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Two Union Square
601 Union Street, Suite 600
Seattle, WA 98101
tel: 206.292.2078 fax: 206.682.7867

Memorandum

To: Mario Isaias-Vera, USDA Forest Service, Holden Mine Remedial Project Manager

Copies: Craig Stevens and Tom Zimmer, Rio Tinto

From: Kara Hitchko, Evan Malczyk, Brett Beaulieu, and Jessi Massingale; Floyd|Snider

Date: March 30, 2020

Project No: RT-Holden

Re: **Biologically Active Zone Literature Review and Proposal for Groundwater Point of Compliance at the Holden Mine Site**

INTRODUCTION

This memorandum was prepared to supplement the 2020 Performance Standards Verification Plan (PSVP) and is based on a discussion with the Agencies at the August 28, 2019, meeting regarding the Agencies' comments on the Draft Revised 2019 PSVP (Floyd|Snider 2019) and Rio Tinto's initial responses. In coordination with the Agencies, it was determined that a technical memorandum, separate from the PSVP, should be prepared that includes the results of a literature review on the hyporheic zone and hyporheic habitat. In addition to a literature review, this memorandum provides the technical rationale for determining the biologically active zone (BAZ) of Railroad Creek and defining potential points of compliance (POCs) for groundwater entering into surface water, which is a conditional point of compliance (CPOC) under the Model Toxics Control Act (MTCA) and in accordance with the Record of Decision (ROD; USFS 2012). The results of the literature review and the evaluation of conditions at the Holden Mine Site (Site) support defining a BAZ for Railroad Creek of 0 to 30 centimeters (cm) and using shoreline well points as the POC for groundwater downgradient of Tailings Pile 3.

The ROD describes several key features of the POC for groundwater entering surface water at the Site including, "Groundwater discharging to surface water must also meet surface water cleanup standards at a POC before the groundwater-surface water interface[1]. Groundwater cleanup levels protective of surface water must be achieved before the portion of the hyporheic zone that supports aquatic life, including fish spawning and benthic macroinvertebrates to be protective of aquatic life, and not simply in the surface water column after dilution has occurred."

1 For Ecology's purposes on behalf of the State of Washington, this point is also a CPOC under MTCA, Washington Administrative Code= 173-340-720(8)(c).

For the purpose of this discussion, the "portion of the hyporheic zone that supports aquatic life" is synonymous with the BAZ.

To better understand the BAZ at the Site as a basis for establishing the depth and location of the POC, a literature review was conducted on the relevant research published by Jack Stanford and others describing the hyporheic zone and the fauna, referred to as hyporheos, of gravel bed creeks and rivers. Additionally, this memorandum describes relevant environmental characteristics of Railroad Creek, the sampling intervals established for benthic macroinvertebrate surveys and sediment, a review of relevant state and federal guidance on determining the BAZ in freshwater creek sediments, and an assessment of the groundwater-surface water interface with respect to establishing a groundwater POC.

Railroad Creek Hydrology and Sediment Characteristics

Railroad Creek is a fourth-order stream that originates near Lyman Glacier, where it flows approximately 22 miles to Lake Chelan (USFWS 2004). The stream channel for the segment of Railroad Creek from 1 mile upstream and 1 mile downstream of the Site exhibits bar development, occasional braiding, and a developed floodplain except for adjacent to the tailings piles (Dames and Moore 1999). Along the tailings piles, the channel is relatively straight with little or no braiding due to being confined by riprap along the south bank, and in some areas confined by a steep embankment along the road on the north bank. Downstream of the Site, Railroad Creek becomes more channelized within a steep-sided valley, and the gradient becomes steeper. Approximately 11 miles downstream of the Site, Railroad Creek flows into Lake Chelan.

Wetted width measured during baseline monitoring activities, defined as the surface of the channel bottom and sides in direct contact with the aqueous body, ranges from approximately 11 to 16 meters along the reach of Railroad Creek from the upstream background sampling locations (approximately River Mile 11.0) to downstream of the Mine Water Treatment Plant near the confluence of Tenmile Creek (approximately River Mile 8.5; MWH 2012). Railroad Creek annual flow rates in the vicinity of the Site at the confluence of Copper Creek (River Mile 9.8) ranged from 26 to 935 cubic feet per second (cfs) and averaged 300 cfs (MWH 2013). Groundwater-surface water interactions are variable by reach along the Site with both gaining conditions (groundwater discharge to surface water) and losing conditions (surface water recharge to groundwater; Floyd|Snider 2020a). Groundwater-surface water interactions in Railroad Creek at the Site are described in detail in the 2019 Annual Compliance Assessment Report (Floyd|Snider 2020a).

