**Technical Report Documentation Page**

| 1. Report No. 1936 1F | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| 4. Title and Subtitle<br>CONTROL OF SEDIMENT DEPOSITION AT BIG SANDY DRAW BRIDGE AND INTERSTATE 20 | | 5. Report Date<br>June, 1992<br>6. Performing Organization Code |
| 7. Author(s)<br>Billy J. Claborn | | 8. Performing Organizaton Report No. |
| 9. Performing Organization Name and Address<br>Dept. of Civil Engineering<br>Texas Tech University<br>Lubbock, TX 79409-1023 | | 10. Work Unit No. (TRA18)<br>11. Contract or Grant No.<br>11-80-91-1936 |
| 12. Sponsoring Agency Name and Address<br>Texas Department of Transportation<br>P.O. Box 5051<br>Austin, TX 78763 | | 13. Type of Report and Period Covered<br>Draft April, 1991 - August, 1992<br>14. Sponsoring Agency Code |

15. Supplementary Notes

16. Abstract


The objective of this study was to identify causes and recommend remedial measures for the sand deposition at the Big Sandy Draw bridges on Interstate 20. The source of the sand is both water and wind erosion on the 11.3 sq mi watershed. Deposition in the vicinity of the bridges is caused by severe backwater from Beals Creek, located about one-quarter mile downstream. Two historical and the one, two, ten, twenty-five, fifty, and one-hundred year precipitation events were modeled using HEC-1. Yang's sediment transport equation was used to estimate the sediment load for each of these events. HEC-2 was used to determine a rating curve above the bridges. The FEMA study data was used to set the Beals Creek water surface for concurrent flow in Big Sandy Draw and Beals Creek. The Bureau of Reclamation's SEDSIZE program was used to evaluate the trapping capabilities of sediment basins of eights sizes located upstream of the bridges.

Based on the results of this study, a basin 400 ft long, 200 ft wide and 12 ft deep will just accommodate the 100-year event. Due to the stochastic nature of the rainfall/runoff no definitive recommendation can be made about basin size. A smaller basin will require more frequent removal of the sediment. Right-of-way and access requirements will likely dictate the best basin size.


| 17. Key Words | 18. Distribution Statement |
|---|---|
| sediment load, sediment trap, sediment basin, sediment transport, water surface profile, rainfall/runoff modelling, Big Sandy Draw shoulder treatment evaluation | No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161 |

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| UNCLASSIFIED | UNCLASSIFIED | 25 | |

Form DOT F 1700.7 (8_72) Reproduction of completed page authorized

# CONTROL OF SEDIMENT DEPOSITION AT BIG SANDY DRAW BRIDGE AND INTERSTATE 20

by

Billy J. Claborn

Research Report Number 11-80-91-1936

Conducted for

Texas State Department of Highways and Public Transportation

by the

DEPARTMENT OF CIVIL ENGINEERING
TEXAS TECH UNIVERSITY

JUNE 1992

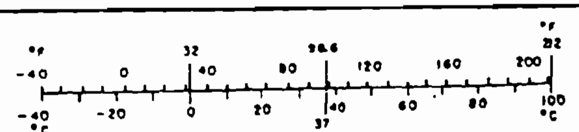
# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

| Symbol | When You Know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| in | inches | *2.5 | centimeters | cm |
| ft | feet | 30 | centimeters | cm |
| yd | yards | 0.9 | meters | m |
| mi | miles | 1.6 | kilometers | km |
| | | **AREA** | | |
| $in^2$ | square inches | 6.5 | square centimeters | $cm^2$ |
| $ft^2$ | square feet | 0.09 | square meters | $m^2$ |
| $yd^2$ | square yards | 0.8 | square meters | $m^2$ |
| $mi^2$ | square miles | 2.6 | square kilometers | $km^2$ |
| | acres | 0.4 | hectares | ha |
| | | **MASS (weight)** | | |
| oz | ounces | 28 | grams | g |
| lb | pounds | 0.45 | kilograms | kg |
| | short tons (2000 lb) | 0.9 | tonnes | t |
| | | **VOLUME** | | |
| tsp | teaspoons | 5 | milliliters | ml |
| Tbsp | tablespoons | 15 | milliliters | ml |
| fl oz | fluid ounces | 30 | milliliters | ml |
| c | cups | 0.24 | liters | l |
| pt | pints | 0.47 | liters | l |
| qt | quarts | 0.95 | liters | l |
| gal | gallons | 3.8 | liters | l |
| $ft^3$ | cubic feet | 0.03 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.76 | cubic meters | $m^3$ |
| | | **TEMPERATURE (exact)** | | |
| °F | Fahrenheit temperature | 5/9 (after subtracting 32) | Celsius temperature | °C |


## Approximate Conversions from Metric Measures

| Symbol | When You Know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| mm | millimeters | 0.04 | inches | in |
| cm | centimeters | 0.4 | inches | in |
| m | meters | 3.3 | feet | ft |
| m | meters | 1.1 | yards | yd |
| km | kilometers | 0.6 | miles | mi |
| | | **AREA** | | |
| $cm^2$ | square centimeters | 0.16 | square inches | $in^2$ |
| $m^2$ | square meters | 1.2 | square yards | $yd^2$ |
| $km^2$ | square kilometers | 0.4 | square miles | $mi^2$ |
| ha | hectares (10,000 $m^2$) | 2.5 | acres | |
| | | **MASS (weight)** | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.2 | pounds | lb |
| t | tonnes (1000 kg) | 1.1 | short tons | |
| | | **VOLUME** | | |
| ml | milliliters | 0.03 | fluid ounces | fl oz |
| l | liters | 2.1 | pints | pt |
| l | liters | 1.06 | quarts | qt |
| l | liters | 0.26 | gallons | gal |
| $m^3$ | cubic meters | 35 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.3 | cubic yards | $yd^3$ |
| | | **TEMPERATURE (exact)** | | |
| °C | Celsius temperature | 9/5 (then add 32) | Fahrenheit temperature | °F |



# SUMMARY

The objective of this study was to identify causes and recommend remedial measures for the sand deposition at the Big Sandy Draw bridges on Interstate 20. The source of the sand is both water and wind erosion on the 11.3 sq mi watershed. Deposition in the vicintiy of the bridges is caused by severe backwater from Beals Creek, located about one-quarter mile downstream. Two historical and the one, two, ten, twenty-five, fifty, and one-hundred year precipitation events were modeled using HEC-1. Yang's sediment transport equation was used to estimate the sediment load for each of these events. HEC-2 was used to determine a rating curve above the bridges. The FEMA study data was used to set the Beals Creek water surface for concurrent flow in Big Sandy Draw and Beals Creek. The Bureau of Reclamation's SEDSIZE program was used to evaluate the trapping capabilities of sediment basins of eights sizes located upstream of the bridges.

Based on the results of this study, a basin 400 ft long, 200 ft wide and 12 ft deep will just accomodate the 100-year event. Due to the stochastic nature of the rainfall/runoff, no definitive recommendation can be made about basin size. A smaller basin will require more frequent removal of the sediment. Right-of-way and access requirements will likely dictate the best basin size.

# IMPLEMENTATION STATEMENT

Implementation of the recommendations contained in this study require the selection of a basin size suitable for the specific location for which the study took place. The site should be immediately upstream of the bridges for maximum benefit. Access to the basin must be available to allow periodic removal of the accumulated sediment. A transition section from the natural channel to the sediment basin should be constructed upstream to insure the use of the full width of the basin. A similar transition may be required at the the exit of the basin.

# TABLE OF CONTENTS

## LIST OF FIGURES

# LIST OF TABLES

## INTRODUCTION

Interstate 20 (I-20) is a major east-west artery in the federal interstate highway system, stretching from Columbia, SC on the east to El Paso, TX where it merges with Interstate 10 which continues on to Los Angeles, CA. At Big Spring, TX I-20 crosses Big Sandy Draw, an intermittent stream, whose terminus at Beals Creek is approximately one-quarter of a mile downstream from the highway, Figure 1. The Big Sandy Draw watershed above I-20 contains 11.2 sq mi. Beals Creek is the main drainage for the City of Big Spring, population 30,000. Immediately upstream on Beals Creek from the confluence with Big Sandy Draw is Little Sandy Draw with a watershed of 12.5 sq mi. About one-quarter of a mile below the Big Sandy Draw-Beals Creek junction is the FM 700 highway crossing. The region between I-20 -- Beals Creek junction -- FM 700 bridge is very flat with a medium dense growth of salt cedars and mesquites. FM 700 crosses Big Sandy Draw approximately three-eights of a mile above I-20. Concurrent with the FM 700 crossing is a Union Pacific Railroad crossing. Between the I-20 bridges and the FM 700/railroad bridges, the channel is well defined with dense undergrowth in the overbank areas. Beyond the FM 700/railroad crossing, the channel parallels the railroad for about three-eights of a mile with the railroad embankment forming the limit of the left overbank. Medium dense brush occupies the right overbank.

The watershed of Big Sandy Draw is devoted almost exclusively to agricultural use; cotton and grain sorghum comprise the usual crops. The area is subjected to strong westerly winds during the spring time, sometimes resulting in intense sand storms. The fields are gently rolling and thunderstorm events result in some water borne erosion, especially from those fields which are not terraced. Sediment is derived both from water and wind erosion.

Four bridges are used to convey the traffic over Big Sandy Draw at I-20: a north access road; the west-bound I-20 traffic; the east-bound I-20 traffic; and, the south access road. The four bridges are quite similar in construction and roadway elevation. At the time of the conversion to interstate status and construction/modification of the bridges, the bed of Big Sandy Draw was 6 to 8 ft below the low chord


Figure 1 Location Map

of the bridges. This clearance has been reduced to as little as 4-ft at times due to the deposition of sediment. Although the sediment can be (and has been) removed to increase the flow area beneath the bridges, more sediment is deposited. After the latest sediment removal, the bridges were again in danger of over topping in a matter of less than three years.

