CITY OF SANTA CRUZ
City Hall
809 Center Street
Santa Cruz, California 95060

WATER COMMISSION

Regular Meeting

November 7, 2022

7:00 P.M. **GENERAL BUSINESS AND MATTERS OF PUBLIC INTEREST, ZOOM WEBINAR**

COVID-19 ANNOUNCEMENT: This meeting will be held via teleconference ONLY.

In order to minimize exposure to COVID-19 and to comply with the social distancing suggestion, the Council Chambers will not be open to the public. The meeting may be viewed remotely, using the following sources:

- **Online:**https://ecm.cityofsantacruz.com/OnBaseAgendaOnline/Meetings/Search?dropid=4&mtids=124
- **Zoom Live (no time delay):** https://us06web.zoom.us/j/84221035122
- **Facebook:** https://www.facebook.com/SantaCruzWaterDepartment/?epa=SEARCH_BOX

PUBLIC COMMENT:
If you wish to comment on items 1-3 during the meeting, please see the information below:

- **Call any of the numbers below. If one number is busy, try the next one. Keep trying until connected.**
  +1 669 444 9171
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- Enter the meeting ID number: **842 2103 5122**
- When prompted for a Participant ID, press #.
- Press *9 on your phone to “raise your hand” when the Chair calls for public comment.
  - It will be your turn to speak when the Chair unmutes you. You will hear an announcement that you have been unmuted. The timer will then be set to three minutes.
  - You may hang up once you have commented on your item of interest.
  - If you wish to speak on another item, two things may occur:
    1) If the number of callers waiting exceeds capacity, you will be disconnected and you will need to call back closer to when the item you wish to comment on will be heard, or
    2) You will be placed back in the queue and you should press *9 to “raise your hand” when you wish to comment on a new item.

NOTE: If you wish to view or listen to the meeting and don't wish to comment on an item, you can do so at any time via the Facebook link or over the phone or online via Zoom.

*Denotes written materials included in packet.

The City of Santa Cruz does not discriminate against persons with disabilities. Out of consideration for people with chemical sensitivities, please attend the meeting fragrance free. Upon request, the agenda can be provided in a format to accommodate special needs. Additionally, if you wish to attend this public meeting and will require assistance such as an interpreter for American Sign Language, Spanish, or other special equipment, please call Water Administration at 831-420-5200 at least five days in advance so that arrangements can be made. The Cal-Relay system number: 1-800-735-2922.

APPEALS: Any person who believes that a final action of this advisory body has been taken in error may appeal that decision to the City Council. Appeals must be in writing, setting forth the nature of the action and the basis upon which the action is considered to be in error, and addressed to the City Council in care of the City Clerk.

Other - Appeals must be received by the City Clerk within ten (10) calendar days following the date of the action from which such appeal is being taken. An appeal must be accompanied by a fifty dollar ($50) filing fee.

Call to Order

Roll Call

Statements of Disqualification - Section 607 of the City Charter states that...All members present at any meeting must vote unless disqualified, in which case the disqualification shall be publicly declared and a record thereof made. The City of Santa Cruz has adopted a Conflict of Interest Code, and Section 8 of that Code states that no person shall make or participate in a governmental decision which he or she knows or has reason to know will have a reasonably foreseeable material financial effect distinguishable from its effect on the public generally.

Oral Communications

Announcements

Consent Agenda (Pages 1.1 – 2.6) Items on the consent agenda are considered to be routine in nature and will be acted upon in one motion. Specific items may be removed by members of the advisory body or public for separate consideration and discussion. Routine items that will be found on the consent agenda are City Council Items Affecting Water, Water Commission Minutes, Information Items, Documents for Future Meetings, and Items initiated by members for Future Agendas. If one of these categories is not listed on the Consent Agenda then those items are not available for action.

1. City Council Actions Affecting the Water Department (Pages 1.1 – 1.2)

   Accept the City Council actions affecting the Water Department.

2. Water Commission Minutes from October 3, 2022 (Pages 2.1 – 2.6)

   Approve the October 3, 2022 Water Commission Minutes.

Items Removed from the Consent Agenda

General Business (Pages 3.1 – 3.87) Any document related to an agenda item for the General Business of this meeting distributed to the Water Commission less than 72 hours before this meeting is available for inspection at the Water Administration Office, 212 Locust Street, Suite A, Santa Cruz, California. These documents will also be available for review at the Water Commission meeting with the display copy at the rear of the Council Chambers.

3. Final Draft Securing Our Water Future Resolution with Policy Guidance for Water Supply Augmentation and Technical Materials That Will be Included in the City Council Agenda Item for Their November 29, 2022, Meeting (Pages 3.1 – 3.87)

   That the Water Commission:

   A. Receive updated presentations on several Securing Our Water Future technical topics and provide feedback to staff on both the presentations and related materials included in the Commission's agenda packet. Topics covered include:
      i. The climate change conditions and water supply reliability modeling results showing water system performance under various weather, climate, and supply augmentation scenarios;
      ii. The comparative analyses for water supply augmentation project concepts;
      iii. The economic impact analysis of water supply curtailments at 2021 Water Shortage Contingency Plan curtailment stages 3, 4, and 5.

   B. Review and provide feedback to staff on the Final Draft Securing Our Water Future Resolution and Water Supply Augmentation Policy Guidance; and

   C. Recommend to the City Council the adoption of the Securing Our Water Future Resolution and Water Supply Augmentation Policy Guidance.

Subcommittee/Advisory Body Oral Reports

4. Santa Cruz Mid-County Groundwater Agency

5. Santa Margarita Groundwater Agency

Director's Oral Report

Information Items

Adjournment

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WATER COMMISSION
INFORMATION REPORT

DATE: 11/03/2022

AGENDA OF: 11/07/2022

TO: Water Commission

FROM: Rosemary Menard, Water Director

SUBJECT: City Council Actions Affecting the Water Department

RECOMMENDATION: That the Water Commission accept the City Council actions affecting the Water Department.

BACKGROUND/DISCUSSION:

October 11, 2022

No items to report.

October 25, 2022

Approval of Plans and Specifications for the Rodriguez Street Water Main Relocation Project and Ratify Construction Contract with Anderson Pacific Engineering – Budget Adjustment (WT)

Motion **carried** to:

Approve the plans and specifications for the Rodriguez Street Water Main Relocation Project (c700003); and

Ratify the Construction Contract for the Rodriguez Street Water Main Relocation Project with Anderson Pacific Engineering Construction, Inc. (Santa Clara, CA) in the amount of $224,026 and authorize the Water Director to execute change orders within the approved project budget; and

Adopt Resolution No. NS-30,056 amending the FY 2023 budget to transfer $225,000 within the Water Department's Capital Investment Program (CIP) from project c701507, Main Replacements - Distribution Section, to project c700003, Main Replacements - Outside Agency.

Dudek Master Service Agreement for California Environmental Quality Act Compliance and Environmental Permitting: First Amendment (WT)

Motion **carried** authorizing the City Manager to execute with Dudek (Santa Cruz, CA) the Master Service Agreement, in a form to be approved by the City Attorney, for California Environmental Quality Act Compliance and Environmental Permitting: First Amendment, authorizing a revised fee schedule and extending the term of the contract, and to authorize the Water Director to execute future Master Service Agreement renewals and amendments per the agreement.

PROPOSED MOTION: Accept the City Council actions affecting the Water Department.

ATTACHMENTS: None.

Water Department

Water Commission
7:00 p.m. – October 3, 2022
Zoom Teleconference

Summary of a Water Commission Meeting

Call to Order: 7:00 PM

Roll Call

Present: D. Alfaro (via Zoom), J. Burks (Vice Chair) (Absent with notification), T. Burns (Via Zoom), D. Engfer (via Zoom), A. Páramo (via Zoom at 7:01 pm), G. Roffe (via Zoom) S. Ryan (Chair) (via Zoom)

Absent: None.

Staff: R. Menard, Water Director (via Zoom); C. Coburn, Deputy Director/Operations Manager (via Zoom); T. Kihoi, Associate Professional Engineer (via Zoom); H. Luckenbach, Deputy Director/Engineering Manager (via Zoom); K. Crossley, Engineering Manager (via Zoom); David Baum, Chief Financial Officer (via Zoom); Sarah Perez, Principal Planner (via Zoom); K. Fitzgerald, Management Analyst (via Zoom); C. Galati Administrative Assistant III (via Zoom)

Others: Five members of the public (via Zoom)

Presentation: None.

Statements of Disqualification: None.

Oral Communications: One member of the public spoke.

Announcements: None

Consent Agenda

1. City Council Items Affecting the Water Department

2. Water Commission Minutes From August 29, 2022

Staff suggested that the motion action block on page 2.4 of the August 29, 2022 minutes be removed as it is a typo.

No public comments were received.

Commissioner Alfaro moved the Consent Agenda as amended. Commissioner Burns seconded.

VOICE VOTE: MOTION CARRIED
AYES: All
NOES: None
DISQUALIFIED: None

General Business

3. Workshop on Water Supply Vulnerability Assessment

R. Menard introduced Dr. Casey Brown (University of Massachusetts, Amherst) for the presentation and discussion of the Workshop on Water Supply Vulnerability Assessment.

For the Aquifer Storage and Recover (ASR), is the 2 million gallons a day (MGD) injection already net of the 19% losses, or are the losses already taken out of the 2 MGD?

- It is 2 MGD minus the 19%.

On the Indirect Potable Reuse (IPR) it was not clear where the water was going to reside before we can input it into the system, would it be injected into the Santa Margarita basin?

- Yes, this is a concept from the Santa Margarita groundwater basin IPR project.

Would the output from the desalination plant be potable deliverable water, as in it would not require additional treatment processes?

- Correct.

How should we interpret the change in slope on the Direct Potable Reuse (DPR) desal line at minus 30% precipitation?

- The supply deficits showing for the desal and DPR project concept results are, in this case, driven by the 3 mgd project sizing and annual operating assumptions that have been used in modeling these two project concepts. In particular, these two project concepts were modeled with the assumption that the plants would operate at 1 mgd during the winter and 2 mgd in the summer when there aren't drought conditions. Under drought conditions, the assumptions changed with the plants operating at full capacity (3 mgd) from the point at which Loch Lomond reached 2 billion gallons to when it was fully recovered. Changing the operating assumptions to ramp up production from 2 to 3 mgd during the summer, for example would, in many cases, eliminate the shortages. Sizing of any DPR or Desal facility is informed both by what you think climate change would require as well as in the DPR case how much wastewater you have to work with.

Can staff explain how variability is being defined?

- In the work that has been done on climate change for Santa Cruz, the coefficient of variation measures the spread around the mean, but it doesn't change the mean. An example with increased variability is that the wet years are wetter and the dry years are drier, but the mean amount of precipitation doesn't increase over what it would be without increased variability. As demonstrated by Dr. Chartrand's presentation on historic hydrology trends, Santa Cruz is already experiencing increased variability.

Do the model runs for ASR take into account the evaporation demand and the impact of climate change?

- Models account for evaporation from the reservoir. The hydrological model accounts for the evaporation demand as well. When the climate warms up we get less runoff.

ASR and IPR project more water being extracted than what was being put in, was that because you banked it over the years?

- Yes. When there is an opportunity to put water in the reservoir you do, and you pull only when you need to.

Does the demand model look at greater irrigations when dry seasons are longer, so would demand go up as a result of the dryer seasons?

- Section 4.8 of the 2020 Urban Water Management Plan includes a brief discussion of this question. The section concludes with the following statement:

  > "Total system demand would be expected to increase by about 0.45 percent per one degree F increase in average daily high temperature. Therefore, in the higher scenario for projected temperature for the end of the century (2070 – 2099) shown in Figure 3-4, if the average temperature in Santa Cruz were to rise by 7 degrees, water demand could be expected according to this analysis to increase by 3.2 percent."

Was the demand based on population? What assumptions were you making about the population? Is the 3% increase over time that we are seeing now, the population coming into the city.

- David Mitchell created an econometric demand forecast that the Department is using. It is done in a very bottom-up kind of way, meaning the number of households average number of people per household. The Association of Monterey Bay Area Government provides population forecasts for both the City and the unincorporated areas. City staff work with County Staff and our consultant to determine the amount of population projected for the unincorporated area and then that is used along with City population data. Using average household size information and other data, the number of dwelling units are projected, and data-driven assumptions about gallons per capita per day use levels are used to create the forecast.

If there is an increase in supply variability, how would that affect the efficacy of the supply augmentation project concepts we're evaluating?

- Augmentation projects that depend on a reasonably reliable supply of surface water are most negatively impacted by increased supply variability. Successful ASR projects need wet season supplies available on a routine basis so that additional storage is created underground and routinely added to help meet system demand during dry seasons. Routine or persistent "winter droughts" such as those experienced in California in water years 2014, 2015, 2018, 2020, 2021 and 2022, don't support ASR very well due to supply constraints during the period usually used to increase stored water.

It appears that the magnitude of the coefficient of variability doesn't affect the "total area under the curve," in terms of the total rainfall of some period, but it does affect its distribution. How does this compare to historical variability? How does this coefficient model the variability we are expecting to see with climate change, even without applying this factor?

- One of the challenging aspects of this work is that predicting future climate variability is a lot more difficult than predicting mean climate changes, so models, like the climate model, tend to be the best at representing the things we care least about and worst at representing the things we care most about. Variability is one of the things we care most about.

In terms of estimating the implications of a 20% increase in variability, for example, we consulted relevant scientific literature to see what is thought to be the most realistic approaches, particularly focusing on a recent study looking at this so-called increasing whiplash effect, that results in increasing year-to-year variability. The approach we ultimately implemented is consistent with the work we reviewed and consistent with climate literature.

Is there any way that various supply augmentation projects, if implemented, would produce additive results?

- In general, yes. The WSAIP will be looking at portfolios or packages of projects and evaluating not only how various supply augmentation pieces could work together but also looking whether there are other issues, such as hydraulic capacities of existing pipelines or pump stations, that would need to be addressed if the two or more projects were implemented together.

What are the implications of drawing down the Loch Lomond reservoir below a billion gallons?

- The Loch Lomond reservoir drawdown limit of a billion gallons is the historic buffer that has been used to protect supply for the following year. This policy makes sense if you only have a single source of stored water and, if additional supply becomes available, the one billion-gallon reserve can be revisited.

What would happen in a scenario with a three-year drought followed by a successive turnover? What would the absolute worst-case scenario look like regarding a reservoir drawdown?

- Once you have emptied it five years go by before you can use it again. The reservoir does suffer after a drought.

R. Menard introduced Dr. Shawn Chartrand (Simon Fraser University, Vancouver, BC) for the presentation and discussion of What We Know About Changing Patterns – A Comparison of Historical and Future Local Hydroclimate.

Does the precipitation pattern since 2017 suggest that we should come up with an augmentation strategy that doesn't rely on the precipitation since it seems to be unreliable?

- That is reflected in some of the options that are presently being considered.

If we had options where we weren't relying so much on precipitation would that give a benefit to stream flows?

Our instream flow rules are set to relate to hydrology, not water demand. If water demand goes up or down, the amount of bypass flow required doesn't change. Adding an alternate supply that doesn't use surface water as its source wouldn't necessarily change that.

Is data from the nineteenth-century period available from local data points?

- Yes. This data comes from a climate station near De Laveaga that had been installed by the National Oceanic and Atmospheric Association.

R. Menard introduced Dr. Robert Raucher and Carolyn Wagner (Raucher LLC.) for the presentation and discussion of The Economic Impact of Water Supply Curtailments.

What is the source of the data that indicates that a large portion of total water use is for single-family houses and multi-family residences?

- The data come from actual billing data for the various customer classes between 2016 and 2018. Water use in this period is quite a bit lower than in 2001 and 2004 and reflects how thoroughly water users in Santa Cruz have accepted and integrated water use efficiency into their daily use.

Regarding differential impacts in different economic sectors, how are you going to anchor or benchmark the standards and other factors that will be used in the analysis?

- There is a fair amount of literature on how water is used in businesses as part of their economic inputs and outputs. There is less information on how large percentage reductions in water availably impact economic productivity. This is why the approach being used looks at plausible scenarios and uses some upper and lower ranges of impacts to provide some sensitivity analysis.

Is there an upside for us avoiding curtailment and can we get greater growth, but maybe at the expense of our neighbors in the State that are not as fortunate?

- It is plausible for businesses to expand or move to Santa Cruz if there is a more secure water future.

The Commissioners provided feedback to staff on the draft resolution.

Two public comments were received.

No action was taken on this item.

Subcommittee/Advisory Body Oral Reports

4. Santa Cruz Mid-County Groundwater Agency (MGA)

September 15, 2022, the meeting was largely administrative. Construction on the new monitoring wells in the basin has begun.

5. Santa Margarita Groundwater Agency (SMGWA)

The SMGWA has not met since August. The next meeting is on October 27th. SMGWA hosted the Managed Aquifer Recharge – Exploring the Possibilities workshop on September 7th, 2022. Two to three dozen people attended and it was a good grounding background for people who are not familiar with ASR.

Director's Oral Report: R. Menard discussed the third La Nina year in a row. Ending the water year at a seventy-five percent storage level at Loch Lomond and which is twenty percent over where we were this time last year.

Looking at hydrologic realizations presented and discussed earlier and looking at the kind of data that we would have for some of the more challenging conditions and Loch Lomond reservoir elevations on the first of March, Water Department staff have assessed the number of years where water shortages would be declared and what stage of the Water Shortage Contingency Plan would be recommended for implementation. In some of the long dry-year sequences, the potential size of shortages is quite large, and recommendations for stages 4 and 5 are common when reservoir conditions on March 1 are below 50% of total storage. Even when circumstances ultimately do not prove dire enough to have required these severe levels of curtailments, the uncertainty going into dry seasons is such that the use of curtailments to reduce the risk of running out of water would be frequent without substantial improvements in available supply.

Information Items: Informational items from the agenda packet were discussed.

Adjournment: The meeting was adjourned at 10:12 PM.

WATER COMMISSION
INFORMATION REPORT

DATE: 10/28/2022

AGENDA OF: 11/07/2022

TO: Water Commission

FROM: Rosemary Menard, Water Director

SUBJECT: Final Draft Securing Our Water Future Resolution with Policy Guidance for Water Supply Augmentation and Technical Materials That Will be Included in the City Council Agenda Item for their November 29, 2022, Meeting

RECOMMENDATION: That the Water Commission:

A. Receive updated presentations on several Securing Our Water Future technical topics and provide feedback to staff on both the presentations and related materials included in the Commission's agenda packet. Topics covered include:
    i. The climate change conditions and water supply reliability modeling results showing water system performance under various weather, climate, and supply augmentation scenarios;
    ii. The comparative analyses for water supply augmentation project concepts;
    iii. The economic impact analysis of water supply curtailments at 2021 Water Shortage Contingency Plan curtailment stages 3, 4, and 5.
B. Review and provide feedback to staff on the Final Draft Securing Our Water Future Resolution and Water Supply Augmentation Policy Guidance; and
C. Recommend to the City Council the adoption of the Securing Our Water Future Resolution and Water Supply Augmentation Policy Guidance.

BACKGROUND: Beginning in April 2022, Water Department staff and Water Commissioners started working together to develop a policy framework for Securing Our Water Future (SOWF) for review and action by the Santa Cruz City Council before the end of 2022. This work has involved bringing together technical and analytical resources from multiple disciplines and preparing, presenting, and discussing topics ranging from project yields and costs to climate change hydrology to economic impacts of curtailments to communications and engagement with interest groups and the broader community, and policy direction to include in the Council's Policy Manual.

The goal of setting a policy framework for SOWF is to codify guidance for selection and incremental implementation of the water supply augmentation projects needed to meet the water supply reliability standard that will be a key part of the SOWF policy framework.

The SOWF policy will define the City's approach to the questions of "how" and "how much" but not the "what" "when" or "where" questions. These latter three questions will be answered through the creation of a detailed road map, the Water Supply Augmentation Implementation Plan (WSAIP), that will be created in collaboration with the Water Commission and approved by the Council in 2023.

For some projects that will be included in the WSAIP, there will be a lot of detail, for example, we have quite a bit of detail on the second phase of ASR in the Mid-County groundwater basin. For other projects, for example IPR in the Santa Margarita basin, the detail will focus on laying out the feasibility analyses and partnership discussions and agreements that would be needed to move that project forward for future decision-making. Part of the WSAIP will include an approach to adaptive management likely using ideas from the adaptive pathways concepts first identified and used in the WSAC process[1][2].

Future Council actions related to water supply augmentation projects would be in the form of approving p and any CEQA required environmental reviews for the WSAIP, as well as implementation actions such as contracts for engineering design, authorizations to advertise for competitive bids for construction or use other alternate project delivery methods, actions to approve loans, issue debt, and approvals for collaborative agreements or partnerships with other local utilities to develop or construct supply augmentation projects.

DISCUSSION: Agenda materials for the Water Commission's November 7, 2022, meeting pull together and summarize the analytical work that has been completed as part of the SOWF process. The goals of the Commission's discussion at this meeting are to provide final feedback about the materials that will go to the Council for review and action at their November 29th meeting and for the Water Commission to vote on its recommendation to the Council on the SOWF policy and water supply augmentation guidance.

The planned package of materials included for this agenda item include:

- Attachment A – Final Draft Securing Our Water Future Resolution;
- Attachment B – Summary memo on the Climate Change and Vulnerability Analysis work completed as part of the SOWF process;
- Attachment C – Summary memo on Water Supply Project Concepts and comparative analysis; and
- Attachment D – Economic Impact Analysis of Potential Water Supply Curtailments

FISCAL IMPACT: None at this time.

PROPOSED MOTION: Motion to recommend to the City Council the adoption of the Securing Our Water Future Resolution and Water Supply Augmentation Policy Guidance

ATTACHMENTS: Attachments are listed in the Discussion section of this staff report.

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[1] See section 3.22 and Figure 8 in the WSAC Final Report on Agreements and Recommendations (pages 55 and 56)
[2] See also https://www.deltares.nl/en/adaptive-pathways/ and the Adaptive Pathways video

DRAFT RESOLUTION

SECURING OUR WATER FUTURE

WHEREAS, for more than 100 years the Santa Cruz water system has been providing residents and businesses in the City of Santa Cruz with drinking water and fire protection services; and

WHEREAS, although water systems are often taken for granted, they are a primary example of critical infrastructure that, if it fails, seriously negatively affects every aspect of our community, including threatening public health, fire safety, and economic sustainability; and

WHEREAS, in 1960 the water system was modified by the addition of raw water storage for seasonal supply by the construction of Newell Creek Dam, which created Loch Lomond Reservoir, specifically to respond to the area's Mediterranean climate, which is typically characterized by a late fall, winter and early spring wet season and late spring, summer, early fall dry season and which requires a source of stored water to meet much of the dry season's customer demand; and

WHEREAS, in the City's process of designing the sizing and siting for Newell Creek Dam, historic weather conditions influenced assumptions about how much storage was needed and how the storage would be operated, including assumptions about how historic precipitation levels would allow for the annual replenishment of reservoir levels and, even in those occasional years when precipitation was lower than normal, would provide enough year-to-year carry-over supply to meet customer demand during drought conditions; and

WHEREAS, over many years Santa Cruz's water service customers have actively embraced water use efficiency practices and behaviors to the degree that Santa Cruz's residential gallons per person (per capita) per day (GPCD) for indoor and outdoor use is stable at 44 GPCD and is among the lowest in the state; and

WHEREAS, in the 60 years since the construction of Newell Creek Dam, multi-year droughts in 1976-1977, 1987- 1991, 2014-2015, and 2020-2021 have shown that, even with significant achievements by customers in adopting highly efficient water use practices, the amount of water storage in the system is inadequate to assure that all water system customers have reliable access to water during drought conditions without imposing burdensome and unsustainable levels of curtailment; and

WHEREAS, following late 1960s construction of the Newell Creek Dam, the City last added to its supply resources with the construction of the Felton Diversion in the 1970s. The Felton Diversion was designed to support the diversion of water from the mainstem of the San Lorenzo River to improve the City's ability to maximize stored water in drier years when flows from Newell Creek and the surrounding watershed lands are inadequate to fill Loch Lomond Reservoir; and

WHEREAS, more or less continuously since weathering the historical worst case (1976-1977) drought, the city has been exploring, conducting feasibility analyses, and developing supply augmentation strategies, with the most recent being the scwd2 desalination project. The scwd2 desalination project was undertaken as a partnership with the Soquel Creek Water District (District) to allow the City and the District to provide drought supply and an alternate source of water that would, among other goals, allow the District to reduce pumping in (and therefore protect from seawater intrusion) what is now called the Santa Cruz Mid-County Groundwater Basin; and

WHEREAS, in 2014 the Santa Cruz City Council addressed community concerns about the need for and advisability of constructing a desalination plant by appointing a diverse community group to evaluate the City's water supply situation, and asked it with defining the problem to be solved, identifying, and evaluating alternative solutions, and developing recommendations to the City Council on water supply augmentation actions to be pursued; and

WHEREAS, the City Council-appointed group that became known as the Water Supply Advisory Committee (WSAC) worked together between April 2014 and October 2015 and produced a set of agreements and recommendations to the Council including, in Section 3.08 of its 2015 Final Report on Agreements and Recommendations[1] a Problem Statement that includes the following language (emphasis added):

> *"Santa Cruz's water supply reliability issue is the result of having only* ***a marginally adequate amount of storage to serve demand during dry and critically dry years*** *when the system's reservoir doesn't fill completely. Both expected requirements for fish flow releases and anticipated impacts of climate change will turn a marginally adequate situation into a seriously inadequate one in the coming years.*
>
> ***Santa Cruz's lack of storage makes it particularly vulnerable to multi-year droughts****. The key management strategy currently available for dealing with this vulnerability is to very conservatively manage available storage. This strategy typically results in regular calls for annual curtailments of demand that may lead to modest, significant, or even critical requirements for reduction. In addition, the Santa Cruz supply lacks diversity, thereby further increasing the system's vulnerability to drought conditions and other risks.*
>
> ***The projected worst-year gap between peak-season available supply and demand during an extended drought is about 1.2 billion gallons.*** *While aggressive implementation of conservation programs will help reduce this gap,* ***conservation alone cannot close this gap****. The Committee's goal is to establish a reasonable level of reliability for Santa Cruz water customers by substantially decreasing this worst-year gap while also reducing the frequency of shortages in less extreme years.";* and

[1] See https://www.cityofsantacruz.com/home/showpublisheddocument/48993/635857012384670000

WHEREAS, circumstances since the completion of the WSAC's work continue to support the WSAC's Problem Statement as an accurate assessment of the water system's water supply reliability issues, even in the face of the substantial long-term demand reduction by existing customers through adoption of water use efficiency practices; and

WHEREAS, as part of its recommendations to the City Council, which the Council unanimously accepted in November 2015, the WSAC recommended that the Water Department be directed to prepare information about a range of water supply augmentation projects that would allow the projects to be compared to each other and that would support data-driven decision-making about which options or portfolio of options to pursue to address the water system's water supply reliability issues; and

WHEREAS, the WSAC's recommended alternatives to be further considered included two strategies, 1) Development of groundwater storage using a combination of both passive and active recharge approaches and available surface water flows during the rainy season; and 2) Development of advanced treated recycled water or desalinated water if needed to address any remaining supply-demand gap; and

WHEREAS, an agreed upon diverse set of evaluation criteria rooted in and building on the WSAC's recommendations and including the WSAC's key decision criteria of cost, yield and timeliness and additional quantitative and qualitative criteria have been identified through the work completed following the WSAC process in 2015; and

WHEREAS, the WSAC's intention was that its recommendations, upon acceptance by the City Council and integration into the Department's 2015 Urban Water Management Plan, would not be self-executing but rather would have to be implemented through the development and implementation strategies and action such as the Water Supply Augmentation Strategies (WSAS) described below, and a more detailed Water Supply Augmentation Implementation Plan (WSAIP) to be developed in collaboration with the Water Commission for City Council review and action in 2023; and

WHEREAS, in 2014 the state of California adopted the Sustainable Groundwater Management Act (SGMA), which requires the development and implementation of Groundwater Sustainability Plans (GSPs) that will bring critically over-drafted, and high and medium priority groundwater basins into sustainability within 20 years; and

WHEREAS, the City of Santa Cruz has participated in the development of two local GSPs, one in collaboration with Santa Cruz County and the Soquel Creek and Central Water Districts for the Santa Cruz Mid-County Groundwater Basin, and one in collaboration with Santa Cruz County, Scotts Valley and San Lorenzo Valley Water Districts, the City of Scotts Valley and the Mt. Hermon Association for the Santa Margarita Groundwater Basin; and

WHEREAS, these GSPs have greatly expanded our understanding of local groundwater resources and provided specific measurable criteria for their sustainable management and use which may, in addition to guiding actions to achieve sustainability in the basins, include use of these basins to store water for use by Santa Cruz as drought supply; and

WHEREAS, beginning late 2015 and continuing to the present, Water Department staff has implemented the WSAS envisioned by WSAC through, among other actions, 1) conducting follow up technical studies and feasibility analyses; 2) conducting detailed assessments of system irrigation demand and opportunities for developing recycled water as a source of supply; 3) conducting pilot testing for water transfers with the Soquel Creek Water District; 4) conducting pilot testing of aquifer storage and recovery technology at the Beltz 8 and Beltz 12 wells; 5) developing environmental analyses and cost information on a wide range of supply alternatives; and 6) providing detailed reports to the Water Commission on a quarterly basis on its progress; and

WHEREAS, in November 2019, in a joint meeting of the City Council and Water Commission, the Council approved a path toward implementation of the WSAC's recommendations using the process included in the WSAC's Final Report on Agreements and Recommendations and, in addition to extending the schedule for completion of the WSAC's endorsed approach for comparative analysis of supply augmentation options, endorsed the concept of early action to develop an Aquifer Storage and Recovery project in the Beltz wellfield area of the Santa Cruz Mid-County Groundwater Basin; and

WHEREAS, in parallel with its work implementing the WSAS, the Water Department has also completed other related work, such as preparing and submitting proposed water rights change petitions to the State Water Resources Control Board that, if approved, would 1) allow the City to deliver treated water to other regional providers as part of water transfer or exchanges; 2) extend the time limit for the development of water allocated to the City under its Felton Permits; and 3) add a point of diversion for water under the Felton Permits at the City's Tait Street diversion. Taken together, all of these measures would substantially increase the City's ability to use its water supplies in the future while still protecting flows in the Felton to Tait reach of the San Lorenzo River to support recovery of endangered coho salmon and threatened steelhead trout; and

WHEREAS, beginning in early 2022, Water Department staff initiated the final phase of implementing the WSAC's recommendations by working with the City Council-appointed Santa Cruz Water Commission to 1) complete the side-by-side comparison of the four main water supply augmentation strategies that have the potential to make a substantial contribution to improving the reliability of Santa Cruz's supply; 2) develop recommended Securing Our Water Future policy direction for City Council consideration; and 3) initiate development of the WSAIP; and

WHEREAS, because it is not feasible to complete the WSAC's recommended side-by-side comparison for every potential water supply option that could be implemented using available resources, the Department proposed, and the Water Commission accepted the suggestion that a set of four representative project concepts be compared during the Securing Our Water Future policy development process; and

WHEREAS, the WSAC's work also considered the implications of climate change on water system reliability and included analysis of climate change scenario that would result from increasing temperatures and changing precipitation patterns; and

WHEREAS, the climate change assessments and actual experiences in recent years indicate that climate change effects, that include increasingly variable and extreme weather conditions are already being experienced; and

WHEREAS, the existing and anticipated effects of climate change, particularly impacts from more frequent dry winters and increased instances of multi-year droughts, are serious threats to the City's water system and add urgency to the City's need to take action to improve its ability to provide a reliable supply for today's customers as well as those of tomorrow; and

WHEREAS, in addition to the anticipated impacts of climate change on water supply reliability, the increase in extreme wet weather conditions associated with atmospheric rivers also threatens key water system infrastructure; and

WHEREAS, working with Professor Casey Brown of the University of Massachusetts at Amherst, Department of Civil Engineering and affiliated Hydrosystems Research Group and Professor Shawn Chartrand of Simon Fraser University's School of Environmental Science, the Water Department developed new water system vulnerability assessment tools that make it possible to assess the reliability and resilience of the water system across more than 8,000 potentially plausible climate change scenarios in order to ascertain the water system's vulnerability to climate change and the related temperature and precipitation changes projected to result therefrom; and

WHEREAS, the Water Department and consultants specifically evaluated results of the vulnerability analyses, particularly as they relate to the availability and reliability of "wet season" water supply for development of a drought supply for Santa Cruz using aquifer storage and recovery, which diverts wet season water, treats it to drinking water standards and injects it into local groundwater aquifers for recovery during the annual dry season or during drought events; and

WHEREAS, the Water Department staff and consultants also specifically evaluated results of the vulnerability analysis of longer and more frequent drought conditions, and results of this analysis project increasing climate variability in the coming decades; and

WHEREAS, based on modeling results over a wide range of climate scenarios, Water Department staff and consultants have concluded that anticipated longer dry periods is the challenge driving the need to augment water supply, and that planned increases in housing in the Santa Cruz water service area, while included in the long-term demand forecast, is not by itself driving the size or timing of needed water supply augmentation projects; and

WHEREAS, the City Council has determined that the adoption of this Resolution, which accepts the WSAC's policy recommendations but does not commit the City to any future water supply augmentation WSAIP or water supply augmentation project, is not subject to CEQA because the

Resolution, by itself, will not cause any direct or reasonably foreseeable indirect environmental effects; and

WHEREAS, a future WSAIP, if and when ultimately approved by the City Council, may include principles, policies, and other content that differ from those found in, or anticipated by, the findings, policy goals and statements, and actions set forth below and adopted through this Resolution, and may result in making revisions to the policy direction included here to ensure alignment of new information and findings developed as part of the WSAIP; and

WHEREAS, following consideration of all the relevant information developed by Water Department staff and presented to and discussed with Water Commissioners through an iterative process of publicly noticed meetings occurring beginning in the spring of 2022, the Water Commission at its regular publicly noticed meeting on November 7, 2022, unanimously approved the findings and policies recommended in this resolution for submittal to the City Council.

