



Technical Memorandum

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Subject: Discussion of Portland Water Bureau's Proposed Variance Monitoring and Research

1. Background

On November 29, 2011 Oregon Public Health Authority, Office of Environmental Public Health, Drinking Water Program (OHA) issued a notice of intent to grant a variance to the Portland Water Bureau (PWB) from the treatment requirements for *Cryptosporidium* of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2 Rule). OHA's decision was based on the record of evidence presented by PWB which included monitoring data and supplemental information which demonstrated that due to the nature of the raw water source, treatment for *Cryptosporidium* at the Bull Run watershed intake is not necessary to protect public health. OHA's finding is subject to specific conditions identified in the notice of intent.

As currently conditioned, the variance would be subject to required watershed controls and stewardship and on-going routine water quality monitoring for *Cryptosporidium* at the Bull Run raw water intake. OHA may revoke the variance at any time if 1) the PWB does not comply with the specified conditions; 2) OHA reasonably believes that the lack of *Cryptosporidium* treatment is posing a threat to the public's health; or 3) conditions in the watershed change to such a degree that the facts supporting the variance no longer support the basis of OHA's decision.

This memorandum discusses the benefits of monitoring and research activities beyond what has been prescribed by OHA in the conditions for maintaining a variance. This evaluation is based on PWB's experience and on the professional opinion of a panel of utility, regulatory, and microbiology experts convened by PWB for a two-day workshop (Monitoring Expert Panel) on May 2nd and 3rd 2011, to help inform PWB's proposal for conditions in the Variance Request (Section 6). PWB's proposal, informed by the Monitoring Expert Panel, included both regulatory monitoring and additional monitoring, management, and research activities designed to help the bureau maintain the variance on a long term basis.

2. Limitations of Relying Solely on Regulatory Monitoring

1. The prescribed regulatory monitoring does not accomplish watershed control or stewardship. The OHA proposed monitoring conditions establish an on-going performance standard at the raw water intake that PWB must meet to maintain a variance. Such an approach, while adequate for ensuring regulatory compliance, will not be sufficient to track and anticipate changes in the watershed as suggested by OHA that may jeopardize continued compliance with this standard. While PWB will always know when it is in violation of the variance conditions, it will lack an early warning that it is at

increased risk of violation, effectively limiting the ability to proactively engage in management strategies that may mitigate this risk.

2. Information obtained through additional monitoring and research is the basis for asserting maintenance of the variance if OHA is considering revoking it. Maintenance of the variance depends on an extraordinary level of performance in terms of *Cryptosporidium* monitoring results. The current OHA-specified conditions mean that two detections of *Cryptosporidium* at the raw water intake within a year could be the basis for OHA to revoke the variance. In the event that the detection of very low levels of *Cryptosporidium* prompts OHA to reconsider the variance and in the absence of additional information characterizing public health risk and conditions in the watershed, PWB would not be prepared to provide scientific evidence to inform OHA's decision-making process.
3. Information obtained through additional monitoring and research is the basis for tracking, detecting and enabling management of changes to watershed conditions that could threaten the variance. OHA stipulates that the variance may be revoked at any time if conditions in the watershed change to such a degree that the facts no longer support the variance. These changes could include but are not limited to changes in climate, hydrology, wildlife populations, forest health, and land use adjacent to the Bull Run Watershed Management Unit (BRWMU). The likelihood and relevance of these changes to the presence of *Cryptosporidium* in the watershed need to be better understood to help inform any decision-making process, an issue that would not be addressed through the regulatory requirements of the variance.

3. Benefits of Additional Monitoring and Research

The inadequacy of the OHA-prescribed monitoring conditions in providing critical watershed data and information necessary to maintain the variance can be addressed through a program of additional monitoring and research designed to ensure that PWB has the most relevant information needed to operate under the unique conditions of a variance. The tangible benefits to Portland would be the ability to respond proactively to changes in the watershed before the conditions of the variance are exceeded and to assess the situation in the watershed in the context of public health risk, if levels of *Cryptosporidium* ever exceed the specified threshold. The Monitoring Expert Panel in their advice to PWB stressed that the monitoring requirements established by the variance conditions would only be one part of the necessary activities PWB would need to undertake in order to maintain a variance.

