

WHAT IS A WATER QUALITY EFFECTIVENESS EVALUATION?

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FREP

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The Forest and Range Evaluation Program (FREP) of the Ministry of Forests and Range provides high quality, science-based information for decision-making and continuous improvement of forest practices, policies, and legislation in British Columbia.

Water quality is one of 11 resource values managed under the *Forest and Range Practices Act* (FRPA). FREP contributes to that management by:

- Developing and implementing the water quality effectiveness evaluation procedure;
- Identifying issues regarding the implementation of forest policies, practices, and legislation as they affect water quality; and
- Implementing continuous improvement of forest management to maintain and improve water quality.

The Water Quality Effectiveness Evaluation focuses on one primary question:

ARE FOREST AND RANGE PRACTICES EFFECTIVE IN PROTECTING WATER QUALITY?

Under *FRPA*, forest agreement holders can customize forest and grazing practices and develop site-specific strategies for environmental protection as long as they are consistent with government's objectives. "Results-based" management is concerned with if, not how, a licensee maintains water quality.

Effectiveness evaluation indicators must therefore be able to provide information on whether the policy of allowing default, customized or innovative forest practices is effectively meeting the government's objectives. To answer these questions, FREP has developed a simple and

repeatable process to evaluate potential forestry and range impacts on water quality.



Photo: Christine Unghy

ARE FRPA POLICIES EFFECTIVE IN PROTECTING WATER QUALITY?

The FREP Water Quality Effectiveness Evaluation selects representative forestry and livestock managed sites throughout the province that are compliant with approved

The FREP Mission:

To be a world leader in resource stewardship monitoring and effectiveness evaluations; providing the science-based information needed for decision-making and continuous improvement of British Columbia's forest and range practices, policies and legislation.
<http://www.for.gov.bc.ca/hfp/frep/index.htm>



results and/or strategies. These evaluations assess outcomes of operational plans to determine the extent to which objectives have been achieved. Recommendations on practices, legislation and policies are provided as they become available.



Photo: Brian Carson. Forest roads near streams can be a major source of fine sediment. At this site a road ditch flows unimpeded over an unarmoured bridge abutment directly into a stream.

HOW DO WE CHOOSE WHICH FORESTRY- AND RANGE- SITES TO EVALUATE?

A list of cutblocks harvested within the past two years is randomly generated for each district. The haul road from the cutblock to the main haul road identifies the sampling area. Sample sites within the sampling area occur where the road crosses a stream, a stream runs parallel to the road, or where a land slide occurs within a cutblock. Sample sites also occur within the cutblock's riparian area, and along skid trail networks. In districts where range lands are wide spread, these same sites will capture the range sites with highest risk.

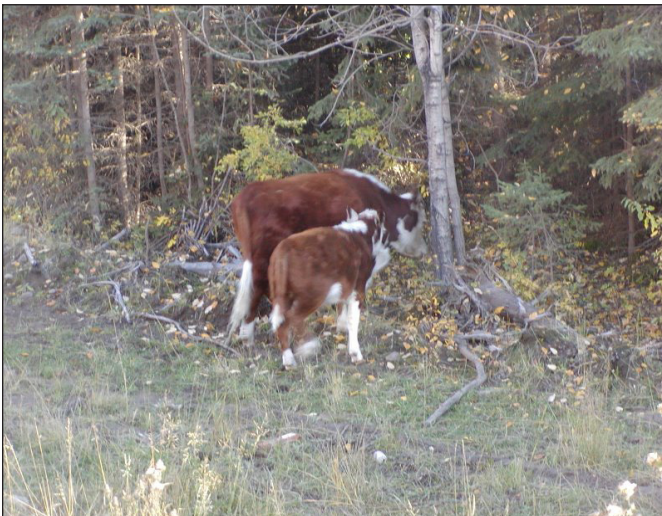


Photo: Brian Carson. Free-grazing livestock close to streams can cause fecal contamination.

1. ASSESS CONNECTIVITY

A site might have exposed mineral soil, but does it contaminate waters flowing in natural drainages?



Photo: Brian Carson. At this location, the forest floor filters sediment laden ditch water (connectivity = 0).

HOW DO WE EVALUATE SELECTED FORESTRY- AND RANGE-SITES?

Once a site is chosen using a random selection process, the evaluator completes the following four steps:

1. Assess whether the managed site and the stream are connected by surface flow.
2. Estimate volume of sediment generated by the site.
3. Estimate volume of sediment delivered to the stream and assigns an impact rating.
4. Review the key aspects of successful management on non-impacted sites and (or) how management could be improved on impacted sites.