NOW THEREFORE, BE IT RESOLVED by the Santa Cruz City Council that City staff shall incorporate the findings, policy goals and statements, and actions set forth below into Section 34 of the City Council's Handbook, as a new Policy 34.7, "Securing Our Water Future and Water Supply Augmentation Policy Guidance":

1. **Statement of Findings:**

1.1 Water is essential to life. Managing Santa Cruz's water resources in a manner that protects the watershed, respects wildlife and the habitats it depends on, and produces and delivers a high quality and reliable supply of water that protects public health and safety and supports economic prosperity will ensure a secure water future for our community.

1.2 Over many decades, Santa Cruz residents and water service customers have placed a high value on stewardship approaches for the management of our region's natural resources and have expected publicly owned natural resources to be managed in a manner that ensures long-term sustainability, protection, and enhancement of ecosystems to support and restore threatened and endangered species, and to serve the needs of the community.

1.3 As identified by the WSAC in its 2015 report, inadequate water system storage is the critical limiting factor that exposes Santa Cruz water service customers to serious shortages and burdensome and unsustainable levels of curtailment should multi-year droughts deplete stored water in Loch Lomond reservoir. The WSAC explicitly acknowledged in its problem statement that long-term water conservation alone cannot ensure supply reliability for Santa Cruz water service customers.

1.4 Santa Cruz water service customers have embraced water use efficiency as a way of life, achieving an unprecedented level of residential indoor and outdoor use of 44 GPCD, with indoor only use stable at 35 GPCD and have taken actions to significantly reduce outdoor water use by more than 35% over the last two decades, which means that the opportunity to include further customer water use curtailments as key elements in Securing Our Water Future is severely limited.

1.5 Due to current customer water use practices, should curtailment of demand be mandatory, mandatory water rationing will be needed. All stages of the City's 2021 Water Shortage Contingency Plan (WSCP) include water rationing in which already highly efficient water use by residential and business customers would be curtailed. To protect the availability of water for public health and safety purposes under water shortage conditions requiring implementation of the WSCP, Section 16.01 of the Santa Cruz Municipal Code establishes significant excess use penalties and other actions for non-compliance with rationing allotments, which could further subject residential and business customers to financial hardship.

1.6 The consequences of routine and potentially significant water use curtailments to water service customers and the impacts to the region's economy and quality of life is a real threat that has been documented by an economic impact analysis of the costs of curtailments developed as part of the Securing Our Water Future initiative. These consequences can be mitigated through expeditious action to add new resources to Santa Cruz's water supply portfolio.

1.7 Climate change, which is already influencing weather patterns in Santa Cruz, is expected to increase the annual variability of Santa Cruz's water supply. This means that more frequent and longer drought conditions are likely, that there will be fewer normal and moderately wet years and that wet conditions, when they occur, are likely to substantially increase flooding events because of a shift in the pattern of precipitation to shorter and more significantly more intense storms. This increased variability is a substantial change from historic conditions and is <u>the</u> key driver of sizing supply augmentation projects.

1.8 Long-term demand projections for the Santa Cruz water service area include modest growth over the 25-year demand projection period and reflect water use required to accommodate increased housing, mostly in the form of multi-family housing, and the additional water that is needed to support student housing as identified by University of California at Santa Cruz's 2020 Long Range Development Plan.

1.9 Even without additional modest growth in water demand, the Santa Cruz water system cannot provide reliable service to its customers because of its lack of storage and resulting vulnerability to severe water shortages should dry conditions persist over multiple years.

1.10 Because the impacts of climate change on Santa Cruz's water resources are already being experienced, there is an urgent need for immediate and sustained action to implement additional supply augmentation projects as needed to meet the reliability goal established by this policy. Additionally, appropriate implementation of adaptive management tools and techniques need to be implemented over time to assure that, as climate impacts evolve, supply reliability will continue to be a focus of assessment and action.

1.11 Based on Climate Stress Testing and Vulnerability Analysis work completed by Dr. Casey Brown and the Water Department's consultants, near term climate change trends indicated increasing variability will be more of a challenge than changes in mean annual precipitation. Longer term climate trends include both increased variability as well as reduced precipitation, resulting in significantly more challenging conditions of longer, more frequent, and deeper droughts.

1.12 Our understanding of and need to continue our work to adapt to climate change is supported by the Vulnerability Analysis, Climate Stress Testing, Water Balance and SCWS modeling tools that have been developed by the Water Department and its consultants as part of the Securing Our Water Future and WSAIP work. Maintaining, updating, and using these tools to inform climate adaptation planning for water supply will be key to the timely development of needed water supply augmentation projects and climate adaptation strategies for ensuring the resilience of water system and its facilities in the face of climate change.

2. Water Supply Reliability Goal

2.1 The City of Santa Cruz's water supply reliability goal shall be achieved by having an adequate supply to meet all customer demand under plausible, worst-case conditions.

2.2 The <u>initial</u> assessment of plausible worst-case conditions shall be based on the review of Water Supply Vulnerability Analysis and Climate Stress Test work completed by Dr. Casey Brown and his team in the summer and fall of 2022 using the following parameters:

2.2.1 **Temperature Parameter:** 2° C increase in temperature (dT = +2º C),

2.2.2 **Precipitation Parameter:** No change in precipitation (dP =100% of average), and

2.2.3 **Coefficient of Variability Parameter**: A +10% coefficient of variability (CV = 1.1).

In selecting these initial climate change parameters to use as the basis for near-term planning for supply augmentation projects, staff has considered a wide range of climate scenarios and chosen parameters that are moderate, plausible, and attempted to choose parameters that do not either over- or under-estimate the potential implications of near-term impacts of climate change on local water resources and water supply reliability.

The parameters shall be reviewed and updated no less frequently every five years as part of the regular update of the City's Urban Water Management Plan. The resulting review and revision may result in modifications to the volume of water that needs to be developed to meet the water supply reliability goal articulated in 2.1 above.

2.3 As curtailment of demand under the provisions of the state mandated Water Shortage Contingency Plan has been found not to be an effective tool for addressing anticipated water shortages for longer or more frequent dry conditions, its use shall be limited to the infrequent implementation of Stage 1 of the plan where the 10% demand reduction associated with Stage 1 curtailments is determined to be critically necessary to protecting supply availability for public health and sanitation purposes.

3. Santa Cruz's Water Supply Portfolio

3.1 Resources available to achieve water supply reliability in Santa Cruz are limited to those available locally, including surface water flows from local rivers and streams during wet seasons, local groundwater resources, various forms of advanced treated recycled water, and seawater desalination.

3.2 All available supply augmentation source options have been found to be technically viable and reliable from a long-term availability perspective considering the potential impacts of climate change. In various circumstances as they may develop into the future, development of one or more of these sources may be determined to be the most appropriate and effective way to ensure water is available to meet the City's public health and safety and economic sustainability goals.

4. Considerations In Developing Water Supply Augmentation Projects

As part of the Securing Our Water Future process, Water Department staff worked with Water Commissioners to use, adapt, and update as needed the evaluation criteria developed and recommended by the WSAC. This policy incorporates these criteria as updated by the Department's active engagement with the Water Commission in the years following completion of the WSAC's work.

The goal of integrating the guiding principles, key criteria and additional criteria in this policy is to confirm that these criteria are important to the consideration and selection of supply augmentation projects to pursue and to set an expectation for transparency. Attachment A to this resolution and policy includes more detailed definitions of each of the key criteria and additional criteria.

4.1 Guiding Principles

4.1.1 Public Health – Protecting public health is every water utility's most fundamental duty. The Water Department as an organization, and its individual employees, work every day to produce and deliver an adequate supply of high-quality water that complies with numerous public health-based regulatory standards and is used for human consumption, sanitation, for other domestic and commercial use and for fire protection.

4.1.2 Affordability and Equitable Access to Water – Water service is critical to public health and community wellbeing. The City and Water Department recognize that rising costs of water to address system vulnerability, climate adaptation and supply reliability presents affordability challenges to customers and are committed to taking steps during the planning and implementation of projects needed to ensure a reliable water supply and equitable access to service for everyone. Given the limitations of Proposition 218 that prohibits directly subsidizing the cost of water service for those least able to pay, options for addressing locally addressing water affordability are limited, but staff is committed to continuing to advocate for state and federally funded programs for those in need.

4.1.3 Public Acceptance – During the WSAC process and throughout the ensuing work in collaboration with the Water Commission over the intervening years, connecting with community interests, customers, and members of the public about the need for and the approach to improving the reliability of Santa Cruz's water supply has been a key focus of the design and execution of the Department's work. Along with the yield, costs, timeliness, and technical feasibility of various supply augmentation alternatives, the WSAC identified and applied criteria reflecting the community's values, and also considered energy use, and environmental impacts of the alternatives. All the WSAC's values and considerations have been carried forward in the work that has occurred following the end of the WSAC process and are recommended to be carried into future work as important criteria that, when objectively evaluated and transparently communicated, are aligned with the goal of establishing and maintaining public trust.

4.1.4 Regional Collaboration – Consistent with the goal of achieving a sufficient water supply, the City is committed to regional collaboration to improve water supplies, achieve groundwater sustainability, protect the Santa Cruz Mid-County Groundwater Basin from further seawater intrusion and support the protection and restoration of critical aquatic habitats and the resources dependent upon these ecosystems.

4.1.5 Incremental Implementation – The reality of developing a water supply augmentation project is that such projects take a long time to fully develop due to the required feasibility work, environmental reviews, design and permitting and what is often multi-year construction. Projects developed with regional partners also require development of agreements and funding arrangements at various stages of the work, which also requires time and effort. An incremental implementation strategy supports near-term progress that is important for reducing Santa Cruz's vulnerability to water shortages caused by multi-year droughts while also allowing for simultaneous work on the often-time-consuming early planning and feasibility work to move forward with long-term projects.

4.1.6 Ongoing Community Engagement – The Santa Cruz Water Commission has a long history of engagement with the Water Department on supply augmentation planning and shall continue to be a forum for the active engagement of community interests and the public in this important work. A key goal of Water Commission engagement shall be to maintain transparency through the process of developing and implementing water supply augmentation projects.

4.2 Primary Evaluation Criteria

4.2.1 Cost Metric – Cost-effectiveness is an important consideration in decision-making about supply augmentation projects under development. Useful cost metrics include total capital costs, annualized capital costs, annualize operation and maintenance costs, and unit costs based on both average production and maximum production. To the degree feasible, cost-effectiveness data will be developed and compared for available supply augmentation alternatives at the time a decision is made to proceed forward with a project or pursue an alternative.

4.2.2 Yield Metric – The Yield Metric is the most straightforward and quantifiable of the evaluation criteria. The supply reliability goal described in section 2 of this policy is used to define the yield needed to achieve reliability. Project yield analyses need to relate to the volume of water needed to meet the supply reliability goal, as it is defined and updated at least every five years as part of the update to the Urban Water Management Plan.

4.2.3 Timeliness Metric – Water projects typically take a decade or more to develop and implement. Planning work on supplemental water supply has been underway since completion of the WSAC work in late 2015. The WSAC's timeliness metric set a10-year target for achieving water supply sufficiency, with sufficiency defined as having a fully functional water system able to meet the supply-demand gap forecasted during extended droughts.

The Securing Our Water Future Policy acknowledges that, due to the length of time required to develop supply augmentation projects, and the need to use an ongoing and evolving understanding of the impacts of climate change on water supply reliability, incremental implementation of augmentation projects to address the supply deficit will be required. To reduce the vulnerability to nearer term droughts, however, supply augmentation producing at least 500 million gallons a year of additional supply by 2027 should be completed.

4.3 Additional Criteria – The following additional criteria are further characterized and defined in Attachment A-1 to this policy. These criteria are aligned with the criteria and values developed by WSAC for use in evaluating water supply augmentation projects and sharing those evaluation results with the community to support both data-driven and transparent decision-making.

4.3.1 Project's supply contribution as a percent of worst year supply shortfall;

4.3.2 Increases resilience to climate change;

4.3.3 Is understood and accepted by the public and key stakeholders;

4.3.4 Scalable or can be implemented incrementally or in phases;

4.3.5 Technical feasibility;
4.3.6 Likelihood of project being funded by state or federal grants;
4.3.7 Opportunity for shared funding;
4.3.8 Greenhouse gas emissions (from both construction and operations);
4.3.9 Time required for implementation;
4.3.10 Operational complexity;
4.3.11 Energy use;
4.3.12 Potential impacts for CEQA-required mitigation;
4.3.13 Adaptable to future regulatory or source water changes; and
4.3.14 Degree of administrative complexity.

5. Policy Implementation

Subject to the same general terms and provisions for Council review and approval used for the development and implementation of capital investment projects in the City of Santa Cruz, the Santa Cruz Water Department is authorized to pursue any of the following or other similarly related activities in implementing this Policy:

5.1 Conduct planning, preliminary engineering, and technical feasibility analyses for supply augmentation alternatives;

5.2 Consider Primary and Additional Evaluation Criteria in Section 4, evaluate and select supply augmentation projects needed to achieve the Water Supply Reliability Goal described in Section 2 of this Policy;

5.3 Prepare project designs, environmental reviews, and complete project permitting activities;

5.4 Select and implement project development and construction delivery methods using any procurement method authorized by the City Charter and Municipal Code;

5.5 Recommend for Council consideration and action any other steps required to achieve compliance with relevant City Charter provisions; and

5.6 Develop and recommend to the City Council for consideration or action as appropriate any agreements with other regional water providers for partnerships, joint ventures, or other collaborative approaches to improving water supply reliability, groundwater sustainability, environmental, and natural resource management and protection, or mutually beneficial projects or partnerships in support of water supply and water system resiliency, and climate adaptation.

The Water Department will continue to actively engage with the Santa Cruz Water Commission and the public in the implementation of this Policy as well as inform and involve the larger community, customers, and interests as appropriate.

Attachment A-1 – Additional Supply Evaluation Criteria

WATER SUPPLY PROJECT EVALUATION CATEGORIES, SUB-CATEGORIES AND DEFINITIONS	
QUANTITATIVE CATEGORIES	
Criterion	**Definition or Explanation** **The criterion provides information about:**
Project Costs	
• Annualized cost per million gallons (and acre foot) of supply	• Full cost analysis of operating and capital costs for the project
Project Yield	
• Project supply contribution as a % of the worst year supply shortfall	• The percent contribution to reducing the worst year supply gap provides information about the degree to which a project can contribute to closing the supply gap
Energy Profile and Climate Mitigation	
• Energy use (KWh/year)	• The amount of energy required annually to operate the project.
• Greenhouse gas emissions associated with the project (metric tons of carbon dioxide equivalents released (MT of CO_{2e})	• The amount of greenhouse gases associated with the construction and operation of a project. (Similar to the energy version of annualized or life-cycle cost)
Timeliness	
• Time required to begin producing additional an increment of water that makes a significant contribution to improving the system's water supply reliability (months/years)	• The number of years required (from date of evaluation and green light to proceed) to complete technical feasibility work, pre-design, design, CEQA, permitting, construction, commissioning and start-up of a project that produces additional water supply
Technical Feasibility	
• Technical Feasibility (yes/no ratings for each element that comprises a project's technical feasibility benchmarks) o Example sub-elements for technical feasibility can include constructability	• The technical and engineering aspects of a project are realistic and achievable and can and will contribute to improving supply reliability
• Operational complexity (high/medium/low)	• Whether/how the project's operation does or does not add significantly to the operational complexity of the existing system

Qualitative Categories	
Criterion	**Definition or Explanation** **The criterion provides information about:**
Environmental Impact	
• Potential impacts of any CEQA-required mitigation that could significantly affect project cost, yield or timeliness parameters (high/medium/low or additional gradations of this scale)	• The likelihood for potentially large impacts to cost, yield, or timeliness parameters from CEQA required mitigation for the supply augmentation project.
Funding and Financing	
• Likelihood of the project being fundable with federal or state grant funds (highly likely/unlikely with gradations)	• The potential for the project to be grant funded. An example is the US Bureau of Reclamation's Title XVI grant program that is specifically designed to fund recycled water projects.
• Opportunity for shared funding (yes/no)	• The potential for shared funding through partnerships with other regional water agencies.
Public Acceptability	
• The degree to which there is public understanding and acceptance for the projects under consideration.	• Whether a project (or projects) is understood and accepted by the public and key stakeholders.
Administrative Feasibility	
• Degree of complexity with respect to regulatory, permitting, right of way, or legal issues and the time required to address and resolve the identified issues (for complexity: high/ medium/low) (for time requirement: number of months or years)	• The complexity and time required to address regulatory, permitting, right-of-way and/or legal issues related to a supply augmentation project and the amount of time needed to address or resolve those issues.
Adaptive Flexibility	
• Increases resiliency to climate change (high, moderate, low) specifically related to: o Certainty of supply during drought o Certainty of supply during extreme wet weather; o Vulnerability to shifting patterns of precipitation due to climate change; o Seawater intrusion; o Coastal inundation and sea level rise; o Wildfire	• How a project may (or may not) be able to adapt to changing conditions or be functional in the face of climate change, wildfire, seismic or other natural disasters.

○ Seismic events ○ Other natural disasters	
• Project includes characteristics that provides for scalability or provides for it to be implemented incrementally or in phases over time (yes/no)	• The degree to which the project can be relatively easily expanded or scaled up over time or implemented in increments or phases.
• Adaptability to future uncertainty from regulations or source water changes (yes/no)	• Whether or how well a project may (or may not) be able to adapt to changing regulations or source water quality changes.

SECURING OUR WATER FUTURE

SUMMARY MEMO
Santa Cruz Climate Vulnerability Assessment and Climate Stress Testing
and
Effectiveness of Water Supply Augmentation Project Concepts in Addressing Shortages

INTRODUCTION:
In water supply planning processes, modeling is a critical tool that supports assessing both the size of the water supply problem that needs to be addressed and how various supply options contribute to reducing or eliminating anticipated shortages. Historically the Santa Cruz Water Department has used the 1990s era Confluence® model for this purpose. Confluence served the City well until it became clear that there was a need to have a modeling system that provided a more robust capacity to evaluate potential future climate changes and their impact on water supply.

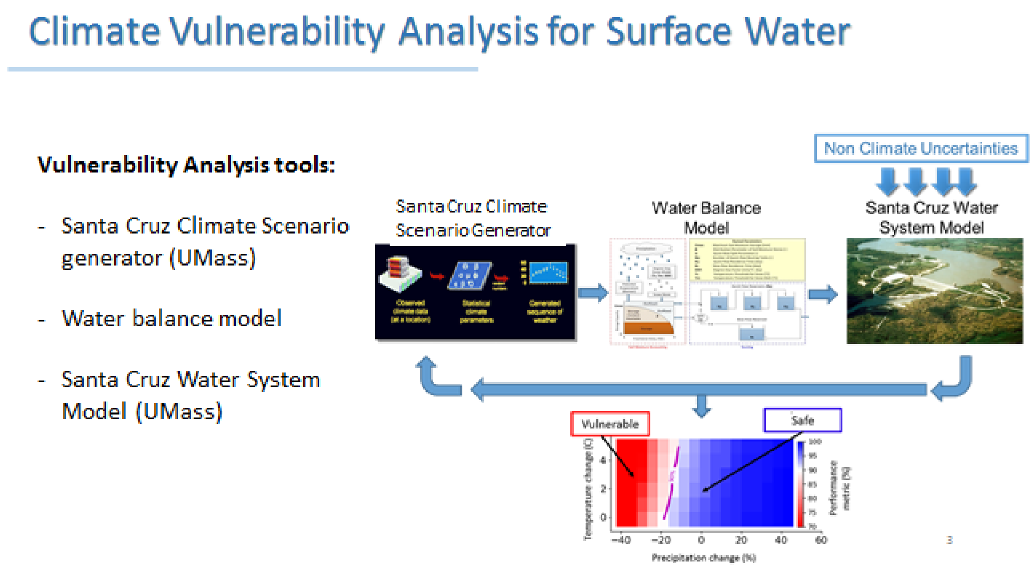
Water Department staff and a team of consultants led by Dr. Casey Brown from the University of Massachusetts at Amherst's Hydrosystems Research Group and Dr. Shawn Chartrand formerly of the City's long-time hydrology consultant, Balance Hydrologics, and now at Simon Fraser University's School of Environmental Science in Vancouver, British Columbia, and including Gary Fiske with his long experience supporting water supply modeling for the Confluence model, has developed a new water supply planning model for the Santa Cruz water system that is now in use. This model is called the Santa Cruz Water System Model (SCWSM). This memo provides a high-level overview of the components of the SCWSM and of key results of the water system vulnerability assessment and evaluation of the effectiveness of water supply augmentation project concepts developed to support the Securing Our Water Future policy-setting process.

Referenced at the end of this Summary Memo are slides from several power-point presentations provided by Drs. Brown and Chartrand to the Santa Cruz Water Commission on May 2nd, July 21st, August 29th, and October 3rd, 2022. Audio and video files for these meetings are available at
https://ecm.cityofsantacruz.com/OnBaseAgendaOnline/Meetings/Search?dropid=4&mtids=124.

VULNERABILITY ANALYSIS INPUTS TO THE SANTA CRUZ WATER SYSTEM MODEL:
Figure 1 is a schematic of the approach being used to conduct the climate vulnerability analysis approach using the new SCWSM. Two key inputs, the Santa Cruz Climate Scenario Generator and the Water Balance Model are used together to create thousands of different climate scenarios that are then run through the SCWSM to see how the system performs across a large range of plausible future climate conditions. The product is a long-term vulnerability assessment where tipping points (or thresholds) are identified. Thresholds are defined as climate conditions (i.e.,

future change in average change in precipitation and temperature) from which the system is no longer performing with the expected level of performance.

Figure 1 – SCWSM Key Inputs and Outputs



Each of the key vulnerability analysis inputs is discussed in more detail below.

Santa Cruz Climate Scenario Generator

Climate change is introducing new challenges for water suppliers. One of those challenges involves identifying climate scenarios to evaluate. Among other things, when choosing climate scenarios, it is important to ensure that those selected provide enough diversity so that planning addresses a reasonable range of potential futures.

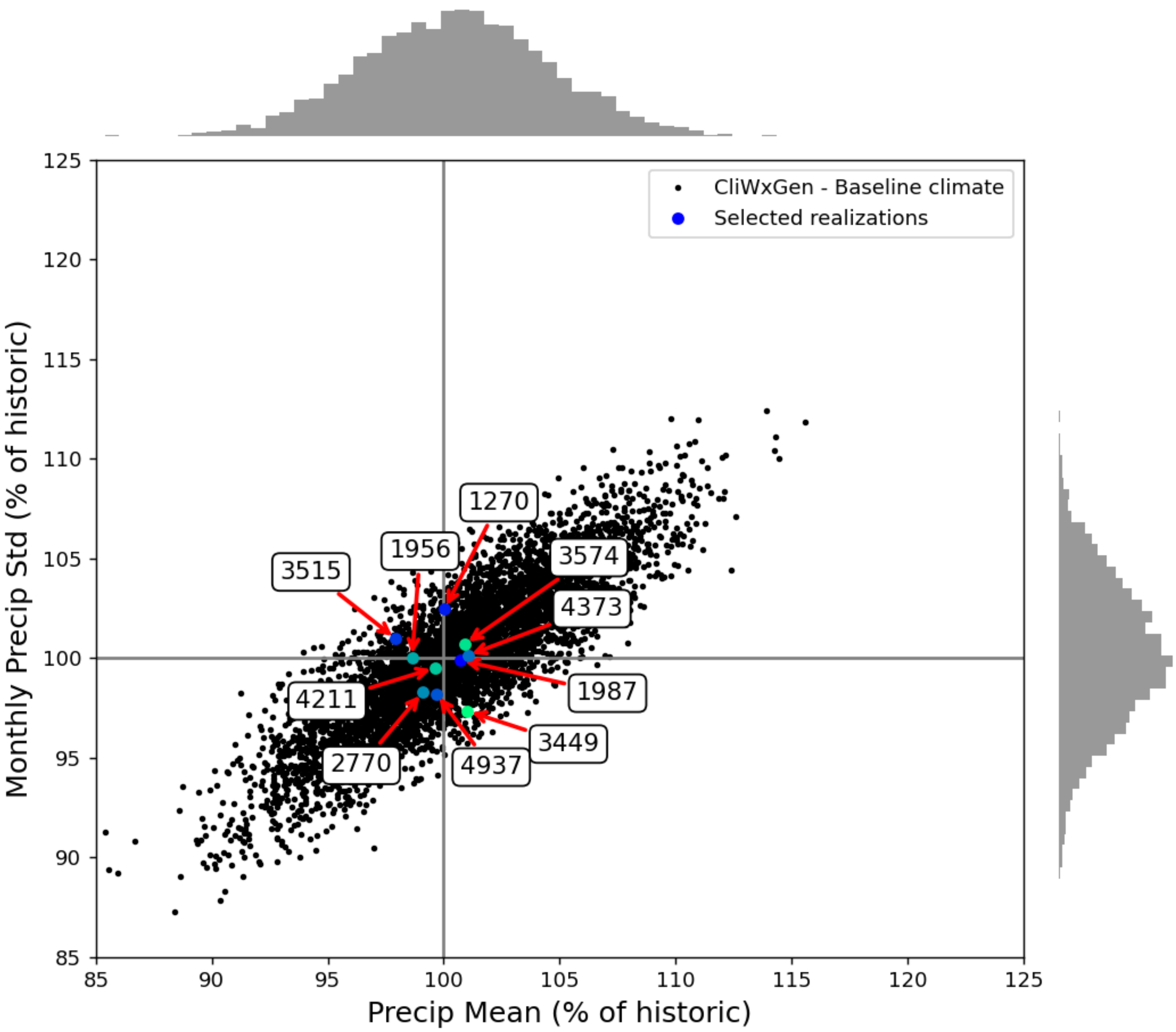
The SCWSM's Climate Scenario Generator creates a wide range of tailored climate change scenarios that are used for "stress testing"[1] the water system. Five thousand plausible climate scenarios (hereafter called realizations) were created to represent the historical climate variability in terms of precipitation and temperature.

