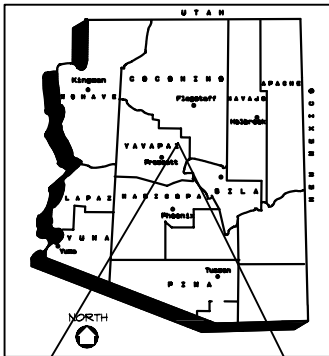


Montezuma Castle Historic Gabion Protection

AS-BUILTS

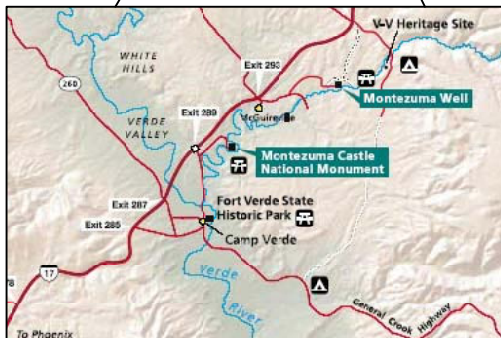
ACOE Permit No.: 2006-01765-DE
 Contractor: Candelaria Corporation
 Subcontractor: Natural Channel Design
 Date Work Commenced: October 17, 2006
 Date Work Completed: October 31, 2006



PREPARED FOR:
 Montezuma Castle National Monument
 National Park Service

INDEX OF DRAWINGS

SHEET NO.	TITLE
1	COVER SHEET: Location, Index, Materials
2	CONSTRUCTION SPECIFICATIONS
3	CONSTRUCTION SPECIFICATIONS
4	PLAN VIEW: Toe Protection & Diversion
5	DETAILS: Toe Rock & Equipment Crossing
6	DETAILS: Pole Plantings & Deer Grass Plantings
7	CROSS-SECTIONS: STA 1+00, STA 3+60, STA 4+40



LOCATION MAP

NE 1/4 Sec 17, T14N, R5E
 Yavapai County, Arizona



Beaver Creek
 Watershed Area = 285 sq mi.

MATERIAL LIST

GABION PROTECTION	
Rock Riprap	350 cy (600 tons)
Length of Treated Bank	500 ft
TEMPORARY DIVERSION	
Channel	100 ft
VEGETATION	
Critical Area Seeding	
Willow Cuttings	400 ea
Deer Grass	87 ea
(Containerized Stock)	
EQUIPMENT CROSSING	
Sand	14 cy
Gravel & Cobble	
Plywood (3/4-in.)	

Natural
 Channel
 Design, Inc

3410 S. Cocopah Dr.
 Flagstaff, Arizona 86001
 (928) 774-1178

DRAWN BY: M.Wirtanen & S.Yard

DESIGNED BY: M.Wirtanen & S.Yard

REV	DATE	BY	REVISION
1	8/23/06	S.Yard	Rev Quants, Add XSects

COVER SHEET: Location, Index, Materials

Montezuma Castle
 Historic Gabion Protection

AS-BUILTS

			
FILE NAME: Montezuma.pro		DATE: Aug 5, 2006	
PROJECT NO:		SHEET: 1 of 7	

GENERAL NOTES

1. Site survey data was collected by NCD June 2006.
2. All stationing refers to base line of construction and is measured horizontal distance.
3. Project survey data provides the most accurate representation of site topographic conditions. All existing conditions are to be verified in the field prior to construction. Any adjustments from the drawings to be made as directed by the ENGINEER.
4. No representation is made as to the existence or nonexistence of any utilities, public or private. Absence of utilities on these drawings IS NOT assurance that no utilities are present. The existence, location and depth of any utility must be determined by the contractor prior to any excavation.
5. Construction activities will be conducted in a manner consistent with all safety regulations and requirements of Sections 404, 401, and 402 of the Clean Water Act.
6. Installation shall be constructed to the lines and grades as shown on the drawings or as staked in the field by the ENGINEER, recognizing there is variation in nature.

CONSTRUCTION MANAGEMENT

Construction shall be timed to allow for the lowest base flows and the lowest chance of flood flows. Construction activities shall be completed in as quick a time frame as possible, reducing the time of disturbance and maximizing the healing of banks.

