Date: February 4, 2015

To: Water Supply Advisory Committee

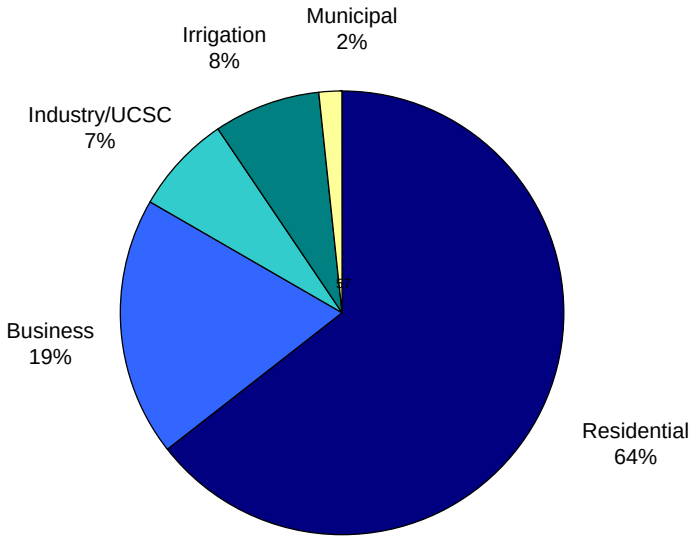
From: Heidi Luckenbach

Subject: Overview of The Santa Cruz Water Department (SCWD) System

This document provides a general overview of the Santa Cruz water system, culled from various existing documents. The purpose of this document is to distill and consolidate information about the Santa Cruz water system in terms of system components, features of those components, and operating parameters. It is this information that forms the basis of supply modeling using the Confluence model. Understanding this information will allow further understanding of the baseline condition, supply modeling and the development and analysis of scenarios.

The Santa Cruz water system covers a service area of approximately 20 square miles. ~30 miles of raw water main and 300 miles of treated water main delivers water to ~25,000 customers. The composition of these customers is shown below.

