Hunters Hole Restoration Project

Final Report
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Grant # 09-166WPF

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HUNTER'S HOLE RIPARIAN AND WETLAND RESTORATION PROJECT

GRANT # 09-166WPF

FINAL REPORT

April 2014

Prepared for:

The Arizona Water Protection Fund
&
Yuma Crossing National Heritage Area

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Executive Summary

The last 23 miles of the Colorado River within the United States, called the Limitrophe Division (Morelos Dam to the southern international boundary), has been extensively modified by over a century of flood-control, water delivery, and agricultural activities, which have affected the native vegetation and wildlife that depend on them. Despite this extensive modification, this reach has retained some natural features, including pockets of native riparian species that were typical of the historic floodplain, due to the high flows experienced out of the Gila and Colorado Rivers during the 1980s and 1990s. Hunter's Hole was selected as a pilot project site in the Limitrophe to initiate habitat restoration efforts.

The original AWPF contract was initiated in 2008 with the primary objectives including 1) Establish approximately 7.5 acres of self-sustaining cottonwood and willow riparian habitat to recover native wildlife communities; 2) Establish approximately 9.75 acres of native mesquite bosque to provide increased wildlife habitat, especially for the invertebrate food base; 3) Establish 9.25 acres of open water and channels to provide habitat for winter migrants and resident water birds; 4) Establish approximately 10.25 acres of native marsh habitat for marsh bird species of concern; and 5) Monitor the project success of the approximately 36.75 acre riparian, wetland, open water revegetation project through plant monitoring and photo point monitoring. The site analyses and further water retention studies revealed that the original grading and planting design would not be feasible for the site. Water provided by the inflow pump quickly drained from the site due to the sandy soils present, and the site could not support the extensive channel and wetland habitats that were originally proposed. Therefore, the grading plan was designed with five separate cells, and commenced in October 2011. The planting design was re-designed to include 16.36 acres of cottonwood/willow, 6.9 acres of mesquite, and 5.5 acres of threesquare. Native seed was dispersed throughout the site in the appropriate habitats types. Planting was initiated in February 2012.

Overall, species height was 2-4 times higher in October 2013 as compared to October 2012 for all native tree species. Survivorship was greater than 80% for all species, except for *Prosopis glandulosa* (honey mesquite). This species may have been affected by high soil salinity and mammalian herbivory. *Prosopis pubescens* (screwbean mesquite) exhibited the highest growth with an average increase in height of 1.96 (SE=0.03) meters. This species aggressively recruited during the first two growing seasons, where species density increased 15 times during 2013 versus the 2012 growing season. *Salix exigua* (coyote willow) increased in height an average of 1 m (SE=0.08) from 2012 to 2013, and it showed the highest recruitment of any species. Species density increased 179 times during the 2013 growing season. *Prosopis glandulosa* (honey mesquite) showed an increase in average height of 0.8m (SE=0.08) from the 2012 to the 2013 growing seasons. The most successful planting technique was seeding where many shrubs and herbaceous understory plants dominated the cover and provided competition for re-colonizing invasive species.

1.0 Introduction

1.1 Site Background and History

Riparian ecosystems are renowned for their high levels of biodiversity, productivity, and dynamism (Noss and Cooperrider 1994). In the arid southwest, these ecosystems comprise of the smallest habitat areas, but support a disproportionately higher species diversity and density than any other habitat type in the overall landscape. However, particularly in Arizona, these ecosystems are increasingly imperiled due to extensive modification and exotic species invasion. The last 23 miles of the Colorado River within the United States, called the Limitrophe Division (Morelos Dam to the southern international boundary), has been extensively modified by over a century of flood-control, water delivery, and agricultural activities, which have affected the native vegetation and wildlife that depend on them. Despite this extensive modification, this reach has retained some natural features, including pockets of native riparian species that were typical of the historic floodplain, due to the high flows experienced out of the Gila and Colorado Rivers during the 1980s and 1990s.

In an effort to recover these existing native habitats and restore the areas dominated by invasive vegetation in the Limitrophe, a coalition of stakeholders was formed, including multiple federal, state, private, and non-profit groups, with the primary goals of restoring native habitats, creating a safe recreation area for the public and provide increased border security for homeland security. Hunter's Hole was selected as a pilot project site in the Limitrophe to initiate habitat restoration efforts. Hunter's Hole is located in Township T10S, Range R25W and Sections 23, 24, 34 and 35 (Appendix A).

This site was selected as a pilot project area because it had an existing water source (MODE Canal siphon inlet), which had created a small wetland overrun by invasive vegetation and scattered native cottonwood and willow species. The Bureau of Reclamation installed a ground water well on the site to provide additional water for restoration efforts. In 2007, the entire site was burned, clearing the site of invasive vegetation. Depth to water and soil salinity site analyses were completed and a planting design was drafted. Follow-up invasive plant clearing was conducted to clear remaining burned stumps and re-growth. Project activities came to a halt when the Yuma Crossing National Heritage Area awaited the Bureau of Reclamation's Multi-Species Conservation Program (MSCP) to provide an agreement for the 50 years of Operation and Maintenance funding for the site. Once the agreement was in place, project activities resumed and the site was graded for flood irrigation and planting was completed. Hunter's Hole is now a key component of a larger, bi-national effort between the U.S. and Mexico to restore habitat within the Limitrophe.

1.2 Statement of the Problem

This area once supported a host of wildlife species, including many species of concern. Southwestern willow flycatchers historically nested within this region and up to 26 willow flycatchers were observed using the site as a stop-over habitat during. The endangered Yuma clapper rail has been detected using this habitat during breeding season as recent as 2002 and in 2006. In fall 2007, the Hunter's Hole area was burned by a transient fire, which leveled 71.5 acres. The Bureau of Land Management (BLM) cleared an additional 257 acres for hazardous fuels reduction. While the fire created an easier platform for restoration, much of the useable habitat for neo-tropical migrating and resident bird species was decimated. Also due to the increased soil salinities from insufficient water flow over the past decades, new native species recruitment after the burn was nearly zero. Aggressive non-native species continued to recruit to the site post-fire, further reducing the site's viability for native plant species recruitment.

1.3 Project goals and Objectives

The goals of the Hunter's Hole Restoration project included:

1. Restore approximately 36.75 acres of self-sustaining, native cottonwood/willow/ mesquite, open water, and marsh habitat in a pilot area within the Limitrophe District of the lower Colorado River.
2. Obtain valuable data to apply to future restoration activities within the Limitrophe District of the lower Colorado River.

The original objectives of the Hunter's Hole project included:

1. Establish approximately 7.5 acres of self-sustaining cottonwood and willow riparian habitat to recover native wildlife communities.
2. Establish approximately 9.75 acres of native mesquite bosque to provide increased wildlife habitat, especially for the invertebrate food base.
3. Establish 9.25 acres of open water and channels to provide habitat for winter migrants and resident water birds.
4. Establish approximately 10.25 acres of native marsh habitat for marsh bird species of concern.
5. Monitor the project success of the approximately 36.75 acre riparian, wetland, open water revegetation project through plant monitoring and photo point monitoring.

These objectives were revised after conducting site analyses and water retention studies at the site that revealed that the site would not sustain open water and channels. The final objectives that were accomplished at the site included:

1. Establish approximately 16.36 acres of self-sustaining cottonwood and willow riparian habitat to recover native wildlife communities.
2. Establish approximately 6.9 acres of native mesquite bosque to provide increased wildlife habitat, especially for the invertebrate food base.

3. Establish approximately 5.5 acres of native marsh habitat for marsh bird species of concern.
4. Monitor the project success of the approximately 28.76 acre riparian and wetland revegetation project through plant monitoring and photo point monitoring.

2.0 Construction and Site Analysis

2.1 Site Assessment

An assessment of the site was conducted during the Wetland Delineation to determine the physical properties and pre-restoration conditions of the project area (Appendix B). These preliminary measurements also acted as the baseline site condition we could compare against post restoration. Soil salinity and depth to water table can be limiting factors for plant growth and survival. These measurements were taken into account when drafting the planting plan. Soil salinity and soil type was sampled at the soil's surface level and at a depth of 5ft for 47 points within 11 transects (Appendix C and D). Depth to water was evaluated at 59 points along the 11 transects (Appendix E). Transects were 500-1000 feet apart running east to west across the Hunters Hole project area. At each data point, a 2005 Series Trimble Geo XT survey unit was used to obtain the GPS location and elevation.

The Hunter's Hole project area had relatively high surface salinity, which is likely due to the naturally high salinity concentration of the Colorado River, agricultural inputs and lack of historical flood regimes that would normally mitigate salt build up in soils. The electrical conductivity units (EC's) on the surface ranged from 12- 25 mmhos/cm (Appendix C). EC's at the 5 foot soil depth ranged from 1-6 mmhos. The acceptable levels of EC's for cottonwood and willow range from 1-3 EC's, for mesquite's 3-9.4 EC's, and for salt tolerant native species 9.4 and above. The soil texture at the surface level was silt with some areas having fine sand. At the 5ft depth, fine sand and sand is the predominant soil type. Depth to water was shallow in areas within and around existing wetland and open water habitats ranging from 0-3ft. The majority of the upland area showed a deep depth to water of 11ft.

2.2 Water Retention Test

Once the ground water pump was installed from the Bureau of Reclamation, a test flow was conducted to determine the water retention of the soils at the site for the proposed security channel and aquatic habitat. The pump was left on for two months to determine if water could fill the whole project site. After the pump was shut down the water drained from the site in two weeks. The test study indicated that the site would not support channels and open water so the grading and planting design was re-designed. In order to retain the planted native vegetation at the site, constant irrigation will be required.

2.3 Site Clearing and Herbicide Spraying

Minimal invasive species clearing was required due to the fire that burned the site in 2007. Any remaining invasive species on site were cleared using a Bobcat with a hydro-axe mulcher, D6H Dozer, Gradall with a tree chopper and chainsaws. Clearing consisted of removing saltcedar (*Tamarix ramosissima*), common reed (*Phragmites* sp.), Bermuda grass *(Cynodon dactylon*), and arrowweed (*Pluchea sericea*). The work also included clearing all burned wood and brush, root masses, rubbish and debris. Extra care was taken during clearing and grubbing to avoid native species, including Fremont cottonwoods (*Populus fremontii*) and Goodding's willow *(Salix gooddingii).* A clearing map can be found in Appendix F.

In non-wetland areas the cut stump method was used with the herbicide Pathfinder II (Triclopyr) was used to control recolonizing saltcedar. This method involved manually cutting the trees to the soil surface then immediately applying herbicide to the individual stumps. In wetland areas a low volume foliar application of Aquamaster (Glyphosate) was used to control Russian thistle, saltcedar, and Bermuda grass. A back pack sprayer or tractor mounted sprayer was used for these applications.

Phragmites regrowth was treated with a combination of Rodeo and Habitat. Due to the amount of regeneration of this undesirable species the treatments were applied using a boomless spray system. This system uses a 25 gallon tank that is fitted with three nozzles that spray a 30 foot swath with each pass. The application rate was 5 gallons of 3% herbicide mix per acre of phragmites infestation. Extra care was taken to prevent herbicide drift and only certified applicators were allowed to complete this scope of work.

2.4 Site Land Leveling, Excavation and Installation of Water Control Structures

The site analyses and further water retention studies revealed that the original grading and planting design would not be feasible for the site. Water provided by the inflow pump quickly drained from the site due to the sandy soils present. Therefore, the site was re-designed with five flood cells. A stamped engineered drawing of the flood cells was created for grading and construction of the flood irrigated cells. More information of the creation of the cells is described below.

MOBILIZATION AND DEMOBILIZATION OF EQUIPMENT

PG&E, the grading and excavation sub-contractor, began moving equipment to the Hunter's Hole project site in mid-October 2011. All mobilization efforts were done in a safe and orderly manner with care not to damage existing vegetation or disturb the ingress-egress routes. Upon completion of all tasks, demobilization from the site included all activities and costs for transportation of personnel, equipment, and supplies not required or included in the contract. This included the disassembly, removal, and site cleanup of offices, buildings, and other facilities assembled on the site specifically for this contract.

PREPARE SITE FOR CONSTRUCTION OPERATIONS

The site boundary and limits of construction were staked out by Fred Phillips Consulting (FPC). Following the initial layout staking PG&E began clearing, grubbing, and stripping the site. All non-native vegetation, trash, and debris was cleared and piled with a bulldozer. Grubbing consisted of completely removing all stumps and roots 1.5 inches or greater in diameter. Stumps were grubbed to a depth of three feet below natural ground. Brush and similar material were grubbed to a minimum depth of 12 inches below natural ground. Stripping consisted of the complete removal of grass, weeds, and all earth materials contaminated by organics. Stripping was done below the footprint of the access roads, agricultural berms, and re-contoured fill and excavation areas. All material was stockpiled in multiple locations on site. Once the woody piles of cleared material were dry they were burned and the ash was raked back into the existing soils. During the clearing, grubbing, and stripping process all native vegetation was avoided. All construction activities were carried out in such a manner that erosion, air, and water pollution was minimized and held within the legal limits, using the standard Best Management Practices. Once the clearing and grubbing was completed, FPC staked out the location of the maintenance roads and flood cell berms.

BORROW & PLACE FILL FOR ROADS, BERMS, AND HABITAT CELLS

Native materials from the site were used for all fill locations. Compacted fill to construct the access the roads and agricultural berms primarily came from the construction of the habitat cells #4 and #5 (Appendix G). Land leveling fill for the habitat cells primarily came from the construction of habitat cells #1, #2, and #3. These cells were balanced internally to minimize haul routes. All habitat cells were cleared, grubbed, and stripped in accordance with the technical specifications. All compacted fills, including fills added to re-grade and improve existing roads were scarified and wetted in preparation for the first lift. All areas requiring compacted fill were compacted with pneumatic tired equipment in six inch layers. Each layer was spread across the entire fill area and deposited longitudinally along the fill area. The fill areas were maintained in a reasonably level condition and hauling equipment was diverted over the full width of each layer to facilitate uniform compaction. All land leveling fill areas were scarified and wetted in preparation for the first lift. Soils were places in lifts that did not exceed six inches. Equipment was routed to obtain compaction that minimized settlement. The habitat cells were smoothed and graded to prevent surface ponding, and finally land leveled to remove surface irregularities and brought to grade as shown on the plans.

FURNISH AND PLACE EROSION PROTECTION ROCK

Erosion protection rock was placed at all pipe outlets, the 21 - mile spillway outlet, and the inlet and outlet of all the water control structures, including a geotextile fabric underlay. All rock sizes conformed to the technical specifications and were obtained from local sources. The geotextile fabric placed under all rock was Class III non-woven with minimum grab tensile strength of 90 pounds, greater than 50% elongation at failure, a minimum of 40 pound puncture

strength, and had a UV resistance of 70% strength retained. All rock was placed by and excavator in a manner that ensured a reasonably homogeneous surface with the larger rocks uniformly distributed and firmly in contact to one another with the smaller rocks and spalls filling the voids between the larger rocks. Some hand placing was done to provide a neat and uniform surface. All geotextile surfaces were placed on prepared surfaces at the locations as shown on the plans and in accordance with the technical specifications.

FURNISH AND INSTALL WATER CONTROL STRUCTURES

All water control structures, including the pre-cast riser structures, tail-wall structures, and culvert pipes were supplied by PG&E in accordance with the technical specifications (Appendix G). Trenches for the water control structures were excavated to extend three feet beyond the ends and one foot beyond the sides of the pipe. The base of the trench was excavated to a depth such that the installed pipe, associated concrete riser, and tail-wall water control structures met the pipe invert elevations as shown on the plans. The resulting bed was fully leveled and compacted throughout the full width and length of the trench, such that the pipe and water control structures are fully supported for the entire length/width, and the water control structures are all level both in width and length. The pipe excavation was excavated to a minimum of four inches lower than the pipe grade shown on the drawings. The pipe was placed on earthen material of uniform density and a grove that closely conforms to the outside surface of the pipe was formed in the bedding.

The pipes were then assembled in accordance with the manufacture's specifications. A concrete aggregate base was placed under each structure and constructed such that all structures are fully supported and level in both width and length. An initial backfill up to 12 inches was placed over the pipes and structures and consisted of soil material that was free of rock, stones, or hard clods more than one inch thick. The first stage of backfill was place to the center of the pipe and the second stage was placed 12 inches above the top of the pipe. The final backfill consisted of suitable site material and was placed in layers of six inches before compaction.

FURNISH AND INSTALL 12" DIAMETER DR 17 IPS HDPE PIPE

The pipeline network that feeds all the habitat cells within the project area was connected to an irrigation manifold that was constructed by the Bureau of Reclamation. All trench excavations for the pipeline network extended three feet beyond the ends and one foot beyond the sides of the pipe. The base of the trenches was excavated to a depth such that the pipe invert elevations meet the elevations shown on the plans. The resulting bed was fully leveled and compacted throughout the full width and length of the trench. The pipe foundation was excavated to four inches lower than the pipe grade shown on the plans. The pipe was placed on a material of uniform density to prevent differential settlement. The earth bedding was compacted to a density equal to the undisturbed earth material adjacent to the trench. After preparation of the trench beds the pipe was joined using electrofusion techniques. An initial backfill up to 12 inches was

placed over the pipes and structures and consisted of soil material that was free of rock, stones, or hard clods more than one inch thick. The first stage of backfill was place to the center of the pipe and the second stage was placed 12 inches above the top of the pipe. The final backfill consisted of suitable site material and was placed in layers of six inches before compaction.

ADDITIONAL ROAD STABILIZATION

In December 2011, PG&E notified the design team that the soil on the site did not contain enough suitable cohesive material to stabilize the roadways within the project area. The roadways were built from material obtained from cells #4 and #5 as per the technical specifications and clay material was obtained from other areas around the site, but there still was not enough material with plasticity to sufficiently stabilize the roadways. Additional fund were approved by the AWPF commission in January 2012 to add a fabric stabilized subgrade with gravel to the roads. The gravel was placed on the roads with a compacted thickness of six inches and a width if 12 feet to cover the top of the roads. The gravel material was watered, rolled, and finished with a bulldozer and provided a stabilized driving surface for single lane traffic.

2.5 Re-vegetate Native Habitat

The site analyses and further water retention studies revealed that the original planting design was not be feasible for the site. Therefore, the planting design was re-developed to include 16.36 acres of cottonwood/willow, 6.9 acres of mesquite, and 5.5 acres of threesquare. The open water and channel objective was eliminated from the design because the water could not be retained in the channel and site. The planting design utilized on the site is discussed further below and can be found in Appendix H.

MARSH AND BANK REVEGETATION

Beginning in February of 2012, FPC began harvesting sandbar willow (*S. exigua*) poles from Cibola Wildlife Refuge. The poles were soaked for two weeks prior to planting at Hunter's Hole. On February 14, 2012, crews began planting the slopes of the lower wetland cells, cells #4 and #5, with the sandbar willow poles harvested from Cibola and saltgrass (*D. spicata*) plugs per the planting design (Appendix H). The holes were dug seven feet on center (O.C.) with a bobcat and auger attachment and three willow poles were planted in each hole. The salt grass plugs were hand planted five feet O.C. Threesquare (*O. scripus*) plugs were planted in the bottom of cells #4 and #5. They were planted using a John Deer Gator A.T.V pulling a shank that cut trenches every five feet, parallel with the longest side of the cell. The plugs were then hand planted every five feet O.C. in the trenches. In cell #5 crews planted approximately 453 sandbar willow bundles, 1,200 saltgrass plugs, and 5,400 three square plugs. Cell #5 also received an additional 98 one gallon yerba mansa (*A. californica*) plants that were not part of the required planting design. The plants were purchased from Greenheart and Mountain State nurseries. In cell #4 crews planted approximately 1,191 sandbar willow bundles, 1,657 saltgrass plugs, and 8,600 threesquare plugs. The contracted costs for the sandbar willow poles, salt grass plugs, and

threesquare plugs was spent on the labor hours for harvesting the plant material from the Yuma East Wetlands.

RIPARIAN REVEGETATION

The four different habitat zones for cells #1, #2, and #3 were staked out and planting efforts on these cells began on March 1, 2012. In cells #1, #2, and #3 crews began by hand planting saltgrass plugs every five feet O.C. in the sandbar willow and Goodding willow habitats. These plugs were harvested from the Yuma East Wetlands (YEW). The mesquite habitat in cell #3 was seeded with 8.75 pounds of Mexican evening primrose (*O. mexicana*) and the cottonwood habitat was seeded with 4.25 pounds of alkali sacaton (*S. airoides*). The mesquite habitat in cell #2 was seeded with 8.75 pounds of desert marigold (*B.multiradiata*) and the cottonwood habitat was seeded with 4.25 pounds of blue grama (*B. gracilis*). The mesquite habitat in cell #1 was split in half and seeded with 8.75 pounds of brittlebush (*E. farinosa*) and 8.75 pounds of globe mallow (*S. ambigua*) and the cottonwood habitat was split in half as well and seeded with 4.25 pounds of alkali sacaton and 4.25 pounds of blue grama. Seeds were spread in the appropriate locations by a seed spreader attached to a Gator A.T.V. A chain link fence weighted down with boulders was attached to the back of the Gator to scarify and rake the seeds into the soil.

After the completion of the seeding, the crew began hand planting the trees in cells #1, #2, and #3. Cell #3 was planted with 978 one gallon sandbar willow pots planted 7 feet O.C., 427 one gallon Goodding willow (*S. gooddingii)* pots planted 15 feet O.C., 194 one gallon cottonwood (*P. fremontii*) pots planted 15 feet O.C., 186 one gallon mesquite (*P. glandulosa*) pots planted 20 feet O.C., and 4,018 saltgrass plugs planted five feet O.C. Planting efforts on cell #3 were completed as per the planting designs. Cell #3 also received an additional 50 one gallon wolfberry (*Lycium spp.*) pots planted seven feet O.C. and 50 one gallon four-wing saltbush (*A. canescens*) pots planted seven feet O.C.

