City of Ventura Special Studies – Phase 3:
Assessment of the Physical and Biological
Conditions of the Santa Clara River Estuary,
Ventura County, California

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A Technical Review Team Assembled by:

Wishtoyo Foundation, Ventura Coastkeeper, and Heal the Bay

March 9, 2018

The Technical Review Team (TRT) has reviewed the Santa Clara River Estuary (SCRE) Final Phase III report (dated February 2018) as prepared by the City of Ventura and Stillwater Sciences. This report is a subsequent version to the November 2018 report that the TRT reviewed in December 2018. It contains many small and large changes and this memo is not meant to provide detailed comments on all of those changes. We do appreciate the changes that were made in response to our original set of comments; however, there are some substantial changes to the February 2018 final report on which we are providing comments as well as discussion of some areas of disagreement as it relates to the findings.

The report now recommends three discharge levels:

- Enhancement Discharge Levels—most fully support 10 beneficial uses "as well as" MUN
- Maximum ecologically protective diversion volume (MEPDV)
- Continued Discharge Level—minimum required to protect existing ecological uses with focus on listed species.

The discharge levels are based on scenarios that evaluate the effect of the effluent during "closed-mouth, dry weather conditions" which is determined to be the most critical to the habitat quality within the lagoon. Presumably the remainder to the year, authorization for additional discharge may be sought by the City. It is not clear what those discharges may be, nor are the months or duration of any additional discharge discussed in the report. The TRT commented in its earlier review that we would favor higher discharge in the wetter season and less in the dry season, however, the TRT requests a more explicit explanation of the months when any of the above discharge levels apply and the expected discharge that may occur outside of those periods. We believe that this needs to be more fully disclosed to the agencies as it is essential in understanding nutrient loading, water levels, and flow regimes that may be present outside of the “dry season”.

We recognize that the report has made changes to the AHP models in numerous places in response to suggestions by ourselves and others, has added a more integrated discussion of Primary Critical Habitat Elements (PCEs) for listed species, added a MUN beneficial use, and where appropriate has recalculated the tables for each of the beneficial uses. We also recognize that the report acknowledged the problems with the sondes and provided some recalibration of the data. The nutrient uptake rate has been modified to account for an area-based update rate (zero-order), that adjustments have been made to the ground water salinity input, and the heat budget model has been adjusted.

We also acknowledge the thorough and transparent discussion of caveats and uncertainties presented in Section 5.6.3 of the report, including the underlying limitations of the modeling tools, the inability to model some factors affecting habitat suitability, and the inherent uncertainty associated with multi-criteria decision-making tools like AHP. However, in their totality, these caveats and uncertainties, combined with a reliance on, in some cases, limited data (e.g., extensive loss of temperature data due to apparent sonde malfunction) and broad assumptions (e.g., nutrient levels as proxy for DO), suggest that the AHP results and scenario rankings should not be relied upon at the expense of sound professional judgment.

The final report presents the most recent iteration of AHP scoring and ranking; however, rather than increasing our confidence in the process, instead indicates the extent to which comparative scenario scores can be modified without the addition of any new data or information. This is evident by the extent to which some scenario scores changed from the previous AHP results to the current version (e.g., normalized percentage for Scenario 11 increased from 58% to 83%) with comparatively minor changes to some metrics and scoring thresholds and a rescoring by a small number of experts. Moreover, we note that the spread amongst normalized scenario scores decreased from 58-100% to 83-100%, suggesting limited differences between discharge scenarios that cannot be adequately quantified with only five sets of relative weight scorings (see Figure 5-29). In light of the assumptions and uncertainties incorporated into the overall analysis and AHP, including the report’s acknowledgment that “the selected thresholds are, in some cases, somewhat arbitrary”, it is not difficult to imagine how a few more AHP refinements and additional rounds of scoring could further adjust the scores and rankings. We commend the City and Stillwater Sciences for recognizing and disclosing the limits of the AHP results, and encourage readers of the final report to carefully review Section 5.6.3 of the report, including the following:

> “While the AHP was used to give rigor to the decision making process, the caveats and uncertainties discussed above dictate caution when interpreting final weighted scores for each VWRF discharge scenario (Figure 5-23 and Figure 5-24). These values, which essentially represent the extent to which each discharge scenario supports the balance of beneficial uses in the SCRE relatable to VWRF discharge, should not be used as an absolute prediction of future conditions in the SCRE, but rather as a ranking of discharge scenarios relative to one another. As such, management decisions should not be based on small differences in scoring values across scenarios, but rather on general trends and large differences across groups of scenarios.”

We fully agree with this caution and suggest that the 7% normalized priority spread across Scenarios 4 (30% discharge reduction) through 8 (70% discharge reduction) is too narrow to be indicative of statistically significant differences given the acknowledged caveats and uncertainties. Ultimately, management decisions across these scenarios will come down to professional value judgments of the appropriate role of wastewater discharges in ecological management.

Regarding this value judgement, we believe it is important to appropriately define existing baseline conditions and species utilization. In its concluding recommendations, the final report notes, for example, that “the MEPDV of 60% reduction in current VWRF discharges, with a Continued Discharge Level of 1.9 MGD in critical, dry weather, closed mouth conditions is not likely to adversely affect steelhead currently using and occupying the SCRE.” As we have noted on other occasions, given that steelhead have not been observed in the SCRE during closed-mouth conditions with any regularity (although this may partially be due to inadequate monitoring), and that one of these rare occasions involved observations of post-breach steelhead mortalities, we do not agree with the approach of using existing conditions as the standard against which reductions in VWRF discharges are evaluated to for potential adverse effects to steelhead and critical habitat given the report’s acknowledgment that “[w]ater quality conditions for steelhead rearing and migration through the SCRE are expected to improve under reduced discharge scenarios”.

Furthermore, there is a more integrated involvement of PCE’s throughout the report; however, the report appears to assume a uniform response of the PCE’s for each discharge scenario based on the existing conditions. For tidewater goby, *Special Management Considerations or Protection* are identified by USFWS immediately after listing the PCE categories in the 2013 Federal Register (73.21) document referenced in the report. USFWS defines special management considerations or protection as actions that “may be necessary to eliminate or reduce the magnitude of threats that affect the physical or biological features essential to the conservation of the tidewater goby”. Ten specific threats, or categories of threats, are identified; many of which pertain to the SCRE including: (1) coastal development projects, (2) water diversions and alterations of upstream flows, (5) discharge of agricultural and sewage effluent, (7) introduced species that prey on tidewater goby, and (10) competition with introduced species. These threats are part of the existing conditions in the SCRE, and should be assessed to the extent the AHP scenarios that trend more towards the existing state (i.e. closer to 100% discharge) would continue to facilitate the persistence of the threats and therefore reduce the PCE values. Discharge scenarios that improve and/or eliminate these threats may therefore provide greater PCE value, even if quantity of the habitat is lower. The concern of valuing habitat quantity over quality has been expressed by the TRT throughout the report review process. We would defer these tradeoffs to regulatory agencies; however, believe this provides further justification for our earlier MEPDV choices.

We remain concerned that the AHP tends to drive the resulting recommendations on the MEPDV and other discharge levels discussed above. It appears that with the adjustments made to the model and its factors, the scoring levels changed significantly for the various discharge scenarios-shifting towards the middle. While we appreciate the sensitivity analysis that was done, the input by four individuals is probably not sufficient to test how best to interpret the outcome. The greater differences appear to be at either end of the scenario scale, but there are still differences in the middle scenarios. The TRT is not convinced that the AHP can be used in an absolute sense given the number of assumptions, difficulty in the interpretation of the field data, and the limited factors being assessed to predict complex problems. While we are not opposed to selecting discharge levels using the AHP, we believe that it should be given more flexibility with a preference towards a smaller discharge than might be selected based on 100 or 99% achievement of all the beneficial uses.

Our earlier review stated that we believe either Scenario 8 (1.4 MGD/70% reduction) or Scenario 9 (0.9 MGD/80% reduction) would represent the most likely amount of discharge under the MEPDV. These are ranked by the current AHP as achieving the percent of the normalized score as either 94% or 86% respectively. We believe that Scenario 8 is well within the range of acceptable scores using this method and in consideration of the uncertainties and variance discussed above.

We defer to the regulatory agencies as to whether they support a Continued Discharge Level (CDL) to maintain habitat for listed species. We do note however that looking at the RARE beneficial use score, Scenario 8 has a relatively high ranking of 0.029 compared to 0.032 for Scenario 7 (1.9 MGD/60% reduction) suggesting that the recommended 1.9 MGD could be reduced to 1.4 MGD (or less).

The final report also presents an Enhancement Discharge Level (EDL) which is stated to represent the flows that in comparison to no discharge provide "fuller realization of the balance of beneficial uses important to the protection of the SCRE". The report recommends EDL levels at 1.9 to 2.8 MGD. We are not in agreement with this assessment as it seems to imply that dry season discharge is necessary for the estuary to function when, in fact, the report does not present an analysis of natural flow patterns that can be compared to the highly artificial patterns that now occur. We do know that, historically, the estuary did support robust populations of listed species, migratory birds, and healthy riparian and wetland communities. Today, due to a variety of issues within the region including the watershed and nearby ocean, but also within SCRE, these populations have declined or are threatened. We believe it is not appropriate to set an EDL without fully considering how best to return the system to a more natural flow pattern including resolution of issues within the watershed that have altered flow patterns. The EDL suggests that sustaining unnatural flow patterns somehow better supports the ecology of the lagoon with which we strongly disagree. While we recognize through our recommendation of an MEDPV that some discharge can be tolerated, and may have some benefits to the lagoon, we are not in agreement that a higher level EDL should be allowed or recommended.

Our comments and conclusions in our December 8th letter provide more detail on the basis for our recommendation on the MEDPV. We recognize the effort by the City and Stillwater Sciences to address those comments; however, our fundamental concerns with the data, model, and AHP remain.

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December 8, 2017

The purpose of this analysis is to provide technical review of the November 2017 Draft of the City of Ventura Special Studies – *Phase 3: Assessment of the Physical and Biological Conditions of the Santa Clara River Estuary, Ventura County, California* (Phase 3 Report). The Phase 3 Report addressed three primary areas related to tertiary treated municipal water discharge effects on the ecological functions of the Santa Clara River Estuary (SCRE) from the Ventura Water Reclamation Facility (VWRF). The Phase 3 Report follows the Consent Decree and Stipulated Dismissal [Consent Decree; case number CV 10-02072-GHK(PJWX)] between the City of San Buenaventura (City), Wishtoyo Foundation (Wishtoyo), Wishtoyo's Ventura Coastkeeper program (VCK), and Heal the Bay (HtB), which requires a determination, through scientific analysis, of the Maximum Ecologically Protective Diversion Volume (MEPDV). The technical review is based on the best available science, with conclusions and recommendations supported by analysis as to how much, if any, discharge is needed and how much discharge should be eliminated, to protect and sustain the Estuary's native and endangered species. The analysis of the Phase 3 Report is intended to:

- Analyze alternative VWRF discharge scenarios to determine whether any discharge, and if so how much, is needed to sustain the SCRE's native species and related beneficial uses;
- Translate these conclusions into the National Pollutant Discharge Elimination System (NPDES) Permit "average annual volume or flow rate for tertiary treated effluent";
- Recommend a MEPDV that is intended to provides the maximum average annual volume or flow of VWRF effluent that can be discharged to the SCRE, if any, while maintaining protection of the ecological functions of the SCRE and its subwatershed, particularly the SCRE's support of native species with emphasis on species listed for protection under the state and federal Endangered Species Acts.

The MEPDV value should be ecologically protective of native species, particularly those that occur within the SCRE and surrounding watershed, and are listed for protection as endangered, threatened, or candidate species. Within the SCRE, two federally endangered species of fish, tidewater goby (*Eucyclogobius newberryi*) and southern California steelhead (*Oncorhynchus mykiss*), and two federally listed avian species, California least tern (*Sterna antillarum browni*) and western snowy plover (*Charadrius alexandrinus nivosus*), are known to occur. For the purposes of the Phase 3 Report, these four species were used as focal species to evaluate the broader ecosystem linkages the management decisions would have on species and their habitat.

The Wishtoyo/VCK/HtB Technical Review Team (TRT) has provided third party scientific review and comments during the preparation of the Phase 3 Report. Participation from the TRT included several rounds of review, conference calls, and an informational workshop with the City and its consultant team and report preparers from Stillwater Sciences. The TRT involvement included the following:

- Review of "Assumptions" and "Habitat Suitability Criteria" sections provided in the May 2017 draft of the Phase 3 Report. TRT written comments were submitted and a conference call was held, to discuss TRT comments with Stillwater Sciences/City on June 30, 2017.
- Review of the August 2017 draft of the Analytic Hierarchy Process framework and provide comments on the framework on August 30, 2017.
- Participation in an informational workshop on August 31, 2017 hosted by Stillwater Sciences on the Analytic Hierarchy Process framework, preliminary metrics, and scoring.
- Review of Chapters 1-4 of the August 2017 draft of the Phase 3 Report. Comments provided to Stillwater Sciences/City on September 15, 2017.
- Review of Chapters 5 and 6 of the September 2017 draft of the Phase 3 Report. Written comments submitted to Stillwater Sciences/City on October 10, 2017. Conference call with TRT, Stillwater Sciences/City, and Wishtoyo/VCK/HtB to discuss TRT comments for Chapters 5 and 6 conducted October 12, 2017.
- Participation in the Phase 3 Report meeting with Stillwater Sciences/City, Wishtoyo/VCK/HtB, state and federal resource agencies, TRT, and the independent Scientific Review Panel on November 8, 2017.

While TRT participation and review was afforded for the Phase 3 Report, and Stillwater Sciences worked in a good faith effort to incorporate TRT comments, persistent concerns remained and were conveyed by the TRT for the Phase 3 Report. Copies of the June 30 and October 10, 2017 submitted written comments are appended to this document, and are incorporated herein by reference. Several of the persistent concerns revolved around issues identified with assumptions made in the collection, interpretation, and projection of data for the SCRE, and represents a fundamental limitation in the ability to use current data to project future conditions in an estuarine system subject to significant physical, biological, and anthropogenic forces. The following sections of this document are intended to discuss key uncertainties and limitations identified in the Phase 3 Report along with areas of outstanding ecological concern. Due to the requirement to identify an MEPDV, or range of discharge, a recommended MEPDV is discussed along with recommendations for areas of ongoing analysis.