Percentage of water use by customer class, 2006 - 2010

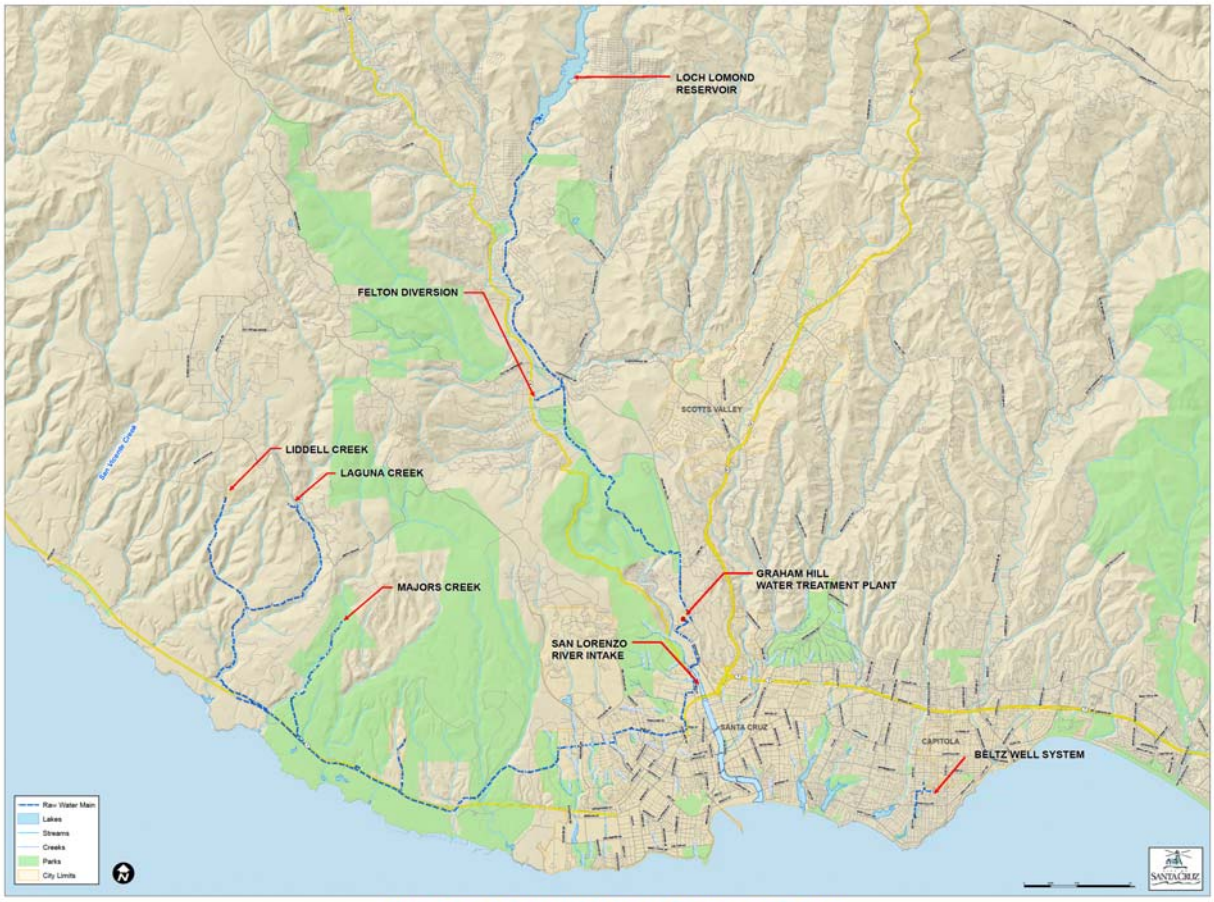


The following table summarizes the major components of the SCWD water system.

SANTA CRUZ WATER DEPARTMENT FACILITIES	
SOURCE – GROUNDWATER	
Beltz Wells 1 & 2 (converted to monitoring wells)	Beltz Well 8
Beltz Well 4 (out of service)	Beltz Well 9
Beltz Well 6 (out of service)	Beltz Well 10
Beltz Well 7 (converted to monitoring wells)	Beltz Well 12
SOURCE – SURFACE WATER	
Laguna Creek Dam	San Lorenzo River Tait Intake
Reggiardo Creek	Felton Diversion Inflatable Dam
Liddell Spring	Newell Creek Dam
Majors Creek	
Tait Well 1	
Tait Well 2 (abandoned)	
Tait Well 3 (out of service)	
Tait Well 4	
TREATMENT PLANTS	
Graham Hill Water Treatment Plant	Beltz Treatment Plant
Beltz 12 Treatment Plant	Loch Lomond Treatment Plant
TREATED WATER STORAGE	
Bay Street Tanks (2@6MG)	Rollingwoods (0.27 MG)
Carbonera Tank (1 MG)	Santa Cruz Gardens Tanks (0.25 MG/0.25MG)
DeLaveaga Tank (1 MG/1 MG)	University 2 Tank (1 MG)
Filtered Water Tank @ GHWTP (1 MG)	University 4 Tank (0.4 MG)
Pasatiempo Tanks (0.3 MG/0.75 MG)	University 5 Tanks (2 MG)
PUMPING FACILITIES	
Carbonera Pump Station	Rollingwoods Pump Station
Coast Pump Station	San Lorenzo River Pump Station
Delaveaga Pump Station	Springtree Pump Station
Dimeo Lane Pump Station	Tait Booster Station
Felton Diversion Pump Station	Thurber Lane
Felton Pump Station	University No. 2
Kite Hill Pump Station	University No. 4
Morrissey Pump Station Pasatiempo Pump Station	University No. 6

Water sources

The system relies entirely on rainfall, surface runoff, and groundwater infiltration occurring within watersheds located in Santa Cruz County. No water is purchased from State or Federal sources or imported to the region from outside the Santa Cruz area.



Where Your Water Comes From

The **Live Oak Well** system (otherwise referred to as the Beltz Well System) consists of three production wells (Beltz 8, 9, and 10) and a treatment plant located in the southeast portion of the City water service area. The facilities were acquired by the City from the Beltz Water Company in 1964, and are occasionally still referred to as the "Beltz" wells. Wells 8 and 9 were installed in 1998 as replacement wells for Wells 1 and 2, which were damaged in the 1989 Loma Prieta earthquake. Well 7, which began operating in 1974, has been replaced by Well 10. The source of water for these wells is the Purisima Formation, which extends east into the mid-County area and serves as a mutual groundwater resource for 2 other public water agencies, several small water systems, and numerous private wells, of which neighboring Soquel Creek Water District is the single largest user.

Beltz 12 and Beltz 12 Treatment plant were put into service in 2015. This facility is located in the northeast portion of the service are with the intended function of moving groundwater pumping inland and to supplement groundwater pumping during critically dry years by 0.3 MGD. This well was designed to draw water from both the Purisima as well as the Santa Margarita.