Among these 5,000 realizations, ten were selected for use in further detailed analyses (numbered colored dot in Figure 2.) The selected realizations best represent the historical climate variability; for instance, Figure 2 shows the 10 selected realizations are clustered around the historical values). Next, future climate change scenarios are created from these 10 realizations by altering some of their statistics, namely the average temperature (increases of zero to + 7 º C), the

[1] Stress testing involves assessing how the water system performs over a wide range of plausible future conditions and helps identify the specific conditions that are most challenging for the system.

average precipitation (ranging from minus 40% to plus 40%) and annual precipitation variability (increase in coefficient of variation[2] up to 50%).

Figure 2 – Climate Scenarios with Selected Realizations shown as Numbered Colored Dots[3]



Water Balance Model

Water systems that are dependent on surface water resources such as Santa Cruz's will typically use hydrologic datasets (flow sets) as an integral input to water system planning. Santa Cruz Water Department has worked with Shawn Chartrand and Balance Hydrologics for decades on

[2] The coefficient of variation is a relative metric that expresses how much a variable fluctuates around its means. Higher coefficient of variation means that the variable fluctuates more.
[3] The vertical axis in Figure 2 shows the monthly standard deviation of precipitation as a % of historic standard deviations.

preparing flow sets[4] for input to the Confluence model to support a wide range of analyses and planning products, including:

- Anadromous Salmonid Habitat Conservation Plan development;
- Water Supply Advisory Committee water supply planning work (2014-2015), and
- Santa Cruz Water Rights Project Change Petitions and Environmental Impact Report.

More recently, Dr. Chartrand has been supporting the water system vulnerability analysis through the development of thousands of new 100-year flow sets using the Climate Scenario Generator's potential future climate options (combinations of future temperatures and precipitation) to be utilized in the water system vulnerability analysis.

Table 1 shows the full spectrum of the scenarios that have been developed, and an example of the 100-year flow sets is provided in Figure 3 below. The scenario in Figure 3 is for Climate Realization 1270, with a 2 degree C increase in temperature, a 10% decrease in annual precipitation, and no change in the coefficient of variability.

Table 1 – Full Range of Climate Change Scenarios for Use in Stress Testing

Scenarios for the climate stress test - Summary

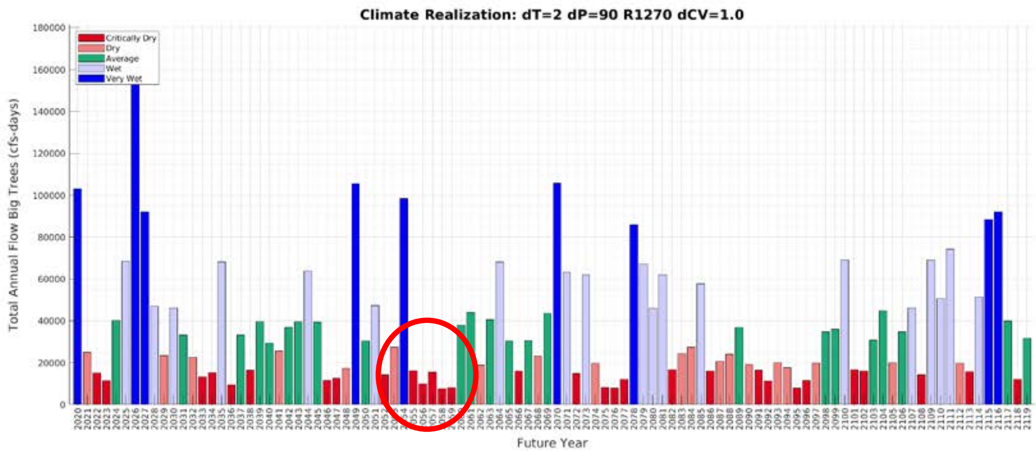
Type of Uncertainty	Sampling Range	Sample Size
Natural climate variability	Stochastic realizations (100-yr long)	10 realizations
Changes in mean annual precipitation	-40% to +40% with 5% increment	17 change factors
Changes in mean annual temperature	0 to 7 C with 1 C increment	8 change factors
Changes in coefficient of variation of annual precipitation	0 to +50% with 10 % increment	6 change factors
Change in mean annual water demand	Water Demand Forecasts (2020 urban water management plan)	5 forecasts
Total		**40,800 simulations** (i.e., 4,080,000 years)

University of Massachusetts Amherst

Hydrosystems Research Group
University of Massachusetts, Amherst | July 21, 2022

[4] Flow sets are developed as a key input to modeling Santa Cruz's surface water resources that are available for diversion to water supply. Available water is diverted up to various constraints such as water rights, hydraulic capacities of various system facilities, customer demand etc. Since developing agreements with state and federal fishery agencies, flow sets for diversion to water supply are resources available after fish flow provisions have been met.

Figure 3 – 100 Year Hydrology for Climate Realization 1270, dT= +2, dP = -10%, CV = 1.0



Running all climate scenarios described in Table 1 through the water balance model produced a wide range of new hydrologic sequences, each covering a 100-year period. The new robust set of potential hydrologic futures being used for planning is both varied and plausible. Running the SCWSM with the new hydrologies modeling results provides insights into how the system performs, for example, during multi-year droughts and supports an ability to evaluate the occurrence of water shortages and their intensity for these future climate conditions, including for identified challenging sequences of back-to-back dry conditions.

Figure 3 provides an example of a challenging back-to-back critically dry year sequence shown in the red circled area of Figure 3. This scenario is a five-year drought that, without supply augmentation, produces three years of back-to-back significant shortages with year 3's shortfall being 1 billion gallons, year 4's being 1.1 billion gallons, and year 5's being 200 million gallons, for a three-year cumulative total of 2.2 billion gallons. The shortages in the last three years of the five-year sequence are so significant because Loch Lomond storage is depleted during the first two years in the drought and precipitation during the subsequent winters wasn't enough to even partially replenish storage.

SCWSM also provides a way to assess the benefit of supply augmentation options in reducing the occurrence and intensity of water shortages.

<u>Climate Scenarios Peer Review Panel</u>
Using climate scenarios that are plausible is important to establishing and maintaining the legitimacy of the water supply augmentation work. In his October 2022 Water Commission meeting presentation, Dr. Chartrand provided a detailed assessment of historic trends in local temperature and precipitation data that show that climate change is already occurring in Santa

Cruz. This analysis provides a strong foundation for the approach to creating climate change scenarios for the SCWSM's forward looking work on water supply planning.

Earlier in the development of SCWSM and related vulnerability analyses tools, a third-party peer review panel[5] was convened to review the assumptions, methods, and products for the critical weather and hydrology inputs to the SCWSM that drive model outcomes. Excerpts of the peer review panel's comments include:

- "The methods […] used to produce the weather generator flows (the Water Balance Model) are satisfactory, very thorough and rigorous."
- "[…] provide a credible baseline dataset for stress testing"
- "the climate perturbation range proposed […] provides an appropriate and adequately taxing range of conditions over which to test system reliability"

Additionally, the review panel made the following recommendation:

- "an additional axis of uncertainty [should be] considered to test the system against changes in precipitation variability of up to +50% increase in the coefficient of variation of precipitation."

<u>Coefficient of Variation</u>

This peer review panel's recommendation on variability of precipitation relates to an emerging weather pattern often referred to as "whiplash weather," in which year to year variability in year-to-year precipitation is increasing resulting in wetter wet years and dryer dry years. Dr. Chartrand's October 2022 Water Commission meeting presentation shows examples of whiplash weather from recent history as well highlighting similar conditions in some of the climate change hydrologies[6] created by the Water Balance Model that are being used in supply planning.

Climate scenarios with increased variability basically result in the wet years getting wetter and the dry conditions becoming drier and longer lasting, although mean annual precipitation levels may not change or slightly deviate from the historic annual mean. For Santa Cruz, longer and more intense dry conditions are particularly challenging because of Santa Cruz's limited ability to store water in wet years that can provide enough stored water for use during drier years or multi-year periods. Using one scenario presented to the July 2022 Water Commission meeting, a 10% increase in variability resulted in about a 20% increase in the volume of shortage over the

[5] William Werick, Joseph Barsugli, and Andrew Schwarz P.E. were convened as the Peer Review Panel for the Weather Generator Model and Climate Change Stress Test, which produced its final report in September 2021. Mr. Werick is a water resources planner Werick Creative Solutions LLC in Culpepper Virginia. Dr. Barsugli is a research scientist at the Cooperative Institute for Research in Environmental Sciences at the University of Colorado at Boulder. Andrew Schwarz is the State Water Project Climate Advisor for the California Department of Water Resources.

[6] Climate change hydrologies are specific 100-year flow set for a climate realization, with specific assumptions about temperature change (from 0º C to 7º), precipitation change (from -40% to +40%) and coefficient of variation (from 1.0 to 1.5).

three worst years. A 20% increase in variability of precipitation increased the volume of shortage estimated for the same condition by nearly 50%.

OUTPUTS OF THE SANTA CRUZ WATER SYSTEM MODEL

Those familiar with the decades-long water system planning work completed by the Santa Cruz Water Department will recognize the kinds of products typically produced by modeling exercises. Included are things like projections of the size and frequency or probability of shortages analyzed under base case conditions[7] reflecting the existing water system, and under conditions in which identified supply augmentation options are implemented. These projections were made using historic hydrologic conditions and/or a limited number of climate change hydrologies. For example, Water Supply Advisory Committee and Water Commissioners have seen modeling work looking at how changes in the Graham Hill Water Treatment Plant treatment process could contribute to increased supply due to increased ability to treat more turbid water than the current plant can handle.

With the advent of increased computing speeds and modeling approaches, the new SCWSM has greatly expanded capability to look at varying conditions and options, including a much greater ability to consider how potential future climates could affect system performance without and with the benefit of various water supply augmentation strategies. The sections below briefly describe the key uses and results of the modeling work completed to date.

Climate Stress Testing

Climate stress testing is a major objective of the work done to develop the new SCWSM and vulnerability analysis tool. Stress testing allows planners to assess conditions such as changes in temperatures, precipitation, or variability associated with climate change and to projected demand to understand the condition changes that are most challenging. Specific objectives include:

- Simulate the widest range of plausible futures to understand sensitivity of the system to climate change conditions;
- Identify climate change conditions that are problematic for the system and are determined to be vulnerabilities of the system;
- Understand the probabilities and size of water supply shortages under various conditions to select climate scenarios to use for water supply planning and for setting a water supply reliability goal.

Climate stress test and vulnerability analyses results were presented at the July 2022 Water Commission meeting. Results were based on the worst year water supply shortage projected from the ten selected Realizations, which turned out to be a five-year drought sequence from Realization 1270. As noted earlier, when modeled, this drought sequence produces a total shortage of 2,200 MG, and shortages weren't recorded for years one and two of the five-year

[7] Base case conditions means conditions without the impacts of climate change.

sequence because storage has been used to meet the deficits during the first two years of the drought. Stress testing results also included one-, two-, and three-year cumulative shortages for the maximum deficit in worst-case condition and for the 98th percentile shortage.[8] Table 2 summarizes the results.

Table 2 Cumulative Shortages under No-Climate Change and Climate Change Scenarios Using 2020 Water System Demands of 2.6 billion gallons/year

	98th percentile of deficit (MG)		Maximum deficit (MG)	
dP[9] **dT[10]**	0% 0C	-10% +2C	0% 0C	-10% +2C
1-YR	27 (1%)	243 (9%)	923 (35%)	1065 (41%)
2-YR	139 (5%)	650 (25%)	1535 (59%)	2095 (80%)
3-YR	257 (10%)	840 (32%)	1561 (60%)	2205 (85%)

The results from Table 2 show the extreme sensitivity of the water system to worst year conditions, with significant increases in deficits between a 98th percentile calculated shortage and a maximum (worst case) shortage. Table 3 provides more detail.

Table 3 Comparison of Cumulative 98th Percentile and Worst-Case Deficits under No Climate Change and Climate Change Scenarios

	No Climate Change			-10% Precip +2°C Climate Change		
	98th percentile deficit (MG)	**Maximum deficit (MG)**	**98th percentile deficit as a percent of the maximum deficit**	**98th percentile deficit (MG)**	**Maximum deficit (MG)**	**98th percentile deficit as a percent of the maximum deficit**
1-YR	27	923	3%	243	1065	23%
2-YR	139	1535	9%	650	2095	31%
3-YR	257	1561	16%	840	2205	38%

Even without the impacts of climate change, the 98th percentile 3-year shortage is just 16% of the maximum deficit. For the climate change scenario, the 98th percentile deficit is 38% of the

[8] The 98th percentile shortage has a 2% chance of occurring in any given year. Sizing a water supply augmentation strategy to meet the shortage deficit for the 98th percentile event requires a smaller volume solution but basically leaves the system exposed to low probability but, as it turns out, very high consequence shortage events be dealt with via other means such as curtailment of demand. Due to the highly efficient water use practices of Santa Cruz's water users, demand curtailments are not a very effective options for dealing with large supply deficits as curtailments would need to be deep and potentially long-standing.

[9] dP = assumption in the climate change hydrology about change in precipitation

[10] dT = assumption in the climate change hydrology about change in temperature

maximum. These results demonstrate what has generally been understood, which is that climate change is likely to make water supply deficits larger, but also show the significant difference between the size of shortages between a 98th percentile figure and the worst-case deficit. These results are important to consider when thinking about sizing water supply augmentation projects and making decisions about the system's water supply reliability goal. Adding a lower volume of additional supply and depending on curtailments to make up the difference may expose customers and the community of the potentially significant and unsustainable levels of curtailments than would be required if the amount of supply augmentation is larger.

Effectiveness of Water Supply Augmentation Project Concepts in Addressing Shortages

To support the Securing Our Water Future policy setting process, Water Department staff has worked with the Kennedy Jenks consulting team led by Claudia Llerandi P.E. to develop a set of water supply augmentation project concepts to evaluate their ability to contribute to reducing or eliminating the water supply deficits identified in the vulnerability analyses and climate stress tests. The four project concepts[11] that have been developed include:

1. Aquifer Storage and Recovery (ASR) in the Santa Cruz Mid-County Groundwater Basin;
2. Indirect Potable Reuse (IPR) of advanced treated wastewater in the Santa Margarita Groundwater Basin;
3. Direct Potable Reuse (DPR) of purified wastewater (advanced purified and disinfected); and
4. Seawater Desalination.

These four projects are examples of the kinds of water supply augmentation options that the City has available using local surface water, wastewater, and seawater resources. The four projects included differing assumptions and constraints, but the constraints are not based on typical constraints used in water system modeling, for example, pipeline hydraulic capacity. Rather, the constraints are based on what was known at the time about how the projects could be configured. Other options exist for configuring projects or combining project types into water supply portfolios, and these options will be more fully explored in the planned Water Supply Augmentation Implementation Plan (WSAIP) process that will be completed in 2024.

In addition to using the four water supply augmentation project concepts to assess how they would reduce or eliminate supply deficits, a second goal was to compare these project concepts against the WSAC's recommended key performance metrics and criteria such as cost, timeliness, yield, greenhouse gas production, operational complexity etc. The results of this comparative evaluation along with additional details for each project are covered in a separate Summary Memo. Here the focus is on how the projects contribute to deficit reduction.

In developing the project concepts, the ASR and IPR projects assume different volumes of both water available to store in the two local groundwater basins (the Santa Cruz Mid-County Groundwater Basin and the Santa Margarita Groundwater Basin, respectively) and different

[11] See separate summary memo on the Water Supply Augmentation Project Concepts for details

volumes of water that are available for withdrawal base on constraints associated with the Groundwater Sustainability Plans for each basin. For the DPR and Desal, both projects assume the construction and operation of treatment facilities with a 3 million gallon per day capacity, which is why the results for these two projects are shown together. Figure 4 summarizes the results of the analysis of how each project impacts deficit reduction.

Figure 4 Supply Augmentation Projects Impacts on Deficit Reduction[12]

Reservoir Drawdown Climate Change (P: -10%, T: +2C)

- **For the planning scenario, DPR/DESAL, ASR, and IPR can respectively decrease the 3-yr deficit during the worst-case multi-year drought from 2,200 MG to 340, 910, and 1500 MG**

	Max Annual Deficit (MG)			
	No Adapt.	with ASR	with IPR	with DPR /DESAL
2058	1,030	160	570	-
2059	1,060	690	840	310
2060	110	60	90	10
3-yr Cumulative	2,200	910	1,500	340

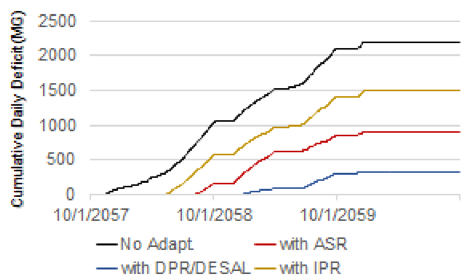


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Figure 6 shows that both ASR and IPR have some impact on reducing the cumulative deficits in the climate change scenario being modeled. However, neither of the options, as configured in the project concepts can fully address the modeled deficits. It may be that other configurations of these options, or perhaps a combination of these options would have a bigger impact, but that is not the question that is being evaluated at this time. The Water Supply Augmentation Implementation Plan (WSAIP) also under development will tackle those issues.

For DPR and Desal, both plants were modeled based on a 3 million gallon per (mgd) day facility operating at 1 mgd during the winter, 2 mgd during the summer and at 3 mgd when Loch Lomond reservoir levels falls to 2 billion gallons and run at 3 mgd until Loch Lomond recovers to full capacity. Clearly these operating assumptions influenced the unmet deficit show in Figure 6. As work on the WSAIP proceeds, alternate operating assumptions for these two augmentation strategies will be evaluated to document their performance in reducing or eliminating deficits.

[12] As noted earlier, the scenario being evaluated in this example is a 5-year drought sequence in which no shortages are recorded in years 1 and 2 (2056 and 2057) because available storage in Loch Lomond is being drawn down to cover customer demand.

CLIMATE CHANGE SCENARIO TO USE IN SUPPLY PLANNING

Work presented to the Water Commission at its July, August and October meetings focused on looking at how the worst year drought across all 10 climate realizations. Realization 1270 with its five-year drought sequence turns out to be the worst case drought for deficits whether you under several different versions of assumptions about precipitation change, including no precipitation change and -10% precipitation change, and under 1.0, 1.1, and 1.2 Coefficients of Variability.

Selecting an initial scenario for use in assessing the volume of water needed to reliably meet demand involved several iterations but ultimately resulted in identifying two scenarios with common outcomes:

1. Realization 1270, no precipitation change (dP = 100), +2° C temperature change (dT = +2° C) and a Coefficient of Variation of 1.1 (CV = 1.1); and
2. Realization 1270, -10% precipitation change (dP = 90%), +2° C temperature change (dT = 2° C) and a Coefficient of Variation of 1.0 (CV = 1.0).

These two scenarios both produce maximum deficits of 2.2 billion gallons over the last three years of the five-year drought sequence, which lends robustness to the results and supports using these moderate, plausible scenarios as the initial basis for supply augmentation planning. The policy section of the Resolution on Securing Our Water Future identifies the first scenario as the initial basis for planning for both better simplicity and clarity, choosing the scenario that doesn't assume a change in precipitation but includes somewhat increased variability because these choices seem more aligned with recent experiences where precipitation patterns are changing more so than total precipitation.

Figure 5 shows is similar to Figure 4 but shows the results for the Realization 1270, with no precipitation change (dP = 100), +2° C temperature change (dT = +2° C) and a Coefficient of Variation of 1.1 (CV = 1.1).

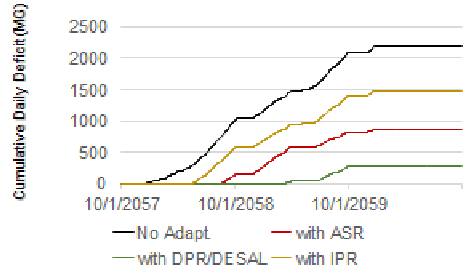
Figure 5 Supply Augmentation Projects Impacts on Deficit Reduction

Reservoir Drawdown

Climate Change (P: 0%, T: +2C, CV: +10%)

- For the planning scenario, DPR/DESAL, ASR, and IPR can respectively decrease the 3-yr deficit during the worst-case multi-year drought from 2,190 MG to 280, 860, and 1,470 MG

	Max Annual Deficit (MG)			
	No Adapt.	with ASR	with IPR	with DPR /DESAL
2058 (Year 4)	1,000	140	570	0
2059 (Year 5)	1,080	690	830	270
2060	110	40	80	10
3-yr Cumulative	2,190	860	1,470	280



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References

May 2, 2022 Water Commission Meeting – Update on Vulnerability Analysis and Climate Change Stress Testing – Dr. Casey Brown
https://ecm.cityofsantacruz.com/OnBaseAgendaOnline/Meetings/ViewMeeting?id=1900&doctype=1

July 21, 2022 – Workshop on Water Supply Vulnerability Assessment – Dr. Casey Brown
https://ecm.cityofsantacruz.com/OnBaseAgendaOnline/Meetings/ViewMeeting?id=1932&doctype=1

August 29, 2022 – Securing Our Water Future Additional Modeling Results for Supply Augmentation Projects – Dr. Casey Brown
https://ecm.cityofsantacruz.com/OnBaseAgendaOnline/Meetings/ViewMeeting?id=1952&doctype=1

October 3, 2022 – Securing Our Water Future Additional Modeling Results for Supply Augmentation – Dr. Casey Brown; Presentation on Local Hydrology historic perspective and potential future climate hydrology – Dr. Shawn Chartrand
https://ecm.cityofsantacruz.com/OnBaseAgendaOnline/Meetings/ViewMeeting?id=1980&doctype=1

SECURING OUR WATER FUTURE

SUMMARY MEMO

Water Supply Augmentation Project Concepts

BACKGROUND/CONTEXT

The Securing our Water Future (SOWF) policy framework codifies guidance for selection and implementation of the water supply augmentation projects needed to meet water supply reliability standards as defined in the policy. While the policy characterizes the scale of the water supply shortage, establishes acceptable levels of curtailment during drought, and identifies the basic source water options that are available to develop supplemental supply, the project(s) and timing for implementation will be defined in the coming years within the Water Supply Augmentation Implementation Plan (WSAIP) that will be created in collaboration with the Water Commission and subsequently approved by City Council within the next 18-24 months.

To support development of the SOWF policy framework, Water Department staff and consulting team members used work completed over the last several years to create a set of four supply augmentation project concepts. These project concepts provided the information needed to complete the comparison of supply augmentation alternatives identified by the Water Supply Advisory Committee (WSAC). (See References below for more information on WSAC.).

Project concepts developed for the SOWF were selected because

1. They were identified by the WSAC as potentially feasible alternatives that should be scrutinized in further detail.
2. They demonstrated a degree of feasibility (or met various feasibility metrics) in solving the water supply gap during the intervening years of evaluation (WSAC and present).
3. They included a project concept for each potential source water resource available, providing relevant and comparable information about a full range of project types that could be developed if/when needed.

The project concepts developed for the SOWF do not

1. Include demand management, or water conservation, as this is an ongoing effort where the community has very successfully met the goals recommended by the WSAC.
2. Include water transfers and exchanges because these alone cannot provide meaningful supply volumes to address Santa Cruz's anticipated future shortages; however, these will be considered in future evaluations of alternative portfolios in the WSAIP.
3. Necessarily meet the water supply gap entirely, in part because of the focus on the basic sources of water but also because an equitable evaluation requires that concepts be based on similar levels of detail; together this limited the scale of some concepts.
4. Combine with other alternatives. Rather they consider only one source of water and one end use; larger projects or portfolios of projects will be considered during the development of the WSAIP.
5. Face the same regulatory and political challenges. For example, direct potable reuse appears to have regulatory support, but the regulations have not yet been finalized. Similarly, desalination support seems to vary depending on scope and scale of the project.

Attached to this memo are four fact sheets describing each project concept, including a map and description of how each alternative meets the various criteria developed by the WSAC and further vetted with the Water Commission.

ALTERNATIVES EVALUATED

The information below describes how and why each project concept was developed, and how they will be considered further in the WSAIP process.

Aquifer Storage and Recovery (ASR) in the Santa Cruz Mid-County Groundwater Basin (MCGB)

The WSAC contemplated the use of excess winter water in the City's flowing sources, following compliance with instream flow requirements and meeting customer demands, for ASR in the MCGB and/or the Santa Margarita Groundwater Basin (SMGWB). (See References below for more information on MCGB and SMGWB.) In concept, ASR is used to store water from flowing sources in the groundwater basins when available and to extract it when needed to meet customer demands. For the City, ASR would be relied upon as a source of supply largely in dry summer months when flowing sources diminish and Loch Lomond storage is dropping. This source of supply is limited to available injection volumes, extraction rates and the volume stored in the basin.

As noted above, Santa Cruz County has two Groundwater Sustainability Agencies (GSAs) created because of the Sustainable Groundwater Management Act (SGMA) enacted in the State of California in January 2015, mandating sustainable groundwater resources management: MCGB and SMGWB.

The MCGB is classified by the California Department of Water Resources (DWR) as a high-priority groundwater basis in critical overdraft due to the thread of seawater intrusion. The MCGB Groundwater Sustainability Plan (GSP), as required by SGMA, was approved by DWR on June 3, 2021. Subsequent to WSAC's consideration of ASR in the MCGB, staff have been evaluating the feasibility of ASR in the MCGB including but not limited to siting studies, geochemical analyses, groundwater modeling, pilot testing. From this work a phased approach to implementing ASR in the MCGB was developed that currently includes:

1. The conversion of existing groundwater wells, known as the Beltz wells, to ASR wells.
2. Construction of 4 – 6 new wells in the City's portion of the MCGB to build-out ASR in that basin.

The alternative considered in the SOWF is referred to as Alternative 11.2 because of its designation in the 40-plus groundwater modeling scenarios performed by Montgomery and Associates. Based on the studies described above, Alternative 11.2 has the potential to inject 2million gallons per day (mgd), extract 3mgd, and meet ½ of the City's water supply gap during drought based on shortage numbers developed during WSAC of 1.2billion gallons per year under climate scenario GFDL2.1 A2. This project is referred to as Concept 1 in the SOWF and includes conversion of existing wells, new wells, well head treatment and improvements to the existing Beltz Water Treatment Plant, and pipelines.

Next Steps for evaluating ASR in the MCGB include additional modeling to refine the number and location of new wells, pilot testing of new wells, evaluation of ASR in combination with other alternatives such as additional ASR in the SMGWB as well as transfers and exchanges. In addition, and a potential limiting factor to ASR in general, is the impact to the long-term reliable availability of surface waters as a result of a changing climate. The work being performed by others (Professor Casey Brown of the University of Massachusetts at Amherst, Department of Civil Engineering and affiliated Hydrosystems Research Group and Professor Shawn Chartrand of Simon Fraser University's School of Environment Science) sheds significant light on the long-term reliability of surface water in the region experienced as potential decrease of surface water availability; this will play into the consideration of ASR as a future water supply project.

<u>Indirect Potable Recharge/Groundwater Injection in the Santa Margarita Groundwater Basin (SMGWB)</u>

The WSAC contemplated the use of advanced treated wastewater for either indirect or direct end-uses. Indirect potable reuse, or IPR, is described here and direct potable reuse, or DPR, is described below. Following the recommendations by the WSAC, the City conducted Phase 1 of the Recycled Water Feasibility Planning Study with the goal of discovering beneficial uses of recycled water that either reduced demand (e.g., Non-potable reuse [NPR] that is largely comprised of irrigation) and/or otherwise offset water supply needs. (See References below for more information on the Recycled Water Feasibility Planning Study.) A variety of projects were developed including irrigation, lake augmentation, stream augmentation, groundwater injection, and direct potable reuse. While NPR projects are being pursued, from a water supply perspective, only groundwater injection and DPR are capable of filling the water supply gap in a significant and reliable manner and were therefore developed further for the SOWF.

The SMGWB is a groundwater basin classified by DWR as being a medium-priority basin. Like the MCGB GSP, the SMGWB GSP contains a set of projects and management actions (PMAs) that could potentially achieve the sustainability goals established by the GSA for that basin. Injection of advanced treated recycled water (indirect potable reuse or IPR) is among the PMAs having demonstrated a degree of feasibility and ability to meet the GSP goals.

IPR in the SMGWB would consist of the expansion of Soquel Creek Water District's Pure Water Soquel (PWS) project, a groundwater replenishment and seawater intrusion prevention project currently in construction in the MCGB. Doubling the capacity of the PWS project would allow for ~1,500 acre-feet per year (afy) of purified water to be injected in to the SMGWB with a portion available for extraction to be used as water supply. The concept developed for the purpose of the SOWF of injecting 1,500afy (1.4mgd), with 20% left in storage in the summer (or 1.1 mgd extraction rate) and 50% left in storage in the winter (or 0.7 mgd). This alternative is referred to as Concept 2 in the SOWF.

Minimal groundwater modeling was performed in the development of the PMAs in the SMGWB; next steps in the development of the WSAIP include updated groundwater modeling, consideration of combining IPR with water transfers and exchanges as well as an ASR project in the MCGB.

