Hazen

Hazen and Sawyer
36-923 Cook Street, Suite 101
Palm Desert, CA 92211

Banning, CA
Established 1913
Proud History
Prosperous Tomorrow

City of Banning Chromium-6 Treatment and Compliance Study Memorandum

July 2016

Hazen and Sawyer
36-923 Cook Street, Suite 101
Palm Desert, CA 92211 • 760-834-8573

Hazen and Sawyer
36-923 Cook Street, Suite 101
Palm Desert, CA 92211 • 760-834-8573

Table of Contents

List of Tables

List of Figures

List of Appendices

Definitions

Abbreviation	Definition
AACE	Authority for Total Cost Management
ADD	Average Day Demand
AFY	Acre-Foot/Year
BAT	Best Available Technology
BV	Bed Volume
BCVWD	Beaumont Cherry Valley Water District
CCPP	Calcium Carbonate Precipitation Potential
cf	cubic feet
Cr3	Trivalent Chromium
Cr6	Hexavalent Chromium
CRRF	Central Resin Regeneration Facility
CVWD	Coachella Valley Water District
DDW	Division of Drinking Water
FTE	Full-time Employee
gpm	Gallons per Minute
IRIS	Integrated Risk Information System
IX	Ion Exchange
LSI	Langelier Saturation Index
M	Million
MCC	Motor Control Center

Abbreviation	Definition
MCL	Maximum Contaminant Level
MDD	Maximum Day Demand
MGD	Million Gallons per Day
NTP	National Toxicology Program
NPDWR	National Primary Drinking Water Regulations
O&M	Operations and Maintenance
OEHHA	Office of Environmental Health Hazard Assessment
PHG	Public Health Goal
PHD	Peak Hour Demand
PLC	Programmable Logic Controller
RCF	Reduction Coagulation Filtration
RCMF	Reduction Coagulation Filtration/Microfiltration
RCRA	Resource Conservation and Recovery Act
RTWM	Rothberg, Tamburini, and Winsor Model
SBA	Strong Base Anion Exchange
SCADA	Supervisory Control and Data Acquisition
Study	Study Memorandum
SWRCB	State Water Resources Control Board
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TDH	Total Dynamic Head
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TTLC	Total Threshold Limit Concentration
UWMP	Urban Water Management Plant
UCMR3	Third Unregulated Contaminant Monitoring Rule
USEPA	United States Environmental Protection Agency
VFD	Variable Frequency Drive
VOC	Volatile Organic Compound
WBA	Weak Base Anion Exchange
WQTS	Water Quality and Treatment Solutions

Executive Summary

The State of California released a new maximum contaminant level (MCL) for hexavalent chromium (Cr6) in drinking water, effective July 1, 2014. Nine of the City of Banning's (City, or Banning) groundwater wells are impacted by naturally occurring Cr6, as well as two co-owned wells with the Beaumont-Cherry Valley Water District (BCVWD). This Cr6 Treatment and Compliance Study aimed to identify the most reliable and cost effective approach for Cr6 compliance. Multiple compliance approaches were evaluated, including alternative sources of supply, well modifications, blending, and treatment. Based on the most viable options, scenarios were developed to determine the treatment configurations, including individual wellhead treatment, clustered treatment, and clustered treatment with blending. The most viable Best Available Technologies (BATs) listed by the State of California were examined to develop cost estimates and identify potential future risks in selection of different options.

Study Approach

The Study used a systematic approach to develop the compliance strategy including the following steps:

- **Define goals**. Cr6 treatment targets dictated the need for and size of treatment facilities. Targets of 60% and 80% of the MCL 6 (µg/L) and 8 µg/L, respectively), were evaluated. Decision criteria were defined to compare compliance scenarios.
- **Identify impacted wells**. Water quality and production records were analyzed to identify wells impacted by Cr6 and quantify the overall impact of Cr6 on the City of Banning water supply.
- **Develop compliance scenarios**. Based on geographical location and water quality, compliance scenarios were developed to evaluate both non-treatment (blending) and treatment approaches. Treatment facilities were sited for individual wells or wells were clustered together for treatment at a plant. The hydraulic impact of treatment location and clustering was also considered to identify required well pump modifications.
- **Summarize costs.** Estimates of capital, operations and maintenance, and lifecycle costs were developed for the treatment and blending scenarios.
- **Scenario evaluation.** The treatment and blending scenarios were compared with respect to the decision criteria to select the recommended compliance strategy that best fits the City's needs.

Treatment scenarios were evaluated in terms of cost, operational complexity, implementation complexity, and other water quality benefits, to site and select the technologies at each required treatment facility. Multiple scenarios were included in the evaluation; however, after considering infrastructure, flexibility, and cost demands, an approach with two clustered treatment facilities and two wellhead treatment facilities with SBA treatment technology was carried forward for further analysis.

Study Findings

The City of Banning's potable water distribution system is comprised of 21 active groundwater wells and 3 wells co-owned with BCVWD with a total nominal production capacity of 24,300 gallons per minute (gpm) (34.99 million gallons per day (MGD), or 39,199 acre-feet per year (AFY)) and a dry year (historical low) production capacity of 17,825 gpm (25.67 MGD, or 28,754 AFY). Maximum day demand in 2015 was 6,791 gpm – an approximate reduction of 27 percent from the prior 4-year average, which represents approximately 28 percent of the City's current nominal supply and 38 percent of the City's current dry year supply. Nine of the City's wells are impacted by Cr6 as well as two of the co-owned wells. Non-treatment and blending approaches were found not to be viable approaches; therefore, City wells will require treatment for compliance. Demand projections indicate estimated supply deficits excluding non-compliant wells range from 4,000 gpm to 11,000 gpm in the short-term (2020) and from 10,000 gpm to 17,000 gpm in the long-term (2035). These ranges account for the difference in wet and dry year supplies. These demand and supply projections were based on a conservative approach, due to the uncertainty of the drought, sustainability of conservations measures, and City growth.

Treatment technologies evaluated included Weak Base Anion Exchange (WBA), Strong Base Anion Exchange (SBA), and Reduction, Coagulation and Filtration/Microfiltration (RCF/RCMF). Treatment technologies were assessed in this study based on lifecycle costs and operability considerations (chemical consumption, residuals waste generation, and staffing requirements). For SBA, onsite regeneration was evaluated for the initial BAT comparison. Treatment capital cost estimates (AACE Class 4, accuracy range -30% to +50%) ranged from approximately $17M to $61M across the various technologies, with annual O&M ranging from $0.5M to $0.98M across technologies (**Table 1**).

Table 1. Summary of Cr6 Treatment Costs for Various BATs

BAT	TOTAL PROJECT CAPITAL ($M)	ANNUAL O&M ($M/Year)	ANNUALIZED CAPITAL + ANNUAL O&M LIFECYCLE ($M/Year)
WBA	18 to 38	0.67 to 0.98	1.4 to 2.6
SBA	17 to 36	0.5 to 0.54	1.2 to 2.1
RCF	23 to 48	0.86 to 0.93	1.8 to 3.1
RCMF	28 to 61	0.86 to 0.98	2.1 to 3.7

SBA was estimated as the least costly treatment technology on a lifecycle basis; however, there are multiple ways to implement SBA at the City of Banning wells. To evaluate this, a cost and operational comparison was performed for SBA with onsite or offsite resin regeneration with hazardous brine disposal or treatment. It was found that the option of regenerating offsite at a centralized resin regeneration facility (CRRF) offered the simplest operation. This approach has minimal treatment equipment at each treatment location including bag filters and conventional SBA vessels. Regeneration would be accomplished by trucking the resin from each treatment location to a centralized regeneration facility.

There are two options for the CRRF: (1) contract with another water agency to participate in a regional CRRF, or (2) include a CRRF at the Foothill West Treatment Cluster. For the latter, the Foothill West CRRF could also include a brine treatment process. The lowest capital cost was option (1), to regenerate SBA resin at a regional CRRF (**Table 2**). Regeneration frequencies for this option were estimated at approximately 10 to 15 total regenerations annually for the City of Banning system based on the current average well utilization.

Table 2: Cost Summary for SBA with Resin Regeneration at Regional CRRF

	Cr6 Facilities
Well C3	• 900 gpm SBA treatment with 300 gpm bypass to serve a total well capacity of 1,200 gpm • New well pump and motor
Well C6	• 700 gpm SBA treatment with 300 bypass for total well capacity of 1,000 gpm. • New well pump and motor • New 50,000 gallon reservoir and 1,000 gpm firm capacity booster station
Foothill West Cluster (Well M3, C2, C4)	• 2,500 gpm SBA treatment with 1,000 gpm bypass to serve a total well capacity of 3,500 gpm • Potential CRRF facility including provisions for resin regeneration and potentially brine treatment • 4,700 ft 12-in raw water transmission mains piping • 900 ft 18-in raw water transmission main piping • 1 MG reservoir • 3,500 gpm finished water pump station • PRV from Foothill West Zone to upper Main Zone
M12 Cluster (Well M10, M11, M12, C6)	• 2,800 gpm SBA treatment with 1,100 gpm bypass to serve a total well capacity of 3,900 gpm • 4,100 ft 12-in raw water transmission mains piping • 1,900 ft 16-in raw water transmission main piping • 1 MG reservoir • 3,900 gpm finished water pump station
CAPITAL COST ($M)	**$12M to $27M**
ANNUAL O&M ($M/YEAR)	**$0.7M to $0.8M**
LIFECYCLE COST ($M/YEAR)	**$1.2M to $2.0M**

Recommendations

SBA with centralized regeneration was identified as the most viable approach for Cr6 compliance at Banning wells. This approach includes minimal treatment equipment at each treatment location such as bag filters and conventional SBA vessels. Regeneration would be accomplished by trucking the resin from each treatment location to a centralized regeneration facility, either a regional CRRF, or a CRRF located at the Foothill West Treatment Cluster.

It is recommended that Banning initiate discussions with the only other water agency with a CRRF, the Coachella Valley Water District (CVWD), to determine the contract requirements and refine the cost estimates associated with participating in the regional CRRF. Based on these negotiations, the City will be able to determine whether including a CRRF at the Foothill West Cluster is needed as part of the current compliance approach or whether it could be added later to support future growth. The City may decide to move forward with the preliminary design of the Foothill West CRRF so that there is the option to incorporate this cost in the rate study and in funding applications.

Depending on the City's resources and funding availability, the City may consider evaluating treatment phasing study during preliminary design to prioritize design and construction of treatment for compliance, or potentially defer the construction of a portion of the treatment facilities. Hydraulic modeling analysis may be used to simulate demand and supply projections and identify any distribution system constraints.

Next Steps

The next steps for the City of Banning are to proceed with the tasks outlined in the Cr6 Compliance Plan including conducting a rate study, preparing funding applications, initiate discussions of participating in the regional CRRF approach with CVWD, and begin preliminary design. The City may also consider evaluating treatment phasing during preliminary design. To inform the preliminary design, pilot testing could be conducted define actual resin regeneration and brine treatment requirements for the City of Banning wells. Site tours could also be conducted of existing similar SBA and brine treatment facilities to give the City a better perspective of the treatment equipment and operational requirements.

1. Introduction and Study Objectives

In July 2014, the California State Water Resources Control Board Division of Drinking Water (SWRCB-DDW) set a new Chromium-6 (Cr6) maximum contaminant level (MCL) of 10 µg/L. Cr6 occurs naturally in the groundwater at the City of Banning (City, or Banning) and nine of the wells within Banning's potable water distribution system have observed Cr6 concentrations near or above the MCL. The City of Banning contracted Hazen and Sawyer to conduct a Cr6 Treatment and Compliance Study (Study) to recommend an efficient and cost effective approach for complying with the Cr6 MCL. The study aimed to analyze the options for removing Cr6 (and other co-occurring constituents if applicable) from the groundwater, and to develop a timetable for design and construction of the recommended treatment facilities. The Study included a treatment process evaluation to assess and compare treatment technologies, including costs and non-cost factors such as footprint, performance, residuals waste, water loss, operational complexity, and removal of other constituents of concern. The City of Banning goals for Cr6 compliance considered for the Study included the following:

- Achieve compliance with the Cr6 MCL for current and projected future water demands
- Identify a robust compliance approach that allows operational flexibility and minimizes operation and maintenance complexity
- Avoid stranded assets
- Reduce chemical and residuals handling requirements
- Identify potential project risks

1.1 Background

Chromium is a naturally occurring element found in rock (including California's state rock, serpentinite), soil, and groundwater. It is the 11th most common element found in the Earth's crust. Chromium is commonly present in the environment in primarily two forms: Cr3 and Cr6. While Cr3 is an essential nutrient for humans, Cr6 is extremely mobile and soluble, and is a probable human carcinogen. Cr6 can be found naturally in the environment, but it can also occur as an industrial byproduct in manufacturing processes for stainless steel, chrome plating, dyes, pigments, leather tanning, and wood preserving. Cr6 occurs naturally in Banning due to the erosion of local sediments.

In the past few years, the toxicology of Cr6 was re-evaluated in a National Toxicology Program (NTP) study.[1] Based primarily on this study, the U.S. Environmental Protection Agency (USEPA) released its draft assessment of Cr6 toxicology for public comment in September 2010. The document identified Cr6 as a likely human carcinogen through ingestion, and proposed a reference dose of 0.0009 mg/kg/day, which was much lower than the current reference dose of 0.003 mg/kg/day for total chromium. However, significant public comments were received and an external peer review panel recommended that the United States Environmental Protection Agency (USEPA) consider the results of peer-reviewed toxicology research prior to reissuing the Integrated Risk Information System (IRIS) Cr6 assessment and

[1] National Toxicology Program, 2008. Toxicology and Carcinogenesis Studies of Sodium Dichromate Dihydrate (CAS No. 7789-12-0) in F344/N Rats and B6C3F1 Mice (Drinking Water Studies). National Institutes of Health (NIH) Publication No. 08-5887.

to date, the assessment is still underway. Cr6 and total Cr (sum of Cr3 and Cr6) were part of the third Unregulated Contaminant Monitoring Rule (UCMR3), which together with the toxicology assessment could set the stage for a modification of the current total Cr MCL of 100 µg/L.

At 50 µg/L for total chromium, the State of California has a lower MCL than the federal limit. In addition, in July 2014 the SWRCB-DDW set a new Cr6 MCL of 10 µg/L. The MCL was set by DDW as close as feasible from a cost and technology feasibility perspective to the California (CA) Office of Environmental Health Hazard Assessment (OEHHA)'s Public Health Goal (PHG) of 0.020 µg/L. Compliance is calculated for a quarterly running annual average of monthly sampling based on rounding calculations such that 10.4 µg/L is in compliance, but 10.5 µg/L is not.

On September 4, 2015, Senate Bill 385 (SB385) was signed by the Governor of California, authorizing DDW to grant additional time for public water systems to come into compliance without being deemed in violation of the Cr6 MCL. Specifically, SB385 requires a Compliance Plan that will bring the system into compliance as soon as feasible, but no later than January 1, 2020. Banning's Cr6 Compliance Plan has been submitted and approved by DDW.

1.2 The City of Banning

The City of Banning, incorporated in 1913, evolved from a railroad and stagecoach stop between Arizona and Los Angeles. The City of Banning currently supplies a population of approximately 30,000 through 11,006 water connections and a total of 21 active potable groundwater wells, with an additional 3 wells co-owned with BCVWD[2]. The City of Banning's mission is to supply high quality water to utility customers, as well as provide resource planning for a long term reliable water supply. Banning's water system is shown in **Figure 1** and described as follows:

- 21 total active potable groundwater wells, which are operated as needed throughout the year.
- 3 co-owned wells with BCVWD of which the City is entitled to half of the capacity. This capacity is accessed by the City through an interconnection with BCVWD near the intersection of Highland Springs Avenue and Sun Lakes Boulevard.
- Wells have depths ranging from 1,000 to 1,500 feet deep.
- Of the Cr6 impacted wells, C2, C3, C4, and C5 currently pump directly into a forebay tank located at each individual well site, which is subsequently pumped into the distribution system via an additional booster station.
- Of the Cr6 impacted wells, C6, M3, M10, M11, and M12 pump directly into the distribution system.
- There are a total of 13 existing reservoirs (including forebay tanks at Wells C2, C3, C4, and C5) that have a total above ground storage capacity of 19.7 million gallons (MG)[3].

[2] City of Banning 2010 Urban Water Management Plan
[3] Ibid.

The City's distribution system is currently configured with six different pressure zones: Foothill East, Foothill West, Mountain North, Mountain South, Main (Upper Main / Lower Main), and Lower 1. It should be noted that, although the valves are in place, the Upper Main and Lower Main Zones are currently operated as a single pressure zone pending the construction of a proposed Lower Main reservoir in order to avoid having wells pump into a closed zone. The City of Banning experiences high distribution system pressures in the southern portion of the (Lower) Main Zone upwards of 200 psi, and will continue to experience high pressures until the proposed Upper Main / Lower Main zone division is complete.

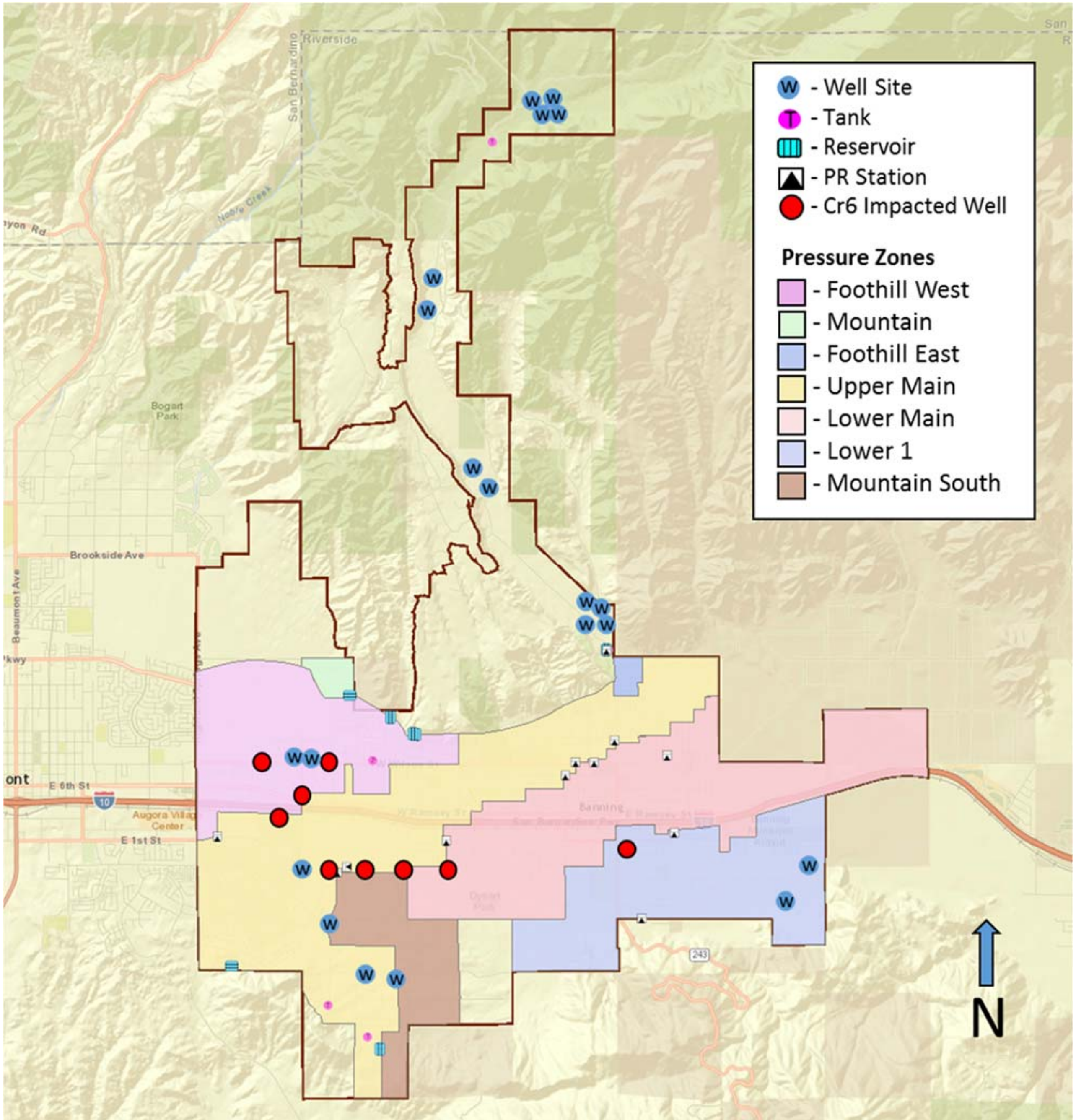

Figure 1: City of Banning Existing Potable Water Distribution System

1.3 Study Approach and Report Organization

The Cr6 Treatment and Compliance Study analyzed the costs and benefits of removing Cr6 and developed a compliance strategy for design and construction of recommended treatment facilities. The Study used a systematic approach to develop the compliance strategy including the following steps:

- **Define goals**. Cr6 treatment targets dictated the need for and size of treatment facilities. Targets of 60% and 80% of the MCL (6 µg/L and 8 µg/L, respectively), were evaluated. Decision criteria were defined to compare compliance scenarios.
- **Identify impacted wells**. Water quality and production records were analyzed to identify wells impacted by Cr6 and quantify the overall impact of Cr6 on the City of Banning water supply.
- **Develop compliance scenarios**. Based on geographical location and water quality, compliance scenarios were developed to evaluate both non-treatment (blending) and treatment approaches. Treatment facilities were sited for individual wells or wells were clustered together for treatment at a plant. The hydraulic impact of treatment location and clustering was also considered to identify required well pump modifications.
- **Summarize costs.** Estimates of capital, operations and maintenance, and lifecycle costs were developed for the treatment and blending scenarios.
- **Scenario evaluation.** The treatment and blending scenarios were compared with respect to the decision criteria to select the recommended compliance strategy that best fits the City's needs.

This report summarizes the Study findings and is organized in the following sections:

- Section 1 provides background for the project, including a discussion of the Cr6 regulation and overview of the Banning water system.
- Section 2 describes Banning's current water supply, infrastructure, and system demands.
- Section 3 presents a summary of available water quality information.
- Section 4 outlines approaches that can be taken to comply with the Cr6 MCL.
- Section 5 provides background information on the available Cr6 treatment technologies.
- Section 6 presents the scenarios that were evaluated and resulting cost estimates.
  Section 7 summarizes the Study conclusions

2. System Supply and Demand

2.1 Groundwater Well Capacity and Infrastructure

The City of Banning obtains 100 percent of its water supply from local groundwater aquifers through the use of 21 groundwater wells, and an additional three co-owned wells with BCVWD, for a total design capacity of 24,300 gpm, or 39,199 acre-feet per year. During a dry year (historical low), the capacity of the wells decrease in response to decreased precipitation and subsequent recharge to a total dry year capacity of 17,825 gpm, or 28,754 acre-feet per year[4]. Nine of the 21 wells that the City owns and operates are impacted with Cr6, seven of which have Cr6 concentrations that are projected to exceed the MCL (Wells C2, C3, C4, C6, M10, M11, M12), and two that, although currently less than the MCL, are close enough to the MCL to require treatment planning (Wells C5 and M3). Two of the three co-owned BCVWD wells are also impacted (Wells 25 and 26).

The nine Cr6 impacted wells represent approximately 40 percent of the City's total nominal production capacity, consisting of approximately 9,600 gpm of the City's total 24,300 gpm well capacity. The capacities of the Cr6 impacted wells are summarized in **Table 3** below. The capacities used in this Study for the purposes of sizing and evaluating treatment systems were estimated to be the greater of the nominal well capacity or historical field test results, rounded up to the nearest 100 gpm.

Table 3: Banning Cr6 Impacted Well Capacities

Well	Nominal Production Capacity (gpm) [1]	Historical Field Test Range (gpm) [2]	Capacity Used for Treatment Evaluation (gpm) [3]
C2	1,100	1,095	1,100
C3	1,200	910 – 1,107	1,200
C4	1,350	1,240 – 1,310	1,400
C5	1,100	890	1,100
C6	1,000	950	1,000
M3	950	540 - 810	1,000
M10	890	856	900
M11	700	570 - 587	700
M12	1,000	1,080 – 1,150	1,200
		Total	**9,600**

[1] Based on City of Banning Well Data Sheet.
[2] Based on field pump test data (See Appendix A).
[3] Greater of the nominal production capacity or historical high field test capacity, rounded up to the nearest 100 gpm.

Wells, C2, C3, C4, and C5 currently pump directly into a forebay tank located at each individual well site, which is subsequently pumped into the distribution system via an additional booster station. Each of these booster stations is equipped with a constant speed pump(s) and a "look-down" pump throttling system where a control valve restricts the booster station flow in order to maintain a constant level in the forebay to prevent excessive starting and stopping of the well and booster pumps. The City has indicated that this configuration was developed to mitigate entrained air in the groundwater, although it is unclear at this time if entrained air in the groundwater is still an issue. At Well C2, there is a dual-zone booster station

[4] City of Banning 2010 Urban Water Management Plan

that can convey water to either the Upper Main or the Foothill West Pressure Zones. Wells C6, M3, M10, M11, and M12 pump directly into the distribution system. Well M12 has currently been taken off of the potable water distribution system and connected to a non-potable system that currently serves the Sun Lakes Community's Champions Golf Course; however, the City may reincorporate Well M12 back into the potable system with the addition of proposed treatment.

A summary of the wells co-owned with BCVWD is provided in **Table 4**. The City is entitled to 50 percent of the co-owned well capacity based on the agreement with BCVWD. These wells are located within the BCVWD potable water distribution system and their capacity is accessed by the City through a metered interconnection with BCVWD located near the intersection of Sun Lakes Boulevard and Highland Springs Avenue, which feeds into the Upper Main Zone. City staff must call BCVWD to manually activate the interconnection, which currently provides one-way flow, although it could potentially flow bi-directionally. City staff have indicated that this interconnection is currently hydraulically limited to approximately 1,000 gpm, although this interconnection could potentially be upsized. There are also future stub-outs for interconnections, although those interconnections have not been made at this time.

Table 4: City of Banning / BCVWD Co-owned Wells[5]

Well	Total Capacity (gpm)	Banning Capacity Allocation (gpm)
24	2,500	1,250
25	2,900	1,450
26	1,500	750
Total	**6,900**	**3,450**

2.2 Water Demands

Existing water demands were calculated based on City well production data from 2010 to 2015. Well production data were utilized as this represents the actual demand on the system including customer usage and non-revenue water. Demands were relatively consistent from 2010 to 2014 and there was a sharp decrease in demand in year 2015 (**Figure 2**), likely due to drought-related conservation efforts. A trend in increasing percentage of total production produced by impacted wells was also observed in recent years, which can be attributed to less availability of groundwater in the canyon well storage units due to drought.

Well utilization, which is expressed as a percentage of water actually produced by a well compared to its nominal production capacity, ranged between 8 percent and 36 percent for the impacted wells from 2010 to 2015, with an average of 20 percent to 32 across all impacted wells for an overall average impacted well utilization of 25 percent. For the purposes of this Study, 25 percent well utilization was assumed for all wells in the development of annual O&M cost estimates. In the future, it is anticipated that the City's well utilization strategy will change with respect to future demands and to optimize system operations and costs.

