BC Hydro

Campbell River Project Water Use Plan

Upper Campbell Drawdown Zone Revegetation Program

Reference: JHTWORKS-3

Revegetation Treatment Report – Year 2

Study Period: 2018

Laich-Kwil-Tach Environmental Assessments Ltd. Partnership and Ecofish Research Ltd.

October 22, 2019

JHTWORKS-3

Upper Campbell Reservoir Drawdown Zone Revegetation Treatment Report – Year 2

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EXECUTIVE SUMMARY

JHTWORKS-3 is a 10-year program with the primary goal of improving the visual quality and riparian habitat values of high profile reservoir shoreline areas impacted by fluctuating water levels of the Upper Campbell Reservoir. The program has three phases that will be implemented over the 10-year period: 1) identification/prioritization of sites for revegetation treatment trials (Year 1); 2) planning, trial implementation, and monitoring of revegetation treatment trials (Years 2-6); and 3) implementation of the final Revegetation Treatment Plan at additional sites around the reservoir (Years 7-10). Site identification, development of a treatment and effectiveness monitoring plans, and collection of baseline data (Phase 1) were conducted in Year 1 (2017).

This report presents accomplishments of the first year of Phase 2 of the program (2018), which is the first year of the implementation of the vegetation trial treatments, and discusses important lessons learned that will be incorporated into future revegetation implementation work. Treatment sites and areas selected for revegetation work in 2018 were chosen to maximize efficiency for machine access and to gain as much practical information as possible to help guide future revegetation efforts. Revegetation work was implemented between October and December at three treatment sites in 2018: JHT-RV02 (Old Buttle Boat Ramp), JHT-RV03 (Buttle Lake Camp Ground), and JHT-RV06 (Buttle Lake Boat Launch). Data collected in 2018 included baseline data for one site that had been moved since plan development (JHT-RV03), and as-built data following implementation of treatments for all areas (polygons) treated in 2018. Treatment trials were implemented as per prescriptions in the Year 1 report; however, in some cases modifications were needed based on site conditions and other factors, in which case these were identified with new labels to allow revegetation success to be linked to specific treatments during future performance evaluation.

Two treatments were implemented at JHT-RV02 on moderate and steep slope polygons and associated lower gradient benches of the upper drawdown zone in 2018. B-1i, which involved preparing substrate (rough and loose) for natural plant colonization, and C-1ii which, involved planting native vegetation stakes on prepared rough and loose substrate (with a 1 m to 1.5 m amplitude between top of mound and bottom of hole). The soil at this site had more fine silt and clay and less sand and rock than the other sites. A control area was relocated to the west of the old boat launch (adjacent to JHT-RV03) where it will be a suitable control for both JHT-RV03 and JHT-RV02. B-1i and C-1ii treatment areas were 714 and 514 m^2 in size, and C-1ii was planted with a total of 348 stakes of Sitka willow (*Salix sitchensis*), black cottonwood (*Populus balsamifera ssp. trichocarpa*), and red-osier dogwood (*Cornus stolonifera*).

Three treatment areas were treated in the steep upper drawdown polygons and steep upland forest in JHT-RV03 in 2018. The C-1ii treatment was similar to that described for JHT-RV02, but a hardened grid of cemented sand was left between the hollows to help resist erosion. The areas targeted for C-2 treatments (hand planting stakes with no site preparation) were reassigned to C-2i (hand planting stakes within excavator-loosened circles) due to hard-pack soil conditions. D-3i treatment (reassigned from D-3; hand planting stakes with no site preparation) also involved planting stakes into prepared

(modified rough and loose) substrate terraced and stabilized with rocks and root wads, into the upland polygon. As stated above, the control area established west of the old boat launch (adjacent to JHT-RV02) will serve as a control for JHT-RV03. Treated areas ranged from 101 to 216 m^2 in size and a total of 992 stakes were planted.

Three treatment areas were treated at JHT-RV06 in moderate to steep upper drawdown polygons and moderate slope in the drawdown zone in 2018. The C-1ii treatment was similar to that described for JHT-RV02 but had little amplitude in the microtopography, and the areas targeted for C-2 treatment (no site preparation) were reassigned to C-2i (trenches loosened every 2 to 3 m up the slope) because issues were encountered with hand planting due to the rocky ground and cemented soils. The soil in areas targeted for B-2 treatment was also too compact for hand planting without site preparation and the originally intended hand-staking technique was modified to a localized rough and loose treatment with soil loosened in craters spaced at 2 m intervals (B-2i). Two control areas were established to the northwest and southeast of the refurbished boat launch.

There were several lessons learned during 2018 from which a number of recommendations were made for future revegetation work, including 2019. These included addressing problems related to access and high water levels, planning for machine at all treatment areas owing to compact soils, developing methods for working with dry soils and for locating and storing cuttings, modifying appearance of planted areas through stake spacing patterns, working with cemented and anoxic soil conditions, and relocation or reclassification of treatment polygons owing to unforeseen circumstances.

An updated schedule, budget, and workplan are provided for treatment implementation and as-built surveys to be conducted in 2019. Given that 2018 was the first year of treatment implementation, effectiveness monitoring will begin in 2019. Effectiveness monitoring will be conducted by assessing conditions in treated areas in relation to baseline (pre-treatment) and as-built (post-treatment) data.

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1. INTRODUCTION

As the Campbell River Water Use Planning (WUP) process reached completion in 2012, several concerns remained with respect to the effects of BC Hydro operations on the substrates and vegetation within the reservoir drawdown zone. Among these was the erosion and destabilization of shoreline vegetation of the Upper Campbell Reservoir, caused by operational changes in water level and accompanying wind and wave action (BC Hydro 2016). Between 1996 and 2004, the Upper Campbell Reservoir operated under a higher than normal annual water budget which caused the removal of substrate and vegetation from a 0.5 m band of shoreline around the reservoir (~ 440 ha). However, since 2004, reservoir operations have returned to lower summer water levels and these exposed shoreline areas have been exposed. Given the resultant visual impacts, the WUP Consultative Committee identified the need to improve the aesthetic quality of the exposed shoreline in locations visible from high-use recreation areas. Consequently, the Comptroller of Water Rights issued a *Water Act* Order that required a terms-of-reference be written to "identify, prioritize and revegetate highly visible reservoir perimeter sites within the drawdown zone". To address these priorities, the Upper Campbell Reservoir Drawdown Zone Revegetation Program (JHTWORKS-3) was initiated.

JHTWORKS-3 is a 10-year program with the primary goal of improving the visual quality and riparian habitat values of high profile reservoir shoreline areas of the Upper Campbell Reservoir impacted by fluctuating water levels. Accomplishment of this goal requires that the natural recolonization of native vegetation communities in the upper drawdown zone of the Upper Campbell Reservoir is actively enhanced (BC Hydro 2016). Additional benefits of this Program are improved Indigenous resource values, wildlife habitat, and a likely increase in shoreline stability. Both Year 1 and Year 2 of JHTWORKS-3 has been implemented by Laich-Kwil-Tach (LKT) with support from Ecofish Research Ltd. (Ecofish).

JHTWORKS-3 has three phases that will be implemented over the 10-year period: 1) identification/prioritization of sites for revegetation treatment trials (Year 1); 2) planning, trial implementation, and monitoring of revegetation treatment trials (Years 2-6); and 3) implementation of the final Revegetation Treatment Plan at additional sites around the reservoir (Years 7-10). In Phase 1, highly visible reservoir perimeter sites within high recreational use areas, that have high potential for revegetation and natural recolonization success, were identified for revegetation treatment. Information on these treatment sites and associated treatment prescriptions are presented in the Year 1 report (Ballin *et al.* 2018). An effectiveness monitoring plan was also developed that outlines the means by which the success of revegetation treatments will be evaluated.

The objectives of this report are to present the accomplishments of the first year of Phase 2 of the program (2018), which is the first year of the implementation of the vegetation trial treatments, and to discuss important lessons learned that will be incorporated into future revegetation implementation work. This report contains descriptions of the treatments implemented in 2018, including changes made to the original trial prescriptions presented in the Year 1 report (Ballin *et al.* 2018), results of the as-built surveys conducted following treatment, and updated budget

and schedule information. Recommendations for trial implementations for 2019 are included within this report and its appendices. The baseline data collection and effectiveness monitoring plan that will be used to evaluate revegetation success is also included as an appendix; however, the first year of the effectiveness monitoring program will not start until Year 2 of Phase 2 (the year following initial treatment implementations).

2. BACKGROUND

Eight revegetation sites were identified for treatment in the Year 1 report (Ballin *et al.* 2018) (Table 1, Map 1). These were classified into four distinct types (labelled A through D; referred to as 'treatment types'), which differ by elevation relative to reservoir operations, slope, substrate, and other environmental factors that affect the optimal types of revegetation treatments that could be implemented (described in Table 2). Specific treatment prescriptions were also identified in the Year 1 report for each treatment site (see Table 3 and Tables 8 through 11 in Ballin *et al.* (2018) for details on revegetation treatment prescriptions), and control treatment types were included in which no treatment will be implemented to support the effectiveness monitoring program. In total, 49 treatment areas (equivalent to, and used interchangeably with, mapped "polygons"), including controls, were identified within the eight treatment sites (two to 14 treatment areas per site), and a minimum of one permanent monitoring plot was established within each area. To allow for tracking of data as needed for future effectiveness analysis, the treatment prescription labels were linked to a specific treatment area for each site and therefore serve two functions: 1) they specify the types of treatments that were implemented in the area; and 2) they uniquely identify each treatment area. Because each treatment area also contains at least one permanent monitoring plot (considered representative of that treatment area), permanent monitoring plot identifiers also are unique to specific treated areas. Baseline data were collected, and effectiveness of revegetation treatments will be monitored, in these treatment areas by characterizing vegetation within monitoring plots and treatment areas as per the baseline data collection and effectiveness monitoring plan (provided in Appendix A). Baseline data collected in 2017 are presented in Appendix F of the Year 1 report (Ballin *et al.* 2018).

The work conducted in 2018 represents the first year of Phase 2 of the JHTWORKS3 program, which is the implementation of revegetation treatment trials at a subset of treatment sites and monitoring of these treatment trials. Treatment sites and areas within sites selected for revegetation work in 2018 were chosen to maximize efficiency for machine access (e.g., coordinating with work that was already occurring in the area in 2018) and to gain as much practical information as possible to help guide future revegetation efforts and adapt the treatment prescriptions as necessary for optimal performance. Revegetation work was conducted at three treatment sites in 2018 (JHT-RV02, JHT-RV03, and JHT-RV06; Table 1). These treatment sites and the treatment areas within them are mapped, and the restoration treatments and ecological site conditions are described, on the site profile maps in Appendix B.

Table 1. **Sites selected for revegetation trials (reproduced from Ballin *et al.* (2018)). Revegetation work was conducted at JHT-RV02, JHT-RV03, and JHT-RV06 in 2018.**

Site Name	Revegetation Site
JHT-RV02	Old Buttle Lake Boat Launch
JHT-RV03	Buttle Lake Campground
JHT-RV04	Rainbow Island Marine Campsite
JHT-RV05	Driftwood Bay Group Site
JHT-RV06	Buttle Lake Boat Launch
JHT-RV07	Buttle Lake Campground Fan
JHT-RV08	Karst Creek Boat Launch
JHT-RV09	Ralph River Campground

Table 2. Physical and ecological description of the four treatment types (reproduced from Ballin *et al.* (2018)).

Label	Treatment Type	Description
A	Low slope or alluvial fan	These areas have slopes under 5% and occupy alluvial fans or shallow bays. They are typically well vegetated with herbaceous species at lower elevations (i.e., below 219 m), and with taller shrubs and trees at progressively higher elevations. The primary objective for revegetation of these areas is increasing visibility of lower elevation shallow areas and stumps to reduce the hazard for boaters. This treatment type supports all of the vegetation communities listed in Ballin *et al.* 2018; however, the target area for revegetation is occupied by the lowest two communities - 'spearwort lakeflat' and 'hairgrass - water sedge', as well as the mudflats that occupy lower elevations than these two communities.
B	Moderate slope drawdown	These areas have slopes under 15%. They are typically sparsely vegetated with patches of herbs and patches of deciduous shrubs. This treatment type occupies elevations suitable for the 'tall and short Sitka willow - water sedge' deciduous shrub communities (i.e., 217.8+ m) as well as the upper extent of the drawdown zone that may be capable of succeeding into terrestrial vegetation communities. The primary objective for revegetation is increasing the shrub cover to improve visual quality and riparian habitat, and support vegetation succession, where possible.
C	Steep upper drawdown	These areas have slopes over 15%. They are typically not vegetated to very sparsely vegetated with deciduous shrubs. This treatment type occupies elevations suitable for the 'tall and short Sitka willow - water sedge' deciduous shrub communities (i.e., 217.8+ m) as well as the upper extent of the drawdown zone that may be capable of succeeding into terrestrial vegetation communities. The primary objective for revegetation is increasing the shrub cover to improve visual quality and riparian habitat, and support vegetation succession, where possible.
D	Steep upland forest	These areas have slopes over 45% and are in a perpetual state of erosion. They are typically not vegetated to sparsely vegetated with herbs, low lying shrubs or the odd large Douglas-fir or Pacific dogwood tree that has slid down the slope and remains rooted above. This treatment type occupies elevations above the current and past 'full pool' of the reservoir (i.e., above 221.0 m) and thus are not, nor have ever been inundated by reservoir operations. These elevations are suitable for establishment of 'upland forest' communities. The primary objective for revegetation of these areas is increasing vegetative cover to stabilize the slope, which will help enable vegetation to establish and grow to improve visual quality.

Table 3. Proposed revegetation treatment prescriptions for all applicable treatment trials implemented in 2018. A full list of all treatment prescriptions, along with rationale and risks/challenges, is located in Ballin *et al.* (2018). Some modifications were made in 2018 based on experiences and results (see Section 3 and associated tables).

Treatment #	Treatment Location	Treatment	Existing Substrate	Restoration Treatment Details		
				Site Preparation and Planting Treatment	Plant Species and Size	Source of Material
B-1i	Moderate slope (5-15%) upper drawdown zone, 217.6-221.0 m elevation	Rough and loose. No planting.	Gravel/Sand/ Cobble	Create rough and loose topography and provide erosion protection/ stabilization with addition of woody debris and boulders/cobble (local wood and rock were strewn around site). Embed woody debris as possible. Add leaf litter/mulch as practical (none available). Do not disturb well vegetated portions of site.	None	Woody debris will be from shoreline or imported from pre-identified and approved cutblock or ROW clearing. Cobble will be from disturbed unvegetated areas surrounding the reservoir.
B-1ii	Moderate slope (5-15%) upper drawdown zone, 217.6-221.0 m elevation	Rough and loose with deciduous stakes planted by machine in trenches or hollows. Plant stakes by hand where necessary.	Gravel/Sand/ Cobble	Create rough and loose topography with trenches/terraces for willow and cottonwood stakes, and provide erosion protection with addition of woody debris and cobble. Embed woody debris as possible. Do not disturb well vegetated portions of site. Stake deciduous species by machine. Hand stake areas with decent herbaceous cover or sparse shrub cover as to not disturb existing vegetation. Plant stakes with 50 cm spacing in rows 2 m apart. Add leaf litter/mulch as practical.	Deciduous stakes: Sitka willow and black cottonwood and red-osier dogwood. Machine planted stakes will be 1-2 m in length, hand planted stakes will be 0.65-1.0 m in length.	Woody debris will be from shoreline or imported from pre-identified and approved cutblock or ROW clearing. Cobble will be from disturbed unvegetated areas surrounding the reservoir. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
B-2	Moderate slope (5-15%) upper drawdown zone, 217.6-221.0 m elevation	No site preparation. Stake deciduous species by hand.	Gravel/Sand/ Cobble	No site preparation. Stake deciduous species by hand. Plant stakes with 50 cm spacing in rows 2 m apart.	Sitka willow, black cottonwood and red-osier dogwood. Hand planted stakes will be 0.65-1.0 m in length.	Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
C-1ii	Steep (>15%) upper drawdown zone, 217.6-221.0 m elevation	Willow and cottonwood stakes planted by machine in trenches.	Gravel/Cobble/ Sand	Create slightly rough and loose topography by creating trenches/ terraces for willow and cottonwood stakes, and provide erosion protection with addition of woody debris and boulders/cobble. Stakes will be 1-2 m in length. Plant stakes with 30 cm spacing in rows 2 m apart. Add leaf litter/mulch as practical.	Sitka willow, black cottonwood and red-osier dogwood. Machine planted stakes will be 1-2 m in length, hand planted stakes will be 0.65-1.0 m in length.	Woody debris will be from shoreline or imported from pre-identified and approved cutblock or ROW clearing. Cobble will be from disturbed unvegetated areas surrounding the reservoir. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
C-2	Steep (>15%) upper drawdown zone, 217.6-221.0 m elevation	No site preparation. Stake deciduous species by hand.	Gravel/Cobble/ Sand	No site preparation. Stake deciduous species by hand. Plant stakes with 30 cm spacing in rows 2 m apart.	Sitka willow, black cottonwood and red-osier dogwood. Hand planted stakes will be 0.65-1.0 m in length.	Woody debris will be from shoreline or imported from pre-identified and approved cutblock or ROW clearing. Cobble will be from disturbed unvegetated areas surrounding the reservoir. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
D-2	Steep (40%+) eroded upland forest slopes, 220.5 m+ elevation with ~zonal forest soils with LFH and A layer absent	Cottonwood stakes planted by hand.	Sand/Mineral Soil	Prepare ground for individual stakes as necessary; stakes will be 0.3-0.7 m in length, spaced every 20 cm.	Black cottonwood	Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.
D-3	Steep (40%+) eroded upland forest slopes, 220.5 m+ elevation with ~zonal forest soils with LFH and A layer absent	Stabilize bottom of slope with logs and boulders. Plant with individual forest plants and cottonwood stakes.	Sand/Mineral Soil	Move logs tight against base of slope and backfill soil. Place 1 log vertically/ parallel to slope every 2 m. Prepare microsites for planting upslope of the logs by loosening soil in pockets. Plant with transplanted forest species, if available. Add leaf litter/mulch as practical. Plant with 70 cm spacing in hollows.	Deciduous stakes: black cottonwood. Forest species may include: Pacific dogwood, shore pine, Douglas-fir.	Coarse wood will be collected from nearby shoreline accumulations or associated with forestry operations. Forest species will be harvested by project crew from pre-identified and approved near-by areas. This may include salvage from WORKS-2 or other maintenance or upgrade projects. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.

ROW = Right-of-way
LFH = Litter/Fermented/Humic

3. ACCOMPLISHMENTS IN 2018

Revegetation work was implemented between October and December at three treatment sites in 2018: JHT-RV02 (Old Buttle Boat Ramp), JHT-RV03 (Buttle Lake Campground), and JHT-RV06 (Buttle Lake Boat Launch) (Map 1, Appendix B). Cuttings (stakes) were taken from the Buttle Lake shoreline, Highway 28 right-of-way, and local logging roads beginning in late October once the leaves had turned and the plants were dormant. Stakes were cut for each site just before they were to be planted to increase viability. Treatment trials were implemented as per prescriptions in the Year 1 report; however, in some cases modifications were needed based on site conditions and other factors. When modifications were made, new treatment labels were provided (e.g., modified C-2 labelled C-2i). Careful tracking of treatment modifications through the identification of new treatment labels (associated with individual treatment areas/polygons) will maintain a clear association between treatment labels and treatments implemented, thereby allowing revegetation success to be evaluated within and between years. A summary of treatments added during 2018 is presented in Table 4 (rationale for modifications are provided in the sections below).

Data collected in 2018 included baseline data, collected prior to treatment implementation, for one site (JHT-RV03), and as-built data following implementation of treatments for all polygons treated in 2018. Although baseline data were collected for all sites in 2017, site JHT-RV03 was moved in 2018 from its originally intended location (see Section 3.2); thus baseline data were collected for the new location prior to treatment in 2018 (presented in Appendix C). As-built data were collected after the treatments were implemented for all three sites by December 6, 2018 and details are provided in Appendix C. Baseline and as-built data were collected as per the baseline data collection and effectiveness monitoring plan (Appendix A). The work implemented is described and results of as-built surveys are summarized (area planted, species and numbers of stakes) for each site at which treatments were implemented in 2018 in the sections below.

Table 4. New treatment prescriptions developed during 2018 (modified from planned treatments).