<u>Direct Potable Reuse</u>

Direct Potable Reuse, or DPR, is the other recycled water alternative contemplated by the WSAC that may be effective at reducing the reliance on existing water supplies to meet customer demand. This concept would treat larger volumes of recycled water available from the City's Wastewater Treatment Facility (larger than the built-out treatment capacity of the PWS project once expanded to 3,000afy therefore requiring an additional advanced purification facility capable of larger yields), pumping this water to the City's surface water treatment plant, the Graham Hill Water Treatment Plant, for further treatment, followed by distribution to the City's customers.

Because there is some flexibility in sizing a DPR project, limited primarily by the availability of source water, or treated wastewater, the DPR project for the SOWF was sized to match that of the desalination project at 3mgd described below. This size is slightly larger than the scwd2 Desalination Project of 2.5mgd to fill the worst year supply gap identified by WSAC of 1.2billion gallons per year (bgy). (Note that the Desalination Feasibility Update Review performed in 2018 sized a desalination project at 3.3mgd operating 365 days per year; for simplicity, 3mgd was used for Concepts 3 and 4 for the SOWF.)

For the purposes of the SOWF, the following operating strategy of a DPR project was developed to retain storage in the Loch Lomond Reservoir while meeting the water demand needs of the City's customers:

1mgd production capacity from November through April; 2mgd from May through October; 3mgd year-round when the reservoir drops below 2.0billion gallons (bg) and until it is full at 2.8bg. This alternative is referred to as Concept 3 in the SOWF.

Next steps in the evaluation of DPR includes assessing the long-term availability of wastewater to meet the supply needs as planned through this alternative; consideration of DPR together with ASR, IPR, desalination, water transfers and exchanges, and other partnerships; and, tracking the regulatory feasibility of DPR as it is yet not a permissible potable water source.

Seawater Desalination

The WSAC recommended that seawater desalination be retained as a potential water supply for the city's customers if other alternatives as described above were not successful at meeting the reliability goals of the city. In 2018, following WSAC recommendations to update the scwd2 Desalination Project scope to recognize 1) the new supply gap identified by WSAC and 2) new regulations put in to place in the interim most notably being the 2016 Amendment to the Water Quality Control Plan for Ocean Waters of California Addressing Desalination Facility Intakes, Brine Discharges, and the Incorporation of Other Non-Substantive Changes included in the California Ocean Plan (SWRCB and CalEPA 2015). This update resulted in a 3.3 mgd project, with a reduced number of ocean intake locations for consideration. (See References below for more information on desalination.)

Similar to the DPR operating strategy and for the purpose of the SOWF, a desalination project would be operated at 1mgd from November through April, 2mgd from May through October and 3mgd year-round when the reservoir drops below 2.0billion gallons, or bg, and until it is full at 2.8bg. This concept is referred to as Concept 4 in the SOWF. (Again, for simplicity, the DPR and desalination concepts rounded to a 3mgd project concept.)

Next steps in the evaluation of seawater desalination includes tracking existing projects on the state level for permitting feasibility and evaluating partnership opportunities.

GENERAL ASSUMPTIONS

- Cost metrics presented in the fact sheets include total capital costs, annualized capital costs, annualize operation and maintenance costs, and total unit costs.
- Results for water supply shortage using the UMass Santa Cruz Water Supply Model are based on model results using climate realization 1270, +2 degrees Celsius warming, no change in precipitation, and a coefficient of climate variability of 1.1.
- Costs are estimated at an AACE Class 5 level with -20 - -50% cost variation on the low end to +30 - +100% on the high end.
- Greenhouse Gas (GHG) calculations are based on average emission rates for PG&E (2014-2018). Low emissions range based on energy use for an average extraction year, and high emissions range based on energy used for a max extraction year. PG&E increase in use of green energy sources in the future will reduce or eliminate GHG emissions. GHG emissions from pipelines represent 1-5% of the total emissions, with the rest being emissions due to energy use.
- Energy use estimates and operational costs are based on the full treatment capacity of the alternative and not showing ranges for the annual variable operational levels.
- Timelines for implementation include pilot testing, permitting, design, contractor procurement and bidding process, construction, and commissioning.
- All projects implemented within either the MGCB or the SMGWB must meet requirements of the respective GSPs. In addition, the City must still meet the requirements of the GSPs even if supply projects not directly impacting these basins are implemented (e.g., DPR and desalination).

ATTACHMENTS

Project Concept Fact Sheets

REFERENCES

To access the Water Supply Advisory Committee Final Report on Agreements and Recommendations:
https://www.cityofsantacruz.com/home/showpublisheddocument/84832/637594497619670000

For more information on the Mid-County Groundwater Agency:
https://www.midcountygroundwater.org/

For more information on the Santa Margarita Groundwater Agency:
https://www.smgwa.org/

To access the Santa Cruz Regional Recycled Water Facilities Planning Study:
https://www.cityofsantacruz.com/home/showpublisheddocument/84834/637594502205400000

To access the Desalination Feasibility Update Review:
https://www.cityofsantacruz.com/home/showpublisheddocument/84842/637594507704230000

Concept 1
Aquifer Storage and Recovery (ASR) in Mid-County Groundwater Basin (MCGB)

Fact Sheet	
Description	Available winter flows from the City's surface water sources, treated at the Graham Hill Water Treatment Plant (GHWTP), would be injected into the Mid-County Groundwater Basin (MCGB) at four existing Beltz wells and four new wells, and recovered as a supplemental groundwater supply in dry summer periods. (Referred to as "Scenario 11.2" in prior ASR feasibility investigations and groundwater modeling efforts) [1]
Water Source(s)	Average Injection: 1.7 MGD (920 AFY / 300 MGY) of potable city water supply [2] Maximum Injection: 2.0 MGD (1,100 AFY / 360 MGY) of potable city water supply [2]
Project Yield	Average Extraction: 0.8 MGD (430 AFY / 140 MGY) of groundwater [3] Maximum Extraction: 3.0 MGD (1,630 AFY / 530 MGY) of groundwater [3]
Evaluation Criteria [4]	
Project's supply contribution as a % of worst year supply shortfall	60% [5]
Increases resilience to climate change	Yes, the project would utilize available capacity in the MCGB for storing winter flows, to be recovered through additional groundwater extraction during dry periods, thereby increasing resilience to drought and the impacts of climate change.
Total Annualized Cost [6]	Total Capital Cost: $96.1 M Annualized Capital Cost: $4.2 M O&M Annual Cost: $2.7 M Total Unit Cost: $4,200 – $15,800 per AF ($13,000 - $48,300 per MG)
Is understood and accepted by the public and key stakeholders	Yes, this alternative is understood and continues to be viewed favorably as a viable alternative to address water shortages.
Scalable or can be implemented incrementally or in phases	Yes, ASR can and in fact should be implemented over time to ensure predicted outcomes. ASR is limited by groundwater basin capacity, surface water availability, and influence of the Pure Water Soquel (PWS) injection to the MCGB.
Technical Feasibility	Yes. Ongoing pilot testing demonstrated technical feasibility.
Likelihood project being funded by state or federal grants	Likely. Funding from the Bureau of Reclamation and State Water Resources Control Board (SWRCB) is available for construction of new wells.
Opportunity for shared funding	No, the City does not have a project partner and would likely assume all costs.
Greenhouse gas emissions	100 - 140 MT of carbon dioxide (CO_2) emissions per year [7]
Time required for implementation	8 to 10 years for complete implementation of all ASR wells[8]
Operational Complexity	Low to Medium; would require minimal changes to current potable water supply operations, but increased effort for O&M of ASR wells.
Energy Use	630,000 – 930,000 KWh/yr [9] 0.6 – 1.4 MWh/AF [9]
Potential impacts for CEQA required mitigations to impact project cost or timeliness	Low. Preliminary analysis indicates that the project would not have significant environmental impacts due to limited footprint of new facilities. The first phase of this project (conversion of existing Beltz Wells) was evaluated in the Water Rights EIR.
Adaptable to future regulatory or source water changes	Yes, for regulatory changes, and ability to adapt to source water changes relies on treatment elsewhere; e.g., GHWTP process improvements. Prior to source water changes, geochemistry, travel time, and post-recovery water treatment needs will need to be revisited.
Degree of administrative complexity	Low. The project is located within the City of Santa Cruz water service area with no need for partnerships with outside agencies.

Fact Sheet

Evaluation Criteria (cont.) [4]	
Ancillary Benefits	• Contributes to groundwater replenishment • May assist in limiting seawater intrusion and meeting GSP objectives • Adds to system supply portfolio • Opportunity for regional collaboration
Ancillary Costs/Risks	• May mobilize constituents in basin • Subject to leakage from groundwater basin, aka "losses" • Sufficient cumulative storage may not be available in time of need • Reliant on surface water availability
Assumptions	• Based on Scenario 11.2 and has not yet been modeled with the Pure Water Soquel project • Pipelines sized for peak injection (2.0 MGD) and peak extraction (3.0 MGD) • Injection period = 6-month (Nov – Apr) • Extraction period = 6-month extraction (May – Oct)

NOTES:

[1] Scenario 11.2 was performed by Pueblo Water Resources and Montgomery & Associates in their Phase 1 ASR Feasibility Investigation groundwater modeling (Pueblo, 2021). This scenario uses 2016-18 demands (2.6 bgy), the GFDL2.1A2 climate change scenario, the four existing Beltz wells plus four new wells. Does not include utilization of native groundwater supplies.

[2] Average and Maximum daily injection rates used as modeled for Scenario 11.2 by Gary Fiske and Pueblo Water Resources (Pueblo 2021).

[3] Average and Maximum annual extraction rates from Santa Cruz Water System Model results for ASR adaptation scenario under Realization 1270 (UMass, 2022).

[4] Evaluation criteria listed in order of importance as ranked by Commissioners.

[5] ASR Project can reduce the water supply shortage during the worst drought sequence projection, from 2,190 MG (cumulative shortage without adaptation project) to 870 MG (cumulative shortage with ASR project). Results for the water supply shortage are based on model results of the Santa Cruz Water Supply System Model for the worst drought sequence of 5 years, using Realization 1270, +2-degree Celsius warming, no change in average annual precipitation, and a change in climate variability coefficient of 1.1.

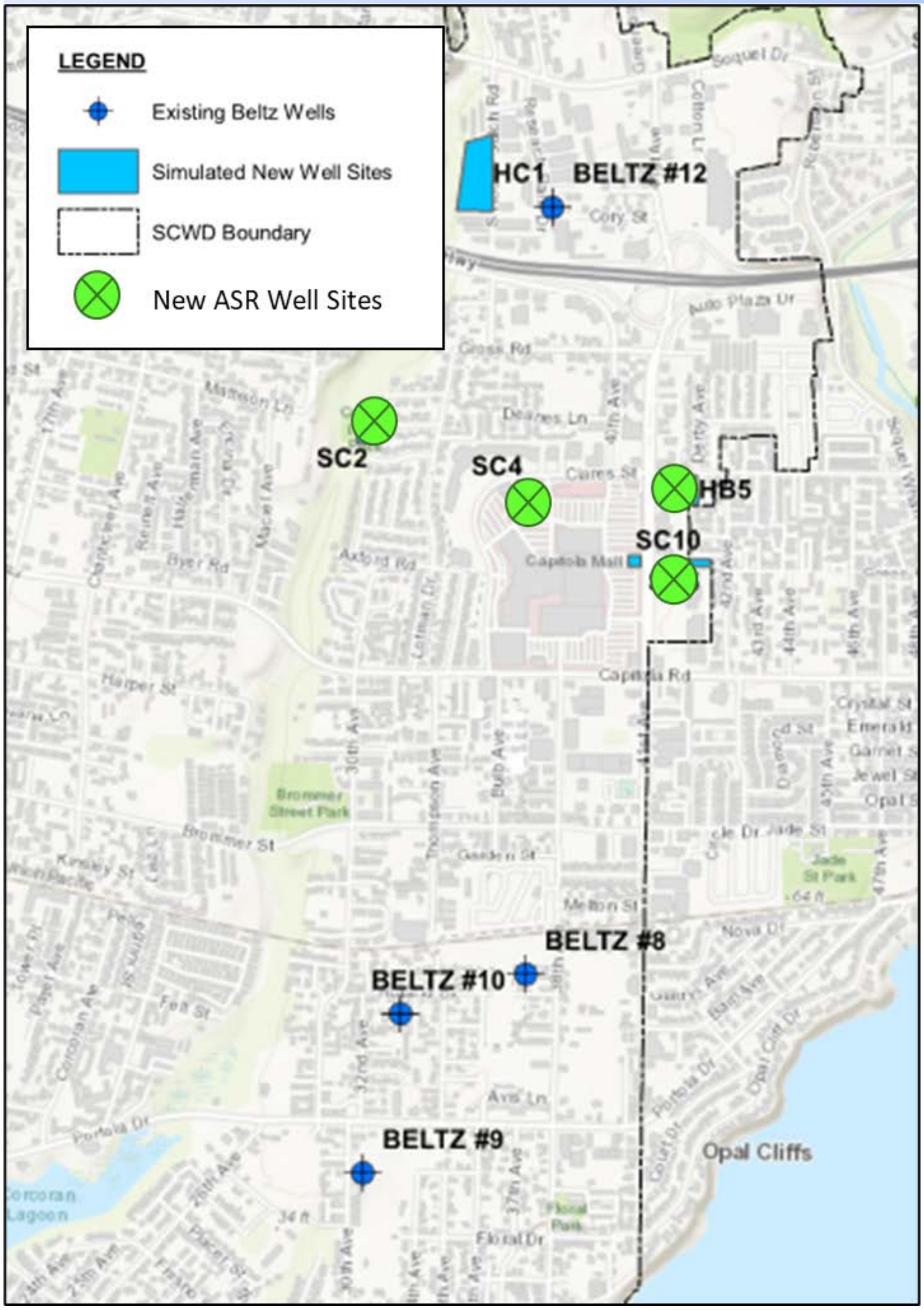
[6] Costs are estimated at an AACE Class 5 level with -/+50% cost variation. Costs include conversion of 4 Beltz wells to ASR wells, 4 new ASR wells, modifications to wellhead treatment for Beltz 12 and wellhead treatment at new wells, upgrades to Beltz Water Treatment Plant, pilot testing, connections to/from water system, site acquisition, and additional facility costs. Costs also include markups, mobilization, contractor overhead, and a 30% estimate contingency. If additional new wells are required, infrastructure and treatment costs would be added accordingly. Escalation of 7% used due to current supply chain impacts and inflation. The cost estimates should be revisited when more design details are available. O&M costs are based on full production capacity. Unit costs are estimated for average production capacity (high end) and max production capacity (low end). Cost sources: Santa Cruz ASR Project - Phase 1 Feasibility Investigation; Summary of Groundwater Modeling Scenario 11.2 Results (Pueblo, 2021); Beltz Treatment Plant Rehabilitation Project (CDM, 2008); Beltz 12 Capital Asset Record Construction & Treatment Cost (City, 2015), and estimates from the City for Beltz 12 ammonia treatment costs (Dec, 2021).

[7] Based on average emission rates for PG&E (2014-2018). Low emissions range based on energy use for an average extraction year, and high emissions range based on energy used for a max extraction year. PG&E increase in use of green energy sources in the future will reduce or eliminate GHG emissions. GHG emissions from pipelines represent 1-5% of the total emissions, with the rest being emissions due to energy use.

[8] Based on estimates from the City and Pueblo Water Resources of 1.5 years for pilot testing existing wells, 3 years for pilot testing new wells, 1.5 years per well for upgrading existing wells, 2.5 years for developing new wells, and assuming 2 years of injection before commencing extraction. Estimates include property acquisition, permitting, design, contractor procurement and construction. To date pilot testing of wells Beltz 8 and 12 has been completed. The rest of the implementation for ASR wells will occur in phases.

[9] Energy estimates for injection and extraction based on pumping information provided by the City. Energy for treatment based on estimate of energy use from Beltz Treatment Plant Rehabilitation Project (CDM, 2008). Low range is based on energy use for an average extraction year and high range is for energy used for a max extraction year. Unit energy estimated based on average and max AFY extraction rates.

Figure 1 - Concept 1 - ASR in the MCGB



Modified figure from "Santa Cruz ASR Project - Phase 1 Feasibility Investigation; Summary of Groundwater Modeling Scenario 11.2 Results (Pueblo, 2021)"

Fact Sheet

Description	Expansion of treatment capacity of the Pure Water Soquel (PWS) Advanced Water Treatment Facility (AWTF) and conveyance of purified water to Scotts Valley for injection into the Santa Margarita Groundwater Basin (SMGWB). This concept would require a purchase agreement with Soquel Creek Water District (SqCWD).
Water Source(s)	1.4 MGD (1,500 AFY / 510 MGY) of purified water [1]
Project Yield	1.1 MGD (950 AFY / 310 MGY) extracted May – Oct (20% leave-behind to replenish SMGWB levels) [2] 0.7 MGD (370 AFY /120 MGY) extracted Nov- Apr (50% leave-behind to replenish SMGWB levels) [2]
Evaluation Criteria [3]	
Project's supply contribution as a % of worst year supply shortfall	32% [4]
Increases resilience to climate change	Yes, the project would utilize available capacity in the SMGWB for storing purified water to be recovered as additional groundwater source during dry periods, increasing resilience to drought and the impacts of climate change.
Total Annualized Cost [5]	Total Capital Cost: $239.7 Mil Annualized Capital Cost: $11.4 Mil O&M Annual Cost: $ 4.7 Mil Total Unit Cost: $10,800 per AF ($31,700 per MG)
Is understood and accepted by the public and key stakeholders	Yes, this alternative is viewed somewhat favorably by the public as a way to address water shortages.
Scalable or can be implemented incrementally or in phases	Yes, although limited by groundwater basin capacity and PWS AWTF expansion capacity unless additional AWTF capacity is added elsewhere.
Technical Feasibility	Yes, groundwater replenishment reuse projects have been succesfully implemented in Southern California for over 50 years. Additional groundwater modeling and/or pilot testing may be required to demonstrate feasibility for the SMGWB.
Likelihood project being funded by state or federal grants	Likely. Funding from the Bureau of Reclamation and SWRCB is available for water reuse projects.
Opportunity for shared funding	Yes, Scotts Valley Water District could provide cost-share, and potentially other member agencies of the Santa Margarita Groundwater Agency (SMGWA)
Greenhouse Gas Emissions	1,180 MT of CO_2 emissions per year [6]
Time required for implementation	8 -10 years [7]
Operational complexity	High. The project would require coordination with multiple agencies to construct and operate the system and meet regulatory requirements.
Energy Use	8,000,000 KWh/yr [8] 5.3 MHh/AF [8]
Potential impacts for CEQA required mitigations to impact project cost or timeliness	High. Short-term construction-related impacts could likely be mitigated through alternative construction techniques, preconstruction surveys, and implementation of best management practices.
Adaptable to future regulatory or source water changes	Yes, beneficial to meet groundwater sustainability goals as well as potential opportunity to blend surface water could be considered.
Degree of administrative complexity	High; due to multi-agency involvement and complex regulatory requirements.

Fact Sheet	
Ancillary Benefits	• Source water supply not entirely reliant on surface water • Contributes to groundwater replenishment • May assist with compliance with GSP objectives • Adds storage water to system supply portfolio • Opportunity for regional collaboration • Provides foundational treatment infrastructure for potential future consideration of DPR
Ancillary Costs/Risks	• May mobilize constituents in basin • Subject to leakage from groundwater basin, aka "losses" • Sufficient cumulative storage may not be available in time of need • Public acceptance of purified recycled water may be limited
Assumptions	• Injection of 1,500 AFY • Leave behind of 20% May – Oct, and 50% Nov to Apr to replenish the SMGWB • Groundwater modeling required to confirm sustainable injection and extraction rates and well locations

NOTES:

[1] PWS project was designed to be able to expand production by an additional 1,500 AFY for a total project capacity of 3,000 AFY of purified water produced. PWS will inject 1,500 AFY of purified water into the MCGB.

[2] Annual extraction rates from Santa Cruz Water System Model results for IPR adaptation scenario under Realization 1270 (UMass, 2022). Assumed a 20% leave behind of the injected flows between May to October, increasing to 50% leave behind of the injected flows between November and April to replenish basin levels. SMGWB Groundwater Sustainability Plan (GSP) objective to restore groundwater levels require maintaining 710 AFY in the basin. The leave behind requirements would be updated in future phases of the work based on the requirements for the SMGWB.

[3] Evaluation criteria listed in order of importance as ranked by Water Commissioners.

[4] IPR Project can reduce the water supply shortage during the worst drought sequence projection, from 2,190 MG (cumulative shortage without adaptation project) to 1,480 MG (cumulative shortage with IPR project). Results for the water supply shortage are based on model results of the Santa Cruz Water Supply System Model for the worst drought sequence of 5 years, using Realization 1270, +2-degree Celsius warming, no change in average annual precipitation, and a change in climate variability coefficient of 1.1.

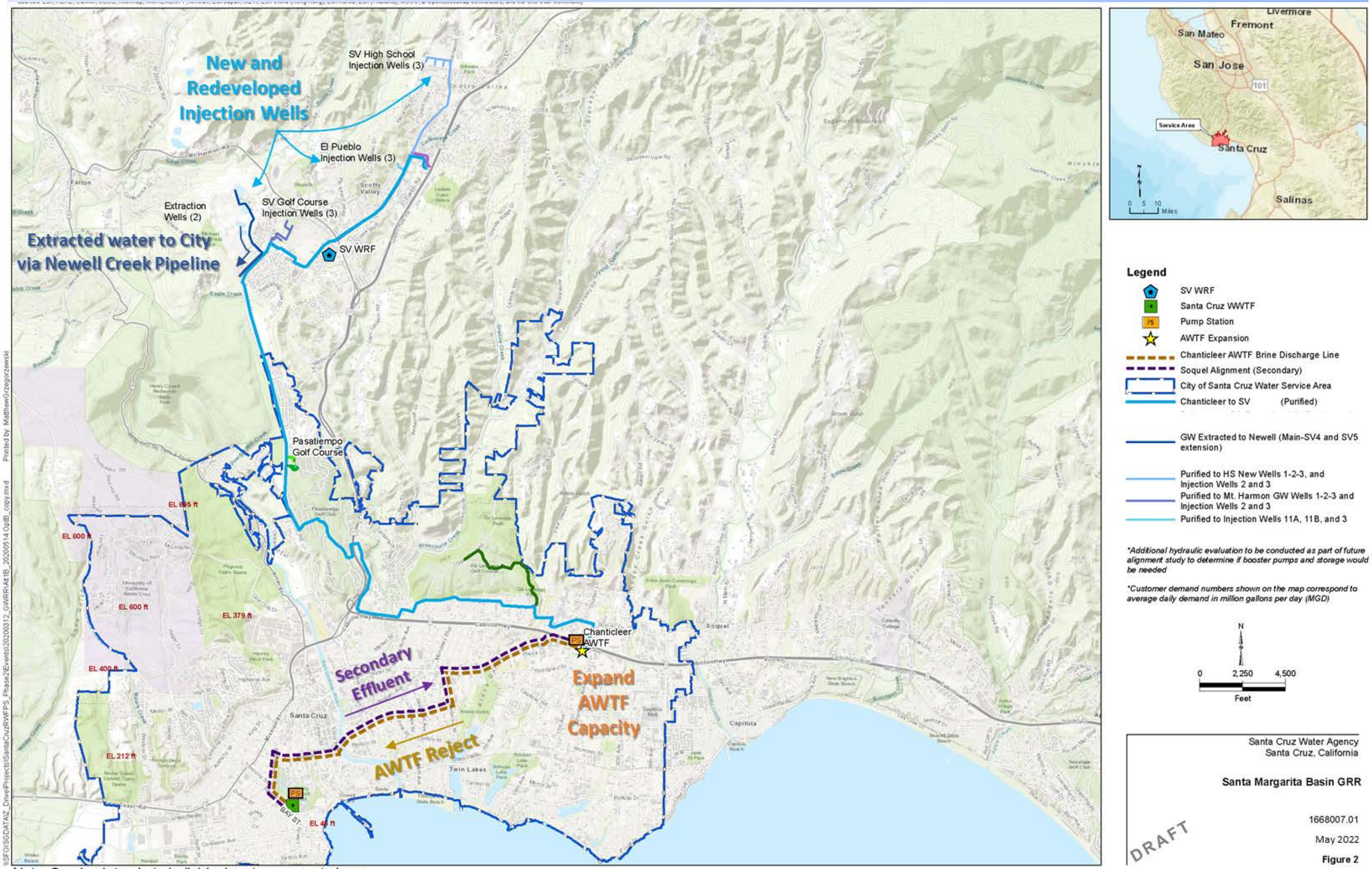
[5] Costs are estimated at an AACE Class 5 level with -/+50% cost variation. Costs include expansion of PWS treatment capacity, conveyance to Scotts Valley, upgrading 2 wells for injection at El Pueblo, 7 new injection wells, 2 new extraction wells, conveyance of extracted water to Newell Creek pipeline connection, and additional facility costs. Costs also include markups, mobilization, contractor overhead, and a 30% estimate contingency. Escalation of 7% used due to current supply chain impacts and inflation. The cost estimates should be revisited often and when more design details are available. O&M costs and unit costs are based on full production capacity of 1,500 AFY. Cost sharing with SVWD is not accounted for. Costs based on Regional Recycled Water Alternatives Evaluation TM (KJ, 2021), escalated to 2022.

[6] Based on average emission rates for PG&E (2014-2018). PG&E increase in use of green energy sources in the future will reduce or eliminate GHG emissions. GHG emissions from pipelines represent 1-5% of the total emissions, with the rest being emissions due to energy use.

[7] Timeline for implementation includes permitting, environmental review, design, bidding, construction, and commissioning.

[8] Energy estimates for treatment and conveyance. Energy estimates are based on total project capacity, not including variations due to seasonal operations.

Figure 1 - Concept 2 - IPR in the SMGWB



Note: Service laterals to individual meters are not shown

Fact Sheet

Description	Develop a new AWTF to treat effluent from the Santa Cruz WWTF and produce purifed water to be blended with raw surface water prior to additional treatment at the GHWTP.
Water Source(s)	4.2 MGD (4,670 AFY/ 1,520 MGY) of Santa Cruz WWTF effluent [1]
Project Yield	3 MGD (2,700 AFY/ 880 MGY) of purified water production capacity [2] 1 MGD produced Nov to April and 2 MGD produced May to October 3 MGD produced when Loch Lomond reservoir levels are below 2.0 billion gallons.
Evaluation Criteria [3]	
Project's supply contribution as a % of worst year supply shortfall	87% [4]
Increases resilience to climate change	Yes, although wastewater flows are linked to customer demands, this project would provide a consistent supply of locally produced, purified water to directly supplement the City's potable water system, increasing resilience to drought and the impacts of climate change.
Total Annualized Cost [5]	Total Capital Cost: $163.2 Mil Annualized Capital Cost: $6.6 Mil O&M Annual Cost: $ 5.0 Mil Total Unit Cost: $4,300 per AF ($13,200 per MG)
Is understood and accepted by the public and key stakeholders	Yes, this project type is generally understood by the public and key stakeholders; however, no additional information would be needed about local understanding and acceptance of this form of water reuse.
Scalable or can be implemented incrementally or in phases	Yes, initial assessments show that the City has adequate source supply and can produce purified water incrementally to fill the water supply gap. Updated source supply assessment is needed.
Technical Feasibility	Yes. The existing and proven treatment technologies are available to meet the proposed criteria and anticipated regulatory requirements for DPR.
Likelihood project being funded by state or federal grants	Likely. Funding from the Bureau of Reclamation and SWRCB is currently available for water reuse and demonstration projects, and additional future funding will likley be made available for DPR once regulations are finalized.
Opportunity for shared funding	No, the City does not have a project partner identified and would likely assume all costs; however, future purchase agreement(s) may present an opportunity for water transfers and exchanges.
Greenhouse Gas Emissions	870 MT of CO_2 emissions per year [6]
Operational complexity	High. This project would require operation of a new AWTF and meeting complex regulatory requirements, which are still in development.
Time required for implementation	More than 10 years.[7]
Energy Use	6,100,000 KWh/yr [8] 1.8 MWh/AF [8]
Potential impacts for CEQA required mitigations to impact project cost or timeliness	High. Short-term construction-related impacts could likely be mitigated through alternative construction techniques, preconstruction surveys and implementation of best management practices.
Adaptable to future regulatory or source water changes	Uncertain and may depend on adopted regulations by the SWRCB Division of Drinking Water, expected by December 2023. Potential opportunities to treat seawater, brackish water, or impaired groundwater at the AWTF could be considered.
Degree of administrative complexity	High due to complex regulatory requirements.

Fact Sheet

Evaluation Criteria (cont.) [3]	
Ancillary Benefits	• Independent source from surface water although linked to water use • Relatively cost-effective compared to $/AF of other alternatives
Ancillary Costs/Risks	• Public acceptance of purified recycled water may be limited, especially for DPR • State regulations not yet in place (pending, anticipated December 2023)
Assumptions	• New AWTF located near the Santa Cruz WWTF • Treatment train based on draft DPR criteria but does not include nitrification of City effluent.

NOTES:

[1] Wastewater availability will be further evaluated to refine sizing of DPR project based on effluent available from the Santa Cruz WWTF for production of purified water, with consideration of effluent required for the Pure Water Soquel project needs.

[2] For modeling this alternative in the Santa Cruz Water Supply System Model, assumed 1MGD production November to April and 2 MGD production May to October. Assumed increased production of 3 MGD when levels at Loch Lomond reservoir are below 2.0 billion gallons and until reservoir levels reach 2.8 billion gallons.

[3] Evaluation criteria listed in order of importance as ranked by Commissioners.