This study was initiated to define the hydraulic causes of the sediment deposition and to recommend remedial measures to economical lessen the potential for over topping at I-20.

All moving fluids have the capacity to transport solids. Water moving through alluvial material will scour (erode) material from the bed and/or banks if there is sufficient "stream power" to do so, or lacking the necessary stream power, may deposit part of the sediment being carried (deposition). In other words, given the available material, the steam will seek to come to a balance between the sediment load it is carrying and the ability to carry the load (stream power) such that neither deposition or scour occur.

The sediment load of a stream may be roughly divided between those particles in suspension *(suspended load)* and those particles rolling or bouncing along the bottom (*bed load).* No such really distinct division can be made: some particles may "bounce" up into the main stream and be carried several hundred feet as suspended sediment before coming into a region where there is insufficient stream power (in the form of turbulence) to maintain suspension. Likewise particles in suspension may enter quiescent regions and settle to the bed to become part of the bedload. In general, the suspended load is kept in suspension by the local stream turbulence and carried forward by the forward motion of the stream. The bed load is moved forward by the shear force or drag of the water on the particle, but does not experience sufficient vertical lift to leave the bed for extended periods of time or distance. Without being too precise, the bedload consists of the "larger" particles and the suspended load contains the finer particles.

## DESCRIPTION OF THE PROBLEM

Several important factors contribute to the deposition of sediment in the vicinity of the I-20 bridges at Big Sandy Draw. These factors include a ready source of sediment, a fluid to move the sediment, and a loss of stream power causing deposition of the sediment in the vicinity of the bridges.

As described earlier, the Big Sandy Draw watershed is largely agricultural in nature. Most of the land is devoted to row crops, requiring plowing during the spring, and some subsequent cultivation during the summer. Particularly during the spring time, strong western winds coupled with warm temperatures frequently strip large amounts of topsoil from the fields. Much of the topsoil is deposited in drainage channels such as the bar ditches and other topographically low places. Intense thunderstorms also occur in the spring, summer and autumn. The runoff from these events provide the motive power to move the wind blown sediment into Big Sandy Draw, as well as washing additional sediment from the fields.

Big Sandy Draw may be classified as a "flashy" stream; i.e., the normally dry stream bed may carry a substantial amount of water for a brief period before returning to the dry status. During the periods of high flows, large amounts of sediment are carried by the stream. As the flow decreases, that sediment which has not been transported from the system into Beals Creek is deposited, only to be scoured from the bed during some subsequent event. While flowing during a runoff event, Big Sandy Draw has the capability of transporting the available sediment at a rate of several thousands of tons per day.

The elevation of the water surface in Big Sandy Draw in the lower reaches is strongly affected by the flows in Beals Creek. When Beals Creek is carrying a large flow, the water level at the confluence causes the water in Big Sandy Draw to "back up" to a depth greater than would be the case if the confluence water level were less. This increased depth in Big Sandy Draw is accompanied by a slowing down of the water and a consequent loss of stream power. Under these circumstances, some of the sediment load is deposited in the backwater from Beals Creek. Runs with HEC-2 indicate the backwater effects extend only slightly upstream of the I-20 bridges. As is expected, samples of sediment taken from the channel of Big Sandy Draw show larger material near the bridges with increasing fineness toward the mouth. Above the bridges, there is little variation in particle size from section to section.

The causes of the sediment deposition in the vicinity of the I-20 bridges can be traced to

1. A ready source of sediment in the watershed;
2. Flow velocities adequate to transport large quantities of sediment; and,
3. A loss of stream power in the vicinity of the I-20 bridges.

## FUTURE OF THE PROBLEM

Over the years, the flows in Beals Creek have increased as more and more urban development within its watershed has occurred. This increased flow has increased the water level at the confluence with Big Sandy Draw. Concurrent with the flow increase over time, the resistance to flow in the Beals Creek channel has increased because of the growth of salt cedars. The increased resistance also raises the water surface at the confluence. If these two trends continue, the backwater effects will play an increasing detrimental role in the sedimentation threatening the I-20 bridges.

Lack of capacity in Beals Creek and flooding some distance upstream of the Big Sandy Draw confluence has led the U. S. Army Corps of Engineers to propose channel improvements for Beals Creek. These improvements would take place upstream of Big Sandy Draw, and the effects at the confluence are difficult to judge. Quite possibly, the channel improvements will sufficiently modify the timing of the flows in Beals Creek and Big Sandy Draw so that, on some occasions, the water surface at the confluence will be decreased. However, the converse may also occur and the two peak flows may sometimes arrive simultaneously. On balance, the best estimate is that the channel modifications will have little effect on the sediment deposition problem.

## POSSIBLE SOLUTIONS

Any of the three causative factors previously cited which can be modified will aid in reducing the sediment problem. Should the agricultural practices on the watershed change so that most of the area is covered by vegetation during the wind storms, significantly less fine sediment would be removed from the fields and deposited in places readily accessible to water erosion. Increased use of terraces would reduce the rate and volume of runoff. Neither of these conservation practices are within the control of the TDHPT; the willingness of the land owner to implement any conservation measures is largely a matter of economics. Likewise, the water level at the confluence of Big Sandy Draw and Beals Creek is beyond the control of TDHPT other than insuring that flow is not impeded by the FM 700 bridge over Beals Creek.

The approach taken in this study is to reduce the stream power at a point upstream of the I-20 bridges to a degree that most of the sediment is deposited in a pre-selected area (a sediment trap) which can periodically be cleaned in an inexpensive manner. The remainder of this report will describe the steps taken to determine the effects of such a sediment trap.

## AVAILABLE DATA

Information existed from several sources which was needed in this study. The FEMA (1981) study was consulted, including the flood plain maps and stream profiles. Detailed data used in that study was obtained from FEMA and from the FEMA contractor (Albert Halff & Associates). This data included the cross sections used to model the water levels in Beals Creek and the lowermost portion of Big Sandy Draw. Copies of TDHPT drawings of the four bridges were obtained to provide data for modeling the flow through these bridges and to establish the channel geometry prior to the development of the present problem. The Fort Worth District office of the Corps of Engineers furnished portions of their study for channel improvements to Beals Creek as well as sieve analysis of Beals Creek and Big Sandy Draw sediment. Precipitation data from recording rain gauges of the HiPlex study were obtained for two significant precipitation events.

## NEW DATA

Stream cross sections of Big Sandy Draw were obtained at 24 locations by TDHPT personnel. These cross sections formed the basis of the description of the flow geometry. Sediment samples were obtained by TTU personnel at 13 sites and sieve analysis performed on each sample. Results of these analysis are shown in Table 1. Numerous field observations by the research team included determination of the Manning roughness values for the channel and overbank areas, validation of bench mark used by TDHPT personnel, and verification of past high water with local residents.

The steps used in evaluating the effects of a sediment trap consists of

1. Determine the sediment load as a function of the flow;
2. Determine the runoff hydrograph for various frequency storms and for historical events;
3. Determine the rating curve (stage versus flow) at the sediment trap site; and
4. Determine the behavior and the trapping efficiency of the sediment trap.

## DETERMINATION OF THE SEDIMENT LOAD

Many empirical equations have been proposed to relate the sediment load to the stream flow characteristics. Figure 2, reproduced from Yang (1973), shows the results of application of several of these equations compared to some measured values. Based on the material in the article, the method of Yang was chosen for this study because the materials used to derive that relationship seemed nearest in size and type to that observed at Big Sandy Draw, e.g. sandy with a minimum variation in particle size. Yang's method requires the settling velocity of the median particle size, the shear velocity, the flow rate, water temperature, the viscosity of the water, the friction slope, the median particle size, and the stream velocity. Settling velocity was taken from Figure 2.2, Vanoni (1975). A water temperature of 60 $^{o}$F was assumed. Shear velocities were obtained from HEC-2 runs. Output consisted of the concentration of sediment and the transport in tons per day, as shown in Table 2.

Table 1 Results of Sieve Analysis

| LOCATION | $D_{10}$ | $D_{30}$ | $D_{50}$ | $D_{60}$ | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|
| At Beals Creek | 0.18 | 0.25 | 0.37 | 0.43 | 3.07 | 1.04 |
| 400 ft above Beals Ck | 0.18 | 0.36 | 0.54 | 0.69 | 3.83 | 1.04 |
| 800 ft above Beals Ck | 0.19 | 0.38 | 0.59 | 0.73 | 3.84 | 1.04 |
| Under S. Access Bridge | 0.17 | 0.34 | 0.53 | 0.67 | 3.94 | 1.01 |
| Upstream face N. Access Bridge | 0.28 | 0.59 | 0.80 | 0.95 | 3.39 | 1.30 |
| 350 ft above I-20 Bridges | 0.28 | 0.55 | 0.76 | 0.90 | 3.21 | 1.20 |
| 450 ft above I-20 Bridges | 0.29 | 0.55 | 0.75 | 0.90 | 3.10 | 1.16 |
| 700 ft above I-20 Bridges | 0.25 | 0.49 | 0.70 | 0.85 | 3.40 | 1.08 |
| At FM 700 and RR | 0.22 | 0.47 | 0.68 | 0.82 | 3.72 | 1.22 |
| Wind Deposit, I-20 Road-side at bridges | 0.18 | 0.31 | 0.39 | 0.42 | 2.33 | 1.27 |
| Field on East side of DA | 0.14 | 0.28 | 0.34 | 0.38 | 2.71 | 1.47 |
| Upstream side Snyder Highway | 0.15 | 0.28 | 0.45 | 0.58 | 3.87 | 0.90 |
| Downstream side Snyder Highway | 0.09 | 0.13 | 0.20 | 0.24 | 2.73 | 0.80 |

$D_{10}$: diameter (mm) of particle such that 10 percent of the sediment is smaller

