YUMA EAST WETLANDS

FINAL REPORT

YUMA EAST WETLANDS RIPARIAN REVEGETATION PROJECT (GRANT # 04-124WPF)

FEBRUARY 2008

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The Arizona Water Protection Fund

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The Arizona Water Protection Fund Commission has funded this entire Project. The views and findings presented are the Grantee's and do not necessarily represent those of the Commission, the State, or the Arizona Department of Water Resources.

Table of Contents

List of Figures

List of Tables

Executive Summary

The riparian area surrounding the Yuma East Wetlands COY 25-Acre Revegetation Project, otherwise known as the Demonstration Garden (Demo Garden), and the Lower Colorado River has been extensively modified by almost a century of flow control activities, channelization, agricultural manipulation, timber harvesting, non-native species invasion, and unregulated dumping. Where large stands of native cottonwood/willow gallery forests and mesquite bosques historically flourished along the river corridor, the current conditions have allowed exotic saltcedar (*Tamarix pentandra* and *T. ramosissima*) and invasive phragmites to dominate. Monotypic stands of tamarisk have created a degraded habitat for birds and other wildlife, including many endangered and threatened species. The Yuma East Wetlands Demo Garden project encompasses 25-acres of the overall proposed 1,392 acre riparian site designed for native plant restoration in order to improve bird and wildlife habitat. The objectives of this project were to restore 25-acres of cottonwood/willow habitat along the lower Colorado River in Yuma, AZ.

The site was cleared of non-native, invasive vegetation in November 2004. Irrigation infrastructure completion and replanting efforts at the site with native vegetation, including Fremont cottonwood (*Populus fremontii*), Goodding willow (*Salix gooddingii*), sandbar willow (*Salix exigua*), honey mesquite (*Prosopis glandulosa*), and screwbean mesquite (*Prosopis pubescens*) were completed in December 2005. Plant and photo monitoring was initiated in April 2006. Minor changes were made to the original planting and irrigation plans due to the results from the site analyses.

The Demo Garden Project has successfully transformed an area that was previously a monotypic stand of invasive tamarisk into productive, native riparian habitat. The first growing season showed tremendous success with the exception of the Goodding willows. Mortality occurred in Goodding willow due to high soil salinities and frequent inundation. The second growing season showed excellent success and the survivorship rate for the end of the second growing season was 84%. Since planting all species have expressed positive growth and in October 2007 average cottonwood height was 139.2 inches (SE= 6.09), Goodding willow was 135.1 inches (SE=9.89), sandbar willow was 73.5 inches (SE= 4.22), screwbean mesquite was 120 inches (SE=4.16) and honey mesquite was 75.4 inches (SE=5.12). Problems with the irrigation system during June 2007 caused a decline in the overall condition of all species, however little mortality occurred due to these problems. Site irrigation is slated to continue for at least two more years in order to insure that planted native species are self-sustaining and have their roots in the water table. Site monitoring and maintenance will continue until the project success criteria are achieved.

1.0 Introduction

The riparian areas surrounding the Yuma East Wetlands have been drastically altered by the historic damming and confinement of the river channel. These changes have decreased seasonal flooding, ended the natural process of salt removal from the soil, and impaired the ability of native cottonwood, willow, and mesquite trees to thrive and regenerate. Non-native tamarisk, (*Tamarix ramosissima* and *Tamarix pentandra*), which is well adapted to high salinity levels and regenerates rapidly, has been able to out-compete native plants. Tamarisk and common reeds (*Phragmites australis*) have invaded the lands of this highly vegetated river, altering the habitat of birds and other wildlife, including many endangered and threatened species.

The Yuma East Wetlands (YEW) is located along the lower Colorado River, east of downtown Yuma. For years this land was used as a dumping ground, as well as a make-shift home for transient people. However, the residents of Yuma recognized the value of the Colorado River and its wetland habitat. In 2001, a comprehensive Yuma East Wetlands Restoration Plan was produced by Fred Phillips Consulting to restore the wetlands and riparian area into valuable wildlife habitat. Partnerships between the City of Yuma, The Quechan Tribe, the State of Arizona, Yuma Crossing National Heritage Area as well as private land owners were formed. A great deal of planning, combined with generous grants have turned the former wasteland into a vibrant ecosystem to benefit wildlife and citizens alike. In its totality, the project revegetated the area between the Ocean-to-Ocean Bridge and the confluence with the Gila River, encompassing the 100-year flood plain within the levee.

The AWPF project titled "Yuma East Wetlands Riparian Revegetation Project," otherwise known as the Demonstration Garden (Demo Garden), was designed to accomplish the goals outlined in the restoration plan. The primary objective of the Demo Garden was to establish and protect 25 acres of long-term, self-sustaining, native cottonwood, willow and mesquite riparian habitat along the 100-year floodplain of the Colorado River. The Demo Garden project area begins at the western end of the YEW Project Area, adjacent to and east of the South Pilot Project (Figure 7.1). Restoration efforts have involved preserving existing stands of native habitat and clearing non-native trees and plants. Tamarisk and other invasive plants were removed and native species were planted, including: Fremont cottonwood (*Populus fremontii),* Goodding willow (*Salix gooddingii),* sandbar willow *(Salix exigua),* screwbean mesquite (*Prosopis pubescens*), and honey mesquite *(Prosopis glandulosa.).* This report discusses all the activities accomplished throughout all phases of the project to its completion, including clearing, site characteristic analysis, construction, monitoring and maintenance. A detailed discussion of proposed actions and actual outcomes of each task will be included.

2.0 Construction and Site Analysis

2.1 Invasive Species Clearing

The contract for this project was initiated by the Arizona Water Protection Fund in June 2004. Invasive species clearing at the Demo Garden site commenced in late October 2004 and was completed in November 2004 (Figure 7.2). Site clearing was proposed for 25 acres, however an additional 6 acres were cleared, for a total of 31 acres, to restore additional wetland and riparian habitat using funding from National Fish and Wildlife Foundation (NFWF). The 6-acre NFWF site is located adjacent to the Demo Garden project and perpendicular to the Colorado River (Figure 7.3). The addition of these 6 acres adjusted the original location of the Demo Garden project up the east bank of and parallel to the Colorado River to maintain the 25 acre area of the project (Figures 7.3 and 7.4).

Invasive species clearing in the upper terrace was conducted using a D-7 low ground pressure bulldozer, excavator and a hydrologic tree axe mounted to a bobcat. Southwest Recycling conducted the entire site clearing. During the clearing mature stands of native trees were retained on site. All cleared exotic plant material was consolidated and piled in windrows on the site. After piled in windrows the plant material was compacted by a bulldozer and then covered with 2 feet of dirt from the site and compacted a second time. The portion of the site located along the riverbank required the use of a grade-all, backhoe, or other appropriate machinery to remove the root crowns of exotic plants to a depth of approximately 3 feet. This machinery was staged on top of the riverbank, well above the channel and ordinary high water mark. After the exotic vegetation was removed the area was graded back approximately 30 feet. Excavation and clearing of the riverbank occurred during low water flows.

On the inside edge of the river bank grading (30 feet from the river bank) a 1 foot high by 2 foot wide Storm Water Pollution Protection Berm (SWPPP) was constructed. This berm continues the length of the project area along the river. On the inside of the SWPPP an 8 foot wide gap was retained before the beginning of the windrows to serve as the temporary maintenance trail for revegetation construction.

After clearing, follow-up site weeding was conducted from May 2005 (the beginning of the growing season) until planting was initiated in December 2005. Re-colonizing tamarisk was eradicated by using a tractor and disc and by applying Garlon 4 herbicide. Phragmites was another aggressive invasive re-colonizing plant. The Arizona Game and Fish Department determined that this native plant was valuable to bankline stabilization along the river and requested

that it be retained along the bank, however this plant was actively removed within the revegetation area.

2.2 Site Analyses

The Site Analyses, including measurements of the depth to water table (DWT) and soil salinities at 2- and 5-foot depths, were conducted in December 2004 after the site was cleared. These analyses were necessary to complete prior to initiating the planting design in order to match the appropriate plant species with tolerable site conditions. Prior to field collection randomly placed sampling locations were placed on a map and the GPS locations were obtained and entered into a Trimble GEO XT survey unit. Field soil sampling and depth to water was conducted by Fred Phillips Consulting, LLC. Soil samples were collected at 2 data points per acre, totaling 50 sampling points about 100 samples for soil salinity. The depth to water was measured at 10 of the sampling points. In the field points were located using the Trimble survey unit, and in the case that the point had to be adjusted a new point was entered into the Trimble. Once the point was located an 8 foot hand auger was used to excavate the soil. Soil samples at the 2 foot and 5 foot depths were place in plastic bags and labeled with the site name, the point name, soil depth, collector and the depth and sent to the Utah State University Analytical Laboratories for analysis.

The depth to water analysis determined that the site was suitable for mesquite, cottonwood, four-wing saltbush and willow species (Table 2.2.1). The depth to water ranged from 0-10 feet across the entire site (Figure 7.5). The soil salinity measured on site was much higher than anticipated, where at the 2 foot soil depth salinity ranged from 4-35 mmhos and at the 5 foot soil depth salinity ranged from 4-40 mmhos (Figure 7.6 and 7.7).

Plant	2' EC (mmhos/cm)	5' EC (mmhos/cm)	Depth to Water (ft)
Willow	0-3	0-3	0-6
Cottonwood	0-3	0-3	0-10
Honey mesquite	0-8	0-8	3-12
Screwbean mesquite	0-9.4	0-9.4	3-12
Four-wing saltbush	0-12	0-12	3-15

Table 2.2.1. Depth to Water (ft) and soil salinity (mmhos/cm) at 2 ft (2' EC) and 5 ft (5' EC) requirements for five native plants of the lower Colorado River. Note these speices grow best under a range of soil salinities and depths to water (Ohmart and Anderson 1982).

Due to the high salinities present at the site, salts were leached from the soil using sulfuric acid prior to planting. Leaching soils to reduce the soil salinity

with sulfuric acid is a common farming and revegetation practice to make the site more hospitable to vegetation. Sulfuric acid was applied to the soil across the entire 25-acre site and then the site was spray irrigated with approximately 7 feet of water over a 20-30 day period.

2.3 Planting Design and Irrigation

Planting Design

The planting design for the 25-acre site was created based on the results from the site analyses. The original planting design consisted of having cottonwood and willow one gallon plantings planted along the Colorado River shoreline above the ordinary high water mark (OHWM) and in the saturated soil zone along the shoreline. This would provide a planting environment that was frequently inundated by the river at high flows, which promotes the natural regeneration of these species and help stabilize the bank. Areas that had a deep depth to water level (>6 feet) and higher salinities would be planted with screwbean and honey mesquite and quailbush. In areas that had a shallow depth to water (0-6 feet) a mix a cottonwood, willow and mesquite would be planted. Areas that had depth to water levels between 0-3 feet in depth would be planted primarily with willow species (Figure 7.8-7.13).

Project planting was delayed six months from the original proposed planting deadline due to contracting issues. Once these issues were resolved and the appropriate contracts were signed planting was initiated in November 2005. Planting was conducted by JSA Landscaping. Planting occurred according to the original design with the exception of the riverbank plantings along the far northern portion of the project area. Because the phragmites in this area was so aggressive, it was impossible to keep up with the cost of weeding and so no plants were planted in this area due to excessive competition. However, the upper terrace of the bank was still planted with poles of native species (Figure 7.14). The cottonwood and willows proposed for planting along the bankline were transferred to areas with shallow depth to water in the southeast portion of the site. This area was originally proposed for mesquite planting. Also, only a total of 20 quailbush and four-wing saltbush combined were planted on site. Since only a few individuals of this species were planted they were only monitored through photo monitoring and plant growth and condition was not measured. The berms were planted with quailbush and four-wing saltbush seed, however none of the seed germinated most likely because these areas did not receive regular irrigation. Finally, the area proposed to be unaltered for the future construction of the South Channel was reduced and the adjacent area proposed for cottonwood and willow was expanded. This occurred because it was determined that the area necessary to excavate was less than previously thought.

Irrigation

The original irrigation design called for approximately 24 acres the revegetated area to be irrigated by drip irrigation (Figure 7.13). This system allows each individual plant to receive water through lateral ½ inch polyethylene tubing fitted with an emitter. The lateral polyethylene tubing connects to 3 inch polyethylene mainline that carries water from a diesel generating pump. Water for the drip irrigation system would be pumped from the Colorado River. The remaining 1-acre of low-lying revegetated project area was proposed for flood irrigation. This area was going to be bound by berms and water pumped into the area until the entire area was inundated. The depth to water and soil conditions would dictate how often flood irrigation was to occur.

Due to the convenience and low cost of drip irrigation, the drip irrigation lines explained above were extended across almost the entire project site to cover most of the area proposed for flood irrigation. The irrigation infrastructure was constructed prior to planting. The irrigation lines were buried under the ground with 6 inch of sediment on top of the mainline and 3 inch minimal cover on top of the laterals. Irrigation was in operation for 1.5-2 hours per day so that a tree receives 15-20 gallons of water per day. Each individual tree received an average of 8 gallons of water per hour. A ¼ acre area that was originally proposed for flood irrigation received a mix of flood irrigation and drip irrigation. Flood irrigation occurred by extending 3-inch polyethylene tubing from the mainline and letting it flow into the lowered cell. Areas within the flood irrigated area that did not receive sufficient water was supplemented with drip irrigation. JSA Landscaping constructed the irrigation infrastructure on site.

Currently, the irrigation system is still functioning in order to promote long-term sustainability by allowing the plant's roots to reach the water table. It was determined that the roots of some of the plants had still not reached the water table, and it is proposed that irrigation continue for at least another two years. One lesson learned from the construction of this irrigation system was that buried irrigation lines are more difficult to maintain than irrigation lines resting on top of the sediment. Polyethylene tubing is very light in weight and therefore easily moved or pulled. If a leak occurred it was difficult to find the leaking area and repair it. Also, by burying the irrigation infrastructure under ground it is impossible to reuse the piping once the irrigation is unnecessary. Future projects that utilized drip irrigation located the irrigation infrastructure on the soil's surface.

3.0 Monitoring Data Collection Methods

3.1 Photo Monitoring Analysis

Six photo monitoring stations were established throughout the site to encompass a visual perspective of the entire site. The photo monitoring datasheet was filled out only during the initial visit to establish the transects. Panoramic pictures consisting of 3-5 photos were taken three times throughout the growing season since the project conception. The stations were located at higher elevations for an overall perspective. Monitoring photos, taken repeatedly over extended periods, provide a valuable scientific visual database. Figure 7.15 shows the locations of the photo monitoring stations in the Demo Garden. The photo monitoring results comparing the first and second year of growth at the Demo Garden are shown in Section 6.0 (Figures 6-1 - 6-5). Additional photo monitoring from the 2006 and 2007 growing seasons are located on the attached CD.

3.1 Plant Monitoring

The primary objective of monitoring revegetation projects is to evaluate the success of revegetation efforts and survival of the native species planted. Plant monitoring methods follow the guidelines from Anderson et al. (2004) and correspondence with Bertin W. Anderson. Quantitative measurements of plant growth, heath and survival were measured for the cottonwood, Goodding willow, sandbar willow, honey mesquite and screwbean mesquite individuals planted through established monitoring transects. The original planting plan called for five individuals of four-wing saltbush and two individuals of quailbush to be monitored, however due to the small number of individuals planted of these two species, they were only monitored through photo monitoring. Also, the original plant monitoring plan called for five transects comprising of five individuals of the same species of cottonwood, Goodding willow, sandbar willow, honey mesquite and screwbean mesquite for a total of 25 transects to measure 6% of the population. However, due to the reduced planting density of sandbar willow only one transect (5 trees) was established for this species, whereas Goodding willow had 6 transects (28 trees) and cottonwood had 8 transects (40 trees) for a total of 25 transects.

Transect locations were selected randomly by using a computer to generate a random number corresponding with a planting hole in each of the 25 acres (Figure 7.15). The selected planting hole represented the first individual in the transect and the next consecutive four holes completed the transect. Once established, the transects were recorded as a GPS location using a Trimble GPS unit. In order to relocate transects, the beginning of each transect was marked with a 3 foot long wooden stake that was spray painted with fluorescent paint

number and transect number and fluorescent flagging. The fluorescent flagging was replaced as necessary.