[5] Beaumont Cherry Valley Water District 2013 Urban Water Management Plan Update

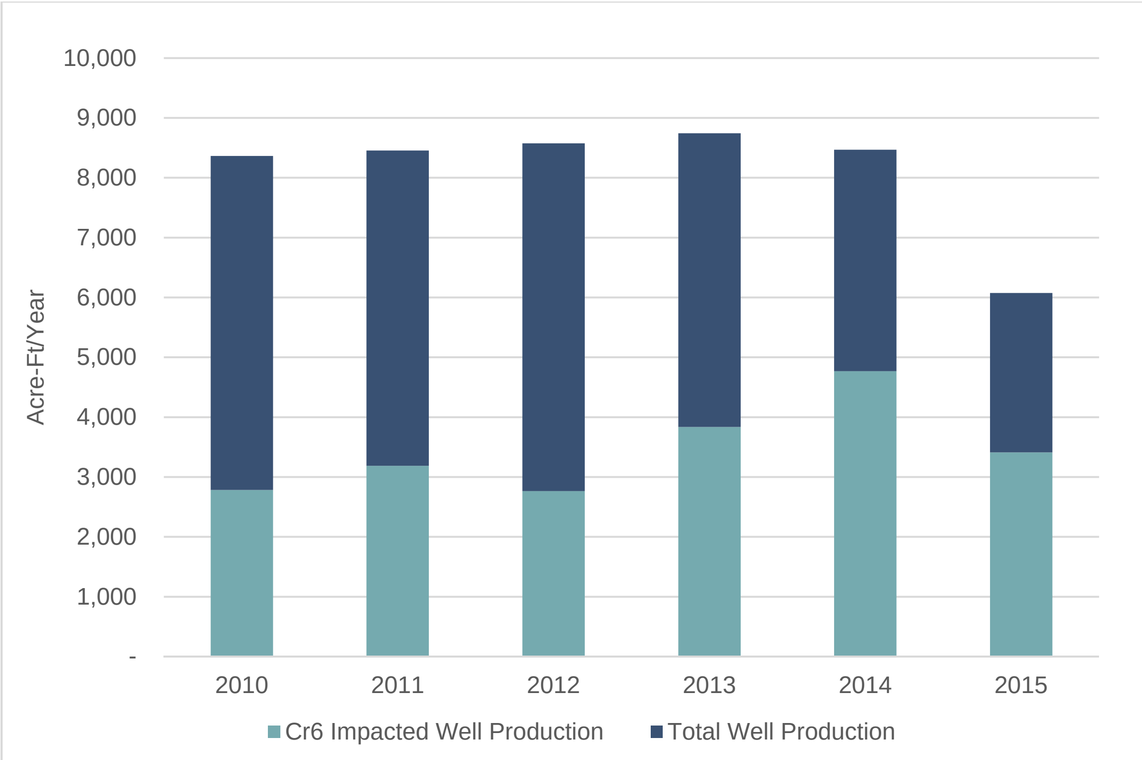

Figure 2: Impacted and Total Banning Well Production

Future demand projections were taken into consideration to estimate how much of the impacted well supply would be required for compliance, and to identify if there are any apparent opportunities for phasing in treatment of impacted wells. Demand projections were based on those made in the 2010 UWMP. While two different projection methods were utilized (population-based, and land use-based), it was observed that recent demand data most closely aligned with the population-based projections; therefore, the population-based projections were utilized for the purpose of this Study. Although actual demand data indicates a recent drop off and deviation from the projections due to drought-related conservation efforts, due to the uncertainty of the sustainability of the conservation measures, City population growth, and City land development, the 2010 UWMP population-based projections were utilized as a conservative approach. Maximum day demand projections were made based on a factor of 2.24 times average day demand, which is consistent with the maximum day demand factor in the City of Banning Water System Hydraulic Modeling Report, prepared by MWH (May 2002). Refer to **Figure 3**.

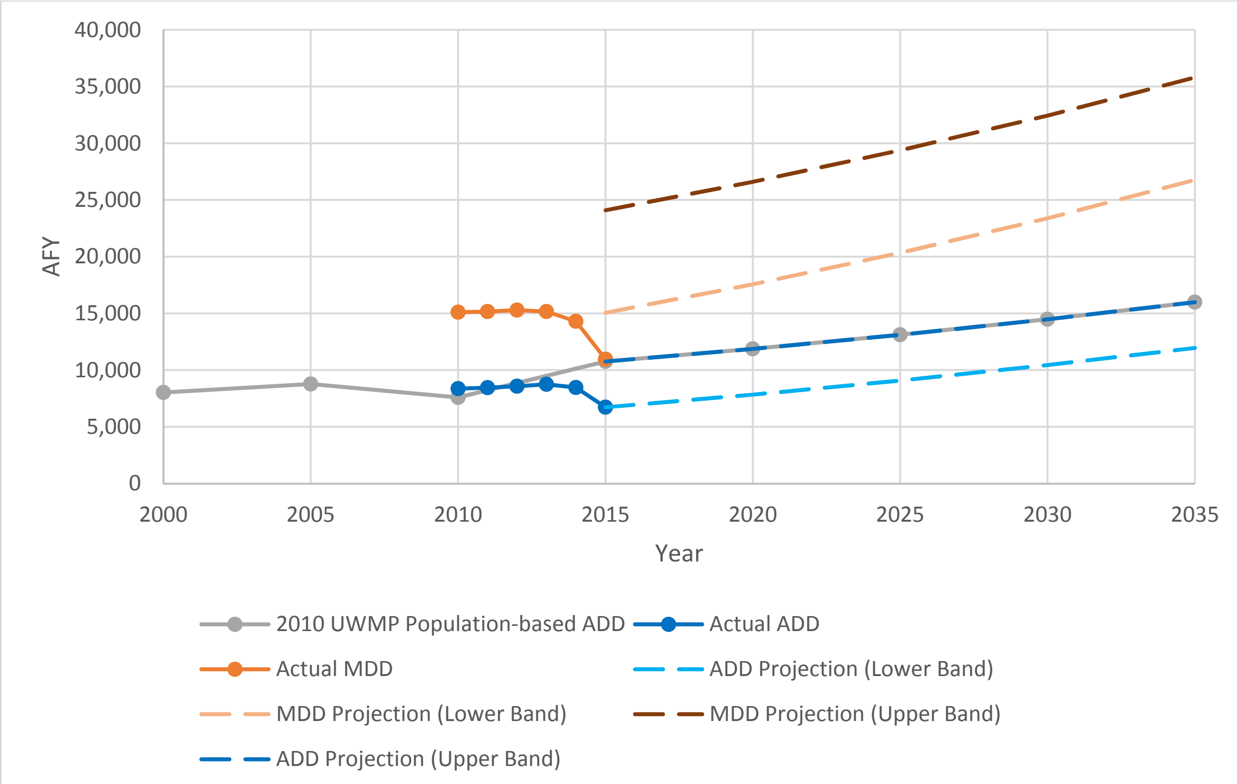

Figure 3: Demand Projections

The demands from 2010 to 2015 as well as short-term (2020) and long-term (2035) demand projections were compared to the existing City water supply in normal and dry years with and without impacted wells to determine if there is enough supply to serve the City now and in the future. While the demand analysis shown in **Table 5** indicates that there is a currently a surplus supply without impacted wells under normal supply years, there are estimated deficits without impacted wells of approximately 4,000 gpm in the short-term and 9,800 gpm in the long-term. During dry years without the impacted wells, there is an existing estimated deficit of approximately 800 gpm, with estimated deficits of approximately 10,500 gpm in the short-term and 16,200 gpm in the long-term. It should also be noted that these figures do not account for routine well downtime for maintenance purposes and do not capture any distribution system-related constraints for supply transfer (i.e., impacted wells are located central to demand concentrations and replacing their supply with a more remote supply may be limited by existing pipeline sizes, etc.). For short-term and long-term planning, it is in the interest of the City to address the Cr6 impacts to ensure that the supply of impacted wells as well as future wells that may be impacted continue to be part of the City's supply portfolio.

Table 5: Demand and Supply

	Annual Demand (AFY)	Average Day Demand (gpm)	Max Day Demand (gpm)[2]	Nominal Well Capacity (Historical High)		Dry Year Well Capacity (Historical Low)	
				Supply Surplus/ Deficit (gpm)[3]	Supply Surplus/ Deficit (gpm) Excluding Impacted Wells (gpm)[4]	Supply Surplus/ Deficit (gpm)[5]	Supply Surplus/ Deficit (gpm) Excluding Impacted Wells (gpm)[4]
2010	8,365	5,186	9,363	14,937	3,137	8,462	-3,338
2011	8,454	5,241	9,401	14,899	3,099	8,424	-3,376
2012	8,575	5,316	9,479	14,821	3,021	8,346	-3,454
2013	8,743	5,420	9,401	14,899	3,099	8,424	-3,376
2014	8,468	5,250	8,865	15,435	3,635	8,960	-2,840
2015	6,723	4,168	6,791	17,509	5,709	11,034	-766
Short-term Projection (2020)[1]	11,880	7,365	16,497	7,803	-3,997	1,328	-10,472
Long-term Projection (2035)[1]	15,989	9,912	22,203	2,097	-9,703	-4,378	-16,178

[1] Average annual demand projection based on population-based projection in City of Banning 2010 UWMP Table 3-1.
[2] Maximum day demand projection based a factor of 2.24 times average day demand consistent with the City of Banning Water System Hydraulic Modeling Report, prepare by MWH (May 2002).
[3] Based on a total supply of 24,3000 gpm per 2010 UWMP Well Capacity (Historical High).
[4] Excludes 9,600 gpm for City of Banning and excludes 2,200 gpm for co-owned wells.
[5] Based on a total supply of 17,825 gpm per 2010 UWMP Dry Year Capacity (Historical Low).

3. Water Quality

Historical water quality (**Appendix B**) information was reviewed to define treatment requirements, select applicable treatment technologies, and evaluate parameters that affect operational costs. Available groundwater well data were compiled to create a water quality database for analysis. The database utilized pivot-tables and pivot-figures for trending analysis. To account for data variability and to provide a level of conservatism in facility design, the maximum water quality concentrations were used for evaluation and design.

3.1 Cr6 and Total Cr

Both Cr6 and total Cr data (**Appendix C**) were reviewed to identify wells impacted by the Cr6 MCL and to observe trends in Cr variability over time. Note that there is a difference in accuracy of the analytical methods for Cr6 and total Cr. Cr6 is analyzed using EPA method 218.6 (reporting limit of 0.050 µg/L), while total Cr is typically analyzed using EPA 200.8 (reporting limit 1.0 µg/L). None of the observed maximum Cr6 samples were apparent outliers in these data, therefore treatment was planned based on the maximum observed Cr6 concentration. Compliance planning for nine of the twenty one wells which have chromium concentrations at or near the Cr6 MCL (wells C2, C3, C4, C5, C6, M3, M10, M11, M12) shown in **Figure 4**. The average total Cr and Cr6 concentrations in Banning wells from 2010 to 2015 are shown in **Figure 5** with error bars representing the maximum and minimum readings.

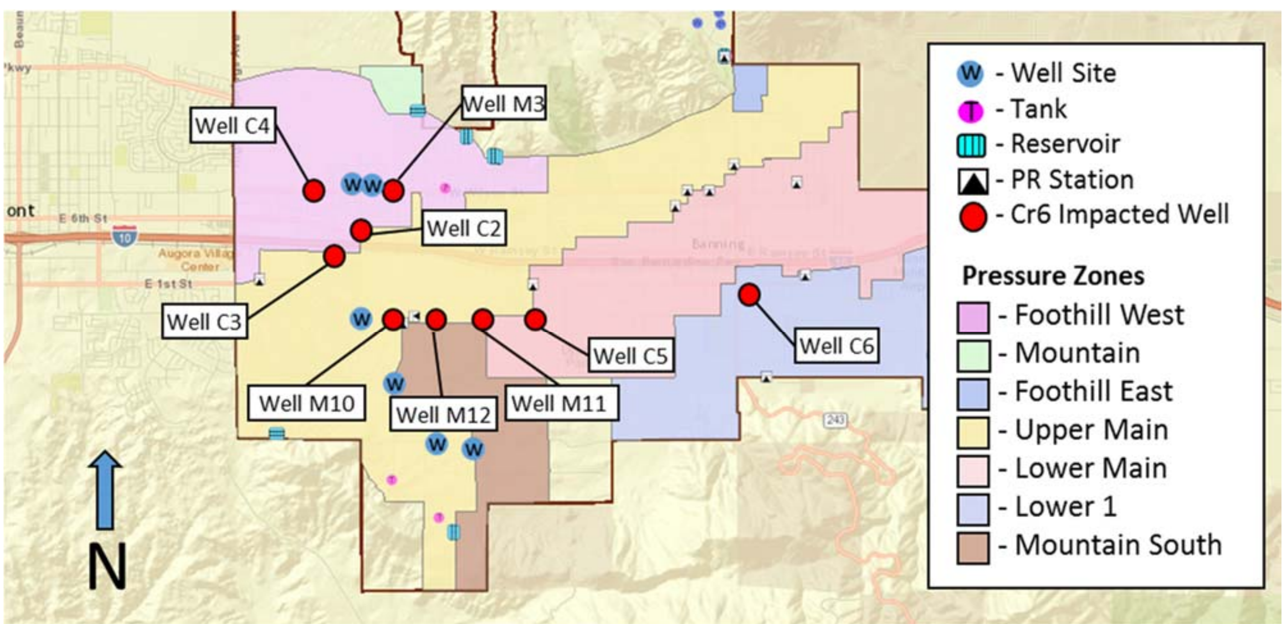

Figure 4: Cr6 Impacted Well Locations

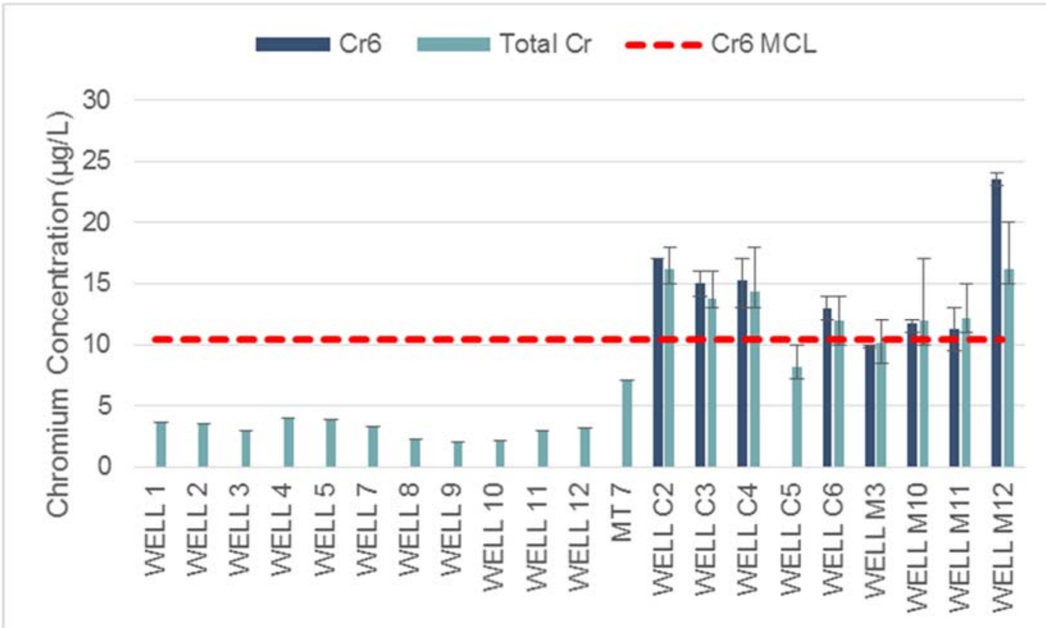

Figure 5: Banning Cr6 Concentration (2010-2015)

3.2 Water Quality Constituents that Impact Treatment Selection

Co-occurring constituents in groundwater can affect treatment selection and operations. For example, if higher levels of nitrate or arsenic are present, it can accumulate and slough off (i.e., chromatographic peaking) in strong base anion exchange systems. Solutions exist for minimizing impacts from nitrate peaking and would require incorporation of safeguards into the design, such as blending of multiple treatment vessels and/or online nitrate monitoring to discharge water in excess of the MCL to waste. Sulfate, alkalinity, total dissolved solids (TDS), pH and calcium can impact the effectiveness of treatment for Cr6 by reducing the resin life (e.g., sulfate competes with Cr6 on SBA resin) or impacting the chemical dosing requirements (e.g., higher alkalinity increases the acid dose needed to reduce the pH for WBA). Additionally, other constituents such as selenium and uranium that are readily removed with anion exchange processes can impact waste disposal options or the effectiveness of waste brine treatment processes. It was found that none of these constituents were present in the Cr6 impacted Banning wells at concentrations requiring treatment or impacting treatment technology selection for Cr6 as discussed below. **Table 6** summarizes the range of concentrations observed for these constituents in the Cr6 impacted Banning wells.

Nitrate. Banning wells that are impacted by Cr6 have low nitrate (maximum concentrations of 11 mg/L as NO_3 compared with the MCL of 45 mg/L as NO_3). While none of these wells require nitrate treatment, nitrate is removed by SBA resin for a short amount of treatment time (usually less than 500 bed volumes (BVs)) compared with Cr6, which has a higher selectivity. Once nitrate is at capacity on the resin ion exchange sites, chromatographic peaking can occur that results in release of nitrate at concentrations two to four times higher than the influent concentration. Even if chromatographic peaking does occur in this case, the concentration of nitrate would still be less than the MCL.

Arsenic. All of the Cr6 affected wells have arsenic levels at or around 3.5 μg/L, which is slightly above the detectable limit of 2 μg/L, but is well below the arsenic MCL of 10 μg/L. Arsenic is removed in the SBA treatment process through the resin (usually less than 3,000 BVs). Similar to nitrate, arsenic chromatographic peaking can occur that results in release of arsenic at levels two times higher than the influent concentration; however, even if chromatographic peaking dose occur in this case, the concentration of arsenic would still be less than the MCL.

Sulfate. The relatively low sulfate concentrations allow for longer SBA runtimes (approximately 20,000 bed volumes) between regenerations, making SBA an attractive option for Banning wells.

Alkalinity. Banning wells have moderate alkalinity ranging from 100 mg/L to 180 mg/L. At these levels, the estimated CO_2 dose required to reach a pH of 6.0 for WBA range from approximately 180 to 290 mg/L.

TDS. TDS ranges from 130 to 300 mg/L in the Cr6 impacted Banning wells, which is below the recommended secondary MCL for TDS of 500 mg/L and the upper limit of 1,000 mg/ for consumer acceptance.

Calcium. Calcium concentrations in Banning wells ranged from 2 mg/L to 44 mg/L. As part of the treatment assessment, corrosively of the treated water is assessed. A positive LSI should be maintained to prevent corrosive water to the distribution system.

Uranium. Based on these SBA resin regeneration frequency estimates and if the waste brine is treated, the resulting uranium in the solid waste is anticipated to be a low level radioactive waste (despite uranium concentrations in the raw well water being relatively low). This could potentially be mitigated with optimization of the brine treatment process or more frequent regeneration of the resin. Generation of LLRW waste requires disposal at an Energy Solutions Facility in Utah. Additional permitting requirements with CDPH Radiologic Branch will also be required.

Selenium. Selenium concentrations are non-detect (less than 5 μg/L) in the Cr6 impacted Banning wells. Despite being non-detect, selenium could be present in the waste brine at concentrations greater than 1 mg/L, requiring treatment if non-hazardous brine disposal is desired. Compared with chromium and uranium, selenium removal from waste brine requires significantly higher iron doses and produces a larger quantity of hazardous solid waste that would require disposal. This could potentially be mitigated with modification of the resin regeneration process to reduce selenium concentrations by reducing the volume of recycle and thereby increasing the overall volume of liquid waste brine. Pilot testing is important to understand any limitations that selenium may place on the City’s treatment options.

Table 6. Banning Well Water Quality (2010 to 2014)

	M3	M10	M11	M12	C2	C3	C4	C5	C6
Cr6 (µg/L)	8.1-10	9.9-12	9.3-13	18-24	14-17	14-16	13-17	5.3-9.6	10-14
Arsenic	<2.0	<2.0	3.2-3.3	3.2-3.2	<2.0	<2.0	<2.0	3.7-3.9	3.9-3.9
Nitrate	7.2-8.2	9.6-11.0	3.7-4.5	6.4-8.0	7.7-11.0	7.4-8.5	4.7-7.5	5.9-6.6	7.1-8.2
Sulfate (mg/L)	35-37	3-4.9	15-18	4.1-6.5	9.3-10	5.9-8.3	9.4-11	7-7.8	16-17
Alkalinity (mg/L as $CaCO_3$)	150-180	100-110	110-140	120-130	150-160	110-140	140-160	110-120	120-150
TDS (mg/L)	250-300	160-180	170-210	170-190	210-240	130-190	180-240	140-180	230-260
pH (s.u.)	7.7-7.9	7.9-8	8.2-8.4	7.8-8.1	7.9-7.9	7.9-8.1	7.7-8.1	8.1-8.3	7.8-7.9
Calcium (mg/L)	39-41	19-22	20-28	24-27	41-44	2-32	36-38	14-16	26-35
Hardness (Mg/L as $CaCO_3$)	150-160	78-82	57-80	80-91	140-150	79-100	120-130	45-53	87-130
Selenium (µg/L)	<5	<5	<5	<5	<5	<5	<5	<5	<5
Uranium (pCi/L)	0.398	n/a	n/a	0.199	0.199	0.696	0.497	0.597	0.298

3.3 Emerging Constituents

The ability of Cr6 treatment options to remove emerging constituents was evaluated to address the potential for selection of an approach that offers the most flexibility and cost savings for future compliance, as well as current compliance.

On the federal level, the Safe Drinking Water Act (SDWA) has several upcoming major regulatory actions that may impact which constituents are regulated in the future, including the preliminary regulatory determinations (RD3) from the third Contaminant Candidate List (CCL3), the draft fourth Contaminant Candidate List (CCL4) that was issued in February 2015, and the Six-Year Review in 2016. Additional pending regulations include the perchlorate draft rule and a draft rule adding eight additional carcinogenic VOCs to the existing VOC regulations.

The final RD3 was released by EPA in January 2016 and included negative determinations for four constituents. The final RD3 decided to delay the final regulatory determination for strontium in drinking water to consider additional data. If the Agency makes a final determination to regulate strontium, EPA will begin the process to propose a National Primary Drinking Water Regulation (NPDWR). The draft CCL4 was issued in February 2015. Changes from CCL3 to CCL4 included the addition of manganese and nonylphenol; the removal of perchlorate (EPA made a positive regulatory determination in 2011); and the removal of the five constituents with preliminary regulatory determinations pending publication of the final RD3. Nitrosamines and chlorate are opined by American Water Works Association (AWWA) to likely be included in the third Six-Year Review. Nitrosamine regulation is uncertain due to high source contribution from food.

In California, several additional constituents have had Public Health Goals (PHGs) decreased and Notification Levels established. A brief description of data for each constituent, is provided in **Table 7** below.

Table 7: Emerging Constituent Concentrations 2010-2015

Parameter	Relevant Limits	Concentrations in Cr6 Impacted Banning Wells
Chlorate	• EPA health reference level (HRL) of 210 µg/L. • Notification level (NL) of 800 µg/L in California. • World Health Organization guideline value of 700 µg/L.	• Chlorate concentrations ranged from 29 µg/L to 130 µg/L in the Banning distribution system and 110 µg/L to 320 µg/L at the BCVWD intertie.
Nitrosamines	• No federal HAL or reference level. • Three nitrosamines (n-nitrosodiethylamine: NDEA, n-nitrosodimethylamine: NDMA, and n-nitrosodipropylamine: NDPA) have NLs in California of 10 ng/L. • NDMA has a PHG of 3 ng/L in California. • No nitrosamine MCLs in California, but require notification if the NL is exceeded.	• No nitrosamine data were available for Banning wells.
1,4-Dioxane	• NL of 1 µg/L in California.	• No detectable 1,4-dioxane concentrations (<0.07 µg/L) for Banning wells.
Antimony	• Federal and California MCL of 6 µg/L. • California Public Health Goal (PHG) of 0.7 µg/L.	• No detectable concentrations of antimony in Banning wells (<6 ug/L).
Molybdenum	• HAL of 40 µg/L • No MCL, NL, or PHG in California.	• There were no detectable concentrations of molybdenum (<1 µg/L).
Perchlorate	• No federal limit. • 6 µg/L MCL in California. • California PHG decreased in 2015 from 6 µg/L to 1 µg/L.	• There were no detectable concentrations of perchlorate (<4 µg/L).
Selenium	• Selenium has a current federal and California MCL of 50 µg/L. California PHG of 30 µg/L.	• 4.6 µg/L in Well M12, non-detect (<5 ug/L) in all other Banning wells.
Strontium	• EPA Health advisory level (HAL) of 4 mg/L for lifetime exposure. • No public health goal, notification level (NL), or MCL.	• There were no detectable strontium concentrations in Banning wells (<0.3 µg/L)
Vanadium	• Vanadium has a NL of 50 µg/L in California and an EPA reference level of 21 µg/L	• There were no detectable vanadium concentrations (<0.2 µg/L)

4. Compliance Approaches

4.1 Alternative Source of Supply

Potential alternative sources of supply identified to replace the Cr6 impacted supply include increased reliance on Banning canyon wells, increased supply from a neighboring water purveyor (BCVWD), or using recycled water to offset potable water demands. These alternatives are displayed graphically in **Figure 6** as listed below and described in the following sections:

1. Inactivate impacted wells
2. Drill additional wells in the Canyon and Banning Bench Storage Unit
3. Increase BCVWD supply
4. Use recycled water to offset demands

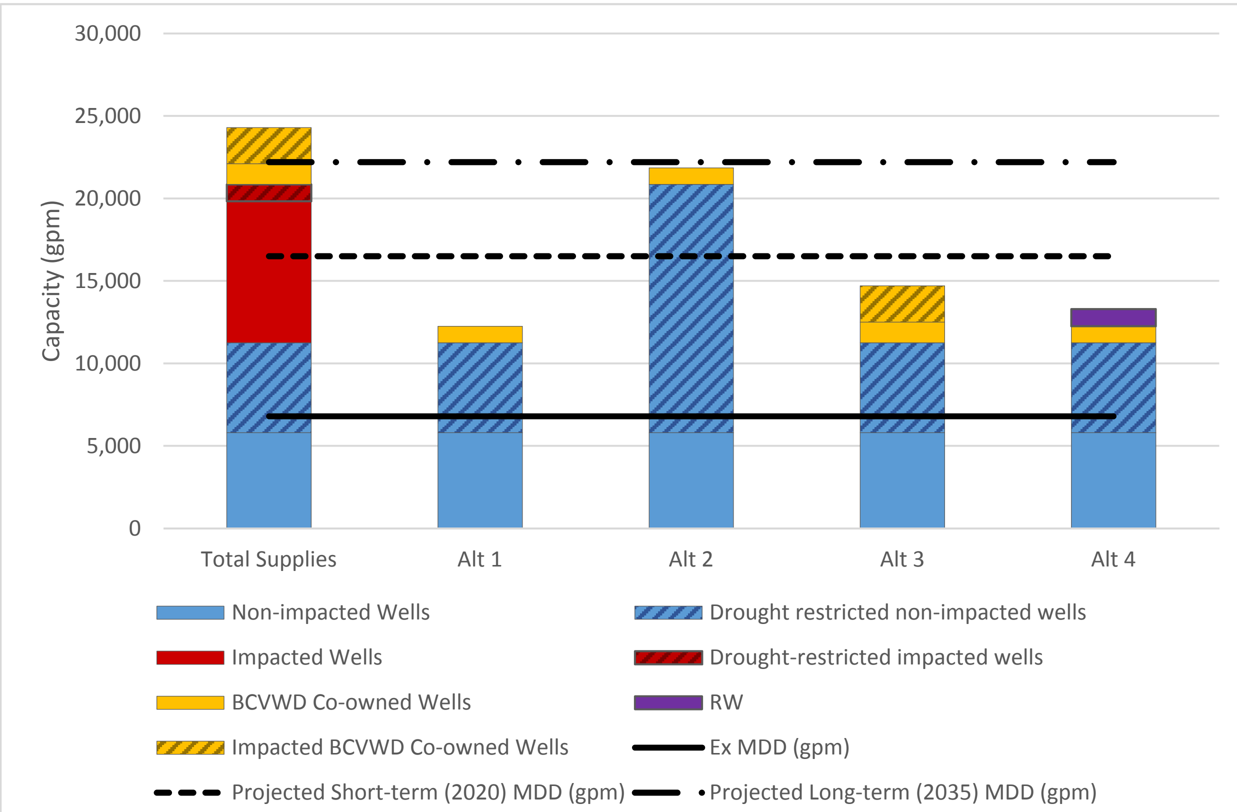

Figure 6: Alternative Supply Comparison

4.1.1 Alternative 1 – Inactivate Impacted Wells

The first option considered for compliance was to inactivate all or a portion of the Cr6 impacted wells and utilize only those wells that are in compliance. If all impacted wells were to be inactivated, it would result in an approximate 40 percent reduction in total water supplies for the City, not including the impacted co-owned BCVWD wells and the dry year supply reduction in the Canyon Storage Unit. Demand projections indicate estimated supply deficits excluding non-compliant wells range from 4,000 gpm to 11,000 gpm in the short-term (2020) and from 10,000 gpm to 17,000 gpm in the long-term (2035). This range accounts for the difference in wet and dry year supplies. These demand and supply projections were based on a conservative approach, due to the uncertainty of the drought, sustainability of conservations measures, and City growth. Based on these projections, inactivating impacted wells is not a feasible approach; however, the City is currently preparing the 2015 UWMP, and changes in the demand and supply projections could potentially present opportunities for phasing in the construction of treatment facilities.

