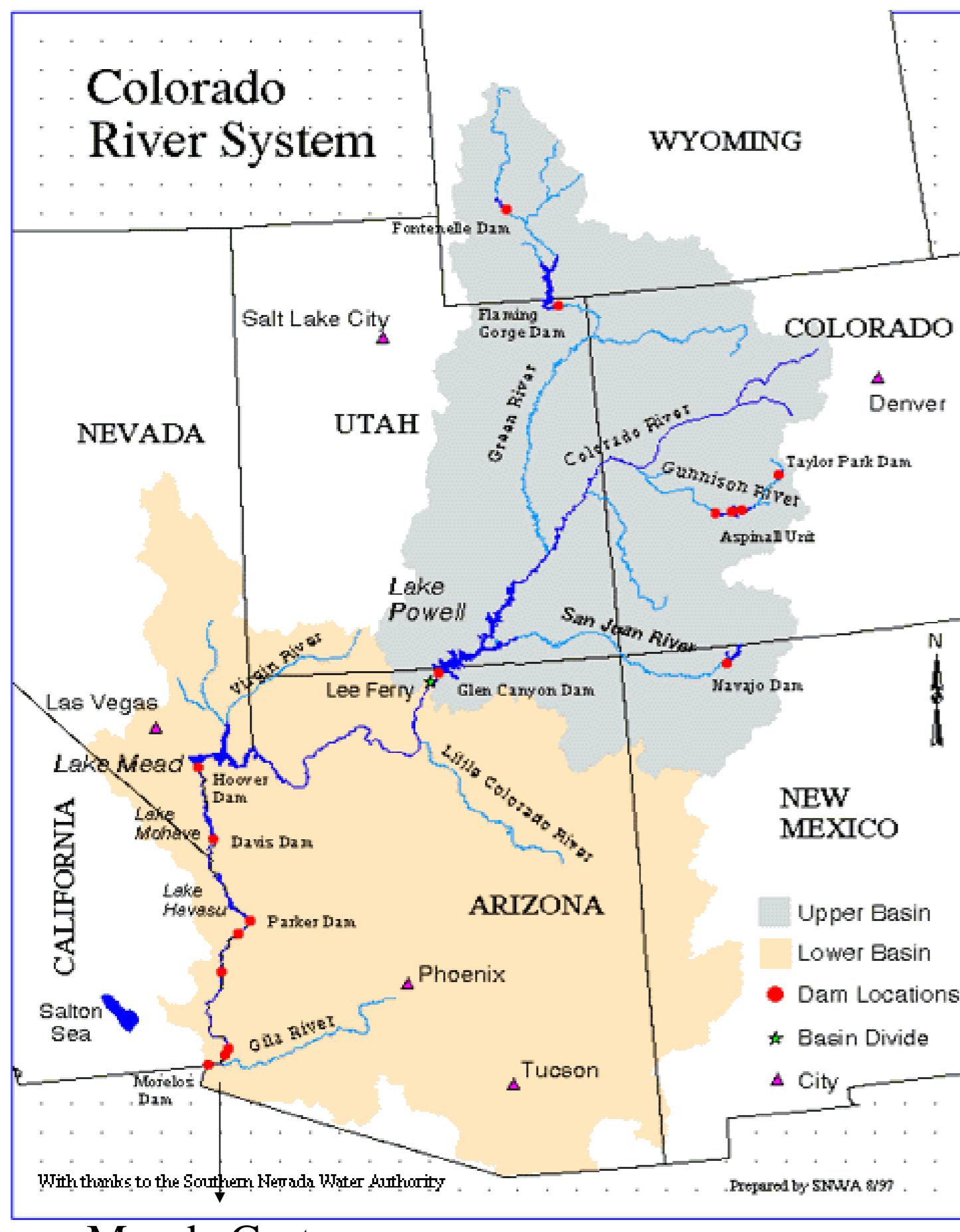






- Recreation Revenue 26 Billion
- 2 million acres delta now 100,000 acres of habitat
- 1920 law based on 18 MAF reality is 15 MAF
- Easter Sunday earthquake destroyed a lot of the farms
- Unprecedented agreement between nations to use water for ecological restoration, Minute 319
- Unprecedented support from the public to restore the river
- 160,000 AF used for pulse flow

Colorado River System



**Habitat
Fragmentation**

4 Large Dams

Glen Canyon

Hoover

Davis

Parker

5 Smaller Weirs

Headgate Rock

Palo Verde Weir

Imperial Dam

Laguna Dam

Morelos Dam

FLOW BELOW HOOVER DAM

1906 THROUGH SEPTEMBER 1999

(UNITS: ENGLISH)

