3.12 Mill Creek

Mill Creek flows from the east side of the Okanagan Basin into Okanagan Lake at Kelowna, B.C. The Mill Creek watershed is approximately 224 km^2 with three main tributaries, Scotty, Whelan and Dilworth Creeks (Associated 2017). The total stream length is 33 km (Eyjolfson & Dunn 2016). Mill Creek flows from its gently rolling forested uplands over moderately steep hillslopes through an entrenched bedrock canyon before entering the valley bottom. A substantial portion of the stream is located in low-gradient valley bottom reaches where it traverses agricultural and industrial lands before flowing through the City of Kelowna (Associated 2017). A summary of creek characteristics is found in Table 3-36 and additional stream-specific data is provided in Appendix B12.

The lower reaches of Mill Creek are impaired with low to moderate riparian vegetation and intense urban influence, along with multiple bridges and pipe arch crossings (Eyjolfson & Dunn 2016). Due to its urban setting, a large portion of the valley bottom reach has experienced some level of modification while approximately 30% has been channelized (Ecoscape 2006). Poor water quality is thought to be the main limitation to fish production capacity (Canadian EarthCare Society 1992). Besides industrial and urban runoff impacts (Ecoscape 2006), high turbidity and siltation of spawning gravels are of concern (Webster 2017). Sediment inputs mainly arise from bank erosion due to riparian vegetation removal (Wildstone Resources 1999, Ecoscape 2006). The channel is characterized by extensive pool habitat resulting from beaver activity. Reduced freshet peak flows from floodwater diversions to Mission Creek, as well as extensive water storage activities, have reduced the stream's seasonal ability to blow out beaver dams and flush streambed substrates of fine sediment (Ecoscape 2006). Habitat restoration initiatives in the late 1990s resulted in a number of restoration activities, including installation of spawning gravels; approximately 745 linear meters of suitable spawning gravels remain in the lower reaches (Ecoscape 2006). The most downstream permanent barrier is a waterfall located 20 km from the mouth (Eyjolfson & Dunn 2016).

Mill Creek is known to currently support populations of Kokanee (spawning) and Rainbow, as well as Burbot and a number of non-salmonid fishes (Associated 2016). Kokanee spawners utilize the lowest 4 km (Webster 2005) with the largest concentration and best habitat for spawners found in 1 km between Elliot Avenue and Lindahl Street (Tredger 1976). Rainbow likely spawn further upstream of the Kelowna International Airport as substrates change from fines to gravel and cobble (Ecoscape 2006).

The Mill Creek headwaters contain a series of small lakes. The largest, Postill Lake, was dammed in the early 1900s for storage of irrigation water (Wildstone Resources 1999). At present there are 149 points of diversion within the watershed and three pending water licence applications (Associated 2019); however, the actual volume extracted is unknown. The Rutland Water Works withdraw groundwater generally within the Mission Creek watershed and distribute it to areas within the Mill and Mission Creek watersheds. Black Mountain Irrigation District manages James Lake (which is in the headwaters of the tributary Scotty Creek; Associated 2016). The Glenmore-Ellison Improvement District operates three reservoirs: Postill, Moore, and South reservoirs (Associated 2016). Inter-basin water transfers do occur between Mill Creek and Mission Creek under flood conditions, when flood waters from Mill Creek are diverted to Mission Creek to prevent flooding in downtown Kelowna.

Mill Creek (along with Coldstream Creek) has the highest base flows of any of the study streams and experiences significant groundwater inflows in the valley bottom reaches (Associated 2019). Poor understanding of annual patterns in upland streamflow contribution, as well as groundwater gains along the valley floor indicate that monitoring of streamflows at several locations along the creek is needed

(Lejbak pers. comm. 2019). Mill Creek is considered fully recorded for all purposes as of 1990 unless storage is provided (Shepherd & Ptolemy 1999). The lower reaches of Mill Creek are not 'flow sensitive' during summer or winter as naturalized flows (Associated 2019) are approximately 35% of LTMAD (Table 3-37). Significant groundwater contributions are thought to contribute to higher baseflows in Mill Creek than most other study streams (Associated 2019). The B.C. MOE holds several conservation licences on Mill Creek which stipulate that 0.3 m^3/s is to be maintained within the creek for fisheries purposes (Dobson 2008).