[4] DPR Project can reduce the water supply shortage during the worst drought sequence projection, from 2,190 MG (cumulative shortage without adaptation project) to 280 MG (cumulative shortage with DPR project). Results for the water supply shortage are based on model results of the Santa Cruz Water Supply System Model for the worst drought sequence of 5 years, using Realization 1270, +2-degree Celsius warming, no change in average annual precipitation, and a change in climate variability coefficient of 1.1.

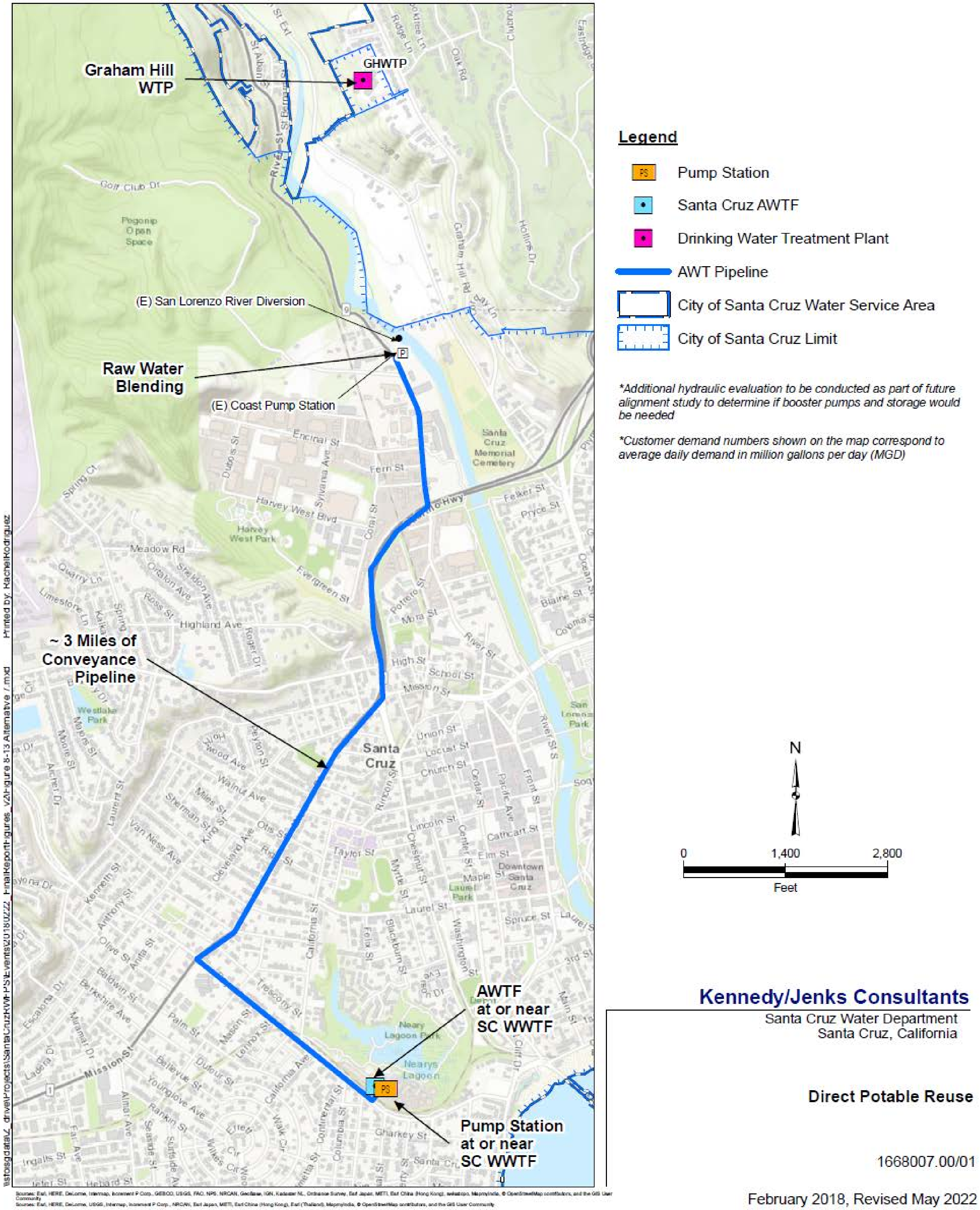
[5] Costs are estimated at an AACE Class 5 level with -/+50% cost variation. Costs include new AWTF, conveyance to raw water blending station, and additional facility costs. Costs also include markups, mobilization, contractor overhead, and a 30% estimate contingency. Costs based on Recycled Water Facilities Planning Study RWFPS (KJ, 2018), escalated to 2022. Escalation of 7% used due to current supply chain impacts and inflation. The cost estimates should be revisited when more design details are available. O&M costs and unit costs are based on full production capacity.

[6] Based on average emission rates for PG&E (2014-2018). PG&E increase in use of green energy sources in the future will reduce or eliminate GHG emissions. GHG emissions from pipelines represent 1-5% of the total emissions, with the rest being emissions due to energy use.

[7] Timeline for implementation includes permitting, environmental review, design, bidding, construction, and commissioning.

[8] Energy estimates for treatment and conveyance, based on RWFPS (KJ, 2018). Energy estimates are based on total project capacity, not including variations due to seasonal operations.

Figure 2 - Concept 3 - DPR with Raw Water Augmentation



Fact Sheet

Description	Construct a new, local seawater desalination facility and ocean intake (3 options considered).
Water Source(s)	6 MGD (5,400 AFY / 1,760 MGY) of seawater from Monterey Bay [1]
Project Yield	3 MGD (2,700 AFY/ 880 MGY) of desalinated water production capacity. 1 MGD produced Nov to April and 2 MGD produced May to October 3 MGD produced when Loch Lomond reservoir levels are below 2.0 billion gallons [2]
Evaluation Criteria [3]	
Project's supply contribution as a % of worst year supply shortfall	87% [4]
Increases resilience to climate change	Yes. Project would provide a consistent supply of locally produced potable water to directly supplement the City's potable water system, increasing resilience to drought and the impacts of climate change. The location of the seawater desalination facility would consider sea-level rise.
Total Annualized Cost [5]	Total Capital Cost: $290.6 - $443.9 Mil Annualized Capital Cost: $13.0 - $23.9 Mil O&M Annual Cost: $ 6.8 - $7.1 Mil Total Unit Cost: $7,400 - $11,500 per AF ($22,700 - $35,300 per MG)
Is understood and accepted by the public and key stakeholders	This project is generally understood by the public and key stakeholders. While desalination is recognized as a potential supply alternative, broad acceptance is unknown.
Scalable or can be implemented incrementally or in phases	Yes. The desalination plant could be designed to be scalable to incrementally fill the water supply gap.
Technical Feasibility	Yes. Although challenging to permit, desalination is technically feasible as demonstrated by projects implemented in the state of California and elsewhere.
Likelihood project being funded by state or federal grants	Likely. Funding from the Bureau of Reclamation is available for desalination projects that have an approved Title XVI feasibility study. Additional future funding from the SWRCB could be available if drought persists.
Opportunity for shared funding	No, the City has not identified a project partner and would therefore likely assume all costs; however future purchase agreement(s) may present an opportunity for water transfers and exchanges.
Greenhouse Gas Emissions	2,500 MT of CO_2 emissions per year [6]
Time required for implementation	More than 10 years. [7]
Operational complexity	High. Would require operation of a new desalination facility; balancing cost to operate versus ramping down or shutting down the plant in favor of less costly supplies.
Energy Use	17,500,000 KWh/yr [8] 4.7 MWh/AF [7]
Potential impacts for CEQA required mitigations to impact project cost or timeliness	High. In addition to short-term mitigations, desalination projects may result in additional required mitigations to protect marine life in Monterey Bay and the complex permitting process would impact timeline for construction.
Adaptable to future regulatory or source water changes	Potentially. Although no current example exists in California, ocean water could potentially be blended with effluent from the Santa Cruz WWTF at the desalination plant to produced purified water to augment the potable water system; or the desalination plant could be converted to a DPR facility once DPR regulations are finalized.
Degree of administrative complexity	High, due to complexity of regulations and permitting requirements.

Fact Sheet

Evaluation Criteria (cont.) [3]	
Ancillary Benefits	• Reliable source water • Independent from surface sources • Potentially expandable if/as future needs arise
Ancillary Costs/Risks	• Regulatory permitting timeline and feasibility is uncertain • Public acceptance of seawater desalination locally is uncertain
Assumptions	• Desalination treatment recovery of 50% (50% reject through membranes).

NOTES:

[1] Estimated assuming 50% recovery through desalination treatment process.

[2] For modeling this alternative in the Santa Cruz Water Supply System Model, assumed 1 MGD production November to April and 2 MGD production May to October. Assumed increased production of 3 MGD when levels at Loch Lomond reservoir are below 2.0 billion gallons and until reservoir levels reach 2.8 billion gallons.

[3] Evaluation criteria listed in order of importance as ranked by Water Commissioners.

[4] Desalination Project can reduce the water supply shortage during the worst drought sequence projection, from 2,190 MG (cumulative shortage without adaptation project) to 280 MG (cumulative shortage with Desalination project). Results for the water supply shortage are based on model results of the Santa Cruz Water Supply System Model for the worst drought sequence of 5 years, using Realization 1270, +2-degree Celsius warming, no change in average annual precipitation, and a change in climate variability coefficient of 1.1.

[5] Costs are estimated at an AACE Class 5 level with -/+50% cost variation. Cost range is based on 3 different Alternatives for ocean intake, SI-1, SI-2, and SI-3, per Desalination Feasibility Study by Dudek (August 2018). Costs were escalated to 2022 costs. Escalation of 7% used due to current supply chain impacts and inflation. The cost estimates should be revisited when more design details are available. O&M costs and unit costs are based on full production capacity.

[6] Based on average emission rates for PG&E (2014-2018). PG&E increase in use of green energy sources in the future will reduce or eliminate GHG emissions. GHG emissions from pipelines represent 1-5% of the total emissions, with the rest being emissions due to energy use.

[7] Timeline for implementation includes permitting, environmental review, design, bidding, construction, and commissioning.

[8] Energy estimates based on SCWD Regional Desalination Plant Phase I Preliminary Design Report-Volume 1 Draft Report (2012, CDM Smith). Unit energy estimated based on volume of water treated. Energy estimates are based on total project capacity, not including variations due to seasonal operations.

Figure 3 - Concept 4 - Seawater Desalination

SOURCE: URS 2013; Updated by Dudek in 2017, Bing 2017

DUDEK 0 750 1,500 Feet

FIGURE 4

Updated Seawater Desalination Project Overview

City of Santa Cruz Seawater Desalination Project

The Economic Impacts of Water Supply Curtailments as May Need to be Implemented by the Santa Cruz Water Department

November 1, 2022

Prepared for:
City of Santa Cruz Water Department

Prepared by:

Robert Raucher
Raucher LLC

Carolyn Wagner
CW Research and Consulting

Colleen Donovan
Social Science Strategies LLC

Under Subcontract to Kennedy Jenks Consultants

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Executive Summary

The City of Santa Cruz is vulnerable to droughts, which are projected to become more frequent and severe under continuing climate change. Santa Cruz needs to supplement its water supply, otherwise demand curtailments are the only tool available to deal with the system's vulnerability to drought (whether the city grows or not).

The water supply augmentation options available to the City are complex and expensive, raising the question about how much it may be worth to pursue supplemental water supply options. Examining the economic cost of potential water supply curtailments provides one yardstick against which the adverse impacts of shortages may be compared to the expense of potential water supply enhancement options.

This Technical Memorandum (TM) provides findings from our analysis of adverse economic impacts associated with potential future water supply curtailments in Santa Cruz. Also presented are descriptions of the Santa Cruz Water Department (SCWD) plan for addressing water shortages and the methodology and data applied to our analysis.

Background and Objective

Water supply curtailments can be undesirable for many reasons, including their adverse impact on the local economy. SCWD's 2021 Water Shortage Contingency Plan (WSCP) details five stages of curtailment, with Stage 1 aiming to reduce peak season use by 10%, Stage 2 targeting an overall 20% reduction, etc. (SCWD, 2021). This TM summarizes the projected adverse economic impacts arising from a potential need to implement Stages 3, 4, and 5 (with 30%, 40%, and 50% targeted reductions in overall peak season water use, respectively). Such curtailment stages are severe, yet they may be necessary given the water system's vulnerability to drought conditions that may worsen under continuing climate change.

The economic analysis represents a "what if" assessment, intended to inform and support City of Santa Cruz deliberations on potential water supply investments aimed at avoiding the need to impose severe water curtailment stages. To the extent that water supply enhancement options reduce the likelihood and severity of future curtailments, the associated reduction in adverse community economic impacts represent an important portion of the *benefits* provided by augmenting the City's water supply. These benefits – estimated here as *avoided economic costs* borne by the community – can then be compared to the expense of the associated water supply augmentation options.

Methods and Approach

The methodology applies a standard "regional economic impact analysis" approach and modeling tool (IMPLAN) to assess curtailment impacts on the City's economy, and on Santa Cruz County as a whole. Text Box A provides an overview of the modeling approach, and a glossary defining key terms is provided at the end of this Summary.

The methodology focuses on water-dependent local businesses, the University of California at Santa Cruz (UCSC), golf courses, and the North Coast agriculture sector. These are business sectors for which access to a relatively large supply of water is essential to the ability to provide their goods and services (i.e., where reduced access to water will adversely impact the level of business operation or, perhaps, lead to business closure).

Sector-specific water supply cutbacks, per the SCWD's WSCP, were translated into anticipated ranges of direct impacts on sector economic output (e.g., net revenues), which are then input for modeled projections of direct, indirect, and induced impacts on regional economic output, labor income, jobs, and local tax revenues. Conservative assumptions were applied to avoid over-stating the estimated impacts (e.g., impacts were limited to a subset of business types).

Text Box A: Regional Economic Impacts and the IMPLAN Model

IMPLAN is an economic input-output (I-O) model, originally developed by the federal government. The model contains information on the relationships within an economy, both between businesses, and between businesses and final consumers. IMPLAN predicts changes in overall economic activity resulting from a flow of money into and out of the local economy (e.g., visitor spending and the subsequent ripple of local "multiplier" effects). Widely used by academics and the public and private sectors, IMPLAN is generally accepted as the standard for economic I-O analysis. Additional detail is provided in the full report.

High-Level Findings

An economic impact analysis is, by its nature, an imprecise exercise in which numerous uncertainties exist and many key assumptions need to be made. Nonetheless, the estimates developed are likely to be conservative, and are consistent with findings derived from investigations of the economic impacts of water supply shortages in other communities.[1] The economic analysis developed a considerable amount of empirical findings. In this summary, we focus on high-level results. Additional detailed empirical information is provided in the full report.

Table ES1 reveals the economic impact on the City, should the SCWD need to implement Stage 3, 4, or 5 level water use curtailments. For example, at Stage 3, City-wide economic output (i.e., the value of industry production within the region) is projected to decline by $114 million to $243 million per year, reflecting a decline of 1.1% to 2.4% of total City economic output in a normal year. Also, between 1,146 and 2,428 jobs are estimated to be lost, and City tax revenues decline by $2.1 million to $5.4 million.

[1] For example, an analysis of the economic impacts of water supply shortages for the East Bay Municipal Utility District developed estimates showing how lost economic output grows rapidly if curtailments rise above a 15% supply shortfall. The estimated loss of output was nearly $20 billion – or more than $2 million per MG of shortage – if a 15% shortage were to grow to a 25% curtailment level (estimates derived from M-Cubed, 2008a and 2008b; updated to 2022 dollars).

Table ES1. City-level negative economic impacts (losses) from select business and other non-residential curtailments

Metric (Losses)	Total impact at Stage 3	Total impact at Stage 4	Total impact at Stage 5
Output lost ($M)	$114.4 – $242.9	$324.3 – $505.3	$578.5 – $789.9
Labor income lost ($M)	$53.8 – $109.1	$141.0 – $218.6	$245.7 – $337.3
Value added lost ($M)	$68.6 – $144.8	$192.2 – $299.3	$341.6 – $467.8
Employment (# of jobs lost)	1,146 – 2,428	3,236 – 5,066	5,752 – 7,902
Tax revenues lost: City of Santa Cruz*($M)	$2.1 – $5.4	$8.0 – $12.7	$15.5 – $21.1
Tax revenues lost: County ($M)	$0.7 – $1.8	$2.7 – $4.3	$5.3 – $7.1
Tax revenues lost: State ($M)	$3.0 – $7.5	$10.9 – $17.1	$20.6 – $28.0
Tax revenues lost: Federal ($M)	48.4 – $17.5	$23.0 – $35.8	$40.6 – $55.6
Total Tax Revenues Lost: Total ($M)	$14.1 – $32.2	$44.6 – $69.8	$82.0 – $111.8

The estimated economic losses also can be interpreted relative to the amount of added water supply that would be needed to avoid a given level of curtailment [e.g., as a cost per million gallons (MG), or cost per acre-foot, of shortage]. The resulting "cost" of not having sufficient water can then be used as a benchmark against which to compare the expense of investments needed to secure that amount of water.

Table 2 summarizes the estimated change in overall impact on City economic output from moving to increasingly more restrictive curtailment stages on businesses and other non-residential sectors that are highly water dependent. Also shown is the implied economic cost per volume of water targeted overall for peak season use reductions.

For example, moving from Stage 3 to Stage 4 reduces estimated annual economic output within the City by between approximately $210 million and $262 million. This amounts to between $1.5 million and $1.9 million of lost economic output per MG of reduced water availability (based on 136 MG of additional water required to avoid moving from one curtailment stage to the next more severe curtailment stage for one water year peak period).[2]

Another way of interpreting this finding is that if enough additional water supply was made available such that the City could avoid applying Stage 4 restrictions and instead implement the less restrictive Stage 3 limits (e.g., adding the equivalent of 10% of normal peak season water usage, i.e., 136 MG), then the City would gain an estimated additional economic output of $210 million to $262 million. This translates to $1.5 million to $1.9 million of added economic output per MG added (compared to the water supply augmentation options currently being evaluated

[2] The 136 MG figure represents 10 % of total average peak season consumption for the 2016-2018 three-year base period SCWD uses for planning.

by the City, which are each expected to cost less than $30,000 per MG produced). This is one way of viewing the value added of developing an additional source of available water supply.

Table ES2. City-only incremental impacts from business curtailments (select industries only)

Impact	Change in output ($M)	$/MG** ($M)	$/AF ($M)
Stage 2* to 3	$114.4 – $242.9	$0.8 – $1.8	$0.3 – $0.6
Stage 3 to 4	$209.9 – $262.4	$1.5 – $1.9	$0.5 – $0.6
Stage 4 to 5	$254.2 – $284.6	$1.9 – $2.1	$0.6 – $0.7

* Assumes *de minimus* economic impact at Stage 2 for businesses

** Applies 136 MG need to meet each Stage's 10% incremental reduction in total peak season demand

The results above are considered conservative as they do not include all the business types that are likely to be adversely impacted by curtailments. Also not included in the results above are the impacts from reduced household disposable income (arising from excess use penalties and drought cost recovery fees). Those additional results are provided in the full report.

Also provided in the full report are the results from an analysis of how the economic impacts arising in the City spill over to the broader county. In brief, county-wide impacts add approximately 10% more impact than experienced in the City alone.

Glossary of Key Economic Terms Used in this Report

Direct impacts are the initial changes in business revenues, such as the increased receipts from enhanced tourism, or a decrease in output when limited water availability constrains businesses operations. For example, ***direct expenditures*** include money tourists spend while visiting the area on food, lodging, and retail purchases.

Indirect impacts: Local businesses that benefit from direct spending then, in turn, spend additional (or reduced) revenues on goods and services that they need to operate their businesses. These are termed ***indirect expenditures***.

Induced impacts: Direct and indirect spending generates employment in the local region, creating additional (or reduced) income for households, which generates further changes in local spending known as ***induced expenditures***.

Economic Output refers to the value of industry production within the region. For manufacturers, output = sales plus/minus change in inventory; for service sector,
output = production = sales; for retail and wholesale trade, output = gross margin (not gross sales).

Value Added refers to the difference between an Industry's or establishment's total Output and the cost of its Intermediate Inputs; it is a measure of the contribution to GDP.

Labor Income is defined as all forms of employment income, including Employee Compensation (wages and benefits) and Proprietor Income.

Employment includes an industry-specific mix of full-time, part-time, and seasonal employment.

Tax revenues accrued by various levels of government authorities, focusing here on local (i.e., city and county) governments and sub-county special districts.

Source: https://support.implan.com/hc/en-us/articles/360044986593-Glossary

The Economic Impacts of Water Supply Curtailments as May Need to be Implemented by the Santa Cruz Water Department

Background

The Santa Cruz Water Department (SCWD, Department) is evaluating several options to enhance the reliability of its water supply in the face of the system's vulnerability to drought and other risks. Shortfalls in supply relative to the community's already hardened demand are anticipated to become more frequent and more severe as the climate continues to change. Santa Cruz needs to supplement its water supply, otherwise demand curtailments are the only tool available to deal with the system's vulnerability to drought (whether the city grows or not).

This Technical Memorandum (TM) examines the economic cost to the City and the served community associated with potential future water supply shortfalls. To the extent that water supply enhancement options reduce the likelihood and magnitude of curtailments, the associated reduction in adverse community economic impacts represent a key portion of the benefits provided by the supply enhancements. These benefits (estimated as avoided economic costs borne by the community) can then be compared to the expense of the associated water supply enhancement alternatives.

Water supply shortages and resulting curtailments can have many adverse impacts on a community, including (but not limited to) negative economic impacts. As water-dependent businesses scale back operations (or close), there are resulting losses in regional output and business revenues, jobs, incomes, and local tax receipts. Many local households also suffer economic losses as lower incomes, drought-adjusted water rates, and excess use penalties reduce their disposable income and thus impact purchases of local goods and services.

This TM provides a summary of the findings of a "regional economic impact analysis" of potential water use curtailments that future conditions may necessitate being implemented by SCWD. SCWD's 2021 Water Shortage Contingency Plan (WSCP) details five stages of curtailment, with Stage 1 aiming to reduce peak season use by 10%, Stage 2 targeting an overall 20% reduction, etc. (SCWD, 2021). This TM summarizes the projected adverse economic impacts arising from a potential need to implement Stages 3, 4, and 5 (with 30%, 40%, and 50% reductions in overall peak season water use, respectively).

Objective

This economic analysis represents a "what if" assessment, intended to inform City of Santa Cruz deliberations on potential water supply investments aimed at avoiding the need to impose severe water curtailment stages. The adverse economic consequences reported here – as well as the additional important community consequences of water supply curtailments, such as the loss of green spaces and their benefits – are a yardstick intended to help the City of Santa Cruz assess the beneficial value of its potential water supply augmentation options.

The SCWD is evaluating several options to enhance the reliability of its water supply in the face of the system's vulnerability to climate change and other risks. Shortfalls in supply relative to the community's already "hardened demand" are anticipated to become more frequent and more severe as the climate continues to change.

Options to enhance the reliability and security of the community's water supply are relatively expensive and complex. However, water supply shortfalls are also costly in many ways, and the potential need to implement severe curtailment stages of the WSCP is the only response available unless the City augments its current water supply portfolio.

To the extent that water supply enhancement options reduce the likelihood and severity of curtailments, the associated reduction in adverse community economic impacts represent an important portion of the *benefits* provided by augmenting the City's water supply. These benefits – estimated here as *avoided economic costs* borne by the community – can then be compared to the expense of the associated water supply augmentation options.

Overview of Curtailment Policies

SCWD has developed a detailed set of plans for how it will address various potential levels of water supply shortages, as detailed in its WSCP [located in Appendix O in the *City of Santa Cruz 2020 Urban Water Management Plan* (SCWD, 2021)]. There are several curtailment stages that may be implemented, depending on how much peak season water use needs to be scaled back [from a baseline of approximately 1,358 million gallons (MG)].[3]

The WSCP was developed to comply with state-imposed requirements, and the curtailment stages are intended to ensure that the system – given its current supply portfolio – does not run out of water when a drought or other event (e.g., wildfire) reduces its available supply. Absent augmentation of the current water supply, these curtailments would be the only mechanism available to keep water flowing to the City's taps. However, the Department's staff does not view the curtailments as being realistically attainable as a water shortage management strategy, and there is concern that meeting the targeted allocations would put public health and safety at risk. And, as discussed below, even attaining compliance with the least restrictive curtailment levels – Stages 1 and 2 – will be very challenging given the level of water use efficiency and conservation that has already been adopted throughout the community.

The distribution of peak season water use across customer classes is shown in Figure 1. Each curtailment stage calls for an overall reduction of water use in 10% increments (e.g., Stages 1 and 2 aim for a 10% and 20% reduction in overall city-wide peak season water use, respectively). Stages 3, 4, and 5 present increasingly drastic cutback targets of 30%, 40%, and 50%, respectively. The amount of water targeted to be saved at each Stage is approximately 136 MG, based on 10% incremental cuts from total peak season demand.

[3] Peak water use season is defined as the six-month period starting May 1 and ending October 31. These are also the months in which there typically is little rainfall, relatively higher (summer) temperatures and, hence, generally higher water demands.

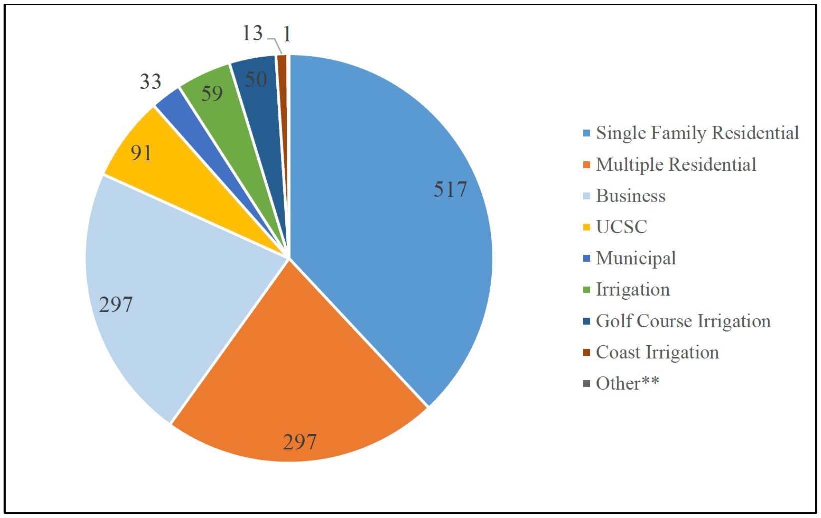

Figure 1. Distribution of peak water use (1,358 MG)
Source: SCWD (2021)

Within each stage, the target allocation of cutbacks varies across different SCWD customer classes, as shown in Table 1. For example, at Stage 3, the overall 30% demand reduction target entails a targeted 32% water use reduction from single family residential households, 15% from business customers, and 55% from golf courses. Overall, the priority is on preserving public health and safety by ensuring adequate allocations meet essential human needs (e.g., drinking, cooking, cleaning, and sanitation) and fire protection. The largest cuts reflect a focus on outdoor irrigation.

The relatively moderate target reductions for businesses reflect a desire to support essential economic activity (recognizing that for many businesses, water use is primarily for on-site kitchen and restroom facilities and, therefore, a public health and safety use). Under Stages 1 and 2, business impacts are expected to be relatively modest, with much of the water-conserving burden placed on outdoor uses. Nonetheless, households may struggle to live within their Stage 1 and 2 allocations (as evident from recent Stage 1 experience, discussed below). Stage 2 curtailments may not be realistically attainable, and impacts are likely to be very onerous at Stages 3 and higher.

Table 1. Customer class reduction goals at each curtailment stage

Customer class	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Single family residential	11%	21%	32%	42%	49%
Multi-family residential	8%	16%	24%	32%	41%
Business	5%	10%	15%	21%	40%
Golf courses	18%	36%	55%	74%	90%
UCSC	9%	19%	28%	38%	45%
North Coast agriculture	5%	10%	15%	25%	70%
Landscape irrigation	25%	50%	75%	100%	100%

Achieving even the Stage 1 and 2 targets are challenging given the extent to which the City's water demands have already been "hardened" (i.e., demand has already been scaled back due to extensive and successful conservation and related demand management efforts by the SCWD and the Santa Cruz community). The City of Santa Cruz already has one of the lowest residential per capita water use outcomes in California, at 45 gallons per person per day as of 2021 for indoor and outdoor use combined, and 35 gallons per capita per day (GPCD) for indoor use alone (City of Santa Cruz, 2021). As an indicator of water efficiency embraced by the Santa Cruz community, note that the City's per capita water use is well below the state's current goal is 55 GPCD GPCD for indoor use only (and even less than the future state standard which is slated to move to 42 GPCD by 2030 for indoor use).[4]

The first use of the updated WSCP was in 2021, when SCWD declared a water shortage and implemented Stage 1 water use curtailments. The updated plan replaced the 2009 WSCP and was revised to reflect substantial reductions in customer water use, resulting in a plan with stages with considerably more negative impacts to all classes of customers than the 2009 plan.

During the 2021 implementation of Stage 1 approximately 30% of households exceeded their Stage 1 allotment, revealing how inelastic water demand may be in the City, and suggesting how challenging meeting future curtailment targets may be. The challenge is likely to be even greater if circumstances require implementing curtailments beyond Stages 1 and 2 (e.g., by Stage 3, the City is looking to reduce household water use by nearly three times as much as the cutbacks imposed under Stage 1).

In future years, when climate change-driven droughts may be more severe and/or of longer (multi-year) duration, without supply augmentation the potential need to implement more restrictive curtailment stages will create even greater challenges. Hence the desire to augment the City's water supply portfolio with additional reliable water sources through, for example, more storage via groundwater augmentation.