Treatment #	Modified From	Treatment Location	Treatment	Existing Substrate	Restoration Treatment Details			Rationale	Risks/Challenges
					Site Preparation and Planting Treatment	Plant Species and Size	Source of Material		
B-2i	B-2	Moderate slope (5-15%) upper drawdown zone, 217.6-221.0 m elevation	Machine loosen circles and stake deciduous species by hand.	Gravel/Sand/ Cobble, cemented or hard packed ground	Machine loosen circles (0.8 m deep x 1 m diameter) spaced every 2 m. Stake deciduous species by hand in craters, spaced at 0.5 m, 5 to a crater.	Sitka willow, black cottonwood and red-osier dogwood. Hand planted stakes will be 0.65-1.0 m in length.	Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.	Woody debris may help to stabilize the substrate and create microhabitats of finer sediments and protected areas where plants can establish and survive. Woody debris will also decay and provide nutrients and moisture retention functions. Staking provides deciduous vegetation an opportunity to establish in an environment that is challenging. Moreover, revegetation can be accelerated by planting species with rhizomatous and/or adventitious root structures.	Securing woody debris and cobble. Collection and staging of transplants and leaf litter. Securing transplants and substrate from erosion. Machine access and timing for appropriate reservoir elevation.
C-2i	C-2	Steep (>15%) upper drawdown zone, 217.6-221.0 m elevation	Machine loosen circles and stake with deciduous species	Gravel/Cobble/ Sand	Machine loosen circles (0.8 m deep x 1 m diameter) spaced every 2 m. Stake deciduous species by hand in craters, spaced at 0.5 m, 5 to a crater. Alternate method is loosening soil in lines every 2 m up the slope and staking every 0.3 m.	Machine loosen circles (0.8 m deep x 1 m diameter) and space every 2 m. Stake deciduous species by hand in craters, spaced at 0.5 m, 5 to a crater. Sitka willow, black cottonwood and red-osier dogwood. Hand planted stakes will be 0.65-1.0 m in length.	Woody debris will be from shoreline or imported from pre-identified and approved cutblock or ROW clearing. Cobble will be from disturbed unvegetated areas surrounding the reservoir. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.	Less ground disturbance and thus reduce potential substrate erosion from reservoir operations. Stakes may grow better in loosened soil and hollows will collect more organics and water.	Machine access and timing for appropriate reservoir elevation. Securing woody debris and cobble. Locating willow donor sites and trees of sufficient size. It may be challenging to install stakes due to compact substrates.
D-2i	D-2	Steep (40%+) eroded upland forest slopes, 220.5 m+ elevation with ~zonal forest soils with LFH and A layer absent	Machine loosen circles. Stake with deciduous species planted by hand.	Sand/Mineral Soil, cemented or hard packed.	Machine loosen circles (0.8 m deep x 1m diameter) spaced every 2 m. Stake deciduous species by hand in craters, spaced at 0.5 m, 5 to a crater. Sitka willow, black cottonwood and red-osier dogwood. Hand planted stakes will be 0.3-0.7 m in length.	Black cottonwood	Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.	Stabilize slopes with fast growing, drought tolerant species that are rhizomatous.	Locating cottonwood donor sites. Some sites are very hot and dry which will limit survival of stakes. These slopes are at an angle that is continuing to erode. The stakes may erode away, especially if they do not have enough moisture to properly establish.
D-3i	D-3	Steep (40%+) eroded upland forest slopes, 220.5 m+ elevation with ~zonal forest soils with LFH and A layer absent	Stabilize bottom of slope with logs and boulders. Loosen soil in pockets and plant with individual forest plants and cottonwood stakes.	Sand/Mineral Soil, cemented or hard packed.	Move logs tight against base of slope and backfill soil. Place 1 log vertically/ parallel to slope every 2 m. Prepare microsites for planting upslope of the logs by loosening soil in pockets. Plant with transplanted forest species, if available. Add leaf litter/mulch as practical. Plant with 70 cm spacing in hollows.	Deciduous stakes: black cottonwood. Forest species may include: Pacific dogwood, shore pine, Douglas-fir.	Coarse wood will be collected from nearby shoreline accumulations or associated with forestry operations. Forest species will be harvested by project crew from pre-identified and approved near-by areas. This may include salvage from WORKS-2 or other maintenance or upgrade projects. Dormant stakes will be harvested by project crew from donor sites in the days preceding planting.	Stabilizing substrate will allow plants time to seed and take root. Plant with local transplants to enhance soil mycorrhizae, other biota and nutrients from forest soils as well as provide competition to invasive species that may rapidly colonize the area. Plant stakes to introduce fast growing tall vegetation that will provide shade to other transplants while improving aesthetics of the eroded slopes. Plant nitrogen fixing trees (e.g. Douglas-fir, red alder) to enhance soil, to improve the microhabitat and compete with invasive species.	Obtaining logs. Collection and staging of transplants. Locating willow and cottonwood donor sites and trees of sufficient size. Even with stabilization from logs, some sites may still be too hot and dry to support vegetation and erosion is likely to remain a strong force until the angle of repose is reached.

ROW = Right-of-way
LFH = Litter/Fermented/Humic

3.1. Old Buttle Lake Boat Launch (JHT-RV02)

The Old Buttle Lake Boat Launch treatment site (JHT-RV02) is in a bay with vegetated islets that is part of the Buttle Lake Campground area. The site varies in elevation, topography, slope, and exposure, and multiple treatment prescriptions have been identified for the polygons in this site including treatments for moderate and steep slopes in the drawdown zone (Appendix B).

The island treatment areas of JHT-RV02 were inaccessible during revegetation works in 2018 due to high water levels; thus, two treatments were implemented on the moderate (B-1i) and steep (C-1ii) slope polygons and associated lower gradient benches in the upper drawdown zone. The substrates on these slopes are dominated by small and large gravels and seepage is present (Table 3 of Appendix D). Relic terrestrial mineral soils persist under the graveled surface as well as at the top of the site at the edge between the drawdown zone and the terrestrial environment. The area identified for a control treatment (C-3) was relocated to the west of the old boat launch and is now a suitable control for both JHT-RV02 and JHT-RV03 (see Section 3.2).

The two treatment prescriptions implemented were:

- B-1i. The substrate was made rough and loose, to create suitable microsites for plant growth and enable seeds to establish before water levels rise, and was left to seed naturally (Figure 1). No stakes were planted (Table 5).
- C-1ii. The substrate was made rough and loose (with a 1 m to 1.5 m amplitude between top of mound and bottom of hole) and hollows were planted with stakes of native vegetation collected by A'Tlegay crews (Figure 2). Planting bars were used to make holes and soil was packed around the stakes. Based on feedback from BC Parks regarding revegetation works at JHT-RV06 (see Section 3.2), the stakes were not planted in rows, but were installed randomly to provide a more natural appearance. Overall 348 stakes were planted including Sitka willow (*Salix sitchensis*), black cottonwood (*Populus balsamifera ssp. trichocarpa*), and red-osier dogwood (*Cornus stolonifera*) (Table 5). The soil at this site had more fine silt and clay and less sand and rock than the other sites.

A number of alterations were made to the original plan owing to access issues and feedback received. In addition to altering the pattern in which stakes were planted, no forest mulch was available (mulch had been anticipated from trail construction at JHT-RV03 which did not proceed in 2018); thus local woody debris (stumps; decay stage 1-2) from a cutblock near Upper Campbell reservoir was placed across the sites near the high water line to help retain and stabilize the substrate. Rock sourced locally was placed along the low water line and materials were stockpiled at the boat launch prior to construction.

Table 5. Size of areas treated in 2018 in JHT-RV02, and number and species of stakes planted within treated areas. Permanent monitoring plots within treatment areas are identified for reference.

Site	Treatment Area	Area (m^2)	Permanent Monitoring Plot	Species Planted[1]			
				black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red-osier dogwood (*Cornus stolonifera*)	Sitka willow (*Salix sitchensis*)	*All species combined*
JHT-RV02 (Old Buttle Boat Ramp)	B-1i	714	JHT-PRM09	0	0	0	*0*
	C-1ii	514	JHT-PRM07/ JHT-PRM08	34	28	320	*382*

[1] Sitka willow is well adapted to local site conditions and is the primary species available at donor sites adjacent to treatment trial areas. Willow is more tolerant to flooding than black cottonwood and red-osier dogwood; although we have also planted some of these species at each site as well.

Figure 1. Machine loosened substrate in B-1i polygon at JHT-RV02 on November 09, 2018.

Figure 2. Machine loosened substrate staked with native vegetation in C-1ii polygon at JHT-RV02 on November 28, 2018.

3.2. Buttle Lake Campground (JHT-RV03)

The Buttle Lake Campground treatment site (JHT-RV03) is located within the high-use Buttle Lake Campground. Treatment polygons are located on steeper shoreline adjacent to a beach that is built up from imported sand.

Three treatment prescriptions were implemented in steep upper drawdown polygons (C-1ii, C-2i) and steep upland forest (D-2i, D-3i) in JHT-RV03 in 2018. Although original treatment areas were situated along the new proposed route for Buttle Lake Campground trail (which was expected to be under construction in 2018), based on feedback by BC Parks, the treatment areas were moved northwest around the point toward the old boat launch to avoid conflicts with a proposed viewing area and potential interference with future trail construction. However, substrate and topographical characteristics of the new areas did not significantly change, with the exception of aspect, and thus neither did treatment types. Nevertheless, except for C-1ii, the specific treatments were modified from that originally proposed due to site conditions and vegetation availability, as described below. A control area (C-3; Table 6) was established adjacent to the old boat launch (also associated with JHT-RV02; see Section 3.1) where the aspect is representative of the site and foot traffic is relatively low. The treatment prescriptions implemented were:

- C-1ii. This site was covered by a layer of cemented sand (sand bonded together likely by oxidation); thus the rough and loose site preparation prescribed for this treatment was

modified by planting stakes in holes dug in a grid pattern and leaving the surrounding cemented sand in place to resist erosion (Figure 3). This created loose pockets to allow rooting and collection of organics and water, and a variable microtopography. Trenching was conducted along the base of the slope to allow planting of some tall stakes (1 m long) in this location. This was intended to allow future capturing of potential eroding sediments; would increase the potential for local seed collection; and would create a barrier for potential wave action. Shorter (60 to 80 cm) stakes of willow, cottonwood, and red-osier dogwood were also planted by hand (Table 6). Rocks and large woody debris root wads were placed along the high water line to protect the loosened soils and encourage terracing. Root wad placement involved digging a hole and partially burying the root wad and placing rocks on and around the root wad to help hold it in place. Some rock was also placed at the low water line to support terracing and help prevent undermining of the plantings. Additionally, brush layering was installed over a short section of the area, using horizontal 2 m long dried willow cuttings that were available from brushing work at Ralph River (by a film crew), as a substitute for the originally proposed logs, to assist with terracing, dissipate wave energy, and contribute to organics over time.

- C-2i/D-2i. The treatment areas targeted for C-2 (hand staking, no site preparation) and D-2 (hand staking, no site preparation) were reassigned to C-2i and D-2i respectively because hard-pack soil conditions were encountered and some site preparation was required. Thus, the originally intended hand-staking technique was modified to hand planting stakes (Table 6) within excavator-loosened circles (1 m diameter craters), spaced at 2 m intervals to facilitate planting (Figure 4).
- D-3i. The treatment area targeted for D-3 (stabilize bottom of slope and plant forest plants) was modified to a D-3i because the soil conditions were hard-packed and forest plants were not available at the time. Stakes (Table 6) were planted into the upland polygon where the site was prepared through a modified rough and loose treatment within which rocks and root wads were incorporated to stabilize the slope and create terraces (Figure 5). Stakes were planted in loosened pockets of substrate and a hardened grid of cemented sand was left in place to support the slope and resist erosion.

Table 6. **Size of areas (three treatment prescriptions and one control) treated or established in 2018 in JHT-RV03, and number and species of stakes planted within treated areas. Permanent monitoring plots within areas are identified for reference.**

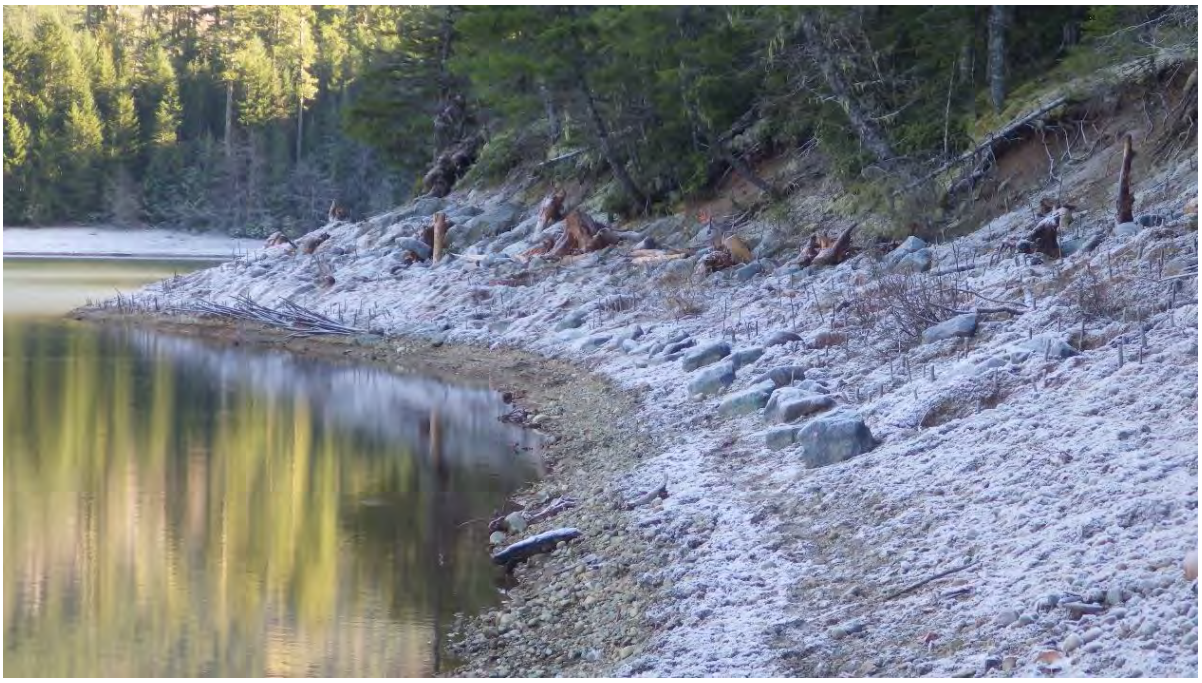
Site	Treatment Area	Area (m^2)	Permanent Monitoring Plot	Species Planted[1]			
				black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red-osier dogwood (*Cornus stolonifera*)	Sitka willow (*Salix sitchensis*)	*All species combined*
JHT-RV03 (Buttle Lake Campground)	C-1ii	216	JHT-PRM53	38	14	342	*394*
	C-2i	196	JHT-PRM51	36	34	386	*456*
	C-3[1]	332	JHT-PRM57	0	0	0	*0*
	D-2i	101	JHT-PRM52	20	8	128	*156*
	D-3i	179	JHT-PRM54	100	0	80	*180*

[1] Sitka willow is well adapted to local site conditions and is the primary species available at donor sites adjacent to treatment trial areas. Willow is more tolerant to flooding than black cottonwood and red-osier dogwood; although we have also planted some of these species at each site as well.

Figure 3. **Two-metre long stakes placed in angled brush layer (far left) and 1-meter long stakes planted in the remaining trench at the toe of the slope in C-1ii polygon at JHT-RV03 on November 28, 2018. Shorter 60-80 cm stakes were planted in loosened soil in hollows (front right) created in a grid of hardened sand.**

Figure 4. **Stakes planted in machine loosened circles in C-2i and D-2i polygons at JHT-RV03, on December 6, 2018.**

Figure 5. **Stakes planted in machine made rough and loose treatment with distributed boulders and coarse wood in D-3i polygon at JHT-RV03 on December 6, 2018.**



3.3. Buttle Lake Boat Launch (JHT-RV06)

The Buttle Lake Boat Launch treatment site (JHT-RV06) has gravel beaches located adjacent to the paved boat launch and contains an island that has variable vegetation. A variety of treatments have been prescribed for the polygons in this site; however, the identification of archaeological sites required alterations to the original plan. This site was selected for treatment in 2018 to maximize efficiency because the Buttle Lake Boat Launch reconstruction was in progress in 2018 and an excavator was therefore on site that could be used for revegetation work.

Three treatment prescriptions were implemented at the Buttle Lake Boat Launch treatment site (JHT-RV06) in moderate to steep upper drawdown polygons (C-1ii, C-2i) and moderate slope in the drawdown zone (B-2i) in 2018. Two control areas have been established to the northwest and southeast of the boat launch to represent moderate slopes (B-3) and steep slopes (C-3) in the upper drawdown zone. The three treatment prescriptions implemented were:

- B-2i. Similar to areas targeted for C-2 treatment, the soil in the area targeted for B-2 treatment was too compact for hand planting without site preparation. As such, the originally intended hand-staking technique was modified to a localized rough and loose treatment (B-2i) (Figure 6). Stakes of Sitka willow and red-osier dogwood (Table 7) were hand planted into the loosened substrate at 2 m intervals within excavator-loosened circles (1 m diameter craters loosened 80 cm deep) (Figure 7). Stakes were planted within these circles in a random pattern to create a natural look.

- C-1ii. Substrate was loosened down 60-80 cm using an excavator in unvegetated areas. A 1 m deep trench was excavated just above 217.8 m of elevation for the installation of stakes, which were then pounded in. Subsequent trenches were created 2 to 3 m apart higher up the beach parallel to the first trench within which the substrate was loosened to help with terracing and for hand staking with 60 to 80 cm stakes (Figure 8). Large root wads and rock were partially buried near the toe of the eroding bank at (or just below high water to provide some protection from wave action, create a more stable terrace with reduced bank slope, and to catch sediment off the eroding bank (Table 7).

- C-2i. The areas targeted for C-2 treatment (no site preparation) were reassigned to a modified C-2i because issues were encountered with hand planting due to the rocky ground and cemented soils. Thus, an excavator was used to loosen soil in trenches, spaced at 2 to 3 m apart up the slope, within which stakes were planted by hand (Table 7, Figure 9).

Table 7. **Size of areas (three treatment and one control) treated or established in 2018 in JHT-RV06, and number and species of stakes planted within treated areas. Permanent monitoring plots within treatment areas are identified for reference.**

Site	Treatment Area	Area (m^2)	Permanent Monitoring Plot	Species Planted			
				black cottonwood (*Populus balsamifera ssp. trichocarpa*)	red-osier dogwood (*Cornus stolonifera*)	Sitka willow (*Salix sitchensis*)	*All species combined*
JHT-RV06 (Buttle Lake Boat Launch)	B-2i	926	JHT-PRM50	0	220	294	*514*
	B-3[1]	1321	JHT-PRM56	0	0	0	*0*
	C-1ii	985	JHT-PRM22	105	85	555	*745*
	C-2i	1185	JHT-PRM21	81	340	81	*502*
	C-3[1]	853	JHT-PRM23	0	0	0	*0*

[1] Control; no treatment implemented.

Figure 6. **Polygon originally targeted for B-2 treatment that was changed to B-2i treatment at JHT-RV06 on October 31, 2018.**

Figure 7. **Localized machine loosening and hand planting of stakes in polygon B-2i at JHT-RV06 on November 6, 2018.**

Figure 8. **Treated C-1ii polygon at JHT-RV06 on November 21, 2018.**

Figure 9. Trenches loosened and stakes planted by hand in polygon C-2i at JHT-RV06 on November 21, 2018.

4. LESSONS LEARNED

There were several lessons learned during 2018 that may be applicable to future revegetation work:

- Challenging site access causes complications and inefficiency. Access was more challenging than anticipated at JHT-RV02 (in part due to high water levels during treatment implementation), which had the potential to impact the shoreline and existing vegetation. In order to reduce such impacts, it was necessary to minimize the number of trips that were made by machine and this created the need to incorporate more local material than had been originally planned (e.g., rock sourced locally). Thus, it is important to evaluate access problems not only with respect to the logistics/efficiency of completion of the planned work, but also in relation to key field components (machine use) and resources (e.g., source of materials) needed.

- High water levels impact work effectiveness and access. Machine operation was challenging at JHT-RV03 because the shoreline topography was steep and the machine was not able to position itself at the toe of the slope owing to high water levels. High water levels also affected access to site by trucks and all materials had to be shuttled by the excavator over multiple loads. At JHT-RV02 and JHT-RV03, some of the sites would have been easier to access in lower water in October before fall rains significantly increased reservoir levels. By December, the lower cuttings were under water. It will be important in future to consider and evaluate

the difficulties and potential losses in efficiency that sub-optimal/abnormal water levels may cause and to plan the timing of work accordingly.

- Treatments that prescribe no site preparation (e.g., C-2) can be difficult to implement. The ability to implement treatments that prescribe no site preparation are conditional on substrate conditions and it may not always be possible to evaluate the compactness of the substrate until treatment implementation is under way. Thus, contingency planning (e.g., machine availability) may be needed for such treatment prescriptions. Given experiences so far, it will likely be beneficial to plan to machine loosen all planting sites and use a planting bar to install stakes to minimize stake damage such as splitting and shredding of the tops.

- The dryness of soil conditions affects planting efficiency and potentially plant viability. Using the planting bar was less effective in dry, loosened soil than after a rain because holes made in dry, loose soil infill immediately. Adding some water to the soil with a pump and hose may be one way to facilitate the process and also to enhance rooting and survival. Soil dryness was less of an issue in the finer textured soil at JHT-RV02.

- Storage of cuttings extends/enhances viability. Soaking and storing the cuttings in a large fish tote filled with water or tied up in the reservoir was effective for enhancing viability (keeps them viable for ~ one week) and helps to prepare them for planting.

- Locating cuttings for planting. Cottonwood cuttings were in short supply thus more planning may be required to locate sources for the next planting season. Clear cuts are a good potential source of cuttings, as is the road right of way between Campbell River and Upper Campbell Reservoir. Saplings found in these areas can be easy to spot in late October and early November when the leaves are changing colour.

- Stakes planted in rows created an unnatural look. Stakes had been planted in rows at JHT-RV06 because it is more efficient for machines to dig trenches within which stakes can be installed in rows and to assist in terracing; however, feedback was received from BC Parks that this created an unnatural look. This initial unnatural look can be improved upon by using a random spacing pattern. This recommendation was implemented at JHT-RV02 (see Section 3.1). However, because the aesthetic benefits are temporary (once stakes begin to grow, they fill out and to original spacing pattern is no longer detectable), the short-term appearance advantages must be weighed against potential inefficiencies in time and effort.

- Unusual soil conditions affect revegetation work and may affect vegetation survival. Due to the cemented sand conditions encountered at most sites (an exception being JHT-RV02 where the soils were fine-textured and softer), hand staking at most locations was not practical or advisable. These cemented soil characteristics may have a deleterious effect on vegetation success. An input of organic matter (with its humic acid) that would change the pH of the soil could potentially reduce precipitation of calcium carbonate, silica dioxide, and/or iron oxide

that may lead to cementation and may therefore help to prevent the hardening process (Polster, pers. comm. 2019). Addition of organic matter, such as mulch products, applied to the surface (at least above highwater) would also be beneficial to the soil in other ways, such as contributing to moisture and nutrient retention. Investigation of a cost effective way to harvest organic soil and duff from road building or other clearing projects is recommended, and this would also provide a seed bank, although there is risk of introducing invasive plants so care must be taken in the selection of donor sites. In spite of such additions, it is, however, possible that the cementing process will continue to occur in the loosened soils which would limit long term rooting success of vegetation. Gaining an understanding of the processes that lead to the cementing of soil would help in development of mitigation and the minimization of this condition in treatment trials over time. The cemented soils were used to advantage in areas of active erosion by providing a grid of hardened soil, which is anticipated to resist erosion, between plantings.

- Placing stakes into anoxic conditions may affect vegetation viability. Although JHTWORKS-3 2018 revegetation work has not yet provided information on viability of stakes planted into anoxic conditions, work in other reservoirs has indicated that anoxic conditions in drawdown zones affect stake viability (Polster, pers. comm. 2018). However, the extent to which plant mortality in such cases is due to soil chemistry and oxidation or flooding is unknown. Based on previous experience, plant viability may be increased if stakes are placed where they are flooded for shorter time periods (with flooding period dependent on the tolerance of the plant species). Reduced flooding can be achieved by creating mounds that extend 0.5 m above high water (Polster, pers. comm. 2018). It is also possible that some plants may start better from seed within drawdown zones where the period of flooding is extensive (creating anoxic conditions), in which case, just creating the rough and loose substrate may be enough to expedite revegetation. Investigation of the reasons for viability impacts in anoxic conditions would help to develop appropriate mitigation, such as identifying a planting elevation threshold (where flooding time and magnitude is reduced) or creating mounds that extend above high water.

