arroyo bottom, in an area just east of Eubank Boulevard and continued its use until around the summer of 1977. The landfill was closed in 1977, in general compliance with the 1974 Solid Waste Management Regulations.

Closure requirements under the '74 regulations required only that the landfill be entirely covered with two feet of clean earth. Following the City's closure of the landfill, an individual contracted with the New Mexico State Land Office, to lease the property for further dumping of construction waste. For several years the area was subjected to the dumping of curb stone, concrete rubble, etc.

New Solid Waste Regulations were promulgated by the State of New Mexico in 1992. Several meetings and discussions have been held with personnel in the Solid Waste Bureau and Surface Water Bureau of the NMED to discuss this project. It was concluded that for the present, the South Eubank Landfill can be grandfathered under the 1992



LEEDSHILL - HERKENHOFF, INC.

FIGURE 2

regulations, providing permanent bank stabilization measures constructed along the Tijeras Arroyo address environmental aspects of the landfill to the satisfaction of NMED.

Interaction between the Tijeras Arroyo and the South Eubank Landfill has significantly altered the path of the natural low flow channel and has resulted in a blighted area that extends for hundreds of feet along the arroyo. The placement of the landfill material inadvertently changed the path of the arroyo to a more southerly alignment. The resulting channel has cut a new low flow channel path nearly thirty feet wide, ten feet deep and more than 2200 feet long during the past twenty-five to thirty years.

Along the eastern portion of the landfill, near the southeast corner, the arroyo has, over-time, eroded the landfill embankment resulting in a vertical cut adjacent to the arroyo bed for approximately 200 linear feet along the channel (see Figure 3). Debris has been carried away from the landfill and deposited downstream (see Figure 4). There is no record of large flows being conveyed in the arroyo since 1967. It is concluded that exposure of the landfill has been accelerated as a result of more frequent runoff generated from development occurring along the north and south watershed area, west of Four Hills Road.

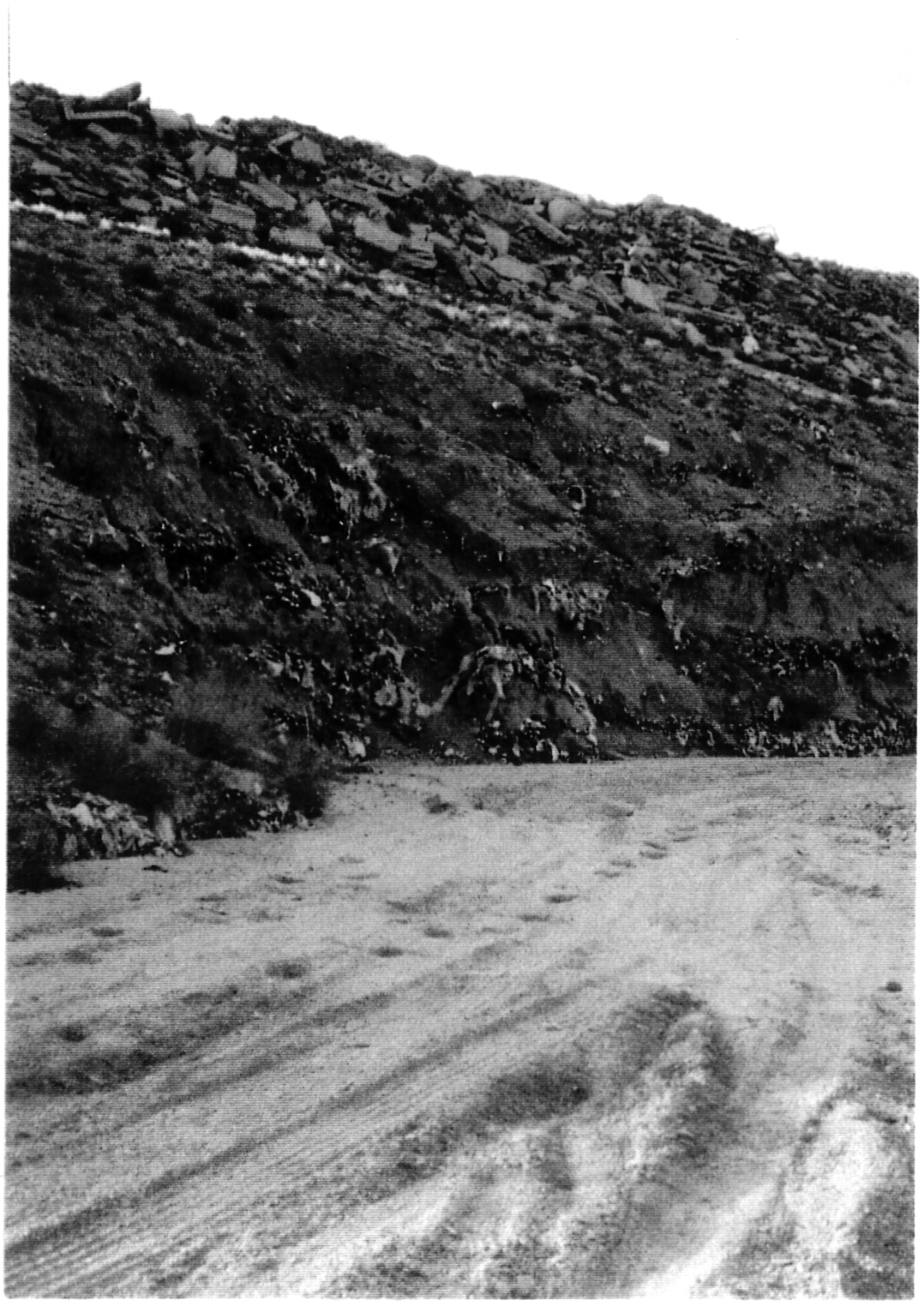


FIGURE 3
Existing Erosion at South Eubank Landfill
(October 1993)



FIGURE 4
Trash and Debris Carried
Downstream of South
Eubank Landfill Erosion
(October 1993)

III. HYDROLOGIC ANALYSIS

A. GENERAL

Several hydrologic studies have previously been prepared for the Tijeras Arroyo. The most recent and well known studies include the:

(1) Corps of Engineering (COE) Hydrologic Report for Kirtland Air Force Base (KAFB), 1979.

(2) FEMA Flood Insurance Study, 1983, and

(3) Tijeras Arroyo Drainage Master Plan Phase I, October 1987 (TADMP, Phase I) and Phase II, November 1990 (TADMP, Phase II).

No hydrologic studies were discovered to have been prepared for this reach of the Tijeras Arroyo since 1987. Table 1 summarizes the comparison of hydrologic results from the above mentioned studies. The project site is located upstream of the junction of Tijeras Arroyo with the Arroyo del Coyote.

B. RUNOFF

The Phase I TADMP report recommended that design flows for the TADMP be based on a 100-year peak discharge east of Arroyo del Coyote of 22,600 cfs. (Q 10-year = 6,400 cfs). In general, the 100-year peak flow rate compared well to the COE results (1979), which were based upon USGS gage data, collected at a station about three miles east of KAFB.

These design flows were subsequently used to develop concepts of alternative improvements to Tijeras Arroyo in Phase II of the Tijeras Arroyo Drainage Master Plan analysis. As well, the Four Hills Bridge structure was designed based on a peak 100-year discharge of 22,600 cfs.

The methodology, assumptions and results for the TADMP hydrologic evaluation were reviewed as part of this study to determine the appropriateness of using the same design flows. It was concluded that no significant events or development has occurred since 1987 which would materially change the hydrologic conditions as previously analyzed. Therefore, the same peak design flows are adopted for use in the hydraulic analysis for the present study.

TABLE 1

COMPARISON OF CALCULATED PEAK DISCHARGE FOR TIJERAS ARROYO

LOCATION	Q PEAK 10-YEAR (cfs)	Q PEAK 100-YEAR (cfs)
Tijeras Arroyo at Four Hills Road		
LH (Existing/Future Development Conditions)	5,700/6,300	16,700/17,900
COE (1979 Report)	5,200	18,050
FEMA FIS		14,300
Tijeras Arroyo After Junction with Arroyo del Coyote		
LH (Existing/Future)	6,500/7,100	21,000/22,200
COE (1979 Report)	6,500	23,850
FEMA FIS		14,700
Tijeras Arroyo at Junction with South Diversion Channel		
LH (Existing/Future)	6,000/6,500	19,800/20,800
COE (1979 Report)	6,200	22,700
FEMA FIS		14,700

Note: Extracted from Table 2 "Tijeras Arroyo Drainage Management Plan, Phase I" report dated October 1987.

New regulations promulgated by FEMA for areas with a potential high sediment load in the waterways require an incremental increase in calculated design flow rates by a percentage equal to the estimated sediment load. This percentage increase is typically referred to as a "bulking factor" and ranges from zero to 20 percent, depending upon local conditions. Based on available data and meetings with AMAFCA, a bulking factor of 10 percent was included for this reach of Tijeras Arroyo, which resulted in the bulked design flow rates shown in Table 2 below.

TABLE 2

PROJECT DESIGN FLOW RATES

DESIGN STORM	UNBULKED	BULKED
100-year storm event	22,600 cfs	24,860
10-year storm event	6,400 cfs	7,040

For a detailed discussion of watershed characteristics, rainfall, soil types, and runoff computations, see Chapter III of the Tijeras Arroyo Drainage Master Plan, Phase I report dated October, 1987.

IV. HYDRAULIC ANALYSIS

A. GENERAL

Water surface profiles for existing channel conditions and for various slope stabilization treatment options were calculated using the U.S. Army Corps of Engineer's HEC-2 computer program. Channel cross-sections used in the analysis were based on cross-sections determined for the City of Albuquerque, FEMA Flood Insurance Study (FIS) equivalent to designated Sections AK (or 221) to AM (or 225). The data base was supplemented with additional sections defined from the 1982 FEMA FIS orthophotobase-topographic mapping to more accurately reflect conditions in the project area (cross-sections numbers with an extension number represent the supplemental sections). Cross section locations and identification numbers are shown on Figure 5.

B. HYDRAULIC CHARACTERISTICS

Channel roughness coefficients were determined based on field inspection, a review of those values listed in the FEMA study, and from recommendations in the City of Albuquerque Design Process Manual (DPM), 1993.

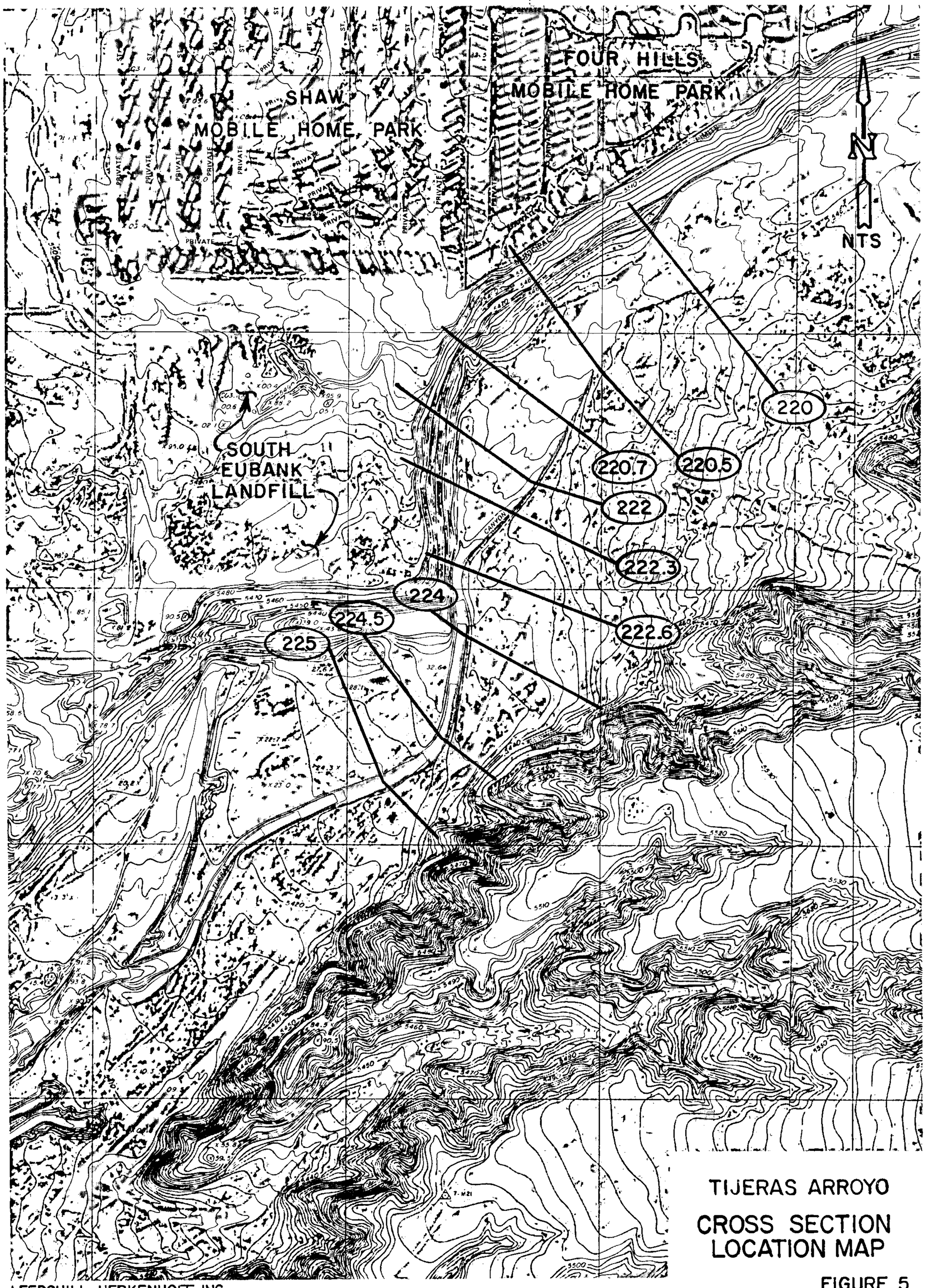
In general the following Mannings "n" values were assigned for characteristic arroyo conditions and slope stabilization options:

Main Channel (Unimproved, Sandy bed)	"n" = .030
Channel Banks (Unimproved, Vegetated)	"n" = .040
Riprap Lining	"n" = .050
Gabion Lining	"n" = .040
Soil Cement Lining (Stepped)	"n" = .035

Water surface profile calculations for existing conditions show that the flow is typically in a critical state throughout the study reach. Calculated supercritical flow velocities during the 10-year storm event range from 9 to 12 feet per second with 100-year storm event velocities in the range of 14 to 17 feet per second.

C. FLOODPLAIN IMPACTS

This portion of the Tijeras Arroyo is included as part of the FEMA FIS and therefore, falls under the jurisdiction of the local flood plain administrator to insure that the floodplain is not detrimentally impacted by development or modification of the arroyo.



TIJERAS ARROYO

CROSS SECTION
LOCATION MAP

FIGURE 5

As shown in Table 1, the 100-year peak design discharge rates of 22,600 cfs, and 24,860 cfs when a 10 percent bulking factor is included (see Section III, B), actually exceed the FEMA 100-year peak flow rate of 14,300 cfs. However, the HEC-2 data base for the FEMA FIS was utilized along with the greater design flow rate for evaluating improvement options in this study. Therefore, the following methodology was implemented to insure that the floodplain and thus, property owners, along this reach, as well as upstream and downstream reaches, are not detrimentally impacted.

First, the 10-year and 100-year water surface profiles with bulking were calculated for the arroyo as it exists. These were identified as baseline conditions. Subsequent, for each analysis of an optional slope stabilization treatment, water surface elevations were compared to the baseline conditions water surface profile for both the 10-year and 100-year storm events. The HEC-2 water surface profile output files for subcritical and supercritical "baseline" conditions are included in Appendix A at the back of this report.

Excavation of the slope opposite the stabilized embankment was quantified and cross-sections were adjusted accordingly, in an iterative process, until a comparison indicated that the resulting water surface elevations associated with improved channel conditions were equal to or less than baseline water surface elevations at each of the HEC-2 coded cross-sections. This analysis was extended for approximately 2,000 feet upstream and 4,000 feet downstream of the project limits to define potential off-site impacts.

In this manner, the 100-year design peak flow rate used in this analysis is higher than the FEMA 100-year peak discharge rate. However, the relative comparison of water surface profiles, as described above, demonstrates that predicted water surface elevations and flow velocities would generally be the same as under existing conditions for the properties located upstream and downstream of the project site, for any flow rates equal to or less than 24,860 cfs (Q 100+ 10% bulking), assuming stable channel conditions.

V. EVALUATION OF ALTERNATIVES

A. GENERAL

In accordance with the contract scope, options were evaluated to determine the most cost-effective stabilization measure to be utilized to protect the landfill slope. The fact that this portion of the arroyo was designated as a Major Open Space Arroyo in the Facility Plan for Arroyos, adopted by the City of Albuquerque in February 1986, was of particular importance in the evaluation.

The Facility Plan states that "Major Open Space Arroyos are to remain in a natural or semi-natural condition with native vegetation and channel stabilization consisting primarily of naturalistic treatments such as ungrouted riprap, gabions, gabion weirs, and geotextile mats. Any arroyo treatment which utilizes concrete should be limited, and if above ground, must be tinted concrete." Additional statements are made that the natural flood plain should be retained and other appropriate stabilization treatments may include soil-cement.

Another constraint on project options includes consideration of regulations pursuant to Section 404 of the Clean Water Act. If discharges of dredged or fill materials into the headwaters and isolated waters of the United States (U.S.) do not result in the loss of more than one acre of waters of the U.S., then the project qualifies under Nationwide Permit No. 26. For discharges which cause a loss of one to ten acres of such waters, notification is required in accordance with General Condition No. 13 of the regulations. Only discharges resulting in the loss of more than ten acres of these waters would require an individual Section 404 permit. The acreage of loss of waters of the U.S. includes the filled area plus waters of the U.S. that are adversely affected by flood, excavation or drainage as a result of the project.

A third consideration in all options is the impact and specific protection of the South Eubank Landfill. Any solution must result in an impermeable protection layer (to a factor of 1×10^{-6} cm/sec) between the surface flows and the landfill.

B. OPTIONAL SLOPE STABILIZATION TREATMENTS

The objective of the present study is to evaluate optional stabilization treatments which (1) are consistent with the criteria outlined in the Facility Plan for Arroyos, (2) least impact the waters of the U.S., (3) satisfy environmental concerns for both the protection of the surface flow from leachates through the landfill and the protection of the landfill from saturation due to channel flow, and (4) are most cost-effective in stabilizing the channel bank.

The following channel stabilization treatments are consistent with criteria outlined in the Facility Plan for Arroyo:

- Riprap slope protection
- Gabion Slope protection
- Soil cement slope protection
- Geotextile mats slope protection
- Channelization
- Gabion drop structures

Geotextile mats would not be appropriate for the high velocity range expected to be experienced in this reach. As a result, a geotextile treatment was eliminated as a viable option. Channelization would result in the greatest disturbance to the natural setting of the arroyo. Therefore, channelization was eliminated from further consideration. Drop structures would essentially be ineffective unless designed to control the entire 100-year peak discharge. Due to the extremely wide 100-year floodplain, the technical feasibility of this option is questionable, and the associated expense would likely be disproportionate to the benefit, so drop structures were not evaluated further. Thus, three treatments were determined to be worthy of a detailed evaluation: riprap, gabion and soil-cement slope protection.

"Riprap slope stabilization is based on the theory that stones placed on a natural embankment will protect the slope by resisting the erosive forces of channel flow. The ability of riprap to provide slope protection depends on the interrelation of stone shape, size, weight, durability; riprap gradation, and layer thickness; and channel alignment, cross-section, gradient and velocity distribution. The bed material and local scour characteristics determine the design of toe protection necessary for riprap revetment stability. The bank material and groundwater conditions affect the need for filters between the riprap and underlying material. Design should be based on the expectation that damage resulting from any storm occurring during the service life of the channel would not cause damage exceeding minimal maintenance or replacement [7]". Section IV, F presents a design summary for riprap slope stabilization for this project.

Gabion slope stabilization utilizes another flexible lining material to protect channel banks from erosion. This consists of rectangular baskets, with lids, all made of a steel wire mesh. The gabions are subdivided into cells of equal size, by diaphragms, and are filled with stone. Dimensions of rocks to be used in gabions are typically significantly less than for riprap rock. A filter placed under the gabion is often necessary to prevent erosion of the face material [5]. Section IV, G discusses the applicability of gabion slope stabilization for this project.

Soil-cement is defined as "a material formed by blending, mixing, compacting, and curing a mixture of soil/aggregate, portland cement, possibly flyash, and water, and

allowed to harden in-place. The main advantage of soil-cement slope stabilization is that it can be produced with on-site materials and can achieve the design compressive strengths and durability required for flow velocities up to 35 feet per second [8]." Figure 6 is a reproduction of Figure I from the AMAFCA Interim Soil Cement Guide, May 1993, which illustrates a typical cross-section for soil-cement slope protection. Section IV, H, discusses the soil-cement option for this project.

C. GEOTECHNICAL EVALUATION

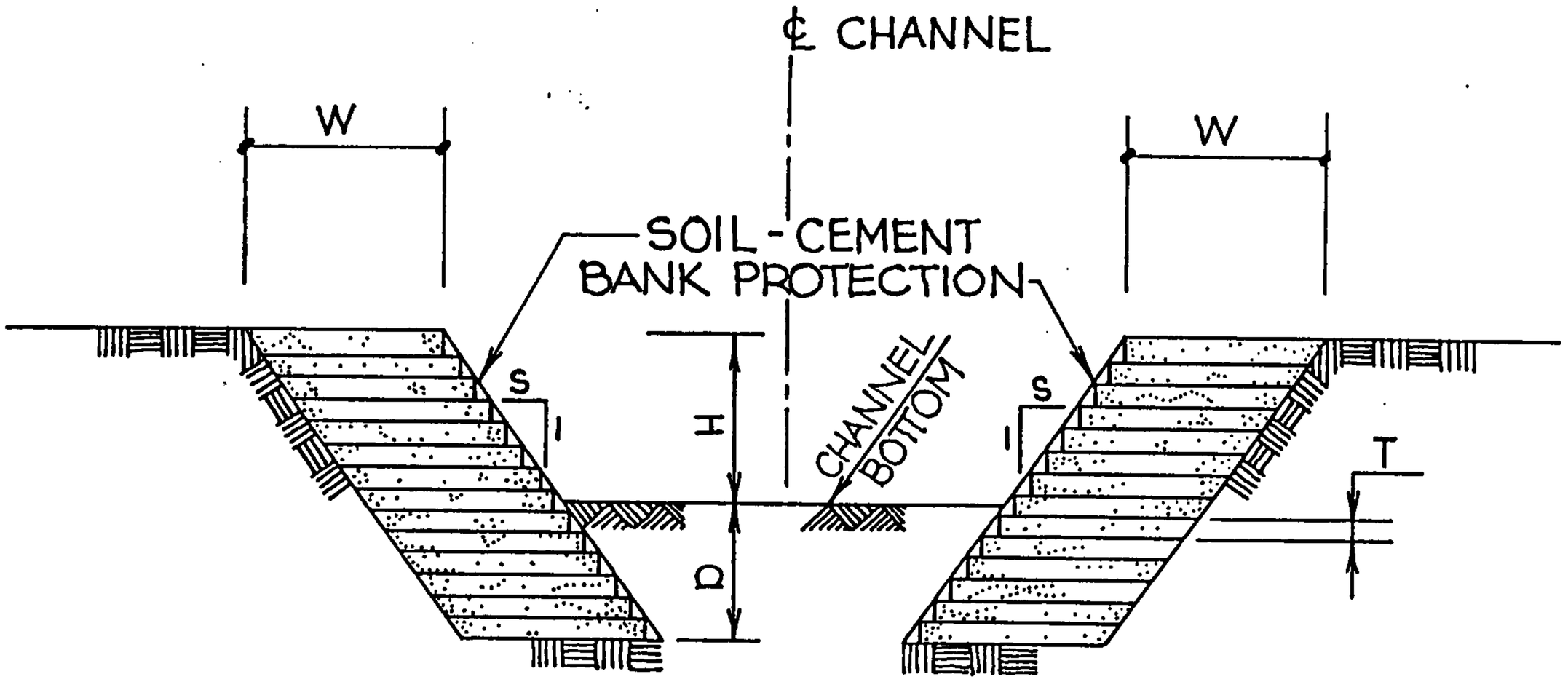
Martin Vinyard and Associates was contracted by Leedshill-Herkenhoff, Inc. to perform field investigations in the project area. The investigation was concluded December 31, 1993, and included three borings along the channel bed as illustrated in Figure 7. The borings were drilled to a depth of 26 plus feet, below grade, to determine the angle of repose for the in-situ material to be excavated during the construction of below grade scour protection. The recommended side slope with a 1.2 factor of safety was two feet horizontal to 1 foot vertical. Neither groundwater nor bedrock were encountered during this investigation.