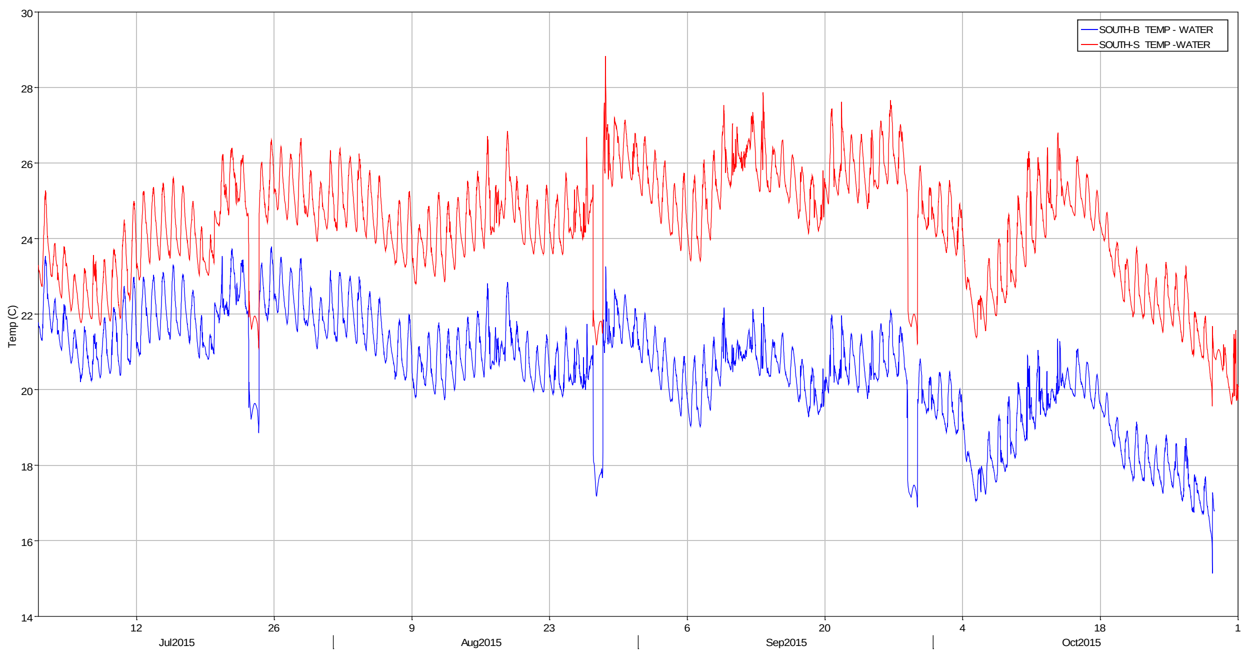
UNCERTAINTIES

Water Quality Data

During the development of the report, the TRT expressed a number of concerns regarding the analytical approaches and assumptions applied to the Phase 3 Report. In response, the City and Stillwater Sciences addressed some of these concerns (e.g., improvements to the water balance model), performed additional analyses (e.g., weighting of beneficial uses) to address other concerns, expanded discussions of uncertainties, and, in some instances, simply acknowledged and disclosed our concerns but retained the underlying assumption. The TRT appreciates the City's efforts in addressing our concerns and notes that

Section 5.6.3. of the report provides a relatively thorough discussion and acknowledgement of a number of the uncertainties and limitations underlying the analysis. Our concerns, as well as the City's responses, are documented in a number of communications and are not fully repeated here. However, we want to draw attention to some of the remaining weaknesses in assumptions as well as potential problems in data interpretation.

For example, one of the underlying assumptions important to much of the water balance and mixing models is that of a well-mixed, unstratified closed-mouth equilibrium state. The analysis relies primarily on the water quality monitoring profiles collected during the 2015-2016 study period. We acknowledge that *in situ* water quality profiles presented in Appendix D of the report generally suggest well-mixed, unstratified conditions in the SCRE when closed; however, very little detailed analysis of the continuous sonde data is presented. A closer look at these data suggest that the "well-mixed" assumption may not be valid during significant periods of time. For example, water temperature data for the South sonde location (unfortunately the only site for which continuous data are available at different depths) suggest ecologically significant differences in surface and bottom temperatures. The graph below shows South sonde surface (red) and South sonde bottom (blue) temperatures from June 1, 2015 through October 31, 2015, a period of time when the mouth of the SCRE was consistently closed. The graph clearly shows a relatively consistent 2 to 4 degree Celsius (°C) difference between the surface and bottom sensors. The surface temperatures are generally within a range that would be considered stressful to steelhead, while the bottom temperatures are well within a suitable range.



The apparent presence of a persistent and ecologically important thermocline under extended closed-mouth conditions not only leads to a question of the overall validity of the "well-mixed" assumption, but also raises concerns about seemingly significant inconsistencies between *in situ* water temperatures profiles collected at the South sonde and continuous sonde data. For example, the August 12, 2015 (Figure D-19) and August 27, 2015 (Figure D-20) profiles for the South sonde do appear to support the assumption of vertically mixed water temperatures, yet sonde data recorded immediately before and after the profiles were collected suggest a 3 to 4°C difference between surface and bottom temperatures. The observed inconsistencies between sonde and profile data raise doubts about *in situ* profile data at other locations (e.g., north and central sondes) where the analysis lacks concurrent continuous data at different depths. The Phase 3 Report acknowledges the data inconsistency issue raised by the TRT, but argues that the instantaneous data are considered more representative of actual estuary conditions since those data were collected using more recently calibrated instruments than the sondes. Even a cursory review of the above graph suggests that this explanation in unlikely to be valid as the sondes were calibrated three times during the June, 1, 2015 through October 31, 2015 monitoring period, and pre- and post-calibration water temperature data maintain the observed differences between surface and bottom temperatures. We acknowledge that the persistence of pre- and post-calibration temperature difference at the South sonde may, in and of themselves, be indicative of unreliable data. Unfortunately, the underlying reasons for the observed inconsistencies between *in situ* and continuous data are not known, and therefore present a significant uncertainty for the analysis presented in the Phase 3 Report. We do note, however, that most of the groundwater data collected during the Phase III and prior studies indicate cooler than ambient water temperatures, as would be expected of groundwater, and that here appears to be a distinct possibility that undocumented groundwater inflows and/or hyporheic river flows may be providing thermal refugia in the SCRE, and that the well-mixed assumption may not be valid for water temperature during the extended closed-mouth conditions that are the primary focus of the comparative discharge scenario analysis.

We acknowledge that in response to our prior comments related to this issue, Stillwater Sciences developed a simplified heat balance model and conclude that, regardless of any water temperature data inconsistencies, VWRF discharges have only a minimal influence on equilibrium water temperatures of the SCRE. However, since this model applies the same vertically uniform temperature assumptions and does not consider the potential influences of depth on water temperature, it does not shed any light on potential future water quality conditions under different discharge scenarios.

Habitat Quantity Over Quality

The Phase 3 Report acknowledges that water quality parameters are essential habitat attributes determining habitat suitability for aquatic species such as steelhead and tidewater goby, and provides a fairly comprehensive overview of habitat requirements related to water temperature, dissolved oxygen (DO), salinity, and metals (dissolved copper). However, some of these parameters (e.g., water temperature) are only evaluated qualitatively or using a proxy (e.g., nutrient concentrations as indicator of potential DO issue) due to a number of study constraints, including insufficient data and/or analytical tools to support predictive modelling. Applying an assumption of well-mixed conditions in the SCRE, the report concludes that most of these water quality parameters are largely unaffected by different discharge scenarios. The validity of this and other assumptions are discussed in more detail in the *Ecological Concerns* section of this document; however, through the process of elimination, water depth emerged as the only steelhead, and dominant tidewater goby, habitat suitability parameter factored into the comparative analysis of alternative discharge scenarios.

While juvenile steelhead rearing in an estuary may avoid excessively shallow waters (presumably due to an increased predation risk) and excessively deep waters (presumably due to decreased DO and food availability) (Boughton et al. 2017), the range of effective water depths usable to steelhead is relatively wide, as acknowledged in the Phase 3 Report. As such, a habitat parameter that is arguably one of the least limiting factors for steelhead estuarine habitat suitability, namely depth, is used as the sole factor for weighing discharge scenarios against each as a measure of potential future steelhead habitat suitability of the SCRE. The reliance on depth as the only habitat suitability factor inherently biases the comparative analysis toward greater discharges and thus, unsurprisingly, the results suggest that a 0% reduction in discharge (i.e., maintaining 100% discharge) would result in most suitable conditions for steelhead, while a 100% reduction (i.e., eliminating all discharges) would result in the lowest extent of “suitable” habitat. Moreover, the MEPDV recommendation provided in the report state (emphasis added): “Diversion volumes in excess of 40% (i.e., > 1.9 MGD) are not considered ecologically protective largely due to reductions in physical habitat area of suitable depth for steelhead rearing." In our opinion, the Phase 3 Report, by default, over-emphasizes the importance of water depth to steelhead habitat suitability, and by extension, over-emphasizes the importance of water depth to the overall ecological function of the SCRE.

Similarly, we note that even if depth, and by extension habitat acreage, is viewed as an important factor determining estuarine habitat suitability for steelhead, an independent analysis conducted by the TRT using hypsometry data provided by Stillwater Sciences (see Table 1) indicates that even with a 70% reduction in discharge (Scenario 8), equilibrium conditions would provide an inundated surface area of approximately 63 acres, approximately 29 acres of which would contain water depths equal to or exceeding 1.5 ft (0.5 m), and approximately 13.5 acres with water depths equal to or exceeding 2.5 ft (0.75 m) based on current lagoon morphology and not considering the effects of potential future campground restoration, which is estimated to create additional aquatic habitat at estimated depths of 2-3 ft even under a 100% discharge reduction scenario (cbec 2015), or changes in riverine freshwater inflows. A 100% reduction in discharges (Scenario 11) would provide a surface area of about 24 acres with approximately 7 acres of 1.5+ ft depths and about 2.4 acres of 2.5+ ft of depths. By comparison, Scott Creek Lagoon, the location of the Bond et al. (2008) and Hayes et al. (2008) research regarding estuarine rearing benefits for steelhead, has a surface area of approximately 4.5 acres with an average depth of 2.4 ft (0.7 m) (Hayes et al. 2011).We recognize that the Santa Clara River watershed area is significantly larger than that of the Scott Creek basin, but abundances of rearing juvenile steelhead in Scott Creek Lagoon are apparently far greater than in the SCRE at the current time (refer to *Challenges for Steelhead* below for a discussion of current steelhead utilization of the SCRE), and substantial recovery of the Santa Clara River steelhead population[1] would likely need to occur before density-dependent pressures in the SCRE could possibly begin to become a quantifiable factor limiting the population.

For tidewater goby, the quantity, or acreage, of aquatic habitat becomes a limiting factor in small coastal drainages that have ephemeral lagoons more subject to drying. The larger the aquatic feature; however, does not necessarily result in better habitat conditions and more secure populations of tidewater goby as populations in San Francisco Bay and Santa Margarita River have been lost. The USFWS considers habitat smaller than 5 acres less stable, with histories of extinction or extirpation; and the most stable populations of tidewater goby occur in habitats ranging in size from 5 to 125 acres (USWFS 2005). Under all discharge scenarios, the SCRE would remain above 5 acres, with even complete elimination of discharge still maintaining over 23 acres of aquatic habitat. Therefore, the acreage of aquatic habitat may be a less important factor, albeit an easier metric to quantify, for tidewater goby as the quality. The Phase 3 Report provides a summary of suitable habitat conditions for the species; however, discharge scenarios that promote water depths less than 2 meters, contain sandy substrate for spawning, eliminate out of season breach events (i.e., non-storm driven breaching characteristic of winter/spring) and reduce and/or eliminate non-native predatory aquatic species would provide better quality habitat for tidewater goby. The complexity of factors that contribute to the suitability of aquatic habitat for the species is not decipherable from a simplified metric of habitat acreage.

[1] Recognizing that substantial uncertainty regarding the mean annual run size that would represent viable southern California steelhead populations, the federal recovery plan for this Distinct Population Segment (DPS) (NMFS 2012) uses a preliminary recovery target of an average of 4,150 spawners per year, persisting through a cycle of poor ocean conditions, within the larger watersheds of the range.

Table 1 – Area within various depth ranges for each scenario.

Scenario No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
MEPDV (%)	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Equil. WSE (ft)	10.2	9.8	9.3	8.8	8.1	7.5	7	6.4	5.8	5.3	4.7
Area within Specified Depth Range (acres)											
Total	139.5	115.9	95.4	90.0	86.6	82.2	76.3	63.2	47.1	37.0	23.7
0-0.5 ft	28.7	20.5	5.4	2.5	3.5	5.9	10.5	12.9	10.2	11.7	7.5
0.5-1 ft	17.0	5.4	2.5	3.1	5.5	10.5	12.8	11.7	11.7	7.7	4.4
1-1.5 ft	4.3	2.5	3.1	4.3	8.9	12.8	12.5	9.8	7.7	4.8	4.7
1.5-2 ft	2.4	3.1	4.3	7.0	13.2	12.5	8.6	9.9	4.8	4.7	3.0
2-2.5 ft	3.9	4.3	7.0	12.4	13.1	8.6	11.4	5.5	4.7	3.5	1.7
2.5-3 ft	5.5	7.0	12.4	13.5	8.9	11.4	6.3	4.5	3.5	1.7	1.6
3-3.5 ft	8.9	12.4	13.5	10.2	11.5	6.3	4.4	3.9	1.7	1.9	0.8
3.5-4 ft	13.2	13.5	10.2	11.7	7.0	4.4	4.2	1.9	1.9	0.8	-
4-4.5 ft	13.1	10.2	11.7	7.7	5.3	4.2	2.2	1.7	0.8	-	-
4.5-5 ft	8.9	11.7	7.7	4.8	4.2	2.2	1.8	1.3	-	-	-
5-5.5 ft	11.5	7.7	4.8	4.7	2.2	1.8	1.5	0.1	-	-	-
5.5-6 ft	7.0	4.8	4.7	3.5	1.8	1.5	0.2	-	-	-	-
6-6.5 ft	4.4	4.7	3.5	1.7	1.5	0.2	-	-	-	-	-
6.5-7 ft	4.4	3.5	1.7	1.6	0.2	-	-	-	-	-	-
7-7.5 ft	2.6	1.7	1.6	1.2	-	-	-	-	-	-	-
7.5-8 ft	1.7	1.6	1.2	-	-	-	-	-	-	-	-
8-8.5 ft	1.6	1.2	-	-	-	-	-	-	-	-	-
8.5-9 ft	0.4	-	-	-	-	-	-	-	-	-	-

Water Balance Model

The analysis provided in the Phase 3 Report relies heavily on a water balance model that was developed specifically for the SCRE. When applying this model, only the magnitude of discharge from the VWRF is varied between the various scenarios in order to provide a prediction of what an equilibrium water surface elevation within the SCRE would be, as well as the number of days a year in an open- or closed-mouth condition. From the predicted equilibrium water surface elevation, distinct areas are then predicted to become various habitat types (e.g., riparian, mudflat, open water, etc.) using a set of habitat evolution rules.

The water balance model includes a number of inputs, and is, like all models, a simplification of reality. Some important hydrologic components may be estimated incorrectly or missing. The water balance model relies upon a large number of estimates to provide inflow and outflow from the SCRE. In some instances, the inputs are measured (e.g., precipitation, river flow[2] or VWRF discharge), which provides a reduction in uncertainty for those components.