Data collection at the site occurred every month during the growing season (April- October) during the first 2006 growing season and the second 2007 growing season (May- October). Data results for the 2006 monitoring season will only utilize the May- October data in order to compare results with the 2007 monitoring season. The original monitoring plan stated that data be collected every month for the first growing season and every other month for the second monitoring season, however in order to provide a better picture of seasonal growth and site health monitoring was conducted every month for the second growing season. For each individual, several parameters were recorded, including: height (inch), growth rate, condition, and other influences on growth. Plant height was measured using a pvc measuring rod with measured interval markings from the base of the trunk to the tallest outstretched leaf. Overall vegetation condition was also recorded for each tree using a 0-4 scale. A score of 0 was given to any plant that is dead; 1, for poor condition; 2, for fair condition; 3, for good condition; and 4, for excellent condition and vigorous growth. Once a tree was dead, it was not used to calculate the overall condition of the species, and if replaced the new tree was not monitored in order to keep the data consistent. Factors that may have affected plant growth and/or health were also evaluated and recorded on the datasheet. These factors included: insect or mammal browsing, water stress, competition from native and non-native volunteer colonization, outgrowth of protective hog-wire fencing, herbicide effects, and maintenance issues. Natural regeneration of both native and non-native plants was also noted.

Success Criteria

In order to determine if this restoration project was successful, we utilized criteria established by Anderson et al. (2004) for restoration projects along the lower Colorado River. The success criteria are based on 5- and 10-year goals and the Demo Garden has only been established for two years. While these criteria are useful, each site should be evaluated separately with separate criteria since site conditions vary from site to site. However, for this project Table 3.2.2 provides a general set of criteria that were used to evaluate success.

	5-year goal		10-year Goal	
Species	**Percent Survival**	**Height (inches)**	**Percent Survival**	**Height (inches)**
Fremont Cottonwood	80-100	200-300	60-90	240-360
Gooding Willow	80-100	200-265	60-75	220-300
Sandbar Willow	75-80	135-265	60-80	140-280
Mesquite (Screwbean, Honey)	75-80	135-265	60-80	140-280
Four-Wing Saltbush	60-80	24-60	50-80	24-72

Table 3.2.2. Success criteria for six species used in riparian restoration projects on the lower Colorado River (Anderson et al. 2004).

4.0 Monitoring Results

4.1 Species-Specific Growth Rates and Conditions

The results presented below are from the first and second growing seasons for each species planted as part of the revegetation efforts for the 25 acre site. Monitoring results are presented below for the following five species:

- Fremont Cottonwood (*Populus fremontii*)
- Sandbar Willow (*Salix exigua*)
- Goodding Willow (*Salix gooddingii*)
- Honey Mesquite (*Prosopis glandulosa*)
- Screwbean Mesquite (*Prosopis pubescens*)

4.1.1 Fremont Cottonwood (*Populus fremontii*)

Cottonwood trees experienced positive growth throughout the 2006 and 2007 growing seasons in the Demonstration Garden site (Figure 4.1.1). The average total growth for the 2006 growing season was 33.5 inches (N=40; SE=2.56) and 25.68 inches (N=36, SE=5.34) for the 2007 growing season. These similar growth rates indicate that cottonwoods have experienced steady, positive growth for the first two years.

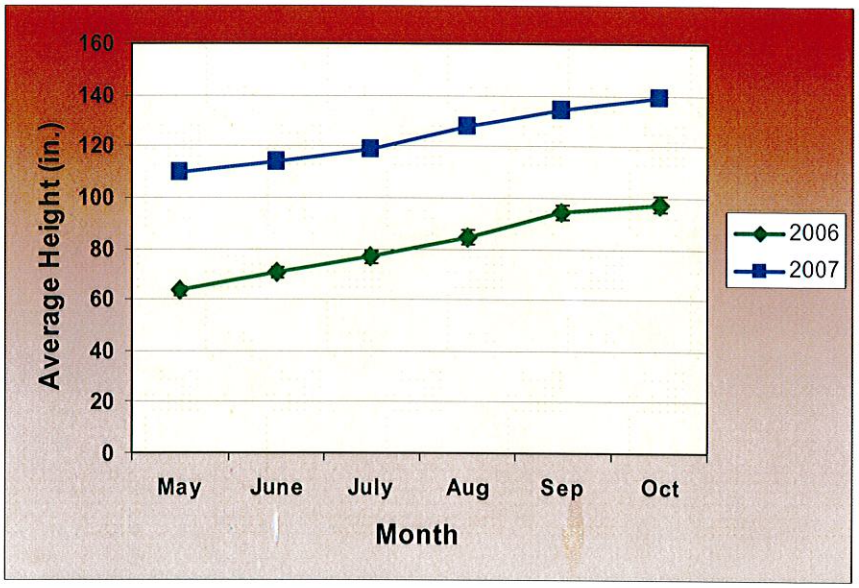


Figure 4.1.1: Average cottonwood height (in.) for May to October, 2006 and 2007 at the Demonstration Garden site, Yuma East Wetlands. Error bars signify standard error.

The overall condition of the surviving cottonwoods for the 2006 and 2007 growing seasons was good to excellent (Figure 4.1.2). Over the first two years of this project cottonwoods have experienced a 90% percent survival rate, losing 2.5% over the 2006/2007 winter and another 7.5% during the second growing season.

During the 2006 monitoring season cottonwoods had 100% survivorship. The primary factor affecting cottonwood health during the 2006 growing season was insect browsing from aphids that affected 60% of trees during the growing season. Insects were treated with soapy water which reduced the percent of the trees affected down to 10% by October. Salt stress, water stress, volunteer competition and hogwire rub affected cottonwoods during the 2006 growing season to a lesser extent, affected less than 13% of the individuals. During the 2007 growing season the primary factor impairing healthy growth was water stress, which in June affected 65% of the cottonwood trees monitored. Early in the season the project experienced large scale irrigation problems. The filtration system failed allowing large amounts of sediment to enter the irrigation lines which consequently clogged the emitters, requiring replacement of the filtration system and repeated flushing of the irrigation system to restore water to the trees. This event is almost entirely responsible for the lower condition rating observed in June and has a large part in the mortality experienced this summer. After the system was repaired plant health rose steadily for the remainder of the growing season. Minor factors also affecting health were insect browsing, hogwire rub and volunteer competition.

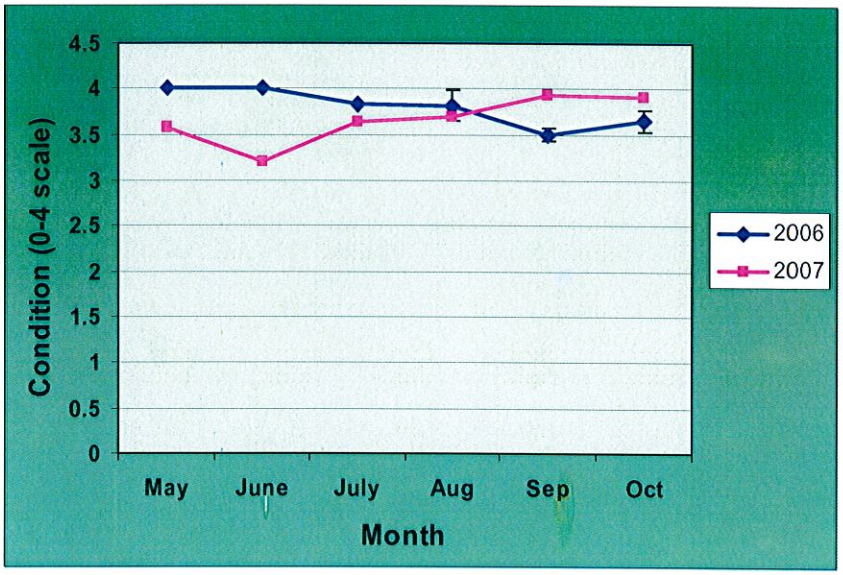


Figure 4.1.2: Average cottonwood condition for May to October, 2006 and 2007 for the Demonstration Garden site, Yuma East Wetlands. 0=dead, 1=poor, 2=fair, 3=good, and 4=excellent. Error bars signify standard error.

4.1.2 Sandbar Willow (*Salix exigua*)

Overall, sandbar willow experienced increased growth during the 2006 and 2007 growing seasons (Figure 4.1.3). Sandbar willow experienced a slight decline in growth during August to September 2007, however by October growth increased. By the second growing season, even though growth declined minimally, the plant was observed heavily recruiting. Average total growth for sandbar willows in the 2006 growing season was 8 inches (N=6; SE=1.92) and for 2007 average total growth was 3 inches (N=6, SE=1.13). The negative average growth observed during August- September 2007 was responsible for the minimal average total growth over the season as compared to sandbar willow growth in 2006.

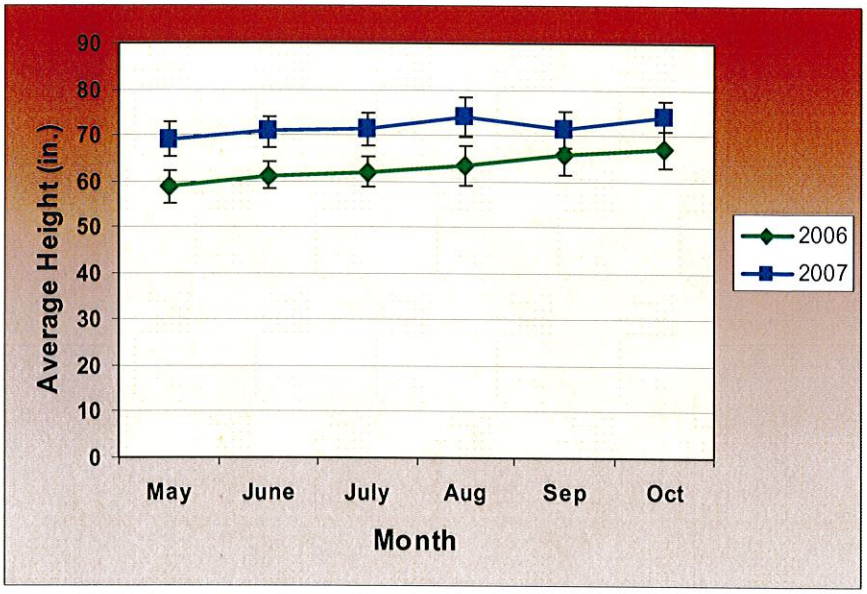


Figure 4.1.3: Average sandbar willow height (in.) for May to October, 2006 and 2007 at the Demonstration Garden site, Yuma East Wetlands. Error bars signify standard error.

The overall condition of the surviving sandbar willows declined slightly in 2007 from 2006, however the individuals were consistently in good to very good condition during 2007 (Figure 4.1.4). Sandbar willow had an 100% survivorship rate in 2006 and one mortality during the 2007 growing season caused the survivorship rate to decline to 86%. The primary factor affecting sandbar willow condition at the Demonstration Garden in 2006 was insect browsing. In September 2006, 100% of the monitored sandbar willows were affected by insect browsing, however by October none were affected and average condition increased. Aphids were the primary insect observed on site, which were observed amassing on the tips of the tree branches. Mammal browsing also was a minor factor, affecting one individual in July 2006.

The primary factor affecting sandbar willow condition at the Demonstration Garden in 2007 was water stress, which is discussed above for cottonwoods. This was most likely the cause of the decline in growth and condition during August to September 2007. The other factors affecting the growth and health of the sandbar willows were insect browsing and volunteer competition. Volunteer competition came mainly from arrowweed and quailbush, both of which are native species which tend to quickly form monotypic stands squeezing out competitors. Although these species are native, their growth is controlled as part of routine maintenance in order to encourage growth and survivorship of planted native species. Insect browsing was a minor effect on overall sandbar willow condition, and shows that the site is promoting wildlife diversity and a food base for bird species.

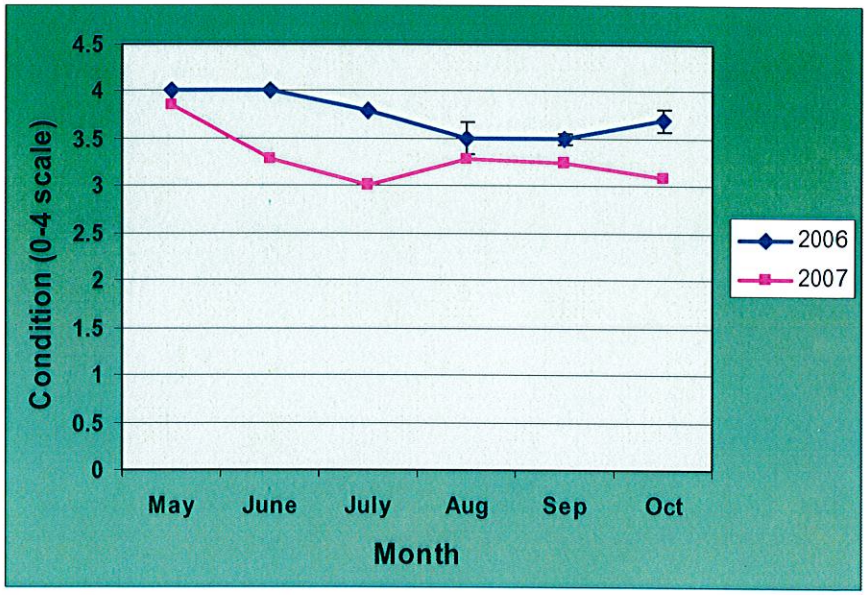


Figure 4.1.4: Average sandbar willow condition for May to October, 2006 and 2007 for the Demonstration Garden site, Yuma East Wetlands. 0=dead, 1=poor, 2=fair, 3=good, and 4=excellent. Error bars signify standard error.

4.1.3 Goodding Willow (*Salix gooddingii*)

Overall, the monitored Goodding willow trees experienced positive growth throughout the 2006 and 2007 growing season in the Demonstration Garden site (Figure 4.1.5). While average height steadily increased during the 2006 growing season, there was a small decline in average height for Goodding willow during June to July 2007. The average total growth during the 2006 growing season was 53 inches (N=17, SE=5.7) and 16.93 inches (N=14, SE=6.43) during the 2007 season. The decreased growth observed during the 2007 season was likely due to three individuals experiencing extreme negative growth that in turn dropped the average. When these three extreme cases were removed from the calculation the average total growth rose to 26.59 inches (N=

11, SE=4.78). The decline in Goodding willow growth in 2007 from 2006 was due to the irrigation problems experienced in June. Most of the negative growth observed in June was caused by the death of the upper branches of the Goodding willows.

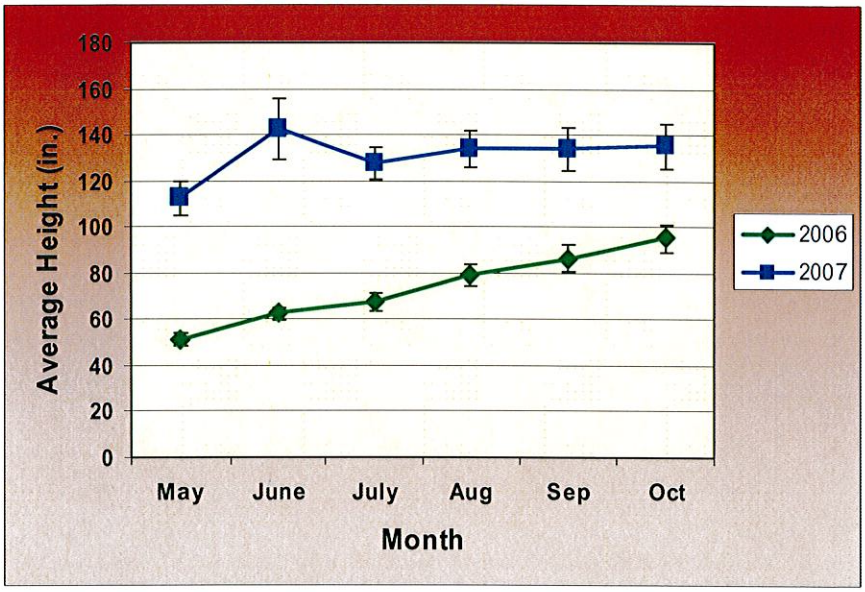


Figure 4.1.5: Average Goodding willow height (in.) for May to October, 2006 and 2007 at the Demonstration Garden site, Yuma East Wetlands. Error bars signify standard error.

The overall condition of the surviving Goodding willow declined precipitously from July to September 2006 at the Demo Garden (Figure 4.1.6). Mortality during the 2006 growing season also increased during August and by the end of the season survivorship was 57%. The decline in Goodding willow condition and high mortality was likely due to water and/or salt stress. These conditions were not noted in the field, however the area where Goodding willow is planted along the Quechan marsh has high soil salinities. Other factors affecting Goodding willow condition during 2006 included insect browsing, volunteer competition, and hogwire rub. Although these factors were present at the site, only 3% were affected by insect browsing, insect presence and hogwire rub and 7% were affected by volunteer competition. Hogwire rub primarily affected the trees outgrowing their protective cages.

