WATER DEPARTMENT
FINAL TECHNICAL MEMORANDUM

DATE: April 12, 2013

TO: Heidi Luckenbach, Desalination Program Coordinator

FROM: Susie O'Hara, Assistant Engineer II

SUBJECT: Evaluation of Future Water Supply Shortages and Need for Supplemental Supply Given Probable Habitat Conservation Plan Conservation Strategy Flow Requirements

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Background and Purpose

In November of 2005, as the culmination of a multi-year, public process, the Santa Cruz City Council resolved to adopt the Integrated Water Plan (IWP). As the City's long-term water management plan, the IWP balanced supply-side additions with demand-side conservative water management in a phased approach. The IWP consisted of a three-part plan:

1. Full implementation of the City's Water Conservation Plan.
2. Acceptance of drought shortages of up to 15% system-wide and,
3. Construction of a 2.5 million gallon per day (MGD) desalination facility with the ability to expand up to 4.5 MGD.

The City Water Department has steadfastly endeavored to satisfy all of the components of the IWP. Implementation of the 2000-2010 Water Conservation Plan was highly successful and resulted in Santa Cruz water customers being one of lowest per capita water users in California. In March 2009, the Council adopted the Water Shortage Contingency Plan and effectively implemented curtailment measures two months later in the face of significant water shortage projections. After six years of research and analysis, the Water Department, along with partner, Soquel Creek Water District, has nearly completed the draft Environmental Impact Review (dEIR) for the **scwd²** Regional Seawater Desalination Project (Project).

A considerable passage of time has taken place since the adoption of the IWP and in that time, the City of Santa Cruz, along with most other California water agencies, has seen substantial shifts in customer water demand as a result of a number of factors[1]. In addition, the City's future surface water supply is jeopardized due to its effort to maintain habitat for endangered fish species in the San Lorenzo River and North Coast streams[2]. Groundwater supplies have become threatened due to the potential for seawater intrusion. With changes to both the water supply and demand projection variables since the 2005 adoption of the IWP, it is very important to re-affirm the purpose and need of the IWP supplemental supply project.

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[1] See Chapter 4, City of Santa Cruz 2010 Urban Water Management Plan
[2] See April 5, 2011 Santa Cruz City Council Habitat Conservation Plan Update

With regard to supply conditions, the City is currently developing an anadromous fisheries Habitat Conservation Plan (HCP) to maintain habitat for endangered fish species and ensure regulatory coverage for all municipal activities that may potentially affect these species. Understanding that the City of Santa Cruz Habitat Conservation Plan is still pending, this memo will attempt to capture the current understanding of potential future water supply shortages given changing demands, drought frequencies and HCP requirements.[3] And further, this memo will attempt to define the need for supplemental supply, given the range of possible outcomes of the HCP process. This information will be utilized to support the dEIR.

Habitat Conservation Plan Summary, Timeline and Current Status

Summary of Requirements

NOAA Fisheries (NMFS), the U. S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) (collectively referred to as the Agencies) have all designated different species as threatened or endangered under the Federal and State Endangered Species Acts (ESA and CESA) that are found on City properties or may be affected by City activities. Critical Habitat for these species has also been designated.[4] Both the San Lorenzo River system and North Coast streams, as well as much of the land where the City's water infrastructure is located, have been designated as Critical Habitat for one, and in some cases, multiple species. This designation means the City must look seriously at activities that could impact this Critical Habitat and potentially result in "take" of special status species.

Any activity that may have the potential to result in a "take" ("take" of an endangered species is defined to include any activity that will harass, harm, pursue, hunt, kill, trap, capture, or collect) of a species or damage to Critical Habitat requires a Federal Section 10(a) Permit. The City of Santa Cruz Water Department extracts water from Critical Habitats to serve the community with potable drinking water. These operations result in a "take" from designated Critical Habitat which can potentially impact fish populations. Leading up to the application for the permit, the City must look critically at its operations and the potential to "take" any listed species and prepare a Habitat Conservation Plan. The HCP is meant to assure the City is, to the extent practicable, minimizing any "take" potential. It is anticipated that the implementation of the forthcoming anadromous fisheries HCP will be beneficial to special-status aquatic species found downstream of City diversions, as well as "resident" species found in the non-anadromous reaches of streams where the City diverts water (Water Dept. Council Agenda Report, July 2010).

The following table outlines the Agencies' regulatory jurisdiction and permitting requirements. As enforcement agencies for the Federal and State ESAs, the City is legally obligated to cure any condition that the agencies find in jeopardy.

[3] The anadromous fisheries HCP will consist of many actionable components. While this memo will focus on the Conservation Strategy, other components include additional monitoring, offsite mitigation, compensation and operational adjustments. The Conservation Strategy dictate how much water will be available for diversion and, therefore, defines supply availability. See April 5, 2011 Santa Cruz City Council Habitat Conservation Plan Update for details. See Draft Habitat Conservation Plan for the Issuance of an Incidental Take Permit Under Section 10(a)(1)B) of the Endangered Species Act for the Operations and Maintenance Habitat Conservation Plan for the City of Santa Cruz for more information on the City's efforts to develop a terrestrial HCP.

[4] NOAA and CDFW have permitting jurisdiction over aquatic species. USFWS has permitting jurisdiction over terrestrial species.

