100% Design Submittal

BASIS OF DESIGN REPORT

SPECIES CONSERVATION HABITAT

DWR PROJECT NO. 4600008734

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Acronyms and Abbreviations

API	American Petroleum Institute
BLM	Bureau of Land Management
CA	California
CDFW	California Department of Fish and Wildlife
cfs	Cubic feet per second
cm	Centimeter
CORS	Continuously Operating Reference Stations
County	Imperial County
DEM	Digital elevation model
DOGGR	California Division of Oil, Gas & Geothermal Resources
DSOD	Division of Safety of Dams
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EIS/R	Environmental Impact Statement/Report
ESRI	Environmental Systems Research Institute
ft	Feet
GPS	Global positioning system
HDPE	High-density polyethylene
IID	Imperial Irrigation District
LGP	Low ground pressure
Lidar	Light Detection And Ranging
mg/L	Miligram per liter
msl	Mean sea level

Acronyms and Abbreviations

N	North
NAD 83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NGS	National Geodetic Survey
NGVD 29	National Geodetic Vertical Datum of 1929
NR	Near
OPUS	On-line Positioning User Service
PEIR	Programmatic Environmental Impact Report
ppt	Parts per thousand
Project	Early start project of the SCH
QSA	Quantification Settlement Agreement
Reclamation	Bureau of Reclamation
RMSEz	Root mean squared error values
RTK	Real Time Kinematic
SCH	Species Conservation Habitat
Sea	Salton Sea
SIO	Scripps Institution of Oceanography
SSAM	Sea Salton Sea Accounting Model
US	United States
USBR	Bureau of Reclamation
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

INTRODUCTION

The Species Conservation Habitat (SCH) project provides shallow water habitat to support fish and wildlife dependent upon the Salton Sea that is being lost due to salinity increases and the declining water surface elevation. The Project is located at the southern end of the Salton Sea (Sea) in Imperial County, California. Through the environmental review process, a Preferred Alternative was selected that encompasses 3,770 acres on both sides of the New River. The Project would include water supplies, berms to contain the water, and various other support facilities.

The early start construction of the project is to develop habitat consistent with the EIS/EIR preferred alternative that is scaled down to fit the level of implementation funding currently available. The design described in this report is for early start project (Project) of the SCH and is limited to the 640 acres located within the bay on the east side of the New River. This report provides a summary of the primary design features and considerations associated with the habitat development. A more detailed discussion of the background, purpose, goals, design elements, Preferred Alternative, and Project impacts can be found in the 2011 draft EIS/EIR.

Project Background

Declining inflows to the Sea from reduced agricultural drainage and the 2017 end of QSA mitigation water will result in significant deterioration of the Salton Sea ecosystem due to increasing salinity and other water quality issues, such as temperature, eutrophication, and related algal productivity and anoxia. The SCH project seeks to address the most serious and immediate threat to the Salton Sea ecosystem associated with rapid salinity increase: the loss of fishery resources that support migratory, piscivorous birds.

The SCH project is designed as a proof-of-concept project in which several project features, characteristics, and operations could be tested under an adaptive management framework for approximately 10 years after completion of construction (until 2025). By then, managers would have had time to identify those management practices, through an adaptive management program, that best meet the project goals. After the proof-of-concept period, the Project would be operated until the end of the 75-year period covered by the Quantification Settlement Agreement (2078), or until funding was no longer available. The California Department of Fish and Wildlife (CDFW) proposes to construct, operate, and maintain the SCH.

Habitat Objectives

Goal 1: Develop a range of aquatic habitats that will support fish and wildlife species dependent on the Salton Sea. The SCH project's purpose is to provide in-kind replacement for near-term habitat losses. The project's target species are those piscivorous bird species that use the Salton Sea and that are dependent on shallow saline habitat for essential habitat requirements and the viability of a significant portion of their population.

Goal 2: Develop and refine information needed to successfully manage the habitat through an adaptive management process. An adaptive management framework provides a flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation, leading to continuous improvement in management planning and project implementation to achieve specified objectives. The information obtained will be used to measure project effectiveness, to refine operations and management of the ponds, to reduce uncertainties about key issues, and to inform subsequent stages of habitat restoration at the Salton Sea.

Description of Project

The State of California Department of Fish and Wildlife (CDFW) plans to construct approximately 640 acres of ponds on the east side of the New River within a shallow bay. The bay was previously connected to the Salton Sea until recently when the elevation of the Sea dropped sufficiently to cut off the bay from the Sea. The bay then received water from a weir on the New River and pumped agricultural return flows. The site is bounded by an existing berm along the New River to the west and southwest, an existing levee road on the east, and the Salton Sea to the north.

The ponds will be formed with constructed berms to retain water pumped in from the Sea and the New River. The maximum water surface in the ponds will be -228 feet msl, equivalent to the recent surface elevation of the Salton Sea until the year 2000 when the level began dropping. Water depth in the SCH ponds varies from very shallow feathered edges to a maximum depth of 6 feet in habitat channels, with an average water depth of 2.7 feet.

Water supply for the habitat ponds will be provided by low-lift pump stations that deliver brackish New River water and saline Salton Sea water. The surface elevation of the Salton Sea is currently at approximately -233 msl and projected to continue dropping to an ultimate surface elevation of -249 msl in 2040. The New River at the project site location has an average water surface elevation of approximately -229 msl except during infrequent storm events.

Figure 1 shows the Project area and the immediate features of the berms and water supplies.

Project Site Property

Habitat Ponds: The SCH primarily occurs on land parcels owned by Imperial Irrigation District (IID). The CDFW is developing a Draft lease agreement with IID to construct and operate the SCH on these lands. One parcel, designated 'USA' on Assessor's parcel maps and determined to be under Bureau of Land Management (BLM) jurisdiction, will be encroached on its easterly boundary. The boundary of this parcel extends slightly to the east of the New River where the pond impoundment berm will be constructed. A permit secured from BLM allows for embankment of the new berm impoundment to be constructed on the affected parcel. The land parcels surrounding the SCH are also owned by IID.

Pump Stations and Pipeline: The river and saline pump stations occur entirely on IID property. The saline water delivery force main occurs primarily on IID land including the IID levee road, Bowles Road, the IID easement adjacent to Kornbloom Road, and the IID levee road north of Young Road. There is a 1-mile section adjacent to Kornbloom Road between Bowles Road and Young Road that is within an IID easement.

Access: The access route to the project site for equipment and material delivery, daily construction traffic, and long term habitat management will be Bowles Road to its western end, and then south along the unnamed IID levee road. The Bowles Road portion, east of Kornbloom Road, is public right-of-way under the jurisdiction of Imperial County Public Works. Use of the IID levee road is by IID encroachment permit for ingress/egress. Access for the saline pump station and force main will be from Young Road and the north-south IID levee in addition to those already noted. Both Young Road and Bowles Road connect with Lack Road and then to State Route 86.

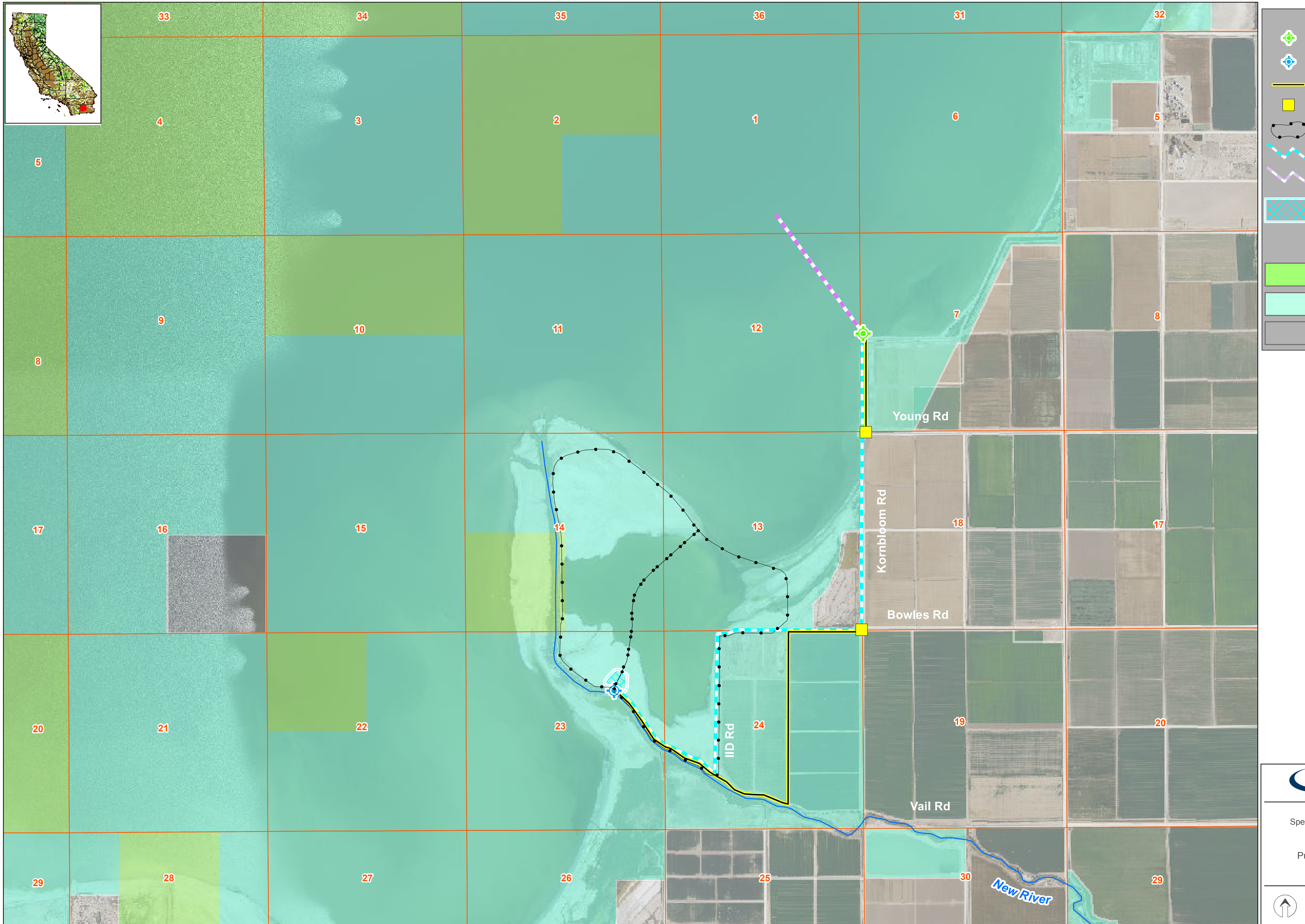

FIGURE 1.