- Identified and classified treatment areas may require relocation/reclassification through unforeseen circumstances. As emphasized in the Year 1 report (Ballin *et al.* 2018), the revegetation treatment plan is a living document and adaptive modification for reasons of efficiency and effectiveness are embraced. This includes modifications required due to unforeseen circumstances. An example of an unexpected alteration in approach that led to the required reclassification of a treatment area was encountered at JHT-RV02. Due to a change in access approach, a control area in the original plan became located along the machine access route to another treatment area, which made it unsuitable given the significant disruption it would have received. It was originally thought the other area could be accessed through an old deactivated roadway; however, vegetation growth had become so well established that accessing the location along the water edge had less impact. The plan was altered so that other

existing control area located on the island and to the west of the old boat launch would be used to monitor long-term results.

5. BUDGET AND SCHEDULE SUMMARY

The spring 2019 treatment trials are scheduled to start on March 18th and are anticipated to take four weeks. The fall trails are scheduled for October 2019. The as-built surveys will be conducted immediately following completion of the treatment trials.

Table 8. JHTWORKS-3 Phase 2 Budget 2018.

Component	Task		Invoiced in 2018
Administration (LKT)	Administration Fee - LKT	$	12,075.76
Administration (LKT) Total		*$*	*12,075.76*
Project Management (Ecofish)	Project Initiation and Tracking - ERL	$	9,905.61
Project Management (Ecofish) Total		*$*	*9,905.61*
Phase 2 (Ecofish)	Treatment Trial Permitting, CEMP & Safety - ERL	$	7,370.08
	Treatment Trial Planning & Scheduling - ERL	$	5,976.26
	Treatment Trial Implementation - ERL	$	18,518.02
	Baseline & Effectiveness Monitoring - EFL	$	3,711.06
	Annual Monitoring Committee Meeting - ERL	$	3,964.06
	Updated Revegetation Treatment Plan Report - ERL	$	9,237.51
Phase 2 (Ecofish) Total		*$*	*48,776.99*
Phase 2 (A-Tlegay)	Treatment Trial Permitting, CEMP & Safety - AFS	$	2,880.00
	Treatment Trial Planning & Scheduling - AFS	$	2,880.00
	Treatment Trial Implementation - AFS	$	42,965.98
	Baseline & Effectiveness Monitoring - AFS	$	-
	Updated Revegetation Treatment Plan Report - AFS	$	-
Phase 2 (A-Tlegay) Total		*$*	*48,725.98*
Grand Total		**$**	**119,484.34**

6. EFFECTIVENESS MONITORING

Given that 2018 was the first year of treatment implementation, evaluation of revegetation effectiveness, conducted by assessing conditions in treated areas in relation to baseline (pre-treatment) and as-built (post-treatment data), will begin in 2019 using the approach and methods outlined in the baseline data collection and effectiveness monitoring plan (Appendix A).

7. RECOMMENDATIONS FOR REVEGETATION TRIALS FOR YEARS 2 AND 3 OF THE TRIAL PROGRAM (PHASE 2)

Lessons learned during the 2018 implementation of treatment trials have been summarized in this report and will be incorporated into future workplans where relevant. Problems created by high water levels during revegetation works in 2018 included problems related to access, which limited the locations where treatments could be implemented and/or caused logistical problems and inefficiencies. Difficulties in implementation of treatment prescriptions without site preparation (e.g., C-2) were documented for three polygons (at sites JHT-RV03 and JHT-RV06); thus, this may be a relatively common problem for this type of treatment prescription and contingency planning (use of a machine) will likely be needed. Other lessons learned included developing methods for working with dry soils and for locating and storing cuttings, modifying appearance of planted areas through stake spacing patterns, working with cemented and anoxic soil conditions, and relocation or reclassification of treatment polygons owing to unforeseen circumstances. Specific recommendations for future years resulting from these lessons are:

- Evaluate access problems in relation to logistics/efficiency as well as resources (e.g., source of materials) needed;
- Plan the timing of work considering the difficulties and potential losses in efficiency that sub-optimal water levels may cause;
- Plan for machine use at all areas, even those for which no site preparation is prescribed;
- Add water to the soil with a pump and hose in locations where soil is too dry and loose for efficient planting;
- Make use of cutting storage methods developed in 2018 (soak cuttings in tote or in lake);
- Consider clear cuts as potential sources of cuttings, especially in late October and early November;
- Consider both appearance and planting efficiency when determining plant spacing patterns;
- Add organic matter, such as mulch products, to the surface of cemented soils to soften soils and help prevent the hardening process; analysis of soil samples and tracking of soil conditions following the addition of organic matter would improve our understanding of the causes of cemented soil which would, in turn, help in the development of effective mitigation for this condition;
- Investigate a cost effective way to harvest organic soil and duff (for organic matter input to cemented soils) that is free from invasive plant seeds but may contain the seeds of native vegetation suitable for growth in the drawdown zone;

- Identify stakes planted in anoxic conditions and track their survival in relation to soil chemistry and flooding extent and duration; investigation of the reasons for any observed mortality in such conditions which will help to develop appropriate mitigation; and
- Continue to adaptively modify locations and classifications of polygons as needed to maximize efficiency and revegetation effectiveness.

The workplan for 2019 treatment trials, which built on information gained during 2018, is presented in Appendix E. Treatment trials are recommended for six treatment sites in 2019. At some sites, treatments which could not be implemented in 2018 due to high water levels and access problems are proposed to be implemented in 2019. Further, some treatment substitutions are recommended if particular conditions are encountered (e.g., change from C-1ii to C-2 at JHT-RV02 if machine access is not possible), and a new treatment is proposed in one location where machine access has been reassessed (at JHT-RV04). Assessment for additional treatment areas is also recommended for one site (JHT-RV05) where areas for treatment are limited due to the presence of archaeological sites.

Treatment trials will continue to be implemented for the next four years. As discussed in Ballin *et al.* (2018), the majority of treatments will be implemented in the first three years of the trial program. Although long term treatment outcomes cannot be monitored within this time frame, the early monitoring results of these revegetation trial prescriptions will inform trials implemented in the later years of the program so they may be adapted to information gained and lessons learned. Thus, outcomes from both 2018 and 2019 revegetation works, which include experience gained during planting and results from monitoring, will be incorporated into recommendations for future years.

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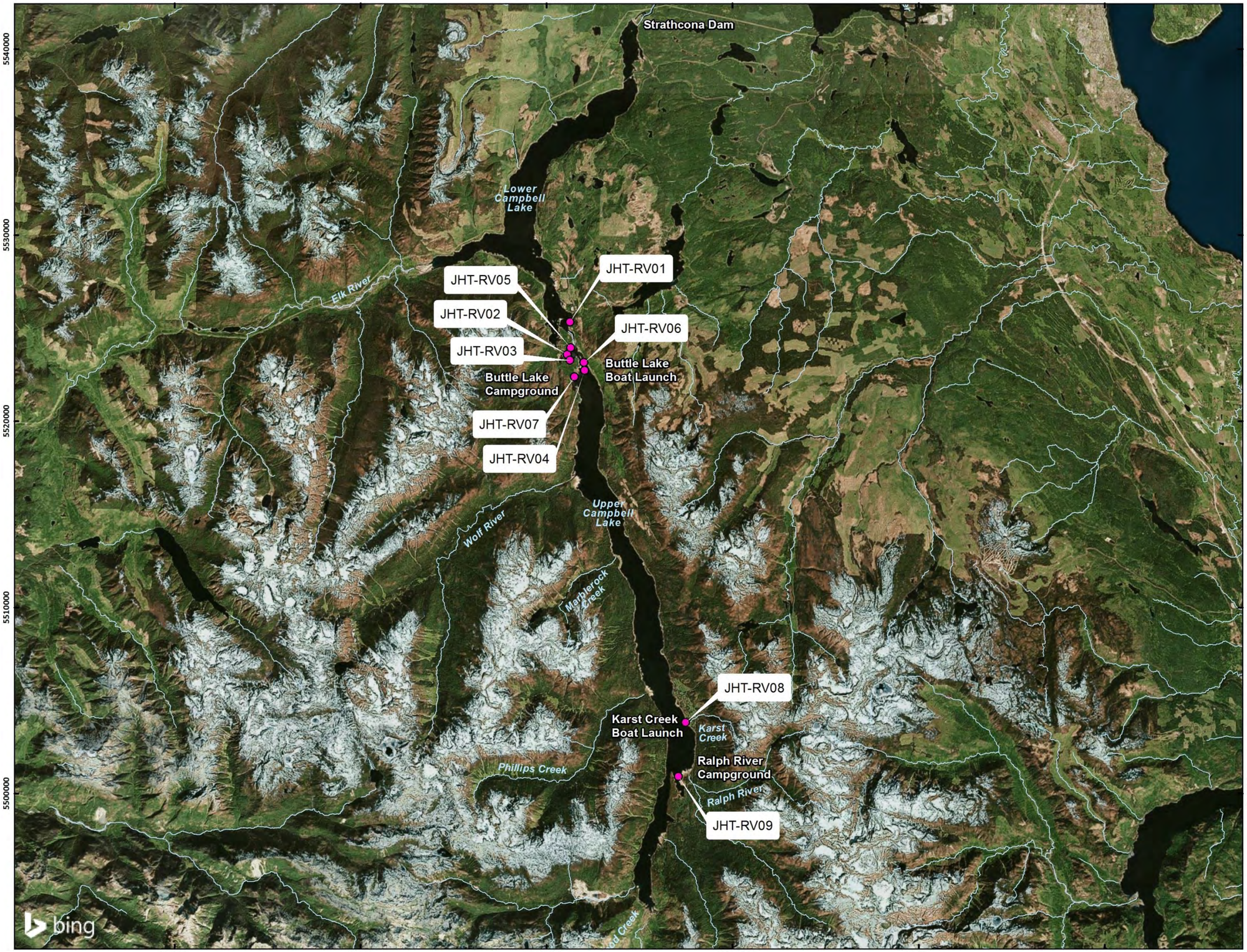
PROJECT MAPS



JHTWORKS-3 Revegetation Trial Sites

Upper Campbell Reservoir Candidate Revegetation Sites

Legend

- Candidate Revegetation Sites
- Stream

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 1 2 4 6 8 10 km

Scale: 1:200,000

NO.	DATE	REVISION	BY
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2			
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5			

Date Saved: 18/07/2017
Coordinate System: NAD 1983 UTM Zone 10N

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Map 1

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APPENDICES

Appendix A. Baseline Data Collection and Effectiveness Monitoring Plan

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MEMORANDUM

TO: **Phil Bradshaw and Jeff Walker, BC Hydro**

FROM: **Leah Ballin, MSFM, R.F.P., R.P.Bio., Deborah Lacroix, M.Sc., R.P.Bio., Matthew Bayly, M.Sc., Mark Sloan, M.Sc., R.F.P., R.P.Bio., Ecofish Research**

DATE: **January 12, 2018**

FILE: **1230-21**

RE: JHTWORKS-3 Upper Campbell Reservoir Drawdown Zone Revegetation Program – Proposed Baseline Data Collection Methods and Effectiveness Monitoring Plan

1. INTRODUCTION

The Identification/Prioritization Phase (Phase 1) of the Upper Campbell Reservoir Drawdown Zone Revegetation Program (JHTWORKS-3) includes three primary goals: (1) the collection of baseline data at proposed revegetation trial sites and surrounding areas to assess the existing conditions, (2) to plan and finalize revegetation trial types, and (3) to assemble the foundational data to monitor the effectiveness of revegetation treatments during the Planning/Trials Phase (Phase 2) of the program. The revegetation treatment areas, including reference sites, were presented, discussed, and selected during the Expert Workshop held on June 19, 2017, and later summarized in the follow-up memorandum (Lacroix and Ballin 2017). During Phase 1 of the program, baseline data is collected in order to understand the environmental condition and setting of each treatment area, including ecological and physical filters, and to identify potential donor sites.

The objective of this memorandum is to present the general approach to baseline data collection, and to describe the detailed data collection approach and data analysis. In future years, the same data collection methods and analytical techniques will be applied to monitor the effectiveness of revegetation treatments, hence allowing a direct comparison of vegetative succession over time in treatment vs. reference areas and an understanding of the effectiveness of treatment prescriptions.

2. GENERAL APPROACH

Data will be collected at two spatial scales: (1) treatment area and (2) plot (e.g., Figure 1). Baseline data will be collected for each treatment area (including reference sites) to provide a description of physical and ecological characteristics representative of the entire area, such as species composition,

percent cover of vegetation and aspect. Treatment area data will include photomonitoring from ground-based points and a drone. Plot data will be collected at selected locations within each treatment area to describe the ecological characteristics that are more specific to a localized area. Plots will be strategically distributed within each treatment area to represent the range of environmental conditions and to capture specific revegetation treatment types, such as planted stump islands or modified brush layers. On sensitive sites, plot data will not be collected to avoid the potential physical harm and/or damage that may be incurred by accessing the plot, for example on steep dry sites. In these cases, only treatment area data will be collected and relied upon, such as photo monitoring.

Baseline data will be collected with the same methods as effectiveness monitoring. Data will be collected during the spring and the fall to capture the beginning and end of the growing season, the effects of the harsher winter and summer climatic conditions, and changing water levels (Table 1). All data parameters will be collected in the fall and standard photopoint monitoring will be collected twice annually, in the spring and fall.

Due to the small size of treatment areas and the diversity of treatment types\ monitoring the success of revegetation treatments at all trial sites will primarily rely on summary statistics and trends/relationships between vegetation density, structure, vigour and composition, environmental characteristics, and visible disturbances.

Figure 1. **Example of treatment area-level and plot-level layout within a revegetation trial area.**

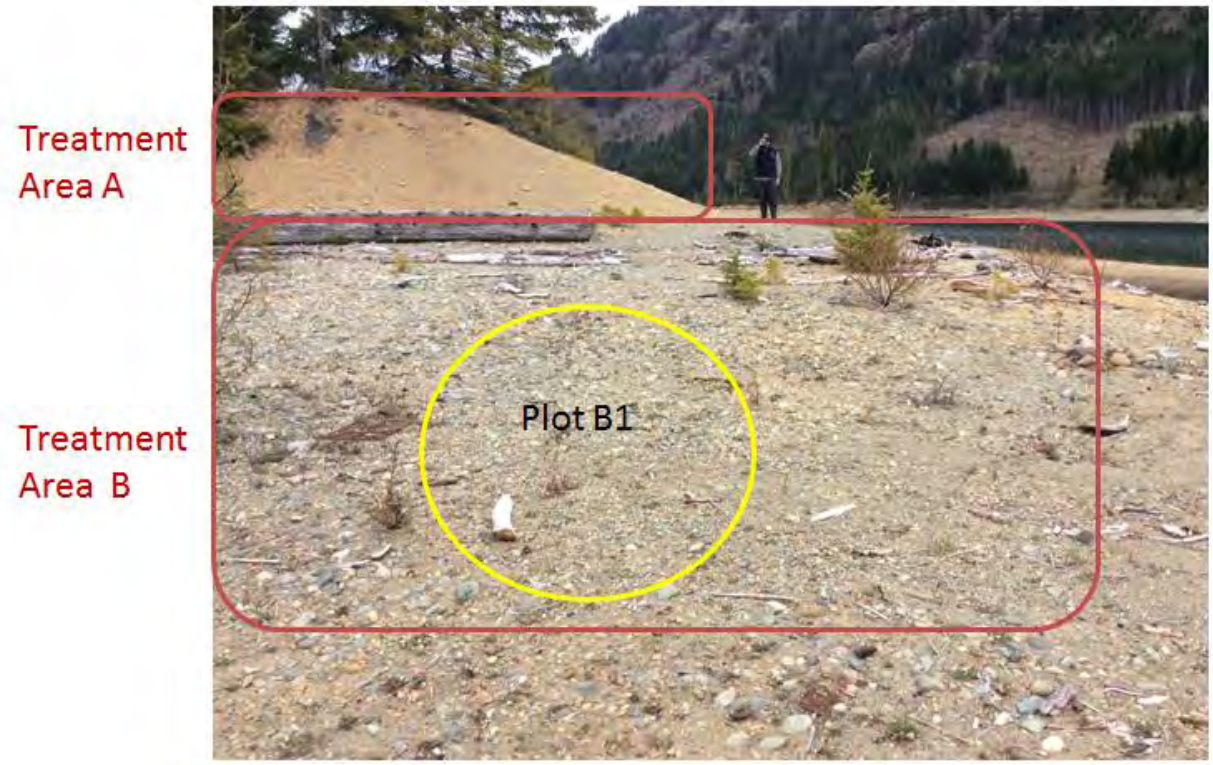

Table 1. **JHTWORKS-3 baseline data collection and effectiveness monitoring schedule during the Identification/Prioritization Phase (Year 1) and Planning/Trial Phase of the program (Years 2 to 6).**

Data type	Monitoring Schedule											
	Identification Phase	Trial Phase										
	Yr 1 (2017)	Yr 2 (2018)		Yr 3 (2019)		Yr 4 (2020)		Yr 5 (2021)		Yr 6 (2022)	
	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Photo monitoring - photopoint	x	x	x	x	x	x	x	x	x	x	x	x
Photo monitoring - drone	x		x		x		x		x		x	
Ecological and Physical Data Collection (Treatment area & Plot)	x		x		x		x		x		x	
Environmental data series	x		x		x		x		x		x	

3. DATA COLLECTION METHODS

3.1. Treatment Area

Field data collection for each treatment area will include photo monitoring (from drone and ground) and the recording of ecological and physical data. Environmental data such as climate and hydrometric data will also be compiled to support the assessment of revegetation success. The same climate and hydrometric datasets will apply to the entire reservoir and thus all treatment areas.

3.1.1. Photo Monitoring

Georeferenced ground-based photo monitoring points and drone imagery will be established and used to provide a repeatable means of qualitatively assessing change in vegetation success and impacts to visual quality.

3.1.1.1. Photopoint

A photo monitoring point will be established at each revegetation trial site that provides an overview of the entire treatment area from the ground. Photographs will be taken at 1.3 m height at a fixed bearing. The azimuth of the photograph from the photo monitoring point towards the treatment area will be recorded as well as the coordinates of the photo monitoring point. Two reference benchmarks will also be established in the field to assist with relocating the photo point and repeating the photographs. The distance and azimuth to these two benchmarks will be recorded. In subsequent years of monitoring, previous years photographs will be taken into the field to ensure repeatability. Once photograph locations are determined, each monitoring site/treatment area will be marked with a caped rebar installed to ensure public safety.

3.1.1.2. Drone imagery

Drone imagery will be collected each year to support qualitative assessment of the vegetative success of each treatment area (e.g. through change in percent cover) and evaluate visual quality. Imagery will be georeferenced and collection methods will be repeated each year to allow for future potential quantitative assessments of vegetation cover, species composition and diversity, and substrate changes.

The drone will be flown at a height of 30 m, which is low enough to allow vegetation to be identified to species. The internal GPS in the drone will be used to georeference the imagery. In addition, distinct natural features will be used to ensure that each year's photographs are georeferenced to exactly the same location and orientation (i.e., correct for geospatial errors, true north consistent).

A colour bar (RGB and BW) will be included in each flight in case image colour calibration is required for future analysis. The elevation of the site will be marked in meter increments on the ground. Elevations will be calculated from the known water surface elevation with a survey station.

All flight registration and safety protocols required by BC Hydro, BC Parks and Transport Canada will be completed and followed.

3.1.2. Ecological and Physical Parameters

Table 2 summarizes the ecological and physical parameters, representing vegetation response, environmental setting and disturbance factors, which will be recorded and collected in the field to assess and evaluate current and future vegetation success and to identify current and future filters. Data collection parameters and methods are based on standard provincial ecosystem description parameters and methodologies (Green and Klinka 1994, RIC 2001, MOF 2010).

3.1.3. Environmental Data Series

Environmental variables such as moisture availability can have a large impact on the effectiveness of treatment prescriptions. Environmental data series will assist in assessing and monitoring trends or anomalies in revegetation success. Climate data will be compiled from Environment Canada representing all treatment areas including but not limited to precipitation and temperature data. In addition, hydrometric data, specifically water level data from the Upper Campbell gauge located at Buttle narrows, will be compiled.

Table 2. Field data collection of ecological and physical parameters for each treatment area.

Data type	Parameter	Field/ Method	Variable or categories	Measure (M) or Estimate (E)	Data class	Equipment
Vegetation response	Total vegetation	Estimate foliar cover per layer	Percent (%) foliar cover per layer (i.e., A, B1, B2, etc.,)[1]	E	Continuous - quantitative	-
	Total cover of each species per layer	Estimate foliar cover of each species by layer	Percent (%) foliar cover of each species by layer (i.e., A, B1, B2, etc.,); classify by cover class[1]	E	Categorical - quantitative	-
	Vigour of each	Estimate vigour of each species	Vigour class 0 - 4, dead to excellent[1], comment on vigour	E	Categorical - qualitative	-
	Distribution of each species by layer	Estimate distribution of each species	Distribution categories 1 - 9, rare individual to dense continuous coverage[1]	E	Categorical - qualitative	-
Environmental setting	Elevation	Survey site elevation, record elevation range of site	Meters (m)	M	Continuous - quantitative	Survey station
	Aspect	Measure aspect	Degrees (°)	M	Continuous - quantitative	Compass
	Slope	Measure slope	Percent (%)	M	Continuous - quantitative	Clinometer
	Exposure	Classify exposure	Full sun, partial sun, full shade	E	Categorical - qualitative	-
	Surface substrate	Estimate substrate composition by type	Percent cover (%) per substrate type or size class (bedrock, boulder, cobble, large gravel, small gravel, sand, mud, wood, organic, water)[3]	E	Categorical - quantitative	-
	Microtopography	Document microtopography	Channelled, gullied, mounded, smooth, tussocked, undulating[1]	E	Categorical - qualitative	-
	Surface shape	Document surface shape	Concave, convex, straight[1]	E	Categorical - qualitative	-
	Soil moisture	Classify soil moisture	Very xeric, xeric, subxeric, submesic, mesic, subhygric, hygric, subhydric, hydric[1]	E	Categorical - qualitative	-
	Water source	Document water source if present	Describe, e.g., seep, stream sub-irrigation or flood	E	Categorical - qualitative	-
	Fetch	Assess fetch	None, low, moderate, high	E	Categorical - qualitative	-
	Erosion	Assess amount of erosion	None, low, moderate, high; describe	E	Categorical - qualitative	-
	Deposition	Assess amount of deposition	None, low, moderate, high; describe	E	Categorical - qualitative	-
	Wood debris	Assess coverage of wood debris	None, low, moderate, high; describe	E	Categorical - qualitative	-
Disturbance	Wildlife, disease or	Assess wildlife damage	None, low, moderate, high; describe	E	Categorical - qualitative	-
	Disease or insect	Assess disease or insect	None, low, moderate, high; describe	E	Categorical - qualitative	-
	Other site disturbance	Document disturbance	None, low, moderate, high; describe	E	Categorical - qualitative	-

[1] MOF 2010

[2] Green and Klinka 1994

[3] RIC 2001

3.2. Plot data

Vegetation success including establishment and survival (starting in Year 2) will be collected from plot data. Plots will be strategically located at representative locations within revegetation treatment areas. Plot size will be 3.99 m in diameter which corresponds to 50 m^2 (FRBC 2001). The number of plots per treatment area will be proportional to the total treatment area. Plots will aim to cover 5-10% of the treatment area. For small treatment areas, a total census of stems will be conducted, when feasible (no plots).