The **North Coast** sources (Liddell, Laguna, Reggiardo, Majors) are located approximately six to eight miles northwest of downtown Santa Cruz. The use of these sources by the City dates back as far as 1890.

The **San Lorenzo River** is the City's largest source of water supply. The main surface water diversion is located at Tait Street near the City limits just north of Highway 1 and dates back to the 1920s. The Tait Street Diversion is supplemented by two shallow, auxiliary wells (Tait 1 and 4) located across the river. These wells are treated as if they are hydraulically connected to the river and tied to the City's appropriative rights for surface diversion. The other diversion on the San Lorenzo River is **Felton Diversion**, which is an inflatable dam and intake structure built in 1974, located about six miles upstream from the Tait Street Diversion. Water is pumped from this diversion through the Felton Booster Station to Loch Lomond Reservoir. The facility is used to augment storage in the reservoir.

Loch Lomond Reservoir was constructed in 1960 and has a maximum capacity of 2,810 million gallons (mg). In addition to providing surface water storage, the reservoir and surrounding watershed are used for no-body-contact public recreation purposes, including fishing, boating, hiking, and picnicking. The Newell Creek watershed above the reservoir is about nine square miles. In addition to the City, the San Lorenzo Valley Water District is entitled to receive a portion of the water stored in Loch Lomond.

The City's SWRCB license for Newell Creek allows for diversion to storage of up to 1,825 million gallons per year (mgy). These water rights allow only for diversion to storage and not for direct diversion. Furthermore, based on the historical use of the reservoir, licensed withdrawals of Newell Creek water from Loch Lomond Reservoir are restricted to 1,042 mgy. Of this total 1,042 mgy, the San Lorenzo Valley Water District ("SLVWD") is entitled to102 mgy (approximately 10%). Although the district has not taken water in recent years, the City has reopened discussions with SLVWD about its entitlement to this water and the City expects that the SLVWD eventually intends to exercise its right to that supply.

The table below, taken from the 2010 UWMP, shows the gross annual water production from the various sources for the period 1985 – 2010.

Year	North Coast Streams	San Lorenzo River	Tait Wells (a)	Loch Lomond Reservoir	Live Oak Wells	TOTAL
1985	1,004.4	1,926.7	331.5	793.9	174.7	4,231.2
1986	1,123.3	1,867.5	27.6	1,192.7	33.6	4,244.7
1987	592.5	2,246.5	172.5	971.8	389.6	4,372.9
1988	692.1	2,066.5	294.1	650.4	429.8	4,132.9
1989	872.3	2,187.2	232.3	455.0	298.6	4,045.4
1990	820.6	2,001.2	152.8	187.0	227.4	3,389.0
1991	661.9	1,921.0	251.1	510.1	178.7	3,522.8
1992	633.7	1,807.6	223.1	625.2	264.4	3,554.0
1993	826.1	1,667.2	102.3	1,035.7	135.5	3,766.8
1994	665.6	1,861.0	235.5	931.8	169.1	3,862.9
1995 (b)	1,207.7	1,317.2	256.8	857.2	90.0	3,728.9
1996	1,312.5	1,267.3	9.9	1,389.8	54.7	4,034.2
1997	1,291.6	1,719.6	5.3	1,304.5	79.9	4,400.9
1998	1,484.8	1,527.7	4.8	996.8	99.6	4,113.7
1999	1,580.0	1,966.0	106.1	583.7	92.4	4,328.2
2000	1,417.3	2,073.2	--	797.0	187.0	4,474.5
2001	1,326.5	2,003.0	--	842.4	171.4	4,343.2
2002	1,386.2	1,976.2	--	538.0	143.8	4,044.2
2003	1,297.0	1,917.9	--	748.5	129.7	4,093.0
2004	1,315.4	1,984.4	--	652.6	123.6	4,076.1
2005	1,487.2	1,573.3	--	583.8	84.9	3,729.2
2006	1,603.8	1,610.2	--	467.3	118.5	3,799.8
2007	848.7	2,261.6	--	487.8	178.9	3,777.0
2008	890.2	2,064.9	--	530.4	164.4	3,649.9
2009	814.5	2,037.8	--	197.1	164.4	3,213.9
2010	1,168.1	1,468.5	--	411.0	151.4	3,199.0
1985-2010:						
Average	1,089.4	1,858.5	160.4	720.8	166.8	3,928.0
Percent of Total	27.7	47.3	4.1	18.4	4.2	100.0
Last Five Years:						
Average	1,065.0	1,888.6	--	418.7	155.5	3,527.9
Percent of Total	30.2	53.5	--	11.9	4.4	100.0

