

Treatment Effectiveness and Maintenance and Safety Monitoring for Erosion Control Sites: Domke Falls Campground (Site 24), Refrigerator Harbor Campground (Site 25), Lucerne Campground (Site 26) and Lucerne Guard Station (Site 27)

INTRODUCTION

Lake Chelan Hydroelectric Project FERC Project No. 637 ARTICLE 401(a) Condition Appendix A, Articles 1(a)1, 1(a)2 and 1(a)3 required Chelan PUD to complete and submit an Erosion Control Implementation Plan, Site-Specific Erosion Control Plans, and an Erosion Monitoring and Maintenance Plan respectively. These plans provide a comprehensive approach to address shoreline erosion associated with the operation of this project. A number of erosion control sites described in the aforementioned plans have been treated to inhibit shoreline erosion on Forest Service lands on Lake Chelan.

This report details 'Treatment Effectiveness Monitoring' of erosion control sites which includes both Implementation Monitoring at years 1 and 3 after treatments and 'Maintenance and Safety Monitoring' every 5 years starting at year 10 after treatments. Although not required until year 10, this report includes information on 'Maintenance and Safety Monitoring' at year 5 as it was easy to collect this data while on site. The erosion control sites were treated with rip-rap, large woody debris (LWD), fabric cloth, wattles, and other means approved in site specific plans.

The erosion control sites described in this report, which are located at lakeside campgrounds, have been informally monitored by Okanogan Wenatchee National Forest boat operators and resource personnel since the projects were completed. The sites are visited frequently for recreation infrastructure operation and maintenance from May through October on an annual basis. These visits constitute monitoring for years 1 and 3. On October 10, 2015 representatives from the Okanogan Wenatchee National Forest (Paul Willard and Lori McAllister) completed a formal 'Treatment Effectiveness Monitoring'. A monitoring form was created to capture site specific information for the 'Treatment Effectiveness Monitoring' and 'Maintenance and Safety Monitoring' objectives. The following sites were monitored: Domke Falls Campground (Site 24), Refrigerator Harbor (Site 25), Lucerne Campground (Site 26) and Lucerne Guard Station (Site 27). The site specific reports follow.

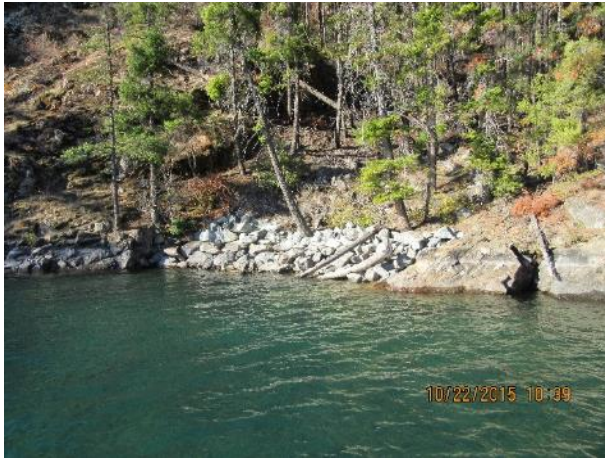
EROSION CONTROL SITE MONITORING

Domke Falls Campground – Site 24

Domke Falls erosion control work commenced in November, 2010 by Cragg's Excavating and was completed in March, 2011. Treatment was completed on 233 linear feet of shoreline. The site contained 6 Treatment Zones which included Single Rock Placement, Double Rock Placement, Enhanced Rock Placement with replaced gravels, and Enhanced Rock Placement and Large Woody Debris (LWD) placement. Several treatments included wattles and fabric cloth. 3 LWD were placed with 3 large rock anchors per log. Rocks were drilled, 1" galvanized rod was attached using epoxy, then threaded through holes in logs and bolted in place.

On October 22, 2015 Paul Willard and Lori McAllister (Monitoring Team) visited the site. Previous cursory inspections by Forest Service personnel found that the treatments appeared to be very effective. The Monitoring Team found the treatments at the Domke Falls Campground to be very successful at this time. All rocks were stable and had not shifted at all. Overall, treatment is effective; one log is gone but 2 new logs have floated in. Picnic area that was reestablished above Treatment T5 is

stable and has not lost any gravel. No new erosion was found and the limited erosion scars above the treatments are stabilizing and naturally revegetating.