Among the largest uncertainties occur with the groundwater inputs and outputs which are estimated with little data to corroborate the estimates. Water level data from wells bordering the SCRE are used along with textural descriptions of the subsurface and corresponding seepage areas, to provide estimates of flux for various zones around the SCRE. It is important to note that very few wells are available to the south of the SCRE in order to estimate that component of surface water-groundwater exchange. While there are no data available to evaluate the groundwater flux estimates, they are assumed to be correct, and any potential inaccuracies are handled with an unmeasured flow term that was manipulated to improve the agreement

[2] While river flow is measured, the measurement location is not located at the edge of the water balance model's domain, and some water may have been gained or lost prior to the flow entering the SCRE. For example, a large losing reach is present in the Santa Clara River downstream of the Vern Freeman Dam, which could significantly alter the volume being delivered to the SCRE.

between the model predictions and observed SCRE water levels. This unmeasured term results in the third largest hydrologic input to the model, following VWRF discharge and river discharge, and also results in an unrealistic temporary overfilling of the estuary following berm closure in reduced VWRF discharge scenarios.

Perhaps the biggest challenge/concern is that there are no data to evaluate the predictive ability of the model under different VWRF discharge scenarios. VWRF is the largest component of the water budget, which is roughly four times the magnitude of river discharge, the next largest component. The model has been calibrated to periods with relatively high VWRF inflow, but data are not available to validate the model's predictions under different VWRF inflow amounts.

In addition, the model relies upon the current topography and bathymetry of the SCRE in the calculations performed. As noted in the Phase 3 Report, both the location of the berm and the morphology of the estuary change. In fact, the berm has migrated upwards of 1,000 ft inland since 2005. The location of the berm, the length of the berm and the shape of the SCRE are important characteristics that dictate the water budget, and it is likely that different results would occur with a different physical configuration (i.e., a different MEPDV could likely be selected). The report notes that the placement of dredging spoils along the coast north of the SCRE resulted in temporarily reduced rates of berm seepage, which highlights the importance of different morphological conditions both within the SCRE as well as along the coast.

The model uses a simplified routine to estimate when the berm would breach based upon the water level in the SCRE. While this deterministic threshold approach is appealing in its simplicity, it leaves an extremely large factor, the wave climate, out of consideration. The threshold approach has been developed through empirical evidence, but it should be noted that the breaching elevation has changed many times through the course of the various studies. While it is used consistently across the scenarios, it is not a good predictor of when future "natural" breaches will occur.

None of these comments regarding the water budget are novel, they have all been acknowledged and/or justified in the Phase 3 Report. However, due to the heavy level of reliance upon the outputs of the water balance model (i.e., predicted equilibrium water surface elevation, number of open mouth days, and hydrologic foundation for all water quality modeling/estimates), it is important that these limitations are adequately understood as opposed to a blind reliance on what the model predicts will occur under various VWRF discharge regimes. These limitations add to the uncertainty in assessing the MEPDV.

Estuary Mixing Model

The analysis provided in the Phase 3 Report relies upon an estuary mixing model to predict water quality conditions under reduced discharge scenarios. This model relies upon the results of the water balance model (discussed above) and observed or estimated concentrations of various parameters (e.g., conductivity, total nitrogen, phosphate). The Phase 3 Report concludes that the VWRF discharge is benefiting (i.e., diluting) the nutrient loading to the SCRE, and that without VWRF discharge, nutrient concentrations would be higher, due to a larger relative contribution for groundwater originating from the north bank. We find this conclusion very counterintuitive based on available data, and feel that the large amount of uncertainty in this analysis leads us to believe it should not be weighed in the MEPDV consideration.

First, in comparing the seasonally predicted nutrient concentrations to the observed values (Table 4-4 of the Phase 3 Report), the model overpredicts the amount of total nitrogen and phosphate in 7 of the 8 seasonal estimates. For these 7 overpredicted values, the overprediction ranges from 47 to 588% for total nitrogen, and 51 to 392% for phosphate. The authors of the Phase 3 Report conclude in Section 4.3 that: "Extending the mixing model to nutrients (N, P) resulted in large overestimates of observed nutrient levels, suggesting that biological uptake should be included in the assessment of future conditions." While they reach this conclusion, they do not provide comparative results that include biological uptake to validate their mixing model.

In Section 5.3.2.2, biological uptake is included in the mixing model that is used to compare various scenarios. In these results, when the model is applied for an idealized period (i.e., generalized inflows and concentrations), the nutrient concentration results for the Scenario 1 (0% diverted), are still considerably greater than the observed results reported in Table 4-4 of the Phase 3 Report. Thus, while including conservative levels of biological uptake does reduce the predicted nutrient concentrations, the estuary mixing model still does not do a good job of accurately predicting nutrient concentrations. While the cause of this overprediction is uncertain, it is likely that one or more of the assumed inputs to the mixing model is incorrect. Figure 3-40 and Table 3-22 of the Phase 3 Report provide summaries of the nutrient concentrations for various groundwater monitoring locations. These results show very high levels of nutrients in some of the groundwater wells. It is likely that these high concentrations are a probable source of the nutrient concentration overprediction of the model. The nutrient concentrations observed in these wells, may not accurately reflect the nutrient concentrations that are delivered to the river. In fact, the nutrient concentrations observed at R-1 or R-005 (which represent surface flow into the estuary) are much lower than the groundwater wells used, even though the source of this water at R-1 and R-005 is the shallow groundwater basin immediately upstream of the estuary underlying the river bed during periods without surface flow (which is the case during a closed mouth condition). Thus, aside from the wells recording percolating water from the VRWF wildlife ponds, the nutrient concentrations observed at R-1 or R-005 most reflect actual nutrient inputs from groundwater to the estuary. While uncertain, it is highly likely that nutrient concentrations will be reduced through a reduction of VRWF discharge, rather than increased as the Phase 3 Report suggests.

Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) was selected by the City as the method to provide a quantitative assessment of VWRF discharge scenarios. There has been considerable research on AHP, many published papers (especially in China), and widespread applications in engineering, planning, and social sciences. The main use of AHP is for complex decision making where there are many factors involved that present competing choices. Rather than consider them *in toto*, the AHP breaks them down into multiple pair-wise comparisons that then allow participants to focus on individual comparisons. The mathematical underpinnings of the methodology come to play when factoring all of these comparisons together. The ultimate outcome is a quantitative assessment of the various possible solutions to the problem to assist the decision makers in evaluating a course of action.

AHP is, no doubt, a powerful technique. However, as experience with this decision-making tool has expanded, so have the issues related to how to interpret the outcomes. This is particularly true as it relates to the level of uncertainty to give to both internal selections and to final rankings. As a result, a number of authors have suggested improvements to the basic AHP process using add-on mathematical programs or use of "fuzzy logic" (Reynolds 2001; Mendoza 2001). The addition of these "add-ons" can assist in evaluating uncertainty in model outcomes. In particular, where there is ambiguity in available information and/or greyness in the choices (vs. black and white), fuzzy set theory can better resolve the outcomes of multiple individual judgements (Sadiq and Tesfamariam 2009; Karimi et al. 2011). Other authors have presented stochastic techniques to handle the uncertainty associated with AHP, particularly as it relates to judgmental errors and inconsistencies in the pairwise comparisons (Eskandari 2007).

Given the large amount of literature on AHP and its numerous modifications, it is not possible to highlight all the issues that must be considered when using this method. However, in the matter of selection of VWRF discharge, there are a number of areas of concern that can lead to uncertainty in the final outcome:

- The water balance model used to predict habitat types under various discharge scenarios has inherent assumptions and errors associated with various inputs and outputs in the model. We have provided extensive comments on these issues in this review and in previous submittals to the City and Stillwater Sciences. While changes have been made based on these submittals, some assumptions remain that we do not agree with and can certainly add to the level uncertainty.

- The habitat models which predict future conditions under various discharges that cannot be verified due to lack of reference conditions, e.g. only 100% discharge can be considered accurate as the other scenarios cannot be tested with any reference observations. There may be considerable variation in actual distribution of habitats under lowered discharge scenarios. For example, aerial photos before the VWRF was constructed do not show a large extent of riparian vegetation in the SCRE (e.g 1947, 1967) so it is hard to believe that under zero discharge, the open water area would be significantly reduced as predicted in the model.

- California Department of Parks and Recreation (California State Parks) is implementing a restoration plan for the campground area that can significantly change the amount of habitat that will be provided for fish and wildlife. When completed, it would alter the amount of habitat available at lower discharge scenarios for those fish and birds that are more depend on open water.

- Habitat distributions and sizes generally drive the assessment of the value of the beneficial use. Of course, there are complex ecological factors involved which cannot be accurately modeled and these led to significant uncertainty in the outcome. The TRT has appreciated the opportunity to provide input on how to improve the model and how factors are evaluated but are limited by the available data and the underlying model outcomes. While the evaluation has been improved, we do not think it has eliminated uncertainty associated with the outcomes.

- Habitat is generally considered to be of high value, however, invasive species (both plant and animal) may affect the quality of habitat under the various discharge scenarios. For example, under high discharge, the model predicts riparian being replaced by freshwater marsh when in reality it may be replaced by invasive *Arundo*. This would certainly not be a beneficial outcome.

Without a substantial analysis of uncertainty associated with the AHP outcome (see Warren 2004), it is dangerous to put too much credence into some of the differences seen between final scores as shown for the various discharge scenarios. We suggest that the uncertainty factor is quite high at this stage in the analysis and therefore advise against using the AHP as the sole tool to make a decision on the MEPDV.

ECOLOGICAL CONCERNS

Altered Hydrology and Non-native Species

The SCRE is a limited and unique ecological resource along the coast of Southern California, and is subject to significant physical, biological, and anthropogenic forces. Alteration of the SCRE over the past 150 years has changed the areal extent, distribution, and ecological functionality of the habitat in the SCRE. These changes have impacted native fish and wildlife species and their habitat, including the Phase 3 Report target species, resulting in current conditions that afford reduced hydrologic variability and facilitates stable conditions that favor non-native species.

Current discharge levels, represented in Scenario 1, produce an artificially full, nutrient rich, freshwater system that leads to a more abiotic stable environment. In section 3.6.4.1, the Phase 3 Report draws a connection between the artificially stabilized conditions that dominate the SCRE, a reduction in seasonally appropriate breach events during drought conditions, and a shift in fish composition in the SCRE that is dominated by non-native species. This connection is consistent with previous publications on the establishment of non-native fish in California which found that high levels of human disturbance and alteration of natural flow dynamics favor successful establishment of non-native fishes (Moyle and Light 1996; Moyle and Marchetti 2006).

In the SCRE, a number of non-native aquatic species have become established and thrived in the system. These include several species that would prey on and/or compete with tidewater goby and steelhead, and include green sunfish (*Lepomis cyanellus*), Mississippi silverside (*Menidia beryllina*,) yellowfin goby (*Acanthogobius flavimanus*), African clawed frog (*Xenopus laevis*), and crayfish (*Procambarus* spp.). The prevalence of non-native species detrimental to the native SCRE species challenges the intuitive assumption that more perennial open water habitat is a desired baseline for the system. California fishes have evolved in variable and dynamic systems, and the conversion of these aquatic habitat to more stable environments (with more consistent depths, temperatures, salinities, etc.) results in favorable conditions for introduced species and diminished competitive advantage of native species (Marchetti and Moyle 2001). The shift in dominance of non-native fishes in the SCRE during the recent period of drought further provides evidence that the discharge from the VWRF directs the SCRE baseline to habitat more favorable of non-native species, as few seasonally appropriate breach events (winter/spring) and prolonged periods of stable freshwater contributed, if not drove, the abundance of non-native fishes and corresponding collapse of native fishes.

The continued maintenance of non-native favored aquatic habitat conditions poses another unique threat to native fishes in the SCRE, which is the threat of new detrimental aquatic species becoming established. Estuaries are notoriously invaded systems; however, that is often due to boat and freighter ballast water (Matern et al. 2002). For the SCRE, which does not support commercial and recreational ports or berths, the threat of introduction through this vector is still surprisingly possible. The California Aqueduct System (aqueduct) draws water from the San Francisco Bay-Delta system and transports freshwater throughout Central and Southern California. The aqueduct has also resulted in the dispersal of non-native species and provides a unique link from the heavily invaded San Francisco Bay to the Santa Clara River watershed. Mississippi silverside, which has become the most abundant species of fish in the SCRE, was first recoded in the SCRE in 2007 with the vector of introduction believed to be the aqueduct (Swift et al. 2014). Mississippi silverside feed on larvae, and pose a significant risk to tidewater goby which have an 18 to 31 day larval duration during which time the species would be susceptible to predation by Mississippi silverside (Spies et al. 2014; Swift et al. 2014). Another introduction to the Santa Clara River watershed from the California aqueduct is a species of goby that poses a significant risk to tidewater goby. Shimofuri goby (*Tridentiger bifasciatus*) is anticipated to directly compete with and prey on tidewater goby, should it reach the SCRE (Howard and Booth 2016). The more stable and favorable the SCRE habitat conditions are to the establishment of non-native species, the greater the potential is for the loss of native fish species. The prevalence of non-native species and continued potential for future introductions through the aqueduct supports a change in the current discharge regime in favor of more natural variability and flows.

Restoring more natural variability and flows can have an impact on behavioral responses of native fishes, which is not considered with the modeled results and are not well suited for incorporation into a predominantly physical set of measured parameters. Fishes native to specific regions have been found to exhibit behavioral adaptations to local flooding regimes (Opperman et al. 2017). For the native fishes of SCRE, the current open water habitat is artificially elevated and is more reflective of the warm water areas more suitable to introduced species such as green sunfish, carp (*Cyprinus* spp.), and western mosquitofish (*Gambusia affinis*). As discussed in section 3.3.6 of the Phase 3 Report, during winter months when the

SCRE receives rainfall and would exhibit seasonally appropriate breaching periods, the SCRE filling rate during storm-induced river flows occurs rapidly and causes a higher overall volume when sandbar breaching occurs. Winters flows are entering a largely stabilized and artificially full pool of water in the SCRE, and would have limited floodplain area to inundate. Behavioral cues that would occur during estuary filling in a more natural flow hydrology, where a smaller perennial estuary pool would fill and flood adjacent wetland and riparian areas, are likely diminished or truncated.

The artificially elevated SCRE level challenges not only native fish but nesting shorebirds as well. Nest monitoring work by California State Parks biologists have documented the loss of two western snowy plover nests and one American avocet due to rising SCRE waters (CSP 2017 pers comm). Shorebird nesting can also be threatened by bank erosion and washouts associated with estuary breaching events.

Natural flow hydrology, restoration of floodplain areas and a reduction in the full bathtub baseline condition, would also allow the SCRE to be shaped and influenced by more storm events. Annual variations in sediment deposition and scour is a natural process in rivers, and is reflective of the dynamic characteristic of estuaries. The Phase 3 Report provides potential vegetation evolution models and open water depth ranges under the various discharge scenarios; however, geomorphic changes and variability resulting from storm events would shape and alter the habitat and are not reflected in the models. It can be argued that the most stable state of the SCRE is maintained by keeping the current discharge level, where an estuary stage at 10 ft maintains a set amount of open water habitat ringed by wetland and riparian, and is less subject to scour and depositional forces characteristic of storm events and high flows, and would be most reflective of the Phase 3 Report predictive models. The lower estuary stages are unlikely to follow the successional models or maintain their existing depths, as high water events would likely exert greater influence on vegetation distribution, scoured depths, and deposition of sediment.

