Agriculture Water Demand Study
Erickson Water Service Area

Report for Regional District of Central Kootenay
December 30th, 2019

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Table of Contents

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Executive Summary

The water demand study has been conducted to help identify the current and potential agricultural demand for water within the Erickson water service area. The project has utilized various resources including the Agriculture Land Use Inventory (ALUI) for Central Kootenay, the BC Agriculture Water Demand Model (AWDM), RDCK water metering data, Farmwest regional climatic data and climate change models developed by UBC and the Pacific Agri-Food Research Center in Summerland.

Land Use and Water Demand

The current irrigated agricultural area within the water service area boundary is 231.5 hectares. A review of the agriculture land use inventory identified an additional 138 hectares of arable non-irrigated land within the boundary that could become irrigated for agricultural use. A long term trend in the agricultural production area has shown a continual and gradual decline in the irrigated land base from 572 ha of tree fruits produced in 1950 to a total of 231 ha of tree fruit and other agricultural crops being produced today. However, a short term trend in recent years has shown an increase in the irrigated land base at a rate of approximately 5 hectares per year due to the re-vitalization of certain crops.

The agriculture water demand model (AWDM) has been applied to project the annual water demand under the current irrigated area and existing crop mix during wet, dry and average years. Under the current irrigated area of 231.5 ha, the annual irrigation requirements are projected to range from approximately 800,000 m^3 in wet years to 1,600,000 m^3 in dry years. Under a build-out scenario

that would include an additional 138 ha of arable land using the same crop mix, the model projects irrigation requirements to range from approximately 1,500,000 m^3 in wet years to 2,800,000 m^3 in dry years. The projected demand under the build-out scenario would reach the existing irrigation licencing capacity on Arrow Creek of 2,253.5 acre feet or 2,779,647 m^3. The average of 3 climate change models applied to the region projected that water demand would increase by an additional 10% over the next 50 years.

Irrigation Water Use Efficiency

Irrigation water use efficiency was analyzed from existing water meter data collected during 2018 and 2019. The metered data represented 19 farms and approximately 30% of the agricultural land base.

Annual water consumption on each farm was compared to the predicted irrigation requirement from the BC agriculture water calculator. The water calculator is capable of estimating demand for each site, cropped area, crop type, soil type and irrigation system within a climatic grid. During 2018 and 2019, the average consumption rate on all metered farms was fairly consistent at approximately 2700 m3/ha or 270 mm of irrigation. The average use fell between 70 and 75% of the agriculture water calculator's predicted demand. However, on individual farms, annual consumption ranged from 128 m^3/ha to 6677 m^3/ha varying from 8% to 114% of the calculator's predicted demand. The variation in consumption can typically be influenced by factors such as crop type, crop age, soil type and irrigation management.

The average annual consumption rate was extrapolated over the existing agricultural land base of 231.5 hectares to estimate annual agricultural consumption. Based on the existing crop mix, the estimated annual agricultural water consumption would have been 640,000 m^3 during 2018 and 620,000 m^3 during 2019. The estimated use for the irrigated land base is approximately 60% of the AWDM projections for a year having average environmental conditions and 40% of the AWDM projections for a dry year. Several cropping and management variables will account for differences between the estimated annual use and AWDM predicted annual requirement which is based on full crop production.

The estimated portioning of water to agriculture has been determined relative to the total volume delivered through the water treatment plant in 2018. Based on the estimated annual consumption of 640,000 m^3, agricultural irrigation would have accounted for 21% of the total annual volume of 3,029,424 m^3. During the primary irrigation period between May 1st and September 30th, agricultural irrigation would have accounted for 31% of the total volume delivered.

The primary concerns related to water demand and supply occur during the peak demand period of July and August. Daily average consumption rates during the peak demand period of July and August were estimated from the monthly flow totals for each farm. The daily average consumption rates per irrigated hectare were compared to the maximum allowable consumption rate of 60.5 m^3/ha/day which is based on the flow rate of 4.5 gpm/acre (0.7 l/sec/ha). However, it was recognized that under normal farming practices, it is unlikely that agricultural irrigation would be applied at the maximum allowable flow rate for an entire month. The average daily consumption of all metered farms during 2018 was 31.2 m^3/ha/day in July and 26.2 m^3/ha/day in August. The average daily consumption of all metered farms during 2019 was 18.8 m^3/ha/day in July and 22.3 m^3/ha/day in August. Again, some variability between farms existed and two farms exceeded that maximum allowable flow rates for the month of either July or August in 2019. The variability and incidental excessive consumption during peak demand indicate that opportunities for improvements to irrigation management and water conservation may exist.

Climate, Soil and Irrigation Systems

The climatic parameters of growing degree days, moisture deficits and evapotranspiration levels as well as Peak Evapotranspiration (ET) values and irrigation district water allotments were compared between Erickson and 4 tree fruit growing regions in the Okanagan Valley. The climatic parameters in Erickson identified a slightly cooler and wetter climate than the 4 Okanagan locations. The climatic data provided a comparative rationalization of the established Peak Et values used to determine irrigation district water allotments in gpm/acre.

The soil type in the Erickson area consists primarily of a silty clay loam having good water holding capacity. Portions of the area deviate towards the coarser textured sandy loam soils with a lower water holding capacity or the finer textured clay loams with slightly higher water holding capacity. Efficient irrigation systems have been adopted by the majority of agricultural producers with 85% of the area being irrigated with either drip, microspray or microsprinkler systems.

Agricultural Cropping

Agricultural cropping patterns have changed over time and are likely to continue to change with decisions being influenced by market opportunities, cultural capabilities and changing farm business plans. These variables may stimulate existing commodities to be planted onto new land or alternative crops to be planted. As we are unable to predict future crop selection and preferences, it would be prudent to consider the agricultural demand for water under the production of high water demanding crops, an expanded agricultural base and the influence of climate change projections.

Recommendations

1. Agriculture will require additional water in future and it is recommended that the volume currently licenced to agriculture be retained. It is likely that more water will be required in the future above that amount.

2. Due to the potential for increased agricultural demand for water and the limitations of supply and flow, the possibilities of additional water sources or water storage infrastructure should be considered.

3. Water meter data should continue to be collected and analyzed to more accurately define irrigation water use efficiency and irrigation water demand for this area.

4. Consideration should be given to the agricultural demand for water under increasing acreage, the production of high water demanding crops and climate change projections.

5. Because agricultural extension support from both government and industry has been gradually eroded, educational assistance is required to help farmers manage irrigation and implement water conservation practices.

Background

The agriculture water demand study has been conducted on behalf of the Regional District of Central Kootenay to help identify the current and potential agricultural demand for water within the Erickson water service area boundary. In response to increasing pressure on demand from both agricultural and non-agricultural users, water use data is required to help plan for and ensure an adequate water supply in future. In recent years, the water treatment plant which provides water for Erickson and the Town of Creston has operated at near peak capacity of 320 L/second during portions of July and August in spite of recent mainline improvements which have reduced line leakages.

Historical Background

A brief history of agricultural development and the water supply in Erickson helps to provide some context to this study. Fruit growing and the agricultural demand for water in Erickson began in the early 1900's with settlers acquiring crown land that had been cleared and sold. With insufficient water to meet crop requirements, the Erickson Irrigation District was formed to exploit Sullivan Creek to the east by means of wood stave pipe. As the flow from this line was inadequate to meet an expanding acreage, the East Creston Irrigation District was formed in 1929 to bring water from Arrow Creek around the side of Arrow Mountain. The system was installed to meet the agricultural demand for water as well as provide domestic water for residents. Initially, farms were ditch irrigated which was often ineffective and inefficient leading to one of the earliest developments of sprinkler irrigation applied to orchards in British Columbia. Sprinkler irrigation allowed for cover crops to occur along with intercropping.

