DISCUSSION PAPER

Arrowsmith Water Service
Englishman River Water Intake Study
Phase 1 - Conceptual Planning

Discussion Paper 3-3 – Water Supply Capacity

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1 Introduction

The objective of this discussion paper is to examine the feasibility of phased construction of the proposed Englishman River water treatment plant and intake, and to project the impact of Aquifer Storage and Recovery (ASR) on water demands and treatment plant capital costs.

2 Background

This discussion paper builds on the water demand projections listed in DP 3-2, the ASR characteristics as detailed in DP 5-2, and on the Class 'D' cost estimates for the proposed water treatment plant, intake, and interconnecting raw water transmission main provided in DP 8-2. Some of the key characteristics and assumptions used in this discussion paper are reviewed in the subsections below.

2.1 Water Demand

DP 3-2 provided high and low water demand projections for 2015 and 2050 that are dependent on the level of water conservation implemented during the 2015-2050 timeline. For this discussion paper the high end of the demand range was used to conservatively estimate plant capacity requirements. Water demands for the years between 2015 and 2050 were estimated using the high end population estimates and growth rates provided in DP 3-1, multiplied by the design per capita demand of 1.375 m^3/day listed in DP 3-2.

2.2 ASR Availability

According to DP5-2 a 1,000,000 m^3 ASR storage capacity could readily be developed in the areas surrounding the Arrowsmith serviced communities. Based on the number of potential ASR storage sites available, it was assumed in this discussion paper that greater storage would be available if needed. DP 5-2 also states that an average well field capacity of 16,350 m^3/day could be developed, with the ability to produce a peak flow rate of 21,255 m^3/day if necessary.

2.3 Groundwater

It was assumed that the groundwater sources identified in DP 3-2, or alternative wells of equivalent capacity, would be used throughout the 2015-2050 period of study. The groundwater yields listed in DP 3-2 do not include any wells developed by the City of Parksville since 2009, or the Fairwinds wells along Northwest Bay Road. It was estimated that the peak yield of the Township of Qualicum (TBQ) Beach groundwater supplies is 20,000m^3/day, and that the combined peak yield of the Parksville and Regional District of Nanaimo (RDN) groundwater supplies is 19,000 m^3/day. In terms of the amount of water that can be reliably provided by the groundwater sources, one must consider the firm yield of the wells, which is defined as the amount of water provided from a groundwater source if the largest capacity well was off-line. The firm yields for the Arrowsmith water system groundwater supplies, with and without TBQ's participation, are listed in **Table 2-1**.

Table 2-1
Arrowsmith Groundwater Supplies

	With TBQ Participation	Without TBQ Participation
Groundwater Peak Capacity (m^3/day)	39,000	19,000
Capacity of Largest Well (m^3/day)	3,800[1]	1,200[2]
Firm Yield (m^3/day)	35,200	17,800

Notes:

1 – Largest documented well capacity in TBQ is 43.9 L/s.

2 – Largest well capacity outside of TBQ is 13.7 L/s, in Nanoose Bay.

For perspective, the projected Arrowsmith water demands were plotted alongside the groundwater firm yields and anticipated ASR capacities in **Figure 2-1**. In addition to the firm yield of the Arrowsmith wells, the extent of their use must be considered, as the wells are not used continuously throughout the year. The approximate annual production of the Arrowsmith wells, based on 2008 and 2009 water records, is listed in **Table 2-2**. A comparison of firm yields to annual production indicates that the wells are infrequently run at full capacity. It is believed that the Arrowsmith wells could run more frequently without impacting their combined performance. Operating the wells more often is advantageous in that they will help meet peak water demands during the summer and will allow for more flexibility in balancing demands against ASR contributions during the winter. For this assessment it is assumed that the combined annual production of the wells can be increased by 75%, as shown in Table 2-2. This is still less than 50% of the annual production that, theoretically, could be reliably achieved.

Figure 2-1
Projected Maximum Day Water Demands and Groundwater Capacities

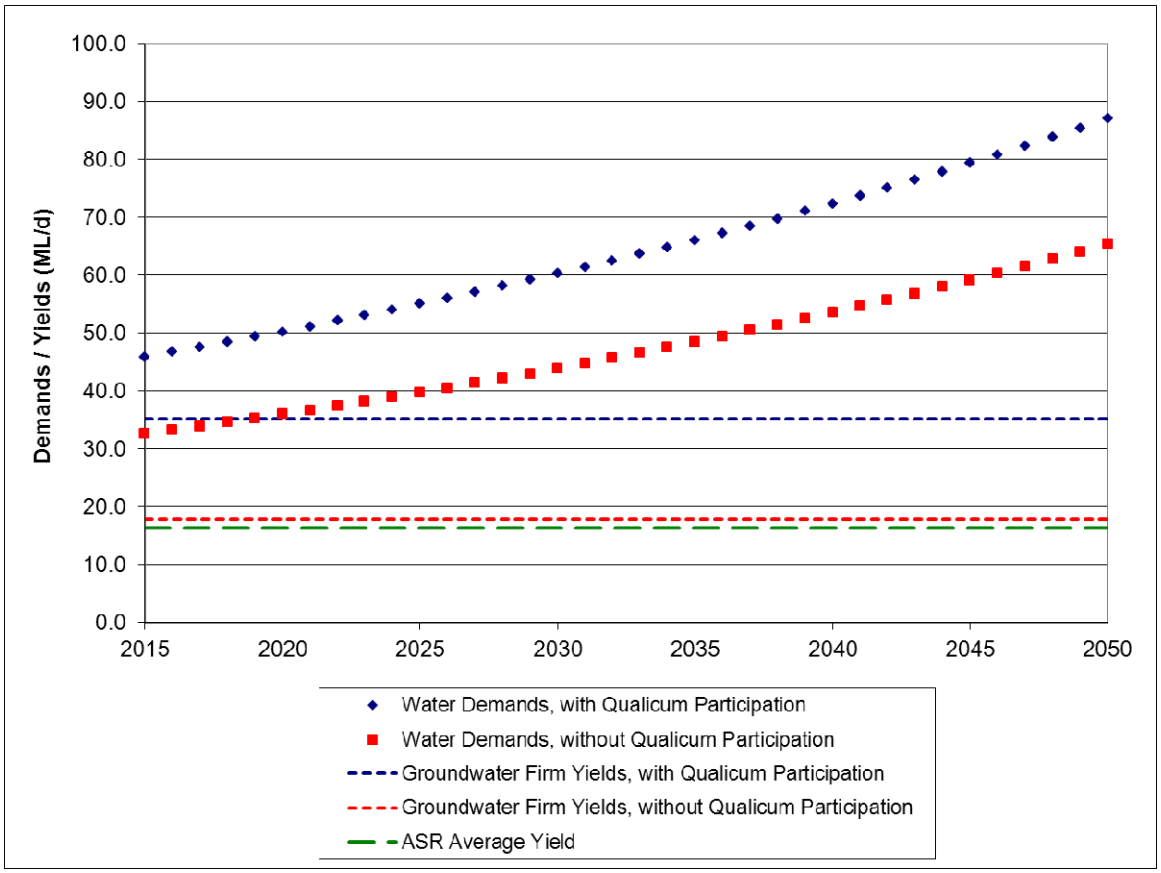

Table 2-2
Annual Well Water Production

	Parksville	RDN[1]	TBQ
Historical	1,120,000 m^3 /year	770,000 m^3 /year	1,900,000 m^3 /year
Assumed	1,950,000 m^3/year	1,350,000 m^3/year	3,270,000 m^3/year

Notes: 1 – Combined output from Nanoose Bay and French Creek wells.

A comparison of projected average and maximum day demands to available groundwater supplies for each of the Arrowsmith partners is summarized in **Table 2-3**. A more detailed breakdown is provided in **Appendix A**. The projections indicate that the available groundwater supplies for Parksville and the RDN are not sufficient to meet current or upcoming community water demands without support from additional water supplies, namely the Englishman River. TBQ is able to meet

current water demands with their groundwater supply, but additional sources will be required by 2040.

Table 2-3
Projected Water Demands and Groundwater Capacities

Partner	Parksville		RDN		TQB	
	Maximum (ML/d)	Annual Total (million m^3)	Maximum (ML/d)	Annual Total (million m^3)	Maximum (ML/d)	Annual Total (million m^3)
Well Yield	9.0	1.95	10.0	1.35[1]	20.0	3.27
2015 Demand	17.7	3.01	14.9	2.54	13.3	2.27
2050 Demand	34.2	5.83	31.1	5.31	21.7	3.69

Notes: [1] Combined output of Nanoose Bay and French Creek wells.

3 Impact of ASR

One advantage of an ASR system is that, if managed effectively, the ASR system will handle some of Arrowsmith's peak and summer water demands and thus reduce the proposed treatment plant's required capacity. Annual water balances were developed to quantify the reduction in minimum treatment plant capacity required if ASR were incorporated.

Water balances were set up for four scenarios that can be grouped into two Series, as follows:

- Series 1: With TBQ Participation
  - Case A: No ASR used
  - Case B: ASR incorporated
- Series 2: Without TBQ Participation
  - Case A: No ASR used
  - Case b: ASR incorporated

3.1 Methodology

Every five years over the time period of 2015 to 2050, a year-long water balance was developed that incorporates water demands, groundwater availability, ASR deposits and withdrawals, and treated surface water capacity. A single year in the water balance was defined as starting in October, typically the beginning of Parksville's wet season, and ending in September of the next year, typically the end of Parksville's dry season. Performing a water balance from November to October captures the actions of building up water reserves in ASR storage, then using the stored water to supplement supplies for the summer. The annual balance was prepared in monthly increments, while the annual balance for 2050 was redone using weekly increments for a more accurate estimate of the maximum ASR storage volume required.

For the annual balances the intent was to achieve a net ASR balance of 0, that is, to have no extra water remaining in ASR storage by the end of the study year. The amount of groundwater used in the water balances was kept consistent to the annual water use listed in Table 2-2. A slight increase in the total volume of groundwater contribution was included in year 2050, with the assumption that by 2050 additional wells would be developed as required.

The procedure for estimating water demands for each year was as follows:

- The Maximum Day Demand (MDD) was calculated as a product of population and per capita demands, plotted in Figure 2-1.
- July historically has the highest water demands, therefore the MDD was assumed to occur in July.
- It was assumed that the Average Day Demand (ADD) for July was roughly 77% (1/1.3) of the MDD.
- The ADD for the other months was estimated as being proportional to the July ADD and to the relative monthly water consumption rates, based on 2008 and 2009 water records, listed in **Table 3-1**.