Assessing the degree of connectivity between a managed site and a natural drainage is central to any water quality analysis. Positive connectivity can often be established conclusively by inspecting the storm discharge pathway between the site (such as a road that runs parallel to a stream) and the receiving waters. A recognizable continuous or discontinuous coarse sediment trail from a road ditch flowing directly into a stream indicates that at least some water laden with fine sediment has travelled that far during past storm events. Forest soils are excellent filters. With no means to transport eroded material or fecal coliform from a managed site to the stream by surface flow, there will be no effect on water quality regardless of the degree of disturbance.



Photo: Brian Carson. A ditch line drains directly into a stream (connectivity = 1).

Sites not “connected” require no further assessment. Simple tables that help evaluators determine degree of connectivity, (See Table 1), have been provided. Connectivity is primarily dependent on the size of the drainage catchment and distance over the forest floor between discharge and stream.

Table 1. Estimates of connectivity
(1 = 100% connectivity, 0 = no connectivity)

| Distance over forest floor between ditch outlet and wetted width of stream (m) | Approximate area of exposed mineral soil upslope of storm drainage outfall (m ²) | | | | | | | |
|--|--|-------|--------|---------|---------|----------|-----------|-------|
| | < 10 | 10-50 | 50-100 | 100-250 | 250-500 | 500-1000 | 1000-2000 | >2000 |
| 0.5-1 | 0.5 | 0.8 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1-2 | 0.2 | 0.5 | 0.8 | 1 | 1 | 1 | 1 | 1 |
| 2-5 | 0 | 0.2 | 0.5 | 0.8 | 1 | 1 | 1 | 1 |
| 5-10 | 0 | 0 | 0.2 | 0.5 | 0.8 | 1 | 1 | 1 |
| 10-20 | 0 | 0 | 0 | 0.2 | 0.5 | 0.8 | 1 | 1 |
| 20-30 | 0 | 0 | 0 | 0 | 0.2 | 0.5 | 0.8 | 0.8 |
| >30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 |

2. ESTIMATE VOLUME OF SEDIMENT GENERATED BY THE SITE

If a managed site is connected to a stream, how do we estimate the amount of fine sediment that has, or will be potentially eroded?

If a slope has experienced a mass failure, or if obvious gullies and rills are apparent on a disturbed surface,

estimating the volume of material lost gives a quantitative measure of mass erosion. All exposed, unconsolidated surface materials are subject to rainfall erosion, with a rate of erosion proportional to the nature of the surface and its degree of vegetation and (or) armouring. Newly exposed soil generally has a high initial rate of erosion (around 1 cm/yr), falling off over time as the surface either re-vegetates or self-armours. Only the portion of a bare surface covered with fine sands or finer material is considered “erosive.” The more recent the disturbance and the greater the portion of fine-textured materials exposed, the greater the likelihood of high rates of erosion. Active road surfaces also can generate fine sediment depending on their slope, use and quality of surfacing material.

The FREP Water Quality Protocol uses a series of tables to help evaluators choose appropriate values to estimate total volumes of sediment generated. As an example, Table 2 provides estimates of expected fine sediment generation from road surfaces under different conditions.



Photo: Brian Carson. A 3 per cent sloping, moderately used haul road with average surfacing material loses an estimated 2mm of fine sediment each year.

3. ESTIMATE VOLUME OF SEDIMENT DELIVERED TO A STREAM AND ASSIGN A WATER QUALITY IMPACT RANKING

How much sediment has been or will be delivered from the site under assessment to the stream?

Combining connectivity with a measure of fine sediment generated at a site provides an indication of how a site will potentially affect water quality. The assessment provides an “order of magnitude” ranking for the relative amount of fine sediment being generated by a site. Each site is assigned to one of five water quality rankings: “Very Low,”

“Low,” “Moderate,” “High” and “Very High” based on the volume of sediment with the potential to reach the stream. Where livestock are present on a managed site with demonstrated connectivity to a stream or lake, the evaluator records the presence of field characteristics that indicate potential water quality decline (e.g. dung adjacent to stream bank).

Table 2. Expected annual rates (m/yr) of surface erosion from roads (0.001m= 1mm)

| (2-10% slope) | Road Surfacing Quality | | | |
|--------------------|------------------------|--------|---------|-------|
| Road Use | Coarse Ballast | Good | Average | Poor |
| Heavy | 0 | 0.002 | 0.005 | 0.01 |
| Moderate | 0 | 0.001 | 0.002 | 0.005 |
| Light | 0 | 0.0005 | 0.001 | 0.002 |
| Deactivated | 0 | 0.0002 | 0.0005 | 0.001 |

4. REVIEW MANAGEMENT TECHNIQUES ON HIGHER IMPACT SITES

Where water quality impact rankings of moderate or higher occur, are opportunities to improve management of the site available?

