1.0 Introduction

Elk River is listed as an impaired water body under Section 303(d) of the Federal Clean Water Act (USEPA, 1999) due to high instream sediment loads and associated adverse impacts to the beneficial uses of water. To address the Elk River sediment impairment, the North Coast Regional Water Quality Control Board (NCRWQCB) adopted Watershed Waste Discharge Requirements (WWDRs), Order No. R1-2006-0042. In addition to this order the NCRWQCB is developing a Total Maximum Daily Load (TMDL) for sediment in Elk River. In May 2016, the Regional Water Board adopted the Action Plan for the Upper Elk River Sediment TMDL as an amendment to the Water Quality Control Plan for the North Coast. The TMDL Action Plan was approved by the State Water Resources Control Board in August 2017 and is undergoing review by the Office of Administrative Law, and then the US Environmental Protection Agency for final approval.

Monitoring and Reporting Program (MRP), Order No. R1-2008-092, describes the monitoring and reporting efforts Green Diamond Resource Company (GDRCo) has been conducting since 2006, as part of the South Fork (SF) Elk River WWDRs. In October 2012, new property wide WDRs (Order No. R1-2012-0087) and an associated MRP (Order No. R1-2012-0088) superseded the SF ELK WWDRs and incorporated its substantive conditions and monitoring program.

Stream crossings are potentially significant sediment sources and addressing them with upgrading or decommissioning efforts is an important part of GDRCo’s sediment reduction strategy. Upgrading and decommissioning stream crossings are accepted and effective measures to reduce sediment loading when implemented correctly (Pacific Watershed Associates 2005). However, these efforts can be vulnerable to erosion following implementation due to the ground disturbance and exposure of bare soil, as well as the judgment required to recreate the stream channel alignment through the road crossing area.

This annual report summarizes the monitoring activities undertaken in 2017 to assess erosion from a site that was decommissioned in 2015 on GDRCo property in Elk River. This site was monitored three times, once following project implementation but before the first winter (i.e., post treatment), once after the first winter season (i.e., post winter) and once after the second winter (i.e., post winter 2). Photographic documentation, void measurements, and longitudinal profiles are the three types of monitoring surveys used to assess the effectiveness of upgraded and decommissioned stream crossings. No new sites were treated in 2017, however, the results included in this report are for a site that was treated in 2015 which adjusted enough during the first winter to warrant a post winter 2 monitoring assessment. As noted in the 2016 annual report, there was no additional treatment completed at this site in 2016 (GDRCo 2016).
2.0 Site Selection

Post Winter Surveys: Based on channel adjustments noted during post winter monitoring in 2016, one site (Site ID = 185.2) was selected for monitoring in 2017. Photo point, longitudinal survey and void monitoring were conducted at site 185.2. The results are detailed below.

Post Treatment (Initial) Surveys: No new road sites were treated in 2017; therefore, no new sites were selected for monitoring.

3.0 Site Descriptions

Post Winter Surveys: One decommissioned site (Site 185.2) was selected for post treatment monitoring in 2015, post winter monitoring in 2016 and post winter 2 monitoring in 2017. The post winter 2 monitoring efforts were conducted on October 18, 2017.

Between the 2015 post treatment monitoring and the 2016 post winter monitoring at Site 185.2, significant channel modification was observed (GDRCo 2016). However, as noted in the 2016 annual report, no additional treatment was recommended (GDRCo 2016) but post winter 2 monitoring was conducted to evaluate if the channel had stabilized.

Site attributes for this stream crossing was collected during the initial photo point surveys following treatment and were summarized in the 2015 annual report (GDRCo 2015). Location of the site monitored in 2017 is displayed in Figure 1.

Post Treatment (Initial) Surveys: No new road sites were treated in 2017; therefore, no new sites were selected for monitoring.

4.0 Methods and Results

Data collection and analysis followed the procedures outlined in the MRP (Order No. R1-2012-0088), the SOP’s, and the Road Erosion Sampling QAPP for the SF Elk River WWDR. Summaries of the monitoring techniques are provided below and further detail can be found in the QAPP and the relevant SOPs.
4.1 Photo Point Monitoring

The photo point monitoring protocol is designed to provide a qualitative visual measure of the effectiveness and response of the treated crossings. Site 185.2 was monitored in 2015, 2016 and 2017 (post treatment, post winter and post winter 2, respectively). All photographs of post winter, post treatment and post treatment 2 conditions are included in Appendix A.