Challenges for Tidewater Goby

For tidewater goby, an endangered species endemic to California coastal estuaries, the species life history is tied to the habitat within the SCRE. Unlike the other focal species, the tidewater goby completes its entire life cycle within SCRE aquatic habitat, and is therefore particularly impacted by SCRE habitat changes. Tidewater goby evolved within the dynamic environment of coastal California estuaries, and is therefore tolerant of a wide range of abiotic conditions (Chamberlain 2006). Where present, the tidewater goby is typically the most abundant species; however, the annual variation can be high as the species typically only lives for one year in the wild (USFWS 2005). The annual variation in tidewater goby population can also make the species particularly susceptible to stochastic events (Swenson 1999).

Data for the SCRE, presented in Fig 3-49 of the Phase 3 Report, has shown a steep decline in the tidewater goby population, with no individuals encountered in 2013 and 2014, and only a small number found in 2015 and 2016. This period of time corresponds to an increase in non-native fish in the SCRE and an apparent shift in fish abundance dominated by non-native species. Non-native species are a significant threat to stable tidewater goby populations, as they can directly prey on larval, juvenile, and adult life stages and can exert competitive pressure for food resources and space (USFWS 2005). For the SCRE, USFWS has identified several known threats to tidewater goby, which includes the presence of non-native fish and frog species, habitat degradation caused by breaching and stream channelization, and point source pollution from wastewater discharge. The previous sections discussion on non-native species and the altered hydrologic state of the SCRE has a direct impact on tidewater goby.

Out of season breaching events pose a direct and potentially significant risk to the tidewater goby population of the SCRE. During winter and spring storms, when coastal estuaries typically breach as the result of precipitation events, tidewater goby adults may exhibit a limited marine dispersal (usually less than 15km) to similar estuarine habitat primarily in the direction of the nearshore current (Earl et al. 2009). During an out of season breach, when similar habitats in adjacent watersheds are unlikely to also be connected to the marine environment, there is very little chance that adult tidewater goby washed out of the SCRE would be able to disperse to suitable habitat and are more likely to be lost. Furthermore, marine dispersal appears to be limited to the adult stage as juveniles and larvae experience high rates of mortality when salinities approach 26 ppt (Spies et al. 2014). Seasonally appropriate breaching events occur most frequently during winter months when tidewater goby reproduction is low and larvae are less likely to be present (Spies et al. 2014). Breach events during the summer and fall; however, can have a direct impact on tidewater goby reproductive success by washing larvae and juveniles into the marine environment where they are unable to survive. As discussed in the Phase 3 Report, numerous out of season, i.e. artificial non-precipitation driven, breach events have occurred in the SCRE, and it's possible that these stochastic events are challenging the population stability of tidewater goby in the SCRE.

Challenges for Steelhead

The potential value of properly functioning, seasonally-closed estuaries to steelhead populations has been documented extensively by researchers such as Smith (1990), Bond et al. (2008), and Hayes et al. (2008). Growth rates of juvenile steelhead rearing in intermittently-closed estuaries have been shown to be among the highest reported in the literature for the species, and are much higher than those of their upstream counterparts (Bond et al., 2008; Hayes et al. 2008). Moreover, juvenile steelhead rearing in these estuaries disproportionally compose the majority of returning adults even though they constitute a minority of the out-migrants (Bond et al. 2008). The higher adult return rates of estuarine-reared steelhead are attributed to the larger smolt size at ocean entry, which increases ocean survival (Hayes et al. 2008; Bond et al. 2008).

However, as summarized by Matsubu et al. (2017), intermittently-closed estuaries "create a conundrum" for diadromous species such as steelhead. Although often considered productive, changes in estuarine water quality conditions can be so sudden and severe that they cause mortality. For example, unseasonal lagoon breaches have been linked to largescale fish kills, including steelhead, in Pescadero Lagoon in San Mateo County (Sloan 2006; Jankovitz 2016) and other estuaries where stratification can lead to hypoxic conditions near the bottom of the water column and rapid lagoon draining mixes waters low in dissolved oxygen throughout the system. Although observations of steelhead in the SCRE have been rare, seven dead steelhead, ranging in size from 227 mm to 310 mm, were observed after a reportedly artificial breach of the SCRE on September 17, 2010 (Cardno/Entrix 2010), apparently confirming the potentially detrimental effects of unseasonal breaches.

Hayes et al. (2008) provided valuable insights into the extensive life history plasticity of steelhead in central California coast watersheds, with the extent of estuarine residence and rearing varying considerably among different life history pathways. Hayes et al. (2008) documented some age 0+ juveniles migrating down to the estuary within just a few months of emergence, some spending 1-2 years rearing in the upper watershed before migrating to the estuary to rear for 1-10 months prior to ocean entry, and yet others rearing almost exclusively in freshwater before emigrating to the ocean with little to no time spent in the estuary. Additionally, Hayes et al. (2011) showed that many juvenile steelhead that recruit to the lagoon in summer return upstream to the stream environment in the fall prior to the first winter sandbar breach when water quality conditions deteriorate, and subsequently migrate back down to the estuary the following spring. More recent work by the NMFS Southwest Science Center showed that juveniles rearing in a seasonally closed estuary may retreat upstream and then return back down to the estuary several times during the summer and fall closed period, presumably in response to changing water quality conditions. Due to the typical lack of summer and fall hydrologic surface connectivity in the lower Santa Clara River, this common escape strategy is not available to steelhead rearing in the SCRE.

Southern California steelhead populations have not been adequately investigated to determine whether, or to what extent they may exhibit an estuarine-rearing life history strategy in various watersheds (NMFS

2012; Anderson and Ambrose 2011). We note that the documented benefit of estuarine rearing for steelhead is the increased smolt size at ocean entry attained through this life history strategy, and smolts documented at Vern Freeman Dam (e.g. Howard and Gray 2010) during outmigration are already within the range of smolt sizes documented by Bond et al. (2008) to represent estuarine-reared steelhead with higher ocean survival and adult returns. In other words, by the time Santa Clara River smolts migrate downstream toward the ocean, they have generally already attained the size typically associated with high ocean survival, although this is not the case for all smolt, and increasing in size once in the estuary would expect to contribute to higher rates of ocean survival, which is already low for the species. Hayes et al. (2008) suggest steelhead in the southern portion of their range may benefit from better winter growing conditions than those in northern latitude streams due to milder temperatures and better food production. Therefore, it is not known whether southern California steelhead are as dependent upon the high productivity afforded by estuarine rearing further north in the species' range. While it is unknown whether the seven post-breach steelhead mortalities that were observed in the SCRE in September 2010 entered the SCRE volitionally as smolts or even parr, it should be noted that the sandbar at the mouth of the estuary that year closed on May 11 and remained closed throughout the summer and early fall. Meanwhile, the United Water Conservation District captured a total of 32 steelhead smolts at Vern Freeman Dam upstream of the SCRE between May 12 and July 19 and released them to the closed SCRE (Howard and Gray 2010). No other juvenile steelhead observations have been reported from the SCRE during multiple surveys, although it should be noted that at least the recent surveys used survey equipment and methodologies specifically targeting tidewater gobies, and the absence of steelhead in the survey results do not prove the absence of juvenile steelhead in the SCRE. A total of only 210 young-of-the-year steelhead, the life-stage most likely to utilize the estuary for extended summer rearing, have been documented moving downstream toward the SCRE at Vern Freeman Dam between 1993-2014 (Booth 2016). These were typically relocated back upstream to freshwater habitats by United Water Conservation District staff, and this practice (terminated in 2014) may have contributed to the apparent lack of documented observations. Moreover, poor Santa Clara River flow conditions between Vern Freeman Dam and the SCRE during recent drought years likely resulted in limited migration opportunities coincident with the absence (since 2014) of steelhead trucking operations to the SCRE.

There currently is not enough information to determine whether the apparent under-utilization of the SCRE by rearing steelhead is due to a historic absence or underrepresentation of an estuarine-rearing life history strategy among southern California steelhead, or the result of significant land use pressures and habitat modifications brought about by human development (e.g., water diversions, agricultural runoff, infrastructure encroachment) in addition to VWRF discharge contaminants. However, we can be fairly certain that southern steelhead life history strategies did not evolve around a dependence on anthropomorphic discharges of tertiary treated wastewater to estuarine habitats. While the steady inflow of freshwater VWRF discharges to the SCRE may be argued to provide a surrogate for the summer stream baseflow inputs more commonly present in central and northern California estuaries, the concomitant addition of known pollutants such as nutrients, heavy metals, and contaminants of emerging concerns raise serious concerns regarding the overall value and suitability of VWRF discharges to the SCRE. The Phase 3 studies investigated the individual concentrations of a wide range of pollutants and concluded that these were either generally below levels considered to be harmful or lethal to aquatic life (e.g., metals) or present in such high background levels (e.g., nutrients) as to be largely unaffected by VWRF discharges. However, the cumulative and synergistic effects of these pollutants remain largely unknown. For example, the Phase 3 Report acknowledges that benthic macroinvertebrate community structure of the SCRE has been documented to vary "considerably from other estuaries" and to be dominated by taxa that are tolerant of disturbance and pollution. Recorded invertebrate abundances and diversity are generally low in the SCRE. The Phase 3 Report notes that low diversity and abundance "may not be an uncommon phenomenon in southern California estuaries" and that the analysis of basic water quality parameters (DO, temperature, salinity, pH) showed no relationship to invertebrate abundance and taxa richness. However, the effects of cumulative exposure to pollutants on invertebrates were not analyzed, but may be important to consider given the dominance of pollution-tolerant taxa in the SCRE. High abundances of invertebrate food resources in functioning estuaries are recognized as the primary reason for the documented benefits of these systems to rearing steelhead (e.g. Smith 1990; Hayes 2008), and conversely, the absence of high secondary productivity renders these benefits unrealized.

A Currently Compromised System

We recognize the inherent difficulties in predicting the ecological effects of changed discharges to the SCRE, and understand the logical progression that has resulted in the recommended MEPDV. However, the resulting emphasis of physical habitat extent over water quality factors that are insufficiently analyzed to predict future conditions, lead us to question the utility, and therefore validity, of the recommendation in the Phase III Report. Moreover, external factors such as implementation of the California State Parks campground restoration project and potential changes to United Water Conservation District's water diversion operations at Vern Freeman Dam were not analyzed in the Phase III Report, but may have significant influences over future habitat extent and quality in the SCRE, including increased aquatic habitat area and freshwater inflows. As discussed above, the reasons behind the apparently limited utilization of the SCRE by steelhead are not fully understood, but using currently impaired conditions as the standard against which potential reductions in discharge are judged based on habitat extent is a flawed approach in our opinion. If steelhead utilization of the SCRE was historically more prevalent than currently documented, incremental management changes aimed at approximating historic conditions would be expected to result in more ecologically protective conditions. If, on the other hand, estuarine rearing was never an important component of the Santa Clara River steelhead life history strategies, retaining a minimum of 60% of current discharge levels to protect against excessive reductions in physical habitat area for steelhead, as recommended in the Phase 3 Report, would be superfluous and misguided. Ultimately, the concept of managing for, among other beneficial uses, steelhead recovery with wastewater discharges runs counter to sound ecological restoration principles.

For tidewater goby, the current condition of the SCRE is compromised and trends in favor of introduced non-native species that can exert a substantial pressure on the tidewater goby population. The concept that more habitat (i.e., greater open water area) is more beneficial for tidewater goby overly simplifies the biotic interactions that are integrated into the habitat. We would point out that if a greater quantity of habitat would provide conditions that are favorable for non-native fishes, then these discharge options are less favorable and should be managed to allow greater variability and more natural flow conditions that are more sympatric with the ecological compatibility of tidewater goby and less so for the non-native species. By maintaining a fuller estuary for the sake of habitat quantity, the management decision would ignore the importance of habitat quality and continuing to stack the deck against tidewater goby.

MEPDV RECOMMENDATION

We believe that the MEPDV needs to be determined based on key ecological considerations as discussed above. While we accept that beneficial uses are a regulatory basis for a decision by the Regional Board and should be evaluated thorough a rigorous non-subjective approach such as the AHP, but it is extremely important to place the restoration of the natural ecology of the SCRE as an underpinning to any final decision. We argue that such a decision needs to consider the following:

- Allow for the dynamic nature of the river mouth to change and alter habitat conditions through time through processes of scour, deposition, transitional habitat and floodplain,
- Restore natural variability and flow on a seasonal and inter-annual basis,
- Improve water quality conditions for native fish, birds, and aquatic invertebrates,

- Assure reduction in non-native plants and animals within the SCRE, and
- Reduce out of season breaching events.

We recognize that SCRE is also impacted by human influences and is likely to change in the future due to influences outside the control of the VWRF such as sea level rise, changing precipitation patterns, discharges from other sources, and actions by California State Parks to manage their property—for recreation as well as for approximately 42 acres of restoration. These uncontrollable influences argue for the greatest flexibility in discharge options whereas engineering of a treatment facility and regulatory processes may argue for less flexibility and greater certainty and predictability. Some of this conflict can be resolved through adaptive management; however, once a facility is constructed and operating it may be difficult or impossible to increase or decrease flows so a decision must be made that provides the overall best balance while achieving some flexibility.

The MEPDV as defined in the Phase 3 Report is the maximum ecologically protective diversion volume or the maximum average annual flow that could be diverted from the SCRE while still protecting ecological functions of the SCRE. It should not be interpreted as the flow that achieves the maximum AHP score for beneficial uses, but rather the score that only allows that discharge volume that is proven to be beneficial to the ecology of the system. In other words, starting from zero discharge, what discharge should be allowed that will provide benefits without harming the natural ecological attributes listed above. This discharge volume also needs to be evaluated in terms of the uncertainties associated with the AHP outcomes, e.g. to not allow higher discharges to occur if there was substantial uncertainty that such a discharge would be harmful. In our view, the starting point should be zero discharge (100% diversion) with incremental discharge being evaluated only as a means to consider if there is substantial benefit to ecological functioning of the SCRE.

We strongly disagree with the statement in the Phase 3 Report that:

> “On balance, current VWRF discharge provides a fuller realization of existing beneficial uses of the SCRE relative to the absence of all VWRF discharge.”

The Phase 3 Report also states that:

> “Scenarios 2 and 3 (10 and 20% reduction) result in only minor decreases in realization. However, greater than 20% reductions in VWRF Discharge result in significant declines.”

This is not the correct manner in which to interpret how much discharge should be allowed and the City should not argue discharge from the reduction standpoint—but from the increasing standpoint based on zero discharge.

We understand that the City is undertaking further revisions of its AHP analysis and most recently has recommended a 40% reduction (Scenario 5) in current authorized discharge as most protective of beneficial uses and does not result in take of listed species. We only have the presentation materials and no update in the confidential Phase 3 Report that supports that determination. We certainly agree that current levels of discharge, while maximizing an AHP score, do not meet the MEDPV requirement and do not allow for natural processes to occur within the estuary.

However, in the analysis provided to the agencies, Scenario 5 has a 75% Priority Score as a percent of maximum weighted score. Subsequently, in the PowerPoint presented at the agency meeting, Scenario 5 has a score of 82% and is the same score as Scenario 7 which represents a 60% reduction.