After the decreased condition observed for Goodding willow at the Demonstration Garden site during the end of the 2006 growing season, condition increased dramatically for surviving individuals during the 2007 growing season (Figure 4.1.6). The survivorship rate was 90% for the season, 93% of remaining individuals received a condition rating of excellent. Two of the three mortalities that occurred this growing season occurred in June, reflecting the strain the irrigation problems placed on the plants. The only other factor affecting Goodding willow condition within the Demonstration Garden

site was volunteer competition. Volunteer competition affected 21% of the Gooding willows until July at which time the competitors were pruned back in order to encourage the Gooding willow's growth. By August, all Goodding willows were in excellent condition with no measured factors affecting plant condition.

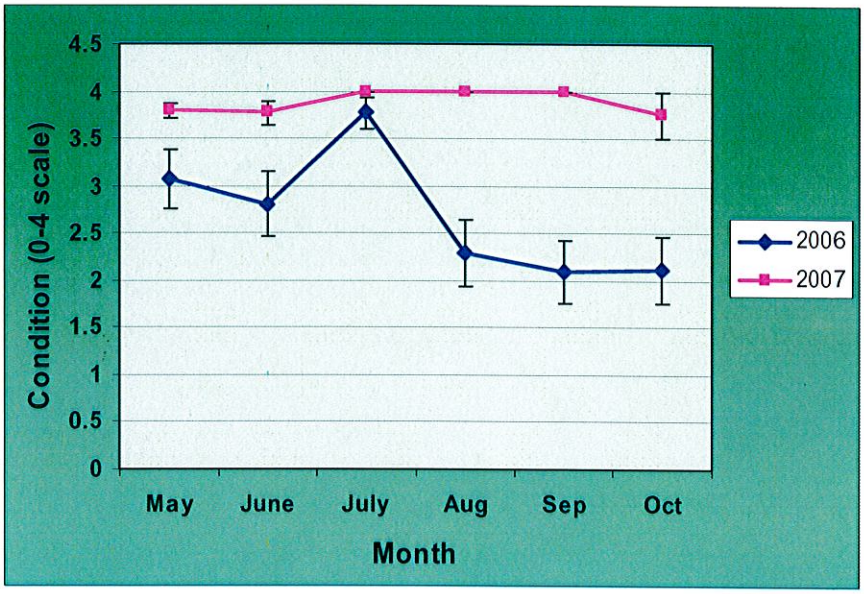


Figure 4.1.6: Average Goodding willow condition for May to October, 2006 and 2007 for the Demonstration Garden site, Yuma East Wetlands. 0=dead, 1=poor, 2=fair, 3=good, and 4=excellent. Error bars signify standard error.

4.1.4 Screwbean Mesquite (*Prosopis pubescens*)

The screwbean mesquites in the Demonstration Garden experienced positive growth during both the 2006 and 2007 growing seasons (Figure 4.1.7). The average total growth for the 2006 season was 42.6 inches (N=25, SE=3.44) and 18.84 inches (N=25, SE=2.62) for the 2007 growing season. Again seasonal growth was much higher during 2006 than in 2007. This may have occurred due to the water stress experienced during 2007 and/or as screwbean mesquites began to mature growth started to slow.

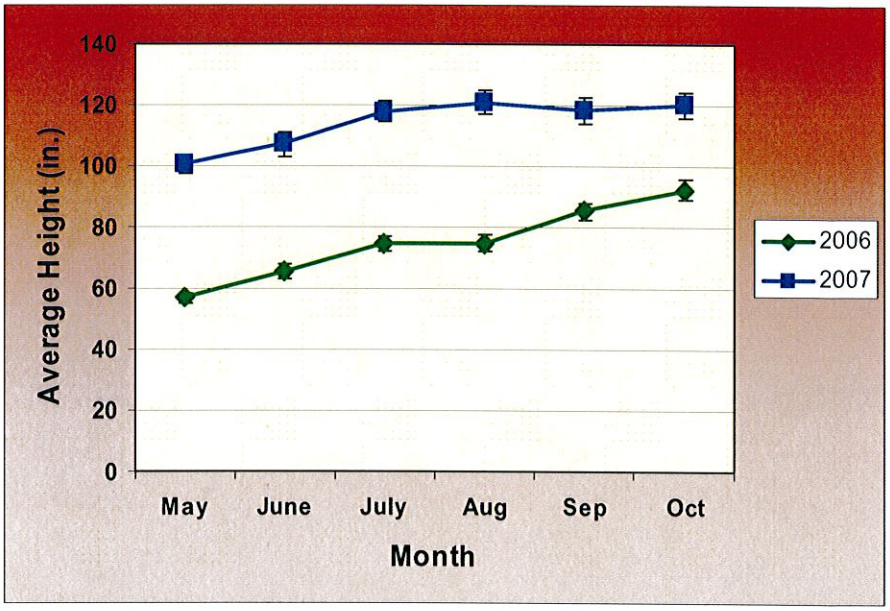


Figure 4.1.7: Average screwbean mesquite height (in.) for May to October, 2006 and 2007 at the Demonstration Garden site, Yuma East Wetlands. Error bars signify standard error.

Screwbean mesquites were in very good to excellent condition throughout the 2006 and 2007 growing seasons (Figure 4.1.8). Also, there continued to be 100% survivorship for this species through the 2007 growing season. The primary factor that affected screwbean mesquite condition in 2006 was insect browsing. Although insect browsing affected 48% of the population in September, by October none of the screwbean mesquite individuals experienced this effect. Signs of insects browsing included: yellowed or deformed leaves and defoliation at the tips of branches. Aphids were the primary insect observed on the trees, and, often times, occurred in mass quantities on the younger portions of the trees. Other factors included root exposure from falling over, volunteer competition, and water stress. Only one tree fell over, which may have been blown over by the wind. Volunteer competition and water stress affected 4% of the population and only during one monitoring session each; therefore these factors did have a significant affect on all the monitored trees.

In 2007, the primary factor that affected screwbean mesquite condition was water stress. Water stress affected 8% of the trees monitored, but overall the irrigation problems had little effect on the screwbean mesquites. This indicates the drought tolerant nature of screwbean mesquites. Volunteer competition from quailbush also affected screwbean mesquite during August, however by September routine maintenance had cut back the competing species allowing the screwbean to be free of competition.

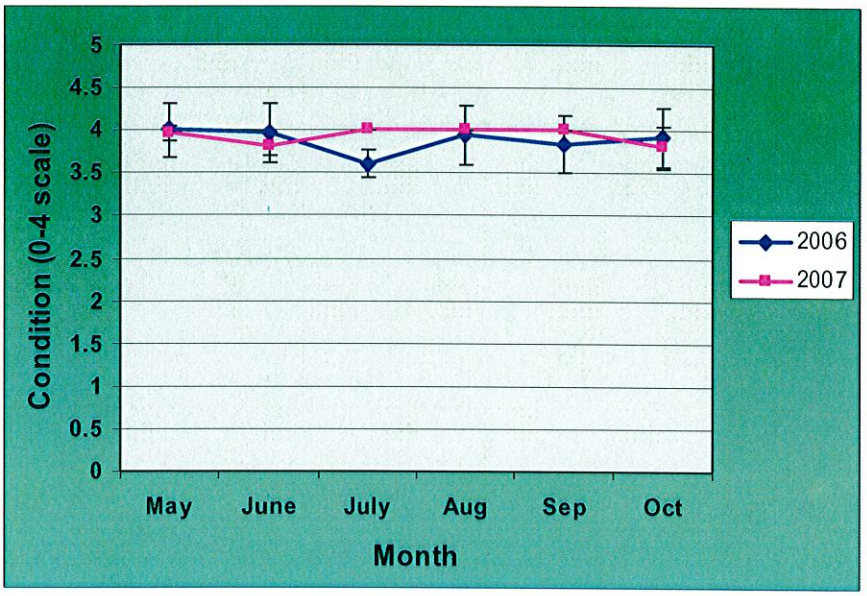


Figure 4.1.8: Average screwbean mesquite condition for May to October, 2006 and 2007 for the Demonstration Garden site, Yuma East Wetlands. 0=dead, 1=poor, 2=fair, 3=good, and 4=excellent. Error bars signify standard error.

4.1.5 Honey Mesquite (*Prosopis glandulosa*)

Honey mesquites had steady positive growth throughout the 2006 and 2007 growing seasons in the Demonstration Garden (Figure 4.1.9). The average total growth for the 2006 season was 9.9 inches (N=24, SE=2.67) and 29.7 inches (N=23, SE=5.12) for the 2007 growing season. Honey mesquite in 2006 experienced a lot of negative growth for the season, which is why growth was higher during the 2007 verses the 2006 growing seasons.

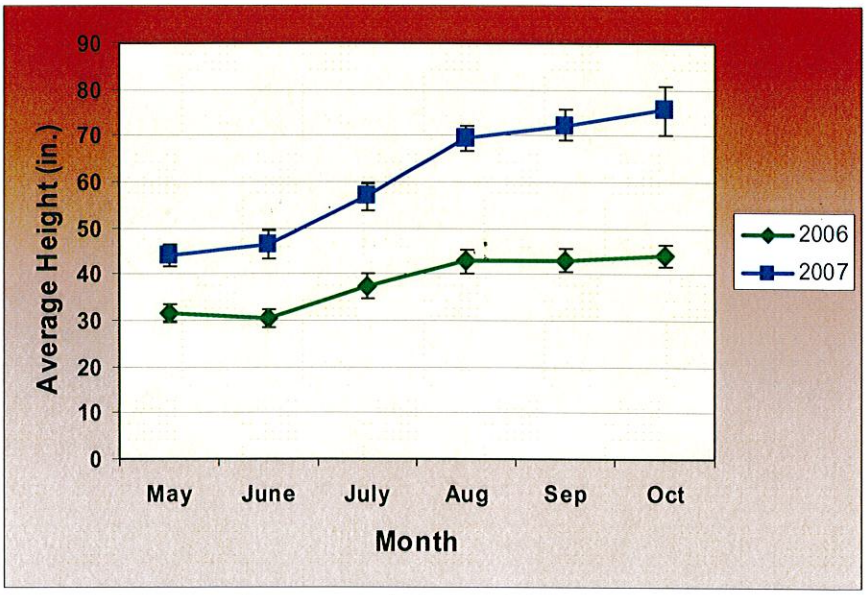


Figure 4.1.9: Average honey mesquite height (in.) for May to October, 2006 and 2007 at the Demonstration Garden site, Yuma East Wetlands. Error bars signify standard error.

The average condition of the honey mesquites for the 2006 growing season declined over time, whereas condition during the 2007 growing season remained good to excellent (Figure 4.1.10). Despite the declined condition by the end of the 2006 growing season, there was a 96% survivorship rate the first growing season, and no new mortalities occurred during the 2007 growing season. Insect browsing and mammal browsing were the primary factors affecting honey mesquite condition in 2006. Insect browsing, primarily by aphids, affected 72% of the monitored individuals and was mainly observed in September and October. The aphids were observed in dense quantities on the younger portions of the trees. Various predatory arthropods, such as spiders, mantids (family: Mantidae) and assassin bugs (family: Reduviidae) were also observed feeding on the aphids, indicating a diverse trophic structure at the site. Signs of insect browsing included yellowed or deformed leaves and defoliation in many cases.

Mammal browsing affected 68% of the monitored honey mesquite in April-July 2006. The protective plastic tree shelters (Tubex) were prematurely removed from many honey mesquite trunks. This allowed rabbits to heavily browse on the trees, and could have increased the afflicted plants' susceptibility to aphids. Other minor factors that affected the monitored honey mesquite condition were water stress and volunteer competition, which affected 12% and 4% respectively. Water stress was most likely responsible for one mortality June. One individual was affected by volunteer competition by four-wing saltbush in May, however as growth progressed through the season the honey mesquite outgrew the four-wing saltbush.

In 2007, the average condition declined slightly during June due in large part to the irrigation problems discussed in earlier sections. However, the trees quickly recovered after the problems were solved. Honey mesquites were also affected by insect browsing, volunteer competition, and mammal browsing. Insect browsing affected 45% of the trees in June then had minimal affect for the rest of the growing season. Volunteer competition had more lingering affects, affecting 39% of the trees in June and 30% in October.

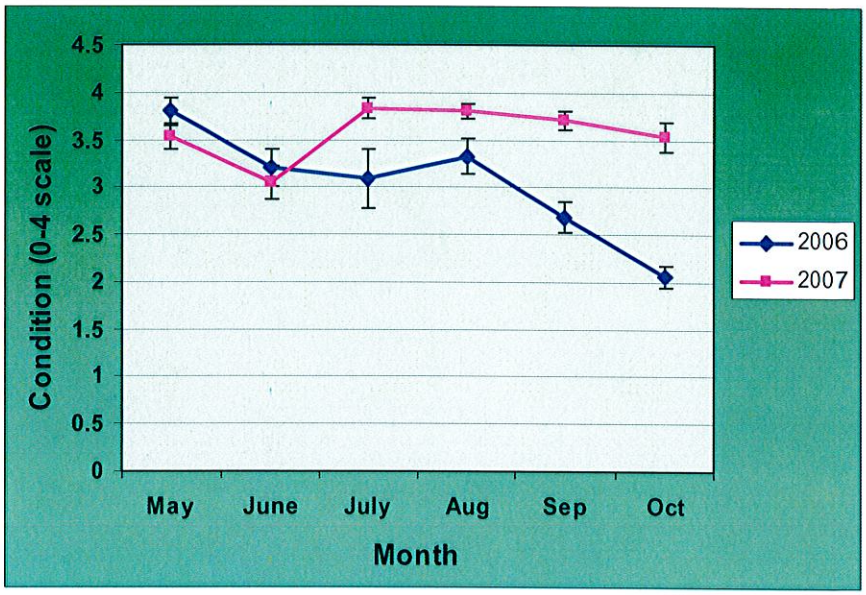


Figure 4.1.10: Average honey mesquite condition for May to October, 2006 and 2007 for the Demonstration Garden site, Yuma East Wetlands. 0=dead, 1=poor, 2=fair, 3=good, and 4=excellent. Error bars signify standard error.

4.2 Survival Rates and Success Criteria

Survival rates are based on a five year goal, because typically, it takes 4 to 5 years for plant roots to grow deep enough to show signs of impact by unsuitable water table depths or soil salinity levels. Figure 4.1.11 displays the actual survival rates calculated for the 2 year growth for the five species discussed above verses the expected minimum 5-year survival rates for those species. The overall survivorship rate for the 2006 growing season was 90% and 93% for the 2007 growing season.

Goodding willows were the only species that fell below the expected minimum 5-year survival rate for the first two years of growth. Eighty-six percent of the mortality observed in Goodding willows occurred within the first year. The low survivorship rates for Goodding willow were primarily due to their placement. Many of the individuals were planted in low lying areas in which water pooled, concentrating salts found in the soil and the irrigation water. Infuric acid was

added to the site's irrigation water to help leach salts from the tree roots during 2006. Upon mortality, Goodding willow was replaced with more tolerant species such as inland saltgrass. Despite the low survival rates of Goodding willow, the other four species are above the desired parameters to determine project success. Survival rates should be calculated every year up to the five year date (after the 2011 growing season) to ensure that the expectations and successes of the project have been met.

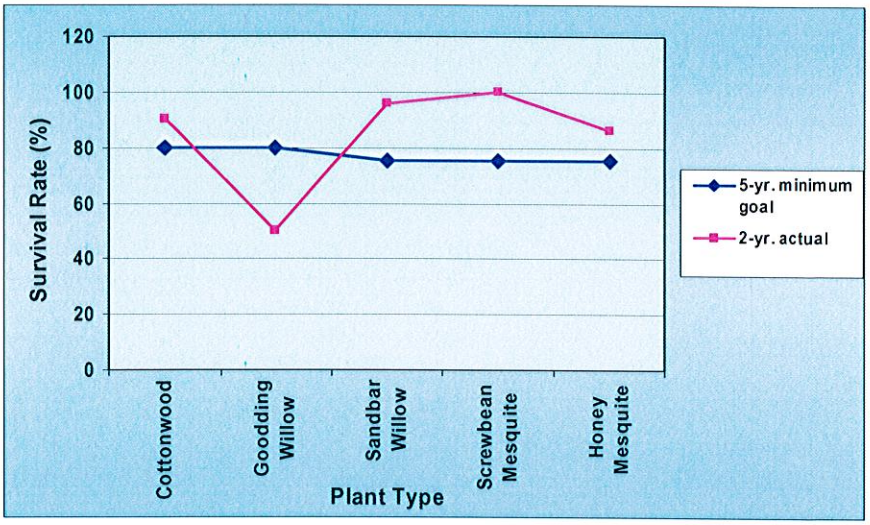


Figure 4.1.11: Actual 2-year percent survival rate verses the 5-year survival rate minimum goal for cottonwood, Goodding willow, sandbar willow, screwbean mesquite and honey mesquite for April 2006- October 2007 for the Demonstration Garden site, Yuma East Wetlands.