Twenty-one test pits were dug with a backhoe along the toe of the existing slope in order to evaluate slope stability measures specifically related to the landfill slope, and to identify the lateral extent of the landfill refuse. The location of these pits is also indicated on Figure 7. The limits of the refuse appear to be fairly well defined, and generally coincide with the toe of the existing slope. In the area where the active channel is eroding the landfill, the refuse appears to extend out slightly more than midway into the channel. The eroded landfill face is potentially unstable and may slough off into the channel at any time. In general, the refuse was found at the surface, or within 4 to 5 feet of the surface, and the refuse encountered consisted of "typical" household garbage, based upon a visual inspection.

Appendix E contains a copy of the geotechnical report completed for this project.

D. SCOUR ANALYSIS

For each optional improvement concept, an estimation of scour was evaluated to quantify the bury depth required below the present low flow channel bed to protect the slope stabilization treatment from being undermined. Two main factors comprise the scour calculation: (1) local scour and (2) contraction scour. Both values are calculated based on hydraulic depth (area/top width) of representative geometric channel sections for the full 100-year flow area, assuming the landfill bank responds like a spur dike. Often, antidune scour is also considered. However, due to the significant depths calculated for local scour, it was concluded that adding antidune scour depth would be extremely conservative. Thus, antidune scour was eliminated from the analysis.



W= WIDTH - MINIMUM OF 9' OR AS DETAILED ON CONSTRUCTION PLANS.

D= DEPTH - MINIMUM OF 4' OR AS DETAILED ON CONSTRUCTION PLANS.

T= LIFT THICKNESS - MAXIMUM OF 12" UNCOMPACTED OR AS DETAILED ON CONSTRUCTION PLANS.

S= SLOPE - MAXIMUM SLOPE 2:1, IF TRIMMED. 1:1 IF STEPPED. MAY BE STEEPER IF ACCESS IS RESTRICTED

H= HEIGHT - ADEQUATE TO PROVIDE FOR DESIGN FLOWS AND FREEBOARD.

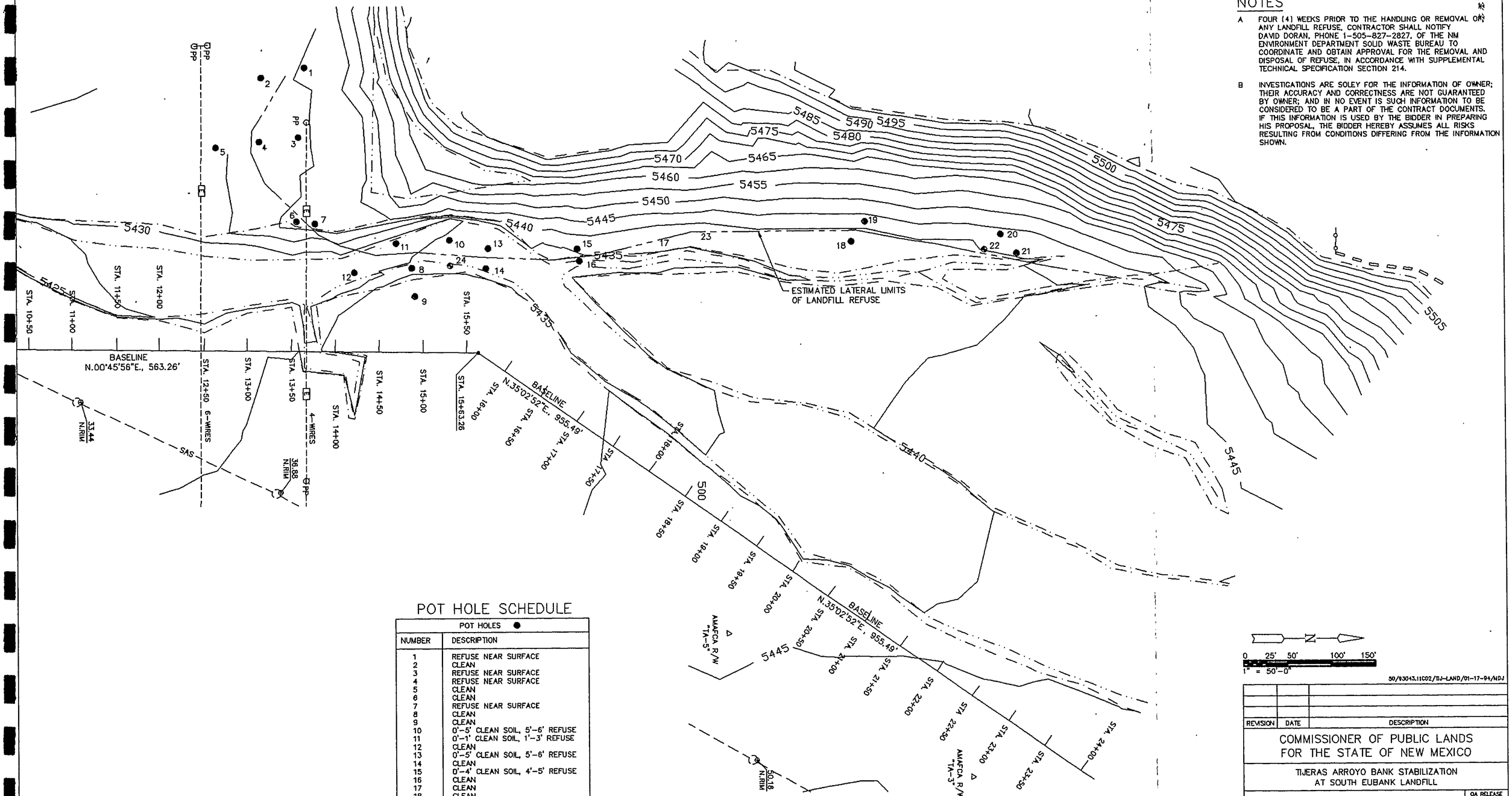
TYPICAL SOIL CEMENT BANK PROTECTION

FIGURE 6

NOTES

A FOUR (4) WEEKS PRIOR TO THE HANDLING OR REMOVAL OF ANY LANDFILL REFUSE, CONTRACTOR SHALL NOTIFY DAVID DORAN, PHONE 1-505-827-2827, OF THE NM ENVIRONMENT DEPARTMENT SOLID WASTE BUREAU TO COORDINATE AND OBTAIN APPROVAL FOR THE REMOVAL AND DISPOSAL OF REFUSE, IN ACCORDANCE WITH SUPPLEMENTAL TECHNICAL SPECIFICATION SECTION 214.

B INVESTIGATIONS ARE SOLEY FOR THE INFORMATION OF OWNER; THEIR ACCURACY AND CORRECTNESS ARE NOT GUARANTEED BY OWNER; AND IN NO EVENT IS SUCH INFORMATION TO BE CONSIDERED TO BE A PART OF THE CONTRACT DOCUMENTS. IF THIS INFORMATION IS USED BY THE BIDDER IN PREPARING HIS PROPOSAL, THE BIDDER HEREBY ASSUMES ALL RISKS RESULTING FROM CONDITIONS DIFFERING FROM THE INFORMATION SHOWN.



POT HOLE SCHEDULE

POT HOLES ●	
NUMBER	DESCRIPTION
1	REFUSE NEAR SURFACE
2	CLEAN
3	REFUSE NEAR SURFACE
4	REFUSE NEAR SURFACE
5	CLEAN
6	CLEAN
7	REFUSE NEAR SURFACE
8	CLEAN
9	CLEAN
10	0'-5' CLEAN SOIL, 5'-6' REFUSE
11	0'-1' CLEAN SOIL, 1'-3' REFUSE
12	CLEAN
13	0'-5' CLEAN SOIL, 5'-6' REFUSE
14	CLEAN
15	0'-4' CLEAN SOIL, 4'-5' REFUSE
16	CLEAN
17	CLEAN
18	CLEAN
19	REFUSE NEAR SURFACE
20	REFUSE NEAR SURFACE
21	CLEAN
BORINGS ⊕	
NUMBER	DESCRIPTION
22	REFUSE 0'-6', CLEAN 6'-26'
23	CLEAN
24	CLEAN

0 25' 50' 100' 150'
1" = 50'-0"

50/93043.11C02/TIJ-LAND/01-17-94/MDJ

REVISION	DATE	DESCRIPTION

COMMISSIONER OF PUBLIC LANDS
FOR THE STATE OF NEW MEXICO

TIJERAS ARROYO BANK STABILIZATION
AT SOUTH EUBANK LANDFILL

LANDFILL REFUSE LIMITS

QA RELEASE –
DESIGN BY RAS
CHECKED BY DD
DRAWN BY KHK
SCALE AS SHOWN
DATE –
SEQUENCE NO. –

LEEDSHILL – HERKENHOFF, INC.
ENGINEERS ARCHITECTS
ALBUQUERQUE SANTA FE SAN DIEGO

LH PROJECT MANAGER

SHEET C4 OF C11

FOR 95% REVIEW ONLY 1/18/94

When an obstruction projects into flood flows, such as the landfill embankment which encroaches the Tijeras Arroyo, scour will be experienced at the toe of the slope "due to an increased boundary shear stress produced by locally increased velocity gradients that result from the reduced roughness of the floodwall as compared to the natural channel. It is reasonable to conclude that scour will continue until the local flow area has increased enough to reduce the local velocity, and hence the local boundary shear stress, to values typical of the rest of the channel cross-section [11]". The scour depth is calculated for each viable option based on equations and theory outlined for "Flow Impinging on the Wall at an Angle" in the draft form of the "Sediment and Erosion Design Guide" dated September, 1993, provided to LH by AMAFCA.

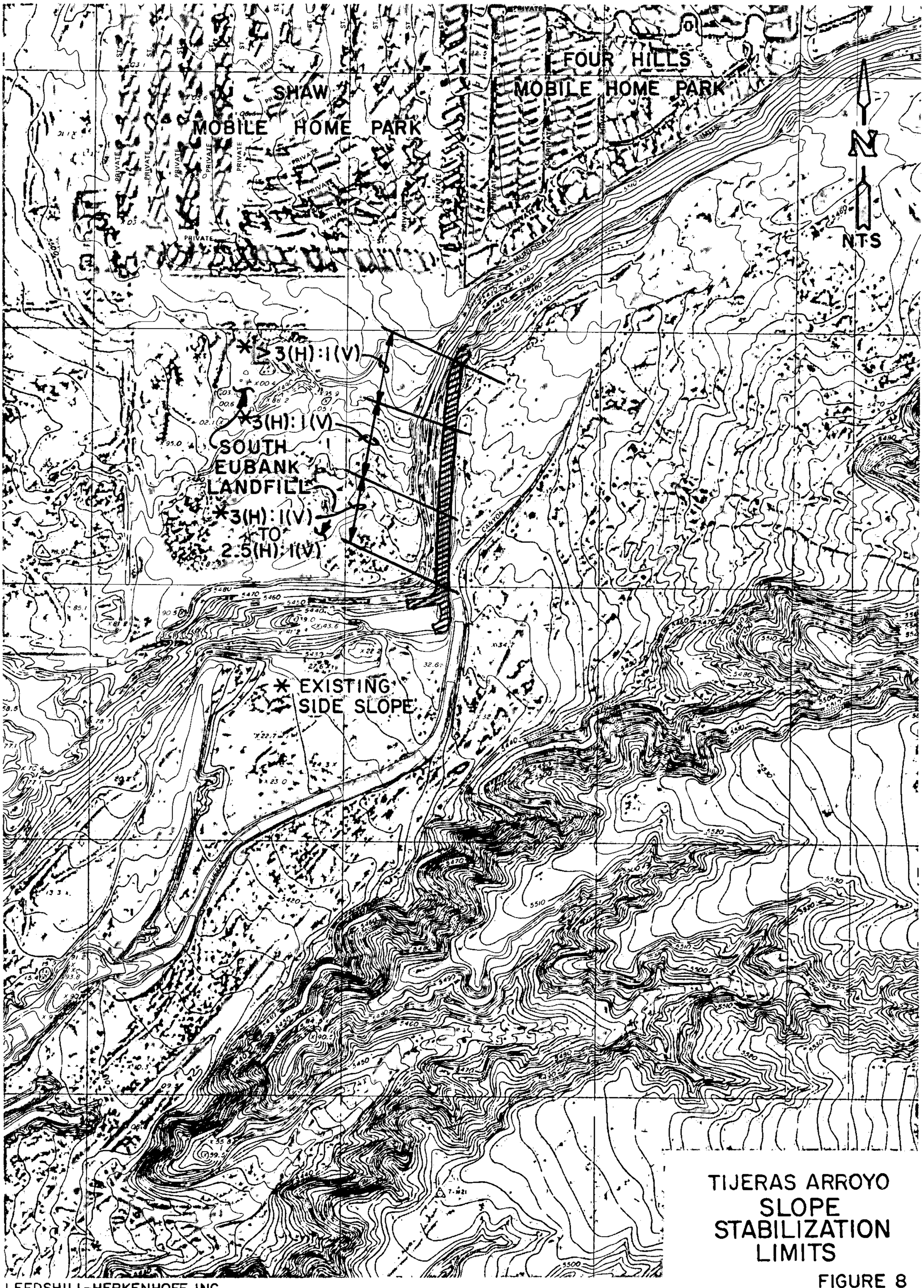
Contraction scour is that which is experienced along a channel bed due to the contraction of the bottom width of the flow area. This scour is additive to local scour quantities. Contraction scour depth is calculated based on theory and equations outlined in Hydraulic Engineering Circular No 18, Federal Highway Administration, dated February, 1991. Scour calculations specific to each option are referenced in the technical appendix for the respective option.