Data collected at the plot or census level will consist of stem counts collected by species (Table 3). Species vigour and health will be noted. Repeatable photographs of each plot or census area will be taken through the plot centre from 3 m south of the plot centre. Plot centers will be marked with a caped rebar installed to ensure public safety.

Table 3. Field data collection of the ecological parameters for each plot

Data type	Parameter	Field/ Method	Variable or categories	Measure (M) or Estimate (E)	Data class	Equipment
Vegetation response	Stem density	Count stems in 3.99 m fixed area plot	Number of stems of each species per plot	M	Continuous - quantitative	Plot cord

4. DATA ANALYSIS

4.1. Treatment Area

4.1.1. Photo Monitoring

Processed drone imagery will be qualitatively assessed each year for changes in vegetation cover, species composition, growth, survival and health, as well as changes to the environmental setting and any disturbances. Images will be compared to previous years and similar treatment areas and treatment types.

A variety of analytical methods are available to quantify change in vegetation communities using UAV aerial imagery. Future data analysis methods may include measurements of vegetation cover using image classification tools that use spectral signatures such as those in ArcGIS or QGIS.

4.1.2. Ecological and Physical Parameters

Year 1 data analysis will focus on summary statistics of the vegetation response and environmental setting parameters (Table 1), including averages, data ranges, graphs and/or box plots.

In future years, if feasible, principal component analysis (PCA) will be conducted to indicate the principal drivers of vegetation success (e.g., treatment type, aspect, substrate, exposure) and explain trends. Future years data analysis will compare data summaries of treatments, years and locations.

Shannon Wiener Index of diversity could also be calculated in future years to measure the diversity and describe the succession of treatments.

4.1.3. Environmental Data Series

Environmental data series will be summarized and presented in graphs showing annual and multiannual trends. This will include: precipitation, temperature and the inundation regime, and how they relate to growing degree units.

4.2. Plot data

Summary statistics of stem counts from plot data will be compiled to demonstrate density, species composition and survival.

5. REPORTING

Baseline data will be compiled and presented in the annual revegetation treatment plan report.

Yours truly,

Ecofish Research Ltd.

Prepared by:	Reviewed by:
Signed	*Signed*
Leah Ballin, MSFM, R.P.Bio., R.P.F.	Deborah Lacroix, M.Sc., R.P.Bio.
Terrestrial Ecologist/ Task Manager	Senior Ecologist/Vice President

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Appendix B. Site-specific Restoration Profiles for 2018 work done

LIST OF MAPS

Map 1. Old Buttle Boat Launch – JHT-RV02 1
Map 2. Buttle Lake Campground - JHT-RV03 2
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Map 7. Karst Creek Boat Launch - JHT-RV08 7
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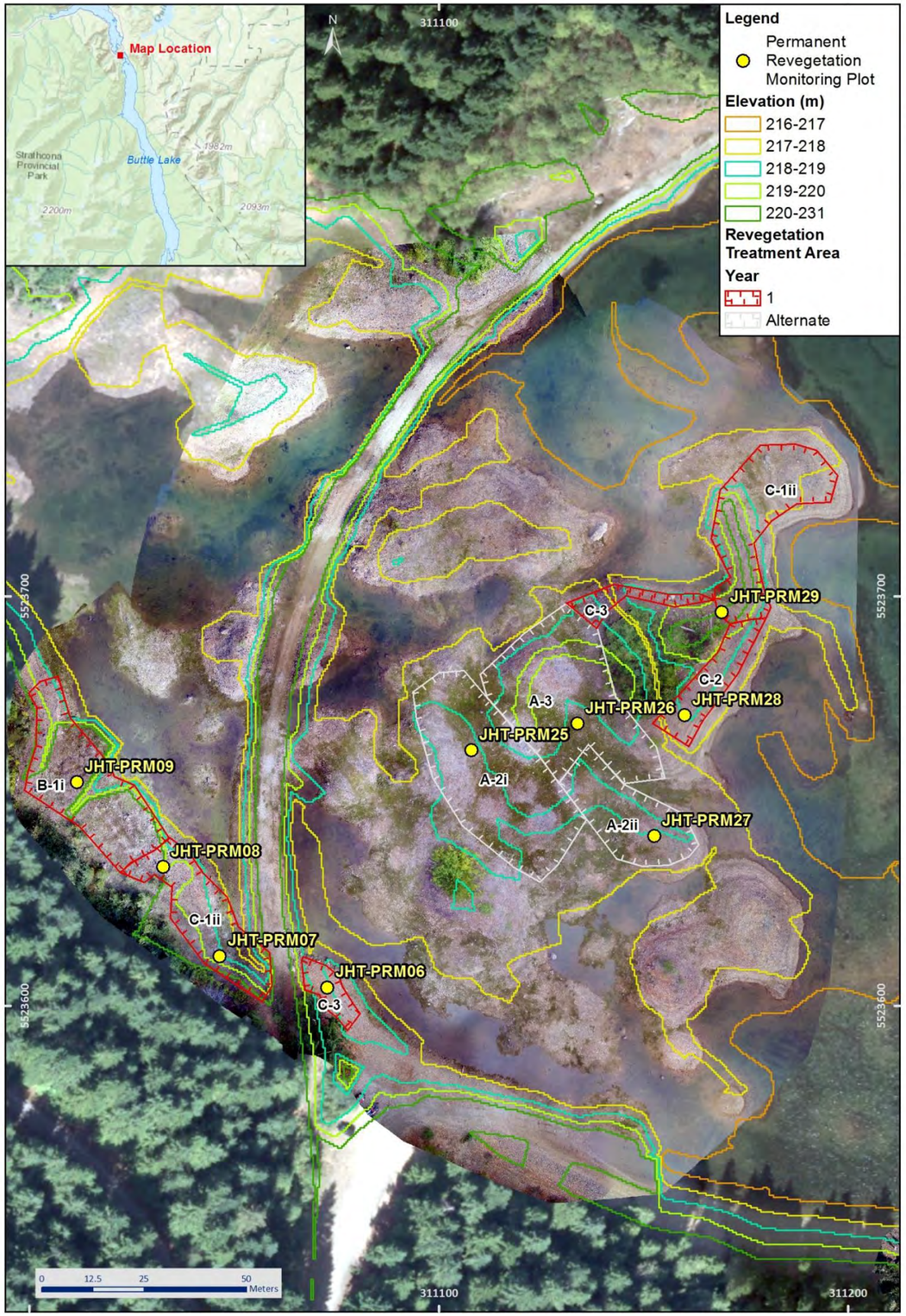

Site Description

Old boat launch within a bay with vegetated islets varying in elevation, topography, slope, and exposure. Part of Buttle Lake Campground.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - from old boat launch at low water
Known or potential physical works:	JHTWORKS-2 trail and swimming dock installation
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible from Driftwood Bay group site (JHT-RV05) and partially visible from Buttle Lake Campground (JHT-RV03) and Westmin Rd.
Public satisfaction:	Abundant area below 219 m; no stumps
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Majority of highly visible areas 10-33% with flatter areas at elevations 217-218 m
Substrate:	Mix of angular dark and round light gravel and cobble size. Mineral soil on flats.
Natural recruitment:	Natural recruitment occurring (including trees) but constrained by erosion and browsing. North aspect shows better recruitment.
Aspect:	All aspects. East-southeast most visible.
Fetch:	Low - mostly protected in bay
Water availability:	Low on islets, moderate adjacent to upslope forest
Human disturbance:	Moderate adjacent to old boat launch, low on islets
Wildlife disturbance:	Moderate - High (evidence of beaver & geese grazing)
Invasive species:	Moderate

JHTWORKS-3 Revegetation Sites

Old Buttle Boat Launch
JHT-RV02

Revegetation Treatment Trials

A - Low Slope or Alluvial Fan

PRESCRIPTION

A-2. Complex and/or stabilize substrate. Mound to above 217.8 m elevation, as guided by surveyed elevations. Use woody debris and boulders to stabilize, as needed.
i. No planting
ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).
A-3. Control

B - Moderate Slope Drawdown

PRESCRIPTION

B-1. Complex and/or stabilize substrate (roughen and loosen, terraces). Use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.
i. No planting

C - Steep Upper Drawdown

PRESCRIPTION

C-1. Substrate complexing and/or stabilization (roughen/loosen and terracing), as directed by a QP. Strategically use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.
ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).
C-2. No site preparation. Stake willow, cottonwood and red-osier dogwood by hand as guided by surveyed elevations (217.8-221.0 m).
C-3. Control

VEGETATION SPECIES

Sitka willow (*Salix sitchensis*)
Black cottonwood (*Populus balsamifera*)
Red-osier dogwood (*Cornus stolonifera*)

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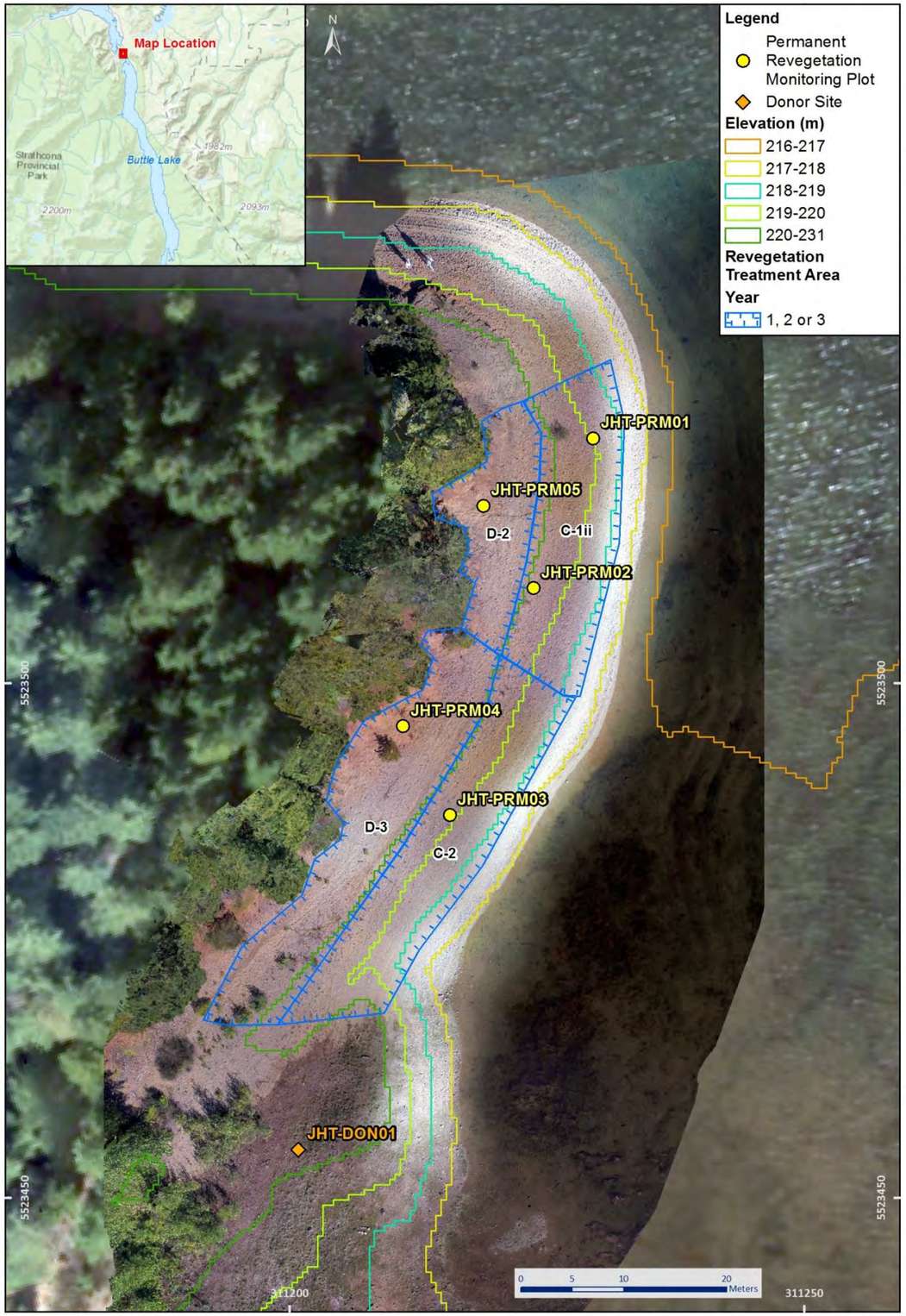

Site Description

Part of high-use Buttle Lake Campground and linked to beach built from imported sand. Potential revegetation area is adjacent steeper shoreline.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - from old boat launch or campground at low water
Known or potential physical works:	JHTWORKS-2 trail and swimming dock installation
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for visitors to Buttle Lake Campground, Buttle Lake boat launch users (JHT-RV06) and boaters in the Narrows. Proposed trail will draw the public to this area for swimming.
Public satisfaction:	Abundant area below 219 m; no stumps
Fish and wildlife habitat:	Moderate - High

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	28-47%
Substrate:	Fines and gravel on flat and lower slopes, with gravel and cobble on steep slopes.
Natural recruitment:	Lower shoreline variably vegetated. Steep slopes adjacent to the beach not vegetated. Recruitment of willow and other trees within southeastern section of bay.
Aspect:	East
Fetch:	Low
Water availability:	Low - Unknown
Human disturbance:	Moderate - walking, boat docking on beach
Wildlife disturbance:	Moderate (evidence of geese & deer grazing)
Invasive species:	Moderate

JHTWORKS-3 Revegetation Sites

Buttle Lake Campground
JHT-RV03

Revegetation Treatment Trials

C - Steep Upper Drawdown

PRESCRIPTION

C-1. Substrate complexing and/or stabilization (roughen/loosen and terracing), as directed by a QP. Strategically use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.

ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).

C-2. No site preparation. Stake deciduous species by hand as guided by surveyed elevations (217.8-221.0 m).

D - Steep Upland Forest

PRESCRIPTION

D-2. Stake cottonwood by hand

D-3. Stabilize bottom of slope with logs and boulders. Add leaf litter/mulch as practical. Stake with cottonwood. Transplant forest plants from new trail to Buttle Lake Campground (JHTWORKS-2) if available.

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Forest species may include:
Shore pine (*Pinus contorta ssp. contorta*)
Western white pine (*Pinus monticola*)
Douglas-fir (*Psuedotsuga menziesii*)
Pacific dogwood (*Cornus nuttali*)
Tall Oregon grape (*Mahonia aquifolium*)
Kinnikinnick (*Arctostaphylus uva-ursi*)

ECOFISH RESEARCH

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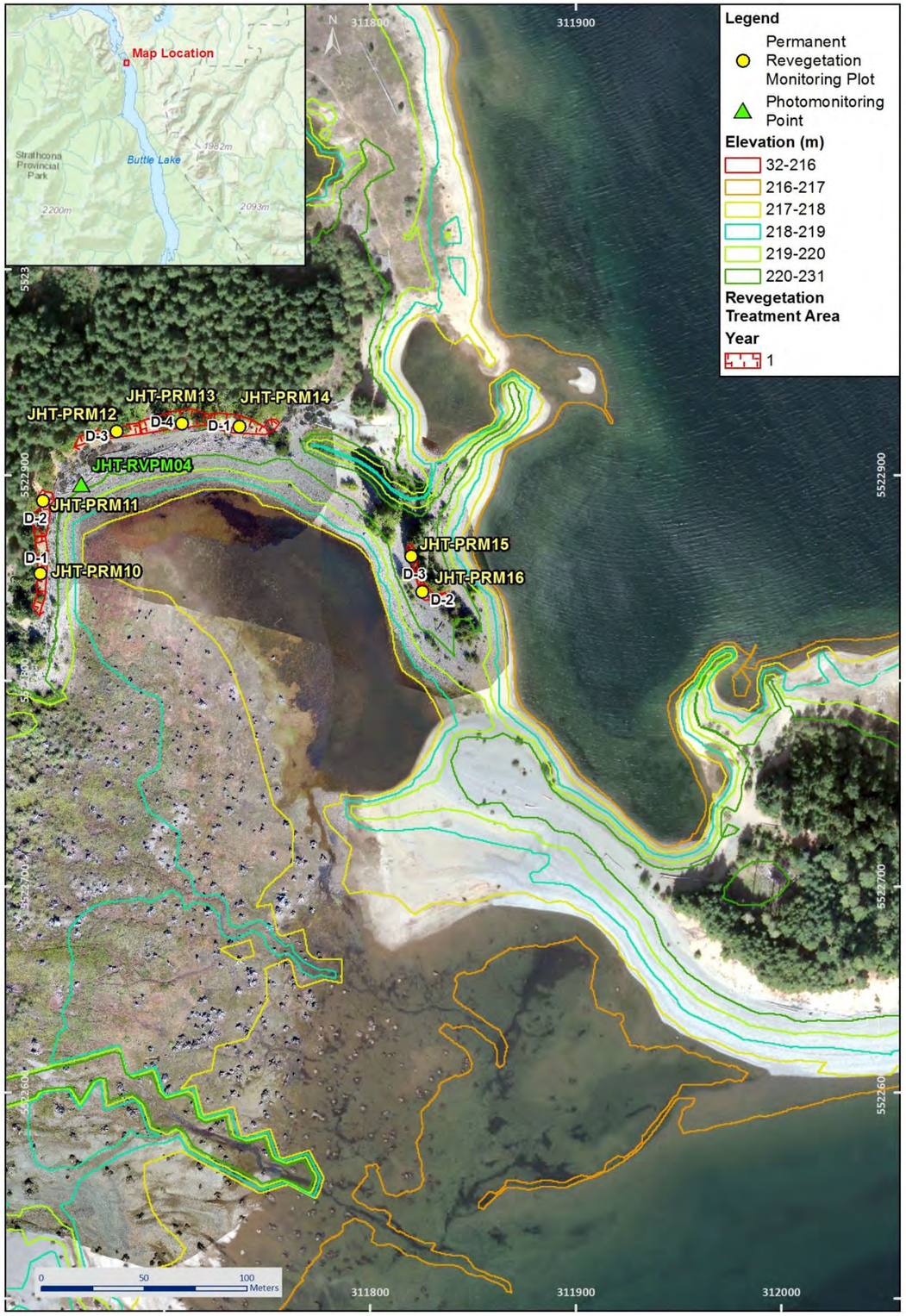

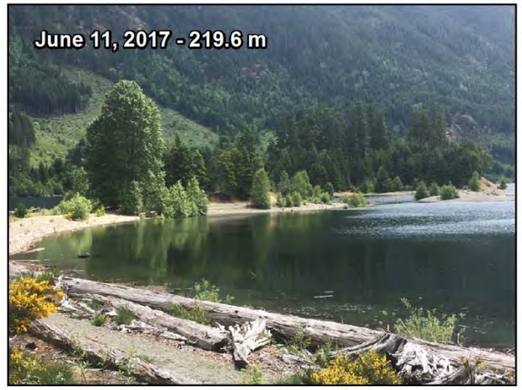

Site Description

High-use site, walk-in campground at Rainbow Island, that provides views up the narrows and to JHT-RV07. The area is comprised of flat areas that are variably vegetated and extensive unvegetated steep slopes including drawdown area and upland eroding forest soils.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Fair - a barge may be required if the existing walking trail is too narrow
Known or potential physical works:	Unknown
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for recreational users walking the beach trail, camping on the island, using the Buttle Lake boat launch (JHT-RV06) and boating in the Narrows
Public satisfaction:	The shoreline slopes to below 219 m. Some areas associated with steep unvegetated shoreline
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Steep upland slopes 47-60%
Substrate:	Gravel and sand in drawdown zone, eroded forest soils upslope.
Natural recruitment:	Recruitment impeded by erosion/deposition and high solar exposure/water deficits. Conifers growing at top of upper drawdown on east aspects. Higher recruitment observed with lower slope.
Aspect:	Variable with a large portion of the site's unvegetated area facing southeast and exposed to a long fetch.
Fetch:	None for upslope areas. High in drawdown.
Water availability:	Low for upslope forest
Human disturbance:	Flat areas heavily used, low on steep upland slopes.
Wildlife disturbance:	Low
Invasive species:	Moderate (high on suitable sites)

JHTWORKS-3 Revegetation Sites

Rainbow Island Marine Site
JHT-RV04

Revegetation Treatment Trials

D - Steep Upland Forest

PRESCRIPTION

D-1. Bioengineer slope with cottonwood modified brush layers installed by hand. Transplant forest plants from new trail to Buttle Lake Campground (JHTWORKS-2) or other source if available, on the created terraces.
D-2. Stake cottonwood by hand
D-3. Stabilize bottom of slope with logs and boulders. Add leaf litter/mulch as practical. Stake with cottonwood. Transplant forest plants from new trail to Buttle Lake Campground (JHTWORKS-2) if available.
D-4. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Forest species may include:
Douglas-fir (*Psuedotsuga menziesii*)
Pacific dogwood (*Cornus nuttali*)
Tall Oregon grape (*Mahonia aquifolium*)
Kinnikinnick (*Arctostaphylus uva-ursi*)