Table 1: NOAA Fisheries and CDFW Regulatory Jurisdiction and Permitting Requirements (Aquatic Species)			
Governmental Agency	**Specific Jurisdiction**	**Permitting Requirements**	**Enforcement Potential**
NOAA Fisheries	Enforcement Agency for the federal Endangered Species Act (ESA) and regulation promulgated thereunder.	Section 10(a)(1)(B) Incidental Take Permit	Unlawful taking of endangered species could result in significant fines or injunctive relief.
California Department of Fish and Wildlife	Enforcement of California Endangered Species Act Section 2081(b)(2)	Section 2081(b)(2) Incidental Take Permit and Streambed Alteration Agreement	Unlawful taking of endangered species could result in significant fines or injunctive relief.

City of Santa Cruz Anadromous Fisheries HCP Timeline and Actions Taken

The City began working with the Agencies to plan and develop a multi-species HCP in early 2002. NOAA Fisheries published a *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (Handbook) in 1996 to “ensure that the goals and intent of the conservation planning process under the Endangered Species Act are realized”. The City of Santa Cruz has followed the Handbook’s guidance on preparing an HCP as outlined below.

Table 2: City of Santa Cruz Anadromous Salmonid HCP Milestones	
Process Steps	**Notes**
Assemble an HCP “steering committee” to “represent affected interests in [the] broad-scale HCP planning area and generally oversee HCP progress.	The City of Santa Cruz assembled the Habitat Conservation Plan Committee (HCPC), representing the Water Commission, Planning Commission, Parks and Recreation Commission, Public Works Commission, San Lorenzo Urban River Plan Task Force, Watershed Management Technical Advisory Task Force, and Integrated Pest Management Technical Advisory Committee, in 2002. This committee was charged with assisting in the development of a citywide HCP.
Establish the role of the permitting agency on the steering committee and in the HCP efforts.	*Ex Officio* members of the HCPC included staff from NOAA Fisheries and CDFW. Although the steering committee disbanded in 2003 due to budgetary constraints, permitting agency involvement in the development of the HCP has been continual.

Table 2: City of Santa Cruz Anadromous Salmonid HCP Milestones	
Process Steps	**Notes**
Define the proposed activities ("project") and identify the "project" impacts or potential levels of take.[5]	The City of Santa Cruz HCPC hired Entrix, Inc. in 2002 to develop and perform the scope of work for a city-wide multi-species HCP and related ESA Section 10a1b and CESA 2081 permits. In 2004, Entrix presented the existing conditions with regard to covered activities (the "project"), species accounts within the sphere of City influence and general potential effects of City activities on those species to USFWS, NMFS, and CDFW. Also at that time, an independent scientific technical advisory committee was convened to provide feedback on development of the HCP. In 2005, refinement of the covered activities and covered species, development of effects analyses and a draft Conservation Strategy for anadromous salmonids were initiated in partnership with the Agencies. Recognizing the relative urgency of take authorization for effects on anadromous salmonids, the City chose to prioritize take authorization for Public Works and Water effects on coho and steelhead and put USFWS – related work on hiatus at this time. The USFWS permitting work was later re-initiated and is nearly complete at this time. During conservation strategy negotiations with DFG and NMFS at this time (circa 2005), numerous additional data needs were identified. The City contracted with Hagar Environmental Sciences and Ebbin, Moser and Skaggs to support this work and concluded the contract with Entrix. Due to the seasonal and flow-dependent nature of the work, collection and analysis of this data took several more years. The City continued to meet with CDFW and NMFS throughout this time to consult on study plans, data interpretation and related matters. Recognizing the lengthy nature of the process, in 2007, the City initiated "interim maintenance flow" bypasses at the North Coast diversions in attempt to partially offset the effects of the Water Department's activities on anadromous salmonids, and as an act of good faith regarding agency negotiations.[6]

[5] Not to be confused with the desalination project. The project within the context of the HCP are the activities that could potentially result in a take, i.e., the City's surface water diversion for municipal use.
[6] The 2007 interim maintenance flows are consistent with Tier 1 flows are described below in Analysis Description.

Table 2: City of Santa Cruz Anadromous Salmonid HCP Milestones	
Process Steps	**Notes**
	From approximately 2007-2010, the City processed and reviewed newly-collected data with agency staff. This process was somewhat prolonged due to staff turnover at CDFW and the relatively complex nature of the data.
Define steps taken to minimize and mitigate the impacts.	The City developed a Conservation Strategy for Steelhead and Coho Salmon in August 2011, which was updated in July 2012. The primary focus of the City's strategy is to avoid or minimize existing and potential effects of its activities to the maximum extent practicable as required by the Federal and State ESAs.
Address alternative actions considered and the reasons why they are not being used.	The City developed a draft Practicability Analysis in September 2011. The purpose of the analysis is to define the extent of which the City can reasonably minimize and mitigate the impacts of the "project" considering cost, existing technology, and logistics in the light of the overall "project" purposes. This analysis is an iterative tool that is being used to assess long-term viability of various instream flow proposals as the City and resource agencies refine the aforementioned Conservation Strategy.
Develop a Monitoring Plan	The City developed a draft Interim Monitoring Plan in December 2011 to ensure continued study of the impacted habitat during development and finalization of the HCP. The HCP will also include a final monitoring plan.
Develop an "effects study" of City diversions on affected endangered species.	The City developed a draft Flow Related Effects of City Diversions on Habitat for Steelhead and Coho Salmon with HCP in August 2011 which will be updated when the final instream flow proposals are developed.
Broader implementation of instream flows in priority stream reaches on a trial basis.	Again, as an effort of good faith, the City voluntarily began implementation of instream flows considered to be protective of anadromous salmonids in key stream reaches during the winter of 2011/2012. These flows are distinguished by those which were initiated in 2007 in that they are better informed by site-specific data, life cycle needs and hydrologic year types. It is anticipated that these flows will be further refined with resource agency staff prior to final incorporation in the Section 10/2081 permits.

