Laguna Conceptual Restoration Design

Task 3:
Final/Preferred Habitat Restoration Concept

Natural Channel Design, Inc.

Fred Phillips Consulting

SWI Shephard Wesnitzer, Inc.
Engineering an environment of excellence

Lower Colorado River Multi-Species Conservation Program

Presentation Outline

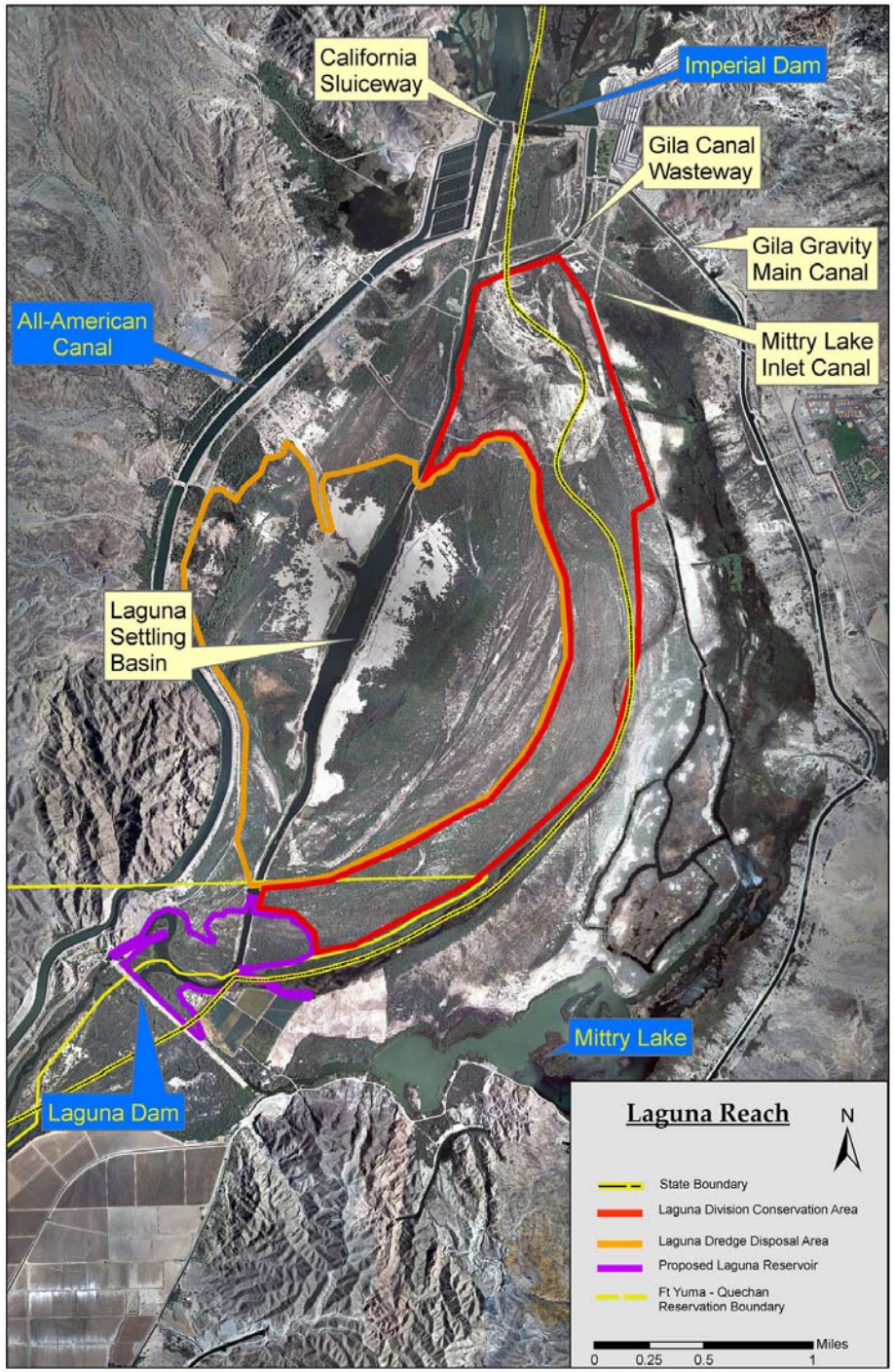
- Purpose and Objectives **(*Allen Haden – NCD*)**
- Site Map
- Project Design Considerations and Alternative Analysis
- Alternative 1 Overview
- Channel Design & Construction
- Water Delivery & Water Control Structures **(*John Wesnitzer – SWI*)**
- Re-vegetation and Habitat **(*Fred Phillips – FPC*)**
- Water Operations and Management **(*George Cathey – NCD*)**
- Cost Summary
- Additional Information Needs
- Timeline for Project Development **(*Bill Singleton – USBR*)**

Purpose & Objectives

- Large Scale Riparian and Marsh Restoration/Enhancement
- Determine the cost effectiveness and technical feasibility of a mosaic of habitat types
- Provide evaluation of three enhancement alternatives
- Provide detailed analysis of preferred enhancement alternative

Project Site Map

- Project Area – 920 acres
- Reach Length – 4 miles
- Existing Conditions
  - Extensive/dense tamarisk monoculture



Project Design Considerations

- Up to 100 cfs available for project use
- Habitat Targets
    - Open Water/Marsh: 50 – 100 ac
    - Cottonwood/Willow: >200 ac
    - Upland(mesquite): <500 ac
    - Include specific habitat for T&E species
- No detrimental effect on existing Mittry Lake or Old River Channel Habitats
- Minimize impacts to existing operations (sluicing, dredge disposal, water delivery, etc.)
- Minimize both initial construction and long-term operating costs

Target Habitats

Target Species

California Black Rail

Yuma Clapper Rail

Southwestern Willow Flycatcher

Yellow Billed Cuckoo

Yuma Hispid Cotton Rat

Colorado River Cotton Rat

Western Least Bittern

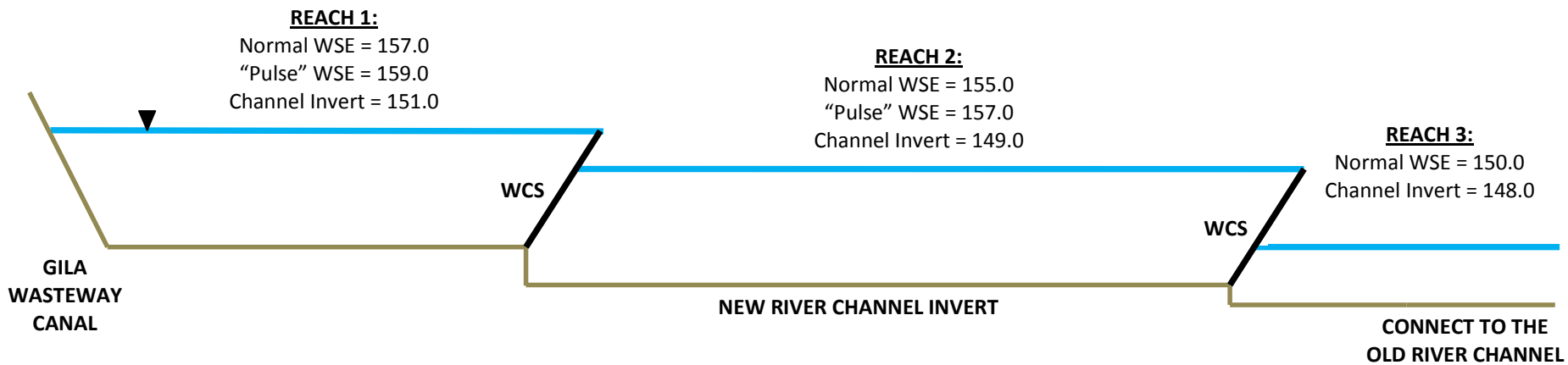
Draft Alternative Analysis & Results

- Three alternatives evaluated based on these design criteria and habitat/species targets

- **Alternative 1** chosen as the preferred alternative based on feedback from the MSCP
  - Maximized habitat based on targets
  - Balanced cut/fill
  - Option stayed within designated project boundaries

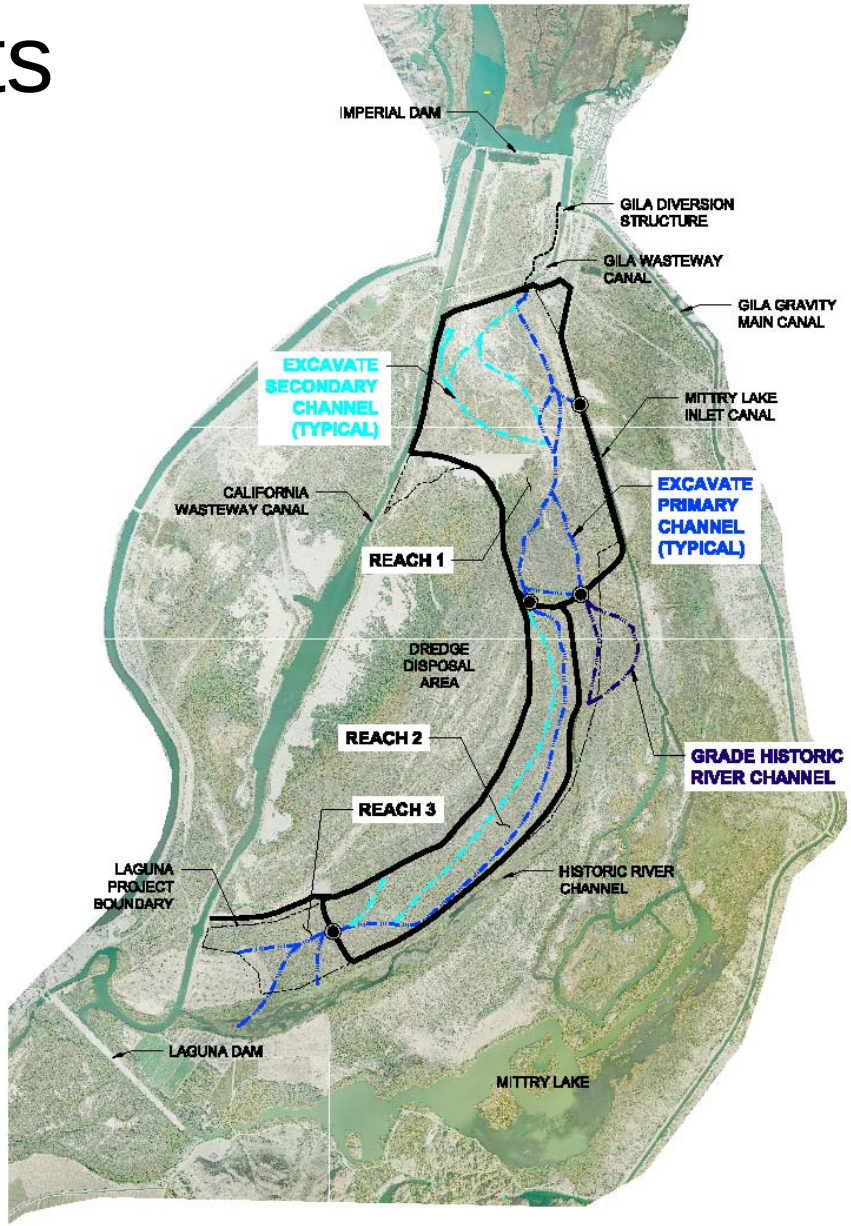
Alternative 1 Overview

- Operate as a managed, leveed wetland rather than a river system to maximize limited water resource
- Use existing overflow channels through project area to minimize excavation
- Use pulse flows to mimic flooding
- Requires water control structures to manage water levels



Channel Improvements

- Provides the topography to support water conveyance and vegetation/ habitat
- Three reaches/cells with primary and secondary channels
- Channel layout utilizes existing channel topography

