2002 (July 2001 - June 2002)

Report Year 2002 was characterized by a serious worsening of the drought cycle. Runoff decreased significantly and no overbank, channel-forming events occurred during the 2001 monsoon season. By contrast, several lesser storm events transported large volumes of sand-sized bedload from nearby tributary channels to be deposited in the study channel. Aggradation raised the bed elevation by about a foot in both reaches. Main channel depth decreased as width:depth ratio increased. Channel width increased with no increase in width of flood prone area therefore entrenchment ratio decreased. Previously evolving Rosgen E channel subreaches disappeared under the accumulating deposits and some instream structures were inundated under deposited sands. Cutoff channels evolved across 3 meander loops in Phase 1 Reach decreasing channel length by about 119 feet. Channel length of Phase 2 Reach decreased by 42 feet. Sinuosity decreased and channel slope increased. As a result channel evolution in response to induced meandering treatment ceased. The Phase 1 Reach remained at Rosgen F-5; Phase 2 retrogressed from C-5 to F-5.

The Year 2001 - 2002 snowpack accumulation in the Pueblo Colorado watershed was estimated at 40% of normal and snowmelt discharge was very low. As a result little channel flushing occurred with Spring runoff or was previously observed during preceding three years of the study.

No new instream structures were constructed during the 2002 reporting period. All structures were maintained and were in good condition in preparation for monsoonal and snowmelt runoff seasons. Maintenance included modifications to block the proliferation or expansion of cutoff channels where possible.

For the first time since initiation of the project in 1997, channel evolution was reversed, channel length decreased, sinuosity decreased, width:depth ratios increased and entrenchment ratios decreased. Structures became less effective as cutoff channels began to evolve across meander apices. The reversal in channel evolution was primarily due to rapid aggradation of the channel due to overwhelming sand-sized bedload deposition. By the same token, streambank vegetation expanded and vigor increased, increasing streambank stability. A significant sediment plug downstream of the project area evolved raising the bed elevation of the channel.

2003 (July 2002 - June 2003)

The drought of 2001 continued through the Year 2003 reporting period. One storm event generated discharge in excess of bankfull during the 2002 monsoon season. However, as in the previous reporting period, numerous small events transported large volumes of sand-sized bedload from nearby tributaries, depositing this material in the project area, raising the bed elevation and increasing channel width. Most pools filled with sand creating a braided channel that bisected several meanders in both Reaches. This phenomenon was exacerbated by reconstruction of Highway 191 where reconfiguration of roadside drainage ditches significantly increased direct sediment loading to the project area. Additionally, expansion of a sediment plug downstream of the project area raised bed elevation of the lower 400 feet of Phase 2 Reach by about 1.5 feet. The net effect of these impacts was a further decrease in channel length, decrease in sinuosity, increase in channel slope, decrease in mean depth, increase in width:depth ratios and decrease in entrenchment ratios. Rosgen channel type remained at F-5 in both Reaches.

Year 2002 - 2003 snowpack was slightly above normal resulting in near normal snowmelt runoff during Spring 2003 although streamflow was somewhat suppressed by diversion to refill Ganado Reservoir. Even so, snowmelt discharge was sufficient to flush accumulated bedload from the study area and rejuvenated Rosgen E subreaches. Erosion of the concave bank at several structures in both Reaches tended to increase width of the flood prone area at the following sites: Reach 1 Baffles 2, 4, 5, 6 and 8, and; Reach 2 Baffles 2, 3, 4, 5, and 6A. Flushing of irrigation ditches during May raised streamflow to near bankfull levels for brief periods of time which further advanced channel development, especially in the Rosgen E subreaches wherever flood prone area exceeded 32 feet. The net result for the 2003 reporting period was that although the flood prone area widened at several locations, channel evolution was slowed or reversed with channel aggradation and the formation of cutoff channels through key meander apices.

In response to above findings, an effort was made to increase the effectiveness of instream structures. Three new post vanes were installed in the Phase 1 Reach, two during November 2002 and one during June 2003. One was installed to counter the formation of a cutoff channel, one to protect a concave bank where meander radius had reached design objectives and one to protect a pretreatment gabion structure. A major modification of Phase 2, Baffle 1 Structure was installed to attempt to repair formation of a cutoff channel which had damaged the structure.

Discussion

Fortunately return of improved moisture conditions during winter of 2002 - 2003, with near-normal snowpack has resulted in improved snowmelt runoff and a cleansing of aggraded sand deposits by saltation. Some remedial treatment in the form of baffle reinforcements and installation of post vanes to counter the evolution of cutoff channels was required. Such structures were installed on an urgent basis by volunteer workers during March 2003 and subsequently modified as needed by labor crews during May - June 2003. Although the channel was not re-measured in Spring 2003, it is apparent that channel evolution toward the Rosgen E Type was reactivated. The limiting factor in continued evolution toward the E Type appears to be limited belt width. Subreaches which have a belt width equal to or exceeding approximately 32 feet are transitioning from F or C channel type to E type. Width of evolving E channel ranges from about 7 to about 11 feet, the ratio of belt width to channel width being about 3 to 4 times channel width.

2004 (July 2003 - June 2004)

The long term drought beginning in Year 2000 continued through the report period of 2004 resulting in total loss of base flow. All residual pools dried up except the spring fed pool at the waterfalls at Wide Reed Ruin itself.

The second largest storm event of the seven year study period occurred during September 2003 reaching a crest elevation of approximately 5.8 feet in the Phase 1 Reach or about 3.3 feet above bankfull. This event eroded the concave bank opposite most deflector sites (baffles and vanes) and scoured as much as 2 feet from the streambanks, significantly widening the flood prone area in some locations such as Reach 1, Baffles 2, 4 and 8 and Reach 2, Baffles 5, 6 and 8. Conversely, the same event widened and made permanent the cutoff channels through Reach 1, Baffle 3, 7 and 9 and Reach 2, Apex 1, Apex 2, and Baffles 1 and 5 and at the NTUA Vane. Much of the NTUA meander apex was buried under a 5-foot high lateral sand bar. As a result, channel length of the Phase 1 Reach was shortened to 1,102 feet, only 28 feet longer than pretreatment, and Phase 2 to 1,602 feet, 24 feet less than pretreatment. The most significant beneficial effect was the removal of the downstream sediment plug thus allowing bed elevation to return to the pretreatment, 1998 level, and restoring the effectiveness of all instream structures west of the NTUA pipeline. Subsequent smaller events again tended to aggrade the bed east of the pipeline with sand-sized bedload deposits. As a result mean depth decreased at four of five permanent cross sections, width:depth ratios increased, entrenchment ratios decreased, sinuosity decreased and slope gradient increased. Phase 1 Reach was classified as Rosgen F-5, Phase 2 as F-5, also. Snowpack accumulations were below normal for the winter of 2003 - 2004 but snowmelt discharge and subsequent irrigation releases were sufficient to flush sediment deposits from the bed. As a result, short Rosgen E-5 subreaches redeveloped wherever the flood prone width exceeded 32 feet or about 4 times the width of the E channel. Examples included subreaches between Riffle 1 and Riffle 4 in Reach 1 and Riffle 8 in Reach 2. Following spring runoff all of Reach 2 west of the pipeline displayed E-5 channel characteristics.

3.2 - Summary of Results

From a casual review of Table 1 it would appear as if the induced meandering experiment at Pueblo Colorado Wash had proven a failure. By the end of the second study period, the term of AWPF Grant 00-104, only three of the various management objectives had been realized; bankfull width of both Phase 1 and Phase 2 Reaches and Rosgen Channel Type of the Phase 1 Reach.

However on closer examination such a conclusion might judge present results to harshly. The Phase 1 Reach has evolved from Rosgen G channel with an average width of only 12 feet to an F channel with a

average width of 31 feet and an even wider flood prone area. Portions of the Reach show a persistent tendency to evolve to Rosgen E when conditions are favorable.

3.3 - Discussion

Failure to achieve Management Objectives for Phase 1 Reach was caused primarily by the development of cutoff channels through Baffle 3, 7 and 9 meanders. This failure was due to excessive bedload aggradation beginning with the onset of the 2000 - 2001 drought cycle which happened to coincide with the initiation of the current study, AWPF-00-104. Formation of these three cutoff channels not only shortened channel length but also reduced shear stress in the near bank region at the base of the concave banks at these locations. Reduction in shear stress curtailed erosion of these banks and permitted rapid growth of protective vegetative cover that improve streambank stability at these sites. This further slowed channel evolution toward meeting the stated objectives.

All structures in Phase 1 Reach were buried under accumulating bedload either as evolving point bars or as bed deposits especially during 2001. It was assumed at that time that those structures had served their purpose and the decision was made not to elevate or extend them further. This decision, in retrospect, not only precluded any further widening of the flood prone area or extension of channel length it facilitated the development of cutoff channels that ultimately reversed favorable trends initially observed during the first four years of the study (1997 - 2000). Had streamflow conditions remained similar to the earlier period, 2001 - 2004, results might have been different. Similarly, had these three structures been aggressively modified to control formation of cutoff channels, it is likely that the channel would have lengthened and that the flood prone area would have widened sufficiently to permit evolution of an E-5 channel.

Conditions in the Phase 2 Reach were more variable than at the onset of the project than in Phase 1 and results have been more variable following treatment. Additionally, treatments were constrained by infrastructure (bridge and pipeline), livestock grazing, and compromised by outside events beyond control of management (highway influences, sediment supply). The pretreatment Channel Type was Rosgen F, the post-treatment channel remains F except that the western subreach has evolved to a stable E type. Again, progress toward meeting management objectives was compromised by channel aggradation and the formation of cutoff channels through newly evolved meander loops.

The implications of the above observations are that:

1. Channel evolution apparently reverses during drought cycles.

2. The original management objective of establishing a Rosgen Type C channel type may have been too conservative. Perhaps objective should be E. Apparently channels can progress from F to E without the intermeding type C.

3. Structure repairs, modifications and extensions should aggressively pursue widening the belt width beyond 32 feet in order to facilitate evolution of E-5 channel type.

Geomorphological Monitoring and Instream Structure Installations

Final Report

July 2004

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Executive Summary

Pueblo Colorado Wash at Ganado, Arizona, is a tributary to the Little Colorado River, draining southwesterly from the Fort Defiance Plateau on the Navajo Indian Reservation. The Project Area is located on Hubbell Trading Post National Historic Site. Efforts to restore the wash to a productive riparian area began on a volunteer basis in 1997, and the project was first funded beginning with the 1998 field season under Arizona Water Protection Fund Grant 97-029. The project was extended for three years (2001-2003) under AWPF Grant 00-104.

Within the project area the wash is approximately one-half mile long. Prior to treatment it was grazed year long by trespass livestock, dominated by exotic woody vegetation, mainly Russian Olive and Tamarisk, had been ditched and straightened for flood control purposes, was intermittent in flow, and deeply incised with low sinuosity. The watershed is in poor hydrologic condition with a downward trend due to long-term overgrazing, a proliferation of low standard roads, and replacement of native grasslands by woody shrubs. Hydrologic condition appeared to worsen during project period.

A new method of stream channel restoration called "induced meandering" was first applied on a pilot basis at the project area. The purpose of the project was to determine if simple instream structures built by hand from native materials could be used to restore an incised, or gullied, channel to a properly functioning stream with channel width, slope, meander pattern and sinuosity appropriate to the landform. If so, such a method might be useful in treating other gullied river systems throughout the Southwest on a cost-effective basis.

Initial results were promising and the induced meandering method seemed effective in halting channel incision, increasing channel width and sinuosity, reestablishing a flood plain, restoring perennial flow to an intermittent system, and creating favorable substrates for reintroduction of native vegetation. Techniques and results obtained are described in this paper. In brief, channel width doubled from 11 to 23 feet, and thalweg length increased by 467 feet from 2,700 to 3,167 feet, sinuosity increased, channel slope decreased by 20%, a floodplain has developed and 19 naturally sustaining permanent pools evolved where only 3 were present at the start of the project. The channel continued to evolve toward a dynamically stable form with a decreasing need for maintenance and modifications of structures.

The induced meandering method employs two basic structures to modify channel shape and control channel slope. These include deflectors, called baffles and vanes, which deflect stream flow and riffle-weirs which control bed elevation and channel slope. Structures are sized in proportion to the cross sectional area of the channel at bankfull discharge and spaced at proper intervals to induce formation of the desired meander pattern. Vegetation is planted or removed at strategic points to retard or stimulate erosion or deposition of bank materials at desired locations and to expedite channel formation. Various structure designs were tested to develop structures having sufficient shear-stress resistance to withstand flow velocities in excess of bankfull discharge and of the proper shape to initiate aggradation of be materials in the desired amounts and locations.

Implementation of the present grant, AWPF 00-104 coincided with the onset of a worsening drought cycle resulting in a reversal in favorable trends reported above. Although channel width continued to increase, channel length and sinuosity decreased returning to pretreatment levels in the Phase 2 Reach. There was a steady rise in bed elevation and a continued expansion of floodplain and in the extent, diversity and vigor of riparian vegetation.

Chapter 1 - Introduction

1.1 - Site Background and History

Pueblo Colorado Wash at the project location was a deeply incised, highly entrenched, intermittent channel having a low width:depth ratio, moderate slope, and cohesive banks armored by dense stands of Tamarisk and Russian Olive. Year-long grazing prevented establishment of native riparian vegetation. The watershed was in poor hydrologic condition with a downward trend due to long-term overgrazing, the proliferation of improperly drained, low standard roads, increasing suburban development and invasion of native grassland by woody trees and shrubs. These impacts have contributed to increasingly severe and more frequent flood events.

In order to provide flood protection to the Trading Post, the Park Service in 1980 erected a flood wall of gabion baskets and straightened the channel. Bed control structures were installed to prevent downcutting of the channel, but these structures failed soon after installation. As a result the channel dropped, becoming even more incised. The stream side and channel bed were littered with rock, concrete rubble and other debris left over from the channel straightening and construction activities.

Beginning in 1997 the Park Service initiated restoration of the Wash for a variety of reasons including historic, ecologic, esthetic, scenic, recreational and flood control benefits.

During the interim since 1980, the science of fluvial geomorphology has progressed steadily in developing a better understanding of fluvial processes, classifying channel types, predicting channel evolution based on the stream environment and watershed trends, and developing management tools and predictive models. Such advances are well described in the recent literature in such works as *A view of the River* by Luna Leopold and *Applied River Morphology* by Dave Rosgen.

River restoration has steadily advanced with new techniques utilizing soft engineering and bioengineering practices in lieu of hard practices such as concrete walled channels, rock and wire baskets, rock mattresses and similar methods. One new approach has been to reconstruct damaged or degraded channels in the form, dimension, pattern and profile that would be expected to occur in that landform setting based upon comparisons with a reference channel or channels. Such reconstructed channels are excavated using heavy equipment, shaped and stabilized using a variety of structures built of natural materials and revegetated using native plant materials. When rebuilt, the channel is expected to function in a normal fashion for the expected stream type with neither excessive degradation nor aggradation of the bed or stream banks through the full expected range of runoff events and flood stages.

While reconstruction has proven highly successful, it relies on the use of heavy equipment which is expensive to operate and imported materials which can be costly to obtain. At Hubbell Trading Post it was decided to experiment with an alternate method using simple, hand-made structures, naturally occurring materials gathered from on-site sources and the power of flowing water to recreate a new channel. The Project would be designed using evolving concepts and principles of river morphology as described in the above-referenced works of Leopold and Rosgen.

1.2 - Statement of the Problem

Within the boundaries of Hubbell Trading Post National Historic Site, Pueblo Colorado Wash project area was a deeply incised, intermittent channel approximately one-half mile long (2,600 feet). The project area was characterized by two reaches: The upper reach was about 1,076 feet long, 12 feet wide, incised from 8 to 12 feet and it was still downcutting into cohesive clay banks. Its bankfull discharge was about 180 cubic feet per second (cfs) and it carried a heavy bedload of sand originating from upstream sources. The start of the reach was bounded by a natural waterfall about 8 feet high cut into limestone of the Chinle Formation. It was fed by a spring providing some perennial flow with a discharge rate of 0.2 cfs. This reach had been straightened artificially and had a valley length of 1,042 feet (sinuosity 1.04). The upper reach was characterized as a Rosgen G-6 channel type. The lower reach was about 1,626 feet long with a valley length of 1,436 feet and a sinuosity of 1.13. It was less entrenched with a channel width of 22

feet, and incised within alternately cohesive clay banks or less cohesive sand and gravel banks. Although not altered by channel excavation, it had been affected by increased discharge velocities and rubble washed downstream from the construction site. The channel was impacted by two utility crossing structures, an abandoned road bridge and a sewer pipeline. The channel displayed four fairly well developed meander apices and streambanks were well armored by woody roots of Tamarisk and Russian Olive. The channel was characterized as Rosgen F-5 channel type and was degrading at mid-length to G-5 due to headcutting action moving upstream from the vicinity of the sewer line crossing.

The overall problem was to stop downcutting in both reaches and to stimulate lateral erosion or extension of the channel banks which would ultimately result in creating sufficient space for an evolving floodplain and a dynamically stable channel condition in which bank erosion would be offset by sediment deposition and bank building processes.

1.3 - Project Goals and Objectives

The project concept was to recreate a dynamically stable channel using induced meandering concepts and technology.

Induced meandering is a new concept for the treatment of incised channels which utilizes the power of running water and the adaptability of native vegetation to reshape and recreate channels in a geomorphologically stable form. In-stream structures are used to redirect channel-shaping flows and control channel slope while streambank vegetation is manipulated to either promote or retard streambank erosion or deposition, thereby accelerating natural channel forming processes that eventually lead to the reconstruction using mechanized equipment, to "hard" engineering practices, and to the use of check dams in stream channels that do not evolve as step pool systems. Each method has its own advantages and limitations, a discussion of which is not the purpose of this report. The principal limitations of induced meandering are the time and uncertainty of relying upon future discharge events to reshape the channel as planned and having the confidence and patience to await predicted results.

Incised channels include Rosgen G and F channel types entrenched within alluvial valleys where the expected mature channel might be a B, C or E type. Under the Rosgen classification system, G and F channels are highly entrenched types having no floodplain, but B, C and E channels have floodplains of increasing widths and decreasing slope gradients where flood energies are dissipated and deposited sediments sustain diverse riparian plant communities and an alluvial water table.

Within the project area specially designed deflectors, called baffles and vanes, were installed in the appropriate configurations and spacing intervals to induce the steam to meander back and forth across the incised channel generating a sine wave of the proper wavelength (meander length) and amplitude (belt width) to create a dynamically stable channel appropriate to the landform.

Baffles are designed to deflect stream current toward the opposite bank and to be readily overtopped by flood flows exceeding bankfull stage. Deflection of the current accelerates flow velocities and directs stream energy toward the base of the opposite bank. The resulting increase in shear stress erodes the channel bank and undercut the opposite bank resulting in formation of a scour pool and subsequent sloughing or collapse of the opposite bank. As the bank collapses, the meander radius increases with a further increase in flow velocities due to increasing centrifugal force. Meanwhile, flow velocities decrease across the surface of the baffle causing bedload and suspended sediments to be deposited upstream, downstream and across the surface of the structure, resulting in point bar formation. Keeping the surface of the baffle at or below bankfull elevation promotes streaming flow and minimizes eddying that would scour away potential deposits. As the opposite bank erodes, the center of flow shifts in that direction further reducing velocity over the surface of the baffle and evolving point bar. It is important that the baffle be stout enough to resist the increasing shear forces associated with increasing flood depths and accelerating velocities.

While using deflectors to generate a meandering channel, it was also necessary to control the channel bed elevation and slope gradient. Grade control was accomplished by using riffle-weirs. The assumption was that bank materials eroded or scoured from the receding banks would be deposited and retained on evolving point bars and as riffles downstream from the point of scour. Ultimately the point bars would evolve into a floodplain. Structure design was in keeping with the project philosophy of using only native materials, hand labor, and hand tools for construction.

Riffles or riffle-weirs are designed to control channel bed elevation and pool depth while maintaining a constant channel slope gradient and unobstructed passage of the bedload. Riffle weirs were installed midway between baffles at the meander crossover point and were oriented with the anticipated future course of the channel as it approached the next downstream baffle. Riffle weirs averaged one half mean depth in height and were equal in length to one half bankfull width of the channel. Initially riffle-weirs were constructed solely of rock, but with experience weirs were stiffened with the addition of wooden stakes or pickets to increase resistance to shear stress forces.

The challenge, then, was to determine appropriate channel dimensions, meander pattern and profile for the created channel by modeling an apparently stable reference reach elsewhere in the watershed. A reference reach on Navajo Reservation lands about 1/4 mile upstream from the project area was selected, measured and characterized. This site was selected as the only relatively stable reach between the bankfull (channel) width, 28 feet; mean depth, 1.5 feet; width:depth ratio, 18:1, entrenchment ratio, 2.20:1; bed material, sand; sinuosity, 1.3; and Rosgen Channel Type, C-5. Meander length was set at 310 feet (Table 1).

Because the reference reach was incised into sandy banks, but the project channel was incised into cohesive clay banks which would better resist erosion, the meander length was calculated by multiplying channel width by 11. The accepted ratio of meander length to channel width ranges from 10 - 14 with the lower multiple used for more cohesive, erosion resistant banks and the larger applied to less cohesive banks. The factor of 11 was arbitrarily selected from the lower end of the range yielding an objective of 310 feet for meander length. The projected channel length was determined by multiplying valley length by sinuosity (2478 x 1.3 = 3221) and rounding off to 3,200 feet. The objective for slope gradient was determined by dividing change in elevation by channel length objective (14 feet ÷ 3200 feet) = .44. The project goal was to realize the above objectives within three years, but with no prior experience, in use of the "induced meandering" method, there was no real basis for the time frame.

It was assumed that modest structures would be installed at the start to initiate the meander process and that subsequently the structures would be modified and enlarged in pursuit of project objectives as the channel responded, but the timing, rate and extent of future alterations was not known. Monitoring of structure performance and channel response would provide information needed to trigger structure modification and maintenance actions. It was further assumed that structures would need to be in good repair at the onset of winter in preparation for spring snowmelt runoff and again by late June in preparation for the summer monsoon period.

Under AWPF Grant 00-104 structures were maintained in good repair in advance of the monsoon season and in advance of snowmelt, however, structures which had become imbedded in streambed or banks were not unearthed or disturbed. Structures were monitored in "as is" condition if discernable.

Table 1 - Pueblo Colorado Wash Channel Geometry
(Response to Treatment, 1998 - 2003)

Parameter	Management Objective	Pre-treatment - June 1998			Post-treatment November 2000			Post-treatment October 2003		
		Phase 1	Phase 2	Total	Phase 1	Phase 2	Total	Phase 1	Phase 2	Total
Bankfull Width (ft)	28	12	22	–	21	23	–	31	30	30
Mean Depth (ft)	1.5	2	1.5	1.5	1.5	1.5	1.5	1.1	1.1	1.1
Width:Depth	18:1	5:1	15:1	–	14:1	14:1	14:1	28:1	28:1	28:1
Entrenchment Ratio	2.20:1	1.21:1	1.27:1	–	Variable	2.80:1	Variable	1:1.51	1:1.23	–
Channel Length (ft)	3,200	1,074	1,626	2,700	1,466	1,701	3,167	1,102	1,602	2,704
Valley Length (ft)	2,478	1,042	1,436	2,478	1,042	1,436	2,478	1,042	1,436	2,478
Sinuosity	1.3	1.04	1.13	1.09	1.41	1.18	1.28	1.06	1.11	1.09
Meander Length	310	215	232	225	293	243	263	220	228	228
Channel Slope (%)	0.44	0.62	0.46	0.53	0.41	0.47	0.43	0.70	0.46	0.55
Pebble Count (Bed/Bank)	Sand/Clay	Sand/Clay	Sand/Clay	Sand/Clay	Sand/Clay	Sand/Clay	Sand/Clay	Sand/Clay	Sand/Clay	Sand/Clay
Rosgen Channel Type	C-5	G-6	F-5	F-5	F-5?	C-5	C-5	F-5	F-5*	F-5

* Lower 400 feet, E-5

Chapter 2 - Methods of Investigation

2.1 Monitoring

Because this was a pilot project in the development of induced meandering technology, careful monitoring was an essential aspect of project management. Monitoring included periodic re-measurement of channel dimensions and structured performance as well as photographing and rephotographing a predetermined grid of 13 permanent photo points including 25 views. The AWPF protocol/or photo monitoring plan was closely followed. Photo points were rephotographed semi-annually during late May following spring snowmelt runoff and during late October following the summer monsoon season. Additionally, all structure sites were individually photographed pre-treatment, upon completion, and annually thereafter to monitor performance and maintenance activity. A map of permanent photo point locations is included as Figure 1a and Figure 1b. Structure dimensions and channel responses were re-measured semi-annually concurrent with photo monitoring activities. Re-measurement included length, width, height of structures and width of channel at structure sites. Notes were made and kept regarding success or failure of structures relative to shear-stress, flood stage, channel features, revegetation success and other factors with suggestions for improvement.

In order to document the occurrence and distribution of pools, a sketch map of pool locations was prepared each June during minimum stream flow periods.

Results of findings were correlated with flood stage information gathered at the Crest gage station by Navajo Water Management Branch.

2.2 - Channel Geometry

Channel geometry was characterized in the pre-treatment stage, during 1997 for Phase 1 and 1998 for Phase 2, and re-measured semi-annually as per the approved monitoring plan. The following protocols were observed while conducting measurements:

Channel length was measured to the nearest foot along the thalweg, initially by tape and subsequently by GPS plotting at a scale of 1:2400 using the Trimble Pathfinder Program. Channel length was re-measured annually following the monsoon season. Under AWPF 00-104, longitudinal profiles were produced annually during October from 2001 through 2003.

Channel width or bankfull width was measured to the nearest tenth foot by tape measure stretched at right angles to the channel between left and right bankfull indicator marks at the meander crossover (riffle). Average bankfull width for the reach was determined by averaging all riffle locations; Phase 1, 9; Phase 2, 13. Five permanent cross sectional profiles were established and re-measured during October 2001 through 2003.

Mean depth was calculated by multiplying maximum depth, in tenths of a foot, at bankfull stage, by 0.6.

Elevations were measured to nearest 0.1 foot using an assumed datum and benchmark. Elevations were first measured using a hand level and/or a builders transit, however serious errors were noted in year 2000 when elevations were re-measured by laser level. To correct earlier discrepancies, early data have been adjusted to agree with laser measurements.

Meander length to nearest foot was measured along the thalweg between natural meander apices or between artificial apices if established by the installation of deflectors.

Valley length was measured to nearest foot between the start and end of the Phase 1 and Phase 2 reaches and summed as two segments to determine total valley length.

Width:depth ratio was computed by dividing bankfull channel width by mean depth.

Figure 1a: Hubbell Trading Post National Historic Site, Pueblo Colorado Wash, Permanent Photo Point Locations, Phase 1 Reach

(Figure 1a) HUBBELL TRADING POST NATIONAL HISTORIC SITE

PUEBLO COLORADO WASH, PHASE 1 REACH.

PERMANENT PHOTO POINT LOCATIONS.

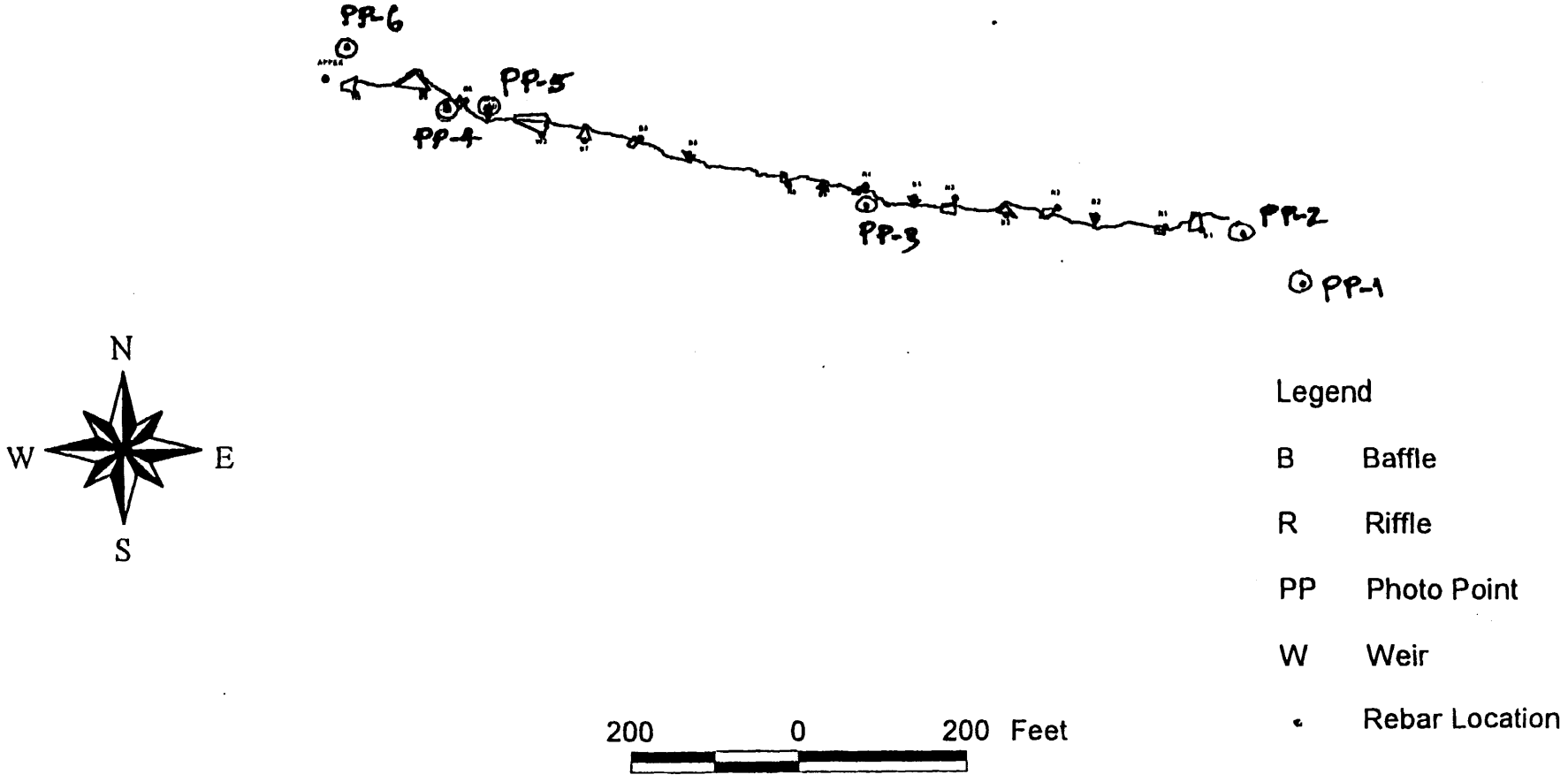
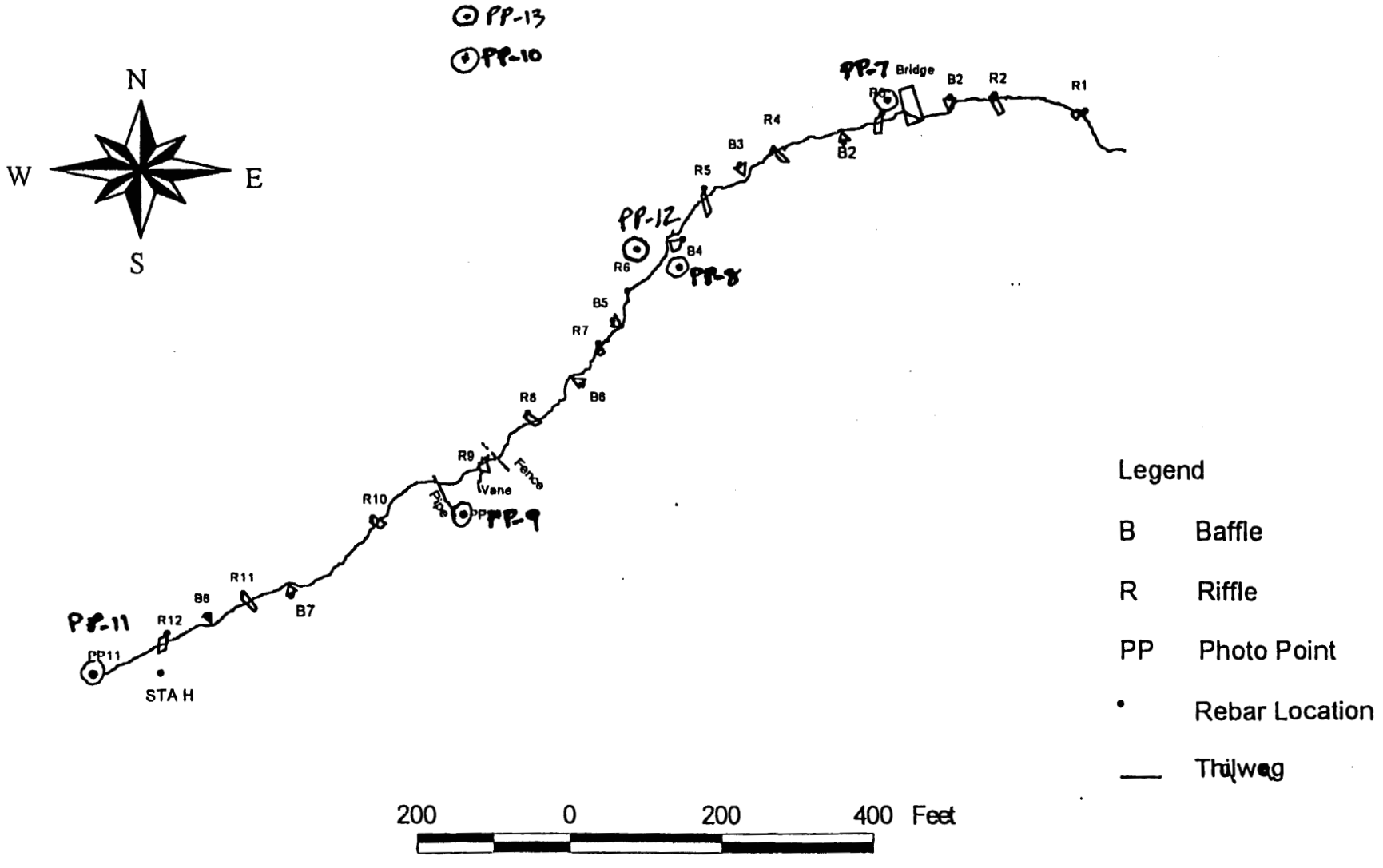


Figure 1b: **Hubbell Trading Post National Historic Site, Pueblo Colorado Wash, Permanent Photo Point Locations, Phase 2 Reach**

(Figure 1b) HUBBELL TRADING POST NATIONAL HISTORIC SITE
PUEBLO COLORADO WASH, PHASE 2 REACH.
PERMANENT PHOTO POINT LOCATIONS.