E. LANDFILL PROTECTION

Main channel velocities along an improved landfill embankment are from supercritical flow conditions and range from 12 to 16 feet per second. Erosive velocities are defined as those which exceed four (4) feet per second. Thus, the entire bank along the east side of the landfill would potentially experience erosion during a 100-year storm event, if not protected. In addition, a rough estimate of channel sinuosity for this reach of the Tijeras Arroyo indicates the possibility of the arroyo re-aligning its low-flow channel with potential impacts to the south face of the landfill. Consequently, any slope protection treatment must extend along the embankment length for approximately 1,074 feet, and continue south and westerly around the corner for approximately an additional 100 feet. Figure 8 identifies the northern and southern limits for which slope stabilization must be implemented.

Similarly, for all stabilization options, an impermeable boundary must be placed along the same embankment to isolate the landfill material from surface flows in the Tijeras Arroyo. The soil-cement option inherently provides an impermeable separation, which satisfies the NMED Solid Waste Bureau without placement of an impermeable membrane being required, providing no cracks fully penetrate the structure. However, the riprap and gabion stabilization treatments would require an impermeable membrane of some type to parallel the backside of the slope stabilization treatment.

Based on consultations with Professor Val Green, of New Mexico Tech, Socorro, New Mexico, and with the Solid Waste Bureau and Surface Water Bureau of the NMED, a system featuring an impermeable membrane comprised of bentonite sandwiched between



TIJERAS ARROYO
SLOPE
STABILIZATION
LIMITS

FIGURE 8

two layers of felt type geotextile material is recommended to meet permeability requirements defined by the NMED Solid Waste Bureau. Commercially available products such as Bentofix, or Claymax, come prefabricated and can provide impermeable separation up to 1 x 10^{-9} cm/sec. This type of material can be placed directly on the slope, requiring little on no compaction, adheres well to the slope (because of the fabric), and is cost-competitive with other liner systems such as HDPE or PVC. Because the "smooth" liners many times require additional felt to prevent slippage, and require seaming, the bentonite-type system is considered a better, more cost-effective solution for this application. In order to protect the integrity of this liner system, it is recommended that one foot of pervious material be placed upon the liner before placing the slope stabilization treatment.

In all cases, the landfill slope lying uphill from the stabilized slope and downhill from the layer of concrete rubble, requires an erosion control treatment. For this area, a minimum of 12-inches of compacted earth is recommended. A gravel mulch surface layer and native grass vegetation and/or wildflowers will also allow a more aesthetic erosion control solution. This composite section will help protect the slope from local erosion and will minimize the potential for problems caused by undercutting and erosion behind the channel slope stabilization treatment. Figure 9a illustrates the recommended composite section for erosion control above the slope stabilization improvements.

Because field investigations have indicated a potential slope failure plane along the existing face of the landfill, construction activities along this face with traditional earth moving equipment may not be feasible. Therefore, it is anticipated that the limited material may have to be removed in these areas, as necessary, to provide a stable slope. Other considerations included in the design of the landfill protection system relate to surface drainage along the slope, and the objective of avoiding excavation in areas containing refuse. Typically, a backslope drain would be provided along the top of the slope to prevent local erosion from landfill runoff. However, as there is currently a large volume of concrete rubble located along the top of slope for the entire reach included in this project, back slope drains would not be practical for this application. Field investigation indicates that this concrete material is "marginally stable", and thus it was determined to be the upper limit of construction along the existing slopes. (The Contractor will be given the option of stabilizing the material further as part of the construction process).

In addition, as the landfill slope extends approximately 30 to 40 feet above the channel slope protection, it is possible to get rill-type erosion along the face of the slope.

Therefore, two optional slope treatments were investigated: gravel mulch, and a terraced slope.

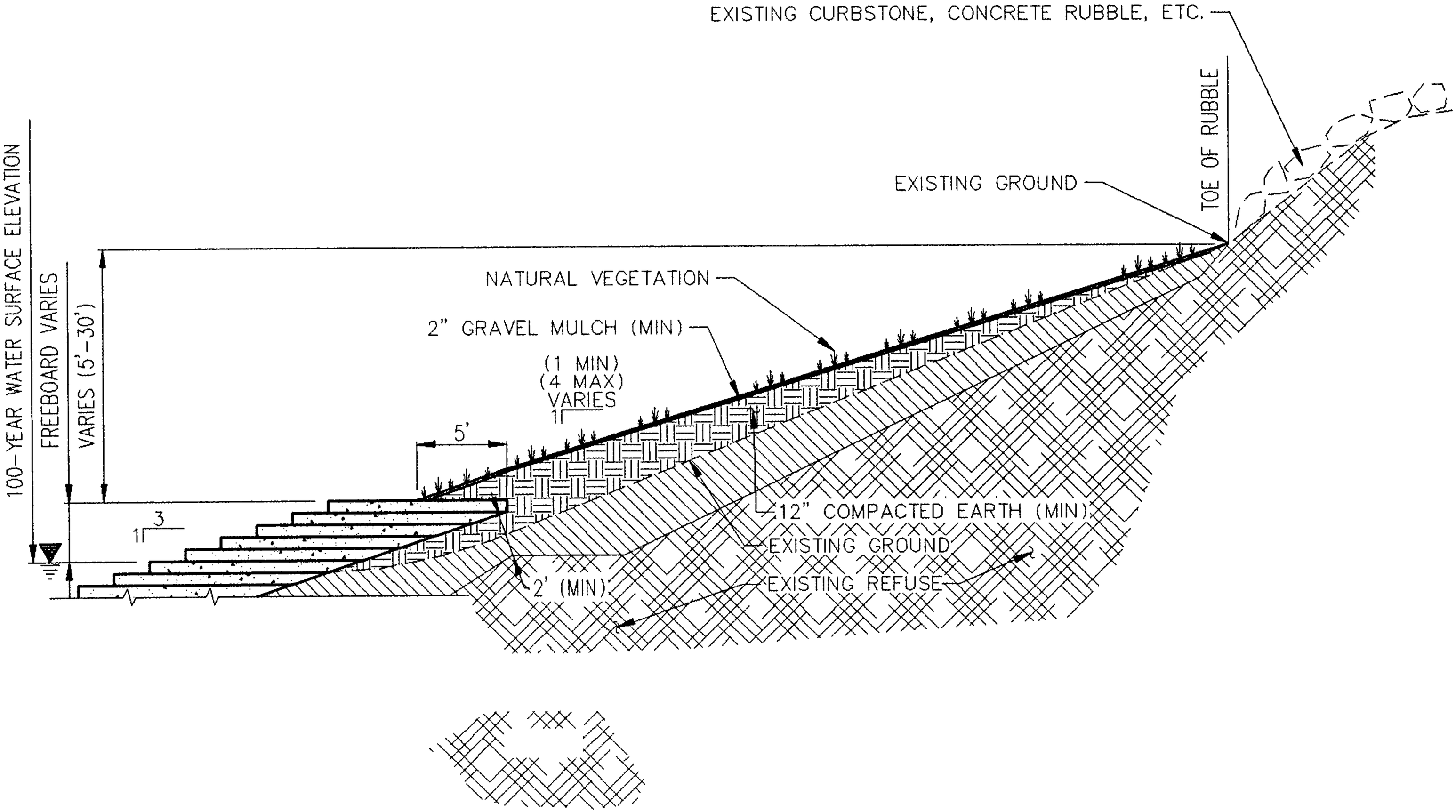


FIGURE 9A

TIJERAS ARROYO
EROSION CONTROL TREATMENTS
VEGETATED GRAVEL MULCH

Vegetated gravel mulch - as shown in Figure 9a, the vegetated gravel mulch allows a 3:1 side slope, and is placed directly over a minimum of 12-inches of earthen fill and the landfill. (The earth fill allows filling of potential voids around the refuse material and helps attain the required compaction density.) AMAFCA has had very positive results with using this type of system on embankments of similar height.

Terraced slope - as shown in Figure 9b, a terraced slope consists of a terraced section with interim channels to intercept local runoff along the face of the slope. This system does not require gravel mulch, but features flatter slopes (4:1) and would require addition embankment and plant materials.

The associated additional costs for terracing do not merit its use for this application. Cost estimates for both treatments have been included in Appendix D; however, the cost for the gravel mulch system, illustrated in Figure 9b, was included in the total cost estimate for each of the options discussed in the later sections.

Because of worker safety issues, potential liability, costs, and current OSHA regulations associated with the handling of solid waste, one of the project design objections was to avoid excavation in refuse. Based upon the "refuse line" determined through the geotechnical investigation, the toe of the slope was located so that the area edged the soil-cement section fell outside of the anticipated refuse as indicated in Figure 10.

While in some cases, this may require extra fill, the associated cost savings far out weigh the costs for the fill. There is one area located within the PNM easement where construction of this section is limited by the extent of the refuse with respect to existing high voltage power lines and power poles. Limited excavation of the refuse in this area, and along the exposed face of the landfill, may be required.

For purposes of cost estimating, this volume of refuse was assumed to be hauled to the Cerro Landfill, a RCRA approved facility currently being used by the City for other transplanted landfill materials. However, during the development of this project, NMED Solid Waste Bureau personnel have indicated that it may be possible to bury a small volume of this material on-site, provided NMED personnel are present during these operations, and provided that it is buried behind the impermeable section.

F. OPTION 1: RIPRAP SLOPE STABILIZATION

The first slope stabilization option evaluated for the project was based on using a riprap bank protection system. The COE publication EM1110-2-1601, dated July, 1991, was referenced for calculating required riprap size, thickness, and gradation.