ECOFISH RESEARCH

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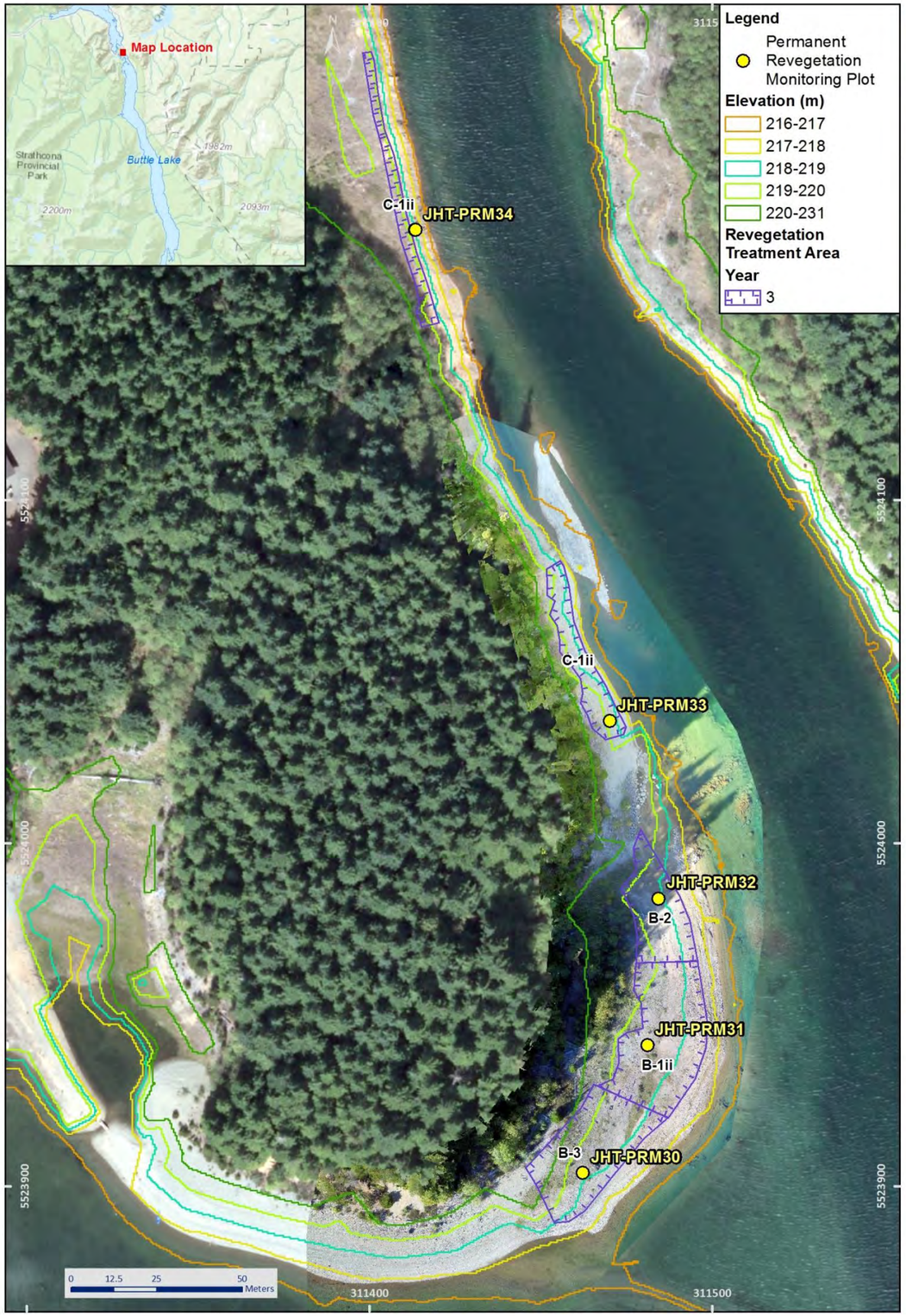


Site Description

Group campsite with a small lower-gradient beach and swimming area. Adjacent beaches are steeper. Site wraps around towards the HWY 287 bridge and steep section of the Narrows.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - adjacent to beach access, old route connects site with JHT-RV02 at low water
Known or potential physical works:	Unknown
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Moderately to highly visible for visitors to the group site and Buttle Lake Campground (JHT-RV02 and JHT-RV03). Partially visible from Westmin Rd. and the bridge over the Narrows.
Public satisfaction:	The shoreline slopes to below 219 m; no stumps
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Beach 7-12% with adjacent steeper shores 33-26%
Substrate:	Gravel and cobble, with sand on gentler slopes. Woody debris embeded and washed ashore.
Natural recruitment:	Recruitment of deciduous trees above 220.0 m. Some coniferous transplants above 220.0 m in Narrows. A slim band of small willow at ~217.8 m elevation on some slopes >15%, patches of herbs below 12% slope.
Aspect:	East-South
Fetch:	Moderate - High, woody debris accumulations near campsite and highly eroded in narrows
Water availability:	Low - Moderate
Human disturbance:	Low for much of site
Wildlife disturbance:	Low - Moderate
Invasive species:	Moderate

JHTWORKS-3 Revegetation Sites

Driftwood Group Campsite
JHT-RV05

Revegetation Treatment Trials

B - Moderate Slope Drawdown

PRESCRIPTION

B-1. Complex and/or stabilize substrate (roughen and loosen, terraces). Use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.
ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221 m).
Hand stake areas with decent herbaceous cover or sparse shrub cover as to not disturb existing vegetation.
B-2. No site preparation. Stake deciduous species dogwood by hand as guided by surveyed elevations (217.8-221 m).
B-3. Control

C - Steep Upper Drawdown

PRESCRIPTION

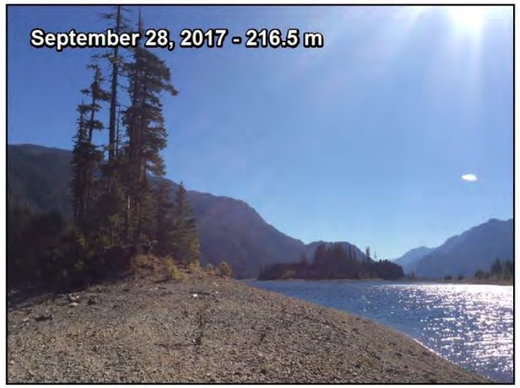
C-1. Substrate complexing and/or stabilization (roughen/loosen and terracing), as directed by a QP. Strategically use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.
ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*) (type B only)

ECOFISH RESEARCH

Path: M:\Projects-Active\1230_JHTMON\MXD\Vegetation\Site Profile Sheets\JHTWORKS3_SiteProfileSheet_Driftwood05_2017Nov01.mxd



Site Description

Paved boat launch with views across the Narrows to JHT RV04 and other sites. Gravel beaches adjacent to boat launch and island with variable revegetation.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Excellent - adjacent to boat launch, good to island when water level is below 216.4 m
Known or potential physical works:	JHTWORKS-2 boat launch upgrade
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Moderately to highly visible from Rainbow Island Marine campsite (JHT-RV04), users of the boat launch and Buttle Lake Campground (JHT-RV03), as well as boaters in the Narrows.
Public satisfaction:	The shoreline slopes to below 219 m; no stumps.
Fish and wildlife habitat:	Low - Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	11-32% in upper drawdown, 45-50% in upslope areas on island
Substrate:	Large gravel in drawdown zone, mineral soil upslope.
Natural recruitment:	Some evidence of recruitment including patches of grasses, sedges, and willows.
Aspect:	All aspects (island), beach (west)
Fetch:	Moderate - high, areas between islet and main island, islet and west shore, and bays have high fetch and wave exposure
Water availability:	Low - Moderate
Human disturbance:	High - adjacent to boat launch, vehicle tracks, trampling, low on island
Wildlife disturbance:	Low
Invasive species:	Low - Moderate

JHTWORKS-3 Revegetation Sites

Buttle Lake Boat Launch
JHT-RV06

Revegetation Treatment Trials

B - Moderate Slope Drawdown

PRESCRIPTION

B-3. Control

C - Steep Upper Drawdown

PRESCRIPTION

C-1. Substrate complexing and/or stabilization (roughen/loosen and terracing), as directed by a QP. Strategically use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.
ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).
C-2. No site preparation. Stake decicuous species by hand as guided by surveyed elevations (217.8-221.0 m).
C-3. Control

D - Steep Upland Forest

PRESCRIPTION

D-1. Bioengineer slope with cottonwood modified brush layers installed by hand. Transplant forest plants from new trail to Buttle Lake Campground (JHTWORKS-2) or other source if available, on the created terraces.
D-2. Stake cottonwood by hand
D-4. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*)
Forest species may include:
Western white pine (*Pinus monticola*)
Douglas-fir (*Psuedotsuga menziesii*)
Shore pine (*Pinus contorta ssp. contorta*)
Salal (*Gaultheria shallon*)
Tall Oregon grape (*Mahonia aquifolium*)
Salal (*Gaultheria shallon*)
Tall Oregon grape (*Mahonia aquifolium*)

ECOFISH RESEARCH

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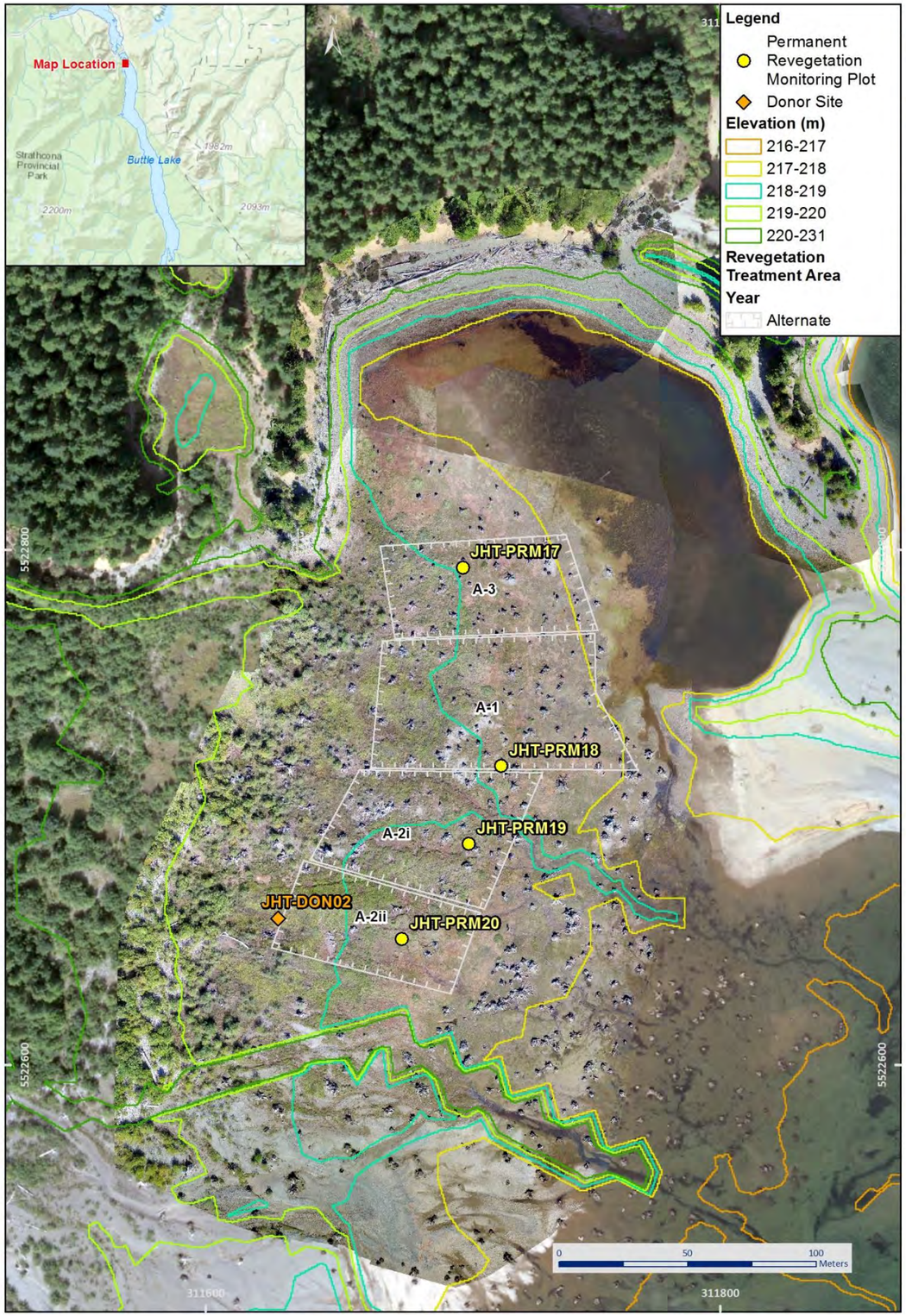


Site Description

Alluvial fan with stumps west of Rainbow Island. Generally very well vegetated above 217.6 m.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Fair - a barge may be required if the existing walking trail is too narrow
Known or potential physical works:	None
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Visible from Rainbow Island (JHT-RV04) and boaters on Buttle Lake.
Public satisfaction:	Extensive low gradient area below 219 m; many stumps present
Fish and wildlife habitat:	High

Environmental Setting and Disturbance

Elevation (m):	217-219+
Slope (%):	1%
Substrate:	Mineral soil, some stumps
Natural recruitment:	High recruitment of vegetation communities typical of the elevation band.
Aspect:	East
Fetch:	Low - disipated by slope
Water availability:	Good - upslope stream and forest and reservoir
Human disturbance:	Low - Nil
Wildlife disturbance:	Moderate
Invasive species:	Low

JHTWORKS-3 Revegetation Sites

Buttle Lake Fan
JHT-RV07

Revegetation Treatment Trials

A - Low Slope or Alluvial Fan

PRESCRIPTION

A-1. Select stumps with a top height over 217.8 m, as guided by surveyed elevations, and fill with soil and plant. Plant stumps with tops below 219.8 m with deciduous stakes. Plant stumps with tops above 219.8 m with flood tolerant forest species (where available). Armour with large gravel or cobble.

A-2. Complex and/or stabilize substrate. Mound to above 217.8 m elevation, as guided by surveyed elevations. Use woody debris and boulders to stabilize, as needed.

i. No planting

ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).

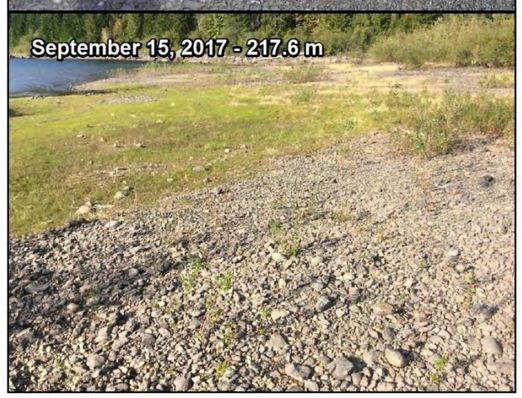
A-3. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*)
Forest species may include:
Western hemlock (*Tsuga heterophylla*)
Western redcedar (*Thuja plicata*)
Shore pine (*Pinus contorta ssp. contorta*)
Salal (*Gaultheria shallon*)

ECOFISH RESEARCH

Path: M:\Projects-Active\1230_JHTMON\MXD\Vegetation\Site Profile Sheets\JHTWORKS3_SiteProfileSheet_ButtleFan07_2017Nov01.mxd



Site Description

Concrete boat launch with variably vegetated areas on either side. Day use area.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Excellent - boat launch
Known or potential physical works:	JHTWORKS-2 boat launch upgrade
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for boat launch users and boaters on Buttle Lake.
Public satisfaction:	Extensive area below 219 m; stumps have been mostly removed
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Majority <6%
Substrate:	Gravel with pockets of mineral soil.
Natural recruitment:	North beach adjacent to creek better vegetated than south.
Aspect:	West (northwest to southwest)
Fetch:	High
Water availability:	Unknown, some subsurface flow from Karst Creek
Human disturbance:	Moderate (to high) - vehicle tracks, trampling, campfires
Wildlife disturbance:	Low
Invasive species:	Low

JHTWORKS-3 Revegetation Sites

Karst Creek Boat Launch
JHT-RV08

Revegetation Treatment Trials

B - Moderate Slope Drawdown

PRESCRIPTION

B-2. No site preparation. Stake deciduous species by hand as guided by surveyed elevations (217.8-221 m).

B-3. Control

VEGETATION SPECIES

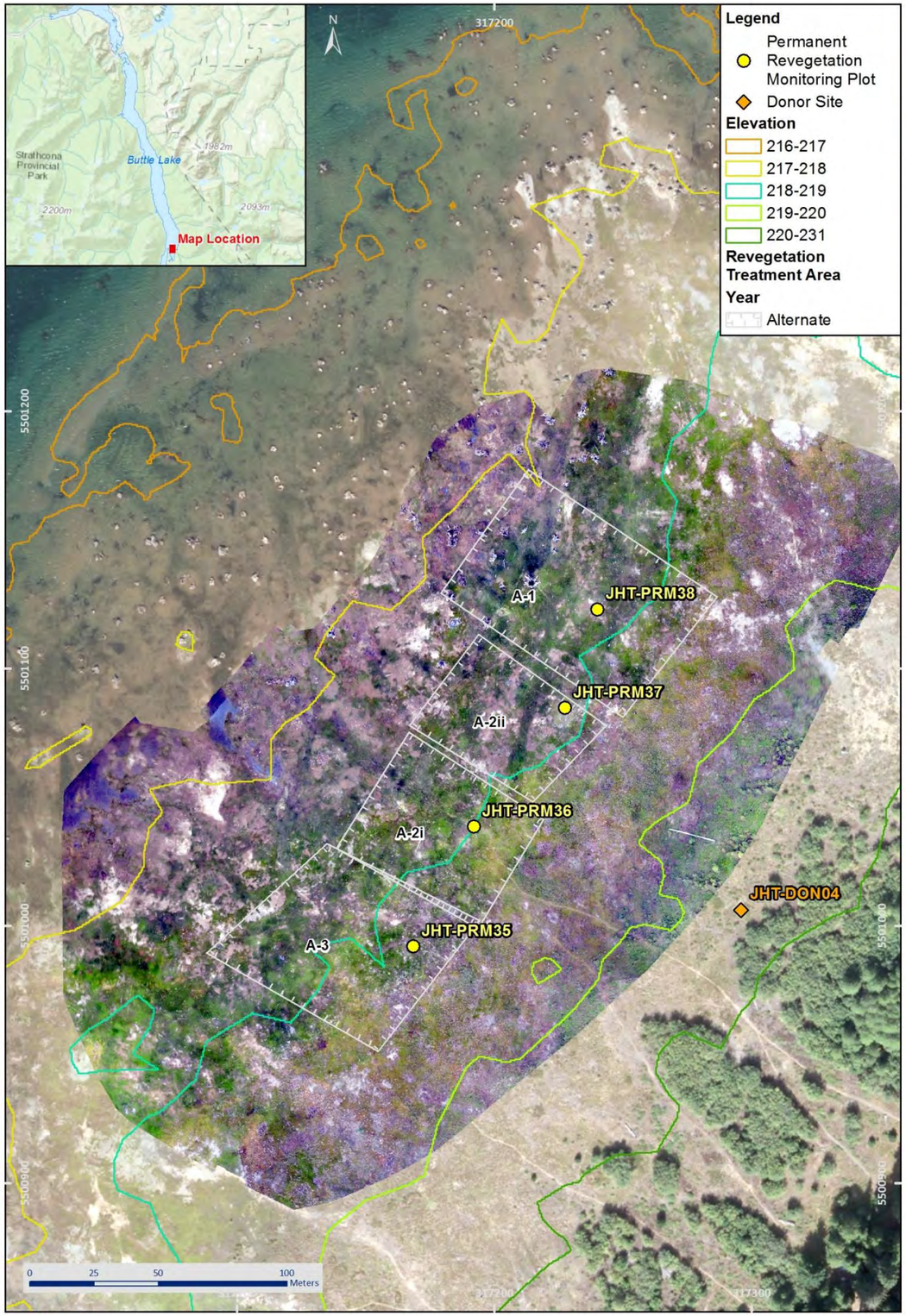
Black cottonwood (*Populus balsamifera*)

Sitka willow (*Salix sitchensis*)

Red-osier dogwood (*Cornus stolonifera*)

ECOFISH RESEARCH

Path: M:\Projects-Active\1230_JHTMON\MXD\Vegetation\Site Profile Sheets\JHTWORKS3_SiteProfileSheet_KarstCreek08_2017Oct20.mxd



Site Description

Well vegetated expansive alluvial fan adjacent to the Ralph River Campground.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - may require temporary road to access lower elevations
Known or potential physical works:	JHTWORKS-2 trail to swimming area
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for visitors to Ralph River Campground
Public satisfaction:	Extensive area below 219 m; some stumps have been removed while those remaining are at lower elevations
Fish and wildlife habitat:	Moderate - High

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	<2%
Substrate:	Mineral soil
Natural recruitment:	High recruitment of vegetation communities typical of elevation bands.
Aspect:	West (northwest to southwest)
Fetch:	High but effect dispersed by slope
Water availability:	Good; higher at north end by Ralph River
Human disturbance:	Low (to moderate) - trampling, campground
Wildlife disturbance:	Moderate - High (evidence of deer, elk, geese grazing)
Invasive species:	Low - Moderate

JHTWORKS-3 Revegetation Sites

Ralph River Campground
JHT-RV09

Revegetation Treatment Trials

A - Low Slope or Alluvial Fan

PRESCRIPTION

A-1. Select stumps with a top height over 217.8 m, as guided by surveyed elevations, and fill with soil and plant. Plant stumps with tops below 219.8 m with deciduous stakes. Plant stumps with tops above 219.8 m with flood tolerant forest species (where available). Armour with large gravel or cobble.

A-2. Complex and/or stabilize substrate. Mound to above 217.8 m elevation, as guided by surveyed elevations. Use woody debris and boulders to stabilize, as needed.

i. No planting

ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).

A-3. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*)
Forest species may include:
Western hemlock (*Tsuga heterophylla*)
Western redcedar (*Thuja plicata*)
Douglas-fir (*Psuedotsuga menziesii*)

ECOFISH RESEARCH

Path: M:\Projects-Active\1230_JHTMON\MXD\Vegetation\Site Profile Sheets\JHTWORKS3_SiteProfileSheet_RalfRiver09_2017Nov01.mxd

Appendix C. Baseline Data Collected in 2018 for JHT-RV03 at the New Site Location

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Table 5. Revegetation Treament Area environmental setting and disturbance factors. 3

Table 6. Measured abundance of tree species in permanent revegetation monitoring plots. 3

Table 7. Measured abundance of shrub species in permanent revegetation monitoring plots. 4

Table 1. Revegetation Treatment Area and Permanent Monitoring Plot locations, elevations, and dates surveyed.