3.1 Conclusions and Recommendations from the Monitoring Expert Panel

1. *Cryptosporidium* is difficult to sample for; however, there are currently no known surrogate parameters to monitor as a substitute. EPA Method 1622/23 is the regulatory standard for measuring *Cryptosporidium* and is therefore an appropriate sampling technique to use to compare Portland's concentration to EPA's 0.000075 oocysts/liter (L) concentration threshold.
2. Genotyping to determine whether any future detections of *Cryptosporidium* in the Bull Run source are human-infectious species is essential to determine the public health implications (if any).

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3. PWB could achieve significant efficiencies and greatly decrease the turnaround time for monitoring results by establishing its own in-house EPA-approved *Cryptosporidium* laboratory program.
4. Assuming that monitoring conditions and regulatory triggers similar to those listed by EPA are imposed, it will be important to establish an independent confirmation of any positive laboratory results due to the extreme impact that any single positive result would have on the overall *Cryptosporidium* concentration relative to the 0.000075 oocyst/L threshold.
5. A single detection of a small number of *Cryptosporidium* oocysts should not automatically terminate eligibility for the variance since the public health consequences of an isolated detection are not measurable. A better trigger for terminating the variance would be based on monitoring results which demonstrate a continued presence of human-infectious *Cryptosporidium* or signs in the community of waterborne disease transmission.
6. The panel discussed other potential non-regulatory watershed control, research, and stewardship programs with the caution that clear goals and corresponding management plans be established to justify the cost-benefit and relevance of any new studies or activities. These ongoing watershed control, research, and stewardship objectives suggestions are paraphrased in below.

3.1.1 Ongoing Watershed Control, Research, and Stewardship Objectives

1. Maintain efforts to preserve the characteristics of the watershed that are presumed to be contributing to the absence of *Cryptosporidium* detections and the corresponding low risk to public health. These features include the natural characteristics of the watershed (the predominant old growth vegetation canopy and density, porous soils, and low carrying capacity for wildlife) and PWB's watershed controls (locked gates; restrictions on public access, tree-cutting, and development; active fire management; and routine surveillance).
2. Monitor for long-term factors that could affect watershed conditions including changes in hydrology, wildlife, vegetation cover, and other land characteristics.
3. Further study of wildlife characterization and movement—particularly of rodents, as the largest population of wildlife in the watershed.
4. Further augmentation of security and other control measures that address risks posed by potential trespassing or other prohibited human activities.
5. Potential augmentation of the disease surveillance efforts of local public health agencies. This suggestion was tempered by the feedback from the Multnomah County Health Department that cryptosporidiosis is currently not, and has never been, a local public health concern.
6. Monitor other currently unmonitored pathogens to establish baselines and observe for long-term changes.
7. Continued efforts to determine the cause of seasonal matrix effects, and provide improvements to matrix spike recoveries in Bull Run raw water under Method 1622/23.

- Continued efforts to adapt and utilize a watershed analysis model to refine the understanding of key watershed inputs and parameters most relevant to the ongoing management of the Bull Run as an unfiltered source with a variance for *Cryptosporidium* treatment.

3.2 PWB's Proposed Monitoring and Research Activities

PWB has proposed to conduct additional monitoring and research in support of maintaining the variance. The proposed activities are the result of PWB's monitoring experience, its careful consideration of the recommendations made by the Monitoring Expert Panel and its experience in developing and characterizing the critical information regarding the Bull Run watershed which persuaded the State to grant a variance. The proposed activities are aimed at addressing the limitations of relying solely on regulatory monitoring at the raw water intake in light of the sensitive conditions of the variance. The relevance and value of the proposed activities are discussed below.

