SCHEDULE E

Form of Completion Report for Studies

Please do not hesitate to contact your project officer to receive an electronic copy of the template of the Completion Report for Studies.

Upon completion of the Feasibility Study, a copy of the Final Study must be submitted along with this Completion Report for Studies.

FCM will post your report on the Green Municipal Fund™ (GMF) website.[1] This is because one of FCM's mandates is to help municipal governments share their knowledge and expertise regarding municipal environmental projects, plans and studies. Before you submit a report to FCM, make sure you hold the copyright for the report (you own all the rights to the content and can decide who is allowed to reproduce and distribute the report) and that it does not contain any confidential information.

If the report contains confidential information, you need to submit two versions: one containing confidential information, to be read by FCM staff, and one that does not contain confidential information, which can be posted on the GMF website. Please contact FCM if you have any questions about copyright and confidentiality.

How to complete the Completion Report for Studies

The purpose of the Completion Report for Studies is simple: to share the story of your community's experience in undertaking a Feasibility Study with others seeking to address similar issues in their own communities.

Please write the report in plain language that can be understood by people who are not specialists on the subject. A Completion Report for Studies is typically in the range of 5–10 pages, but may be longer or shorter, depending on the complexity of the Feasibility Study.

GMF grant recipients must enclose **final** copies of the Completion Report for Studies and the Final Study, both in electronic format, with their final Request for Contribution. The reports, including all attachments and appendices, must be submitted in PDF format with searchable text functionality. Reports that are not clearly identifiable as final reports, such as those displaying headers, footers, titles or watermarks containing terms like "draft" or "for internal use only," will not be accepted by GMF. Additionally, reports must be dated. If you have questions about completing this report, please consult GMF staff.

[1] http://www.fcm.ca/home/programs/green-municipal-fund.htm

Completion Report for Studies

GMF number	15159
Name of lead applicant (municipality or other partner)	The Corporation Of The Village of Cumberland
Name, title, full address, phone, fax and e-mail address of lead technical contact for this study	Paul Nash, Project Coordinator - Liquid Waste Management Planning Ph 604 740 7328 Email paul@alpinewaterandenergy.com
Date of the report	July 30, 2018

1. Introduction

1) Who was involved in doing the Feasibility Study, and what are their affiliations? Please include name, title and contact information. Those involved could include municipal staff, engineers and other consultants, a representative from a non-governmental organization, and others.

The Study work was carried out by a small consulting team of;

- LWMP Project Coordinator:

  Paul Nash (paul@alpinewaterandenergy.com), and

- Technical consultants;

  Dr Troy Vassos, P.Eng , Environmental and process lead (Troy.Vassos@integratedsustainability.ca), and

  Larry Sawchyn, P.Eng, Constructability lead (lsawchyn@mcelhanney.com)

With assistance from Village of Cumberland staff

Chief Administrative Officer, Sundance Topham (stopham@cumberland.ca)

Operations Manager, Rob Crisfield (rcrisfield@cumberland.ca)

2. The Feasibility Study

a. Describe the process that you undertook to make this feasibility study a reality, from concept, to council approval, to RFP, to final deliverable.

Cumberland has been planning for wastewater treatment upgrades to its lagoon system since 1998, but the unique characteristics of Cumberland's situation, and progressively more stringent environmental regulations, had precluded an effective solution from being developed. In 2015, Cumberland council decided to abandon the then preferred option of joining a proposed regional system, as it had become very expensive and not in keeping with the environmental goals of the village.

The Village wanted to restart its "Liquid Waste Management Plan" (LWMP) – a provincially structured process for developing, financing and implementing long-term wastewater treatment plans.

In January 2016, the Village hired the Project Coordinator, to steer the planning, study and public engagement process. The Project coordinator developed a "road map" for how the study process would play out over the next two years, to study, develop and select a solution, and then finance the implementation. The plan was approved in March 2016, a Wastewater Advisory Committee was struck in April 2016, and the technical consultants were hired in May of 2016. With the team complete, process began with a public lagoon tour and first committee meeting in May 2016.

A limited budget was available for the study and in August 2016, application was made to the Green Municipal Fund for funding of the LWMP as a Feasibility Study. This was successful and allowed the study to be expanded to thoroughly investigate its original scope, and expand it to look at some innovative treatment options.

The study process was broadly for the Committee to set the goals and represent the community values, and the consulting team to develop options to meet both the mandatory (regulatory) requirements, and the community goals. As this progressed, results were brought back to the Committee for discussion and evaluation, and then taken to the public before major decisions were made by the Committee, which then went to Village Council for approval.