$D_{30}$: diameter (mm) of particle such that 30 percent of the sediment is smaller

$D_{50}$: median diameter; diameter (mm) of particle such that 50 percent of the sediment is smaller

$D_{60}$: diameter (mm) of particle such that 60 percent of the sediment is smaller

$C_u$: the uniformity coefficient; the ratio of $D_{60}$ to $D_{10}$

$C_c$: the coefficient of curvature

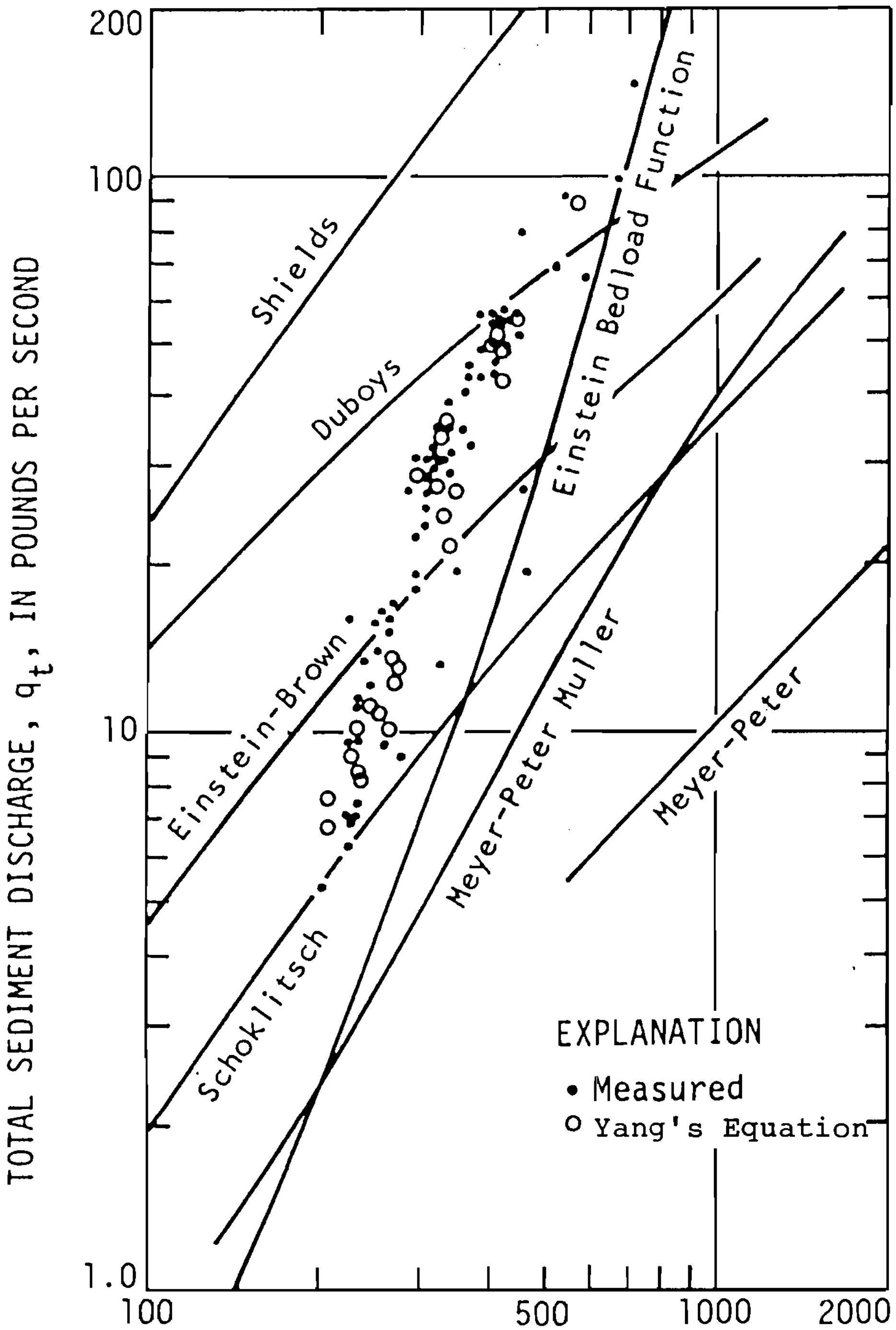



Figure 2 Measured Total Sediment Discharge for Niobrara River Near Cody, Neb., Compared With That Computed by Vanoni, et al. (1975) Using Various Sediment Transport Equations, and With That Computed by Yang's Equation (Yang, 1972)

## DETERMINATION OF THE FLOW HYDROGRAPH

The HEC-1 program was used to determine the runoff hydrograph at the I-20 bridges for the 1-year, 2-year, 10-year, 25-year, 50-year, and 100-year events. Two historical events, May 23, 1987 and Sep 3-5, 1986 were also modeled. Figure 3 shows the Big Sandy Draw watershed, and the sub-basins used in the modeling. Precipitation data for the n-year events was obtained from HYDRO-35 and TP-40 for durations through the 24-hour event. Precipitation for the historical events was obtained from gauges TB990000 and TA890000 of the HiPlex project. Table 3 shows the rainfall depths from HYDRO-35 and TP-40 for the various return periods. The runoff hydrographs are shown in Figures 4 through 11. Peak flows from these runs were used as the flow rate in HEC-2.

Table 2 Sediment Load Based on Yang's Method

| Flow | Concentration (ppm) | Load (tons/day) |
|---|---|---|
| 100 | 2549 | 687 |
| 250 | 3189 | 2150 |
| 500 | 3971 | 5354 |
| 750 | 4506 | 9114 |
| 1,000 | 4944 | 13334 |
| 1,500 | 5596 | 22632 |
| 2,000 | 6145 | 33020 |

Table 3 Rainfall Depths (inches) for Various Frequencies

| Duration (hrs) | 1-yr | 2-yr | 10-yr | 25-yr | 50-yr | 100-yr |
|---|---|---|---|---|---|---|
| 0.0833 | 0.30 | 0.44 | 0.59 | 0.68 | 0.76 | 0.83 |
| 0.25 | 0.63 | 0.84 | 1.19 | 1.41 | 1.57 | 1.74 |
| 1.0 | 1.10 | 1.45 | 2.24 | 2.69 | 3.04 | 3.39 |
| 2.0 | 1.30 | 1.66 | 2.75 | 3.20 | 3.65 | 4.04 |
| 3.0 | 1.42 | 1.80 | 2.90 | 3.41 | 3.92 | 4.42 |
| 6.0 | 1.75 | 2.20 | 3.60 | 4.08 | 4.75 | 5.36 |
| 12.0 | 2.00 | 2.50 | 4.20 | 4.91 | 5.56 | 6.27 |
| 24.0 | 2.30 | 2.90 | 4.88 | 5.75 | 6.48 | 7.31 |

