

Bull Run Treatment Variance

Watershed Inspection and Monitoring Plan



**Prepared by the
Portland Water Bureau**

**September 25, 2015
Version 3**



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Section 1

Introduction

In June 2011, the Portland Water Bureau (PWB) submitted a request to the Oregon Health Authority (OHA) for a *Cryptosporidium* treatment variance for its Bull Run source water under 42 USC § 300g-4(a)(1)(B) (Portland Water Bureau 2011). A Final Order granting the Bull Run Treatment Variance was issued by OHA on March 14, 2012 (Oregon Health Authority 2012). The Variance is subject to several conditions, including ongoing monitoring, maintenance of watershed protections, and reporting. Variance Final Order condition 1(a)D required PWB to propose a plan to OHA for conducting field inspections and environmental sampling within the Bull Run watershed.

The Bull Run Treatment Variance Watershed Inspection and Monitoring Plan (Watershed Inspection and Monitoring Plan) was developed by PWB to meet Variance Final Order condition 1(a)D and to guide PWB's inspection and monitoring activities in support of the Variance. PWB's field inspections and monitoring must be conducted according to the most current inspection and monitoring plan approved by OHA. Results of field inspections and monitoring are reported to OHA on an annual basis in the Bull Run Treatment Variance Watershed Report.

1.1 Watershed Inspection and Monitoring Plan Version 3

The first version of the Watershed Inspection and Monitoring Plan was submitted to OHA on July 30, 2012. The plan received approval from OHA on August 1, 2012 and was implemented beginning Water Year 2013. A second version that included minor modifications was approved by OHA on August 6, 2014. On December 19, 2014, PWB proposed additional small changes to the plan for the sections describing watershed security inspections, wildlife area inspections, and tributary monitoring. The plan modifications were proposed in the Bull Run Treatment Variance Watershed Report for Water Year 2014 and approved by OHA on May 18, 2015. Additionally, a minor modification to the section describing scat monitoring and genotyping was proposed on October 17, 2014 and approved by OHA on October 29, 2014 and a proposal to update scat analysis methods was submitted on May 15, 2015 and approved by OHA on July 1, 2015. This current Watershed Inspection and Monitoring Plan (Version 3) reflects all of the proposed changes approved by OHA as of July 23, 2015. The plan modifications are summarized by section below:

- **Watershed Security Inspections** – The list of 18 Bull Run watershed gates designated as focal points for inspection of boundary access points was modified in Version 2. Three gates that are not central to Bull Run security (Road 2503 W Gate 2, Road 1211411, and Bureau of Land Management [BLM] 2503 Gate) were removed from the list. Walker Prairie Gate was added to the list. Version 3 is updated to reflect that the area around the BLM Sandy Ridge Trail System will be inspected by PWB rangers from area roads, particularly the Homestead Gate on Road 14, not necessarily by foot inspections of the trail

- **Soil Erosion Area Inspections** – Annual reporting on the condition of the North Fork landslide was eliminated in Version 2. PWB plans to continue monitoring the site in the course of routine aerial inspections and will report any significant erosion, if observed.
- **Wildlife Area Inspections** – Inspections will focus on wildlife areas close to the primary intake structures and storage reservoirs while inspections of more distant areas (Wildlife Inspection Areas #8-#13) are discontinued in Version 3. Scat collection throughout the watershed will continue.
- **Tributary Monitoring** – Tributary samples will continue to consist of at least 10 liters; however, Version 3 clarifies that composite samples and/or greater sample volumes may be used depending on the sampling objectives. Samples may also be filtered on site.
- **Wildlife scat monitoring** – Version 2 added trapping as an additional technique for collecting scat samples from small mammals and specified that for each target species, higher sampling efforts will be allocated to the times of the year when the species' populations are larger and more active and when fresh scats are most available. Version 3 broadens the methods that may be used to test scat samples for *Cryptosporidium* to include PCR and clarifies that *Cryptosporidium*-positive samples may be submitted for genotyping.

1.2 Plan Organization

This Watershed Inspection and Monitoring Plan (Version 3) has been abridged to include only the sections of the plan that describe field inspections, environmental sampling, and reporting and notification. Background information on the plan development, identified risk factors for the introduction of *Cryptosporidium* into the Bull Run watershed, and the overall plan objectives and approach are available in the July 2012 version of the Watershed Inspection and Monitoring Plan.

This current version of the plan is divided into Field Inspections (Section 2), which includes watershed security, the Diversion Pool, wildlife areas, soil erosion areas, and sanitary facilities; Environmental Sampling (Section 3), which includes water monitoring at tributaries and wildlife scat monitoring; and Reporting and Notification (Section 4). Maps of the Bull Run watershed showing inspection and monitoring locations are shown in Figures 1 and 2.

1.3 Plan Updates

Because this plan is adaptive, PWB anticipates that its field inspection and environmental sampling programs will continue to evolve over time. PWB will analyze data on an ongoing basis and consider other relevant information to assess whether its existing plan warrants any modifications. If either PWB or OHA sees a need for a modification to the plan based on new information, PWB shall propose the revisions to OHA for approval prior to implementing the proposed changes. Modifications and approvals shall be made in writing.