Table 3-1
Historical Monthly Water Demands

Month	Percentage of Total Annual Demands	Percentage of July ADD
October	7.8%	57%
November	6.0%	43%
December	6.3%	46%
January	5.7%	41%
February	5.6%	41%
March	6.1%	44%
April	6.1%	44%
May	8.4%	61%
June	11.0%	80%
July	13.8%	100%
August	12.8%	93%
September	10.4%	75%

As per discussion in DP5-2, it was assumed that no water was lost while being held in the ASR reserves. In terms of operational philosophy, it was assumed that the groundwater and ASR reserves would be primarily used during the summer, when the Englishman River flows are at a seasonal low. If annual production of the wells is increased by 75%, it was assumed that the excess production would be used in the winter to supplement peak demands during the winter. It was assumed that ASR levels would be replenished by the water treatment plant during the winter when the plant has excess capacity available, and that the plant would run at reduced capacity during the summer to account for low seasonal flows in the Englishman River.

After completing the annual water balance, the minimum required treatment plant capacity was estimated as the greater of these three calculations:

- *Step 1:* Find the greatest ADD for a month that is supplied by the treatment plant alone, that is, without any groundwater or ASR contributions. Treatment plant capacity was then sized as the MDD for that particular month, roughly estimated as 1.3 times the ADD.
- *Step 2:* Identify the largest average capacity required from the treatment plant, for that year. The highest average capacity typically occurs when the plant is providing water to meet community demands and at the same time provide input to the ASR reserves. If the average capacity is greater than the plant capacity sized in Step 1, the treatment plant capacity was increased to meet the larger average flow.
- *Step 3:* Determine the MDD for July of a given year, calculated as 1.3 times the month's ADD. Subtract the sustainable yield of the groundwater wells and the long-term supply capacity of the ASR reserves to determine the treatment plant's MDD for the summer. If the summer MDD is greater than the capacities calculated in Step 1 and Step 2, than the minimum plant capacity required is the MDD calculated in this step.

3.2 Treatment Plant Capacity

The projected minimum required capacities of the proposed water treatment plant are illustrated in **Figure 3-1** and listed in **Table 3-2**. The annual water balances, in monthly and weekly intervals, are provided in **Appendix B**.

Figure 3-1
Projected Treatment Plant Capacity Requirements

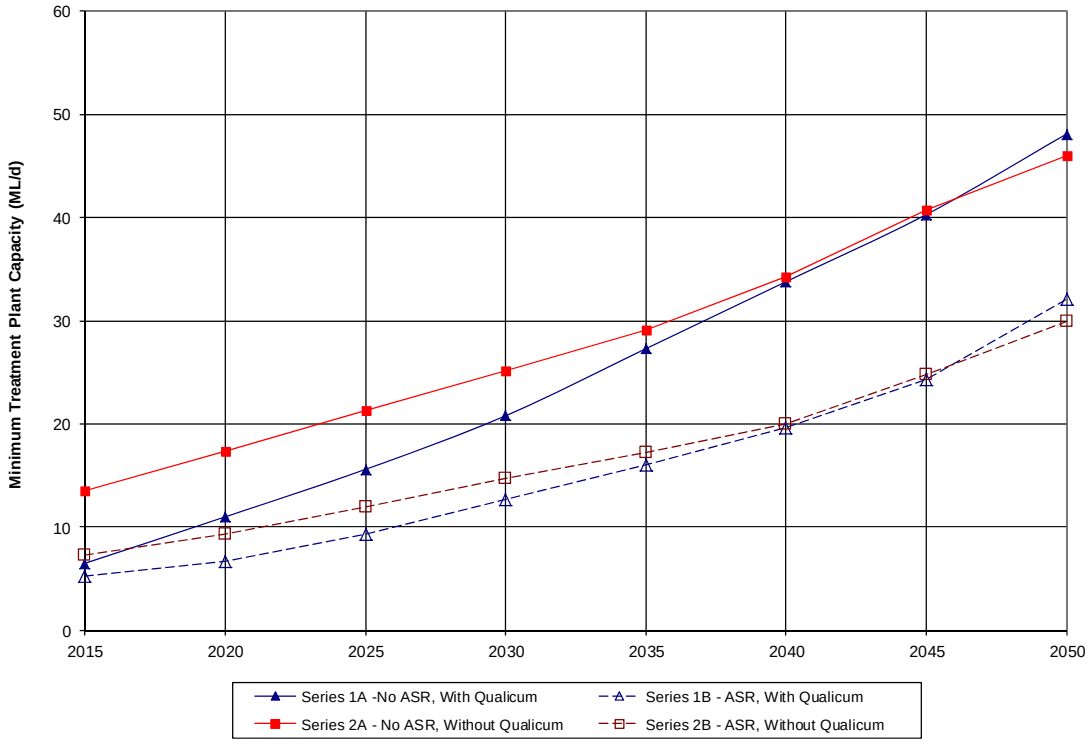

Table 3-2
Projected Treatment Plant Capacity Requirements

Year	Series 1A (ML/d)	Series 1B (ML/d)	Series 2A (ML/d)	Series 2B (ML/d)
2015	6.5	5.7	13.5	8.7
2020	11.7	6.7	17.4	10.7
2025	15.6	9.3	21.3	13.3
2030	20.8	12.7	25.2	14.7
2035	27.3	16.0	29.1	17.3
2040	33.8	19.7	34.3	20.0
2045	40.3	24.3	40.8	24.8
2050	48.1	32.1	46.0	30.0

When assuming more regular use of available well supplies, that is, a 75% increase in annual production, the excess production would offset any demand spikes that occur in the winter. Therefore, plant size was not dictated by winter maximum day demands in any of the scenarios reviewed.

Series 1A and 2A, that is, the scenarios where no ASR is involved, have similar 2050 design capacities. Without the additional summer capacity available from ASR, peak summer demand dictated plant size for Series 1A and 2A in every scenario. For Series 1B and 2B, where ASR is involved, the added capacity available from ASR supplemented surface and groundwater supplies during the summer. Plant size was then, for the most part, dictated by the average capacity required to simultaneously meet winter demands and contribute to ASR reserves. However, by 2040 peak summer demands began to exceed the excess capacity provided by wells and ASR. For both Series 1B and 2B, plant sizing is dictated by summer demands from 2040 onwards.

Because ASR is able to supplement high summer demands, significantly less treatment plant capacity was required in the year 2050, which translates to capital savings, lower operational requirements, reduced footprint, and reduced demand on the Englishman River. Based on the water balance conducted for 2050, the approximate volume of ASR storage required is 1,000,000 m^3 for Series 1B and 1,300,000 m^3 for Series 2B.

3.3 Phased Construction

For the proposed water treatment plant, intake, and related piping, capital costs were estimated in DP 8-2 with the assumption that all of the infrastructure would be constructed at the same time. A frequently used alternative is to build the infrastructure in several phases of construction. For a timeline of 2015 to 2050, it is recommended that phased construction of the treatment plant be done in no more than two phases. For example, the infrastructure completed in Phase 1 would be sufficient to meet community demands up to the year 2035, with Phase 2 adding sufficient infrastructure to meet 2050 demands. In general, the total cost of phased construction is greater than the cost of building the same system in a single step. However, by phasing construction some capital costs can be deferred to a later date.

The capacities for the treatment plant when built in phases, using the minimum sizing requirements listed in Table 3-2, are listed in **Table 3-3**.

Table 3-3
Water Treatment Plant Sizing

	Series 1A	Series 1B	Series 2A	Series 2B
Phase 1 (2015 – 2035)	27 ML/d	16 ML/d	29 ML/d	17 ML/d
Phase 2 (2035 – 2050)	48 ML/d	32 ML/d	46 ML/d	30 ML/d

If it is decided to incorporate ASR into the water supply system, the ASR system does not need to be completed in the same year that the plant is constructed. Based on the capacities calculated in **Table 3-3**, the Phase 1 capacity of the proposed treatment plant would be sufficient to meet summer demands without ASR support for a few years. For Series 1B, a 16 ML/d surface water treatment plant would provide sufficient capacity to meet AWS demands until between 2025 and 2030. For Series 2B, a 17 ML/d treatment plant would require ASR after 2015 but before 2020. However, it is advantageous to incorporate ASR sooner than these required dates, as the ASR supply will reduce the amount of water that must be drawn from the Englishman River during the summer.

4 Capital Costs

Class 'D' capital cost estimates were developed for the construction of the water treatment plant, intake, and interconnecting raw water main for Series 1A through 2B when implemented in two phases of construction. Costs were developed for Site 1B, one of the top-listed sites detailed in DP8-2. The same assumptions and layouts used to develop the treatment site cost estimates in DP 8-2 were used to develop the phased construction costs below.

Table 4-1 summarizes the direct capital costs for the intake and treatment plant at Site 1B. The cost of developing an ASR system, estimated at $5 million in DP 5-2, was included in the cost estimates.

Table 4-1
Summary of Capital Costs – Site 1B

Categories	Series 1A	Series 1B	Series 2A	Series 2B
Direct Cost - Intake and Treatment Plant Phase 1	$20,076,000	$15,839,000	$19,842.000	$16,851,000
Direct Cost – Intake and Treatment Plant Phase 2	$4,567,000	$3,849,000	$4,056,000	$2,365,000
Direct Construction Cost - Distribution Mains Core Area	$2,289,000	$2,289,000	$2,289,000	$2,289,000
Direct Construction Cost – Distribution Mains Outside Core Area[1]	$7,265,000	$7,265,000	$6,795,000	$6,795,000
Property Purchases	$1,106,000	$1,106,000	$1,106,000	$1,106,000
Design and Construction Contingency (25% of Direct Costs)	$8,826,000	$7,587,000	$8,522,000	$7,352,000
Direct Cost Subtotal	$44,129,000	$37,935,000	$42,609,000	$36,758,000
Indirect Costs	$8,826,000	$7,587,000	$8,522,000	$7,352,000
Subtotal	$52,955,000	$45,521,000	$51,131,000	$44,110,000
HST (3%)[2]	$1,589,000	$1,366,000	$1,534,000	$1,323,000
Interim Financing	-	-	-	-
ASR Cost	-	$5,000,000	-	$5,000,000
Total Capital Cost	$54,543,000	$51,887,000	$52,665,000	$50,432,000

Notes: 1 – Costs as provided in June 16, 2010 presentation “Englishman River Water Intake, Treatment Facilities and Supply Mains”.
2 – HST estimate reduced from 12% to 3% based on the amount of HST that can be reclaimed by the municipalities as rebates.

When comparing Series 1B and 2B to Series 1A and 2A, there are significant capital savings achieved from building a smaller capacity treatment plant. However, these savings are only slightly less than the amount of money that would be invested in developing the ASR system.

5 Conclusions

In terms of capital cost alone, the savings achieved from requiring a smaller capacity water treatment plant do not significantly offset the investment required to implement ASR. The appeal of an ASR system for AWS would be based on non-capital factors, including the following:

- Smaller treatment facility footprint.
- Reduced operation costs at the treatment plant.
- Reduced withdrawals from the Englishman River during low flow periods in the summer.
- The potential to add ASR storage in a location that improves flow through the distribution system.