4.1.2 Alternative 2 – Drill Additional Wells in Canyon Storage Unit

The City of Banning has 12 canyon wells located in the northern canyons in the Canyon and Banning Bench Storage Units that are supplied mostly by percolation from rainfall and surface runoff. These wells consistently have less than 1 ppb of Cr6 concentrations and are operated with higher priority over Banning's remaining wells due to the lower operational cost and good water quality. Data in the 2010 UWMP indicates that well capacities in the Canyon and Banning Bench Storage Units can be impacted up to 51 percent under dry year (historical low) conditions, and City staff have recently confirmed that the current prolonged drought has in fact had a significant impact on the capacity of the canyon wells, with an approximately one-third reduction noted. While the supply and demand analysis shows that these non-impacted wells could potentially serve existing demands, the canyon wells would not alone be able to support neither short-term nor long-term future projected demands. The 2010 UWMP indicates that the safe yields of the Canyon and Banning Bench Storage Units are 4,070 AFY and 1,960 AFY, respectively. This combined total of 6,030 AFY suggests that there may be some limited opportunities for adding well supply in these Storage Units of roughly 2,700 gpm assuming existing and additional wells would continue to have utilizations around 25 percent; however, any additional capacity in these Storage Units could be subject up to a 51 percent reduction under dry year conditions, and the distribution system would need to be analyzed to determine if any improvements would be required in order to convey the supply the long distances from the north throughout the entire city. Based on the apparent limited amount of yield that may be obtained from the Canyon and Banning Bench storage units coupled with the uncertainty of reliable supply given the extent of the current ongoing drought, reliance upon canyon wells as an alternative source of supply was judged to be infeasible by City staff.

4.1.3 Alternative 3 – Increase BCVWD Supply

The City of Banning's service area borders that of the Beaumont-Cherry Valley Water District (BCVWD). There is one existing 12-inch interconnection between the two agencies at the western boundary of Banning's service area near the intersection of Highland Springs Avenue and Sun Lakes Boulevard. The interconnection currently conveys water in a single direction and could be improved to serve water in either direction based on hydraulic gradients. The City has indicated that the capacity of this interconnection is 1,000 gpm, which could potentially be increased. Although an additional capacity of 2,450 gpm would help ensure that City has access to their supply entitlement, it would not actually serve to increase the City's supply portfolio. Additionally, two of the co-owned wells (25 and 26) that are located in the same Beaumont Storage Unit as other Banning wells, are also out of compliance due to Cr6, representing a combined impacted capacity of 2,200 gpm, and may not be relied upon without treatment. It is not anticipated that increasing deliveries from BCVWD would serve to avoid treatment, and a separate analysis would need to be performed to determine any required distribution system improvements to support deliveries beyond the current contractual limitations. Even if it is determined that BCVWD has a surplus in supply beyond what they may currently wheel to the City, increasing this supply component would decrease the City of Banning's control on their water supply. For these reasons, increased supply from a neighboring water purveyor was not considered a viable approach for Cr6 compliance.

4.1.4 Alternative 4 – Recycled Water Offset

The City currently uses secondary-treated recycled water to recharge the Cabazon Storage Unit and is developing a program to use recycled water for irrigation purposes. Part of the recycled water planning includes upgrading the City of Banning Wastewater Treatment Plant (WWTP) to produce 1,680 acre-ft per year[6] of tertiary-treated water for irrigation of golf courses, parks, medians, greenbelts, and groundwater recharge. The City is also planning to continue discussions to interconnect recycled water systems with BCVWD following the expansion of the WWTP. Banning has recently designated Well M12 as a non-potable well to be used for golf course irrigation, although it may be converted back to a potable well with the proposed treatment. While developing recycled water is part of a comprehensive water supply portfolio, the amount of recycled water used to decrease potable water demands is only 8 percent of the total alternative supply and is not anticipated to be great enough to replace the Cr6 impacted potable supply, and therefore was not considered a viable approach for compliance.

4.2 Well Modification

Well modification could consist of installing packers, an engineered suction, modifying the well flow rate, or a combination thereof, in order to limit or eliminate water produced from poor water quality zones within the well casing screens, and maximize the water produced from the good water quality zones. The goal of well modification would be to produce water with a Cr6 concentration below the MCL in order to avoid treatment. Prior to performing well modification, dynamic flow and chemistry profiling studies are done to understand the production and water quality within the well casing zones, and likelihood of well modification success.

The City performed well profiling studies for the co-owned Wells 25 and 26 in April and June of 2015, respectively. The results of the profiling study for Well 25 indicated that 33 percent of the well's screen sections produce good to excellent water quality, and if combined with some marginal and poor water quality sections, appeared to offer an economically viable solution. The profiling study recommended a phased approach, combining a series of packers with an engineered suction and pumping rate testing. This proposed approach was estimated to reduce Well 25 production up to 35 percent. The results of the profiling study for Well 26 indicated that the majority of the well casing screens produced Cr6 concentrations above the MCL with the exception of the very upper and lower sections that, if viable,

[6] City of Banning 2010 Urban Water Management Plan

could produce a resulting water quality below the Cr6 MCL. Additional testing was recommended to confirm the very bottom screen production capacity and to identify if there is any short circuiting from the higher zones above.[7,8]

Based on the results of well profiling thus far, it can be expected that well modification for the remaining impacted wells may or may not be a potential solution depending on individual well and groundwater basin characteristics. To assess the likelihood of Cr6 compliance through well modification, the City would be required to perform well profiling on every impacted well. Additional field testing may also be required to verify profiling study findings. Any estimated reductions in well capacity due to modification must be weighed against providing treatment. At this point in time, the City is currently evaluating funding opportunities to continue with testing, and conduct well profiling studies on the remaining impacted wells.

4.3 Blending

Blending options were analyzed to assess whether treatment requirements could be eliminated or reduced. Ideally, impacted wells would be blended directly with non-impacted wells for a blend of water that is below the MCL. Alternatively, impacted wells could be blended with distribution system water. In order to avoid circular pumping, the blend water supply must come from a hydraulically-isolated supply independent from where the blended water would be discharged, for example, blending of water from an isolated pressure zone. Attempting to blend within a single pressure zone or within interconnected pressure zones will invariably produce compliance issues due to circular pumping and difficulty in controlling blending flow rates and effluent Cr6 concentrations. Several blending options were evaluated as part of this Study, from system-wide blending to individual well blending. All blending flow capacities were calculated using a target Cr6 blended effluent concentration of 8 ppb, which would allow for blending with supplies treated to 6 ppb while still staying below the MCL with a margin of safety.

To evaluate system-wide blending of all of the Cr6 impacted wells, the capacities and maximum Cr6 concentrations were used to calculate the blending flow requirement, assuming a blending flow Cr6 concentration of 1 ppb (representative of the canyon wells) and a final Cr6 effluent concentration of 8 ppb. The higher the well capacity and Cr6 concentration in the impacted well, the higher the blending flow requirement. The results of the blending calculations, shown in **Table 8**, indicate that a total blending flow of 11,458 gpm would be required to blend all of the impacted wells, which is roughly equal to the City's entire non-impacted supply, not accounting for dry year supply reductions. The dry year capacity of the Canyon wells is further limited to 7,000 gpm, which is insufficient to cover all of the impacted wells. Refer to **Appendix D** for detailed blending calculations.

[7] Dynamic Flow and Chemistry Profile Report: Well 25, prepared by BESST Inc., April 15, 2015
[8] Dynamic Flow and Chemistry Profile Report: Well 26, prepared by BESST Inc., June 8, 2015

Table 8: System-wide Blending Requirements

Well	Capacity Used for Treatment Evaluation (gpm)	Max Cr6 (µg/L)	Blending Flow Req'd (gpm)
C2	1,100	17	1,414
C3	1,200	16	1,600
C4	1,400	17	2,100
C5	1,100	9.6	293
C6	1,000	14	1,000
M3	1,000	12	667
M10	900	12	600
M11	700	13	583
M12	1,200	24	3,200
Total	**9,600**	**-**	**11,458**

In addition to the limitations on available blending supply, the hydraulic logistics must also be considered. The canyon wells are located up to 8 miles from the City's service area, and while although the City has a strong backbone system, because the canyon wells have the ability to serve every one of the City's pressure zones, it would not be feasible to isolate any blended effluent from what would be blended source water. While system-wide blending was not determined to be feasible, localized blending scenarios were also evaluated, which are described in **Section 6.1.**

4.4 Treatment

Best Available Technologies (BATs) for Cr6 treatment were assessed, including Ion Exchange (Strong Base Anion Exchange (SBA) or Weak Base Anion Exchange (WBA)) and Reduction, Coagulation, and Filtration/Microfiltration (RCF/RCMF). Reverse Osmosis is also a BAT but was not included in the technology evaluation due to the higher water loss associated with this technology (15 to 25 percent compared with less than 1 percent for the other BATs). A comprehensive treatment evaluation was performed including assessment of individual wellhead treatment, clustered treatment, and a combination of clustered treatment and blending scenarios (discussed further in **Section 6**).

5. Treatment Technologies

Cr6 treatment technologies were assessed with respect to treatment effectiveness and residuals management (including quantity and quality of waste generated and treatment and disposal options). Additionally, system operations were considered, including staffing requirements and system flexibility with respect to down time. The potential for future cost escalations with respect to availability and cost of chemicals and residuals disposal options is also discussed. WBA, SBA, and RCF/RCMF, can be applied in different configurations to manage waste residuals. For this analysis, the approaches evaluated provide bookends for a range of approaches, as summarized in **Table 9**. Current methods for waste management (e.g., SBA brine recycling and rinse water return, RCF/RCMF backwash water recycling) and process optimization (e.g., RCMF with a 5 minute reduction time) were incorporated into the analysis. The advantages and disadvantages of each technology are summarized in the sections below.

Table 9: Treatment Approaches Evaluated

Technology	Key Features	Waste Handling
WBA	8 to 10-ft diameter carbon steel vessels operated in lead/lag pairs; carbon dioxide and aeration for pH adjustment	WBA resin disposal as hazardous waste, no brine waste handling.
SBA	8 to 10-ft diameter carbon steel vessels operated in parallel; onsite regeneration, on-site brine treatment with non-hazardous brine hauling	Non-hazardous brine hauling or sewer disposal, hazardous solids disposal.
SBA	3-ft diameter FRP vessels housed in a 12x20 conex; onsite regeneration with hazardous brine hauling	Hazardous brine hauling
SBA	12-ft diameter carbon steel vessels with CVWD standard design; haul resin offsite by truck for regeneration at CVWD's CRRF; no waste disposal except at CRRF	None by City, contract with Nearby Water Agency
SBA	12-ft diameter carbon steel vessels operated in parallel; haul resin to Banning CRRF by truck for regeneration; CRRF includes brine treatment with non-hazardous brine sewer disposal	Non-hazardous brine hauling or sewer disposal, hazardous solids disposal.
RCF	Filtration with granular media; backwash water recycled and non-hazardous sludge disposed to the sewer (estimated 1% water loss)	Non-hazardous backwash water sludge to sewer.
RCMF	Filtration with microfiltration membranes; backwash recycled and non-hazardous sludge disposed to the sewer (estimated 1% water loss)	Non-hazardous backwash water sludge to sewer.

5.1 Weak Base Anion Exchange (WBA)

WBA removes Cr6 from the water and converts it into Cr3 on the resin surface. With continuing operation of the resin, Cr6 concentrations in the treated water slowly increase as the resin capacity for Cr6 is used. WBA resin is replaced, rather than regenerated, when the target goal is exceeded. **Figure 7** illustrates a schematic of the WBA treatment process. Particles are removed from the groundwater using bag filters to minimize pressure drop in the resin bed and to minimize the need for backwashing. WBA resins are sensitive to pH and work most effectively for Cr6 removal at a pH of 6.0. pH adjustment can be accomplished using carbon dioxide (CO_2) or acid (sulfuric or hydrochloric). Alkalinity and pH primarily determine the CO_2 or acid dose necessary, with higher pH and alkalinity requiring more CO_2 or acid. Banning wells have moderate alkalinity (approximately 130 mg/L), resulting in an estimated required CO_2 dose of approximately 300 mg/L. Chemical expenses for pH adjustment were included in the O&M cost estimates.

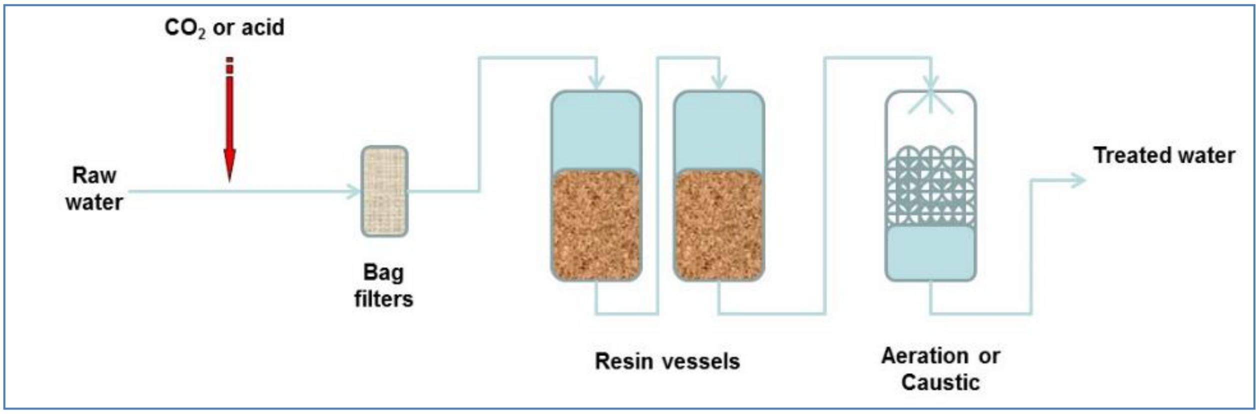

Figure 7: WBA Treatment

Three WBA resins have been identified as having a high capacity for Cr6. These resins can operate for more than 300- to 400-thousand bed volumes (more than three years) before they require replacement. By comparison, SBA resins typically require replacement or regeneration on the order of months. The typical configuration for WBA resin includes trains of two vessels in series (lead/lag). Aeration or caustic is used downstream of the WBA resin to raise the pH of treated water to avoid corrosive water quality conditions in the distribution system. If aeration is used, the treatment system breaks head and additional pumping is required to meet distribution system pressure requirements. In this case, a clearwell and booster pump station are also included in the treatment system design.

Residuals generated by the WBA process include spent resin, flush water generated at resin replacement, and backwash wastewater (although backwash is not expected unless the well is a sand/silt producer and bag filters are ineffective). Spent resin is expected to be a non-RCRA hazardous waste due to a high chromium concentration above the California Total Threshold Limit Concentration (TTLC) and Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) or Low Level Radioactive Waste (LLRW) if significant uranium accumulates. Thus, the spent resin needs to be disposed of to a non-RCRA hazardous waste landfill if disposed in California or at EnergySolutions in Utah if determined to be a LLRW. With naturally occurring uranium in the groundwater and the long life of WBA resin, uranium accumulation on the resin is likely and resin disposal costs are included in O&M cost estimates based on an assumption of non-RCRA hazardous TENORM waste.

Flush water and backwash water are expected to be non-hazardous and can be discharged to the sewer. For WBA, this water loss is predicted to be less than 0.01 percent of the treated water flow. Refer to **Table 10** for advantages and disadvantages of WBA.

Table 10: WBA Considerations

Advantages	Disadvantages
• High capacity for Cr6 (more than three years of operation before resin change out) • Ease of operation • Minimal water loss	• Resin disposal • pH adjustment • Requires booster pumps due to breaking head during aeration

5.2 Strong Base Anion Exchange (SBA)

In the SBA process, water passes through a resin bed and Cr6 is removed by replacing other negatively charged inert ions (e.g., chloride). Similar to WBA, particles are removed using bag filters (strainers) to minimize pressure drop through the resin bed and reduce the need for backwashing. Water passes through the SBA resin, which selectively removes Cr6 from the water. Cr6 in the treated water gradually increases over time as the resin capacity for Cr6 is filled. Other ions with similar charge in the water can also compete with Cr6 and exhaust the resin bed more quickly. Resin capacity can range between 10,000 BVs to more than 20,000 BVs (approximately one month of operation with full utilization) primarily depending on sulfate concentration. SBA is regenerated with a salt (brine) solution when the treated Cr6 concentration reaches the treatment target level. Regeneration involves elution of the Cr6 off the resin into the brine, in the process restoring capacity of the resin for additional Cr6 removal. A process flow schematic depicting the SBA process is provided in **Figure 8**.

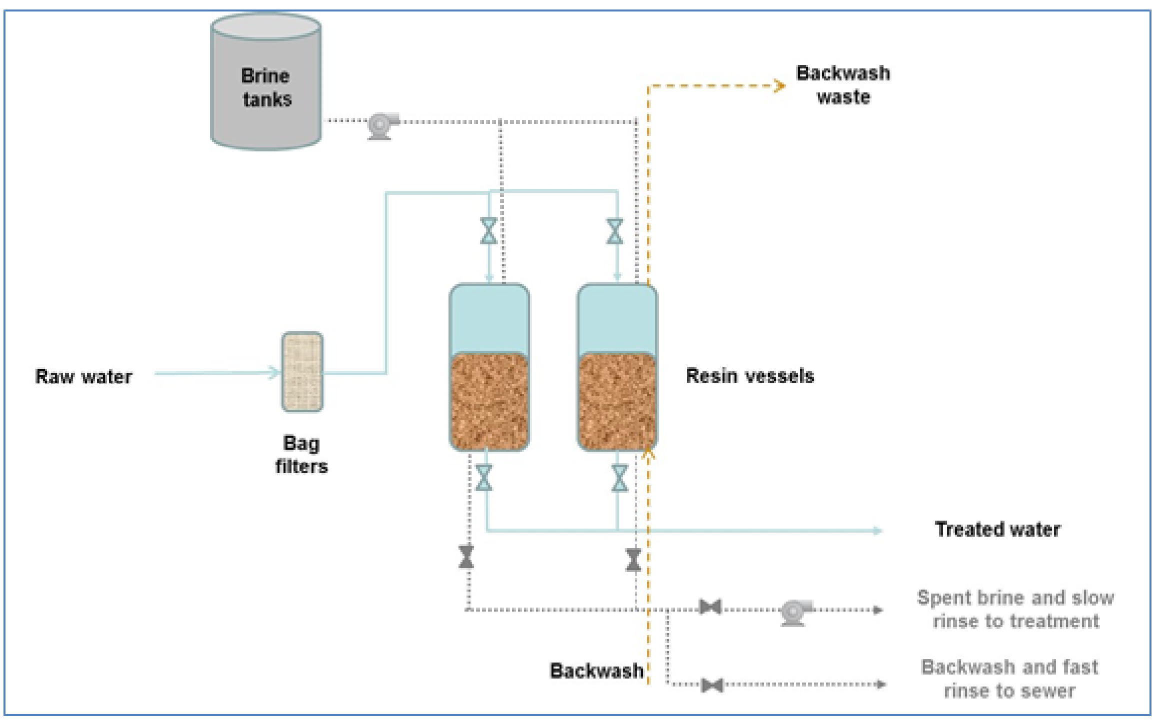

Figure 8: SBA Treatment Process

SBA resin is not sensitive to the pH of the water for effective Cr6 removal (unlike WBA resin), which eliminates the need for pre-treatment pH adjustment. However, post-treatment pH adjustment may be necessary, if the treated water quality is corrosive toward piping materials. Calcium carbonate precipitate potential (CCPP) or Langelier Saturation Index (LSI) can be used as indicators of water corrosivity. Alkalinity is removed by the resin during a short period in each resin service cycle after regeneration, which results in reduced pH in treated water. Treated water alkalinity and pH typically returns to the raw water concentration in a day. If multiple vessels are operated in parallel or water is bypassed around treatment with final blending, changes in alkalinity and pH can be minimized.

Residuals from SBA include spent brine and rinse wastewater produced during the regeneration process, including a slow rinse and fast rinse. Prior to regeneration, a backwash step is sometimes applied to ensure even distribution of resin before brine is added. The final step requires a rinse to remove any residual brine from the resin bed. Brine management is a challenge for SBA applications due to the high anion and TDS concentrations found in the spent brine. Spent brine has been reported to be a non-RCRA hazardous waste due to the high Cr6 concentrations. Recent testing has shown that the brine might contain selenium as well. An example of this was observed for some Coachella Valley wells, where despite low concentrations in the groundwater, concentrations in the brine were present at greater than 1 mg/L making the brine RCRA hazardous waste. Spent brine could be either disposed as a non-RCRA or RCRA hazardous waste or can be treated to remove Cr6 before disposal as a non-hazardous waste. Strategies to minimize residual volumes include regeneration optimization, segmented regeneration, and brine recycle with or without treatment. For SBA with brine recycle, water loss is less than approximately 0.01 percent of the treated water flow.

SBA has been tested extensively from bench- to full-scale for Cr6 removal. All studies have shown that SBA can remove Cr6 effectively and consistently to below 10 µg/L, although the resin life before regeneration varied for raw water qualities, resin products, and test conditions. Sulfate has been identified as having the most impact on resin capacity for Cr6. Banning wells have relatively low sulfate (3 to 37 mg/L), resulting in a manageable required regeneration frequency. **Table 11** summarizes the advantages and disadvantages that are associated with using SBA.

Table 11: SBA Considerations

Advantages	Disadvantages
• More history of applications in drinking water treatment than WBA (i.e. for other constituents including arsenic, nitrate, and perchlorate) • No pH adjustment needed for pre-treatment • Booster pumping not required as system does not break head during treatment • Minimal water loss	• Runtimes dependent on background water quality (especially sulfate) • Regeneration waste brine handling and disposal

Cr6 removal with SBA is straightforward; however, regeneration requirements and subsequent brine management are more complex. For this reason, multiple options for SBA were considered including onsite and offsite resin regeneration, onsite brine treatment, and hazardous brine disposal. For the offsite resin regeneration option, the concept of building and maintaining a centralized regeneration facility as well as utilizing a central resin regeneration facility being built by Coachella Valley Water District (CVWD) was evaluated.

5.3 Reduction, Coagulation, and Filtration/Microfiltration (RCF/RCMF)

The RCF process involves reduction of Cr6 to Cr3 using ferrous iron, coagulation of Cr3 with ferric hydroxides, and filtration to remove the Cr-associated particles. **Figure 9** illustrates a schematic of the RCF treatment process. Components in the RCF process include ferrous iron addition, a reduction tank that provides time for ferrous iron to reduce Cr6 to Cr3 and coagulate, hypochlorite (or air) addition to oxidize remaining ferrous to ferric, polymer addition to a rapid mixing tank to enhance floc formation (if granular filters), granular media filtration and backwash recovery. For the RCMF process, instead of granular media filtration for particle removal, membrane filtration is used (without the addition of polymer). Testing indicates that granular media filters can reliably remove total Cr to below 5 µg/L, while microfiltration can remove total Cr to below 1 µg/L. In general, RCF and RCMF processes are not as affected by raw water quality (such as nitrate or sulfate) compared with SBA.

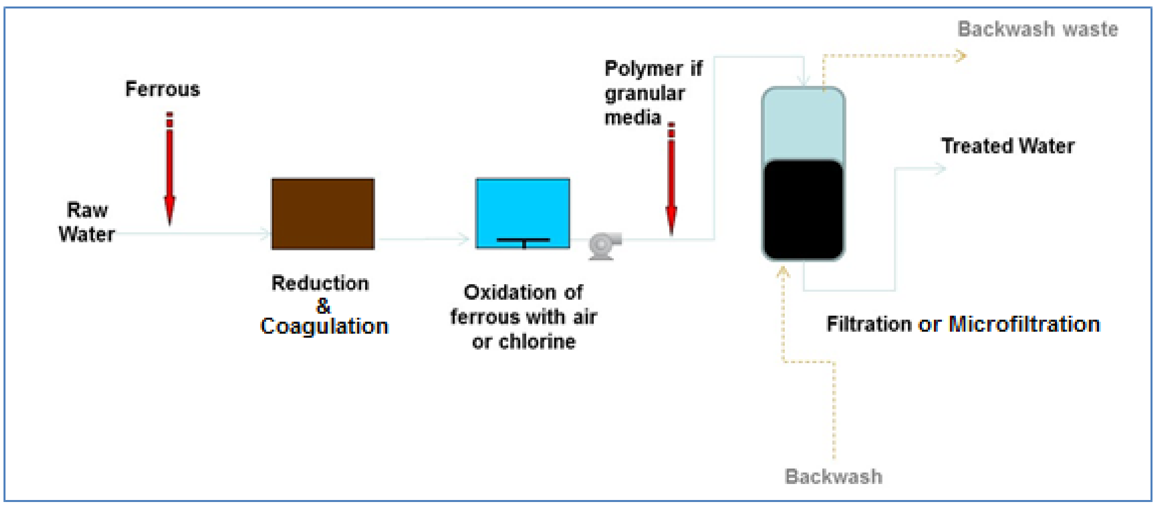

Figure 9: RCF/RCMF Treatment Process

Backwashing makes up about 3 to 5 percent of the flow for RCF and up to 5 to 6 percent for RCMF. Backwash water recovery can be incorporated in the RCF or RCMF process to recycle water and reduce overall system water loss to less than 1 percent. The processed backwash water contains Cr3 and may be discharged directly to the sewer if acceptable to the Banning WWTP. For the RCMF process, chemical cleaning and clean-in-place solutions will also require disposal. **Table 12** summarizes the advantages and disadvantages that are associated with using RCF/RCMF.

Table 12: RCF/RCMF Considerations

Advantages	Disadvantages
• Less susceptible to water quality changes • No pH adjustment typically needed • Filter backwash water can be discharged to sewer, eliminating hazardous waste residuals	• Aeration or chlorine addition is needed • Relatively complex system, larger footprint • Backwash disposal • Repumping likely required

6. Scenario Evaluation

6.1 Treatment System Sizing

Treatment systems were sized using a partial stream treatment approach. This approach bypasses a portion of the raw water around treatment, blending it with the treatment effluent, allowing for the treatment system to be sized to treat only the fraction of water needed to meet the target Cr6 concentration in the final blend. At the request of the City, target Cr6 concentrations 6 µg/L and 8 µg/L were assessed as a conservative approach to provide capacity for fluctuations in groundwater or treated water concentrations. The 2 µg/L differential in treatment target did not significantly reduce the capital cost (systems are similar in size requiring the same number of major equipment components). The treatment target does impact O&M costs. A higher goal of treating to 8 µg/L for example, would reduce operating costs, but would adversely impact any potential blending opportunities by requiring increasing amounts of blending water supply in order to achieve compliance. In operation, these goals could be adjusted to maintain a treated water concentration below the Cr6 MCL. The range in treatment targets of 6 µg/L to 8 µg/L are reflected in the range of O&M estimates (Section 6.7).

6.2 Treatment Configurations and Scenario Development

Several configurations for treatment were evaluated as potential compliance scenarios, including: individual wellhead treatment, clustered treatment, and clustered treatment with blending. These scenarios are described in detail in the following sections.

6.2.1 Scenario A - Individual Wellhead Treatment

Wellhead treatment facilities were sized based on well capacity, maximum Cr6 concentration, a treated Cr6 target of 6 µg/L, and rounded up to the nearest 100 gpm. The resulting treatment system capacity and bypass are presented in **Table 13**. For SBA, WBA, and RCMF treatment technologies, a Cr6 treatment goal of 2 µg/L in treatment system effluent and 6 µg/L in the final blend with bypass were the design criteria used to size the capital facilities. For RCF, the treatment systems are slightly larger with less or no bypass, as the Cr6 concentration in the treatment effluent from these types of systems have been observed as high as 5 µg/L. The individual treatment locations and respective sizing estimates are shown in **Figure 10**.

Table 13: Individual Cr6 Treatment System Sizing

Well	Max Cr6 (µg/L)	Well Capacity (gpm)	Treatment Design Capacity: WBA, SBA, and RCMF (gpm)	Bypass Fraction: WBA, SBA, and RCMF	Treatment Design Capacity: RCF (gpm)	Bypass Fraction: RCF
C2	17	1100	900	18%	1100	0%
C3	16	1200	900	25%	1100	8%
C4	17	1400	1100	21%	1300	7%
C5	9.6	1100	600	45%	900	18%
C6	14	1000	700	30%	900	10%
M3	12	1000	600	40%	900	10%
M10	12	900	600	33%	800	11%
M11	13	700	500	29%	700	0%
M12	24	1200	1000	17%	1200	0%

Figure 10: Individual Wellhead Treatment

Individual wellhead treatment would require available footprint at each well site for the equipment associated with the type of selected treatment technology. The space constraints at each site dictated the types of treatment that could be implemented on the respective well sites. During the well site visits, the available space was evaluated and compared against the typical footprint required for each treatment technology (**Table 14**). The SBA with CRRF option was identified as the only individual wellhead treatment option that would fit at all well sites.

Table 14: Available Footprint and Treatment Sizing Viability

Location	Approx. Footprint Available (ft^2)	Conventional SBA	Containerized SBA	SBA With CRRF	WBA	RCF	RCMF
C2	2,800		✓	✓			
C3	4,000	✓	✓	✓			
C4	4,900	✓	✓	✓	✓	✓	✓
C5	1,000			✓			
C6	4,600	✓	✓	✓	✓	✓	✓
M3	5,700	✓	✓	✓	✓	✓	✓
M10	1,700			✓			
M11	2,100		✓	✓			
M12	18,900	✓	✓	✓	✓	✓	✓

6.2.2 Scenario B - Clustered Treatment

Clustered treatment involves piping two or more wells together at centralized treatment sites, with the benefits including minimizing the number of treatment facilities and increasing the potential treatment technologies that could be implemented, as the identified clustered treatment sites would not have the same space constraints as the individual well sites. The City could benefit from close proximity of several impacted wells.

