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Staff Analysis
Community Water Fluoridation in Denver Water's Operations

August 21, 2015*

This memorandum provides context regarding how Denver Water became and remains involved in community water fluoridation ("CWF"); what other water suppliers in Colorado are doing; and how fluoride in drinking water is addressed by federal agencies. Because state and local public health agencies and Denver Water all rely on recommendations from the U. S. Public Health Service ("PHS") regarding the appropriate level of fluoride concentration, this memo focuses on the PHS's 2015 recommendation.

Background and Context

1. Denver Water's History with Fluoridation

Denver Water began adding fluoride at the Moffat Water Treatment Plan in 1953 at the request and expense of the Denver Board of Health, because water imported through the Moffat Tunnel was "deficient", while South Platte water was considered to contain adequate fluoride.[1] For the next 25 years, the Denver Health Department established the dosage level in reliance on federal recommendations (generally 1.0 ppm), paid for fluoride and the operational costs of fluoridation, and monitored fluoride levels in the water supply. In 1978, Denver Water assumed the costs of fluoridation, based on its purchasing power regarding water treatment chemicals, the growth in outside-City customers, and the minimal operational costs of supplementing with fluoride. The 1978 contract stated, "Inasmuch as the fluoridation of the water supply is a public health function, the Denver City Health Department will continue to prescribe the fluoride dosage and to perform the necessary analytical tests for fluoride concentration in the above described waters on a routine bases, at no charge to the Board."[2]

In 1980, the Colorado Department of Health provided a grant of $80,000 to pay for fluoridation feed equipment and one year's supply of fluoride so that Denver Water could expand fluoride supplementation to the Kassler (later replaced by Foothills) and Marston treatment plants "in the interest of the prevention of dental decay throughout the State."[3] The grant agreement noted that the Denver Board of Health and Hospitals had previously requested Denver Water to add fluoride to water supply within Denver "as a public health measure in the interest of prevention of dental caries and in the interest of health promotion." It therefore appears that management of fluoride levels expanded to all three treatment plants in 1981 or 1982. At some point later, Denver Water assumed the responsibility of monitoring water quality and reporting to EPA. Each subsequent purchase of fluoride by Denver Water has been premised on recommendations "by both Denver and Colorado Departments of Health for the prevention of dental caries."[4]

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It appears that Denver Water began and continued managing fluoride levels at its treatment plants at the request of Denver and Colorado public health agencies. Denver Water agreed to perform this public health intervention, and relied on those agencies to decide what fluoride concentration should be targeted. For the first 25 years, possibly longer, the public health agencies participated financially. The agencies continued to determine the appropriate level of supplementation based on recommendations by PHS. For example, in 1995 the state Department of Health communicated that the optimum level for Denver Water's system was 0.9 (determined on the basis of average temperature within Denver Water's service area), with an operating control range of 0.8 to 1.1.[5]

2. Fluoride in Colorado Water Systems

Most water supplies in Colorado contain some fluoride. Approximately 275 public water suppliers of all sizes have natural fluoride levels in their treated water that average 0.6 or higher.[6] Most have average levels higher than 0.7.[7] CDPHE reports to CDC the fluoride status of all public water suppliers in Colorado. Of the 50 largest systems listed, serving several million Coloradans, 40 report an average concentration of 0.7 ppm, indicating management of fluoride levels through supplementation, while six suppliers have levels lower than 0.7, and 4 report levels above 0.7 ppm.[8] The fluoride concentrations in these databases are not always consistent with the water supplier's annual water quality report, and there are other data problems (e.g., double listing of Denver Water and our distributors), but the information is useful in establishing the prevalence of fluoride management by water suppliers in Colorado, and the wide variation in natural fluoride levels. Fluoride levels in source waters vary widely; one tributary may have concentrations much different from the next tributary downstream.

It was mentioned at the public forum that Aurora, the second-largest drinking water provider in the Denver area, does not fluoridate its water. Since Denver Water and Aurora share storage in Strontia Springs Reservoir, it might be assumed that Aurora's source water contains concentrations similar to Denver Water's, and that Aurora had made a different policy choice. The facts contradict those assumptions. The easiest way to determine water quality in a drinking water system is to look at the supplier's Consumer Confidence Report, which is required by EPA to be published each year. Measurements are taken at the introduction point to the distribution system, after the water has been treated. Aurora's CCRs demonstrate average fluoride concentrations in excess of 0.7 ppm. Where the report provides ranges, even the lowest concentration exceeds 0.7 ppm. Under these circumstances, supplementation is not needed to provide dental health benefits.

3. Fluoride in Denver Water's Source Water

While some regularity and simplicity in Denver Water's source water might have been assumed, fluoride levels in fact vary widely as shown by the data in the PDF "Fluoride data for DW watersheds", reflected in the table below.

North Fork from upstream to confluence		South Platte mainstem from upstream to confluence		Confluence downstream to treatment plants	
Blue River	0.34 – 0.54	Above Cheesman	0.22 – 0.88	Below confluence	0.44 – 1.08
No Fork w/o Blue River	0.11 – 0.42	Tributary	1.25 – 1.86	Foothills influent	0.44 – 1.02
Elk Creek	0.96 – 1.31	Cheesman outlet	0.45 – 0.98	Marston influent	0.47 – 0.89
Above confluence	0.22 – 0.73	Horse Creek above Deckers	2.20 – 3.09		
		Above confluence	0.63 – 1.52		

- As the table demonstrates, fluoride levels vary along the North Fork and along the mainstem of the South Platte. Blue River water contains more fluoride than the North Fork at the east end of the Roberts Tunnel. The South Platte mainstem has higher levels than the North Fork. Horse Creek above Deckers has levels that exceed the SMLC of 2.0 ppm. If Horse Creek levels were treated water levels, they would be subject to public notice. When and where it rains can alter fluoride levels into Strontia Springs Reservoir, as can whether the Roberts Tunnel is operating and at what volume.
- Water is delivered to Foothills treatment plant directly through Conduit 20 from Strontia Springs, and fluoride levels in water delivered may vary significantly up and down. Levels at the treatment plant are monitored closely and adjustments made frequently to try to achieve the average of 0.7 over time. As shown in PDF "Fluoride at DW WTPs", our operators are able to achieve this average on a monthly basis, despite variations in influent concentrations.
- Water delivered from Strontia to Marston treatment plant goes into storage in the forebay, where the water mixes, and the fluoride levels become more stable.
- In contrast, fluoride concentrations in the influent to the Moffat treatment plant range from only 0.12 to 0.33, well below the optimal level for prevention of dental caries. These low levels explain why the Denver Board of Health first asked Denver Water to supplement fluoride concentrations at Moffat in 1953.
- It seems that not managing fluoride concentrations at Foothills and Marston, as some have suggested, would not result in a dependable average concentration, because variations are significant and not very predictable.

4. Federal Water Quality Approach to Fluoride

Fluoride in drinking water is addressed along a continuum of concentration by two federal agencies with different purposes in mind. This situation results from the fact that fluoride is beneficial to tooth enamel in lower concentrations, but can be harmful to tooth enamel at higher concentrations. It is helpful to understand the two federal agencies and the structure they have created.

A. The U.S. Public Health Service

The PHS is led by the Surgeon General and was formally established by an Act of Congress in 1889.[9] Historically, the PHS has considered reducing the prevalence of dental caries to be an important public health goal.[10] Dental caries can be reduced through fluoridation of various mediums including water, salts, and milk. PHS has chosen water for reasons ranging from cost to effectiveness in reducing dental caries. Fluoride occurs in water as a result of erosion of natural deposits and discharges from fertilizer and other sources. Another factor in the choice to use community water in this public health initiative was the variation in natural fluoride levels; many citizens lived in areas where the fluoride concentration in the source water was below the optimal level. As a result, PHS seeks to determine and recommend to communities with low fluoride levels the optimal concentration that prevents dental caries, while minimizing the risk of dental fluorosis.