Overall Status of Ongoing Anadromous Fisheries HCP Development

Subsequent to the August 2011draft City of *Santa Cruz HCP Conservation Strategy for Steelhead and Coho Salmon* and studies to support the HCP analysis, several alternative Conservation Strategies were evaluated to determine: 1) the practicability of each potential Conservation Strategy and 2) the associated potential effects on listed species.[7]

The City is currently trying to come to a resolution with the Agencies on the Conservation Strategy. With resolution, the fish bypass flows will be established and the diversion potential for the City will be defined. This memo will use the framework established by the draft Conservation Strategy, supporting documents, and City/Agency discussion around alternatives, to evaluate the potential impacts of the HCP on water supply reliability.

Defining the Purpose and Need for Supplemental Supply: 2005 IWP

As noted in the Executive Summary of the 2005 IWP, integrated planning should focus on "how much and how often the community is willing and able to tolerate cutbacks in water use in future water shortages, and what degree of hardship corresponding with different size water shortages constitutes an acceptable risk." With the two most important planning variables being level of shortage and acceptable risk, the IWP fully vetted both parameters using supply and demand forecasting and evaluation criteria.[8] With the final adoption of the IWP, the community of Santa Cruz defined the acceptable risk by sizing the supplemental supply project modestly at 2.5 MGD (with the ability to expand to 4.5 MGD to meet future demands) and tolerating a 15% curtailment requirement in supply shortages similar to those faced in the 1977 drought. The IWP also defined the acceptable frequency of expected shortages less than 15%. For the purpose of the 2005 IWP, the forecasted long-term demand range and water supply reliability targets from which the Project was approved and sized are outlined below.

Table 3: IWP Annual Demand Forecasts Under Average Weather Conditions (MGY)							
Year	2000	2005	2010	2015	2020	2025	2030
Demand	4409	4627	4817	4961	5157	5238	5321

Table 4: IWP Water Supply Reliability Targets[9]				
	Probability Of:			Acceptable Worst-Year Peak-Season Shortage (%)
	0-10% Peak-Season Shortage	10-20% Peak-Season Shortage	20-30% Peak-Season Shortage	
Acceptable Frequency	15% of years (9 in 59)[10]	2% of years (1 in 59)	0	15

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[7] As of March 2013, City and Agency discussions have centered on a particular Conservation Strategy. See the last section of this technical memorandum, **Description and Status of Current HCP Negotiations**, for more information.

[8] Evaluation criteria included cost, curtailments, vulnerability to external events, environmental impacts, energy consumption, impacts to the Purisima Aquifer and ease of implementation. See the 2005 City of Santa Cruz IWP for more information.

[9] IWP Reliability Targets include acceptable frequencies of different shortage ranges as well as the worst-year peak-season shortage. Both variables should be considered when evaluating the need for supplemental supply because communities can be adversely impacted by frequent shortages of small magnitude and/or infrequent shortages of large magnitude.

[10] This includes only years with non-zero shortage.

Analysis Description

Evaluating the Purpose and Need for Supplemental Supply: 2012 Desal EIR Update

Similar to the approach taken in the 2005 IWP, this memo will estimate how much and how often the community will experience water shortages given today's supply and demand forecasting and compare those conditions to the IWP City Council Resolution of Water Supply Reliability Targets (IWP Targets) to affirm the purpose and need of the supply project. As mentioned above, since the adoption of the 2005 IWP, the City of Santa Cruz Water Department has been actively engaging with the Federal and State agencies to reach agreement on the Habitat Conservation Plan while, in concert, collaborating with Soquel Creek Water District to develop a new supplemental water supply. Primarily, current HCP work has focused on reaching an agreement on the City's Conservation Strategy. The Conservation Strategy will ultimately define the amount of water that is to remain in the flowing sources and, in turn, what is available to the City for diversion. Given the uncertainty of the final Conservation Strategy agreement, it is difficult to discern the actual shortfall of water supply in the near and long term. Coupled with other unknowns such as changing water demands, climate change, new business and industrial opportunities and growth as defined by the City's Adopted 2030 General Plan, estimating the probable levels of severity and frequencies of future shortages is difficult. However, as is more fully described below, evaluation of the potential Conservation Strategies developed within the context of ongoing City/Agency HCP discussions allows for reasonable range of conclusions to be drawn.

The potential Conservation Strategy scenarios evaluated in this memo describe the different environmental/bypass flow types in wet, average, dry and critically dry years and define the amount of water that will remain in the San Lorenzo River and North Coast streams. The April 5, 2011 Habitat Conservation Plan Update to the Santa Cruz City Council categorized the environmental/bypass flow types as Tier 1, 2 and 3 as described below (Fiske, 2011)[11].

- Unimpaired refers to North Coast stream and San Lorenzo river flows available to the City for diversion without consideration for habitat needs[12].
- Tier 1 refers to the flows that would maintain current (2007- now) fish habitat levels.
- Tier 2 refers to flows that would improve habitat compared to what now exists.
- Tier 3 flows would significantly improve stream flows to provide 80% of optimal flows for fish habitat.

One Conservation Strategy, Tier 2, was analyzed but subsequently removed from consideration because it represents an obsolete strategy. Two Conservation Strategy scenarios were analyzed in greater depth to bracket the HCP affects: one (Tier 3/2 Hybrid) that is currently being contemplated and considered a fair compromise between habitat conservation and municipal water supply by the City Water Department and one (Tier 3) that has been identified as currently the most conservative approach for habitat conservation, which would leave the maximum amount of water in the streams and river and provide the least amount to the City's water customers. The table below outlines the three scenarios.

