Greater Vernon Water (GVW)

Technical Memorandum No. 1
Domestic & Agricultural Water Demand Forecast

Jointly Submitted by:

AECOM
Suite 201 – 3275 Lakeshore Road 250 762 3727 tel
Kelowna, BC, Canada V1W 3S9 250 762 7789 fax
www.aecom.com

Associated Engineering (B.C.) Ltd.
Suite 610 – 1632 Dickson Avenue 250 763 3638 tel
Kelowna, BC, Canada V1Y 7T2 250 763 8880 fax
www.ae.ca

Kerr Wood Leidal Associates Ltd.
Suite 202 – 3334 30 Avenue 250 503 0841 tel
Vernon, BC, Canada V1T 2C8 250 503 0847 fax
www.kwl.ca

AECOM Job Number:

60224916

Date:

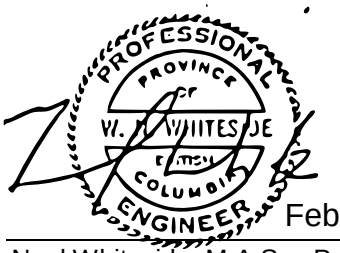
February 26, 2013

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	NW	February 16, 2012	Original Draft
2	NW	May 18, 2012	Draft #2
3	NW	June 26, 2012	Draft #3
4	NW	October 22, 2012	Final - revised irrigated areas, including distinction between allocation and allocation with agricultural water rate, addressed RDNO comments, added OWSDP memo as appendix.
5	NW	January 22, 2013	Consistency/typo corrections, details for 2011 domestic flow, Tavistock Demand Assignment, provide 2031 - 2052 growth rate.
6	NW	February 6, 2013	Final version of Summit and AE reports on agricultural water demands
7	NW	February 26, 2013	Miscellaneous typo's and clarification corrections as per RDNO comments.

Signatures

Report Prepared By:



February 26, 2013

Neal Whiteside, M.A.Sc., P.Eng.
Technical Lead - Hydraulics

Report Reviewed By:

PER

Mike Nolan, M.Eng., P.Eng.
Principal

Table of Contents

List of Figures

List of Tables

Attachments

1. Associated Engineering, Agricultural Demand Projections – OWSDP, October 22, 2012. File 20112887.100 E.04.00.
2. Summit Environmental Consultants, Final Report, Okanagan Water Supply and Demand Project – GVW Agricultural Water Demand Review, October 22, 2012.

1. Introduction

1.1 Scope

Development of a long-term water supply plan for the Greater Vernon area requires an understanding of current and forecast land use, population and agricultural service areas. This technical memorandum provides the basis for water supply and treatment planning, by confirming the planning horizon, summarizing related community development and land use plans, documenting current water demands and providing projected water demands into the future.

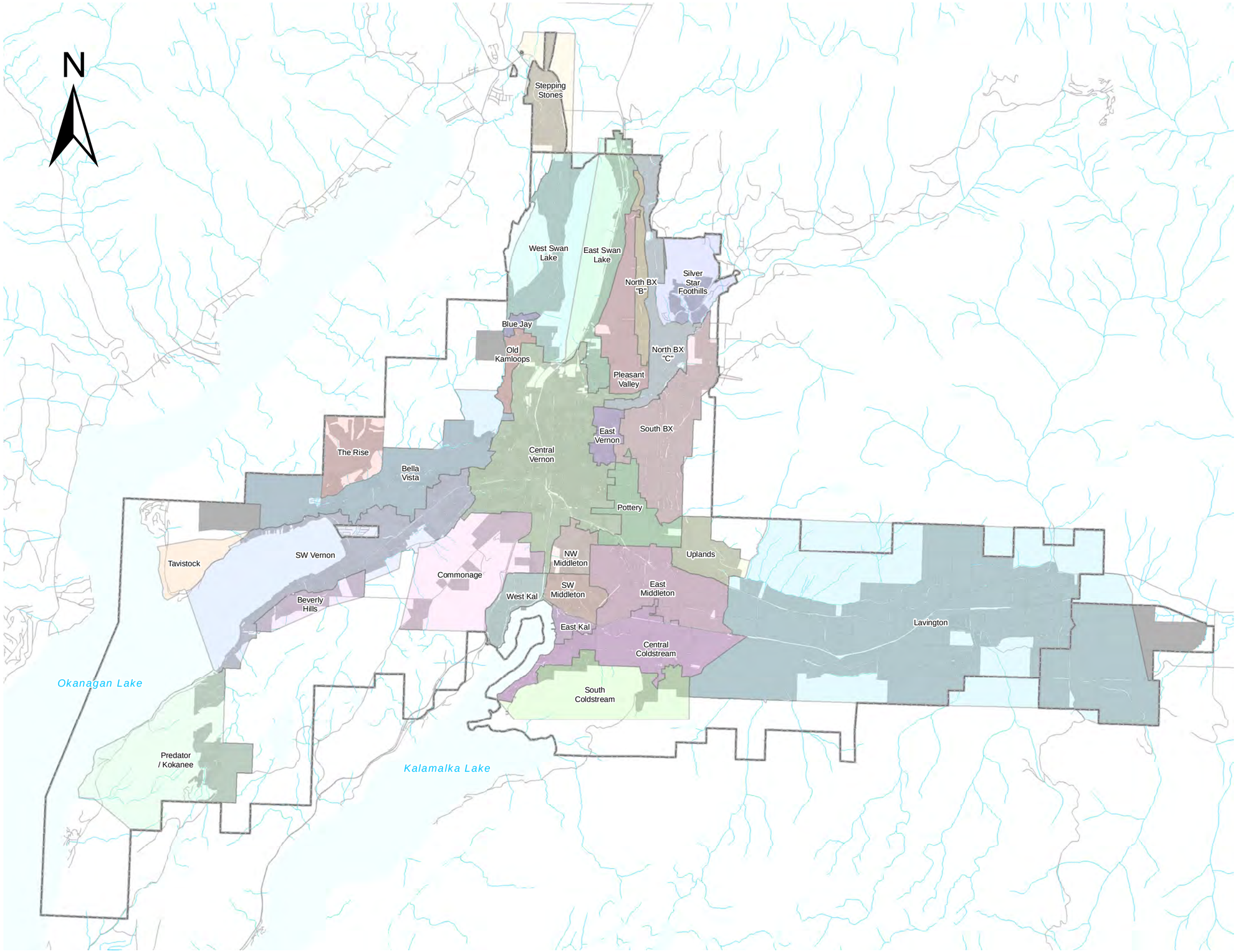
The purpose of this technical memorandum is to:

- Review existing demands,
- Disaggregate agricultural and domestic water uses,
- Develop an agricultural water consumption estimate for the RDNO water system, and
- Develop domestic water demand forecasts for the Greater Vernon water system including serviced areas of the City of Vernon, the District of Coldstream, and RDNO Electoral Areas 'B' and 'C'. The general Greater Vernon Water service area is shown in Figure 1-1 (note, also includes currently serviced portions of Area "D" and Spallumcheen). Some areas within the RDNO boundary are serviced by separate small systems (such as Outback and Delcliffe) and some areas are not serviced.

1.2 Report Objectives

This technical memorandum reviews the existing system demands and provides a forecast for future demands. The memorandum addresses the following items from the Terms of Reference:

- Task 1 – Establishment of a Planning Horizon.
- Task 3 – Inventory of Existing Demands.
- Task 4 – Community Development and Land Use.
- Task 6 – Projection of Water Demands.



Greater Vernon Water
2012 Master Water Plan

Legend

Jurisdiction Boundary

Name — Sub-Area

Associated Engineering

AECOM
SUITE 201, 3275 LAKESHORE ROAD
KELOWNA, B.C. V1W 3S9
T 250-762-3727 F 250-762-7789
WWW.AECOM.COM

KERR WOOD LEIDAL
consulting engineers

2,000 0 2,000 (m)

1:100,000

Project No.	Date
811-015	January 2013

Definition Plan for Domestic Service Sub-Areas

Figure 1-1

Path: O:\10800-0899\811-015\430-GIS\TechMemo_01\MXD-Rpt\811015_TM01_Fig1-1.mxd Date Saved: 22/01/2013 1:23:37 PM
Author: JLau

2. Existing Demands

2.1 Total Consumption from Source Flows

Table 2-1 and Figures 2-1 and 2-2 summarize overall system demands observed for the system, including both domestic and agricultural uses. Historical demand data is based on RDNO SCADA system data exports provided by RDNO.

Total yearly consumption was reviewed for the last number of years and was found to vary between 22,000 ML and 27,000 ML. It is noted that source flow data gaps, especially with respect to flows into/out of Goose Lake, limit the accuracy of the above analysis. In some years prior to 2010, draining of Goose Lake to Swan Lake may artificially increase the reported total flows.

Peak hour flows are not available from the data provided (daily volumes provided only).

Table 2-1: Typical Overall System Demands (MLD)

	Average	Base (Winter)	Seasonal	Max. Day (1)
2009 and 2010				
Kalamalka Lake	22.5	16	24	40
Duteau Creek / Goose Lake	42.4	4.7	153	158
Deer Creek (King Edward)	1.4	0.0	13	13
Other (Wells)	0.4	0.0	5.8	5.8
East Kalamalka Lake Coldstream Creek Rd. (2)	0.6	0.2	1.4	1.6
Total	**67**	**21**	**190**	**211**
2011				
Kalamalka Lake	21.4	15	30	45
Duteau Creek / Goose Lake	40.2	3.4	142	146
Deer Creek (King Edward)	0.1	0.0	0.0	0.0
Other (Wells)	0.2	0.0	5.1	5.1
East Kalamalka Lake Coldstream Creek Rd. (2)	0.4	0.0	0.0	0.0
Total	**62**	**21**	**171**	**192**

Notes:
(1) Max. day demands are not corrected for tank volume variations. Peak hour observed data was not available.
(2) The east Kalamalka Lake (Coldstream Creek Rd.) intake is no longer in use. Sporadic use only in 2011 with zero flow in winter and on max. day.

2.2 Domestic Component

The estimated existing domestic demands include residential and ICI indoor and outdoor water use but exclude agricultural irrigation and unaccounted for water associated with irrigation.

The GVW system demands subject to significant variability due to:

- extreme changes in water use between winter and summer, and
- variable summer weather conditions year-to-year (hot/dry vs. cool/wet summers).

To better analyze these conditions, average day demand (ADD), base (winter) demand (BD), and maximum day demand (MDD) are each assessed. Seasonal demand (SD) is taken as the difference in demand between MDD and BD.

Existing demands from the 2008 water model update are shown in Table 2-2. These demands reference observed 2007 water use. Water use rates were developed from this data based on data current at that time (including 2006 census data for population). The water use rates were based on flow data from the Mission Hill Water Treatment Plant source which services nearly all domestic uses (very few agricultural irrigation connections). These rates were then used to estimate overall domestic usage. Note, demands were constructed using 2007 observed demands and adjusted for population growth from 2007 to 2011, accounting for slight differences in observed values.

Table 2-2: Existing Domestic Demands (MLD)[1]

	ADD	BD	SD	MDD
RDNO 'B'	1.7	1.2	3.1	4.3
RDNO 'C'	1.5	1.0	2.8	3.8
Coldstream	5.1	3.4	9.6	13
City of Vernon	17.0	13	22	36
Spallumcheen	0.10	0.08	0.09	0.17
Total (2007)	**25.4**	**18.9**	**38.1**	**57.0**
Estimate for 2011 - adjusted for pop. growth only	26.5	19.7	39.7	59.4

Table 2-3: Derivation of Domestic Demands

Demand Component	Service Area	Daily Amount	Days	Yearly Amount
Minimum Winter Base Demand	MHWTP Only	14.2 MLD	365	5,190 ML
		Service Pop'n 36,447 ca; 48,604 PE (1)		
	Unit Rate	292 L/PE/day		
	Entire Service Area	Service Pop'n: 53,421 ca, 66,541 PE		
		19.4 MLD	365	**7,180 ML**
Seasonal Demand (on MDD)	MHWTP Only	24.9 MLD	62 (2)	1,550 ML
		Irrigable Residential Lot Area = 937 ha ; 30,392 employees / 12157 ICI PE		
	Unit Rate	20,600 L/ha/day	463 L/PE(ICI)/day	
	Entire Service Area	Irrigable Lot Area = 1559 ha 32,801 employees or 13120 ICI PE		
		38.3 MLD	62	**2,370 ML**
Maxim Demand Day / Total Yearly Demand	Entire Service Area	**58.0 MLD**		**9,550 ML**
	Entire Service Area (adjusted for 2011 Census Pop. Observed)	**59.4 MLD**		**9,670 ML**

(1) PE = population equivalents including ICI, 2.5 employees equivalent to 1 PE.
(2) Effective irrigation days.