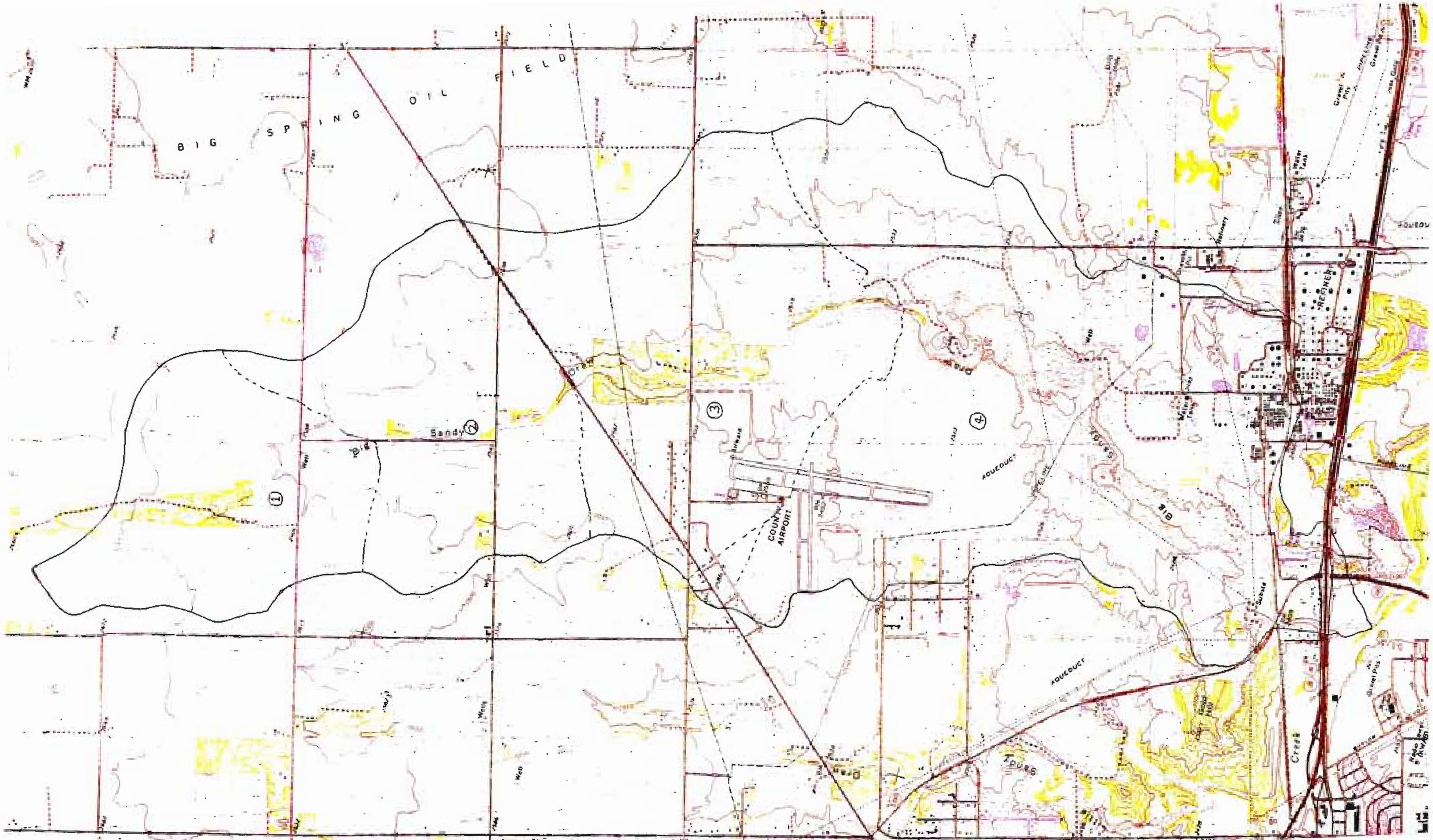



Figure 3 Big Sandy Draw Watershed

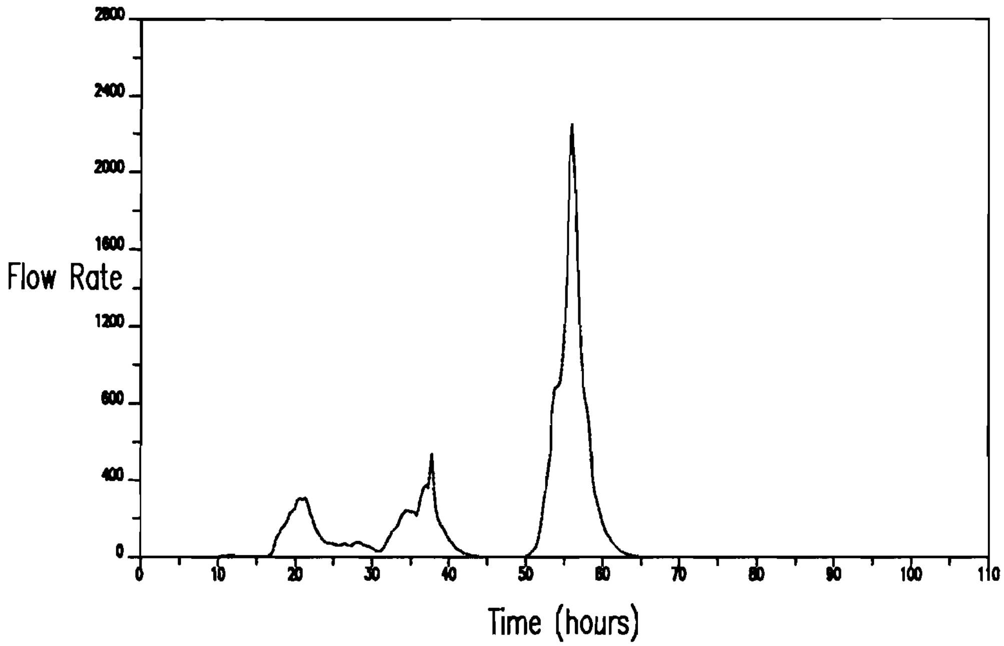



Figure 4 Event of Sep 3-5, 1986

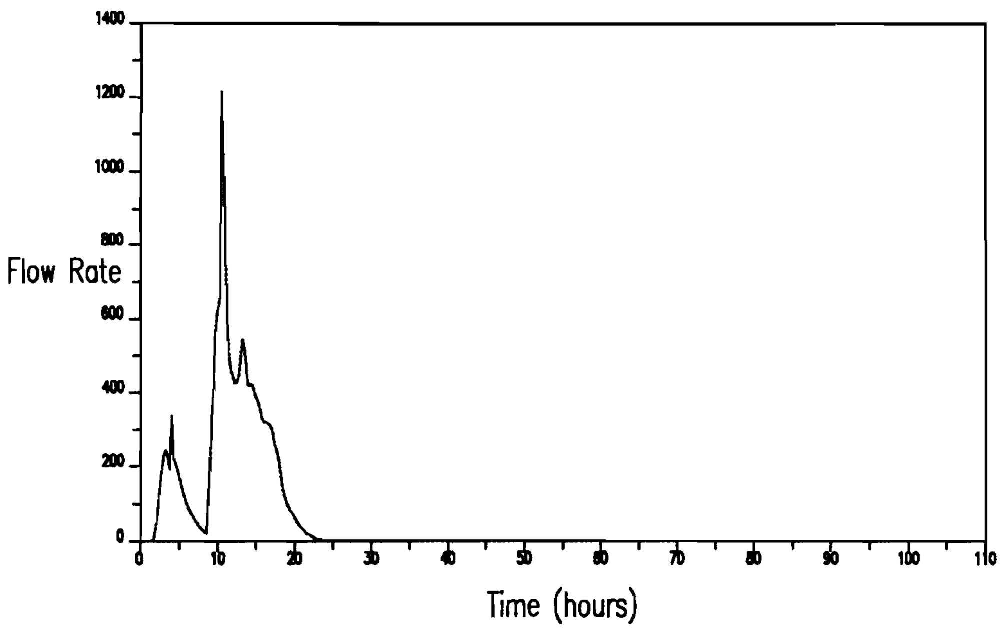



Figure 5 Event of May 23, 1987

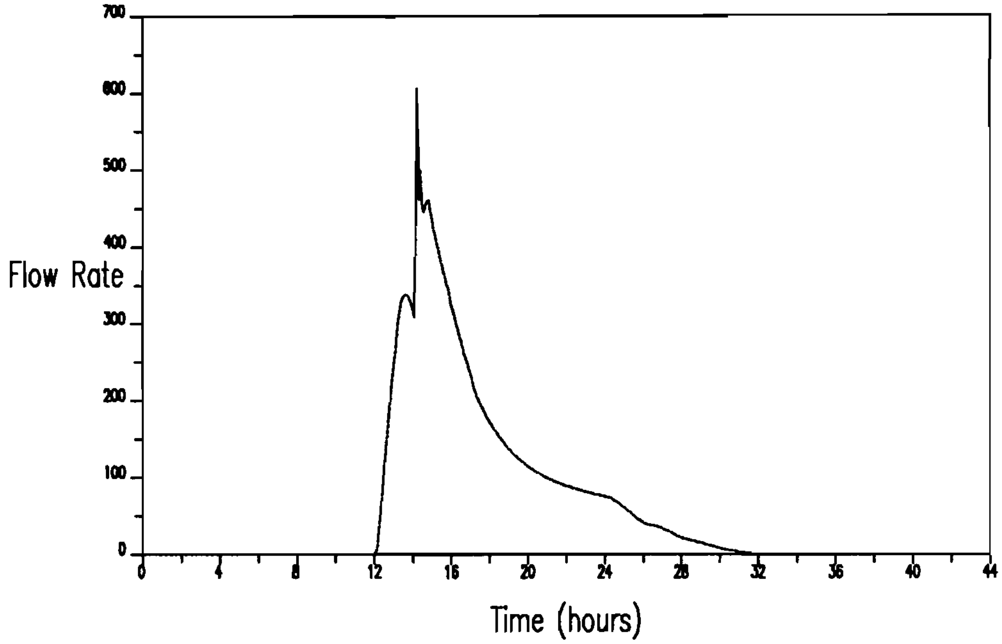



Figure 6 One-Year Event

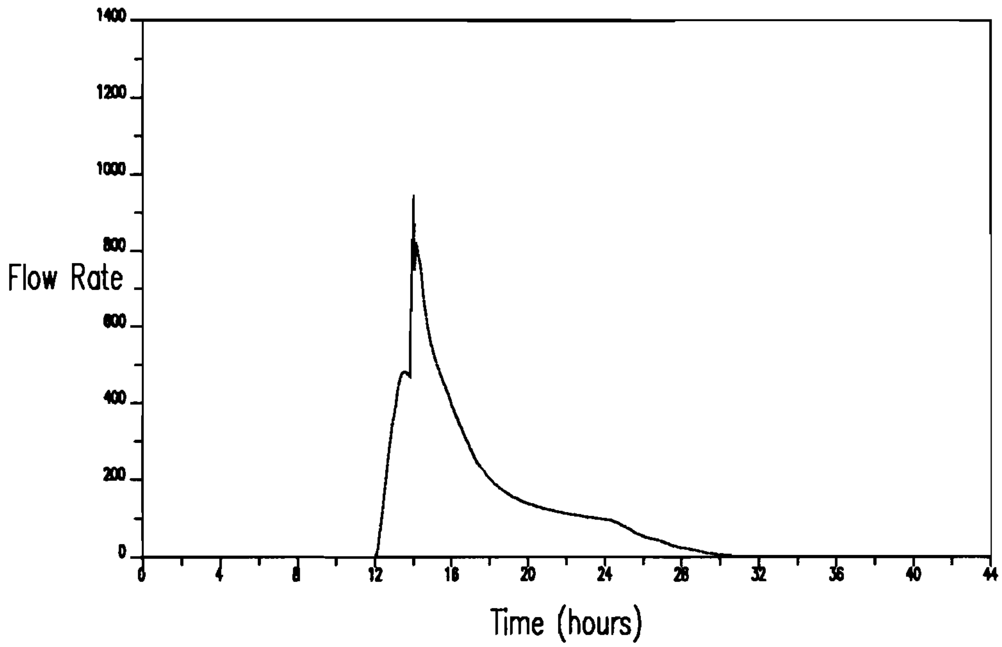



Figure 7 Two-Year Event

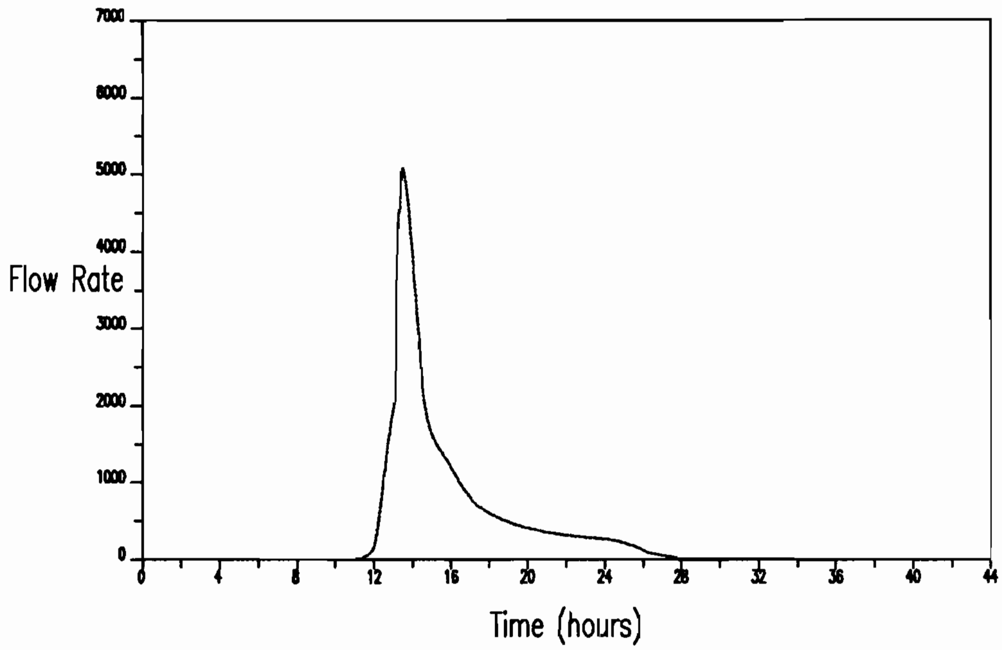



Figure 8 Ten-Year Event

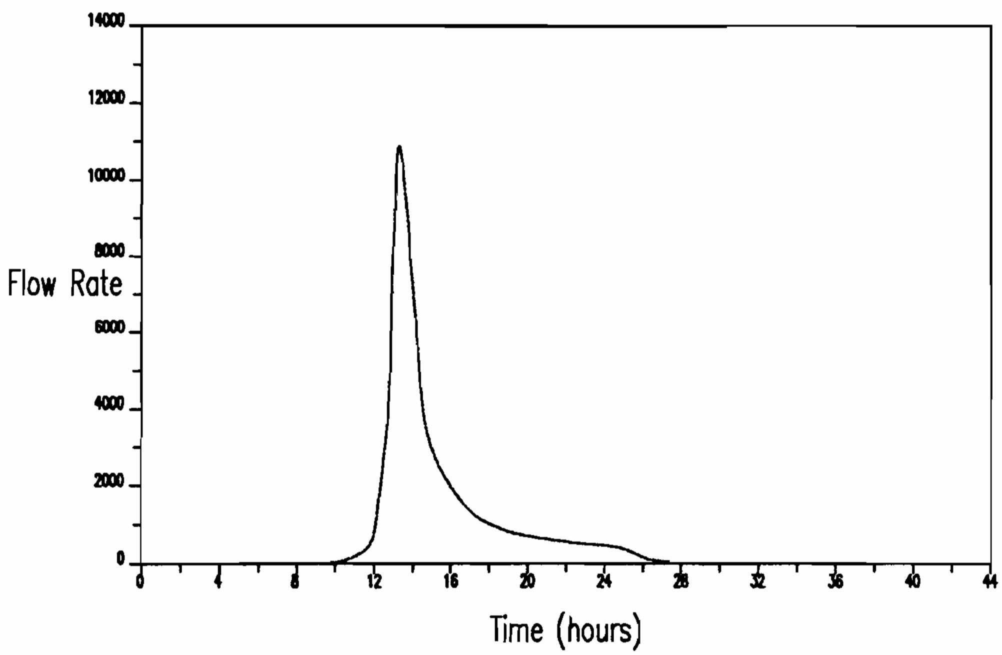



Figure 9 Twenty-five Year Event

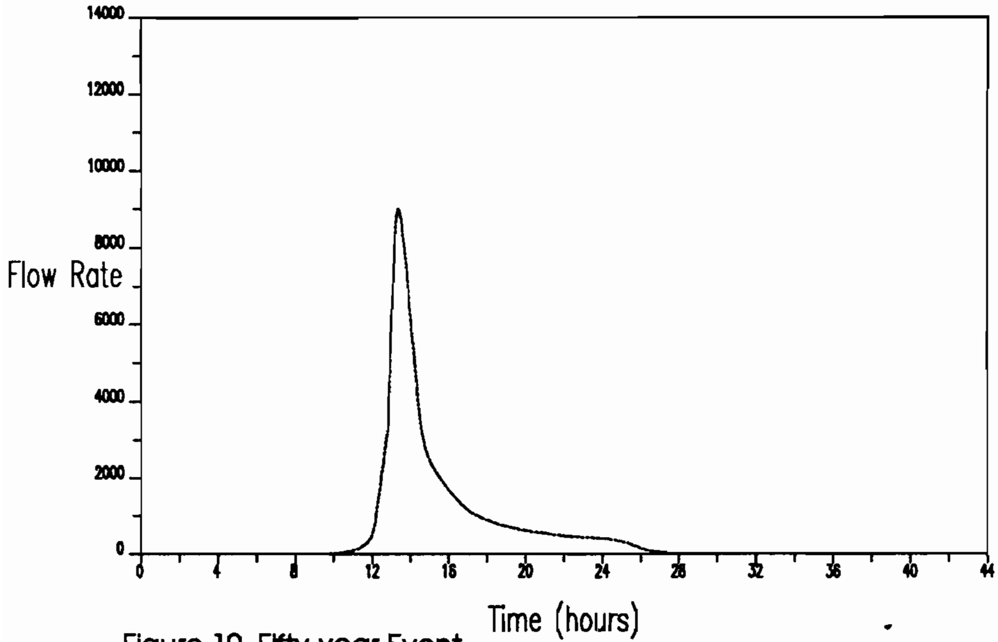



Figure 10 Fifty-year Event

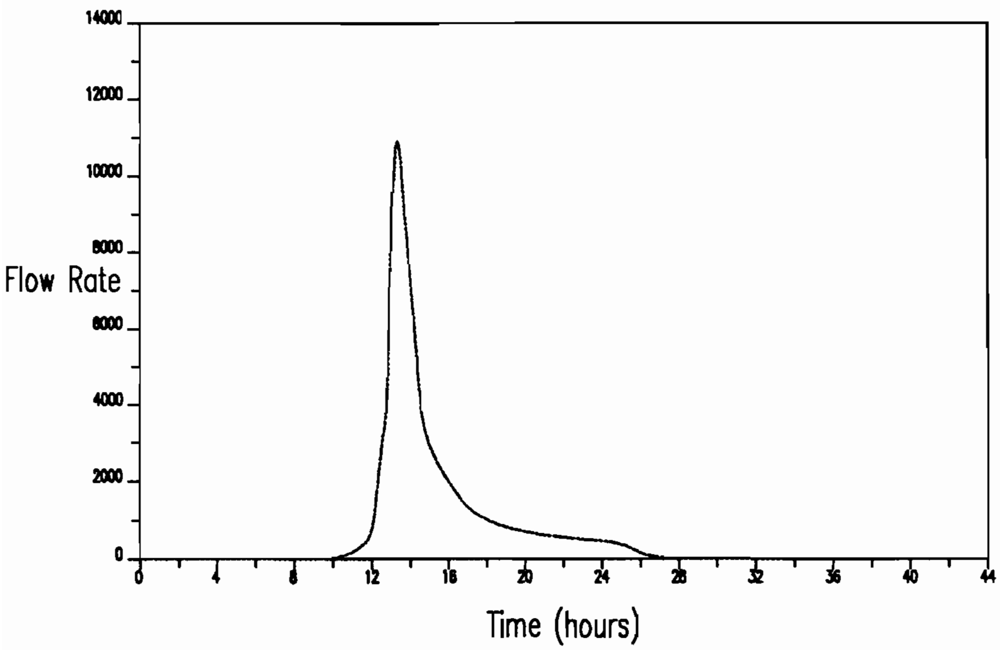



Figure 11 One-hundred Year Event

## DETERMINATION OF WATER SURFACE ELEVATIONS

HEC-2 calculates the water surface profile for a steady flow in a natural channel. The cross section from the FEMA study immediately downstream of the Big Sandy Draw-Beals Creek confluence was used to determine the water surface for various flows in Big Sandy Draw. Concurrent flows in Big Sandy Draw and Beals Creek were determined by plotting FEMA values for both streams for the 10-, 50- 100- and 500-yr events, Figure 12. These starting elevations were used in HEC-2 runs for flows in Big Sandy Draw ranging from 10 to 15,000 cfs. Figure 13 shows the approximate location of the cross sections used; Figure 14 shows the resulting water surface profiles. From these runs the shear velocity, the friction slope, and the channel velocity were used in calculating the sediment concentration by Yang's equation. Eight settling basins were modeled using HEC-2; widths of 100 and 200 ft, lengths of 300 and 400 ft and depths of 8 and 12 ft. Side slopes were assumed as 2.5:1 (H:V). All basins end at Station 1740.

## DETERMINATION OF RATING CURVE FOR SEDIMENT AND FLOW AT THE SETTLING BASIN

Water surface elevation data at cross section 2140 from the HEC-2 runs was plotted versus the flow rates and a smooth curve drawn through the plotted points (Figure 15). Sediment concentrations from Yang's method (Figure 2) were plotted versus flow rates and a smooth curve drawn through the plotted points (Figure 16). Data from each of these plots became input to SETSIZE.