Two clustered treatment sites were identified with the intent of minimizing the lengths of raw water piping that would be required: 1) the M12 well site, hereinafter referred to as the "M12 Cluster", and 2) an undeveloped parcel located on the west side of Highland Home Road just north of West Wilson Street (not currently owned by the City), hereinafter referred to as the "Foothill West Cluster". The M12 Cluster could include Wells C5, M10, M11, and M12, while the Foothill West Cluster could include Wells C2, C4, and M3. Wells C3 and C6 were not included in a cluster due to either long pipe runs or challenges with pipeline alignments; instead, a hybrid treatment option was developed with two clustered treatment facilities and individual wellhead treatment at Wells C3 and C6. **Table 15** summarizes the treatment design capacities for the clustered treatment scenario. Clustered treatment utilize the proximity of the wells, but will still require the addition of pipelines, as well as clearwells and booster pumps (described further in Section 6.4). The clustered treatment configuration with the proposed raw water transmission piping is shown on **Figure 11**.

Table 15: Clustered Treatment Sizing

Well	Max Cr6 (µg/L)	Well Yield	Treatment Design Capacity: WBA, SBA, and RCMF (gpm)	Bypass Fraction: WBA, SBA, and RCMF	Treatment Design Capacity: RCF (gpm)	Bypass Fraction: RCF
C5, M10, M11, M12	14.8	3500	2500	29%	3200	9%
C2, C4, M3	15.7	3350	2400	28%	3100	7%
C3	16	1000	800	20%	1000	0%
C6	14	800	600	25%	800	0%

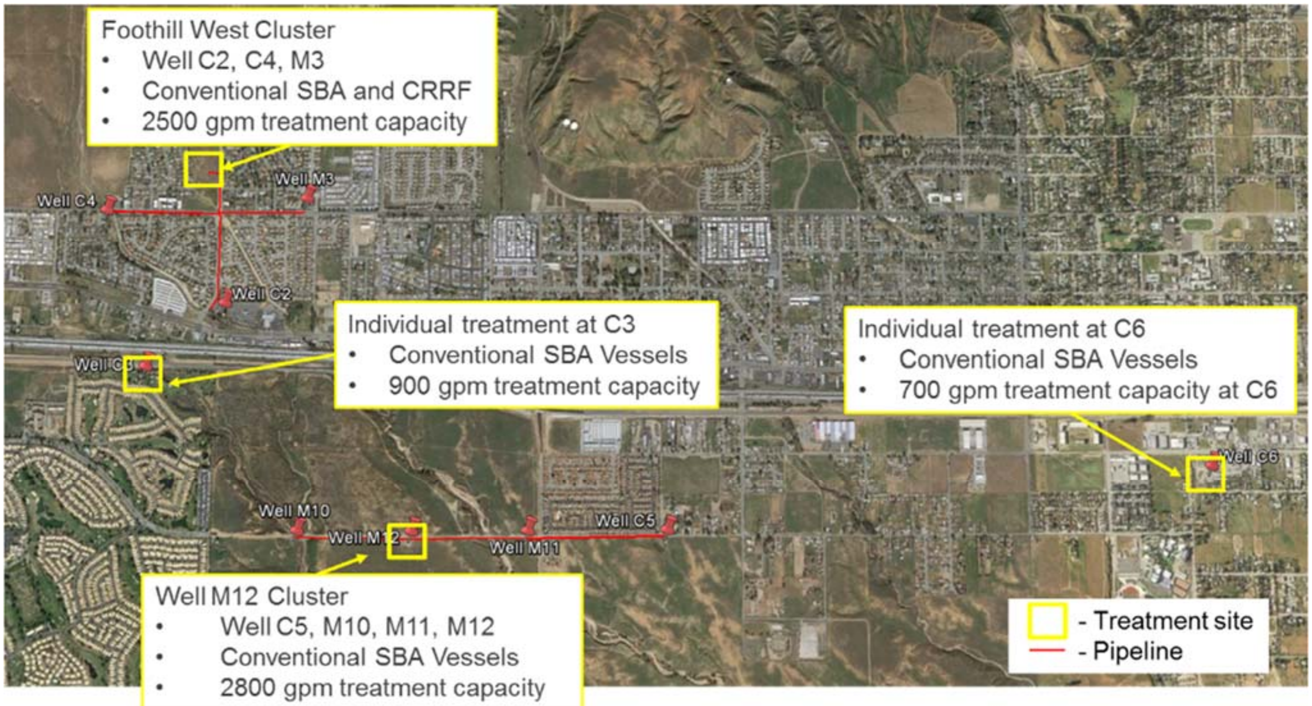

Figure 11: Hybrid Cluster/Individual Treatment

6.2.3 Scenario C - Clustered Treatment with Blending

Building upon the clustered treatment configuration described above, blending options were again considered, albeit on a more localized level, in an effort to potentially reduce or eliminate treatment requirements.

The first localized blending option that was considered was to treat one of either the Foothill West Cluster or the M12 Cluster and use that cluster to blend with the non-treated cluster. This was determined not to be feasible based on the extensive amount of piping, pumping, and pressure reducing that would be required. In addition, it would hinder the operational flexibility of the system, requiring both clusters to be in operation simultaneously. In order to maintain feasible blending flow volume requirements, this option would also require the Cr6 treatment target at the treatment cluster to be less than 2 ppb. This reduced treatment target increased treatment costs, thereby eliminating potential savings from avoiding treatment at the non-treated cluster.

The second localized blending option that was considered was individual well blending at either Well C6 or C3. Blending at Well C6 was determined not to be feasible, as circular pumping could not be avoided based on having no access to blend water from an independent pressure zone. Although Well C6 is located in close proximity to the pressure zone boundary between the (Lower) Main Zone and the Lower 1 Zone, the (Lower) Main Zone directly feeds the Lower 1 Zone through pressure reducing stations, which does not allow for separation of the blending flow and effluent.

Individual blending at C3 was evaluated with two potential blending supply sources: 1) Foothill West Zone distribution system water, and 2) BCVWD. The Foothill West Zone blending water supply would be supplied primarily from the Foothill West Cluster, although the City does have the ability to boost water from the canyon well supply in the (Upper) Main Zone to the Foothill West Zone with the booster station at the Well C2 site. Since Well C3 has a relatively high Cr6 (16 ppb) level and is one of the higher capacity wells, the amount of blending water required assuming the Foothill West Cluster is treated to a Cr6 concentration of 6 ppb is estimated at 4,800 gpm, which would require a long stretch of minimum 20-inch diameter pipeline, and would exceed the mixing capacity of the existing forebay tank at Well C3, which has a storage volume of roughly 30,000 gallons. The connection point of Well C3 to the Foothill West Pressure zone is shown in **Figure 12**, which would occur just upstream of the Highland Springs & Sun Lakes pressure sustaining valve (PSV), and would require approximately 4,600 feet of piping to reach Well C3 (shown in red). Due to site constraints, it would not be possible to install a new blending tank with much more capacity than the existing one. It would also require significantly increasing the capacity of the existing booster station to convey the combined blended effluent.

An approach to reduce this blending flow rate requirement at Well C3 is to treat the blending water (i.e., all sources of supply in the Foothill West Zone) to a Cr6 concentration of less than 2 µg/L, which would reduce the estimated blending flow rate to 1,200 gpm and associated pipeline to 12-inches in diameter. To do this, additional treatment capacity (i.e., no bypass) at the Foothill West Cluster would be required. In order to meet this requirement, all incoming water supplies for the Foothill West pressure zone would not be able to have measurable Cr6 concentrations, significantly restraining distribution system operational flexibility as new supplies are introduced. Additionally, while avoiding treatment at Well C3, additional treatment requirements at the Foothill West Cluster will be needed, eliminating potential treatment cost savings (discussed further in Section 6.3 below).

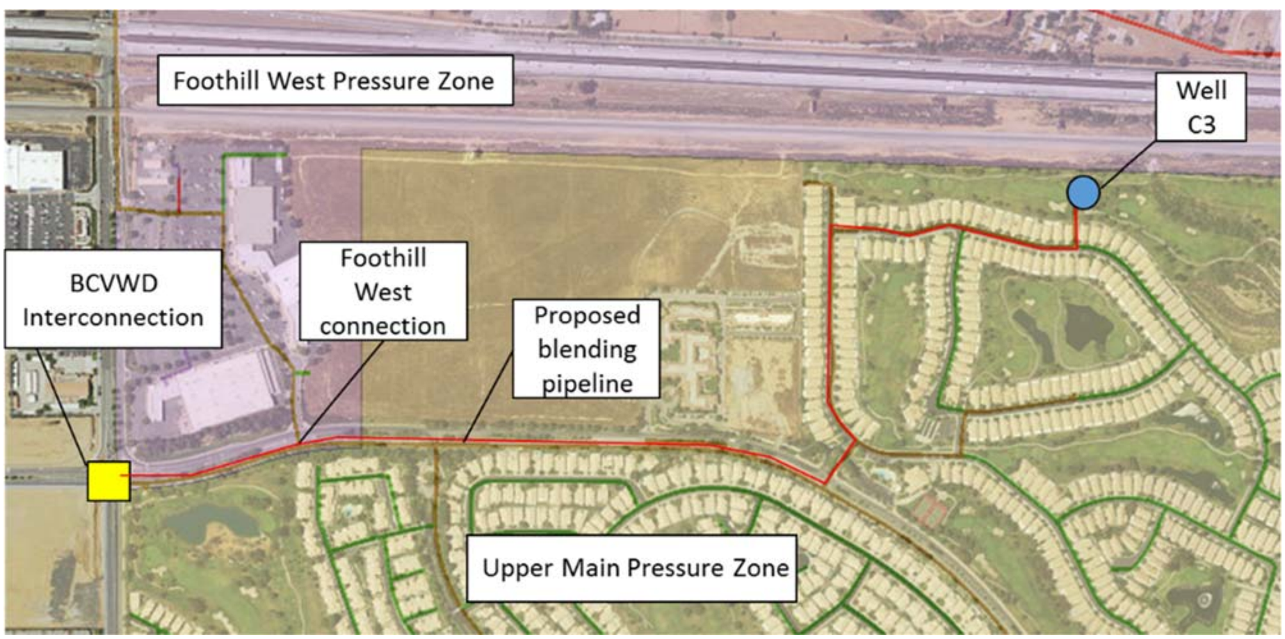

Figure 12: Potential Blending Pipelines

The second potential blending water supply identified for Well C3 was the BCVWD interconnection (see **Figure 12**) was determined not to be a valid blending source as two of the three co-owned wells are also impacted by Cr6. Based on a sample Banning collected at the interconnection in April 2016, a Cr6 concentration of 6.3 µg/L was observed. Based on a 6 µg/L Cr6 concentration, there are similar challenges to those for the first Foothill West Zone blending option. In addition, the interconnection is currently limited to 1,000 gpm and is activated manually where the City must call BCVWD. This option would require an increase in capacity and/or the construction of additional interconnections, automation, and would need to be active every time Well C3 is in operation. Due to the extensive infrastructure, interagency coordination, and hydraulic restrictions, all localized blending options were dismissed and the clustered treatment was considered for further analysis.

6.2.4 Summary of Compliance Scenarios

The individual wellhead, clustered, and blending scenarios are summarized in **Table 16**. The approach for evaluating treatment technologies for the compliance scenarios included the following steps (discussed further in **Section 6.3** below):

1. Compare treatment costs for Scenario A – Wellhead Treatment to Scenario B – Clustered Treatment for the BATs that fit the footprint at each identified treatment location and identify the technology with the lowest lifecycle cost.

2. Evaluate whether lifecycle costs can be further reduced with the addition of blending at Well C3 by comparing the lowest lifecycle cost for Scenario B – Clustered Treatment for the same technology in Scenario C – Blending.

Table 16: Compliance Scenarios Evaluated

Scenario	Cr6 Facilities
A – Individual Wellhead Treatment	Nine Cr6 treatment facilities: • Located at wellhead and ranging in size from 500 to 1,100 gpm
B – Clustered Treatment	Four Cr6 treatment facilities: • Well C3 – 900 gpm • Well C6 – 700 gpm • Foothill West Cluster – 2,500 gpm • M12 Cluster – 2,800 gpm
C – Clustered Treatment with Blending (Blending)	One blending and three Cr6 treatment facilities: • Blending at Well C3 with 4,800 gpm water from Foothill West Pressure Zone • Well C6 – 700 gpm • Foothill West Cluster – 3,500 gpm • M12 Cluster – 2,800 gpm

6.3 Treatment Technology Evaluation

WBA, SBA, and RCF/RCMF treatment technologies were compared based on the estimated total project capital cost, annual O&M costs, and lifecycle costs. The cost estimates were prepared based on the planning and cost assumptions outlined in **Appendix E**. For Scenario A- Wellhead Treatment, SBA was the only technology that could be accommodated within the existing footprint of the well sites. For Scenario B- Clustered Treatment, the costs for four BATs were compared.

The estimated total project capital costs are shown in **Figure 13.** The range in costs reflect the accuracy of estimate at this phase of the project and are consistent with AACE Class 4 costs with an accuracy range of -30% to +50%. It was found that WBA and SBA had the lowest capital cost estimated at approximately $25M to $40M. **Figure 14** shows the lifecycle costs for each technology (annualized debt service for total capital cost plus the annual O&M cost) for each treatment technology based on a 30 year period at a rate of 1.9 percent. SBA for the clustered treatment scenario had the lowest estimated lifecycle cost ($1.3M to $2.1M per year). Based on this finding, SBA was carried forward in the evaluation for further analysis.

In an attempt to reduce compliance costs and potential treatment requirements, blending options at Well C3 were also evaluated (Scenario C - Blending). As mentioned previously, this scenario avoided treatment at Well C3, but required additional capacity at the Foothill West Cluster to produce high quality source water for blending. A comparison of the estimated lifecycle costs for these scenarios is provided in **Figure 15**. In additional to the distribution system operational restrictions associated with Scenario C, there was no significant savings in compliance cost associated with this approach. Based on this finding, SBA treatment for Scenario B – Clustered was carried forward in the evaluation for further analysis.

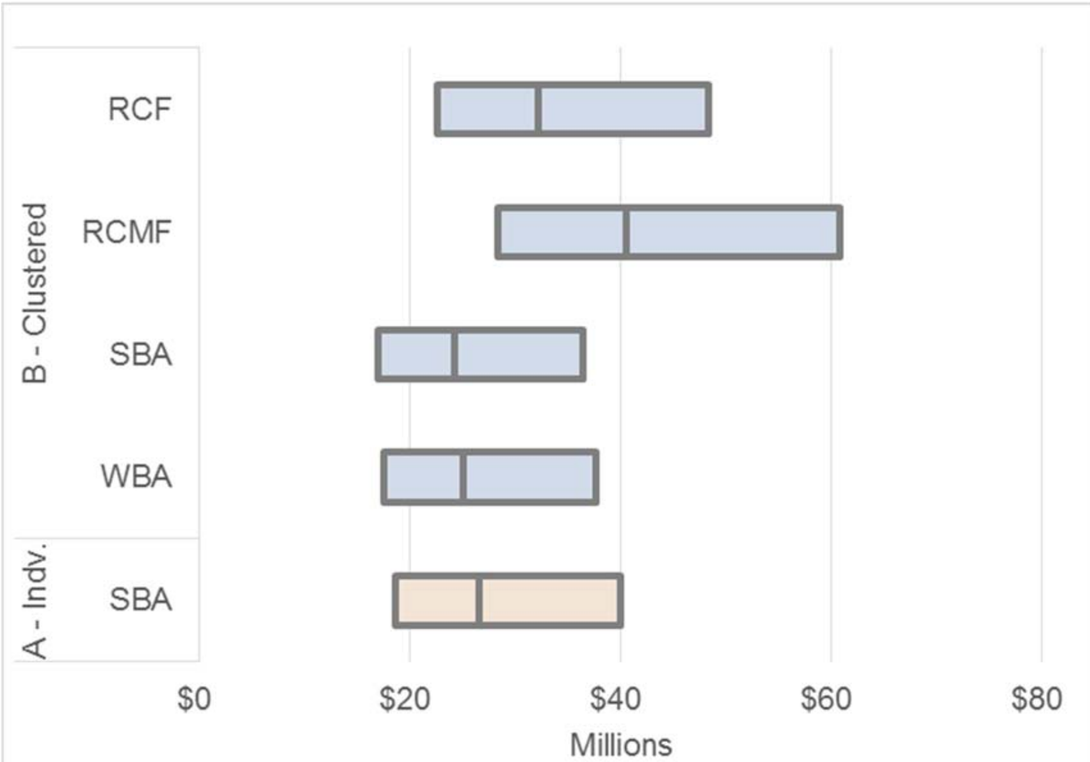

Figure 13: Total Project Capital Cost Comparison for Scenario A and Scenario B

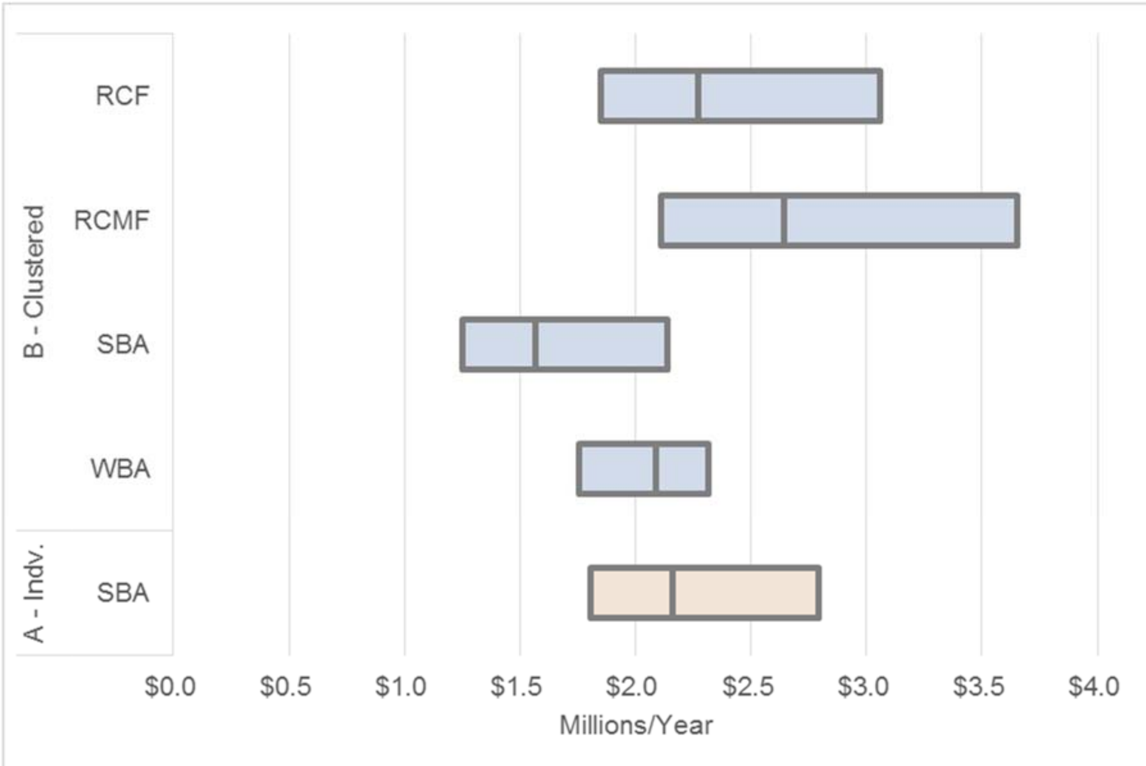

Figure 14: Lifecycle Cost Comparison for Scenario A and Scenario B

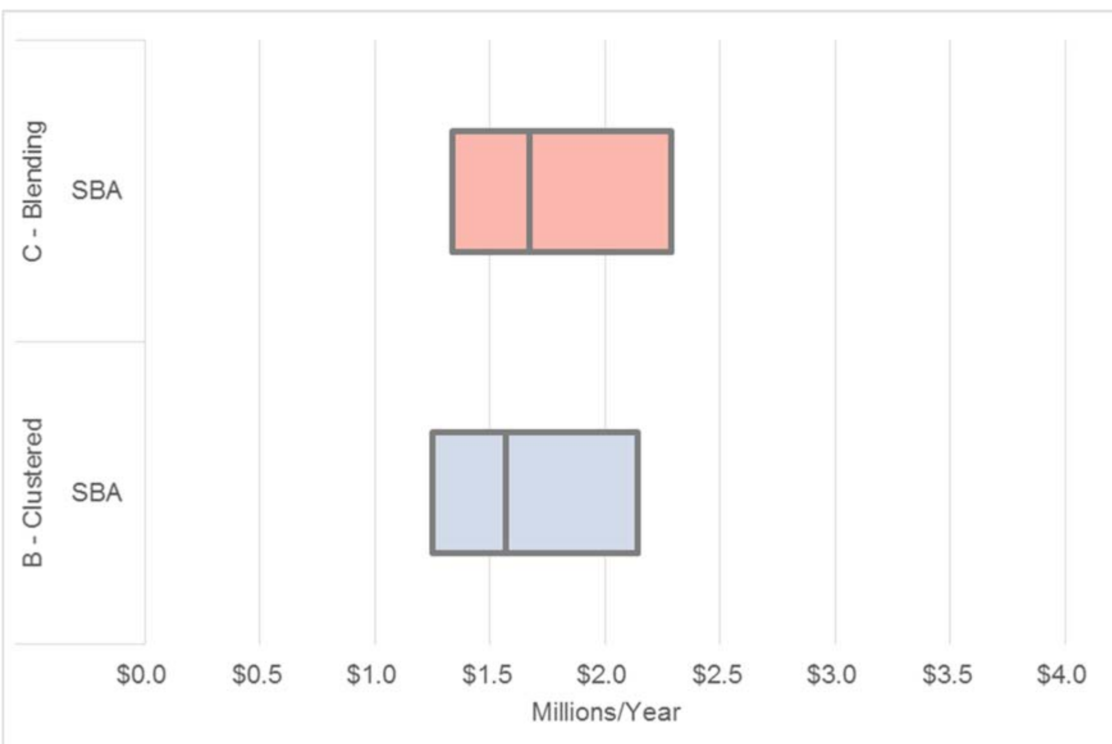

Figure 15: Lifecycle Cost Comparison for Scenario B and Scenario C

6.4 SBA Implementation Scenarios

Based on the comparison of estimated lifecycle costs, Scenario B – Clustered Treatment with SBA as the treatment technology was selected for further analysis. There are multiple ways to implement SBA at Banning wells depending on preferences for the type of equipment and preferences for managing the resin regeneration and brine handling requirements at each site:

- **Conventional versus Pre-Engineered Containerized Package SBA systems.** Conventional SBA designs include two to three traditional large diameter (8 to 12 ft diameter, 17 ft tall) steel vessels, while pre-engineered package systems offer eight to twelve fiberglass vessels (3ft diameter) housed in a 10 ft tall shipping container. Examples are shown in **Figure 16**.
- **Onsite versus offsite resin regeneration**. The capacity of resin for Cr6 will fill over time, requiring resin regeneration with a salt brine solution. Regeneration equipment includes a salt briner, rinse tank, waste tank, and associated connected piping and pumps, which can be located at each treatment site or a centralized location (requiring resin trucking to and from the regeneration site).
- **Hazardous brine hauling versus brine treatment**. The waste brine produced from the regeneration process can be hauled and disposed of as a hazardous waste or can be treated to render a non-hazardous liquid brine that can be sent to the sewer. Brine treatment equipment include ferrous and polymer chemical systems, reaction tank, and plate settler.

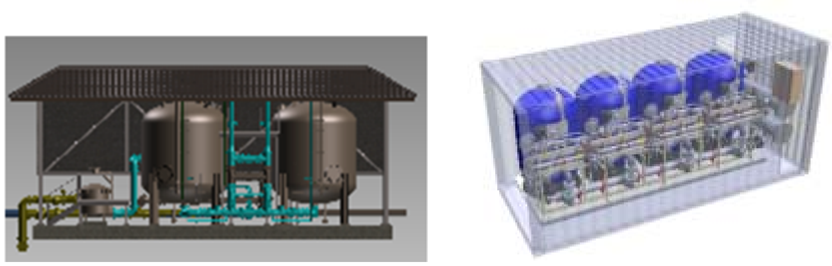

Figure 16. Conventional and Containerized SBA Examples

To evaluate these various SBA implementation options for the City, and building upon Scenario B, additional Scenarios D and E were defined:

- **Scenario D- SBA with Onsite Regeneration**. This scenario included a combination of containerized SBA systems at the individual wellhead treatment locations (Well C3 and Well C6) and conventional SBA systems with brine treatment at the clustered treatment locations (Foothill West and M12). Onsite regeneration would occur at each treatment location. Hazardous brine would be hauled and disposed from Wells C3 and C6, while non-hazardous brine would be sent to the sewer from Foothill West and M12.
- **Scenario E – SBA with Centralized Regeneration**. This scenario includes conventional SBA vessels at each treatment location with the provisions for resin transfer and trucking to a centralized resin regeneration site. Options for the CRRF are as follows:

- **E1- CRRF at a Nearby Water Agency.** CVWD is currently constructing an SBA CRRF with available capacity that could serve as a regional facility.
- **E2- CRRF at Foothill West Cluster**. Resin could be trucked from each treatment site to the Foothill West Cluster for regeneration. The brine waste is hauled and disposed of as a hazardous waste in this scenario.
- **E3- CRRF at Foothill West Cluster with Brine Treatment**. This scenario builds upon E2 to include brine treatment so that the treated non-hazardous brine can be sent to the sewer for mixing with the WWTP. Brine treatment generates hazardous solids that also require disposal.

A summary of the SBA Implementation Scenarios is presented in **Table 17**. The operational details and cost estimates for these scenarios are compared in following sections.

Table 17: SBA Implementation Scenarios Evaluated

Scenario	Cr6 Facilities	Regeneration	Brine Treatment and Residuals Disposal
D – Onsite Regeneration	• Containerized SBA at Well C3 and Well C6 • Conventional SBA at Foothill West and M12 Clusters	Onsite	Hazardous hauling from Wells C3, and C6 and Chemical precipitation treatment at Foothill West and M12 Clusters
E1 – Centralized Regeneration (at Nearby Water Agency)	• Conventional SBA Vessels at Well C3, Well C6, Foothill West Cluster, and M12 Cluster	Offsite at CVWD	None by City of Banning (managed through contract with CVWD)
E2 – Centralized Regeneration (at Foothill Cluster)	• Conventional SBA Vessels at Well C3, Well C6, Foothill West Cluster, and M12 Cluster • Resin hauling to CRRF facility at Foothill West Cluster	Offsite at Foothill West Cluster	No brine treatment, hazardous brine hauling and disposal
E3 – Centralized Regeneration (at Foothill Cluster with Brine Treatment)	• Conventional SBA Vessels at Well C3, Well C6, Foothill West Cluster, and M12 Cluster • Resin hauling to CRRF facility at Foothill West Cluster • Brine treatment facility included at Foothill West CRRF	Offsite at Foothill West Cluster	Brine Treatment (chemical precipitation) included at Foothill West Cluster with non-hazardous brine sent to sewer and hazardous solids disposal

6.5 Well Pump Analysis

The estimated operational impacts to each well pump due to the proposed SBA treatment were assessed for Scenario B - Clustered Treatment. Well pumps were analyzed beginning with field pump test data to estimate new operating points based on treatment impacts and revised total dynamic head (TDH) requirements. There are two notable existing well pumping configurations: (1) wells that pump directly into the distribution system; (2) wells that pump directly into a forebay, which are then boosted into the distribution system via a separate booster station. For the purpose of this Study, for wells proposed in clustered treatment facilities that currently pump into forebays, it was assumed that the forebays and booster stations will be removed and that the well pumps will pump directly to the clustered facility. This configuration will allow the City to remove the existing tanks and booster stations, thereby reducing the number of facilities to maintain, limit the number of pumping stages, and increase the operational efficiency. The City has expressed their desire to either eliminate or replace the existing "look-down" throttling system with variable frequency drive (VFD) pumps where applicable for energy efficiency reasons.