[1] *Derived from 2007/2008 Water Model Update Report.*

The 2011 estimated average domestic demand of 26.5 MLD or 9,670 ML/year amounts to 35-40% of the overall water consumed each year (22,000 to 27,000 ML); the remainder being agricultural irrigation and un-accounted for water loss. On the maximum demand day, the domestic component accounts for approximately 30% of total system demand.

2011 census data shows that there has been an annualized regional growth rate of 1.05% since 2006[2]. This produces an estimated 2011 water consumption of 19.7 MLD domestic base (winter) demand and 59 MLD domestic maximum day demand. The base (winter) demand estimate fits the 2011 observed data (19.4 MLD estimated versus 21 MLD observed). It is difficult to assess the accuracy of the maximum day demand (MDD) domestic estimate due to the inability to isolate the agricultural demand component and variability in MDD year-to-year.

The relative distribution of existing domestic demands throughout the service is shown on Figure 2-3.

2.3 Agricultural Component

The agricultural irrigation component was calculated as the difference between source flows and the domestic demand. Using this method (as shown in Table 2-4), the total estimated agricultural consumption for 2011 was 12,600 ML.

Table 2-4: 2011 Consumption Breakdown from Source Flows

	Yearly Volumes (ML)			Flow Rates			
	Base	**Seasonal**	**Total**	**Average**	**Base**	**Seasonal**	**Max. Day**
Total (All Uses)	7,305	14,965	22,270	**62**	**21**	**171**	**192**
Domestic (Residential and ICI)	7,205	2,460	9,670	26.5	19.7	39.7	59.4
Agricultural Estimate	100	12,505	12,600	35.5	1.3	131.3	132.6
Agricultural Metered Consumption			8,403				
Notes: (1) Leakage / unaccounted for water is included in above (source flows).							

RDNO provided meter data for agricultural customers for 2011. Figure 2-4 shows graphically the portion of property allocation that was actually used in 2011 based on the meter data provided. Note that the properties with allocation that show as being un-metered may:

- Be metered from a neighbouring lot,
- Have no agricultural irrigation usage (not on the agricultural water rate), or
- Require metering.

There are also a number of lots that are in the agricultural meter reading database but have no allocation, these typically are billed at a domestic rate. The total metered usage was 8,403 ML or 67% of the total 2011 agricultural consumption estimate.

The variance between the metered consumption and the source flow based estimate can be attributed to:

- Missing unmetered connections (see Figure 2-4 for potential locations).
- Meter under-reading,
- Meter reading errors,
- Leakage,

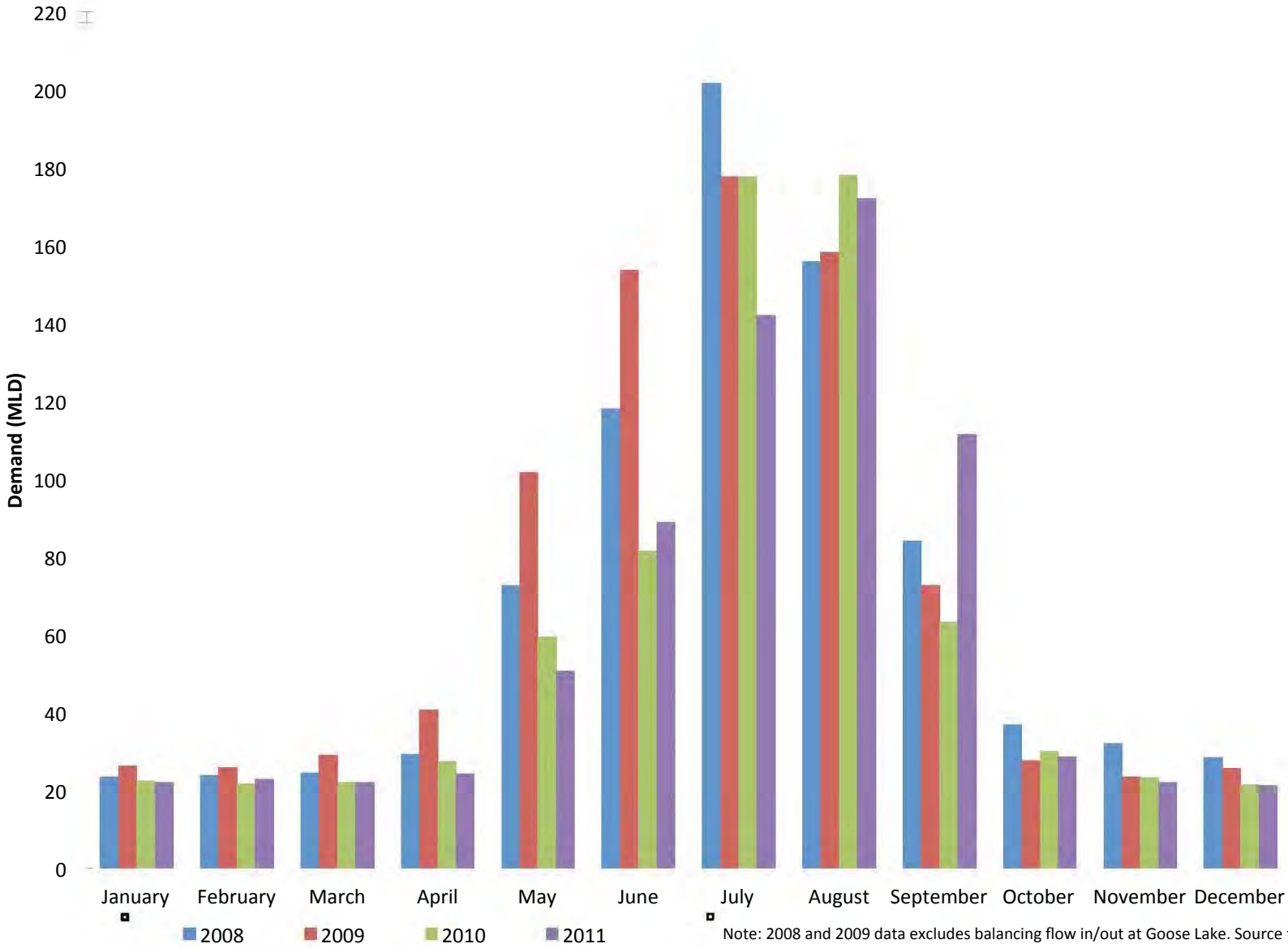
[2] *2011 Statistics Canada Census Data for City of Vernon, Coldstream, North Okanagan B, and North Okanagan C*

- Flushing, and
- Errors in the source flow record / source flow meter error.

Using the meter data distribution of demands and the source flow records together the distribution of agricultural demands is shown on Figure 2-5.

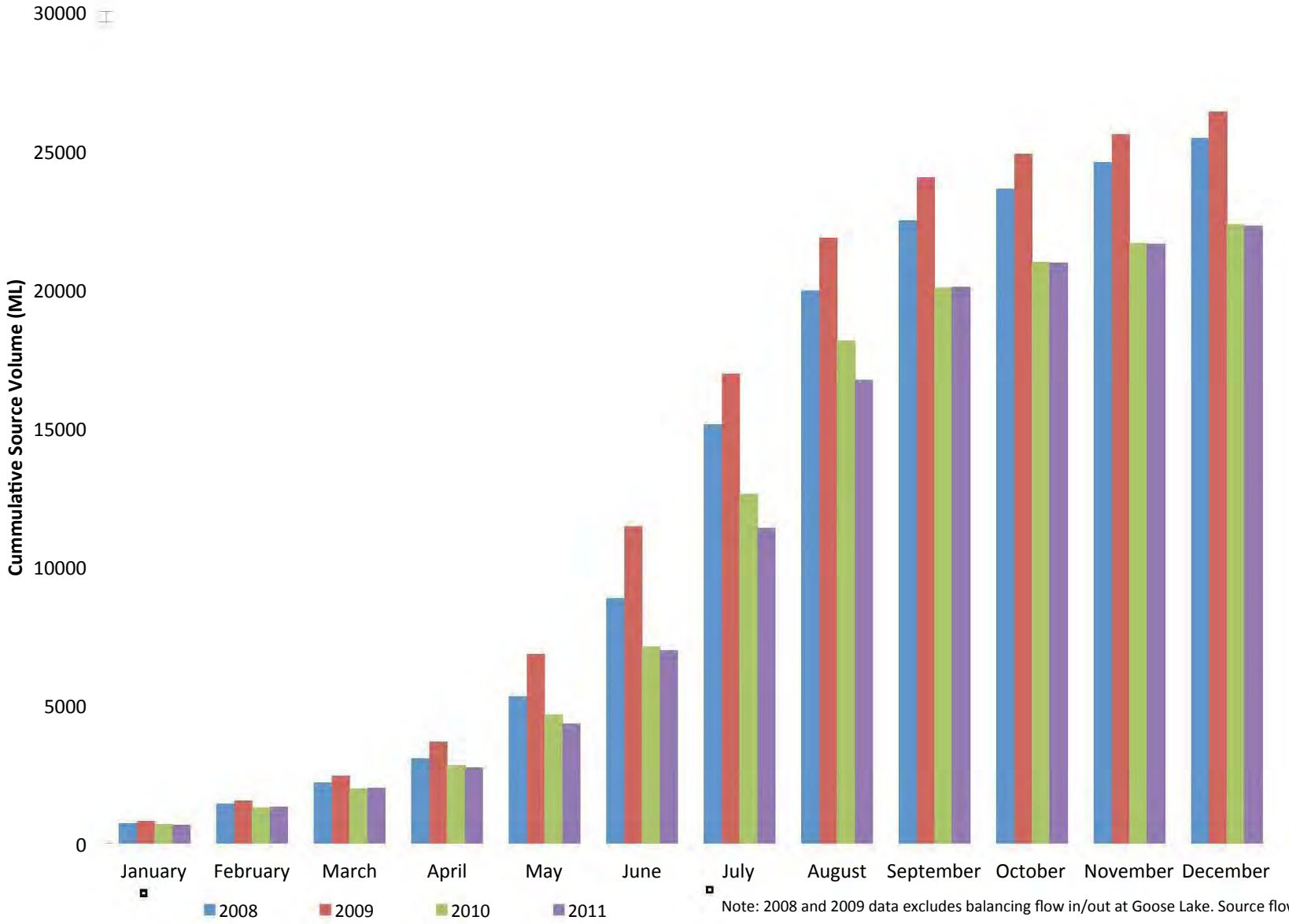
The observed 2011 agricultural demand of 12,600 ML compares to a total allocation of 18,986 ML (an irrigation rate of 5.5 ML/ha or 550 mm application over the entire 3,452 ha of allocation). However, if only those lots with an agricultural water rate are considered (2,564 ha of allocation), the comparison becomes much closer 12,600 ML consumed vs. an active allocation of 14,102 ML. It is noted that 2011 was not a high demand year (relatively wet) and consumption would have been below historic maximum values.

Figure 2-1: Monthly Water Demand (2008 - 2011)

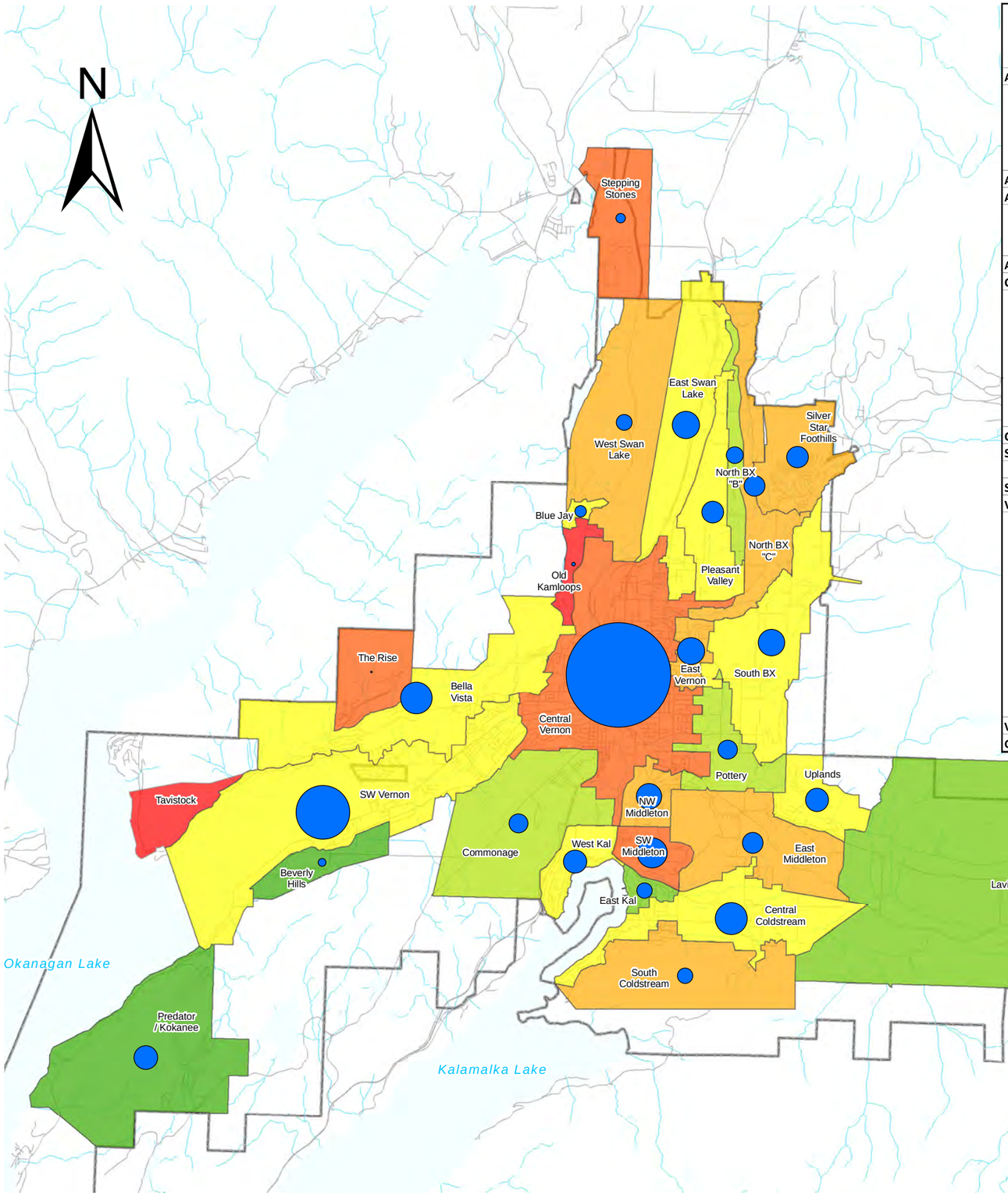


0000-0999:0800-0899:811-015:410-Demand Loading:20120619_HistoricalDemandCompiled.xls