5.0 Conclusions

The Yuma East Wetlands Demonstration Garden Project has successfully transformed a twenty five acre area of severely degraded habitat dominated by monotypic stands of salt cedar into a thriving cottonwood willow woodland and mesquite bosque. Native plants are growing rapidly, supporting diverse insect populations, diversifying the canopy height, recruiting and producing seed. All species planted, including Fremont cottonwood, Gooding and sandbar willow, and honey and screwbean mesquite appear well suited for this area and continue to flourish. All of these species have been observed producing propagules. The second year ended with good to excellent average plant condition and an overall survival rate of 85% over the life of the project. Prospects are excellent for the area to continue to thrive.

The Demonstration Garden was resilient to many of environmental stresses that affect other sites, including salt stress. During the 2006 growing season, honey mesquites appeared to be a desired plant for both mammals and insects as demonstrated by the heavy rabbit grazing and presence of aphids. These factors did affect plant growth, however upon treating the problem (protective sheathing to prevent mammal browsing and soapy foliar spray to treat the aphids) the trees recovered quickly. Mammals and insects also showed an affiliation to cottonwood trees, however the protective hogwire fence that encircled the cottonwoods prevented any adverse effects from beaver browsing and the aphid presence did not appear to affect cottonwood condition or health. The presence of insects and mammals in this area suggests that upon reaching a size threshold, these species and the project as a whole will function as a natural ecosystem supporting diverse animal communities.

The main factor impacting plant growth and health during the 2007 growing season was water stress caused by the irrigation difficulties experienced in June. In early June, the filtration system failed allowing large amounts of sediment to enter the irrigation lines; the result was a large scale clogging of the emitters serving the trees in the Demonstration Garden. It took only a few days to get the filters replaced, but it required three weeks of purging irrigation lines and clearing emitters to restore the system. For nearly a month during this period the plants received restricted and intermittent water. The condition and growth data reflected this accordingly.

Plants received supplemental water at the rate of 8 gallons of water per plant per day during the monitoring seasons, with the exception of June 2007 when the irrigation system was malfunctioning. Irrigation not only alleviates the stresses caused by low water tables but also dilutes soil salinity levels near the surface, where the young root systems are concentrated. Most of the planting's root systems were not well developed or deep enough to have reached the water table after the first two years of growth (it typically takes 4 or 5 years).

Supplemental irrigation will continue to be administered for at least another two years, which will allow the vegetation's roots to reach the water table and survive without irrigation. Maintenance and weeding of non-native species has been successful in controlling non-native species infestation. Naturally recruiting native under-story species were recolonizing and functioning like a natural ecosystem. Arrowweed is one of the most aggressive native species that recolonizes sites after initial clearing and sometimes can out-compete the planted native species. In this case arrowweed was controlled in order to give the planted native species every opportunity to thrive. Other recruiting native species were retained on the site. Maintenance and weeding will continue for at least another year to prevent non-native species re-colonization and to give plantings a competitive advantage. Plant monitoring will also continue on an annual basis in order to provide information to the Army Corps of Engineers.

The Demonstration Garden was one of the original revegetation projects initiated in the Yuma East Wetlands, and the first Arizona Water Protection Fund funding applied to restoration in the YEW. Therefore, the restoration process was an educational experience as the site conditions presented their own unique challenges. High soil salinities have been a challenge in all restoration projects conducted at the YEW. By applying sulfuric or infuric acid to the soil has been a successful technique utilized to mitigate the affects of high soil salinities. This process was first applied at the Demonstration Garden and the success of this technique is supported by the positive growth and health of the species planted at the Demo Garden. Another lesson learned from this project was the problems that occurred with the buried irrigation infrastructure and small emitters that clogged with an increase in sediment. New irrigation infrastructure techniques have been applied to subsequent restoration projects. Finally, this project has displayed great success and we expect that in the future this project will maintain the same trajectory.

6.0 Photo Monitoring Results

6.1 YAWPF 25-Acre Revegetation Project Photo Monitoring Point #1

6.2 YAWPF 25-Acre Revegetation Project Photo Monitoring Point #2A

6.3 YAWPF 25-Acre Revegetation Project Photo Monitoring Point #2B

6.4 YAWPF 25-Acre Revegetation Project Photo Monitoring Point #3A

6.5 YAWPF 25-Acre Revegetation Project Photo Monitoring Point #3B

6.6 YAWPF 25-Acre Revegetation Project Photo Essay #1

6.7 YAWPF 25-Acre Revegetation Project Photo Essay #2

Yuma East Wetlands Demonstration Garden Photomonitoring Location # 1. October 2006.

Yuma East Wetlands Demonstration Garden Photomonitoring Location # 1. October 2007.

Yuma East Wetlands Demonstration Garden Photomonitoring Location # 2A. October 2006.

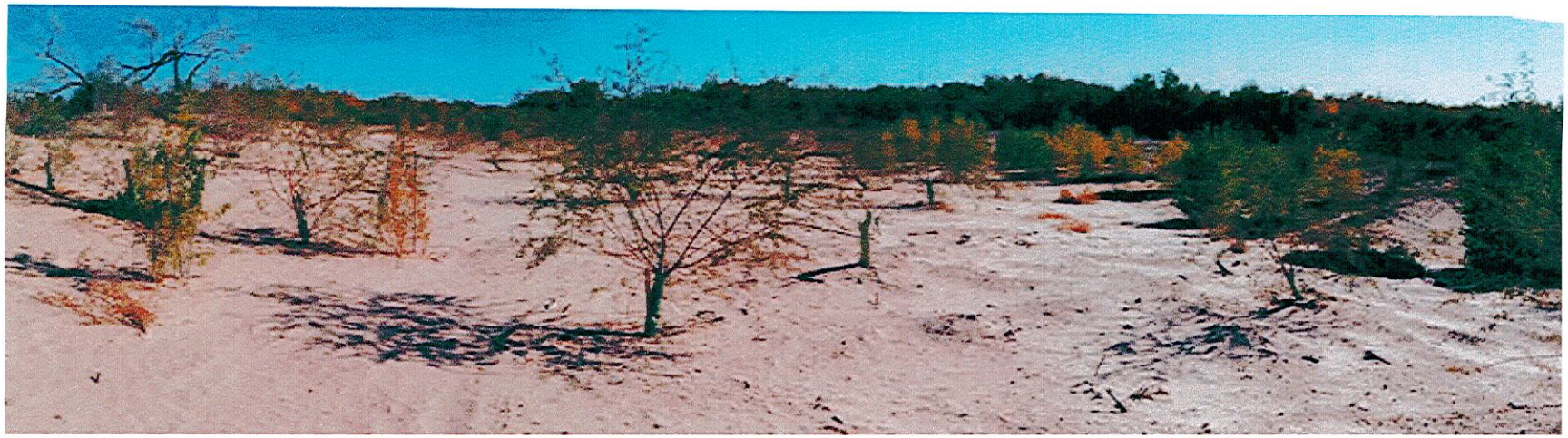
Yuma East Wetlands Demonstration Garden Photomonitoring Location # 2A. October 2007.

Yuma East Wetlands Demonstration Garden Photomonitoring Location # 2B. October 2006.

Yuma East Wetlands Demonstration Garden Photomonitoring Location # 2B. October 2007.

Yuma East Wetlands Demonstration Garden Photomonitoring Location # 3A. October 2006.

Yuma East Wetlands Demonstration Garden Photomonitoring Location # 3A. October 2007.



Yuma East Wetlands Demonstration Garden Photomonitoring Location # 3B. October 2006.

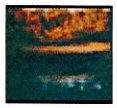
Yuma East Wetlands Demonstration Garden Photomonitoring Location # 3B. October 2007.

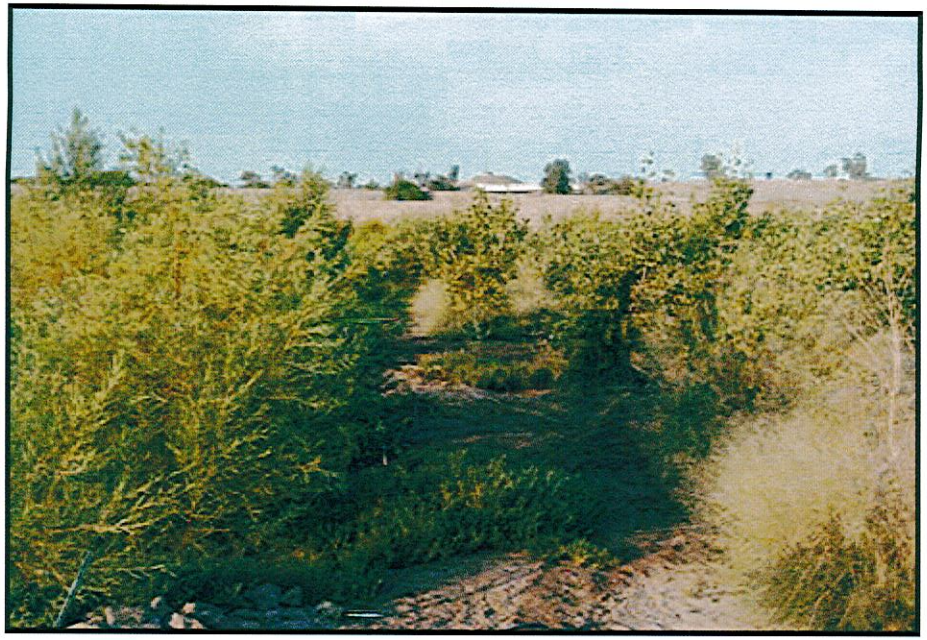
An aerial view of the Demonstration Garden in early March of 2007. The Demonstration Garden contains 25 acres of land along the Lower Colorado in which native cottonwoods, mesquites and willows have been planted to simulate natural forests that once flourished in the area.

International volunteers from the American Conservation Experience transplant salt grass plugs to generate ground cover.

Alkali sacaton was planted around young cottonwoods to promote more biodiversity within this budding forest.

The riparian vegetation planted at the Demo Garden is adjacent to the restored marsh of the QAWPF. This habitat transition from the riparian to marsh provides excellent habitat for an abundance of wildlife.

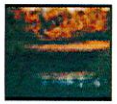




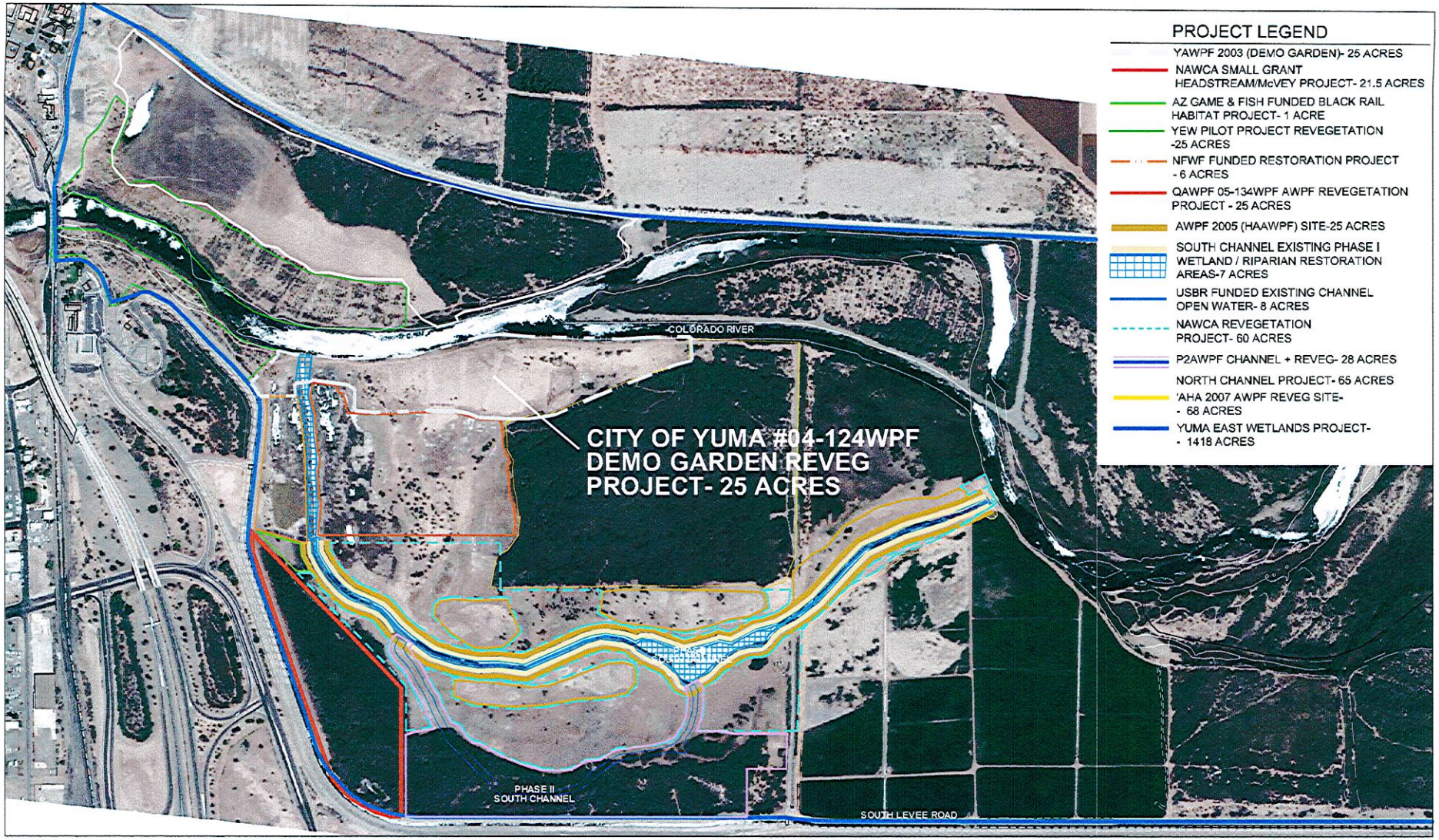
Top Left: Native cottonwoods and willows are flourishing at the Demo Garden. Average cottonwood growth for the 2007 season was over 2 feet.

Bottom Left: Temporary maintenance roads are used to access sites for weed control and irrigation maintenance.

Honey mesquites showed the greatest growth for the 2007 monitoring season, growing almost 2.5 feet.



7.0 Reference Maps



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

REV.	COMMENT	DATE

YUMA EAST WETLANDS
AWPF– "DEMONSTRATION GARDEN"
25 ACRE REVEGETATION PROJECT– 25 ACRES
CITY OF YUMA

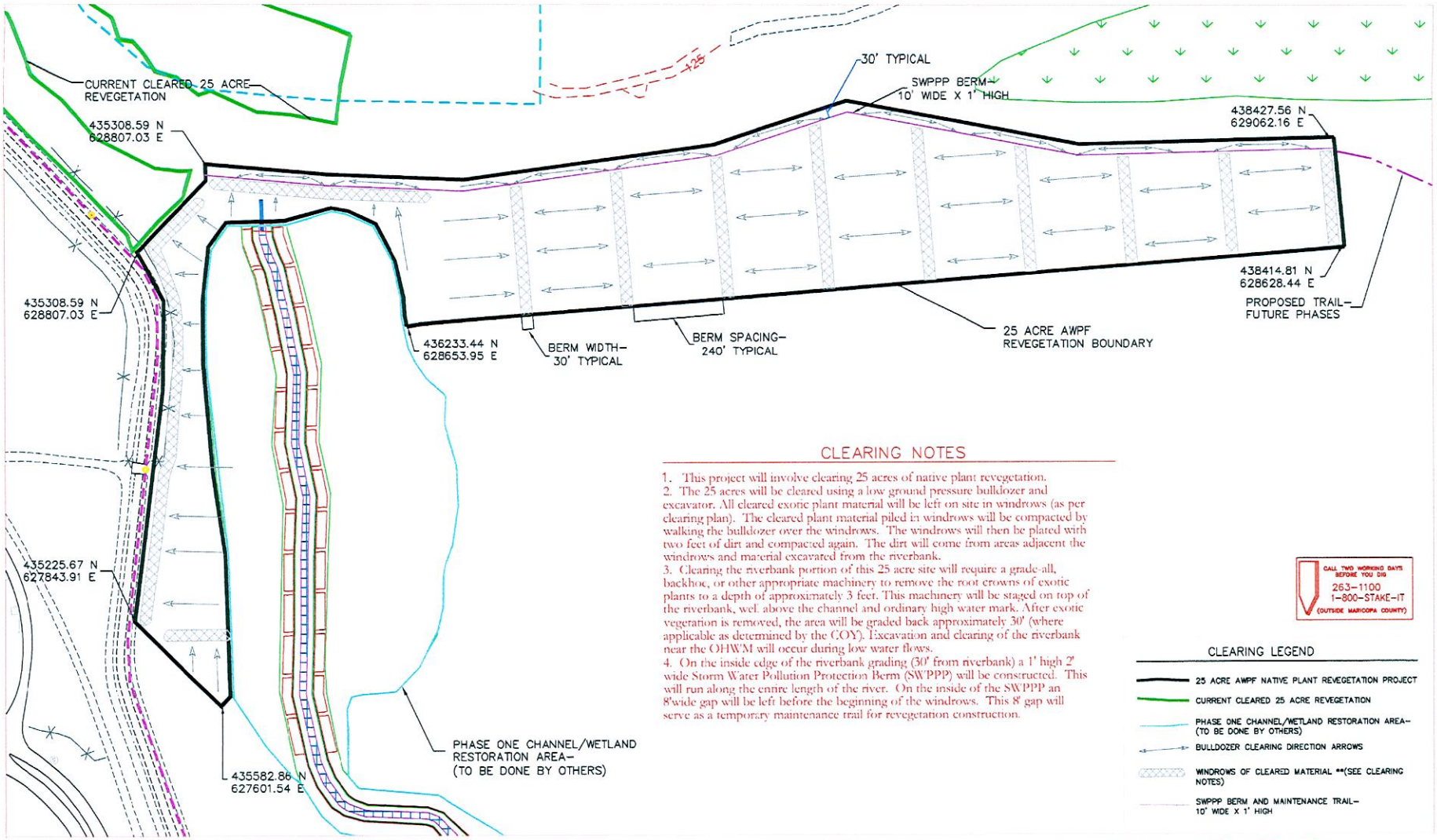
CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
PROJECT SITE MAP

