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# Mission Creek Habitat and Intake Mapping

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Disclaimer: Okanagan Nation Alliance Fisheries Department reports frequently contain preliminary data, and conclusions based on these may be subject to change.

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# Executive Summary

Mission Creek, kel'wna (Kelowna) BC, provides about one quarter of flows into the kɬusxənitkʷ (*Okanagan Lake*) and has a watershed of approximately 860 square kilometers (MCRI 2015). Extensive channelization in the 1950s on Mission Creek has resulted in the following reduction (Alex et al. 2016);

- 60% of total channel length,
- 80% of spawning and rearing habitat for fish, and
- 75% of wetland and riparian habitat.

The three main objectives for this project are to:

1) Map the main habitat types within the wetted parameter of Mission creek (lower 12km).
2) Map the intakes and outlets along Mission Creek, both known and unknown.
3) Complete a thermal profile of the creek based on the discovered locations of surface-groundwater interactions.

Summary of key findings are:

- Mission Creek is largely dominated by glides with little habitat diversity.
- As slope increases upstream, large-cobble riffles appear in areas with more hydraulic energy.
- In the more natural reaches upstream, there is a more even distribution of habitat types in Reach 6 and a larger diversity of habitat types in Reach 7.
- There are many intakes/outlets of varying condition, some unknown, throughout the study area.
- Thermal profiling methods were proved to be unsuccessful for this project.

*Recommendations include:*

- Repeat habitat mapping in all or certain sections of the creek at the same approximate flow in which it was first mapped in response to the bed changes in the flood year of 2017.
- Investigate frequency of habitat and intake mapping on a larger time scale.

*Next steps include:*

- Follow up on intakes which;
    - were identified as unknown,
    - did not have a fish screen meeting provincial/federal regulations,
    - appeared to be outside of their license conditions (eg. modifying the stream, potentially taking more than allocated, not having a license), and
    - were not found in the field but appear on iMap (GeoBC 2013).
- Follow-up on outlets to determine;
    - where the water is coming from, and
    - if it meets water quality standards for discharging into a water body.
- Investigate and assess options for progressing with thermal profiling of Mission Creek and develop a work plan.

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- Volunteer, Lindsay Bellingham, for helping complete field work.
- The several landowners met during this project for sharing their knowledge and for allowing us to access their properties.

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# List of Figures and Tables

# List of Acronyms & Okanagan names

| Acronym | Organizations and Programs |
|---|---|
| ONA | Okanagan Nation Alliance |
| OBWB | Okanagan Basin Water Board |
| UBC-O | University of British Columbia - Okanagan |
| FLNRO | Ministry of Forests, Lands and Natural Resource Operations |
| **Acronyms and or Abbreviations** | **Terminology** |
| Temp | Temperature |
| XS | Cross section |
| P | Pool |
| SC | Side channel |
| BW | Back water |
| WL | Water level |
| WW | Wetted width |
| US | Upstream |
| DS | Downstream |
| LB | Left bank |
| RB | Right bank |
| GB | Gravel bar |
| RR | Riprap |
| R | Riffle |
| DY | Dike |
| G | Glide |

| nsyilxcn Place Names* | Location |
|---|---|
| nx̌ʷaqʷaʔstn | Mission Creek area |
| kelʼwna | Kelowna |
| kłusxənitkʷ | Okanagan Lake |
| q̓awsitkʷ | Okanagan River |
| **nsyilxcn Species Names*** | **Aquatic Species** |
| kəkn̓i or kəkniʔ | Kokanee |

* Indigenous Peoples of the Okanagan are the exclusive owners of their cultural and intellectual properties[1]

[1] As referenced through the United Nations Declaration on the Rights of Indigenous Peoples (2007)

# 1.0 Introduction

Mission Creek provides about one quarter of flows into the kɬusxənitkʷ (*Okanagan Lake*) and has a watershed of approximately 860 square kilometers (MCRI 2015). The creek provides habitat for multiple aquatic and terrestrial species including spawning populations of kəkniʔ (Kokanee salmon) and species-at-risk including Painted Turtles, Spotted Bats, White-throated Swifts, Western Screech Owls, and the Great Blue Heron (MCRI 2015).

Extensive channelization in the 1950s on Mission Creek has resulted in the following reduction (Alex et al. 2016);

- 60% of total channel length,
- 80% of spawning and rearing habitat for fish, and
- 75% of wetland and riparian habitat.

The availability of water is of increasing importance due to the effects of climate change in an area with intrinsically arid climate conditions. In February 2016, The BC Water Sustainability Act came into effect initiating a process whereby surface water and groundwater would be managed in the same way and governed as one resource. In response, more information is needed on the groundwater in the nx̌ʷaqʷaʔstn (Mission Creek area).

## 1.1 Project objectives

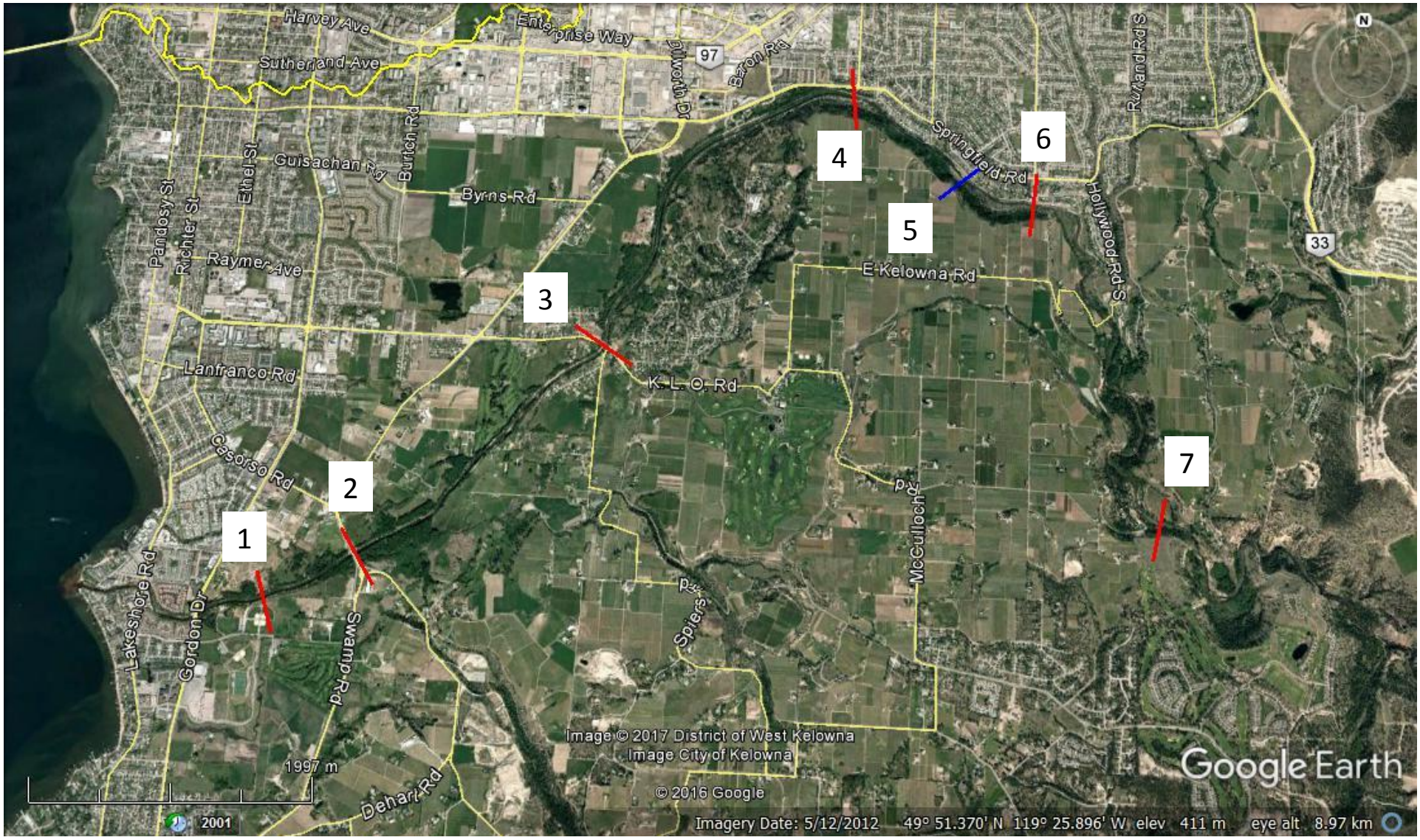
There are three main objectives for this project:

1) Map the main habitat types within the wetted parameter of Mission creek (lower 12km).
2) Map the intakes and outlets along Mission Creek, both known and unknown.
3) Complete a thermal profile of the creek based on the discovered locations of surface-groundwater interactions.

