July 6, 2007

File: 444250-20-4105A

Ms. Linda Sullivan
Canadian Environmental Assessment Agency
Suite 320 – 757 West Hastings Street
Vancouver, B.C V6C 1A1

Dear Ms. Sullivan:

As part of the review of the Application for an Environmental Assessment Certificate for the South Fraser Perimeter Road (SFPR) project, the Ministry of Transportation (MoT) has received comments from federal reviewing agencies regarding the scope of the cumulative effects assessment (CEA) for the project. As a result of those comments, and discussion with federal reviewing agencies, the MoT has revised the CEA. Please find attached a revised draft CEA which includes a consideration of issues raised by federal reviewing agencies including:

- broader scoping of potential projects for inclusion in the CEA;
- potential effects associated with Terminal 2 (T2) expansion at Deltaport;
- potential indirect (zone of influence) effects on wildlife as a result of the SFPR project; and
- potential indirect effects on fisheries values related to stormwater and drainage infrastructure.

As the review process for SFPR is not yet complete, the revised CEA may also require additional work prior to finalization. At this time, MoT believes that it would be appropriate to provide this revised draft of the CEA to federal reviewing agencies in its current form and seek feedback on whether comments raised to date on the CEA have been adequately addressed. Therefore, please note that the attached document is a draft. Please follow up with me if you have any additional questions regarding this matter.

Sincerely,

Malcolm Smith
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10.3 CUMULATIVE ENVIRONMENTAL EFFECTS

10.3.1 Introduction

Cumulative environmental effects are changes to the environment that are caused by an action in combination with other past, present and future human actions. According to the CEAA guide (Hegmann *et al.* 1999), cumulative environmental effects occur when:

- impacts on the natural and social environments are so frequent, or close, that the combined individual effects cannot be assimilated into the environment; or when
- the impacts of one activity combine with those of another in a synergistic manner creating a cumulative effect that is at least equal, or often greater, in intensity than the total of the individual effects.

This cumulative environmental effects assessment (often called a cumulative effects assessment, or CEA) of the proposed SFPR project has been undertaken to determine the combined effects of the project with other projects and activities in the study area[1]. It determines the incremental contribution of residual effects of the SFPR project, with the impacts caused by all past, present, and where possible future, human activities.

A cumulative environmental effects assessment is a requirement of every screening study under section 16(1) (a) of CEAA. This CEA has been completed using the CEAA practitioners guide as a framework (Hegmann *et al*. 1999), and uses their definition of cumulative effects:

> *"An assessment of the incremental effects of an action on the environment when the effects are combined with those from other past, existing and future actions."*

This CEA has been specifically completed as part of the SFPR project Application for EA Certification. To be considered cumulative, an impact from the project must interact with those from other historical, existing and future projects. Potential interactions with impacts from the SFPR project are the focus of the assessment, and this CEA does not attempt to be a regional resource or land use study that assesses the effects of many developments.

10.3.2 Methodology

The methodology and approach for this CEA is adapted from the five-step approach recommended by Hegmann *et al*. (1999), i.e., scoping, analysis of impacts, significance evaluation, mitigation and monitoring, and follow-up.

10.3.2.1 Scoping

The key component to undertaking this CEA was scoping the issues, identifying:

[1] Different impacts are assessed over a variety of spatial extents; for example impacts on fish are considered at a catchment scale, but air quality impacts are assessed over the much larger airshed of the Fraser Valley.

- SFPR-related potential residual impacts (from the Application) and their spatial and temporal extent;
- residual impacts from historical projects (as requested by reviewers) that define existing conditions in the study area; and
- activities from other projects that may interact with the potential residual impacts of the SFPR project, and the likely impacts.

10.3.2.2 Analysis of Impacts

A matrix was compiled with the issues (SFPR residual impacts) and projects / activities identified in the scoping (**Table 10.3-3**). Where there was an interaction between an issue and a project or activity, there is regarded to be potential for cumulative environmental effect that needed to be considered in the CEA.

To investigate the potential cumulative effects, background data about the issues and activities were collected. These data were quantitatively or qualitatively analysed to assess the potential cumulative effects of the SFPR project with other past, present and future projects. The residual impacts of the SFPR were taken from sections 7 and 8 of the Application. Reference to the appropriate sections of the Application will assist with details of sampling methodology and other impact assessment information used in this CEA.

10.3.2.3 Significance Evaluation

The significance (level) of the cumulative effects, including the contribution of the residual impact of the proposed SFPR project to the total cumulative effect was assessed. A range of characteristics (e.g., magnitude, extent, duration and frequency) of the potential effects was considered (section 10.3.5). This significance evaluation is the MOT's assessment, but final determination of significance remains the responsibility of the regulatory agencies.

10.3.2.4 Mitigation and Monitoring Recommendations

Where possible, mitigation measures and monitoring for the identified cumulative effects have been recommended. Follow-up mechanism(s) to ensure the effective application of mitigation is also recommended. In many cases mitigation and monitoring falls beyond the MoT mandate to undertake management, and may require the involvement of other companies and government agencies.

10.3.3 Scoping

The scoping of the CEA identified projects (**Tables 10.3-1 and 10.3-2**) and issues (**Table 10.3-3**) that could interact with the SFPR. Scoping ensures that the CEA is focussed, and the analysis manageable and practical. It assists in determining if the projects and activities reviewed have the potential to contribute to any cumulative impacts.

10.3.3.1 Scoping Historical, Existing and Future Projects and Activities

Residual impacts, associated with construction and operation of the SFPR Project may act in a synergistic manner with residual effects from other past, present and future projects in the Project corridor, and result in a cumulative environmental impacts. This section describes the criteria that were used in determining which other projects were appropriate for inclusion in the CEA (**Table 10.3-1 and**

10.3-2), summarizes the projects that have been considered and provides a rationale for why some projects have not been considered.

Table 10.3-1 Historical and existing activities and projects, and associated issues, that interact with the SFPR and are considered in the CEA.

Project / Activity	Issue	Activity location
Development in Burns Bog peat mining farming	Impacts to bog and riparian forest and wetland habitat.	Southwest Delta
Dyking of Fraser foreshore	Impacts to fisheries values, riparian habitat and wetlands.	Fraser foreshore, Mission to Delta.
Development of railway BNSF railway CN railway SkyTrain	Impact to fisheries values, riparian, wetland, and cultivated field habitat.	Throughout study corridor including upland areas and areas adjacent to Fraser River.
Municipal development Farming Fraser River ports Housing development Industrial parks	Loss of all habitat types, habitat fragmentation & wildlife movement change. Aquatic, air quality and noise impacts.	Listed projects located up to 500 m either side of SFPR corridor.
Transportation infrastructure Highways (1, 17 & 99) Major roads (River Rd) Minor (municipal roads) Bridges	Loss of all habitat types, habitat fragmentation & wildlife movement change. Aquatic, air quality and noise impacts.	Listed projects located up to 500 m either side of SFPR corridor.
Highway 91 between 64th Ave and the Alex Fraser Bridge	Emissions of CAC and GHG. Bog and riparian forest and wetland habitat loss. Change to wildlife movement and habitat fragmentation.	North Delta / Nordel area.

Table 10.3-2 Future activities and projects, and associated issues, that interact with the SFPR and are considered in the CEA.

Project / Activity	Issue	Activity location
Border Infrastructure Project	Emissions of CAC and GHG.	Canadian Lower Fraser Valley
Pitt River Bridge Project	Emissions of CAC and GHG	Canadian Lower Fraser Valley
Port Mann Hwy. 1 Project	Emissions of CAC and GHG	Canadian Lower Fraser Valley
Golden Ears Bridge	Emissions of CAC and GHG and habitat loss.	Canadian Lower Fraser Valley
BC Hydro transmission line	Impacts to cultivated fields.	Southwest Delta
Deltaport Third Berth	Emissions of CAC and GHG	Canadian Lower Fraser Valley
Terminal 2	Emissions of CAC and GHG	Canadian Lower Fraser Valley

The study area assessed in this CEA has been intensively developed over many years. However, an examination of the impact of residential, industrial and infrastructure development over the long-term (past 100+ years) would be of limited value in the context of considering the cumulative impacts associated with the SFPR, as it would show that the SFPR contributed proportionally little to any cumulative impacts compared to other more extensive residential, industrial, commercial and agricultural developments. Historical development in the study area includes:

- approximately 3,950 ha of residential development for around 110,000 people (Table 8.3-3);
- industrial and commercial activity utilising 1,600 ha (Figures 8.3-1a and b);
- transportation infrastructure dominating the south bank of the Fraser River and;
- agricultural activity that encompasses 7,500 ha (Table 7.1-3).

These have dramatically altered the pre-contact conditions. The Fraser River would have once been more mobile (i.e., moving across the floodplains of Delta and Bridgeview), the slopes of the south bank escarpment would have been fully forested, and wetlands and watercourses surrounding Burns Bog would have held habitat for a different suite of species and been more connected to the Fraser River.

The SFPR impacts on approximately 250 ha of land, most of which is already developed and would be a very small component of the cumulative impact in the context of such significant changes. As such the approach adopted in this CEA considers the existing level of development (past and present projects and activities) and layers the impacts of the SFPR and other projected projects on these. As such the temporal scope of this CEA primarily considers the impacts of projects and activities in the past 30 years, though some older projects, that have been particularly defining for cumulative effects in the study areas, have been included (i.e., railway development on the south bank of the Fraser River, channelisation of Cougar Canyon Creek and Burns Bog peat mining).

Each of the projects considered in this CEA (**Tables 10.3-1 and 10.3-2**), the potential for impacts from them to interact with those of the SFPR, and the rationale for exclusion from the analysis (where applicable) is presented below. Analysis of the potential for cumulative impacts is presented in section 10.3.4.