Since the early 1900's, tree fruits have remained the primary agricultural crop in Erickson while vegetable and berry crops have occupied a smaller percentage of the irrigated land base. Aerial mapping reviewed by Kevin Murphy in 1980 identified the area of land devoted to tree fruit production in 1950 as compared to the area at that time. The earlier data has been compared to the recent acreage summary completed in 2019 (table 1) illustrating the long term trend. The irrigated tree fruit area declined at each of these points in time from 572 ha (1950) to 382 ha (1980) to the most recent summary of 187 ha (2019). The area devoted to tree fruit production in 2019 was 49% of the land base of 1980 and

33% of the land base of 1950. The summary in 2019 identified an additional 44 hectares of land devoted to other irrigated agricultural crops however the area of those crops were not recorded in the earlier study.

Table 1. Comparative summary of land use within the Erickson water service area.

	1950 Hectares	1980 Hectares	2019 Hectares
Irrigated tree fruit crops	572	382	187
Other irrigated crops	Not recorded	Not recorded	44
Housing/landscape	29	153	182
Miscellaneous	154	220	342
Total	755	755	755

Provincial Water Licencing and District Bylaws

In relation to irrigation requirements, agricultural producers are primarily concerned about volume and flow. The volume of irrigation water from Arrow Creek is governed by provincial water licencing (table 2) whereas the rate of flow is managed by the regional district to help protect and conserve the resource.

Table 2. Provincial water licencing on Arrow Creek serving Erickson and the Town of Creston.

Licence	Licence Holder	Purpose	Quantity (m^3/yr)	Max. daily diversion rate (m^3/day)
C129760	RDCK-ERK	Irrigation	629,100	
C129802	RDCK-ERK	Irrigation	2,150,600	
C129760	RDCK-ERK	Waterwork	222,300	909.2
C129799	RDCK-ERK	Waterwork	165,900	454.6
C129869	RDCK-ERK	Waterwork	277,300	1,837.0
C129813	Town-Crst	Waterwork	893,500	2,448.0
C129817	Town-Crst	Waterwork	1,787,000	4,896.0
C129818	Town-Crst	Waterwork	896,034	3,673.0
C129868	Town-Crst	Waterwork	277,300	1,837.0
Total	Combined	All Purposes	7,299,034	

For irrigation purposes, licence C129760 provides for 629,100 m^3/yr (510 acre feet) and licence C129802 provides for 2,150,600 m^3/yr (1743.5 acre feet) producing a combined total volume of 2,779,200 m^3/yr (2253.5 acre feet). The licencing would provide sufficient water over an entire season for approximately 455 hectares (1125 acres) of irrigation based on a volume of 2 acre feet.

The regional district bylaw permits agricultural irrigation to occur up to a maximum flow rate 4.5 US gpm/ac (0.7 L/sec/ha). This flow rate is considered to be adequate to meet peak demand for agricultural crops produced in the region and is the peak flow value utilized in irrigation design.

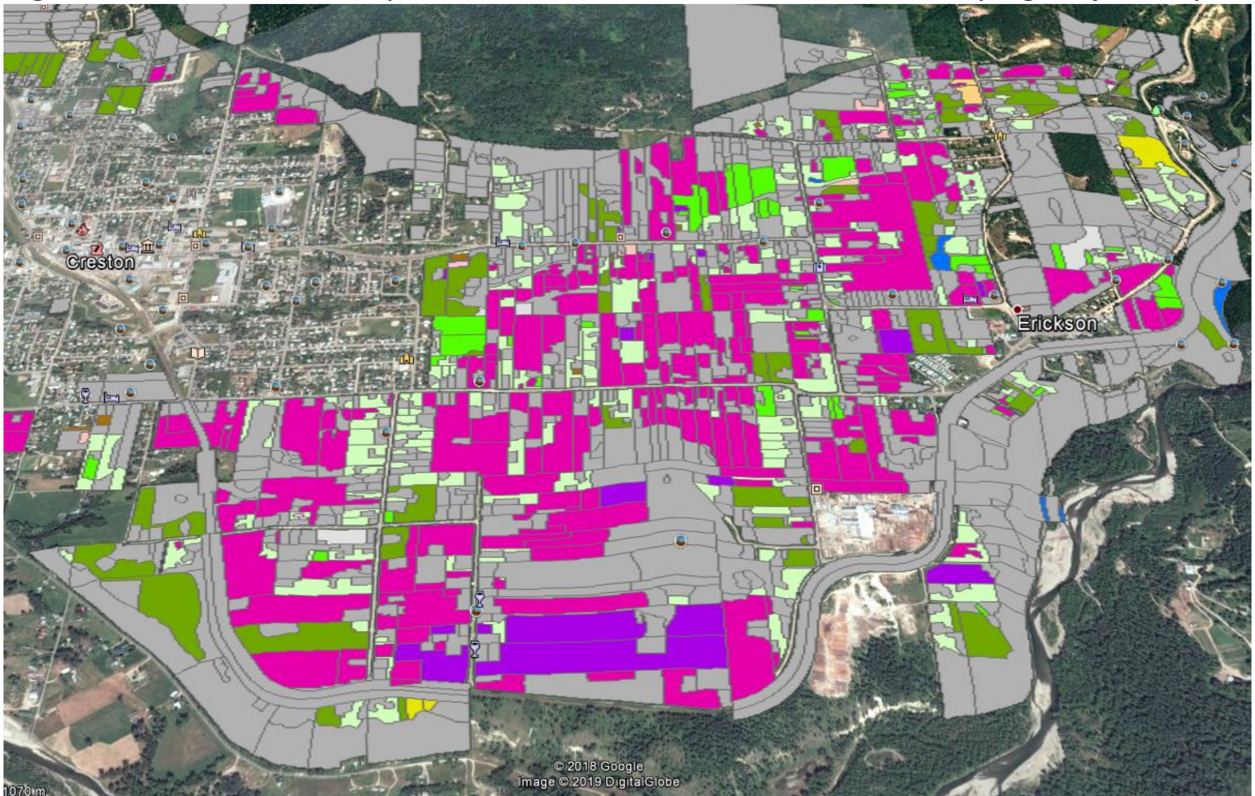
Methodology

To assist with identifying the current and potential agricultural demand for water within the Erickson water service area, several parameters have been studied including; a review of the agricultural land use inventory, the application of the agricultural water demand model, an analysis of recent water meter data and a review of relevant climate data, soil types and irrigation systems within the area.

The Agriculture Land Use Inventory (ALUI) for RDCK completed in 2016 provided the basis to update the current irrigated area devoted to agricultural production as well as the non-irrigated area having the potential to become irrigated for agricultural use. The 2016 ALUI map (figure 1) illustrates the major crop groups produced within the Erickson water service area boundary. Some land use changes have occurred since that time which have been accounted for in the acreage update. Irrigated agricultural expansion would potentially arise from the areas identified as unspecified as well as from the large sized yards.

The BC Agriculture Water Demand Model (AWDM) was applied to the current irrigated agricultural land base to project water demand during dry, wet and average years represented by 2003, 2005 and 2009 respectively. The model incorporates the influence of climate, soil type, crop type, and irrigation system on all lots within the water service area boundary. The AWDM was also applied to a build-out scenario with consideration given to agricultural expansion as well as to the influence of climate change projected over the next 50 years.

Figure 1. 2016 GIS map of Erickson water service area identifying major crops.



Tree Fruits	Grapes/Berries	Vegetables	Forage	Yard	Unspecified

Irrigation water use efficiency was reviewed through the analysis of water meter data from 19 farms covering 70 hectares and representing approximately 30% of the irrigated area devoted to agriculture. The annual water use on each farm was compared to the BC agriculture water calculator's annual projected requirements based on the crop type, soil type, irrigation system and climatic grid. The daily average flow during the peak demand period of July and August were also reviewed in relation to the maximum allowable flow rates.

