Guidelines for In-Stream and Off-Channel Routine Effectiveness Evaluation

April 2003

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1.0 Introduction

With the implementation of many Aquatic Restoration and Rehabilitation projects, considerable funds, time and effort will have been invested in restoring habitat in numerous watersheds throughout the province. A standardised effectiveness evaluation procedure is required to ensure that restoration projects are:

1. successful at achieving the watershed objectives as defined in a Restoration Plan (RP) or restoration design report (i.e., Work Plan);
2. conducted in a cost-effective manner;
3. optimised and adjusted to best meet restoration objectives based on lessons learned from successes and failures in the field through an adaptive management process.

A framework for conducting effectiveness evaluations for all watershed restoration components (up-slope, stream and riparian) was developed to provide a rationale for undertaking effectiveness evaluations throughout the province (Gaboury and Wong, 1999). The framework breaks effectiveness evaluations into three levels based on statistical rigor and scope. The most basic level of evaluation defined in the framework is Routine Effectiveness Evaluations (REE), while Intensive Effectiveness Evaluation (IEE) and Operational Techniques Refinement (OTR) are more focussed at addressing specific questions or issues in watershed restoration.

While the effectiveness evaluation framework applies to all watershed restoration components, each component requires specific procedures be undertaken to determine the overall component effectiveness. This document describes the REE procedures to be implemented for the stream and off-channel restoration components of watershed restoration work in target watersheds.

2.0 Objective

Routine Effectiveness Evaluations provide a low intensity, standardised procedure for determining the success of stream and off-channel restoration projects at a broad scale, and low cost. The intent of the REE procedure is to examine all sites within restoration projects to determine, at a qualitative level, if physical and biological objectives at the site, component and watershed level are being met satisfactorily (see Gaboury and Wong, 1999 for objective definitions). REE also provide limited feedback regarding the overall appropriateness of prescriptions at a site level.

The outputs of REE are:

1. recommendations for site-specific maintenance or remedial works;
2. documentation of unexpected and instructive site-specific successes and failures;
3. a statement of progress towards component restoration completion including a time frame for additional evaluation and;
4. recommendations (if any) for potential IEE and OTR projects stemming from REE findings.

The REE outputs may be used to determine restoration component completion in eligible watersheds by feeding information back to Restoration Plans (RP's) and could be rolled up to summarise province-wide REE findings in an annual compendium. Recommendations from the annual REE compendium form a component of an adaptive management loop that may be used to adjust Aquatic Restoration and Rehabilitation treatment diagnoses, designs or construction practices.

3.0 Methods

The REE methodologies follow directly from Koning et al. (1998). However, the methods have been updated to reflect changes in the program that have occurred in recent years. Updated field forms for entering REE information modified from Koning et al. (1998) are included as Appendix A-1 for in-stream and Appendix B-1 for off-channel evaluations.

The site-specific objectives for in-stream restoration can relate to short-term habitat generation or long-term channel re-forming processes. As such, it is important that the watershed level objectives be reviewed as per the RP to determine the nature and intent of in-stream works prior to undertaking a REE. Otherwise, restoration works successful at providing long-term channel recovery could be identified as failing to create short-term fish habitat and remedial actions recommended.

Objectives for in-stream and off-channel projects must be indicated on the REE field form (completed examples are included in Appendices A-2 and B-2, resp.). This is accomplished by placing a circle in the appropriate columns for physical and biological performance objectives for each site as per the methodology of Koning et al. (1998). The task of the REE methodology is to contrast the planned performance with the realised performance of the site.

Timing for conducting REE on in-stream projects will need to be considered. If the site objectives all pertain to high flow conditions, REE should be timed for freshet. If objectives are better observed at low flow, then REE should be conducted at low flows.

4.0 Completing Restoration Works Summary Forms

A Restoration Works Summary must be completed immediately after construction of instream restoration treatments (Appendix A1) or off-channel developments (Appendix B1). All 'General Information' and 'Site Description' information (see relevant sections below) should be completed on the summary form(s). Those physical and/or biological objectives that were intended to be addressed by the implemented restoration treatment should be identified by placing a circle within the appropriate cell on the form. For example, circles have been placed in Appendix A-2 to indicate that the physical objective of the multiple LWD structure was to scour a pool, with the associated biological objectives of improving overwintering and rearing habitat for juvenile bull trout. Information pertaining to 'Site Description', and physical and/or biological objectives must be completed on each constructed restoration treatment.

5.0 Completing REE Data Forms

5.1 General Information

Name of Sponsor
Enter the name of the company or group that is managing or funding the project.

Project Name
Enter the name of the watershed restoration project on which the REE is being conducted.

Forest District
List the Ministry of Forests forest district in which the REE is being completed.

Watershed
Identify the name of the watershed or watershed group in which the in-stream restoration was completed, as referenced in the Regional Resource Management Plan.

Sub-watershed
Identify the sub-watershed in which the restoration works were completed.

Date
Enter the day, month and year that the REE was completed.

Survey Crew
Enter the initials of the survey crew and the organisation with which they are affiliated.

Weather
Enter the weather and flow conditions on the date of the REE survey (very high – greater than bankfull, high – bankfull, moderate – intermediate flow less than bankfull, low – low flow, typical of late summer). Note, the REE should be conducted in a flow that is suitable for assessing the performance of structures. As such, very high and high flows are excessive for the majority of REE, and should be avoided.

REE Interval
Enter the period for which the REE is being completed (e.g. one, three or five years following construction, or following a 1 in 5 year or greater discharge event).

Other Components Surveyed
Identify what other watershed components are being evaluated within the watershed (e.g. upslope, riparian, fish access and off-channel). Listing this information will facilitate the compilation of all REE summaries in a provincial REE compendium.

5.2 Specific Information for In-Channel Projects

5.2.1 Site Description

These definitions apply to the stream project evaluation criteria for the REE field form (Appendix A-1):

Stream
List the particular stream within the watershed that is being evaluated.

Distance
Measure the distance from the start of the reach to the restoration structure being evaluated.

Site ID #
Individual restoration sites must be entered as separate line items and identified in a consistent fashion with REE plans, as-built reports and other REE documents.

Structure Type
Enter the appropriate code for the restoration structure being evaluated. As the REE is a non-intensive evaluation procedure, all possible restoration structure types have not been listed. Use the code that best describes the structure being evaluated. If a structure type is not listed, use the “other” category and supply a list describing the additional codes.

LWD-single	LWD-1
LWD-multiple/A-jam	LWD-M / LWD-A

LWD-revetment	LWD-R
LWD-deflector (single or double)	LWD-D
LWD-sill logs	LWD-S
LWD-bar stabilisation	LWD-B
Bioengineering – Bar stabilisation	BIO-BAR
Bioengineering – Bank stabilisation	BIO-BANK
Boulder-single	BLD-1
Boulder-cluster	BLD-C
Boulder-groyne	BLD-G
Rip rap	RR
Rock Riffle	RIFF
Fertilisation (reach level)	FERT
Gravel placement	GRAV

Site Objective
The site objective of a particular restoration structure is a simplified and generic statement of purpose that parallels the site-specific objective. For an LWD jam, the intended function could be to scour a pool, deflect flow from an area of erosion or induce deposition of sediment to accelerate revegetation. The intended function will come from restoration summaries, REE plans developed at the prescription development phase or previous REE reports.

Species
Enter the target species for the restoration site, using species definitions found in Appendix A-4. If multiple species are targeted at a given a site, list all species abbreviations.

Life Stage
List all lifestages for which the particular restoration structure was designed to provide habitat.

5.2.2 Performance Objectives

The data collected at the level of performance objectives allows for the systematic review of physical and biological performance objectives to determine if in-stream restoration structures are adequately meeting site objectives.

All performance objectives are scored on a 4-point scale to indicate how well a restoration structure is, or is not meeting an objective. In all cases, a score of 4 indicates the structure is exceeding expectations for that particular attribute, and a score of 1 represents a failure to achieve the site or component objective. Half point scoring is allowed to provide a greater degree of discretion to REE implementers. The following definitions, modified from Koning et al. (1998), apply for stream component REE activities:

Score	Condition
4	Site conditions resulting from works are exceeding expectations and objectives.
3	Site conditions resulting from works are meeting expectations and objectives.
2	Site conditions resulting from works are failing to meet expectations or objectives.
1	Site conditions resulting from works fail to meet objectives. Expectations are not met.

For each of the physical and biological objectives, a series of scoring definitions are provided to guide the evaluation of structure performance. Site objectives and on-site conditions must be considered when evaluating structure performance. It is acknowledged that the scoring definitions do not apply to all projects or site objectives. If additional definitions are required for unique or non-standard sites or projects, summarise the definitions used in the REE report.