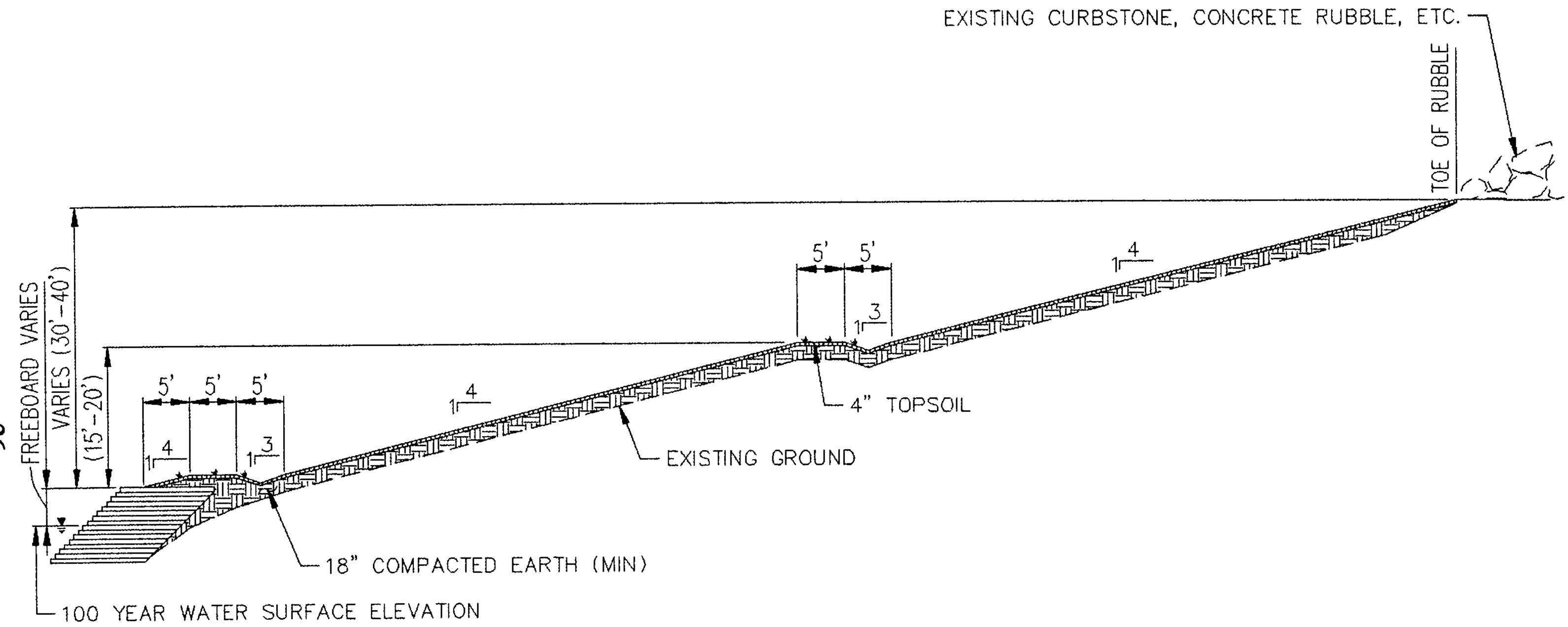
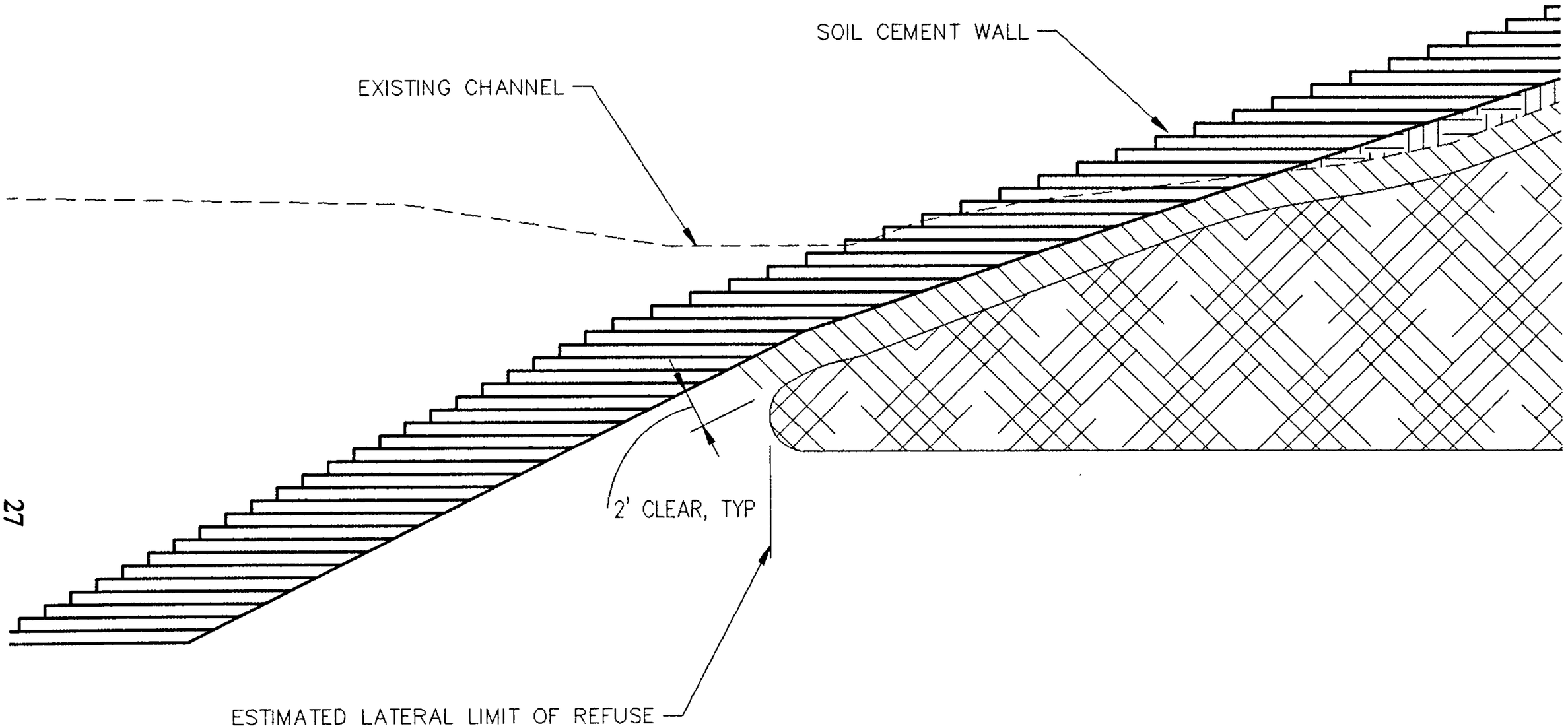


FIGURE 9B

TIJERAS ARROYO
EROSION CONTROL TREATMENT
TERRACED SLOPE



TIJERAS ARROYO

LOCATION OF IMPROVEMENTS
WITH RESPECT TO REFUSE LINE

FIGURE 10

Flow characteristics for this option vacillate around critical flow conditions. Consequently the supercritical model for water surface profile calculations was utilized to identify design velocities (which represent the worst case scenario). Riprap placement was assumed to be on a minimum 2.5 H:1V sideslope or at existing slopes, whichever is less steep. A typical section is illustrated in Figure 11.

Average design velocities range from 12 to 16 fps. These are adjusted to estimate the depth - averaged local velocity over the slope at a point 20 percent of the slope length from the toe of slope, which range from 17 to 20 fps. Following the COE design procedure, and assuming a unit weight of 165 pounds per cubic foot (pcf), 30 percent of the total weight of the riprap material must contain a minimum rock size of 30-inches be able to withstand the design velocities. This translates to a maximum stone diameter of 54-inches and a placement depth of over six feet (see Appendix B). This rock size is extraordinarily large compared to more typical applications of riprap slope stabilization in the Albuquerque area. Gradation of stones is critical to the riprap's resistance to erosion (7). This results in the need to test a quarry's ability to produce a particular size of stone. Testing riprap at these sizes will be very difficult, at best.

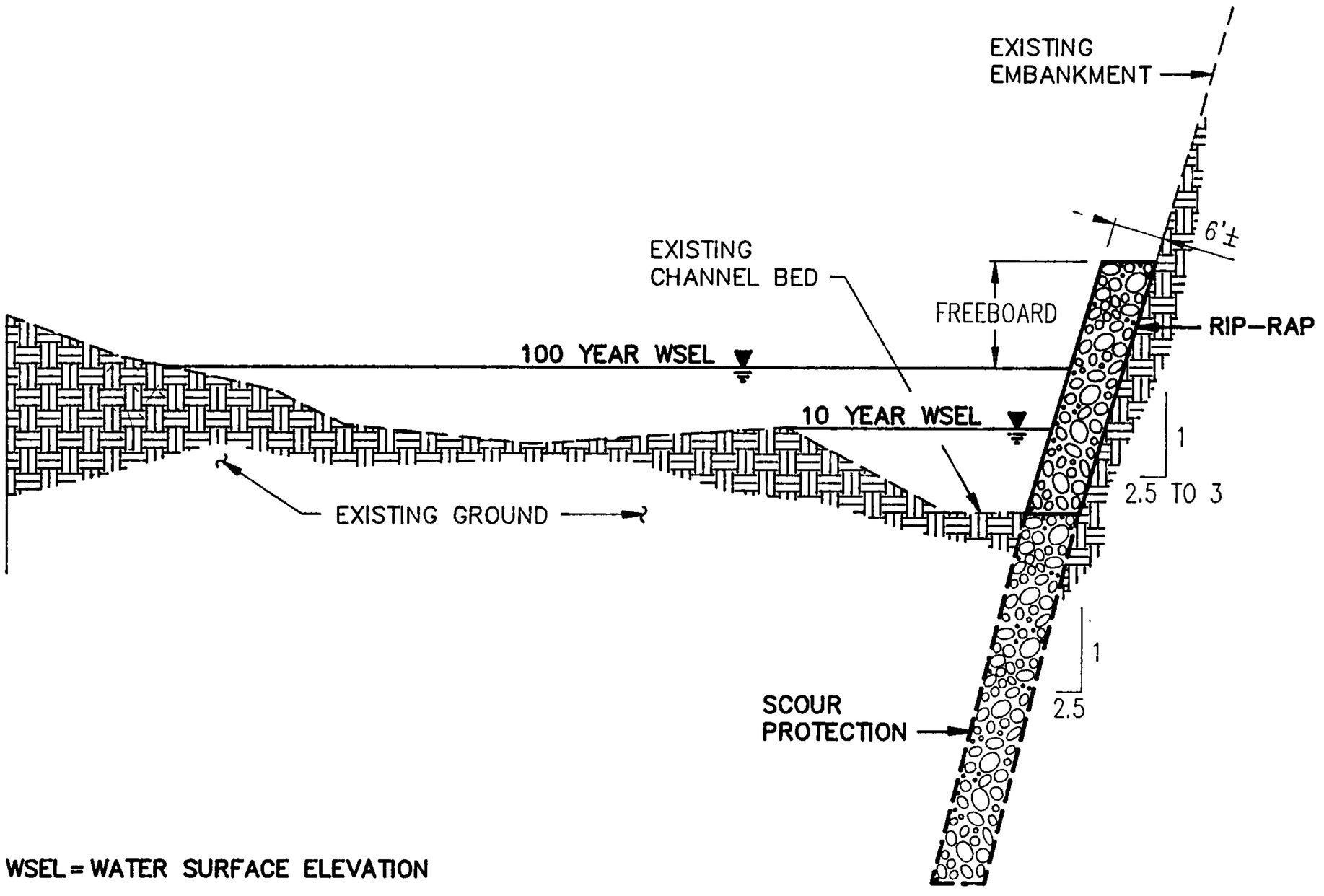
Local contractors and suppliers were contacted to determine the availability of riprap in dimensions of this proportion. Although available from the limestone quarry located east of the City, costs to provide and deliver to the site would be in the range of $40 to $50 cy. This includes the cost for hauling to the site. Western Mobile estimated that it would take approximately six months to produce the quantity of riprap needed. A preliminary cost estimate of this option resulted in a total cost of $2,143,300, which exceeds that of Option 3 (see Appendix D).

Much concern has been expressed by City officials and AMAFCA over the use of a large expanse of riprap for slope stabilization due to the creation of an attractive habitat for rodents and, as a result, an increased risk for spreading disease. Due to the complications in producing riprap of this size, the limitations in testing proper gradation, the high total estimated cost, and the associated public health issues, the riprap option was eliminated from further consideration.

G. OPTION 2: GABION SLOPE STABILIZATION

The gabion slope stabilization option was evaluated based on current manufacturer's reference materials published by Maccafferri Gabion.

