Advanced Water Treatment Study for Hexavalent Chromium in Drinking Water

WaterSMART 2011

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City of Glendale Water & Power

GWP

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Bureau of Reclamation - Funding Opportunity R11SF80351

May 6, 2011

OMB Number: 4040-0004
Expiration Date: 04/31/2012

Application for Federal Assistance SF-424

Version 02

*1. Type of Submission

☐ Preapplication

☐ Application

☐ Changed/Corrected Application

*2. Type of Application

☑ New

☐ Continuation

☐ Revision

*If Revision, select appropriate letter(s):

* Other (Specify)

*3. Date Received:

4. Application Identifier:

5a. Federal Entity Identifier:

*5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: City of Glendale Water And Power

* b. Employer/Taxpayer Identification Number (EIN/TIN): 96-6000714

*c. Organizational DUNS: 03-038-4325

d. Address:

*Street1: 141 N. Glendale Avenue, Level 5
Street 2:
*City: Glendale
County: Los Angeles
*State: CA
Province:
Country: 91206
*Zip/ Postal Code:

e. Organizational Unit:

Department Name: Water and Power

Division Name:

f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Mr.
First Name: Don
Middle Name:
*Last Name: Froelich
Suffix: P.E.

Title: Project Manager

Organizational Affiliation:
City Department

*Telephone Number: 949-525-2672
Fax Number: 818-240-5754

*Email: donaldfroelich@cox.net

OMB Number: 4040-0004
Expiration Date: 04/31/2012

Application for Federal Assistance SF-424

Version 02

9. Type of Applicant 1: Select Applicant Type: C. City or Township Government

Type of Applicant 2: Select Applicant Type: - Select One -

Type of Applicant 3: Select Applicant Type: - Select One -

*Other (specify):

*10. Name of Federal Agency:
Bureau of Reclamation, Denver Office

11. Catalog of Federal Domestic Assistance Number:
15.507

CFDA Title:

*12. Funding Opportunity Number: R11SF80351

*Title: WaterSMART: Advanced Water Treatment Pilot and Demonstration Project Grants

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):
State of California, County of Los Angeles, Cities of Glendale, Los Angeles, Burbank, and San Fernando

*15. Descriptive Title of Applicant's Project:
Advanced Water Treatment Study for Hexavalent Chromium in Drinking Water

Attach supporting documents as specified in agency instructions.

OMB Number: 4040-0004
Expiration Date: 04/31/2012

Application for Federal Assistance SF-424

Version 02

16. Congressional Districts Of:

*a. Applicant CA-09 *b. Program/Project: US-ALL

Attach an additional list of Program/Project Congressional Districts if needed.

17. Proposed Project:

*a. Start Date: 07/01/2010 *b. End Date: 12/31/2011

18. Estimated Funding ($):

*a. Federal	$400,000.00
*b. Applicant	
*c. State	
*d. Local	$800,000.00
*e. Other	$420,000.00
*f. Program Income	
*g. TOTAL	$1,620,000.00

***19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on
☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.
☐ c. Program is not covered by E.O. 12372

*20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes", provide explanation.)
☐ Yes ☑ No

21. *By signing this application, I certify (1) to the statements contained in the list of certifications** and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)

☑ **I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: Mr. *First Name: James

Midd le N ame:

*Last Name: Starbird

Suffix:

*Title: City Manager

*Telephone Number: 818-548-4844 Fax Number: 818-547-6740

*Email: jstarbird@ci.glendale.ca.us

*Signature of Authorized Representative: [signature] Date Signed: 04/28/11

APPROVED AS TO FORM
[signature]
Assistant City Attorney

DATE 4/27/11

OMB Approval No. 4040-0007
Expiration Date 04/30/2008

ASSURANCES - NON-CONSTRUCTION PROGRAMS

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NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee-3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

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Prescribed by OMB Circular A-102

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

* SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	* TITLE
Completed on submission to Grants.gov [signature: James E. Starbird]	CITY MANAGER
* APPLICANT ORGANIZATION	* DATE SUBMITTED
CITY OF GLENDALE, CA	Completed on submission to Grants.gov

Standard Form 424B (Rev. 7-97) Back

APPROVED AS TO FORM

[signature]

Assistant City Attorney

DATE 4/27/11

Advanced Water Treatment Study for Hexavalent Chromium in Drinking Water

A partnership with Southern California water utilities, water industry groups, and the Federal and State drinking water regulatory agencies

Los Angeles Department of Water & Power

Association of California Water Agencies
Leadership Advocacy Information Since 1910

City of San Fernando
Historic & Visionary

City of Burbank Water and Power Since 1913

Water Research Foundation
Advancing the Science of Water

WaterSMART: Advanced Water Treatment Pilot and Demonstration Project Grants

U.S. Department of the Interior
Bureau of Reclamation
Notice of Funding Opportunity
No. R11SF80351

City of Glendale, Water and Power

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Technical Proposal

Executive Summary

The Advanced Water Treatment Study for Hexavalent Chromium in Drinking Water (Study) managed by the city of Glendale, Los Angeles County, California, is designed to provide cost information and technical feasibility for removing hexavalent chromium [Cr(VI)] from drinking water supplies. The Study, conducted at demonstration-scale facilities, provides water utilities effective treatment options in response to the U.S. Environmental Protection Agency's (USEPA) and California Department of Public Health (CDPH) pending action to establish a Maximum Contaminant Level (MCL) for Cr(VI) that could be significantly lower than the current MCL for total chromium. This phase of the Study, extending from July 2010 through December 2011, evaluates two treatment technologies shown in pilot testing to have promise for removing Cr(VI) to low parts-per-billion (ppb) levels in drinking water. Drinking water from an impaired groundwater basin can then be delivered to a distribution system serving customers, while achieving the larger goal of proving and optimizing Advanced Water Treatment (AWT) technologies that can be readily implemented by the drinking water industry. The Study is supported by an impressive list of local, state, and national partners including:

- Water utilities from the cities of Los Angeles (LADWP), Burbank, and San Fernando; and the Metropolitan Water District of Southern California (Metropolitan);
- Industry groups such as the Water Research Foundation, Association of California Water Agencies, National Water Research Institute, San Fernando Valley Business Group; and
- Regulatory agencies such as the USEPA, the California Department of Water Resources (DWR) and CDPH.

Background Data

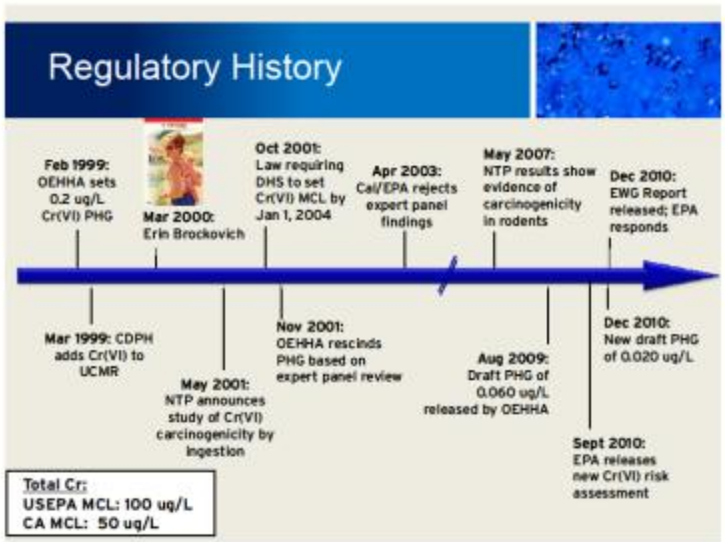
Regulatory Pressure

The regulatory history of chromium is based on an evolving understanding of chromium toxicity. Chromium is a naturally occurring element that is typically present in several valence states, with trivalent [Cr(III)] and Cr(VI) being the most common. While Cr(III) is an essential nutrient for humans, Cr(VI) compounds have been found to be carcinogenic by inhalation and ingestion. Major uses of Cr(VI) include metal plating, manufacture of pigments and dyes, corrosion inhibitors, chemical synthesis, refractory production, leather tanning, and wood preservation.

In the past few years, the toxicology of Cr(VI) was re-evaluated in a National Toxicology Program (NTP) study. Based primarily on this study, the USEPA recently released its peer-reviewed draft assessment of Cr(VI) toxicology for public comment in September 2010. The document identifies Cr(VI) as a carcinogen through ingestion, such as from drinking water, and proposes a reference dose of 0.0009 mg/kg/day, which is much lower than the current reference dose of 0.003 mg/kg/day for total chromium. The reference dose serves as a predecessor to an MCL. If the proposed Cr(VI) reference dose is finalized, an MCL at a low ppb level is possible for Cr(VI).

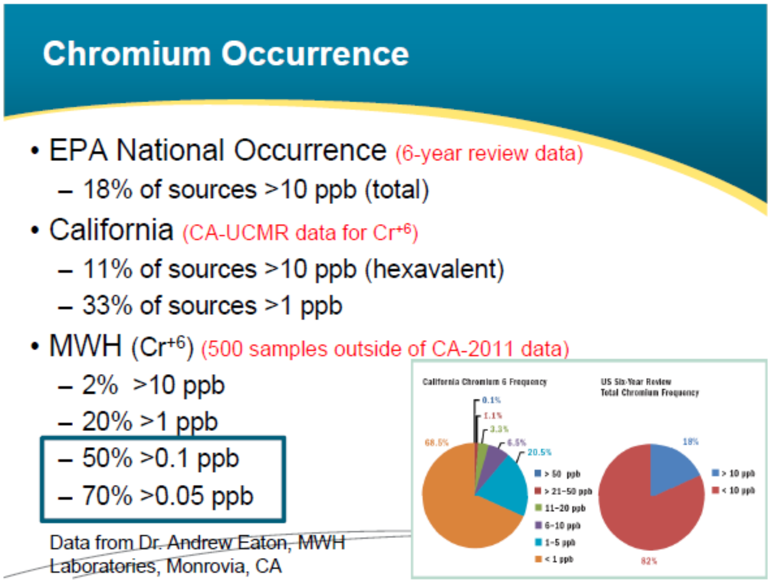
The State of California currently has a lower MCL of 50 ppb for total chromium. California State law requires CDPH to set a Cr(VI)-specific MCL. Adoption of this MCL depends on the California Office of Environmental Health Hazard Assessment's (OEHHA) publication of a Public Health Goal (PHG). A PHG was formerly set in California, but was rescinded until additional information from the NTP toxicology study was available (Figure 1). In August 2009, OEHHA released a draft PHG of 0.060 ppb for Cr(VI), which was later lowered to 0.020 ppb in December 2010. After the PHG is finalized, CDPH will consider the cost information from this research effort to perform cost-benefit analyses to set a Cr(VI) MCL.

FIGURE 1- REGULATORY HISTORY OF CR(VI) IN CALIFORNIA AND FEDERALLY



If the MCL is set at or below single-digit ppb levels, a significant number of sources in California would require treatment technologies for Cr(VI) removal to retain use of local supply. Throughout California, 20.5 percent of sources tested for this contaminant as part of the Unregulated Chemical Monitoring Requirement (UCMR) had Cr(VI) at levels between 1 and 5 ppb and 11 percent of sources had levels exceeding 5 ppb. Nationwide, the USEPA has estimated that 18 percent of utilities have Cr(VI) concentrations above 10 ppb, while another national survey indicated that 50 percent of water samples had Cr(VI) above 0.1 ppb (Figure 2).

FIGURE 2 - HEXAVALENT CHROMIUM IN CALIFORNIA AND NATIONWIDE



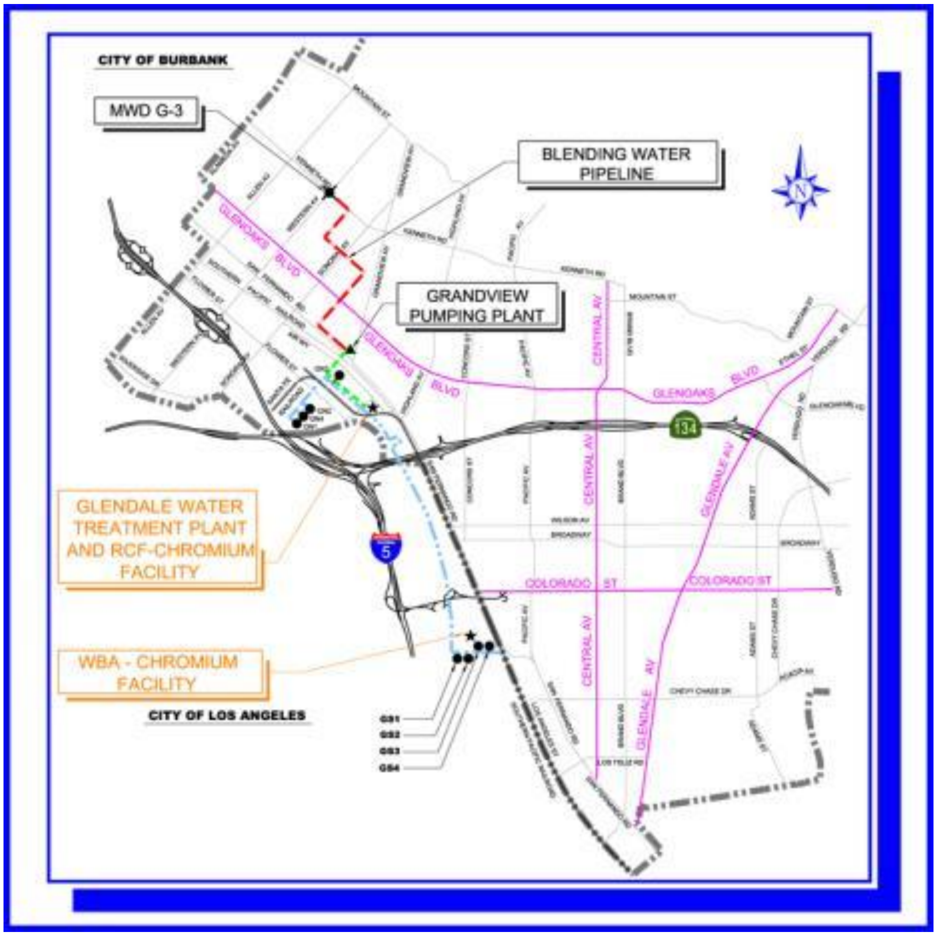
If a low Cr(VI) MCL is set, a large number of drinking water sources across the nation may need treatment specifically for Cr(VI) removal. However, treatment technologies for Cr(VI) removal have predominantly been developed for the treatment of industrial waste streams that contain Cr(VI) at levels significantly higher than those found in typical drinking water supplies (e.g., mg/L versus ppb) and with treatment goals at the current MCL rather than at potentially lower future regulatory levels. The ability to remove Cr(VI) to low ppb levels was not known before Glendale began their decade-long research campaign in 2001. Conventional water treatment (i.e., coagulation and filtration) is not effective in removing Cr(VI), but can remove Cr(III) associated with particles.

In response to an Environmental Working Group (EWG) report released in December 2010, U.S. Senators Barbara Boxer and Diane Feinstein are pressing the USEPA to expedite establishment of a federal Cr(VI) MCL. In addition, California has a legislative mandate to set a Cr(VI) MCL. The potential for a low Cr(VI) MCL, both in California and federally, is the principal motivation for drinking water utilities to better understand how to effectively remove Cr(VI) in their water supplies, which will be accomplished in this project.

Project Area

The project area for the research is located in the cities of Glendale and Los Angeles (see Figure 3). The beneficiaries of this research project are the cities of Los Angeles and Glendale, plus other water utilities in the State of California and the United States that have Cr(VI) in their drinking water supplies. This research effort is being conducted to address a water quality problem across the United States.

FIGURE 3 - TEST SITE LOCATIONS



The research work is being conducted in three phases with Phase I bench scale testing managed by the LADWP and Phases II and III managed by the city of Glendale (Glendale). Phases I and II are complete. While the Phase III demonstration facilities (2) located in both Los Angeles and Glendale have been completed and are now operational, the research associated is underway and will be of considerable benefit to many water utilities throughout the U.S. in addressing a potentially low MCL for Cr(VI).

City of Glendale – Principal Investigator

Glendale is located in Los Angeles County adjacent to the cities of Los Angeles, Burbank, and Pasadena (Figure 4). The population in Glendale is about 200,000, the third largest city in Los Angeles County. Glendale is over 100 years old and has evolved from an agricultural, to residential, and now highly urbanized city. The current water use is about 28,000 acre-feet per year (AFY) and projected to increase to 37,000 AFY by year 2030. The population is not expected to increase much appreciably the next 20 years as Glendale is built out and future water increases will occur as a result of replacing single family units with multi-family units and commercial development. Local water projects include expansion of its recycled water delivery system for landscape irrigation, and for sanitary flushing in high-rise office buildings and reuse of local water supplies previously contaminated with volatile organic compounds (VOCs) and Cr(VI).

FIGURE 4 - METROPOLITAN MEMBER AGENCY MAP – AERIAL VIEW OF SOUTHERN CALIFORNIA

In its early history, Glendale's water supply came from local ground water. As it continued to grow, the city became one of the 13 original member agencies in the 1928 formation of Metropolitan. Glendale started taking deliveries in 1946 from the Colorado River and later from the State Water Project. Glendale's ground water supply was impacted by water rights litigation with the city of Los Angeles over water supplies in the San Fernando Basin and later by VOC contamination, and the completion in 2000 of Superfund facilities to pump and treat the VOC contamination. In the 1980s and 1990s, its reliance on Metropolitan was close to 100 percent. By 2000, Glendale completed the VOC groundwater treatment facility called the Glendale Water Treatment Plant (GWTP) and eight extraction wells under federal Superfund laws. Glendale also greatly expanded its recycled water delivery system. That helped reduce its imported water supply from Metropolitan to 70 percent.

Now these ground water supplies are again threatened with the presence of Cr(VI) and the implementation of federal and state water quality standards for Cr(VI) that could result in the reduction in the use of ground water. This impending action prompted Glendale's interest and efforts to manage the studies to identify technologies for removing Cr(VI) from water supplies to retain the use of this resource.

Current and Past Relationships with U.S. Bureau of Reclamation

The city of Glendale had and currently has relationships with Reclamation that include power and water aspects. Table 1 lists Glendale's current and past relationships:

TABLE 1 - CURRENT AND PAST RELATIONSHIPS WITH RECLAMATION

Date	Project	Contract
1941	U.S. Department of Interior, Bureau of Reclamation (Reclamation) Boulder Canyon Between the United States and city of Glendale	I 1r 1340
1987	Between U.S. Department of Energy Western Power (DOE) Administration Boulder Canyon Project and city of Glendale	DE-MS65-86WP39581
1995	Boulder Canyon Project Implementation Agreement - Between the United States acting thru Western Power Administration, DOE, Reclamation Boulder Canyon Project Electric Service Contractors, and city of Glendale	95-PAO-10616
1986	Boulder Canyon Project Electric Service Contractors and city of Glendale for the Advance of Funds for the Uprating Program at Hoover Power Plant Between U.S. Department of Interior, Reclamation, Boulder Canyon Project and the city of Glendale.	6-07-30-P1009
Oct 1988 to Oct 2017	Boulder Canyon Project (Hoover) Electric Service Contract	07-07-30-P1026

Project Description

Objectives

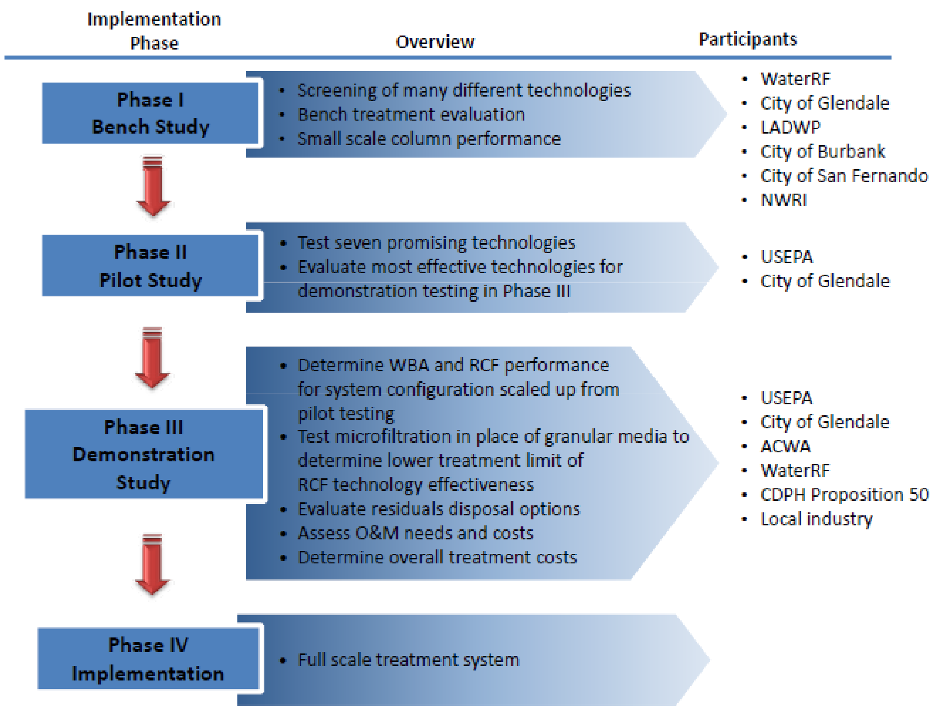
The overall goal of this demonstration-scale study is to evaluate the effectiveness of two AWT technologies shown to have promise in Phase II pilot testing for removing Cr(VI) to low ppb (or sub-ppb, if possible) levels in drinking water. Project objectives fall primarily into one of three categories: treatment, operational, and regulatory objectives.