5.2.2.1 Physical Objectives

The categories of data collected for the physical performance objectives relate to the impact of the structure on the morphology of the stream channel. The scoring of attributes relates only to those attributes that the structure was designed to effect. Those attributes should be marked with a circle and available from the REE plan as described above. Thus, a boulder cluster would not have a site-specific objective of scouring a pool. Thus the pool column would be left blank, and another column, such as stream cover selected.

Some restoration structures may fulfil additional objectives than what they were originally designed. To separate out design objective rankings from unanticipated benefits, designed benefits should be recorded in circles and non-designed objectives should be recorded without circles (see Appendix A-2 for an example of a completed form).

Pool
This column is suitable for those structures with the objective of scouring or preserving pool habitat. Has the structure managed to scour or maintain a pool to the expectations of the site specific restoration objectives? Does a pool exist according to the definitions of Johnston and Slaney (1996)? Has the pool filled in with sediment? Does the pool appear to be stable and present in high flow? Is a pool with an acceptable residual depth present in low flow? The REE crew may not be present in high flow or low flow, so judgement will need to be used when considering this performance objective.

4. The pool created by the structure is exceeding expectations in terms of surface area and residual depth. The pool is stable and effective throughout all flow conditions.

3. The pool created by the structure is meeting expectations in terms of surface area and depth. However, it is not exceeding expectations of size or function.

2. The pool does not meet expectations. It is either too small, too shallow, has partially filled in or is not functional at high and or low flows.

1. Site Failure. The structure has failed in its performance objective and has not formed or protected a pool adequately. The pool does not exist and or the structure has been displaced from the location. The pool washes out in high flow and or is non-existent in low flows.

Riffle
For constructed, full spanning rock riffles and or log sills. Riffles are designed to return a measure of horizontal and vertical stability to channelised or otherwise uniform stream sections. Riffles must be evaluated in terms of meeting these objectives. Has a riffle remained in place? Is there an indication of erosion at the riffle tail? In-filling at the head? Do flows go subsurface in low flow?

4. The riffle is exceeding expectations. Pools have formed upstream and or downstream of the structure. Spawning gravel has been trapped at the pool tail-out.

3. The riffle is meeting restoration objectives adequately. It is stable, there is no evidence of material movement, and the riffle is meeting design expectations

2. The riffle has partially failed, but is not adversely deflecting stream flow. The tail of the riffle is being eroded. Pool upstream or downstream is filling in. Maintenance may be required to increase functionality of the structure. Erosion around the edges of the riffle may also be occurring.

1. The riffle has failed. It has washed out, filled in, been abandoned by the channel, or otherwise has failed to meet objectives.

Gravel Bar
For prescriptions to stabilise gravel bars, induce deposition, or vegetate gravel bars. Has a gravel bar formed as a result of the structure? Is there evidence of aggradation? Is vegetation regenerating on gravel bars?

4. Gravel bars have aggraded, vegetation has extensively regenerated, and the stream channel is down cutting. No movement of bar stabilisation components, the site has trapped additional LWD and SWD. Evidence of soil build-up and rootmass binding.

3. Gravel bars objectives are being achieved as described in the restoration summary, but not beyond expectations.

2. Gravel bar structures are not attaining objectives. Scour and erosion may be occurring instead of deposition and aggradation. Soil is washing out or not being maintained on bar surfaces.

1. Gravel bar stabilisation failure. Washout of stabilisation structure, substantial scour and erosion as a result of structure.

Streambank
Some restoration structures have the objective of protecting streambanks from erosion. This can be facilitated through the placement of LWD and or boulders along the margins of stream channels and or through soil bioengineering techniques. Thus, restoration with an objective of protecting streambanks must be evaluated in terms of bank condition resulting from restoration structures.

4. Revetment type works are protecting streambanks upstream, downstream and at site. The structure has trapped additional materials (SWD and LWD). Extensive habitat values have formed in addition to bank protection. Erosion is being prevented on both the inside and outside bends of the channel.

3. The streambank is adequately protected as per the restoration prescription and restoration objectives. No evidence of erosion associated with structure.

2. Structure still in place, but erosion evident in vicinity or within structure. Structure not adequately protecting streambank or preventing input of sediment to the stream channel. Stream has migrated away from structure.

1. Structure has failed. Bank erosion is continuing and or has accelerated following instillation of restoration structure.

Stream Cover
The objective of some restoration projects is to provide stable cover for the target species. The effectiveness of cover must be evaluated from a physical performance perspective.

4. Abundant cover has formed that exceeds expectations. Complex habitat made up of several cover components (overhanging vegetation, deep pools, LWD, undercut banks, boulders). Additional cover material has been trapped and the quantity and or quality of cover have increased following major works.

3. The components of stream cover installed have not moved following instillation. The cover installed in the stream channel meets expectations. Quality fish habitat and cover are abundant at the site.

2. As a result of cover elements shifting, being buried or otherwise compromised little quality cover exists.

1. Total failure of cover to be provided at the site resulting from the complete washout, burial or destruction of stream cover components.

Nutrient
Stream fertilisation has become an increasingly important component of restoration projects. Evaluations of effectiveness at the routine level should include an assessment of stream productivity by observing primary and secondary production. However, for streams undergoing fertilisation, it is required that samples are obtained for nutrient assay (consult Ashley and Slaney (1997) and fertilisation approval documents for additional detail).

4. Abundant periphyton growth (substrate is very slimy). Evidence of abundant benthic macro-invertebrates. Whole reach appears productive.

3. Adequate amount of periphyton on substrate surface. Response to fertilisation treatment is visible throughout the reach.

2. Little evidence of fertilisation throughout the treated stream reaches. Low productivity evident through reaches.

1. No evidence of fertilisation having taken place in treated reaches. There are no visible differences in periphyton abundance between treated and untreated areas. Very low benthic invertebrate production. Overall sterile conditions predominate throughout the reach.

Overall Rating
Review the desired physical performance objectives for each site and compare with the recorded performance objective value for all physical performance ratings. List the overall rating as the lowest value identified as a structure objective (e.g. ignore unexpected successes). Once all structures have been evaluated, the mean and standard deviation of physical performance objectives will be charted for all structures as well as for each type of structure (see Appendix A-3 for example figures).

5.2.2.2 Biological Objectives

Overwinter
One of the most critical fish habitats compromised by streamside forest harvesting is overwinter habitat. The effectiveness of restoration structures that have a focus on overwintering habitat needs to be evaluated in terms of stable pool habitat with abundant cover.

4. Abundant, stable, deep pools have formed as a result of restoration structure. The influence of the structure upstream and downstream in terms of providing overwintering habitat is in excess of expectations.

3. Adequate stable, deep pools have formed as a result of restoration structure.

2. Insufficient stable, deep pools have formed as a result of restoration structure.

1. No pool habitat has formed that is conducive to providing overwintering habitat to the target species and lifestage.

Rearing
Juvenile rearing habitat differs for various species and lifestages. The overall effectiveness of restoration for all target species rearing must be evaluated.

4. Abundant rearing habitat has formed upstream and downstream of the site as a result of the restoration structure, in excess of expectations.

3. Adequate rearing habitat has formed at the site as a result of the structure.

2. Insufficient rearing habitat has formed at the site. Partial failure of structure threatens continued provision of rearing habitat.

1. Structure fails to provide rearing habitat.

Holding
Resident trout and char species may spend months to years in stream or river habitats. As such, adult holding habitat may be a critical factor to be considered as a restoration objective. While this is very important for resident species, adult salmon and steelhead also require holding habitat for weeks or even months that they spend in freshwater prior to spawning. For projects with an objective of providing adult holding habitat, the following should be considered in routine effectiveness evaluations:

4. Holding habitat has been formed for all target species as a result of the restoration structure. Deep stable pools with abundant cover provide habitat for multiple adults.

3. Adequate holding habitat generated as a result of the restoration structure. Cover is present, but only to support a limited number of adults.

2. Limited holding habitat has formed from the instillation of the restoration structure. Pools have filled in, cover has been lost, and few adults can coexist in the available space.

1. Total failure of the structure to provide holding habitat for adult salmonids.

Spawning
Some restoration structures focus on trapping, preserving or otherwise obtaining high quality and stable spawning habitat. The quantity and quality of spawning habitat must be assessed in terms of both physical and spatial criteria (e.g. does gravel exist, is it the right size, is there enough of it, is it clean, is it at a suitable location to be conducive for spawning?).

4. The structure has created extensive spawning habitat in stable areas that are in areas conducive to use by the target species.