B. Environmental Protection Agency

The EPA regulates fluoride under the 1974 Safe Water Drinking Act, which establishes standards for the purpose of preventing "adverse health effects."[11] EPA regulates drinking water by establishing: (1) maximum contaminant level goals ("MCLG"), set for the purpose of preventing adverse health effects, but not enforceable; (2) maximum contaminant levels ("MCL"), the regulatory standard, set as close as possible to the MCLG, taking into account cost and the best available technology; and (3) secondary maximum contaminant levels ("SMCL"), which are lower than MCLs, established as guidelines, and not enforceable. If the drinking water exceeds a particular MCL, then the provider must remove the contaminant prior to delivery.

In 1986, EPA established the MCL and MCLG for fluoride at 4.0 ppm, the level necessary to protect the general public from the adverse health effects of skeletal fluorosis and bone fracture. Water suppliers with fluoride concentrations higher than the MCL must reduce the level.[12] Unfortunately, the only techniques approved by EPA for fluoride removal are distillation and reverse osmosis, both very expensive. The SMCL was established at 2.0 ppm to prevent severe dental fluorosis, which was considered to be a cosmetic problem and not an adverse health effect. Because this level is not an enforceable limit, water suppliers with levels above 2.0 must provide public notice to their customers.[13]

Because it is relevant to the 2015 PHS recommendation decision, this is a brief description of a study conducted in 2006 at the request of EPA by the National Research Council, the research agency of the National Academy of Sciences.[14] The NRC examined EPA's standards for fluoride, meaning fluoride levels between 2 ppm and 4 ppm. The NRC found no evidence substantial enough to support health effects other than severe dental fluorosis at those concentrations.[15] However, NRC concluded that severe dental fluorosis should be considered to be an adverse health effect, and that EPA should consider lowering the MCLG below 4 ppm.[16] The NRC also concluded that at concentrations less than 2 ppm, the occurrence of severe dental fluorosis is almost zero.[17]

In response to the NRC report, EPA in 2010 commissioned a Dose-Response Analysis for Non-Cancer Effects for fluoride to examine "the effects of ingested fluoride on dental fluorosis and bone structure."[18] The report determined that 1.87 ppm is the fluoride concentration necessary to protect against severe dental fluorosis in children. EPA determined that this level would also protect adults from skeletal effects.[19]

C. Summary of PHS and EPA Fluoride Roles

In summary, the PHS recommendation concerns the addition of fluoride where natural concentrations are lower than the optimal level to prevent dental caries, and the EPA's MCL is intended to establish a maximum level and require removal of fluoride above that level to avoid adverse health effects.

Agency	F Concentration	Purpose	Water Supplies Targeted
PHS	0.7 ppm	Add F to Prevent Dental Caries Prevention	Water supplies below 0.7 mg/L
EPA	4 ppm (MCL)	Remove F to Prevent Adverse Health Effects	Water supplies above 4 mg/L
	2 ppm (SMCL)	Public Notice to Avoid Severe Dental Fluorosis	Water supplies above 2 mg/L

2015 PHS Decision Document

Available online:
http://www.publichealthreports.org/documents/PHS_2015_Fluoride_Guidelines.pdf

The primary goal of PHS related to CWF is to further public health by finding the optimal fluoride concentration in drinking water that provides the best balance of protection from dental caries while limiting the risk of dental fluorosis. The PHS recommends that communities whose water sources do not contain naturally occurring fluoride at or above the optimal level supplement their supplies with fluoride to achieve the optimal level.

1. Process

The U. S. Department of Health and Human Services convened a panel of experts to review scientific evidence relevant to the 1962 PHS recommendation for fluoride concentrations in drinking water, and to update the recommendation based on current science. This Federal Panel on Community Water Fluoridation was an interdepartmental, interagency group of experts from the CDC, National Institutes of Health, Food and Drug Administration, Agency for Healthcare Research and Quality, EPA, and U.S. Department of Agriculture.[20] As described by the Surgeon General, the panel was comprised of "physicians, epidemiologists, environmental health experts, dental professionals, toxicologists, health policy professionals, statisticians, and economists."[21] The panel evaluated studies, reports, and systematic reviews (comprehensive summaries of the best available science on a particular subject matter) regarding all aspects of community water

fluoridation. Panel scientists accepted the 2006 study of fluoride in drinking water by NRC (described above) as defining health hazards.

The conclusions of the panel and their rationale for recommending a change to 0.7 ppm were summarized in the Federal Register on January 13, 2011. That date marked the beginning of a 93-day comment period. Four years later, on May 1, 2015, the Federal Panel issued the "U.S. Public Health Service Recommendation for Fluoride Concentration in Drinking Water for the Prevention of Dental Caries."[22]

2. The PHS recommendation to alter the optimal fluoride concentration from a range of 0.7 – 1.2 ppm to a single target concentration of 0.7 ppm.

PHS' 1962 standard for CWF ranged from 0.7 to 1.2 ppm, depending upon the outdoor air temperature of geographic areas of the United States. The 2015 standard changed the recommended fluoride concentration to a single target fluoride concentration based on considerations including the following four factors: [23]

i. Scientific evidence related to the effectiveness of water fluoridation in caries prevention and control across all age groups;
ii. Fluoride in drinking water as one of several available fluoride sources;
iii. Trends in the prevalence and severity of dental fluorosis;
iv. Current evidence on fluid intake of children across various outdoor air temperatures.

A. <u>Scientific evidence of effectiveness of fluoridation in prevention of caries</u>

The panel reviewed various systematic reviews of scientific evidence related to fluoride, which concluded that CWF is effective in reducing caries in both children and adults. When the reviews were limited to studies conducted after the introduction of fluoride toothpaste and other sources of fluoride, beneficial effects of CWF over the lifespan were still apparent. PHS noted that tooth decay is still one of the most common chronic childhood diseases, and that one in four children living below the federal poverty level has untreated tooth decay.[24]

B. <u>Sources of fluoride other than drinking water</u>

PHS noted the increase in other sources of fluoride since 1962, especially fluoridated toothpaste, which now represents 90% of the toothpaste market. PHS also noted a 2010 EPA study entitled "Fluoride: Exposure and Relative Source Contribution Analysis," which examined exposure, by age group, to fluoride from various sources, including food, commercial beverages, toothpaste, soil, and pesticide residue.[25] PHS made its recommendation for an optimal concentration in drinking water "in the current context of multiple sources" of fluoride.

C. <u>Trends in the prevalence and severity of dental fluorosis</u>

Based primarily on data from two national surveys – the 1986-87 Oral Health of U. S. Children Survey ("1987 Survey") and the 1999-2004 National Health and Nutrition Examination Survey

("2004 Survey"), PHS concluded that the prevalence of dental fluorosis has increased nationally, but mostly in the very mild and mild forms. For example, among adolescents aged 12-15 years, prevalence of very mild and mild fluorosis increased from 21.3% in the 1987 Survey to 37.1% in the 2004 Survey. Estimates of severe fluorosis among adolescents in both surveys were statistically unreliable because too few cases were identified among survey participants.

The 1987 Survey is important because it is the only national survey that assessed the water fluoride exposure and the dental health of individual children. A later analysis of data from the 1987 Survey published in the Journal of Public Health in 1997 was able to quantify the relationship between dental caries and dental fluorosis at varying levels of water fluoride concentrations as follows:[26]

- Dental caries declined significantly as fluoride levels increased to 0.7 ppm.
- The reduction in dental caries plateaued at levels from 0.7 to 1.2 ppm.
- The occurrence of at least very mild fluorosis increased gradually as concentrations rose from less than 0.3 to more than 1.2 ppm, but did not rise above the mild level.