Figure 2-2: Cumulative Volumes Supplied (2008 - 2011)



0000-0999:0800-0899:811-015:410-Demand Loading:20120619_HistoricalDemandCompiled.xls



	Total Area (ha)	Population (ca)	Population Equivalents (PE)	Base Demand (MLD)	Max. Day Demand (MLD)	Annual Consumption (ML/y)
Area B						
East Swan Lake	636	1,349	1,724	0.52	1.89	275
North BX "B"	143	608	617	0.19	0.83	109
Old Kamloops	83	32	42	0.01	0.02	4.6
Pleasant Valley	345	1,075	1,075	0.33	1.24	176
West Swan Lake	825	643	670	0.20	0.53	93
Area B Total	**2,032**	**3,707**	**4,128**	**1.25**	**4.50**	**657**
Area C						
North BX "C"	389	1,061	1,085	0.32	1.03	162
Pottery	276	787	807	0.25	1.08	142
South BX	675	1,574	1,575	0.48	1.87	261
Area C Total	**1,340**	**3,422**	**3,467**	**1.05**	**3.98**	**566**
Coldstream						
Central Coldstream	571	2,168	2,279	0.69	2.55	367
East Kal	63	447	474	0.15	0.73	90
East Middleton	603	1,070	1,097	0.33	1.06	165
Lavington	5,313	1,920	2,200	0.71	4.13	471
South Coldstream	659	630	633	0.19	0.50	88
SW Middleton	154	2,508	2,583	0.75	1.89	346
Uplands	222	1,249	1,250	0.38	1.33	196
West Kal	167	1,271	1,314	0.39	1.33	202
Coldstream Total	**7,752**	**11,262**	**11,830**	**3.59**	**13.53**	**1,926**
Spallumcheen						
Stepping Stones	400	301	301	0.09	0.18	38
Spallumcheen Total	**400**	**301**	**301**	**0.09**	**0.18**	**38**
Vernon						
Bella Vista	898	2,423	2,456	0.74	2.49	378
Beverly Hills	179	61	66	0.03	0.28	25
Blue Jay	30	305	311	0.09	0.35	50
Central Vernon	1,360	19,979	30,823	8.92	19.82	3,941
Commonage	795	449	797	0.25	1.05	140
East Vernon	105	1,925	1,947	0.57	1.50	267
NW Middleton	134	1,578	1,764	0.52	1.46	248
Predator / Kokanee	1,081	754	835	0.28	1.96	206
Silver Star Foothills	358	1,126	1,136	0.34	1.09	171
SW Vernon	1,435	6,127	6,663	2.01	7.21	1,056
Tavistock	204	-	-	-	-	-
The Rise	294	-	18	0.00	0.01	2.3
Vernon Total	**6,874**	**34,729**	**46,816**	**13.76**	**37.23**	**6,484**
Grand Total	**18,398**	**53,421**	**66,541**	**19.74**	**59.42**	**9,671**

Greater Vernon Water
2012 Master Water Plan

Legend

Estimated Non-Agricultural MDD Water Use Rates (L/day/PE)

- 0 - 500
- 501 - 750
- 751 - 1000
- 1001 - 1250
- 1251 - 1500
- 1501 - 2000
- 2001 - 4250

Estimated Non-Agricultural Max. Demand

Data Source: RDNO Water Model, areas with larger lot sizes/ca are attributed higher usage.

Associated Engineering
AECOM
SUITE 201, 3275 LAKESHORE ROAD
KELOWNA, B.C. V1W 3S9
T 250-762-3727 F 250-762-7789
WWW.AECOM.COM
KERR WOOD LEIDAL consulting engineers

2,000 0 2,000 (m)

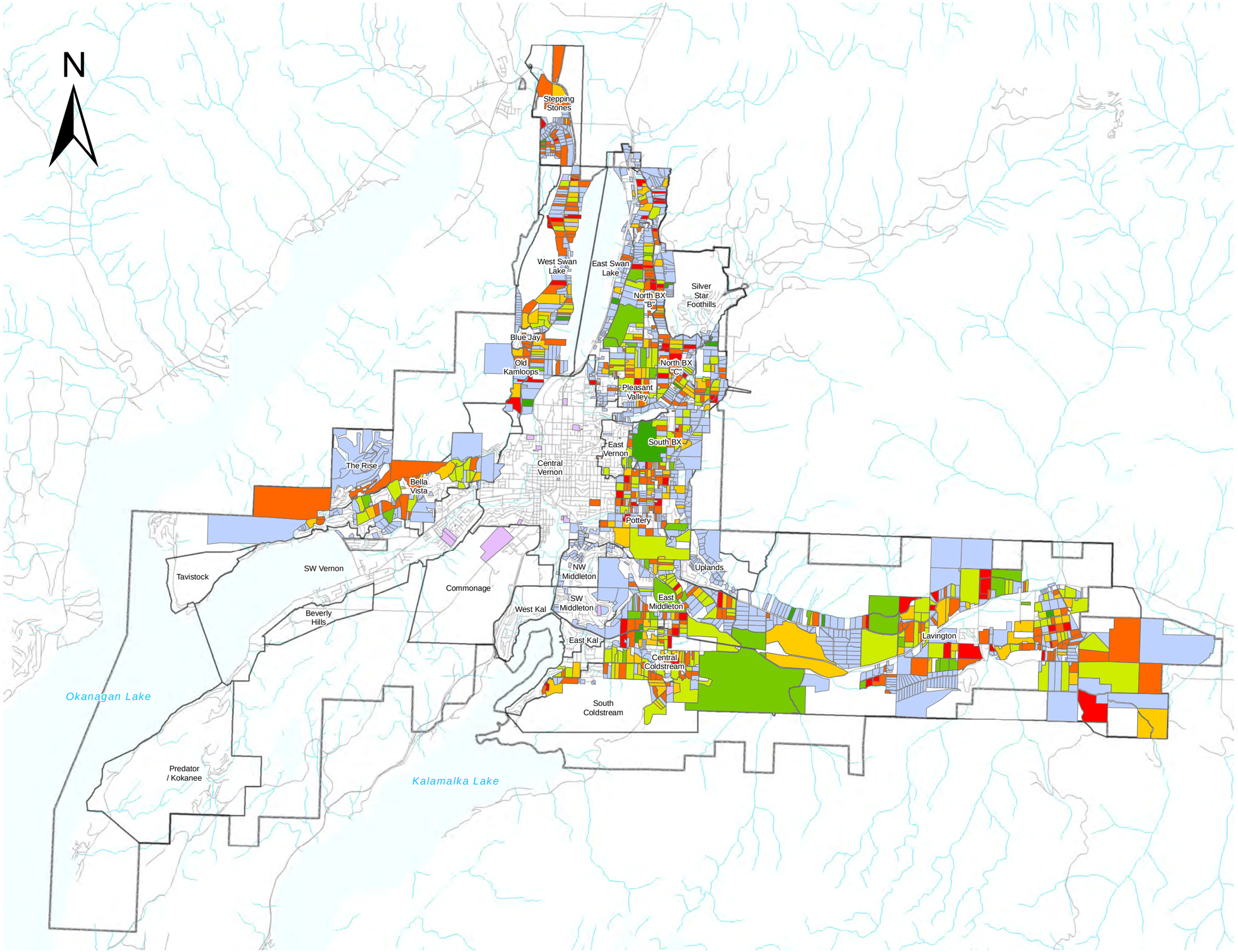
1:100,000

Project No.	Date
811-015	January 2013

Domestic Water Demands (Excluding Agricultural Uses)

Figure 2-3

Path: O:\0800-0899\811-015\430-GIS\TechMemo_01\MXD-Rpt\811015_TM01_Fig2-3.mxd Date Saved: 22/01/2013 1:39:55 PM
Author: JLau



Greater Vernon Water
2012 Master Water Plan

Legend

Percent of Allocation Consumed
(as per 2011 meter readings)

- 0%
- 1% - 25%
- 26% - 50%
- 51% - 100%
- 101% - 150%
- >150%
- Properties with metered agricultural connect with no allocation (Typically on Domestic Rate)
- Properties with allocation but not metered (May be Metered off Neighbouring Lot)

Data Source: 2011 Agricultural Meter Readings and Allocations supplied by RDNO.

Associated Engineering

AECOM
SUITE 201, 3275 LAKESHORE ROAD
KELOWNA, B.C. V1W 3S9
T 250-762-3727 F 250-762-7789
WWW.AECOM.COM

KERR WOOD LEIDAL
consulting engineers

2,000 0 2,000 (m)

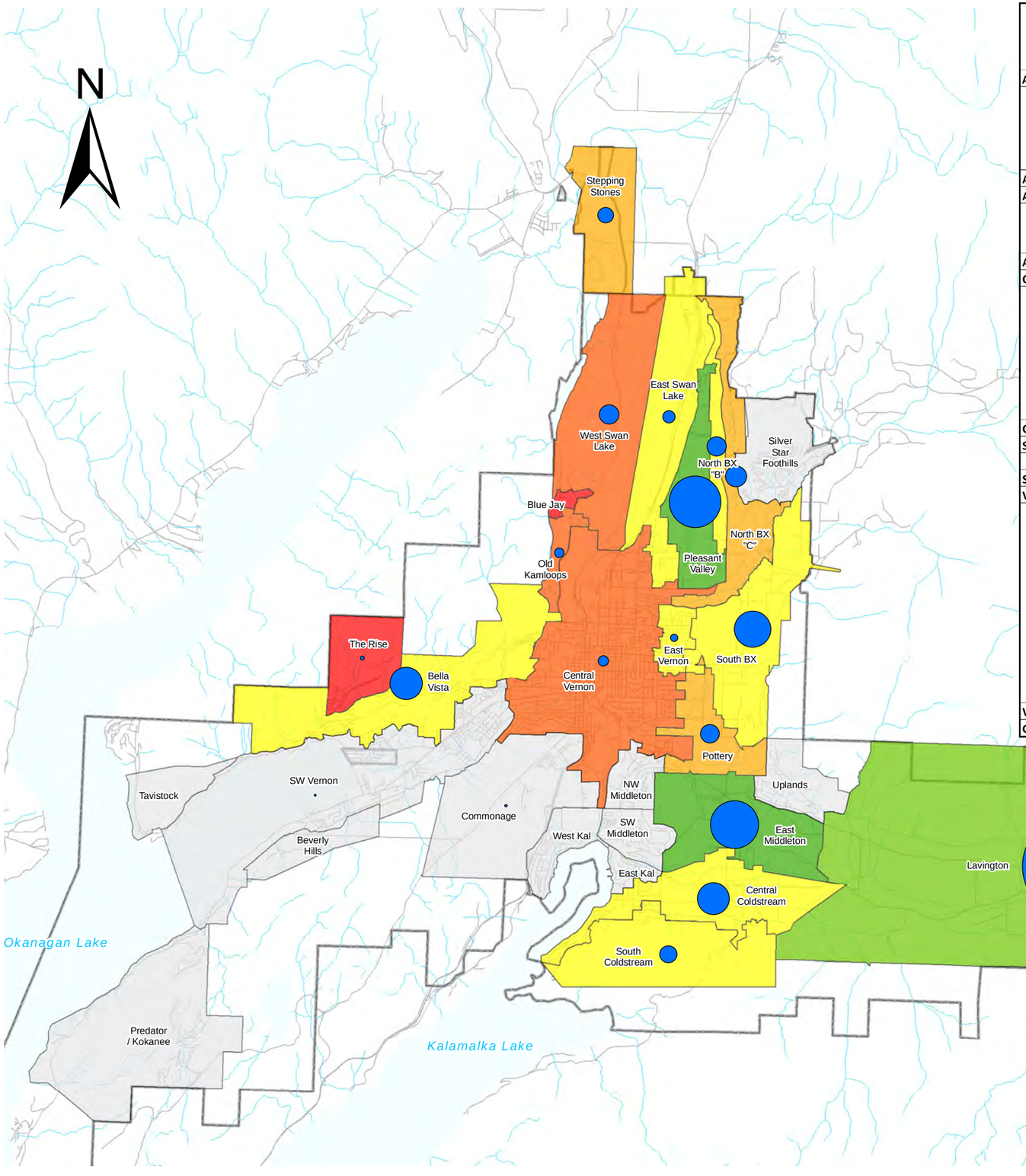
1:100,000

Project No.	Date
811-015	February 2013

Metered Agricultural Consumption

Figure 2-4

Path: O:\0800-0899\811-015\430-GIS\TechMemo_01\MXD-Rpt\811015_TM01_Fig2-4.mxd Date Saved: 25/02/2013 10:41:44 AM
Author: JLau



