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SECTION 3: Proof of Performance

Santa Rosa's 50 Years of Agricultural Water Reuse Experience

The mayor of Santa Rosa, **Jane Bender**, welcomed everyone and congratulated the City of Santa Rosa on its efforts in water reuse. "Can we afford not to do these things across the country? Most people are dealing with scarcity that is tied to energy. We must be able to look 40 years down the road. We are all in this together," she said. The City of Santa Rosa has a long history of water reuse. According to **Daniel Carlson**, deputy director for the City of Santa Rosa, the community began recycling water about 50 years ago, with the production of hops.

In the 1950's, Santa Rosa's population was 40,000 with a wastewater flow of 3 million gallons per day (MGD). Most of the water delivered for hop production, about 12 percent of the wastewater flow, had undergone secondary treatment. Between the 1970s and 1990s, Santa Rosa rapidly grew to 100,000 people with 15 MGD wastewater flow. Hops gave way to dairies and other secondary crops, city-owned farms were established, and wastewater storage ponds were built. During this period, about 30 percent of the wastewater flow was used for agriculture.

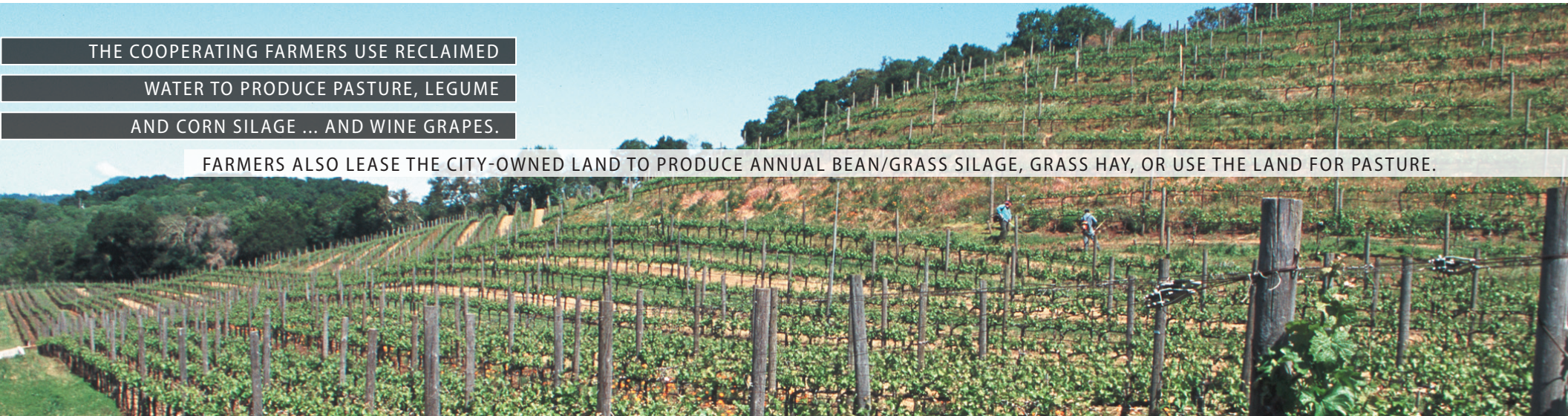
In 1990, Santa Rosa improved its treatment level to tertiary treatment and water recycling. Reuse has continued to increase and now includes edible vegetables, energy production, and the wine grape industry. With a population of more than 150,000 people, reuse of wastewater is now at approximately 88 percent per year. The challenge for the future will be to match the amount of water produced to the demand.