PHS also noted a study from Hong Kong in which a reduction of 0.2 ppm in the mean fluoride concentration in drinking water resulted in a detectable reduction in fluorosis prevalence without an increase in dental caries. Based on these studies, PHS concluded that the risk of fluorosis could be reduced while maintaining caries prevention at the lower end of the 1962 recommendation, and that 0.7ppm was therefore the optimal concentration.[27]

D. Evidence on fluid intake of children across various outdoor temperatures

Based on two studies from the 1950's finding that children drank more water in warmer climates, the fluoride concentration recommended in 1962 varied from 0.7 to 1.2 ppm, based on the outdoor air temperature of geographic areas to make total fluoride intake more consistent nationwide. In its 2015 decision, PHS determined that studies conducted since 2001 indicate that children in warmer climates may not consume more water, and to the extent any difference exists, less than 1% of the difference is explained by temperature. PHS attributed this lack of difference in water consumption to the increased use of air conditioning and more sedentary lifestyles. Based on these recent studies, PHS concluded that one target fluoride concentration across all temperature zones in the United States would be effective and far simpler to implement.[28]

3. PHS Response to Concerns Raised During the Public Comment Period

During the public comment period after Federal Register notice in 2011, PHS received approximately 19,300 responses, of which 18,500 (96%) "were nearly identical to a letter submitted by an organization opposing community water fluoridation, often originating from the website of that organization." Both these standard letter comments and unique comments were categorized and reported to the full federal panel. The panel again reviewed the underlying scientific information and "again considered carefully whether or not the proposed recommendations and standards on fluoride in drinking water continue to provide the health

benefits of community water fluoridation while minimizing the chance of unwanted health effects from too much fluoride." [29] The panel's responses to comments were based on "conclusions of evidence-based reviews and/or expert panels that reviewed and evaluated the best available science." After review, the panel did not identify compelling new information to alter its assessment that 0.7 ppm provides the best balance of benefit to potential harm. Because the public comments opposing the PHS recommendation mirrored objections raised at the Board's public forum, understanding how the panel of experts responded to these concerns is helpful.

A. Dental Fluorosis

The period of risk for fluorosis of permanent teeth occurs from birth through age 8, so the goal of minimizing the risk of fluorosis is focused on young children. The benefit of protecting teeth from dental caries extends to both children and adults. In responding to comments that the new standard would not eliminate dental fluorosis, PHS stated:

- National surveys found that over 90% of the dental fluorosis in the U.S. is either very mild or mild.
- EPA's 2010 Dose-Response Analysis concluded that only severe dental fluorosis should be classified as an adverse health effect.
- Severe dental fluorosis is rare in the U.S. Its prevalence among adolescents cannot be accurately determined because the small numbers are statistically unreliable.
- The National Research Council's 2006 report concluded that the occurrence of severe dental fluorosis was practically zero at concentrations below 2 ppm.[30]

Some comments expressed concern about infants consuming formula mixed with water fluoridated under the new standard. PHS noted a 2011 study finding that infants exclusively consuming baby formula constituted with fluoridated water may have an increased chance of developing mild dental fluorosis. PHS expressed the belief that its new recommendation, set at the lowest concentration in the previous range, should help reduce exposure. PHS suggested that parents might want to reduce this risk by using low-fluoride bottled water some of the time to mix infant formula.[31] This advice appears on the websites of CDC and the American Dental Association.

B. Bone fractures and skeletal fluorosis

In response to concerns expressed in comments, PHS reviewed the most recent studies regarding bone fractures and skeletal fluorosis. [32]

- The 2006 NRC study looked at consumption of fluoride at 4.0 ppm in drinking water, and concluded that Stage III skeletal fluorosis is a rare condition in the U. S., but could not determine if Stage II skeletal fluorosis is occurring at that level of fluoride consumption.
- A 2013 Swedish study found no association between drinking water with fluoride concentration of 2.7 ppm and bone fractures.
- In its Dose-Response Analysis for Non-Cancer Effects study of fluoride in 2010, EPA concluded that the fluoride intake level estimated to protect against severe dental fluorosis among children (currently the SMGL set by EPA at 2.0 ppm) would make skeletal effects among adults unlikely.

C. Carcinogenicity

Some public comments pointed to a 2006 study which found an association between water fluoride exposure, based on length of residency in a community, and bone cancer. PHS responded by examining this study and later studies. [33]

- A 2011 study of bone cancer using actual bone fluoride concentration, a more accurate fluoride measurement than residency, showed no association between fluoride and bone cancer.
- Numerous systemic reviews and three ecological studies found no association between fluoride and bone cancer.
- The European Commission's Scientific Committee on Health and Environmental Risks ("SCHER") in 2011 found no clear link between fluoride and bone cancer or cancer in general. SCHER examined animal and epidemiological studies and found that they did not support classifying fluoride as a carcinogen.
- California EPA's Proposition 65 Carcinogen Identification Committee determined in 2011 that fluoride has not been clearly shown to cause cancer and should not be classified as a carcinogen.

D. IQ and neurological effects

In response to comments expressing concern about fluoride's impact on the brain, especially the possibility of lowering IQ, PHS described the state of the science on this issue.

- The European Commission's SCHER, after reviewing well-controlled studies, determined that not enough evidence existed to find a link between fluoride and lower IQ scores.
- A 2015 New Zealand study did not find a relationship between exposure to fluoride and lower IQ scores measured in a long term prospective study of a birth cohort.
- The 2006 NRC study noted Chinese studies reporting a link between fluoride concentrations of 2.5 – 4.1 ppm and lower IQ scores, but found their significance to be uncertain due to the inability to determine whether important procedural details were followed by the studies.
- A 2012 meta-analysis of studies conducted in rural China (including those considered by NRC) identified an association between high fluoride concentrations (up to 11.5 ppm) and lower IQ scores. However, the authors of the meta-study acknowledged the low quality of the studies and the inability to rule out other explanations for the results.

Because the NRC review focused on adverse effects from water fluoride concentrations of 2 – 4 ppm, PHS concluded that the review did not implicate the lower concentrations recommended for CWF.[34]

E. Endocrine disruption

Comments expressed concern that fluoride disrupts endocrine system function. PHS described the 2006 NRC review's consideration of studies concerning a potential association between fluoride exposure and changes to various glands. NRC found that the studies were flawed due to failure to measure actual hormone concentrations of fluoride or to report nutritional status or other confounding factors. NRC called for better measurement in studies and more directed research on the response of the endocrine system to fluoride, if any. One study from 2007 found no evidence of health risk to people with chronic kidney disease who drink water with fluoride at the concentrations used in community water fluoridation.[35]

F. Effectiveness of water fluoridation in caries prevention

Comments criticized the lack of randomized controlled trials to demonstrate the benefits of water fluoridation. PHS pointed out that such trials are not possible; community-wide fluoridation does not permit randomization of individuals within the community or the establishment of control groups. However, community trials have been conducted, and the panel's review of this scientific evidence found community water fluoridation is effective in decreasing dental caries. PHS rejected comments that certain children would not benefit from CWF, citing the 2004 Survey, which documented a decline in the prevalence and severity of dental caries across racial and ethnic groups, and among children living in poverty.[36]

G. Cost-effectiveness of water fluoridation

Some comments questioned the cost of CWF. The PHS reviewed studies of the cost-effectiveness of community water fluoridation, which concluded that the community water fluoridation is cost saving. The annual per person cost of community water fluoridation ranged from $0.50 - $3.70 based on size of the water system, but the cost remains a small fraction of the cost of one dental filling.[37]

H. Safety of fluoride additives

Some comments expressed concern over the safety of silicofluoride compounds. PHS noted that all additives used to treat drinking water are subject to standards, testing, and certification. [38]

- Drinking water treatment chemicals are subject to ANSI/NSF Standard 60, which requires that any impurities in fluoride products will not contribute more than 10% of the MCL set by EPA for that constituent. In the period from 2001 to 2011, NSF found no impurities that exceeded the levels allowed by Standard 60.
- SCHER of the European Commission studied the health and environmental risks associated with the use of silicofluoride used in CWF and found that any resulting contaminants in drinking water are well below guidelines established by the World Health Organization.