After two years and two months, a false start on an unsuccessful grant funding application, 15 committee meetings, four open houses and detailed technical studies, the Feasibility Study was completed and unanimously approved by council in July 2018.

b. What were the objectives of the Feasibility Study (what was it seeking to determine)?

Council had set the strategic goal for the study;

> "to develop an environmentally sustainable method of treating the liquid waste that is generated by the Village"

Once the Wastewater Advisory Committee did its goal setting process, and considered the economic, environmental and social goals, the strategic objective expanded to capture these goals, and became;

> "To develop an *affordable* method of treating the liquid waste generated by the Village that is economically *productive*, environmentally *enhancing* and socially *beneficial*."

Cumberland had two specific issues to be addressed that had stymied previous attempts at a solution;

1) Very high winter wet weather flows, resulting from part of the Village having a combined storm sewer system. This leads to flow increase from summer dry weather of 800 cu.m.day to winter peaks of up to 20,000 cu.m.day, for an unprecedented peaking factor of 25:1
2) Very low summer dilution in the initial receiving waters of Maple Lake Creek, and a summertime "in stream" phosphorus objective for the final receiving water of the Trent River of <0.005mg/L.

This combination of very high flows in one season, and very high quality nutrient removal in another, had stymied previous attempts to develop an affordable solution.

The solution also had to provide capacity for the Village growth for the next 20 years.

c. What approach (or methodology) was used in the Feasibility Study to meet these objectives?

The study was Stage 2 of a "Liquid Waste Management Plan", a 3-stage format prescribed by the BC Ministry of Environment, with mandatory public engagement throughout the process. It is an embodiment of the "systems approach" to problem solving, with three stages being:

1. Identify

• Define the baseline – Where are we now?

• Set the goals, using the Official Community Plan and Sustainability Plan for context – where do we want to be?

• Develop the "long list" of options – how do we get there?

• Screen the options to the "short list" – the best ways to get there

• Identify any knowledge gaps and further studies needed to fill them

2. Evaluate

• Carry out required environmental studies, what are the quality requirements, how do they impact the options?

• Technical study of the short listed options – various ways to achieve those requirements

• Detailed evaluation of the short list, using the goals and evaluation system

• Select preferred option

3. Adopt

• any further required study of the preferred option

• Identify steps for implementation

• Develop a financing plan

• Council decision to adopt and implement

• Approval by the BC Minister of Environment

The Cumberland Study was officially "Stage 2", as Stage 1 had been completed some years ago. But the Study effectively started at Stage 1, updating all information to the present day, particularly the community goals, which led to a weighted criteria evaluation system for

selecting the preferred option. Only then could the technical study of options development begin.

d. Please describe any public consultations conducted as part of the Feasibility Study and their impact on the Study.

The LWMP process mandates extensive pubic engagement, and prescribes an advisory committee process. The Study was directed by a Wastewater Advisory Committee, which included Village staff, the consulting team, and representatives from;

- BC Ministry of Environment (ex-officio)
- BC Ministry of Municipal Affairs & Housing
- Vancouver Island Health Authority
- K'omoks First Nation
- The public – six volunteer members from Cumberland

This Committee had 15 meetings over the two-year study period, all of which were open to the public. Additional public consultations included;

- A site tour of the lagoon treatment system
- Four open houses prior to major decision points, where the committee had evaluated options, and wanted public feedback before making final decisions.
- Six newsletters published over the course of the study.

The consultations were well received.

3. Feasibility Study Findings and Recommendations

a. What were the environmental findings related to the options explored in the Feasibility Study? Please provide quantitative results and summary tables of these results (or the page numbers from the Feasibility Study report).

The major environmental results were that;

In summer, the only water flow in Maple Lake Creek is the effluent discharge itself, and this makes up half of the summer flow in the lower Trent River.

Table 6-6-2 Field Flow Measurements for discharge to Maple Lake Creek, July 31, 2017 (p.41)

Location	Flow (m^3/d)	Measurement
MLC upstream of lagoons	Effectively zero	Visual observation
Lagoon discharge	800	Lagoon Measuring weir
End of MLC wetland reach (1 km upstream of Trent) "Site 6A"	660	Temporary measuring weir
Trent River at Hwy 19 (1 km upstream of MLC)	660	Temporary measuring weir

Estimated flow in Trent at MLC confluence	1,320	Visual observation

This meant that sending the treated water somewhere else (i.e. alternative disposal locations) were not an option, as (in summer) they would dry up the creek, and have severe consequences for the aquatic habitat in the Trent River. From the report (p. 42)

As Cumberland grows, so too will the summer flow of treated water to Maple Lake Creek, eventually doubling from its current level. With improved treatment quality, this increase in flow will be beneficial to the downstream aquatic life in MLC and the Trent in summer droughts. It is a rare case of where urban growth will create a direct benefit to a local ecosystem!"