Table 3-36: Mill Creek description

Drainage Area	224 km^2
Median Elevation	983 m
WSC station	No active stations 08NM117 (historic) Kelowna Cr at Rutland Station (1950-1975) 08NM053 (historic) Kelowna Cr near Kelowna (Lower stn) (1922-1998) 08NM061 (historic) Kelowna Cr near Rutland (1924-1931) 08NM026 (historic) Kelowna Cr near Rutland (Upper Station) (1911-1922) 08NM036 (historic) Scotty Creek near Rutland (1911-1964) 08NM145 (historic) Bulman Creek at the Mouth (1968-2004) 08Nm234 (historic) Moore Lake Reservoir at the dam (1973-1986)
LTMAD	0.774 m^3/s (Associated 2019)
Fish species expected	Rainbow, Kokanee, Eastern Brook Trout, Burbot, Northern Pike minnow, Longnose Sucker, Largescale Sucker, Leopard Dace, Longnose Dace, Prickly Sculpin, Redside Shiner, Carp, Peamouth Chub (ESSA & Solander 2009)
Land use	Forestry in the upper watershed, and agriculture and urban development in the lower watershed (Associated 2016)

No WUW data was collected in Mill Creek. Naturalized flow data were provided by Associated (2019) with an estimated data quality rating of C (data error between 25% and 50%); residual and maximum licensed flows were not available at the time of reporting. Okanagan Tennant EFNs for Mill Creek were developed in accordance with the methods outlined in Section 2.2. Fish periodicity and flow standards described in Table 2-2 to Table 2-6 were used. Contrary to most other study streams, naturalized flows and recorded residual flows in Mill Creek are much greater than flow standards during the non-freshet period. Recommended EFNs were adjusted upward from Okanagan Tennant EFNs to approach naturalized flows as well as minimum flows stipulated by the conservation licence. The recommended EFNs are intended to maintain current levels of fish production in Mill Creek by protecting flow conditions that local populations have become adapted to. Further, the extensive channel alterations and water quality problems (Wightman and Taylor 1978) in Mill Creek likely necessitate higher flows than those provided by flow standards. A summary of EFNs for Mill Creek is provided in Table 3-38 including the median EFN and the range of weekly EFNs, with weekly details in Figure 3-26, Figure 3-27 and Appendix B12, and flow sensitives in Table 3-37. Further information on EFN setting in Mill Creek is provided at the end of this section.

Table 3-37: Flow sensitivities in Mill Creek

Species & life stage	1-in-2 yr 30-day summer low flow		1-in-2 yr 30-day winter low flow	
	Flow (m^3/s)	% LTMAD	Flow (m^3/s)	% LTMAD
Rainbow rearing	0.266	36%		
Insect production				
Kokanee spawning				
Rainbow overwintering			0.257	35%
Kokanee egg incubation				

Source: Associated (2019)

Table 3-38: EFN summary table for Mill Creek

Species & life stage	Time period	Okanagan Tennant Recommended EFN				Critical flow	
		Median (m^3/s)	% LTMAD	Min (m^3/s)	Max (m^3/s)	Median (m^3/s)	% LTMAD
Rainbow rearing & insect production [a]	April 1 – Oct 31	0.250	34%	0.250	0.644	0.037	5%
Rainbow spawning	May 20 – Jul 10	1.23	165%	0.801	2.82	0.372	50%
Kokanee spawning	Sep 17 – Oct 13	0.250	34%	0.250	0.250	0.074	10%
Rainbow overwintering	Nov 1 – Mar 31	0.250	34%	0.250	0.250	0.037	5%

a while EFNs apply to the entire period, median values are presented for the summer low flow period from Jul 15-Sept 30.