In our view, based on the level of uncertainty likely to exist in the AHP ranking, either Scenario 8 (70% reduction) or 9 (80% reduction) is ‘significantly different’ and would represent the most likely amount of discharge that should be allowed into the estuary that would promote natural processes to occur and would be supportive of native fishes, both listed and non-listed species. It is our view that this recommendation will result in the most likely average monthly discharge into the estuary that could be characterized as “beneficial” without causing adverse harm to SCRE. Assuming the landscape models are correct, it will result in sufficient area for steelhead and goby rearing and foraging habitat by providing sufficient open water area (61-70 acres not including the proposed California State Parks Restoration Area) and will support sufficient snowy plover and least tern foraging habitat without potential damaging flooding to nesting areas. We also believe that these scenarios substantially reduce the risk of unseasonable breaches to the ocean in the summer months.

We recognize that there is a desire to have a steady state discharge authorization for practical and economic reasons. However, if flexibility existed in discharge scenarios, we will favor one in which discharge during winter and spring months is higher and during summer and fall months is lower. This would be more equivalent to natural conditions in the estuary. We would also be in favor of allowing higher winter and spring discharge rates than under our recommended MEPDV. Such variation in discharge should be thoroughly considered as reclaimed water is in higher demand in the dry season and storage would not necessarily be a problem.

We also recognize that discharge reduction while providing some beneficial water to SCRE, there are issues that may need to be resolved through an adaptive management plan to be prepared by VWRF. We recommend that such an adaptive management plan include:

- Monitoring of habitat distribution and type under the MEPDV
- Monitoring of water quality parameters such as temperature and salinity
- Invasive species monitoring that may have an effect on habitat quality
- Performance standards developed from the Phase III studies and AHP factors
- Triggers to initiate additional analysis or study to see if failure to meet performance standards is related to the MEDPV
- Possible additional actions to remedy problems that shown to be the result of the MEDPV. Proposed actions do not necessarily need to result in a change in the discharge that is allowed by the RWQCB and designed into the facility, but could include some additional restoration or management actions within the SCRE.

We believe that a robust adaptive management plan will address the uncertainties with the recommended MEDPV and should be part of the overall approval by the RWQCB.

RECOMMENDATIONS FOR ONGOING ANALYSIS

As noted previously, the water budget modeling that has been relied upon reflects the current condition of the SCRE in a simplified form. It is likely that a given VWRF discharge amount will result in a different equilibrium water level within the SCRE than the predicted value. It is also likely that habitat types may not exactly match what the habitat evolution model predicted, even before the morphology of the system changes. Due to the level of uncertainty regarding the results of the modeling conducted (i.e., water balance, water quality, habitat evolution), it is very important that an adaptive management framework be embraced early in this effort.

A modification to the magnitude of VWRF discharge should be made relying upon the available data, predictive tools, and judgment; however, that magnitude may need to be further adjusted based upon monitoring data collected during the future condition. While the equilibrium water level is an important component of the habitat that remains, or is altered, it should not overshadow the potential water quality effects of reducing the amount of effluent discharged to the SCRE. While data from groundwater wells were used to as inputs to the water quality modeling, there is a distinct possibility that the data used does not accurately represent all of the groundwater entering the estuary, and a reduction in VWRF discharge could result in substantially lower nutrient inputs to the SCRE. Given the degraded current state of the SCRE, the quality of the water is likely much more important than the quantity of the water.

Furthermore, an adaptive management approach is also vital because many components of the system are in flux. As discussed, the shape of the estuary and the beach and nearshore will continue to evolve in response to floods and swells. Any change to the morphology of the SCRE will affect the components of the water balance, and the potential for the development and extent of various habitat types. Likewise, sea level rise will also have a significant effect on the morphology of the estuary, and the components of the water budget. While these changes will not likely be significant in the immediate future, the effects of sea level rise will certainly be seen within the time frame of the permit in question.

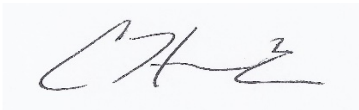
In addition to changes that result from runoff or coastal conditions, the morphology of the estuary will likely change in the near future as a result of the planned habitat restoration project that is underway for the McGrath State Beach Campground. An extensive stakeholder outreach effort has already occurred, resulting in a feasibility study, which included 30% complete design drawings that provide for a larger estuary. Funds have been allocated in the State's budget, and the next phase of the project, 65% designs and permitting, have already been initiated by State Parks. The proposed habitat enhancement project will likely result in greater areas of inundated habitat as compared to the current condition, which suggests the same amount of habitat may be supported by a smaller amount of VWRF discharge to the SCRE.

Potential changes to the amount of water flowing down the Santa Clara River will also affect the SCRE's water balance. United Water Conservation District is in the process of preparing a Multi-Species Habitat Conservation Plan, where several operational scenarios have been suggested, many of which would result in less water flowing down the Santa Clara River below Vern Freeman Dam. In addition, a lawsuit is underway, set to go to trial in 2017, that could result in greater amounts of water being released to the Santa Clara River below Vern Freeman Dam. In short, the amount of water flowing down the Santa Clara River could be more or less in the near future as a result of these processes.

The proliferation of exotic species also needs to be carefully considered, and adaptively managed for. The current hydrologic regime is benefiting a number of exotic species in the SCRE. While it is possible to make informed estimates as to how changes in the amount of VWRF discharge will impact or benefit the exotic species present, there is still considerable uncertainty in these estimates. Furthermore, new exotic species will likely colonize the SCRE, and have the potential to impact native species to an even greater degree than present.

With all of this uncertainty regarding the system and its future geomorphic and ecological trajectory, an adaptive management approach is essential. A trial period should be used where a reduced amount of VWRF discharge is provided to the estuary. Monitoring data from this period should then be used to test the assumptions utilized in this effort, to better understand the water balance and the water quality of the system. It is possible that the initial VWRF discharge amount will provide for the beneficial uses that the SCRE provides, but it is also possible, that with more data (particularly more data collected during a significantly reduced VWRF discharge) a different amount of VWRF discharge will be determined to be necessary to provide for the beneficial uses within the SCRE.

Report Prepared By:



December 7, 2017

Chris Hammersmark, cbec — Date

December 7, 2017

Mike Podlech — Date

December 7, 2017

Mike Josselyn, WRA, Inc. — Date

December 7, 2017

Dan Chase, WRA, Inc. — Date

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Appendix A

Copy of the TRT comments on “Assumptions” and “Habitat Suitability Criteria” sections in:

May 2017 draft of the *Phase 3: Assessment of the Physical and Biological Conditions of the Santa Clara River Estuary, Ventura County, California*.

Submitted to the City and Stillwater Sciences on June 30, 2017

Appendix A

City of Ventura Special Studies – Phase 3:
Assessment of the Physical and Biological
Conditions of the Santa Clara River Estuary,
Ventura County, California

May 2017 Draft

Comments Prepared on Behalf of

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Michael Podlech, aquatic ecologist
Michael Josselyn WRA, Inc. estuarine ecologist
Dan Chase, WRA, Inc. fisheries ecologist

June 30, 2017

The following comments are provided following the review of May 2017 Confidential Draft from the City of Ventura Special Studies – *Phase 3: Assessment of the Physical and Biological Conditions of the Santa Clara River Estuary, Ventura County, California*. At this time in our review, our focus on the Assumptions used and the Habitat Suitability Criteria. We are also commenting on any additional analyses that may be desirable prior to re-runs of the model.

1.0 Comments on Assumptions

General assumptions

1) Assumption 2 needs more explanation of the habitat types evaluated, especially within the wetland category. There may be habitat types such as mudflat and/or unvegetated shallow water that have benefits to shorebirds whereas deeper open water may be more beneficial to benthic invertebrates.

Recommend explanation of habitat types and relationship to the species that are most affected by changes in habitat type. Include more definition of the habitat types evaluated and consider adding categories within wetland category.

2) Assumption 4 needs more explanation related to how focal species can be surrogates to more abundant and common species. Steelhead is a migratory species and tidewater goby is more tolerant to estuarine conditions than perhaps other species. Least tern and snowy plover are not representative of the more common shorebirds present in the lagoon.

Recommend cross walk table of how focal species relate to the more common estuarine and marine species present in the SCRE.

Habitat suitability

1) Assumption 1 may need more explanation and/or additional focal species added to the analysis.

Recommend table showing how focal species relate to other more common fish and wildlife in the SCRE. Also consider more recent literature such as:

Caro, T.M. and G. O'Doherty. 1999. On the use of surrogate species in conservation biology. Conservation Biology 13(4): 805-814.

Siddig, A.A.H., A.M. Ellison, A. Ochs, C. Villar-Leeman, and M.K. Lau. 2015. How do ecologists select and use indicator species to monitor ecological change? Insights from 14 years of publication in Ecological Indicators. Ecological Indicators 60: 223-230.

2) Assumption 2 builds on Assumption 1. In other words, assuming that the four focal species represent the rest of the aquatic and avian species using SCRE, the model assumes that the physical habitats available under various discharge scenarios and water quality parameters will then be representative of habitat requirements of all other species.

Recommend (same as above)

3) Please provide examples of variable that were excluded from the analysis for Assumption 4.

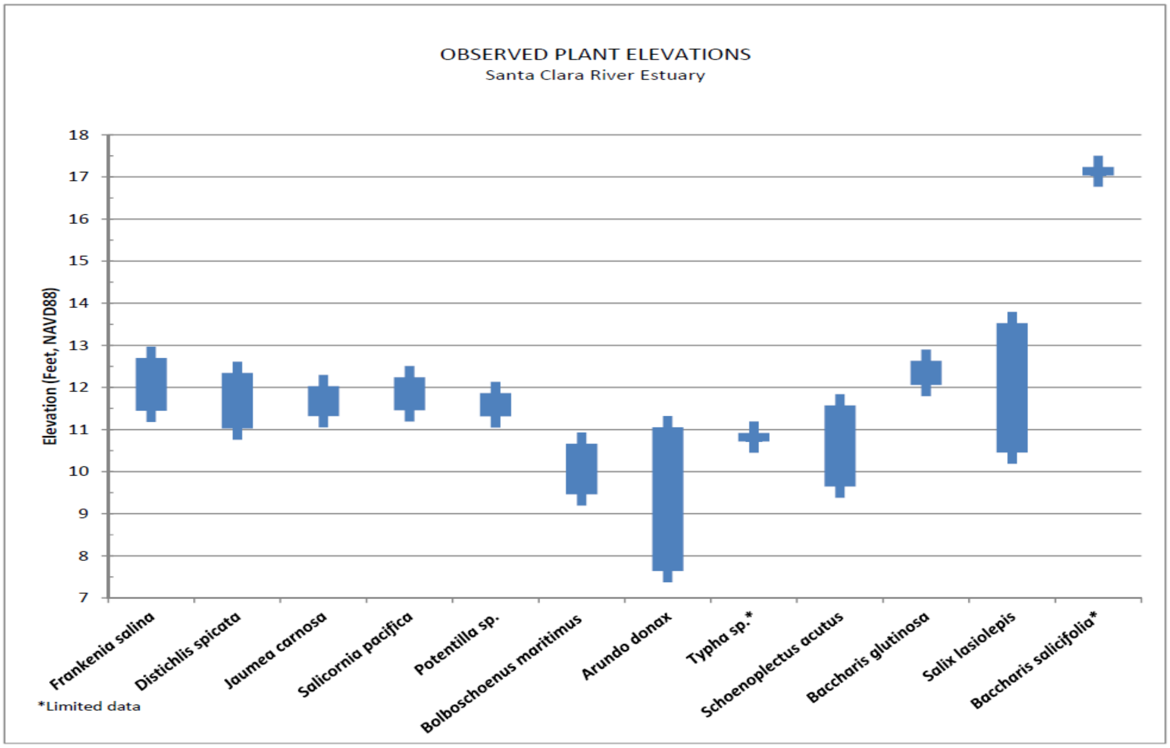
Modeled changes in vegetation community and habitat types

1) WRA conducted survey information for the restoration plan at McGrath State Park and found the following as it relates to elevation of various vegetation types. This was done in relationship to NAVD 88 and is provided in the graph below. Water elevations for vegetation communities in the City study was reported at equilibrium water surface elevation (WSE). Can you please check to see that these two data sets are in general agreement and, if there are discrepancies, how they may be resolved?

Also, note that *Arundo* can become established in the freshwater portions of the Estuary (depending upon inflows) and maybe come dominant over time. This species should be considered a degradation of conditions in the Estuary, but is not clear how such habitat change is evaluated in the model. Presumably it is considered within the freshwater marsh component; however, its habitat value would be less to wildlife species and it can reduce mudflat areas.

Finally, does the model allow for vegetation establishment along the fringes should water levels be lowered over several years?

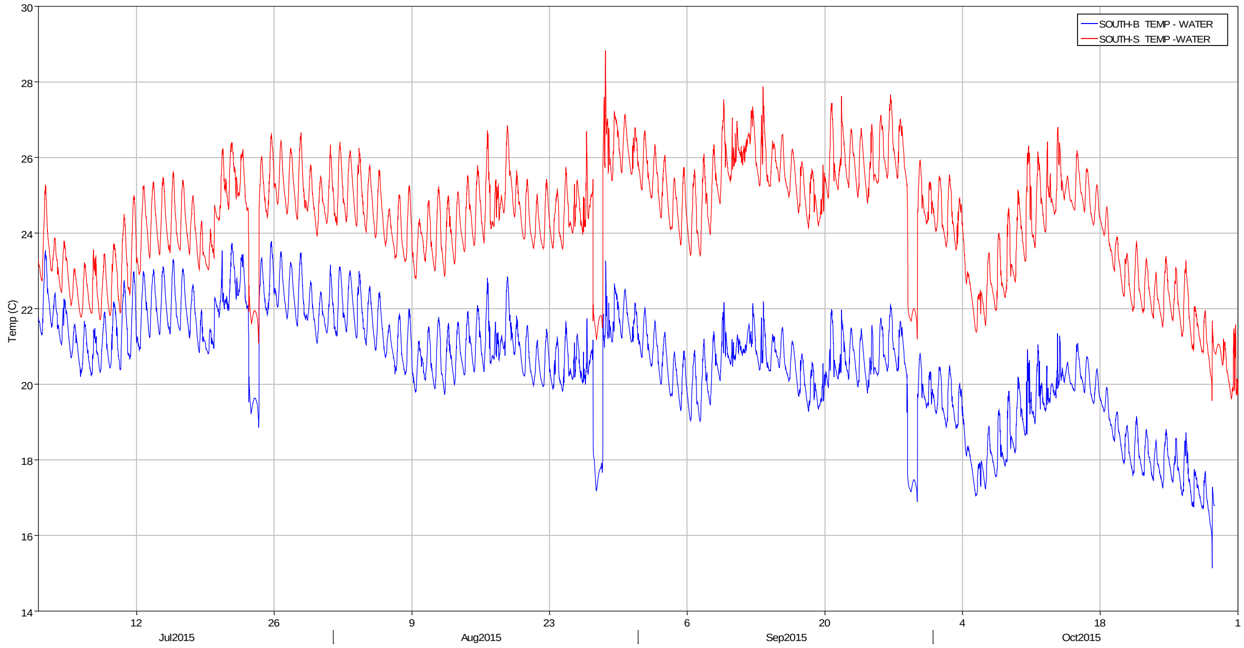
Recommend the model be adjusted to be consistent with the elevational data collected by WRA and that the model consider if *Arundo* becomes more dominant due to WSE within its suitable range and salinity is reduced to allow *Arundo* establishment.