Relevant climatic data was analyzed for the Erickson area relative to 4 tree fruit growing regions in the Okanagan to help rationalize water demand between regions where similar crops are produced. The climatic parameters of growing degree days, moisture deficits and evapotranspiration values were compared along with the peak ET values used to determine water allotments for irrigation districts. Existing soil types and irrigation systems currently in use in Erickson were also analyzed relative to their influence on water demand.

Land Use Results

The irrigated land use area by crop type within the Erickson water service area is shown below (table 3). The total land area currently devoted to irrigated agriculture is 231.2 hectares. The primary crop in production is cherries (145.7 ha) followed by apples (28.3 ha), field vegetable crops (19.2 ha), grapes (15.8 ha) and peaches (9.6 ha). Remaining agricultural crops cover a total area of 12.9 ha.

Table 3. Irrigated land use area by crop

Irrigated Crop	Crop Area Ha	Number of parcels with crop planted	Mean crop area per parcel (Ha)
Cherries	145.7	80	1.8
Apples	28.3	35	0.8
Vegetables	19.2	21	0.9
Grapes	15.8	5	3.2
Peaches	9.6	17	0.6
Berries	3.0	9	2.6
Nursery	2.6	3	2.6
Forage	1.7	4	0.9
Cereals	1.6	1	1.6
Pears	1.4	6	0.2
Apricots	1.1	5	0.2
Greenhouse	0.8	3	0.3
Plums	0.7	4	0.2

The non-irrigated arable area of land capable of becoming irrigated for agricultural use was assessed through on-site visitations in conjunction with the Agriculture Land Use Inventory. It was determined that within the water service area boundary, approximately 138 hectares of non-irrigated land could potentially be expanded into irrigated agricultural production. The current uses of the non-irrigated land having potential to become irrigated are categorized below (table 4). There may also be a limited number of parcels of uncleared land within the boundary having potential for agricultural production.

Table 4. Non-irrigated land having potential for irrigated agricultural use.

Non-irrigated arable use (current use)	Total Area Ha	Mean size Ha
Non-irrigated forage	41	3.1
Idle or vacant land	76	2.5
Non-irrigated yard	21	1.1

Cropping patterns and land use preferences change over time as influenced by market opportunities, cultural capabilities/limitations and changing farm business plans. Long term and short term trends provide some insight into potential changes to the irrigated land base. The long term trend has shown a continual decline in tree fruit acreage from 572 ha in 1950 to 382 ha in 1980 falling further to the current production area of 187 ha (2019). The reduction in cropping area has been combined with an increase in residential housing, landscapes and anthropogenic uses of land limiting the potential for re-growth of the industry to the earlier status of 1950. However, a more recent short term trend over the past few years has shown an expansion of the irrigated agricultural land base. Cherry plantings have largely replaced apple plantings since the mid 1980's and this crop is expanding back onto vacant or idle land which had not been irrigated at least in recent years. Since 2016, approximately 20 hectares of new cherry plantings have been established in Erickson including 9 hectares on to vacant or idle land which had not recently been irrigated. In addition to the increased cherry production area, an additional 6 hectares of idle land had been placed back into irrigated agricultural production with the planting of grapes, vegetable crops and nursery stock. Over the recent 3 year period, 15 hectares of non-irrigated land has been placed back into irrigated agricultural production. Based on the recent growth rate of 5 hectares per year, the non-irrigated land base of 138 hectares could potentially become irrigated for agricultural use within 30 years whereby the total irrigated area would approach the tree fruit land base irrigated in 1980.

The likelihood of agricultural expansion onto the non-irrigated land base was evaluated by the author's discretionary assessment of individual properties. Properties were placed into one of two categories having either a low or high likelihood of irrigated agricultural expansion. Properties having a low likelihood of being expanded upon were limited by one or more factors including small lot size, microclimatic limitations, steep slope, semi-permanent alternative land uses or encumbrances on or adjacent to the land. A low likelihood of agriculture expansion was considered to be present on approximately 35 of the 138 hectares of non-irrigated arable land whereas the remaining area was considered to have a higher likelihood and capability of supporting agricultural growth.

Although it is difficult to predict cropping patterns and trends of the future, it would be prudent to give consideration to water demand requirements under the scenario of all arable land being irrigated to high water consuming crops with sprinkler irrigation in dry seasons. The agriculture water demand model (AWDM) is capable of generating reports that give consideration to all of these variables.

Agriculture Water Demand Model Results

The Agriculture Water Demand Model (AWDM) is capable of generating reports that predict annual water use according to climatic grid, soil type, irrigation system and crop acreage of a specific area. The model has been applied to the Erickson water service area under the current irrigated land base and crop mix, an expanded irrigated land base having the same crop mix and under climate change projections using the current and expanded irrigated land base. Within each of these scenarios, water demand is predicted for 3 types of seasons representing dry years (2003), wet years (2005) and average years (2009).

AWDM under Current Acreage and Crop Mix

The annual water demand for the existing 231.5 hectares of irrigated land under the current crop mix would range from 818,763 m^3 in wet years to 1,571,893 in dry years. The corresponding irrigation requirement for each type of season is illustrated in table 5 below. The demand required by each specific crop and current acreage is further provided in Appendix A, tables 1, 2 and 3.

Table 5. Water demand projections under current irrigated area and crop mix.

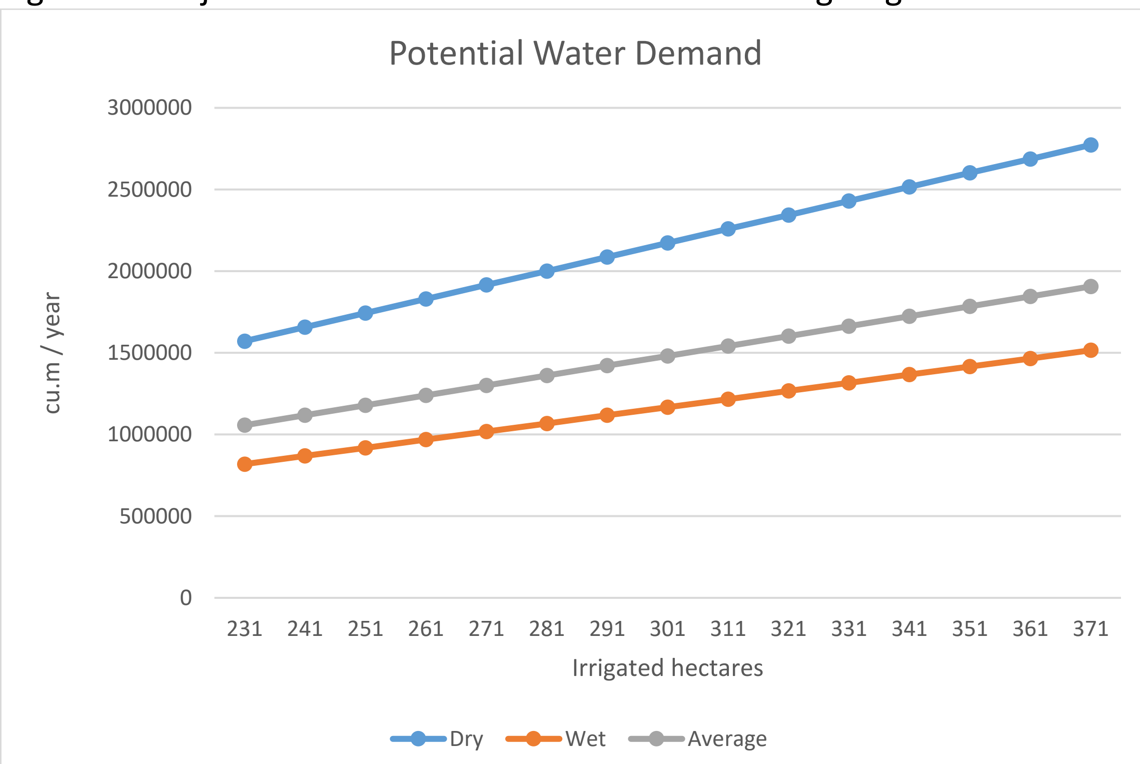
	Irrigated Area (ha)	Irrigation Demand (m^3)	Irrigation req'd[1] (mm)
2003 (dry year)	231.5	1,571,893	679
2005 (wet year)	231.5	818,763	354
2009 (average year)	231.5	1,056,857	457

Note: 1mm irrigation/precipitation = 10m^3/ha

AWDM under Build-out Scenario with Increased Acreage

The projected annual water demand for an expanded irrigated agricultural base would include the additional 138 hectares of non-irrigated land for a total area of 369.5 ha. Over this expanded irrigated area, the water demand would range from 1,509,679 m^3 in wet years to 2,761,753 m^3 in dry years. The water demand has been projected over increasing incremental units of 10 hectares from the current irrigated area of 231.5 ha to the potential irrigated area of 369.5 ha (figure 2). This build-out scenario is based on a proportional increase of the current crop mix.

