

## City of Banning Demonstrates the Efficacy of SafeGuard™ H2O Technology for Cost-Effective and Sustainable Cr6 Remediation

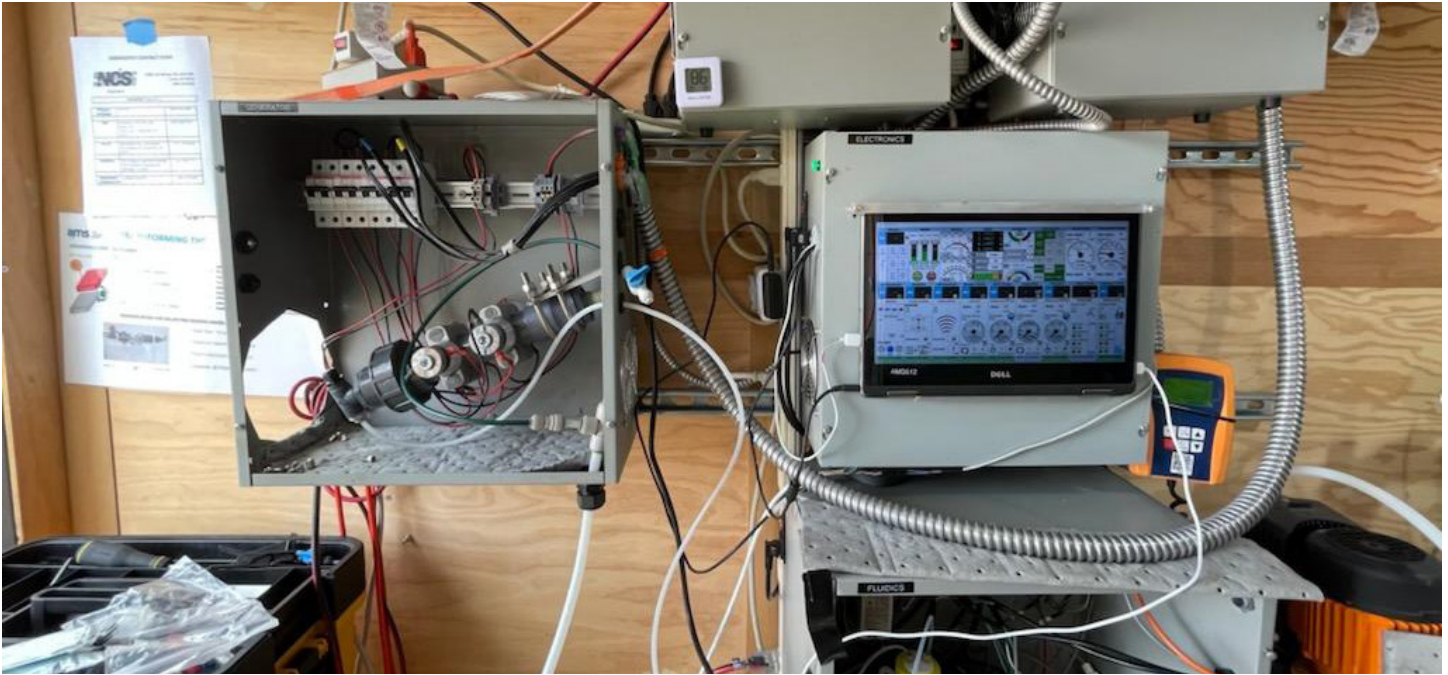


As California prepares to adopt a primary drinking water standard for hexavalent chromium (Cr6) with a maximum contaminant limit (MCL) of 10 parts-per-billion (ppb), the State Water Resource Control Board (SWRCB) has identified reduction/coagulation/filtration (RCF) as one of three Best Available Technologies (BATs) for Cr6 treatment.

SafeGuard™ H2O, a new RCF technology that generates a stannous reagent in-situ via an electrolytic process, is unique in its ability to provide economical and reliable treatment compared to other BATs. SafeGuard™ H2O drastically reduces the costs and circumvents the risks associated with more traditional forms of RCF systems that are dependent on the storage, handling, and use of toxic and hazardous bulk chemicals. As a result, the technology has been evaluated by several utilities across California that are impacted by Cr6 contamination because of its ability to provide an affordable, non-hazardous and environmentally sustainable Cr6 remediation solution.

One such utility is the City of Banning, California, which serves a community of 30,000, and relies on well water with elevated levels of Cr6 for its drinking water supply. In 2017, when the city began to evaluate Cr6 treatment solutions, BATs were expensive in terms of capital and operating costs. For example, one viable technology was estimated to cost up to \$35 million and required upwards of \$700,000 a year to operate—a significant expense, especially for a community of Banning's size.