During biomonitoring activities in 2018 and 2019 stream substrates were predominantly gravel/cobble with occasional boulders, and with average sand/fines (less than 2 millimeters) percentages up to 16 percent by weight (Arcadis 2019, Appendix G of Floyd|Snider 2020a). The Wolverine fire in 2015 temporarily increased the delivery of sand and fine sediments to the stream channel, especially within burned riparian areas.

Sampling Depths for Benthic Macroinvertebrate Surveys and Sediment Sampling

Several sampling intervals for monitoring conducted under the PSVP program have been established at the Site. For evaluating the benthic macroinvertebrate community, samples are collected by agitating the sediment to a depth of 15 cm, which is consistent with Washington State Department of Ecology (Ecology) biological monitoring guidance (Ecology 2010). This sampling depth is similar to or potentially deeper than the sample collection depths used by Ecology in their ongoing Ambient Freshwater Biological Monitoring program for benthic macroinvertebrates at Railroad Creek (4 to 5 cm after the removal of large stones; Ecology 2010).

To evaluate the protectiveness for aquatic life of concentrations of contaminants of concern (COCs) in sediment, sediment samples will be collected as part of the fall 2020 PSVP field program for chemical analysis and bioassay testing from 0 to 30 cm as described in the 2020 PSVP (Floyd|Snider 2020b). As described in the *Sediment Cleanup User's Manual II* (SCUM II) for freshwater sites, "a site-specific decision will need to be made regarding the representative benthic organisms to be protected and the associated biologically active zones to be sampled" (Ecology 2019). The sediment sampling interval of 0 to 30 cm is the assumed BAZ for Railroad Creek based on U.S. Environmental Protection Agency (USEPA) recommendations designed to include the 80th percentile of biota depth distributions in freshwater lotic habitat types (flowing water ecosystems; USEPA 2015). A BAZ of 35 cm was assigned to streams with coarse grains and sand; a BAZ of 25 cm was assigned to streams with coarse grains and sand with fines greater than 20 percent by weight (refer to Table 5 of USEPA 2015). Because Railroad Creek contains fines at some locations up to 16 percent by weight (Appendix G of Floyd|Snider 2020a), the BAZ was calculated as the average of the BAZ values reported for the two habitat types and consistent with the Ecology SCUM II guidance, and is the interval that is representative of benthic organisms to be protected.

LITERATURE REVIEW

A literature review was conducted to support the evaluation of the BAZ in Railroad Creek for determining the POC for groundwater entering surface water and was inclusive of those studies and papers identified by the Agencies in the 2019 Draft Revised PSVP comments. As stated in the ROD, "…cleanup levels established for the protection of aquatic life must be achieved before the portion of the hyporheic zone that supports aquatic life, including fish spawning and benthic macroinvertebrates…" (USFS 2012). Therefore, an operational definition of the BAZ may support the determination of the groundwater POC by establishing the depth that is representative of organisms to be protected.

This section presents the summary of the review of the information presented in the following documents:

- An Ecosystem Perspective of Alluvial Rivers: Connectivity and the Hyporheic Corridor (Stanford and Ward 1993)
- Determination of the biologically relevant sampling depth for terrestrial and aquatic ecological risk assessments (USEPA 2015)

- Ecology and management of the hyporheic zone: stream-groundwater interactions of running water and their floodplains (Boulton et al. 2010)
- Evaluating Ground-Water/Surface-Water Transition Zones in Ecological Risk Assessments (USEPA 2008)
- Hyporheic communities of two Montana rivers (Stanford and Gaufin 1974)
- Riverine salmonid egg burial depths: review of published data and implications for scour studies (DeVries 1997)
- The hyporheic habitat of river ecosystems (Stanford and Ward 1988)
- The hyporheic zone as an invertebrate refuge: a review of variability in space, time, taxa, and behaviour (Stubbington 2012)
- The role of the hyporheic zone across stream networks (Wondzell 2011)
- Hyporheic exchange in Mountain Rivers I: Mechanics and Environmental Effects (Tonina and Buffington 2009)