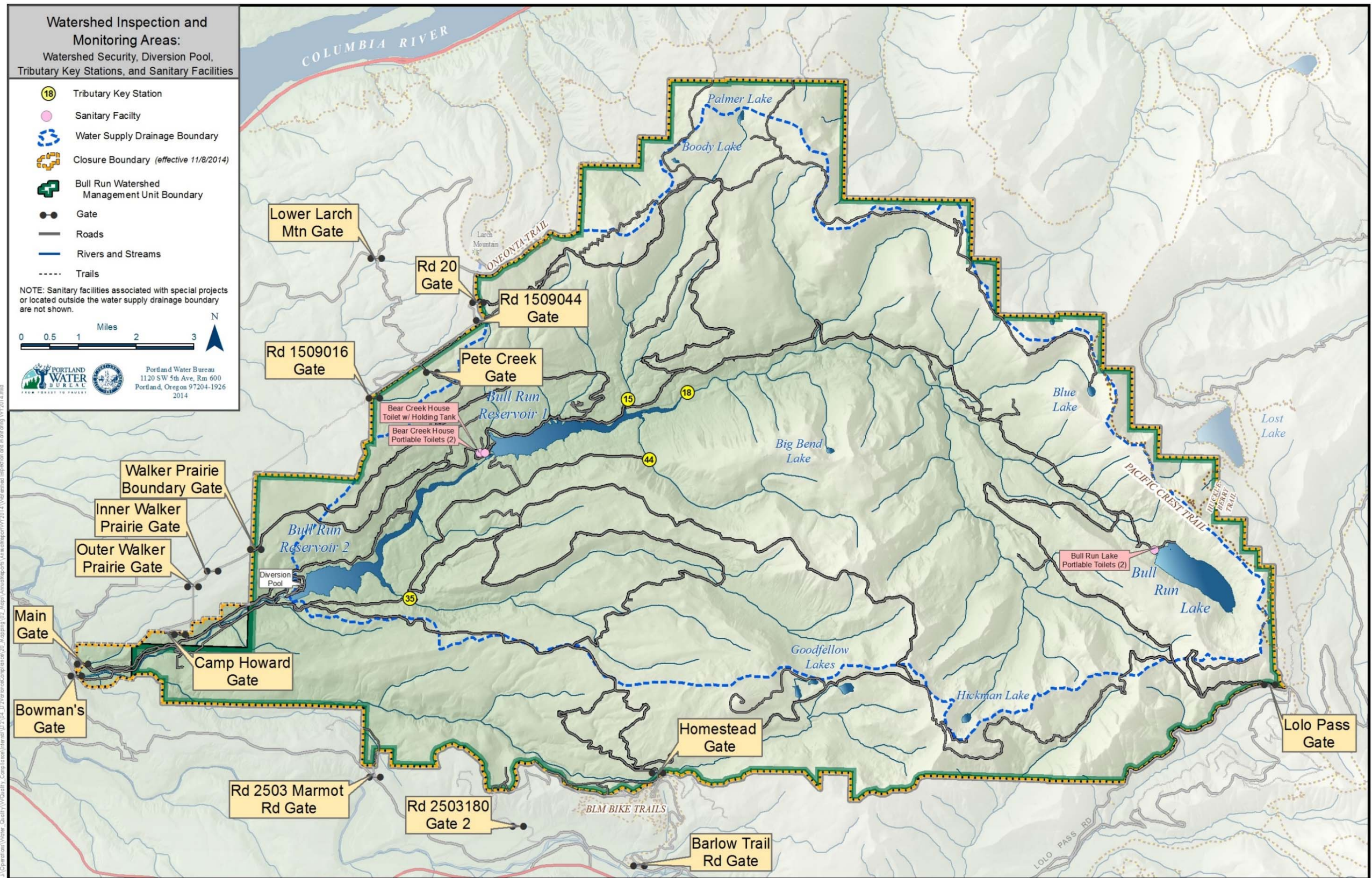


Figure 1. Watershed Inspection and Monitoring Areas: Watershed Security, Diversion Pool, Tributary Key Stations, and Sanitary Facilities

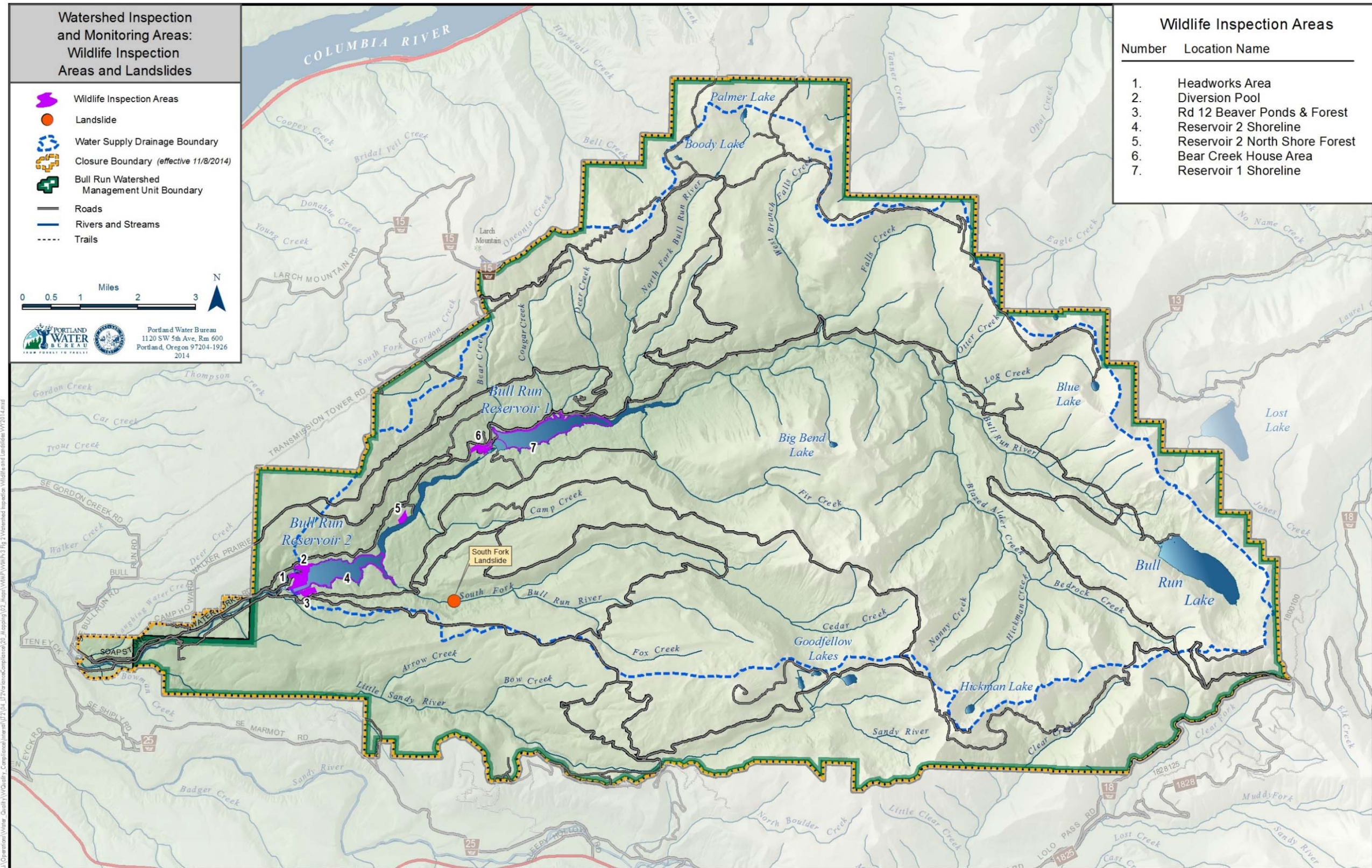


Figure 2. Watershed Inspection and Monitoring Areas: Wildlife Inspection Areas and Landslides