Site	Treatment Area	Permanent Monitoring Plot	UTMs (Zone 10U)		Plot Elevation (m)	Elevation Range (m)	Survey Date
			Easting	Northing			
JHT-RV03	C-1ii	JHT-PRM53	311192	5523542	219.0	217.8-220.5	2018-11-07
	C-2i	JHT-PRM51	311150	5523550	219.0	217.8-222.3	2018-11-07
	C-3[1]	JHT-PRM57	311123	5523563	218.0	218.0-223.0	2018-11-28
	D-2i	JHT-PRM52	311148	5523547	221.0	220.5-223.0	2018-11-07
	D-3i	JHT-PRM54	311189	5523543	221.0	220.5-223.0	2018-11-07

[1] This control was also used as a control for JHT-RV02

Table 2. Revegetation Treament Area vegetation response - structural stage and percent vegetation cover per layer.

Site	Treatment Area	Permanent Monitoring Plot	Structural Stage[1]	Total vegetation count per layer (%)				
				A	B1	B2	C	D
JHT-RV03	C-1ii	JHT-PRM53	1a	5-25%	0%	1-5%	1-5%	0%
	C-2i	JHT-PRM51	1a	0 (0%)	0%	1-5%	5-25%	0%
	C-3[1]	JHT-PRM57	1a	5-25%	0%	1-5%	<1%	0%
	D-2i	JHT-PRM52	1a	5-25%	0%	1-5%	0%	0%
	D-3i	JHT-PRM54	1a	25-50%	0%	5-25%	1-5%	0%

[1] This control was also used as a control for JHT-RV02

[2] Structural Stage Categories: 1a = sparse

[3] An increase in A layer vegetation was recorded in the new treatment area location due to the soft edge of the upland forest being included in the treatment area in some locations

Table 3. Revegetation Treament Area environmental setting - aspect, slope, exposure, and substrate.

Site	Treatment Area	Permanent Monitoring Plot	Aspect (°)	Slope (%)	Exposure	Surface Substrate[2]									
						Bedrock	Rock	Cobble	Large Gravel	Small Gravel	Fines	Mud	Mineral Soil	Wood	Organic Matter
JHT-RV03	C-1ii	JHT-PRM53	11	30	full shade			T	D	SD				T	
	C-2i	JHT-PRM51	20	34	partial sun			T	SD	D	T			T	
	C-3[1]	JHT-PRM57	36	30	partial sun		T	T	SD	D	SD		D	T	
	D-2i	JHT-PRM52	0	30	partial sun					SD	D				
	D-3i	JHT-PRM54	36	30	partial sun				SD	D				T	

[1] This control was also used as a control for JHT-RV02

[2] D = dominate, SD = subdominant, T = trace

Table 4. Revegetation Treament Area environmental setting - microtopography, surface shape, soil moisture, water source.

Site	Treatment Area	Permanent Monitoring Plot	Microtopography	Surface Shape	Soil Moisture	Water Source
JHT-RV03	C-1ii	JHT-PRM53	smooth	straight	xeric	precipitation, flooding
	C-2i	JHT-PRM51	smooth	straight	xeric	precipitation, flooding
	C-3[1]	JHT-PRM57	smooth	straight	xeric	precipitation, flooding
	D-2i	JHT-PRM52	smooth	straight	xeric	precipitation
	D-3i	JHT-PRM54	smooth	straight	xeric	precipitation

[1] This control was also used as a control for JHT-RV02

Table 5. Revegetation Treament Area environmental setting and disturbance factors.

Site	Treatment Area	Permanent Monitoring Plot	Fetch[2]	Erosion[2]	Deposition[2]	Wood debris[2]	Wildlife, Disease or Insect Damage[2]	Human Disturbances[2]	Invasive Species[2]	Other Site Disturbances[2]
JHT-RV03	C-1ii	JHT-PRM53	L	M	N	L	N	M	N	L
	C-2i	JHT-PRM51	L	M	L	L	N	M	L	N
	C-3[1]	JHT-PRM57	L	M	L	L	N	M	L	N
	D-2i	JHT-PRM52	L	M	L	L	N	L	L	M
	D-3i	JHT-PRM54	L	M	L	L	N	L	L	M

[1] This control was also used as a control for JHT-RV02

[2]H = high, M = moderate, L = low, N = none

Table 6. Measured abundance of tree species in permanent revegetation monitoring plots.

Location	Treatment Type	Permanent Monitoring Plot	black cottonwood (*Populus balsamifera ssp. trichocarpa*)	Douglas-fir (*Pseudotsuga menziesii*)	shore pine (*Pinus contorta var. contorta*)	western hemlock (*Tsuga heterophylla*)	western redcedar (*Thuja plicata*)	red alder (*Alnus rubra*)	*All tree species*
Buttle Lake Campground (JHT-RV03)	C-1ii	JHT-PRM53	8	0	0	0	0	0	*8*
	C-2i	JHT-PRM51	2	5	0	0	0	0	*7*
	C-3[1]	JHT-PRM57	1	0	0	0	0	0	*1*
	D-2i	JHT-PRM52	0	7	2	0	0	0	*9*
	D-3i	JHT-PRM54	0	3	0	4	1	0	*8*

[1] This control was also used as a control for JHT-RV02

Table 7. Measured abundance of shrub species in permanent revegetation monitoring plots.

Location	Treatment Type	Permanent Monitoring Plot	dull Oregon-grape (*Mahonia nervosa*)	red huckleberry (*Vaccinium parvifolium*)	red-osier dogwood (*Cornus stolonifera*)	salal (*Gaultheria shallon*)	Sitka willow (*Salix sitchensis*)	trailing blackberry (*Rubus ursinus*)	*All shrub species*
Buttle Lake Campground (JHT-RV03)	C-1ii	JHT-PRM53	0	0	14	0	88	0	*102*
	C-2i	JHT-PRM51	0	0	0	0	2	1	*3*
	C-3[1]	JHT-PRM57	0	0	0	0	2	0	*2*
	D-2i	JHT-PRM52	5	6	0	0	4	1	*16*
	D-3	JHT-PRM54	0	6	0	0	1	1	*8*

[1] This control was also used as a control for JHT-RV02

Appendix D. As-built Site Description Data for Sites Treated in Fall 2018

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Table 7. Measured abundance of shrub species in permanent revegetation monitoring plots. 6

Table 1. Revegetation Treatment Area and Permanent Monitoring Plot locations, elevations, and dates surveyed.

Site	Treatment Area	Permanent Monitoring Plot	UTMs (Zone 10U)		Plot Elevation (m)	Elevation Range (m)	Survey Date
			Easting	Northing			
JHT-RV02	B-1i	JHT-PRM09	311011	5523655	218.0	218.0-221.5	2018-11-28
	C-1ii	JHT-PRM07	311046	5523612	218.0	218.0-221.5	2018-11-28
	C-1ii	JHT-PRM08	311033	5523634	218.0	218.0-221.5	2018-11-28
JHT-RV03	C-1ii	JHT-PRM53	311192	5523542	218.0	218.0-220.5	2018-11-28
	C-2i	JHT-PRM51	311150	5523550	220.5	218.0-221.5	2018-11-28
	C-3[1]	JHT-PRM57	311123	5523563	218.0	218.0-223.0	2018-11-28
	D-2i	JHT-PRM52	311148	5523547	218.0	220.5-223.0	2018-12-06
	D-3i	JHT-PRM54	311189	5523543	220.5	220.5-223.0	2018-12-06
JHT-RV06	B-2i	JHT-PRM50	311987	5523202	220.0	218.0-221.0	2018-11-06
	B-3	JHT-PRM56	311995	5523243	218.0	218.0-221.5	2018-11-21
	C-1ii	JHT-PRM22	312071	5523109	218.0	218.5-221.0	2018-11-21
	C-2i	JHT-PRM21	312034	5523143	218.0	218.0-221.5	2018-11-21
	C-3	JHT-PRM23	312103	5523088	218.0	218.0-221.5	2018-11-21

[1] This control was also used as a control for JHT-RV02, data replicated from baseline survey

Table 2. Revegetation Treament Area vegetation response - structural stage and percent vegetation cover per layer.

Site	Treatment Area	Permanent Monitoring Plot	Structural Stage[2]	Total vegetation count per layer (%)				
				A[3]	B1	B2	C	D
JHT-RV02	B-1i	JHT-PRM09	1a	0%	<1%	0%	0%	0%
	C-1ii	JHT-PRM07	1a	0%	<1%	0%	0%	0%
	C-1ii	JHT-PRM08	1a	0%	5-25%	0%	5-25%	0%
JHT-RV03	C-1ii	JHT-PRM53	1a	5-25%	0%	1-5%	1-5%	0%
	C-2i	JHT-PRM51	1a	0%	0%	1-5%	1-5%	0%
	C-3[1]	JHT-PRM57	1a	5-25%	0%	1-5%	<1%	0%
	D-2i	JHT-PRM52	1a	5-25%	0%	1-5%	0%	0%
	D-3i	JHT-PRM54	1a	25-50%	0%	1-5%	0%	0%
JHT-RV06	B-2i	JHT-PRM50	1a	0%	0%	1-5%	25-50%	0%
	B-3	JHT-PRM56	1a	0%	0%	1-5%	1-5%	0%
	C-1ii	JHT-PRM22	1a	0%	1-5%	1-5%	5-25%	0%
	C-2i	JHT-PRM21	1a	0%	5-25%	1-5%	1-5%	0%
	C-3	JHT-PRM23	1a	0%	0%	1-5%	1-5%	0%

[1] This control was also used as a control for JHT-RV02, data replicated from baseline survey

[2] Structural Stage Categories: 1a = sparse

[3] An increase in A layer vegetation was recorded in the new treatment area location due to the soft edge of the upland forest being included in the treatment area in some locations.

Table 3. Revegetation Treament Area environmental setting - aspect, slope, exposure, and substrate.

Site	Treatment Area	Permanent Monitoring Plot	Aspect (°)	Slope (%)	Exposure	Surface Substrate[2]									
						Bedrock	Rock	Cobble	Large Gravel	Small Gravel	Fines	Mud	Mineral Soil	Wood	Organic Matter
JHT-RV02	B-1i	JHT-PRM09	220	15	full shade			T	SD	D				T	
	C-1ii	JHT-PRM07	219	20	full sun				SD	D					
	C-1ii	JHT-PRM08	36	30	full sun				D	SD					
JHT-RV03	C-1ii	JHT-PRM53	0	30	partial sun			T	D	SD	SD				
	C-2i	JHT-PRM51	0	30	partial sun				T	D	SD				
	C-3[1]	JHT-PRM57	36	30	partial sun		T	T	SD	D	SD		D	T	
	D-2i	JHT-PRM52	219	20	partial sun					SD	D				
	D-3i	JHT-PRM54	30	15	partial sun					SD	D	SD		T	
JHT-RV06	B-2i	JHT-PRM50	270	13	full sun			D	SD	T	T			T	
	B-3	JHT-PRM56	36	30	partial sun		T	T		D	SD			T	
	C-1ii	JHT-PRM22	30	10	full sun		T	T	T	SD	D	T		T	T
	C-2i	JHT-PRM21	212	11	full sun			SD		D					
	C-3	JHT-PRM23	212	11	full sun					D					

[1] This control was also used as a control for JHT-RV02, data replicated from baseline survey

[2] D = dominate, SD = subdominant, T = trace

Table 4. Revegetation Treament Area environmental setting - microtopography, surface shape, soil moisture, water source.

Site	Treatment Area	Permanent Monitoring Plot	Microtopography	Surface Shape	Soil Moisture	Water Source
JHT-RV02	B-1i	JHT-PRM09	mounded, undulating	straight	mesic	seeps, flooding, precipitation
	C-1ii	JHT-PRM07	mounded	straight	mesic	precipitation, seeps, flooding
	C-1ii	JHT-PRM08	mounded	straight	mesic	precipitation, seeps, flooding
JHT-RV03	C-1ii	JHT-PRM53	mounded	straight	xeric	precipitation, flooding
	C-2i	JHT-PRM51	mounded	straight	xeric	precipitation, flooding
	C-3[1]	JHT-PRM57	smooth	straight	xeric	precipitation, flooding
	D-2i	JHT-PRM52	mounded, undulating	straight	xeric	precipitation
	D-3i	JHT-PRM54	mounded	straight	xeric	precipitation
JHT-RV06	B-2i	JHT-PRM50	undulating	straight	xeric	precipitation, flooding
	B-3	JHT-PRM56	undulating	straight	subxeric	precipitation, flooding, seepage
	C-1ii	JHT-PRM22	smooth	straight	xeric	precipitation, flooding
	C-2i	JHT-PRM21	smooth	straight	xeric	precipitation, flooding
	C-3	JHT-PRM23	smooth	straight	xeric	precipitation, flooding

[1] This control was also used as a control for JHT-RV02, data replicated from baseline survey

Table 5. Revegetation Treament Area environmental setting and disturbance factors.

Site	Treatment Area	Permanent Monitoring Plot	Fetch[2]	Erosion[2]	Deposition[2]	Wood debris[2]	Wildlife, Disease or Insect Damage[2]	Human Disturbances[2]	Invasive Species[2]	Other Site Disturbances[2]
JHT-RV02	B-1i	JHT-PRM09	L	L	L	M	N	L	N	N
	C-1ii	JHT-PRM07	L	L	L	M	N	L	N	N
	C-1ii	JHT-PRM08	L	L	L	M	N	L	N	N
JHT-RV03	C-1ii	JHT-PRM53	L	M	L	L	N	M	N	N
	C-2i	JHT-PRM51	L	M	L	L	N	M	L	N
	C-3[1]	JHT-PRM57	L	M	L	L	N	M	L	N
	D-2i	JHT-PRM52	L	L	L	L	N	L	N	M
	D-3i	JHT-PRM54	L	L	L	L	N	L	N	N
JHT-RV06	B-2i	JHT-PRM50	L, M	L	L	L	L	H	L	M
	B-3	JHT-PRM56	L	L	L	N	N	L	L	N
	C-1ii	JHT-PRM22	L	L	L	L	N	M	N	N
	C-2i	JHT-PRM21	L	L	L	L	N	M	L	N
	C-3	JHT-PRM23	L	L	L	L	N	L	L	N

[1] This control was also used as a control for JHT-RV02, data replicated from baseline survey

[2]H = high, M = moderate, L = low, N = none

Table 6. Measured abundance of tree species in permanent revegetation monitoring plots.

Location	Treatment Type	Permanent Monitoring Plot	black cottonwood (*Populus balsamifera ssp. trichocarpa*)	Douglas-fir (*Pseudotsuga menziesii*)	shore pine (*Pinus contorta var. contorta*)	western hemlock (*Tsuga heterophylla*)	western redcedar (*Thuja plicata*)	red alder (*Alnus rubra*)	*All tree species*
Old Buttle Boat Ramp (JHT-RV02)	C-1ii	JHT-PRM07	2	0	0	0	0	0	*2*
	C-1ii	JHT-PRM08	0	0	0	0	0	0	*0*
	B-1i	JHT-PRM09	0	0	0	0	0	0	*0*
Buttle Lake Campground (JHT-RV03)	C-1ii	JHT-PRM53	0	0	0	0	0	0	*0*
	C-2i	JHT-PRM51	10	0	0	0	0	0	*10*
	C-3[1]	JHT-PRM57	1	0	0	0	0	0	*1*
	D-2i	JHT-PRM52	11	0	0	0	0	0	*11*
	D-3i	JHT-PRM54	9	1	1	4	1	0	*16*
Buttle Lake Boat Launch (JHT-RV06 - shoreline)	B-2i	JHT-PRM50	0	0	0	0	0	0	*0*
	B-3	JHT-PRM56	0	0	0	0	0	1	*1*
	C-1ii	JHT-PRM22	7	0	0	0	0	0	*7*
	C-2i	JHT-PRM21	0	0	0	0	0	0	*0*
	C-3	JHT-PRM23	0	0	0	0	0	0	*0*

[1] This control was also used as a control for JHT-RV02, data replicated from baseline survey

Table 7. Measured abundance of shrub species in permanent revegetation monitoring plots.

Location	Treatment Type	Permanent Monitoring Plot	dull Oregon-grape (*Mahonia nervosa*)	red huckleberry (*Vaccinium parvifolium*)	red-osier dogwood (*Cornus stolonifera*)	salal (*Gaultheria shallon*)	Sitka willow (*Salix sitchensis*)	trailing blackberry (*Rubus ursinus*)	*All shrub species*
Old Buttle Boat Ramp (JHT-RV02)	C-1ii	JHT-PRM07	0	0	0	0	40	0	*40*
	C-1ii	JHT-PRM08	0	0	10	0	55	0	*65*
	B-1i	JHT-PRM09	0	0	0	0	0	0	*0*
Buttle Lake Campground (JHT-RV03)	C-1ii	JHT-PRM53	0	0	0	0	60	0	*60*
	C-2i	JHT-PRM51	0	0	8	0	68	0	*76*
	C-3[1]	JHT-PRM57	0	0	0	0	2	0	*2*
	D-2i	JHT-PRM52	6	4	4	20	32	2	*68*
	D-3i	JHT-PRM54	0	2	0	30	12	0	*44*
Buttle Lake Boat Launch (JHT-RV06 - shoreline)	B-2i	JHT-PRM50	0	0	294	0	226	0	*520*
	B-3	JHT-PRM56	0	0	0	0	27	0	*27*
	C-1ii	JHT-PRM22	0	0	6	0	54	0	*60*
	C-2i	JHT-PRM21	0	0	12	0	18	0	*30*
	C-3	JHT-PRM23	0	0	0	0	0	0	*0*

[1] This control was also used as a control for JHT-RV02, data replicated from baseline survey

Appendix E. Workplan for 2019

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MEMORANDUM

TO: **Mark Sherrington, Natural Resource Specialist, BC Hydro**

FROM: **Veronica Woodruff, Dip. Tech., Patrick Walshe, B.Sc., R.P.Bio., Heidi Regehr, Ph.D., R.P.Bio., and Deborah Lacroix, M.Sc., R.P.Bio., Ecofish Research Ltd. and Jim Meldrum, Laich-Kwil-Tach Environmental Assessments Ltd. Partnership**

DATE: **March 11, 2019**

FILE: **1230-33**

RE: **Workplan Summary for JHT WORKS-3 2019 Treatment Trials: Planning, Permitting, and Budgeting - Draft V1**

1. INTRODUCTION

The Upper Campbell Reservoir Drawdown Zone Revegetation Program (JHTWORKS-3) is a ten-year program with the primary goal of improving the visual quality and riparian habitat values of high-profile reservoir shoreline areas impacted by fluctuating water levels. JHTWORKS-3 is divided into three phases that are being implemented over the ten-year period: 1) identification/prioritization of sites for revegetation treatment trials (Year 1); 2) planning, trial implementation, and monitoring of revegetation treatment trials (Years 2-6); and 3) implementation of the final Revegetation Treatment Plan at additional sites around the reservoir (Years 7-10). The objective of the revegetation treatments is to employ a variety of revegetation techniques to achieve the establishment of naturally-occurring vegetation communities in and above the drawdown zone of the Upper Campbell River reservoir (Ballin *et al.* 2018[1]). Thus, treatment prescriptions were designed for specific site conditions and using plant species that are likely to support natural succession in these conditions.

This memorandum represents a workplan for the second year of Phase 2 of the program, which is the second year of the implementation of the revegetation treatment trials (treatment implementation began in 2018). In Phase 1, highly visible reservoir perimeter sites within high recreational use areas, that have high potential for revegetation and natural recolonization success,

were identified for revegetation treatment (Ballin *et al.* 2018[1]). Revegetation treatment prescriptions were developed for these high priority revegetation sites by treatment type (four types; A through D) based on naturally occurring species composition and site conditions, as well as other key factors that affect establishment and survival of plants (see Tables 8 through 11 in Ballin *et al.* (2018[1]) for details on revegetation treatment prescriptions for treatment types A through D). Some of these treatments were modified during work conducted in 2018 due to site conditions and other factors, and when modifications were made, new treatment labels were provided to permit tracking and evaluation of revegetation success in relation to specific treatments.

The objective of this memorandum is to provide summary information on key field components for the implementation of treatment trials that is proposed for six treatment sites in 2019. This includes type of treatment prescription, information on the areas (equivalent to, and used interchangeably with, mapped "polygons") within the sites where the treatments will occur (location, size), materials and equipment needed, on-site pre-treatment considerations, and estimated on-the-ground effort for field crews. The information was collated to support planning, permitting, and budgeting of this work.

2. TREATMENT SITE PRESCRIPTIONS

Eight revegetation sites were identified for treatment during the program (Table 2 in Ballin *et al.* 2018[1]). Of these, the following six have been selected for the implementation of treatments in 2019:

1. Old Buttle Lake Boat Launch (JHT-RV02);
2. Rainbow Island Marine Campsite (JHT-RV04);
3. Driftwood Bay Group Site (JHT-RV05);
4. Buttle Lake Campground Fan (JHT-RV07);
5. Karst Creek Boat Launch (JHT-RV08); and
6. Ralph River Campground (JHT-RV09).

Information on key field components for each of these sites is summarized by treatment site in the sections below. The associated maps showing the treatment sites are appended to this document.

It should be noted that although one of the recommendations from the 2018 work was to plan machine use at all areas (owing to compacted soils), even those for which no site preparation is prescribed, treatments proposed for 2019 include hand-planting without machine use. If site conditions encountered in 2019 are similar to those encountered in 2018, these treatments may need to be modified to machine-use treatments, as was done in 2018.

[1] Ballin, L., T. Gower, M. Bayly, M. Hocking, M. Sloan, H. Regehr, and D. Lacroix. 2018. JHTWORKS-3: Upper Campbell Reservoir Drawdown Zone Revegetation Treatment Report – Year 1. Consultant's report prepared for BC Hydro by Laich-Kwil-Tach Environmental Assessments Ltd. Partnership and Ecofish Research Ltd., January 12, 2018.

2.1. Old Buttle Lake Boat Launch (JHT-RV02)

The Old Buttle Lake Boat Launch treatment site (JHT-RV02) is in a bay with vegetated islets that is part of the Buttle Lake Campground area. Two treatment trials were successfully implemented at this site in 2018. However, treatment trials were not implemented at two proposed treatment polygons on the island portion of JHT-RV02 in 2018 due to high water levels and resultant problems with machine access. We propose to complete the treatment trials at these two areas in spring 2019, prior to a rise in water levels.

Two treatment prescriptions have been identified for these areas: C-1ii and C-2. However, treatment C-1ii involves planting stakes by machine and it is not yet known whether machine access to these island locations will be possible (the substrate may be too soft). If machine access is not appropriate, the C-1ii treatment will be changed to a C-2 treatment, which does not require a machine. Table 1 summarizes the treatment plan for 2019.