Domke Falls Treatment Zones A and A1



Domke Falls Treatment Zone B



Domke Falls Treatment Zones C, C1 and C2



2015 Erosion Control Monitoring and Maintenance:
Field Data Sheet

Lake Chelan Hydroelectric Project
FERC Project No. 637

Erosion Site #: Domke Falls – Site 24 Initial Treatment Date (YR completed): NTP November, 2010.
Completion March, 2011

Monitoring Date: October 11, 2015 Monitoring Personnel: Willard, McAllister

Implementation Monitoring Yrs 1-5 only 1 Year 3 Years 5 Years

1. Slope Stabilization Objective: 90% success rate in treated areas
Observed Success Rate: 100% Comments: No new raveling above erosion treatments
2. Native to non-native Vegetation Cover Ratio Objective*: Similar to that found nearby on undisturbed slopes on 90% of the treated area: Treatment covered 95% of erosion area with rock.

There is no headcutting on slopes above the treatment. Undisturbed slopes were primarily duff with minimal vegetation.

<20% Cover on undisturbed slope <10% Cover on treated site on 5% of treated area.

3. Noxious Weed Objective: Do not introduce noxious weeds through treatments. **No new noxious weeds introduced.**

Y/N - Presence of noxious weeds before treatment. Species of weed(s): Y – Cheatgrass

Y/N - Current presence of noxious weeds. If yes, give species of weed(s): Y – Cheatgrass

4. LWD objective: Ensuring LWD is stable.

Y/N **Yes, Overall LWD is stable.** Two pieces stable, one piece gone but replaced with two naturally placed logs. If no, then provide comment:

Maintenance and Safety Monitoring Yrs 10+ @ 5 year intervals

1. Inspection of LWD systems and recommended repairs.

Safety Comments: None

Stability Comments: LWD is stable.

2. Repair conducted on LWD systems

Safety Repairs: None at this time

Stability Repairs: None Needed

3. Toe Rock Stability

Linear feet of toe rock needing maintenance: 0 Comments: Toe is stable.

4. Inspection of vegetation (planted and naturally occurring).

Are additional actions needed: No.

Refrigerator Harbor - SITE 25

Refrigerator Harbor erosion control work commenced in November, 2011 by Cragg's Excavating and was completed in March, 2012. Treatment was completed on 802 linear feet of shoreline. The site contained 5 Treatment Zones which included Double Rock Placement, Enhanced Rock Placement with crib wall, Enhanced Rock Placement and Large Woody Debris (LWD) placement. Several treatments included wattles and fabric cloth. 13 LWD were placed with 3 large rock anchors per log. Rocks were drilled, 1" galvanized rod was attached using epoxy, then threaded through holes in logs and bolted in place.

On October 22, 2015 Paul Willard and Lori McAllister (Monitoring Team) visited the site. Previous cursory inspections by Forest Service personnel found that the treatments appeared to be very effective. The Monitoring Team found the treatments at the Refrigerator Harbor to be very successful at this time. All rocks at the crib wall were stable and had not shifted at all. Overall, treatment is effective; one log is gone and one log has shifted slightly but all remaining 11 pieces are in place and

stable. No new erosion was found and the old erosion scars above the treatments are stabilizing and naturally revegetating.