The initial reuse facilities were constructed in the late 1970s and included the Laguna Treatment Plant, an extensive pipeline distribution system delivering recycled water for agriculture to approximately 3,000 acres. Today, the Laguna Subregional Wastewater Treatment Plant and Water Reclamation System provide advanced wastewater treatment and include filtration and UV disinfection. The recycled water meets California Title 22 Wastewater Reclamation Criteria for unrestricted reuse. The Laguna plant produces 20 million gallons of tertiary-treated and UV-disinfected water every day. This water must then be delivered to users or stored. Agriculture irrigation was one of the city's first reuse options and remains a key component of their reuse system. Production water from the treatment plant is unrestricted for any agricultural crop. The system has expanded since initial construction and now consists of 17 storage reservoirs that help provide almost 3 billion gallons of recycled water each year to irrigate about 1,500 acres of city-owned and about 4,500 acres of privately owned land. The privately owned land is operated by 60 individual cooperating farmers, each

has a contract with the city for the use of reclaimed water. The cooperating farmers use reclaimed water to produce pasture, legume and corn silage, hay, turf/sod, a variety of vegetables, and wine grapes. Farmers also lease the city-owned land to produce annual bean/grass silage, grass hay, or use the land for pasture. The combination of city-owned and privately owned land provides operational flexibility during unusual weather years.

In 1997, Gallo Wines partnered with the city on a project that included a storage reservoir, 4 miles of piping and a new 300-acre premium wine grape vineyard that uses recycled water to meet 100 percent of their daily operations. This partnership has proven successful for both Gallo and the city.

Prior to 1990, the City of Santa Rosa paid farmers to use secondary-treated recycled water. Since then, new users are provided the water free of charge or pay the city a nominal amount. Future efforts will focus on additional urban reuse, additional recharge of the Geysers Geothermal Steam Fields, and expansion of agricultural reuse outside of the existing immediate area. The only way to expand the amount of water reused each year is to increase storage and that is being evaluated. The availability of recycled water is helping sustain the agricultural industry immediately adjacent to the urban area. It is anticipated that the future will bring even more crop diversity and system expansion.



THE COOPERATING FARMERS USE RECLAIMED WATER TO PRODUCE PASTURE, LEGUME AND CORN SILAGE ... AND WINE GRAPES.

FARMERS ALSO LEASE THE CITY-OWNED LAND TO PRODUCE ANNUAL BEAN/GRASS SILAGE, GRASS HAY, OR USE THE LAND FOR PASTURE.

Proof of Performance

One of the most effective means of achieving behavior change is through demonstration sites, where innovative concepts are implemented under real-world circumstances.

Conference participants toured three such demonstration sites, where the City of Santa Rosa provides recycled water to a diverse group of agricultural producers who use recycled water in vegetable and flower production, dairy production, and viticulture. These producers found innovative ways to incorporate recycled water into their irrigation schedules to enhance the volume and reliability of irrigation. The City of Santa Rosa's visionary approach, coupled with the producer's willingness to innovate, has forged a highly successful partnership where recycled water can augment or replace other irrigation sources—and expand available water for the city's citizens.

QUETZAL FARMS— SANTA ROSA, CA

As you approach Quetzal Farms in Santa Rosa, CA, you can find purple-labeled signs identifying the use of recycled water every 500 feet as you pass the surrounding fields. The owner, Kevin McEnnis, has a successful organic vegetable operation with a large variety of quality vegetables and some ornamental flowers. McEnnis sells his produce at farmer's markets around the area. McEnnis hires a small number of farm workers who assist in the daily operation. There are approximately 8 to 12 workers who help maintain the high quality crops of sweet peppers, eggplant, zucchini, sunflowers, and other specialty crops. Emitter clogging hazard is slightly higher when irrigating with recycled water, and therefore filtration requirements are increased. His peppers are grown using a disk filter into drip tape with non-clogging emitters.

The City of Santa Rosa provides, at little cost, irrigation assistance through a pump station, a special disk filter, a pressure regulator, and irrigation pipe to distribute the water at a suitable pressure and location for use on the property. There is a slight salt buildup (recycled water has a TDS of about 425 mg/L) but this does not affect McEnnis' crops or production. McEnnis monitors the water quality on and off his farm each spring and fall. Quetzal Farms maintains very good irrigation practices to ensure that ponded water is minimized to control mosquitoes. Regulatory agencies require groundwater monitoring and the City of Santa Rosa has set up a program to detect if there is movement of contaminants, particularly nitrate due to percolation. The recycled water meets all State of California Title 22 requirements which allow irrigation where vegetables come into direct contact with the recycled water.