1. Treatment Objective: The level to which the AWT technologies can remove Cr(VI) and Chromium will be tested to identify the lower limits of treatment efficacy. Currently, no treatment technology has been proven at levels of the California draft PHG of 0.02 ppb. While it is not expected that the MCL will be set this low, the study will demonstrate removal from an influent of approximately 80 ppb to low single-digit levels or below. These lower limits of removal are not known and will be elucidated in this study.
2. Operational Objective: Demonstration-scale experience with the two AWT technologies will provide valuable information on operational requirements of the systems, including labor, operations and maintenance costs, and any issues associated with scaling up the technology from demonstration-scale to larger scale. Residuals disposal options, and opportunities to minimize residuals disposal costs, will also be investigated through this study.
3. Regulatory Objective: In advance of a Cr(VI) MCL, cost estimates determined in this study will be developed in collaboration with CDPH and USEPA to ensure that the information will be useful in regulatory cost-benefit analyses for setting an MCL. To achieve this objective, actual treatment costs will be compiled and cost curves developed for different influent concentrations and potential MCLs. A range of system sizes will be evaluated to represent small to large sized utilities with respect to costs.

Findings from this study have been widely disseminated to the water community, regulatory agencies, professional groups, and other interested parties to ensure that the findings are practical and useful.

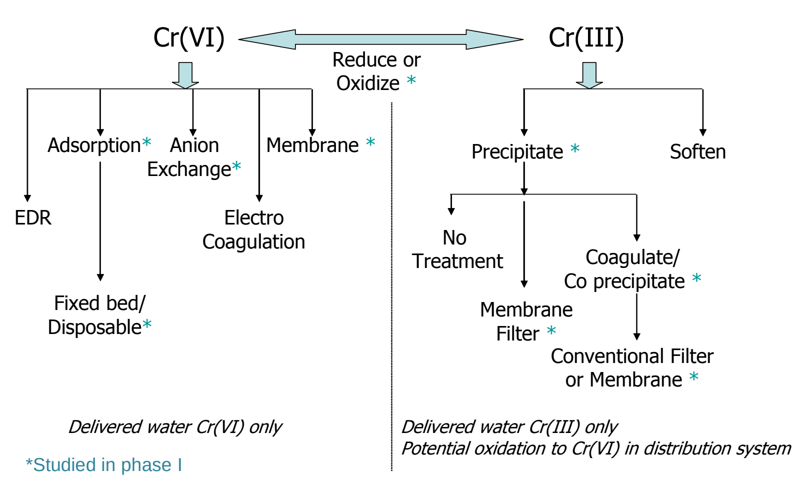
Glendale and its partners have been leading the research effort to identify and test low level Cr(VI) treatment technologies for drinking water. Figure 5 represents the four phased research effort, key goals and involved parties.

FIGURE 5 - PHASES OF THE OVERALL RESEARCH EFFORT



The Phase I bench study to screen available treatment technologies involved the cities of Los Angeles, Burbank, and San Fernando, the USEPA, the American Water Works Association Research Foundation (AwwaRF, currently named the Water Research Foundation, WaterRF), and the National Water Research Institute (NWRI). Figure 6shows the treatment processes that were investigated and then studied in Phase I and (managed by the city of Los Angeles).

FIGURE 6 – TECHNOLOGIES EVALUATED IN PHASE I BENCH-SCALE TESTING



Phase II pilot testing and Phase III demonstration-scale testing have been managed by the city of Glendale. Phase II included pilot testing of technologies found to be promising in Phase I, with funding from the USEPA. Pilot testing included evaluation of the following treatment processes: strong-base anion exchange, weak-base anion exchange, zeolite adsorption media, reduction with coagulation and filtration, reduction with filtration, and iron-impregnated granular activated carbon (GAC).

The current Phase III demonstration-scale testing is being conducted in partnership with the USEPA, CDPH and California Department of Water Resources (through Proposition 50), the Association of California Water Agencies (ACWA), WaterRF, and local industry. Phase III builds upon prior bench and pilot studies to assess treatment technology feasibility, the ability to meet the water community's needs with respect to treatment goals, and potential consequences of treatment on water quality. Earlier bench- and pilot-scale testing revealed that three technologies were considered significantly mature enough and capable of achieving target treatment goals, including reduction/coagulation/filtration (RCF), weak-base anion exchange resin (WBA), and strong-base anion exchange (SBA). An expert panel of treatment and regulatory experts (Project Advisory Committee and others) were gathered in 2006 to identify which AWT technologies should be selected for demonstration-scale testing. It was determined that RCF and WBA would be appropriate technologies for further study. SBA was eliminated from demonstration-scale testing due to (1) the inability to dispose of brine in a long-term, sustainable manner; and (2) the need for brine treatment to remove Cr(VI), which would make the brine hazardous unless it was removed.

Demonstration-scale testing of RCF treats a 100 gallon per minute (gpm) flow from Glendale's GN-3 (Glendale North) well, which currently has approximately 80 ppb Cr(VI) concentrations. WBA testing will treat the full 425 gpm flow at the GS-3 (Glendale South) well containing approximately 40 ppb Cr(VI). Technical descriptions of the two processes are provided below:

- The RCF process uses ferrous sulfate to reduce and co-precipitate chromium with iron oxyhydroxide particles. Pilot testing revealed that the reduction process is very effective at reducing Cr(VI) to Cr(III), resulting in Cr(VI) levels consistently below 1 ppb. Since Cr(III) is associated with particles at this pH, total chromium removal is therefore intrinsically tied to the effectiveness of particle removal by filtration. Demonstration-scale testing will investigate the treatment levels that two different filtration processes—granular media filtration or microfiltration (MF)—can achieve. While granular media filtration offers a lower cost option, MF may provide a better barrier to particles resulting in lower effluent Cr(VI) concentrations. Note: It is important to remove Cr(III) from the effluent because post disinfection with chlorine or chloramine concentrations in the distribution system will re-oxidize a large fraction of the Cr(III) back to Cr(VI).

- WBA treatment involves pH reduction to 6.0 and filtration of the water through vessels containing resin. Pilot testing showed that one resin tested had a capacity exceeding fifty times that of traditional SBA resins, making WBA feasible for cost-effective use as a disposable single-pass resin. Additional testing after piloting showed that WBA removes Cr(VI) by reducing Cr(VI) to Cr(III), and that the Cr(III) is complexed with the resin (rather than being present as particles on the resin, making the chromium more stable on the resin).

This Phase III demonstration-scale study, and preceding bench and pilot-scale studies, will form the basis for setting Cr(VI) regulatory limits since it is the most comprehensive research effort to date on available AWT technologies for Cr(VI) removal to low ppb levels in drinking water. The USEPA and CDPH are both closely monitoring and funding the study and are engaged as reviewers and project advisory committee members. Both agencies have been providing input regarding specific information needed to develop Cr(VI) regulations, thus demonstrating the importance of this study in developing future regulations of Cr(VI). A much lower MCL for Cr(VI) is under consideration compared to USEPA's total chromium MCL of 100 ppb or CDPH total chromium MCL of 50 ppb. This research is a critical link in determining what levels can be achieved using AWT and the associated costs of achieving those levels.

Test Sites

Glendale has a total of eight wells (four north and four south of the GWTP, which treats the wells for VOC removal using air stripping and GAC. The eight wells were installed to capture and treat contaminant plumes as part of a USEPA Superfund Remedy, with a combined flow rate of 5,000 gpm. The demonstration-scale testing is being conducted at two different locations: WBA testing at the GS-3 well site and RCF testing adjacent to the GWTP.

The WBA GS-3 well site is located in the city of Los Angeles (Figure 7). The site was selected for testing due to the relatively high Cr(VI) concentration in the water (approximately 40 ppb) and the presence of two unused vessels intended to contain GAC that could be inexpensively retrofit to house ion exchange resin. Effluent from the AWT technology testing will be joined into the USEPA's Glendale Operable Unit (GOU) south transmission main with the other three GS wells then sent to the GWTP for VOC treatment prior to distribution. Backwash water can be discharged at the GS-3 site to a sewer line under an existing discharge permit.

FIGURE 7 - WBA TEST LOCATION AT GS-3

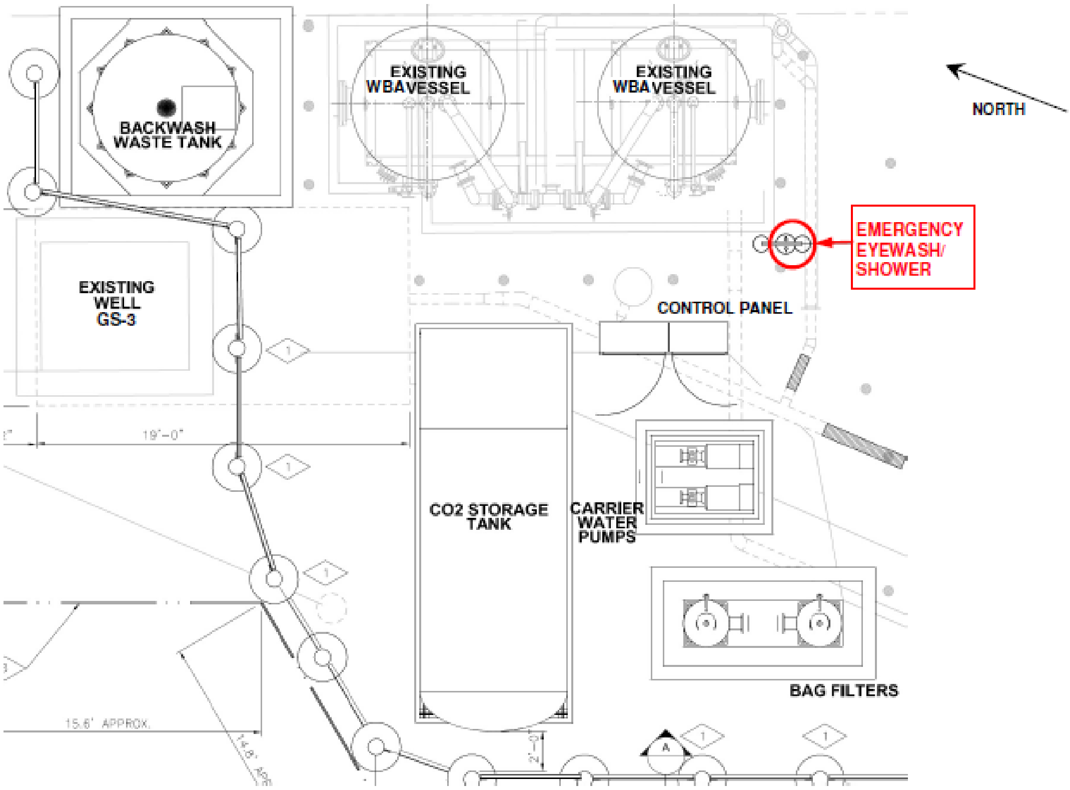
The RCF demonstration-scale testing site is located adjacent to the GWTP facility in Glendale (Figure 8). A new pipeline was installed to transfer water directly from the GN-3 well [containing approximately 80 ppb Cr(VI)] to the testing site so that a higher concentration than the combined flow of the GN wells (approximately 11 ppb) could be tested. Effluent from the AWT technology testing at the RCF site will join with the GOU north transmission main with the other three GN wells and the balance of the GN-3 flow for transit to the GWTP for VOC treatment prior to distribution. Backwash water can be discharged from the RCF treatment facility to a sewer line under an existing discharge permit.

FIGURE 8 - RCF TEST LOCATION ADJACENT TO THE GWTP

Demonstration-Scale System Configuration - WBA

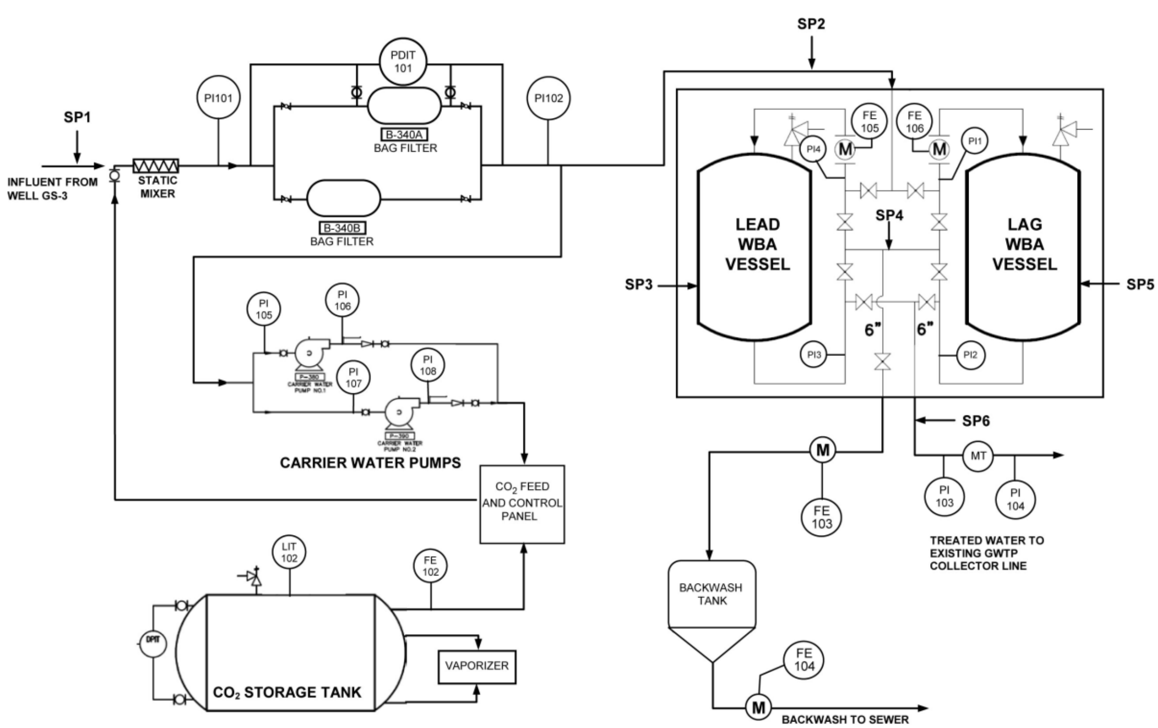
Figure 9 provides a process flow schematic for the WBA system and Figure 10 shows the facility layout. The system consists of a pair of lead/lag vessels with upstream carbon dioxide addition for pH depression. Due to the resin's high capacity and difficulty in regeneration, WBA resin will be used as a once-through, non-regenerable media. Influent water from the GS-3 well will be pH-adjusted by the addition of carbon dioxide from the initial pH of approximately 6.8 to a pH of approximately 6.0. The water is then filtered for sand and silt removal prior to flowing through the treatment vessels, where chromium is removed by WBA resin. The design flow for the WBA treatment system is 425 gpm.

FIGURE 9 - WBA TREATMENT PROCESS TRAIN



Note: CO_2 = carbon dioxide

FIGURE 10 - WBA DEMONSTRATION-SCALE STUDY SITE PLAN



Demonstration-Scale System Equipment Description - WBA

The WBA demonstration-scale system includes a carbon dioxide pH control system, bag filters for particulate removal from the raw water (and to provide additional mixing of the carbon dioxide into the water), two ion exchange vessels operated in lead-lag configuration, and a backwash system to hold backwash water during startup and allow a low, metered flow to the sewer. These systems and their operations are described in more detail below.

Carbon Dioxide pH Control System

Carbon dioxide, CO_2, is used to reduce the pH of the water fed to the WBA vessels from a pH of approximately 6.8 to 6.0. CO_2 reacts with water to form carbonic acid and reduces the pH. The CO_2 pH control system consists of the following components:

- 14-ton liquid CO_2 storage tank (Photo 1) including refrigeration unit, CO_2 vaporizer, CO_2 vapor heater, and pressure regulator.
- CO_2 Control System including carbonic acid feed control panel with a human-machine interface (HMI) and programmable logic controller (PLC), carrier water pumps, control panels, skids, valves, and carbonic acid diffuser assembly.

PHOTO 1 - CARBON DIOXIDE SYSTEM WITH ION EXCHANGE VESSELS

The design criteria for the CO_2 feed system are provided in Table 2.

TABLE 2 - WBA ION EXCHANGE VESSEL DESIGN CRITERIA

Parameter	WBA Vessel (each)
Design Flow	425 gpm
Maximum Capacity of Vessel Underdrain	600 gpm
WBA Loading Rate	2.5 gpm/cf
Required Usable WBA Volume at Design Flow	170 cf
Vessel Diameter	8 ft
Vessel Total Straight Shell Height	7 ft
Vessel Rounded Bottom Height	2 ft
Total volume of Vessel	553 cf (4,136 gallons)
Unusable Volume from Bottom of Vessel to Top of Nozzle	1 ft
Unusable Resin Below Nozzle	15 cf

Parameter	WBA Vessel (each)
Total WBA Resin Required at Design Flow	185 cf
Available Bed Expansion at Maximum Design Flow	42%
Straight Shell Depth of Resin at Design Flow	2.68 ft
Available Bed Expansion at Design Flow	62%
Minimum Required Backwash Rate for 60% Bed Expansion	3.5 gpm/sf (176 gpm)
Backwash Supply	Raw water from GS transmission line
WBA Resin	Rohm & Haas Amberlite PWA7
WBA Resin Particle Size Range	0.3–1.2 mm
Underdrain Lateral Screen Size	0.25 mm (60 mesh)

Bag Filters

Two 20-micron bag filter vessels in parallel are upstream of the WBA vessels for particulate matter removal. The filters are sized so that filter bag changes can be completed without shutting down the treatment system.

Ion Exchange Resin and Vessels

Two ion exchange vessels will be operated in series in a lead/lag configuration. The system was designed as a demonstration-scale facility that will have a limited operating period. It is not expected that the facility will need to be in operation for 30 or more years, so the construction material choices are based on a limited life cycle demonstration facility. The design criteria for the WBA vessels are listed in Table 2.

Pilot testing revealed that one of the six resins tested had a sufficiently high Cr(VI) capacity and ability to meet target treatment goals so that use of resins was cost-competitive with the RCF process. The resin selected for this study, Rohm & Haas PWA7 (now produced by Dow), consists of a phenol-formaldehyde backbone and secondary amine functional groups to bind the chromium. Two 8-ft. diameter vessels currently at the GS-3 well site (never used for their intended purpose of GAC treatment) were retrofit for holding ion exchange resin (and sampling at various bed depths) in early 2010. The resin manufacturer recommended a bed volume of 185 cubic feet per vessel, corresponding to a volumetric design flow rate of approximately 2.5 gpm per cubic foot.

Backwash System

The backwash tank is a 3,000-gallon, cross-linked high-density polyethylene (HDPE), cone-bottom tank mounted on a steel stand. The tank is sized to receive a 17-minute backwash at 176 gpm. The backwash water supply will be provided by non-disinfected water from the GOU south transmission line. Pilot testing showed that backwashing is likely not necessary (except during startup) when upstream bag filters prevent particle buildup in the ion exchange beds.

Containment Pads and Ancillary Equipment

The backwash tank, filters, and carrier water pumps are mounted on concrete pads with elevated sidewalls to serve as containment areas for nuisance spills or leaks. The containment pads are for identifying minor pipe leaks and preventing discharges of the well water to the storm sewer. Level switches located inside sumps in each pad alert operators at the control panel and the remote monitoring location that the pad is filling with liquid.

The site piping materials are epoxy-lined and coated steel for above grade piping and cement-lined and coated steel pipe and ductile iron pipe for below grade piping. Exposed valves are cast iron butterfly valves. Buried valves are ductile-iron, body-resilient, wedge, gate valves installed in traffic-rated valve cans with the valve operators below grade. The piping materials for the carbonic acid system are Schedule 40 galvanized steel for the CO_2 gas and stainless steel for the dissolved carbonic acid solution after the feed panel.

Process Monitoring and Control

Most functions of the WBA facility are designed for automatic operation and include a supervisory control and data acquisition (SCADA) system for remote monitoring and control of many of the treatment system parameters from the GWTP control room. Local control of the plant is possible through the HMI located on the control panel at the facility.

Well GS-3 is normally controlled via the existing SCADA system in an automatic-remote manner with manual-remote operation possible from the GWTP control room and local control at the well. The well pump is equipped with a variable-frequency drive that is automatically controlled to match the plant flow rate setpoint.

Critical equipment is interlocked by hardwiring directly to control devices. Operating conditions that exceed setpoints either trigger an alarm or equipment shutdown. The specific alarm conditions must be returned to normal operation before the individual alarm light can be reset.

Detailed Operations and Maintenance Manual and a Startup Procedures Document were prepared prior to startup of the facilities and can provide additional details.

Test Conditions - WBA

During normal operation, water quality and process-related parameters will be maintained as close as possible to values shown in Table 3. The vessels will be run in a lead/lag configuration until 5 ppb is observed in the effluent of the lag vessel, at which time the flow to the vessels will be switched and the former lead bed replaced with new media and placed into the lag position. No other changes during operations are expected, since the primary goal of the demonstration-scale testing of WBA is to evaluate the effectiveness of the AWT technology in removing Cr(VI), which requires constant conditions to assess resin capacity.