Pictures are organized by site number, photo point, orientation, and survey period [e.g. post treatment, post winter]. Each photograph is indexed and available in higher resolution digital files upon request. The format for naming digital photographs is as follows: <"site number"_"photo point, letter" and "orientation"_"photo number"_"survey period" (post treatment = PT, post winter 1 = PW1 and post winter 2 = PW2).jpg>. For example, a picture of Site 9 at photo point A looking downstream, taken post winter would be labeled: “P9_AD_1_PW1.jpg”.

Figure 1. Location of stream crossing monitored in 2017.
4.2 Void Measurements

The results from the void monitoring are summarized below (Table 1).

At Site 185.2, no slumps or slides were observed during the post winter 2 survey. Due to the lack of remaining indicators of the post treatment channel, channel scour calculations were made based on the longitudinal survey elevations, the length of the original excavation and the average active width of the post winter 2 channel. Between post winter 1 and post winter 2 monitoring, the excavation reach experienced an estimated 1.6 yds$^3$ of scour and 1.8 yds$^3$ of deposition. The net change was 0.2 yds$^3$ of deposition. Therefore, no significant channel scouring or gullying was observed between post winter 1 and post winter 2 monitoring. However, this site delivered an estimated 34.7 yds$^3$ of sediment between post treatment and post winter 1 monitoring. Overall, the site treatment was 78.2% effective. Based on the minimal adjustment measured and observed we do not recommend any further treatment or monitoring for this site.

### Table 1. Summary of void monitoring results for Site 185.2 (decommission).

<table>
<thead>
<tr>
<th>Year</th>
<th>Monitoring Period</th>
<th>Bank Slides &amp; Slumps</th>
<th>Channel Scouring &amp; Gullying</th>
<th>Total Volume Delivered (yds$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Erosion (yds$^3$)</td>
<td>Sediment Delivered (yds$^3$)</td>
<td>sediment Delivered (yds$^3$)</td>
</tr>
<tr>
<td>2016</td>
<td>post winter</td>
<td>20.64</td>
<td>20.22</td>
<td>97.97%</td>
</tr>
<tr>
<td>2017</td>
<td>post winter 2</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00%</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td>20.64</td>
<td>20.22</td>
<td>97.97%</td>
</tr>
</tbody>
</table>

* There was 0.2 yds$^3$ deposited over the 87 foot long excavation reach.

4.3 Longitudinal Profile Surveys

Longitudinal profiles are used to assist in interpreting void monitoring surveys. Below are the results from monitoring conducted in 2017.

A longitudinal profile survey was conducted at one decommissioned stream crossing (Site 185.2). The results from post treatment, post winter and post winter 2 monitoring surveys are presented below (Figure 2). Due to channel adjustment observed at this site during the post winter monitoring in 2016, a post winter 2 longitudinal survey was conducted in 2017.
Figure 2. Comparative longitudinal profiles at Site 185.2 collected in 2015 (post treatment, solid black line), in 2016 (post winter, solid blue line) and in 2017 (post winter 2, dashed orange line).

4.4 Summary of Post winter 2 Monitoring Results

One site (185.2) that was treated in 2015 was monitored 2017. A summary of the monitoring surveys conducted at this stream crossing is provided below (Table 2).

Void, photo point and longitudinal profile monitoring at Site 185.2 documented no substantial adjustment post winter 2.

Table 2. Summary results from Site 185.2 (decommission).

<table>
<thead>
<tr>
<th>Year</th>
<th>Period</th>
<th>Watershed Area Above Crossing (ac.)</th>
<th>Priority</th>
<th>Photo Point Monitoring (Y/N)</th>
<th>Long Profile Monitoring (Y/N)</th>
<th>Void Monitoring (Y/N)</th>
<th>Assessed Potential Future Yield (yds³)</th>
<th>Sediment Delivered (yds³)</th>
<th>Percent Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>post winter</td>
<td>125.0</td>
<td>H</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>159</td>
<td>34.70</td>
<td>78.17%</td>
</tr>
<tr>
<td>2017</td>
<td>post winter 2</td>
<td>125.0</td>
<td>H</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>124.30</td>
<td>0.00*</td>
<td>100.00%</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td>125.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>159</td>
<td>34.70</td>
<td>78.17%</td>
</tr>
</tbody>
</table>

* There was 0.2 yds³ deposited over the 87 foot long excavation reach.
4.5 Summary of Post treatment Monitoring Sites

During the 2017 summer period, GDRCo did not decommission or upgrade any road crossings associated with the Programmatic Road Management WDR (Order No. R1-2010-004) in Elk River. Since no new road work was conducted in 2017, no post winter monitoring is planned for 2018. If any new road work is conducted in 2018, it will be monitored post treatment in 2018 and included in the 2018 annual report.