Entrenchment ratio was determined by doubling maximum depth to establish flood prone width, then dividing flood-prone width by bankfull width.

Pebble counts were not conducted, particle size class was estimated ocularly.

2.3 - Structure Measurements

A protocol was developed to standardize structure measurements. Photographs of typical structures and sitings appear in Appendix II. Drawings of typical structures and spacing intervals are appended as Appendix III. By 2001, due to accumulating bed and bank materials, many structures were no longer visible and structure dimensions were not discernable. Where discernable dimensions were measured to the nearest foot.

Deflectors

Baffle length was measured horizontally to nearest 0.1 foot along the adjacent bank parallel with channel length at bankfull mark.

Baffle width was measured horizontally to nearest 0.1 foot from base to tip parallel with channel width. A rebar pin was set at the bankfull mark to standardize this measurement.

Baffle height was measured to nearest 0.1 foot above thalweg.

Vane length was measured parallel with channel length to the nearest 0.1 foot.

Vane width was measured to nearest 0.1 foot from bankfull mark to upstream tip of structure parallel with channel width.

Vane height was measured to 0.1 foot above thalweg.

Riffle-weirs

Length of riffle-weir was measured to nearest 0.1 foot parallel with channel length.

Width of riffle-weir was measured to nearest 0.1 foot parallel with channel width.

Height of riffle-weir was measured above thalweg to nearest 0.1 foot.

Rosgen Channel Types conform to protocols established in Chapter 5. Applied River Morphology, except that pebble counts were not conducted. Pebble counts were not conducted due to the overwhelming dominance of sand on the bedload composition. Larger particles were introduced artificially, and consisted of cobble or boulder sized materials introduced during the 1980 flood control project or with the present project. Coarser particles of natural origin accumulated only in the lower 400 feet of the Phase 2 Reach.

Chapter 3 – Results and Discussion

3.1 – Channel Response to Treatment

Annual and Cumulative Effects

1997 Phase 1 Initial Treatment

Initial treatment using induced meandering concepts began in June 1997 and was completed in July. Channel dimensions, pattern and profile were modeled after a reference reach located ¼ mile above Hubbell Trading Post boundaries on Navajo Reservation. Based on reference parameters, management objectives were set at: channel width, 28 feet; mean depth, 1.5 feet; width:depth ratio, 18:1; meander length, 310 feet; channel slope, 0.62%; sinuosity, 1.3. Reference channel was a Rosgen C-5 type with a sand bedload but with cohesive clay banks.

Eighteen instream structures were installed during June and July 1997 consisting of 9 Baffles and 9 Riffle-weirs comprising 4.5 meander lengths. Structures were numbered from east to west in a downstream direction with odd number structures on the left bank and even numbered on the right. Phase 1 structure locations are displayed in Figure 2.

No bankfull events occurred during the summer or fall of 1997, but several lesser events occurred initiating channel evolutionary processes. The most significant initial response was a gradual wetting of the toe of the stream banks, especially the left bank due to exposure to pooled water stored behind riffle-weirs. As the wetting spread upward through capillary action, extensive cracks developed along the left bank parallel with the channel opposite Baffles 2 and 4. Some minor sloughing occurred during October 1997, widening the channel by one to two feet in a few places. Simultaneously, small point bars began to form adjacent to Baffles 2, 3, 4, 5, 8 and 9. Some sloughing also occurred opposite Baffle 9. By the time treatment was initiated in 1998 under APWF Contract 97-029, channel width had increased to 12 feet. Initial maintenance during the Fall of 1997 consisted of removing root wads and debris from the channel.

1998 Phase 1 Reach

Snowpack in the Pueblo Colorado Wash watershed during the spring of 1998 was more than 400% of normal. Snowmelt discharge began in February and persisted through April with a discharge on the order of 150 cfs or near bankfull. Significant channel downcutting occurred with two headcuts in evidence. The first proceeded upward from Baffle 3 to Baffle 1, the other from Baffle 9 to Baffle 7 with a depth of 2.5 feet.

Significant bank sloughing occurred opposite Baffles 2, 4 and 9, widening the channel from 1 to 2 feet but root wads within the slumped materials blocked the channel thereby reducing beneficial results and damaging Baffles 2, 3, 4, 5 and 7. It was not possible to remove root wads until snowmelt runoff subsided. Shear forces associated with these floods and eddying around root wads damaged some structures by plucking rocks and rubble from the outer 1-3 feet of the tips of the baffles and scouring channels through some riffles.

As required by Task 5 of AWPG Grant 97-029, all Phase 1 structures were re-measured and evaluated to assess the effects of 1998 snowmelt runoff as the basis for planning maintenance and modifications of Phase 1 structures and the installation of Phase 2 structures (Task 6).

Maintenance and modification of Phase 1 structures began in May 1998 and were completed in June. All structures were modified using rock and concrete rubble from on-site sources. To increase erosion resistance, structures were edged with sod plugs of rooted aquatic herbaceous vegetation, mainly American three square (Scirpus americana), which was readily available from the streambank and floodplain. Upon project completion, all structures were photographed and measured to document dimensions. On July 29, 1998, overbank flooding occurred, with a discharge of 800 cfs (5 times bankfull). Although most structures were damaged, channel response was significant.

Two important aspects of the channel evolutionary process became apparent at this time: First, the rapid growth of dense Scirpus sod mats on point bars, riffles and lateral bars that increased channel roughness, trapping large quantities of bed load and accelerating bank development on the inside bank and second, the ability of Scirpus to rapidly re-colonize new bed load deposits, and grow up through bedload deposit when covered by sediments.

1998 Phase 2 Reach

Phase 2 structure locations are displayed in Figure 3. Construction in Phase 2 Reach began in June 1998 and was nearly completed in late July when hit by the July 29 flood (800 cfs, or five times bankfull). All rock and rubble structures were damaged; some were destroyed. Baffles constructed of rock and rubble did not have sufficient resistance to withstand shear forces associated with this event. As a result, structures were re-designed and modified to increase their resistance to shear stress. Modifications consisted of adding wooden pickets (stakes) and/or wicker (stakes with interwoven tree boughs) to the margins and interior of baffles and of replacing rock only riffle-weirs with low rock and wicker weirs. Wicker weirs were built to extend from 6 to 8 inches above bed elevation and equal to channel width in length and comprised of 3 to 5 parallel wicker placements. Reconstruction was completed by September and all structures in both reaches were in good repair going into the winter of 1998-99.

1999 Both Reaches

Snowpack was near normal for the winter of 1998-99. Little or no channel degradation occurred during spring snowmelt runoff. All structures received routine maintenance during May and June and were in good repair at the onset of the monsoon season. The condition of all structures was assessed by the consultant and specific maintenance needs or modifications were prescribed and documented by structure. Fourteen pools scoured by snowmelt runoff contained water throughout the low flow period of May and June.

An epic flood occurred August 28, 1999 with a maximum stage at 11 feet where bankfull stage is 1.5 feet (estimated discharge, 9000 cfs). More than half of structures were destroyed or severely damaged. Most structures were replaced or repaired by November 1999. Again maintenance was prescribed and documented by structure. Those not replaced or repaired in Phase 1 Reach included Weir 1, Baffle 1, Baffle 6, Baffle 7, and Weir 2; and in Phase 2 Reach, Baffle 3, Riffle 5, Riffle 6. Significant channel aggradation had occurred in Phase 2 Reach west of Baffle 4, but the channel had degraded between Baffle 2 and Baffle 4 with the subreach evolving from a Rosgen C to a Rosgen G type channel.

Channel length and sinuosity decreased in both reaches and bankfull indicators were obliterated making re-measurement of channel width difficult during the October monitoring cycle.

2000 Both Reaches

Snowpack was less than normal during the winter of 1999-2000 with low snowmelt discharge. Structures were unaffected by snowmelt runoff with only minor repairs required. The decision was made to make major modifications of all structures that had not performed well or had not been replaced following the August 28, 1999 event. As a result, the following adjustments were made to Phase 1 Reach: Weir 1 was abandoned. Baffle 1 was moved 30 feet downstream and labeled B-1a; Baffles 6 and 7 were removed and replaced with Post Vanes and the damaged portion of Weir 2 was replaced with a wicker weir. In Phase 2 Reach, Riffle 4 was moved 30 feet upstream, Riffle 5 was raised, Baffles 2 and 3 were replaced as Post Vanes, Riffle 8 was relocated upstream and replaced by a Post Vane, the 1997 concrete Vane was supplemented with a picket baffle, a new picket baffle was added at Apex 4 and a new Post Vane was installed west of Riffle 12. All structures were in good repair for the year 2000 monsoon season.

Two overbank events occurred during July 2000. All structures performed well without damage and channel response was significant adding about 300 feet to channel length. All structures were maintained and in good repair prior to the Winter of 2000-2001.

Figure 2: **Structure Locations and Status, Phase 1, May 19, 2004**

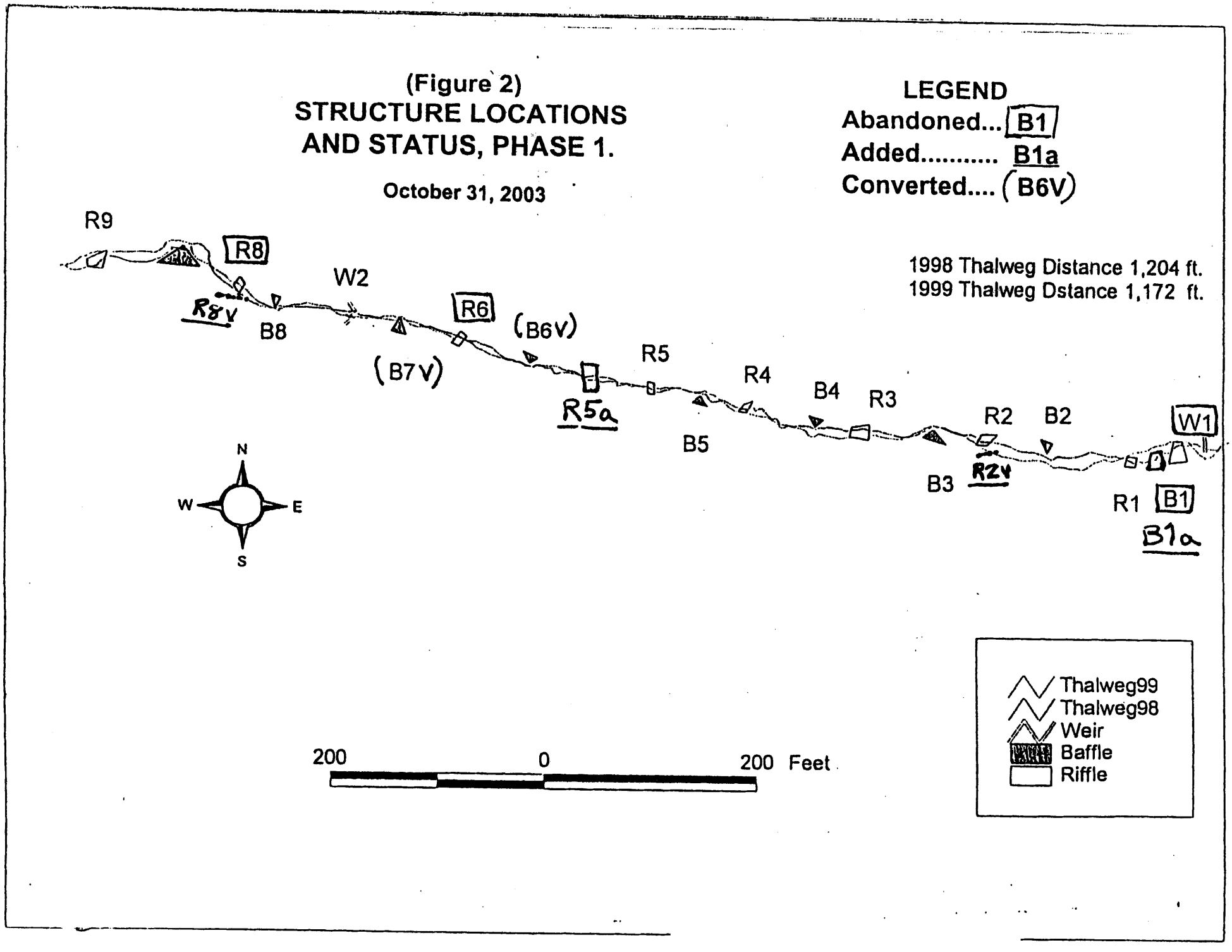
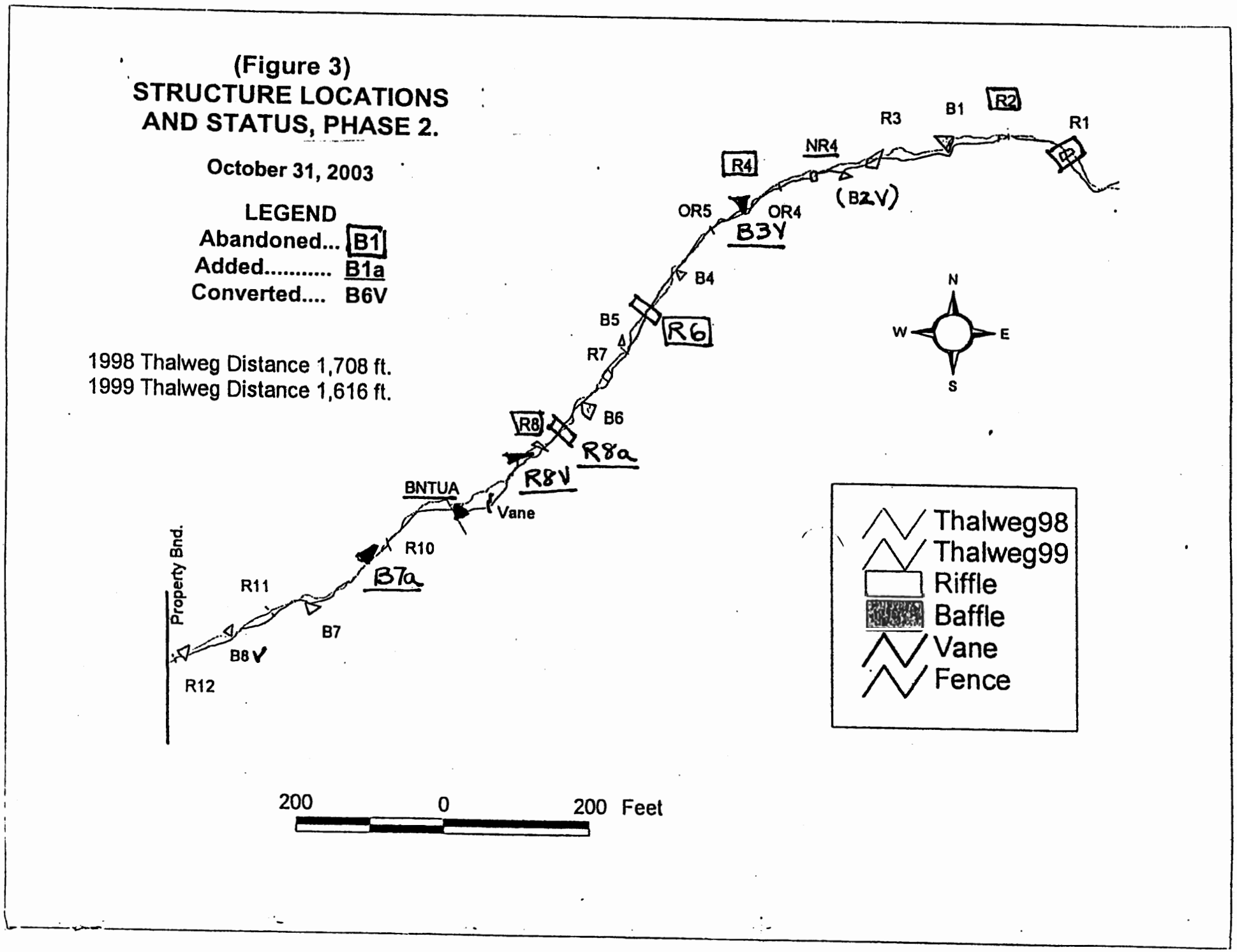


Figure 3: **Structure Locations and Status, Phase 2, May 19, 2004**



The yearly status of all structures, by Reach, as of November 1st annually, is displayed in Table 2 and Table 3.

Changes in structure dimensions with measurements of bankfull channel widths are displayed in Table 4 and Table 5.

3.2 - Summary of Results

1998-2000 (AWPF 97-021)
Results are displayed in Table 1. In summary, change in channel morphology was more dramatic in the Phase 1 Reach where channel length increased from 1,074 to 1,466 feet (Figure 4), channel width increased from 12 to 21 feet, sinuosity increased from 1.04 to 1.41, channel slope decreased from 0.62 to 0.41% and meander length increased to 293 feet. Change in channel widths in response to structure installations is displayed in Tables 4 and 5. An obvious floodplain up to 35 feet wide has evolved in the upper 400 feet where no floodplain existed prior to treatment. One permanent pool was present in the Phase 1 Reach prior to treatment, but 9 pools were present through the year 2000 low flow period. Flood prone areas are well stocked by vigorous stands of Scirpus and an increasing diversity of other herbaceous riparian species. Overall the Rosgen channel type is F-5 with 2 short subreaches of Type E channel and one residual subreach of G. If the present trend continues, the entire reach is expected to evolve to Type E-5 within the next three years.

Changes in Phase 2 Reach were more variable and less dramatic. Channel length increased from 1,628 to 1,701 feet (Figure 5), channel width increased slightly to 23 feet, sinuosity increased from 1.13 to 1.18, channel slope decreased slightly and meander length increased from 232 to 243 feet. The channel type evolved from F-5 to C-5, however, a short subreach of Type G channel evolved between Riffle 3 and Riffle 6 in response to headcutting activity. The number of permanent pools increased from 2 to 10 and the distribution and abundance of Scirpus and other native riparian vegetation expanded, although less dramatically in the area open to livestock grazing prior to August 1999.

3.3-Discussion

The cooperators are well pleased with the obvious success of the project especially in the Phase 1 Reach. The rate of change has far exceeded expectations. Although, the project has not been without its problems, adaptive management has resulted in changing the design, construction, and placement of structures and structure types. These modifications have accelerated the rate of channel evolution and proven the effectiveness of the induced meandering concept.

The most significant setback occurred on August 28, 1999 when a summer storm generated a peak discharge of about 9,000 cubic feet per second and water depths of 11 feet above bankfull stage. More than half of in-stream structures were destroyed. Channel straightening and new waves of headcutting activity occurred. Planted cottonwood and willow cuttings were 97% destroyed. Developing beds of Scripus were buried under deep layers of bedload. Almost all structures had to be rebuilt or relocated and a few were abandoned. However, in hindsight, this storm set the stage for the rapid changes in channel characteristics that evolved during year 2000 and in retrospect proved highly beneficial. Channel response to the August 28 storm was enabled by changes in channel configuration that resulted from the initial in-stream structures. For example, large volumes of bedload with particles up to ½ meter in diameter were deposited on point bars initially formed by the first baffle installations. Additionally, the 1999 storm broadened the evolving floodplain and lowered channel banks which further improved the entrenchment ratio.

The greatest problem encountered in the design and performance of baffles and riffle-weirs was their incompetence to withstand the high shear stress associated with high flow velocities at greater than bankfull stage. Initially, structures were built of loosely paced boulders and cobble sized materials arranged in arrowhead shaped form that protruded outward from the bank to mid-channel. Although this type structure could withstand less-than-bankfull events, larger events washed away all but those boulders closest to the bank. This problem was solved by replacing rock baffles with stakes or pickets.

Table 2
Status of Structures
Phase 1 Reach

Site	2000	2001	2002	2003	Planned Maintenance 2003	Planned Maintenance 2004
W-1	A	A	A	A	None	None
B-1	A	A	A	A	None	None
B-1a	R&P	R&P	R&P	R&P	None	None
R-1	R	R	R	R	None	None
B-2	R	R&P	R&P	R&P	Add Pickets	None
R-2	R&W	R&W	PV	PV	None	None
B-3	R&P	R&P	P&P	A	Add Pickets	None
R-3	R&W	R&W	R&W	R&p	None	None
B-4	R&P	R&P	R&P	R&P	Add Pickets	None
R-4	R&W	R&W	R&W	R&W	None	None
B-5	R&P	R&P	R&P	R&P	None	None
R-5	R&W	R&W	R&W	A	None	None
B-6	A	A	A	A	None	None
B-6a	PV	PV	PV	PV	Add Posts	None
R-6	A	A	A	A	None	None
B-7	PV	PV	PV	PV	None	None
W-2	R&W	R&W	R&W	A	None	None
B-8	R&P	R&P	R&P	R&P	None	None
R-8	A	A	PV	PV	None	None
B-9	R&P	R&P	R&P	A	None	None
R-9	SS	SS	SS	SS	Add Post Vanes	None

Table 3
Status of Structures
Phase 2 Reach

Site	2000	2001	2002	2003	Planned Maintenance 2003	Planned Maintenance 2004
Apex 1	SS	SS	SS	SS	None	None
R-1	SS	SS	SS	SS	None	None
Apex 2	SS	SS	SS	SS	None	None
R-2	A	A	A	A	None	None
B-1	R&P	R&P	R&P	R&P	Add Pickets	Add Pickets
R-3	R&W	R&W	R&W	R&W	None	None
B-2	PV	PV	PV	P	Install Baffle	Add Pickets
R-4	R&W	R&W	R&W	R&W	None	None
B-3	PV	PV	PV	PV	Add Posts	None
R-5	R&W	R&W	R&W	R&W	None	None
B-4	R&W	R&W	R&W	R&W	None	None
R-6	SS	SS	P	P	Add Pickets	Add Pickets
B-5	P	P	P	P	None	None
R-7	R&W	SS	SS	SS	Add Pickets	Add Pickets
B-6	R&P	R&P	R&P	R&P	Add Posts	Add Posts
R-8	R&W	SS	SS	SS	None	None
Vane	PV	PV	PV	PV	None	Add Posts
Apex 3	SS	SS	SS	SS	None	None
R-9	SS	SS	SS	SS	None	None
Vane	P	P	P	P	None	None
B-NTUA	R	R	A	A	None	None
R-10	R&W	R&W	R&W	R&W	None	None
B	P	P	P	P	Add Pickets	None
Apex 4	SS	SS	SS	SS	None	None
B-7	P&P	R&P	P&P	R&P	Add Pickets	None
R-11	R&W	R&W	R&W	R&W	None	None
B-8	P	P	PV	PV	Add Posts	Add Posts
R-12	R&W	R&W	SS	R&W	None	None
Vane	PV	PV	PV	PV	None	None

Table 5
Change in Channel Width, Phase 2 Reach
Channel Width at Bankfull (ft)

Site	May - 98	Nov - 00	May - 04	Change 5/98 - 5/04	Change 11/00 - 5/04
Apex 1	10	21.0	25	15	4
R-1	19	29.0	31	12	2
Apex 2	14	15.3	9	-5	-7
R-2	27	9.5	11	-16	2
B-1	28	31.7	9	-19	-23
R-3	27	24.7	24	-3	-1
B-2	21	18.5	20	-1	2
R-4	29	8.0	18	-11	10
B-3	28	27.0	23	-5	-4
R-5	28	15.0	22	-6	7
B-4	23	11.3	16	-7	5
R-6	25	24.0	16	-9	-10
B-5	18	30.5	10	-8	-21
R-7	14	30.0	10	-4	-20
B-6	16	30.0	11	-5	-19
R-8	19	25.0	11	-6	-14
R-9	18	–	14	-4	–
Apex 3	18	27.5	14	-4	-14
R-10	18	18.0	10	-8	-8
Apex 4	20	–	11	-9	–
B-7	23	18.0	11	-12	-7
R-11	27	29.0	10	-17	-19
B-8	18	20.0	11	-7	-9
R-12	19	21.5	14	-5	-8
MEAN					
BAFFLES	21.8	22.7	14.0	-7.8	-7.7
RIFFLES	22.5	22.8	15.9	-6.6	-6.9

Figure: 4

HUBBELL TRADING POST RESTORATION PROJECT
Thalweg Change
Phase 1

1998 Thalweg 1,204"
2004 Thalweg 1,196 "



2004 Phase 1
1998 Phase 1

200 0 200 Feet

N
W E
S

Figure: 5

HUBBLE TRADING POST RESTORATION PROJECT
Thalweg Change
Phase 2

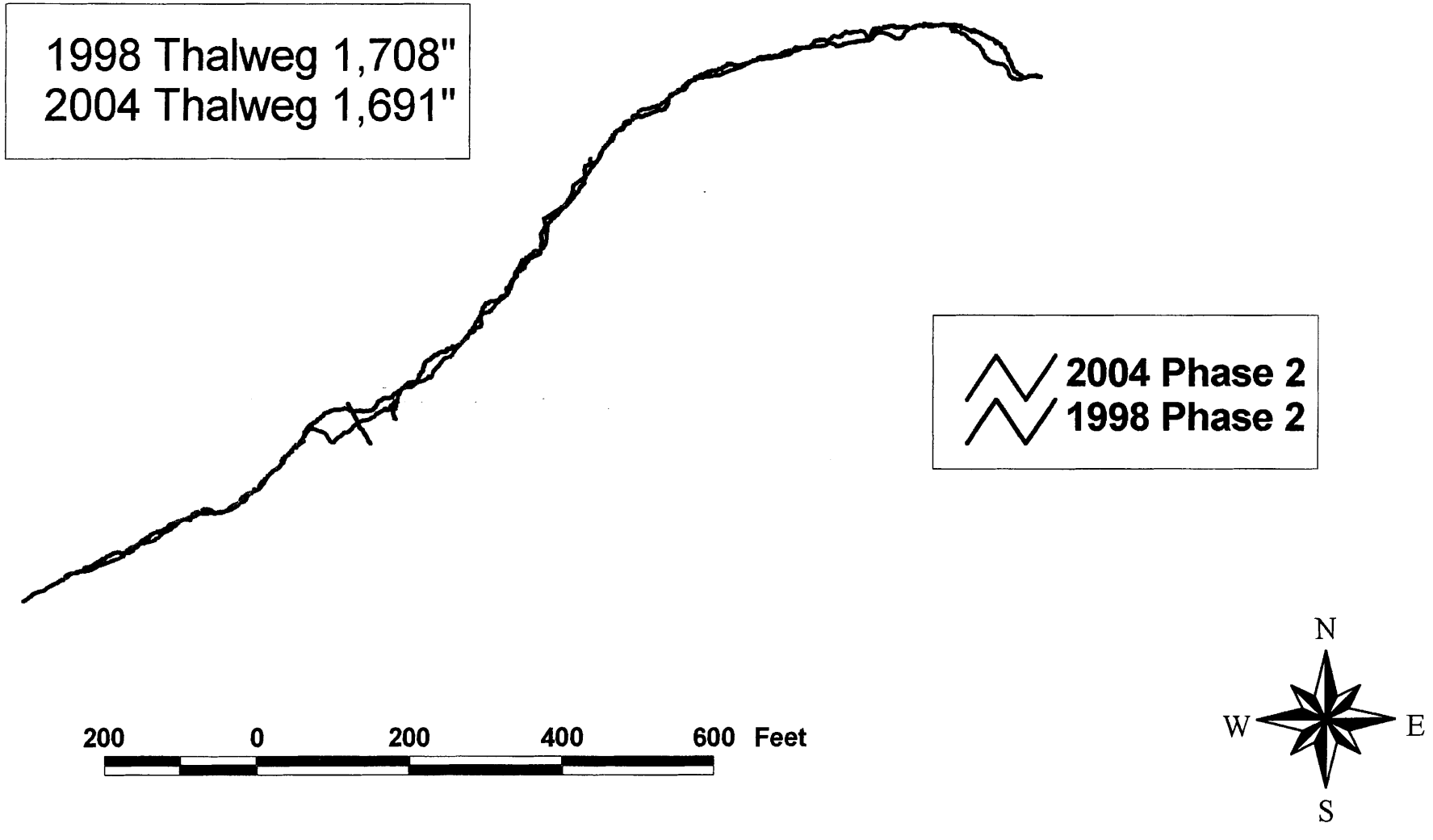
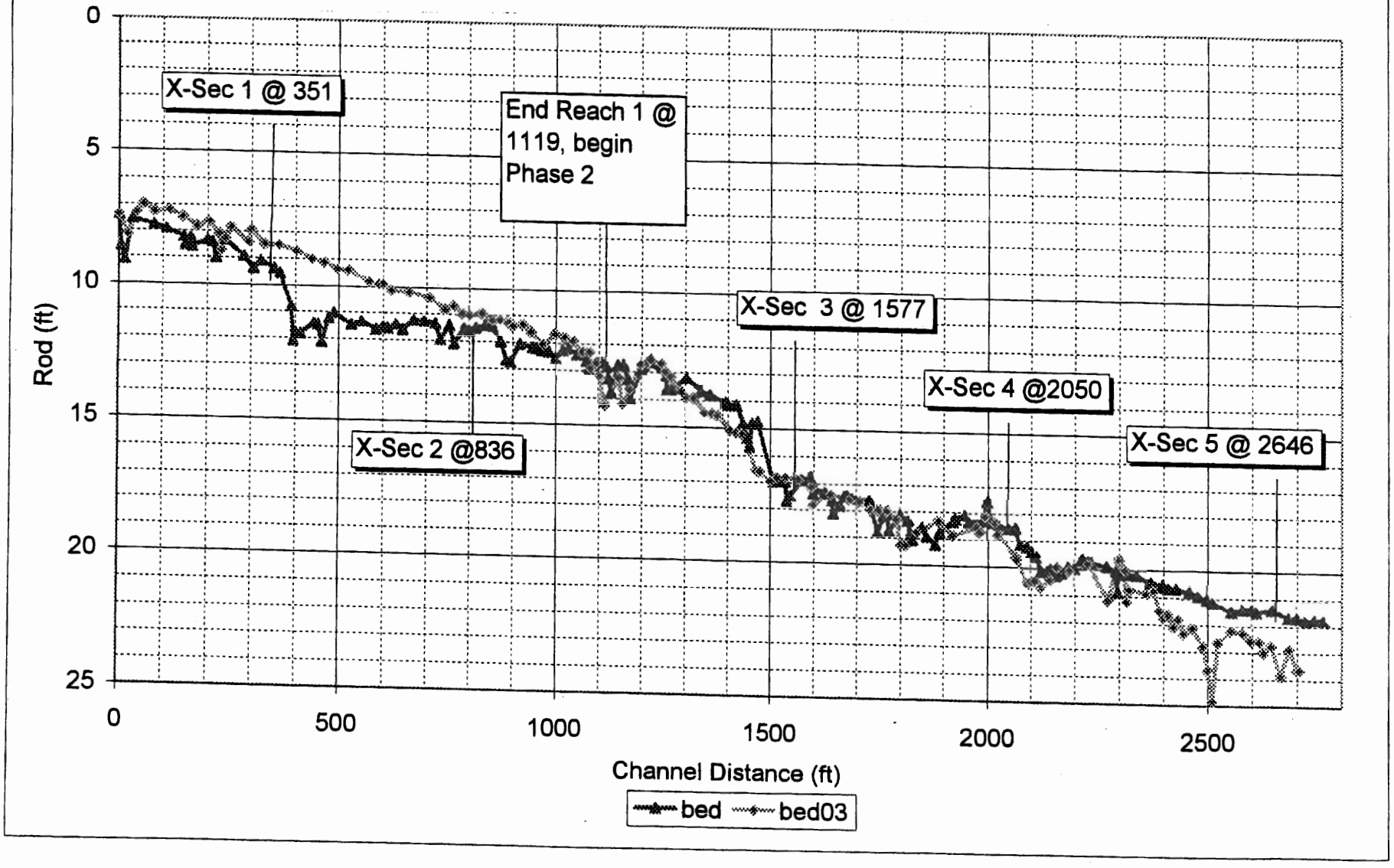


Figure 6: Pueblo Colorado Wash
Longitudinal Profile, 2002 and 2003



4 - Conclusions and Recommendations

4.1 - Project Conclusions

Several key geomorphological goals were not realized as expected, and in fact, favorable trends established during the initial study were reversed during the current study.