	Total Area (ha)	Allocated Lot Area (ha)	Allocated Area (ha)	Allocation (ML/y)	Metered Allocation (ML/y)	2011 Consumption (ML/y)
Area B						
East Swan Lake	636	144	83	440	154	65
North BX "B"	143	97	82	433	322	150
Old Kamloops	83	134	50	264	194	34
Pleasant Valley	345	287	255	1,350	1,244	1,024
West Swan Lake	825	345	167	884	507	149
Area B Total	**2,032**	**1,007**	**636**	**3,370**	**2,420**	**1,423**
Area C						
North BX "C"	389	303	159	845	487	171
Pottery	276	206	91	480	391	138
South BX	675	529	253	1,341	981	506
Area C Total	**1,340**	**1,038**	**503**	**2,666**	**1,859**	**814**
Coldstream						
Central Coldstream	571	278	262	1,387	883	387
East Kal	63					
East Middleton	603	474	282	1,497	1,207	893
Lavington	5,313	2,779	1,100	5,831	6,163	4,190
South Coldstream	659	107	57	304	261	121
SW Middleton	154	28	9.2	49		
Uplands	222	79	26	135		
West Kal	167	0.95	0.10	0.53		
Coldstream Total	**7,752**	**3,747**	**1,737**	**9,205**	**8,515**	**5,591**
Spallumcheen						
Stepping Stones	400	158	86	458	234	93
Spallumcheen Total	**400**	**158**	**86**	**458**	**234**	**93**
Vernon						
Bella Vista	898	712	191	1,015	967	403
Beverly Hills	179					
Blue Jay	30	10	5.1	27	8.6	0.00
Central Vernon	1,360	138	66	352	172	45
Commonage	795					3.0
East Vernon	105	11	5.7	30	42	20
NW Middleton	134	27	13	68		
Predator / Kokanee	1,081					
Silver Star Foothills	358					
SW Vernon	1,435	22	5.6	30		2.0
Tavistock	204					
The Rise	294	180	9.2	48	71	8.6
Vernon Total	**6,873**	**1,099**	**296**	**1,569**	**1,260**	**483**
Grand Total	**18,397**	**7,049**	**3,258**	**17,268**	**14,289**	**8,403**

Greater Vernon Water
2012 Master Water Plan

Legend

2011 Percent of Irrigation Allocation Actually Consumed (as Metered)

- 0% - 15%
- 16% - 30%
- 31% - 40%
- 41% - 50%
- 51% - 60%
- 61% - 70%
- 71% - 80%

2011 Annual Argicultural Metered Demand (Relative portion of total agricultural demand)

Data Source: 2011 Agricultural Meter Readings and Allocations supplied by RDNO.

Associated Engineering

AECOM
SUITE 201, 3275 LAKESHORE ROAD
KELOWNA, B.C. V1W 3S9
T 250-762-3727 F 250-762-7789
WWW.AECOM.COM

KERR WOOD LEIDAL
consulting engineers

2,000 0 2,000 (m)

1:100,000

Project No. 811-015

Date January 2013

Agricultural Allocation and Consumption

Figure 2-5

Path: O:\0800-0899\811-015\430-GIS\TechMemo_01\MXD-Rpt\811015_TM01_Fig2-5.mxd Date Saved: 22/01/2013 1:36:41 PM
Author: JLau

3. Establishment of Planning Horizon

The RDNO 2012 Master Water Plan update is based on a 40-year planning horizon (RDNO, 2011), for the period of 2011 to 2052. This builds on the extensive earlier planning work completed ten years ago in the North Okanagan Water Authority Master Water Plan of 2002 (NOWA, 2002) and subsequent MWP Addendum of 2004 (GVW, 2004), which covered the period of 2001 to 2041.

For the purposes of this memorandum, population and water use forecasts are developed on the following time increments:

- 2011 (current);
- 2016 (5 years);
- 2021 (10 years);
- 2026 (15 years);
- 2031 (20 years); and
- 2052 (40 years).

These increments are based on the population forecasts available in the jurisdiction's planning documents, which provide growth projections to 2031. Later stages of the 2012 Master Water Plan Update will link capacity and facility construction to the water demand forecasts.

4. Community Development and Land Use

Forecasts of population, growth areas and irrigation demand have been developed through review of current Official Community Plans (CoV, 2008) (DoC, 2005) and the Regional Growth Strategy (RDNO, 2011). The local government planning staff have provided further advice on information subsequent to those community plans.

Relevant information from these plans incorporated in the water demand forecasts are as follows.

<u>Regional Growth Strategy</u>

- Identifies 'Growth Areas', 'Future Growth Areas' and 'Rural Protection Areas';
- Growth Areas are to be fully serviced with water;
- Infrastructure shall be developed in a way that makes efficient use of existing and future public infrastructure investment;
- Development is designed to avoid or minimize impact on agricultural lands;
- Local and regional government will respect the Rural Protection Areas;
- (Development and policy) shall consider the full cost of servicing including water and sewer infrastructure;
- Undertake a phased approach to Growth Areas, including phased infrastructure expansion;
- Future Growth Areas are identified in the municipal OCPs, and are contingent on provision of water (etc.) including the identification of water sources;
- The expansion of (domestic) water service into Rural Protection Areas is discouraged;
- Water is to be managed in a sustainable way:
  - Water metering, and efficient use of water allocation are encouraged;
  - Explore opportunities to expand the use of reclaimed water for agriculture;
  - Explore the feasibility of a North Okanagan Agricultural Water Reserve;
- Support a robust agricultural economic sector:
  - Create an inventory of agri-industrial operations, infrastructure and lands;
- Protection of groundwater:
  - Develop policies to evaluate proposed use of groundwater considering long-term supply, impact on existing users and adherence to the precautionary principle;
  - Develop a regional groundwater monitoring program to better understand hydrogeologic conditions;
- Protect and conserve water resources:
  - Enact water conservation measures;

  - Fully consider the implications of future intra- and inter-basin water transfers;
  - Develop an integrated North Okanagan Supply and Demand Water Model;
  - Encourage review of regulations to enable expanded reclaimed water use in residential developments;
- Consider the true cost of water:
  - Develop and implement a consistent full cost accounting framework; and
- Provides population growth projections for 2006 – 2031.

City of Vernon and District of Coldstream

- Various local policies supporting water conservation and expanded use of reclaimed water;
- Identification of growth areas, focused on the 'city centre' areas, and phased neighbourhood planning areas;
- Identification of ALR boundaries and Reclaimed Water Application Areas; and
- Population projections.

5. Methodology for Projecting Domestic Demands

The approach for developing demands was discussed with planning staff from Vernon, Coldstream, and RDNO on January 26, 2012, and confirmed in a meeting with RDNO on February 2, 2012. Key methodology includes:

- Existing water demand loadings were kept constant, projected and growth was added to existing;
- RDNO's 'Nodal A' forecast of dwelling units and employment growth to yr-2031 were used to develop distribution of the growth component (as per GIS shapefiles provided by RDNO);
- Overall population growth was as per the Regional Growth Strategy to yr-2031 (identifies average persons per dwelling unit (ca/DU) for growth component);
- Single-family development was assigned a higher dwelling unit occupancy (ca/DU) than multi-family;
- Existing unit rates (L/ca/day, L/emp/day , and L/ha/day) were used to set water demand growth;
- Seasonal demands for residential and ICI take into consideration differences between infill and expansion (i.e., lower seasonal demands for higher-density development);
- Available land allows for more growth than is anticipated in the Regional Growth Strategy;
- No forecast exists for growth from yr-2031 onward (to yr-2052). Beyond 2081 growth is based on:
  - Declining growth rate (growth between yr-2031 and yr-2052 slightly lower than projected between 2011 and 2031 (0.75%/annum system-wide average); and
  - Growth between yr-2031 and yr-2052 was established and distributed evenly geographically and by demand types (pro-rated based on yr-2031 demands).
- Future growth shown in the Regional Growth Strategy for the south-east sector of Spallumcheen was not considered. Present policy requires that this area would develop its own water source separate from the RDNO combined system.

6. Domestic Unit Rates

Based on GVW operational records and conservation planning approach, the following unit rates were used to develop the water demand forecast.

Table 6-1: Domestic Unit Rates

Description	Value	Unit	Source
Base residential water use (winter)	250	L/ca/day	Existing average value is 271 L/ca/day from 2009 Model Update. 250 L/ca/day accounts for move to fully metered residential demand, and water conservation efforts.
Dwelling Unit Density			
Single-Family	2.62	ca/DU	Values based on increase in dwelling units and population forecasted in Regional Growth Strategy
Multi-Family	2.12	ca/DU	
Base ICI water use	100	L/emp/day	Existing observed value derived from 2009 Model Update report.
Leakage	8.3	MLD	Existing estimate (KWL, 2009) distributed as 3 % of current MDD (no variation - winter to summer)
Seasonal water demand rate			
Residential	17,300	L/ha/day	Observed values from metered residences (2007).
Residential Density			
(average lot area/DU)			
Single-family detached	600	sq.m./DU	Observed value from recent developments.
Single-family attached	300	sq.m./DU	Assumed
Multi-family medium density	150	sq.m./DU	Assumed
Multi-family high density	100	sq.m./DU	Assumed
Seasonal ICI water use	185	L/emp/day	from existing average (2009 model report)

7. Anticipated Domestic Growth

7.1 Population and Service Area Growth

Projected population ICI, and service area growth are summarized in Table 7-1.

Table 7-1: Residential / ICI Growth Forecast

Year	Population				Residential Service Area (ha)
	Residential (ca)	ICI (employees)	ICI (PE)[1]	Total (PE)	
2011	53,421	32,801	13,120	66,541	1,559
2016	55,242	34,059	13,624	68,866	1,633
2021	62,514	35,057	14,023	76,537	1,716
2026	64,512	36,035	14,414	78,926	1,797
2031	68,862	36,982	14,793	83,655	1,840
2041	74,204	39,851	15,940	90,145	1,982
2052	80,479	43,265	17,306	97,785	2,152

1. ICI (Industrial, Commercial and Institutional).
2. PE = Population Equivalents.

7.2 Year-2052 Domestic Demand Forecast

Table 7-2 and Figure 7-1 summarize the forecast to 2052 by jurisdiction.

Table 7-2: Domestic Demand Forecast (2052)

	Base Demand (MLD)	Seasonal Demand (MLD)	Max. Day Demand (MLD)	MDD incl. Leakage Allowance
RDNO 'B'	1.4	3.7	5.2	5.2
RDNO 'C'	1.2	3.3	4.4	4.4
Coldstream	4.3	11	16	16
City of Vernon	20.5	32	53	53
Spallumcheen	0.08	0.09	0.17	0.17
Total	27	50	78	79

7.3 Domestic Maximum Day Demand Forecast

Tables 7-3 and 7-4 summarize the maximum day demand forecast by jurisdiction and area. Figure 1-1 defines the different areas / jurisdictions for domestic system planning.

It is noted that the demand forecast represents a best estimate of future demands (without contingency), not a design value. A suitable demand contingency may be warranted for facility design purposes. The rate of increase in water demand is expected to be lower than the population growth rate due primarily to densification (and less additional irrigation per capita).