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[11] It is likely that the final HCP document will use descriptive (i.e. "bypass flows approx. 80% of the habitat index value") nomenclature rather than the Tier categories to reference the environmental/bypass flow types. Nevertheless, this memo will continue to use the Tier categorization for consistency and clarity with other historical HCP related documents.

[12] For the purpose of the HCP analysis, "unimpaired" is defined as production unhindered by bypass flows, but doesn't account for other water agency or private user diversions.

Table 5: Description of Conservation Strategy Scenarios Considered			
Conservation Strategy Scenario	**Description of flow types and water year classifications**	**Habitat Benefits**	**Comments**
Tier 2 (obsolete/no further analysis)	Tier 2 in all years: wet, average, dry and critically dry	Habitat improved in wet and average years.	Conservation Strategy scenario presented to Agencies in conjunction with the August 2011 *Draft Conservation Strategy for Steelhead and Coho Salmon*. Least conservative approach for habitat protection.
Tier 3/2 Hybrid	Tier 3 in wet years and average years, and Tier 2 in dry and critically dry years	Habitat significantly improved in wet and average year and improved in dry and critically dry years	*Draft City of Santa Cruz HCP for Steelhead and Coho Salmon Revised Conservation Strategy Flow Proposal Summary* submitted to Agencies in July 2012. Currently under consideration.
Tier 3	Tier 3 in all years: wet, average, dry and critically dry	Habitat significantly improved in all years.	Conservation Strategy requested by Agencies for evaluation during meeting discussions. Most conservative approach for habitat protection. Would provide the least amount of water for the City customers.

These Conservation Strategy scenarios have been modeled by Water Department staff and consultant, Gary Fiske and Associates, Inc., to quantify probable water supply shortfalls based on long-term (73 years of historical hydrologic records) surface and ground water availability of supply with changing future demands.[13] The modeling result data summarized below identifies the City's probable future shortfall magnitudes and expected frequencies given the range of Conservation Strategy scenarios currently under consideration.

<u>Analysis Assumptions</u>

Key Changes since the 2005 IWP

Supply

Surface Water

Supply planning for the IWP did not take into consideration future surface supply losses due to the ESA/CESA or habitat conservation planning. This memo will assume that a range of future surface supply losses are feasible given the current status of the HCP process. As indicated above, this range will include the Tier 3/2 Hybrid and Tier 3.

[13] All modeling results are included in *Final Analytical Results for Desalination Reliability Impacts*, Gary Fiske and Associates, Inc., March 2013.

Groundwater

Supply planning for the IWP did not take into consideration future groundwater supply losses due to the potential for seawater intrusion. Since the adoption of the IWP in 2005, the City has been working with Soquel Creek Water District to cooperatively manage groundwater pumping and monitor coastal groundwater levels. These efforts lead the City to reduce groundwater extractions by 50% from historical levels.[14] This memo will assume the further loss of groundwater availability if a regional supplemental supply is not constructed in Northern Santa Cruz County.

Demands

Forecasting water demands is complex and driven by many dynamic assumptions. Water managers world-wide are faced with difficult planning choices as articulated below.

> Climate change and other factors external to water management (such as demography, technology, politics, societal values, governance and law) are demonstrating accelerating trends or disruptions. Yet in spite of these challenges and the increasing complexity of dealing with them, we know less and less about water resources and how they are being used (WWAP, 2009b, figure 13.1). This creates new risks and uncertainties for water managers and for those who determine the direction of water actions (*The Dynamics of Global Water Futures, Driving Forces 2011-2050*, United Nations World Water Assessment Programme, 2012).

As noted above, water supply planning, in the age of new uncertainties around climate change, market trends, technology, societal values, and growth, has become one of the most important public topics of concern and discussion world-wide. With this level of uncertainty, one predominant theory has resonated above others; the need for a more integrated approach to water supply planning, with special attention paid to “building assets [that are] able to cope with this magnitude of uncertainty” (Graydon, Water 2011 Conference, London). With this in mind, it is imperative for the City of Santa Cruz to contemplate and understand the potential range of future demands when considering the need for supplemental supply.

Future demands for this modeling exercise are consistent with Water Demand Forecast Scenario 1 and Scenario 2 of the 2010 Urban Water Management Plan (2010 UWMP). These system-wide demands vary from the low, near-term of approximately 3,500 million gallons per year (MGY) to the high, long-term of approximately 4,500 MGY.

Scenario	**Table 6: 2010 UWMP Future Demand Projections, 2010-2030**				
	Projected System-Wide Demand (MGY)				
	2010	**2015**	**2020**	**2025**	**2030**
1[a]	3993	4161	4329	4433	4537
2[b]	3522	3684	3847	3946	4046

a. Assumes existing (2010) water demands recover to previous levels experienced in the early 2000s.
b. Assumes existing (2010) water demands recover to 2007-08 levels.

[14] See *Beltz Well No 12, Final Environmental Impact Report*, Chambers Group, Inc., 2011

A sizable amount of time and effort has been focused on analyzing and confirming system-wide demand forecasts by City Water Department staff. The City has an obligation to plan prudently and to carefully consider all feasible future conditions, especially when contemplating a new supplemental supply of water. Because of this obligation, further research on the potential effects of climate change and social and economic/market drivers on water demand was conducted to validate the demand assumptions used in this memo.