Appendix A – Maximum and Annual Water Demands and Groundwater Yields

AWS ENGLISHMAN RIVER INTAKE STUDY
WATER SUPPLY PROJECTS

ANNUAL

Area	Annual Groundwater Supply Capacity (million m3)		Projected Annual Demand (million m3)							
	Current Volume	Potential Volume (75% Increase in Use)	2015	2020	2025	2030	2035	2040	2045	2050
RDN										
Nanoose	0.70	1.23	1.29	1.44	1.61	1.80	2.01	2.25	2.51	2.81
French Creek	0.07	0.12	0.17	0.19	0.22	0.25	0.28	0.32	0.37	0.41
EPCOR	n/a	n/a	1.08	1.19	1.30	1.43	1.57	1.73	1.90	2.09
City of Parksville	1.12	1.95	3.01	3.31	3.64	4.00	4.39	4.83	5.30	5.83
Town of Qualicum Beach	1.87	3.27	2.27	2.43	2.60	2.79	2.99	3.21	3.44	3.69
		Sum	7.82	8.56	9.37	10.27	11.24	12.34	13.52	14.83

ANNUAL SURFACE WATER SUPPLY REQUIRED

Area	Annual Groundwater Supply Capacity (million m3)		Annual Surface Water Supply Required (million m3)							
	Current Volume	Potential Volume (75% Increase in Use)	2015	2020	2025	2030	2035	2040	2045	2050
RDN										
Nanoose	0.70	1.23	0.06	0.21	0.38	0.57	0.78	1.02	1.28	1.58
French Creek	0.07	0.12	0.05	0.07	0.10	0.13	0.16	0.20	0.25	0.29
EPCOR	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
City of Parksville	1.12	1.95	1.06	1.36	1.69	2.05	2.44	2.88	3.35	3.88
Town of Qualicum Beach	1.87	3.27	< 0	< 0	< 0	< 0	< 0	< 0	0.17	0.42

MAXIMUM DAY

Area	Maximum Day Groundwater Supply Capacity (ML/d)		Projected Maximum Day Demand (ML/d)							
			2015	2020	2025	2030	2035	2040	2045	2050
RDN										
Nanoose	4.8		7.6	8.5	9.5	10.6	11.8	13.2	14.8	16.5
French Creek	1.0		1.0	1.1	1.3	1.4	1.6	1.9	2.1	2.4
EPCOR	4.2	(approx.)	6.3	7.0	7.6	8.4	9.2	10.1	11.1	12.2
City of Parksville	9.0		17.7	19.5	21.4	23.5	25.8	28.3	31.1	34.2
Town of Qualicum Beach	20		13.3	14.3	15.3	16.4	17.6	18.8	20.2	21.7
		Sum	45.9	50.4	55.1	60.3	66.0	72.3	79.3	87.0

MAXIMUM SURFACE WATER SUPPLY CAPACITY

Area	Maximum Day Groundwater Supply Capacity (ML/d)		Maximum Surface Water Capacity Required (ML/d)							
			2015	2020	2025	2030	2035	2040	2045	2050
RDN										
Nanoose	4.8		2.8	3.7	4.7	5.8	7.0	8.4	10	11.7
French Creek	1.0		0.0	0.1	0.3	0.4	0.6	0.9	1.1	1.4
EPCOR	4.2	(approx.)	2.1	2.8	3.4	4.2	5.0	5.9	6.9	8.0
City of Parksville	9.0		8.7	10.5	12.4	14.5	16.8	19.3	22.1	25.2
Town of Qualicum Beach	20		< 0	< 0	< 0	< 0	< 0	< 0	0.2	1.7

Appendix B – Annual Water Balances

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2015
Series 1A - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	600	500	100	100	0	0	0	0
Nov	450	320	130	130	0	0	0	0
Dec	480	360	120	120	0	0	0	0
Jan	450	300	150	150	0	0	0	0
Feb	420	270	150	150	0	0	0	0
Mar	480	320	160	160	0	0	0	0
Apr	480	340	140	140	0	0	0	0
May	630	590	40	40	0	0	0	0
Jun	840	840	0	0	0	0	0	0
Jul	1050	1050	0	0	0	0	0	0
Aug	960	960	0	0	0	0	0	0
Sep	810	750	60	60	0	0	0	0
	7650	6600		1050				

Plant sizing estimate

Step 1: Winter MDD:		624	ML/30 d			
	or	20.8	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	0 ML/d
Step 2: Largest ADD:		160	ML/30 d or			5.3 ML/d
Step 3: Summer ADD:		1365	ML/30 d or			
		45.5	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	6.5 ML/d

Therefore, minimum WTP capacity for this year is **6.5 ML/d**

Series 2A - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	420	300	120	120	0	0	0	0
Nov	330	180	150	150	0	0	0	0
Dec	330	180	150	150	0	0	0	0
Jan	300	100	200	200	0	0	0	0
Feb	300	60	240	240	0	0	0	0
Mar	330	60	270	270	0	0	0	0
Apr	330	80	250	250	0	0	0	0
May	450	300	150	150	0	0	0	0
Jun	600	530	70	70	0	0	0	0
Jul	750	530	220	220	0	0	0	0
Aug	690	530	160	160	0	0	0	0
Sep	570	450	120	120	0	0	0	0
	3300	3300		3300				

Plant sizing estimate

Step 1: Winter MDD:		429	ML/30 d			
	or	14.3	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	0 ML/d
Step 2: Largest ADD:		270	ML/30 d or			9.0 ML/d
Step 3: Summer ADD:		975	ML/30 d or			
		32.5	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	13.5 ML/d

Therefore, minimum WTP capacity for this year is **13.5 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2020
Series 1A - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	660	500	160	160	0	0	0	0
Nov	510	320	190	190	0	0	0	0
Dec	540	350	190	190	0	0	0	0
Jan	480	260	220	220	0	0	0	0
Feb	480	260	220	220	0	0	0	0
Mar	510	290	220	220	0	0	0	0
Apr	510	340	170	170	0	0	0	0
May	720	590	130	130	0	0	0	0
Jun	930	840	90	90	0	0	0	0
Jul	1170	1050	120	120	0	0	0	0
Aug	1080	1050	30	30	0	0	0	0
Sep	870	750	120	120	0	0	0	0
	8460	6600		1860				

Plant sizing estimate

Step 1: Winter MDD:	702	ML/30 d				
or	23.4	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	0	ML/d
Step 2: Largest ADD:	220	ML/30 d or			7.3	ML/d
Step 3: Summer ADD:	1521	ML/30 d or				
	50.7	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	11.7	ML/d

Therefore, minimum WTP capacity for this year is **11.7 ML/d**

Series 2A - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	480	300	180	180	0	0	0	0
Nov	360	180	180	180	0	0	0	0
Dec	390	180	210	210	0	0	0	0
Jan	330	100	230	230	0	0	0	0
Feb	330	60	270	270	0	0	0	0
Mar	360	60	300	300	0	0	0	0
Apr	360	80	280	280	0	0	0	0
May	510	300	210	210	0	0	0	0
Jun	660	530	130	130	0	0	0	0
Jul	840	530	310	310	0	0	0	0
Aug	780	530	250	250	0	0	0	0
Sep	630	450	180	180	0	0	0	0
	6030	3300		2730				

Plant sizing estimate

Step 1: Winter MDD:	507	ML/30 d				
or	16.9	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	0	ML/d
Step 2: Largest ADD:	310.0	ML/30 d or			10.3	ML/d
Step 3: Summer ADD:	1092	ML/30 d or				
	36.4	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	17.4	ML/d

Therefore, minimum WTP capacity for this year is **17.4 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2025
Series 1A - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	720	480	240	240	0	0	0	0
Nov	540	300	240	240	0	0	0	0
Dec	570	300	270	270	0	0	0	0
Jan	540	240	300	300	0	0	0	0
Feb	510	210	300	300	0	0	0	0
Mar	570	270	300	300	0	0	0	0
Apr	570	300	270	270	0	0	0	0
May	780	600	180	180	0	0	0	0
Jun	1020	1050	0	0	0	0	0	0
Jul	1260	1050	210	210	0	0	0	0
Aug	1170	1050	120	120	0	0	0	0
Sep	960	750	210	210	0	0	0	0
	9210	6600		2640				

Plant sizing estimate

Step 1: Winter MDD:		741	ML/30 d			
	or	24.7	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	0 ML/d
Step 2: Largest ADD:		300	ML/30 d or			10.0 ML/d
Step 3: Summer ADD:		1638	ML/30 d or			
		54.6	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	15.6 ML/d

Therefore, minimum WTP capacity for this year is **15.6 ML/d**

Series 2A - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	510	300	210	210	0	0	0	0
Nov	390	180	210	210	0	0	0	0
Dec	420	180	240	240	0	0	0	0
Jan	390	100	290	290	0	0	0	0
Feb	360	60	300	300	0	0	0	0
Mar	420	60	360	360	0	0	0	0
Apr	420	80	340	340	0	0	0	0
May	570	300	270	270	0	0	0	0
Jun	720	530	190	190	0	0	0	0
Jul	930	530	400	400	0	0	0	0
Aug	840	530	310	310	0	0	0	0
Sep	690	450	240	240	0	0	0	0
	6660	3300		3360				

Plant sizing estimate

Step 1: Winter MDD:		546	ML/30 d			
	or	18.2	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	0 ML/d
Step 2: Largest ADD:		400.0	ML/30 d or			13.3 ML/d
Step 3: Summer ADD:		1209	ML/30 d or			
		40.3	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	21.3 ML/d

Therefore, minimum WTP capacity for this year is **21.3 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2030
Series 1A - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	780	480	300	300	0	0	0	0
Nov	600	300	300	300	0	0	0	0
Dec	630	300	330	330	0	0	0	0
Jan	570	240	330	330	0	0	0	0
Feb	570	210	360	360	0	0	0	0
Mar	630	270	360	360	0	0	0	0
Apr	630	300	330	330	0	0	0	0
May	840	600	240	240	0	0	0	0
Jun	1110	1050	60	60	0	0	0	0
Jul	1380	1050	330	330	0	0	0	0
Aug	1290	1050	240	240	0	0	0	0
Sep	1050	750	300	300	0	0	0	0
	10080	6600		3480				

Plant sizing estimate

Step 1: Winter MDD:		819	ML/30 d			
	or	27.3	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	0 ML/d
Step 2: Largest ADD:		360	ML/30 d or			12.0 ML/d
Step 3: Summer ADD:		1794	ML/30 d or			
		59.8	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	20.8 ML/d

Therefore, minimum WTP capacity for this year is **20.8 ML/d**

Series 2A - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	570	300	270	270	0	0	0	0
Nov	450	180	270	270	0	0	0	0
Dec	450	180	270	270	0	0	0	0
Jan	420	100	320	320	0	0	0	0
Feb	420	60	360	360	0	0	0	0
Mar	450	60	390	390	0	0	0	0
Apr	450	80	370	370	0	0	0	0
May	630	300	330	330	0	0	0	0
Jun	810	530	280	280	0	0	0	0
Jul	1020	530	490	490	0	0	0	0
Aug	930	530	400	400	0	0	0	0
Sep	780	450	330	330	0	0	0	0
	7380	3300		4080				