The Hyporheic Zone and Hyporheos

The hyporheic zone is generally defined as the portion of a shallow aquifer beneath a stream where groundwater mixes with surface water (Ecology 2017), which can be delineated based on hydraulic, geochemical, or biological methods depending on the goals. Because hyporheic exchange acts over multiple spatial and temporal scales, no single definition for the hyporheic zone exists that will suit all applications and study goals (Tonina and Buffington 2009). For biologically focused applications of the hyporheic zone, researchers have expanded the concept of the stream ecosystem to include both the vertical and horizontal dimensions of surface water-groundwater interactions within the hyporheic zone. According to the ROD "The hyporheic zone is the transition zone between surface water and groundwater. Within this zone, exchanges of water, nutrients, and organic matter occur in response to variations in discharge and stream bed topography and porosity; portions of this zone support aquatic life (see Boulton et al. 1998)." From a regulatory perspective as defined in SCUM II, the BAZ is the interval that defines the extent of the habitat utilized by the representative benthic organisms to be protected (Ecology 2019).

Previous efforts to provide a more specific definition of the hyporheic zone based on the distribution of hyporheic invertebrates or chemical differences between channel and groundwater have proved challenging (Boulton et al. 2010) given the spatial and temporal variability and limits of data collection (Tonina and Buffington 2009). The diversity of hyporheic zone types across different riverine systems and the complexity of interactions led to describing the biologically defined hyporheic zone as a dynamic ecotone. The dynamic ecotone concept recognizes that the extent of the hyporheic zone and hyporheos fluctuates within a waterbody in response to changing sediment characteristics and hydrologic exchange. Benthic and epibenthic communities (invertebrates and fish) utilize portions of this transition zone for part or all of their life cycle (USEPA 2008). As described by Stanford and Ward (1993), the hyporheic zone of alluvial rivers may be defined as three primary concepts: the groundwater zone utilized by amphibiotic stream organisms, the groundwater zone involving biogeochemical cycling that affects the stream channel and riparian vegetation, and physically the groundwater volume that interacts with channel surface water.

Boulton et al. (2010) describe the interactions among variables across overlapping spatial scales (landscape, catchment-reach, and reach-sediment particle) that may influence the hyporheic zone and hyporheos. At the catchment-reach scale, whether a reach is gaining or losing (upwelling or downwelling) can be one of the greatest factors in affecting the extent of the hyporheos. While gaining reaches are described as potential hot spots of primary productivity in the surface stream that can result from upwelling nutrient-rich water, losing reaches can provide organic matter and dissolved oxygen deeper into the sediments.

Hyporheic Habitat and Invertebrate Distributions

Factors affecting the subsurface and lateral distribution and composition of the hyporheos fauna are complex and include, but are not limited to, hydrogeology, hydrology, sediment composition, water quality, existing hyporheos fauna, and other biological interactions (Boulton et al. 2010, Stubbington 2012). Riverine water can circulate deep within the streambed substrata and laterally from the stream channel, which may extend the area of suitable hyporheos habitat from the river channel for specific types of river systems (Stanford and Gaufin 1974).

Notable research from Stanford and colleagues in the 1970s and 1980s highlighted the extensive distribution of hyporheic habitat at several river systems in Montana. At the Tobacco River, a detritus-based invertebrate community was present at least 4.2 meters (m) below and 50 m laterally from the river channel (Stanford and Gaufin 1974). Similarly, the extent of the invertebrate community of the Flathead River within the Kalispell Valley was about 3 kilometers (km) wide with an average depth of 10 m, whereas the river channel was about 50 m wide with most benthic organisms found in the upper 25 cm of channel substrata (Stanford and Ward 1988). Stoneflies were the most abundant permanent residents of these deeper reaches of the biologically defined hyporheic zone within the groundwater aquifer (Stanford and Ward 1993).

In these three articles, the authors suggest that streams or rivers with similar hydrogeology will exhibit extensive hyporheic areas. Additionally, Stanford and Gaufin report that, "we emphasize that deep hyporheic habitats may exist only in streams in which the channel and adjacent substrata are composed of loosely compacted floodplain gravels" (Stanford and Gaufin 1974). The Tobacco River and Flathead River are large braided riverine systems and are dissimilar to the steep-gradient, channelized mountain stream of Railroad Creek at the Site.