- **Development in Burns Bog**

The historic extent of Burns Bog is estimated to be 4,800 ha (Rigg and Richardson 1938, cited in Hebda *et al*. 2000). Farming, peat mining, industry, infrastructure development (landfill, utilities, roads and railways) and residential housing have reduced the area of the bog to approximately 2,800 ha. Drainage and land clearance for farming since the 1870s have contributed to habitat loss and impacts to hydrological conditions as a result of their activities in and around the bog. Peat mining from the 1940s to the mid 1980s has resulted in alterations to habitat and hydrology and habitat loss, but much of the land disturbed by mining (other than that occupied by the City of Vancouver landfill) remains part of the bog. Railway (BNSF), road (Highway 91, see below), utility (gas, transmission line and sewer), industry (River Road industrial sites) and residential housing (Panorama Heights) have also reduced the area of the bog. Impacts to Burns Bog associated with all these activities are considered in this CEA.

- **Dyking of Fraser River foreshore**

Containing the movement of the Fraser River has contributed to loss of fisheries habitat, as the movement of water and fish into tributary reaches has been constrained by the dykes. While there are no residual effects on fisheries habitat predicted as a result of the SFPR, impacts to fish habitat as a result of historical activities are considered in this CEA.

- **Development of railway**

Development of the Burlington Northern Santa Fe (BNSF) Railway (adjacent to Highway 91 and the Fraser River), the Canadian National (CN) and Canadian Pacific (CP) Railway (adjacent to Fraser River) and the SkyTrain (parallel to the Pattullo Bridge) was considered in the CEA. The Development and operation of the CN/CP and BNSF railways contribute to habitat loss, air and noise emissions in the study area and have been considered in this CEA, but the SkyTrain does not and it has not been assessed.

- **Municipal Development (residential, rural and industrial development)**

Development within municipalities consistent with the respective OCP that is considered in this CEA includes farming (berry, crop and livestock), ports (Fraser Surrey Docks, Gunderson Slough and other port facilities on the south bank of the Fraser River), industrial developments (Tilbury Island, River Road, Nordel area, South Westminster and Bridgeview), the CN Intermodal yard and housing development (North Delta, Annieville, South Westminster, Bridgeview, Bolivar Heights and Fraser Heights). Such development has contributed to habitat loss in the study area, and allows for other activities that contribute to air and noise emissions. Habitat loss and fragmentation, wildlife mortality, stormwater runoff and air and noise emissions from all these activities have been considered in this CEA. The exceptions to this are habitat loss due to port activities, as there is no impact on the Fraser River foreshore as a result of the SFPR.

- **Transportation Infrastructure**

Transportation infrastructure in the study area, including highways 1, 10, 17, 91 (see below) and 99, major roads (Deltaport Way, River Road, South Fraser Way, King George Highway, 176th Street and Scott Road), bridges (Pattullo and Alex Fraser bridges) and all minor municipal roads (including 72nd Street) are considerd in this CEA for their contribution to regional air

quality. The noise created by traffic on these roads is also assessed, as is their contribution to stormwater impacts.

- **Highway 91**

Highway 91 between 64th Ave and the Alex Fraser Bridge was constructed in the mid 1980s through an area adjacent to Burns Bog. The habitat loss, fragmentation and hydrology alteration issues associated with this road are assessed in this CEA. The impacts of vehicles on this road on air quality and noise in the study area are also considered in this CEA.

- **Border Infrastructure Project (BIP)**

Improvements to highways 10, 11, 15 and 91/91A as part of the Border Infrastructure Project are considered in this CEA with respect to air quality issues. In general it is considered that the BIP is too distant from the SFPR local study area to interact with impacts associated with the SFPR, but there is potential for it to contribute to cumulative regional air quality changes and the potential for these impacts have been considered.

- **Pitt River Bridge Project**

Improvements to the Pitt River Bridge and Maryhill Interchange (part of the North Fraser Perimeter Road Project proposed by the Gateway Program) are considered in this CEA in respect of regional air quality changes.

- **Port Mann Highway. 1 Project**

Improvements to the Port Mann Bridge and Highway 1 (part of the Gateway Program) are considered in this CEA as they pertain to air quality and noise issues, and to a small extent habitat loss.

- **Golden Ears Bridge Project**

The new Golden Ears Bridge crossing of the Fraser River (a TransLink project due for completion in 2009) is considered in this CEA as it contributes air emissions to the regional airshed. Some minor habitat loss issues are also considered.

- **BCTC transmission line upgrade**

Habitat loss associated with the BCTC transmission line upgrade through southwest Delta is not considered in this CEA, as the loss of habitat is negligible (replacing two lines of towers with one), and environmental values in the transmission line corridor (i.e., cultivated field values to wildlife) will likely remain after construction is complete. In addition, it does not involve additional operational activities relative to those that currently exist.

- **Deltaport Third Berth Project**

The Vancouver Port Authority Deltaport Third Berth project (due for completion in 2009) is considered in this CEA for its potential to contribute cumulatively to regional air quality changes.

- **Terminal 2 Project**

  The Vancouver Port Authority Terminal 2 (T2) Project may occur at some time in the future, but the extent of the project is not accurately known because the VPA "has not advanced the proposal beyond the point of identifying a potential site location [Roberts Bank] and desired capacity [1.9 -2.2 million twenty foot equivalent units (TEU, a measure of goods throughput)]" (VPA 2007). With this knowledge the potential for cumulative impacts on regional air quality (i.e., number of vessels, trucks and trains) was considered in this CEA. However, the potential for cumulative impacts on habitat cannot be considered, because "on-site services and offsite road and rail requirements have not been established and will require extensive studies before they can be confirmed" (VPA 2007).

  The schedule for Terminal 2 is yet to be determined, but it is included in this CEA because it is regarded to be a foreseeable project. When the T2 project undergoes its own environmental assessment, a CEA that includes the SFPR project will likely be undertaken.

  While all the residual impacts from T2 which might interact with the SFPR are not known, an assessment of the predicted air quality impacts can be undertaken and is included in this CEA.

The general contribution of residential, industrial, commercial and agricultural activities on emissions of air quality contaminants in the study area (**Table 7.2-2**) are considered in the assessment of regional air quality impacts presented in this CEA analysis. This includes the mobile sources such as cars and trucks on all highways, bridges and roads in the regional study area, ships and airplanes, and non-mobile sources such as residential housing, industrial and institutional emissions. This assessment and the data used are consistent with Greater Vancouver Regional District data on air emissions in the Canadian lower Fraser Valley airshed, which also includes all mobile (i.e., cars, trains, ships and airplanes) and non-mobile (i.e., industrial and residential) sources.

Noise impact assessments are, by their nature, cumulative assessments because they include noise created by all existing activities (and do not need to include historic projects that are no longer operational). In this CEA, the impacts of existing projects and activities in the study area are included. Baseline measurements of noise at locations in the SFPR corridor include vehicles on all existing roads, trains, airplanes, ships, industry and residential activity. The potential noise of the SFPR and relevant future projects (e.g., Port Mann Highway 1 Project) is then added to the baseline.

The projects or activities considered in the CEA have all satisfied the following test that considers the relevance of the project for analysis in the CEA (Hegmann *et al.* 1999):

- Temporal – the effects of other planned projects or activities must occur or overlap with the time when the effect of the SFPR Project is expected to occur; or
- Spatial – the effects of the other planned project or activity must be expected to overlap the spatial area affected by SFPR Project; or
- Type – the environmental effect of the other planned project or activity must be sufficiently similar or capable of interacting with the effect of SFPR Project to produce a combined effect on the ecosystem component in question.

The past, present and potential future activities assessed in this CEA satisfy at least one of the above noted tests.

It is difficult and often impossible to accurately predict the effects of future projects. However, in addition to the criteria identified above, and as outlined in the Approved Terms of Reference for the Project, the CEA for SFPR has considered, "other significant projects that: are within a defined corridor of reasonable scale and significance; are known to have required permits and authorizations which would allow the projects to proceed to implementation; or have secured funding and schedules and timelines known to be imminent in their commencement up to the submission of the SFPR Application". For this CEA this includes

Within the study area there are other potential projects that could take place that are not considered in the CEA. As per the criteria identified above, potential residual effects from the projects noted below have not been considered in the CEA. The projects and the rationale for their exclusion from CEA analysis is as follows.

- **Potential development of agricultural lands by the Tsawwassen First Nation (TFN)**

The potential for agricultural land to be converted to other uses as a result of the treaty with TFN is unknown. All that is known is that ownership of this land might change, but there is no indication of the extent, if any, that this will result in a change to agricultural production. This activity is not assessed further, as the likelihood of change is highly speculative, and agricultural use of land, a socio-community issue, is not considered in a CEA unless there is a biophysical impact (section 10.3.3.2).

- **Potential expansion of rail corridors**

In conjunction with the Deltaport Third Berth Project there will be minor expansion of a siding west of Highway 17 adjacent to Deltaport Way, but this was not judged to result in the potential for cumulative effects. Until any rail expansion is announced and the impacts identified no cumulative effects assessment can be undertaken.

- **Future residential/commercial and agricultural development.**

The assessment of potential cumulative impacts between the SFPR and future residential/commercial and agricultural projects and activities is not considered in this CEA, except as it contributes to air quality.

It is assumed that the respective OCP in the study area have predicted and planned for the potential impacts of build-out to the extent of the OCP, such that there are no residual impacts from such municipal development. As the SFPR does not require changes to the OCP it is therefore considered that there are no cumulative impacts. Development to the extent of the OCP will occur with or without the SFPR, but the rate of such development may be faster as a result of the SFPR (section 8.4). The potential for OCP build-out to occur faster is not predicted to lead to residual impacts, as the actual impacts on habitat loss and fragmentation, wildlife pattern changes and collision risk is the same with or without the SFPR. For these reasons future residential/commercial and agricultural development impacts on habitat loss, fragmentation, wildlife pattern changes, wildlife mortality, aquatic impacts and noise is not assessed as part of this CEA, except as they affect air quality. Increases in population and land

use changes are included in regional air quality modelling. So for the CEA air quality assessment of future residential/commercial and agricultural development, the GVRD air quality inventory was used. This assumes development to the extent of the currently approved OCP for each municipality and the contribution of such development to air quality.