Importantly, Denver Water independently tests each load of fluoride delivered to ensure compliance with Standard 60, before it is used in the treatment process.

I. Ethics of water fluoridation.

In response to comments from those opposing CWF, the PHS addressed the issue of adding fluoride to the public water supply without express consent. PHS stated that the ethical issue of a public health action's impact on the preferences of individuals requires a careful analysis of both the benefits and risks of the particular action. The PHS panel believes that there is clear evidence of the benefits of CWF in reducing dental caries, while the documented risk of CWF is restricted to dental fluorosis, and the panel noted that CWF decisions are made by state and local governments.[39]

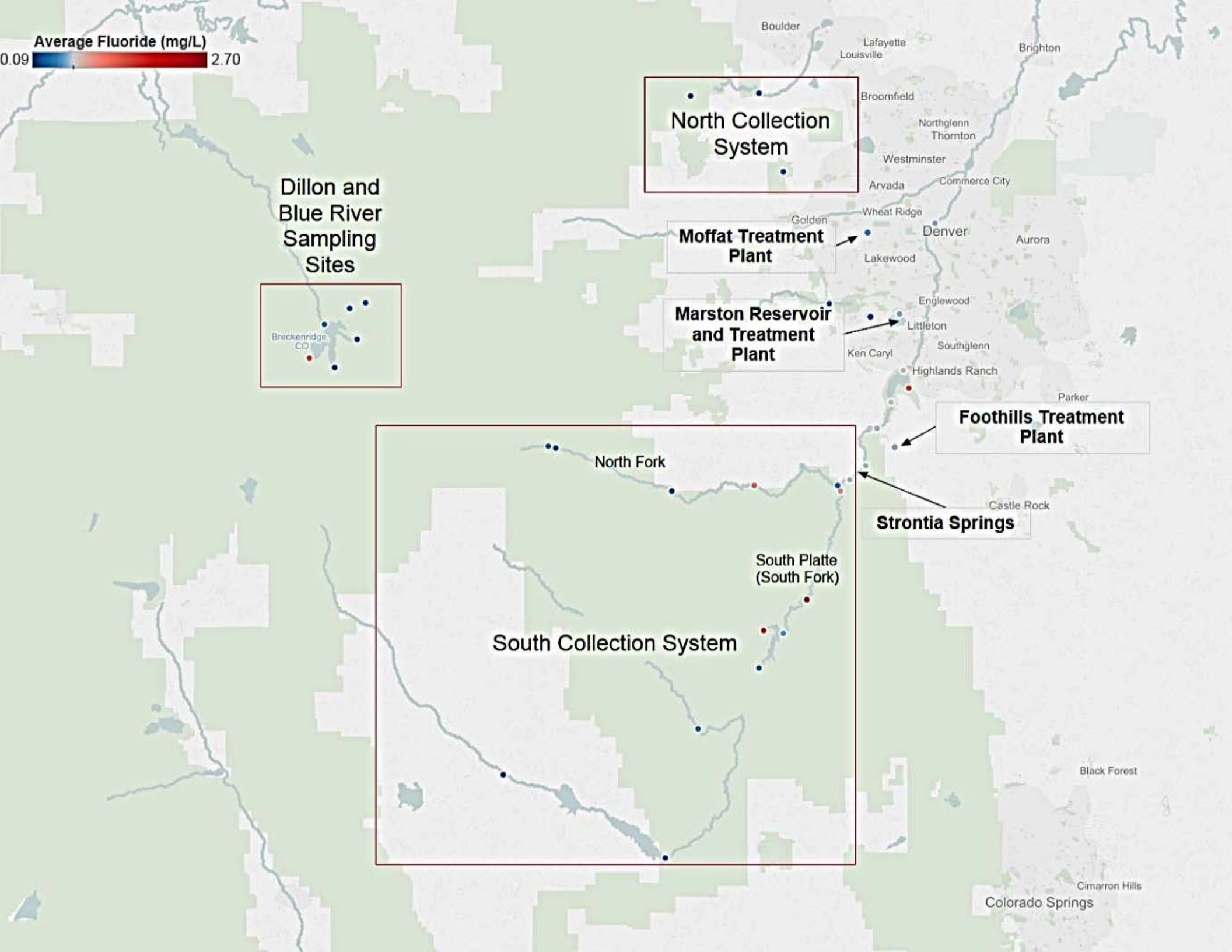
It is worth noting that twelve states mandate CWF, generally adhering to the latest PHS recommendations.[40] Many local governments and public health agencies have chosen to supplement naturally low fluoride concentrations in the drinking water through CWF.[41] A minority has decided not to supplement or to cease supplementing. Each of these governing bodies has made a public health policy decision. Public health initiatives are generally understood as having the purpose of protecting and promoting the health of populations in general rather than of individuals.

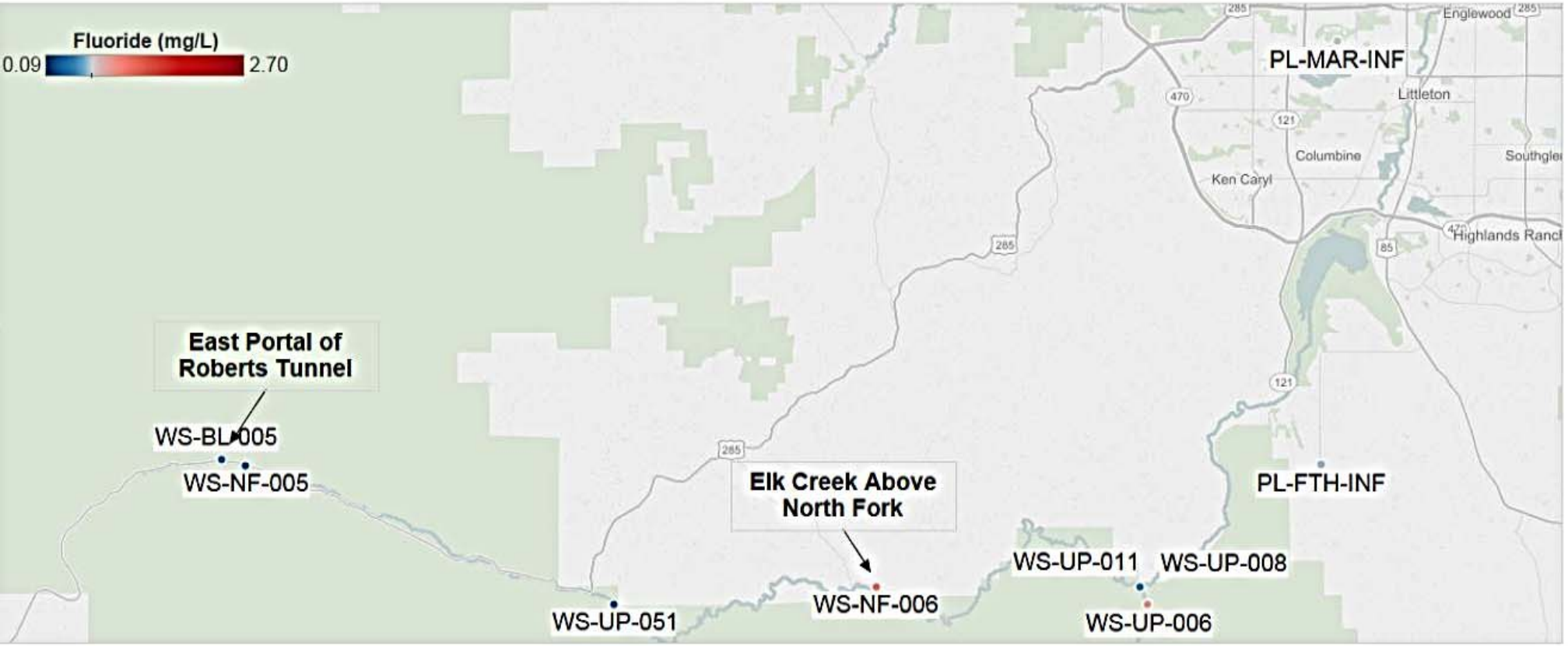
Courts uniformly have rejected challenges to CWF, determining that a significant government interest in the health and welfare of the public generally overrides individual objections to public health regulation. In upholding CWF, courts have held that: (1) fluoride is a nutrient, not a medication, and is present naturally in the environment; (2) no one is forced to drink fluoridated water because alternative sources are available; and (3) there is a difference between the freedom to believe, which is absolute, and the freedom to practice beliefs, which may be restricted in the public interest. Courts have consistently ruled that water fluoridation is not a form of compulsory mass medication or socialized medicine. [42]