While the research presented by Jack Stanford and colleagues represents an advancement in understanding the complex ecological systems involved within extensive hyporheic areas, the process for applying this research in a regulatory context is undefined and therefore is not considered a suitable analogue or appropriate to apply to the Site. Additionally, the ecological importance of these deep hyporheic zone organisms in ecosystem functioning is not known (Jones and Holmes 1996) and metrics for assessing the health of hyporheos have not been established.

Expected Fish Spawning Sediment Depth and Feeding Behavior in Railroad Creek

The ROD specifies that "groundwater cleanup levels protective of surface water must be achieved before the portion of the hyporheic zone that supports aquatic life, including fish spawning." Fish species collected from Railroad Creek during 2019 biomonitoring activities include rainbow trout, cutthroat trout, and a rainbow/cutthroat hybrid (Appendix G; Floyd|Snider 2020a). Trout spawning and feeding activities are expected to occur within the hyporheic zone to various degrees.

The egg burial depth for cutthroat and rainbow trout ranges from 10 to 20 cm (DeVries 1997) and is likely to occur within the mixing zone of groundwater and surface water for many reaches of Railroad Creek based on available porewater data (Floyd|Snider 2020a). Factors affecting egg burial depth may include the size of the female, available spawning habitat, and the chosen spawning location (e.g., creek substrate size, water velocities, and water depths).

Rainbow and cutthroat trout are opportunistic feeders that will consume drifting invertebrates, emerging insects, terrestrial insects that fall onto the water surface, and other smaller fish. Benthic macroinvertebrates, most of which utilize the hyporheic zone during various life history stages, are a primary food source for trout. The protection of water quality conditions within the BAZ of the hyporheic zone will protect fish spawning and feeding activities, which will further support trout production in Railroad Creek.

Challenges in Assessing Hyporheic Health in a Regulatory Application

Although the dynamic ecotone definition of the hyporheic zone reflects the complexity of surface-groundwater interactions and hyporheos fauna distribution and provides a useful complement to hyporheic zone definitions based on hydraulic or geochemical conditions (Tonina and Buffington 2009), the lack of an operational definition makes it difficult to apply the information in a regulatory context. An additional challenge is that effective environmental policy to assess hyporheic health and the ecological integrity of the hyporheic zone have not been established within environmental monitoring and remediation programs (Stubbington 2012). While several measures of hyporheic health have been proposed, the adoption by regulators is limited by a lack of baseline data and protocols (Boulton et al. 2010).

The hyporheic zone is expected to have reach-to-reach variability both spatially and temporally due to the physical heterogeneity of the stream waterway and changes in seasonal hydrology (Wondzell 2011). Modelling these complex groundwater and surface water interactions and the response of organisms to environmental patterns in the hyporheic zone requires further study (Stubbington 2012). Additionally, the ecological importance of hyporheos diversity and abundance, including the subterranean biota described by Stanford and Gaufin in 1974, is not well understood (Jones and Holmes 1996; Wondzell 2011). More research outside the scope of the Holden PSVP program is needed to support modeling efforts and to establish the ecological and functional significance of the hyporheic zone before it can be applied to river restoration and conservation in a regulatory context.

Establishing a site-specific BAZ along Railroad Creek through field-collected data would be problematic and require an extensive amount of data collection. We would expect highly variable results along Railroad Creek due to the range of hydrogeology, hydrology, sediment composition, water quality, seasonality, and hyporheos that we are already aware of at the Site. Given this variability, we would still need to assess how best to apply an operational definition to the Site or various areas of the Site. The time required to investigate the extent of the hyporheic zone and BAZ given the range of site conditions and seasonal creek variability, would necessitate multiple years of expensive data collection, and still may not produce a clear result suitable for establishing a POC consistent with the ROD.

PROPOSED BIOLOGICALLY ACTIVE ZONE OF THE HYPORHEIC ZONE

In the absence of any available robust technical or regulatory guidance to characterize the operational definition of a BAZ, and considering the dynamic nature of the hyporheic zone along a large reach of Railroad Creek, the USEPA-recommended guidance for determining the biologically relevant sampling depth is proposed for use at the Site (USEPA 2015). As described previously, the surface sediment BAZ of 0 to 30 cm will be applied in Railroad Creek to assess sediment quality and potential impacts to benthic macroinvertebrates through bioassay testing (Floyd|Snider 2020b). The USEPA guidance considers the hyporheic zone and establishes practical default values for the depth of the biotic zone in various habitats. Although the scientific literature (including the USEPA's 2015 guidance) highlights the likelihood that hyporheos may extend deeper than 30 cm, and laterally away from the river channel in certain river systems and substrates, the majority of these organisms live in the upper 15 to 35 cm in lotic systems (USEPA 2015). The USEPA's 2015 guidance "does not cover fauna that live strictly in groundwater zones that can be located 2-3 km from river channels (noted in Stanford and Ward, 1993)."