3. Adequate amounts of spawning gravel have been trapped by the structure, but not in excess of expectations.

2. Little spawning gravel has been trapped, or it is in a poor location, or is in an unstable configuration.

1. The structure has failed to trap spawning gravel suitable for the target species.

Incubation
Restoration projects need to provide more than just spawning gravel. For the project to be successful, eggs must be successfully incubated throughout their gestation period. Thus, restoration projects with an objective of providing spawning habitat also need to be evaluated in terms of the potential for incubation success.

4. No evidence of redd scour in vicinity of structure. Spawning substrate is located in stable areas, is free of fines, and has suitable flows for the target species incubation requirements.

3. Little evidence of redd scour. Spawning gravel is present and appears to be stable, free of fines and with sufficient flow for the target species.

2. Evidence of redd scour. Spawning gravel partially washed out or filled in with fines. Flows are not ideal for the target species.

1. Incubation is poor as a result of structure. Redds are extensively scoured, gravel washed out, filled in and insufficient or excessive flows have compromised the ability of the gravel to sustain eggs to fry.

Overall Biological Performance Rating
Review performance for all biological performance ratings that pertain to site objectives. List the overall biological performance rating as the lowest value identified as a structure objective (e.g. ignore unexpected successes). Once all structures have been evaluated, the mean and standard deviation of the biological performance rating will be graphed for all structure types, and broken out for each type of structure. See Appendix A-3 for model figures.

5.2.2.3 Overall Performance

The overall performance of any structure must be summarised to develop an understanding of how it has performed in relation to its site objectives. The overall performance ratings can be summarised across like structures in a project and discussed in the REE report to illustrate how performance among structures relative to objectives has developed. Overall performance objectives also allow for an indication of maintenance requirements in the projects.

Structural Condition
This category relates to the overall physical condition of the restoration structure including, the state of LWD, cables, rock fragmentation, condition of epoxy or adequacy of ballast.

4. The structure is in excellent condition, all components are solid and there is no evidence of breakage or wear. Material recruited to the site is also in excellent condition. Many years of function left in the structure.

3. The structure is in adequate condition. Normal wear and tear may have caused localised damage to the condition, but nothing out of the ordinary.

2. The structure condition is poor, evidence of decay in LWD, cable is rusting, and clamps have broken or are otherwise not functioning. Boulders are fragmenting, and epoxy has failed at several locations.

1. Overall condition of the structure is very poor and it is unable to meet any performance objectives. LWD collapsed, boulders crumbled, cables rusted and failed and the structure will not last another high flow season.

Structural Stability
This criterion for evaluations relates to the extent that a structure has moved as a result of scour or sheer stress in comparison to how it was designed and built.

4. The structure is very stable in its configuration. No movement is detectable and no erosion is evident that could threaten the long-term function of the structure.

3. The structure has settled and shifted to a small degree. However, function has not been compromised, and the shifting has not led to any perceived loss of stability. Small amounts of bank erosion may occur as the channel adjusts to the presence of the structure.

2. The structure has shifted substantially following instillation. Structure movement has compromised function, but a degree of functionality still exists. Long-term function is doubtful because of stability issues. Excessive bank or bar erosion from structure is destabilising the channel.

1. The structure has failed and does not meet design objectives.

High Flow
Though not a performance objective, structures or major works must be evaluated with respect to their effectiveness and or functionality at all flow levels. Some areas may emphasise an objective relating to high flow scour habitat, or low flow. Regardless, the efficacy of the structure at bankfull or greater flow conditions must be appraised.

4. The structure is exceeding design expectations during high flow. Evidence of substantial scour during freshet periods. No evidence of structure movement, failure, bank erosion or other adverse response in the channel as a result of restoration structure.

3. The structure functions at high flows, but does not fulfil additional objectives.

2. Evidence of failure at some areas. Erosion evident, but not immediately threatening the structure. No scour occurring at site, conversely excess scour occurring that threatens to collapse or otherwise destabilise restoration structure.

1. Total failure of structure to achieve objective at high flows. Failure of structure, extensive erosion, harmful effects to adjoining habitat units or washout of structure.

Low Flow
As per the high flow evaluation, the structure's or major works' physical performance must be evaluated in terms of its effectiveness at low flow periods, regardless of objectives.

4. The structure is functioning in excess of expectations at low flow conditions. Cover is abundant; material has been recruited that exceeds expectations of structures.

3. At low flows, the structure adequately meets its objectives. Pools have been scoured to an acceptable residual depth, boulders continue to provide rearing habitat and riffles are still flooded.

2. The structure is functioning according to its objectives, but not in an optimal condition. Pools have not scoured sufficiently to provide abundant low-flow refugia, riffles are locally de-watering or failing to concentrate sufficient flow to allow for fish passage.

1. Failure of structure to achieve restoration objectives at low flow. The structure is not in the wetted channel width. No pool has scoured; flow over riffles is entirely sub-surface. Fish passage is not possible due to structure placement or effect in low flow conditions.

Maintenance Recommendations
A recommendation for maintenance or remedial works is required for each site as a result of REE. Does the structure meet its site objectives? Are remedial works warranted? Will remedial works or maintenance help achieve component and watershed level objectives?

4. No repairs of maintenance required.

3. Minor repairs or remedial works could be undertaken but are not required. Repairs / remedial works were undertaken at the time of REE survey and no follow-up is required.

2. Repairs are required to return the site to a functioning state. However, the works are minor, or do not require immediate action (can be completed within a year).

1. Major repairs are required using the existing or new prescriptions or plans. Works are required as a priority and must be undertaken within a short time frame (e.g. less than six months).

Photo Numbers
Enter the number and roll of all photographs taken of the structure.

Photographs
Photographs are required as a component of REE. As the REE compendium is limited to four pages, few photographs will be incorporated. Emphasis for photographs should be placed on those structures or works that demonstrate opportunities for learning. Unexpected successes and failures should be documented, as well as areas/sites recommended for remedial works. Other noteworthy photographs should be included at the discretion of the REE project supervisor.

5.2.2.4 Comments

Any comments regarding the function or failure of restoration sites, or anything else worth noting that will help with understanding why a structure is meeting, exceeding, or failing its objectives should be included on the form.

5.3 Specific Information For Off-Channel Projects

5.3.1 Site Description

These definitions apply to the off-channel project evaluation criteria for the REE field form (Appendix B-1):

Stream and or Project Name
List the particular stream and or project name within the watershed that is being evaluated.

Reach
List the stream reach containing the off-channel restoration project.

Distance and UTMs
Measure the distance from the start of the reach to the off-channel site being evaluated. Determine the UTMs for the off-channel outlet using a handheld GPS unit.

Site ID #
Individual off-channel sites must be entered as separate line items and identified in a consistent fashion with REE plans, as-built reports and other REE documents.

Off-channel Type
Enter the appropriate code for the off-channel site being evaluated. Use the code that best describes the structure being evaluated. If an off-channel type is not listed, use the "other" category and supply a list describing the additional codes. There are primarily two types of restored Off-Channel habitat: surface fed channels (SF) and groundwater fed (GF) channels.

Site Objective
The site objective of a particular off-channel project is a simplified and generic statement of purpose that parallels the site-specific objective. For a groundwater fed side channel, the intended function could be to provide coho salmon overwintering habitat. The intended function will come from restoration summaries, REE plans developed at the prescription development phase or previous REE reports.

Species
Enter the target species for the off-channel restoration project, using species definitions found in Appendix C-1. If multiple species are targeted at a given site, list all species abbreviations.

Life Stage
List all lifestages for which the particular off-channel area was designed to provide habitat.

5.3.2 Performance Objectives

The performance indicator data collected allows for the systematic review of biological performance objectives and physical performance indicators to determine if off-channel restoration sites are adequately meeting site and component objectives.

All performance indicators are scored on a 4-point scale to indicate how well a restoration site is, or is not performing. In all cases, a score of 4 indicates the site is exceeding expectations for that particular attribute, and a score of 1 represents a failure to achieve the site or component objective. **Half point scoring is allowed to provide a greater degree of discretion to REE implementers.** The following definitions, modified from Koning et al. (1998), apply for off-channel component REE activities:

4. site conditions resulting from works are exceeding expectations and objectives;
3. site conditions resulting from works are meeting expectations and objectives.
2. site conditions resulting from works are failing to meet expectations or objectives;
1. site conditions resulting from works have failed to meet objectives. Expectations have not been met.

5.3.2.1 Biological Objectives

For each of the biological objectives, a series of scoring definitions are provided to guide the evaluation of structure performance. Site objectives and on-site conditions must be considered when evaluating off-channel site performance. It is acknowledged that the scoring definitions do not apply to all projects or site objectives. If additional definitions are required for unique or non-standard sites or projects, summarise the definitions used in the REE report.