For all of these projects there is no certainty that they will occur; and if they do the nature, scope and extent of project related impacts, and the timeline in which they may occur, is unknown. As such, it is not possible to determine whether or how such developments may interact with residual impacts from the SFPR in order to produce a cumulative impact.

10.3.3.2 Issues Scoping

All residual impacts from the SFPR project, and residual impacts from historical projects (e.g., fisheries impacts were not assessed as residual impacts, but are considered at the request of reviewers), that interact with impacts from other projects were included in the issues scoping. The criteria used to determine residual impacts are detailed in the respective portions of sections 7 and 8.

The following issues were considered appropriate to the CEA analysis for the SFPR:

- **Habitat Loss**

A reduction in habitat potentially affects the resources available to support threatened and other wildlife species and affects the intrinsic values of the habitat. The specific habitats (VEC) that have potential residual impacts as a result of the SFPR are: riparian forest, upland forest, Burns Bog habitats, cultivated fields and wetlands. Though for many of these, proposed compensation such as protection of an equivalent or larger area will address the residual impacts. Despite this, the loss of these habitats impacts a range of species including; threatened mammal species (e.g., red-backed vole), red-legged frog and other amphibians, red-backed vole and other small mammals, sandhill crane and threatened aquatic insects. Habitat loss reduces the area available for these and other species, and also has implications for fragmentation and isolation of habitats.

The spatial extent for these VEC will differ; for riparian forest it includes the riparian zones in the catchment of watercourses crossed by the SFPR alignment. For Burns Bog, it is the extent of the identified area required to support a viable water mound (Hebda *et al*. 2000). For upland forest it is the assessed study area; within 250-500 m of the centreline of the proposed SFPR (section 7.7).

- **Habitat Fragmentation**

Vegetation clearance, in addition to removing the habitat for wildlife (see above), can also disrupt the continuity of previously intact habitats that support wildlife species dependent on contiguous habitat (habitat fragmentation). While small losses of habitat that lead to fragmentation might only slightly reduce the habitat available, its impacts are greater than this small loss indicates. This is because many species are unable to survive in areas that are bisected by unsuitable habitat, or the disturbances introduced by the fragmentation lead to mortality (see below), or the impacted areas are a barrier to movement (see below).

For the SFPR, the habitats impacted by fragmentation are riparian forests that support Pacific water shrew, and amphibians, and upland forests that provide resources for raptors and songbirds.

The study area for assessing the potential cumulative effect of these impacts (and similar impacts from other projects) is the wildlife and vegetation study area 250 to 500 m from the centreline of the proposed SFPR (section 7.7).

- **Wildlife Pattern Changes**

The introduction of noise and visual disturbances as a result of the SFPR is predicted to be a residual impact on the use of parts of the study area by wildlife. For many species such disturbances will cause them to avoid the area and these impacts are essentially habitat loss, as they reduce the resources available. The species that are affected include raptors (particularly nesting raptors), and small mammals (particularly threatened small mammals and mammals used as prey by raptors). The disturbances introduced by a linear development can also act as a barrier to movement of wildlife. In the SFPR study area there are a number of routes used by wildlife for travel corridors. These include deer, amphibians, reptiles and small mammals travelling between Burns Bog and other forest areas (Fraser Heights) and adjacent wetland and or agricultural areas for foraging.

The study area for assessing the potential cumulative effect of these impacts (and similar impacts from other projects) is the area 250 to 500 m from the centreline of the proposed SFPR (section 7.7).

- **Wildlife Mortality from Collisions**

The impact of wildlife colliding with vehicles has potential to result in individual mortalities, and with similar impacts from other projects and activities may over time, result in population level impacts. Wildlife mortality is greater for new roads that bisect previously undisturbed habitats, than for existing roads. There were potential residual impacts as a result of wildlife mortality from SFPR-related collisions identified, especially for barn owl.

The spatial extent (study area) of wildlife collisions is the footprint area of roads adjacent to habitat in which susceptible species are located (predicted location of potential residual impacts due to collision, see section 7.7). For the SFPR this is road segments through fields adjacent to Burns Bog and Crescent Slough near the proposed Highway 99 Interchange. Mitigation measures identified in the Wildlife Crossing Mitigation Plan (submitted to reviewers April 2007) including wildlife crossings and fencing, will minimize the residual environmental effects.

- **Aquatic Habitat Impacts**

The potential impacts on the aquatic environment that could contribute to cumulative effects on aquatic habitats are the loss of aquatic and riparian habitat, and changes to water quality and quantity. There is potential for aquatic and riparian habitat loss, but avoidance measures and mitigation will not result in the potential for residual environmental effects (Section 7.4).

The proposed SFPR project will achieve no net loss of aquatic habitat because the impacts (estimated at 3.1 ha of aquatic habitat and 14.5 ha of riparian habitat) are less than the areas

available for compensation. As a result there will be no residual impacts on aquatic habitats, and therefore there is no potential for cumulative effects are predicted. However, a CEA assessment has been conducted because there are other projects in the study area (watercourses crossed by the SFPR) that have in the past impacted aquatic habitat.

The study area contains a large number of watercourses that could be impacted by changes to water quality including increased sedimentation and / or changes in water quantity (related to changes in impervious surface area). Mitigation measures, including meeting stormwater management performance objectives identified in section 4.2.2.1 and best management practices to avoid and minimize impacts on water quality are anticipated to ensure no residual impacts on water quality. In addition to these mitigation measures outlined in the EA Application, the stormwater management plan (submitted to reviewing agencies during the Application review) and computer models developed to aid design of drainage infrastructure in Delta to further demonstrate how the project will avoid residual impacts on water quality. As a result, there is not anticipated to be any interactions with the impacts of other projects and hence no potential for cumulative impacts. While no residual impacts are identified, this issue is discussed further as there are other activities in the study area that contribute similarly to water quantity.

The study area for assessing aquatic impacts is the watercourses crossed by the proposed SFPR alignment.

- **Air Quality**

There is potential for an increase in air emissions (criteria air contaminants, CAC and greenhouse gases, GHG) as a result of the proposed SFPR, and this in conjunction with other projects and activities in the area (other roads and highways, shipping, trains, commercial and residential development) may lead to cumulative environmental impacts.

No residual impacts were identified associated with an increase in SFPR-related air emissions (section 7.2), as the impacts from the SFPR were not identified as being significant. However, air quality has been considered in this CEA, because other projects and activities in the study area (the Canadian lower Fraser Valley airshed) contribute to air emissions, which currently exceed some regulatory standards, and there is interest in including air quality in this CEA as indicated by reviewing agencies. The GVRD emissions inventory, which was used as the basis for this assessment, includes the emissions from all mobile (cars and trucks, trains, airplanes and ships) and non-mobile (industrial and residential) sources in the study area. As such, the CEA analysis for air quality includes all the activities in the study area (the Canadian lower Fraser Valley airshed) that contribute to emissions.

- **Change in Noise Levels**

Impacts to noise as a result of traffic on the SFPR Project identified the potential for residual impacts, and these in conjunction with other projects and activities in the area have the potential to contribute to cumulative environmental effects.

For the SFPR, despite the application of mitigation as per the MOT noise policy, noise increases are predicted for 7 sites (each representing a residential enclave). The impact at

these sites was assessed as 'severe,' as predicted by the percentage of highly annoyed residents. However, the use of quiet pavement, coordination of traffic signals and noise walls (i.e., mitigation measures) reduces the residual impacts to just one site. Further evaluation of noise walls will be completed during detailed design to reduce noise impacts. Health impacts, measured through speech/sleep interference, range from minor to moderate when noise barriers and quiet pavement are utilized in the affected areas.

The study area for the noise assessment is all residential land uses along the study corridor where it is reasonably expected that ten years after project completion, 24-hour Equivalent Sound Level ($L_{eq}(24)$[2] at ground floor level (due to the new or upgraded highway, and all other non-highway sources as appropriate), will equal or exceed 55 dBA $L_{eq}(24)$. Also see section 8.1, which describes how the data to be used in this assessment were generated.

These issues, and in particular the interaction of project-related activities with other projects are discussed below in the analysis of effects (section 10.3.4).

In addition to the issues noted above that are considered in the CEA, there are a number of issues and associated VEC and valued socio-community components (VSC) that were considered during scoping, but analysis was not undertaken in the CEA. The following provides rationale for why these were not included.

Archaeology – The study area contains significant archaeological resources that could potentially be impacted by the Project including those at the St. Mungo and Glenrose Cannery sites. However, based on work done to-date to confirm the distribution of archaeological resources, in addition to future recommended work and proposed measures to protect archaeological resources during and post-construction, no residual impacts on such resources are anticipated. This issue is not discussed further.

Hydrogeology – There are a number of areas through the corridor, including the area adjacent to Burns Bog, where potential effects on ground water could occur. The development of a highway design and construction method that maintains water levels and water chemistry associated with Burns Bog is proposed to ensure that impacts to hydrogeological values do not occur. Given the complexity of hydrogeological conditions in and adjacent to Burns Bog, a monitoring and follow up program (section 7.5.5.7) is also required in order to ensure that the proposed design mitigation functions effectively and achieves the intended performance objectives. Design of mitigation measures to ensure that there is no impact on hydrogeology has been advanced in the area around Burns Bog (March and April 2007), in consultation with the managers of Burns Bog.

[2] The principal metric for the noise environment in this assessment is the 24-hour equivalent sound level, or $L_{eq}(24)$, a single-number descriptor of the average sound energy exposure over a 24-hour day. The $L_{eq}(24)$ is commonly used to describe noise from road and railways. In addition, to reflect the greater sensitivity of residential communities to intrusive noise at night another metric was also used. The day-night average noise level, or L_{dn}, is a time-averaged sound energy level like $L_{eq}(24)$, but it does not treat daytime and night time noise equally. To compute L_{dn}, a 10 dBA night time penalty is applied to all noise levels projected to occur between 10:00 PM and 07:00 AM.