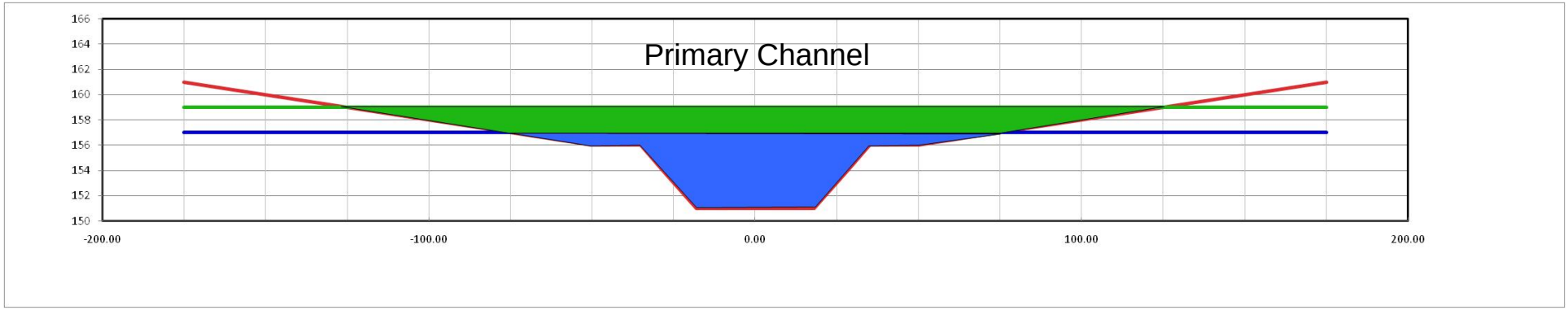


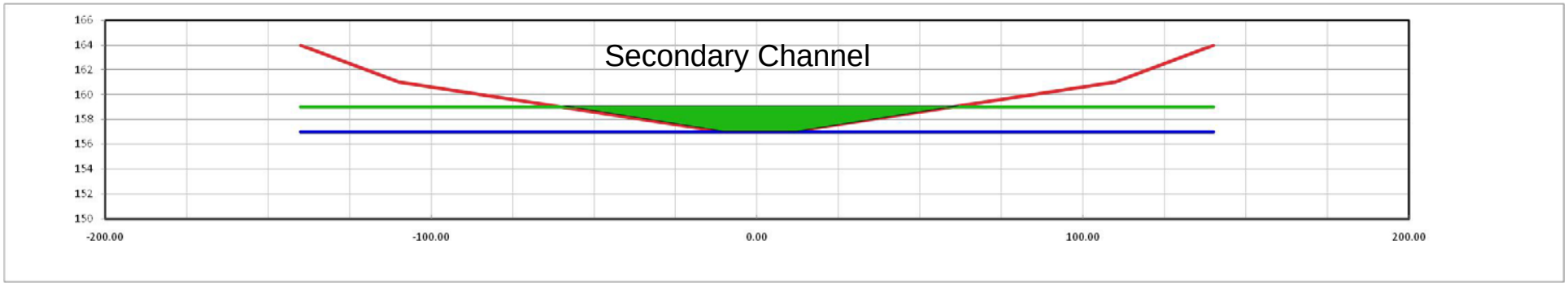
Primary Channel

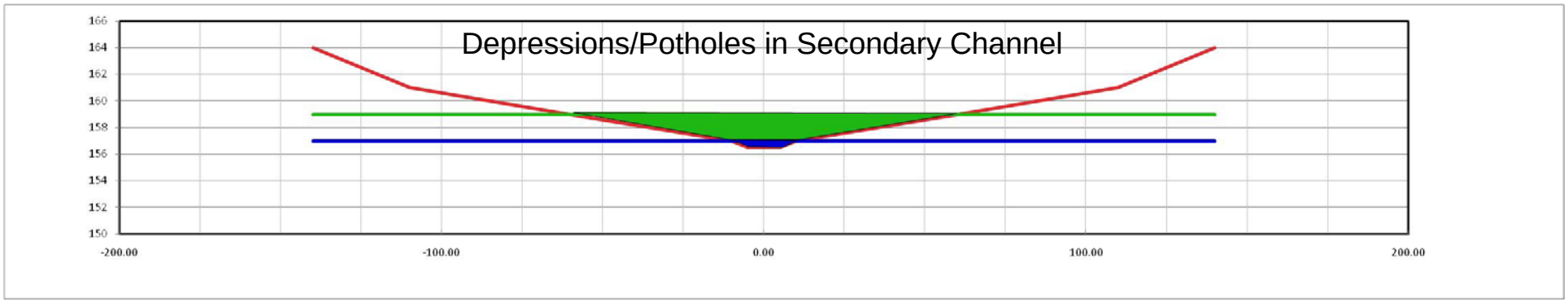
Normal water depth

Pulse water depth

Typical Cross Sections

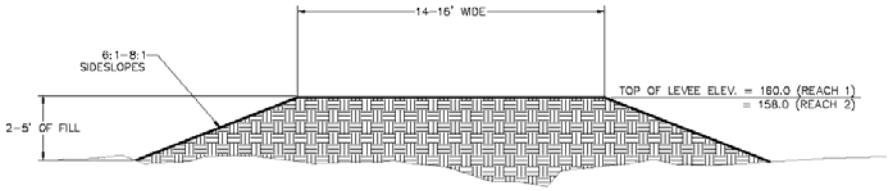




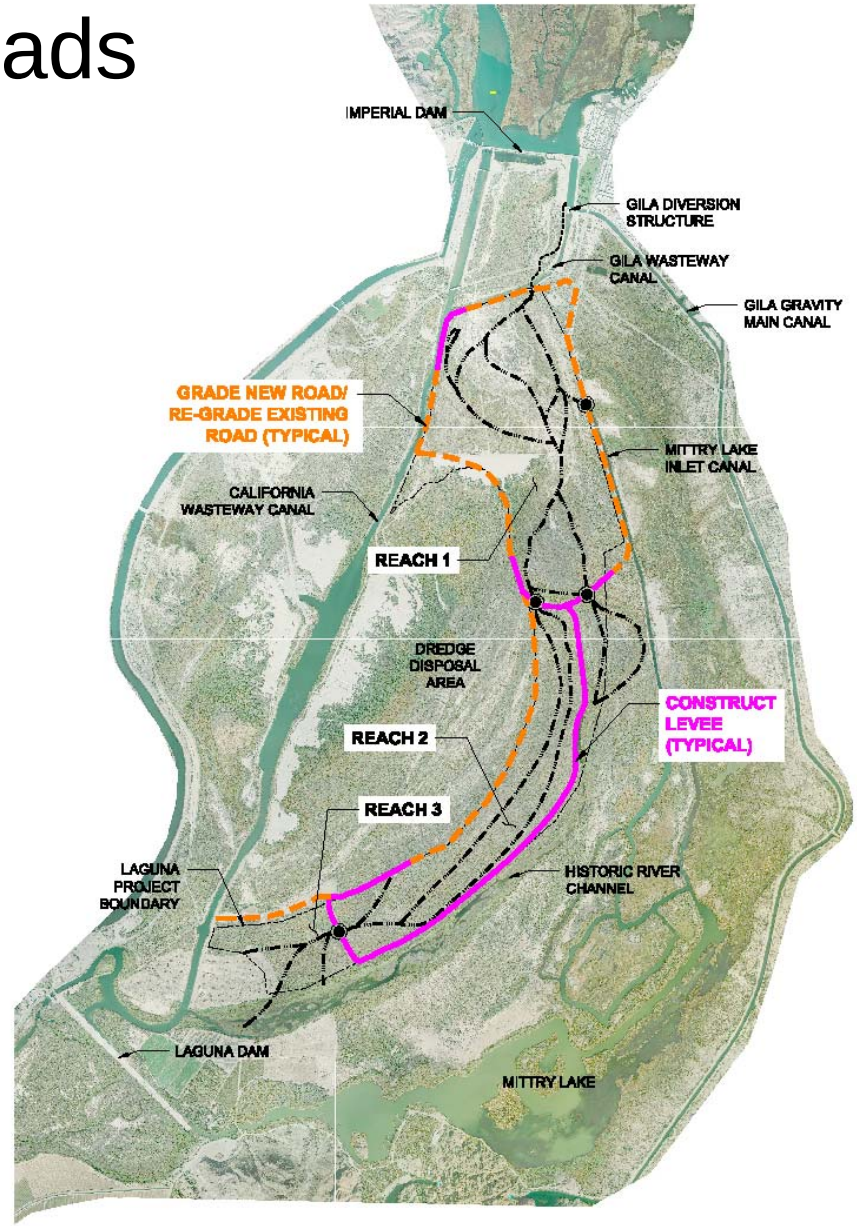


Levees and Access Roads

- New levees constructed using material from channel excavation (additional spoil areas between braided channels)
- Provides access to water control structures and the interior of the site and ties into existing access road system
- Allows Reaches 1 and 2 to be operated at different water levels
- Provides separation between Historic River Channel and the Project Area
- Provides separation between Laguna Dredge Disposal Area and the Project Area while providing additional access to the Dredge Disposal Area



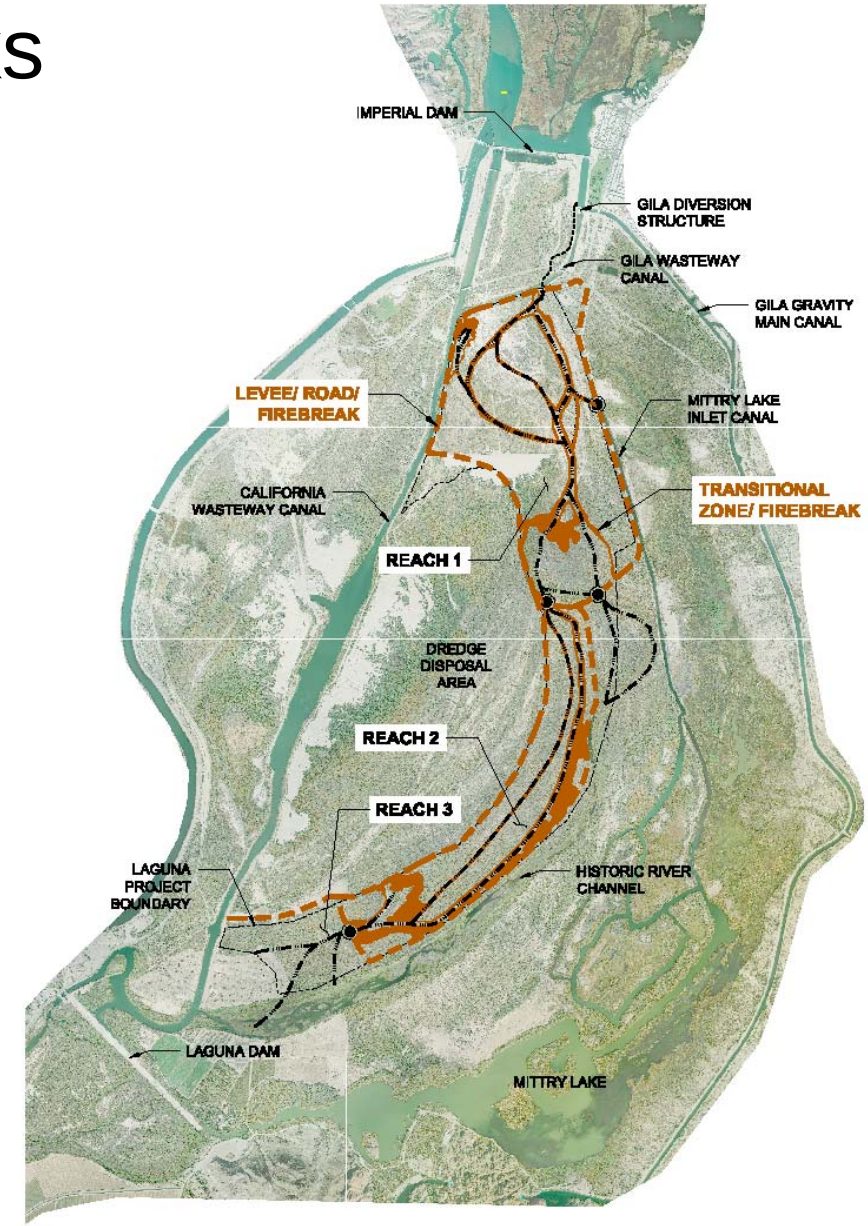
Typical Levee Section



Fire Control/Fire Breaks

- Roads and levees provide equipment access and fire breaks
- Transitional zone vegetated primarily with salt grass acts as a firebreak
- Open water zone provides additional firebreak