Notes:

(a) Tait Wells production is included with the San Lorenzo River beginning in 2000

(b) Coast treated water main placed into service

Major Components and Status

The City operates four **water treatment facilities**. All surface water is treated at the Graham Hill Water Treatment Plant, (GHWTP); the Live Oak Treatment Plant treats groundwater from wells 8, 9 and 10; Beltz 12 treats water from Beltz Well 12; and, for completeness, there is a small membrane plant at Loch Lomond for treating to potable water standards.

Generally speaking, the **Graham Hill Water Treatment Plant (GHWTP)** is limited by the following.

- Overall age and need for routine maintenance;
- Solids handling;
- Filters: The rate at which the filters can treat the water has been reduced over the last several years; this is being corrected with the current Filter Rehab Project;
- Source water quality: the current treatment process is limited with regards to turbidity.

The SCWD capital improvement program includes approximately $20 million (M) in improvements to the GHWTP including a $4M project that is currently underway to rehabilitate the filters.

The **Live Oak Treatment Plant** treats groundwater to remove iron and manganese from three wells. The limitations at the treatment plant are due to reduced source water availability. The treatment facility was designed (and wells constructed) to treat 1MGD in all years and 2MGD in critically dry years. Declining groundwater levels have reduced these volumes to 0.8MGD to 1.1MGM, respectively, relying on Beltz 12 for a portion of this production capacity.

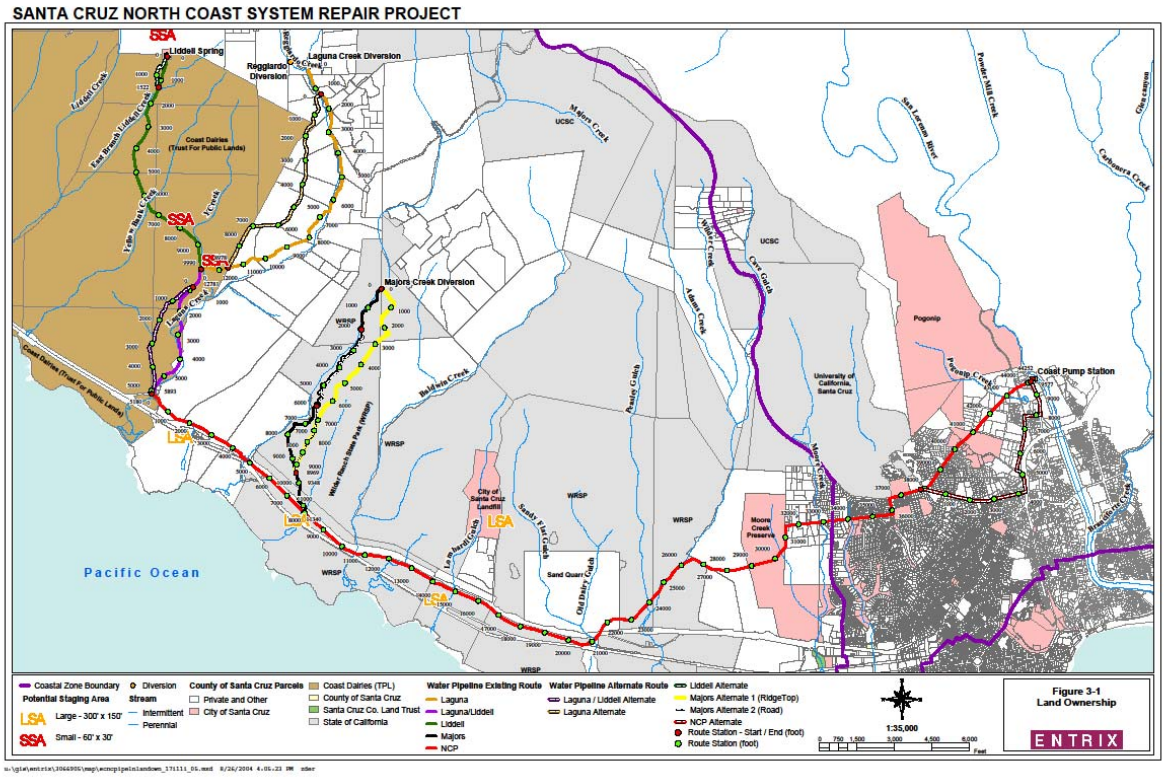
Beltz 12 was put into service in 2015 with the intent to move groundwater pumping inland and to add to groundwater supply in critically dry years (0.3MGD).