Section 2

Field Inspections

PWB will conduct field inspections in areas of the Bull Run watershed that were identified as posing a potential risk for the introduction of *Cryptosporidium* to the source water. Under the Bull Run Treatment Variance, PWB is required to conduct the following:

*Semi-annual field inspections of high-risk areas, including the boundary of the watershed, the fence around the Diversion Pool, tributaries where wildlife is known to exist in higher concentrations, any suspected locations of illicit activities or human entry/camping, high risk soil erosion areas, or other areas as identified by PWB. One of these inspection events must occur during dry weather (peak hiking season and peak riparian grazing), and one must occur in the wet weather season (during a period of time without snow on the ground on the inspected area). Observations to be noted during the inspections include the visual presence of debris or water contamination, trash, human wastes, high concentrations of wildlife scat, evidence of fire or landslides, and any evidence of domesticated animal wastes. Any suspicious activity or potential *Cryptosporidium* source, excluding wildlife, should be fully investigated and re-inspected as necessary. (Condition 1(a)D.ii)*

This section presents the objectives of the field inspections, the rationale for prioritizing each area, and outlines the procedures that PWB will follow for conducting field inspections.

PWB will conduct field inspections at a minimum once during the wet season (October – May) and once during the dry season (June – September), except as noted in Section 2.1.3. Wet-season inspections will be conducted when there is no snow on the ground at the inspection location. For all types of inspections, the standard observations to be recorded will include the visual presence of debris or water contamination, trash, human waste, high concentrations of wildlife scat, evidence of fire or landslides, and any evidence of domesticated animal wastes. More specific observations may be made for each type of inspection described below. Any suspicious activity or potential *Cryptosporidium* source, excluding wildlife, will be fully investigated and reinspected as necessary.

2.1 Watershed Security Inspections

2.1.1 Objectives

The objectives of security field inspections are to inspect areas of the watershed where unauthorized entry is more likely to occur, as well as areas of allowed and routine entry, including:

- Areas near the watershed boundary that are known to have human activity and are potential access points for unauthorized entry
- The Oneonta and Pacific Crest Trails

2.1.2 Rationale

Although human activity is restricted in the Bull Run watershed, there are areas outside the watershed boundary that have regular human activity. As such, there is an increased risk of entry near these areas. The sections of the Oneonta and Pacific Crest trails that are within the watershed boundary are areas of allowed entry along the designated trails and an increased risk for further unauthorized entry or illicit activities.

2.1.3 Methodology

Semi-annual field inspections will be conducted at the following locations:

- Watershed boundary access points, including areas near the BLM Sandy Ridge mountain bike trail system, will be inspected for human activity and signs of unauthorized entry at minimum once during the wet season and once during the dry season (see Figure 1). Routine patrols of the watershed boundary and inspections of access points by PWB Rangers and Forest Service law enforcement officers are an established practice for preventing human trespass. These routine patrols will supplement the semi-annual inspections of the watershed boundary access points.
- The Pacific Crest Trail (PCT) has an 8.3-mile section within the Bull Run Watershed Management Unit. Of that 8.3-mile section, approximately 1.2 miles is within the water supply drainage. This section of the PCT is typically accessible only from late spring through mid-October. The Oneonta trail has an approximately 1-mile section within the water supply drainage and has a similar window of time that it is accessible. Two inspections of the PCT and Oneonta trail will occur annually when the trails are accessible. Based on accessibility, both sets of inspections may need to be conducted during the dry season.

Observations

During patrols, PWB Rangers will look for any sign of human entry or illicit activity, such as trash, human waste, evidence of campfire rings, and any evidence of domesticated animals. For the Oneonta and Pacific Crest Trails, the number of hikers encountered, adequate signage, and the presence of any side trails will also be noted. Over time, these observations—as well as any information that can be provided by Forest Service recreation staff—may lead to better estimates of the number of users on these trails. For the BLM Sandy Ridge Trail System, the area will be inspected for signs of bikers who have strayed off the authorized trails in the direction of the watershed, particularly the Homestead Gate on Road 14. A summary of these patrols and overall findings will be made available to OHA on an annual basis.

Quality Control

PWB Security maintains a database to track the activities of its Rangers. The database includes the times and locations of the patrols as well as reports and case numbers of significant events and observations. The security status of gates, fences and locks during patrols is also tracked. The database can also track locations, individuals contacted, arrests, and reference reports that contain a complete description of the incident and the action taken. The Forest Service and law enforcement agencies also provide PWB with information relevant to the watershed but do not

give PWB direct access to the agencies' databases. All data, as well as anecdotal information, are reviewed and analyzed by Security Managers and PWB Rangers to better strategize and direct security efforts.

Investigations, Reinspections, and Follow-up

PWB Security places particular emphasis on tracking locations where illicit activity occurs. Illicit activities include trespass involving camping, campfires, use of vehicles, and other evidence of human intrusion. These activities are given higher priority for follow-up investigation, surveillance or implementation of other technological solutions such as concealed cameras.

Rangers investigating intrusions usually make contact with violators. The Rangers conduct an investigation at the time of contact. Rangers attempt to determine the route used by the trespasser, whether forced entry was used, whether suspect vehicles are present, and what type of signage is posted in the area. The Rangers also attempt to determine the purpose of the trespass, such as for hunting, hiking, mountain biking or other prohibited activities. The appropriate law enforcement authority is contacted either at the time of the offense or as soon as practical to process the violator for the applicable criminal charge. In the event that sources of potential *Cryptosporidium* contamination other than wildlife are encountered in the watershed, the Water Quality Compliance group will be notified to evaluate the available facts (e.g., the evidence of human or domesticated animal waste, its proximity to waterways, and the duration of the intrusion) and whether surveillance monitoring is warranted. Sources of potential *Cryptosporidium* contamination include human intruders or domesticated animals. Evidence of intrusion would include direct contact or signs of activity (e.g., for humans: human waste, trash, or campfire rings, and for animals: scat or other signs of disturbance).