## 1.2 Study area

The study area is in kel'wna (Kelowna), B.C. and covers approximately 12 km of Mission Creek, from the creek's confluence with kɬusxənitkʷ (*Okanagan Lake*) to the Greenway pedestrian bridge below Gallagher's Canyon (Figure 1).

**Figure 1:** Seven reaches studied in this project covering the lower 12 km of Mission Creek. Reach five is also a known Water Survey of Canada hydrometric station. These reach breaks were defined by Associated Environmental (2016). (Google Earth, 2016).



# 2.0 Habitat and Intake Mapping

Diverse habitat types and riparian areas are essential for the overall health of rivers and streams. Mapping habitat types within Mission Creek helps provides further understanding of the quality of habitat that exists and helps initiate plans to improve, enhance and protect this highly-valued river.

Habitat types categorized in this project include;

- glides,
- small cobble/gravel riffles,
- large cobble/boulder riffles,
- primary pools,
- backwater pools,
- pool tailouts, and
- off-channel habitats.

Since Mission Creek is such a large tributary to kɬusxənitkʷ (*Okanagan Lake*), there are many water users for domestic, irrigation, land improvement, and conservation purposes. Intake surveys and mapping are important to determine;

- if there are intakes unaccounted for,
- the condition of all intakes and if they meet regulations,
- if outlets are present, and
- what is being discharged into the creek that could affect water quality and habitat.

The intake mapping included in this project will identify where the known intakes and outlets are located, whether or not a fish screen is present and the total volume withdrawn from Mission creek according to provincial records. In addition, locations and photos of the unknown intakes and outlets will be provided in order to follow-up with the landowners and/or the Ministry of Forests, Lands and Natural Resource Operations (FLNRO).

## 2.1 Sampling methods

Methods and descriptions for the following can be found in Appendix A:

- Habitat type
- Water withdrawals and outlets

## 2.2 Data and discussions

As a highly modified stream, Mission Creek is largely dominated by glides with little habitat diversity (Table 1). Reach 1 is backwatered 38% from Okanagan Lake and Reach 2, containing the Phase I restoration site, mostly consists of small-cobble riffles. As the slope increases upstream, large-cobble riffles appear in areas with more hydraulic energy. In the more natural reaches upstream, there is a more even distribution of habitat types in Reach 6 and a larger diversity of habitat types in Reach 7. Reach 4 side channel is a man-made channel constructed in 1988 to provide spawning habitat for adult kəkńi (Kokanee salmon) (Friends of Mission Creek Society 2013). Some off-channel habitat, areas connected to the mainstem but dry, does exist in Reaches 3 and 7 (Table 2). See additional GIS shape files and Google Earth kmz files for the habitat and intake/outlet maps.

**Table 1:** Summary of habitat types by reach in Mission Creek from the mouth to 12km upstream.

| | Sum of area ($m^2$) | % habitat type/reach |
|---|---|---|
| **Reach 1** | **29410** | |
| Backwater | 11173 | 38% |
| Glide | 12245 | 42% |
| Pool Tailout | 19 | 0% |
| Primary Pool | 1947 | 7% |
| Sm Cobble Riffle | 4026 | 14% |
| **Reach 2** | **18036** | |
| Backwater | 771 | 4% |
| Glide | 3692 | 20% |
| Primary Pool | 1264 | 7% |
| Sm Cobble Riffle | 12309 | 68% |
| **Reach 3** | **43238** | |
| Backwater | 288 | 1% |
| Glide | 23653 | 55% |
| Lg Cobble Riffle | 407 | 1% |
| Pool Tailout | 192 | 0% |
| Primary Pool | 2562 | 6% |
| Sm Cobble Riffle | 16136 | 37% |
| **Reach 4** | **41992** | |
| Glide | 20934 | 50% |
| Lg Cobble Riffle | 5251 | 13% |
| Primary Pool | 837 | 2% |
| Sm Cobble Riffle | 14970 | 36% |
| **Reach 5** | **15877** | |
| Glide | 8400 | 53% |
| Lg Cobble Riffle | 676 | 4% |
| Sm Cobble Riffle | 6801 | 43% |
| **Reach 6** | **9716** | |
| Glide | 4501 | 46% |
| Lg Cobble Riffle | 3047 | 31% |
| Sm Cobble Riffle | 2168 | 22% |
| **Reach 7** | **64020** | |
| Glide | 250 | 0% |
| Lg Cobble Riffle | 34630 | 54% |
| Primary Pool | 1762 | 3% |

| | | |
|---|---|---|
| Sm Cobble Riffle | 27378 | 43% |
| **Reach 4 Side Channel** | **6579** | |
| Glide | 4607 | 70% |
| Lg Cobble Riffle | 394 | 6% |
| Primary Pool | 1220 | 19% |
| Sm Cobble Riffle | 358 | 5% |
| **Grand Total** | **228868** | |

**Table 2:** Off-channel habitat by reach in Mission Creek from the mouth to 12km upstream.

| | Sum of off-channel area ($m^2$) | Sum of wetted area/reach ($m^2$) |
|---|---|---|
| **Reach 3** | 130 | 43238 |
| **Reach 7** | 3155 | 64020 |
| **Grand Total** | 3285 | |

It should be noted that depending on the flow and time of year, small-cobble riffles could be seen as glides and vice versa, so it is important to correlate the recorded habitat types with the associated flows (Table 3). The data was collected in late August and early September which is considered the low flow time of year and optimal for the methods used in this study. Also this is the time when most intakes are operational due to high water demands.

**Table 3:** Stream flow for each sampling date from station 08NM116 (WSC 2017).

| Field date | Discharge ($m^3/s$) |
|---|---|
| 22-Aug-16 | 1.8 |
| 23-Aug-16 | 1.88 |
| 24-Aug-16 | 1.93 |
| 25-Aug-16 | 2.07 |
| 26-Aug-16 | 2.22 |
| 29-Aug-16 | 2.21 |
| 30-Aug-16 | 2.22 |
| 8-Sep-16 | 2.45 |
| 9-Sep-16 | 2.34 |

There were many outlets and unknown intakes or outlets throughout the study area of Mission Creek (Table 4). Some of the intakes have no screen and will require follow-up with the licensee and FLNRO if needed. In addition, there were several licenses that appear on iMap (GeoBC 2013) that were not located in the field, so further follow-up on these as well as communication with landowners may be required (Table 5). More detailed information on known licenses including volumes allocated can be found in Appendix B.