SBA treatment, which includes pumping through two bag filters and ion exchange (IX) vessels in parallel, would introduce additional headloss into the well pumping system, estimated at 25 psi under fouled condition and 11 psi under clean condition, which includes the bag filters, vessels, and associated piping and appurtenances. Based on information provided by containerized treatment vendors, the headloss between a containerized design and conventional SBA design should be relatively similar; therefore, one set of hydraulic results has been applied for these SBA treatment scenarios. For Wells C2, C3, C4, and C5, since they currently pump into reservoirs, the addition of SBA treatment and any increase in destination elevation would increase the TDH requirement for the well pump moving up the pump curve and decreasing flow, which often requires a new higher head pump and higher horsepower motor. For Wells M3, M10, M11, and M12, since they currently pump directly into the distribution system and the clustered treatment scenario proposes to break head with a finished water clearwell after treatment, the TDH requirement for these well pumps would be greatly decreased while moving down the pump curve and increasing flow, often resulting in a new bowl assembly with lower required head and lower horsepower motor (de-staging). Alternatively, during preliminary design, the provision of an entirely new pump assembly for construction phasing, warranty, or other reasons may be considered. For Well C6, since the (Lower) Main Zone is currently interconnected with the (Upper) Main Zone, the well experiences high discharge pressures upwards of 200 psi. Conventional SBA treatment equipment has a standard working pressure rating of 125 psi; therefore, it will be necessary to break head at Well C6 to isolate the treatment system from the distribution system pressure by installing an estimated 50,000 gallon finished water clearwell and 1,000 gpm firm capacity booster station. Recommendations were developed for each well based on the existing configuration and the estimated impacts from SBA treatment under the proposed treatment scenario, summarized in **Table 18**. Detailed hydraulics calculations for each well pump have been included in **Appendix A**. Recommended improvements were made for any well that did not meet the following criteria under the proposed treatment conditions:

- New estimated overall efficiency of 60 percent minimum.
- New estimated operating point within 70 to 120 percent of the existing pump's best efficiency point (BEP).

Table 18: Well Treatment Impacts and Recommended Improvements

Location	Well	Current Flow (gpm)	Current Overall Efficiency	Estimated New Flow (gpm)	Estimated New Overall Efficiency	Flow Change	Recommendation
Foothill West Cluster	C2	1095	63%	730	54%	-33%	New Pump
	M3	540	44%	980	27%	81%	De-Stage Pump
	C4	1310	61%	1030	56%	-21%	New Pump
M12 Cluster	C5	890	65%	580	55%	-35%	New Pump
	M10	856	74%	1075	52%	26%	De-Stage Pump
	M11	587	66%	815	44%	39%	De-Stage Pump
	M12	1080	65%	1550	48%	44%	De-Stage Pump
Individual Treatment	C3	940	74%	1387	48%	48%	New Pump
	C6	1107	60%	920	56%	-17%	New Pump, Break Head

In addition to the well pump improvements, the Foothill West Cluster will require the following improvements:

- Approximately 4,700 feet of 12-inch and 900 feet of 18-inch raw water transmission main piping to convey the raw well water from the existing well site to the proposed treatment site;
- 1 million gallon (MG) finished water clearwell to equalize flow and provide operational flexibility;
- 3,500 gpm firm capacity finished water pump station to deliver the treated water from the clearwell into the distribution system;
- Pressure reducing station from Foothill West Zone to Upper Main Zone to replace the capacity lost from decommissioning the C2 Booster Station that pumps into the Upper Main Zone.

In addition to the well pump improvements, the M12 Cluster will require the following improvements:

- Approximately 4,100 feet of 12-inch and 1,900 feet of 16-inch raw water transmission main piping to convey the raw well water from the existing well site to the proposed M12 treatment site;
- 1 MG finished water clearwell to equalize flow and provide operational flexibility;
- 3,900 gpm firm capacity finished water pump station to deliver the treated water from the clearwell into the distribution system.

6.6 SBA Operations Comparison

Treatment system operations including chemical consumption, waste generation, and staffing requirements were evaluated for the SBA Scenarios (**Table 19**). Chemical and residuals handling requirements relate to number of treatment locations and whether brine treatment is included in the process. The trucking requirements for resin, chemicals, and waste handling are dependent on the required regeneration frequency for the resin. Due to Banning's high water quality, regenerations are infrequent (**Table 20)**, with an estimated total annual average of 13 regenerations for the Banning system with a potential peak month of four regenerations (100% utilization of wells during peak demand)**.** These estimates are based on a projected resin life of approximately 20,000 bed volumes based on Banning water quality. The range of regenerations presented represent the range in treatment goal of 6 to 8 μg/L, where the lower goal requires more frequent resin regeneration.

Table 19: Operations Comparisons for SBA Treatment Scenarios

	D- SBA with Onsite Regeneration	E1 – Centralized Regeneration (at Nearby Water Agency)	E2 – Centralized Regeneration (at Foothill Cluster)	E3 – Centralized Regeneration (at Foothill Cluster with Brine Treatment)
Residuals Waste	• 2.3 kgal of hazardous brine from C3 and C6 to Phibrotech per regeneration at $1.12/gal (up to $3.00/gal) • 2.7 to 11 kgal[1] of non-hazardous brine from Foothill West and M12 per regeneration sent to sewer for WWTP mixing	• Resin regeneration offsite, no waste handling by the City	• 4.5 kgal of hazardous brine to Phibrotech per regeneration at $1.12/gal (up to $3.00/gal)	• 4.5 to 18 kgal[1] of non-hazardous brine per regeneration sent to sewer for WWTP mixing • 1000 lbs/regen of LLRW iron solids at $1.61/lb at Energy Solutions in UT
Total Staff	• 2.1	• 0.8	• 2.1	• 2.1
Operability	• Onsite brine treatment operations are more complex. Hazardous brine disposal (containers) requires additional permitting and warrants cost risk analysis. Infrequent regenerations (one to three months) result in manageable hazardous brine trucking requirements.	• Simplest operations with no waste residuals to manage. Infrequent regenerations (one to three months) result in manageable resin trucking requirements.	• Regenerations (one to three months) result in batch processing of brine.	• Onsite brine treatment operations are more complex. Infrequent regenerations (one to three months) result in batch processing of brine.

[2]Range in estimated non-hazardous brine generation reflects differing brine treatment method if selenium is present in the waste brine.

Table 20: Regeneration Frequency

Location	Annual Average SBA Regenerations	Max Month SBA Regenerations (100% Well Utilization)
Total System	9 - 13	3 - 4
C3	1.1 - 1.9	0.4 - 0.6
C6	0.9 - 1.4	0.3 - 0.5
M12 Cluster	3.6 - 4.6	1.1 - 1.5
Foothill West Cluster	3.4 - 5	1.2 - 1.7

6.7 SBA Cost Summary

Capital, annual O&M, and lifecycle costs (presented as the sum of annualized capital and annual O&M) were estimated for each SBA scenario and are presented in the figures below. **Figure 17** presents the total project capital cost estimates. The range in costs reflect the accuracy of estimate at this phase of the project and are consistent with AACE Class 4 costs with an accuracy range of -30% to +50%. SBA with regeneration at the CVWD CRRF was the lowest capital cost option as it has the least amount of equipment (bag filters and SBA vessels only as compared to regeneration equipment including briner, pumps, rinse tanks, and waste tanks), followed by the other SBA options.

Annual O&M costs are presented in **Figure 18**. For the SBA options, ranges are included in the O&M to represent the sensitivity of cost estimates to key assumptions, including:

- SBA with CRRF at a nearby water agency (Scenario E1) – these costs include equipment for the bag filters and SBA vessels only, and a range of operating costs should the City decide to participate in CVWD's CRRF for resin regeneration. A cost estimate of $36 to $46 per cubic foot of resin regenerated was assumed. Actual rates may increase or decrease based negotiated rates between Banning and CVWD.

- SBA with hazardous brine disposal (Containerized systems in Scenario D and Scenario E2) – these costs do not include onsite brine treatment; instead, they involve hauling the hazardous brine directly to a disposal facility. Regeneration steps that result in non-hazardous brine or rinse water are recycled. The error bars here represent the range of hazardous brine disposal quotes for facilities that will accept this waste.

- SBA with brine treatment (Clusters in Scenario D and Scenario E3) – these costs include the treatment of SBA hazardous brine to render non-hazardous brine for hauling and hazardous solids for disposal. There are currently no third party operating facilities for the treatment of SBA brine from Cr6 treatment facilities and these processes may require optimization for effectiveness. The brine treatment process will vary depending on the constituents present and their concentrations (e.g. selenium, uranium). The error bars here represent a range of brine treatment requirements.

Annual O&M costs were estimated at $0.50M to $0.69M depending on the SBA approach. Scenario E2 CRRF at Foothill West with hazardous brine hauling had the lowest estimated O&M cost; however, this estimate would be impacted significant if the hazardous brine disposal cost increased. In this case, a brine treatment process could be added, as reflected in the estimate for Scenario E3.

Based on the estimated total project capital and annual O&M costs, lifecycle costs were also prepared (**Figure 19**). Lifecycle costs are presented as the sum of annual O&M and capital debt service based on a 30-year lifecycle and assumed SRF loan rate of 1.9%. While the accuracy bands of the cost estimates overlap, Scenario E1 - SBA with CRRF at a nearby water agency had the lowest point estimate lifecycle cost relative to the other treatment options. A summary of treatment cost estimates is presented in **Table 21**.

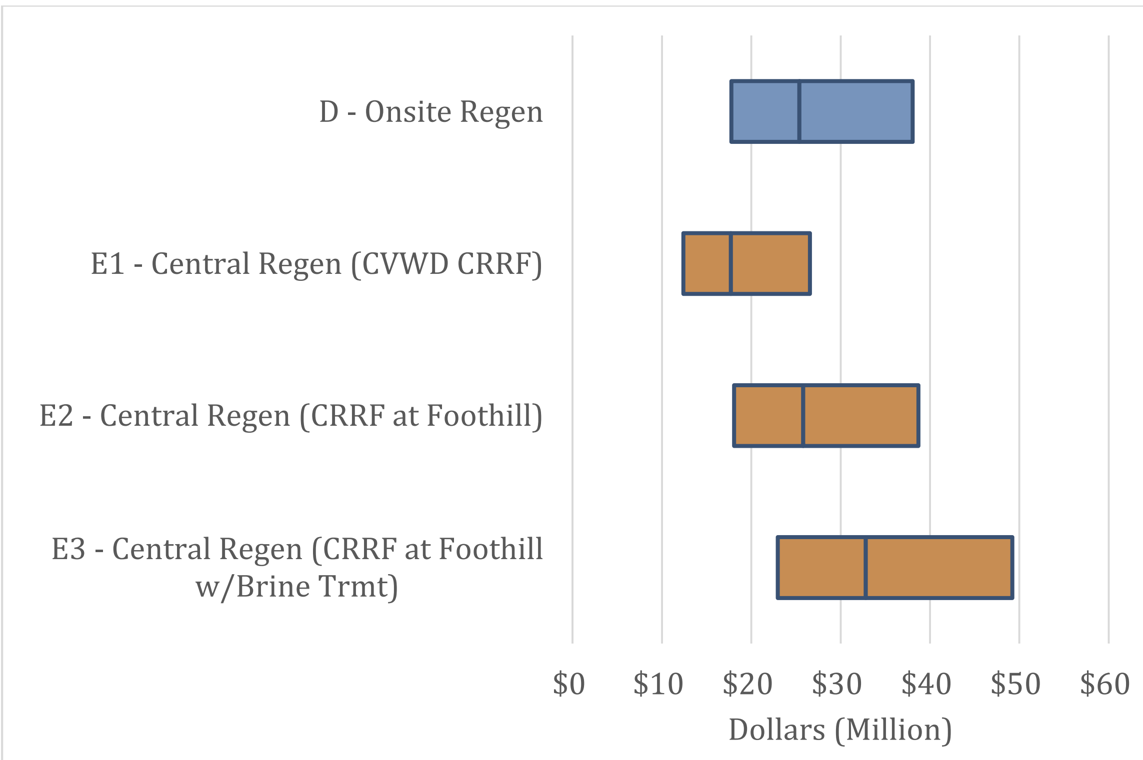

Figure 17. Capital Cost Comparison

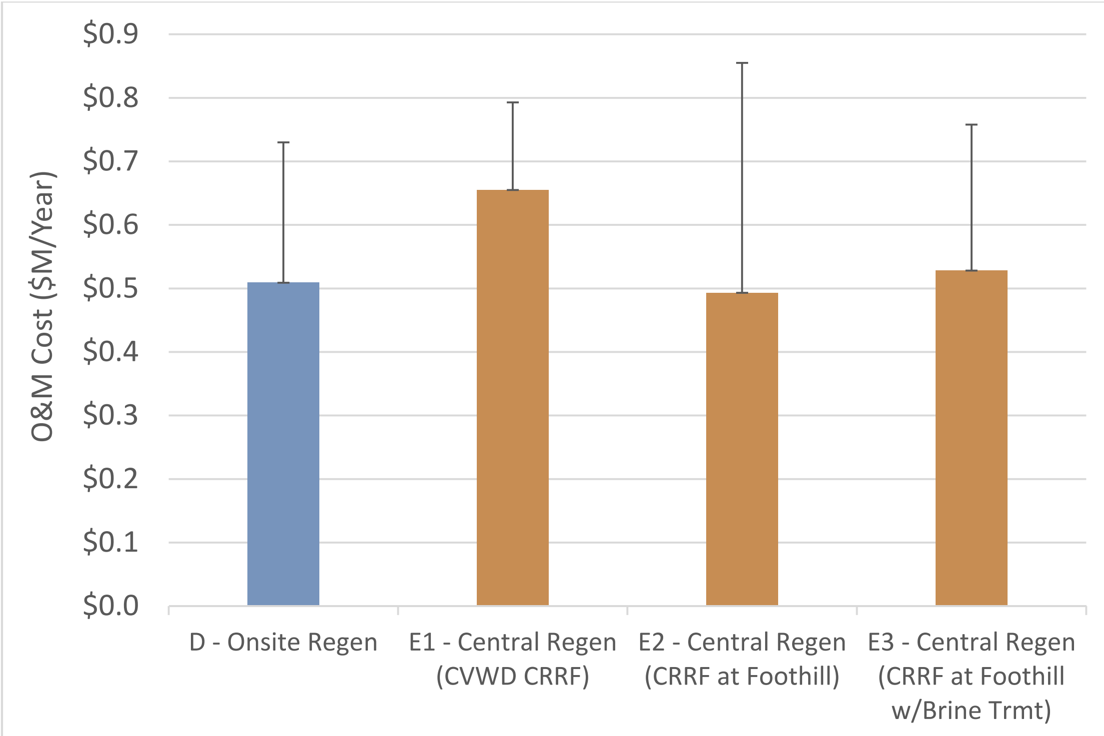

Figure 18. Annual O&M Cost Comparison

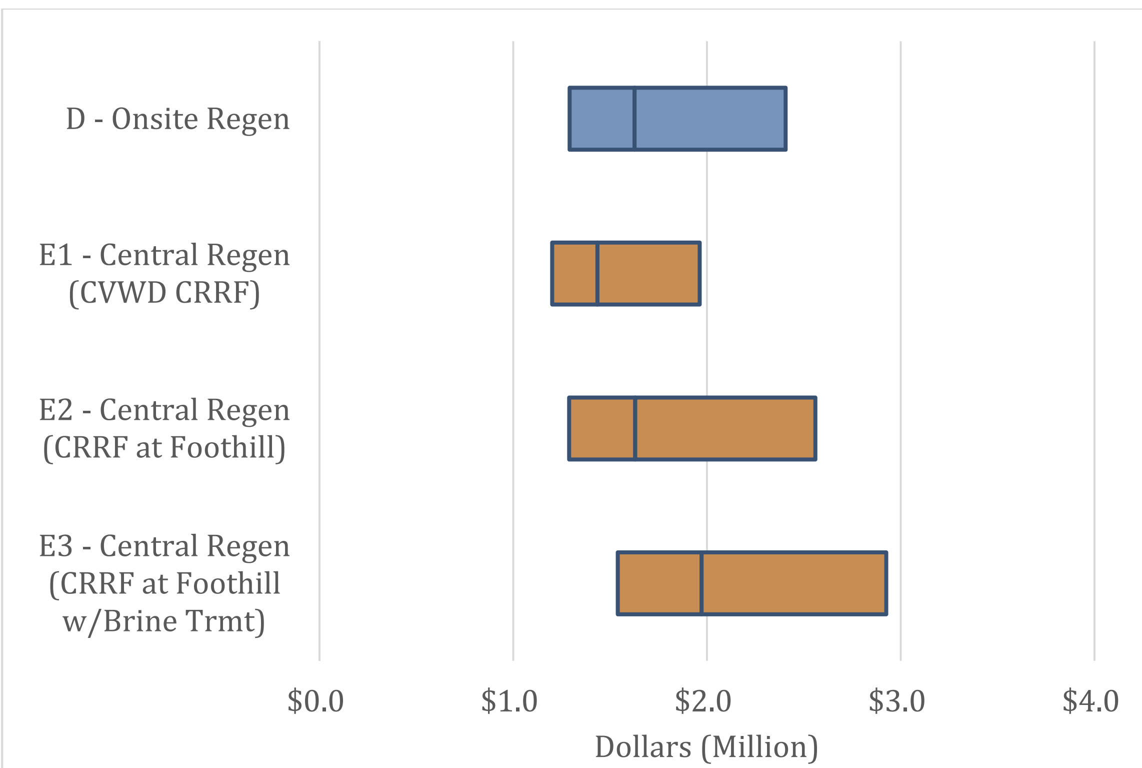

Figure 19. Lifecycle Cost Comparison

Table 21: Summary of Point Estimate SBA Treatment Costs

	D- SBA with Onsite Regeneration	E1 – Centralized Regeneration (at Nearby Water Agency)	E2 – Centralized Regeneration (at Foothill Cluster)	E3 – Centralized Regeneration (at Foothill Cluster with Brine Treatment)
CAPITAL COST ($M)	**25**	**18**	**26**	**33**
Well C3	3.3	2.3	2.3	2.3
Well C6	3.2	2.5	2.5	2.5
Foothill West Cluster	9.1	6.2	14.3	21
M12 Cluster	9.9	6.6	6.6	6.6
ANNUAL O&M ($M/YEAR)	**0.51**	**0.66**	**0.49**	**0.53**
Well C3	0.09	0.12	0.10	0.12
Well C6	0.09	0.13	0.10	0.12
Foothill West Cluster	0.17	0.19	0.15	0.14
M12 Cluster	0.15	0.22	0.15	0.14
LIFECYCLE COST ($M/YEAR)	**1.6**	**1.4**	**1.3**	**2.0**

6.8 Decision Criteria Process

A systematic approach to recommending a compliance scenario was used to compare the SBA scenarios. This approach included scoring each scenario against decision criteria outlined by the City. With the use of a decision matrix approach, factors that are not easily quantified are assessed for the value added to the project. **Table 22** shows the decision criteria selected by the City. These criteria were used to categorize the differences between the SBA scenarios, accounting for the advantages and disadvantages of each SBA approach.

Table 22: Decision Criteria

Criteria	Definition
Treatment Flexibility	Impacts from intermittent or seasonal use
O&M Complexity	Equipment complexity and staff requirements
Chemical and Residuals Handling	Chemical deliveries and generation of liquid and solid wastes – frequency of generation, trucking, and disposal options
Environmental Impacts / Community Acceptance	Treatment plant footprint, permitting, and public acceptance
Cost	• Total Project Capital Cost • Annual O&M Cost • Lifecycle Cost = Annualized Capital + Annual O&M
Risk	Future escalation of operational cost burden Price volatility in chemicals and/or residuals disposal

Treatment flexibility examines the impact of intermittent use on the treatment process. For SBA, there are operational considerations for the resin. Resin manufacturers recommended as a best practice flushing 24 to 48 hours (for approximately 2 bed volumes). For extended shutdowns longer than a week, resin manufacturers recommend that the resin be submerged in brine and backwashed at start-up. These recommended best practices may vary based on resin type and manufacturer and could potentially impact resin warranty (if available). For the SBA scenarios, both short and long term shut downs are manageable with a well operations plan; however, Scenario E1- Offsite Regeneration at a Nearby Agency may present additional constraints as in this scenario the City does not have provisions to store the resin in brine during an extended period shut-down. In this case, continued weekly flushing may be needed.

O&M complexity addresses the type of equipment associated with each process and the level of staffing required to operate the treatment process. Additional treatment introduces more equipment complexity. The addition of resin regeneration and brine treatment facilities increases O&M complexity and the estimated number of full-time equivalent operations staff needed. It is anticipated that these treatment facilities will be classified as T3 treatment facilities in accordance with Title 22 of the California Code of Regulations, requiring minimum operator certifications for a chief operator and shift operators at T3 and T2, respectively.

Chemical and residuals handling requirements relate to number of treatment locations and whether brine treatment is included in the process. The trucking requirements for resin, chemicals, and waste handling are dependent on the required regeneration frequency for the resin. Scenario E1 includes offsite resin regeneration at CVWD and therefore involves hauling of resin only and no residual waste. This is compared to the other SBA options that involve the handling of brine either as a hazardous liquid or once treated as a non-hazardous liquid with hazardous solids that also require disposal.

Environmental and community impacts including public acceptance were compared for SBA options. Scenario E1 with offsite regeneration at CVWD has the lowest impact in this category as it has the smallest treatment footprint and involves no waste handling by the City (waste is managed through the contract with CVWD). For the other offsite resin regeneration options (Scenarios E2 and E3) the additional treatment equipment associated with regeneration and brine treatment are centralized at the Foothill West Cluster, where property will be acquired to provide ample available footprint for treatment and also minimizing community impact by trucking waste from one centralized site. The environmental and community impact will be greatest for Scenario D where resin regeneration occurs at each treatment site. In this option, hazardous waste is generated at each treatment location requiring disposal.

Cost estimates (presented above in **Section 6.7**) indicated that the lowest capital cost option was Scenario E1, followed by D and E2, which were nearly equivalent. The highest capital option for SBA was Scenario E3, as this option has the additional treatment equipment associated with the brine treatment process. O&M cost estimates were lowest for Scenarios E2 and E3 where the CRRF is located at the Foothill West Cluster. The O&M estimate for Scenario E1 was the highest, but has the most uncertainty as this rate will be determined based on contract negotiations with another water agency. The resulting lifecycle costs (as represented by the annual O&M cost plus the debt service on project capital) were lowest for Scenario E1, as the lower capital cost for this option resulted in a lower lifecycle cost.

Risk was assessed with respect to potential escalation in operating costs and for the City to remain unbeholden to waste haulers or vendors. Scenario E3 presented the lowest risk in this category as the City would remain in complete control of the regeneration and brine treatment process, ultimately disposing of the brine for mixing at the City's WWTP. Scenarios D and E2 involve hazardous brine hauling that could be subject to future increases or changing quality requirements for disposal. This uncertainty is already apparent in the waste disposal quotes gathered for this Study. The risk of Scenario E1 can be managed through the contract terms. If there is a desire for a regional approach to Cr6 waste management, generally an agreement in place between water agencies will be lower risk than with vendors who operate for profit and under other agencies' permits.

Decision criteria were compared and the technical team including Hazen and Sawyer and City staff assigned scores for each SBA scenario (**Figure 20**). Scenario E1 scored the highest based on the lower capital cost required for this option and the lower associated waste handling risk. This was followed by Scenarios E2 and E3, where the City would remain independent by operating their own CRRF located at the Foothill West cluster. Scenario D scored the lowest. The concept of operating two different types of systems and managing the residuals from each of the four treatment locations was scored lower than the centralized resin regeneration options.

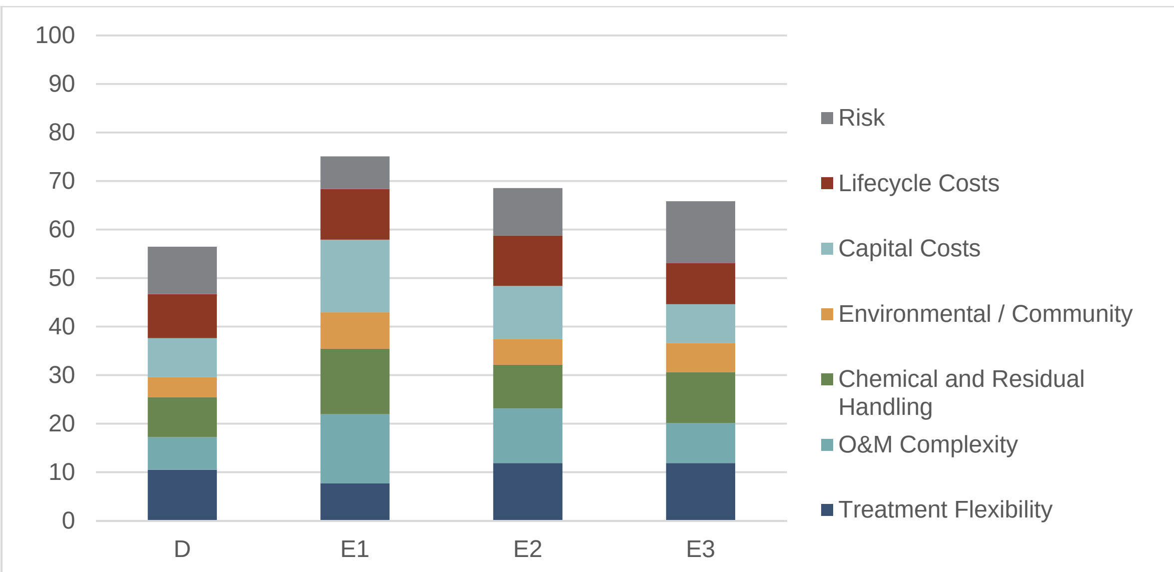

Figure 20: Scoring Chart

7. Conclusions

7.1 Study Findings

Approximately 40 percent of the City of Banning's water supply is impacted by the new Cr6 MCL, including nine of the City's 21 wells and two of the three co-owned wells with BCVWD. This Study considered multiple compliance approaches for these wells, including alternative sources of supply, well modifications, blending, and treatment. Based on the most viable options, several compliance scenarios were evaluated to determine treatment configurations, including individual wellhead treatment, clustered treatment, and clustered treatment with blending.

Blending as a compliance approach was also evaluated. System wide blending was not an option as the volume of blend water required exceeded the capacity of high quality water from the Canyon wells and it would not be possible to isolate the blending water from the effluent water. Localized blending options at wells C3 and C6 were also considered. Blending at Well C6 was determined not to be feasible, as circular pumping could not be avoided based on having no access to blend water from an independent pressure zone.

Blending at Well C3 was evaluated with two potential blend water supply sources: 1) Foothill West Zone distribution system water, and 2) BCVWD. The Foothill West Zone blending water supply would be supplied primarily from the Foothill West Cluster. To reduce the blend water flow rate requirement to a feasible volume, the water from the Foothill West Zone needs to have a Cr6 concentration of less than 2 µg/L. To achieve this, additional treatment capacity (i.e., no bypass) at the Foothill West Cluster would be required. Additionally, all incoming water supplies for the Foothill West pressure zone cannot have measurable Cr6 concentrations, which could significantly restrain distribution system operational flexibility. While blending allowed for treatment to be avoided at Well C3, the additional treatment requirements at the Foothill West Cluster offset any potential cost savings. Blending with BCVWD water was also determined to be infeasible. It was found that water from the BCVWD connection had Cr6 concentrations of approximately 6 µg/L, requiring a large blend water flow and an increase in capacity and/or the construction of additional interconnections. Due to the extensive infrastructure, interagency coordination, and hydraulic restrictions, all localized blending options were dismissed and the clustered treatment was considered for further analysis.

Best available treatment technologies considered for Banning wells included WBA, SBA, and RCF/RCMF. Technologies were assessed based on lifecycle costs and operability considerations (chemical consumption, residuals waste generation, and staffing requirements). While the accuracy range of lifecycle costs overlap for each of the alternatives, it was found that SBA treatment technology located at clustered treatment facilities was the lowest point estimate lifecycle cost compared with WBA and RCF/RCMF. The resulting proposed treatment facilities are summarized in **Table 23**.

Table 23: Cr6 Treatment Facilities

Treatment Location	Total Well Capacity (gpm)	Treatment Capacity (gpm)	Bypass (gpm)	Improvements[1]
Well C3	1200	900	300	• 900 gpm SBA treatment with 300 gpm bypass to serve a total well capacity of 1,200 gpm • New well pump and motor
Well C6	1000	700	300	• 700 gpm SBA treatment with 300 bypass for total well capacity of 1,000 gpm. • New well pump and motor • New 50,000 gallon reservoir and 1,000 gpm firm capacity booster station
Foothill West Cluster (Well M3, C2, C4)	3500	2500	1000	• 2,500 gpm SBA treatment with 1,000 gpm bypass to serve a total well capacity of 3,500 gpm • Potential CRRF facility including provisions for resin regeneration and potentially brine treatment • 4,700 ft 12-in raw water transmission mains piping • 900 ft 18-in raw water transmission main piping • 1 MG reservoir • 3,500 gpm finished water pump station • PRV from Foothill West Zone to upper Main Zone
M12 Cluster (Well M10, M11, M12, C6)	3900	2800	1100	• 2,800 gpm SBA treatment with 1,100 gpm bypass to serve a total well capacity of 3,900 gpm • 4,100 ft 12-in raw water transmission mains piping • 1,900 ft 16-in raw water transmission main piping • 1 MG reservoir • 3,900 gpm finished water pump station

[1]Additional distribution system and site specific improvements beyond what are noted above may be required and will be confirmed during the design process.