3.2.1 Upstream Monitoring

As part of the Variance Request, PWB developed a watershed monitoring program that targeted locations upstream of the raw water intake. The purpose of this monitoring element was to sample at locations in the watershed where *Cryptosporidium* oocysts were most likely to enter the source water during normal conditions and during storm events that increase the likelihood that pathogens will be mobilized with the goal of understanding if *Cryptosporidium* was prevalent in the watershed. Results from upstream monitoring confirmed the low risk of *Cryptosporidium* contamination in Bull Run water and provided critical supplementary evidence in support of a variance.

The results of upstream monitoring over the last two years establish a baseline against which future changes (or lack of changes) in the watershed can be assessed. Continued monitoring at these locations would provide a concrete benchmark to evaluate if conditions in the watershed are changing and the temporal and spatial extent of changes. Upstream monitoring may also provide leads on the sources of any emerging issue and the level of appropriate response. Similarly, upstream monitoring results would provide information to assess the extent and degree of contamination in the event that the detection of very low levels of *Cryptosporidium* at the raw water intake prompts OHA to reconsider the variance (i.e., is there a widespread problem in the watershed or is it an isolated event of low public health significance?). The upstream monitoring program can also be used to better understand the mobilization and transport of pathogens in the watershed and to validate the absence of risk under a range of environmental conditions.

3.2.2 Scat Monitoring

Scat monitoring efforts during the variance and interim sampling period demonstrated that wildlife, the only potentially significant source in Bull Run, has a very low and sporadic occurrence of *Cryptosporidium*. The extremely low levels of *Cryptosporidium* in Bull Run wildlife are likely the greatest contributing factor to the low risk from this pathogen in the watershed. Any major change in the infection status of wildlife could significantly impact PWB's ability to maintain a variance.

Continued scat monitoring would be a useful tool, complimentary to other wildlife research activities, for PWB to assess the infectious status of wildlife with respect to *Cryptosporidium*

and to anticipate changes that may translate into an increased risk in the watershed. Scat monitoring results over time will provide PWB with a deeper understanding of the dynamics of wildlife *Cryptosporidium* infection in the Bull Run watershed that can be used to address specific questions, such as the types of wildlife that may carry *Cryptosporidium*; the degree to which wildlife species represent a risk based on infection patterns, demographics and ecology; the types of *Cryptosporidium* that are carried by wildlife; and the likelihood of cross-infection risks among wildlife species. These types of questions are extremely pertinent for assessing whether management activities can be employed to mitigate any emerging risk in the watershed. In addition, scat monitoring results and what they indicate about the overall risk in the watershed could be used to inform the significance of any positive result at the raw water intake.

3.2.3 Genotyping and DNA Sequencing

EPA method 1623 is the only method currently approved for regulatory monitoring of *Cryptosporidium* in raw drinking water and is the method prescribed by OHA in the conditions of the variance. This method has the limitation of not differentiating between species of *Cryptosporidium* that are of different public health concern. Genotyping and DNA sequencing to determine whether any detections of *Cryptosporidium* in the Bull Run watershed are human-infectious species would be essential to assess the public health importance of any oocyst detection.

Most cases of cryptosporidiosis are linked to two species of *Cryptosporidium*, *C. hominis* and *C. parvum*, which are associated with human and domesticated animal sources that are not of major concern in the Bull Run watershed. More likely, should any *Cryptosporidium* be detected in the Bull Run watershed, it will be a wildlife species of limited public health significance. While the conditions specified by OHA do not provide for a differentiation in the type(s) of *Cryptosporidium* species detected, PWB should employ genotyping and DNA sequencing to establish the types of *Cryptosporidium* that may be found in the watershed and the public health significance of any detections at the raw water intake.