Cardno ENTRIX

SALTON SEA

Species Conservation Habitat Project

Pump Station Concept - Final

0 250 500 1,000 1,500 2,000 Feet

Date: 11/25/2013

Projection: CA State Plane, Zone 6
Datum: NAD 83

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Cost Considerations and Design Approach

The design and construction of the SCH Project at the Salton Sea is challenging due to the location of the project and site-specific soil conditions. Many factors contribute to the costs for construction when compared to other wetland projects. The cost to construct the SCH project is estimated to be approximately $25 million, or about $39,000 per acre. For comparison, tidal wetland restoration projects in areas that have soft soils in the San Francisco bay area ranges have construction costs that range from $4,500 to $23,000 per acre. Factors that contribute to the cost for construction include:

- The native soils at the Sea are very weak and dispersive. Therefore, specialized construction techniques are required to support the berms and strengthen the foundation. The simple approach of excavation and placement of berm fill material will not work on this site and a more complicated design was required.
- Capital costs to build the water supply infrastructure are required. These include the pumped river diversion, and saline water pump station and pipeline. As the Sea continues to recede, these facilities may need to be modified to continue to provide their intended function.
- Electric power utility poles and lines need to be installed to extend power to the river and saline pump stations.
- The constructed berms will be subject to substantial wind wave forces. Winds at the Sea are known to be high, requiring erosion control methods to be built into the design of the ponds.
- The project includes habitat channels dredged up to 6 feet deep for predation control and to give fish refuge during seasonally extreme environmental conditions. Large and small islands are also constructed to give birds a safe place to rest and nest. Such safe areas are severely limited around the Salton Sea.

The SCH project has been carefully designed to take into consideration the challenging circumstances of its location. No other similar projects have been constructed on the receding Sea bed, and this design forges new territory in this type of habitat development. The SCH project strikes a balance between delivering habitat goals and cost-saving, pragmatic engineering solutions.

It is emphasized that achieving a balance between quality habitat, adequate water supply and stable pond impoundment structures in a cost efficient manner is extremely challenging when developing habitat on the playa and in the Sea. The project site was selected as being the best location for providing the most acres of habitat for the available construction budget. It should be expected that future projects with similar project goals will have a higher habitat cost per acre considering water supply and drainage points, topography, existing soil characteristics and Sea surface elevation at the time of construction. Attempting to develop habitat impoundment berms within the Sea, even in shallow water, will have a significantly higher cost per acre. See the discussion under Pond Impoundments for associated considerations. The 2011 draft EIS/EIR contains analysis of other project sites investigated.

Risk

An assessment of risk has been integral to the design process to achieve a balance between the structural stability of the pond impoundments and construction cost. The berms are not designed to be levees with the required structural integrity and height to withstand infrequent threats such as significant wave erosion or earthquakes known to occur in this region. To do so would require removal of approximately 3 to 8 feet of weak soils and building the berm foundations up from firmer underlying soil layers.

There is little risk to property or life because failure of an impoundment berm would result in an uncontrolled release of water only to the Salton Sea. Thus, the berms are designed to impound water under normal conditions rather than for earthquake loading or severe wave action.

The berms will require periodic inspection and maintenance for a variety of factors that include:

- Erosion from wind waves on side slopes and berm tops. With a freeboard of 2 feet, spray from waves during high wind events will overtop the berms.
- Seepage through or beneath the berm embankments causing internal erosion. Seepage that begins to erode the downstream berm slopes or causes unacceptable water losses will require intervention by means of cutoff trench coring or vinyl sheetpile installation in affected areas of the berm.
- Settlement of berms. Differential settling is expected along the berm alignments due to the variability in the quality and strength of the foundation soil layers. Settling will be partially addressed through building the berms in stages and allowing settlement between each stage. If a section of berm settles below the design crest elevation, it will need to be raised to maintain the needed freeboard.
- Berm or foundation soil failure due to ground shaking from the active earthquake faults in this region. The Salton Sea Trough has three main fault zones: San Andreas, San Jacinto, and Elsinore. The Imperial Valley portion of the Salton Trough is very active and has experienced relatively frequent small to moderate earthquakes, as well as occasional stronger earthquakes with a magnitude greater than 6.0. It is an accepted risk that the SCH pond berms could experience settlement, deformation and cracking resulting in a breach in the event that the sandy foundation soils with little cohesion liquefy or otherwise fail. The SCH berms are not designed to withstand earthquake induced soil failures due to the small impact of an uncontrolled release of impounded water. Should berm failure result in a release of water from the SCH ponds, water would flow out onto the playa into the Sea, into the New River near its mouth, or potentially inundate a portion of the adjacent agricultural field. Beyond the SCH pond infrastructure itself, the chance for property damage or human injury is low. Construction of the berm impoundments to a standard designed to provide a substantial resistance to deformation or failure would require excavation and replacement of a large volume of the weak in-situ base soils. Such an earthwork undertaking would incur excessive cost rendering the project infeasible.

STUDIES AND SITE INVESTIGATIONS

Previous Studies

There are numerous prior studies and reports relating to Salton Sea habitat restoration projects and restoration planning that were used to inform the design of the SCH, including:

- Salton Sea Ecosystem Restoration Program Final Programmatic Environmental Impact Report (PEIR) (DWR and DFG 2007)
- Implementation Plan for Species Conservation Habitat (DWR 2009)
- Construction Report - Shallow Habitat Wetland Project at the Alamo River (Agrarian Research 2006)
- Restoration of the Salton Sea Summary Report - Draft (Reclamation 2007)
- White Paper on Shallow Habitat at the Salton Sea (CH2M Hill 2004)
- Performance Evaluation of the New River Demonstration Wetlands (Tetra Tech 2006)
- The Future of the Salton Sea With No Restoration Project (Pacific Institute 2006)
- Characterization of Shallow Sub-Surface Sediments of the Salton Sea (Agrarian Research 2003)
- Salton Sea Restoration Project - Preliminary In-Sea Geotechnical Investigation (URS 2004)
- Salton Sea Revitalization Plan - Geotechnical Data Report (URS 2007)
- Salton Sea Salinity Control Research Project (USBR and Salton Sea Authority 2004)

Special Studies

The Salton Sea Species Conservation Habitat Project - Draft Environmental Impact Statement/ Environmental Impact Report (Cardno ENTRIX 2011) contains in-depth context for the design of this project, including several studies focused on ecorisk and fishery ecology.

Topographic Surveys and Terrain Modeling

Project Datum.

The horizontal datum is the California Coordinate System of 1983, Zone 6 (0460), NAD 83 (CORS96) derived from Static GPS observations corrected using the NGS OPUS program.
The vertical datum is National Geodetic Vertical Datum of 1929 (NGVD 29) derived from RTK GPS ties to the NGS Benchmark "X 750". This benchmark was used to establish the project vertical datum as it is taken to be the basis of the USGS Gauging Station "10254005 Salton Sea near Westmorland, CA". The gauging station provides water surface elevation for the Salton Sea. Utilizing this vertical datum and benchmark allows the project design elevations to be referenced to the reported sea surface elevations, both current and historical.

USGS Surveys

Airborne Lidar

Dewberry & Davis collected high resolution topographic data along the perimeter of the Salton Sea during November 9-13, 2010. Lidar cannot penetrate water or dense vegetation such that these data coverage gaps must be gathered with other survey techniques. The Lidar data were compiled to meet a vertical accuracy of 9.25 cm and based on independently survey checkpoints the RMSEz is 3.5 cm. The original ESRI grid files (DEM) provided by USGS were re-projected to State Plane Zone 6 in US Survey feet, converted from meters to feet for elevation, and lowered 2.05 feet to account for the NAVD88 to NVGD29 delta computed for this particular region by NADCON software.

Bathymetry

Scripps Institution of Oceanography (SIO) collected multi-beam data in deeper water (November 2008-February 2009) and single beam data in shallow areas along the perimeter of the Sea (February 2009-March 2009). Data was provided in NGVD 29 referenced to the primary SCH benchmark USGS Gage 10254005 – Salton Sea NR Westmorland CA.

CA Department of Water Resources Surveys

Ground-based Lidar

SIO collected a limited amount of topography utilizing a ground based Lidar unit (October-December, 2010). This data was not incorporated into the terrain model since other more complete coverage was available from other sources.

Bathymetry

Cardno-ENTRIX subcontracted two bathymetric surveys:
O'Day Consultants surveyed subsurface topography along the shore extending east and west from the mouth of the New River during August, 2011.
Ducks Unlimited collected bathymetric data within the New River channel (November, 2011), in the delta bay on the east side of the New River (April, 2011), offshore along the beach to the east of the New River mouth (April, 2011), and along originally the proposed saline water supply pipeline to the west of the New River mouth (May, 2012). A limited amount of bathymetry was mapped within and offshore of Morton Bay at the Alamo River delta (April, 2011).

Terrestrial Survey

Cardno-ENTRIX, subcontracted to Ducks Unlimited, performed topographic data collection of the playa to the east and west of the New River delta (August, 2010), around Morton Bay at the Alamo River delta (August, 2010), and water surface elevations upstream along the New and Alamo Rivers at several locations (June, 2010).

Imperial Irrigation District Surveys

Terrestrial Survey

IID provided survey data of the west end of Bowles Road, the levee road extending south from the west end of Bowles Road, and the adjacent agricultural field. Data was collected in May, 2012.
IID provided survey data for southerly portion of the existing New River berm that received repair work after the Lidar data for the Salton Sea was acquired. Data was collected in 2013.
IID provided survey data of the north end of Kornbloom Road. Data was collected in 2013.

Aerial Photo Background

The Construction Plans incorporate 2011 6-inch and 12-inch resolution imagery to the plan and detail sheets. The images were provided by DWR, source and flight dates unknown, (NAD83, UTM Zone 11N, Meters). Larger scale exhibits and site plan sheets are based on the lower resolution 2010 image (flight dates: 5-5-10 and 5-26-10). Source: USDA Farm Service Agency (NAD83, UTM Zone 11N, Meters) with a 1 meter ground sample distance.

Terrain Model

A composite topographic model was developed integrating the data from the various sources. Overall, the vertical accuracy of the terrain model is consistent with a 1-foot contour map in the dry land, bare earth areas. Accuracy will be less for the bathymetric data and along the New River where heavy vegetation made data collection difficult.

Geotechnical Investigation

Hultgren-Tillis Engineers, through a contract with Cardno-ENTRIX, performed a preliminary investigation of the New River and Alamo River areas (September, 2010) and a follow up more detailed investigation of the New River site (October, 2011). In general, the site can be characterized by having soft fine grained soils that are dispersive in nature. The soils have a relatively low strength that make supporting construction equipment and embankments challenging. The results of those studies, discussion and recommendations can be found in reports dated January, 2011 and April 7, 2014.

Geothermal Resources

The SCH occurs in an area of known geothermal resources, however it is outside of the current focus area of development that occurs around the Alamo River delta. There are not any visible gas vents commonly called "mud pots" within the footprint of the habitat ponds.

A query search of the California Division of Oil, Gas & Geothermal Resources (DOGGR) shows an abandoned geothermal well, “Westmorland” 47 (API # 025-90105), at the southern end of the SCH ponds. According to records, the exploratory geothermal well was 5-5/8" hole with 1" tubing, presumably galvanized pipe. Records indicate it was capped with "2 sack of concrete".

An IID survey crew attempted to relocate the well with the record coordinates and metal detector without success. Due to the corrosive saline environment, there may not be enough pipe left to detect, and the hole likely has filled with sediment and/or collapsed. DOGGR suggested that the abandoned well would not pose a hazard to construction of the SCH if it is encountered. If the well is found, DOGGR should be notified for an inspection, and likely will want the hole filled with concrete.