There are multiple ways to implement SBA at Banning wells depending on preferences for the type of equipment and preferences for managing the resin regeneration and brine handling requirements at each treatment site. Regeneration frequencies for the Banning system were estimated at 10 to 15 regenerations annually based on current demands. Additional compliance scenarios were developed to assess SBA options including conventional versus pre-engineered containerized package SBA equipment, onsite versus offsite resin regeneration, and hazardous waste hauling versus treatment of the brine waste generated during the regeneration process. These options were compared in the following scenarios:

- **Scenario D - SBA with Onsite Regeneration**. This scenario included a combination of containerized SBA systems at the individual wellhead treatment locations (Well C3 and Well C6) and conventional SBA systems with brine treatment at the clustered treatment locations (Foothill West and M12). Onsite regeneration would occur at each treatment location. Hazardous brine would be hauled and disposed from Wells C3 and C6, while non-hazardous brine would be sent to the sewer from Foothill West and M12.
- **Scenario E – SBA with Centralized Regeneration**. This scenario includes conventional SBA vessels at each treatment location with the provisions for resin transfer and trucking to a centralized resin regeneration facility. Options for the CRRF are as follows:

- **E1- CRRF at a Nearby Water Agency.** CVWD is currently constructing an SBA CRRF with available capacity to serve as a regional facility.
- **E2- CRRF at Foothill West Cluster**. Resin could be trucked from each treatment site to the Foothill West Cluster for regeneration. The brine waste is hauled and disposed of as a hazardous waste in this scenario.
- **E3- CRRF at Foothill West Cluster with Brine Treatment**. This scenario builds upon E2 to include brine treatment so that the treated non-hazardous brine can be sent to the sewer for mixing with the WWTP. Brine treatment generates hazardous solids that also require disposal.

Scenarios E1, E2, and E3 emerged as the most viable options. Scenario E1 had the lowest lifecycle cost, but requires contracting with another water agency. Scenario E3 could allow for the City to be un-beholden to other agencies or waste haulers, but has the highest estimated capital cost and most complex treatment process. Point estimates for capital costs for these options ranged from $18M to $33M (with -30% to +50% accuracy). Annual O&M estimates for these options ranged from $0.5M to $0.7M per year. A summary of these options is provided in **Table 24**.

Table 24: Cost Summary for SBA with Centralized Resin Regeneration

	SBA with Centralized Resin Regeneration (Range of Scenarios E1, E2, E3)
CAPTIAL COST ($M)	**$18M to $33M**
Well C3	$2.4M
Well C6	$2.5M
Foothill West Cluster	$6M to $21M
M12 Cluster	$6.6M
ANNUAL O&M ($M/YEAR)	**$0.5M to $0.7M**
LIFECYCLE COST ($M/YEAR)	**$1.5M to $2.0M**

7.2 Recommendations

SBA with centralized regeneration was identified as the most viable approach for Cr6 compliance at Banning wells. This approach has minimal treatment equipment at each treatment location including bag filters and conventional SBA vessels. Regeneration would be accomplished by trucking the resin from each treatment location to a centralized regeneration facility. There are two options for the CRRF: (1) contract with another water agency to participate in a regional CRRF, or (2) include a CRRF at the Foothill West Treatment Cluster. For the later, the Foothill West CRRF could also include a brine treatment process.

It is recommended that Banning initiate discussions with CVWD to determine the contract requirements and refine the cost estimates associated with participating in the regional CRRF. Based on these negotiations, the City will be able to determine whether including a CRRF at the Foothill West Cluster is needed as part of the current compliance approach or whether it could be added later to support future growth. The City may decide to move forward with the preliminary design of the Foothill West CRRF so that there is the option to incorporate this cost in the rate study and in funding applications.

Depending on the City's resources and funding availability, the City may consider evaluating treatment phasing study during preliminary design to prioritize design and construction of treatment for compliance, or potentially defer the construction of a portion of the treatment facilities. Hydraulic modeling analysis may be used to simulate demand and supply projections and identify any distribution system constraints.

7.3 Next Steps

The next steps for the City of Banning are to proceed with the tasks outlined in the Cr6 Compliance Plan including conducting a rate study, preparing funding applications, initiate discussions of participating in the regional CRRF approach with CVWD, and begin preliminary design. The City may also consider evaluating treatment phasing during preliminary design. To inform the preliminary design, pilot testing could be conducted define actual resin regeneration and brine treatment requirements for the City of Banning wells. Site tours could also be conducted of existing similar SBA and brine treatment facilities to give the City a better perspective of the treatment equipment and operational requirements.

Appendix

Appendix A: Well Pump Hydraulic Calculations

Table 1 and Table 2 show the recommended pump alterations for the WBA and RCF/RCMF technologies, respectively.

Table 1: Well Pump Analysis and Recommendation for WBA Treatment

Well	Pressure Zone	Current Flow	Current Efficiency	Estimated New Flow	Estimated New Efficiency	Flow Change	Recommendation
C2	Upper Main Pressure Zone	1095	63%	775	49%	-29%	New Pump
M3	Mountain Pressure Zone	540	44%	990	26%	83%	De-Stage Pump
C4	Mountain Pressure Zone	1310	61%	1060	56%	-19%	New Pump
C5	Lower Main Pressure Zone	890	65%	610	53%	-31%	New Pump
M10	Upper Main Pressure Zone	856	74%	1080	51%	26%	De-Stage Pump
M11	Upper Main Pressure Zone	587	66%	810	45%	38%	De-Stage Pump
M12	Upper Main Pressure Zone	1080	65%	1555	47%	44%	De-Stage Pump
C6	Lower 1 Pressure Zone	940	74%	1390	47%	48%	De-Stage Pump
C3	Upper Main Pressure Zone	1107	60%	950	53%	-14%	New Pump

Table 2: Well Pump Analysis and Recommendation for RCF/RCMF Treatment

Well	Pressure Zone	Current Flow	Current Efficiency	Estimated New Flow	Estimated New Efficiency	Flow Change	Recommendation
C2	Upper Main Pressure Zone	1095	63%	1095	63%	0%	none
M3	Mountain Pressure Zone	540	44%	1010	25%	87%	De-Stage Pump
C4	Mountain Pressure Zone	1310	61%	1310	61%	0%	none
C5	Lower Main Pressure Zone	890	65%	890	65%	0%	none
M10	Upper Main Pressure Zone	856	74%	1085	50%	27%	De-Stage Pump
M11	Upper Main Pressure Zone	587	66%	835	40%	42%	De-Stage Pump
M12	Upper Main Pressure Zone	1080	65%	1600	45%	48%	De-Stage Pump
C6	Lower 1 Pressure Zone	940	74%	1410	45%	50%	De-Stage Pump
C3	Upper Main Pressure Zone	1107	60%	1107	60%	0%	none

Well C2

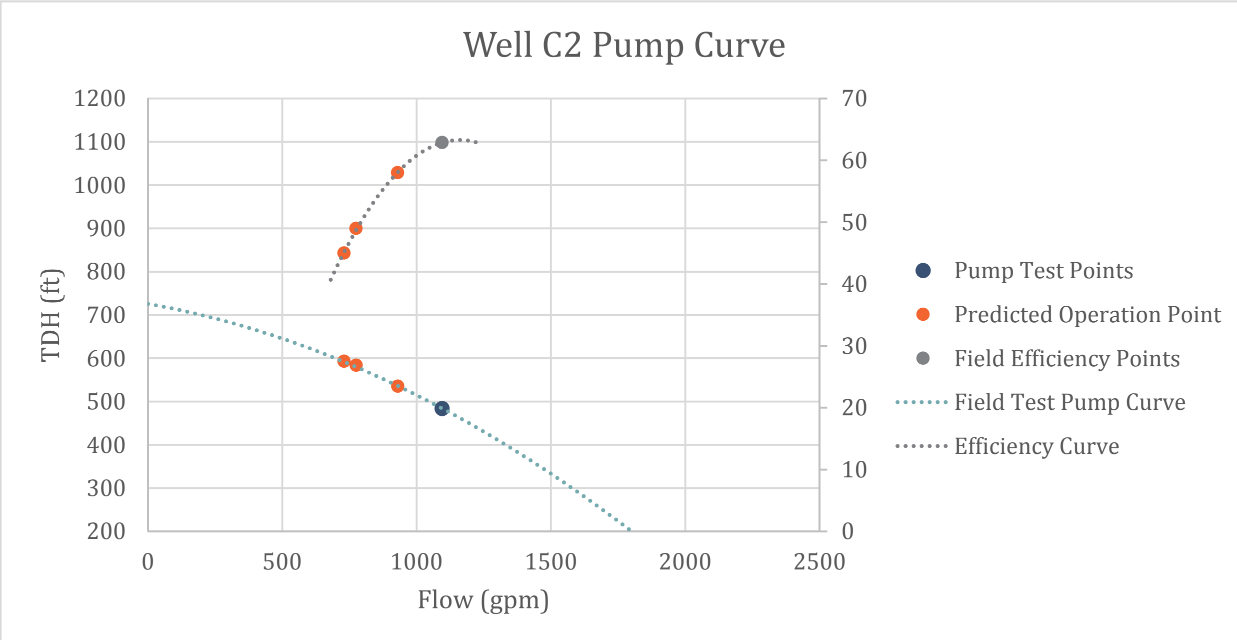

Figure 1: Well C2 Pump and Treatment Analysis

Table 3: Well C2 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
730	593.65	45	SBA
775	584.41	49	WBA
930	535.9	58	RCF

Well C3

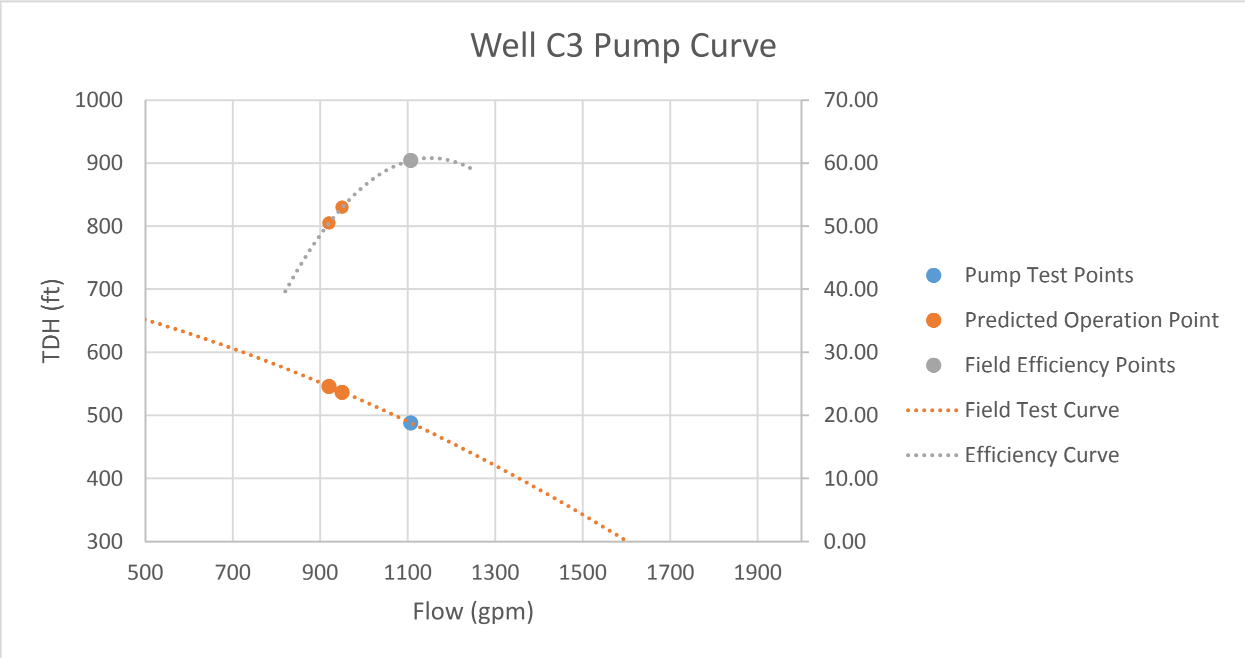

Figure 2: Well C3 Pump and Treatment Analysis

Table 4: Well C3 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
920	545.75	50.50	SBA
950	537	53.00	WBA
1107	488	60.44	RCF

Well C4

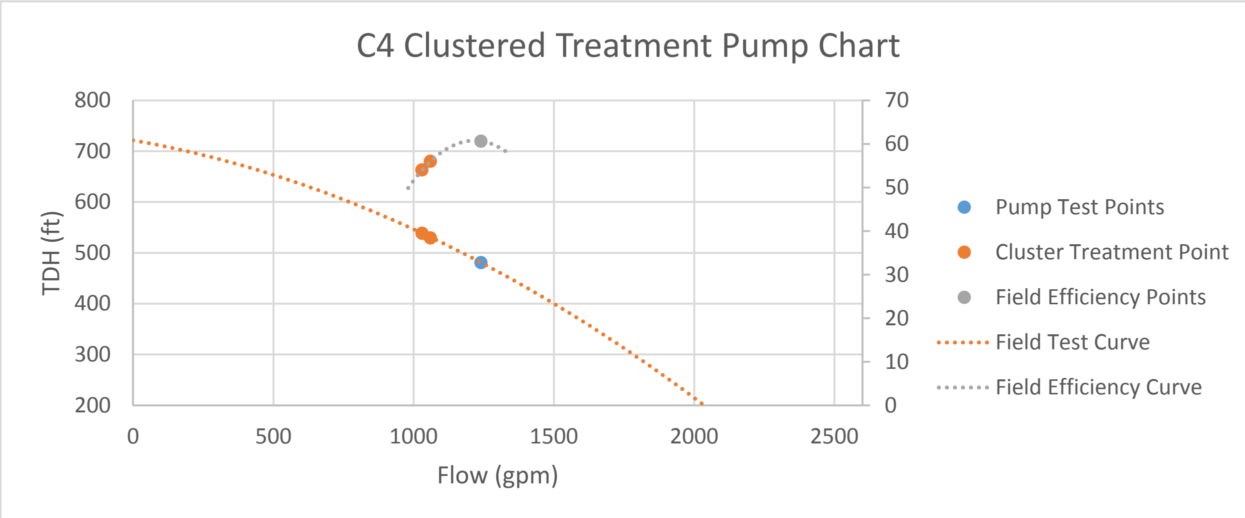

Figure 3: Well C4 Pump and Treatment Analysis

Table 5: Well C4 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
1030	538.75	54	SBA
1060	529.51	56	WBA
1240	481	60.64	RCF

Well C5

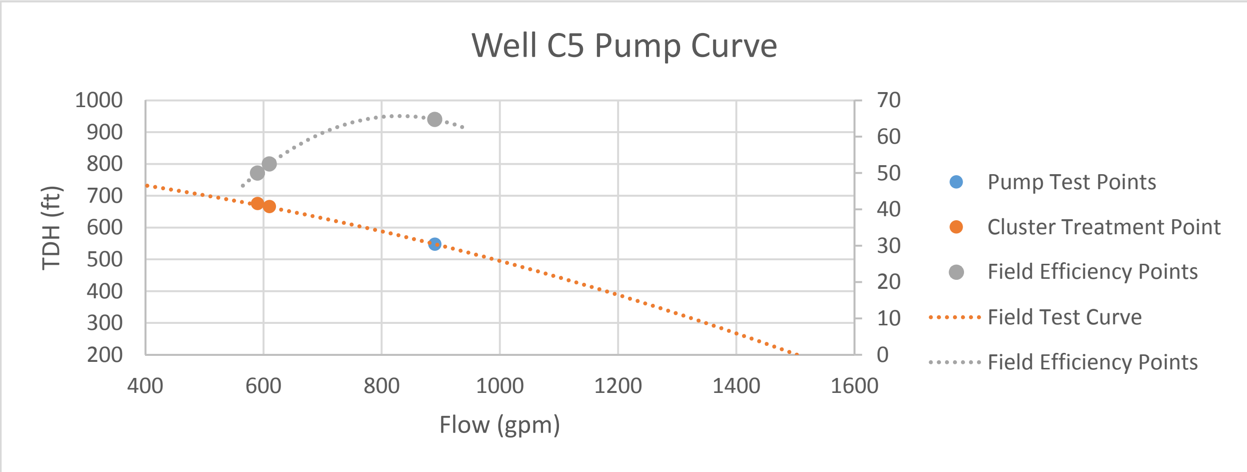

Figure 4: Well C5 Pump and Treatment Analysis

Table 6: Well C5 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
590	676	50	SBA
610	667	52.5	WBA
890	618	64.74	RCF

Well C6

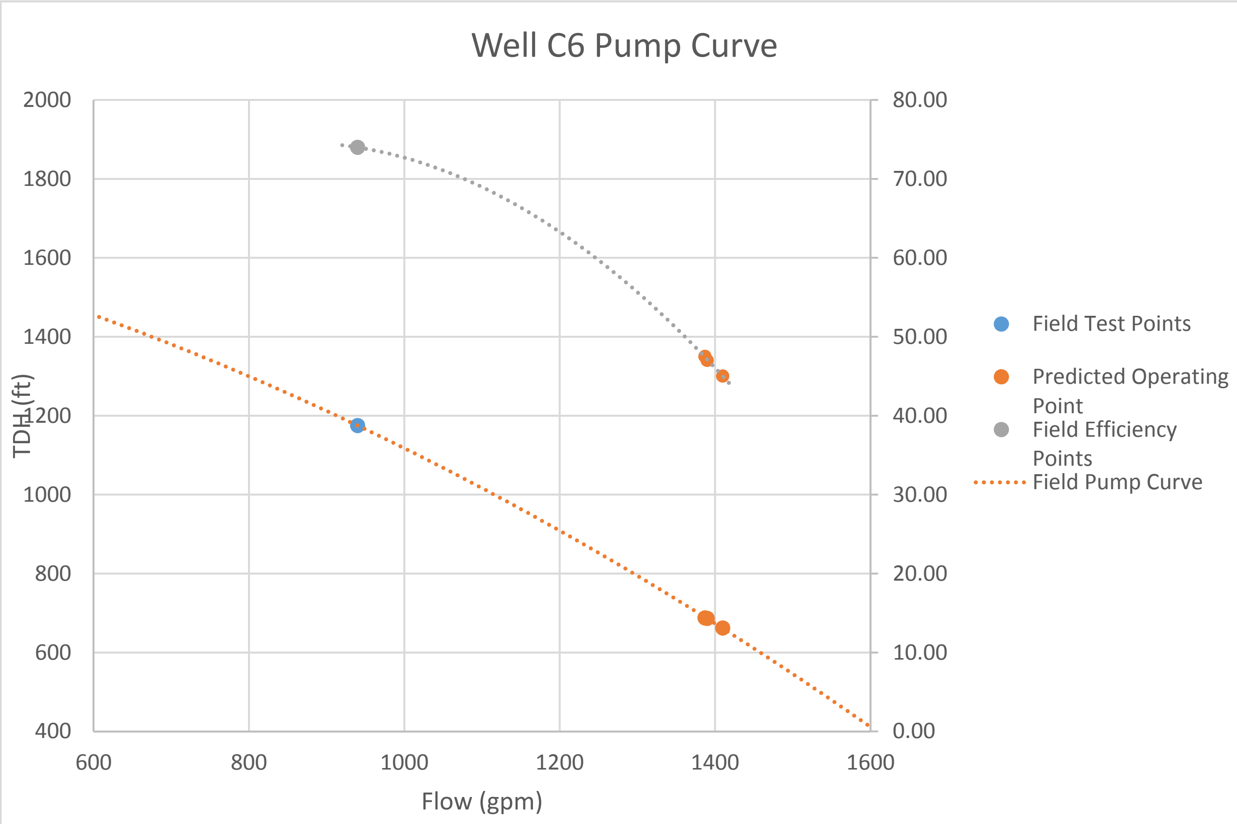

Figure 5: Well C6 Pump and Treatment Analysis

Table 7: Well C6 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
1387	688	47.50	SBA
1390	686	47	WBA
1410	662	45	RCF

Well M3

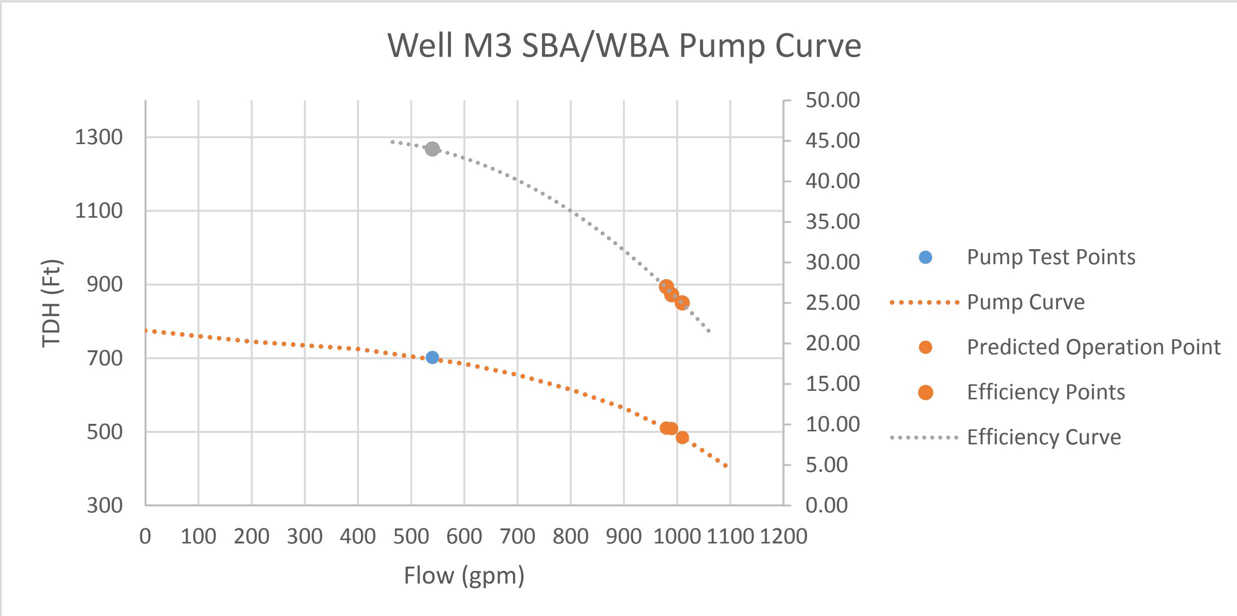

Figure 6: Well M3 Pump and Treatment Analysis

Table 8: Well M3 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
980	510	27	SBA
990	509	26	WBA
1010	485	25	RCF

Well M10

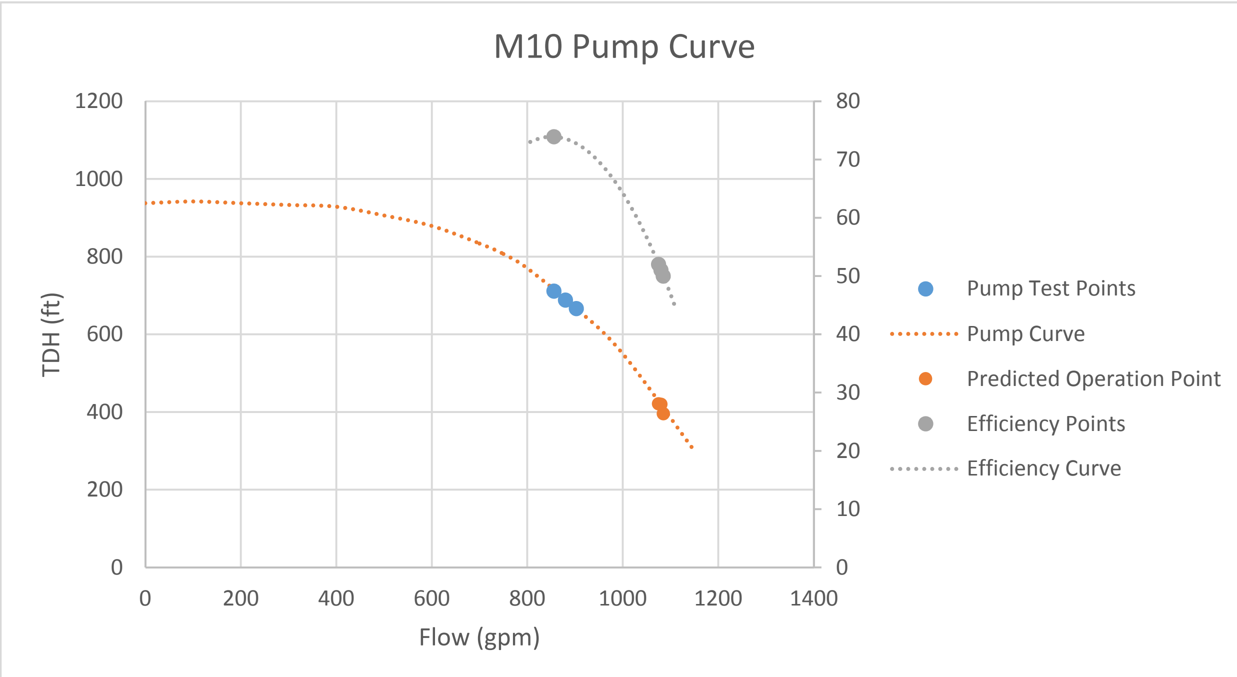

Figure 7: Well M10 Pump and Treatment Analysis

Table 9: Well M10 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
1075	421.34	52	SBA
1080	420.185	51	WBA
1085	395.93	50	RCF

Well M11

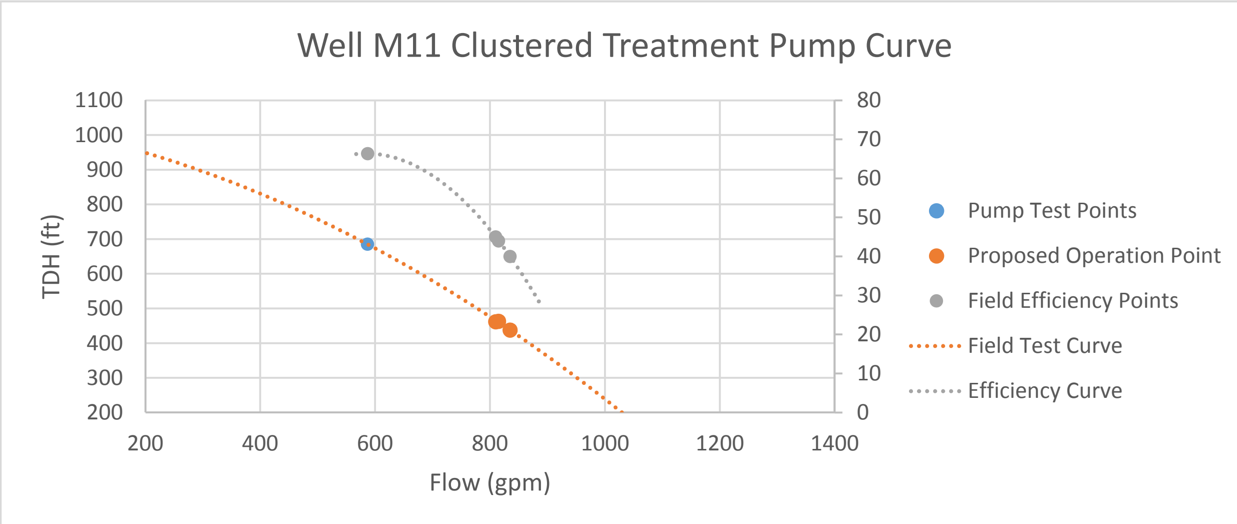

Figure 8: Well M11 Pump and Treatment Analysis

Table 10: Well M11 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
815	462.66	44	SBA
810	461.505	45	WBA
835	437.25	40	RCF