Cell #2 was planted with 533 one gallon sandbar willow pots planted seven feet O.C., 310 one gallon Goodding willow pots planted 15 feet O.C., 175 one gallon cottonwood pots planted 15 feet O.C., 185 one gallon mesquite trees pots planted 20 feet O.C., and 3,515 saltgrass plugs planted five feet O.C. After planting efforts in cell #2 were complete as per the planting designs, this cell also received an additional 50 one gallon wolfberry shrubs planted 7 feet O.C. and 50 one gallon four-wing saltbush shrubs planted seven feet O.C.

Cell #1 was planted with 1,245 one gallon sandbar willow pots planted seven feet O.C., 582 one gallon Goodding willow pots planted 15 feet O.C., 336 one gallon cottonwood pots planted 15 feet O.C., 382 one gallon mesquite pots planted 20 feet O.C., and 4,860 saltgrass plugs planted five feet O.C. After planting efforts in cell #1 were complete as per the planting designs, this cell also received an additional 50 one gallon wolfberry shrubs planted 7 feet O.C. and 50 one gallon four-wing saltbush shrubs planted 7 feet O.C. The contracted cost for the salt grass plugs was spent on the labor hours for harvesting the plant material from the Yuma East Wetlands.

2.6 Project Maintenance

FPC actively maintained the project area by weeding non-natives on a daily basis. A backpack herbicide sprayer, hand tools and an ATV were used for site maintenance. A combination of hand weeding and chemical application was used to control undesirable weeds on the project. Timely control activities and competition from native grass species that were planted on the site resulted in a significant decrease in weed encroachment once the native plants established. Other routine work in the area included the removal of trash, broken branches and trees, and dry plants that the wind had blown into the area. Once a large amount of dead organic matter had been collected, and a chipper was used to mulch the debris. The mulch was spread along maintenance roads for stabilization and nutrient recycling.

Active planting occurred on site to replace any mortality that may have occurred since the projects inception. In 2013, 445 bulrush plugs and 590 inland salt grass plugs were harvested on site and planted throughout the project area. The harvest method used was a checkerboard pattern to prevent large bare areas on the ground. Once harvesting was completed, dirt and litter was spread over the area of harvest to promote natural regeneration.

The Bureau of Reclamation and the FPC project foreman worked together to ensure optimal operation of the irrigation system and pumps. As plantings continued to mature and ground cover increased irrigation times for the cells also had to increase. During the summer months irrigation on the project was kept at a 14 day cycle. The pump runs 3 days a week, irrigating half the cells one week and the other half the following week. This method decreased pump run time and ensured that the entire cell was irrigated. The winter irrigation schedule that ran from November 1 through March 31 was kept at a 28 day cycle, irrigating half the cells one week and the other half the following week then waiting 14 days before irrigating again.

The 21 mile spill way varied in its discharge and the above schedules were altered to accommodate for the additional flow. There were months were Hunters Hole did not receive any water through the spill way, and there were months the site received water two or three times per week. The 21 mile spill way is an emergency discharge source for the water users association and could not be counted on to deliver water in any regularity. The MODE canal syphon normally remained locked and was rarely used for irrigation.

3.0 Monitoring Data Collection Methods

3.1 Photo Monitoring Analysis

Qualitative data-collection methods for vegetation included photo point monitoring. Five permanent photo monitoring stations were established on site from a vantage point that captured the overall site growth. Photos included landmark features in the background for reference such

as a rock outcropping or distant hill. Each photo point was marked with rebar and construction fence and a GPS point was taken at each spot in order to relocate the points.

Photos were taken with the same type of camera, at the same height, and same compass bearing as the previous photos. The previous photos were brought to make sure the photos were aligned with the previous photos. The frame number, speed, f-stop, aperture, photo name and description were recorded for each photo. Photo monitoring results are located in Appendix I.

3.2 Vegetation Monitoring

Monitoring techniques at the Hunters Hole site followed the Multi-Species Conservation Program (MSCP) of the Bureau of Reclamation habitat monitoring protocols in order to compare results across the entire Lower Colorado River. A reduced protocol was implemented to evaluate planting success (i.e. first and second season plant mortality), growth, and frequency and species richness of herbaceous plant species through time.

Monitoring was conducted one time during the 2012 and 2013 growing seasons during October-November. Monitoring was conducted in the fall for several reasons; 1) to evaluate the current years' recruitment; 2) the trees will be at the end of the growing season during the fall monitoring period, 3) monitoring must take place after bird species have fledged their young.

Ten permanent monitoring plots (10m x 40m) were randomly established at Hunter's Hole (Appendix J). Plots were established by locating virtual transects (using ArcMap) along the gradient of planting and were divided into 60-meter segments. For each 60-meter segment, using a restricted random approach, a number was selected from the following: 5, 15, 25, 35, 45, and 55; this number represented the meter distance along each 60-meter segment that became the secondary transects starting locations. The secondary transects were laid across the gradient of planting in an attempt to capture more diversity. Global Positioning System (GPS) coordinates (points) were systematically generated along each transect every 40 meters. From these points, 10 were randomly selected to establish the 10m x 40m intensive plots (Appendix J). A buffer was created ensuring that the edges of plots were not within ~15 meters of the phase edges. Compass bearings were determined for transects at each site.

In the field, intensive plots were permanently marked at the center and four corners with fencing stakes and fluorescent construction fence and marked with a GPS. Tree and shrub heights and tallies were recorded within the A plot. A stadia rod was used to measure five trees of each species, within each size class or category. The measured values were used to estimate height for the remaining trees (standard trees SC 3 and 4; mesquite trees SC 1 and 2) within each plot. The measured trees were indicated on the datasheets. Height measurements were collected to a tenth of a meter (0.10 m) if a true measurement was possible and to a half meter (0.50m) if height was estimated. Mean tree and shrub heights were calculated from measured and estimated heights. All species were then tallied. Per plot densities for trees and shrubs were calculated by species

within plot area (Plot A = 0.10 acres); and trees and shrubs per acre were calculated as total trees or shrubs divided by total combined plot acres. Any species not measured for height or counted was recorded as an incidental species.

4.0 Monitoring Results

Tree and Shrub Height

Overall, species height was 2-4 times higher in October 2013 as compared to October 2012 (Figure 4-1). *Prosopis pubescens* (screwbean mesquite) exhibited the highest growth with an average increase in height of 1.96 (SE=0.03) meters. This species aggressively recruited during the first two growing seasons, where species density increased 15 times during the 2013 growing season as compared to the 2012 growing season. *Salex gooddingii* (Goodding willow) exhibited the second highest growth with an average increase of 2.1 meters (SE=0.19). *S. gooddingii* also aggressively recruited during the first two growing seasons, where species density was two times higher during the 2013 growing season as compared to the 2012 growing season. *Populus fremontii* (Fremont cottonwood) showed an increase in average height of 2 meters (SE=0.25), and only one additional individual was recruited. *Salix exigua* (coyote willow) increased in height an average of 1 m (SE=0.08) from 2012 to 2013, and it showed the highest recruitment of any species. Species density increased 179 times during the 2013 growing season as compared to the 2012 growing season. *S. exigua* is a rapid colonizer of riparian sites by developing shoot buds on lateral roots to form extensive spreading colonies. *Prosopis glandulosa* (honey mesquite) showed an increase in average height of 0.8m (SE=0.08) from the 2012 to the 2013 growing seasons. In the monitoring plots, this species showed no recruitment.

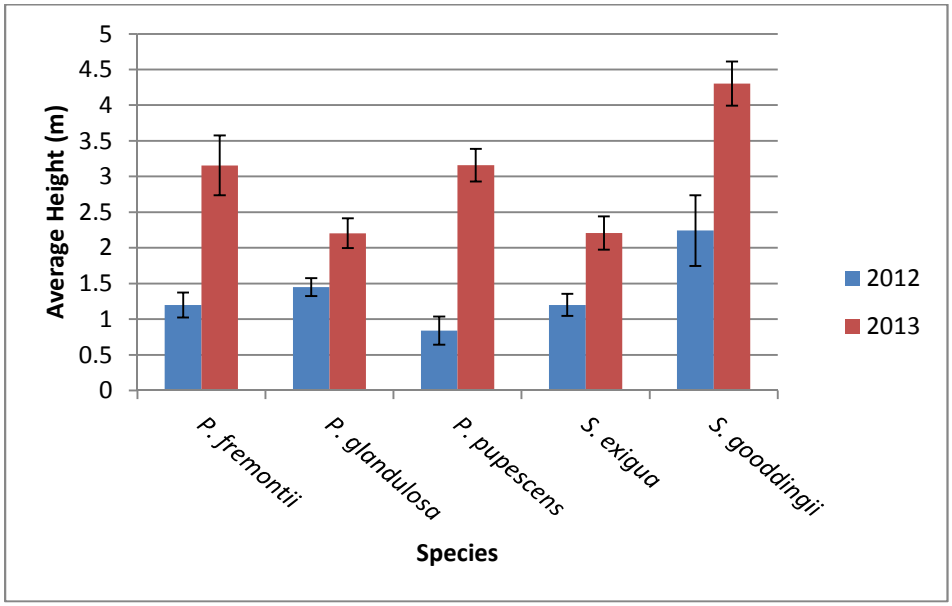


Figure 4-1. Average tree height (m) by species for 2012 and 2013 at the Hunter's Hole restoration site. Error bars represent standard error.

Many native shrubs were detected during the 2013 growing season, which increased the diversity and density of vegetation at the Hunter's Hole site (Figure 4-2). Few shrubs were recorded during the 2012 vegetation monitoring season, with the exception of *S. exigua* described above and *Baccharis salicifolia* (mulefat), so many of the shrubs detected likely came up from seed. The site was planted with a variety of native grass, herbaceous and shrub species seed. Also, the surrounding native populations may have contributed to the propagation of additional species not planted. *Atriplex canescens* (four-wing saltbush) was the tallest of the shrub species recorded (1.2m); however only one individual was recorded in the plots. Only one individual of *Lycium andersonii* (wolfberry) was recorded within the monitoring plots (0.65m); however the individual was in excellent condition. *Encelia farinosa* (brittlebush) and *Sphaeralcea parvifolia* (smallflower globemallow) were the most prolific propagators from seed, with a total of 99 and 22 individuals recorded in the plots respectively. *Baccharis salicifolia* (mulefat) had a total of four individuals detected within the plots. In addition to the species recorded above, other species that were recorded on the site included *Disticulus spicata* (saltgrass), *Sporabolis airoides* (alkali sacaton), *Bouteloua gracilis* (blue grama), *Leptochloa fusca spp. uninervia* (Mexican sprangletop), *Sesuvium verrucosum* (western sea purslane), *Baileya multiradiata* (desert marigold), *Oenothera speciosa* (pinkladies), *Conyza Canadensis* (Canadian horseweed), *Heliotropium curassavicum* (heliotrope), *Malvella leprosa* (alkali mallow), *Tiquilia plicata* (fanleaf crinklemat), *Helianthus petiolaris* (prairie sunflower) and *Tamarix sp* (saltcedar).

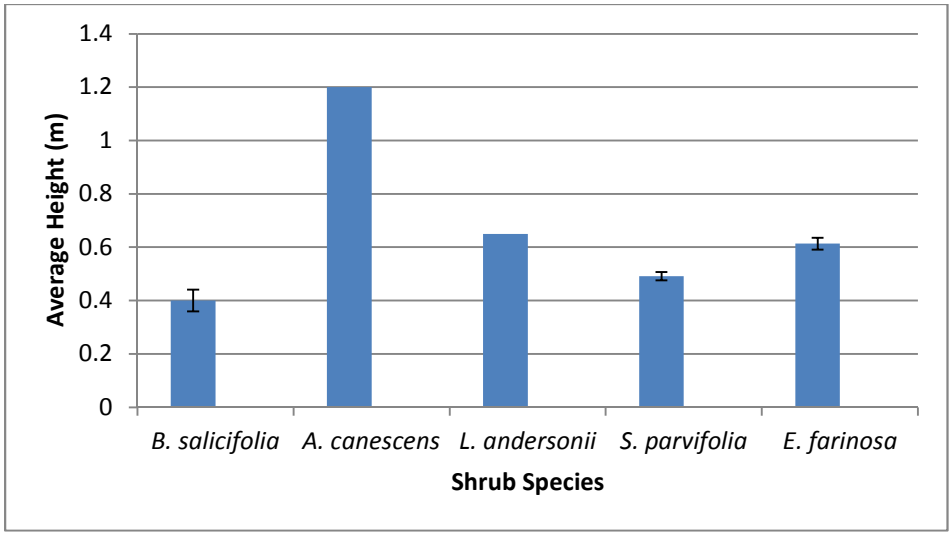


Figure 4-2. Average shrub height (m) by species for the 2013 growing season at Hunter's Hole restoration site. Error bars indicate standard error. The lack of error bars indicates that only one individual was recorded (*A. canescens* and *L. andersonii*).

Tree and Shrub Density and Survivorship

Tree and shrub density is presented as the estimated number of trees and shrubs per acre for all plots combined during the 2012 and 2013 growing seasons at the Hunter's Hole site (Table 4-1).

Overall, there was a higher density of trees and shrubs in the monitoring plots during 2013 when compared to 2012. During 2013, *P. pubescens* was the most abundant tree species at the Hunter's Hole site (395 trees/acre) and showed high recruitment with 2.4 times more individuals in 2013 when compared to 2012. In 2013, *S. gooddingii* (247 trees/acre), which showed 97% survivorship from 2012 (when the site was planted) to 2013. *P. fremontii* abundance was 68 trees/acre in 2013, and this species had 86% survivorship from 2012 to 2013. *P. glandulosa* showed the lowest survivorship of any tree species at 29%. In 2013, *P. glandulosa* abundance was 53 trees/acre.

S. exigua was the most abundant shrub during the 2012 and 2013 growing seasons, with an abundance of 9,295 shrubs/acre calculated in 2013. *S. exigua* showed high recruitment with 12 times more individuals in 2013 than in 2012. *B. salicifolia* abundance was 84 shrubs/acre in 2013, and this species had two times more individuals in 2013 as compared to 2012. No other shrubs were detected during the 2012 growing season. In 2013, following *S. exigua*, *E. farinosa* had a high abundance (526 shrubs/acre), followed by *S. parvifolia* (126 shrubs/acre), *B. salicifolia* (84 shrubs/acre), and *A. canescens* (11 shrubs/acre). *L. andersonii* had the lowest abundance (5 shrubs/acre) for the shrub species. *Tamarix* sp. was detected in small abundances at the site (11 shrubs/acre).

Table 4-1. Tree (trees/acre) and shrub (shrubs/acre) density estimates for 'All species' and individual species during the 2012 and 2013 growing seasons at Hunter's Hole.

TREES			**SHRUBS**		
Species	**Trees/Acre**		**Species**	**Shrubs/Acre**	
All Species	**2012**	679	All species	**2012**	805
	2013	763		**2013**	10,058
	2012	**2013**		**2012**	**2013**
P. fremontii	79	68	*B. salicifolia*	42	84
P. glandulosa	184	53	*A. canescens*	0	11
P. probscens	163	395	*S. exigua*	805	9,295
S. gooddingii	253	247	*L. andersonii*	0	5
			Tamarix sp.	0	11
			S. parvifolia	0	126
			E. farinosa	0	526

5.0 Conclusions and Recommendations

5.1 Project Conclusions

The 28.8 acre Hunters Hole Project has successfully transformed severely degraded riparian and wetland habitat that was dominated by non-native salt cedar and phragmites to a thriving habitat supported by native vegetation. This transformation has created invaluable habitat for many wildlife species. The monitoring data shows the excellent health and vigor that the Hunter's Hole restoration site had during the 2012 and 2013 growing seasons. Survivorship was greater than 80% for all species with the exception of honey mesquite. *P. glandulosa* may have experienced high mortality due to high soil salinity and/or mammalian herbivory. This species was replaced by other native grasses, herbs and trees through natural recruitment.

S. exigua showed the highest increase in density for the riparian plants, which is typical for this species. *S. exigua* develops shoot buds on lateral roots to form extensive spreading colonies, which allows it to colonize sites rapidly. *P. pubescens* had the highest growth for the 2013 growing season and experienced aggressive recruitment. This species has been declining across the Lower Colorado River due to an unknown malady. Research is currently being conducted to further understand this decline and the mechanism behind it. For now, Hunter's Hole provides a stronghold for this species. The recruitment of this species indicates the importance of mesquites to wildlife, as the mesquite seeds were likely spread by coyotes and birds that use them for food. *P. pubescens* and *P. glandulosa* both provide essential components to the resident and neo-tropical migrating wildlife in the riparian habitat in the lower Colorado River. Without this habitat, low-quality *Tamarix* sp. would dominate.

S. gooddingii had the highest overall height, which was likely due to the mature individuals that were already established at the site. The mature *S. gooddingii* provided habitat to wildlife species while the site matured. *Tamarix* sp. was detected within the monitoring plots in low density. The *Tamarix* sp. individuals detected were immature and small. The site is regularly maintained to remove invasive species to promote the growth of native species.

Although not recorded for the reduced effort monitoring, herbaceous and grass species dominate the understory, and, in some areas, bare ground cannot be seen. Seeding native grass, herbaceous and shrub species combined with flood irrigation promoted the extensive growth of these species. Four shrub species were not detected during the 2012 monitoring season, including *A. canescens*, *L. andersonii*, *S. parvifolia*, and *E. farinosa*. However, they were abundantly growing during the 2013 growing season. Seeding and rapid establishment of native understory grasses has greatly increased the value of the habitat and reduced the amount of weed maintenance at the site. Dense native understory growth provides a natural way to reduce the re-growth of invasive vegetation and reduced the use of herbicides. Almost 100 individuals were recorded for *E. farinosa* in the monitoring plots, which shows their capability for germinating and thriving from

seed. *S. parvifolia* also germinated well from seed. Only one individual was detected from *L. andersonii* and *A. canescens*, but these individuals were in good condition.

Prior to restoration, Hunter's Hole was dominated by a mix of native cottonwood, willow and mesquite and non-native tamarisk and phragmites. When the fire burned the site the cottonwood and mesquite was decimated and did not recolonize. However, Goodding and sandbar willow re-established after the fire.

The incredible native plant growth and recruitment and minimal re-colonization of invasive species experienced at the Hunter's Hole site indicates the restoration success of this project. The photo monitoring attests to the advanced growth of this site just one year after planting. The Multi-Species Conservation Program is going to take over the long-term maintenance and monitoring of the site starting in 2014. It is suspected that as the habitat continues to mature many endangered and threatened species will return to the site to use the habitats.

5.2 Recommendations for Future Projects

There were many 'lessons learned' and recommendations for future projects that could be gleaned from the activities conducted on the AWPF Hunter's Hole Restoration Project. Conducting the preliminary site analysis and water retention studies at the site ensured that the project was a success. Without those studies a lot of money would have been spent on design, engineering and planting material that would not have been successful. Also, the high success of seeding native species, as evidenced in the results, should be used as a restoration technique for all riparian and wetland projects in Arizona. Seeding native herb, grass and shrub understory species provides higher quality habitat, out-competes recolonizing non-native species, and reduces the use of chemical control and maintenance costs. The species that we found to work most successfully from seed on the lower Colorado River include: *Sporabolis airoides* (alkali sacaton), *Bouteloua gracilis* (blue grama), *Baileya multiradiata* (desert marigold), *Oenothera speciosa* (pinkladies), and *Malvella leprosa* (alkali mallow), *Encelia farinosa* (brittlebush) and *Sphaeralcea parvifolia* (smallflower globemallow). Another planting method that expedited planting efforts at the site included using an implement on the back of a bobcat to create a ditch that could be rapidly planted with plugs.

After the fire at the site, non-native phragmites aggressively recolonized. The complete control of this aggressive species was essential to the successful establishment of native species. Several herbicide treatments were required to control this species. The initial upfront effort to remove this species eliminated the potential competition on the establishment and growth of native species.

Another lesson learned at the site, occurred when the irrigation outfall structure collapsed. The fill that held the structure in place was not strong enough to support the pressure that was created from the water to irrigate the site. In order to mitigate the collapse, additional material was

brought in to reinforce and secure the structure. The appropriate material will be used in future projects to ensure that structures do not collapse. Additionally, in order to provide more efficient water dispersal in the cells, the southern field should have been split into two to three cells. Smaller flood irrigated cells will be utilized in future projects.

One of the challenges that occurred at the site happened when the MODE siphon was turned off in 2011 and no longer provided water to the site. The MODE siphon is a canal that carries pumped groundwater from agricultural activities with salinities that are too high to dispense into the Colorado River. The water is carried to and released into the Cienega de Santa Clara, Mexico. The MODE canal passes adjacent to the Hunter's Hole site on its way to Mexico. Prior to restoration, the MODE canal provided additional water to the site. The BOR pump that was established as the main irrigation for the Hunter' Hole restoration site provides all the water to the site. Turning the siphon back on would reduce the demand on the pump and help sustain moist soils in the marsh areas.

The Minute 319 pulse flow that occurred during April 2014 was released in the dry Colorado River channel through the Limitrophe District with the intention of reaching the Delta and providing water to restoration projects along the dry river bed. Hunter's Hole occurs in an old oxbow of the Colorado River that was created during high flow events during 1982 and 1992 and sits apart from the main river channel. Since the water retreated from the site and prior to restoration, the native vegetation occurring on site was sustained by water from the MODE siphon. The Minute 319 flow did not directly benefit the Hunter's Hole site, because the water never reached the site.