WATER QUALITY AND WATER SUPPLY

The ability of habitat managers to deliver water to the SCH and maintain desired water quality conditions within the ponds units will require a variety of structures to be installed. The SCH will have water supplied from both a river water source and a saline sea water source, with additional incidental agricultural drainage. The EIS/R contains discussion on water supply and water quality considerations from the Sea and New River resources feeding the project. Water control structures and pipe will be installed to allow for the management of water into and between ponds, and for drain discharge to the sea. Development of the water supply requirements within desired water quality goals and in a cost efficient manner that supports the SCH habitat ponds was an iterative process. Analysis of pond operation modeling and the water supply requirements can be found in the following Cardno-ENTRIX memorandums:

- "Analysis of SCH Pumping Requirements" dated January 8, 2013 (Appendix 1).
- "Updated Pumping Rates for SCH Ponds" dated April 22, 2013 (Appendix 2).
- "Final Pump Size Recommendations" dated August 15, 2013 (Appendix 3).

Water Loss Through Playa Cracks

Potential seepage loss through surface shrinkage cracks in the playa sediments under the berms could be a significant issue. Seepage losses will require replenishment from the river and saline water supplies. Remedial measures are addressed in the impoundment and maintenance sections of this report.

Hydrology

Natural runoff is excluded from the ponds by berms and the only uncontrolled inflow will be from rainfall directly on the pond surface.

Salinity Range Target

The water supply for the SCH ponds is designed to keep salinities between20 and 40 parts per thousand (ppt). The salinity within the ponds may be managed differently between units or vary over the seasons. For example, the salinity range in winter may be kept lower to keep fungus and stress on fish down during low temperatures. Summer salinity may be managed higher to keep vegetative growth, mosquito production and selenium uptake into the food chain to a minimum.

Residence Time Target

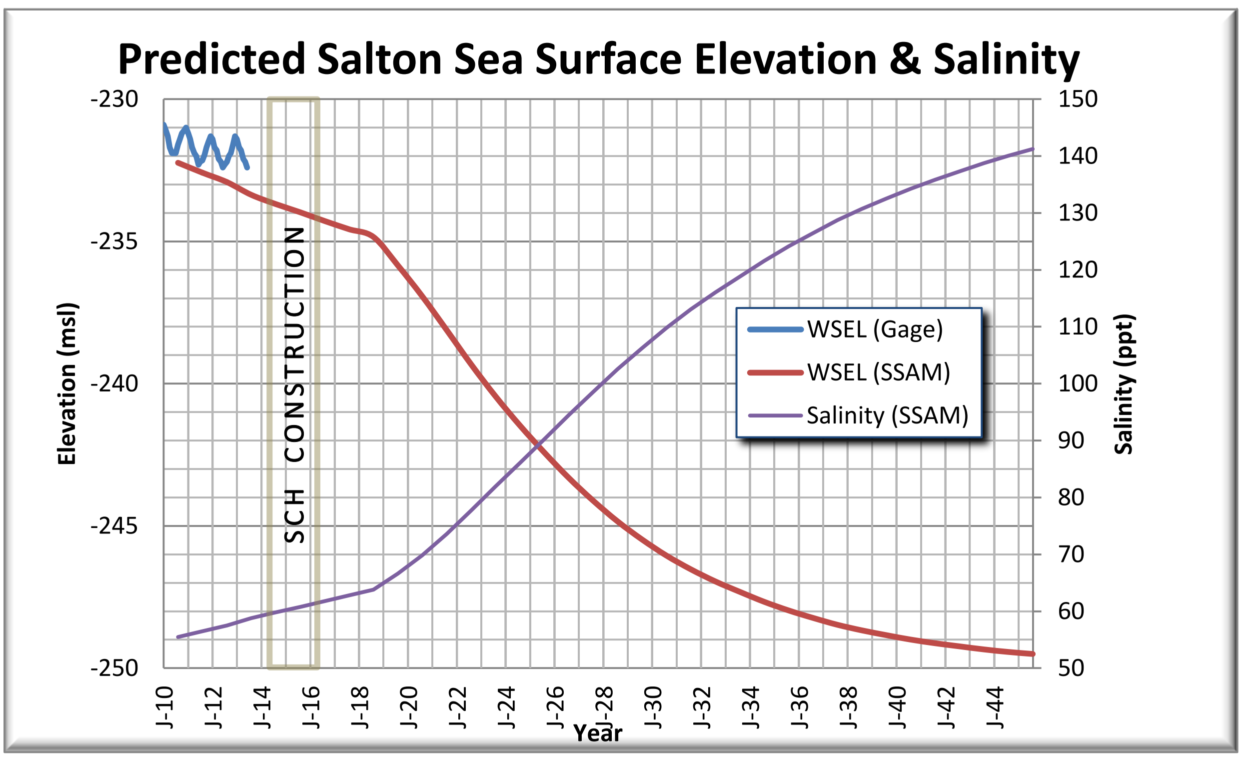
Residence time, the amount of time that an average drop of water will remain in a pond, can affect pond ecology in several ways. A short residence time would minimize algal blooms by flushing out phytoplankton before large blooms can develop. The time period necessary for adequate flushing is not known, but it is estimated to be shorter than is economically practicable due to the associated cost of water supply. Some plankton productivity is needed to support the food web, but too much can cause problems such as reduced dissolved oxygen at night or during cloudy weather. Monitoring during several different residence times would be ideal, and help determine what will provide a stable and productive environment for fish. A longer residence time may be more acceptable during winter when day length is short, helping control algal blooms. Ideally, several different residence times would be used, either in one pond or in different ponds, with monitoring of water quality and biota to determine what works best to meet project goals.

Due to the high infrastructure and utility cost of pumped water supply, initial objectives of providing the capacity to increase delivery inflows in order to reduce retention time, i.e. one month, and allowing excess water to spill out to the Sea was eventually eliminated from consideration. The retention time, or residence time, will be equal to the rate at which water is replenished in the ponds to compensate for losses to evaporation and seepage. The average retention time is estimated to be approximately one year.

Operations modeling performed on a daily time step demonstrated that the ponds could be maintained with pumping rates up to 15 cfs for the river pumping station and up to 9 cfs for the saline pumping station, assuming a seepage rate of 0.50 inches per day.

Saline Water Pump Station

Supplying saline water to the SCH ponds in order to achieve the desired salinity will require pumping from the Salton Sea which has a lower water surface than that of the pond units. The water surface elevation of the Sea fluctuates by approximately 1-foot throughout the year, and is generally declining (USGS Gaging Station 10254005 SALTON SEA NR WESTMORLAND CA). The predicted water surface elevations are taken from the Sea Salton Sea Accounting Model (SSAM) developed by Reclamation (Restoration of the Salton Sea Summary Report - Draft, 2007).



Several factors have made the supply of saline water to the SCH ponds a focus of intense study. A declining water surface elevation and associated receding shoreline (approximately 1,000 feet per foot of water surface drop in the areas of the intake channel) make delivery of water supply in the future a challenge. Infrastructure installation is difficult in the broad spans of very soft soils between dry playa and water deep enough to float construction equipment. Strong winds and wave action require careful planning for any infrastructure to be maintained in the Sea and at the shore.

Pump Station and Saline Water Intake Location

A range of options for the saline intake to the pump station was considered. The purpose of saline water is essentially to supply salt to maintain water quality objectives in the ponds. If the salinity of Sea water varied spatially, location of the pump station and intake would be considered accordingly. Of particular interest was the documented wind driven counter clockwise current in the southern basin that would have a tendency to push the fresher river water outflow to the east. Also of note are frequent periods of time when wind is less than 5 mph for 2 weeks or more, in which case a current may not be present.

Salinity measurements within the Sea taken in the vicinity of the New River delta showed little variation, indicating that the location of the intake will not be affected by the fresher water influence of the river or agricultural drains as long as it is not located immediately adjacent to these flows. Salinity at the time measurement in January, 2013 ranged from 40 to 45 ppt.

The primary considerations for locating the pump station were reliability of the supply source, keeping maintenance cost as low as possible, practicality of integration with the rest of the design layout, ease and cost of installation, and ease and cost of periodic maintenance.

Three alternatives for locating the pump station in relation to the intake were considered: 1) The pump station located on a platform out in the Sea with a pipeline delivering water back to shore, 2) the pump station on shore with an intake pipe drawing water from the Sea, and 3) the pump station on- or near-shore with an intake channel from the Sea. In any of the cases, the intake would be located to provide a reliable water supply for the 10 year proof-of-concept period as the Sea recedes and surface elevation drops.

The first alternative, using a pump station on a platform in the Sea, was determined to be infeasible due to the high capital cost and difficulty of installation of the pump station structure, utility power and delivery pipeline in the Sea. The pumps in the saline environment will have a limited life span and would require being progressively relocated further out as the Sea recedes. In addition, maintenance and future relocation of the pump station would require boat transportation that will become difficult due to the limited availability of launch sites as the Sea recedes.

The second alternative, utilizing an intake pipe to draw water from the Sea, was likewise determined to be infeasible due to the high capital cost and difficulty of installation. Maintenance and future extension of the intake pipe will likewise be difficult as the Sea recedes. Methods of pipe installation in the Sea that were explored included anchoring on top of the Sea floor, horizontally drilled pipe, dredged trench and backfill, and hydraulically plowed trenching and backfill. All of these options require costly materials and specialized equipment for installation.

The most cost effective means of developing the saline water intake, the third alternative, incorporates a dredged channel to bring the Sea water to a pump station located on land. This alternative requires the least amount of infrastructure and allows for the easiest installation. The channel will have to be maintained and deepened by dredging as the sea recedes. The intake channel may serve as the only possible access out to the Sea at the southern end in the future. A boat ramp is integrated into the pumping basin at the shore end of the intake channel to provide boat access to the Sea as well as access to the channel for maintenance dredging. A discussion pertaining to mobilization of a dredge for use at the project site can be found in the Ducks Unlimited memorandum "Dredge Mobilization" dated June 27, 2012 (Appendix 4).

The saline water pump station is located at the north end of Kornbloom Road to take advantage of the existing topography of the seabed. At this location, the bottom of the Sea is relatively low compared to other areas around the project site, providing deeper water closer to shore for the intake. The preferred alignment for the water supply force main was determined to be along the existing levee roads. This allows for convention construction equipment and methods to be employed, and avoids costly and difficult construction on the soft soils of the playa and in the Sea.

The geotechnical investigation did not include sampling along the intake channel alignment due to the cost of mobilizing equipment once this alignment was selected. The construction contract will include measures for the contractor to conduct his own soils investigation for determining payment quantities on bid unit rates.

Saline Water Delivery Demand

Based on the assumed pond operations and losses, the required diversion quantity for saline water is 4 to 9 cubic feet per second (cfs). The saline water pump station is designed to accommodate 3 pumps at 3.0 cfs each for a total pumping capacity of 9 cfs. While the design analysis considered installing only two pumps as part of the initial construction and adding the third pump in the future, it was determined that the project will proceed with all three pumps being installed with the initial construction. The pier could also be extended and pumps added to serve future ponds, if needed.

Capacity for future expansion

Development of water supply infrastructure for the SCH with excess capacity was evaluated for the benefits of flexibility in the water delivery to the project ponds as well as future habitat projects. SCH-like ponds are an integral part of the planning for the larger Salton Sea habitat restoration as a way of addressing both habitat and air quality mitigation needs. Construction of a pumping facility with excess capacity to accommodate more pumps would shorten the start-up time of future habitat ponds and may provide an overall cost savings. Construction of a larger facility for future expansion must be balanced with the availability of current funding.