Well M12

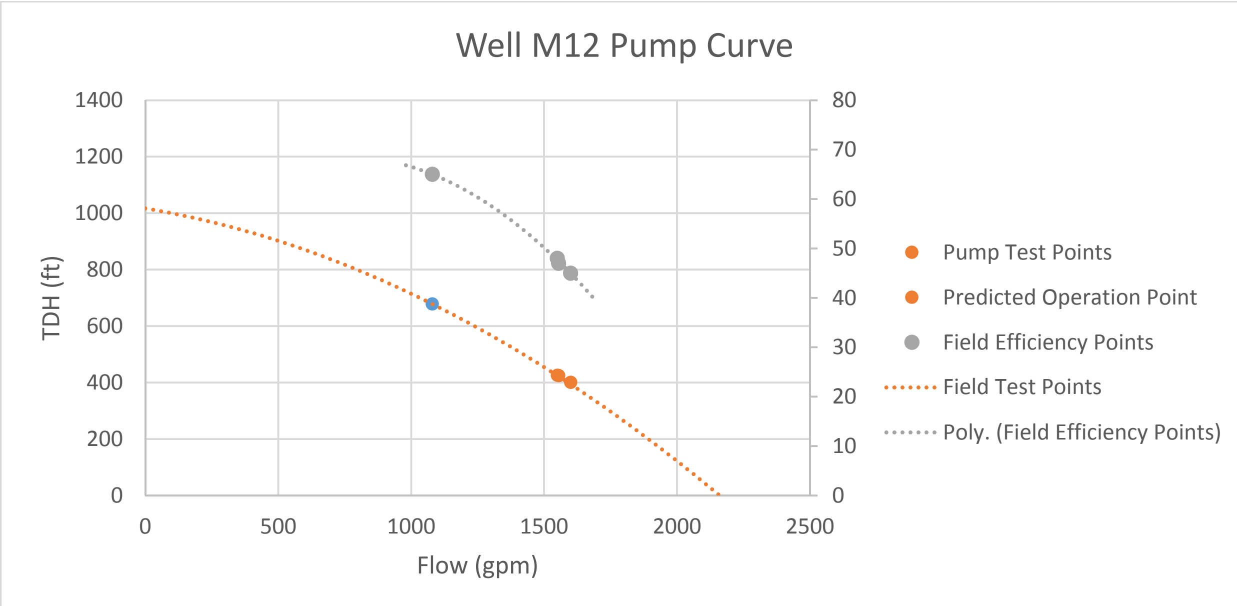

Figure 9: Well M12 Pump and Treatment Analysis

Table 11: Well M12 Treatment Operating Points

Q (gpm)	TDH (ft)	Eff (%)	
1550	426.21	48	SBA
1555	425.055	47	WBA
1600	400.8	45	RCF

Appendix B: Water Quality

Row Labels	WELL C2				WELL C3				WELL C4				WELL C5				WELL C6				WELL 1				WELL 2			
	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg
ALKALINITY	5	150	160	158	5	110	140	132	5	140	160	156	5	110	120	118	3	120	150	133	4	130	140	138	4	130	150	143
BICARBONATE	5	190	200	198	5	140	160	156	5	180	190	188	5	140	150	146	3	150	180	163	4	160	170	168	4	160	180	173
CALCIUM	5	41	44	42.8	5	25	32	29.8	5	36	38	37	5	14	16	15.6	3	26	35	31	4	37	41	39.5	4	36	41	39
CARBONATE	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
CHLORIDE	5	8.9	11	10.28	5	9.2	12	11.02	5	7.1	10	8.02	5	11	14	13	3	12	13	12	4	2.4	2.8	2.625	4	2.7	3.7	3.225
HARDNESS	5	140	150	146	5	79	100	94.4	5	120	130	124	5	45	53	50.8	3	87	130	112	4	140	150	147.5	4	140	150	147.5
PH, LABORATORY	5	7.9	7.9	7.9	5	7.9	8.1	8	5	7.7	8.1	7.98	5	8.1	8.3	8.26	3	7.8	7.9	7.9	4	7.5	7.8	7.675	4	7.4	7.6	7.525
SODIUM	5	24	26	25.4	5	30	33	31.2	5	24	27	26	5	44	51	49.2	3	31	34	32	4	7.9	9.2	8.575	4	8.6	11	9.9
SPECIFIC CONDUCTANCE (E.C.)	5	380	390	382	5	310	320	318	5	340	360	356	5	300	310	308	3	340	390	370	4	310	380	347.5	4	310	340	330
TURBIDITY	5	0.26	0.26	0.26	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	0.36	0.36	0.36	4	ND	ND	ND	4	0.25	0.25	0.25
SULFATE	5	9.3	10	9.72	5	5.9	8.3	6.62	5	9.4	11	10.4	5	7	7.8	7.58	3	16	17	16	4	16	18	17.5	4	16	21	19
IRON (FE)	5	ND	110	55	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
MANGANESE (MN)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
MAGNESIUM	5	9.3	9.5	9.46	5	4.3	5.9	5.46	5	7.4	9.1	8.04	5	2.5	3.1	2.8	3	5.2	9.5	7.8	4	12	13	12.5	4	12	13	12.75
POTASSIUM	5	1.3	1.5	1.38	5	1.5	1.8	1.62	5	1.3	1.5	1.42	5	1.4	1.7	1.48	3	1.3	1.7	1.5	4	3.1	3.1	3.1	4	3.1	3.2	3.15
ALUMINUM (AL)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
ANTIMONY	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
ARSENIC (AS)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	3.7	3.9	3.8	3	3.9	3.9	3.9	4	ND	ND	ND	4	ND	ND	ND
ASBESTOS	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
BARIUM (BA)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	20	20	20	4	ND	ND	ND	4	ND	ND	ND
BERYLLIUM	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
CADMIUM (CD)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
CHROMIUM (Total Cr) (ug/L)	4	15	18	16.25	5	13	16	13.8	5	13	18	14.4	5	7.2	10	8.16	3	10	14	12	4	3.6	3.6	3.6	4	3.5	3.5	3.5
Chromium-6	3	17	17	17	3	14	16	15	3	13	17	15	ND	ND	ND	ND	3	12	14	13	ND	ND	ND	ND	ND	ND	ND	ND
CYANIDE	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
FLUORIDE	5	0.3	0.4	0.32	5	0.5	0.9	0.6	5	0.3	0.3	0.3	5	0.2	1.4	1.12	3	0.3	0.7	0.5	4	0.3	0.7	0.5	4	0.4	0.8	0.625
MERCURY (HG)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
NICKEL	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
NITRATE	6	7.7	11	9.3	6	7.4	8.5	7.8	6	4.7	7.5	5.4	6	5.9	6.6	6.3	3	7.1	8.2	7.8	5	3	4.7	3.9	4	2.8	9.5	5.2
NITRITE AS NITROGEN (N)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
PERCHLORATE	6	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND	3	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
SELENIUM (SE)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
THALLIUM	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
COPPER (CU)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
LEAD (PB)	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
GROSS ALPHA	5	0.92	1.56	1.33	5	0.66	1.55	1.19	5	1.32	1.6	1.49	5	0.887	1.32	1.06	2	1.82	2.21	2.02	4	0.25	1.22	0.68	4	0.252	0.73	0.49
RADIUM 228	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	0.0115	0.0115	0.0115	1	ND	ND	ND	ND	ND	ND	ND	1	0.218	0.218	0.218
Uranium	1	0.199	0.199	0.199	1	0.696	0.696	0.696	1	0.497	0.497	0.497	1	0.597	0.597	0.597	1	0.298	0.298	0.298	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Carbon Tetrachloride	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,4-Dichlorobenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,1- Dichloroethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,2- Dichloroethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,2- Dichloropropane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,1-Dichloropropene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Ethylbenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Methyl tert butyl Ether	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Styrene	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
1,1,2,2-Tetrachloroethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,1,1-Trichloroethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,1,2-Trichloroethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Trichlorofluoromethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Trichlorotrifluoroethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Vinyl Chloride	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Xylenes (m+p)	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Xylenes (ortho)	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Xylenes (Total)	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Alachlor	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	7	ND	ND	ND	6	ND	ND	ND
Atrazine	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	7	ND	ND	ND	6	ND	ND	ND
Bentazon	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Benzo(a)pyrene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	7	ND	ND	ND	6	ND	ND	ND
Carbofuran	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Chlordane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Dalapon	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
DEH-Adipate	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND
DEH-Phthalate	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	7	ND	ND	ND	6	ND	ND	ND
Dinoseb	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Diquat	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Endrin	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Endothall	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Glyphosate	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Heptachlor	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Heptachlor Epoxide	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Hexachlorobenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Hexachlorocyclopentadine	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND

Row Labels	WELL C2				WELL C3				WELL C4				WELL C5				WELL C6				WELL 1				WELL 2			
	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg
Lindane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Methoxychlor	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Molinate	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	7	ND	ND	ND	6	ND	ND	ND
Pentachlorophenol	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Pichloram	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Polychlorinated Biphenyls (Total PCB's)	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Simazine	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	7	ND	ND	ND	6	ND	ND	ND
2,4,5-TP Silvex	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
DIOXIN	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Thiobencarb	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	7	ND	ND	ND	6	ND	ND	ND
Toxaphene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Bromodichloromethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Bromoform	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Chloroform	6	0.5	0.51	0.506667	4	0.51	0.51	0.51	4	0.5	0.51	0.506667	4	0.5	0.51	0.506667	1	ND	ND	ND	6	0.51	0.51	0.51	6	ND	ND	ND
Dibromochloromethane	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
1,1,1,2-Tetrachloroethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,1- Dichloroethene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,2,3-Trichlorobenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,2,4-Trichlorobenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,2,4-Trimethylbenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,2-Dichlorobenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,3,5-Trimethylbenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,3-Dichlorobenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,3-Dichloropropane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
1,3-Dichloropropene (total)	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
2,2-Dichloropropane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
2,4-D	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
2-Butanone(MEK-EPA 8260)	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
2-Chlorotoluene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
3-Hydroxycarbofuran	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
4-Chlorotoluene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
4-Methyl-2-Pentanone(MIBK)	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Aldicarb (TEMIK)	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	0	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
Aldicarb Sulfone	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Aldicarb Sulfoxide	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Aldicarb TEMIK)	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Aldrin	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Chloromethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Bis(2-chloroethyl)ether (Non-NELAP)	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Bromobenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Bromochloromethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Bromomethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Carbaryl (Sevin)	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Chlorobenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Chloroethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
cis-1,2-Dichloroethene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
cis-1,3-Dichloropropene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
DEH-Adiptat	5	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Ethylene dibromide	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Dibromochlorometeane	5	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Dibromochloropropane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Dibromomethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Dicamba	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Dichlorodifluoromethane	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Dieldrin	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Hexachlorobutadiene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Isopropylbenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
MBAS	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	3	0.08	0.08	0.08	4	ND	ND	ND	4	ND	ND	ND
Methiocarb (MESUROL)	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	9	ND	ND	ND	9	ND	ND	ND
Methomyl	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Methylene Chloride	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Naphthalene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
n-Butylbenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
n-Isopropyltoluene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
n-Propylbenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Oxamyl (Vydate)	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Propachlor	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Propoxur (BAYGON)	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
sec-Butylbenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Strene	5	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
tert-Butylbenzene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Tetrachloroethene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Toluene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
trans-1,2-Dichloroethene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
trans--1,3-Dichloropropene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND
Trichloroethene	6	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	6	ND	ND	ND	6	ND	ND	ND

Row Labels	WELL 3				WELL 4				WELL 5				WELL 7				WELL 8				WELL 9				WELL 10			
	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg
ALKALINITY	5	130	220	170	4	130	140	138	2	130	140	135	4	120	140	135	4	130	150	145	4	150	170	165	4	110	140	133
BICARBONATE	5	150	270	204	4	160	180	170	2	160	170	165	4	150	170	165	4	160	190	180	4	180	210	200	4	130	160	152.5
CALCIUM	5	35	59	45.6	4	34	39	36.25	2	35	37	36	4	34	41	38.25	4	35	42	39.5	4	38	43	41.5	4	31	40	37.25
CARBONATE	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
CHLORIDE	5	2.5	15	7.76	4	1.7	2.4	2.175	2	2.1	3	2.55	4	1.8	2.5	2.175	4	2.2	4.1	2.875	4	1.5	2.2	2	4	1.2	1.5	1.275
HARDNESS	5	140	250	188	4	130	150	140	2	140	140	140	4	130	160	147.5	4	140	170	157.5	4	160	180	175	4	120	150	142.5
PH, LABORATORY	5	7.3	7.4	7.36	4	7.3	7.6	7.425	2	7.2	7.9	7.55	4	7.3	7.5	7.4	4	7.3	7.4	7.375	4	7.2	7.4	7.275	4	7.2	7.5	7.325
SODIUM	5	8	29	17	4	7.3	8.3	7.95	2	7.7	7.9	7.8	4	7.2	9.7	8.6	4	8.6	9.5	9.175	4	9.2	9.5	9.425	4	5.7	6.8	6.375
SPECIFIC CONDUCTANCE (E.C.)	5	310	600	432	4	310	320	317.5	2	310	320	315	4	300	370	340	4	320	360	345	4	350	370	357.5	4	270	320	305
TURBIDITY	5	0.78	0.78	0.78	4	0.31	0.31	0.31	2	3.6	3.6	3.6	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	0.28	0.31	0.295
SULFATE	5	16	50	30.8	4	15	17	16	2	16	17	16.5	4	16	19	18	4	16	22	19.5	4	19	21	20	4	15	19	17.5
IRON (FE)	5	150	150	150	4	ND	ND	ND	2	940	940	940	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
MANGANESE (MN)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
MAGNESIUM	5	12	26	18	4	11	12	11.75	2	12	12	12	4	11	14	12.75	4	13	15	14	4	16	18	17.25	4	9	11	10.5
POTASSIUM	5	3.1	3.4	3.26	4	3.1	3.3	3.15	2	2.9	3.1	3	4	3	3.3	3.15	4	3.1	3.5	3.35	4	3.6	3.7	3.625	4	2.8	2.9	2.825
ALUMINUM (AL)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
ANTIMONY	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
ARSENIC (AS)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
ASBESTOS	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
BARIUM (BA)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
BERYLLIUM	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
CADMIUM (CD)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
CHROMIUM (Total Cr) (ug/L)	5	3	3	3	4	4	4	4	2	3.9	3.9	3.9	4	3.3	3.3	3.3	4	2.3	2.3	2.3	4	2	2	2	4	2.2	2.2	2.2
Chromium-6	ND	ND	ND	ND	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CYANIDE	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
FLUORIDE	5	0.4	1.1	0.72	4	0.3	0.6	0.475	2	0.3	0.4	0.35	4	0.3	0.8	0.575	4	0.3	0.4	0.35	4	0.4	0.5	0.425	4	0.4	0.6	0.5
MERCURY (HG)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
NICKEL	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
NITRATE	6	3.3	11	6	5	4.4	4.8	4.6	2	2.3	2.3	2.3	5	3.3	3.3	3.3	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
NITRITE AS NITROGEN (N)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
PERCHLORATE	8	ND	ND	ND	5	ND	ND	ND	3	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
SELENIUM (SE)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
THALLIUM	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
COPPER (CU)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
LEAD (PB)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
GROSS ALPHA	5	1.45	4.24	2.67	4	0.47	1.32	0.72	2	0.43	2.24	1.34	4	0.22	1.16	0.48	4	0.15	1.4	0.49	3	0.558	0.91	0.68	4	0.09	0.74	0.33
RADIUM 228	ND	ND	ND	ND	1	0.332	0.332	0.332	1	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	1	0.253	0.253	0.253	1	ND	ND	ND
Uranium	2	4.12	4.12	4.12	ND	ND	ND	ND	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND
Benzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Carbon Tetrachloride	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,4-Dichlorobenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1- Dichloroethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2- Dichloroethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2- Dichloropropane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1-Dichloropropene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Ethylbenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Methyl tert butyl Ether	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Styrene	1	ND	ND	ND	1	ND	ND	ND	0	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
1,1,2,2-Tetrachloroethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1,1-Trichloroethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1,2-Trichloroethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Trichlorofluoromethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Trichlorotrifluoroethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Vinyl Chloride	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Xylenes (m+p)	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Xylenes (ortho)	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Xylenes (Total)	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Alachlor	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	5	ND	ND	ND
Atrazine	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	5	ND	ND	ND
Bentazon	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Benzo(a)pyrene	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	5	ND	ND	ND
Carbofuran	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chlordane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dalapon	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
DEH-Adipate	1	ND	ND	ND	2	ND	ND	ND	0	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	2	ND	ND	ND
DEH-Phthalate	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	5	ND	ND	ND
Dinoseb	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Diquat	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Endrin	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Endothall	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Glyphosate	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Heptachlor	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Heptachlor Epoxide	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Hexachlorobenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Hexachlorocyclopentadine	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND

Row Labels	WELL 3				WELL 4				WELL 5				WELL 7				WELL 8				WELL 9				WELL 10			
	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg
Lindane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Methoxychlor	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Molinate	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	5	ND	ND	ND
Pentachlorophenol	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Pichloram	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Polychlorinated Biphenyls (Total PCB's)	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Simazine	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	5	ND	ND	ND
2,4,5-TP Silvex	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
DIOXIN	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Thiobencarb	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	5	ND	ND	ND
Toxaphene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromodichloromethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromoform	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chloroform	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dibromochloromethane	1	ND	ND	ND	1	ND	ND	ND	0	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
1,1,1,2-Tetrachloroethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1- Dichloroethene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2,3-Trichlorobenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2,4-Trichlorobenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2,4-Trimethylbenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2-Dichlorobenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,3,5-Trimethylbenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,3-Dichlorobenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,3-Dichloropropane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,3-Dichloropropene (total)	1	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	0	ND	ND	ND
2,2-Dichloropropane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
2,4-D	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
2-Butanone(MEK-EPA 8260)	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
2-Chlorotoluene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
3-Hydroxycarbofuran	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND
4-Chlorotoluene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
4-Methyl-2-Pentanone(MIBK)	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Aldicarb (TEMIK)	1	ND	ND	ND	1	ND	ND	ND	0	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
Aldicarb Sulfone	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND
Aldicarb Sulfoxide	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND
Aldicarb TEMIK)	3	ND	ND	ND	3	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND
Aldrin	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chloromethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bis(2-chloroethyl)ether (Non-NELAP)	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromobenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromochloromethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromomethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Carbaryl (Sevin)	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND
Chlorobenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chloroethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
cis-1,2-Dichloroethene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
cis-1,3-Dichloropropene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
DEH-Adiptat	4	ND	ND	ND	3	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND
Ethylene dibromide	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dibromochlorometeane	4	ND	ND	ND	3	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND
Dibromochloropropane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dibromomethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dicamba	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dichlorodifluoromethane	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dieldrin	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Hexachlorobutadiene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Isopropylbenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
MBAS	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Methiocarb (MESUROL)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	7	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND
Methomyl	4	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND
Methylene Chloride	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Naphthalene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
n-Butylbenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
n-Isopropyltoluene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
n-Propylbenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Oxamyl (Vydate)	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Propachlor	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Propoxur (BAYGON)	5	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND
sec-Butylbenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Strene	4	ND	ND	ND	3	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND
tert-Butylbenzene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Tetrachloroethene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Toluene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
trans-1,2-Dichloroethene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
trans--1,3-Dichloropropene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Trichloroethene	5	ND	ND	ND	4	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND

Row Labels	WELL 11				WELL 12				WELL M3				MT 7				WELL M10				WELL M11				WELL M12			
	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg
ALKALINITY	4	130	130	130	5	130	130	130	5	150	180	172	1	130	130	130	5	100	110	108	5	110	140	116	4	120	130	123
BICARBONATE	4	150	160	152.5	5	160	160	160	5	190	220	212	1	160	160	160	5	130	140	136	5	140	170	146	4	150	160	152.5
CALCIUM	4	36	37	36.75	5	39	39	39	5	39	41	40.4	1	9.5	9.5	9.5	5	19	22	20.8	5	20	28	22.2	4	24	27	24.75
CARBONATE	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
CHLORIDE	4	1.2	1.6	1.5	5	1.4	1.7	1.64	5	14	15	14.6	1	14	14	14	5	11	12	11.8	5	6.8	8	7.6	4	7.6	8.4	8.2
HARDNESS	4	130	140	137.5	5	140	140	140	5	150	160	158	1	45	45	45	5	78	82	80	5	57	80	64.6	4	80	91	82.75
PH, LABORATORY	4	7.2	7.7	7.575	5	7.2	7.6	7.52	5	7.7	7.9	7.84	1	8.3	8.3	8.3	5	7.9	8	7.96	5	8.2	8.4	8.32	4	8	8.1	8.075
SODIUM	4	5.6	6.4	6.2	5	5.7	6.1	6.02	5	38	39	38.4	1	51	51	51	5	26	31	28.8	5	37	42	40.6	4	27	34	32.25
SPECIFIC CONDUCTANCE (E.C.)	4	310	310	310	5	280	310	286	5	450	470	464	1	330	330	330	5	290	300	292	5	290	330	304	4	300	310	302.5
TURBIDITY	4	0.31	0.31	0.31	5	0.36	1.8	1.512	5	0.36	0.36	0.36	1	ND	ND	ND	5	0.58	0.58	0.58	5	0.36	0.7	0.53	4	0.7	0.7	0.7
SULFATE	4	17	18	17.25	5	17	18	17.2	5	35	37	36	1	3.5	3.5	3.5	5	3	4.9	3.86	5	15	18	16.2	4	4.1	6.3	5.75
IRON (FE)	4	ND	ND	ND	5	110	110	110	5	ND	110	82.5	1	110	110	110	5	ND	110	82.5	5	ND	110	55	4	ND	110	55
MANGANESE (MN)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
MAGNESIUM	4	10	11	10.75	5	9.6	9.9	9.84	5	13	14	13.8	1	5	5	5	5	6.6	7.1	6.72	5	1.9	2.6	2.16	4	4.6	5.7	4.875
POTASSIUM	4	2.6	2.9	2.825	5	2.6	2.6	2.6	5	2	2.3	2.2	1	3.4	3.4	3.4	5	1	1.6	1.44	5	1.3	1.5	1.36	4	1.4	1.6	1.55
ALUMINUM (AL)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
ANTIMONY	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
ARSENIC (AS)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	3.2	3.3	3.233333	4	3.2	3.2	3.2
ASBESTOS	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
BARIUM (BA)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
BERYLLIUM	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
CADMIUM (CD)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
CHROMIUM (Total Cr) (ug/L)	4	3	3	3	5	3.2	3.2	3.2	5	8.5	12	10.1	1	7.1	7.1	7.1	5	9.9	17	11.98	5	11	15	12.2	4	15	20	16.25
Chromium-6	ND	ND	ND	ND	ND	ND	ND	ND	3	9.7	10	9.9	ND	ND	ND	ND	3	11	12	11.66667	2	9.5	13	11.25	2	23	24	23.5
CYANIDE	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
FLUORIDE	4	0.3	0.4	0.325	5	0.3	0.3	0.3	5	0.3	0.5	0.4	1	0.6	0.6	0.6	5	0.6	0.7	0.68	5	0.4	1.5	1.12	4	0.5	1.7	1.4
MERCURY (HG)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
NICKEL	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
NITRATE	4	ND	ND	ND	5	ND	ND	ND	5	7.2	8.2	7.88	2	8.7	8.8	8.75	5	9.6	11	10.02	6	3.7	4.5	4.15	5	6.4	8	7.12
NITRITE AS NITROGEN (N)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
PERCHLORATE	6	ND	ND	ND	7	ND	ND	ND	7	ND	ND	ND	2	ND	ND	ND	7	ND	ND	ND	6	ND	ND	ND	5	ND	4.6	3.066667
SELENIUM (SE)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
THALLIUM	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
COPPER (CU)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	87	87	87
LEAD (PB)	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
GROSS ALPHA	4	0.33	0.33	0.33	5	0.23	0.24	0.24	4	0.5	0.94	0.83	1	1.89	1.89	1.89	4	0.56	0.61	0.60	5	1.26	1.5	1.43	4	0.93	1.03	0.96
RADIUM 228	1	0.249	0.249	0.249	1	0.009	0.009	0.009	1	0.247	0.247	0.247	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium	ND	ND	ND	ND	ND	ND	ND	ND	1	0.398	0.398	0.398	1	0.597	0.597	0.597	ND	ND	ND	ND	ND	ND	ND	ND	1	0.199	0.199	0.199
Benzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Carbon Tetrachloride	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,4-Dichlorobenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1- Dichloroethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2- Dichloroethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2- Dichloropropane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1-Dichloropropene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Ethylbenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Methyl tert butyl Ether	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
1,1,2,2-Tetrachloroethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1,1-Trichloroethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1,2-Trichloroethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Trichlorofluoromethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Trichlorotrifluoroethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Vinyl Chloride	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Xylenes (m+p)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Xylenes (ortho)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Xylenes (Total)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Alachlor	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Atrazine	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Bentazon	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Benzo(a)pyrene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Carbofuran	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chlordane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dalapon	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
DEH-Adipate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	2	ND	ND	ND
DEH-Phthalate	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Dinoseb	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Diquat	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Endrin	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Endothall	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Glyphosate	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Heptachlor	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Heptachlor Epoxide	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Hexachlorobenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Hexachlorocyclopentadine	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND

Row Labels	WELL 11				WELL 12				WELL M3				MT 7				WELL M10				WELL M11				WELL M12			
	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg	n	Min	Max	Avg
Lindane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Methoxychlor	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Molinate	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Pentachlorophenol	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Pichloram	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Polychlorinated Biphenyls (Total PCB's)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Simazine	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
2,4,5-TP Silvex	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
DIOXIN	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	2	ND	ND	ND
Thiobencarb	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
Toxaphene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromodichloromethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromoform	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chloroform	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
1,1,1,2-Tetrachloroethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,1- Dichloroethene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2,3-Trichlorobenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2,4-Trichlorobenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2,4-Trimethylbenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,2-Dichlorobenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,3,5-Trimethylbenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,3-Dichlorobenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,3-Dichloropropane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
1,3-Dichloropropene (total)	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
2,2-Dichloropropane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
2,4-D	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
2-Butanone(MEK-EPA 8260)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
2-Chlorotoluene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
3-Hydroxycarbofuran	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
4-Chlorotoluene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
4-Methyl-2-Pentanone(MIBK)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Aldicarb (TEMIK)	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND
Aldicarb Sulfone	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Aldicarb Sulfoxide	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Aldicarb TEMIK)	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND
Aldrin	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chloromethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bis(2-chloroethyl)ether (Non-NELAP)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromobenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromochloromethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Bromomethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Carbaryl (Sevin)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chlorobenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Chloroethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
cis-1,2-Dichloroethene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
cis-1,3-Dichloropropene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
DEH-Adiptat	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND
Ethylene dibromide	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dibromochlorometeane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND
Dibromochloropropane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dibromomethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dicamba	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dichlorodifluoromethane	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Dieldrin	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Hexachlorobutadiene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Isopropylbenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
MBAS	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	1	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND	4	ND	ND	ND
Methiocarb (MESUROL)	4	ND	ND	ND	6	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	8	ND	ND	ND	8	ND	ND	ND
Methomyl	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Methylene Chloride	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Naphthalene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
n-Butylbenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
n-Isopropyltoluene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
n-Propylbenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Oxamyl (Vydate)	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Propachlor	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Propoxur (BAYGON)	4	ND	ND	ND	6	ND	ND	ND	4	ND	ND	ND	2	ND	ND	ND	4	ND	ND	ND	5	ND	ND	ND	5	ND	ND	ND
sec-Butylbenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Strene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	3	ND	ND	ND	3	ND	ND	ND
tert-Butylbenzene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Tetrachloroethene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Toluene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
trans-1,2-Dichloroethene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
trans--1,3-Dichloropropene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND
Trichloroethene	1	ND	ND	ND	2	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	1	ND	ND	ND	4	ND	ND	ND	4	ND	ND	ND