The natural wetlands and beaver ponds in Maple Lake Creek are doing a great job of contaminant removal, making up for the poor treatment performance of the existing lagoons.

Table 7-7-1 Average Water Quality Concentrations, April 25 to September 25, 2017 (p. 51)

LOCATION	Total BOD (mg/L)	Soluble BOD (mg/L)	TSS (mg/L)	TP (mg-P/L)	Ortho-P (mg-P/L)	$NH4^+$ (mg-N/L)	E. coli CFU/100mL	Fecal Colif. CFU/100mL
Influent	292	175	282	6.8	4.08	41.4	1,350,000	2,176,750
Aerated Lagoon	38	8	100	6.4	4.46	43.2	16,100	115,500
Facultative Lagoon	17	< 6	49	4.7	3.50	24.6	2,692	12,618
Wetland Treatment	< 6	< 6	< 4	0.2	0.231	0.366	48	398
Trent 100 m U/S	< 6	< 6	<4	< 0.005	< 0.005	0.235	3	34
Trent 100 m D/S	< 6	< 6	< 4	0.035	0.024	0.132	10	55

From the report (p. 53)

While the existing Discharge Permit defines the point of discharge as the release of water from the facultative lagoon into Maple Lake Creek, treatment continues as the water flows along Maple Lake Creek to the Trent River. The development of wetlands along Maple Lake Creek is a natural occurrence and response to the nutrients being released to the creek and serves as a buffer or polishing stage to protect water quality in the Trent River.

The BC Ministry of environment has a summertime, "in-stream" objective for the Trent River of total phosphorus <0.005mg/L. With 1:1 dilution of the of MLC water, the P concentration at the exit of Maple Lake Creek needs to also be 0.005 mg/L, or 99.9% ("three log") removal. This is unachievable with conventional wastewater treatment technology, and at first, it was considered the only way to meet this objective was to remove the effluent from MLC entirely, by reuse or sending to another watershed. But if the upgraded treatment can provide the bulk of the phosphorus removal, from 5 to <1mg/L, then the wetlands will be able to polish and remove most, if not all, of the remainder.

Thus, the natural wetlands on Maple Lake Creek are a real-world example of an "eco-asset", performing a valuable treatment polishing function.

b. What were the financial findings related to the options explored in the Feasibility Study (for example, results of a cost-benefit analysis, financial savings identified, and so on)? Please provide quantitative results and summary tables of these results (or the page numbers from the Feasibility Study report).

Three treatment options were developed and costed;

1. An "Upgraded Lagoon" system, with various enhancements, as Phase 1, followed by 2A (25-25 effluent) or 2B (10-10) effluent
2. A Baseflow Mechanical" system, with a mechanical treatment plant for baseflows (to 10-10 effluent), and the lagoons retained in operations for lagoon treatment of winter excess flows (to 25-25 effluent)
3. A "Full Flow" mechanical system, for treatment of all flows (baseflow to 10-10, excess to 25-25), allowing the lagoons to be decommissioned entirely,

Two additional features were developed;

- A "biochar media reed bed" (constructed wetland) for polishing of treated effluent to remove trace organic contaminants such as pharmaceuticals. This component can be added to ay treatment Option, and is a $1million budgeted cost.
- The distribution of treated effluent to the adjacent north wetlands area, to further polish the effluent and restore natural summertime "wet" conditions to this are, which was drained for agriculture in the 1930's. This will include an environmental restoration and public access enhancement of the area. This component can be added to any Option, and is an integral part of Option 1, Phase 2A. It has a $1million budgeted cost.