Construction Supervision

Supervision shall be provided for all structural tasks.

Construction Equipment

The following equipment are expected to be utilized during the construction:

- Front End Loader: Moving structure rock and varolous fill
- Large Excavator/Trackhoe: Channel excavation, diversion, rock placement, backfilling
- Small Dump Truck: Hauling rock, miscellaneous hauling

Construction Sequence

The following is a recommended construction sequence:

1. Cover and construct earthen ramps for equipment crossing over gabions
2. Construct temporary stream diversion.
3. Excavate trench along toe of gabion as shown on drawings. Stockpile spoils.
4. Install dormant willow cuttings in toe trench.
5. Place rock (machine and hand-placed) under scoured sections of gabion and in toe trench.
6. Cover riprap with material excavated during trenching.
7. Remove and smooth temporary diversion structure
8. Remove gabion crossing materials
9. Seed and mulch disturbed areas and plant deer grass containers.

Equipment Access

Access routes are from the Visitor Center parking lot down to the picnic area and along the upper right bank to the project site.

Equipment Use in Stream

The use of heavy equipment in the stream will be kept to an absolute minimum.

Permitting Requirements

No construction shall begin until all necessary permits are obtained.

PROJECT DESCRIPTION

Existing historic gabion structure has been undercut by recent floods, threatening the integrity of the structure. The project will excavate bed material (sands and gravels) in front of the gabion and place graded rock under the gabion and in the trench to prevent future scour and undermining of the gabion structure. In order to protect the natural appearance of the river running through the Park, riprap will be covered with native river bed material after placement and disturbed area planted with native willows and deer grass.

CONSTRUCTION SPECIFICATIONS

POLLUTION CONTROL and RESOURCE PROTECTION

Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution are minimized and held within legal limits. The measures and works shall include, but are not limited to, the following:

1. Diversions: Diversions to divert water from work areas are temporary and shall be removed and the area restored to its near original condition when they are no longer required or when permanent measures are installed.
2. Staging Areas: Transportation routes for materials, personnel, and equipment to, from, and within the project area shall be limited to designated areas determined in the field by Park Service Representative or authorized representative.
3. Revegetation: Impacts to existing vegetation and habitats shall be minimized. All disturbed areas shall be replanted with native vegetation.
4. Stream Crossings: Stream crossing points shall be minimized and shall be removed and the area restored to its near original condition when crossings are no longer required.

TEMPORARY DIVERSION

A temporary low-flow channel will need to be constructed to dewater and divert the stream from the project area to the extent that construction operations can be performed under stable conditions. See SHEET 4 for location.

- Construct temporary stream diversion by excavating entrance to existing overflow channel (about 50 ft upstream of STA 0+00) and placing excavated material in existing channel.
- Construct temporary diversion channel only large enough to divert flow around the site.
- Construction of the channel shall start from the overflow channel and work upstream.

TOE ROCK

- The work shall consist of excavation, delivery of rock, and installation of rock for rock riprap as shown on the drawings or staked in the field by the authorized representative.
- The rock shall be well graded from a minimum of six inches to a maximum size of 22 inches with greater than 50% by weight being larger than 16 inches.
- The rock shall be angular, dense, sound and free from cracks, seams, or other defects conducive to accelerated weathering. The least dimension of an individual rock shall not be less than one-half the greatest dimension.
- The rock source shall be approved by the ENGINEER or authorized representative and have a bulk specific gravity of not less than 2.0.
- See SHEET 5 for Detail.

BACKFILL

Cover riprap with material excavated during trenching. All finished surfaces shall be generally smooth and pleasing in appearance and blend into surrounding terrain.

**Natural
Channel
Design, Inc**

3410 S. Cocopah Dr.
Flagstaff, Arizona 86001
(928) 774-1178

DRAWN BY: M.Wirtanen & S.Yard			
DESIGNED BY: M.Wirtanen & S.Yard			
REV	DATE	BY	REVISION

CONSTRUCTION SPECIFICATIONS

Montezuma Castle Historic Gabion Protection

AS-BUILTS

FILE NAME:		DATE: Aug 5, 2006	
PROJECT NO:		SHEET: 2 of 7	

VEGETATION PLAN

Vegetation Plan shall include native grass and forb seeding (with fertilization and /or mulching), deer grass plantings, and willow plantings. Use local native material.