3.2.4 Verification of Positive Results

Although the likelihood of false-positive detections of *Cryptosporidium* appears to have declined as the method of detection has improved (e.g., purification techniques and antibody specificity) and analyst skills have increased, it remains possible that a positive result will occur in the absence of an actual oocyst. Given the extreme impact of a single oocyst detection to maintaining the variance, the Monitoring Expert Panel advised PWB of the importance of establishing visual confirmation of any positive *Cryptosporidium* result at the raw water intake through a second independent laboratory.

3.2.5 Public Health Studies

PWB worked with Multnomah County Health Department (MCHD) in 2010 while conducting the intensive sampling in support of the Variance Request to develop risk communication plans for various *Cryptosporidium* detection scenarios and to develop appropriate public communications and management responses (in coordination with OHA). PWB should continue to work with MCHD to update and improve risk communication plans in the event that *Cryptosporidium* is detected at the raw water intake while operating under a variance. PWB may also opt to work with MCHD to improve disease surveillance,

particularly among sentinel populations that may provide an early indication of any increased risk associated with the Bull Run source water.

3.2.6 Watershed Analysis and Model Support

As part of the variance sampling plan and study, PWB undertook the adaptation of a Pathogen Catchment Budget Model that describes the sources, fate, and transport of selected pathogens including *Cryptosporidium*. Although the outputs of the model had limited applicability, the model functioned to effectively prioritize information gathering efforts and organize information in the watershed. Continued efforts to adapt and utilize the watershed analysis model will help refine the understanding of key watershed processes most relevant to the ongoing management of the Bull Run and may be used as a tool to evaluate the impact of future scenarios.

3.2.7 Wildlife Research and Microbial Source Tracking

PWB, its federal management partners, and state and federal wildlife management agencies know relatively little about the wildlife issues in the Bull Run watershed--certainly far less than they know about the hydrology, vegetation, and soil characteristics of Bull Run. Throughout the development and implementation of the sampling program that supported the variance request, PWB relied on external assistance from Phil Rickus (David Evans and Associates) and Rob Atwill (University of California, Davis) for advice on wildlife issues. The information on wildlife, including the scat monitoring program was instrumental in defining the risk in the watershed and framing the arguments that supported OHA's decision.

As PWB proceeds to operate under the conditions of a variance, developing a deeper understanding of the wildlife issues in Bull Run that may impact risk levels in the future should be a priority that will require internal resources currently not available. Without continued development of the wildlife dynamics in Bull Run through ongoing monitoring, PWB will lack critical information regarding the most likely source of *Cryptosporidium* in the watershed. Specific gaps in information that have been identified include more robust data on wildlife populations and ranges within and adjacent to the watershed; a better understanding of the likelihood that domestic animals in areas adjacent to the BRWMU could act as reservoir of infection under current and future conditions; assessment of the vulnerabilities to *Cryptosporidium* contamination based on the ecology of wildlife species and the use of source tracking tools; and development of realistic management strategies for addressing identified threats to water quality posed by wildlife.

4. Conclusions

The monitoring results that have qualified Bull Run for a variance from the treatment requirements of the LT2 Rule reflect both the natural characteristics of the watershed and the historic protection and stewardship policies that have preserved these characteristics. If PWB hopes to maintain the *Cryptosporidium* monitoring results demonstrated in the last two years of monitoring, it will need to both continue and enhance its source water protection activities and conduct additional monitoring, research, and model development to proactively address any changes in factors that could affect the presence of *Cryptosporidium* in the watershed.

Should there be detections of low levels of *Cryptosporidium* at the raw water intake that do not conclusively indicate a public health risk or a future change in the watershed conditions

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underlying OHA's decision to grant a variance, PWB should be prepared to provide scientific evidence to help characterize the risk and the existing watershed conditions.

Prescribed monitoring as it is currently described by OHA will not be adequate to manage the watershed for the purpose of maintaining the variance. Additional monitoring and research is necessary to provide the information most relevant to ensuring ongoing public health and continuing to avoid the conventional treatment requirements of the LT2 Rule.