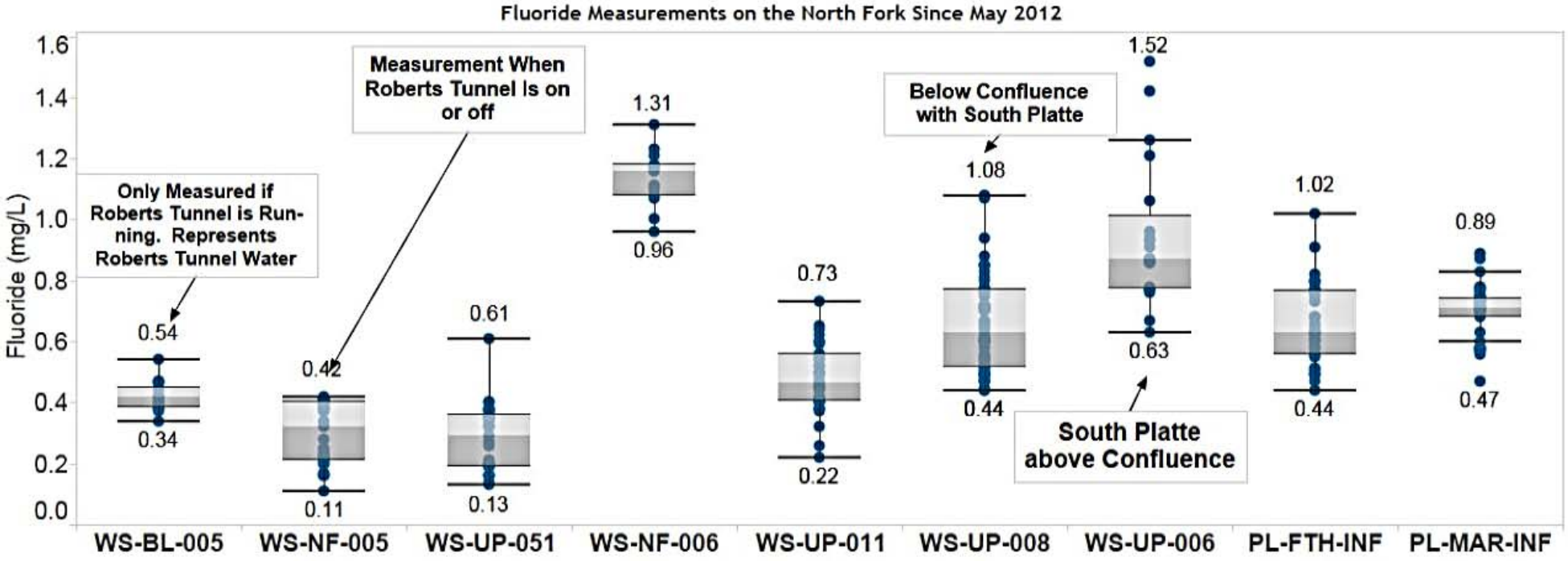
[1] Agreement between Board and Department of Health and Hospitals, November 18, 1953.
[2] Amendment to Fluoride Agreement with City Health Department, August 30, 1978.
[3] Agreement between the Board and Colorado Department of Health, September 8, 1980.
[4] *See* various Board items re "Tabulation of Bids for Sodium Silicofluride," 1996, 1997, 1999, etc. (all stating "Sodium Silicofluoride is used at all Denver Water treatment plants as recommended by both Denver and Colorado Department of Health for the prevention of dental caries.")
[5] Letter from Bill McCusker, Fluoridation Engineer, to Roger Richards, Marston Water Treatment Plant, dated March 17, 1995.
[6] Centers for Disease Control and Prevention, My Water's Fluoride, State Fluoridation Reports, https://nccd.cdc.gov/DOH_MWF/Reports/Default.aspx (last visited Aug. 21, 2015).
[7] *Id*.
[8] *Id*.
[9] Commissioned Corps of the U.S. Public Health Service, America's Health Responders, History, http://www.usphs.gov/aboutus/history.aspx (last visited Aug. 21, 2015).
[10] U.S. Public Health Service Recommendation for Fluoride Concentration in Drinking Water for the Prevention of Dental Caries ("PHS Final Recommendation"), Public Health Reports, Volume 130, 5, July-August 2015, *available at* http://www.publichealthreports.org/documents/PHS_2015_Fluoride_Guidelines.pdf.
[11] Safe Drinking Water Act, 42 U.S.C. § 300f *et seq*.
[12] 40 C.F.R. § 141.62 (2015) – Maximum Contaminant levels for inorganic contaminants, *available at* http://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID=8d5c3f8dcc6e16ab96e474ef406ed77d&ty=HTML&h=L&mc=true&n=pt40.23.141&r=PART#se40.23.141_1208

[13]40 C.F.R. §141.208 (2015) - Special notice for exceedance of the SMCL for fluoride, *available at http://www.ecfr.gov/cgi-in/retrieveECFR?gp=1&SID=8d5c3f8dcc6e16ab96e474ef406ed77d&ty=HTML&h=L&mc=true&n=pt40.23.141&r=PART#se40.23.141_1208*. This regulation requires a notice to be provided to a community when samples exceed 2 ppm. The notice must include the following mandatory language stating, *inter alia*, that "children drinking water containing more than 2 milligrams per liter (mg/l) of fluoride may develop cosmetic discoloration of their permanent teeth (dental fluorosis). … Drinking water containing more than 4 mg/L of fluoride (the U.S. Environmental Protection Agency's drinking water standard) can increase your risk of developing bone disease. Your drinking water does not contain more than 4 mg/l of fluoride, but we're required to notify you when we discover that the fluoride levels in your drinking water exceed 2 mg/l because of this cosmetic dental problem."
[14] NATIONAL RESEARCH COUNCIL, FLUORIDE IN DRINKING WATER: A SCIENTIFIC REVIEW OF EPA'S STANDARDS, The National Acadamies Press (2006), *available at* http://www.actionpa.org/fluoride/nrc/NRC-2006.pdf.
[15] The PHS Report, *supra* note 10, at 5.
[16] NATIONAL RESEARCH COUNCIL, *supra* note 14, at 299.
[17] The PHS Report, *supra* note 10, at 7.
[18] U.S. ENVIRONMENTAL PROTECTION AGENCY, FLUORIDE: DOSE-RESPONSE ANALYSIS FOR NON-CANCER EFFECTS, Office of Water, Health and Ecological Criteria Division (Dec. 2010), *available at* http://water.epa.gov/action/advisories/drinking/upload/Fluoride_dose_response.pdf.
[19] The PHS Report, *supra* note 10, at 7.
[20] *Id*. at 5.
[21] Vivek H. Murphey, MD, MBA, *Surgeon General's Perspectives*, PUBLIC HEALTH REPORTS, Volume 130, 2, July-August 2015, *available at* http://www.publichealthreports.org/documents/Surgeon_General_Perspective_FG.pdf.
[22] The PHS Report, *supra* note 10.
[23] *Id*. at 1, 2-5.
[24] *Id*.at 2.
[25] *Id*. at 4; *See also* ENVIRONMENTAL PROTECTION AGENCY, FLUORIDE: EXPOSURE AND RELATIVE SOURCE CONTRIBUTION ANALYSIS, Office of Water, Health and Ecological Criteria Division (Dec. 2010), *available at* http://water.epa.gov/action/advisories/drinking /upload/fluoridereport.pdf.
[26] The PHS Report, *supra* note 10, at 4.