Although channel width and width of the flood prone area continued to increase, channel length and sinuosity decreased to pretreatment levels in the Phase 2 Reach and nearly that in Phase 1 Reach. Channel slope gradient increased. The riparian zone widened with an increase in the density and diversity of riparian vegetation. Bank erodability decreased. Both Reaches were classified as Rosgen F-5 channel types indicating that the belt width had not yet widened sufficiently to accommodate a type C channel which was the management goal.

Aggrading sediments from outside the project area have gradually overwhelmed and engulfed many of the original structures used to implement the induced meandering method of treatment. All structures not embedded in accumulating sediments have been currently maintained twice annually as required by the terms of the Grant. Some structures were modified or extended to increase their effectiveness but embedded structures were not replaced and the effectiveness of some structures in altering the direction of channel flow has declined.

Over the course of the present study an interesting pattern in channel evolution emerged. The channel was observed to widen, steepen and straighten during summer monsoonal flood events and to narrow, flatten, lengthen and become more sinuous during snownmelt discharge in the Spring. As a result the predominant channel type has been Rosgen F in late Summer and Fall but with many subreaches of E Type during late Winter and Spring. The lower 400 feet of Phase 2 Reach has evolved to a stable E Type. The length and maturity of the E subreaches appears to be related to the magnitude and duration of snowmelt discharge. Since snowmelt runoff has been subnormal coincident with the worsening drought, evolution toward a sinuous E channel has been retarded. Due to inadequate belt width a Rosgen C channel Type did not develop.

The induced meandering treatments first initiated in 1997 and continued under the auspices of two AWPF Grants have triggered evolution of a widening floodplain and increasingly robust and more functional riparian zone. Lessons learned and methods developed at Hubbell Trading Post have been applied to more than 40 project locations across Arizona and New Mexico.

4.2 - Recommendations

It is recommended that disciplined monitoring of the project area continue in order to take advantage of the monitoring grid already established (photo points, cross sectional profiles, etc). Continued monitoring would lead to a better understanding of the role of induced meandering in promoting the evolution of stable stream channels and functional riparian areas in the Southwest.

Appendix I

Pueblo Colorado Wash

Channel and Vegetation Response to Induced Meandering

May 1998 - May 2004



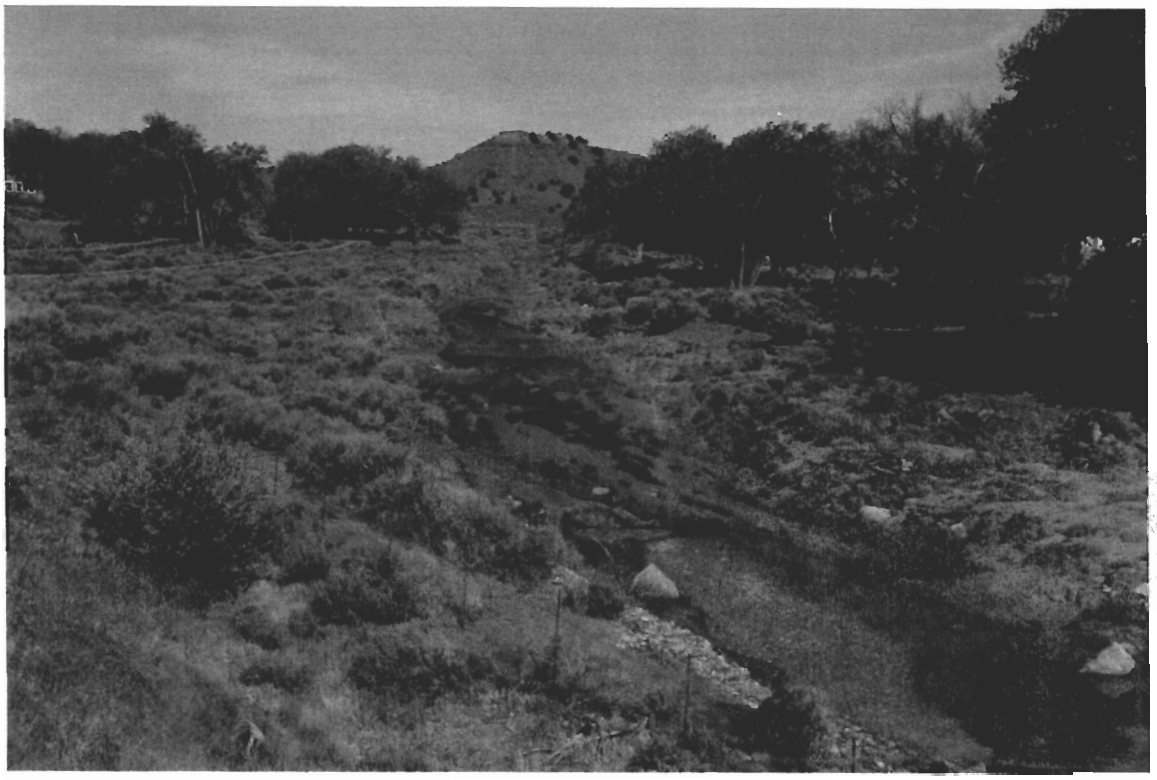
Permanent Photo Point 10 v 2, May 28, 1998. View East from Hubbell Hill toward Wide Reed Ruin. Old bridge center midground.



Same view, Permanent Photo Point 10 v 2, May 18, 2004. Channel has increased in width and sinuosity. Floodplain greatly expanded, wetland vegetation expanded. Exotic vegetation removed from North bank, left.



Permanent Photo Point 1. View West from Wide Reed Ruin toward Hubbell Hill, May 28, 1998.



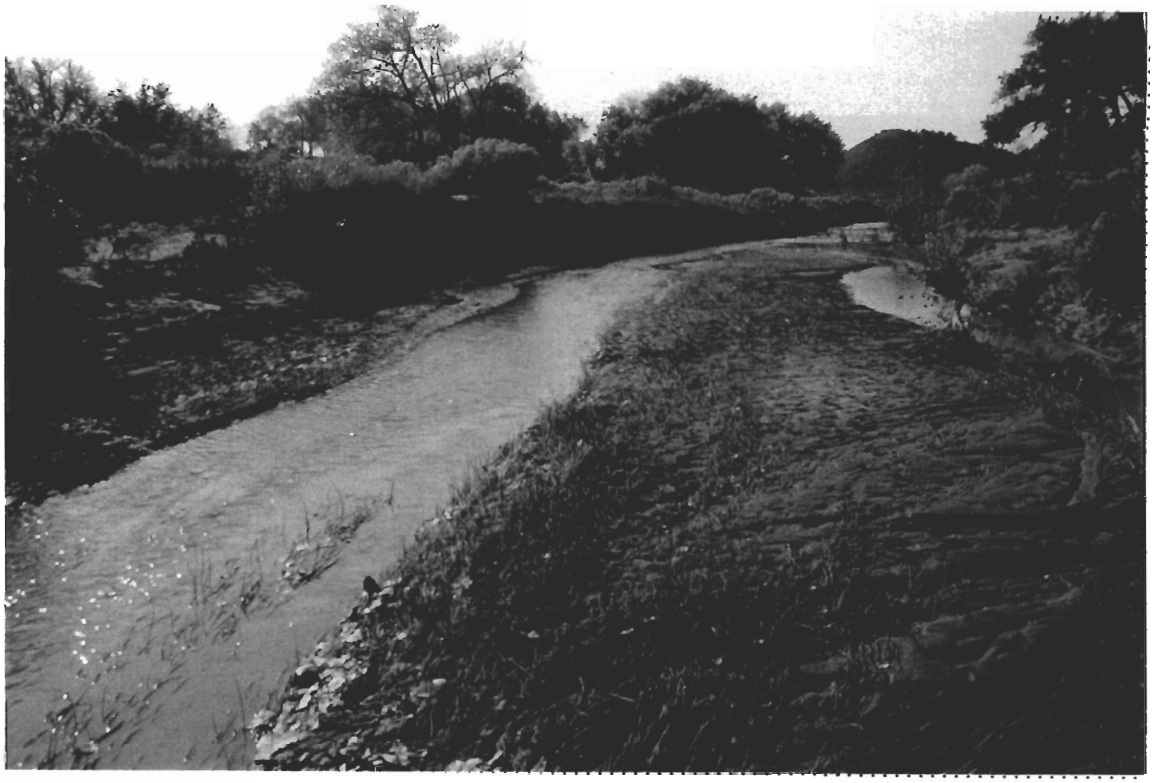
Same view, Permanent Photo Point 1, May 18, 2004. Left (South) bank has evolved 30 feet to South. Exotic vegetation has been removed. Stream bed elevation has raised about 1.5 feet, left terrace has lowered more than 2 feet due to effects of 1999 2003 floods.



Phase 1, Baffle 4. A rock only Baffle, June 1998.



Same structure as modified with pickets. Baffle has become incorporated into evolving flood plain, November 2, 2000.



Same view, Phase 1, Baffle 4, December 6, 2003.



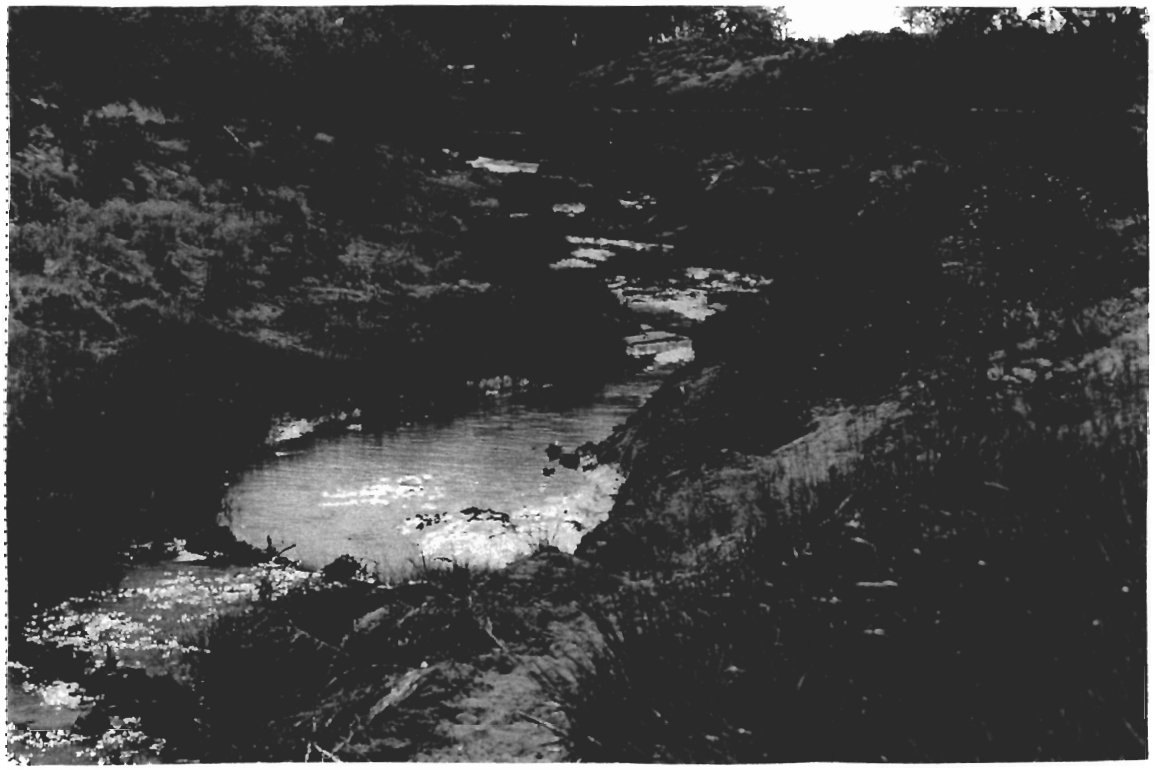
Same view, Phase 1, Baffle 4, May 18, 2004.



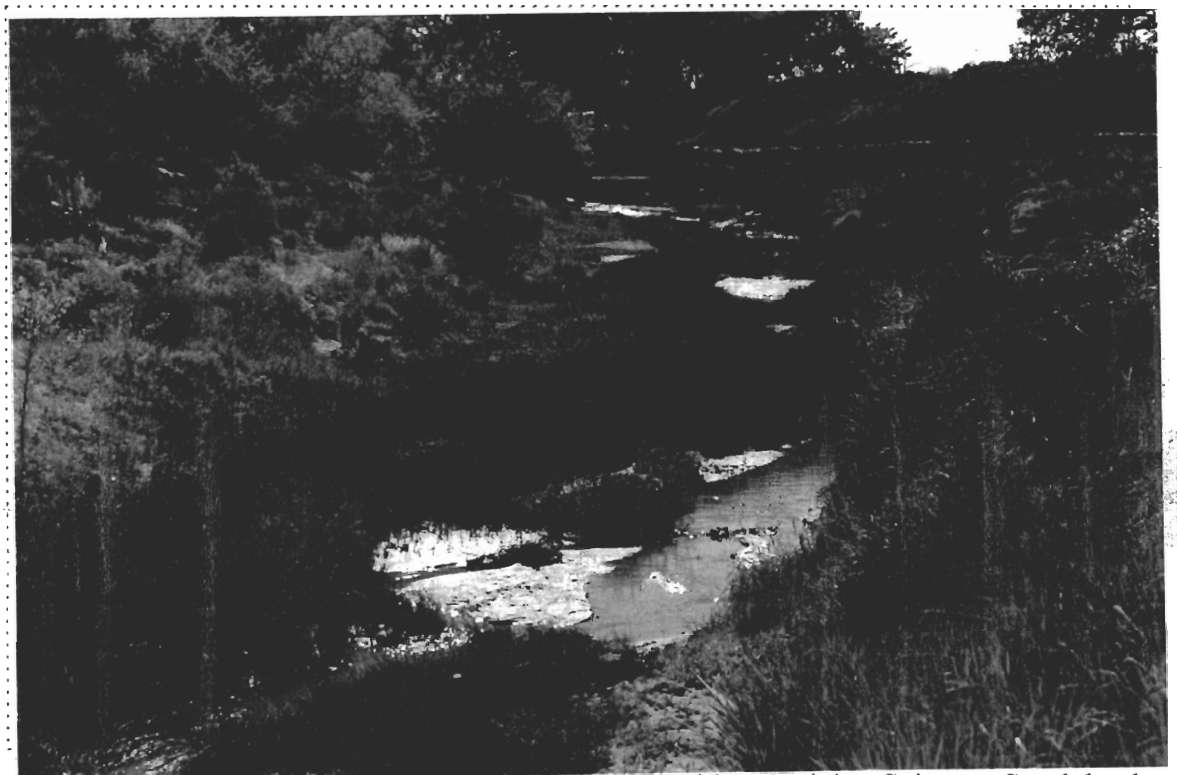
Permanent Photo Point 3x2, view east from top of south bank. Baffle 4, foreground, as initially installed by volunteers in June 1997, prior to AWPF Grant 97-029: Note narrow, steep channel, low sinuosity, some early point bar development and bank collapse, May 29, 1998.



Same view, May 28, 1999. Note expanding point bar at Baffle 4, foreground, flattening of channel at Riffle 3 midground, bank collapse, right foreground.



Same view, May 25, 2000, slight change of camera angle due to bank collapse following 1999 flood. Wicker weir, Riffle 4, foreground.



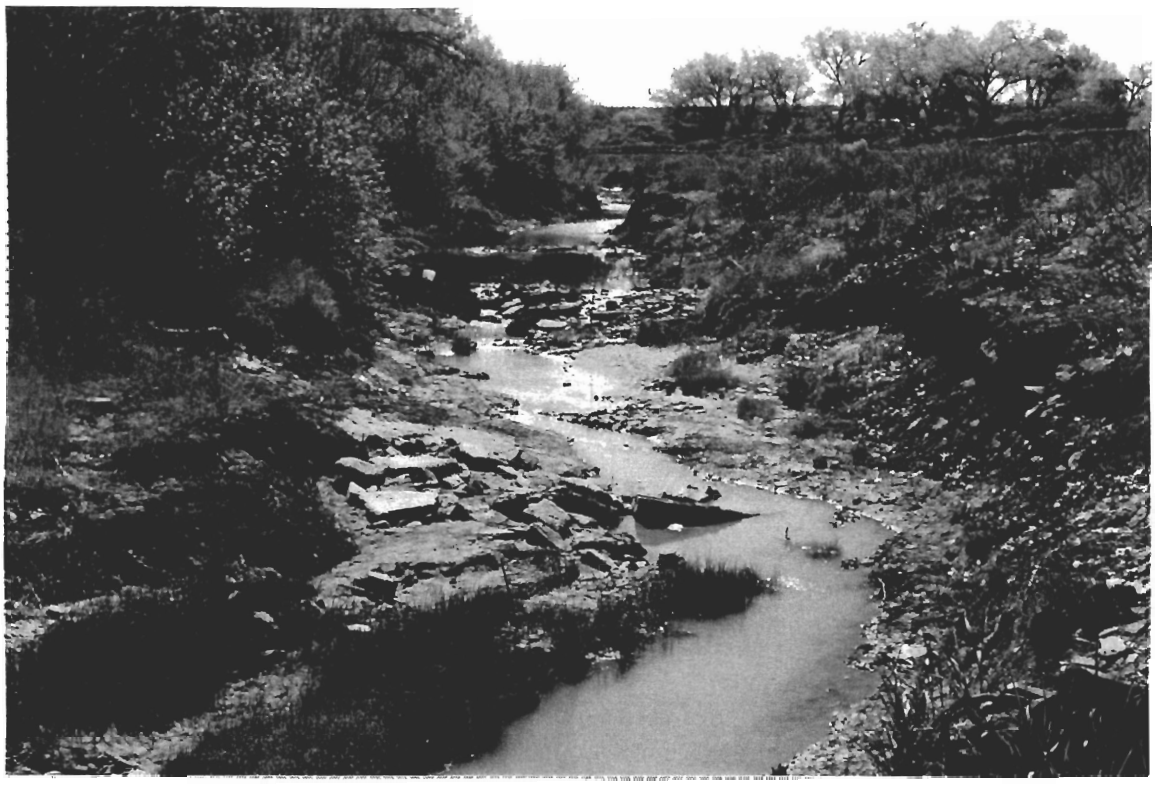
Same view, May 23, 2001. Riffles have stabilized with colonizing Scirpus. South bank, right, continues to retreat. Floodplain widening.



Same view, Photo Point 3 v 2, October 30, 2003.



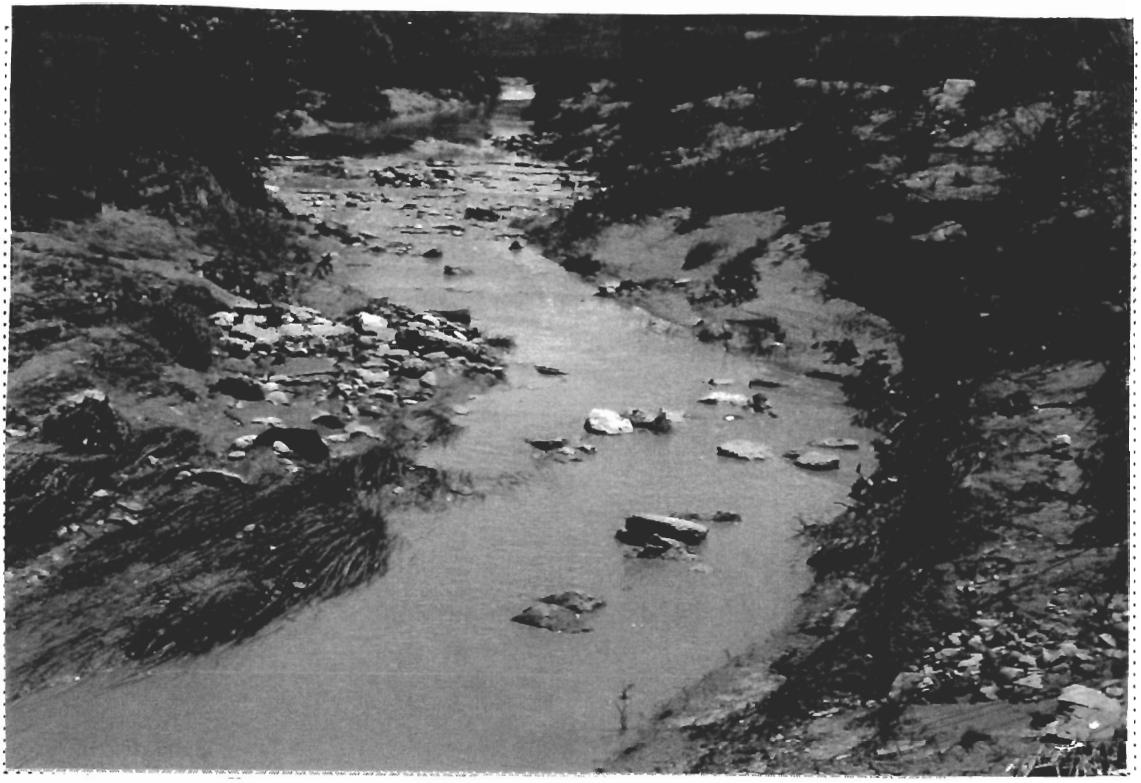
Same view, May 18, 2004. Channel continues to erode South bank, right midground, and floodplain is expanding.



Permanent Photo Point 4, View East, May 28, 1998. Rock structures installed by volunteers, June 1997. Baffle 8 left foreground.



Same view, July 29, 1998. Channel at bankfull stage.



Permanent Photo Point 4 after July 29, 1998 flood. Baffle 8 left foreground. Scattered rocks are from damaged structures.



Same view, May 23, 2001. Baffle 8 reinforced with pickets and stabilized.



Same view, Permanent Photo Point 4, October 30, 2003. Thalweg braided and choked with sand from late summer flows.



Same view, Permanent Photo Point 4, May 18, 2004. Channel better defined following snowmelt discharge.



Permanent Photo Point 9 v 1, May 28, 1998. View East from top of NTUA pipeline.



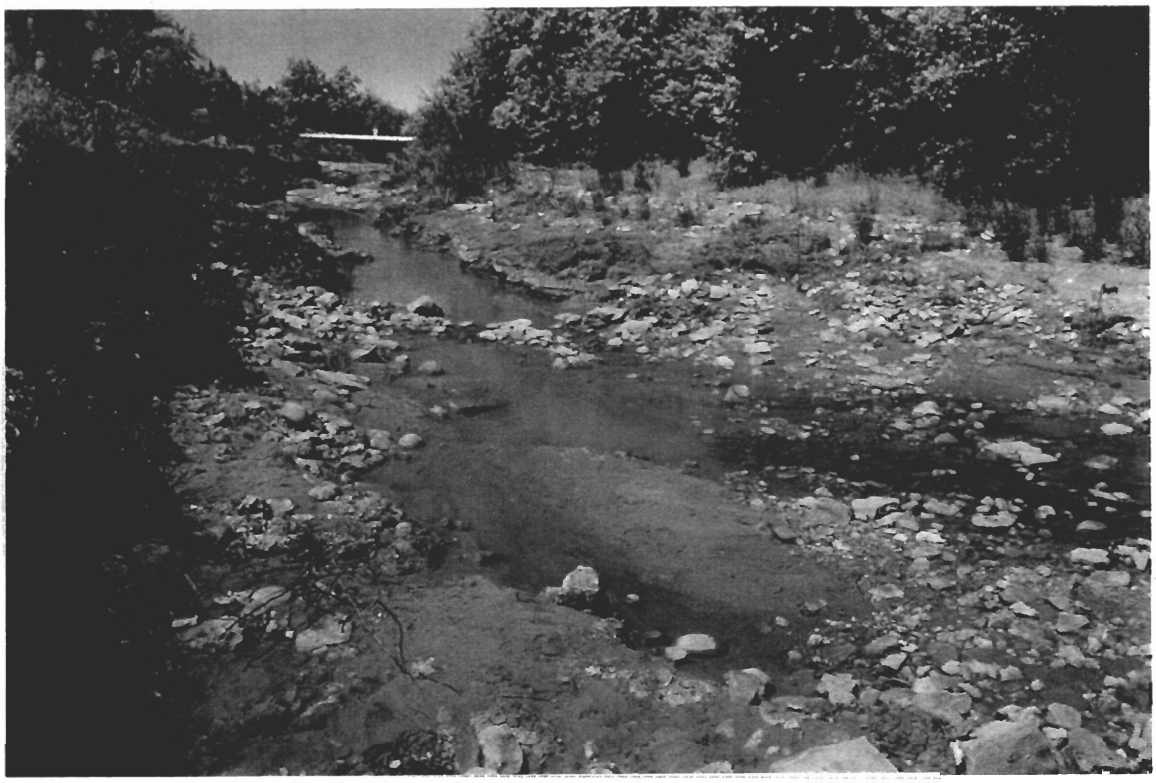
Same view, Permanent Photo Point 9 v 1, May 18, 2004. Note increased sinuosity, wider floodplain, exclosure fence removed and relocated downstream out of view. Exotics removed.



Phase 2, Riffle 10 and New Picket Baffle below Riffle 10, November 2, 2000.



Same view, May 19, 2004. Channel has narrowed and deepened to Rosgen E type. Note successful establishment of cottonwood, willows, Scirpus, Hordeum and other herbaceous wetland species.



Phase 2, Baffle 5 site. Pretreatment, June 19, 1998.



Same view. Phase 2, Baffle 5. As built July 17, 1998. Riffle 7 in midground.



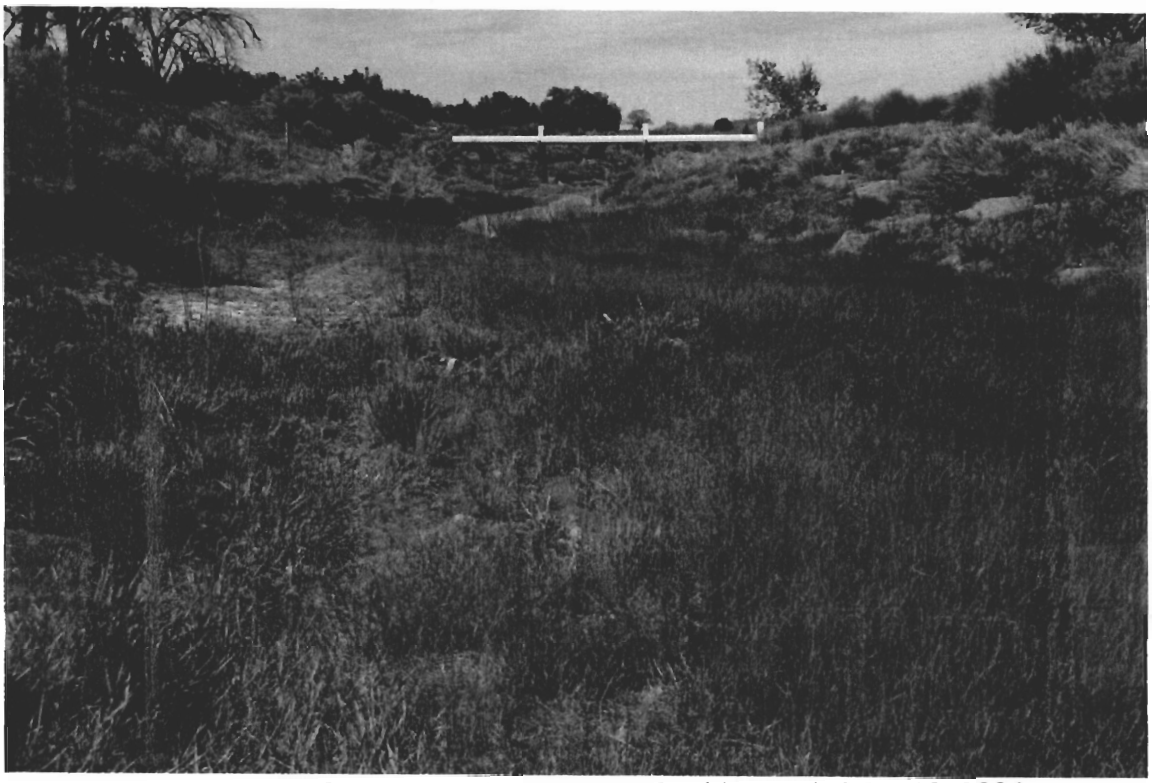
Phase 2, Baffle 5 site. Rock baffle replaced by pickets only following August 1999 flood. November 2, 2000.



Same view, Phase 2, Baffle 5 site, May 19, 2004.



Same view. Phase 2, Baffle 5, right foreground Baffle 6, left midground. November 2003.



Same view. Riffle 7, left foreground, Baffle 6, left midground. May 19, 2004.



A Post Vane at site Phase 2, Baffle 3, view West. November 2, 2000.



Same view, May 18, 2004.



Permanent Photo Point 11, July 2, 1998. View East from West boundary toward NTUA pipeline. Phase 2, Baffle 8 site, left midground.