The evaluation concluded that the saline pump station should be designed only for the current saline water demand flowrate of 9 cfs without expanding the footprint. Over time as the Sea salinity increases, the volume of saline water needed to achieve a given pond salinity will decline. This will free-up capacity in the 24-inch diameter force main as less saline water is needed. That capacity could be used for future expansion.

Screening

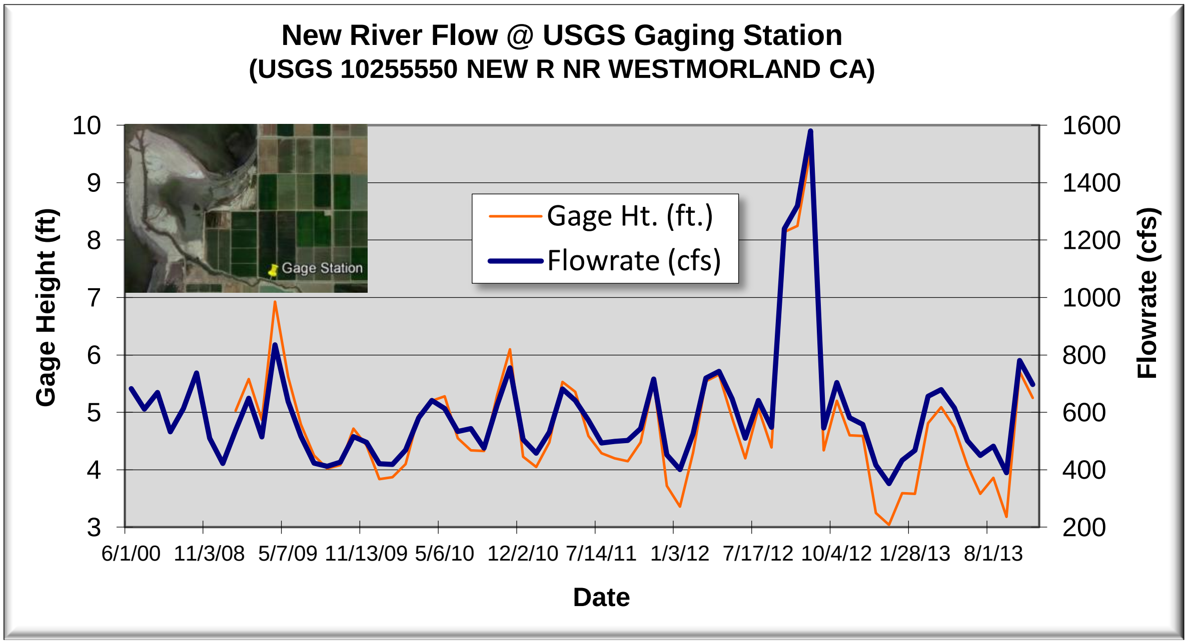
Desert pupfish protection measures for the saline water diversion were determined to be necessary. The intake is required to be screened (1/8 inch maximum openings) until the Sea reaches a salinity of 68 ppt around year 2020 as shown on the figure above, at which point pupfish are not expected to inhabit the water body of the Sea.

Future Saline Water Supply Considerations

As the Sea surface elevation drops, the saline water in the intake channel will eventually be too shallow to adequately supply the required pumping rates. When the Sea surface reaches an elevation of -243 (Year 2026 projected water surface elevation), the intake channel will need to be dredged for greater depth and the pump suction column will have to be lengthened.

River Water Pump Station

A pump station will be required for the river water diversion located at the project site. A lift pump is required because the water surface elevation in the river at the project site is below the design water surface elevation of -228 for the SCH ponds. The water surface elevation of the river fluctuates by approximately 18 inches throughout the year, along with the variability in the flow rate (USGS Gaging Station 10255550 NEW R NR WESTMORLAND CA). A gage height of 5 feet equates to an approximate water surface elevation in the ponds of -229. The pump station structure will not impact the existing capacity of the river channel to pass high flows and the diversion rate will not significantly impact the amount of water flowing out into the Sea. Analysis of the river water resources is contained in the project EIS/R.



An existing water control structure constructed by IID and located within the east bank of the New River has historically been used to allow gravity flow of water to provide shallow sheet flooding of the adjacent playa for bird habitat and dust control. Because the water surface elevation of the ponds will be higher than that of the river at this water control structure, in order to provide maximum depth for the fish species, the structure will be removed and replaced with the low-lift pump station at an alternate location.

River Water Delivery Demand

Based on the assumed pond operations and losses the required diversion quantity for river water is 10 to 15 cfs. The river water pump station is designed to accommodate 5 pumps, however only 3 will be installed initially. This option provides a flowrate of 15 cfs and still keeps the construction cost within a reasonable budget. The fourth and fifth pumps can be installed in the future if it is deemed necessary.

Capacity for Future Expansion

Similar to the saline water delivery system, design of excess capacity into the river water supply infrastructure for future habitat projects was evaluated. It was determined that the footprint of the river pumping station should be enlarged to accommodate future expansion. The expanded design accommodates 1 additional pump that matches the 4 pumps designed for the SCH including a larger intake pipe, larger discharge lines to the ponds, and a larger concrete pump structure. The additional capacity will allow for expansion to deliver water to future habitat ponds as well as compensate for the reduced flowrate of the saline supply as the Sea recedes and its salinity increases.

Screening

There were no desert pupfish protection measures identified to be required for the river water diversion.

Future River Water Supply Considerations

The water surface elevation of the river, being relatively close to that of the SCH ponds, allows for efficient pumping. The current river water surface could change if the geometry of the channel or flowrate changes. The flow in the river, essentially being agricultural drainage, will be reduced if irrigation application within its watershed decreases through decreased irrigated acreage, increased conservation, or increased irrigation efficiency. If the river breaks through the existing banks during a high flow event, repairs will be required to restore the flow within the existing channel. A third risk to the river supply would occur as the river is expected to lower over time as the Sea recedes and a headcut in the channel bed forms. An existing sediment plug within the channel at the north end of the river before it enters the Sea currently maintains the water surface profile in the channel in the reach along the SCH. The sediment plug is approximately 7 feet above the existing channel bottom elevation and almost 10 feet above the Sea floor north of the mouth. This sediment plug is expected to erode as the Sea surface drops. Installation of a control structure within the river channel may be required in the future to maintain the historic flow profile that the pump station depends on.

Agricultural Discharge

At the west end of Bowles Road, there are two existing pumps that discharge agricultural water to the Sea. The agricultural drainage is a byproduct of irrigation application to the neighboring agricultural fields. There are two sources of discharge present: tailwater and tilewater. Tailwater is the residual surface water from the irrigations and tilewater is the water that has seeped through the soil and collected in drains buried about six feet below the surface.

The two sump pumps (WP-7 and SS-8) operated by IID discharge the agricultural tile drainage and surface water onto the playa area proposed as the east unit of the SCH ponds. The sump pumps collect drainage from an area that is irrigated and farmed adjacent to the project site. In addition, the lessee farmer periodically installs a temporary system to pump excess surface water that the permanent facility lacks the capacity to discharge. The amount of water discharged from both pumps is calculated to be approximately 1,060 acre-feet per year.

Allowing the agricultural drainage to continue to be discharged into the SCH would result in a corresponding decrease in pumping demand from the New River and from the Salton Sea. The drain water however, is not considered part of the dependable SCH water supply. Allowing this water to flow into the SCH provides an opportunity for additional water that would, at the moment when it is available, offset other dependable supplies (New River and Salton Sea).

The discharge from the two pumps was sampled and tested for water quality parameters, including those of primary concern: Dissolved oxygen, salinity, and selenium. While the tailwater is of a quality similar to the irrigation water applied to the field (and better water quality than the New River), the tilewater may, at times, be of a quality that is lesser than the New River. Blending the two drain water sources yields a concentration similar to the New River, which also is comprised of drain water from other agricultural sources. The blended water will vary in quality depending on the flow from each source at the time of blending. Typically, the tilewater has a higher salinity, selenium, and some metals than the New River water. However, if monitoring showed the tilewater to be adverse to the SCH (during times of low inflow to the ponds) any potential water quality problems can be addressed through opening the pond outlet gates and pumping more New River water into the SCH to flush the tilewater.

Given the cost of constructing a bypass line to avoid discharging the agricultural drainage into the SCH ponds (estimated at $0.5 million), it was determined that allowing these sources to continue their existing discharge course into the SCH pond is a reasonable and prudent solution. Improvements to the existing system will be required to raise the outlets above the design water surface of the SCH ponds to eliminate the potential for saline water to backflow into the agricultural lands. Additionally, the facility will be improved to incorporate the farmer's temporary tractor-driven pumping so that pipes are not laid across Bowles Road which would block access.

The Vail Drain just north of the project site discharges agricultural drainage to the Sea. This potential source of water for the SCH ponds was assessed and determined to be too unreliable to be considered a viable source.

Assessment of the water quality of the river and drains near the SCH can be found in the following Cardno-ENTRIX memorandums:

- "Possible use of Vail Drain flows in lieu of New River" dated July 8, 2013 (Appendix 5).
- "Summary of Water Quality Data Collected by IID from SCH-Area Drains" dated August 5, 2013 (Appendix 6).
- "Assessment of Bowles Road Drains for Discharge to the SCH Ponds" dated August 30, 2013 (Appendix 7).

Salt Concentration and Return

The conceptual idea of capturing discharge from the primary pond units in a tailwater collection pond was modeled and evaluated. The tailwater collection would allow for an efficient return source of saline water to the habitat ponds by increasing salinity through evapoconcentration (allowing the salinity to increase by evaporating the fresh water and leaving the salts behind). A tailwater return pump would be utilized to return water that would otherwise be lost as discharge back to the top of the system. The cost of providing enough flow to the ponds for shorter retention times, however, has been determined to be infeasible. Without a significant discharge (outflow) that could potentially be captured for salt concentration and return, a tailwater collection pond would not provide a substantial benefit for habitat management, and would reduce the area available for the primary habitat ponds.

Evapoconcentrating water from the New River in a separate pond unit to provide an alternative source of saline water was also evaluated due to the high cost of constructing and operating a pumping system for Sea water. The loss of water through seepage and large area required to provide a meaningful level of flow proved this option uneconomical. A detailed discussion of initial pumping system concepts for Sea water and modeling of evapoconcentration as a saline water supply can be found in the Cardno-ENTRIX memorandum "Analysis of SCH Pumping Requirements" dated January 8, 2013 (Appendix 1).

Saline Groundwater

Because pumping saline water from the Sea has a high cost associated with water delivery infrastructure development and maintenance, a feasibility analysis of installing production wells for a saline water supply was conducted by DWR, USGS, IID, SIO and Cardno-ENTRIX. Based on the best data available, it was determined that developing wells near the project site to supply saline water was not practical due to the low the permeability (hydraulic conductivity) of the most promising sandy strata layers, and that groundwater would not be a viable source of water supply for the project. Results of the study can be found in the Cardno-ENTRIX memorandum "Potential for Shallow Groundwater as a Water Supply" dated March 26, 2013 (Appendix 8).