2.2 Diversion Pool Inspections

2.2.1 Objectives

The objectives of the Diversion Pool field inspections are to:

- Maintain existing protections
- Identify any deficiencies in existing protections
- Initiate corrective action for any identified deficiencies
- Document the maintenance of existing protections, the identification of deficiencies, and the initiation and completion of corrective action(s)

2.2.2 Rationale

The Diversion Pool serves as the primary source of supply for both raw water intake structures. The maintenance of existing drainage systems and perimeter controls reduces the likelihood that wildlife waste will be transported to or directly deposited in the Diversion Pool.

2.2.3 Methodology

At least once during the wet season and once during the dry season, Watershed Specialists will complete a comprehensive inspection of the Diversion Pool to verify the physical integrity of the perimeter controls and drainage systems. These comprehensive inspections will be supplemented by routine inspections of the Diversion Pool conducted by Water Treatment Operators working at the Headworks facility. The radial distance from the Diversion Pool that is the inspection area is shown in Figure 3.



Figure 3. Inspection Area for the Diversion Pool Perimeter and Drainage Systems

Observations

During semi-annual inspections, PWB staff will inspect the area around the Diversion Pool to verify the physical integrity of the drainage systems and perimeter controls. Staff will take digital photographs at designated locations and will record relevant observations on a standard inspection form. Relevant observations include deficiencies in the existing barriers and unusual signs of wildlife activity. Unusual signs of wildlife activity may include the presence of animals in the Diversion Pool, signs of burrowing that could compromise the integrity of the perimeter controls, or unusually high levels of scat in the perimeter of the Diversion Pool.

Quality Control

Diversion Pool inspections will adhere to a work flow process. The work flow process will aid in the completion of scheduled inspections and support the timely completion of requested maintenance, repair, reinspections, and follow-up inspections. Work orders for the Diversion Pool inspections will be automatically generated and scheduled by PWB's Computerized

Maintenance Management System (CMMS). Quarterly reports of work orders associated with the Diversion Pool and their completion status will be produced through CMMS and delivered electronically to the Water Quality Compliance group, Water Treatment group Supervisor, Conduits/Watershed group Supervisor, and other Operations group management staff as needed.

Investigations, Reinspections, and Follow Up

Deficiencies in the physical integrity of the perimeter controls or drainage systems, signs of suspicious activity, or potential *Cryptosporidium* sources noted during inspections will trigger further investigations, reinspections, or follow up. If a need for maintenance, repair, reinspections, or follow-up inspections are identified as evidenced by deficiencies in the existing barriers or unusual signs of animal activity, a new work order will be initiated for items that require further action. To help prioritize follow-up work orders and ensure timely completion of critical tasks, the Diversion Pool has been assigned a high criticality code (8 out of 9) and requested work can be assigned a task priority code ranging from 1 through 9 depending on the urgency of the task. Critical deficiencies in the Diversion Pool fence or drainage system and unusual signs of wildlife activity will be assigned a task priority code of 9. When follow-up work orders are assigned a task priority code of 9, the Water Quality Compliance group, Water Treatment group Supervisor, Conduits/Watershed group Supervisor, and other Operations group management staff, as needed, will be notified immediately. Items requiring further action will be fully investigated and deficiencies will be addressed as soon as possible. In the event that signs of potential *Cryptosporidium* sources (including unusual signs of wildlife) are encountered, the Water Quality Compliance group will evaluate whether surveillance monitoring is warranted.

2.3 Wildlife Area Inspections

2.3.1 Objective

In the Bull Run watershed, wildlife represents the most likely potential source of *Cryptosporidium* contamination. Therefore, areas of wildlife activity, particularly if located in proximity to intake locations where there is less opportunity for removal or attenuation of pathogens due to shorter travel times through the environment, represent a potential risk for the introduction of *Cryptosporidium*. The objective of the wildlife area inspections is to monitor wildlife as a potential source of *Cryptosporidium* contamination. PWB will conduct field inspections in areas of the watershed with known or suspected wildlife activity focusing on areas where the risk of transport to the intake is higher due to proximity.

2.3.2 Rationale

Based on relative risk, PWB has prioritized areas for wildlife inspections that are in proximity to the intake structures including the Diversion Pool and the two raw water storage reservoirs. Although there is currently no evidence of high levels of wildlife activity around the Diversion Pool, this structure serves as the primary source of supply for both raw water intake structures

and will be inspected for signs of wildlife activity. PWB will also continue to inspect areas adjacent to the reservoirs where evidence of wildlife activity was observed during the variance study and interim period scat monitoring. These areas are primarily around Reservoir 2 since Reservoir 1, in general, has a very steep and forested shoreline that is not well-suited for wildlife and is difficult to survey on foot. In addition to these areas, the shorelines of Reservoirs 1 and 2 will be inspected using a boat once during the dry season after drawdown and once during the early part of the wet season.

2.3.3 Methodology

PWB will conduct field inspections in the focal areas designated in Figure 2 which include:

- The perimeter of the Diversion Pool
- Areas adjacent to the Bull Run Reservoir 1 and Reservoir 2 where evidence of wildlife activity exists
- The shorelines of Reservoirs 1 and 2

Table 1 lists each inspection area and the rationale for selecting each location. Inspections will be conducted at least semi-annually at each of these locations, once during the wet season and once during the dry season. Wet- and dry-season inspections will be timed to coincide with maximum wildlife presence and activity in the watershed. Although the timing of wildlife presence and activity varies by species, in general, animals are more numerous and active in the watershed in late spring, summer, and fall when the higher-elevation areas of the watershed are not covered with snow.

The focal areas targeted for field inspections may be modified periodically to reflect PWB's evolving understanding of risk with regard to wildlife. Modifications may be based on evolving knowledge of Bull Run wildlife such as species' habitat preferences, population levels, and seasonal migration patterns or on information from the scientific community's study of wildlife-associated *Cryptosporidium*.