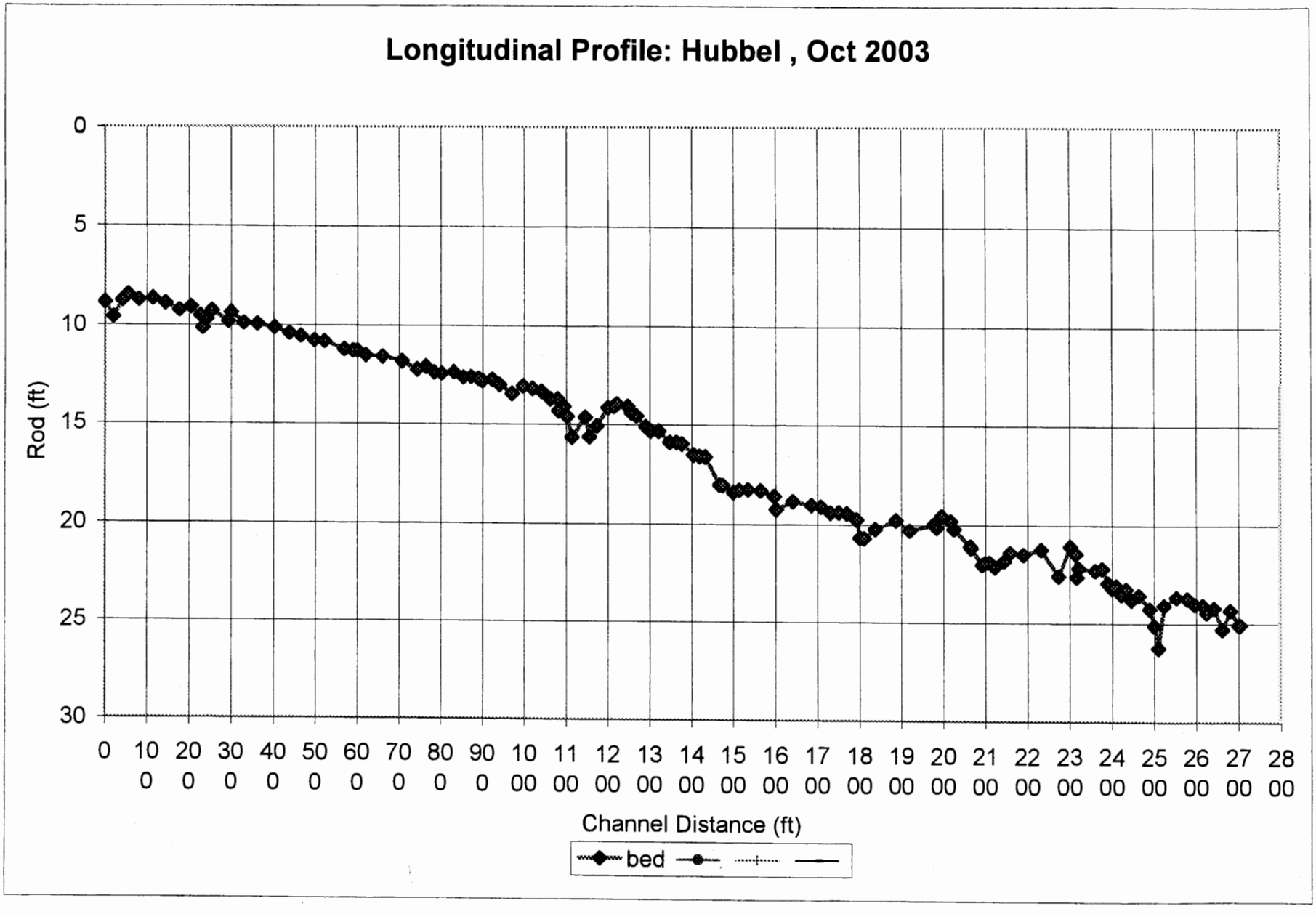


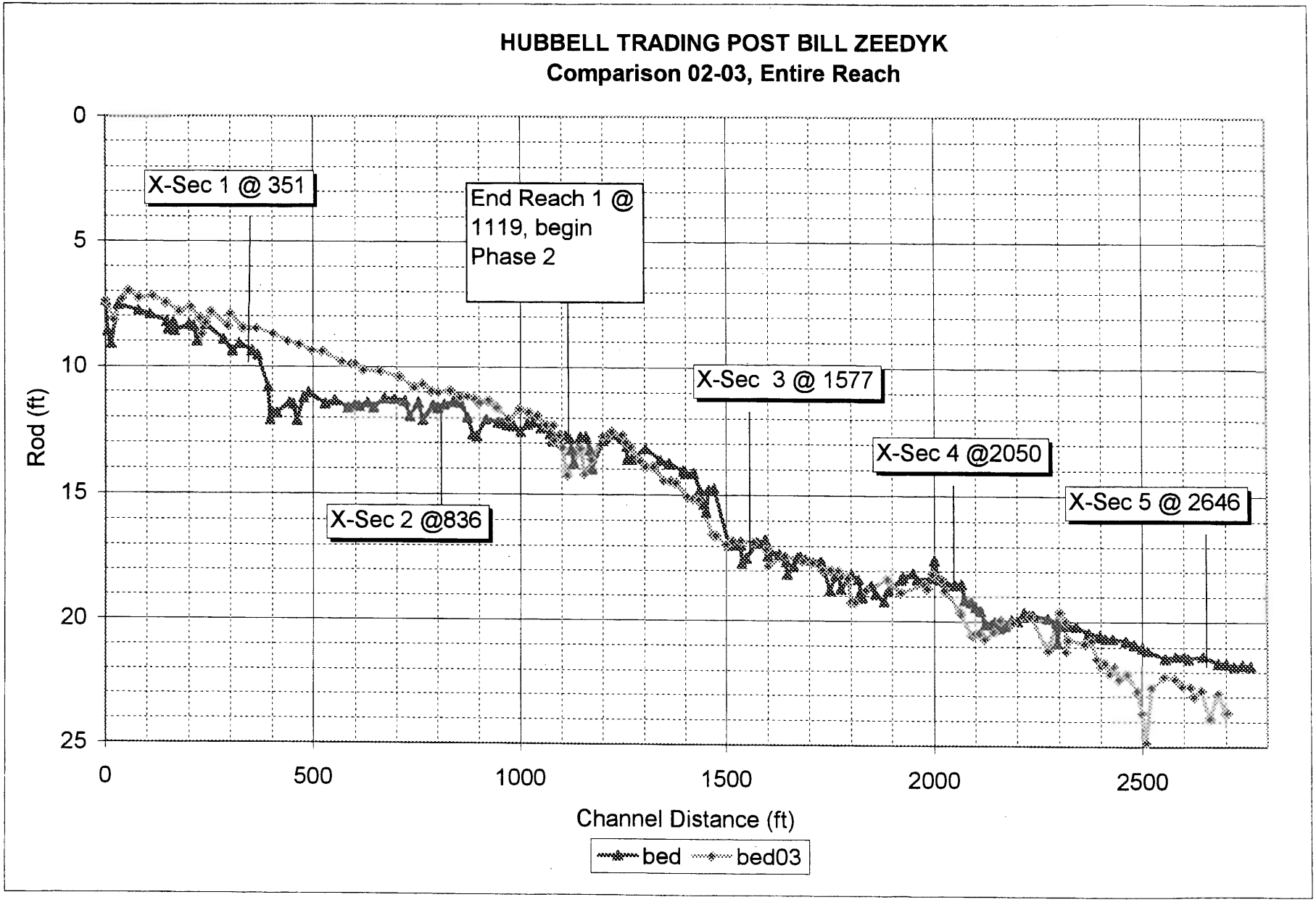
Permanent Photo Point 11, relocated 30 feet East, May 18, 2004. Channel has narrowed and evolved from Rosgen F to Rosgen E type with increased sinuosity and well vegetated floodplain.

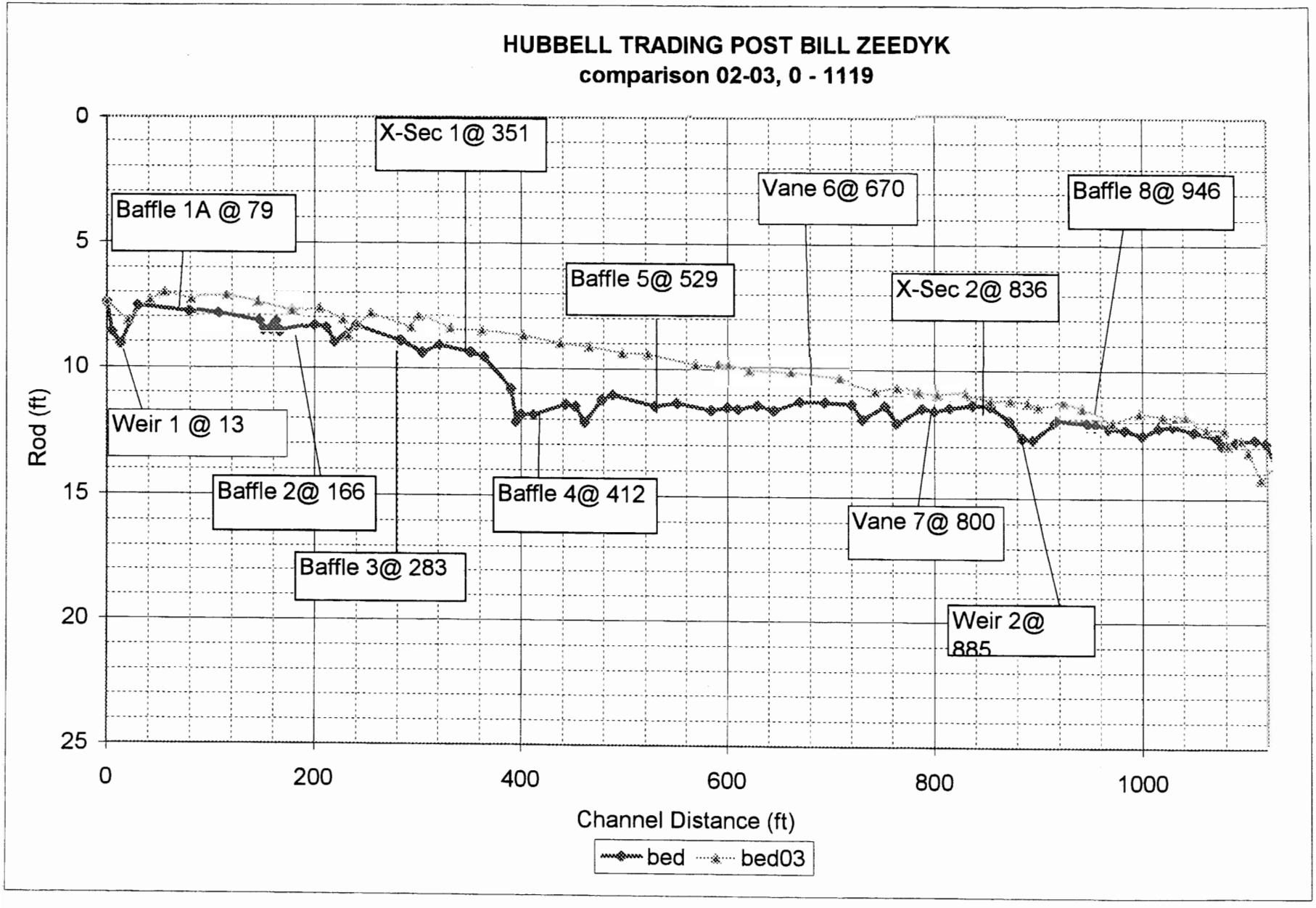
Appendix I

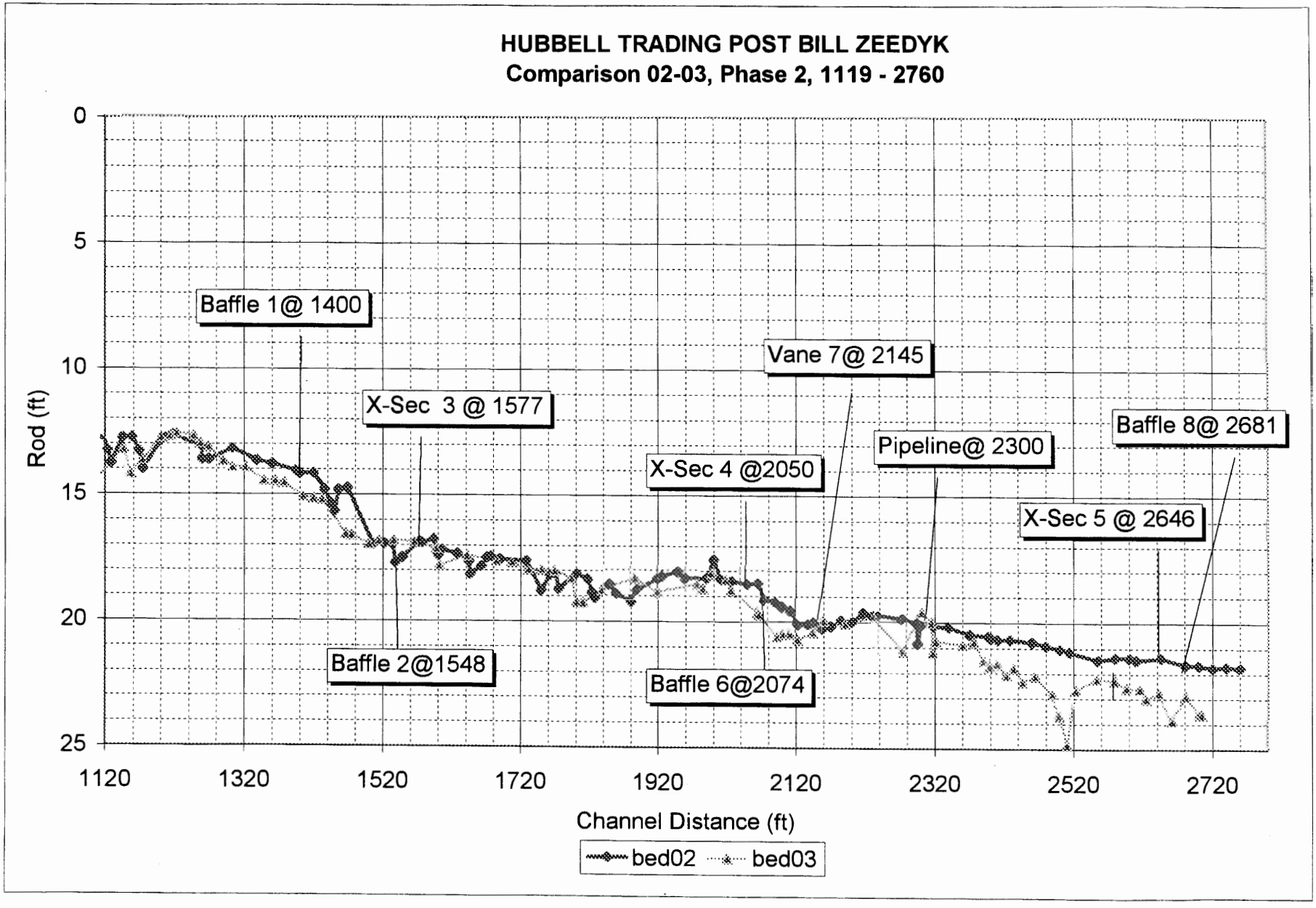
Longitudinal Profiles

October 28 - 29, 2003


Longitudinal Profile: Hubbel , Oct 2003
Rod (ft)
0
5
10
15
20
25
30
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
18000
19000
20000
21000
22000
23000
24000
25000
26000
27000
28000
Channel Distance (ft)
bed


HUBBELL TRADING POST BILL ZEEDYK
Comparison 02-03, Entire Reach
X-Sec 1 @ 351
End Reach 1 @ 1119, begin Phase 2
X-Sec 3 @ 1577
X-Sec 4 @2050
X-Sec 5 @ 2646
X-Sec 2 @836
Rod (ft)
0
5
10
15
20
25
0
500
1000
1500
2000
2500
Channel Distance (ft)
bed
bed03


HUBBELL TRADING POST BILL ZEEDYK
comparison 02-03, 0 - 1119
Rod (ft)
0
5
10
15
20
25
0
200
400
600
800
1000
Channel Distance (ft)
X-Sec 1@ 351
Baffle 1A @ 79
Vane 6@ 670
Baffle 8@ 946
Baffle 5@ 529
X-Sec 2@ 836
Weir 1 @ 13
Baffle 2@ 166
Baffle 4@ 412
Vane 7@ 800
Baffle 3@ 283
Weir 2@ 885
bed
bed03


HUBBELL TRADING POST BILL ZEEDYK
Comparison 02-03, Phase 2, 1119 - 2760
Rod (ft)
0
5
10
15
20
25
1120
1320
1520
1720
1920
2120
2320
2520
2720
Channel Distance (ft)
Baffle 1@ 1400
X-Sec 3 @ 1577
Vane 7@ 2145
Pipeline@ 2300
Baffle 8@ 2681
X-Sec 4 @2050
X-Sec 5 @ 2646
Baffle 2@1548
Baffle 6@2074
bed02
bed03

SURVEY DATA ⟹ LONGITUDINAL PROFILE Part I

GAGE: [redacted] No: 1

Location: Rudra Colorado Wash [redacted] Date: 10/29/03

Party / Notes: Bill Zeedyk

Item	Distance; Point; or STATION FL	Back-Sight BS FL	Height of Instrument HI FL	Fore-Sight FS FL	Height; Depth; or Elevation FL	REMARKS / COMMENT / NOTES
1	TP1	2.71	102.71			BM1 = BP2
2	0			8.83	93.84	End of Reach
3	20			9.58		
4	41			8.73		B1
5	55			8.41		
6	81			8.70		B1A
7	114			8.63		R1
8	194			8.88		
9	117			9.23		B2
10	205			9.06		
11	227			9.52		Vane
12	232			10.16		
13	241			9.70		Bridge Trib
14	254			9.26		Start Cutoff
15	293			9.82		
16	300			9.35		
17	330			9.90		355 Cross #1
18	362			9.93		W3
19	402			10.12		B4
20	438			10.42		
21	466			10.55		W4
22	498			10.80		
23	522			10.84		B5
24	569			11.24		W5
25	590			11.31		
26	600			11.31		
27	620			11.56		
28	660			11.62		Vane 6 est
29	707			11.84		
30	743			12.27		Pool
31	764			12.12		Vane 7 Tip
32	784			12.40		Pool
33	802			12.46		
34	830			12.38		Cross Section 2
35	854			12.63		

SURVEY DATA ⟹ LONGITUDINAL PROFILE Part II

GAGE: No: Date:

Item	STATION FL	BS FL	HI FL	FS FL	Elevation FL	NOTES / COMMENT / REMARKS
36	873			12.61		
37	890			12.70		
38	900			12.84		
39				[illegible]		[illegible]
40	923			12.77		
41	941			13.03		
42	971			13.48		Vane @ B8
43	997			13.10		
44	1020			13.21		
45	1041			13.35	89.36	
46	TP	6.70	96.77	12.04		Temp BM
47	1062			8.06		
48	1079			8.05		
49	1082			8.65		
50	1095			8.44		
51	1102			8.92		End Phase 1
52	1114			9.98		Phase 2
53	1146			8.97		
54	1156			9.96		
55	1173			9.40		
56	1200			8.47		
57	1214			8.40		Cut off Left
58	1222			8.29		
59	1247			8.41		
60	1256			8.73		
61	1268			8.87		
62	1290			9.42		
63	1303			9.65		
64	1322			9.65		
65	1348			10.20		Baffel #1
66	1364			10.22		
67	1377			10.28		
68	1404			10.83		Lower Bridge Piling
69	1419			10.90		
70	1432			10.93		Riffel 3
71	1466			12.32		Bottom Riffel 3
72	1474			12.35		
73	1500			12.70		
74	1514			12.57		Baffel 2

SURVEY DATA ⟹ LONGITUDINAL PROFILE Part I

GAGE: No: 2

Location: Pueblo Colorado Wash Phase 2 Date: 10/29/03

Party / Notes: Bill Zeedyk & Leander Lee

Item	Distance; Point; or STATION FL	Back-Sight BS FL	Height of Instrument HI FL	Fore-Sight FS FL	Height; Depth; or Elevation FL	NOTES / COMMENT / REMARKS
1	1535		96.77	12.55		Cross Section 3
2	1565			12.60		W-4
3	1597			12.88		
4	1601			13.55		
5	1641			13.14		Baf-3
6	1685			13.35		Top W-5
7	1707			13.40		Bottom W-5
8	1731			13.71		
9	1750			13.70		
10	1769			13.74		
11	1793			14.04		
12	1800			14.98		
13	1810			15.00		
14	1837			14.53		
15	1887			14.08		
16	1920			14.60		
17	1984			14.28		
18	1977			14.44		Cross-Section 4
19		8.56	88.21	13.85		Temp BM
20	1996			9.57	78.64	
21	2017			9.81		
22	2025			10.23		
23	2064			11.09		
24	2066			11.19		
25	2092			12.05		Vane 7
26	2100			11.95		
27	2110			11.94		
28	2122			12.17		
29	2144			11.87		
30	2159			11.44		Old Fence
31	2190			11.52		NTUA Vane
32	2232			11.26		NTUA Cutoff
33	2274			12.62		Scour Pool
34	2301			11.09		
35	2315			11.47		Headcut

SURVEY DATA ⟹ LONGITUDINAL PROFILE Part II

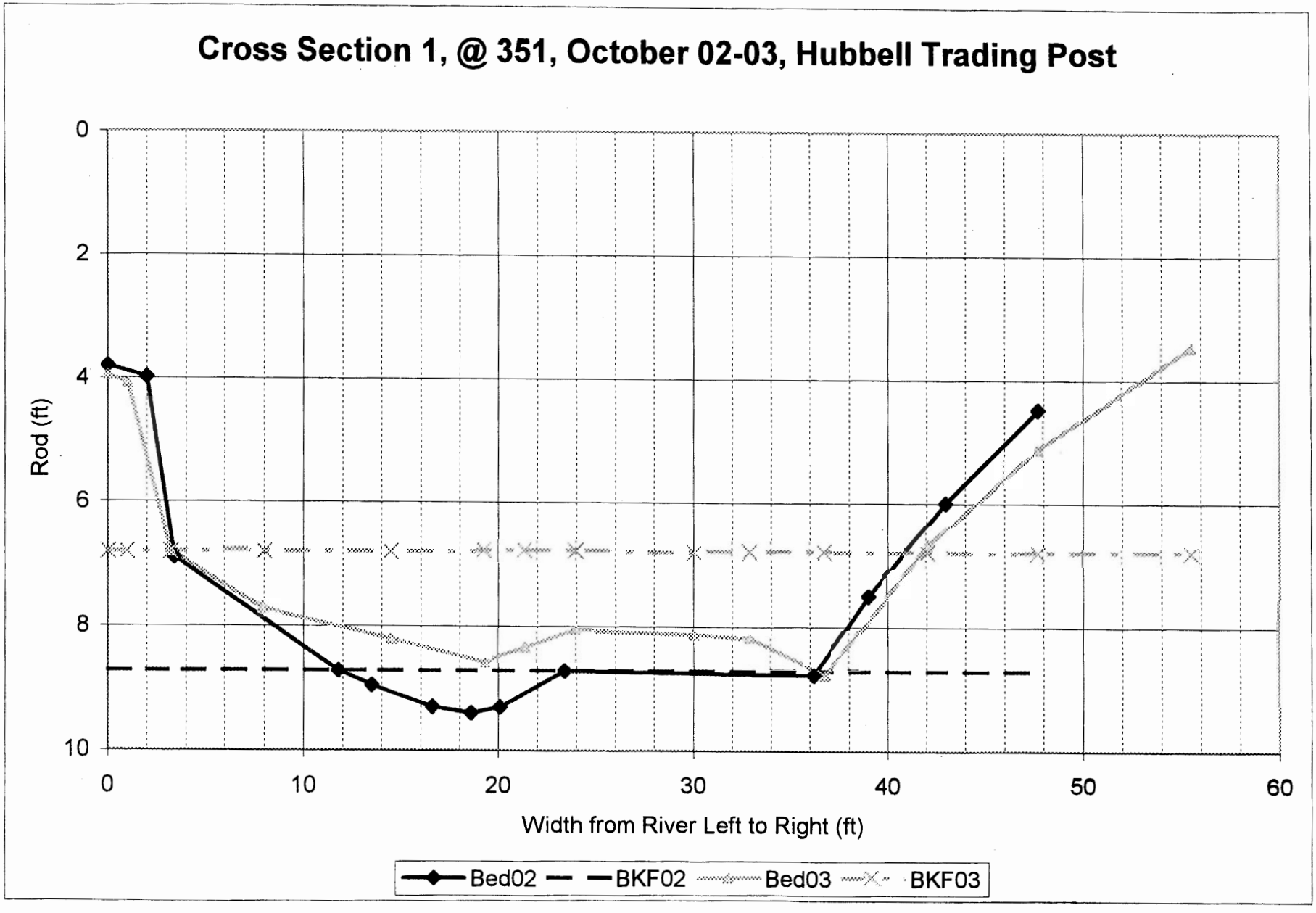
GAGE: No: Date:

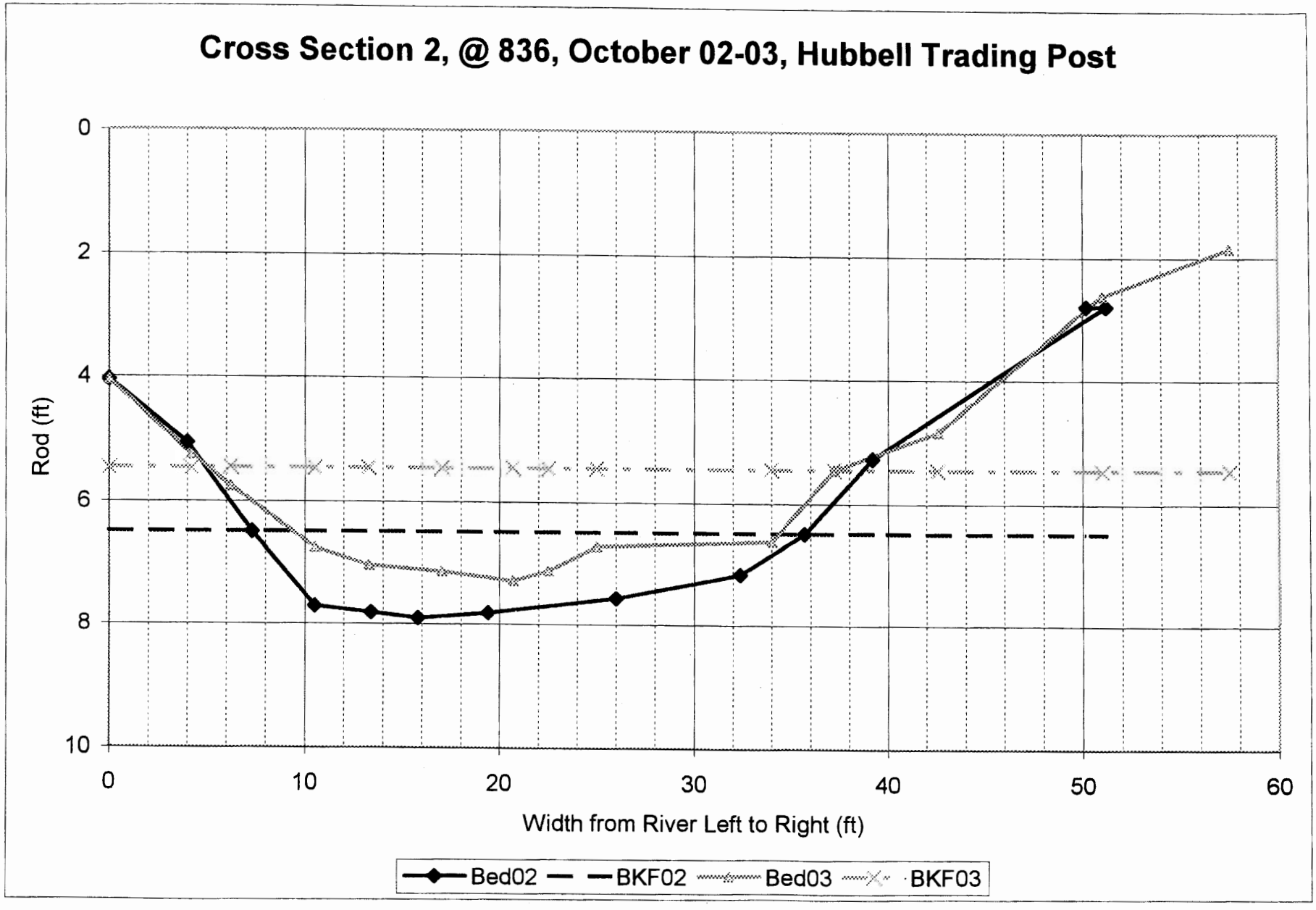
Item	STATION FL	BS FL	HI FL	FS FL	Elevation FL	NOTES / COMMENT / REMARKS
36	2317			12.66		Scour Pool
37	2321			12.22		Weir
38	2360			12.34		
39	2376			12.23		
40	2390			12.97		
41	2400			13.23		
42	2410			13.12		
43	2424			13.55		
44	2433			13.28		
45	2446			13.82		
46	2464			13.58		
47	2489			14.25		
48	2500			15.15		Baf 7
49	2510			16.30		Pond Pool
50	2523			14.12		
51	2553			13.68		Weir 11
52	2579			13.75		
53	2596			14.04		Vane 8 Cross 5
54	2615			14.08		
55	2624			14.46		Baf-8
56	2642			14.23		
57	2662			15.33		
58	2681			14.36		
59	2700			15.10		
60	2704			15.10		End (Boundary)
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						