Refrigerator Harbor Treatment Zone A and B



Refrigerator Harbor Treatment Zone C and D



Refrigerator Harbor Treatment Zone C, D and E

Erosion Site #: Refrigerator Harbor – Site 25 Initial Treatment Date (YR completed): NTP October, 2011. Completion March, 2012

Monitoring Date: October 11, 2015 Monitoring Personnel: Willard, McAllister

Implementation Monitoring Yrs 1-5 only 1 Year 3 Years 5 Years

1. Slope Stabilization Objective: 90% success rate in treated areas
Observed Success Rate: 100% Comments: No new raveling above erosion treatments
2. Native to non-native Vegetation Cover Ratio Objective*: Similar to that found nearby on undisturbed slopes on 90% of the treated area: Treatment covered approximately 80% of erosion area with rock. There is no headcutting on slopes above the treatment. Undisturbed slopes were primarily duff with minimal vegetation.
<20% Cover on undisturbed slope <10% Cover on treated site on 20% of treated area
3. Noxious Weed Objective: Do not introduce noxious weeds through treatments. **No new noxious weeds introduced.**

Y/N Presence of noxious weeds before treatment. Species of weed(s): Y – Knapweed & Cheatgrass
Y/N Current presence of noxious weeds. If yes, give species of weed(s): Y – Knapweed & Cheatgrass
4. LWD objective: Ensuring LWD is stable.
Y/N **Yes, Overall LWD is stable.** One log is gone and one log has shifted. 11 remaining logs are stable. If no, then provide comment:

Maintenance and Safety Monitoring Yrs 10+ @ 5 year intervals

1. Inspection of LWD systems and recommended repairs.
Safety Comments: None
Stability Comments: One log is gone and one log has shifted. 11 remaining logs are stable. It appears that changing the attachment method from the wire cable to the epoxied pin bolted through the log is a success. This method allows less movement and as a result, less friction.
2. Repair conducted on LWD systems
Safety Repairs: None at this time
Stability Repairs: None Needed
3. Toe Rock Stability
Linear feet of toe rock needing maintenance: 0 Comments: Rocks are stable.
4. Inspection of vegetation (planted and naturally occurring).
Are additional actions needed: No.

Lucerne Campground - Site 26

Lucerne Campground erosion control work commenced in October, 2012 by Cragg's Excavating and was completed in March, 2013. Treatment was completed on 803 linear feet of shoreline. The site contained 9 Treatment Zones which included Single Rock Placement, Double Rock Placement, Enhanced Rock Placement (re-armor crib wall) and Large Woody Debris (LWD) placement. Treatments included wattles and fabric cloth. A total of 16 LWD were placed with 3 large rocks anchors per log. Rocks were drilled, 1" galvanized rod was attached using epoxy, then threaded through holes in logs and bolted in place.

On October 22, 2015 Paul Willard and Lori McAllister (Monitoring Team) visited the site. Previous cursory inspections by Forest Service personnel found that the treatments appeared to be very effective. The Monitoring Team found the treatments at Lucerne Campground to be very successful at this time. All rocks at the crib wall were stable and had not shifted at all. Overall, treatment is effective; 2 logs have shifted slightly but all remaining logs are in place and stable. No new erosion was found and the old erosion scars above the treatments are stabilizing and naturally revegetating.



Lucerne Campground Treatment Zones A, B and C



Lucerne Campground Treatment Zones C and D



Lucerne Campground Treatment Zones E, F1, F2 and F3



Lucerne Campground Treatment Zones F3 and G

2015 Erosion Control Monitoring and Maintenance:
Field Data Sheet

Lake Chelan Hydroelectric Project
FERC Project No. 637

Erosion Site #: Lucerne Campground – Site 26 Initial Treatment Date (YR completed): NTP October, 2012. Completion: March, 2013

Monitoring Date: October 11, 2015 Monitoring Personnel: Willard, McAllister

Implementation Monitoring Yrs 1-5 only 1 Year 2-3 Years 5 Years

1. Slope Stabilization Objective: 90% success rate in treated areas
Observed Success Rate: 90% Comments: Very stable overall. Treatment Zones F3 and G have experienced some erosion from extreme wave action in front of the Guard Station. Will need to add 6-7 larger rocks at top of treatment to prevent further erosion. Gravel will need to be brought in to re-establish the trail that has eroded.
No new raveling above other erosion treatments.

2. Native to non-native Vegetation Cover Ratio Objective*: Similar to that found nearby on undisturbed slopes on 90% of the treated area: Treatment covered entire erosion area with rock in zones E, F1, F2, F3, & G. Due to flat nature of the site there is no slope above the treatment. See below for values for zones A-D
<20 % Cover on undisturbed slope <10 % Cover on treated site on 100% of treated area.