Agriculture – While there are impacts to agricultural land, associated with direct footprint impacts in southwest Delta, the impact to such land in the context of potential impacts on the agricultural sector is not evaluated in the CEA (as per CEAA guidelines). Proposed compensation (i.e., support for an Agricultural Enhancement Strategy March 2007) to offset impacts to agricultural land (section 7.1.5.4) is expected to ensure that there is no residual impact on the agricultural sector in southwest Delta as a result of the SFPR. The loss of agricultural land, in the context of it providing some wildlife habitat value (loss of agricultural land that supports waterfowl and other avian species) is discussed in the CEA (section 10.3.4.1).

Contaminated sites – While there are a number of potentially contaminated sites throughout the corridor, all contamination will be managed in compliance with relevant legislation and regulation. As such, it is anticipated that the Project will not result in adverse residual impacts from contaminated sites, and in some cases may result in improvements (i.e., reduction in the number of contaminated sites in the study area). This issue is not discussed further.

Socio-Community/Socio-economic – While there are a limited number of potential adverse impacts on socio-community and socio-economic conditions in the SFPR corridor, the majority of these have been/will be addressed in future stages of project planning and no residual impacts were identified. Where adverse impacts have been identified (e.g., loss of commercial/industrial land), it is not expected that they will result in changes to VEC or VSC. As such, socio-community and socio-economic values potentially impacted by the Project have not been considered in the CEA. Furthermore, socio-community / socio-economic impacts (including agriculture and archaeology) are not within the scope of a CEA (as per CEAA guidelines), unless the impact is attributed to a biophysical impact. As such, in the case of SFPR, socio-community and socio-economic values are not considered in the CEA.

Table 10.3-3 Potential cumulative effects identified by the interactions of the SFPR residual impacts (with other projects), and the scoped environmental issues (VEC).

Issue	Habitat Loss					Habitat Fragmentation		Wildlife pattern changes	Wildlife Mortality	Aquatic Impacts	Air Quality		Noise
Project / VEC	Riparian Forest	Upland Forest	Cultivated Fields	Wetlands	Bog Forest	Riparian Forest	Upland Forest	Mammals	Barn owl	Fisheries Values	CAC	GHG	Change in noise
SFPR	■	■	■	■	■	■	■	■	■				■
BIP (2005)			■					■			■	■	
Pitt River Bridge (2009)											■	■	
Port Mann / Hwy 1	■	■								■	■	■	■
GEB (2009)	■	■		■				■			■	■	
Hwy 91	■			■	■	■		■	■		■	■	■
BCTC power line upgrade (2008)			■										
DP3 (2009)								■	■		■	■	■
Terminal 2											■	■	■
Railway growth	■		■	■				■		■			
Dyking Fraser River	■			■						■			
Municipal development	■	■	■	■	■	■	■	■		■	■	■	■
Transportation infrastructure (hwys/local rds)											■	■	■
Burns Bog developments	■			■	■								

* A full list of the projects and activities included in these headings is given in the projects scoping, section 10.3.3.1.

10.3.4 Analysis of Effects

Each of the issues (**Table 10.3-3**) is discussed below relative to effects on appropriate issues (VEC), and in particular the residual effects related to the actions of the SFPR Project. The assessments that follow are summarised in **Table 10.3-5**.

10.3.4.1 Habitat Loss

Habitat loss in general, and habitat losses that affect particular species, are considered in this CEA. The overarching principle for the assessment of habitat loss impacts as a result of the SFPR is to consider ecosystems (habitats) that in turn provide for the maintenance of individuals and populations of species. Thus, the framework for the assessment of impacts is based on the SFPR footprint impacts on habitat categories identified in the vegetation and wildlife assessment report (Technical Volume 12, and section 7.7.3.5). There are also indirect (non-footprint) impacts related to disturbance (i.e., zone of influence impacts) adjacent to the road where wildlife use is diminished. These indirect impacts are assessed qualitatively.

Within this assessment framework, the SFPR mitigation and compensation proposals are built around the maintenance and/or enhancement of regional ecosystem function (rather than addressing site- or species-specific impacts). It is acknowledged that there are species and locations (red- and blue-threatened plant communities and species) vital for maintaining regional biodiversity. These components are specifically considered in the Application and in this CEA, especially where mitigation and compensation for habitat protection alone is insufficient to address residual impacts. This includes specific mitigation measures to address fragmentation, changes to wildlife movement patterns and collision risk (i.e., nesting boxes for barn owls and hedgerows to minimize the potential for vehicle collisions with sandhill crane).

Disturbance to vegetation has the potential to affect plant communities and species that are both common and uncommon (rare or threatened), both are considered in this CEA.

Habitat loss affecting rare (red- or blue-listed) communities and plant species (SARA and or red- or blue-listed) may involve only a small area, but this may have an impact because rare plant species may not occur elsewhere in the area and they have important biodiversity value.

Threatened plant ecosystems are distinct from threatened species because an association of species, some of which may be common, can have significance. Like the threatened plant species mentioned above, these ecosystems may not occur elsewhere in the area, or anywhere else. The reasons for their threatened status can include being naturally uncommon, or occurring in places that are prone to disturbance.

Upland Forests

Upland forests in the study area support wildlife species, some of which are threatened (e.g., western screech owl) and uncommon / notable bird species in the Fraser Heights forests (e.g., red-breasted sapsucker, northern shrike and yellow-rumped warbler). The Fraser Heights and Delta Ravines areas are particularly important locations for these forests. These forests also support threatened plant communities (e.g., western red cedar / foamflower and sitka spruce / salmonberry).

The impacts on upland forest as a result of the SFPR are 15.6 ha, of which 13 ha are threatened plant communities (1.15 ha red-listed and 11.86 ha blue-listed). All the impacts are in the forests of Bridgeview and Fraser Heights. None of these forests are formally protected for ecological or conservation purposes; and much of it is disturbed by past developments such as residential housing in the upland areas of Surrey and Delta, so that only components of the original forests remain. Residential housing that currently covers approximately 3950 ha of the study area has removed more upland forest than any other activity. However, these remaining forests are valuable, because unlike other parts of the study area they do offer value to wildlife and still retain some of their original floral components. Some of the affected forest is in a portion of the study area that supports a number of species at risk, and includes insects, amphibians, small mammals and birds. Mitigation has been proposed to address the potential SFPR impacts on these species such that no residual impacts were identified. However, compensation for predicted residual impacts associated with upland forest habitat loss in general is proposed. This includes adding blue-listed upland forest of a similar quality and value to vegetation and wildlife in other areas along the corridor. The only other recent project in the study area that will potentially impact on upland forests is the Golden Ears Bridge (GEB) Project. It is predicted that 12.3 ha of "combined forested and shrub woodlot and riparian edge habitat" would be impacted (GEB environmental assessment). To compensate for the impacts to these (unprotected) areas, most of which were privately owned and with development potential, the GEB project proposed implementing formal conservation protection on the areas that remain after construction of the project.

As a result of this assessment the potential cumulative effects as a result of the SFPR have been assessed as low. This assessment takes into account the existing (disturbed and unprotected) values of the habitats, the industrial, residential, agricultural and transport developments that have already removed most of this habitat in the study area, and that compensation associated with the SFPR and Golden Ears Bridge projects is similar in area and values to that lost.

Riparian Forests

Riparian forest in the study area provides habitat for wildlife species, some of which are threatened (i.e., Pacific water shrew), they also contain threatened plant communities (i.e., redcedar / sitka spruce–skunk cabbage), and are an important feature for the protection of aquatic habitat values from sedimentation and erosion.

In the study area most of the riparian forests will be unaffected by the SFPR, though there are a few locations near the Port Mann Bridge, in Fraser Heights and at the proposed 176th Street Interchange where the alignment impacts on 8.5 ha of these habitats. Many of these impacts are on relatively disturbed areas, but nonetheless the habitat that these areas offer to wildlife and the aquatic habitat protection conferred, are of considerable value. Most of the riparian forest habitat impacted (8.4 ha) are either red-listed (0.9 ha) or blue-listed (7.5 ha).

In the study area, the Port Mann /Highway 1 and GEB projects, construction of Highway 91 and historical railway developments are also considered to have impacts on riparian forest habitat. The GEB Project is anticipated to impact 12.3 ha of habitat that includes some (undefined) riparian areas, some of which is habitat for Pacific water shrew. The Port Mann Highway 1 Project may impact riparian and upland forest in the study area. While the likelihood, extent and significance of this potential impact is unknown at this time, it is likely to be minor as the corridor is already intensively developed for transportation. Construction of the BNSF Railway in the late 1800's and Highway 91 in the mid 1980s likely impacted riparian forests

adjacent to wetlands and watercourses at the break of slope between the North Delta uplands (Delta Nature Reserve) and Burns Bog. The spatial extent of such impacts is unknown. Historical railway development and port and other activities on the Fraser River banks probably impacted heavily on riparian forests, particularly on the Fraser River foreshore in the early 1900s. The time since these developments and lack of documentation of the impacts on riparian forests due to Highway 91 construction and railway development precludes a quantitative assessment of these impacts.

As a result of the above, the cumulative effect of the SFPR project is assessed to be low. The magnitude and extent of the impacts from the SFPR are small in comparison to other past impacts (especially historical railway development), and mitigation and compensation is available to provide protection of aquatic and riparian forest values. Fisheries compensation proposals for the SFPR (up to 17.5 ha) and land acquisition (6.9 ha of riparian forest in Fraser Heights, 3.5 ha red-listed and 3.4 ha blue-listed), and the GEB Project that will also provide additional riparian habitat area, will address that lost.

