HEXAVALENT CHROMIUM COST METHODOLOGY & ASSUMPTIONS

Methodology

1. Obtained all WQIR data for hexavalent chromium for the period from January 14, 2014 to May 12, 2020.
2. Changed information about specific sources based on district feedback. A full list of changes is in Appendix A.
3. Removed wholesalers (these systems will be addressed at a later date) and separated Community Water Systems from Non-transient Noncommunity (NTNC) Water Systems, creating two sets of active water sources. The following steps apply to both sets of sources but were completed separately.
4. All hexavalent chromium findings for each source were averaged to determine the average concentration in each well. This value functions as the concentration determining compliance to possible MCLs for this analysis, rather than the most recent year average, which determines source compliance in the regulations.
5. If the average finding for a source is above the potential MCL, it is assumed to need treatment.
6. If a source needs treatment, an estimated volume of water treated annually is needed. If the amount of water used by the system is reported in the 2018 (preferred) or 2017 EAR, that value is used. If water use is not reported in the 2018 or 2017 EAR, a value equivalent to 179 gallons per capita per day is used to estimate system water use.
7. Once system water use is obtained, it is divided by the number of active sources in that system to estimate the amount of water produced by that source. Note: if the source production obtained from an EAR seems unreasonably high (>10,000 gpm per source), a data error is assumed to have occurred, and 179 gallons per capita per day will be used to estimate water production instead.
8. The cost of treatment for each source is calculated by using the water production for that source with the appropriate capital and O&M cost equations.
9. O&M costs are adjusted up (multiplied by 1.2) to account for the fact that water is treated to approximately 80% of the MCL to avoid violating the MCL.
10. O&M costs are adjusted down (dividing by peaking factor) because peak sizing will not change the annual O&M expenses needed to treat the water produced.
11. Capital costs are annualized with an amortization factor (0.0944) representing the costs over 20 years at 7%.

General Assumptions

- The peaking factor is 1.5 * 2.25 (= 3.375), consistent with the California Water Works Standards.

- An adjustment factor of 0.36 is applied to O&M costs to reflect (a) a utilization rate based on average flow instead of design flow (peaking factor = 1.5*2.25) and (b)

a lower resin changeout trigger (i.e., use 80% of potential hexavalent chromium MCL instead of exceeding a potential hexavalent chromium MCL, which increases costs by 20%; trigger level factor = 1.2); adjustment factor = 1.2/(1.5*2.25) = 0.3556.

- Water quality data from the State Water Board's WQIR database provides a sufficient starting basis for a cost analysis for the proposed regulations.

- Any source exceeding a proposed MCL (by averaging all available sample data) will treat the source to come into compliance.

- Each affected source requiring treatment will have its own treatment plant and will incur capital, O&M, and monitoring costs.

- Water production for some systems is available in the Electronic Annual Reports (EAR). If available, the 2018 (preferred) or 2017 EAR was used to determine the water produced by each system.

- If 2017 and 2018 EAR data is not available or seems unreasonably high (> 10,000 gpm per source assumes a data error), the average demand is calculated using 179 gallons/person/day.

- All divisible system characteristics (service connections, population, water use, etc.) are assumed to be evenly distributed among the active sources.

- The hexavalent chromium concentration in the treated water is at a level equal to 80% of the MCL, except for SBA treatment, which is treated to below the DLR.

- All sources are vulnerable to hexavalent chromium.

- The population exposed to hexavalent chromium is equal to the system population divided by the number of active sources.

- Operator costs adjustments specifically due to changes in water treatment facility class were not considered as a specific cost.

- If a source has a design flow below the minimum (below 10 gpm for WBA and below 100 gpm for other treatment types) used to formulate the cost equations, instead the minimum will be used as the design flow.

- Interpolation will be used to calculate the treatment cost for an MCL that lies between two established (in literature) MCL costs.

- Two sets of cost equations are developed for each treatment type. The first is a set of best fit equations, which are all polynomial and have very high R-squared values. The best fit equations are used when the design flow is within the given design flows used to formulate the cost equations (and below the highest flows

specifically researched). The second set of equations are linear equations to be used when the design flow is higher than the maximum flow researched (10,000 gpm for SBA and 2,000 gpm for other treatment types).

Model-specific assumptions (Hazen & Sawyer, 2013)

- Design raw water quality was assumed to have no volatile organic chemicals (VOC).
- Capital and O&M costs excluded off-gas treatment of VOC using vapor phase granular activated carbon.
- O&M costs excluded compliance monitoring from O&M analytical costs, as the costs of compliance monitoring are determined separately.

Model-specific assumptions (Water Research Foundation, 2014)

- Waste brine is assumed to be hauled off site (higher O&M costs) rather than discharged to a sewer (slightly lower O&M costs).

Health Benefits Assumptions

- Treated water hexavalent chromium concentration is assumed to be 80% of the MCL.
- Risk for a carcinogen is linear.
- The hexavalent chromium concentration for an untreated source is the average of all findings for that source.
- Risk = [hexavalent chromium concentration] * 1,000,000 / PHG
- Theoretical lifetime cancer cases = Risk * Source Population
- Theoretical annual cancer cases = Theoretical lifetime cancer cases / 70 years

Sources Relied Upon

Hazen & Sawyer (2013). *Hexavalent Chromium Removal Research Project: Phase III Demonstration Study – RCF and WBA Costs*. Glendale Water and Power. Retrieved from: https://www.glendaleca.gov/home/showpublisheddocument?id=14854.

Water Research Foundation (2014). *Impact of Water Quality on Hexavalent Chromium Removal Efficiency and Cost – Web Report #4450 – Appendix A*. Water Research Foundation. Retrieved from: https://www.waterrf.org/research/projects/impact-water-quality-hexavalent-chromium-removal-efficiency-and-cost.

Appendix A

The following is a list of changes made to the data after it was pulled from the system and before the costs were estimated. Each system number is listed followed by the change that was made.

- 0110003 – changed all population to 23600 to result in an est population impacted of 2950 per source
- 0110010 – changed all population to 42480 to result in an est population impacted of 3540
- 0710002 – changed all population to 3360 to result in an est population impacted of 1120
- 3810011 – changed all population to 4000 to result in an est population impacted of 1000
- 3410020 – changed population of non-SW sources to 116000 to result in an est population impacted of 4000
- 3410017 – changed population of non-SW sources to 64000 to result in an est population impacted of 4000
- 3410029 – changed population of non-SW sources to 132000 to result in an est population impacted of 4000
- 5710006 – changed population of non-SW sources to 32000 to result in an est population impacted of 4000
- 5710001 – changed population of non-SW sources to 36000 to result in an est population impacted of 4000
- 5710009 – changed population of non-SW sources to 24000 to result in an est population impacted of 4000
- 5010010 – changed population of all sources to 86220 to result in est pop of 1437
- 3910011 – changed population of non-SW sources to 4000 to result in an est population impacted of 400
- 5010005 – changed population of all sources to 6996 to result in est pop of 1166
- 3910012 – changed population of non-SW sources to 28238 to result in an est population impacted of 2017
- 3910001 – changed population of non-SW sources to 32825 to result in an est population impacted of 1313
- 3610029 – cut population in half to 28499 to reduce customers served by 50%
- 3610018 – cut population of GW in half to 100975 to reduce customers served by 50%
- 3610055 – cut population of GW in half to 27146 to reduce customers served by 50%
- 3610037 – cut population of GW in half to 35777 to reduce customers served by 50%

- 3610041 – cut population of GW in half to 114950 to reduce customers served by 50%
- 1910097 – changed population of –011 to 550 to result in an est pop of 110