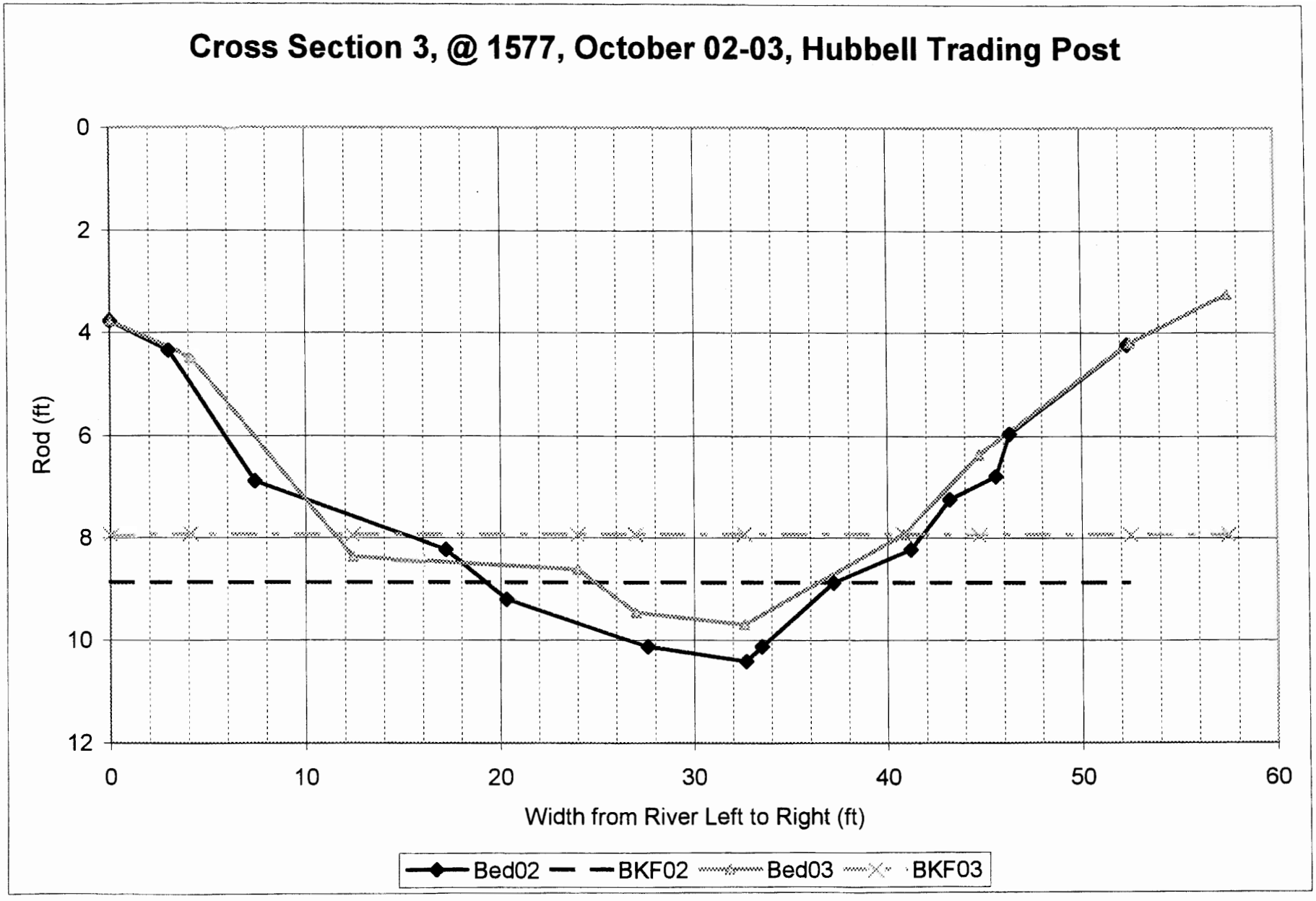
Appendix II

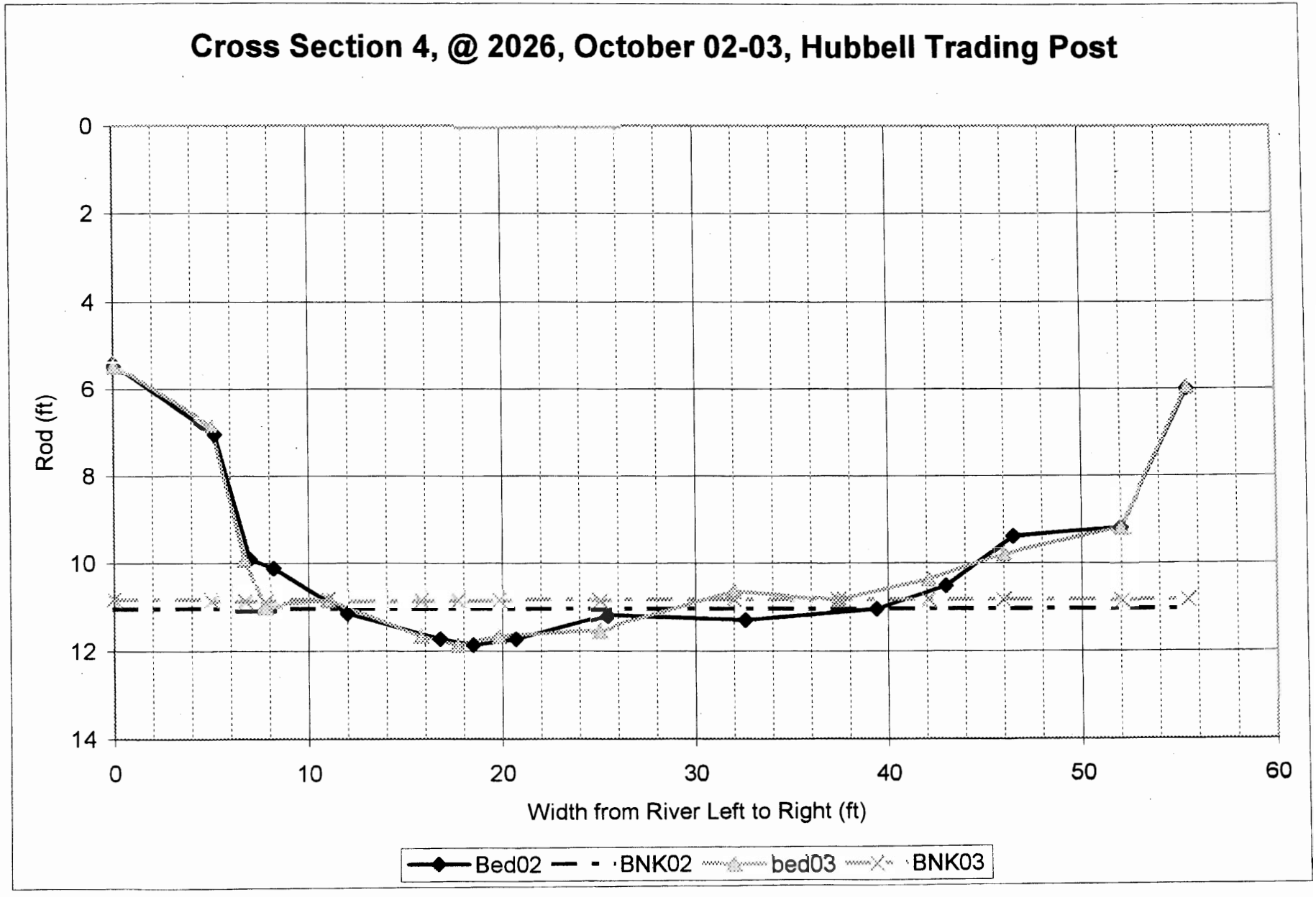
Cross Section Profiles

October 28 - 29, 2003

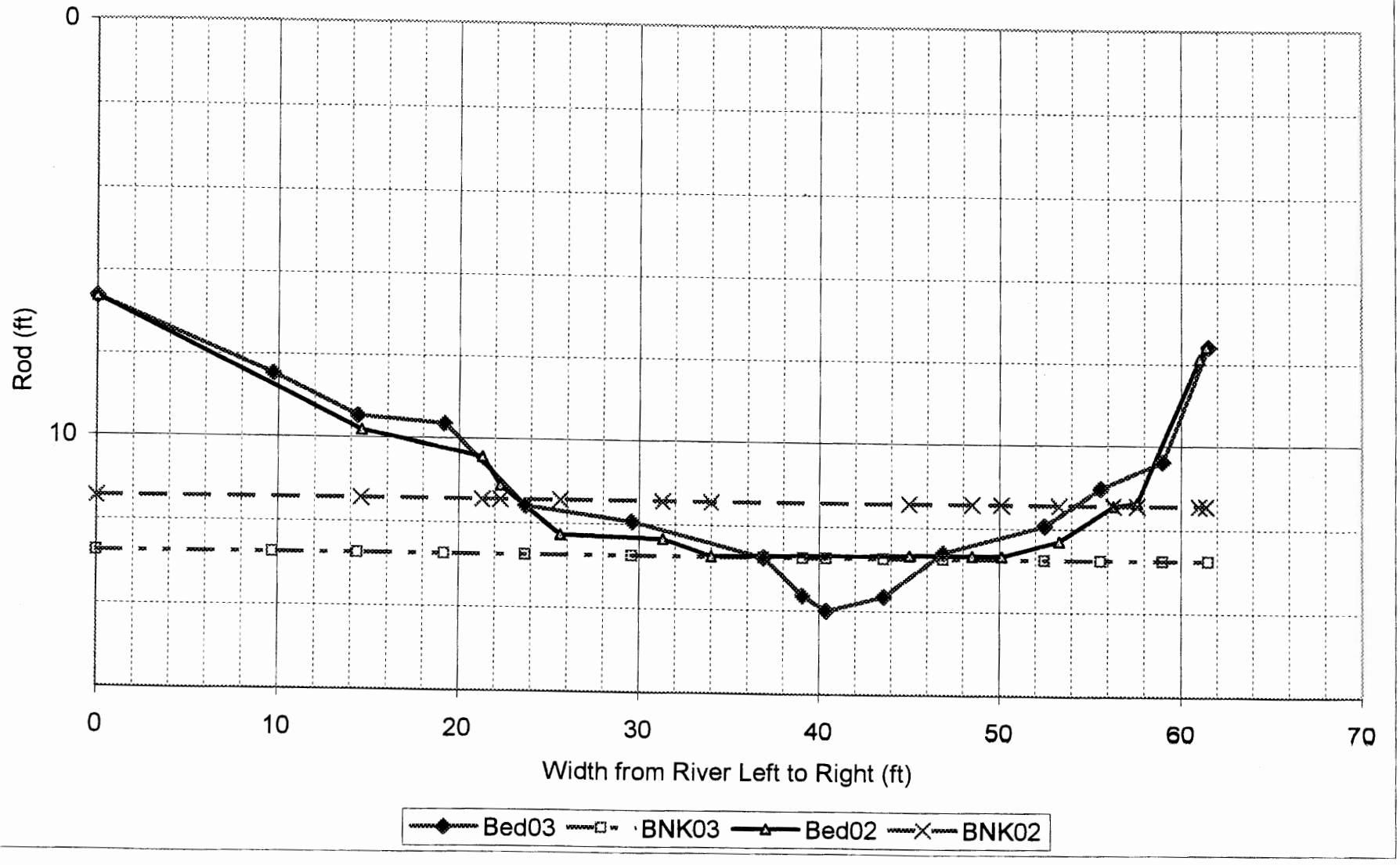

Cross Section 1, @ 351, October 02-03, Hubbell Trading Post
Rod (ft)
0
2
4
6
8
10
0
10
20
30
40
50
60
Width from River Left to Right (ft)
Bed02
BKF02
Bed03
BKF03


Cross Section 2, @ 836, October 02-03, Hubbell Trading Post
Rod (ft)
0
2
4
6
8
10
0
10
20
30
40
50
60
Width from River Left to Right (ft)
Bed02
BKF02
Bed03
BKF03


Cross Section 3, @ 1577, October 02-03, Hubbell Trading Post
Rod (ft)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
Width from River Left to Right (ft)
Bed02
BKF02
Bed03
BKF03


Cross Section 4, @ 2026, October 02-03, Hubbell Trading Post
Rod (ft)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
Width from River Left to Right (ft)
Bed02
BNK02
bed03
BNK03

Cross Section 5, @ 2646, October 02-03, Hubbell Trading Post



SITE: Date: 10/25/03

Location: Rock Colorado Wash @ 355

Party / Notes: B. Zeedyk Erin Peshlakai

Item	Distance; Point; or STATION FL	Back-Sight BS FL	Height of Instrument HI FL	Fore-Sight FS FL	Height; Depth; or Elevation FL	NOTES / COMMENT / REMARKS
1	0			5.38		Left Pin
2	1			5.51		'03 flood
3	3.2			8.23		Lbf Better
4	8			9.16		
5	14.5			9.63		Lew
6	19.3			10.01		TAL
7	21.4			9.79		Rew
8	24			9.50		
9	30			9.55		
10	32.9			9.62		
11	36.8			10.21		TAL 2
12	42.1			8.11		RBF
13	47.7			6.56		Right Pin
14	55.5			4.9		'03 flood
15						
16						
17						
18	3.2	16.1	8.23		1.77	
19	19.3		10.01			
20						
21	42.1		8.2			
22	3.2					
23	39.9					
24						
25			~~10.01~~		8.23	
26					- 1.77	
27					6.46	
28						45/39
29	6.4	L	Bank		2.3	} 45.2
30		R	Bank		47.5	
31						
32					ER =	1: 1.15
33						
34		Rosgen F=5			W:D=	39/1.1 = 32:1
35						

CROSS - SECTION DATA

SITE: Date:

Item	STATION FL	BS FL	HI FL	FS FL	Elevation FL	NOTES / COMMENT / REMARKS
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						

SURVEY DATA ⟹ CROSS - SECTION

SITE:

Date: 10/28/03

Location: Pueblo Co Canada Wash 832

Party / Notes: Zeedyk and Erin

Item	Distance; Point; or STATION FL	Back-Sight BS FL	Height of Instrument HI FL	Fore-Sight FS FL	Height; Depth; or Elevation FL	NOTES / COMMENT / REMARKS
1	0			9.20		Left Pin less than '03 flood
2	4.2			10.40		
3	6.2			10.90		Lbf
4	10.5			11.89		
5	13.3			12.18		Lew
6	17.0			12.28		
7	20.7			12.43		THAL
8	22.5			12.26		Rew Better
9	25.0			11.86		
10	34			11.76		
11	37.2			10.60		Rbf Better
12	42.6			9.99		
13	51.0			7.77		Right Pin
14	57.5			7.0	est.	'03 flood
15						
16						
17						
18						
19						
20		12.43		1.63		
21		10.60		.6		37.2
22		1.83		1098		6.2
23		8.77				310
24						
25						
26		8.77	Left Bank	= 0.6		} 47 1:1.51
27		8.77	Right Bank	= 47.5		
28						
29						
30		W:D = 31/1.1		28:1		ER = 1.151
31						
32		mean dgt = 1.1				
33						
34			Rosgen	B5c		
35						

SURVEY DATA ⟹ CROSS - SECTION

SITE:

Date:

Item	STATION FL	BS FL	HI FL	FS FL	Elevation FL	NOTES / COMMENT / REMA
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						

SITE: Rancho Colorado cross section 3 Date: 9/29/03

Location: TP2 @ 1535

Party / Notes: BM Zeedyk + Lecander Kee

Item	Distance; Point; or STATION FL	Back-Sight BS FL	Height of Instrument HI FL	Fore-Sight FS FL	Height; Depth; or Elevation FL	NOTES / COMMENT / REMARKS
1	0			6.65		Left Pin = 2003 Flood
2	4.1			7.34		TOB 0 Bank
3	12.4			11.23		LBF poor
4	24.0			11.49		LBF?
5	27.0			12.32		LEW
6	32.6			12.56		TH at @ 1535
7	40.8			10.79		RBF Better
8	44.7			9.23		
9	52.5			7.07		Right Pin
10	57.5			6.13		2003 flood
11						
12						
13						
14						40.8 = RBF
15		12.56 T				12.4 LBF
16		10.79 RBF				28.4
17		1.77				
18						
19		9.02				
20						
21		9.02 = Right Bank				= 45.7
22		= Left Bank				= 7.0
23		dm				39.7
24		1.77		38.4		
25		.6		1.1		
26		1.062				
27						
28						
29	W:D	36:1				
30						
31	ER=	39.7 / 28.4 =		1:1.39		
32						
33						
34			Rosgen	F-5		
35						

SURVEY DATA ⟹ CROSS - SECTION #4 TP2

SITE: Cherry Creek 4 @ 1977 Date:

Item	STATION FL	BS FL	HI FL	FS FL	Elevation FL	NOTES / COMMENT / REMARKS
36	0			8.36		Left Pin
37	4.5			9.69		TOB 2003 Flood
38	6.7			12.32		LBF
39	9.8			13.43		
40	15.0			13.56		LEW
41	18.3			14.49		THAL
42	24.0			13.73		~~RBF~~ REW
43	35.7			13.90		
44	37.0			13.51		RBF Better
45	42.7			12.90		
46	49.0			11.05		
47	54.4			8.91		2003 flood
48	55.5			8.58		Right Pin
49						
50						
51						
52						
53		Thal =		14.49		1449 37.0
54		RBF		13.51		8.91 6.7
55				.98		5.58 30.3
56	dm					
57	.94			13.51		
58	.6			= 98		
59	~~.58~~			12.53		
60						
61		12.53 @		Left Bank		6.8
62				Right Bank		44.0
63						37.2
64		2003 F	lood Stage =		5.58	
65						
66						
67		W:D ~~50~~ :1				
68						
69		ER 1: 1.23				
70						F-5
71				Rosgen		
72						
73						
74						

SITE:

Date: 10/29/03

Location: Phase 2, @ 1977

Party / Notes: Zeedyk + Kee

Item	Distance; Point; or STATION FL	Back-Sight BS FL	Height of Instrument HI FL	Fore-Sight FS FL	Height; Depth; or Elevation FL	NOTES / COMMENT / REMARKS
1	0			7.98		Left Pin
2	5.0			9.40		T.O.B
3	6.7			12.48		
4	7.7			13.52		LBF (steep)
5	11.0			13.41		
6	15.8			14.23		LEW
7	17.7			14.44		Thal
8	19.8			14.23		REW
9	25.0			14.09		
10	32.0			13.21		
11	37.4			13.40		RBF (Gould)
12	42.1			12.93		
13	46.0			12.36		
14	52.0			11.76		Base of bank
15	55.5			8.52		Right Pin
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						

SURVEY DATA ⟹ CROSS - SECTION

SITE:

Date:

Item	STATION FL	BS FL	HI FL	FS FL	Elevation FL	NOTES / COMMENT / REMA
36						
37	Channel Width					37.4 − 7.7 = 29.7
38						
39						
40						
41	Thal			14.44		
42	RBF			13.40		
43				1.04		
44				× .6		
45				.60		
46						
47	MxD			14.44		
48		−		2.08		
49				12.36		
50						
51						
52	Left Bank			12.36		= 6.5
53	Right			12.36		= 46.0
54						39.5
55						
56						
57	W.D = 29.7 / .6					= 1:49
58						
59						
60						
61	ER = 1:33				39.5 / 29.7	
62						
63						
64						
65						
66		Rogen		F-5		
67						
68						
69						
70						
71						
72						
73						
74						

SURVEY DATA ⟹ CROSS - SECTION

SITE: Date:

Location: Cross Section @ 2598

Party / Notes: Zachy + Leandra Kee

Item	Distance; Point; or STATION FL	Back-Sight BS FL	Height of Instrument HI FL	Fore-Sight FS FL	Height; Depth; or Elevation FL	NOTES / COMMENT / REMARKS
1	0			6.64		Left pin Top Bank
2	9.7			8.47		2003 flood
3	14.4			9.47		1st tarus
4	19.2			9.64		1st tarus
5	23.7			11.59		
6	29.6			11.94		[redacted]
7	36.9			12.75		LBF Better
8	39.1			13.65		LEW
9	40.4			14.0		Thal
10	43.6			13.65		REW
11	46.9			12.59		RBF
12	52.5			11.93		
13	59.6			11.02		
14	59			10.37		
15	61.5			7.58		Right pin
16						
17						
18						
19						
20						dm
21		Thal		14.0		1.4
22				12.75		x 1.6
23				1.25		8.4
24						
25				10.50		
26						
27		10.50 Left	bank			21.0 7
28			Right Bank			58.0
29						37.0
30						
31		W:D = 12:1				
32						
33		ER = 1:3.90				Rosgen E-5
34						
35						

Item	STATION FL	BS FL	HI FL	FS FL	Elevation FL	NOTES / COMMENT / REMAI
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						

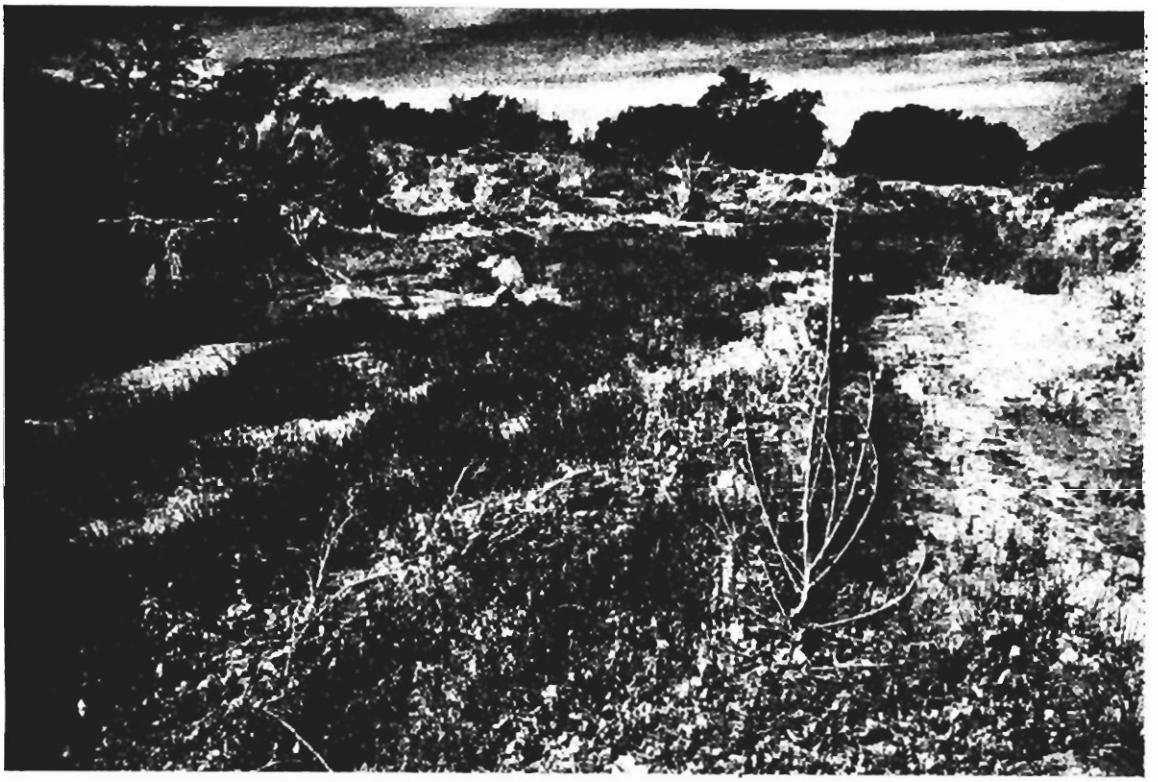
HUBBELL TRADING POST
National Historic Site

AWPF
Grant Number 00-104 WPF

APPENDIX III

Photo Documentation of Structures

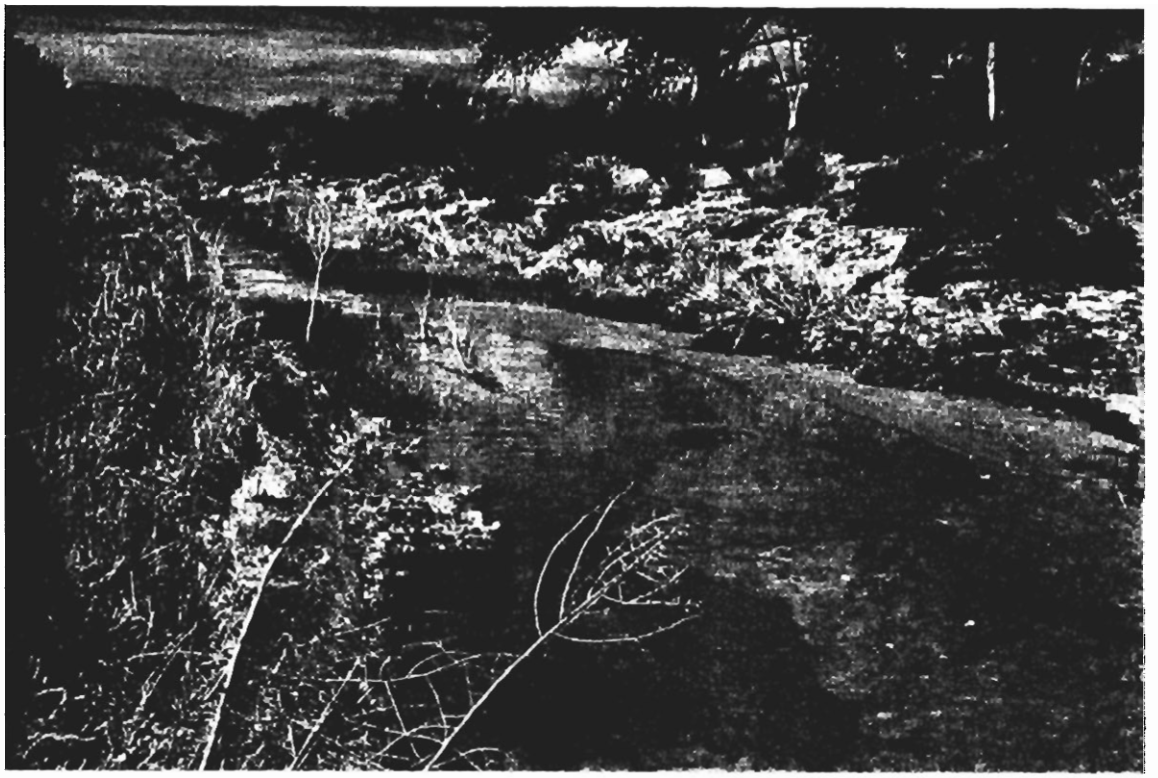
May 19, 2004



Phase 1, Baffle 2, May 19, 2004.



Phase 1, Riffle 3, foreground, Baffle 4 midground, May 19, 2004.



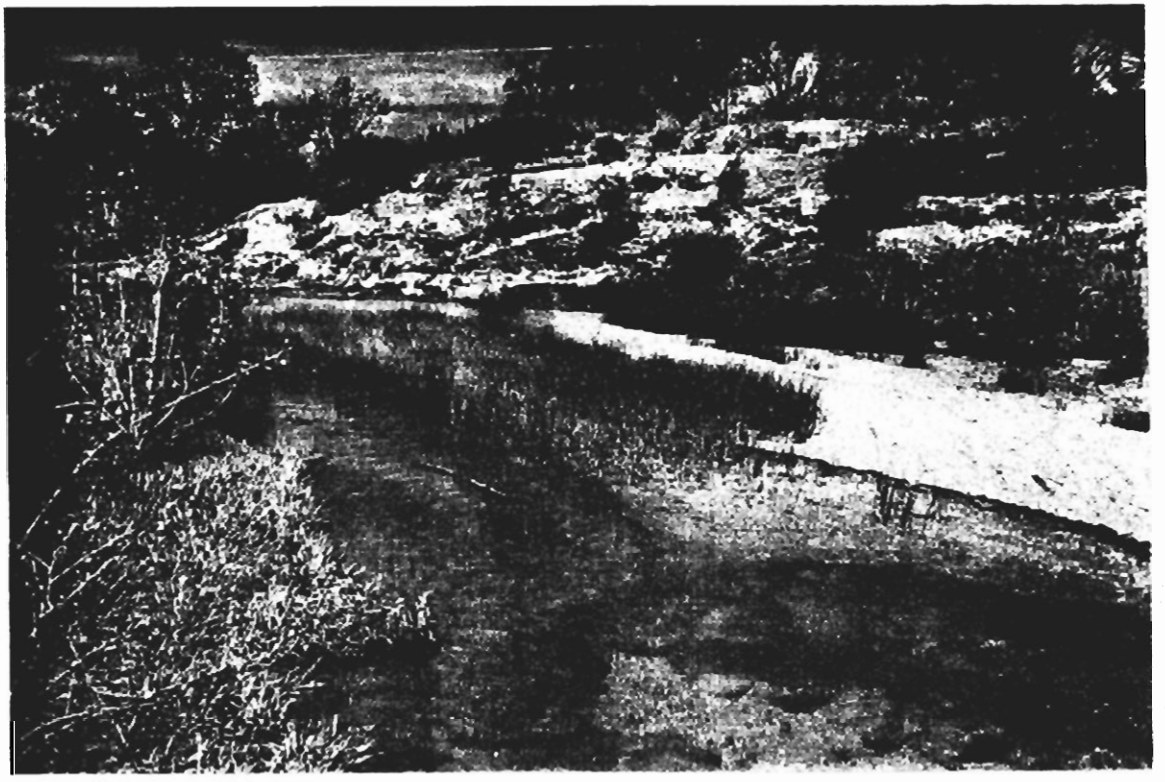
Phase 1, Baffle 5, May 19, 2004.



Phase 1, Baffle/Vane 6, May 19, 2004.



Phase 1, Weir 2 foreground, Baffle 8 midground, May 19, 2004.



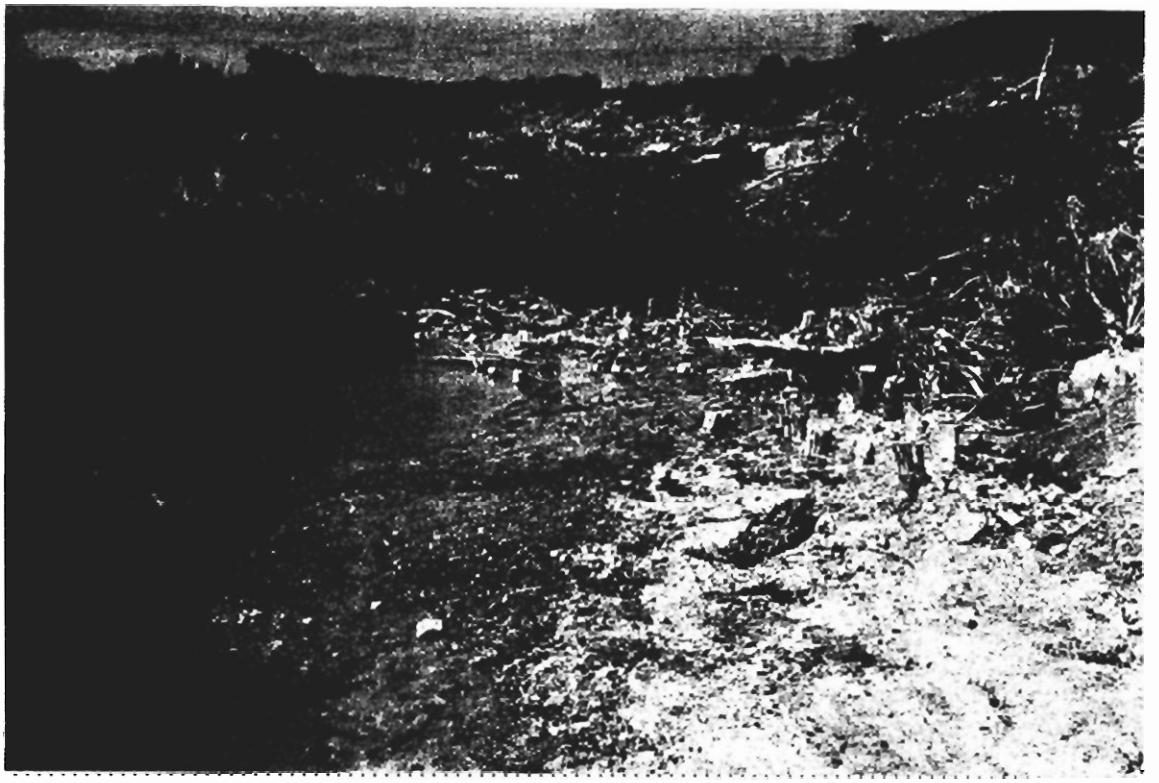
Phase1, Baffle 9, May 19, 2004.



Phase 1, Riffle 9. End of Phase 1 Reach, May 19, 2004.



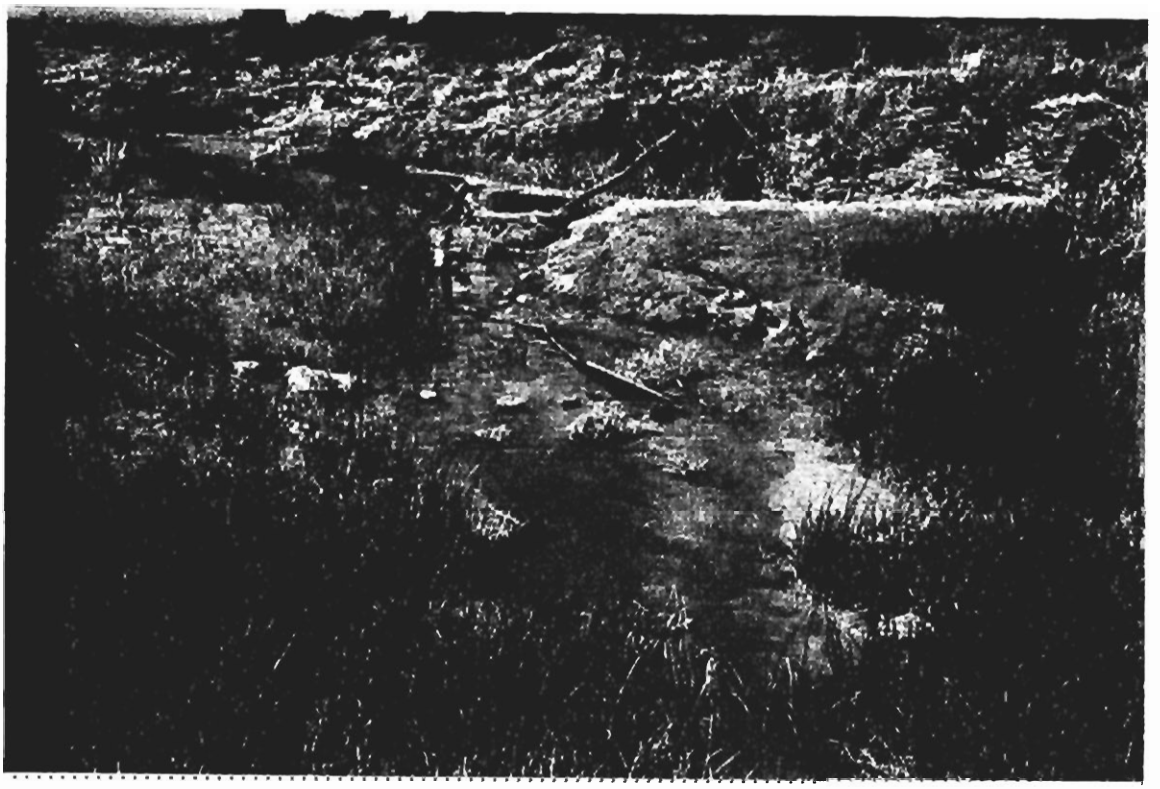
Phase 2, Apex 2, May 19, 2004.



Phase 2, Baffle 1, May 19, 2004.



Phase 2, Baffle 2, May 19, 2004.



Phase 2, Riffle 4, May 19, 2004.