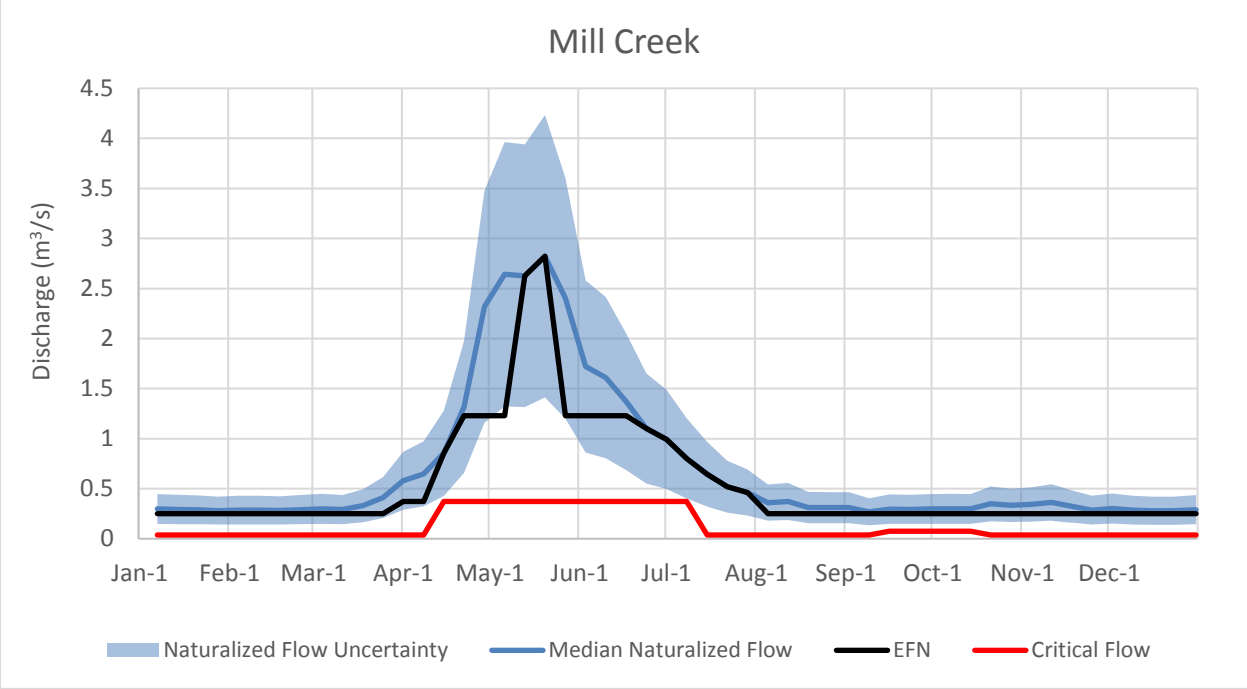

Figure 3-26: Weekly EFNs, critical flow and streamflows in Mill Creek

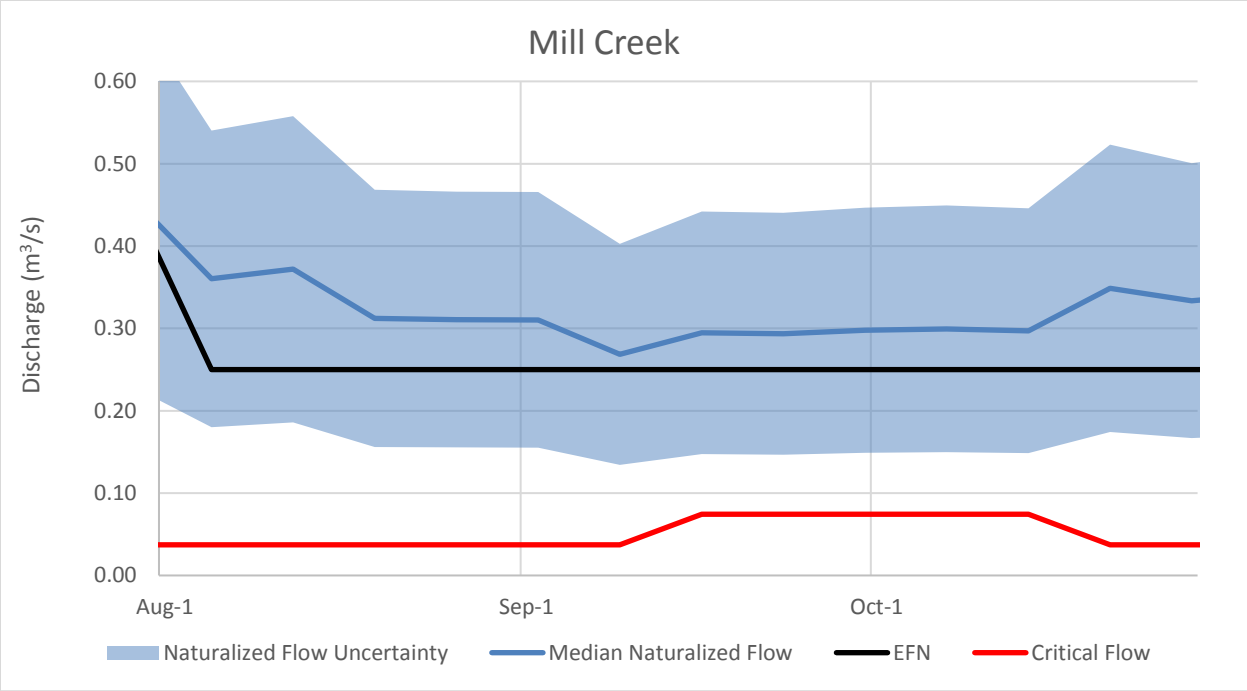

Figure 3-27: Weekly EFNs, critical flow and streamflows during the summer and fall period in Mill Creek