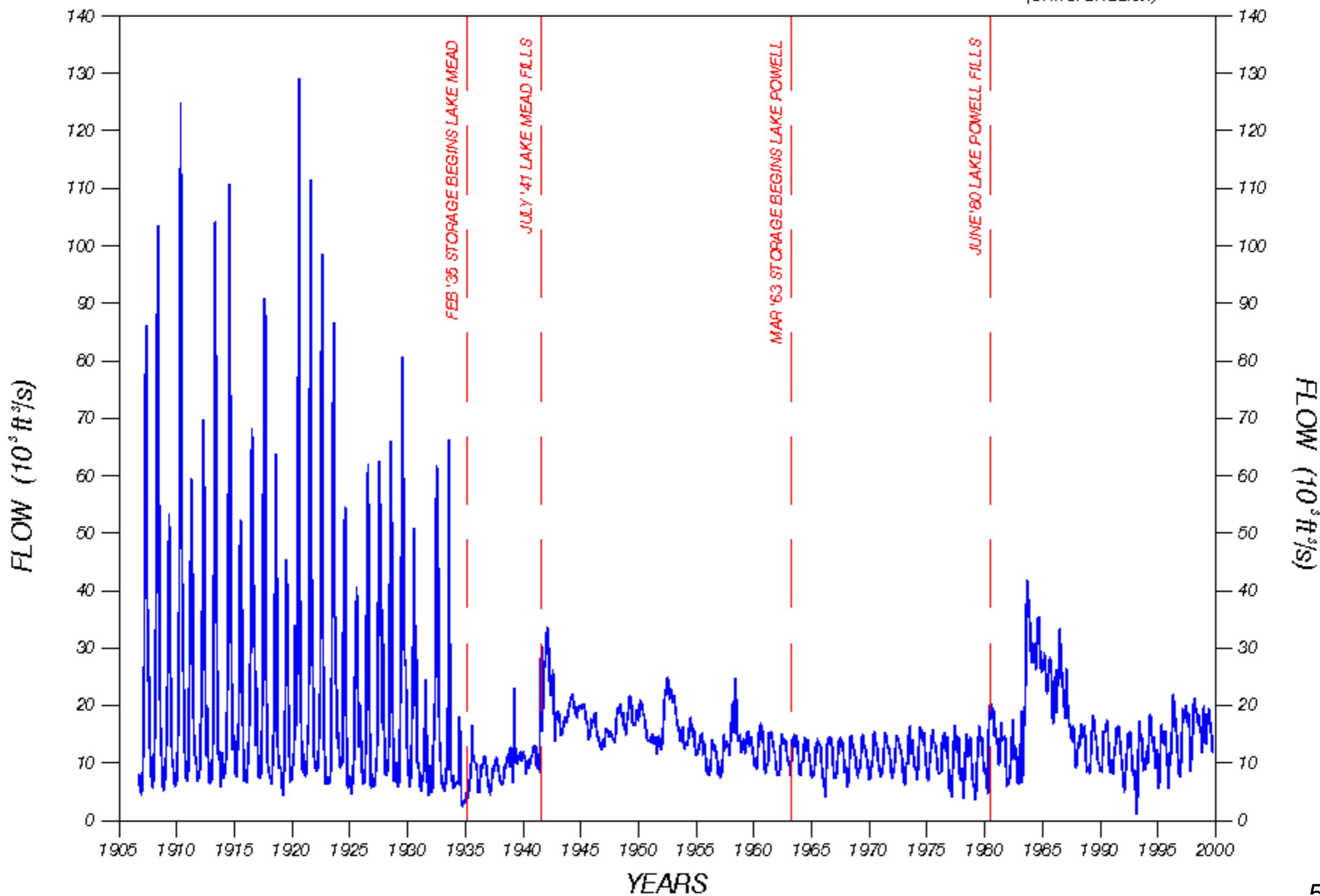














Photo by Pete McBride
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A worker in a white shirt and blue jeans stands near the excavator.

























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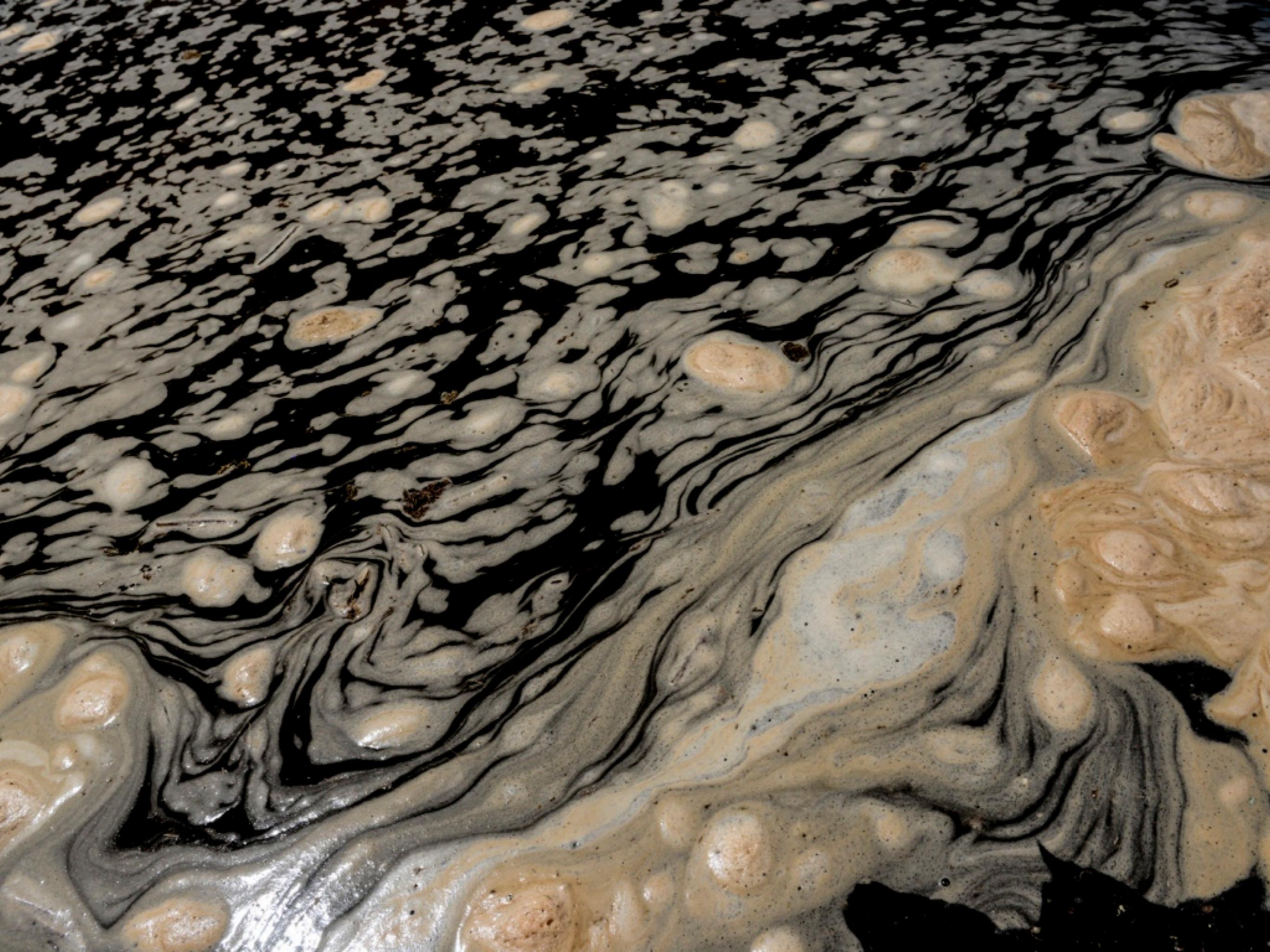
