Cultivated Fields

Agriculture in southwest Delta is the predominant use of land (2,860 ha of the land use in **Figure 8.2-2a**). Of the smaller study area assessed for wildlife and vegetation impacts (section 7.7), cultivated fields are approximately 460 ha, or almost 50% of the southwest Delta part of this study area. While cultivated fields are anthropogenic, they do offer value to wildlife, particularly for water-associated birds (i.e., old-fields, grazing, forage, crops, fallow and water reservoirs), and small mammals that are prey items for raptors. Some of the species that utilize these habitats are threatened (e.g., sandhill crane).

The total impacts on cultivated fields that offer value as wildlife habitat in the study area is 35.7 ha (25 ha of forage crops, 9 ha of seasonal crops and 1.7 ha of old field habitat). These are predicted to be residual impacts. However, these impacts were not predicted to affect habitat used by threatened sandhill crane species. In addition, the SFPR Project has undertaken to assist (with funding) the activities of organizations that set aside fields for wildlife habitat. In addition, much of the agricultural land purchased for the project, but that is surplus to requirements and cannot be farmed afterward (14.7 ha) may converted to old field as habitat for wildlife.

Other projects and activities in the study area that have potential to impact on similar habitat include the Vancouver Island Transmission Project (negligible to nil impacts) and the Border Infrastructure Project (outside the study area). As a result of the low to negligible impacts from these other projects, no cumulative impacts were identified. Historical development of major roads like highways 17, 91, 99 and Ladner Trunk Road and minor roads such as 72nd Street, and railway development (only a small portion of the southwest Delta part of the study area), have contributed to either past losses of cultivated fields, or reduced the potential for areas to be converted to agricultural use.

Wetlands

Prior to development of the Lower Fraser there were substantial areas of wetlands. Development activities including: drainage; dyking, filling and clearing have impacted much of the wetland habitat in the study area (and in the region) and it is estimated that 70% of wetlands in the Lower Fraser have been lost (FREMP 1994). In the study area, wetlands account for 66 ha or approximately 3% of the total area. In Burns Bog approximately 40% of the original area remains (due to agricultural, commercial, transport and residential developments), and 29% of its original dynamic storage capacity remain (Hebda *et al*. 2000).

While effort has been made to avoid and mitigate for SFPR-related impacts to wetlands, including the Fraser Heights wetland bridge which spans an important wetland, there are impacts to approximately 11 ha in the study area. Many of these wetland areas are roadside ditches with lesser values, and proposed mitigation is focused on avoiding direct impacts to the most pristine wetland area (Fraser Heights wetland). Nonetheless, residual impacts have been identified for wetland habitat losses. Compensation for fisheries impacts (section 7.4.6), which includes 4 ha of habitat creation will mitigate much of this loss. In addition, long-term protection of wetland habitat will also contribute to compensating for impacts of the SFPR. As a result of these efforts no significant adverse impacts as a result of the SFPR are identified, despite this the potential for cumulative environmental impacts is analysed because of the importance of the remaining wetland areas in the study area.

For some of the other projects identified (**Table 10.3-1 and 10.3-2**) no impacts to wetlands were noted (Golden Ears Bridge Project, Port Mann Highway 1). For others that occurred at some time in the past and where documentation is lacking (Historical development of Burns Bog and the Fraser River, agricultural commercial and residential development, and railway development) it is difficult to analyse their impact on wetlands. However, it is known that wetland habitat losses occurred. While a quantitative assessment is impossible with the lack of information about the former extent of wetlands, the paucity of wetlands in the study area points to high impacts. In the case of the construction of Highway 91, it has also proved impossible to quantify the impacts, but an understanding of how construction affected Burns Bog is possible (Hebda *et al*. 2000). Highway 91 was constructed on compacted sand, woodchips and sawdust, which was allowed to sink onto compressed bog material. This construction has likely altered the hydrology of the area, including the water supply between the upland area of North Delta and Burns Bog, though the exact extent and magnitude of the change has not been documented. Wetlands (and lagg zones) in the area between the two are now likely occupied by Highway 91. Such construction is informing the design for the SFPR on the other side of Burns Bog so that similar impacts can be avoided (see Burns Bog below).

The relatively greater degree of impacts on wetlands as a result of other projects, and the attention to avoiding and mitigating or compensating for impacts as a result of the SFPR points to a lack of cumulative effects as a result of the SFPR. There do not appear to be impacts on wetlands as a result of other projects, which could interact in a synergistic manner with SFPR-related impacts; therefore no cumulative impact was identified.

Burns Bog

Burns Bog historically covered a larger area estimated to range between 4,000 and 4,800 ha. Currently, Burns Bog as defined in the Burns Bog Ecosystem Review, encompasses an area of 3,041 ha (including 220 ha of cranberry and blueberry fields) and includes 2,821 ha of land that is considered “ecologically available”. The Burns Bog Ecosystem Review identifies 2,450 ha of remaining bog as “required to preserve Burns Bog as a viable ecosystem”. The acquisition of bog land, in Burns Bog, by provincial, regional and local governments created the Burns Bog Partnerships Lands, which total 2033 ha. In Burns Bog approximately 40% of the original area remains (due to agricultural, commercial, transport, landfill and residential developments and peat mining reducing the original size), and 29% of its original dynamic storage capacity remains (Hebda *et al*. 2000). As a result of these activities, Burns Bog has been substantially reduced in size and hydrological activities have been affected. Its ability to support wildlife has likely been reduced as a result of habitat loss and fragmentation from forests in the uplands area of Delta and Surrey by the BNSF Railway and Highway 91. The upland forest areas have also been reduced in extent and have further affected wildlife in Burns Bog.

Impacts to hydrogeological conditions in Burns Bog associated with the SFPR are expected to be mitigated through specialized design and construction. The development of design mitigation is being informed by considering the impacts on hydrogeology that have occurred as a result of agricultural development, peat mining, the Vancouver Landfill and Highway 91. However, the SFPR is expected to cause footprint impacts to 28.79 ha of land in zones required for, or supporting, the viability of Burns Bog. Of this total, approximately 13 ha have been impacted by past development (rural/industrial, berries, seasonal crops, upland shrub or disturbed) though it continues to provide hydrogeological values to Burns Bog. Thus, the potential residual impacts to areas recognised as supporting the viability of Burns Bog is approximately 16 ha.

The extent and magnitude of the impact to ecologically available bog habitat (approximately 16 ha) is small compared to the area of Burns Bog. Moreover, the majority of the areas that are crossed by the alignment are outside the water mound which is required to support the viability of Burns Bog. For example, 5.6 ha of the affected land with ecological values is in zone 1 or in the water mound and required for Burns Bog viability and 10.7 ha is outside the water mound or supporting but not required for Burns Bog viability in zones 2, 3 and 'insufficient data'. Compensation for these impacts is proposed to include the provision of bog forest that might be added to the protected area, some of which is red-listed ecosystem, and a financial contribution to ongoing management of Burns Bog.

Highway 91 (on the east side of Burns Bog, between it and the adjacent North Delta uplands, was constructed on compacted sand, woodchip and sawdust, which was allowed to sink onto compressed bog material. This construction has reduced the area of Burns Bog and likely altered the hydrology of the area (Hebda *et al*. 2000), including the water supply and runoff between the upland area of North Delta and Burns Bog. However, construction of the Northeast Interceptor Canal (also known as Cougar Canyon Creek) is understood to have contributed most to the impacts on hydrology in this area. While runoff from the North Delta uplands formerly was understood to flow both north and south, it now flows under Highway 91 into Burns Bog, reducing the area and quality of bog habitat on both sides of Highway 91.

The relatively greater degree of impacts on Burns Bog as a result of other projects (i.e., peat mining, agriculture, transportation, utility and commercial developments), and the attention to avoiding and mitigating or compensating for impacts as a result of the SFPR (hydrological mitigation and compensation for habitat loss) points to any cumulative impacts as a result of the SFPR being of low significance.

Indirect Habitat Loss Impacts

Roads have been shown to have adverse impacts on plants, amphibians and many bird species in adjacent habitats. Such indirect impacts include reduction in habitat quality, species avoidance, barriers to movement and habitat fragmentation. Conversely, positive impacts can occur for some species (i.e., small mammals and certain raptors) by increasing their access to food resources. A qualitative assessment of the potential for cumulative impacts of the SFPR and other projects and activities was conducted.

For cultivated fields there may be an indirect impact (i.e., habitat loss) on sandhill crane and waterfowl that currently use areas between Highway 17 and Highway 99 and on the east of the SFPR north of Highway 99 to about the 72nd Street overpass. However, the area of indirect impact is confounded by the influence of activities on existing roads (e.g., Ladner Trunk Road and Highway 99) and railway lines, and agricultural activities, which all reduce the area of cultivated field habitat available for these species. Raptors also use cultivated fields, but no residual indirect impacts on these were identified because raptors are generally not affected by sensory disturbances. While there is potential for a residual impact on cultivated fields, the

impacts from these other activities are considered to be of higher magnitude (in totality) than those from the SFPR, and as a result the impacts of the SFPR are not thought to be a significant component of any cumulative impacts.

For wetlands (and some riparian forests) in the SFPR study area, there are not considered to be indirect habitat loss impacts on the species that utilise these areas (i.e., small mammals and amphibians). This is because noise and visual impacts are not considered to be as important an influence as fragmentation and isolation of habitat (a direct footprint effect). As a result of proposed wildlife crossing corridors (Wildlife Mitigation Crossing Plan submitted to reviewers April 2007) at the locations of important wetland habitat for amphibians and small mammals, no residual impacts are anticipated as a result of the SFPR. Therefore no cumulative impacts from indirect habitat loss of wetlands have been identified.