Rainbow parr rearing

The recommended EFN for Rainbow rearing is 0.250 m^3/s (34% LTMAD, Table 3-38) which is slightly lower than median naturalized flows during the mid-July to late September period (0.311 m^3/s) and approximately equal to the naturalized 1-in-2 year 30-day low flow (Table 3-37). It is slightly below the required minimum release of 0.3 m^3/s stipulated by the conservation licence (Dobson 2008). Historical EFN recommendations of 0.7-1.6 m^3/s were provided by ESSA & Solander (2009). The recommended critical flow for Rainbow rearing is 0.037 m^3/s (5% LTMAD) based on the LTMAD criterion (Table 2-7).

Estimated weekly naturalized flows are always greater than the recommended EFN (Figure 3-26). Estimated residual flows were not available; however, median daily recorded flows at the WSC hydrometric station 08NM053 between 1950 and 1996 were generally all at or above the recommended EFN (Figure B12-1, Appendix B12). A trend of declining summer flows below the recommended EFN (and conservation licence minimum flow) is apparent toward the end of the record in the 1990s. No recent flow records exist. Achieving EFNs for Rainbow rearing in Mill Creek is relatively feasible in comparison to other Okanagan streams, due to the comparatively high naturalized and residual flows.

Rainbow spawning

The recommended Tennant EFN for Rainbow spawning is 1.23 m^3/s, which is equal to the flow standard of 165% LTMAD (Table 3-38). Naturalized flows are greater than the recommended EFN for most of the Rainbow migration and spawning period (Figure 3-26). A previous EFN recommendation was 1.7 m^3/s (ESSA & Solander 2009) but based on WUW information from other study creeks with similar size and channel characteristics (e.g., Coldstream Creek), a flow of 1.23 m^3/s is considered sufficient. The recommended critical flow for Rainbow spawning is 0.372 m^3/s (50% LTMAD) based on the LTMAD criterion (Table 2-7).

Estimated residual flows were not available; however, median daily recorded flows at the WSC hydrometric station 08NM053 between 1950 and 1996 were at or above the recommended EFN for the month of May (Figure B12-1, Appendix B12). It is likely that the timing of Rainbow spawning in Mill Creek varies to coincide with peak flows. However, the impact of water storage activities on peak flows is apparent in the observed flow record in that the EFN is not achieved at all or only for a short duration (< 1 week) in approximately 30% of the years on record.

Kokanee spawning

The recommended EFN for Kokanee spawning is 0.250 m^3/s (34% LTMAD, Table 3-38) which is slightly lower than median naturalized flows during the spawning period (0.297 m^3/s) and approximately equal to the naturalized 1-in-2 year 30-day low flow (Table 3-37). It is slightly below the required minimum release of 0.3 m^3/s stipulated by the conservation licence (Dobson 2008). The recommended critical flow for Kokanee spawning is 0.074 m^3/s (10% LTMAD) based on the LTMAD criterion (Table 2-7).

Estimated weekly naturalized flows are greater than the recommended EFN (Figure 3-27). Estimated residual flows were not available; however, median daily recorded flows at the WSC hydrometric station 08NM053 between 1950 and 1996 were all at or above the recommended EFN (Figure B12-1, Appendix B12). A trend of declining summer flows below the recommended EFN (and below the conservation licence minimum flow) is apparent toward the end of the record in the 1990s. No recent flow records exist. Achieving EFNs for Kokanee spawning in Mill Creek is considered relatively feasible in comparison to other study streams, due to the comparatively high naturalized and residual flows.

Historical EFN recommendations ranged from 0.5 to 0.9 m^3/s (Mackinnon 1988, ESSA & Solander 2009) and recommended minimum discharges range from 0.14 m^3/s to 0.25 m^3/s, at which changes in usability were detected (Mackinnon 1988). WUW information was not collected in Mill Creek for this project; however, it is suspected based on WUW information from other streams as well as historical observations (Mackinnon 1988) that Kokanee spawning capacity increases at flows somewhat greater than the recommended EFN of 0.250 m^3/s, and higher flows should be encouraged.