Figure 2. Projected water demand under an increasing irrigated area.



AWDM under Climate Change Projections

Three climate change models were selected and applied to capture changes in the extremes of climatic indices most significant to water supply (winter precipitation and maximum temperature) and agricultural water use (summer precipitation and maximum temperature). Each model provides different possibilities selected out of a set of data to project 50 years ahead from the representative years of

2003, 2005 and 2009. The models selected were; Access 1, Canesm2 and Cnrmcm5. While all of these models trend upward in temperature over time, each would vary independently over individual years. An average of the 3 model predictions was chosen to illustrate the potential affect that climate change might have on water demand under the current and potential irrigated area of land (table 6). The water demand in 50 years as projected from the average of 3 climate change models over dry, wet and average seasons is estimated to increase by approximately 10%. The results of each model are presented individually in Appendix A; tables 4, 5 and 6.

Table 6. Projected irrigation requirements under the current irrigated area (231.5 ha) and potential irrigated area (369.5 ha) area under climate change projections.

	Current Irrigated Area 231.5 Ha		Projected Irrigated Area 369.5 Ha	
	m^3	mm	m^3	mm
Dry Year	1,669,115	721	3,159,225	855
Wet Year	884,330	382	1,732,955	469
Average Year	1,138,980	492	2,176,355	589

Considerations for Increasing Water Demand

The ability to meet increasing agricultural demand for water in future may become restricted by irrigation licencing on Arrow creek which currently allows for an annual volume of 2,779,647 m^3 per year. Consideration in regard to the agricultural allocation should be given to the following:

- We do not know what types of crops are going to be grown in future and demand may increase.
- The irrigated agricultural area may expand or may need to be expanded in future as part of a sustainable food strategy.
- Climate change will result in a higher water requirement.

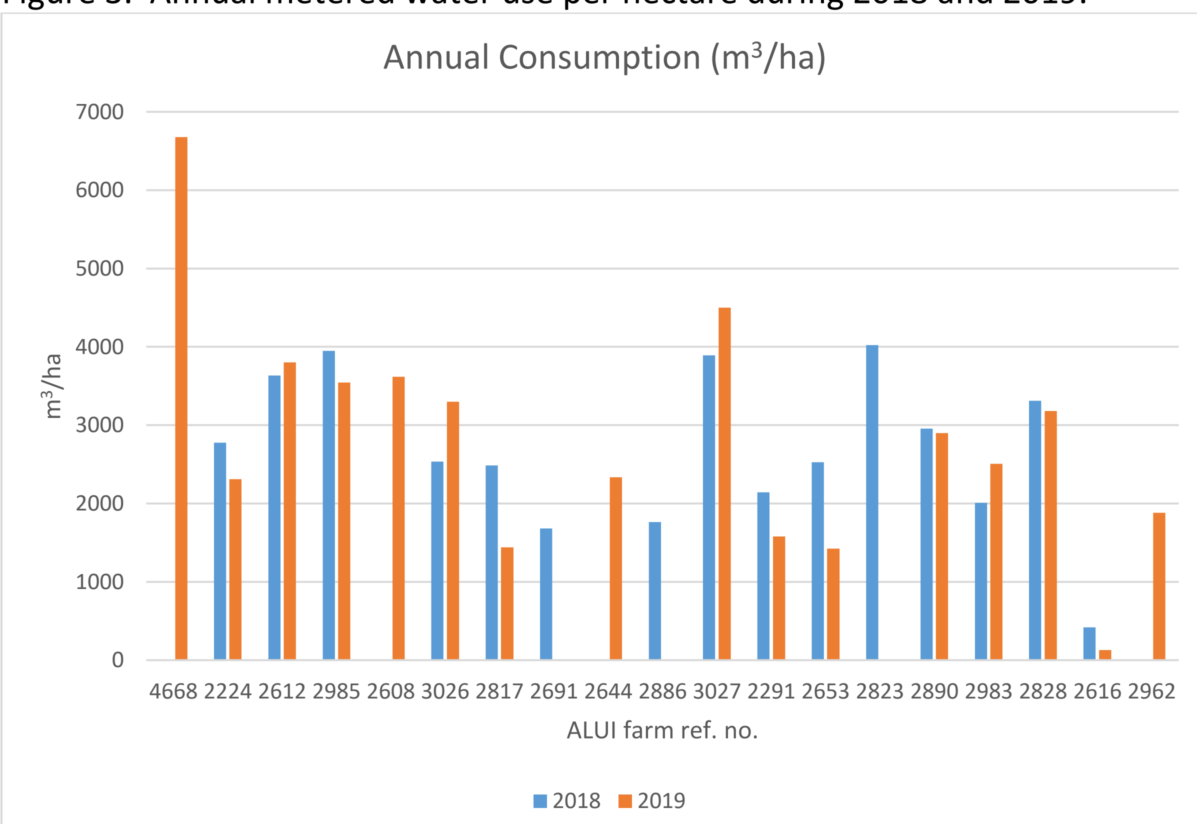
Irrigation Water Use Efficiency

Water use efficiency was analyzed from recent water meter data collected during the 2018 and 2019 growing seasons on 19 farms. Meter readings were taken on approximately 31% of the irrigated agricultural area during both years. The metered data represented varying crop production areas including tree fruit crops (83%), vegetable crops (8%) and grapes (9%). Individual farm data was reviewed in relation to annual water consumption as well as estimated daily consumption with consideration given towards overall agricultural demand, water licencing and maximum allowable flow rates.

Annual Irrigation Water Consumption

The average annual water consumption on the metered farms was relatively consistent between years at 2750 m^3/ha during 2018 and 2682 m^3/ha during 2019. However, wide variability in water consumption existed between farms over the 2 year period ranging from 128 m^3/ha to 6677 m^3/ha as shown (figure 3).

Figure 3. Annual metered water use per hectare during 2018 and 2019.



Differences in annual water consumption between farms may be justifiably attributed to site specific variables such as differing crop requirements, differences in crop age, microclimatic zones and varying soil factors such as soil texture, seepage, drainage and hardpan layers all influencing irrigation management decisions. The possibility of either over or under irrigation at certain times of the season may also exist providing opportunities for greater awareness, improved crop quality and increased water conservation efforts.

The annual water consumption on metered farms for 2018 and 2019 was reviewed and compared to the BC agriculture water calculator's predicted demand (table 7). The agriculture water calculator estimates water demand for each site based on the microclimatic grid, soil type, irrigation system, crop type and cropping area for an average climatic year.

Table 7. Metered water use on individual farms and predicted demand.