0 163 325 650ft NORTH

DATE: DECEMBER 2007
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.1



CLEARING NOTES

1. This project will involve clearing 25 acres of native plant revegetation.
2. The 25 acres will be cleared using a low ground pressure bulldozer and excavator. All cleared exotic plant material will be left on site in windrows (as per clearing plan). The cleared plant material piled in windrows will be compacted by walking the bulldozer over the windrows. The windrows will then be plated with two feet of dirt and compacted again. The dirt will come from areas adjacent the windrows and material excavated from the riverbank.
3. Clearing the riverbank portion of this 25 acre site will require a grade-all, backhoe, or other appropriate machinery to remove the root crowns of exotic plants to a depth of approximately 3 feet. This machinery will be staged on top of the riverbank, wel. above the channel and ordinary high water mark. After exotic vegeration is removed, the area will be graded back approximately 30' (where applicable as determined by the COY). Excavation and clearing of the riverbank near the OHWM will occur during low water flows.
4. On the inside edge of the riverbank grading (30' from riverbank) a 1' high 2' wide Storm Water Pollution Protection Berm (SWPPP) will be constructed. This will run along the entire length of the river. On the inside of the SWPPP an 8'wide gap will be left before the beginning of the windrows. This 8' gap will serve as a temporary maintenance trail for revegetation construction.

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

CLEARING LEGEND

- 25 ACRE AWPF NATIVE PLANT REVEGETATION PROJECT
- CURRENT CLEARED 25 ACRE REVEGETATION
- PHASE ONE CHANNEL/WETLAND RESTORATION AREA- (TO BE DONE BY OTHERS)
- BULLDOZER CLEARING DIRECTION ARROWS
- WINDROWS OF CLEARED MATERIAL **(SEE CLEARING NOTES)
- SWPPP BERM AND MAINTENANCE TRAIL- 10' WIDE X 1' HIGH

C.I.P. NO. XXXXX AWPF 25 AC REVEG PROJECT BID NO. XXXXXXXXXX

Fred Phillips Consulting, LLC
9730 NORTH ROSEWOOD DRIVE
FLAGSTAFF, AZ
86004
TEL 928 773 1530
FAX 928 773 1530
Ecosystem Restoration Land Planning

REV.	COMMENT	DATE

YUMA EAST WETLANDS

AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
CLEARING PLAN

CITY OF YUMA YUMA, ARIZONA

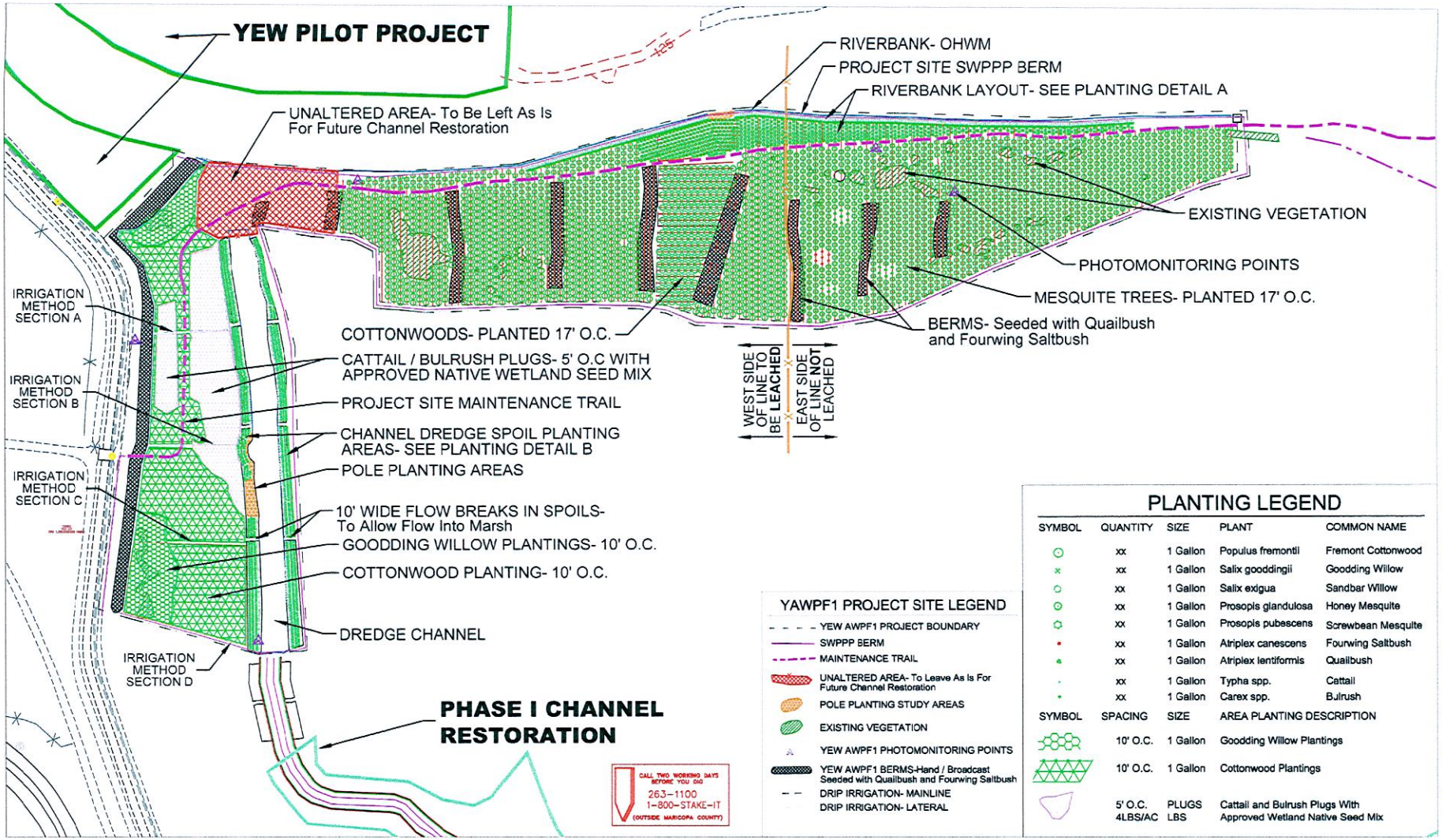
SHEET TITLE :
CLEARING PLAN

0 60 120 240feet NORTH

DATE: AUGUST 18, 2004
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:

FIGURE 7.2



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9730 NORTH ROSEWOOD DRIVE
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Ecosystem Restoration Land Planning

REV.	COMMENT	DATE

YUMA EAST WETLANDS
AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
PLANTING / IRRG PLAN with SWPPP MEASURES
CITY OF YUMA YUMA, ARIZONA

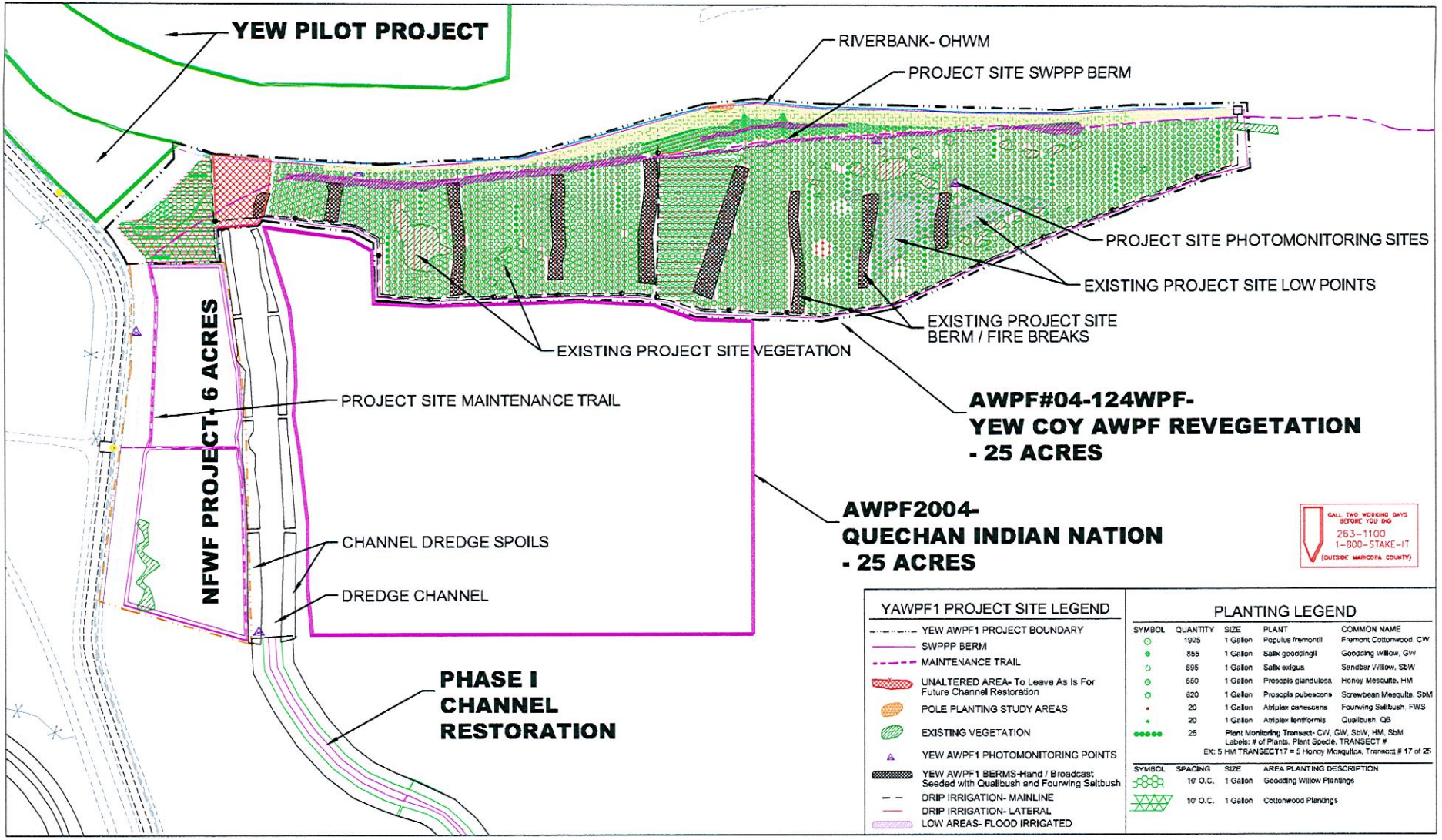
SHEET TITLE :
PLANTING / IRRG PLAN

0 60 120 240feet NORTH

DATE: JANUARY 28, 2005
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.3

C.I.P. NO. XXXXX AWPF 25 AC REVEG PROJECT BID NO XXXXXXXXXX



Fred Phillips Consulting, LLC
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86004
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Ecosystem Restoration Land Planning

REV.	COMMENT	DATE

YUMA EAST WETLANDS
AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
EXISTING SITE PLAN with SWPPP MEASURES
CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
PLANTING + IRRIGATION MAP

0 60 120 240feet NORTH

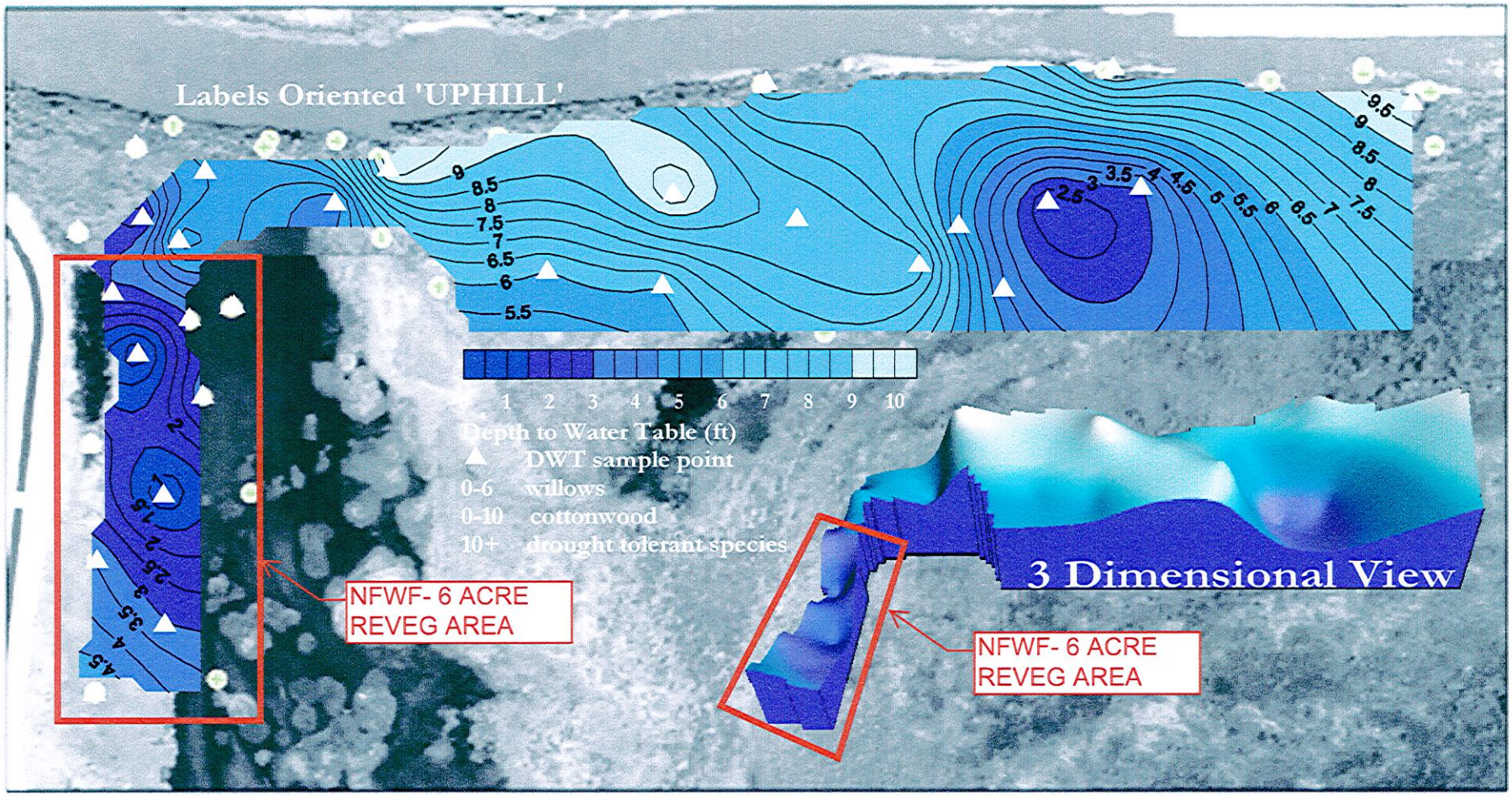
DATE: DECEMBER 2007
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.4

YUMA EAST WETLANDS

Arizona Water Protection Fund (YAWPF1)

25 acre revegetation project



Depth to Water Table (ft)

Prepared for City of Yuma

Prepared by
Fred Phillips Consulting, LLC
9730 Rosewood Drive
Flagstaff, AZ 86004