With SafeGuard™ H2O, the city found a technology that supports small, underserved communities for whom traditional Cr6 treatment technologies are too expensive and complex to operate. The fully automated SafeGuard™ H2O technology uses a food-grade tin metal precursor and an in-situ electrolytic generator to create a non-toxic stannous reagent onsite and on demand. The technology system has been awarded NSF/ANSI/CAN 60 and 61 standards certification and received the WQA Gold Seal. The SafeGuard™ H2O process is simple, effective, and carbon neutral.



SafeGuard™ H2O Cr6 demonstration at the City of Banning.

### Onsite Testing at City of Banning

A SafeGuard™ H2O demonstration system was installed onsite for testing at the City of Banning's Facility Well C2 from June-September 2022. Facility Well C2 is one of nine groundwater production wells operated by the city impacted by Cr6. With a nominal production capacity of approximately 1,100 gallons-per-minute (gpm), Facility Well C2 represents 40 percent of the city's total nominal production capacity impacted by Cr6 contamination.

The scope of this demonstration focused on the safe, reliable reduction of Cr6 to Cr3 using SafeGuard™ H2O electrogenerated stannous reagent. Specifically, to evaluate the technology's ability to achieve the following goals:

- Convert influent Cr6 to Cr3 with no more than 5 ppb residual Cr6 remaining
- Residual total chromium [Cr(T)] in the treated water should be no greater than 10 ppb
- Residual tin in the treated water should be no greater than 50 ppb

### Overview of SafeGuard™ H2O Cr6 Removal Technology

SafeGuard™ H2O uses the electrolytic process coupled with real-time water quality monitoring to achieve stannous generation and optimized dosing. The fully automated system uses a food-grade tin metal precursor and an in-situ electrolytic generator to create a non-toxic stannous reagent onsite and on demand. SafeGuard™ H2O features automatic dosing and incorporates proprietary continuous, real-time monitoring of Cr6 levels at the influent and effluent to ensure optimal treatment and compliance with regulatory and operational targets 24/7/365. Because the system can be fully controlled, monitored, and optimized remotely, the presence of personnel on site for supervision is minimized, further reducing operating costs.

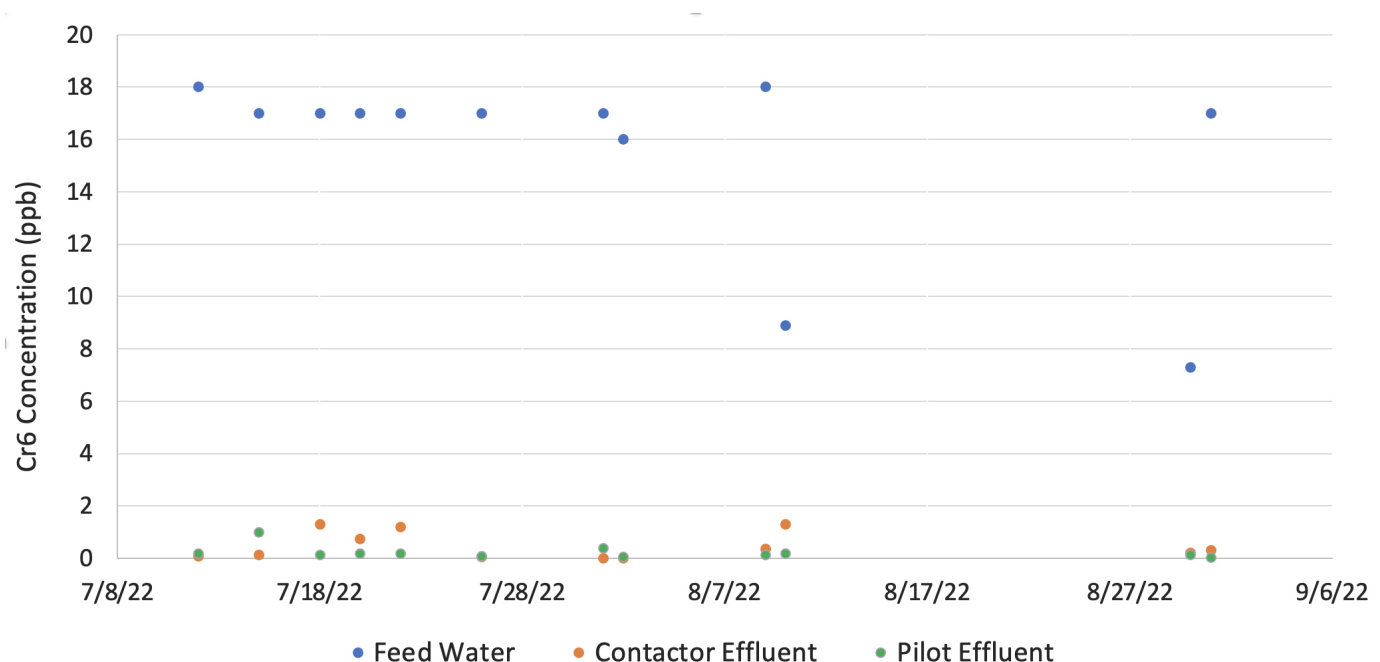
## Demonstration Results

A SafeGuard™ H2O treatment system with a capacity of 3 gpm (150 mL/minute) was installed onsite at the City of Banning for testing from June-September 2022. The SafeGuard™ H2O demonstration system was composed of seven key components:

1. Stannous reagent generator (RG\*)
2. Galvanostat and control system
3. Real-time Cr6 monitoring system with online trace metal analyzer
4. Generator conditioning solution feed system
5. Contactor vessel
6. Sand media filtration system
7. Aluminum chlorohydrate (ACH) coagulant dosing system

\* The RG is a proprietary electrolytic cell (electrolyzer) capable of releasing stannous ions into solution on demand based on applied current.