Overwinter
One of the most critical fish habitats compromised by streamside forest harvesting is overwinter habitat. The effectiveness of off-channel restoration sites that have an emphasis on overwintering habitat needs to be evaluated in terms of stable pool habitat with abundant cover. Off-channel habitats often have deep pools excavated at the time of construction. These must be reviewed to ensure they have not filled in or been otherwise compromised.

4. Stable, deep pools have been maintained throughout the off-channel area. There is no evidence of in filling or collapse following construction at any sites throughout the channel length. Abundant cover in the form of LWD and overhanging vegetation has been maintained at all pool sites and new cover elements have been recruited following construction.

3. Stable deep pools have been maintained throughout the majority of the off-channel area. Cover has been maintained but there is little or no increase in cover quantity or quality following construction.

2. The majority of deep pool areas have partially filled in; LWD has been lost from pools. Little habitat diversity remains in deep pool areas following construction.

1. Almost all pools have filled in, and there has been a substantial loss of habitat and cover features throughout excavated pools. Little overwinter habitat has been maintained following construction.

Rearing
Juvenile rearing habitat differs for various species and lifestages. The overall effectiveness of restoration for all target species rearing must be evaluated.

4. Abundant rearing habitat has been maintained throughout the off-channel area. Rearing habitat has increased following construction as additional habitat components have been recruited to the off-channel area.

3. Adequate rearing habitat has been maintained at the off-channel site following construction. The LWD and boulder elements placed in the off-channel area during construction have been maintained but there is little or no increase in rearing habitat or cover following construction.

2. Insufficient rearing habitat has been maintained at the off-channel site. Rearing habitat elements such as LWD or boulders have been buried or flushed from the system.

1. The off-channel area has failed to provide rearing habitat. Habitat elements have been buried, flushed from the channel or otherwise compromised following construction.

Spawning
Off-channel areas often are designed with the objective of supplementing or providing spawning habitat for the target species. Chum salmon and sockeye salmon spawning channels have been very successful at increasing production throughout the species distribution in the province. In unstable watersheds, off-channel areas may provide the only source of stable, long-term habitat suitable for the target species spawning requirements. The quantity and quality of spawning habitat must be assessed in terms of both physical and spatial criteria (e.g. does gravel exist, is it the right size, is there enough of it, is it clean, is it at a suitable location to be conducive for spawning?), whether it has been placed in the channel or is naturally occurring.

4. Stable, clean, non-compacted spawning gravel suited for use by the target species has been maintained in all placement locations in the off-channel site. Additional spawning habitat has developed following construction and there is evidence of spawning (e.g. adult spawners, carcasses and or redds) in the channel.

3. Stable, clean, non-compacted spawning gravel suited for use by the target species has been maintained in most placement locations in the off-channel site. There is evidence of spawning (e.g. adult spawners, carcasses and or redds) in the channel.

2. Little spawning gravel has been maintained in the off-channel area. Gravel has filled in with fines, dewaters in low flows or otherwise compromises the success of the project objective. Little evidence of use by target species spawners.

1. Little or no quality spawning gravel remains in the placement areas of the off-channel project. There is no evidence of use by target species spawners.

Incubation
Off-channel restoration projects need to provide more than just spawning gravel. For the project to be successful, eggs must be successfully incubated throughout their gestation period. Thus, off-channel restoration projects with the objective of providing spawning habitat also need to be evaluated in terms of the potential for incubation success.

4. No evidence of hydrological redd scour throughout the off-channel area. Spawning substrate is located in stable areas, is free of fines, not compacted, has suitable substrate size and water flows for the target species incubation requirements and there is no evidence of the channel dewatering during the incubation period.

3. There is little evidence of redd scour throughout the off-channel area. Spawning gravel is present in appropriate locations and appears to be stable, free of fines, not compacted and has sufficient flow for the target species.

2. There is some evidence of redd scour in the off-channel area. Incubation success has been compromised because of spawning gravel partially washing out or filling in with fines. Gravel is compacted and flows are not sufficient to ensure incubation success for the target species.

1. Incubation success is very poor as a result of extensive redd scour, gravel washing out, filling in compaction and insufficient or excessive flows.

Overall Rating
Review performance for all biological performance ratings that pertain to site objectives. List the overall biological performance rating as the lowest value identified as an off-channel objective (e.g. ignore unexpected successes). Once all objectives have been evaluated, plot the mean and standard deviation of the biological performance for all off-channel projects in the watershed. See Appendix B-5 for model figures

5.3.2.2 Physical Condition

Physical condition variables apply to all off-channel projects. As such, they do not represent objectives as above, but relate to indicators of physical performance that may require maintenance, regardless of the overall side channel objectives.

As opposed to biological performance objectives, where off-channel projects are reviewed only in terms of relevant objectives, all physical condition indicators pertinent to a project are reviewed for off-channel restoration projects (e.g. if a berm was constructed, evaluate the physical performance of the berm, if no berm was constructed, ignore and move on to the next parameter).

Dissolved Oxygen
The ultimate success of any off-channel watershed restoration project relates to the presence of dissolved oxygen. Surface water fed channels are not limited in the same way as ground water channels as the mixing of surface waters prior to entering the off-channel area is sufficient to ensure well oxygenated water is available to support the target species. However, groundwater fed side channels may be seasonally limited in the amount of oxygen they contain. As such, oxygen levels in ground water fed off-channel projects need to be determined during REE. To account for the difference in water temperature, dissolved oxygen must be considered in terms of percent saturation. Methods for determining dissolved oxygen levels may be through the use of a titration procedure (e.g. Winkler titration), kit (e.g. Haach Kit), or probe (e.g. Y.S.I. dissolved oxygen probe). Appendix B-6 provides a summary of dissolved oxygen requirements for various salmonids and lifestages (see Bjorn and Reiser (1991) for a review of dissolved oxygen requirements for salmonids).

It is essential that the time of year D.O. is evaluated correspond with the off-channel project objectives (e.g. off-channel ponds designed to provide coho overwinter habitat must be evaluated for dissolved oxygen suitability in winter).

4. Dissolved oxygen levels are above optimal for target species in the watershed.

3. Dissolved oxygen levels are optimal for target species.

2. Dissolved oxygen levels are between optimal and lower lethal for target species.

1. Dissolved oxygen levels are approximating lower lethal for the target species.

Nutrients
Off-channel areas may be limited in their success if there are insufficient nutrients available to support rearing species. As this may prevent the project from fulfilling its objectives, the nutrient levels of off-channel restoration areas need to be verified at a qualitative level.

4. There is abundant periphyton production, benthic invertebrates are prevalent on substrate and there is an abundance of leaf/needle litter in the channel. The whole channel appears productive.

3. Adequate amount of periphyton on substrate surface. Some benthic invertebrates are visible on substrate. Sufficient leaf/needle litter is available as food source for invertebrates. Production appears adequate for supporting target species and lifestages.

2. There is only patchy evidence of primary and secondary production and little in the way of leaf or needle litter entering the channel. There does not appear to be sufficient periphyton or benthic invertebrate production for the target species and lifestage.

1. The channel appears sterile. There is little or no evidence of periphyton or invertebrate production and no leaf or needle litter associated with the side channel.

Intake Integrity / Function
Surface water fed off-channel areas require intake structures to supply water to the side channel area. These intakes are often engineered structures that may or may not require manual operation to regulate flows to the off-channel area. Intake structures must be evaluated at the time of REE to ensure function identify maintenance concerns.

4. The intake is functioning in excess of expectations. Scour around the intake is preserving function, long-term flow is available to off-channel system.

3. The intake function is working to expectations. There is no evidence of substrate filling in around intake or obstructing flow into the off-channel area. No erosion is visible around intake.

2. Intake has partially filled in with sediment, bank erosion visible around pipe, some debris hanging up on restoration structure. Channel shifting is threatening to isolate intake.

1. Intake structure has failed. The intake has filled in with substrate or otherwise been compromised. Debris has damaged intake, rendering non-functional. Channel movement has isolated intake.

Flow
Insufficient flow may reduce the capability of off-channel pond areas for both surface water and ground water fed channels. Flows must be evaluated at the time of year most relevant to the fulfilment of site objectives (spawning channels must be evaluated during periods of spawning and incubation, overwintering channels must be visited during winter months, etc.).

4. Flow is excellent for the off-channel pond objectives. There is no evidence of high flow in the channel damaging function, or low flow stranding or isolating fish or otherwise compromising the off-channel function.

3. Flow is adequate for the off-channel objectives. Some evidence of flow fluctuation that may lead to compromised performance, but within the natural range of variability.