Plant sizing estimate

Step 1: Winter MDD:		585	ML/30 d			
	or	19.5	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	0.5 ML/d
Step 2: Largest ADD:		490.0	ML/30 d or			16.3 ML/d
Step 3: Summer ADD:		1326	ML/30 d or			
		44.2	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	25.2 ML/d

Therefore, minimum WTP capacity for this year is **25.2 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2035
Series 1A - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	870	480	390	390	0	0	0	0
Nov	660	300	360	360	0	0	0	0
Dec	690	300	390	390	0	0	0	0
Jan	630	240	390	390	0	0	0	0
Feb	630	210	420	420	0	0	0	0
Mar	690	270	420	420	0	0	0	0
Apr	690	300	390	390	0	0	0	0
May	930	600	330	330	0	0	0	0
Jun	1230	1050	180	180	0	0	0	0
Jul	1530	1050	480	480	0	0	0	0
Aug	1410	1050	360	360	0	0	0	0
Sep	1140	750	390	390	0	0	0	0
	11100	6600		4500				

Plant sizing estimate

Step 1: Winter MDD:	897	ML/30 d				
or	29.9	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	0	ML/d
Step 2: Largest ADD:	480	ML/30 d or			16.0	ML/d
Step 3: Summer ADD:	1989	ML/30 d or				
	66.3	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	27.3	ML/d

Therefore, minimum WTP capacity for this year is **27.3 ML/d**

Series 2A - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	630	300	330	330	0	0	0	0
Nov	480	180	300	300	0	0	0	0
Dec	510	180	330	330	0	0	0	0
Jan	450	100	350	350	0	0	0	0
Feb	450	60	390	390	0	0	0	0
Mar	510	60	450	450	0	0	0	0
Apr	510	80	430	430	0	0	0	0
May	690	300	390	390	0	0	0	0
Jun	900	530	370	370	0	0	0	0
Jul	1110	530	580	580	0	0	0	0
Aug	1050	530	520	520	0	0	0	0
Sep	840	450	390	390	0	0	0	0
	8130	3300		4830				

Plant sizing estimate

Step 1: Winter MDD:	663	ML/30 d				
or	22.1	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	3.1	ML/d
Step 2: Largest ADD:	580.0	ML/30 d or			19.3	ML/d
Step 3: Summer ADD:	1443	ML/30 d or				
	48.1	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	29.1	ML/d

Therefore, minimum WTP capacity for this year is **29.1 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2040
Series 1A - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	960	480	480	480	0	0	0	0
Nov	720	300	420	420	0	0	0	0
Dec	750	300	450	450	0	0	0	0
Jan	690	240	450	450	0	0	0	0
Feb	690	210	480	480	0	0	0	0
Mar	750	270	480	480	0	0	0	0
Apr	750	300	450	450	0	0	0	0
May	1020	600	420	420	0	0	0	0
Jun	1350	1050	300	300	0	0	0	0
Jul	1680	1050	630	630	0	0	0	0
Aug	1560	1050	510	510	0	0	0	0
Sep	1260	750	510	510	0	0	0	0
	12180	6600		5580				

Plant sizing estimate

Step 1: Winter MDD:	975	ML/30 d				
or	32.5	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	0	ML/d
Step 2: Largest ADD:	630	ML/30 d or			21.0	ML/d
Step 3: Summer ADD:	2184	ML/30 d or				
	72.8	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	33.8	ML/d

Therefore, minimum WTP capacity for this year is **33.8 ML/d**

Series 2A - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	690	300	390	390	0	0	0	0
Nov	540	180	360	360	0	0	0	0
Dec	570	180	390	390	0	0	0	0
Jan	510	100	410	410	0	0	0	0
Feb	510	60	450	450	0	0	0	0
Mar	540	60	480	480	0	0	0	0
Apr	540	80	460	460	0	0	0	0
May	750	300	450	450	0	0	0	0
Jun	990	530	460	460	0	0	0	0
Jul	1230	530	700	700	0	0	0	0
Aug	1140	530	610	610	0	0	0	0
Sep	930	450	480	480	0	0	0	0
	8940	3300		5640				

Plant sizing estimate

Step 1: Winter MDD:	741	ML/30 d				
or	24.7	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	5.7	ML/d
Step 2: Largest ADD:	700.0	ML/30 d or			23.3	ML/d
Step 3: Summer ADD:	1599	ML/30 d or				
	53.3	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	34.3	ML/d

Therefore, minimum WTP capacity for this year is **34.3 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2045
Series 1A - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	1050	480	570	570	0	0	0	0
Nov	810	300	510	510	0	0	0	0
Dec	840	300	540	540	0	0	0	0
Jan	750	240	510	510	0	0	0	0
Feb	750	210	540	540	0	0	0	0
Mar	810	270	540	540	0	0	0	0
Apr	810	300	510	510	0	0	0	0
May	1110	600	510	510	0	0	0	0
Jun	1470	1050	420	420	0	0	0	0
Jul	1830	1050	780	780	0	0	0	0
Aug	1710	1050	660	660	0	0	0	0
Sep	1380	750	630	630	0	0	0	0
	13320	6600		6720				

Plant sizing estimate

Step 1: Winter MDD:		1092	ML/30 d				
	or	36.4	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	0	ML/d
Step 2: Largest ADD:		780	ML/30 d or			26.0	ML/d
Step 3: Summer ADD:		2379	ML/30 d or				
		79.3	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	40.3	ML/d

Therefore, minimum WTP capacity for this year is **40.3 ML/d**

Series 2A - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	780	300	480	480	0	0	0	0
Nov	600	180	420	420	0	0	0	0
Dec	630	180	450	450	0	0	0	0
Jan	570	100	470	470	0	0	0	0
Feb	570	60	510	510	0	0	0	0
Mar	600	60	540	540	0	0	0	0
Apr	600	80	520	520	0	0	0	0
May	840	300	540	540	0	0	0	0
Jun	1080	530	550	550	0	0	0	0
Jul	1380	530	850	850	0	0	0	0
Aug	1260	530	730	730	0	0	0	0
Sep	1020	450	570	570	0	0	0	0
	9930	3300		6630				

Plant sizing estimate

Step 1: Winter MDD:		819	ML/30 d				
	or	27.3	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	8.3	ML/d
Step 2: Largest ADD:		850.0	ML/30 d or			28.3	ML/d
Step 3: Summer ADD:		1794	ML/30 d or				
		59.8	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	40.8	ML/d

Therefore, minimum WTP capacity for this year is **40.8 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2050
Series 1A - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	1140	480	660	660	0	0	0	0
Nov	870	300	570	570	0	0	0	0
Dec	920	300	620	620	0	0	0	0
Jan	840	240	600	600	0	0	0	0
Feb	810	210	600	600	0	0	0	0
Mar	900	270	630	630	0	0	0	0
Apr	900	300	600	600	0	0	0	0
May	1230	600	630	630	0	0	0	0
Jun	1605	1050	555	555	0	0	0	0
Jul	2010	1050	960	960	0	0	0	0
Aug	1860	1050	810	810	0	0	0	0
Sep	1530	750	780	780	0	0	0	0
	14615	6600		8015				

Plant sizing estimate

Step 1: Winter MDD:		1196	ML/30 d			
	or	39.9	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	0.9 ML/d
Step 2: Largest ADD:		960	ML/30 d or			32.0 ML/d
Step 3: Summer ADD:		2613	ML/30 d or			
		87.1	ML/d	Subtract GW output of 39 ML/d	WTP min capacity =	48.1 ML/d

Therefore, minimum WTP capacity for this year is **48.1 ML/d**

Series 2A - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	840	300	540	540	0	0	0	0
Nov	660	180	480	480	0	0	0	0
Dec	690	180	510	510	0	0	0	0
Jan	630	100	530	530	0	0	0	0
Feb	600	60	540	540	0	0	0	0
Mar	660	60	600	600	0	0	0	0
Apr	660	80	580	580	0	0	0	0
May	930	300	630	630	0	0	0	0
Jun	1200	530	670	670	0	0	0	0
Jul	1500	530	970	970	0	0	0	0
Aug	1410	530	880	880	0	0	0	0
Sep	1140	450	690	690	0	0	0	0
	10920	3300		7620				

Plant sizing estimate

Step 1: Winter MDD:		897	ML/30 d			
	or	29.9	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	10.9 ML/d
Step 2: Largest ADD:		970.0	ML/30 d or			32.3 ML/d
Step 3: Summer ADD:		1950	ML/30 d or			
		65	ML/d	Subtract GW output of 19 ML/d	WTP min capacity =	46 ML/d

Therefore, minimum WTP capacity for this year is **46 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2015
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	600	500	100	100	0	0	0	0
Nov	450	330	120	120	0	0	0	0
Dec	480	340	140	140	0	0	0	0
Jan	450	320	130	160	30	0	0	30
Feb	420	320	100	160	60	0	0	90
Mar	480	320	160	160	0	0	0	90
Apr	480	340	140	140	0	0	0	90
May	630	580	50	20	0	30	0	60
Jun	840	800	40	10	0	30	0	30
Jul	1050	1050	0	10	10	0	0	40
Aug	960	950	10	10	0	0	0	40
Sep	810	750	60	20	0	40	0	0
	7650	6600		1050				

Plant sizing estimate

Step 1: Winter MDD: 624 ML/30 d

Subtract GW output and ASR output

or 20.8 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 160 ML/30 d or 5.3 ML/d

Step 3: Summer ADD: 1365 ML/30 d or

Subtract GW output and ASR output

45.5 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 0 ML/d

Therefore, minimum WTP capacity for this year is **5.3 ML/d**

Series 2B - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	420	230	190	190	0	0	0	0
Nov	330	130	200	200	0	0	0	0
Dec	330	130	200	200	0	0	0	0
Jan	300	120	180	220	40	0	0	40
Feb	300	180	120	220	100	0	0	140
Mar	330	160	170	220	50	0	0	190
Apr	330	100	230	220	0	10	0	180
May	450	260	190	190	0	0	0	180
Jun	600	530	70	70	0	0	0	180
Jul	750	530	220	110	0	110	0	70
Aug	690	530	160	110	0	50	0	20
Sep	570	400	170	150	0	20	0	0
	5400	3300		2100				

Plant sizing estimate

Step 1: Winter MDD: 429 ML/30 d

Subtract GW output and ASR output

or 14.3 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 220.0 ML/30 d or 7.3 ML/d