Table 1: Wildlife Inspection Areas in the Bull Run Watershed

Number	Location Name	Rationale for Selection
1	Headworks Area	<ul style="list-style-type: none"> The grassy plots in this area provide forage for a small population of deer year round and for bear and Canada geese seasonally. The presence of prey species periodically attracts coyote, bobcat, and cougar.
2	Diversion Pool	<ul style="list-style-type: none"> Proximity to the intake.
3	Rd 12 Beaver Ponds and Forest	<ul style="list-style-type: none"> Proximity to Reservoir 2 The wetland vegetation and open forest provide food and shelter for ungulate species. The pond provides habitat for both beaver and otter.
4	Reservoir 2 Shoreline	<ul style="list-style-type: none"> Proximity to Reservoir 2
5	Reservoir 2 North Shore Forest	<ul style="list-style-type: none"> Proximity to Reservoir 2 The low grade and the presence of forage are favorable to herbivorous species. The presence of herbivorous species periodically attracts coyote, bobcat, and cougar.
6	Bear Creek House Area	<ul style="list-style-type: none"> Proximity to Reservoir 2 The buildings in this area provide habitat for rodents. The low grade and presence of forage is favorable for herbivorous species. The presence of prey species periodically attracts coyote, bobcat, and cougar.
7	Reservoir 1 Shoreline	<ul style="list-style-type: none"> Proximity to Reservoir 1

Observations

During field inspections, staff will record signs of wildlife on a standardized wildlife observation form. Observations to be noted include wildlife sightings, number of animals present, and other signs of wildlife activity in the area such as tracks, markings, burrows, grazing, and scat. For all scat observed in the area, staff will record the identity of the animal host and provide counts observed in the inspection areas. When scat samples from target wildlife species that meet freshness criteria are found in the inspection areas, representative samples from each species present will be collected and tested for the presence of *Cryptosporidium* oocysts (see Section 3.2). When collecting scat samples, staff will record the identity of the host animal for each sample and the total number of samples collected at each inspection location.

Quality Control

Staff conducting wildlife field inspections will receive training on scat identification, evaluation of scat freshness, and other important considerations for completing field inspections. Field staff will follow standard operating procedures for wildlife field inspections and will record information pertinent to field inspections in the standardized wildlife observation form. PWB digitally stores and manages information gathered during field inspections of wildlife areas.

Scat sample collection and analysis will follow quality control procedures specified for scat sampling (see Section 3.2).

Investigations, Reinspections, and Follow-up

Unusual signs of contamination discovered during field inspections will trigger follow-up surveillance. Follow-up surveillance may include all or some of the following activities, as appropriate: 1) reinspection of the area, 2) collection of additional scat samples, and 3) collection of water samples at relevant locations to be analyzed for *Cryptosporidium* or other applicable water quality parameters. Scat samples that test positive for *Cryptosporidium* may be submitted for genotyping. Pertinent information gathered during follow-up surveillance will be summarized and evaluated to decide whether additional follow-up is warranted.

2.4 Soil Erosion Area Inspections

2.4.1 Objectives

The objectives of soil erosion inspections are to:

- Monitor the South Fork landslide, a recent landslide with bare sediment reaching the stream edge
- Inspect the watershed for new landslides with bare sediment reaching the stream edge

2.4.2 Rationale

Based on PWB's current understanding, soil erosion does not represent a high-risk transport pathway for *Cryptosporidium* in the Bull Run watershed. Nevertheless, PWB routinely conducts inspections of major historical landslides after turbidity events that are of a magnitude that trigger switching from the Bull Run source to the back-up groundwater source. PWB will continue these inspections while operating under a variance.

2.4.3 Methodology

At least three tools are available for field inspections: 1) ground inspections, 2) inspections from fixed-wing aircraft or helicopters, and 3) photo-point analysis (i.e., taking photos from a reference point and comparing photos over time). These methods will be used interchangeably as conditions dictate to complete field inspections. Inspections will occur on a semi-annual basis—once during the wet season and once during the dry season. Safety will be an important consideration while conducting field inspections, particularly near landslides and high-erosion areas far from roads and trails.

PWB will inspect the landslide on the South Fork tributary (see Figure 2). The most recent slide at South Fork took place in late January 2012. The site is not re-vegetated and still has bare sediment reaching the stream edge. No road or trail access exists to the South Fork slide; the area is accessible only by wading up the South Fork channel for three-quarters of a mile from the Road 12 crossing or walking through dense vegetation not on an established trail for approximately one-half mile from Road 14. Therefore, the primary tools that will be used to inspect this landslide are inspections from fixed-wing aircraft or helicopters, and photo-point analysis. Ground inspections may be used to supplement aerial inspections as needed.

During the course of erosion inspections conducted from the air and other field inspections described in this plan, PWB will also look for new landslides or new debris movement at any past landslides in the Bull Run watershed. In the event that these circumstances are discovered, factual documentation of details related to erosion such as maps, photos, and original records will be included in the annual report.

Observations

Field staff will record details related to erosion at the South Fork landslide and any new landslide observed during an inspection. Observations will include status of vegetation, any evidence of a changing boundary of the scarp, and evidence of debris movement. An analysis of landslide changes may be carried out by comparing present and historical photos and observations.

Quality Control

During inspections of landslides, staff will complete standard observation forms, consistently noting characteristics observed during each visit. PWB has developed a system to manage these records digitally.

Investigations, Reinspections, and Follow-up

If evidence indicates significant erosion in the South Fork landslide or another new landslide, PWB will follow up with an assessment of the necessity, feasibility, and probable effectiveness of implementing erosion-control measures (e.g., riprap and tree planting). PWB's ability to perform remediation efforts at these sites may be limited by accessibility and safety considerations. If new landslides are identified during field inspections, the available information (e.g., magnitude and location) will be evaluated to decide whether the landslide location should be added to the semi-annual inspections.

2.5 Sanitary Facility Inspections

Under the Bull Run Treatment Variance, PWB is required to manage the risk posed by human sewage within the Bull Run watershed per the following condition:

Ensure that any human sewage within the Bull Run watershed is contained within portable toilets or permanent sanitary facilities. Where possible portable toilets or sanitary facilities are to be kept at least 200 feet from any stream, lake, or reservoir within the watershed, except when being transported for disposal outside the watershed. Any portable toilet that cannot be physically located more than 200 feet from a stream, lake, or reservoir must have secondary containment to prevent the release of waste. PWB must ensure that pump-outs and transport of portable toilets are performed with extreme caution to prevent spills and releases. (Condition 1(a)C)

To ensure that this condition is consistently met, PWB will conduct semi-annual field inspections of sanitary facilities located within the water supply drainage.

2.5.1 Objectives

The objectives of sanitary facility inspections are to inspect the condition of permanent and portable sanitary facilities located within the water supply drainage and to assess the waste transport procedures to minimize the risk of *Cryptosporidium* reaching the reservoirs or Diversion Pool.