PLANT MATERIAL PROCUREMENT and HANDLING

Woody Plant Materials:

All woody species shall be native and collected from designated local sources. Native willow such as Coyote willow (*Salix exigua*) will be planted along the toe of the bank.

Dormant unrooted hardwood cuttings can be taken after leaf fall and before bud burst in the spring. The best rooting success is from cuttings that are disease-free, green plants that are 2-10 years old. The best diameters for pole planting, vertical bundles, and trenches are 3/4 to 2 inches and 3 to 6 inches for post plantings. Cutting length varies depending on the application. It shall be long enough to reach 6 to 8 inches into the lowest water level of the year and high enough to expose at least one to two buds.

Cuts shall be made with clean, sharp tools. The bottom end of the stem cutting shall be cut to a 45-degree angle and the tip end shall be cut square across or horizontal to the stem. Trim off all side branches and the terminal bud (bud at the growing tip) so energy will be rerouted to the lateral buds for more efficient root and stem sprouting. Do not trim terminal bud from cuttings for vertical bundles and willow trench until after planted. Trimmed tip ends shall be sealed by dipping in latex paint or similar. Cuttings should be soaked in water long enough (commonly 5-7 days) to allow the buds to swell. Do not allow the roots to emerge from the bank.

Containerized Stock:

Deer grass (*Muhlenbergia rigens*) plants will be propagated from on site seed sources by a reputable nursery in 1-gallon containers. These plants will be planted along and out from the toe of the gabions. Container plants shall be healthy and well rooted with roots showing no evidence of damage, restriction or deformed growth. Containerized plantings should be stored in an approved area and watered enough to maintain adequate soil moisture between delivery and planting.

INSTALLATION OF PLANTINGS

POLE PLANTINGS and POLE CLUSTERS:

Pole cuttings are placed in the ground deep enough to reach the lowest water table of the year and high enough to expose at least one to two buds. Root primordia will develop when good soil-to-stem contact is made and exposed sections of the cutting will sprout stems and leaves.

Dormant cuttings can be planted with a digging bar, auger, water-jet, or if the soil is saturated, they may be pushed into the soil. Pole Plantings are planted in the Bank and Floodplain Zone and shall be spaced 4 feet apart in the row. In multiple row plantings, spacing between rows shall be staggered with respect to those in adjacent rows. See SHEET 6.

CONTAINERIZED STOCK (Deer Grass):

The planting hole shall be slightly deeper than the planting container and at least twice the width. The sides of the hole shall be tapered outward and slightly deeper than the center and roughened to facilitate root penetration. The bottom shall be loosened to a minimum depth of 6 inches. After digging, some back-fill soil shall be placed in the center of the hole, elevating the plant so that its soil line is slightly below the level of the surrounding ground.

Loosen roots slightly by gently untangling the sides and bottom of the root ball prior to planting. Place plant in center of the hole and spread out the roots. Back-fill around the roots until hole is half full, mixing the greenhouse soil with native soil. If slow-release fertilizer is used, apply at bottom of hole. Fill the rest of the hole to surrounding soil level and firm in to eliminate air pockets. Where applicable, make a ber of soil around plant to catch water and keep plant moist. Water thoroughly and check to make sure that top of root ball is covered with soil.

SEEDING and MULCHING

Disturbed areas will be seeded with native grasses. Prepare seedbed where needed. Seed can be drilled or broadcast by hand. Seed shall be incorporated into the soil, but not more than 1-inch deep. Reseeding may be required for successful plant establishment.

Seeding dates vary for different grasses, legumes, and forbs. Seed shall be purchased from a reliable supplier or collected on-site. The following is a suggested native grass seed mix prepared by USDA Natural Resources Conservation Service. The seeding rates below are for planting with a rangeland drill with application rates of 5 pounds to the acre for the cool season planting and 2 pounds to the acre for the warm season planting. If seeding is done by hand broadcast the rates need to be increased by a factor of 2 (doubled). Forbs (wildflowers) can be added to seed mix to increase diversity and improve aesthetics. A list of possible forbs (wildflowers) and shrubs are also listed below.