Based on the review of literature and USEPA recommendations, and considering the specific properties of Railroad Creek, a 0- to 30-cm BAZ for creek sediments is expected to be inclusive of the extent of the hyporheic zone depth utilized by representative benthic and epibenthic organisms to be protected and organisms assessed during biomonitoring activities (fish and benthic macroinvertebrates).

GROUNDWATER POINT OF COMPLIANCE

The ROD language for the groundwater POC prescribes that the following key directives are met (Section 12.2.2 of USFS 2012):

- "Groundwater cleanup levels (protective of surface water) must be achieved within groundwater before the portion of the hyporheic zone that supports aquatic life, including fish spawning and benthic macroinvertebrates, and not simply in the surface water column after dilution has occurred."[2]

- "Based on this, a POC for groundwater entering into surface water (which is a conditional POC under MTCA) is established within groundwater before (i.e., hydraulically upgradient of) the groundwater–surface water interface."[3]
- "Groundwater quality at this POC shall be monitored using upland monitoring wells."[4]

A 30-cm depth porewater sample would generally be expected to provide a suitable sampling type for monitoring groundwater entering surface water that is protective of the hyporheic habitat utilized by representative benthic and epibenthic organisms to be protected. However, given the many factors that present challenges in establishing a site-specific BAZ, including the complexities of hyporheic exchange and the spatial and temporal variability of ecotones, and the lack of technical or regulatory guidance on how to establish a monitoring program protective of a dynamic BAZ, a more conservative approach is proposed for the stretch of Railroad Creek downgradient of Tailings Pile 3, that uses existing upland well points.

Under the PSVP program (Floyd|Snider 2020b), groundwater COC concentrations are monitored in porewater and well point groupings along the bank of Railroad Creek between SG-7R and SG-11, and in monitoring wells that extend downstream to within approximately 150 feet of Railroad Creek near SG-9 (refer to Figure 1). Specifically, the network of potential locations for monitoring groundwater at a POC protective of the 0- to 30-cm BAZ proposed in this memorandum include:

- Porewater sample collection screens located 12 inches (30 cm) or 36 inches (91 cm) beneath Railroad Creek.
- Upland well point (shallow, hand-driven) monitoring wells typically screened from 5.5 to 6 feet below ground surface and located 5 to 20 feet from the stream channel.
- Upland Shallow Zone monitoring wells screened from between approximately 15 and 25 feet below ground surface that extend downgradient of Tailings Pile 3 to within approximately 150 feet of Railroad Creek at SG-9.

Given these options, there are several considerations that suggest upland well point monitoring wells are the most appropriate POC locations to assess the BAZ. Porewater samples would not meet the ROD requirement to use upland monitoring wells as the POC. Nearby Shallow Zone monitoring wells appear to be outside the hyporheic zone based on distance from Railroad Creek and screened depth. In addition, Shallow Zone monitoring wells are located at a considerable distance from the stretch of Railroad Creek where recent data (Floyd|Snider 2020a) support the previous conceptual site model of upwelling conditions. The nearest Shallow Zone monitoring

2 Refer to page 2-50 of the ROD.
3 Refer to page 2-105 of the ROD.
4 *Ibid.*

well (DS-9S) is located approximately 150 feet from Railroad Creek near SG-9, and approximately 500 and 900 feet upstream of SG-10 and SG-11, respectively.

Use of well points as groundwater POC locations for the stretch of Railroad Creek downgradient of Tailings Pile 3 is protective and consistent with the ROD and will provide several specific advantages over porewater samples or samples from drill rig-installed monitoring wells:

- Well points provide for substantial additional lateral and vertical separation between the hyporheic zone groundwater that is sampled and the representative 0- to 30-cm BAZ. Use of well points as POC locations would therefore be protective of the small fraction of hyporheic zone organisms that may extend outside this representative zone in some locations, at some times.
- Well points are located within the hyporheic zone, close enough to Railroad Creek to produce samples representative of water that is expected to enter the BAZ, and potentially Railroad Creek surface water.
- Well points would meet the ROD requirement for monitoring groundwater quality at the POC using upland monitoring wells. Given the considerable difficulty in attaining drill rig access to the Railroad Creek banks downstream of Tailings Pile 3, and the associated forest damage required, hand-installed well points are appropriate tools for monitoring shallow groundwater in accordance with the ROD.