## MODELING THE BEHAVIOR OF THE SETTLING BASIN

SETSIZE is a Bureau of Reclamation program which allows one to size a settling basin. This program was modified to accept variable time steps so that the passage of a real or hypothetical flood could be modeled. The hydrographs generated by each of the HEC-1 runs was used to create a set of values representing the average *hourly* flow rates. Each of these hourly hydrographs was used as input to SETSIZE to determine the amount of sediment trapped. The eight sediment basins modeled by HEC-2 were studied. Table 4 shows the

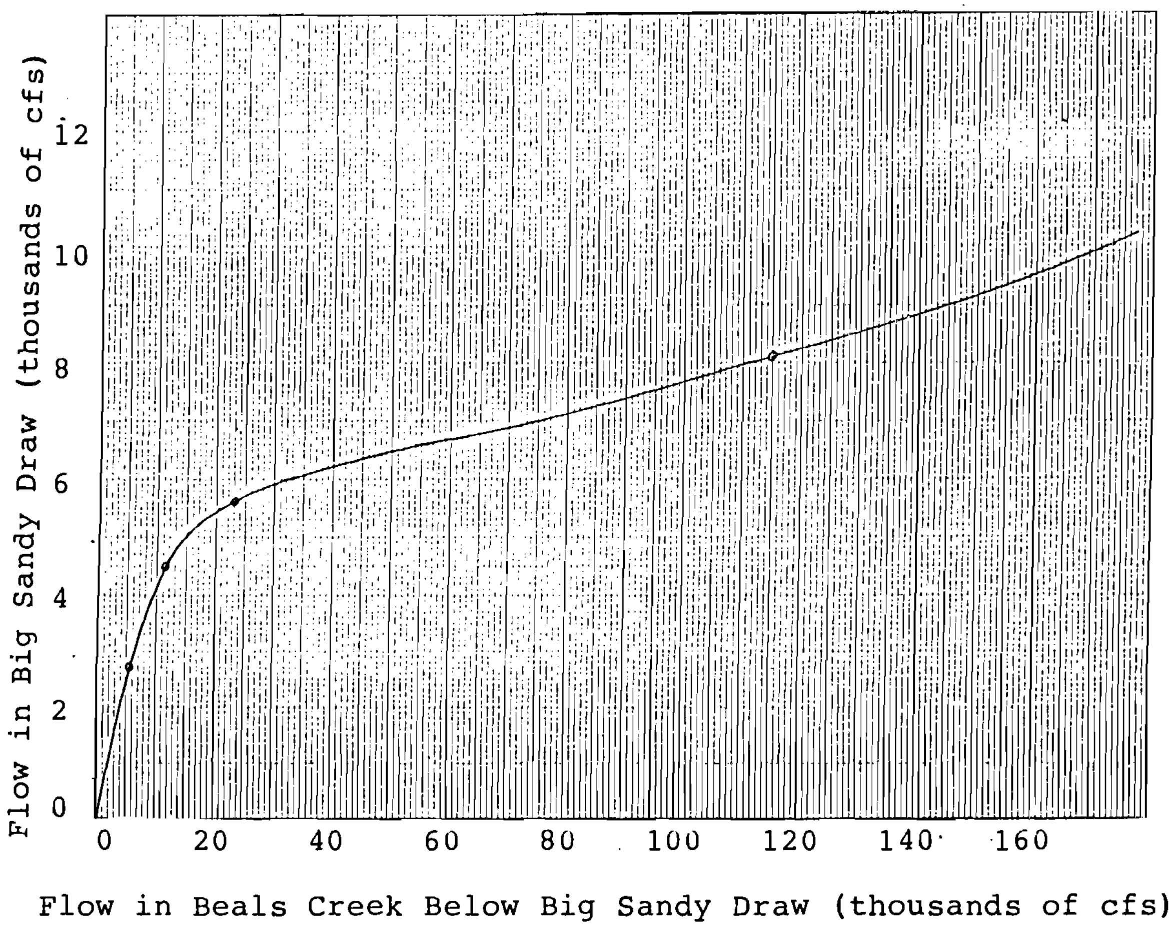



Figure 12 Relation Between Flows in Big Sandy Draw and Beals Creek (based on FEMA Study)