Additional discussions resulted in a conclusion that small point wells could be installed between the outer berm and the Sea to provide water for “topping off” the ponds but not as a dependable water supply.

Sedimentation

Suspended sediments will be present in the river and saline waters that are pumped into the SCH pond units. Removal of the heavier sands and silts from the influent is desirable so that the ponds and channels remain as deep as possible without being affected by a buildup of sediment. A sedimentation basin to remove the heavier suspended sediment from the influent water before it enters the SCH ponds is located within each pond unit. These in-pond sedimentation basins will gradually fill in with settled solids.

A traditional stand alone sedimentation basin was eventually eliminated from the design for several reasons:

- Higher cost of initial construction
- Increased operations and maintenance expense due to the need for annual cleaning
- Additional risk of selenium uptake and vegetation management

While the bottom of the basins may become anoxic, this condition is not expected to cause habitat issues detracting from the quality of the habitat ponds. Because finer sediments will stay in suspension for long periods of time, expecting to remove them from the water supply is impractical. These finer sediments will disperse widely throughout the pond units without significantly affecting local water depths due to deposition and accumulation of sediment.

It is assumed that the saline water supply will not contain substantial amounts of heavier sediments. During periods of high winds, sediments will be resuspended from the Sea floor, but are not expected to contribute a significant supply of material in the saline water supply. Water supply from the New River will be taken from mid-depth to avoid heavier sediments being transported along the bottom as well as debris floating on the surface. Sediment inputs are based on the following parameters:

- Total suspended solids concentration of 220 mg/L
- A removal rate of 80%
- A maximum river water influent flow rate of 11 cfs

For analysis of the expected sediment load, see the Cardno-ENTRIX memorandum "Suspended Sediment Settling Rate for New River Water" dated November 6, 2013 (Appendix 9).

Based on these assumptions, an estimated 1,130 cubic yards of sediment would be settled from the water supply into the each basin annually. With each basin designed to capture 22,600 cubic yards of sediment before reaching the habitat channel flowline elevation of -234, the sediment basins have an expected life span of 20 years before dredging will need to be performed.

POND IMPOUNDMENTS

Initial pond development concepts focused on building impoundment structures, such as berms, within the Sea in order to obtain the maximum water depth while avoiding being defined as a jurisdictional dam as defined by the State of CA, Division of Safety of Dams (DSOD). After a thorough investigation, all methods of working with the weak, dispersive soils in even shallow water were deemed to be economically infeasible. Compounding the problem of working with soft and dispersive soils are the large water body, long wind fetch reaches and high wind velocities requiring durable erosion control until the Sea recedes beyond the berm footprint. Alternative methods to earth fill including geotubes, cellular dams, and sheet pile walls are likewise cost prohibitive.

The early start of the SCH has been scaled down from the Preferred Alternative to the basin area where berms can be constructed in the highest, firmest ground available to achieve the most habitat area for the available construction funding. The existing topography within the New River bay will not provide the minimum 6 feet of water depth required for supporting a fishery, and thus deeper refugia channels will be dredged to provide this critical habitat feature.

Readers are encouraged to peruse the Hultgren-Tillis Geotechnical Investigation Report dated April 7, 2014. The report provides an excellent narrative of the site setting, engineering considerations and risk assessment as well as a detailed compilation of the results of the soils investigation, analysis, and recommendations that informed the design of the SCH.

Design Water Surface Elevation Considerations

In 1907, the Colorado River stopped flowing into the Sea, and evaporation greatly exceeded inflow, resulting in a rapidly declining water level until 1924. Today, evaporation remains the only outlet as the Sea exists in a closed basin. Increased irrigation development, improved agricultural drainage systems and several major rainstorms caused inflow to exceed evaporation, which resulted in a gradual rise in the Sea until 1980 when the elevation stabilized at approximately 228 to 227 feet below mean sea level (msl). The surface elevation remained fairly consistent until 2000 when QSA water transfers decreased irrigation to farmlands, and therefore less agricultural drainage flowed into the Sea. The Salton Sea surface elevation subsequently began declining to around -233 as of the date of this report. The SCH ponds are designed to have a water surface elevation no higher than -228 so that similar conditions to those of the recent Sea are reestablished.

East of the IID levee road adjacent to the east side of SCH are three IID-owned parcels. Two are leased for agriculture and one is fallowed because of inadequate drainage. Reestablishment of the historic Sea surface elevation of -228 msl could have the potential for increasing the amount of water needing to be drained off the farms because of the seepage relative to what has occurred in the last few years. Drainage is achieved by lowlift pumps located in the northwest corner of the area at the west end of Bowles Road that discharge into the delta bay within the proposed easterly SCH pond.

DSOD Considerations

The Division of Safety of Dams (DSOD) has been consulted and has determined that the SCH ponds and embankments will not be considered a jurisdictional dam based on two informational memos submitted February 9, 2011 and July 12, 2012 (Appendix 10). The SCH ponds are designed to impound a maximum of six feet of water determined from the maximum design water surface elevation at the water control structures to the downstream toe of the embankments. An outlet water control structure will allow for the emergency draining of each pond to 50% of its volume within 7 days.

Earthwork and Construction Methodology

Earthwork will be required to construct the berms, islands, working pads and ditches. In addition, the habitat channels will be excavated or dredged to achieve the desired depth profiles. Specialized equipment and techniques will be required to work in the soft delta sediments found at the project site.

These issues are compounded when working in wet saline environments in an extremely hot climate. A variety of methods are anticipated to be required due to the wide variability of localized site conditions. Low ground pressure equipment including excavators, dump trucks, scrapers, and dozers, and floating equipment such as dredges will all be employed to build the pond infrastructure.

The onsite soils exhibited a wide range of characteristics, including soil strength, at the time of the geotechnical investigation. The containment berms are being constructed on weak soils, which are typically not used to support engineered impoundment structures, such as levees. The various berm designs included on the plans are designed to provide cost effective pond containment berms. Six different berm design geometries were developed to account for existing ground elevations (fill height), subsurface conditions (strength of underlying foundation soils) and location (water on one or both sides). A seventh berm design geometry was developed to provide for the heavy construction traffic and power pole utility line installation for the section along the New River leading to the maintenance pad.

The central part of the pond berm is the "core berm" constructed with fill that has reasonable strength and resistance to seepage. The berm core is compacted fill that will support construction traffic and reduce the amount of water that can seep through. In areas where the existing ground elevation is high, above -229, the core berm will be all that is required. Added to side slopes at lower elevations that impound a greater depth of water, the berm core will have "stability berm" fill on the pond side and "seepage berm" fill on the downstream side. The stability berm fill can be constructed from soils of lesser quality and primarily provides a gradually sloped bank that adds stability to the entire berm section. The seepage berm fill will constructed from sandy soils that act as a filter for water seeping through the berm as well as providing stability. Because the inner berm has water on both sides, stability berm fill is used to create the bank slopes on both sides of the core berm.

Wherever possible, the berms will be constructed on top of the existing ground with a methodology that maintains a stable foundation and avoids failing the upper crust (equipment and fill sinking into the soft soils). Underlying soils that are weaker require berm sections that have shallower side slopes and a wider base to remain stable. An inner berm bisects the SCH site creating two ponds. The inner berm is constructed in the middle of the bay that until recently has been inundated with water and contains very weak soils that cannot support a person walking. This berm will be constructed by pushing fill material into the soft sediments until they sink to stiffer soil layers. The displaced sediments will create a mud wave to the sides of the berm.

The construction contractor will develop techniques and methodology for placement of earth fill and compacting material into the berms and islands through close observation, foundation soil strength monitoring, and trial and error. Utilizing equipment and methods that minimize the potential for failing the stronger upper crust will be essential to the productivity and effectiveness of building in this area with soft substrates. While other smaller projects along the shore of the Sea have accomplished earthwork activities where heavy equipment could be supported by stiffer soils at relatively shallow depths, the weak sediment soils at the New River delta are deeper making removal cost prohibitive.

Before beginning construction of the berms, the contractor will need to develop a methodology for working on the various areas of the site with different soil strengths. The contractor will be required to practice with the equipment and techniques for placing fill by building test strips for all berm design geometry types on the soft foundation soils that each was designed for. The test fill strips provide the contractor the opportunity to develop methods for fill operations before working in the footprint of the berms as located on the design plans. Once underlying foundation soils fail, their strength characteristics change in a way that cannot be reversed or easily compensated for. It's important that the contractor stays on top of the dry upper layer of soil without sinking through into softer materials below. Where this occurs, the contractor will likely have to build a displacement berm similar to the design of the inner berm, with a higher associated cost.

While the design plans indicate location of berm section types that are anticipated to provide a stable embankment, the contractor will select the most appropriate berm section type and employ construction methodology developed during test fill strip procedures for the foundation soil strengths found at the time of construction. The contractor will construct the most cost efficient berm section that can be achieved while maintaining the stability of the foundation soils. The overall approach consists of the following progression of work:

- The contractor will test at regular intervals the existing foundation soils to determine strength along the berm alignment.
- The contractor will select the appropriate berm section type based on measured foundation soil strength and the table provided in the technical specifications. The berm section types are designed to provide a wide enough base to support and spread the load of the berm and construction equipment. The width of the base and design of the berm will vary depending on the localized underlying soil strength.
- Construction of berms will occur in two stages separated by a designated period of time in order to allow for anticipated settlement. The berms will initially be overbuilt to compensate for settlement that occurs as the underlying soils compress and build strength. Most of the settlement is expected to occur within the construction time period. The period of time allocated for settlement is six months.
- After the initial settlement period, the contractor will bring any low areas up to minimum design top elevation and finish grade the berm. Gravel (aggregate base) will be placed on top as a last step of construction for all weather vehicle access.

Existing New River Berms

The New River bounds the project on the west side with an existing berm between the river and the proposed SCH ponds. The existing river berm has a top elevation that is relatively high (approximately -221 to -224) compared to the SCH pond berms (-226), and is being relied on to protect the project from New River flood events. One of the highest vulnerabilities of the project is being washed out by the New River breaking out of its cast-up sandy berms. The existing berms were not designed as flood protection embankments. The existing berm on the east side of the river (adjacent to the project site) is higher along most of its length than the existing berm on the west side of the river. This is significant because in the occasional event that the river floods, it will tend to spill out of its west bank to the Sea rather than into the project site.

The existing river berm on the east (project) side either over topped or eroded to the point of blowing out at the south end of the project site during high flows in August, 2012. In this particular area, the east river berm is lower than the west berm. The project design includes rebuilding the existing east berm in the area of temporary repair, and lowering the west berm to provide emergency release to the west, away from the project site, during the next high flow event. The design did not include a hydraulic analysis to quantify the flow release needed or an engineered control weir. The lowered sections of the west berm are intended only to provide a few release points at high flow. If overtopping occurs that results in erosion, the area would need to be repaired as a maintenance activity, as was done on the east side in 2012.

A separate project berm is proposed offset of the toe of the existing river berm. The new berm for the impoundment structure for the SCH ponds along the New River side of the Project will be offset of the landside toe of the existing river berm. This new berm will be separate from the existing river berm.