TABLE 3 - WBA TEST CONDITIONS

Parameter	Value
Facility effluent Cr(VI) target concentration	< 5 ppb
Operating pH	5.7 to 6.3
Design Flow Rate	425 gpm

Sampling and Analysis Plan - WBA

Figure 9 shows a schematic of the WBA system with sampling ports represented by “SP”. Sampling locations for the WBA treatment system include raw water (before CO_2 addition, designated as Sample Port 1, or SP1), WBA influent (after CO_2 addition, SP2), lead vessel 50 percent bed depth (SP3), lead vessel effluent (SP4), lag vessel 50 percent bed depth (SP5), and lag vessel effluent (SP6). The monitoring locations and sampling frequencies for the water quality parameters are summarized in Table 4. Descriptions of analytical methods for each water quality parameter are provided in Table 5.

Critical water quality parameters for the demonstration-scale WBA system include Cr(VI), total chromium, and pH. Pilot testing highlighted the importance of pH depression and constant pH control for the effective operation of the PWA7 resin. Other chemical and physical parameters, including temperature, conductivity, turbidity, and alkalinity, will be routinely measured. Anions that may impact ion exchange, such as sulfate, nitrate, and silicate, will also be monitored. Nitrosamines, which have been found to leach from ion exchange resins, will be measured during WBA facility startup to determine the amount of time necessary to flush the resins if nitrosamine leaching occurs. In addition, a broad scan for tentatively identified compounds (TICs) will be conducted with each new batch of resin.

Besides chemical and physical water quality analyses, process-related parameters will be recorded to evaluate the operations of the WBA system. The process-related parameters include flow rate, system pressure, head loss through the bag filters and resin vessels (both lead and lag vessels), backwash frequency, empty bed contact time (EBCT), numbers of bed volumes to breakthrough (> 5 ppb), numbers of bed volumes to 50 percent saturation of the lead vessel, and CO_2 feed rate and volume use rate.

TABLE 4 - SAMPLING AND ANALYSIS FREQUENCY FOR WBA

Analytical Measurement	Monitoring Locations							
	SP1	SP2	SP3	SP4	SP5	SP6	Residuals Spent Resin	Residuals Backwash water
Cr(VI)	M	W	W	W	W[1]	W	–	A
Total Cr	M	W	W	W	W[1]	W	–	–
pH	–	–	–	W	–	W	–	–
Bac-t	M	M		W		W		
Temperature	–	–	–	W	–	W	–	–
Sulfate (SO_4^{2-})	–	M	–	–	–	M	–	–
Nitrate (NO_3^-)	–	M	–	–	–	M	–	–
Phosphate (PO_4^{3-})	–	M	–	–	–	M	–	–
Silicate	–	M	–	–	–	M	–	–
Iron (Fe)	–	M	–	–	–	M	–	–
Alkalinity	–	M	–	–	–	M	–	–
Conductivity	–	M	–	–	–	M	–	–
Turbidity	–	M	–	–	–	M	–	–
Nitrosamines[2]	–	S	–	S	–	M[3]	–	–
BNA SVOC	–	S	–	S	–	M[3]	–	–
Aldehydes/ketones	–	S	–	S	–	M[3]	–	–
TCLP, CWET	–	–	–	–	–	–	A	–
Uranium	–	–	U	–	–	A	A	–

Notes:
W: Weekly; M: Monthly; A: Annually; S: Start-up
U: every 10,000 BV (approximately 21 days); BV = bed volume (1,272 gallons)
[1] Samples collected only when the lead vessel effluent exceeds 5 ppb.
[2] Nitrosamines will be analyzed at a frequency required by the CDPH permit.
[3] Start of test and monthly thereafter
BNA SVOC = base, neutral, acid semi-volatile organic compounds including phenol and tentatively identified compounds (TICs)
CWET = California Waste Extraction Test
TCLP = Toxicity Characteristic Leaching Procedure

TABLE 5 - ANALYTICAL METHODS AND LOCATIONS OF ANALYSES - WBA

Analysis	Analytical Method	Analysis Location	Method Detection Limit (MDL)	Notes
Cr(VI) - Lab	USEPA 218.6	ELAP-certified lab	0.015 µg/L	Reporting limit: 0.10 µg/L
Total Cr	USEPA 200.8	ELAP-certified lab	0.192 µg/L	
pH	SM 4500H+ B	Field	N/A	
Bac-t	SM9223B SM9215B	ELAP-certified lab	N/A	Total coliform + *E. coli* by presence/absence Total coliform + *E. coli* by enumeration Heterotrophic plate count
Temperature	SM 2550	Field	N/A	
Sulfate (SO_4^{2-})	Hach 8051	Field	5 mg/L	
Nitrate (NO_3^-)	USEPA 300.0	ELAP-certified lab	0.009 mg/L	
Phosphate (PO_4^{3-})	Hach 8048	Field	0.5 mg/L	
Silicate	Hach 8185	Field	1 mg/L	
Total Iron (Fe)	Hach Method 8008 (FerroVer)	Field	0.02 mg/L	
Alkalinity	Hach 8203 (Titration)	Field	10 mg/L as $CaCO_3$	
Conductivity	SM 2510B	Field	N/A	
Turbidity	SM 2130 B	Field	0.02 NTU	
Nitrosamines	USEPA 521	ELAP-certified lab	Less than 1 ng/L for each nitrosamine	Includes: NDMA, NMEA, NDEA, NDPA, NYPR, NPIP, NDBA
BNA SVOCs	USEPA 625	ELAP-certified lab	Varies by compound	Including TICs and unknown GC/MS peaks
Aldehydes/ketones	USEPA 556	ELAP-certified lab	Varies by compound	Including TICs and unknown GC/MS peaks
Residuals – TCLP	USEPA 1311	ELAP-certified lab	Varies by element	
Residuals – CWET	CWET (Title 22)	ELAP-certified lab	Varies by element	
Residuals – Uranium	ASTM5174-91 (KPA Method)	ELAP-certified lab	0.004 mg/kg	

Notes:
ASTM = American Society of Testing and Materials
BNA SVOCs = base, neutral, acid semi-volatile organic compounds including phenol and tentatively identified compounds (TICs)
CWET = California Waste Extraction Test; TCLP = Toxicity Characteristic Leaching Procedure
ELAP = Environmental Laboratory Accreditation Program
USEPA = United States Environmental Protection Agency
SM = Standard Methods

Demonstration-Scale System Configurations – RCF

Figure 11 provides a process flow schematic for the RCF system that consists of reduction of Cr(VI) using ferrous sulfate (and concomitant iron hydroxide precipitate formation that sorbs or incorporates Cr(III)), coagulation to fully oxidize the ferrous iron to ferric iron and build up particle size through the use of polymer, and filtration to remove iron-chromium particles. The filters must be backwashed, which necessitates inclusion of a backwash handling system.

FIGURE 11 - RCF TREATMENT PROCESS TRAIN

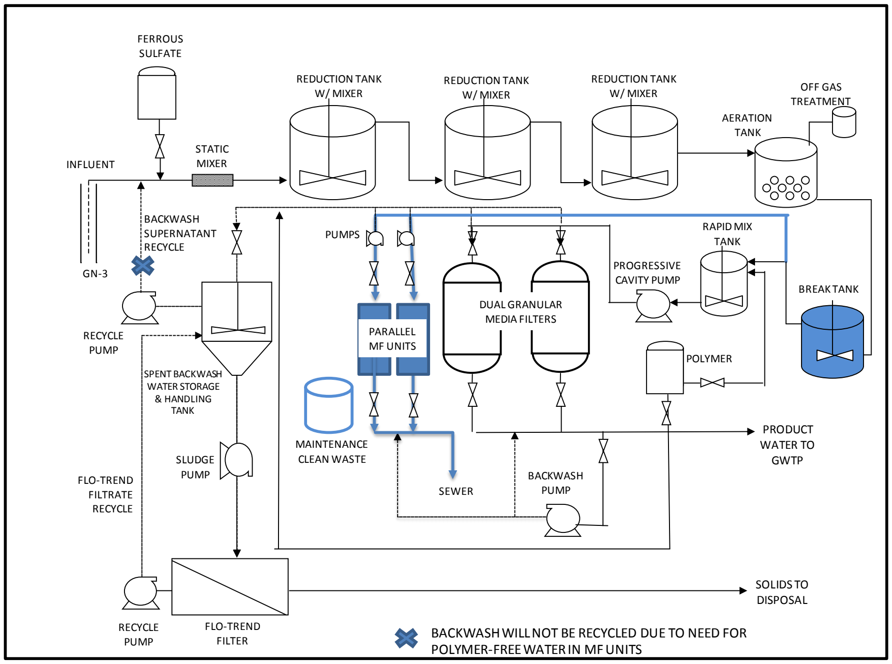
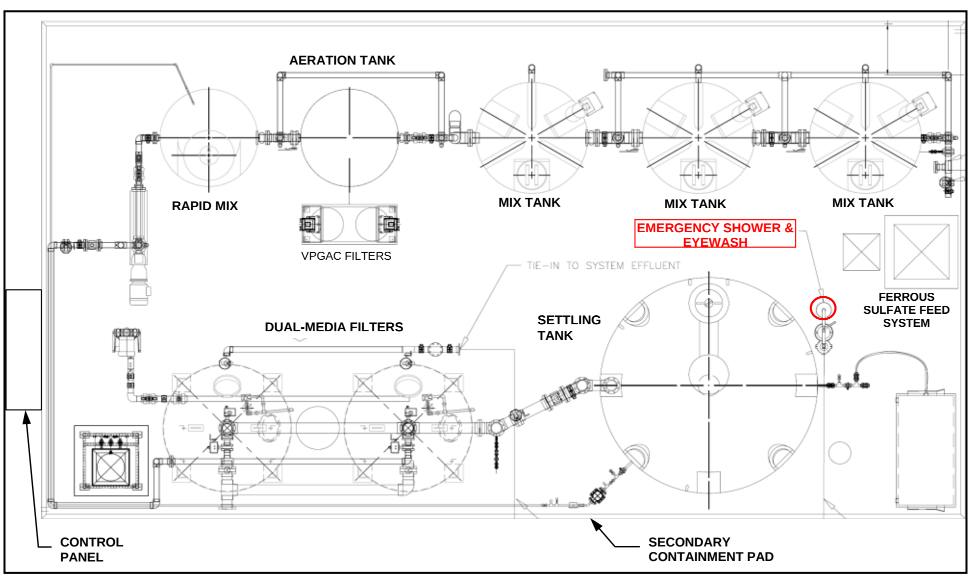


Figure 12 shows the RCF demonstration-scale testing facility as constructed, with ferrous sulfate chemical feed system, three reduction tanks in series, an aeration tank with off-gas GAC treatment, a rapid mix tank for polymer addition, and two parallel granular media filters. Up to two MF units will also be installed in summer 2011 as shown in blue on Figure 11.

FIGURE 12 - RCF DEMONSTRATION-SCALE STUDY SITE PLAN



Demonstration-Scale System Equipment Description - RCF

The demonstration-scale system that will be used in the study includes a ferrous sulfate storage tank and feed system, three reduction tanks in series (each with 15 minutes of detention time) with mixers, an aeration tank with GAC off-gas treatment for VOCs, a rapid mix tank for polymer addition, a progressive cavity pump, parallel granular media filters (operating one at a time), a backwash settling tank, and passive sludge dewatering system. A finding from the earlier pilot study was that no pH adjustment or additional aeration (beyond that provided by the dissolved oxygen in the water) was necessary for Glendale's water quality.

Photo 2 shows the RCF demonstration-scale system. The system was designed by AECOM in conjunction with Layne Christensen (as part of a Design-Build contract), the latter having designed and installed many coagulation/filtration systems for arsenic treatment.

PHOTO 2 - RCF DEMONSTRATION-SCALE SYSTEM

In the final three months of testing, MF will be tested in parallel with granular media filtration. The potential advantage of MF over granular media filtration is physical removal of smaller sized particles using membranes, whereby small particles might penetrate a granular media bed and not achieve as high of removals as membranes.

Ferrous Sulfate Feed System

Ferrous sulfate will be used to reduce Cr(VI) to Cr(III) in the first step of the treatment process. The iron dosage is based on the influent Cr(VI) concentration, with a 25:1 mass ratio of iron to Cr(VI) shown to be effective in RCF pilot testing. The ferrous sulfate feed system consists of a ferrous sulfate storage tank, a dosing pump and a static mixer. Ferrous sulfate solution (5 percent as iron) stored in the storage tank will be added to the influent pipeline by the dosing pump, and mixed into the water flow by the static mixer. The ferrous sulfate dose rate will be checked and adjusted manually based the influent Cr(VI) concentrations.

Reduction Tanks with Mixers

After the static mixer, the iron-spiked influent water will flow to three identical reduction tanks piped in series. Each 1,500 gallon reduction tank is 6 feet 1 inch in diameter and 9 feet 6.5 inches high and is equipped with a mechanical mixer. The three reduction tanks (Photo 3) in series provide a total detention time of 45 minutes for the 100-gpm water flow. The purpose of using three tanks in series is to increase mixing efficiency by minimizing short circuiting and back flow problems, as well as facilitating tests of less reduction time. The three reduction tanks are also designed with the ability to bypass one or two tanks so that any maintenance or malfunction issues with the tank and/or mechanical mixer will not cause a shut-down of the whole RCF system.

PHOTO 3 - REDUCTION TANKS WITH MIXERS

Aeration Tank

An aeration tank with off-gas GAC treatment is included in the RCF process to verify the necessity of an aeration step on iron oxidation and chromium removal. The aeration tank can be bypassed when desired. The aeration tank at Glendale also has GAC off-gas treatment (due to VOCs in the water that might be stripped during aeration). The 710-gallon aeration tank is 4 feet 9 inches in height, 5 feet 1 inch in diameter, providing up to 7 minutes of detention time for a 100 gpm flow.

Rapid Mix Tank for Polymer Addition

After the reduction tanks and the aeration tank (if not bypassed), the water will flow to a 685-gallon rapid mixing tank, into which polymer will be injected for enhanced iron and chromium floc formation. The mixing tank will provide an additional 5 minutes for floc formation. Different anionic polymers, Magnafloc Ciba E38, E40, and Nalco 9901, were tested during the RCF pilot study. Pilot testing revealed that 0.1 mg/L of Magnafloc Ciba E38 polymer was effective for floc formation in the RCF process.

A 30-gallon tank will be used to as a day tank for polymer and will be continuously stirred by a magnetic stirrer to prevent stratification of the polymer solution. Polymer in the tank will be added to the rapid mixing tank by a chemical dosing pump.

Progressive Cavity Pump

After the rapid mix tank, water containing iron and chromium floc will be pumped by a progressive cavity pump to a pressurized dual media filter in down-flow mode. One lesson learned from the pilot study was that the use of progressive cavity pump is necessary for enhanced filtration performance by minimizing the break-up of iron and chromium floc that has already been formed.

Granular Media Filter and Backwash System

The RCF system consists of two granular media filters, with one serving as a standby filter during normal operations and the other filtering 100 gpm of flow. The dual media filters consist of approximately 26 inches of anthracite and 14 inches of sand, with a supportive underdrain of 2 inches of gravel. The design hydraulic loading rate for both filters is approximately 3 gpm per square foot (gpm/sf). The vertical pressure vessels are 6.5 feet in diameter, as shown in Photo 4. Filter effluent blends with water from other GOU north wells (and the balance of the GN-3 well) and undergoes further VOC treatment at the GWTP. Filters are backwashed periodically (refer to Table 7**Error! Reference source not found.** for filter runs) at a flow rate of 400 gpm for 10 minutes with air scour, with a preceding low flow 200 gpm backwash for 5 minutes and an subsequent low flow

200 gpm backwash for 2 minutes to restratify the bed. Air scour is included in the backwash procedure. Filter backwash water will be transferred to a settling/storage tank.

PHOTO 4 - VERTICAL PRESSURE VESSELS

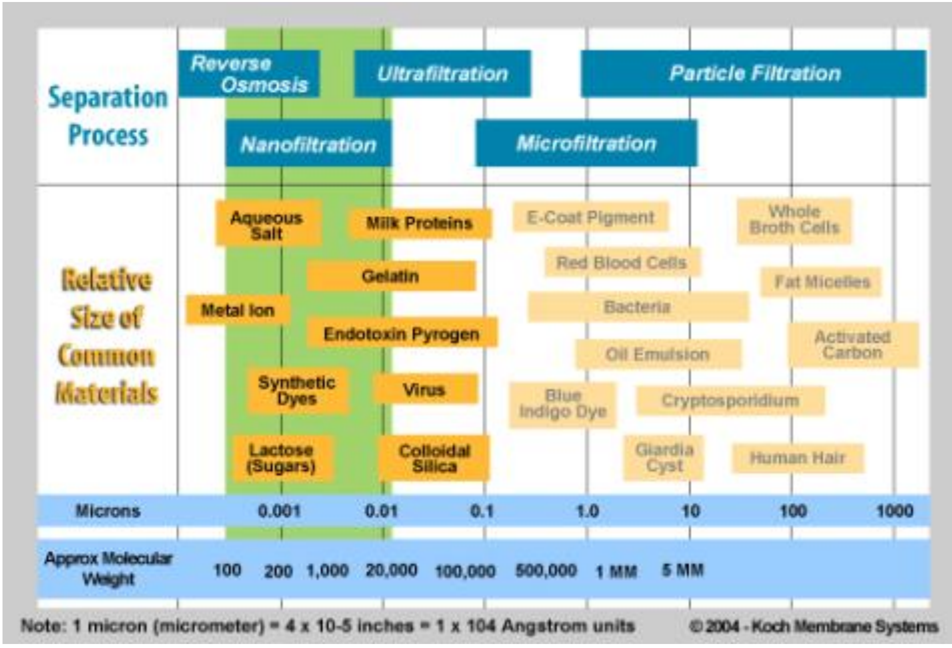
Magnafloc Ciba E38 anionic polymer will be added to the backwash tank at a concentration of 1 mg/L to assist solids settling based on preliminary testing of doses in piloting. In pilot testing, supernatant from the backwash storage tank contained approximately 30 ppb chromium and 1 mg/L iron, so the water was deemed acceptable for recycle to the head of the RCF system at a rate of 4 to 5 percent of the influent flow (i.e., 4 to 5 gpm). Settled backwash solids are sent to a passive filtration system called the SludgeMate, as shown in Photo 5. The SludgeMate consists of Flo-Trend felt filtration material to separate solids from liquid. The filtrate is expected to have a water quality similar to the backwash supernatant and may also be recycled to the spent backwash water storage tank. Dewatered solids captured on the Flo-Trend material will be shipped for disposal at a non-RCRA hazardous waste landfill.

PHOTO 5 - PASSIVE SLUDGE DEWATERING SYSTEM - SLUDGEMATE

Microfiltration

MF offers the potential to remove smaller particles than granular media filtration by means of size exclusion from pores in the membranes. Figure 13 shows the typical size exclusion chart for a variety of filtration options. Jar testing has shown that the particles formed in the RCF process are pinpoint-type floc, which may be better removed with MF because the pinpoint floc can penetrate the granular media. In fact, initial testing has shown improvement of the granular media filters in terms of particle removal as a function of time (up to the longest run time of 48 hours), indicating that better particle removal is achieved when a surface layer of particles build up on the top of the filters.

FIGURE 13 - SIZE EXCLUSION CHART SHOWING MF COMPARED TO OTHER FILTRATION PROCESSES



Two primary types of membranes are used in MF drinking water treatment: polymeric and ceramic membranes. Of polymeric, submerged and encased are available, whereby submerged is generally considered to have a higher tolerance for solids loading (e.g., in membrane bioreactor applications). Since the demonstration process train does not have a coagulation/settling step, it is a direct filtration application. One membrane manufacturer is recommending a submerged polymeric membrane system for this application; others indicated that the doses that will be tested are not problematic for their encased membrane systems. Minimal fouling is also a key benefit of ceramic membranes. Although capital costs are higher for ceramic, the costs can be similar on a life-cycle basis because polymer membranes might have to be replaced more frequently.

MF membrane suppliers (industry leaders Pall, Siemens, GE/Zenon, Krueger) were contacted to preliminarily determine the availability of pilot skids, interest, and experience in this application (i.e., ferrous iron), and rental costs. The availability of this type of membrane is limited to a short list of vendors due to the uniqueness and highly specialized nature of the technology. Therefore, as part of testing, a Request for Proposals (RFP) will be issued to the various vendors and the PAC together with Glendale will select two membrane suppliers for demonstration testing. Proposals submitted by all membrane vendors will be scored based firm capacity and experience (particularly in treating water of similar quality), ability to meet the schedule, and offers of in-kind service or cost sharing. It is anticipated, based on initial discussions with vendors that the MF vendors will propose on the systems shown in Table 6.

TABLE 6 - MICROFILTRATION SYSTEMS ANTICIPATED TO BE PROPOSED BY VENDORS

Vendor	System Type	Membrane material	Nominal Pore size	Typical Flow Rate Range for Pilot Skids	Typical Flux Rate
Pall	Pressure	Polyvinylidene fluoride (PVDF)	0.1 µm	20 to 30 gpm	40 to 60 gfd (typically 50)
Siemens	Pressure	PVDF	0.1 µm	20 to 30 gpm	Not provided
Zenon	Pressure	PVDF	0.02 µm	20 to 30 gpm	40 gfd
Zenon	Submerged*	PVDF	0.04 µm	20 to 37 gpm	30 gfd
Krueger	Ceramic	Ceramic	0.1 µm	18 to 25 gpm	100 to 200 gfd

* Zenon indicated that they would likely recommend a submerged system to handle iron concentrations above 2 mg/L; other vendors did not view this iron concentration as a limitation to their systems.