For upland forests there is likely to be an indirect habitat loss impact on small mammals and passerines as a result of the SFPR. This is limited to the upland forest areas around Burns Bog (especially east of the Vancouver Landfill) and at Fraser Heights. In general these are the largest upland forests in the study area, and others along the alignment (Delta Ravines and Bridgeview) are so small that they have confounding influences from the other activities (roads and residential developments) around their perimeter such that there are no additional indirect effects from the SFPR. Notwithstanding that there are potentially residual indirect impacts on small mammals and passerines in upland forests, there are also confounding influences on these forests from other road, rail and residential activities around the periphery of these forests that reduce the additional sensory impacts from the SFPR. Other projects and activities in the study area also have an indirect impact on species inhabiting upland forests, these include the Vancouver Landfill, railways and other major (highways 91 and 99) and minor roads. The magnitude of indirect impacts from each of these activities is unknown, and attributing impacts on these is too speculative to assess the potential for cumulative impacts.

10.3.4.2 Habitat Fragmentation

Fragmentation of upland and riparian forests and wetlands in the study area have the potential to impact on species that require these habitats to be contiguous (e.g., large and small mammals and amphibians). Some of these species (i.e., red-legged frog) are threatened. SFPR-related fragmentation impacts were identified, but mitigation in the form of the provision of wildlife crossings, and alignment of the SFPR on the edge of habitats reduces the potential for residual impacts. In general, the SFPR alignment skirts around areas that have wildlife and vegetation values (i.e., Burns Bog), thus fragmentation impacts are limited, and / or they are confined to the periphery of those areas. In locations where the alignment does bisect habitat (i.e., Delta Ravines and Fraser Heights Wetland), structures are proposed to retain habitat connectivity across the SFPR. Previous activities in the study area that have contributed to habitat fragmentation include the development of railways and roads (e.g., River Road) that have isolated habitat on either side of the development. Residential housing development in the past, and in the future as build-out to the OCP continues, fragments and isolates habitats, particularly upland forest habitat in the study area.

There are no predicted synergistic actions between any impacts of the SFPR on habitat fragmentation (as noted above minor and mitigated by crossing structures) and other projects and activities in the study area. In general, other projects in the study area that have contributed more to habitat fragmentation (e.g., previous development of railways, River Road and Highway 91 and residential development in

upland forests) will not interact with the SFPR such that fragmentation impacts will become worse. No cumulative impacts on habitat fragmentation are predicted as a result of the SFPR.

10.3.4.3 Wildlife Pattern Changes

Project-related sensory impacts on the use of parts of the study area by wildlife was predicted to be a residual impact. In particular, habitat used by nesting raptors were considered to be impacted. The visual and noise disturbances introduced by the SFPR were predicted to indirectly reduce the area available to these wildlife, forcing them to use other areas. This is likely to be an impact felt more in upland forest habitats adjacent to the SFPR than elsewhere in the study area, as elsewhere there is existing noise and visual disturbances from roads and railways and little nesting habitat. The wildlife pattern change impacts of the SFPR during construction of the SFPR are anticipated to be greater (but temporary) than those during operation. For some species, particularly cosmopolitan species that can adapt to changes in disturbance, the impacts even during operation are likely to be temporary, as these species will likely return to habitat under the lower-level disturbances of highway operations. This will reduce the impacts to raptors in the long-term. Many raptors are noted to utilise road corridors preferentially, as habitat for their prey (small mammals) is common. Mitigation to avoid or reduce the collision of raptors with vehicles on the SFPR is proposed, this includes revegetation along the highway in certain areas to encourage raptors to fly higher over the road.

For many of the species living adjacent to the proposed SFPR (e.g., small mammals, reptiles and amphibians), wildlife crossing structures (Wildlife Mitigation Crossing Plan submitted to reviewers April 2007) will allow continued passage on existing routes between habitats on either side.

Other highway projects such as the Border Infrastructure and Golden Ears Bridge projects that pass through similar areas might also have similar impacts on wildlife movement patterns to those of the SFPR. However, these other impacts are located at some distance from those of the SFPR, and they are unlikely to have synergistic or additive impacts. Highway 91 and the railways, which are located closer to the SPFR than other highway projects have likely also had an indirect impact on the use of habitat by wildlife in the study area. Other projects and activities that have introduced linear (e.g., utilities, railways and roads) or large-scale developments (e.g., residential housing and industrial developments) have also contributed to these effects in the study area. No cumulative effects are identified, as the proportional impact from the SFPR is considered low.

10.3.4.4 Wildlife Mortality from Collisions

The potential for increased risk of collision between wildlife and vehicles as a result of the SFPR was identified as a residual impact in one location of the study area. Where the SFPR alignment runs between the fields adjacent to Crescent Slough and Burns Bog there are known deer and barn owl movement corridors. Barn owl travelling from roosting areas east of Crescent Slough to the fields immediately to the west, and deer crossing the proposed alignment to and from these fields and Burns Bog are potentially impacted. Mitigation is proposed to minimize the impacts on barn owl (vegetated buffer plantings to force barn owl to fly over roads at a greater height and reduce their chance of collision with vehicles (section 7.7). At the northern extent of this area (proposed 72nd Street Overpass) wildlife crossing locations for deer are proposed. For many of the small terrestrial species living adjacent to the proposed SFPR (e.g., small mammals, reptiles and amphibians), wildlife crossing structures (Wildlife Mitigation Crossing Plan submitted to reviewers April 2007) will allow continued passage on existing routes between habitats on either side, avoiding or reducing potential collision risks.

The only other projects or activites that are also considered to present a wildlife mortality risk are the Deltaport Third Berth Project and Highway 91. Deltaport Third Berth is also predicted to have an impact on barn owl (other projects are outside the lower Fraser Delta and hence don't affect the same populations) and Highway 91 potentially impacts deer living in Burns Bog. However, the accuracy of predictions that indicated no impacts on deer populations as a result of Highway 91 (contained in the impact assessment report), are unknown. The extent and significance of the population level impacts on barn owl from both these projects is unknown, though for Deltaport Third Berth the potential impact is the result of more traffic on an existing road (Deltaport Way). With the SFPR the impacts are likely to be higher because the road will be new in an undeveloped (for transportation) corridor. The mitigation proposed to avoid the impacts, and the physical separation of the two locations where impacts are predicted indicate that the potential for residual impacts are low to moderate.

10.3.4.5 Aquatic Impacts

As required under the *Fisheries Act*, the fisheries assessment for SFPR has focused on ensuring that potential effects to fisheries values, as a result of the Project, are either avoided, mitigated, or where necessary compensated for in order to achieve the objective of no-net-loss to fish habitat. As outlined in habitat balance in section 7.4, the Project currently shows a positive balance for both aquatic and riparian fisheries habitat and no residual effect exists.

However, it is recognized that fisheries values in the corridor have been impacted by historic development including: dyking of the Fraser; development of the rail corridor as well as residential, commercial and residential development. The magnitude of the impact is difficult to assess though some information is available. For example it is known that:

- since 1948 approximately 300 km of the Fraser River foreshore has been dyked. Such activity has reduced the amount of riparian habitat along the foreshore and impeded access to upland water courses that provided rearing habitat (Steve Litke, Fraser Basin Council pers. comm.);
- development of rail corridors and ports through the SFPR study area has also contributed impacts to riparian and aquatic habitat where stream crossings occur;
- over 70% of wetland in the Lower Fraser have been lost to development including: drainage; filling; dyking and clearing. Such wetlands would have formed part of the upland system of watercourses that supported fisheries populations;
- of 148 streams existing in the Steveston to Langley section of the Fraser River, 45 streams have been lost, there are no wild streams remaining and the remainder are threatened (8) or endangered (95).

Projected related impacts (before compensation) are estimated at 3.1 ha (aquatic) and 14.5 ha (riparian) and can be considered relatively small compared to historical development related effects such as noted above. Proposed compensation of 8 ha (aquatic) and 17.5 ha (riparian) will result in positive habitat balance and no residual impact. While historic losses of, and impacts to, fisheries values in the Lower Fraser can be considered a cumulative effect of past development, there are no opportunities for synergistic effects with residual effects from the other past, present and future projects in the study area, as it is projected that proposed avoidance, mitigation and compensation associated with the SFPR will result in a positive habitat balance.

No residual impacts on stormwater are predicted due to the SFPR, largely as a result of avoidance and mitigation measures proposed in the development of stormwater infrastructure (Stormwater Management Plan, February 2007). The SFPR will use an integrated stormwater management approach with performance objectives that aims to have no net impact on water quality. Current best management practices will be used in the design and management of stormwater from the SFPR.

Although not required due to the absence of residual impacts, an analysis of the impervious surfaces in the study area was conducted to assess the cumulative impact of the SFPR on stormwater because historical projects were considered by reviewers to have had residual impacts. The proportion of impervious surfaces was calculated for representative portions of five land use types using aerial photograph interpretation. These proportions were applied to the total area of each particular land use type (based on land use assessment, section 8.3) to calculate the total impervious surface (4896 ha) in the study area (9975 ha). The total of impervious surfaces was compared to the increase in impervious surface due to the SFPR, 78 ha (126.4 ha total SFPR impervious surface – 48.2 ha of existing impervious surface). The results indicate that the SFPR would increase the impervious surface in the study area by less than 1% (0.78%). This very small increase in impervious surface in the study area, which is currently 49% impervious, is not predicted to lead to cumulative impacts.

10.3.4.6 Air Quality

CAC

Local air quality conditions were assessed for the SFPR (section 7.2 and Technical Volume 7). Regional air quality conditions (using the analysis from the SFPR, Port Mann Highway 1 and North Fraser Perimeter Road local air quality assessments) were assessed for the Gateway Program (Technical Volume 16). The regional air quality assessment for the Gateway Program, plus other air quality analyses for other projects, was used for the assessment of cumulative impacts (also Technical Volume 16).

