District of Summerland

Water System Separation Analysis Report

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1.0 INTRODUCTION

This report documents water distribution system separation analyses for the District of Summerland. The analyses were undertaken as part of an overall water quality improvement plan for the District of Summerland proposed by Associated Engineering Ltd in their report, *Water Quality Review*, 2001.

In April 2004, Urban Systems Ltd undertook to update the water quality plan. In that exercise, the marginal costs of the system separation versus the costs of treatment (capital costs only) were compared to determine the most economical sizing for the Trout Creek water treatment plant.

The comparison determined a "break-even" point with a plant size of approximately 70 – 75 ML/d and separation of 75 ML/d as unfiltered irrigation water. This could be achieved with the separation of Trout Creek Main 1 and 2, Laterals 1, 2, 3 and 4 (referenced from the Associated Engineering Ltd report).

Provision of supplementary water from Okanagan Lake (through the District's current Licenses) was also briefly examined to service Lower Town (below elevation 460 m). It was assumed that UV disinfection and chlorination would be acceptable treatment for Okanagan Lake water.

The conceptualized use of Okanagan Lake water was to isolate the lower zone (below elevation 460 m) and supply this zone with treated Okanagan Lake water over a 120 day period each year. Winter use would revert to Trout Creek water.

The initial concept was based on a filtration plant of 72 ML/d capacity with 72 ML/d agricultural irrigation demand separated from the current maximum day demand (MDD) of (144 ML/d). Further separation in future would yield filtration capacity for residential growth. The concept included:

- Direct Filtration Plant (72 ML/d)
- Separation (5 areas-72 ML/d)
- Garnet System Treatment (To supply Garnet Valley service area only)

Through the course of evaluating the costs of separation, and determining the most viable option, four overall separation scenarios were developed. The concepts, assumptions and results of each of these scenarios are discussed in Section 2 through Section 5 of this report.

The concepts presented in this report were developed and presented to the District in September 2005. Following this presentation additional work was done in conjunction with the new water treatment plant. This work is summarized in the attached Technical Memo #1 (Appendix C). The demand patterns in 2005 were evaluated against historic values and resulted in reducing existing maximum day demands to 110 ML/day with future 20 year demands estimated at between 120 and 149 ML/day. A number of water supply strategies were reviewed and identified the need for a maximum separation requirement of 42 ML/day providing that 6 ML/day of ground water could be developed. The impact of this updated analysis will be discussed at the conclusion of this report.

1.1 Objective

The objective of the separation analysis was to supply at least 72 ML/day for irrigation with untreated water, leaving the remaining demand to be supplied with water from the treatment plant. The 72 ML/day target was arrived at through a comparison of the capital costs of expanded treatment versus the capital costs of system separation.

1.2 Methodology

A Geographic Information System (GIS) based demand model was used to spatially distribute domestic and irrigation demand points. In the GIS theme "du.shp", demand points are flagged by a field which designates whether the demand for that point requires treated or untreated (irrigation) water. When these points are joined spatially to the service areas, the demand attributed to each of the nodes is selected and summarized so as to separate demands as required for that particular scenario. For each of the separation scenarios, specific service area catchments were created to summarize and extract the demand data which could then be imported to the water distribution model, using WaterCAD Version 7.0, Service Pack 2.

For modeling purposes, the following principles were adopted as the basis of developing the separation plan:

1. Where there are two watermains in the same road ROW, the larger watermain would be used to carry untreated water and the smaller watermain would be used to carry treated water. It was also considered that in most cases where there are two watermains within the same road right of way, most of the domestic services are usually connected to the smaller-diameter watermain.

2. If a new watermain is required in a road ROW where a single watermain already exists, the new one would be used to carry treated water while the existing one would be used to carry untreated water.

3. In agricultural areas, irrigation demand is significantly higher than domestic demand during the irrigation season.

4. Many of the watermains are AC (asbestos-cement), these were assumed to be less desirable for domestic use.

1.3 Scope

The scope of this report is to complete the following tasks:

- Outline the scenarios that were developed
- Include an illustrative schematic for each scenario, including any phasing
- Summarize the reasoning, assumptions, and results associated with each separation scenario
- Include figures and tables that illustrate/summarize select results for select scenarios.
- Identify the key issues and conclusions about each scenario
- Summarize the key components of the most feasible separation scenario.