Salt Grass & Open Water



LAGUNA RESTORATION

Earthwork

Conceptual Level Cost Estimate

ITEM NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	COST
1	Mobilization, SWPPP, & Construction Staking (*8%)	L.S.	1	$552,000.00	$552,000.00
2	404/401 Permits (*0.2%)	L.S.	1	$14,000.00	$14,000.00
3	Site Preparation (Burning, Clearing and Grubbing)	ACRE	1,000	$2,000.00	$2,000,000.00
4	Cut Primary and Secondary River Channels	C.Y.	854,000	$8.00	$6,832,000.00
5	Strip Levee Footprint of Vegetation	C.Y.	18,800	$2.00	$37,600.00
6	Grade New Roads/Re-Grade Existing Roads	L.F.	15,850	$1.90	$30,115.00
				Subtotal Construction Items =	**$9,465,715.00**
				25% Engineering Services and Conceptual Stage Contingency =	**$2,366,428.75**
				Total Construction Items =	**$11,832,143.75**

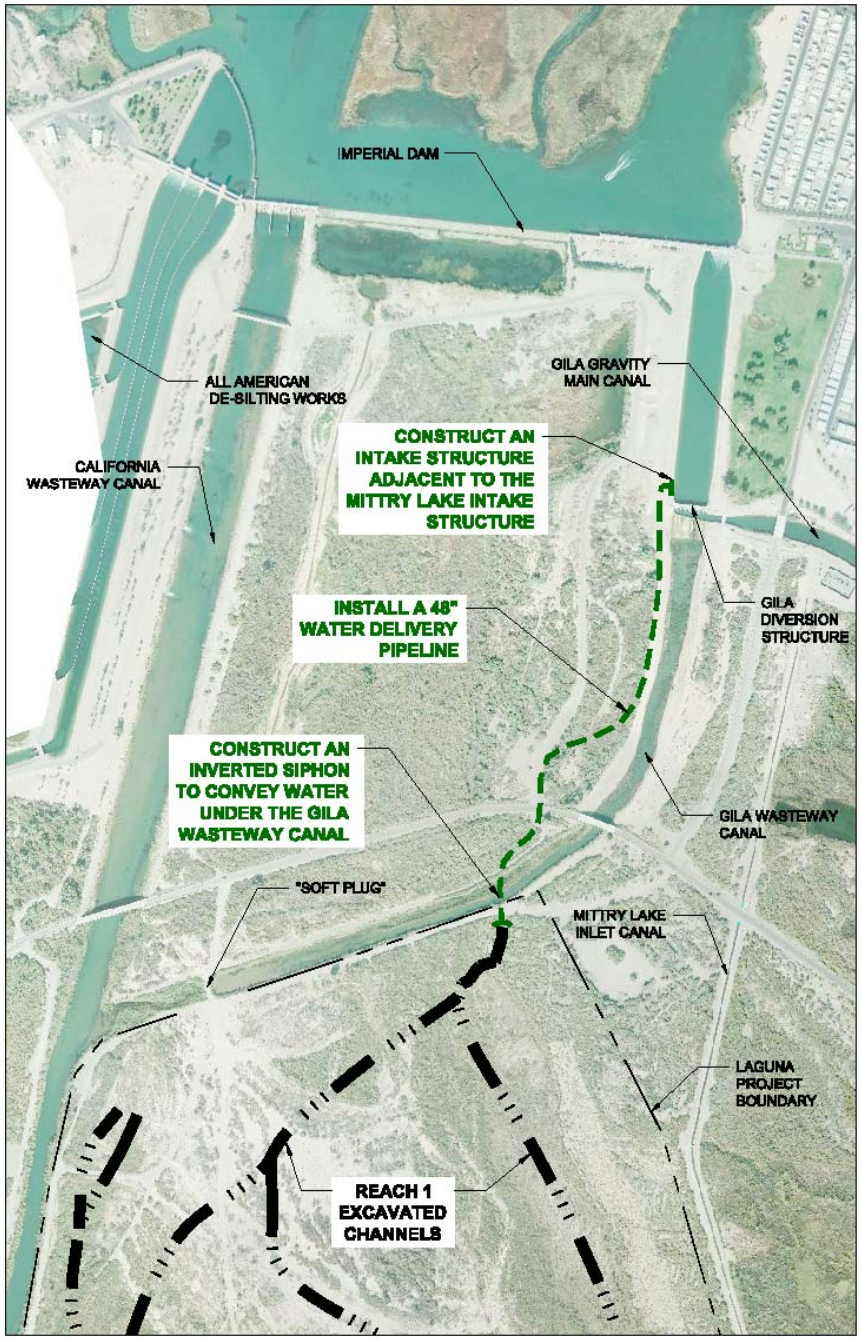
(* Appoximate % of Construction Subtotal, not induding site preparation)

Present Value Life Cycle Costs (50 year Life Cycle, yearly interest rate of 5%):					
6	Operation & Maintenance	EA.	1	$438,142.21	$438,142.21
				Subtotal Lifecycle Items =	**$438,142.21**
				20% Conceptual Stage Contingency =	**$87,628.44**
				Total Lifecycle Items =	**$525,770.65**

TOTAL = $12,357,914.40

Water Delivery Overview

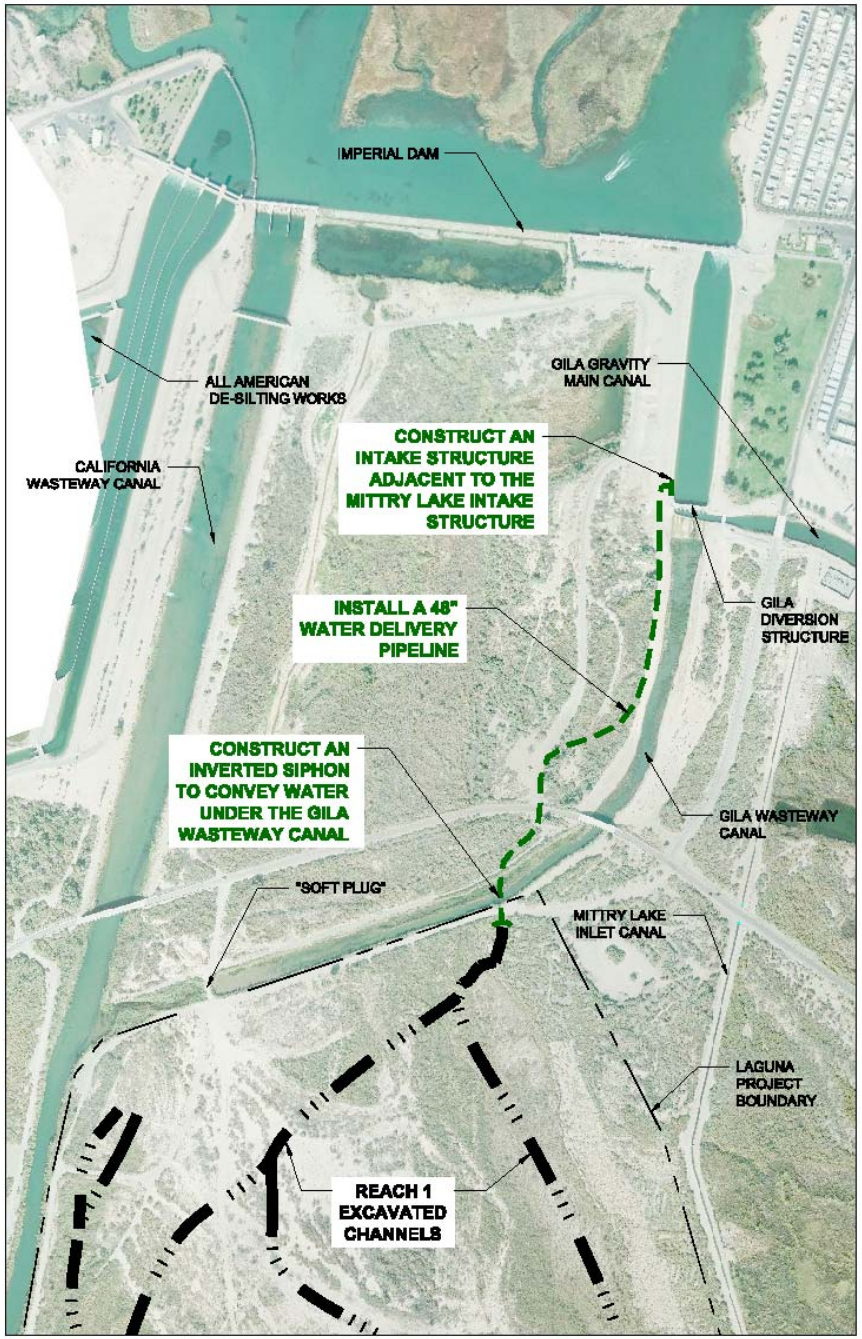
- Utilize/modify existing infrastructure at the northern extent of the project area
- Convey 100 cfs base flow to the project site
- Other System Design Criteria
  - Minimize impacts to dam operations
  - Low O&M critical
  - Long life cycle ideal
- Pipeline chosen over open channel and pump delivery options



Water Delivery

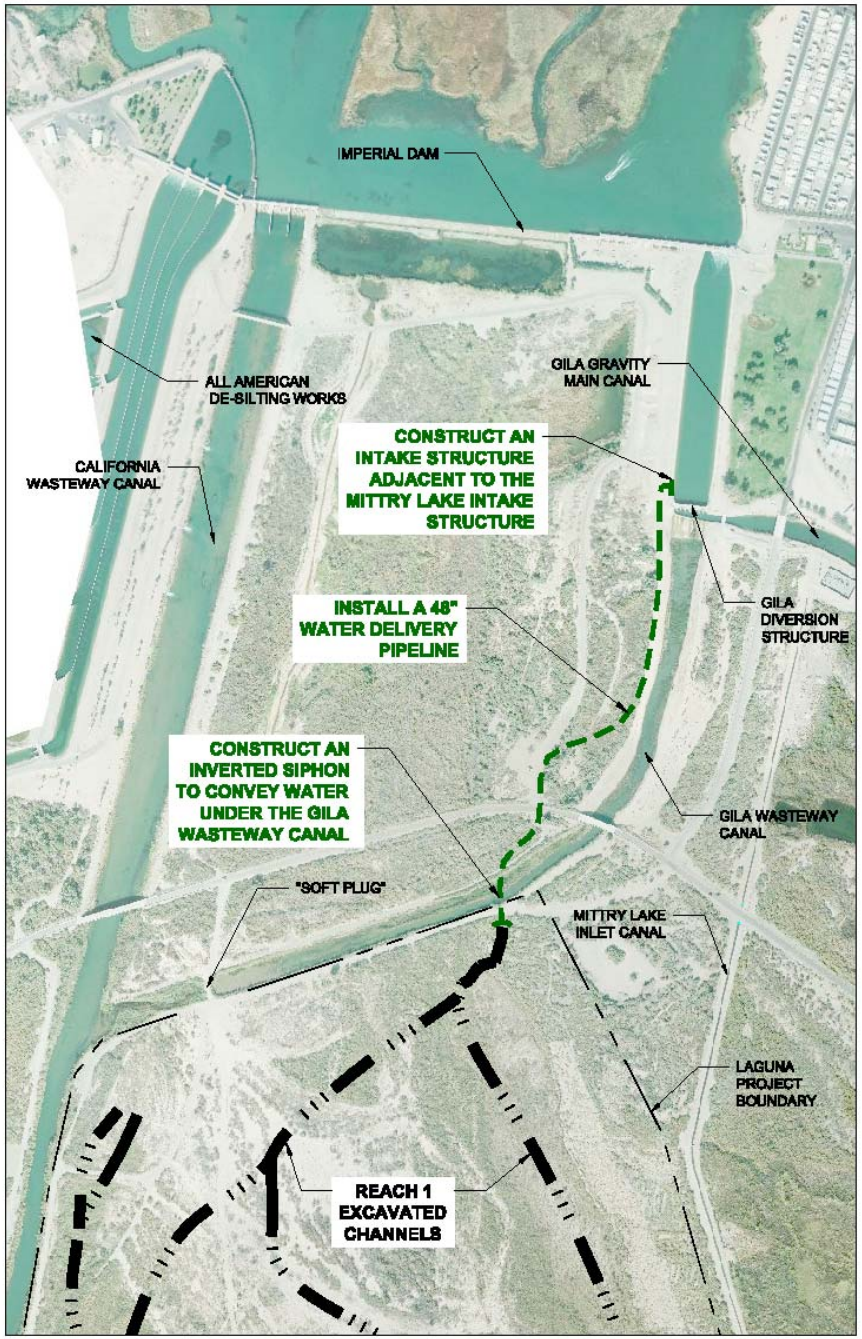
Gravity Feed From a New Pipeline

- Gravity system is relatively low maintenance
- Independent delivery system with limited impacts to existing dam operations
- High quality water (low salinity/sediment load) at take out point
- Piped system reduces evaporation/infiltration as water is conveyed to the Reach 1