There were no significant adverse effects on local air quality predicted as a result of the SFPR (section 7.2) due to anticipated improvements in the efficiency of fuel use by the vehicle fleet, and reduced sulphur in the fuel. Contaminant emissions on the existing road network in 2021 (with or without SFPR) will be reduced compared to the 2003 scenario and the difference between the SFPR and non-SFPR scenarios is small (section 7.2). However, given that the lower Fraser Valley (LFV) airshed is a managed air shed where vehicle emissions form a significant portion of total air emissions and taking into account the relationship of SFPR to the other Gateway Program road improvement projects (i.e., Port Mann Highway 1 and North Fraser Perimeter Road) and other projects in the region, consideration of the cumulative impacts on air quality in the region was undertaken.

The assessment of regional air quality, and the cumulative effects assessment considered the regional air quality data and data from other regional projects that could impact air quality (e.g., the Golden Ears Bridge, Sea to Sky, Border Infrastructure, Canada Line, Deltaport Third Berth and Terminal 2 projects). The collection of such data was guided by a work plan and the Approved Terms of Reference (EAO 2004), both of which were developed in consultation with the Biophysical and Socio-Community Working Groups involved in the SFPR review (Technical Volume 16). This assessment used the GVRD emissions inventory as the basis for the analysis. This emissions inventory considers all mobile (cars, trucks, trains, ships and airplanes) and non-mobile (residential and industrial) activities that currently contribute to emissions. Predicted growth in population, the economy, employment and travel were used for forecasts of future emissions from these same emissions sources. The basis for future air quality predictions is the

GVRD growth management strategy (GMS), which uses population and land uses changes predicted and planned for in municipal OCP. Refinements to the GVRD emissions estimates for vehicle traffic were used to incorporate more accurate data obtained during the development of the SFPR and other Gateway Program projects (section 3.1.1.5). Predicted emissions from other large future projects in the study area were obtained from impact assessment reports for each of the projects.

The results of the regional air quality impact assessment show that regional traffic-related emissions of all CAC, except NH_3, decrease compared to the existing 2003 situation for both projected 2021 scenarios (with and without the Gateway Program). This decrease is despite a projected increase in regional traffic from 2003 to 2021, because of improved vehicle emission standards and reduced sulphur content in diesel and gasoline in future years. When considered in the context of regional emissions from all other existing mobile and non-mobile sources in the GVRD and future growth associated with municipal OCP, the projected 2021 with Gateway scenario is expected to result in emissions that are marginally higher than the projected 2021 without Gateway scenario (except for VOC which decreases in both scenarios). The differences in ambient concentrations between 2021 with and without the Gateway Program are:

- -0.01% for VOC;
- 0.004% for O_3;
- 0.01% for SO_2;
- 0.04% for PM_{10} and 0.08% for $PM_{2.5}$; and
- 0.1% for NH_3; and NO_2.

These differences are due to a variety of factors including: an increase in capacity; a projected increase in the estimated total vehicle-kilometres travelled in the region; and the provision of congestion reduction measures on Highway 1, such as HOV extension, improved transit and electronic tolling on the Port Mann Bridge, which help to reduce the growth in single-occupancy vehicle traffic.

The cumulative impacts assessment, takes into account emissions associated with other planned (future) regional transportation projects not specifically accounted for in current predictions of future air quality (e.g., Border Infrastructure, Sea to Sky, Golden Ears Bridge, Canada Line (RAV), Deltaport Third Berth and Terminal 2 projects), in conjunction with the Gateway Program (**Table 10.3-4**). In the cumulative impacts assessment of air quality, ambient concentrations of air contaminants are predicted to increase as follows:

- 0.1% VOC;
- 0.1% 0_3
- 0.3% NH_3;
- 0.4% PM_{10};
- 0.6% $PM_{2.5}$;
- 0.9% SO_2; and
- 1.4% NO_2.

Collectively these changes are relatively larger than those as a result of the Gateway Program alone.

From a regional perspective, the contribution of Gateway Program-related emissions to GVRD predictions of changes in future ambient CAC concentrations in the Lower Fraser Valley is predicted to be small (-0.01% (a decrease) for VOC to 0.1% increase for NO_2). When the contribution of CAC from other proposed regional infrastructure projects is taken into account, the cumulative impact of the SFPR on regional emissions and ambient air quality is not considered significant in the context of forecast regional air quality trends.

Table 10.3-4 Summary of CAC and GHG (CO_2E) emissions from other projects in the SFPR regional air quality study area.

Project	Scenario	Emissions (tonnes/year)							
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO2	VOC	NH3	CO_2E
Highway 10 Expansion	Future Baseline 2021	1,137	54	3.3	1.6	1.0	41	12	50,139
	Project Operation 2021	1,353	71	4.6	2.1	1.4	49	17	60,235
	Net Change in Emissions	+216	+17	+1.3	+0.6	+0.4	+8	+5	+10,096
Highway 15 Expansion	Existing Baseline[1]	754	30	1.9	1.1	1.7	29	7	33,133
	Project Operation 2021	1,859	74	5.3	2.5	1.8	70	18	79,799
	Net Change in Emissions	+1,105	+44	+3.4	+1.4	+0.1	+41	+11	+46,666
Sea to Sky	Future Baseline 2025	2,090	190	10	5.5	2.7	216	32	136,331
	Project Operation 2025	2,293	206	11	6.0	2.9	237	35	149,178
	Net Change in Emissions	+203	+16	+1.0	+0.5	+0.2	+21	+3	+12,847
GEB	Project Operation 2021	4,514	184	9.0	4.2	2.8	211	32	76,642
	Net Change in Emissions	+4,514	+184	+9.0	+4.2	+2.8	+211	+32	+76,642
Canada Line	Project Operation 2021	-9	-14	-0.6	n/a	n/a	n/a	n/a	-23,014
	Net Change in Emissions	-9	-14	-0.6	n/a	n/a	n/a	n/a	-23,014
DP3	Project Operation 2021	92	189	13	12	53	12	0.7	20,611
	Net Change in Emissions	+92	+189	+13	+12	+53	+12	+0.7	+20,611
Terminal 2	Project Operation 2021	404	730	51	50	219	48	3	84,791
	Net Change in Emissions	+404	+730	+51	+50	+219	+48	+3	+84,791
Total Net Change in Emissions[2]		+6,364	+1,154	+78	+69	+275	+324	+52	+218,490

GHG

Unlike emissions of most CAC, which are expected to decrease over time due to improvements in emissions control technologies and fuels, emissions of GHG from mobile sources including road vehicles, are expected to increase, with or without Gateway Program projects. The increase is a result of expected increases in vehicle kilometres driven in the region which are associated with future population and economic growth. Increases in global concentrations of GHG are linked to climate change related impacts including: increases in sea-level rise, increased frequencies of storm events and extreme weather events.

A regional assessment of Gateway Program projects on GHG emissions, in concert with predicted growth in the GVRD (from the growth management strategy) indicates that, currently, mobile sources (i.e., vehicles, planes, trains and marine transportation) contribute 34% of regional GHG emissions in the LFV (Technical Volume 16). By 2020 total regional GHG emissions are projected to increase by approximately 20%, with the contribution of GHG from mobile sources increasing to 38% of total regional GHG emissions in the lower Fraser Valley (LFV) by 2020.

A specific analysis of GHG emissions illustrate that traffic on the existing (2003) regional roadway network in the Canadian LFV (not all mobile sources as above), accounts for 25.4% of the total GHG emissions from all sources in the LFV. In the projected 2021 without Gateway scenario, GHG emissions from traffic on the regional roadway network in the Canadian LFV are predicted to increase compared to the existing situation, and account for 27.0% of forecast total regional GHG emissions. In the projected 2021 with Gateway scenario, traffic-related GHG emissions in the Canadian LFV are expected to increase compared to the projected 2021 without Gateway scenario and account for 27.4% of forecast regional GHG emissions. This regional assessment of Gateway Program projects on GHG emissions from traffic indicates a net increase in total regional GHG emissions due to the Gateway Program of 0.4%.

The cumulative impacts assessment of traffic-related GHG emissions in the Projected 2021 Gateway Program scenario (i.e., including all Gateway Program related emissions, and emissions from other proposed projects not specifically identified in GVRD GHG forecasts) shows a net increase of regional GHG emissions of 0.6% compared to the projected 2021 without Gateway or other planned projects. This magnitude of increase is considered low in the context of the total GHG inventory for the region and the magnitude of predicted increases from other sources (**Table 10.3-4**). As a consequence no cumulative impacts on GHG emissions affecting air quality are predicted as a result of the Gateway Program.

While cumulative effects to air quality associated with Gateway Program projects are considered in the CEA, it should also be noted that the Gateway Program is part of a suite of overall Provincial initiatives to reduce vehicle emissions and improve air quality, including but not limited to:

- Reducing GHG emissions by 33% by 2020;
- Expanding the transit network reducing GHG emissions;
- Introducing new tail pipe emissions standards to reduce CO_2 by 30%;
- Developing practical options and actions for making BC carbon neutral by 2020;
- Reducing vehicle emissions from congestion related idling;
- Expanding HOV and cycling choices; and
- Tolling the Port Mann to help limit growth in traffic over time.

Particulate Matter in Burns Bog

Based on modelled ambient concentrations of road dust from SFPR adjacent to Burns Bog, there is little potential for deposition of mineral particulate matter from the SFPR in Burns Bog. The rates of deposition of particulate emissions are too low; the area where deposition might occur is limited and the predominant wind directions would likely take airborne emissions away from Burns Bog where the SFPR is located. In addition, while the precise mineral component of particulate matter is unknown, the low total quantities involved, and the likelihood that some of the particulate matter is organic rather than mineral suggest that there are no residual impacts as a result of the SFPR (and other road activities in the study area), and therefore no potential for cumulative effects.

Estimated annual average concentrations of PM_{10} from vehicle exhaust is less than 0.05 µg/m^3 along the west and north perimeters of Burns Bog, and for road dust PM_{10} the annual average concentration is about 0.3 µg/m^3. In both cases the concentrations decrease with increasing distance from the road. In comparison the annual average ambient background of PM_{10} is about 13 µg/m^3; much higher than SFPR-derived particulates. Assuming that the above concentrations are distributed evenly over Burns Bog, and that the particulate matter in the cubic metre at ground level is completely deposited on the ground (i.e., a conservative assessment that all particulates one metre above ground fall to the bog), the following rate of deposition can be calculated.