**Table 4:** Intakes and outlets located in the lower 12km of Mission Creek.

| Name/Distance from mouth (m) | Type | Screen | Picture number | Reach Name | License number | Comments |
|---|---|---|---|---|---|---|
| 72 | Outlet | No | 3112-3113 | Reach 1 | | |
| 170 | Outlet | No | 3114-3115 | Reach 1 | | |
| 241 | Outlet | No | 3116 - 3118 | Reach 1 | | |
| 254 | Outlet | No | 3119-3120 | Reach 1 | | |
| 256 | Outlet | No | 3121-22 | Reach 1 | | |
| 305 | Outlet | No | 3124-25 | Reach 1 | | |
| 319 | Outlet | No | 3126-28 | Reach 1 | | |
| 319 | Outlet | No | 3127-28 | Reach 1 | | |
| 422 | Unknown | No | 3129-30 | Reach 1 | Unknown | 3 pipes, all unknown |
| 444 | Unknown | No | 3133-34 | Reach 1 | Unknown | 2 pipes, both unknown |
| 452 | Outlet | No | 3135-36 | Reach 1 | | |
| 1177 | Unknown | No | 3189 | Reach 1 | Unknown | |
| 1234 | Unknown | No | 3179 | Reach 1 | Unknown | |
| 2239 | Outlet | No | 3219 | Reach 3 | | No pipe |
| 2315 | Outlet | No | 3215-17 | Reach 3 | | No pipe |
| 4079 | Intake | No | 3256-58 | Reach 3 | 2 PODs at location on iMap (GeoBC 2013), 13 current licenses, 1 pending license | |
| 4614 | Outlet | Yes | 3249-50 | Reach 3 | | Diversion channel |
| 4741 | Outlet | No | 3271 | Reach 4 | | No pipe |
| 4750 | Outlet | No | 3272 | Reach 4 | | |
| 4944 | Outlet | No | 3277 | Reach 4 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5452 | Intake | No | 3287 | Reach 4 | No known license | Pump and pipes but not operational at time of observation |
| 5896 | Unknown | No | 3291 | Reach 4 | Unknown | |
| 6666 | Outlet | No | 3300 | Reach 4 | | Large concrete drainage, picture shows large grate |
| 6677 | Outlet | No | 3298-99 | Reach 4 | | Spawning channel outlet |
| 6744 | Unknown | Unknown | 3301-03 | Reach 4 Side Channel | No licenses shown on iMap (GeoBC 2013) | In spawning channel |
| 7821 | Intake | Yes | iPad 0031 (Aug 26, 2016) | Reach 4 | 12 current licenses, all FLNRO | Spawning channel |
| 7892 | Intake | Yes | iPad 0030 (Aug 26, 2016) | Reach 5 | 61 current licenses, 1 pending license | Diversion channel |
| 8085 | Outlet | No | 3333-3336 | Reach 5 | | Groundwater spring |
| 8085 | Unknown | No | 3332 | Reach 5 | Unknown | |
| 8684 | Outlet | No | iPad 0051-52 (Aug 30, 2016) | Reach 5 | | No pipe, general location unsure |
| 9116 | Unknown | No | 3365-66 culvert | Reach 7 | Unknown | |
| 9451 | Outlet | No | 3360, 3364 | Reach 7 | | |
| 9451 | Outlet | No | 3362, 3364 | Reach 7 | | |
| 9598 | Unknown | No | 3358-59 | Reach 7 | Unknown | |
| 10171 | Outlet | No | 3385, 3387-3388 | Reach 7 | | Culvert above concrete blocks |
| 10380 | Intake | Yes | 3389 | Reach 7 | No license shown on iMap (GeoBC 2013) | Exact location unknown |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10520 | Intake | Yes | 3390 | Reach 7 | No license shown on iMap (GeoBC 2013) | |
| 10837 | Outlet | No | 3394 | Reach 7 | | No pipe |
| 11172 | Unknown | No | 3396-97 | Reach 7 | | |
| 11178 | Unknown | No | 3395 | Reach 7 | | |
| NA | Intake | Yes | iPhone 3923 (Aug 26, 2016) | Diversion | Part of diversion channel (assumed license part of diversion) | |
| NA | Outlet | No | Unknown | Diversion | | |

**Table 5:** Current/pending intakes not found in the field but appear on iMap (GeoBC 2013).

| | |
|---|---|
| Reach 1 | US Gordon Bridge (C025668) |
| Reach 3 | US FID 15 (F070384, F070185, F070184) |
| Reach 3 | between FID 15 and 17 (C128821, C128822 ) |
| Reach 3 | between Casorso and KLD Bridges, side/diversion channel? (F015962) |
| Reach 4 | DS EECO centre C046380 (RDCO) |
| Reach 4 | DS spawning channel and diversion channel intakes C060403 (RDCO) |

# 3.0 Thermal Profiling

Understanding aquifer-stream connectivity at all spatial scales is essential in determining stream sensitivity and water allocations (Middleton 2006). The goal of thermal profiling is to determine at which points and/or areas of the creek have a direct interaction with groundwater at the stream bed by noticing thermal changes. Since groundwater temperature does not fluctuate like surface water, the optimal time to do this study is on an overcast day with no rain and either in the heat of summer, when groundwater would be cooler, or at the end of winter, when groundwater would be warmer. Winter was chosen for this project after the ice had melted on the creek but before flows increased too high (beyond $4m^3/s$).

There are a number of indicators that can be used for thermal profiling. Temperature is a reliable indicator of groundwater-surface water interactions but it can be measured in combination with electronic conductivity as well as dissolved oxygen to add confidence to the results. Electronic conductivity (EC) is the measure of the electrical current that passes between ions in a solution. The larger the concentration of ions means the higher the electronic conductivity, as is the case with groundwater. Changes in water chemistry within a stream can therefore indicate an influx of groundwater (Moore et al. 2008). Dissolved oxygen (DO) is the amount of oxygen dissolved into a body of water by rapid water movement. Points in a stream that show a lower DO could mean groundwater interaction at the bed.

## 3.1 Sampling methods

A trial day was completed in order to test the proposed methods and equipment on a section of Mission Creek with known groundwater – surface water interaction. Determination of the methods and equipment used were discussed at length between multiple professionals at ONA, UBC-O and FLNRO.

Equipment used included:

- 2 HOBO water level//temperature loggers
- 3 HOBO temperature loggers
- 1 Onset DO logger
- 3 handheld temperature/DO probes (1 also measuring EC)
- 3 pieces of ~1.5m wood doweling
- PVC to case loggers, holes drilled throughout and ends open
- Strips of rubber to buffer loggers within casing
- Nuts and bolts to place at the top and bottom of PVC to secure loggers in casing

A HOBO water level/temperature logger was placed upstream and downstream the study area for control measurements. The time interval was set for every 30 minutes.

Three HOBO temperature loggers were attached to the end of 1.5m long pieces of wood doweling for use at right bank, left bank and mid-channel. These loggers were encased in a PVC tube with rubber tubing for protection and with holes throughout to allow for uninterrupted water flow. The loggers were set to start logging at the same time and at an interval of 2 seconds, the approximate time it takes to walk one step in the creek. A DO logger was fixed to the mid-channel stick next to the temperature logger, as this logger is bigger and requires a greater depth of water for accuracy.

Three additional handheld DO/temp probes were used, one of these measured EC as well, in order to spot check certain areas that had noticeable changes and to allow for comparison with the logged data.

Three people walked the loggers and handheld probes slowly downstream the reach remaining in line with one another across the stream and kept the loggers as submerged as possible.

### 3.2 Data and discussions

Corrected temperature was calculated by determining the temperature drift which accounts for daytime warming for the time duration of the data collection (Figure 2). The corrected temperature shows a very weak correlation to conductivity indicating that there may be some merit to the methods used.

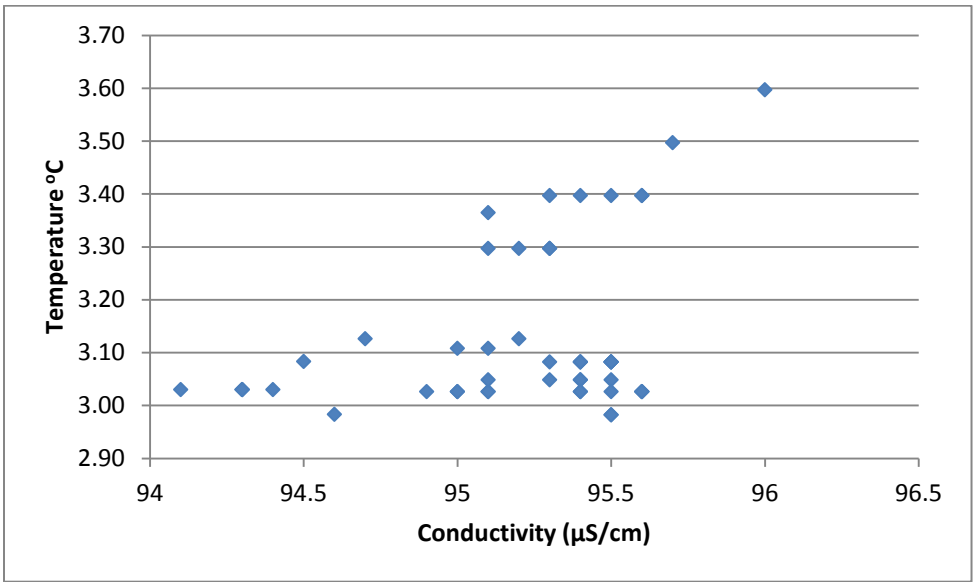



**Figure 2:** Correlation between corrected temperature and electronic conductivity from a trial field day of thermal profiling in Mission Creek between approximately 11am and noon on March 27, 2017.