1.4 Design Criteria and Assumptions

The design criteria used in this analysis are those used in the development of the existing system water model. For a detailed account of design criteria and how demands were developed, refer to *District of Summerland Water Model Update Report* (USL, 2006), contained in Appendix E.

Existing MDD used in the model for separation analyses is 158 ML/d. Existing MDD was reduced to 144ML/d based on historical records for the purpose of determining source requirements. The reduced MDD was not modeled as it would have insignificant impact on distribution system performance.

The recorded consumption pattern breaks down as follows:

Winter Domestic – Inside Use Only	**7 ML/day**
(November through March) MDD	
Spring/Fall MDD	**35 ML/day**
Includes residential sprinkling	
(April 1 – May 15, September 15 – October 30)	
Summer MDD	**144 ML/day**
Includes residential sprinkling and agricultural irrigation	
(May 15 – September 15)	

Figure 1 depicts the breakdown of domestic / irrigation (treated / untreated) demands in each sub-area of Summerland. The "Treated" fraction includes residential lawn and garden sprinkling, while the "Untreated" fraction represents agricultural irrigation. The total current demands from Figure 1 are:

Treated	36 ML/d
Untreated	109 ML/d
Total	144 ML/d

Future demand alternatives were created for Separation Scenario 4B; these future demands do not include demand for development allocated to ALR lands, such as the Summerland Hills development. Ultimate MDD in this model scenario is 168 ML/d.

It was initially assumed that the Lower Town area would not be separated since there is little agricultural activity in this area. The Garnet valley area is serviced by Garnet Lake and is not entered into the analysis.

The largest agricultural parcels lie in the areas of:

- Prairie Valley/Dale Meadows
- Jones Flats (East and West)
- Giant's Head
- Paradise Flats
- South Victoria

Figure 2 depicts the areas that would merit consideration for separation of agricultural irrigation water.

1.5 In-System Storage

At the present time the Trout Creek Reservoir provides the majority of the peak hour and fire flow balancing within the system. By separating the system the separated irrigation system will remain directly connected to the Trout Creek Reservoir and its associated balancing storage. However, the potable water system that is routed through the new water treatment plant will no longer have access to this balancing storage. Within the new water treatment plant there is included the construction of a storage tank that will provide both chlorine contact time and fire flow storage. However, it has not been sized to provide peak hour balancing storage and therefore, a supplementary line is required to route water directly from Trout Creek Reservoir to the treated water system.

In order to remove this supplementary line there will be the need to install in-system storage for peak hour, fire flow, and emergency balancing requirements. Within this analysis we have included in-system storage for two areas. The first area is for the area serviced by the new lake intake and treatment plant (Scenarios 3 and 4). This reservoir (2,500 m^3) has been sized based on balancing the initial demand of 6 ML/day. The second area is in Paradise Flats where a storage tank has been included to address a local zone serviced by a new booster station. This reservoir has been sized at 4,200 m^3. Additional storage will be required to service existing users and demand growth and has not been included within the scope or costs presented in this report.

1.6 Unit Cost Assumptions for Comparison

Unit costs were applied to the improvements identified in each scenario without consideration to site specific concerns. These budgetary cost estimates were prepared for the purpose of evaluating the relative cost implications of each of the scenarios. Costs included 40% above the capital cost to account for construction cost contingency and engineering costs.

The unit cost for tie-ins was applied in areas where less than 25m of pipe is required to extend the existing system. Similarly where the removal of short lengths of existing pipe is required it has been accounted for in the disconnect cost.

The unit cost applied to new tanks, including 40% for E & C, was $560 / m^3.

For pump stations, a unit cost of $700,000, including 40% E & C, was used. Where a pump station requires very minor upgrades or a new domestic pump is required for one or two houses, the assumed capital costs were significantly less. All cost estimates in this report were produced for budgetary purposes in 2005 and have not been updated to reflect current dollar value or current construction costs.

Table 1.1: Pipe unit cost table.