Based on these considerations, the network of well points monitored under the PSVP program from the edge of Tailings Pile 3 to SG-11 (SG-7R-WP, SG-8-WP, SG-9-WP, DS-14, SG-17-WP, SG-10-WP, SG-18-WP, and SG-11-WP) are proposed as POC locations (Figure 1). The designation of these well points as POC locations would not change the monitoring program in the PSVP. Monitoring at the current porewater and upland monitoring well locations will continue until a change is requested for consideration by the Agencies. As described in the PSVP, data collected through this program will be used to evaluate attenuation between well points and the estimated margin of the BAZ portion of the hyporheic zone. To account for this attenuation, the concentrations of COCs measured in well points may be adjusted based on an empirically derived factor that is approved by the Agencies.

SUMMARY

The hyporheic zone of rivers and streams is generally defined as the portion of a shallow aquifer beneath a stream where groundwater mixes with surface water, and may be delineated based on hydraulic, geochemical, or biological methods specific to the goals of a given study, given the tremendous complexity and temporal and spatial variability. Recent studies with a biological focus have characterized the hyporheic zone as a dynamic ecotone that allows the movement of water, nutrients, organic matter, and benthic organisms between the surface water body and groundwater. The interstitial spaces within portions of this transition zone are utilized by a diverse array of aquatic organisms (the hyporheos), the vast majority of which are present in the upper 35 cm of sediment for most river systems especially high-gradient, channelized mountain streams such as Railroad Creek.

Although the dynamic ecotone definition of the hyporheic zone reflects the complexity of surface-groundwater interactions and the distribution of hyporheos and provides a useful complement to hyporheic zone definitions based on hydraulic or geochemical conditions, the lack of an operational definition makes it difficult to impossible to apply the information in a regulatory context. Additionally, protocols to assess the condition of the hyporheic habitats in the context of environmental remediation have not been established. More research is needed to establish the ecological and functional significance of the hyporheic zone before it can be applied to river restoration and conservation. Establishing a site-specific BAZ based on field-collected data is not expected to be effective due to the known variability of site conditions and expected timeline for conducting an extensive BAZ study. Based on the review of literature and USEPA recommendations, and considering the specific properties of Railroad Creek, a 0- to 30-cm BAZ for creek sediments is expected to be inclusive of the extent of the hyporheic zone depth utilized by representative benthic and epibenthic organisms to be protected and organisms assessed during biomonitoring activities (fish and benthic macroinvertebrates).

As stated in the ROD with regard to determining a groundwater POC, “Groundwater cleanup levels (protective of surface water) must be achieved within groundwater before the portion of the hyporheic zone that supports aquatic life, including fish spawning and benthic macroinvertebrates, and not simply in the surface water column after dilution has occurred.” Specifically, the network of potential locations for monitoring groundwater at a POC protective of the 0- to 30-cm BAZ proposed in this memorandum for the area downgradient of Tailings Pile 3 include existing porewater sample locations, upland Shallow Zone monitoring wells, and upland well points. However, existing porewater and upland Shallow Zone monitoring wells are not appropriate locations to establish the POC. Porewater sampling locations do not address the ROD requirement to utilize upland monitoring wells as the POC and existing upland monitoring wells are located outside the hyporheic zone and too far from key PSVP monitoring locations in Railroad Creek.

Based on the requirements in the ROD, the use of existing well point locations (SG-7R-WP, SG-8-WP, SG-9-WP, DS-14, SG-17-WP, SG-10-WP, SG-18-WP, and SG-11-WP) are proposed as conservative groundwater POCs to ensure protection of the BAZ for Railroad Creek downgradient of Tailings Pile 3. To account for the estimated attenuation between well points and the point where groundwater discharges to the estimated base of the BAZ within the hyporheic zone, the concentrations of COCs measured in well points may be adjusted based on an empirically derived factor that is approved by the Agencies. The final groundwater POC locations and/or sampling depths will be determined in coordination with the Agencies and will be informed by this memorandum and the continued evaluation of site data collected as part of the PSVP monitoring program.