KUNDE VINEYARDS— SANTA ROSA, CA

The Kunde Vineyards total 275 acres in the Russian River Valley in central Sonoma County, CA, and is owned by Saralee and Rich Kunde. The Kunde's chose this site because of its cool climate with rich valley soil and plentiful hills. They have the latest in vineyard technology and more than 75 different selections of fruit. The Kunde's can track each vine to its original mother vine through extensive data records. The vineyard has year-round employees who need to be ready and willing to pick at a moment's notice, since delivery is at the pleasure of the winery that purchases the harvest. There are 18 varieties of grapes. At the time of this tour, almost all the harvesting was complete, with approximately 1,800 tons of grapes collected. There were 60 tons remaining for a late harvest. This vineyard primarily grows grapes for three types of wine: Chardonnay, Merlot, and Zinfandel. This vineyard now sells to more than 46 different wineries.

The vineyard has a well-landscaped pond filled with recycled water. Carefully selected trees and shrubs surround the pond. Prior to becoming a successful vineyard, this land was a working dairy through the late 1980s. There were no vines anywhere on this dairy farm and methane gas was present in the groundwater. The farm had a large manure pit, which the Kunde's emptied and then filled with recycled water to create a pond. They use recycled Santa Rosa water for irrigation and frost control. Leaves are removed to expose the grape clusters to light and air movement that enhances both color, flavor and reduces the conditions for disease development and improves spray coverage. Today, Santa Rosa has made vast improvements in the quality of its recycled water and monitoring wells were set up here to ensure that groundwater quality is not impacted.

LAFRANCHIE FARM— SANTA ROSA, CA

Arthur Lafranchie's family farm, established in 1962, used water directly from Laguna de Santa Rosa in 1964. Ten years later pipelines were installed, a pond was built, and recycled water delivery began. Between April 1 and October 1, the farm uses approximately 120 million gallons of tertiary-treated recycled water. The City of Santa Rosa treats the water and delivers it through low pressure underground pipes. Without this recycled water, this dairy and others like it would struggle to exist and could be forced to shut down their operations. The City of Santa Rosa provides the farms with recycled water because it is a cost-effective means of disposal. Through this partnership, agricultural open space is preserved by maintaining farms near the city. The issues of recycled water delivery logistics and seasonality, proximity of farms to waste treatment facilities, and whether future treatment plants will be specifically designed to produce recycled water are all relevant to California agriculture today.

Agricultural water reuse also provides a benefit to the public by maintaining local farms with smaller dairy herds (that vary from 150 to 1,100 head), when compared with Central Valley large-scale (5,000-head) farms. Some farms have onsite storage, but most rely on the city to store the water until they can use it. This farm (and others like it) receives water at a minimum of 60 psi.

The Lafranchie farm uses genetically modified corn to decrease their herbicide usage and improve sustainability. The City of Santa Rosa works as a partner with farmers to help ensure there is no buildup of nutrients in both input and output water.

Farms get recycled water primarily to grow crops, but they also use recycled water for cleaning and washdown of the bedding areas. Reuse water cannot be used in the milking areas. Solids captured during washdown are separated from liquid waste through a screen and then ground into finer particles. The material is then composted and used as a bedding material. The remaining liquid that is pumped to a manure pond serves as fertilizer for the crops irrigated with recycled water. This is necessary because the high level of treatment required for the recycled water reduces its fertilizer value, to about one-third of the crop's requirement. When asked about the partnership with the city, LaFrankie reiterated that it was critical to his farm's survival.

Use of Recycled Water to Irrigate Edible Crops in Monterey County, CA

Robert Holden and James Heitzman, of the Monterey Regional Water Pollution Control Agency (MRWPCA), identified water reuse as the key to sustaining their $3 billion per year agricultural and $2 billion per year tourist industries in California's Salinas River Valley and Monterey County.