Water Delivery
Gravity Feed From a New Pipeline

- Construction Costs
  - $943,500
- Life Cycle Costs
  - $58,500
- Overall Costs
  - $1,002,000



LAGUNA RESTORATION

Water Delivery Pipeline

Conceptual Level Cost Estimate

ITEM NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	COST
1	Mobilization, SWPPP, & Construction Staking (*8%)	L.S.	1	$56,000.00	$56,000.00
2	Supply 48" DR 32.5 HDPE Pipe	L.F.	2725	$110.00	$299,750.00
3	Install 48" DR 32.5 HDPE Pipe	L.F.	2725	$27.00	$73,575.00
4	Trench & Backfill 48" DR 32.5 HDPE Pipe	C.Y.	6459	$4.26	$27,516.44
5	Construct a New Intake for the Pipeline Near the Mittry Lake Pipeline Intake	L.S.	1	$15,000.00	$15,000.00
6	De-watering During Intake Construction	DAY	8	$184.00	$1,472.00
7	Temporary Coffer Dam During Intake Construction	L.S.	1	$30,000.00	$30,000.00
8	Supply and Install 48" Red Valve Megaflex Manual Pinch Valve Near Intake	EA.	1	$100,000.00	$100,000.00
9	Supply and Install 2" Combination Air Release Valve Near Intake	EA.	3	$5,000.00	$15,000.00
10	Supply and Install Flow Measurement Instrumentation	L.S.	1	$60,000.00	$60,000.00
11	Supply and install fittings for 48" HDPE pipe	L.S.	1	$20,000.00	$20,000.00
12	Supply and install "valve house"	L.S.	1	$30,000.00	$30,000.00
13	Construct a Concrete Outlet Headwall and apron	C.Y.	5	$850.00	$4,250.00
14	De-watering During Inverted Siphon & Outlet Structure Construction	DAY	25	$184.00	$4,600.00
15	Temporary Coffer Dam During Inverted Siphon & Outlet Structure Construction	L.S.	1	$15,000.00	$15,000.00
16	Rip-Rap at the Pipeline Outlet	C.Y.	10	$100.00	$1,000.00
17	Road S-24 Pavement Sawcut and Replace	S.Y.	36	$42.00	$1,512.00
				Subtotal Construction Items =	**$754,675.44**
				25% Engineering Services and Conceptual Stage Contingency =	**$188,668.86**
				Total Construction Items =	**$943,344.31**

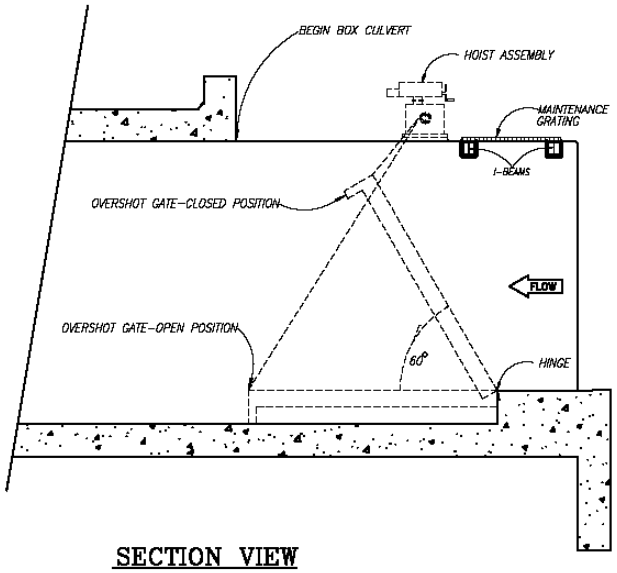
Present Value Life Cycle Costs (50 year Life Cycle, yearly interest rate of 5%):					
18	Operation & Maintenance	EA.	1	$19,168.72	$19,168.72
19	Replacement Costs	EA.	1	$29,530.28	$29,530.28
				Subtotal Lifecycle Items =	**$48,699.00**
				20% Conceptual Stage Contingency =	**$9,739.80**
				Total Lifecycle Items =	**$58,438.80**

(* Appoximate % of Construction Subtotal)

TOTAL = $1,001,783.10

Water Control Structures

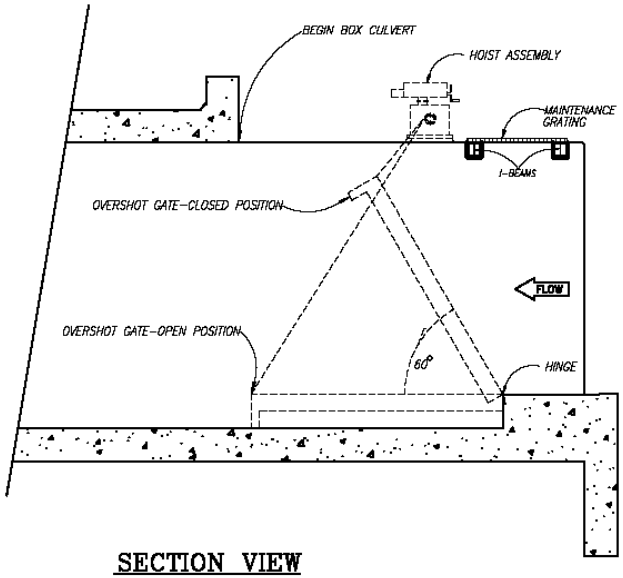
Overshot Gates



- Ease of adjusting water surface elevation via geared hoist and gas powered actuator (potential to automate)
- Precise water elevation control (0.25 inch increments)
- Minimal leakage if J-seal and Aluminum rubbing plate installed
- Gate allows surge flows and debris to pass over and carry on downstream

Water Control Structures

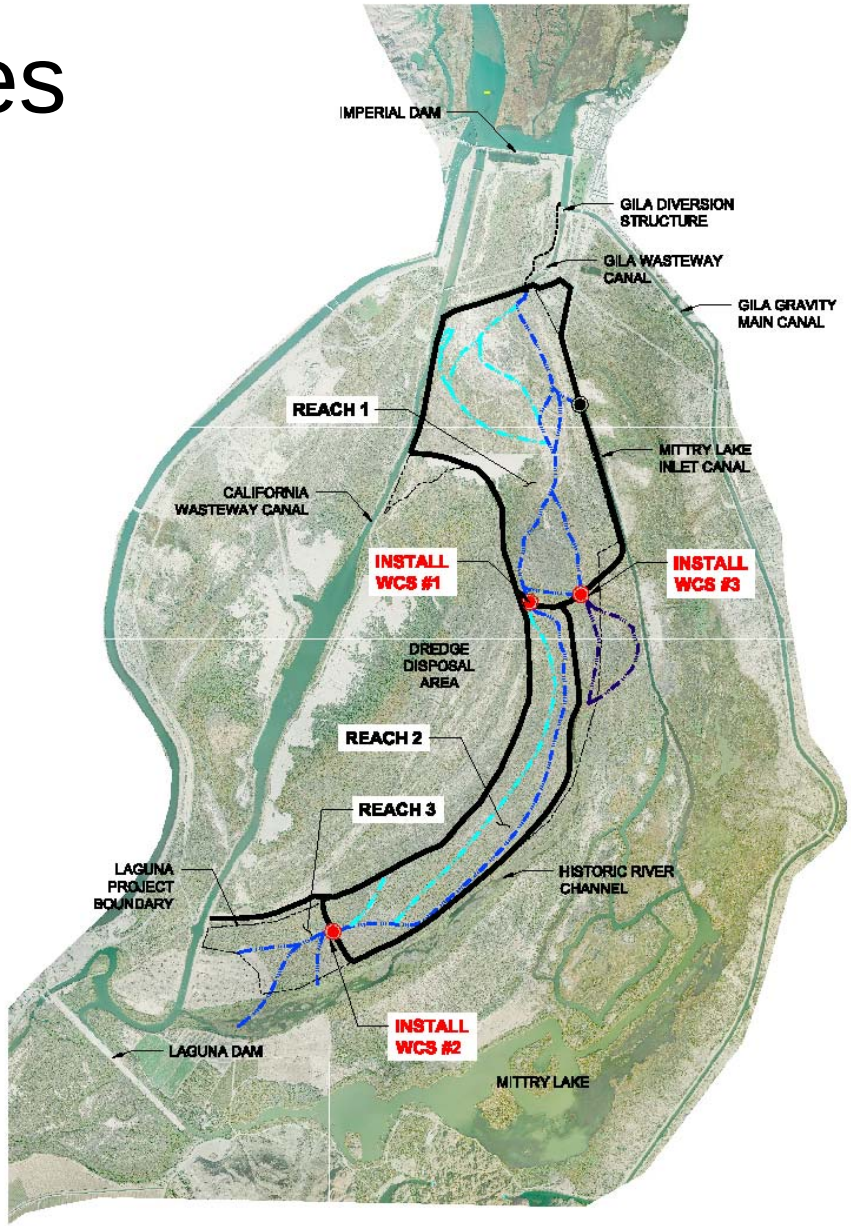
Overshot Gates



- Construction Cost - $255,000 /EA.
- Life Cycle Cost - $85,000 /EA
- Overall Cost - $340,000 /EA

Water Control Structures Overview

- Three (3) structures to control water surface elevations within the new units
  - WCS#1 and #2: In-line with new units
  - WCS#3: Turn-out for the Historic River Channel Alignment
- Structure Design Criteria
  - Allow easy water elevation adjustment to meet seasonal habitat and wildlife needs
  - Low O&M critical
  - Long life cycle ideal
  - Present worth lifecycle cost for 3 structures is $1,007,643.