[4] Per the Senate Bill passed and signed into law on September 28, 2022, by Governor Newsom.

Direct Costs Borne by SCWD

There are two categories of costs borne by the SCWD: (1) lost revenue from decreased water sales and (2) administrative costs to implement the water curtailments.

Lost revenues

SCWD's rates are structured to generate 90% of needed revenues through the sale of water that customers pay for according to the number of billing "units" used (1 unit = 748 gallons or one hundred cubic feet CCF). To offset the costs of lost revenues from decreased water sales during curtailments, SCWD imposes and collects drought cost recovery fees from its customers. These fees will be collected as a monthly fixed fee based on meter size for an entire fiscal year (SCWD, 2021). The size of the fixed fee increases as the curtailment stage increases. This offset is assumed in our analysis to result in no change to an individual customer's total annual water bill (i.e., that customers will pay the same amount for less water). However, the fixed rates are based on meter size and some customers may end up paying more than their customary use bills (especially the low volume users). These higher total water bill costs are not included in our analysis, though they could have a negative impact on household and business incomes and, thus, adversely impact the local economy.

Administrative costs

Implementing water curtailments will result in administrative costs for the SCWD to pay for additional staff, equipment, etc. The SCWD anticipates using reserve funds to pay for these added administrative costs and then replenishing reserves over time from ongoing rate revenues. Table 2 summarizes the total estimated costs at each curtailment stage, revealing how the cost rises at an increasing rate as the Department progresses to higher curtailment stages (e.g., added administrative cost at Stage 3 are nearly ten times the added cost at Stage 1). Although there might be a small boost to the local economy associated with SCWD staff growth, we do not factor these costs into this analysis as, ultimately, the expense will be borne by SCWD customers.

Table 2. Estimated additional administrative costs borne by the SCWD at each water curtailment stage

Water curtailment stage	Additional administrative costs
1	$146,500
2	$704,900
3	$1,362,100
4	$1,759,200
5	$2,122,400

Methodology for Economic Impact Analysis

The methodology applies a standard "regional economic impact analysis" approach and associated modeling tool to assess curtailment impacts on the City's economy, and on Santa Cruz County as a whole.

Focusing on Water-Dependent Business Sectors

The methodology focuses on local business, UCSC, golf course, and North Coast agriculture sectors that are highly water dependent (see Table 3 below for a full listing of sectors). These are business sectors for which access to a relatively large supply of water is essential to the ability to provide their goods and services (i.e., where reduced access to water will adversely impact the level of business operation or, perhaps, lead to business closure). These water-dependent business sectors were identified and assessed based on the SCWD's water use data and are consistent with a prior analysis conducted for the City (Mitchell, 2015)[5].

The analysis uses projected industry-level changes in economic output (e.g., business net revenues), based on scenarios of how businesses may respond to water curtailment levels of varying severity (as described in a subsequent section of this TM, and in Appendix A).

Within the analysis, multiple "industries" (business types) can be included in a "sector". We applied the sector-level change to output to each industry within the sector. More specifically, the IMPLAN regional economic impact model we applied (as detailed further in a subsequent section of this TM) defines the Food Manufacturing sector as including 19 industries, each of which has a different multiplier effect and subsequent economic impact (e.g., a 20% decrease to output in the "creamery butter manufacturing" industry has a different multiplier effect than the "coffee and tea manufacturing industry"). We identified the individual industries following the same approach used to identify the sectors, as included in Appendix B.

Direct Economic Impact Scenarios by Business Sector

For each highly water-dependent sector, the *direct impacts* on business "output" at each potential curtailment stage were assigned based on available data and professional judgement.[6]

For example, the tourism-related business sectors include accommodations (e.g., hotels and motels) and food service providers (e.g., restaurants). Both business types are relatively large water users and highly dependent on water supply to operate at their desired levels. Reductions in the amount of water allocated to these businesses are expected to result in reductions in the number of guests that hotels and restaurants can host over the course of a drought period (e.g., restaurants may need to scale back their hours or days of operation, and hotels may limit occupancy levels). The recent COVID pandemic provides useful insights into the relationship between key tourism-related businesses and the associated level of water use in those business types, per Text Box 1.

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[5] There are a few differences from the Mitchell (2015) analysis: Computer and electronic products were excluded from our main analysis and only included as part of the sensitivity analysis; UCSC and North Coast Agriculture were added.

[6] Economic output in this type of analysis typically refers to the net revenues of a business (Demski, 2020).

Given data limitations and uncertainties regarding how various businesses would respond (see section on Caveats and Limitations, as well as Appendix A), a range of direct impacts were assigned to each sector for each of potential curtailment Stages 3, 4 and 5. These percentage reduction "direct impact scenarios" for each water dependent business sector are shown in Table 3.

Text Box 1: Tourism Economic Impacts and Associated Water Use

The pandemic had a significant impact on tourism and the economic returns that accommodation and food service businesses across Santa Cruz County, as documented by a report issued by the State of California's *Visit California* program: *The Economic Impact of Travel* (Visit California, 2022). Comparing data from a "normal" 2019 to COVID-impacted 2020, total tourism spending in the county declined by nearly half, with associated negative impacts on business earnings (e.g., net revenues, output), employment, and local tax revenues declining by 23% to 28%.

Also shown is the associated similar decline of 28% in peak season water use by the restaurant and accommodation sectors combined, based on SCWD consumption and billing data. This comparison suggests that at a Stage 4 business-targeted water use reduction of 21%, for example, we might expect tourism-related business output to contract by roughly 20% to 30%.

Tourism-Sector Impacts and Water Use: 2020 v. 2019

Total Spending	-47%
Earnings	-23%
Jobs	-23%
Local Tax Revenues	-28%
Peak Season Water Use (Hotels and Restaurants combined)	-28%

Sources: Visit California, 2022; SCWD Billing Data

Table 3. Percentage output reduction scenarios for water dependent business sectors

Sector	Stage 3	Stage 4	Stage 5
Nursery, landscape, and garden	45% – 60%	50% – 70%	50% – 70%
Food services and drinking places	5% – 15%	25% – 40%	50% – 65%
Food manufacturing	5% – 15%	25% – 40%	50% – 65%
Breweries and distilleries	5% – 15%	25% – 40%	50% – 65%
Car washes	5% – 15%	25% – 40%	50% – 65%
Cement/concrete manufacturing	5% – 15%	25% – 40%	50% – 65%
Accommodation	5% – 15%	20% – 30%	40% – 60%
Amusement and theme parks	5% – 15%	20% – 30%	40% – 60%
Fitness and Recreational Centers	5% – 15%	20% – 30%	40% – 60%
Tourism-supported retail	5% – 15%	20% – 30%	40% – 60%
UCSC	15% – 25%	30% – 65%	30% – 65%
Golf courses	25% – 35%	40% – 60%	65% – 85%
North Coast agriculture	5% – 15%	20% – 30%	40% – 60%

Nursery, landscape, and garden

These businesses will be hit hardest by any curtailments because their customer base is largely homeowners who will also have less capacity to water and purchase plants. We assume these businesses will already be hit hard at Stage 2, such that the incremental change of moving to Stage 3 will be modest.[7]

Restaurants, manufacturing, and car washes

These businesses are grouped together because the impacts of curtailments are likely going to be similar. Tourism-related economic data (Visit California, 2022) and SCWD water usage data from 2019 to 2022 demonstrates the food services sector suffered a 46% reduction in consumer spending during the pandemic as compared to the previous year and used 42% less water. The Stage 4 curtailment is assumed to have a similar impact as that of the pandemic on water usage in the applicable sectors. Manufacturing and car washes are very water-dependent and are assumed to be similarly impacted by curtailments.[8]

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[7] Landscape service-providers and related businesses are likely to have seen a significant shift in their business sector as the result of the series of water supply shortfalls experienced over the past decade. Those landscape and garden businesses that have survived have likely done so by shifting to providing xeriscape and related water efficient goods and services compatible with a more water-constrained and water-conserving customer base.

[8] It is unlikely many of the businesses in these sectors would make rapid recoveries at the end of the peak water use season, as it is likely to take many months to restore the SCWD's reservoir levels, and multi-year drought periods are likely to reoccur periodically.

Tourism and recreation

The business sectors that fall into this category include accommodation, amusement and theme parks, fitness and recreational centers, and tourism-supported retail. Tourism-related economic data (Visit California, 2022) and SCWD water usage data demonstrates the accommodation sector endured a 34% reduction in consumer spending during the pandemic as compared to the previous year, and it ended up using 23% less water in the peak season. The impact on accommodation was not as severe as it was on the food service sector, which is why they are treated differently in this analysis. The Stage 4 curtailments (21% water use reduction) are assumed to have a similar impact as that of the pandemic on water usage (23%) and the associated impacts on the sector's net revenues and the local economy. The same shock is assumed to occur with the other tourism-related businesses.

Golf courses

The SCWD provides water to two golf courses in its service area: the public DeLaveaga Golf Course and the private Pasatiempo Golf Course. The Pasatiempo Golf Course receives recycled water (secondary treated wastewater) from Scotts Valley for 90% of its irrigation needs, so will likely be relatively unimpacted by the curtailments. The DeLaveaga Golf Course, however, relies on SCWD water service and will likely be highly impacted by curtailments. We assume that DeLaveaga would have to close operations at a Stage 5 water curtailment (of 90%) because there will be insufficient water to irrigate the greens. The DeLaveaga Golf Course will likely need to take additional actions to remain in business during Stage 4 and 5 curtailments, such as actions taken by Australian golf courses because of the Millennium Drought, as well as similar actions taken by several California golf facilities.[9]

UCSC

UCSC's water use is 23% for irrigation, and the balance for student housing, food services, and other indoor uses. By Stage 3, the targeted 28% reduction will need to cut into indoor uses. By Stages 4 and 5, cutbacks to meet the associated reduction targets of 38% and 45% may not be feasible if students remain residing or spending large portions of their days on campus.

SCWD water usage data demonstrates that UCSC's water use went down significantly when students went remote during the pandemic, with a 39% reduction in peak season water use. We assume the impact of a Stage 4 curtailment scenario would thus be similar the impact of the pandemic because UCSC would have to require students to go remote to avoid going over its water allocation. We assume no change between stages 4 and 5 because the big 'hit' comes when students go remote at stage 4.

North Coast Agriculture

Given the 12 farms in the service area receive water from multiple sources, we assumed a similar relationship to output as we did for the restaurant sector. We assume that over time with less water, farmers will be forced to irrigate fewer acres, or switch to less water-intensive crops.

[9] Examples of golf course adaptations include installing liners in artificial lakes, turning off sprinklers in less trafficked areas, and investing in recycled water (including use of on-site treatment facilities) (Anderson, 2015).

Direct Economic Impacts on Household Customers

The Water Shortage Contingency Plan (SCWD, 2021) outlines an excessive use penalty system to provide a financial disincentive for customers to stay within their allocation. The inclusion of excess use penalties during water rationing is consistent with the same approach used in the 2009 WSCP and included in the City's Municipal Code provisions codifying WSCP provisions since that time.

Note that the Department does not wish to impose these penalties. Rather, under dire circumstance imposed on the system by severe or extended drought, the penalties serve as a necessary tool to incentivize everyone to do their part to ensure that scarce water is available for essential human health and safety purposes. The penalties are structured to disincentivize those who would otherwise ignore their allocations and instead opt to pay for their overuse of water. While the penalties might be viewed as draconian or as "punishment," their necessary objective is to have everyone in the community share the real burden of keeping the taps from running dry. As noted in the Santa Cruz Municipal Code [Section 16.01.140 I] (SCWD 2021):

> *The city's water is a scarce and irreplaceable commodity and [these penalties are] intended to equitably distribute that commodity among water department customers and to assure that, to the extent feasible, city water is conserved and used only for purposes deemed necessary for public health and safety… [T]he penalty schedule is not to be construed as creating a "water pricing" structure pursuant to which customers may elect to pay for additional water at significantly higher rates. To this end, a customer's repeated violation of this chapter shall result in either the installation of a flow restriction device or disconnection of the customer's property from the city's water service system at the customer's cost.*

Excess use penalties are charged on a per unit basis based on the amount of customer water use over its allocation (see Table 4) and is applied on the customer's monthly water bill. These penalties are additional costs customers will have to pay should their water use exceed their allocation and are therefore important to account for in this analysis as a reduction in disposable income. Disposable income is money that is available to be saved or spent (Clouse, 2021a). Reductions in household disposable income will in turn result in some reduced spending on locally provided goods and services, which in turn will work its way through the regional economy as indirect and induced impacts.

Table 4. Excess use penalties based on overage

Overage	Excess use penalty per overage
1 CCF over allocation	$25
2 CCF over allocation	$75
3 CCF over allocation	$125

The SCWD currently has 19,000 single family and 7,085 multifamily residential households (SCWD, 2021, and SCWD account data) – a total of 26,085 households in its service area. The

2014 and 2015 water restrictions imposed by the SCWD resulted in an average of 5% of households exceeding their allocation. These restrictions were Stage 3 curtailments under the old Water Use Management Plan, which were 15-25% reduction of water use (SCWD, 2016).

SCWD's former water restrictions (from 2016) were far less stringent than the current SCWD (2021) restrictions. For example, under Stage 3 of the 2016 policy, residential customers received a 10 CCF per month allocation.[10] In contrast, the 2021 plan limits the residential allocation at Stage 1 to only 5 CCF per customer, and to 3 CCF at Stage 3 (based on a household size of three).

Additionally, over the past several years, the demand has become more hardened in the SCWD's service area. As a result, we apply scenarios of the SCWD imposing the excess use penalty to 30% of households under a Stage 3 curtailment scenario (with a 4 CCF monthly limit for households of 3 persons), and 50% under Stage 4 and Stage 5 curtailment scenarios (with a water allotment of 3 CCF per household of 3 persons). These scenarios are based on the Department's experiences with households exceeding their allotments during the 2021 Stage 1 curtailments.

Tables 5 and 6 present the specific assumptions at each stage and the associated costs assuming the full six months of the peak season. The total excess use penalties at each stage are used in the economic impact analysis to reflect the direct impact on disposable household income. The estimated total penalties amount to significant sums, and the Department hopes not to impose such penalties by augmenting its water supply to ensure the City does not run out of water in a multi-year drought.

Table 5. Scenario for excess use penalties on households for Stage 3

Overage above 4 CCF	Excess use penalty per overage	Percent of noncompliant households	Number of noncompliant households	Total excess use penalty
1 CCF over	$25	20%	5,217	$782,550
2 CCF over	$75	10%	2,609	$1,173,825
Total		30%	7,826	$1,956,375

Table 6. Scenario for excess use penalties on households for Stages 4 and 5

Overage above 4 CCF	Excess use penalty per overage	Percent of noncompliant households	Number of noncompliant households	Total excess use penalty
1 CCF over	$25	10%	2,609	$391,275
2 CCF over	$75	20%	5,217	$2,347,650
3 CCF over	$125	20%	5,217	$3,912,750
Total		50%	13,043	$6,651,675

[10] For a household of up to 4 people. Additional water was allocated to those customers with larger households.

Indirect and Induced Economic Impacts (Applying the IMPLAN Model)

The direct economic impacts from the scenarios described above were used as input for the widely applied and well-accepted regional economic impact, input-output (I-O) model, IMPLAN.[11] The IMPLAN model, and types of economic impacts it is used to analyze, are briefly described in Text Box 2. In essence, the IMPLAN model simulates how direct economic impacts in each sector work their way through the local economy in the form of *indirect* and *induced* economic impacts.

For example, reduced occupancy at local hotels means reduced hotel revenues (a *direct* impact), which is likely to result in reduced wages and salaries paid to hotel employees, reduced purchases of goods and services provided (in part) by local laundry and foodstuff vendors, etc. (*indirect* impacts). The indirect impacts in turn will reduce incomes in those affected local sectors, with subsequent reductions in expenditures on other local goods and services (*induced* impacts). Outputs from the IMPLAN simulations include reductions in regional economic output, employment, labor income, and tax revenues.

The IMPLAN analysis was conducted for two separate sets of Stage-specific impacts: (1) the impact on business activities of key water-dependent sectors[12] and (2) the impact of reducing residential customers' household disposable incomes due to anticipated excess use penalties.[13] IMPLAN uses zip code data. We included all zip codes included in the Santa Cruz Water SCWD, specifically 95060, 95062, 95064, 95065. The base year is 2019 and all dollars are reported in 2022 dollars.

Economic Impact at County level

Our economic analysis focuses primarily on the combined direct, indirect, and induced impacts within and to the City of Santa Cruz, as reflected by the SCWD service area. In addition, we explored how the economic impacts of a SCWD water shortage also extend beyond City boundaries and impact Santa Cruz County as a whole. That is, direct impacts created within the City also are magnified and distributed throughout the broader regional economies, specifically between the SCWD service area and the county outside the service area.

To assess County-wide impacts, we used IMPLAN's Multi-Regional Input-Output Analysis (MRIO). "Multi-Regional Input-Output (MRIO) analysis makes it possible to track how an impact on any of the 546 IMPLAN Industries in a Study Area region affect the production of all 546 Industries and household spending in any other region in the US (state to state, county to county, zip code to zip code, county to multi-county, county to state, etc.)" (Clouse, 2022).

We defined our regions as follows:

- All zip codes within the SCWD service area; and
- All zip codes within Santa Cruz County, not including those within the SCWD service area.

[11] IMPLAN was initially developed and applied by the federal government (see history of IMPLAN at https://implan.com/history/).
[12] The impact on business was run as an "industry output event" following Clouse (2021b)
[13] The impact on households were run as a change in household income, following Clouse (2021c) and discussions with IMPLAN staff.

Text Box 2: Regional Economic Impacts and the IMPLAN Model

The IMPLAN model (IMpact Analysis for PLANning) is an economic input-output (I-O) model, originally developed by the federal government, that contains information on the relationships within an economy, both between businesses, and between businesses and final consumers. IMPLAN uses this information to predict changes in overall economic activity resulting from a flow of money into and out of the local economy (e.g., a visitor spending). IMPLAN is widely used by academics and the public and private sectors, and it is generally accepted as the standard for economic I-O analysis.

To estimate regional economic impacts, IMPLAN constructs local level multipliers. Multipliers describe the response of the economy to a change in demand or production. Multipliers measure the economic impact of direct effects, as well as how the direct effects ripple through the economy to create indirect and induced impacts. The magnitude of indirect and induced effects depends on the propensity of businesses and households in the region to purchase goods and services from local suppliers. Purchases from local suppliers have ripple effects in the economy, whereas purchases from non-local (outside of the county in this case) suppliers does not result in ripple effects because the money spent for inputs leaves the local economy. IMPLAN accounts for this in the development of local multipliers by assigning regional purchase coefficients to goods and services purchased by individual sectors and households. IMPLAN also reports implications for state and local tax revenues.

IMPLAN measures the direct, indirect, and induced impacts of changes to a regional economy described as:

- ***Direct impacts*** are the initial changes in business revenues (“output") such as the increased receipts from enhanced tourism, or a decrease in receipts when limited water availability limits businesses operations. Direct impacts include money tourists spend while visiting the area on food, lodging, and retail purchases.
- Local businesses that benefit from direct spending then, in turn, spend additional (or reduced) money on goods and services that they need to operate their businesses. These are termed ***indirect expenditures***.
- Direct and indirect spending generates employment in the local region, creating additional (or reduced) income for households, which generates further changes in local spending known as ***induced expenditures***.

More information on IMPLAN can be found on their website: https://implan.com/.

Key Findings

The economic analysis provides a considerable amount of empirical detail. In this section, we focus on some of the higher-level findings. Additional and more detailed empirical results are provided in Appendices C through F.

An economic impact analysis is, by its nature, an imprecise exercise in which numerous uncertainties exist and many key assumptions need to be made (as described throughout this TM and highlighted in the next section). Nonetheless, the estimates developed here may well be conservative, and are consistent with findings derived from other investigations of water supply shortages (e.g., M-Cubed, 2008a, 2008b, for East Bay Municipal Water District). [14]

As shown in the tables and associated text discussions that follow, water supply curtailments at Stages 3, 4 and 5 are anticipated to create significant economic losses to the community. These estimated losses in economic output, jobs, tax revenues, and other key metrics reveal how much value there is likely to be if/when the City makes investments to reduce the size of potential future water supply shortfalls.

For example, the estimated economic losses can be interpreted relative to the amount of added water supply that would be needed to avoid a given level of curtailment (e.g., as a cost per MG, or acre-foot, of shortage). The resulting "cost" of not having sufficient water can then be used as a benchmark against which to compare the expense of investments needed to secure that amount of water. That is, the economic cost of not having enough water may be viewed as the benefit (avoided cost) of acquiring the additional water. Further, by investing in a more secure and reliable water supply portfolio, the community may be able to attract businesses from locations in which the water supply is less secure and less reliable.

High-Level Results

Table 7 summarizes the estimated change in overall impact on City economic output from moving to increasingly more restrictive curtailment stages on businesses and other non-residential sectors. Also shown is the implied economic cost per volume of water targeted overall for peak season use reductions.

For example, moving from Stage 3 to Stage 4 reduces estimated annual economic output within the City by between approximately $210 million and $262 million. This amounts to $1.5 million and $1.9 million of lost economic output per MG of reduced water availability (based on 136 MG of additional water required to avoid moving from one curtailment stage to the next more severe curtailment stage for one water year peak period).

Another way of interpreting this finding is that if enough additional water supply was made available such that the City could avoid applying Stage 4 restrictions and instead implement the less restrictive Stage 3 limits (e.g., adding the equivalent of 10% of normal peak season water usage, i.e., 136 MG), then the City would gain an estimated additional economic output of $210 million to $262 million. This translates to $1.5 million to $1.9 million of added economic output per MG added (compared to the water supply augmentation options currently being evaluated by the City, which are each expected to cost less than $30,000 per MG produced). This is one way of viewing the value added of developing an additional source of available water supply.

[14] For example, an analysis of the economic impacts of water supply shortages for the East Bay Municipal Utility District indicates that estimated lost economic output grows rapidly if curtailments rise above a 15% supply reduction. The estimated loss of output was nearly $20 billion – or more than $2 million per MG foregone – if a 15% shortage were to grow to a 25% curtailment level (derived from M-Cubed, 2008a and 2008b; updated to 2022 dollars).

Table 7. City-only incremental impacts from business curtailments (select industries only)

Impact	Change in output ($M)	$/MG** ($M)	$/AF ($M)
Stage 2* to 3	$114.4 – $242.9	$0.8 – $1.8	$0.3 – $0.6
Stage 3 to 4	$209.9 – $262.4	$1.5 – $1.9	$0.5 – $0.6
Stage 4 to 5	$254.2 – $284.6	$1.9 – $2.1	$0.6 – $0.7

* Assumes *de minimus* economic impact at Stage 2 for businesses
** Applies 136 MG need to meet each Stage's 10% incremental reduction in total peak season demand

Table 8 provides the same information as Table 7 but includes County-wide economic impacts. The results in Table 8 reflect the degree to which impacts generated within the City – by SCWD-imposed water curtailments on its non-residential customers – "spill over" to also impact the broader county-level economy. In general, county-wide impacts on regional economic output from City-based curtailments are roughly 10% greater than the impacts experienced within the City itself.

Table 8. County-level incremental impacts from business curtailments (select industries only)

Impact	Change in output ($M)	$/MG** ($M)	$/AF ($M)
Stage 2* to 3	$126.1 – $266.8	$0.9 – $2	$0.3 – $0.6
Stage 3 to 4	$229.4 – $287	$1.7 – $2.1	$0.5 – $0.7
Stage 4 to 5	$277.8 – $311.2	$2 – $2.3	$0.67 – $0.75

* Assumes *de minimus* economic impact at Stage 2 for businesses
** Applies 136 MG needed to meet each Stage's 10% incremental reduction in total peak season demand

Economic output is only one measure of the losses incurred from water supply curtailments imposed on businesses and other non-residential water customers. Table 9 shows the losses estimated at each Stage from business and other non-residential sector impacts, stated in terms of number of jobs, labor income, value added, and tax revenues, as well as the economic output foregone.

Table 9. City-level negative economic impacts (losses) from select business and other non-residential curtailments

Metric (Losses)	Total impact at Stage 3	Total impact at Stage 4	Total impact at Stage 5
Output lost ($M)	$114.4 – $242.9	$324.3 – $505.3	$578.5 – $789.9
Labor income lost ($M)	$53.8 – $109.1	$141.0 – $218.6	$245.7 – $337.3
Value added lost ($M)	$68.6 – $144.8	$192.2 – $299.3	$341.6 – $467.8
Employment (# of jobs lost)	1,146 – 2,428	3,236 – 5,066	5,752 – 7,902
Tax revenues lost: City of Santa Cruz*($M)	$2.1 – $5.4	$8.0 – $12.7	$15.5 – $21.1
Tax revenues lost: County ($M)	$0.7 – $1.8	$2.7 – $4.3	$5.3 – $7.1
Tax revenues lost: State ($M)	$3.0 – $7.5	$10.9 – $17.1	$20.6 – $28.0
Tax revenues lost: Federal ($M)	$8.4 – $17.5	$23.0 – $35.8	$40.6 – $55.6
Total Tax Revenues Lost: Total ($M)	$14.1 – $32.2	$44.6 – $69.8	$82.0 – $111.8

Including household-driven economic impacts arising from reduced disposable incomes (due to excess use penalties), along with the non-residential sector impacts described above, increases the total amount of loss associated with water supply curtailments, but only to a very small degree (Table 10). That is, the adverse economic impact of estimated excess use penalties on households has a relatively small impact on the community's overall economy as shown in Table 10, although some economically challenged individual households may be burdened considerably.

Table 10. City-level negative economic impacts (losses) from residential curtailments

Metric (Losses)	Stage 3	Stages 4 and 5
Output lost	$459,128.9	$1,561,038.1
Labor income lost	$164,992.5	$560,974.6
Value added lost	$302,656.8	$1,029,033.1
Employment (# of jobs lost)	3.0	10.0
Tax revenues lost: City of Santa Cruz*	$11,222.2	$38,155.3
Tax revenues lost: County	$7,818.3	$12,901.1
Tax revenues lost: State	$16,456.6	$55,952.6
Tax revenues lost: Federal	$29,866.3	$101,545.3

* Includes sub-county general and sub-county special districts (e.g., road maintenance, fire protection). [15]

[15] A complete list of the Santa Cruz Special Districts can be found at: https://www.co.santa-cruz.ca.us/Departments/Auditor-ControllerHome/CountySpecialDistricts/ListofSantaCruzCountySpecialDistricts.aspx

Table 11 provides City-level impacts from the combined effects of curtailments on both the SCWD's residential and non-residential customers.

Table 11. City-level negative economic impacts (losses) from combined business and residential curtailments

Metric (Losses)	Total impact at Stage 3	Total impact at Stage 4	Total impact at Stage 5
Output lost ($M)	$114.9 – $243.4	$325.9 – $506.9	$580.1 – $791.5
Labor income lost ($M)	$54.0 – $109.3	$141.6 – $219.2	$246.3 – $337.9
Value added lost ($M)	$68.9 – $145.1	$193.2 – $300.3	$342.6 – $468.8
Employment (# of jobs lost)	1,149 – 2,431	3,236 – 5,066	5,752 – 7,902
Tax revenues lost: City of Santa Cruz*($M)	$2.1 – $5.4	$8.1 – $12.7	$15.6 – $21.1
Tax revenues lost: County ($M)	$0.7 – $1.8	$2.7 – $4.3	$5.3 – $7.1
Tax revenues lost: State ($M)	$3.0 – $7.5	$10.9 – $17.1	$20.7 – $28.0
Tax revenues lost: Federal ($M)	$8.4 – $17.5	$23.1 – $35.9	$40.7 – $55.7

The sections below summarize key empirical results for each of Stage 3, 4 and 5. Further results and details are provided in Appendices C, D and E.

Key Results for Stage 3 Curtailments on Businesses and Other Non-Residential Customers

Table 12. Range of negative economic impacts (losses) of Stage 3 water curtailments on included businesses: City/Service Area

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Direct	$104.3 – $220.9	$50.0 – $100.8	$62.7 – $132.1	1,088 – 2,302
Indirect	$6.8 – $15.3	$2.6 – $5.9	$3.7 – $8.3	37 – 82
Induced	$3.3 – $6.7	$1.2 – $2.5	$2.1 – $4.4	21 – 43
Total	$114.4 – $242.9	$53.8 – $109.1	$68.6 – $144.8	1,146 – 2,428

Table 13. Range of In-City negative tax impacts (losses) of Stage 3 water curtailments on included businesses

Impact type	Tax revenues lost: City of Santa Cruz* ($M)	Tax revenues lost: County ($M)	Tax revenues lost: State ($M)	Tax revenues lost: Federal ($M)	Tax revenues lost: Total ($M)
Direct	$1.8 – 4.9	$0.6 – $1.7	$2.7 – $6.8	$7.7 – $16.0	$12.8 – $29.3
Indirect	$0.1 – 0.3	$0.1 – $0.1	$0.2 – $0.5	$0.5 – $1.1	$0.9 – $1.9
Induced	$0.1 – 0.2	$0.0 – $0.1	$0.1 – $0.2	$0.2 – $0.5	$0.4 – $0.9
Total	$2.1 – 5.4	$0.7 – $1.8	$3.0 – $7.5	$8.4 – $17.5	$14.1 – $32.2

* Includes sub-county general and sub-county special districts (e.g., road maintenance, fire protection)[16]

Key Results for Stage 4 Curtailments on Businesses and Other Non-Residential Customers

Table 14. Range of negative economic impacts (losses) of Stage 4 water curtailments on included businesses: City/Service Area

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Direct	$294.6 – $458.8	$129.6 – $200.8	$175.0 – $272.4	3,067 – 4,802
Indirect	$21.0 – $32.9	$8.2 – $12.8	$11.5 – $18.0	113 – 176
Induced	$8.7 – $13.6	$3.2 – $5.0	$5.7 – $8.8	56 – 88
Total	$324.3 – $505.3	$141.0 – $218.6	$192.2 – $299.3	3,236 – 5,066

Table 15. Range of negative tax impacts (losses) of Stage 4 water curtailments on included businesses

Impact type	Tax revenues lost: City of Santa Cruz* ($M)	Tax revenues lost: County ($M)	Tax revenues lost: State ($M)	Tax revenues lost: Federal ($M)	Tax revenues lost: Total ($M)
Direct	$7.5 – $11.7	$2.5 – $4.0	$9.9 – $15.6	$20.9 – $32.5	$40.8 – $63.8
Indirect	$0.4 – $0.6	$0.1 – $0.2	$0.6 – $1.0	$1.5 – $2.4	$2.7 – $4.1
Induced	$0.2 – $0.3	$0.1 – $0.1	$0.3 – $0.5	$0.6 – $0.9	$1.2 – $1.8
Total	$8.0 – $12.7	$2.7 – $4.3	$10.9 – $17.1	$23.0 – $35.8	$44.6 – $69.8

* Includes sub-county general and sub-county special districts (e.g., road maintenance, fire protection) [17]

[16] Ibid.