Finally, the Hunter's Hole restoration site has become a successful model for bi-national restoration. Since the completion of Hunter's Hole, four other restoration projects along the Limitrophe District and the Colorado River delta have been planned, initiated and built. What started as a vision in the early planning stages has now become a model to restore this forgotten landscape.

Appendix A: Hunter's Hole Restoration Site Location Map

REGIONAL MAP

CALIFORNIA

ARIZONA

LIMITROPHE AREA

BAJA CALIFORNIA NORTE

SONORA

UNITED STATES AND MEXICO

UNITED STATES OF AMERICA

LIMITROPHE AREA

MEXICO

YUMA WEST WETLANDS -30 Acres

YUMA EAST WETLANDS -1400 Acres

Northern International Boundary

MORELOS DAM

GILA / COLORADO RIVER CONFLUENCE

LIMITROPHE DIVISION

HUNTER'S HOLE PILOT PROJECT- 435 Acres

PROPOSED AWPF HUNTER'S HOLE RIPARIAN AND WETLAND RESTORATION PROJECT- 36.75 Acres

Southern International Boundary

US- California

Mexico- Baja California Norte

US- Arizona

Mexico- Baja California Norte

COLORADO RIVER

Legend

- Colorado River Miles
- Mexico / US Border- 1973
- Proposed Project Boundary- AWPF
- Hunter's Hole Restoration
- Quechan Tribal Lands
- Yuma East Wetlands Restoration
- Yuma West Wetlands Restoration

Arizona Land Ownership

- Other Public + Private
- Cocopah Tribal Lands
- Limitrophe Division

0 3,000 6,000 12,000 18,000 Feet

0 700 1,400 2,800 4,200 5,600 Meters

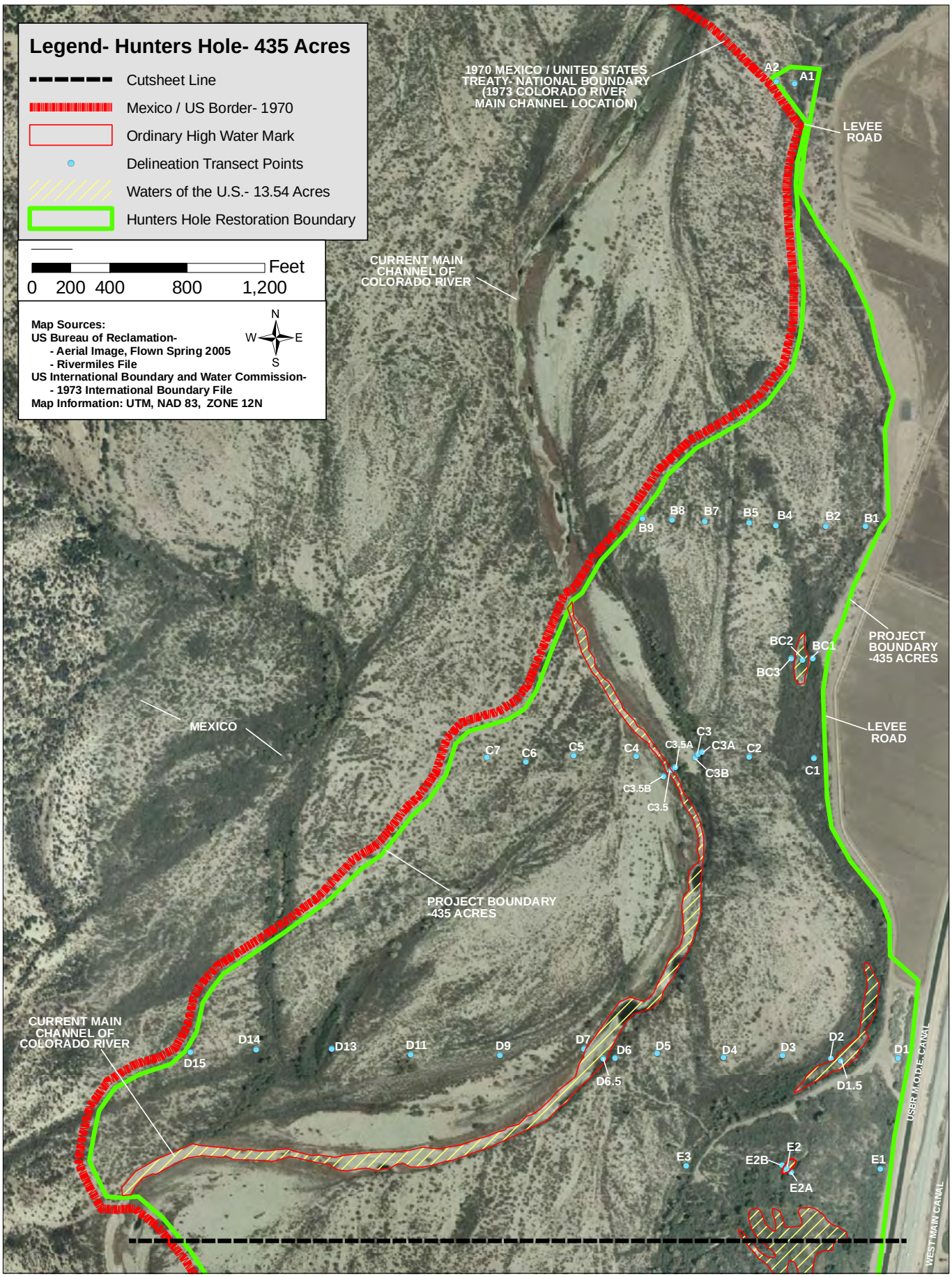
Map Sources:
US International Boundary and Water Commission-1973 International Boundary,
USGS- 7.5 Min Quad
US Bureau of Reclamation- Rivermiles

Map Information:
UTM, NAD 1927, ZONE 11

HUNTERS HOLE RIPARIAN + WETLAND RESTORATION PROJECT- 37 ACRES

PROJECT LOCATION MAP FIGURE 1

Appendix B. Hunter's Hole Restoration Site Wetland Delineation



PREPARED FOR: US BUREAU OF RECLAMATION (USBR) & YUMA CROSSING NATIONAL HERITAGE AREA (YCNHA)
180 WEST FIRST STREET
SUITE E
YUMA, AZ 85364
928-373-5190

PREPARED BY:
FRED PHILLIPS CONSULTING, LLC
401 SOUTH LEROUX STREET
FLAGSTAFF, AZ 86001
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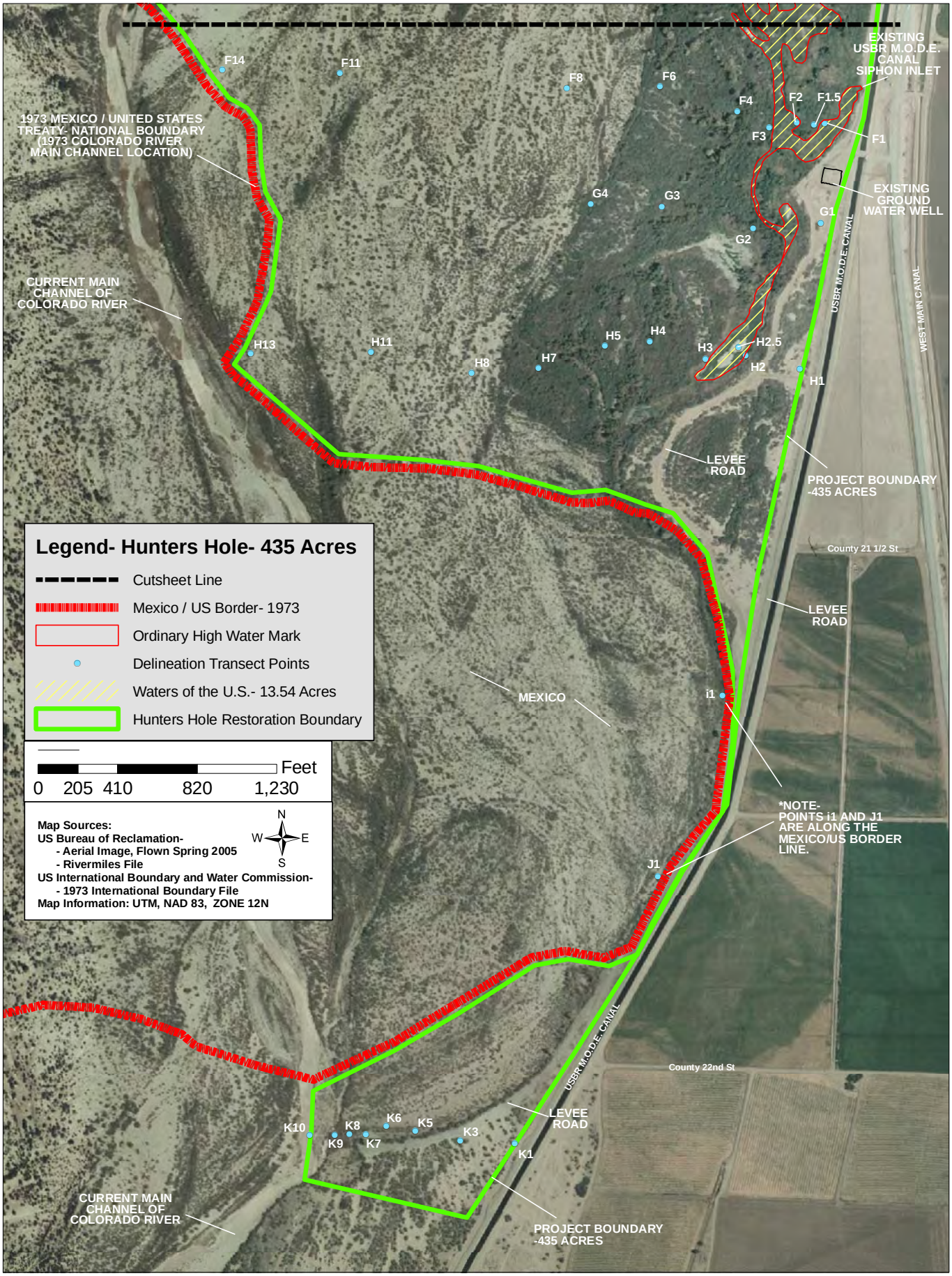
COLORADO RIVER LIMITROPHE DIVISION HUNTERS HOLE RESTORATION POTENTIAL JURISDICTIONAL WATERS U.S.A.C.E.

FIGURE 3- NORTH:
AERIAL PHOTOGRAPH WITH PROPOSED JURISDICTIONAL DELINEATION

DECEMBER 2, 2008



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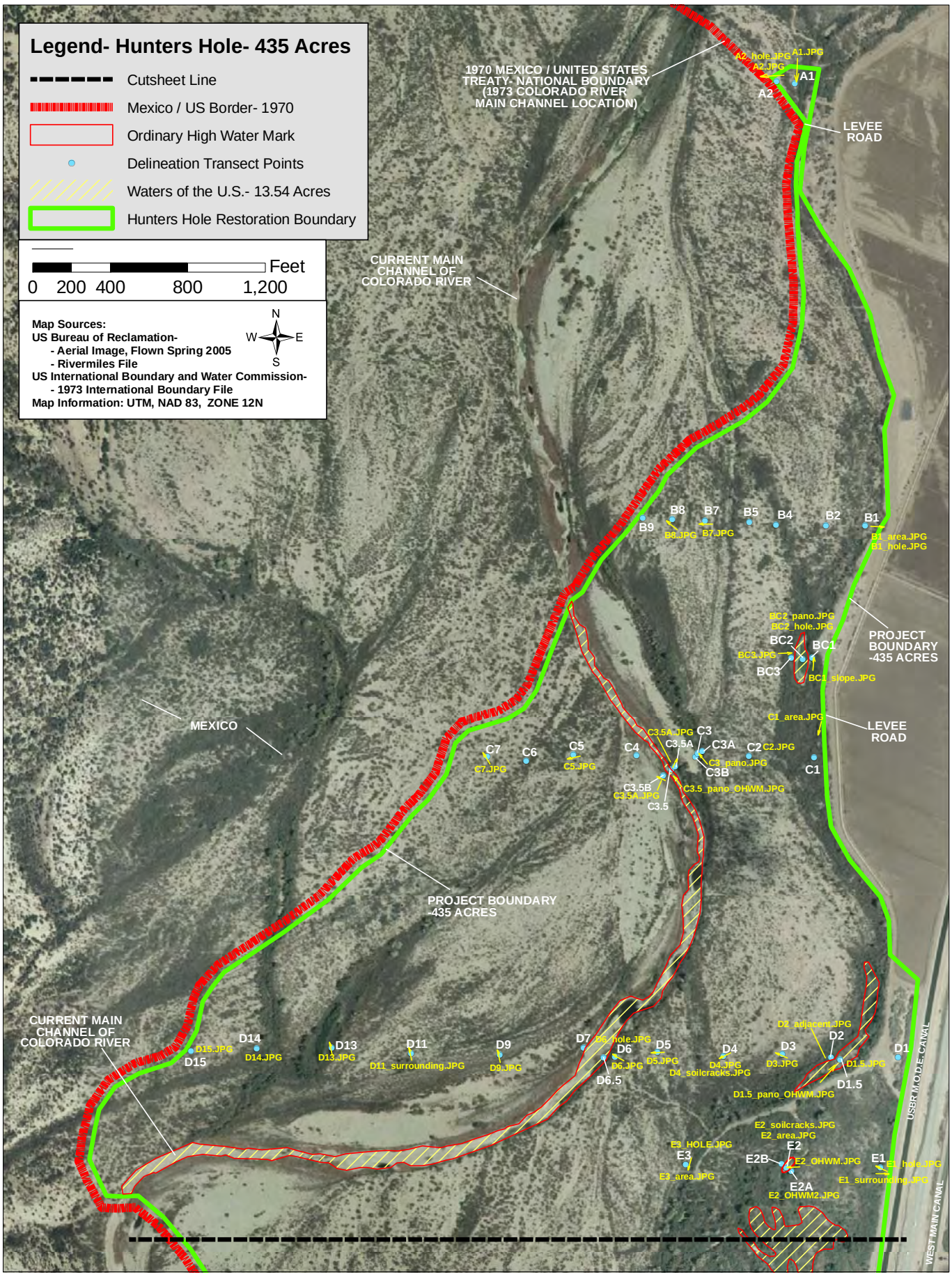
COLORADO RIVER LIMITROPHE DIVISION HUNTERS HOLE RESTORATION POTENTIAL JURISDICTIONAL WATERS U.S.A.C.E.

FIGURE 4- SOUTH: AERIAL PHOTOGRAPH WITH PROPOSED JURISDICTIONAL DELINEATION

DECEMBER 2, 2008



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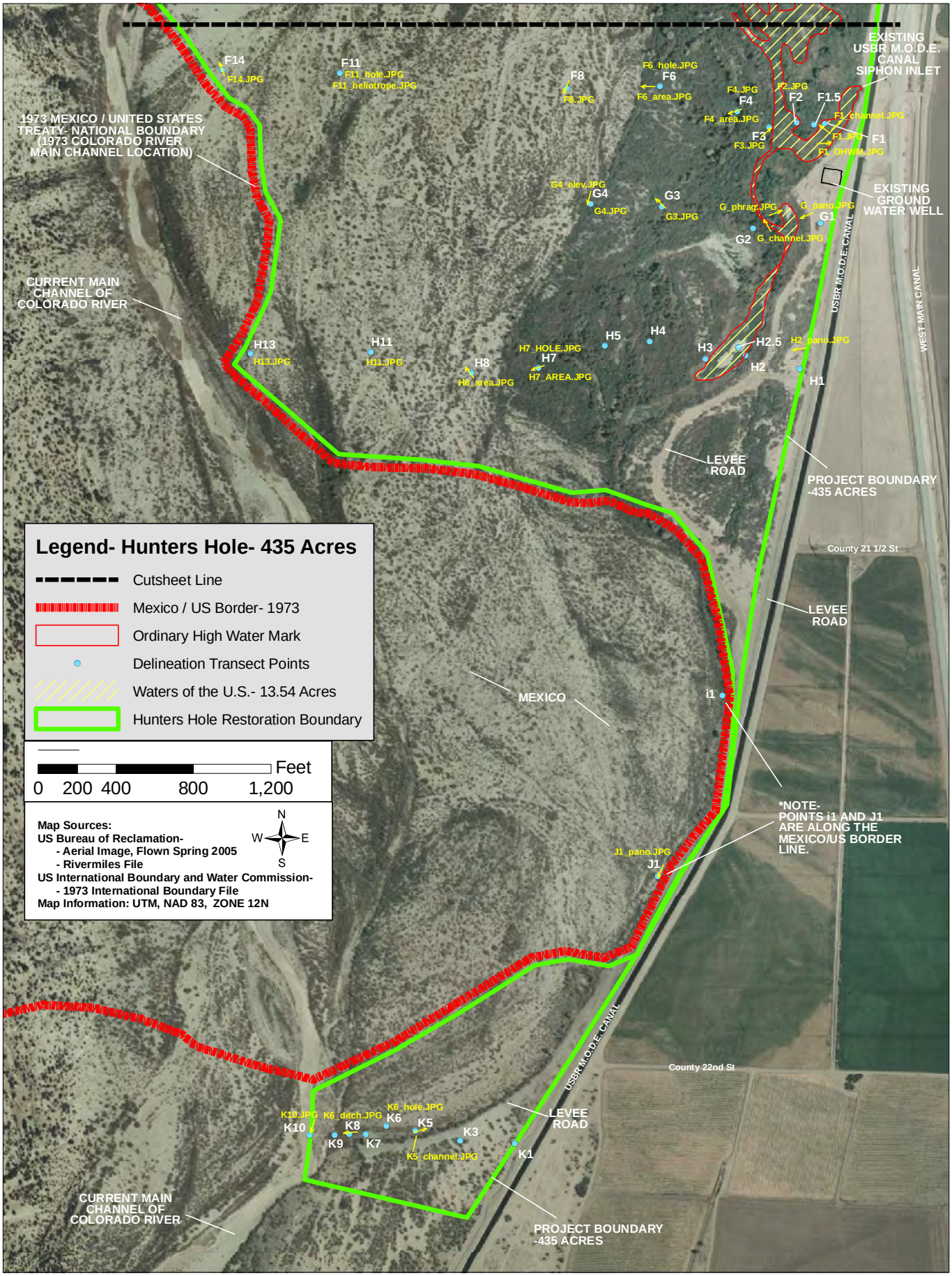
COLORADO RIVER
LIMITROPHE DIVISION
HUNTERS HOLE RESTORATION
POTENTIAL JURISDICTIONAL WATERS
U.S.A.C.E.

FIGURE 5- NORTH:
FIELD PHOTOGRAPH
LOCATION MAP

DECEMBER 2, 2008



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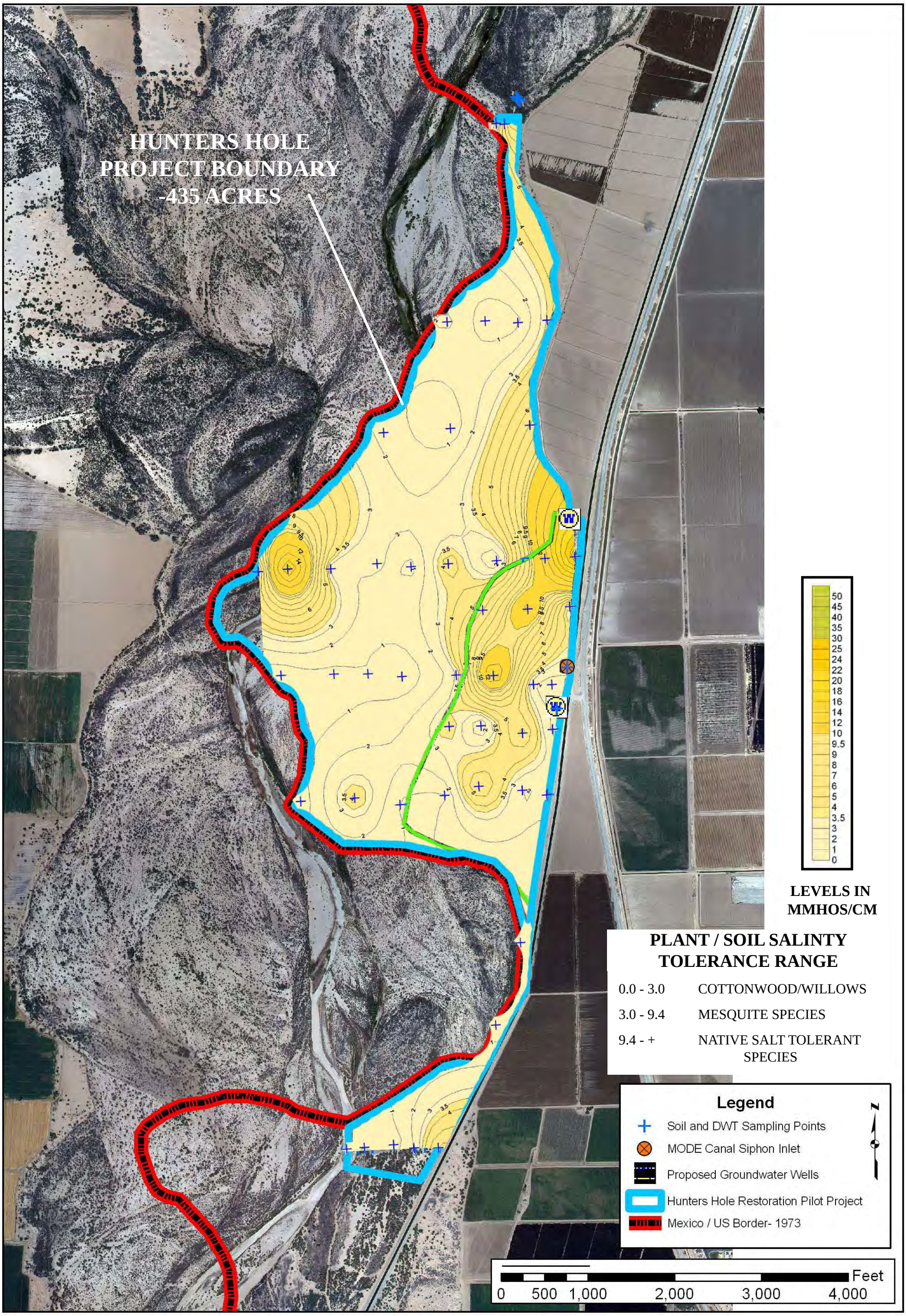
COLORADO RIVER LIMITROPHE DIVISION HUNTERS HOLE RESTORATION POTENTIAL JURISDICTIONAL WATERS U.S.A.C.E.