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- Huge PR success Outcomes
- 80% of pulse flow went into groundwater
- Less than 5% made it to the estuary
- Increased the health of existing habitat
- Created minimal new habitat
- **Lessons learned will guide next international agreement**
- **It is going to happen again!**
- **Raised public awareness**

Lessons Learned

- Utilize infrastructure to capture water in old meanders for restoration
- Do more to create ideal conditions for germination and creation of riparian habitat
- Stretch the use of water out over five years vs one major event
- **Conserve water! (ag, humans, industry)**







AERIAL PHOTO POINT 1

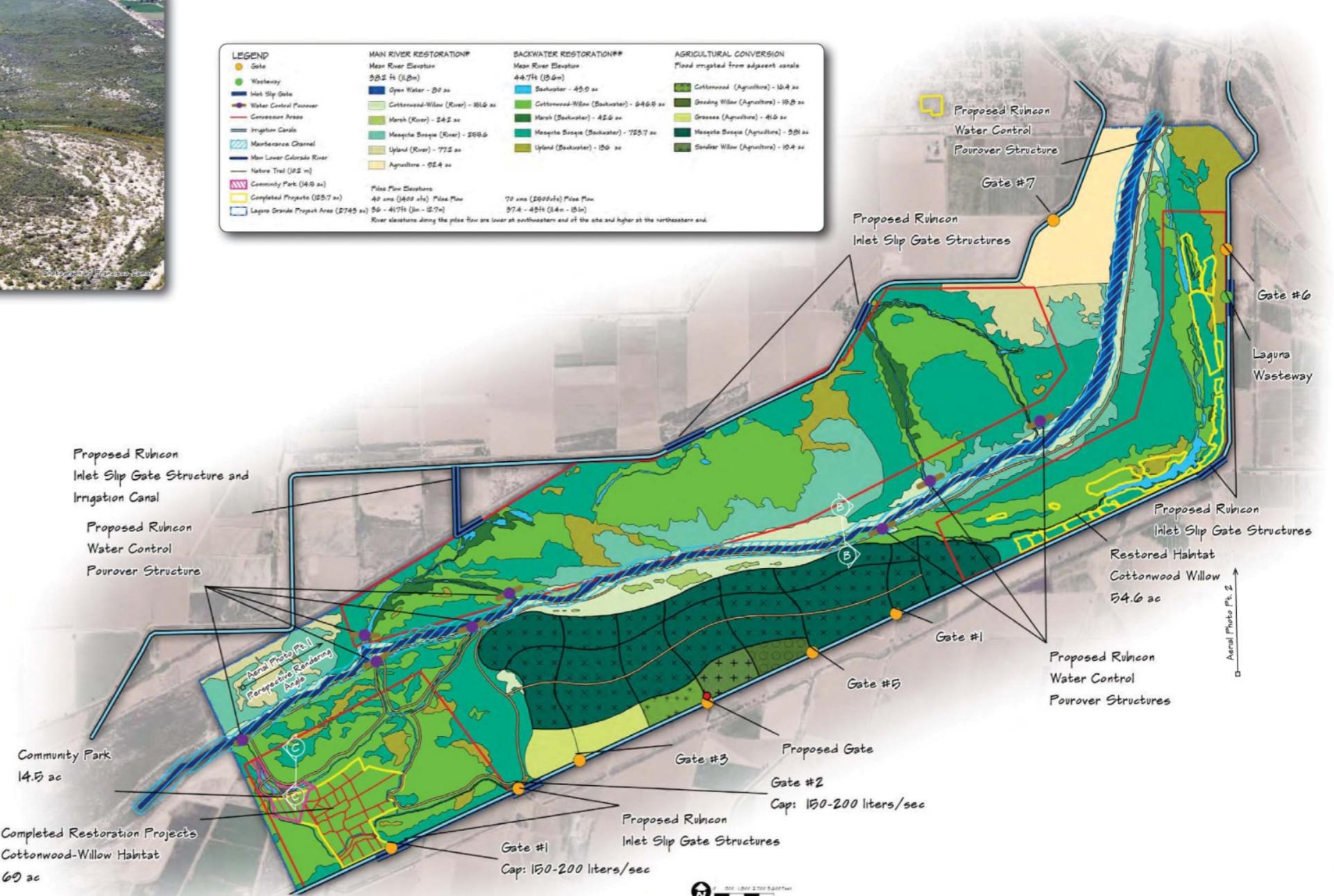


AERIAL PHOTO POINT 2

* Main River Restoration design is dependent on existing groundwater conditions and conditions enhanced by the proposed pulse flow

** Backwater Restoration design utilized historic channels, oxbows, and existing infrastructure to capture and hold water from pulse and base flow waters (delivered via the main river channel and adjacent irrigation canals) to improve groundwater conditions and allow for restoration of native riparian habitat.