The **Loch Lomond Treatment Plant** is used to treat surface water for the purpose of providing potable water at the Loch Lomond Recreational facility and the Ranger's house.

The City maintains a number of **treated water storage tanks** distributed throughout the service area. The largest was the Bay Street Reservoir which was originally constructed in 1924. Together with the filtered water tank, it provided water pressure to the gravity zone which encompasses the majority of the City water service area, and serves as distribution storage for pumping to elevated zones. The reservoir reached the end of its useful life and was deconstructed in 2008. The second of two 6 MG replacement tanks is currently being constructed and should be in service in April 2015. The remaining system tanks are all on an inspection and maintenance schedule: in 2013 University 2 Tank was rehabilitated for $1.5M; in 2014 the DeLaveaga Tanks were rehabilitated for $1.4M; and the University 5 and 6 Tanks are

scheduled for maintenance in FY 16 and 17. While this work will extend the useful life of each facility, redundancy and capacity issues have not always been addressed.

The ~18-mile long **North Coast Main** delivers raw water diverted at the North Coast sources by gravity to the Coast Pump Station, where it is pumped to the GHWTP. The system includes five distinct pipeline reaches and the City is in the process of implementing a long-term (10-20 year), ~$35M rehabilitation and replacement program for the entire North Coast system. Both pipeline and diversion structures are and will be rehabilitated or replaced to restore their integrity and reduce transmission losses. New pipeline will be replaced partly in its current alignment and partly in a new alignment to avoid sensitive habitats. The first phase between Highway 1 and the Bay Street Reservoir was completed in 2007 (construction costs ~$2M). The second phase between Highway 1 and the Coast Pump Station was completed in 2012 (construction costs ~$3M. The third phase between Wilder Ranch State Park and Scaroni Road is currently in final design and permitting and going to bid in 2015 (engineer's construction estimate of ~$6M).



The 9-mile long, 50-year old **Newell Creek Pipeline** delivers raw water from Loch Lomond Reservoir through Henry Cowell State Park to the GHWTP. The age and condition of the pipe, coupled with the environmental conditions through which the pipeline was installed, require that portions of this pipeline

be replaced and possible realigned. Inspection of this pipeline is scheduled for 2017; $13M is currently budgeted (as a placeholder) in subsequent years for replacement/rehabilitation.

The **Coast Pump Station** is located next to the **Tait Street Diversion** and pumps raw water from the North Coast and San Lorenzo River sources up to the GHWTP. The Coast Pump Station and ancillary facilities are in fairly good condition. The Tait Street Diversion and Tait Street Wells will be evaluated in the current and subsequent fiscal years to evaluate their condition, replace existing wells, and potentially install new wells.

The **Felton Booster Pump Station** is used to pump water from the Felton Diversion to NCD and from NCD to the GHWTP. The entire pump station was modernized in 2006.

Felton Diversion is operated intermittently as needed. It is normally used in the winter months of dry years, but the diversion dam is inflated every year for maintenance purposes and to facilitate fisheries research. Monies are budgeted to evaluate and rehabilitate this facility.

Operations

The Water Department follows a variety of policies, procedures, and legal restrictions in operating the water supply system. In general, the system is managed to take advantage of the better quality and least expensive sources as a first priority, and to retain the maximum amount of water possible in Loch Lomond Reservoir to safeguard against future droughts. In addition to considerations for cost, water quality, and storage, legal constraints on the diversion of surface waters contained in the City's water rights govern the operation of the water system.