Step 3: Summer ADD: 975 ML/30 d or

Subtract GW output and ASR output

32.5 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 0 ML/d

Therefore, minimum WTP capacity for this year is **7.3 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2020
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	660	500	160	160	0	0	0	0
Nov	510	330	180	180	0	0	0	0
Dec	540	340	200	200	0	0	0	0
Jan	480	320	160	200	40	0	0	40
Feb	480	320	160	200	40	0	0	80
Mar	510	320	190	200	10	0	0	90
Apr	510	340	170	200	30	0	0	120
May	720	580	140	140	0	0	0	120
Jun	930	800	130	100	0	30	0	90
Jul	1170	1050	120	100	0	20	0	70
Aug	1080	950	130	100	0	30	0	40
Sep	870	750	120	100	0	20	0	20
	8460	6600		1880				

Plant sizing estimate

Step 1: Winter MDD: 702 ML/30 d

or 23.4 ML/d — Subtract GW output and ASR output of (39 + 16) = 55 ML/d — WTP min capacity = 0 ML/d

Step 2: Largest ADD: 200 ML/30 d or — 6.7 ML/d

Step 3: Summer ADD: 1521 ML/30 d or

50.7 ML/d — Subtract GW output and ASR output of (39 + 16) = 55 ML/d — WTP min capacity = 0 ML/d

Therefore, minimum WTP capacity for this year is **6.7 ML/d**

Series 2B - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	t During AS (ML)	Balance (ML)
Oct	480	230	250	250	0	0	0	0
Nov	360	130	230	230	0	0	0	0
Dec	390	130	260	260	0	0	0	0
Jan	330	120	210	280	70	0	0	70
Feb	330	180	150	280	130	0	0	200
Mar	360	160	200	280	80	0	0	280
Apr	360	100	260	280	20	0	0	300
May	510	260	250	250	0	0	0	300
Jun	660	530	130	130	0	0	0	300
Jul	840	530	310	140	0	170	0	130
Aug	780	530	250	140	0	110	0	20
Sep	630	400	230	210	0	20	0	0
	6030	3300		2730				

Plant sizing estimate

Step 1: Winter MDD: 507 ML/30 d

or 16.9 ML/d — Subtract GW output and ASR output of (19 + 16) = 35 ML/d — WTP min capacity = 0 ML/d

Step 2: Largest ADD: 280.0 ML/30 d or — 9.3 ML/d

Step 3: Summer ADD: 1092 ML/30 d or

36.4 ML/d — Subtract GW output and ASR output of (19 + 16) = 35 ML/d — WTP min capacity = 1.4 ML/d

Therefore, minimum WTP capacity for this year is **9.3 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2025
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	720	500	220	220	0	0	0	0
Nov	540	330	210	210	0	0	0	0
Dec	570	340	230	230	0	0	0	0
Jan	540	330	210	280	70	0	0	70
Feb	510	310	200	280	80	0	0	150
Mar	570	360	210	280	70	0	0	220
Apr	570	340	230	280	50	0	0	270
May	780	540	240	240	0	0	0	270
Jun	1020	800	220	140	0	80	0	190
Jul	1260	1050	210	140	0	70	0	120
Aug	1170	950	220	140	0	80	0	40
Sep	960	750	210	170	0	40	0	0
	9210	6600		2610				

Plant sizing estimate

Step 1: Winter MDD: 741 ML/30 d

or 24.7 ML/d — Subtract GW output and ASR output of (39 + 16) = 55 ML/d — WTP min capacity = 0 ML/d

Step 2: Largest ADD: 280 ML/30 d or — 9.3 ML/d

Step 3: Summer ADD: 1638 ML/30 d or

54.6 ML/d — Subtract GW output and ASR output of (39 + 16) = 55 ML/d — WTP min capacity = 0 ML/d

Therefore, minimum WTP capacity for this year is **9.3 ML/d**

Series 2B - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	510	230	280	280	0	0	0	0
Nov	390	130	260	260	0	0	0	0
Dec	420	130	290	290	0	0	0	0
Jan	390	120	270	360	90	0	0	90
Feb	360	180	180	360	180	0	0	270
Mar	420	160	260	360	100	0	0	370
Apr	420	100	320	360	40	0	0	410
May	570	260	310	310	0	0	0	410
Jun	720	530	190	180	0	10	0	400
Jul	930	530	400	180	0	220	0	180
Aug	840	530	310	180	0	130	0	50
Sep	690	400	290	240	0	50	0	0
	6660	3300		3360				

Plant sizing estimate

Step 1: Winter MDD: 546 ML/30 d

or 18.2 ML/d — Subtract GW output and ASR output of (19 + 16) = 35 ML/d — WTP min capacity = 0 ML/d

Step 2: Largest ADD: 360.0 ML/30 d or — 12.0 ML/d

Step 3: Summer ADD: 1209 ML/30 d or

40.3 ML/d — Subtract GW output and ASR output of (19 + 16) = 35 ML/d — WTP min capacity = 5.3 ML/d

Therefore, minimum WTP capacity for this year is **12.0 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2030
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	780	460	320	320	0	0	0	0
Nov	600	300	300	300	0	0	0	0
Dec	630	310	320	320	0	0	0	0
Jan	570	330	240	380	140	0	0	140
Feb	570	310	260	380	120	0	0	260
Mar	630	360	270	380	110	0	0	370
Apr	630	340	290	380	90	0	0	460
May	840	540	300	280	0	20	0	440
Jun	1110	800	310	180	0	130	0	310
Jul	1380	1050	330	180	0	150	0	160
Aug	1290	1050	240	180	0	60	0	100
Sep	1050	750	300	200	0	100	0	0
	10080	6600		3480				

Plant sizing estimate

Step 1: Winter MDD: 819 ML/30 d

Subtract GW output and ASR output

or 27.3 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 380 ML/30 d or 12.7 ML/d

Step 3: Summer ADD: 1794 ML/30 d or

Subtract GW output and ASR output

59.8 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 4.8 ML/d

Therefore, minimum WTP capacity for this year is **12.7 ML/d**

Series 2B - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	570	230	340	340	0	0	0	0
Nov	450	130	320	320	0	0	0	0
Dec	450	130	320	320	0	0	0	0
Jan	420	120	300	440	140	0	0	140
Feb	420	180	240	440	200	0	0	340
Mar	450	160	290	440	150	0	0	490
Apr	450	100	350	440	90	0	0	580
May	630	260	370	370	0	0	0	580
Jun	810	530	280	220	0	60	0	520
Jul	1020	530	490	220	0	270	0	250
Aug	930	530	400	220	0	180	0	70
Sep	780	400	380	310	0	70	0	0
	7380	3300		4080				

Plant sizing estimate

Step 1: Winter MDD: 585 ML/30 d

Subtract GW output and ASR output

or 19.5 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 440.0 ML/30 d or 14.7 ML/d

Step 3: Summer ADD: 1326 ML/30 d or

Subtract GW output and ASR output

44.2 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 9.2 ML/d

Therefore, minimum WTP capacity for this year is **14.7 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2035
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	870	500	370	370	0	0	0	0
Nov	660	250	410	360	0	50	0	-50
Dec	690	270	420	380	0	40	0	-90
Jan	630	330	300	480	180	0	0	90
Feb	630	310	320	480	160	0	0	250
Mar	690	360	330	480	150	0	0	400
Apr	690	340	350	480	130	0	0	530
May	930	540	390	420	30	0	0	560
Jun	1230	850	380	240	0	140	0	420
Jul	1530	1050	480	240	0	240	0	180
Aug	1410	1050	360	240	0	120	0	60
Sep	1140	750	390	370	0	20	0	40
	11100	6600		4540				

Plant sizing estimate

Step 1: Winter MDD: 897 ML/30 d

Subtract GW output and ASR output
or 29.9 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 480 ML/30 d or 16.0 ML/d

Step 3: Summer ADD: 1989 ML/30 d or

Subtract GW output and ASR output
66.3 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 11.3 ML/d

Therefore, minimum WTP capacity for this year is **16 ML/d**

Series 2B - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	630	230	400	400	0	0	0	0
Nov	480	130	350	350	0	0	0	0
Dec	510	130	380	380	0	0	0	0
Jan	450	120	330	520	190	0	0	190
Feb	450	210	240	520	280	0	0	470
Mar	510	190	320	520	200	0	0	670
Apr	510	100	410	520	110	0	0	780
May	690	200	490	490	0	0	0	780
Jun	900	530	370	250	0	120	0	660
Jul	1110	530	580	250	0	330	0	330
Aug	1050	530	520	250	0	270	0	60
Sep	840	400	440	380	0	60	0	0
	8130	3300		4830				

Plant sizing estimate

Step 1: Winter MDD: 663 ML/30 d

Subtract GW output and ASR output
or 22.1 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 520.0 ML/30 d or 17.3 ML/d

Step 3: Summer ADD: 1443 ML/30 d or

Subtract GW output and ASR output
48.1 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 13.1 ML/d

Therefore, minimum WTP capacity for this year is **17.3 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2040
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	960	500	460	460	0	0	0	0
Nov	720	250	470	470	0	0	0	0
Dec	750	270	480	480	0	0	0	0
Jan	690	330	360	590	230	0	0	230
Feb	690	310	380	590	210	0	0	440
Mar	750	360	390	590	200	0	0	640
Apr	750	340	410	590	180	0	0	820
May	1020	540	480	480	0	0	0	820
Jun	1350	850	500	290	0	210	0	610
Jul	1680	1050	630	290	0	340	0	270
Aug	1560	1050	510	290	0	220	0	50
Sep	1260	750	510	460	0	50	0	0
	12180	6600		5580				

Plant sizing estimate

Step 1: Winter MDD: 975 ML/30 d

Subtract GW output and ASR output

or 32.5 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 590 ML/30 d or 19.7 ML/d

Step 3: Summer ADD: 2184 ML/30 d or

Subtract GW output and ASR output

72.8 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 17.8 ML/d

Therefore, minimum WTP capacity for this year is **19.7 ML/d**

Series 2B - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	690	230	460	460	0	0	0	0
Nov	540	130	410	410	0	0	0	0
Dec	570	130	440	440	0	0	0	0
Jan	510	120	390	600	210	0	0	210
Feb	510	210	300	600	300	0	0	510
Mar	540	190	350	600	250	0	0	760
Apr	540	100	440	600	160	0	0	920
May	750	200	550	550	0	0	0	920
Jun	990	530	460	300	0	160	0	760
Jul	1230	530	700	300	0	400	0	360
Aug	1140	530	610	300	0	310	0	50
Sep	930	400	530	480	0	50	0	0
	8940	3300		5640				

Plant sizing estimate

Step 1: Winter MDD: 741 ML/30 d

Subtract GW output and ASR output

or 24.7 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 600.0 ML/30 d or 20.0 ML/d