ALUI Farm Ref. #	Irrigated area ha	Primary Crop	Soil Type	Irrigation type	Metered water use 2018 (mm)	Metered water use 2019 (mm)	Ag Calc. predicted demand (mm)
4668	1.5	Cherries	Loam	drip		445	390
2224	3.88	Cherries	sl.cl.lm.	drip	278	231	394
2612	3.56	Cherries	sl.cl.lm.	drip	363	380	384
2985	15.09	Cherries	Loam	mic.spr.	395	355	417
2608	3.5	Cherries	sl.cl.lm	Drip		362	397
3026	3.40	Cherries	snd.lm.	Drip	253	330	467
2817	3.52	Cherries	sl.lm.	Drip	249	144	363
2691	3.36	Cherries	sl.cl.lm.	Drip	168		372
2644	2.1	Cherries	Sl.cl.lm.	Drip		233	380
2886	5.26	Cherries	sl.lm.	Drip	177		364
3027	2.59	Cherries	snd.lm.	Drip	389	450	472
2291	3.60	Cherries	sl/cl.lm.	mic.spr.	215	158	398
2653	4.15	Cherries	sl.cl.lm.	mic.spr.	253	143	388
2823	0.89	Cherries	Loam	drip	402		412
2890	6.88	Fruit/Veg	sl.lm.	drip	296	290	327
2983	2.27	Mix fruit	Loam	drip	305	251	350
2828	2.83	Field veg	Sl.lm.	Sprinkler	331	318	393
2616	6.92	Grapes	sl.cl.lm.	drip	42	13	164
2962	6.19	Cherries	Loam	Drip		188	384

Blank cells within metered water use columns indicate missing data.

The metered water use on most farms for both years fell below the agriculture calculators projected demand with the exception of one farm during 2019. The average consumption on metered farms was 275 mm during 2018 and 269 mm during 2019. The metered average use was 74% and 72% of the agriculture water calculator's estimated demand for these 2 years respectively. This may indicate that the agriculture calculator over-estimated annual water demand on these farms over the past 2 seasons. A further breakdown of the data found that the average monthly water use as a percentage of the calculator projection was 64% in June, 75% in July, 83% in August and 38% in September. Less irrigation water was used during the shoulder seasons than in mid-summer in comparison to the agriculture water calculator projections.

Assuming the average annual consumption on metered farms represented the whole, agricultural use of water was estimated for the irrigated area of 231.5 ha for both years. At the consumption rates of 275 mm (2018) and 269 mm (2019), annual agricultural water consumption was estimated to be 640,000 m^3 in 2018 and 620,000 m^3 in 2019. These estimates are approximately 60% of the AWDM projected requirement of 1,056,857 cubic meters for an average climatic year. The difference between estimated actual use and the AWDM projections may be partially explained in that the model assumes crops in full production and cannot consider site specific factors influencing irrigation management.

The portioning of water to agriculture relative to the water treatment plant volume has been estimated for 2018. The estimated agricultural consumption of 640,000 m^3 would have accounted for approximately 44% of the Erickson flow total and 21% of the annual treatment plant volume for 2018 shown as by monthly totals (table 8). During the irrigating period of May through September, agricultural consumption would have accounted for approximately 57% of the Erickson flow total and 31% of the annual treatment plant volume.

Table 8. Monthly water treatment plant flow totals during 2018.

Month	Days/month	WTP Total (m3)	Reset Inlet meter (m3)	Creston Total (m3)	Erickson Total (m3)
January	31	145,564	142,148	98,804	46,760
February	29	133,374	131,480	91,048	42,326
March	31	147,672	145,181	98,154	49,518
April	30	147,661	145,438	97,579	50,082
May	31	256,148	252,709	145,623	110,525
June	30	312,969	311,231	160,700	152,269
July	31	636,923	636,121	238,274	398,649
August	31	590,230	579,121	236,433	353,797
September	30	245,758	242,644	141,074	104,684
October	31	154,820	152,066	94,062	60,758
November	30	126,589	124,216	85,572	41,017
December	31	131,716	128,362	91,821	39,895
	Annual Total	3,029,424	2,990,717	1,579,144	1,450,280

Daily Irrigation Consumption during Peak Demand

Meter readings on the metered farms were recorded on a monthly basis over the irrigating period so daily use can only be estimated from the monthly totals. The agricultural irrigating period typically occurs over a 5 month period between May 1st and September 30th. During this 5 month period, July and August each account for approximately 1/3 of the seasonal irrigating water use. With cherries being the primary crop currently in production, a coefficient curve for this crop is provided in appendix A figure 4 to illustrate the evapotranspiration rate of cherries relative to a reference crop which is typically grass.

The average daily consumption per irrigated hectare for each metered farm during July and August is illustrated in figures 4 and 5 below for 2018 and 2019.

Figure 4. Average daily consumption for each metered farm July/August 2018.

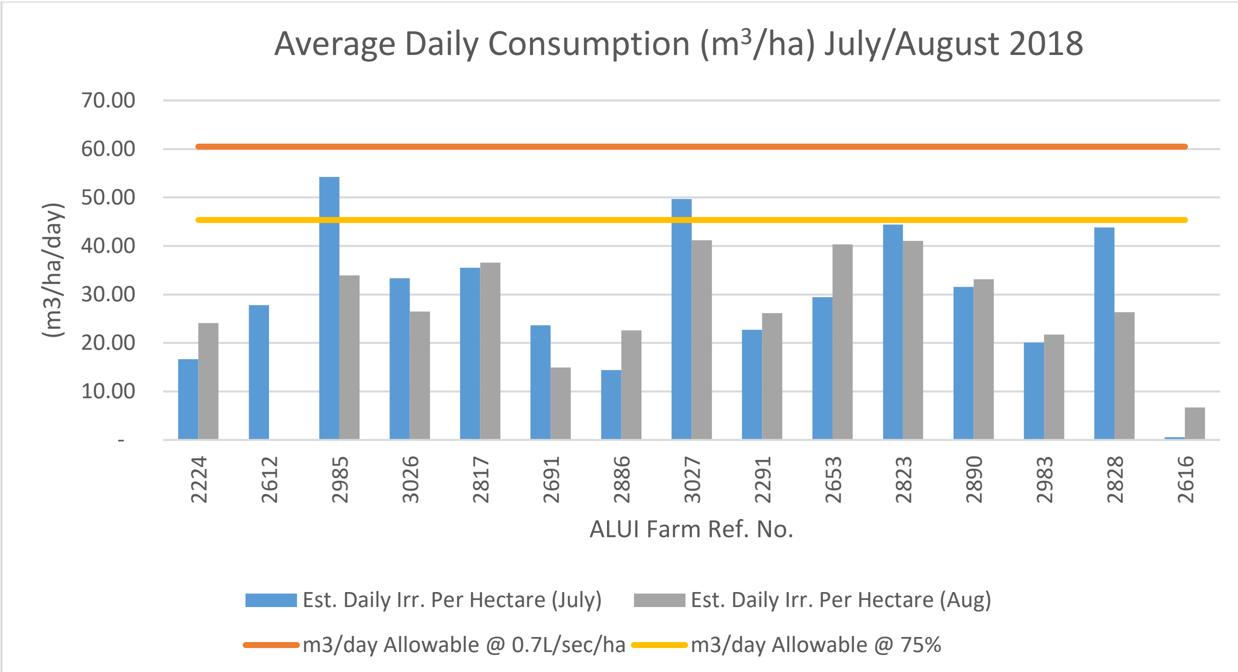
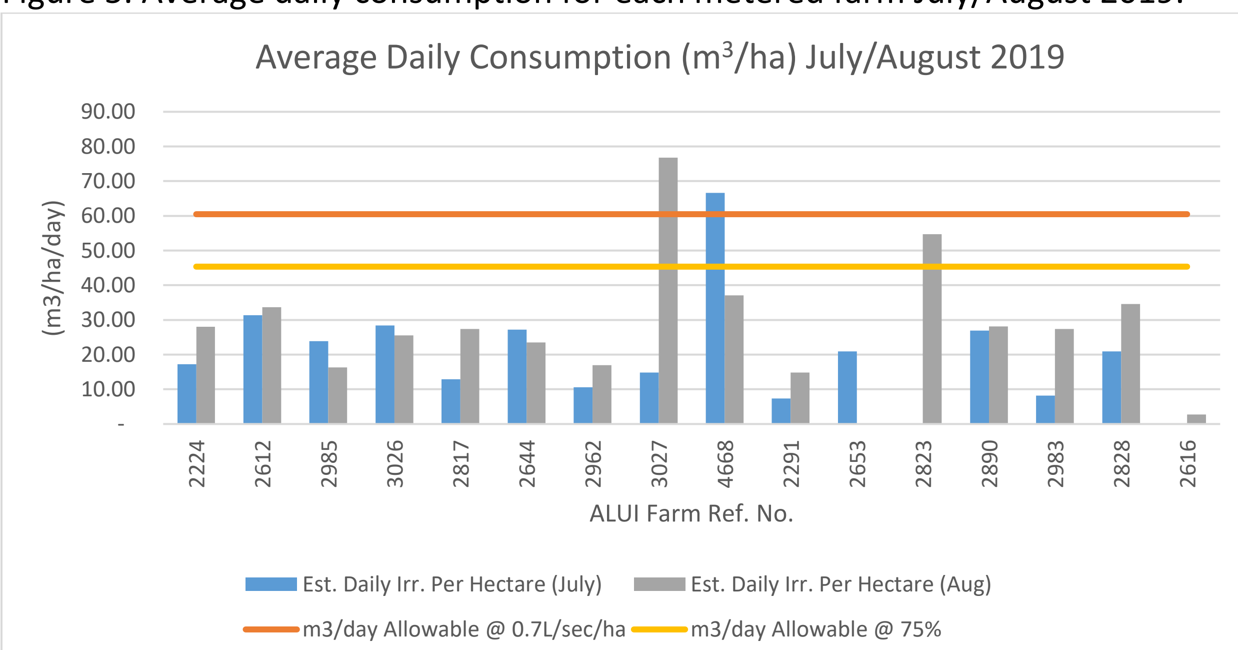