Appendix C: Historical Chromium Concentrations

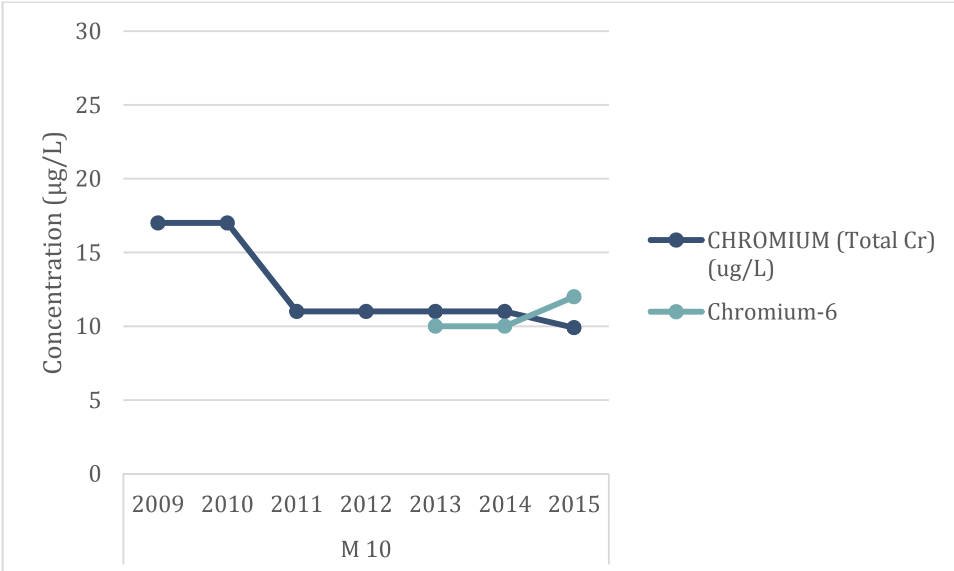

Figure 10: Well M10 Historical Chromium Concentrations

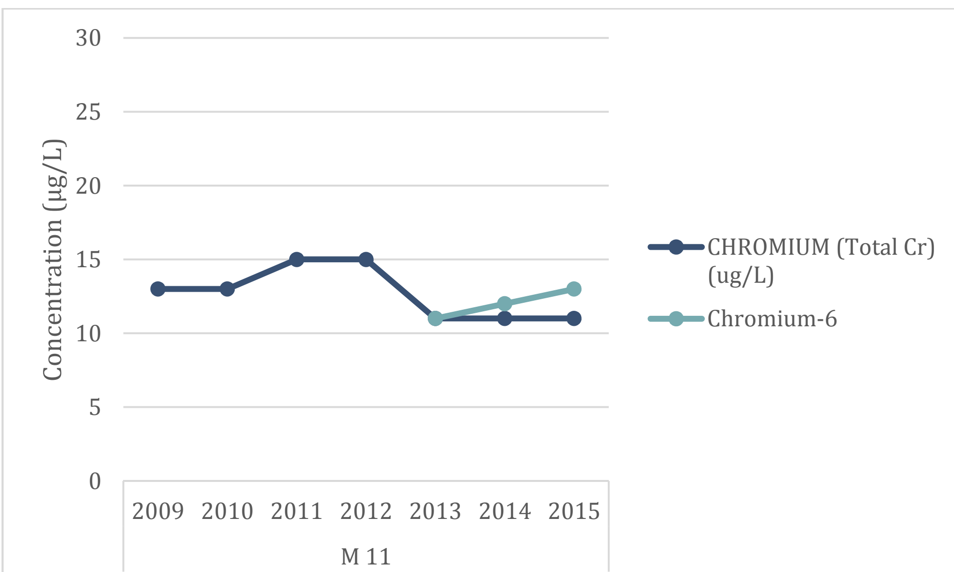

Figure 11: Well M11 Historical Chromium Concentrations

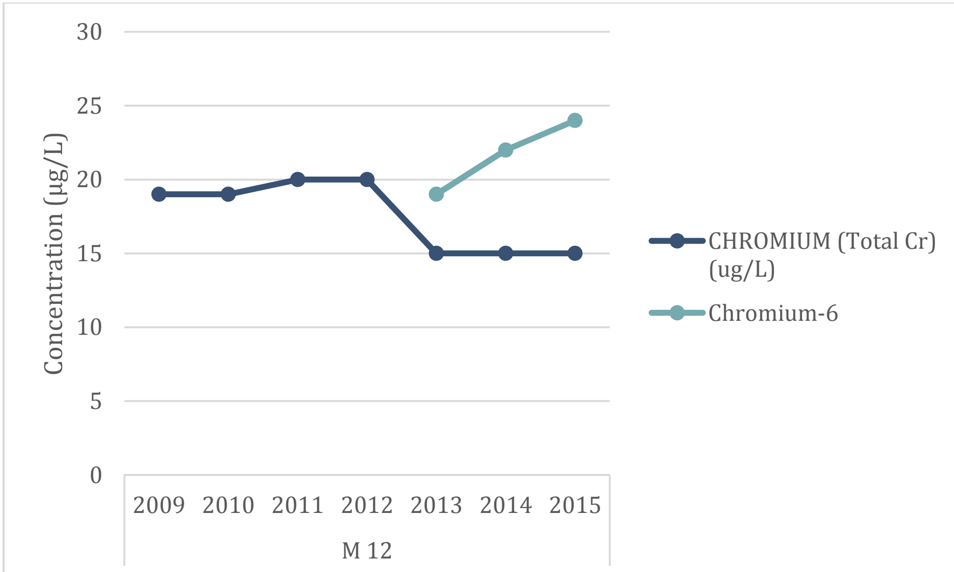

Figure 12: Well M12 Historical Chromium Concentrations

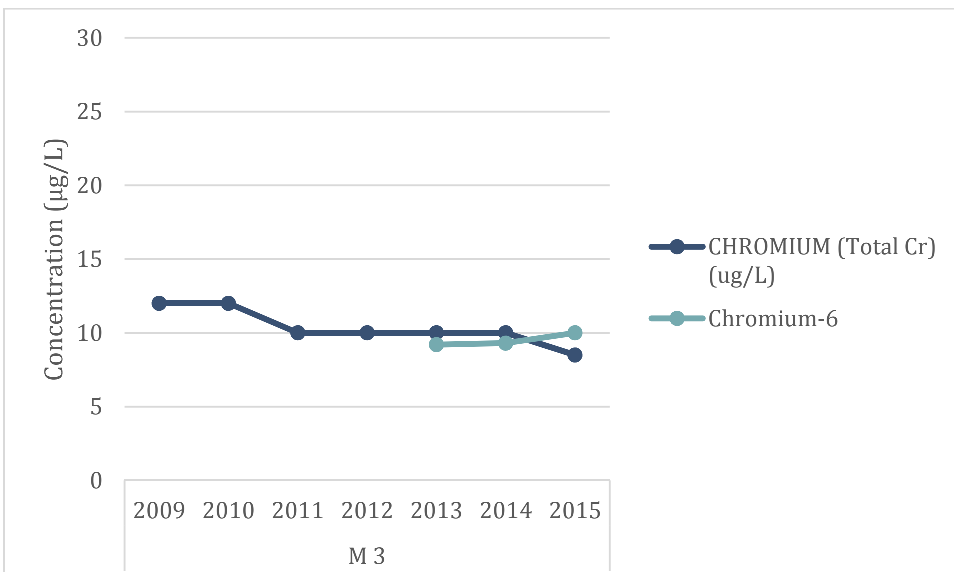

Figure 13: Well M3 Historical Chromium Concentrations

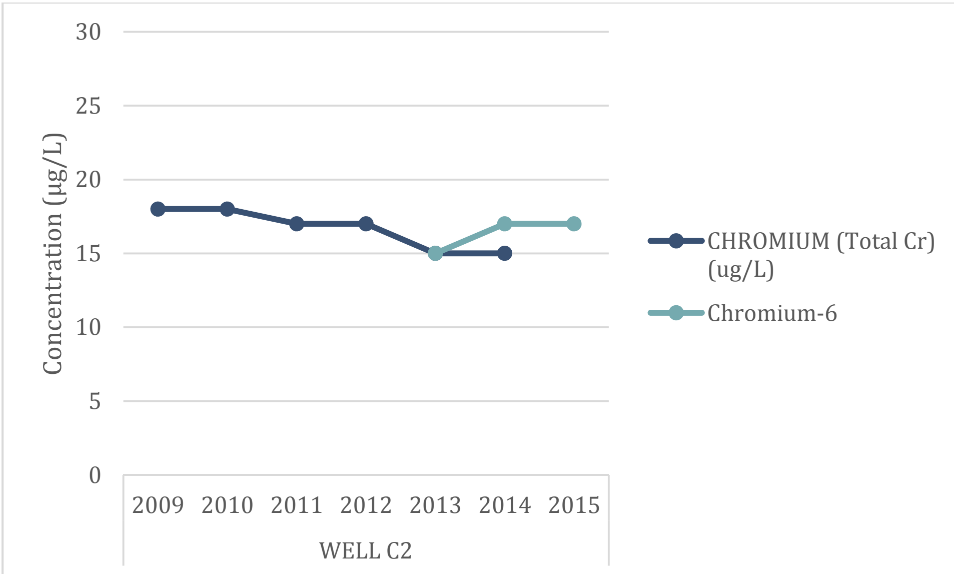

Figure 14: Well C2 Historical Chromium Concentrations

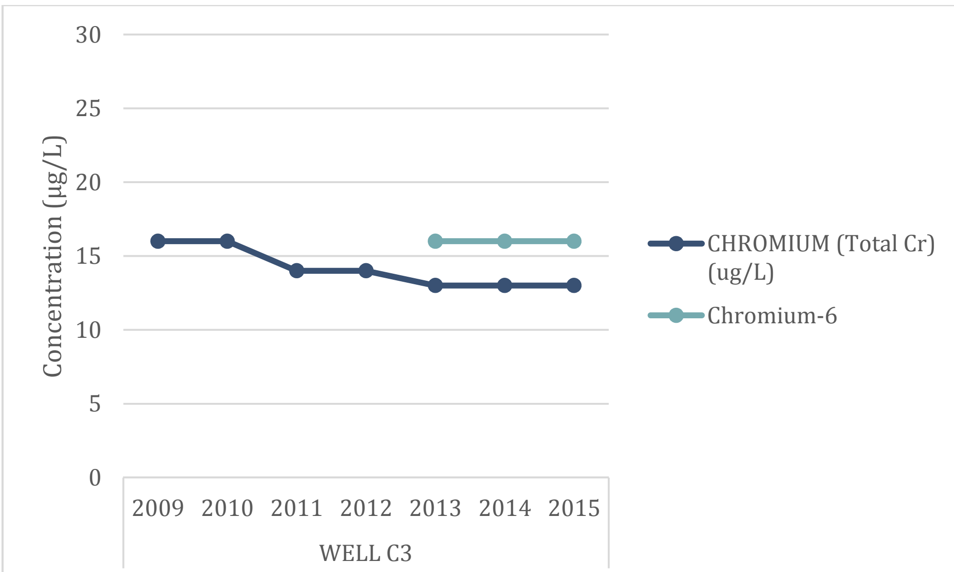

Figure 15: Well C3 Historical Chromium Concentrations

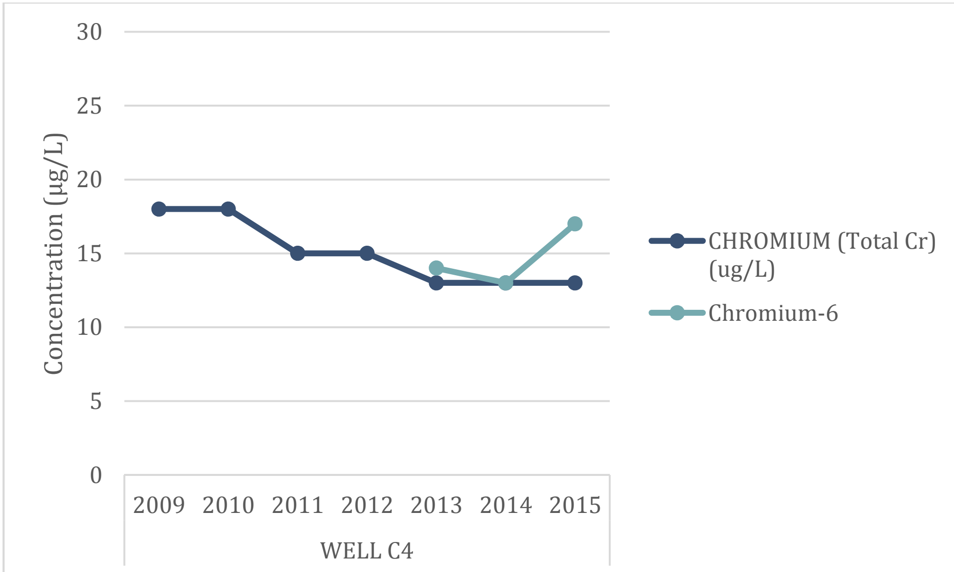

Figure 16: Well C4 Historical Chromium Concentrations

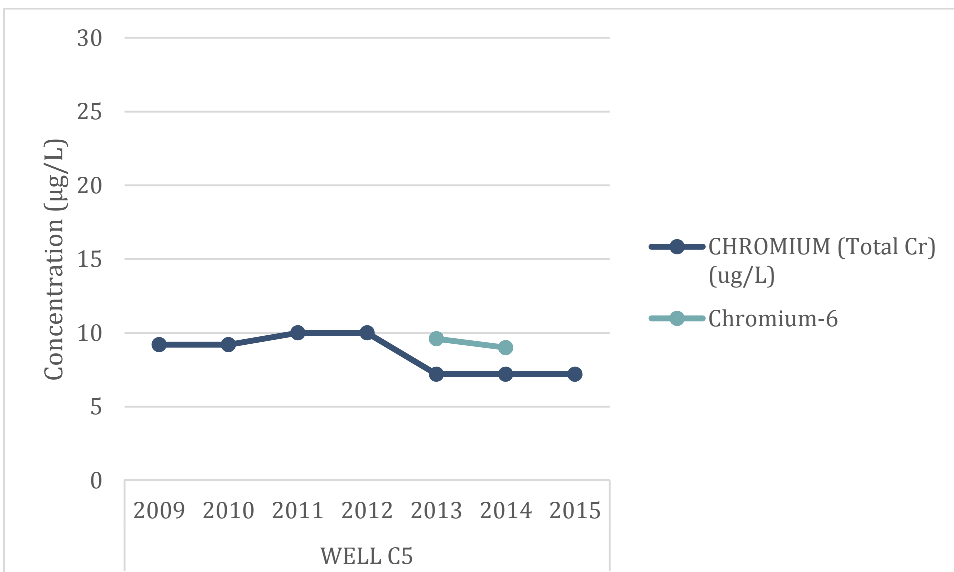

Figure 17: Well C5 Historical Chromium Concentrations

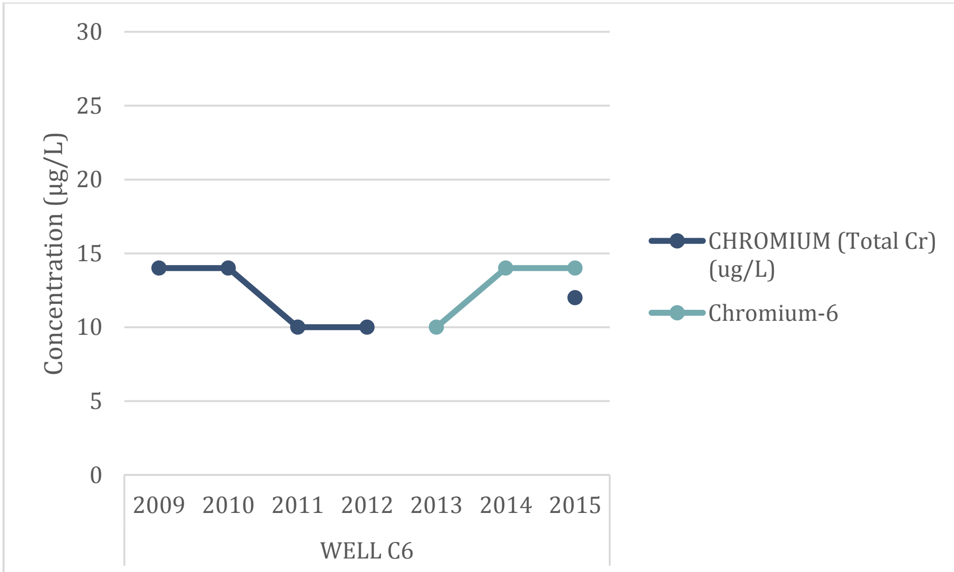

Figure 18: Well C6Historical Chromium Concentrations

Appendix D: Blending Analysis

System Wide Blending Analysis

To utilize the canyon wells as a system-wide blending source for each impacted well, roughly 11.5 thousand gallons per minute is required which is shown in **Table 12**.

Table 12: Well Blending Requirements for system-wide Blending

Well	Capacity Used for Treatment Evaluation (gpm)	Max Cr6 (µg/L)	Blending Flow Req'd (gpm)
C2	1,100	17	1,414
C3	1,200	16	1,600
C4	1,400	17	2,100
C5	1,100	9.6	293
C6	1,000	14	1,000
M3	1,000	12	667
M10	900	12	600
M11	700	13	583
M12	1,200	24	3,200
Total	**9,600**	**-**	**11,458**

[1] Well Capacity Used for Treatment Evaluation

[2] $$Q_2 = Q_1 \frac{(c_1 - c_F)}{(c_F - c_2)}$$

[3] Must be less than 10 ppb

Well C2 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,100	Well capacity[1]
c1, ppb	Concentration 1	17	Based on water quality data
Q2, gpm	Flow rate 2	1,414	Mixing flow required[2]
c2, ppb	Concentration 3	1	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	2,514	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well C3 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,200	Well capacity[1]
c1, ppb	Concentration 1	16	Based on water quality data
Q2, gpm	Flow rate 2	1,600	Mixing flow required[2]
c2, ppb	Concentration 3	2	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	2,800	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well C4 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,400	Well capacity[1]
c1, ppb	Concentration 1	17	Based on water quality data
Q2, gpm	Flow rate 2	2,100	Mixing flow required[2]
c2, ppb	Concentration 3	2	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	3,500	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well C5 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,100	Well capacity[1]
c1, ppb	Concentration 1	10	Based on water quality data
Q2, gpm	Flow rate 2	293	Mixing flow required[2]
c2, ppb	Concentration 3	2	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	1,393	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well C6 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,000	Well capacity[1]
c1, ppb	Concentration 1	14	Based on water quality data
Q2, gpm	Flow rate 2	1,000	Mixing flow required[2]
c2, ppb	Concentration 3	2	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	2,000	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well M3 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,000	Well capacity[1]
c1, ppb	Concentration 1	12	Based on water quality data
Q2, gpm	Flow rate 2	667	Mixing flow required[2]
c2, ppb	Concentration 3	2	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	1,667	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well M10 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	900	Well capacity[1]
c1, ppb	Concentration 1	12	Based on water quality data
Q2, gpm	Flow rate 2	600	Mixing flow required[2]
c2, ppb	Concentration 3	2	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	1,500	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well M11 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	700	Well capacity[1]
c1, ppb	Concentration 1	13	Based on water quality data
Q2, gpm	Flow rate 2	583	Mixing flow required[2]
c2, ppb	Concentration 3	2	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	1,283	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well M12 System-wide Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,200	Well capacity[1]
c1, ppb	Concentration 1	24	Based on water quality data
Q2, gpm	Flow rate 2	3,200	Mixing flow required[2]
c2, ppb	Concentration 3	2	Based on canyon well water quality w/ safety factor
QF, gpm	Final flow rate	4,400	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Well C3 Individual Blending

Well C3 was evaluated to be blended with the Foothill West treated water. The first Well C3 individual blending scenario is blending with water treated to a Cr-6 level of the typical 6 ppb.

[1] Well Capacity Used for Treatment Evaluation

[2] $$Q_2 = Q_1 \frac{(c_1 - c_F)}{(c_F - c_2)}$$

[3] Must be less than 10 ppb

Well C3 Individual Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,200	Well capacity[1]
c1, ppb	Concentration 1	16	Based on water quality data
Q2, gpm	Flow rate 2	4,800	Mixing flow required[2]
c2, ppb	Concentration 3	6	Assumes Foothill West Cluster treated to 6 ppb
QF, gpm	Final flow rate	6,000	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

The second Well C3 individual blending scenario is blending with water treated to a Cr-6 level of 0 ppb with a safety factor to 2 ppb.

Well C3 Individual Blending Calculations

Parameter	Description	Value	Comment
Q1, gpm	Flow rate 1	1,200	Well capacity[1]
c1, ppb	Concentration 1	16	Based on water quality data
Q2, gpm	Flow rate 2	1,600	Mixing flow required[2]
c2, ppb	Concentration 3	2	Assumes Foothill West Cluster treated to 0 ppb w/ safety factor to 2 ppb
QF, gpm	Final flow rate	2,800	Total flow ($Q_1 + Q_2$)
cF, ppb	Final concentration	8.0	Target blending concentration[3]

Appendix E: Basis of Cost Estimates

Planning Assumptions

This section outlines the key assumptions used for evaluating alternative technologies for the Cr6 treatment facilities and developing cost estimates. These assumptions are based on current industry trends.

The assumptions used for estimating Conventional SBA treatment system costs include:

- SBA process includes bag filters for particle removal, ion exchange vessels in a parallel configuration, resin regeneration, and spent brine treatment process. Each system includes a minimum of 2 vessels plus a standby/regen vessel.
- A caustic soda feed system was not included because CCPP was positive even with one vessel returning from regeneration.
- SBA resin life was assumed to be 7 years. This cost of resin replacement was annualized and included in the annual O&M estimate.
- Resin regeneration frequency is based on maximum historical sulfate concentration in raw water and a function of bed volumes versus sulfate.
- Resin regeneration procedure consists of regen (12% brine, 4 BVs total comprised of 3 BVs to be recycled and 1 BV to waste), slow rinse (1 BVs, all 1 BV to be recycled), and fast rinse (3 BVs all to waste).
- For onsite brine treatment:
    - Spent brine is treated before disposal. Backwash and fast rinse waste are non-hazardous and contain low TDS and can be disposed to sewer without treatment. Recycle of fast rinse waste may be feasible.
    - Spent brine treatment is based on a ferrous dose of 2,000 mg/L. This iron dose can be optimized with testing, which may reduce costs.
    - Treated brine was assumed to be non-hazardous with high TDS, which would be hauled off-site for disposal as TDS concentrations are higher than acceptable discharge limits.
    - Dewatered solids are non-RCRA hazardous waste due to chromium concentrations. The dewatered solid quantity was estimated using a mass balance, assuming all chromium and iron are settled and removed as dewatered solids. Moisture content was assumed 80 percent, based on results observed at Glendale for dewatered solids.
    - Total labor was assumed to be 3.3 FTE.

- For hazardous brine disposal:
    - Spent brine and slow rinse waste (if not recycled for the next regeneration) were hauled for disposal as hazardous waste at a cost.

The assumptions use for Conventional SBA with offsite regeneration at CVWD’s CRRF:

- SBA process includes bag filters for particle removal and two 12-ft diameter ion exchange vessels operated in a parallel configuration. There is no standby vessel as each vessel is sized to accommodate the full flow for when regenerations are conducted.
- SBA resin life was assumed to be 7 years. This cost of resin replacement was annualized and included in the annual O&M estimate.
- Resin regeneration frequency is based on maximum historical sulfate concentration in raw water and a function of bed volumes versus sulfate.
- Resin regeneration fee will be set based on a negotiated rate between the City of Banning and CVWD. For purposes of this evaluation, a range of unit costs from $36/cf to $46/cf of resin, or $21,600 per vessel regenerated to $27,600 per vessel regenerated were used. Actual rates may increase or decrease based negotiated rates accounting for the construction and operational costs of the facility, which were not finalized at the time of this evaluation.
- Total labor costs were estimated at 2.0 FTE.

The assumptions used for estimating WBA treatment system costs include:

- WBA process includes bag filters for particle removal, pH adjustment using carbon dioxide (CO_2), ion exchange vessels in a lead/lag configuration, and post pH adjustment using aeration.
- CO_2 was assumed to achieve a pH target of 6.0. CO_2 dose was estimated using the RTW model.
- For aeration, anti-scalant (polyphosphate) at a dose of 1 mg/L was included to minimize calcium carbonate precipitation in the aerator (actual dose is to be determined based on water quality and manufacturer recommendations in design). No aeration off-gas treatment was included.
- WBA resin life was assumed to be 368,000 BVs for the lead bed when the lag bed effluent achieves 2 µg/L or 400,000 BVs when the lag bed effluent achieves 6 µg/L. These estimates are conservative based on previous studies by Hazen and Sawyer and others.
- During WBA resin change-out, 6 BVs of water were assumed for resin flushing. This wastewater was assumed to be stored in a separate temporary tank and disposed of as non-hazardous waste to the sewer.
- Spent WBA resin was assumed as non-RCRA hazardous waste and TENORM (after blending with adsorbent) that can be disposed to US Ecology's landfill in Idaho (the same landfill that City of Glendale uses for their spent WBA resin).
- The total required labor was assumed to be 2 full time equivalent (FTE).

The assumptions used for estimating RCF with recycle treatment system costs include:

- RCF treatment consists of ferrous sulfate addition, a reduction tank (5-minute contact time), chlorination for residual ferrous iron oxidation, and granular media filtration.
- Annually, 10% media replacement due to attrition was assumed.
- Wastewater was assumed to account for 3-5% of the total production flow, which is then settled and recycled to reduce the overall process waste to less than 1%, which can be disposed of to the sewer.
- Cr6 treatment target was assumed to be 5 µg/L for RCF based on findings of total chromium removal by this process.
- The total required labor was assumed to be 4.0 FTE.

The assumptions used for estimating RCMF with recycle treatment system costs include:

- RCMF treatment consists of ferrous sulfate addition, a reduction tank (5-minute contact time), chlorination for residual ferrous iron oxidation, and microfiltration.
- MF membrane life was assumed to be 10 years. O&M cost includes replacement cost for 10% of the membranes every year.
- Wastewater was assumed to account for 5-6% of the total production flow, which is then settled and recycled to reduce the overall process waste to less than 1%, which can be disposed of to the sewer.
- Cr6 treatment target was assumed to be 2 µg/L for RCMF based on findings of total chromium removal by this process.
- The total required labor was assumed to be 4.0 FTE.

Cost Assumptions

Manufacturer equipment and O&M estimates provided to the City were standardized in terms of components to allow a comparison between technologies. Uncertainty associated with certain cost elements was also incorporated to provide an understanding of the impact of key assumptions like brine disposal. Treatment system cost estimates were developed for WBA, SBA, and RCF/RCMF to enable comparison of the technologies. In the case of SBA, multiple options were evaluated: (1) Conventional SBA with onsite regeneration and brine treatment and non-hazardous brine disposal, (2) Containerized SBA with onsite regeneration and hazardous brine disposal, (3) SBA with offsite regeneration at a centralized resin regeneration facility (CRRF) operated by Coachella Valley Water District (CVWD), (4) Conventional SBA with offsite regeneration at a Banning CRRF located at the Foothill West Cluster (either with hazardous brine disposal or brine treatment and sewer discharge).

Capital costs were generated using Hazen and Sawyer cost models, which are based on costs estimated for a range of water system sizes (100, 500, 2,000, and 7,000 gpm). These estimates are consistent with Association for the Advancement of Cost Engineering (AACE) Class 5 estimate with an accuracy range of -30% to +50%. Annualized capital costs are based on an interest rate of 1.9% (assuming SRF loans) and a period of 30 years. Industry standard multipliers were applied to the equipment cost estimates to assess the total project capital cost (**Table 13**).

Table 13. Capital Cost and Engineering Factor Assumptions

Item	Percentage	Description
Capital Cost Assumptions		
Installation	30%	Equipment Installation costs
General Requirements	8%	"Division 1" requirements including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%	Excavation, backfill, and fill required to construct the project
Site Work	5%	Roadways, curb and gutter, sidewalk, and landscaping
Valves, piping, and appurtenances	15%	Major system piping and valves
Electrical, Instrumentation and Control	15%	Motor control center (MCC), conduit and wire, programmable logic controller (PLC) and supervisory control and data acquisition (SCADA) equipment
Engineering Factor Assumptions		
Contractor's Overhead and Profit	20%	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Engineering, Legal and Administrative	20%	Includes permits, legal fees, and engineering fees for design and construction.

O&M costs were developed based on the design assumptions described in the following sections and include media replacements (such as resins), labor, chemicals, residuals, electricity, lab and field analysis, and equipment maintenance. O&M costs include additional energy requirements to overcome treatment losses, but do not include electricity for existing pumping. A summary of unit prices is provided below in **Table 14.**

Table 14. Unit Prices for Chemicals, Residuals Disposal, Labor, and Electricity

Item (Unit)	Unit Price	Source
Electricity ($/kWh)	$0.10	Average Banning energy cost
CO_2 unit price ($/lb)	$0.07	TOMCO unit cost for Coachella Valley
Spent WBA resin disposal ($/cf)	$342	Average cost at City of Glendale for WBA
Sewer discharge ($/hcf)	$3.15	Budgetary estimate for sewer discharge
Labor annual salary ($/yr)	$105,000	US Bureau of Labor Statistics Water Operator average for California ($65.5K*1.6 for a burdened rate) and also the IonexSG operator unit labor rate for a T2 during normal hours ($50/hr)
Salt ($/ton, including shipping)	$136	Average cost at CVWD
Ferrous Sulfate ($/gal)	$2.50	Brenntag quote
Ferric Chloride and Ferrous Sulfate Blend ($/gal)	$9.93	Average cost at CVWD
Polymer ($/gal)	$30	Average cost at CVWD
Clarified brine disposal for SBA with on-site regen ($/kgal)	$300	Average cost at CVWD
Hazardous brine disposal for SBA with on-site regen ($/gal)	$1.12 - $3.00	Phibrotech. Higher quotes were obtained from Evoqua, US Ecology, and Clean Harbors.
Non-RCRA hazardous solids disposal ($/lb)	$1.61	Cost at City of Glendale for non-RCRA hazardous waste
SBA resin unit price ($/cf)	$188	Purolite's quote for A600E/9149, with extra 15% for tax and freight and $15/cf for resin installation. Evoqua's quote for Dow SAR resin is $150.
WBA resin unit price ($/cf)	$265	Budgetary price for S106 resin- $10,000 added for turnkey installation.