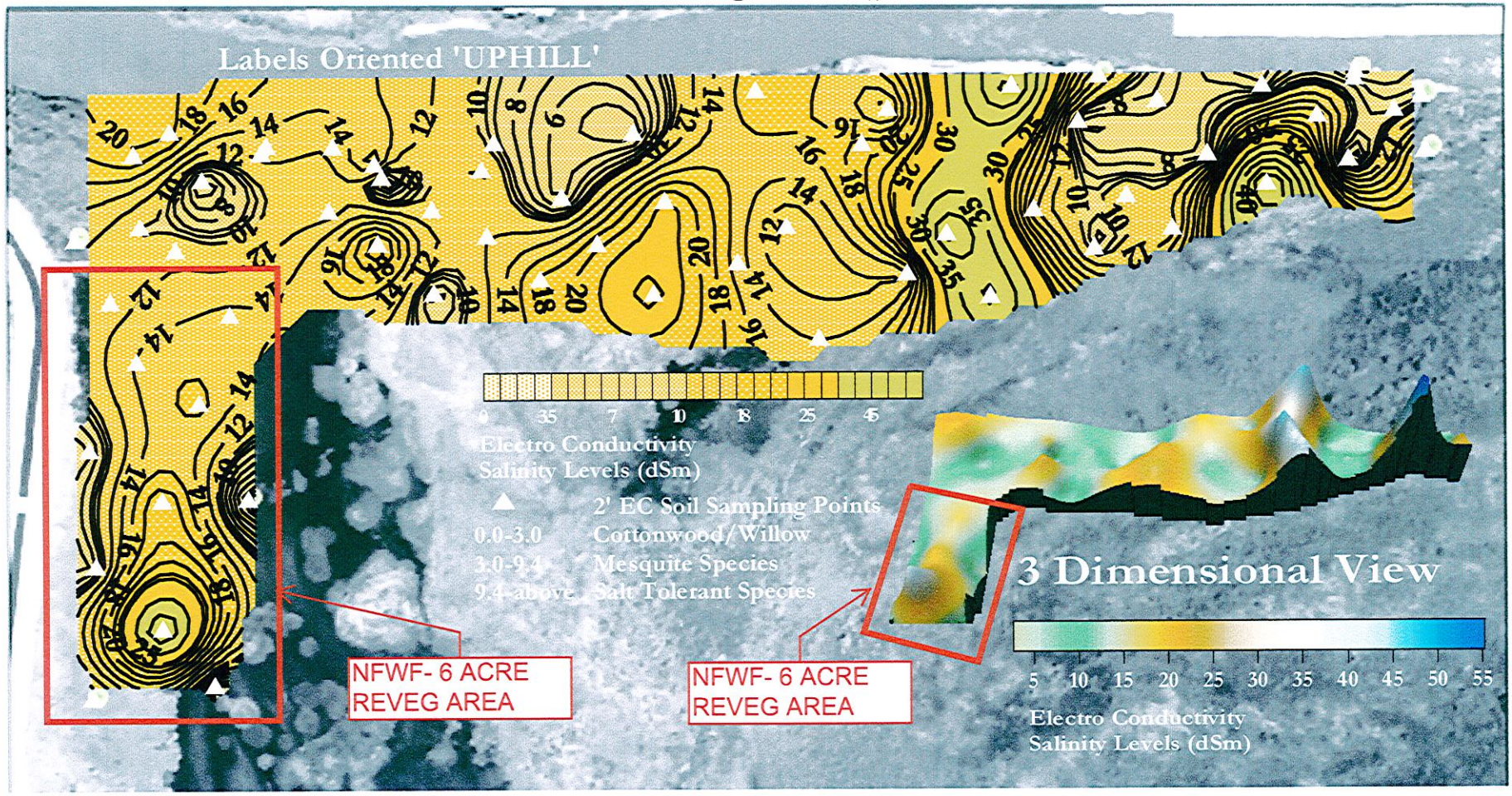
December 2004

Figure 7.5

YUMA EAST WETLANDS

Arizona Water Protection Fund (YAWPF1)

25 acre revegetation project



2 foot EC salinity levels (dSm)

Prepared for
City of Yuma

Prepared by
Fred Phillips Consulting, LLC
9730 Rosewood Drive
Flagstaff, AZ 86004

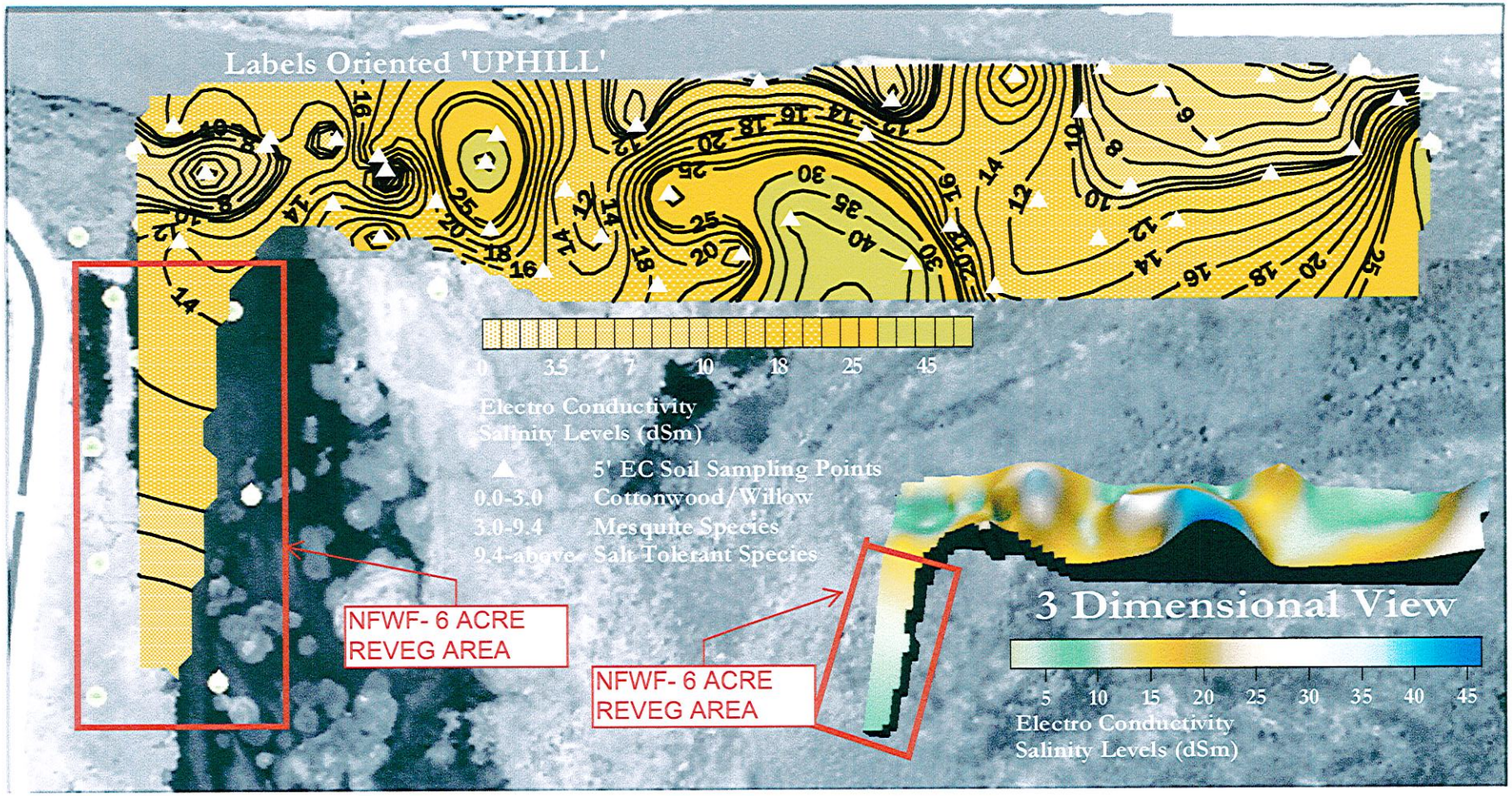
December 2004

Figure 7.6

YUMA EAST WETLANDS

Arizona Water Protection Fund (YAWPF1)

25 acre revegetation project



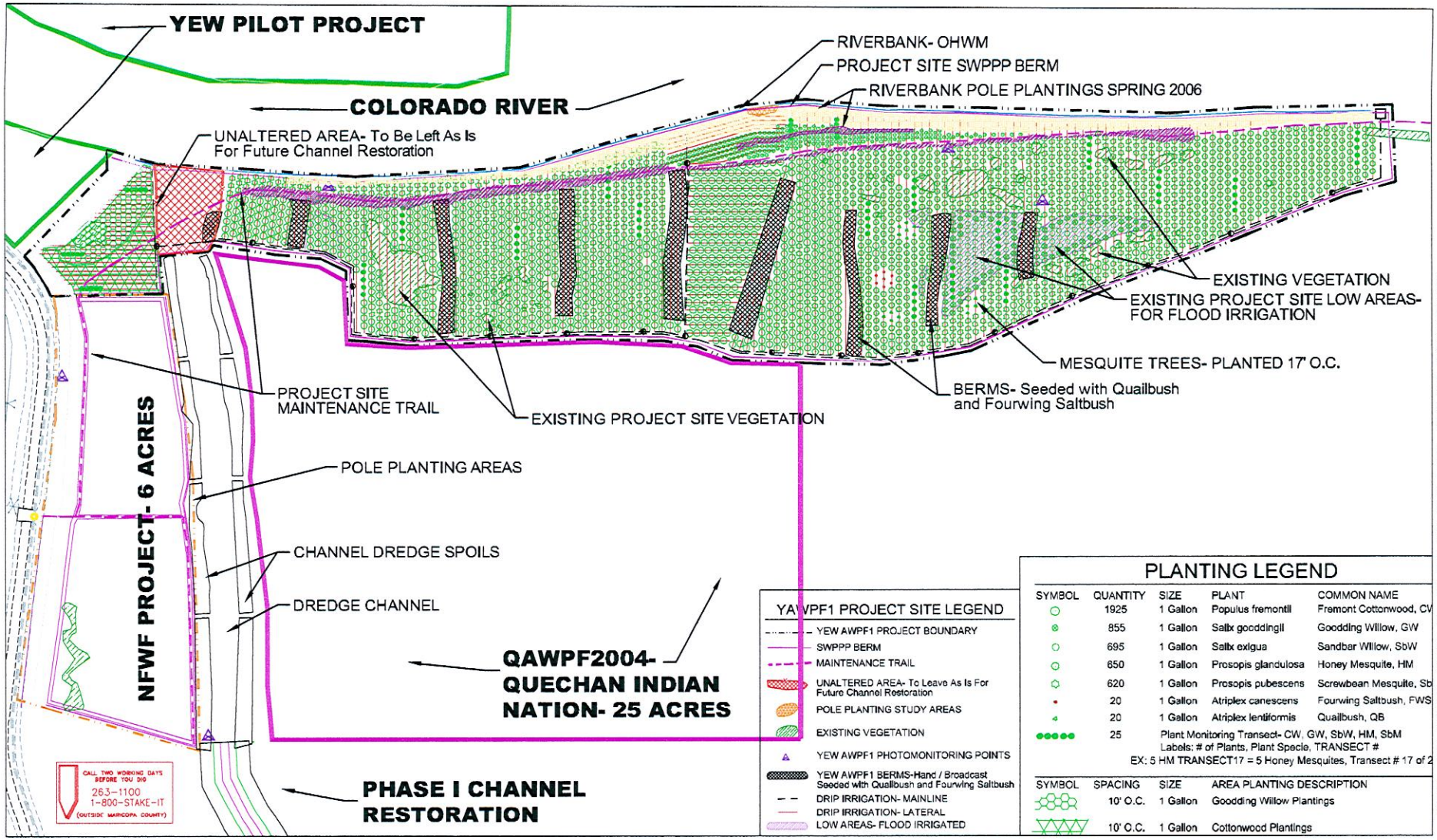
5 foot EC salinity levels (dSm)

Prepared for
City of Yuma

Prepared by
Fred Phillips Consulting, LLC
9730 Rosewood Drive
Flagstaff, AZ 86004

December 2004

Figure 7.7



C.I.P. NO. XXXXX AWPF 25 AC REVEG PROJECT BID NO. XXXXXXXXXX

Fred Phillips Consulting, LLC
9730 NORTH ROSEWOOD DRIVE
FLAGSTAFF, AZ
86004
TEL 928 773 1530
FAX 928 526 1543
Ecosystem Restoration Land Planning

REV.	COMMENT	DATE

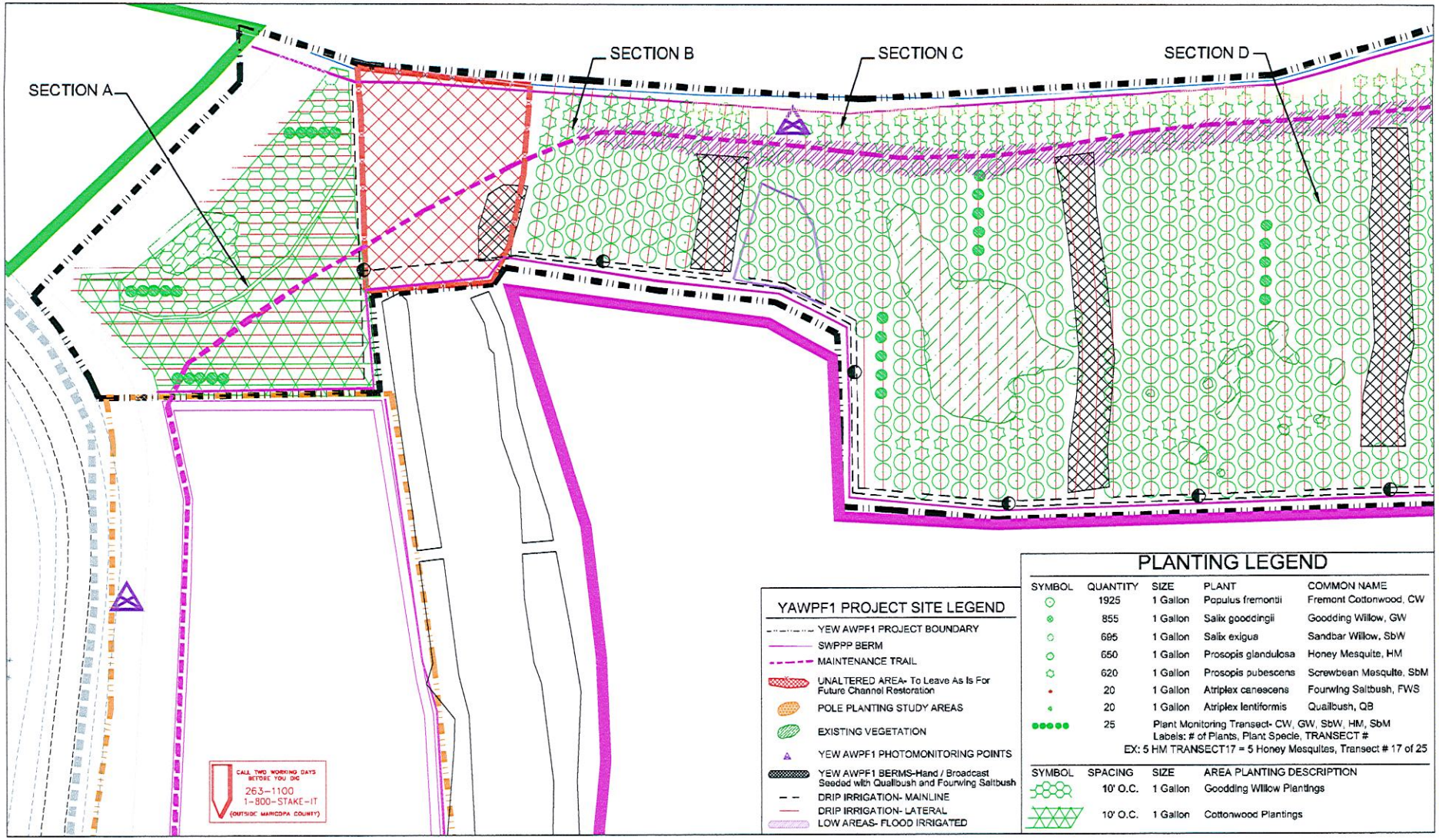
YUMA EAST WETLANDS
AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
PLANT + IRRG PLAN WITH SWPPP MEASURES
CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
PLANTING + IRRG PLAN

0 50 100 200feet NORTH

DATE: MARCH 4, 2005
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.8



YAWPF1 PROJECT SITE LEGEND

- YEW AWPF1 PROJECT BOUNDARY
- SWPPP BERM
- MAINTENANCE TRAIL
- UNALTERED AREA- To Leave As Is For Future Channel Restoration
- POLE PLANTING STUDY AREAS
- EXISTING VEGETATION
- YEW AWPF1 PHOTOMONITORING POINTS
- YEW AWPF1 BERMS-Hand / Broadcast Seedad with Quailbush and Fourwing Saltbush
- DRIP IRRIGATION- MAINLINE
- DRIP IRRIGATION- LATERAL
- LOW AREAS- FLOOD IRRIGATED