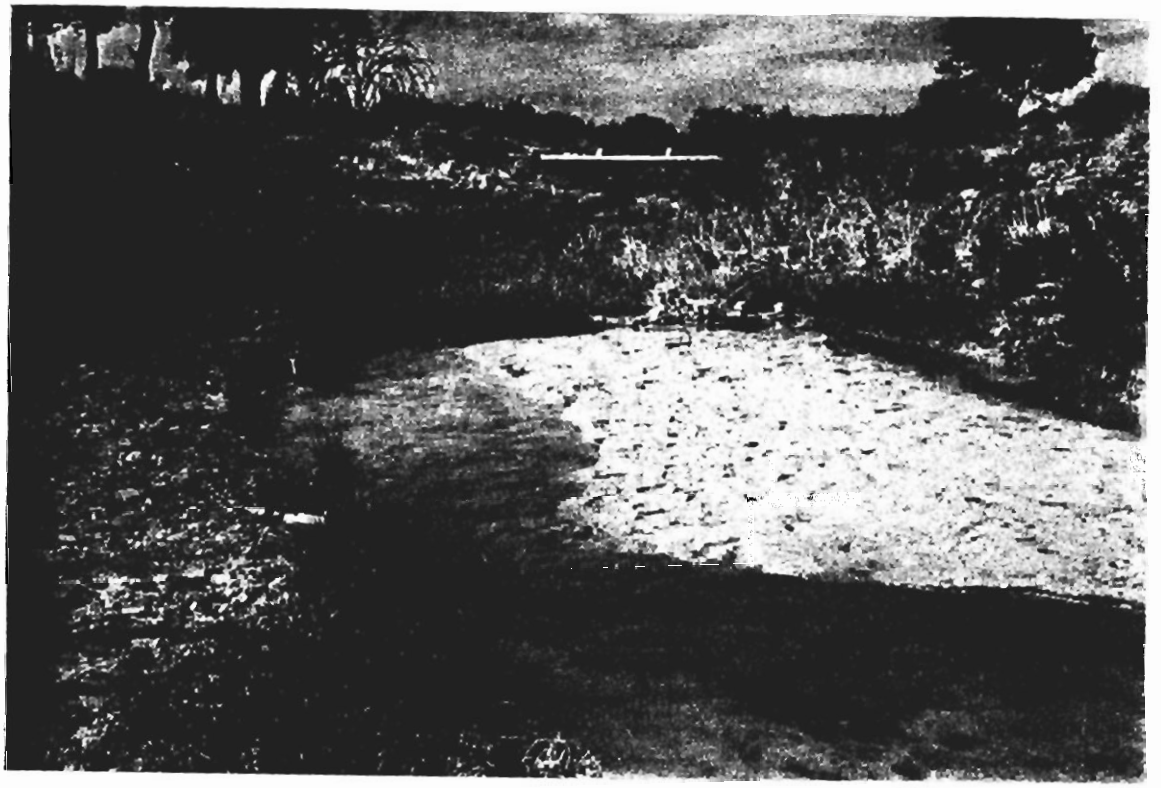
Phase 2, Baffle/Vane 3, May 19, 2004.



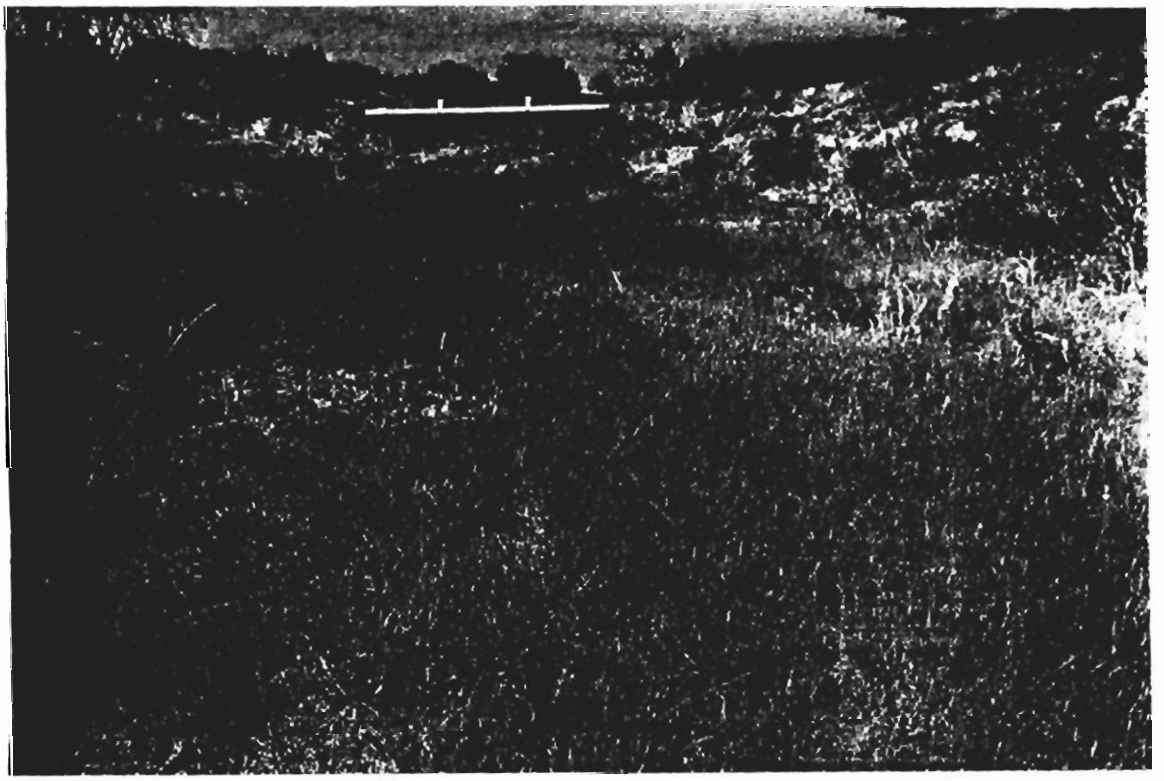
Phase 2, Riffle 5, May 19, 2004.



Phase 2, Baffle 4, May 19, 2004.



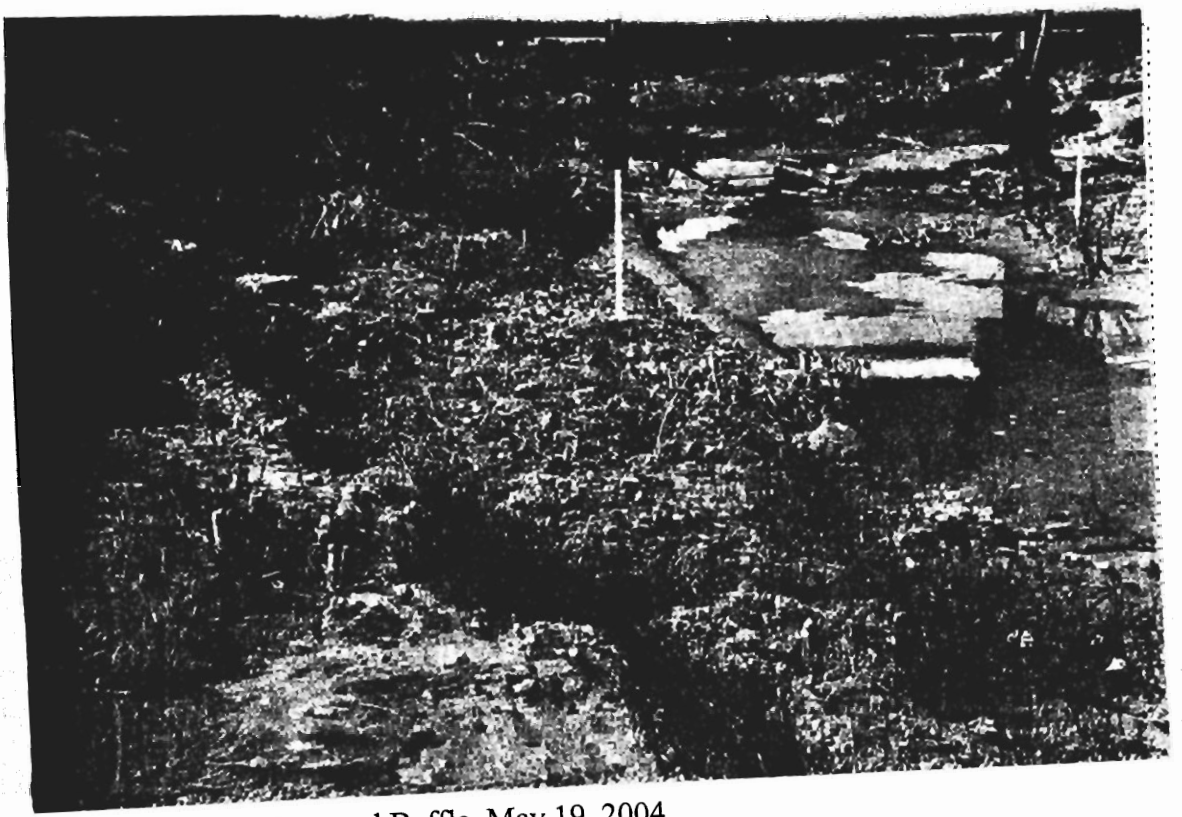
Phase 2, Baffle 5, May 19, 2004.



Phase 2, Riffle 7, May 19, 2004.



Phase 2, Baffle 6, May 19, 2004.



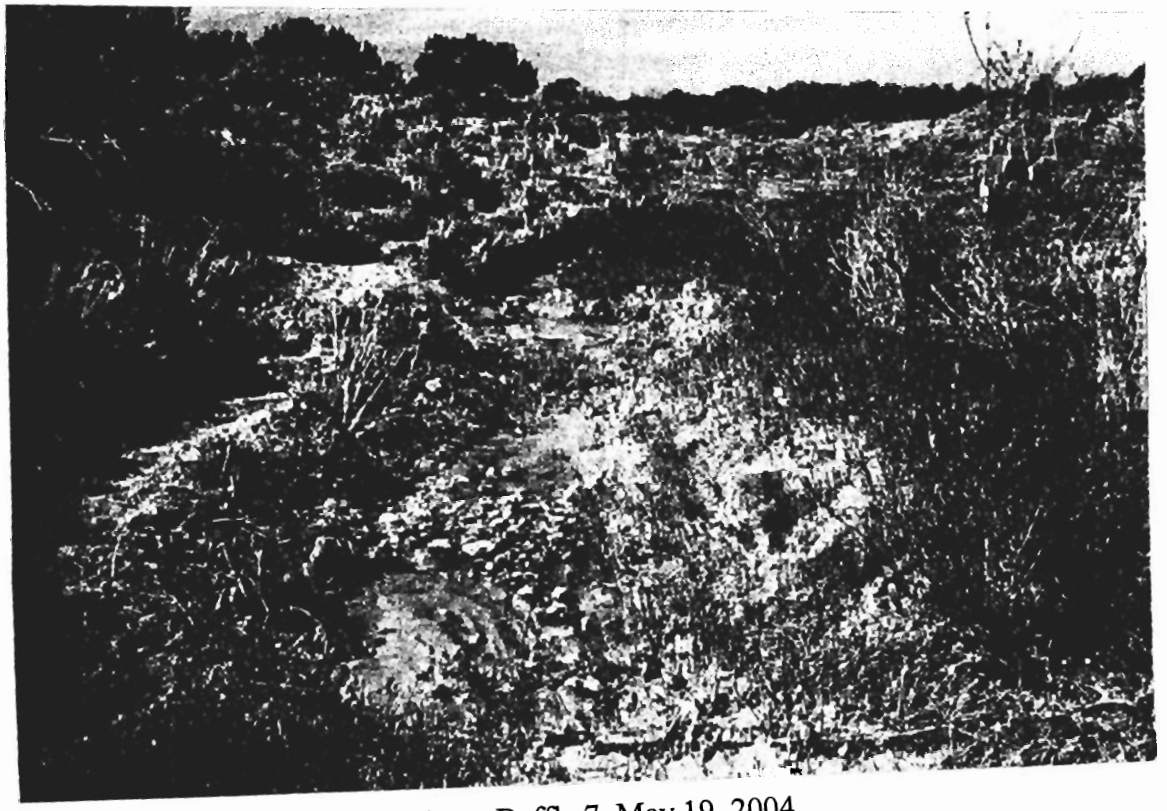
Phase 2, NTUA Vane and Baffle, May 19, 2004.



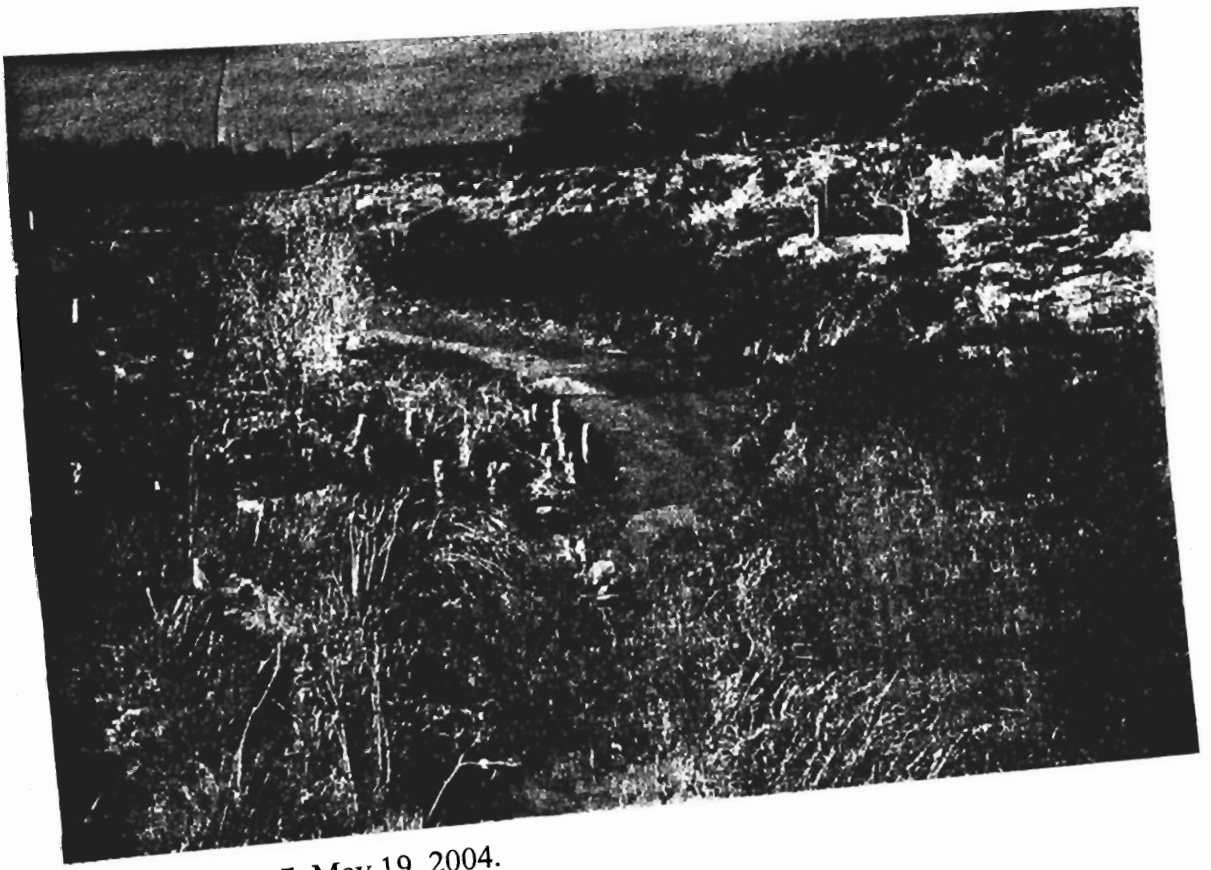
Phase 2, Riffle 10, May 19, 2004.



Phase 2, Baffle at Riffle 10, May 19, 2004.



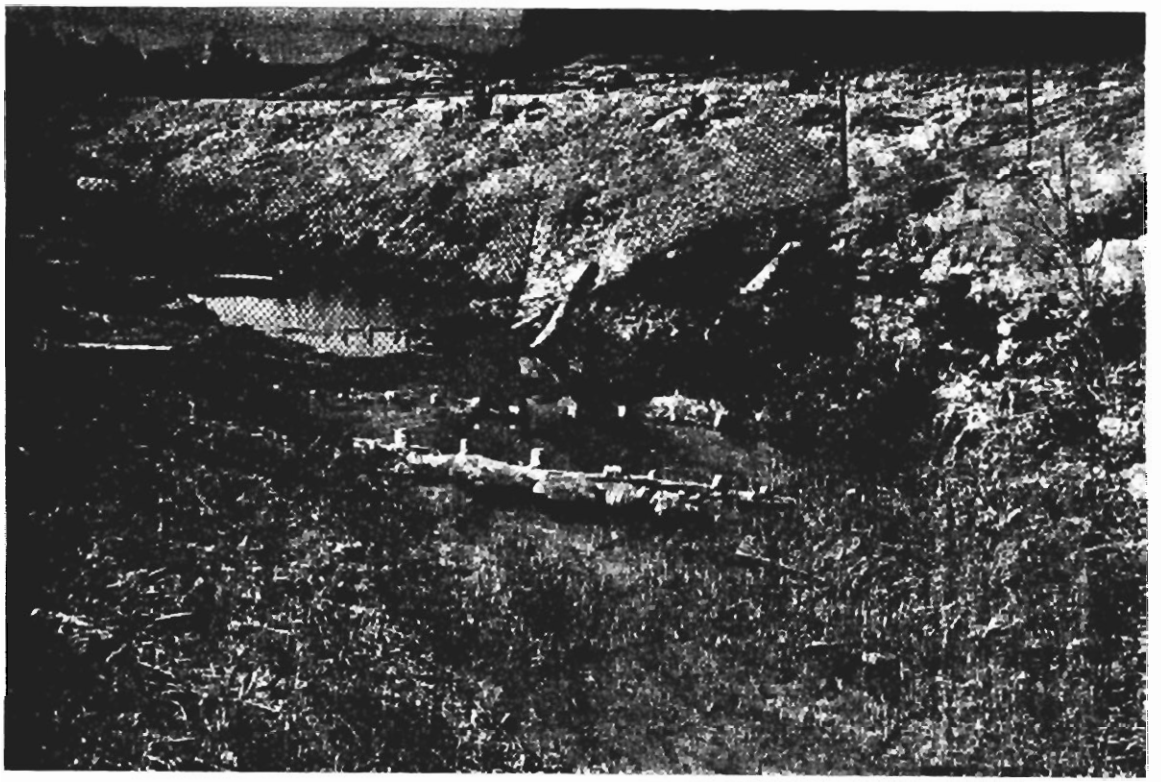
Phase 2, Evolving E Channel above Baffle 7, May 19, 2004.



Phase 2, Baffle 7, May 19, 2004.



Phase 2, Riffle 11 foreground, Baffle 8 midground, May 19, 2004.



Phase 2, Riffle 12. End of Phase 2 Reach. May 19, 2004

HUBBELL TRADING POST, NHS

PUEBLO COLORADO WASH

AWPF GRANT

NUMBER 00 - 104 WPF

APPENDIX IV

PERMANENT PHOTO RETAKES

OCTOBER 30, 2003



Photo Point 1, Retake October 30, 2003. Changes: August 2003 storm formed single thread channel at Baffle 1A, raised bed at Riffle 1, channel at Baffle 3 has widened.



Photo Point 2, October 30, 2003. Changes: Channel has narrowed to single thread, Point bar at Baffle 1A, Right bank is building higher.



Photo Point 3 v 1, Retake October 30, 2003. Changes: Renewed bank building at Baffle 4 and bed rise at Riffle 4 with additional sand deposits.



Photo Point 3 v 2, Retake October 30, 2003. Changes: Scirpus beds smothered in sand. Maximum flood stage, August 2003 storm exceeded 5 feet, 1 foot above right terrace.



Photo Point 3 v 3, Retake October 30, 2003. Changes: Low flow channel is braided, choked with sand.



Photo Point 3 v 4, Retake October 30, 2003. Changes: Post vane at Baffle 6 no longer visible, increased height and vigor of cottonwood poles planted on right bank.



Photo Point 4, Retake October 30, 2003. Changes: Channel has widened, bed elevation unchanged.



Photo Point 5 v 1, Retake October 30, 2003. Changes: Reduced sinuosity between Baffle 7 and Weir 2, bank building left foreground (North Bank).

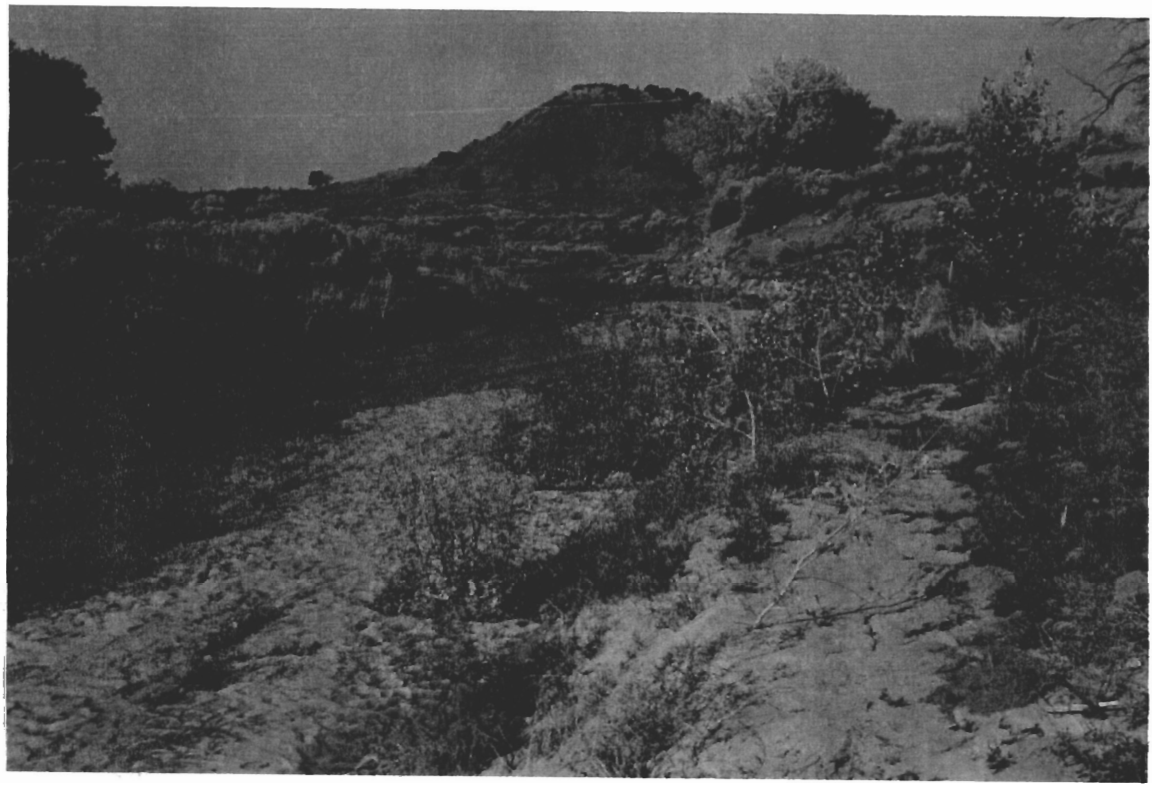


Photo Point 5 v 2, Retake October 30, 2003. Changes: Cutoff channel formed through Baffle 9, increased height and vigor of willow and cottonwoods right bank.



Photo Point 6 v 1, Retake October 30, 2003. Changes: Cutoff channel through Baffle 9 has reduced channel length and sinuosity.



Photo Point 6 v 2, Retake October 30, 2003. Changes: Cutoff channel evolving through Apex 2, to the left, significant bank building right, increased growth of willows.



Photo Point 7 v 1, Retake October 30, 2003. Changes: Channel, foreground, has widened and deepened due to debris dam at old bridge abutments left. Baffle 1 buried by sediments.



Photo Point 7 v 2, Retake October 30, 2003. Changes: Renewed bank building, left bank at Baffle 2, delta fan evolving, right, at Riffle 4.



Photo Point 8 v 1, Retake October 30, 2003. Changes: Rise in bed elevation, renewed scour of north bank.



Photo Point 8 v 2, Retake October 30, 2003. Changes: Rise in bed elevation, Baffle 5 covered, channel shifted toward right bank, bank building, left.



Photo Point 9 v 1, Retake October 30, 2003. Changes: Channel has widened, NTUA Baffle, foreground, buried by sand deposits, bank building both banks, vane buried.



Photo Point 9 v 2, Retake October 30, 2003. Changes: Channel, foreground, has moved left, channel has widened beneath pipeline.



Photo Point 10 v 1, Retake October 30, 2003. Changes: Increased growth and vigor of upland vegetation where woody exotics were removed, reduced sinuosity Phase 1 Reach.



Photo Point 10 v 2, Retake October 30, 2003. Changes: Reduced sinuosity Phase 1 Reach, bank building, Phase 2 Reach.



Photo Point 10 v 3, Retake October 30, 2003. Changes: Increased growth, vigor, density of vegetation on cleared area.

Photo Point 10 v 4, not taken.



Photo Point 11, Retake October 30, 2003. Changes: Profound shift of channel toward south bank, more narrow and deeper, increased channel length and sinuosity. Change due to erosion of sediment plug downstream on Navajo Reservation.



Photo Point 12 v 1, Retake October 30, 2003. Changes: Rise in bed elevation, Baffle 5 buried with sand, channel shift toward North bank as noted at P.P.8.



Photo Point 12 v 2, Retake October 30, 2003. Changes: Riffle 5 buried by rise in bed elevation, renewed bank building, South bank.



Photo Point 13 v 1, Retake October 30, 2003. Changes: Channel change at Apex 2, reduced sinuosity Phase 1.

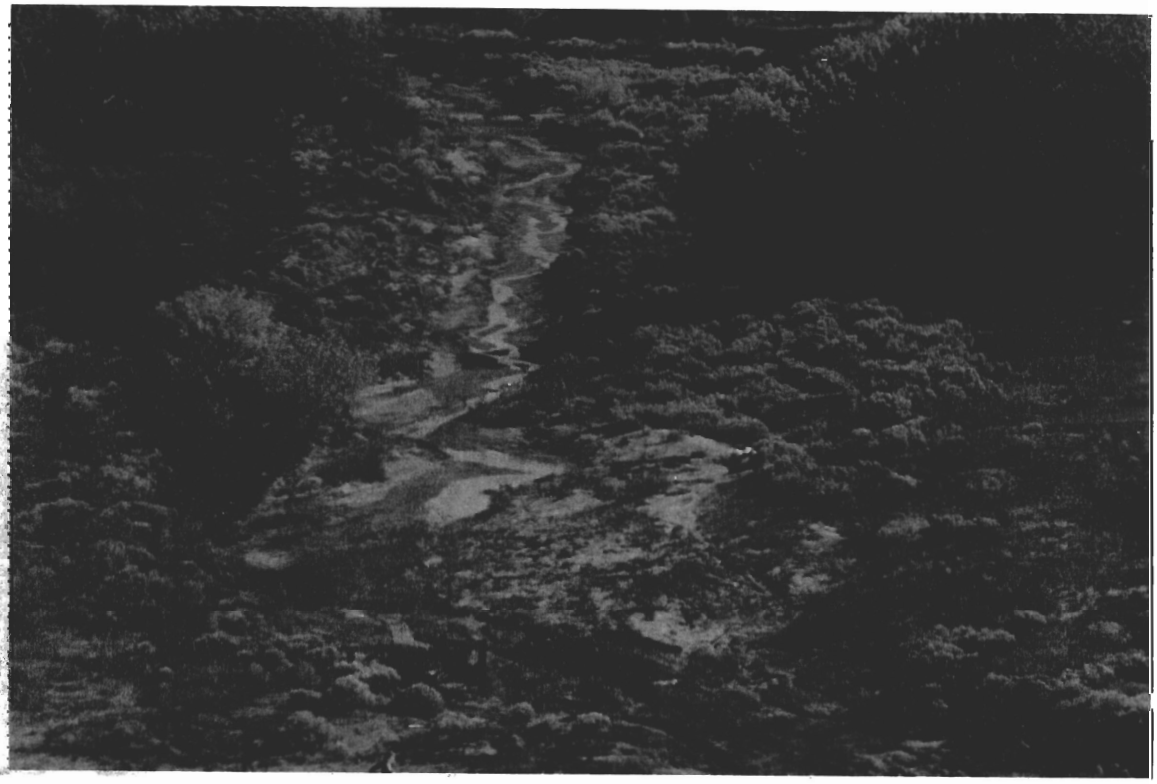


Photo Point 13 v 2, Retake October 30, 2003. Changes: Expansion of point bar at Apex 1, channel shift at Apex 2, as noted above, reduced sinuosity, Phase 1.

Appendix IV - a

Permanent Photo Point Retakes

Record Forms

October 30, 2003

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 1 Date 10/30/03 Time 9:30 am ~~pm~~
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Max ASA 400
Sigma 28-200

VIEW 1 1 of 2	VIEW 2	VIEW 3
Camera Height 48	Camera Height	Camera Height
Compass Bearing 451	Compass Bearing	Compass Bearing
Lens 50 Filter	Lens Filter	Lens Filter
F-stop 11 Speed 250	F-stop Speed	F-stop Speed
Focus Distance Inf	Focus Distance	Focus Distance

Condition of Point Monument and References: Good, Reposited 10/29/03

Weather conditions or recent events that may have influenced conditions at the site:
Bright, smokey haze, wind 20-30. Temp 45°

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height	Camera Height	Camera Height

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 2 Date 10/30/03 Time 9:35 am ~~pm~~
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Max ASA 400

3 + 4

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height_____	Camera Height_____
Compass Bearing 269	Compass Bearing_____	Compass Bearing_____
Lens 50 Filter_____	Lens_____ Filter_____	Lens_____ Filter_____
F-stop_____ Speed 250	F-stop_____ Speed_____	F-stop_____ Speed_____
Focus Distance Inf	Focus Distance_____	Focus Distance_____

Condition of Point Monument and References: Good, Repainted 10/29

Weather conditions or recent events that may have influenced conditions at the site:
Smoky haze, wind 20-30

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height_____	Camera Height_____	Camera Height_____

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 3 Date 10/30/03 Time_____ am pm
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Ranger ZX-5 Film Kodak Max ASA 400
- Sigma 28-200

VIEW 1 5x6	VIEW 2 7+8	VIEW 3 9+10	11+12
Camera Height 56	Camera Height 56	Camera Height 56	56
Compass Bearing 77	Compass Bearing 77	Compass Bearing 287	287
Lens 50 Filter_____	Lens 80 Filter_____	Lens 50 Filter_____	80
F-stop_____ Speed 250	F-stop_____ Speed 250	F-stop ~~22~~ Speed 250	100 250
Focus Distance 100	Focus Distance 100	Focus Distance 100	

Condition of Point Monument and References: Good, Refurbished 10/29

Weather conditions or recent events that may have influenced conditions at the site:

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____ Film_____ ASA_____
-

VIEW 1	VIEW 2	VIEW 3
Camera Height_____	Camera Height_____	Camera Height_____

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 4 Date 10/30/03 Time 9:55 am ~~pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeeclyk
Camera Pentax ZX-5 Film Kodak Max ASA 400
Sigma 28-200
13+14

VIEW 1	VIEW 2	VIEW 3
Camera Height 54	Camera Height_____	Camera Height_____
Compass Bearing 82	Compass Bearing_____	Compass Bearing_____
Lens 50 Filter_____	Lens_____ Filter_____	Lens_____ Filter_____
F-stop_____ Speed 500	F-stop_____ Speed_____	F-stop_____ Speed_____
Focus Distance 100	Focus Distance_____	Focus Distance_____

Condition of Point Monument and References: Good Repainted 10/29/03

Weather conditions or recent events that may have influenced conditions at the site:
Smoky haze, wind 20-30.