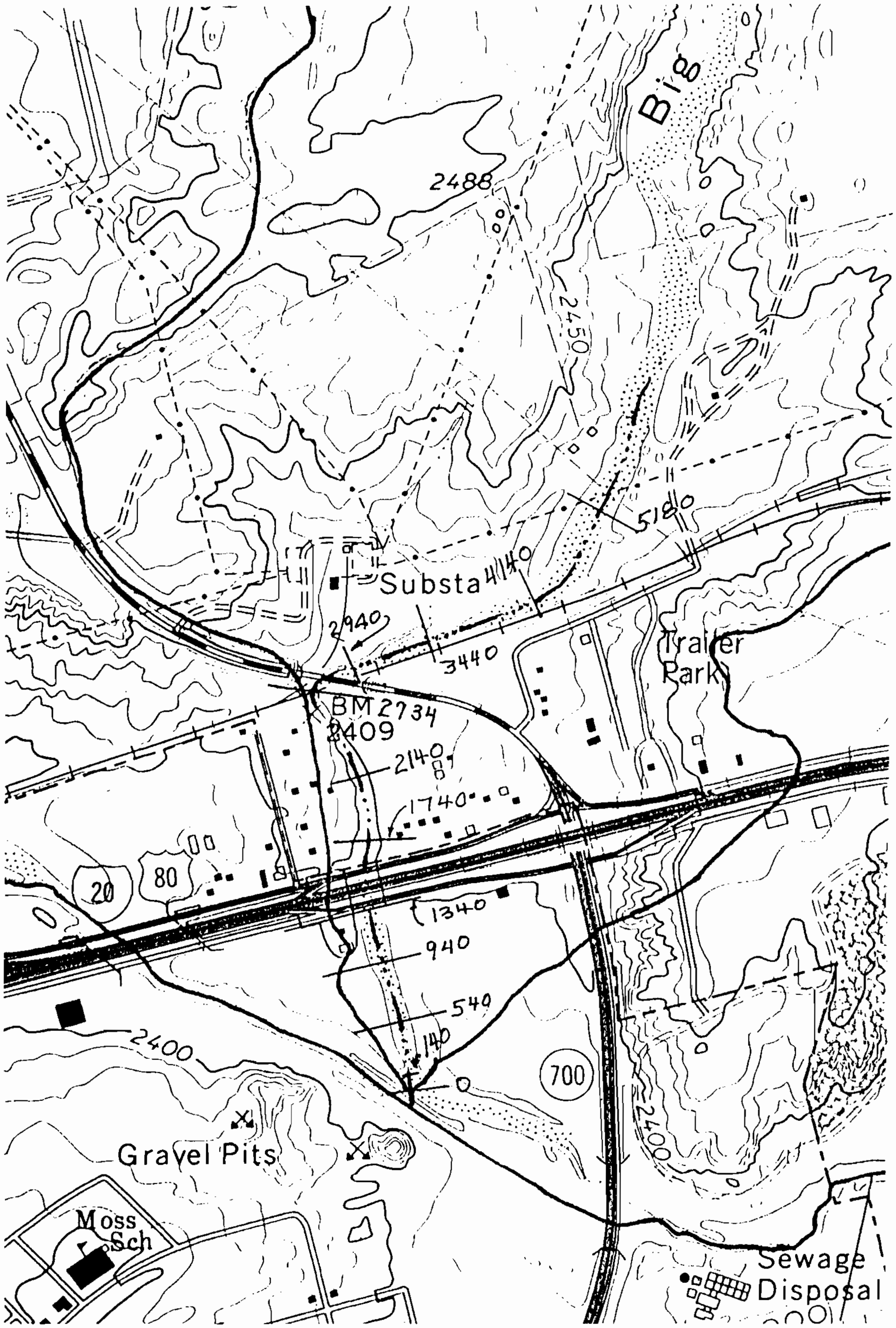



Figure 13  Approximate Location of Cross Sections Used in HEC-2

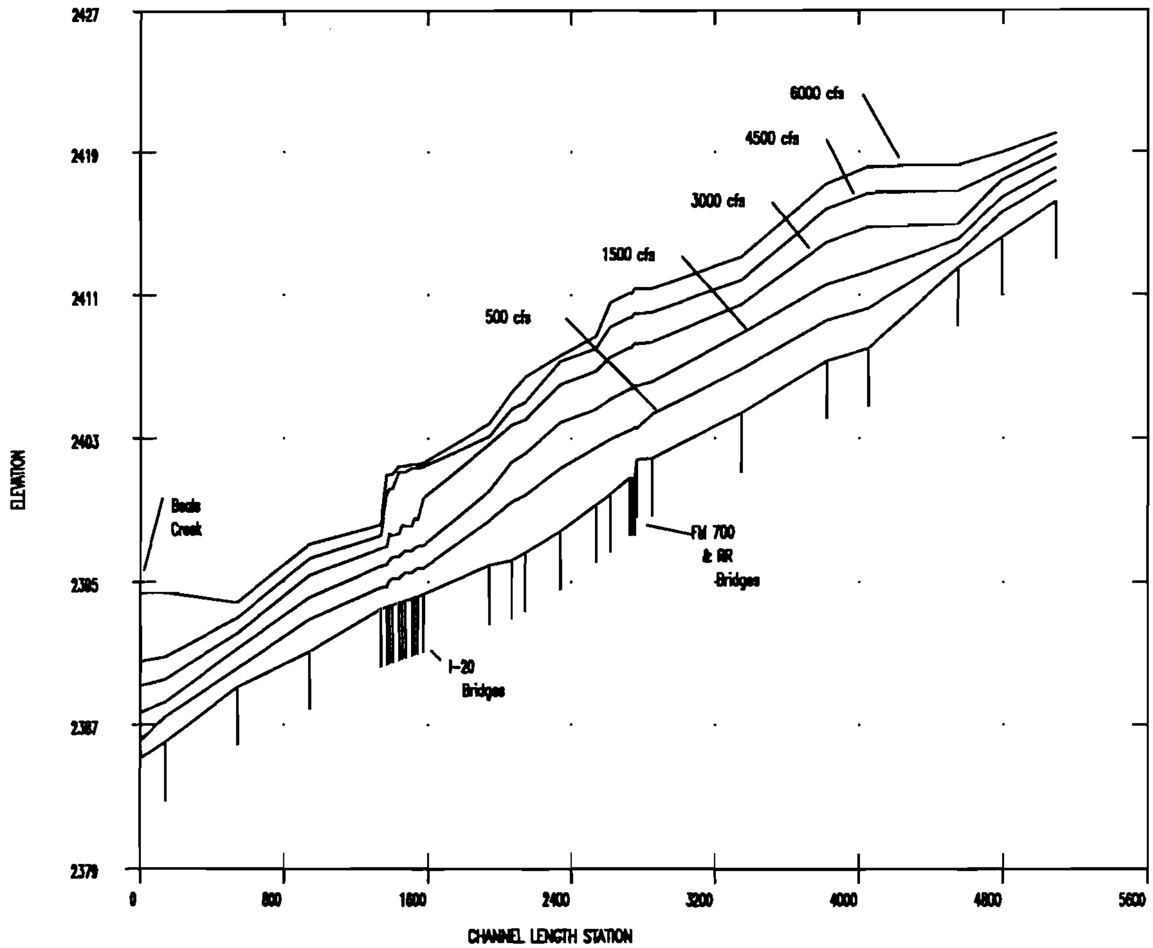



Figure 14-a Water Surface Profiles Before Settling Basin

basin size, the depth of deposition, and the percent of the total sediment trapped for each event for the various basins. In all cases the basin ends just upstream of the bridges at cross section 1740.

## EVALUATION OF RESULTS

The results shown in Table 4 should be viewed as "best" estimates of the results of constructing a particular size sediment trap. Sediment transport in a natural stream is imperfectly described by the equations available today and is the most sensitive variable in this analysis. The estimate of sediment load shown in Table 2, based on Yang's work, appears to give a conservative value, e.g., the method of Colby gives smaller values for the sediment in Big Sandy Draw. The HEC-2 runs indicates that supercritical flows may occur in portions of the reach

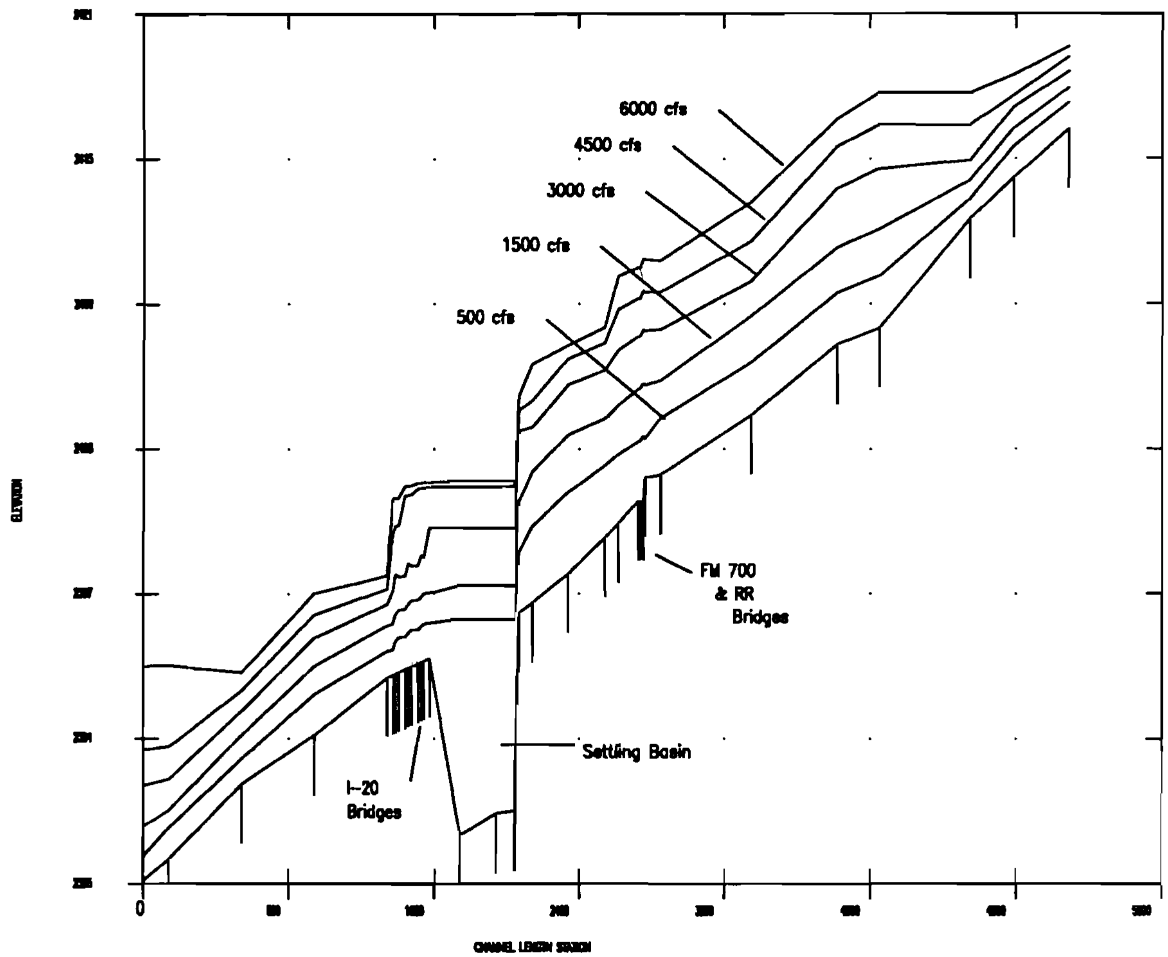



Figure 14-b Water Surface Profiles with Settling Basin

between FM 700 and I-20 due to the narrow channel throughout much of the distance. Unless the bed becomes "armored", scour should occur readily in supercritical flows. However, some armoring is evident in the reach. The HEC-2 runs were made assuming a horizontal bed at the I-20 bridge, i.e., assuming that the full width of the bridge openings was available. As discussed earlier, deposition occurs in the region from the I-20 bridges to Beals Creek largely because of high water in Beals Creek. The starting elevations in the HEC-2 runs represent only a "best guess", but should be