Field challenges and items to be considered moving forward:

- DO logger was too large for the depth of the water so it was not fully submerged and therefore DO data was not used for analysis.
- Some ice remained on creek edges and banks making it difficult to visually recognize groundwater seepage.
- At known groundwater seepage locations, large changes in temperature, DO and EC were not being recognized by the handheld probes even when directly placed into the springs. Even though discharge was 2.8$m^3$/s (station 08NM116, WSC 2017), it was still too high compared to groundwater inflows which were maybe a few liters per second and therefore mixed so quickly into the main stream flow.
- There is no real time correction for temperature drift possible for handheld probes. The operator would have to look for an abrupt change in DO/temp to identify groundwater inflows.
- The window of opportunity is very small to do this work. It requires very low flows after ice melt but before flows pick up from melt.

- Air temperatures should be around zero to readily identify when the logger is lifted out of water. If air and water temperatures are similar, it is impossible to identify if a slightly higher/lower temperature exists due to groundwater or because the probe was out of water.

# 5.0 Recommendations

It has been a valuable opportunity to map the habitat features and intakes/outlets on Mission Creek. Although the thermal profiling component was not successful for this project, the process and method testing was extremely useful and can be a foundation for future work and collaboration between multiple organizations and governments that share a keen interest.

*Recommendations include:*

- Repeat habitat mapping in all or certain sections of the creek at the same approximate flow in which it was first mapped in response to the bed changes in the flood year of 2017.
- Investigate frequency of habitat and intake mapping on a larger time scale.

*Next steps include:*

- Follow up on intakes which;
    - were identified as unknown,
    - did not have a fish screen meeting provincial/federal regulations,
    - appeared to be outside of their license conditions (eg. modifying the stream, potentially taking more than allocated, not having a license), and
    - were not found in the field but appear on iMap (GeoBC 2013).
- Follow-up on outlets to determine;
    - where the water is coming from, and
    - if it meets water quality standards for discharging into a water body.
- Investigate and assess options for progressing with thermal profiling of Mission Creek and develop a work plan.

The ONA looks forward to continuing to collaborate with OBWB and other organizations and governments on these projects as part of the larger vision of Okanagan Nation Elders in healing the watershed and "bringing it back" *kt cp'ək' stim'.*

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# Appendix A: Methods

## A1: Habitat Type

| *Habitat Type – In Channel (fieldwork only)* | | | | | | |
|---|---|---|---|---|---|---|
| _____% of wetted surface area encompasses backwater pools | _____% of wetted surface area encompasses beaver ponds | _____% of wetted surface area encompasses glides | _____% of wetted surface area encompasses large cobble-boulder riffles | _____% of wetted surface area encompasses pool tail-outs | _____% of wetted surface area encompasses primary pools | _____% of wetted surface area encompasses small cobble-gravel riffles |

### Description/Rationale

Habitat types are measurable physical characteristics about the environment relevant to a salmonid view of the stream (Lestelle *et al*., 2004). Because of the abundant heterogeneity of habitat types encountered in an aquatic system, the initial data collection effort for this parameter is labor intensive. Field practitioners must physically walk each reach, using a GPS to geo-reference each habitat type, and afterwards post-process the GPS data to create a map of the reach.

All months are rated the same for this attribute, although it is recognized that the relative amount of this habitat type can change over a wide range of flow levels. When rating this attribute, a moderate flow level should be assumed. Habitat types are entered as a point estimate of the percentage of the stream reach wetted width for the particular habitat type.

*Backwater Pool*

Percentage of the wetted channel surface area comprising backwater pools. Backwater pools are habitat units located along the channel margins but are otherwise enclosed — though still connected to the main channel (or side channel). Note: backwater pools as defined here include "alcoves" as described by Nickleson *et al*. (1992). Backwater pools are located along channel margins, resulting in low water velocities through these habitat units. They often are relatively shallow with fine-grained substrates. Backwater pools are particularly important as nursery areas for fry of some salmonid species (e.g., coho and chinook), as well as for continued rearing during summer. They also serve as refuge areas during winter, particularly within deeper backwater pools.

*Glide*

Percentage of the wetted channel surface area comprising glides, a habitat type that is intermediate between pool and riffle. The definition applied here is from the ODFW habitat survey manual (Moore *et al*. 1999): an area with generally uniform depth and flow with no surface turbulence, generally in reaches of <1% gradient. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. They are generally deeper than riffles with few major flow obstructions and low habitat complexity.

*Large Cobble/Boulder Riffle*

Percentage of the wetted channel surface area comprising large cobble/boulder riffles. Particle sizes of substrate modified from Platts *et al*. (1983): gravel (0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).

*Pool Tail outs*

Percentage of the wetted channel surface area comprising pool tail outs. Pool-tail outs are a primary spawning habitat for nearly all salmonids.

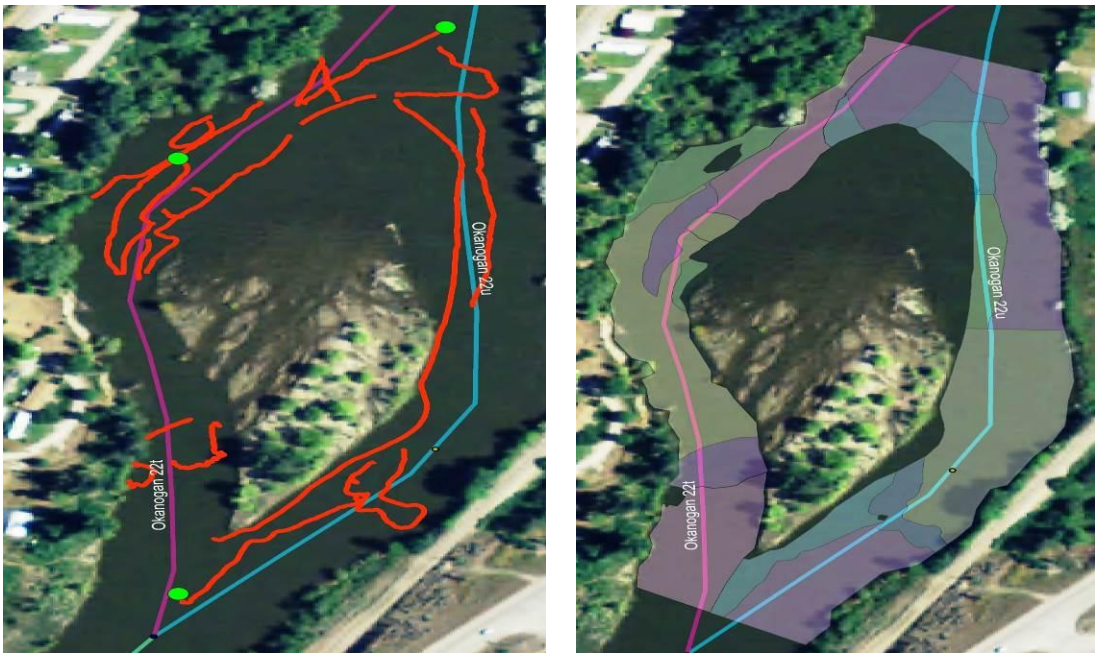
*Primary Pool*
Percentage of the wetted channel surface area comprising pools, excluding beaver ponds. Pools serve as key habitat for some life stages of virtually all salmonids.