Water quality conditions

1) While Assumption 5 may or may not be valid, it is insufficiently supported in the report. While occasional references to the spot-check water quality profiles and summaries of seasonal averages (e.g., Table 3-5) are provided, very little detailed analysis of the sonde data is presented. A closer look at these data suggest that the "well mixed" assumption may not be valid during significant periods of time. For example, water temperature data for the South sonde location (unfortunately the only site for which continuous data are available at different depths) suggest ecologically significant differences in surface and bottom temperatures. The graph below shows South sonde surface (red) and South sonde bottom (blue) temperatures from June, 1, 2015 through October 31, 2015, a period of time when the mouth of the SCRE was consistently closed. The graph clearly shows a relatively consistent 2-4 degree Celsius (C) difference between the surface and bottom sensors. The surface temperatures are generally within a range that would be considered stressful to steelhead, while the bottom temperatures are well within a suitable range. In addition to the vertical variation shown below, the data presented in Figure 3-34 show the spatial variation in temperature at different sites can vary by up to 3 degrees C as compared to the computed average temperature.

Recommend discussing the implications of these observed temperature differences in terms of habitat suitability and as they relate to the "fully mixed" assumption.



2) We recognize that data from the South bottom sonde were excluded from the analysis for approximately half of August 2015 (8/12-8-28) and almost all of September 2015 (9/2-9/28) (Table 2-3). The justification for the frequent and extensive data exclusions during the study period is provided in Section 2.2.3, which states that "[b]ased upon comparisons with *in situ* DO readings from the deployed sonde and spot checks from a recently calibrated unit, all data showing deviations greater than 2 mg/L at retrieval were considered out of range and flagged for exclusion." While not entirely clear, this statement seems to indicate that the data from all probes on a given sonde, including the temperature and salinity probes, were excluded based on observed inconsistencies in dissolved oxygen data.

Given that DO and temperature are measured on separate probes, and the DO probe is far more prone to malfunction (e.g., wiper malfunction), it does not appear reasonable to exclude temperature and salinity data based on DO probe malfunction. Moreover, it should be noted that temperature data from the surface sonde were not excluded from the analysis during the time periods when the bottom data were excluded, yet the surface and bottom temperature probes appeared to be tracking very consistently throughout the June-October monitoring period, both during excluded and non-excluded data periods. As such, we do not see a compelling reason to exclude the South sonde bottom temperature data from the analysis.

Recommend either providing justification for the exclusion of South sonde bottom temperatures in August and September 2015 and other periods, or revising the assumption of well-mixed conditions, at least for temperature.

3) As mentioned above, the qualitative water quality analysis described in the deliberative review draft appears to have been based primarily on the results of spot-check water quality profiles, particularly as it relates to supporting the "well mixed" assumption. However, accepting the

caveat of the potentially unresolved validity of the excluded South sonde bottom water temperature data discussed above, we note that seemingly significant inconsistencies between water temperatures profiles collected at the South sonde and continuous sonde data recorded before and after the profile was taken. For example, the August 12, 2015 (Figure D-19) and August 27, 2015 (Figure D-20) profiles for the South sonde do appear to support the assumption of vertically mixed water temperatures, yet the bracketing sonde data suggest a 3-4 C difference between surface and bottom temperatures. If, as we suggest above, the excluded bottom sonde temperature data should not be excluded, the observed inconsistencies between sonde and profile data raise doubts about profile data at other locations (e.g., north and central sondes) where we do not have concurrent continuous data at different depths.

While extensive analysis of the data is beyond the scope of this review, we also note substantial inconsistencies between continuous and instantaneous measurements for dissolved oxygen data at the Central sonde (Figure 3-31), and for water temperature and dissolved oxygen data at the North sonde (Figure 3-32). As you may recall, our recommendations during the workplan development phase for these studies, we strongly encouraged the City to deploy sondes at varying depths at multiple locations, but were repeatedly told that the well-mixed conditions of the SCRE during closed conditions did not warrant the expense and effort of more extensive sonde deployment. The City did, however, agree to deploy surface and bottom sondes at the South location to justify the well-mixed assumption. Based on the sonde data we have reviewed for this location, this assumption does not always appear to be valid, at least for water temperature, and the lack of continuous data at different depths at other location now appears to potentially compromise the analysis.

Recommend providing (a) an analysis of the noted inconsistencies between continuous and instantaneous data, (b) a justification for the apparent prioritization of instantaneous data over continuous data in the analysis, and (c) a thorough discussion of the potential implications of limited sonde data on the overall analysis and conclusions.

4) Based on an initial review of salinity and dissolved oxygen data at the South sondes, it appears that vertically mixed conditions may be present for those water quality parameters. This raises the question of why water temperatures appear to be considerably cooler at the bottom. We note that most of the groundwater data collected during the Phase III and prior studies indicate cooler than ambient temperatures, as would be expected of groundwater. There appears to be a distinct possibility that groundwater inflows may be providing thermal refugia in the SCRE.

While the use of thermal refugia by steelhead and other salmonids has been well established in freshwater systems, recent research in the Russian River estuary show that juvenile steelhead responded to closed sandbar conditions by moving considerable distances before aggregating near thermal refugia (Matsubu et al., 2017). The researchers conclude that their findings “show the importance of recognizing these strategies when contemplating changes to estuary management and highlight the significance of tributary hydrogeomorphic processes and groundwater linkages in subwatersheds that are sources of cool water for thermal refugia in intermittently closed estuaries.”

Recommend a comprehensive discussion of available surface and groundwater temperature data, the potential for groundwater inflows, and the ecological benefits of such potential inflows, in terms of habitat suitability under existing and reduced VWRF discharges. In addition, it is likely that temperature modeling is required in order to quantify differences in resulting thermal regimes due to effluent reduction scenarios.

Matsubu, W., C. A. Simenstad, and G. E. Horton. 2017. Juvenile steelhead locate coldwater refugia in an intermittently closed estuary, Transactions of the American Fisheries Society, 146:4, 680-695.

Beneficial Use Assessment

1) We were originally told in the Work Plan that beneficial uses would be evaluated using weighting factors—e.g. some beneficial uses would have higher importance than others. While the text provides some information on this in a qualitative sense; weighting factors are not provided. It is not possible to determine if weighting factors alter the result and, if so, what the model's outcome is to those various weighting factors.

Recommend that more information be provided on the weighting factors and that some type of analysis be conducted to determine if the results are sensitive to modifications in the weighting factors.

2) RARE Assumption 4: This assumption reflects the relatively narrow focus of the analysis as presented throughout the report. While aerial extent of open water, and changes in salinity and nutrient loading are undoubtedly factors that should be considered, water temperature, DO concentrations, and food resources do not appear to receive sufficient consideration in the analysis. We understand the inherent difficulties in temperature and dissolved oxygen modelling, let alone predictions of food availability under different discharge scenarios, but the importance of these parameters with respect to habitat suitability and productivity appears to be minimized by this assumption. Moreover, the apparent reliance on yearly means, minima and maxima, rather than more fine-grained analysis of time series of individual and concurrent parameter data (e.g., stage vs. temperature; air temperature vs water temperature) renders even the qualitative consideration of water quality data in the discharge scenario analysis very superficial. As described by Boughton et al. (2017), water quality parameters used to inform habitat availability and productivity for juvenile salmonids estuaries include temperature, DO and salinity, with suboptimal levels of these water quality parameters resulting in increased energy expenditure, slower growth, and eventually mortality at extreme levels. Aerial extent of open water habitat, which appears to have been the primary quantitative parameter used in the analysis of discharge scenarios, is arguably far less important than water quality parameters and food availability.

Recommend a more thorough analysis and presentation of the sonde data (e.g., as individual time series and comparisons of concurrent parameter data), both in terms of existing conditions and reduced discharge scenarios.

COMM

Can you be more specific as to which “target species” are included in this category. Is it correct to say that even with high water levels, if salinity is low, the value to COMM is reduced as most of the relevant species are marine. Not sure how this interacts with MAR conclusion.

Recommend providing further information on the target species and the salinity criterion used.
EST

Can you be more specific on the tolerance ranges that you used for estuarine species—are they the same as used for the focal species? Also, is there likely to be an impact on these species by the duration of closure events and can that be included in the model?

Recommend listing estuarine species used in the evaluation and how closure was evaluated under various scenarios.

MAR

Not sure if MAR was given a zero weighting or just not evaluated.

Recommend more explanation of weighting of MAR in evaluation.

REC-2

It can be assumed that if the campground is flooded that is a significant impact on this beneficial use.

Recommend this beneficial use receive a higher weighting factor.

WET

See discussion above about elevations. Also, it is important to try to evaluate the effect of the discharge on invasion by *Arundo.* Presumably, more freshwater in the system will promote *Arundo* but it may also expand in the lower intertidal if water levels are lowered. Of course, the time of year when *Arundo* can become established should be considered. There is a lot of literature on its establishment and since it may have a significant impact on the quality of the habitat, it should be considered.

Algal growth can be adverse if it occurs in the wetland habitats. The cover photo on the report seems to indicate substantial algal growth near the discharge in the riparian areas. Therefore, some evaluation of nutrient impacts on wetlands needs to be considered.

Recommend that more evaluation be placed on the potential for *Arundo* to become established under various discharge scenarios. Also consider how nutrients may affect wetland quality.

WILD

Wildlife habitat can be significant impacted by the quality of the wetlands (see comments on *Arundo* above). In addition, wildlife habitat is dependent upon available food sources—large benthic invertebrates within SCRE. If available food sources are not present, habitat structure itself is not sufficient. There is some information on BMI in the report. Can these data be used to assess WILD?

Recommend incorporation of BMI information into either WILD or EST.

Determination of Enhancement

1) Assumption 1: While we agree with the underlying premise of the assumption, we do not agree that "changes in habitat and water quality conditions" are adequately quantified to allow for a reliable comparison of potential changes under different discharge scenarios.

Recommend either revising the analysis to incorporate greater consideration of water quality parameters, or revising the assumption to clearly acknowledge that physical habitat extent (defined simply as depths > 0.5 m) constituted the primary habitat suitability criterion considered in the analysis.

2) Assumption 2: We are not convinced that the "accumulated information and modeling tools" are sufficient, particularly due to the apparent prioritization of physical habitat extent over water quality parameters, and the inadequately supported assumption of well mixed conditions.

Recommend providing convincing evidence to support the validity of this assumption, or revise the assumption to clearly describe the limitations/constraints of the available data and tools.

MEPDV Recommendations

Assumption 2 notes that COMM, EST, MIGR, RARE, SPWN, WET, and WILD were of primary importance in determining the maximum amount that VWRF discharge can be reduced while still fully supporting the realization of each beneficial use, but does not describe the relative importance of each of these to the others (e.g., are COMM and RARE of equal "primary importance"? If so, why? If not, how was their importance weighted relative to each other?).

Recommend describing weighting system used in the development of the MEPDV recommendations. If no such weighting system was used, recommend its development and use in the analysis. We suggest prioritizing (i.e., assigning greater weight) aquatic focal species in the analysis along with other highly weighted factors.

2.0 Comments on Focal Species and Habitat Suitability

Steelhead

1) The report states that gammarid amphipods and chironomid midge larvae have been found to make up a large portion of the estuarine diet of steelhead, and notes that these prey items have been well documented in the SCRE (p. 153). Boughton et al. (2017) confirm the importance of

amphipods as a primary food source for steelhead, but consider chironomid midges to constitute prey of relative secondary importance. The report also notes that the SCRE BMI community composition varies considerably from other similarly-sized estuaries in coastal southern California, and acknowledges that species tolerant of disturbance, such as chironomid midges and oligochaetes, are more abundant in the SCRE than elsewhere (p. 148). In fact, these two taxa typically dominate the SCRE species composition. The report does not discuss the potential reasons for the unusual BMI composition of the SCRE compared to other similar estuaries, including the documented dominance of tolerant and secondary steelhead prey taxa, nor are the potential effects of different VWRF discharge scenarios on existing and future BMI population composition and dynamics discussed in any detail beyond "reduced VWRF discharge scenarios are likely to decrease the total BMI biomass supported by the SCRE" (p. 229) and "BMI community composition is likely to continue to be dominated by taxa tolerant of variable salinity conditions" (p. 230). An obvious question being raised by the available BMI data is how VWRF discharges have affected the SCRE BMI community, whether a reduction of VWRF discharges might shift the SCRE BMI community composition closer toward those observed in other southern estuaries?

Recommend expanded and updated discussion of the importance of BMI abundance and composition relative to steelhead habitat suitability and productivity, including effects of existing and decreased VWRF discharges on BMI habitat suitability, and thus steelhead prey productivity. Update steelhead prey discussion with information provided by:

Boughton D., J. Fuller, G. Horton, E. Larson, W. Matsubu, and C. Simenstad. 2017. Spatial structure of water-quality impacts and foraging opportunities for steelhead in the Russian River Estuary: An energetics perspective. NOAA-TM-NMFS-SWFSC-569.

2) The analysis relies on only one quantitative habitat parameter: depth, noting that any depth >0.5 m is assumed to constitute suitable habitat, and that no maximum depth is believed to apply to this habitat. Depth, in turn, is used to determine the surface area extent of suitable habitat under varying discharge regimes. While depth is certainly an important habitat factor for juvenile steelhead, it is arguably far less important than water quality parameters and should not be used as the primary determining evaluation criterion in the analysis. Moreover, the presented discussion of water depth as it relates to habitat suitability is overly simplistic, relying largely on Daniels et al. (2010), who do not provide any justification for their depth criteria, and should be updated with the far more thorough discussion of the depth-related trade-offs between foraging opportunities and predation risk provided by Boughton et al. (2017).

Recommend reducing the analytical overreliance on depth as a habitat suitability factor and weighing water quality parameters more heavily. This may require a reevaluation of the "fully mixed" conditions assumption discussed above, which likely requires a more fine-grained analysis of continuous sonde data, as described above.

3) The analysis considers the effects of water temperature on habitat suitability qualitatively, relying largely on temperature studies and recommendations applicable to freshwater systems. Boughton et al. (2017) discuss water temperature suitability in estuaries with a focus on thermal growth potential and consider water temperatures exceeding 25 C unsuitable. While we

recognize the prevalent consensus that southern steelhead may exhibit higher temperature tolerances than more northern strains (e.g., Boughton et al., 2015), one must also consider the confounding effects of other water quality parameters in determining estuarine habitat suitability.

As described by Boughton et al. (2017), “water quality rating criteria should be applied with caution, due to likely complex interactions in how temperature, salinity and DO affect salmonid energetics and foraging behaviors stemming from those energetics. For example, because metabolic rate increases with water temperature, it is likely that some levels of DO that are sufficient to prevent impairment at low temperatures may not prevent impairment at high temperatures. Similarly, the energetic demand of physiologically adapting to high salinity may interfere with tolerance for high water temperatures, which also has high energetic demand”.