Figure 5. Average daily consumption for each metered farm July/August 2019.



In each of the charts above, the average daily consumption may be compared to the maximum allowable consumption of 60.5 m^3/ha/day based on the allowable flow rate of 4.5 gpm/acre (0.7 l/sec/ha) as represented by the red line. Applying the maximum allowable flow rate to the existing 231.5 ha of irrigated land would account for a daily consumption rate of 14,000 m3/day or approximately 50% of the water treatment plant capacity. In practice, it is unlikely that farms would irrigate or be required to irrigate at the maximum flow rate each day over an entire month. The more likely scenario is that farms would irrigate at an average daily rate of approximately 75% of the maximum allowable flow rate or 45 m^3/ha/day during July and August as represented by the yellow line.

The average daily consumption for July and August inclusive of all metered farms was calculated to be; 31.2 m3/ha/day (July 2018), 26.2 m3.ha/day (August 2018), 18.8 m3/ha/day (July 2019) and 22.3 m3/ha/day (August 2019). However, variability in consumption between farms was again evident in both years and 2 farms had exceeded the maximum allowable flow rate based on daily averages for the month during 2019. The cause of excessive water use may be related to over-irrigation although broken lines and leaks which have not been attended to may also contribute to excessive water consumption.

Climate, Soil and Irrigation Systems

Climatic Influences

The climatic indices of growing degree days, moisture deficits and evapotranspiration (ET) for Erickson and four Okanagan districts were compared over a 17 year period between 2003 and 2019 (table 9). These indices are used to determine peak ET values and help establish irrigation water allotments for districts. The climatic data have been analyzed from the Farmwest weather stations (https://farmwest.com/) located in Erickson (Connel Rd), Vernon (Bella Vista), Winfield (North), East Kelowna (lower bench) and Osoyoos (EC).

Table 9. Climatic data averages from 2003 to 2019.

Location	Peak ET (mm)	District Allotments US gpm/ac	Season Length (days)	Growing DD (base 10)	Moisture Deficit (mm)	Accum. ET (mm)
Erickson	5.5	4.5	135	1133	528	564
Vernon	6.2	5.0	145	1247	615	641
Winfield	6.4	6.0	145	1186	625	649
E. Kelowna	6.4	5.0 – 6.5	148	1258	668	695
Osoyoos	8.3	8.0	157	1466	726	755

The data illustrate that the Erickson area is slightly cooler and wetter than Okanagan districts and more closely related climatically to the 3 locations in the north central Okanagan than to Osoyoos. The growing degree days in Erickson were found to be within 90 to 95% of the north central Okanagan locations while the moisture deficits and accumulated ET values for Erickson ranged from 79% to 87% of the 3 north central Okanagan locations. These differences help to rationalize the lower peak ET values and water allotments for Erickson relative to the north Okanagan locations.

The similarities and differences in these climatic parameters over the 17 year period can be more easily recognized in graphical form illustrated in figures 6, 7 and 8. It is notable that the climatic parameters show a closer relationship between Erickson and the north central Okanagan in recent years than had occurred in earlier years. This may or may not be related to changing climates as the period analyzed is relatively short. It was also evident that the moisture deficit and ET values in 2017 and 2018 were found to be drier than average years.