3. Noxious Weed Objective: Do not introduce noxious weeds through treatments. **No new noxious weeds introduced.**

Y/N Presence of noxious weeds before treatment. Species of weed(s): Y – Knapweed & Cheatgrass
Y/N Current presence of noxious weeds. If yes, give species of weed(s): Y – Knapweed & Cheatgrass

4. LWD objective: Ensuring LWD is stable.
Y/N **Yes, Overall LWD is stable.** 2 logs have shifted a short distance. Remaining logs are stable. If no, then provide comment:

Maintenance and Safety Monitoring Yrs 10+ @ 5 year intervals

1. Inspection of LWD systems and recommended repairs.
Safety Comments: None
Stability Comments: None

2. Repair conducted on LWD systems
Safety Repairs: None at this time
Stability Repairs: None Needed

3. Toe Rock Stability
Linear feet of toe rock needing maintenance: 0 Comments: Rocks are stable.

4. Inspection of vegetation (planted and naturally occurring).
Are additional actions needed: No.

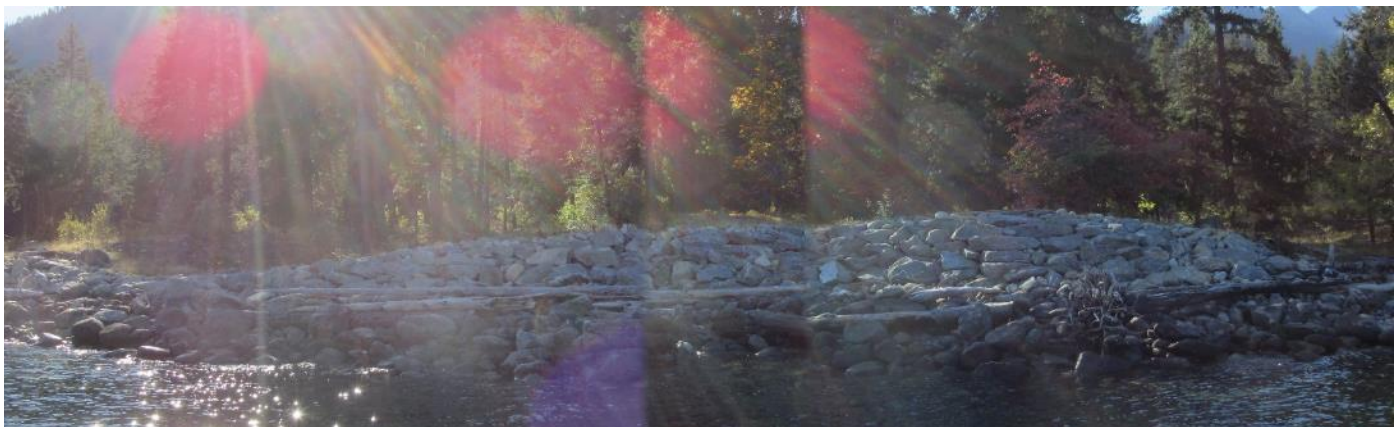
Lucerne Guard Station – Site 27

Lucerne Guard Station erosion control work commenced in October, 2012 by Cragg’s Excavating and was completed in March, 2013. Treatment was completed on 578 linear feet of shoreline. The site contained 8 Treatment Zones which included Single Rock Placement, Scattered double rock placement, Enhanced Rock Placement and Large Woody Debris (LWD) placement. Several treatments included wattles and fabric cloth. A total of 24 LWD were placed with 3 large rocks anchors per log. Rocks were drilled, 1” galvanized rod was attached using epoxy, then threaded through holes in logs and bolted in place.