[17] Ibid.

Key Results for Stage 5 Curtailments on Businesses and Other Non-Residential Customers

Table 16. Range of negative economic impacts (losses) of Stage 5 water curtailments on included businesses: City/Service Area

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Direct	$524.9 – $716.6	$225.0 – $308.9	$310.5 – $425.3	5,448 – 7,484
Indirect	$38.3 – $52.3	$15.1 – $20.6	$21.1 – $28.7	206 – 282
Induced	$15.3 – $21.1	$5.6 – $7.7	$10.0 – $13.7	99 – 136
Total	$578.5 – $789.9	$245.7 – $337.3	$341.6 – $467.8	5,752 – 7,902

Table 17. Range of negative tax impacts (losses) of Stage 5 water curtailments on included businesses

Impact type	Tax revenues lost: City of Santa Cruz* ($M)	Tax revenues lost: County ($M)	Tax revenues lost: State ($M)	Tax revenues lost: Federal ($M)	Tax revenues lost: Total ($M)
Direct	$14.5 – $19.6	$4.9 – $6.6	$19.0 – $25.8	$36.8 – $50.4	$75.1 – $102.4
Indirect	$0.7 – $0.9	$0.2 – $0.3	$1.1 – $1.5	$2.8 – $3.8	$4.8 – $6.5
Induced	$0.4 – $0.5	$0.1 – $0.2	$0.6 – $0.8	$1.0 – $1.4	$2.1 – $2.9
Total	$15.5 – $21.1	$5.3 – $7.1	$20.6 – $28.0	$40.6 – $55.6	$82.0 – $111.8

* Includes sub-county general and sub-county special districts (e.g., road maintenance, fire protection) [18]

Caveats and Limitations

All economic impact analyses and forecasts – and the tools and data applied in developing such assessments – inevitably are subject to numerous uncertainties and by necessity include several assumptions. Nonetheless, with suitable care, use of conservative and transparent assumptions, and sensitivity analyses, the outcomes provide useful information. In this section, we aim to describe the key uncertainties we faced, articulate the key assumptions made in developing the analysis, and describe the impact they may have on our results.

Business Sectors Included or Excluded

Several types of water-dependent businesses were included in the analysis, and several excluded because of uncertainty about their relevance as potentially large water users within the SCWD service area. This is most evident in the food manufacturing and computer and electronics sectors. Appendix B provides details on the business types used within the core analysis, and Appendix C provides details on those added in our sensitivity analysis.

[18] Ibid.

Throughout this TM, we report the results from the more conservative, shorter list of businesses impacted (see Table B1). Adding in the additional business types increases the extent of economic loss. For example, at Stage 3, there is an increase in output lost ranging from $9.4 and $28.2 million annually and additional jobs lost ranging from 22 to 65. Additional detail is provided in Appendix B.

Additionally, we did not include non-residential water service customers in the medical facilities, nursing care, and related medical and elder-care service sectors because we assume they would take priority over other businesses in terms of water usage, even though they tend to be relatively high-volume water users. This is a conservative omission, and it assumes businesses will stay within their allocations. It is possible, however, that medical and related care services would need to be scaled back to meet curtailment targets, with an associated nonmonetary cost to the community (in terms of patient care) as well as a potentially large adverse economic impact (which likely would be significant, given the large revenues the sector earns from the services provided).

Business Recovery after Peak Season

In the analysis, we apply a business downturn for the full year, not just the six-month peak water use season. If some businesses can rebound quickly after a curtailment period, then our results might overstate the economic losses. However, many of the businesses most impacted – such as accommodations, restaurants, and other tourism-related sectors – have strong seasonal business patterns that match the peak water use period. Further, in the months following a drought-impacted peak water use period, the City is likely to still be in a water-short situation and seeking to refill Loch Lomond and hedge against the increasing likelihood of a multi-year drought continuing into the following year or beyond. And, after a year or two of water shortage-impacted business revenues, some businesses may choose to close entirely or relocate. Thus, we do not expect that our use of year-long impacts generates an over-statement of adverse economic impacts.

New Businesses Attracted to the City

Increased water supply reliability is likely to help attract new businesses to the region, whereas the risk of water shortages is likely to create a disincentive for new enterprises to locate (or existing companies to expand) in the City. We have not included such potential business location impacts within our analysis, which likely results in an underestimate of the adverse impacts of curtailments.

Impacts from Penalty-Based Reductions in Household Disposable Income

Estimated levels of excess use penalties are applied in our analysis to assess the impact of reducing disposable income on those residential households projected to exceed their water use allotments in Stages 3, 4 and 5. There are several uncertainties associated with this aspect of the analysis, including how many households would actually exceed their water allotments, the degree to which the SCWD would apply and enforce collection of such penalties, and how the loss of disposable income would impact household spending patterns.[19] However, the adverse economic impact projected from household-level losses from the penalties is relatively very small, and we rely predominantly on the impacts on the non-residential customers in reporting our key findings (i.e., the household level impacts we develop do not affect our key outcomes and interpretations).

In addition, not included in our economic impact estimates are the adverse effects of the additional costs borne by SCWD customers due to increased administrative costs borne by the utility at high-level curtailment stages, or the impact of drought cost recovery fees. Ultimately, all these costs would be borne by the customers of the system, to cover the actual total costs of service incurred by the Department.

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[19] From Implan re: change in HH spending (Clouse, 2021c): *"In the case of a rate hike, you would see a reduction or negative impact in households… Giving a household less disposable income doesn't necessarily mean they won't pay their student loans or buy groceries. They may instead cut their utility usage or decrease their entertainment budget. If the increase is small enough it may have little to no impact on household spending for any group. Remember, different households may respond differently, depending on the size of the rate increase, their needs, and income level. A larger increase will likely affect the spending of lower income households but may not affect the spending of higher income households as these payments may come from savings (leakages in IMPLAN).*
Per conversations with IMPLAN, modelers are advised to add taxes and savings into the IMPLAN inputs to account for the fact they are removed during the model runs. However, to be conservative, we did not make assumptions on taxes and savings and therefore our results may be an underestimate of the impacts."

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Appendix A: Economic Impacts Grow Proportionally Greater as Curtailments get More Restrictive

The degree to which a business' economic activity declines with water supply curtailments will vary according to many case-specific circumstances. Nonetheless, the level of adverse impact on a business is likely to grow at a proportionally increasing rate as curtailments get more severe (i.e., a 10% more restrictive curtailment is likely to lead to a greater than 10% impact on output). The following discussion explains this likely relationship of proportionally greater economic impacts as curtailment levels get more restrictive.

Some business customers may use all the water they purchase as essential inputs to their output production. In such cases, there is little or no room to accept water supply limitations without also cutting back on the level of production, and economists would say that output in this case is "inelastic" with respect to water availability. In such cases, a 20% reduction in water supply (for example) would likely result in a significant reduction in production levels, which in turn would likely translate into reduced payroll (workers laid off or hours scaled back), reduced business income, fewer tax revenues generated, and so forth.

In other and probably more typical circumstances, CII entities use water for a variety of purposes, including landscape irrigation, cleaning, cooling, and production processes. In such situations, a CII customer can probably accommodate a modest curtailment in water supply by eliminating or reducing nonessential water uses (e.g., landscape irrigation), and apply the remaining allocation to essential production processes without a loss of product output and income.

One way of visualizing this important relationship between CII output and water supply curtailment levels is shown in Figure A.1. The vertical axis represents the output of the firm, and the horizontal axis reflects the percentage of water use restrictions. With a full allotment of water (0% curtailment), the firm produces 100% of its targeted output, as shown at point "a" on the curve.

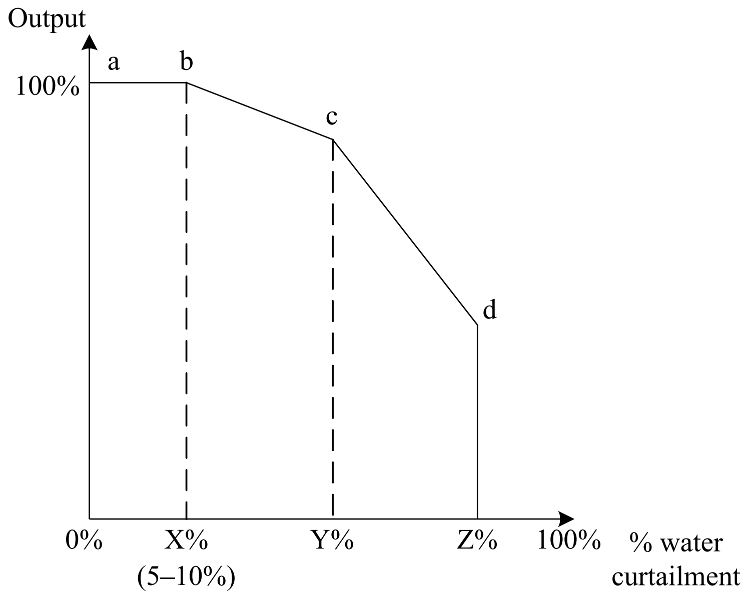

Figure A.1. Relationship between business output and the level of water supply curtailment.

To the extent that the CII entity uses water in "nonproduction" activities (e.g., landscape irrigation around a factory or office building), it can incur some level of water-use curtailments without impacting output. Thus, there is some level of curtailment for which little or no impact on production output is anticipated. This is depicted as the CII entity being at point "b" in the graph, using up to X% less water but still able to produce 100% of its product output. For some CII customers, X% may be quite high—perhaps 10%, or even greater than 40%, depending on specific circumstances. This means that if water use restrictions of X% or less are placed on the entity, there would be little or no change in production and, hence, little or no regional economic impact. However, for some CII entities, X may be close to 0%, meaning that any level of water supply curtailment would have an adverse impact on production and, hence, a negative economic impact.

Beyond X% of normal year water consumption, the firm's water use is directed at its main production processes. Thus, any curtailment greater than X% begins to have a negative impact on output and, hence, the regional economy. Thus, the output curve declines beyond an X% curtailment. This is shown in the figure by the decrease in production output as the CII entity faces curtailment levels greater than X%.

For curtailments exceeding X%, perhaps the CII entity has opportunities to make more efficient use of some of its water-consuming production activities. In such a case, output falls at a relatively modest rate relative to the water-use curtailment beyond X%, say up to a Y% curtailment, where the firm is operating at point "c." In other words, the output impacts from a loss of water availability of between X% and Y% may be proportionately less than the additional water curtailment, for some productive water uses. This results in a relatively low level of output decline between points "b" and "c."

However, beyond a Y% curtailment, the limited availability of water may have an increasingly significant impact on the ability (or willingness) of the firm to produce, resulting in proportionately greater output impacts as less water is available. This is reflected where the output curve begins to decline more steeply at curtailments greater than Y%, as shown by the steeper slope between points “c” and “d.”

At some level of curtailment, Z%, the level of water supply reduction reaches a point where the firm is no longer able or willing to continue production. It may simply be physically impossible to operate their facility at water curtailment levels of Z% or greater, or it may no longer be economically viable to operate at production levels below what it is feasible to generate at Z%. Or, it may become economically advantageous to relocate activities to another, more water abundant region (either temporarily or permanently). Thus, once a firm reaches point “d” in Figure A.1, output drops to zero (i.e., the local plant is shut down).

Naturally, the exact shape of the relationship shown in Figure A.1 will vary considerably across sectors, and even across entities within the same general business or industrial category. However, the basic relationship is likely to be consistent across most CII entities. As water supply becomes less reliable, firms may be able to withstand initial small restrictions in water use with limited impacts on their levels of production, employment, and income. However, as curtailments increase in severity, it is increasingly likely that production will start to decline dramatically, and that at some level of water shortage, the facility may decide to shut down operations entirely. The value of water supply reliability to the firm, and to the greater community, will depend on the entity-specific shape of the generalized relationship depicted in Figure A.1.

Source: This graphic and associated discussion draws from Raucher et al. (2015).

Appendix B: Business sectors and industries included in the analysis

Table B1. Business sectors and industries included in the IMPLAN analysis

Sector	IMPLAN Industry
UCSC	Junior colleges, colleges, universities, and professional schools
Car Washes	Car washes
Nursery, landscape, and garden	Greenhouse, nursery, and floriculture production
	Landscape and horticultural services
Accommodation	Hotels and motels, including casino hotels
	Other accommodations
Food Services and Drinking Places	Retail – Food and beverage stores
	All other food and drinking places
	Full-service restaurants
	Limited-service restaurants
Amusement and Theme Parks	Amusement parks and arcades
Golf Courses and Country Clubs	Other amusement and recreation industries
Fitness and Recreational Centers	Fitness and recreational sports centers
Food Manufacturing	Creamery butter manufacturing
	Animal, except poultry, slaughtering
	Seafood product preparation and packaging
	Bread and bakery product, except frozen, manufacturing
	Dry pasta, mixes, and dough manufacturing
	Roasted nuts and peanut butter manufacturing
	Coffee and tea manufacturing
	Spice and extract manufacturing
North Coast Agriculture	Vegetable and melon farming
	Fruit farming

Table B1. Business sectors and industries included in the IMPLAN analysis

Sector	IMPLAN Industry
Breweries and distilleries	Breweries
	Distilleries
Cement/concrete manufacturing	Cement manufacturing
	Ready-mix concrete manufacturing
Tourism-supported retail	Retail – Food and beverage stores
	Retail – Clothing and clothing accessories stores
Food manufacturing included in sensitivity analysis	Dog and cat food manufacturing
	Other animal food manufacturing
	Nonchocolate confectionery manufacturing
	Confectionery manufacturing from purchased chocolate
	Frozen specialties manufacturing
	Canned fruits and vegetables manufacturing
	Frozen cakes and other pastries manufacturing
	Meat processed from carcasses
	Rendering and meat byproduct processing
	Cookie and cracker manufacturing
	All other food manufacturing
Computer included in sensitivity analysis	Electronic computer manufacturing

Appendix C: Sensitivity analysis

Table C1. Additional business sectors and industries included in the sensitivity analysis

Sector	IMPLAN Industry
Food manufacturing	Dog and cat food manufacturing
	Other animal food manufacturing
	Nonchocolate confectionery manufacturing
	Confectionery manufacturing from purchased chocolate
	Frozen specialties manufacturing
	Canned fruits and vegetables manufacturing
	Frozen cakes and other pastries manufacturing
	Meat processed from carcasses
	Rendering and meat byproduct processing
	Cookie and cracker manufacturing
	All other food manufacturing
Computer	Electronic computer manufacturing

Table C2. Range of economic impacts of Stage 3 water curtailments with additional business sectors and industries: City impact only

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Selected industries	$114.4 – $242.9	$53.8 – $109.1	$68.6 – $144.8	1,146 – 2,428
All industries identified as potentially relevant	$123.8 – $271.1	$55.2 – $113.4	$70.8 – $151.6	1,168 – 2,493
Difference	$9.4 – $28.2	$1.4 – $4.3	$2.2 – $6.8	22 – 65

Table C3. Range of economic impacts of Stage 4 water curtailments with additional business sectors and industries: City impact only

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Selected industries	$324.3 – $505.3	$141.0 – $218.6	$192.2 – $299.3	3,236 – 5,066
All industries identified as potentially relevant	$369.2 – $576.3	$147.8 – $229.4	$202.9 – $316.2	3,344 – 5,237
Difference	$44.9 – $71.0	$6.8 – $10.8	$10.7 – $16.9	108 – 171

Table C4. Range of economic impacts of Stage 5 water curtailments with additional business sectors and industries: City impact only

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Selected industries	$578.5 – $789.9	$245.7 – $337.3	$341.6 – $467.8	5,752 – 7,902
All industries identified as potentially relevant	$668.3 – $909.9	$259.3 – $355.4	$363.0 – $496.7	5,967 – 8,185
Difference	$89.8 – $120.0	$13.6 – $18.1	$21.4 – $28.9	215 – 283

Appendix D: County-level results

Business

Table D1. Range of economic impacts of in-City Stage 3 water curtailments on included businesses, at the County-wide level

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Direct	$104.3 – $220.9	$50.0 – $100.8	$62.7 – $132.1	1,088 – 2,302
Indirect	$9.4 – $20.8	$3.5 – $7.8	$5.0 – $11.1	51 – 113
Induced	$12.3 – $25.1	$3.9 – $8.1	$7.9 – $16.0	72 – 146
Total	$126.1 – $266.8	$57.4 – $116.6	$75.6 – $159.3	1,211 – 2,561

Table D2. Range of economic impacts of in-City Stage 4 water curtailments on included businesses, at the County level

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Direct	$294.6 – $458.8	$129.6 – $200.8	$175.0 – $272.4	3,067 – 4,802
Indirect	$28.4 – $44.4	$10.8 – $16.8	$15.3 – $23.9	154 – 241
Induced	$32.6 – $50.6	$10.5 – $16.2	$20.8 – $32.3	190 – 294
Total	$355.5 – $553.8	$150.8 – $233.9	$211.0 – $328.6	3,411 – 5,337

Table D3. Range of economic impacts of in-City Stage 5 water curtailments on included businesses, at the County level

Impact type	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)
Direct	$524.9 – $716.6	$225.0 – $308.9	$310.5 – $425.3	5,448 – 7,484
Indirect	$51.4 – $70.2	$19.6 – $26.8	$27.8 – $37.9	279 – 382
Induced	$57.0 – $78.2	$18.3 – $25.1	$36.4 – $49.9	332 – 455
Total	$633.3 – $865.0	$262.9 – $360.8	$374.6 – $513.2	6,058 – 8,322

Residential

Table D4. Range of negative economic impacts (losses) of Stage 3 water curtailments on disposable household income at the County-wide level

Metric	Impact (losses)
Output lost	$485,557.7
Labor income lost	$173,005.5
Value added lost	$319,391.8
Employment (# of jobs lost)	3
Tax revenues lost: City of Santa Cruz	$11,957.5
Tax revenues lost: County	$4,043.1
Tax revenues lost: State	$17,548.2
Tax revenues lost: Federal	$31,481.5

Table D5. Range of negative economic impacts (losses) of Stage 4 and 5 water curtailments on disposable household income at the County-wide level

Metric	Impact (losses)
Output lost	$1,655,497.2
Labor income lost	$589,632.0
Value added lost	$1,088,847.9
Employment (# of jobs lost)	10
Tax revenues lost: City of Santa Cruz	$40,781.9
Tax revenues lost: County	$13,789.3
Tax revenues lost: State	$59,851.8
Tax revenues lost: Federal	$107,319.8

Appendix E: Sector-level results

Table E1. Range of negative economic impacts (losses) of Stage 3 water curtailments on included businesses by sector: City/Service Area.

Sector	Assumed reduction	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)	Tax revenues lost: City of Santa Cruz*($M)
Nursery, landscape, and garden	45% – 60%	$53.6 – $71.4	$28 – $37.3	$32.5 – $43.4	506 – 675	$0.1 – $0.3
Food services and drinking places	5% – 15%	$29.7 – $89.1	$13.3 – $39.8	$18.8 – $56.5	330 – 990	$0.9 – $2.6
Food manufacturing	5% – 15%	$5 – $15.1	$1 – $3	$1.5 – $4.5	23 – 69	$0.1 – $0.4
Breweries and distilleries	5% – 15%	$1.2 – $3.5	$0.1 – $0.4	$0.5 – $1.4	3 – 8	$0.1 – $0.3
Car washes	5% – 15%	$1 – $2.9	$0.5 – $1.4	$0.7 – $2	6 – 19	$0.1 – $0.2
Cement/concrete manufacturing	5% – 15%	$1.1 – $3.4	$0.2 – $0.6	$0.4 – $1.1	3 – 8	$0 – $0.02
Accommodation	5% – 15%	$4.2 – $12.6	$1.8 – $5.3	$2.6 – $7.9	37 – 112	$0.1 – $0.3
Amusement and theme parks	5%-15%	$2.9 – $8.8	$1.2 – $3.7	$1.9 – $5.7	37 – 111	$0.1 – $0.3
Fitness and Recreational Centers	5%-15%	$0.3 – $0.8	$0.1 – $0.3	$0.1 – $0.4	5 – 16	$0 – $0.01
Tourism-supported retail	5%-15%	$4.6 – $13.9	$1.9 – $5.6	$2.8 – $8.4	44 – 131	$0.2 – $0.7
UCSC	15% – 25%	$4.3 – $7.2	$2.1 – $3.4	$2.8 – $4.6	64 – 107	$0.06 – $0.09
Golf courses	25%-35%	$3.3 – $4.6	$1.7 – $2.4	$1.8 – $2.5	51 – 71	$0.04 – $0.07
North Coast agriculture	5%-15%	$3.2 – $9.6	$1.9 – $5.8	$2.1 – $6.3	37 – 110	$0.01 – $0.04
Total		$114.4 – $242.9	$53.8 – $109.1	$68.6 – $144.8	1,146 – 2,428	$2.1 – $5.4

* Includes sub-county general and sub-county special districts (e.g., road maintenance, fire protection). [20]

[20] A complete list of the Santa Cruz Special Districts can be found at: https://www.co.santa-cruz.ca.us/Departments/Auditor-ControllerHome/CountySpecialDistricts/ListofSantaCruzCountySpecialDistricts.aspx

Table E2. Range of negative economic impacts (losses) of Stage 4 water curtailments on included businesses by sector: City/Service Area.

Sector	Assumed reduction	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)	Tax revenues lost: City of Santa Cruz*($M)
Nursery, landscape, and garden	45% – 60%	$59.5 – $83.4	$31.1 – $43.6	$36.2 – $50.6	562 – 787	$0.4 – $0.5
Food services and drinking places	5% – 15%	$148.5 – $237.6	$66.3 – $106	$94.2 – $150.7	1,651 – 2,641	$4.3 – $6.8
Food manufacturing	5% – 15%	$25.2 – $40.3	$5.1 – $8.1	$7.6 – $12.1	116 – 185	$0.6 – $1.0
Breweries and distilleries	5% – 15%	$5.8 – $9.3	$0.7 – $1	$2.3 – $3.7	13 – 21	$0.5 – $0.7
Car washes	5% – 15%	$4.8 – $7.7	$2.3 – $3.7	$3.4 – $5.4	31 – 50	$0.3 – $0.4
Cement/concrete manufacturing	5% – 15%	$5.6 – $9	$1 – $1.6	$1.8 – $2.9	13 – 20	$0.03 – $0.06
Accommodation	5% – 15%	$16.8 – $25.2	$7 – $10.5	$10.5 – $15.7	150 – 224	$0.4 – $0.5
Amusement and theme parks	5%-15%	$11.7 – $17.5	$5 – $7.5	$7.7 – $11.5	148 – 222	$0.4 – $0.6
Fitness and Recreational Centers	5%-15%	$1.1 – $1.7	$0.5 – $0.7	$0.6 – $0.8	21 – 32	$0.02 – $0.03
Tourism-supported retail	5%-15%	$18.5 – $27.8	$7.5 – $11.3	$11.2 – $16.7	175 – 262	$1.0 – $1.5
UCSC	15% – 25%	$8.6 – $18.6	$4.1 – $8.9	$5.6 – $12	128 – 277	$0.1 – $0.2
Golf courses	25%-35%	$5.3 – $8	$2.8 – $4.2	$2.9 – $4.3	82 – 122	$0.07 – $0.1
North Coast agriculture	5%-15%	$12.8 – $19.3	$7.8 – $11.6	$8.4 – $12.6	147 – 220	$0.06 – $0.1
Total		$324.3 – $505.3	$141 – $218.6	$192.2 – $299.3	3,236 – 5,066	$8.0 – $12.7

* Includes sub-county general and sub-county special districts (e.g., road maintenance, fire protection). [21]

[21] Ibid.

Table E3. Range of negative economic impacts (losses) of Stage 5 water curtailments on included businesses by sector: City/Service Area

Sector	Assumed reduction	Output lost ($M)	Labor income lost ($M)	Value added lost ($M)	Employment (# of jobs lost)	Tax revenues lost: City of Santa Cruz*($M)
Nursery, landscape, and garden	45% – 60%	$59.5 – $83.4	$31.1 – $43.6	$36.2 – $50.6	562 – 787	$0.7 – $1.1
Food services and drinking places	5% – 15%	$297 – $386.1	$132.5 – $172.3	$188.4 – $245	3,301 – 4,292	$8.5 – $11.1
Food manufacturing	5% – 15%	$50.3 – $65.4	$10.1 – $13.1	$15.1 – $19.7	232 – 301	$1.2 – $1.6
Breweries and distilleries	5% – 15%	$11.6 – $15.1	$1.3 – $1.7	$4.7 – $6.1	27 – 35	$0.9 – $1.2
Car washes	5% – 15%	$9.7 – $12.6	$4.6 – $6	$6.8 – $8.8	63 – 82	$0.6 – $0.7
Cement/concrete manufacturing	5% – 15%	$11.3 – $14.6	$2 – $2.6	$3.6 – $4.7	26 – 33	$0.06 – $0.09
Accommodation	5% – 15%	$33.6 – $50.4	$14.1 – $21.1	$21 – $31.5	299 – 449	$0.7 – $1.1
Amusement and theme parks	5%-15%	$23.4 – $35.1	$9.9 – $14.9	$15.3 – $23	296 – 445	$0.9 – $1.3
Fitness and Recreational Centers	5%-15%	$2.2 – $3.4	$0.9 – $1.4	$1.1 – $1.7	43 – 64	$0.03 – $0.06
Tourism-supported retail	5%-15%	$37 – $55.5	$15 – $22.6	$22.3 – $33.5	350 – 525	$2.0 – $2.9
UCSC	15% – 25%	$8.6 – $18.6	$4.1 – $8.9	$5.6 – $12	128 – 277	$0.1 – $0.2
Golf courses	25%-35%	$8.6 – $11.3	$4.5 – $5.9	$4.7 – $6.1	133 – 173	$0.1 – $0.2
North Coast agriculture	5%-15%	$25.7 – $38.5	$15.5 – $23.3	$16.8 – $25.2	293 – 440	$0.1 – $0.2
Total		$578.5 – $789.9	$245.7 – $337.3	$341.6 – $467.8	5,752 – 7,902	$15.5 – $21.1

* Includes sub-county general and sub-county special districts (e.g., road maintenance, fire protection). [22]

[22] Ibid.

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POLLUTION

A Growing Drinking Water Crisis Threatens American Cities and Towns

The Jackson, Miss., disaster rings alarm bells about myriad problems lurking in water systems across the country

By Robin Lloyd on September 9, 2022

Jamiya Williams, left, watches as her fiance, Terrence Carter, right, pours bleach into the water before washing dishes in response to the water crisis on September 01, 2022 in Jackson, Mississippi. The water pressure increased in their apartment on Wednesday however the water is still unsafe to drink. Jackson has been experiencing days without reliable water service after river flooding caused the main treatment facility to fail. Credit: Brad Vest/Getty Images

Residents of Jackson, Miss., recently experienced a week without reliable water service. And an advisory to boil any water that does flow from faucets in that capital city of 150,000 people has been in place since late July. This is just some of the alarming drinking-water-related news that has surfaced as summer winds down in the U.S. Other reports have told of arsenic in tap water in a New York City public housing complex, potentially sewage- or runoff-related *Escherichia coli* bacteria in West Baltimore's water supply and a lawsuit alleging neurological issues linked to thousands of liters of jet fuel that leaked into drinking water in Hawaii last year.

In the aftermath of the drinking-water contamination crisis that hit Flint, Mich., in 2014, a growing number of similar incidents have received national attention, eroding confidence in neglected drinking-water and wastewater treatment systems that once were considered among the world's most sophisticated and robust. Some ground will be gained as billions of dollars from the Biden administration's Bipartisan Infrastructure Law start to flow to states for improvements to local water systems—including the replacement of dangerous lead pipes that run from public water lines to buildings' plumbing. But money alone cannot solve larger structural and systemic issues afflicting the nation's thousands of aging public and private water and wastewater systems, experts say.

Upmanu Lall, a hydroclimatologist at Columbia University and a luminary in his field, has co-authored and led numerous studies that document the rise of contaminated drinking water in the U.S. He and his colleagues assessed a national data set of 17,900 water utilities and other community drinking-water systems, revealing that water-quality violations of the U.S. Safe Drinking Water Act more than doubled between 1980 and 2015. In the latter year, drinking-water systems serving nearly 21 million people in the U.S. were cited for such water-quality violations. In other studies and projects, Lall and his colleagues also have examined rational and effective ways to build more resilient water and wastewater systems globally and to address water scarcity.

To learn more about the national context and implications of Jackson's ailing water system, *Scientific American* spoke with Lall about what the future holds for U.S. water and wastewater systems—and what can be done to improve the outlook and to secure safer drinking water for coming generations.