Step 3: Summer ADD: 1599 ML/30 d or

Subtract GW output and ASR output

53.3 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 18.3 ML/d

Therefore, minimum WTP capacity for this year is **20.0 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2045
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	1050	500	550	550	0	0	0	0
Nov	810	250	560	560	0	0	0	0
Dec	840	270	570	570	0	0	0	0
Jan	750	330	420	700	280	0	0	280
Feb	750	310	440	700	260	0	0	540
Mar	810	360	450	700	250	0	0	790
Apr	810	340	470	700	230	0	0	1020
May	1110	490	620	600	0	20	0	1000
Jun	1470	900	570	350	0	220	0	780
Jul	1830	1050	780	350	0	430	0	350
Aug	1710	1050	660	350	0	310	0	40
Sep	1380	750	630	590	0	40	0	0
	13320	6600		6720				

Plant sizing estimate

Step 1: Winter MDD: 1092 ML/30 d

Subtract GW output and ASR output

or 36.4 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 700 ML/30 d or 23.3 ML/d

Step 3: Summer ADD: 2379 ML/30 d or

Subtract GW output and ASR output

79.3 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 24.3 ML/d

Therefore, minimum WTP capacity for this year is **24.3 ML/d**

Series 2B - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	780	230	550	550	0	0	0	0
Nov	600	130	470	470	0	0	0	0
Dec	630	130	500	500	0	0	0	0
Jan	570	120	450	720	270	0	0	270
Feb	570	210	360	720	360	0	0	630
Mar	600	190	410	720	310	0	0	940
Apr	600	100	500	720	220	0	0	1160
May	840	200	640	640	0	0	0	1160
Jun	1080	530	550	360	0	190	0	970
Jul	1380	530	850	360	0	490	0	480
Aug	1260	530	730	360	0	370	0	110
Sep	1020	400	620	510	0	110	0	0
	9930	3300		6630				

Plant sizing estimate

Step 1: Winter MDD: 819 ML/30 d

Subtract GW output and ASR output

or 27.3 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 720.0 ML/30 d or 24.0 ML/d

Step 3: Summer ADD: 1794 ML/30 d or

Subtract GW output and ASR output

59.8 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 24.8 ML/d

Therefore, minimum WTP capacity for this year is **24.8 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2050
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss **0%**

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	1140	500	640	640	0	0	0	0
Nov	870	250	620	620	0	0	0	0
Dec	920	270	650	650	0	0	0	0
Jan	840	330	510	860	350	0	0	350
Feb	810	310	500	860	360	0	0	710
Mar	900	360	540	860	320	0	0	1030
Apr	900	340	560	860	300	0	0	1330
May	1230	490	740	700	0	40	0	1290
Jun	1605	900	705	435	0	270	0	1020
Jul	2010	1050	960	430	0	530	0	490
Aug	1860	1050	810	430	0	380	0	110
Sep	1530	750	780	670	0	110	0	0
	14615	6600		8015				

Plant sizing estimate

Step 1: Winter MDD: 1196 ML/30 d

Subtract GW output and ASR output

or 39.9 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 860 ML/30 d or 28.7 ML/d

Step 3: Summer ADD: 2613 ML/30 d or

Subtract GW output and ASR output

87.1 ML/d of (39 + 16) = 55 ML/d WTP min capacity = 32.1 ML/d

Therefore, minimum WTP capacity for this year is **32.1 ML/d**

Series 2B - Parksville and RDN

Month	Total Demand (ML)	GW Available (ML)	Amount Needed (ML)	Amount to Take from Surface Water (ML)	To ASR (ML)	From ASR (ML)	Water Lost (ML)	Balance (ML)
Oct	840	190	650	650	0	0	0	0
Nov	660	120	540	540	0	0	0	0
Dec	690	120	570	570	0	0	0	0
Jan	630	120	510	820	310	0	0	310
Feb	600	230	370	820	450	0	0	760
Mar	660	200	460	820	360	0	0	1120
Apr	660	100	560	820	260	0	0	1380
May	930	200	730	720	0	10	0	1370
Jun	1200	530	670	410	0	260	0	1110
Jul	1500	530	970	410	0	560	0	550
Aug	1410	530	880	410	0	470	0	80
Sep	1140	430	710	630	0	80	0	0
	10920	3300		7620				

Plant sizing estimate

Step 1: Winter MDD: 897 ML/30 d

Subtract GW output and ASR output

or 29.9 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 0 ML/d

Step 2: Largest ADD: 820.0 ML/30 d or 27.3 ML/d

Step 3: Summer ADD: 1950 ML/30 d or

Subtract GW output and ASR output

65 ML/d of (19 + 16) = 35 ML/d WTP min capacity = 30 ML/d

Therefore, minimum WTP capacity for this year is **30.0 ML/d**

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2050
Series 1B - Parksville, RDN, and Qualicum Beach

ASR Loss: 0%

	A	B	C	D (B-C)	E	F (A-D)	G (A-D-F)	H (H+C-G)
	Time Period (weeks)	Assumed ADD (m^3/day)	Customer Water Demands (Weekly Total) (m^3)	Amount Pumped from River (m^3)	Englishman River WTP Output		Sustainable Well Capacity* (m^3)	Well Output to Meet Demand (m^3)	ASR Withdrawals (m^3)	Water Lost during ASR Storage (m^3)	ASR Balance (m^3)
					To ASR (m^3)	To Consumer Demand (m^3)					
1	1-Oct	37,969	265,784	175,000	-	175,000	240,000	90,784	-	-	-
2	8-Oct	37,969	265,784	175,000	-	175,000	240,000	90,784	-	-	-
3	15-Oct	37,969	265,784	175,000	-	175,000	240,000	90,784	-	-	-
4	22-Oct	37,969	265,784	175,000	-	175,000	240,000	90,784	-	-	-
5	29-Oct	37,969	265,784	175,000	-	175,000	240,000	90,784	-	-	-
6	5-Nov	31,710	221,973	175,000	-	175,000	240,000	46,973	-	-	-
7	12-Nov	29,207	204,449	175,000	-	175,000	240,000	29,449	-	-	-
8	19-Nov	29,207	204,449	175,000	-	175,000	240,000	29,449	-	-	-
9	26-Nov	29,207	204,449	175,000	-	175,000	240,000	29,449	-	-	-
10	3-Dec	29,833	208,830	175,000	-	175,000	240,000	33,830	-	-	-
11	10-Dec	30,667	214,672	175,000	-	175,000	240,000	39,672	-	-	-
12	17-Dec	30,667	214,672	175,000	-	175,000	240,000	39,672	-	-	-
13	24-Dec	30,667	214,672	175,000	10,000	165,000	240,000	49,672	-	-	10,000
14	31-Dec	30,667	214,672	175,000	10,000	165,000	240,000	49,672	-	-	20,000
15	7-Jan	27,747	194,227	175,000	58,000	117,000	240,000	77,227	-	-	78,000
16	14-Jan	27,747	194,227	175,000	58,000	117,000	240,000	77,227	-	-	136,000
17	21-Jan	27,747	194,227	175,000	58,000	117,000	240,000	77,227	-	-	194,000
18	28-Jan	27,747	194,227	175,000	58,000	117,000	240,000	77,227	-	-	252,000
19	4-Feb	27,469	192,280	175,000	60,000	115,000	240,000	77,280	-	-	312,000
20	11-Feb	27,260	190,819	175,000	62,000	113,000	240,000	77,819	-	-	374,000
21	18-Feb	27,260	190,819	175,000	62,000	113,000	240,000	77,819	-	-	436,000
22	25-Feb	27,260	190,819	175,000	62,000	113,000	240,000	77,819	-	-	498,000
23	4-Mar	28,651	200,555	175,000	52,000	123,000	240,000	77,555	-	-	550,000
24	11-Mar	29,694	207,857	175,000	45,000	130,000	240,000	77,857	-	-	595,000
25	18-Mar	29,694	207,857	175,000	45,000	130,000	240,000	77,857	-	-	640,000
26	25-Mar	29,694	207,857	175,000	45,000	130,000	240,000	77,857	-	-	685,000
27	1-Apr	29,694	207,857	175,000	45,000	130,000	240,000	77,857	-	-	730,000
28	8-Apr	29,694	207,857	175,000	45,000	130,000	240,000	77,857	-	-	775,000
29	15-Apr	29,694	207,857	175,000	45,000	130,000	240,000	77,857	-	-	820,000
30	22-Apr	29,694	207,857	175,000	45,000	130,000	240,000	77,857	-	-	865,000
31	29-Apr	29,694	207,857	175,000	45,000	130,000	240,000	77,857	-	-	910,000
32	6-May	39,290	275,033	175,000	35,000	140,000	240,000	135,033	-	-	945,000
33	13-May	40,890	286,229	175,000	35,000	140,000	240,000	146,229	-	-	980,000
34	20-May	40,890	286,229	175,000	-	175,000	240,000	111,229	-	-	980,000
35	27-May	40,890	286,229	175,000	-	175,000	240,000	111,229	-	-	980,000
36	3-Jun	46,314	324,198	175,000	-	175,000	240,000	149,198	-	-	980,000
37	10-Jun	53,546	374,823	175,000	-	175,000	240,000	199,823	-	-	980,000
38	17-Jun	53,546	374,823	126,000	-	126,000	240,000	240,000	8,823	-	971,177
39	24-Jun	53,546	374,823	126,000	-	126,000	240,000	240,000	8,823	-	962,353
40	1-Jul	67,176	470,233	126,000	-	126,000	240,000	240,000	104,233	-	858,120
41	8-Jul	67,176	470,233	126,000	-	126,000	240,000	240,000	104,233	-	753,887
42	15-Jul	67,176	470,233	126,000	-	126,000	240,000	240,000	104,233	-	649,654
43	22-Jul	67,176	470,233	126,000	-	126,000	240,000	240,000	104,233	-	545,421
44	29-Jul	67,176	470,233	126,000	-	126,000	240,000	240,000	104,233	-	441,188
45	5-Aug	63,699	445,894	126,000	-	126,000	240,000	240,000	79,894	-	361,294
46	12-Aug	62,308	436,158	126,000	-	126,000	240,000	240,000	70,158	-	291,136
47	19-Aug	62,308	436,158	126,000	-	126,000	240,000	240,000	70,158	-	220,977
48	26-Aug	62,308	436,158	126,000	-	126,000	240,000	240,000	70,158	-	150,819
49	2-Sep	58,970	412,793	84,000	-	84,000	240,000	240,000	88,793	-	62,027
50	9-Sep	50,626	354,379	84,000	-	84,000	240,000	240,000	30,379	-	31,648
51	16-Sep	50,626	354,379	84,000	-	84,000	240,000	240,000	30,379	-	1,269
52	23-Sep	50,626	354,379	126,000	-	126,000	240,000	228,379	-	-	1,269
Annual Total			14,800,659	8,239,000				6,562,929			

RUN GROUNDWATER WELLS AT PEAK CAPACITY IN SUMMER; REST IN THE WINTER
RUN ENGLISHMAN RIVER WTP AT PEAK RATE IN WINTER TO RECHARGE ASR; RUN AT REDUCED RATE IN SUMMER

* Note: Maximum capacity of all available wells is 273,000 m3/wk. Assumed that the firm capacity of 240,000 m3/wk would not be exceeded.