Table 1. Key field components for the implementation of revegetation treatments at JHT-RV02.

JHT-RV02: OLD BUTTLE LAKE BOAT LAUNCH			
Treatment Area(s)	**Area (m^2)**	**Task**	**Details**
C-1ii	~459	Site Preparation and Planting Treatment	Substrate complexing and/or stabilization (roughen/loosen, terraces). Embed woody debris as possible. Stake willow, cottonwood and red-osier dogwood by machine and by hand as guided by surveyed elevations. Add leaf litter mulch as practical.
		Materials and Equipment Required	Excavator and operator Boulders and cobbles Large woody debris Leaf litter/mulch, where practical Willow, cottonwood and red-osier stakes
		Pre-treatment Considerations	Evaluation access for machine and other material delivery (boulder/LWD). Assess site for existing available materials for construction. Asses leaf/litter and mulch availability including appropriate donor site.
		Anticipated Effort	~4 days on site work (harvesting, collecting and planting)
C-2	~271	Site Preparation and Planting Treatment	No site preparation required. Stake willow, cottonwood and red-osier dogwood by hand as guided by surveyed elevations.
		Materials and Equipment Required	Willow, cottonwood and red-osier stakes
		Pre-treatment Considerations	Identify appropriate donor sites for staking.
		Anticipated Effort	~4 days on site work (harvesting, collecting and planting)

2.2. Rainbow Island Marine Campsite (JHT-RV04)

The Rainbow Island Marine Campsite (JHT-RV04) is adjacent to a bay that is connected to Buttle Lake Campground. The site contains flat areas that are variably vegetated, as well as extensive unvegetated steep slopes within drawdown areas and within upland forest areas where soils are eroding. These steep slopes are the targets of revegetation treatments. Three treatment prescriptions were initially proposed for the steep upland forest at this site (D-1, D-2, D-3), one of which (D-3) required machine support to implement. However, after re-assessing site access, it has been determined that machine access is poor and the treatment size too small (~188 m^2) to warrant barging a machine to the site. Instead, we propose to replace D-3 with a treatment prescription that has not been identified for treatment type D. This new treatment prescription (labelled D-5) is the planting of nursery stock of suitable native species. Because the steep upper slopes of this site are quite dry, we propose to plant the site with kinnikinnick (*Arctostaphylos uva-ursi*) and tall Oregon grape (*Mahonia aquifolium*). We propose to complete this treatment in fall of 2019. The revised treatment plan is presented in Table 2.

Table 2. Key field components for the implementation of revegetation treatments at JHT-RV04.

JHT-RV04: RAINBOW ISLAND MARINE CAMPSITE			
Treatment Area(s)	**Area (m^2)**	**Task**	**Details**
D-1	~403	Site Preparation and Planting Treatment	Bioengineer slope with willow and modified brush layers.
		Materials and Equipment Required	Willow stakes and whips
		Pre-treatment Considerations	Evaluate soil surface compaction prior to planting. Assess site for existing available plant materials. Asses leaf/litter and mulch availability including appropriate donor site (i.e., RV03 trail construction).
		Anticipated Effort	<6 days on site work (harvesting, collecting and planting)
D-2	~985	Site Preparation and Planting Treatment	No site preparation required. Stake willow, cottonwood and red-osier dogwood by hand as guided by surveyed elevations.
		Materials and Equipment Required	Willow, cottonwood and red-osier stakes
		Pre-treatment Considerations	Identify appropriate donor sites for staking. Evaluate soil surface compaction prior to planting.
		Anticipated Effort	~3 days on site work (harvesting, planting)
D-5	~188	Site Preparation and Planting Treatment	Plant slopes with appropriate native species.
		Materials and Equipment Required	Nursery stock
		Pre-treatment Considerations	Purchase materials from nursery
		Anticipated Effort	1 day for a crew of two to plant

2.3. Driftwood Bay Group Site (JHT-RV05)

The Driftwood Bay Group Site treatment site (JHT-RV05) is located on a small low gradient beach with a swimming area adjacent to which there are steep slopes. The site is visible from Highway 28 through the narrows that connect Upper Campbell Lake to Buttle Lake. The archaeological assessment determined there were important archaeological sites in the original proposed treatment polygons. The presence of these archaeological sites restricted treatment options and only two polygons will be treated (with treatment prescription C-1ii). We propose to complete this treatment in fall 2019. Table 3 summarizes the treatment plan for 2019.

We also propose to assess other potential treatment areas at this site closer to the Highway 28 Bridge (Figure 1); however specific locations have not yet been identified. One of the goals of these additional treatment areas at JHT-RV05 would be to improve the aesthetic value of the riparian area from Highway 28.

Figure 1. Looking north from JHT-RV05 at Highway 28 bridge.

Table 3. Key field components for the implementation of revegetation treatments at JHT-RV05.

JHT-RV05: DRIFTWOOD BAY GROUP SITE			
Treatment Area(s)	**Area (m^2)**	**Task**	**Details**
C-1ii	~608	Site Preparation and Planting Treatment	Substrate complexing and/or stabilization (roughen/loosen, terraces). Embed woody debris as possible. Stake willow, cottonwood and red-osier dogwood by machine and by hand as guided by surveyed elevations. Add leaf litter mulch as practical.
		Materials and Equipment Required	Excavator and operator Boulders and cobbles Large woody debris Leaf litter/mulch, where practical Willow, cottonwood and red-osier stakes
		Pre-treatment Considerations	Evaluation access for machine and other material delivery (boulder/LWD). Assess site for existing available materials for construction. Asses leaf/litter and mulch availability including appropriate donor site.
		Anticipated Effort	~8 days on site work (harvesting, collecting and planting)

2.4. Buttle Lake Campground Fan (JHT-RV07)

The Buttle Lake Campground Fan treatment site (JHT-RV07) is located west of Rainbow Island (JHT-RV04) and is generally well vegetated above 217.6 m. It is an alluvial fan within the reservoir that has an abundance of stumps that can pose a navigation hazard. We propose to implement treatment prescription A-1, which is to fill and plant stump cavities with a variety of species, with the selection of species to be planted dependent on the surveyed elevation of the stumps. Stumps with tops at elevations between 217.8 m and 219.8 m will be augmented with soil and planted with flood tolerant deciduous species (i.e., red-osier dogwood). Stumps with tops at elevations greater than 219.8 m will be planted with flood tolerant coniferous (e.g.., shore pine (*Pinus contorta*)) and deciduous species (e.g., salal (*Gaultheria shallon*). The stumps will be prepared using a combination of hand tools (e.g., mattock) and power tools (e.g., power drill). Some plant species will need to be purchased from a native plant nursery.

The work will need to be supported by a light vehicle (ATV or a light truck; to be determined based on tolerance of the substrate in the spring) and trailer. Although the treatment polygon is large (~10,000 m^2), only the stumps with the appropriate elevation will be treated which will limit the actual planting work required. Note the stumps within elevation bands are visible in the imagery of Map of JHT-RV07. The revised treatment plan is presented in Table 4. This work will be completed in spring 2019.

Table 4. Key field components for the implementation of revegetation treatments at JHT-RV07.

JHT-RV07: BUTTLE LAKE CAMPGROUND FAN			
Treatment Area(s)	**Area (m^2)**	**Task**	**Details**
A-1	~10,347	Site Preparation and Planting Treatment	Fill stumps with soil, plant stumps with species appropriate to the top height elevation (as guided by surveyed elevation).
		Materials and Equipment Required	Light Vehicle Support (ATV and Trailer) Soil Hand tools- Mattock, axe Power tools- Drill with various bits, potentially chainsaw Survey Equipment Nursery Stock
		Pre-treatment Considerations	Evaluation access for light vehicle access Identify appropriate donor sites for stakes Purchase of nursery stock
		Anticipated Effort	~8 days on site work (harvesting, preparation and planting)

2.5. Karst Creek Boat Launch (JHT-RV08)

The Karst Creek Boat Launch treatment site (JHT-RV08) is located in the Karst Creek Boat Launch day use area of Buttle Lake. The proposed treatment within this large treatment polygon (~2430 m^2) is to stake deciduous species by hand. We propose to complete this treatment in the fall of 2019. The treatment plan is presented in Table 5.

Table 5. Key field components for the implementation of revegetation treatments at JHT-RV08.

JHT-RV08: KARST CREEK BOAT LAUNCH			
Treatment Area(s)	**Area (m^2)**	**Task**	**Details**
B-2	~2,430	Site Preparation and Planting Treatment	No site preparation. Stake willow, cottonwood and red-osier dogwood by hand as guided by surveyed elevations (217.8-221 m)
		Materials and Equipment Required	Willow, cottonwood and red-osier stakes
		Pre-treatment Considerations	Identify appropriate donor sites for staking
		Anticipated Effort	~7 days on site work

2.6. Ralph River Campground (JHT-RV09)

The Ralph River Campground treatment site (JHT-RV09) is similar to the Buttle Lake Campground Fan treatment site (JHT-RV07) in that it is an alluvial fan with an abundance of stumps and is generally well vegetated above 217.6 m. We propose to implement the same treatment prescription as for the Buttle Lake Campground treatment site (JHT-RV07), which is to plant stumps with the types of species to be planted dependent on the surveyed elevation of the stumps (treatment prescription A-1). The elevational bands and types of species selected for each, as well as the planting methods, will be the same as those described for JHT-RV07 (see Section 2.4). The treatment polygon in JHT-RV09 is large (~10,860 m^2); however, as also discussed for JHT-RV07, only the stumps within the appropriate elevational band will be treated (stumps and elevational bands visible in imagery of JHT-RV09). The revised treatment plan is presented in Table 6. This work will be completed in spring 2019.

Table 6. Key field components for the implementation of revegetation treatments at JHT-RV09.

JHT-RV09: RALPH RIVER CAMPGROUND			
Treatment Area(s)	**Area (m^2)**	**Task**	**Details**
A-1	~10,860	Site Preparation and Planting Treatment	Fill stumps with soil, plant stumps with species appropriate to the top height elevation (as guided by surveyed elevation)
		Materials and Equipment Required	Light vehicle support (ATV and Trailer) Soil Hand tools - mattock, axe Power tools - drill with various bits, potentially chainsaw Survey equipment Nursery stock
		Pre-treatment Considerations	Evaluation access for light vehicle access Identify appropriate donor sites for stakes Purchase of nursery stock
		Anticipated Effort	~8 days on site work (harvesting, preparation and planting)

3. CLOSURE

This memorandum summarizes the revegetation treatments that will be implemented within treatment areas at six treatment sites in 2019 along with key field the requirements.

Please do not hesitate to contact the undersigned if you have any questions or comments.

Yours truly,

Ecofish Research Ltd.

Prepared by:	Reviewed by:
Signed	*Signed*
Veronica Woodruff, Dipl. Tech.	Deborah Lacroix, M.Sc., R.P.Bio.
Environmental Biologist	Senior Ecologist

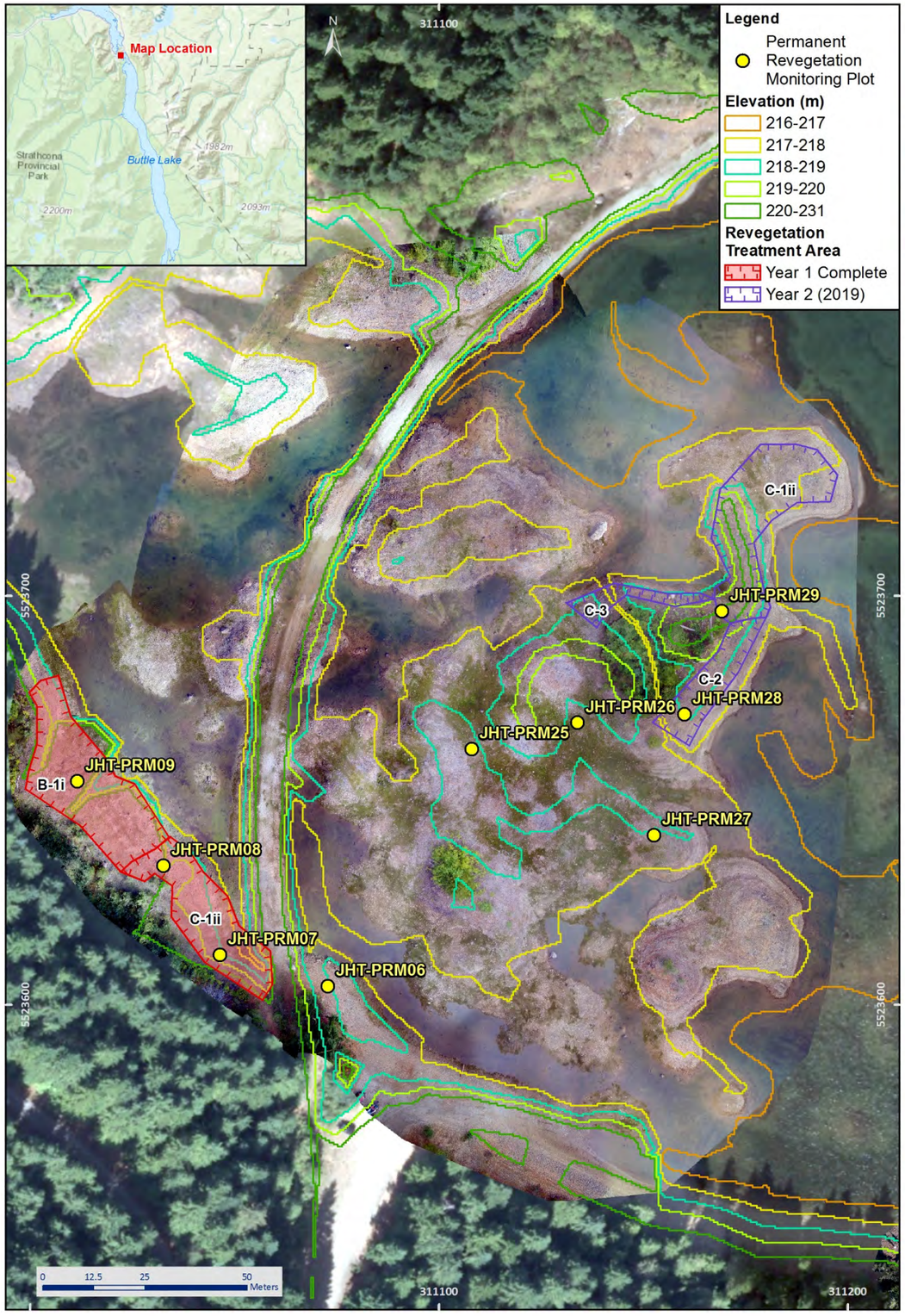
Attached:

Appendix A. Maps of Revegetation Treatment Trial Sites and Prescriptions for 2019

Appendix A. Maps of Revegetation Treatment Trial Sites and Prescriptions for 2019

LIST OF MAPS

Map 1. Old Buttle Boat Launch – JHT-RV02 1
Map 2. Rainbow Island Marine Site – JHT-RV04 2
Map 3. Driftwood Group Campsite – JHT-RV05 3
Map 4. Buttle Lake Fan – JHT-RV07 4
Map 5. Karst Creek Boat Launch – JHT-RV08 5
Map 6. Ralph River Campground – JHT-RV09 6



Site Description

Old boat launch within a bay with vegetated islets varying in elevation, topography, slope, and exposure. Part of Buttle Lake Campground.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - from old boat launch at low water
Known or potential physical works:	JHTWORKS-2 trail and swimming dock installation
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible from Driftwood Bay group site (JHT-RV05) and partially visible from Buttle Lake Campground (JHT-RV03) and Westmin Rd.
Public satisfaction:	Abundant area below 219 m; no stumps
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Majority of highly visible areas 10-33% with flatter areas at elevations 217-218 m
Substrate:	Mix of angular dark and round light gravel and cobble size. Mineral soil on flats.
Natural recruitment:	Natural recruitment occurring (including trees) but constrained by erosion and browsing. North aspect shows better recruitment.
Aspect:	All aspects. East-southeast most visible.
Fetch:	Low - mostly protected in bay
Water availability:	Low on islets, moderate adjacent to upslope forest
Human disturbance:	Moderate adjacent to old boat launch, low on islets
Wildlife disturbance:	Moderate - High (evidence of beaver & geese grazing)
Invasive species:	Moderate

JHTWORKS-3 Revegetation Sites

Old Buttle Boat Launch
JHT-RV02

Revegetation Treatment Trials

B - Moderate Slope Drawdown

PRESCRIPTION

B-1. Complex and/or stabilize substrate (roughen and loosen, terraces). Use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.

i. No planting

C - Steep Upper Drawdown

PRESCRIPTION

C-1. Substrate complexing and/or stabilization (roughen/loosen and terracing), as directed by a QP. Strategically use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.

ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).

C-2. No site preparation. Stake willow, cottonwood and red-osier dogwood by hand as guided by surveyed elevations (217.8-221.0 m).

C-3. Control

VEGETATION SPECIES

Sitka willow (*Salix sitchensis*)

Black cottonwood (*Populus balsamifera*)

Red-osier dogwood (*Cornus stolonifera*)

ECOFISH RESEARCH

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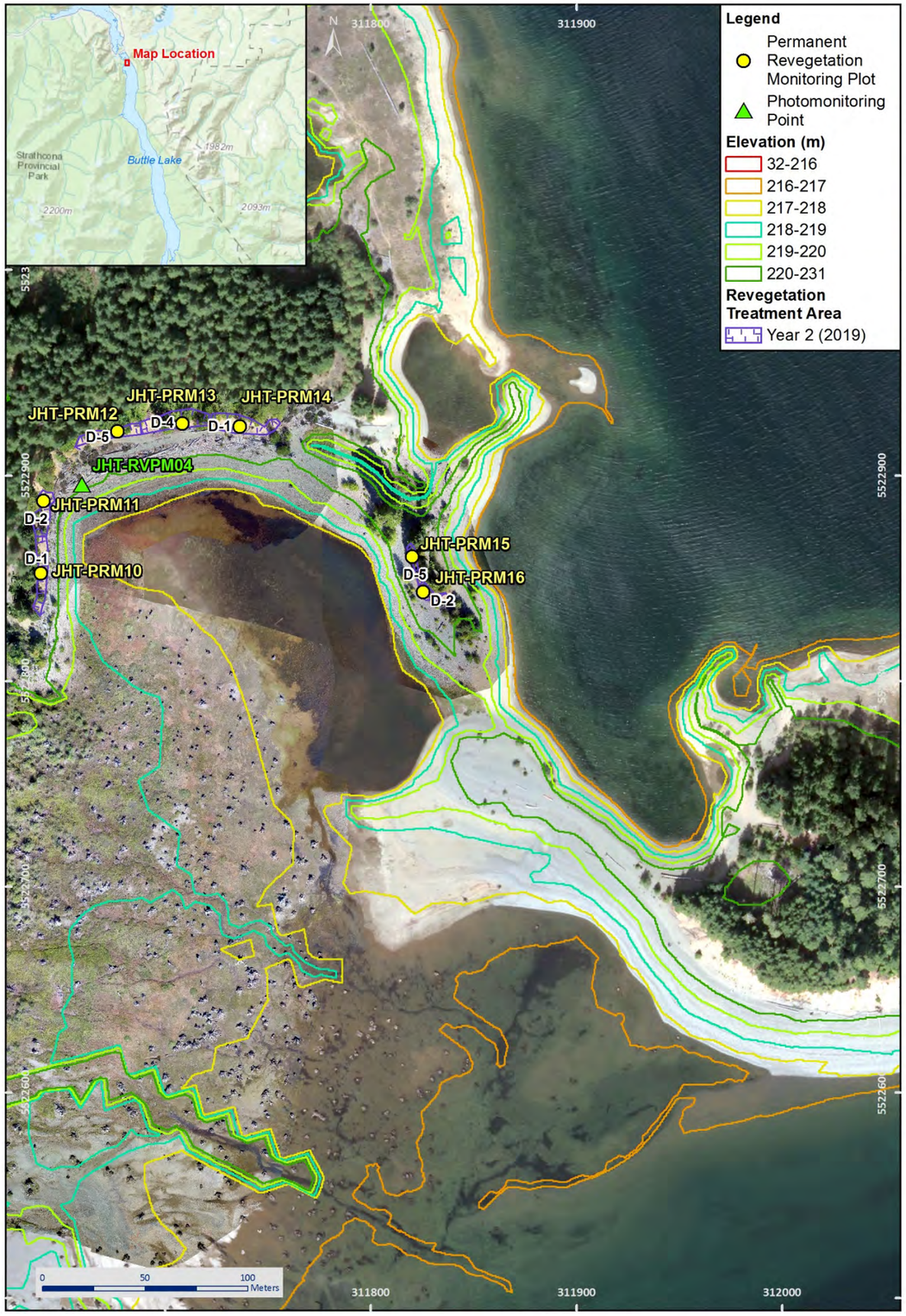

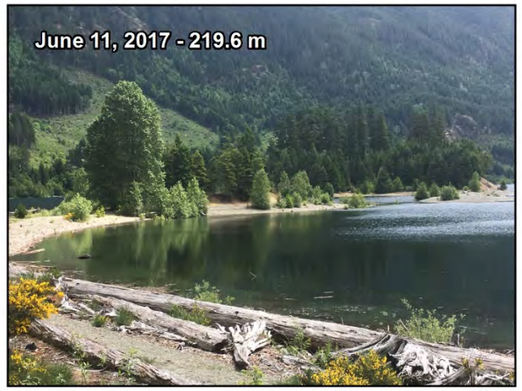

Site Description

High-use site, walk-in campground at Rainbow Island, that provides views up the narrows and to JHT-RV07. The area is comprised of flat areas that are variably vegetated and extensive unvegetated steep slopes including drawdown area and upland eroding forest soils.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Fair - a barge may be required if the existing walking trail is too narrow
Known or potential physical works:	Unknown
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for recreational users walking the beach trail, camping on the island, using the Buttle Lake boat launch (JHT-RV06) and boating in the Narrows
Public satisfaction:	The shoreline slopes to below 219 m. Some areas associated with steep unvegetated shoreline
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Steep upland slopes 47-60%
Substrate:	Gravel and sand in drawdown zone, eroded forest soils upslope.
Natural recruitment:	Recruitment impeded by erosion/deposition and high solar exposure/water deficits. Conifers growing at top of upper drawdown on east aspects. Higher recruitment observed with lower slope.
Aspect:	Variable with a large portion of the site's unvegetated area facing southeast and exposed to a long fetch.
Fetch:	None for upslope areas. High in drawdown.
Water availability:	Low for upslope forest
Human disturbance:	Flat areas heavily used, low on steep upland slopes.
Wildlife disturbance:	Low
Invasive species:	Moderate (high on suitable sites)

JHTWORKS-3 Revegetation Sites

Rainbow Island Marine Site
JHT-RV04

Revegetation Treatment Trials

D - Steep Upland Forest

PRESCRIPTION

D-1. Bioengineer slope with cottonwood modified brush layers installed by hand. Transplant forest plants from new trail to Buttle Lake Campground (JHTWORKS-2) or other source if available, on the created terraces.
D-2. Stake cottonwood by hand
D-4. Control
D-5. Plant appropriate native species from nursery stock.