Containment Pads and Ancillary Equipment

All of the components except the PLC and electrical cabinet will be mounted on concrete pads with elevated sidewalls to serve as containment areas for nuisance spills or leaks. The containment pads are for identifying minor pipe leaks and preventing discharges of the well water to the storm sewer. Level switches located inside sumps in each pad alert operators at the control panel and the remote monitoring location that the pad is filling with liquid.

The site piping materials are Schedule 80 PVC for above grade piping and cement mortar line and coated ductile iron pipe for below grade piping. Exposed PVC is painted to protect against ultraviolet light. The velocities in the piping must be maintained below 5 feet per second in PVC piping to protect against surge. Exposed valves are PVC butterfly valves. Buried valves are ductile-iron, body-resilient, wedge, gate valves.

Process Monitoring and Control

The RCF facility is an automated system that has an option of setting its equipment (i.e., pumps, blowers, fans, and valves) in manual control operation. The plant's automation features include automatic backwash sequencing and duration, and monitoring numerous plant conditions with appropriate alarms and shutdowns should an aberrant condition occur.

The RCF facility has a single main control panel with an HMI to allow operator input and communication with the system. The plant's instrumentation and control equipment includes pressure and flow instrumentation to monitor flow rate, throughput, and differential pressure. The system also monitors differential pressure across each filter and the media trap. The plant has a level sensor to monitor backwash tank level and scales for the chemical feed tanks. Process variables are transmitted via SCADA system to the GWTP control room.

Critical equipment is interlocked by hardwiring directly to control devices. Operating conditions that exceed interlock setpoints either trigger an alarm or equipment shutdown. The specific alarm conditions must be returned to normal operation before the individual alarm condition can be reset and the plant restarted.

The wells supplying the raw groundwater are normally controlled via the existing SCADA system in an automatic-remote manner with manual-remote operation possible from the GWTP control room and local control at the well. The well pumps are equipped with variable-frequency drives that are automatically controlled to match the plant flow rate setpoint.

Detailed Operations and Maintenance Manual and a Startup Procedures Document were prepared prior to startup of the facilities and can provide additional details.

Test Conditions – RCF

Unlike the WBA system that has static test conditions and operates to reach a breakthrough target, the RCF system will be adjusted throughout the demonstration-scale testing to evaluate technology effectiveness under a variety of operating conditions. Pilot-scale testing revealed that Cr(VI) and chromium removal to less than 1 ppb could be achieved under the following conditions:

- 25:1 iron:chromium mass ratio,
- 45 minutes of reduction time,
- Aeration step to oxidize remaining iron,
- Rapid mix with polymer feed of 0.1 mg/L,
- Granular media filtration at a hydraulic loading rate of 3 to 4 gpm/sf, and
- 24 to 48 hour filter run lengths.

Demonstration-scale testing will investigate the ability to scale-up these conditions that were effective in pilot testing. In addition, several variables will be adjusted to further optimize the RCF system. These variables include: raw water Cr(VI) concentration, the amount of reduction time, the presence or absence of an aeration unit process, Iron to Cr(VI) ratios, and filter run lengths. Table 7 shows the number of weeks that will be dedicated to each testing condition. Note that the testing began in April 2010, so the runs through this point in time reflect actual operating conditions and any challenges encountered during the periods. For example, initial testing was extended when it was discovered that the aeration diffuser holes may have been clogged.

TABLE 7 - RCF DEMONSTRATION-SCALE SYSTEM OPERATING CONDITIONS

Weeks	Dates	Reduction Time	Aeration Step	Fe:Cr Ratio	Filter Run Length	Notes
1–3	4/13/10 – 5/3/10	45 min.	No	25:1	24 hrs	
4–13	5/4/10 – 7/12/10	45 min.	Maybe*	25:1	24 hrs	Baseline conditions
14	7/13/10 – 7/19/10	45 min.	Maybe	30:1	48 hours	Higher run length time
15–17	7/20/10 – 8/9/10	45 min.	Maybe	35:1	48 hours	Higher ratio
18–20	8/10/10 – 8/30/10	45 min.	Yes	35:1	48 hours	Discovered no bubbles on 8/9; redrilled holes
21–25	8/31/10 – 9/30/10	45 min.	Yes	25:1	48 hours	Baseline condition
26	10/1/10 – 10/6/10	45 min.	No	25:1	48 hours	Verify effect of no aeration
27–29	2/16/11- 3/9/11	45 min.	Yes	25:1	48 hours	Bring system back online
30–32	3/9/11- 3/30/11	30 min.	Yes	25:1	48 hours	Less reduction time
33–35	3/30/11- 4/20/11	15 min.	Yes	25:1	48 hours	Less reduction time
36	4/20/11- 4/27/11	45 min.	Yes	25:1	48 hours	Bring system back to baseline
37–39	4/27/11- 5/18/11	45 min.	No	25:1	48 hours	Verify effect of no aeration
40–41	5/18/11- 6/1/11	45 min.	Yes	25:1	72 hours	Longer filter run length
42–56	6/1/11 – 9/28/11	45 min.	Yes	25:1	48 hours	MF units running in parallel

* Note that diffuser holes may have been clogged.

As shown in Table 7, the final three months of operation will include testing of MF in parallel with granular media filtration. Figure 9 shows the locations at which the MF units will be integrated in the existing treatment process train. Flow rates for the MF skids are expected to range from approximately 15 to 20 gpm each; remaining flow will be routed through the granular media filters. Up to two MF units will be tested in parallel. MF testing is intended for a 3-month period (plus a month prior for re-plumbing and startup) to allow sufficient time to establish design criteria and to evaluate the effectiveness of several chemical clean-in-place events (typically 30–40 days apart). During MF testing, the following specific objectives will be tested using the evaluation criteria shown in Table 8.

TABLE 8 - MF TESTING OBJECTIVES AND EVALUATION CRITERIA

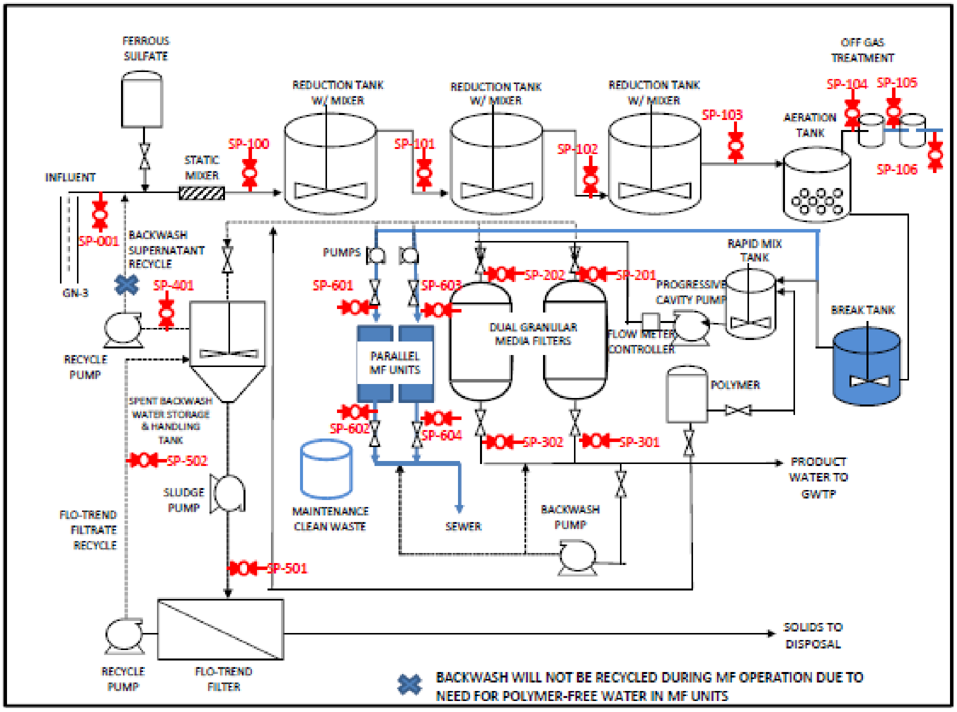
Objectives	Evaluation Criteria
1. Determine if MF consistently achieves sub-ppb total Cr levels	• Cr(VI) and total Cr effluent concentrations collected at a frequency to evaluate removals during the post-CIP period, a moderately fouled condition, and more severely fouled condition • Turbidity levels in effluent water • Feed water temperature • Impact of VOCs on removals and fouling
2. Assess whether iron fouling is problematic in direct filtration mode of operation for the RCF process	• Transmembrane pressure (TMP) values measured continuously during operation and before and after backwashing, maintenance cleans, and clean-in-place cycles (recovery cleans) • Necessary frequency of backwashing and cleans • Test fouling impacts on two different kinds of membranes (of ceramic membranes, polymer encased membranes, and submerged membranes) • Post-mortem autopsy of membrane fibers to identify degree of fouling
3. Identify design criteria for full-scale MF in an RCF treatment process	• Target operating range for flux • Cleaning (maintenance and recovery) frequency • Backwashing frequency • System recovery

In addition to testing the effectiveness of the MF process in achieving lower chromium and turbidity treatment goals than granular media filtration is able to achieve, a primary reason for conducting MF pilot testing is to develop design criteria that will be provided to vendors when the supply of the full-scale system goes out to bid. Given the unusual application of MF to a system feeding ferrous iron, the potential for fouling of membranes will be tested. Cleaning and backwashing frequencies and effectiveness in returning the membranes to their original state will be assessed. Post-mortem autopsies will also be conducted by the vendor on the polymeric membrane fibers to determine the degree of fouling (and a report on findings provided).

Sampling and Analysis Plan - RCF

Figure 14 shows a schematic of the RCF system with sampling ports represented by "SP". Sampling locations for the RCF treatment system include raw water (before ferrous sulfate addition, designated as Sample Port 1, or SP-001).

FIGURE 14 - RCF SAMPLING LOCATIONS



The monitoring locations and sampling frequencies for the water quality parameters are summarized in Table 9. Descriptions of analytical methods for each water quality parameter are provided in Table 10. Sampling and analysis frequency for process-related parameters are shown in Table 11.

Critical water quality parameters in the demonstration-scale RCF study include Cr(VI), chromium, total iron, turbidity, dissolved oxygen (DO), and pH. Cr(VI) and chromium concentrations in process influent and effluent samples are measured to determine whether the treatment goal of less than 1 ppb Cr(VI) and chromium is achieved and to determine chromium removal efficiencies. Total iron, turbidity, and DO from selected sampling ports provide good indicators of the RCF system performance and can be easily measured using onsite instruments. RCF pilot studies demonstrated that chromium concentration in the filter effluent greater than 5 ppb were coupled with high filter effluent turbidity (i.e., greater than 1 NTU) and high total iron concentration (i.e., greater than 0.19 mg/L). A high DO concentration in the influent (above approximately 5 mg/L) ensures that enough dissolved oxygen is available to oxidize excess ferrous sulfate in the treatment process; pH from selected sampling ports is another important parameter that needs to be routinely monitored. Other chemical and physical parameters, including ferrous iron (Fe^{2+}), pH, temperature, and total suspended solids (TSS) will be routinely measured to monitor any drastic water quality changes within the RCF process and investigate the possible causes of water quality changes.

TABLE 9 - SAMPLING AND ANALYSIS FREQUENCY FOR RCF

Sample Point	Laboratory Analysis					Field Analysis					
	Cr(VI)	Total Cr	TSS	VOC	Bac-t[4]	Cr(VI)	Total Fe	Fe^{2+}	Turbidity	pH/Temp[1]	ORP
SP-001	1/W, 3/W[6]	1/W, 3/W[6]	—	—	—	1/W	1/M	1/M	1/M	Continuous	Continuous
SP-100	—	—	—	—	—	—	1/W	1/W	—	—	—
SP-101[2]	—	—	—	—	—	—	1/D, 1/W	1/D, 1/W	—	1/W	—
SP-102	—	—	—	—	—	—	1/M	1/M	—	1/W	—
SP-103[2]	1/W	—	—	1W	—	—	1/D, 1/W	1/D, 1/W	—	1/W	1/W
SP-104	—	—	—	—	—	—	—	—	—	—	—
SP-105	—	—	—		—	—	—	—	—	—	—
SP-106	—	—	—	—	—	—	—	—	—	—	—
SP-201[3]	3/W[6]	3/W[6]	3/W, 1/W	1/W	—	—	1/W[6]	—	1/W[6]	1/W	1/W
SP-202[3]	—	—	3/W, 1/W	—	—	—	—	—	—	1/W	1/W
SP-301[2]	1/D, 1/W	1/D, 1/W	—	—	—	1/W	1/D, 1/W	1/W	Continuous	1/M	1/M
SP-302[2]	1/W	1/D, 1/W	—	—	—	1/W	1/D, 1/W	1/W	Continuous	1/M	1/M
SP-303	1/W	1/W	—	—	1/W	1/W	1/W	1/W	Continuous	1/W	1/W
SP-401	1/W	1/W	—	—	—	1/W	1/W	1/W	1/W	1/M	1/M
SP-501	—	—	1/M	—	—	—	—	—	—	—	—
SP-502	1/W	1/W	—	—	—	1/M	1/M	1/M	1/W	1/M	1/M
SP-601[5]	—	—	—	—	—	—	—	—	Continuous	Continuous – temp.	—
SP-602[5]	3/W	3/W	—	—	—	—	1/W	—	Continuous	—	—
SP-603[5]	3/W	3/W	—	—	—	—	1/W	1/W	Continuous	Continuous – temp.	—
SP-604[5]	3/W	3/W	—	—	—	—	1/W	—	Continuous	—	—
SP-605[5]	—	3/W	—	—	—	—	1/W	—	1/W	—	—
SP-606[5]	—	3/W	—	—	—	—	1/W	—	1/W	—	—

Notes:

1/M = once per month; 1/W = once per week; 1/D = once per day

[1] pH and temperature will be monitored at the same frequency because the pH meter selected for the RCF study has temperature compensation function to ensure more accurate measurement.

[2] Samples collected daily for first week of operation and weekly thereafter.

[3] Samples collected 3 times per week during startup and once per week thereafter

[4] Bac-T = Bacteria, coliforms, and heterotrophic plate count (HPC)

[5] Samples will be collected at these sample points only for the final three months of testing in which MF is tested.

[6] Additional samples collected during MF testing.

Table 10 - Analytical Methods and Locations of Analyses - RCF

Sample Analysis	Analytical Method	Analysis Location	Method Detection Level (MDL)	Notes
Cr(VI) – Lab	USEPA 218.6	ELAP-certified lab	0.015 µg/L	
Total Cr	USEPA 200.8	ELAP-certified lab	0.192 µg/L	
TSS	USEPA 160.2	ELAP-certified lab	4 mg/L	
Cr(VI) – Field	Hach 8023	Field	10 µg/L	
Total Iron	Hach Method 8008	Field	0.02 mg/L	
Ferrous Iron	Hach Method 8146	Field	0.02 mg/L	
pH	SM 4500H+ B	Field	N/A	
pH (Continuous)[1]	SM 4500H+ B	Online	N/A	
Temperature	SM 2550	Field	N/A	
Turbidity[2]	SM 2130 B	Field	0.02 NTU	
Turbidity (Continuous)[3]	SM 2130 B	Online	0.02 NTU	
DO	Hach Method 8166	Field	0.3 mg/L	
DO (Continuous)[4]	Hach Method 10360 [5]	Online	0.1 mg/L	
Bac-t	SM9223B SM9215B	ELAP-certified lab	N/A	Total coliform + *E. coli* by presence/absence Total coliform + *E. coli* by enumeration Heterotrophic plate count

Notes:
1. Based on Hach LGI DPC1R2A pH sensor
2. Based on Hach 2100P Turbidimeter
3. Based on Hach 1720E Low Range Turbidimeter
4. Based on Hach LDO Dissolved Oxygen probe
5. USEPA approved method

Table 11 - Monitoring and Sampling Schedule for Process-Related Parameters

Process-related parameters	Frequency
Influent water flow rate and total volume	Once Daily
Ferrous sulfate injection rate and liquid level	Once Daily
Raw water polymer injection rate and liquid level	Once Daily
Dual media filter inlet pressure	Once Daily
Dual media filter differential pressure	Once Daily
Media trap differential pressure	Once Daily
Drawdown flow rate and total volume	Once every backwash cycle
Backwash water flow rate and total volume	Once every backwash cycle
Backwash polymer injection rate and liquid level	Once every backwash cycle
Backwash supernatant recycle flow rate and total volume	Once every backwash cycle
Settled backwash solids total volume	Once every backwash cycle
Flo-Trend filtrate recycle total volume	Once every backwash cycle
Dewatered sludge total quantity	Once every off-site disposal
Off gas treatment inlet pressure	Once Daily
Off gas treatment influent pressure, temperature, and flow rate	Once Daily

During testing of MF, Cr(VI) and chromium will be monitored at a higher frequency of three times every week (compared with one time per week in other testing). Assuming that the membranes will become fouled and a clean-in-place is needed approximately every 30 days, the Cr(VI) and chromium monitoring frequencies will provide at least three data points for each of the following periods prior to the clean-in-place:

- Unfouled membranes
- Moderately fouled membranes
- Fouled membranes

In addition to process-related parameters shown in Table 11, MF operating parameters that will be tested during the MF test period include flux, transmembrane pressure (TMP), backwash parameters (i.e., frequency, aeration duration, backwash flow rate), enhanced maintenance cleaning parameters (i.e., frequency, chemicals and doses, duration), clean-in-place parameters (i.e., frequency, chemicals and doses, duration). The potential for extending periods of time between cleanings will be assessed (e.g., if vendors recommend testing two different types of chemicals). Membrane flux is a key design parameter for MF. Along with recovery and downtime for intermittent operating procedures, flux will determine the number of membrane racks, modules and footprint required for the full-scale system. Up to three flux rates will be tested during the pilot study to identify the proper flux at which desired chromium removal can be achieved. TMP is a measure for membrane performance, and will be used to assess fouling and backwash efficiency. TMP data will be used for membrane system pump sizing for the full-scale system. At each flux rate tested, backwash, enhanced maintenance cleaning and CIP parameters will be selected and tested to investigate the effectiveness of these cleaning procedures. Backwash and chemical cleaning intervals will affect system downtime and the membrane area for the full-scale system–thus, capital cost. In addition, backwash and chemical cleaning intervals and procedures also affect power, chemicals, and labor costs–thus, O&M costs. Membrane system recovery will be monitored for all test runs, which will also be considered in O&M costs.

Particle counters for membrane feed and filtrate will be equipped in the pilot units or installed, which will provide numbers of particles per milliliter in different particle size ranges. Particle size distribution in membrane feed and filtrate combined with chromium removal results will help to understand the relationship between particle size and ppb (or sub-ppb) level Cr(VI) removal, with the goal of improving chromium removal with the MF process.

Quality Assurance/Quality Control

A detailed Quality Assurance Project Plan (QAPP) was prepared for each demonstration-scale facility in accordance with USEPA requirements. All laboratory analysis will be performed using analytical methods that conform to EPA guidelines and recommended test methods, including those in *Standard Methods for the Examination of Water and Wastewater* (APHA, 1999). Standard Operating Procedures (SOPs) will be used for all measurements. Quality assurance/quality control (QA/QC) sampling will include field-collected duplicate samples, field blanks, laboratory control samples, instrument performance checks, matrix spikes, initial calibration verification standards, continuing calibration verification standards. Briefly, field-collected duplicate samples of at least 10 percent of samples will serve to ensure acquisition of representative samples, consistency of sampling, and precision of the analytical methods. Laboratory QA/QC sampling will ensure accuracy and precision of analytical results. Additional details are available in project QAPP documentation.

Cost Implications of Cr(VI) Treatment for Utilities

The objective of this study component is to develop capital and operations and maintenance (O&M) cost implications of potential MCLs for utilities. Cost extrapolation will entail the development of cost curves so that a utility can quickly ascertain financial impacts of potential MCLs.

Capital costs will be developed for five system flow rates—10, 100, 500, 2,000, and 5,000 gpm—that encompass a majority of systems that would require Cr(VI) treatment. Capital costs will incorporate the assumption that source water Cr(VI) concentration and Cr(VI) treatment target level do not significantly impact capital costs.

O&M costs require consideration of a number of independent variables, including system flow rate, Cr(VI) treatment target level, and source water Cr(VI) concentration. As with capital costs, O&M costs will be developed for five flow rates. Six Cr(VI) treatment target levels will be considered, including 1 ppb, 2 ppb, 5 ppb, 10 ppb, 25 ppb, and 50 ppb. Five source water Cr(VI) concentrations will be used in the calculations, including 5 ppb, 10 ppb, 25 ppb, 50 ppb, and 100 ppb. Levels were selected based on the CDPH database (to allow projections of state-wide costs) and our understanding of the range of most likely MCLs.

The cost basis and design assumptions for establishing treatment capital and O&M costs will be documented in the same manner (i.e., technical justifications, discussion of uncertainties, and utility for the regulatory development process) as done for arsenic treatment in the following document: *USEPA Technologies and Costs for Removal of Arsenic from Drinking Water*, EPA Document 815-R-00-028, Chapters 3 and 4.

Capital Costs for WBA and RCF

Actual capital costs for the 425-gpm WBA and 100-gpm RCF demonstration-scale study of treatment systems located at Glendale will first be assembled. The WBA actual capital cost will reflect a retrofitted system using two existing contactors and minimal site construction. To extrapolate the cost estimates for all utilities, capital costs for a new facility will be determined from actual costs determined at Glendale (e.g., CO_2 system and other new equipment) plus quotations from vendors (new vessels, backwash tanks, chlorine disinfection system). The RCF capital cost will reflect an entirely newly constructed system.