LAGUNA RESTORATION

Water Control Structures

Conceptual Level Cost Estimate

ITEM NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	COST
1	Mobilization, SWPPP, & Construction Staking (*8%)	L.S.	1	$45,000.00	$45,000.00
2	Construct and install Overshot Gate and Culvert	EA.	3	$170,100.00	$510,300.00
2A	Construct Cast-in-Place Box Culvert - 10' Span x 10' High x 40' Long	C.Y.	192	$850.00	$163,200.00
2B	Construct Cast-in-Place Overshot Gate Bay - 10' Span x 10' High x 10' Long	C.Y.	24	$850.00	$20,400.00
2C	Construct Cast-in-Place Inlet Wing-Walls - 10' High, 2:1 Fill Slopes	C.Y.	69	$850.00	$58,650.00
2D	Construct Cast-in-Place Outlet Wing-Walls & Apron - 10' High, 2:1 Fill Slopes	C.Y.	93	$850.00	$79,050.00
2E	Supply & Install 10' Wide x 8' High Overshot Gate and Appurtenances	EA.	3	$63,000.00	$189,000.00
3	Rip-Rap Inlet and Outlet	C.Y.	120	$100.00	$12,000.00
4	Maintenance Grating	L.F.	36	$750.00	$27,000.00
5	De-watering During Structure Construction	DAY	75	$184.00	$13,800.00
				Subtotal Construction Items =	**$608,100.00**
				25% Engineering Services and Conceptual Stage Contingency =	**$152,025.00**
				Total Construction Items =	**$760,125.00**

Present Value Life Cycle Costs (50 year Life Cycle, yearly interest rate of 5%):					
6	Operation & Maintenance	EA.	3	$68,460	$205,379.16
7	Replacement Costs	EA.	3	$295	$885.91
				Subtotal Lifecycle Items =	**$206,265.07**
				20% Conceptual Stage Contingency =	**$41,253.01**
				Total Lifecycle Items =	**$247,518.08**

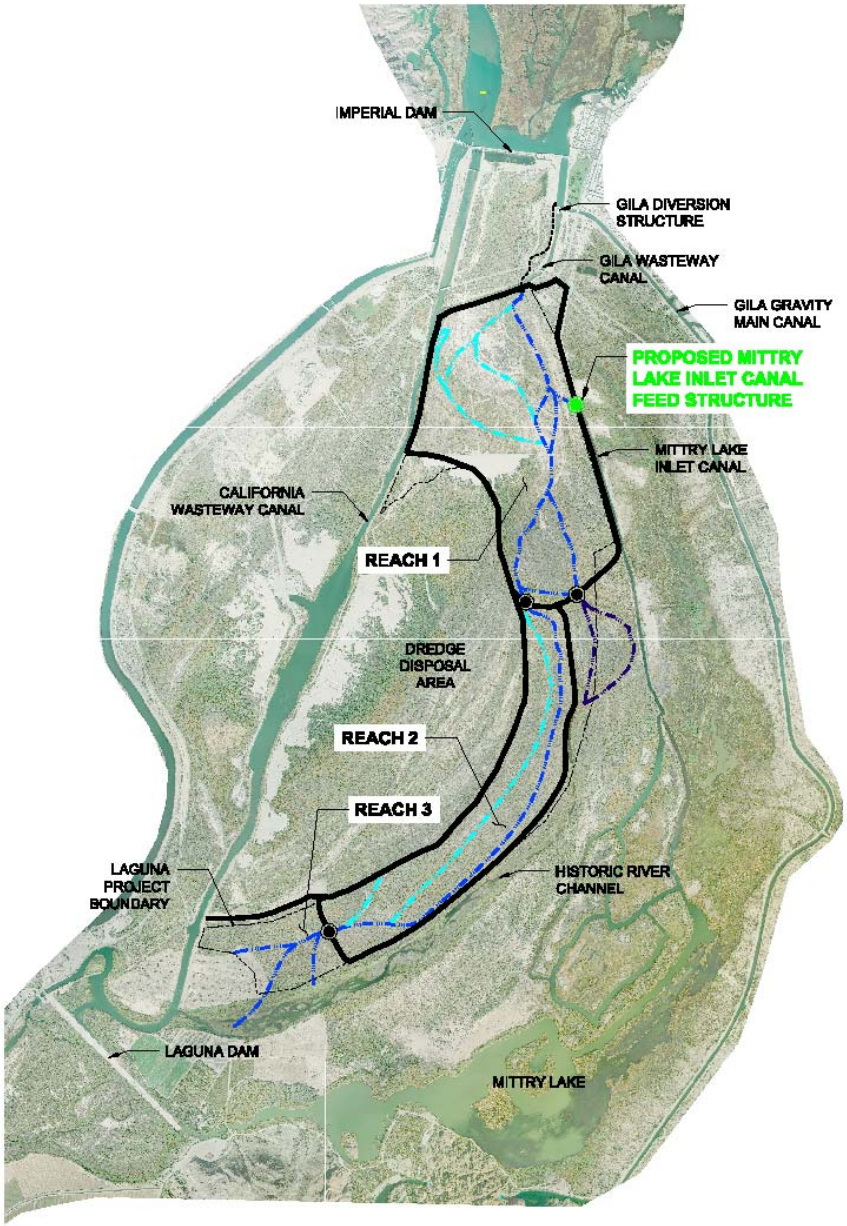
(* Appoximate % of Construction Subtotal)

TOTAL = $1,007,643.08

Proposed Mittry Lake Inlet Canal Feed Structure

Overview

- Analysis requested by AZGFD to enhance Mittry Lake habitat
- Similar Overshot Gate Structure as used to control flow through project, only smaller.
  - Would allow surplus water to be diverted from Upper Unit (Reach 1) to Mittry Lake Inlet Canal.
  - May require modifications to Mittry Lake Outlet Control and/or the proposed Laguna Inlet Water Delivery Pipeline.
- Structure Design Criteria
  - Allow easy water control of flow rate into Mittry Lake Inlet Canal.
  - Present worth lifecycle cost of structure is $182,706.



LAGUNA RESTORATION

Mittry Lake Inlet Canal Feed Structure

Conceptual Level Cost Estimate

ITEM NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	COST
1	Mobilization, SWPPP, & Construction Staking (*8%)	L.S.	1	$6,000.00	$6,000.00
2	Construct Cast-in-Place Box Culvert - 5' Span x 5' High x 40' Long	C.Y.	32	$850.00	$27,200.00
3	Construct Cast-in-Place Overshot Gate Bay - 5' Span x 5' High x 10' Long	C.Y.	4	$850.00	$3,400.00
4	Construct Cast-in-Place Inlet Wing-Walls - 5' High, 2:1 Fill Slopes	C.Y.	12	$850.00	$10,200.00
5	Construct Cast-in-Place Outlet Wing-Walls & Apron - 5' High, 2:1 Fill Slopes	C.Y.	16	$850.00	$13,600.00
6	Supply & Install 5' Wide x 4' High Overshot Gate and Appurtenances	EA.	1	$10,500.00	$10,500.00
7	Rip-Rap Inlet and Outlet	C.Y.	20	$100.00	$2,000.00
8	Maintenance Grating	L.F.	6	$750.00	$4,500.00
9	De-watering During Structure Construction	DAY	15	$184.00	$2,760.00
				Subtotal Construction Items =	**$80,160.00**
				25% Engineering Services and Conceptual Stage Contingency =	**$20,040.00**
				Total Construction Items =	**$100,200.00**

Present Value Life Cycle Costs (50 year Life Cycle, yearly interest rate of 5%):					
10	Operation & Maintenance	EA.	1	$68,460	$68,459.72
11	Replacement Costs	EA.	1	$295	$295.30
				Subtotal Lifecycle Items =	**$68,755.02**
				20% Conceptual Stage Contingency =	**$13,751.00**
				Total Lifecycle Items =	**$82,506.03**

TOTAL = $182,706.03

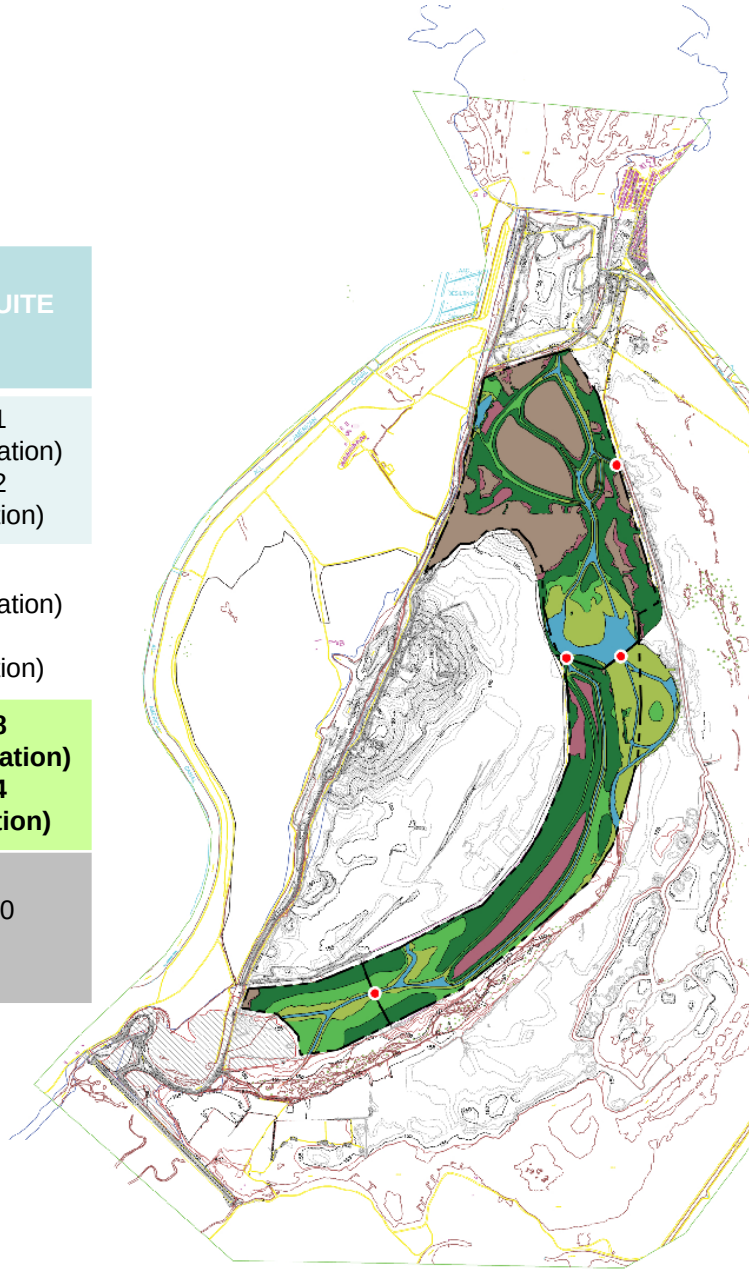
Revegetation Design Rationale

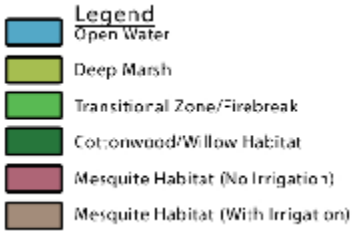
- Design includes methods that have proven to be successful in creating marsh and transitional habitats
- 15 years of experience on the LCR has provided the following insights:
  - Germination success of salt tolerant native marsh herbaceous species seeds
  - Plantings of *Anemopsis californica* have thrived in wet areas that are frequently inundated
  - Specify plug or liner plantings for the cottonwood and willow species based on salinity. Sandbar willow or honey mesquite should be planted instead of cottonwood and gooding willow if the salinity exceeds 1000 ppm.
  - In general one-gallon pot plantings of *Prosopis glandulosa* var. *torreyana* have had a higher ratio of establishment success than smaller plug plantings when planted directly into moist soils (the existing water table) with no supplemental irrigation.
  - 2 ¼" plugs of *Distichlis spicata* planted on 5' centers in moist/wet soils will establish a solid cover within one year.
  - In general plugs used for emergent marsh planting will yield much higher success than using seeds.
  - Planting all the emergent marsh species mentioned at 5' O.C. should yield a solid cover of emergent plants within 1 year of planting.
  - Weeding and maintenance of the revegetation site in the first and part of the second year of growth are critical. The second year usually transitions into an as needed basis. However, it is anticipated that maintenance will need to occur until all exotic species and phragmites are out competed by native grasses and trees.