Dia (mm)	Unit_Cost w/ E&C ($/m)	Tie-Ins (LS)	Disconnects (LS)
50	$ 140	$ 2,100	$ 800
100	$ 280	$ 4,200	$ 950
150	$ 350	$ 5,250	$ 1,100
200	$ 392	$ 5,880	$ 1,300
250	$ 406	$ 6,090	$ 1,700
300	$ 490	$ 7,350	$ 2,200
350	$ 490	$ 7,350	$ 2,600
400	$ 595	$ 8,925	$ 3,100
450	$ 651	$ 9,765	$ 3,500
500	$ 686	$ 10,290	$ 4,400
600	$ 875	$ 13,125	$ 6,000
750	$ 1,092	$ 16,380	$ 8,500
900	$ 1,400	$ 21,000	$ 13,000
1200	$ 2,100	$ 31,500	$ 35,000

Table 1.2: Pressure sustaining/pressure reducing valve and pump station cost table.

Category	Units	Unit Price	With E&C
PS/PRV	LS	$ 200,000	$ 280,000
PS/PRV	LS	$ 220,000	$ 308,000
PS/PRV	LS	$ 250,000	$ 350,000
PS/PRV	LS	$ 275,000	$ 385,000
PS/PRV	LS	$ 300,000	$ 420,000
PS/PRV	LS	$ 350,000	$ 490,000
PS/PRV	LS	$ 400,000	$ 560,000
Tank	m3	$ 400	$ 560
Pump Stations	LS	$ 500,000	$ 700,000

2.0 SEPARATION SCENARIOS 1A, 1B

Concept

The concept for scenarios 1A and 1B is to maximize access to untreated water for agricultural irrigation. As such, in areas with only single water mains, this requires full duplication of pipes, pressure reducing valves, and pumps. For example, in the area of Jones Flats the water distribution network does not carry existing paired pipes as in some other areas; to provide separate untreated water and treated water, the full network in this area must be duplicated. Therefore, these mains were not modeled separately but instead flagged as, "Assumed Twin for Cost Estimates Only" and were counted into the cost estimate as a new watermain.

There were two sub-options considered in this scenario: Scenario 1A and Scenario 1B. Scenario 1A represents full separation with South Victoria area serviced via Cedar Avenue while Scenario 1B represents the same level of separation but with South Victoria area serviced via Paradise Flats.

These scenarios are depicted in Figures 3 and 4.

Assumptions

- Where there are two existing pipes in a right of way, the larger of the two will be allocated to the unfiltered irrigation system.
- If a new watermain is required in a road ROW where a single watermain already exists, the new one would be used to carry treated water while the existing one would be used to carry untreated water.

Results

In developing this scenario, it became clear that a number of existing pipes which are already paired are not adequately sized to sustain required pressures under peak demand. For this reason, there are extensive upgrades required throughout the District to achieve separation of 90 ML/day irrigation demand. Remaining irrigation demand is sparsely distributed through predominantly residential areas and not cost effective to separate out.

In both cases, the estimated costs (in 2005 dollars) were in the order of $30 million to achieve the provision of 90 ML/day irrigation water (or $330,000 / ML/day). The initial phase to achieve 72 ML/day was estimated at roughly $21 million (or $230,000 / ML/day).

The initial phase costs were considered prohibitive for the District's ability to finance.

Table 2.1: Scenario 1A Budgetary Capital Costs & Separated Demand Summary

Service Area Separation Implementation Order	Cumulative Totals	
	MDD (ML/d)	Cost (millions)
Prairie Valley / Dale Meadows	15.6	5.8
Cartwright Mountain	21.1	6.5
Giant's Head	34.5	7.9
Downtown	35.0	8.9
Lower Town	35.0	8.9
Paradise Flats	49.3	16.1
South Victoria	63.4	19.9
Trout Creek	70.7	20.7
Jones Flat - West	75.8	21.7
Jones Flat - East	90.0	27.6

Table 2.2: Scenario 1B Budgetary Capital Costs & Separated Demand Summary

Service Area Separation Implementation Order	Cumulative Totals	
	MDD (ML/d)	Cost (millions)
Prairie Valley / Dale Meadows	15.6	5.4
Cartwright Mountain	21.1	6.1
Giant's Head	34.5	7.5
Downtown	35.0	8.9
Lower Town	35.0	8.9
South Victoria	49.1	14.3
Trout Creek	56.4	15.8
Jones Flat - West	61.5	16.8
Paradise Flats	75.8	23.9
Jones Flat - East	90.0	29.8