Arrowsmith Water Services
Englishman River Intake and Water Treatment Plant
Water Balance - 2050
Series 2B - Parksville and RDN

ASR Loss: 0%

	A	B	C	D (B-C)	E	F (A-D)	G (A-D-F)	H (H+C-G)
	Time Period (weeks)	Assumed ADD (m^3/day)	Customer Water Demands (Weekly Total) (m^3)	Amount Pumped from River (m^3)	Englishman River WTP Output		Sustainable Well Capacity* (m^3)	Well Output to Meet Demand (m^3)	ASR Withdrawals (m^3)	Water Lost during ASR Storage (m^3)	ASR Balance (assume no loss) (m^3)
					To ASR (m^3)	To Consumer Demand (m^3)					
1	1-Oct	28,404	198,827	130,000	-	130,000	120,000	68,827	-	-	-
2	8-Oct	28,404	198,827	130,000	-	130,000	120,000	68,827	-	-	-
3	15-Oct	28,404	198,827	130,000	-	130,000	120,000	68,827	-	-	-
4	22-Oct	28,404	198,827	130,000	-	130,000	120,000	68,827	-	-	-
5	29-Oct	28,404	198,827	130,000	-	130,000	120,000	68,827	-	-	-
6	5-Nov	23,722	166,054	135,000	-	135,000	120,000	31,054	-	-	-
7	12-Nov	21,849	152,944	135,000	-	135,000	120,000	17,944	-	-	-
8	19-Nov	21,849	152,944	135,000	-	135,000	120,000	17,944	-	-	-
9	26-Nov	21,849	152,944	135,000	-	135,000	120,000	17,944	-	-	-
10	3-Dec	22,317	156,222	140,000	-	140,000	120,000	16,222	-	-	-
11	10-Dec	22,942	160,591	140,000	-	140,000	120,000	20,591	-	-	-
12	17-Dec	22,942	160,591	140,000	-	140,000	120,000	20,591	-	-	-
13	24-Dec	22,942	160,591	140,000	-	140,000	120,000	20,591	-	-	-
14	31-Dec	22,942	160,591	140,000	-	140,000	120,000	20,591	-	-	-
15	7-Jan	20,757	145,297	190,000	70,000	120,000	120,000	25,297	-	-	70,000
16	14-Jan	20,757	145,297	190,000	70,000	120,000	120,000	25,297	-	-	140,000
17	21-Jan	20,757	145,297	190,000	70,000	120,000	120,000	25,297	-	-	210,000
18	28-Jan	20,757	145,297	190,000	70,000	120,000	120,000	25,297	-	-	280,000
19	4-Feb	20,549	143,840	190,000	100,000	90,000	120,000	53,840	-	-	380,000
20	11-Feb	20,393	142,748	190,000	100,000	90,000	120,000	52,748	-	-	480,000
21	18-Feb	20,393	142,748	190,000	100,000	90,000	120,000	52,748	-	-	580,000
22	25-Feb	20,393	142,748	190,000	100,000	90,000	120,000	52,748	-	-	680,000
23	4-Mar	21,433	150,031	190,000	80,000	110,000	120,000	40,031	-	-	760,000
24	11-Mar	22,213	155,493	190,000	80,000	110,000	120,000	45,493	-	-	840,000
25	18-Mar	22,213	155,493	190,000	80,000	110,000	120,000	45,493	-	-	920,000
26	25-Mar	22,213	155,493	190,000	80,000	110,000	120,000	45,493	-	-	1,000,000
27	1-Apr	22,213	155,493	190,000	55,000	135,000	120,000	20,493	-	-	1,055,000
28	8-Apr	22,213	155,493	190,000	55,000	135,000	120,000	20,493	-	-	1,110,000
29	15-Apr	22,213	155,493	190,000	55,000	135,000	120,000	20,493	-	-	1,165,000
30	22-Apr	22,213	155,493	190,000	55,000	135,000	120,000	20,493	-	-	1,220,000
31	29-Apr	22,213	155,493	190,000	55,000	135,000	120,000	20,493	-	-	1,275,000
32	6-May	29,392	205,746	180,000	5,000	175,000	120,000	30,746	-	-	1,280,000
33	13-May	30,589	214,122	180,000	-	180,000	120,000	34,122	-	-	1,280,000
34	20-May	30,589	214,122	180,000	-	180,000	120,000	34,122	-	-	1,280,000
35	27-May	30,589	214,122	180,000	-	180,000	120,000	34,122	-	-	1,280,000
36	3-Jun	34,647	242,526	117,000	-	117,000	120,000	120,000	5,526	-	1,274,474
37	10-Jun	40,057	280,398	120,000	-	120,000	120,000	120,000	40,398	-	1,234,077
38	17-Jun	40,057	280,398	120,000	-	120,000	120,000	120,000	40,398	-	1,193,679
39	24-Jun	40,057	280,398	120,000	-	120,000	120,000	120,000	40,398	-	1,153,281
40	1-Jul	50,253	351,772	120,000	-	120,000	120,000	120,000	111,772	-	1,041,510
41	8-Jul	50,253	351,772	120,000	-	120,000	120,000	120,000	111,772	-	929,738
42	15-Jul	50,253	351,772	120,000	-	120,000	120,000	120,000	111,772	-	817,967
43	22-Jul	50,253	351,772	120,000	-	120,000	120,000	120,000	111,772	-	706,195
44	29-Jul	50,253	351,772	120,000	-	120,000	120,000	120,000	111,772	-	594,424
45	5-Aug	47,652	333,564	120,000	-	120,000	120,000	120,000	93,564	-	500,860
46	12-Aug	46,612	326,281	120,000	-	120,000	120,000	120,000	86,281	-	414,579
47	19-Aug	46,612	326,281	120,000	-	120,000	120,000	120,000	86,281	-	328,298
48	26-Aug	46,612	326,281	120,000	-	117,000	120,000	120,000	89,281	-	239,017
49	2-Sep	44,115	308,802	160,000	-	100,000	120,000	100,000	108,802	-	130,216
50	9-Sep	37,872	265,103	160,000	-	100,000	120,000	100,000	65,103	-	65,113
51	16-Sep	37,872	265,103	160,000	-	100,000	120,000	100,000	65,103	-	9
52	23-Sep	37,872	265,103	160,000	-	160,000	120,000	105,103	-	-	9
Annual Total			11,072,064	8,037,000				3,218,073			

RUN GROUNDWATER WELLS AT PEAK CAPACITY IN SUMMER; REST IN THE WINTER
RUN ENGLISHMAN RIVER WTP AT PEAK RATE IN WINTER TO RECHARGE ASR; RUN AT REDUCED RATE IN SUMMER

* Note: Maximum capacity of all available wells is 133,000 m3/wk. Assumed that the firm capacity of 120,000 m3/wk would not be exceeded.

Appendix C – Direct Cost Estimates

Revision Date: 12-Oct-10
Previous Version Date: 27-Aug-10

ARROWSMITH WATER SERVICES
ENGLISHMAN RIVER INTAKE AND WATER TREATMENT PLANT

SUMMARY OF DIRECT COST ESTIMATE

Site	1B											
Series		1A		1B		2A		2B	
Expansion		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Capacity		27 ML/d	48 ML/d	16 ML/d	32 ML/d	29 ML/d	46 ML/d	17 ML/d	30 ML/d
Intake	General & Sitework	$ 208,690	$ -	$ 141,596	$ -	$ 188,296	$ -	$ 132,604	$ -
	Structural	$ 464,655	$ -	$ 333,123	$ -	$ 446,069	$ -	$ 295,985	$ -
	Mechanical	$ 551,600	$ -	$ 430,934	$ -	$ 517,496	$ -	$ 386,539	$ -
	E, I&C	$ 76,100	$ -	$ 76,100	$ -	$ 76,100	$ -	$ 76,100	$ -
Raw Water Main		$ 914,000	$ -	$ 914,000	$ -	$ 914,000	$ -	$ 914,000	$ -
WTP	General & Sitework	$ 1,247,770	$ 360,675	$ 985,929	$ 303,506	$ 1,225,217	$ 348,988	$ 976,388	$ 263,107
	Structural	$ 6,927,181	$ 1,769,161	$ 5,064,091	$ 1,738,685	$ 6,848,700	$ 1,530,552	$ 6,100,467	$ 742,610
	Mechanical	$ 4,851,967	$ 1,318,783	$ 3,930,413	$ 940,153	$ 4,802,646	$ 1,214,668	$ 3,950,016	$ 769,470
	E, I&C	$ 818,800	$ 205,200	$ 794,800	$ 96,751	$ 855,120	$ 150,210	$ 649,100	$ 116,509
	Subtotal	$ 16,060,762	$ 3,653,819	$ 12,670,986	$ 3,079,095	$ 15,873,643	$ 3,244,418	$ 13,481,199	$ 1,891,696
	Contractor Profit and Overhead	$ 4,015,191	$ 913,455	$ 3,167,746	$ 769,774	$ 3,968,411	$ 811,105	$ 3,370,300	$ 472,924
	Phase Total Cost	$ 20,075,953	$ 4,567,274	$ 15,838,732	$ 3,848,869	$ 19,842,054	$ 4,055,523	$ 16,851,498	$ 2,364,620
	Total WTP Base Cost	$ 24,643,227		$ 19,687,602		$ 23,897,577		$ 19,216,118	