Monterey Regional Water Pollution Control Agency has provided recycled water to 12,000 acres of prime agricultural land around Castroville, in central California, since 1998, with funding through loans from the Bureau of Reclamation and the State Water Resources Control Board.

Within the Salinas Valley, the Castroville Seawater Intrusion Project provides research into a gravity system that delivers treatment plant production water to downstream edible crop farms (e.g., artichokes, lettuce, celery, cauliflower, broccoli, spinach, and strawberries) irrigated by sprinkler, drip, and some furrow irrigation. The experiments began in 1976 as randomized split-plot trials evaluated for microbes and viruses that might have been associated with the recycled water. Researchers found no natural virus detected in the recycled water. When they seeded virus into the production stream, there was a five-log (99.999 percent) removal of the virus during treatment plus about one log (90 percent) further reduction every 3 days after the water was used for irrigation.

The treatment consists of trickling filters and solids contact followed by chemical coagulation/flocculation, granular filtration, and gaseous chlorine disinfection. The water then flows by gravity to 112 turnouts, which provide water to 222 parcels of land.

Since the treatment plant was completed in 1998, no emerging viral or bacterial pathogens (E. coli 0157:H7, Legionella, salmonella, or shigella) have been detected in recycled water. The intermittent protozoan cysts that were detected represented a negligible health risk. Maximum Cryptosporidium, Giardia, and Cyclospora were 2.3, 0.3, and 0.034 cysts/L, respectively, as compared to 50/L for illness risk of 1 in 10,000 from drinking one cup of water. Crop quality and yield were unaffected, while some crops experienced some yield increases with the application of recycled water. Workers remained healthy and safe, and heavy metal concentrations were below detection limits as indicated by frequent medical examinations. The conclusion was that food crops irrigated with recycled water could safely be eaten raw. Growers used a combination of signage and a training video to alert the farm workers to the use of recycled water. Growers continue to monitor the fields and production water for pathogens at least 3-4 times per year.

The projects have been very successful, based on several measures. The project is the largest supplier of recycled water for food crop irrigation in the United States. More than 95 percent of the growers within the project area voluntarily use the recycled water. The coliform and pathogen test results show that recycled water compares very favorably with other irrigation waters. Many of the project growers have asked to have the recycled water system extended to land they have which is outside the current project boundaries. Finally, there have been some health issues on crops grown within the project area. Investigators from the Food and Drug Administration and the California Department of Health, once they have seen the coliform and pathogen data on the MRWPCA Web site (http://www.mrwpca.org), have immediately concluded that, "It's not the water" and have looked elsewhere for the source of contamination. The project will continue to be successful for three main reasons. First, the Water Quality & Operations Committee meets monthly and has consistently had safety as its number one goal. This committee consists of six growers, the county environmental health director, and the general managers of MRWPCA and of the County Water Resources Agency. Second, MRWPCA samples for more constituents and more often than required by regulation. Finally, there is a proactive approach towards the future exemplified by studying the effects of recycled water on soils, by sampling for emerging pathogens, and by looking at emerging contaminants. The project began with strong community support, but it requires continuous public outreach and education (classroom teaching, civic group presentations, event booths, tours, etc.), to maintain and increase understanding and acceptance of the project.

GALLO SONOMA VINEYARD'S COMMITMENT TO SUSTAINABILITY AND THE ROLE OF WATER RECYCLING

The wine industry is leading the way towards sustainability, according to Jim Collins of Gallo Wine. In California alone, there are currently 17 vineyards on 4,200 farmed acres that are practicing sustainable wine growing. Vineyards today view value chains (Porter 1985) in a much broader and more holistic way. The market is much more environmentally conscious now than in the past decades. The wine industry is constantly seeking new ways to fit into the sustainability trend.

One country that is leading the way in sustainability is Australia, which has a strategy of "sustaining success." The Australian wine industry is committed to the continual improvement of its environmental performance through the use of ecologically sustainable practices in all aspects of its operation. Good stewardship is critical to future success and will ensure that the needs and expectations of a wider community and its customers are met.