3.0 SEPARATION SCENARIO 2

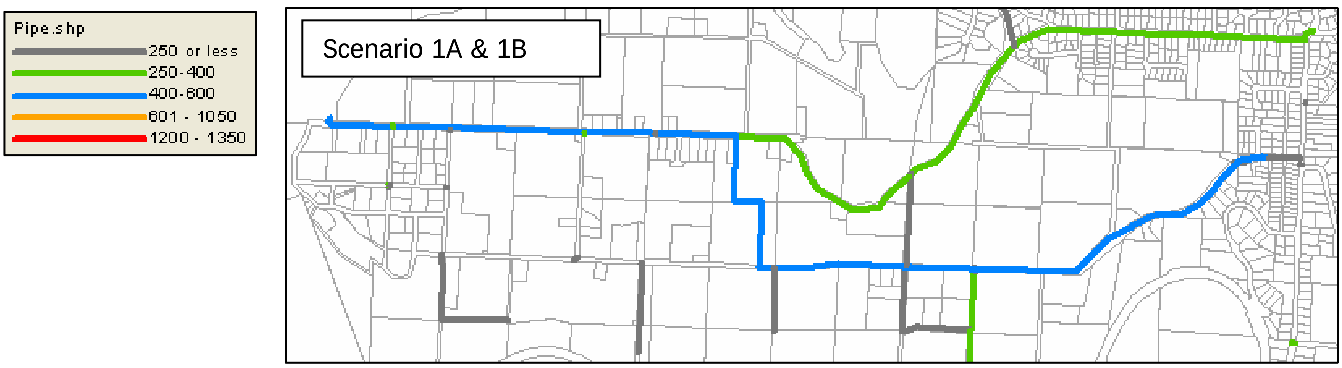
Concept

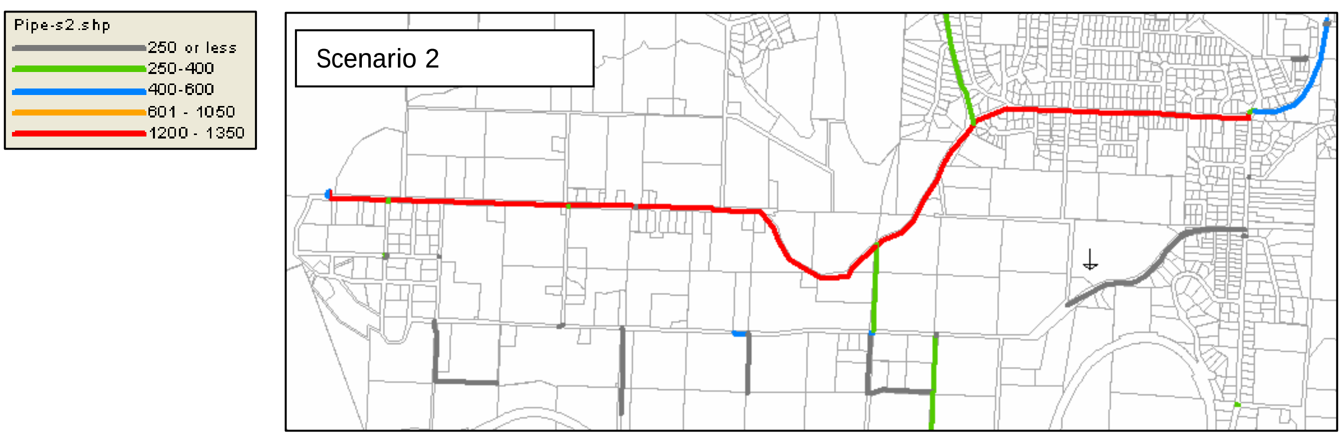
Similar to Scenarios 1A and 1B, Scenario 2 targets a separation of 90 ML/day of irrigation but differs on the designation of some key existing paired pipes, switching between treated and untreated flow in relation to previous scenarios.

Scenario 2 is depicted in Figure 5.

Assumptions

- Rather than install a new treated water trunk main along Dale Meadows as outlined in Scenario 1, it would be installed along Prairie Valley Road.





- Some of the treated/untreated watermain pairs were switched in Scenario 2.

Results

Issues arising from this scenario included:

- The proposed 1200mm on Prairie Valley Road is probably too large.
- Using the larger existing watermains for the treated water is not preferred because most of the domestic connections are off the smaller diameter watermains.
- If work is to be done, the preferrence is to construct new lines for the treated water.
- Total prelimenary separation costs far exceed the allotted $8 million [District of Summerland planned budget for system separation]

As a result, this scenario was abandoned in favour of other scenarios.