Several factors were considered in determining that a new berm would serve as the SCH impoundment structure rather than the existing river berm:

- Avoidance of jurisdictional dam requirements. The maximum allowable difference between the SCH design water elevation of -228 and the downstream toe of the impoundment berm is 6 feet. The flowline of the New River ranges from approximately -234 to -240 in the reach adjacent to the SCH ponds, making it ineligible as the SCH impoundment structure because the difference would exceed the 6 foot jurisdictional requirement. The downstream toe of the all new berms will be at elevation -234 or higher (6 feet or less elevation difference).
- Protection from seepage induced erosion and embankment failure. The hydraulic gradient between the habitat pond water surface elevation of -228 and the river water surface will vary depending on flows in the New River. The new berm provides adequate separation between the two water bodies to minimize the chance for either one to cause seepage induced erosion.
- The existing river berm has been built from uncompacted soils of unknown quality. While the existing berm has served its purpose of containing river flows, the integrity would not be expected to hold up to heavy construction traffic.
- Requirement of roadway for power line installation. In the reach from the southern end of the project site to the river pump station, a roadway with specific conditions for compaction and clear distance from vegetation is required for the electric utility pole installation. A new berm will provide the necessary foundation and buffer from vegetation for the power line that would not be met by the existing berm.

IID Levee Road

An existing levee road bounds the project site on the east side and has functioned as the historical barrier to the Salton Sea when its water surface elevation was at -228. The levee road includes the western end of Bowles Road and the IID levee road that runs south from that point. These existing levee roads will remain intact and become a Project feature. The top elevation is relatively high (approximately -222 to -220) compared to the other constructed SCH pond berms (-226) and will remain intact as an access road. The side slopes will be protected by added rock riprap for erosion control.

The corner at the west end of Bowles Road will need to be widened in order to accommodate equipment transport and material delivery trucks. The pump station at the end of Bowles Road (see section on agricultural drainage) will be improved to accommodate intermittent agricultural discharge where farmers currently lay temporary pipes across the top of the road for pumped drainage from the agricultural fields.

Outer Berm

Between the mouth of the New River at the northern end of the project site and the existing levee road at the eastern end, a new outer berm will form the impoundment for the project ponds. Downstream of the berm is the Salton Sea. The top elevation will be approximately -226, to provide two feet of freeboard for the design water surface of -228. The berm at the time of construction will be slightly higher to compensate for future settlement. The outer berm will be compacted fill from locally generated embankment material.

The outer berm alignment is located along an existing higher "ridge" or "beach" of sorts that backs water up in the existing bay. After much analysis, it was determined that constructing a berm in the Sea along the -234 contour (as proposed in the EIR with a maximum 6-foot differential between the design water surface of -228 and the downstream toe of embankment) was impractical for several reasons:

- The underlying sediments are very soft, having never been dried and consolidated. To achieve an 8-foot high berm, excessively flat side slopes would be required to stabilize the soils from failure.

Traditional barge-mounted equipment with a clam-shell dredge would not have a long enough reach to excavate an adjacent borrow trench and place the material into a berm with the required base width.

- Constructing a berm in the Sea with soft material placed on top of weak substrate would require phased lifts in order to allow the base material to dewater, consolidate and build strength before additional height was added. The time period required between each lift could be on the order of a year, making the construction time period longer than desired.
- Soft, dispersive material embanked in the sea would be highly vulnerable to erosion until the Sea surface elevation recedes from the berm. Protection from wave erosion would need to be substantial due to the long fetch and must be able to be supported on the weak foundational soils. Hard protective measures such as rock riprap or sheet pile would be very expensive. An alternative would be a long, shallow sloped sacrificial sand beach that would require a substantial amount of extra material to be placed.
- The use of geotubes, consisting of geotextile fabric that encapsulates hydraulically dredged and pumped sand, was studied to provide both stability to the embankment and temporary erosion protection from the Sea. Unique to this project site is a source of sandy material at the northern of the ponds that would be suitable for filling the geotubes. While geotubes were found to be the most cost effective means of developing water retention structures requiring installation within the Sea, the cost was greater than the SCH construction budget could afford. See the EIS/R and project geotechnical report for a more detailed assessment.

Locating the outer berm in the driest, highest terrain possible was found to be the most cost effective method of impounding water. Low ground pressure (LGP) equipment such as excavators, bulldozers and tracked earthmoving trucks provide the best production rates for the cost, and is the preferred method of construction when feasible.

Inner Berm

In order to provide two ponds of equal size with similar depth profiles, the SCH project site is bisected by an inner berm. The berm traverses the interior bay that has the softest soils within the project site. The sediments are soft enough that they will essentially flow under very low stress. The berm will be constructed by the displacement method: Pushing embankment material out into the bay along the design alignment. The material deposited onto the soft soils is expected to create a wave of displaced mud as the fill is pushed down, and continuing until it encounters the underlying stiffer layers that will support the base of the berm.

Borrow Material

On-site material will be used for construction of the berms and habitat features such as islands. The amount of excavated material is balanced with the amount of fill needed for constructing the berms and other features, thus eliminating the need for importing embankment material. The primary area for the source of borrow material occurs in the northern most area of the project site where silty sand and sandy silt material occurs. Secondary borrow sources are available from the higher, drier terrain along the west side of the project site. Suitable material can also be excavated adjacent to the embankments.

A range of quality in the onsite soils to be used for fill embankments was found. During construction, the contractor will classify the borrow soils and use appropriate material for the particular types fill required for berm and island construction.

Water Control Structures

Outflow from the ponds will be controlled through an outlet structure composed of a concrete box with stoplogs, and an outlet pipe. There will be one outlet structure for each pond unit. The top of the outlet structure is set at -228 feet to maintain the maximum water surface elevation in the ponds. Stoplogs will be used to manage the pond water surface elevations and to adjust the discharge rate. Complete removal of the stoplogs would be used to drain a pond. The outlet pipes are sized to accommodate the typical volume that will be passed through the ponds as part of normal operations, overflow during a 100-year rainfall event, and emergency release flows.

A water control structure is also located within the interior bisecting berm. This structure will allow water to flow by gravity between the pond units when desired by habitat managers to provide flexibility in the management of water resources supplied to the ponds. To operate the water control structure, the water surface elevation of the receiving pond will be lowered below the water elevation of the source water pond.

The concrete riser structure uses the standard IID precast structure because of the suitability of application, availability, and standardization with other IID infrastructure. Trash racks are not deemed necessary since the saline water within the habitat ponds will inhibit significant vegetative growth that could clog the outlet works. The top of the structure will be set at the design water surface elevation of -228. The immediate vicinity of the water control structures will be surcharged with overburden soil to consolidate the underlying soils prior to installation of the structure and outlet pipe and minimize the potential for future settlement. Should the structure sill need to be adjusted to compensate for future settlement, the top can be grouted to a finish surface as necessary. Solid wall HDPE pipe was chosen for the outlet pipe for its structural stability, flexibility, and inert properties in a corrosive environment. A sand envelope filter will be used on the downstream side of the structure to control seepage and avoid soil loss from piping.

Erosion Control

Wind Wave Induced Erosion

The native soils used as source material for the berms are characterized as dispersive in freshwater, with tests indicating less of a dispersive tendency with increased salinity. Dispersive soils will erode easily with water disturbance. The Salton Sea's frequent wind events, the deeper water depth and long fetch in the SCH ponds relative to shallow flooded wetlands require erosion control measures for the berm and island side slopes.

Five methods of controlling erosion of the berm and island side slopes from wind waves were considered: engineered retaining structures, soil cement application, articulated concrete mats, rock riprap, and gently sloping sacrificial beaches. Engineered soil retention systems are prohibitively expensive with many having limited lifespans without protective vegetation cover. Soil cement was eliminated from consideration due to the limited lifespan of the protection measure. Riprap was found to be superior to concrete mats due to a similar level of protection for lower cost. Sacrificial beaches are considered to be an appropriate measure for areas where only shallow water exists at the berm toe.

The reuse of broken concrete as an alternative to rock riprap was eliminated from consideration due to the CDFW Lake and Streambed Alteration Agreement that precludes the placement of such material within waters of the State. Soil cement would likewise have to be evaluated for compliance with the permit conditions.

The small islands have a minimum 2 feet of freeboard at the peak, with shallow slopes down to the water line. Initial fill for small islands will be slightly higher to compensate for expected settlement of the foundation soils. The islands are protected with a ring of riprap to protect the islands slopes from erosion and wave splash. The ring of rock is offset from the shoreline so the birds have access to shallow sloped sandy beach. Maintaining shallow water around the islands for some distance will reduce the potential for wind waves to splash over the ring of riprap onto the island shores during high winds.

The berms that impound the pond units also have a minimum 2 feet of freeboard. The side slopes of the berms will have riprap protection where water is more than about 6 inches deep. The amount and height of the riprap on the side slopes varies depending on the expected wave run-up. Sacrificial beaches are utilized in limited area where only shallow water exists at the berm toe. The tops of the berms will have gravel (aggregate base) for all-weather vehicle access, providing some protection from rain and wave splash erosion.

Seepage Induced Erosion

Water from the pond impoundments will seep through the berm embankments. This seepage flow can carry with it small particles that eventually could cause a degree of erosion that would put the integrity of the berms at risk of failure. Excessive seepage can result from berm widths that are too narrow, improperly compacted fills, and fills embanked with soils of poor quality such as the borrow materials found onsite that have a tendency to be dispersive in nature.

Those measures found to be most economical for this project include sand filters on the outboard slope toe, excavation of an inspection trench where foundation soils exhibit cracking, compaction of the embankment material, and a wide berm base. Sand filters are designed around the water control structure outlet pipes to intercept seepage and safely drain the water through the embankment without the risk of piping. For a detailed discussion of the causes and mitigation measures of piping, see the geotechnical report for this project.

Periodic monitoring of the berms will need to check that erosion is repaired before the integrity of the berms is impacted. A source of borrow material will be stockpiled for maintenance and repair of the berms as required.

The sections of inner berm constructed using the displacement method will be mostly uncompacted and will have poor seepage resistance. The inner berm is not designed to provide suitable protection from seepage induced erosion and possible resulting failure. Lowering the water level in one of the ponds, whether intentional or in emergency situations, will put the inner berm at significant risk. In these cases, the inner berm should be carefully monitored. The quickest remedial measure would be to reduce the differential water surface elevations between the ponds. Longer term actions may include installation of a vinyl sheetpiling cutoff wall.

Construction Water Source

Construction operations at SCH will require a water supply for moisture conditioning of the soils going into the embankments. The rate of demand is expected to be highly variable over the course of construction and throughout any given day. The construction contractor may use nearby IID irrigation water sources through submittal of an application for temporary construction water, using the encroachment permit form. Likely locations include 2 or 3 draw points along Vail Lateral 7 (Kornbloom Road); one near the river, and one at Bowles Road. A temporary draw typically consists of an elevated tank, and a pump with suction hose. The closest canal to the proposed pier area at the north end of Kornbloom appears to be Vail Lateral 6C along Young Road.

Drainage Ditch

Development of the SCH will not change any agricultural discharge locations or inhibit any existing overflow drainage patterns from precipitation events. A drain ditch will be excavated at the far east side of the project site to improve discharge drainage from the east pond outlet structure to the Sea and from the neighboring lands. A short drain ditch will also be excavated at the north end of the project site to provide drainage to the Sea for the west pond outlet structure.

HABITAT FEATURES

While many habitat features were desirable, only those deemed critical to achieve the objectives of the project were included in the design due to the limited funding level.