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height_____	Camera Height_____	Camera Height_____

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 5 Date 10/30/03 Time 10.05 am ~~pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax ~~ZX~~-5 Film Kodak Max ASA 400
Sigma 28-200

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height 48	Camera Height
Compass Bearing 93	Compass Bearing 275	Compass Bearing
Lens 50 Filter	Lens 50 Filter	Lens Filter
F-stop Speed 500	F-stop Speed 500	F-stop Speed
Focus Distance 150	Focus Distance 150	Focus Distance

15+16 17+18

Condition of Point Monument and References: Damaged by 2003 Flood, Replaced on ~~approximate~~ same location 10/29/03

Weather conditions or recent events that may have influenced conditions at the site:

Smoky haze, wind 20

Photo Point No._____ Date_____Time_____am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____Film_____ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height	Camera Height	Camera Height

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 6 Date 10/30/03 Time 10:17 am ~~pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-10
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax EX-5 Film Kodak Max ASA 400
Sigma 28-200

VIEW 1 (19 & 20)	VIEW 2 (21 & 22)	VIEW 3
Camera Height 60	Camera Height 60	Camera Height
Compass Bearing 88	Compass Bearing 271	Compass Bearing
Lens 50 Filter	Lens 50 Filter	Lens Filter
F-stop Speed 500	F-stop Speed	F-stop Speed
Focus Distance 100	Focus Distance 100	Focus Distance

Condition of Point Monument and References: Good, Repainted 10/29/03

Weather conditions or recent events that may have influenced conditions at the site:
Wind 20-30+

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height	Camera Height	Camera Height

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 7 Date 10/30/03 Time 10:25 am ~~pm~~
Project Name Hubbell Tracking Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax EXL5 Film Kodak Max ASA 400
Sigma 28-200

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height 48	Camera Height
Compass Bearing 83	Compass Bearing 228	Compass Bearing
Lens 50 Filter ~~Zpo~~	Lens 50 Filter ~~Zpo~~	Lens Filter
F-stop Speed 250	F-stop Speed 250	F-stop Speed
Focus Distance 100	Focus Distance 100	Focus Distance

23+24 25+1

Condition of Point Monument and References: Damaged, repaired, reparinted 10/29/30

Weather conditions or recent events that may have influenced conditions at the site:
~~[illegible]~~
Wind.. 20-30+

Photo Point No._____ Date_____ Time_____ am pm
Project Name _____ WPF Grant No._____
L Landowner/Management Unit
_____ County_____
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height	Camera Height	Camera Height

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 8 Date 10/30/03 Time 10:40 am pm
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak MAX ASA 400
Sigma 28-200

VIEW 1 (2+3)	VIEW 2 (4+5)	VIEW 3
Camera Height 48	Camera Height 48	Camera Height
Compass Bearing 15	Compass Bearing 215	Compass Bearing
Lens 50 Filter	Lens 50 Filter	Lens Filter
F-stop Speed 500	F-stop Speed 500	F-stop Speed
Focus Distance 100	Focus Distance Inf	Focus Distance

Condition of Point Monument and References: Damaged, Repaired, Repainted 10/29/03

Weather conditions or recent events that may have influenced conditions at the site:
Views obscured by vegetation
Wind 30+

Photo Point No._____ Date_____Time_____am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____Film_____ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height	Camera Height	Camera Height

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 9 Date 10/30/03 Time 11:05 ~~am pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Max ASA 400
Sigma 28-200

VIEW 1 (10 & 11)	VIEW 2 (12 & 13)	VIEW 3
Camera Height 5'	Camera Height 5'	Camera Height
Compass Bearing 43	Compass Bearing 254	Compass Bearing
Lens 50 Filter	Lens 50 Filter	Lens Filter
F-stop Speed 500	F-stop Speed 500	F-stop Speed
Focus Distance Inf	Focus Distance Inf	Focus Distance

Condition of Point Monument and References: Repainted 10/29/03

Weather conditions or recent events that may have influenced conditions at the site:
Dust, smoky haze, wind 40+

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height	Camera Height	Camera Height

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 10 Date 10/30/03 Time 11:40 am ~~pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Max ASA 400
- Sigma 28-200

VIEW 1	VIEW 2	VIEW 3
Camera Height 58	Camera Height 58	Camera Height 58
Compass Bearing 77	Compass Bearing 77	Compass Bearing
Lens 50 Filter	Lens 80 Filter	Lens 80 Filter
F-stop Speed 500	F-stop Speed 500	F-stop Speed 500
Focus Distance Inf	Focus Distance Inf	Focus Distance Inf

.58
35
1 of

Condition of Point Monument and References: Good, repaired 10/29/03

Weather conditions or recent events that may have influenced conditions at the site:
View 4 not taken due to wind. wind 40+, blowing sand.

Photo Point No._____ Date_____ Time_____ am pm
Project Name _____ WPF Grant No._____
L Landowner/Management Unit
_____ County_____
Photographer_____
Camera_____ Film_____ ASA_____
-

VIEW 1	VIEW 2	VIEW 3
Camera Height_____	Camera Height_____	Camera Height_____

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 11 Date 10/30/03 Time 11:15 am ~~pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Max ASA 400
Sigma 28-200
14 + 15

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height_____	Camera Height_____
Compass Bearing_____	Compass Bearing_____	Compass Bearing_____
Lens 50 Filter_____	Lens_____ Filter_____	Lens_____ Filter_____
F-stop_____ Speed_____	F-stop_____ Speed_____	F-stop_____ Speed_____
Focus Distance 100	Focus Distance_____	Focus Distance_____

Condition of Point Monument and
References: Midslope, Right Bank, 5 Feet east of fence. Staked + painted 10/2 03

Weather conditions or recent events that may have influenced conditions at the site:
Dust + smoky haze. Wind 30-40

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height_____	Camera Height_____	Camera Height_____

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 12 Date 10/30/03 Time 10:50 am pm
Project Name Hubbell Trading Post WPF Grant No. ~~[illegible]~~ 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax EX-5 Film Kodak Nox ASA 400

6+7 5+9

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height 48	Camera Height_____
Compass Bearing 194	Compass Bearing 44	Compass Bearing_____
Lens 50 Filter_____	Lens 35 Filter_____	Lens_____ Filter_____
F-stop_____ Speed 500	F-stop_____ Speed 500	F-stop_____ Speed_____
Focus Distance Inf	Focus Distance 10'	Focus Distance_____

Condition of Point Monument and References: Repainted 10/29/03

Weather conditions or recent events that may have influenced conditions at the site:
Smoky haze, wind SW

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height_____	Camera Height_____	Camera Height_____

HUBBELL TRADING POST, NHS

PUEBLO COLORADO WASH

AWPF GRANT

NUMBER 00 - 104 WPF

Appendix V

PERMANENT PHOTO RETAKES

MAY 18, 2004

Appendix V - a

PERMANENT PHOTO POINT
RETAKES

RECORD FORMS

MAY 18, 2004

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 1 Date 5/18/04 Time 9:18 am ~~pm~~
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold 200 ASA 200
- Frame 1-2

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height	Camera Height
Compass Bearing 251	Compass Bearing	Compass Bearing
Lens 50 Filter	Lens Filter	Lens Filter
F-stop 11 Speed 250	F-stop Speed	F-stop Speed
Focus Distance Inf	Focus Distance	Focus Distance

Condition of Point Monument and References: Exc Reguinted 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:
Clear, windy 15-20, Dry

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 2 Date 5/18/04 Time 9:25 am pm
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
- Frame 3-4

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height	Camera Height
Compass Bearing 269	Compass Bearing	Compass Bearing
Lens 50 Filter	Lens Filter	Lens Filter
F-stop 11 Speed 250	F-stop Speed	F-stop Speed
Focus Distance Inf	Focus Distance	Focus Distance

Condition of Point Monument and References: Exc. Reguinted 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:
Clear, Dry Windy 15-20

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 3 Date 5/18/04 Time 9:40 am ~~pm~~
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200

From 5+6 From 7+8 From 9+10 From 11+12 View 4

VIEW 1	VIEW 2	VIEW 3	56
Camera Height 56	Camera Height 56	Camera Height 56	287
Compass Bearing 77	Compass Bearing 77	Compass Bearing 287	50
Lens 50 Filter	Lens 50 Filter	Lens 50 Filter	8 - 25
F-stop 11 Speed 250	F-stop 8 Speed 250	F-stop 11 Speed 250	100
Focus Distance 100	Focus Distance 100	Focus Distance 100	

Condition of Point Monument and References: Exc Reg'd 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:

Clear, Windy, Dry

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 4 Date 5/18/04 Time 9:56 am ~~pm~~
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200

From 13+14

VIEW 1	VIEW 2	VIEW 3
Camera Height 54	Camera Height	Camera Height
Compass Bearing 82	Compass Bearing	Compass Bearing
Lens 50 Filter	Lens Filter	Lens Filter
F-stop 11 Speed 250	F-stop Speed	F-stop Speed
Focus Distance 100	Focus Distance	Focus Distance

Condition of Point Monument and References: Restaked, Reg'd 5/17/04, Relocated 1 ~~2~~' Northeast

Weather conditions or recent events that may have influenced conditions at the site:

Clear, wind 5-10

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 5 Date 5/18/04 Time 10:01 am ~~pm~~
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
- Frame 15+16 From 17+18

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height 48	Camera Height
Compass Bearing 93	Compass Bearing 275	Compass Bearing
Lens 50 Filter	Lens 50 Filter	Lens Filter
F-stop 11 Speed 500	F-stop 11 Speed 500	F-stop Speed
Focus Distance 150	Focus Distance 150	Focus Distance

Condition of Point Monument and References: Remonumented on same location, Reprinted 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:
Clear, wind 5-10

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 6 Date 5/18/04 Time 10:05 am ~~pm~~
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
- Frame 19+20 From 21-22

VIEW 1	VIEW 2	VIEW 3
Camera Height 60	Camera Height 60	Camera Height
Compass Bearing 85	Compass Bearing 271	Compass Bearing
Lens 50 Filter	Lens 50 Filter	Lens Filter
F-stop 11 Speed 500	F-stop 11 Speed 500	F-stop Speed
Focus Distance 100	Focus Distance 100	Focus Distance

Condition of Point Monument and References: Exc. Reprinted 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:
Windy 5-10, Clear.

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 7 Date 5/18/04 Time 10:25* am ~~pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
Sigma 28-200
Frame 23+24 From 1+2*

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height 48	Camera Height
Compass Bearing 83	Compass Bearing 228	Compass Bearing
Lens 50 Filter	Lens 50 Filter	Lens Filter
F-stop 11 Speed 500	F-stop 11 Speed 500	F-stop Speed
Focus Distance 100	Focus Distance 100	Focus Distance

Condition of Point Monument and References: Exc. Reposinted 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:

* Camera jammed after 1st Roll. Continued photo retake with new roll of film at 11:00 am.

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 8 Date 5/18/04 Time 11:13 am ~~pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
Sigma 28-200
Frame 7+8 Frame 9+10

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height 48	Camera Height
Compass Bearing 15	Compass Bearing 215	Compass Bearing
Lens 50 Filter	Lens 60 Filter	Lens Filter
F-stop 11 Speed 500	F-stop 11 Speed 500	F-stop Speed
Focus Distance 100	Focus Distance 15ft	Focus Distance

Condition of Point Monument and References: Exc. Reposinted, Remonumented 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:

Clear, wind 5-10

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 9 Date 5/18/04 Time 11:25 am ~~pm~~
Project Name Hubbell Trading Post UHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
Sigma 28-200

VIEW 1	VIEW 2	VIEW 3
From 11+12	From 13+14	
Camera Height 54	Camera Height 54	Camera Height
Compass Bearing 43	Compass Bearing 254	Compass Bearing
Lens 50 Filter	Lens 50 Filter	Lens Filter
F-stop 11 Speed 500	F-stop 11 Speed 500	F-stop Speed
Focus Distance Inf	Focus Distance Inf	Focus Distance

Condition of Point Monument and References: Exc, Remonument, Reprint 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:
Clear windy 10-15

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 10 Date 5/18/04 Time 11:50 am ~~pm~~
Project Name Hubbell Trading Post UHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
Sigma 28-200

VIEW 1	VIEW 2	VIEW 3
~~From~~ 19	~~From~~ 20+21	From 22+23 24+25 ~~23+24~~
Camera Height 58	Camera Height 58	Camera Height 58 58
Compass Bearing 77	Compass Bearing 72	Compass Bearing
Lens 50 Filter	Lens 80 Filter	Lens 50 Filter 35
F-stop 11 Speed 500	F-stop 11 Speed 500	F-stop 11 Speed 500
Focus Distance Inf	Focus Distance Inf	Focus Distance Inf

Condition of Point Monument and References: Good,

Weather conditions or recent events that may have influenced conditions at the site:
Very windy 30-40+, Difficult conditions

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 11 Date 5/18/04 Time 11:32 am ~~pm~~
Project Name _____ WPF Grant No. 00-104
L Landowner/Management Unit
_____ County _____
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
Sigma 28-200
- Frame 15+16

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height	Camera Height
Compass Bearing	Compass Bearing	Compass Bearing
Lens 50 Filter	Lens Filter	Lens Filter
F-stop 11 Speed 500	F-stop Speed	F-stop Speed
Focus Distance 100	Focus Distance	Focus Distance

Condition of Point Monument and
References: Permanent, Repaint 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:
Clear, wind 10-20

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 12 Date 5/13/04 Time 11:05 am ~~pm~~
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
_____ County _____
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
- Frame 3+4 Frame 5+6

VIEW 1	VIEW 2	VIEW 3
Camera Height 48	Camera Height 48	Camera Height
Compass Bearing 194	Compass Bearing 44	Compass Bearing
Lens 50 Filter	Lens 35 Filter	Lens Filter
F-stop 11 Speed 500	F-stop 11 Speed 500	F-stop Speed
Focus Distance Inf	Focus Distance 100	Focus Distance

Condition of Point Monument and
References: Repainted 5/17/04

Weather conditions or recent events that may have influenced conditions at the site:
clear wind 5-10

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 13 Date 5/18/04 Time 11:45 am ~~pm~~
Project Name Hubbell Trading Post NHS WPF Grant No. 00-104
L Landowner/Management Unit
County
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Gold ASA 200
Sigma 28-200

Frame 17 Frame 18

VIEW 1	VIEW 2	VIEW 3
Camera Height 54	Camera Height 54	Camera Height
Compass Bearing 94	Compass Bearing 94	Compass Bearing
Lens 80 Filter	Lens 200 Filter	Lens Filter
F-stop 8 Speed 250	F-stop 6.3 Speed 250	F-stop Speed
Focus Distance Inf	Focus Distance Inf	Focus Distance

Condition of Point Monument and
References: 4 Feet East of Lana Hubbell Gravestone. Not marked.

Weather conditions or recent events that may have influenced conditions at the site:

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. Date Time am pm
Project Name WPF Grant No.
L Landowner/Management Unit
County
Photographer
Camera Film ASA

VIEW 1	VIEW 2	VIEW 3
Camera Height	Camera Height	Camera Height
Compass Bearing	Compass Bearing	Compass Bearing
Lens Filter	Lens Filter	Lens Filter
F-stop Speed	F-stop Speed	F-stop Speed
Focus Distance	Focus Distance	Focus Distance

Condition of Point Monument and
References:

Weather conditions or recent events that may have influenced conditions at the site:

Bearing and distance____

Reference Point 3
Description_____

Bearing and distance____

RETAKE

PERMANENT PHOTO POINT RECORD

Photo Point No. 13 Date 10/30/03 Time 11:35 am pm
Project Name Hubbell Trading Post WPF Grant No. 00-104
L Landowner/Management Unit
County_____
Photographer Bill Zeedyk
Camera Pentax ZX-5 Film Kodak Max ASA 400
Sigma 28-200

VIEW 1	VIEW 2	VIEW 3
Camera Height 54	Camera Height 54	Camera Height
Compass Bearing 94	Compass Bearing 94	Compass Bearing
Lens 80 Filter	Lens 200 Filter	Lens Filter
F-stop Speed	F-stop Speed	F-stop Speed
Focus Distance Inf	Focus Distance Inf	Focus Distance

Condition of Point Monument and References: 4 Feet East of Lena Hubbell Gravestone. Not marked.

Weather conditions or recent events that may have influenced conditions at the site:

Photo Point No._____ Date_____ Time_____ am pm
Project Name_____ WPF Grant No._____
L Landowner/Management Unit
County_____
Photographer_____
Camera_____ Film_____ ASA_____

VIEW 1	VIEW 2	VIEW 3
Camera Height	Camera Height	Camera Height

FINAL REPORT

AWPF GRANT NO. 00-104WPF

EXOTIC SPECIES ERADICATION AND NATIVE SPECIES

REVEGETATION AND VEGETATION MONITORING

JUNE 30, 2004

FINAL REPORT
Exotic Species Eradication
Native Species Revegetation
Due June 30, 2004

Exotic Species Eradication

Exotic species eradication within the park boundary has essentially been completed except for a thin fringe of Russian Olive/Tamarisk along our northern boundary which acts as a screen/buffer for an adjacent private homesite to the north. Additional thinning of this stretch occurs each year. With continuous and consistent removal of resprouts from all areas treated in previous years of the project, for all intensive purposes, the Russian Olive/Tamarisk is gone. However, because of the continuous source of seeds upstream, monitoring of resprouts will need to continue. Although the percentage of resprouts declines, if left untreated, the new plants can get out of hand quickly.

Removal of exotic species along the riparian area of the Pueblo Colorado Wash on Navajo Nation land (outside the AWPF project boundary) has also continued with our most current efforts focussed downstream of the park. We have eliminated most of the exotics for one mile upstream and one mile downstream of the park. Student Conservation Association crews selected from local Navajo youth in the community and funded through Public Land Corps grants and Wildland Urban Interface funds were responsible for all of the cutting and treating in late 2003 and 2004. These efforts are helping to maintain the exotic-free AWPF project area.

A Mesa Verde Fire Crew assisted by fire personnel from Ganado Fire District burned many of the slash piles under strict fire management controls in February 2004. The burn permit from Navajo Nation is attached as well as the signed cover sheet of the Burn Plan prescribed for the park.

Native Species Revegetation

Volunteers from the University of New Mexico, Albuquerque campus and from Outdoor Arizona were here the weekend of March 13, 2004 to help with maintenance of instream structures and some willow planting. A survey of the Wash environment in early July could not determine individual plants because so much vegetation had grown up along the stream edge despite continuing drought conditions. Willow bunches had grown together and spread. Only a small sliver of sand remains in the center of the channel. The only permanent pool existing before a bankful event on July 26, 2004 was located at the springs at the east end of the project area yet the vegetation is flourishing throughout the project area, Phase 1 and Phase 2. Several stands of willow are 5 feet tall, bullrush is plentiful and the grasses are well established. Cottonwoods that have been naturally recruited from seeds from on-site sources seem to be the most successful. Some of the cottonwood poles that were planted are establishing themselves but the success rate of the planted poles is not as high. Certain environments and/or soil types are more conducive to greater viability, but the reasons for this is not always readily apparent.

Planted willow cuttings do even better than the cottonwoods. Almost all of the willows succeed in growing, and most are flourishing. They spread by themselves and withstand high water events. It is not always possible to accurately monitor numbers of willow clumps at this stage in

the restoration because they disperse and spread so easily. In general, they do better than the cottonwood poles.

The return of scirpus/juncus after excluding livestock has been quite dramatic. In both 2003 and 2004, it has been obvious that deer are frequenting the riparian area near the permanent pool. In July, 2004, two male elk were observed crossing our entrance road on their way to the pool.

Another project funded through the National Park Service Cooperative Conservation Initiative funded additional plantings of native riparian species that were no longer present in the Wash, but which, when established, will hopefully increase the potential for wildlife habitat in the Wash environment. Three hundred and ninety nine plants were obtained from the Natural Resource Conservation Service, Los Lunas Native Plants Materials. These plants were planted with PVC pipes set in adjacent to the plant so that watering would go directly to the roots of the plant. A July 7, 2004 monitoring indicated a high survival rate. Only 4 plants have not survived.

Despite continuing drought conditions in the southwest which has affected plant viability over the last several years, 2004 has produced the most dramatic season of instream vegetation.

In previous years, high water events have adversely affected plants placed at bankful level or below due to the extreme force of the high water. Cottonwood poles were broken off at ground level or considerable debris would gather on the upstream side, applying weight and pressure on the pole. With natural recruitment, only the strongest seedlings will survive these events. However, the original high number of seedlings guarantees that even the small proportion that do rebound from the high water event can eventually lead to large enough trees to produce a grove of mature trees. In our plantings, the small number of poles planted in comparison to the naturally regenerated seedlings which appear before the high water events can not replicate the natural situation (i.e. we lose most if not all the poles).

NAVAJO AIR QUALITY CONTROL PROGRAM

PO Box 529
Fort Defiance, AZ 86504
TEL: (520) 729-4246
FAX: (520) 729-4323

OPEN BURNING PERMIT

Permission to burn: *Slash burn / weed abatement*

At: *Hubbell Trading Post*

To: *Nancy Stone, Hubbell Trading Post* TEL: *928/755-3475*

Address: *P.O. Box 150, Ganado, Arizona* FAX: *928/755-3405*

is granted by the Director of the Navajo Environmental Protection Administration subject to the following conditions:

1. This permit is valid until *02 February 2004 to 02 March 2004*

2. Burning shall be conducted between *8:00 a.m.- 5:00 p.m.*

3. Material to be burned shall be readily combustible and piled [x] collected in a pit [ ] placed in an approved waste burner [ ] ignited in place using high temperature mechanical burners on ditch banks and/or fence rows [ ] in such quantities that it will be completely consumed within the permitted burn hours.

4. Piled or pit contained material shall be no less than 50 feet from any structure. Burner contained material shall be no less than 15 feet from any structure.

5. **Open burning of the following materials is forbidden: asphalt shingles, tar paper, plastic and rubber products (such as tires and electrical wire insulation), waste petroleum products (such as waste crankcase oil, transmission oil and oil filters), hazardous material containers including those that contained inorganic pesticides, lead, cadmium, mercury, or arsenic compounds.**

6. No fire shall be ignited when any air stagnation advisory is in effect in the area of the burn, or during periods when smoke can be expected to accumulate to the extent that it will significantly impair visibility. Such visibility impairment can be anticipated during periods of heavy regional haze and/or calm wind conditions.

7. If practical, the local fire fighting agency shall be notified prior to the setting of the fire. Such agency may prohibit open burning when atmospheric conditions or local circumstances make such fires hazardous.

8. Burning shall be conducted only during wind conditions which prevent dispersion of smoke into populated areas, visibility impairment on traveled roads or airports to the extent that a safety hazard results, or otherwise create a public nuisance, and do not cause uncontrollable spreading of the fire.

9. Fires shall be attended at all times and the person attending the fire shall have available the necessary equipment (water supply, water hose, shovel, sand, etc.) to control the burning and to put out the fire if the need arises. Fires must be completely extinguished before leaving unattended.

10. This permit shall not be construed to relieve the permittee from liability from resulting damages or the obligation to comply with other applicable laws, regulations, or ordinances.

11. Person(s) conducting open burning authorized by this permit shall have a copy of the permit on-site during permitted open burning operations.

Senior Environmental Specialist's Name: Iris Shirley Date: *23 January 2004*

Iris Shirley, Senior Environmental Specialist

NATIONAL PARK SERVICE
HUBBELL TRADING POST N.H.S.

Hubbell Prescribed Burn Plan

Winter/Spring 2004

Prepared by: _____ Date: 1/30/04
Doug Paul
Fuels specialist

Recommended by: _____ Date: 1/30/04
Ross Wilmore
MEVE Fire Management Officer

Approved by: _____ Date: 2/4/04
Nancy Stone
HUTR Superintendent

The approved Prescribed Fire Plan constitutes a delegation of authority to burn. No one has the authority to burn without an approved plan or in a manner not in compliance with the approved plan. Actions taken in compliance with the approved Prescribed Fire Plan will be fully supported. Personnel will be held accountable for actions taken which are not in compliance with elements of the approved plan regarding execution in a safe and cost-effective manner.

FINAL REPORT

AWPF GRANT NO. 00-104WPF

WATER QUALITY AND QUANTITY MONITORING

JUNE 30, 2004

DEMONSTRATION ENHANCEMENT OF PUEBLO COLORADO WASH

HUBBELL TRADING POST NATIONAL HISTORIC SITE

GRANT NO. 97-029WPF

WATER QUANTITY/QUALITY MONITORING

PREPARED BY

THE NAVAJO NATION ENVIRONMENTAL PROTECTION AGENCY

WATER QUALITY PROGRAM

JULY 2, 2004

DISCUSSION OF MONITORING ACTIVITIES:

One water quality sample event happened on March 25, 2004. The results are attached in Appendix A. Water quality results were within limits set by the Navajo Nation Water Quality Standards. Comparisons of water quality data for previous years show no significant water quality improvements to already good water quality. Sediment loads to the project reach can be extremely heavy during precipitation events and spring snowmelt. The project's vegetative component has responded very well and continues to expand. Flows are being slowed by the vegetation, as projected, thereby allowing suspended sediment deposition. The stream bottom has aggraded and the point bars have increased in size. There are flow events that overwhelm the project reach with sediment. These events cause the turbidity to spike above the standard. Until the condition of the upper watershed is addressed, turbidity spikes will continue to happen.

The crest stage gage and monitoring wells were read once during the year. These activities took place on June 29, 2004. The monitoring forms, with results, are attached in Appendix B. The area is still in drought. However, within the past year, an event occurred that tore the crest stage gage away from its support. The bridge pier adjacent to the gage had debris wrapped around it at approximately 5.5 feet above the stream channel. No reading could be obtained from the gage.

The shallow well water levels continue to fluctuate. A comparison of the yearly data indicates no sustained increase in shallow groundwater levels at either well. However, with the drought as a factor, and there having been no significant precipitation since late March, the water level in Well # W1 is over three feet higher than last year. The water level in Well # W2 has remained essentially the same. This could possibly indicate that channel aggradation and increased riparian vegetation have increased the storage capacity of the alluvial aquifer and that moisture is moving laterally from the channel into the streambanks. If that is the case, the project has been successful in attaining that goal.

The precipitation gage survey was nonexistent this year. The Navajo Nation Water Management Branch had been collecting precipitation data. However, this past year the rain can was ignored with no data collection and no maintenance. That data sheet is included in Appendix C. Precipitation overall is below normal for the year. Snowpack was 98% of normal during February but had dropped to 8% of normal by mid March due to very warm temperatures and a rapid runoff period. There were two days of limited, spotty rains during June. The rainy season normally occurs during July and August but has been known not to start until September.

Overall, water quality continues to be good except for spikes in turbidity. No significant improvements in water quality have been observed during the project period. However, water quality, except for turbidity, was good to start with. Sediment deposition is occurring due to vegetative and geomorphic factors. Water quantity in the alluvium is stable or has shown an increased despite the drought. There is good riparian vegetative growth in the channel, at bankfull, and in the floodprone areas indicating adequate subsurface flows or stored moisture.

APPENDIX A

WATER QUALITY SAMPLE RESULTS

Aerotech Environmental — Analytical Report

Date: *19-Apr-04*

CLIENT: Navajo Nation EPA Water Quality
Lab Order: 04031377
Project: Long Term Suite 2004
Lab ID: 04031377-01A

Client Sample: 18PUEBLOCO02
Tag Number:
Collection: 3/25/2004 12:30:00 PM
Matrix: WATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ANIONS BY ION CHROMATOGRAPHY		E300				Analyst: LB
Chloride	160	10	D2	mg/L	5	4/6/2004 12:59:00 AM
Fluoride	< 0.40	0.40		mg/L	1	3/26/2004 7:01:00 PM
Nitrogen, Nitrate (As N)	< 0.20	0.20		mg/L	1	3/26/2004 7:01:00 PM
Sulfate	44	2.0		mg/L	1	3/26/2004 7:01:00 PM
ALKALINITY		M2320 B				Analyst: T A
Alkalinity, Bicarbonate (As CaCO3)	190	2.0		mg/L CaCO3	1	4/2/2004
Alkalinity, Carbonate (As CaCO3)	< 2.0	2.0		mg/L CaCO3	1	4/2/2004
Alkalinity, Hydroxide (As CaCO3)	< 2.0	2.0		mg/L CaCO3	1	4/2/2004
Alkalinity, Total (As CaCO3)	190	6.0		mg/L CaCO3	1	4/2/2004
RESIDUE, FILTERABLE		M2540 C				Analyst: AC
Total Dissolved Solids	550	10		mg/L	1	3/30/2004
RESIDUE, NON-FILTERABLE		E160.2				Analyst: T A
Suspended Solids (Residue, Non-Filterable)	24	10		mg/L	1	3/31/2004

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory

Aerotech Environmental — Analytical Report — Date: *19-Apr-04*

CLIENT: Navajo Nation EPA Water Quality
Lab Order: 04031377
Project: Long Term Suite 2004
Lab ID: 04031377-01B

Client Sample: 18PUEBLOCO02
Tag Number:
Collection: 3/25/2004 12:30:00 PM
Matrix: WATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ICP METALS, TOTAL RECOVERABLE		**E200.7**				Analyst: TD
Aluminum	1.1	0.10		mg/L	1	3/29/2004
Boron	0.23	0.050		mg/L	1	3/29/2004
Calcium	76	2.0		mg/L	1	3/29/2004
Hardness, Calcium (As CaCO3)	190	5.0		mg/L	1	3/29/2004
Magnesium	15	2.0		mg/L	1	3/29/2004
ICP METALS, DISSOLVED		**E200.7**				Analyst: TD
Cobalt, Dissolved	< 0.010	0.010		mg/L	1	3/29/2004
Molybdenum, Dissolved	< 0.010	0.010		mg/L	1	3/29/2004
Vanadium, Dissolved	< 0.010	0.010		mg/L	1	3/29/2004
ICP/MS METALS, TOTAL RECOVERABLE		**E200.8**				Analyst: RF
Antimony	< 0.0010	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Arsenic	0.0024	0.0010		mg/L	1	3/31/2004 1:12:18 PM
Barium	0.30	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Beryllium	< 0.0010	0.0010		mg/L	1	4/1/2004 8:41:33 AM
Cadmium	< 0.0010	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Chromium	< 0.0010	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Copper	0.0022	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Lead	< 0.0010	0.0010		mg/L	1	3/31/2004 1:12:18 PM
Molybdenum	0.0013	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Nickel	0.0092	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Selenium	< 0.0010	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Silver	< 0.0010	0.0010		mg/L	1	3/30/2004 12:27:14 PM
Thallium	< 0.0010	0.0010		mg/L	1	3/31/2004 1:12:18 PM
Zinc	< 0.010	0.010		mg/L	1	3/30/2004 12:27:14 PM
ICP/MS METALS, DISSOLVED		**E200.8**				Analyst: RF
Antimony, Dissolved	< 0.0010	0.0010		mg/L	1	3/30/2004 1:57:32 PM
Arsenic, Dissolved	0.0023	0.0010		mg/L	1	3/30/2004 1:57:32 PM
Beryllium, Dissolved	< 0.0010	0.0010		mg/L	1	4/1/2004 9:23:45 AM
Cadmium, Dissolved	< 0.0010	0.0010		mg/L	1	3/31/2004 3:19:40 PM
Chromium, Dissolved	< 0.0010	0.0010		mg/L	1	3/30/2004 1:57:32 PM
Copper, Dissolved	0.0018	0.0010		mg/L	1	3/30/2004 1:57:32 PM
Lead, Dissolved	< 0.0010	0.0010		mg/L	1	3/31/2004 3:19:40 PM
Nickel, Dissolved	0.0029	0.0010		mg/L	1	3/30/2004 1:57:32 PM
Selenium, Dissolved	< 0.0010	0.0010		mg/L	1	3/30/2004 1:57:32 PM
Silver, Dissolved	< 0.0010	0.0010		mg/L	1	3/31/2004 3:19:40 PM
Thallium, Dissolved	< 0.0010	0.0010		mg/L	1	3/31/2004 3:19:40 PM
Zinc, Dissolved	< 0.010	0.010		mg/L	1	3/30/2004 1:57:32 PM
MERCURY, TOTAL		**E245.1**				Analyst: CU

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory

CLIENT: Navajo Nation EPA Water Quality
Lab Order: 04031377
Project: Long Term Suite 2004
Lab ID: 04031377-01B

Client Sample ID: [illegible]
Tag Number:
Collection Date: 3/25/2004 12:30:00 PM
Matrix: WATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
MERCURY, TOTAL		E245.1				Analyst: CU
Mercury	< 0.00020	0.00020		mg/L	1	3/31/2004 12:02:23 PM

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory

Aerotech Environmental — Analytical Report — Date: *19-Apr-04*

CLIENT:	Navajo Nation EPA Water Quality	**Client Sample**	18PUEBLOCO02
Lab Order:	04031377	**Tag Number:**	
Project:	Long Term Suite 2004	**Collection**	3/25/2004 12:30:00 PM
Lab ID:	04031377-01C	**Matrix:**	WATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
NITROGEN, AMMONIA AS N		E350.3				Analyst: HS
Ammonia-N	< 0.50	0.50		mg/L	1	4/2/2004 8:40:00 AM
NITRATE AND NITRITE IN WATER		E353.2				Analyst: D N
Nitrogen, Nitrate/Nitrite Total (As N)	< 0.050	0.050		mg/L	1	3/31/2004

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory

Aerotech Environmental — Analytical Report — Date: *19-Apr-04*

CLIENT:	Navajo Nation EPA Water Quality	**Client Sample**	18PUEBLOCO02
Lab Order:	04031377	**Tag Number:**	
Project:	Long Term Suite 2004	**Collection**	3/25/2004 12:30:00 PM
Lab ID:	04031377-01F	**Matrix:**	WATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
CYANIDE, TOTAL		**M4500-CN E**				Analyst: **PJS**
Cyanide, Total	< 0.020	0.020		mg/L	1	4/2/2004 2:45:00 PM

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory

Aerotech Environmental Analytical Report Date: *19-Apr-04*

CLIENT:	Navajo Nation EPA Water Quality	**Client Sample**	18PUEBLOCO02
Lab Order:	04031377	**Tag Number:**	
Project:	Long Term Suite 2004	**Collection**	3/25/2004 12:30:00 PM
Lab ID:	04031377-01G	**Matrix:**	WATER

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
SULFIDE, TOTAL		**M4500-S C,D**				Analyst: D N
Sulfide	< 0.050	0.050		mg/L	1	3/29/2004

Footnotes: All analysis performed at AEL Phoenix laboratory unless indicated by footnotes.
(1) AEL - Tucson Laboratory
(2) AEL - Knudsen Laboratory

13.11 LSS

U/S well

FORM NO. 9—1904—E

U.S. DEPT. OF INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

GROUND WATER SITE INVENTORY
WATER-LEVEL DATA

MP at Top of casing
(-1.5' -ft)

Site Ident. No. H,U,B,B,2,4,5 # W,1 (8 — 15)

R-23W T-A

ALT. LSD _____ MSL

DATE	WATER LEVEL (LSD)	STATUS	METHOD	HOUR	HOLD	CUT	WATER LEVEL (MP)	REMARKS	MEAS. BY	DATE ENTERED
235 # 10/12/1998	237 - 13.75	238 - G	239 - W	1630	13.25	—	>13.25	initial - estimated	LS	
235 # 10/20/1998	237 - 13.75	238 - G	239 - S	1200	13.25	—	>13.25		LS	
235 # 11/30/1998	237 - 13.75	238 - G	239 - E	1400	13.25	—	>13.25	method unknown	BZ	
235 # 02/09/1999	237 - 10.65	238 - G	239 - S	1450	13.25	1.10	12.15		LS	
235 # 04/26/1999	237 - 9.00	238 - G	239 - S	1420	13.00	2.50	10.50		LS	
235 # 06/23/1999	237 - 9.42	238 - G	239 - Z	1145	13.25	2.33	10.92	rock & string	BZ	
235 # 07/19/1999	237 - 10.33	238 - G	239 - B	1235	13.25	0.42	12.83		LS	
235 # 09/24/1999	237 - 10.52	238 - G	239 - S	1450	13.20	0.18	13.02		TM/ER	
235 # 11/05/1999	237 - 10.55	238 - G	239 - S	1320	13.25	0.20	13.05	Evidence of flow in well	LS	
235 # 12/25/2000	237 - 9.80	238 - G	239 - S	1300	13.00	1.70	11.30	Cold & wind	LS/TM	
235 # 01/01/2000	237 - 8.89	238 - G	239 - S	1415	13.00	2.61	10.39	Hot & calm	LS/DG	
235 # 06/29/2000	237 - 13.75	238 - G	239 - S	1415	13.25	—	>13.25	Dry well - Channel Spring fed	LS/TM	
235 # 09/06/2000	237 - 10.50	238 - G	239 - S	1000	13.25	0.25	13.00	recent high Q. flow	LS	
235 # 03/22/2001	237 - 9.47	238 - G	239 - S	1135	13.00	2.03	10.97	good flow in channel	LS	
235 # 01/12/2001	237 - 10.01	238 - G	239 - S	1015	13.3	0.19	13.11	minimal flow, good veg	LS/TM	
235 # / /	237 - 10.1	238 -	239 -	1445	13.3	3.98	9.32	DROUGHT CONDITIONS	TM/DS/LM	
235 # 06/19/2003	237 - 10.1	238 -	239 -	10:00	13.3	5.20	8.10	Water at 5'2" from bottom		
235 # 08/07/2003	237 - 10.1	238 -	239 -	1530	13.25	0.30	12.95	No Flow, Recent BF EVENT	JM	
235 # 06/29/2004	237 - 10.1	238 -	239 -	1600	~~13.25~~	~~3.60~~	7.73	Channel Dry	TM	
235 # / /	237 - 10.1	238 -	239 -		13.25	3.91	9.34	Channel Dry	TM	
235 # / /	237 - 10.1	238 -	239 -							
235 # / /	237 - 10.1	238 -	239 -							
235 # / /	237 - 10.1	238 -	239 -							
235 # / /	237 - 10.1	238 -	239 -							
235 # / /	237 - 10.1	238 -	239 -							

GPO : 1976 OL—214-152

Precede water levels above LSD with a minus sign (-).