2. Low flow periods cause localised dewatering of the off-channel project. Some evidence of high flow alteration of channel function. Fish may be isolated in pools but are not at high risk of being stranded (e.g. totally de-watered)

1. Flow routinely insufficient for objectives of off-channel area. Flow is frequently subsurface, or excessive flows render habitat unsuitable to fulfil of-channel objectives. Fish are routinely isolated and stranded.

Outlet Integrity / Function
Off-channel areas must be evaluated in terms of the outlet function. Outlets may erode, agrade, or otherwise change in such a way that fish access is not possible. Alternatively, the mainstem channel may be laterally migrating, which could threaten the continued function of the off-channel project either from erosion or isolation. If the target fish species and lifestage can not access the off-channel area, the project is failing to achieve its site, component or watershed level objectives.

4. The off-channel outlet is functioning well. No evidence of outlet erosion or excess sediment deposition, the area well revegetated. No evidence of lateral mainstem channel migration eroding or isolating the outlet area. Excellent access for target species and lifestages at all flows of main channel.

3. The outlet is functioning as planned, minimal erosion of banks, ample access for target species and lifestages at most main-channel flows.

2. The outlet has eroded or aggraded but is still marginally functional and fish can still access the side channel. Insufficient flows periodically prevent access for the target species and lifestage. Lateral mainstem channel migration threatens outlet function.

1. The outlet has failed. Erosion is widespread and the structural integrity of the project has been compromised. Flows prevent use of the off-channel area by the target species. Lateral channel migration has eroded or isolated the outlet, causing the off-channel project to fail.

Berm Stability
Off-channel areas often rely on constructed safe-fail berms to prevent high mainstem river flows from destroying constructed off-channel habitats. It is necessary to examine the condition of berms and ensure they are not threatened with failure. Undermining, vegetative piping and overtopping all may reduce the effectiveness of a berm structure. As such berms must be evaluated to determine their condition.

4. There is no evidence of the berm being eroded or breached, post-construction revegetation has increased the integrity of the berm. High flows have been prevented from disturbing the off-channel area. There is no evidence of leakage or piping through the berm.

3. The berm is functioning adequately. There is no unexpected improvement in berm integrity following construction. Only minimal undermining or erosion of the berm is evident.

2. There was a partial failure of the berm during high flows. Some leakage or piping of water threatens the longevity of the structure. Evidence of erosion and undermining of berm

1. There was a substantial failure of the berm. Berm overtopped in less than expected return flood. Collapse of berm due to undermining and erosion.

Mainstem Stability
A vital component of the off-channel evaluation is a determination of the stability of the mainstem channel in the proximity of the off-channel project. Off-channel projects are often constructed in areas where mainstem conditions preclude in-stream works because of channel instability. A risk in these situations is that the mainstem can avulse and destroy an off-channel project. Thus it is important at a routine level to walk the mainstem channel associated with the off-channel project to determine if conditions have changed following construction that can now endanger the short to long-term success of the project. Starting at a point upstream of the off-channel project on the mainstem channel, the channel should be walked to note changes in overall stability since construction that may serve as a warning for the continued success of the project.

4. Overall channel stability unchanged or improved since construction of side channel. Gravel bars vegetating, no evidence of lateral channel migration.

3. Channel stability has not changed since construction. Little evidence of lateral channel migration, gravel bars have not changed.

2. Fresh erosion scars along streambanks and newly formed gravel bars are evident in mainstem channel. Indications of recent lateral channel migration are evident that may threaten off-channel project.

1. Evidence of rapid channel migration towards off-channel project. Complete wash out of off-channel project due to instability of mainstem channel.

Cut-Slope Stability
The third stability consideration with respect to off-channel projects is the stability of cut slopes. Off-channel projects are often constructed in areas of unconsolidated soils that can slough or slump into the off-channel area. This can have minor or serious implications for the physical success of the project depending on the extent and location of the cut-slope failure in the project.

4. Off-channel cut-slope is revegetating or has revegetated over the total excavation area. There is no evidence of cut-slope erosion or sloughing into the wetted area of the off-channel project.

3. An adequate amount of revegetation has established following excavation. There is some localised areas of sloughing or erosion that have since stabilised.

2. There is a poor amount of revegetation in the excavated area. A substantial amount of erosion or sloughing is evident from the cut-slope into off-channel area. There is no evidence of cut-slope stabilisation.

1. No revegetation is evident on the cut-slopes. Sloughing and erosion are evident throughout the off-channel area, compromising the functional integrity of the off channel project.

Revegetation
Off-channel areas are often revegetated following construction. The objectives of this may be to minimise erosion, provide cover and or to provide allochthonous carbon input to the off-channel area. While wildlife browsing is a natural process, if it threatens the survival and compromises the success at revegetating a site, maintenance may be required (e.g. deployment of browse prevention devices).

When evaluating revegetation it is important to consider the goals and objectives of any revegetation prescription relative to that of the whole off-channel project. While a thick mat of grass may be excellent for controlling erosion, it will be of limited use if it is choking out conifers or shrub species planted to provide cover over the mid- to long-term. Thus, both erosion control and tree and shrub regeneration/survival need to be considered when scoring this category. If trees and shrubs will not become established, and that was an objective of the revegetation prescription, score success lower, regardless of the erosion protection afforded by the results of grass seeding

4. Complete revegetation of off-channel site. No evidence of erosion or infilling from overland flow of water. Nearly all whips are viable and seedlings and plugs have high survival. No evidence of browse damage.

3. Some areas remain unvegetated, but overall high level of success. Some browse damage evident and high levels of planting survival.

2. Substantial areas remain unvegetated following construction. Evidence of erosion from overland flow. Many seedlings browsed to the point of threatening viability and there is low survival of plantings.

1. The revegetation treatment has failed. Much of off-channel area remains unvegetated. There is substantial evidence of erosion affecting the off-channel area. A very high level of mortality is evident among seedlings, whips and plugs.

Cover Elements
Off-channel projects often contain cover elements to increase the quantity and quality of habitat. These cover elements can range from large woody debris placements to riffles to boulder clusters, depending on the size and type of off-channel project. When evaluating an off-channel project it is important to consider the overall physical performance of these cover elements. An off-channel project may contain many diverse applications of cover, and as such this variable will represent the overall physical condition of cover elements. If a single structure has failed, a lower score is warranted, but maintenance may be a lesser priority than if many structures failed and the overall physical condition of the off-channel was compromised.

Have the cover elements moved? Are they providing cover as intended? Are they causing any inadvertent impacts to the off-channel project (e.g. bank erosion, scour, flow diversion etc.)? Are the cover elements still structurally sound?

4. Cover elements are exceeding physical objectives. Cover has increased following construction and become more stable as a result of new material inputs or other means.

3. Cover elements are adequately meeting physical objectives. Little movement, in-filling, erosion or structural decay has occurred.

2. Cover elements are not adequately meeting physical objectives. Cover elements have moved, in-filled, caused bank erosion or otherwise been compromised and in their present configuration are not able to meet physical performance objectives.

1. Cover elements are failing to meet physical condition objectives. Structures have failed through collapse or in-filling and may threatening the overall structural integrity of the off-channel project.

Overall Rating
Review the physical condition ratings and list the overall physical condition rating as the lowest value identified. Once all off-channel sites have been evaluated, plot the mean and standard deviation of the physical condition for the watershed. See Appendix B-5 for model figures.

5.3.2.3 General

Maintenance
A recommendation for maintenance or remedial works is required for each off-channel area evaluated under REE. Does the off-channel site meet its site objectives? Are remedial works warranted? Will remedial works or maintenance help achieve component and watershed level objectives?

4. No repairs of maintenance required.

3. Minor repairs or remedial works could be undertaken but are not required. Repairs / remedial works were undertaken at the time of REE survey and no follow-up is required.

2. Repairs are required to return the site to a functioning state. However, the works are minor, or do not require immediate action (can be completed within a year).

1. Major repairs are required using the existing or new prescriptions or plans. Works are required as a priority and must be undertaken within a short time frame (e.g. less than six moths).

Photos
Enter the number and roll of all photographs taken of the structure.

Photographs are required as a component of REE. As the REE compendium is limited to four pages, few photographs will be incorporated. Emphasis for photographs should be placed on those off-channel areas that demonstrate opportunities for learning. Unexpected successes and failures should be documented, as well as areas/sites recommended for remedial works. Other noteworthy photographs should be included at the discretion of the REE project supervisor.

5.3.2.4 Comments

Any comments regarding the function or failure of off-channel restoration sites, or anything else worth noting that will help with understanding why a site is meeting, exceeding, or failing its objectives should be included on the form.

6.0 Detailed REE Requirements

Additional data may be required or desirable under REE. This is called a Detailed REE and it is implemented when additional information is needed to evaluate specific restoration objectives in greater detail.