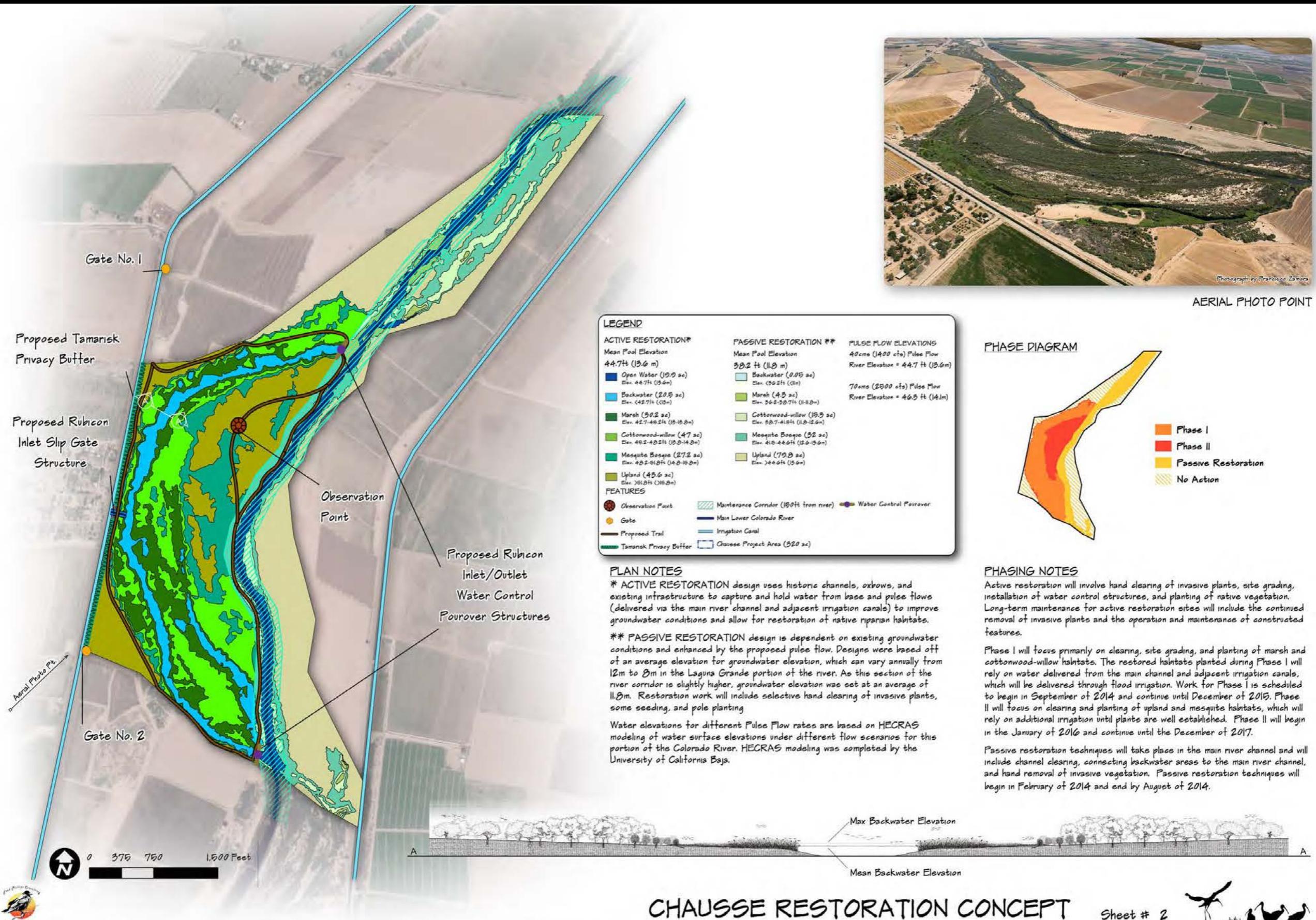
*** Agricultural Conversion design creates a series of flood irrigated cells, using water from existing irrigation infrastructure. Irrigation cells immediately adjacent to irrigation canals will be used to cultivate nursery stock for native riparian, wetland, and upland species.



LAGUNA GRANDE RESTORATION CONCEPT

Sheet # 3







PERSPECTIVE LOCATIONS



PERSPECTIVE 1: OVERVIEW OF THE BACKWATER RESTORATION AT THE CHAUSSE SITE



PERSPECTIVE 2: CANOEING THE BACKWATER, HEADING SOUTH



CHAUSSE PERSPECTIVES , VIEWS OF PROPOSED RESTORATION DESIGN*

Sheet # 3



CHAUSSE

PRELIMINARY EVALUATION OF POST-RESTORATION WATER NEEDS

The table below is a preliminary assessment of post-restoration water needs for the Chausse project area, based on the "Chausse Restoration Concept Design" developed by Fred Phillips Consulting, LLC. This table serves as an initial accounting of minimum water needs to sustain the restored areas given anticipated hydrologic losses from evaporation, evapotranspiration, and seepage. It is important to note that the estimates below do not represent the results of a site specific model. Accurately estimating hydrologic losses, especially related to site specific seepage losses, requires detailed soil and groundwater data combined with complex modeling procedures, which are beyond the scope of this conceptual analysis. Instead it is assumed that hydrologic loss relationships and calculations developed at a sister restoration site, located upstream along the Lower Colorado River near Yuma, AZ, can be applied to the Chausse site to estimate preliminary water needs. With these assumptions and limitations in mind, these water needs estimates are provided as a feasibility-level tool for future restoration planning.

System Losses		Evaporation ⁽¹⁾		Evapotranspiration ⁽²⁾						Seepage ⁽³⁾		Total			
Habitat Type		Open Water/Backwater ⁽⁴⁾		Normal ⁽⁵⁾		Cottonwood-Willow ⁽⁶⁾		Mesquite Bosque ⁽⁷⁾		Upland ⁽⁸⁾		Perimeter Losses ⁽⁹⁾			
Habitat Acreage & Associated Water Needs		Habitat Area (acres)	Water Needs ⁽¹⁰⁾ (acre-ft/year)	Habitat Area (acres)	Water Needs ⁽¹⁰⁾ (acre-ft/year)	Habitat Area (acres)	Water Needs ⁽¹⁰⁾ (acre-ft/year)	Habitat Area (acres)	Water Needs ⁽¹⁰⁾ (acre-ft/year)	Habitat Area (acres)	Perimeter Length (ft)	Water Needs ⁽¹⁰⁾ (acre-ft/year)	Habitat Area (acres)	Water Needs ⁽¹⁰⁾ (acre-ft/year)	
Project Phase	Phase 1	20.5	136	30.2	184	47.0	249	2.8	15	0.0	0	18647	8821	100.5	6105
	Phase 2	0.0	0	0.0	0	0.0	0	24.4	131	26.8	135	0 ⁽¹¹⁾	0	512	266
	TOTAL	20.5	136	30.2	184	47.0	249	27.2	146	36.8	135	18647	8821	151.7	6371

(1) Evaporation is the process by which water in its liquid or solid state is transformed into water vapor which mixes with the atmosphere.

(2) Evaporation rates for tree water surfaces/open water/backwater areas near Yuma, AZ calculated per Cooley, K.R., 1970, "Evaporation from open water surfaces in Arizona"; University of Arizona College of Agriculture, folder 109.

(3) Evapotranspiration is the process by which water is lost to the atmosphere from the ground surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants whose roots top the capillary fringe of the groundwater table and whose leaves release water vapor via stomata.