2.5.2 Rationale

Human sewage, if not safely contained and transported, presents a risk for the introduction of human-infectious *Cryptosporidium* to the Bull Run source water. PWB has established standard operating procedures for the placement of sanitary facilities, secondary containment, use of designated sanitary facilities, use of personal sanitary equipment, pump-outs of sanitary facilities, transport of portable toilets, and spill response. PWB's field inspections of sanitary facilities will serve to prevent and correct any deficiencies and further reduce the likelihood of any human sewage contamination within the water supply drainage.

2.5.3 Methodology

Semi-annual sanitary facility inspections are divided into two categories: Facility Condition and Waste Transport.

Facility Condition Inspections: PWB staff will complete field inspections of the condition of all permanent and portable sanitary facilities located within the water supply drainage at the time of the facility condition inspection. The dry-season inspection will include the seasonal portable facilities located at Bull Run Lake.

Waste Transport Inspections: For each contracted provider assigned to service sanitary facilities in the Bull Run water supply drainage, PWB staff will observe and inspect the pump-out and waste transport procedures for at least one portable sanitary facility. The servicing of each permanent sanitary facility in the Bull Run water supply drainage will be observed and inspected semi-annually.

Observations

Facility Condition Inspections: PWB staff will use standardized observation forms to record the condition of each sanitary facility. PWB will cross-check the facility's specifications with PWB's current inventory and will verify its location using a map and Global Positioning System (GPS), noting whether it is within 200 feet of a stream, lake, or reservoir, and noting the presence and type of any secondary containment. PWB staff will record the condition of each facility, including any issues with the door, roof, walls, floor, lid, seat, and tank. The service maintenance log will be inspected to ensure toilets are being cleaned on a regular basis. Any secondary containment will be inspected for structural issues and the presence of waste, debris, or rain water. Any structural or cleanliness issues, cracks, leaks, or run-off will be noted for immediate follow-up as needed.

Waste Transport Inspections: PWB staff will observe the contracted provider during the pump-out and servicing of at least one portable sanitary facility and all permanent facilities within the water supply drainage. During the assessment, PWB staff will verify that the contracted provider adheres to PWB's standards to ensure that the transport of waste is performed with extreme caution to prevent spills and releases. Observations will include the presence and condition of the contractor's spill response kit, the pump-out and cleaning procedure, the condition of portable toilets upon delivery and removal, and the securing of the vehicle prior to departure. Any concerns shall be noted and addressed with the contractor.

Quality Control

Staff conducting sanitary facility inspections will record information pertinent to field inspections using standardized observation forms. Photographs may also be taken to document inspections and any deficiencies or concerns. PWB will digitally store and manage information gathered during inspections and any follow-up actions taken.

Investigations, Reinspections, and Follow-up

Any observations that could increase the risk of *Cryptosporidium* introduction into the source water will trigger investigation, corrective action, and reinspection as necessary. Any sanitary facilities found to have deficiencies will be repaired, replaced, or otherwise corrected, as soon as possible.

Section 3

Environmental Sampling Plan

Under the Bull Run Treatment Variance, PWB is required to conduct the following:

Semi-annual environmental sampling in priority locations identified during the field inspections. At a minimum, this must include sampling wildlife scat in high risk areas, and sampling water in tributaries previously identified as high risk due to erosion potential, wildlife habitat, or evidence of storm impacts. The sites may be based on previous monitoring results, a combination of continuous stations and/or those selected probabilistically. (Condition 1(a)D.iii)

Under this plan, PWB will conduct environmental sampling of water and wildlife scat in areas of the watershed that have been identified as posing a potential risk for the introduction of *Cryptosporidium* into the Bull Run source water. The following sections present the objectives, methodology, and quality-control specifications for PWB's tributary and wildlife scat monitoring programs.

3.1 Tributary Monitoring

For tributary water monitoring under the Bull Run Treatment Variance, PWB will retain the four Key Stations previously monitored during the one-year variance study and interim period. At a minimum, PWB will collect scheduled samples at each station semi-annually, once during the wet season and once during the dry season. When conditions permit, PWB may collect additional scheduled and event-based samples in order to track levels of *Cryptosporidium* under a broader range of conditions. As discussed in Section 3.2.5, storm event conditions may pose a greater risk for *Cryptosporidium* transport into the surface water. Therefore, PWB may collect samples during or following representative storm events.

3.1.1 Site Selection

PWB will monitor the same tributary sites that have been part of its previous *Cryptosporidium* monitoring programs. The four PWB Key Stations are located on the four major tributaries to Bull Run Reservoirs 1 and 2. These four tributaries contribute more than 80 percent of the total annual average water discharge in the watershed (Figure 4).

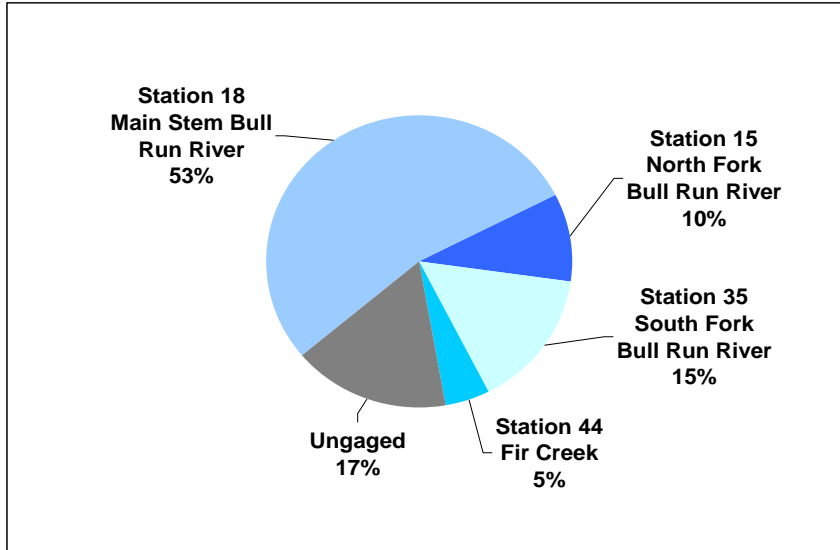


Figure 4: Average Annual Water Discharge from Bull Run Reservoir Tributaries. Together, the four major tributaries selected for monitoring constitute more than 80 percent of the total flow in the watershed.