Method of Measurement (238 -): A sounder, C calibrated, sounder, E estimated, G pressure gage, H calibrated, pressure gage, L geophysical log, M manometer, R reported, S steel tape, T electric tape, V calibrated electric tape, Z other

Site Status (238 -): D dry, E flowed recently, F flowing, G nearby, flowing, H nearby, recently flowing, O obstruction, P pumping, R recently pumped, S nearby, pumping, T nearby, recently pumped, V foreign, substances, X surface-water, effect, Z other

WELL NO. # W1

OWNER WMB | Hubbell

Sketches on back

SENT BY:Navajo Nation EPA ; 7- 2- 4 ; 13:06 ;Water Quality/NNPDES→ 5207553405;#11/16

d/s well

FORM NO. 9—1904—E

U.S. DEPT. OF INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

GROUND WATER SITE INVENTORY
WATER-LEVEL DATA

MP at top of casing (-1.5 ft)

Site Ident. No. H,U,B,B,E,L,L, #,W,2 (5–10) R-234 * T-A *

ALT. LSD _____ MSL

	DATE	WATER LEVEL (LSD)	STATUS	METHOD	HOUR	HOLD	CUT	WATER LEVEL (MP)	REMARKS	MEAS. BY	DATE ENTERED
235 #	10/12/1998 *	237 - 6.50 *	238 - G *	239 - E *	1300	11.00	3.00	8.00	initial - estimate	LS	
235 #	10/20/1998 *	237 - 5.92 *	238 - G *	239 - S *	1130	11.00	3.58	7.42		LS	
235 #	11/30/1998 *	237 - 6.30 *	238 - G *	239 - E *	1330	11.00	3.20	7.80	method unknown	BZ	
235 #	02/09/1999 *	237 - 5.50 *	238 - G *	239 - S *	1447	11.00	4.00	7.00		LS	
235 #	04/26/1999 *	237 - 5.45 *	238 - G *	239 - S *	1407	10.00	3.05	6.95		LS	
235 #	06/23/1999 *	237 - 5.42 *	238 - G *	239 - E *	1135	11.00	4.08	6.92	rock & shiney	BZ	
235 #	07/19/1999 *	237 - 4.80 *	238 - G *	239 - S *	1515	9.00	2.70	6.30	recent flow at well site	LS	
235 #	09/24/1999 *	237 - 5.10 *	238 - G *	239 - S *	1435	9.00	2.40	6.60		TM/ER	
235 #	11/05/1999 *	237 - 5.30 *	238 - G *	239 - S *	1500	10.00	3.20	6.80	large LB sand dune at well	LS	
235 #	02/25/2000 *	237 - 5.16 *	238 - G *	239 - S *	1235	9.00	2.34	6.66		LS/TM	
235 #	05/11/2000 *	237 - 5.08 *	238 - G *	239 - S *	1405	9.00	2.42	6.58	Hot & calm; dune still @ well	LS/DS	
235 #	06/29/2000 *	237 - 6.95 *	238 - G *	239 - S *	1415	9.00	1.55	7.45	channel spring fed only	LS/TM	
235 #	09/06/2000 *	237 - 5.79 *	238 - G *	239 - S *	0940	9.00	1.71	7.29	recent rain flow; Yellow	LS	
235 #	03/22/2001 *	237 - 5.91 *	238 - G *	239 - S *	1130	9.00	2.49	6.51	good flow in channel	LS	
235 #	07/12/2001 *	237 - 6.12 *	238 - G *	239 - S *	1000	9.00	1.38	7.62	Low Flow Good Veg	LS/TM	
235 #	/ / *	237 - *	238 - *	239 - *	1430	9.00	0.81	8.19	No flow - drought	TM/NS/JM	
235 #	/ / *	237 - *	238 - *	239 - *		10.85	4.75	6.10	water 4 7/8"		
235 #	10/11/2003 *	237 - *	238 - *	239 - *							
235 #	08/07/2013 *	237 - *	238 - *	239 - *	1515	9.00	1.03	7.97	DO Flow Recent Bankfull Event	TM	
235 #	06/29/2014 *	237 - *	238 - *	239 - *	1620	9.00	1.66	7.34	Channel Dry	JM	
235 #	/ / *	237 - *	238 - *	239 - *							
235 #	/ / *	237 - *	238 - *	239 - *							
235 #	/ / *	237 - *	238 - *	239 - *							
235 #	/ / *	237 - *	238 - *	239 - *							
235 #	/ / *	237 - *	238 - *	239 - *							

Precede water levels above LSD with a minus sign (-).

GPO : 1978 OL—214-152

Method of Measurement (238 =): A airline, C calibrated airline, E estimated, G pressure gage, H calibrated pressure gage, L geophysical logs, M manometer, R reported, S steel tape, T electric tape, V calibrated electric tape, Z other

Site Status (238 =): D dry, E flowed recently, F flowing, G nearby flowing, H nearby recently flowing, O obstruction, P pumping, R recently pumped, S nearby pumping, T nearby recently pumped, V foreign substances, X surface-water effect, Z other

WELL NO. # W2

OWNER WMB | Hubbell

Sketches on back

SENT BY:Navajo Nation EPA ; 7- 2- 4 ; 13:06 ;Water Quality/NNPDES→ 5207553405;#12/16

APPENDIX B

CREST STAGE GAGE/MONITORING WELL DATA

Navajo Nation Water Management Branch
Crest Stage Gage Measurement Form

Station: Pueblo Colorado (Ganado Wash)

Date	HWM outside staff (ft)	HWM inside stick (ft)	Observer	Comments
9/2/98			LS, JB, TM	CSG installed
11/30/98	3.30	3.30	BZ	highest mark; d/s debris dam may have led to high stage
11/30/98	1.94	1.94	BZ	second stage mark
4/26/99	2.00	1.95	LS	first mark; needs more cork.
4/26/99	1.42	—	LS	second mark; no cork on inside stick
				*NOTE light debris & mud on U/S side of cotrell at 3.0 ft
7/19/99	---	1.95 mud line	LS	Earwigs covering bottom & inside stick & in cork holder; HWM inside is most likely same as 4/26/99 reading; blue shaded the stick.
				Cleaned outside staff plate
9/2/99	overtop	overtop	TM	Peak flow on 8/28/99 overtopped CSG. Based on Kuichling gage d/s & CSG rating, Peak flow est 1600 cfs (±200 cfs).
9/29/99	2.50	2.50	TM/ER	water stage @ time & reading was 0.65 ft
11/5/99	—	—	LS	stage @ time & reading was 0.37 ft & isolated pool
02/25/00	1.20	1.16	LS/TM	Water level = 0.57 cold
05/01/00	0.45	—	LS/BG	tree branch in the way of outside staff
				stage @ time & reading was ~0.40 ft & flowing in split channel
06/29/00	0.48	—	LS/TM	Channel completely dry bottom of channel = 0.30 ft
09/06/00	3.31	3.31	LS/TM	debris on gage, clean, chalk line
03/22/01	0.50	none	LS	CSG isolated from RB channel in LB pool, recent pool elev by 0.50 ft.
7/12/01	Not Distinct	1.22	LS	Bottom of well needs cleaning out.
7/15/02	Not Distinct	1.02	TM	Drought, Channel Dry
6/18/03	not distinct	.1	NS+LK	DRought-Channel dry
8/07/03	Not Distinct	2.42	TM	Channel Dry
06/29/04	Gage Has Been Dislodged is in the downstream channel. There			
	is Debris on the bridge pier at about 5.5 ft. above the channel.			

APPENDIX C

PRECIPITATION DATA

Navajo Nation Water Management Branch
Precipitation Storage Gage Worksheet

W42000

Station: Hubbell T.P.

Date	Dip Stick Reading	Depth = dip x 10 (inches)	Δ in Precip. (inches)	Total cumulative (inches)	Charge (inches)	Observer	Comments
10/14/99	0.39	3.90	—		3.90	IB	recharged for W42000
2/25/00	0.48	4.80				EK	
3/22/00	0.60	6.00	—			EK	
4/26/00	0.79	7.90				EK	
6/17/00	0.79	7.9				EK	
7/29/00	0.85	8.5				EK	
8/20/00	.96	9.6				EK	
10/4/00	.90	9.0				MF	
2/5/01	.73	7.30				MY	Recharged pre 2.00 11/3/00 >> 5.48
2/5/01	.73	7.3				MY	
4/6/01	.67	6.7				NS	
5/1/01	.75	7.5				NS	
6/5/01	.86	8.6				NS	Screen installed
7/2/01	.865	8.65					[redacted] Dame
9/28/01	...	12.3					
							recharge 1.7
11/07/01	.20	2.0				CH	9:13 and 55°
6/18/03	1.12	11.2				MS LK	first measurement 03
7/11/03	1.15	11.5			...	MS	
8/07/03	1.31	13.1				TM	
9/17/03	1.55	15.1				NS	after storm of
6/29/04	0.19	1.9			-13.2	TM	WNS Can not maintained. No Data

FINAL REPORT

AWPF GRANT NO. 00-104WPF

WILDLIFE SURVEY

JUNE 30, 2004

FOR NANCY --

ARIZONA DEPARTMENT OF WATER RESOURCES
ARIZONA WATER PROTECTION FUND
500 North Third Street, Phoenix, Arizona 85004
Telephone (602) 417-2400
Fax (602) 417-2423

JANE DEE HULL
Governor

JOSEPH C. SMITH
Director

December 13, 2001

Nancy Stone, Superintendent
Hubbell Trading Post National Historic Site
P.O. Box 150
Ganado, AZ 86505

Subject: **Approval of the Wildlife Survey Plan and Water Quantity Monitoring Plan for Grant No. 00-104WPF titled "Continued Enhancement of Pueblo Colorado Wash at Hubbell Trading Post National Historic Site."**

Dear Nancy,

The purpose of this letter is to provide you with formal written approval of the above-mentioned project work plans. This approval is based on the comments received by AWPF on November 30, 2001 and November 28, 2001 respectively. Please note that any modification to any of the approved project work plans needs to be submitted to AWPF for review and approval prior to implementation.

The contract states: "*The Wildlife Survey Plan shall establish baseline data, make a determination as to whether wildlife use is increasing, and document the species occurrence and distribution within the park boundary*". All these factors are clearly delineated in the survey plan except "the determination as to whether wildlife use is increasing". Based on the comments received by APWF on November 30, 2001 and per conversation with Mr. Harley Shaw it was stated that this wildlife survey would be conducted to establish baseline conditions only. No additional studies will be done to determine if wildlife use is increasing.

The contract states: "*The Grantee shall prepare and submit to the Project Manager for approval, a Water Quality and Quantity Monitoring Plan. This Plan shall include provisions for extending the staff gage to accommodate high flows such as a hundred-year flood.*" A request to modify the contract to state that modifications to the staff gauge will not be made was received by AWPF on November 28, 2001. Upon further review by the APWF hydrology staff it was determined that the project would not be hindered if modifications to the staff gauge were not made and recommends that the Grantee continue to gather data with the current gauge.

AWPF agrees that these changes to the contract should not affect the outcome of the project. An amendment to the contract will be drafted to reflect these changes. If you have any questions regarding this letter or the project please contact me at 602-417-2400 ext. 7167 or by e-mail at rsteran@adwr.state.az.us.

Sincerely,

Reuben Terán

Reuben Terán
Project Manager

SUMMARY OF 2004 WINTER AND SPRING SURVEYS, HUBBELL TRADING POST, WITH COMPARISONS TO 2002 DATA

Progress report on NPS contract No. P7420030026.

Submitted by Harley G. Shaw
June 26, 2004

This is intended as a progress report, not a final analysis. As such, the results are preliminary and may be modified with more detailed analysis of data by the time a completion report is written.

Birds

Number of bird species was lower for both winter and spring 2004 surveys, compared with May 2002 (Table 1). Total individual birds seen remained high, but this was the result of the presence of a large number of cedar waxwings during the survey period.

Note that the measure of diversity used here (Shannon's H) is sensitive to a large number of individuals of a single species. This can at times provide somewhat misleading results. An example is the apparent increased diversity in winter, 2004, compared with winter 2002, even though the number of species seen was greater in 2002. This resulted from the large flocks of piñon jays seen in 2002 diluting the Shannon's H index. For the purpose of the surveys at Hubbell Trading Post, simple species number may be a better measure of species diversity than more sophisticated indices.

Of special interest were the gray catbird, Eurasian collared dove, and rock wrens, species not previously sighted during our surveys. The collared doves are continuing to expand their range throughout the United States. The rock wrens were apparently nesting in one of the cut banks of Pueblo Colorado Wash. Catbirds have been observed near Chinle (Larue, personal comm.).

TABLE 1. COMPARISON OF WINTER AND SPRING 2002 AND 2004 BIRD SURVEYS. HUBBELL TRADING POST.

	2002				2004			
	February		May		January		May	
SPECIES	A*	D**	A	D	A	D	A	D
American Goldfinch	1	0.39	17	4.59	1	0.26	0	0
American Raven	12	4.68	7	1.86	39	10.23	14	3.20
Ash-throated Flycatcher	0	0	1	0.27	0	0	1	0.23
Audubon Warbler (Yellow-rumped)	0	0	3	0.80	14	3.67	1	0.23
Barn Swallow	0	0	10	2.70	0	0	0	0
Black-chinned Hummingbird	0	0	1	0.27	0	0	4	0.91
Black-faced ibis	0	0	0	0	0	0	4	0.91
Black-headed Grosbeak	0	0	1	0.27	0	0	0	0
Blue Grosbeak	0	0	2	0.54	0	0	2	0.46

* Relative abundance as used here is the greatest number of individuals of a given species seen on any single run of a transect.

** Abundance/ (avg. strip width X transect length), birds/hectare.

Broad-tailed Hummingbird	0	0	2	0.54	0	0	0	0
Bullock's Oriole	0	0	5	1.35	0	0	11	0.25
Bushtit	0	0	1	0.27	0	0	2	0.46
Brewer's Blackbird	8	3.12	0	0	0	0	1	0.23
Catbird (?)	0	0	0	0	0	0	1	0.23
Cedar Waxwing	7	2.73	75	20.3	0	0	201	45.89
Cliff Swallow	0	0	10	2.70	0	0	4	0.91
Cowbird (Brown-headed)	0	0	5	1.35	0	0	1	0.23
Crow	2	0.78	0	0	14	3.67	1	0.23
Great Blue Heron	0	0	0	0	0	0	0	0
Green-tailed towhee	0	0	0	0	0	0	0	0
House finch	0	0	0	0	2	O.52	0	0
English Sparrow	10	3.90	1	0.27	0	0	1	0.23
Eurasian collared dove	0	0	0	0	0	0	1	0.23
Junco	52	20.3	0	0	7	0	0	0
Juniper Titmouse	0	0	1	0.27	0	0	2	0.46
Kestrel	0	0	1	0.27	0	0	2	0.46
Kildeer	0	0	0	0	0	0	3	0.68
Lark Sparrow	0	0	9	2.43	0	0	0	0
Lazuli Bunting	0	0	1	0.27	0	0	0	0
Lesser Goldfinch	0	0	0	0	0	0	2	0.46
Lewis Woodpecker	0	0	4	1.08	0	0	0	0
Lucy's Warbler	0	0	0	0	0	0	0	0
Mallard	0	0	2	0.54	0	0	4	0.91
MacGillivrey's Warbler	0	0	1	0.54	0	0	0	0
Mockingbird	0	0	3	0.80	0	0	0	0
Mourning Dove	0	0	6	1.62	0	0	14	3.20
Mountain Chickadee	1	0.39	1	0.27	0	0	0	0
Nashville Warbler	0	0	0	0	0	0	0	0
Northern Flicker	8	3.12	0	0	15	3.93	0	0
Olive-sided Flycatcher	0	0	1	0.27	0	0	0	0
Orange-crowned Warbler	0	0	0	0	0	0	0	0
Pinyon Jay	150	58.59	1	0.27	0	0	1	0.23
Plumbeous Vireo	0	0	1	0.27	0	0	0	0
Purple Finch	0	0	0	0	0	0	0	0
Red-tailed Hawk	1	0.39	0	0	0	0	0	0
Red-winged Blackbird	0	0	1	0.27	0	0	0	0
Roadrunner	1	0.39	0	0	0	0	0	0
Robin	31	12.10	2	0.54	83	21.78	2	0.45
Rock Wren	0	0	0	0	0	0	1	0.23
Rufous-sided Towhee	1	0.39	0	0	1	0.26	1	0.23
Sage Thrasher	0	0	0	0	0	0	0	0
Scrub Jay	2	0.78	0	0	7	1.83	0	0
Sharp-shined Hawk	1	0.39	0	0	2	0.52	0	0
Song Sparrow	2	0.78	1	0.27	2	0.52	1	0.23
Starling	9	3.51	20	5.40	22	5.77	26	5.94
Townsend's Solitaire	2	0.78	0	0	0	0	0	0
Turkey Vulture	0	0	0	0	0	0	5	1.14
Unidentified sparrow	0	0	0	0	0	0	1	0.23
Violet-green Swallow	0	0	20	5.40	0	0	0	0
Western Bluebird	22	8.59	0	0	13	3.41	0	0
Western Kingbird	0	0	3	0.80	0	0	4	0.91
Western Tanager	0	0	0	0	0	0	0	0
Western Wood Pewee	0	0	1	0.27	0	0	0	0
White-crowned Sparrow	34	13.28	1	0.27	43	11.29	0	0
White-winged Dove	0	0	1	0.27	0	0	0	0
Wilson's Warbler	0	0	3	0.80	0	0	4	0.91
Yellow-bellied Sapsucker	0	0	0	0	0	0	0	0
Yellow-breasted Chat	0	0	1	0.27	0	0	1	0.23
Yellow-headed Blackbird	0	0	1	0.27	0	0	0	0
Yellow Warbler	0	0	2	0.54	0	0	0	0
Unidentified Seagull	0	0	2	0.54	0	0	0	0
Unidentified Hummingbird	0	0	0	0	0	0	0	0
Unidentified Warbler	0	0	0	0	0	0	0	0
Unidentified Sparrow	0	0	0	0	0	0	0	0
Total birds	357 (207)	139.39(80.8)	232	62.8	265	69.55	324	73.97
Total Species on transects	21		42		15		33	
Shannon's H	1.72		2.75		2.11		1.76	

General habitat descriptions for the various species were taken from Sibley and Monroe (*Distribution and taxonomy of birds of the world.* Yale University Press. 1990). Within the constraints of these general descriptions, no trend in loss or gain of any particular guilds of birds can as yet be seen. Most of the species at Hubbell Trading Post use a fairly broad array of habitats and are therefore not necessarily attracted specifically to the site repelled from it by its unique habitat availability or by recent habitat changes. The proximity of the sewage lagoons allows periodic observation of waterfowl and shorebird species that might not occur otherwise.

Winter counts

Birds seen winter 2002, not 2004:

Brewer's blackbird	Brushy areas, riparian woodland, near water
Cedar waxwing	Forest, edge, woodland, orchards, towns
English sparrow	Towns, farmlands
Mountain chickadee	Coniferous forest
Piñon jay	Pinyon-juniper woodland
Red-tailed hawk	Woodlands, fields, deserts, mountains
Roadrunner	Desert scrub, chaparral, arid open woodland, brush
Townsend's solitaire	Coniferous forest, woodland

Total of 8 birds in this category.

Birds seen winter 2004, not 2002:

Yellow-rumped (Audubon) warbler	Coniferous and deciduous forest, woodland
House finch	Open woodland, farmlands, arid scrub, open areas

Total of 2 birds in this category.

Birds seen both winter surveys:

American goldfinch	Edge
American raven	Varied habitats, generalist
Crow	Open woodland, orchards, towns
Junco	Forest edge, bogs, open woodland, brushy areas
Robin	Forest edge, open woodland, pastures, towns
Northern flicker	Forest, open woodland, pine-oak, towns
Rufous-sided Towhee	Dense woodland, chaparral, shrubby areas
Scrub jay	Riparian brush, scrub, chaparral, piñon-juniper
Sharp-shinned hawk	Forest, woodland, scrub
Song sparrow	Brushy, shrubby, grassy areas near water
Starling	Farmlands, open country, woodlands, towns
Western bluebird	Open woodland, forest edge, farmlands, savanna
White-crowned sparrow	Stunted trees, shrubs, thickets, edge

Total of 13 birds in this category.

Spring counts

Birds seen in May 2002 but not in May 2004:

American goldfinch	Edge
Barn swallow	Plains

Black-headed grosbeak	Riparian, Woodland
Broad-tailed hummingbird	Forest, woodland, thickets
Lark Sparrow	Edge
Lazuli bunting	Riparian thickets, woodland
Lewis woodpecker	Open forest, woodland
Macgillivary warbler	Forest, riparian thickets, chaparral
Mockingbird	Edge
Mountain chickadee	Coniferous forest
Olive-sided flycatcher	Coniferous forest, open woodland
Plain titmouse	Oak and pinyon woodland
Plumbeous virio	Pinyon-juniper, oak woodland
Red-winged blackbird	Marsh
Unidentified seagull	Lakes
Violet-green swallow	Open forest and woodland
Western wood peewee	Forest edge, riparian woodland
White-crowned sparrow	Stunted trees, shrubs, thickets, edge
White-winged dove	Scrub, woodland, riparian
Yellow warbler	Scrub, second growth, thickets, riparian, near water
Yellow-headed blackbird	Marsh, fields

A total of 21 birds in this category.

Birds seen in May, 2004 that were not seen in May 2002:

Black-faced ibis	Fields, lakes
Brewer's blackbird	Brushy areas, riparian woodland, near water
Gray Catbird	Open woodland, riparian woodland.
Crow	Open woodland, orchards, towns
Eurasian collared dove	Open areas, scrub, brushy areas, desert
Kildeer	Agricultural area, streams, wetlands
Lessor goldfinch	Woodland edge, chaparral, riparian, piñon juniper
Rock wren	Rocky slopes, cliffs, rock walls, brushy vegetation
Rufous-sided towhee	Dense woodland, chaparral, shrubby areas
Turkey vulture	Open areas, generalist.

A total of 10 birds in this category.

Birds seen during both May surveys:

American Raven	Varied habitats, generalist
Audubon warbler	Coniferous and deciduous forest, woodland
Ash-throated flycatcher	Desert scrub, pinyon juniper and oak woodland
Black-chinned hummingbird	Riparian, desert
Blue grosbeak	Riparian woodland, scrub, thicket, farms
Bullock's oriole	Riparian woodland, oak forest, orchards, savanna
Bushtit	Woodland, chaparral, piñon-juniper, riparian
Cedar waxwing	Forest, edge, woodland, orchards, towns
Cliff swallow	Open country, water, towns
Cowbird	Woodland, deciduous forest, edge, prairie
English sparrow	Towns, farmlands
Juniper titmouse	Oak and piñon-juniper woodland
Kestrel	Open country, scrub, desert, farmland
Mallard	Waterways, small ponds
Mourning dove	Open forest, farmlands, deserts, towns
Piñon jay	Pinyon-juniper woodland

Robin	Forest edge, open woodland, pastures, towns
Song sparrow	Brushy, shrubby, grassy areas near water
Starling	Farmlands, open country, woodlands, towns
Wilson's warbler	Bogs, thickets, brushy areas near water.
Yellow-breasted chat	Riparian undergrowth, thickets, scrub

A total of 21 birds in this category.

Lizards and snakes

Three species of lizard were found, one less than was seen in 2004. Lizard surveys were made only on one day, and observation rate was approximately one-third that of 2002. The greatest difference seemed to be a reduction of lizards on the terraces above the stream. Virtually all lizards seen were on the steep erosion banks on the north side of the wash. No lizards were found on the south side. This reduction in lizards on the level benches may be a result of the increasing shrub and herbaceous vegetation on these benches. Such habitat seems less acceptable to the lizard species present than the bare ground that was present immediately after exotic tree control had taken place. It is possible that a change in species present will become evident over time, as the habitat changes.

No snakes were seen along the wash.

Table 2. Lizard observations for Pueblo Colorado Wash, Hubbell Trading Post, May 2002 and 2004.

Species	MAY 2002		MAY 2004	
	NO.	LIZ./HR	NO.	LIZ./HR
Cnemidophorus velox	29	5.3	5	1.56
Sceloporus undulatus	13	1.78	3	0.0
Sceloporus graciosus	6	1.25	0	0.94
Holbrookia maculata	1	0.38	0	0.0
Unidentified	0	0.00	1	0.29
Total	49	8.7	9	2.79

Amphibians

No amphibians were calling along the wash during the survey period, but 7 Woodhouse toads were located during a visual survey at night. One of these was an immature barely one inch in length. The remainder were large adults. Woodhouse toads were calling at the sewage lagoons, but not in the wash. NPS personnel at Hubbell said toads had been calling along the wash about two weeks prior to the May 19, 2004 survey.

Other observations

Feral house cat numbers have definitely been reduced at the site, and canid tracks, some of which appear to be red fox are present. Gopher activity is increasing as herbaceous vegetation increases along the wash, and NPS personnel reported hearing owls, probably great-horned, perhaps reflecting an increasing small rodent populaltion. We did not, however, hear owls during our nighttime amphibian survey.

Upland revegetation

As of June 4, 2004, the wash crew has planted 217 shrubs and trees on the upland bench north of Pueblo Colorado Wash. Species selected were those known to grow on the Colorado Plateau and considered useful as bird food or cover or for soil-holding capabilities. These include:

Shrub oak	15
New Mexico locust	8
Fremont barberry	67
Three-lobed sumac (skunkbush)	50
New Mexico olive	30
Golden current	6
Utah serviceberry	3
Banana yucca	7
Utah agave	4
Beargrass	10
Four-wing saltbush	7
Torrey wolfberry	2
False indigo	2
Fringed sage	3
Wood's rose	2
Peraphyllum sp.	1

FINAL REPORT

AWPF GRANT NO. 00-104WPF

EDUCATIONAL OUTREACH

JUNE 30, 2004

FINAL REPORT
Educational Outreach
June 30, 2004

Background

A National Park Service (NPS) ranger in 1999 initiated an education outreach program with the Ganado School District. This program was soon integrated into the school's science curriculum. The program integrated classroom curricula with on-site field visits to the Pueblo Colorado Wash to increase student/teacher awareness of environmental stewardship issues. The ranger attended classroom sessions to introduce the project to the students and the teachers. After coordinating with the teachers, classes came to the project site and performed a variety of tasks such as planting native species, removing exotic species, setting up monitoring stations, constructing stream structures to slow water velocity and shape the flow. The students were introduced to biological diversity, recycling, grazing impacts, the effects of pollution, etc.

Objectives/Strategies

In 2000, the ranger began developing a curriculum-based student workbook. Some funding was procured through the National Park Service's Cooperative Ecosystem Studies Unit (CESU) at Northern Arizona University at Flagstaff to assist the park to eventually produce a more professional product. The completed workbook is intended to be the core of the program enabling park staff, students and their teachers to continue their involvement in the Wash restoration project. The workbook will help to determine what additional equipment, supplies, tools, training for teachers and rangers alike might be necessary. It is feasible that the workbook and program results will be integrated into other compatible school programs such as the GLOBE program, which utilizes environmental monitoring stations set up by students from around the world.

The outreach ranger position was vacated in February of 2001, however park staff, teachers, and the workbook developer from NAU continued to meet and discuss the program in order to build on the positive aspects and make improvements where necessary. Due to budget shortages, the outreach ranger position has still not been filled as of summer 2004. However, the workbook was completed and delivered to the park along with classroom materials, measuring devices and field instruments.

The lack of staff is the only constraint to completing this goal of the project. This interruption in the momentum of the project will probably require reintroduction of the restoration concepts and recruitment of new teachers of the Ganado Unified School District teachers since teacher turnover has significantly reduced the number of teachers who were previously involved in this project. However, the concepts are still attractive and the workbook is very compelling for teachers so we expect the project to be viable in the future. A copy of the completed workbook is attached.