- the total assumed deposition resulting from SFPR PM emissions (2021) is 0.03 kg/hectare; and
- the assumed deposition resulting from ambient background concentrations is 1.14 kg/hectare; therefore
- total PM_{10} emissions from SFPR (road dust plus exhaust) would increase the deposition over background ambient concentrations by less than 3%.

The frequency of wind speed and direction near Burns Bog indicates that the prevailing wind along the section of SFPR near Burns Bog is from the east (away from Burns Bog relative to the location of the SFPR). The frequency of winds from the northwest and southwest (toward Burns Bog relative to the location of the SFPR) is relatively low.

The estimated increase in deposition of mineral particulate matter material to Burns Bog as a result of operation of the proposed SPFR are considered to be minimal in relation to current atmospheric deposition from other regional sources. In addition, the impact of the prevailing wind direction on particulate matter deposition is considered to have little influence.

10.3.4.7 Change in Noise Levels

The SFPR noise assessment predicted that with mitigation (quiet pavement and coordination of traffic signals) the noise generated by the SFPR at six of seven locations where 'severe' impacts (section 8.1) were predicted would be reduced using noise walls (further mitigation) so that the percentage of highly annoyed residents would be below the 'severe' threshold. While further assessment work will be conducted during detailed design to confirm the effectiveness of noise wall mitigation at residential enclaves identified as requiring mitigation, preliminary analysis indicates that noise walls (as well as quiet pavement and coordinated signals) would achieve at least 5 dBA of noise reduction (Technical Volume 13). The areas where noise walls might be required (where there is potential for residual impacts) are near Ladner Trunk Road, North Delta and west Whalley. Near 136th Street in Bridgeview, noise walls may

not reduce the impacts below the 'severe' threshold and while further design and noise modelling will be completed to reduce the impacts in this area, it is likely a residual impact of the SFPR.

The noise impact assessment takes into consideration the current noise levels from traffic on existing roads (including the Port Mann Bridge and Highway 1 where it is close to the SFPR). It also considers noise from other existing activities (e.g., existing railway, residential and port activities). However, it does not include an assessment of increased noise from these activities. There is no information available to undertake such a quantitative assessment from railway, residential and port activities, but an assessment of noise as a result of existing traffic on Port Mann and Highway 1 shows that existing noise at sites 21 and 22 (the sites closest to both projects) is greater than the noise from SFPR, leading to marginal increases, for example:

- site 21 has a baseline of 58 dBA and SFPR would add 50 dBA, leading to 58.3 dBA total noise (a 0.3 dBA increase); and
- site 22 has a baseline of 48 dBA and SFPR would add 50 dBA, leading to 52 dBA total noise (a 4.0 dBA increase).

With the Port Mann Highway 1 expansion added to this, site 21 would increase to 60.9 (2 dBA additional as a result of Port Mann Highway 1) and site 22 would increase to 53 dBA. Mitigation (noise walls) is likely to be effective in reducing the effects of this noise so that they are non-residual.

The impact on the noise environment in the study area from other projects and activities is not considered to lead to cumulative effects, because the activities are too far away from the SFPR for cumulative effects to occur, or existing activities already produce relatively high levels of noise.

10.3.5 Significance Evaluation

The significance of adverse cumulative environmental impacts identified in the analysis (section 10.3.4) and summarised in the right column of **Table 10.3-5**, was determined by taking into account characteristics of the impact. These included:

- magnitude – the degree of change relative to the baseline;
- geographic extent or spatial area;
- duration - the length of time over which the environmental effect occurs;
- frequency – how often the effect occurs within a given period;
- reversibility – the potential for the impact to lessen and for the baseline conditions to re-establish; and
- ecological context – an indication of the extent to which the area affected is relatively pristine and / or ecologically fragile.

The significance of the potential cumulative impacts is discussed below, and summarised in **Table 10.3-5**. This significance assessment is the opinion of the MOT, and the federal reviewing agencies will make a final determination of significance.

This assessment details only the negative cumulative impacts of the proposed SFPR project, and other projects and activities in the study area. However, there are also positive impacts, in particular relating to the provision of better transportation and access as a result of the project. The study area relies heavily

on transportation, and as the existing network is becoming increasingly congested (section 3) the provision of a new road to replace the under performing existing routes in the area have the potential for positive cumulative impacts associated with direct and indirect economic growth.

10.3.6 Conclusion

The scope of the CEA undertaken for the Project (**Table 10-3-3**) considered 8 issues and 14 VEC where residual impacts exist after taking into account mitigation and compensation. Fisheries, was considered in the CEA, as discussed with DFO, in the context of considering residual impacts from historical development. While there appear to be residual impacts on fish habitat from past development, the Project is not expected to result in residual impacts so the cumulative impact is considered “nil”.

For three VEC (habitat fragmentation riparian/upland forest and changes in wildlife (raptor) movements) no residual impacts were noted from other projects and the cumulative impact was considered “nil”.

For the remaining 9 VEC related to: habitat loss (bog, wetland, cultivated fields, riparian forest and/or upland forest); changes in wildlife movements (mammals); air quality (CAC and GHG emissions); and noise (change in noise levels) residual impacts from other projects were identified and cumulative impacts were assessed.

For the majority of cumulative impacts (6 of the 9 VEC with potential cumulative impacts) the cumulative impact is considered low. The cumulative impact on air quality (CAC emissions) as a result of SFPR in conjunction with Gateway Program projects plus other regional transportation projects is considered negligible. Low-moderate cumulative effects were identified for 2 VEC including: air quality (GHG emissions); and noise (change in noise levels) though cumulative effects for noise are considered site specific and the assessment of significance does not apply to the entire corridor.

Table 10.3-5 Significance evaluation of potential cumulative effects (from Table 10.3-3).

Potential cumulative effect	SFPR contribution	Extent	Magnitude	Duration	Reversibility	Ecological / social context	Probability	Significance (level) [1]
Habitat Loss Bog habitat	Low	Local (SW Delta)	Low	Long	No	Well-developed	Low	**Low**
Habitat Loss Cultivated fields	Low	Local (SW Delta)	Low	Long	Change	Developed	Low	**Low**
Habitat Loss Upland Forest	Moderate	Regional (Delta/Surrey)	Low	Long	No	Well-developed	Low	**Low**
Habitat Loss Riparian Forest	Low	Regional (Delta/Surrey)	Low	Long	No	Well-developed	Low	**Low**
Habitat Loss Wetland / open water)	Moderate	Regional (Delta/Surrey)	Low	Long	No	Developed	Low	**Nil (n.a.)**
Fragmentation Riparian forest	Low	Regional (Delta/Surrey)	Low	Long	No	Developed	Low	**Nil**
Fragmentation Upland forest	Low	Regional (Delta/Surrey)	Low	Long	No	Developed	Low	**Nil**
Changes in wildlife movements	Low	Local (corridor)	Moderate	Long	Change	Developed	Low	**Nil**
Wildlife mortality (collisions)	Low	Local (corridor)	Low	Long	Change	Developed	Low	**Low -Moderate**
Aquatic Impacts Fish habitat	Negligible	Regional (Lower Fraser)	Low	Long	Change	Well-developed	Low	**Nil (n.a.)**
Air quality CAC emissions	Negligible	Local (corridor)	Low	Long	Change	Well-developed	Low	**Negligible**
Air Quality GHG emissions	Low	Local (corridor)	Low	Long	Change	Well-developed	Low	**Low**
Change in noise after mitigation	Moderate (site specific)	Local (site specific)	Low-Mod (site-specific)	Long	Change	Well-developed	Low	**Low -Moderate**

[1] This significance assessment is the opinion of the MOT, and the federal reviewing agencies will make a final determination of significance.

Notes for Table 10.3-5:

Contribution of this Project: contribution of the effect of the SFPR Project to the overall cumulative effect (including other projects) identified.

Negligible –effect from this Project is a very small contribution to total cumulative effect.

Low –effect from this Project is a small contribution to the total cumulative effect.

Moderate –effect from this Project is a moderate contribution to the total cumulative effect.

High – residual effect from this Project is a high contribution to the total cumulative effect.

Extent: geographic extent of the cumulative effects identified.

Project Area – Project footprint and beyond to 2 km.

Local – Project footprint and beyond to 5 km.

Regional – Project footprint and beyond to greater than 5 km.

Magnitude: magnitude of the cumulative effect**.**

Negligible – no change over the baseline

Low – impact expected above baseline, but in generally accepted standards.

Moderate – impact expected to be considerably above baseline or could cause a change in ecological, social or other parameters.

High – impact expected to exceed accepted criteria and to cause a measurable change well beyond the natural variability.

Duration / frequency: likely duration of the potential cumulative effect.

Short – less than 60 days.

Medium – 30 to 60 days.

Long – greater than 60 days.

Reversibility: potential for the cumulative effect to be reversed or naturally ameliorated back to the baseline level after the duration of the effect.

Yes – environment will return to baseline after effect is removed.

No - environment will not return to baseline after effect is removed

Change – baseline will change after impact, but the effect on the environment will reverse (to a new baseline) after it is removed.

Ecological / Social Context: the ecological or social context and its' ability to absorb change.

Intact – a near-pristine landscape, ecological situation or social environment.

Developed –developed or altered landscape, ecological environment or social situation.

Well developed - Intensely developed or altered landscape, ecological situation or social environment.

Probability: likelihood of cumulative effect occurring if the Project proceeds:

Low – up to 25 % chance of predicted total cumulative effect occurring.

Moderate – 25 to 50 % chance of predicted total cumulative effect occurring.

High - over 75 % chance of predicted total cumulative effect occurring.