4.0 SEPARATION SCENARIOS 3A, 3B

Concept

Scenarios 3A and 3B looked at options for adding supply from Okanagan Lake to avoid expanding the capacity of the Trout Creek water treatment plant. The combined portion of the system would be supplied both by the new water treatment plant as well as disinfected water from Okanagan Lake. In these scenarios, there is 13 ML/day provided from Okanagan Lake, and 83 ML/day agricultural irrigation demand separated from the domestic supply; effectively removing 96 ML/day demand from the Trout Creek water treatment plant.

Scenarios 3A and 3B vary in terms of the Okanagan Lake supply, whether the South Victoria and Trout Creek areas are serviced during summertime peaks via Paradise Flats (Pumphouse #4) or via the proposed Cedar Avenue booster station. Scenario 3A reflects the Paradise Flats option while Scenario 3B reflects the Cedar Avenue option.

Scenarios 3A and 3B are depicted in Figures 6 and 7.

Assumptions

- While the cost of pumping water from Okanagan Lake is more costly than treating water from Trout Creek, this source need only be run during peak demand times (a maximum of 120 days per year). During the remainder of the year, the capacity of the treatment plant could accommodate the full demand.

Results

By supplying part of the system from Okanagan Lake, there is a decrease in the flow from the water treatment plant through the proposed trunks on Prairie Valley and Dale Meadows roads. The reduced flows are insufficient to reduce the diameter of the entire trunk line. However, the reduction is sufficient to eliminate the need for the proposed 750 mm upgrade on Victoria between Dale Meadows and Prairie Valley.

Overall, the unit costs for separation and provision of Okanagan Lake supply are:

Scenario 3A:	$30 million / 96 ML/day	=	$313,000 / ML/day
Scenario 3B:	$32 million / 96 ML/day	=	$333,000 / ML/day

An initial phase achieving 72 ML/day would cost roughly $22 million, or $306,000 / ML/day. This was still too costly for further consideration.

Table 4.1: Scenario 3A Budgetary Capital Costs & Separated Demand Summary

Service Area Separation Implementation Order	Cumulative Totals	
	MDD (ML/d)	Cost (millions)
Prairie Valley / Dale Meadows	15.6	5.0
Cartwright Mountain	21.1	5.7
Giant's Head	34.5	7.1
Downtown	35.0	8.3
Okanagan Lake	48.1	14.5
Jones Flat - West	53.2	15.3
Paradise Flats	67.5	22.4
South Victoria	81.6	25.7
Trout Creek	88.9	27.3
Jones Flat - East	96.1	30.5

Table 4.2: Scenario 3B Budgetary Capital Costs & Separated Demand Summary

Service Area Separation Implementation Order	Cumulative Totals	
	MDD (ML/d)	Cost (millions)
Prairie Valley / Dale Meadows	15.6	5.0
Cartwright Mountain	21.1	5.7
Giant's Head	34.5	7.1
Downtown	35.0	8.3
Okanagan Lake	48.1	14.5
Jones Flat - West	53.2	15.3
South Victoria	67.3	20.9
Trout Creek	74.6	22.4
Paradise Flats	88.9	29.3
Jones Flat - East	96.1	32.4

5.0 SEPARATION SCENARIO 4

Concept

The Scenario 4 objective was to minimize cost and maximize capture for irrigation water demand. It adopted 3 basic premises:

1. Deal with those areas that already have interconnected dual systems,
2. Supply Lower Town from Okanagan Lake (summer only), and
3. Leave the extremities for later separation.

Accordingly, the four areas selected for separation were:

- Prairie Valley / Dale Meadows
- Cartwright Mountain
- Giant's Head
- South Victoria / Trout Creek

Scenario 4 is depicted in Figure 8. Scenario 4B would be a future expansion of separated areas to include Paradise Flats and South Victoria / Trout Creek to provide additional agricultural irrigation water. Figure 9 presents the 4B concept.

Results

There are four primary areas which would be separated in this scenario: Prairie Valley/Dale Meadows, Cartwright Mountain, Giant's Head, and Trout Creek. The other areas would receive treated water from the water treatment plant, while Lower Town would be supplied via Okanagan Lake. The key is that the treated water would be mixed from the two sources near the downtown area so that it can flow unhindered to the various demands using the existing combined system.