The United States Geological Survey (USGS) recently finalized and published a report that studied and documented the potential effects of climate change on future water supply and demand for the Russian River Valley and Santa Cruz Mountains. This case study of our local water resources offers an unprecedented and comprehensive analysis of future water supply and demand variability and concludes[15]:

> Results indicated large spatial variability in climate change and the hydrological response across the region; although there is warming under all projections, potential change in precipitation by the end of the 21st century differed according to model. Hydrologic models predicted reduced early and late wet season runoff for the end of the century for both wetter and drier future climate projections, which could result in an extended dry season. In fact, summers are projected to be longer and drier in the future than in the past regardless of precipitation trends. While water supply could be subject to increased variability (that is, reduced reliability) due to greater variability in precipitation, water demand is likely to steadily increase because of increased evapotranspiration rates and climatic water deficit during extended summers.

In essence, the report concluded that even with greater variability in precipitation and increased rain in winter months, long-term water supply is expected to decrease. This coupled with steady increases in water demand can lead to greater water shortages in the future due to climate change.

In addition to climate change repercussions, additional influences on water demand are ever-present and should be considered when planning a new supplemental water supply. These include social and economic/market forces that the City could have a difficult time influencing.

> Each of the water use sectors is driven by a number of external forces (such as demographic changes, technological developments, economic growth and prosperity, changing diets, and social and cultural values) which in turn dictate their current and future demands for water. Unfortunately, predicting how these drivers will evolve over the next few decades – and how they will ultimately affect water demand – is fraught with a multiplicity of uncertainties (*Managing Water under Uncertainty and Risk*, The United Nations World Water Development Report 4, Volume 1, 2012).

Although system-wide demands in the range of 4500 MGY were experienced within the last decade, future demands are not necessarily expected to reach the highest levels identified by the 2010 UWMP. In addition, although current demands are on the order of 3200 MGY, less than current projections, it is reasonable to assume growth and variability in demand because of climate change and other unknown drivers, even with continued water conservation efforts. There-

[15] See USGS *Simulation of Climate Change in San Francisco Bay Basins, California: Case Study in the Russian River Valley and Santa Cruz Mountains*, by Lorraine E. Flint and Alan L. Flint for more information.

fore, this memo will consider Forecast Scenario 2 to describe the possible implications of the HCP on future water supply. 4,000 MGY, the expected year 2030 demand without new conservation measures, will be evaluated to demonstrate the worst-case supply shortage that may be realized in the long-term. And intermediary long-term demand of 3,800 MGY will be evaluated to demonstrate realistic 2030 system-wide demands with additional conservation[16]. 3,500 MGY will be utilized to demonstrate realistic current/near-term demands. The following table outlines the demand assumptions used in this memo.

Table 7: 2012 Modeled Near-Term and Long-Term Demands		
Projected System-Wide Demand (MGY)		
Near-Term	**Long-Term (with New Conservation Program)**	**Long-Term (without New Conservation Program)**
3500[17]	3800	4000

Desalination Purpose and Need Supply/Demand Planning Range

Based on the updated supply and demand assumptions, a planning range was developed to evaluate the purpose and need of the Project. This range is bracketed from a near-term demand coupled with a Tier 3/2 Hybrid Conservation Strategy (lowest need for supplemental supply) to a long-term demand coupled with a Tier 3 Conservation Strategy (highest need for supplemental supply). This range will be evaluated with current groundwater availability as well as with projected groundwater losses. The table below outlines the assumed planning range.

Table 8: 2012 Desalination Purpose and Need Supply/Demand Planning Range (to be evaluated with current and projected groundwater availability)		
Demand	**HCP Conservation Strategy**	**Comments**
3500	Tier 3/2	Near-term demand, least restrictive HCP, lowest need for supplemental supply
3,800	Tier 3/2	Long-term demand with new conservation program, least restrictive HCP, low to moderate need for supplemental supply
3,800	Tier 3	Long-term demand with new conservation program, most restrictive HCP, moderate to high need for supplemental supply
4,000	Tier 3	Long-term demand without new conservation program, most restrictive HCP, highest need for supplemental supply

Curtailment

[16] The City of Santa Cruz Water Department is currently conducting a baseline/market penetration study to evaluate the potential for future water conservation in the City. With this work nearly complete, Water Department staff has developed a preliminary estimate of conservation potential by the year 2030 for the purpose of informing the Project EIR, *Evaluation of Potential for Additional Long-Term Water Demand Reduction through Water Conservation Measures,* by Toby Goddard, Oct. 2012. . This work estimates an approximate conservation potential of an additional 200 MG by 2030. When the baseline study, and subsequent long-term conservation master plan update, is complete, the estimate of 200 MG will be updated.

[17] Considered accurate given volatile but upward trending demands since 2008. See December 3, 2012 Water Commission Report for more information on current demands. (http://www.cityofsantacruz.com/Modules/ShowDocument.aspx?documentid=29888).

Levels of City-wide shortage and curtailment are identified in the 2009 City of Santa Cruz Water Department Water Shortage Contingency Plan. These stages vary from a "Water Shortage Alert" to a "Critical Water Shortage Emergency". Levels of water shortage for each stage are defined below. This memo will describe future shortages based on these parameters in addition to comparing projected shortage conditions to the IWP Targets, which differ slightly in shortage range levels.

Table 9: Water Shortage Contingency Plan Stages

Stage	Magnitude of Water Shortage	Stage Title
1	0-5%	Water Shortage Alert
2	5-15%	Water Shortage Warning
3	15-25%	Water Shortage Emergency
4	25-35%	Severe Water Shortage Emergency
5	35-50%	Critical Water Shortage Emergency

Confluence® Modeling Parameters and Assumptions

The *Confluence*® model was developed to support the IWP evaluation to "meet the diverse requirements associated with water supply planning" for the City. *Confluence*® is the primary tool used by the City to evaluate future supply conditions and strategies, given an array of evaluation criteria and system operating constraints. *Confluence*® was developed to "reflect the physical capacities that constrain delivery of water from all supply sources, including the physical delivery of the source as well as the capacities of transmission links and treatment plants through which the water from the source must flow. In addition to these physical constraints, *Confluence*® also permits specification of various rules to govern the operation of the water supply system." With this comprehensive model, the supply availability is dictated by the physical constraints of the system and the governance rules (*Final City of Santa Cruz Integrated Water Plan*, Gary Fiske and Associates, June 2003).