(4) Evapotranspiration rates for "Marsh" habitat provided by the US Bureau of Reclamation as part of the Lower Colorado Accounting System (LCRAS) - ET Data for Phreatophyte and Riparian Vegetation; average of years 2005-2007 for "Marsh (40% cattail, bulrush, phragmites [bamboo]).

(5) Evapotranspiration rates for "Cottonwood-Willow" habitat provided by the US Bureau of Reclamation as part of the Lower Colorado Accounting System (LCRAS) - ET Data for Phreatophyte and Riparian Vegetation; average of years 2005-2007 for "Cw (61-100% cottonwood and willow trees)".

(6) Evapotranspiration rates for "Mesquite Bosque" habitat provided by the US Bureau of Reclamation as part of the Lower Colorado Accounting System (LCRAS) - ET Data for Phreatophyte and Riparian Vegetation; average of years 2005-2007 for "Ms-high (61-100% screwbean/honey mesquite) & < 25% arrow weed".

(7) Evapotranspiration rates for "Upland" habitat provided by the US Bureau of Reclamation as part of the Lower Colorado Accounting System (LCRAS) - ET Data for Phreatophyte and Riparian Vegetation; average of years 2005-2007 for "Au (61-100% arrow weed & < 10% any trees)".

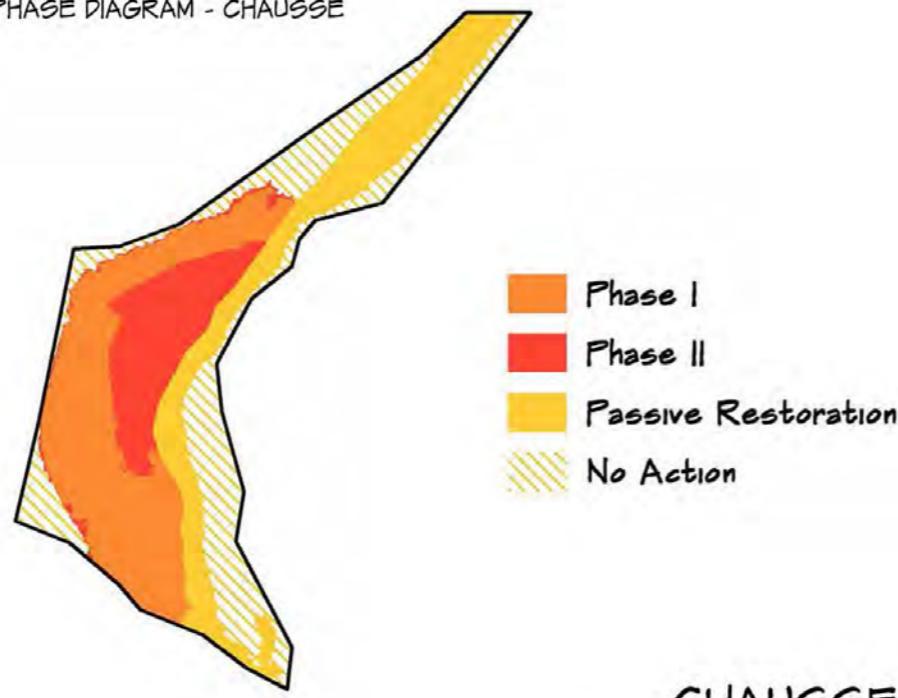
(8) Seepage, in soil mechanics, is the movement of water in soils. Seepage can occur when there is a slope or gradient in the water table. Seepage depends on several factors, including permeability of the soil and the pressure gradient.

(9) Based off the current conceptual restoration design, it is assumed that each project phase will have improvements made (i.e. water control structures installed and/or perimeter earthwork completed) to allow water surface elevations within the restored units to be operated at an artificially higher water surface elevation than surrounding groundwater and surface water elevations. The gradient between water elevations in the restored areas and surrounding surface/groundwater elevations will likely cause subsurface seepage out of the restored areas along their perimeters. Seepage rate estimates are based on average estimated losses from the perimeter of Reach 1 of the Laguna Division Conservation Area, calculated as part of a preliminary analysis conducted by BOR, using an average hydraulic conductivity for fine sand. The methodology provided a rough estimate of seepage rates for conceptual purposes and assumes the Chausse site has similar soil conditions and perimeter gradients as the Laguna Division Conservation Area. These estimates should be used with care as actual seepage values are highly sensitive to hydraulic conductivity of the soil. The methodology should be refined as the project progresses based on actual soil hydraulic conductivity for the site and estimated hydraulic gradients between the mean water surface elevation of the restored areas and adjacent open water in the Colorado River and groundwater elevations surrounding the site.

(10) "Water Needs" is the minimum amount of water required to sustain the restored areas given anticipated hydrologic losses from evaporation, evapotranspiration, and seepage.

(11) Assume the Phase 2 area is completely contained within the Phase 1 area, and associated Phase 1 perimeter improvements.

PHASE DIAGRAM - CHAUSSÉ



CHAUSSE POST-RESTORATION WATER NEEDS

Sheet # 4





Legend

Shallow Marsh Salt Grass	Mesquite Deep Pot
Shallow Marsh Three Square	Cottonwood
Deep Marsh	Gooding Willow
Open Water	Sandbar Willow
Upland Seed Mix	

Reach 1

Mean Water Level = 158
Max Water Level = 160
Open water = 59.1 AC
Deep Marsh = 85.9 AC
Shallow Marsh *Scripus olneyi* = 19.9 AC
Shallow Marsh *Distichlis spicata* = 29.1 AC
Sandbar Willow = 22 AC
Gooding Willow = 27.2 AC
Cottonwood = 128.8AC
Mesquite Deep Pot = 108.1 AC
Upland Seed Mix = 55.5 AC
Total Acreage Reach 1: 540.8 Acres