Table 7-3: Domestic Demand Forecast – MDD (MLD)

	Yr-2011	Yr-2016	Yr-2021	Yr-2026	Yr-2031	Yr-2052
RDNO 'B'	4.5	4.4	4.4	4.5	4.5	5.2
RDNO 'C'	4.0	3.8	3.9	3.9	3.9	4.4
Coldstream	14	13	13	14	14	16
City of Vernon	37	39	41	44	46	53
Spallumcheen	0.18	0.17	0.17	0.17	0.17	0.17
Total	59	60	63	66	68	79

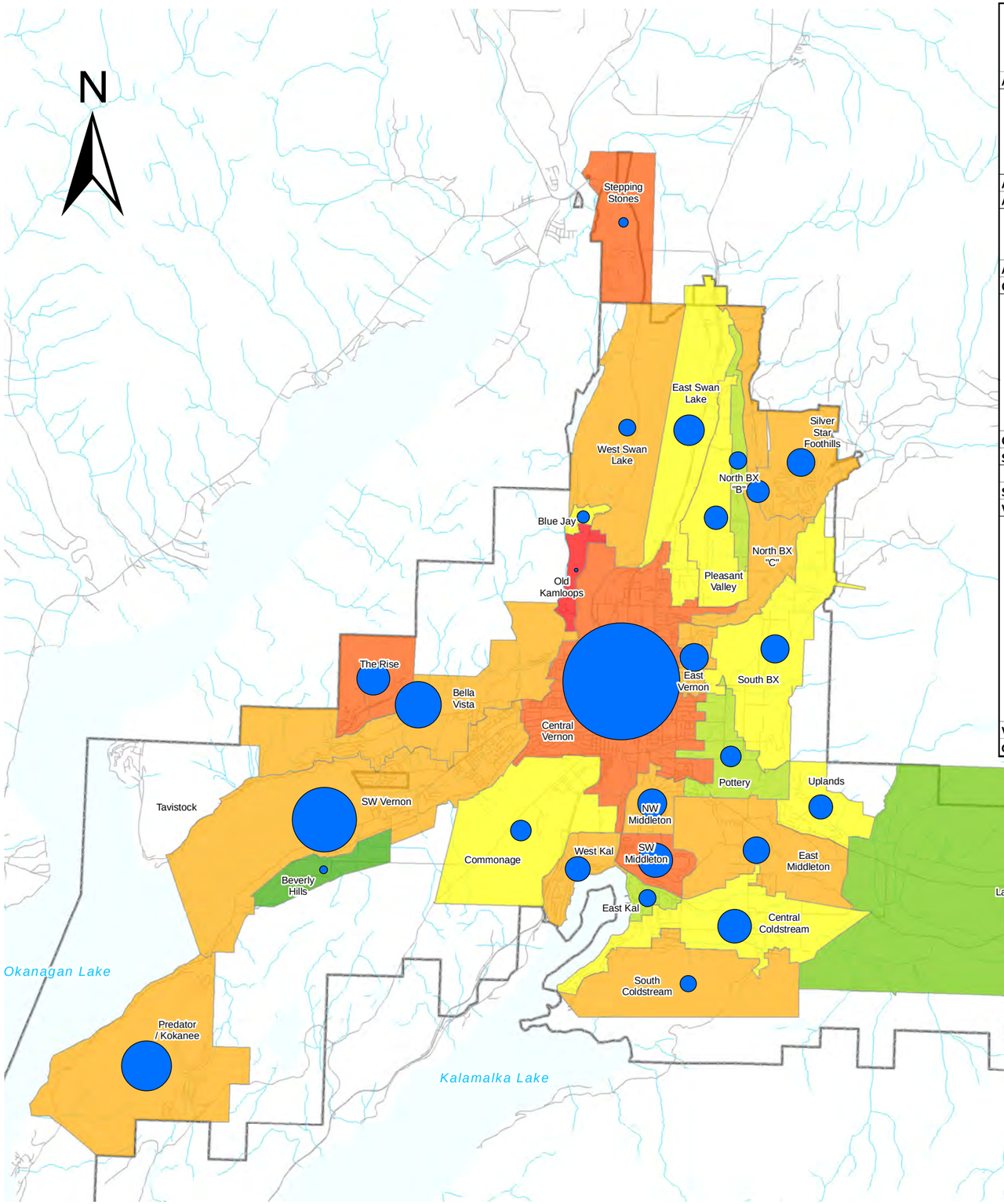
The domestic demand forecasts are significantly lower than the 2002 MWP (NOWA, 2002) estimate of demands. For yr-2031 the estimate in 2004 MWP (Working Paper 5) was 89 MLD compared to current estimate of 68 MLD. This can be attributed to:

- Differences in population estimates (current estimate for yr-2031 is 68,862 ca vs. old estimate of 93,250 ca). It is noted that the current population of the RDNO area is 53,421 vs. old estimate of 54,800 for 2011. The assumed rate of growth in the old plan averaged 2.7%/annum whereas the current forecast is 1.3%/annum.
- Differences in assignment method (seasonal demands assigned based on increases in lot area vs. old method of application of a peaking factor of 2.0 on average demand)
- Change in base demand unit rate. The current forecast uses a base demand rate of 250 L/ca/day rather than an average demand rate in assigning demands. However for comparison an averaged-out seasonal usage can be calculated as 380 L/ca/day (in the yr-2031 forecast). This compares to a previous estimate of 415 L/ca/day.
- The 2002 MWP forecasted a domestic demand incl. unaccounted for water of 10,586 ML/yr in 2011 for domestic usage. This compares to the current estimate of 9,672 ML/yr (see Section 2.2).

Table 7-4: Forecast Domestic Maximum Day Demands by Sub-Area and Year (MLD)

		Yr-2016	Yr-2021	Yr-2026	Yr-2031	Yr-2052
Area B	East Swan Lake	1.8	1.9	1.9	2.0	2.3
	North BX "B"	0.80	0.80	0.80	0.80	0.92
	Old Kamloops	0.02	0.02	0.02	0.02	0.02
	Pleasant Valley	1.2	1.2	1.2	1.2	1.4
	West Swan Lake	0.51	0.51	0.51	0.51	0.59
	Total	4.4	4.4	4.5	4.5	5.2
Area C	North BX "C"	1.0	1.0	1.0	1.0	1.2
	South BX	1.8	1.8	1.8	1.8	2.1
	Pottery	1.0	1.1	1.1	1.1	1.2
	Total	3.8	3.9	3.9	3.9	4.4
Coldstream	Central Coldstream	2.5	2.5	2.5	2.5	2.9
	East Kal	0.71	0.72	0.72	0.72	0.82
	Lavington	4.0	4.0	4.1	4.1	4.5
	South Coldstream	0.48	0.48	0.48	0.48	0.55
	West Kal	1.3	1.3	1.3	1.3	1.5
	SW Middleton	1.9	2.0	2.0	2.0	2.4
	East Middleton	1.1	1.2	1.2	1.3	1.5
	Uplands	1.3	1.3	1.3	1.3	1.5
	Total	13	13	14	14	16
Vernon	Bella Vista	3.0	3.4	3.8	4.0	4.6
	Beverly Hills	0.27	0.27	0.27	0.27	0.30
	Blue Jay	0.34	0.34	0.34	0.34	0.39
	Central Vernon	19	20	20	21	25
	East Vernon	1.4	1.4	1.4	1.4	1.7
	SW Vernon	7.3	7.6	8.0	8.1	9.2
	Tavistock [3]	0.00	0.00	0.00	0.00	0.00
	Kokanee / Predator	2.7	3.4	4.5	4.9	5.5
	The Rise	0.53	1.2	1.5	1.7	2.0
	Silver Star Foothills	1.1	1.2	1.4	1.5	1.7
	Commonage	1.0	1.0	1.0	1.1	1.2
	NW Middleton	1.5	1.5	1.6	1.6	1.8
	Total	39	41	44	46	53
Spallumcheen	Stepping Stones	0.17	0.17	0.17	0.17	0.17
Total	**All**	60	63	66	68	79

[3] *Current water demand forecast provided by RDNO was based on a population growth model that did not include assignment of any growth in the Tavistock subdivision. It is noted that 21 L/s or 1.8 MLD is the design demand for Phases 1 through 3 of the subdivision.*



	Total Area (ha)	Population (ca)	Population Equivalents (PE)	Base Demand (MLD)	Max. Day Demand (MLD)	Annual Consumption (ML/y)
Area B						
East Swan Lake	636	1,710	2,174	0.64	2.27	336
North BX "B"	143	675	686	0.21	0.92	121
Old Kamloops	83.2	41.8	53.8	0.01	0.02	5.8
Pleasant Valley	345	1,196	1,196	0.36	1.37	195
West Swan Lake	825	720	752	0.22	0.59	103
Area B Total	**2,032**	**4,343**	**4,861**	**1.45**	**5.17**	**760**
Area C						
North BX "C"	389	1,202	1,231	0.36	1.16	182
Pottery	276	908	931	0.28	1.22	162
South BX	675	1,748	1,749	0.53	2.07	289
Area C Total	**1,340**	**3,858**	**3,911**	**1.18**	**4.44**	**632**
Coldstream						
Central Coldstream	571	2,448	2,598	0.78	2.85	413
East Kal	62.9	530	562	0.17	0.82	104
East Middleton	603	1,758	1,861	0.53	1.54	257
Lavington	5,313	2,295	2,659	0.84	4.54	537
South Coldstream	659	699	703	0.20	0.55	96.3
SW Middleton	154	3,215	3,310	0.95	2.36	434
Uplands	222	1,408	1,410	0.42	1.48	219
West Kal	167	1,491	1,542	0.46	1.52	232
Coldstream Total	**7,752**	**13,845**	**14,644**	**4.35**	**15.67**	**2292**
Spallumcheen						
Stepping Stones	400	286	286	0.08	0.17	36
Spallumcheen Total	**400**	**286**	**286**	**0.08**	**0.17**	**36**
Vernon						
Bella Vista	898	5,824	5,924	1.66	4.60	790
Beverly Hills	179	67.9	73.3	0.03	0.30	27.2
Blue Jay	30.0	348	355	0.11	0.39	56.4
Central Vernon	1,360	25,929	39,440	11.20	24.71	4929
Commonage	795	573	980	0.30	1.17	162
East Vernon	105	2,150	2,176	0.63	1.66	295
NW Middleton	134	1,998	2,258	0.65	1.79	309
Predator / Kokanee	1,081	6,195	6,675	1.85	5.55	904
Silver Star Foothills	358	2,024	2,087	0.59	1.68	284
SW Vernon	1,435	10,018	10,695	3.08	9.23	1506
Tavistock	204	-	-	0.00	0.00	0.00
The Rise	294	2,820	3,220	0.86	1.97	383
Vernon Total	**6,874**	**57,946**	**73,883**	**20.96**	**53.05**	**9646**
Grand Total	**18,398**	**80,279**	**97,585**	**28.0**	**78.5**	**13,366**

Greater Vernon Water
2012 Master Water Plan

Legend

Non-Agricultural MDD Water Use Rates (L/day/PE)

- 379 - 500
- 501 - 750
- 751 - 1000
- 1001 - 1250
- 1251 - 1500
- 1501 - 2000
- 2001 - 4530

Non-Agricultural Annual Consumption (ML)

Data Source: RDNO Water Model

Associated Engineering
AECOM
SUITE 201, 3275 LAKESHORE ROAD
KELOWNA, B.C. V1W 3S9
T 250-762-3727 F 250-762-7789
WWW.AECOM.COM
KERR WOOD LEIDAL
consulting engineers

2,000 0 2,000 (m)

1:100,000

Project No.	Date
811-015	January 2013

Year 2052 Forecast Domestic Water Demands (Excluding Agricultural Uses)

Figure 7-1

Path: O:\0800-0899\811-015\430-GIS\TechMemo_01\MXD-Rpt\811015_TM01_Fig7-1.mxd Date Saved: 22/01/2013 1:29:35 PM
Author: JLau

8. Agricultural Demand Forecast

Table 8-1 summarizes current agricultural irrigation areas and volumes.

Table 8-1: Agricultural Irrigation Allocations and Usage (system-wide)

	Irrigated Area	Rate (ML/ha/yr)	Volume
Observed (1)	1,985 ha	6.35	12,600 ML/yr
Allocation with Agricultural Water Rate (2)	2,564 ha	5.5	14,102 ML/yr
Allocation without Agricultural Rate	888 ha	5.5	4,884 ML/yr
Total Allocation	3,452 ha	5.5	18,986 ML/yr

Notes:
(1) Observed irrigated area is from OWSDP, Observed volume is from 2011 flow records less estimated domestic consumption. Rate is calculated (for 2011). 2011 was not a high use year (relatively wet) and consumption would have been below historic maximum values.
(2) Agricultural irrigation allocations are from RDNO records. Rate is a defined value.