Figure 6. Degree day accumulation from 2003 to 2018

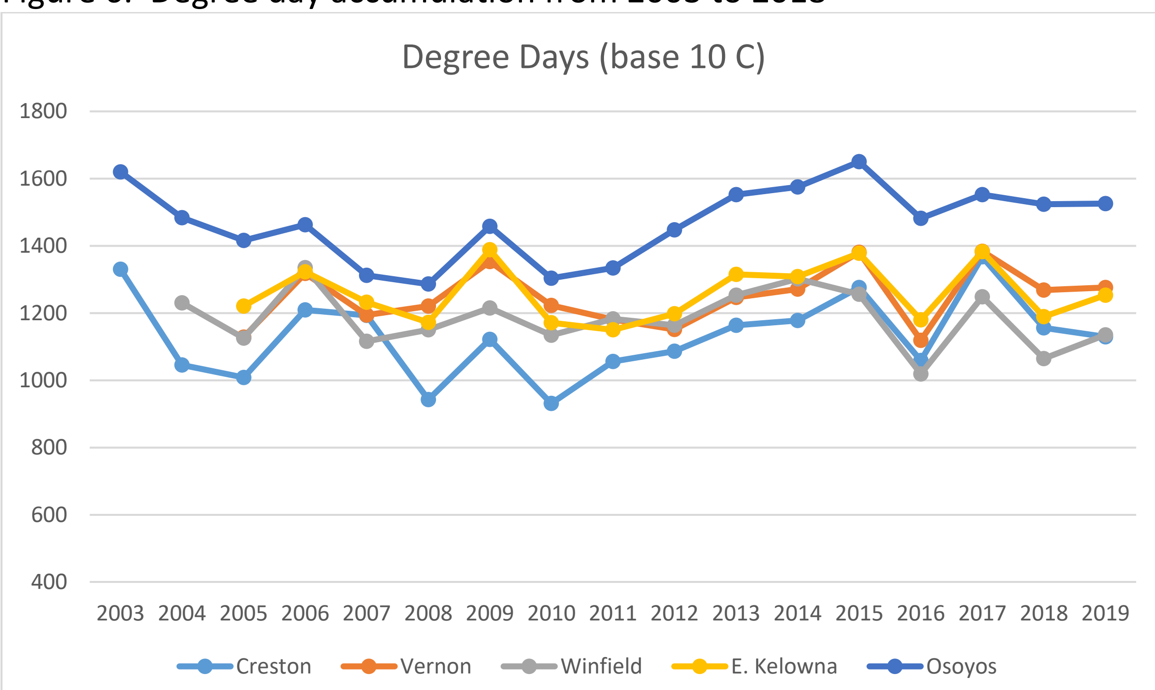


Figure 7. Moisture deficit from 2003 to 2018

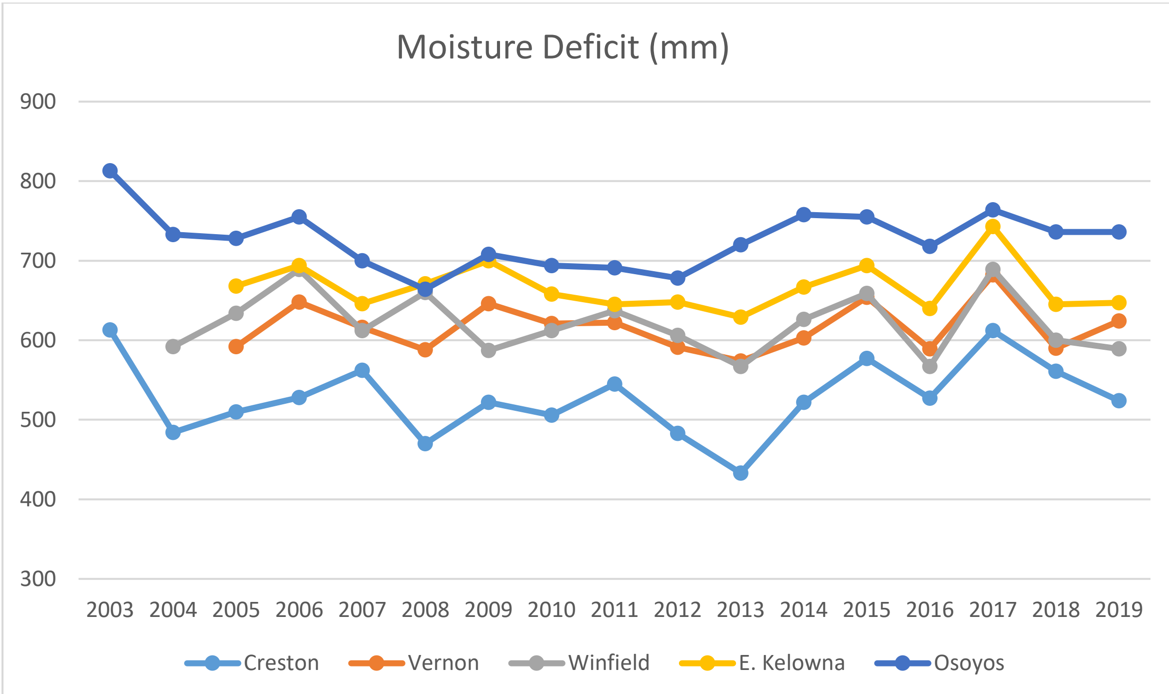
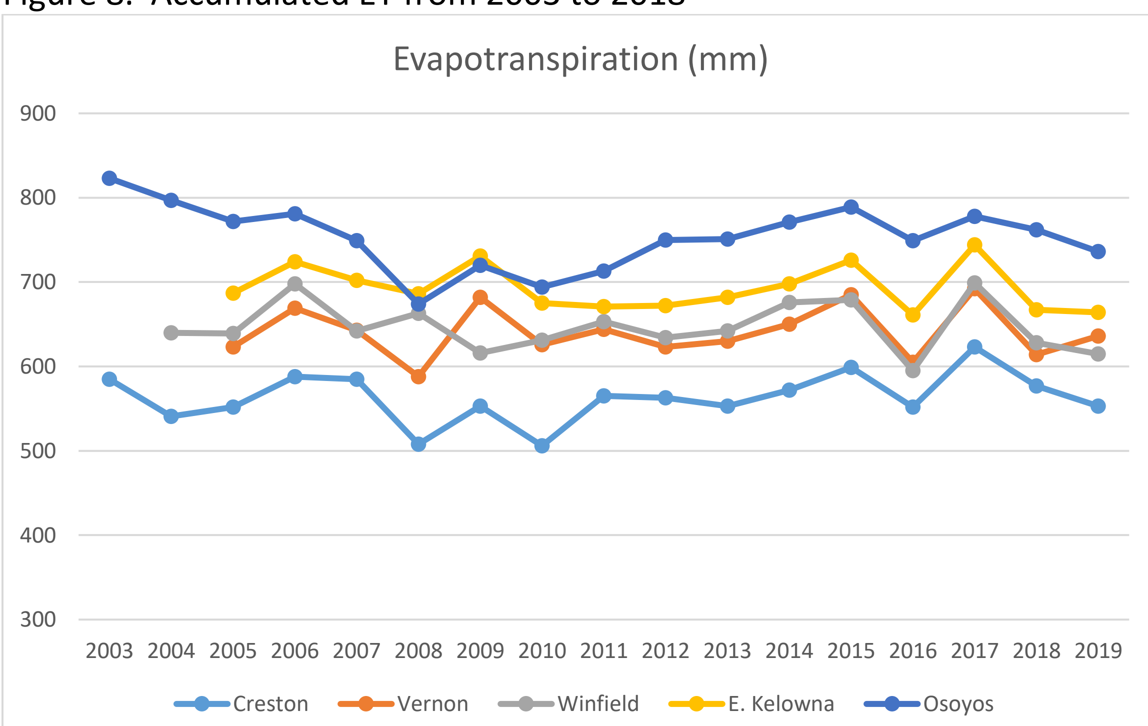


Figure 8. Accumulated ET from 2003 to 2018



Soil Types

The soil texture within the Erickson water service area generally has good water holding capacity. Approximately 85% of the irrigated land base consists of a silty loam soil which is considered to provide good water holding capacity relative to coarse textured soils. The balance of soil textures are divided among the coarser sands and sandy loam soils towards the north eastern boundary and the finer silty clay loam soils towards the south western boundary.

Irrigation System Efficiency

Efficient irrigation systems have been adopted by the majority of commercial producers. The predominant irrigation system in use is drip irrigation covering 59% of the irrigated area followed by microspray (15%), microsprinkler (11%) and sprinkler (15%).

As cropping patterns change over time, the annual water demand for selected crops under each type of irrigation system has been illustrated for comparative purposes (table 10). The water requirements are based on the BC agriculture water calculator predictions for 1 hectare of land on a silt loam soil under a typical growing season for Erickson of 135 days.

Table 10. Annual water demand for selected crops on a silt loam soil in Erickson.

Crop	Drip (m^3)/ha	Microspray (m^3)/ha	Microsprinkler (m^3)/ha	Sprinkler (m^3)/ha
Apples	3165	3215	3413	4011
Cherries	3637	3739	3961	4660
Peaches	3712	3788	4011	4735
Grapes	1594	1619	1695	2019
Blueberries	3039	3089	3314	3862
Strawberries	2491	2518	2666	3165
Peppers	3788	3413	3637	4285
Tomatoes	3338	3413	3637	4285
Nursery	3936	4011	4285	5009
Forage				5009

The table illustrates the comparative efficiency of irrigation system types across several selected crops with drip irrigation providing the most efficient use of water. Alternative systems to drip are considered to be proportionally less efficient by 2% (microspray), 8% (microsprinkler) and 27% (sprinkler). The differences in water demand between crops is consistent across each irrigation type. Seasonally, cherries will require 15% more water than apples but slightly less than some of the higher water demanding crops such as peppers, nursery stock and forage crops.

Cropping Considerations

Extreme weather events such as minimum winter temperatures and the number of frost free days often define where crops can be grown. Changing climates may allow for an expansion of agricultural commodities onto land not previously used for irrigated agriculture. Dr. Denise Neilsen of the Pacific Agriculture Research Center has shown that the number of hot days in summer (>35°C) has increased and the number of cold days in winter (<-20°C) has decreased in Summerland over the past 100 years. These changes have become more prevalent since 1980 and may contribute to an expanding agricultural base.