Based on the Glendale cost analyses, capital costs for WBA and RCF will be extrapolated to represent costs for five flow rates: 10, 100, 500, 2000, and 5000 gpm.

The WBA capital costs will include one or more trains of lead/lag contactors (i.e., two vessels per train), with the number of contactors dependent on the capacity of modular contactor systems. Separate cost curves will be developed for the following treatment processes associated with WBA:

- pH reduction with carbon dioxide,
- pH reduction with hydrochloric acid,
- ion exchange vessels and resin,
- post-treatment pH adjustment, and
- post-treatment disinfection with chlorine.

The WBA PWA7 resin requires pH reduction to approximately 6.0 for effective Cr(VI) removal; quantities of CO_2 or acid that are required by Glendale will be considered representative of other utilities in the state, since Glendale's groundwater has fairly high buffering capacity and will provide a relatively conservative estimate. The demonstration-scale WBA system does not have post-treatment pH adjustment since the effluent is blended with other water sources and then sent through an air stripping tower to remove VOCs. However, post-treatment of WBA effluent would be required under normal operations for many other utilities, so capital costs that are developed in this task will include a post-treatment pH adjustment system for corrosion control and a chlorine disinfection system. All WBA systems will be assumed to apply the same operational parameters (e.g., EBCT, pH) as for the Glendale demonstration-scale WBA system.

RCF capital costs will consist of a ferrous sulfate addition system, reduction tanks, aeration tank and air compressor system, a polymer addition system, granular media filters or MF (for removal to less than 1 ppb, assuming at this point that the MF process will be effective at achieving this goal), a passive sludge settling and dewatering system akin to that used in the Glendale demonstration RCF process, and a chlorine disinfection system. Separate cost curves will be developed for the following treatment processes associated with RCF:

- RCF with granular media filters,
- RCF with MF, and
- post-treatment disinfection with chlorine.

All RCF systems will be assumed to apply the same or linearly-scaled operational parameters (e.g., iron:chromium ratio, polymer dose, backwash frequency) as determined to be most efficient for Cr(VI) removal during the demonstration-scale study.

WBA Operations & Maintenance Costs

Actual O&M costs for the 425-gpm WBA treatment system at Glendale will first be assembled. O&M costs for WBA will include chemicals (acid or carbon dioxide for pH reduction), resin, labor, energy, residuals disposal and lab analysis, based on the one-year operational experience. No WBA post-treatment pH adjustment is involved for Glendale due to water blending and downstream air stripping, but costs for other utilities will be developed for post-treatment caustic addition and chlorine disinfection (designed based the goal of achieving positive Calcium Carbonate Precipitation Potential (CCPP) and Langelier Saturation Index (LSI) values, as well as chlorine disinfection to achieve a 0.5 to 1.0 mg/L free chlorine residual).

Based on the Glendale results, we will develop O&M costs for Cr(VI) treatment at the five system sizes using WBA technology for six potential Cr(VI) MCLs: 50 ppb, 25 ppb, 10 ppb, 5 ppb, 2 ppb, and 1 ppb.

Laboratory analytical costs expected for compliance requirements will be identified and included in the O&M costs. Any other recommended additional sampling to achieve better process control and how these samples can be used for treatment process optimization will be discussed. Residuals disposal costs will be based on classification of spent WBA resin as a California-regulated hazardous waste (i.e., a non-RCRA hazardous waste) and a Technically Enhanced Naturally Occurring Radioactive Material (TENORM).

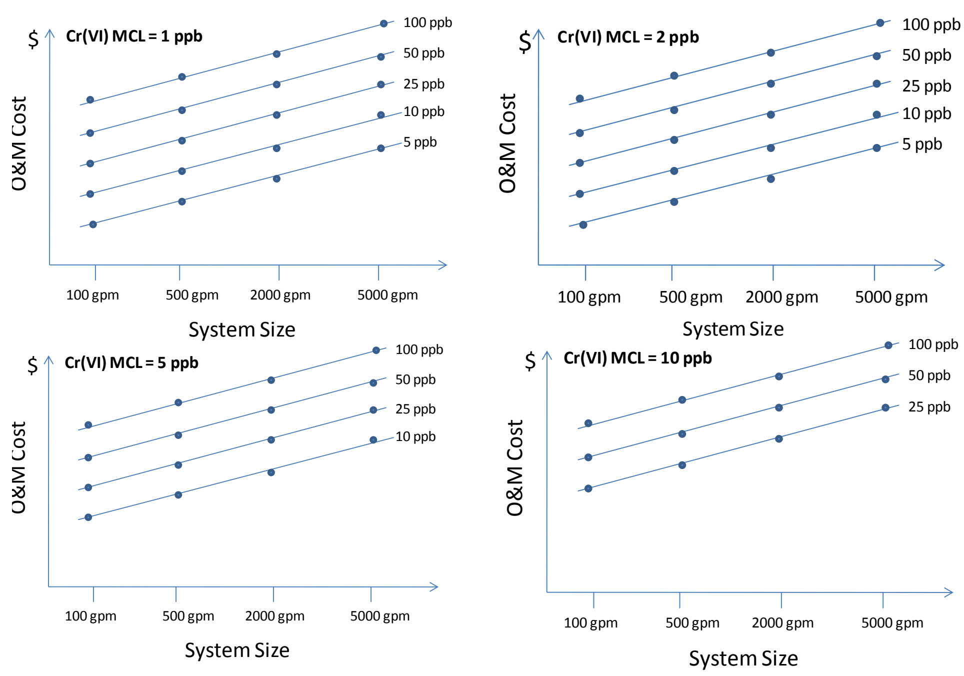
Initial use of the resin required a "brine squeeze" procedure to remove residual formaldehyde, which was performed by Siemens. Costs of this procedure will be identified. Siemens has indicated that the next batch of resin to be installed will not require the "brine squeeze". We will discuss findings of the next installation and necessity of this step. Potential impacts of formaldehyde control on O&M costs and operations will be discussed if the next batch of resin requires the brine squeeze procedure.

WBA O&M costs are expected to be significantly affected by resin operational life, due to a relatively high cost of the resin media and spent resin disposal charges. Resin operational life, in turn, depends on the source water Cr(VI) concentration and the treatment target level, assuming that spent resin waste characteristics and disposal cost do not affect resin changeout. Thus, five source water Cr(VI) concentrations will be evaluated for O&M cost extrapolation, including: 100 ppb, 50 ppb, 25 ppb, 10 ppb, and 5 ppb.

Expected resin operational life will be quantified by the number of bed volumes (BVs) of water treated before which a target Cr(VI) level is reached for a certain influent Cr(VI) concentration. Chromium breakthrough curves for the five source water Cr(VI) concentrations will be developed based on available data from pilot and demonstration studies assuming that the resin capacity is independent of the influent concentration and other water quality parameters. Bed volumes associated with treating to each Cr(VI) MCL level will be estimated using the breakthrough curve for each influent Cr(VI) concentration. Subsequently, resin replacement frequency will be calculated based on the estimated bed volumes.

WBA O&M cost curves (Figure 15) will be developed based on the source water Cr(VI) concentrations, potential Cr(VI) MCL levels, and flow rate. One graph will be developed for each potential Cr(VI) MCL level.

FIGURE 15 - EXAMPLE WBA O&M COST CURVES TO BE DEVELOPED

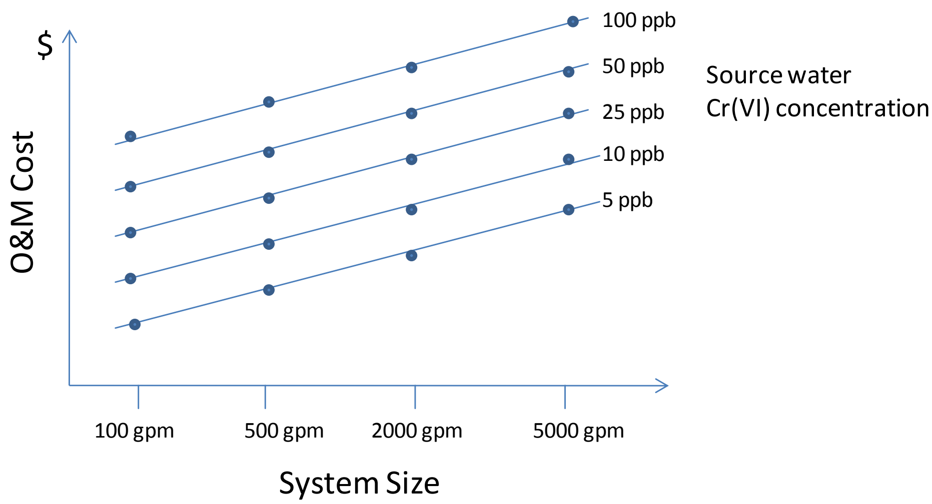


RCF Operations & Maintenance Costs

Actual O&M costs for the 100-gpm RCF treatment system at Glendale will be compiled. O&M costs for RCF will be based on our one-year operational experience and will include chemicals (ferrous sulfate, polymer, chlorine to yield between 0.5 and 1.0 mg/L residual), labor, energy, residuals disposal and analytical costs. Laboratory analytical costs expected for compliance requirements will be identified and included in the O&M costs. Any other recommended additional sampling to achieve better process control and how these samples can be used for treatment process optimization will be discussed.

Unlike the WBA process, the RCF process is not amenable to selection of a target effluent concentration. Demonstration testing indicates that chromium concentrations between 1 ppb to 5 ppb can be achieved with granular media filtration; lower concentrations may be achieved with MF. Consequently, costs for the RCF process will be estimated on the basis of source water Cr(VI) concentrations and flow rates. Source water Cr(VI) concentrations will affect ferrous sulfate dose (i.e., chemical costs). If ferrous sulfate accounts for a significant portion of the RCF O&M cost, separate O&M cost curves will be developed for different source water Cr(VI) concentrations, as illustrated in Figure 16. Otherwise, only one cost curve will be developed to cover different source water Cr(VI) concentrations.

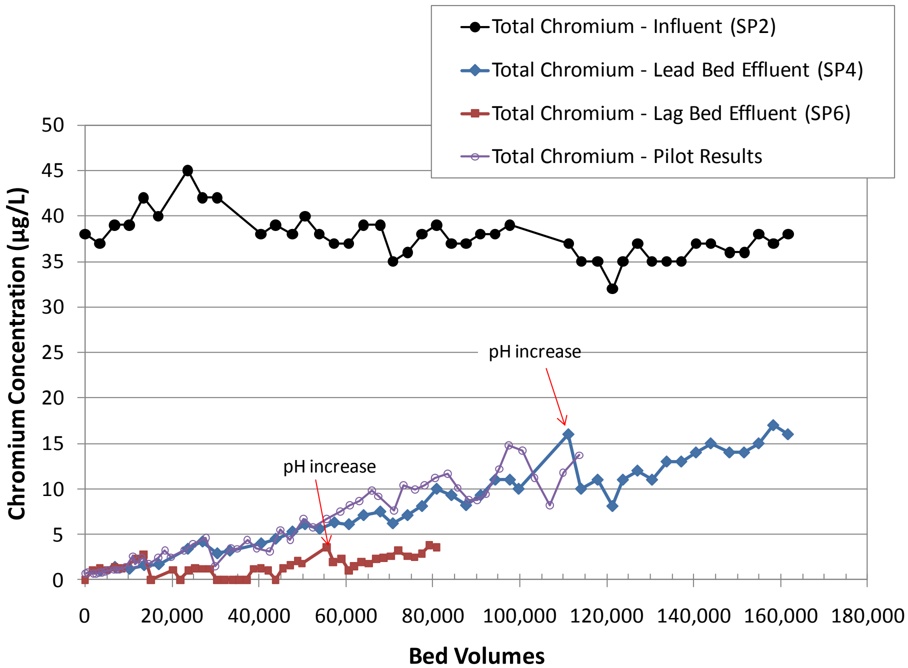
FIGURE 16 - EXAMPLE RCF O&M COST CURVES TO BE DEVELOPED



Technical Success

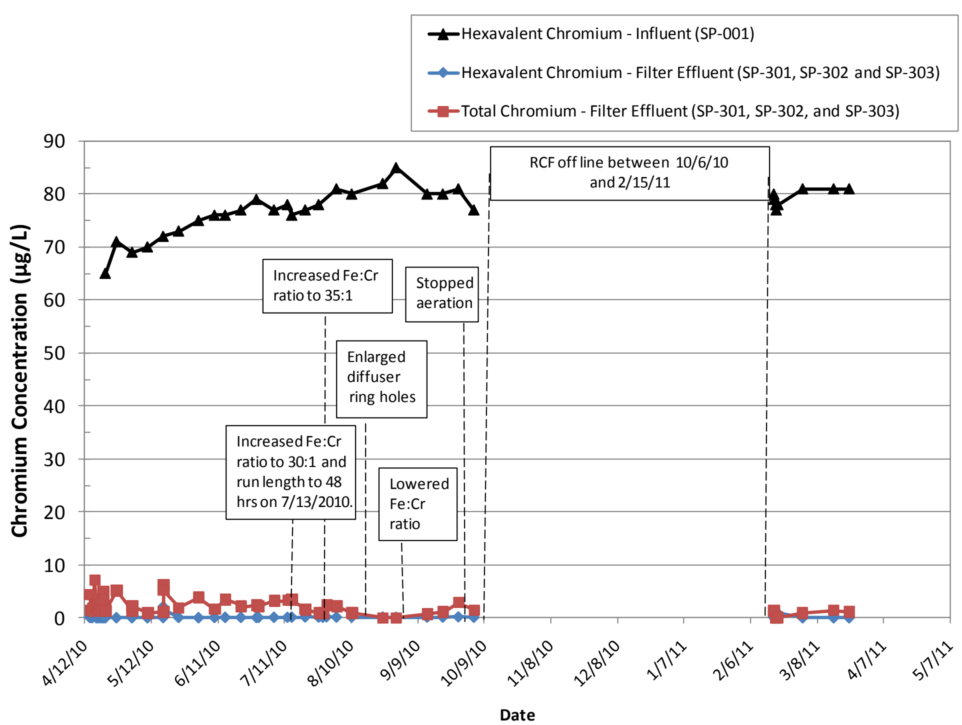
Demonstration-scale testing to date has shown that both technologies can reliably remove Cr(VI) to levels below 5 ppb. Figure 17 shows the breakthrough curves for the WBA AWT technology. More than one year of operation was complete before the first lead bed required replacement, which corresponded to more than 160,000 bed volumes of water treated. Additional testing will consist of determining the steady-state breakthrough curves and resin throughput after the first bed was exchanged.

FIGURE 17 - WBA TOTAL CHROMIUM BREAKTHROUGH CURVES (AS OF 3/3/11)



The RCF process has shown consistent removals to below 5 ppb (Figure 18), but not to chromium levels consistently below 1 ppb. Additional chromium removals to levels below 1 ppb (and approaching the draft PHG) will be assessed using MF as the filtration mechanism for the RCF process.

FIGURE 18 - RCF TOTAL CHROMIUM REMOVALS (AS OF 3/3/11)



Evaluation Criteria

Evaluation Criteria A: Addressing Projected Water Supply Imbalances

Subcriterion No. A1—Potential Quantity of Water Produced

Approximately 20 percent of local water supplies are in jeopardy because of Cr(VI). As more testing is performed, more Cr(VI) is expected to be discovered in water supplies. Depending on the State of California and EPA's MCL and the lack of proven treatment solutions, many agencies may have to discontinue the use of the local supplies or rely on more imported water supply because of Cr(VI). This study would provide solutions for local agencies to construct local Cr(VI) removal facilities as an option to minimize the need for additional Colorado River and State Water Project supplies.

In the Metropolitan service area, about 1 million AFY of ground water is used. If 20 percent of the supply is impacted, this means that potentially 200,000 AFY of local water would be unusable unless treatment technologies are available. This is the Metropolitan service area alone and does not include other impacted water supply in central and northern California and the rest of the U.S.

Subcriterion No. A2—Percentage of Water Supply Imbalance

Metropolitan's service area presents an imbalance created by regulatory changes, climate change, and population growth. According to recent analysis, Metropolitan could experience shortages of firm and replenishment demands up to 550,000 acre feet (AF) by 2035, even with continual aggressive development of water conservation actions. If 200,000 AF of annual groundwater production is unavailable due to Cr(VI), regional water supply is affected significantly. In a service area of 5,200 square miles and serving almost 19 million people, this quantity of water alone represents over 5 percent of total regional potable water supplies and close to 10 percent of all local supplies in the region. Furthermore, this water is about 15 percent of the average annual groundwater use, which averages close to 1.4 million acre-feet per year. As Metropolitan's service area realizes the potential 200,000 AF of unavailable water with potential overall shortage demands of 550,000, the potential impact of returning Cr(VI) contaminated water back into the system measures a 36 percent water supply imbalance.

$$\frac{200{,}000}{550{,}000}\times 100\% = 36\%$$

While available resources continue to be reduced, population and resultant supply demands continue to increase. In terms of replacement cost of comparable potable supplies and purchased on the transfer market based on costs paid by Metropolitan in recent history, supply can be expected to cost \$70 to \$340 per acre-foot, for a total of \$14 to \$68 million dollars per year.

Subcriterion No. A3—Likelihood that the Proposal will Lead to a "New" Sustainable Source of Water

This research effort will "retain" and "return" in some cases a local water resource. Since federal and state water agencies are in the process of setting an MCL for Cr(VI) in drinking water supplies, a significant part of local ground water resources is in jeopardy. Depending on the MCL established, water utilities across the U.S. would be adversely impacted.

The potential negative impacts to local water supplies has great magnitude, This research effort will demonstrate the technical feasibility of removing Cr(VI) from water and quantify operating and capital costs. Since no full-scale drinking water treatment systems currently exist in the U.S. specifically for Cr(VI) removal, consequently the Study will provide critical information concerning treatment options and associated costs to achieve Cr(VI) removal.

In Glendale, the Study's results so far indicate that the treatment technologies being tested will be successful and utilities would be able to retain local supply water previously containing Cr(VI).

Evaluation Criteria B: Energy-Water Nexus

Subcriterion No. B1—Implementing Renewable Energy Improvements

Part of the demonstration-scale studies will evaluate opportunities for incorporation of renewable energy into project facilities for implementation at full-scale. Specific opportunities are unknown at this time; however, background calculations into potential energy savings resulting from this project are discussed in the following section.

The AWT full-scale project will incorporate renewable energy and energy efficiency in the final design concepts. The city of Glendale generates and has contracts for renewable resources in excess of 20 percent of its electrical needs. These include electrical generation from wind, solar, geothermal, hydro, and landfill gas. The design will include evaluation of use of variable speed pumps, high efficiency LED lighting, solar electrical generation, and review of opportunities to incorporate operation of the water treatment facilities into the operation of water storage facilities to minimize on-peak electrical energy use to reduce costs and minimize operation of less efficient generation facilities. Glendale has also installed SMART Meters on its electrical distribution to better monitor electrical energy use patterns and review opportunities to reduce energy use and minimize on-peak consumption. Additionally, in the final report for this research effort, information will be provided on opportunities to improve energy efficiency and use of renewable energy resources for use by all agencies.

Subcriterion No. B2—Increasing Energy Efficiency in Water Management

In the absence of completing this research project, there could be a major reduction in the use of local supplies and great use of energy intensive imported water supplies.

In terms of energy savings, use of demonstration-scale ground water is compared to importing State Water Project supplies (Table 12). The total energy required to supply, treat, and distribute water utilizing the State Water Project system through Metropolitan for the demonstration-scale treatment facility alone would be 7.6 million kWh per 2100 AF produced. Energy requirements to supply treat and distribute water total 2.1 million kWh per 2100 AF. Total savings of demonstration-scale production over State Water Project supply totals 5.5 million kWh per 2100 AF.

Table 12 - Glendale Water and Power Energy Savings utilizing local supply

Glendale Water and Power Annual Totals	Value	Units
Production	2,100	acre-feet
Local energy required to supply, treat, & distribute water	1,000	kWh/AF
Total local energy required to supply, treat, & distribute water	2,100,000	kWh
State Project energy required to supply, treat, & distribute water	11,111	kWh/MG
Total State Project energy required to supply, treat, & distribute water	7,600,358	kWh
Energy savings from utilizing demonstration scale production instead of State Project Water	**5,500,358**	**kWh**
CO_2 emissions conversion factor	1.37	lbs/CO_2
CO_2 emissions reduction	61,114,481,140	lbs/CO_2
	30,557,241	tons/CO_2

From a regional standpoint, if 20 percent of the region's groundwater is affected by Cr(VI), and approximately 200,000 AF of water is impacted in the Metropolitan service area, than the energy savings of course would be much greater. For every 200,000 acre-feet of water produced, local energy required to supply, treat, and distribute water would be 1,000 kWh. If regional supplies were affected and offset with State Project water, energy use would increase to 723 million kWh per 200,000 AF. Energy savings by using regional water over State Project Water would total 523 million kWh per 200,000 AF (Table 13). The implementation of the chromium treatment facilities would certainly be more efficient in terms of energy consumption compared to imported water supplies.