FIGURE 6- SOUTH: FIELD PHOTOGRAPH LOCATION MAP

DECEMBER 2, 2008

Appendix C. Hunter's Hole Restoration Site Soil Salinity Levels at Surface and 5 Foot Depth



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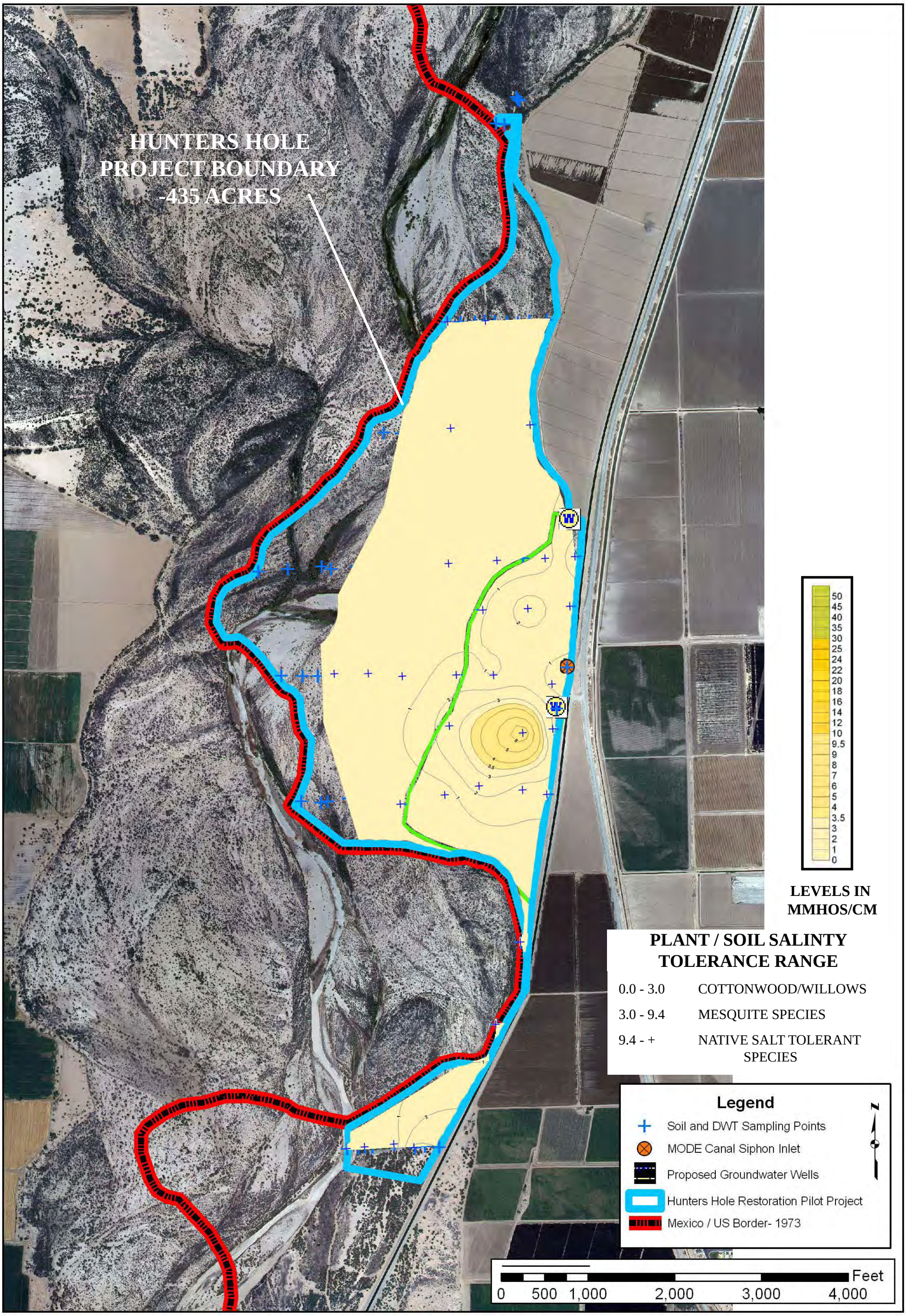
NATIONAL HERITAGE AREA

COLORADO RIVER LIMITROPHE DIVISION HUNTERS HOLE RESTORATION PILOT PROJECT

SOIL SALINITY LEVELS
AT SURFACE DEPTH MAP

JULY 2008

FIGURE 1



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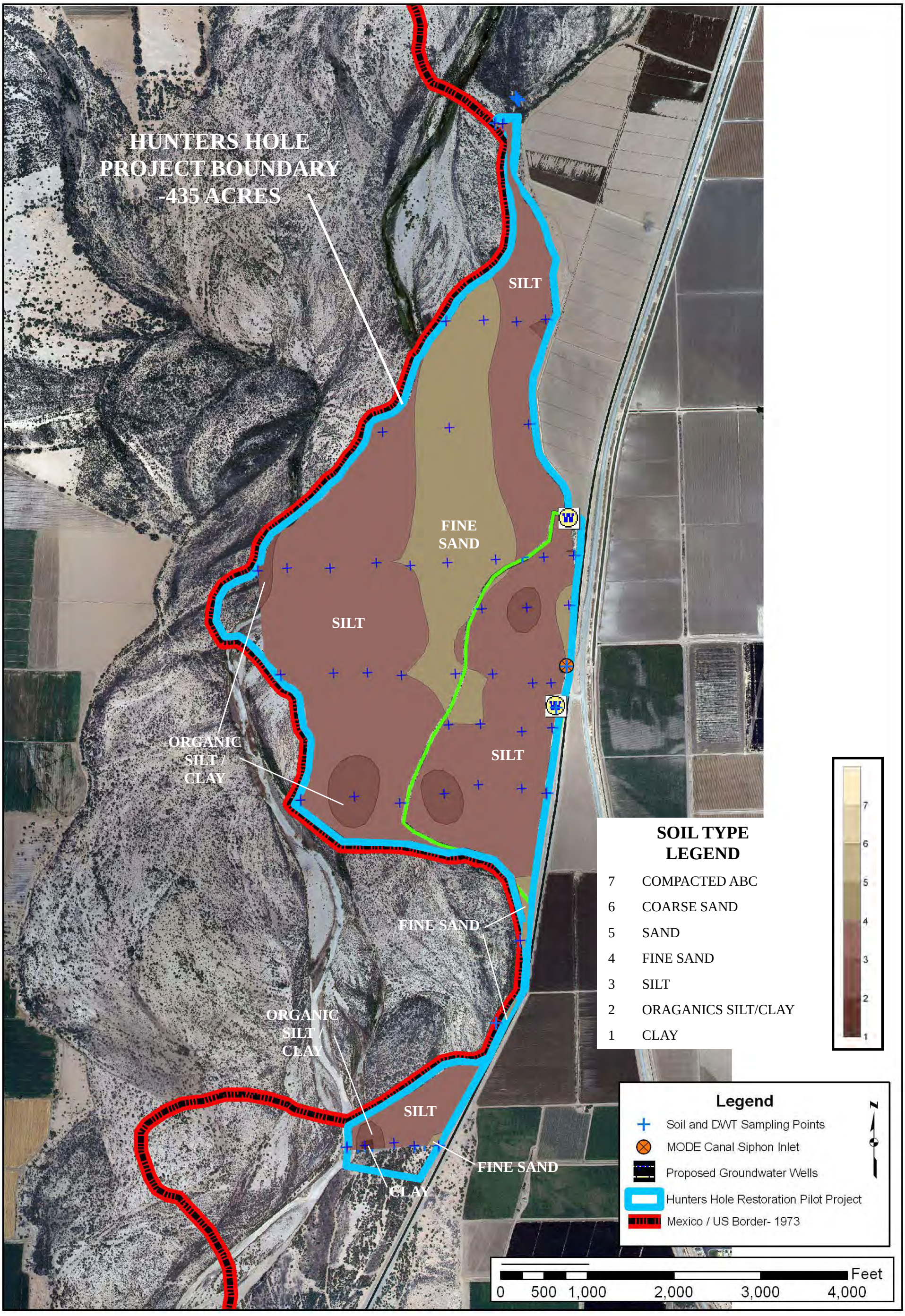
COLORADO RIVER LIMITROPHE DIVISION HUNTERS HOLE RESTORATION PILOT PROJECT

SOIL SALINITY LEVELS AT 5 FOOT DEPTH MAP

JULY 2008

FIGURE 2

Appendix D. Hunter's Hole Restoration Site Soil Texture at Surface and 5 Foot Depth



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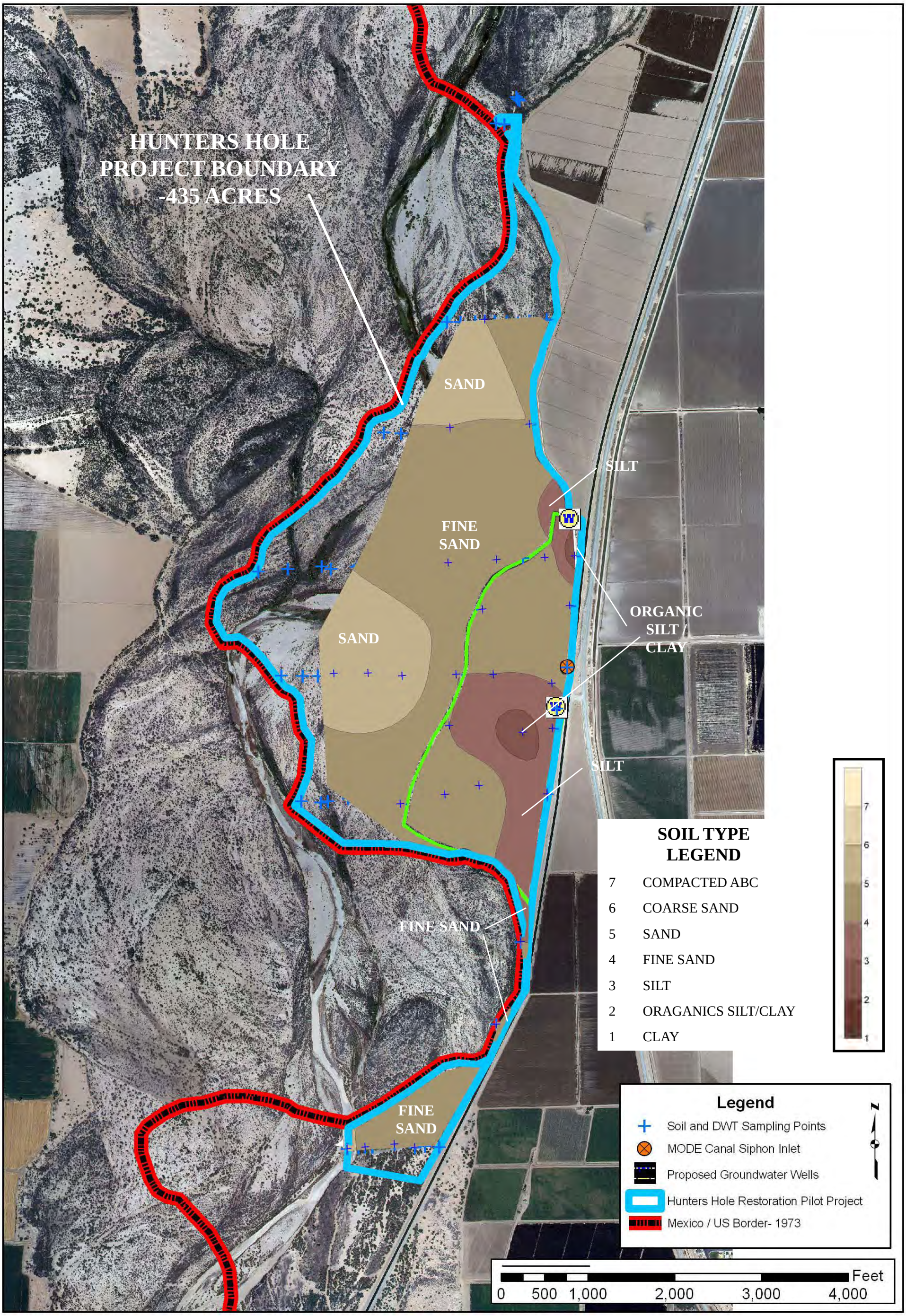
NATIONAL HERITAGE AREA

COLORADO RIVER LIMITROPHE DIVISION HUNTERS HOLE RESTORATION PILOT PROJECT

SOIL TEXTURE TYPE
AT SURFACE DEPTH MAP

JULY 2008

FIGURE 4



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NATIONAL HERITAGE AREA

COLORADO RIVER
LIMITROPHE DIVISION
HUNTERS HOLE RESTORATION
PILOT PROJECT

SOIL TEXTURE TYPE
AT 5 FOOT DEPTH MAP

JULY 2008

FIGURE 5

Appendix E. Hunter's Hole Restoration Site Depth to Water Table

**NOTE-
The Depth To Water Table (DWT) contour levels showing 10 feet is not an accurate reading. Field data was not able to be collected past the 10 foot level. In Mexico, Pronatura collected DWT data and it is provided, showing as the light yellow dots and a DWT reading.

DWT- 0.0

DWT- 19.5FT

HUNTERS HOLE
PROJECT BOUNDARY
-435 ACRES

DWT- 16.5FT

DWT- 16.5FT

DWT- 21.75FT

DWT- 23.0FT

DWT- 19.5FT

DWT- 20.5FT

DWT- 29.5FT

DWT- 23.0FT

PLANT / DEPTH TO WATER TABLE THRESHOLDS

0 - 6 FT	WILLOWS
0 - 10 FT	COTTONWOOD
10 +	MESQUITE & DRAUGHT TOLERANT SPECIES

15 14 13 12 11 10 9 8.5 8 7.5 7 6.5 6 5.5 5 4.5 4 3.5 3 2.5 2 1.5 1 0.5 0 -0.5

DWT IN FEET

Legend

- Soil and DWT Sampling Points
- MODE Canal Siphon Inlet
- Proposed Groundwater Wells
- Hunters Hole Restoration Pilot Project
- Mexico / US Border- 1973

N

0 500 1,000 2,000 3,000 4,000 Feet

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NATIONAL HERITAGE AREA

COLORADO RIVER LIMITROPHE DIVISION HUNTERS HOLE RESTORATION PILOT PROJECT

DEPTH TO WATER TABLE LEVELS MAP

JULY 2008

FIGURE 3

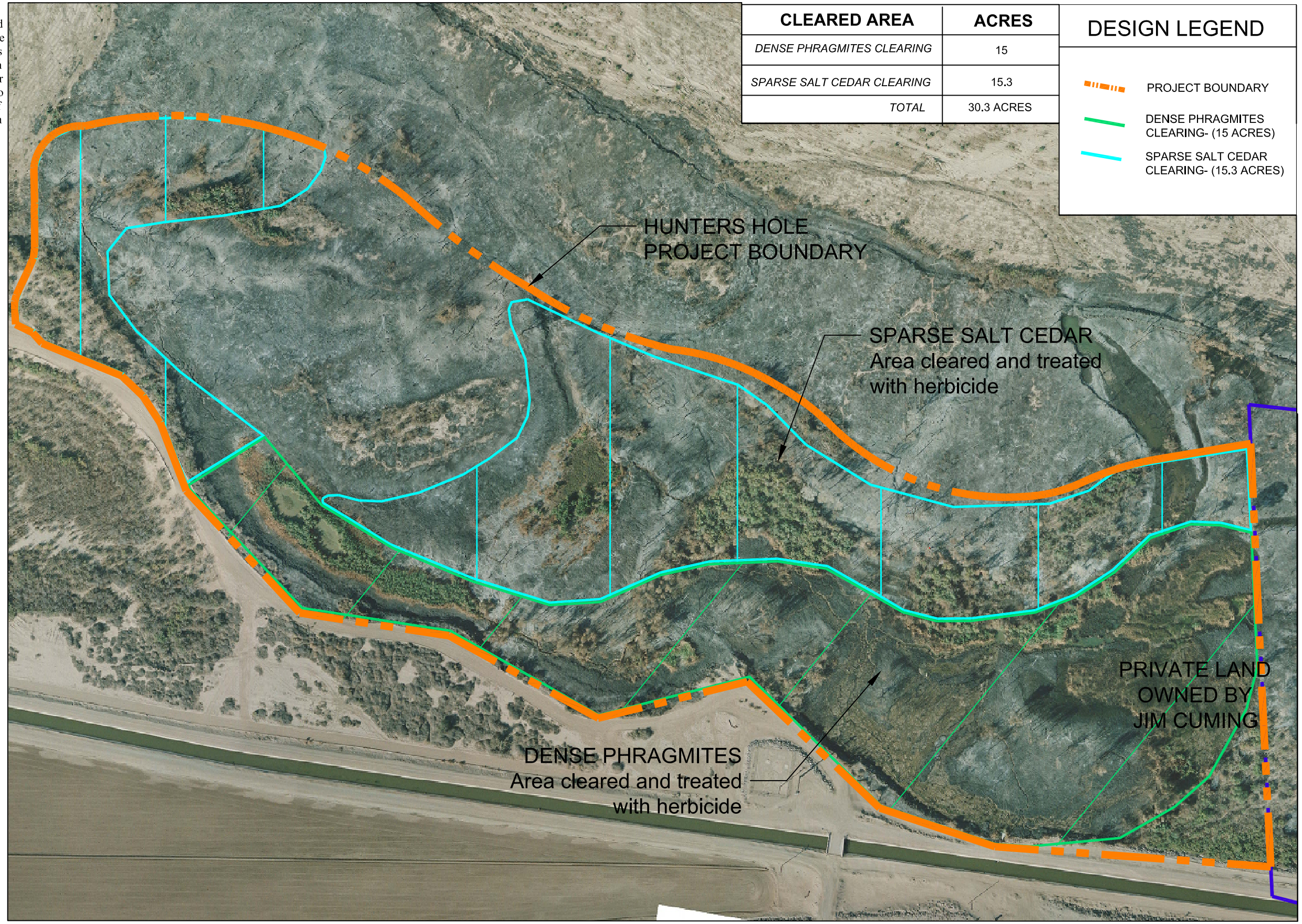
Appendix F. Hunter's Hole Restoration Site Clearing Map

Scope of Work completed by Contractor:
Phragmites regrowth was treated with a combination of Rodeo and Habitat. Due to the amount of regeneration of this undesirable species the treatments were applied using a boomless spray system. This system uses a 25 gallon tank that is fitted with three nozzles that spray a 30 feet swath with each pass. The application rate was 5 gallons of herbicide mix per acre of phragmites infestation. Backpack sprayers were also used to apply this mix to areas that could not be treated effectively with the use of the boomless sprayer. Salt Cedar regrowth was first cut and then immediately treated with Garlon with the use of a backpack sprayer.