On October 22, 2015 Paul Willard and Lori McAllister (Monitoring Team) visited the site. Previous cursory inspections by Forest Service personnel found that the treatments appeared to be very effective. The Monitoring Team found the treatments at Lucerne Guard Station to be very successful at this time. All rocks at the crib wall were stable and had not shifted at all. Overall, treatment is effective; one log has shifted slightly but the remaining pieces are in place and stable. No new erosion was found and the minimally exposed area at the interface of the top of the treatments and bank are stabilizing and naturally revegetating.



Lucerne Guard Station Treatment Zones A, B and C



Lucerne Guard Station Treatment Zones C, C2, D and E



Lucerne Guard Station Treatment Zone F and G

2015 Erosion Control Monitoring and Maintenance:
Field Data Sheet

Lake Chelan Hydroelectric Project
FERC Project No. 637

Erosion Site #: Lucerne Guard Station – Site 27 **Initial Treatment Date (YR completed):**

NTP October, 2012. Completion: March, 2013

Monitoring Date: October 11, 2015 **Monitoring Personnel:** Willard, McAllister

Implementation Monitoring Yrs 1-5 only X 1 Year x 2-3 Years 5 Years

1. Slope Stabilization Objective: 90% success rate in treated areas
Observed Success Rate: 100% Comments: Very stable. No new raveling above erosion treatments
2. Native to non-native Vegetation Cover Ratio Objective*: Similar to that found nearby on undisturbed slopes on 90% of the treated area: Treatment covered entire erosion area with rock. Due to flat nature of the site there is no slope above the treatment.
N/A % Cover on undisturbed slope **N/A** % Cover on treated site on of treated area.
3. Noxious Weed Objective: Do not introduce noxious weeds through treatments. **No new noxious weeds introduced.**

Y/N - Presence of noxious weeds before treatment. Species of weed(s): Y – Knapweed & Cheatgrass

Y/N - Current presence of noxious weeds. If yes, give species of weed(s): Y – Knapweed & Cheatgrass

4. LWD objective: Ensuring LWD is stable.

Y/N **Yes, Overall LWD is stable.** 1 log has shifted a short distance. Remaining logs are stable. If no, then provide comment:

Maintenance and Safety Monitoring Yrs 10+ @ 5 year intervals

1. Inspection of LWD systems and recommended repairs.
Safety Comments: None
Stability Comments: None
2. Repair conducted on LWD systems
Safety Repairs: None at this time
Stability Repairs: None Needed
3. Toe Rock Stability
Linear feet of toe rock needing maintenance: 0 Comments: Rocks are stable.
4. Inspection of vegetation (planted and naturally occurring).
Are additional actions needed: No.

**Vegetation Cover Ratio Objective derived from USDA Forest Service Erosion Control Implementation and Erosion Monitoring and Maintenance Plan, 3.1 Treatment Effectiveness Monitoring. Implementation monitoring. 2.*

EROSION CONTROL SITE MONITORING SUMMARY COMMENTS

The monitoring team expected to see successful treatments at the sites monitored for this report. Forest Service boat operators had frequently conducted informal inspections of the sites after treatments were completed and continually through the spring-fall seasons. The results of the inspection and monitoring proved that the treatments have been very successful for meeting the primary objective of slope stability. This objective was met via rock armoring treatments, functional LWD, and vegetation recovery.

Slope stability was highly successful with slopes above the treatments being 95-100% stable as measured by inspecting existing head cuts and associated soil movement. Soil movement observed throughout the treatments was insignificant. The rock armoring exhibited minimal movement characterized by a small number of rocks that have rolled out of the armoring. This rock movement had negligible effect on the effectiveness of the current treatment. The LWD placed at the sites is almost entirely intact. The monitoring team found improved anchoring of LWD with a new system of boulders and epoxied bolts to retain LWD. The LWD portions of the treatments are clearly functioning quite well. Many of the sites had rock treatment on a majority of the eroding slopes. Therefore, there was limited area to observe vegetation recovery. The trajectory for vegetation recovery at many sites is expected to slowly trend towards a percentage of vegetation equal to that found nearby on 90% undisturbed slopes in the treated area. The loss of topsoil and organic matter in the eroded head cuts does not provide an ideal area for vegetation recovery. However, the stabilized slopes will aid in vegetation recovery.