Table 13 - Regional Energy Costs and savings using local Supply

Regional Annual Totals	Value	Units
Production	200,000	acre-feet
Local energy required to supply, treat, & distribute water	1,000	kWh/AF
Total local energy required to supply, treat, & distribute water	200,000,000	kWh
State Project energy required to supply, treat, & distribute water	11,111	kWh/MG
Total State Project energy required to supply, treat, & distribute water	723,843,648	kWh
Energy savings from utilizing regional production instead of State Project Water	**523,843,648**	**kWh**
CO_2 emissions conversion factor	1.37	lbs/CO_2
CO_2 emissions reduction	5,820,426,775,244	lbs/CO_2
	2,910,213,388	tons/CO_2

Evaluation Criteria C: Relationship of Project to Current AWT Applications and Reclamation's Research Goals

The proposed study will advance two different potential AWT technologies for Cr(VI) removal, WBA and RCF, from pilot to demonstration (wellhead treatment sized) scale. Both technologies are new applications in removing Cr(VI) during drinking water treatment. Until this study and preceding pilot testing, potential technologies for achieving low ppb levels of Cr(VI) in drinking water had not been proven. Pilot testing at a 2-gpm flow rate indicated that WBA and RCF could achieve treatment goals, but the ability to scale-up AWT technology for performance at more typical municipal flow rates will be studied in this effort.

The use of a WBA resin (PWA7) that was previously used in the food processing industry represents a significant breakthrough in AWT technologies because it offers minimal residuals generation in the form of spent resin. By comparison, regenerable strong-base ion exchange results in up to several percent of the flow as brine liquid waste that must be treated for Cr(VI) removal then disposed.

The RCF process is a specially-tailored variation on a more conventional water treatment approach of flocculating solids and removing them through filtration. A reduction process upstream of coagulation/filtration performs Cr(VI) reduction to Cr(III) through ferrous iron oxidation to ferric iron, resulting in iron and chromium co-existing in particles that are then removed with filtration. Aeration is added to the process to ensure full oxidation of all ferrous iron (the necessity of this aeration step will be tested in this study). The reduction and aeration steps offer an innovative approach to conventional treatment for the specific purpose of achieving Cr(VI) removal. The demonstration-scale testing will also include a comparison of MF and granular media filtration removal of chromium from the water to evaluate whether lower concentrations can be attained.

Both WBA and RCF technologies have significant potential for implementation across the U.S. and the world. For example, the USEPA is looking to these technologies and this project to perform cost-benefit analyses of Cr(VI) treatment in advance of regulatory determinations. Demonstration-scale testing will be informative about the AWT technologies' capabilities, limitations, and considerations that utilities should weigh during technology selection.

In line with Reclamation's Goal 1, approaches to minimizing residuals and hence environmental impacts when disposing of residuals will be studied, and opportunities to reduce waste volumes identified. Both WBA and RCF AWT technologies offer significant advantage over technologies that produce voluminous brine wastes (such as SBA, reverse osmosis, electrodialysis).

Reclamation's Goal 2 is also an integral part of this study, wherein costs associated with treatment (inclusive of all aspects) will be developed based on the demonstration-scale costs extrapolated to various potential Cr(VI) regulatory limits. A Project Technical Approach that was developed provides additional details on the cost study. Opportunities to minimize full-scale costs through the research will be identified, such as running resins to various capacities to avoid triggering more onerous and costly disposal options. The successful demonstration-scale testing of the two AWT processes fits squarely within Reclamation's identified research goals and also provides valuable information to the industry on potential Cr(VI) removal technologies.

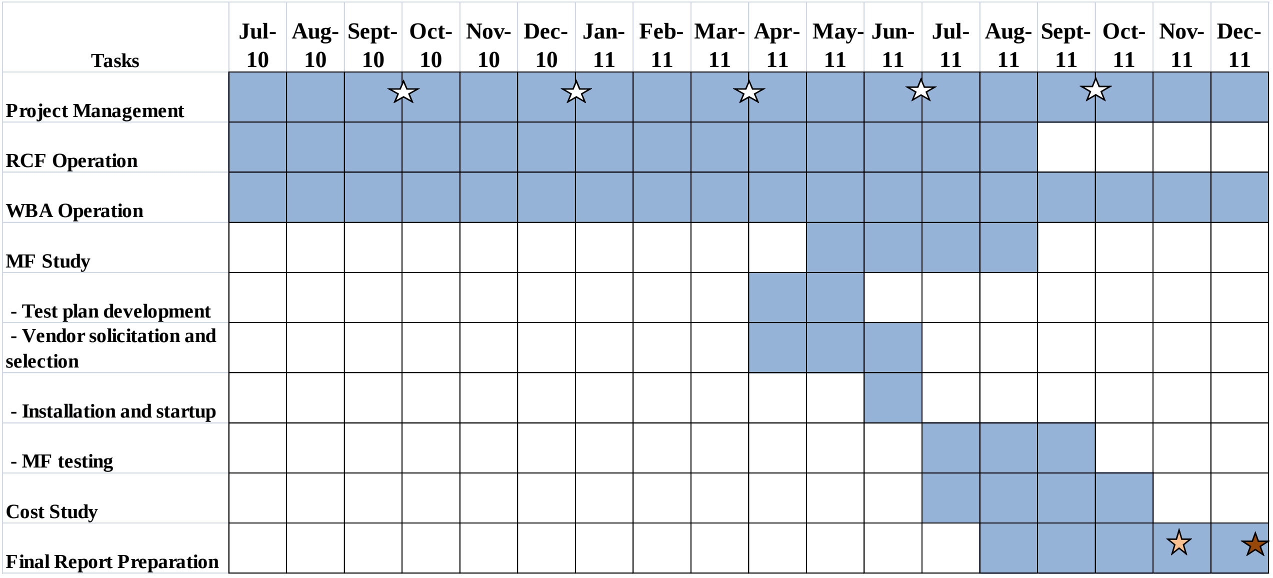
Evaluation Criteria D: Project Organization

Subcriterion No. D1—Readiness to Proceed

The city of Glendale is currently operating the demonstration-scale project. All environmental compliance requirements, including NEPA and CEQA, have been satisfied. Construction of the WBA and RCF facilities was completed in 2010, with the installation of the MF units planned for installation in June 2011. No additional permits will be necessary for the additional MF testing that will be added to the existing operations, and for completing the operational research optimization efforts.

Table 14 is the 2010–11 project schedule. The WBA and RCF facilities were started up in April 2010 and continue to operate as shown during the depicted time period. The WBA is intended to be run through the end of 2011 to provide information on resin capacity and disposal needs for multiple batches of resin. RCF is planned to operate through the end of August 2011.

[1]TABLE 14 - PROJECT SCHEDULE



MF testing in the final three months of RCF operation will involve a number of tasks. The first MF study task will involve test plan development, which will be conducted in parallel with vendor solicitation using an RFP process. Vendors will be allowed approximately two weeks to respond to an RFP, and it is anticipated that two units will be selected the following week. Most vendors indicated they would need approximately six weeks from award of the contract to delivery at the site. Once the skids are delivered, installation will require approximately two weeks. The MF units will then be started up with troubleshooting over approximately a two week period. MF testing will be conducted for 3 months. Data analysis and report preparation will overlap with the testing period. The cost study will be conducted from July through October 2011, overlapping with the MF testing and report preparation.

Quarterly progress reports will be produced as shown in the schedule. The draft report will be submitted in November 2011, and the final report is planned to be submitted by the end of December 2011.

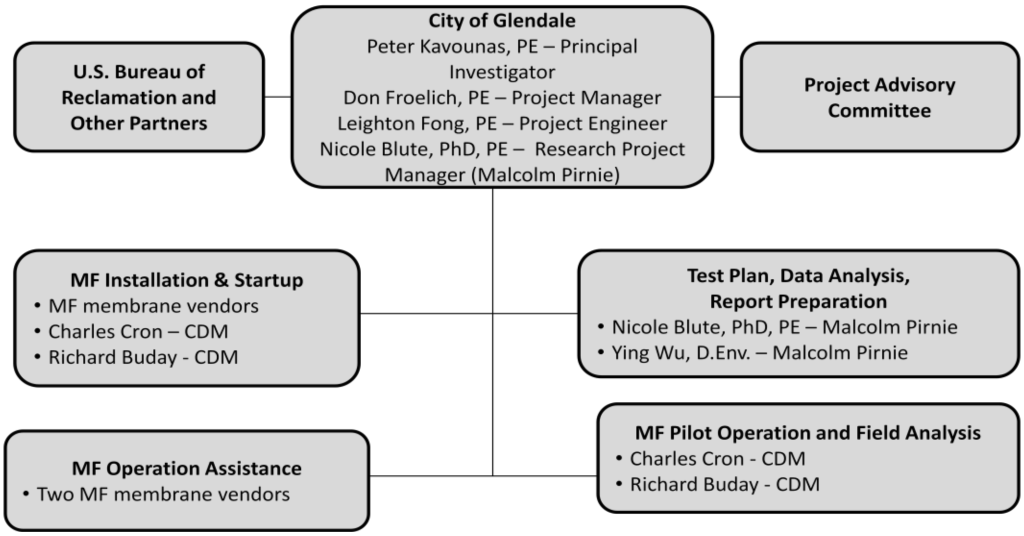
Subcriterion No. D2—Qualifications of the Management Team

The city of Glendale has worked closely with CDM and Malcolm Pirnie staff since the initial stages of this research effort. Malcom Pirnie, Inc., has been the principal researchers since 2000. CDM has been operating the GWTP facility since year 2000 and operated the Cr(VI) demonstration facilities since 2010. Continuity over the phased approach and institutional knowledge of the key persons involved add tremendous value to this study and minimize cost. To date, the city of Glendale has managed the demonstration-scale effort and the subcontractors: CDM for operations and Malcolm Pirnie for study-related support. The individuals involved bring to the project a breadth of expertise on past projects, a history of involvement in the studies since the beginning, and a hands-on solid performance in the operations of the facilities.

[1] Stars denote progress reports in schedule.

The management team for this demonstration-scale study (Figure 19) will consist of representatives from Glendale Water and Power, Malcolm Pirnie, Inc., and CDM with oversight from Mr. Peter Kavounas (Assistant General Manager – Water Services, who has overall responsibility for the research). The Project Manager for Glendale will be Mr. Donald R. Froelich, with assistance from Mr. Leighton Fong the Project Engineer. Drs. Nicole Blute and Ying Wu of Malcolm Pirnie, Inc., will assist Mr. Kavounas in planning, execution, and reporting for the study. CDM, including Mr. Charles Cron and Mr. Rich Buday, comprise the Operations group for testing. Relevant credentials, experience, and past performance for each are discussed below.

FIGURE 19 - PROJECT ORGANIZATIONAL CHART FOR STUDY



Peter Kavounas, PE, city of Glendale. Mr. Kavounas is the Assistant General Manager - Water Services for Glendale Water and Power since 2004 and has 20 years of experience in the water industry. Mr. Kavounas is responsible for managing the operation, maintenance, and engineering activities of the water system serving the City's 200,000 residents. Most recently, his activities have focused on the EPA's groundwater cleanup activities in the Glendale area, construction of treatment facilities, and managing a number of studies in cooperation with other water agencies concerned about Cr(VI) issues in water supplies. Mr. Kavounas will assure the City's commitment to providing the support and resources necessary to locate pilot and demonstration facilities within the City's water system. Mr. Kavounas replaced Mr. Froelich as the Water Services Administrator for the city of Glendale.

Donald R. Froelich, PE, city of Glendale. Mr. Froelich will act as the Project Manager for this research effort and has 30 years of water industry experience. Prior to his April 2004 retirement, Mr. Froelich was the Water Services Administrator for the city of Glendale with a long history of involvement in the EPA Superfund activities in Glendale, and the implementation of the four-phase Cr(VI) removal research program. Due to his long involvement in the Cr(VI) efforts, Mr. Froelich has been retained by Glendale to manage this research effort.

Leighton Fong, PE, city of Glendale. Mr. Fong will be the Glendale Project Engineer working with Mr. Froelich in managing the research effort. Mr. Fong has a long history in water quality and

Superfund activities in the city of Glendale and city of Burbank, and participation in the pilot-testing program. He will manage the schedule and financial activities for this research project.

Nicole K. Blute, PhD, PE, Malcolm Pirnie, Inc. Dr. Blute is a Principal Engineer at Malcolm Pirnie, Inc. Dr. Blute has been working with Glendale on their Cr(VI) research effort since 2002 and brings an in-depth knowledge of all of the technical aspects of the technologies and research findings. Dr. Blute has prepared and presented study findings for Glendale at more than a dozen forums ranging from public meetings and workshops to technical drinking water meetings. Dr. Blute will develop the test plan and ensure that the objectives of the testing and necessary project reporting are met.

Ying Wu, DEnv, Malcolm Pirnie, Inc. Dr. Wu is a Staff Environmental Specialist at Malcolm Pirnie, Inc. Dr. Wu has been actively involved in many projects focusing on drinking water treatment technology testing and implementation, including Glendale Cr(VI) research, and an on-going Cr(VI) feasibility study for city of Burbank, California. Dr. Wu conducted numerous bench-scale tests, led monitoring and operations of many pilot- and demonstration-scale studies, including tests of submerged MF, pressure MF and reverse osmosis at Coachella Valley. She will assist Dr. Blute with test plan development, data analysis, and report preparation.

Charles Cron, CDM. Mr. Cron is a Senior Operations and Maintenance Specialist for CDM and the Plant Manager for the GWTP. He supported the Phase II pilot studies of Cr(VI) treatment and is currently overseeing the Phase III demonstration studies. Mr. Cron will continue in this role during the MF testing.

Rich Buday, CDM. Mr. Buday is a Senior Operations and Maintenance Specialist and an Operator for the Glendale Water Treatment Plant. Mr. Buday has extensive experience in operating a full-scale micro and nanofiltration system for a southern California water district. He is charged with the day-to-day operations of the WBA and RCF facilities.

In a technical advisory capacity, the project includes experienced and top level expertise. The Project Advisory Committee (PAC) includes:

- Sun Liang, Ph.D., P.E., Metropolitan Water District of Southern California
- Bruce Macler, Ph.D., U.S. Environmental Protection Agency
- Heather Collins, P.E., California Department of Public Health
- Pankaj Parekh, Ph.D., Los Angeles Department of Water and Power
- Rick Sakaji, Ph.D., East Bay Municipal Utility District

In addition to the project team members, a number of universities and research institutions have been involved in this work, including:

- University of California at Los Angeles – Project advisory role
- University of Colorado at Boulder – Project advisory role; bench testing support
- Utah State University – Project advisory role and analytical support
- Wellesley College – Residuals testing
- Massachusetts Institute of Technology – Residuals testing
- Lehigh University – WBA desorption and capacity bench tests
- Argonne National Laboratory – Residuals testing

A list of presentations and reports published on research is provided below, demonstrating the team's dedication to disseminating the information learned in this research program.

- Blute, N.K., **"Treatment Options for Hexavalent Chromium, Perchlorate, and Nitrate,"** invited speaker at Babcock Laboratories Technical Environmental Analytical Meeting (TEAM), Riverside CA, March 23, 2011.
- Blute, N.K. and Kavounas, P. **"Chromium (VI) Overview,"** invited speaker at the California Nevada AWWA Simultaneous Compliance Workshop, Los Angeles, CA, January 20, 2011.
- Blute, N.K., **"Optimization Studies to Assist in Cr(VI) Treatment Design,"** ***Proceedings***, Annual Conference and Exposition of the American Water Works Association (AWWA), Chicago, IL, June 2010.
- Blute, N.K., Porter, K.M., Kuhnel, B.T., **"Cost Estimates for Two Hexavalent Chromium Treatment Processes,"** ***Proceedings***, Annual Conference and Exposition of the American Water Works Association (AWWA), Chicago, IL, June 2010.
- Blute, N.K., **"Optimization Studies to Assist in Cr(VI) Treatment Design,"** presented at the Annual Spring Conference of the American Water Works Association (AWWA), California-Nevada Section, Hollywood CA, March 29–April 1, 2010.
- Porter, K.M., Blute, N.K., Kuhnel, B.T., **"Cost Estimates for Two Hexavalent Chromium Treatment Processes,"** presented at the Annual Spring Conference of the American Water Works Association (AWWA), California-Nevada Section, Hollywood CA, March 29–April 1, 2010.
- Blute, N.K., **"Optimization of a Reduction/Coagulation/Filtration Process for Hexavalent Chromium Removal from Drinking Water,"** ***Proceedings***, Annual Conference and Exposition of the American Water Works Association (AWWA), San Diego CA, June 14–18, 2009.
- Blute, N.K., **"Hexavalent Chromium Treatment Technologies for Drinking Water,"** presented at the Winter Educational Extravaganza, American Water Works Association (AWWA), California-Nevada Section, Santa Clarita CA, December 5, 2008.
- Blute, N.K., McGuire, M.J., Kavounas, P., Brabander, D.J., Newville, M., Sarkar, S., SenGupta, A., **"Chromium Treatment for Glendale, California's Groundwater Supply: Mechanistic Studies of Weak-Base Anion Exchange,"** ***Proceedings***, Inorganic Contaminants Workshop, American Water Works Association, Albuquerque NM, January 27–29, 2008.
- Blute, N.K. 2008. "**Considerations in Drinking Water Treatment of Groundwater to Remove Emerging Contaminants."** *Water Quality and Wetlands Committee Newsletter,* American Bar Association.
- McGuire, M.J., Blute, N.K., Qin, G., Kavounas, P., Froelich, D., and Fong, L. **"Hexavalent Chromium Removal Using Anion Exchange and Reduction with Coagulation and Filtration,"** *American Water Works Association Research Foundation Report*, Denver, CO, 2007.
- Blute, N.K., **"Status of Glendale, California's Research Program on Hexavalent Chromium Removal from Drinking Water,"** presented at the Association of California Water Agencies Safe Drinking Water Subcommittee Meeting, Sacramento CA, September 20, 2007.
- Qin, G., Blute, N.K., McGuire, M.J., **"Analysis of Spent Weak-Base Anion Exchange Resin from Hexavalent Chromium Treatment Implications for Residuals**

Management," ***Proceedings***, 126th Annual Conference and Exposition of the American Water Works Association (AWWA), Toronto ON, June 23–28, 2007.

- Qin, G., Blute, N.K., McGuire, M.J., **"Hexavalent Chromium Removal from Drinking Water Source Using Weak Base Anion Exchange Technology,"** ***Proceedings***, Spring Conference of the American Water Works Association, California-Nevada Section, Las Vegas NV, April 16–20, 2007.
- Blute, N.K., McGuire, M.J., Qin, G., Kavounas, P., **"Pilot Studies of Hexavalent Chromium Removal from Groundwater in Glendale, California,"** presented at the 18th Symposium on Groundwater Contaminants in the Series on Emerging Contaminants in Groundwater: A Continually Moving Target, Groundwater Resources Association (GRA) of California, Concord CA, June 7–8, 2006.
- Blute, N.K., Seidel, C., McGuire, M.J., Kavounas, P., **"Conceptual Cost Estimates for Pilot-Tested Hexavalent Chromium Removal Technologies,"** presented at the Spring Conference of the American Water Works Association, California-Nevada Section, Burlingame CA, April 24–28, 2006.
- McGuire, M.J., Blute, N.K., Seidel, C.J., Qin, G., Fong, L., **"Pilot-Scale Studies of Hexavalent Chromium Removal from Drinking Water,"** ***Journal of the American Water Works Association***, Vol. 98, No. 2, pp. 134–143, February 2006.
- Blute, N.K., McGuire, M.J., Qin, G., Kavounas, P., **"Hexavalent Chromium Removal from Drinking Water Using Weak Base Anion Exchange Technologies,"** presented at the Inorganic Contaminants Workshop of the American Water Works Association, Austin TX, January 29–31, 2006.
- Blute, N.K., Seidel, C., and McGuire, M.J. **"Conceptual Cost Estimates for Pilot-Tested Hexavalent Chromium Removal Technologies."** *CA NV AWWA Spring Section Meeting*. Burlingame, CA, March 2006.
- Qin, G., McGuire, M.J., Blute, N.K., Seidel, C.J., Fong, L., **"Hexavalent Chromium Removal by Reduction with Ferrous Sulfate, Coagulation, and Filtration: A Pilot-Scale Study,"** ***Environmental Science and Technology***, Vo. 39, No. 16, pp. 6321–6327, 2005.
- Seidel, C.J., McGuire, M.J., Blute, N.K., Qin, D., Fong, L., **"Field Pilot Testing of Hexavalent Chromium Removal by Reduction, Precipitation, and Coagulation,"** ***Proceedings***, 124th Annual Conference and Exposition of the American Water Works Association, San Francisco CA, June 12–16, 2005.
- Blute, N.K., McGuire, M.J., Qin, D., Seidel, C.J., Fong, L., **"Removing Hexavalent Chromium by Ion Exchange: A Suite of Pilot-Scale Results,"** presented at the 124th Annual Conference and Exposition of the American Water Works Association, San Francisco CA, June 12–16, 2005.
- Blute, N.K., **"Pilot-Scale Investigations of Hexavalent Chromium Removal,"** invited speaker at the UCLA Department of Civil and Environmental Engineering, Los Angeles CA, October 19, 2004.
- Blute, N.K., **"Pilot-Scale Investigations of Hexavalent Chromium Removal to Low ppb Concentrations,"** presented at the Annual Conference of the American Water Works Association, California/Nevada Section, Sacramento CA, October 12–14, 2004.
- Blute, N.K., **"Chromium (VI)-Success of Pilot Treatment Processes and Project Status,"** invited speaker at Annual Conference of the American Water Resources Association, SoCal Section, Glendale CA, June 9, 2004.