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Forest species may include:
Douglas-fir (*Psuedotsuga menziesii*)
Pacific dogwood (*Cornus nuttali*)
Tall Oregon grape (*Mahonia aquifolium*)
Kinnikinnick (*Arctostaphylus uva-ursi*)

ECOFISH RESEARCH

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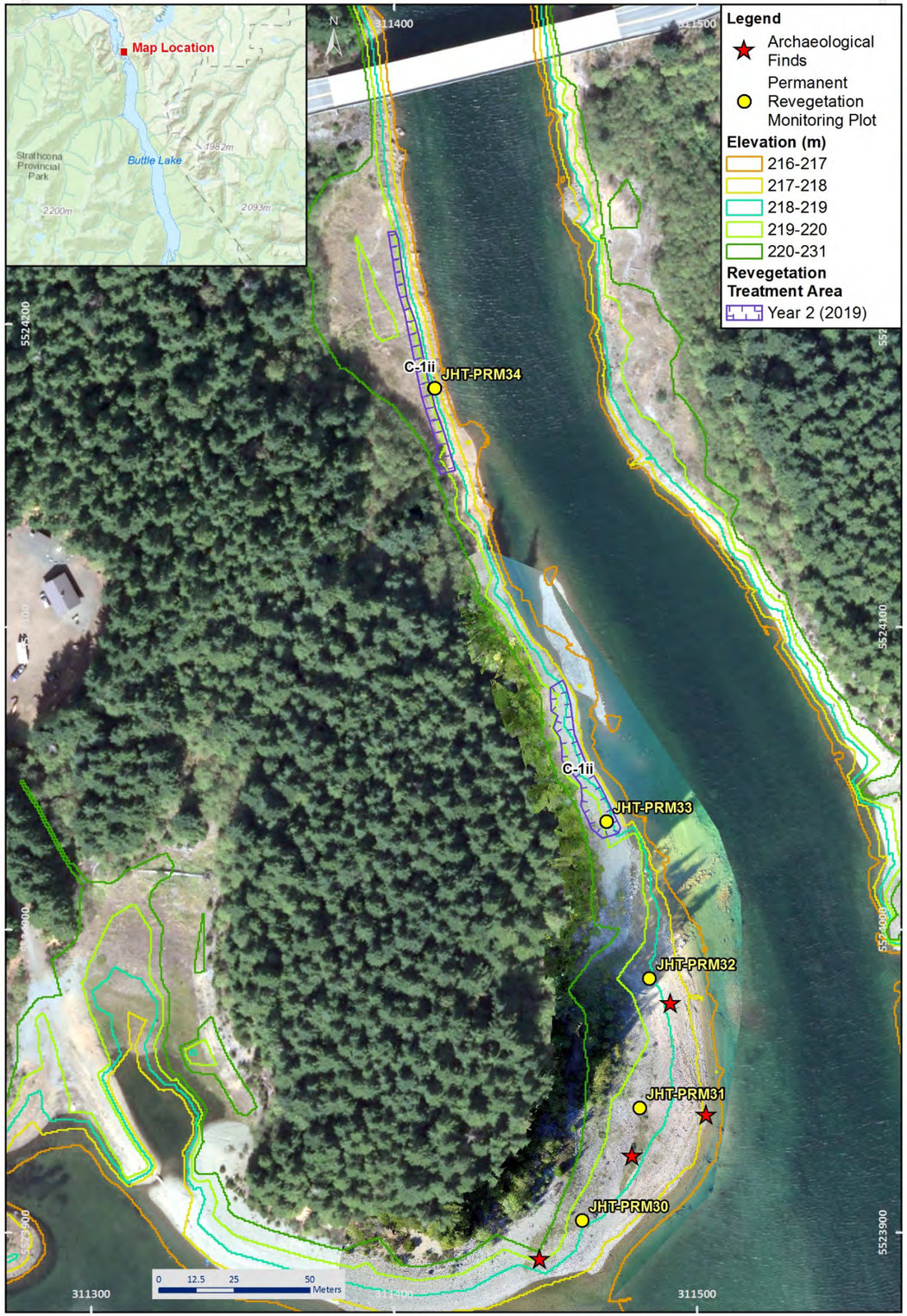

Site Description

Group campsite with a small lower-gradient beach and swimming area. Adjacent beaches are steeper. Site wraps around towards the HWY 287 bridge and steep section of the Narrows.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - adjacent to beach access, old route connects site with JHT-RV02 at low water
Known or potential physical works:	Unknown
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Moderately to highly visible for visitors to the group site and Buttle Lake Campground (JHT-RV02 and JHT-RV03). Partially visible from Westmin Rd. and the bridge over the Narrows.
Public satisfaction:	The shoreline slopes to below 219 m; no stumps
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Beach 7-12% with adjacent steeper shores 33-26%
Substrate:	Gravel and cobble, with sand on gentler slopes. Woody debris embeded and washed ashore.
Natural recruitment:	Recruitment of deciduous trees above 220.0 m. Some coniferous transplants above 220.0 m in Narrows. A slim band of small willow at ~217.8 m elevation on some slopes >15%, patches of herbs below 12% slope.
Aspect:	East-South
Fetch:	Moderate - High, woody debris accumulations near campsite and highly eroded in narrows
Water availability:	Low - Moderate
Human disturbance:	Low for much of site
Wildlife disturbance:	Low - Moderate
Invasive species:	Moderate

JHTWORKS-3 Revegetation Sites

Driftwood Group Campsite JHT-RV05

Revegetation Treatment Trials

C - Steep Upper Drawdown

PRESCRIPTION

C-1. Substrate complexing and/or stabilization (roughen/loosen and terracing), as directed by a QP. Strategically use woody debris and boulders/cobble to stabilize as needed. Add leaf litter/mulch as practical.
ii. Stake deciduous species by machine as guided by surveyed elevations (217.8-221.0 m).

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*) (type B only)

ECOFISH RESEARCH

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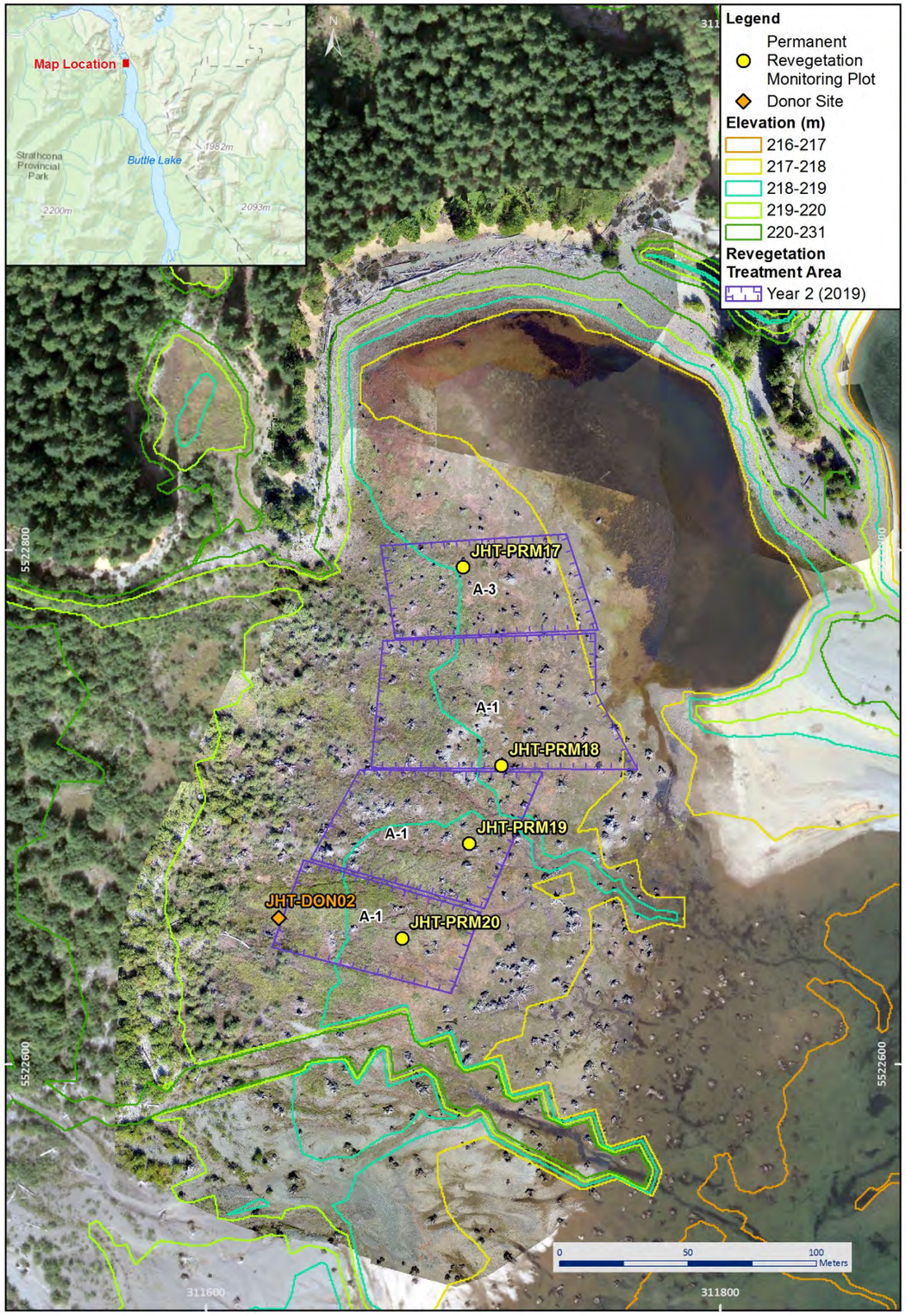

Site Description

Alluvial fan with stumps west of Rainbow Island.
Generally very well vegetated above 217.6 m.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Fair - a barge may be required if the existing walking trail is too narrow
Known or potential physical works:	None
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Visible from Rainbow Island (JHT-RV04) and boaters on Buttle Lake.
Public satisfaction:	Extensive low gradient area below 219 m; many stumps present
Fish and wildlife habitat:	High

Environmental Setting and Disturbance

Elevation (m):	217-219+
Slope (%):	1%
Substrate:	Mineral soil, some stumps
Natural recruitment:	High recruitment of vegetation communities typical of the elevation band.
Aspect:	East
Fetch:	Low - disipated by slope
Water availability:	Good - upslope stream and forest and reservoir
Human disturbance:	Low - Nil
Wildlife disturbance:	Moderate
Invasive species:	Low

JHTWORKS-3 Revegetation Sites

Buttle Lake Fan
JHT-RV07

Revegetation Treatment Trials

A - Low Slope or Alluvial Fan

PRESCRIPTION

A-1. Select stumps with a top height over 217.8 m, as guided by surveyed elevations, and fill with soil and plant. Plant stumps with tops below 219.8 m with deciduous stakes. Plant stumps with tops above 219.8 m with flood tolerant forest species (where available). Armour with large gravel or cobble.
A-3. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*)
Forest species may include:
Western hemlock (*Tsuga heterophylla*)
Western redcedar (*Thuja plicata*)
Shore pine (*Pinus contorta ssp. contorta*)
Salal (*Gaultheria shallon*)

ECOFISH RESEARCH

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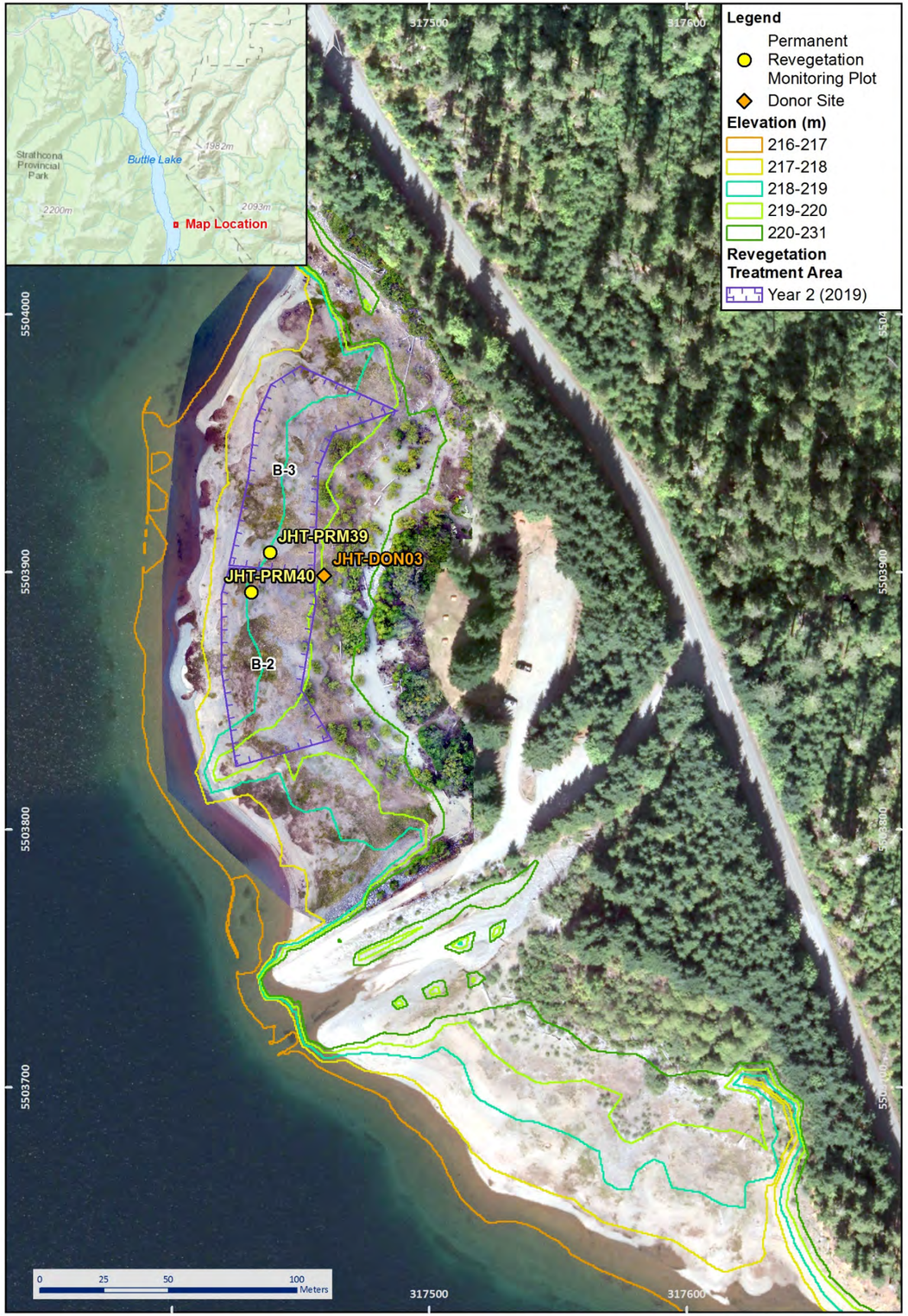

Site Description

Concrete boat launch with variably vegetated areas on either side. Day use area.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Excellent - boat launch
Known or potential physical works:	JHTWORKS-2 boat launch upgrade
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for boat launch users and boaters on Buttle Lake.
Public satisfaction:	Extensive area below 219 m; stumps have been mostly removed
Fish and wildlife habitat:	Moderate

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	Majority <6%
Substrate:	Gravel with pockets of mineral soil.
Natural recruitment:	North beach adjacent to creek better vegetated than south.
Aspect:	West (northwest to southwest)
Fetch:	High
Water availability:	Unknown, some subsurface flow from Karst Creek
Human disturbance:	Moderate (to high) - vehicle tracks, trampling, campfires
Wildlife disturbance:	Low
Invasive species:	Low

JHTWORKS-3 Revegetation Sites

Karst Creek Boat Launch
JHT-RV08

Revegetation Treatment Trials

B - Moderate Slope Drawdown

PRESCRIPTION

B-2. No site preparation. Stake deciduous species by hand as guided by surveyed elevations (217.8-221 m).

B-3. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)

Sitka willow (*Salix sitchensis*)

Red-osier dogwood (*Cornus stolonifera*)

ECOFISH RESEARCH

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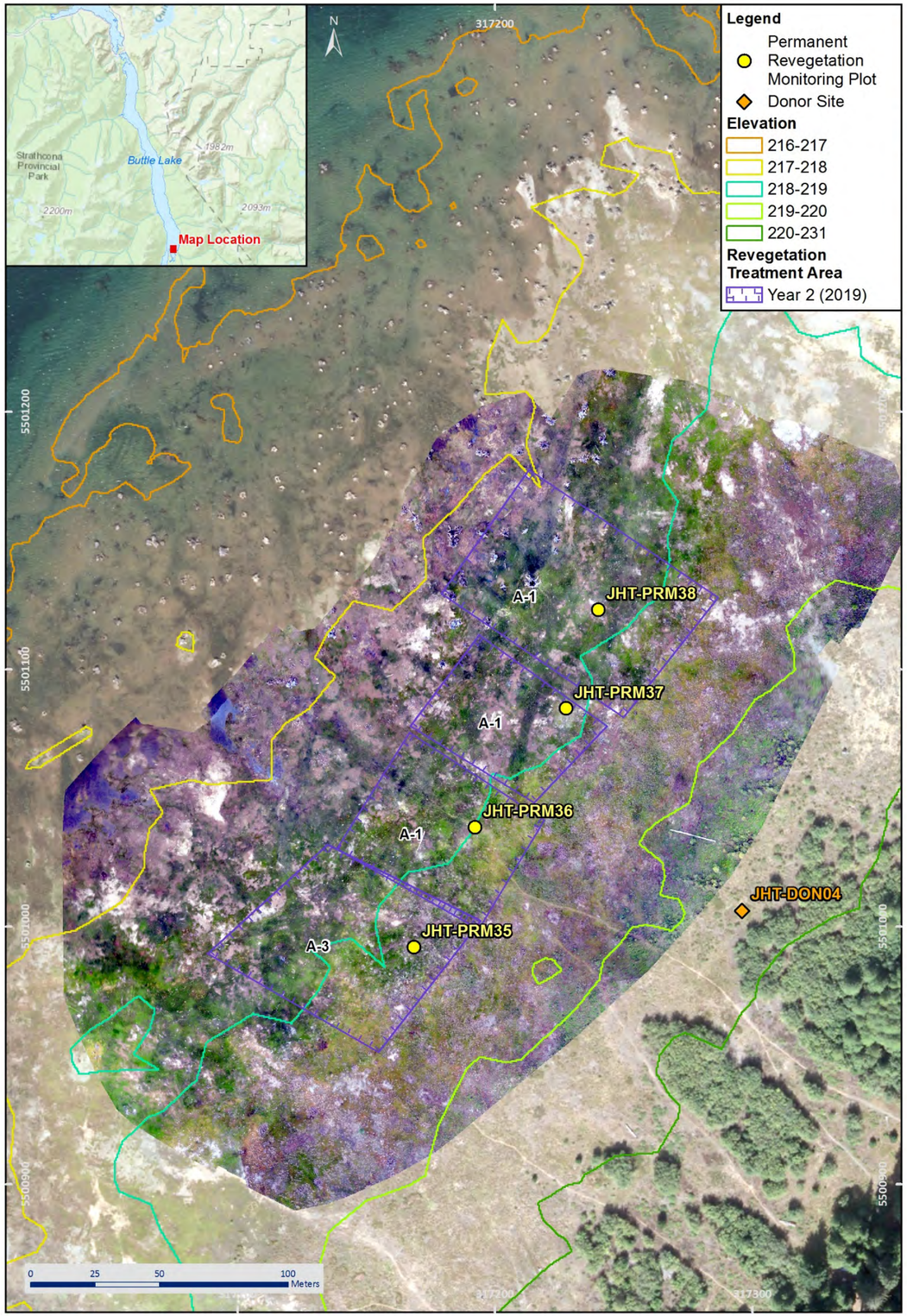

Site Description

Well vegetated expansive alluvial fan adjacent to the Ralph River Campground.

Revegetation Site Attributes

Revegetation Opportunity

Land ownership:	Crown Land (drawdown zone) - BC Parks
Machine access:	Good - may require temporary road to access lower elevations
Known or potential physical works:	JHTWORKS-2 trail to swimming area
Plant species and ecological communities at risk:	None expected

Revegetation Priority

Visibility:	Highly visible for visitors to Ralph River Campground
Public satisfaction:	Extensive area below 219 m; some stumps have been removed while those remaining are at lower elevations
Fish and wildlife habitat:	Moderate - High

Environmental Setting and Disturbance

Elevation (m):	217-221+
Slope (%):	<2%
Substrate:	Mineral soil
Natural recruitment:	High recruitment of vegetation communities typical of elevation bands.
Aspect:	West (northwest to southwest)
Fetch:	High but effect dispersed by slope
Water availability:	Good; higher at north end by Ralph River
Human disturbance:	Low (to moderate) - trampling, campground
Wildlife disturbance:	Moderate - High (evidence of deer, elk, geese grazing)
Invasive species:	Low - Moderate

JHTWORKS-3 Revegetation Sites

Ralph River Campground
JHT-RV09

Revegetation Treatment Trials

A - Low Slope or Alluvial Fan

PRESCRIPTION

A-1. Select stumps with a top height over 217.8 m, as guided by surveyed elevations, and fill with soil and plant. Plant stumps with tops below 219.8 m with deciduous stakes. Plant stumps with tops above 219.8 m with flood tolerant forest species (where available). Armour with large gravel or cobble.

A-3. Control

VEGETATION SPECIES

Black cottonwood (*Populus balsamifera*)
Sitka willow (*Salix sitchensis*)
Red-osier dogwood (*Cornus stolonifera*)
Forest species may include:
Western hemlock (*Tsuga heterophylla*)
Western redcedar (*Thuja plicata*)
Douglas-fir (*Pseudotsuga menziesii*)

ECOFISH RESEARCH

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