CLEARED AREA	ACRES
DENSE PHRAGMITES CLEARING	15
SPARSE SALT CEDAR CLEARING	15.3
TOTAL	30.3 ACRES

DESIGN LEGEND

- PROJECT BOUNDARY
- DENSE PHRAGMITES CLEARING- (15 ACRES)
- SPARSE SALT CEDAR CLEARING- (15.3 ACRES)



Fred Phillips Consulting, LLC
401 SOUTH LEROUX STREET
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TEL 928 773 1530
FAX 928 774 4166
Ecosystem Restoration Land Planning

PREPARED FOR:
YUMA CROSSING NATIONAL HERITAGE AREA IN PARTNERSHIP WITH THE BUREAU OF RECLAMATION

HUNTER'S HOLE
RIPARIAN AND WETLAND RESTORATION

CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
AS-BUILT CLEARING PLAN

Scale: 1" = 200'
0' 100' 200' 400' 600' NORTH

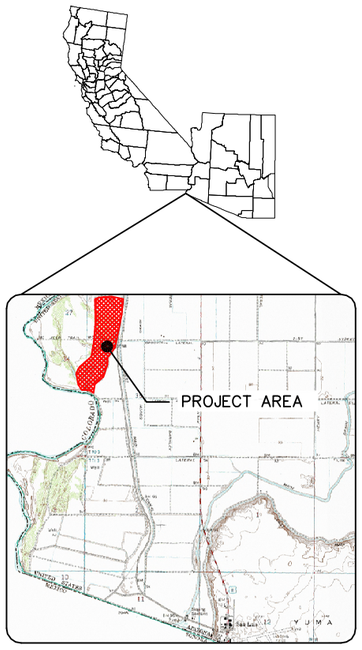
DATE: March 15, 2012
JOB NO.:
DRAWN BY: KI
DESIGNED BY: FOP/DB
CHECKED BY: FOP

SHEET NO.:
FIGURE 1

Appendix G. Hunter's Hole Restoration Site Grading and Irrigation Plan

HUNTER'S HOLE
RIPARIAN AND WETLAND RESTORATION PROJECT
GRADING AND IRRIGATION PLAN

ARIZONA WATER PROTECTION FUND
GRANT NO. 09-166WPF



VICINITY MAP
ARIZONA, GILA & SALT RIVER MERIDIAN
T10S, R25W, SEC26 & SEC35
YUMA COUNTY, ARIZONA

INDEX OF DRAWINGS:

SHEET NO.	DRAWING NO.	DESCRIPTION
1	CVR01	COVER SHEET
2	GEN01	EXISTING CONDITIONS MAP & CONTROL POINT LIST
3	GD01	GRADING & IRRIGATION PLAN
4	DT01	GRADING & IRRIGATION PLAN DETAIL & TYPICAL CROSS SECTIONS FOR GRADING
5	DT02	IRRIGATION & WATER CONTROL STRUCTURES TYPICAL SECTIONS & DETAILS
6	DT03	IRRIGATION PIPELINE PROFILES

ESTIMATED QUANTITIES:

MOBILIZATION & DEMOBILIZATION (SPECIFICATION SECTION A)
1.) (1 LS) MOBILIZE & DEMOBILIZE EQUIPMENT

SITE PREPARATION (SPECIFICATION SECTION B)
2.) (1 LS) PREPARE SITE FOR CONSTRUCTION OPERATIONS

EARTHWORK (SPECIFICATION SECTION C)
3.) (18,600 CY) BORROW AND PLACE COMPACTED FILL FOR ROADS & BERMS
4.) (17,700 CY) BORROW AND PLACE LAND-LEVELING FILL FOR HABITAT CELLS

ROCK (SPECIFICATION SECTION D)
5.) (230 CY) FURNISH & PLACE EROSION CONTROL ROCK

WATER CONTROL STRUCTURES (SPECIFICATION SECTION E)
6.) (2 EA) FURNISH AND INSTALL WATER CONTROL STRUCTURES

IRRIGATION (SPECIFICATION SECTION F)
7.) (1,695 LF) FURNISH AND INSTALL 12 INCH DIAMETER DR 17 IPS HDPE PIPE

PREPARED FOR:

PROJECT MANAGER:
ARIZONA WATER PROTECTION FUND
ARIZONA DEPARTMENT OF WATER RESOURCES
3550 NORTH CENTRAL AVENUE
PHOENIX, ARIZONA 85012
PHONE: (602) 771-8532

PROJECT ADMINISTRATOR:
YUMA CROSSING NATIONAL HERITAGE AREA
180 W. FIRST STREET, SUITE E
YUMA, AZ 85364
PHONE: (928) 373-5192

PROJECT PARTNER:
LOWER COLORADO RIVER
MULTI-SPECIES CONSERVATION PROGRAM
BUREAU OF RECLAMATION
PO BOX 61470, (LC-8460)
BOULDER CITY, NV 89006
PHONE: (702) 293-8159

PROJECT PARTNER:
BUREAU OF LAND MANAGEMENT
2555 EAST GILA RIDGE ROAD
YUMA, AZ 85365
PHONE: (928) 317-3200

TECHNICAL CONSULTANTS:

CIVIL & ECOLOGICAL ENGINEERS/PLAN PREPARER:
NATURAL CHANNEL DESIGN, INC.
206 SOUTH ELDEN STREET
FLAGSTAFF, AZ 86001
PHONE: (928) 774-2336

ECOLOGICAL RESTORATION DESIGNERS:
FRED PHILLIPS CONSULTING, LLC.
401 S. LEROUX ST.
FLAGSTAFF, AZ 86001
PHONE: (928) 773-1530

ABBREVIATIONS:

@	AT
AB	AGGREGATE BASE
AC	ACRE
ACP	ASPHALT CONCRETE PAVEMENT
APPROX	APPROXIMATELY
CC	CENTER TO CENTER
CFS	CUBIC FEET PER SECOND
℄	CENTER LINE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
CP	CONTROL POINT
CY	CUBIC YARD
ø	DIAMETER
DIPS	DUCTILE IRON PIPE SIZE
DR	DIMENSION RATIO
DTL	DETAIL
DWG	DRAWING
EA	EACH
ELEV	ELEVATION
EX	EXISTING
FG	FINISHED GRADE ELEVATION
FL	FLOWLINE ELEVATION
FPT	FEMALE PIPE THREAD
FT	FEET
FTG	FITTING
GA	GAUGE
GALV	GALVANIZED
GB	GRADE BREAK
GPM	GALLONS PER MINUTE
H	HEIGHT
HDPE	HIGH DENSITY POLYETHYLENE
IE	INVERT ELEVATION
IN.	INCH
IPS	IRON PIPE SIZE
L	LENGTH
LB	POUNDS
LF	LINEAR FEET
LS	LUMP SUM
MAX	MAXIMUM
M.E.	MATCH EXISTING
MIN	MINIMUM
MISC	MISCELLANEOUS
MPT	MALE PIPE THREAD
NCD	NATURAL CHANNEL DESIGN, INC.
NO.	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
PE	LOW DENSITY POLYETHYLENE
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
R	RADIUS
REQD	REQUIRED
SCH	SCHEDULE
SF	SQUARE FEET
SHT	SHEET
SS	STAINLESS STEEL
STA	STATION
STD	STANDARD
SY	SQUARE YARD
TN	TONS
TYP	TYPICAL
VLV	VALVE
W	WIDTH
W/	WITH
WCS	WATER CONTROL STRUCTURE
WSE	WATER SURFACE ELEVATION

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86001 (928) 773-1530

DRAWN BY: G. CATHEY
DESIGNED BY: G. CATHEY
REVIEWED BY: S. YARD, F. PHILLIPS

REV	DATE	BY	REVISION

COVER SHEET

HUNTER'S HOLE
RIPARIAN & WETLAND RESTORATION PROJECT
GRADING & IRRIGATION PLAN

Registered Professional Engineer (Civil)
CERTIFICATE NO.
52164
GEORGE F.
CATHEY
DATE SIGNED 8/5/11
ARIZONA U.S.A.
Exp. 6 / 30 /14

UNAUTHORIZED CHANGES & USES
THE ENGINEER PREPARING THESE PLANS WILL NOT BE RESPONSIBLE FOR, OR LIABLE FOR, UNAUTHORIZED CHANGES TO OR USES OF THESE PLANS. ALL CHANGES MUST BE IN WRITING AND MUST BE APPROVED BY THE PREPARER OF THESE PLANS.

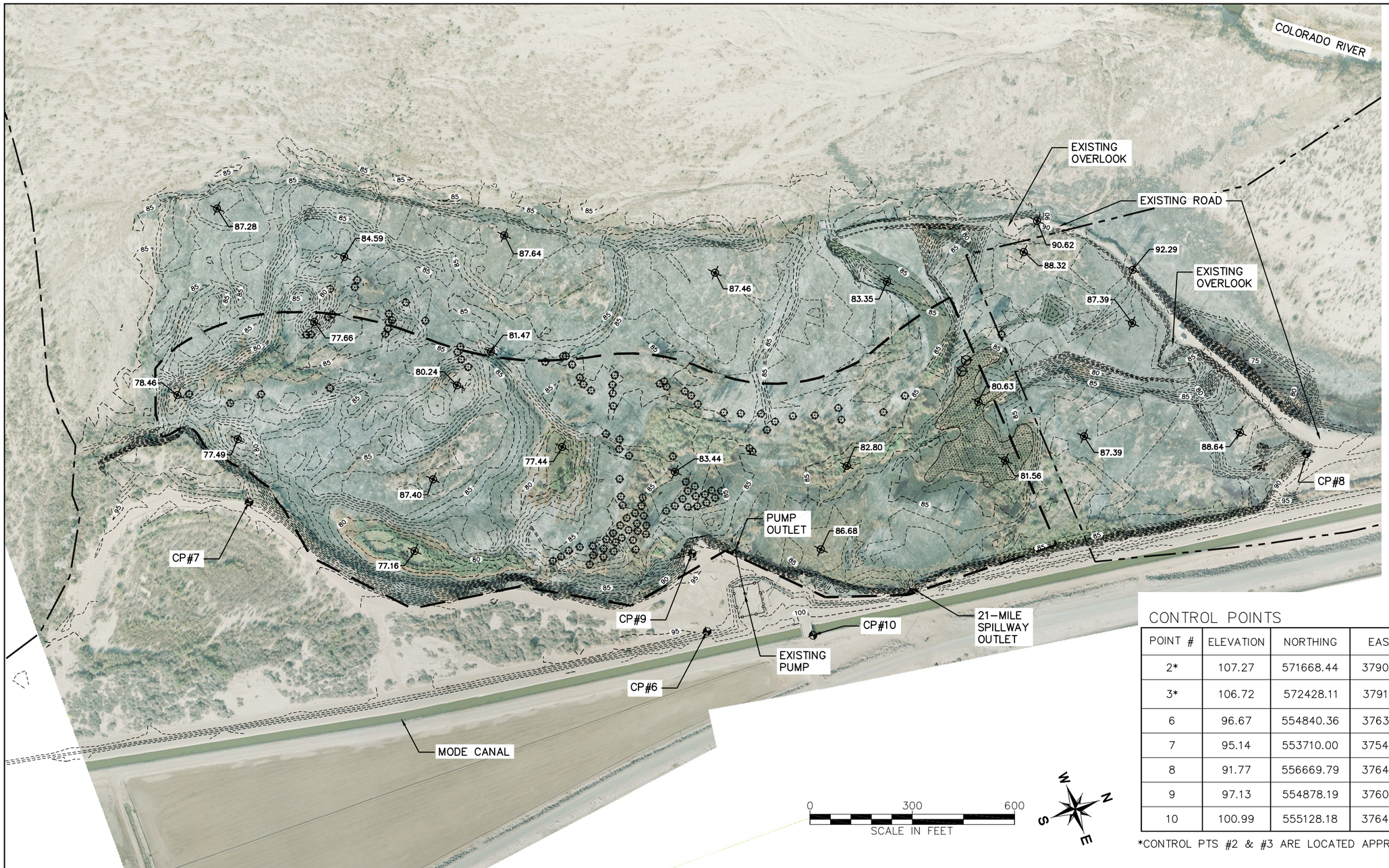
CALL TWO WORKING DAYS BEFORE YOU DIG
263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

DATE:
08-05-11

DRAWING NO:
CVR01

NCD PROJECT NO:
09-170-AZ

SHEET NO:
1 OF 6



LEGEND:

- CONTROL POINT
- RE-SPROUTING WILLOWS
- SURVIVING COTTONWOODS
- EXISTING BULRUSH
- U.S./MEXICO BORDER (APPROX)
- PRIVATE LAND OWNED BY JIM CUMING (APPROX)
- PROJECT BOUNDARY
- XX EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING SPOT ELEVATION
  - XX.XX

DATUM & COORDINATE GRID INFORMATION	
HORIZONTAL DATUM	NORTH AMERICAN DATUM 1983 (NAD83)
COORDINATE PROJECTION	ARIZONA STATE PLANE ARIZONA WEST 203, SURVEY FEET
VERTICAL DATUM	NAVD88
GEOID MODEL	GEOID03(CONUS)
SURVEY BY: NCD	SURVEY DATE: 8/11/2009 TO 8/13/2009

CONTROL POINTS

POINT #	ELEVATION	NORTHING	EASTING	DESCRIPTION
2*	107.27	571668.44	379084.86	REBAR A – USBR
3*	106.72	572428.11	379149.14	REBAR/AC B – USBR
6	96.67	554840.36	376314.42	NCD CAP
7	95.14	553710.00	375495.03	NCD CAP
8	91.77	556669.79	376430.86	NCD CAP
9	97.13	554878.19	376084.69	NCD CAP
10	100.99	555128.18	376432.07	BRASS CAP ON BRIDGE

*CONTROL PTS #2 & #3 ARE LOCATED APPROX 3 MILES NORTH OF THE PROJECT SITE

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DESIGNED BY: G. CATHEY			
REVIEWED BY: S. YARD, F. PHILLIPS			
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EXISTING CONDITIONS MAP & CONTROL POINT LIST

HUNTER'S HOLE
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(OUTSIDE MARICOPA COUNTY)

DATE: 08-05-11

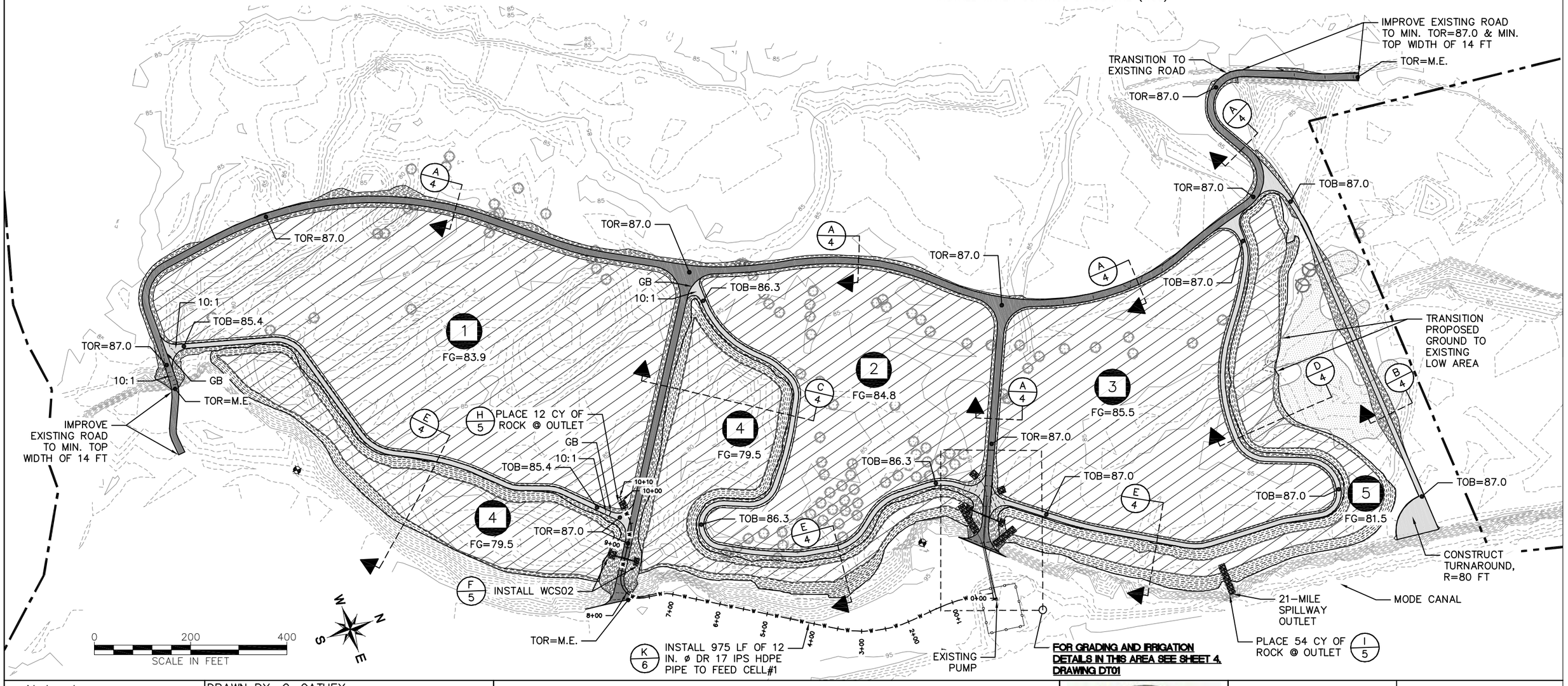
DRAWING NO: GEN01

NCD PROJECT NO: 09-170-AZ

SHEET NO: 2 OF 6

LEGEND:

- CONTROL POINT (SEE SHEET 2)
- RE–SPROUTING WILLOWS (TO BE PROTECTED)
- SURVIVING COTTONWOODS (TO BE PROTECTED)
- EXISTING BULRUSH (TO BE PROTECTED)
- U.S./MEXICO BORDER (APPROX)
- PRIVATE LAND OWNED BY JIM CUMING (APPROX)
- XX EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- (1) HABITAT CELL NUMBER
- (F/6) CROSS SECTION LOCATION (SHEET REFERENCE / CROSS SECTION IDENTIFIER)
- CONSTRUCT LAND–LEVELED FIELD
- CONSTRUCT ACCESS ROAD (MIN TURNING RADIUS OF 60 FT)
- CONSTRUCT AGRICULTURAL (AG) BERM (MIN TURNING RADIUS OF 35 FT)
- PLACE EROSION PROTECTION ROCK
- INSTALL WATER CONTROL STRUCTURE (WCS)
- W INSTALL 12 IN. DR17 IPS HDPE IRRIGATION PIPELINE
- FG FINISHED GRADE ELEVATION OF LAND–LEVELED HABITAT CELL
- TOR TOP OF ACCESS ROAD ELEVATION
- TOB TOP OF AGRICULTURAL BERM ELEVATION
- X:1 TRANSITION RAMP SLOPE (HORIZONTAL: VERTICAL)



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GRADING & IRRIGATION PLAN

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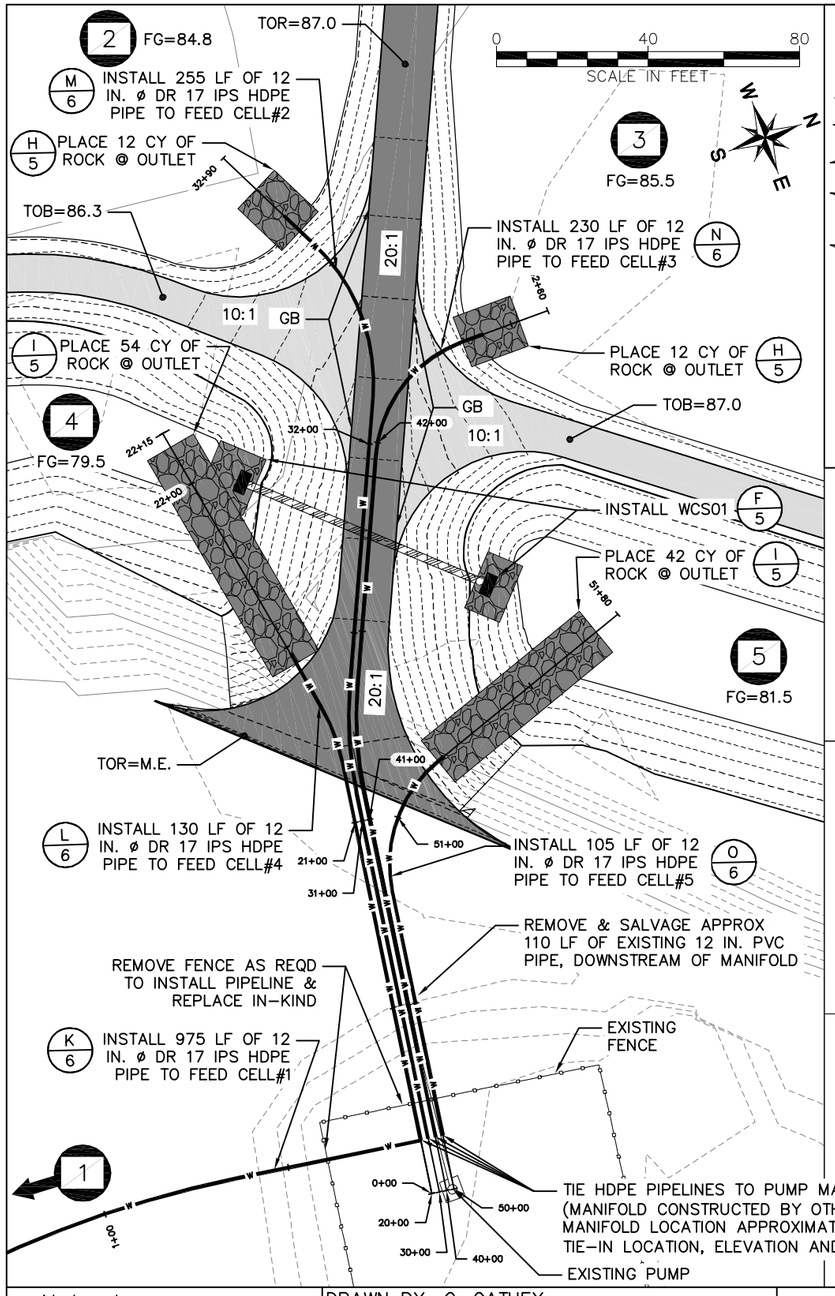
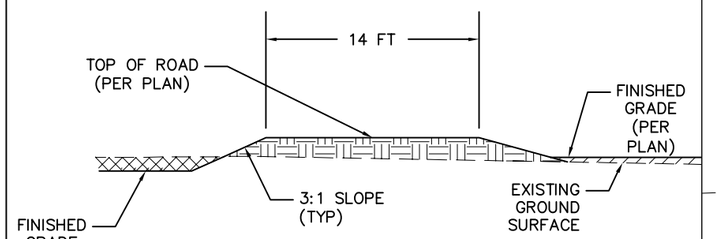
DATE: 08–05–11	DRAWING NO: GD01
NCD PROJECT NO: 09–170–AZ	SHEET NO: 3 OF 6