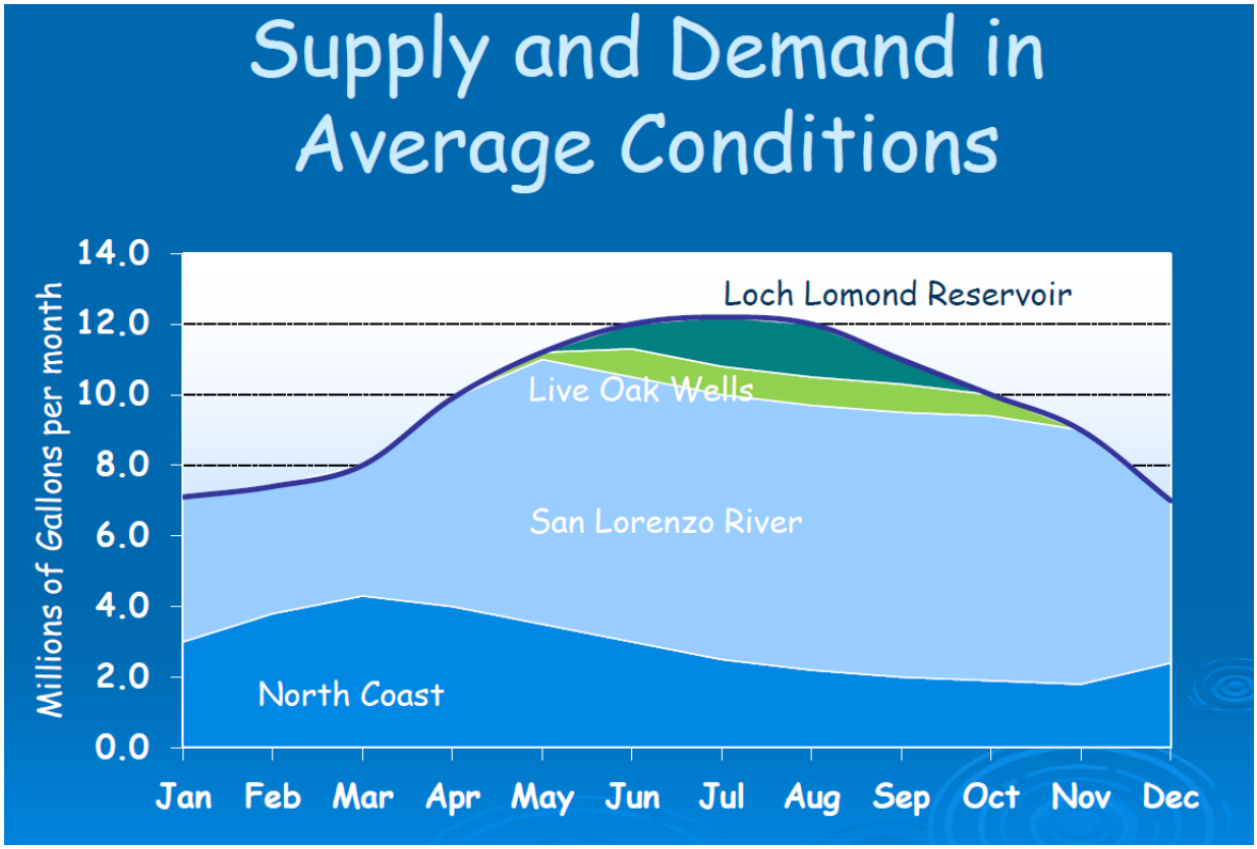
Water supplies are generally dispatched to meet daily demands in the following order:

1. North Coast
2. San Lorenzo River
3. Live Oak Wells
4. Loch Lomond Reservoir

Due to the excellent water quality and the lowest production cost, the North Coast sources are used to the greatest extent possible. As pre-1914 sources, the City's North Coast diversions are least affected by water rights limitations. Production from these sources is limited by both infrastructure constraints in winter/spring months, by flows in the dry season, and by fishery bypass issues. Recent production figures are ~2mgd.

Additional water needed to meet daily demands is pumped from the San Lorenzo River at Tait Street. Under favorable conditions, up to 7.5 mgd can be produced from the Tait Street Diversion and wells throughout the dry season.

During the summer and fall, when the City's flowing sources are inadequate to meet peak season daily demands, supplemental water is brought in from the Live Oak Wells and from Loch Lomond Reservoir. On a typical summer day the Live Oak Wells contribute about 0.8 mgd. Withdrawals from the reservoir vary between 2 and 4 mgd depending on weather and customer demand. Withdrawals are also made from Loch Lomond during the winter season when the North Coast and San Lorenzo River sources become untreatable due to excessive turbidity from storm runoff.



Limitations

In-Stream Flow Releases In accordance with the requirements of its water rights, the City releases a minimum flow of 1.0 cubic foot per second (cfs) (equal to 0.65 mgd or approximately 20 million gallons per month) from storage in Loch Lomond Reservoir, to support fishery resources beneath the dam. (This flow has been temporarily reduced to 0.2cfs during the 2014 drought.)