Revegetation Design
Habitat Types

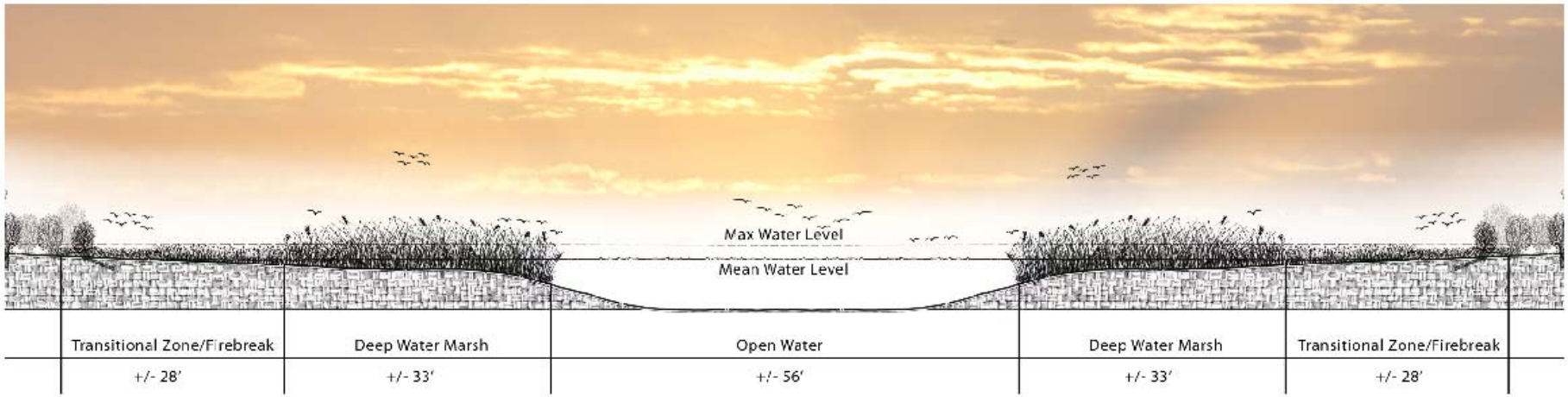
Habitat Acreages

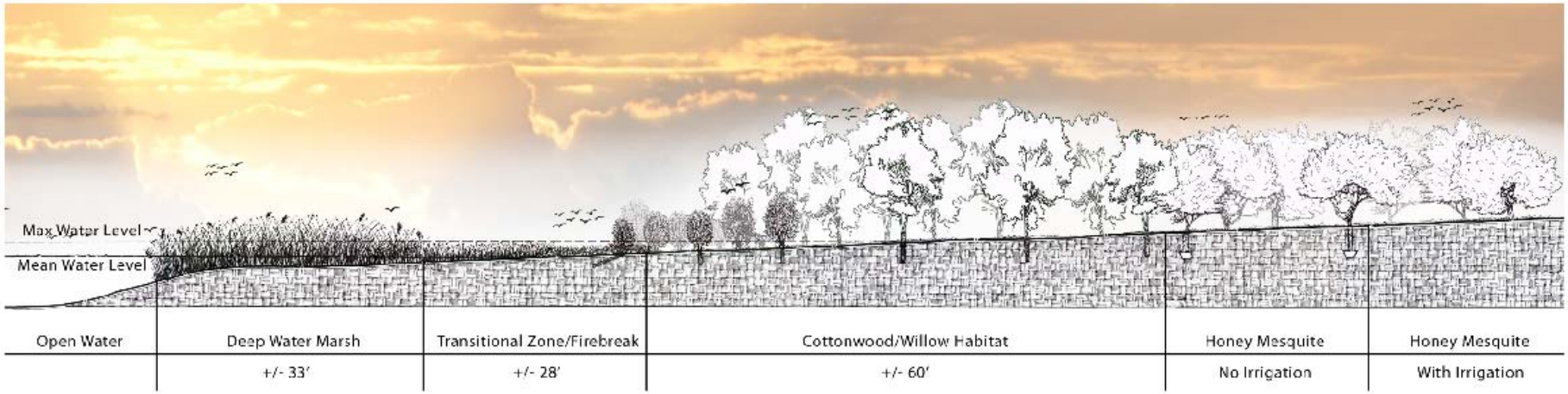
	OPEN WATER	DEEP MARSH	TRANSITION ZONE/ FIRE BREAK	COTTONWOOD/ WILLOW	MESQUITE
Reach 1	47	53	44	139	151 (no irrigation) 182 (irrigation)
Reach 2	37	111	126	174	57 (no irrigation) 2 (irrigation)
Project Totals	**84**	**164**	**170**	**313**	**208 (no irrigation) 184 (irrigation)**
MSCP Targets	50-100			>200	<500





Revegetation Design
Primary Channels





Natural Channel Design, Inc.

Fred Phillips Consulting

SWI Shephard & Wiesnitzer, Inc.

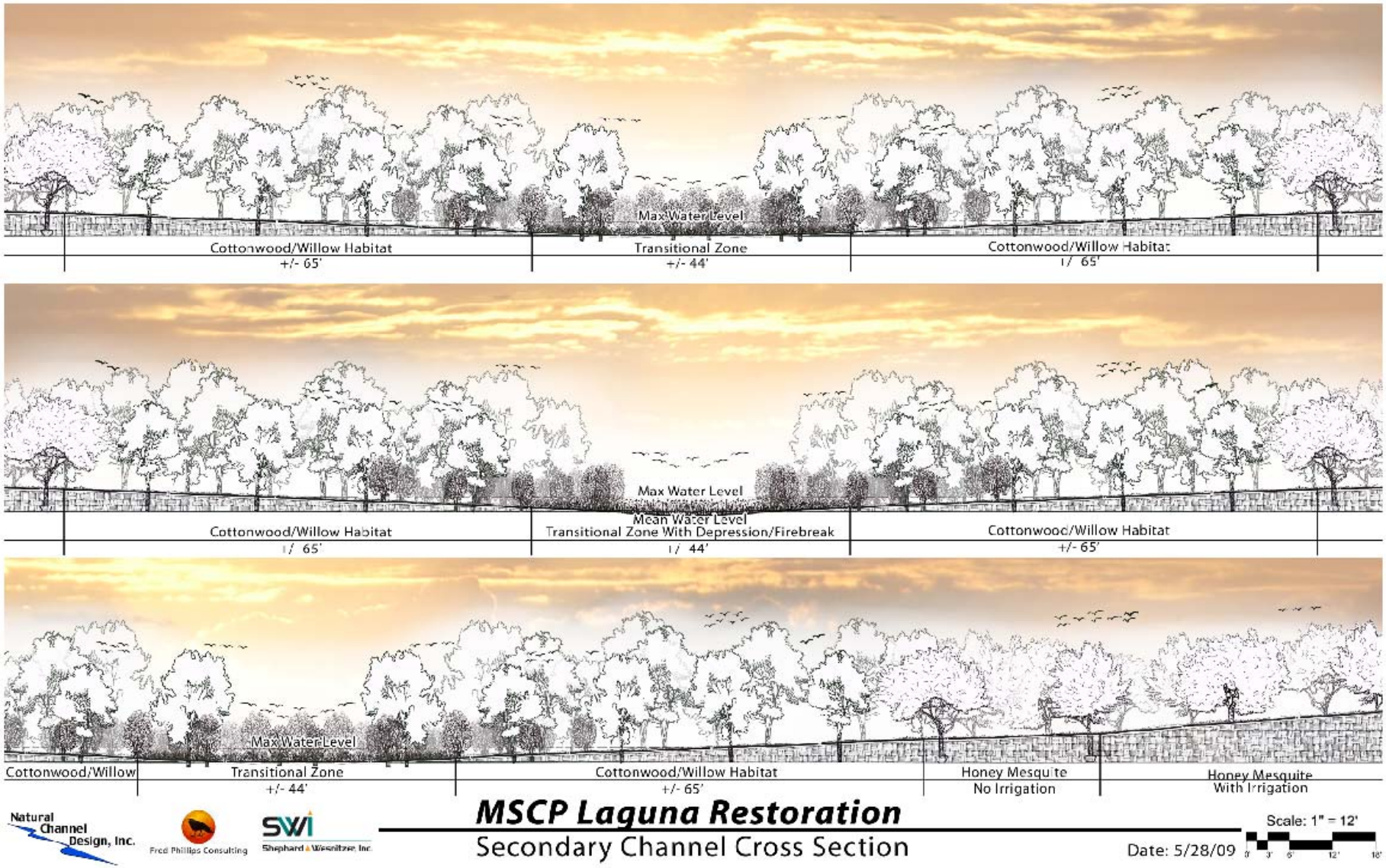
MSCP Laguna Restoration

Primary Channel Cross Section

Date: 5/28/09

Scale: 1" = 12'