Pre- and Post-Restoration Photo points
Detailed REE requirements may include establishing pre-restoration photopoints and obtaining photographs at photo points whenever REE is undertaken. A methodology for photo point monitoring is described in Appendix C-2.

Fish Sampling
Fish sampling is not a requirement of the basic REE methodology. Observation and professional judgement are to be used to determine if fish are present and or using the restoration structure in a manner in accordance with the site objectives.

At a more detailed level, fish sampling can be expanded to include snorkel surveys, smolt trapping, electroshocking, G-trapping, angling or seining. Details of fish sampling including level of rigour (presence versus population estimates), timing and requirements for obtaining and analysing age structures should be developed beforehand and outlined in a written sampling protocol.

Water Quality Evaluation
Water quality may be included in a REE plan. Typically, this will include temperature monitoring, dissolved oxygen monitoring, suspended sediment or turbidity sampling, and inorganic nutrients (total phosphorous, soluble reduced phosphorous, total nitrogen and nitrate).

Temperature is best measured at short intervals (e.g. hours) over extended time periods (e.g. seasons). This is easily facilitated with the use of automated recording devices.

Dissolved oxygen may be measured with probes or through Winkler titration. Samples must be collected and analysed according to appropriate methodologies (e.g. Wetzel and Likens, 2000). Samples must be collected at appropriate intervals and at appropriate seasons to address the evaluation objective (e.g. overwintering ponds should be assessed periodically throughout the winter).

Suspended sediment and turbidity sampling may be considered as an additional requirement for REE. This will only be a consideration as an add-on for those projects that have had an objective of reducing sediment transport to streams.

Inorganic nutrients shall be measured at time frames and to requirements as specified by WRP specialists and discussed in Ashley and Slaney (1997). Methods for data collection and analysis will follow standard methods (e.g. Wetzel and Likens, 2000). This level of data collection is only required for projects with an in-stream fertilisation perspective.

7.0 Format for REE Report

REE deliverables should be provided in both hardcopy and digital formats. The hardcopy should include all data sheets and mounted photos. The digital files should include the REE report, including tables, figures and raw data, along with all digital photos. The digital files should have the following content and format:

1. One Adobe Acrobat file (PDF file) on CD-ROM with colour photos imbedded in the text.

2. Photographs are to be in TIF format, greyscale, and 7.4 cm long by 4.8 cm high.
3. The raw REE data is to be supplied in a Microsoft Excel or Access database.

The REE report should summarise all relevant effectiveness evaluation findings at the site, and component level. An example of a REE report is included on the FIA website. A description of the content of the report is included below.

The REE deliverable should be in the form of a 3 to 4 page compendium summary. This summary will represent a stand-alone document and will include summary graphs (see Appendices A-3 and B-3 for examples) and photographs of items of particular interest. The REE deliverable is a key component in the adaptive management loop. As such, the information presented in a particular REE may have implications for the way that restoration projects are implemented throughout the province. REE reports must present information in a format that will facilitate information transfer. In so doing, restoration practitioners can learn and change how works are planned, implemented and evaluated.

The output of REE may also be used to identify opportunities for more focussed evaluation. The Intensive Effectiveness Evaluation (IEE) and Operational Techniques Refinement (OTR) procedures allow for a more detailed assessment of particular restoration techniques to determine their benefit towards attaining site, component and watershed level objectives. These more detailed procedures may evolve out of REE, or be planned independently of REE findings.

8.0 References

Ashley, K.I. and P.A. Slaney. 1997. Accelerating recovery of stream, river and pond productivity by low level nutrient replacement. Chapter 13 in P.A Slaney and D. Zaldokas, eds. Fish habitat rehabilitation procedures. Watershed Restoration Technical Circular No.9, Watershed Restoration Program, Ministry of Environment, Lands and Parks, Vancouver.

Bjorn, T.C. and D.W. Reiser. 1991. Habitat requirements for salmonids in streams. Pages 83-138 *in* W.R. Meehan [editor] Influences of forest and range land management of salmonid fishes and their habitats. American Fisheries Society Special Publication 19, Bethesda, MD.

Gaboury, M. and R. Wong. 1999. A framework for conducting effectiveness evaluations of Watershed Restoration Projects. Province Of British Columbia, Ministry of Environment, Lands and Parks and Ministry of Forests, Watershed Restoration Technical Circular No. 12: 40 p.

Johnston, N.T. and P.A. Slaney. 1996. Fish Habitat Assessment Procedures. Watershed Restoration Technical Circular No. 8, watershed Restoration Program, Ministry of Environment, Lands and Parks, Vancouver.

Koning, C.W., M.N Gaboury, M.D. Feduk and P.A. Slaney. 1998. Techniques to evaluate the effectiveness of fish habitat restoration works in stream impacted by logging activities. Canadian Water Resources Journal. 23: 191-203.

Wetzel, R.G. and G.E. Likens. 2000. Limnological Analysis. 3rd Edition. Springer - Verlag.

Zaldokas, D.O. 1998. Annual compendium of aquatic rehabilitation projects for the watershed restoration program 1997-1998. Province of British Columbia, Ministry of Environment, Lands and Parks, Watershed Restoration Program Project Report No. 8.

Zaldokas, D.O. 1999. Annual compendium of aquatic rehabilitation projects for the watershed restoration program 1998-1999. Province of British Columbia, Ministry of Environment, Lands and Parks, Watershed Restoration Program Project Report No. 13.

Appendix A-1. Field Form for In-Stream REE

Form 1. Routine Effectivness Evaluation Restoration Works Summary - In-Stream Component

Name of Sponsor_____ **Watershed** _____ **Survey Crew**_____ **REE Interval**_____

Project Name _____ **Sub-watershed**_____ **Weather / Flow**_____ **Other Components** _____

Forest District _____ **Date** _____

					Performance Objectives														Overall						Comments
					Physical							Biological													
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Nutrient	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	

Appendix A-2. Example Entry for In-Stream REE Field Form

Form 1. Routine Effectivness Evaluation Restoration Works Summary - In-Stream Component

Name of Sponsor: XXXXX **Watershed:** Frank River **Survey Crew:** ZZ/EE **REE Interval:** 1 year following construction

Project Name.: Zappa Creek Rehab. **Sub-watershed:** Zappa Creek **Weather / Flow:** Overcast / Low **Other Components:** Off-channel, riparian

Forest District: Squamish **Date:** September 15, 2001

					Performance Objectives														Overall						Comments
					Physical							Biological														
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Nutrient	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Zappa	0+580m	98-01	LWD-M	scour pool	(4)			3			4	BT	JUV	(4)	(2)		3.5		2	4	2.5	3.5	2	4	1-3	excellent pool habitat in winter, but insufficient residual depth in summer flows

Appendix A-3. Model Figures for Summarising REE Performance Data

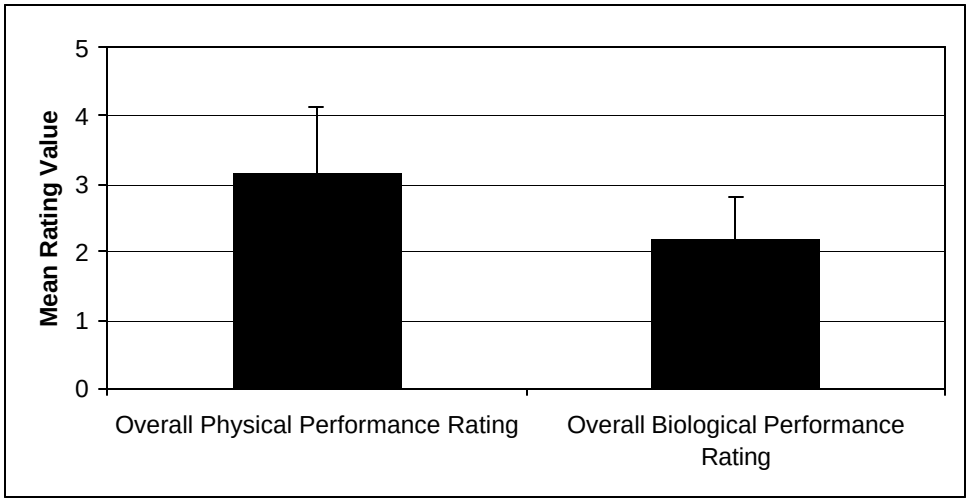

Figure 1. Summary of performance ratings across all structure types in Unnamed Watershed (± one standard deviation).