5.0 Problems Encountered

Two problems were encountered during the 2017 post winter 2 surveys:

1) At Site 185.2, there is large woody debris (LWD) covering the channel upstream and downstream of the excavation (see Figures 3, 4, 6, 7, 9 and 10). This makes it impossible to get repeatable measurements between and under the LWD which can cause inconsistent measurements during the longitudinal profile survey (Figure 2). For example, if a point was surveyed one year but not the other, it will artificially appear to have scoured or deposited. Therefore, the longitudinal profile results outside of the excavation reach should not be considered an accurate portrayal of the channel elevation.

2) At Site 185.2, the standard void measurement technique (using a tape measure in the field to measure length, width and depth) to estimate channel scour and gullyng would have been difficult to accurately measure. This is due to the lack of post treatment channel indicators, length of excavation and the extent of channel modification between post treatment and post winter monitoring. Therefore, the standard measurement technique was replaced by using the longitudinal profiles to calculate channel scour and gullying. We believe that this produced a more accurate estimation of the amount of material scoured and deposited within the excavation reach.

One problem was encountered during the 2016 post winter survey that is persistent in this 2017 annual report. It was discussed in the 2016 annual report but is worth reiterating because the 2016 post winter photos are included in Appendix A. During the 2016 surveys an iPhone 6 was used instead of an Olympus Stylus Tough-8000. While comparisons can still be made, the resolution of the iPhone images after cropping was of lower quality than the Olympus. A new Olympus Stylus TG-870 camera was used during the 2017 post winter 2 that gave a similar quality as the original Olympus Stylus Tough-8000. The Olympus Stylus TG-870 or a camera of equal or better quality will be used in the future.
6.0 Quality Assurance Summary

Special training requirements apply to all GDRCo staff involved in the implementation of this monitoring project. All staff was previously trained to perform assigned responsibilities (Table 3). Training was performed on all aspects of field work including: taking measurements and recording data, and calibrating or adjusting equipment. Training in the office included: downloading and data entry. Data management training included: data proofing, quantification, summary, and updating of files.

Table 3. Summary of training for GDRCo staff implementing the Road Erosion Monitoring protocols.

<table>
<thead>
<tr>
<th>Staff</th>
<th>Position</th>
<th>Job status</th>
<th>Photo point Monitoring</th>
<th>Longitudinal Profiles</th>
<th>Void Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matt Nannizzi</td>
<td>Field Personnel</td>
<td>Current</td>
<td>10/14/2014</td>
<td>10/14/2014</td>
<td>10/14/2014</td>
</tr>
<tr>
<td>Jonathan O'Connell</td>
<td>Field Personnel</td>
<td>Current</td>
<td>10/18/2017</td>
<td>10/19/2017</td>
<td>10/18/2017</td>
</tr>
</tbody>
</table>
Literature Cited


Appendix A.
Figures displaying post treatment and post winter photographs collected from photo point monitoring efforts conducted in 2015, 2016 and 2017. In all figures, photos were cropped to provide the best example of site characteristics.
Figure 3. Photo of Site 185.2, Point A (25 feet upstream of excavation) looking downstream, taken post treatment 2015 (A), post winter 2016 (B) and post winter 2 2017 (C).
Figure 4. Photo of Site 185.2, Point A (25 feet upstream of excavation) looking upstream, taken post treatment 2015 (A), post winter 2016 (B) and post winter 2 2017 (C).
Figure 5. Photo of Site 185.2, Point B (top of excavation) looking downstream, taken post treatment 2015 (A), post winter 2016 (B) and post winter 2 2017 (C).
Figure 6. Photo of Site 185.2, Point B (top of excavation) looking upstream, taken post treatment 2015 (A), post winter 2016 (B) and post winter 2 2017 (C).
Figure 7. Photo of Site 185.2, Point C (bottom of excavation) looking downstream, taken post treatment 2015 (A), post winter 2016 (B) and post winter 2 2017 (C).
Figure 8. Photo of Site 185.2, Point C (bottom of excavation) looking upstream, taken post treatment 2015 (A), post winter 2016 (B) and post winter 2 2017 (C).
Figure 9. Photo of Site 185.2, Point D (25 feet downstream of excavation) looking downstream, taken post treatment 2015 (A), post winter 2016 (B) and post winter 2 2017 (C).
Figure 10. Photo of Site 185.2, Point D (25 feet downstream of excavation) looking upstream, taken post treatment 2015 (A), post winter 2016 (B) and post winter 2 2017 (C).