While the model is not a perfect representation of the day to day operation of the City's water system, *Confluence*® conservatively reflects supply availability conditions given the most up-to-date system operating conditions and future projections of demand and hydrologic conditions[18]. For the purpose of this memo's analysis, *Confluence*® was updated to include the potential range of HCP Conservation Strategy flows, demands and groundwater supply conditions. Other system operating constraints, such as order of supply dispatch, operation of flowing supplies, transmission losses, desalination capacity shared use, etc., are consistent with the some additional modeling work done in August 2011.

<u>Analysis Results</u>

Water Supply Reliability Results by Water Shortage Contingency Plan Stages

The following tables outline the frequency and magnitude of future water shortages within the desalination purpose and need supply/demand planning range.

[18] *Confluence* modeling results err towards conservative. Actual system operations may be more flexible and allow for more efficient use of water supply sources. *Confluence* modeling results do demonstrate the worst-case foreseeable conditions for water supply. More details on the *Confluence* results and the nuances of the evaluation will be included in the Conclusion section of this memo.

Table 10: Supply Reliability/Shortage Stages with Current Groundwater Availability							
Demand /Conservation Strategy	Total Future Years in Shortage (%)[19]	Magnitude of Future Peak-Season Shortage (% of future years in stage)					Worst Peak Season Shortage (%)
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	
		Alert (0-5%)	Warning (5-15%)	Emergency (15-25%)	Severe Emergency (25-35%)	Critical Emergency (35-50%)	
3,500 MGY/ Tier 3/2 Hybrid	**21**	5	10	4	1	0	**29**
3,800 MGY/ Tier 3/2 Hybrid	**42**	15	14	10	3	1	**37**
3,800 MGY/ Tier 3	**48**	8	12	11	3	14	**73**
4,000 MGY/ Tier 3	**74**	21	19	11	8	15	**75**

Table 11: Supply Reliability/Shortage Stages with Projected Groundwater Losses							
Demand /Conservation Strategy	Total Future Years in Shortage (%)	Magnitude of Future Peak-Season Shortage (% of future years in stage)					Worst Peak Season Shortage (%)
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	
		Alert (0-5%)	Warning (5-15%)	Emergency (15-25%)	Severe Emergency (25-35%)	Critical Emergency (35-50%)	
3,500 MGY/ Tier 3/2 Hybrid	**37**	11	12	10	3	1	**39**
3,800 MGY/ Tier 3/2 Hybrid	**68**	21	29	8	8	3	**46**
3,800 MGY/ Tier 3	**74**	19	19	11	8	16	**80**
4,000 MGY/ Tier 3	**96**	21	30	15	7	23	**81**

[19] Figures are rounded to the nearest ten. Rounding of data can cause the total future years in shortage to be slightly off from the cumulative number of years in all five water stages.

The analysis of projected water shortage results is described below.

Conclusions

Expected Need for Supplemental Supply Based on Range of Potential HCP Conservation Strategies

While it is impossible to predict the exact level of future water demand and loss of available municipal supply due to the reasons described above, it is imperative, due to these same reasons, to evaluate the need for a supplemental supply based on a range of potential future demands and supply availability, and then focus on a conservative planning assumption that is most consistent with current predictions.

To demonstrate the impacts of future shortages due to changing demands and HCP requirements, this memo will also provide a comparison matrix of the desalination purpose and need supply/demand planning range to the IWP Targets. The following tables outline the results with current and future groundwater availability.

Table 12: Comparison of Demands/Conservation Scenarios to IWP Reliability Targets (with Current Groundwater Availability)

Demands/Conservation Strategy	Probability Of:				Meets IWP Targets?		
					Frequency Target		
	0-10% Peak-Season Shortage	10-20% Peak-Season Shortage	20-30% Peak-Season Shortage	>30% Peak-Season Shortage	Individual Peak Season Shortages	Cumulative Peak Season Shortage (All Ranges Combined)	Worst-Year Peak Season Shortage
IWP Reliability Targets	15% of years	2% of years	0	0		**17%**	**15%**
Current Demand: 3,500 MGY HCP: Tier 3/2	8% of years	10% of years	3% of years	0	**No**	**No 21%**	**No 29%**
Long-Term Mid-Range Demand: 3,800 MGY HCP: Tier 3/2	23% of years	10% of years	8% of years	1% of years	**No**	**No 42%**	**No 37%**
Long-Term Mid-Range Demand: 3,800 MGY HCP: Tier 3	18% of years	7% of years	8% of years	15% of years	**No**	**No 48%**	**No 73%**
Long-Term Worst-Case Demand: 4,000 MGY HCP: Tier 3	33% of years	12% of years	10% of years	19% of years	**No**	**No 74%**	**No 75%**