The large number of properties with allocation but not on an agricultural water rate is an important consideration in determining overall use forecasts. The relatively low cost of maintaining an allotment (as per the current rate bylaw $59.50/ha/year versus the cost of purchasing new allocation $6,000/ha (subject to availability), has resulted in a large number of properties which do not receive the agricultural water rate but still maintain an irrigation allocation. These properties total 888 ha of allocation. A forecast that included providing agricultural irrigation to all of these properties would be overly conservative.

As part of the Water Utility Master Plan, Summit Environmental Consultants Ltd. completed an agricultural water demand review [Summit, 2012] which is appended to this Technical Memorandum. The analysis is based on the Okanagan Water Supply and Demand Project (OWSDP) completed for the BC Ministry of Environment.

The Summit report hypothesizes a wide range of potential agricultural water use rates and overall consumption depending on a number of factors including the climate change model, agricultural irrigation efficiency, and the agricultural land base.

It is noted that the Summit work is based on water use rates to meet design crop needs for the climate model considered (range of 660 to 875 mm/yr) not on the current allocation of 550 mm/yr (5.5 ML/ha/yr). As well, the work is based on actual irrigated areas (excl. areas where irrigation is not in use) not on allotments (1,987 ha observed irrigation area vs. 2,564 ha of active allotment).

Assuming a ‘dry’ climate model, improving agricultural efficiency, and a constant agricultural land base; the estimated yearly agricultural consumption from 2010 to 2040 varies between 13,000 ML/yr to 17,400 ML/yr (the climate model includes wet and dry years). If the agricultural land base is expanded to the entire available agricultural land by yr-2040 (but other factors remain constant), water use would be expected to increase to approximately 25,000 ML/yr.

As summarized in AE’s October 22, 2012 memorandum (attached), the design flows shown in Table 8-2 are recommended.

Table 8-2: Agricultural Design Flows (system-wide)

	Area	Rate	Allocation	Allowance for Addl. Ag. Water Use	Design Value
Yearly Flow	2564 ha	5.5 ML/ha/yr	14,102 ML/yr	23.4%	17,400 ML/yr
Maximum Day Demand (incl. Leakage)	2564 ha	0.779 L/s/ha	2,000 L/s 172 MLD	23.4%	2,465 L/s 213 MLD

By assigning a maximum allocation of 17,400 ML/yr, GVW provides for an adequate quantity to irrigate existing irrigated lands to 2052. The design values allow for some re-introduction of dormant allotments and/or increase of the volume per hectare of allotment (to meet expected climate change). The allowance also allows for some flexibility in the short term for minor expansion with the understanding that short term increases in irrigated lands would need to be offset by additional irrigation efficiency.

It is recommended that actual flow quantities be measured annually, and that the design value of 17,400 ML/yr be re-evaluated every five years to confirm the validity of the scenarios.

The following design flows are derived for the supply areas.

Table 8-3: Agricultural Demand Forecast (MLD)

	Allocation (ha)	Max. Day Demand (MLD)	Storage Allocation (ML/yr)
RDNO 'B'	376	31.2	2,550
RDNO 'C'	317	26.4	2,160
Coldstream/ RDNO 'D'	1,627	135.0	11,040
City of Vernon	194	16.2	1,320
Spallumcheen	48	4.1	330
Total	2,564	213	17,400

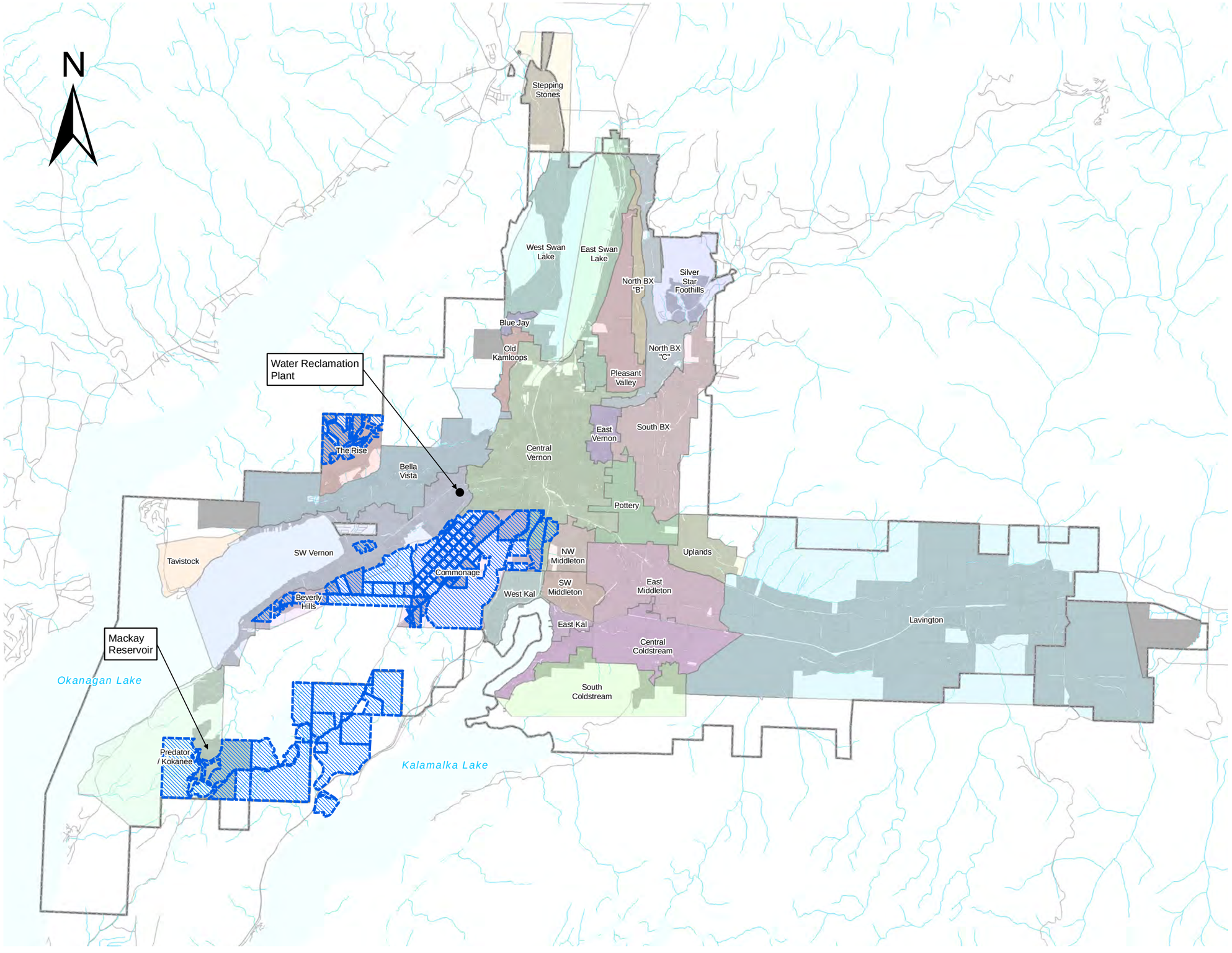
9. Reclaimed Water Irrigation System

The 2012 Master Water Plan Update will consider means to integrate the existing and expanded reclaimed water system. For the purposes of understanding the extent and annual irrigation volumes, Figure 9-1 illustrates the current reclaimed water application area, and Table 9-1 provides the recent annual volumes.

Table 9-1: Reclaimed Water Volumes (2000 to 2011)

Year	Volume (ML)	Average Flow (MLD)
2000	4,670	12.8
2001	4,700	12.9
2002	4,860	13.3
2003	5,080	13.9
2004 - 2007	No record	
2008	4,570	12.5
2009	5,200	14.2
2010	4,900	13.4
2011	4,500	12.3

The City of Vernon is currently examining the future direction for the reclaimed water system through the Liquid Waste Management Planning process. The implications of this direction, and coordination with the 2012 Master Water Plan Update, will be incorporated in later technical memoranda.



Path: O:\0800-0899\811-015\430-GIS\TechMemo_01\MXD-Rpt811015_TM01_Fig9-1.mxd Date Saved: 22/01/2013 1:16:27 PM
Author: JLau

Greater Vernon Water
2012 Master Water Plan

Legend

- Jurisdiction Boundary
- Name — Sub-Area
- Serviced Lots
- Reclaimed Water Application Areas and Management Units

Associated Engineering

AECOM
SUITE 201, 3275 LAKESHORE ROAD
KELOWNA, B.C. V1W 3S9
T 250-762-3727 F 250-762-7789
WWW.AECOM.COM

KERR WOOD LEIDAL
consulting engineers

2,000 0 2,000 (m)

1:100,000

Project No.	Date
811-015	January 2013

Reclaimed Water Application Area (2012)

Figure 9-1

10. Overall Demands

Expected overall system demands are as follows (excluding reclaimed water system).

Table 10-1: Demand Forecast

	Annual Demand (ML)				Max. Day Demand Consumption (MLD)		
Year	**Domestic**	**Agricultural (actual)**	**Agricultural (allotment)**	**Total[4]**	**Domestic**	**Agricultural**	**Total**
2011	9,670	12,600	17,400	27,100	59.4	213	272[5]
2016	9,880		17,400	27,300	60.1	213	273
2021	10,470		17,400	27,900	63.1	213	276
2026	11,060		17,400	28,500	66.0	213	279
2031	11,550		17,400	29,000	68.1	213	281
2041	12,450		17,400	29,900	73.4	213	286
2052	13,360		17,400	30,800	78.5	213	292

The demand forecast represents a best estimate of future demands (with limited contingency for agricultural demands), not a design value for facilities. A suitable demand contingency is typically warranted for facility design purposes.

11. References

City of Vernon, ***Plan Vernon, OCP Bylaw 5151, Schedule 'A'***, October 2008 (CoV 2008)

Cohen and Kulkami, ***Water Management and Climate Change in the Okanagan Basin, Environment Canada and UBC***, 2001 (Cohen 2001)

District of Coldstream, ***OCP Bylaw 1445, Schedule 'A'***, 2005 (DoC 2005)

Greater Vernon Water, ***Master Plan Addendum***, March 2004 (GVW 2004)

Greater Vernon Water, ***Master Water Plan Update 2012, Request for Proposals #2011-18 Eng***, August 2011 (GVW, 2011)

Kerr Wood Leidal Associates Ltd., ***RDNO 2007/2008 Water Model Updates***, updated March 2009 (KWL 2009)

North Okanagan Water Authority, ***Master Water Plan***, Final Report, April 2002 (NOWA 2002)

Regional District of North Okanagan, ***Regional Growth Strategy, "One Region One Future, Bylaw 2500, Schedule 'A'***, June 2011 (RDNO 2011)

Summit Environmental Consultants Inc., ***Okanagan Water Supply and Demand Project – GVW Agricultural Water Demand Review,*** October 2012 (Summit, 2012)

[4] Total Annual consumption is agricultural allotment (2564 ha @ 550 mm/yr) + domestic.
[5] Observed Maximum Demand of 192 MLD for 2011 (wet summer).

Attachment 1 – AE Memo

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Date:	October 22, 2012	**File:**	20112887.100 E.04.00
To:	Brett deWynter, P. Eng.		
From:	Rod MacLean, P.Eng.		
Project:	Greater Vernon Water - 2012 Water Master Plan		
Subject:	Agricultural Demand Projections - OWSDP		

MEMO

The following analysis is a supplement to the Summit (2012) report. This recently completed work was a review of agricultural water demand of modeling results from the 2011 Okanagan Water Supply and Demand Project (OWSDP) completed for the BC Ministry of Environment.

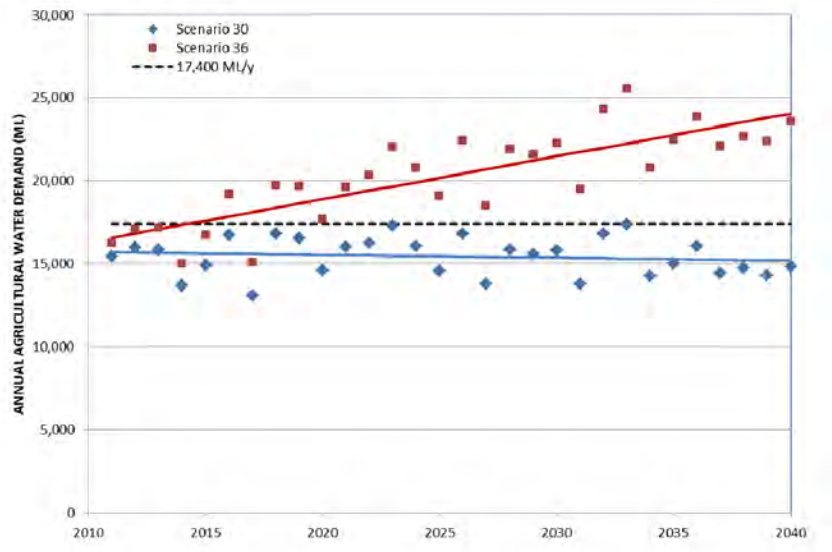
The Master Water Plan Technical Committee and the Consultant team examined the results of two data sets considered to represent the two extremes of climate change and expansion scenarios being examined for this water master plan. The results, summarized in red and blue in the figure below, outline two climate change and growth scenarios:

- Scenario 30 – Assumes a Climate Change weather scenario with no growth in Agricultural allotment.
- Scenario 36 – Assumes a Climate Change weather scenario including expansion of the irrigation base to a maximum allotment.