During the demonstration period, the influent Cr6 levels varied between 7.3 and 18 ppb, with an average raw water concentration of 15.5 ppb. The SafeGuard™ H2O technology effectively treated Cr6 contamination in the source drinking water to well below 10 ppb, successfully meeting the testing objective to produce an effluent with Cr6 levels below 5 ppb. Following treatment with the in-situ electrogenerated stannous reagent, effluent Cr6 levels were consistently at or below 1 ppb, with an average of 0.22 ppb which is a 98.55% reduction from raw influents levels before treatment.



Cr6 concentrations from the feed water, contactor effluent and pilot effluent at SafeGuard™ H2O technology demonstration with the City of Banning, California.

The SafeGuard™ H2O technology also underwent a series of challenge tests simulating potential failure conditions that could occur during treatment, including water, electrical, and chemical failures. The technology's performance and resilience were evaluated under these failure conditions. During the period from June-September 2022, the SafeGuard™ H2O system operated continuously except for scheduled maintenance such as backwashing and chemical changeouts. The SafeGuard™ H2O in-situ stannous reagent generation technology met all the testing objectives, proving itself reliable at removing Cr6 contamination from drinking water.

The main conclusions from the challenge tests are summarized below:

- During start-up, the SafeGuard™ H2O system was able to generate stannous immediately after start-up and reach a plateau of stannous concentration after 30 minutes. SafeGuard™ H2O was able to treat Cr6 to below 10 ppb after 30 minutes.
- In the event of a total water supply failure, the SafeGuard™ H2O system response detected no-flow conditions by flowmeters. These shut off power to the system and generated the system shut-down alarm. On reintroduction of water supply, the system returned to steady state operation.
- In the event of loss of power to the electrodes, SafeGuard™ H2O's controller detected a current drop to the electrode to be zero. This shut off the system and generated the system failure alarm. Reintroducing the power allowed for the system to return to steady-state operation.
- If the water system operator does not replace the tin electrode when notified to do so by the controller, the SafeGuard™ H2O system generated the Media Life Interlock notification alarm when 30% of the electrode mass remained. The expected system response of shutting down was also achieved at 20% media mass remaining.
- In the event of the RG being taken offline, the SafeGuard™ H2O system was able to automatically shut down and send out an alarm. Upon restarting the RG, the system was able to resume normal operation.
- In the event of a total power failure, after power to the system was shut off, the SafeGuard™ H2O system generated a 24V DC Power Interlock email alarm. Upon power reintroduction, the 24V DC Power Interlock OK email alarm was generated. The SafeGuard™ H2O system showed resiliency and was not impacted significantly by the challenge condition. Effluent from the SafeGuard™ H2O system was able to maintain Cr6 under 1 ppb and Cr(T) under 5 ppb within 120 minutes after the restart.
- In the event of an acid feed failure, an elevation in pH levels in the stannous reagent concentrate initiated the SafeGuard™ H2O system to generate the shutdown alarm. Upon priming the system and achieving an optimal pH range of 1-2, the SafeGuard™ H2O system generated the pH range OK alarm and resumed normal operation. During 30 minutes after the acid injection failure, and 60 minutes after resuming acid injection, the effluent from the SafeGuard™ H2O demonstration system had Cr6 at or below 2.0 ppb and Cr(T) at or below 5.3 ppb, showing resiliency to acid injection failure.
- Recycling of the backwash reduced water loss to a negligible 0.07%. Through the backwash recycling the system was able to achieve effluent Cr6 levels at or below 0.12 ppb and Cr(T) at or below 5.1 ppb.
- The SafeGuard™ H2O system generated relatively low amounts of waste during operation. The toxicity analysis of the treatment sludge confirmed that it is not a hazardous waste under federal RCRA or California Title 22 rules.

The demonstration at the City of Banning validated the effectiveness of the SafeGuard™ H2O technology to treat Cr6 and Cr(T) below 10 ppb, granting it conditional acceptance from the California SWRCB Division of Drinking Water for use of the technology by public drinking water systems to treat Cr6 contamination.

The SafeGuard™ H2O technology and its unique process of generating a non-toxic stannous reagent on demand via an electrolytic process offers utilities an affordable, effective and sustainable Cr6 remediation solution for California communities of all sizes impacted by Cr6 contamination.