Table 13: Comparison of Demands/Conservation Scenarios to IWP Reliability Targets (with Projected Groundwater Losses)							
Demands/Conservation Strategy	**Probability Of:**				**Meets IWP Targets?**		
					Frequency Target		
	0-10% Peak-Season Shortage	**10-20% Peak-Season Shortage**	**20-30% Peak-Season Shortage**	**>30% Peak-Season Shortage**	**Individual Peak Season Shortages**	**Cumulative Peak Season Shortage (All Ranges Combined)**	**Worst-Year Peak Season Shortage**
IWP Reliability Targets	15% of years	2% of years	0	0		**17%**	**15%**
Current Demand: 3,500 MGY HCP: Tier 3/2	21% of years	7% of years	8% of years	1% of years	**No**	**No 37%**	**No 39%**
Long-Term Mid-Range Demand: 3,800 MGY HCP: Tier 3/2	38% of years	16% of years	7% of years	7% of years	**No**	**No 68%**	**No 46%**
Long-Term Mid-Range Demand: 3,800 MGY HCP: Tier 3	30% of years	15% of years	5% of years	23% of years	**No**	**No 74%**	**No 80%**
Long-Term Worst-Case Demand: 4,000 MGY HCP: Tier 3	40% of years	21% of years	11% of years	25% of years	**No**	**No 96%**	**No 81%**

Note: Yellow highlighted rows represent the to-date most probable water shortage conditions associated with long-term demand, HCP, and groundwater supply conditions. This range may change based on HCP negotiations and actual future demands.

As demonstrated in the above tables, the effects of the Habitat Conservation Plan on water supply availability during the peak season are significant; IWP Reliability Targets are never met and greatly exceeded in many instances. This position is reinforced even more given the projected losses to groundwater availability and uncertainties around climate change and demand projections.

Role of the Desalination Project in Meeting the IWP Reliability Targets

Desalination, as a supplemental supply, was added to the *Confluence*® model to determine its effectiveness in decreasing projected water shortages. The following tables outline the potential role of the proposed desalination project in meeting the IWP Reliability Targets.[20]

[20] Model dispatched full 2.5 MGD of Project during the entire peak season to determine the capacity of the proposed project to meet the IWP Reliability Targets. In reality, operational decisions will be made on an annual basis in an attempt to balance the social and economic costs associated with running the plant and curtailing water use. See referenced Gary Fiske and Associates, Inc. memo for more information on typical operating conditions.

Table 14: Role of the Desalination Project in Meeting the IWP Reliability Targets (with a 2.5 MGD Plant/Full Dispatch)							
Demands/Conservation Strategy	**Probability Of:**				**Meets IWP Targets?**		
					Frequency Target		
	0-10% Peak-Season Shortage	**10-20% Peak-Season Shortage**	**20-30% Peak-Season Shortage**	**>30% Peak-Season Shortage**	**Individual Peak Season Shortages**	**Cumulative Peak Season Shortage (All Ranges Combined)**	**Worst-Year Peak Season Shortage**
IWP Reliability Targets	15% of years	2% of years	0	0		**17%**	**15%**
Current Demand: 3,500 MGY HCP: Tier 3/2	**No years in shortage with full capacity plant dispatch**						
Long-Term Mid-Range Demand: 3,800 MGY HCP: Tier 3/2	**No years in shortage with full capacity plant dispatch**						
Long-Term Mid-Range Demand: 3,800 MGY HCP: Tier 3	5% of years	3% of years	7% of years	3% of years	**No**	**No 18%**	**No 47%**
Long-Term Worst-Case Demand: 4,000 MGY HCP: Tier 3	11% of years	3% of years	5% of years	7% of years	**No**	**No 26%**	**No 56%**

Table 15: Role of the Desalination Project in Meeting the IWP Reliability Targets (with a 4.5 MGD Plant/Full Dispatch)							
Demands/Conservation Strategy	**Probability Of:**				**Meets IWP Targets?**		
					Frequency Target		
	0-10% Peak-Season Shortage	**10-20% Peak-Season Shortage**	**20-30% Peak-Season Shortage**	**>30% Peak-Season Shortage**	**Individual Peak Season Shortages**	**Cumulative Peak Season Shortage (All Ranges Combined)**	**Worst-Year Peak Season Shortage**
IWP Reliability Targets	15% of years	2% of years	0	0		**17%**	**15%**
Current Demand: 3,500 MGY HCP: Tier 3/2	**No years in shortage with full capacity plant dispatch**						

Table 15: Role of the Desalination Project in Meeting the IWP Reliability Targets (with a 4.5 MGD Plant/Full Dispatch)							
Demands/Conservation Strategy	Probability Of:				Meets IWP Targets?		
					Frequency Target		Worst-Year Peak Season Shortage
	0-10% Peak-Season Shortage	10-20% Peak-Season Shortage	20-30% Peak-Season Shortage	>30% Peak-Season Shortage	Individual Peak Season Shortages	Cumulative Peak Season Shortage (All Ranges Combined)	
Long-Term Mid-Range Demand: 3,800 MGY HCP: Tier 3/2	**No years in shortage with full capacity plant dispatch**						
Long-Term Mid-Range Demand: 3,800 MGY HCP: Tier 3	5% of years	0% of years	1% of years	0% of years	**No**	**Yes 7%**	**No 28%**
Long-Term Worst-Case Demand: 4,000 MGY HCP: Tier 3	4% of years	5% of years	1% of years	1% of years	**No**	**Yes 12%**	**No 34%**

The Purpose and Need of the Desalination Plant Defined

Recognizing a significant current and future water shortage problem, the Santa Cruz City Council resolved to adopt the Integrated Water Plan in November of 2005. The overarching goal of the IWP was to reduce near term drought shortages and provide a more reliable public water supply through the year 2030. Desalination, as a supplemental supply, was just one component of the integrated plan to meet that goal.