*Small Cobble/Gravel Riffle*
Percentage of the wetted channel surface area comprising small cobble/gravel riffles. Particle sizes of substrate modified from Platts *et al*. (1983): gravel (0.2 to 2.9 inch diameter), small cobble (2.9 to 5 inch diameter), large cobble (5 to 11.9 inch diameter), boulder (>11.9 inch diameter).

*Off-Channel Habitat*
A multiplier used to estimate the amount of off-channel habitat based on the wetted surface area of the all combined in-channel habitat. Off-channel habitat consists of oxbows, back swamps, riverine ponds, and the channels that connect them to the main channel or its side channels.

## Field Procedures:

1. Multiple habitat types may occupy parallel surface area along the length of the river.
2. Use GPS point and line features to mark locations where one habitat type changes to the next habitat type. Where habitat types encompass large areas, delineate habitat types within the wetted surface area by walking the boundary between habitat types with the Trimble GeoXT or marking transitions with waypoints. Exposed gravel bars that are submerged at higher flows must be delineated with a line feature by walking the perimeter.
3. When a side channel is encountered, walk the side channel as you would the main channel, but select Side Channel under Channel Type in the GeoXT.
4. When off-channel habitat is encountered, walk the off-channel habitat so it can be quantified. Select Off-Channel under Channel Type in the GeoXT.
5. During post processing of the GIS data, the wetted surface area is represented by a polygon divided into each of the habitat types encountered. Channel width measurements taken in the field are useful for recreating the polygon in the office.
6. Photograph dominant habitat type as well as unique circumstances that may require further discussion among crew members.




**Examples of raw mainstem GPS data on the left and post processed GIS data on the right. Red line on the left is the line feature created when walking the habitat type boundaries in the field, green dots are waypoints created when marking significant features in the field. The colored polygons on the right are the mapped habitat types created in the office during post processing. The pink and blue lines in each picture are the GIS base file stream layer.**

### GIS Post Processing:

1. Using GIS back in the office, post process the "line" feature to remove extraneous noise in the line so that it accurately represents the thalweg of the stream. Calculate the total length of the "line" feature after post processing. Create a polygon for the entire reach's wetted width and then use the “Cut polygons tool” to map out each habitat type observed.
2. Export data from the GIS tables into Excel for further processing.
3. Obtain the habitat type area values from GIS and get a percent of the total wetted area of the reach for each habitat type.

### A2: Water Withdrawals and outlets

**Description/Rationale:**

Water withdrawals, as referred to in this section, are the number and relative size of the water withdrawals in the stream reach (Lestelle *et al*. 2005). The role of this parameter is to identify the quantity and quality of water use on the creek and to determine the potential risk for fish species to be entrained by withdrawals or injured by screening (Lestelle *et al*. 2005). To assess the significance of the withdrawal, data should be gathered during the month when withdrawals are the greatest.

**Field Procedures:**

1. While traversing the reach, map all intakes and outlets with a point on the Trimble GeoXT.
2. Also record if the intake is screened or not and include comments on the condition of the intake and/or screen if necessary.
3. Take close up photos of all intakes and outtakes and also zoomed out photos to show location on the stream bank.

**Office Procedures:**

1. Delineate the appropriate reach on iMapBC (http://webmaps.gov.bc.ca/imfx/imf.jsp?site=imapbc).
2. Zoom map to only include the appropriate reach.
3. Select “Layers” on the top toolbar.
4. In the window to the right of the screen select “Add Layers.”
5. In the “Layer Manager” window select the folder titled “Fresh Water and Marine.”
6. Select the boxes titles “Points of Diversion” and “Water License Points of Diversion – Water Utilities.” Points representing the diversions should appear on the map.
7. Select “Toolsets” from the top toolbar. A selection of toolsets should appear in the window to the right. Select “Analytical” and new icons should appear in the second toolbar.
8. Select the “Extract to Excel” icon and follow the steps to download an excel spreadsheet of the listed water license holders and quantity of water per license.
9. Assess the number of diversions and the quantity of the license holders compared to the relative size of the stream to determine the appropriate rating category. Map all diversions for ground-truthing and checks for screening.
10. Include unknown intakes and outlets and associated information in the final report in order to provide opportunity for follow-up.