Each Key Station site is located at a U.S. Geological Survey (USGS) gaging station. The USGS gaging equipment measures stream discharge every half-hour. New data are available every hour from the website <http://waterdata.usgs.gov>. These sites allow PWB to incorporate flow event-based sampling into its tributary monitoring plan.

Station 18, on the main stem of the Bull Run River, is accessible only by an approximately 1.5-mile trail hike; the other three Stations (15, 35, and 44) are adjacent to roads. Each site is shown in the Watershed Inspection and Monitoring Areas map (Figure 1), summarized in Table 2, and shown in Figures 5a–d.

Table 2: Tributary Sampling Sites in the Bull Run Watershed

PWB Site	USGS Station #	Rationale	Access
Station 15 North Fork Bull Run River	14138900	Major tributary to Reservoir 1. Downstream of potential wildlife grazing areas and a historic landslide (1972).	Located at a bridge on 10 Road. Road is plowed in winter.
Station 18 Main Stem Bull Run River	14138850	Major tributary to Reservoir 1. Downstream of potential wildlife grazing areas.	Located at the end of a maintained trail. Road to trailhead is plowed, but low-elevation snow events, flooding, or downed trees occasionally limit road and/or trail passage during the winter.
Station 35 South Fork Bull Run River	14139800	Major tributary to Reservoir 2. Downstream of potential wildlife grazing areas and a 2012 landslide.	Located at a bridge on 1211 Road. Road is plowed in winter.
Station 44 Fir Creek	14138870	Major tributary to Reservoir 1.	Located at a bridge on 1211 Road. Road is plowed in winter.



Figure 5a: Station 15 on the North Fork Bull Run River



Figure 5b: Station 18 on the Main Stem Bull Run River



Figure 5c: Station 35 on the South Fork Bull Run River



Figure 5d: Station 44 on Fir Creek

3.1.2 Sampling Methodology

Scheduled Sampling

Scheduled samples will be collected on a predetermined basis and are intended to capture baseline stream conditions. Scheduled samples will be collected at least semi-annually, once during the wet season and once during the dry season.

Event-Based Sampling

For the purposes of the tributary monitoring program, PWB defines events as high streamflow conditions that occur in response to storms that produce substantial rainfall. PWB first began event-based tributary monitoring for its one-year variance study in March 2010. During the interim period, PWB continued to collect event-based samples at a rate comparable to the variance study to build a larger data set and to capture a greater variety of streamflow conditions.

PWB may continue to target some representative storm events by sampling during or following high streamflows at the four Key Stations. PWB staff will monitor flow conditions and weather forecasts to remain aware of current conditions and anticipate the intensity and duration of expected storms. Available resources include the USGS gaging stations, SNOTEL stations, and weather stations from sites within the Bull Run.

Sample Collection

PWB staff will follow a Standard Operating Procedure (SOP) for the collection of all tributary samples. One water sample of at least 10 liters will be collected in the field from each site using an auto-sampler. PWB has developed manual back-up collection methods for some of the sampling stations in the event that the auto-samplers malfunction. Sampling may be rescheduled or cancelled if inclement weather conditions or safety issues prevent samples from being collected as scheduled.

The samples will be shipped as filters or bulk containers depending on time constraints. In rare cases in which the filter clogs prior to filtration of the required sample volume, the remaining volume will be processed using additional filters as necessary to ensure that the entire sample volume is analyzed.

3.1.3 Analytical Methods and Quality Control

The U.S. Environmental Protection Agency's (EPA) Method 1623 (U.S. EPA 2005), or another EPA-approved method that applies at the time samples are taken, will be used to analyze all water samples for the presence of *Cryptosporidium* and *Giardia*. All water samples will be analyzed by a laboratory approved under EPA's Laboratory Quality Assurance Evaluation Program for Analysis of *Cryptosporidium* in Water (U.S. EPA 2002) or under an equivalent State certification program, whichever is responsible for the approval and ongoing oversight of the laboratories at the time. Samples that contain any detection of *Cryptosporidium* oocysts will be submitted for genotyping.

Subsamples will be processed if a sample yields a packed pellet volume in excess of 0.5 milliliter (mL). PWB has requested that the entire concentrated sample be analyzed by the laboratory.

For quality control, matrix spike samples¹ will be collected to determine the effect of the matrix (water) on the recovery rate of the analytical method. As required by Method 1623, matrix spike samples will be collected at each site at a frequency of no less than 1 per 20 field samples.

One matrix spike will be scheduled at each site during late summer or fall when recovery rates at the intake are typically lower and again during the spring when recovery rates at the intake are typically higher. According to 68 matrix spike samples collected by PWB during 2010–2012, matrix spikes in the tributaries had an overall average recovery rate of 52%, well within the Method 1623 specifications of 13–111%. Additionally, no seasonal trends in the tributary recovery rates were observed, suggesting that the four sites experience acceptable average recovery rates throughout the year.

3.2 Wildlife Scat Monitoring

Among the conditions for maintaining the Bull Run Treatment Variance, the Variance Final Order specifies that, as part of the required semi-annual environmental sampling, PWB must sample wildlife scat in high-risk areas. PWB will comply with this requirement through the implementation of a wildlife scat monitoring program in the Bull Run watershed. The objective of this program is to monitor wildlife as the most likely potential source of *Cryptosporidium* contamination in the Bull Run watershed. Scat samples from wildlife species will be collected and analyzed for *Cryptosporidium* presence and type. This section describes the sample collection plan, analytical methods, and quality-control specifications for PWB's wildlife scat

¹ A matrix spike is a sample prepared by adding a known quantity of organisms to a specified amount of sample matrix (water) for which an independent estimate of target analyte concentration is available.

monitoring plan. PWB may periodically modify this plan in response to evolving knowledge of Bull Run wildlife and *Cryptosporidium* risk while continuing to meet the requirements of the Variance Final Order.

3.2.1 Target Wildlife Species

Scat collection efforts will be targeted to wildlife species sampled during PWB’s study in support of the variance request (see Table 3). This list includes Bull Run wildlife that were identified as having the greatest potential to contribute to *Cryptosporidium* loading in the Bull Run watershed based on general risk criteria. As PWB’s knowledge of species’ habitat preferences, population levels, and seasonal migration patterns evolves, and the state of knowledge of wildlife-associated *Cryptosporidium* continues to develop, PWB may refine the target wildlife list to focus its effort on wildlife species that present the greatest risk in the Bull Run watershed.