The costs for the options were estimated as follows

Table 9-2 Cost Comparison for all Treatment Options (p. 82)

	Option 1			Option 2	Option 3
	Phase 1	**Phase 2A**	**Phase 2B**		
Capital Cost for 1-Phase execution	$5.6M	$8.7M*	$10.6M	$ 9.3 M	$14.8 M
Capital Cost for 1-Phase with Wetland	$6.6M	$8.7M*	$11.6M	$10.2M	$15.8M
Capital cost for 2-Phase execution	n/a	$9.5M*	$ 11.7M	$10.2M	$16.3M
Capital cost for 2-Phases with wetland	n/a	$9.5M*	$12.7M	$11.2M	$17.3M
Operating Cost	$350k	$375k	$425k	$450k	$500k

* Includes the wetland as this is integral to Phase 2A

The technical comparison of the options is as follows

Table 9-3 Technical Comparison of Treatment Options (p. 83)

	Present System	Option 1			Option 2	Option 3
		Phase 1	Phase 2A	Phase 2B		
Description	Aerated and Facultative Lagoons	Upgraded Lagoon to Permit Compliance	Upgraded Lagoon to MEP	Upgraded Lagoon to GEP	Base flow mechanical to GEP	Full flow mechanical to GEP
Population capacity	<4,000	5,000	7,000	7,000	7,000	7,000
Discharge Location	Maple Lake Creek	Maple Lake Creek	North Wetlands	Maple Lake Creek	Maple Lake Creek	Maple Lake Creek
Effluent Quality (BOD-TSS, mg/L)	30-30	25-25	25-25	10-10	10-10	10-10
Suitable for reclaimed water use	No	No	Wetlands only	yes	yes	yes
Disinfection by PAA	None	< 200 CFU/100mL	< 100 CFU<100mL	<1 CFU/100mL	<1 CFU/100mL	<1 CFU/100mL
Biosolids Withdrawal	Periodic dredging (last done 2009)	Periodic dredging + low vol. continuous	Periodic dredging + low vol. continuous	Periodic dredging + low vol. continuous	Continuous biosolids wasting	Continuous biosolids wasting
Operational Class	1	2-3	2-3	3	4	3-4
Energy use	Low	Moderate	Moderate	Moderate	High	Highest
Carbon Footprint	Very Low	Low	Low	Low	High	Highest
Land Reclaimed	No	No	No	No	No	Yes – Lagoons 4Ha

Using the weighted criteria evaluation system developed right at the start of the study process, the options were evaluated, effectively providing the “cost-benefit” analysis.

Table 20 Results of Committee Evaluation (p. 154)

		Option 1 Upgraded Lagoon		Option 2	Option 3
	Category Score	**Phase 1 + Phase 2A**	**Phase 1+ Phase 2B**	**Baseflow Mechanical**	**Full Flow Mechanical**
Water Quality		MEP	GEP	GEP	GEP
Discharge Location		N. Wetland	MLC	MLC	MLC
Capital Cost		$8.7M	$10.6M	$9.3M	$14.8M
Annual Operating Cost		$375k	$425k	$450k	$500k
Weighted Scoring Evaluation Results					
Affordability	40	36.6	27.5	26.7	11.4
Economic Benefits	20	12.9	11.5	8.8	9.3
Environmental Benefits	20	16.5	14.1	12.9	14.5
Social Benefits	20	13.9	12.4	10.4	10.4
Total Score	**100**	**79.8**	**65.6**	**58.8**	**45.7**

c. Based on the environmental and financial findings above, what does the Feasibility Study recommend?

The major recommendations from the Study are that;

- The discharge flow continues to go to Maple Lake Creek, to maintain summer flow and habitat in the Creek and the lower Trent River.
- The preferred discharge path is indirectly to the creek via the north wetlands
- The preferred Treatment Option is Option 1, Phases 1+2A. This is the enhanced lagoon system to 25-25 effluent quality.
- The "biochar media reed bed" be added to the Treatment Option, subject to further study and successful field/pilot testing.
- The project be implemented as one project, rather than split into the two phases, if grant funding can be secured to facilitate this.

4. Lead Applicant's Next Steps

a. Taking the Feasibility Study's recommendations into account, what next steps do you as the municipality plan to take? What potential benefits or internal municipal improvements would result from these next steps?

The next steps Cumberland is taking are to:

- Pursue grant funding for the complete project in 2018, through Green Municipal Fund, and Federal-Provincial Infrastructure funds.

- implement the treatment upgrades in 2019-2020. If grant funding is secured, the entire project will be implemented. And if not, then Phase 1 will be implemented, to achieve regulatory compliance, and Cumberland will pursue funding for Phase 2 in the future.

The major municipal benefits will be;

- The satisfaction of resolving the wastewater issue that has been in the planning stages for 20 years
- Some civic pride from the innovative "made in Cumberland" solution that has been developed. Particularly, making use of naturalized treatment systems (the reed bed, north wetlands and MLC wetlands), which has been an aspirational goal for the entire twenty years.
- Wastewater treatment capacity for Village growth to double the current population, to about 2039.
- Lowest practical operating costs and complexity for wastewater treatment.