The lake pump station is proposed near Peach Orchard Road, with a balancing tank located on the hill south of the Rosedale / Prairie Valley Road intersection. The tank would be at an elevation of approximately 490 m, which means that it would have to be boosted into the gravity zone controlled by the PRV at Victoria and Prairie Valley (563.3 m).

This scenario utilizes the existing 1350 mm main on Prairie Valley Road for domestic supply and the 500/600 mm main on Dale Meadows Road for irrigation supply.

A proposed implementation plan for an initial phase of Scenario 4 is depicted in Figure 10 and described in greater detail in Appendix B.

Table 5.1: Scenario 4 Budgetary Capital Costs & Separated Demand Summary

Service Area Separation Implementation Order	Cumulative Totals	
	MDD (ML/d)	Cost (millions)
Prairie Valley / Dale Meadows	16.0	$ 2.1
Cartwright Mountain	21.7	$ 2.4
Giant's Head	34.9	$ 4.6
South Victoria/Trout Creek	44.5	$ 6.1

6.0 SCENARIO COMPARISON

For comparison purposes, the total required maximum day demand was estimated at 144.5 ML/d of which 36.5 ML/d is required for domestic use and 108.0 ML/d is required for agricultural irrigation. As outlined in the Introduction, this exceeds the currently estimated maximum daily demand of 110 ML/day but falls within the 20 year estimation for maximum daily demands.

Note that in Table 6.1 below, cost estimates for separation and Okanagan Lake supply were made in 2005, based on budgetary 2005 construction costs and dollars. However, the water treatment plant cost listed at $ 18.1 million is the current actual tendered construction value, including engineering and contingency, at the time of this report. Also note that preliminary estimates prepared for Scenario 2 were comparable to Scenarios 1A and 1B and due to preferred use of new pipes for domestic supply, Scenarios 1A and 1B were favoured and Scenario 2 was abandoned.

Table 6.1: Scenario cost and demand comparison.

Scenario	Initial Separation		Okanagan Lake		Water Treatment Plant		Total	
	ML/day	Million	ML/day	Million	ML/day	Million	ML/day	Million
1A	70.7	$ 20.7	-	-	72	$ 18.1	142.7	$ 38.8
1B	75.8	$ 23.9	-	-	72	$ 18.1	147.8	$ 42.0
3A	55	$ 16.0	13	$ 6.2	72	$ 18.1	140	$ 40.3
3B	54	$ 14.7	13	$ 6.2	72	$ 18.1	139	$ 39.0
4	**44**	**$ 6.1**	**6**	**$ 4.5**	**72**	**$ 18.1**	**121.9**	**$ 28.7**
4B	70.6	$ 13.1	6	$ 4.5	72	$ 18.1	148.5	$ 35.7

As illustrated Scenario 4 is the lowest cost alternative. Furthermore, it allows the greatest flexibility by phasing of the separation program to coincide with demand growth.

7.0 CONCLUSIONS

The analyses of several approaches to separation of irrigation water from domestic water indicate the following:

1. There is no cost benefit in denser residential areas to separate water for residential lawn sprinkling as the costs of re-instatement are extremely high.

2. The cost of double mains in the outlying agricultural areas is also high.

3. The range of costs per ML/day of irrigation water capture is from $140,000 per ML/day to $300,000 per ML/day. The lowest cost is under Scenario 4 which utilizes those areas which already have some double mains and requires the least amount of new construction.

4. The calculated irrigation water capture under Scenario 4 is 44 ML/day. This would result in a source split as follows:

   Water Treatment Plant — sized for 72 ML/day

   Okanagan Lake — sized for initial capacity of 6 ML/day
   - *Potential future capacity up to 27 ML/day*

   Separation — sized for initial capture of 44 ML/day
   - *Potential future additional separation to capture up to 70 ML/day.*

The cost of separation under Scenario 4 was estimated at $6.1million in 2005 (including engineering and contingency). Costs have risen substantially in 2006 and are expected to rise even further in 2007. The construction estimates should be reviewed again closer to the time of implementation.

APPENDIX A

Project Notes – Water Separation Analyses

APPENDIX B

Separation Scenario 4 – Phase 1 Implementation Plan

APPENDIX C

Technical Memo #1 – Water Quality Strategy Review

APPENDIX D

Summary Costs by Scenario

APPENDIX E

Water Model Update Report

APPENDIX F

Data CD