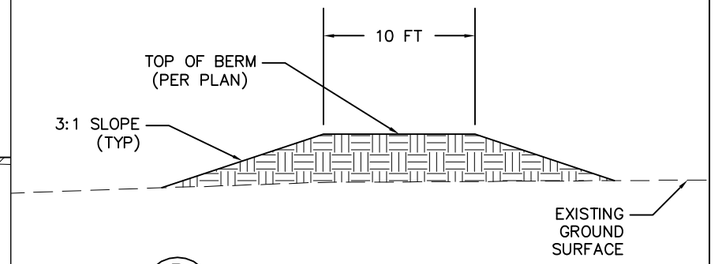


LEGEND:

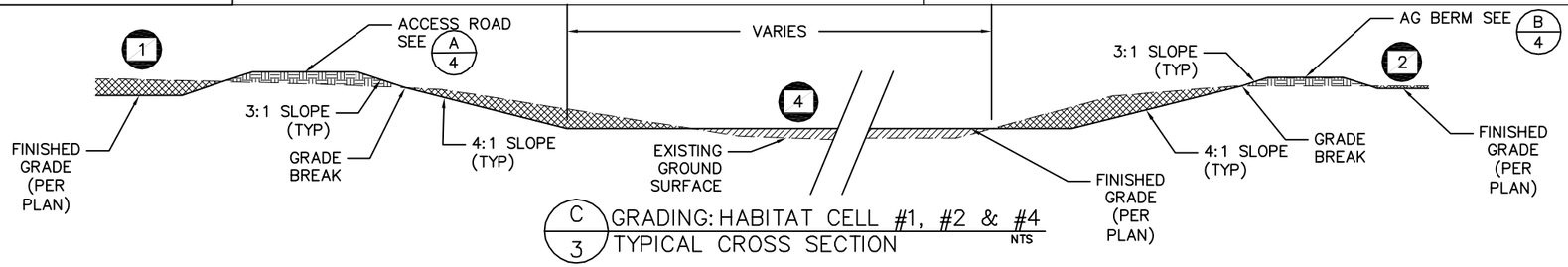
- EXISTING GROUND
- FINISHED GROUND
- PROPOSED CUT
- PROPOSED LAND -LEVELING FILL
- PROPOSED COMPACTED FILL
- (1) HABITAT CELL NUMBER



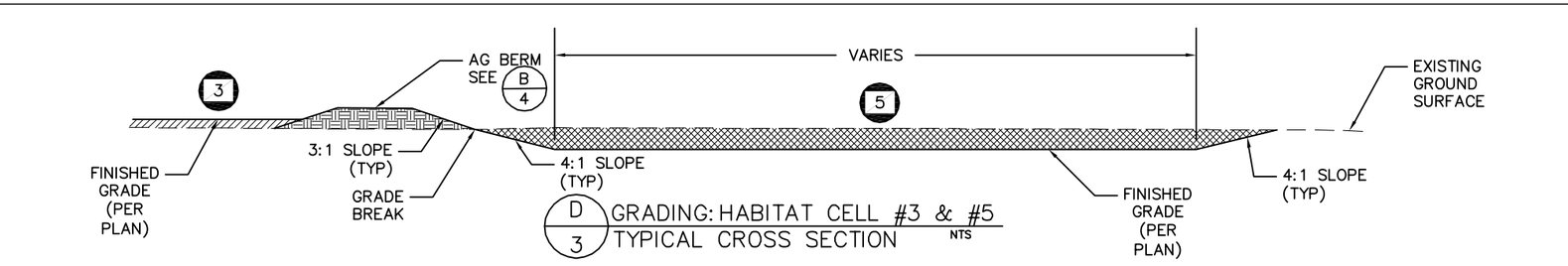
A 3,4 ACCESS ROAD TYPICAL CROSS SECTION NTS



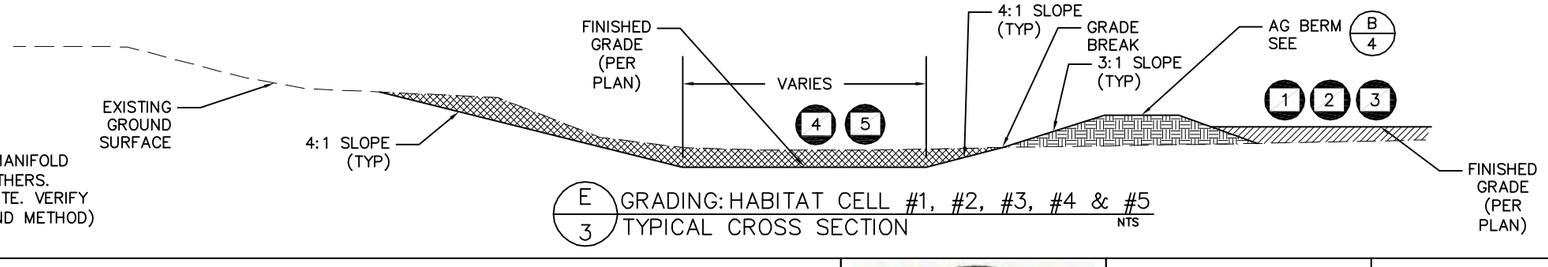
B 3,4 AGRICULTURAL (AG) BERM TYPICAL CROSS SECTION NTS



C 3 GRADING: HABITAT CELL #1, #2 & #4 TYPICAL CROSS SECTION NTS



D 3 GRADING: HABITAT CELL #3 & #5 TYPICAL CROSS SECTION NTS



E 3 GRADING: HABITAT CELL #1, #2, #3, #4 & #5 TYPICAL CROSS SECTION NTS

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DRAWN BY: G. CATHEY
DESIGNED BY: G. CATHEY
REVIEWED BY: S. YARD, F. PHILLIPS

REV	DATE	BY	REVISION

GRADING & IRRIGATION PLAN DETAIL & TYPICAL CROSS SECTIONS FOR GRADING

HUNTER'S HOLE RIPARIAN & WETLAND RESTORATION PROJECT GRADING & IRRIGATION PLAN

Registered Professional Engineer (Civil) CERTIFICATE NO. 52164 GEORGE F. CATHEY DATE SIGNED 8/5/11 ARIZONA U.S.A.
Exp. 6 / 30 / 14

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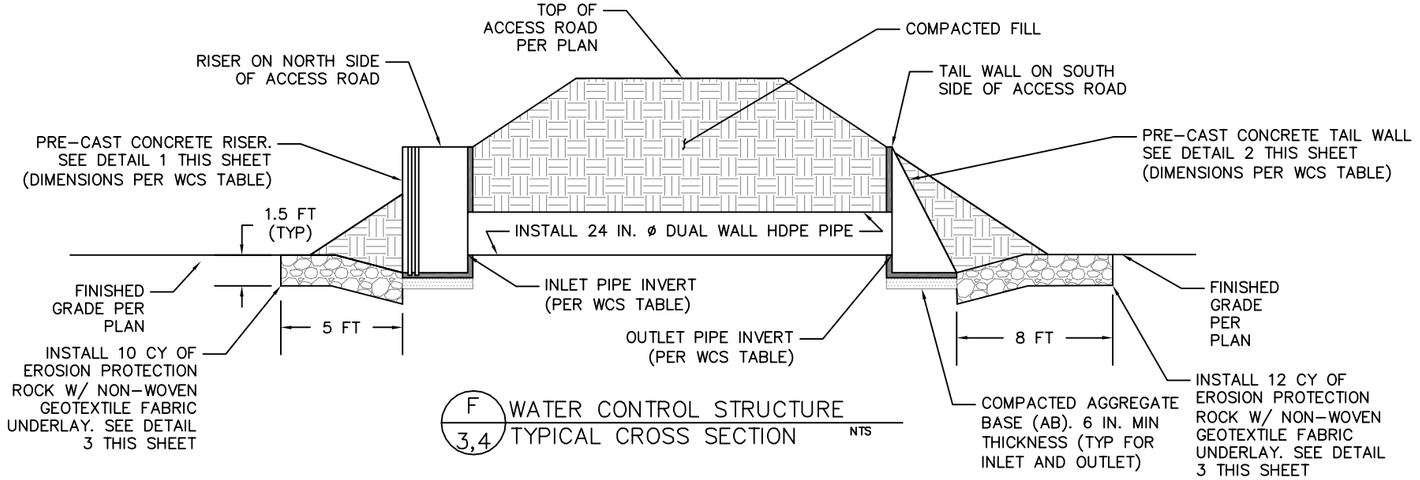
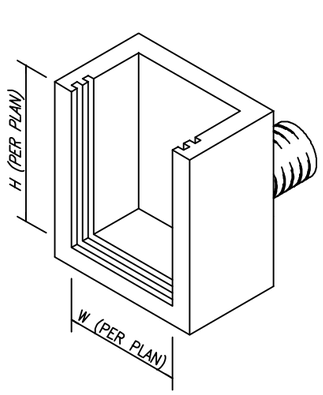
(OUTSIDE MARICOPA COUNTY)

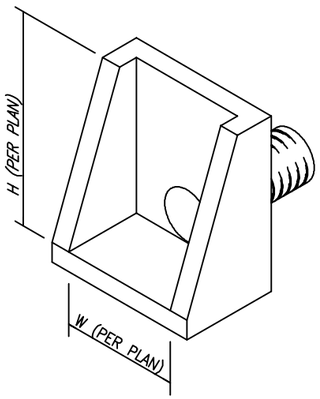
DATE: 08-05-11
DRAWING NO: DT01
NCD PROJECT NO: 09-170-AZ
SHEET NO: 4 OF 6



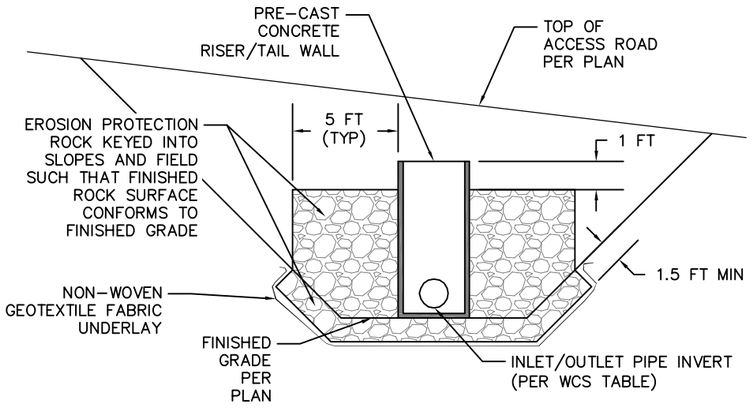
F 3,4 WATER CONTROL STRUCTURE TYPICAL CROSS SECTION NTS



1 5 PRE-CAST CONCRETE RISER TYPICAL DETAIL NTS



2 5 PRE-CAST CONC TAIL WALL TYPICAL DETAIL NTS

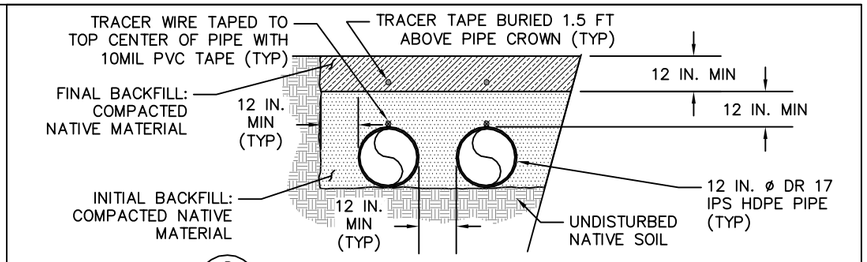


3 5 EROSION PROTECTION ROCK TYPICAL WCS END VIEW NTS

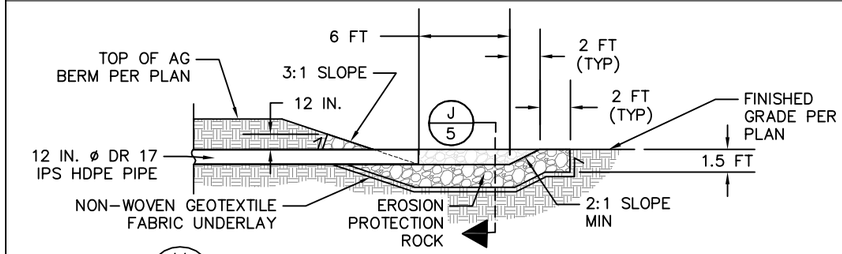
WATER CONTROL STRUCTURE TABLE

STRUCTURE NUMBER	PRE-CAST CONCRETE INLET STRUCTURE					PRE-CAST CONCRETE OUTLET STRUCTURE					CULVERT PIPE***		
	TYPE	WIDTH (W)	HEIGHT (H)	CANAL GATES	PIPE IE	TYPE	WIDTH (W)	HEIGHT (H)	CANAL GATES	PIPE IE	TYPE***	DIAMETER (D_p)	LENGTH
WCS01	TWIN TRACK RISER	3	5	C-10 INSERTS ONLY*	81.5	TAIL WALL	3	5	C-10 INSERTS ONLY*	79.5	HDPE	24	70
WCS02	TWIN TRACK RISER	3	5	C-10 INSERTS ONLY*	79.5	TAIL WALL	3	5	C-10 INSERTS ONLY*	79.5	HDPE	24	45

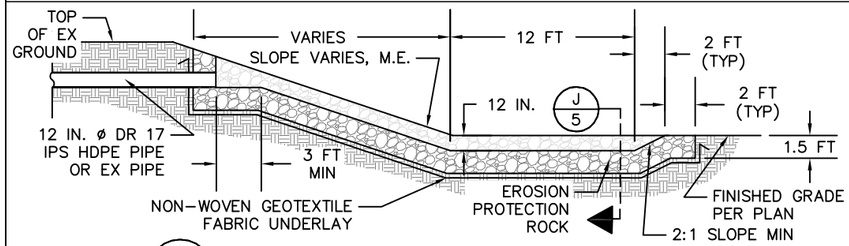
* PRE-CAST STRUCTURES DESIGNATED FOR INSERTS SHALL HAVE BOLT INSERTS CAST INTO THE WCS TO ALLOW FUTURE INSTALLATION OF A WATERMAN C-10 CANAL GATE.
** STRUCTURES SHALL HAVE A STUB OF HDPE CAST INTO THE INLET AND OUTLET STRUCTURE AS SPECIFIED ON THE PLANS
*** ALL CULVERT PIPE SHALL BE DUAL WALL HDPE



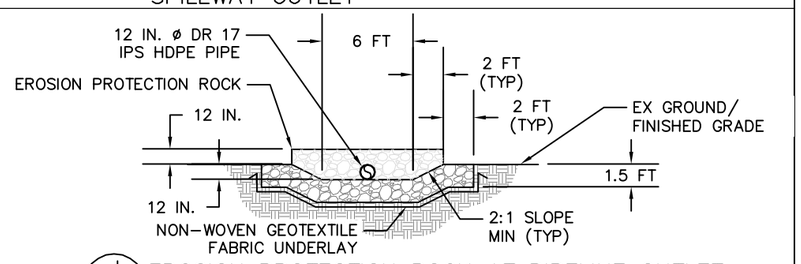
G 6 PIPELINE TYPICAL TRENCH SECTION NTS



H 3,6 EROSION PROTECTION ROCK AT PIPELINE OUTLET TYPICAL PROFILE FOR CELLS #1, #2, & #3 NTS



I 3,6 EROSION PROTECTION ROCK AT PIPELINE OUTLET TYPICAL PROFILE FOR CELLS #4, #5 & 21-MILE SPILLWAY OUTLET NTS



J 3,6 EROSION PROTECTION ROCK AT PIPELINE OUTLET TYPICAL CROSS SECTION NTS

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DRAWN BY: G. CATHEY			
DESIGNED BY: G. CATHEY			
REVIEWED BY: S. YARD, F. PHILLIPS			
REV	DATE	BY	REVISION

IRRIGATION & WATER CONTROL STRUCTURES TYPICAL SECTIONS & DETAILS

HUNTER'S HOLE RIPARIAN & WETLAND RESTORATION PROJECT GRADING & IRRIGATION PLAN

Registered Professional Engineer (Civil) CERTIFICATE NO. 52164 GEORGE F. CATHEY DATE SIGNED 8/5/11 ARIZONA U.S.A.
Exp. 6 / 30 / 14

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NCD PROJECT NO: 09-170-AZ

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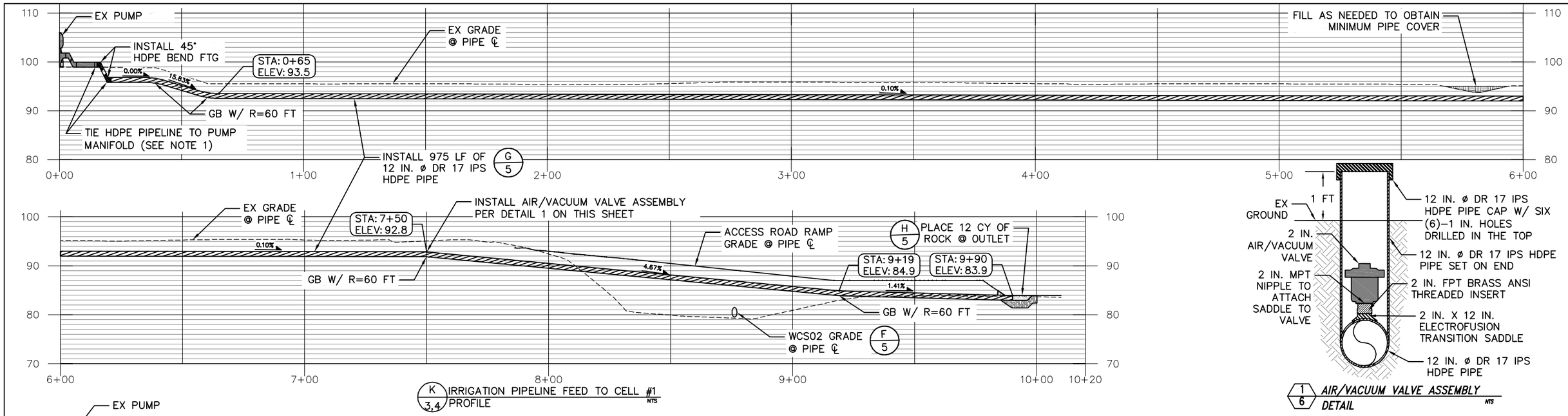
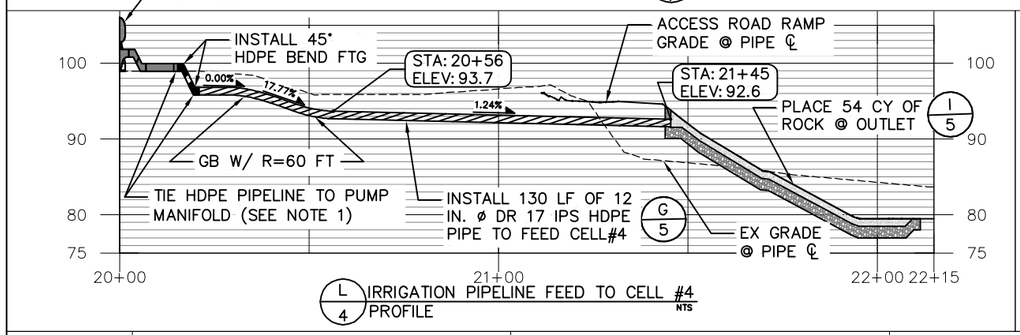
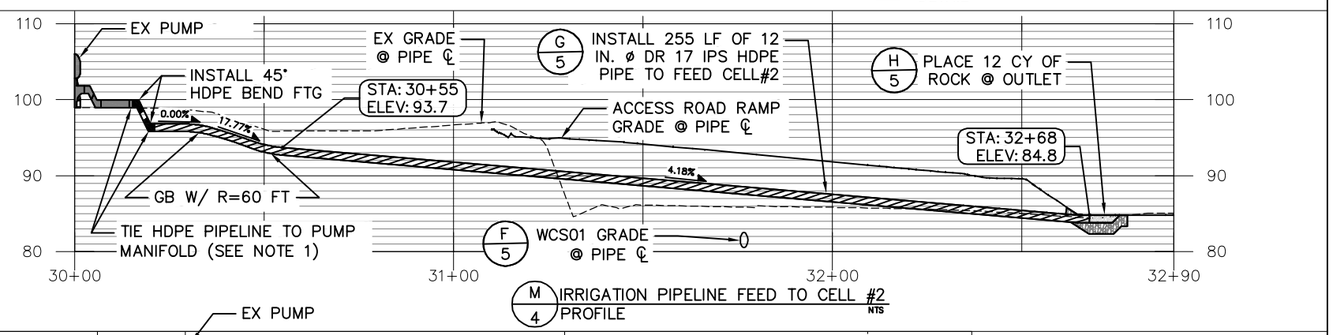


K 3,4 IRRIGATION PIPELINE FEED TO CELL #1 PROFILE NTS

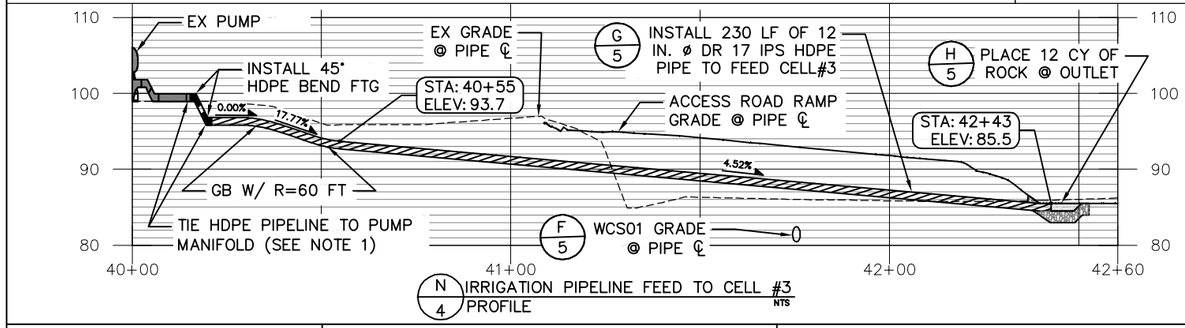
1 6 AIR/VACUUM VALVE ASSEMBLY DETAIL NTS



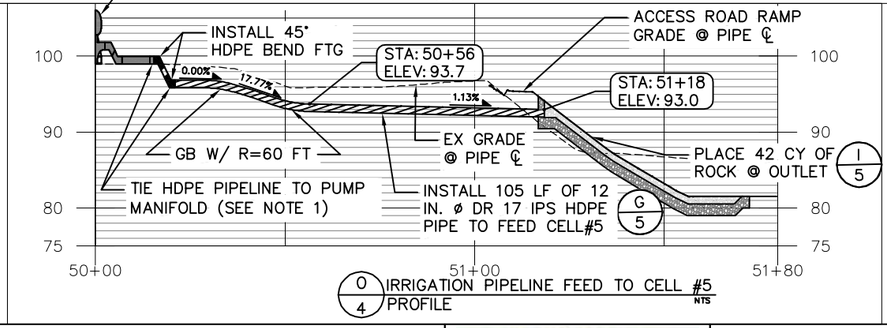
L 4 IRRIGATION PIPELINE FEED TO CELL #4 PROFILE NTS



M 4 IRRIGATION PIPELINE FEED TO CELL #2 PROFILE NTS



N 4 IRRIGATION PIPELINE FEED TO CELL #3 PROFILE NTS



O 4 IRRIGATION PIPELINE FEED TO CELL #5 PROFILE NTS

NOTES:
1. MANIFOLD CONSTRUCTED BY OTHERS. MANIFOLD LOCATION APPROXIMATE. VERIFY MANIFOLD LOCATION, TIE–IN ELEVATION AND TIE–IN METHOD.