Recommend consider reducing the temperature criterion to 25 C, especially given the predominance of secondary BMI prey taxa and periodic low BMI abundances (e.g., 2015) in the SCRE.

4) The analysis applies a minimum DO criterion of 5 mg/l, based on Daniels et al. (2010). Boughton et al. (2017) consider 5 mg/l in estuaries to constitute moderate impairment and recommend a minimum concentration of 6 mg/l as a “minimal or no impairment” threshold criterion. As described above, the use of more conservative water quality criteria in estuaries appear appropriate given the complex interactions between DO, temperature, and salinity, especially in light of potentially suboptimal foraging opportunities in the SCRE.

Recommend consider increasing the DO criterion to 6 mg/l for steelhead.

5) The analysis uses a salinity criterion of < 10 ppt and a dissolved copper criterion of < 5ug/l. Both of these evaluation criteria seem reasonable given the best information currently available (e.g., Boughton, 2017; Baldwin, 2015). However, no evaluation criteria are presented for additional water quality parameters relevant to steelhead habitat suitability (e.g., ammonia) do not appear to have been considered in the analysis. For example, see Carter (2008; previously provided) for discussion of sub-lethal impacts of ammonia and criteria recommendations.

Recommend expanding the list of water quality parameters and evaluation criteria to include all parameters that influenced by VWRF discharges and are known to affect steelhead and tidewater goby habitat suitability.

6) The report (p. 154) states: “Because adult steelhead as well as resident *O. mykiss* spawn at upstream locations within the tributary watershed of the Santa Clara River, fry are assumed to rear in upstream locations, with only smolt-sized individuals (i.e., sub-adults) using the lagoon for rearing prior to emigration. Because sub-adult steelhead are expected to be of comparable or greater size relative to other predatory fishes in the SCRE (e.g., sculpins, green sunfish), birds are the predominant predatory risk to steelhead in the SCRE.” This assumption appears to suggest that one of the three steelhead life history pathways documented by Hayes et al. (2008), namely the direct recruitment of juveniles to an estuary after spending only a few months in the upper watershed, would not occur with the Santa Clara River watershed and SCRE. While we recognize that the seasonal drying of the main channel Santa Clara River reduces opportunities

for juveniles to reach the estuary, we believe insufficient data is available to support complete elimination of an entire life history pathway from consideration in the analysis.

Recommend revising discussion of steelhead life stages that have the potential to occur in the SCRE, and reconsider predation risk accordingly.

7) The report considers breaching frequency and duration in the context of adult and smolt steelhead migration opportunities, but appears to disregard this important habitat suitability parameter for juvenile steelhead rearing. Smith (1990) documented high productivity in estuaries during open, tidally-influenced conditions, as well as in closed lagoons that have fully converted to freshwater, noting however that the intervening periods of brackish conditions tend to present low productivity conditions. Breaching events during the summer low flow period are widely considered be stressful to detrimental to steelhead. For example, while steelhead are capable for adapting to full saltwater, the process comes at an energy cost that appears sufficiently large to affect growth (Boughton et al., 20017), and repeated unseasonal breaches (often artificially-induced at the SCRE and elsewhere) would be expected to significantly affect juvenile steelhead growth and survival.

Recommend adding a discussion of the effects of summer breaching events on juvenile steelhead habitat suitability of the lagoons in general, and the SCRE in particular.
Regarding breaching frequencies, the report concludes (p. 238): "Although salinity in the SCRE is typically very low during closed mouth conditions and variations in VWRF flows under alternative discharge scenarios do not appreciably affect salinity (Table 5-6), mouth breach frequency and duration of open mouth conditions is likely to decrease under reduced VWRF discharge scenarios, resulting in reduced ocean inputs to the SCRE (Figure 5-3 through Figure 5-5). <u>However, because breach events primarily occur during winter, reductions in VWRF discharge are unlikely to have significant effects on salinity-related habitat suitability for rearing juvenile steelhead in the SCRE.</u>"

The analysis presented in Section 5.2 appears to directly contradict the underlined conclusion offered above. The model results summarized in Figures 5-3 through 5-5 and Table 5-8 suggest an ecologically significant reduction in both breaching frequencies and durations during the June -September juvenile rearing period under the 50% and 100% VWRF discharge reduction scenarios. Given the substantial efforts by regulatory agencies aimed at reducing unseasonal lagoon breaching frequencies throughout coastal California as part of steelhead recovery efforts, these results appear particularly relevant to the SCRE analysis.

Recommend updating the analysis of the modelled breaching results as they pertain to different seasons/life stages under reduced discharge scenarios.

Tidewater Goby

1) The report assumes that more water in the SCRE will provide more rearing habitat for tidewater goby and that there will be a reduced risk of interactions with potential predators; see pages ES-10, ES-13. Non-native species detrimental to tidewater goby are found in high abundance in the SCRE and thrive in stable warm water and low salinity conditions. An equally

valid assumption appears to be that the increased aquatic habitat will result in a greater abundance and density of non-native predatory species detrimental to tidewater goby resulting in greater predation on and competition with tidewater goby. The shift in fish assemblage to a non-native dominated system from 2008-2016 and the corresponding positive association between native fish assemblage and breaching events discussed on page 165 further challenge the assumption that increased aquatic habitat from the VWR discharge is beneficial for tidewater goby.

Recommend revising or providing evidence for the assumption that more aquatic habitat will reduce predation on and competition by non-native species on the tidewater goby.

2) Research by Spies *et al* 2014 provides information on duration of the pelagic larval phase for tidewater goby. Specimens analyzed with this work include tidewater goby samples from the SCRE, and the species was found to have a pelagic phase duration of 18-31 days.

Recommend updating pelagic larval information, see pages 159 with:

Spies, Brenton T.; Tarango, Berenice C.; and Steele, Mark A. (2014) "Larval Duration, Settlement, and Larval Growth Rates of the Endangered Tidewater Goby (Eucyclogobius newberryi) and the Arrow Goby (Clevelandia ios) (Pisces, Teleostei)," *Bulletin of the Southern California Academy of Sciences*: Vol. 113: Iss. 3 Available at: http://scholar.oxy.edu/scas/vol113/iss3/2

3) Table 3-30 on page 162 indicates that tidewater goby is considered “abundant” in the SCRE; however, survey results in Figure 3-49 show tidewater goby numbers decreasing sharply since 2010, with no detections in 2013 or 2014 and only minimal detections in 2015 and 2016. This time period represents 5 plus generations of decline for the tidewater goby. In contrary, Mississippi silverside which was the most numerous species encountered in the 2015 and 2016 survey results in Table 3-31 are only considered “common” in Table 3-30.

Recommend revising Table 3-30 to indicate that tidewater goby is “uncommon” or “variable”, unless other survey data can support an “abundant” qualification. Would also revise Mississippi silverside and western mosquitofish to be listed as “abundant” in Table 3-30.

4) Mississippi silverside is one of, if not the most, abundant fish in the SCRE and is known to feed on larvae of other fish species. Swift *et al* 2014 poses that Mississippi silverside could pose a significant risk to tidewater goby through predation of the pelagic larvae. The threat of predation to pelagic larvae is included for wester mosquitofish on page 167; however, is not included for Mississippi silverside.

Recommend including text on Mississippi silverside as a threat for predation of larval tidewater goby. Update Table 3-30, changing Mississippi silverside from “no” to “yes (larval)” under the “Tidewater goby predator column”. Incorporate the Swift et al 2014 paper as appropriate:

Swift, Camm C.; Howard, Steve; Mulder, Joel; Pondella, Daniel II; and Keegan, Thomas P. (2014) "Expansion of the non-native Mississippi Silverside, Menidia audens (Pisces,

Atherinopsidae), into fresh and marine waters of coastal southern California," *Bulletin of the Southern California Academy of Sciences*: Vol. 113: Iss. 3. Available at: http://scholar.oxy.edu/scas/vol113/iss3/1

5) The invasive shimofuri goby has become established in the upper watershed of the Santa Clara River Watershed, and poses a significant threat to tidewater goby if it reaches the SCRE (Howard and Booth 2016). This species has the potential to prey upon and potentially out compete tidewater goby as it fulfills a similar ecological niche (see work by Matern and Fleming 1995 and Matern 2001). Shimofuri goby salinity tolerance is lower than tidewater goby, and has been found to not exceed 21 ppt in laboratory conditions. Maintaining low salinity water quality, diluting estuary salinity levels during breaching events, and maintaining areas of low salinity during breaches, may all further contribute to providing suitable habitat for shimofuri goby. This species is not addressed in the document and should be incorporated with the threats facing tidewater goby survival in the SCRE.

Recommend including analysis and an evaluation on the threat shimofuri goby poses to tidewater goby. Additional analysis should be provided to determine if the VWRF discharge is increasing habitat suitability for shimofuri goby. Publications to review and include are:

Howard, S.R., and M.T. Booth. 2016. Range expansion of the Shimofuri goby (*Tridentiger bifasciatus*) in southern California, with emphasis on the Santa Clara River. *California Fish and Game* 102(2):45-49.

Matern, S. A., and K. J. Fleming. 1995. Invasion of a third Asian goby, *Tridentiger bifasciatus,* into California. *California Fish and Game* 81:71–76.

Matern, S. A. 2001. Using temperature and salinity tolerances to predict the success of the Shimofuri Goby, a recent invader into California. *Transactions of the American Fisheries Society* 130:592–599.

Snowy plover/Least Tern

1) Both species are migrants to the SCRE and do not adequately represent year round residents. The least tern is a piscavore and the snowy plover feeds on insects and small invertebrates at the immediate shoreline near their nesting sites. Most resident species such as shorebirds and herons/egrets forage over a larger area and in the case of shorebirds, feed on benthic invertebrates. These species were stated to be represented within the WILD beneficial use analysis based on habitats as designated by the CDFG (1988). However, it is not clear from the report if exposed mudflat habitat was one of the habitat areas evaluated in the model as it appears that it may be included within wetland category that can include both vegetated and non-vegetated habitat.

Recommend that the habitats to be evaluated include shallow water/mudflat areas that would more accurately depict the benefits under WILD.

2) As demonstrated in the graphs in response to habitat area change, nesting habitat is similar for both species with SCRE stage, however, foraging habitat for snowy plover decreases with stage and least tern foraging habitat increases with stage (presumably due to increased open water habitat). It is not clear whether the two off-set one another in the analysis and how that is being weighted, if at all in the model. Also, snowy plover are more likely forage only on sand bars, not mudflats which may be exposed at lower stage.

Recommend that an analysis be run that compares mudflat area at various stages with snowy plover foraging area to see if there is a significant difference. If so, it may be necessary to consider if adding an additional focal species, e.g. shorebirds, would alter the findings.

3.0 Additional Comments/Recommendations on data analysis/modeling

1) Some of the profiles do demonstrate periods of stratification; especially with salinity and dissolved oxygen. Wind mixing may play a role in reducing stratification, especially with shallow water conditions. Is there any relationship of the stratification events with either water level, inflow of discharge water, and/or temperature of inflows?

Recommend that there be a correlation analysis be performed to see if the observed periods of stratification with either discharge rates or water level conditions at the time.

2) Despite previous requests, no temperature modeling is provided. Nor is any estimation of future thermal regimes due to reduced inflows. Only the following is provided: “Cumulatively, the information above suggests that the increased lagoon depths under current conditions results in somewhat lower temperatures than under reduced discharge scenarios.” (Pg. 220)

Recommend Temperature modeling be conducted to compare potential differences between scenarios, as at present conditions exceed thermal suitability thresholds during times of the year.

3) In the water budget modeling VCWPD Station 723 flow data were used for a portion of the simulation period. As noted in the report these data are often not reliable, particularly for lower flow conditions. Furthermore, UCWD flow below Freeman Diversion were used for another part of the simulation period. There is a significant losing reach downstream of the Freeman Diversion (it is not uncommon for 60-80 cfs to percolate) which would result in these flows being much larger in magnitude than what actually flows to the estuary.

Recommend Compare gage data to actual flow measurements to either validate the flows used are reasonable or develop an adjustment (up or down) for flow records applied to the model. Reassess model calibration based upon this and other suggested changes

4) Groundwater flow assumptions - “Pond seepage in this area seepage flows were assumed to flow to the ocean and were included in the SCRE water balance.” (Pg. A-3) Aside from the typo, do you mean they were *excluded* from the water balance?

Recommend Revising text to clarify how these flows were or were not incorporated into the modeling.

5) Unmeasured GW flows were used to close the water balance. Likely a large portion of these "unmeasured flows" are not groundwater at all and are more likely wave over wash, particularly immediately following a closure event. After which they would diminish significantly as the bar elevation builds. The use of the stage relationship to estimate these unmeasured flows may result in an overestimate of GW contribution to the lagoon, particularly during reduced effluent flow scenarios, which may result in differences in estimated beneficial uses, altering the outcome of the MPEDV selected. In addition, better estimation of wave over wash may improve the simulation of salinity with the Estuary Mixing Model.

Recommend Including a separate estimated wave over wash input to the model to improve (reduce) the unmeasured GW flows input at lower lagoon water levels.

6) Lagoon water levels are used to trigger breaching events. Different triggers are used for different seasons and low and high runoff conditions. The berm elevation is likely not linked to season or flow, rather it is linked to wave energy.

Recommend Tying these breaching thresholds to the relevant driving force. It is highly likely the results will be similar (wave energy is probably correlated with precipitation). Other efforts to simulate berm building and breaching dynamics in California bar-built estuaries have mechanistically relied upon both fluvial (runoff) and coastal (wave energy) inputs, for example see Rich et al. (2013) and Behrens et al. (2013).

Behrens, D.K., F.A. Bombardelli, J.L. Largier and E. Twohy. 2013. Episodic closure of the tidal inlet at the mouth of the Russian River – a small bar-built estuary in California. *Geomorphology*, http://dx.doi.org/10.1016/j.geomorph.2013.01.017

Rich, A., and E.A. Keller. 2013. A hydrologic and geomorphic model of estuary breaching and closure. Geomorphology 19: 64-74.

7) Lagoon water level is poorly simulated for portions of 2015. This is explained in the text as due to a wider berm resulting from the placement of dredge spoils to the west of the lagoon, which seems reasonable. However, the model is calibrated to simulate this anomalous condition, and it requires higher "unmeasured GW flows" to close the water budget. This results in an over-estimate of "unmeasured GW flows" (see earlier comment as well), which could have an impact on the results of the reduced effluent inflow scenarios.

Recommend Calibrating water budget model to the typical conditions that occur through the summer months of 2015, which would result in the model underpredicting water level during the initial filling period of 2015. However, the model would better reflect conditions during the extend closed mouth period later in the year.

Appendix B

Copy of the TRT comments on Chapters 5 and 6 of:

September 2017 draft of the *Phase 3: Assessment of the Physical and Biological Conditions of the Santa Clara River Estuary, Ventura County, California*.