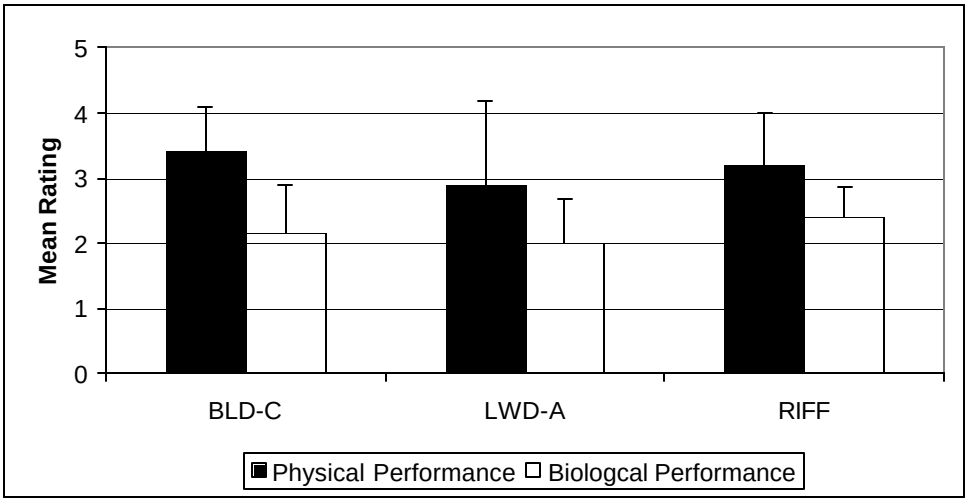

Figure 2. Summary of performance ratings for structure types in Unnamed Watershed (± one standard deviation).

Table 1. Summary of remedial work recommendations for the Unnamed Watershed.

Priority	Watershed	Distance	Site Id	Maintenance Score	Problem / Fix	Estimated Cost of Work	Person Days Required	Materials and Equipment Required	Prescription Required
1	Unnamed Creek Reach 1	0+240	LWD-7	1	Structure failure due to NSF ballast. Add ballast	$2,500	4	Spyder, 5-1000kg boulders, epoxy and cable	No
2	Unnamed Creek Reach 1	0+80	LWD-1	1	Bank erosion due to structure. Install bank protection structure	$3,500	5	Spyder, 10-1000kb boulders, 5 LWD, cable, epoxy	Yes
3	Unnamed Creek Reach 2	1+120	LWD-9	2	Re-epoxy broken cable, add SWD	$500	1	30 m cable, 10 tubes epoxy	No
4	Unnamed Trib 1	0+300	RIFF-4	3	Re-seed streambank to stabilise exposed soil	$250	0.25	10 kg bag Coastal reclamation mix grass seed	No
5	Unnamed Trib 2	0+90	RIFF-1	3	Re-seed stream bank to stabilise exposed soil	$250	0.25	10 kg bag Coastal reclamation mix grass seed	No

Appendix B-1. Field Form for Off-Channel REE

Form 1. Routine Effectivness Evaluation Restoration Summary - Off-Channel Component

Name of Sponsor _____ Watershed _____ Survey Crew _____ REE Interval _____

Project Name _____ Sub-watershed_____ Weather / Flow _____ Other Components_____

Forest District _____ Date _____

						Targets		Biological Performance Objectives					Physical Condition											General		Comments
Stream	Reach	Distance	Site ID #	Off-Channel Type	Site Objective	Species	Lifestage	Overwinter	Rearing	Spawning	Incubation	Overall Rating	Dissolved Oxygen	Nutirents	Intake Integrity / Function	Flow	Outlet Integrity / Function	Berm Stability	Mainstem Stability	Cut-Slope Stability	Revegetation	Cover Elements	Overall Rating	Maintnenance	Photos	

Appendix B-2. Example Entry for Off-Channel REE Field Form

Form 1. Routine Effectivness Evaluation Restoration Summary - Off-Channel Component

Name of Sponsor: XXXXX **Watershed:** Frank River **Survey Crew;** ZZ/EE **REE Interval:** 1 year following construction

Project Name.: Zappa Creek Rehab. **Sub-watershed:** Zappa Creek **Weather / Flow;** Overcast / Low **Other Components:** In-stream, riparian

Forest District: Squamish **Date:** September 15, 2001

						Targets		Biological Performance Objectives					Physical Condition											General		
Stream	Reach	Distance	Site ID #	Off-Channel Type	Site Objective	Species	Lifestage	Overwinter	Rearing	Spawning	Incubation	Overall Rating	Dissolved Oxygen	Nutirents	Intake Integrity / Function	Flow	Outlet Integrity / Function	Berm Stabiltiy	Mainstem Stability	Cut-Slope Stability	Revegetation	Cover Elements	Overall Rating	Maintnenance	Photos	Comments
Zappa	2	2+340	OFF2	SF	RB rearing	RB	JUV	(4)	(4)			4	4	2	3	3	1	4	3	3	3	3	2.9	1		outlet failed, more work needed

Appendix B-3. Model Figures for Summarising REE Performance Data

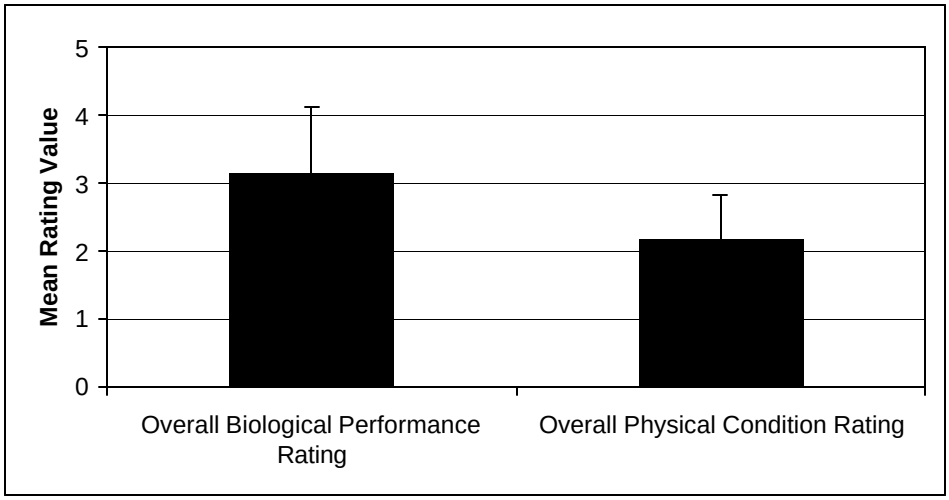

Figure 1. Summary of performance and condition ratings for the Unnamed Watershed groundwater fed side channel (± one standard deviation).

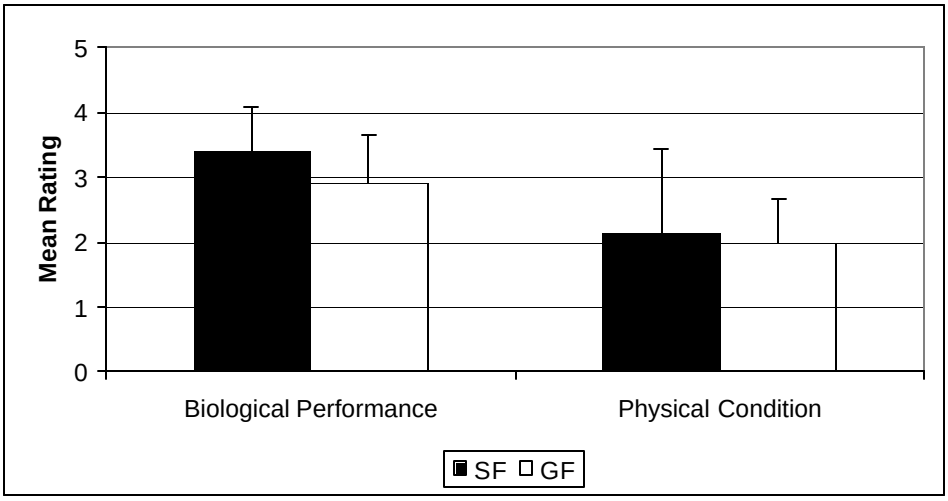

Figure 2. Summary of performance ratings for surface water fed (SF) and groundwater fed (GF) off-channel sites in the Unnamed Watershed (± one standard deviation).

Table 1. Summary of remedial works recommended for the Unnamed Watershed off-channel projects.