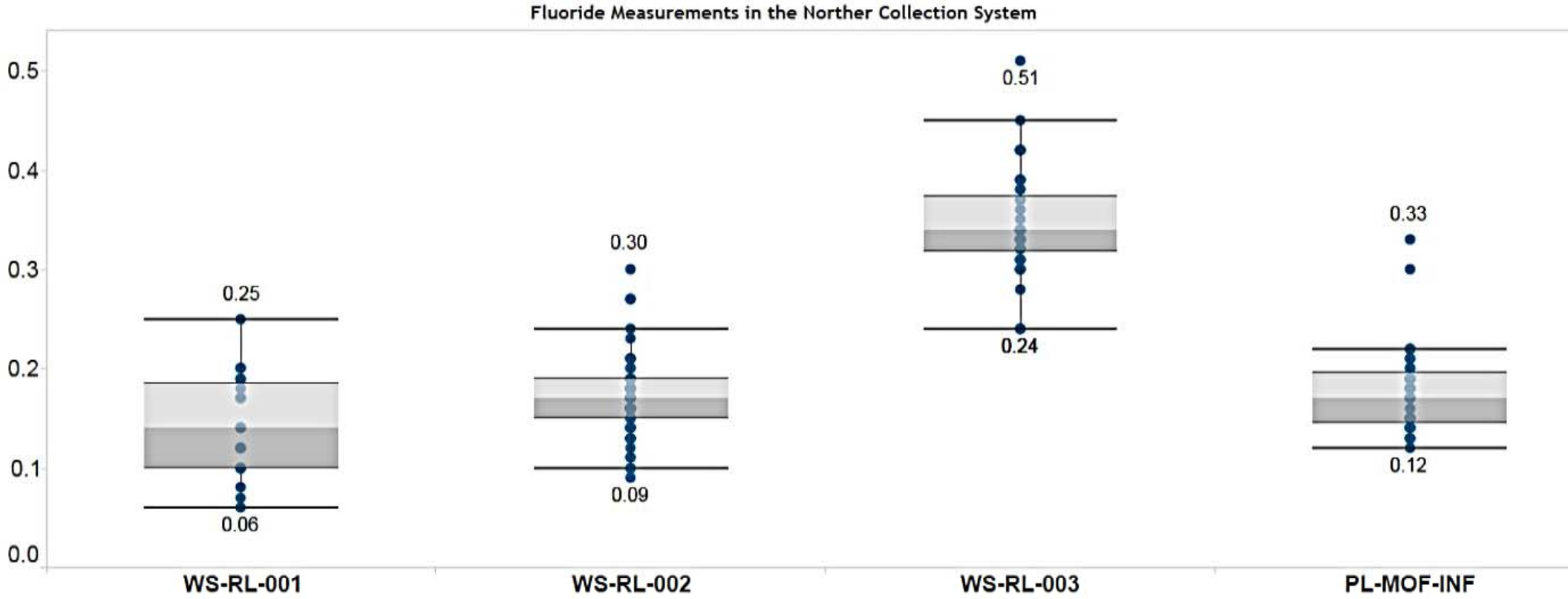
[27] *Id*. at 4-5.
[28] *Id*. at 5.
[29] *Id*. at 6.
[30] *Id.* at 6-7.
[31] *Id*. at 7.
[32] *Id*. at 7.
[33] *Id*. at 7-8.
[34] *Id*. at 8.
[35] *Id*.
[36] *Id*. at 8-9
[37] *Id*. at 9.
[38] *Id*.
[39] *Id.* at 9-10.
[40] Twelve States currently have fluoridation mandates: CA, CT, DE, GA, IL, KY, LA, MN, NE, NV, OH, and SD.
[41] Centers for Disease Control and Prevention, Community Water Fluoridation, 2012 Water Fluoridation Statistics, http://www.cdc.gov/fluoridation/statistics/2012stats.htm (last visited Aug. 21, 2015).
[42] *See e.g., Schuringa v. City of Chicago*, 198 N.E.2d 326 (Ill. 1964); *Commonwealth of Pennsylvania, DEP v. City of Lebanon*, 482 Pa. 66 (S.Ct. 1978)(holding that evidence supported DEP's conclusion that fluoridation of domestic water supplies was an important means of preventing tooth decay, especially in children, thereby protecting the public health); *Protect the Peninsula's Future v. City of Port Angeles*, 304 P.3d 914 (Wash. Ct. App. 2013); *Coshow v. City of Escondido*, 34 Cal. Rptr. 3d 19, 27 (Cal. Ct. App. 2005)("Courts through[out] the United States have uniformly held that fluoridation of water is a reasonable and proper exercise of the police power in the interest of public health. [Citations omitted.]The matter is no longer an open question.")