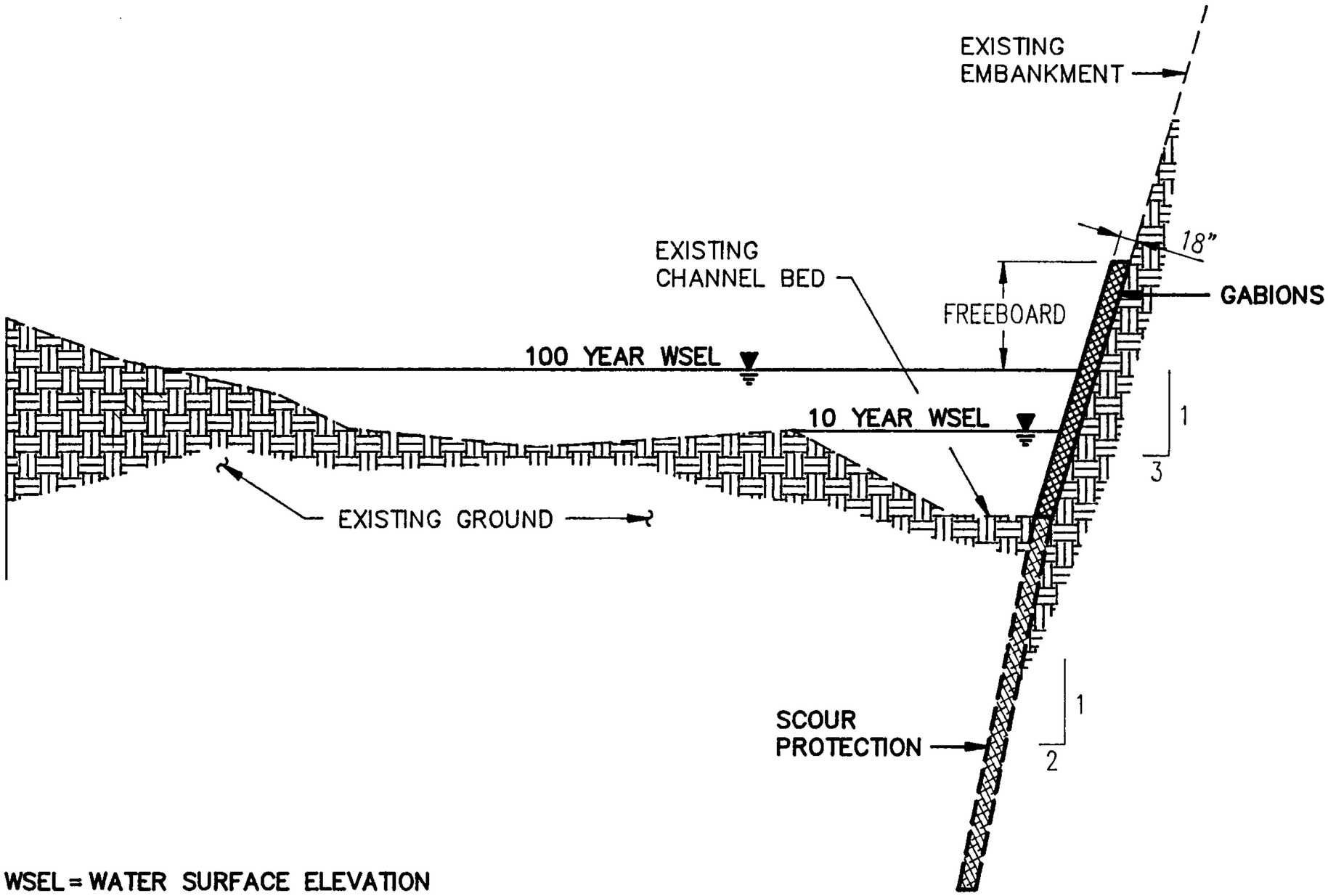
As was true for the riprap analysis, flow characteristics for this option vacillate around critical flow conditions. Based on the supercritical water surface profile, which represents the worst case scenario, design velocities ranging from 12 to 16 fps were identified. A typical section is illustrated on Figure 12.



WSEL = WATER SURFACE ELEVATION

FIGURE 11

TIJERAS ARROYO
TYPICAL SECTION
OPTION 1: RIP–RAP
SLOPE STABILIZATION



WSEL = WATER SURFACE ELEVATION

FIGURE 12

TIJERAS ARROYO
TYPICAL SECTION
OPTION 2: GABION
SLOPE STABILIZATION

The reference guide, along with conversations with the Maccafferri-West Coast manufacturer's representative, indicate that gabion slope stabilization is effective for channel velocities up to 21 fps. Design velocities for this project result in a gabion thickness of 18-inches with the diameter of rock fill ranging from 4-inches to 10-inches, and the need for a 6-inch granular material and filter fabric between the gabions and slope face (see Appendix B). (The impermeable membrane previously discussed is an acceptable substitute for the filter fabric).

A preliminary cost estimate of Option 2 resulted in a cost of $2,104,000, which exceeds that of Option 3; so, the gabion option was also eliminated from further consideration (see Appendix D).

H. OPTION 3: SOIL-CEMENT SLOPE STABILIZATION

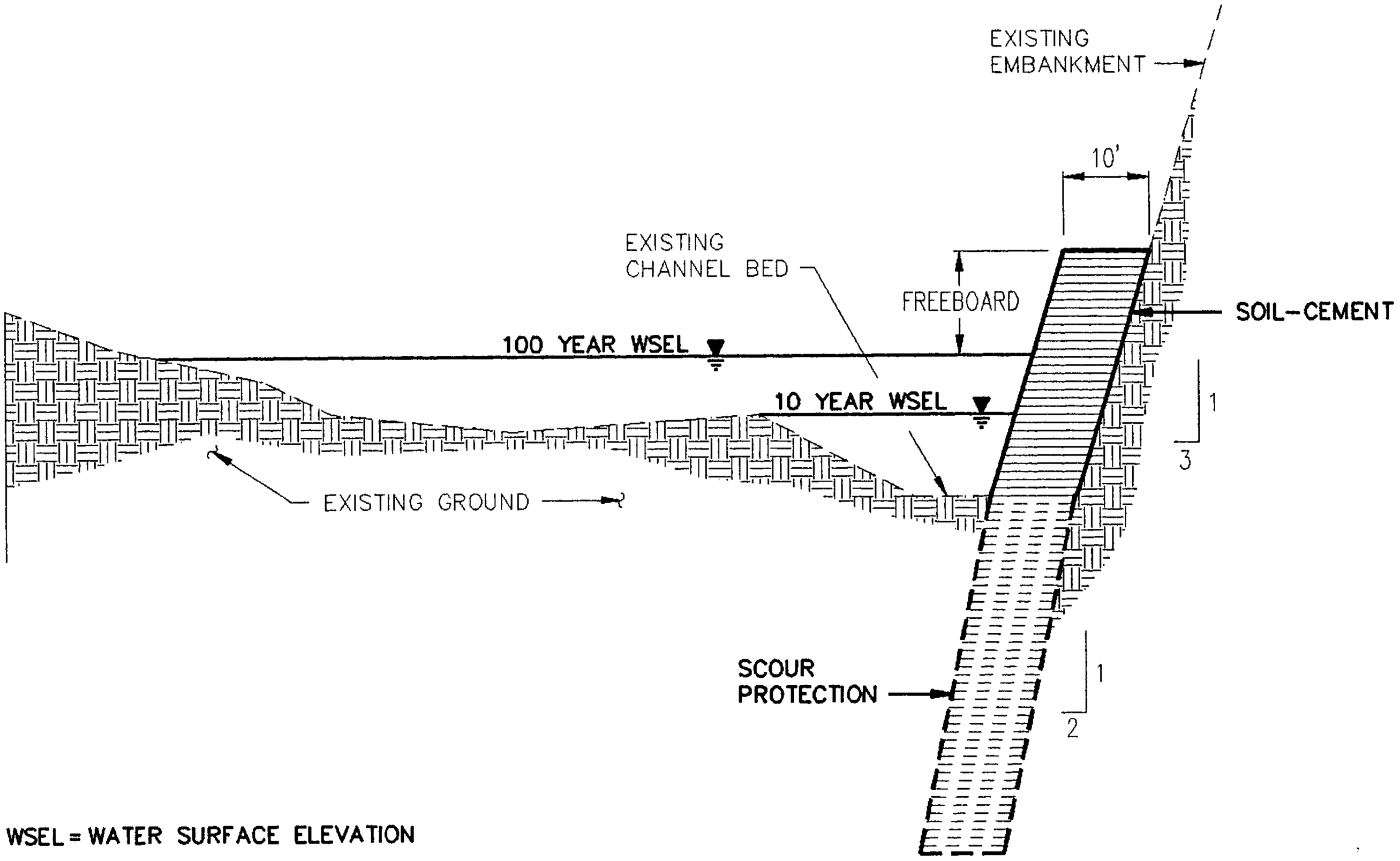
The development and evaluation of Option 3 - soil-cement slope stabilization was based upon the "Soil-Cement and Roller Compacted Concrete for Water Control", 1986, Portland Cement Association, and the draft copy of AMAFCA's "Interim Soil Cement Guide", 1993. Based on these references, a minimum placement slope of 3H:1V was used above grade and a maximum 2H:IV slope below grade was set according to the geotechnical investigation results. Placement was assumed at 8 to 9-inch compacted lifts, 10 feet wide, which allows construction using standard roadway construction equipment. A typical section is illustrated in Figure 13. It should be noted that the Geotechnical Report for this project indicated that the in-situ material, with screening, was suitable for use in soil-cement.

Flow characteristics for the soil-cement option reflect a supercritical flow regime. Supercritical average flow velocities range from 12 to 16 fps, which are within the recommended values for soil-cement applications.

Excavation of approximately 11,000 cy of material from the opposite bank is needed both upstream and downstream of the site to maintain flow depths, consistent with the depths found under existing "baseline" condition. Excavation of some material from the opposite bank is needed for all three options, but Option 3 requires the least amount of excavation necessary to yield flow characteristics similar to "baseline" conditions. Table 3 summarizes the comparison of maximum water surface elevations associated with Option 3 to those for "baseline" conditions.

1. Design Height

The required height of slope stabilization needed to protect the landfill from a 100-year storm event, was calculated based on the depth of flow plus freeboard, above the existing channel bed invert elevation. A comparison of design depths for subcritical



WSEL = WATER SURFACE ELEVATION

TIJERAS ARROYO
TYPICAL SECTION
OPTION 3: SOIL-CEMENT
SLOPE STABILIZATION

FIGURE 13

TABLE 3

COMPARISON OF OPTION 3 MAXIMUM WATER SURFACE ELEVATIONS TO BASELINE CONDITIONS

SEC NO.	WATER SURFACE ELEV.	
	BASELINE	OPTION 3
220.7	5446.7	5446.5
222.0	5445.7	5444.9
222.3	5443.4	5442.6
222.6	5441.7	5441.2
224.0	5439.8	5439.3

and supercritical flow velocities is summarized in Appendix C. Freeboard is defined as the sum of the velocity head and one-half of the antidune wave action height or three feet, whichever is greater. This calculation was made for both subcritical and supercritical flow conditions at each defined cross-section. Freeboard depths were calculated ranging from 2.6 to 7.2 feet. The supercritical flow conditions resulted in the greatest total design height for slope stabilization above the channel bed, ranging from a height of 10.6 feet at Section 220.7 to 14.9 feet at Section 224.0.

2. Scour

The 1992 New Mexico Solid Waste regulations are not expected to be imposed on this project. Yet, compliance with providing a level of protection for up to the 100-year event is considered to be a reasonable design approach. Local scour and contraction scour were calculated and summed for each of the defined cross-sections based on 100-year supercritical water surface profile and shear velocity calculations for Option 3 (see Appendix C). Table 4 summarizes the scour depths calculated at each design cross-section. As seen on Table 4, total scour depths range from 17.4 to 22.2 feet. Although it is feasible to excavate, below grade, a sufficient area to construct the soil-cement section to the full depth of potential scour (Option 3A), it was surmised that other materials or methods are available that will provide the same level of protection, possibly at a lower cost. Alternatives considered for providing this scour protection include:

Option B: Sheet piles driven to the total depth of scour.

Option C: Placing a stockpile of riprap in the low flow channel at a volume sufficient to fill the void created by scour.

Option D: Intrusion grouting to total depth of scour.

Option E: Concrete trench wall, either reinforced or unreinforced, constructed to below total depth of scour.

Based upon the soils investigation, existing subgrade conditions are generally conducive to any of the alternative scour protection measures considered. In all of the options, the soil-cement slope would be extended below grade to approximately one-third (1/3) of the total scour depth, which ranges from about six to eight feet. Whatever material is used to protect the lower two-thirds of scour depth (ranging from 6 feet to 14 feet), would be tied into the base of the soil-cement slope.

Similar to Option 1, Option 3C (stockpile of riprap) is dependent upon the availability of large diameter riprap. Based on the limitations previously discussed of this material, and the high unit cost for the size needed, Option 3C was eliminated from further consideration.