HORIZONTAL SCALE:
0 40 80
SCALE IN FEET

VERTICAL SCALE:
0 20 40
SCALE IN FEET

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IRRIGATION PIPELINE PROFILES

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1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

DATE:	DRAWING NO:
08–05–11	DT03
NCD PROJECT NO:	SHEET NO:
09–170–AZ	6 OF 6

Appendix H. Hunter's Hole Restoration Site Planting Plan

HUNTERS HOLE RIPARIAN AND WETLAND RESTORATION PROJECT

PREPARED FOR:

YUMA CROSSING NATIONAL HERITAGE AREA

MULTI-SPECIES CONSERVATION PROGRAM LOWER COLORADO RIVER

BUREAU OF RECLAMATION

Bureau of Land Management

Arizona Water Protection Fund

Arizona Department of Water Resources
3550 North Central Avenue
Phoenix, AZ 85012

SHEET INDEX:

OVERALL PLANTING DESIGN	1
PLANTING DETAIL LAYOUTS:	
MESQUITE	2
COTTONWOOD	3
GOODING WILLOW	4
SANDBAR WILLOW	5
THREE SQUARE MARSH	6
PLANTING SCHEDULE	7-8

LOCATION MAP:

Fred Phillips Consulting, LLC
401 SOUTH LEROUX STREET
FLAGSTAFF, AZ
86001
TEL 928 773 1530
FAX 928 774 4166
Ecosystem Restoration Land Planning

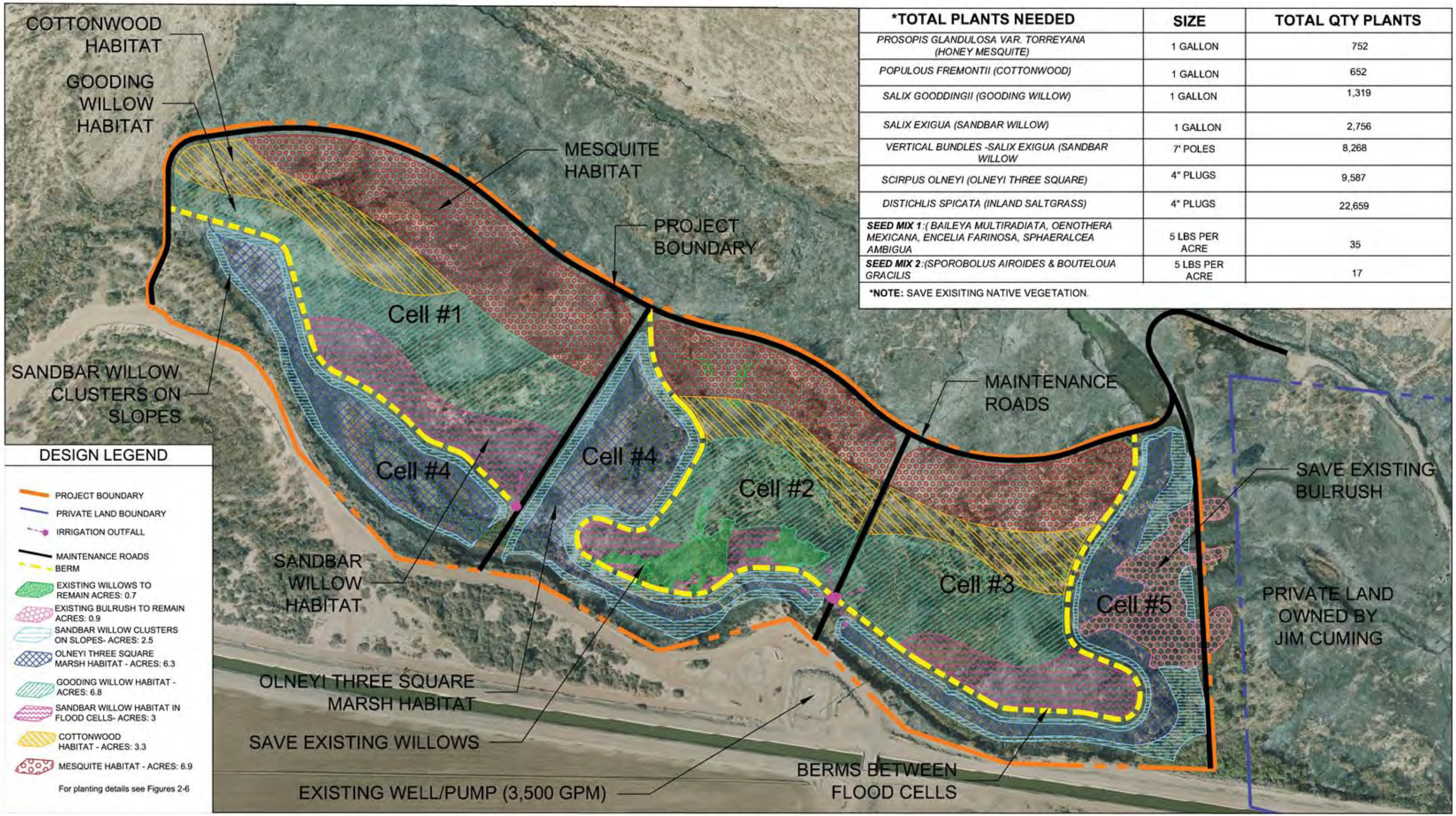
REV.	COMMENT	DATE

HUNTERS HOLE RIPARIAN AND WETLAND RESTORATION PROJECT

MEXICO / UNITED STATES BORDER

SHEET TITLE:
COVER SHEET

DATE: JULY 8, 2011
JOB NO: 08002-3
DRAWN BY: DB/KI
DESIGNED BY: FOP/DB
CHECKED BY: FOP



*TOTAL PLANTS NEEDED	SIZE	TOTAL QTY PLANTS
PROSOPIS GLANDULOSA VAR. TORREYANA (HONEY MESQUITE)	1 GALLON	752
POPULOUS FREMONTII (COTTONWOOD)	1 GALLON	652
SALIX GOODDINGII (GOODING WILLOW)	1 GALLON	1,319
SALIX EXIGUA (SANDBAR WILLOW)	1 GALLON	2,756
VERTICAL BUNDLES -SALIX EXIGUA (SANDBAR WILLOW	7' POLES	8,268
SCIRPUS OLNEYI (OLNEYI THREE SQUARE)	4" PLUGS	9,587
DISTICHLIS SPICATA (INLAND SALTGRASS)	4" PLUGS	22,659
***SEED MIX 1**:(BAILEYA MULTIRADIATA, OENOTHERA MEXICANA, ENCELIA FARINOSA, SPHAERALCEA AMBIGUA*	5 LBS PER ACRE	35
***SEED MIX 2**:(SPOROBOLUS AIROIDES & BOUTELOUA GRACILIS*	5 LBS PER ACRE	17

***NOTE:** SAVE EXISITING NATIVE VEGETATION.

Fred Phillips Consulting, LLC
401 SOUTH LEROUX STREET
FLAGSTAFF, AZ
86001
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FAX 928 774 4166
Ecosystem Restoration Land Planning

PREPARED FOR:
YUMA CROSSING NATIONAL HERITAGE AREA IN PARTNERSHIP WITH THE BUREAU OF RECLAMATION

HUNTER'S HOLE
RIPARIAN AND WETLAND RESTORATION

CITY OF YUMA

YUMA, ARIZONA

SHEET TITLE :
REVISED PLANTING PLAN

Scale: 1" = 200'
0' 100' 200' 400' 600' NORTH

DATE: July 8, 2011
JOB NO.:
DRAWN BY: KI
DESIGNED BY: FOP/DB
CHECKED BY: FOP

SHEET NO.:
FIGURE 1

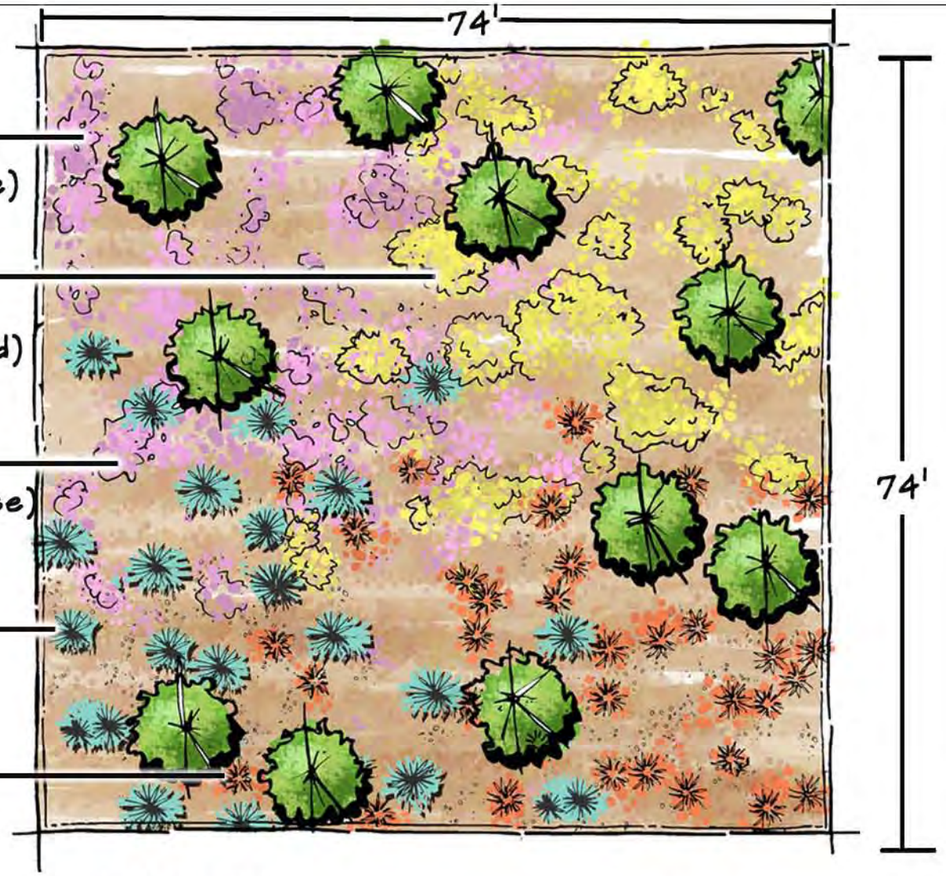
Prosopis glandulosa var. torreyana (Honey Mesquite)

Baileya multiradiata (Desert Marigold)

Oenothera mexicana (Evening Primrose)

Encelia farinosa (Brittlebush)

Sphaeralcea ambigua (Globe Mallow)



PLAN VIEW
1/8 of an Acre

0 7.5' 15' 30'

SECTION VIEW: 2-3 YRS

PLANTING ZONE PROPERTIES

Plant Specs:
* Prosopis glandulosa var. torreyana, 1 gallon, hand planted randomly 20' O.C.

Seed entire area 5 lbs per acre with Seed Mix 1:
- *Oenothera mexicana
- *Baileya multiradiata
- *Encelia farinosa
- *Sphaeralcea ambigua

Fred Phillips Consulting

Designed By: FPC

HUNTERS HOLE RIPARIAN AND WETLAND RESTORATION PROJECT

PLANTING DETAIL MESQUITE HABITAT

Figure 2

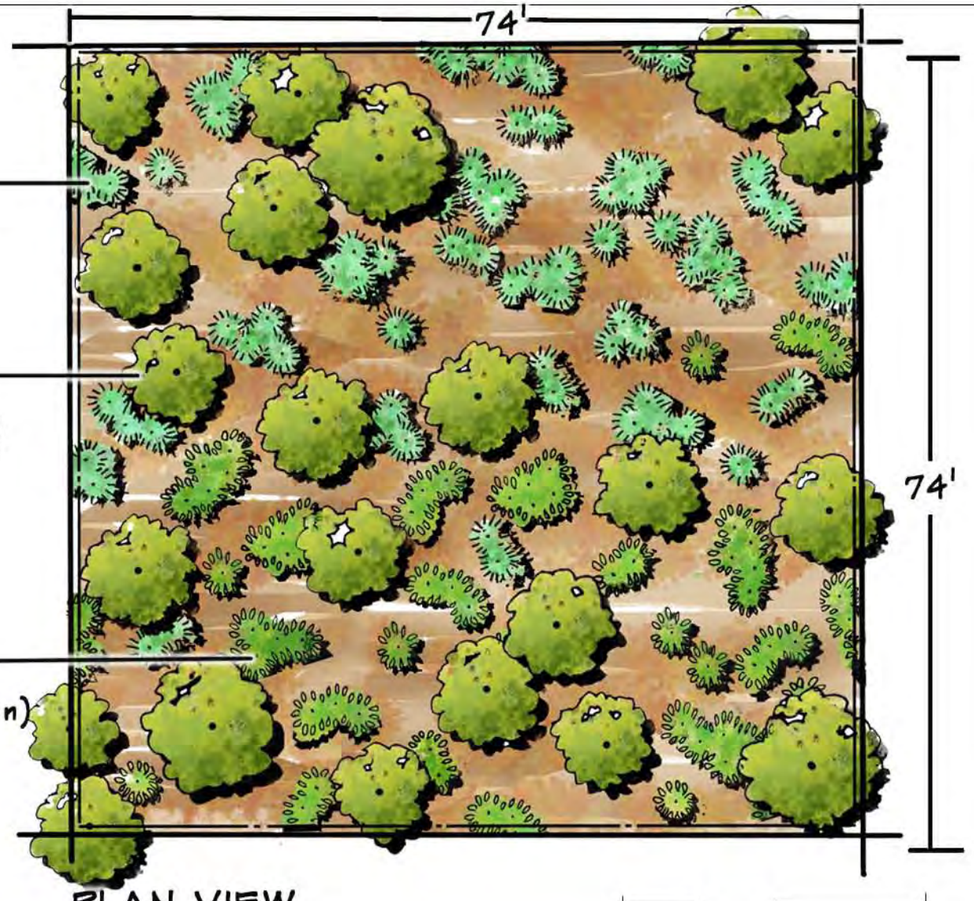
Date: 7/8/11

Natural Channel Design, INC

Boutelova gracilis (Blue grama)

Populous fremontii (Cottonwood)

Sporobolus airoides (Alkali sacaton)



PLAN VIEW
1/8 of an Acre

SECTION VIEW: 2-3 YRS

PLANTING ZONE PROPERTIES:

* Populous fremontii 1 gallon, hand planted randomly 15' O.C.

* Seed entire area 5 lbs per acre with Seed Mix 2:
  * Sporobolus airoides
  * Boutelova gracilis

Fred Phillips Consulting

Designed By: FPC

HUNTERS HOLE RIPARIAN AND WETLAND RESTORATION PROJECT

PLANT DETAIL COTTONWOOD HABITAT

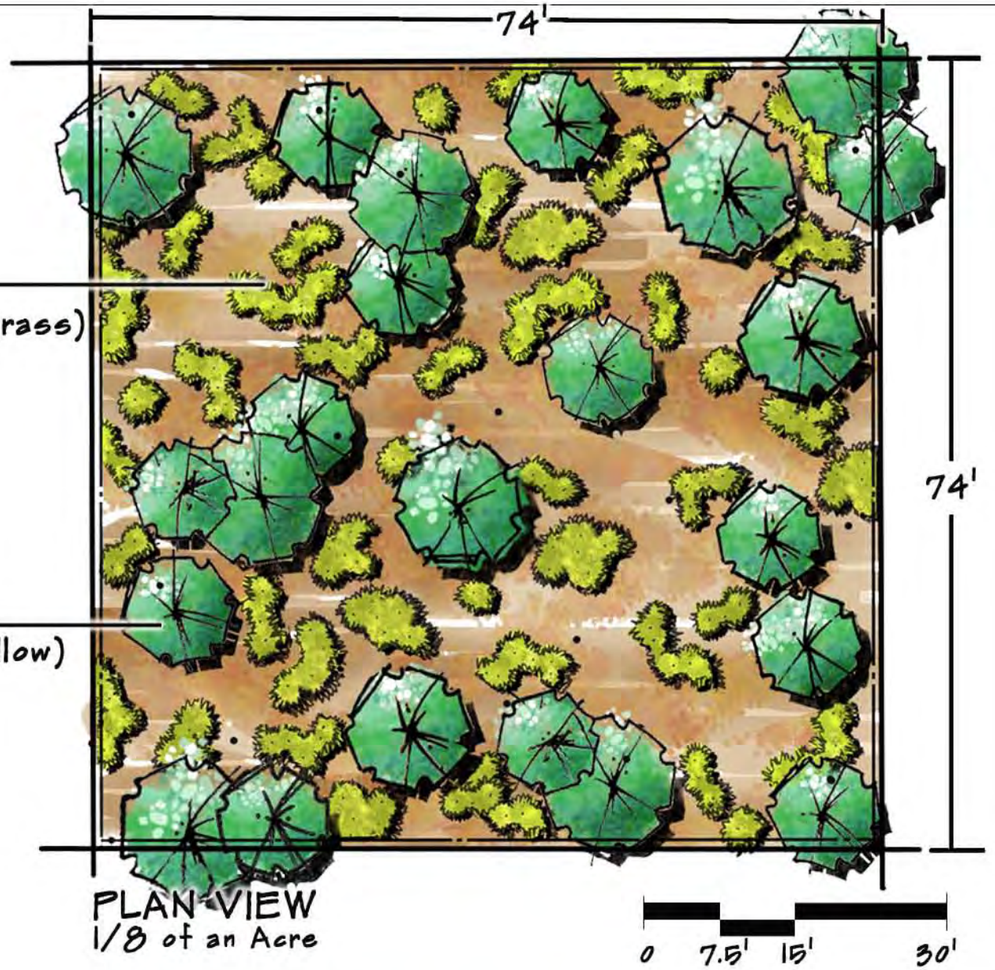
Figure 3

Date: 7/8/11

Natural Channel Design, INC

Distichlis spicata (Inland Saltgrass)

Salix gooddingii (Gooding Willow)



PLAN VIEW
1/8 of an Acre

SECTION VIEW: 2-3 YRS

PLANTING ZONE PROPERTIES:

* Salix gooddingii 1 gallon, hand planted randomly 15' O.C.

* Distichlis spicata 4" plugs, hand planted randomly 5' O.C.