Priority	Watershed	Distance	Site Id	Maintenance Score	Problem / Fix	Estimated Cost of Work	Person Days Required	Materials and Equipment Required	Prescription Required
1	Unnamed Creek Reach 1	0+240	SF1	1	Berm failure. Rebuild berm	$10,000	5	Large capacity excavator	Yes
2	Unnamed Creek Reach 1	0+80	SF1	1	Intake failure. Replace intake with modified structure. Protect with LWD jams	$7,500	3	Spyder, 10-1000kb boulders, 5 LWD, cable, epoxy	Yes
3	Unnamed Creek Reach 2	1+120	GW1	2	Cable LWD to prevent shifting in high flows.	$1,500	3	30 m cable, 10 tubes epoxy	No
4	Unnamed Trib 1	0+300	GW2	3	Re-seed off-channel project to stabilise exposed soil	$250	0.25	10 kg bag Coastal reclamation mix grass seed	No
5	Unnamed Trib 2	0+90	SF4	3	Re-seed off-channel project to stabilise exposed soil	$250	0.25	10 kg bag Coastal reclamation mix grass seed	No

Appendix B-4. Dissolved Oxygen Requirements for Salmonids

Adapted from Bjornn and Reiser (1991).

Spawning salmonids minimum dissolved oxygen requirement:

- 80% saturation and a minimum of 5 $mg \cdot L^{-1}$.

Incubating salmonids minimum dissolved oxygen requirement:

- At or near saturation.

Rearing salmonids minimum dissolved oxygen requirement:

- Adequate: 76%-93% saturation and a minimum of 8 $mg \cdot L^{-1}$.
- Poor: 57-72% saturation and a minimum of 6 $mg \cdot L^{-1}$.
- Very poor: 38-51% and a minimum of 4 $mg \cdot L^{-1}$.

Appendix C-1. Fish species definitions to be used in REE

CODE	COMMON NAMES	LATIN NAMES
Salmonids (Salmon, Trout, Char)		
SA	Salmon (General)	*Oncorhynchus spp., Salmo salar*
AO	All Salmon	*Oncorhynchus spp., Salmo salar*
AS	Atlantic Salmon	*Salmo salar*
GB	Brown Trout	*Salmo trutta*
AGB	Anadromous Brown Trout	*Salmo trutta*
CM	Chum Salmon, Dog Salmon	*Oncorhynchus keta*
CH	Chinook Salmon, Spring Salmon, King Salmon, Tyee	*O. tshawytscha*
PK	Pink Salmon, Humpback Salmon	*O. gorbuscha*
CO	Coho Salmon	*O. kisutch*
SK	Sockeye Salmon	*O. nerka*
KO	Kokanee	*O. nerka*
CT	Cutthroat Trout (General)	*O. clarki*
ACT	Anadromous Cutthroat Trout	*O. clarki*
CCT	Coastal Cutthroat Trout	*O. clarki clarki*
WCT	Westslope Cutthroat Trout, Yellowstone Cutthroat Trout	*O. clarki lewisi*
RB	Rainbow Trout, Kamloops Trout	*O. mykiss*
ST	Steelhead	*O. mykiss*
AC	Arctic Char	*Salvelinus alpinus*
BT	Bull Trout	*S. confluentus*
DV	Dolly Varden, Dolly Varden Char	*S. malma*
ADV	Anadromous Dolly Varden, Anadromous Dolly Varden Char	*S. malma*
EB	Brook Trout, Eastern Brook Trout	*S. fontinalis*
AEB	Anadromous Eastern Brook Trout	*S. fontinalis*
SPK	Splake	*Salvelinus fontinalis x namaycush*
LT	Lake Trout, Lake Char	*S. namaycush*
Sturgeon		
SG	Sturgeons (General)	*Acipenser spp.*
GSG	Green Sturgeon	*A. medirostris*
WSG	White Sturgeon	*A. transmontanus*
Cod		
BB	Burbot, Freshwater Ling Cod, Ling, Loche, Lawyer	*Lota lota*
Whitefish		
WG	Whitefish (General)	*Prosopium spp., Coregonus spp., Stenodus sp.*
PW	Pygmy Whitefish, Coulter's Whitefish	*Prosopium coulteri*
GPW	Giant Pygmy Whitefish	*P. sp., poss. subspecies of Prosopium coulteri*
MW	Mountain Whitefish, Rocky Mountain Whitefish	*P. williamsoni*
RW	Round Whitefish	*P. cylindraceum*
LW	Lake Whitefish, Common Whitefish, Humpback Whitefish	*Coregonus clupeaformis*
HW	Humpbacked Whitefish	*C. pidschian*
BW	Broad Whitefish, Round-nosed Whitefish, Sheep-nose Whitefish	*C. nasus*
SQ	Squanga	*C. sp.*
CS	Least Cisco	*C. sardinella*
CA	Arctic Cisco	*C. autumnalis*
CL	Lake Cisco	*C. artedii*
IN	Inconnu, Sheefish, "Conny"	*Stenodus leucichthys*
Grayling		
GR	Arctic Grayling	*Thymallus arcticus*

Appendix C-2. Photo Point Monitoring Method

(Modified after Anonymous. 1997. Watershed Restoration Effectiveness Monitoring Protocol. US Dept. Agric., Forest Serv. Pacific Northwest Region and Mt. Baker Snoqualmie National Forest.)

EQUIPMENT:

___
|__| Camera - _____35mm automatic or _____
|__| Film and type _____
|__| Clinometer
|__| Compass
|__| Stakes and paint
|__| Flagging
|__| Permanent marker
|__| Pencils
|__| 100 ft. tape and/or hip chain
|__| Copies of project layout map(s)
|__| Copies of previous photo point form
|__| Blank photo point field forms
|__| Clipboard
|__| Pruning shears (optional)

HOW TO ESTABLISH A REFERENCE PHOTO POINT:

1. Obtain copies of original layout maps before going into the field.
2. Try to keep photo point locations logical, either on one side of the stream or up one side and down the other.
3. Establish the photo point:
   - Locate photo point reference markers in a safe spot and certainly above the bank full discharge mark in order to minimize loss.
   - Stake or otherwise mark the photo point and/or reference marker by labelling the stake or marker with the photo point number. Drive any stakes firmly into the ground.
   -Mark the stake location with flagging at visible eye level.
4. Record the photo point location on the field form.
   - Describe where the photo point is in reference to one or more prominent geographic markers and/or establish easily located reference stakes. Use compass headings and measure distances with a tape or hip chain. Example: 50 ft, 120^{o} off SE corner of bridge.
5. Mark the photo point location and any reference markers on the project map.

HOW TO TAKE AND RECORD PHOTOS FROM A PHOTO POINT:

Each photo point will have one or more photos taken from that location. Minimize the number of photo points needed by taking an upstream shot and a downstream shot from the same point if views are good.

1. For 35 mm cameras, record the film roll number on the field sheet - this need only be recorded once every page or when you change rolls. Mark the film canister with the project name and roll number when film is removed from the camera. For digital cameras, the unique photo number should be recorded on the field sheet.
2. Record the photo number - this consists of the photo point number, an alpha suffix, and the year. Example: the second photo taken at photo point 1 in 1990 would be labelled 1B 90. If more than one set of photos are taken in a calendar year, add a numeric suffix. Example: second set of photos taken in 1990 would be labelled 1B 90-2. It would be necessary to go back and label the first set as 1B 90-1 to indicate that more than one set of photos were taken.
3. Record the compass bearing from the photo point.

4. Describe the photo: include what the focus of the photo is, any reference markers within the frame such as distinct landforms or trees, what the center of the photo is, and the type of structure being photographed. Include the inclination or angle from horizontal of the photo if helpful. If it helps in identifying and numbering the slides after development, record the exposure number off the camera in the far left column also.

REPLICATING PREVIOUSLY ESTABLISHED PHOTOS:

1. Locate the photo point by duplicating the previous photo description bearing. Use the photo numbering sequence described above and reference any previous photo numbers in the comments, if renumbering to this new sequence.
2. If replicating photo points where there has been a lot of structure or channel change, take additional photos at other bearings or locations to capture the changes if necessary. Number the new photos with sequential numbers not previously recorded, and mark new photo points on the map.
3. Record the channel and structure changes on the map copy.
4. Supplement the photo point field form with additional field notes if necessary.

WHEN YOU GET BACK TO THE OFFICE . . .

It's important to properly file your field data as soon as possible! Field copies become quickly illegible even to those who wrote them. Please follow these steps upon your return:

1. File a perfectly legible photo point field form into the project binder. Bring forward onto the new form descriptions of the last photo taken from all photo points regardless if they are replicated. This allows the next person to need only a copy of the last form in the field.
2. File your field-revised map in the project folder. Please put your name and date on the map copy.
3. Save all digital photos on a labelled CD and place in the project file.
4. Summarize the photo point initial/follow-up visit. Include significant channel changes and immediate maintenance needs and recommendations in addition to no-change reports. Place a hard copy in the project file.
5. As soon as slides or photos have been developed, label them with the project name and photo number, insert them into plastic file sheets, and put them into the project binder.

SKETCH MAP OR NOTE AREA