# Appendix B: Licensee information

**B1: Intake – diversion channel**

| LICENCE_NO | PRIORITY_DATE | LIC_STATUS | LIC_STAT_DATE | MAPSHEET_POD | PURPOSE | QUANTITY | UNITS | FILE_NO | PROC_STATUS | LICENSEE | ADDRESS_LINE1 | ADDRESS_LINE2 | POSTAL_CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F056838 | 18730725 | ABANDONED | 19920930 | 82.E.083.4.4.2 A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369836 | N/A | KELLER RICHARD C | 2020 KLO RD | KELOWNA BC | V1W2H7 |
| F070814 | 18910206 | ABANDONED | 19930618 | 82.E.083.4.4.2 A (PD57696) | IRRIGATION: PRIVATE | 35770.92 | MY | 346570 | N/A | WOULD ROY L | 1950 MUNSON ROAD | KELOWNA BC | V1W2G7 |
| C132393 | 18910206 | CURRENT | 20150916 | 82.E.083.4.4.2 A (PD57696) | IRRIGATION: PRIVATE | 5180.624 | MY | 8003254 | N/A | DUFF MARGARET ELIZABETH | C/O A.R. CASORSO | 3860 CASORSO ROAD | V1W4R7 |
| C133341 | 18851210 | CURRENT | 20160912 | 82.E.083.4.4.2 A (PD57696) | IRRIGATION: PRIVATE | 39650 | MY | 8003611 | N/A | 629582 B.C. LTD. | 218-1626 RICHTER STREET | KELOWNA BC | V1Y2M3 |
| F057906 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2 A (PD57696) | IRRIGATION: PRIVATE | 888.106 | MY | 369823 | N/A | HURLBURT GREGORY B & WIEBE DAWN | 2076 FISHER RD | KELOWNA BC | V1W2H2 |
| F053843 | 18730725 | CANCELLED | 20160920 | 82.E.083.4.4.2 A (PD57696) | IRRIGATION: PRIVATE | 4933.92 | MY | 346698 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F057900 | 18910206 | ABANDONED | 19960201 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 1011.454 | MY | 369817 | N/A | TOMKINS CURTIS R | 2061 FISHER RD | KELOWNA BC | V1W2H3 |
| F056489 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 986.784 | MY | 369505 | N/A | 0325125 BC LTD | 5168 CHUTE LAKE CRESCENT | KELOWNA BC | V1W4L7 |
| F056491 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 789.427 | MY | 369507 | N/A | HILL HELEN & TREMBLAY BERYL M | 1790 CHAMBERLAIN RD | KELOWNA BC | V1W3P4 |
| C121952 | 18770223 | CURRENT | 20080603 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 210530.37 | MY | 310231 | N/A | BYRNES FARMS LTD | C/O GEORGE E DAY | 2225 BURTCH RD | V1Y7Z5 |
| F066549 | 18730725 | ABANDONED | 19960415 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 12334.8 | MY | 346591 | N/A | CATHOLIC PUBLIC SCHOOLS OF NELSON DIOC | 813 WARD ST | NELSON BC | V1L1T4 |
| C130975 | 18910206 | CURRENT | 20140117 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 1900 | MY | 346578 | N/A | R 366 ENTERPRISES LTD | 300 2000 SPALL RD | KELOWNA BC | V1Y9P6 |
| F057907 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 2417.621 | MY | 369824 | N/A | AYLWARD KATHLEEN A | 2080 FISHER RD | KELOWNA BC | V1W2H2 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F070815 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 40951.536 | MY | 346571 | N/A | KALSAM ORCHARDS LTD | 4132 BEDFORD RD | KELOWNA BC | V1W4N6 |
| F070810 | 18910206 | PENDING | 19891004 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 23436.12 | MY | 346562 | APPORTIONMENT PEND | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| F055106 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 3700.44 | MY | 367587 | N/A | JABS CONSTRUCTION LTD | 200-1889 SPRINGFIELD RD | KELOWNA BC | V1Y5V5 |
| F056837 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369835 | N/A | ROBERTSON HENRY ALLAN & MARY KATHLEEN | 2060 K.L.O ROAD | KELOWNA BC | V1W2H7 |
| F070813 | 18910206 | CURRENT | 19891004 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 95964.744 | MY | 346569 | N/A | MUNSON TIMOTHY ET AL | 970 MONTCALM DRIVE | KELOWNA BC | V1Y8E4 |
| C057896 | 18910206 | ABANDONED | 19960501 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 14801.76 | MY | 370235 | N/A | R 288 ENTERPRISES LTD | 3902 BLUEBIRD ROAD | KELOWNA BC | V1W1X6 |
| F070809 | 18910206 | ABANDONED | 20101105 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 22696.032 | MY | 265686 | N/A | AL STOBER CONTRUCTION LTD | 515-1632 DICKSON AVENUE | KELOWNA BC | V1Y7T2 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C053535 | 18730725 | ABANDONED | 19960403 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 5970.043 | MY | 346595 | N/A | OKANAGAN REGIONAL LIBRARY | 1430 K L O RD | KELOWNA BC | V1W3P6 |
| C056841 | 18730725 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369838 | N/A | KUCKELKORN HUBERT | 2070 K L O RD | KELOWNA BC | V1W2H7 |
| F070817 | 18910206 | CURRENT | 19891004 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 17762.112 | MY | 346577 | N/A | D'ANZICA ANTONIO | 2568 K.L.O ROAD | KELOWNA BC | V1W4A5 |
| F053554 | 18730725 | ABANDONED | 19930308 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 5674.008 | MY | 346670 | N/A | DESJARLAIS GERALD J & PATRICIA M | 1540 KLO RD | KELOWNA BC | V1V1C6 |
| C058808 | 18911222 | ABANDONED | 19930618 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 3700.44 | MY | 370324 | N/A | WANKE ALFRED | 1 880 LEATHEAD RD | KELOWNA BC | V1X2J8 |
| F056833 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 912.775 | MY | 369831 | N/A | BARTLEY MICHAEL T & LAURIE M | 3010 LEADER RD | KELOWNA BC | V1W2E8 |
| F056834 | 18730725 | CURRENT | 19950801 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369832 | N/A | SCOTT MATTHEW RANDOLPH | 2030 K.L.O. ROAD | KELOWNA BC | V1W2H7 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C133340 | 18851210 | CURRENT | 20160912 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 24280 | MY | 270908 | N/A | STONEBRIDGE VENTURES LTD | C/O RICHARD BULLOCK | 1394 LADNER ROAD | V1W3M7 |
| F056482 | 18730725 | ABANDONED | 19960222 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 1282.819 | MY | 368298 | N/A | BASSINGTHWAIGHTE RICHARD D & SICH JANICE | 3029 HOLLAND RD | KELOWNA BC | V1W3P7 |
| C130976 | 18910206 | CURRENT | 20140122 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 3100 | MY | 370237 | N/A | R 366 ENTERPRISES LTD | 300 2000 SPALL RD | KELOWNA BC | V1Y9P6 |
| F070821 | 18910206 | ABANDONED | 19930118 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 24669.6 | MY | 346584 | N/A | DANZICA ANTONIO & CARELLA | RR 3 MCCULLOUGH RD E | KELOWNA BC | V0H1G0 |
| F056483 | 18730725 | ABANDONED | 19960131 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 1110.132 | MY | 368299 | N/A | BASSETT LYLE A | 3009 HOLLAND RD | KELOWNA BC | V1W3P7 |
| F062421 | 18910206 | CANCELLED | 20131106 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 21413.213 | MY | 346060 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| F060754 | 18730725 | ABANDONED | 20050125 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 2220.264 | MY | 370327 | N/A | 352039 BC LTD | 4574 FULLER RD | KELOWNA BC | V1W1Z7 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C056842 | 18730725 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369839 | N/A | MOIR CARRIE LEE & EBURNE BRADLEY GORDON | 2080 K.L.O. ROAD | KELOWNA BC | V1W2H7 |
| F060755 | 18730725 | CANCELLED | 20160920 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 4933.92 | MY | 370329 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| F057510 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 27629.952 | MY | 346586 | N/A | KALSAM ORCHARDS LTD | 4132 BEDFORD RD | KELOWNA BC | V1W4N6 |
| F060756 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 4933.92 | MY | 370330 | N/A | PERRETTA DONATO & MARIA | 19 IDLEWILD BAY | WINNIPEG MB | R2P1H3 |
| C063078 | 18770223 | CURRENT | 19851031 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 12334.8 | MY | 370599 | N/A | REID DIANE MARIAN | 2921 BELGO ROAD | KELOWNA BC | V1P1E2 |
| C133333 | 18730725 | CURRENT | 20160818 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 2275 | MY | 346599 | N/A | BERARD WILLIAM HENRY & BRENDA SUSAN | 1740 KLO ROAD | KELOWNA BC | V1W3P6 |
| F070819 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 73466.069 | MY | 346580 | N/A | KALSAM ORCHARDS LTD | 4132 BEDFORD RD | KELOWNA BC | V1W4N6 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C058810 | 18911222 | CANCELLED | 20061219 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 5180.616 | MY | 370326 | N/A | 4110 INVESTMENTS LTD | 218 1626 RICHTER STREET | KELOWNA BC | V1Y2M3 |
| C057911 | 18910206 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369828 | N/A | METCALFE DAVID CECIL & RABB BERNADETTE J | 2057 FISHER RD | KELOWNA BC | V1W2H3 |
| F070818 | 18910206 | CURRENT | 19891004 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 6167.4 | MY | 346579 | N/A | 1104492 BC LTD. | 303-570 RAYMER AVENUE | KELOWNA BC | V1Y4Z5 |
| F070808 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 32070.48 | MY | 346598 | N/A | WESTERN GLOBAL ENTERPRISES INC | 119 GLENMARY ROAD | ENDERBY BC | V0E1V3 |
| F056836 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369834 | N/A | SHELVEY BERNARD | 2050 KLO RD | KELOWNA BC | V1W2H7 |
| C133334 | 18730725 | CURRENT | 20160818 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 11002 | MY | 8003604 | N/A | SINGH HARSIMER PREET ET AL | 2623 SPRINGFIELD ROAD | KELOWNA BC | V1X1B9 |
| F070816 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 24669.6 | MY | 346572 | N/A | KALSAM ORCHARDS LTD | 4132 BEDFORD RD | KELOWNA BC | V1W4N6 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F055107 | 18910206 | ABANDONED | 20130508 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 2466.96 | MY | 367588 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| C132391 | 18910206 | CURRENT | 20150916 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 65374.538 | MY | 346589 | N/A | CASORSO VELMA IRENE | 2240 MAYER ROAD | KELOWNA BC | V1W2G1 |
| C058807 | 18911222 | ABANDONED | 20130722 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 10854.624 | MY | 265669 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| F054286 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 49339.2 | MY | 346573 | N/A | R 288 ENTERPRISES LTD | 3902 BLUEBIRD ROAD | KELOWNA BC | V1W1X6 |
| F057910 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 1060.793 | MY | 369827 | N/A | MARKEWICH RYAN J & TRINE | 2899 LEADER RD | KELOWNA BC | V1W2E9 |
| C133510 | 18730725 | CURRENT | 20161103 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 7401 | MY | 346671 | N/A | PHAM DUNG TIEN & MAI | 593 CASSIAR ROAD | KELOWNA BC | V1V1M8 |
| F054291 | 18730725 | ABANDONED | 19960227 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 3626.431 | MY | 346759 | N/A | MOONEN WILLIAM C | C/O MRS MARTINE GIRARD | 3125 THACKER DR | V1Z1X6 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F057909 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 2787.665 | MY | 369825 | N/A | PICCO REMI | 2077 FISHER ROAD | KELOWNA BC | V1W2H4 |
| F014054 | 19470507 | ABANDONED | 19930201 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 1233.48 | MY | 167209 | N/A | TRANSPORTATION & INFRASTRUCTURE MIN OF | 1540 SPRINGHILL DR | KAMLOOPS BC | V2E2H1 |
| C056166 | 18730725 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 13074.888 | MY | 346590 | N/A | WESTERN GLOBAL ENTERPRISES INC | 119 GLENMARY ROAD | ENDERBY BC | V0E1V3 |
| F053847 | 18730725 | CANCELLED | 20150302 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 4933.92 | MY | 346699 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| C111170 | 18730725 | CURRENT | 19961021 | 82.E.083.4.4.2A (PD57696) | LWN, FAIRWAY & GRDN: RES | 4933.92 | MY | 346668 | N/A | THE REGIONAL DISTRICT OF CENTRAL OKANAGA | 1450 K.L.O. ROAD | KELOWNA BC | V1W3Z4 |
| F051182 | 18791212 | ABANDONED | 19930401 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 3700.44 | MY | 346163 | N/A | SCHOOL DISTRICT NO 23 KELOWNA | 1940 HAYNES RD | KELOWNA BC | V1X5R2 |
| C128447 | 18730725 | CURRENT | 20120628 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 59200 | MY | 346601 | N/A | SINNEAVE ROBERT GEORGE REGINALD | 3567 BENVOULIN ROAD | KELOWNA BC | V1W4M6 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C057902 | 18910206 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369819 | N/A | BAUER JASON M & TINA L | 2047 FISHER RD | KELOWNA BC | V1W2H3 |
| F053846 | 18730725 | CANCELLED | 20160920 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 4933.92 | MY | 346603 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| F056839 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 838.766 | MY | 369837 | N/A | ODELL LOUISE ANNE | 3020 LEADER RD | KELOWNA BC | V1W2E8 |
| C040149 | 18851210 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 8387.664 | MY | 310220 | N/A | MAYERS LYNDA D | 3430 BENVOULIN RD | KELOWNA BC | V1W4M5 |
| C070635 | 18990729 | CURRENT | 19890802 | 82.E.083.4.4.2A (PD57696) | CAMPS & PUB FACIL: PUBLIC | 6.819 | MD | 242030 | N/A | THE REGIONAL DISTRICT OF CENTRAL OKANAGA | 1450 K.L.O. ROAD | KELOWNA BC | V1W3Z4 |
| C057903 | 18910206 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369820 | N/A | WHITWORTH TIMOTHY E | 1919 FISHER RD | KELOWNA BC | V1W2H1 |
| F054290 | 18730725 | ABANDONED | 19960227 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 5180.616 | MY | 346758 | N/A | OLSON ALLAN J | C/O MRS MARTINE GIRARD | 3125 THACKER DR | V1Z1X6 |