- Brandhuber, P.J., Blute, N.K., Seidel, C.J., Frey, M., Yoon, J., Amy, G., Froelich, D., **"Alternative Treatment Technologies for the Removal of Hexavalent Chromium to Very Low Levels,"** presented at the Inorganic Contaminants Workshop of the American Water Works Association, Reno NV, February 1–3, 2004.
- Brandhuber, P.J., Frey, M., McGuire, M.J., Chao, P.-F., Seidel, C., Amy, G., Yoon, J., McNeill, L., and Banerjee, K. **"Low-Level Hexavalent Chromium Treatment Options: Bench-Scale Evaluation,"** *American Water Works Association Research Foundation Report*, Denver, CO, 2004.

Evaluation Criteria E: Other Contributions to Water Supply Sustainability

The demonstration-scale study plant will evaluate the feasibility of developing a full-scale project that would mitigate current and future water shortages and ultimately help to achieve the water resources goals established by Metropolitan's Integrated Resources Plan (IRP). A fundamental outcome of Metropolitan's IRP recognizes that regional water supply reliability could be achieved through the implementation of a diverse portfolio of resource investments and measures. The IRP also provides a strategy balanced between the use of local resources and imported supplies. In a dry year, about 55 percent of the region's water resources would come from local resources and conservation if fully developed. Through the IRP process, Metropolitan identified solutions that offer long-term reliability at the lowest possible cost to the region. New state legislation calls for water districts to reduce per capita water use by 20 percent by year 2020. Agencies may achieve this mandate by a combination of treating formerly unusable water, conservation efforts and development and use of recycled water, and reclaiming and retaining the use of previously contaminated groundwater supplies.

Regional water supply reliability largely depends on a water utility's preparedness to adapt to water supply uncertainties. An adaptive management approach was utilized in developing a strategy that will prepare the region to deal with unforeseen water supply shortages in a sustainable way. An important step in this approach is identifying where additional water supply will come from.

Evaluation Criteria F: Technical Merit

Subcriterion No. F1—Appropriateness of the Technology

The city of Glendale, along with partnering agencies, initiated a four-phase effort to identify and test Cr(VI) treatment technologies. Prior to this effort, no technology had been proven effective at achieving the desired low ppb levels in drinking water. Phase I bench-scale testing started in 2001 to identify potential treatment options for Cr(VI). Exhaustive bench-scale tests included the following technologies: fixed bed and dispersed ion exchange, adsorptive media, reverse osmosis and nanofiltration, sulfur modified iron media, reduction, precipitation, and RCF. Of technologies with merit at the bench-scale, six processes were advanced to pilot-scale testing, including SBA, WBA, adsorptive zeolite media, iron-impregnated GAC, RCF, and reduction/filtration. Iron-impregnated GAC required too frequent media replacements to make the technology cost-effective. Zeolite media was effective but required a long detention time, de-aeration, and had a relatively small capacity for Cr(VI), making the process ineffective compared to other technologies. Reduction/filtration was not effective at removing chromium from the water at pilot-scale. Thus, three technologies emerged from pilot testing as promising, including WBA, RCF, and SBA.

An Expert Panel of treatment and regulatory experts were gathered in 2006 to identify the AWT technologies to advance to demonstration-scale testing, resulting in the recommendation that RCF and WBA move forward. SBA was eliminated from demonstration-scale testing due to (1) the inability to dispose of brine in a long-term, sustainable manner, and (2) the need for brine treatment to remove Cr(VI), which would create a hazardous brine.

Glendale chose to test two technologies since each offers dramatically different operational needs, complexities, and cost drivers. WBA is relatively simple to operate, consisting of pH adjustment and water flowing through beds of resin. However, WBA O&M costs are fairly high due to the resin replacement and disposal fees. By comparison, RCF is more akin to a conventional water treatment plant in complexity, but offers a much lower O&M cost though capital is high. Glendale is testing both of these promising technologies with the intention of identifying factors that should be Glendale considered when a utility is at the process selection phase.

Subcriterion No. F2—Applicability of the Technology

From the beginning, Glendale intended for the work of identifying and testing Cr(VI) treatment technologies to be directly useful to all water systems throughout the U.S., rather than simply addressing a Glendale concern. The research has been structured in such a way as to have tested a range of technologies at the screening stages, and then leading candidates advanced to the next round of testing. Many different cities and agencies have contributed to the projects and the work is guided by a long-standing PAC comprised of utility leaders and health regulators, all of whom are focused on the implications of the research to the broader community. The WBA and RCF AWT technologies in the demonstration-scale testing phase are applicable in other locations.

USEPA and CDPH are both represented on our PAC, guiding the research so that it is applicable to a broad range of utilities. In particular, USEPA and CDPH both contributed to the team's development of the cost evaluation approach to ensure that the costs developed will be useful in performing the cost-benefit analysis necessary in establishing an MCL.

The CDPH recently stated:

> *"The Department appreciates the City's [Glendale] continued efforts in supporting and managing the research and study of Chromium VI treatment options. The technical information, operational experiences, and cost information gained from this study is invaluable to the Department especially in the development of regulations for Chromium VI."*

Ms. Leah Walker, Chief,
CDPH Division of Drinking Water and Environmental Management
March 24, 2011

This same importance exists with the USEPA as they also are considering the need for regulating Cr(VI) in water supplies:

> *…"the [Glendale's Study] sole source of practical information for drinking water regulators."*

Dr. Bruce Macler, US EPA
Region 9 Newsletter

In addition to testing technologies that can be applied across the U.S., the demonstration-scale project results will be documented in a thoroughly-prepared report, which will also contain extensive cross-referencing to prior testing results gleaned over the past decade of testing (and include a compilation of all reports). The Technical Approach section describes how the results of this demonstration-scale study will be used to develop cost curves for cost estimation purposes by other utilities. Thus, both technical and economic questions that are answered by this project will be available to all who are interested.

As described in Subcriterion D2, the project team strives to disseminate the information to a wide variety of local and national conferences, publications, and the community with funding partner involvement and input. At the end of a project phase or at a crossroads in the work, a PAC meeting is convened, with the proceedings shown on local cable access television in Glendale and on the Intranet through real-time streaming media. In these ways, the findings of these landmark studies can reach everyone from community members to other utilities in need of Cr(VI) solutions.

Evaluation Criteria G: Connection to Reclamation Project Activities

The Cities of Glendale and Los Angeles receive Reclamation water through Metropolitan's contracts with the Department of Interior's Bureau of Reclamation for its Colorado River Water entitlements. The city of Glendale is a member agency of Metropolitan, and relies on Metropolitan imported supplies to supplement its local supplies to meet customer demands. Although this project aims to retain use of an existing water supply, the study could reduce the demand stress of the imported supplies throughout Metropolitan's service area.

Performance Measures

The key value of this research effort is to retain or return a local water supply as well as address a public concern with Cr(VI) in their water supplies.

The overall goal of this demonstration-scale study is to evaluate the effectiveness of two AWT technologies shown to have promise in pilot testing for removing, Cr(VI), to low ppb (or sub-ppb, if possible) levels in drinking water. Project objectives fall primarily into one of three categories: treatment, operational, and regulatory objectives.

1. <u>Treatment Objective</u>: The level to which the AWT technologies can remove Cr(VI) and chromium will be tested to identify the lower limits of treatment efficacy. Currently, no treatment technology has been proven at levels of the California draft PHG of 0.02 ppb. The lower limits of removal are not known and will be elucidated in this study.
    a. Performance Measure: A key outcome will be whether the AWT technologies will be able to remove Cr(VI) to meet anticipated, but unknown, water quality standards to be set by the federal and state governments. We know from experience that the two AWT technologies being studied will remove Cr(VI) to low ppb levels. A key objective is to see "how low" the concentrations can be reduced to on a reliable basis to meet applicable standards using the two treatment technologies being studied. The project will be deemed successful if this information can be developed by the end of the research work for use by other utilities and regulatory agencies.
2. <u>Operational Objective</u>: Demonstration-scale experience with the two AWT technologies will provide valuable information on operational requirements of the systems, including labor, O&M

costs, and any issues associated with scaling up the technology from pilot to larger scale. Residuals disposal options, and opportunities to minimize residuals disposal costs, will also be investigated through this study.

   a. Performance Measure: System needs for operations, including factors contributing to labor demands and costs, will be quantified. This objective will be achieved if a good understanding of the practical aspects of system operations is gained that will be of use to other utilities requiring chromium treatment.

3. Regulatory Objective: In advance of a Cr(VI) MCL, cost estimates determined in this study will be developed in collaboration with CDPH and USEPA to ensure that the cost information will be useful in regulatory cost-benefit analyses for setting an MCL. To achieve this objective, actual treatment costs will be compiled and cost curves developed for different influent concentrations and potential MCLs. A range of system sizes will be evaluated to represent small to large sized utilities with respect to costs.

   a. Performance Measure: A key outcome from this research will be the development of capital and O&M costs for the operation of treatment systems to achieve low concentrations of Cr(VI) in water supplies. A sensitivity analysis will be performed to identify the operational parameters that have the greatest impact on costs and those that are not cost drivers in the treatment process. This information is critical as part of the federal and State standard setting process. The State of California has identified what they need in terms of information and discussion is underway with the USEPA for their needs. The project will be deemed successful if this information can be developed by the end of the research work for use by regulatory agencies.

Primary values for the research include the following:

- This research project is designed to address a nationwide issue.
- Identification of treatment technologies and cost information that can be used by communities as they address treatment and cost options to remove Cr(VI).
- This research effort will identify treatment options and improve the quality of water available to Indian tribes if Cr(VI) is in their water supplies.
- The presence of Cr(VI) in water supplies can certainly impact water supply balance in a community. It can lead to the loss of a supply and/or the need for considerable funds to either remove this contaminant from water or identify a new water supply.
- The presence of Cr(VI) in water supplies could also impact regional and state water planning efforts by altering their assumptions relative to the availability of this local source to meet projected needs.
- Widespread support has been committed for this research due to its significant value with funding, technical support, and key partners closely following the development of the technical information and cost on Cr(VI) removal.
- The federal and state governments are involved and will utilize the results of this research as they set water quality standards for Cr(VI) in drinking water.
- Industry that "may" be responsible for the contamination of ground water supplies is a significant contributor to the research as they too want to make sure the study is performed in a comprehensive manner as they may be required to pay for, and construct and operate removal facilities.

- The USEPA has provided significant funds for this research and the Superfund Branch anticipates using this information to set requirements for constructing appropriate Cr(VI) removal facilities backed by sound research and testing before identifying specific facilities.
- The research work will greatly expand the technical knowledge base relative to removing Cr(VI) from water supplies. The WaterRF and the NWRI have been significantly involved both in funding and participation in the research.
- The State of California is the largest contributor to the effort, about $3.3 million, since a legislative directive required an MCL for Cr(VI) by 2004, a timeframe that has long passed. Now legislation is pending to apply even great pressure to the State government to establish the MCL. The Glendale research will identify the cost and feasibility information.
- This project will maximize local water use and minimize the need to seek imported water from other areas at higher energy costs, greater environmental impacts, and reduced imported supplies available to others.
- This project will maintain the use of a local resource that can be utilized at a much lower energy input cost compared to imported water and demonstrate to the community the energy efficiencies that exist in using this local resource. Energy conservation can certainly be incorporated in the full-scale facilities. This could include solar panels, variable speed pumps, lighting, and other such items.
- The use and firmness of the local water supplies gives the community more local water supply security.
- Local communities should maximize their use of local resources by all reasonable means before going to imported water from other areas.

In summary, there is a need for a community to use and develop as much of their local water resources before abandoning these supplies and importing more water. This study has many benefits for the water industry, business, and regulatory entities nationwide. Partners have come together to fund and follow this effort in a program that has grown from a $2 million research effort to over $7 million. With the Reclamation funds, we can complete the Study.

Environmental Compliance

As mentioned previously, the research project will focus on the operation of the existing Cr(VI) demonstration-scale facilities for optimizing the treatment process and the developing cost data. The demonstration testing of MF will be added to the existing, permitted RCF treatment system. It is expected that this will be a skid mounted system installed in a plastic type containment system and small diameter plastic above ground pipe installed to inter connect with the existing RCF facilities. Responses to specific questions focusing on the requirements of NEPA and the CEQA are given below.

1. The project will have minimal impact on the surrounding environment. All piping and equipment will be above ground so there will be no earth-disturbing work. All waste and product streams from the pilot MF unit will be disposed into the city of Glendale sewer system. Therefore, air, soil, and water quality within the project area will not be affected. Also since the MF will be on a paved surface adjacent to the existing RCF demonstration facility, animal habitats will not be disturbed.
2. We are not aware of any species listed or proposed to be listed as a Federal endangered or threatened species, or designated Critical Habitat in the project area.

3. There are no wetlands or other surface waters inside the project boundaries that potentially fall under the Federal Clean Water Act jurisdiction as "waters of the United States" inside the boundaries of the pilot or demonstration treatment facility project area.

4. The water delivery system consisting of the demonstration and pilot project area was completed in 2009.

5. The project will not result in any modification of or effects to individual features of an irrigation system.

6. No buildings, structures, or features in the project area are listed or eligible for listing on the National Register of Historic Places.

7. There are no known archeological sites in the project area.

8. The project will not have any disproportionately high or adverse effect on low income or minority populations. The objective of this project is just the opposite as it strives to provide a better quality of water to all segments of the population.

9. The project will not limit access to ceremonial use of Indian sacred sites or result in other impacts on tribal lands.

10. The project will not contribute to the introduction, continued existence, or spread of noxious weeds or non-native species know to occur in the area.

A negative mitigation declaration was prepared in year 2008 relative to the construction of the Cr(VI) removal demonstration-scale facilities. These projects were completed in year 2009 and have been in operation since that time. The remaining work under this research effort pertains to operational optimization of facilities for the development of cost and feasibility of treatment data.

Required Permits or Approvals

No permits or regulatory approvals are required except for normal letter permit from CPDH. We continue to work with the CDPH relative to the operation and associated studies as they relate regulatory requirements. Additionally, the demonstration facilities were constructed and are being operated as the U.S. Superfund's GOU. Superfund projects are not required and on occasion not allowed to obtain "regulatory permits," and must comply with all applicable regulations

Funding Plan and Letters of Commitment

The total cost for this proposed phase of the project is $1.620 million. The non-Reclamation share of project costs is $1.220 million. Letters of commitment have been obtained from three groups that are providing funds for the project: State of California, $800,000; San Fernando Valley Business Community, $250,000; WaterRF, $150,000, and Metropolitan $20,000. Federal funds from the USEPA will not be used as part of the research effort under this $1.620 million research project. Copies of the funding commitment letters are attached.

The City has received a confirmation from the State of California for an approval of the additional $800,000 for the project and has executed a contract. The Glendale City Council has authorized the Glendale City Manager to execute the agreement.

The City has received an executed contract from WaterRF has sent the City including approval of the work plan.

The San Fernando Valley Business Group, also known as the Glendale Respondents Group has executed an agreement. The City has received the funds from the agreement.

Metropolitan has committed to in-kind funding totaling $20,000.

With respect to the funding plan,

1. The funding plan as proposed does not involve any City funds except to "cash flow" the research work as it progresses. Invoices submitted by those performing the work are paid, and then the City seeks reimbursement from the funding sources. The City has sufficient funds to "cash flow" from reserves and water rates.

2. The research work covered in this grant request commenced on July 1, 2010. Since that time, the demonstration facilities have been operating with minimal downtime and the researchers have been gathering technical data. The plan is to include costs for the research effort starting July 1, 2010 and ends on December 31, 2011. The key objectives of the project are to (1) Identify the level to which AWT technologies can treat Cr(VI), (2) Determine operational requirements for the AWT technologies, and (3) Develop cost estimates that will benefit other utilities and the regulatory process.

   For the WBA, the main cost driver is the weak base resin and identifying the number of "bed volumes" before resin exhaustion, spent resin disposal costs, and resin conditioning requirements. The plan for the project is to operate the facilities for at least three change outs to firm up the bed volumes and disposal costs, which will take about three years. The time frame of this grant will allow for one additional resin/disposal change out. This involves many possible variables in operation for the RCF and will take about 12 months of operation to obtain this data. These study variables have been underway since July 1, 2010, and will continue until the project ends.

   Between July 1, 2010, to April 1, 2011(nine months), the City has spent about $800,000 of the $1.620 million project. Detailed information on the expenditure dates is available.

3. Information on funding partners is provided in Table 15.

4. There is no federal funding in the $1.220 million match.

5. All non-reclamation requests for funding have been committed beyond the proposed Reclamation grant of $400,000.

Please see Table 16 for summary information on budgets and federal and non-federal sources.

TABLE 15 - SUMMARY OF NON-FEDERAL AND FEDERAL FUNDING SOURCES

Funding Sources	**Funding Amount**
Non-Federal Entities	
1. Water Research Foundation	150,000
2. San Fernando Valley Industry	250,000
3. State of California	800,000
4. Metropolitan	20,000
Non-Federal Subtotal:	1,220,000
Other Federal Entities	0
Other Federal Subtotal:	*0*
Requested Reclamation Funding:	*400,000*
Total Project Funding:	***$1,620,000***

WATER RESEARCH FOUNDATION
ADVANCING THE SCIENCE OF WATER

March 16, 2011

Peter Kavounas
Glendale Water & Power
141 North Glendale Avenue, Level 4
Glendale, CA 91206-4975

Dear Mr. Kavounas:

I am pleased to inform you that your Tailored Collaboration proposal, "Research Effort to Investigate the Feasibility of Microfiltration in the RCF Process for Hexavalent Chromium Removal," has been approved for funding by the Foundation's Tailored Collaboration Review Committee (TCRC). The funding from Water Research Foundation is $150,000, with a participant(s) cash match of $150,000.

Hsiao-wen Chen has been assigned as the Foundation's Research Manager to the project and will be contacting you soon, if she hasn't already. Hsiao-wen can be reached at 303-347-6103 or by email at Hchen@WaterRF.org. Until then, if you have any questions, please contact Rick Karlin at 303.347.6104 or rkarlin@WaterRF.org. The Foundation is confident that your research in this area will benefit the water supply community. We look forward to working with you and to the successful completion of this important project.

Sincerely,

Robert C. Renner, P.E., DEE
Executive Director

RCR:ps:TC-10-011

c: Donald Froelich - Glendale Water & Power

6666 West Quincy Avenue
Denver, CO 80235-3098 USA
P 303.347.6100
F 303.730.0851
www.WaterRF.org
info@WaterRF.org

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY EDMUND G. BROWN JR., Governor

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

January 10, 2011

Mr. Peter Kavounas, Assistant General Manager
City of Glendale
141 North Glendale Ave - Level 4
Glendale, California 91206

CITY OF GLENDALE REQUEST FOR ADDITIONAL FUNDING UNDER THE WATER SECURITY, CLEAN DRINKING WATER, COASTAL AND BEACH PROTECTION ACT OF 2002, PROJECT NUMBER P50-1910043-054

Dear Mr. Kavounas:

The California Department of Water Resources (DWR) has reviewed the City of Glendale's request for additional grant funds in the amount of $800,000.

This request is to perform pilot studies on microfiltration (MF) technologies at the Reduction/Coagulation/Filtration (RCF) facility and to cover additional costs including operation and maintenance (O&M) costs at the RCF facility as well as the Weak-base Anion exchange (WBA) demonstration facility. This amount would increase existing grant funding from $2.5 million to $3.3 million; and would require matching funds to increase from $2.5 million to $3.3 million.

The State of California has determined that Project Number P50-1910043-054 is eligible for grant funding in the amount of $3.3 million and approves the request for additional funds contingent on meeting the following requirements.

Prior to executing a Funding Agreement Amendment, the City of Glendale must submit the following to DWR.

1. **An adopted resolution reflecting the revised funding amounts.**
2. **A signed revised Page 6 of the application reflecting the cost classifications and revised total cost breakdowns.**
3. **Documentation that Matching Funds of $800,000 have been secured by the City of Glendale.**

The State commends the City of Glendale for taking steps to correct the deficiencies that will be remedied by this investigation in order to provide safe drinking water to your consumers. If you have any questions, please contact Steve Giambrone, Program Analyst, at (916) 653-9722 or by email at sgiambro@water.ca.gov.

Sincerely,

Linda Ng, Chief
Safe Drinking Water Office
Division of Fiscal Services

CITY OF GLENDALE, CALIFORNIA
City Attorney

613 East Broadway, Room 220
Glendale, California 91206-4394
(818) 548-2080 Fax (818) 547-3402
www.ci.glendale.ca.us

April 4, 2011

KYLE S. KAWAKAMI, ESQ.
Irell & Manella LLP
840 Newport Center Drive, Suite 400
Newport Beach, CA 92660

RE: Chromium 6 Treatment Facilities Demonstration Facilities
Proposition 50 Grant Funding

Dear Mr. Kawakami:

This correspondence shall memorialize the agreement reached, by and between City of Glendale ("City") and Glendale Respondents Group, LLC ("GRG"), during our meeting of November 18, 2010, with regards to the additional funding related to City's Chromium 6 Treatment Demonstration Facilities.

- In late 2010, the State of California invited the City to apply for an additional to increase in its Proposition 50 Grant funding, in the amount of Eight Hundred Thousand Dollars ($800,000), thereby increasing the total grant amount from $2.5 million to $3.3 million.
- In order to be considered for the additional $800,000 in Proposition 50 Grant funding, the City will have to make available $800,000 in matching funds.
- GRG has agreed to contribute the amount of Two Hundred Fifty Thousand Dollars ($250,000) to the City, towards the City's portion of the $800,000 in matching funds for the additional Proposition 50 Grant funding.
- GRG will pay the $250,000 in matching funds to the City in April 2011.
- The City and GRG hereby agree that nothing in this letter agreement obligates the GRG to pay and/or contribute any additional matching funds or any other funds in the future with respect to the Chromium 6 Treatment Demonstration Facilities.