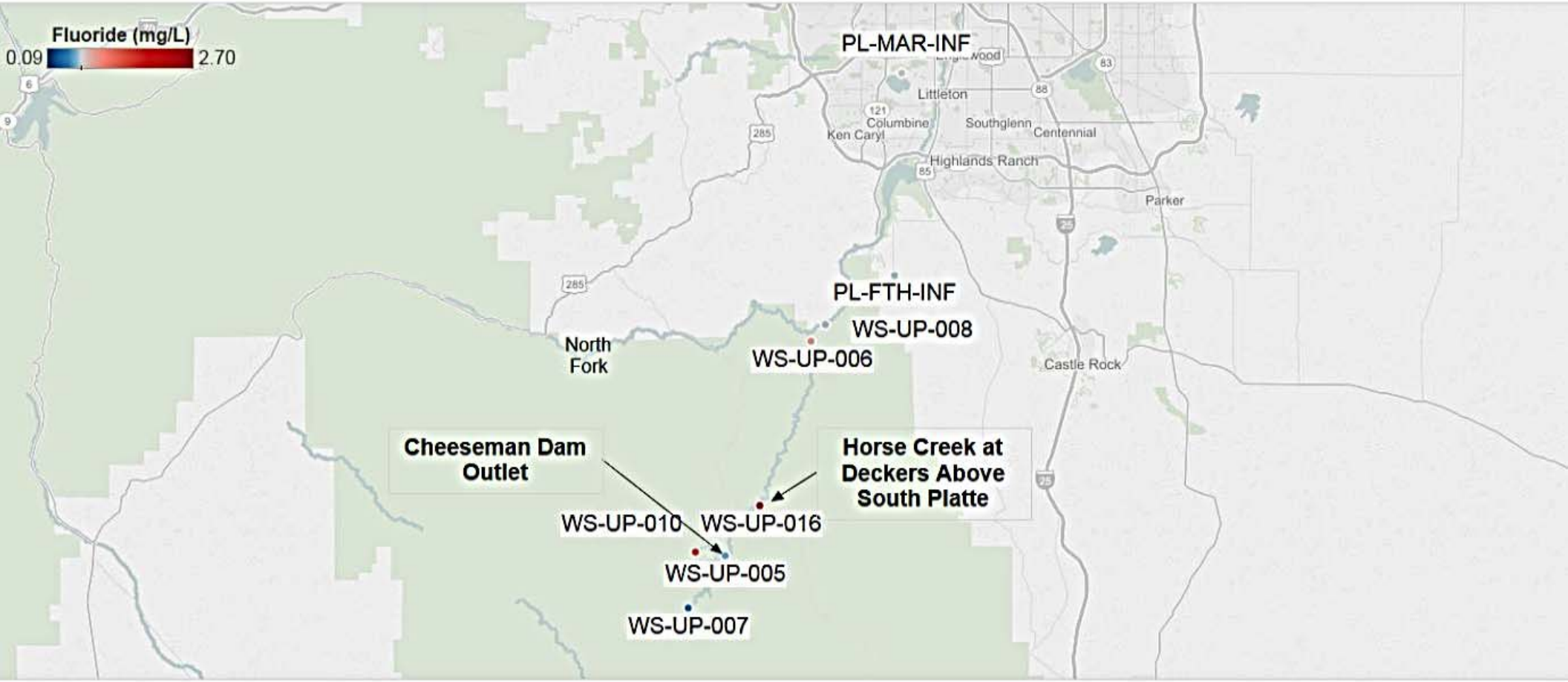

Average Fluoride (mg/L)
0.09
2.70
Boulder
Lafayette
Louisville
Brighton
North Collection System
Broomfield
Northglenn
Thornton
Westminster
Arvada
Commerce City
Wheat Ridge
Golden
Moffat Treatment Plant
Denver
Aurora
Lakewood
Dillon and Blue River Sampling Sites
Breckenridge, CO
Marston Reservoir and Treatment Plant
Englewood
Littleton
Ken Caryl
Southglenn
Highlands Ranch
Parker
Foothills Treatment Plant
North Fork
Castle Rock
Strontia Springs
South Platte (South Fork)
South Collection System
Black Forest
Cimarron Hills
Colorado Springs

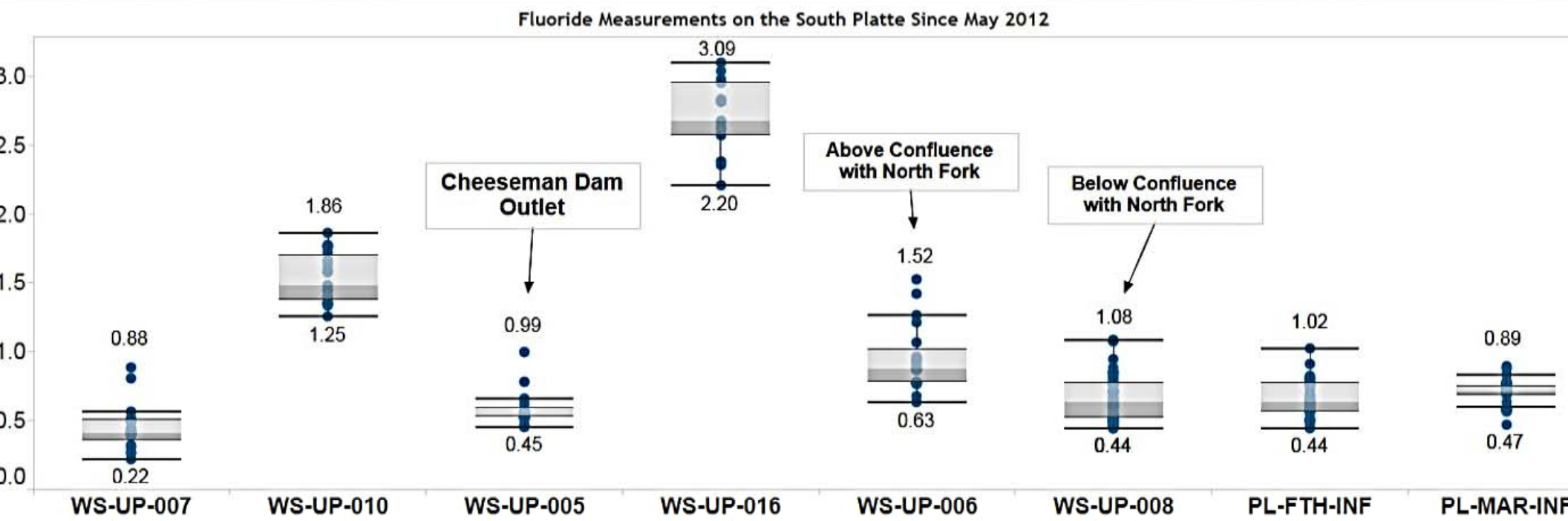

Fluoride (mg/L)
0.09
2.70
PL-MAR-INF
Littleton
Columbine
Ken Caryl
Englewood
Highlands Ranch
East Portal of Roberts Tunnel
WS-BL-005
WS-NF-005
Elk Creek Above North Fork
WS-NF-006
WS-UP-051
WS-UP-011
WS-UP-008
WS-UP-006
PL-FTH-INF


Fluoride Measurements on the North Fork Since May 2012
Fluoride (mg/L)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Only Measured if Roberts Tunnel is Running. Represents Roberts Tunnel Water
Measurement When Roberts Tunnel Is on or off
Below Confluence with South Platte
South Platte above Confluence
0.54
0.34
0.42
0.11
0.61
0.13
1.31
0.96
0.73
0.22
1.08
0.44
1.52
0.63
1.02
0.44
0.89
0.47
WS-BL-005
WS-NF-005
WS-UP-051
WS-NF-006
WS-UP-011
WS-UP-008
WS-UP-006
PL-FTH-INF
PL-MAR-INF