PLANTING LEGEND

SYMBOL	QUANTITY	SIZE	PLANT	COMMON NAME
	1925	1 Gallon	Populus fremontii	Fremont Cottonwood, CW
	855	1 Gallon	Salix goodingii	Goodding Willow, GW
	695	1 Gallon	Salix exigua	Sandbar Willow, SbW
	650	1 Gallon	Prosopis glandulosa	Honey Mesquite, HM
	620	1 Gallon	Prosopis pubescens	Screwbean Mesquite, SbM
	20	1 Gallon	Atriplex canescens	Fourwing Saltbush, FWS
	20	1 Gallon	Atriplex lentiformis	Quailbush, QB
	25		Plant Monitoring Transect- CW, GW, SbW, HM, SbM Labels: # of Plants, Plant Specie, TRANSECT # EX: 5 HM TRANSECT17 = 5 Honey Mesquites, Transect # 17 of 25	

SYMBOL	SPACING	SIZE	AREA PLANTING DESCRIPTION
	10' O.C.	1 Gallon	Goodding Willow Plantings
	10' O.C.	1 Gallon	Cottonwood Plantings

C.I.P. NO. XXXX AWPF 25 AC REVEG PROJECT BID NO. XXXXXXXXX

Fred Phillips Consulting, LLC
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86004
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FAX 928 526 1543
Ecosystem Restoration Land Planning

REV.	COMMENT	DATE

YUMA EAST WETLANDS

AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
PLANTING PLAN WITH SWPPP MEASURES

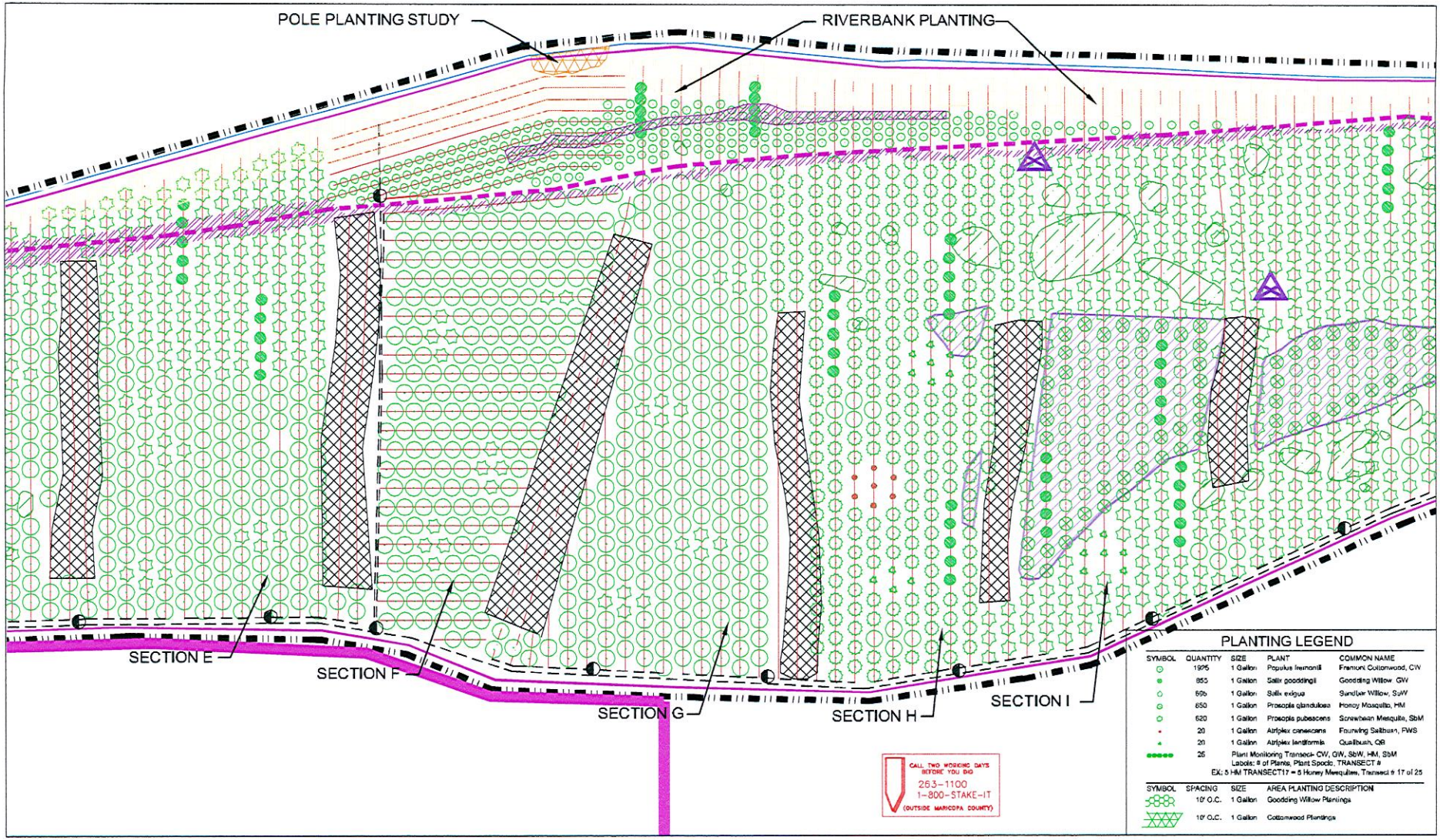
CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
PLANTING PLAN

0 20 40 80ft NORTH

DATE: MARCH 4, 2005
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.9



PLANTING LEGEND

SYMBOL	QUANTITY	SIZE	PLANT	COMMON NAME
	1995	1 Gallon	Populus fremontii	Fremont Cottonwood, CW
	855	1 Gallon	Salix goodingii	Goodding Willow, GW
	695	1 Gallon	Salix exigua	Sandbar Willow, SaW
	850	1 Gallon	Prosopis glandulosa	Honey Mesquite, HM
	620	1 Gallon	Prosopis pubescens	Screwbean Mesquite, SbM
	20	1 Gallon	Atriplex canescens	Fourwing Saltbush, FWS
	20	1 Gallon	Atriplex lentiformis	Quailbush, QB
	25		Plant Monitoring Transect- CW, GW, SbW, HM, SbM Labels: # of Plants, Plant Specie, TRANSECT # Ex: 5 HM TRANSECT17 = 5 Honey Mesquites, Transect # 17 of 25	

SYMBOL	SPACING	SIZE	AREA PLANTING DESCRIPTION
	15' O.C.	1 Gallon	Goodding Willow Plantings
	15' O.C.	1 Gallon	Cottonwood Plantings

C.I.P. NO. XXXXX AWPF 25 AC REVEG PROJECT BID NO. XXXXXXXXXX

Fred Phillips Consulting, LLC
9730 NORTH ROSEWOOD DRIVE
FLAGSTAFF, AZ
86004
TEL 928 773 1530
FAX 928 526 1543
Ecosystem Restoration Land Planning

REV.	COMMENT	DATE

YUMA EAST WETLANDS

AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
PLANTING PLAN WITH SWPPP MEASURES

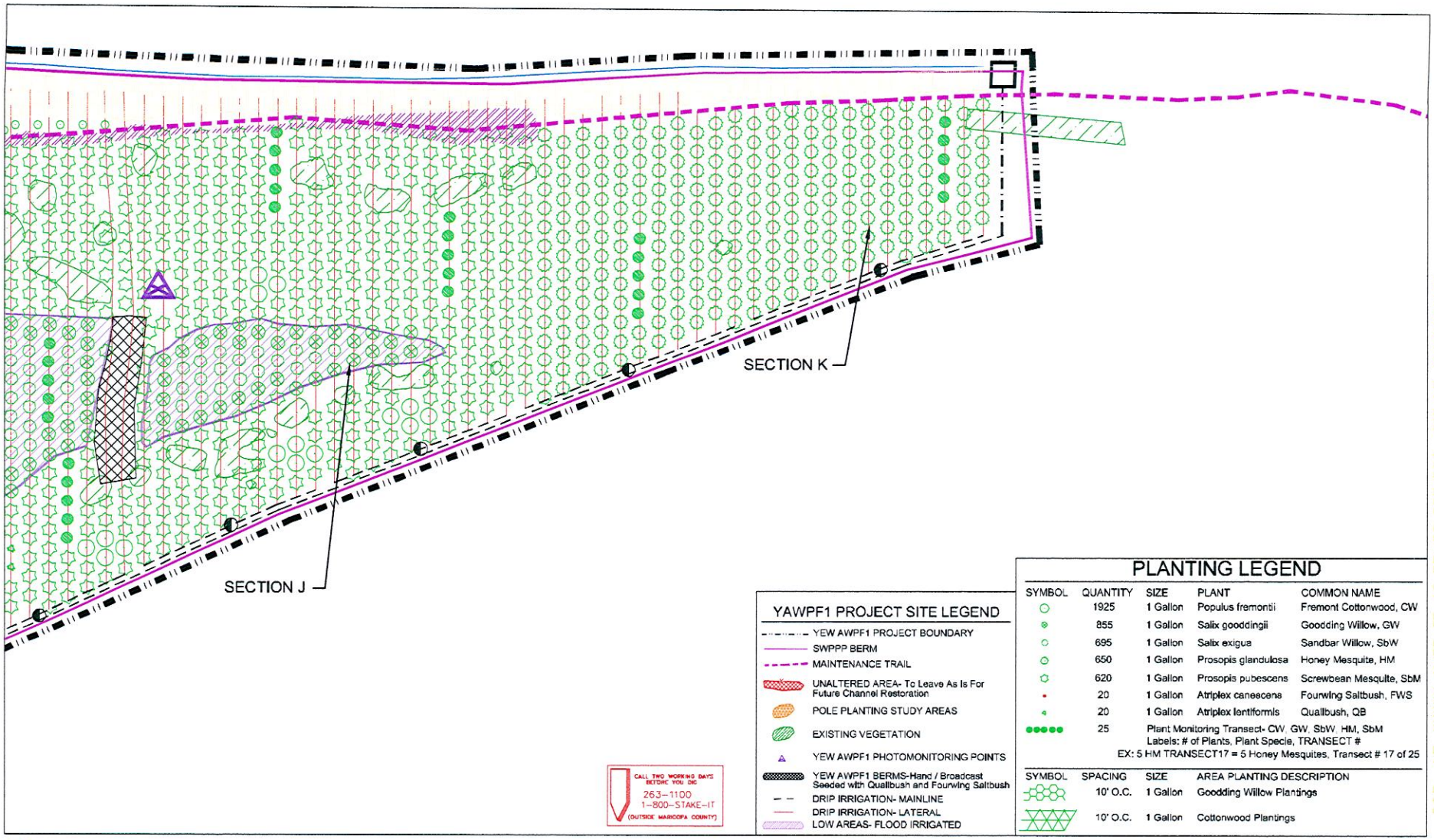
CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
PLANTING + IRRG PLAN

0 20 40 80ft NORTH

DATE: MARCH 4, 2005
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.10



YAWPF1 PROJECT SITE LEGEND

- YEW AWPF1 PROJECT BOUNDARY
- SWPPP BERM
- MAINTENANCE TRAIL
- UNALTERED AREA- To Leave As Is For Future Channel Restoration
- POLE PLANTING STUDY AREAS
- EXISTING VEGETATION
- YEW AWPF1 PHOTOMONITORING POINTS
- YEW AWPF1 BERMS-Hand / Broadcast Seeded with Qualibush and Fourwing Saltbush
- DRIP IRRIGATION- MAINLINE
- DRIP IRRIGATION- LATERAL
- LOW AREAS- FLOOD IRRIGATED

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PLANTING LEGEND

SYMBOL	QUANTITY	SIZE	PLANT	COMMON NAME
	1925	1 Gallon	Populus fremontii	Fremont Cottonwood, CW
	855	1 Gallon	Salix gooddingii	Goodding Willow, GW
	695	1 Gallon	Salix exigua	Sandbar Willow, SbW
	650	1 Gallon	Prosopis glandulosa	Honey Mesquite, HM
	620	1 Gallon	Prosopis pubescens	Screwbean Mesquite, SbM
	20	1 Gallon	Atriplex canescens	Fourwing Saltbush, FWS
	20	1 Gallon	Atriplex lentiformis	Quailbush, QB
	25		Plant Monitoring Transect- CW, GW, SbW, HM, SbM Labels: # of Plants, Plant Specie, TRANSECT # EX: 5 HM TRANSECT17 = 5 Honey Mesquites, Transect # 17 of 25	

SYMBOL	SPACING	SIZE	AREA PLANTING DESCRIPTION
	10' O.C.	1 Gallon	Goodding Willow Plantings
	10' O.C.	1 Gallon	Cottonwood Plantings

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YUMA EAST WETLANDS

AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
PLANTING PLAN WITH SWPPP MEASURES

CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
PLANTING + IRRG PLAN

0 20 40 80ft NORTH

DATE: MARCH 4, 2005
JOB NO.:
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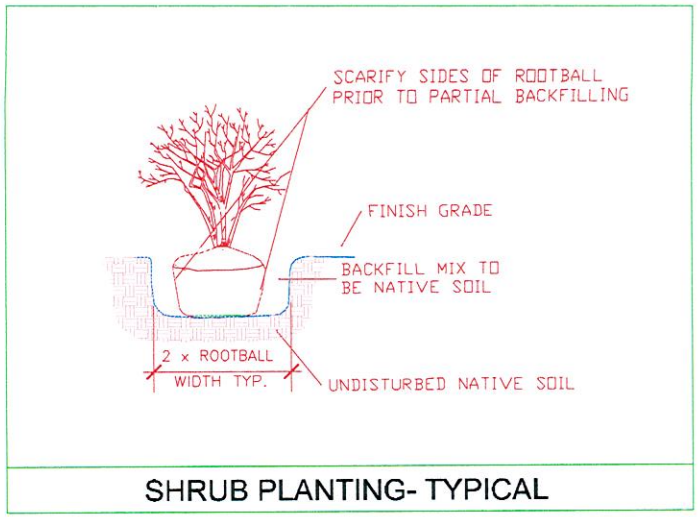
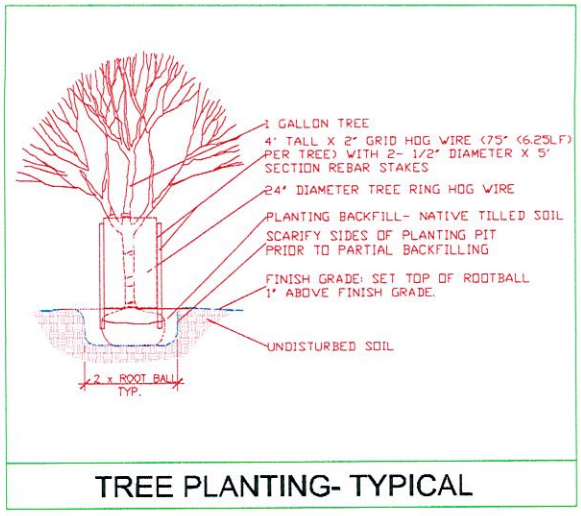
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.11

CIP NO XXXXX AWPF 25 AC REVEG PROJECT BID NO XXXXXXXXXX



SHRUB PLANTING- TYPICAL



TREE PLANTING- TYPICAL

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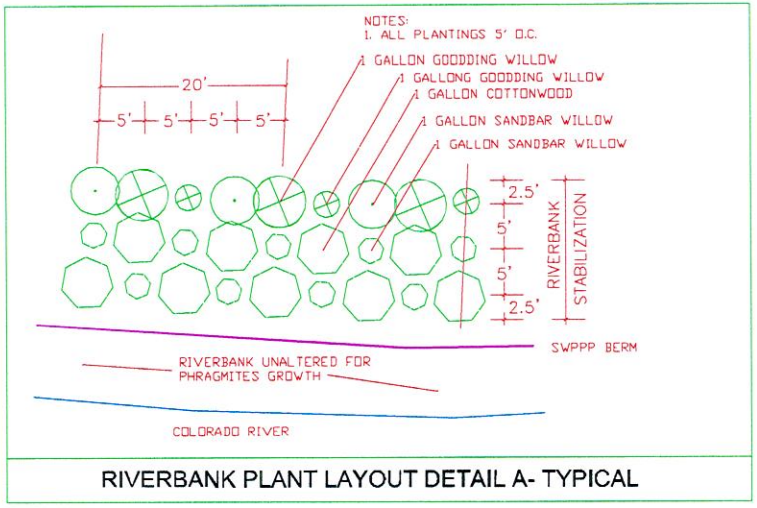
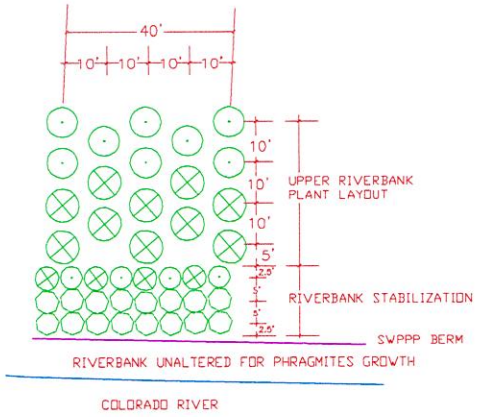
(OUTSIDE MARICOPA COUNTY)