Current level growth patterns for agricultural areas appear to suggest that irrigation area in the GVW is anticipated to remain stable, or potentially decrease. Irrigated areas could, however, potentially increase, depending on economic conditions and social drivers. Given this uncertainty into the future, it was felt that the level (or declining) water demands demonstrated in Scenario 30 did not allow for any growth.

The modeling results for 2564 ha of irrigated land for Scenario 30 demands ranged from 13,085 ML/yr (510 mm/ha) to a maximum of 17,400 ML (678 mm/ha). By assuming a maximum allocation of 17,400 ML/y, GVW can assure that there is adequate quantity to irrigate existing lands to 2041, as well as provide some flexibility in the short term for minor expansion. GVW can plan and coordinate projects and infrastructure to effectively deliver these volumes.

We recommend that actual flow quantities be measured annually, and that this curve be re-evaluated every five years to confirm the validity of the scenarios.



Attachment 2 – Summit Environmental - Agricultural Water Demand Review

SUMMIT ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

Date:	October 22, 2012	**File:**	20112887.100.E.04.00
To:	Rod MacLean, Associated Engineering B.C. Ltd.		
From:	Drew Lejbak, Summit Environmental Consultants Inc.		
Project:	GVW Water Master Plan		
Subject:	Okanagan Water Supply and Demand Project - GVW Agricultural Water Demand Review		

FINAL REPORT

1.0 INTRODUCTION

This final report provides a review of agricultural water demand within the Greater Vernon Water (GVW) service area estimated by the Okanagan Water Supply and Demand Project (OWSDP) and in the new GVW 2012 Water Master Plan. The agricultural water demand estimates included within the GVW 2012 Water Master Plan are summarized in Technical Memorandum No. 1 – Water Demand Forecast (AECOM, Associated Engineering B.C. Ltd., and Kerr Wood Leidal Associates Ltd. 2012), while the estimates provided by the OWSDP are discussed in the following sections.

2.0 BACKGROUND REVIEW

In 2004, the B.C. Ministry of Environment initiated the Okanagan Water Supply and Demand Project (OWSDP). The OWSDP is a multi-phase work program focused on improving the state of knowledge of the water resources of the Okanagan Basin (Summit Environmental Consultants Inc. (Summit) 2010). The OWSDP is currently in Phase 3, with Phases 1 and 2 completed in 2005 and 2010, respectively. Phase 1 identified and evaluated the information available for a comprehensive basin-wide analysis of water supply and demand in the Okanagan Basin and identified data gaps, while Phase 2 was a series of scientific investigations and hydrologic modeling to determine the current supply and demand of water, as well as potential future changes. Phase 3 is focused on updating and improving the Phase 2 data and models and turning the results into policy.

2.1 Okanagan Water Demand Model

Included in Phase 2 of the OWSDP was the development of the Okanagan Water Demand Model (OWDM) by the Ministry of Environment and Agriculture and Agri-Foods Canada. The OWDM was developed to provide current and future estimates of agricultural and indoor and outdoor water demands in the Okanagan Basin. The OWDM is based on a Geographic Information System (GIS) database that contains cadastre information (showing the boundaries of land ownership), crop type, irrigation system type, soil texture, and climatic data (van der Gulik *et al*. 2010). The information was assembled from background information as well as high resolution orthophotos and GIS, and was confirmed by ground surveys in 2006. Land uses (including crop type and method of irrigation) were identified and water demands were estimated at the scale of individual land parcels and finer (van der Gulik *et al*. 2010). Accordingly, the model can provide estimates of water demand for individual crops on a parcel of land, or for an entire watershed, local government jurisdictions, or water supplier areas (e.g. irrigation districts) by summing the demands within those areas (van der Gulik *et al*. 2010). In Phase 2 of the OWSDP, the water demands were linked to extractions from water sources (e.g. streams, lakes, and aquifers) by mapping "water use areas" and identifying the source(s) of water supplying each of the delineated areas.

The OWDM calculates the daily evapotranspiration demand for each land parcel using a form of the Penman-Monteith equation. It also computes the existing soil moisture and the daily precipitation, and the irrigation requirement is the leftover demand that can't be met from these two sources. The climate dataset is the key dataset that drives the evaporation calculations. In the Okanagan Basin, a 1961-2100 gridded dataset consisting of cells measuring 500 m by 500 m was created, including temperature (minimum, maximum, and mean) and total precipitation for each day of the year (Summit 2010). A detailed description of how the model calculates agricultural and indoor/outdoor water demands is provided by van der Gulik *et al*. (2010).

It is important to note that the OWDM is a mathematical model that estimates irrigation water demand based on climate, land use, soils, and the irrigation systems that are present. The water use model approximates actual use if all water users consume at optimal rates, leakage is predictable, and users do not over-water or under-water their crops.

2.2 Climate Datasets and Scenarios

One of the most important drivers of the OWDM is the climate dataset. Twelve (12) climate datasets were developed for the Okanagan Basin using different Global Circulation Models (GCMs). For Phase 2 of the OWSDP, the CGCM2 (A2) dataset was selected for use within the OWDM, while under Phase 3 two other datasets were utilized to represent "dry" (HadCM3 (A2)) and "wet" (CGCM3 (B1)) climate conditions.

Within Phase 2 and 3 of the OWSDP, multiple scenarios were selected to focus on the key factors that could affect water resources in the Okanagan in the future (Summit 2010), including:

- Changes in climate;
- Changes in forest cover as a result of mountain pine beetle, wildfire, and forest harvesting;
- Changes in water use efficiency;
- Changes in the amount of agricultural land under irrigation; and
- Changes in population.

3.0 GREATER VERNON WATER – WATER DEMAND ESTIMATES

In order to compare water demand estimates from the OWSDP to those developed for the GVW 2012 Master Water Plan, two OWSDP scenarios were examined. The scenarios included Scenario 30 and 36 from Phase 3 and are summarized in Table 3-1. A description of the identified climate models, water use efficiencies, and population growth rates are provided by Summit (2010) and Polar Geoscience Ltd. (2012).

Table 3-1 Summary of Okanagan Water Supply and Demand Project scenarios used for comparison purposes.

Scenario number	Time Period	Climate Model	Domestic (indoor & outdoor) Efficiency	Agricultural Efficiency	Agricultural Land Base	Population growth
30	2011-2040	HadCM3 A2 = "dry"	Maintained constant at 2006 level	Improves at expected rate	Maintained constant at 2006 level	Expected rate of population growth (increase at 1% +/- per year)
36	2011-2040	HadCM3 A2 = "dry"	Maintained constant at 2006 level	Improves at expected rate	Irrigate all available agricultural land	Expected rate of population growth (increase at 1% +/- per year)

Scenario 30 and 36 are similar, except that Scenario 36 includes a future condition where all available agricultural lands are irrigated, while Scenario 30 includes current (based on 2006 levels) agricultural lands. Note that under Scenario 36, the agricultural land increase begins in 2010 and occurs stepwise over the course of the 2011-2040 period and the land base increases are assigned randomly over the course of the modeling period. As a result, the starting agricultural land bases are slightly different between Scenarios 30 and 36 and the final agricultural land base in Scenario 36 represents all total available agricultural lands.

Note that the agricultural water demands within the OWDM for GVW have been identified by the Ministry of Agriculture and Agriculture and Agri-Foods Canada to be slightly overestimated at this time and further refinement of the OWDM is currently underway to improve the estimates (D. Neilsen, pers. comm., 2012). The overestimates have been identified for grass and forage crop calculations within the OWDM; the magnitude of overestimation is not known at this time.

3.1 Okanagan Water Demand Model – GVW Water Use Areas

Included within the OWDM are four "water use areas" that represent the GVW water supply areas (Figure 3-1). The four GVW "water use areas" and their associated water source are as follows:

- GVW_1 – Duteau Creek
- GVW_2 – Aquifer 266
- GVW_3 – Kalamalka Lake
- GVW_4 – Reclaimed

In addition to the four GVW "water use areas", two "other" areas were defined (i.e. Other_1 and Other_13) within the GVW supply area (Figure 3-1). These "other" areas represent residual "water use areas" (within and adjacent to the Vernon Creek watershed) that are supplied by a mixture of surface (e.g. Kalamalka and Okanagan Lakes) and groundwater, but are not necessarily supplied by GVW.

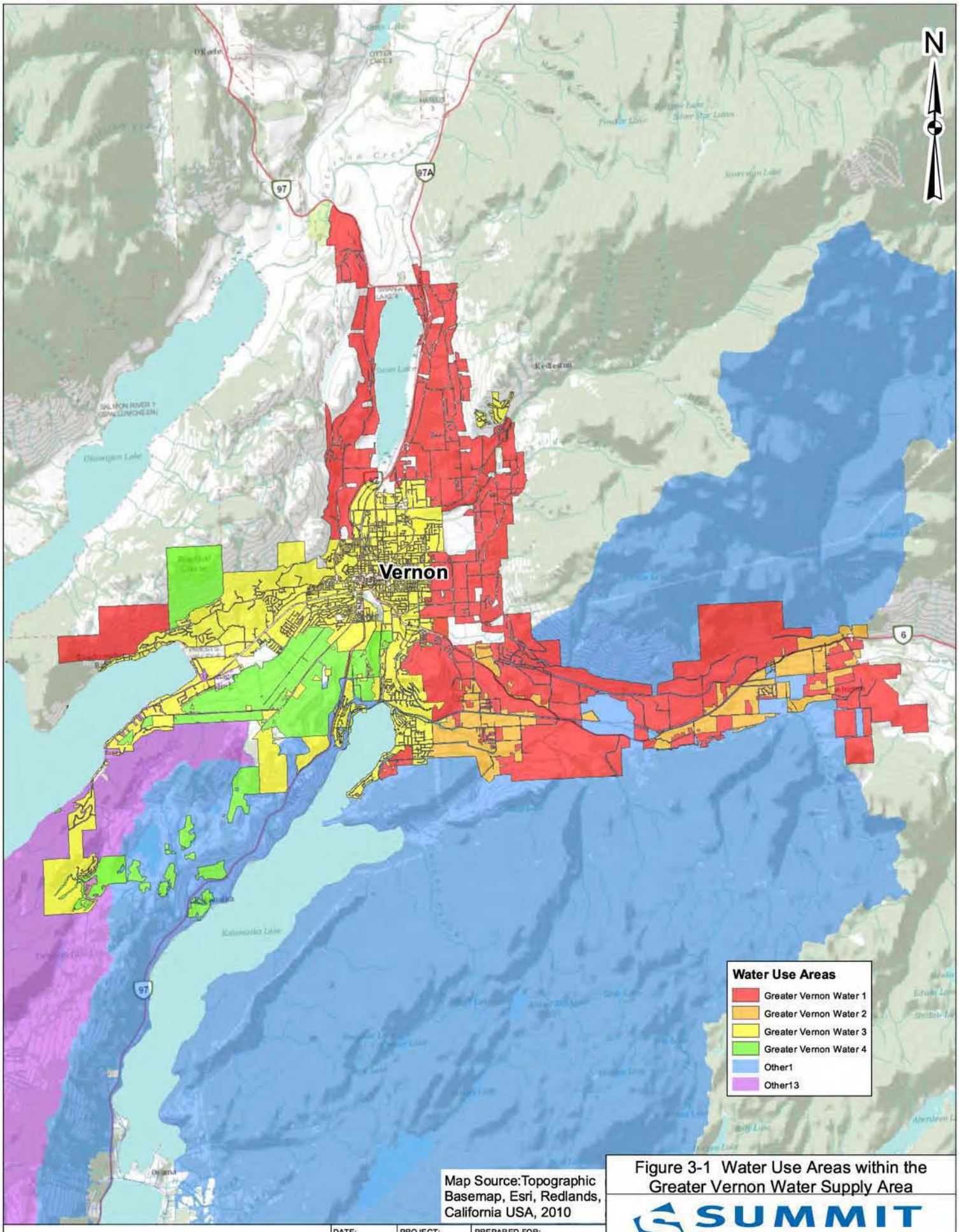
Within each of the "water use areas", individual land parcels identified during the background review and ground surveying for the OWDM were grouped respectively. It is important to note that the areas in Figure 3-1 represent the boundary of each "water use area", but only those areas located within the GVW water supply area are included in this review[1]. Table 3-2 provides a summary of the "water use areas" and their respective water use types under Scenarios 30 and 36 for all outdoor defined water uses based on 2006 land use levels.

Table 3-2 Summary of the total area for outdoor water use types defined within the respective water use areas of Vernon Creek watershed by the Okanagan Water Demand Model.