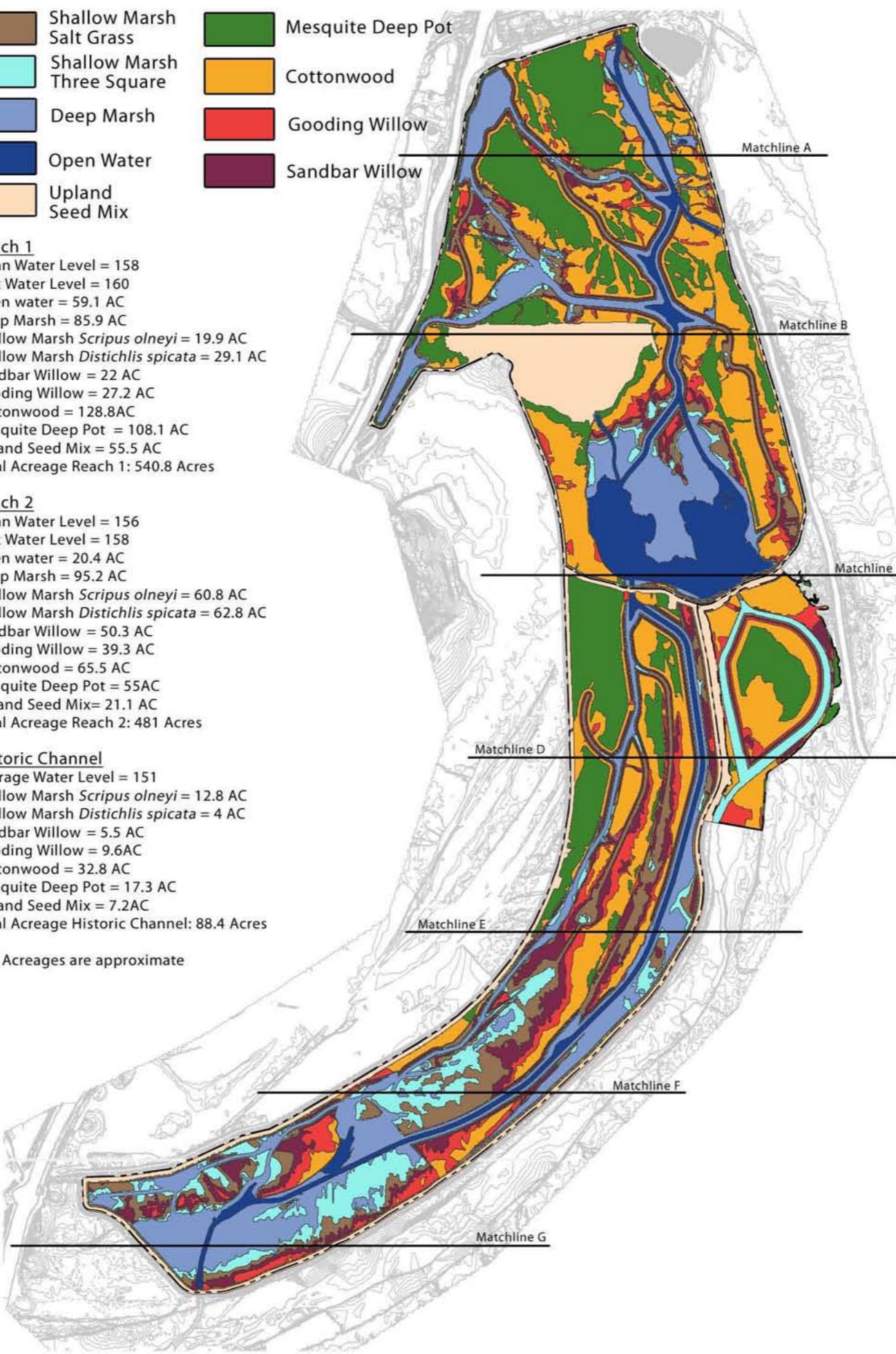
Reach 2

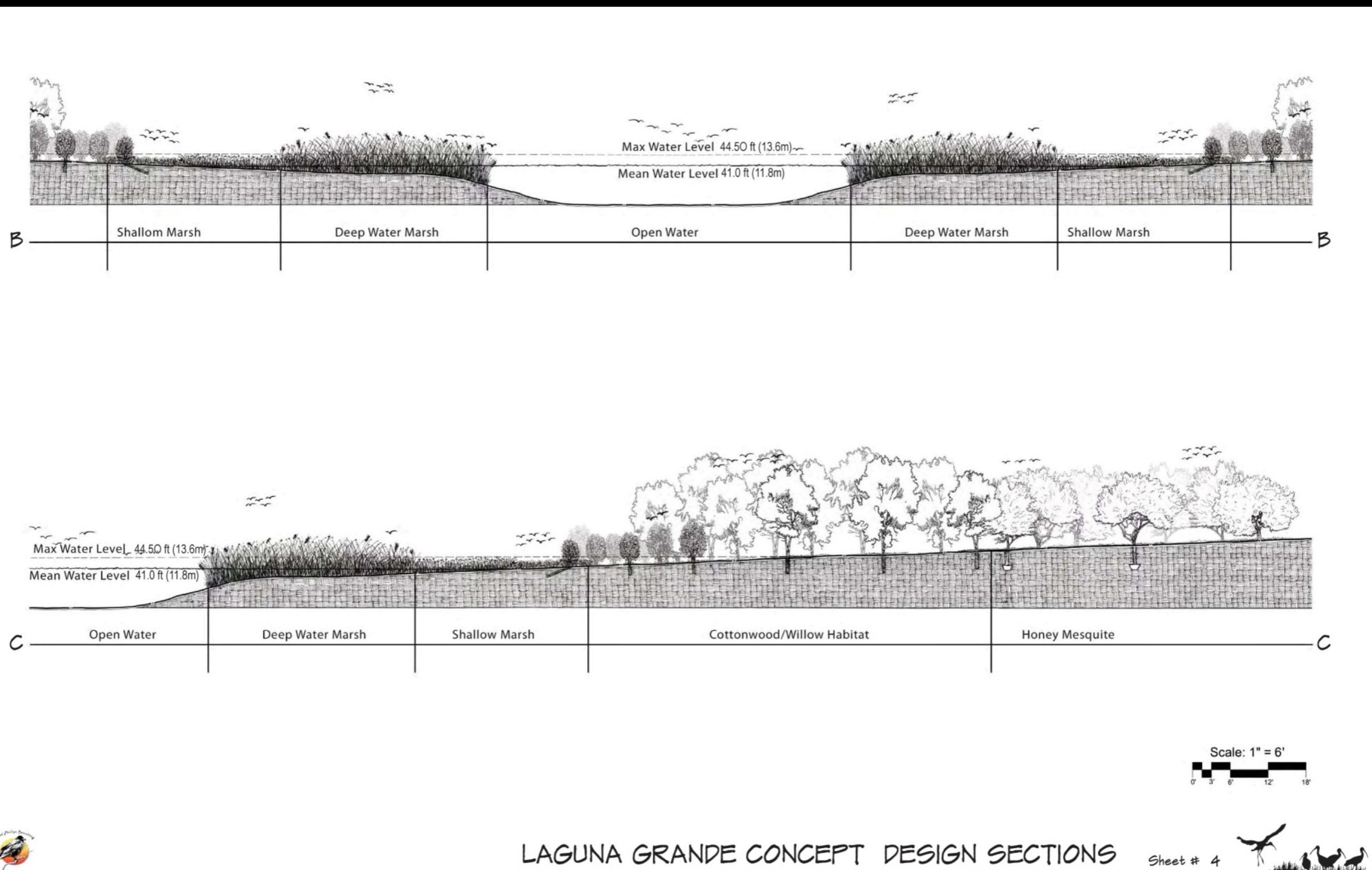
Mean Water Level = 156
Max Water Level = 158
Open water = 20.4 AC
Deep Marsh = 95.2 AC
Shallow Marsh *Scripus olneyi* = 60.8 AC
Shallow Marsh *Distichlis spicata* = 62.8 AC
Sandbar Willow = 50.3 AC
Gooding Willow = 39.3 AC
Cottonwood = 65.5 AC
Mesquite Deep Pot = 55AC
Upland Seed Mix= 21.1 AC
Total Acreage Reach 2: 481 Acres