TABLE 4
SCOUR DEPTH CALCULATION
OPTION 3: SOIL–CEMENT SLOPE STABILIZATION

SECTION NUMBER	LOCAL						CONTRACTION				TOTAL SCOUR DEPTH
	FLOW AREA	TOP WIDTH	BOTTOM WIDTH	HYDRAULIC DEPTH	FROUDE NUMBER	SCOUR DEPTH	ENERGY SLOPE	SHEAR VELOCITY	K1	SCOUR DEPTH	
220.7	1996.6	525.3	380.0	3.80	0.95	17.4	0.012560	1.91	0.64	0.0	17.4
222.0	2045.0	520.5	357.5	3.93	1.06	18.6	0.008836	1.32	0.64	0.2	18.8
222.3	2105.7	460.7	236.5	4.57	0.87	20.5	0.005232	1.10	0.64	1.4	21.8
222.6	2141.7	486.8	150.0	4.40	0.96	20.3	0.007080	1.25	0.64	1.5	21.7
224.0	2091.7	516.1	90.0	4.05	1.09	19.3	0.008813	1.34	0.64	1.6	20.9

SCOUR.WK1

Structural stability, integrity, and feasibility of the four remaining alternatives were also investigated. Since the success of intrusion grouting is not certain until the grouted soil is exposed, and because of the depths required for the scour protection, the success of this option is risky. For these reasons, Option 3D was also eliminated from further consideration. Options 3B and 3E would require less excavation than Option 3A but result in a greater wall construction cost. In addition, the cantilever type structure required by these options results in a very deep pile configuration. Option 3B would be subject to corrosion although it could be oversized to increase its design life.

Options 3A, 3B, and 3E appeared to be equally feasible from a constructability and technical vantage, so project cost estimates were evaluated for each to select the best option (see Appendix D). The estimates are based on preliminary designs, design assumptions, and unit costs, however, the same assumptions were used for each Option for cost comparison. Options 3B and 3E were evaluated only for wall construction costs. The more economical section, Option 3B, was then compared to Option 3A to evaluate the trade off between excavation costs and wall construction costs (see Appendix D).

Preliminary costs estimates resulted in a cost of $1,211,900 for Option 3A, and $1,342,400 for Option 3B. The two cost estimates are within $130,500 of each other. It is important to note; however, that Option 3B - soil-cement slope stabilization combined with sheet piling scour protection is somewhat of a less reliable solution for scour protection. Even though excavation costs are saved by not placing soil-cement to the full scour depth, the sheet piling alternative may not provide as solid of a barrier as the soil-cement structure. Spacing between sheet piles could occur if boulders obstruct the placing of the piles, which is a likely possibility.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. RECOMMENDED ALTERNATE IMPROVEMENT: OPTION 3A

Several slope stabilization and scour protection treatments were investigated for this project. Of those evaluated in detail, soil-cement slope stabilization and soil-cement scour protection offers the best solution for the least cost, complies with Open Space Arroyo criterion and results in the least disturbance to the channel, and to the existing landfill. Consequently, Option 3A is recommended as the most cost-effective alternative to satisfy project objectives.

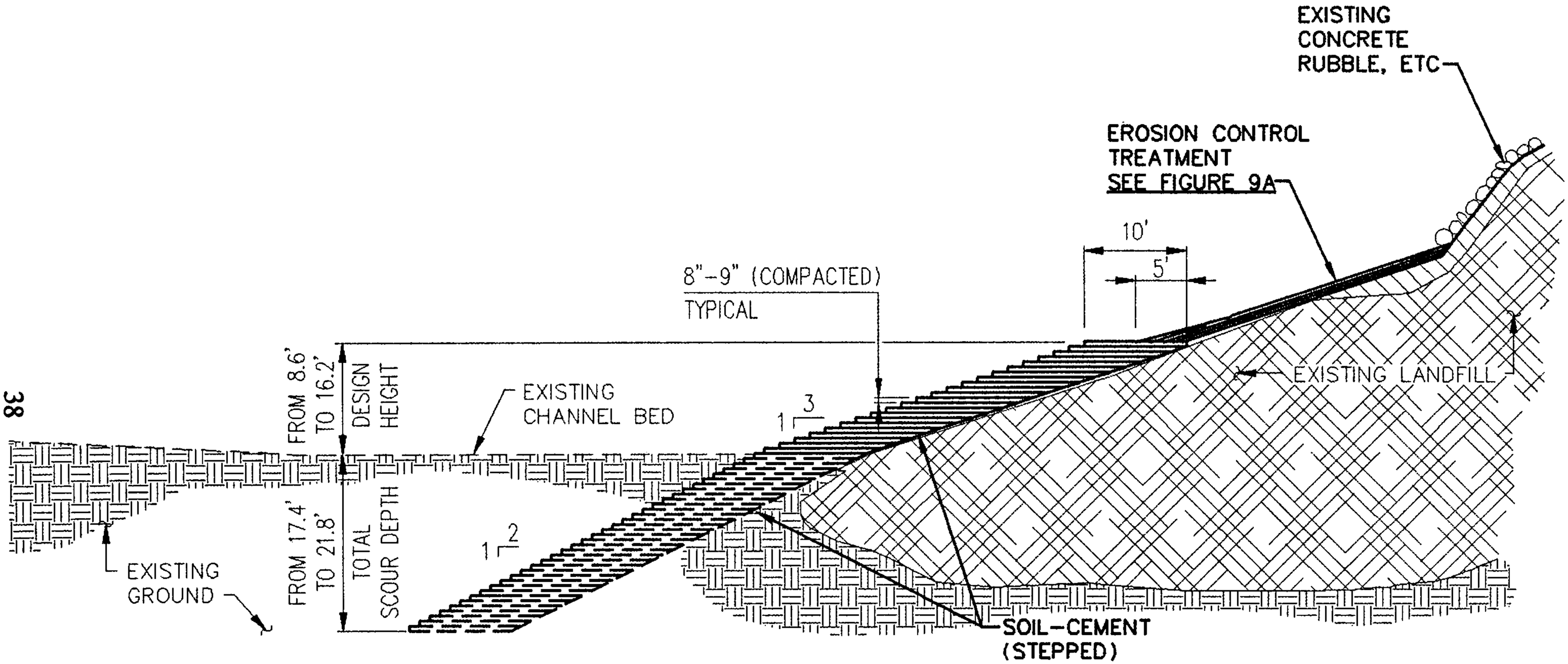
A typical section of Option 3A is shown on Figure 14. The ranges of slope heights and scour depths are summarized on the figure. Also, as shown, a gravel mulch erosion control treatment in combination with the soil-cement is recommended to minimize problems associated with local runoff generated on the landfill bank.

B. PERMIT REQUIREMENTS

Permit requirements for construction of the recommended channel improvements are discussed below:

1. COE Nationwide Permit No. 26 pursuant to Section 404 of the Clean Water Act: The recommended improvement, Option 3A, impacts the U.S. waters by an amount less than one (1) acre. As a result, the project satisfies the existing COE determination that the project qualifies for a Nationwide Permit No. 26, which is valid until November, 1995.

2. EPA Stormwater Pollution Prevention Plan: As a part of the EPA Stormwater Quality permitting, a Stormwater Pollution Prevention Plan (SP3) is required for construction projects disturbing more than one acre of contiguous land. This plan consists of temporary erosion control details and construction sequencing and other measures designed to mitigate the potential for sediment and other pollutants from entering stormwater runoff. To allow the State a more competitive bid process, the temporary erosion control details to be used on this project will be developed and included in the plans. However, as the construction sequencing directly impacts how the Contractor does the job, it is recommended that the Contractor be responsible for incorporating the erosion protection details into the SP3 and subsequent submittal of this plan.



TIJERAS ARROYO

TYPICAL SECTION
OPTION 3A: SOIL-CEMENT
SLOPE STABILIZATION
AND SCOUR PROTECTION

FIGURE 14

3. Because Federal permits (COE NW Permit No. 26 and NPDES) are required for the Tijeras Arroyo project, the project falls under the jurisdiction of the National Historic and Prehistoric Sites Preservation Act, and coordination with the New Mexico State Historic Preservation Office (SHPO) is required. A copy of this report will be submitted to the SHPO for an assessment of the potential impacts of the project on known archeological sites, while the project is located on a waterway which provides some likelihood of finding artifacts, because of past practices of gravel mining and landfill activities in the immediate project vicinity, there is a higher likelihood that any potential sites have already been disturbed.

4. New Mexico Environment Department Solid Waste Bureau: The NMED Solid Waste Bureau must be contacted by the Contractor prior to handling any refuse from the landfill. The Contractor, through coordination with Solid Waste Bureau personnel, will be required to develop a plan for safe removal, handling, and disposal of any refuse. Approval of the plan must be obtained from the Solid Waste Bureau prior to performance of work efforts which may expose refuse.

5. City Environmental Health - Depending upon final design details, the City of Albuquerque Environmental Health will subject the Contractor to certain air pollution, dust control, noise control, and other environmental ordinances.

6. City Traffic Control - Depending on the details of how a Contractor chooses to haul landfill waste away from the site and on whether fill will be transported to the site on public roads, the Contractor will need to present a traffic control plan to the City of Albuquerque for review and approval.

7. City Solid Waste - The City of Albuquerque Solid Waste will require review and approval of any hauling and relocation of debris or refuse from the South Eubank Landfill.

C. CONSTRUCTION EASEMENTS

Construction activities will require access from the top of the landfill down to the bottom of the arroyo, and construction of slope stabilization and scour protection measures along the east and south slopes of the South Eubank Landfill.

The most practical approach to access the arroyo bottom would be to utilize the existing dirt road which has been established along the 150 foot wide Public Service Company of New Mexico (PNM) easement, paralleling two existing power lines. It begins at Eubank Boulevard and continues easterly to the arroyo bottom.

Figure 15 illustrates property owners in and adjacent to the construction site. As can be seen, the property owned by St. John's Cathedral Church, AMAFCA, and Mary Johnson, et.al. (cross-hatched on the figure) would be trespassed upon, in addition to the property owned by the New Mexico State Land Office (NMSLO). Construction limits will be identified for the Contractor in the design drawings. Limits will reflect the same cross-hatched area as seen on Figure 15.

The Land Commissioner has already obtained formal authorization from St. John's Cathedral Church and AMAFCA to trespass and construct upon their respective properties, as necessary. PNM has provided written authorization to use their easement for ingress and egress to the construction site and for limited construction activities within the easement. The NMSLO is pursuing owners of the remaining property that is impacted, to obtain similar authorization to trespass during construction.