Revegetation Design
Secondary Channels



LAGUNA RESTORATION

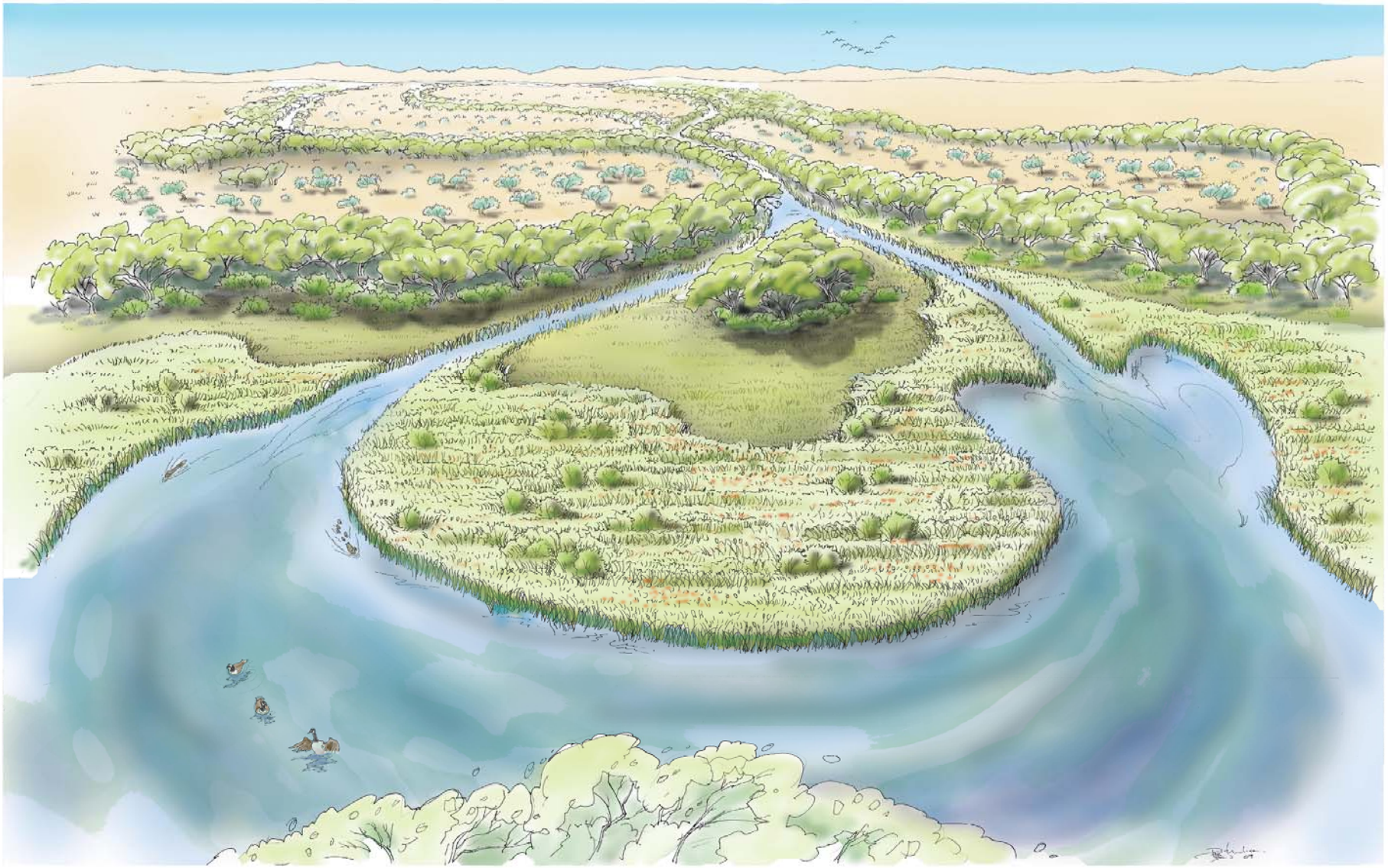
Revegetation

Conceptual Level Cost Estimate

ITEM NO.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	COST
	Deep Marsh Revegetation (harvested and planted)				
1	Plugs, Harvested, 5' O.C. @ 1742 Plants/Acre	ACRE	164	$3,338.50	$547,514.00
	Transitional Zone Revegetation (harvested and planted)				
2	Plugs, Harvested, 5' O.C. @ 1742 Plants/Acre	ACRE	170	$3,338.50	$567,545.00
3	Disking/Seeding, 20lbs/Acre, Various Understory	ACRE	170	$170.00	$28,900.00
	Cottonwood /Willow Revegetation				
4	Liners, 5-12' O.C. @ 1742 Plants/Acre	ACRE	313	$2,198.90	$688,255.70
5	Plugs, Harvested, 5' O.C. @ 1742 Plants/Acre	ACRE	313	$3,338.50	$1,044,950.50
6	Disking/Seeding, 20lbs/Acre, Various Understory	ACRE	313	$170.00	$53,210.00
	Mesquite No Irrigation				
7	Mesquite, 1 Gallon Deep Pots, 30' O.C. @ 50 Plants/Acre	ACRE	108	$972.00	$104,976.00
8	Plugs, Harvested, 5' O.C. @ 1742 Plants/Acre	ACRE	54	$3,338.50	$180,279.00
9	Disking/Seeding, 20lbs/Acre, Various Understory	ACRE	108	$170.00	$18,360.00
	Mesquite, With Irrigation				
10	Mesquite, 1 Gallon Deep Pots, 30' O.C. @ 50 Plants/Acre	ACRE	184	$1,972.00	$362,848.00
11	Plugs, Harvested, 12' O.C. @ 302 Plants/Acre	ACRE	184	$1,000.00	$184,000.00
12	Disking/Seeding, 20lbs/Acre, Various Understory	ACRE	184	$170.00	$31,280.00
				Subtotal Revegetation Items =	**$3,812,118.20**

Present Value Life Cycle Costs (5 year Life Cycle, yearly interest rate of 5%):					
13	Operation & Maintenance	L.S.	1	$2,595,608	$2,595,607.85
				Subtotal Lifecycle Items =	**$2,595,607.85**

TOTAL = $6,407,726.05



Natural Channel Design, Inc.

Fred Phillips Consulting

SWI Shephard Wesnitzer, Inc.

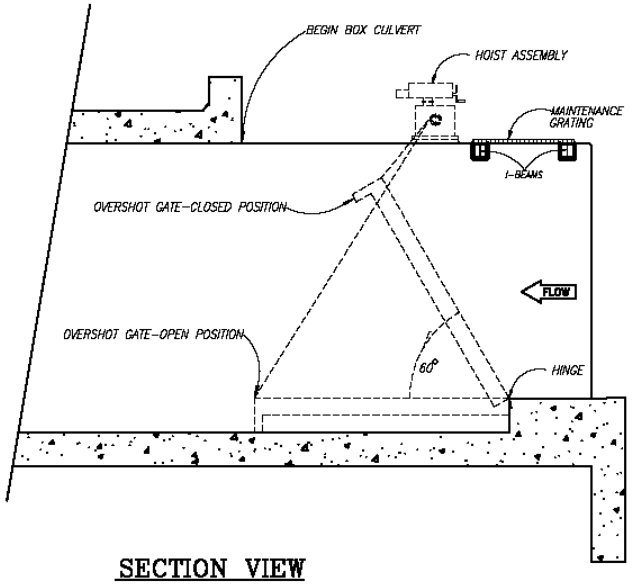
MSCP Laguna Restoration

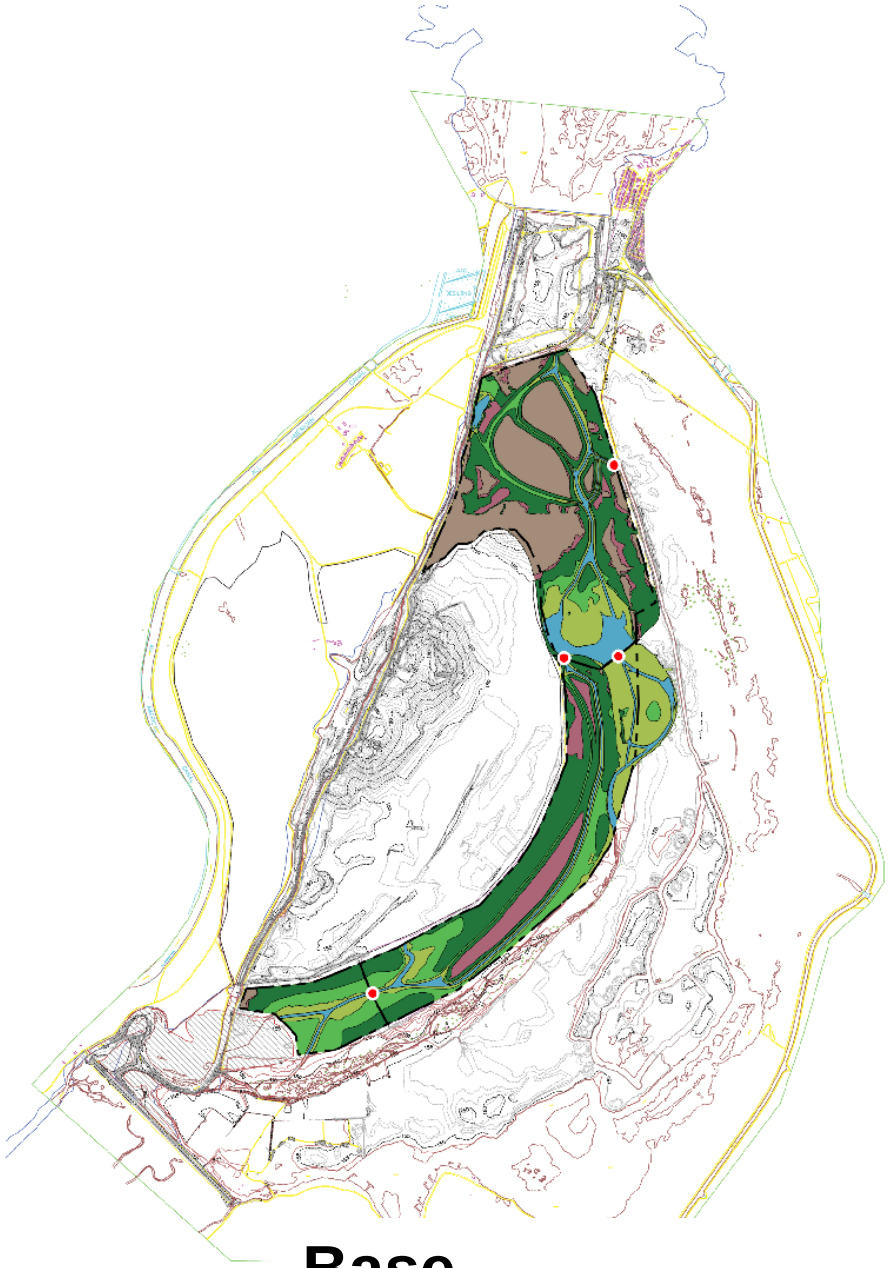
Reach 1 Concept Drawing

Date: 8/18/09

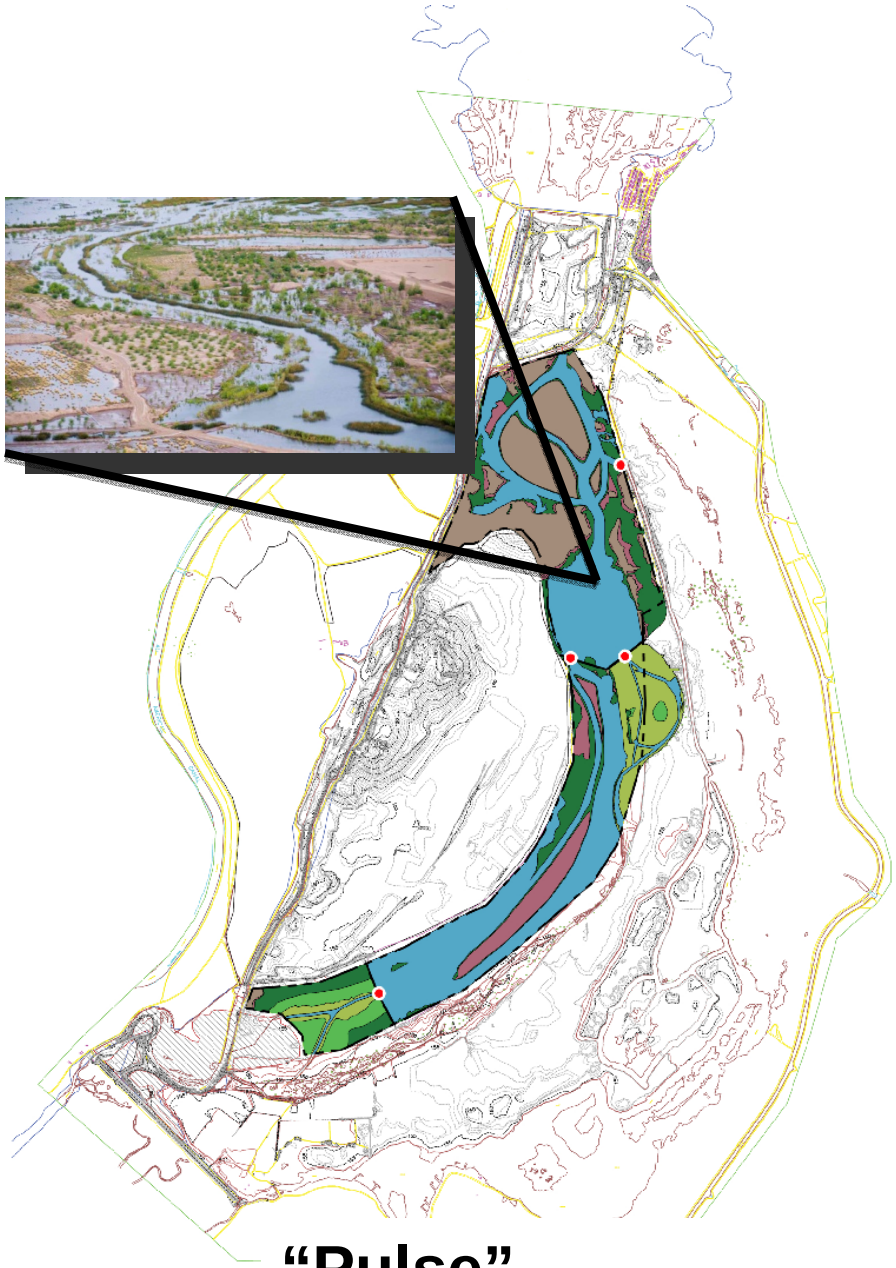
System Operation Overview

- Utilize overshot gates to manage water surface elevations in Reach 1 and Reach 2
  - Overshot gates allow easy water elevation adjustment
  - Will allow irrigation of cottonwoods & willows at higher elevations through simulated flood events (pulse flows)
  - Reach 1 and Reach 2 are in-series cells – water management will require choreography of Reach 1 and Reach 2 gates
- Adaptive management
  - Adjust operation as seasonal habitat and wildlife needs dictate
  - Adjust operation as vegetation matures