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| F056167 | 18730725 | CURRENT | 19811110 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 15702.2 | MY | 346600 | N/A | KELOWNA SOCIETY FOR CHRISTIAN EDUCATION, | 2870 BENVOULIN ROAD | KELOWNA BC | V1W2E3 |
| C057119 | 18910206 | CANCELLED | 20140108 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 14801.76 | MY | 346564 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| F056490 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 912.775 | MY | 369506 | N/A | FORLIN DANIEL | 3140 BENVOULIN RD | KELOWNA BC | V1W2E5 |
| C056840 | 18730725 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369829 | N/A | RUSSO FRANCO O & VALITA M | 2050 POLO RD | KELOWNA BC | V1W2H5 |
| F070811 | 18910206 | CURRENT | 19891004 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 13321.584 | MY | 346566 | N/A | DOUBLE S CANNERY GROUP INC THE | 3303 BOUCHERIE RD | KELOWNA BC | V1Z2H3 |
| F057908 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 1060.793 | MY | 369826 | N/A | KARIUS TRENT & CORRINE | 2212 SAUCIER ROAD | KELOWNA BC | V1W4B8 |
| F063077 | 18770223 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 76969.152 | MY | 310232 | N/A | REID ALLEN D | 1980 BYRNS RD | KELOWNA BC | V1W2G4 |

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| C057895 | 18910206 | ABANDONED | 19960501 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 9867.84 | MY | 370234 | N/A | R 288 ENTERPRISES LTD | 3902 BLUEBIRD ROAD | KELOWNA BC | V1W1X6 |
| F056488 | 18730725 | ABANDONED | 20160714 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 1036.123 | MY | 369504 | N/A | 0796838 BC LTD | C/O GLAZIER POLLEY | 2-1674 BERTRAM STREET | V1Y9G4 |
| C057901 | 18910206 | CURRENT | 19910813 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369818 | N/A | VIITA WARREN B & PATRICIA L | 2051 FISHER RD | KELOWNA BC | V1W2H3 |
| F056835 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 863.436 | MY | 369833 | N/A | KHODARAHMI AFSHIN | 1966 RICHTER ST | KELOWNA BC | V1Y2N5 |
| F053553 | 18730725 | CANCELLED | 20170410 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 12458.148 | MY | 346597 | N/A | DO NOT CHANGE TO BE DETERMINED AND | PO BOX 9340 STN PROV | VICTORIA BC | V8W9M1 |
| C055598 | 18910206 | ABANDONED | 19980129 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 7400.88 | MY | 346568 | N/A | TOSTENSON BRIAN D | 590 BROME CRES | KELOWNA BC | V1W2M5 |
| C064271 | 18730725 | CURRENT | 19870210 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: LOCAL PROVIDE | 7622.906 | MY | 346592 | N/A | THE REGIONAL DISTRICT OF CENTRAL OKANAGA | 1450 K.L.O. ROAD | KELOWNA BC | V1W3Z4 |

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| C132392 | 18910206 | CURRENT | 20150916 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 30837.046 | MY | 8003253 | N/A | CASORSO JOHN L A | 3860 CASORSO RD | KELOWNA BC | V1W4R7 |
| F070820 | 18910206 | CURRENT | 19891004 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 70111.003 | MY | 346581 | N/A | PAHL BRIAN & LINDA | 2255 SCENIC ROAD | KELOWNA BC | V1V2C8 |
| F053845 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 4933.92 | MY | 346701 | N/A | PUCCI FLORINDO & ANNA | 3763 LAKESHORE RD | KELOWNA BC | V1W3K3 |
| F065145 | 18730725 | ABANDONED | 19941205 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 2466.96 | MY | 369503 | N/A | WILLIAMS RICHARD L & ARTHUR W | C/O 1790 KLO RD | KELOWNA BC | V1W3P3 |
| F051181 | 18791212 | ABANDONED | 19960523 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 33057.264 | MY | 265683 | N/A | OKANAGAN COLLEGE | 1000 KLO RD | KELOWNA BC | V1Y4X8 |
| F052037 | 18851210 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 4933.92 | MY | 310222 | N/A | THURNHEER THOMAS & LAURA ANN | 1725 RAMPONE ROAD | KELOWNA BC | V1W4M5 |
| F060753 | 18730725 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 2540.969 | MY | 346602 | N/A | MILLER DIANE M | 3089 BENVOULIN RD | KELOWNA BC | V1W2E4 |