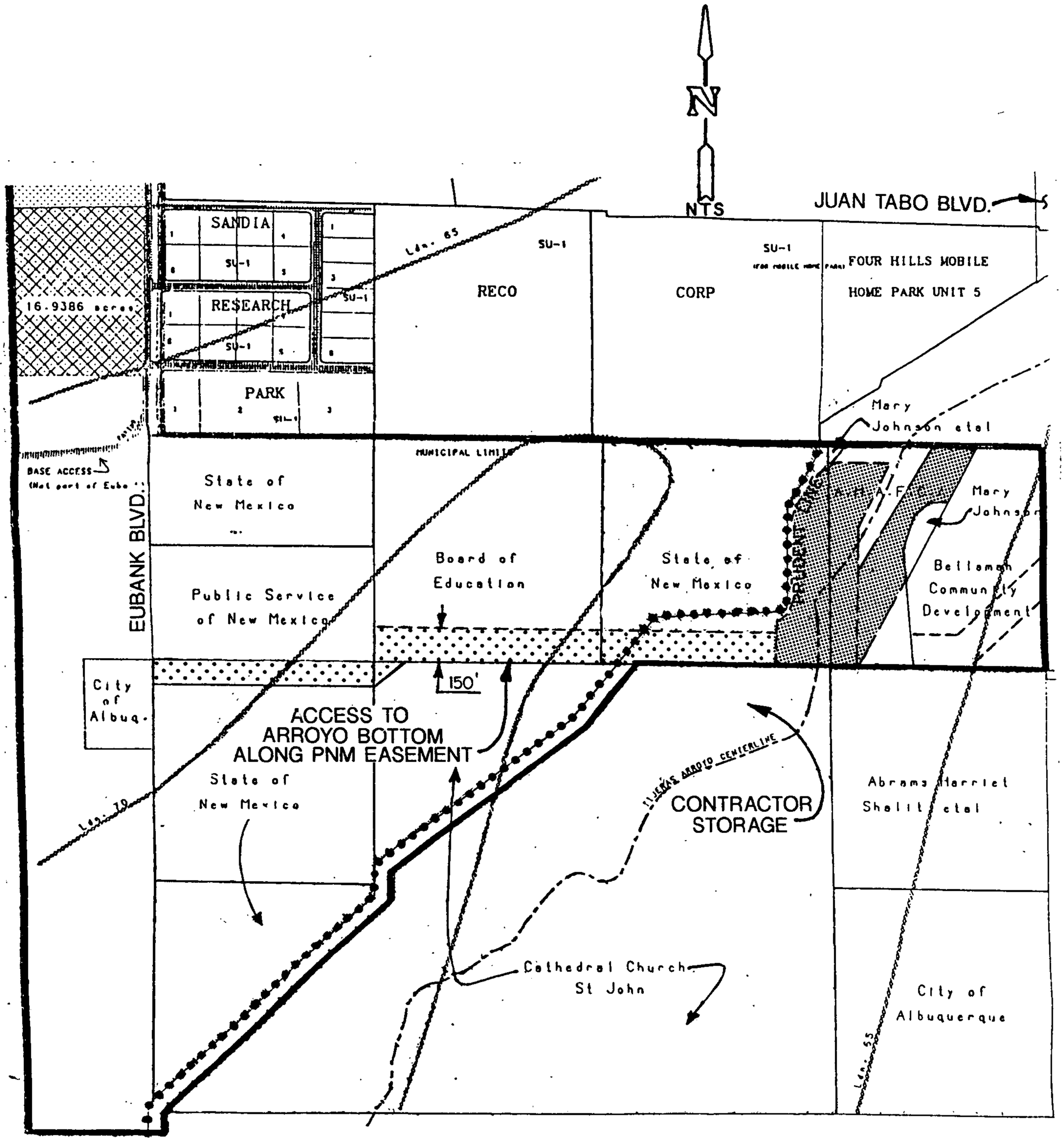
D. CONSTRUCTION COST ESTIMATE

The Construction costs for Option 3A were estimated at $1,211,900. Costs associated with engineering, inspection, and the testing of landfill refuse for hazardous are not included in the construction cost estimate. Table 5 summarizes the construction cost items, quantities, unit costs, and total costs for this option. Unit costs were derived from several sources. For those items common to channel stabilization projects in the Albuquerque area, unit costs were taken from the City of Albuquerque Spring, 1992 City Engineer's Estimated Unit Prices for Construction Items. Other unit costs were obtained through estimates by Means, suppliers, manufacturers and local contractors, or bid tabulations from recent projects of a similar nature. Quantity take-offs and cost estimate details are included in Appendix D. A fifteen percent (15%) contingency factor is included to provide an appropriate estimate of cost for budgeting purposes.

E. CONSTRUCTION SCHEDULE

If construction funds are approved by the 1994 NM Legislative Session, actual money will likely not be available for use until June 1994. The advertisement, bid, and award process requires a minimum of six weeks. AMAFCA has prohibited any construction to occur within the arroyo between May 15 and October 15, 1994. Therefore, a feasible construction start date is October 15, 1994.

In reality, there are no constraints to performing construction efforts during the time period anywhere from October 15, 1994 to May 15, 1995. Actual project construction may take only three or four months. However, if the contractor is given a start date of October 15, 1994, and a completion date of May 15, 1995, with the freedom to perform the work any time during that period, bid prices may be more competitive. Therefore,



CONSTRUCTION LIMITS

TIJERAS ARROYO
PROPERTY OWNERSHIP

FIGURE 15

TABLE 5

TIJERAS ARROYO GRADE AND BANK STABILIZATION
PRELIMINARY PROJECT COST ESTIMATE
OPTION 3A

DESCRIPTION	QUANITY	UNIT	EXTENSION	
			UNIT COST	TOTAL
DIVISION 1				
MOBILIZATION\DEMOBILIZATION	1	LS	$8,500.00	$8,500
CONSTRUCTION STAKING	1	LS	15,700.00	15,700
COMPLIANCE TESTING	1	LS	48,400.00	48,400
DIVISION 2				
CLEARING AND GRUBING	7	LS	600.00	4,200
REMOVE UNSATISFACTORY MATERIAL	30	CY	100.00	3,000
UNCLASSIFIED EXCAVATION (EAST BANK)	11,020	CY	4.00	44,080
UNCLASSIFIED EXCAVATION (CHANNEL)	55,593	CY	4.00	222,372
BACKFILL	43,875	CY	5.00	219,375
COMPACTED FILL	6,348	CY	5.00	31,740
INSTALL SOIL–CEMENT IN	13,952	CY	32.00	446,464
8"–9" x 10' WIDE COMPACTED LIFTS				
GRAVEL MULCH AND NATIVE VEGETATION	7,382	SY	1.35	9,966
SUBTOTAL				1,053,797
CONTINGENCES	15.00	%		158,070
TOTAL BASE BID				**$1,211,866**

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it is recommended that the advertisement for bids be scheduled to begin on September 1, 1994, with award of contract on or before October 15, 1994, and a firm completion date of May 15, 1995.

F. MAINTENANCE

The project area lies within a reach, from the east boundary of KAFB east to the Tramway Diversion Channel, for which no entity has official responsibility for maintaining the arroyo channel or its floodplain and banks.

To insure the long-term integrity of construction improvements which are recommended to protect the closed South Eubank Landfill from future channel erosion by the Tijeras Arroyo, a resolution should be made regarding which entity is responsible for maintenance. Further, an inspection schedule should be established so that any maintenance needs can be identified early-on.

VII. REFERENCES

1. City Engineer's Estimated Unit Prices for Contract Items - Spring 1992, City of Albuquerque, NM.

2. Development Process Manual; Jan, 93; Chapter 22 Section 2 - Hydraulics, City of Albuquerque.

3. Evaluating Scour At Bridges; Feb, 1991; Publication FHWA-1D-90-017 (AKA HEC-18) pg 13-9, 13-7, Case 1a.

4. Facility Plan for Arroyos, Multiple Use of Albuquerque's Arroyos and Their Floodplains, City of Albuquerque, NM, Draft, August 1985.

5. Flexible Reno Mattress and Gabion Linings for Channels and Canalized Water Courses, Maccaferri Gabions West Coast Inc.

6. HEC-2 Water Surface Profile Users Manual, US Army Corps f Engineers, September 1990.

7. Hydraulic Design of Flood Control Channels, 1 July 1991, US Army Corps of Engineers, Publication EM 1110-2-1601.

8. Interim Soil Cement Guide, May 1993, AMAFCA.

9. Letter Report by Corps of Engineers to Mr. Richard Leonard, Executive Engineer, AMAFCA, covering the floodplains along Tijeras Arroyo between Four Hills Road and KAFB, December 7, 1979.

10. Means Building Construction Cost Data, 1993, R.S. Means Company, Inc.

11. Sediment & Erosion Design Guide (Draft) Sept 93; AMAFCA.

12. Stream Stability at Highway Structures; Feb, 1991; Publication # FHWA-1P-90-014 (AKA. HEC-20). Pg 35-40, Sec 3.2.

13. Tijeras Arroyo Drainage Master Plan Phase I, October 1987, prepared for City of Albuq, NM, (Appendix D - August 1987) Leedshill-Herkenhoff, Inc.

14. Tijeras Arroyo Drainage Management Plan, Phase II, August, 1990. Prepared for City of Albuquerque, NM, Leedshill-Herkenhoff, Inc.

ENGINEERS ESTIMATE
TIJERAS ARROYO BANK STABILIZATION
AT SOUTH EUBANK LANDFILL

BID ITEM NO.	DESCRIPTION	UNIT	EST. QUANITY	UNIT PRICE	AMOUNT
1	MOBILIZATION / DEMOBILIZATION	LS	1	$8,500	$8,500
2	CONSTRUCTION STAKING	LS	1	15,700	15,700
3	STORMWATER POLLUTION PREVENTION PLAN	LS	1	10,000	10,000
4	CLEARING AND GRUBBING	AC	7	600	4,200
5	REMOVE AND BURY LANDFILL REFUSE ON-SITE	CY	20	50.00	1,000
6	REMOVE AND DISPOSE OF LANDFILL REFUSE OFF-SITE	CY	30	100.00	3,000
7	UNCLASSIFIED EXCAVATION	CY	66,613	4.00	266,452
8	BACKFILL	CY	43,875	5.00	219,375
9	COMPACTED FILL	CY	6,348	5.00	31,740
10	BORROW	CY	1,050	4.00	4,200
11	SOIL-CEMENT	CY	13,952	20.00	279,040
12	PORTLAND CEMENT FOR SOIL-CEMENT	TON	2,260	72.00	162,720
13	NATIVE GRASS SEEDING WITH GRAVEL MULCH	AC	5	2,700	13,500
	SUBTOTAL				1,019,427
14	COMPLIANCE TESTING (AMOUNT PREDETERMINED, SAME FOR ALL BIDDERS)				48,400
15	CONTRACT ALLOWANCE (AMOUNT PREDETERMINED, SAME FOR ALL BIDDERS)				45,000
	SUBTOTAL				1,112,827
	NEW MEXICO GROSS RECEIPTS TAX (5.8125)				64,683

ENGINEERS ESTIMATE $1,177,510

ENGR_EST.WK1

LEEDSHILL-HERKENHOFF, INC.
500 Copper Avenue N.W.
P. O. Box 1217
Albuquerque, New Mexico 87103
(505) 247-0294

80-93043.11-94

01/24/94

SPOKE W/ DAN H., TOLD HIM THAT I HAVE VERBALLY TOLD ~~SUS~~ DEBRA DIXON THAT THE CITY HAS DEFERRED REVIEW & APPROVAL TO AMAFCA, THIS IS OUTSIDE CITY'S JURISDICTION, DAN SAID WE DO NOT NEED TO SEND ANYTHING IN WRITING

January 18, 1994

Pleas M. Glenn
Assistant Commissioner
State of New Mexico
Office of the Commissioner of Public Lands
P.O. Box 1148
Santa Fe, New Mexico 87504-1148

RE: TIJERAS ARROYO BANK STABILIZATION AT SOUTH EUBANK LANDFILL

G. ALDAZ

In accordance with our Agreement and subsequent discussions, we are hereby transmitting fifteen (15) copies of the Final Summary Report (five include the technical appendices), and ten (10) copies of the construction drawings (95% complete) and specifications.

We have prepared an engineer's estimate of construction costs based on the 95% complete drawings, attached for your review. The total engineer's estimate equals $1,177,510. This cost includes a $45,000 contract allowance for the purpose of encumbering funds for possible change orders during construction. This amount does not include expenses associated with engineering, inspection, and testing of landfill refuse for hazardous constituents.

It is our understanding that you will use all of the documents which we are transmitting as aids when you request construction funding from the 1994 session of the NM Legislature. If we can be of further service in this endeavor, please do not hesitate to contact us.

We will remain on hold on this project until we are notified that funding was obtained. At that time, we will be prepared to begin performance of the Phase Three scope of work, as described in the Agreement and as detailed in the original Request for Proposal.

Courtesy copies of the Summary Report, plans, specifications and engineer's estimate will be forwarded to the following agencies:

Albuquerque Metropolitan Flood Control Authority	Attn: Larry Blair
City of Albuquerque Public Works Department/Hydrology	Attn: Bob Gurule
City of Albuquerque Solid Waste	Attn: Gene Romo
NMED Solid Waste Bureau	Attn: David Duran
NMED Surface Water Quality Bureau	Attn: Richard Powell/ Brian Wurtz

Courtesy copies of the Summary Report only will be forwarded to the following agencies:

City of Albuquerque Open Space	Attn: Randy Reed
City of Albuquerque Chief Administrative Officer	Attn: Lawrence Rael
Bernalillo County, Director of Public Works	Attn: Buz Romero
Kirtland Air Force Base	Attn: Major Rosoff
Corps of Engineers, Albuquerque District	Attn: Jean Manger
NM State Historic Preservation Office	Attn: Thomas Merlan

Please call me or Deborah Dixon should you have any questions regarding this information.

It has been a pleasure working with you over these past few months. We look forward to continuing efforts, once funding has been obtained, to implement the recommended improvements.

SUSAN M. ALVAREZ, P.E.
Project Manager

DD:bz

Attachments