The wineries in the United States are also doing their part toward promoting environmental practices throughout the industry. There is a growing sentiment about sustainability certification and a broader worldwide acceptance of these certifications. Ernest and Julio Gallo Winery is a recognized leader in environmental stewardship and was the first winery in the United States to receive the International Standards Organization's ISO 1400i certification. These standards are incorporated in an environmental management system, used at every level of the operation, and help improve the overall business. Gallo was instrumental in helping to develop and implement the Code of Sustainable Wine Growing Practices. The code promotes sustainable practices that are environmentally sound, economically feasible and socially equitable. These practices include minimizing the use of synthetic chemicals, fertilizers, and pesticides in the vineyard; recycling and reusing processed wastewater; creating new wetlands; and protecting existing riparian habitats to benefit a variety of plants and wildlife. All of these practices are incorporated into the management philosophy of Gallo Vineyards.

Reclaimed Water Use on Citrus and Other Crops in Florida

Phil Cross began by pointing out that, in 2006, Florida's agricultural industry celebrated 40 years of applying recycled water.

In 2005, 465 domestic wastewater treatment facilities provided 660 MGD of reclaimed water for delivery to 438 recycled water systems. Florida is one of the leading states in using recycled water. Also in 2005, 92 MGD of recycled water irrigated 38,040 acres of agricultural land. While 15.5 MGD irrigated 13,914 acres of edible crops, the majority of the recycled water irrigated 24,126 acres of other agricultural crops. Citrus represents the primary edible crop irrigated with recycled water, but that water also irrigated a wide range of other edible crops, including tomatoes, cabbage, peppers, watermelon, cantaloupe, corn, eggplant, strawberries, pecans, peaches, plums, persimmons, okra, grapes, figs, peas, beans, herbs, squash, and cucumbers.

Farmers began applying treated wastewater in Tallahassee in 1966, and the Water Conserv II (http://waterconservii.com/) began in 1986. In 1988, the Reuse Program was inaugurated and, in 1989, Floridians adopted Chapter 17-610 of the Florida Administrative Code (FAC) and finally Chapter 62-610, FAC, in 1993. Florida's water reuse rules, originated in 1989, are detailed, comprehensive, and consistent with national guidelines. These rules involve slow-rate land application systems, restricted public access, and irrigation of non-food crops, secondary treatment, basic disinfection before use, and setback distances. The use of reclaimed water to irrigate other agricultural crops (such as sod, forest products, pastureland, and feed, fodder, fiber, and seed

crops) is addressed in Part II of Chapter 62-610, FAC. This part of the rule requires that the recycled water receive, at a minimum, secondary treatment and basic disinfection for irrigation of these crops. Rule 62.610-425 pertains to cattle grazing, outlining 15-day restrictions on milk cow grazing, no restrictions with high-level disinfection, and no restriction on other cattle. Recycled water is approved for non-food crops such as timber, biomass, sod, seed, pasture grass, and hay. Edible crops are approved if there is direct contact of irrigation with edible crops and the crop is peeled, skinned, cooked, or thermally processed prior to consumption with the responsibility for an inventory of crop and recycled water use up to the permit holder.

Approximately 49 percent of the water reuse volume is applied to public access areas such as parks, schools, residential lawns, and golf courses. There are 130 irrigated agricultural enterprises that account for 14 percent of the volume. Groundwater recharge requires 16 percent and an additional 14 percent feeds the industrial requirements. Another 7 percent addresses any other demands for recycled water. Of the 130 agricultural enterprises, 19 are farms growing edible crops using 16 MGD of the total 92 MGD and accounting for 13,914 of the possible 38,040 irrigated farm acres. Recycled water fees ranged from a flat rate per month of free to $167.67 (average $64.47) to a per 1,000-gallon charge of free to 70 cents (average 35 cents). These fees are currently under review.