Cool Season Planting (Early Spring)

Western wheatgrass (<i>Pascopyrum smithii</i>)	2.7 lb/ac	PLS
Sand dropseed (<i>Sporobolus cryptandrus</i>)	0.1 lb/ac	PLS
Muttongrass (<i>Poa fendleriana</i>)	1.6 lb/ac	PLS
Indian ricegrass (<i>Achnatherum hymenoides</i>)	0.5 lb/ac	PLS
	4.9 lb/ac	PLS

Warm Season Planting (Late June/Early July)

Alkali sacaton (<i>Sporobolus airoides</i>)	0.2 lb/ac	PLS
Cane bluestem (<i>Bothriochloa barbinodis</i>)	0.1 lb/ac	PLS
Sand dropseed (<i>Sporobolus cryptandrus</i>)	0.1 lb/ac	PLS
Sideoats grama (<i>Bouteloua curtipendula</i>)	0.8 lb/ac	PLS
Curly-mesquite (<i>Hilaria belangeri</i>)	0.7 lb/ac	PLS
	1.9 lb/ac	PLS

FORBS/HERBS (WILDFLOWERS)

Colorado four o'clock (*Mirabilis multiflora*)
Arizona blanketflower (*Gallardia arizonica*)
California poppy (*Eschscholzia Cham.*)

SHRUBS

Fourwing saltbush (*Atriplex canescens*)
Winterfat (*Krascheninnikovia lanata*)

Natural
Channel
Design, Inc

3410 S. Cocopah Dr.
Flagstaff, Arizona 86001
(928) 774-1178

DRAWN BY: M.Wirtanen & S.Yard

DESIGNED BY: M.Wirtanen & S.Yard

REV	DATE	BY	REVISION

CONSTRUCTION SPECIFICATIONS

Montezuma Castle Historic Gabion Protection

AS-BUILTS

FILE NAME:

DATE: Aug 5, 2006

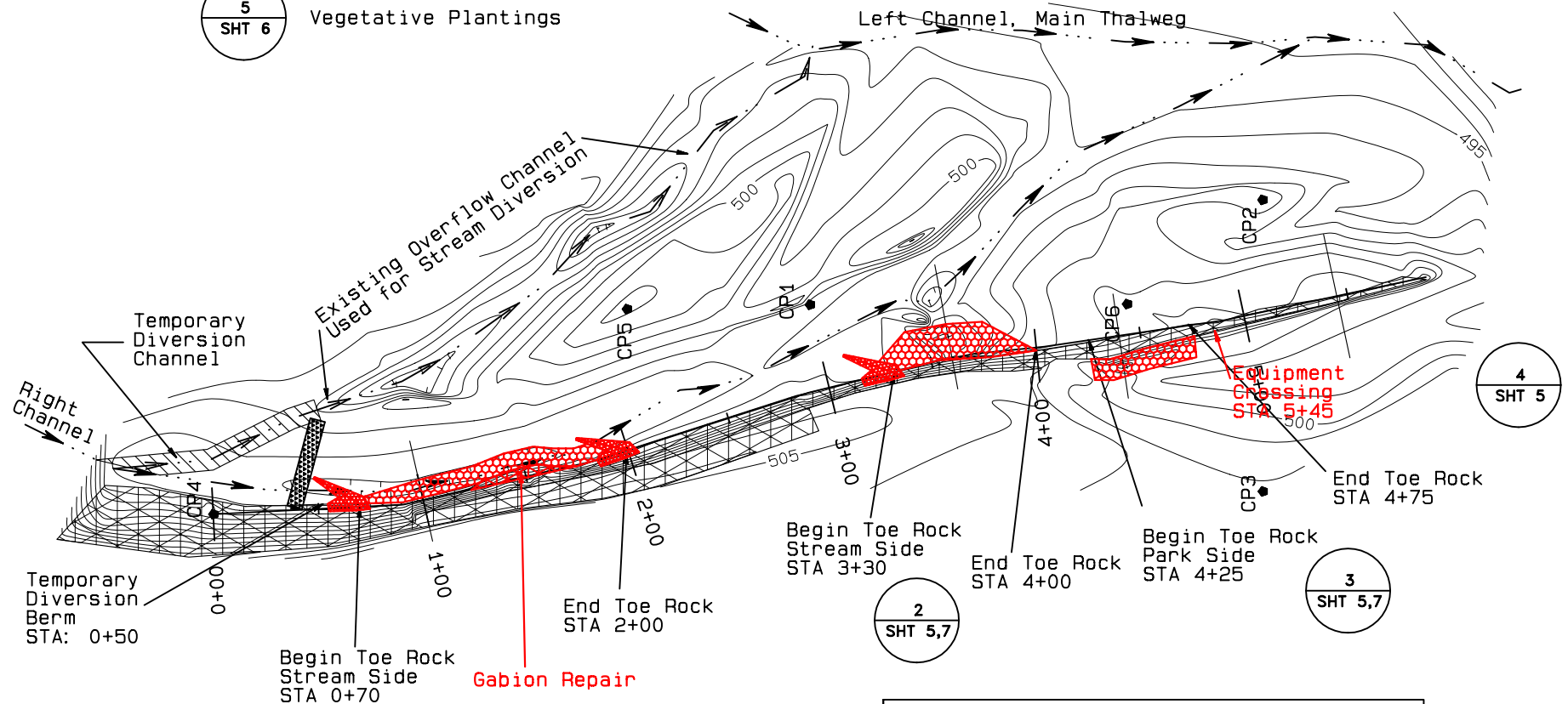
PROJECT NO:

SHEET:

3 of 7

5
SHT 6

Vegetative Plantings



4
SHT 5

2
SHT 5,7

3
SHT 5,7

1
SHT 5,7

CONTROL POINTS				
	Northing	Easting	Elevation	Notes
CP1	5151.46	4998.95	497.25	1/2" Rebar, NCD Yellow Cap
CP2	4936.79	5048.74	500.00	1/2" Rebar, NCD Yellow Cap
CP3	4936.57	4910.30	502.13	1/2" Rebar, NCD Yellow Cap
CP4	5434.48	4899.47	499.30	1/2" Rebar, NCD Yellow Cap
CP5	5238.30	4996.89	502.70	1/2" Rebar, NCD Yellow Cap
CP6	5001.02	4999.23	500.88	1/2" Rebar, NCD Yellow Cap

*NCD = Natural Channel Design

**Natural
Channel
Design, Inc**

3410 S. Cocopah Dr.
Flagstaff, Arizona 86001
(928) 774-1178

DRAWN BY: M.Wirtanen & S.Yard

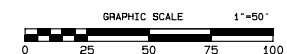
DESIGNED BY: M.Wirtanen & S.Yard

REV	DATE	BY	REVISION
1	8/23/06	S.Yard	Add XSects
2	10/25/06	S.Yard	Add three streambarbs

PLAN VIEW: Toe Protection & Diversion

Montezuma Castle
Historic Gabion Protection

AS-BUILTS



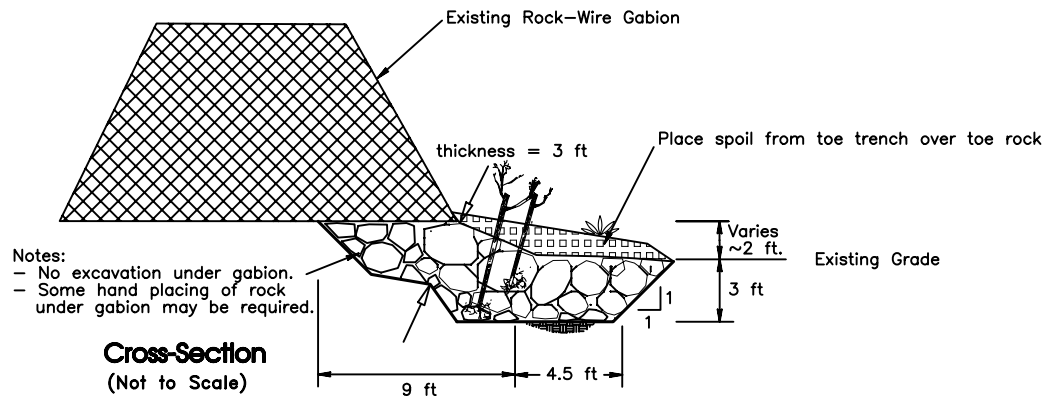
FILE NAME:

DATE: Aug 5, 2006

PROJECT NO:

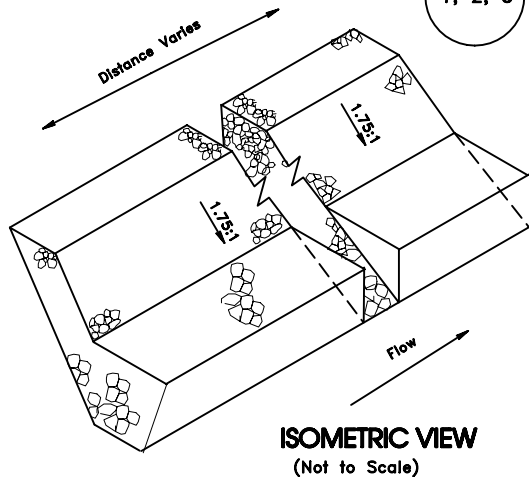
SHEET:

4 of 7



1, 2, 3

TOE ROCK DETAIL

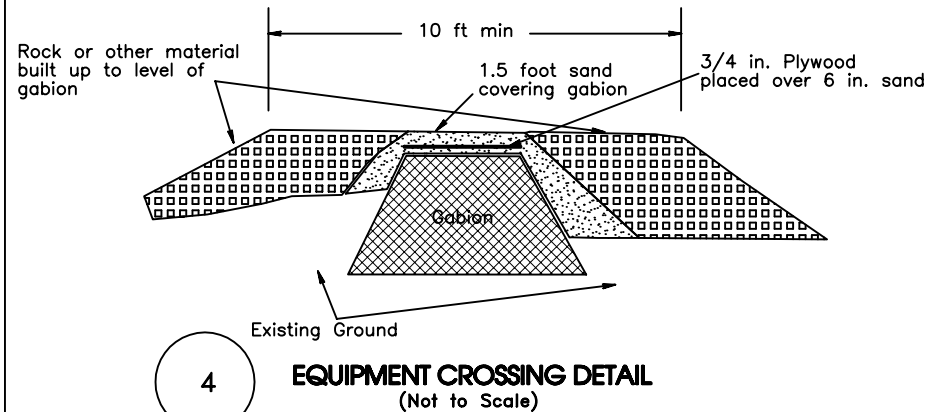


ROCK VOLUMES

Section Volume = 0.7 cy/linear foot
Linear feet = 500 ft
Total Rock = 350 cy
Total wt (based on granite) = 600 tons

ROCK SPECIFICATIONS

Use well-graded, angular rock with bulk specific gravity greater than 2.0
Rock Riprap Rocks: Dmin = 12 in
D50 = 16 in
Dmax = 22 in



EQUIPMENT CROSSING STA 5+45

**Natural
Channel
Design, Inc**

3410 S. Cocopah Dr.
Flagstaff, Arizona 86001
(928) 774-1178

DRAWN BY: M.Wirtanen & S.Yard

DESIGNED BY: M.Wirtanen & S.Yard

REV	DATE	BY	REVISION
1	8/23/06	S.Yard	Rev Quants

DETAILS: Toe Rock & Equipment Crossing

Montezuma Castle Historic Gabion Protection

AS-BUILTS

FILE NAME:

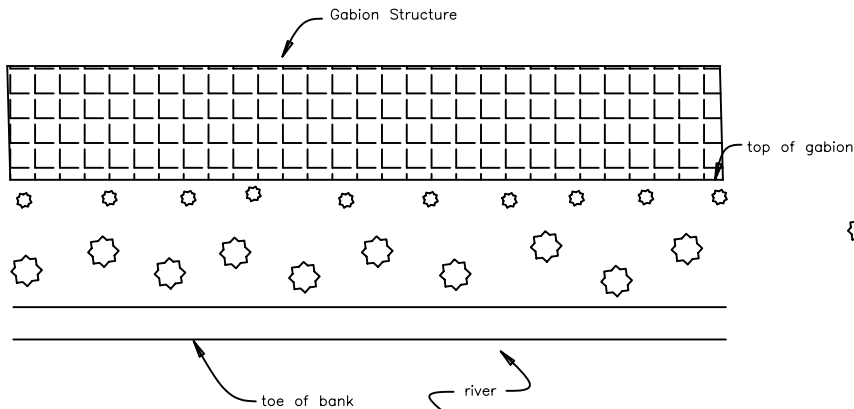
DATE: Aug 5, 2006

PROJECT NO:

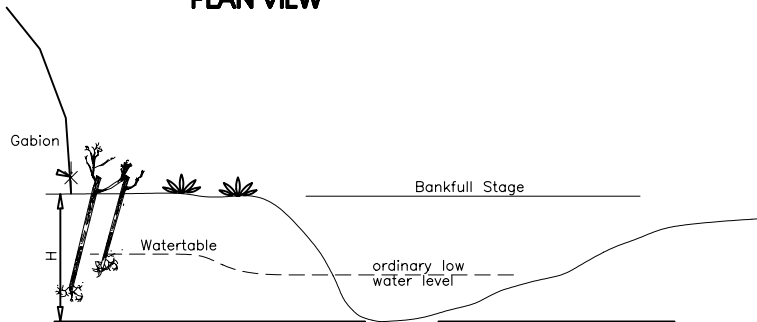
SHEET:

5 of 7

NOTES:
DRAWING NOT TO SCALE



PLAN VIEW



SECTION VIEW

POLE PLANTINGS

Staggered 4 ft. x 4 ft.
placement of dormant
native stakes or poles.

Species Willows

Dia 3/4 to 2 in.

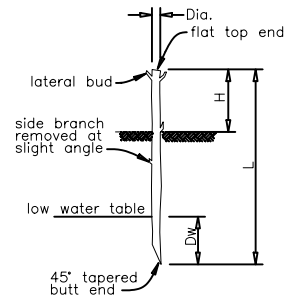
Length 2 to 4 ft.

Deer Grass Plantings

1 gal. containerized
plants

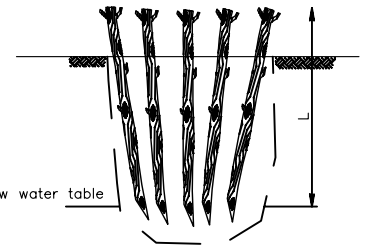
Species Deer Grass

Size 1 gallon containers



POLE PLANTING DETAIL

NOTES
Use 3/4 to 2 in. cuttings
Plant cutting perpendicular to the bank.
Holes around poles filled with dirt/water slurry.



POLE CLUSTER DETAIL

NOTES
Use 3/4 to 2 in. cuttings.
In holes excavated with a backhoe, place around 8 to 10 cuttings in hole to maximize sprouting success per effort.
Holes are backfilled with excavated material and watered.



NOTES
Use 1 gallon containerized plantings
Holes around poles filled with dirt/water slurry.

DEER GRASS DETAIL

NOTES:
See SHEET 3 for plant material procurement, handling, and installation.

5

Vegetative Plantings

**Natural
Channel
Design, Inc**

3410 S. Cocopah Dr.
Flagstaff, Arizona 86001
(928) 774-1178

DRAWN BY: M.Wirtanen, S.Yard

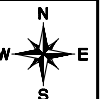
DESIGNED BY: M.Wirtanen, S.Yard

REV	DATE	BY	REVISION

DETAILS:
Pole Plantings and Deer Grass Plantings

**Montezuma Castle
Historic Gabion Protection**

AS-BUILTS

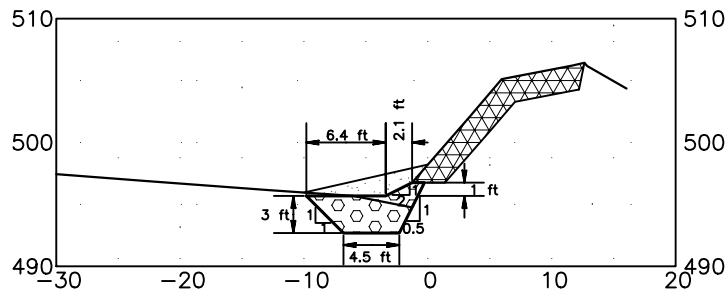


FILE NAME:

DATE: Aug 5, 2006

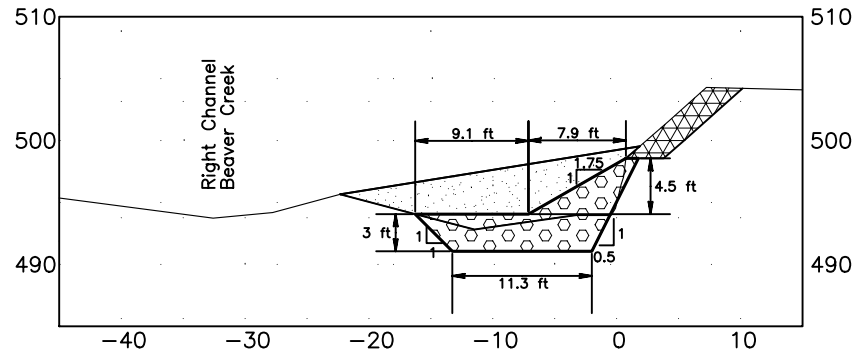
PROJECT NO:

SHEET: **6** of **7**



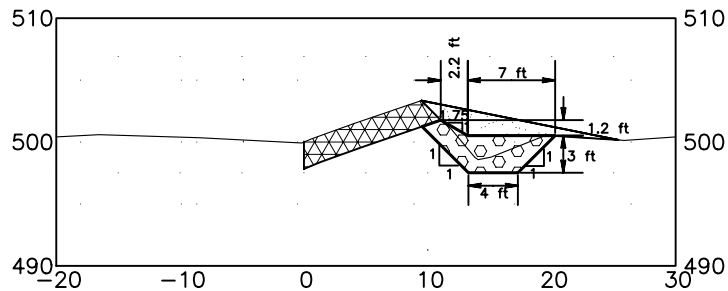
1

STA 1+00



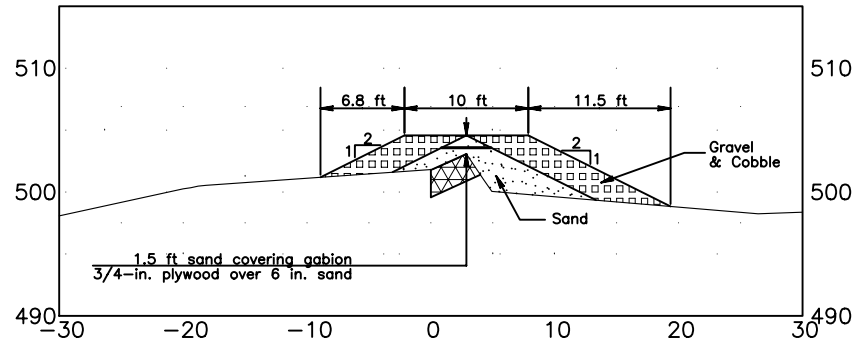
2

STA 3+60



3

STA 4+40



4

STA 5+45
Equipment Crossing

LEGEND

	Historic Rock-Wire Gabion
	Toe Rock
	Spoil from excavation

**Natural
Channel
Design, Inc**

3410 S. Cocopah Dr.
Flagstaff, Arizona 86001
(928) 774-1178

DRAWN BY: M.Wirtanen & S.Yard

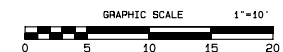
DESIGNED BY: M.Wirtanen & S.Yard

REV	DATE	BY	REVISION
1	8/23/06	S.Yard	Add XSects

CROSS-SECTIONS
STA 1+00, STA 3+60, STA 4+40

Montezuma Castle
Historic Gabion Protection

AS-BUILTS



FILE NAME:

DATE: Aug 5, 2006

PROJECT NO:

SHEET: 7 of 7