ATTACHMENT

Figure 1 Proposed Groundwater POC Locations Downgradient of Tailings Pile 3

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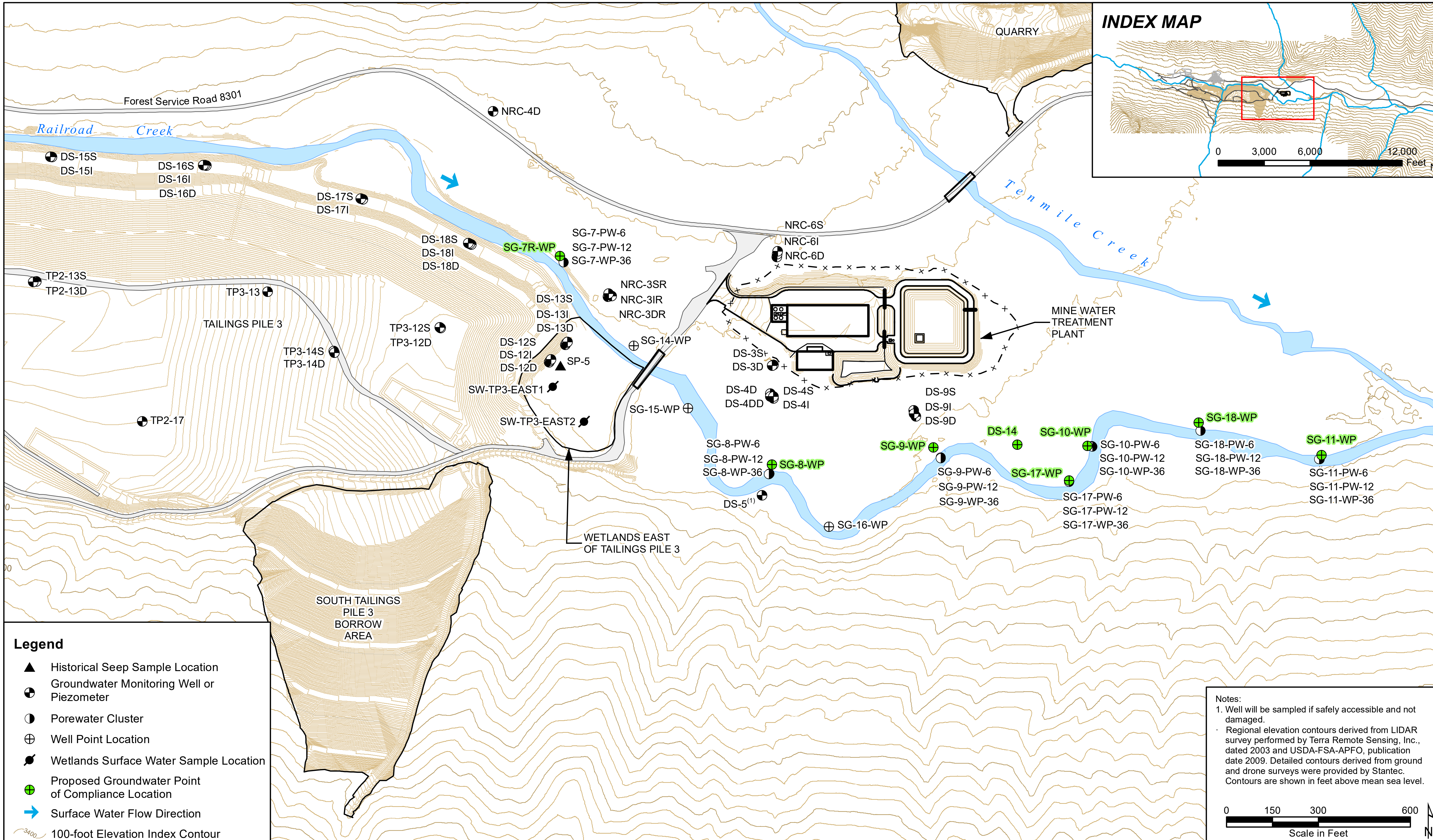
Figure



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Biologically Active Zone Memorandum
Holden Mine Site
Chelan County, Washington

Figure 1
Proposed Groundwater Point of Compliance Locations
Downgradient of Tailings Pile 3

I:\GIS\Projects\RT-Holden\MXD\BAZ Memo\Figure 1 Proposed GW POC Locations Downgradient of TP-3.mxd
3/18/2020