Following a site assessment, the evaluator identifies if opportunities are available to reduce potential water quality impacts for sites that scored a “Moderate,” “High” or “Very High” ranking. How a road is located, constructed, and maintained, how a cutblock is harvested, and how a pasture is grazed will determine if and how much water quality may be affected. Placing culverts properly, crowning roads, employing ditch blocks and diversion culverts, using better quality surfacing materials, ensuring wind-firm riparian zones, and controlling livestock access to streams all strongly influence how water quality might be affected. These opportunities for improvement can be used for both mitigating site impacts and as guidance to improve future practices.



Photo: Brian Carson. An evaluator assesses how management has affected fine sediment delivery to nearby stream.

Sediment management must be considered during all phases of a road’s life, from location and design to construction, maintenance and deactivation. Special care is required adjacent to streams when locating, designing and installing bridges. Bridge approaches should be designed to effectively intercept ditch water before it reaches a creek, bridge decks should be placed above road grade so water flows away from the bridge, and any unconsolidated material exposed during excavation carefully armoured to limit surface erosion.



Photo: Brian Carson. Special attention is always required when working near streams.

CASE STUDIES

Two examples of sites and evaluation results are provided below.

Example Site 1.

Low levels of fine sediment generated from branch road crossing creek.



Photo: Brian Carson.

Characteristics of this site used in evaluation:

Connectivity: 1

Portion of fines in native soil: 0.5

Surface erosion from cutbank:

$$1 \times 0.5 \times 50m \times 1m \times 0.01m = 0.25m^3$$

Surface erosion from road:

$$1 \times 1 \times 50m \times 5m \times 0.001 = 0.5m^3$$

Total fine sediment delivery to creek:

$$0.25 + 0.50 = 0.75m^3$$

0.75m³ falls into "Low" WQ Impact Class

Management Implications:

Practices at this crossing are good with reasonable quality road surface materials used and re-vegetated cutbanks. No changes to management are recommended.

Example Site 2.

Very high levels of fine sediment generated by mass failure caused by excess road drainage.



Photo: Brian Carson.

Characteristics of this site used in evaluation:

Portion of fines in native soil: 0.5

Volume of slide material: 20m x 10m x 1m = 200m³

Volume of slide material still on site:

$$10m \times 8m \times 2m = 160m^3$$

Volume of slide material reaching creek:

$$200m^3 - 160m^3 = 40m^3$$

Total fine sediment delivery to creek:

$$0.5 \times 40m^3 = 20m^3$$

20m³ falls into "Very High" WQ Impact Class

Management Implications:

Practices at this site have failed to preserve water quality. Increased number of culverts in road ditch upslope could have prevented this failure and its severe water quality impact on creek.

RESULTS

The water quality assessments for 2007 and 2008 are provided in Table 3. During the two-year period 1,202 sites were evaluated throughout the province. Overall, 71 per cent of sites were rated “Very Low” or “Low” for potential sediment generation, indicating water quality is being preserved. Twenty-five per cent of the sites scored in the moderate range, with 6 per cent in the high and very high category. Any mitigation response to a site that scored Moderate or higher will involve a balancing of available budgets, ecological assessments, and priorities.

Table 3. Results of 2007 and 2008 water quality monitoring

| 2007 and 2008 Water Quality Evaluation Results | | | |
|---|------------|------------|--------------|
| Rank | 2007 | 2008 | Combined |
| Very low <0.2m ³ | 233 (43%) | 227 (34%) | 460 (38%) |
| Low 0.2m ³ - 1.0m ³ | 151 (28%) | 223 (33%) | 374 (31%) |
| Moderate 1.0m ³ - 5.0m ³ | 121 (23%) | 181 (27%) | 302 (25%) |
| High/Very High >5.0m ³ | 32 (6%) | 34 (5%) | 66 (6%) |
| Total | 537 | 665 | 1,202 |

CONSIDERATIONS FOR PROFESSIONALS AND DECISION MAKERS

Specific management actions cited through field evaluations that resulted in low levels of fine sediment generation or could have improved water quality at sample sites with a “Moderate” or “High” to “Very High” water quality impact centered on:

- Installing more frequent, strategically placed culverts;
- Armoring or re-vegetating disturbed ground as soon as possible after construction; and,
- Providing effective and timely road maintenance that is in balance with the risk to the road, its users and the environment.

In addition to its use in the provincial FREP program, the Water Quality Protocol has been adopted by a number of forest licensees working in community watersheds in British Columbia for their forest management certification requirements.

The FREP Water Quality Protocol provides forest and range professionals with a simple but rigorous assessment of water quality impact of forestry operations and management practices that can help reduce and (or) minimize those impacts.



Photo: Andrea Lyall.

To learn more about the FREP Water Quality Protocol please refer to FREP website:

<http://www.for.gov.bc.ca/ftp/hfp/external/!publish/frep/indicators/Indicators-WaterQuality-Protocol-2009.pdf>

More information about FREP visit:

<http://www.for.gov.bc.ca/hfp/frep/>

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