The City appreciates GRG's continuous contribution to this very important effort.

Please sign this correspondence at the space designated below, acknowledging your approval of and

agreement to the terms memorialized herein on behalf of GRG.

Very truly yours,

SCOTT H. HOWARD, CITY ATTORNEY

By: ______________________
Dorine Martirosian
Deputy City Attorney

Approved as to content, terms and conditions.

____
Kyle S. Kawakami, Esq.
Counsel for Glendale Respondents Group, LLC

cc: Carolyn S. Monteith, Lockheed Martin EESH
Peter Kavoenas, Asst. General Manager

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Office of the General Manager

April 27, 2011

Mr. Peter Kavounas
Associate General Manager, Water Services
City of Glendale, Water and Power
141 North Glendale – Level 4
Glendale, CA 91206

Reply to: 700 Moreno Avenue
La Verne, CA 91750

Dear Mr. Kavounas:

Letter of Commitment for U.S. Department of the Interior Bureau of Reclamation Funding Opportunity Announcement No. R11SF80351: Water SMART: Advanced Water Treatment Pilot and Demonstration Project Grants for the Project: *Advanced Water Treatment Study for Hexavalent Chromium in Drinking Water*

The Metropolitan Water District of Southern California is interested in participating with the City of Glendale on your proposal entitled, *Advanced Water Treatment Study for Hexavalent Chromium in Drinking Water*. The purpose of this letter is to provide an in-kind commitment for the above referenced project. We are pleased to have an opportunity to be involved in a project to evaluate the effective advanced water treatment technologies for hexavalent chromium to low parts-per-billion (or sub parts-per-billion, if possible) levels in drinking water. Findings from this study will be widely disseminated to the water community and regulatory agencies to determine what hexavalent chromium levels can be achieved with associated costs.

We understand that our participation in this project will include in-kind services for Dr. Sun Liang to serve as Technical Advisor to review test plans, results, and related reports as well as to participate in workshops and project meetings. We estimate that our utility can support this research effort with in-kind services worth up to $20,000. We hope that our efforts in this very important project will enlighten utilities about issues concerning the effective advanced water treatment technologies for hexavalent chromium.

I look forward to hearing about the success of this proposal in the near future.

Sincerely,

Mic Stewart, Ph.D.
Water Quality Section Manager

SL:smh
H:\letters\sl usbr r11sf80351.docx

700 N. Alameda Street, Los Angeles, California 90012 ● Mailing Address: Box 54153, Los Angeles, California 90054-0153 ● Telephone (213) 217-6000

Letters of Project Support

Included in the proposal are letters of support from a legislative office and member agencies in the southern California area that all share concerns and interest in the success of this proposal based upon the potential ramifications of Cr(VI) present in local ground water.

May 3, 2011

Peter Kavounas
Assistant General Manager - Water Services
Glendale Water & Power
141 N Glendale Ave, Level 4
Glendale, CA 91206

SUBJECT: **SUPPORT for City of Glendale Water & Power's WaterSmart Grant Application – Continuing Hexavalent Chromium Research**

Dear Mr. Kavounas:

Hexavalent chromium (chrom 6) continues to be a significant public concern on both the state and federal levels. Currently, there are pending legislative and regulatory initiatives on state and federal levels regarding the establishment of chrom 6 public health goals (PHG) and the Maximum Contaminant Levels (MCL).

Glendale's effort since the year 2000 to develop the technology to remove chrom 6 from drinking water and understand the resulting cost impacts has been supported by a wide coalition of both public and private partners. The effort will yield reliable and accurate cost and feasibility data that are absolutely critical in the standard setting process.

As such, we are signing this letter to show our strong support for the City of Glendale's WaterSmart Grant application for funding to continue and complete the necessary studies for a reasonable and safe state and federal drinking water quality standard for chrom 6.

Sincerely,

SUPPORTING MEMBER AGENCY SIGNATORIES

USBR Grant Application Support – Member Agency for Hexavalent Chromium Funding

SIGNATORIES

Don Calkins
City of Anaheim Utilities Dept.

William O. Mace, Jr. P.E.
City of Burbank

Kevin Hunt
MWD of Orange County

Tom Love
Inland Empire UA

John Mundy
Las Virgenes MWD

Shane Chapman
Upper San Gabriel Valley MWD

Susan B. Mulligan
Calleguas Municipal Water District

James B. McDaniel
Los Angeles DWP

APPROPRIATIONS COMMITTEE
SUBCOMMITTEE ON STATE, FOREIGN OPERATIONS, AND RELATED PROGRAMS
SUBCOMMITTEE ON COMMERCE, JUSTICE, SCIENCE AND RELATED AGENCIES
SUBCOMMITTEE ON FINANCIAL SERVICES
SELECT INTELLIGENCE OVERSIGHT PANEL
PERMANENT SELECT COMMITTEE ON INTELLIGENCE
SUBCOMMITTEE ON TERRORISM, HUMAN INTELLIGENCE, ANALYSIS AND COUNTERINTELLIGENCE
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
SUBCOMMITTEE ON TECHNICAL AND TACTICAL INTELLIGENCE
JUDICIARY COMMITTEE

U.S. HOUSE OF REPRESENTATIVES

ADAM B. SCHIFF
29TH DISTRICT, CALIFORNIA

WASHINGTON OFFICE:
2447 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-4176
FAX: (202) 225-5828

DISTRICT OFFICE:
87 NORTH RAYMOND AVENUE
SUITE 800
PASADENA, CA 91103
(626) 304-2727
FAX: (626) 304-0572

E-MAIL VIA WEB ADDRESS AT
www.house.gov/schiff

May 5, 2011

Ms. Michelle Maher, Grants Officer
Acquisition Operations Group
Bureau of Reclamation
Mail Code: 84-27810
P.O. Box 25007
Denver Federal Center, Bldg 67, Rm 152
Denver, CO 80225

Re: **CFDA No. 15.507**. City of Glendale *Water & Power*'s WaterSmart Grant Application – Continuing Hexavalent Chromium Research

Dear Ms. Maher:

Since I served in the California State Senate in 1996, the presence of hexavalent chromium in California's ground water supply has been of great concern to me. In more recent years, Senator Boxer and I have joined together to provide significant funding to the City of Glendale to develop technology to remove hexavalent chromium from the drinking water supply.

The City of Glendale's Advanced Water Treatment Study for Hexavalent Chromium in Drinking Water (Study) is designed to provide cost information and technical feasibility for removing hexavalent chromium (Cr(VI)) from drinking water supplies. The Study, conducted at demonstration-scale facilities, provides water utilities effective treatment options in response to the U.S. Environmental Protection Agency's (USEPA) and California Department of Public Health (CDPH) pending action to establish a Maximum Contaminant Level (MCL) for Cr(VI) that could be significantly lower than the current MCL for total chromium. The Study is widely supported by federal, state and local partners.

The continuation of these research efforts is essential to water agencies throughout California that have hexavalent chromium in their drinking water supply. I have been an advocate of this critical issue for over a decade and I urge you to extend full and fair consideration to the City of Glendale's grant proposal. Please let me know if I may be of any further assistance, and do not hesitate to contact me for more information.

Sincerely,

ADAM B. SCHIFF
Member of Congress

Official Resolution

Adopted
4/26/11
Manoukian/Weaver
All Ayes

RESOLUTION NO. 11-88

A RESOLUTION OF THE COUNCIL OF THE CITY OF GLENDALE, CALIFORNIA, AUTHORIZING THE APPLICATION FOR AND EXECUTION OF A FUNDING AGREEMENT AND RELATED DOCUMENTS WITH THE UNITED STATES BUREAU OF RECLAMATION FOR AN AMOUNT NOT-TO-EXCEED $400,000 TO FINALIZE THE FUNDING NEEDS FOR THE PHASE IIIA RESEARCH STUDY OF REMOVAL OF CHROMIUM 6 FROM DRINKING WATER SUPPLIES

WHEREAS, in April 2010, the City of Glendale, as part of its research efforts to develop technologies to remove hexavalent chromium ("chrom 6") from drinking water supplies recently completed the construction of two demonstration facilities to study two chrom 6 removal possibilities; and

WHEREAS, there is a continuing need to operate the demonstration facilities to obtain optimized operational data in order to develop accurate cost estimates for the ongoing and underlying research efforts; and

WHEREAS, the City has prepared and designated a project budget, to complete the research effort, in the amount of $1.6 million; and

WHEREAS, the City has obtained grant funding in the amount of $1.2 million towards this effort from the State of California under the Proposition 50 Program ("Proposition 50") , Water Research Foundation ("WRF"), and the San Fernando Valley Industry known as the Glendale Respondents Group ("GRG"); and

WHEREAS, the City is now seeking funding, in the amount of $400,000 from the United States Bureau of Reclamation (USBR) to finalize the funding needs for the research efforts for the removal of chrom 6 from drinking water supplies.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF GLENDALE, CALIFORNIA THAT:

SECTION 1: The City Council hereby adopts a Project budget of $1.6 million.

SECTION 2: The City Manager is hereby authorized to direct staff to submit an application to the USBR for funding for up to $400,000.

SECTION 3: The City Manager is hereby authorized to enter into and execute a funding agreement with USBR, as well as any documents related thereto.

8 B 1

SECTION 4: The City Manager is further authorized (1) to direct staff to coordinate with the USBR to meet established deadlines for entering into a cooperative agreement, and (2) to authorize the use of the matching funds from the State of California Proposition 50 ($800,000), WRF ($150,000), and GRG ($250,000) for and towards the funding of the herein project.

Adopted by the Council of the City of Glendale on this 26th day of April, 2011.

Mayor

ATTEST:

City Clerk

STATE OF CALIFORNIA) SS.
COUNTY OF LOS ANGELES)

I, Ardashes Kassakhian, City Clerk of the City of Glendale, hereby certify that the foregoing Resolution No. 11-88 was adopted by a majority vote of the Council of the City of Glendale, California, at a regular meeting held on the 26th day of April, 2011, and that the same was adopted by the following vote:

Ayes: Manoukian, Najarian, Quintero, Weaver, Friedman
Noes: None
Absent: None

City Clerk

APPROVED AS TO FORM

Deputy City Attorney

DATE 4/20/11

J:FilenetCopy\Dorme\Council\Resolution authorizing funding agmt with USBR (revised 4-1-11)

Project Budget Application

Budget Proposal

Budget Narrative

The salaries and wages for key Glendale personnel are provided in Table 16. The only Glendale staffs to charge to this project are Donald Froelich, Project Manager (part-time employee) and Leighton Fong, Project Engineer (full time employee). Peter Kavounas, Assistant General Manager--Water Services is the Principal Investigator. Mr. Kavounas as well as other staff people are not included as they are part of the City's overhead rate that is discussed below. No rate increases are expected over the time frame of this research.

The Glendale approach in this project is to retain consultants and contractors to perform the research effort. Glendale staff is used primarily for project management services, administering the miscellaneous grants, preparation of specialized technical reports, consultant oversight, and report preparation. At times we pay regulatory agencies miscellaneous fees, retain specialized services, and materials as noted below.

Fringe Benefits

The fringe benefit rate for full time employees is 55 percent and for part-time employees is 13 percent. No rate increases are expected over the time frame of this research.

Travel

It is anticipated that the results of this research project will be of interest to other agencies, consultants, and engineers. Therefore funding is requested to present the findings at relevant conferences and publications. The most likely will be at the AWWA Water Quality and Technology Conferences in November 2011 and California Nevada AWWA Fall conference in October 2011. Based on past experiences, a travel budget will be established at $3,000 for each of two such conferences for a total cost of $6,000. The presenters will be from Malcolm Pirnie and this amount will be included in the Malcolm Pirnie budget (Table 16).

Equipment

The demonstration facilities are in place. The only additional piece of equipment anticipated for this project will be the rental of the MF units and installation. At the present time, we are preparing the RFP for the rental and installation of the MF equipment. The budget for this is included in the information provide below for CDM Constructors as they will contract for this equipment. Beyond this item, we do not anticipate any other equipment needs for this project.

Materials and Supplies

The only major material acquired for the project is the resin for the weak base anion treatment system. We normally replace the resin after 9 months. Other material and supplies are obtained by consultants to the City. Other items will be included in the Contractual section (Table 16).

Contractual

The City has two major contracts in force at the present time and some minor contracts. One contract is with Malcolm Pirnie, Inc., which is the firm that has performed the overall research activities since inception of the project through the bench, pilot, and demonstration projects. The other contract is with CDM Constructors, who have been operating the demonstration facilities since

2008. The attached form SF-424 provides detailed information on scope of the various consultant activities covering the period July 1, 2010, to December 31, 2011.

Environmental and Regulatory Compliance Costs

This project is not expected to have any environmental impacts or require any permits or approvals. Consequently, no environmental compliance costs have been budgeted for this project. We do have regulatory fees for such groups as the fire departments because of the presence of chemicals on site, and sewer discharge costs. The costs are expected to be in the area of $15,000 for the study period.

Reporting

Data analysis and report writing will be conducted by the City's consultants and City staff. For City staff, these costs are included in the category Salaries and Wages and for consultants under the category consultants.

Other

Indirect Costs

Glendale has significant overhead costs like other utilities. However under agreement with the EPA and other federal agencies, the City doesn't factor its overhead in the budget for federal projects. Therefore, none is included here.

Contingency Costs

No contingency costs are included in these financials

Total Cost

The total cost of the project is estimated to be $1.620 million, with $1.220 million funded by non-federal agencies and $400,000 requested in funding from Reclamation.

SF-424

TABLE 16 - BUDGET PROPOSAL

Budget Item Description	Computation $/Unit and Unit	Computation Quantity	Recipient Funding	Reclamation Funding	Total Cost
Salaries And Wages					
Donald Froelich, GWP	72 / hr	885 HRS	52,100.00	11,600.00	63,700.00
Leighton Fong, GWP	57 / hr	815 HRS	37,200.00	9,300.00	46,500.00
Fringe Benefits			-		
Full-Time Employees	55%	25,500.00	18,000.00	7,500.00	25,500.00
Part-Time Employees	13%	8,300.00	6,700.00	1,600.00	8,300.00
Subtotal			**114,000.00**	**30,000.00**	**144,000.00**
Travel (see below)			-		
Supplies/Materials			-		
Resin Purchase	100,000 / load	2	**200,000.00**		**200,000.00**
Contractual			-		
Malcolm Pirnie:			-		
Cost Study	40,000.00	1	40,000.00		40,000.00

Budget Item Description	Computation $/Unit and Unit	Quantity	Recipient Funding	Reclamation Funding	Total Cost
Final Report	40,000.00	1	40,000.00		40,000.00
MF Study:			-		
Proj. Mang.	10,000.00	1	-	10,000.00	10,000.00
Test Plan	15,000.00	1	-	15,000.00	15,000.00
Vendor Selection	15,000.00	1	-	15,000.00	15,000.00
Data Analysis	20,000.00	1	-	20,000.00	20,000.00
Project report	30,000.00	1	-	30,000.00	30,000.00
Subtotal	90,000.00		-	90,000.00	90,000.00
Conf/Publications/Travel	6,000.00	1	6,000.00		6,000.00
Operat. Support	90,000.00	1	90,000.00		90,000.00
Total MP	266,000.00		**176,000.00**	**90,000.00**	**266,000.00**
CDM Constructors:			-		
Operation of WBA:			-		
Chemicals	33,000.00		33,000.00		33,000.00
Analyticals	99,000.00		99,000.00		99,000.00
O & M Labor	52,000.00		52,000.00		52,000.00
Resin pre-conditioning	50,000.00		50,000.00		50,000.00
Resin Disposal	80,000.00		80,000.00		80,000.00
Engineering Support	18,000.00		18,000.00		18,000.00
Noise Abatement	4,000.00		4,000.00		4,000.00
Subtotal WBA	336,000.00		**336,000.00**		**336,000.00**
Operation of RCF			-		
Chemicals	35,000.00		35,000.00		35,000.00
Analyticals	80,000.00		80,000.00		80,000.00
O & M labor	169,000.00		169,000.00		169,000.00
Sludge Disposal	15,000.00		15,000.00		15,000.00
Engineering Support	35,000.00		35,000.00		35,000.00
Construction Support	18,000.00		18,000.00		18,000.00
Non-routine O & M	7,000.00		7,000.00		7,000.00
Subtotal RCF	359,000.00		**359,000.00**		**359,000.00**
			-		
MF Study			-		
Engineering	5,000.00		-	5,000.00	5,000.00
MF Rental	100,000.00		-	100,000.00	100,000.00
Installation	120,000.00		-	120,000.00	120,000.00
Operations	35,000.00		-	35,000.00	35,000.00
Analysis	20,000.00		-	20,000.00	20,000.00
Subtotal	280,000.00		-	**280,000.00**	**280,000.00**
Environmental/Regulatory	15,000.00		15,000.00		**15,000.00**
Metropolitan Advisory	20,000.00		20,000.00		**20,000.00**
Other reporting	-		-		
Total Direct Costs			**1,200,000.00**	**400,000.00**	**1,620,000.00**
Indirect Costs - __ %					
Total Project Costs			**1,200,000.00**	**400,000.00**	**1,620,000.00**

TABLE 17 - SF-424 BUDGET FORM

BUDGET INFORMATION - Non-Construction Programs

OMB Approval No. 0348-0044

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
1. WaterSMART 2011	15.507	$	$	$ 400,000.00	$ 1,220,000.00	$ 1,620,000.00
2.						0.00
3.						0.00
4.						0.00
5. Totals		$ 0.00	$ 0.00	$ 400,000.00	$ 1,220,000.00	$ 1,620,000.00

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1)	(2)	(3)		Total (5)
a. Personnel	$	$	$ 20,900.00	$ 89,300.00	$ 110,200.00
b. Fringe Benefits			9,100.00	24,700.00	33,800.00
c. Travel					0.00
d. Equipment					0.00
e. Supplies				200,000.00	200,000.00
f. Contractual			370,000.00	871,000.00	1,241,000.00
g. Construction					0.00
h. Other				35,000.00	35,000.00
i. Total Direct Charges *(sum of 6a-6h)*	0.00	0.00	400,000.00	1,220,000.00	1,620,000.00
j. Indirect Charges					0.00
k. TOTALS *(sum of 6i and 6j)*	$ 0.00	$ 0.00	$ 400,000.00	$ 1,220,000.00	$ 1,620,000.00
7. Program Income	$	$	$	$	$ 0.00

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SECTION C - NON-FEDERAL RESOURCES				
(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e) TOTALS
8. Water 2025	$ 1,122,931.00	$ 0.00	$ 13,351.00	$ 1,136,282.00
9.				0.00
10.				0.00
11.				0.00
12. TOTAL *(sum of lines 8-11)*	$ 1,122,931.00	$ 0.00	$ 13,351.00	$ 1,136,282.00

SECTION D - FORECASTED CASH NEEDS					
	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 466,214.00	$ 65,950.00	$ 217,388.00	$ 91,438.00	$ 91,438.00
14. Non-Federal	817,142.00	246,029.00	230,709.00	182,296.00	158,108.00
15. TOTAL *(sum of lines 13 and 14)*	$ 1,283,356.00	$ 311,979.00	$ 448,097.00	$ 273,734.00	$ 249,546.00

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT				
(a) Grant Program	FUTURE FUNDING PERIODS (Years)			
	(b) First	(c) Second	(d) Third	(e) Fourth
16.Water 2025	$ 441,378.00	$	$	$
17.				
18.				
19.				
20. TOTAL *(sum of lines 16-19)*	$ 441,378.00	$ 0.00	$ 0.00	$ 0.00

SECTION F - OTHER BUDGET INFORMATION	
21. Direct Charges:	22. Indirect Charges: For Districts, predetermined, 38.011% on salary 576,795, indirect costs 219,245
23. Remarks: Indirect costs also include provisional rate of 76% on MWD salary of 7,586, MWD indirect costs of 5,765. Total project indirect costs of 225,011	

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List of Acronyms

ACWA	Association of California Water Agencies
AF	Acre Feet
AFY	Acre Feet per Year
AWT	Advanced water treatment
CDPH	California Department of Public Health
CR(III)	Trivalent chromium
Cr(VI)	Hexavalent chromium
DO	Dissolved oxygen
DWR	California Department of Water Resources
EBCT	Empty bed contact time
EWG	Environmental Working Group
GAC	Granular Activated Carbon
GOU	Glendale Operable Unit
GN	Glendale North (wells)
GS	Glendale South (wells)
GWTP	Glendale Water Treatment Plant
HDPE	High density polyethylene
HMI	Human-machine interface
IRP	Integrated Resource Plan
LADWP	Los Angeles Water and Power
MCL	Maximum Contaminant Level
Metropolitan	The Metropolitan Water District of Southern California
MF	Microfiltration
NTP	National Toxicology Program
NWRI	National Water Research Institute
OEHHA	California Office of Environmental Health Hazard Assessment
PAC	Project Advisory Committee
PHG	Public Health Goal
PLC	Programmable Logic controller
ppb	Parts per billion
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCF	Reduction/Coagulation/Filtration
RFP	Request for Proposal
SBA	Strong-base Anion Exchange
SCADA	Supervisory control and data system
TENORM	Technically Enhanced Naturally Occurring Radioactive Material
TIC	Tentatively identified compounds
TMP	Transmembrane pressure
TSS	Total suspended solids
UCMR	Unregulated Chemical Monitoring Requirement
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WaterRF	Water Research Foundation
WBA	Weak-base Anion Exchange