Submitted to the City and Stillwater Sciences on October 10, 2017

Appendix B

SCRE Phase III September 2017 Draft Report

Comments on Chapters 5 & 6

Comments provided by: Mike Podlech, Mike Josselyn, Dan Chase and Chris Hammersmark

October 10, 2017

As requested by Stillwater, these comments represent “bullet points” on significant issues that we have found in our review of Chapters 5 and 6. These were done in preparation for our technical team phone call on October 12, 2017.

1. Overall comment: Reiterating comments made during the October 4, 2017 conference call, we recommend that the draft report as a whole, and Chapters 5-6 in particular, acknowledge the limitations of the analysis as they pertain to water quality (e.g., water temperature, DO), and emphasize that “habitat suitability” in the context of the analysis relies heavily on “physical habitat availability” over habitat quality, particularly for more sensitive species such as steelhead. Since open water habitat extent drives a large part of the AHP analysis, this is an exceedingly important disclosure to include and reiterate in applicable report sections.

2. Page 207: Not sure what is meant by the “existing beneficial uses” as it implies that existing conditions (0% diversion) is somehow supporting beneficial uses that need to be sustained—when in fact, we are trying to figure out what discharge will result in the best combination of beneficial uses for SCRE and how to maintain as natural a system as possible given other constraints/anthropogenic effects on SCRE.

3. Page 208: I think that is better to say that the AHP is one tool—but not to say that “to resolve this”. Seems that we are assuming that this tool is the only way to resolve the decision when in fact it is just a tool. I think we need to recognize the pros and cons of this tool more in this section. I really am not an expert in this tool, but this slide show states some of the cons related to difficulty in modifying the model once set up, the difficulty of use when number of criteria is high. https://www.slideshare.net/ujjmishra1/analytic-hierarchy-process

   To me, it is an interesting procedure, but I think a more critical review is needed at the start so that the readers do not think it is the “final decision maker”. Here is a link to the complexity of this tool and how sometimes poor assumptions lead to poor results… http://www.sciencedirect.com/science/article/pii/S0895717707001033

4. Page 212: Concerned about the steady state assumption in the model that drives the wetland/riparian community area. I understand that during the dry season, there may be an equilibrium, but it gets reset (in most years) by winter/spring breaches and sometimes summer breaches by humans. I think more discussion needs to be made on how this model may

overestimate vegetated wetland (especially riparian areas) as the tendency is for storm events to reset the lagoon. Mass exodus of riparian vegetation would take some time to recolonize. Aerial photos before the VWTP was constructed do not show a large extent of riparian vegetation in the SCRE (e.g 1947, 1967) so it is hard to believe that under zero discharge, the open water area would be significantly reduced as predicted in the model.

In addition, on this page, there is no mention of *Arundo*, which is likely to be the first colonizer of these 'available' wetland areas. So, the estuary beneficial use may be diminished if non-native species are the dominants in the freshwater systems that you modeled. Somehow this needs to be considered in the GIS assumptions as the figures seem to simply show a conversion from one "natural" habitat to another. I realize that this assumption would drive towards higher VWRF discharge, but *Arundo* may also be the first to colonize riparian areas that are flooded and the trees die. It may be necessary to consider an adaptive management program to deal with *Arundo* invasion so that some areas subject to change by the discharge can be managed to promote native community establishment.

5. Table 5-4 drives the scenarios in Appendix F. More detail is needed on the justifications. When water levels are high, it suggests that riparian converts to freshwater marsh, but as described above, the riparian may die out and *Arundo* will replace it. Also, how does the AHP handle the areas in your depictions when it states "open water (exposed mudflat when mouth open)? Does the model have a temporal factor worked in that shows that in the winter when the mouth is open, that those species dependent upon open water will have less habitat?

   I agree that when the campground "wetlands" are flooded, this is not a good outcome. There are pollutants (oil and grease), flooding of toilets, and other problems that should not be modeled as beneficial habitat conversion. The SCRE McGrath Feasibility Study showed that there was low DO water in the campground, that in the event of a breach would flow into the estuary and likely be detrimental.

6. Page 220-222. This section needs much greater clarity on how the various factors are included in the model to estimate water. For example, I am not sure how the hydraulic residence time is used in the model. Please explain where this is used to determine water quality parameters. Why does scenario 11 result in a higher HRT similar to scenario 7 (60% diversion). With water quality a major consideration, there needs a clearer explanation of how all the factors you are discussing in this section relate to a finding with various discharge scenarios.

7. Page 231: Sport and Bait fish are more likely to be supported in the portion of the lagoon closest to the beach. But the model does not distinguish between open water in the riverine portion vs that within SCRE proper. Suggest changing metric to only area within the SCRE. Also, can you provide evidence that green sunfish could not escape higher salinities by just moving to another portion of the estuary where the water is fresher. Seems that the lower scoring of longer duration salinity is really not a viable factor under COMM.

8. Page 234 and Table 5-12. Open water is driving the EST variable, when in fact, it is a range of habitats that is important to this…including vegetation and wildlife. Focusing on fish along

seems to duplicate COMM and RARE and pushes more towards open water habitat. This variable needs to be re-written, but time doesn't permit us to make a recommendation at this point.

9. Section 5.5.6 Shouldn't fish RARE species be separate from avian and plant RARE species? The inclusion of all RARE species into one category seems to homogenize the results and skews the scoring to a more full estuary being the better discharge scenario. For the avian species, they have the opportunity to forage in areas outside the SCRE lagoon, as CLT can and does forage in the ocean and WSP would use the tidal area of the beach for foraging. The fish RARE are more directly tied to the SCRE estuary for part/all of their life cycle. This would also provide more weighting towards two (or three) RARE categories, and further reduce the weighting for less important categories in the hierarchy such as REC-1 and COMM.

10. Data reported in Table Fish counts by species and sampling dates for seine surveys conducted 2015–2016 should be checked:

    The Mississippi silverside number reported in the June 2015 report appears too low; the total does not account for any of the ">" values recorded.

    Each survey had a different number of sample sites and total area sampled. Recommend standardizing the number of fish collected by the Catch Per Unit Effort, to provide a more accurate evaluation between surveys.

Survey Date	Locations Sampled	Total Area Sampled (sq ft)
Jan 2015	Not In Appendix B	Not in Appendix B
Mar 2015	22	8,000
Jun 2015	20	2,500
Sept 2015	17	4,200
Sept 2016	20	12,250

11. Section 5.5 What's the basis for the current order of each beneficial use? Should this order be based on the weighting of most important to least important use?

12. Section 5.5.6.1 RARE Aquatic Species 3. Physical habitat area for tidewater goby spawning; for the Score of 0:

    Previously provided comment: I'm not sure the 30% cut off makes sense for this threshold (between "0 "points and "1" or more) for tidewater goby spawning and rearing habitat metrics. USFWS 2005 recovery document states tidewater goby habitat that's smaller than about 5 acres generally have histories of extinction, extirpation, or low population levels. Most of the stable populations of tidewater goby are found in habitats that are 5 to 125 acres in size. It seems like avoiding a lagoon size of 5 acres or less would be a "0". Based on the tidewater goby rearing habitat figure (5-11) all of the scenarios would provide >5 acres of habitat, with 10% still providing over 10 acres. For spawning habitat (figure 5-12) all of the scenarios would provide >5 acres of habitat, with 20% still providing around 15 acres.

In fact, almost all the variables under RARE have 100% of maximum open water area with highest scoring. The variable for steelhead and tidewater goby does have a depth, but others seem to include both the SCRE and Riverine habitats when the latter may be less desirable for least term foraging, for instance. Terns can use the ocean even when the lagoon is lower. There is also an assumption that western snowy plover actually benefit from having longer berm foraging area, when given the low numbers, the amount of available food is less important that protection from predators, for example. So, available foraging area may not be the controlling factor on the population size and unimportant as a factor allowing the species to be retained within the study area.

13. Section 5.5.6.1 RARE Aquatic Species 5. Salinity conditions selecting against tidewater goby predators and competitors; for Score of 1:

    Shouldn't a score of "0" be for a discharge scenario that provides 0 days of salinity >18 ppt and then a continuous score between 1-2 for 1-7 days at salinity >18 ppt. It seems that having some days at salinity >18ppt would be scored higher than no days at or above that threshold, and any scenario that does not have any days >18 ppt should not receive a 1.

14. Water Contact recreation is a low beneficial use and it is more related to accessible water rather than total water open area. In other words, the only really accessible water would be near the campground and the back of the beach. The campground has only one or two trail heads that lead to the water, so it may actually be the length of the beach (same criteria as used with the snowy plover)

15. Boating is also not necessarily related to the amount of open water, but to access to that open water. It seems that by relating so many uses to the amount of open water, it just pushes the analysis to more discharge when in fact there may be many other issues affecting use. As long as there is any amount of open water, someone could put an inner tube in it! They could care less if it was 5 acres or 100 acres! It is the availability of the launching areas (e.g. not too far to carry the boat) and the quality of the water. This needs to be entirely rethought. Maybe use criteria 4 from the camping analysis.

16. 5.5.8.1 REC 2 number 2 Opportunities for camping; scoring: is it known how much flooding the campground can have before CA State Parks would close the entire campground? Maybe this metric should be a 0 or 2 score possible, with the threshold being when the campgrounds would be open or closed.

17. Page 259: The Board considers riparian habitat as a wetland habitat just like freshwater wetland when it comes to beneficial uses https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2008/rs2008_0026.pdf

    Therefore, it seems incorrect to based WET on freshwater marsh only and not consider, at least in some way, riparian habitat. Otherwise, this factor seems to favor freshwater marsh and not riparian habitat which is a key habitat component to the SCRE. May need to create another variable to assess riparian habitat beneficial uses.

18. Page 264. The decline in available mudflat assumes that riparian habitat colonizes areas near the beach when these areas may be scoured. I would suggest some threshold where riparian habitat reaches a maximum at a lower discharge scenario rather than increasing. Needs more discussion as it is surprising that riparian habitat hasn't expanded to the maximum already during the drought years.

19. Concerned with including the scoring and ranking in the Appendices from the August 2017 workshop; pages 120-126. The AHP was in a draft form at the time, and the workshop discussed several changes that should be made to the various criteria. The scoring and ranking of the draft form of the AHP was done as an exercise, as some of the criteria scores are likely to change with an updated AHP. By including the scores and ranking with the report, it gives the appearance that recommendations to criteria scoring would have been made after reviewing how each scenario scored for a given metric. Recommendations to scoring criteria and categories were provided before scenario scores were run.

20. Page 268. Somewhere there needs to be some recognition on how many times some of the factors in the analysis are being used—for example, the number of times that % maximum open water receives a high score. It seems to be very repetitive in each of the factors and I think a summary table showing # times a variable is part of the analysis would be useful here.

21. Page 269. This chart is a good place to discuss the overweighting of RARE, but also needs to point out that RARE also benefits from more open water and that there are limitations in the succession model that can greatly skew the outcome.

22. Page 270: Should be expanded to discuss limitations of AHP.

23. Page 271: We would like to revisit this conclusion section once some of the issues above are resolved and discussed in more detail.

24. Section 5.3.2.1: Please explain why evaporation is excluded from the hydraulic residence time calculations? Figure 4-4 suggests evaporative losses can be significant.

25. Section 5.3.2.4: The statement "reaeration by wind-mixing is relatively high" appears here and elsewhere in the report, but is never quantified in any way.

26. Section 5.3.2.5: The heat balance modelling appears to support the notion that VWRF discharges do not significantly affect SCRE water temperatures within an assumed well-mixed equilibrium state. However, different VWRF discharge scenarios are expected to alter equilibrium stage by up to 6.3 ft (Table 5-5), and could therefore affect thermal stratification suggested by South sonde data. Recognizing our differences in opinion regarding the validity of the sonde data, this section would benefit from (a) a through description of the limitations of the water temperature analysis used in this study, and (b) at least a qualitative description of how future changes in equilibrium stage may affect potential localized (the South bottom sonde was located 1-2 ft deeper than the other two bottom sondes) vertical temperature variations, and therefore the availability of potential temperature refugia.

27. Section 5.5.1.1, *Salinity conditions suitable for freshwater sport fish*: Here and/or elsewhere, please describe the basis for selecting a 7-day elevated salinity duration threshold for this analysis, or acknowledge that it is largely arbitrary.

28. Section 5.5.1.2: "Assuming constant VWRF nutrient concentrations across discharge scenarios, nutrient loading from VWRF discharge decreases linearly as a function of decreasing discharge, with each 10% reduction in discharge resulting in a 10% decrease from current nutrient loads." Please explain why nutrient *loading* rather than concentration is used in the DO analysis? While total loading would decrease linearly with decreased discharges, nutrient concentrations would not change linearly. Given that eutrophication potential is used as a proxy for the DO analysis, and this potential is described in terms of nutrient concentrations elsewhere in the report (e.g., Table 3-19, Table 5-9), why is nutrient loading used in scoring DO conditions?

29. Section 5.5.2.1, *Physical habitat amount*: "The amount of suitable habitat for native estuarine fish species is quantified by the fraction of the maximum open water habitat simulated by the water balance under equilibrium closed mouth conditions for any of the VWRF discharge scenarios." As we commented in our review of the AHP Draft Hierarchy spreadsheet, quantifying the amount of "suitable" habitat as a fraction of maximum simulated open water habitat inherently selects for higher discharge scenarios. Recognizing the lack of quantitative water quality assessment tools used, this factor and metric should be defined as evaluating the amount of "physical" habitat, not "suitable" habitat.

30. Section 5.5.4.1, *Migration opportunities*: Why were only three discharge scenarios (0%, 50%, and 100% reductions) modelled? Please model the other discharge scenarios as well (see following comment).

31. Section 5.5.4.2: "Modeled results indicate steeper reductions in the number of open mouth days with each 10% reduction in VWRF discharge associated with Scenarios 1–6, with relatively minor decreases in Scenarios 6–11." This statement is based on only three modelled scenarios (see above). While the limited data presented in Figure 5-9 supports this statement, the limited data set does not allow for a reliable assessment of the rate of decrease between scenarios. Modelling of other scenarios may show that the slope of the reduction rate changed with higher or lower discharges than those represented by Scenario 6. Please model the other discharge scenarios so the inflection points can be evaluated more accurately.

32. Section 5.5.6.1, *factors considered but not included:* This section is missing the water temperature factor.

33. Section 5.5.6.2: Consistent with our comment on *Physical habitat amount* above, recommend editing the first sentence from "Juvenile steelhead rearing habitat is maximized under Scenario 1…" to "**Physical** juvenile steelhead rearing habitat is maximized under Scenario 1…".

34. Section 5.5.9: Suggest reminding the reader that analysis of this beneficial use is focused on non-TWG spawning.

35. Section 6.5.2: "Understanding that variations in open water, vegetation, and wetland extent are variable within the SCRE in response to flood scour and berm position, we recommend that an

MEPDV of up to 50–60% is possible and would be protective of the ecological functions of the SCRE, including aquatic habitats supporting native fish species, nesting and foraging habitat for many native birds as well as other wildlife species." Recommend noting that a 50-60% reduction in discharges is estimated to reduce equilibrium stage by 2.9-3.6 ft, thereby reducing the potential for vertical temperature variations that may provide localized temperature refugia for steelhead.