Deeper Water Channels

Habitat channels offer a greater diversity of depths and underwater habitat connectivity. The depth of water in the channels will be 6 feet to provide a level of refugia for the fish. The channels are distributed to provide connectivity between shallower (less than 2 feet) and deeper areas (up to 4 feet) of the pond units. The intention is to provide travel lanes where the fish can come up onto the shallower benches to feed and then have the channels to retreat to for refugia. While drainage of the pond units can be achieved through the outlet water control structures, it's assumed that this would be a rare event for potential maintenance or emergency purposes (i.e. berm failure or disease outbreak). The channels are therefore designed primarily for access lanes for the fish rather than for pond drainage. It is for these reasons that the channels are laid out in more of “criss cross” than dendritic pattern.

The perimeter channels also serve as predator discouragement. While the islands are set back from the berms for protection from predators, the fairly shallow pond units make the setback somewhat less effective for terrestrial predator control. The 30-foot wide perimeter channels would require a terrestrial predator to immediately start swimming that, combined with the distance, would hopefully discourage further progress. The interior channels are also located away from islands so that the shallow bench between the island and the channel can act as a wave break that provides protection from wave erosion during strong winds.

Where the channels occur in higher terrain areas of the project site, the drier surface soil may be excavated for borrow material to be used for the berms and islands. In many areas within the pond units, the material to be removed for the channels will be too soft and saturated to be productively used as embankment. In these cases, a hydraulic dredge would be used to create the channels, with the spoils discharged outside of the exterior berm onto the playa.

Islands

Islands for roosting and nesting are designed to provide habitat for bird species that will be most vulnerable to the evolving ecology of the Sea. Notes on the preliminary design consideration can be found in "Species Conservation Habitat (SCH) Bird Focus Group Meeting" dated May 17, 2011 (Appendix 11).

Noted objectives in the design approach for the SCH islands include: Mimicking the habitats that the target bird species have used historically and continue to use presently in the Salton Sea; accounting for environmental factors, particularly temperature; developing multiple alternative sites of quality for both nesting and loafing; providing replication with respect to size and shape of islands for comparison studies; and protection from terrestrial predators. All of these goals were weighed against the economic and spatial feasibility of island construction at the project site.

A literature review was conducted on the observations of bird nesting islands that have been developed as part of the habitat restoration efforts in the Napa-Sonoma Marshes and South San Francisco Bay, see "Summary of Literature Search into Island Use by Birds in the San Francisco Bay Area" dated July 5, 2013 (Appendix 12). In addition, discussions were held with habitat managers concerning bird nesting observations that may apply to the SCH. See "Summary of island discussion with South San Francisco Bay" dated June 19, 2013 and "Interview with Karen Taylor on Napa Plant Site Islands" dated May 16, 2013 (Appendix 13).

Floating islands, as an alternative to the islands constructed of local soils, were considered as an option. Islands constructed of synthetic materials would float on the pond's surface and have a top substrate material of sand or gravel to provide nesting and roosting areas. The cost for installing floating islands was found to be approximately $1.5 million. It was determined that earthen islands could be constructed for significantly less cost, ranging from $50,000 to $200,000 per acre depending on the height and amount of substrate coverage.

Tall Islands

The taller, larger islands are 1 to 2 acres in size, and were designed with consideration given to providing optimum value for target bird species, primarily double-crested cormorants. The primary objectives for bird habitat is to mimic the historically productive Mullet Island nearby with features that provide birds with a clear view of approaching predators, provide habitat heterogeneity with a combination of slopes and flat areas, and large substrate for nesting surfaces.

Data on the existing foundation soils is limited, and assumptions must be made concerning the depth of recent soft sediment deposits that the islands will be built on. To ensure a reasonable degree of confidence in the stability of the fill on weak foundation soils the location of the islands is limited to the northern region of the project site with the highest, firmest soils and the height limited to approximately 20 feet.

Terraces and outcrops of boulders, rock and cobble are spread around the islands to provide substrate for nesting. The islands are oriented such that the long side faces north to east for protection from the summer sun, noting that cormorants have exhibited a preference for the northeast side of Mullet Island. In order to provide protection from terrestrial predators, the islands are located 900 feet away from the berm. The soils around the islands will be excavated for fill materials needed to construct the berms and islands, and serving a secondary function of providing deeper water around the islands to discourage predators from swimming to the islands.

Small Islands

The smaller nesting and loafing islands are 1 acre or less in size, and were designed with consideration given to providing optimum value for target bird species, primarily Caspian terns, black skimmers and gull-billed terns. The nesting islands have shallow slopes extending into the water suited to the small chicks. Several shapes and orientations are provided for variability.

A great deal of consideration was given to the small island locations, balancing proximity to the berms for monitoring with the need for adequate distance from the berms for predator protection. While deeper water provides protection from predators, the existing soils in the lower areas of the project site do not have enough strength to support even relatively small areas of fill. The islands must therefore be restricted to areas with existing ground elevations above elevation -231.

Orientation of the small islands took primarily wind direction into account. Prevailing winds are from the west, north and southeast, with the strongest winds tending to come from the west. Locating the islands in deeper surrounding water makes them more vulnerable to wind waves, with lots of spray expected to overtop the smaller islands in very strong winds. Most of the islands are oriented with the steeper slope side facing the wind and the shallower sloped side away from the prevailing winds. Riprap rings the islands, acting as a splash berm and erosion protection. Locating the riprap offshore allows for shallow wading habitat, with gaps that allow for water circulation.

A variety of substrates will be placed on the small islands for nesting. Gulls, a major predator on nesting shorebirds, have been observed to prefer “chunkier” substrate for nesting. The substrate materials for the small islands should therefore be limited in size. It has also been observed that eggs laid directly on clay and silt based substrates sometimes became cemented to the soil when parent birds tried to wet the eggs to cool them. Other detriments to young chicks have likewise been observed from sticky or cracking soils. The top 12 inches of the small islands will therefore be sand or silty sands available from onsite borrow sources. The substrate materials provided for nesting area include barnacle shells, gravels and small rounded cobble.

The loafing islands are provided as roosting areas, and generally located in areas with reasonable surrounding water depths and relatively close to berms for cost efficiency. Naming them "loafing islands" doesn’t mean that other activities won’t occur, such as nesting. Overall, the project provides multiple alternative sites of quality for both nesting and loafing.

Roosting and Nesting Structures

A number of existing tree snags still stand within the eastern pond unit. While the longevity of the trees that died long ago isn't certain, the snags will be left undisturbed to provide roosting and nesting sites for birds. Tamarisk vegetation that is required to be cleared will be used to a limited extent as small brushy islands that may be used for roosting or nesting by herons, egrets and other species. The brush islands will be located close to the perimeter berms due to the difficulty and cost associated with mobilizing the material further out into the ponds on the weak soils.

Artificial structures were considered desirable as a habitat feature, but were considered to be non-essential and could be added at a future time should funding be available.

Pond Substrate

Placement of a wide variety of materials on the ponds bottom was considered to provide structure for aquatic invertebrates. While substrate is desirable, providing enough coverage over the pond bottoms to be significant would be cost prohibitive.

Predator Discouragement

Islands are set back from the berms to discourage access by land-based predators such as coyotes and raccoons. Habitat channels are located along the perimeter of the berms so that predators will experience deeper water close to the berms should they attempt to start wading towards the islands.

The inner berm has the potential for providing roosting and nesting habitat for birds. Predator exclusion fencing and gates are located at each end to discourage access by larger predatory mammals such as coyotes and raccoons. The gates are located 900 feet from the adjacent berms to mitigate the potential for predators that might attempt to swim across from the perimeter access berms. Fencing along the side slopes at the gate locations extend into the water to inhibit predators from swimming around the gates. The fence utilizes 6 foot tall "Game Fence" with a maximum opening size of 4 inches, determined to be sufficient to preclude such predators from getting through the fence or gate. The fencing will be vinyl coated welded wire and the posts and framing will be pressure treated wood for longevity in the saline environment. The aluminum roller tubes, "Coyote Rollers", prevent the animals from getting a paw hold along the top to climb over. A concrete sill is placed under the gate and an apron placed along the toe of the fence to prevent larger animals from digging under the fence.

FACILITIES

A variety of maintenance and site access features are included in the design for proper management of the habitat area. Many of these features will be used during construction of the project.

Site Access

The primary access route to the project site will be by Bowles Road to its western end, and then south along the unnamed IID levee road. Bowles Road is an dirt road west from Lack Road to Kornbloom Road, maintained by the County. Farmers state that ruts in the road are due to traffic after precipitation, and that irrigations don't saturate the road. Access for the saline river pump station and force main will be from Young Road and Kornbloom Road.

In order to provide adequate turning radius and passing for large trucks hauling materials and equipment to the project site, the corner at the end of Bowles Road is widened. Otherwise, improvements to access routes were not determined to be needed.

The access berm to be constructed from the existing IID levee road to the maintenance pad area will be wider and compacted to stricter requirements than the rest of the berms to support the heavy construction traffic.

Maintenance Pad Area

The maintenance pad provides suitable space to allow for large trucks to turn around and for storage of equipment and supplies. The pad is large enough to accommodate delivery, erection and launching of large dredging equipment. It is assumed that the most of the project construction will be staged from the maintenance pad area, once it is constructed. A preliminary staging area is provided at the south end of the project site adjacent to the agricultural field to allow the contractor a suitable area to launch the first stages of construction activities. This staging will need to be filled to design elevations in order to serve as an adequate base for equipment. IID and the tenant farmer have agreed that the staging area pad can be left in place at the completion of construction.

Boat Ramps

A boat ramp for each pond unit will allow boat access for monitoring and maintaining the ponds and habitat conditions. The ramps are designed to accommodate airboats similar to the CDFW or USFWS boats currently used on the Sea. The ramps sloping into the deeper sediment basins allow for larger, conventional crafts or dredging equipment to be launched.

Articulated concrete mats provide a flexible structure that will not be prone to cracking, slumping and separation like a concrete slab would over the extended period of expected settlement of the base soils. The mats can withstand considerable wave energy coming across the deeper water of the sediment basins. Additionally, the ramps can accommodate the launching of hydraulic dredge vessels used to create and maintain the deeper habitat channels.

Pump station operation

The standard design is based on site-operation of the pumping facilities that entails operator control of the pumping plants at the station site, with capabilities to program pumping. The pump stations have safety features to automatically shut off pumps in emergency cases such as overheating or low water at the intake. Remote status monitoring and operation of the pumping facilities was considered an option, with alternative means of communication: 1) Fiber optic cable, 2) leased telephone line, or 3) radio. Due to the cost of telemetry components, it was determined to include an empty cabinet section in the Pump Control Panel at each station that will accommodate future installation of the remote operation equipment if this capability is desired in the future.

Security

Access control gates and fencing are located at the primary points of entry into the project site by way of the berms. Materials were chosen to provide adequate protection from the saline environment of the SCH.

Public Use

Recreational use (i.e. angling, hunting, bird watching, kayaking) of the SCH habitat area may be allowed at CDFW's discretion if it can be done without jeopardizing the goals of the ponds. While specific features or facilities for public access are not designed into the plans at the time of construction, nothing in the design would preclude public use of the area should opportunities be developed in the future.