5. Lessons Learned

In answering the questions in this section, please consider all aspects of undertaking the Study — from the initial planning through each essential task until the Final Study was prepared.

1) What would you recommend to other municipalities interested in doing a similar Feasibility Study? What would you do differently if you were to do this again?

    - The first and best thing is to thoroughly identify and understand the community's broader goals. This sets the context for the outcomes the project is trying to achieve. It may also identify possibilities to achieve some goals (e.g. wetland restoration and GHG reductions in this case) that are not normally a direct part of the infrastructure project itself. If you know the broader goals at the start, then the question can be asked "how could this project be re-imagined to achieve/maximize each of these major specific goals?" This sort of conceptual thinking may identify opportunities and innovative solutions that would not be revealed by traditional linear-reductionist problem solving.
    - Active involvement of Council and the public in the goal identifying and setting process
    - Develop a thorough understanding of the environmental conditions relating to the project. In this case, it revealed a solution to a problem (phosphorus) that was widely thought unsolvable.
    - Give the consultants the widest latitude to develop conceptual solutions. Allow them to challenge any arbitrary or long held constraints.
    - Be aware of funding opportunities, and their requirements, while doing the feasibility study. Some specific funding requirements, such as GHG emissions, may not be part of the normal study scope. But by being aware of these funding requirements, they can be evaluated as part of the Study process, to maximize the potential for funding of the chosen option.

    For what would be done differently, there is one major "thing". Six months into the study process, a federal/provincial grant funding opportunity came up, to get 83% funding of a

project. The chance at was considered too good to pass up, and so work was fast tracked to develop a treatment option ("full flow mechanical") for this funding opportunity. However, with the Study being incomplete, especially in regard to lagoon and environmental data, many conservative assumptions had to be made, which increased the cost and ruled out certain options, such as the upgraded lagoon concept. The funding application was unsuccessful, and the funding attempt ultimately led to an extra six months and $100k of cost for the study process. While the consultants and entire community supported the funding application, in retrospect, it would have been better to stay the course and complete the Study first – a much better solution was developed that was two thirds the cost.

2) What barriers or challenges (if any) did you encounter in doing this Feasibility Study? How did you overcome them?

The major challenge for Cumberland was funding of the study itself. A comprehensive study process such as the provincial Liquid Waste Management Plan is a significant expense. It costs about the same whether the community is 3,000 or 23,000 people. For Cumberland (3700 people), this challenge was overcome by getting funding for the LWMP itself, being this GMF funded Feasibility Study. It simply would not have been possible to study the innovative options, such as the biochar media reed bed, without this funding.

The secondary challenge was for the consulting team to thoroughly understand the regulatory, financial and environmental circumstances of the Village. These defined the mandatory constraints that had to be satisfied, before any of the aspirational goals could be met. And once they were truly understood, new possibilities revealed themselves, such as the performance of the wetlands for phosphorus removal, and some other approaches, such as removing all the water (and thus the phosphorus) from the creek were revealed to be dead ends.

It was a good real-world example of the adage from Charles Kettering (1876-1958, director of research for General Motors) that;

"a problem, well stated, is already half solved"

This Feasibility Study was as much about defining the problem, as it was about solving it.

6. Knowledge Sharing

1) Is there a website where more information about the Feasibility Study can be found? If so, please provide the relevant URL.

All of the information for the study is on the Village of Cumberland website, where there is a section devoted to the Liquid Waste Management Plan. It includes final Stage 2 Liquid Waste Management Plan report, and also all the records and materials of committee meetings, public open houses and information newsletters.

https://cumberland.ca/liquid-waste-management-plan/

In addition to the Feasibility Study results, has your Feasibility Study led to other activities that could be of interest to another municipality (for example, a new policy for sustainable community development, a series of model by-laws, the design of a new operating practice, a manual on public consultation or a

measurement tool to assess progress in moving toward greater sustainability)? If so, please list these outcomes, and include copies of the relevant documents
(or website links).

The Study has not led to other activities specifically, but several of the study components (contained within the Stage 2 LWMP report) could be of interest and use to other municipalities. The specific components are the;

- Development of the weighted evaluation system, based on the community's goals (Report Section 2
- Concept of the biochar media reed bed for effluent polishing (Report Section 10 &11)
- Comprehensive grant funding analysis (Report Section 17)
- Public engagement and decision making process (Report Sections 19 and 20)

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