In 2007 the City voluntarily began releasing in-stream flows from the North Coast system on an interim basis. Over the last 3 years combined in-stream flow releases on the North Coast system have averaged 0.38 mgd or about 11 million gallons per month to maintain habitat below the diversion points. Since that time, the City has provided enhanced flows above and beyond the previous interim flows which address all life history needs of special status salmonids in streams that the City diverts from. These flows are commonly referred to as "short term flows" and are part of an agreement between the City and DFW regarding tolling of an agreement to wait on completion of streambed alteration agreements for the North Coast diversions until after the anadromous salmonid HCP is completed. However, it is anticipated that these agreements would mirror the HCP and that there will not be a second round of negotiations on streambed alteration agreement - related flows once the HCP is completed. The City anticipates having to bypass substantially more flow in the future from the North Coast sources and from the San Lorenzo River once a final, long-term agreement with regulatory agencies has been negotiated.

Well Operations and Groundwater Production The City's wells are normally operated 150 to 200 days of the year during the dry season at a steady combined production rate of about 0.8 mgd. Historically, annual groundwater production has varied from less than 100 mgy to as much as 430 mgy, depending on hydrologic conditions and the availability of water from other sources. As indicated in the table above, groundwater production peaked during the 1987-92 drought. During that period, the system was operated at times at its full 2 mgd design capacity.

Annual water production from the Purisima Formation by the City of Santa Cruz and the Soquel Creek and Central Water Districts over the past five years is presented in the table below. In addition, it is estimated that approximately 1,000 +/- private urban, rural, and small water system wells produce an additional 667 mgy from the aquifer (Hydrometrics, 2011).

Groundwater Production by Public Agencies, 2006-2010 (million gal)

Year	2006	2007	2008	2009	2010
City of Santa Cruz	119	179	164	164	151
Soquel Creek Water District	966	1,027	1,021	934	914
Central Water District	7	4	6	12	7
Total	**1,092**	**1,210**	**1,191**	**1,110**	**1,072**

Reduced Groundwater Availability The City has been advised by its hydrogeologist that the yield of the Live Oak well field now is substantially less than the 420 mgy that the City had long assumed for

water supply planning purposes, and that the dry season pumping rate that can be sustained without causing seawater intrusion in average years appears to be not more than 170 mgy (Hopkins, 2010). Likewise, the Soquel Creek Water District recently has been presented with a reevaluation of the safe yield of the Soquel Aptos basin that is considerable lower than previously thought.

Because of reduced groundwater availability, the City relocated pumping further inland with the construction of Beltz 12.

This unexpected loss of drought year groundwater yield is emblematic of the continuing change and uncertainty facing the City in its effort to provide a safe, reliable, and adequate municipal water supply. The City operates the Beltz wells within parameters agreed upon by both the City and the District. These parameters were developed to sustain groundwater levels and reduce the possibility of seawater intrusion.

The City maintains **water rights** of various types on its surface water sources. These rights and their conditions are shown on the table below.

Summary of Water Rights Held by the City of Santa Cruz

Source	License/ Permit Number	Period	Maximum Diversion Rate (cfs)	Fish Flow Requirement (cfs)	Annual Diversion Limit (mil gal)
North Coast	Pre-1914	Year round	No limit	None	None
San Lorenzo River:					
Tait Street Diversion and Wells	1553, 7200	Year-round	12.2	None	None
Felton Diversion to Loch Lomond Reservoir	16601, 16123	Sept	7.8	10	977
		Oct	20	25	
		Nov-May	20	20	
		Jun-Aug	0	--	
Newell Creek:	9847				
Collection to storage (max amount/year)		Sept-Jun	No limit	--	1,825
Withdrawal		--	--	1	1,042

These restrictions on use present some operational limitations to the City. These have been incorporated in to the Confluence model.

Water Supply Modeling

The City has been using the Confluence Model to assist with water supply planning since the 1990s. Over the past few decades, conditions in the system have changed and warranted modifications to the modeling assumptions. The following table shows some of the inputs to the model that have been scrutinized by staff and modified over the years as operational and environmental conditions change.