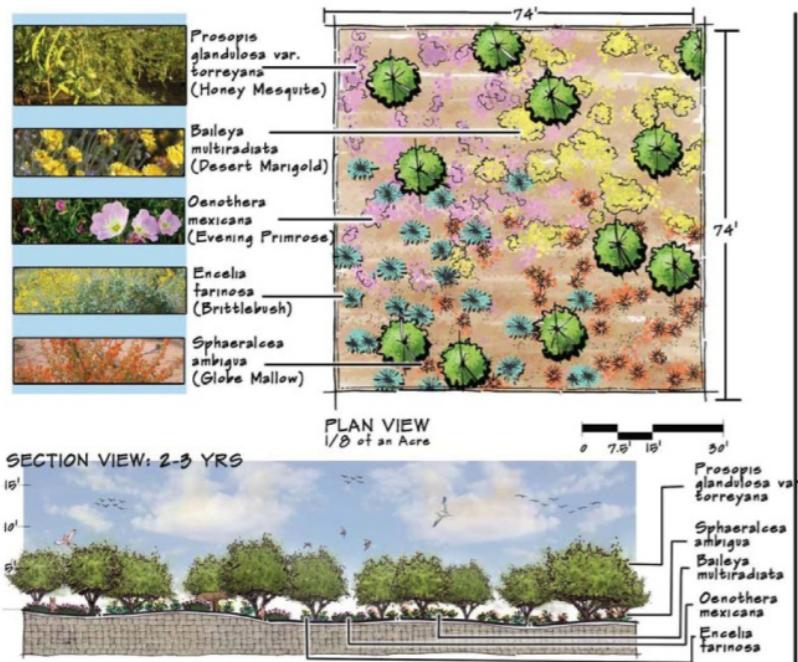
Historic Channel

Average Water Level = 151
Shallow Marsh *Scripus olneyi* = 12.8 AC
Shallow Marsh *Distichlis spicata* = 4 AC
Sandbar Willow = 5.5 AC
Gooding Willow = 9.6AC
Cottonwood = 32.8 AC
Mesquite Deep Pot = 17.3 AC
Upland Seed Mix = 7.2AC
Total Acreage Historic Channel: 88.4 Acres