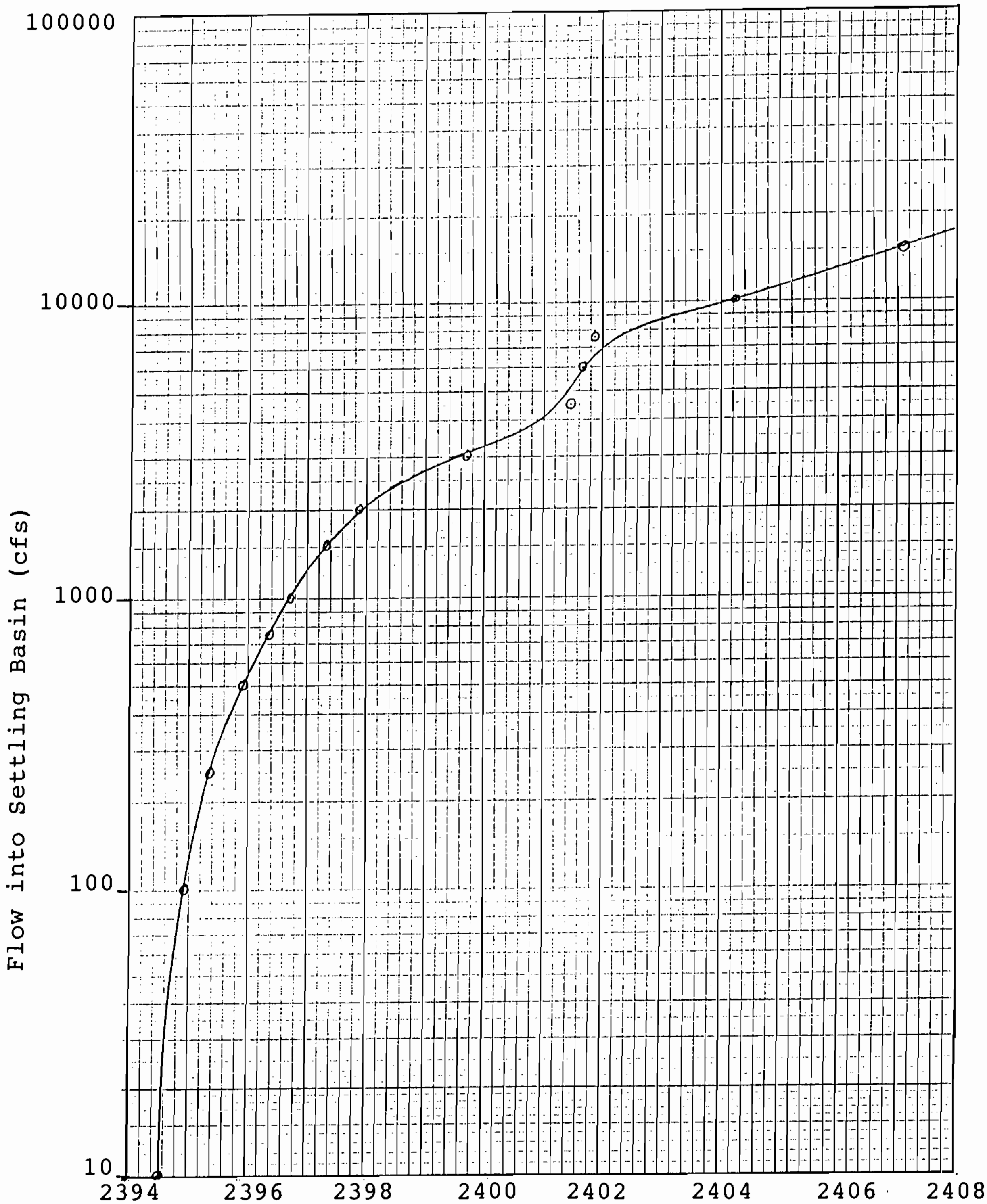



Figure 15 Rating Curve at Settling Basin

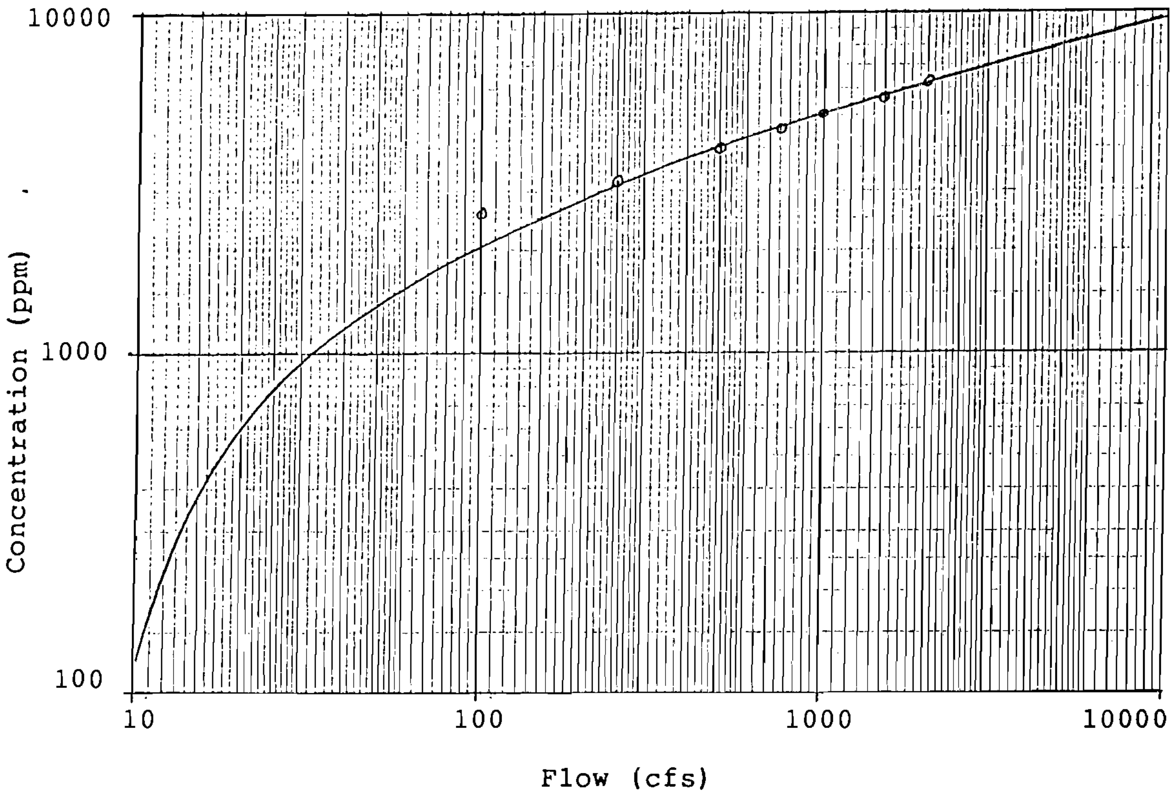



FIGURE 16 Sediment Concentration Versus Flow for Big Sandy Draw

conservative. Whenever Big Sandy Draw experiences substantial runoff and Beals Creek is not carrying much water, there will be some scour in the reach between I-20 bridges and Beals Creek. The opposite situation seems likely to occur, with large flows in Beals Creek and low flows in Big Sandy Draw. Under this scenario, Beals Creek will scour below Big Sandy Draw. This condition has been observed throughout this study.

## CONCLUSIONS AND RECOMMENDATIONS

Based on the evidence gathered in this study, Big Sandy Draw can transmit large amounts of sediment. The TDHPT can do little or nothing to reduce the amount of sediment transported. Deposition in the lower reaches of Big Sandy Draw occur primarily because of backwater from Beals Creek. The effects of this backwater reaches

Table 4 Sediment Trap Performance

| EVENT | 300' x 100' x 8' | | 400' x 100' x 8' | | 300' x 100' x 12' | | 400' x 100' x 12' | |
|---|---|---|---|---|---|---|---|---|
| | Percent Trapped | Sediment Depth (ft) | Percent Trapped | Sediment Depth (ft) | Percent Trapped | Sediment Depth (ft) | Percent Trapped | Sediment Depth (ft) |
| Sep 3-5, 1986 | 99.9 | 0.93 | 99.9 | 0.70 | 99.9 | 0.93 | 99.9 | 0.70 |
| May 23, 1987 | 99.9 | 0.37 | 99.9 | 0.28 | 99.9 | 0.37 | 99.9 | 0.28 |
| 1-year storm | 99.9 | 1.33 | 99.9 | 1.01 | 99.9 | 1.33 | 99.9 | 1.01 |
| 2-year storm | 99.9 | 2.00 | 99.9 | 1.51 | 99.9 | 2.00 | 99.9 | 1.52 |
| 10-year storm | ***71.3*** | ***8.00*** | ***90.7*** | ***8.00*** | 99.9 | 10.85 | 99.9 | 8.73 |
| 25-year storm | ***49.4*** | ***8.00*** | ***62.7*** | ***8.00*** | ***79.0*** | ***12.00*** | 99.9 | 11.92 |
| 50-year storm | ***39.6*** | ***8.00*** | ***49.7*** | ***8.00*** | ***63.1*** | ***12.00*** | ***79.5*** | ***12.00*** |
| 100-year storm | ***35.7*** | ***8.00*** | ***40.0*** | ***8.00*** | ***51.1*** | ***12.00*** | ***63.8*** | ***12.00*** |

| EVENT | 300' x 200' x 8' | | 400' x 200' x 8' | | 300' x 200' x 12' | | 400' x 200' x 12' | |
|---|---|---|---|---|---|---|---|---|
| | Percent Trapped | Sediment Depth (ft) | Percent Trapped | Sediment Depth (ft) | Percent Trapped | Sediment Depth (ft) | Percent Trapped | Sediment Depth (ft) |
| Sep 3-5, 1986 | 99.9 | 0.47 | 99.9 | 0.36 | 99.9 | 0.47 | 99.9 | 0.36 |
| May 23, 1987 | 99.9 | 0.19 | 99.9 | 0.14 | 99.9 | 0.19 | 99.9 | 0.14 |
| 1-year storm | 99.9 | 0.68 | 99.9 | 0.51 | 99.9 | 0.69 | 99.9 | 0.51 |
| 2-year storm | 99.9 | 1.04 | 99.9 | 0.78 | 99.9 | 1.04 | 99.9 | 0.78 |
| 10-year storm | 99.9 | 6.63 | 99.9 | 5.12 | 99.9 | 6.64 | 99.9 | 5.13 |
| 25-year storm | ***83.7*** | ***8.00*** | 99.9 | 7.39 | 99.9 | 9.44 | 99.9 | 7.41 |
| 50-year storm | ***65.7*** | ***8.00*** | ***84.6*** | ***8.00*** | 99.9 | 11.75 | 99.9 | 9.35 |
| 100-year storm | ***44.5*** | ***8.00*** | ***67.1*** | ***8.00*** | ***81.8*** | ***12.00*** | 99.9 | 11.52 |

just upstream of the I-20 bridges. Bed sediment samples indicate a decrease in $D_{50}$ between the I-20 bridges and the confluence with Beals Creek. A sediment trap constructed just upstream of the bridges will be quite effective until it is full, but must then be cleaned to restore effectiveness.

Eight sediment traps were simulated. As expected, providing increased depth, length, or width increases the amount of sediment which will be trapped, as well as increasing the time between required sediment removal. The largest basin tested just managed to contain the 100-year event, while each of the historical storms deposited only a minor amount. Because both the inflow and the stage at Beals

Creek are stochastic in nature, no prediction regarding frequency of sediment removal from the trap can be made. Choice of size of the basin may well be dictated by available space. Whatever the size selected, a transition from the natural channel to the width of the basin must be provided, as well as an access for removal of the deposited sediment.

## REFERENCES

---*Five- to 60-Minute Precipitation Frequency For the Eastern and Central United States* NOAA Technical Memorandum NWS HYDRO-35, June 1977

--- *Flood Insurance Study*, City of Big Spring, Texas, Howard County, Federal Emergency Management Agency, Federal Insurance Administration, March 30, 1981.

---*Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains*, U.S. Geological Survey, Baton Rouge, LA, Apr 1984

--- *Results of Tests of Soil Samples Beals Creek Channel Improvements*, SWDED-GL Report No. 15245, U.S. Army Corps of Engineers, Fort Worth District, Southwestern Division Laboratory, Dallas, TX Oct, 1990

---*Rainfall Frequency Atlas of the United States* U.S. Department of Commerce, Weather Bureau, Technical Paper No. 40, May 1961

Pemberton, Ernest L. and Joe M. Lara *Procedure to Determine Sediment Deposition in a Settling Basin* Sedimentation Investigations Technical Guide Series, Section E. Intake Works and Desilting Basins Part 2. Settling Basins, Bureau of Reclamation, U.S. Department of the Interior, Aug 1971

Randle, Timothy J., *User's Guide to Computer Modeling of Settling Basins* Bureau of Reclamation, U.S. Department of the Interior, Feb 1984

Vanoni, Vito A. **Sedimentation Engineering**, American Society of Civil Engineers, New York, NY, 1975

Yang, Chih Ted *Unit Stream Power and Sediment Transport*, Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 98, No. HY10, Oct, 1972.