Summary of Santa Cruz Confluence Input Changes

Demands	IWP	IWP Update	HCP pre-2013	Desal EIR	HCP Current
Service Area Annual Demand (BG)	4.6-5.3	3.5-4.5	3.5-4.0	3.5-4.0	3.5-3.2
North Coast Annual Demand (BG)	31	81	81	81	40
Percent occuring in Peak Season	64%	→	→	→	59%
Hydrology					
Hydrologic Record	59 years	73 years	→	→	→
Available Flows	Linsley- Kraeger	Balance	Multiple Scenarios	Tier 2/3 Tier 3	City Proposal (T3/2) & DFG5
Diversions					
Turbidity Constraints	25 ntu	Updated 25 ntu	Updated 25 ntu; 200 ntu	Updated 25 ntu	Updated 25 ntu
Tait Street Buffer (cfs)	0	→	→	→	0.5
North Coast Transmission losses	15%=>1%	8%=>3%	→	→	→
Groundwater Availability					
Beltz (mgd)	1.0-2.0	3 scenarios 0.3-1.0 in PS months	0.8 all years + 0.3 dry years in PS months	2 scenarios: (1) 0.8 all years + 0.3 dry years in PS months (2) 0.3 dry years in PS months	0.8 all years + 0.3 dry years in PS months
Tait Street Well Capacity (cfs)	1.78				1.29 off-pk; 0.78 pk
Loch Lomond					
Rule curves	Optimize to end of 1977	Optimize to end of 1977	Optimize to end of 1990	Optimize to end of 1977	Optimize to end of 1990
Max/usable capacity (mg)	2810/1710	2810/1740	→	→	→
Water rights					
3200 AF withdrawal	Total Newell & Felton	→	→	→	Newell Only
Allowable diversion months	Oct-May	Nov-May			Sept - Jun
Treatment Plants					
GHWTP summer/winter capacity (mgd)	20/20	20/20	16.5/16.5	16.5/16.5	16.5/10
Desalination		Sharing w/ SqCWD	Sharing w/ SqCWD	Sharing w/ SqCWD & 2 operating modes	N/A

In 2005 the City Council of the City of Santa Cruz adopted the Integrated Water Plan (IWP) and certified the Environmental Impact Report for the IWP. This series of events established the framework, or metrics, against which reliability of the water supply has been measured. These reliability guidelines are summarized below, excerpted from the Draft Environmental Impact Report (DEIR) for the scwd^2 Regional Seawater Desalination Project.

Results of the supply/demand analysis (Appendix C of the DEIR) were expressed in terms of frequency and severity of water supply shortages. The IWP recommended limiting shortages of water and associated curtailment of water during times of drought by no more than 15 percent of average annual demand and further recommended limiting the frequency of curtailments as follows.

Individual Peak Season Shortage Targets (Individual Frequency Targets): This target would be exceed if peak season shortages between 0 and 10 percent occur in more than 15 percent of the years and/or if peak season shortages of 10 to 20 percent occur in more than 2 percent of the years.

Cumulative Peak Season Shortage Targets (Cumulative Frequency Targets): The cumulative frequency target would be exceeded if shortages between 0 and 20 percent occur in more than 17 percent of the years.

Worst Year Peak Season Shortage Target: The worst peak season shortage target would be exceeded if any shortage is greater than 15%.

Frequency Targets (Expressed as a probability of exceeding the target)				
Individual Peak Season Shortage Targets				
0-10% Peak Season Shortage	**10-20% Peak Season Shortage**	**20-30% Peak Season Shortage**	**Cumulative Peak Season Shortage**	**Acceptable Worst Year Peak Season Shortage (15%)**
15% of years	2% of years	0	17% of years	15

The 2010 UWMP contemplated several levels of future demand ranging from 2030 annual volumes of 4 billion gallons per year (bgy) to 4.5bgy. The DEIR for the desalination project reevaluated future demands based on existing and new conservation projects and programs as well as existing conditions in the community and based its analyses on 2030 demands ranging from 3.5bgy to 4bgy. More recent work by staff and the WSAC technical team reduce 2030 demand to ~3,300 mgy.

The Confluence model is built around the physical infrastructure and operational parameters of the water system. The model has been modified over time as operational conditions change such as changes in demand or hydrology for example. As the WSAC considers various scenarios, the Confluence model may be used to evaluate other conditions such as other demand patterns, climate change, etc.

References:

City of Santa Cruz, 2011. "*City of Santa Cruz 2010 Urban Water Management Plan*," prepared by City of Santa Cruz Water Department, December 2011.

Gary Fiske & Associates, 2003. "*City of Santa Cruz Integrated Water Plan*," adopted in November 2005. Prepared by Gary Fiske & Associates for the City of Santa Cruz, June 2003.

URS Corporation, 2013. "*City of Santa Cruz and Soquel Creek Water District Proposed scwd^2 Regional Seawater Desalination Project Draft Environmental Impact Report*," prepared by URS Corporation, May 2013.