Although many of the planning assumptions used to evaluate water supply reliability have changed since the adoption of the IWP, the supplemental supply evaluation framework established through the IWP process remains valid. As noted in the Executive Summary of the IWP,

> …the current worst-year peak season shortage is 45%. Even with the City's extensive conservation programs, this shortage remains high throughout the planning period. This means that, to reduce the risk of shortage even to the highest acceptable level, the City must develop a new supply as soon as possible. Additional increments of supply will be needed in the future to maintain an acceptable shortage risk as future demand grows.

This framework was used to evaluate the purpose and need of the desalination project to inform the EIR. Similar, and even more extreme results, were realized. Rather than a 45% worst-case peak season shortage, the City could be facing 48-80% worst-case peak season shortages. Shortages could be experienced between 61 and 75% of all future years. Shortages over 25%, the "highest level of worst peak-season shortage that is tolerable for Santa Cruz water customers"[21], may account for up to 50% of all future years.

The desalination project plays a vital role in meeting the goals of the IWP. As noted in Table 14 and Table 15, the Project has the capacity to meet the stated goals of the IWP[22], to reduce near-term drought shortages and provide long-term water supply reliability. The 2.5 MGD plant is adequately sized for near-term conditions. Depending on the outcome of the HCP negotiations, a 4.5 MGD plant may be required to meet long-term demands.

Of equal importance to playing a role in meeting the goals of the IWP, the desalination project will diversify our water supply, and serve as a critical municipal asset in the face of uncertainties around climate change and other factors external to water management.

Additional Considerations

Equivalent Loss of Water System Capacity as a Result of the Pending HCP

A similar study was run by Water Department staff in 2012 to determine the average water system capacity loss due to the pending HCP.[23] Water system capacity, or the availability of adequate supply, is not only defined by the amount of water contained in the Water Department sources each year, but also the ability of the water infrastructure to transfer, treat and deliver that water to customers within the applicable regulatory parameters. Every water utility has a water system capacity, which is a function of unrestricted water source yield, infrastructure constraints, management and operations of the system, regulatory constraints and demand for water. For the City of Santa Cruz Water Department, the estimated water system capacity is approximately 4.3 billion gallons, plus or minus 200 million gallons of potable water delivered to customers each year.

Water System Capacity =
f(yield,infrastructure,management and operation,regulations,demand)

In long-range water planning, utilities often evaluate existing water system capacity and the potential availability of excess capacity for allocation. Having accurate allocation information, combined with reasonable demand projections, helps ensure that water supply systems achieve a high level of public health protection, operate within regulatory parameters, operate within the limitations of their system to produce safe water, and meet the water supply needs of future residential, commercial and industrial users in a timely manner.

As noted above, the HCP will include substantial new and regimented bypass flows to support all stages of life and reproduction. Because of this effect on the supply yield, new HCP bypass flow requirements will have an influence on existing and future water system capacity, thereby eliminating the potential of using that capacity allocation for customers.

The results of the study indicated that, on average, the City will be losing approximately 24% of its water system capacity due to the HCP. These results are consistent with the modeling conclusions outlined in this technical memorandum.

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[21] See 2005 City of Santa Cruz Integrated Water Plan and 2001 Water Curtailment Study for more information.
[22] With one notable exception: neither the 2.5 MGD nor 4.5 MGD plant is capable of meeting the 15% worst-case peak season shortage with Tier 3 flows. However, both plant sizes significantly reduce the worst-case peak season shortages
[23] See *Average Water System Capacity Loss to Habitat Conservation Planning Requirements*, Linette Almond, 2012

Description and Status of Current HCP Negotiations

As noted in Table 5, the City submitted the *Draft City of Santa Cruz HCP for Steelhead and Coho Salmon Revised Conservation Strategy Flow Proposal Summary* to the Agencies in July of 2012. CDFW responded with comments in a letter dated September 18, 2012. Since that time, HCP negotiations have focused on evaluating the CDFW recommended flow proposal and potential water infrastructure modifications, very similar in scope to modifications studied during the IWP evaluation process of existing source optimization.

CDFW's September 18, 2012 response letter focuses on two major recommendations: modified flow proposal to achieve instream flow and life history stage goals in all conditions, and potential operational and infrastructure changes to increase water availability and reliability.[24] Extensive *Confluence*® water modeling has been initiated to evaluate the potential for decreased future water shortages with the following system infrastructure changes:

- Add a second, 20 cfs pipe at Felton Diversion to the Graham Hill Water Treatment Plant.
- Add a second, 20 cfs pipeline between Felton Diversion and Loch Lomond Reservoir
- Remove turbidity constraints at Tait St.
- Adjust Loch Lomond annual withdrawal constraint to allow for increased withdrawals from Loch Lomond.

Preliminary modeling work on these suggested modifications shows worst year water shortages of approximately 65% (current demand of 3500 MGY). Adding a second pipeline between Felton Diversion and Loch Lomond yielded negligible improvements in peak-season reliability. Likewise, adding a second pipe between Felton Diversion and Graham Hill Water Treatment Plant yielded negligible improvements in peak-season reliability. Increasing the Loch Lomond annual withdrawal limit yielded no improvement in peak-season reliability. However, removing turbidity constraints at Tait Street yielded the largest improvement in peak-season reliability reducing worst-year shortages from 65% to 60%.

Continued discussions around CDFW's suggested flow proposal and water infrastructure changes have narrowed the likely outcome of the Conservation Strategy agreement. While achieving modest shortage reductions, the most recent flow proposal iterations have all yielded results that fall within the Desalination Purpose and Need Supply/Demand Planning Range as outlined above.

[24] Infrastructure change recommendations are similar in scope to those studied by Carollo Engineers in 2000 and then again as part of the development of the IWP in 2003. See City of Santa Cruz Integrated Water Plan for more information.