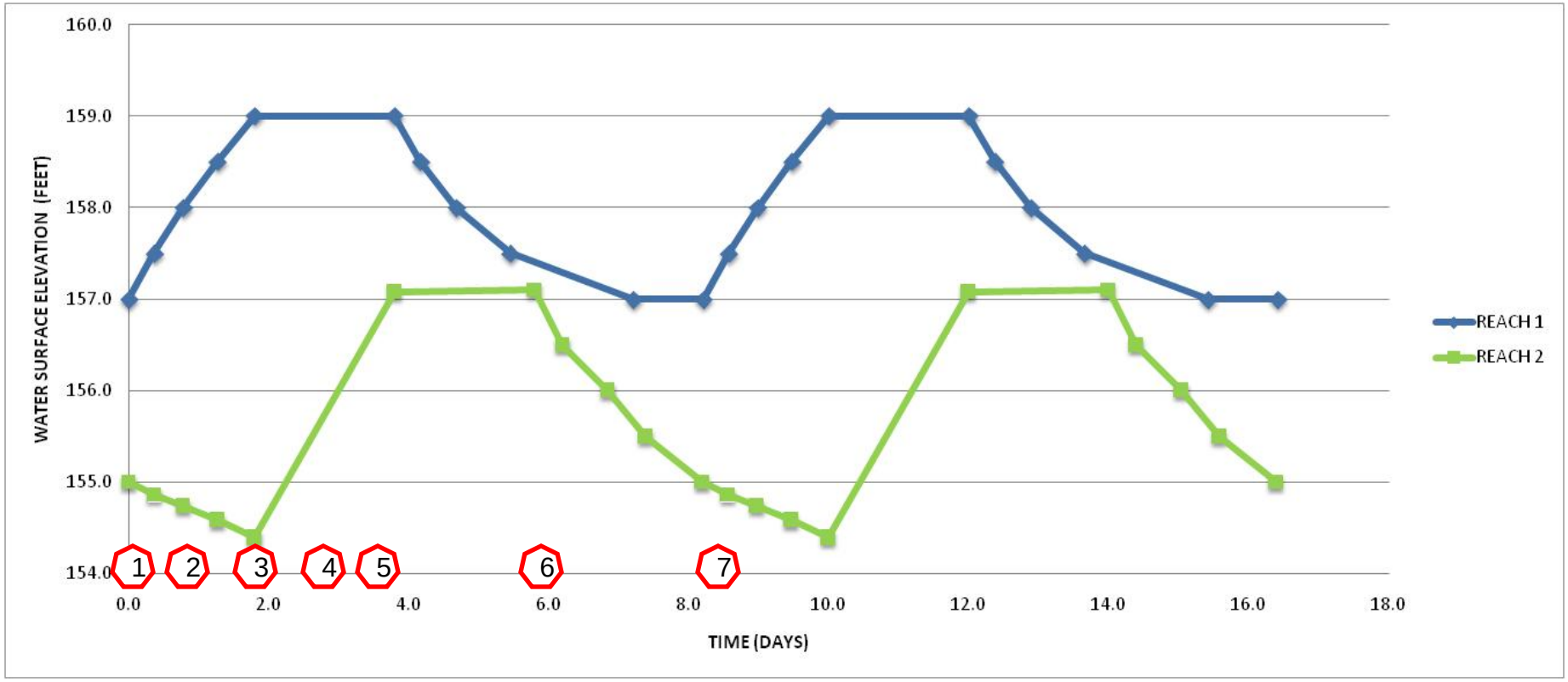


Base
Water Level
430 acre-feet



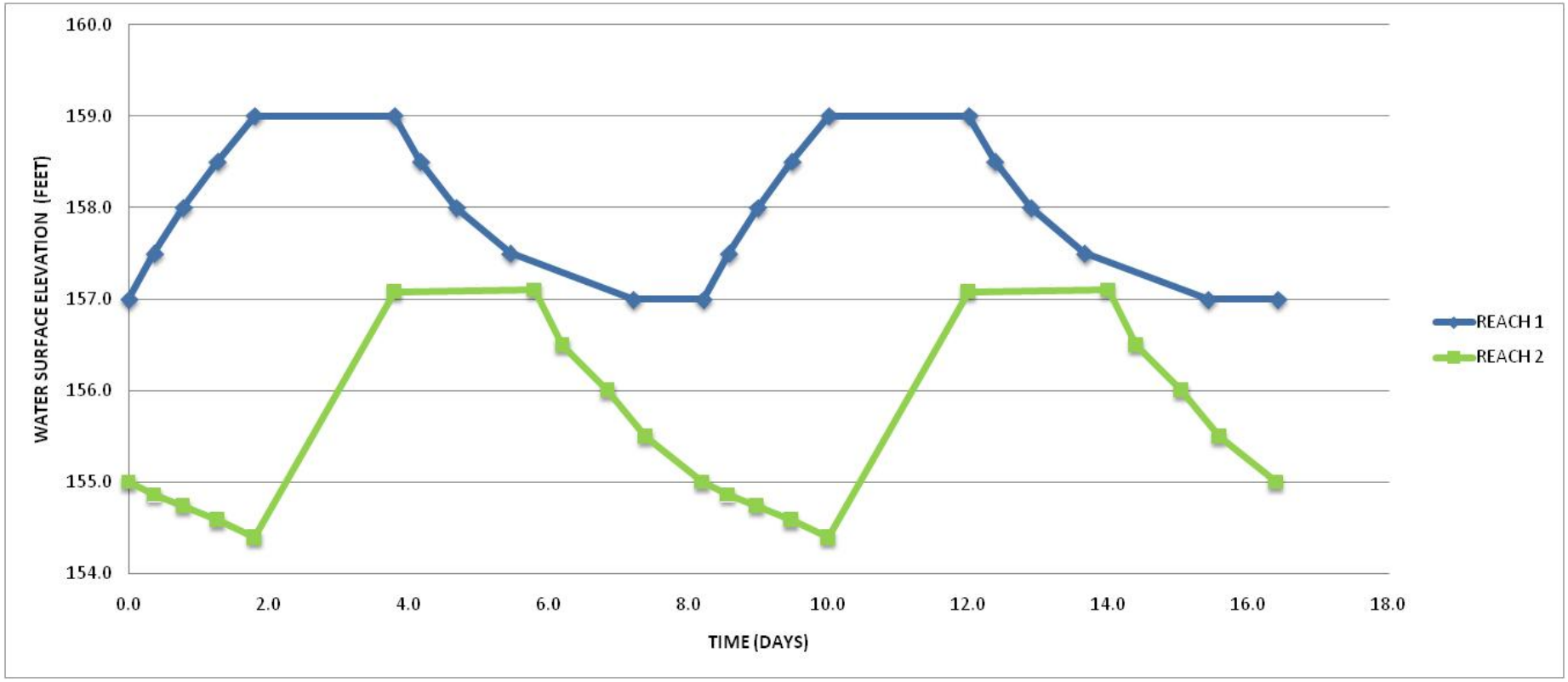
“Pulse”
Water Level
1030 acre-feet

Conceptual System Operation Hydrograph



1. Reach 1 overshot gate “closed”. Flows to Reach 2 are cut-off.
2. Reach 1 fills. With no influx, Reach 2 loses water to ET/EVAP/Seepage
3. Reach 1 hits “pulse” water surface and begins to overtop its overshot gate. Reach 2 overshot gate “closed” and Reach 2 begins to fill with overflow water from Reach 1.
4. Reach 1 is kept at “pulse” water surface for two days, allowing soils to saturate and reach deep pot plantings of mesquite and cottonwood. Reach 2 fills to it’s “pulse” water surface elevation.
5. Reach 1 overshot gate is adjusted to pre-pulse position and water in Reach 1 is drawn-down. Reach 2 is kept at “pulse” water surface for two days (see #4, Reach 1). Reach 2 gate is adjusted to maintain pulse water surface elevation and allow for additional draw-down flows from Reach 1.
6. Reach 1 continues to draw down. Reach 2 overshot gate is adjusted to pre-pulse position and water in Reach 2 is drawn-down.
7. Next irrigation cycle begins ~ 6.2 day gap between pulses

Conceptual System Operation Hydrograph



- Conceptual Model
  - Modeled the month of July (highest ET/EVAP rates)
  - Fill rates will change with ET/EVAP/Seepage rates
  - System operation will require tweaking – overshot gates allow that
- Long-term Adaptive management
  - Once vegetation is established and can be stressed, pulse events can be decreased
  - Example: Steadier flows are beneficial for black rail nesting (April – June)

Conceptual Water Budget

POST-DEVELOP ET/EVAP (acre-ft/yr)*	POST-DEVELOP SEEPAGE (acre-ft/yr)**	POST-DEVELOP TOTAL (acre-ft/yr)	PRE-DEVELOP ET (acre-ft/yr)*
5750	615	6365	5560

* Evaporation rates per Cooley, K.R., 1970, Evaporation from open water surfaces in Arizona: University of Arizona College of Agriculture, folder 159. Evapotranspiration rates for different habitat types provided by BOR (average of years 2005-2007)

** Seepage rate calculations for Reach 2 based on groundwater and soil log data for well AP-103-08. Reach 1 groundwater is at or above the proposed channel invert so seepage is assumed to be minimal.

Conceptual Level Cost Estimate Summary

Project Component	Construction Costs	O & M Costs (50-Year Life Cycle)	Component Total
Earthwork	$11.8M	$0.5M	$12.3M
Water Delivery & Control Structures	$1.7M*	$0.3M	$2.0M
Revegetation	$3.8M	$2.6M**	$6.4M
PROJECT TOTAL	**$17.3M**	**$3.4M**	**$20.7M**

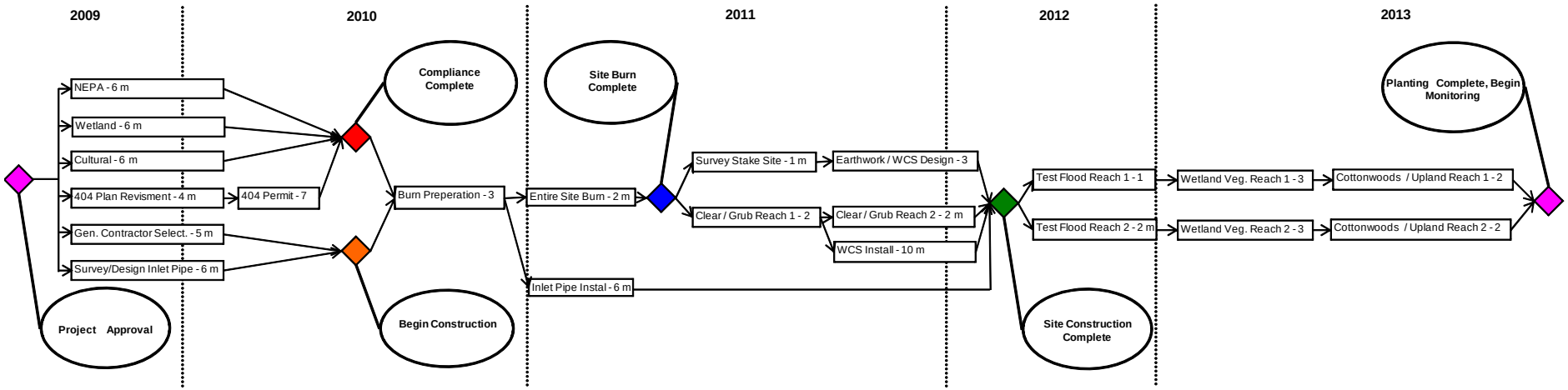
* Does not include the Mittry Lake Inlet Canal Structure
** Assumes 5-years of intensive work at the beginning of the project, minimal work thereafter

Additional Information Needs

- Soil information
  - Salinity
  - Texture
  - Nutrients
- Additional Monitoring Wells along Proposed Channels
  - Groundwater information
  - Soil cores
- Existing Infrastructure Information
- Existing vegetation information
- Detailed topographic survey

Timeline for Project Development

Laguna Division Conservation Area
Proposed Schedule



Key	
◆	Milestone
	Project Start and End
	Compliance
	Begin Construction
	Burn
	Complete Construction

Questions?