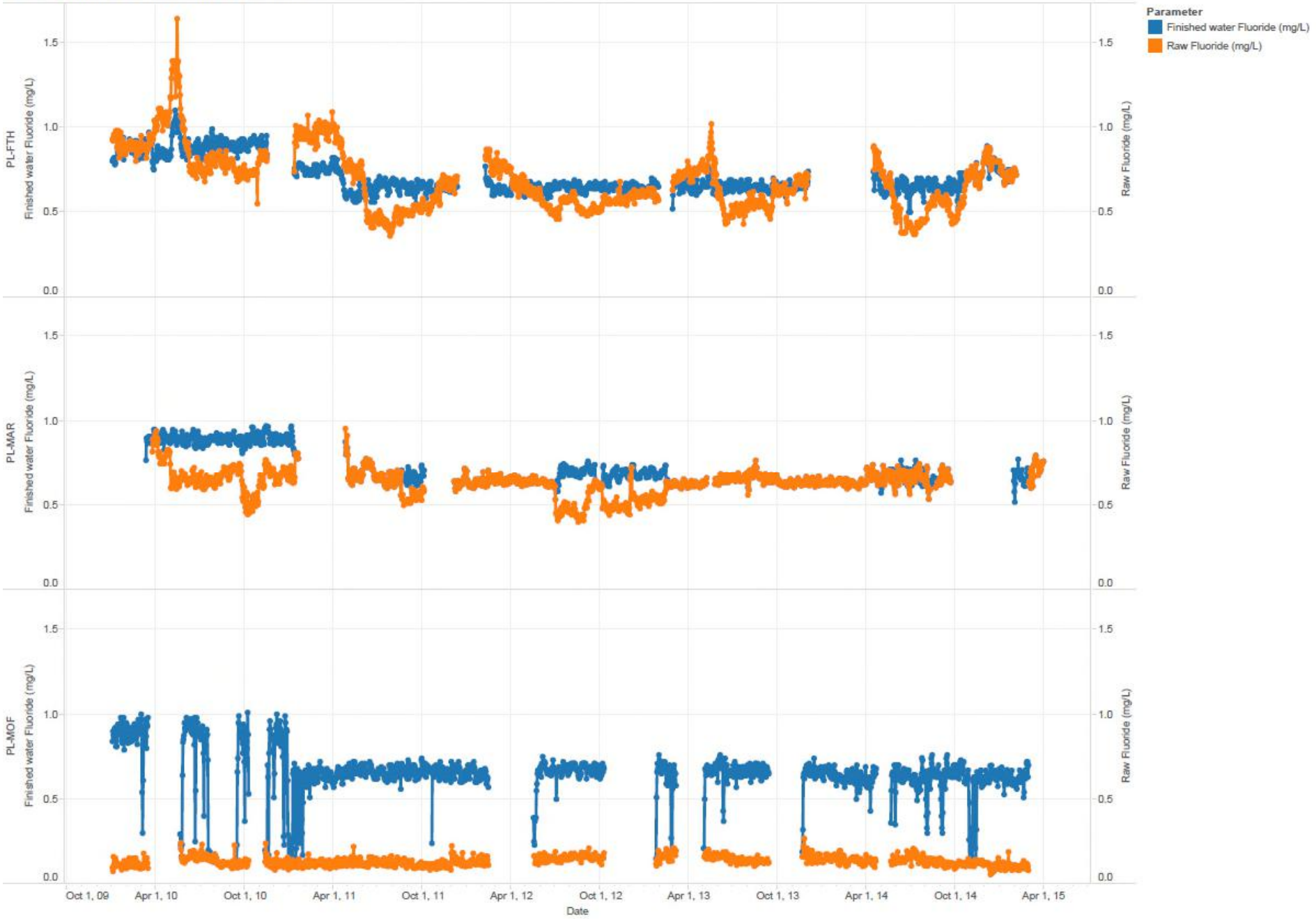

Fluoride (mg/L)
0.09
2.70
WS-RL-001
WS-RL-002
S. Boulder Creek at Diversion
Broomfield
Northglenn
Thornton
Ralston Creek
Ralston Reservoir
WS-RL-003
Westminster
Arvada
Commerce City
Wheat Ridge
Golden
PL-MOF-INF
Denver


Fluoride Measurements in the Norther Collection System
0.5
0.4
0.3
0.2
0.1
0.0
0.25
0.06
0.30
0.09
0.51
0.24
0.33
0.12
WS-RL-001
WS-RL-002
WS-RL-003
PL-MOF-INF


Fluoride (mg/L)
0.09
2.70
PL-MAR-INF
Littleton
Columbine
Ken Caryl
Southglenn
Centennial
Highlands Ranch
Parker
PL-FTH-INF
WS-UP-008
WS-UP-006
North Fork
Castle Rock
Cheeseman Dam Outlet
Horse Creek at Deckers Above South Platte
WS-UP-010
WS-UP-016
WS-UP-005
WS-UP-007

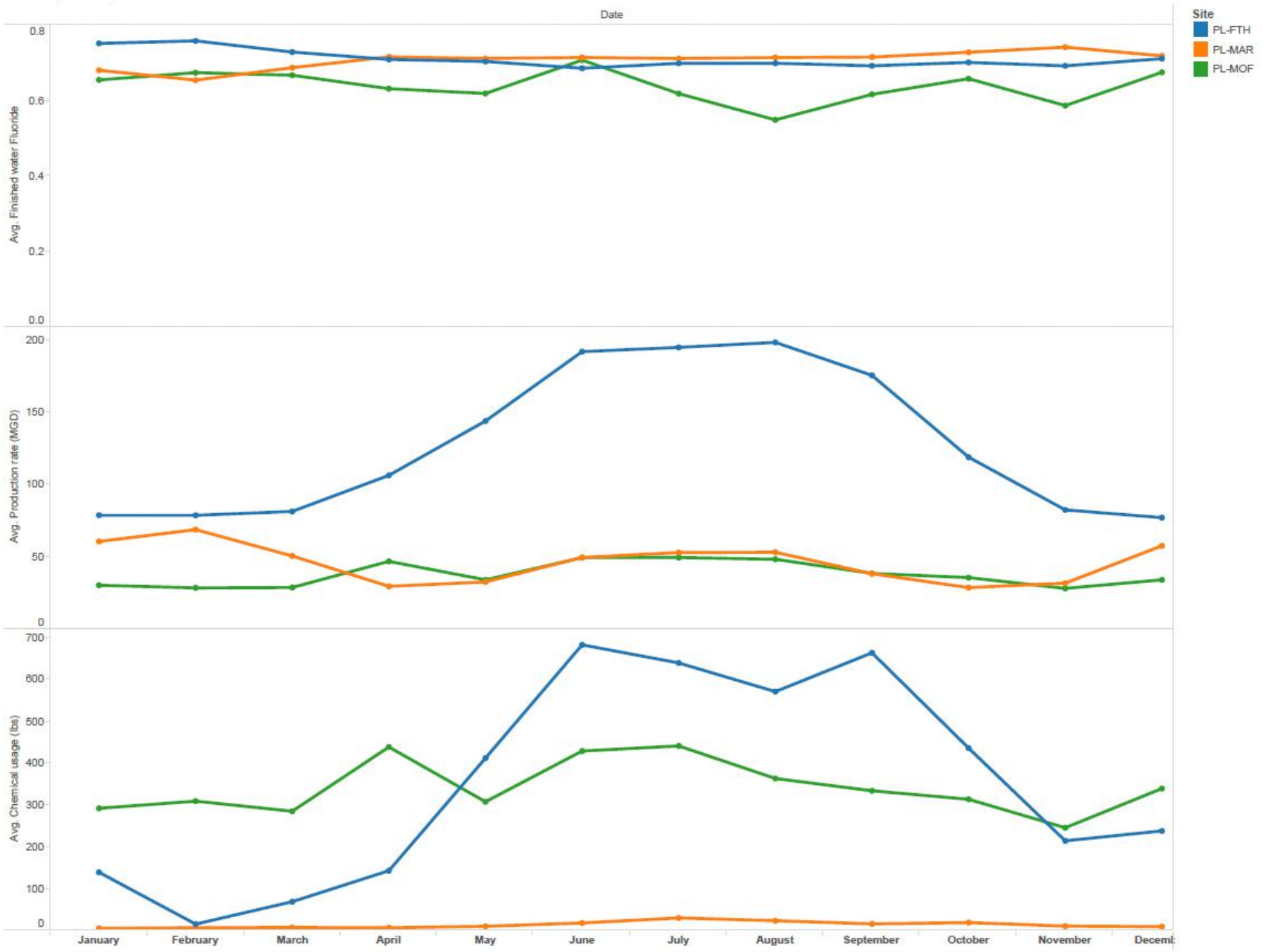

Fluoride Measurements on the South Platte Since May 2012
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.88
0.22
1.86
1.25
Cheeseman Dam Outlet
0.99
0.45
3.09
2.20
Above Confluence with North Fork
1.52
0.63
Below Confluence with North Fork
1.08
0.44
1.02
0.44
0.89
0.47
WS-UP-007
WS-UP-010
WS-UP-005
WS-UP-016
WS-UP-006
WS-UP-008
PL-FTH-INF
PL-MAR-INF

Raw and Finished Fluoride Concentrations



The trends of Finished water Fluoride (mg/L) and Raw Fluoride (mg/L) for Date Day broken down by Site. Color shows details about Finished water Fluoride (mg/L) and Raw Fluoride (mg/L). The view is filtered on Site and Exclusions (DAY(Date),Site). The Site filter keeps PL-FTH, PL-MAR and PL-MOF. The Exclusions (DAY(Date),Site) filter keeps 5,695 members.

Monthly Averages



The trends of average of Finished water Fluoride, average of Production rate (MGD) and average of Chemical usage (lbs) for Date Month. Color shows details about Site.