TO DATE, THE APPLICATION OF RECYCLED WATER IN AGRICULTURE HAS ALLOWED THE PRODUCTION OF HIGH QUALITY FRUITS AND NUTS, VEGETABLES, AND FORAGE GRASSES.

The Mid Florida Citrus Foundation was formed in the 1980s as a non-profit organization to act as the research arm of Water Conserv II. Foundation goals focus on: maintenance of a safe and clean environment, evaluation of the long-term effects of citrus irrigation with recycled water, assessment of the economic viability of particular agricultural crops, and promotion of urban and rural cooperation. Water reuse applications up to 100 inches per year show no significant issues, have not promoted weed growth, tend to dilute solids, and maintain a high tree and fruit quality. Fluoride levels in recycled water are too high for seed germination of annual plants—but boron and phosphorus levels did not appear to promote issues with soil pH. To date, the application of recycled water in agriculture has allowed the production of high quality fruits and nuts, vegetables, and forage grasses.

Photo courtesy of NRCS

Solving Agricultural Irrigation Issues with Reclaimed Water: The Hawaii Experience

According to **Chauncey Ching**, water reuse in Hawaii is not an option, but a necessity, since the City and County of Honolulu are projected to run out of fresh water in 2023.

Water reuse in Hawaii's agriculture is part of a complex set of issues, including but not limited to energy, fragile ecosystems, the needs of and obligations to an indigenous people and their culture, the high cost of production, technology development and testing, education, and linkages to practically all economic sectors. When you add a year-round growing season, rich renewable energy resources, and a small and isolated island state, Hawaii is an ideal venue to address water reuse. The population in Hawaii is steadily increasing as urban development continues on each main island of the Hawaiian chain. Populations are expected to expand significantly through 2025:

	1995	2025	% Change
U.S.	*262,765,000*	*337,815,000*	*28.6*
Hawaii	*1,187,000*	*1,812,000*	*52.7*

Source: U.S. Census Bureau

Water is Hawaii's most limiting natural resource, from both an agricultural and general economic development perspective. While Hawaii is truly a subtropical paradise, drought is a major concern. Hawaii residents cannot focus their attention only on water as a limiting resource, but they need to address linkages to other resources that condition their future—primarily energy and land. Hawaii's agriculture is in transition from large-scale plantation agriculture to smaller-scale and more diversified agriculture.

Hawaii has a year-round growing season. Without a vibrant agriculture in Hawaii, Hawaii residents will drown in their waste. Hawaii relies on fossil fuels for electricity more than any other state. Hawaii is the state with the widest range of renewable energy sources. An aging public utility distribution infrastructure increases the attractiveness of small-scale distributed systems. Two of Hawaii's largest industries, the military and tourism (both of which are controversial), are major users of water and their uses are major factors in water public policy formulation and implementation.

In Hawaii, R-1 Water is tertiary treated recycled water that has undergone a significant reduction in viral and bacterial pathogens. This type of treated water can be utilized for spray irrigation without restrictions on use. R-1 is approved for spray irrigation of golf courses, parks, athletic fields, schoolyards, residential properties where managed by an irrigation supervisor, road sides/medians, and for vegetables and fruits that are eaten raw. R-2 Water is disinfected secondary treated recycled water. Spray irrigation is limited to evening hours, and requires a 500-foot

buffer zone between the approved use area and adjacent properties. Food crops that are irrigated with R-2 water must be either irrigated via subsurface systems or, if irrigated with spray irrigation, undergo additional processing before certified suitable for human consumption. R-3 water is non-disinfected secondary treated recycled water. There are strict limitations on its use. Currently, only a couple of ranches use this type of recycled water to irrigate pastures.

Recycled water makes sense for some crops, one of which is the seed industry—a major component of a transformed agriculture. Recycled water is a viable substitute for potable water in selected uses. When Hawaii residents link lessons learned to their island context, they find that recycled water can be an economic driver and not all crops are suitable for recycled water. Hawaii is a natural laboratory in which to develop, test, demonstrate, and evaluate novel approaches to water reuse in agriculture.



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