Tree fruits have remained the primary agricultural crop in Erickson since the early 1900's and their crop specific water requirements and limitations should be recognized. Research in Summerland has shown that periods of high temperature (32-37°C) approaching harvest are detrimental to the fruit quality of both cherries and apples. The risk of insufficient irrigation to meet water demand under high temperatures will negatively affect fruit quality, fruit marketability and the economic viability of these crops. Other horticultural crops including some vegetables and berries may also be impacted similarly under high temperature extremes which tend to occur most frequently in mid-summer.

Recommendations

1. Agriculture will require additional water in future and it is recommended that the volume currently licenced to agriculture be retained. It is likely that more water will be required in the future above that amount.

2. Due to the potential for increased agricultural demand for water and the limitations of supply and flow, the possibilities of additional water sources or water storage infrastructure should be considered.

3. Water meter data should continue to be collected and analyzed to more accurately define irrigation water use efficiency and irrigation water demand for this area.

4. Consideration should be given to the agricultural demand for water under increasing acreage, the production of high water demanding crops and climate change projections.

5. Because agricultural extension support from both government and industry has been gradually eroded, additional educational assistance is required to help farmers manage irrigation and implement water conservation practices.

Appendix A

Table A1. AWDM predicted water use in 2003 representing a dry year.

Crop Group	Irrigated Area (ha)	Irrigation Demand (m^3)	Irrigation Req'd (mm)
Cherries	145.7	1,074,705	737
Apples	28.3	199,779	707
Peaches	9.6	63,026	656
Pears	1.4	7,511	536
Apricots	1.1	7,765	706
Plums	0.7	4,447	635
Grapes	15.8	52,130	329
Berries	3.0	12,841	434
Vegetables	19.2	106,997	558
Nursery	2.6	16,428	642
Forage	1.7	14,690	861
Greenhouse	0.8	5,925	773
Cereals	1.6	5,647	353
Total	231.5	1,571,893	679

Table A2. AWDM predicted water use in 2005 representing a wet year.

Crop Group	Irrigated Area (ha)	Irrigation Demand (m^3)	Irrigation Req'd (mm)
Cherries	145.7	573,342	393
Apples	28.3	105,211	372
Peaches	9.6	33,192	346
Pears	1.4	3,956	283
Apricots	1.1	4,089	372
Plums	0.7	2,342	355
Grapes	15.8	18,746	118
Berries	3.0	6,276	212
Vegetables	19.2	50,055	261
Nursery	2.6	6,925	271
Forage	1.7	8,611	504
Greenhouse	0.8	3,044	380
Cereals	1.6	2,974	186
Total	231.5	818,763	354

Table A3. AWDM predicted water use in 2009 representing an average year.

Crop Group	Irrigated Area (ha)	Irrigation Demand (m^3)	Irrigation Req'd (mm)
Cherries	145.7	732,355	502
Apples	28.3	135,012	478
Peaches	9.6	42,593	443
Pears	1.4	5,076	363
Apricots	1.1	5,284	477
Plums	0.7	3,006	429
Grapes	15.8	26,229	166
Berries	3.0	7,688	260
Vegetables	19.2	72,978	381
Nursery	2.6	8,836	346
Forage	1.7	10,410	610
Greenhouse	0.8	3,610	451
Cereals	1.6	3,817	239
Total	231.5	1,056,857	457

Table A4. AWDM climate change prediction using access1 model.

	Current Acreage 231.5 hectares		Build-out Acreage 369.5 hectares	
Year	Irrigation Demand (m^3)	Avg.Req. (mm)	Irrigation Demand (m^3)	Avg.Req. (mm)
2053	1,396,885	588	2,570,267	724
2055	1,364,819	575	2,473,919	696
2059	921,673	388	1,663,999	468

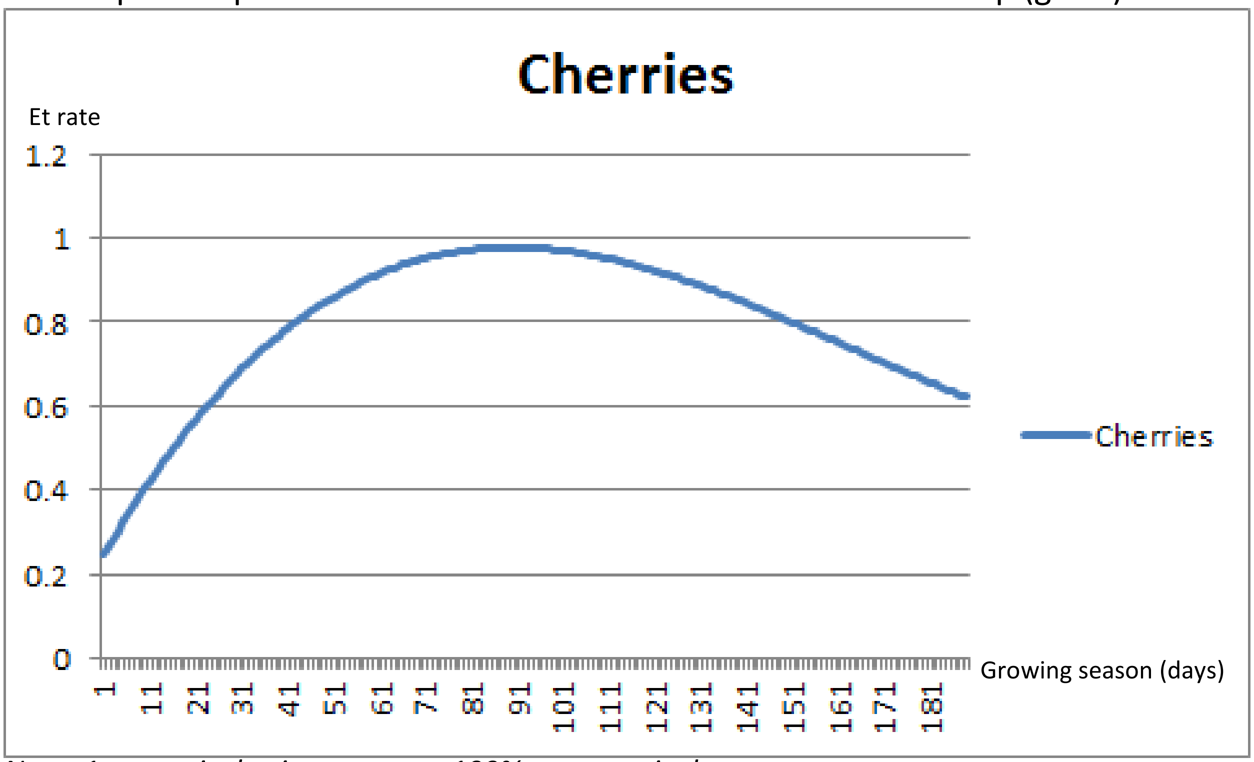
Table A5. AWDM climate change prediction using canesm2 model.

	Current Acreage 231.5 hectares		Build-out Acreage 369.5 hectares	
Year	Irrigation Demand (m^3)	Avg.Req. (mm)	Irrigation Demand (m^3)	Avg.Req. (mm)
2053	1,844,596	777	3,305,284	930
2055	1,088,640	458	2,029,239	571
2059	1,432,267	603	2,623,433	739

Table A6. AWDM climate change prediction using cnrmcm5 model.

Year	Current Acreage 231.5 hectares		Build-out Acreage 369.5 hectares	
	Irrigation Demand (m^3)	Avg.Req. (mm)	Irrigation Demand (m^3)	Avg.Req. (mm)
2053	1,174,069	494	2,178,708	614
2055	765,134	323	1,426,656	402
2059	1,107,312	466	1,984,504	559

Figure 1. Crop coefficient curve for cherries during a growing season illustrating the evapotranspiration rate of cherries relative to a reference crop (grass).



Note: 1 on vertical axis represents 100% grass equivalency