Water Use Area	Water Source	Scenario	Agricultural[1] (ha)	Outdoor Domestic (ha)	Golf (ha)	Park (ha)	Total Outdoor (ha)
GVW_1	Duteau Creek	30	1,529	461	23	9	2,103
		36	2,371	443	23	9	2,846
GVW_2	Aquifer 266	30	315	122	0	3	440
		36	488	120	0	2	610
GVW_3	Kalamalka Lake	30	129	587	2	76	794
		36	381	593	2	66	1,042
GVW_4	Reclaimed	30	581	1	155	10	747
		36	716	5	155	10	886
Other_1	Multiple Sources	30	14	115	0	0	129
		36	26	116	0	0	142
Other_13	Multiple Sources	30	0	3	0	0	3
		36	0	3	0	0	3
Total	Not including Reclaimed	30	1,987	1,288	25	88	3,388
		36	3,266	1,275	25	77	4,633

Note:
1. Values do not include blank crops (i.e. where observations reported no crops were being grown), inactive crops (i.e. fields left fallow or in disuse), or areas with no irrigation system or the irrigation system was not apparently in use.

[1] Only a minor fraction of the Other_1 and Other_13 "water use areas" are included within the GVW water supply area.



Map Source:Topographic Basemap, Esri, Redlands, California USA, 2010

DATE:	PROJECT:	PREPARED FOR:
Oct., 2012	2011-2887.100 (140)	Greater Vernon Water
DRAWN BY: DA		

Figure 3-1 Water Use Areas within the Greater Vernon Water Supply Area

SUMMIT ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

3.2 Okanagan Water Demand Model – GVW Water Demands

For Scenarios 30 and 36, water demand estimates are available for the GVW "water use areas" for the period 2011-2040. In order to compare these results to the estimates provided in the GVW 2012 Water Master Plan, only agricultural water demands from the OWDM are considered. The annual agricultural water demands for GVW (excluding reclaimed water and including the "other" areas) under Scenarios 30 and 36 are presented in Figure 3-2.

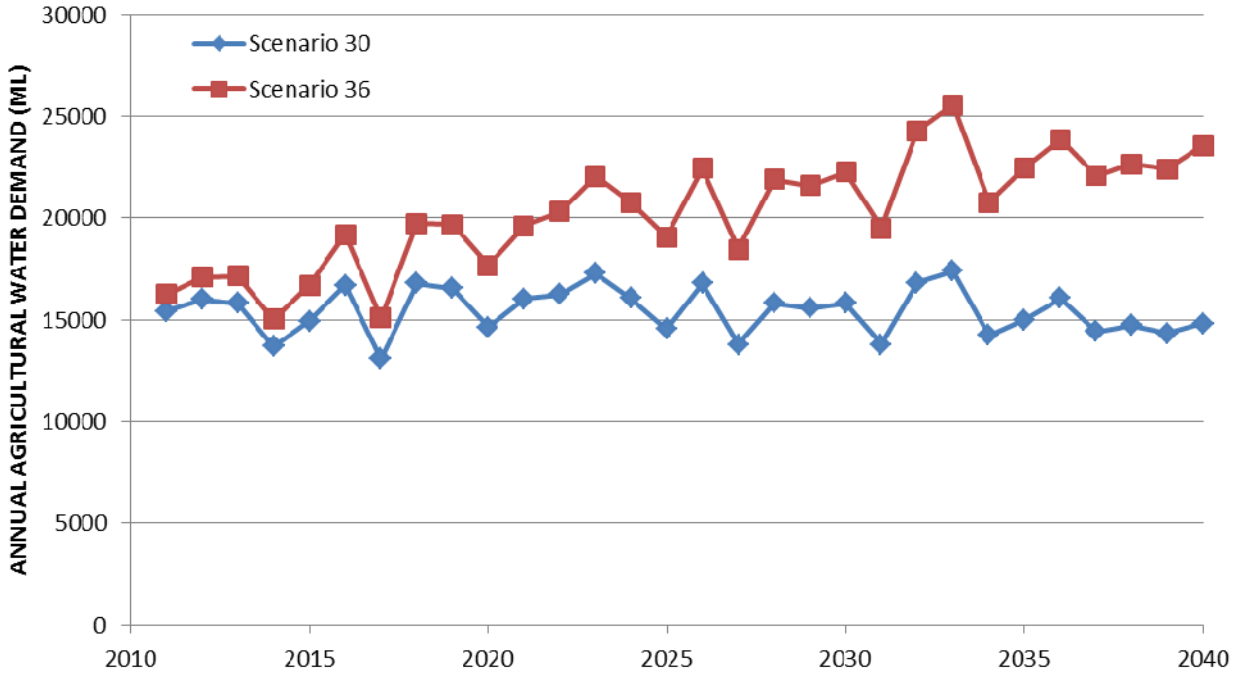


Figure 3-2 Agricultural water demands estimates for GVW under Scenarios 30 and 36 over 2011-2040.

For Scenario 30, the annual agricultural water demands for GVW range between 13,085 ML to 17,396 ML, with a slightly decreasing trend over the 2011 to 2040 period. For Scenario 36, the water demand trend is increasing based on the expansion of agricultural lands included in this scenario. Under Scenario 36, the agricultural water demands for GVW range between 15,026 ML to 25,556 ML and an increase to all available agricultural lands could increase the annual water demand by 8,725 ML (based on comparing years 2040 between scenarios).

Some additional results from Scenarios 30 and 36 include:

- Under a dry climate scenario and assuming everything remains as it is currently (i.e. land use and irrigated lands) or increases at an expected rate (i.e. population, water use efficiency); the annual agricultural water demand trend is expected to slightly decrease by approximately 3% over the 2011-2040 period[2], relative to the present; and
- Under a dry climate scenario and assuming that everything increases at an expected rate (i.e. population, water use efficiency) and all available agricultural lands become irrigated; the annual agricultural water demand trend is

[2] The trend of the 2011-2040 period for both Scenario 30 and 36 was estimated using a line of best-fit.

expected to increase by approximately 45% over the 2011-2040 period, relative to present. This assumes that agricultural expansion occurs stepwise from 2011-2040.

4.0 AGRICULTURAL WATER DEMAND COMPARISON

Based on the results from Scenario 30, the OWDM includes 1,987 ha of agricultural land within the GVW water supply area (i.e. GVW_1, GVW_2, GVW_3, and others). This area does not include agricultural lands within in the City of Vernon Reclaimed Water System (581 ha). However, if golf course and parks water use types are included, the area increases to 2,100 ha. Based on information from the GVW 2012 Water Master Plan, the total agricultural lands that are currently being used are 2,564 ha (not including the reclaimed areas). The 577 ha difference in agricultural lands between the OWDM and the new 2012 GVW Water Master Plan, is likely related to the difference in years when the agricultural lands were reviewed (i.e. 2006 for the OWDM versus 2011 for the GVW 2012 Water Master Plan). In addition, the difference could also be related to the method of agricultural land delineation (i.e. grouping of all agricultural land reserve lands versus detailed orthophoto review of active crop lands). Under Scenario 36, the total available agricultural land base was estimated at 3,266 ha, which is close to the 3,452 ha reported within the GVW 2012 Water Master Plan.

For Scenario 30, the agricultural water demand results are higher than those reported by the GVW 2012 Water Master Plan. In 2011, the OWDM reports a total agricultural water demand of 15,434 ML, as compared to the 12,600 ML reported by the GVW 2012 Water Master Plan. In addition, the GVW 2012 Water Master Plan projects an average future agricultural water demand of 13,400 ML from 2016 to 2040, while the OWDM suggests an average water demand of approximately 15,500 ML for the same period.

The results in Scenario 30 also indicate annual agricultural water demand rates range between 660 mm/year to 880 mm/year (calculated as a result of the agricultural water demand divided by the total agricultural area). The GVW Water Master Plan reports that agricultural water allocation is based on an agricultural water supply of 550 mm/year, but the level of drought (i.e. 10-year return period) was not reported. The GVW's rate structure and penalty system is based on this value.

Within Scenario 36, the starting point for the agricultural expansion was 2010. By 2011, the agricultural build out includes additional areas from 2010 and 2011 and occur stepwise over the course of the 2011-2040 period. This land base increase is assigned randomly over the course of the Scenario 36 modeling period, which is different than the agricultural expansion plan identified within the GVW 2012 Water Master Plan. However, based on the results of Scenario 36, under all available agricultural lands (i.e. year 2040), the OWDM estimates that the annual agricultural water demand would be approximately 23,000 ML, as compared to the total agricultural allocation of 17,400 ML reported by the GVW 2012 Water Master Plan for the same period.

The results from Scenarios 30 and 36 are both higher than the estimates provided within the GVW 2012 Water Master Plan. As noted earlier, agricultural water demands within the OWDM for GVW have been identified to be slightly overestimated; this could result in some of the differences observed. In addition, the OWDM also approximates actual use if all water users consume at optimal rates, leakage is predictable, and users do not over-water or under-water their crops. This assumption might not be reflected within the results included within the GVW 2012 Water Master Plan. Lastly, the climate model included in this analysis represents a "dry" climate scenario and since the OWDM is largely climate driven, the higher estimates produced by the OWDM could reflect differences in the climate conditions (i.e. dry, wet, average conditions) included in the comparison.

4.0 SUMMARY

The OWDM developed as part of the OWSDP was used to compare agricultural water demand estimates reported within the GVW 2012 Water Master Plan. Two OWSDP scenarios were examined to complete the comparison, which included Scenarios 30 and 36. Both of these scenarios represented a "dry" climate scenario and include water use efficiencies and population growth rates increasing at expected rates and a constant agricultural land base (Scenario 30) or all available agricultural lands (Scenario 36).

The results indicated that under Scenario 30, annual agricultural water demand trend is expected to slightly decrease over the 2011-2040 period, while under Scenario 36, the annual water demand trend is expected to increase. The results from Scenarios 30 and 36 are both higher than the estimates provided within the GVW 2012 Water Master Plan. In particular, the annual agricultural water demand rate is predicted to range from 660 mm/year to 880 mm/yr over 2011 to 2040; while the drought agricultural water supply allocation value of 550 mm/year is currently being utilized by GVW for drought planning purposes.

5.0 RECOMMENDATIONS

As part of the GVW Water Master Plan updates every three years, GVW should:

- Work with the Okanagan Basin Water Board, Ministry of Agriculture, and Agriculture and Agri-Foods Canada to further refine the results from the OWDM that have been identified to be overestimated for GVW. Once the refinements have been made, the agricultural water demand comparison completed in this summary report should be updated.
- Compare OWDSP modeling results from a variety of scenarios that include different climate models (i.e. dry, wet, and average conditions) for a full range of agricultural water demand projections into the future.
- Determine what "design drought" (i.e. return period) the 550 mm/yr agricultural water supply corresponds to and make a decision as to whether the design drought is streamflow-based or precipitation-based. Similarly, the design droughts for all other agricultural water supply values identified in the GVW Drought Management Plan (EBA Engineering Consultants Ltd. 2007) should also be determined:
    - Normal/Stage 1 = 550 mm/yr;
    - Stage 2 = 440 mm/yr;
    - Stage 3 = 275 mm/yr; and
    - Stage 4 = 110 mm/yr.

  Once decided upon, the OWSDP models could then be used to help examine the normal and advance drought stage water supply allocations and help recommend any changes into the future. Note that any change to the agricultural water supply value could impact timing of future supply or other capital projects designed to increase yield or promote water conservation.

6.0 LITERATURE CITED

AECOM, Associated Engineering B.C. Ltd., and Kerr Wood Leidal Associates Ltd. 2012. Technical Memorandum No. 1 – Water Demand Forecast. Draft #3. Prepared for Regional District of North Okanagan as part of the 2012 Greater Vernon Water (GVW) Water Master Plan update, June 2012.

EBA Engineering Consulting Ltd. 2007. Drought Management Plan. Prepared for Greater Vernon Services, May 2007.

Neilsen, Denise. Agricultural and Agri-Foods Canada. Personal communication with Drew Lejbak of Summit Environmental Consultants Inc., August 2012.

Polar Geoscience Ltd. 2012. Phase 3 Okanagan Basin Water Supply and Demand Project: Projected Water Supply and Use in the Okanagan Basin (2011-2040) – Okanagan Basin Water Accounting Model Results. Prepared for Okanagan Basin Water Board with federal funding support through Natural Resources Canada's Regional Adaptation Collaborative Program. March 2012.

Summit Environmental Consultants Inc. (Summit). 2010. Okanagan Water Supply and Demand Project: Phase 2 Summary Report. Prepared for the Okanagan Basin Water Board, July 2010.

van der Gulik, T., Neilsen, D., and R. Fretwell. 2010. Agricultural Water Demand Model. Prepared for Okanagan Basin Water Board with funding support through the Canada-British Columbia Water Supply Expansion Program, April 2010.