	Capacity	27 ML/d	48 ML/d	Total Cost
	Division 1 - General Requirements	$ 88,000	$ 48,000	$ 136,000
	Division2 - Site Work	$ 2,282,460	$ 312,675	$ 2,595,135
	Intake	$ 208,690	$ -	$ 208,690
	Water Main	$ 904,000	$ -	$ 904,000
	Water Treatment Plant	$ 1,169,770	$ 312,675	$ 1,482,445
	Division 3 - Concrete	$ 5,370,974	$ 1,513,563	$ 6,884,537
	Intake	$ 301,792	$ -	$ 301,792
	Water Treatment Plant	$ 5,069,182	$ 1,513,563	$ 6,582,745
	Division 4 - Masonry	$ 861,175	$ 31,500	$ 892,675
	Intake	$ 116,925	$ -	$ 116,925
	Water treatment plant	$ 744,250	$ 31,500	$ 775,750
	Division 5 - Metals	$ 257,137	$ 61,903	$ 319,040
	Intake	$ 14,720	$ -	$ 14,720
	Water Treatment Plant	$ 242,417	$ 61,903	$ 304,320
	Divison 6 - Wood and Plastics			
	Assume cost of wood included in concrete costs			
	Division 7 - Thermal and Mosture Protection	$ 267,679	$ 70,215	$ 337,894
	Intake	$ 31,218	$ -	$ 31,218
	Water Treatment Plant	$ 236,461	$ 70,215	$ 306,676
	Division 8 - Doors and Windows	$ 60,000	$ -	$ 60,000
	Division 9 - Finishes	$ 534,870	$ 91,980	$ 626,850
	Division 10 - Specialties	$ 40,000	$ -	$ 40,000
	Division 11 - Equipment	$ 3,527,467	$ 1,063,533	$ 4,591,000
	Intake	$ 458,000	$ -	$ 458,000
	Water Treatment Plant	$ 3,069,467	$ 1,063,533	$ 4,133,000
	Division 12 - Furnishings			
	n/a			
	Division 14 - Cranes	$ 95,000	$ 5,000	$ 100,000
	Division 15 - Mechanical	$ 1,781,100	$ 250,250	$ 2,031,350
	Intake	$ 93,600	$ -	$ 93,600
	Water Treatment Plant	$ 1,687,500	$ 250,250	$ 1,937,750
	Division 16 - Electrical and Controls	$ 894,900	$ 205,200	$ 1,100,100
	Intake	$ 76,100	$ -	$ 76,100
	Water treatment plant	$ 818,800	$ 205,200	$ 1,024,000
	Cost Summary	**$16,060,762**	**$ 3,653,819**	**$19,714,581**
	- Intake	$ 1,370,735	$ -	$ 1,370,735
	- Water main	$ 914,000	$ -	$ 914,000
	- Water treatment plant	$13,776,027	$ 3,653,819	$17,429,846
	Contractor O/H @ 15%	$ 2,409,114	$ 548,073	$ 2,957,187
	Contractor Profit @ 10%	$ 1,606,076	$ 365,382	$ 1,971,458
	Total	**$20,075,953**	**$ 4,567,274**	**$24,643,227**

	Capacity	16 ML/d	32 ML/d	Total Cost
	Division 1 - General Requirements	$ 88,000	$ 48,000	$ 136,000
	Division2 - Site Work	$ 1,953,525	$ 255,506	$ 2,209,031
	Intake	$ 141,596	$ -	$ 141,596
	Water Main	$ 904,000	$ -	$ 904,000
	Water Treatment Plant	$ 907,929	$ 255,506	$ 1,163,435
	Division 3 - Concrete	$ 3,557,317	$ 1,566,866	$ 5,124,183
	Intake	$ 200,390	$ -	$ 200,390
	Water Treatment Plant	$ 3,356,927	$ 1,566,866	$ 4,923,793
	Division 4 - Masonry	$ 805,298	$ 34,985	$ 840,283
	Intake	$ 97,048	$ -	$ 97,048
	Water treatment plant	$ 708,250	$ 34,985	$ 743,235
	Division 5 - Metals	$ 237,914	$ 24,693	$ 262,607
	Intake	$ 9,774	$ -	$ 9,774
	Water Treatment Plant	$ 228,140	$ 24,693	$ 252,833
	Divison 6 - Wood and Plastics			
	Assume cost of wood included in concrete costs			
	Division 7 - Thermal and Mosture Protection	$ 234,083	$ 52,921	$ 287,004
	Intake	$ 25,911	$ -	$ 25,911
	Water Treatment Plant	$ 208,172	$ 52,921	$ 261,093
	Division 8 - Doors and Windows	$ 60,000	$ -	$ 60,000
	Division 9 - Finishes	$ 462,603	$ 59,220	$ 521,823
	Division 10 - Specialties	$ 40,000	$ -	$ 40,000
	Division 11 - Equipment	$ 2,631,629	$ 803,049	$ 3,434,678
	Intake	$ 360,716	$ -	$ 360,716
	Water Treatment Plant	$ 2,270,913	$ 803,049	$ 3,073,962
	Division 12 - Furnishings			
	n/a			
	Division 14 - Cranes	$ 95,000	$ 5,000	$ 100,000
	Division 15 - Mechanical	$ 1,634,718	$ 132,104	$ 1,766,822
	Intake	$ 70,218	$ -	$ 70,218
	Water Treatment Plant	$ 1,564,500	$ 132,104	$ 1,696,604
	Division 16 - Electrical and Controls	$ 870,900	$ 96,751	$ 967,651
	Intake	$ 76,100	$ -	$ 76,100
	Water treatment plant	$ 794,800	$ 96,751	$ 891,551
	Cost Summary	**$12,670,986**	**$ 3,079,095**	**$15,750,081**
	- Intake	$ 981,752	$ -	$ 981,752
	- Water main	$ 914,000	$ -	$ 914,000
	- Water treatment plant	$10,775,233	$ 3,079,095	$13,854,329
	Contractor O/H @ 15%	$ 1,900,648	$ 461,864	$ 2,362,512
	Contractor Profit @ 10%	$ 1,267,099	$ 307,910	$ 1,575,008
	Total	**$15,838,732**	**$ 3,848,869**	**$19,687,602**

	Capacity	29 ML/d	46 ML/d	Total Cost
	Division 1 - General Requirements	$ 88,000	$ 48,000	$ 136,000
	Division2 - Site Work	$ 2,239,513	$ 300,988	$ 2,540,501
	Intake	$ 188,296	$ -	$ 188,296
	Water Main	$ 904,000	$ -	$ 904,000
	Water Treatment Plant	$ 1,147,217	$ 300,988	$ 1,448,205
	Division 3 - Concrete	$ 5,260,009	$ 1,307,776	$ 6,567,786
	Intake	$ 289,720	$ -	$ 289,720
	Water Treatment Plant	$ 4,970,289	$ 1,307,776	$ 6,278,065
	Division 4 - Masonry	$ 856,498	$ 29,959	$ 886,457
	Intake	$ 112,248	$ -	$ 112,248
	Water treatment plant	$ 744,250	$ 29,959	$ 774,209
	Division 5 - Metals	$ 278,548	$ 38,721	$ 317,270
	Intake	$ 14,131	$ -	$ 14,131
	Water Treatment Plant	$ 264,417	$ 38,721	$ 303,139
	Divison 6 - Wood and Plastics			
	Division 7 - Thermal and Mosture Protection	$ 266,431	$ 66,714	$ 333,145
	Intake	$ 29,969	$ -	$ 29,969
	Water Treatment Plant	$ 236,461	$ 66,714	$ 303,175
	Division 8 - Doors and Windows	$ 60,000	$ -	$ 60,000
	Division 9 - Finishes	$ 533,282	$ 87,381	$ 620,663
	Division 10 - Specialties	$ 40,000	$ -	$ 40,000
	Division 11 - Equipment	$ 3,467,511	$ 966,125	$ 4,433,636
	Intake	$ 425,840	$ -	$ 425,840
	Water Treatment Plant	$ 3,041,671	$ 966,125	$ 4,007,796
	Division 12 - Furnishings			
	n/a			
	Division 14 - Cranes	$ 95,000	$ 5,000	$ 100,000
	Division 15 - Mechanical	$ 1,757,631	$ 243,542	$ 2,001,173
	Intake	$ 91,656	$ -	$ 91,656
	Water Treatment Plant	$ 1,665,975	$ 243,542	$ 1,909,517
	Division 16 - Electrical and Controls	$ 931,220	$ 150,210	$ 1,081,430
	Intake	$ 76,100	$ -	$ 76,100
	Water treatment plant	$ 855,120	$ 150,210	$ 1,005,330
	Cost Summary	**$15,873,643**	**$ 3,244,418**	**$19,118,061**
	- Intake	$ 1,227,961	$ -	$ 1,227,961
	- Water main	$ 914,000	$ -	$ 914,000
	- Water treatment plant	$13,731,682	$ 3,244,418	$16,976,100
	Contractor O/H @ 15%	$ 2,381,047	$ 486,663	$ 2,867,709
	Contractor Profit @ 10%	$ 1,587,364	$ 324,442	$ 1,911,806
	Total	**$19,842,054**	**$ 4,055,523**	**$23,897,577**

	Capacity	17 MIL/d	30 ML/d	Total Cost
	Division 1 - General Requirements	$ 88,000	$ 48,000	$ 136,000
	Division2 - Site Work	$ 1,934,992	$ 215,107	$ 2,150,099
	Intake	$ 132,604	$ -	$ 132,604
	Water Main	$ 904,000	$ -	$ 904,000
	Water Treatment Plant	$ 898,388	$ 215,107	$ 1,113,495
	Division 3 - Concrete	$ 4,540,714	$ 566,192	$ 5,106,906
	Intake	$ 192,242	$ -	$ 192,242
	Water Treatment Plant	$ 4,348,472	$ 566,192	$ 4,914,664
	Division 4 - Masonry	$ 805,231	$ 30,058	$ 835,289
	Intake	$ 74,481	$ -	$ 74,481
	Water treatment plant	$ 730,750	$ 30,058	$ 760,808
	Division 5 - Metals	$ 257,470	$ 24,693	$ 282,163
	Intake	$ 9,377	$ -	$ 9,377
	Water Treatment Plant	$ 248,093	$ 24,693	$ 272,786
	Divison 6 - Wood and Plastics			
	Assume cost of wood included in concrete costs			
	Division 7 - Thermal and Mosture Protection	$ 197,145	$ 62,447	$ 259,592
	Intake	$ 19,886	$ -	$ 19,886
	Water Treatment Plant	$ 177,259	$ 62,447	$ 239,706
	Division 8 - Doors and Windows	$ 60,000	$ -	$ 60,000
	Division 9 - Finishes	$ 495,893	$ 59,220	$ 555,113
	Division 10 - Specialties	$ 40,000	$ -	$ 40,000
	Division 11 - Equipment	$ 2,746,746	$ 640,733	$ 3,387,479
	Intake	$ 326,916	$ -	$ 326,916
	Water Treatment Plant	$ 2,419,831	$ 640,733	$ 3,060,564
	Division 12 - Furnishings			
	n/a			
	Division 14 - Cranes	$ 85,000	$ 10,000	$ 95,000
	Division 15 - Mechanical	$ 1,504,808	$ 118,737	$ 1,623,545
	Intake	$ 59,623	$ -	$ 59,623
	Water Treatment Plant	$ 1,445,185	$ 118,737	$ 1,563,922
	Division 16 - Electrical and Controls	$ 725,200	$ 116,509	$ 841,709
	Intake	$ 76,100	$ -	$ 76,100
	Water treatment plant	$ 649,100	$ 116,509	$ 765,609
	Cost Summary	**$13,481,199**	**$ 1,891,696**	**$15,372,895**
	- Intake	$ 946,510	$ -	$ 946,510
	- Water main	$ 914,000	$ -	$ 914,000
	- Water treatment plant	$11,625,689	$ 2,112,446	$13,738,135
	Contractor O/H @ 15%	$ 2,022,180	$ 283,754	$ 2,305,934
	Contractor Profit @ 10%	$ 1,348,120	$ 189,170	$ 1,537,289
	Total	**$16,851,498**	**$ 2,364,620**	**$19,216,118**