[*An edited transcript of the interview follows*.]

How do the recent drinking water problems in Jackson fit into the larger landscape of U.S. water distribution systems?

Jackson is one of many cities where things like this are happening. It is perhaps one of the larger such crises. And it's a more chronic one. The smaller water problems, unless they are something like Flint, just don't get reported. So the larger context is that what's happened has caught people's attention.

How far can the Bipartisan Infrastructure Law go toward addressing problems such as those afflicting residents of Jackson?

Some of the primary water concerns that the infrastructure bill proposes to address is to replace a whole bunch of lead service lines and to put money to figuring out why PFASs—perfluoroalkyl and polyfluoroalkyl substances [often called "forever chemicals" because of their persistence in the environment]—are present in water and what to do about it. These are good things. I don't want to criticize them. But what they speak to is that when one particular issue becomes prominent, then Congress or other bureaucracies start paying attention to it. But the one issue that they should be paying attention to is that the whole infrastructure system with water and wastewater is failing. And many leaders and officials don't get that because it's too big an issue. The problem with what they're doing is that when you focus on "Okay, we're going to go replace a bunch of lead service lines," money is being spent on that one issue—but it's not addressing the basic issue across the board.

What should leaders and officials focus on instead when it comes to our water and wastewater systems?

Here's the challenge: Water and wastewater systems can be divided into the following components. One is storage, such as reservoirs and dams. Then the second is conveyance, which is the pipes that bring the water to you or sewers that take the wastewater back, as well as the associated pumps. And finally, there is the treatment system. So these are the three components that we have to deal with. The median age of U.S. dams is around 60 years. They were designed to last for 50. And the state of maintenance or the condition of around two thirds of the dams in the country is actually unrated and unknown. Regarding conveyance, the number of water-main failures is estimated at around 850 daily in the North America.

And then the treatment systems—we have increasing reports of pathogens in drinking water, which lead to "boil water" notices. That trend has been driving more and more people to consume bottled water or to buy filtration systems. So in totality, each of the components is aging and failing, and the reliability of service in each component is now a question mark. This is why one has to think about how they can collectively be upgraded.

Smaller communities in particular do not have the financial or technical resources to actually figure out what they should do. And so as a result, we have a systemic risk of failure.

How does climate change figure into this problem?

The systemic risk of failure is amplified by changing climate. If you have a drought, you have a lower amount of water available, a higher concentration of chemicals entering water and limited treatment capacity. At the other extreme, for example, nearly four years ago, heavy rains flooded the Highland Lakes area, which supplies water to Austin, Tex. The reservoirs filled up with sediment. The city's treatment plant did not have the capacity to deal with so much sediment. So the city's water utility asked residents to go a water-rationing spree and issued a boil-water advisory that lasted one week in the middle of very wet conditions.

Beyond its current regulatory and other roles, what more could the federal government do to secure safer drinking water for people in the U.S.?

There is no central planning for water investments in the U.S. Compare that with the situation for energy, where we have the Energy Information Administration and the Department of Energy. Whether they do a good job or not, there are at least some people tasked with thinking about what should be done and to put some requests for money on the table. In contrast, we have seven or eight different federal agencies with some sort of jurisdiction on water. And that structure is then replicated at the state level and at the local level. The federal government had strong investments in water infrastructure in the middle of the 20th century and up to around 1980. We were state of the art as a result. Today it is time to renew such efforts in a thoughtful way that best uses new digital technologies to assure performance.

Could the country spend its way out of this problem?

It's a bigger issue than that. Again, I'll make the comparison with the energy situation. The energy policy makers are seriously working on how to replace fossil fuels, how to expand transmission capacities, how to improve the reliability of the system. A lot of this is done in the private sector, but there is some facilitation by federal government sources and state sources. There is no corresponding story on water. And so the challenge is not money. It's having some group that is actually working on what should be the 21st-century architecture for the U.S. water system. Because otherwise, what happens is that we have piecemeal approach, such as focusing on replacing lead pipes.

What types of solutions does your research point to?

Obviously, we have to think about how we replace all these aging components. But then, if we want to design a system for the 21st century, we probably want to have some digital capacity such that—when somebody turns on a faucet or uses water for flushing toilets, showering, drinking or cooking—in each case, an instrument on-site should assess the relevant chemicals of concern and indicate whether you have an issue or not.

It also turns out that 70 to 80 percent of our water systems' expenditure in the U.S. is on conveyance: pumps, pipes and sewers. So suppose you localize treatment. Every neighborhood, or possibly every house or building, could have a treatment system. Then you could obtain immediate feedback with sensors as to whether or not that treatment was effective. Then we could have the ability to take wastewater that is locally generated and treat it to our drinking-water standards. Rainwater that falls from roofs could be captured and treated to our drinking-water standards. All that starts becoming feasible. We can start looking at a system that is still going to need wells and other water supplies. But you could probably reduce your draw of water from nature by 70 percent or so in many settings. You would have much higher service reliability and quality.

Similarly with agriculture, which is the largest water user, there are options such as agrivoltaics and shifting which crops are grown where. So you start thinking about restructuring the whole system. That is not just a question of liberating money. It's more a question of getting some good, higher-level planning and thinking in place and then putting money behind these plans and innovations.

What happens if we do not pursue such changes to water storage, conveyance and treatment systems in the U.S.?

One big concern is the California drought. The agriculture industry there is at an extremely high risk of dying. And that will have an impact on the food supply. More generally, we will see a slowly evolving epidemic of water system failures like the one in Jackson. So it's not going to be a sharp catastrophe, but there's going to be something that will continue unfolding slowly until you say, "Hey, what the hell is going on?"

ABOUT THE AUTHOR(S)

Journalist **Robin Lloyd**, a contributing editor at *Scientific American*, is president of the Council for the Advancement of Science Writing's board of directors. Follow Robin Lloyd on Twitter. *Credit: Nick Higgins*

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Amid a historic drought and record shortages, Coalinga searches for extra water to make it through the year

By Joshua Partlow
October 10, 2022 at 6:00 a.m. EDT

CORRECTION

A previous version of this article mischaracterized where the city's name comes from. Coalinga's name derives from its history as a coaling station on a railroad line, not a coal mining town. The article has been corrected.

COALINGA, Calif. — The residents of this sun-scorched city feel California's endless drought when the dust lifts off the brown hills and flings grit into their living rooms. They see it when they drive past almond trees being ripped from the ground for lack of water and the new blinking sign at the corner of Elm and Cherry warning: "No watering front yard lawns."

The fire chief noticed it when he tested hydrants in August — a rare occurrence as Coalinga desperately seeks to conserve water — and the first one shot out a foot-long block of compacted dirt. The second one ejected like a can of Axe body spray.

The schools superintendent could only think *drought* on the first day of school when a 4-year-old fell onto unwatered turf, breaking an arm; or when the chain saws dropped three coastal redwoods outside Henry F. Bishop Elementary that had withered and died. Superintendent Lori Villanueva even lost a portion of her own right lung last year from a drought-aggravated illness, valley fever, that's caused by breathing soil fungus whipped up off the dry ground.

But what lies ahead might be far worse for the 17,000 residents living amid the oil derricks and cattle farms on the western edge of the state's Central Valley. Coalinga has only one source of water — a shrinking allotment from an aqueduct managed by the federal government — and officials are projecting the city will use up that amount before the end of the year.

That looming threat has left city officials racing between meetings in Sacramento and phone calls to the U.S. Bureau of Reclamation seeking to increase their water supply. Some residents have begun stockpiling five-gallon water jugs in their homes, while many expect major spikes in their water bills. If Coalinga can't find relief, it would be forced to buy additional water on the open market at exorbitant prices that could swamp the city's budget.

That was the grim scenario facing Mayor Ron Ramsey when he rapped his knuckles on the table and cursed at a City Council meeting in early August. Everyone but Ramsey had just voted to ban watering front yards and to ramp up penalties on overuse — measures they conceded would not save nearly what was needed. But it was more than Ramsey could stomach.

"It's too much. Too fast," Ramsey told the room. On top of that, he said, it wasn't fair.

"Go to the state capitol and they got green grass, don't they?" he said. "They can do it, but why can't we?"

Coalinga, named for its history as a coaling station on a railway line, is a small Republican outpost in liberal California. The city had already defied state leadership in 2020, passing a resolution that declared all businesses essential to avoid mandatory pandemic closures. When it was time for the state to distribute covid-19 relief funds to municipalities, Coalinga didn't get any.

The water shortage felt to some like another kind of retaliation.

"How do you not give farmers water when they feed everybody unless you're trying to put them out of business?" asked Scott Netherton, owner of Coalinga's lone movie theater and executive director of its chamber of commerce.

"It feels like we're being singled out, small towns," he said. "It's like they're trying to force them out to where you've got to move into the bigger cities."

Coalinga's brackish groundwater has never been a reliable option. Before a canal was completed in the early 1970s that connected Coalinga to a major aqueduct, the city relied on water delivered by train. After a 1983 earthquake that destroyed some 300 homes in town and spread concerns about water contamination, residents resorted to donations; Anheuser-Busch sent drinking water to Coalinga in beer cans and bottles.

But the drought has made residents question the very survival of their city.

"We've never been this bad where they said we're going to run out of water," Mayor Ramsey said.

A future with far less access to water

The most severe drought in the American West since the 9th century is now in its 23rd year. All across the region, communities are confronting shortages worse than they have ever known. The biggest reservoirs have fallen to record lows. Whole neighborhoods have lost their water supply as wells have gone dry. States along the dwindling Colorado River are negotiating water cuts that could bring dramatic disruptions to some of the country's most important agricultural belts.

The hotter and drier climate has forced California and other states to reckon with a future in which they will have access to far less water, even as populations continue to grow. In August, Gov. Gavin Newsom (D) presented a 19-page plan to deal with the expected loss of 10 percent of the state's water supply by 2040.

"The hots are getting a lot hotter. The dries are getting a lot drier," Newsom told reporters at the time. "We have to adapt to that new reality, and we have to change our approach."

California started the year with its driest four months on record. Snowpack in the Sierra Nevada this year was a small fraction of the historical average. Depleted reservoirs have led to restrictions on outdoor watering for millions of state residents.

Coalinga's water comes from the San Luis Reservoir, about 90 miles to the north, and is delivered along a portion of the California Aqueduct that was built in the 1960s and helped fuel the region's agricultural growth. This is part of the Central Valley Project, a network of dams, reservoirs and canals now severely hobbled by drought.

Farmers received no allocation from that network this year; municipalities and industrial users were limited to what the Bureau of Reclamation calculates as their "public health and safety" needs — a first in the history of the Central Valley Project, which dates to the 1930s.

For Coalinga, that meant 1,920 acre-feet of water — a quarter of its historic allotment and just over half of what it expected to consume this year. Federal officials raised that in April to 2,500 acre-feet — a level that still fell more than 1,000 acre-feet short of what Coalinga needed. An acre-foot is about 326,000 gallons, what it would take to cover an acre of land with one foot of water.

Over the summer, city officials calculated the city's supply would run out by mid-September.

Beyond that point, if Coalinga kept using water from the aqueduct, it would belong to someone else.

"You don't have the right to take that water," was the message Sean Brewer, Coalinga's assistant city manager, said he got from Reclamation officials.

The bureau said in a statement that it had been working closely with Coalinga on its "unique water supply circumstances and challenges." Brewer agreed that the bureau has been "extremely helpful" even as its "hands are tied." Federal officials gave him names of vendors who might sell the city the extra water it needed. But as Brewer worked his way down the list of irrigation districts, farmers and other private interests, the news wasn't good.

"Nobody has water to sell right now," he said.

Those who do are not selling it cheap.

"I cringe when I say this," Brewer told the City Council on Aug. 4, as he reported that water that normally cost the city $190 per acre-foot was being sold on the open market for as much as $2,500 per acre-foot. The city might need up to $2.5 million to buy enough water to last the year, he said. The city's entire budget is $10 million.

“We just don’t have $2.5 million to buy water,” City Council member Adam Adkisson said in an interview, calling the water prices “criminal.”

“In a natural disaster, you can’t increase the cost of bottled water 2,000 percent; you’d go to jail for that,” he said. “But somehow these people can increase it 2,000 percent and everything’s just fine.”

Fear of that kind of “drought profiteering” prompted state Sen. Melissa Hurtado (D) to write Attorney General Merrick Garland in May asking for an investigation into the anti-competitive practices of hedge funds and other investors that “literally steal our most life dependent resource from ourselves and future generations in exchange for a profit.”

Hurtado talked to Adkisson in August as he was searching for a solution for Coalinga and found him “in panic mode.”

“The price of water, the cost of water, is increasing, but it’s not just going to be to the Central Valley; it’s going to be statewide,” Hurtado said. “We’re in a crisis situation in a matter of weeks, I think.”

‘What do you do when the water runs out?’

In the High Times marijuana store — a burgeoning industry for Coalinga, which has two prominent dispensaries downtown and a pot farm run out of a defunct prison owned by Bob Marley’s son Damian — manager Luis Zamora is just starting to register a new level of concern about the water crisis.

“Just in the last probably two days, I’ve had people asking me, like, what do you do when the water runs out?”

He laughed.

“*Exactly*. What do you do?”

Coalinga has tried to get tough on water waste. The city has code enforcers and even police officers patrolling for water violations. The city put a moratorium on building swimming pools, raised water rates several times and last year began imposing “drought fees” for overuse. But the city soon voted to refund the $277,000 it had raised in fees because water use wasn’t declining enough.

“It was supposed to be a deterrent,” said Netherton, the chamber of commerce’s executive director. “It wasn’t deterring anybody.”

Zamora has been slowly stockpiling five-gallon water bottles at home — he’s up to nine of them. He has stopped watering his lawn and watched as his neighbors’ yards have also turned brown. But others’ lawns in town are still green, and residents are keenly aware who is still watering.

“They encourage people to kind of rat each other out, out here,” Zamora said. “So if you water, people will be taking pictures of you.”

“I’m watching your yard,” Mary Jones, a Coalinga resident, told Mayor Ramsey at an Aug. 18 City Council meeting.

Ramsey, who had by then accepted the ban on watering front lawns, resorted to spraying on his own remedy to keep his lawn looking nice.

“Hey, you know why mine’s green?” he asked Jones. “I painted it.”

“I would paint mine, too, but it’s dirt,” she responded. “I can’t fool anyone with dirt.”

A short-term reprieve

Coalinga’s two biggest water users sit next to each other on a lonely two-lane road several miles outside of town. The Pleasant Valley State Prison and the Department of State Hospitals-Coalinga, a psychiatric hospital for sexually violent predators, together consume about 20 percent of the city’s water allocation. And both institutions have told the city they can’t conserve more water than they already do.

Outside the psychiatric hospital, there is a long row of coastal redwoods that appear green and bushy, a landscaping flourish Coalinga residents view with increasing suspicion.

“Go look at our coastal redwoods in our medians; they’re all dead. The ones at the school? Dead,” said Adkisson, the council member. “I think there’s opportunities for them to conserve when it comes to landscaping.”

The hospital has operated under a drought plan for the past eight years. The facility has removed most grass from “non-patient care areas,” has removed shrubs and plants, has resorted to controlled shower times, closely monitors leaks and “continues to make every effort” to use water efficiently, according to Ralph Montano, a spokesman for the Department of State Hospitals.

“Unfortunately, [the hospital’s] coastal redwoods are brown and dying from lack of water also,” Montano said in a statement.

The prison did not respond to requests for comment.

City officials argued that the burden of saving water on behalf of the two state-run institutions was unfairly being borne by residents. In August, with Coalinga just weeks from running out of water, the Bureau of Reclamation responded by increasing the city’s allotment by 531 acre-feet “to assist with meeting public health and safety needs,” the bureau said in a statement.

But Coalinga officials say they are still about 600 acre-feet short and that buying additional supplies remains extremely expensive. They now project they will run out of water sometime in early December.

When that happens, no one knows exactly what to expect.

“You don’t want to say that they’ll never turn the water off. I don’t see how they could,” Mayor Ramsey said. “I hate to say this, but with the government we have right now, you never know.”

As drought drives prices higher, millions of Californians struggle to pay for water

Approximately 13 million Californians living in low-income households bear the brunt of higher water costs.
(Mel Melcon / Los Angeles Times)

BY DORANY PINEDASTAFF WRITER

OCT. 24, 2022 5 AM PT

Several months ago, Rosario Rodriguez faced a financial dilemma that has become all too common for millions of drought-weary Californians — either pay the electric bill, which had skyrocketed to about $300 during a scorching summer in western Fresno County, or pay the $220 combined water, sewer and trash bill.

"Our water is expensive, even though we can't drink it because it's contaminated," Rodriguez said in Spanish.

In the end, Rodriguez opted not to pay the electric bill from May to July, knowing she could get help from the Fresno Economic Opportunities Commission, a local nonprofit. No such assistance that she knew of was available for water, however.

For a family of four living off $25,000 a year, a water bill of more than $200 a month is an economic burden. Now, with 1 in 10 California households falling into arrears on water payments, calls are mounting for the state to step in and help.

"If we had a water discount, we'd have a little extra money for food or to buy our daughters clothes, shoes and other things they need for school," said Rodriguez, whose family rents a home in the rural, unincorporated community of El Porvenir.

The Rodriguez family is among an estimated 13 million Californians living in low-income households who bear the brunt of soaring water costs, experts say.

Although the state has declared that all residents have a right to clean, safe and affordable drinking water, officials have yet to make good on that promise.

Most recently, Gov. Gavin Newsom vetoed Senate Bill 222, legislation that would have required all California community water and wastewater systems to offer rate assistance to residential water customers.

In his veto letter, Newsom said that while safe and affordable drinking water was a top priority of this administration, the program lacked a source of funding. "Signing this policy would result in significant General Fund pressures in the billions of dollars to continuously provide such assistance," he said.

The veto came as a blow to water affordability advocates, who say the governor had vastly overestimated the cost of the program.

"This is both an environmental and racial justice issue," said Michael Claiborne, directing attorney for the Leadership Counsel for Justice and Accountability. "The state has said a lot of good things in terms of commitment to addressing environmental and racial justice, but I think this is another example where we, as a state, have fallen short and need to do more."

Across the state, water utility prices are escalating faster than other “big ticket” items such as college tuition or medical costs, according to David Mitchell, an economist specializing in water.

“Cost containment is going to become an important issue for the sector in the coming years” as climate change worsens drought and water scarcity, he said.

The price of water on the Nasdaq Veles California Water Index, which is used primarily for agriculture, hit $1,028.86 for an acre-foot on Oct. 20 — a roughly 40% increase since the start of the year. An acre-foot of water, or approximately 326,000 gallons, is enough to supply three Southern California households for a year.

Mitchell said there are short- and long-term factors contributing to rising water costs.

Long-term factors include the replacement of aging infrastructure, new treatment standards, and investments in insurance, projects and storage as hedges against drought.

In the short term, however, drought restrictions play a significant role. When water use drops, urban water utilities — which mostly have fixed costs — earn less revenue. They adjust their rates to recover that revenue, either during or after the drought.

“So it’s not right now a pretty picture,” Mitchell said.

As rates climb statewide, water affordability will only become a bigger challenge for many Californians.

Adjusting for inflation, the average family was paying 45% more per month for water in 2015 than in 2007, according to a 2020 report by the California State Water Resources Control Board. It’s a financial burden that disproportionately affects low-income and Black, Latino, Indigenous and other households of color.

A recent survey on the COVID-19 financial impact on water systems and customers found that 12% of California households were behind on their water bills, with an average debt of $500 per household. Statewide, Californians owe $1 billion; of that, $600 million was specifically for drinking water. The debt was most acute in Los Angeles.

Elizabeth Hicks, a Willowbrook resident, fell behind on her water bills a few years ago. She had lost her job as a banker and was making $300 a month sitting on the board of directors of her local water district. She received financial assistance from the city, and a couple of years later had bounced back.

Although her monthly water bill now is fixed at $67.84, Hicks is starting to worry again as water prices continue to rise — not only for herself and her husband, but also for her community.

Willowbrook and Compton, its southeastern neighbor, have some of L.A. County's worst affordability challenges — and a history of receiving discolored, contaminated water.

"It's a disadvantaged community," Hicks said. "We have senior citizens and certain individuals that cannot afford to pay their bill. ... I don't want to see my community go more into debt."

Kelsey Hinton, communications director for the Community Water Center, said that "with everything getting more expensive because of inflation, because of COVID, because of the status quo right now, that is only going to increase as we continue moving forward."

Average water bills vary considerably across the state, with water systems reliant on groundwater tending to have lower rates, while smaller ones usually have higher costs because system investments are pricier.

Every month, families like Rodriguez's must choose between bills to pay and are left wondering whether they'll have enough money left over for other household expenses and needs like prescriptions, child care or school supplies.

Though state programs exist that offer ongoing support for other utilities and essentials (CalFresh and the California Alternate Rates for Energy, for example), the California Water and Wastewater Arrearage Payment Program, enacted in response to the pandemic, and the Low Income Household Water Assistance Program offer only one-time funding assistance for indebted households.

"So even if their debt gets wiped out today, there's nothing available to keep you from accruing more debt in the future," Hinton said.

Even then, water companies must choose to participate in the arrearage programs; those who don't exclude their customers from financial aid. But not everyone who can benefit from these programs has access to them. People without legal status are often left out.

Lauren Ahkiam, director of the Water Justice L.A. Campaign, said households that have their water shut off because they can't afford the bill are vulnerable to larger problems: liens can be put on their homes or children can be taken away if there's no running water in the household.

"Even if the water bill isn't the largest portion of someone's expenses, the way that it can trigger public health concerns for folks or snowball into other impacts to a family that's already struggling, that's really concerning to us as well," she said.

Although water affordability concerns are part of the larger issue of poverty, advocates said that legislation like SB 222 would mitigate the financial burden of rising water prices.

"The evidence is overwhelming of the need," said Gregory Pierce, co-director of the Luskin Center for Innovation at UCLA. Even if the bill lacked funding, signing it would have been an important step "to get the work started," he said.

But state Sen. Bill Dodd (D-Napa), who introduced SB 222, said he wasn't surprised it was rejected, given Newsom's history of vetoing bills without a funding source.

"It was one of those bills that me and my fellow legislators passed through both houses that didn't have funding attached, and we were hoping to get funding attached, but at the 11th hour, with other needs, that funding melted away," he said.

Dodd and a coalition of affordable water advocates said the governor's office overestimated the program's annual cost.

The water board's report estimated the program would have cost approximately $200 million a year, not the billions referenced in the veto letter.

Even so, many water agencies opposed the legislation, expressing concerns over the program's proposed enrollment process.

Cindy Tuck, deputy executive director for government relations for the Assn. of California Water Agencies, which represents more than 460 public water companies, said the way the program divided state and local responsibilities "would drive up administrative costs unnecessarily and waste money that could be going to help low-income households."

As the state works to create more resilient water systems, experts said the issue would only get worse, and that delaying solutions would put more people at risk of losing access to water.

ACWA, Dodd and affordable water advocates said they would continue to work closely next year with the governor's office and the state water board to find funding for a long-term water assistance program.

"The writing's on the wall," Pierce said. "Water prices are going up for the next several decades, so we need some assistance program in place like we have in so many other sectors. Water is pretty much the first service that the government can and should provide."

Dorany Pineda

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Dorany Pineda covers the drought in California for the Los Angeles Times.

COLUMN

ALINA CLOUGH

The American West should look to Israel for climate solutions

Israel's successful combination of public and private support for developing water technology is reason for optimism.

(October 3, 2022 / JNS) The American West is learning climate lessons the hard way. This summer especially, droughts have required the federal government to settle disputes over water shortages between states, signaling rising tensions in U.S. water policy. While these challenges are uncharted territory for the U.S., time-tested solutions from other countries may be closer than they seem. Israel, in particular, having weathered extremely tight water margins for years, is several steps ahead in climate innovation. We should look to it for inspiration.

Despite 71% of the earth being covered in water, just half a percent is drinkable fresh water. For this reason, the Colorado River is a lifeline for more than 40 million people across seven U.S. states and even parts of Mexico—but the reservoir that feeds it has dropped to only 25% of its capacity. California has been experiencing a similar decline in fresh water availability. Its drought is worsening, despite some areas conserving water at record levels.

Government officials responded to this problem by imposing strict rations on water usage and, in some cases, long-term policy actions like the Sustainable Groundwater Management Act, which requires local agencies to adopt sustainability plans to stop groundwater depletion. While necessary, these measures are emergency care, not a cure. Many of the areas affected by this summer's droughts are on track to literally run out of water or already have.

Current policy focuses heavily on the demand for water, encouraging households and farms to restrict their use. Still, these policies fail to elicit long-term change because the base levels of water needed to support humans and the food they eat aren't sustainable without supply-side interventions.

This brings us to Israel. The tiny country surrounded by deserts only sees rain in the winter and has limited sources of freshwater. With a growing population and a strong agricultural industry, Israel's need for water has long outgrown its conventional supply—as is the case in much of the American West. As recently as 2015, Israel had a one billion cubic meter potable water deficit. Now? It produces 20% more water than it needs.

In addition to regulations intended to optimize its use of groundwater, much of the country's focus has been on increasing the supply of water by less conventional means. In a typical year, half of Israel's water supply comes from the desalination of seawater or from reclaimed water via flood overflow and sewage processing.

The American impulse may be to begin large-scale government projects to mimic these efforts, but many government projects become more expensive and longer-lasting than planned. Crucial to

Israel's success has been a climate innovation ecosystem that helps create solutions driven by market incentives rather than tax dollars. Israel is ahead of the curve on this issue, as a recent report by the Boston Consulting Group found that government investment in cleantech alone is not enough to curb climate change. Private investment will need to multiply eightfold.

One of the innovations developed by Israel is its use of drip irrigation, which reduces agricultural water usage by placing water directly onto the roots of plants. U.S. water usage is dominated by agriculture, and Israel used to be in the same boat. Since 2000, however, Israel has cut agricultural water usage in half by using both drip irrigation and reclaimed sewage water. Seventy-five percent of Israeli agriculture now uses drip irrigation, compared with only about a third of U.S. farms.

Similarly, desalination has been crucial to Israel's water efficiency, allowing the country to use reverse osmosis to turn water from the Mediterranean Sea into potable water. The Israeli government has relied on public-private partnerships with a wide range of private water companies that have driven the country's success in the production of clean water. This water is then employed both for domestic use and billions of dollars in exports. Rather than the state taking control of these projects the way many American initiatives reflexively begin, companies bid to provide the most competitive solutions.

Israeli government support facilitates these privately-developed climate innovations. Earlier this month, the Israeli government announced a partnership with Microsoft that will help climate tech startups attract private funding, including from the tech giant itself. The Israel Innovation Authority similarly provides proof of concept for even earlier stage climate tech, particularly in the fields of commercialization support and access to private capital for research and development.

Israel is far from solving every climate challenge, even in its home country. The Dead Sea has been suffering, due in part to Israeli water use in the area, with its levels now dropping more than a meter each year. Still, the country's rapid turnarounds from droughts and water shortages through market-focused climate innovation should be an optimistic case study for a rapidly drying American West.

Alina Clough is an energy and environment fellow with the American Conservation Coalition and Young Voices.

Tap Water Failures and Distrust of Government: A Conversation with Manny Teodoro

Bad tasting and polluted tap water are not just infrastructure problems.

When they distrust tap water, low-income residents and people in communities of color often turn to bottled water or water kiosks like this one in California's Central Valley. Photo © J. Carl Ganter/Circle of Blue

Circle of Blue · Speaking of Water – Tap Water Failures and Distrust of Government: A Conversation with Manny Teodoro

By Brett Walton, Circle of Blue – October 3, 2022

Bad tasting and polluted tap water are not just infrastructure problems. Municipal drinking water failures like the crisis in Jackson, Mississippi, are also threats to government legitimacy.

That's one of many arguments that Manny Teodoro and co-authors Samantha Zuhlke and David Switzer make in a compelling new book titled The Profits of Distrust.

Teodoro, an associate professor at the University of Wisconsin-Madison, told Circle of Blue that tap water in the United States is the "most intimate relationship between a government and its people." Water is provided primarily by publicly operated utilities. The treated water enters the home, where people bathe in it, cook with it, drink it.

“So to drink tap water is to trust government,” Teodoro says. “To drink bottled water, or its commercial alternatives, is a sign that you distrust government, because you’re willing to pay tens to hundreds of times more for a commercial product that you believe is superior” — even though bottled water is less stringently regulated.

Who distrusts tap water the most? Based on the evidence, low-income households and communities of color. Those groups most frequently experience discolored, foul tasting, or contaminated water from their faucets.

Teodoro says that this mistrust is exploited by companies who sell water in bottles or in kiosks that are strategically installed outside grocery stores and strip malls in poorer neighborhoods. Those companies earned $36 billion in revenue from water sales in 2020. That’s significantly more money than Congress provides each year for drinking water and sewer infrastructure.

Breaking the vicious cycle of drinking water failures that result in loss of trust will not be easy, Teodoro cautions. But it can be done with focused efforts in the areas of administration, funding, data collection, and communications.

“One of the deep and fundamental challenges we have in the water sector,” he says, “is reaching and connecting with the people who already distrust us.”

Brett Walton

Brett writes about agriculture, energy, infrastructure, and the politics and economics of water in the United States. He also writes the Federal Water Tap, Circle of Blue's weekly digest of U.S. government water news. He is the winner of two Society of Environmental Journalists reporting awards, one of the top honors in American environmental journalism: first place for explanatory reporting for a series on septic system pollution in the United States(2016) and third place for beat reporting in a small market (2014). He received the Sierra Club's Distinguished Service Award in 2018. Brett lives in Seattle, where he hikes the mountains and bakes pies. Contact Brett Walton