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| F054288 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 49339.2 | MY | 346756 | N/A | R 288 ENTERPRISES LTD | 3902 BLUEBIRD ROAD | KELOWNA BC | V1W1X6 |
| F062121 | 19090107 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 39471.36 | MY | 265666 | N/A | KELOWNA TRINITY BAPTIST CHURCH LEGACY FO | 1905 SPRINGFIELD ROAD | KELOWNA BC | V1Y7V7 |
| F056480 | 18730725 | CANCELLED | 19960604 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 3231.718 | MY | 368296 | N/A | KLO ROAD BAPTIST CHURCH | 1370 KLO RD | KELOWNA BC | V1Y3X8 |
| F056832 | 18730725 | CURRENT | 19830503 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 7400.88 | MY | 369830 | N/A | MARKEWICH RYAN J & TRINE | 2899 LEADER RD | KELOWNA BC | V1W2E9 |
| F051183 | 18791212 | ABANDONED | 19930401 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 17515.416 | MY | 44905 | N/A | SCHOOL DISTRICT NO 23 KELOWNA | 1940 HAYNES RD | KELOWNA BC | V1X5R2 |
| F070812 | 18910206 | CURRENT | 19910814 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 54273.12 | MY | 346567 | N/A | VICTOR PROJECTS LTD | 205-2365 GORDON DR | KELOWNA BC | V1W3C2 |
| F056477 | 18910206 | ABANDONED | 19930115 | 82.E.083.4.4.2A (PD57696) | IRRIGATION: PRIVATE | 4933.92 | MY | 346582 | N/A | AYNSLEY EVELINE | 2320 BENVOULIN ROAD | KELOWNA BC | V1W2C6 |

**B2: Intake – spawning channel**

| LICENCE_NO | PRIORITY_DATE | LIC_STATUS | LIC_STAT_DATE | MAPSHEET_POD | PURPOSE | QUANTITY | UNITS | FILE_NO | LICENSEE | ADDRESS_LINE1 | ADDRESS_LINE2 | POSTAL_CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C057893 | 18770223 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0.002 | MS | 270927 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C054364 | 18910312 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: USE OF WATE | 0.078 | MS | 265687 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C069470 | 18930220 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: USE OF WATE | 0.001 | MS | 8001249 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C058620 | 18720318 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0.011 | MS | 265681 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C056478 | 18730725 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0.001 | MS | 265682 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C056473 | 19550321 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0.113 | MS | 207242 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C056831 | 18730725 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0.001 | MS | 346605 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C111591 | 18730725 | CURRENT | 19961021 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 19316.3 | MY | 8002506 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C057899 | 18910206 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0.001 | MS | 346575 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C058806 | 18910206 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0.002 | MS | 346576 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C069470 | 18930220 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0 | TF | 8001249 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |
| C057894 | 18910206 | CURRENT | 19910813 | 82.E.083.4.4.2 C (PD57695) | CONSERVATION: CONSTRUCT W | 0.001 | MS | 346574 | FISH & WILDLIFE SCIENCE & ALLOCATION SEC | ATTN: TARA WHITE, SR FISH | 102 INDUSTRIAL PLACE | V2A7C8 |

**B3: Intake downstream of KLO Br**

| LICENCE_NO | PRIORITY_DATE | LIC_STATUS | LIC_STAT_DATE | MAPSHEET_POD | PURPOSE | QUANTITY | UNITS | FILE_NO | PROC_STATUS | LICENSEE | ADDRESS_LINE1 | ADDRESS_LINE2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F020145 | 19610113 | CURRENT | 19910814 | 82.E.083.4.2 KK (PD58511) | IRRIGATION: PRIVATE | 6784.14 | MY | 234382 | N/A | ISARIA HOLDINGS INC | 2048 PARSONS ROAD | KELOWNA BC |
| F052040 | 18730725 | CURRENT | 19910814 | 82.E.083.4.2 UU (PD58512) | IRRIGATION: PRIVATE | 65004.4 | MY | 305016 | N/A | B P Y A 1129 HOLDINGS LTD | C/O ALEX GUIDI | 2901-1050 BURRARD STREET, Vancouver, BC |
| C126510 | 18851210 | CURRENT | 20110706 | 82.E.083.4.2 UU (PD58512) | IRRIGATION: PRIVATE | 33300 | MY | 310223 | N/A | BROWN MARK WILLIAM & ELLEN MAY | 3527 BENVOULIN ROAD | KELOWNA BC |
| F052038 | 18851210 | CURRENT | 19910814 | 82.E.083.4.2 UU (PD58512) | IRRIGATION: PRIVATE | 1726.872 | MY | 310221 | N/A | BASRAN JAGMOHAN SINGH & SANGHERA KAMALJI | 697 ARBORVIEW DRIVE | KELOWNA BC |

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| F018041 | 1874041 7 | ABANDONED | 2016081 0 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATION: PRIVATE | 7203.523 | MY | 246 905 | N/A | GASPAR PROPERTIES LTD | 3755 CASORSO ROAD | KELOWNA BC |
| C126511 | 1885121 0 | CURRENT | 2011070 6 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATION: PRIVATE | 33300 | MY | 800 303 8 | N/A | BASRAN SATNAM SINGH & SANGHERA SUCHA SIN | 3443 BENVOULINE ROAD | KELOWNA BC |
| F019430 | 1874041 7 | CURRENT | 1991081 4 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATION: PRIVATE | 29603.52 | MY | 242 026 | N/A | ROMAN CATHOLIC BISHOP OF NELSON | 3665 BENVOULIN ROAD | KELOWNA BC |
| F015960 | 1885121 0 | CURRENT | 1991081 4 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATION: PRIVATE | 14308.37 | MY | 800 197 0 | N/A | CETINSKI ANTHONY M & NANCY J | 3563 BENVOULIN RD | KELOWNA BC |
| C111005 | 1891020 6 | CURRENT | 1996051 7 | 82.E.083. 4.2 UU (PD58512 ) | LWN, FAIRWAY & GRDN: WATE | 21955.94 | MY | 800 243 2 | N/A | ABBOTT STREET HOLDINGS LTD | 1959 K.L.O. RD | KELOWNA BC |
| C120283 | 1874041 7 | CURRENT | 2006072 1 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATION: PRIVATE | 12951.54 | MY | 800 197 6 | N/A | DAVARA HOLDINGS LTD | 1 911 BORDEN AVE | KELOWNA BC |

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| F003672 | 1874041 7 | CURRENT | 1991081 4 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATI ON: PRIVATE | 35277. 53 | MY | 800 197 5 | N/A | RISSO JAMES A | 3755 CASORSO RD | KELOWNA BC |
| F018042 | 1874041 7 | ABANDO NED | 2017012 7 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATI ON: PRIVATE | 14999. 12 | MY | 246 906 | N/A | RUSSO GUERINO & IDA V | 3616 BENVOULI N RD | KELOWNA BC |
| C121704 | 1954111 6 | CURRENT | 2006032 2 | 82.E.083. 4.2 UU (PD58512 ) | LWN, FAIRWAY & GRDN: WATE | 9251.1 | MY | 206 031 | N/A | ABBOTT STREET HOLDING S LTD | 1959 K.L.O. RD | KELOWNA BC |
| C111004 | 1873072 5 | CURRENT | 1996051 7 | 82.E.083. 4.2 UU (PD58512 ) | LWN, FAIRWAY & GRDN: WATE | 28370. 04 | MY | 346 604 | N/A | ABBOTT STREET HOLDING S LTD | 1959 K.L.O. RD | KELOWNA BC |
| F051180 | 1873072 5 | ABANDO NED | 2016091 5 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATI ON: PRIVATE | 937.44 5 | MY | 305 017 | N/A | STRACHA N GEORGE G & ARLENE | 3379 GORDON DR | KELOWNA BC |
| F011920 | 1893022 0 | CANCELL ED | 1996112 7 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATI ON: PRIVATE | 37004. 4 | MY | 242 029 | N/A | FRANCES CUTTI L | 3410 GORDON DR | KELOWNA BC |
| C111006 | 1891020 6 | CURRENT | 1996051 7 | 82.E.083. 4.2 UU (PD58512 ) | LWN, FAIRWAY & GRDN: WATE | 36757. 7 | MY | 346 407 | N/A | ABBOTT STREET HOLDING S LTD | 1959 K.L.O. RD | KELOWNA BC |

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| F011918 | 1893022 0 | PENDING | 1963090 6 | 82.E.083. 4.2 UU (PD58512 ) | IRRIGATI ON: PRIVATE | 53582. 37 | MY | 242 029 | APPOR TIONM ENT PEND | DO NOT CHANGE TO BE DETERMI NED AND | PO BOX 9340 STN PROV | VICTORIA BC |

## Appendix C: Photos

(Please see separate PDF file)