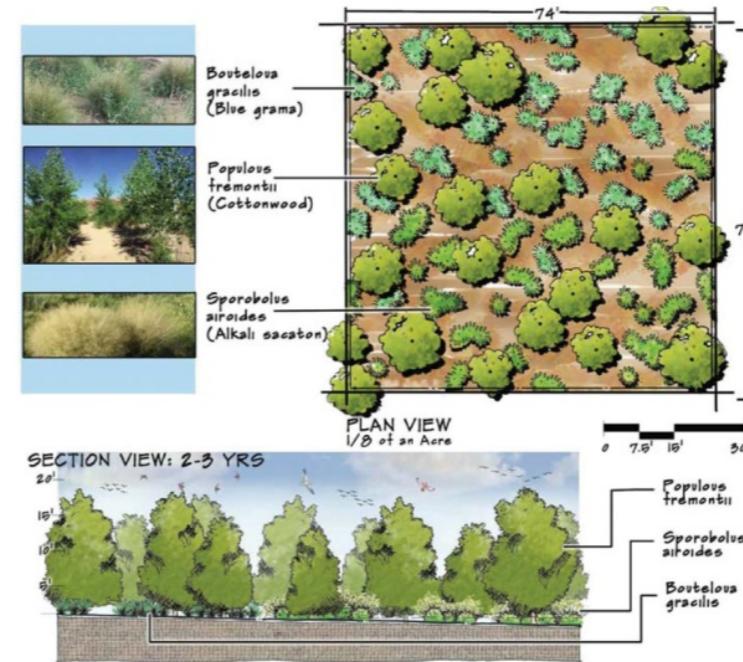
*All Acreages are approximate



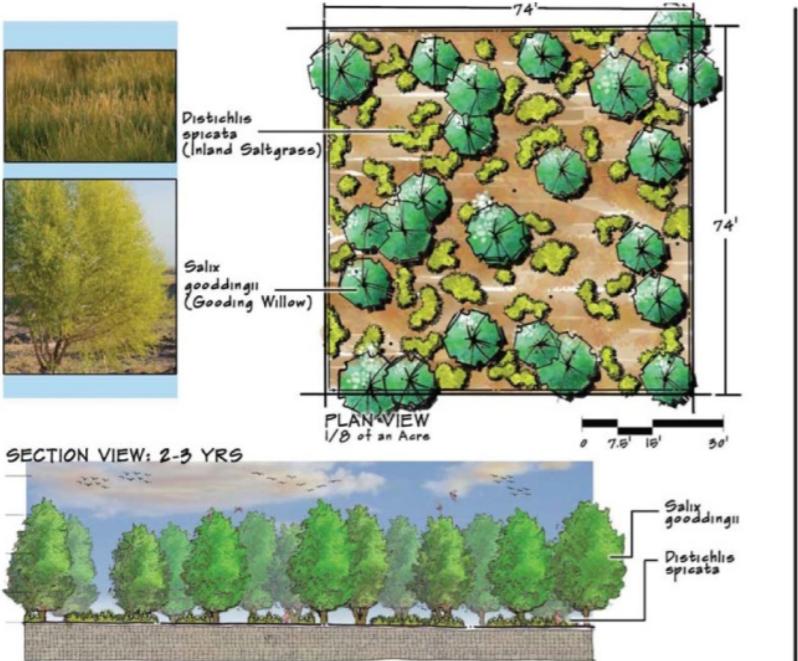




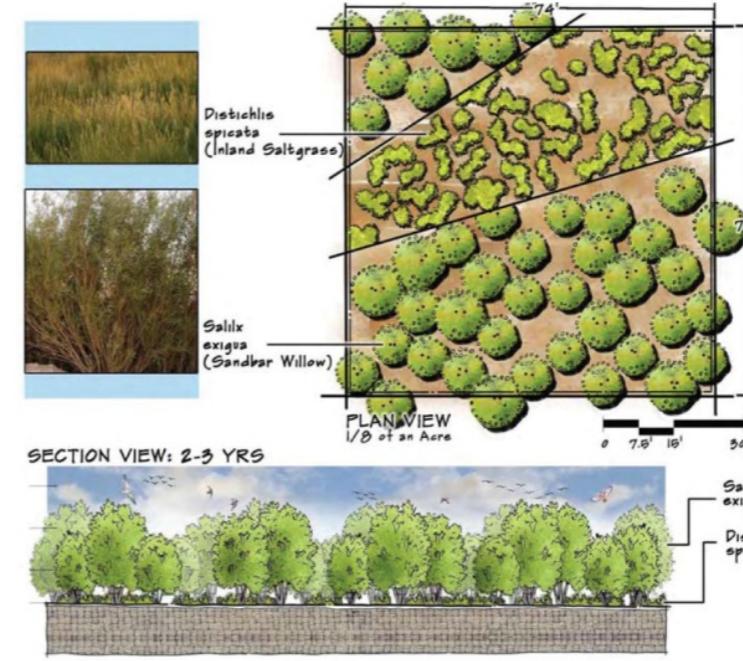
PLANTING DETAIL MESQUITE HABITAT



PLANT DETAIL COTTONWOOD HABITAT



PLANT DETAIL GOODING WILLOW HABITAT



PLANT DETAIL SANDBAR WILLOW HABITAT

- * *Populus fremontii* 1 gallon, hand planted randomly 15' O.C.
- * Seed entire area 5 lbs per acre with
Seed Mix 2:
 - * *Sporobolus zizanioides*
 - * *Bouteloua gracilis*

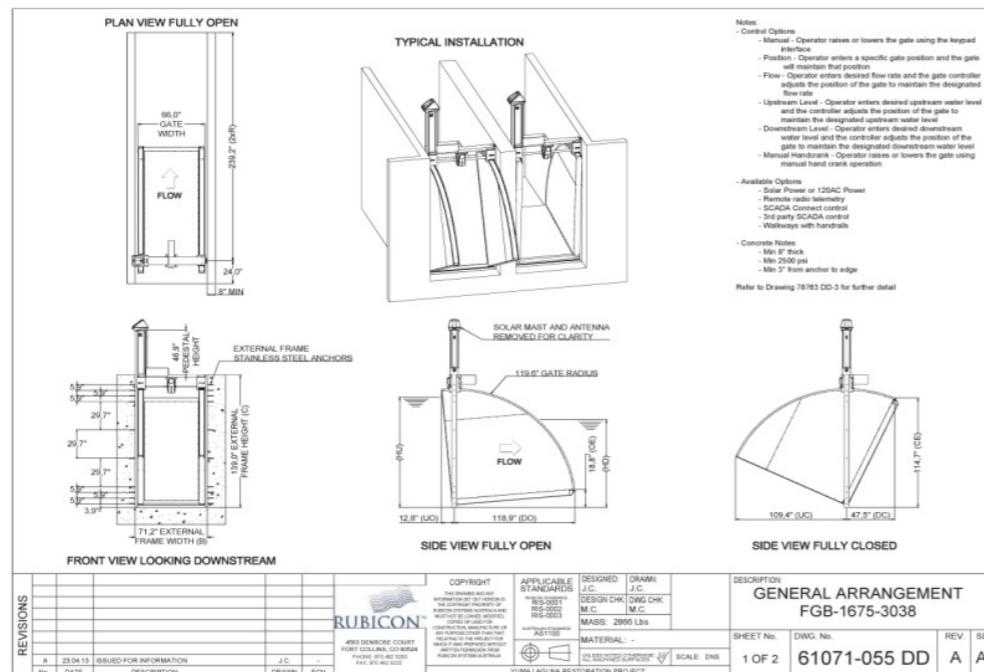
PLANTING ZONE PROPERTIES:
Plant Specs:
* *Salix exigua* 1 gallon, hand planted
randomly 7' O.C.
* *Distichlis spicata* 4" plugs hand
planted randomly 5' O.C.



RUBICON SLIP METER, CANAL INLET



EXAMPLE OF EARTHEN LEVEE TO CONTAIN WATER IN BACKWATER AREAS



DETAIL OF PROPOSED RUBICON POUROVER STRUCTURE



PROPOSED RUBICON POUROVER STRUCTURE



PROPOSED RUBICON POUROVER STRUCTURE WITH STOPLOG SLOTS



PROPOSED RUBICON POUROVER STRUCTURE

WATER CONTROL STRUCTURE DETAILS