RIVERBANK PLANT LAYOUT DETAIL A- TYPICAL



UPPER RIVERBANK PLANT LAYOUT DETAIL B- TYPICAL, NTS

C.I.P. NO XXXXX AWPF 25 AC REVEG PROJECT BID NO XXXXXXXXX

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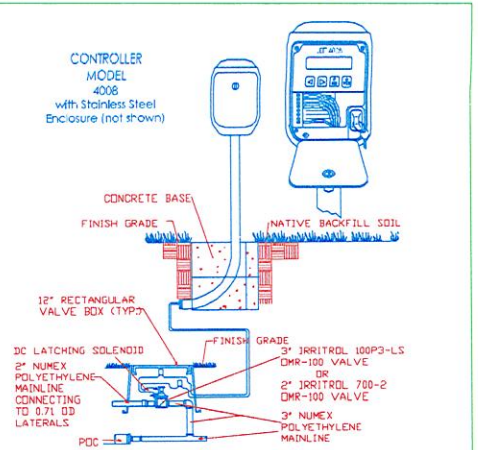
YUMA EAST WETLANDS
AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
PLANTING PLAN WITH SWPPP MEASURES
CITY OF YUMA YUMA, ARIZONA

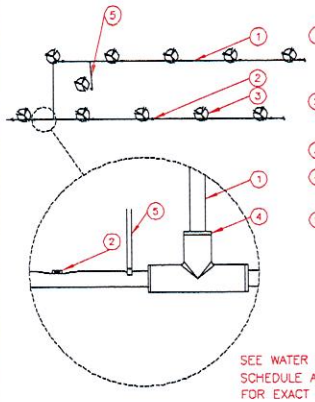
SHEET TITLE :
PLANTING
DETAILS

DATE: MARCH 4, 2005
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.12



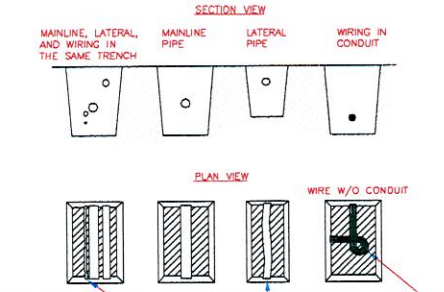
IRRIGATION CONTROLLER AND VALVE DETAIL– TBD



1. (0.710OD) COMPRESSION POLYETHYLENE TUBING WITH IN-LINE EMITTERS– PEPCO
2. EMITTER (PRE-INSTALLED ON TUBING)– RAINBIRD PC-07
3. PLANT MATERIAL
4. 1/2-INCH COMPRESSION TEE: PEPCO
5. (0.25 OD) COMPRESSION POLYETHYLENE TUBING– PEPCO

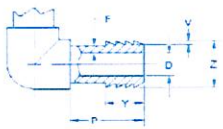
SEE WATER DISTRIBUTION SUPPLY SCHEDULE ATTACHED TO PLAN DRAWINGS FOR EXACT SPECIFICATIONS

POLY TUBE + EMITTER DETAIL– TYP



PIPE & WIRE TRENCHING DETAIL– TYP

SPECIFICATIONS FOR PVC INSERT FITTINGS

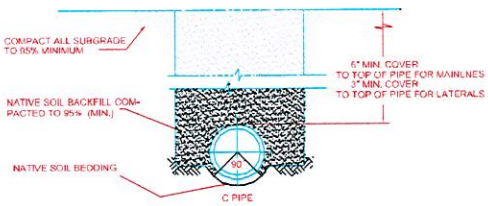


RECOMMENDED INSTALLATION

THE RIGHT WAY TO CLAMP POLYETHYLENE PIPE IS ON THE BARBS AS SHOWN

NOMINAL PIPE SIZE	INSERT LENGTH P min.		BARBS LENGTH Y min.		BARBS OUTSIDE DIAMETER Z max.		BARBS OUTSIDE DIAMETER Z min.		NO. min.	DEPTH V min		WALL THICKNESS F min		INSIDE DIAMETER D min	
	INCH	MM	INCH	MM	INCH	MM	INCH	MM		INCH	MM	INCH	MM	INCH	MM
1/2	1 1/4	32	3/4	20	0.865	21.97	0.835	21.21	4	0.015	0.38	0.085	2.16	0.562	14.27
3/4	1 1/4	32	3/4	20	0.865	21.97	0.835	21.21	4	0.015	0.38	0.085	2.16	0.562	14.27
1	1 1/4	32	3/4	20	1.095	27.81	1.065	27.05	4	0.020	0.51	0.100	2.54	0.750	19.00
1 1/4	1 1/4	32	3/4	20	1.425	36.20	1.395	35.43	4	0.025	0.64	0.110	2.80	0.995	25.27
1 1/2	1 1/2	38	3/4	20	1.665	42.29	1.630	41.40	4	0.030	0.76	0.110	2.80	1.125	28.58
2	1 1/2	38	3/4	20	2.125	53.98	2.085	52.96	4	0.030	0.76	0.110	2.80	1.656	42.06
2 1/2	2	50	1	25	2.520	64.00	2.487	63.17	4	0.030	0.76	0.120	3.05	2.062	52.00
3	2 1/8	54	1 1/8	29	3.125	79.38	3.086	78.38	4	0.030	0.76	0.125	3.18	2.600	66.00
4	3	76	1 1/4	32	4.090	103.89	4.044	102.72	4	0.030	0.76	0.130	3.30	3.525	89.54

TYPICAL INSERT FITTINGS FOR POLYETHYLENE PIPE



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NOTES

1. NATIVE SOIL MAY BE USED FOR BACKFILL WHEN APPROVED BY THE CITY ENGINEER, BUT IN NO CASE SHALL NATIVE BACKFILL BE USED ON U.S.B.R. PROPERTY.
2. MINIMUM COVER DOES NOT PROVID ADEQUATE COVER FOR SUPPORT OF VEHICULAR LOADS.
3. BEDDING SHOWN IS A MINIMUM STANDARD FOR SHALLOW TRENCHES AND ACCEPTABLE NATIVE BASE. EXACT TYPE OF BEDDING SHALL BE DETERMINED BY THE CITY ENGINEER.
4. DITCH SIDES SHALL BE SLOPED OR SHORED AS REQUIRED PER O.S.H.A. STANDARDS.

Issued: October 2001

CITY OF YUMA
CONSTRUCTION STANDARD DETAIL DRAWINGS

TYPICAL WATER MAIN TRENCH BACKFILL

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YUMA EAST WETLANDS
AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
IRRIGATION PLAN
CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
IRRIGATION DETAILS

DATE: MARCH 4, 2005
JOB NO.:
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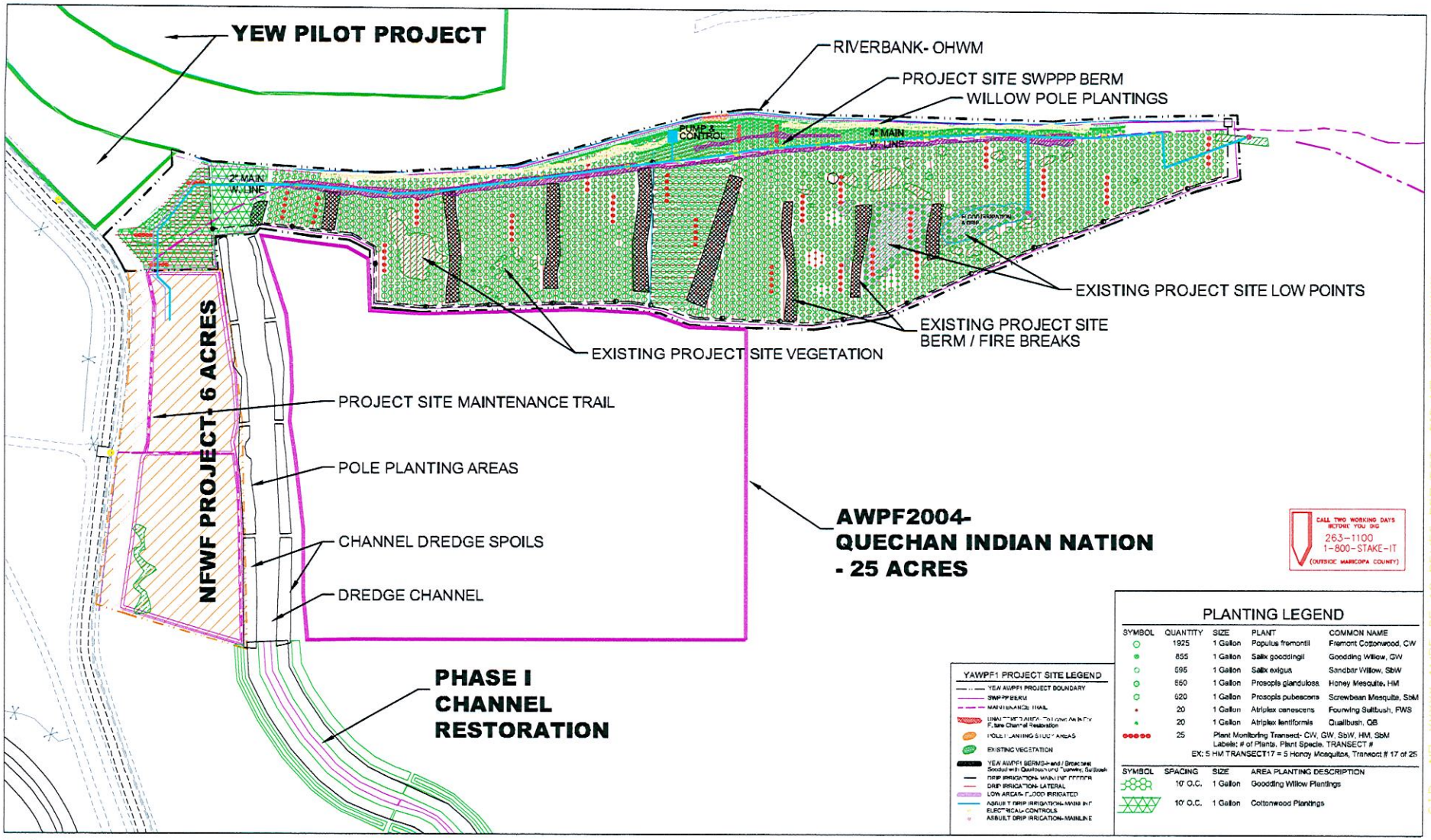
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.13

CAP NO XXXXX AWFF 25 AC REVEG PROJECT BID NO XXXXXXXXXX



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REV.	COMMENT	DATE

YUMA EAST WETLANDS
AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
EXISTING SITE PLAN with SWPPP MEASURES
CITY OF YUMA YUMA, ARIZONA

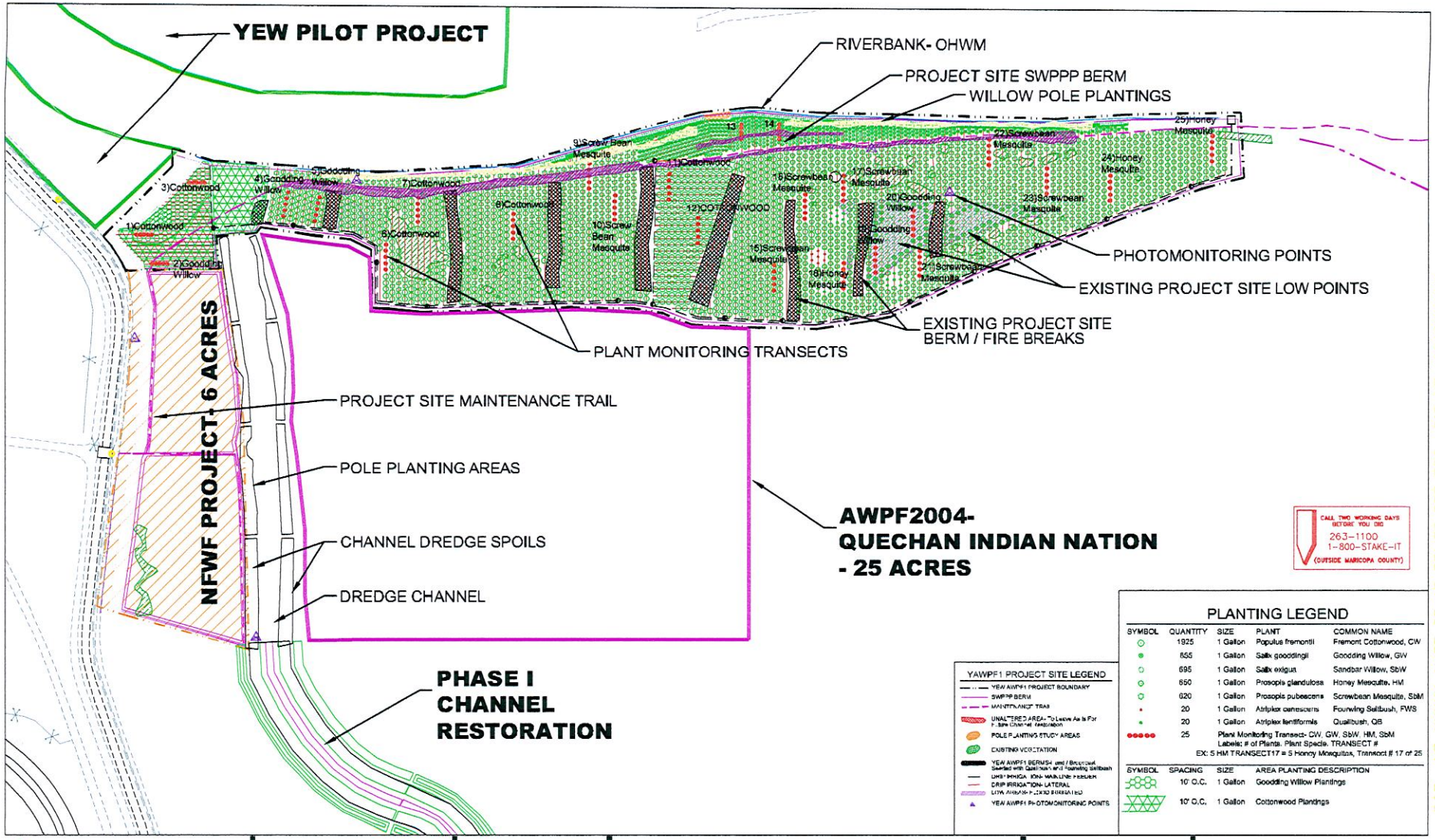
SHEET TITLE :
ASBUILT MAP
SITE PLAN

0 60 120 240feet NORTH

DATE: DECEMBER 2005
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.14

C.I.P. NO XXXXX AWPF 25 AC REVEG PROJECT BID NO XXXXXXXXXX



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REV.	COMMENT	DATE

YUMA EAST WETLANDS
AZ WATER PROTECTION FUND
25 ACRE REVEGETATION PROJECT
EXISTING SITE PLAN with SWPPP MEASURES
CITY OF YUMA YUMA, ARIZONA

SHEET TITLE :
PHOTOMONITORING AND PLANT TRANSECTS MAP

0 60 120 240feet NORTH

DATE: DECEMBER 2005
JOB NO.:
DRAWN BY: AH
DESIGNED BY: FOP/AH
CHECKED BY: FOP

SHEET NO.:
FIGURE 7.15

C.I.P. NO XXXXX AWPF 25 AC REVEG PROJECT BID NO XXXXXXXXXX

8.0 References

Anderson, B.W., P.E. Russell, and R.D. Ohmart. 2004. Riparian Revegetation: An Account of 2 Decades of Experience in the Arid South West, Avvar Books, Blythe, CA.

Ohmart, R.D. and B.W. Anderson. 1982. North American Desert Riparian Ecosystems. Reference Handbook on the Deserts of North America, Greenwood Press.

Phillips Consulting, LLC. 2001. Yuma East Wetlands Restoration Plan: Draft Concept Plan. Phillips Consulting, Flagstaff, AZ.

Phillips Consulting, LLC. 2005. Arizona Water Protection Fund, Yuma East Wetlands 25-Acre Revegetation Project: Revegetation and Project Monitoring Plan. Phillips Consulting, Flagstaff, AZ.