Fred Phillips Consulting

HUNTERS HOLE RIPARIAN AND WETLAND RESTORATION PROJECT

Figure 4

Designed By: FPC

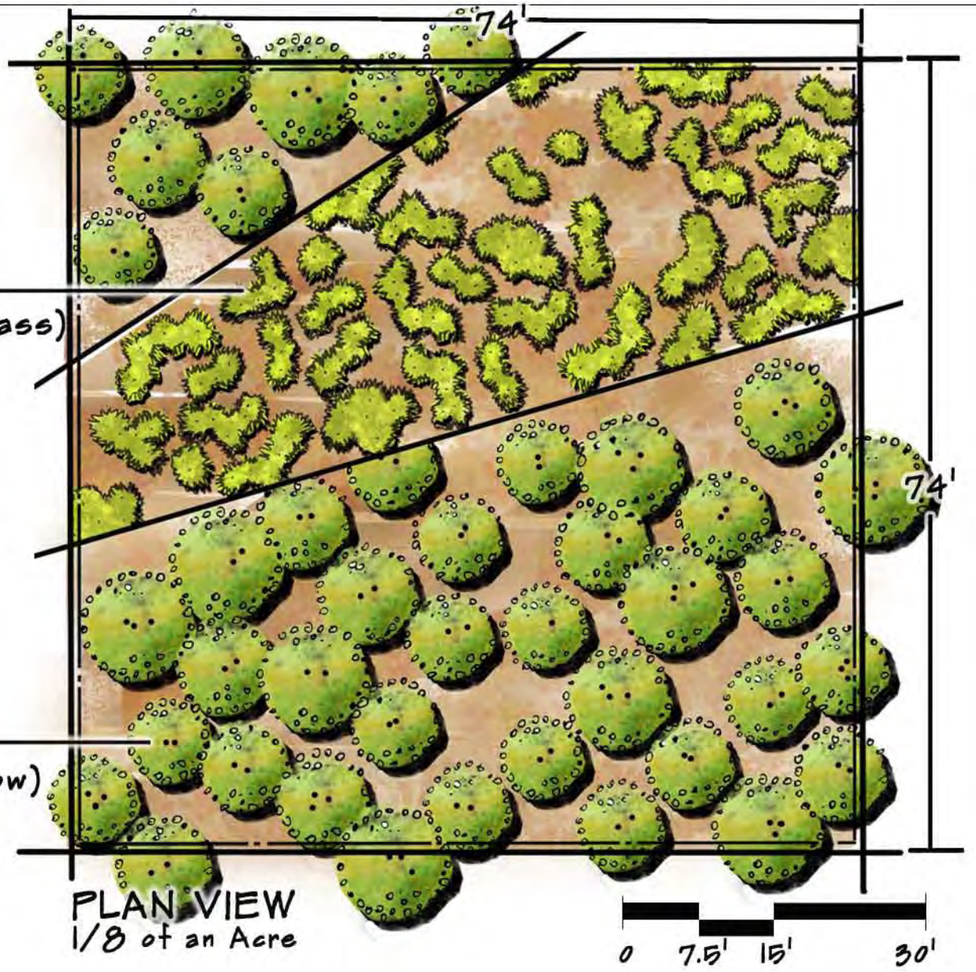
PLANT DETAIL GOODING WILLOW HABITAT

Date: 7/8/11

Natural Channel Design, INC

Distichlis spicata (Inland Saltgrass)

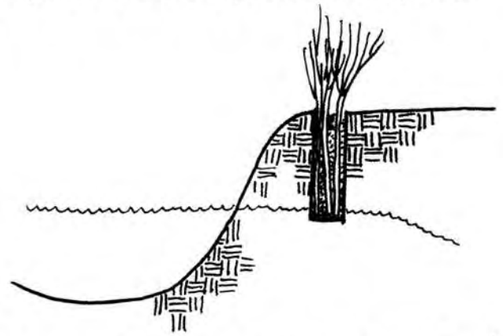
Salilx exigua (Sandbar Willow)



PLAN VIEW
1/8 of an Acre

SECTION VIEW: 2-3 YRS

CLUSTER PLANTING DETAIL



Each cluster will have 3 poles at least 7' in length with a minimum diameter of 1/2". Holes will be augured at a 6" diameter to the lower water table of the year. All poles will be planted at the bottom of the lowest water table of the year. The above ground portion of the pole will be cut at a maximum height of 2' high and a minimum height of 18". When planted all poles will be slurried in with a water auger leaving no air gaps between pole and soil. To maintain maximum soil to stem contact.
All willow pole plantings will be soaked for a minimum of 7 days prior to planting. The entire pole will be under water while being soaked. Once poles are removed from water they will not spend more than 6 hours out of water before planting. All poles will be cut locally during plant dormancy. The tops of all poles will be sealed with latex paint to seal in moisture.

PLANTING ZONE PROPERTIES:

Plant Specs:

* Salix exigua 1 gallon, hand planted randomly 7' O.C.

* Distichlis spicata 4" plugs hand planted randomly 5' O.C.

Fred Phillips Consulting

HUNTERS HOLE RIPARIAN AND WETLAND RESTORATION PROJECT

Figure 5

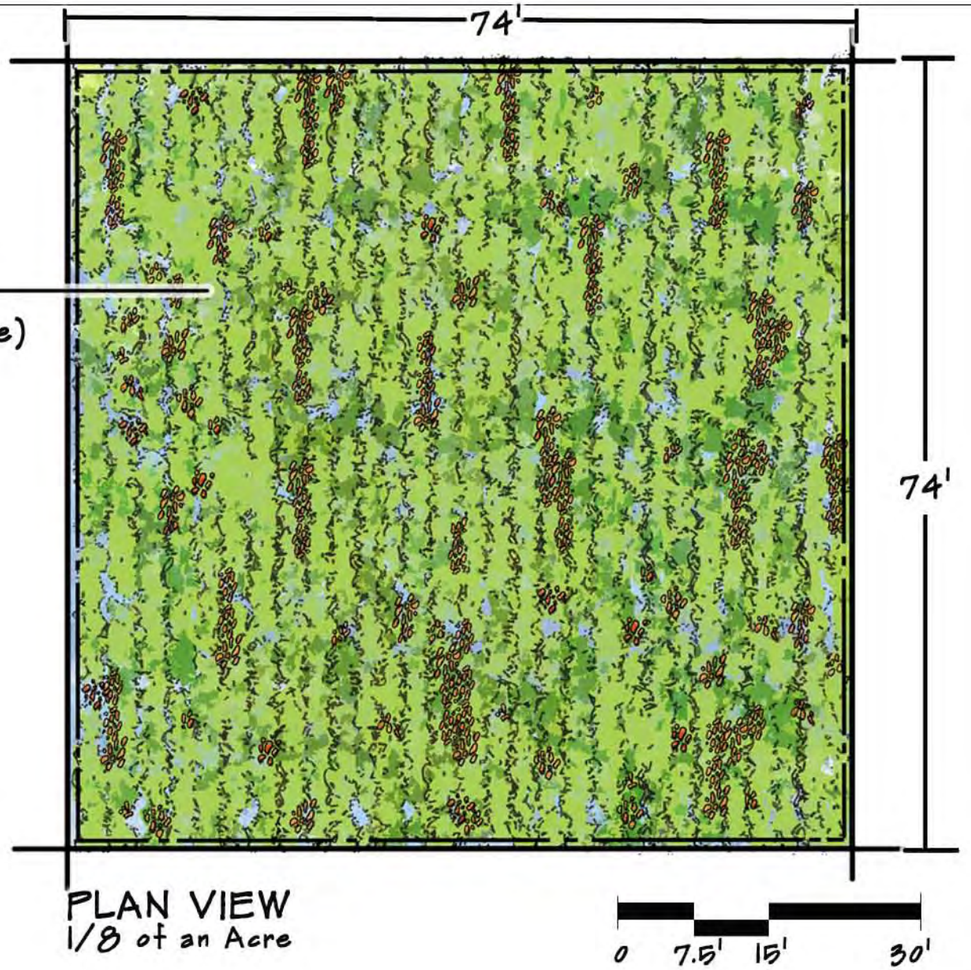
Designed By: FPC

PLANT DETAIL SANDBAR WILLOW HABITAT

Date: 7/8/11

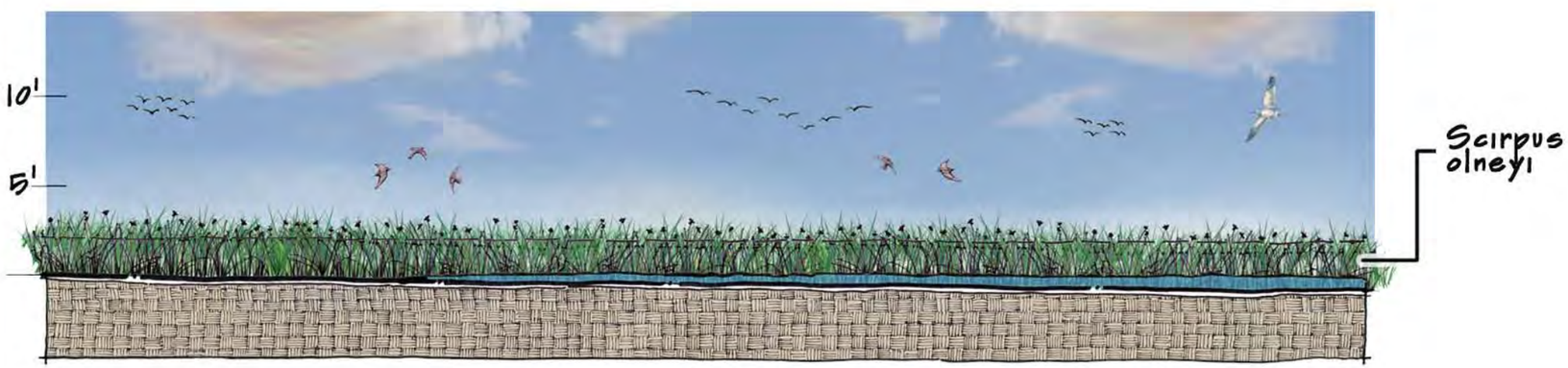
Natural Channel Design, INC

Scirpus olneyi (Three Square)



PLAN VIEW
1/8 of an Acre

SECTION VIEW: 2-3 YRS



PLANTING ZONE PROPERTIES:

* Scirpus olneyi 4" plugs hand planted randomly 5' O.C.

Fred Phillips Consulting

Designed By: FPC

HUNTERS HOLE RIPARIAN AND WETLAND RESTORATION PROJECT

PLANT DETAIL THREE SQUARE MARSH HABITAT

Figure 6

Date: 7/8/11

Natural Channel Design, INC

HUNTERS HOLE PLANTING SCHEDULE

Areas	Planting Method	Acreages	Prosopis glandulosa var. torreyana 1 gallon	Populous fremontii 1 gallon	Salix gooddingii 1 gallon	Salix exigua 1 gallon	Salix exigua 5' poles	Distichlis spicata 4 inch plugs	Scirpus olneyi 4 inch plugs	Seed Mix 1	Seed Mix 2	Planting Description
Cell #1												
Mesquite Habitat	**Hand Planted**	3.50	382							18		*Prosopis glandulosa var. torreyana* , 1 gallon plants hand planted 20' O.C. Seed with 5 lbs/ac of seed mix 1: *Oenothera Mexicana, Baileya multiradiata,Encelia farinose, and Sphaeralcea ambigua.*
Cottonwood Habitat	**Hand Planted**	1.46		283							7	*Populous fremontii,* 1 gallonows hand planted 15' O.C. Seed with 5 lbs/ac of seed mix 2: *Sporobolus airoides* and *Bouteloua gracilis.*
Gooding Willow Habitat	**Hand Planted**	3.00			582			5,229				*Salix gooddingii* , 1 gallon hand planted 15' O.C. *Distichlis spicata,* 4 inch plugs hand planted 5' O.C.
Sandbar Willow Habitat	**Hand Planted**	1.40				1,245		2,440				*Salix exigua* , 1 gallon hand planted 7 ' O.C., *Distichlis spicata* , 4 inch plugs hand planted 5' O.C.
Total		**9.36**	**381.50**	**283.24**	**582.00**	**1244.60**	**0.00**	**7669.20**	**0.00**	**17.50**	**7.30**	

Cell #2												
Mesquite Habitat	**Hand Planted**	1.70	185							9		*Prosopis glandulosa var. torreyana* , 1 gallon plants hand planted 20' O.C. Seed with 5 lbs/ac of seed mix 1: *Oenothera Mexicana, Baileya multiradiata,Encelia farinose, and Sphaeralcea ambigua.*
Cottonwood Habitat	**Hand Planted**	0.90		175							5	*Populous fremontii,* 1 gallonows hand planted 15' O.C. Seed with 5 lbs/ac of seed mix 2: *Sporobolus airoides* and *Bouteloua gracilis.*
Gooding Willow Habitat	**Hand Planted**	1.60			310			2,789				*Salix gooddingii* , 1 gallon hand planted 15' O.C. *Distichlis spicata,* 4 inch plugs hand planted 5' O.C.
Sandbar Willow Habitat	**Hand Planted**	0.60				533		1,046				*Salix exigua* , 1 gallon hand planted 7 ' O.C., *Distichlis spicata* , 4 inch plugs hand planted 5' O.C.
Total		**4.80**	**185.30**	**174.60**	**310.40**	**533.40**	**0.00**	**3834.60**	**0.00**	**8.50**	**4.50**	

Figure 7

Laguna
Plant Schedule

Cell #3												
Mesquite Habitat	**Hand Planted**	1.70	185							9		*Prosopis glandulosa var. torreyana* , 1 gallon plants hand planted 20' O.C. Seed with 5 lbs/ac of seed mix 1: *Oenothera Mexicana, Baileya multiradiata,Encelia farinose, and Sphaeralcea ambigua.*
Cottonwood Habitat	**Hand Planted**	1.00		194							5	*Populous fremontii,* 1 gallonows hand planted 15' O.C. Seed with 5 lbs/ac of seed mix 2: *Sporobolus airoides* and *Bouteloua gracilis.*
Gooding Willow Habitat	**Hand Planted**	2.20			427			3,835				*Salix gooddingii* , 1 gallon hand planted 15' O.C. *Distichlis spicata,* 4 inch plugs hand planted 5' O.C.
Sandbar Willow Habitat	**Hand Planted**	1.10				978		1,917				*Salix exigua* , 1 gallon hand planted 7 ' O.C., *Distichlis spicata* , 4 inch plugs hand planted 5' O.C.
Total		**6.00**	**185.30**	**194.00**	**426.80**	**977.90**	**0.00**	**5751.90**	**0.00**	**8.50**	**5.00**	

Cell #4												
Sandbar Willow Habitat (Cluster Planting)	**Hand Planted**	1.85					4,934	3,225				*Salix exigua* , poles hand planted 7 ' O.C., *Distichlis spicata* , 4 inch plugs hand planted 5' O.C.
Olneyi Three Square Habitat	**Hand Planted**	3.90							6,798			*Scripus olneyi, 4 inch plugs hand planted 5' O.C.*
Total		**5.75**	**0.00**	**0.00**	**0.00**	**0.00**	**4933.95**	**3224.55**	**6797.70**	**0.00**	**0.00**	

Cell #5												
Sandbar Willow Habitat (Cluster Planting)	**Hand Planted**	1.25					3,334	2,179				*Salix exigua* , poles hand planted 7 ' O.C., *Distichlis spicata* , 4 inch plugs hand planted 5' O.C.
Olneyi Three Square Habitat	**Hand Planted**	1.60							2,789			*Scripus olneyi, 4 inch plugs hand planted 5' O.C.*
Total		**2.85**	**0.00**	**0.00**	**0.00**	**0.00**	**3333.75**	**2178.75**	**2788.80**	**0.00**	**0.00**	
PLANT TYPE			**Prosopis glandulosa var. torreyana 1 gallon**	**Populous fremontii 1 gallon**	**Salix gooddingii 1 gallon**	**Salix exigua 1 gallon**	**Salix exigua 7' poles**	**Distichlis spicata 4 inch plugs**	**Scirpus olneyi 4 inch plugs**	**Seed Mix 1**	**Seed Mix 2**	
PLANT TOTALS			**752**	**652**	**1,319**	**2,756**	**8,268**	**22,659**	**9,587**	**35**	**17**	

Figure 8

Appendix I. Hunter's Hole Restoration Site Photo Monitoring

Hunter's Hole

Photomonitoring

July 2013

Hunter’s Hole Photomonitoring

Hunter’s Hole Photomonitoring Point #1. Looking southwest at cells 1 and 4 from the northeast end. 3 pics no zoom. April 2012.
N 32° 31’09.29” W 114° 48’04.50”

Hunter’s Hole Photomonitoring Point #1. Looking southwest at cells 1 and 4 from the northeast end. 3 pics no zoom. July 2013.
N 32° 31’09.29” W 114° 48’04.50”

Hunter’s Hole Photomonitoring

Hunter’s Hole Photomonitoring Point #2. Looking northwest at cells 4 and 2 from the east side. 3 pics no zoom. April 2012.
N 32° 31’10.63” W 114 ° 48’04.24”

Hunter’s Hole Photomonitoring Point #2. Looking northwest at cells 4 and 2 from the east side. 3 pics no zoom. July 2013.
N 32° 31’10.63” W 114 ° 48’04.24”

Hunter's Hole Photomonitoring

Hunter's Hole Photomonitoring Point #3. Looking east at cell 2 from the midpoint of the cell's boundary road. 3 pics no zoom.
April 2012. N 32° 31' 15.51" W 114° 48' 10.27"

Hunter's Hole Photomonitoring Point #3. Looking east at cell 2 from the midpoint of the cell's boundary road. 3 pics no zoom.
July 2013. N 32° 31' 15.51" W 114° 48' 10.27"

Hunter’s Hole Photomonitoring

Hunter’s Hole Photomonitoring Point #4. Looking northeast at cell 3 from the west boundary road. 3 pics no zoom. April 2012.
N 32° 31’21.64” W 114 ° 48’07.06”

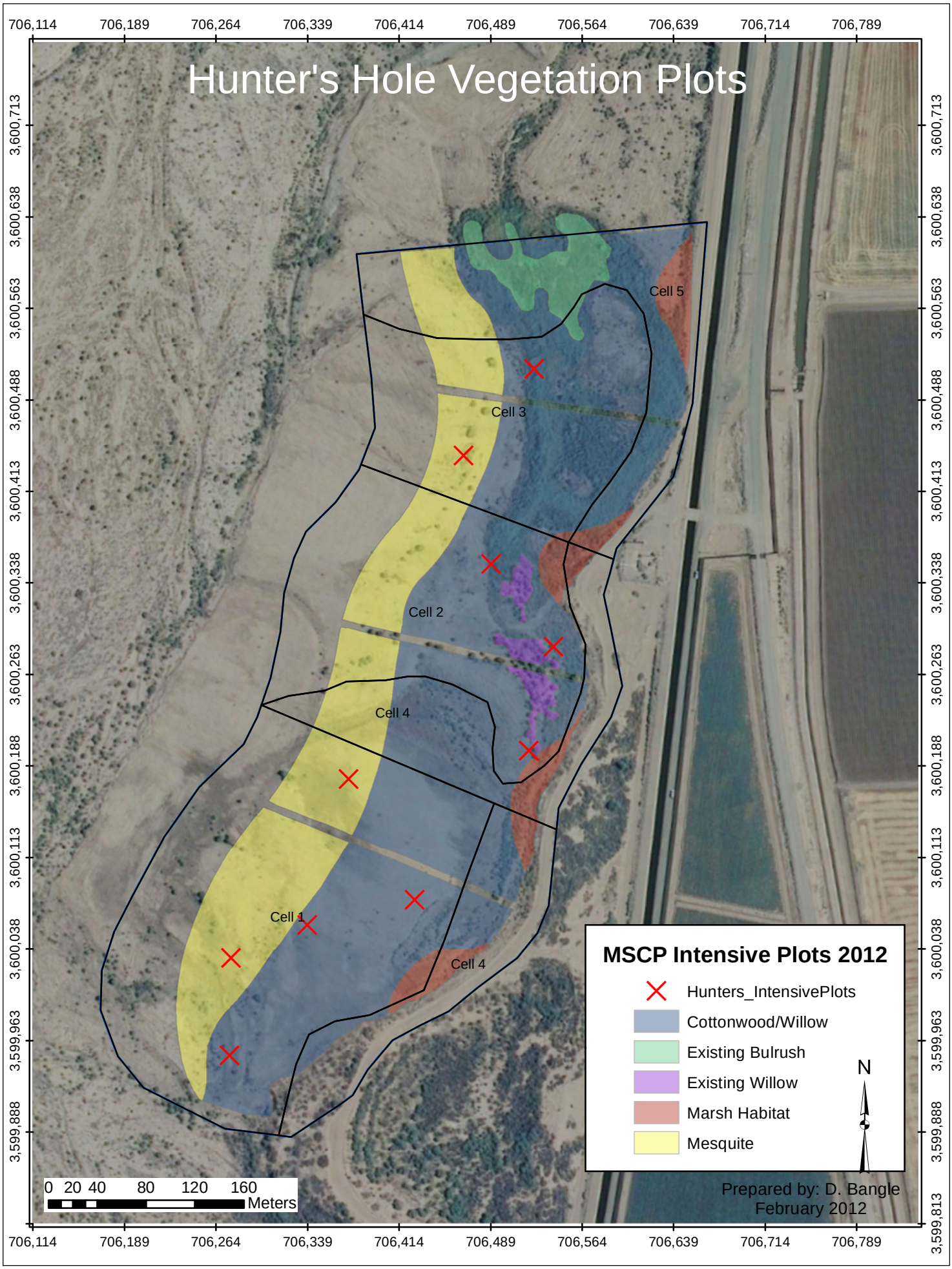
Hunter’s Hole Photomonitoring Point #4. Looking northeast at cell 3 from the west boundary road. 4 pics no zoom. July 2013.
N 32° 31’21.64” W 114 ° 48’07.06”

Hunter’s Hole Photomonitoring

Hunter’s Hole Photomonitoring Point #5. Looking west at cells 3 and 5 from the east boundary road. 3 pics no zoom. April 2012.
N 32° 31’21.52” W 114 ° 47’59.44”

Hunter’s Hole Photomonitoring Point #5. Looking west at cells 3 and 5 from the east boundary road. 3 pics no zoom. July 2013.
N 32° 31’21.52” W 114 ° 47’59.44”

Appendix J. Hunter's Hole Restoration Site Vegetation Monitoring Plots


Hunter's Hole Vegetation Plots
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706,189
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706,639
706,714
706,789
3,600,713
3,600,638
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3,600,188
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3,600,038
3,599,963
3,599,888
3,599,813
Cell 5
Cell 3
Cell 2
Cell 4
Cell 1
Cell 4
MSCP Intensive Plots 2012
Hunters_IntensivePlots
Cottonwood/Willow
Existing Bulrush
Existing Willow
Marsh Habitat
Mesquite
N
0 20 40 80 120 160
Meters
Prepared by: D. Bangle
February 2012