SURFACE WATER

Study geographic boundaries: A project effects assessment area (PEAA) was defined to help assess the geographic extent of project environmental effects on surface water resources. The PEAA for the surface water resource assessment includes the channel reach between the project-affected point of interest on the watercourse (i.e., the upstream extent of any project-related environmental effects, usually the watercourse crossing) and the confluence with the next downstream watercourse or, where applicable, the inlet to a mapped lake (as shown on available 1:30,000 scale mapping). Such a downstream boundary was considered to be the point at which measurable environmental effects of the project would be difficult to distinguish from natural changes in the hydrological and hydraulic characteristics of the watercourse downstream from the confluence.

Study time boundaries: Project-related environmental effects have been assessed for three scenarios:

- Peak construction, as changes in vegetative cover and ground disturbance may be expected to alter surface drainage patterns and flows
- Peak operations (assumed to be five years into the operational life of the project), as ongoing site access and vegetation management could alter surface drainage patterns and flows
- Decommissioning, as reclamation activities would include the restoration of surface drainage patterns and natural vegetative cover. This scenario assumes that the pipelines, including watercourse crossing sections, are abandoned in place and that surface facilities (i.e., pump stations, Kitimat Terminal) are removed and the sites reclaimed to a stable vegetative cover. It also assumes that all potential hydrological and geomorphological changes due to construction and operations have stabilized by the time of project decommissioning

Project works and activities considered in the study*: Construction – Right-of-Way (RoW) and site preparation; temporary and permanent road development; powerline development; infrastructure construction; pipeline construction; hydrostatic testing; camp operations; tunnelling and waste rock disposal; groundwater management. Operations – RoW and infrastructure PDA; developed areas of roads; operations; powerlines. Decommissioning – site restoration; road removal; revegetated (or reclaimed) RoW and infrastructure PDA and developed area of roads.

Study methods: Hydrological effects were assessed by using two measures: channel flows and channel geomorphology. Channel flows can be characterized using measures such as mean annual total discharge, the 1:100 year peak discharge and the 7Q10 (1:10 year return period, 7-day duration) low flow. Channel geomorphology can be characterized using relationships between channel size (width and depth), channel slope, discharge and flow velocity.

Streamflow data, channel dimensions, and sediment data are available for few of the channels being crossed or potentially affected by the project. Therefore, regional data from Environment Canada (Water Survey of Canada) were used to establish or predict streamflow characteristics for the channels along the pipeline. Based on these estimates, six distinct hydrological zones were defined along the pipeline route, including the Prairies (KP 0 to KP 81), Foothills (KP 81 to KP 485), Rocky Mountains (KP 485 to 714), Central Interior (KP 714 to KP 915), Central Mountains (KP 915 to KP 1052) and Coast Mountains (KP 1052 to Kitimat Terminal).

Computer modeling was used to predict the effects of project-related activities on rainfall and snowmelt runoff in affected watersheds. This modeling focused on the effects of vegetation clearing and changes to ground cover (gravel pads at pump stations, for example), which can cause a greater amount of precipitation to run off at a faster rate. The environmental effects on channel geomorphology are qualitatively assessed based on the predicted environmental effects on streamflows and sediment loading, taking into account the effectiveness of mitigation along the RoW and at infrastructure sites.

VEC	Key Issues	KIR	Baseline Results	Measurable Parameter	Potential Project Effects**	Proposed Mitigation	Residual Effects	Cumulative Effects
Hydrology	Changes to annual water yield Changes to peak and low flows Surface soil erosion and sediment delivery to surface channels Changes to in-stream sediment concentrations Changes to channel geomorphology	n/a	Streamflows vary widely from year to year depending on the rate and timing of precipitation and runoff. Channels within each zone were found to have distinct annual runoff, peak flow and low flow characteristics. The hydrological zones also account for differences in other factors along the pipeline that affect streamflows, including variations in precipitation patterns, watershed elevation and terrain (flat, rolling or mountainous). Similarities exist among the hydrological zones regarding the annual distribution of streamflows. Streamflows are generally lowest over the winter period, particularly in February and March. Winter discharges in small watersheds in the Prairies and Foothills hydrological zones frequently approach zero. The onset of spring runoff varies with basin size and elevation but generally commences in late March or April with peak flows occurring between April and June. Streamflows generally decline after the spring runoff, but may increase again in late summer and fall due to storm runoff from rainfall events. Flows continue to decline in the late fall (October onwards) to the low flow period over the winter months. Limited data have been gathered regarding geomorphological conditions along the pipeline route. In general, channel size (width, bank height) is directly related to channel flows, while bed material size is related to channel slope. Finer bed material is normally observed in low gradient channels and coarser bed material is generally seen in steeper channels. Many of the watersheds along the pipeline route are already affected by human activity. These activities include agriculture (Prairies, Foothills and Central Interior zones), forestry (all hydrological zones except the Prairies) and mining (Central Interior and Central Mountains).	Channel flows	It was found that the effects of the project on annual total runoff, peak flows and low flows were generally very low and, in most cases, could not be measured. The environmental effects of the project on hydrology will be greatest during construction when ground cover and stream banks are being actively disturbed.	RoW re-vegetation Stream bank restoration	With appropriate mitigation, the environmental effects of the project will decline over time.	
				Channel geomorphology	Channel geomorphology can be affected by changes in streamflow, which would be seen as changes in flow velocity and water depth. Channel geomorphology can also be affected by changes to sediment loading in watercourses, which might result from increased surface soil erosion from affected areas. Destabilization of channel banks because of disturbance during construction could also affect channel geomorphology.		Environmental effects on channel geomorphology will not be significant because of the low predicted effects on channel streamflows, hydraulic characteristics of the channels (width, depth and flow velocity) and channel sediment concentrations.	

*Refer to Figure 3.1 in *section 3, Project description*, for the full list of physical works and activities. **The effects of spills and malfunctions will be included in the update for the supplemental filing.