Table 3: PWB’s Target Wildlife List

Common Name	Scientific name
Black-tailed deer	<i>Odocoileus hemionus columbianus</i>
Roosevelt elk	<i>Cervus elaphus roosevelti</i>
Bobcat	<i>Lynx rufus</i>
Cougar	<i>Puma concolor</i>
Coyote	<i>Canis latrans</i>
Black bear	<i>Ursus americanus</i>
River otter	<i>Lontra canadensis</i>
American beaver	<i>Castor canadensis</i>
Snowshoe hare	<i>Lepus americanus</i>
Canada goose	<i>Branta canadensis</i>
Small rodents	Rodentia

3.2.2 Sampling Methodology

Sampling Frequency

PWB will collect scat samples during the wet season and dry season to meet the Variance Final Order requirement of semi-annual environmental sampling. For each target species, higher sampling efforts will be allocated to the times of the year when the species’ populations are larger and more active and when fresh scats are most available.

Sampling Sites

Scat samples will be collected from areas in the Bull Run watershed prioritized by PWB for wildlife inspections (see Section 2.3). These locations are shown in the Watershed Inspection and Monitoring Areas map (Figure 2). Figures 6a–b provide a zoom-in view of two of these locations—the Diversion Pool and the Bull Run Reservoir 1 Bear Creek House area. Additional scat samples may be collected in other areas of the Bull Run watershed to attempt to represent all of the species on PWB’s target wildlife list. Samples may also be collected in response to

evidence of wildlife *Cryptosporidium* contamination resulting from laboratory testing or unusual signs of contamination discovered during field inspections.



Figure 6a: Diversion Pool Wildlife Inspection Area (Location #2)



Figure 6b: Bull Run Reservoir 1 Bear Creek House Area (Location # 6)

Scat Collection

During field inspections, staff will check each area for the presence of wildlife scat belonging to species on PWB's target wildlife list (Table 3). Trained field staff will determine the identity of the animal host of fecal deposits based on characteristics of the fecal deposit (e.g., size, shape, color, and contents) and other identifying wildlife signs (e.g., tracks, markings, and burrows). Staff will also note relevant observations including the date of sample collection, wildlife sightings, number of animals present, and other signs of wildlife activity (e.g., tracks, markings, burrows, or grazing). The location of each scat sample will be recorded using GPS units. A subset of the scat samples found in the inspection area will be collected and submitted for *Cryptosporidium* and *Giardia* analysis.

PWB staff will follow a Standard Operating Procedure (SOP) for the collection of scat samples. Staff will collect most scat samples directly from the ground. For rodent species, scat samples

will be collected from the interior surface of bait stations placed in areas of the watershed with known rodent activity. Trapping may be used as an additional technique for collecting scat samples from small mammals.

Scat samples will be visually inspected for freshness based on a sheen indicating high moisture content, remaining fraction of digestion by-products, and pliability. For most wildlife species, a scat sample will consist of one fecal deposit. For species such as rodents and hare that have small scat volumes, multiple fecal deposits collected from one area will be combined to make a composite sample. Each scat sample will be photo-documented and then collected aseptically. The scat samples will be packaged on ice and shipped overnight to the analyzing laboratory.

3.2.3 Analytical Methods and Quality Control

Scat samples will be prepared for analysis using either no-concentration, immunomagnetic separation (IMS) or density gradient separation. *Cryptosporidium* presence will then be detected with either polymerase chain reaction (PCR) or immunofluorescence antibody (IFA) microscopy. Scat samples positive for *Cryptosporidium* by IFA will be considered presumptively positive until confirmed by PCR. Isolates from *Cryptosporidium*-positive samples may be submitted for genotyping to characterize the species of *Cryptosporidium* that are carried by wildlife. If DNA sequencing fails due to insufficient PCR product or otherwise demonstrates that the PCR product is not from the *Cryptosporidium* genome, the final sample result will be negative.

Quality control for microscopy-based samples will include the following: a subset of the scat samples from each target wildlife species will be spiked with an internal control to determine pathogen recovery efficiency for each wildlife species. For each target wildlife species, scat samples will be spiked at a minimum frequency of one spiked sample per every ten samples analyzed.

Quality control for PCR-based samples will include the following: the application of a negative control, a positive control, and an inhibition control on a routine basis. In addition, a subset of scat samples will be spiked with an internal control to periodically evaluate detection limits for target wildlife species or groups.

As analytical methods for the detection of *Cryptosporidium* in scat evolve or the objectives of PWB's scat sampling plan change, it might be appropriate to employ analytical methods different from those described in this section. PWB will continue to rely on the expertise of its contract laboratory to select and optimize analytical methods that are most suitable for its scat monitoring program.

Section 4

Reporting and Notification

4.1 Bull Run Watershed Report

As required under OHA condition 1(c)A, PWB maintains a system for documenting its watershed inspections, monitoring, and investigation results in accordance with this plan. Inspection and monitoring results will be reported to OHA on an annual basis in a Bull Run Watershed Report. The report will include results of inspections, laboratory results from water and scat, maps of the locations of inspection and monitoring and photos used for analyses, recording, or comparison. If detections of *Cryptosporidium* are found in the watershed, a map showing the locations will be included in the report.

The annual inspection and monitoring reporting period will be defined as one water year, which is considered October 1 through September 30. The annual report will be submitted to OHA no later than December 31 for the previous water year.

4.2 Positive Result Notification

As required under OHA condition 1(c)B, PWB will notify OHA, Environmental Public Health, Drinking Water Services within 24 hours of receiving any laboratory results that include any *Cryptosporidium* detections from water or scat collected as part of this plan. PWB understands that OHA has designated the Drinking Water Services Unit Manager of Technical Services Region 1 (or designee) as the primary OHA contact for notifications. For samples collected under this plan, contact will be made by email or telephone.

Section 5

References

Oregon Health Authority Public Health Division, Office of Environmental Public Health Drinking Water Program. Final Order In the Matter of Portland Water Bureau's Request for Variance under 42 USC § 300g-4(a)(1)(B). March 14, 2012. Available at <https://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Rules/LT2/Documents/pwb/VarianceFinalOrder.pdf>. Accessed July 30, 2012.

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