PRELIMINARY SITE PREPARATION

Certain activities were identified to adequately prepare the project site before the main construction activities begin. Diverting major sources of water to help prevent the site from being inundated and clearing vegetation and debris were the primary goals.

Vegetation Clearing

Vegetation clearing is required for the protection of nesting birds and to minimize the risks of costly construction delays. Protection of birds and their nests from "take" due to construction activities was a focused topic of consideration. The two primary means of protection are clearing of vegetation necessary for project construction during the non-breeding season and biological monitoring for special status species during construction activities.

Vegetation required to be cleared will be removed prior to the start of construction to the extent feasible as part of preliminary site preparation activities, during the non-breeding season. The primary area of clearing is along the New River including the existing river berm top and the playa along the toe of the existing berm.

At times the northwest corner of the adjacent agricultural field is inundated with irrigation tailwater that supports the rapid growth of wetland vegetation. At other times the field is dry and graded clean of vegetation. Because marsh vegetation could become Yuma clapper rail habitat, preventive measures will include routine maintenance of the adjacent agricultural drainage areas to minimize wetland plant establishment that could attract the rails.

Handling of Cleared Vegetation

Vegetation required to be cleared for construction activities can be handled in a variety of ways including burning, chipping, spraying, off hauling and leaving it onsite.

Burning
Elimination of most of the cleared material by burning has the advantage of eliminating the potential for use of live vegetation by nesting birds and for the material to interfere with construction operations. Challenges to utilizing this technique are a lack of readily available regulatory clearance options, time required for drying, and emissions limits during burns.

Chipping
Chipped materials are less likely to be used for nesting habitat, and could be utilized as slope protection.

Spraying
Spot application of herbicide in critical areas on the SCH playa may be performed if necessary by CDFW licensed applicators. A larger magnitude vegetation treatment by spraying on the non-agricultural lands, near water, with Category 1 herbicides would require a Pesticide Use Permit filed at the Agricultural Commissioner's Office, and was determined not to be employed for the preliminary SCH site preparation activities. It's noted that foliar spraying (as opposed to cutting and stump spraying) may not be completely effective at preventing regrowth of tamarisk, however this is not of concern for this project since long-term tamarisk control will be accomplished by the saline water in the ponds.

Off-hauling
Removing vegetation that has been cleared, burned and/or chipped from the project site and hauled to an alternative location has the advantage of minimizing conflicts with construction and the chance for becoming active nesting habitat. Off-hauling was dismissed because of the costs associated with the process.

Leaving Vegetation in the Ponds
Cleared vegetation could provide benefits as habitat substrate structure, and as a wave attenuation break to protect berms from erosion. Decomposition of the biomass is not expected to cause significant water quality problems such as oxygen depletion. Material left relatively whole with stumps and/or clumped into island or windrows would minimize the chance for floating and wind driven transport of material within the pond units. The primary concern of leaving cleared vegetation onsite is the potential for nesting habitat to develop that could cause costly construction delays.

Because of the significant expenses incurred in handling of materials by burning, chipping or off-hauling, and the low probability for nest establishment in the cleared material, it was determined to place cleared vegetation into windrows along the toe of the new berms for erosion protection. Some of the cleared tamarisk and root wads are to be placed into small islands for the added value of roosting and nesting structures attractive to herons, egrets and cormorants. The small islands will be made up of piles with dirt mounded around them so the trees don’t float free, and located relatively close to the areas being cleared to reduce costs. To minimize the potential for the islands, constructed of cleared tamarisk, to serve as predator perches nearby to nesting islands, placement will be confined to allow at least a 500 foot buffer from any other island types.

Temporary site drainage

The central bay area of the project site has remained inundated with water even as the Sea has receded beyond the delta area. The two sources of water are agricultural discharge from the adjacent farm fields and the existing IID turnout structure feeding water from the New River. Allowing the project site to dry out will improve construction conditions as well as minimize growth of vegetation.

In October, 2013 IID excavated a small ditch from the west end of Bowles Road to the east by the existing habitat ponds that collects a mixture of agricultural drainage from the pumps, shallow groundwater, and drainage from the adjacent managed wetland habitat. The ditch terminates in a small basin to allow for evaporation and seepage. The New River turnout structure to the playa was blocked with a heavy concrete barrier to eliminate the recurring practice of people removing the stoplogs from the diversion structure, thereby allowing water to flow onto the playa.

The small amount of vegetation on the playa within the project site will be allowed to dry out by cutting off freshwater sources from the river and agricultural discharge to minimize attractiveness of the site to nesting birds. Once the project site is inundated as habitat, the dried vegetation will become substrate within the pond units.

Debris Clearing

Existing debris such as tires and concrete pipe that have been used by burrowing owls, a special status species, will be removed from the project site prior to construction, during the non-nesting season.

MAINTENANCE

The SCH occurs in a region with extreme environmental conditions and constructed from onsite soils that are highly erodible. A rigorous project site monitoring and maintenance program will be required to ensure that the habitat ponds continue to function as intended.

Seepage Monitoring and Control

The berms will need to be monitored for seepage induced erosion evidenced by saturated soils and water daylighting on the downstream slope, particularly at the toe. Internal erosion, called piping, occurs when particles of soil are carried away with the seeping water. Left uncontrolled, piping can result in failure and breach of the berm. The dispersive nature of the onsite soils used for embankments could lead to rapid development of a piping condition and the loss of the embankment. If it is determined that seepage is occurring, control can be accomplished with several techniques designed to reduce the head gradient through the berm and/or its foundation including construction of a vertical cutoff trench, addition of sand to the seepage berm or installation of vinyl sheetpiling. A discussion of methods to control internal erosion is included in the project geotechnical report. Addition of sand to the seepage berm is the simplest approach with material available from the onsite borrow stockpiles. If more rigorous intervention is necessary, methodology and requirements for berm coring of a cutoff trench are included in the construction technical specifications. Installation of vinyl sheet piling may be necessary, with consultation of a geotechnical engineer being appropriate.

All of the outer berm toe of slope and IID levee road should be monitored periodically for seepage problems. Likewise, the existing New River berm should be monitored on the project side for seepage along the toe. Because the river water surface is at or below the adjacent elevation of the playa, problematic seepage from the river through the existing levee would only be expected to occur during infrequent high flow events.

Draining the ponds will not be a routine maintenance activity, but may be required if a berm was damaged or under another type of emergency situation. In the event that one pond unit is drained for maintenance or due to an uncontrolled release of water, the inner berm will be particularly vulnerable to seepage failures. The inner berm is not designed to provide adequate protection from internal piping with one pond unit full and the other drained or with a significantly lower water surface. If seepage problems become an issue in such a case, the full pond unit may need to be at least partially drained to avoid a failure of the berm due to internal erosion.

Erosion Monitoring and Control

It is expected that the berms will need to be periodically inspected and maintained for the variety of erosion that will occur from wind driven waves and rain. Erosion control measures included in the design for the SCH ponds are rock riprap, sacrificial beaches and wave attenuation windrow breaks of cleared vegetation. All of these will require maintenance and repair in specific areas as high wind events take their toll on the pond impoundment slopes. The top of berm is covered with gravel (aggregate base) for all-weather maintenance access that also serves as erosion protection from rain and splashing from wind waves, as well as from vehicle traffic. The road surface gravel (aggregate base) on the top of the berm will need replenishing periodically.

The existing river berm that provides some protection to the project site from flooding by the river during high flow events needs to be periodically monitored for bank erosion. The river side slope appears to be well protected by heavy vegetation, but that vegetation also makes inspection of the bank integrity difficult. If significant bank erosion occurs, maintenance and repair measures will need to be implemented. The outside banks of bends in the river and the river pump station site should receive particularly careful observation. For monitoring purposes, the top of the existing berm should be kept clear of vegetation. The existing river berm should not be traveled by heavy traffic, and any traffic that does occur should maintain a good buffer from the river side shoulder to avoid failing the sandy bank slope.

An inspection of the SCH and New River berms should be performed after significant precipitation and wind events to document and address potential damage. Monitoring should only be done during low river stages. A slump and breach could occur quickly within existing New River berms during a high flow event. No personnel should be allowed onsite during extreme river flows. No flood fighting measures are recommended be taken along the New River berms due to the risk of life concerns in the event of berm failure.

Sediment Basin and Channel Dredging

Both the sediment basins and intake channel to the saline water pump station are designed with a limited lifespan before dredging will be required. The sediment basins will fill over time with material that settles out of the river water influent. The basins are sized to allow at least 20 years of service before maintenance dredging is required. The saline water intake channel may become blocked over time with wind wave driven beach deposits at the mouth or from soils eroded from the channel side slopes. The intake channel is designed to serve the pump station until the water surface elevation in the Sea recedes to

-243 msl. The channel will need to be dredged to provide adequate flow capacity for the pumping rates to remove deposited sediment to restore the original depth or to provide a lower channel bottom when the Sea declines further.

The habitat channels interior to the pond units are designed to have stable side slopes and are expected to remain intact as constructed for an indefinite period of time. Re-suspension of the fine-grained sediments on the bed of the ponds may occur during high wind events. Settling of re-suspended solids would be expected to occur throughout the project site, including the habitat channels. If reaches of channel become filled over time with sediment settling or slumping side slopes, removal may be desired when other dredging maintenance activities occur.

Pump Stations

Routine maintenance for the pumping facilities includes periodic inspection of the structural components such as the pier and wood frame canopies to ensure that any deterioration of materials is addressed. The anchoring systems for the pumps are to be inspected for corrosion or other signs of distress.

For the pumps, maintenance will include inspecting and replacing pump mechanical seals, and inspecting the pump impellers and pump columns for abnormal wear or corrosion. Pump check valves will be inspected regularly for wear and/or fouling.

Records should be kept of pump capacities so that over time any reduction in pumping capacity can be recognized and if the drop in capacity is significant, remedial measures can be taken. Individual pump capacities can be checked by operating a single pump at one time and measuring the head over the weir in the mixing basins at the New River pump station.

Electrical equipment maintenance consists primarily of routine inspections of cabinetry for signs of vermin and taking appropriate action. Ventilation fans must be checked to ensure they are operating. Annual cleaning of the insides of the cabinetry will provide an opportunity to check for corrosion and prevent deterioration of the components.

Agricultural Drain Pumps

The agricultural drain pumps located at the end of Bowles Road will continue to be operated and maintained by IID, as has historically been done.

Drain Ditch

The ditches that provide drainage for the water control structure outlets and nearby private wetlands may need to be periodically cleaned of vegetation and sediment deposits to ensure adequate capacity to pass drain flows.

Water Control Structures

Stoplogs used to manage the water surface elevation in the ponds are premium corrosion resistant "boards" that should provide a suitable seal from leakage. The stoplogs should be periodically inspected for fowling or clogging they would inhibit the removal in emergency situations. Any debris that collects in the vicinity of the structures should be removed.

Facilities

Access gates and fencing materials were chosen to provide a reasonable degree of corrosion resistance. Choice of materials was balanced with cost and ease of replacement when required.

HABITAT MANAGEMENT AND POND OPERATION

For descriptions of management and operation activities required to achieve the habitat goals, see Appendix D and E of the Draft Environmental Impact Statement/ Environmental Impact Report (Cardno ENTRIX 2011) and the Monitoring and Adaptive Management Plan (MAMP).